

Smart Harness

Group #15 Members

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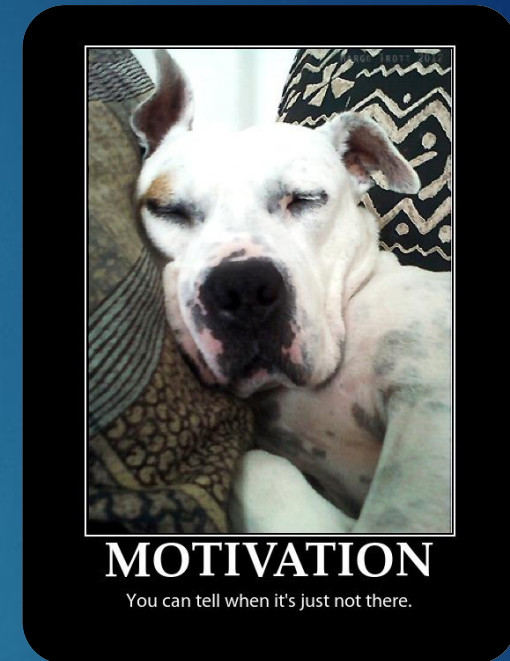
Project Description

- ❖ Harness that is designed for dogs
- ❖ The harness will be mounted with an electronic device
- ❖ Device will measure health information from the dog
- ❖ Harness will be connected with a mobile device using a bluetooth connection
- ❖ The mobile application will store information about the dog's health as well as show real time vital information



Project Motivation

- ❖ To enable owners to have real-time health information about their dog
- ❖ To tackle the lack of available smart technologies for dogs
- ❖ To enable owners to store pet information and access it easily
- ❖ Because dogs are awesome!!



Project Goals

- ❖ To obtain the heart rate and temperature of a dog and display that information on a mobile device
- ❖ Assist the owner in maintaining the health of their pet by incorporating an activity tracker (Pedometer)
- ❖ To allow the owner to store any information relevant to their pet such as weight, immunizations, etc.
- ❖ Alert the owner of possible health issues (such as dangerously high heart rate or a fever)
- ❖ The harness needs to be comfortable, lightweight, durable, and safe for all dogs



You gotta start somewhere

GOALS

Why a harness and not a collar?

- ❖ Comfort - it does not choke or injure the dog's throat
- ❖ Surface Area - more space to place the PCB and any peripherals
- ❖ Durability - harness fabric will help protect some components
- ❖ Safety – wiring will be easier to protect from damage and also deter the dog from damaging any of the components
- ❖ Aesthetics - circuit/sensor placement and wiring will be easier to conceal for a more attractive look



Veterinarian Consultation



- ❖ Ideal location for external sensors
- ❖ Canine temperature can vary wildly
- ❖ Typical fever for a dog begins at 103.5 °F
- ❖ Normal resting heart rate range for dogs:
 - Puppies - 160 to 220 bpm
 - Large Adult - 60 to 100 bpm
 - Small Adult - 100 to 140+ bpm
- ❖ Could be used in veterinarian offices
- ❖ Healthy dogs should be walked a minimum of 30 min. a day

Project Specifications

- ❖ Low Cost: Under \$300.00
- ❖ Small Size: PCB dimensions 3" x 3" or less
- ❖ User Friendly: Application displays info with minimal input
- ❖ Quick Response: Information displayed in 25s (heart rate)
- ❖ Water resistant
- ❖ Durable: Design can last for 3+ years

Harness Examples



Circuit Enclosure Examples

- ❖ Waterproof by design
- ❖ Durable
- ❖ Low Cost - \$2 - \$10 at Mouser Electronics website
- ❖ Small in size
- ❖ Very light weight (weight is in ounces)
- ❖ Waiting on PCB board for exact sizing



Overall Design Flowchart



Puppers

Temperature Sensor

Heart Rate Sensor

Step Counter (Accelerometer)

Wireless Communication Module (Bluetooth)

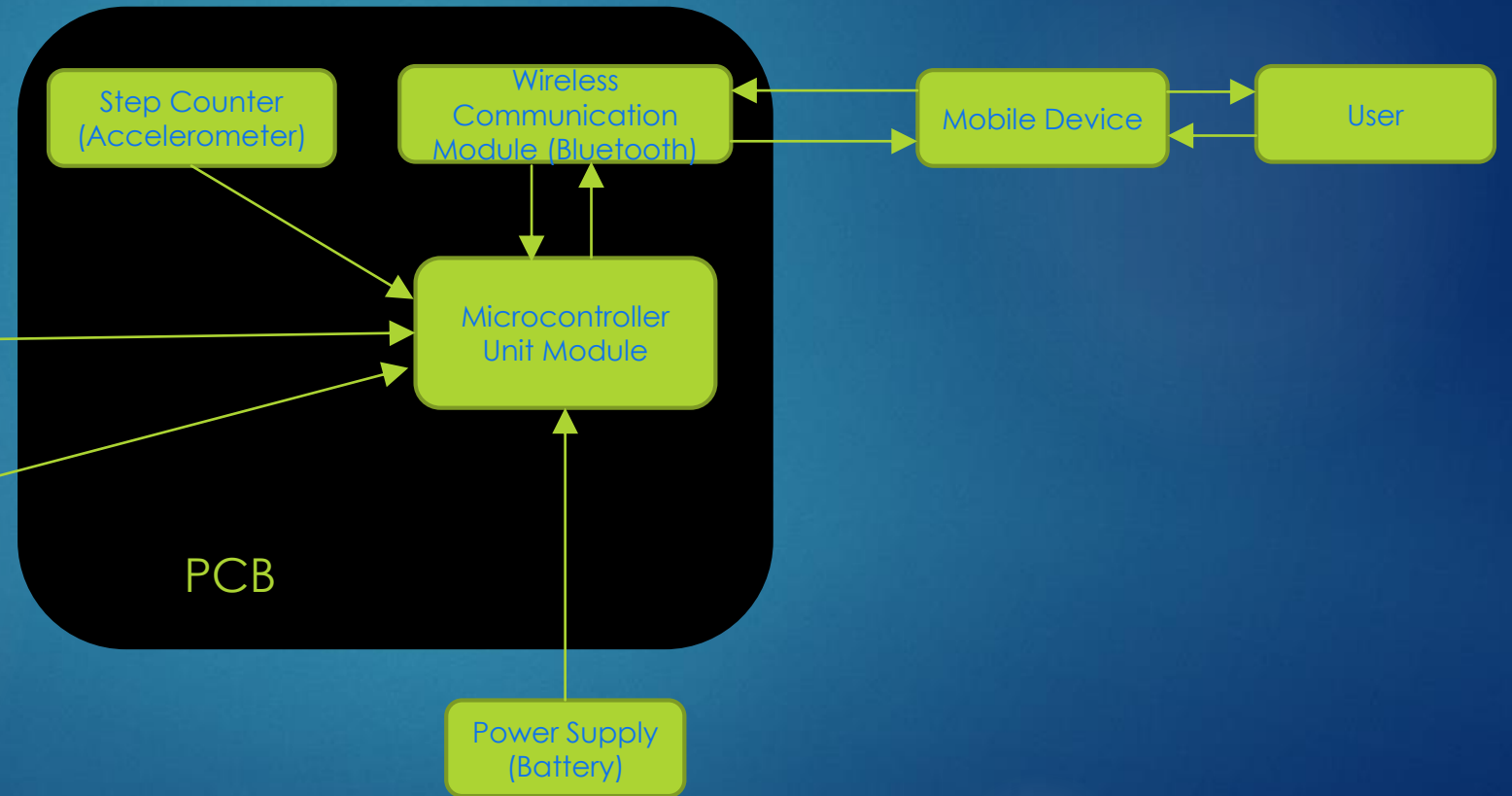
Microcontroller Unit Module

PCB

Power Supply (Battery)

