ECOCAR CONTROL SYSTEM

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GM

EcoCAR
The Next Challenge

Presentation Contents

- Problem Formulation
- Performance Requirements
- Solution Generation
- Top Design Selection
- Demo Prototype Product
- Evaluation results
- Design Constraints
- Conclusions

Problem Formulation

Mimic the current design of the two-mode hybrid power train supervisory control strategy while:

- Minimizing unnecessary work from the ICE
- Ensuring maximum output based on any given external driving condition
- Ensuring safe operation of vehicle power train

EcoCAR Performance Requirements

Conform to SAE standard J1711 for Hybrids

- Facilitate acceleration 0-60mph in less than 14s
- Facilitate acceleration 50-70mph in less than 10s
- At least 30 MPG over a typical city drive cycle
- Facilitate a car start time of less than 10s
- Facilitate a smooth transition between ICE and motor

Methodology

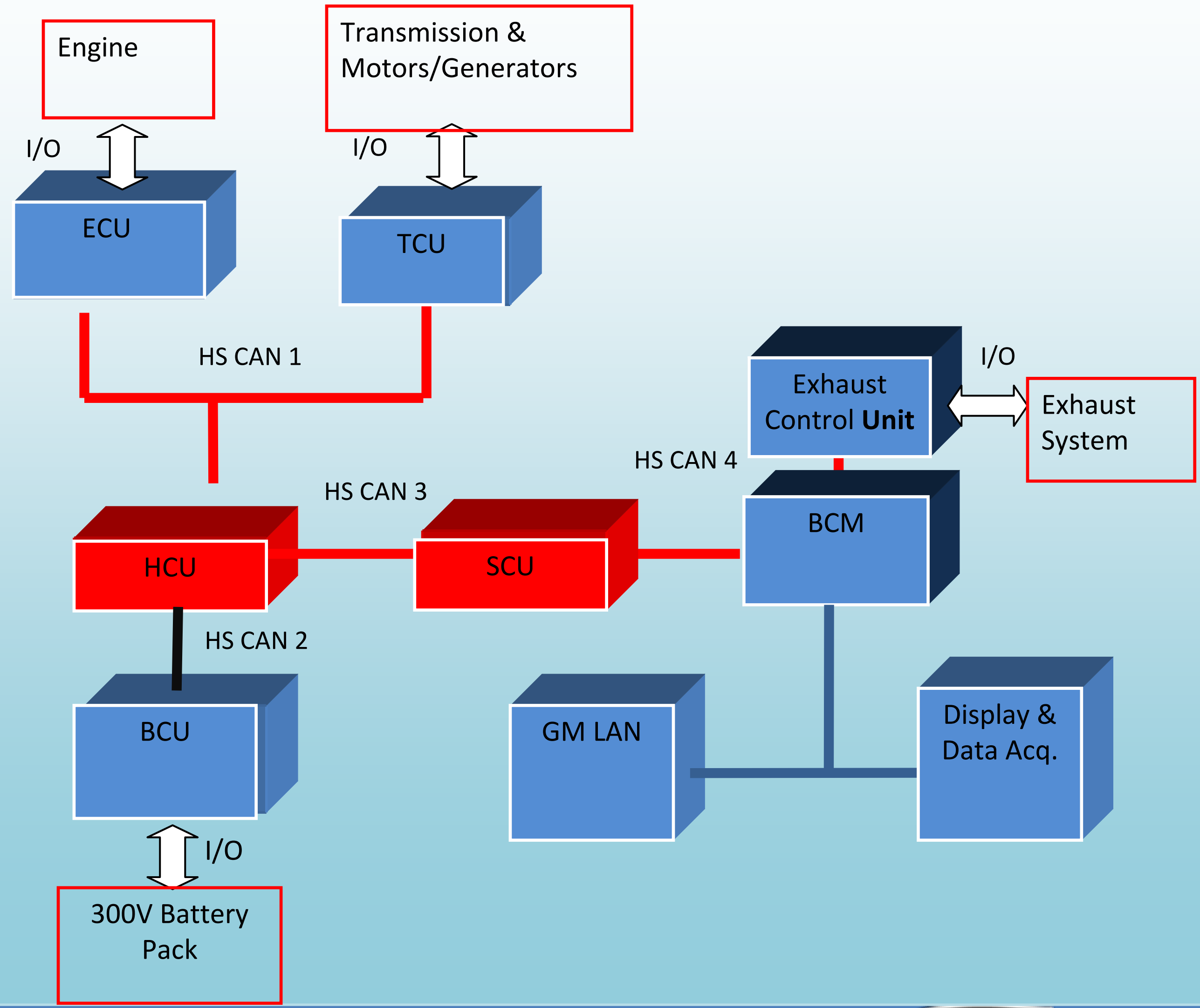
- Design Requirements
- Build Algorithm
- Build Model based on Algorithm using software such as Simulink
- Testing the Design model with Sim Driveline and Control Desk

