VSCADA Preliminary Design Report

PDR Covering the LFEV Software Design

Road Map

- Resource Availability
- Project Overview
- Risk Assessment
- Requirements Analysis
- System Design and Subsystem Overview
- Interface
- System Control States
- System Test Plan
- Software Maintainability Plan
- Cost Analysis
- Team Schedule Overview

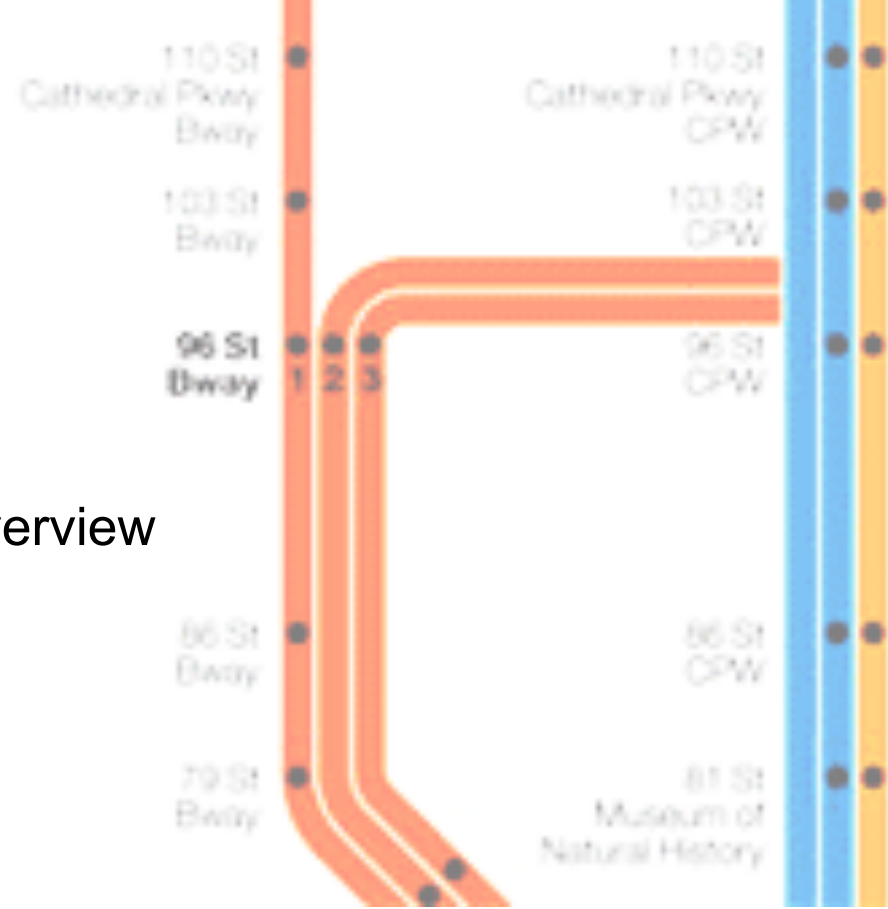
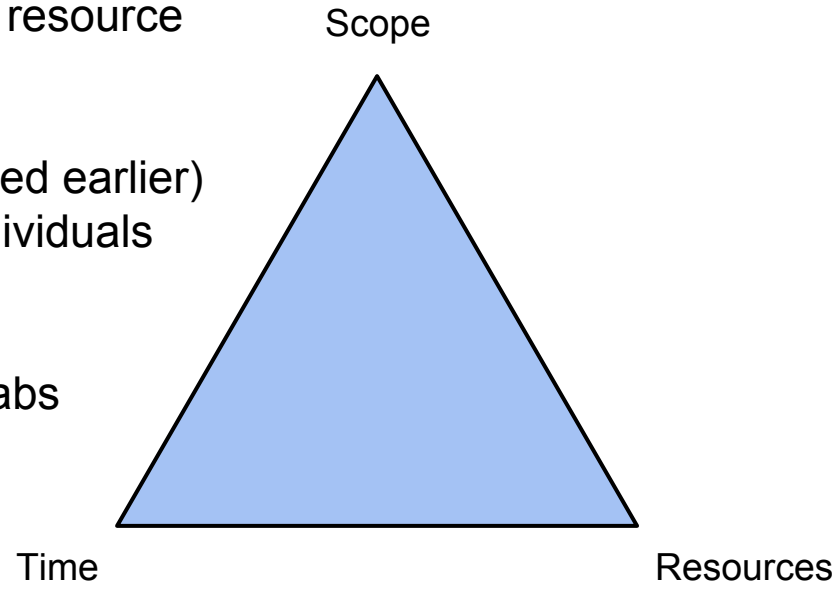
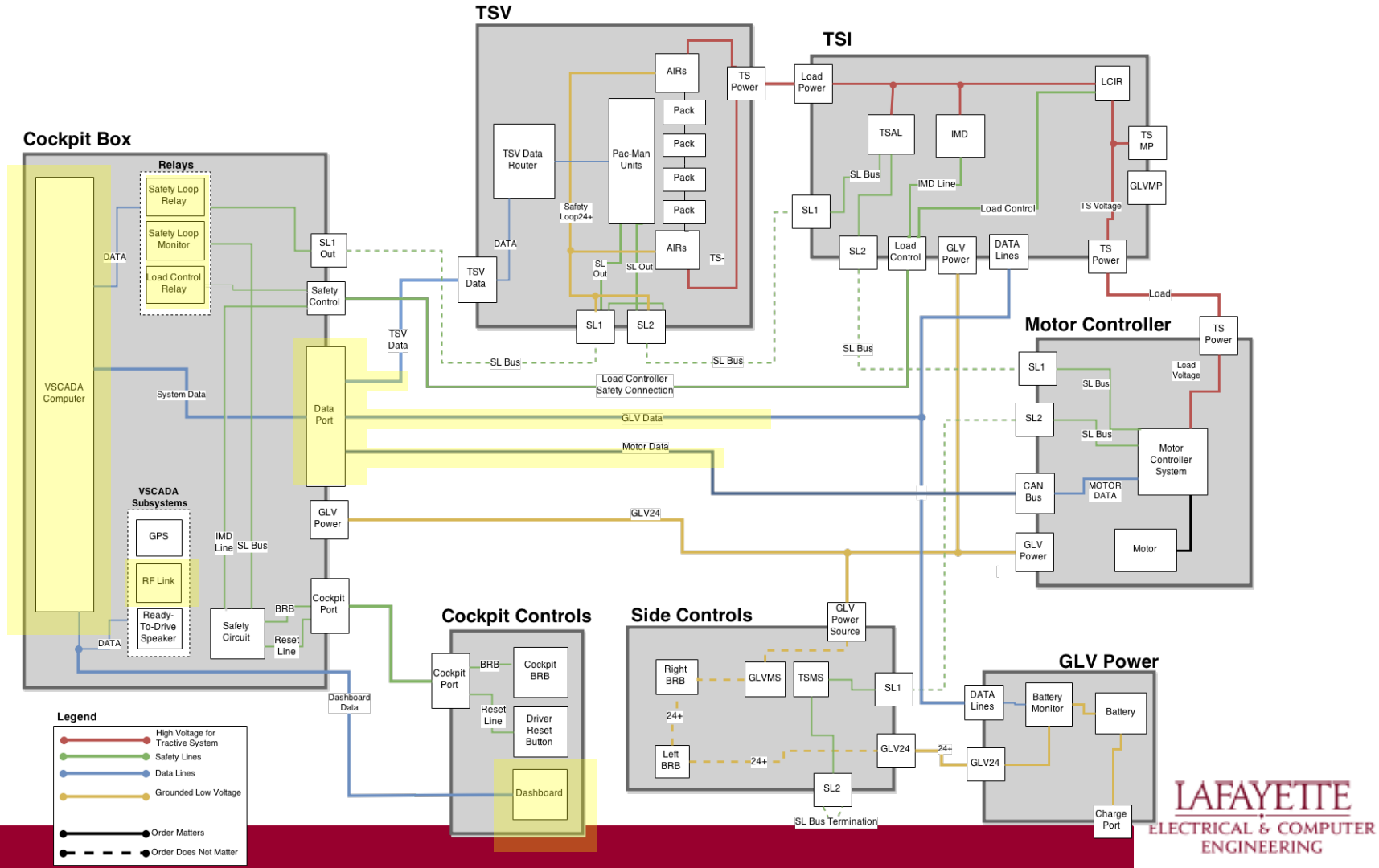


