Sociable Objects

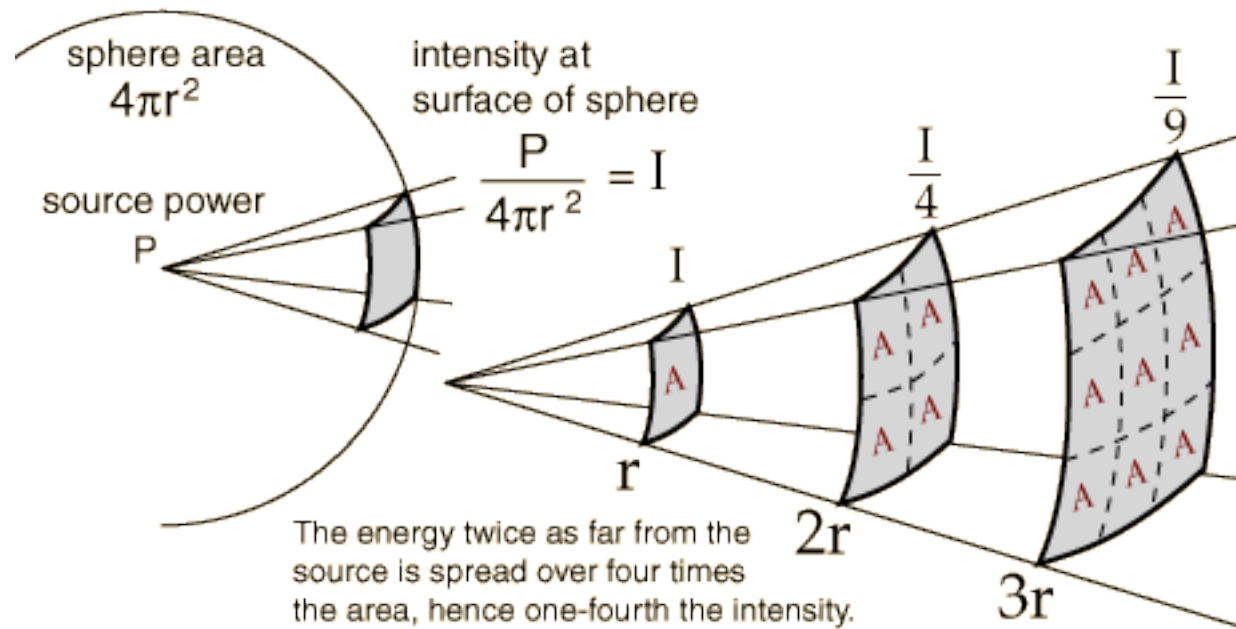Instructor: Rob Faludi
Class 2

Readings

- Economist demonstrates cutting edge

- Weiser: history

- Bradbury: importance of humans

Radio Communications

- What is radio?

    - electromagnetic waves

    - no medium required

- Modulation

- Well-described mystery: "air waves" "wireless" "ethereal communication"

- posters

Why Wireless?

- why wireless   (mesh ≠ wireless)

- inverse square law

sphere area
$4\pi r^2$

intensity at
surface of sphere

$$\frac{P}{4\pi r^2} = I$$

source power
P

I

r

The energy twice as far from the
source is spread over four times
the area, hence one-fourth the intensity.
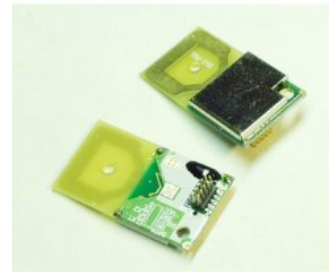
$\frac{I}{4}$

2r

$\frac{I}{9}$

3r

- what technologies can be used for device communication?

