SMART HOME SYSTEMS

Group 10

Daniel Moody CpE

Thien Luu EE

Joel LeGros EE

Vu Ha EE

Motivations

- Energy efficiency
  - light automation, appliance control
- Convenience
  - control through your portable smartphone
- Security
  - Motion detection, windows and doors sensing

Objectives

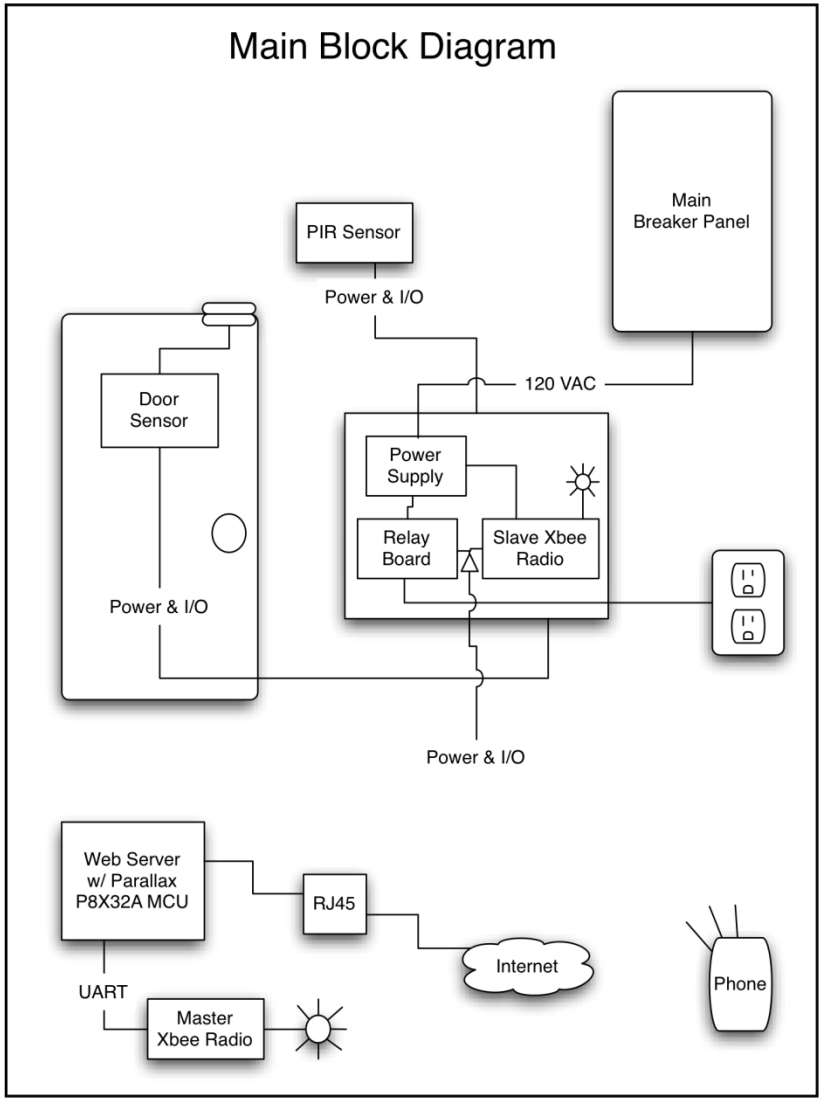
1. Control systems and status
   - Relay switch control from internet
   - Motion/security sensing
2. Wireless communications
   - Wireless networks
   - Portable control device
3. Database management

Specs and Requirements

- Low power usage
  - System modules needs to use less then 3 Watts
- Low Cost
  - Less than $300 for basic system setup
  - Less than $600 for development cost
- Requires smart phone or similar device
- Needs internet connection to fully utilize system

Overall Block Diagram

- Processor chip
  - Parallax Propeller P8X32A
- WIZnet W5100 Ethernet Controller
- Wireless Modules
  - Master and Slave Configuration
- PCB Module
  - Power supply
  - Supports XBee
- PIR sensor
- Seco Magnetic sensor
- Smartphone application

