Midway Design Review

S.H.A.R.C.
Simulated Hand and Arm Remote Control

Team 6
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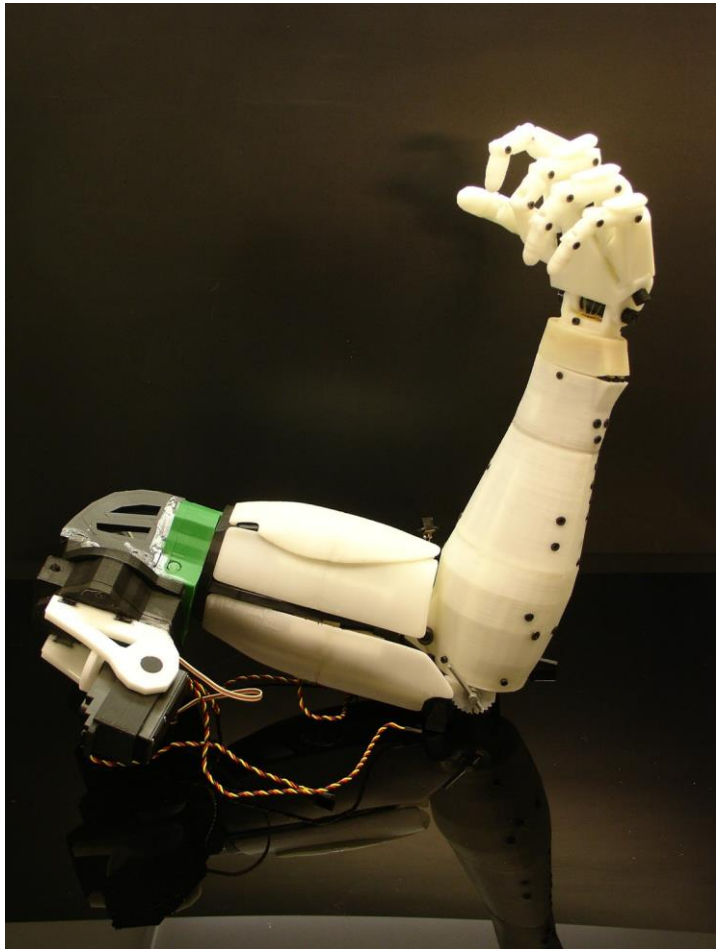
Project Description

- Our SDP team is going to design and build a system that controls a robotic arm wirelessly using wearable sensors.
- The robot arm is an open-source 3D printed design in order to focus our efforts on designing and building the controller

The Arm

- InMoov Robot Project
  - Open source
  - Directions on how to assemble the arm are provided
  - All parts and 3D models are given
  - Currently Built: Forearm, Wrist, Hand
  - Next: Bicep, Shoulder



