ECOCAR CONTROL SYSTEM

TEAM I.C.E
DAMILOLA AINA
SHANELL HALEY
YEMI SONOIKI
ANTONIO SCOTLAND
CHINNAZOR UKEEKWE

1867
HOWARD UNIVERSITY

Managed by
Argonne NATIONAL LABORATORY

GM

EcoCAR The NeXt Challenge

Presentation Contents

- Problem Formulation
- Solution Generation
- Top Design Selection
- Final Solution Product
- Demo Prototype Product
- Team Progress
- Milestones
- Issues hampering progress
- Plan for Next 5 weeks & Implementation
- Conclusions

Problem Formulation

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

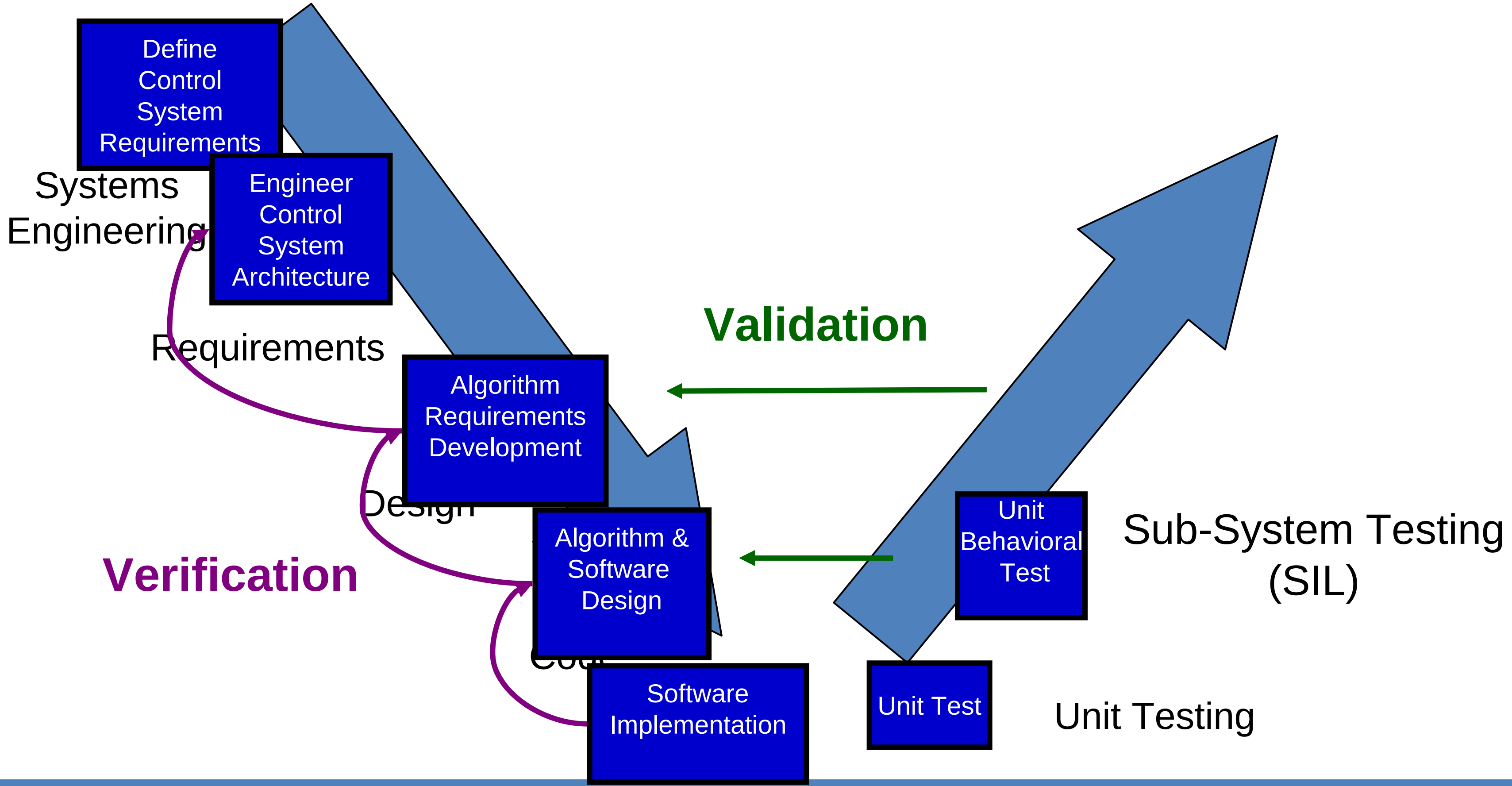
- Developing efficiently managed control Area Network (CAN) Architecture
- Minimizing unnecessary work from the ICE
- Ensuring maximum output based on any given external driving condition
- Ensure safe operation of vehicle power train

