CDR Presentation
March 9th, 2017
Minutes

System Overview

- 1 accumulator, 4 TSV Packs, each 7 cells, 96V
- Cabling question: are we routing the GLV voltage and safety loop in a 4-pin connector?
    - GLV has a 4-pin
    - Safety loop is now with VSCADA
    - More details later in the presentation
- CanBus Protocol: Sensors and ID Numbers don't have highest priority with lowest ID
    - Ordering doesn't matter as much
    - Period ensures we don't clutter line
    - If something spams bus, pulling the line? Yes
    - Look into extended CAN frames → we don't need that much additional space but we also don't have 2000 sensors which is the limit
    - Each sensor will successfully transmit every second at the moment
    - TSI has the important information and we want that quickly but everyone else we are just observing general trends
        - Quickly jabbering = 1x per second
        - ~100 sensors in all the packs can get out at 13ms
        - 125k bus rate
    - Of 100 sensors, roughly less than 30 temp sensors
        - Which has a low enough mass that you need it to be checked at 1x per second
        - If a component in the cell failed
        - Thermal mass low enough that you want 1/second?
            - It's a requirement for all sensors
- Layout of panels and locations
    - Human factors, analysis, mock-ups
    - None yet but we hope to build them in the dyno room so that if things aren't looking or feeling right, we can change it before building the car panel
- Software Layouts
    - The remote layout is not a screenshot but cell app is

Schedule

- Does this accurately represent effort or amount of work that needs to be done? Has there been any estimations of time it takes for these tasks?
    - This just shows tasks done
    - There's nothing to show time and effort of each subsystem
    - Nadovich: We never asked to figure out how long each would take. We just want to know it how much work they have left / where they are at.
- Nadovich: We can reduce the scope if needed.
- Time is very linear. Obligations of being a student make time not linearly. Has that been accounted before?
    - No
    - Estimated time spent per student per week is approximately 40 hours
- JG left SCADA around week 12 → we think SCADA can get things working
- Could WBS take into consideration the weeks getting to know the materials?
    - No, because WBS only takes account of tangible deliverables
- Was there a way to document efforts to begin learning around systems?
    - PDR was the beginning of Week 4
- When did you break apart into subteams?
    - Got statement of work before end of last semester
    - Teams were decided on by the beginning of this semester
- Why is Physics at 0%? Are there any intermediate steps?
    - We are encouraging it to go faster
- Management
    - If we go at this rate, we will go crazy by week 12
    - If this is how we communicate, there should be an additional view
    - This doesn't capture how teams interact / effect
    - Gant charts could be helpful about time/effort and where everyone is at and what needs to get done for the end goal
    - We need a big picture
    - Gating item = This team needs to tell Cabling how long the wire lengths are
    - This analysis will also help determine what won't be delivered
- Is management worth 5 people?
- If we go to competition week 14, wouldn't we be 5% short
    - Some deliverables are for final deliveries as a class like presentation and poster and video
    - We can cut corners along the ways
- Schedule is linear but what about spring break?
    - Each team can decide whether or not they will take off spring break
    - Each team is told to keep that in mind while working and doing WBS
    - Some teams will be staying over break
- Do you know the percentage that is needed for the running car to work at competition?
    - Depends on competition
    - Most competition rules are requirements

Cost Analysis

- Isn't today HPD?
    - Yes, but we are not going to meet it
    - After spring break we expect an increase in purchasing
    - Teams are behind schedule (i.e. TSI is behind because of forms like ESF (~50-60 pages) and thus could not compete schematic meaning it could not be approved for purchase, thus it was not purchased)