Overall Requirements - Specifications

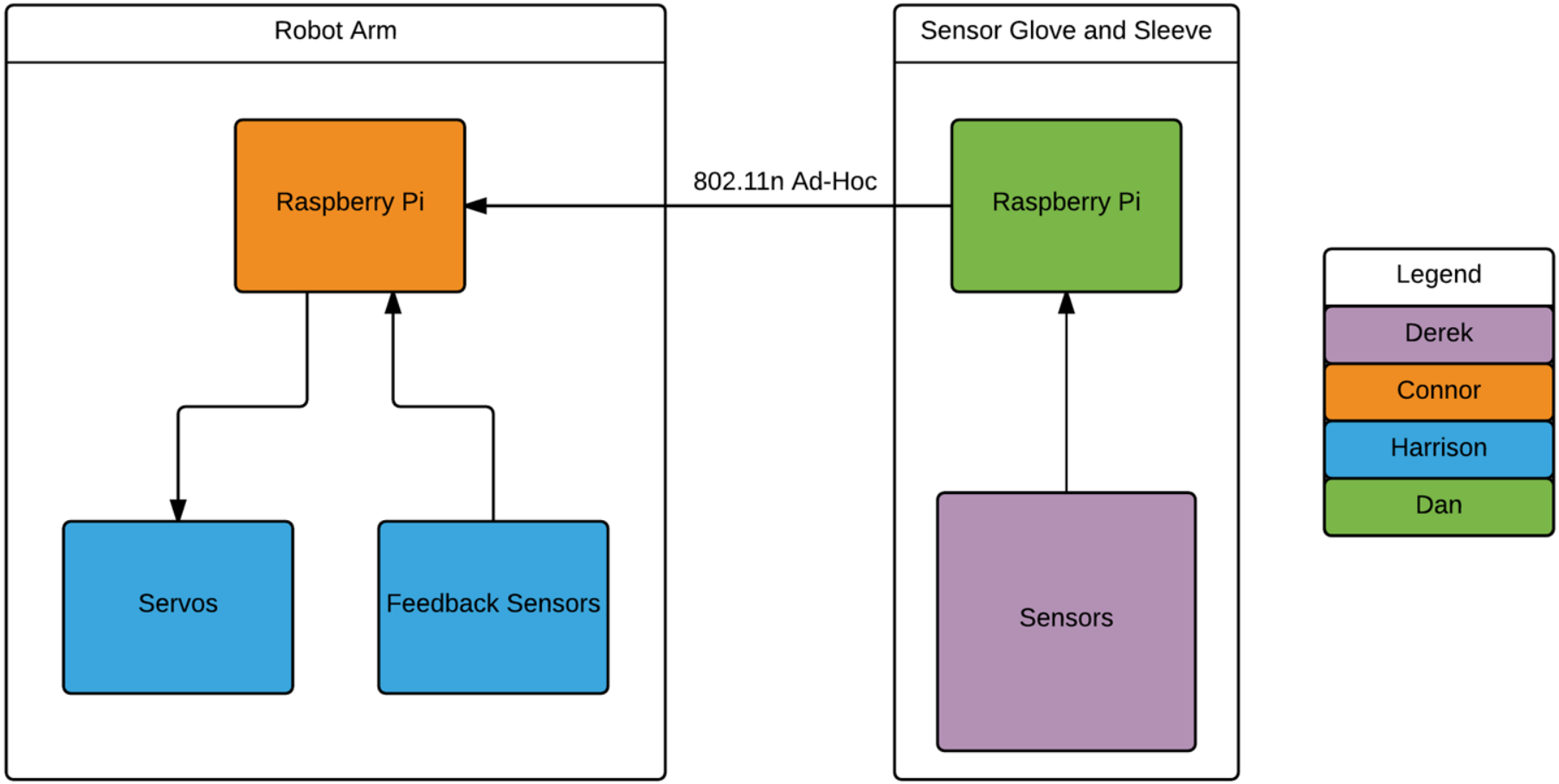
- 5 Degree of Freedom Arm movement
- Individual finger control
- Wireless communication between sensor glove and robot arm
- Maximum latency of 500ms
- Sensor glove/sleeve can be used by multiple users
- Compatibility with Portable Power Supply

MDR Deliverables (from PDR)