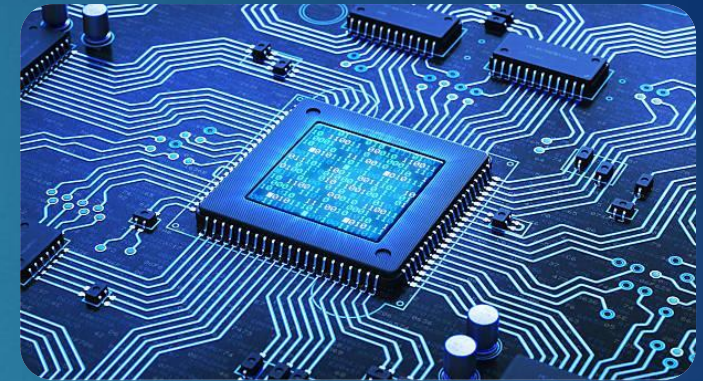
Mobile Device

User



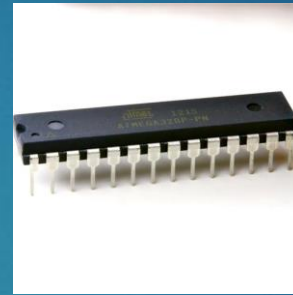
Hardware Components

- ❖ Microcontroller – Atmel ATmega328P
- ❖ Accelerometer – Adafruit 3-Axis MMA8451
- ❖ Bluetooth - SH-HC-08 (CC2541)
- ❖ Heart Rate Sensor – SEN 11574 (APDS 9008)
- ❖ Temperature Sensor – DS18B20
- ❖ Battery - 9V Alkaline



Microcontroller – Atmel ATmega328P

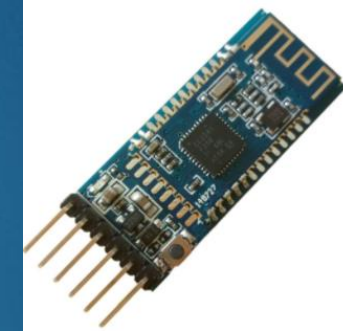
	<u>Arduino Uno</u>	<u>MSP430 Launchpad</u>	<u>Adafruit Trinket</u>	<u>PICAXE 08M2</u>
Chip	ATmega328P	MSP430G2553	Atmel ATiny85	PICAXE 08M2
Cost	\$24.95	\$9.99	\$6.95	\$2.95
Removable Chip	Yes	Yes	No	N/A
Testing Board Included	Yes	Yes	Yes	No
Onboard Clock	Yes	Yes	Yes	Yes
Clock Speed	16 MHz	16 MHz	8MHz - 16 MHz	32 MHz
Memory	32 KB	16 KB	8 KB	2 KB
Voltage	1.8V - 5.5V	1.8V - 3.6V	3V or 5V	4.5V - 5V
Number of Pins	23	24	5	6



- ❖ Voltage – 2.5 V, 3.3 V, 5 V
- ❖ Memory – 32 KB Flash
- ❖ Arduino compatible
- ❖ UART communication capable
- ❖ Cost – Development board \$24.95 / MCU \$1.95
- ❖ Acquisition – Arduino website/Arrow electronics

Bluetooth Module – SH-HC-08

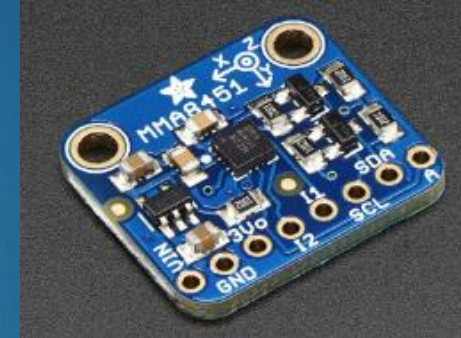
	nRF8001	BGM 113	nRF51822	SH-HC-08
Voltage input	3V – 5V	1.85V – 3.8V	1.8V – 3.6V	3.3V - 5V
Current TX+RX	100mA	16.9mA	17.7mA	9mA
Temp. operation	unknown	-40°C to +85°C	-25°C to +75°C	40°C to +85°C
Dimension	29mm x 28mm	15.73mm x 9.15mm	21mm x 18.5mm	26.7mm x 13mm x 2mm
Distance	10m	10m	10m	10m
Flash memory	Unknown	256kB	128kB	Unknown



- ❖ UART wireless communication module
- ❖ Bluetooth Version 4.0
- ❖ Range – 10 meters
- ❖ Voltage – 3.3 V to 5.5 V
- ❖ Low current draw, only 9 mA
- ❖ Arduino compatible
- ❖ Cost – \$ 7.99
- ❖ Acquisition – Amazon

Accelerometer – Adafruit 3-Axis MMA8451

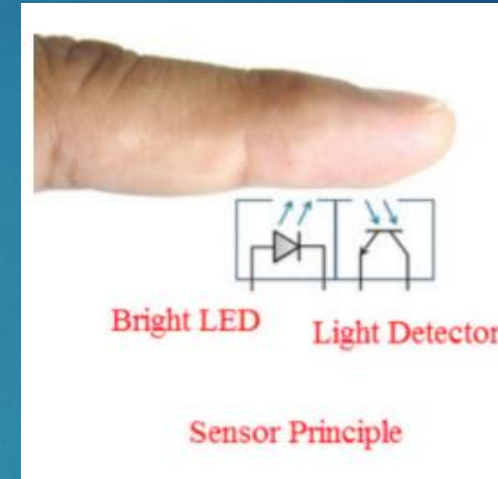
	<u>Adafruit MMA8451</u>	<u>GY-27</u>	<u>FLORA LSM303</u>	<u>ADXL345-BB</u>
Size	3mm x 3mm (small)	3.2 cm x 1.5 cm (large)	14 mm diameter (small)	25mm x 25mm (moderate)
Cost	\$7.95	\$5.82	\$14.95	\$5.01
Precision	14-bit (High)	Unknown (datasheet unavailable)	16-bit (Very High)	13-bit (Moderate)
Supply Voltage	1.95 V - 3.6V	3 V - 5 V	2.16 V - 3.6 V	2.0 V - 3.6 V



- ❖ Detects motion, tilt, and basic orientation
- ❖ Voltage – 3V
- ❖ Current Consumption - 6 μ A to 165 μ A
- ❖ Arduino compatible
- ❖ Cost – \$ 7.95
- ❖ Acquisition – Adafruit website

Heartbeat Sensor - SEN 11574

	MAX 30102	SI 1143	SEN 11574
Voltage input	1.8V – 5.0V	1.8V – 3.6V	3V-5V
Current input	0.7 μ A	9 μ A	4mA
Dimension	5.6mm x 3.3mm	32mm x 22mm	16mm x 3mm
Cable	No	No	yes
Temp. operation	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Price	\$10	\$20	\$5

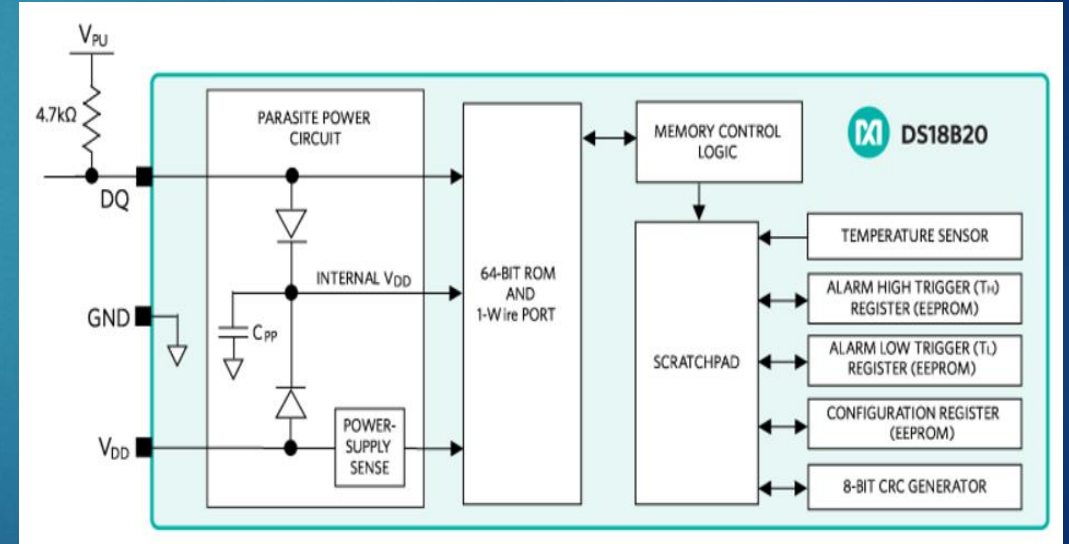
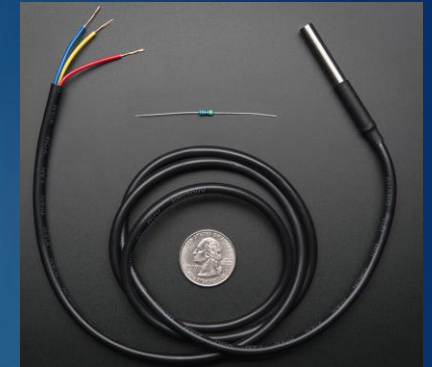


