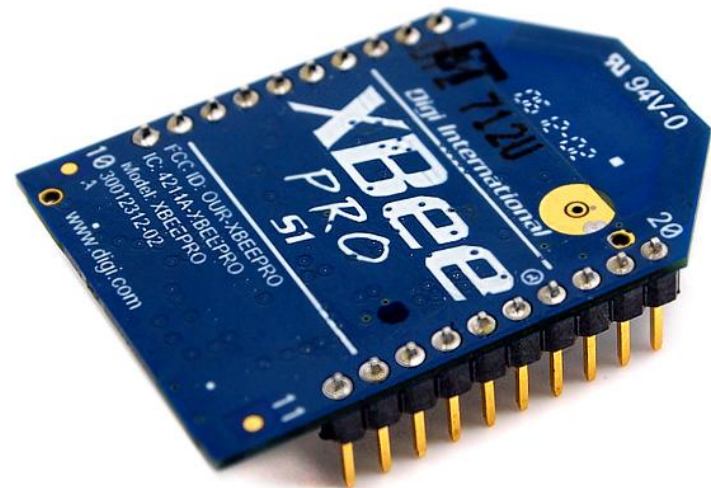


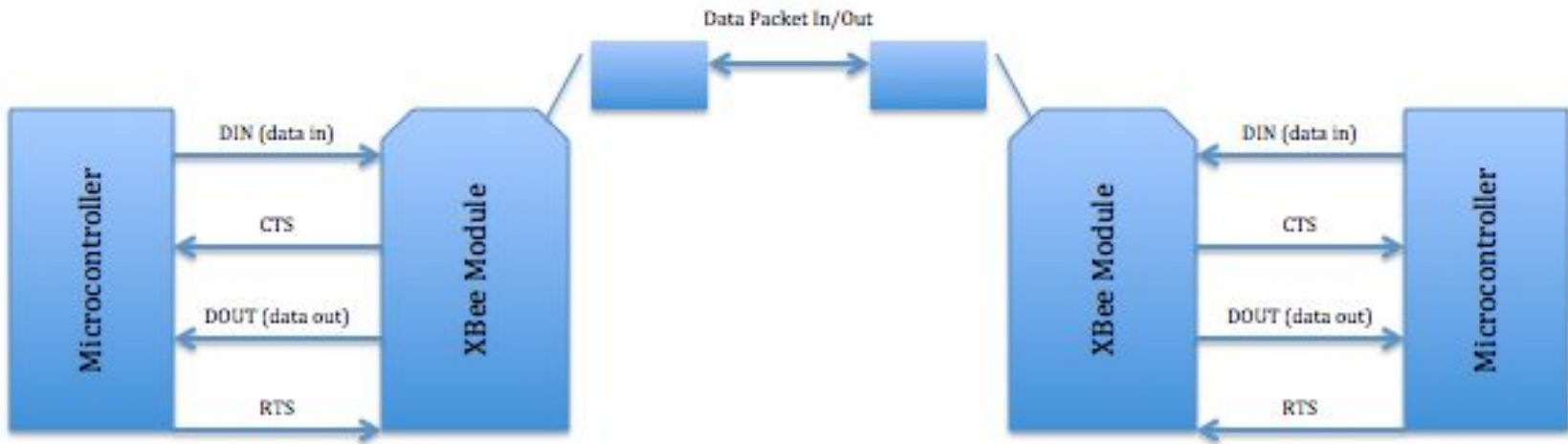
# Networking

Critical Design Review  
Presentation

Raydan Bala  
Ernesto Lorenzo

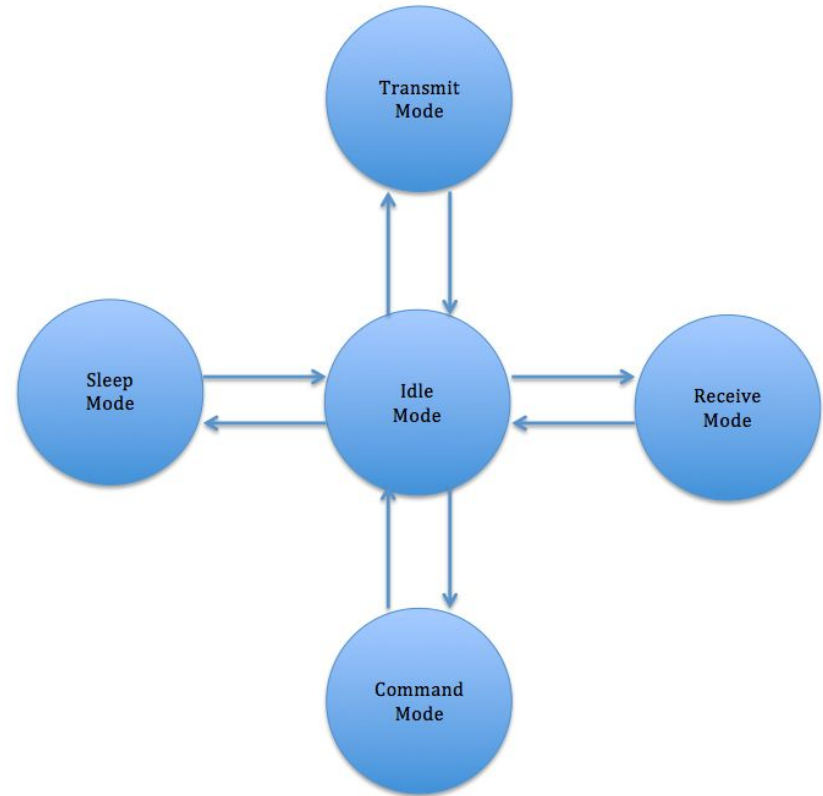


# Block Diagram



# Operation Modes

- **Idle Mode**
  - Not Receiving or Transmitting
- **Transmit/Receive Modes**
  - Transmit/Receive data packets
- **Sleep Mode**
  - Enter state of low-power consumption when not in use
- **Command Mode**
  - Incoming characters interpreted as commands



# Bill of Materials

<b>Networking - Bill of Materials (BOM) v1</b>								
<b>Part Description</b>	<b>Mounting Type</b>	<b>Part Value</b>	<b>Manufacturer</b>	<b>Manufacturer P/N</b>	<b>Distributor</b>	<b>Distributor P/N</b>	<b>Unit Cost</b>	<b>Sub-Cost</b>
Arduino Uno R3 (Atmega328 - assembled)	-	-	Arduino	REV3	Adafruit	50	\$24.95	\$49.90
Sparkfun XBee Shield	PTH	-	Sparkfun	WRL-12847	Sparkfun	WRL-12847	\$14.95	\$29.90
XBee Pro S2B	PTH	-	Digi	XBP24BZ7SIT-004	Digi-Key	602-1677-ND	\$30.75	\$61.50
XBee Pro 802.15.4 63MW PCB	PTH	-	Digi	XB24-API-001	Digi-Key	602-1280-ND	\$32.00	\$64.00