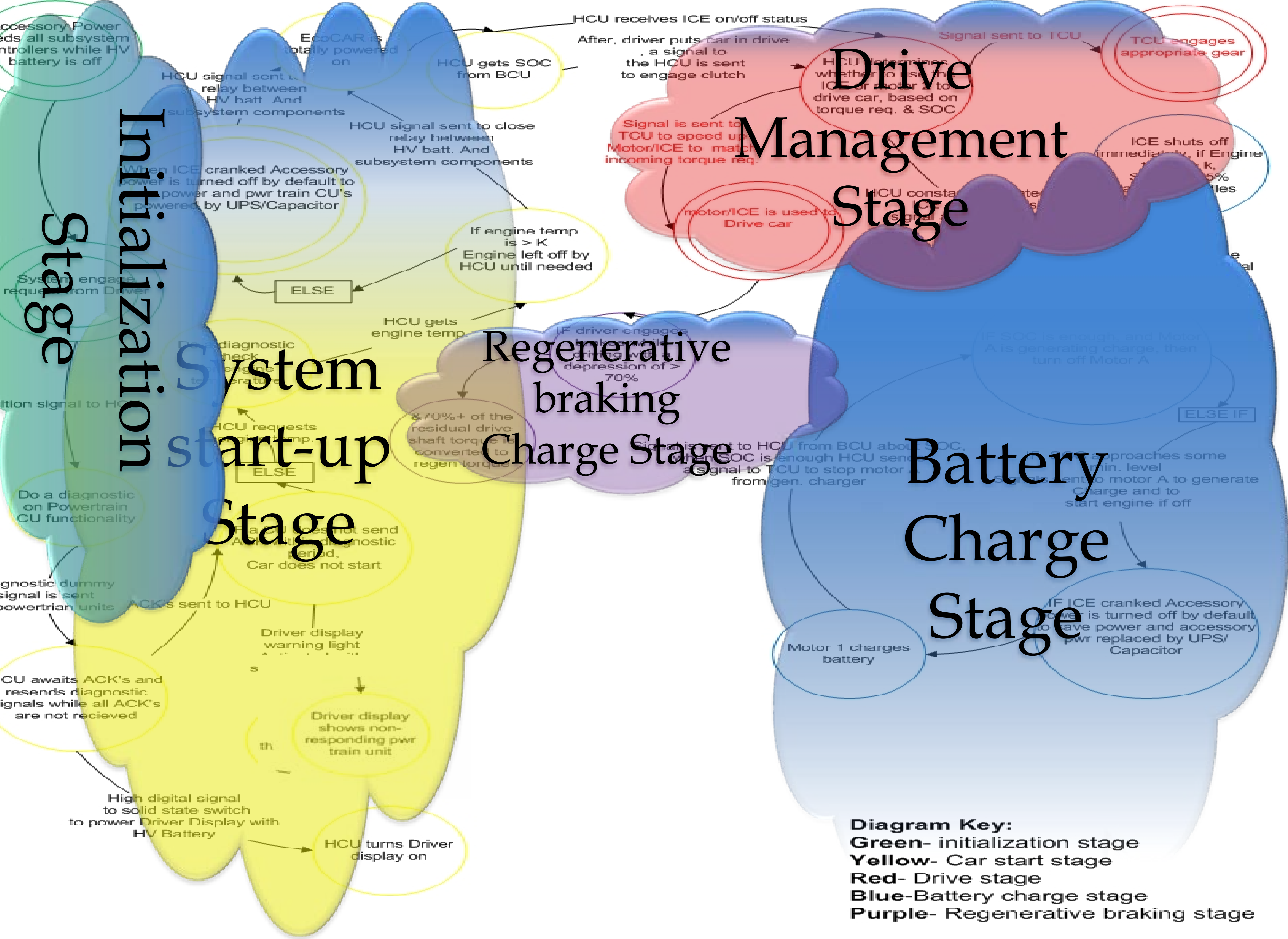
Decision Matrix

Feature and Weight	Solution I	rating	Weighted Score	Solution II	rating	Weighted Score	Solution III	rating	Weighted Score
Symplicity of design **10**	Team I.C.E will want to focus on only making the engine run perfect before any emissions system is implemented with a well designed hybrid supervisory control system. The ME team will make the exhaust leak proof and use a diesel particulate filter with no regeneration to ensure that fuel emissions meet the SAE standards	4	0.4	The additional exhaust system promises to be a extremely complicated highly priced custom made system	3	0.3	The SCU requires development but is much simpler to make than the HCU	1	0.1
Level of feasibility given time constraints **20**	High level of feasibility given the level of planning done thus far	5	1	Level of time line expansion is immeasurable given our unfamiliarity with control system design; however, it will be well over the year 1 project time-line. Our estimate is 1-2 years of development and testing of the exhaust system with the help of our mentor school OSU	2	0.4	The additional develoment stage for the SCU should take approx. 50% of the time it takes to make the HCU, but will not be finished with our current project deadline	4	0.8