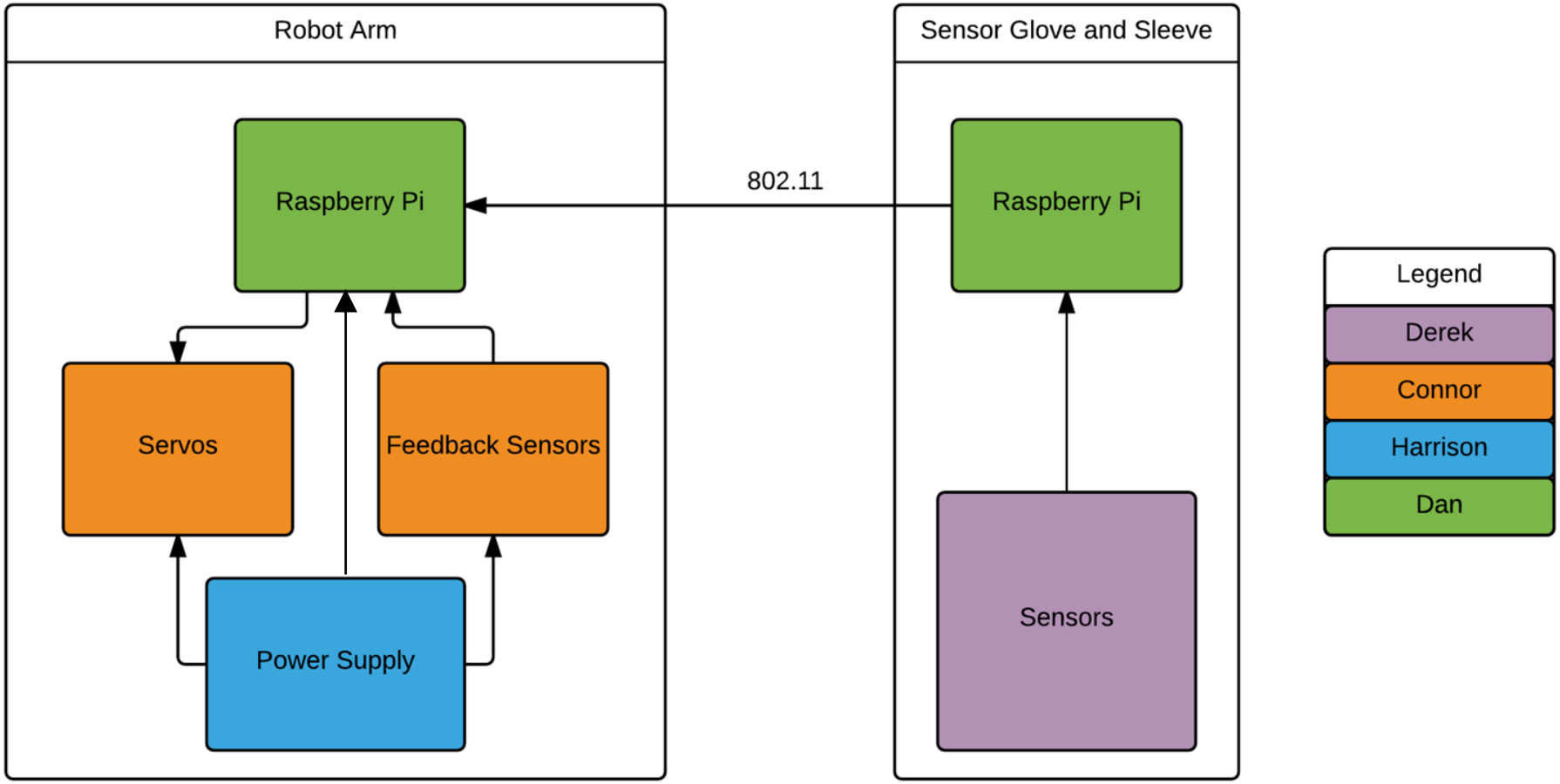
- "Functioning ad-hoc Wi-Fi communication between Raspberry Pi's (Dan)
- Sensor glove complete and sending signals to Raspberry Pi (Derek)
- Raspberry Pi on robot arm sending control signals to finger servos (Connor)
- Servo power supply for fingers and assembly servo calibration (Harrison)