image reference: New York Metro

Resource Availability

- Need to find a balance of the three resource components
- Time:
  - Limited time (need to be finished earlier)
  - Flexible schedule between individuals
- Resources
  - ~$1000
  - 24 hours available computer labs
  - Advice from Professors
  - Design from previous years
- Scope
  - Need to be cut down
  - Major structure done in week 9
  - Other requirements can be addressed later




TSV
TSV Data Router
Pac-Man Units
AIRs
Pack
Pack
Pack
Pack
AIRs
TS Power
Safety Loop24+
DATA
TSV Data
SL Out
SL Out
TS-
SL1
SL2
TSI
Load Power
LCIR
TSAL
IMD
TS MP
GLVMP
SL Bus
IMD Line
Load Control
TS Voltage
SL1
SL2
Load Control
GLV Power
DATA Lines
TS Power
Load
Cockpit Box
Relays
Safety Loop Relay
Safety Loop Monitor
Load Control Relay
DATA
SL1 Out
Safety Control
TSV Data
SL Bus
SL Bus
Load Controller Safety Connection
VSCADA Computer
System Data
Data Port
GLV Data
Motor Data
Motor Controller
TS Power
SL1
SL Bus
Load Voltage
SL2
SL Bus
Motor Controller System
CAN Bus
MOTOR DATA
Motor
GLV Power
VSCADA Subsystems
GPS
RF Link
Ready-To-Drive Speaker
IMD Line
SL Bus
GLV Power
GLV24
Cockpit Port
BRB
Reset Line
Safety Circuit
DATA
Dashboard Data
Cockpit Controls
Cockpit Port
BRB
Reset Line
Cockpit BRB
Driver Reset Button
Dashboard
Side Controls
GLV Power Source
Right BRB
GLVMS
TSMS
SL1
24+
Left BRB
24+
GLV24
SL2
SL Bus Termination
GLV Power
DATA Lines
Battery Monitor
Battery
GLV24
24+
Charge Port
Legend
High Voltage for Tractive System
Safety Lines
Data Lines
Grounded Low Voltage
Order Matters
Order Does Not Matter