- ❖ Heart Rate Sensor - SEN 11574 (APDS 9008)
- ❖ long cable.
- ❖ Cost \$5
- ❖ Acquisition - Amazon
- ❖ Current Consumption - 4mA

Temperature Sensor - DS18B20

	DS18B20	MCP9700	MCP9808
Price	\$ 9.95	\$ 4.95	\$ 4.95
Usable temperature	-55°C to 125°C	-40°C to 125°C	-40°C to 125°C
Accuracy	±5°C	±2°C	±0.25°C
Cable	Yes	No	No
Voltage	3.3 – 5.5 V	2.3 – 5.5 V	2.7 – 5.5 V
Current	9 μA	6 μA	200 μA
Water Proof	yes	No	No
Size	Long cable	20mm x 0.8mm	21mm x 13mm

- ❖ Temperature Sensor
- ❖ Current Consumption - 9uA
- ❖ Water resistant
- ❖ Long Cable.
- ❖ Acquisition - Amazon
- ❖ Cost \$9.95



Power System (Theory)



- ❖ Supply Power with 9V Alkaline (550mAh)
 - ATmeage328p
 - DS18B20 (Temperature sensor)
 - SEN11574 (Heartbeat sensor)
 - SH-HC-08 (Bluetooth)
 - MMA8451 (Accelerometer)
- ❖ Amp consumption table.

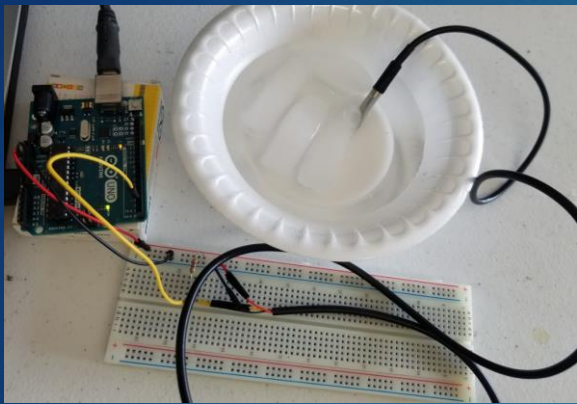
Amp Consumption Table (Active only)	
ATmeage328p (8Mhz)	11.68mA
DS18B20 (temperature sensor)	1.5mA
SEN11574 (Heartbeat sensor) (APDS9008)	4mA
SH-HC-08 (Bluetooth) (CC2541)	8.5mA
MMA8451 (accelerometer)	0.165mA
Heat, Resistor, Capacitor, Diode, etc.	10mA
Total	35.845mA

- ❖ Formula for Current drain.

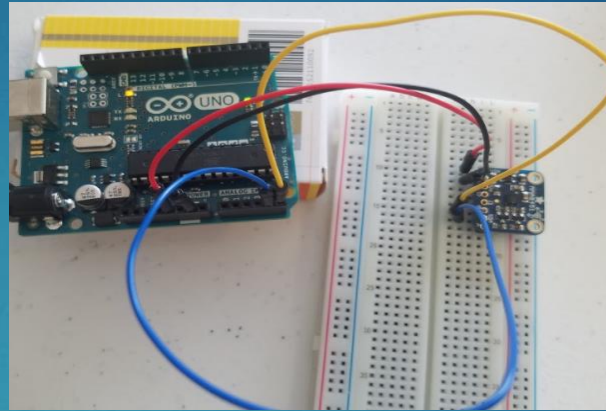
$$hour = \frac{total\ capacity\ (mAh)}{Actual\ current\ consumption(mA)}$$