- 3D printed and assembled robot hand/arm (All)"

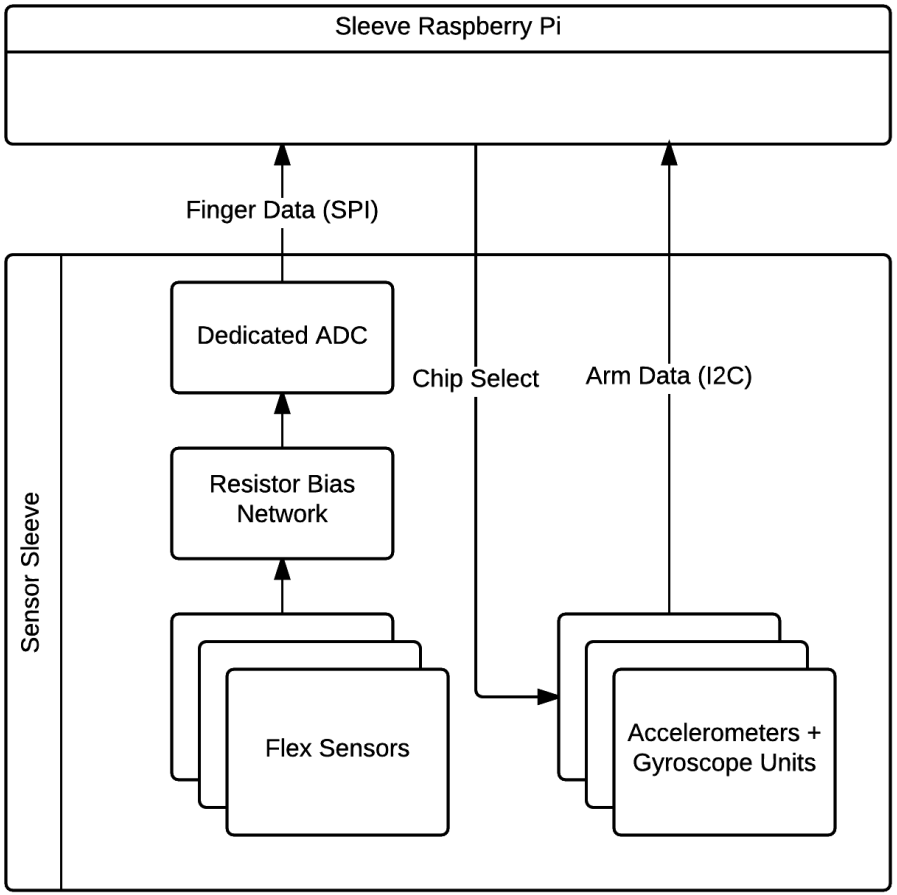
High Level Block Diagram (from PDR)