VSCADA Interface

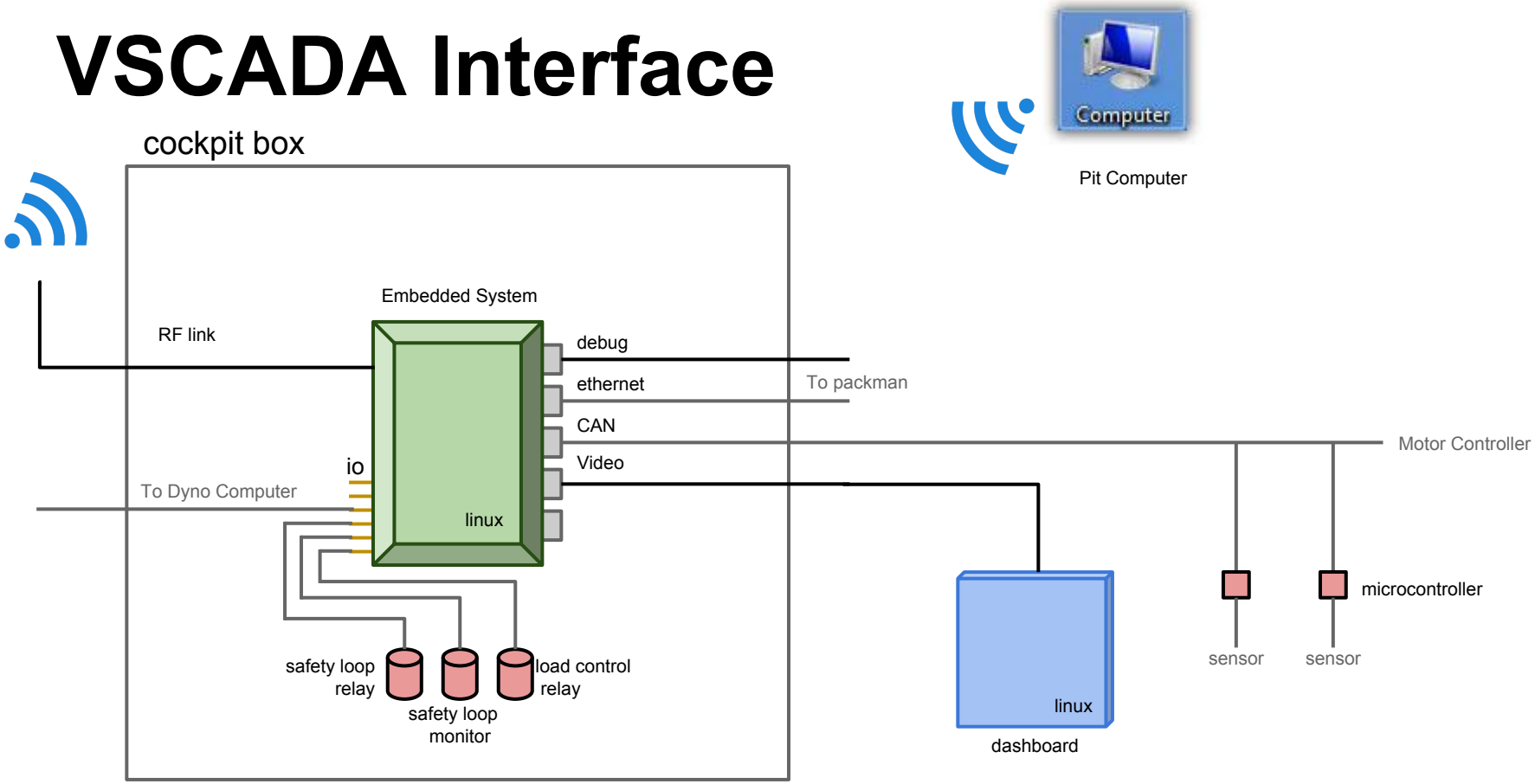


image reference: github, microsoft

Deliverable

- Maintenance Mode
  - Minimal restriction, ability to overwrite config files
- Drive Mode
  - Minimal display, load and clear
- Demonstration Mode
  - Pre-programed, labelled “Demo”
- API
- SDK
- Database
- Datalogging
- Configuration management, no recompile

image reference: Charles Waller

Requirements Out of Scope

- Mobile App (~S009)
- Automatic Hardware Configuration (still check for sensors) (S017)
- GPS (S034)
- Long-term shutdown mode (S023)
- Plug-in and forget charging (S025)
- Plot data (S038)
- Dynamometer data acquisition (S042)
- Automated Charging of TSV (S013)
- Pre-Charge Discharge Circuits (EV 4.9)

image reference: Windows 95

Risk Assessment

- Coding Style
- Maintenance mode
- Warning/Fault Detection
- On-board Computer Handling
- Project Physical & Mental Health Effects

Requirements Analysis

- Back End Software
  - GLVIS - Grounded Low Voltage Interface Software
  - TSVIS - Tractive System Voltage Interface Software
  - MIS - Motoro Interface Software
  - DB - Data Base
  - DAA - Data Acquisition and Analysis
- DOC - Documentation
- Front End Software