XBee DigiMesh 2.4 1MW Wire Ant	PTH	-	Digi	XB24-DMWIT-250	Digi-Key	XB24-DMWIT-250-ND	\$19.00	\$38.00
XBee Pro XSC S3B 900MHZ 250Mw	PTH	-	Digi	XBP9B-XCWT-002	Digi-Key	602-1297-ND	\$39.00	\$78.00
Battery Pack NiMH 7.2V 2100mAh	-	7.2 V	-	-	Digi-Key	P017-F023-ND	\$31.83	\$63.66
Duck Antenna RP-SMA	-	900MHz	Sparkfun	WRL-09143	Sparkfun	WRL09143	\$7.95	\$15.90

- Includes parts used during testing as well as information about the part

# Power Budget

Power Budget v1						
Device Name	Idle(mA)	Typical Current Draw (mA)	Max Current Draw (mA)	Avg Current Draw (mW)	Avg Power Consumed (mW)	Max Power Consumed (mW)
Xbee Pro S2B	15	205	220	15.02077333	49.56855198	49.56855198
Xbee S1 wire antenna	50	45	45	49.99945333	164.998196	164.998196
Xbee Pro S1 trace antenna	55	250	250	55.02131999	181.570356	181.570356
Atmega 328P (3V)	0.7	1.7	2.7	1.2	3.96	8.91
Vreg 3.3V (Xbee Shield)	-	0.35	0.9	0.175	0.5775	2.97
Battery	Voltage (V)	Current (mAh)	Useable %			
2100 mAH NiMH 7.2	7.2	2100	80			

# Progress

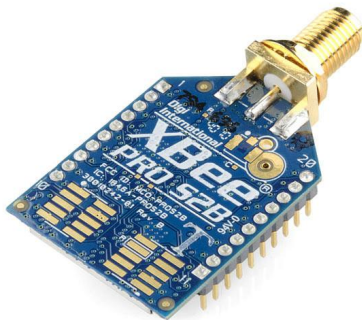
- Communication between XBees
  - XBee Pro S2B
  - XBee S1 wire antenna
  - XBee Pro S1 trace antenna
- Test plan for debugging



