
Wireless Inductive Charging

By Tesla Unplugged

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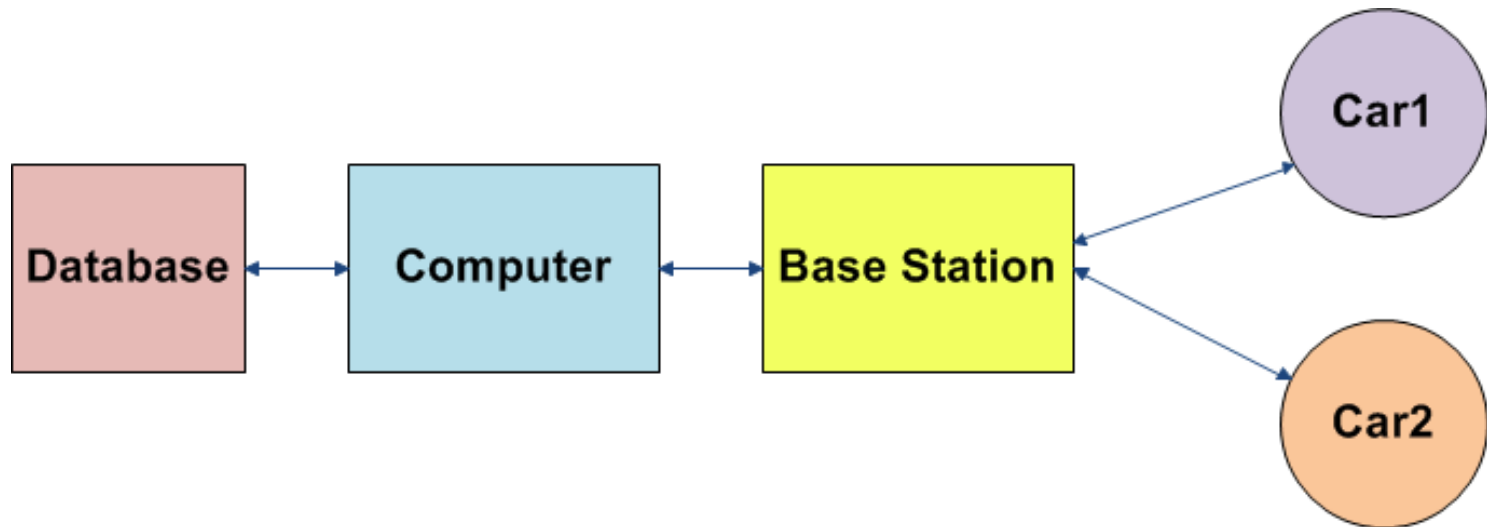
http://www.eng.utah.edu/~zwilcox/senior_project/

Intro

Comprised of four main parts:

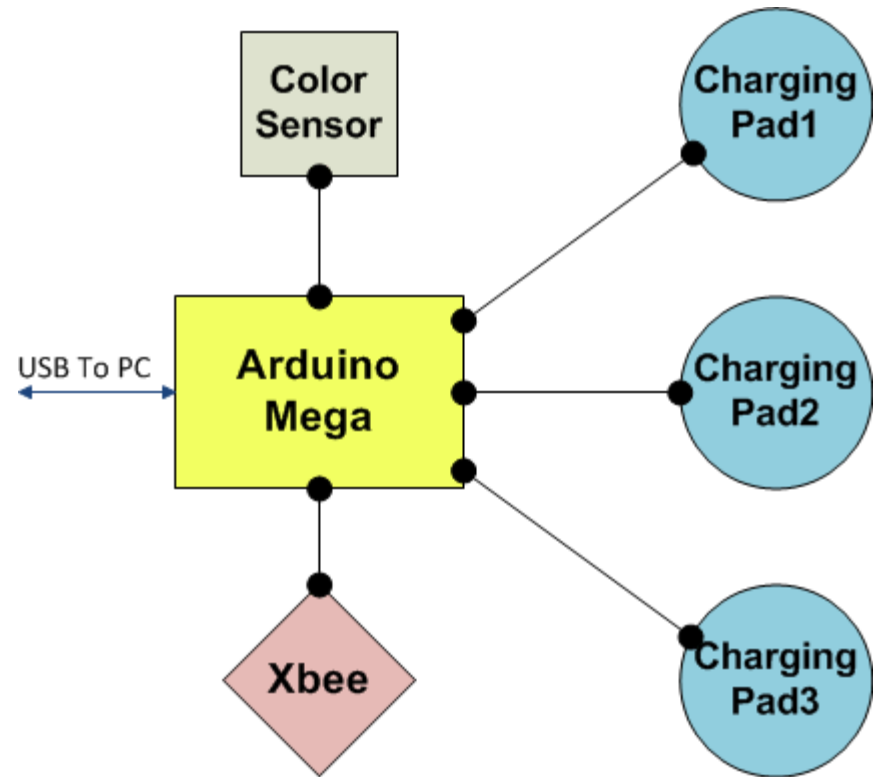
- Base Station
- Electric Vehicles
- Charging Circuit
- Computer for data collection