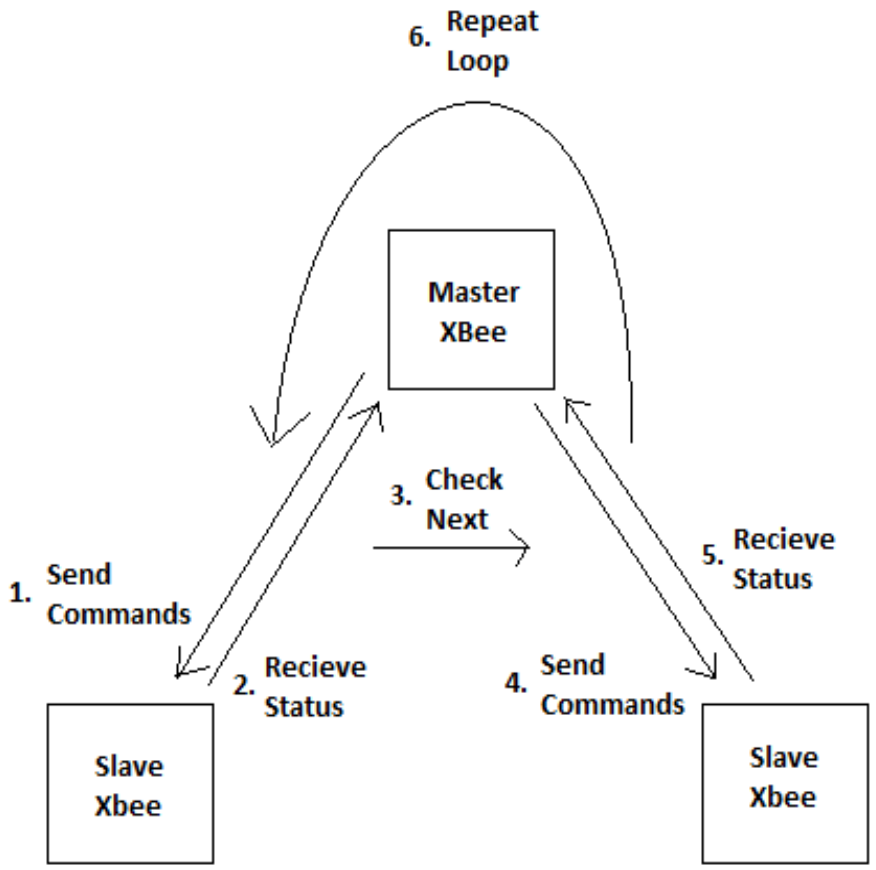


Wireless Modules

- Xbee 802.15.4 Series 1
- 1 mW RF antenna
- 2.4 GHz frequency band (accepted world-wide)
- Industrial temperature rating (-40C to 85C)
- Supply voltage 2.8-3.4 VDC;
- transmit current 45 mA, receive current 50 mA
- 3.3V CMOS UART interface level

Wireless Network

- The wireless network is setup in a master-slave configuration
- The slave units do not initiate communication, they only respond to the master unit ‘s request to avoid data collisions
- The master unit will loop through all the slave units sending commands and letting the slave unit know it is OK to broadcast



Wireless Module Master Protocol

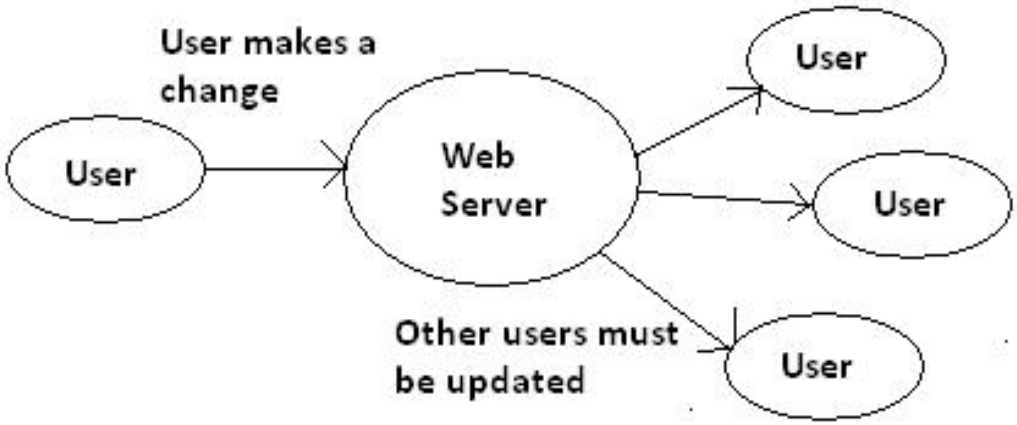
- The master unit reads commands from the web server through a transfer and receive UART communication lines.
- The web server tells the master which address of the slave unit to broadcast to
- The web server I/O pins are connected to the master Xbee's I/O pin, and takes a reading from the I/O pins for the corresponding module

Android Application

- Home Status is for basic control functions
  - Change I/O
  - Get status updates
- User can log in to verify who is interfacing with the system

Android Programming

- Application is being programmed in Eclipse IDE with Android plug-ins.
- The application uses Apache libraries to setup network communication.
- The application will store the user accounts, system status changes and commands in an SQLite database.
- The database will need to be updated from the web server so all instances of the application will be congruent.