System States

- Off switch for the packs?
    - In the future, yes
    - Goals is just to get the packs to work
    - Why isn't it there already…
    - It should be there next year
- Car will go into neutral while driving, by design
    - Would there be back EMF that would throw you forward
    - Neutral is essentially throttle = 0
    - It's not different than taking foot off accelerator
    - If you take your foot off the pedal, there would be 50A back to the packs that the accumulators can handle
- Are all states maintained centrally?
    - Distributed throughout subsystem
    - What if lose contact with a subsystem?
        - Each system can still do checks and pop safety loop which will put you in the GLV on state automatically
    - There is no time dependencies on the states
- Is there a hardware throttle in the rules?
    - Competition you cannot go into cruise control
    - If on panel, say it is dyno testing button
    - Hard to prove it won't be connected so don't have it on dash
- Have we tried bringing engine up to speed and turning off airs
    - We have at 50A
        - They are rated for it
        - It would kill lifetime of AIRS to go higher
        - We have 1 spare air
    - Have not tried it with the motor because back EMF
- 3-phase AC motor
- Does the motor qualify?
    - Yes, covered motor will pass a sprinkler
    - 2min wash is only if wet conditions on track
- Competition question: AMS compliant with the connector we need?
    - AMS board needs to have cell unplugged and have a raw voltage or potentiometer
    - Different competition have different rules, but this might still be ok
    - We will look into it
- How long will it run?
    - 51 minutes
    - In the past they just do 12 minutes

VSCADA

- "Why do we need VSCADA" slide
- Installing Software
    - What tool chains do you need installed?
        - Just Java8
    - How much code?
        - DBHandler = 300-400 lines and going
        - UI Code will have a lot
        - Server code
        - Expecting 2000-3000 lines of code
    - Working demos? What works and what doesn't work?
        - Prioritized data acq and will do UI later
        - Web server is running
        - SQLite database is working
        - Cell app uses server
        - Working on config handler and maintenance view
            - functionality made
            - interface is being done later
- Control Flow
    - How do the modes relate to neutral and drive from system states diagram
        - Drive mode means VSCADA is ready to drive mode
        - Mode is more of a layout view of the data
    - Checking sensors to be in a range (sanity check) is it from historical data or just static ranges?
        - Set-up params will set stable and advisory and critical levels
        - System will react if data passes the inputted thresholds
    - Physical vs Virtual
        - Press pedal is physical
        - Sending data to safety loop is virtual
    - System Reaction
        - If it drops out, only a single point, will it actually mean we should react?
        - Is it a sudden change or it gradually occured
        - Discussing a timeout of if it isn't resolved by then, take action
        - Can take out of critical level?
            - Yes
        - If we are testing, you can disable error warnings
    - Table matrix is decided by user or unilateral decision?
        - Made by Greg and Nadovich based on norms or competition rules
- Web Server
    - Always running? What is always?
        - Starts when car is powered on
    - Where is this physically?
        - In the GLV box

        - Currently on lafayette server but will be hosted in the car
- Database Structures
    - Calibration Capabilities and how are the calibration factors stored?
        - Currently just slope and offset
    - Time for timestamp
        - SQL generates it on the insert as current system time
        - Current system time is set by the pi
        - Maintains state when turned off, like a normal computer
    - How much can you store? How much time can you collect?
        - Limited by the size of the chip in the pi / SD card
        - 64GB card with each entry 40B
    - Upwards of 100 sensors. Calibration are only offset and slope. Are the sensors are all linear?
        - Making them non-linear is out of scope
        - All sensors send linear data
    - Pi3 does not have any onboard power. Will it connect to internet for time?
        - Yes
        - At competition, what happens if you do not have time?
        - Cell App knows the time
        - Logging data you will reset time and date each time
        - Correlating data you will want to keep it constant
        - You also need to use UTC instead of different time zones
        - There are solutions for this to easily add with a BoB → this might be something GLV needs to look into
    - How will you deal with the difference in time from measuring the value to recording the value?
        - Adding skew
        - Know when measurement happened, not when it was taken to database
        - You ‘t can’t assume monotonicity based on screw
        - Hardware isn’t going at a regular rate
        - Make sure you get even samples so sampling of system doesn’t
        - ASM to PacMAN to CAN → Source of view in there you need to consider
            - A lot of this is on downstream components
            - Look into signal screw and signal process
            - Digital processing requires monotonicity
        - Requirement discussion
            - Does the SD card have bandwidth for KHz of things coming at it
            - No required to sample all sensors at once per second
            - If you can some this at this interval, solve skew, and it will work out for all other cases
        - When driver pulls it off the line, can you stamp it?
            - Puts it into a buffer but only puts it in when pulled
            - You can queue all requests