Overall Block Diagram



Base Station

Arduino Mega
XBee Radio
XBee Shield
Light Sensors
Voltage Sensors
Inductive Chargers
PC Connection



Base Station

Arduino Mega

54 digital I/O lines

We need 11

XBee Radio needs two pins:

Rx, Tx (0,1)

Light sensors need two each:

SDA, SCL

Rx1, Tx1

Rx2, Tx2

Charge pad enable needs pins:

2, 3, 4

Compatible with XBee Radio



[1]

16 analog I/O lines

We need 6

Read power from three pads:

A0, A1, A2, A3, A4, A5

XBee Radio + Shield

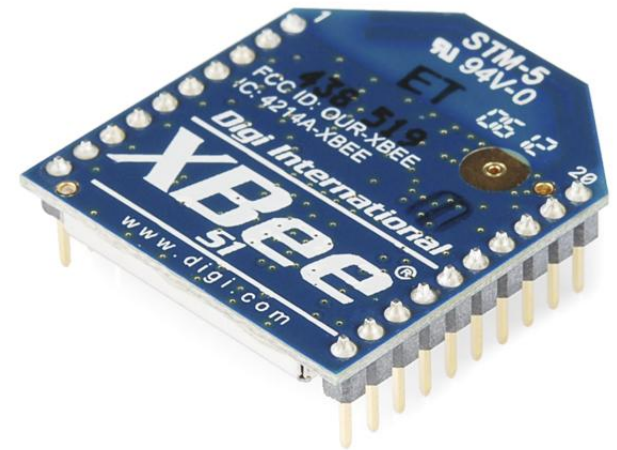
Uses pins 0 and 1 on
Arduino

Easy to use

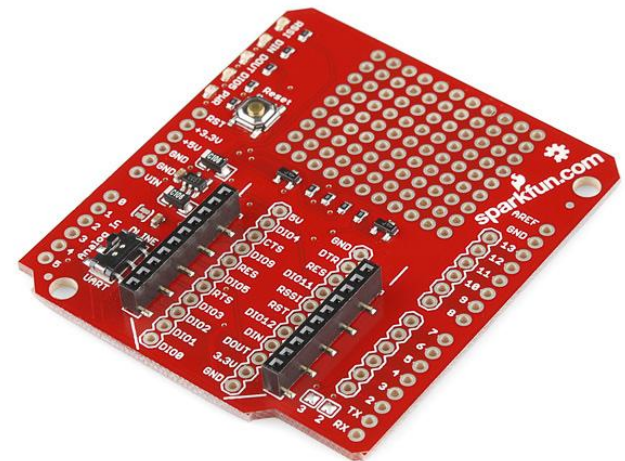
Easy to set up

802.15.4 Network Topology

Broadcasts



[2]



[3]