Problem Formulation- EcoCAR Performance Requirements

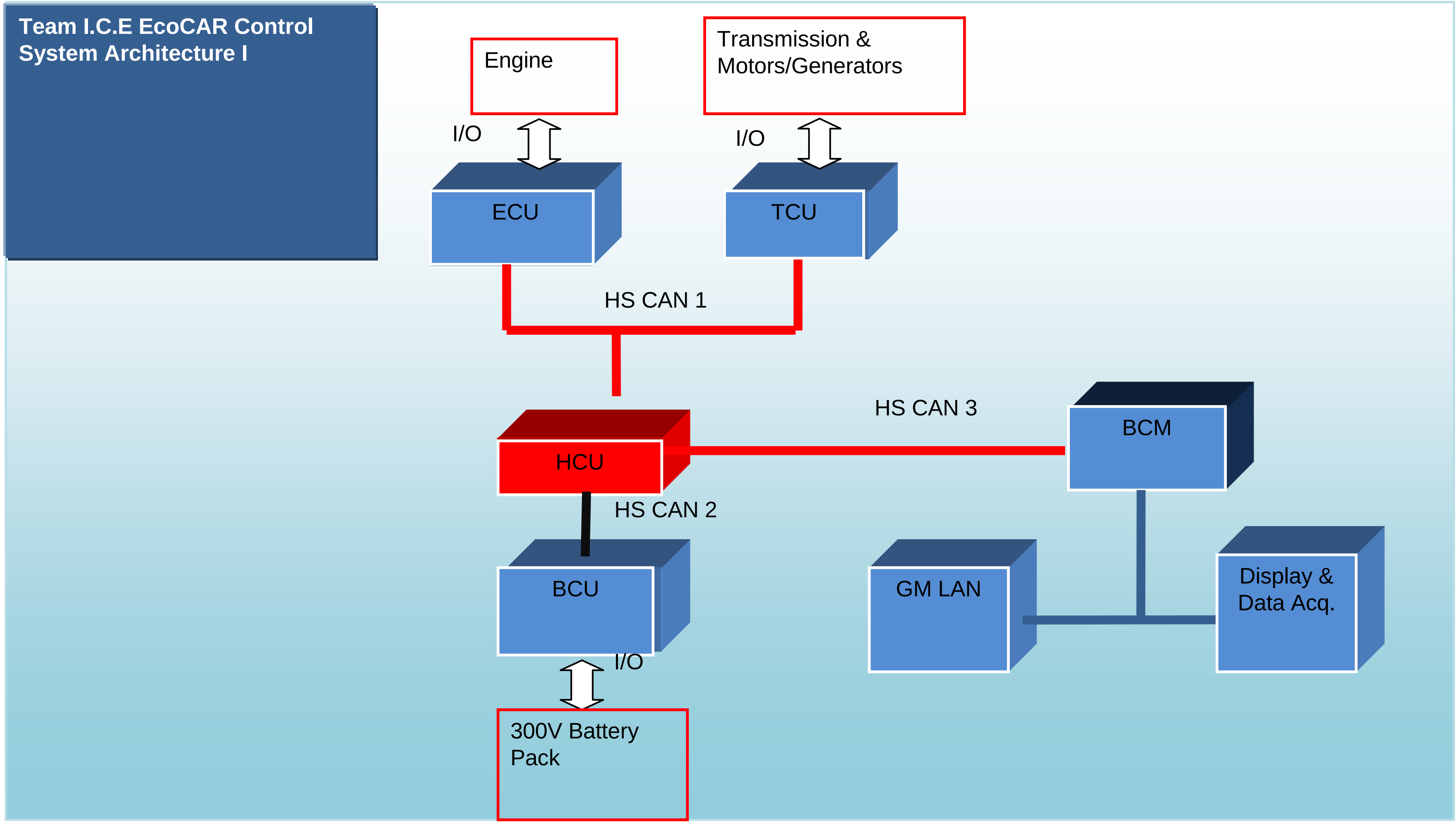
- Conform to SAE standard J1711 for Hybrids
- Facilitate acceleration 0-60mph in less than 14s
- Facilitate acceleration 50-70mph in less than 10s
- Facilitate a car start time of less than 1
- Facilitate a smooth transition between ICE and motor