High Level Block Diagram (updated for MDR)



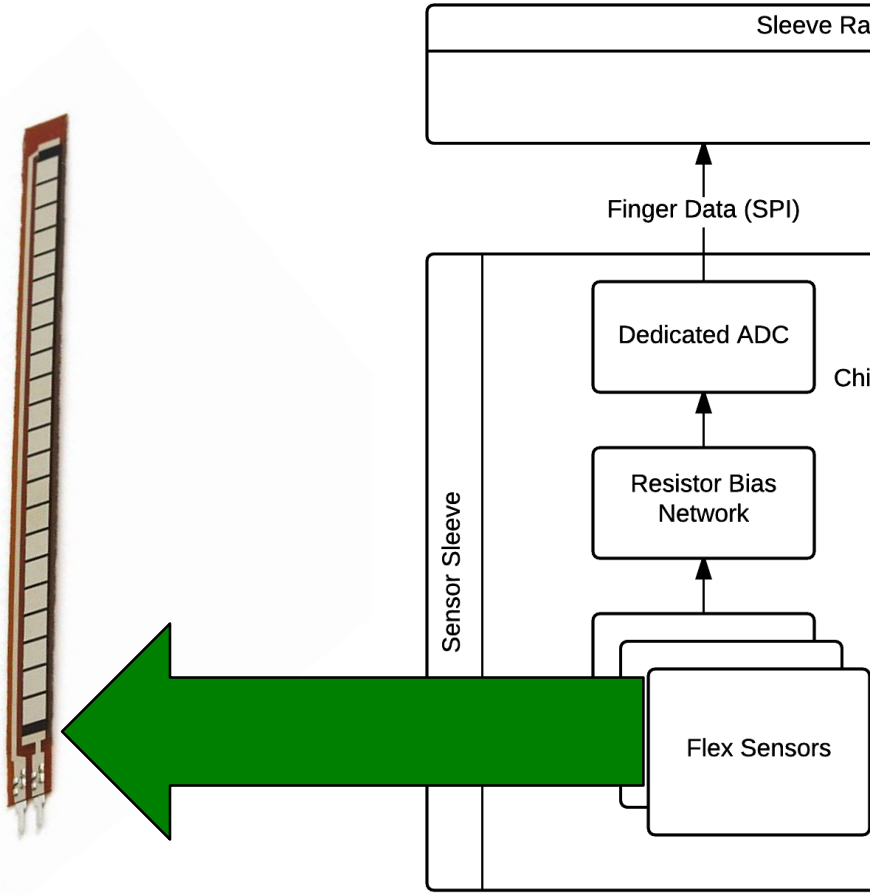
Glove, Sleeve, Sensors - Derek



- Proposed at PDR
- Fully implemented finger data path
- MCP3008 – 10 Bit ADC

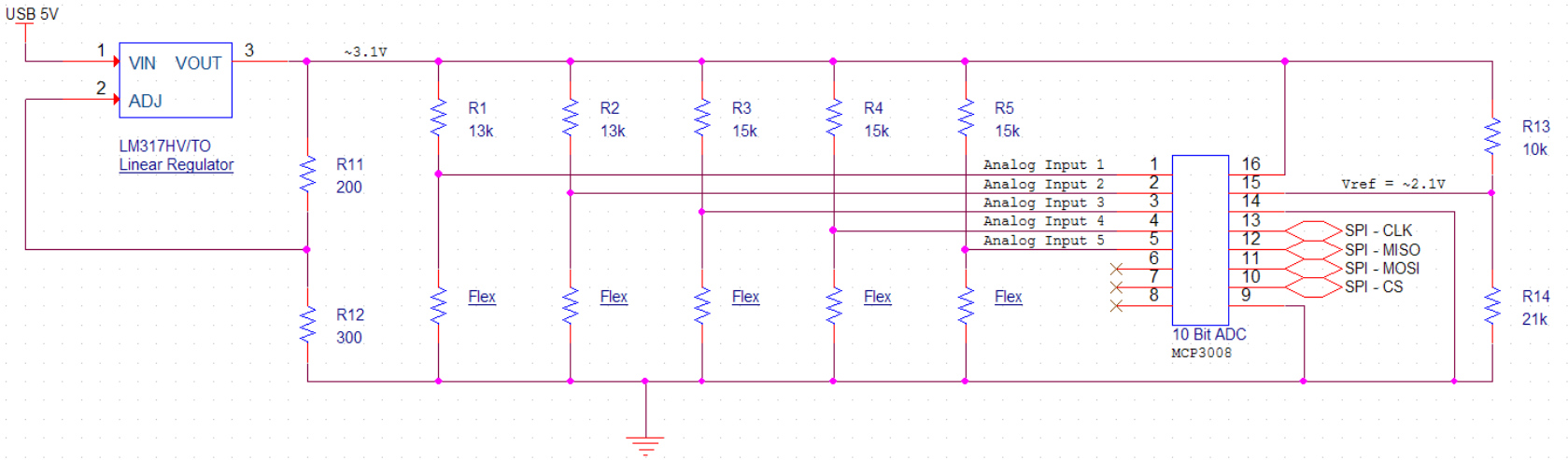
Glove: Sensors - Derek

- Flex sensor
  - Variable resistance based of bend of strip
- Voltage divider with flex sensor to measure finger movement
- Bias resistor values chose to maximize voltage swing



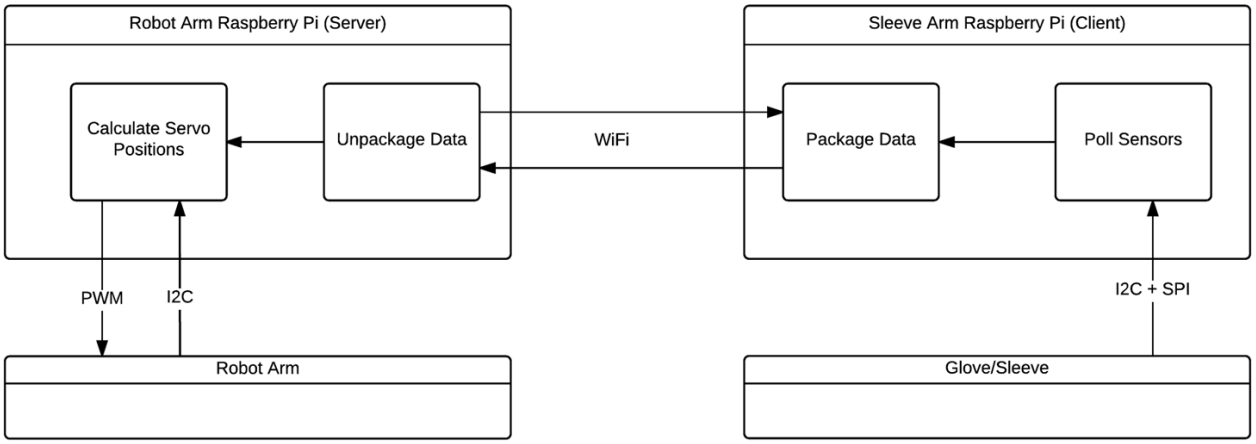
Glove: Circuit Schematic - Derek

- Power – Finger signals
  - ADC inputs sample resistive dividers
  - Powered via USB 5V shared with RPI
- Average power consumption: 3.5W(RPI) + ~23mW(ADC network) = 3.523W