Apache

eclipse

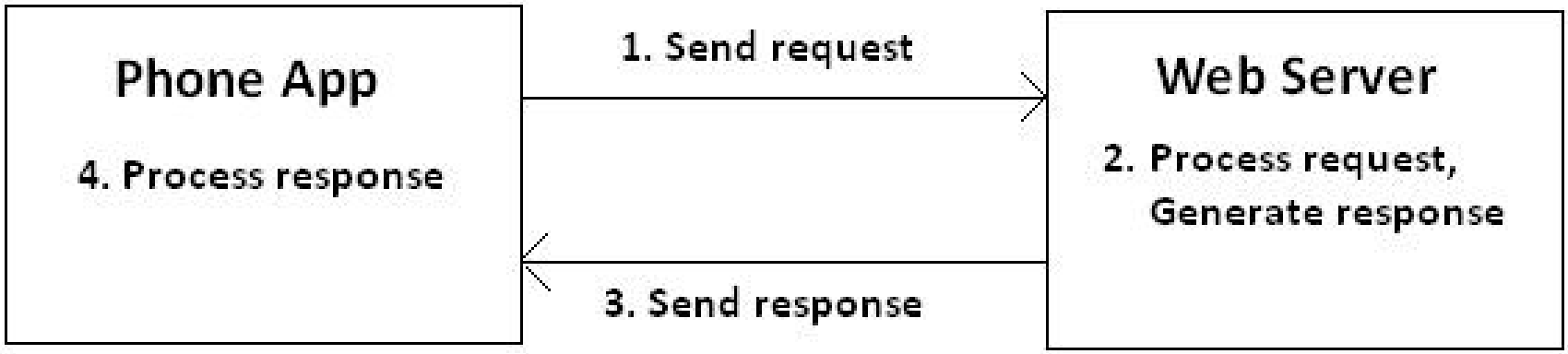
SQLite

Smartphone Database

- The android application will use SQLite to store user information and module information in separate tables for quick lookup.
- A string will be generated from a text file on the web server, and will be parsed and the correct information will be stored in corresponding fields on the phone database.
- After an update the database will then be immediately opened and the needed data will be read from the database.

Application communication

- So far the commutation between the spinneret web server and home is a simple design.
- The communication transactions are always: send a request and web server sends a response.
- Depending on the request the web server will execute commands, and then send back a response, indicating what it did and the current state of something.



Web Server Security

- Because the web server is receiving request, there needs to be a way to identify which user is accessing the system.
- User names and passwords will be used to verify identity.