- ❖ $550mAh/35.845mA = 15.34h$

Prototype & Testing



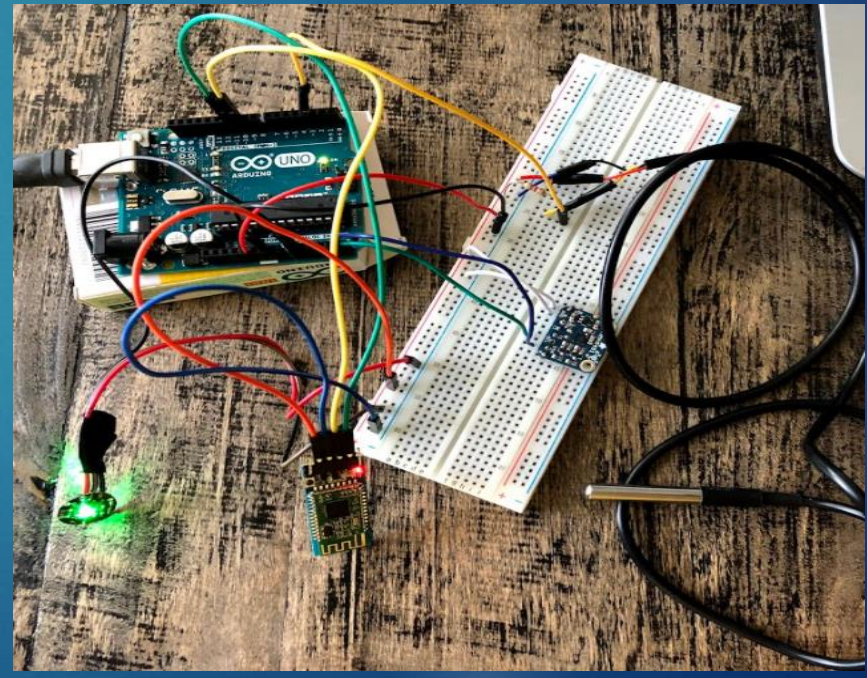
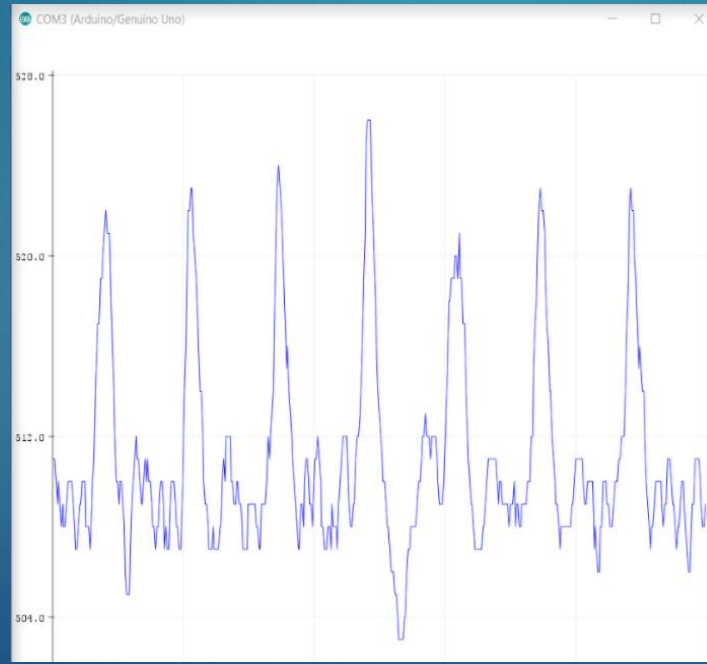
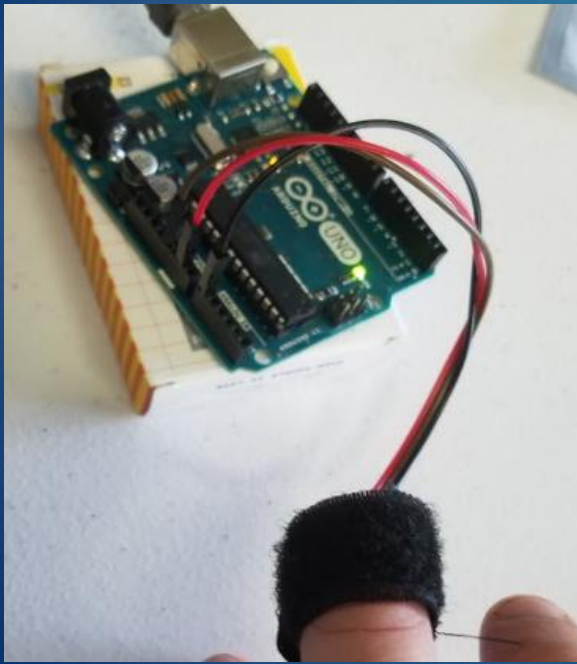
```
Temperature =45.28 F
Temperature =44.94 F
Temperature =44.60 F
Temperature =44.26 F
Temperature =44.04 F
Temperature =43.81 F
Temperature =43.59 F
Temperature =43.36 F
Temperature =43.25 F
Temperature =43.03 F
Temperature =42.91 F
Temperature =42.69 F
Temperature =42.58 F
Temperature =42.46 F
Temperature =42.35 F
```



```
SD2-UCF-GROUP15-TESTING!
MMA8451 is found
Range = 2G
X:    40    Y:    -212    Z:    4152
X:    0.12  Y:    -0.53  Z:    9.85    m/s^2
Portrait Up Front

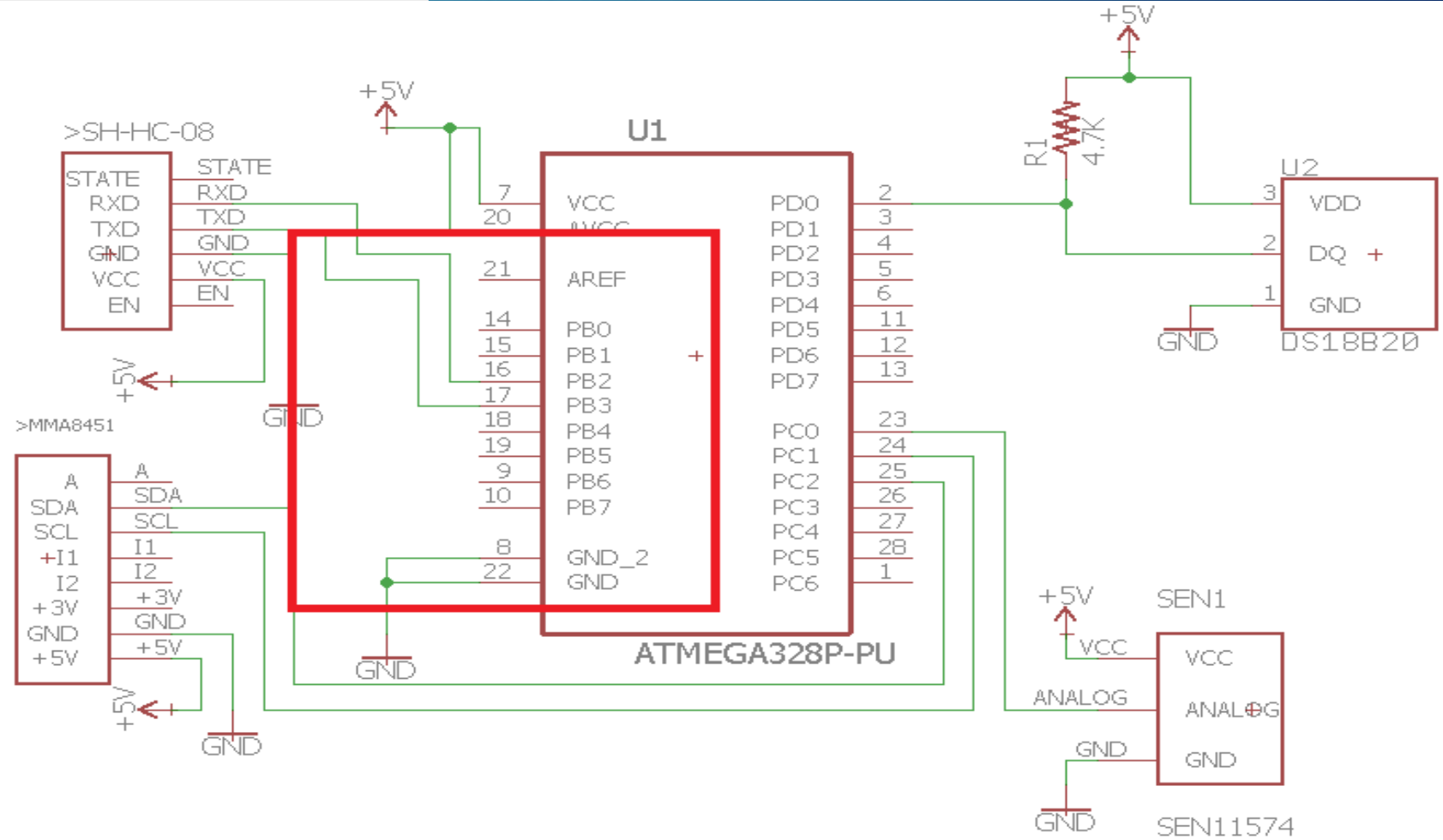
X:    58    Y:    -212    Z:    4124
X:    0.11  Y:    -0.51  Z:    9.84    m/s^2
Portrait Up Front

X:    44    Y:    -218    Z:    4112
X:    0.11  Y:    -0.53  Z:    9.78    m/s^2
Portrait Up Front
```



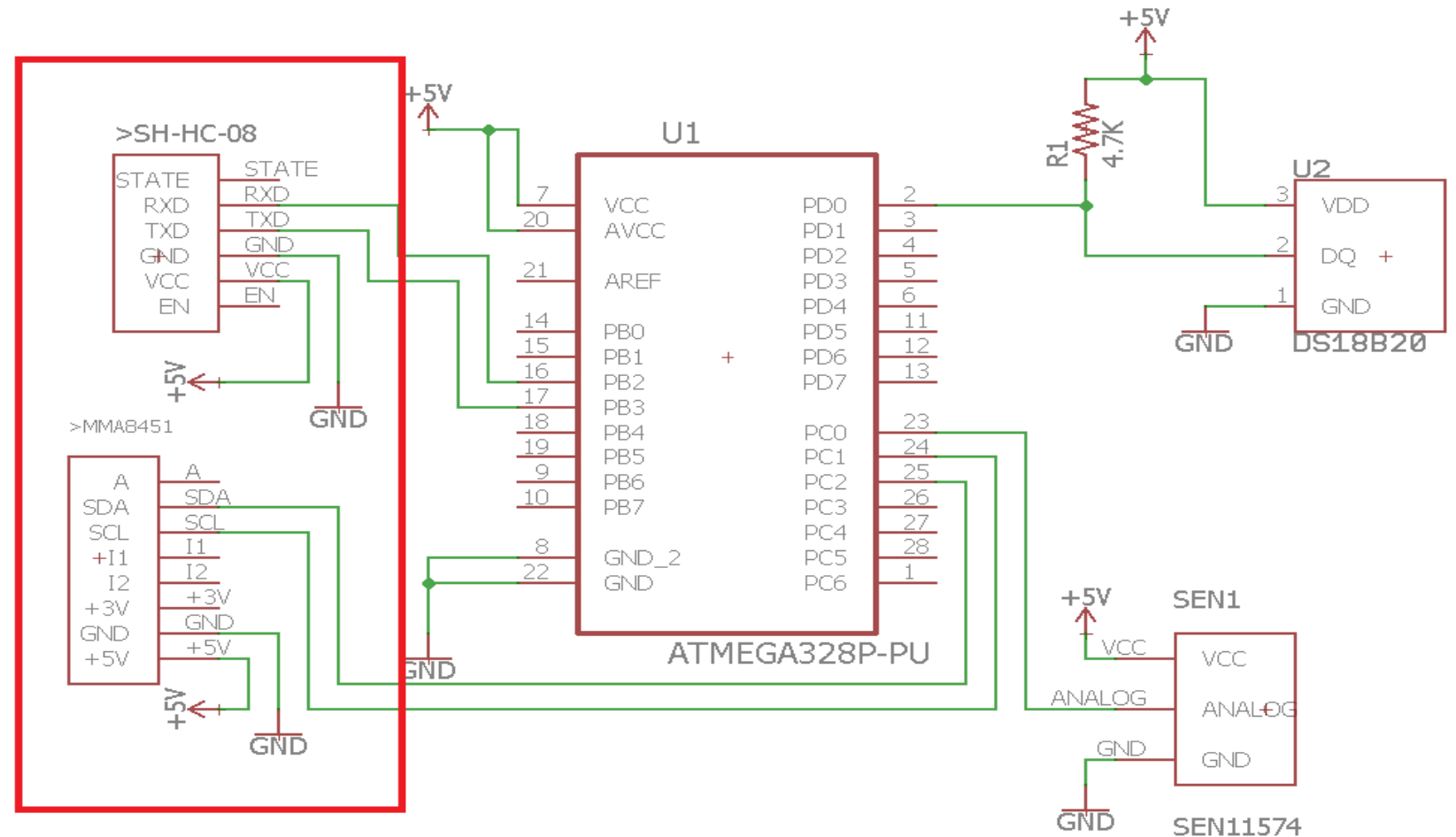
Hardware Schematic

- ❖ 1st schematic
- ❖ ATmega chip at 8 MHz for saving power.
- ❖ Ignore the crystal support for atmega chip at 16Mhz.

