Team Apple Final Presentation

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Overview

Project background

Goals for our project

Block diagram

How we accomplished our goals

Final status

Remaining problems

Future Improvements

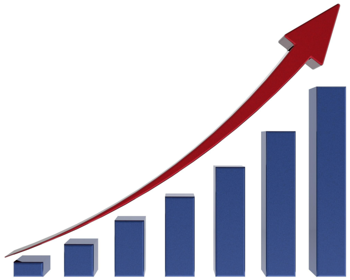
Project Background/Motivation

Problem: Cost of Energy in Hawaii is high

- University of Hawaii at Manoa (UHM) paid $35M for their electricity bill in 2012
- After implementations of energy efficient measures, UHM paid $34.3M for electricity in 2014
- Price of electricity per kilowatt hour has increased

Solution: Create an environmental sensor network

- Collect meteorological data (solar irradiance, temperature, humidity and pressure)
- Forecast solar irradiance patterns
- Find optimal locations on UHM campus for renewable energy installments



Project Constraints

- Build off the previous working Apple version 2.3
  - Apple 2.3 is a working weatherbox that was deployed on the roof of Holmes Hall
  - Modular design using breakout boards and an Arduino
  - Use similar parts with the same firmware
- Limited documentation
  - Andy's thesis
  - Apple 2.3 Eagle schematic, board layout and physical PCB

Goals For Our Project

- Explore ways to advance the current Apple design
  - Create an easy to assemble housing structure
  - Solve power problems
- Improve the documentation of Apple
  - Update the schematic and board design
- Build 5-6 Apple weather boxes
- Have a network of Apple boxes that communicate with each other
- Continue to refine the design of Apple

Block Diagram

How we Accomplished Our Goals

Broke up task

Tryston - Eagle design

Tyrin - Power Budget

Kaeo - Bill of Materials

Michael - Documentation, Soldering

Brianne - Housing design

Problems We Came Across

Problems

- Voltage Swing in Charging chip
- On/Off switch pins on board is mixed up

Solutions

- Implemented a 3.3 voltage regulator before the boost converter
- We bypassed the switch for now and will later implement it to the board

Power Budget

Apple Board Power Budget Version III						
5 Volt Module	**Data Sheet Values**			**Calculated Values**		
Part Name	**Idle Current (mA)**	**Typical Current (mA)**	**Max Current Draw (mA)**	**Average Current Draw (mA)**	**Average Power Consumed (mW)**	**Max Power Dissipated (mW)**
Arduino Uno R3	0.0001	**20**	50	10.00005	50.00025	50.00025
DC Current Sensor	0.006	0.7	1	0.353	1.765	5
GPS Sensor	4	12	20	8	40	100
Humidity/Temperature	0.0003	0.028	1	0.01415	0.07075	5
Pressure Sensor	0.001	0.65	1	0.3255	1.6275	5
Roof Temperature	0.75	1	1.5	0.875	4.375	7.5
Solar Irradiance	**0.0001**	0.3	**0.3**	0.15005	0.75025	1.5
Total	4.7575	34.678	74.8	19.71775	98.58875	174.00025

3.3 Volt Module	**Data Sheet Values**			**Calculated Values**		
Part Name	**Idle Current (mA)**	**Typical Current (mA)**	**Max Current Draw (mA)**	**Average Current Draw (mA)**	**Average Power Dissipated (mW)**	**Max Power Dissipated (mW)**
XBee Pro S2B	0.0035	205	220	205.00164	676.505412	726
Total	0.0035	205	220	205.00164	676.505412	726

Overall Power						
Overall Totals	Total Idle Current (mA)	Net Typical (mA)	Net Max Current (mA)	Net Average Current Draw (mA)	Net Average Power (mW)	Net Max Power (mW)
Values	4.761	239.678	294.8	224.71939	775.094162	900.00025

Battery Supply			
Part Name	Supply Voltage (V)	Max Discharge Current (mA)	Usable Energy
3.7V 6600 mAh	3.7	3300 (.5 C)	80%

XBee Characteristics	
Idle Time	99.9891%
Transmit Time	0.01093%

Calculated Run Time						
Energy (mWh)	Efficiency of Regulator	Max Power Consumed (mW)	Run Time at Max Ideal (Hours)	Run Time at Max Non-Ideal (Hours)	Conversion (Days and Hours)	Average Conversion
19536	80.00%	900.00025	21.70666064	17.36532851	0 Days, 17.37 Hours	1 Days, 1.2 Hours