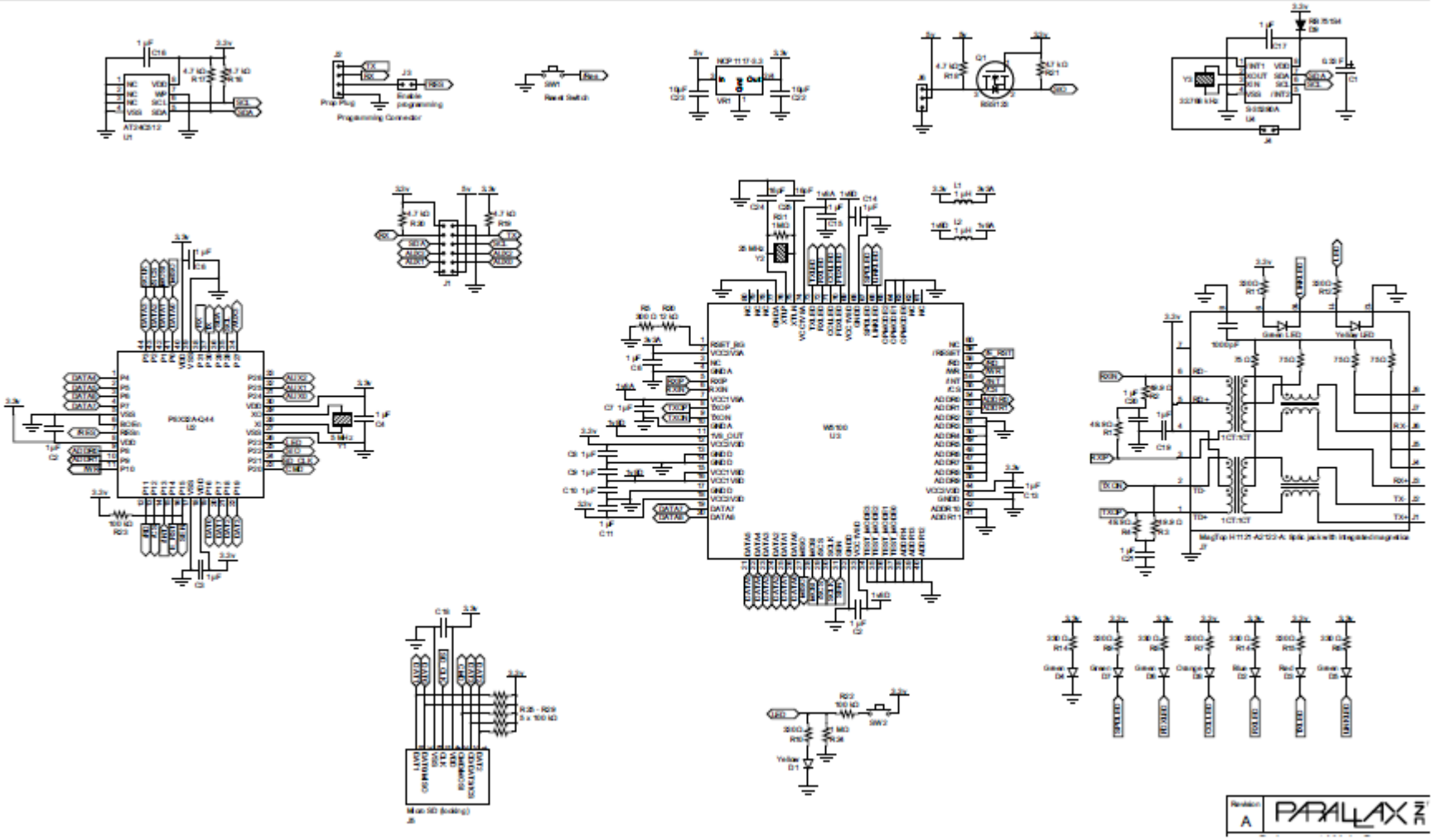
Web server database

- The web server will use text files to store the user and module information on the SDcard.
- The text files will use space, comma, period and newline characters to organize data within the text file.
- When a phone needs to be update it request the entire database text file and process it on the phone.

Propeller Programming

- An open-source multi-socket web server program was modified for the purposes needed in this project.
- The program is written in an OO language, SPIN (similar to python), specifically made for propeller chips.
- Several spin libraries were used for drivers of the SDcard, Xbee communication, and a custom database object was created.

Web server Schematic



Web server

- Cheap and efficient chips to run a web server.
  - Propeller P8X32A – 160 MIPS(~80 MHz), 32K RAM, 32 I/O
  - Wiznet W5100 - Ethernet Controller, 16K Tx/Rx Buffer
- Pros
  - MicroSD slot for data storage
  - Doesn't require OS
- Cons
  - Rated at 80 Mhz processor

Use of Web server

- The web server is the master control unit of the system
- Database information is stored on the web server
- Phone application updates it self through request to the web server
- The web server issues commands to the Xbee network to be transferred to the power outlet modules

Lighting/Outlet Control

- JQX-15F(787) Relay
- rated up to 220 VAC at 20 Amps
- Single pole double throw
- controlled by Xbee series 1 module
- 3.2 V signal can turn the relay off and on

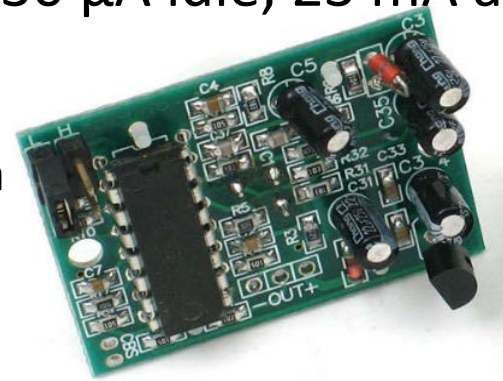
Parallax PIR Motion Sensor

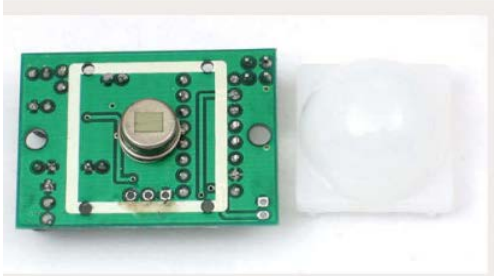
- Detect a IR source up to 30 ft. away
- 110 degrees x 70 degrees detection range
- Power: 3.3 to 5 VDC input; 130 µA idle, 23 mA active
- Single bit high/low output
- Dimensions: 1.27 x 0.96 x 1.0 in
- **Applications**:

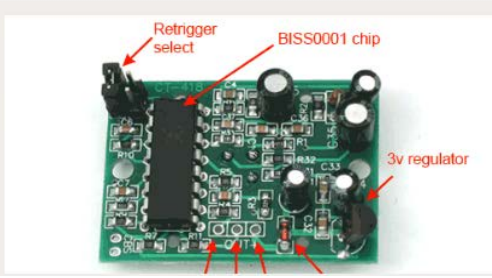
  Motion-activated lights

  Alarm systems

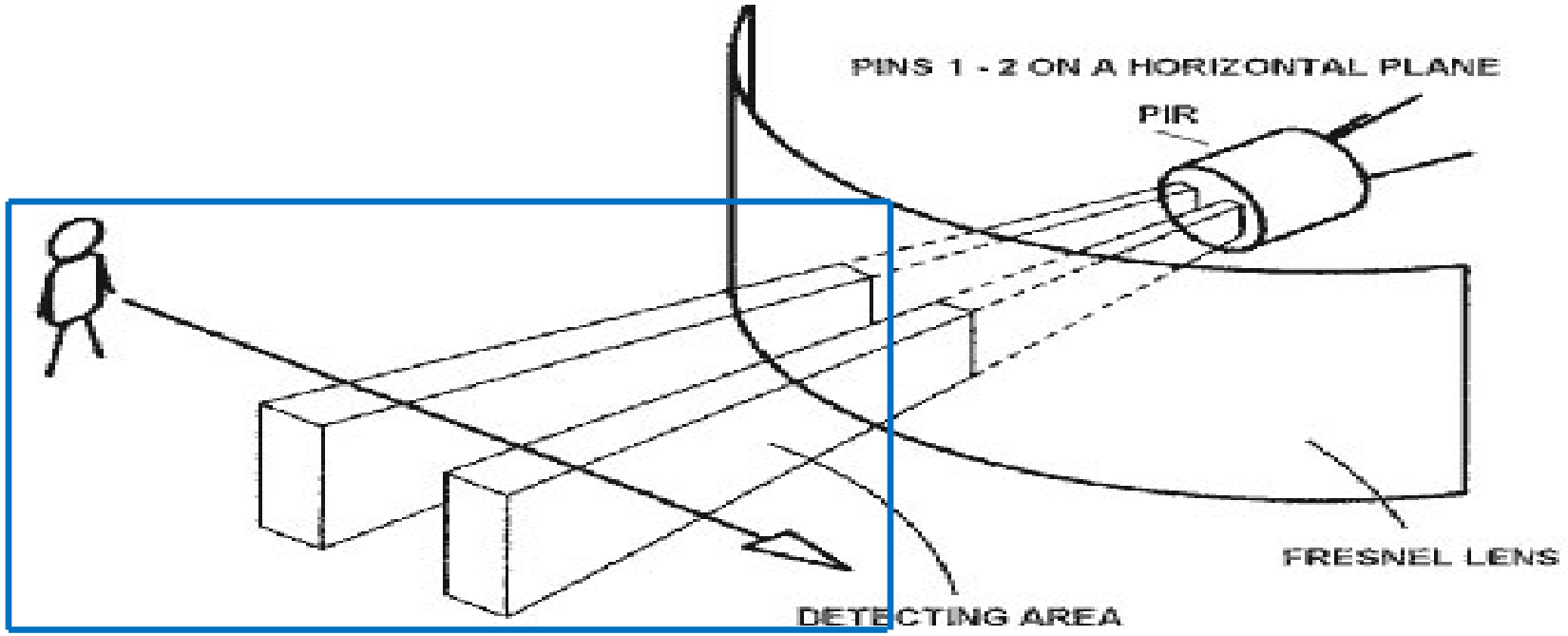
  Holiday animated props

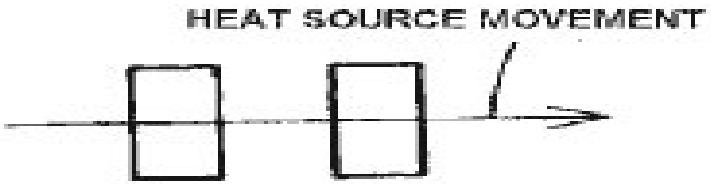


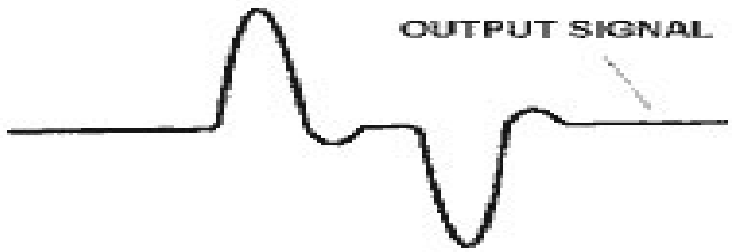




PIR Motion Sensor



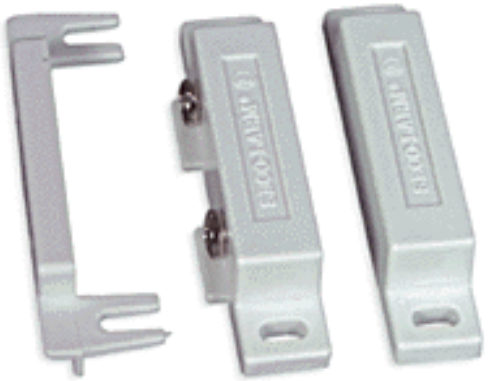




Security Sensors

Door/Window Sensor

- SECO-LARM SM-200Q/WH Surface Mount Magnetic Contact Switch
- Weight: 0.05 lbs
- Dimensions: 2.48" x 0.5"
- Compatibility: Closed circuit systems
- handle up to 100mA at 100 volts DC
- up to 50 million openings and closings
- operate in temperatures between -15°F and 160°F