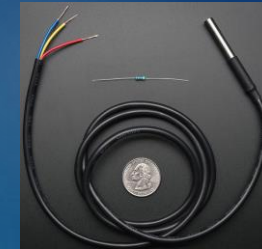


Hardware Schematic (continue)

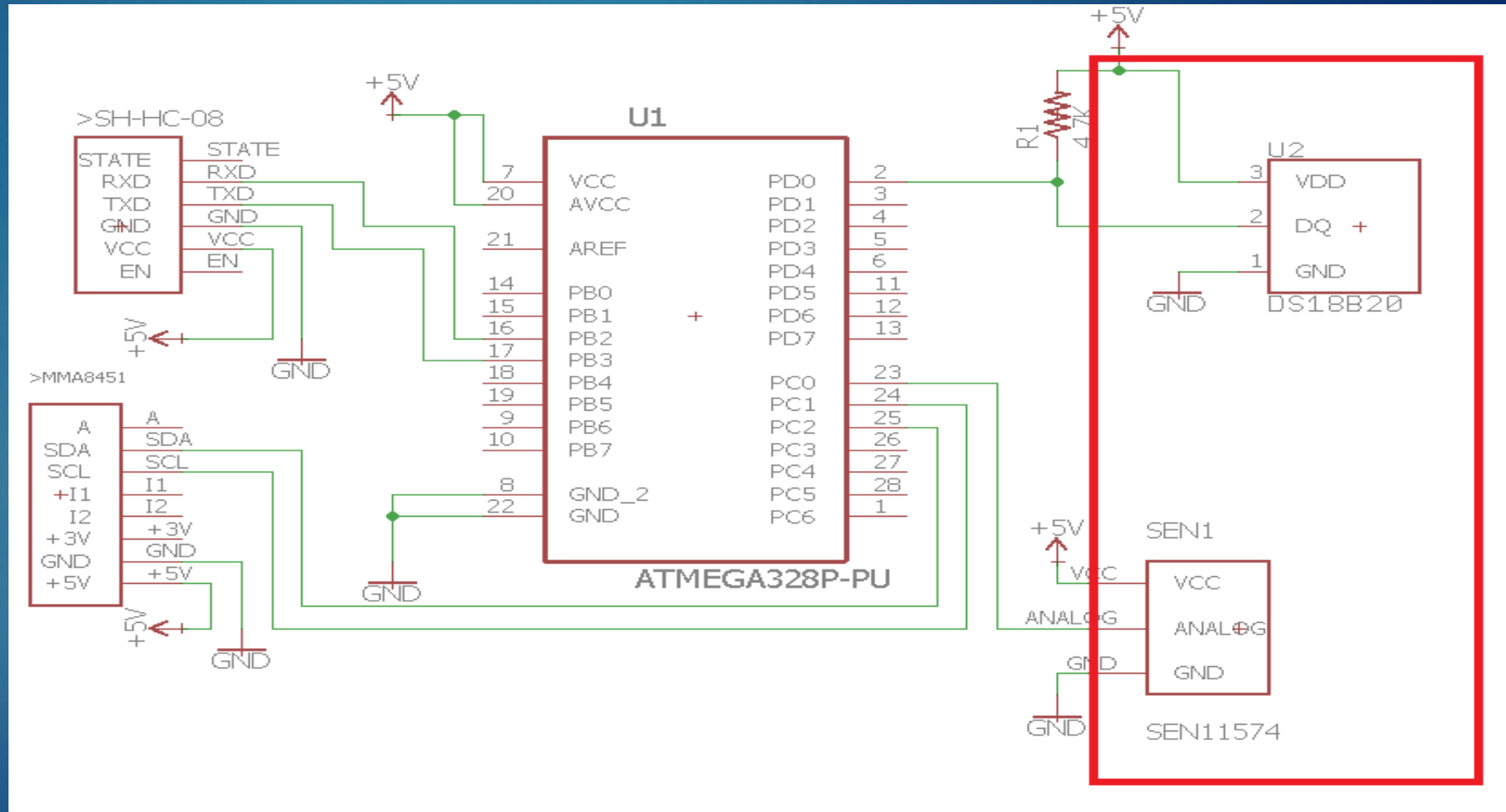
- ❖ SH-HC-08 (bluetooth) and MMA8451 (Accelerometer) will be integrated inside the circuit.



Hardware Schematic (continue)



- ❖ DS18B20 (temperature sensor) and SEN11574 (heartbeat sensor) will not be integrated



Power System

- ❖ Schematics for the power supply system.
- ❖ PCB blueprint.
- ❖ Cost to build power supply system.

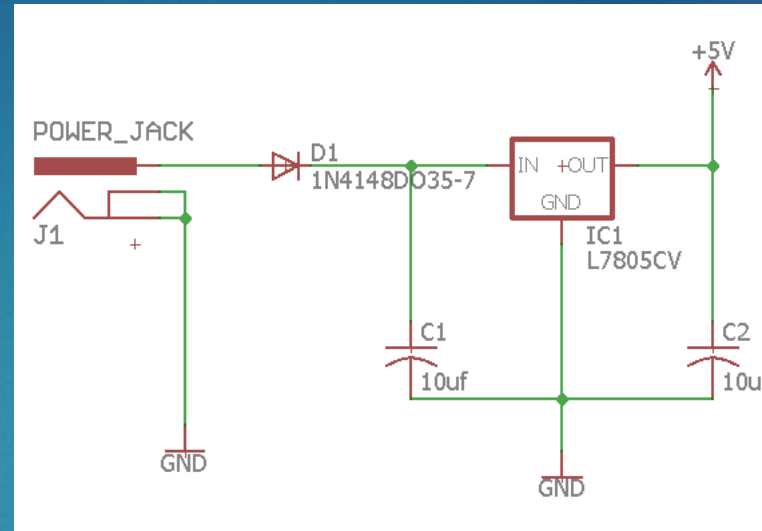
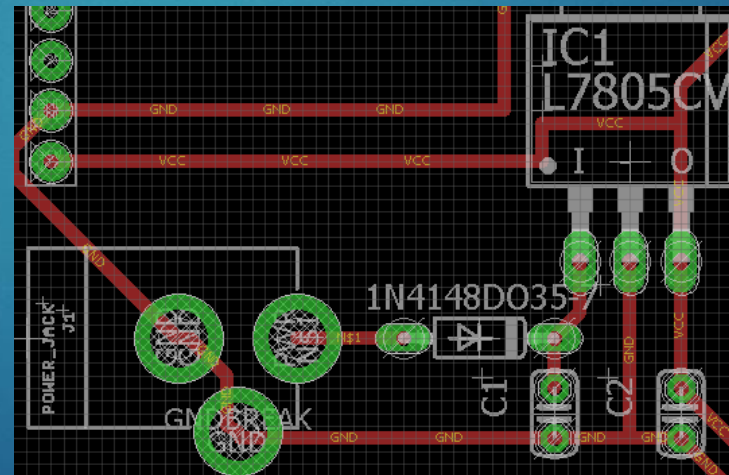