  UI- User Interface

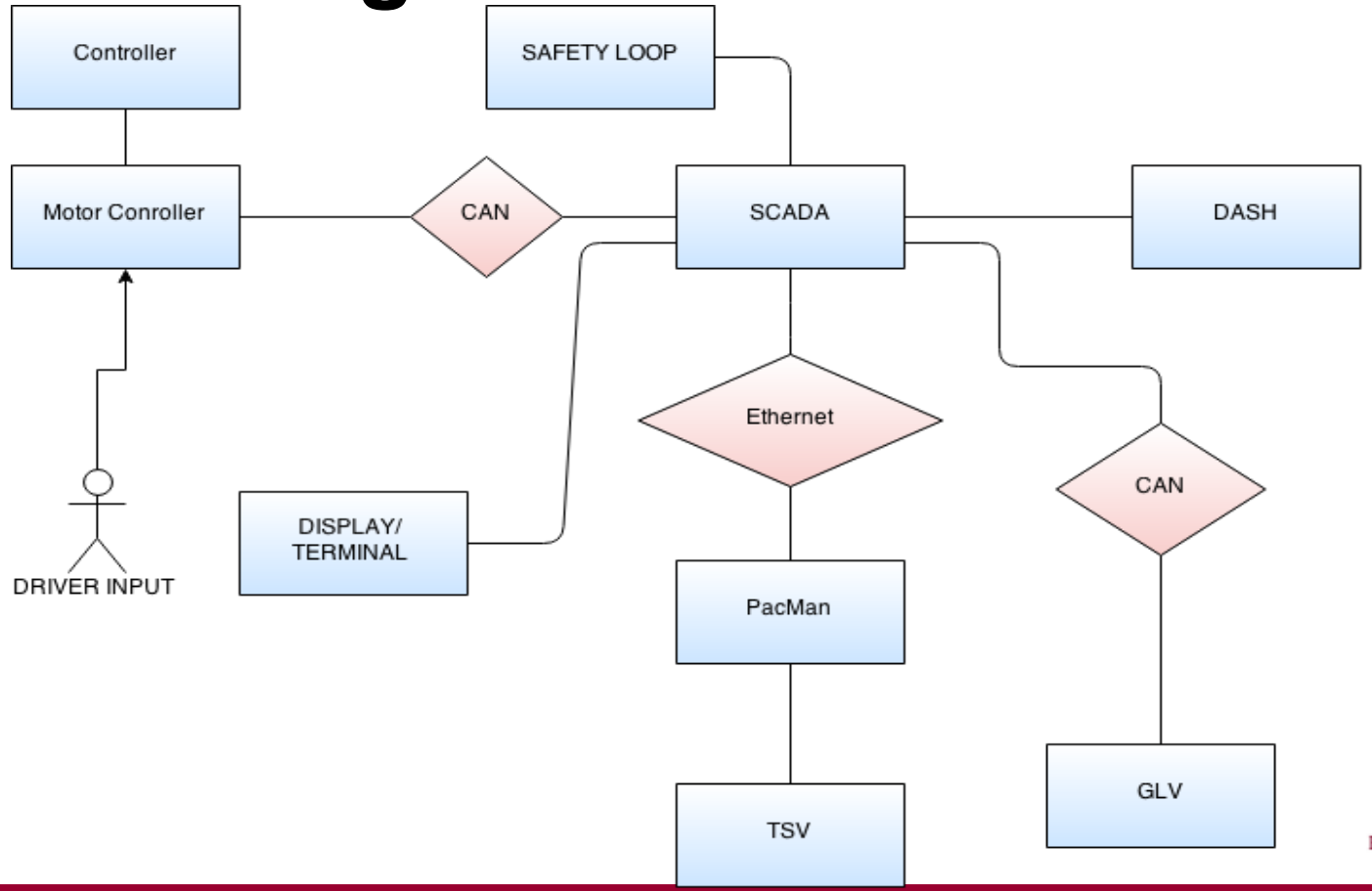
  Comm - Communication

System Design

- VSCADA gathers information from other systems in electric vehicle and monitors these systems.
- Communicate with three different systems.
  - TSV(PacMan) using Ethernet
  - GLV using CAN bus protocol
  - Dyno(Motor Controller) using CAN bus protocol
- Safety loop is also included in case of emergency and system shut down.
- Operates on Linux OS.

image reference: linux.com, Namco

System Design Overview

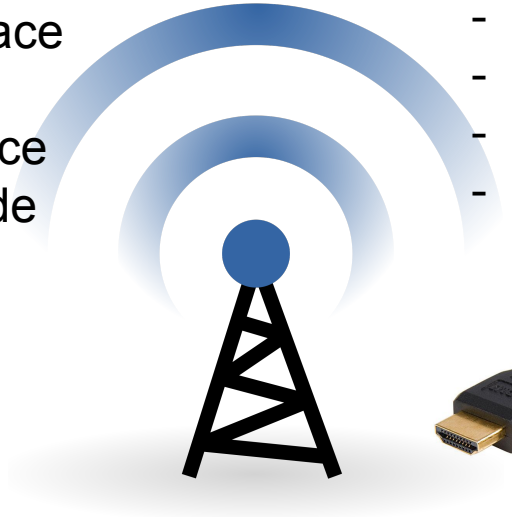


System Hierarchical BreakDown

- VSCADA is divided into two subsystems frontend and backend.
- Backend and Frontend are further divided into smaller subsystems.

Frontend (User Interface)

- Dashboard Interface
- ~~Mobile Interface~~
- Pit Station Interface
- Maintenance Mode
- Drive Mode
- Demo Mode