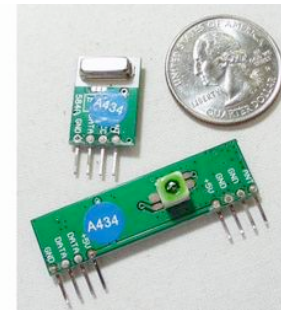# Existing Methods for Device Communication

- Bluetooth
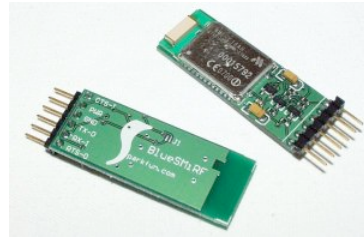
- "RF"

- XPort TCP/IP

- WiPort TCP/IP

- MatchPort

- Cell Phone Data GPRS

ZigBee & 802.15.4

- ZigBee is built on top of the IEEE 802.15.4 protocol

- XBee radios can be purchased with or without ZigBee
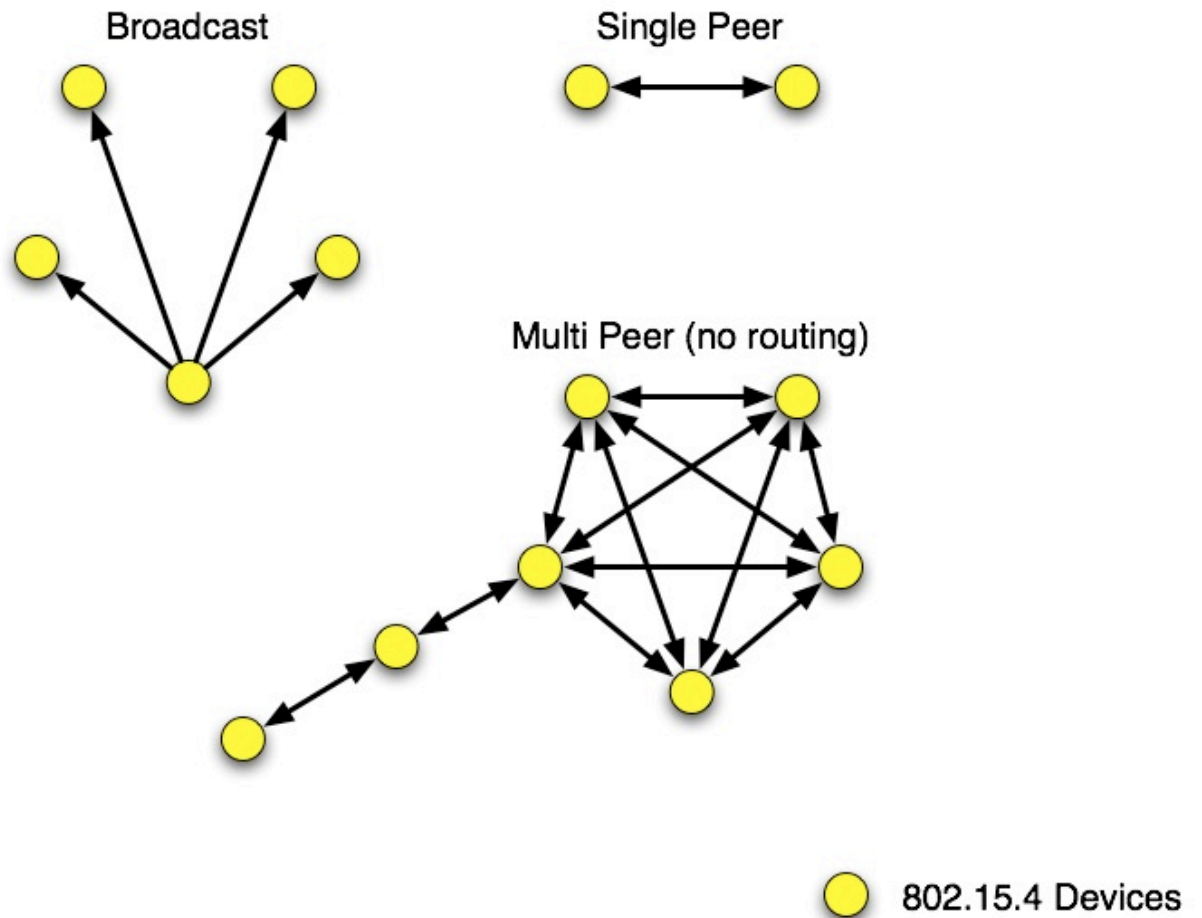
- Both ways are useful