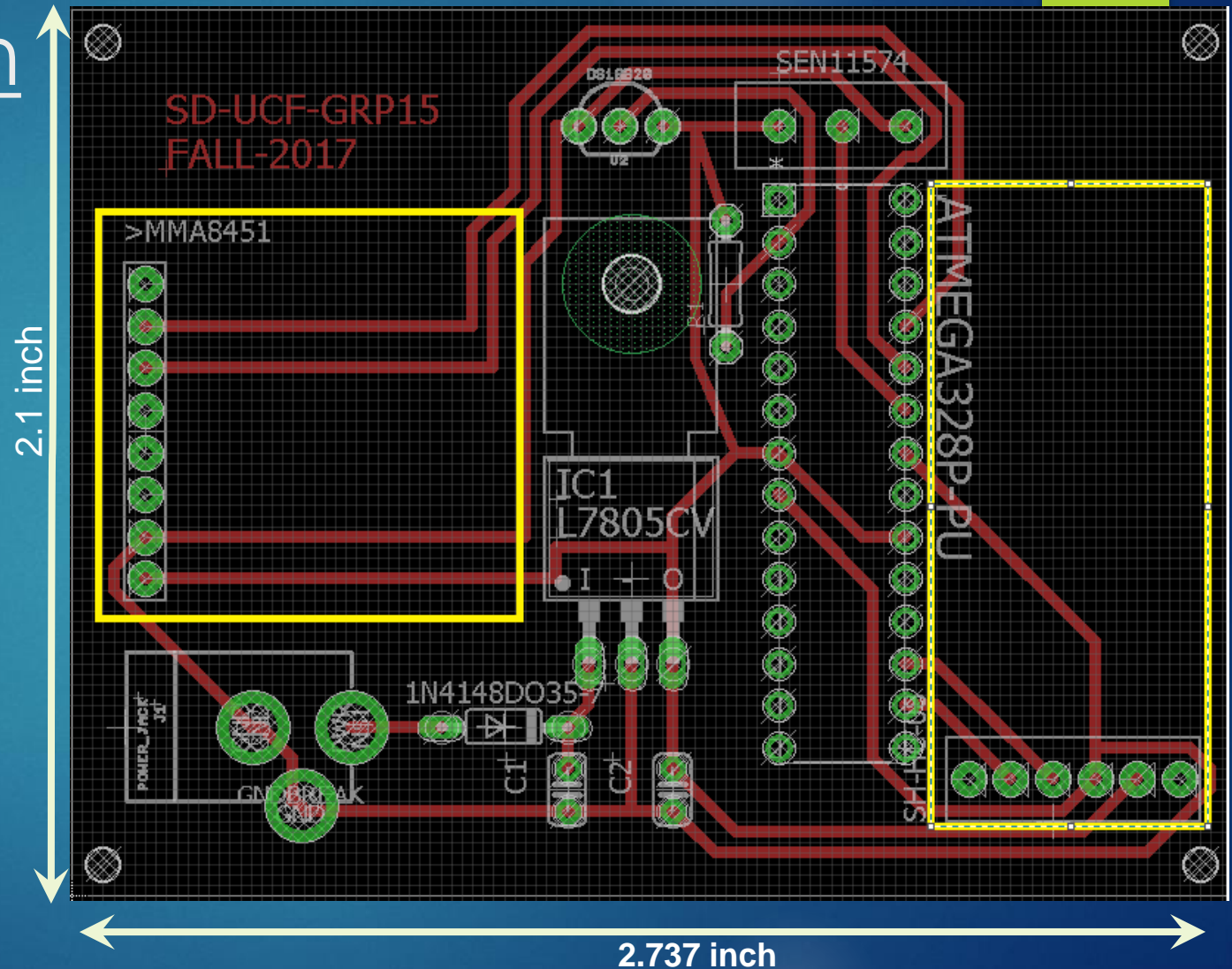
Table cost for power system	
Battery 9V.	\$1.4
2 capacitors 10uf	\$0.54
Diode 1N4148	\$0.06
3.5mm & 2.1 power jack	\$1.55
L7805CV	\$0.44
Total	\$3.99



all part is available @
<http://www.mouser.com>
distributed by Mouser
Electronics INC

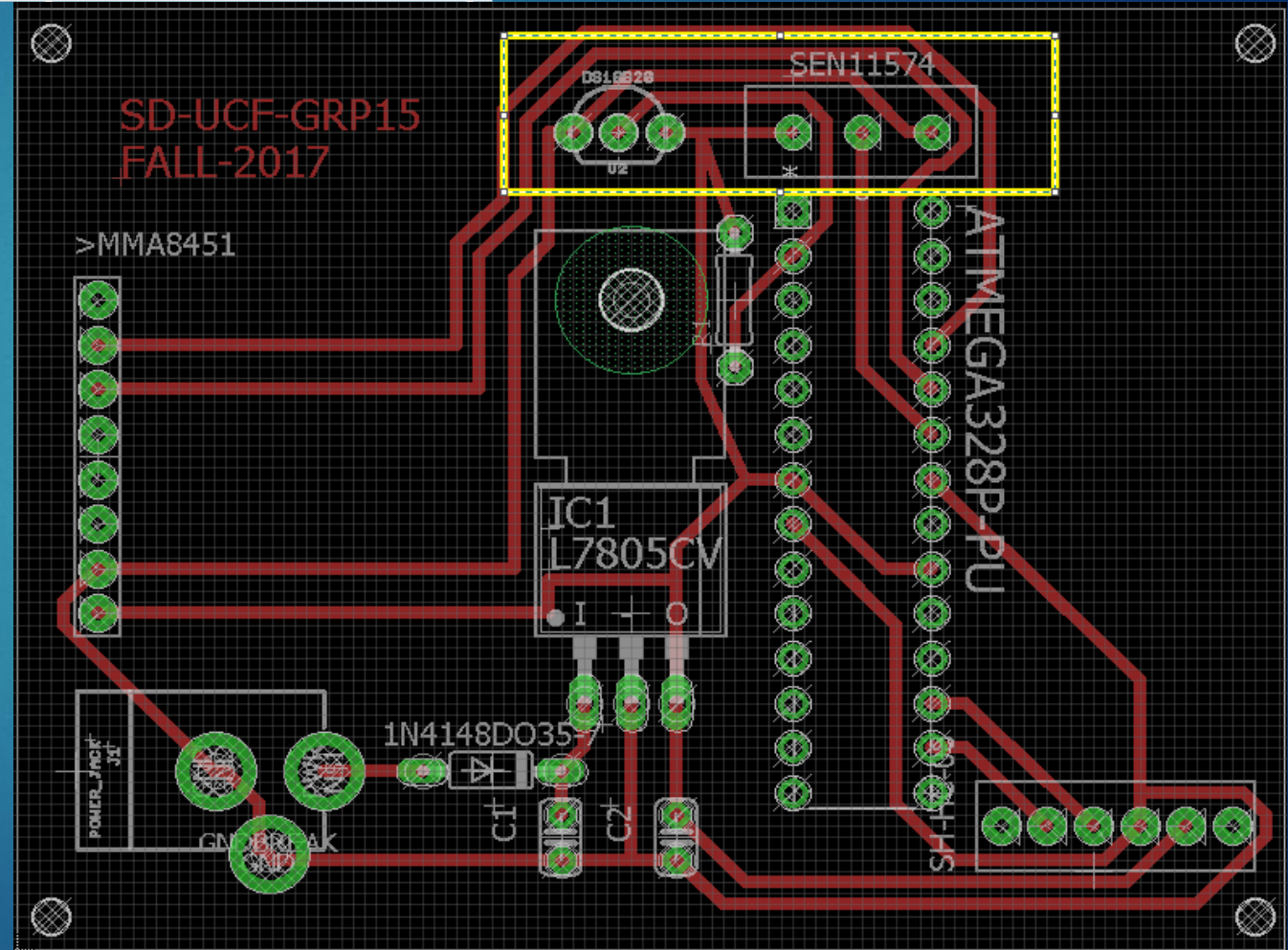
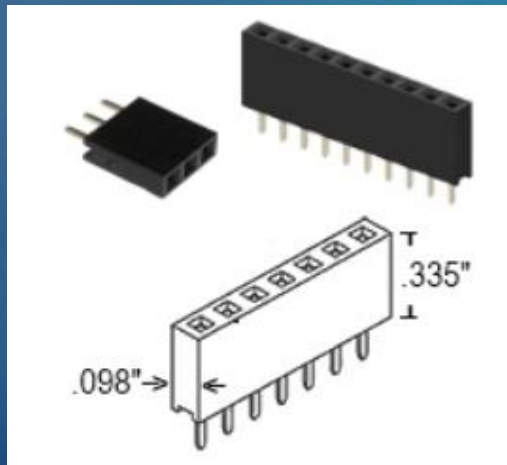
Hardware Design

- ❖ The 1st PCB layout.
(dimens 2.737 x 2.1
inch)
 - 1 layer.
 - 4 screw at each
corner
- ❖ Integrated on the pcb



Hardware Design (continue)

- The yellow area where DS18B20 and SEN 11574 will be connected with PCN with a pin.
- Need to account for and identify bad connections
- Pin 2.54mm female header will be used for the reinforcement pin connection for sensors.



