LUGGAGE LINK

Group 15

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Project Overview

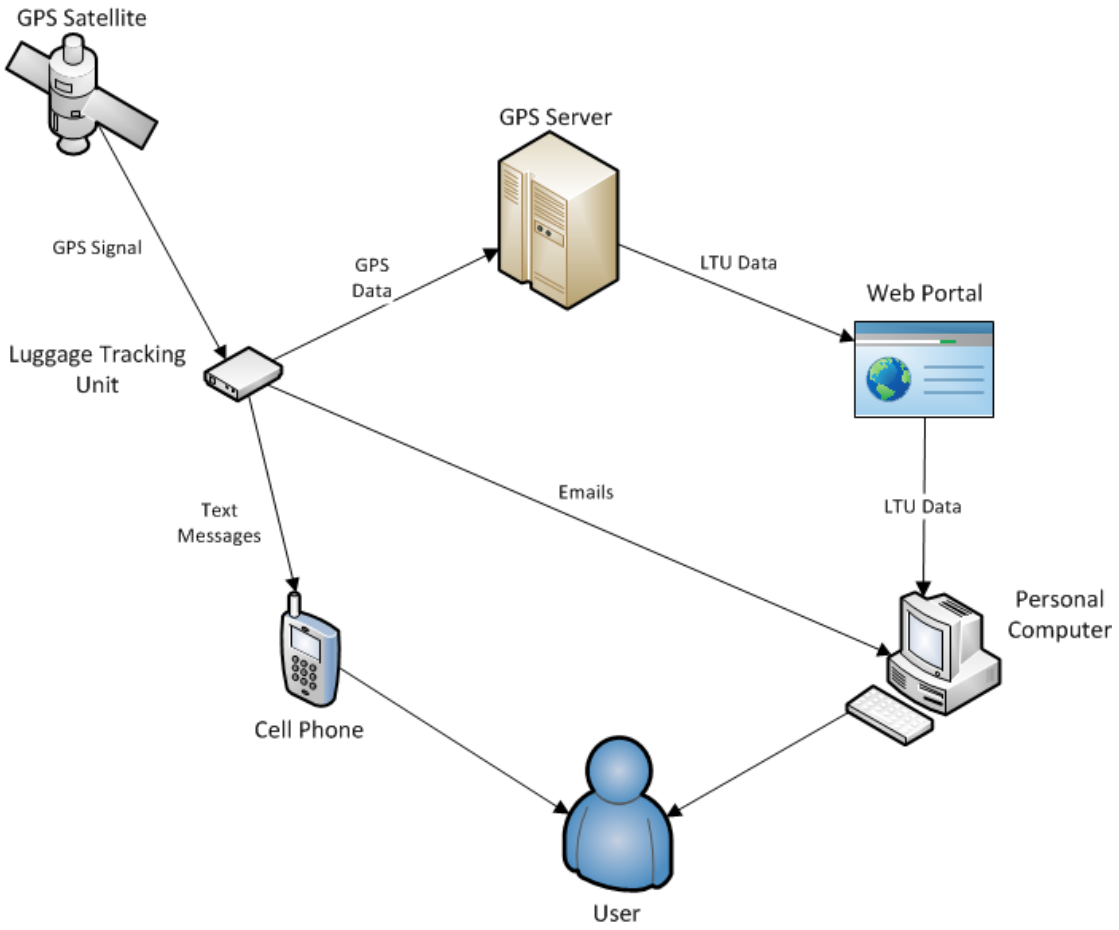
- Luggage Tracking Unit
  - GPS
  - GSM
  - Microcontroller
- Light sensor
- Pressure sensor
- GPS Server
- iPhone App

Motivation

- Provide a reliable way to track luggage anywhere in the world
- Decrease reliance upon airlines to handle luggage
- Less stress and fewer headaches!

System Concept Diagram

- User receives data from 3 sources
  - Text message
  - Email
  - Website

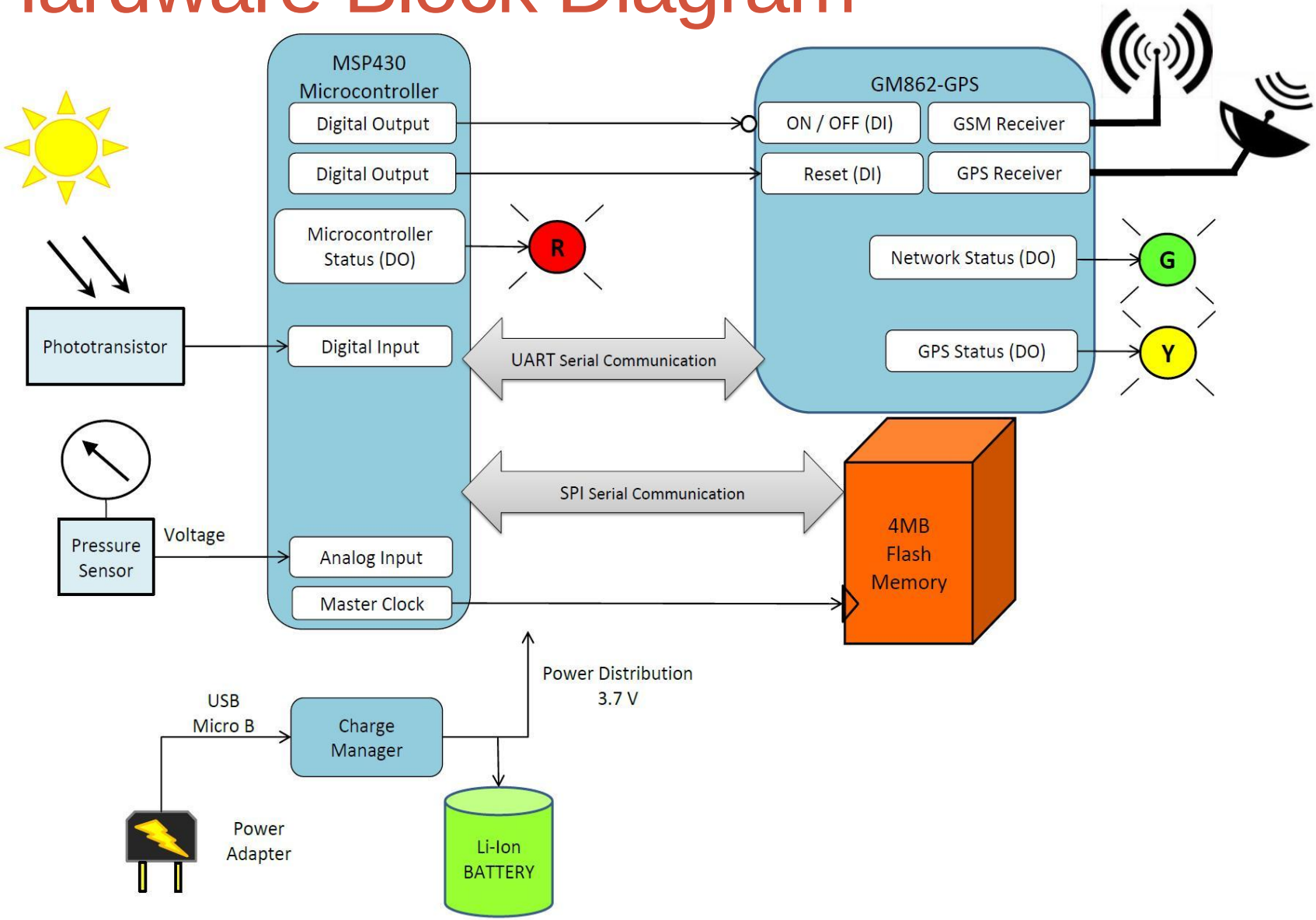


Development Strategy

- Phased development to mitigate risk
- Ensures product that can be demoed is ready well in advance

Phase	Capabilities and Features
A	Ability to receive GPS signal and send GPS coordinates via SMS text message and email
B	All capabilities of Phase A plus a GPS server interface which receives data from one or more tracking units
C	All capabilities of Phase B plus an iOS app interfaced with the GPS server

Hardware Block Diagram



Microcontroller

- Functions as the brain of the system
- “Hobbyist” microcontrollers not allowed

MSP430G2553

Texas Instruments

•Supply voltage 1.8 V to 3.6 V

•16 I/O pins

•Universal Serial Communication Interface (USCI)

•UART with Auto Baud rate Detection

•Synchronous SPI

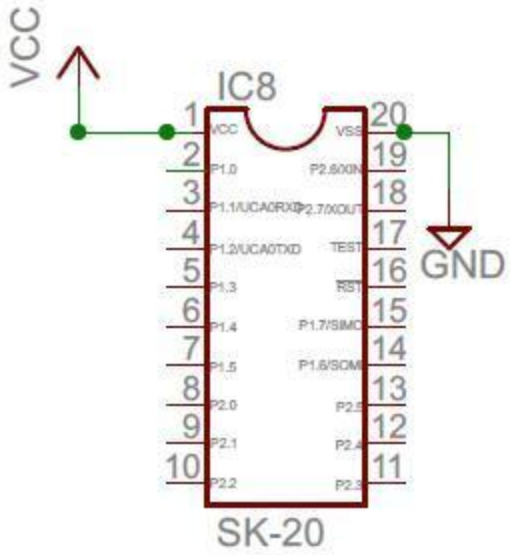
•Supports Analog-to-Digital Conversion (ADC10)

•16 KB Flash

•512 B Ram

Microcontroller

Pros	Cons
Low cost	Code written in C
Widely used	Steep learning curve
Low power consumption	Code and RAM size limitations
Online tech support forums and sample code readily available	Must deal with low level controls (i.e. interrupts)



GSM / GPRS

- Provides uplink to the server, SMS and GPS receiver.