Solution Generation

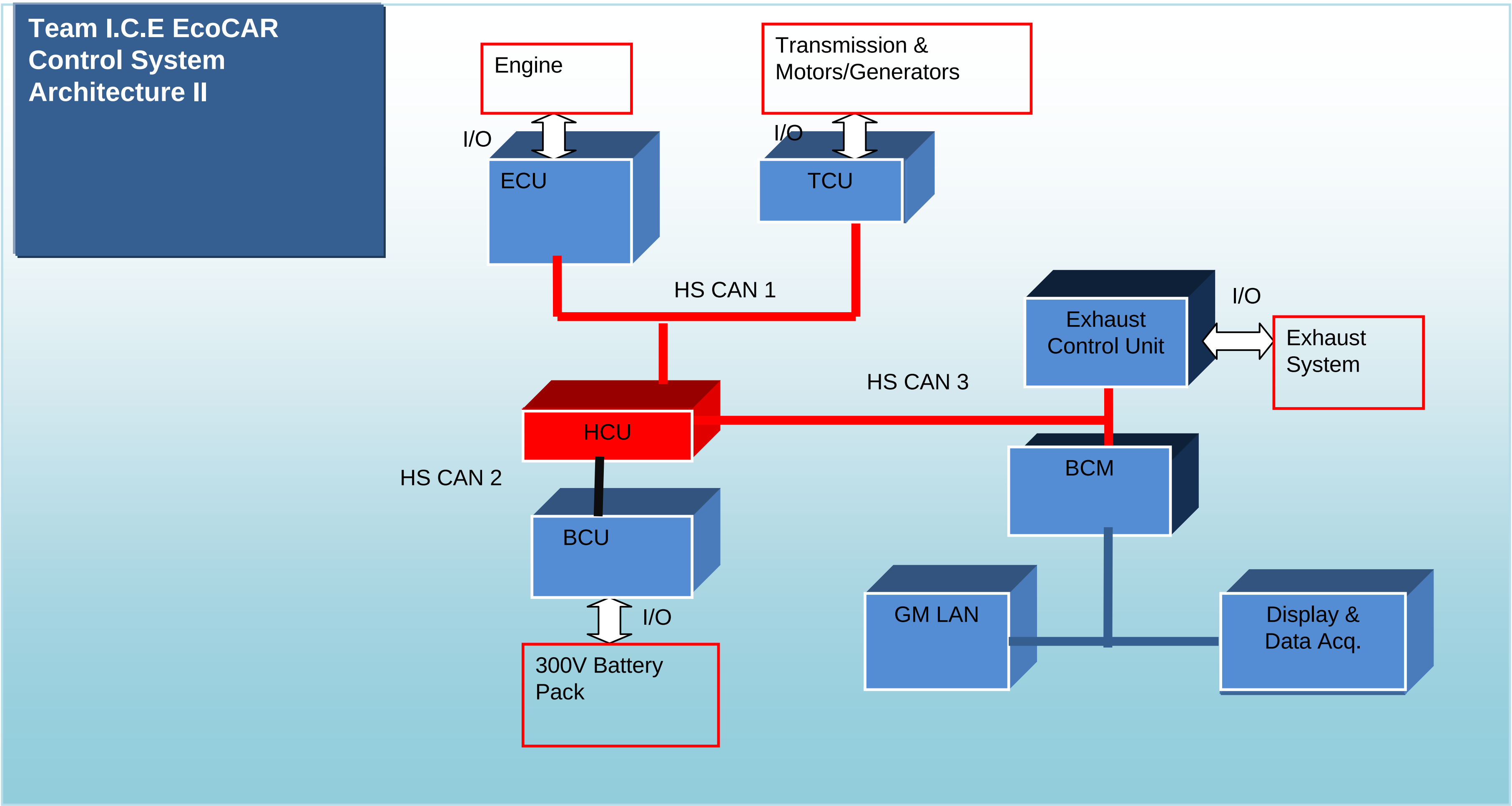
- Process Overview:



Solution I


Team I.C.E EcoCAR Control System Architecture I
Engine
Transmission & Motors/Generators
I/O
I/O
ECU
TCU
HS CAN 1
HS CAN 3
BCM
HCU
HS CAN 2
BCU
GM LAN
Display & Data Acq.
I/O
300V Battery Pack

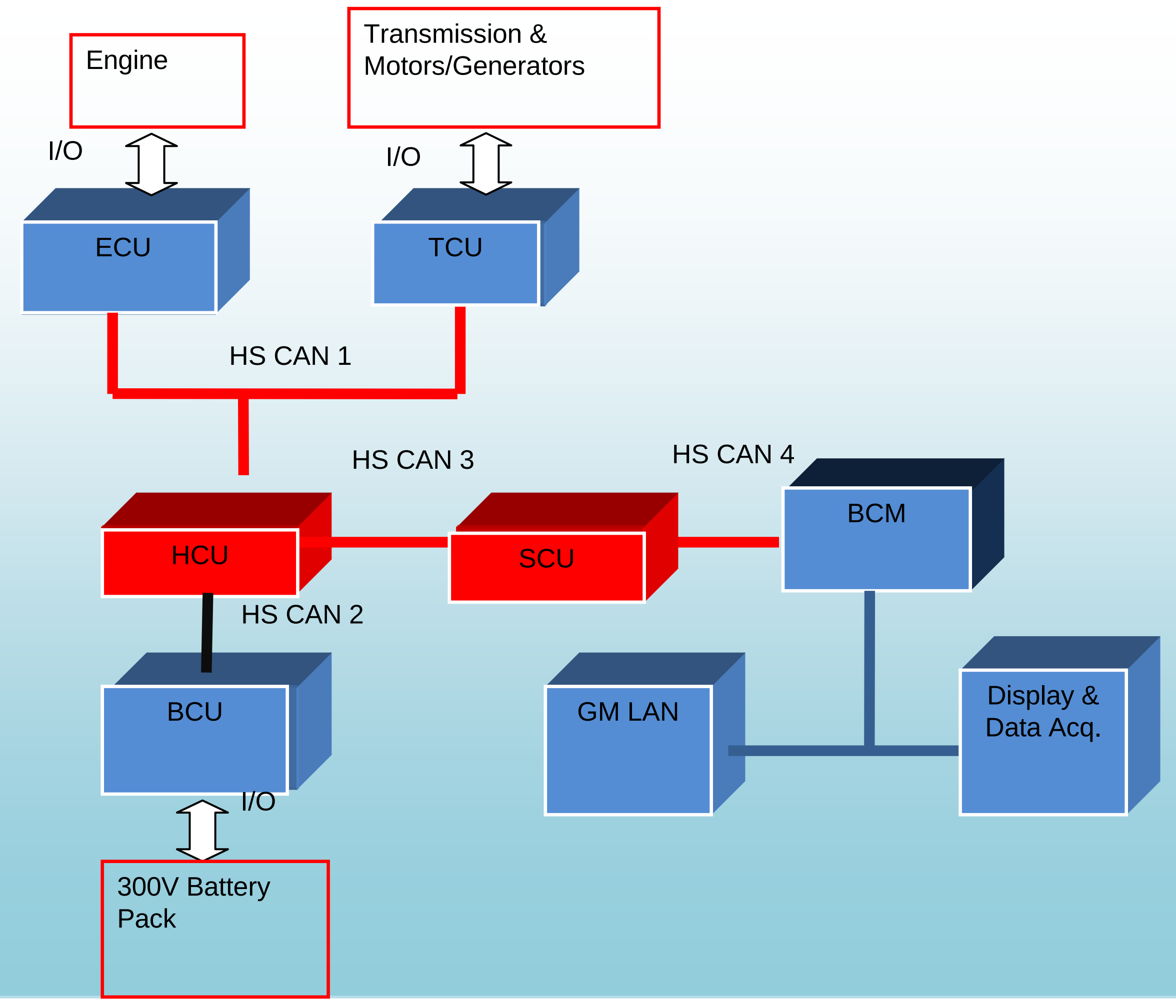
Solution II



Team I.C.E EcoCAR Control System Architecture II
Engine
Transmission & Motors/Generators
I/O
I/O
ECU
TCU
HS CAN 1
I/O
Exhaust Control Unit
Exhaust System
HS CAN 3
HCU
HS CAN 2
BCM
BCU
I/O
GM LAN
Display & Data Acq.
300V Battery Pack