                - You can also push it further to sensor
                - Assuming latency matters because a couple ms might not matter
            - Do we need that accuracy? Is this necessary given time we have to finish the project?
                - Maybe this is something to consider but something to be fixed next semester
            - CANBus uses arbitration ID so any sensor can be stepped on by any other sensor based on ID
            - Key to stress : Recognize there is clock skew and try to determine it
        - Master Key vs CAN ID
            - Sensor ID is master key and CAN ID
        - Might need more columns in some of these tables. Two's complement or offset binary. Are you sure there are signed consistency. Every sensor is signed but what happens when you find one that isn't and breaks the system
            - It would give you incorrect data, not crash system
        - Criticality
            - Scale can be worked on
            - Scale leading to actions can be determined later
        - Bus arbitration for CAN. Where on the bus do sensors fall? Where does it get on the can bus? Either use extended CAN or break down CAN ID. Class of how important is this sensor as well as ID. Missing priority of sensor. Address at protocol level. If you leave it for next year, your code may not be very useful.
            - AVR chip can do CAN2.0? - Yes it can
        - Errors is a subset of the log table?
            - Might be able to get with query
            - Are these unique rows? No so you can have many errors per sensor
            - Should have a primary key ID
                - Config table should have an ID
            - Have an error ID so you can grab it
            - Autoincrement
- Maintenance View
    - Is this on a web app? Will it crash whenever java updates?
        - Already making a web server so you should just keep going with it
    - Nadovich: Purpose is not just to show it nicely but also a way to maintain the system. You should be able to look at raw data and low level. Supposed to be something better than CAN Dump but not necessarily beautiful view of the system.
        - What was used to demo today is current Maintenance view
        - Keep everything you used to debug because if you needed it other people will probably need it too
    - Average is decimals but max and min aren't → keep consistent
    - How do you get to settings like calibration

    - Developer note: Have your friends use it! The more people who use it, the more feedback you get, the better it is
    - What tech are you using?
        - Java Swing → Why not FX? → Doesn't run on Pi because it's ARM processor
        - Steve can help being a java developer with Swing
        - Not sure about the rest
- Drive View
    - Current is important
    - SoC of batteries are important
    - During competition you have 10 seconds to see if anything is flashing
        - Driver should know when motor is overheating
    - Is display is peripheral vision?
        - In front of you and a bit down
        - Hazard triangle is flashing yellow
    - You might want more than one symbol for different errors
    - Cruise Control
        - There just to show if on or off
        - There is also an LED to show it
        - Cruise Control isn't valid on competition so why even display to driver?
            - This is screen in active cruise control
            - What's the difference between demo and competition?
            - Race official wouldn't want to see it
            - Diagnostic display might be what you want to see especially for dyno
            - Change name of cruise control
    - Is there an audible sound for if they cannot see it?
        - There is not a noise for driver's attention
- Charging View
    - Can you monitor for differential pack discharge? Image shows all at very different levels
        - Not criticizing the screen
        - But if this happens in competition, do you have an error condition for what happens if packs are at different SoC?
            - Issue with structure
            - Should be able to compare pack data
            - Cause this could destroy cells
            - Geoff's algorithm ranks pack cells in order of SoC and find the greatest different and essentially allow the other packs to catch up
- Extra Question
    - Pi 3 is not the most powerful and if you have a web server and display and sensors, you could lag because Pi3 isn't real time
        - Pi has performance issues -> Can overheat and melt itself

        - Heat sink
    - You can use another computer, and maybe even based on software design you don't need to use a Pi and it can be put on other things
    - Another embedded Pi Computer
    - Another class used an industrial $400 item
    - Pi is a toy and doesn't belong in the LFEV
        - If we don't change it, make next year aware
        - It's cheap and powerful but not the best for this purpose