GM862-GPS **Telit**

•Supply voltage 3.2 V to 4.5 V

•13 I/O pins

•Serial link through UART (RS-232)

•Quad-band GSM/GPRS modem

• -107 dBm @ 850/900 MHz

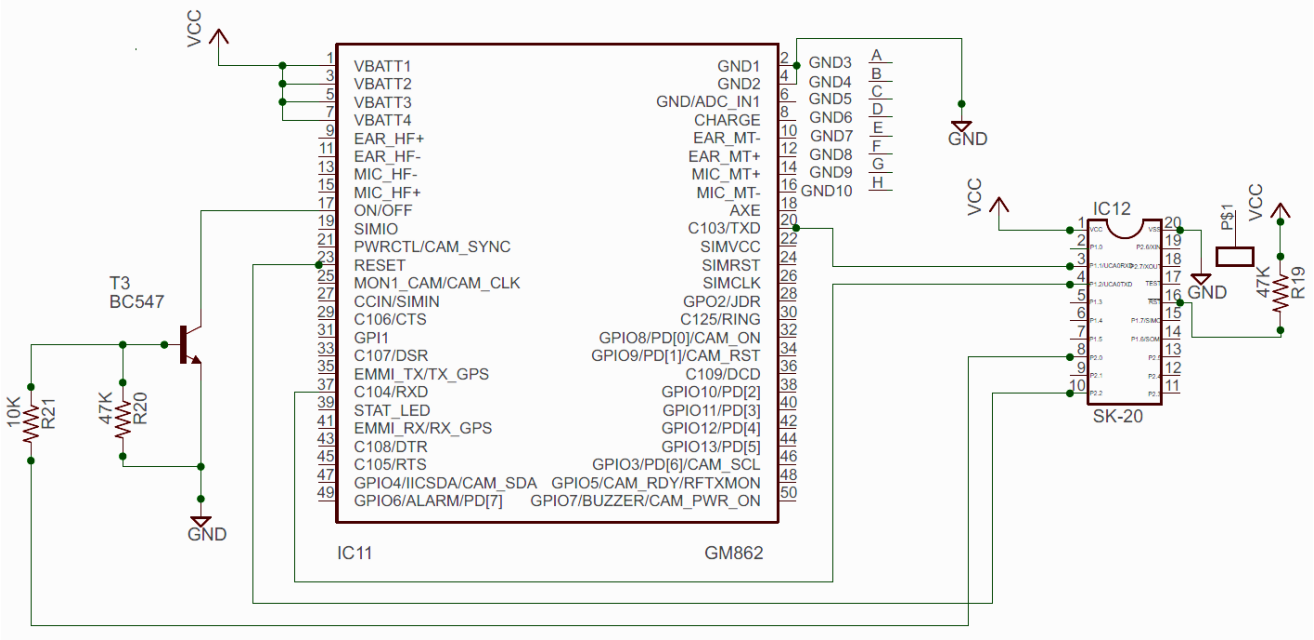
•SMS cell broadcast

•GPS receiver up to 20-channels

•Accuracy: 2.5 m position resolution

•High sensitivity for indoor reception, up to -159 dBm with active antenna

GSM / GPRS



Pros	Cons
Relative small foot print to features ratio	High cost
Integrated SIM card holder	Control via AT Commands
Integrated GSM and GPS antenna connectors	Online tech support not readily available
Low power consumption	

GSM and GPS Antenna

- Active antenna for Cellular and GPS reception

FXP07.09.0100A

Taoglas

- Flexible GSM antenna
- Efficiency: 83% GSM

GPS3620

EAD

- Compact internal GPS patch
- LNA gain 20dB
- Active antenna
- 2.5 V to 5 V

Memory

- Functions as temporary storage until network connection is available

AT45DB041D **Atmel**

•Supply voltage 2.5V to 3.6V

• 4-megabit data flash

• RapidS Serial Interface SPI Compatible up to 66 MHz

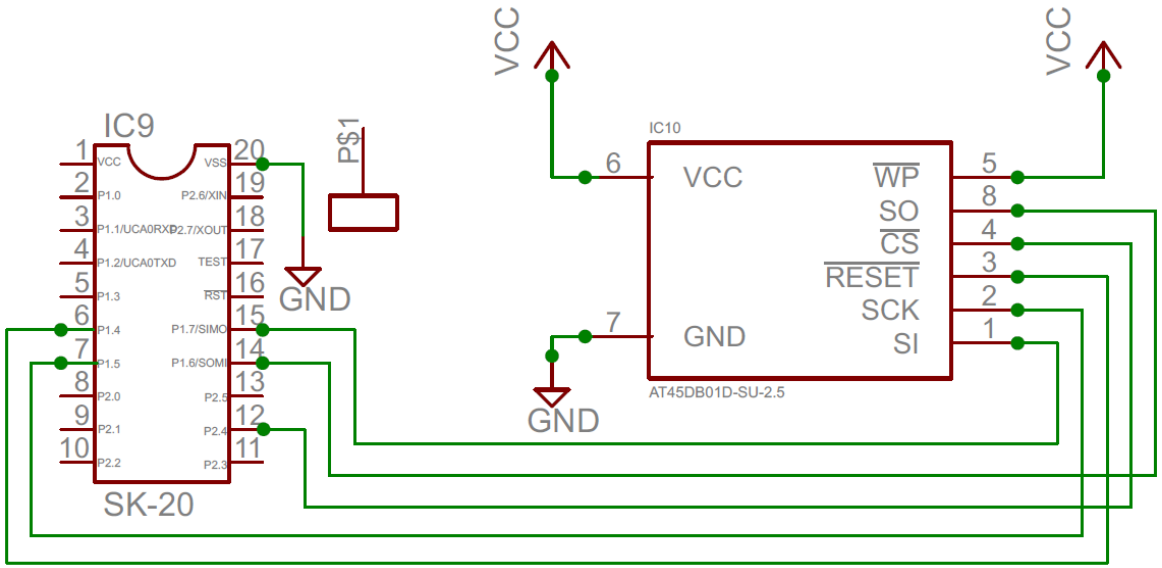
•Two SRAM Data Buffers (256/264 Bytes)

• Low-power dissipation

• Hardware and software data protection features

•100,000 Program/Erase cycles per page

Memory



Pros	Cons
Low cost	Difficult to solder to PCB.
Widely used	Pin width: 0.51 mm Pin Separation: 1.27 mm
Low power consumption	Steep learning curve