Solution III

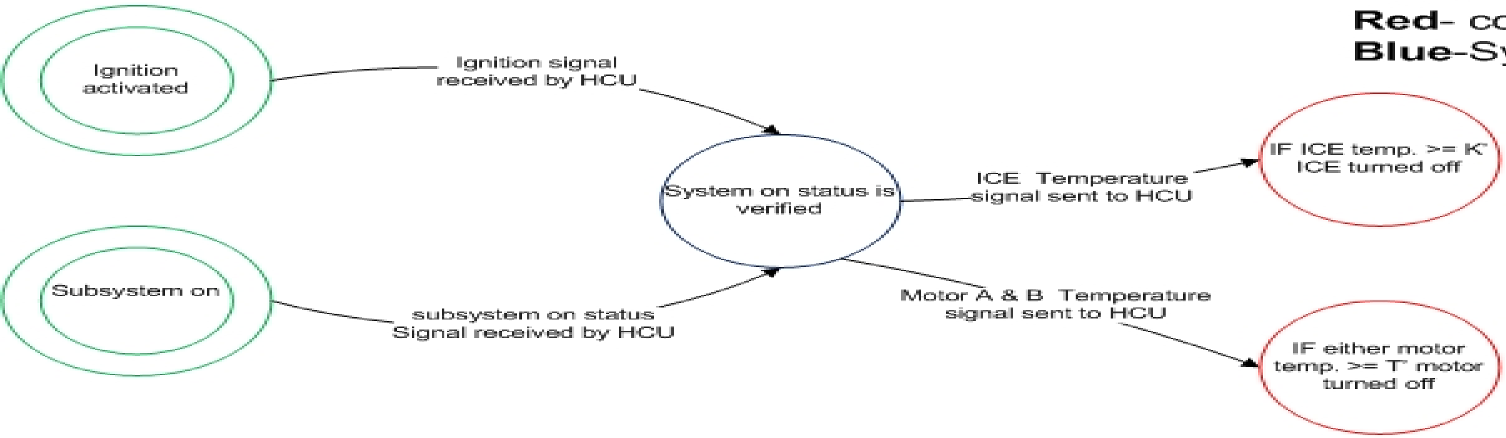
Team I.C.E EcoCAR Control System Architecture III