Backend

- Data Acquisition
- Vehicle control
- DataBase
- Computer System

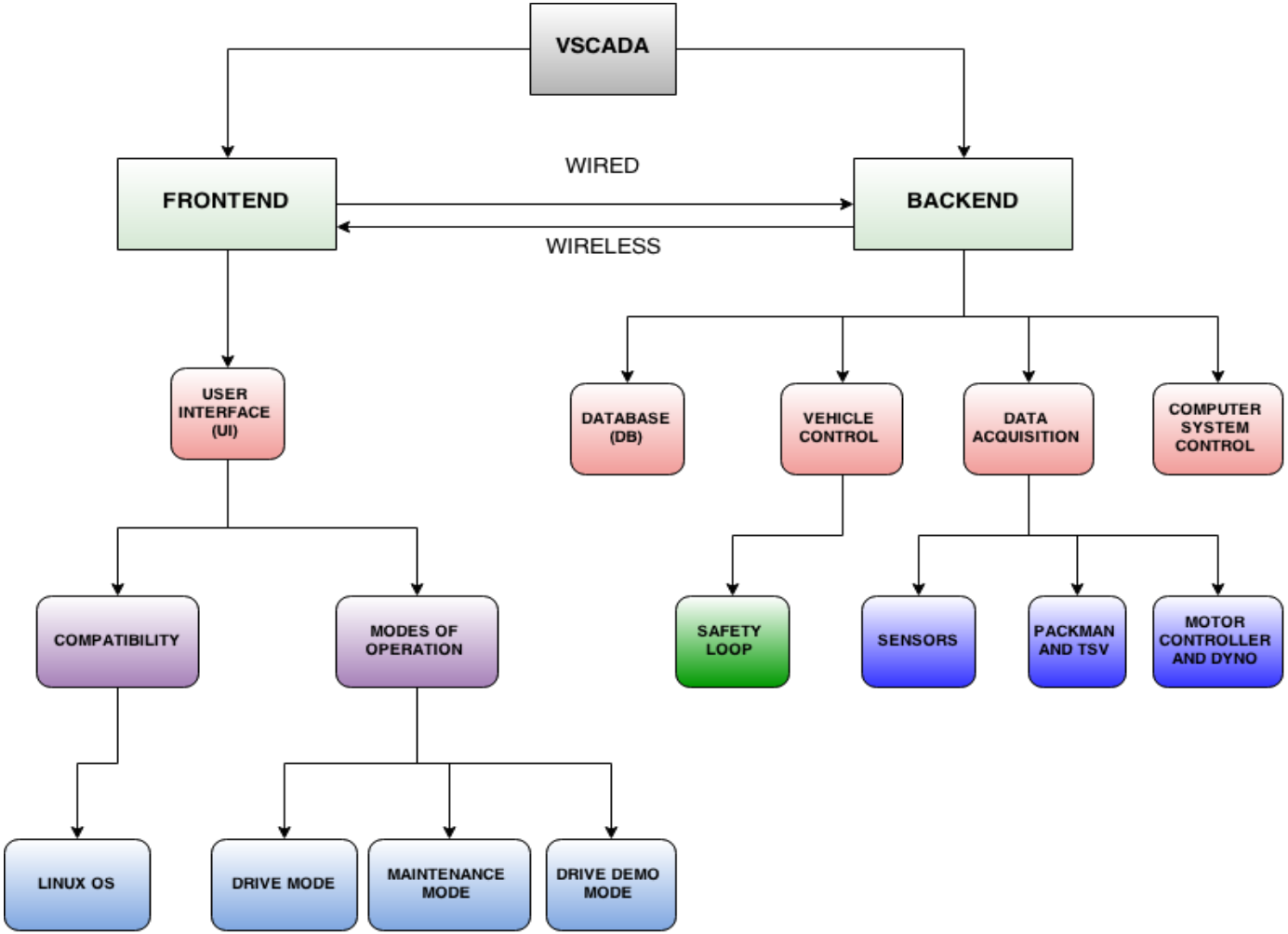


Fig. 2. System Hierarchical Breakdown

Interface

TSV

General Sensor Interface

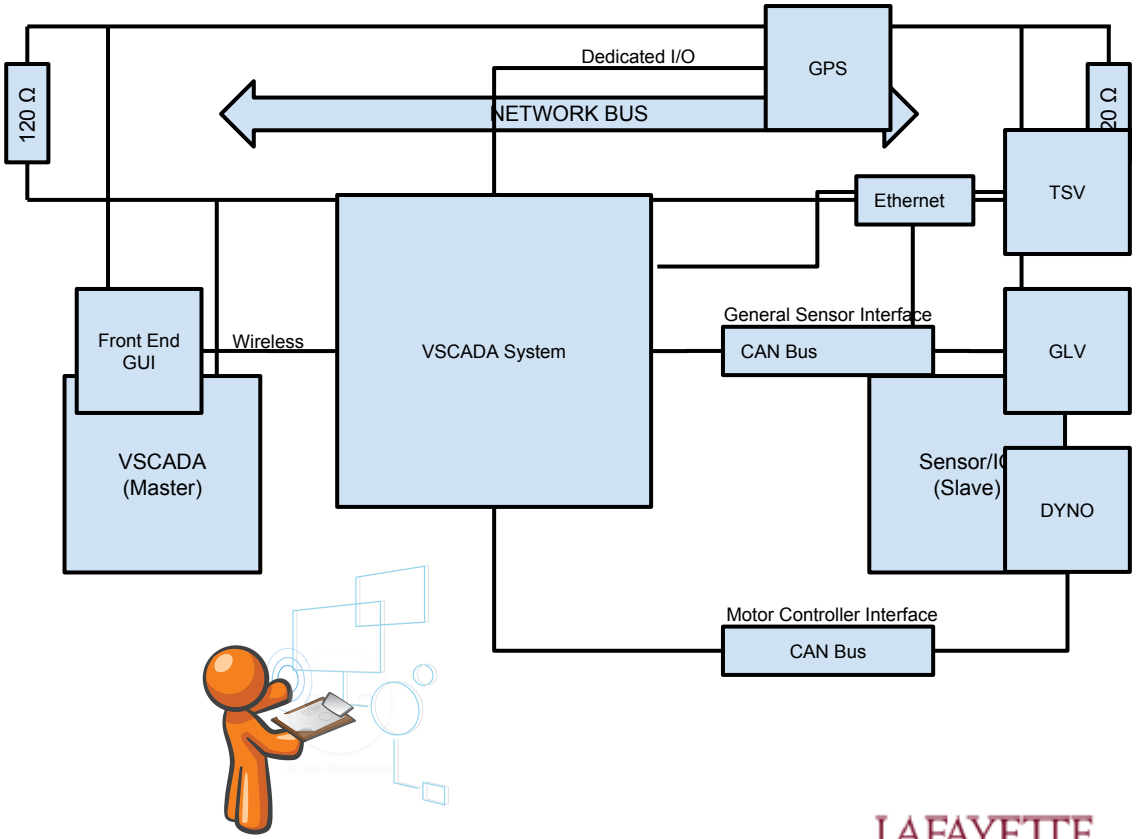
GLV

General Sensor Interface

DYNO

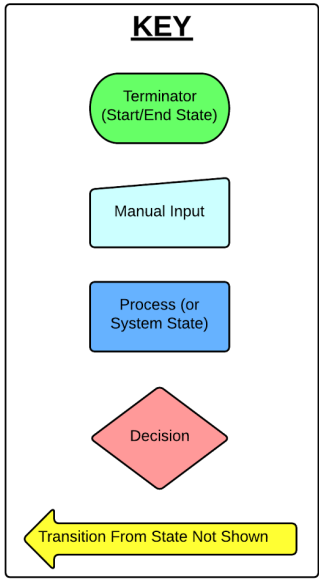
General Sensor Interface

Motor Controller (CAN)