Apple Notes and Assumptions
*Typical Current of Arduino is the DC Current Per I/O Pin *Battery voltage low power mode polls every 10 minutes *Solar Irradiance polls every 3 seconds *Battery Voltage and Panel polls every 10 seconds *Everything else polls every 30 seconds *XBee transmits every 3 seconds *XBee receives every 3 seconds *Values are in bold are assumed *Xbee Characteristics % and the Usable Energy % given to us by our mentors *XBee Max Power calculated using double the Average Power

Bill Of Materials

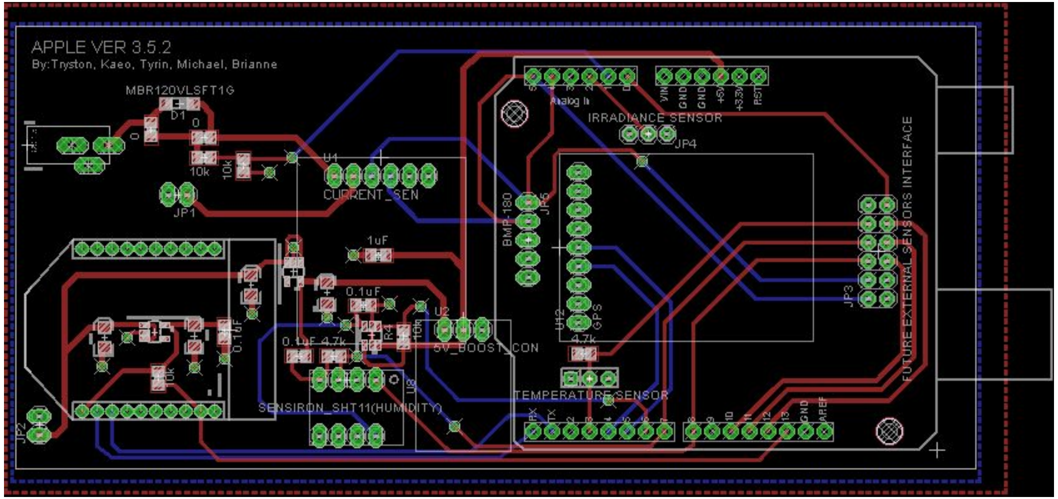
Apple Board 2.3 Bill Of Materials								
#	Part Description	Part Name	Part Package	Vendor	Product ID/#	Unit Cost	Quantity	Reason
1	Charging Chip	USB LiPoly/Li-Ion Charger (3.7/4.2V) MCP73871	N/A (using headers)	Adafruit	MCP73871	$17.50	1	Charger compatible with the battery
2	Microprocessor	Arduino Uno R3	N/A (using headers)	Adafruit	50	$24.95	1	Easy to use and beginner-friendly
3	N/A	Ultimate GPS Breakout v3	N/A (using headers)	Adafruit	746	$39.95	1	GPS option at Adafruit
4	Transciever	Digi International XBee Pro S2B	N/A (using headers)	Adafruit	967	$37.95	1	Compatible with the lab since it already utilizes XBee Tranceivers
5	Battery	Tenergy Li-Ion 18650 3.7V 6600 mAh	N/A (using headers)	Adafruit	353	$29.50	1	Battery provides enough power to supply board
6	Pressure Sensor	Barometric Pressure Sensor BMP085 (Older model)	THRU	Adafruit	1603	$9.95	1	Previous model discontinued, newer model smaller in size
7	Current Sensor	INA 219 High SIde DC Current Sensor Breakout 26V ± 3.2A Max	THRU	Adafruit	904	$9.95	1	Recommended current sensor on Adafruit
8	N/A	Interface Cable - RPSMA Female to RPSMA Male (25cm)	N/A	Sparkfun	12860	$4.95	1	Helps place antenna to minimize attenuation
9	Solar Irradiance Sensor amplifier	Silicon-Cell Pyranometer SP-215	THRU	Apogee	SP-215	$235.00	1	Model that is self powered and does not require an operational amplifier
10	Solar Panel	Large 6V 3.4W Solar Panel 3.4 Watt	N/A (Barreljack)	Adafruit	500	$39.00	2	Good size and provided enough power
11	Solar Irradiance Sensor Stabilizer	AL-100 Solar Sensor Leveling Plate	N/A	Apogee	AL-100	$35.00	1	Needed in order to stabilize the pyranometer
12	N/A	One Wire Digital Temperature Sensor - DS18B20	N/A	Sparkfun	245	$4.25	1	Temp sensor that fit inside of the box
13	Duck Antenna	2.4GHz Duck Antenna RP-SMA - Large	N/A	Sparkfun	558	$9.95	1	Compatible duck antenna with the XBee
14	Temp/Humidity sensor	Sensirion Temperature/Humidity Sensor - SHT11	N/A (using headers)	Adafruit	246	$35.00	1	Dual sensor module that was power efficient
15	Boost Converter (U28)	5V Boost Converter: NCP1402-D	N/A (using headers)	Sparkfun	10968	$5.95	1	
16	On/Off Switch (U36)	5V On/Off Switch	N/A (using headers)	SkyWorks	AAT4280	-	1	
17	3.3V Regulator (U34)	3.3V Regulator: MIC5219	N/A (using headers)	Digi Key	SOT23-5	$0.74	2	
	Unit Sub Cost							
	$571.90							