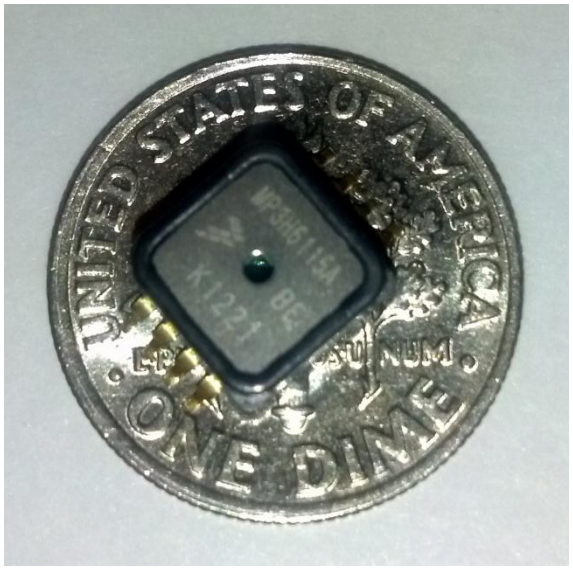
Pressure Sensor

- Functions as an altimeter for Air Plane mode
- Barometric sensor

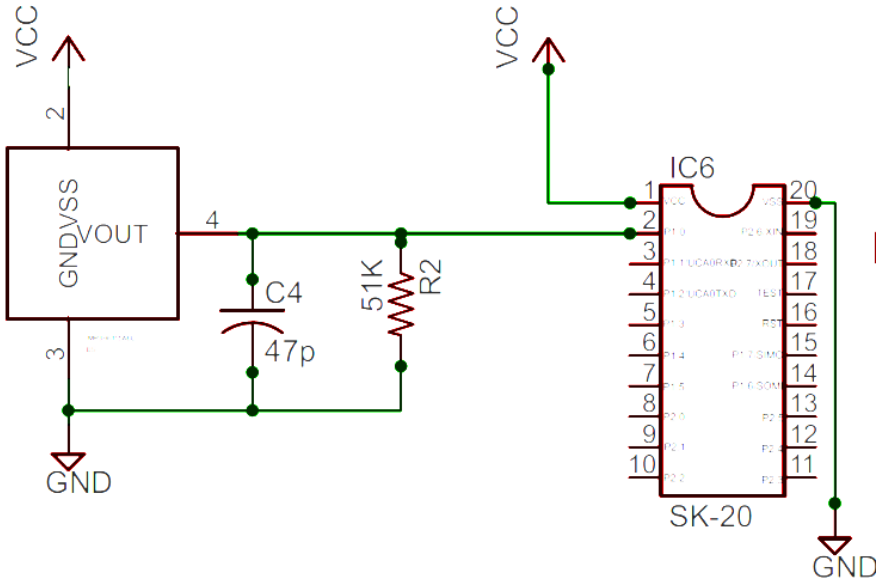
MP3H6115A

- Supply voltage 2.7 V to 3.3 V
- Measures absolute pressure 150 to 115kPA (2.2 to 16.7 psi
- Temperature compensated
- Fast response time 1.0 ms
- Accuracy 1.5% V_{FSS}

Freescale Semiconductors



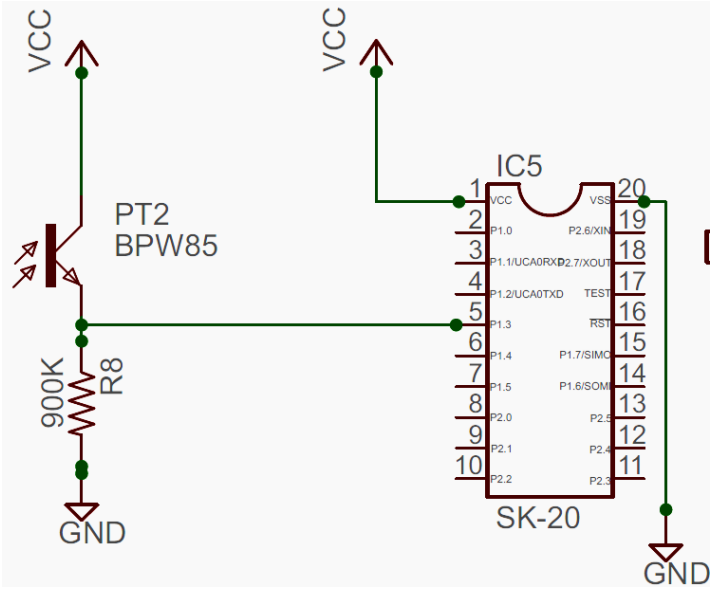
Pressure Sensor



Pros	Cons
Low cost	Relatively large footprint
Temperature compensated	Power consumption is low, however since it has to be one at all times, it will draw power from the battery
High accuracy	

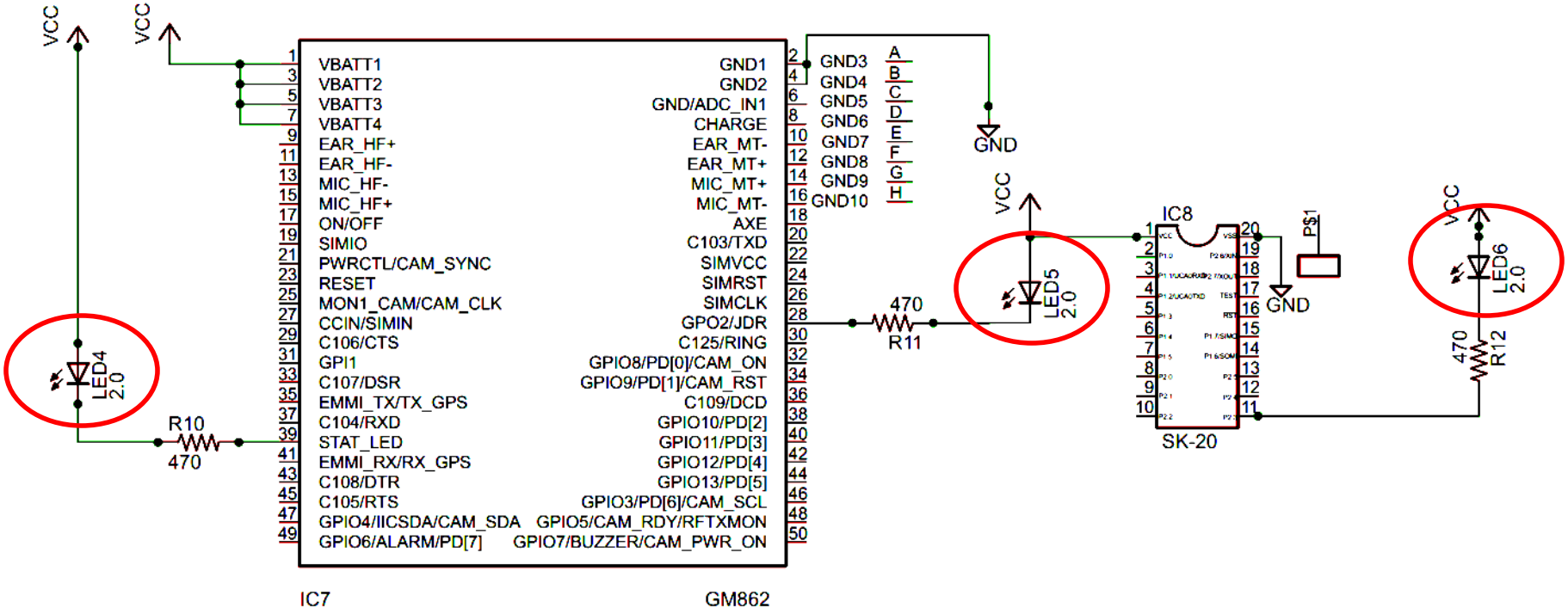
Phototransistor

- Functions as detection of luggage being opened
- High sensitivity to ambient light



LEDs

Network Status = Green Led
GPS Status = Yellow Led
Microcontroller Status = Red Led



Battery

- Rechargeable Li-Ion battery provides power to the LTU

UBP002

- Voltage range 3.0 V to 4.2 V, 3.7 V average
- Capacity 900 mAh
- Rated for 2.1 A Hold Current
- Energy 3.4 Wh
- Cycle Life > 500 cycles
- No memory effect