Colored Light Sensors

Use I2C interface

All sensors on address 0x74

Need three I2C busses

22 Registers to read from

Two bus accesses to read/write

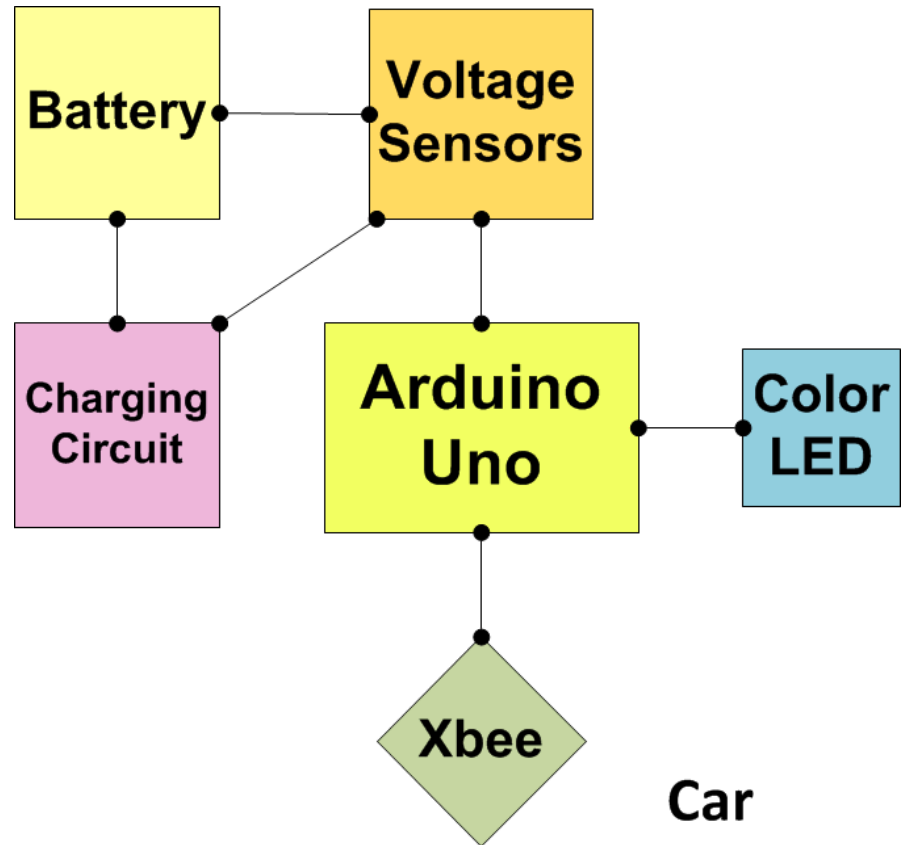
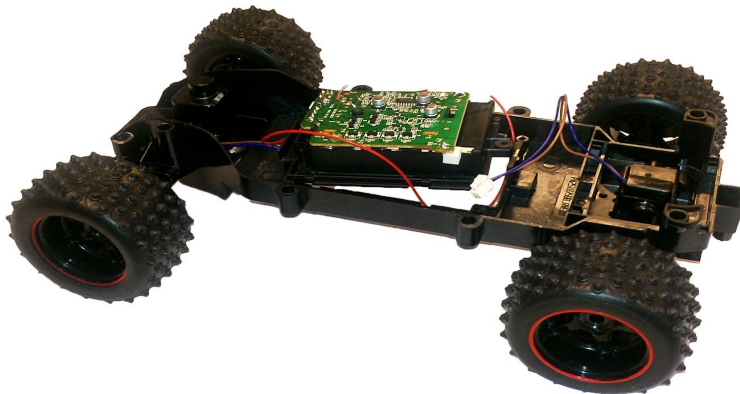
1.2ms to read full sensor value



[4]

Cars

Arduino Uno
Voltage Sensors
Color LEDs
XBee Radio
XBee Shield



Arduino Uno

Cheap & Simple

14 Digital IO pins

We need 4

XBee Radio needs two pins:

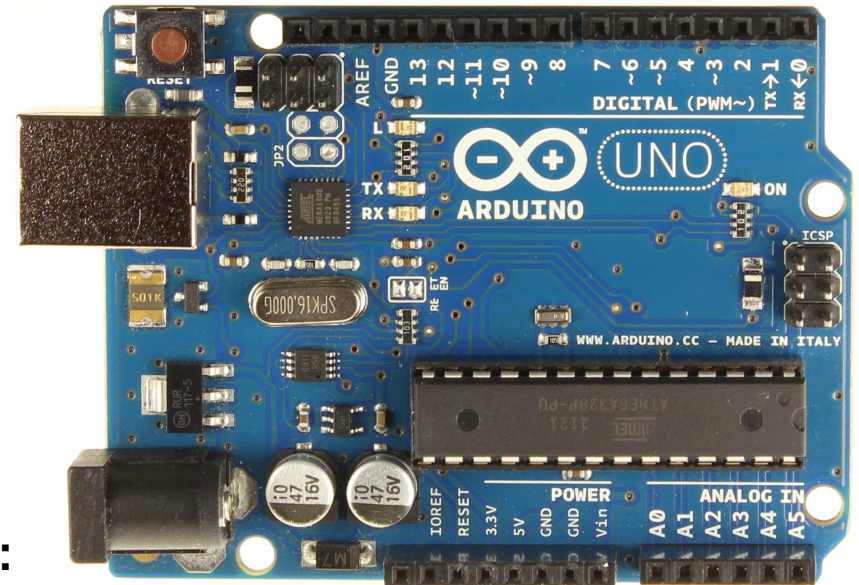
RX, TX (0,1)

LED needs one pin:

Pin 2

Charge enable switch takes one:

Pin 3



[5]

5 Analog IO pins

We need 3

Read voltage received (A0)

Battery voltage (A1)

Power Consumption (A2)

Inductive Circuit

How do we create an inductive wireless charge?

WITH SCIENCE...

...Magnets...

...and Miracles!!

Audience Cue: "What Three Things?!"

Inductive Circuit

Not that complicated:

AC Power + Coils = Magnetic Field!