Board 2.3 Passive Components										
#	Part Description	Part Name	Product ID/#	Vendor	Part Package	Part Value	Part Unit	Unit Cost	Quantity	Reason
1	CAP CER 0.1UF 50V 0805	C2=C13,C4=C14	1276-1007-1-ND	Digi-Key	SMD	0.1	uF	$0.10	2	
2	CAP CER 1UF 16V Y5V 0805	C5=C15	311-1457-1-ND	Digi-Key	SMD	1	uF	$0.10	1	
3	CAP CER 10UF 10V Y5V 0805	C1=C11, C3=C12	311-1355-1-ND	Digi-Key	SMD	10	uF	$0.16	2	
4	RES 0.0 OHM 1/8W JUMP 0805 SMD	R8=R34, R9=R33, R12=R38, R13=39	311-0.0ARCT-ND	Digi-Key	SMD	0	KΩ	$0.10	4	
5	RES 1.15K OHM 1/8W 1% 0805	R7=R30	MBR120VLSFT3GOSCT-ND	Digi-Key	SMD	1.15	KΩ	$0.10	1	
6	RES 4.7K OHM 1/10W 5% 0402 SMD	R5=R29, R10=R36, R11=R37	P4.7KJCT-ND	Digi-Key	SMD	4.7	KΩ	$0.10	3	
7	RES 10K OHM 1/8W 5% 0805	R1=R27,R2=R26, R3=R32, R4=R35	RMCF0805JT10K0CT-ND	Digi-Key	SMD	10	KΩ	$0.10	4	
8	RES 22K OHM 1/8W 5% 0805	R6=R31	RMCF0805JT22K0CT-ND	Digi-Key	SMD	22	KΩ	$0.10	1	
9	DIODE SCHOTTKY 20V 1A SOD123FL	D1=D3	MBR120VLSFT3GOSCT-ND	Digi-Key	SMD	N/A	N/A	$0.38	1	
10	Header Female									
11	Header Male									
	Unit Sub Cost									
	$2.30									

Total Unit Sub Cost
$574.20

Eagle Design: Version 3.5.3

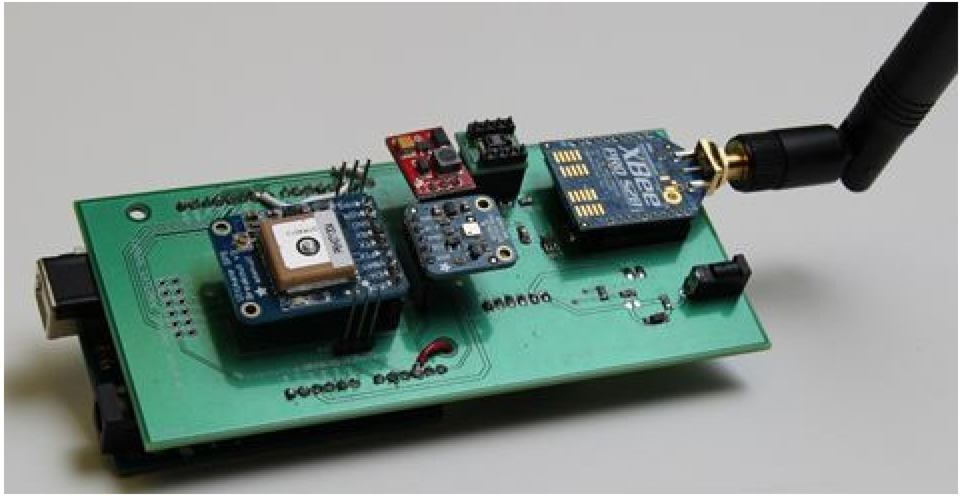
- Improved the previous Apple design version 2.3
  - Created a new schematic
  - Upgraded to better/newer parts
  - Reroute bad traces and reduce board real estate
  - Placed breakout boards and sensors to maximize sensor values and reduce overall size



Final Status of Apple

Five fully functional apple boards

Will be using a clamp as our mounting technique



Remaining Problems

Integrate the On/Off Switch correctly into circuit

Implement the current sensor and GPS

Housing

Future Improvements

Transition away from breakout boards

Finding more mounting techniques for different roofs

Reduce cost of production

Questions?