Decision Matrix

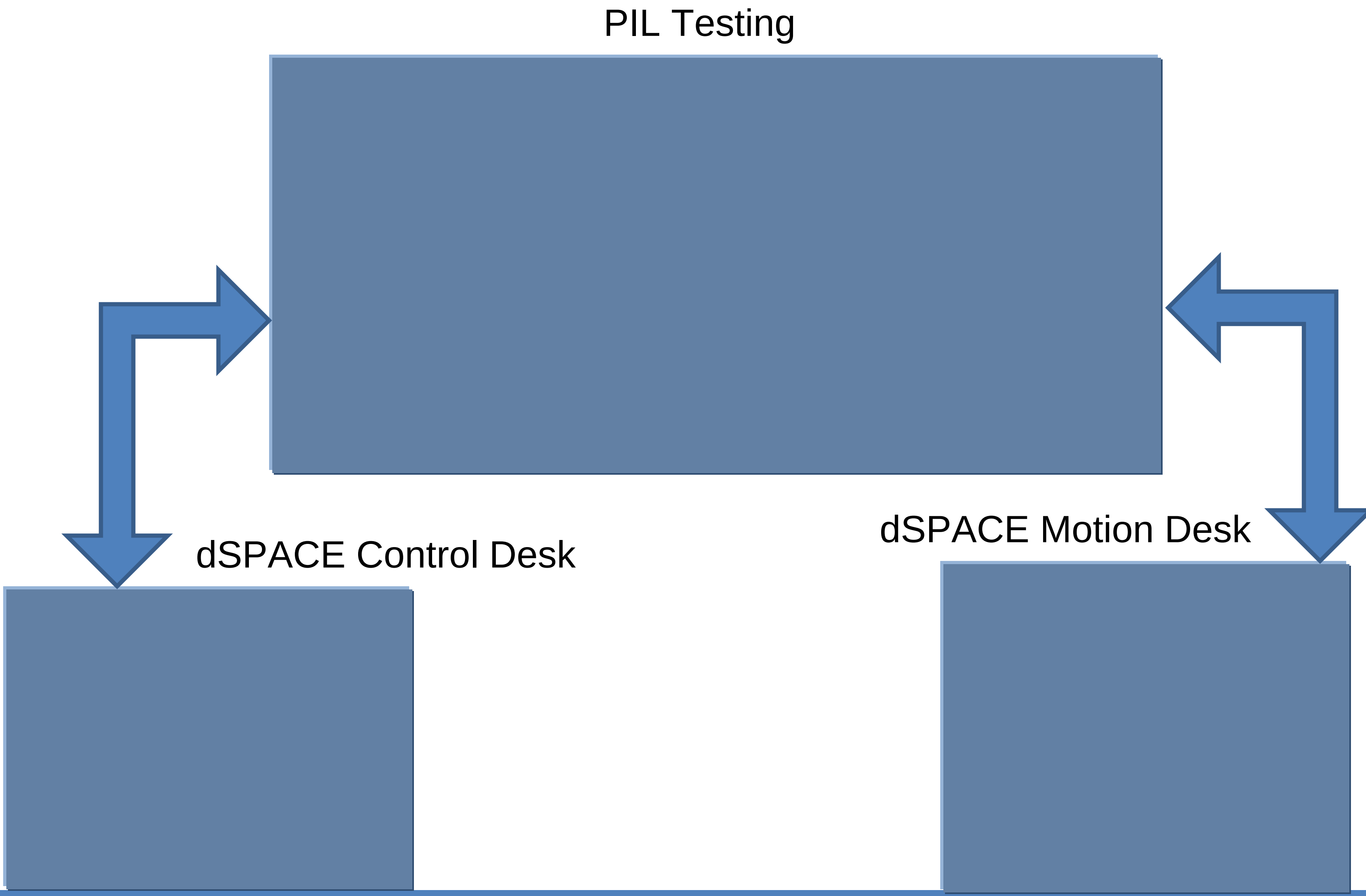
Feature and Weight	Solution I	rating	Weighted Score	Solution II	rating	Weighted Score	Solution III	rating	Weighted Score
Symplicity of design **10**	Team I.C.E will want to focus on only making the engine run perfect before any emissions system is implemented with a well designed hybrid supervisory control 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