802.15.4

- low power

- addressing

- cheap

- wireless

- small

- standardized

802.15.4 Topologies
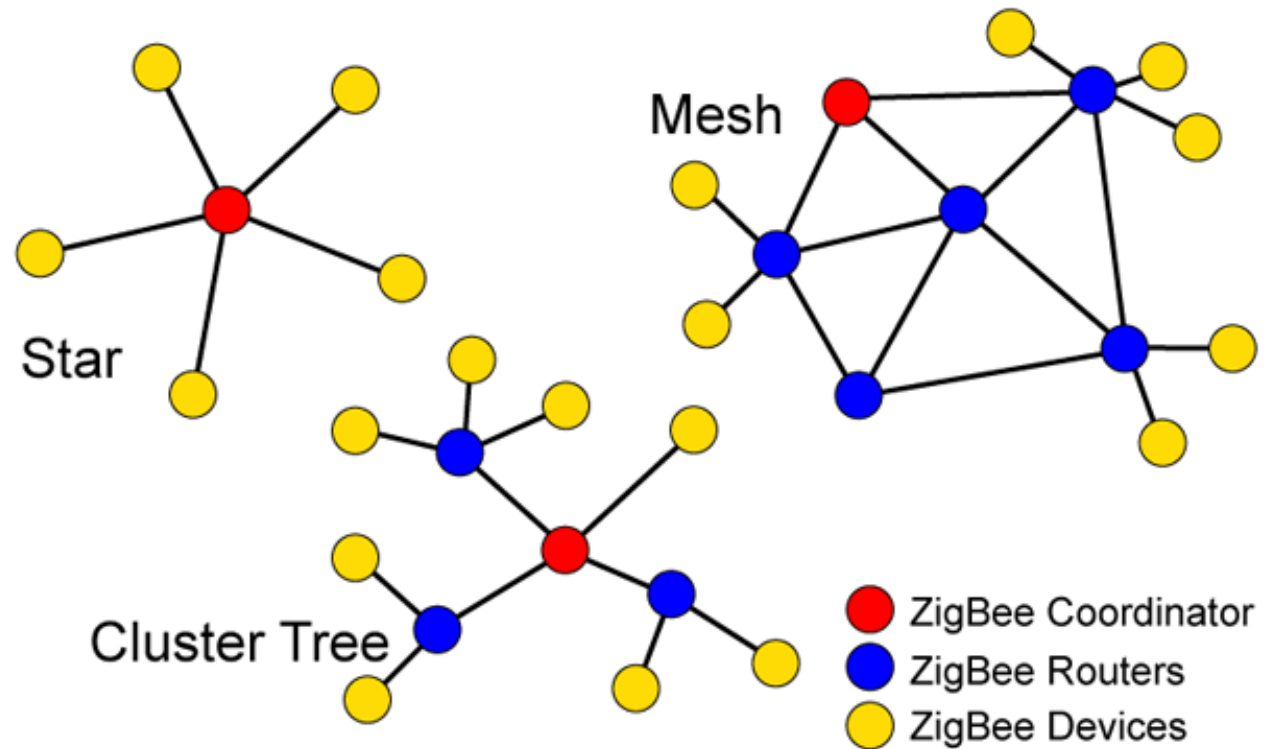
- single peer

- multi-peer

- broadcast

ZigBee

- routing

- self-healing mesh

- ad-hoc network creation

ZigBee Topologies

- peer

- star

- mesh

- routing

Demo:
Soldering
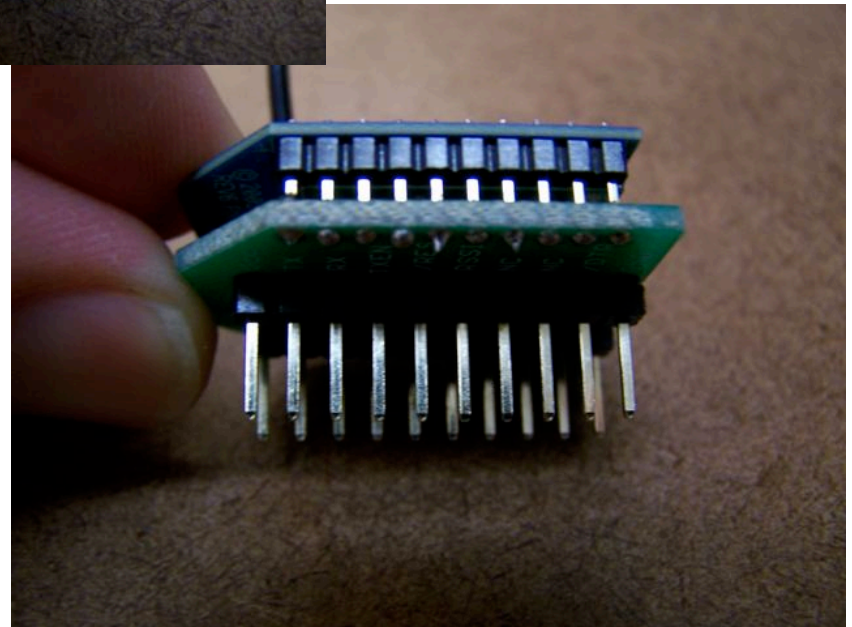
Materials

- XBee OEM Module (30-100 m range) $19
  XBee Pro (100m - 1.6 km range) $32