Functionaity/ Design Constraints **40**	Will not be able to monitor and respond to exhaust emissions level	3	1.2	Will be able to monitor emissions level at all times and communicate with the hybrid supervisory control unit to ensure the vehicle meets the SAE emissions standards at all times	5	2	The SCU adds a measure of redundancy and increases the reliability of the system	3	1.2
Expenses for parts and components **20**	All components offered by our sponsors	5	1	MotoTron ECU555-80 unit not donated by GM in first year of the competition	3	0.6	MotoTron ECU555-80 unit not donated by GM in first year of the competition	3	0.6
Safety **10**	Failsafe systems are encoded in stock control units being offered by GM in the Saturn Vue	5	0.5	Failsafe systems are encoded in stock control units being offered by GM in the Saturn Vue	5	0.5	Failsafe systems are encoded in stock control units being offered by GM in the Saturn Vue	5	0.5
	Total		4.1	Total		3.8	Total		3.2
	Rank		1	Rank		2	Rank		3

Solution I

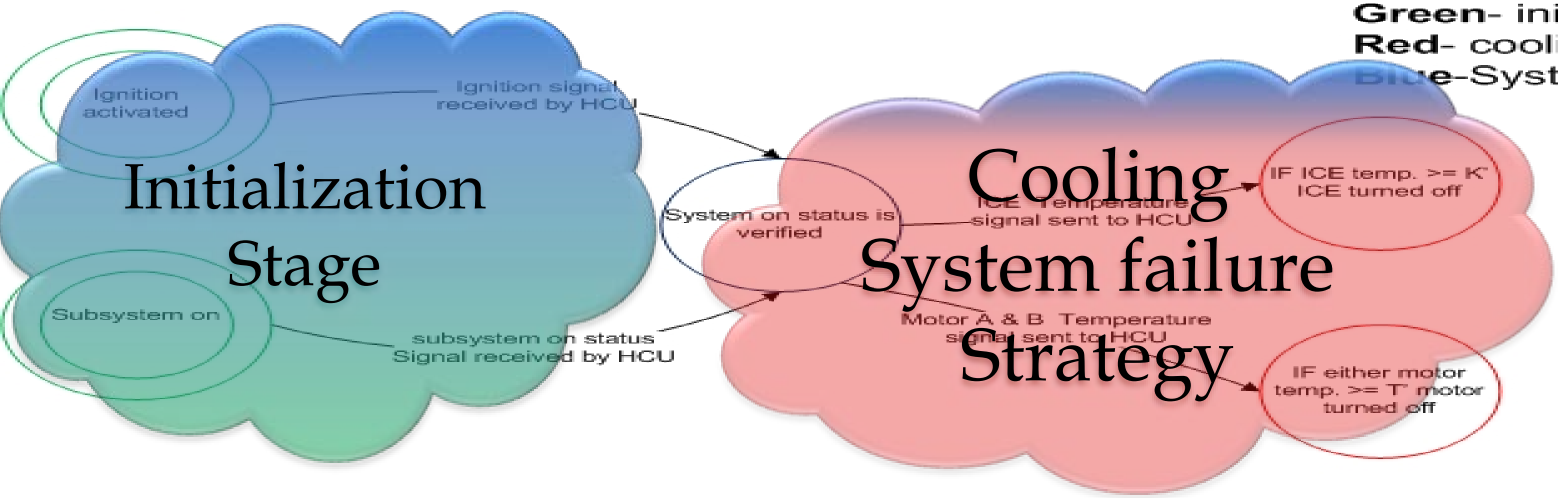
Team I.C.E EcoCAR Control System Architecture