Magnetic Field + Coils = AC Power!

Our solution: Google!

Following Guide found on Instructable.com

- "Wireless Power Charger!"

Inductive Circuit

Broken into two parts:

1 Primary Circuit

- a) Powered with AA batteries
- b) Controlled by base station

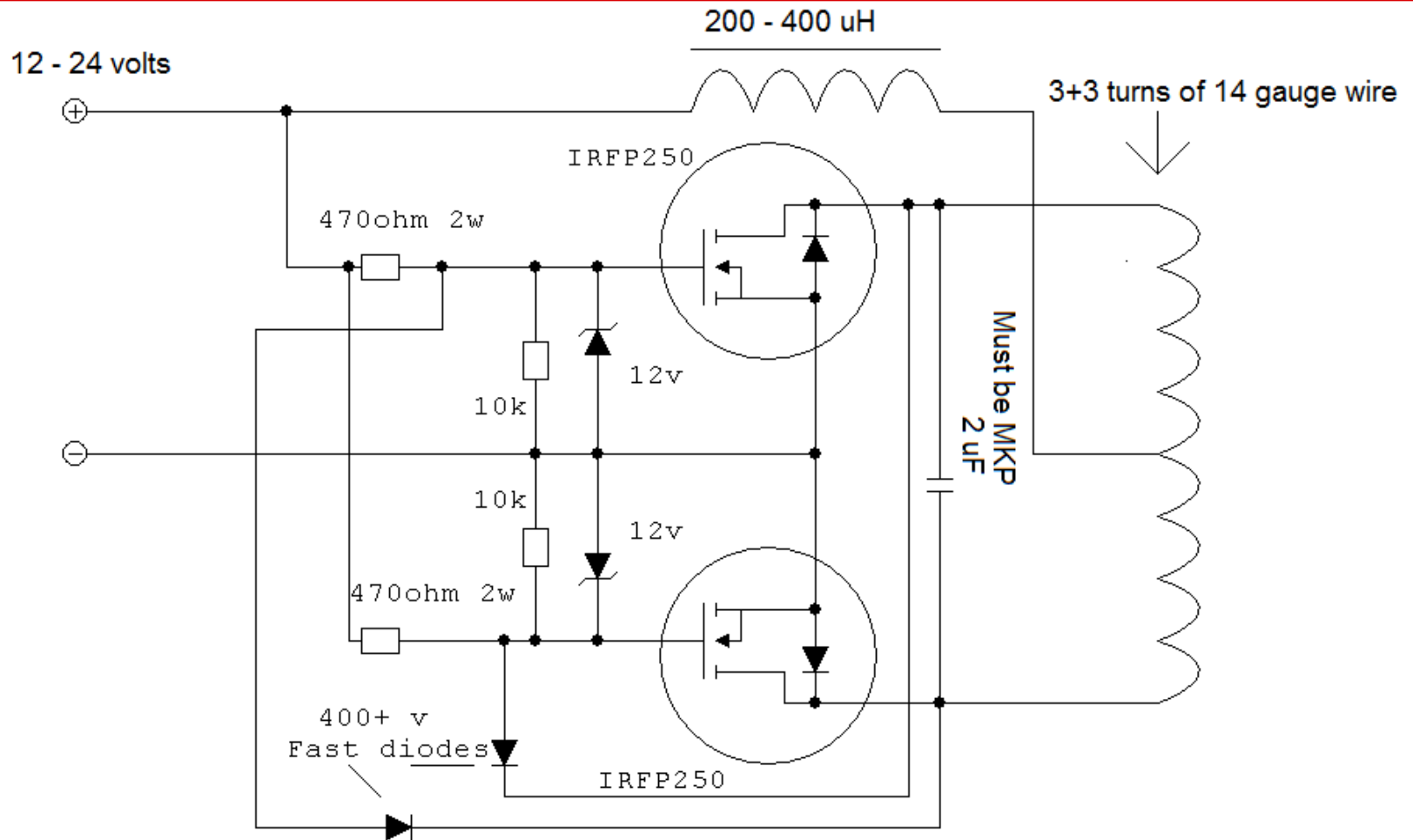
2 Secondary Circuit

- a) Connects to USB LiPo battery charger
- b) Located on Car

3 Coils (3 Turns)

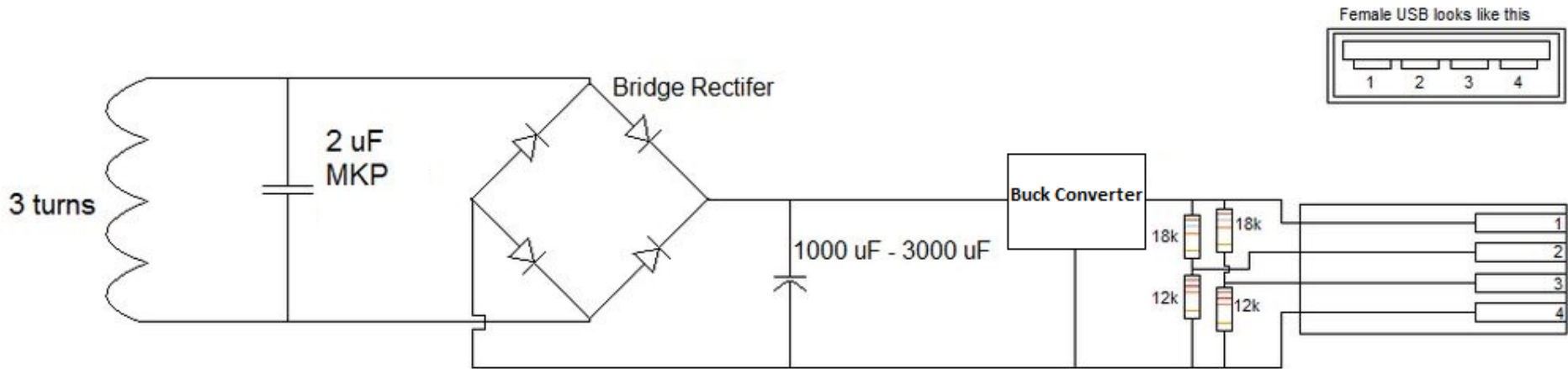
Each about 7-9 feet of 14 gauge wire

Primary Circuit



[6]