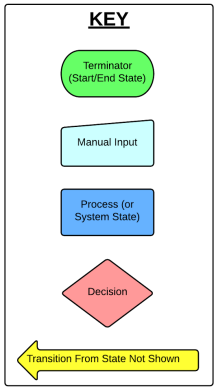


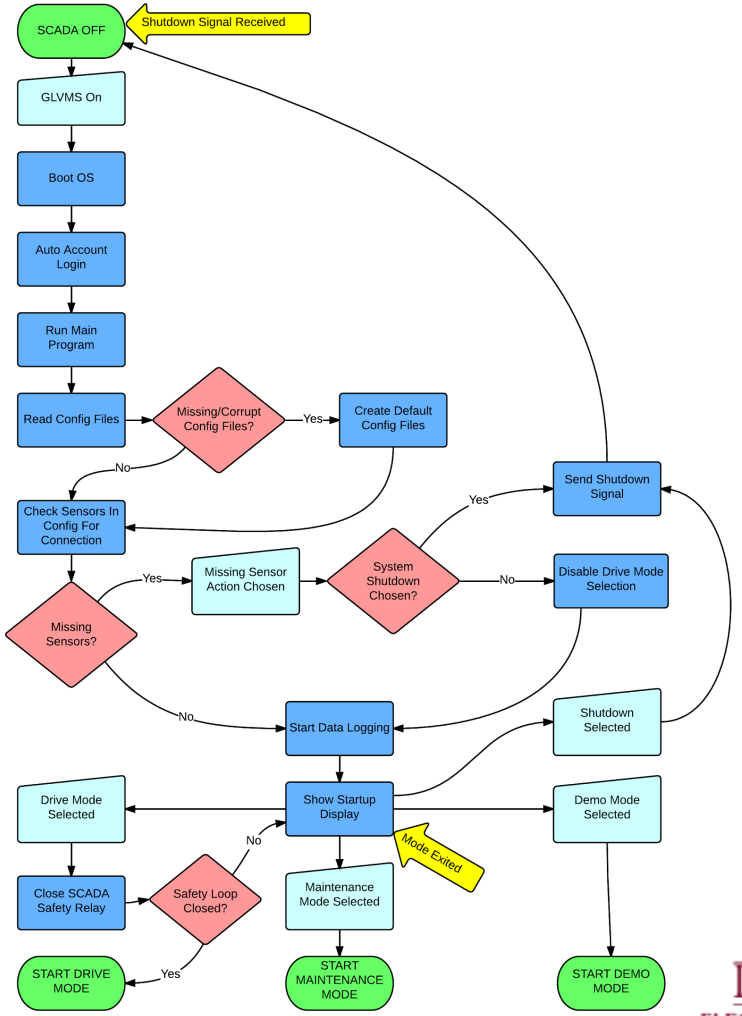
System Control States

- Flowcharts created represent:
  - System Startup Logic
  - Drive Mode
  - Maintenance Mode
  - Demonstration Mode



Startup States





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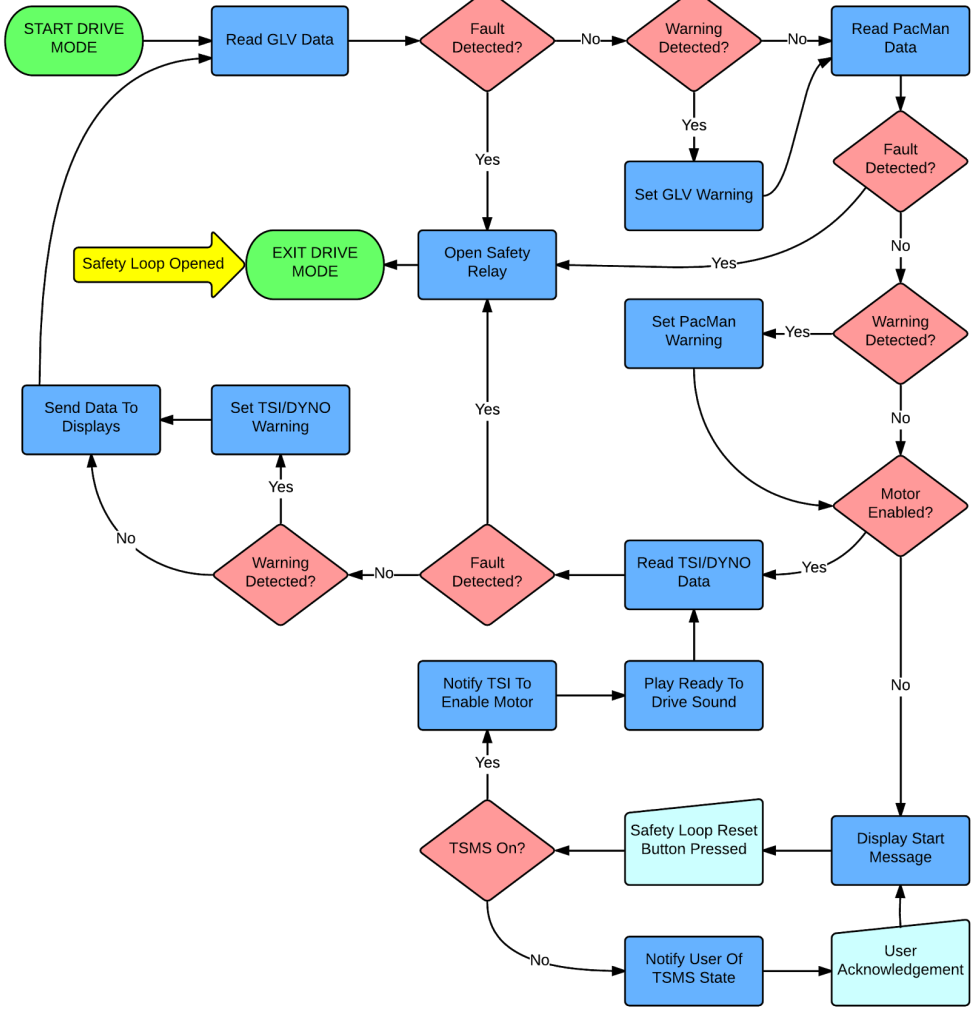
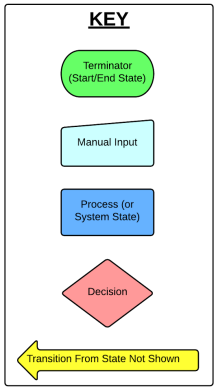
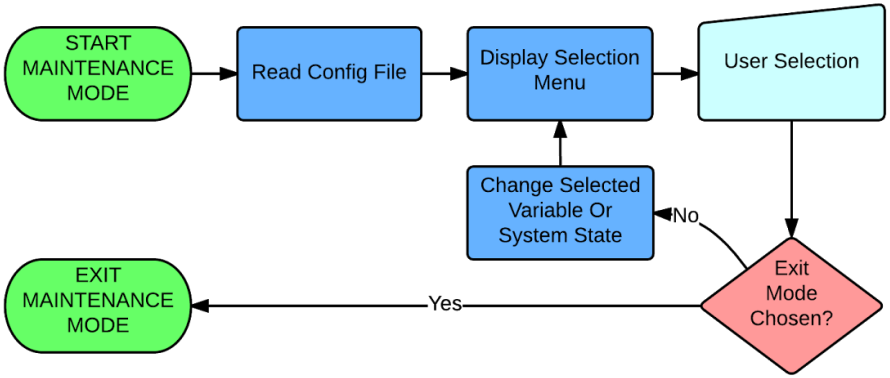
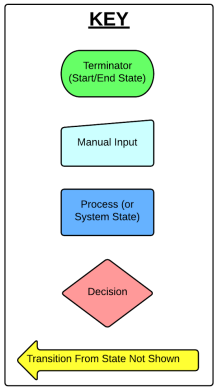
Drive Mode States