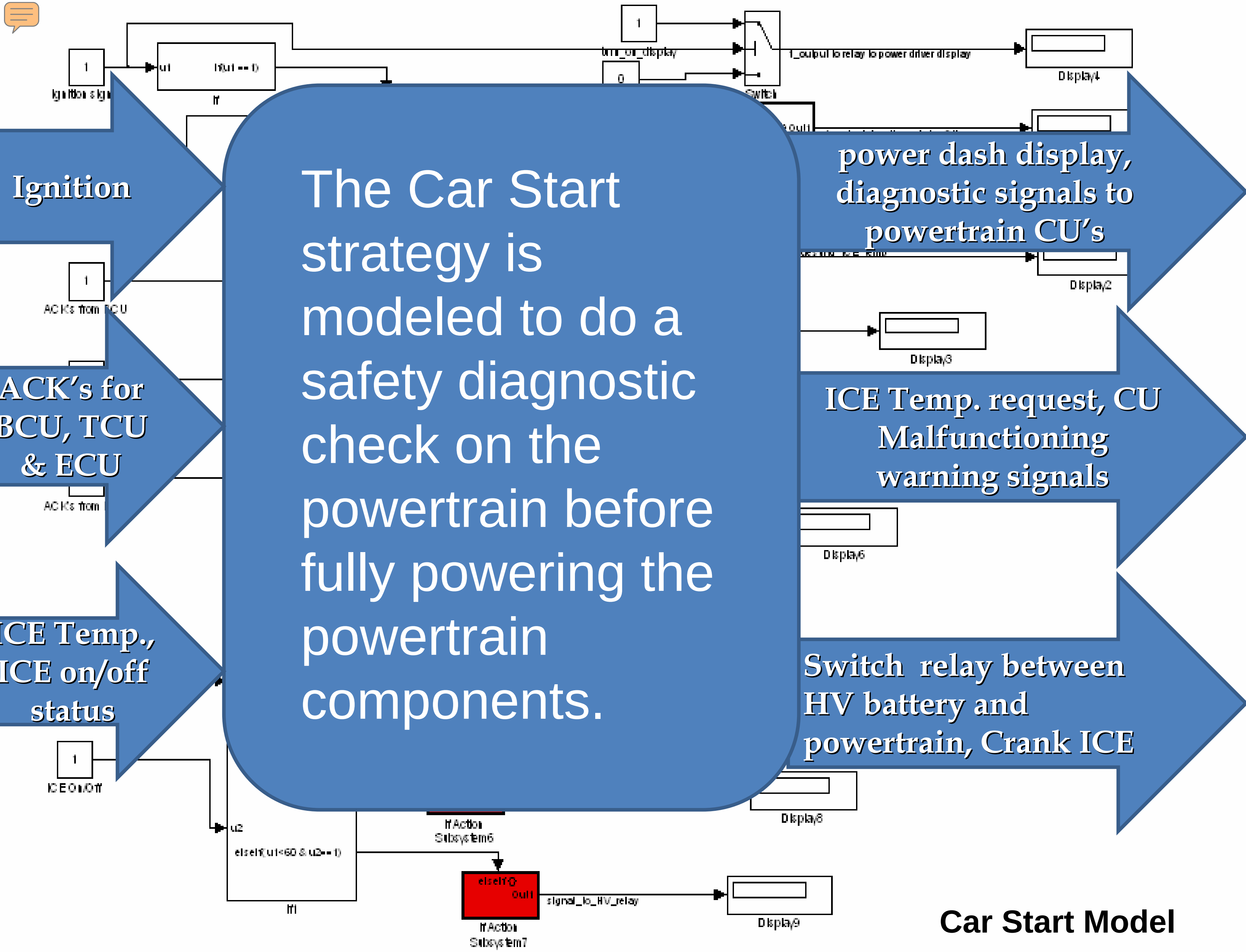


TEAM I.C.E MODE 1 Algorithm - Level 1 ex. Safety Measures & System Cooling strategy

Diagram Key:
Green- initialization stage
Red- cooling failure stategy
Blue-System on check