Security Sensor Applications

- Motion sensing light activations
- Status updates to know if someone has tripped a sensor
- Door or window sensing to detect if the home has been breached

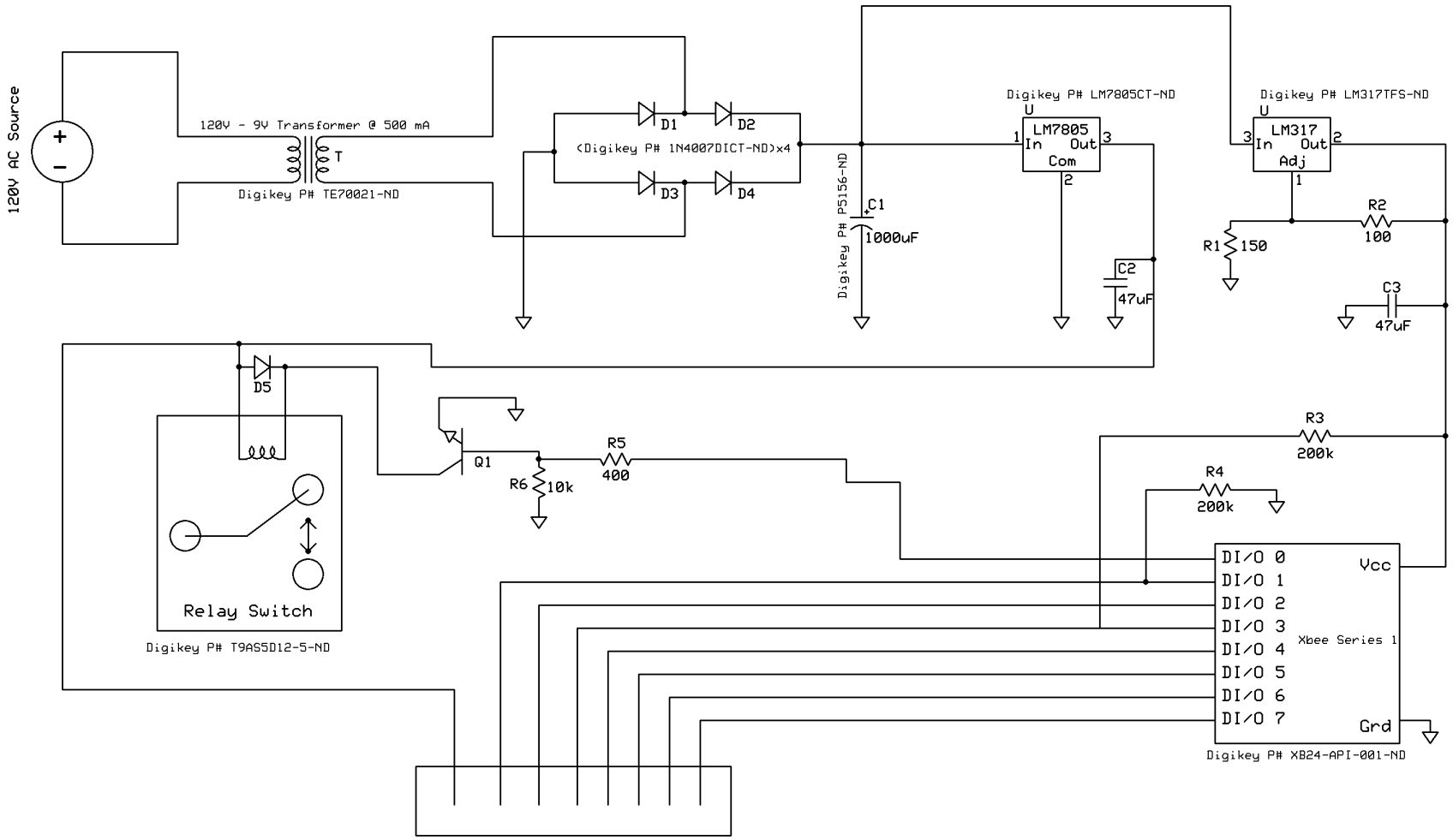
PCB Requirements

- PCB needs to
  - Support a power system for the slave Xbee, sensors and relay switch
  - Allow for I/O connections from the sensors to the Xbee to read sensor input
  - Provide an I/O to send control signals to the relay switch
  - Allow the outlet to work without the system in case system is down