Cell App

- Layout
    - Think of how it will be used
        - Often it will be applied for a review or a visitor
        - Communication during competition between engineers on campus and out with the car
    - Handling push data requests
        - Not implemented yet
        - Sending requests to SCADA
        - Method are being set up
        - Sent through different web server
        - Updating displays when user gives specific time intervals
    - Directly pulling from SCADA web server
        - Can request current or previous info every minute
        - Open ports on the Pi to the web? That seems like a security issue
            - How large is the queue? Can everyone go in and crash the car with a ton of data?
            - Password or private server
            - Make sure not everyone can get to data
        - Push to Lafayette server and then it can take care of itself
            - Adds to complexity and overhead
            - Ensuring server up and running will be expensive or not be able to be done in time left this semester
        - Maybe just have a PIN to get on
        - If we don't have it done now, that just means spectators can't see it
        - Create a mitigation plan for now and then next year make sure they get a jump start on this
            - Set this up so it can easily be changed up so next year they can actually do this
            - Make it so you can move all of the black boxes and just keep putting the code where you need it in the future
        - Maybe just drop SQLite and make an SQL database that you can pick up, move, and send to IP address
            - Can restrict IP address so you know who can get
            - Just point to another IP address
            - Don't point to an IP address for Cell App
        - CAN Bus Jabber
            - In future we hope to poll sense, not jabber
            - If we have a read-only to take data and distribute it, that would add a lot of complexity and it would just be best to just buy a better computer

- Activity Diagram
- Data structures
- Content Diagram

TSI

- System Overview
- High Level Block Diagram
    - If the course is windy, what happens if I'm stuck so going forward will not help me?
        - Rules do not allow us to go in reverse
        - You also can't see behind you when in driver's seat
            - Shouldn't we have mirrors?
                - Only one person on track or officials on track
    - TSMP: what measures that
        - Competition officials measure it with banana jacks
    - Is the fuse on board?
        - Off board
    - Any plan for connector between PCB and deutsch external connectors
        - PLEASE do not use screw terminals
        - Wire to board connectors might work
        - Don't do raw wiring
        - Build one wiring harness from GLV to board so you can just disconnect and pull out your board
        - Don't want it to rattle loose
        - maybe something with a clip
        - Screw terminals will most likely lead to you blowing up your PCB
    - Direct feedback of driver (lights) and screen (through SCADA) and you talk to SCADA so is data duplicated? Who is in charge?
        - Data sent to SCADA does not need to be shown to driver
        - Cockpit lights might not need to be known to SCADA
- System State Diagram
    - UART SCADA to TSI
        - RS232
        - Deutsch 3-pin connector
        - Why not CAN?
            - Didn't want throttle commands to need to wait
        - Why you should use CAN
            - Seems great for CAN application and better physical interface for sending data to microcontroller
            - You wouldn't know if CAN got jammed if you aren't using it
            - Reduces wiring
            - You have the bandwidth
    - Nadovich: Cruise control isn't needed for competition and isn't really truly important at this time
- Throttle Plausibility
    - Plausibility window checks for 10% of expected value. What sets the expected value?

        - It checked diffference between each other, not set
    - Thermal characteristics of potentiometers → if they heat up, resistance changes, do you need to recalibrate?
        - Something to look into
    - Are the pots selected?
        - Yes and rated for automotive application
- Throttle Enable
- Microcontroller
    - Question from TSI to alumni: This microcontroller has a watch dog, so why do we have an external?
        - The external has a brown-out watchdog but essentilly it just handles different cases
    - If this reboots, what happens to the car?
        - Restart to the IDLE state
        - If you were moving, you couldn't touch trottle
        - Do the ports turn things off / fatal state?
        - Can the microcontroller pull the safety loop?
            - No but the IMD and other offboard items can
            - So you can't trip safety loop based off reboot of microcontroller
        - Maybe lock state until the process is stable enough
        - How long from reboot does it take to bring it all back up?
            - It wou;dn't have enough time to drive you off the track
        - Upon reboot, it puts throttle to 0
            - During reboot it grounds the throttle
        - If it resets when it boots back up, select line is in an unknowns state
            - Will look into it
            - Maybe pull-down
        - Driver will see drive light turned off but you can't enable throttle while gas is pushed
    - What goes out to CAN Bus to say what you did?
        - VSCADA gets the state
- High Voltage Inputs
    - Same current sensor as Packs. Doesn't that use up a lot of current like 100s of mA. In the packs, if the airs are not closed, they don't use the current sensors. Current sensors are being powered by GLV.
        - Will look into putting an enable on the current sensor
    - Concerned about lower current output?
        - More concerned about higher states when more can go wrong
    - Is this just for logging?
        - Just passing data to SCADA
    - If oversaturate, you'll get hysteresis so be careful if you try to look at lower current later