TEAM I.C.E System Cooling failure Contingency strategy



Ignition

ACK's for BCU, TCU & ECU

ICE Temp., ICE on/off status

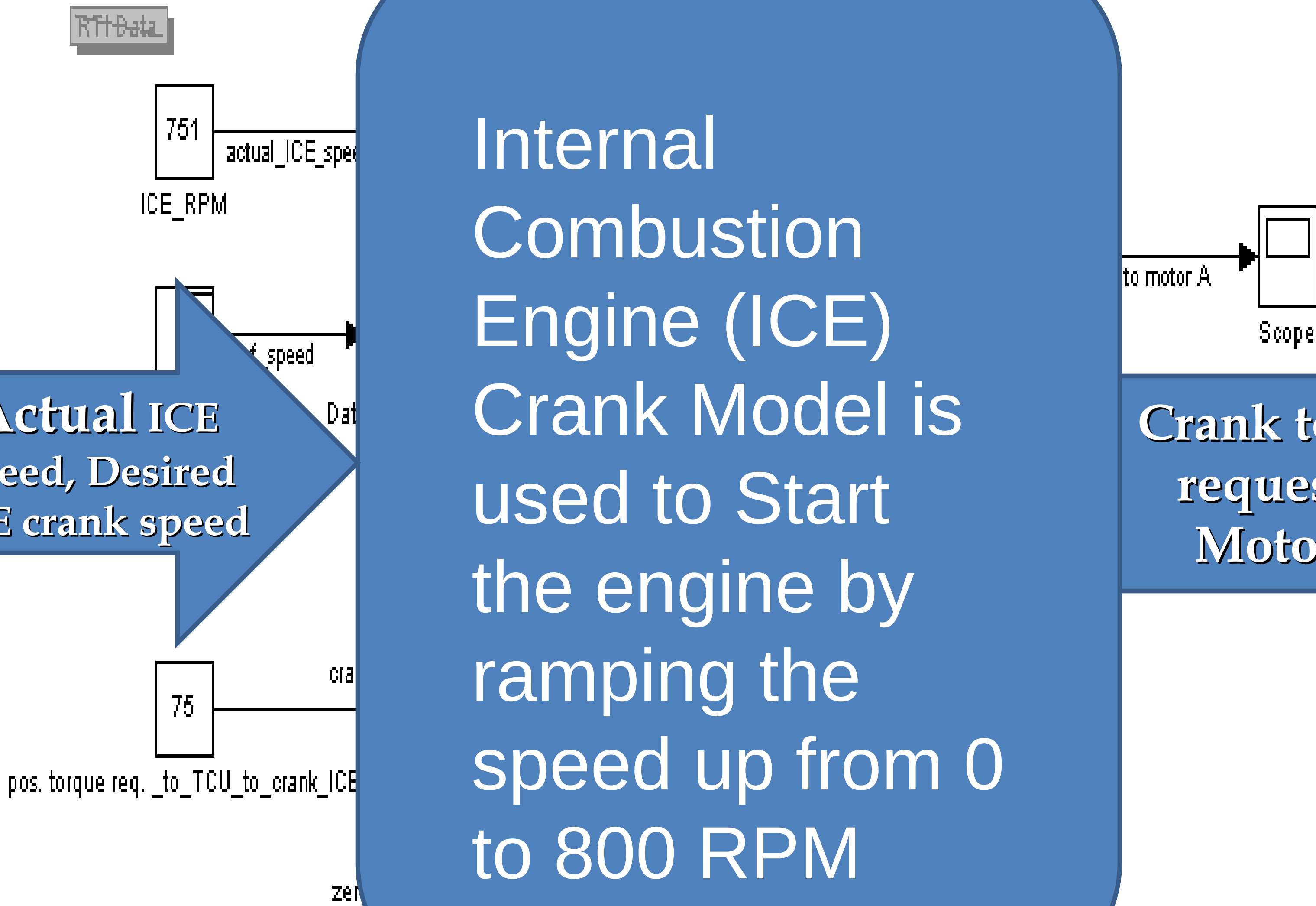
The Car Start strategy is modeled to do a safety diagnostic check on the powertrain before fully powering the powertrain components.

power dash display, diagnostic signals to powertrain CU's

ICE Temp. request, CU Malfunctioning warning signals

Switch relay between HV battery and powertrain, Crank ICE

Car Start Model



Actual ICE speed, Desired ICE crank speed

Internal Combustion Engine (ICE) Crank Model is used to Start the engine by ramping the speed up from 0 to 800 RPM