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

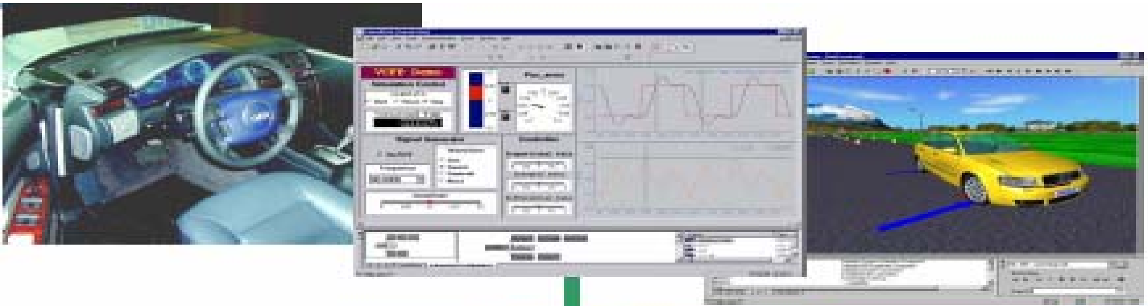


TEAM I.C.E System Cooling failure Contingency strategy

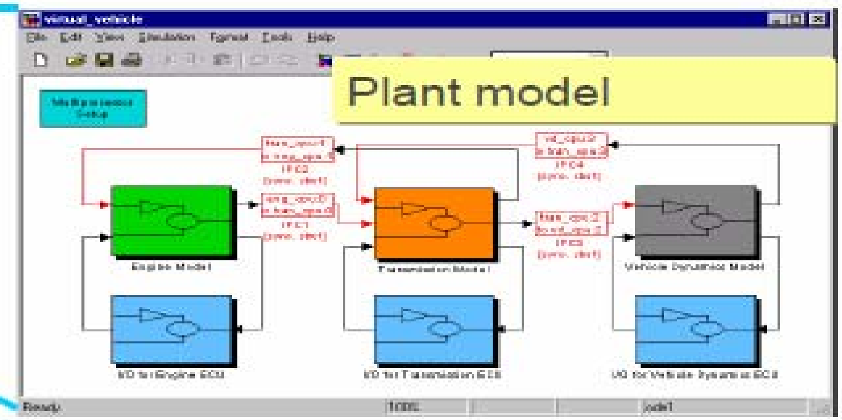
Demo Prototype Product



HIL Testing



User Interfaces for control of the Model and the ECU



Plant model

ECU test with a model of the plant that runs on the real-time hardware

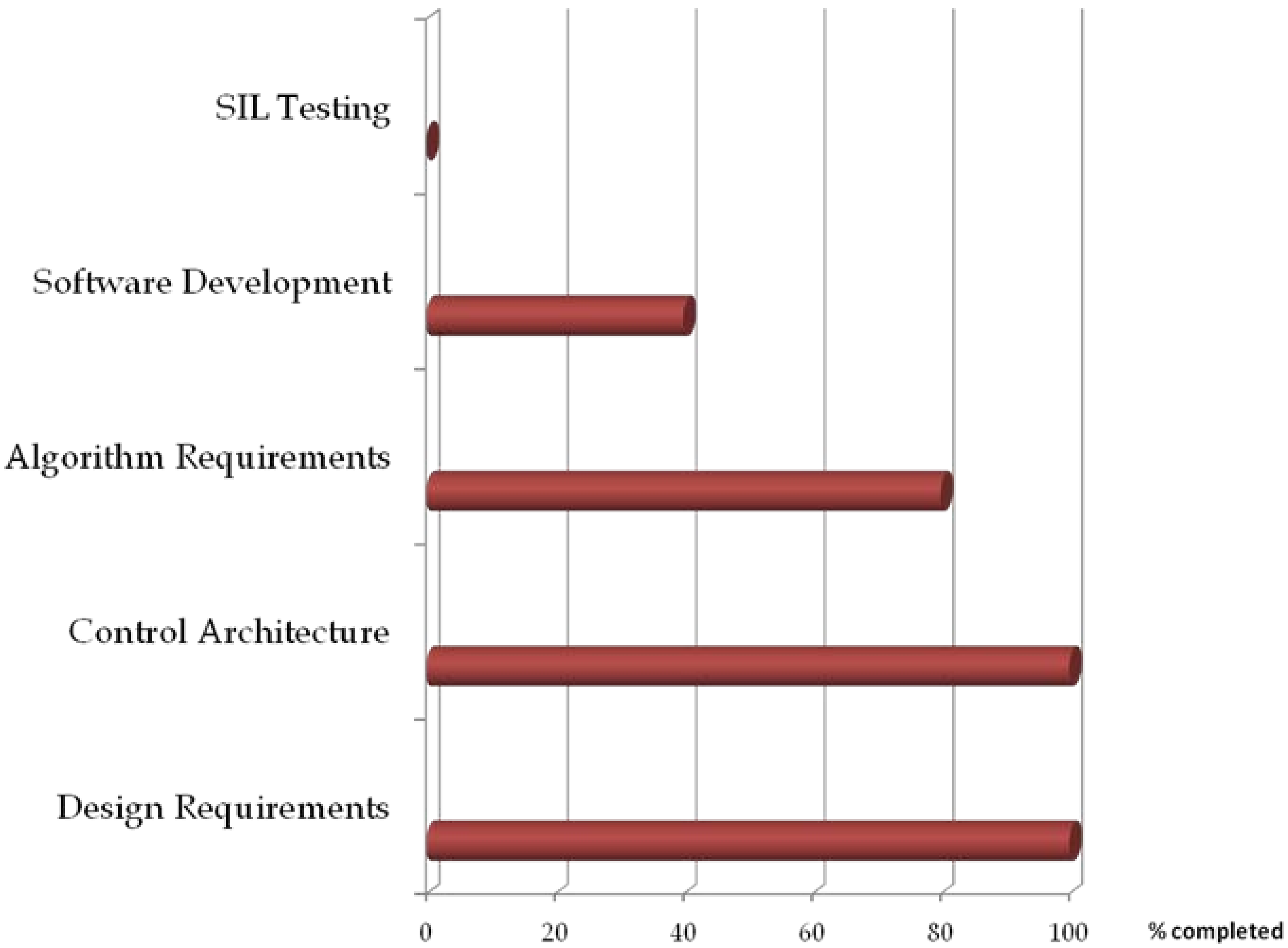
Issues impeding progress

- Immense latency in getting information from HU Mechanical team
  - Get information and assistance from OSU Mechanical Team
- Errors in the SOC model
  - Debugged by adding data conversion blocks
  - Minimizing model blocks i.e. simplifying

Risk Management – Newly identified Risks

- Inadequate Algorithm
  - Mitigated by constant referencing of Design requirement and Architecture
  - Checking for logic errors using simulink Verification and Validation tool
  - Utilizing team advisors/experts
- Latency in getting information and equipment from GM
  - Be resourceful at all times
  - Keep in constant contact with GM advisors and Mentor

Milestones

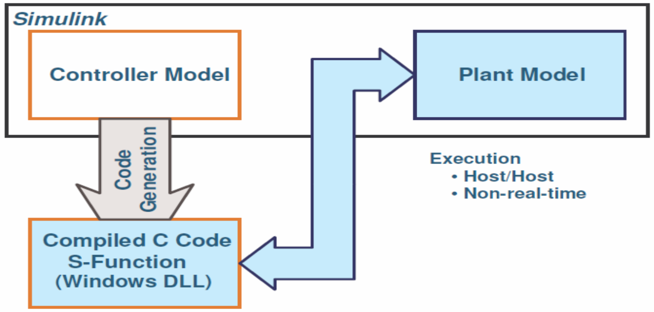

SIL Testing
Software Development
Algorithm Requirements
Control Architecture
Design Requirements
0
20
40
60
80
100
% completed

Plan for next 5 weeks

- Algorithms for Regenerative breaking, drive cycle management, Safety systems
- Get ICE and motor torque maps form OSU or HU mechanical teams