- Throttle/Voltage Isolation
    - PacMAN does it with I2C isolator and I2C ADC. Why are we doing it with an optoiso here? Voltage divider can split you 1000V to 1V pretty accurately. GLV is also doing it, so why are you doing optoisoamps?
        - Throttle must be 100% analog
        - Nadovich says that this works
- High Voltage Present Light
    - Is there an isolation barrier?
        - Yes, the vertical line isn't drawn and the 24V is GLV
        - Nadovich: Wait, that doesn't work if GLV is off
        - Replace it with a DC/DC Converter
    - Doesn't the circuit do a couple of Amps?
    - It seems like there are several DC/DC converters on here. Why so many? What are the current requirements?
        - They made estimates early on but will be redesigning
    - Are you just trying to make an LED light up if over 30V? Have an oscillator, transformer, and a diode and this can work fine.
    - One of the lights is on the cockpit and needs to be isolated
    - KiCAD on repo needs to be updated
- Inventor Drawings
    - Estimates for power dissipation?
        - Approximately 1W per bar
        - We will be adding airflow into box design
        - Have you considered conducting it into the case?
            - No because isolation
        - Airflow would be passive and just let air in as the car moves
    - Will this be used in the test-rig?
        - We would take the panel out for testing and maybe mount it in a rack
        - Label on the box so no one runs it too hot
    - Keep in mind that it might rain at some point
        - Looking into covers and making sure if water comes in it won't stay
    - Barrier down the middle is in what material?
        - Not sure yet
        - Mock-up is acrylic
        - Has to be non-conductive material
- Extra Questions
    - Need CANBus isolation
        - Same one as dyno room

GLV

- SubSystems
    - Where are you getting 24V?
        - Battery which will be discussed later
- GLV Power
    - Current draw estimate came from where?
        - Asked all the subsystems, compiled, and overestimated
    - Timing based off of 100% depth of discharge?
        - Yes but battery management should protect it so it doesn't become a disposable battery
        - Also the Packs don't run anywhere near 3 hours
    - Where did you buy the battery from?
        - Powerstream http://www.powerstream.com/LLLF-24v-10ah.htm
- Safety Loop
- VUI
- Panels
- VCI
    - What's coming in through I2C and UART?
        - Huff Box
        - VSCADA can set load in dynoI2C and UART
- Safety Loop Monitoring
- High Level System Design
- Physical Layout
    - Do you have power estimations for how much heat?
        - They will cut a hole and add a fan if too hot
        - Can't measure heat since no BoB yet, but will do measurement
- Box Design
    - Do not use screw terminals
        - use wire to board connector that accepts 18 Gauge cable
        - Get something with a clip, not just floating around
        - They also shouldn't be able to rattle loose
    - Nadovich: Spin it like this tomorrow and then when we respin it you can add something else → maybe add
    - 10A Circuit Breaker but does it have sufficient I2T value
        - Essentially plan is to double up on circuit breakers of 15A and 8A
        - Should other subsystems have cascading turn-on or 15A that will end badly?
        - Battery connecting directly to something is worrisome
            - They will consider other options
    - Purple lines on schematic should only be connected to Pi
    - BMS is probably there for protecting the battery, so be cautious of thinking it will protect your circuit / whatever you hook up

- BoB
    - Layout Comments
        - Definitely send it to get spun → so early you can always respin
        - Large Trace to Small Traces → Hard to follow current path, seems like dead ends
            - Look into if you need them
            - Could branch a large trace to a small trace
            - If U4 is the current sensors, your big trace won't be helpful
            - Tapper aggressive → it won't be pretty but smoother transition
            - If the component doesn't need the size of the trace, your trace might just be unnecessarily too big
            - If your small trace heats up, the big trace helps dissipate it
            - Trace ¾ of the size of SL1 and then short traces come from resistor to ADC
        - Bottom Area you can reduce the number of VIAs
            - Tried to have one metal vertical and one horizontal (VLSI rules)
            - Reducing vias make it more simple
        - Tear stuff down, reroute it, reduce VIAs
        - Maybe just make a note for it for next year