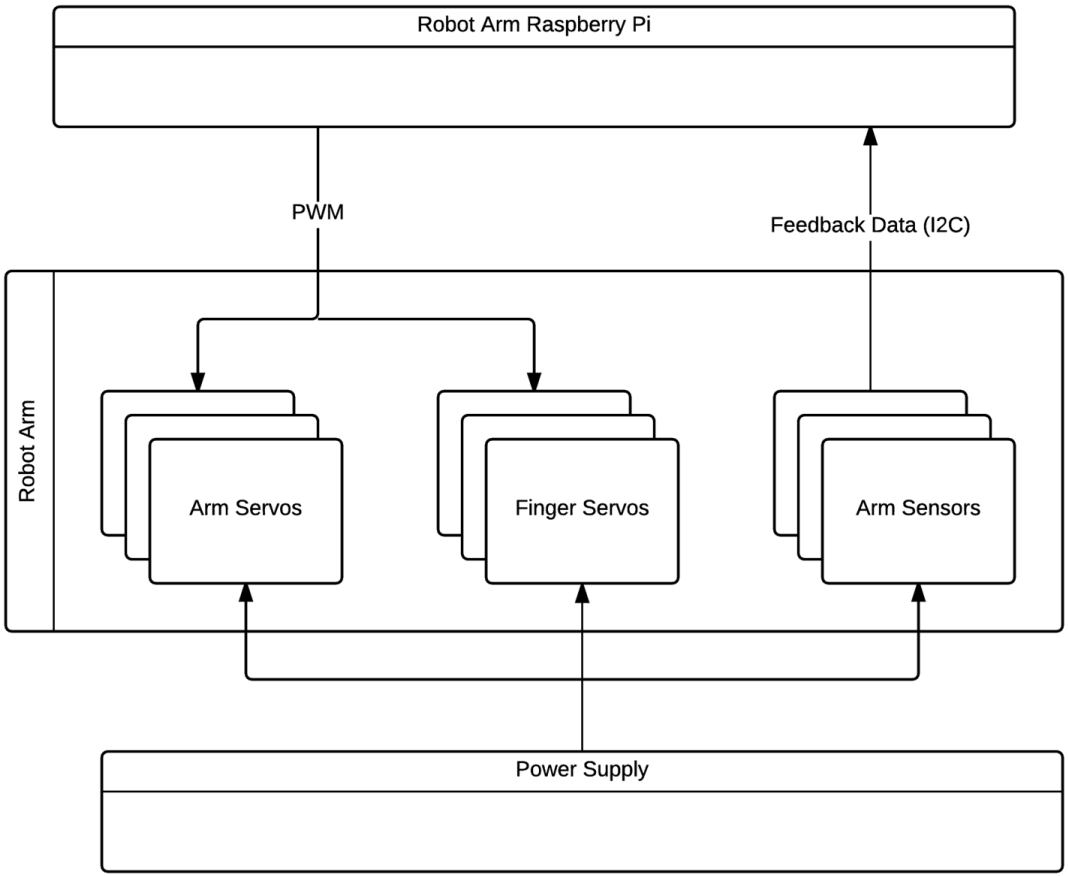


Glove RPi, Robot RPi - Dan

- Requirement: Low latency wireless communication between RPi's
- Network delay is between 3-5ms
- Robot Arm Pi acts as server that receives data from the Sleeve Pi (the client)



Robot Arm Assembly, Sensors - Connor



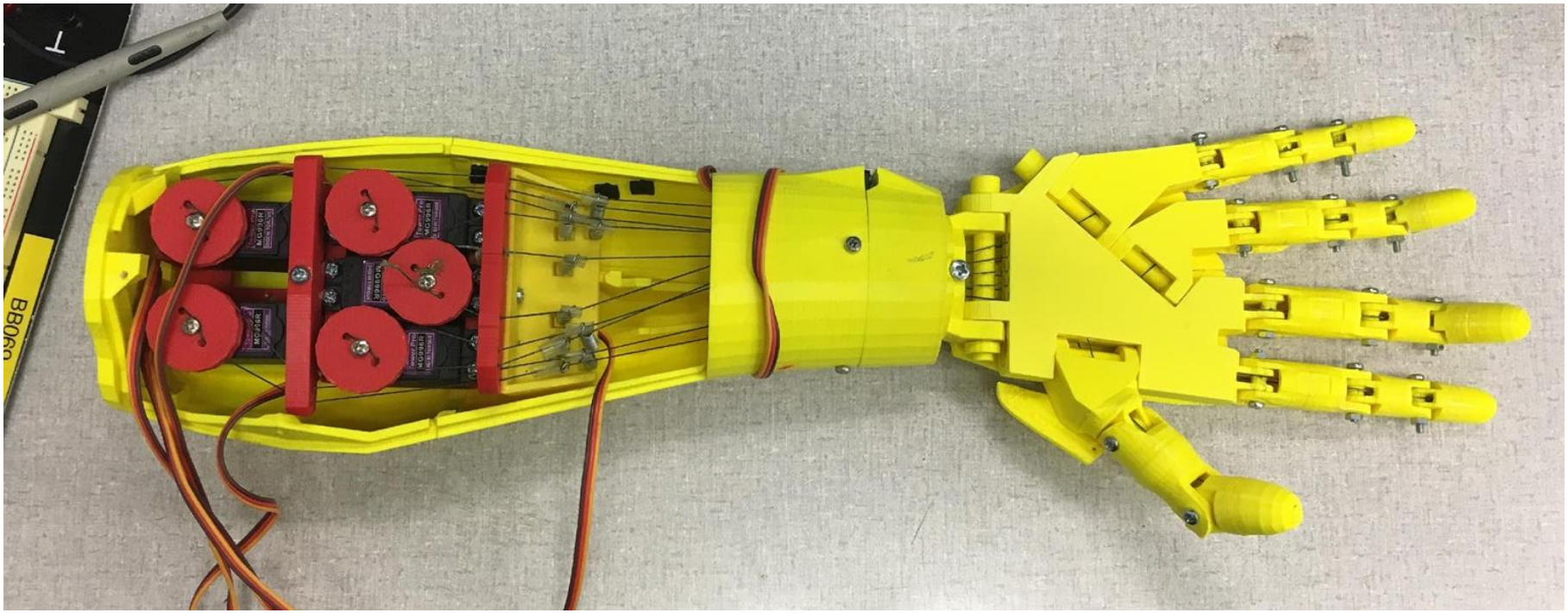
Proposed at PDR

Assembled Hand/Forearm w/Servos and Finger Actuation

3D Printed w/uPrintSE Plus (in M5)