Ultralife

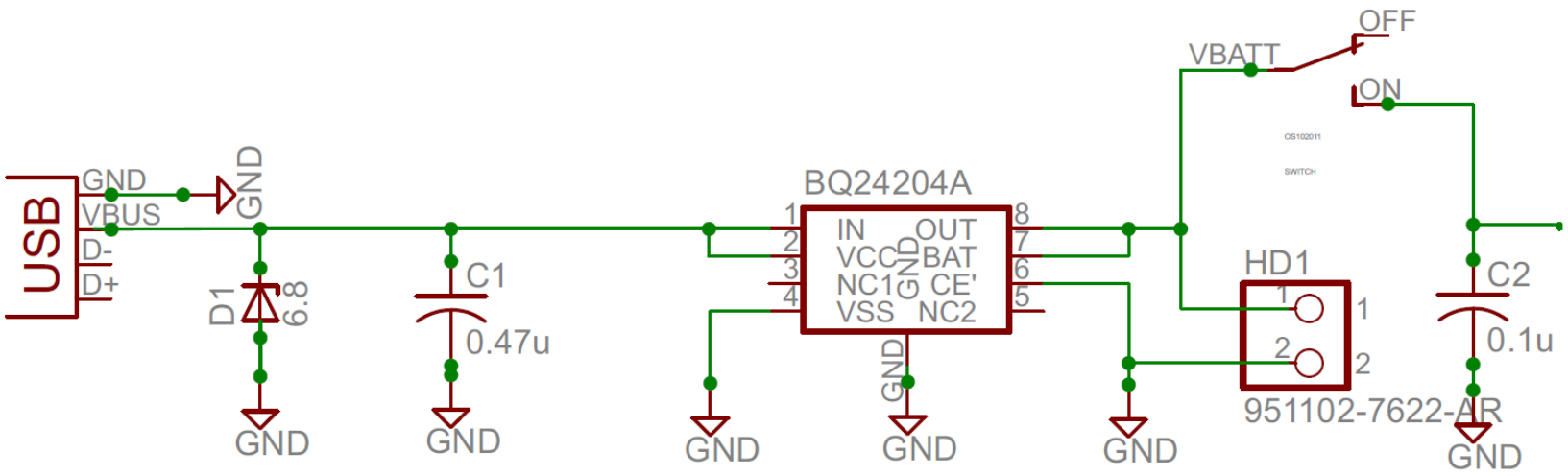
Charge Manager

- Functions as the charge manager for Li-Ion battery

BQ24204 **Texas Instruments**

- Designed to work with current-limited wall supplies
- Ideal for Low Dropout Charger Design Single-Cell Li-Ion Packs
- Charge regulation voltage of 4.2 V
- Battery detection
- Pre-Charge conditioning
- Charge termination
- Sleep Mode for low-power consumption

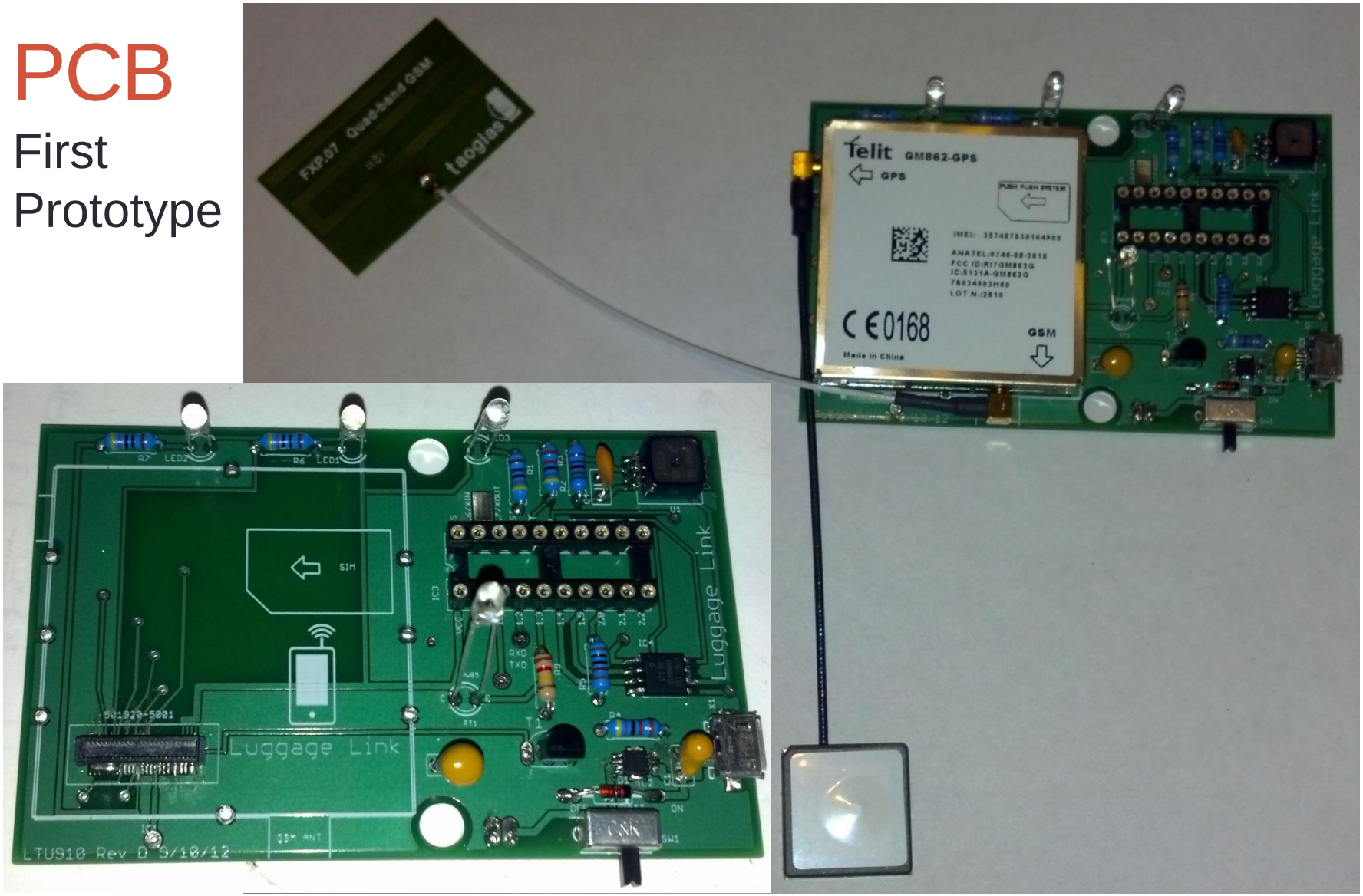
Charge Manager



Pros	Cons
Low cost	Difficult to solder to PCB.
Widely used	Pin width: 0.35 mm
Low power consumption	Pin separation: 0.65 mm
Will allow the use of the same wall adapter as the users cell phone	