Application Requirements

- ❖ User Friendly
 - easily accessible information
 - least clicks as possible
- ❖ Useful
 - pertinent information
 - accurately display vitals
- ❖ Communicate with the harness
 - wireless
 - able to transfer data
- ❖ Store Data
 - keep track of previous readings
 - display previous data to see trends
- ❖ Notifications / Alerts
 - alerts when readings are critical
 - notifications when necessary



Implementation

❖ Platform: Android vs Apple

	AVAILABILITY	USABILITY	POPULARITY	PROJECT SIZE	COST	ACCESSIBILITY
ANDROID	✓	✓	✓	✓	✓	✓
APPLE	✓	✓	✓	✓		✓



Operating System	4Q16 Units	4Q16 Market Share (%)	4Q15 Units	4Q15 Market Share (%)
Android	352,669.9	81.7	325,394.4	80.7
iOS	77,038.9	17.9	71,525.9	17.7
Windows	1,092.2	0.3	4,395.0	1.1
BlackBerry	207.9	0.0	906.9	0.2
Other OS	530.4	0.1	887.3	0.2
Total	431,539.3	100.0	403,109.4	100.0

Implementation

❖ IDE: Android Studio vs IntelliJ

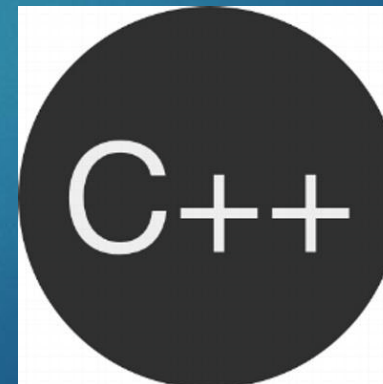
	AVAILABILITY	USABILITY	POPULARITY	PROJECT SIZE	COST	ACCESSIBILITY
ANDROID STUDIO	✓	✓	✓	✓	✓	✓
INTELLIJ	✓	✓		✓		✓



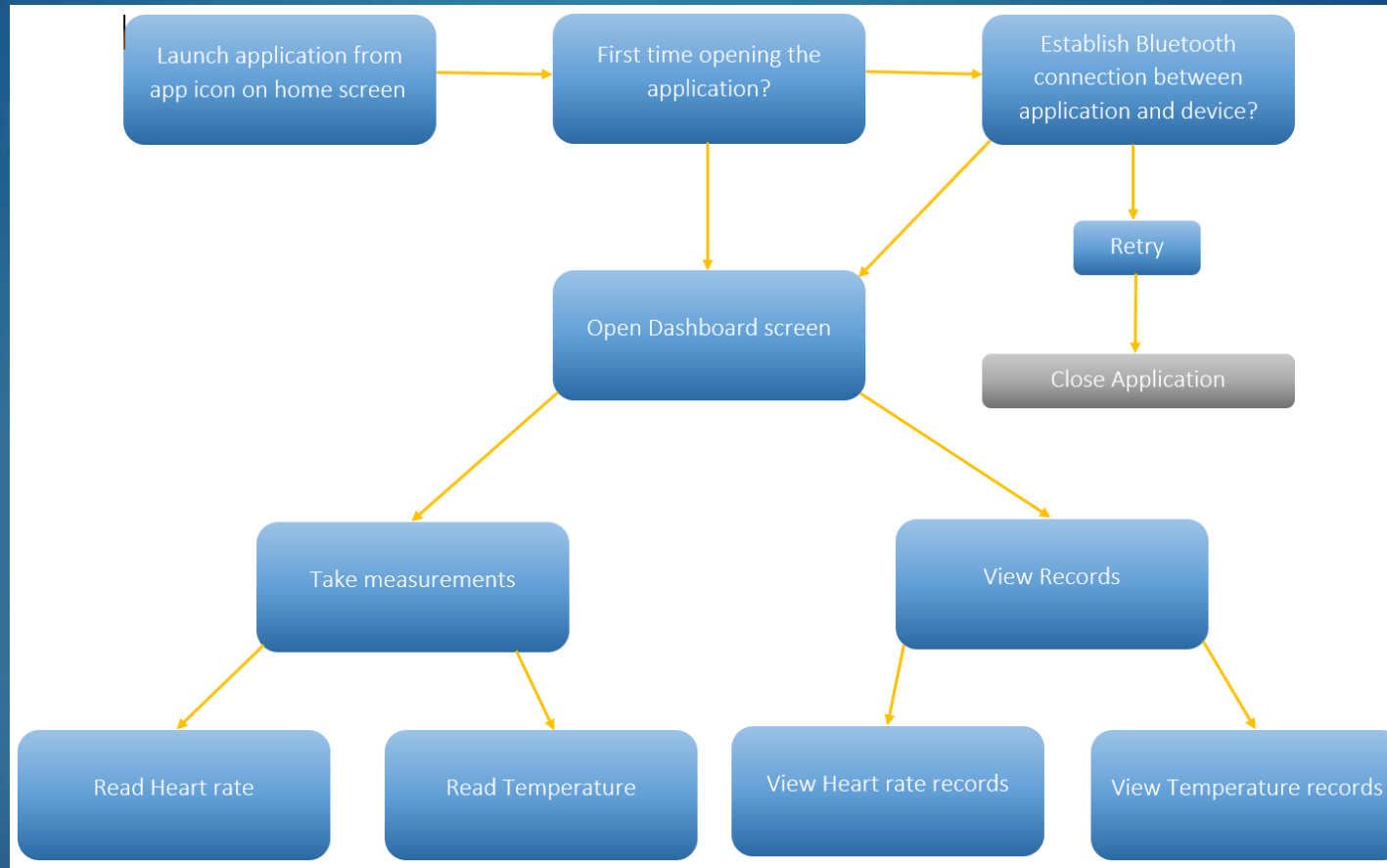
Implementation

❖ Language: Java vs C++

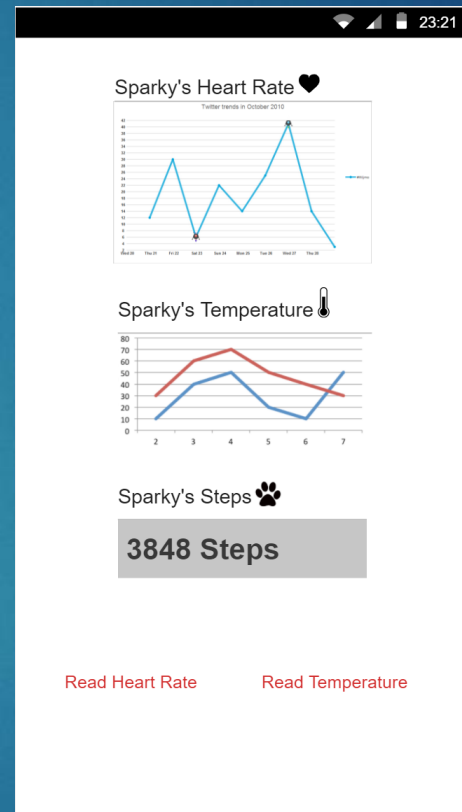
	AVAILABILITY	USABILITY	POPULARITY	PROJECT SIZE	COST	ACCESSIBILITY
JAVA	✓	✓	✓	✓	✓	✓
C++	✓	✓	✓	✓	✓	