Secondary Circuit

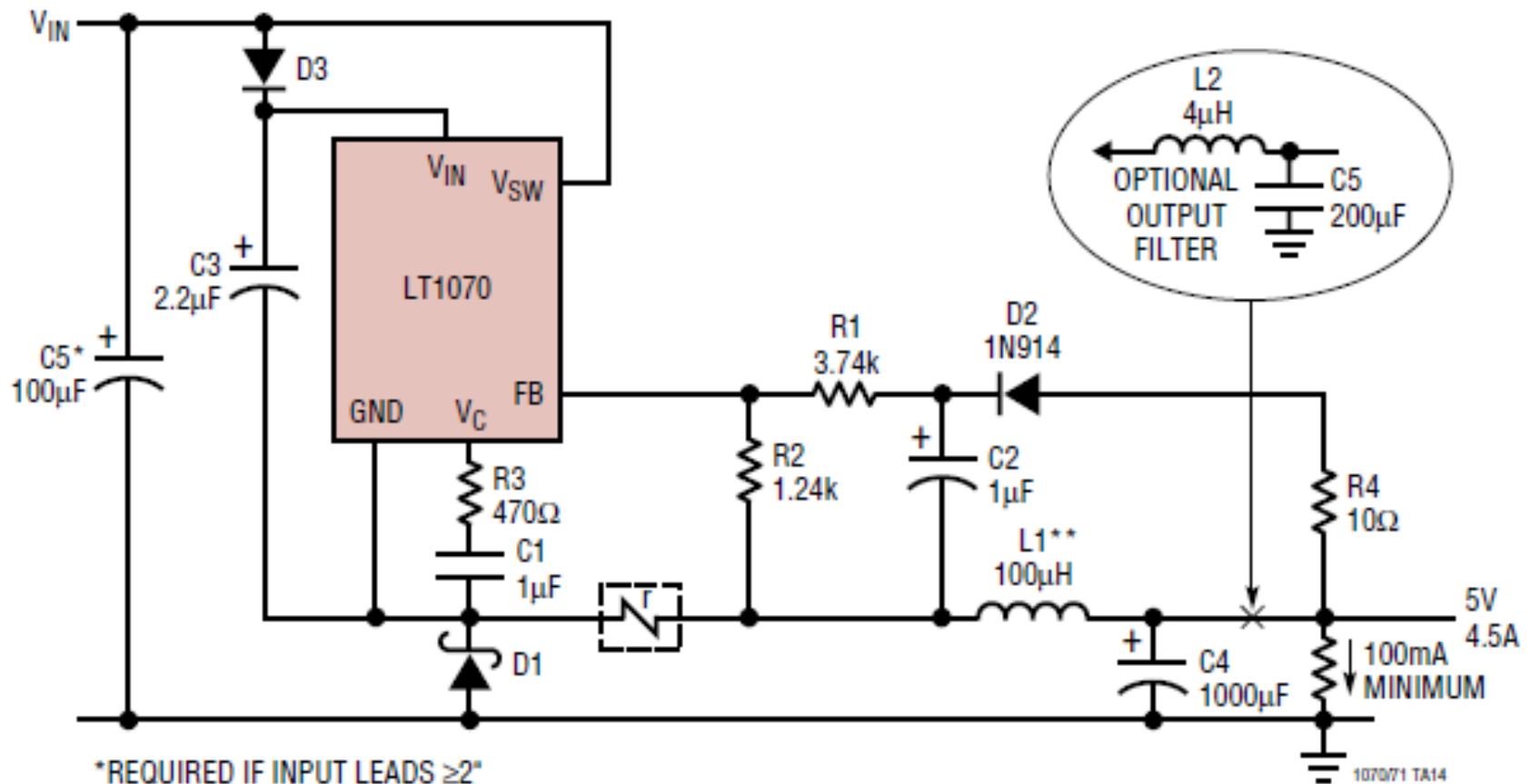


[6]

Using Buck Converter

- LT1070 boost converter
- DC-to-DC Converter
- 93% efficient [7]

Buck Converter



[8]

Battery Charger

- Vehicle natively uses 5-AA batteries (1.5 V ea)
- Initial testing shows our vehicle stops functioning below 2 V.
 - Runs fine at 3.7 V
- Single Cell LiPo Battery Supplies 3.7 V
- Selected a LiPo USB Battery charger
 - 'SYS OUT' - "allows connection from the charging circuit directly to the load without disconnecting the charger " [9]
 - Hopefully will allow us to charge battery while it's in use