PCB

- First Prototype



PCB

- First Prototype

Development Boards

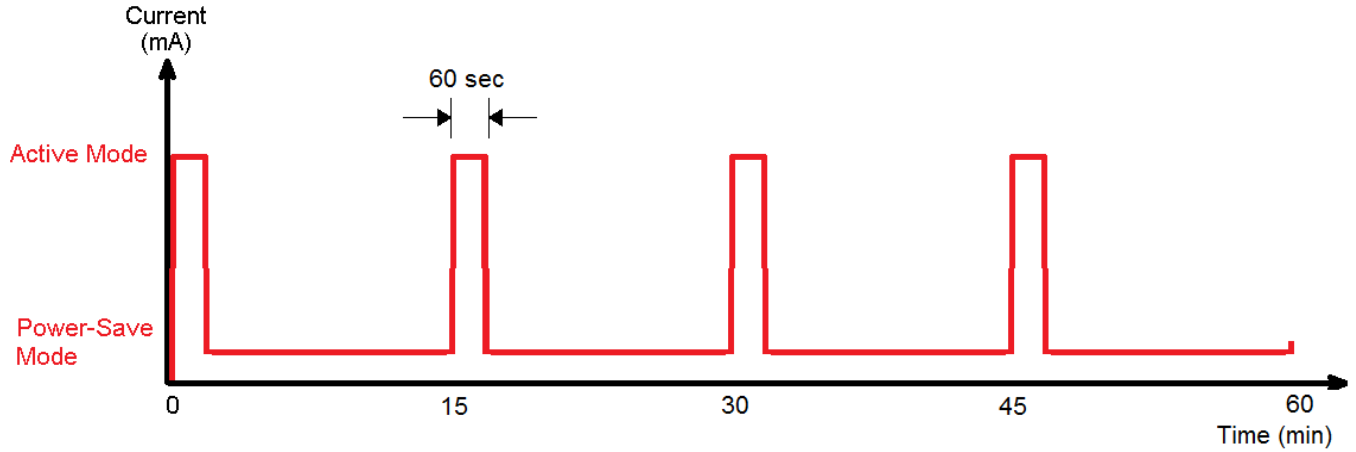
- GM862 Cellular Evaluation Board - USB

- MSP-EXP430G2 LaunchPad Value Line Development kit

Power Consumption

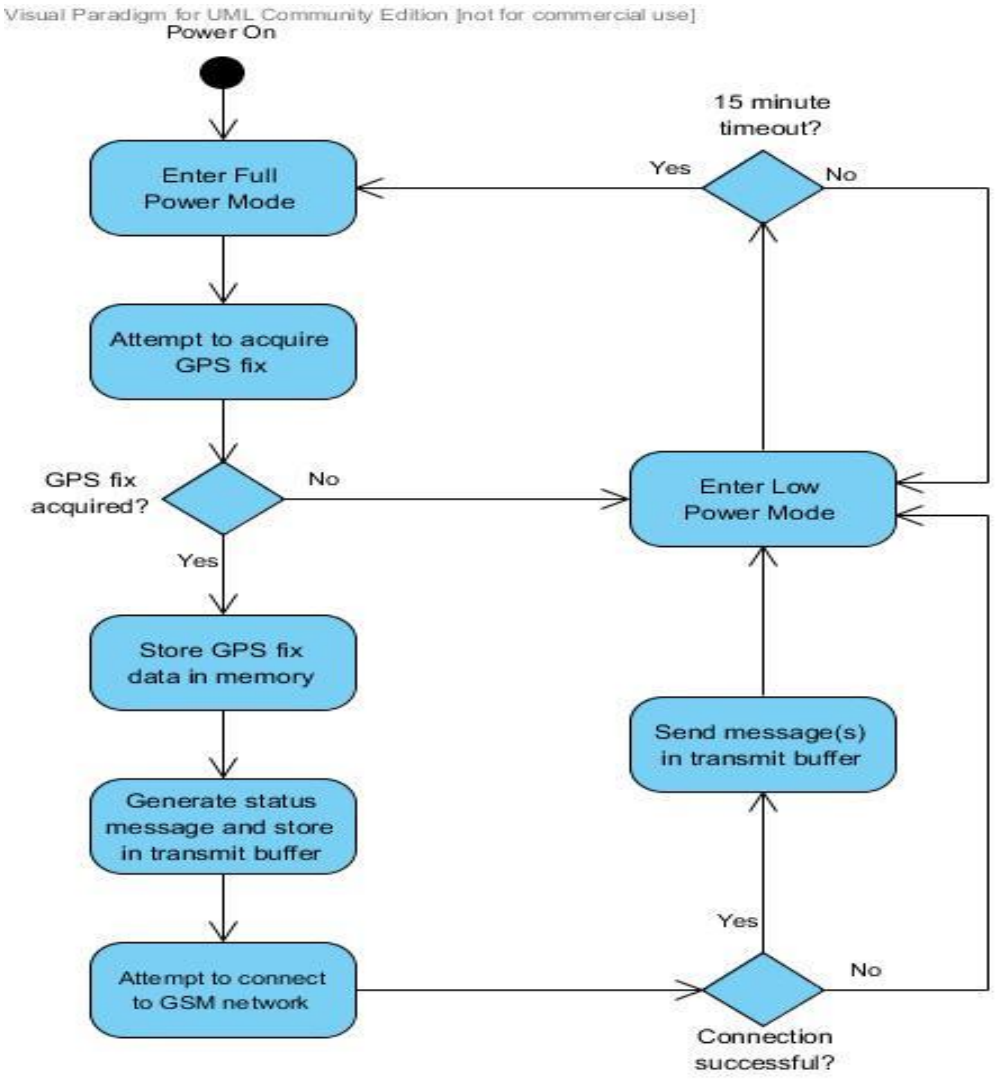
Component	Power-Saving Mode	Active Mode
Microcontroller	11 μW	506 μW
GSM / GPRS	96 μW	1369 mW
GPS Antenna	96 μW	259 mW
Memory	54 μW	26 mW
Pressure Sensor	14.8 mW	14.8 mW
Phototransistor	2.96 mW	100 mW
Total	**18.02 mW**	**1769.31 mW**
Current @ 3.7 V	4.87 mA	478.2 mA

Battery Life

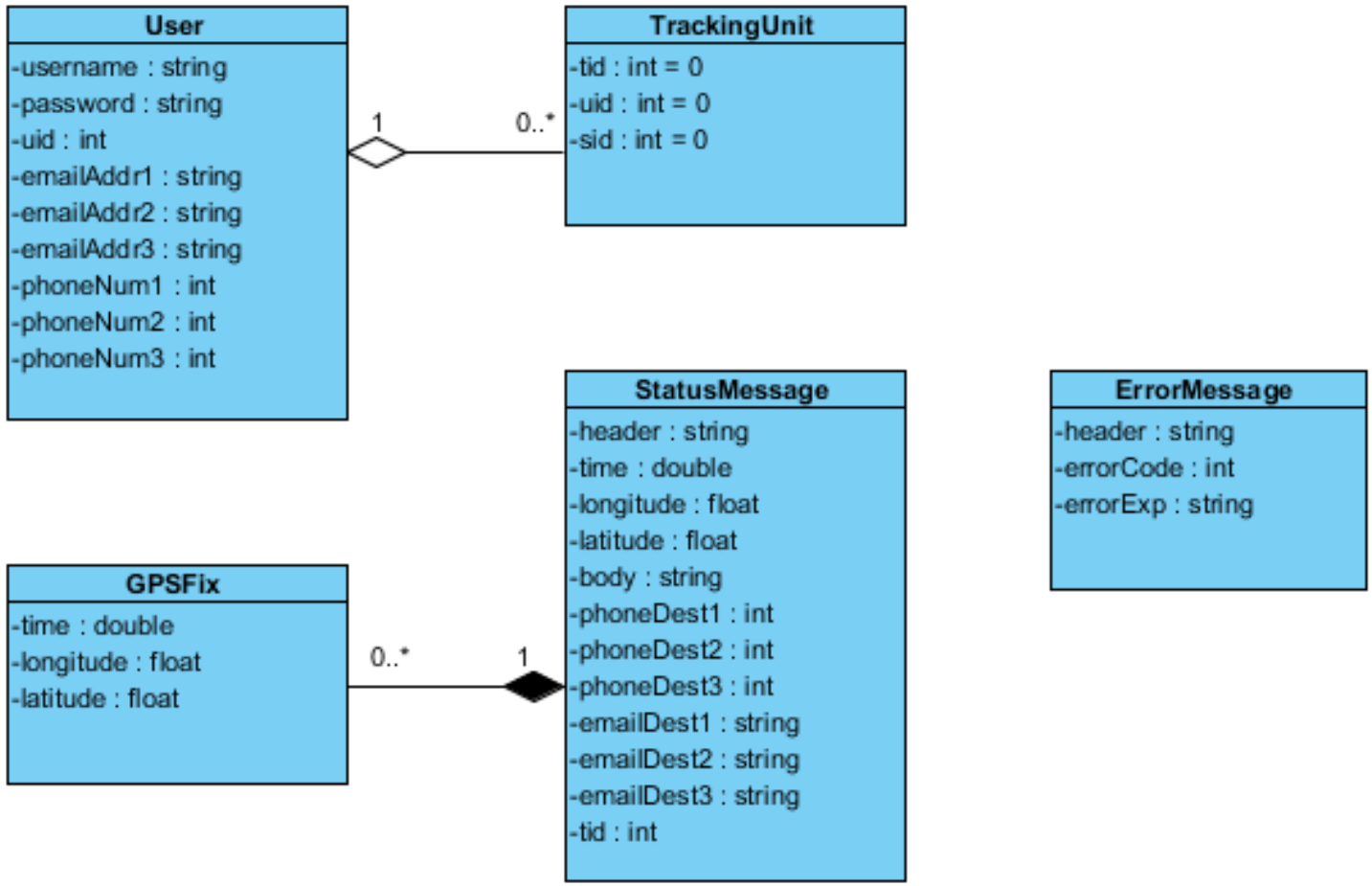


Battery Capacity	900 mAh
Current consumption during Power-Saving Mode	4.87 mA
Current consumption during Active Mode	478.2 mA
Number of wakes per hour	4
Duration wakes	60 seconds
Self discharge per month	<10%
Estimated Battery Life	**5.91 days**