Cooling

- Main Goal & Objective
- Overall Electrical Connections
    - Why ardunio uno instead of BoB?
        - It is more familiar for them
        - Nadovich: There is no use of JGB anymore
    - Is this just for the dyno demos?
        - No, this will be in the car
- Water Cooling Layout
    - Anything special or just water?
        - Coolant
        - Same vendor as the pump
    - Do you know how much heat you need to account for?
        - Motor seems to be 20-25% heat
    - Do you know how many L/min compared to the old?
        - Better than the old one
- Compatibility and Independence
    - Are calibration and set points derived from VSCADA?
        - They are just sending data to VSCADA
        - This is configured independently
- Automatic Speed Control with Manual Override
    - CAL travels with it and not independently
- CAN Bus Interface
    - To clarify
        - MCP2551 on that shield is the can controller
        - MCP2515 is the can transciever
    - How often does cooling system but data on CAN?
        - Once per second
- Safety Loop
- Other Questions
    - What is the physical hardware? What is the connections? Schematic?
        - All electrical parts will be in the box
        - The box will have holds for all connections
    - What is the plan for connecting it all? Make a schematic of the electric connections
    - You have 4 temp sensors so which “high temp” trips sensor?
        - Each sensor measures the temperature of something different
        - Fluid temp will trip loop
        - Motor controller temp should be controlling it no?
        - If there isn’t flow when there should be, a warning should be sent
    - Have we taken into account that if you try to take data on the same CAN bus as the motor controller, it fails. You may need multiple CAN buses.

        - CANBus we have only demonstrated just packs → we will see what happens when Motor Controller is added to test
        - Custom compiled computer was fine, but other computers crashed at the kernel level
    - Have you bought the reservior, pump, etc?
        - Yes all bought but not assembled
        - Keep in mind that the air will create issues so keep bubbles out
    - Where are the 2 temp sensors not in cooling layout?
        - Flow meter + External
        - Total of 3 temp sensors and 1 flow meter
    - Work on a mechanical layout
    - Team is highest on schedule metrics but Nadovich thinks there is more work

System Test Plan

- Overview
- Accumulator Integration
    - Pass / Fail Criteria:
        - Normal current draw
        - Throttle acts as expected
        - Thresholds needed to be passed
- Accumulator Charging
    - Components of Accumulator Integration are not connected
        - This image only shows what is essential for showing the accumulator works
        - Throttle will be taken by the MechEs at some point
        - We should test what the packs do when someone sits down in the car and presses the throttle
    - Strategy for passing ATP is to make sure that one team doesn't kill it all
        - Still need to test invalid error states
            - What happens when throttle while charging
        - Not just does it work, but does it break properly?
    - This can be a pack QA test, not a system test
    - Rules prohibit charging packs while in the car
- CAN Bus Link
    - Assume that all tests for individual parts are passed prior to integration tests
- Safety Loop
- Cruise Control
- 24h Endurance Test
    - Includes doing ATP, just not running motor just leave the system on
    - GLV battery only lasts 3 hours,
        - We can use a 24V power supply
        - Battery load will be a QA test
- Shutdown
    - Raspberry Pi is notorious for corrupting SD Card when shut down unexpectingly
        - Can put USB in Pi
        - Can put database on USB running in parallel
        - USB has to pass 40G test? Is it just the packs or the whole car
- Overall Testing
    - fIn general, test low level and then keep going to test integration (more boxes to check means better grade?)
    - If a subsystem fails a part, it will be a case-by-case basis of if they can participate in the integration testing, just not using the failed components (if possible)
        - I.e. If TSI doesn't have a IMD working, that part is a failed but they can keep testing just taking different precautions
    - VSCADA testing
        - Stress testing?

- Web server ran on a Pi will probably crash repeatedly when a packet gets corrupted going into the Pi

General Questions / Notes

- Where does GLV Battery live?
    - Just behind the driver
- Any other structural testing?
- Add Ferrite beads to GLV Power lines