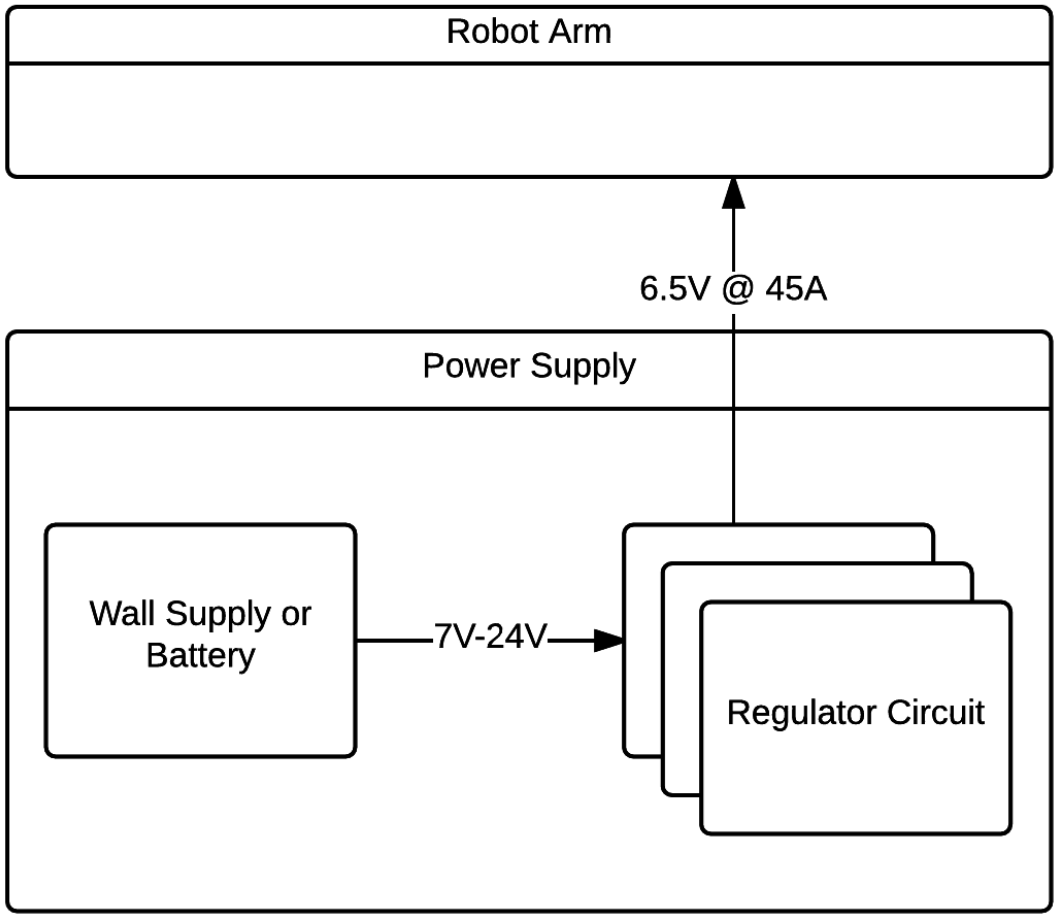
- Material: ABSPlus
- Acetone Fusing

Robot Arm: Assembled Hand, Forearm, Wrist



- Fully Assembled Forearm/Wrist/Hand
- x6 MG996r servos installed; actuation on all five fingers (grasping), actuation on wrist (rotation)
- Extension Springs -> Precise Tension