Software Architecture



Class Diagram



User Interface

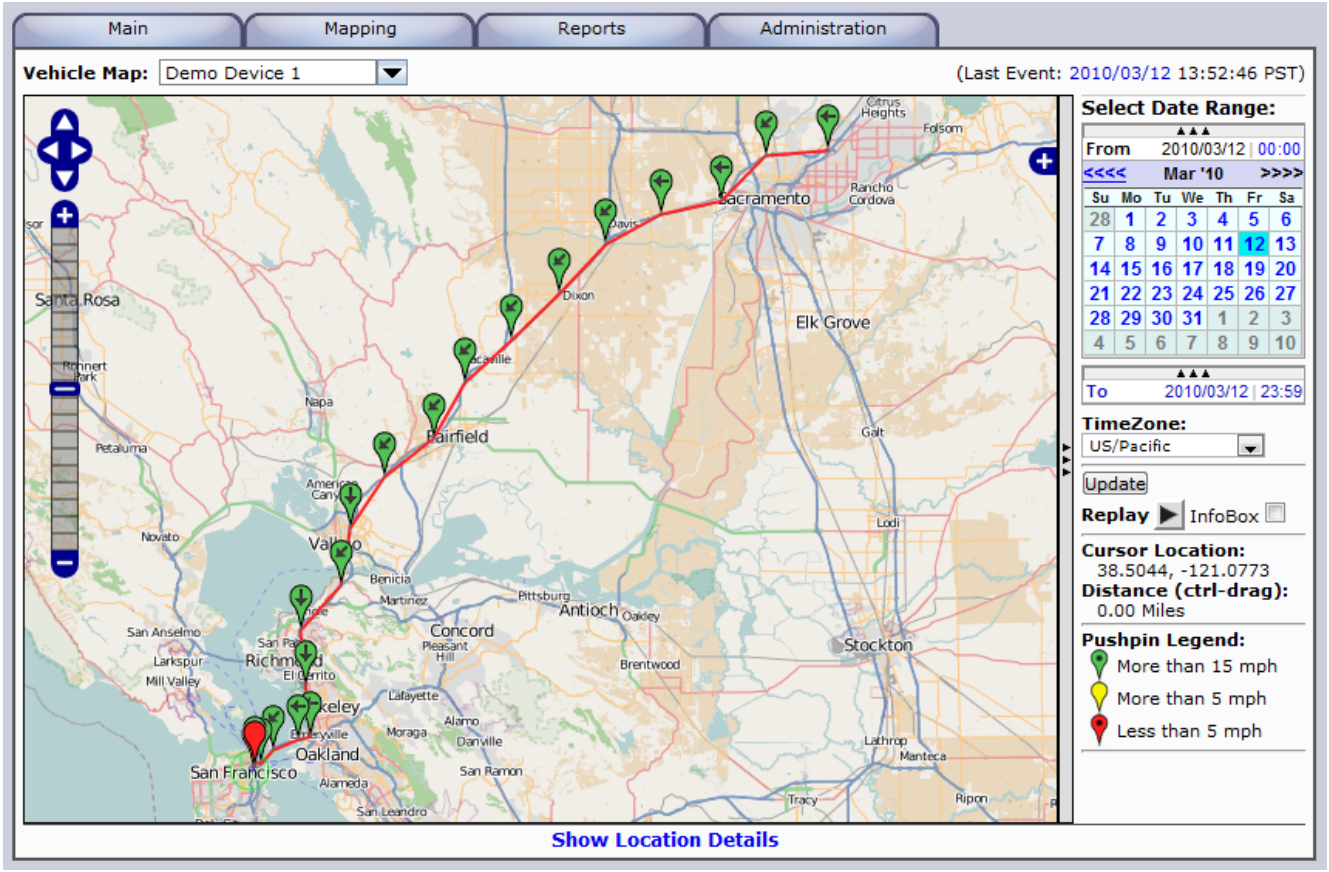
- Only external connector is mini-USB port for recharging
- Tracking unit settings cannot be modified by user
- Goal: implement text message user interface
  - Add/Remove phone numbers
  - Add/Remove email addresses
  - Change frequency of GPS fixes
  - Power down tracking unit

GPS Server

- No server experience, so open source server must be implemented
- OpenGTS Server
  - Web portal
  - Map plotting
  - Geozones
  - Tracking unit data

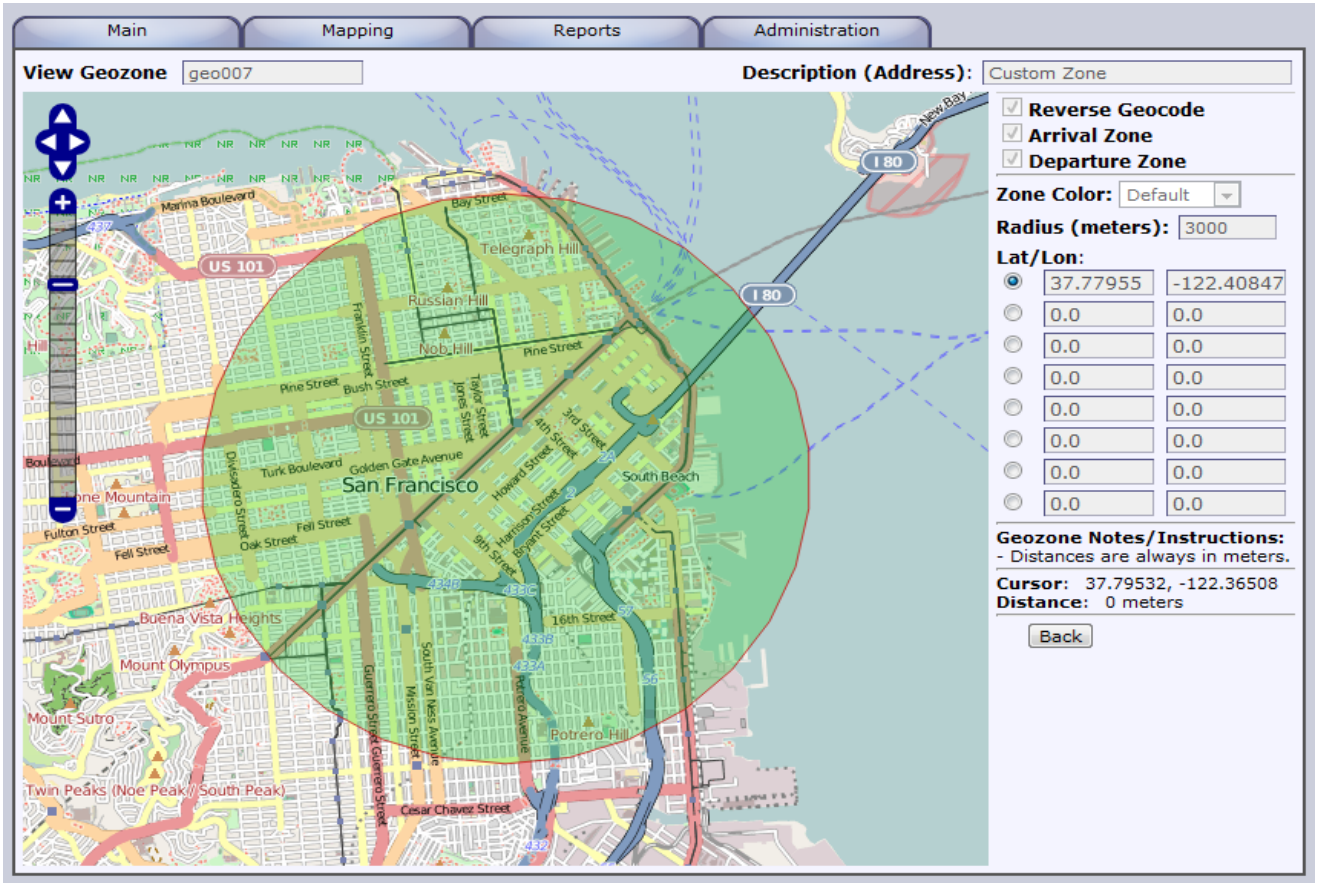
GPS Server

- Map plotting



GPS Server

- Geozones



iPhone App

- Will be implemented if time permits
  - Focusing on core functionality
  - Scalability
- Main purpose is for user convenience
  - Tracking
  - Alerts: Text and Email
- Features
  - User login portal
  - Map plotting
  - Geozones