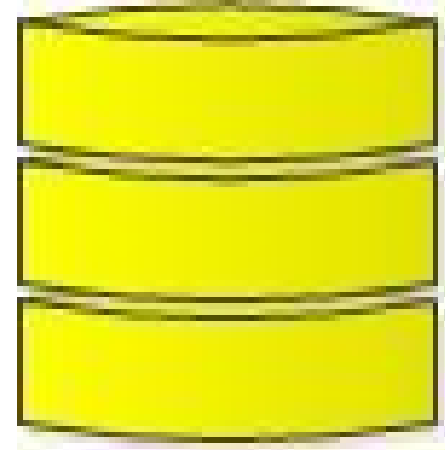
Database

Authentication

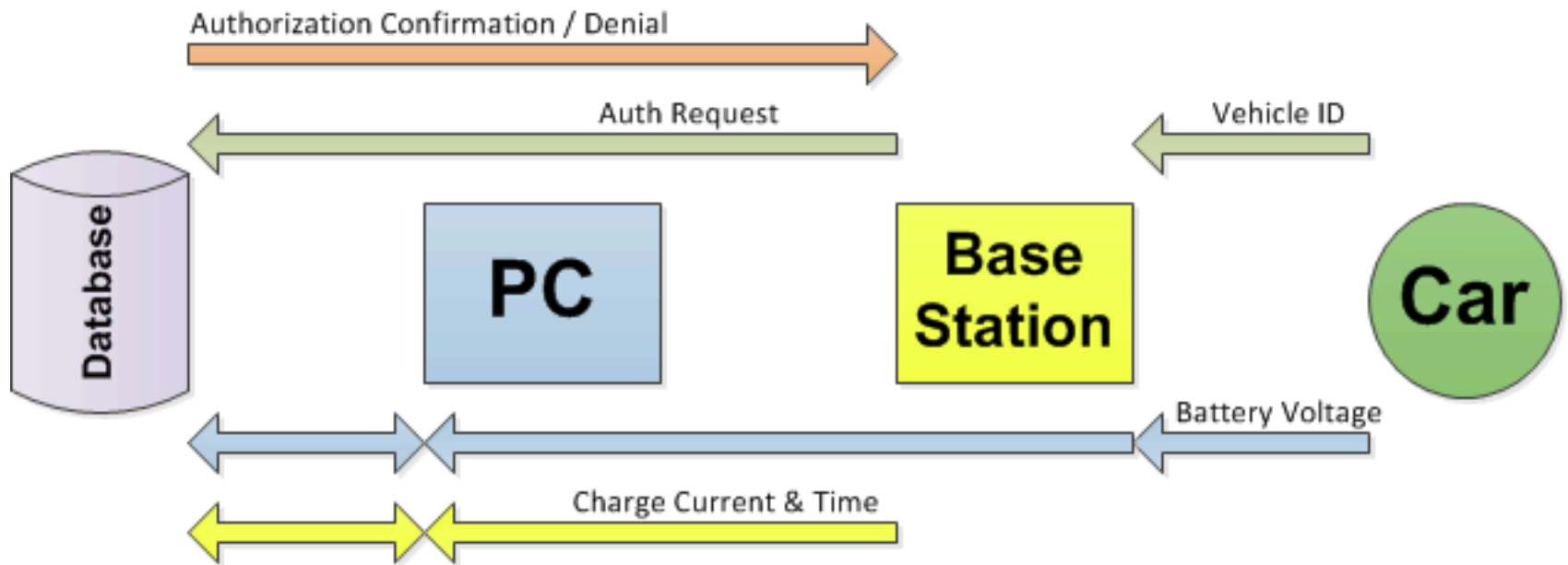
Vehicle history information

MySQL Community Server

- Can easily handle our data
- Uses Standard Query Language (SQL)
- Free



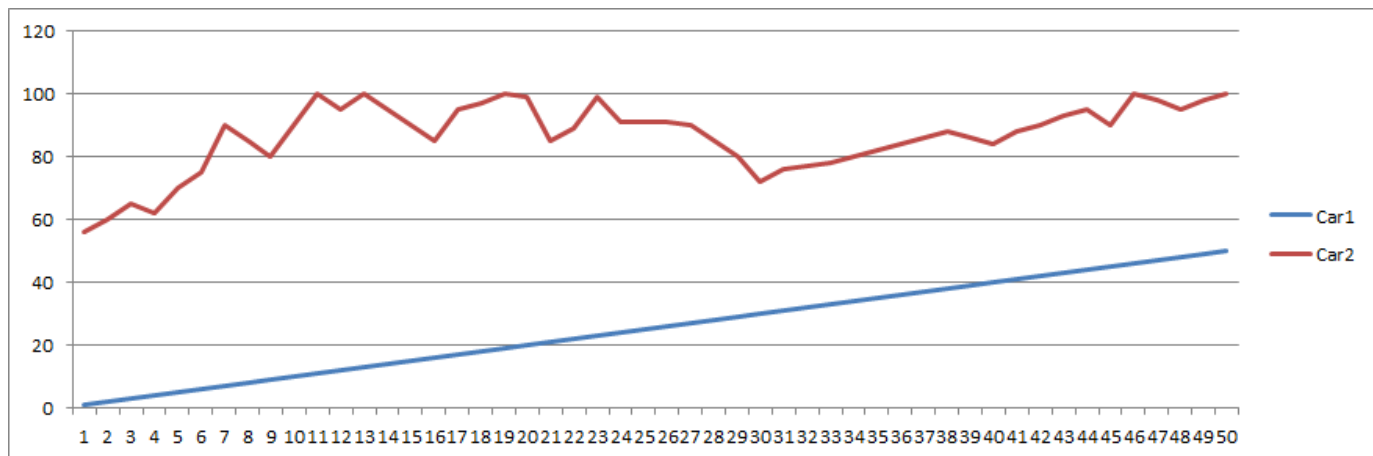
Data Flow



Data Visualization

Data for each vehicle

- Battery voltage levels
- Current provided to charge
- Length of time charged



Breaking it Up

TASK

Parts Acquisition

Charging System

Base Station Control of Charging Circuit

Car Battery Monitor

Car to Base LED / Color Sense

Base Station to PC Communication

Database

GUI

PC Software to Store Data

LEAD

Everyone

Zach

Zach

Ari

Ari

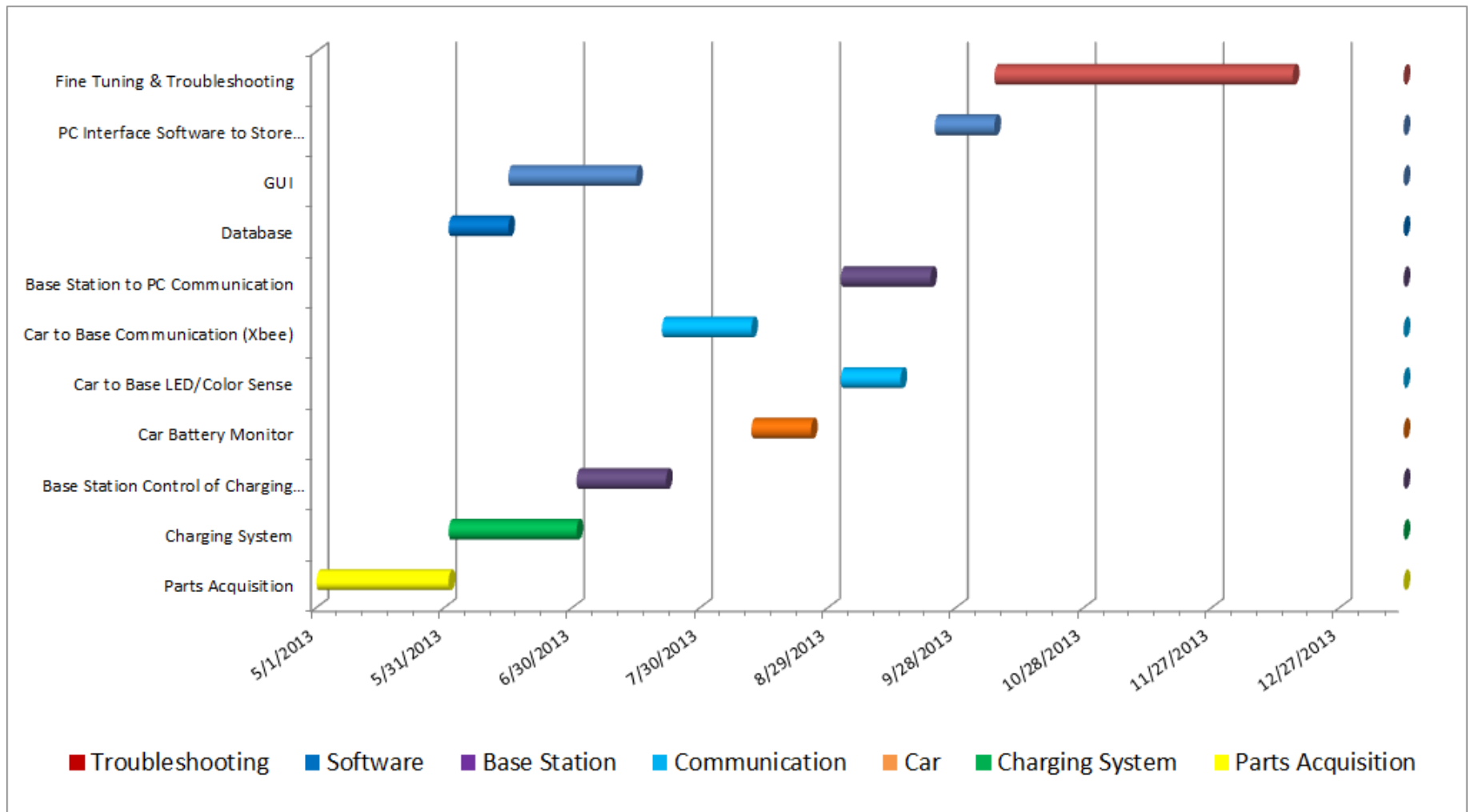
Zach

Jeff