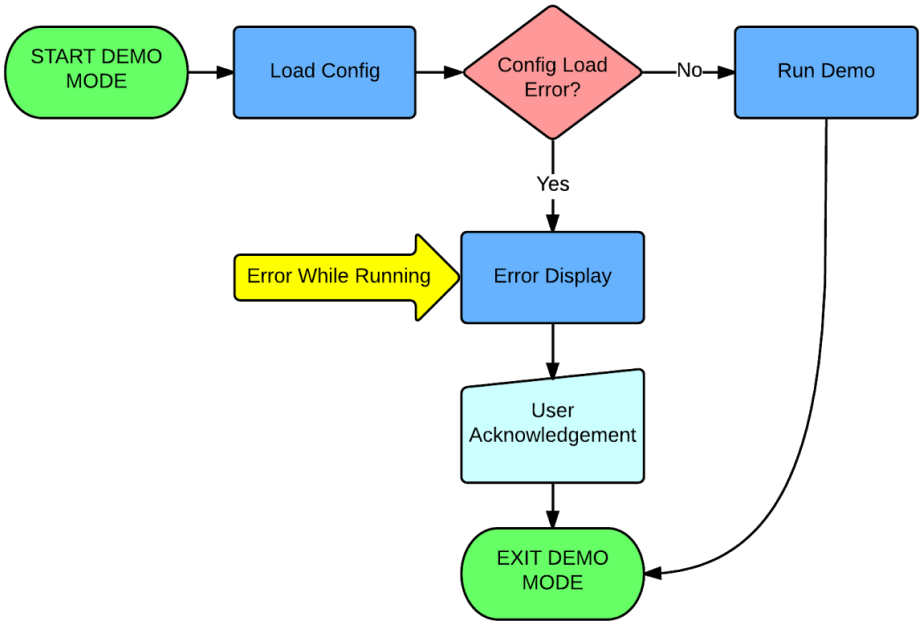


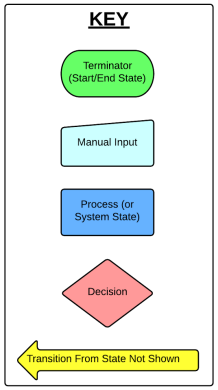
Maintenance Mode States





Demonstration Mode States

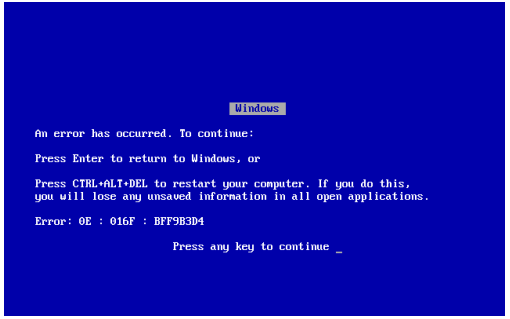




Acceptance Test Strategy

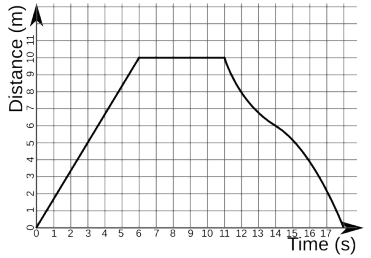
- Show that all requirements are met
- High-level outline to be expanded into ATP
- Compliance can be proved by
  - Analysis
  - Inspection
  - Test

ATP Test Outlines



- T000 - System Startup Test
  - Tests successful VSCADA startup on GLV power without human interaction
- T001 - TSV Communication Test
  - Tests communication of VSCADA with Pacman using 2014 protocol
- T002 - System Failure Recovery Test
  - Tests ability of system to recover in event of unexpected failure

ATP Test Outlines (cont.)



- T003 - Motor Controller Test
  - Tests ability of VSCADA system communicating with motor controller
- T004 - User Interface Test
  - Tests simultaneously functionality across all physical interfaces
- T005 - Data Logging Test
  - Tests successful and accurate logging and plotting of measurands

ATP Test Outlines (cont.)