Power Supply - Harrison



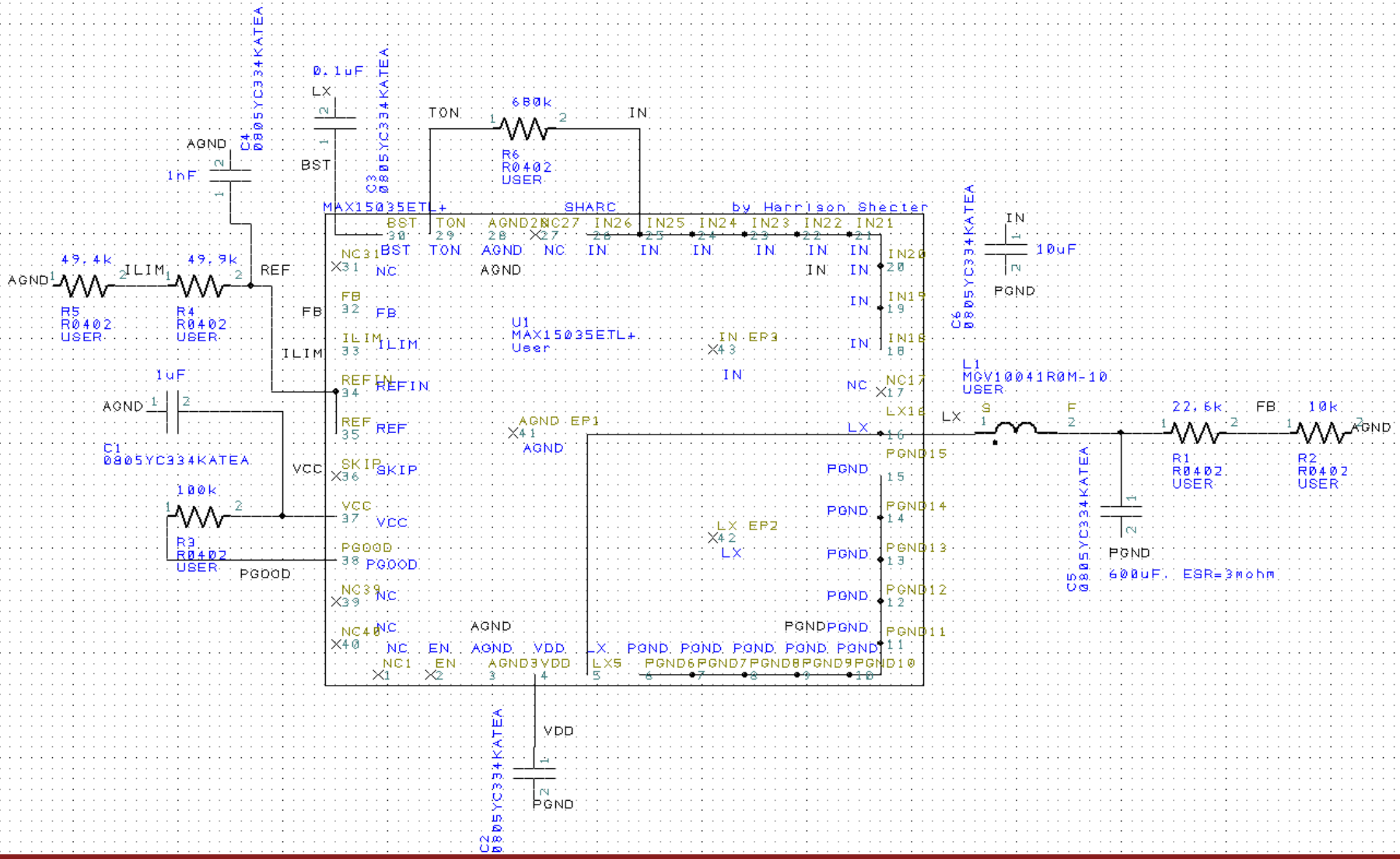
Not Proposed for PDR
-> New Addition

Sample Regulators
MAX15035ETL +
Adjustable Voltage, 15A Current

Custom Designed PCB with x3 to x4 Regulators On-Board

Compatible w/Varied Inputs:
High Power Transformers,
Portable High Voltage Batteries.

Power Supply: Regulator Schematic - Harrison



CDR Deliverables

Derek	· Fully Operational Accel/Gyro Sensor Sleeve Network · I2C Communication to RPI · USB 5V → 3.3V Regulator → Accel/Gyro Units
Dan	· Motion Capture Mode + Replay · Reading Data from Accel/Gyro Sensors · Mapping Accel/Gyro Data to % Duty Cycle Transform Chart
Connor	· Fully Assembled Bicep/Shoulder (Entire Thing) · w/Elbow Actuation x1 D.o.F. · w/Shoulder Actuation x3 D.o.F. · Creation of % Duty Cycle Transformation Chart
Harrison	· Assembled & Tested Regulator PCB's · Input Voltages; 7V-24V → Output Voltage: 6.5V · Proper Thermal Ventilation (Up to 45A)
All	· Determination of need of feedback sensors on robot arm or not, and how we would implement that.

Challenges Going Forward

- Modifying the HS808BB Servos (Connor)
  - 3D Printed Parts: Assembly w/Acetone Fusing
  - Torque Values: HS808BB; Reasonable Safety
- Power Components: Output Cap w/Low ESR, and High Voltage Rated Caps (Harrisons)
  - PCB Design: Heatsinking & RF Shielding
  - PCB Assembly: QFN Soldering
- Increasing ADC resolution (Derek)
  - ADC Measure Range 0-2.1V
  - Voltage Divider Limits Approx. 1.1-2.1V
- Improved Finger Movement Model (Dan)
  - Look Up Table In Place of Linear Mapping

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