iPhone App

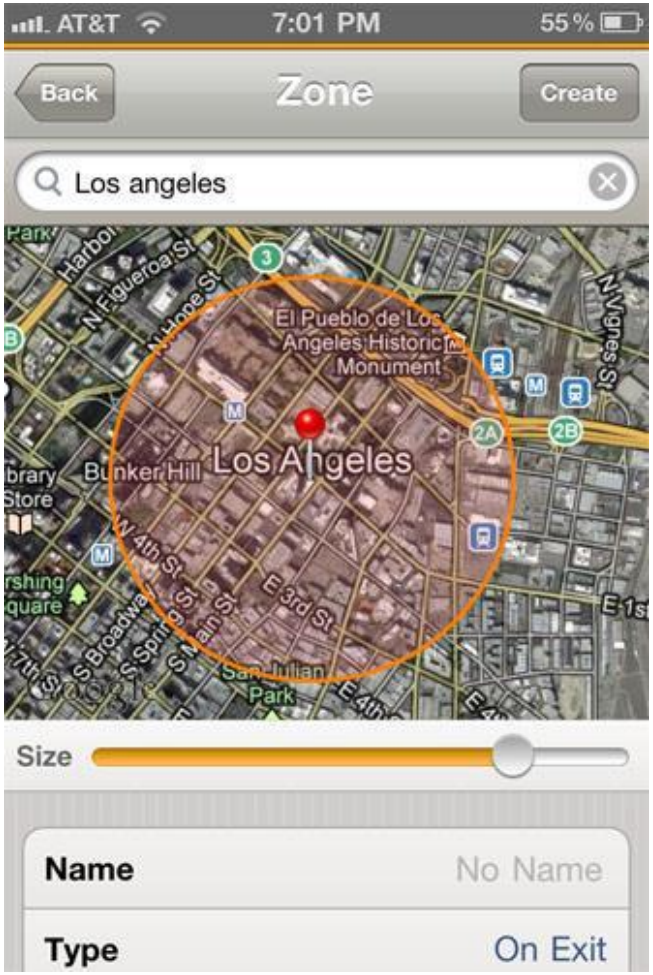
- User Login Portal
  - User-specific ID
    - Assign each piece of luggage to ID
    - Simultaneous tracking
  - Memory Log: Item Information
    - Location with timestamp
    - Light sensor exposure
    - Altitude tracking

iPhone App

- Map Plotting
  - Google Maps
    - Pinpoint current location of item
    - Can find multiple items at once
  - Track Path
    - Ability to determine route traveled
    - View location history
      - Not just current position

iPhone App

- Geozones
  - Arriving or leaving a specified zone
    - Set central location of Geozone
    - Adjust radius to user's preference
  - Notifications
    - Text and Email alerts when entering or leaving defined geozones
    - Multiple Uses:
      - Airport boundary
      - Home / Hotel boundary



Budget & Financing

decimal.
Outsourced Accounting Services

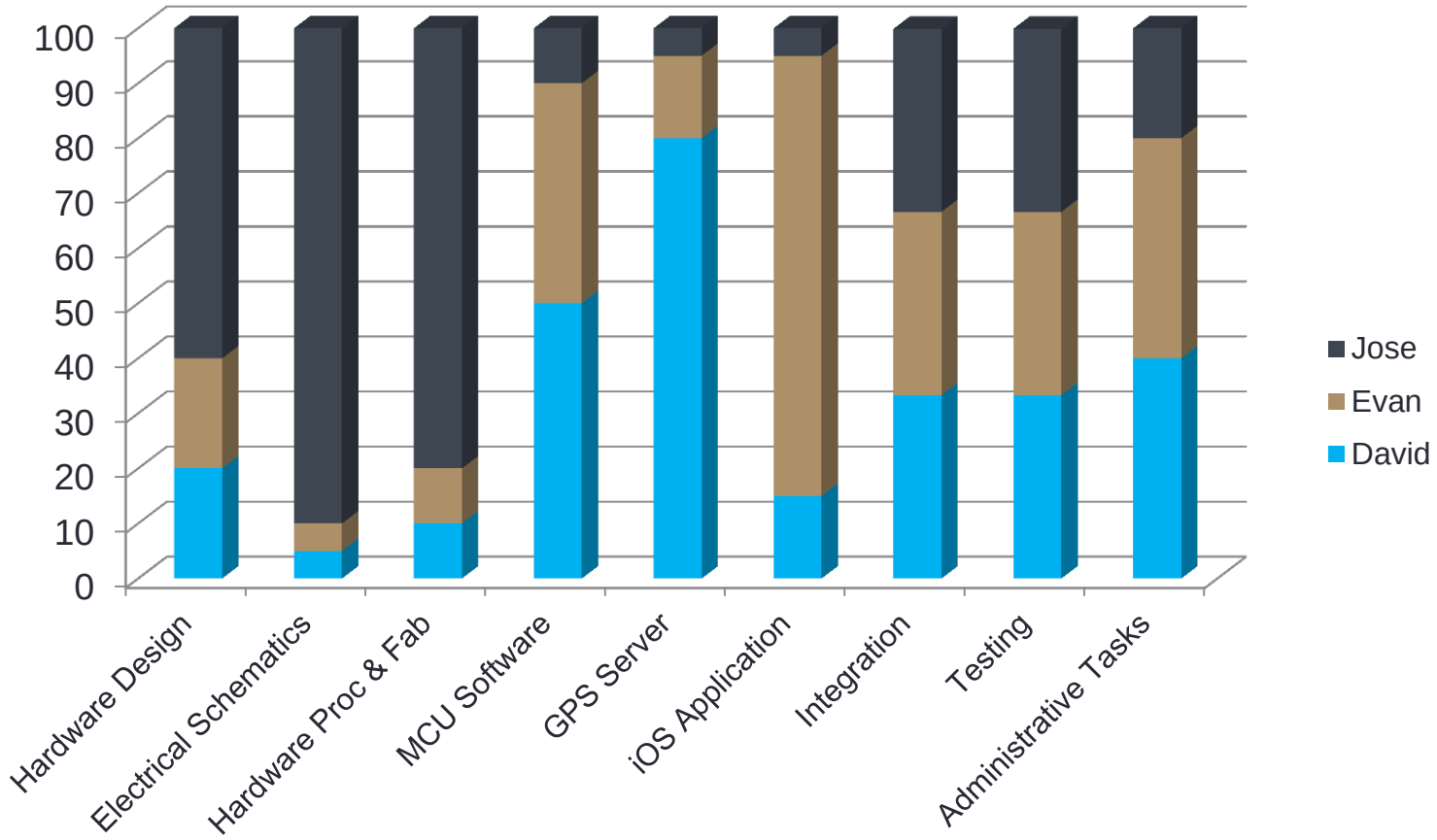
- $500 donation from project sponsor
- Total expenditure goal: $1,000 or less

Project Budget					
Part	**Estimate**	**Qty**	**Estimated Total**	**Actual Total**	**Balance**
GM862 Module	120.00	2	240.00	241.29	(1.29)
GM862 Evaluation Board	100.00	1	100.00	84.71	15.29
GSM Antenna	20.00	2	40.00	29.64	10.36
GPS Antenna	15.00	2	30.00	33.91	(3.91)
Mini USB cable & port	5.00	2	10.00		10.00
Battery & charger	45.00	2	90.00	33.14	56.86
Pressure sensor	10.00	2	20.00	22.23	(2.23)
Phototransistor	1.00	2	2.00	0.92	1.08
Minor electrical components	20.00	1	20.00	5.51	14.49
Microcontroller	5.00	2	10.00	9.68	0.32
Memory	10.00	2	20.00	2.00	18.00
Printed Circuit Board	35.00	4	140.00	150.45	(10.45)
50-pin connector	10.00	2	20.00	21.78	(1.78)
Enclosure	15.00	2	30.00	3.84	26.16
AT&T Cellular Service	16.25	6	97.50	65.00	32.50
iOS Developer Membership	100.00	1	100.00		100.00
Total			**$ 969.50**	**$ 704.10**	**$ 265.40**