PCB Design

- Allow AC to DC voltage conversion using a transformer and a diode rectifying bridge to bring 120V AC to 9V DC
- Two regulators to take the 9V DC to 3.2V and 5V DC required by Xbee, sensors, and relay
- Use capacitors to stabilize the DC voltage from ripple voltage from the rectifying bridge
- Use screw terminals to allow sensors to be connected to the Xbee module

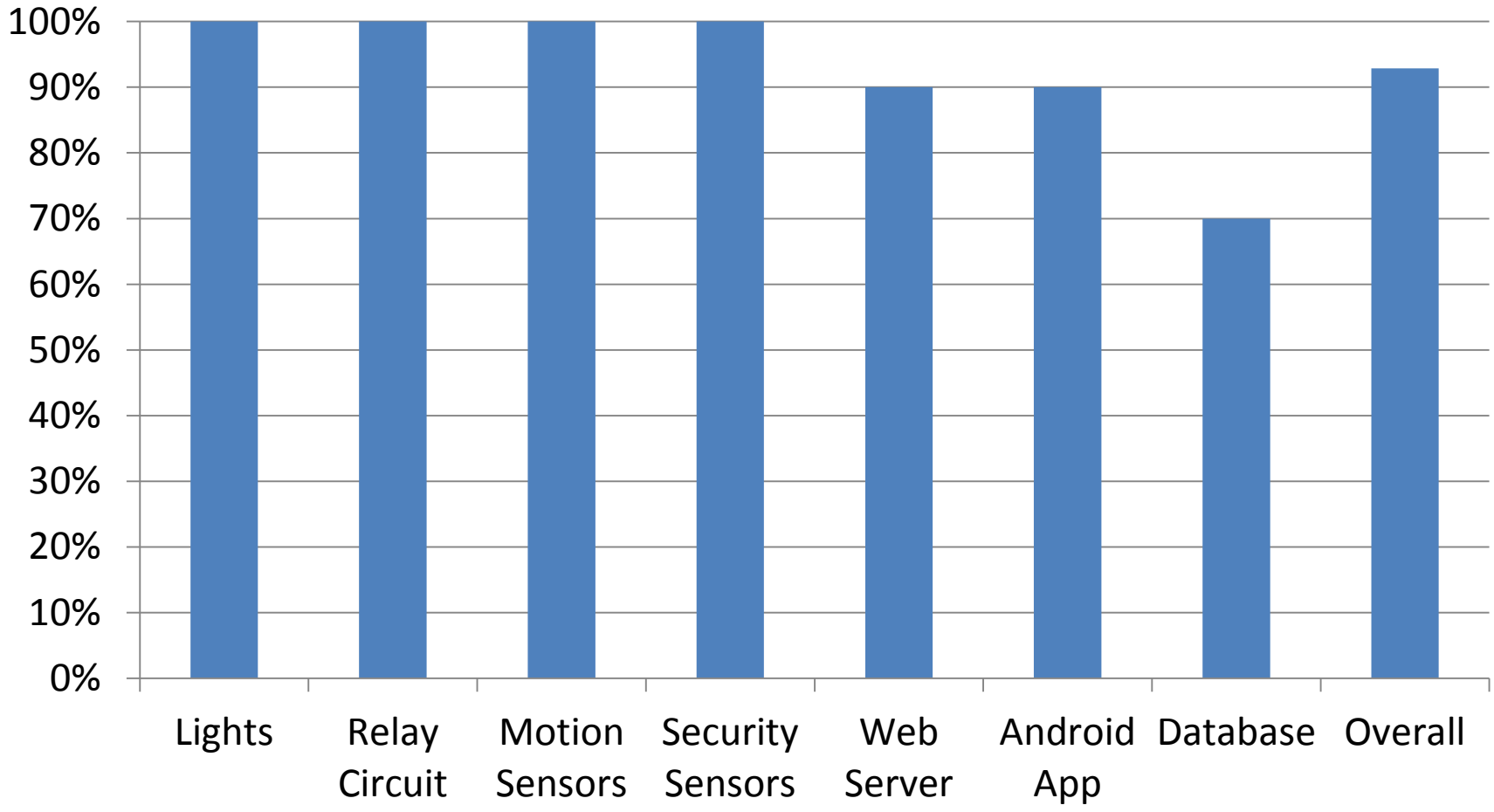
PCB Power Schematic



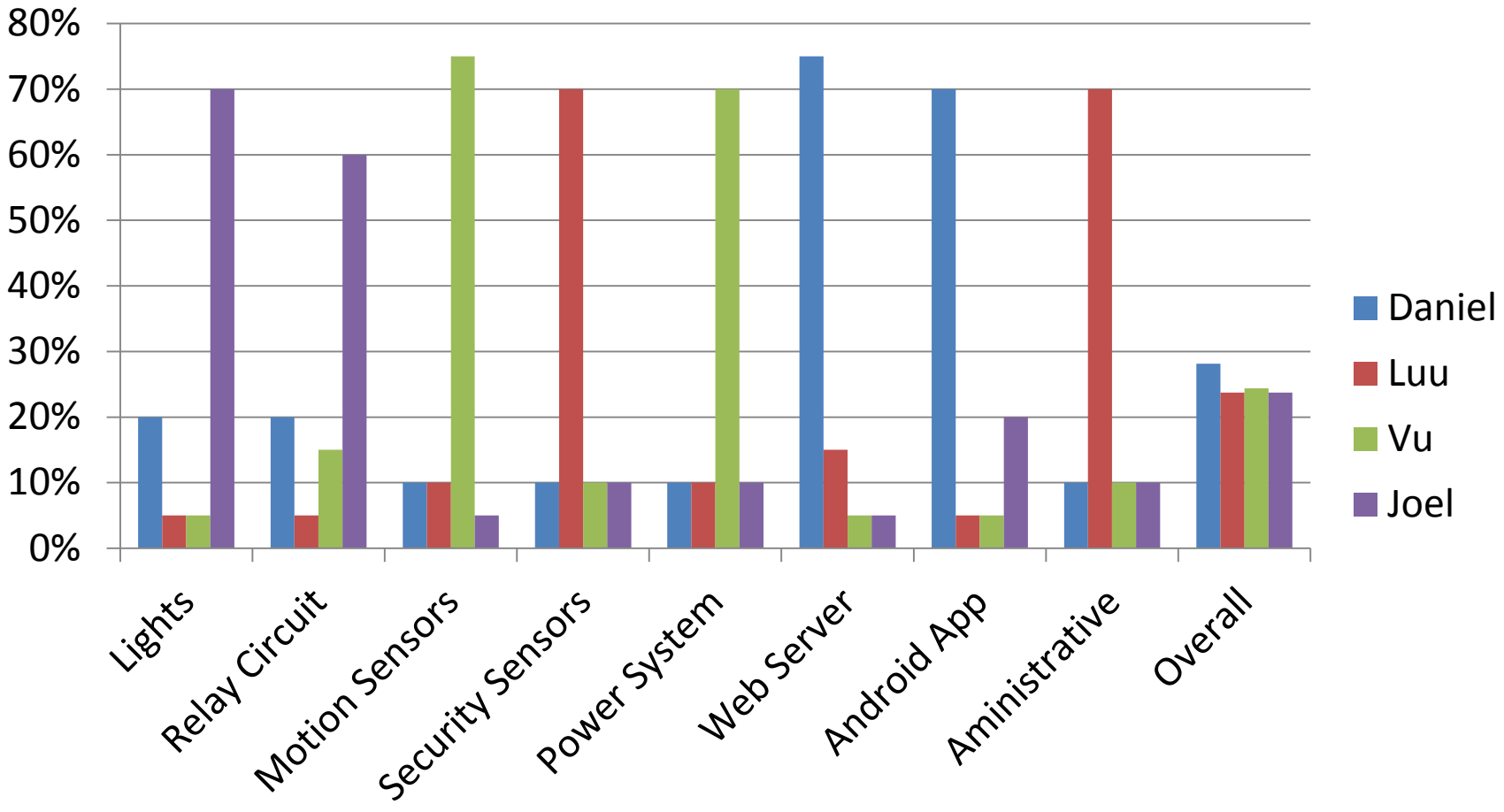
Power Supply

- System runs on 110V AC
- Power outlet modules have AC-DC power system
- Web Server needs external AC-DC adapter at 7V, 400 mA
- Power outlet modules draw 300 mA at 9 V (less than 3 watts)

Progress


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Lights
Relay Circuit
Motion Sensors
Security Sensors
Web Server
Android App
Database
Overall

Work Distribution



Budget

Item	Manufacturer	Quantity	Cost per unit	Total
Web server	Parallax	1	$59.99	$59.99
Xbee Modules	Digi International	9	$21.99	$197.91
Relay Switch	Generic	2	$5.00	$10.00
GFCI outlet	Leviton	2	$10.00	$20.00
Motion Sensors	Parallax	1	$10.00	$10.00
PCB	ExpressPCB	3	$28.36	$85.10
Door Sensor	Seco	3	$6.33	$20.00
Circuit components	N/A	3	$30.00	$90.00
			Grand Total	$493.00

Our Goal Budget

- Budget = $600
- Current spending = $493.00
- Spending room = $107
- Percent of budget used = 82.2%

Problems

- Motion sensors sensitivity
- System Speed
- Alerting the user of changes
- Deleting modules

Questions