- Get pedal position calibration information form OS or HU mechanical teams
- Create PID controller for ICE crank and ICE and motor power output
- Model mode 1 and mode 2 of the transmission and drive cycle management modules
  - low range operation
  - high Range operation
- Create and connect the subsystems of all modules

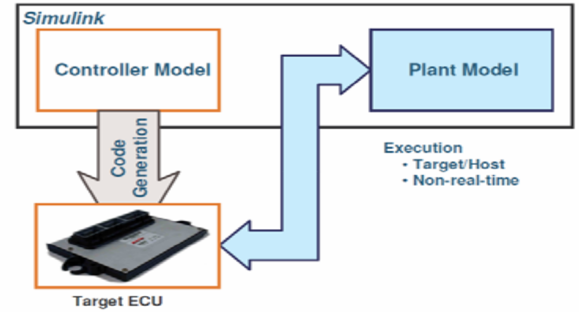
Plan for next 5 weeks

- Software in the Loop Testing



- Implement CAN I/O using control desk blocks
- Setup control desk instrument panel
- Processor in the Loop

(for demonstration purposes)



Senior Project Implementation plan

Algorithm Requirements

- By March 14th, with 6 weeks left

→

Software Development

- By March 22nd, with 3 weeks left

→

SIL Testing & PIL setup

- By April 10th , with 5 days left

Next Challenge Competition- Future deliverables

Research a viable HIL test plan

- By March 22nd, with 6 weeks left

Report 4: System Development and Integration

- By April 15th
- highlights the complete HIL setup design

Conclusion

- Inter-departmental project
- Steep learning curve made steeper by latency in information exchange
- Future progress depends on timely information exchange between teams
- Completion of HIL testing plan depends on team progress
- Competition requirements met based on team progress
- Modeling 40% complete, Algorithms 80% complete, and SIL testing not yet started

Questions

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