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
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
VSCADA Interface

cockpit box

Embedded System
- debug
- ethernet
- CAN
- Video

To Dyno Computer
- RF link
- io

To packman
- ethernet
- CAN
- Video

To Pit Computer
- linux
- microcontroller
- sensor

Motor Controller
- linux
- dashboard

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**
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)
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
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.
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
Drive Mode States
Maintenance Mode States
Demonstration Mode States

1. START DEMO MODE
2. Load Config
3. Config Load Error?
   - No: Run Demo
   - Yes: Error Display
4. Error While Running
5. User Acknowledgement
6. EXIT DEMO MODE
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

<table>
<thead>
<tr>
<th>EXPENSE DESCRIPTION</th>
<th>TOTAL COST</th>
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<tr>
<td>Embedded Computer</td>
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<td>Dashboard LCD Display</td>
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<td>Wireless Radios</td>
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<td>Power/Safety Loop Electronics</td>
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<td>Interface Demonstration Microcontrollers</td>
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<td>Miscellaneous Hardware Costs</td>
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Team Schedule Overview

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

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<th>milestones</th>
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<tr>
<td>Name</td>
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<tr>
<td>PDR presentation</td>
<td>2/10/2015</td>
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<tr>
<td>CDR presentation</td>
<td>3/11/2015</td>
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<td>phase one demonstration</td>
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<td>final demonstration</td>
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<td>user manual</td>
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<td>calibration and accuracy</td>
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<td>maintainability plan</td>
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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

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<td>Summary of Approved System Level Test Plan</td>
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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

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<th>End Date</th>
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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?