Crank torque request to Motor A

ICE Crank Model

SOC, gear ratio, ICE Temp, ICE Speed

Motor A torque, ICE status

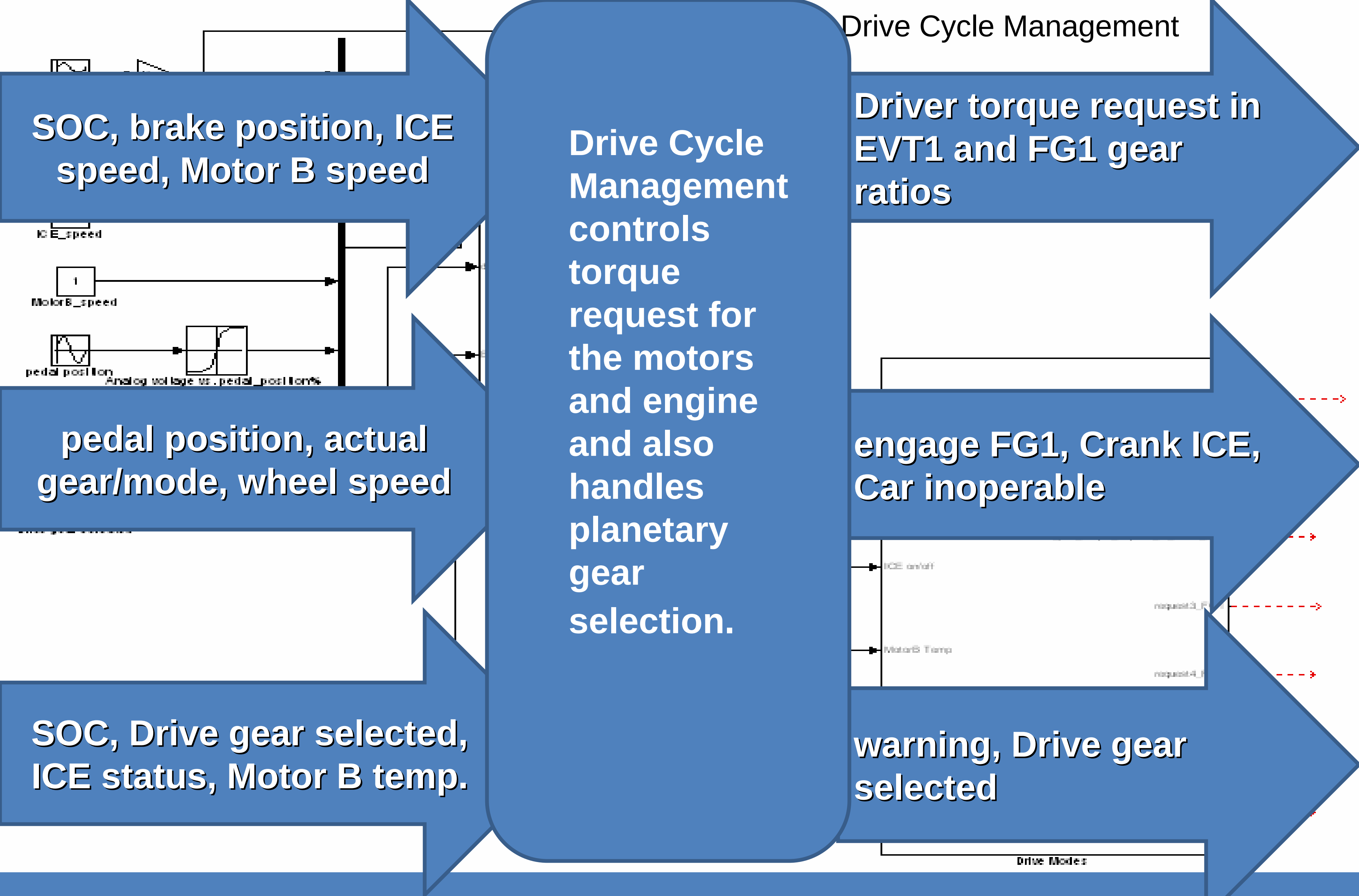
State of Charge (SOC) model maintains a battery charge between 50-80%

Stop charging if SOC > 80%

start charging if SOC < 50%

If SOC >= 65%, & ICE on & car is not driven by ICE & ICE temp. is > 66K, then stop ICE after 2 minutes