    - MaxStream: http://www.maxstream.net

- Breakout Board, 2mm to 10 mil pin spacing. From me or Sparkfun

- Female headers 2mm

- Male headers 10 mil

Breakout Board Soldering

- Why breakout boards

- Why headers

- Good solder / bad solder

- Desoldering

XBee with Breakout Board (pre-female header era)
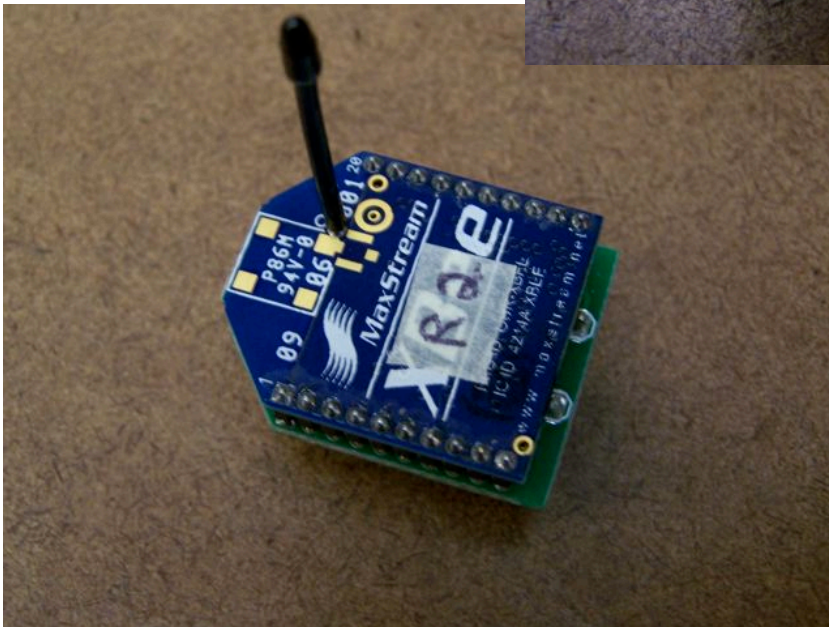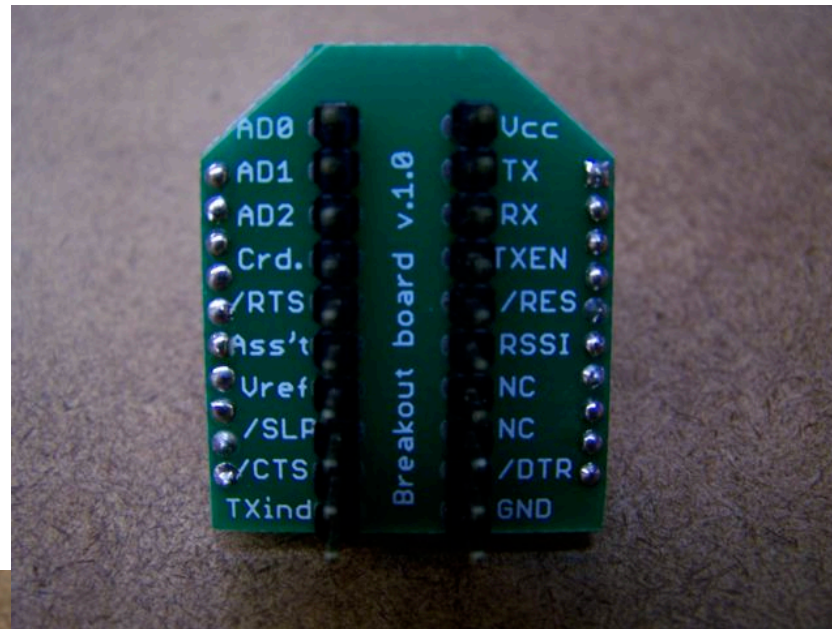
Soldering Breakout Boards: pin spacing