Issues & Challenges

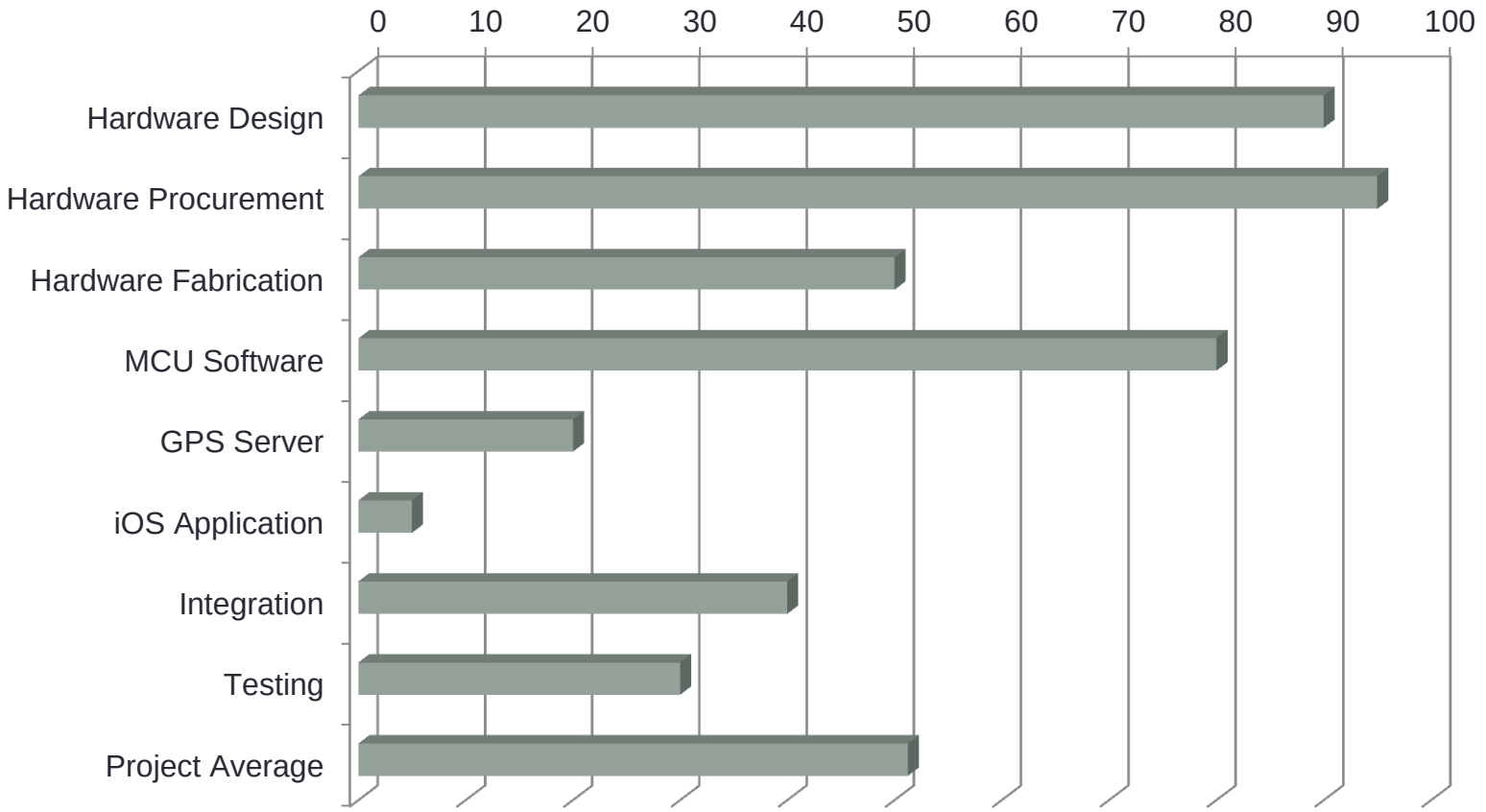
- Manpower and availability
  - Only 3 group members
  - Little availability outside of school and work
- GPS/GSM to MCU communication
  - Poorly designed/documented evaluation board was root cause
  - Delayed development by ~2 weeks
- MSP430 learning curve
  - Cryptic code slows development significantly
- Inexperience in numerous areas
  - Communication protocols (i.e. UART, SPI)
  - Server setup/integration
  - iOS application development

Work Distribution



Total Distribution ~ 33.3% per person

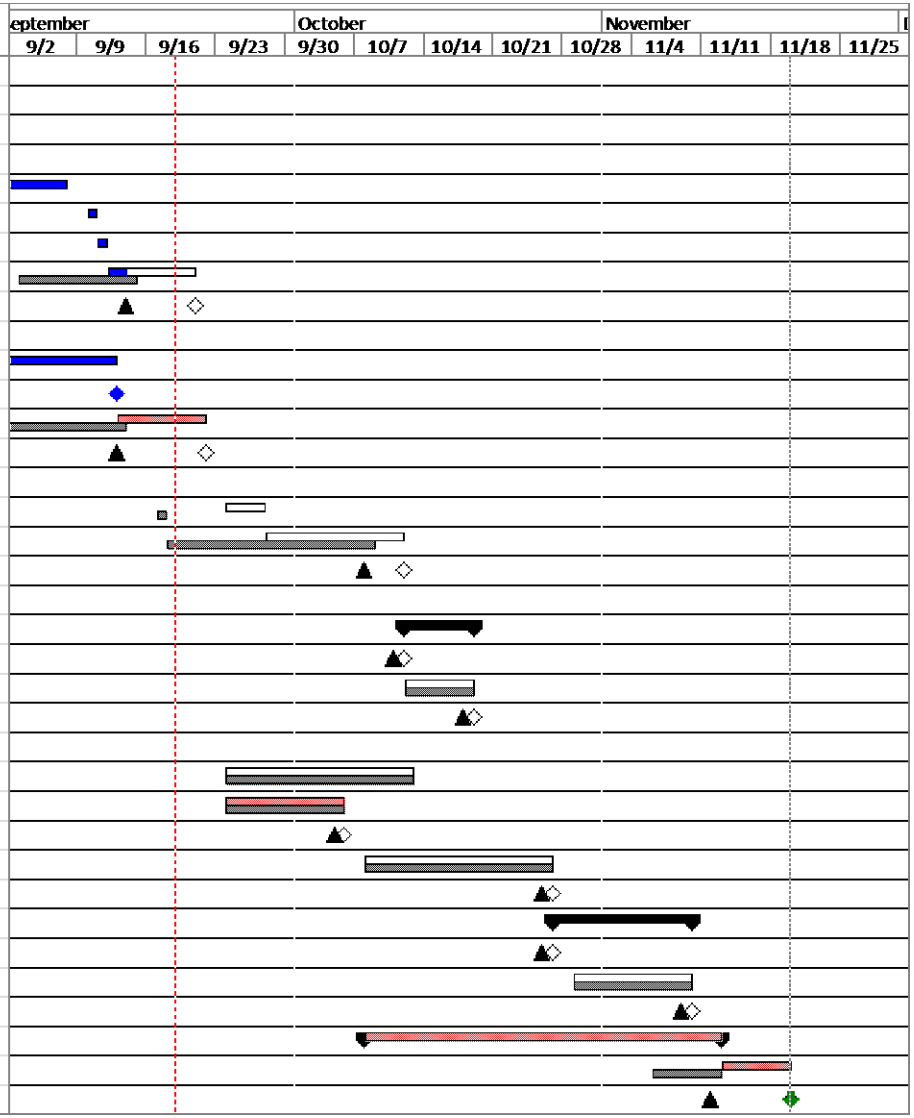
Statement of Progress



Total Progress ~ 50% Complete

Plans for Completion

ID	Task Name	Start	Finish
27	**Senior Design II**	**8/17/12**	**11/19/12**
28	**CDR**	**9/6/12**	**9/27/12**
32	**Phase A**	**8/17/12**	**10/11/12**
33	**Hardware**	**8/17/12**	**9/20/12**
34	PCB design	8/17/12	9/7/12
35	PCB layout complete	9/10/12	9/10/12
36	PCB ordered	9/11/12	9/11/12
37	PCB fab and ship	9/12/12	9/20/12
38	PCB delivered	9/20/12	9/20/12
39	**Software**	**8/17/12**	**9/21/12**
40	Initial software development	8/17/12	9/12/12
41	MSP430 to GM862 Comm Achieved	9/12/12	9/12/12
42	Phase A software development	9/13/12	9/21/12
43	Phase A software complete	9/21/12	9/21/12
44	**System**	**9/24/12**	**10/11/12**
45	LTU-A assembled	9/24/12	9/27/12
46	LTU-A testing	9/28/12	10/11/12
47	Full LTU-A functionality demonstrated	10/11/12	10/11/12
48	**Phase B**	**9/24/12**	**11/9/12**
49	**Hardware**	**10/11/12**	**10/18/12**
50	PCB ordered	10/11/12	10/11/12
51	PCB fab and ship	10/12/12	10/18/12
52	PCB delivered	10/18/12	10/18/12
53	**Software**	**9/24/12**	**10/26/12**
54	Phase B software development	9/24/12	10/12/12
55	GPS Server Setup	9/24/12	10/5/12
56	GPS Server Setup Complete	10/5/12	10/5/12
57	GPS Server Integration	10/8/12	10/26/12
58	Full GPS Server functionality demonstra	10/26/12	10/26/12
59	**System**	**10/26/12**	**11/9/12**
60	LTU-B assembled	10/26/12	10/26/12
61	LTU-B testing	10/29/12	11/9/12
62	LTU-B full functionality demonstrated	11/9/12	11/9/12
63	**Phase C**	**10/8/12**	**11/12/12**
68	Final Testing	11/13/12	11/19/12
69	Final Testing Complete	11/19/12	11/19/12



Questions?