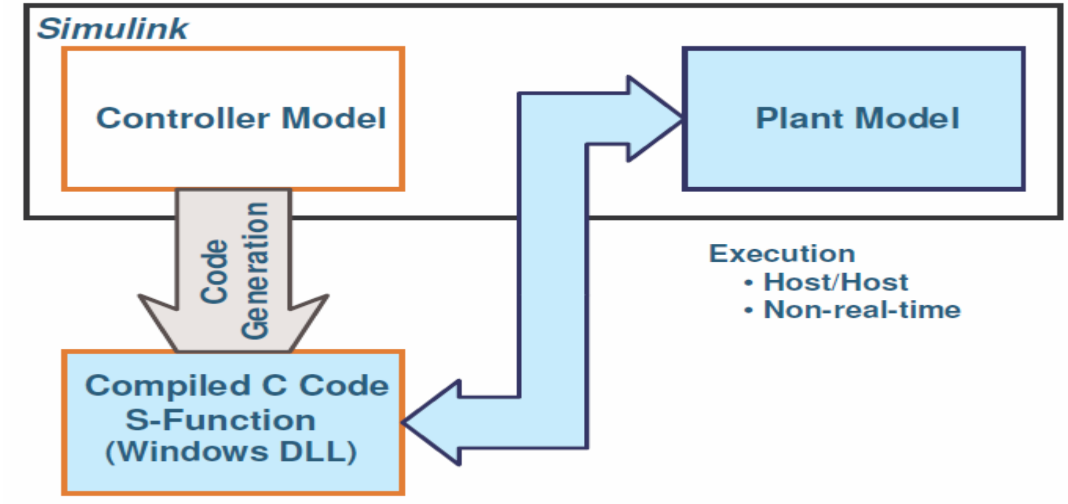
SOC Management



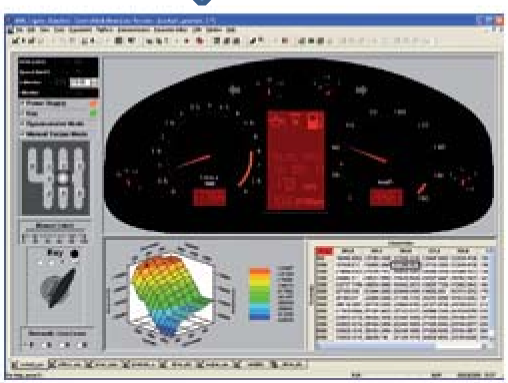
The NeXt Challenge

Demo Prototype Product

Software in the Loop (SIL) Testing

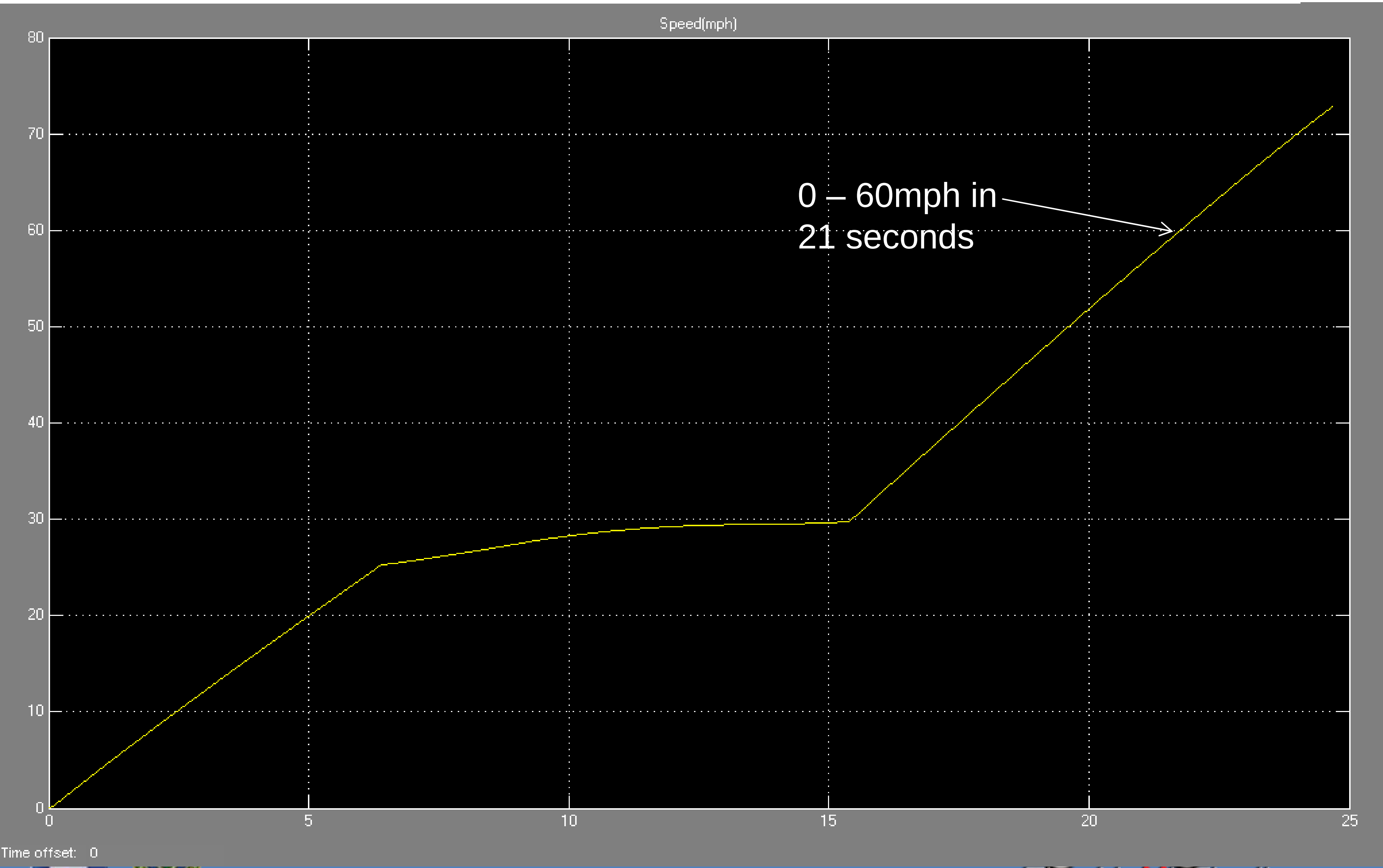


dSPACE Control Desk

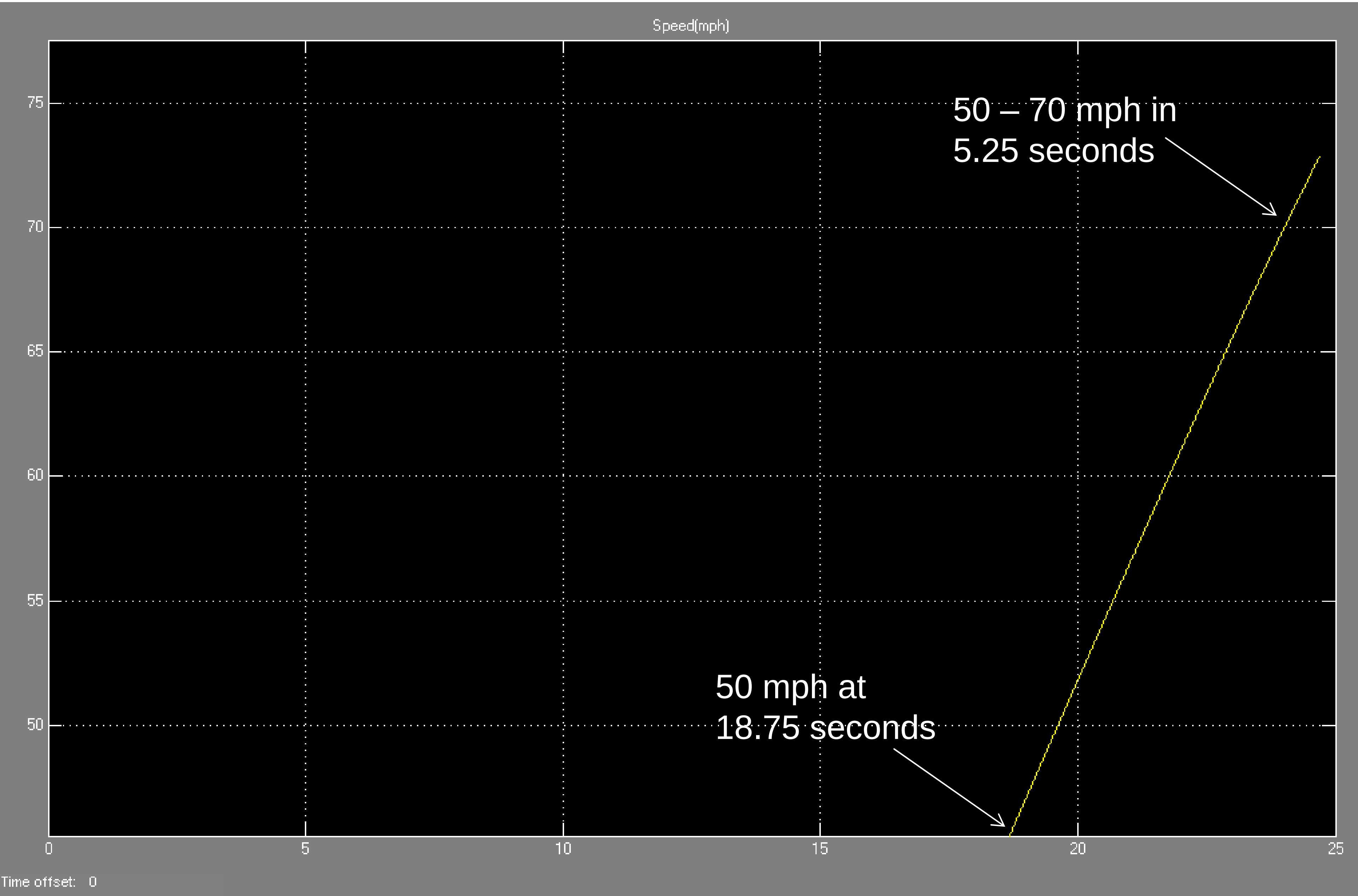


dSPACE Motion Desk

Evaluation results – 0-60mph



Evaluation results – 50-70mph



Evaluation results – Miles Per Gallon (MPG)

37 MPG in Mode 1

Design Constraints

- The plant used is a Sim Driveline plant that performs optimally with a variable step size
- Sim driveline torque and motion sensor blocks are unstable in fixed step size simulations.
- Variable step size models cannot be used for Hardware in the loop (HIL) testing

Conclusion

- The project's design requirements were satisfied
- Since the project is part of a 3 year long competition, there is room for improvement
- Project utilized knowledge from other classes, such as linear controls.
- Flexibility and ease of control system design facilitated by Mathworks tools like, Simulink

Acknowledgments

Dr. Charles Kim - Professor

Eric Schacht – OSU Advisor

Dr. Grant Warner – HU Advisor

Questions

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