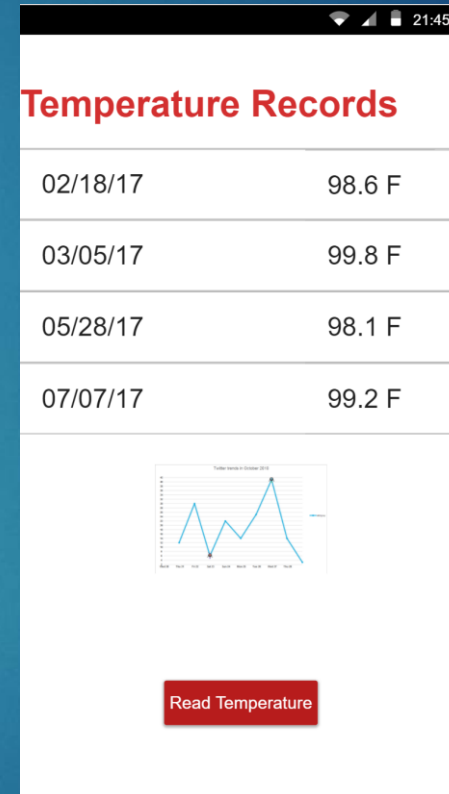
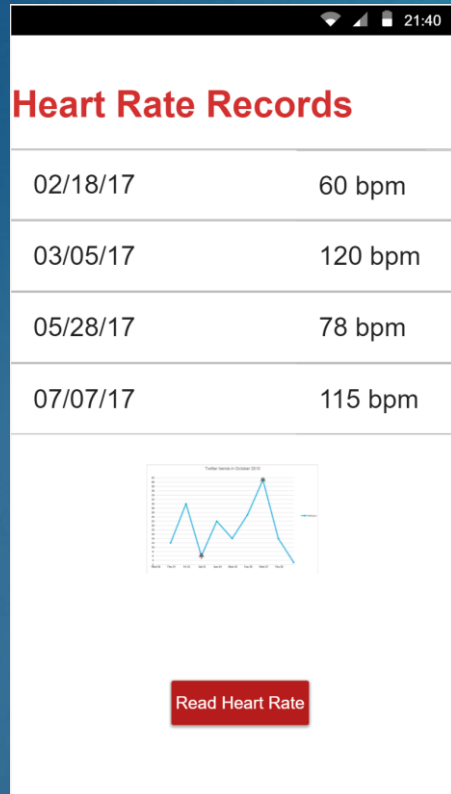
Software Design



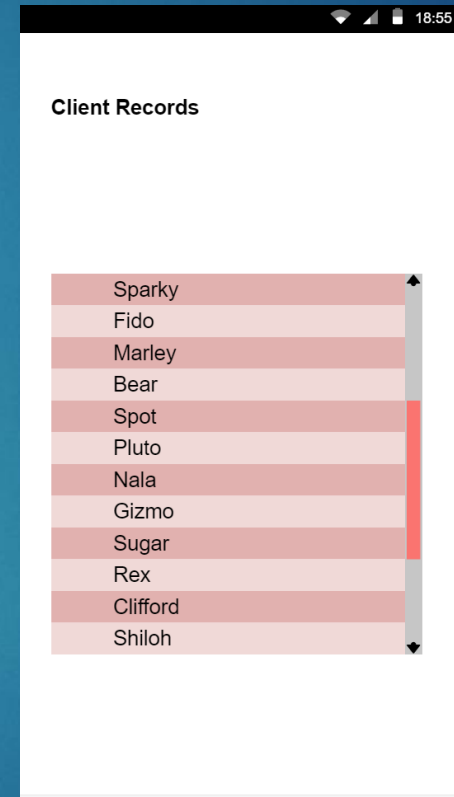
UI Flow and Design



UI Flow and Design



UI Flow and Design



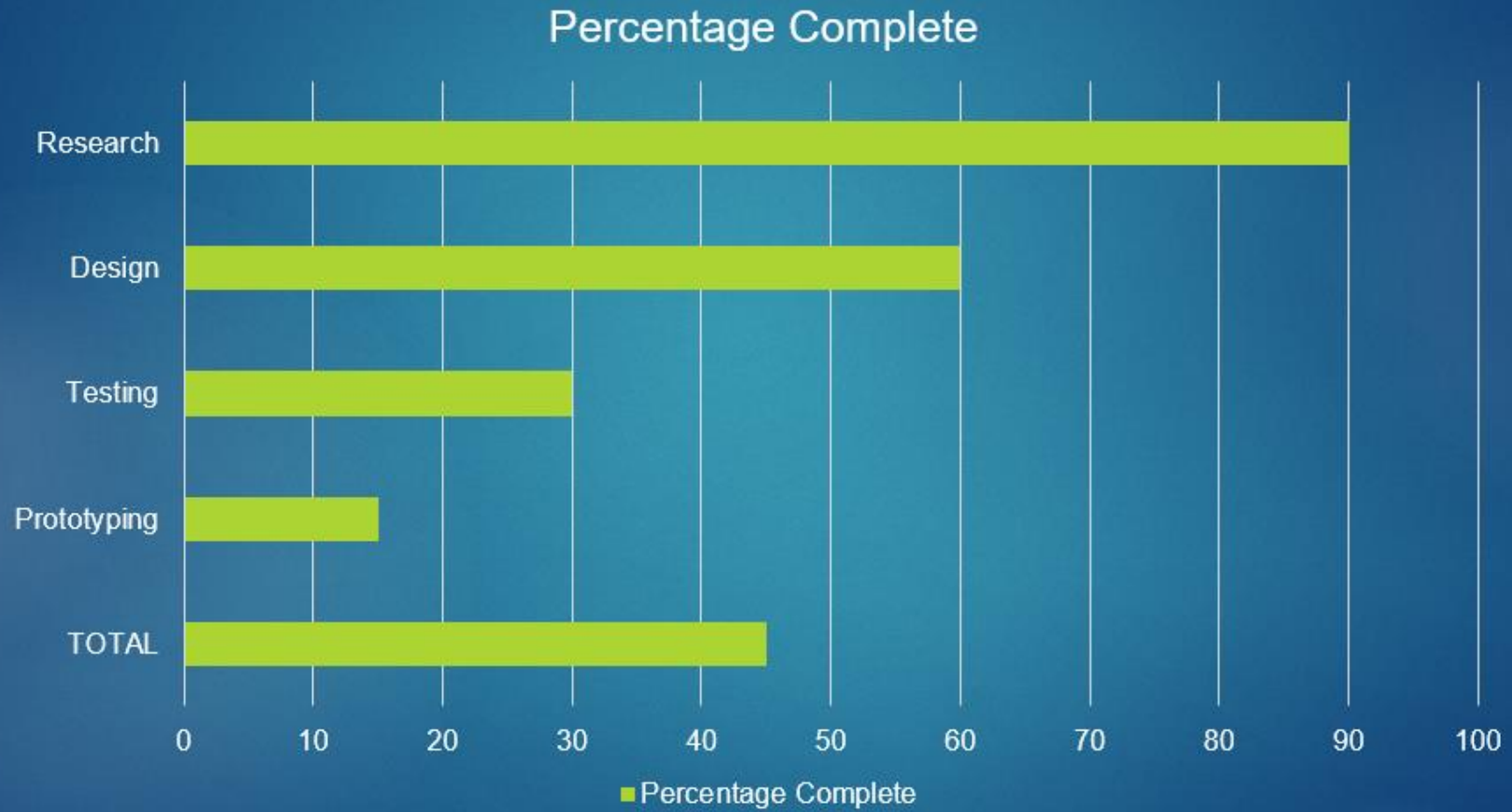
Team Member Design Breakdown

	Design PCB, PCB etching, Soldering	Assembly Coding	Installation PCB to Harness	Software Application	Testing
Dominic Vu			Primary	Primary	Primary
Matthew Horton	Secondary	Primary	Primary		Primary
Hai Nguyen	Primary	Secondary	Secondary	Secondary	Primary

Actual Cost Per Unit

Cost Per Unit	
PCB	\$ 9.57
Soldering	\$0
Power Supply Build Above.	\$ 3.99
ATmega328p	\$1.95
DS18B20	\$9.95
SH-HC-08	\$5.99
MMA8451	\$7.95
SEN 11574	\$5.00
Pin Dip, Resistor, Container	\$1
Software Development	\$0
Harness	\$0
Container	\$0
Total.	\$45.4

Project Progress



What next?

- ❖ Development of the assembly code.
- ❖ Software Implementation.
- ❖ Connection and communication between software and hardware.
- ❖ Integrate PCB into the harness.
- ❖ Testing.
- ❖ Checking for and fixing any issues.
- ❖ Final Presentation.

Questions?