Jeff

Jeff

Schedule



Risks

- High Risk:
 - Inductive Circuit
 - Found a Design online that works
- Medium Risk
 - Charging Battery while vehicle is in use
- Low Risk
 - Electric Noise
 - XBee Radio interference

Damage (BOM)

New Brite R/C	Qty: 2	RadioShack	\$25.00	ea
100 Feet 14-Gauge Wire	Qty: 1	Vendor: Home Depot	\$50.57	ea
Heatsink & Fan	Qty: 3	Vendor: Newegg	\$22.99	ea
Lithium Polymer - USB Charger and Battery	Qty: 3	Vendor: Sparkfun	\$24.95	ea
Polymer Lithium Ion Battery 850mAh - LT107	Qty: 2	Vendor: Sparkfun	\$8.95	ea
Arduino Mega	Qty: 3	Vendor: Linear Tech	Free Samples	
Arduino Uno	Qty: 1	Vendor: Sparkfun	Already owned	
XBee Shield	Qty: 2	Vendor: Sparkfun	\$29.95	ea
XBee Radio	Qty: 3	Vendor: Sparkfun	\$24.95	ea
8-Pin Stackable Headers	Qty: 3	Vendor: Sparkfun	\$22.95	ea
Light Sensor	Qty: 6	Vendor: Sparkfun	\$0.50	ea
MySQL Community Server 5.6.10	Qty: 3	Vendor: Sparkfun	\$14.95	ea
	Qty: 1	Vendor: MySQL	Free	

Grand Total: \$513.74

References

- [1] <http://arduino.cc/en/Main/ArduinoBoardMega>
- [2] <https://www.sparkfun.com/products/11215>
- [3] <https://www.sparkfun.com/products/10854>
- [4] <https://www.sparkfun.com/products/10701>
- [5] <http://arduino.cc/en/Main/ArduinoBoardUno>
- [6] <http://www.instructables.com/id/Wireless-Ipod-Charger/>
- [7] http://en.wikipedia.org/wiki/Buck_converter
- [8] <http://cds.linear.com/docs/Datasheet/10701fe.pdf>
- [9] <https://www.sparkfun.com/products/9876>

Questions?

Comments?

Concerns?