# Tested XBees

## XBee Pro S2B

- 1 mile range
- 250 kbps data rate
- 295 mA @ 3.3 V power consumption



## XBee S1 Wire Antenna

- 300 ft range
- 250 kbps data rate
- 50 mA @ 3.3 V power consumption



## XBee Pro S1 Trace Antenna

- 1 mile range
- 250 kbps data rate
- 215 mA @ 3.3 V power consumption



# Through Wall Testing

	No Wall (RSSI)	1 Wall (RSSI)	2 Wall (RSSI)
XBee Pro S2B	<b>-32</b> 0/25 Packets lost	<b>-56</b> 0/25 Packets lost	<b>-77</b> 0/25 Packets lost
XBee S1 wire antenna	<b>-67</b> 0/25 Packets lost	<b>-75</b> 0/25 Packets lost	- All Packets lost
XBee Pro S1 trace antenna	<b>-70</b> 0/25 Packets lost	- All Packets lost	- All Packets lost

## **RSSI: Received Signal Strength Indicator**

- Measure of the power level that a RF device is receiving from the radio infrastructure at a given location and time



# Holmes Hall Testing

	Roof (RSSI)	4th Floor (RSSI)	3rd Floor (RSSI)	2nd Floor (RSSI)	Ground Floor (RSSI)
XBee Pro S2B	<b>-32</b> 0/25 Packets lost	<b>-57</b> 0/25 Packets lost	<b>-66</b> 0/25 Packets lost	<b>-70</b> 0/25 Packets lost	- All Packets lost
XBee S1 wire antenna	<b>-67</b> 0/25 Packets lost	<b>-79</b> 6/25 Packets lost	- All Packets lost	- All Packets lost	- All Packets lost
XBee Pro S1 trace antenna	<b>-70</b> 0/25 Packets lost	- All Packets lost	- All Packets lost	- All Packets lost	- All Packets lost

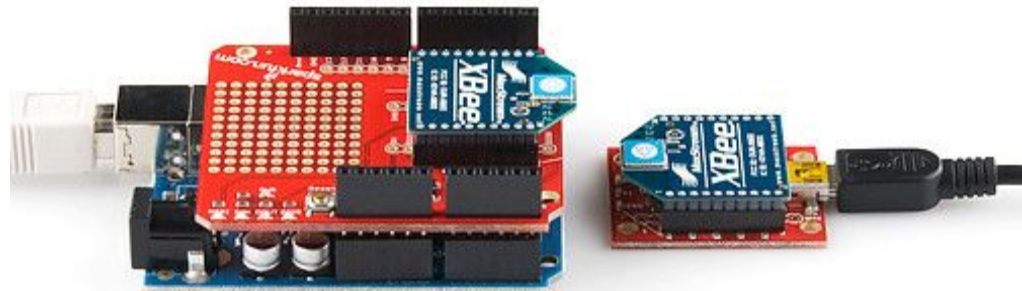
# Test Plan

## Plan:

- Parts:
  - Two Arduinos
  - Two XBee Shields
  - LEDs
- LEDs will signify if packets are being sent

## Problems:

- Knowing the exact amount of packets lost



# Remaining Tasks

- XBee Pro S3B XSC
- Range testing
- Find limit of ranges
- Networking of XBees
- Solder on test board



# Problems

- Communication
  - Metal/Walls
  - Enclosed Spaces

# Possible Solutions

- Switch to XBees capable of using U.FL antenna
  - 12db of gain added to a system can double range
- Further Research into Stronger XBee



Questions?

# Works Cited

## Website References:

[http://ftp1.digi.com/support/documentation/90000976\\_W.pdf](http://ftp1.digi.com/support/documentation/90000976_W.pdf)

[http://ftp1.digi.com/support/documentation/90000982\\_S.pdf](http://ftp1.digi.com/support/documentation/90000982_S.pdf)

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## Photo References:

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[http://www.seeedstudio.com/depot/images/product/XBee%20Pro%20PCB\\_01.jpg](http://www.seeedstudio.com/depot/images/product/XBee%20Pro%20PCB_01.jpg)

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<http://www.seancarney.ca/sites/www.seancarney.ca/files/styles/medium/public/2012/10/15/xbee-shield.jpg>