- T006 - Wireless Link Communication Test
  - Tests successful communication between interfaces with minimal latency over wireless link
- T007 - Hardware Detection Test
  - Tests autodetection of sensors without software recompilation
- T008 - Rules Test
  - Tests setting of user defined alarm/shutdown rules

Cost Analysis

Embedded Computer

The ‘Brain’ of VSCADA

Embedded Linux System

LCD Display

Driver Dashboard Display

Miscellaneous Hardware

Supporting Hardware

Connectors

Unexpected Costs

Budget Summary

EXPENSE DESCRIPTION	TOTAL COST
Embedded Computer	$200.00
Dashboard LCD Display	$100.00
Wireless Radios	$100.00
Power/Safety Loop Electronics	$55.00
Interface Demonstration Microcontrollers	$60.00
Miscellaneous Hardware Costs	$235.00
TOTAL	**$750.00**

Team Schedule Overview

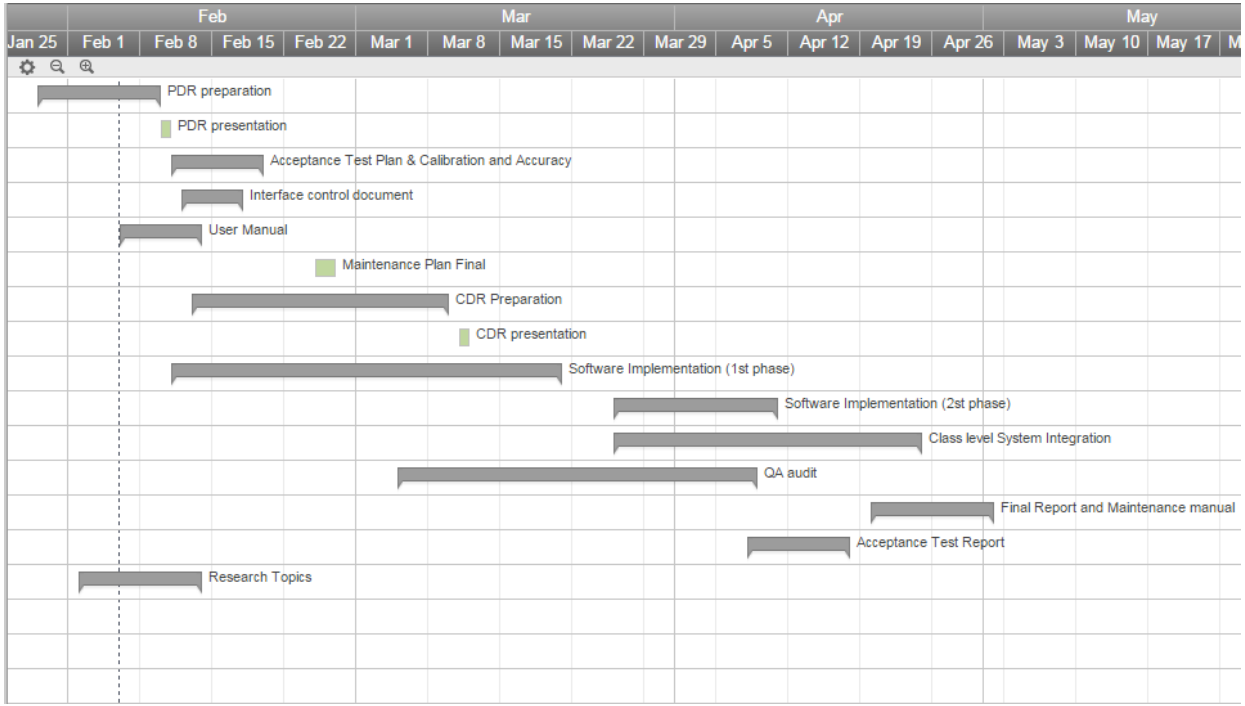
- 15 week project
- first 9 weeks should design, build and test a simplified, working version
- Crucial deadlines:

milestones	
Name	Due Date
PDR presentation	2/10/2015
CDR presentation	3/11/2015
phase one demonstration	3/25/2015
acceptance test	4/13/2015
final demonstration	5/1/2015

Deliverables	
PDR materials	2/8/2015
user manual	2/13/2015
calibration and accuracy	2/16/2015
acceptance test plan	2/19/2015
maintainability plan	2/26/2015
CDR materials	3/9/2015
QA audit report	4/8/2015
acceptance test report	4/17/2015
final report	4/27/2015

Team Schedule Overview (cont.)

- Timeline
- Has 12 main tasks, each with sub tasks



Team Schedule Overview (cont.)

- example part of the full task list
- shows tasks completed for PDR
- total of 103 tasks

TASK NAME	ID	LENGTH (DAYS)	START	FINISH
CDR Preparation	34			
Summary of Approved System Level Test Plan	35	2	2/20	2/23
Safety Plan	36	1	2/13	2/13
Updated System Design/System report draft	37	4	2/16	2/19
Detailed Specifications for each subsystems	38	3	2/17	2/19
Enhanced requirement analysis	39	3	2/17	2/19
Program budget	40	2	2/23	2/24
Revised Program schedule	41			
Update with current progress	42	1	2/25	2/25
List of completed/incomplete tasks	43	1	2/26	2/26
CDR material check/revisit	44	3	3/3	3/5
CDR write up/slide show	45	2	3/6	3/9
CDR Presentation	46	1	3/11	3/11

Team Schedule Overview (cont.)

- Individual tasks
  - Some are short tasks, required a day or two
  - Some are more complicated and may take more than one week, and the assignees are responsible for proposing his detailed weekly plan

task id 1	task name PDR preparation	Start Date	End Date
5	Requirements Analysis	1/29/2015	2/3/2015
7	Risk Assessment	2/3/2015	2/4/2015
101	Research sensors/protocols already on the system and possible additions	2/4/2015	2/9/2015
22	User manual: Block Diagram	2/9/2015	2/10/2015
26	User manual: FAQ	2/10/2015	2/12/2015
39	Enhanced requirement analysis	2/17/2015	2/19/2015
44	CDR material check/revisit	3/3/2015	3/5/2015
67	VCI: Dyno	2/27/2015	3/6/2015

Conclusion

- VSCADA is a subsystem of LFEV-Y3-2015 project. This preliminary design will serve as a baseline for the VSCADA team to enter a more detailed design phase.
- Moving forward, the VSCADA team will
  - expand and complete the Acceptance Test Plan
  - develop a user manual
  - finalize the breakdown of the system into implementable software modules
  - decide on the libraries and software tools to use
  - purchase the main interface, an embedded Linux device

Questions?