2mm

0.1"
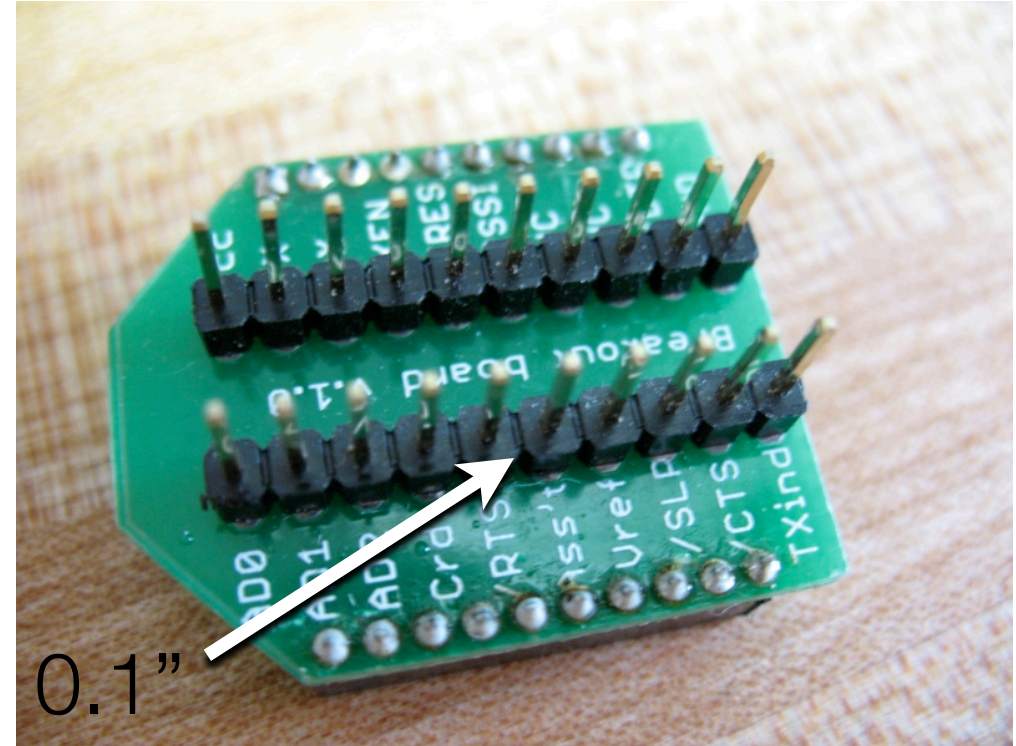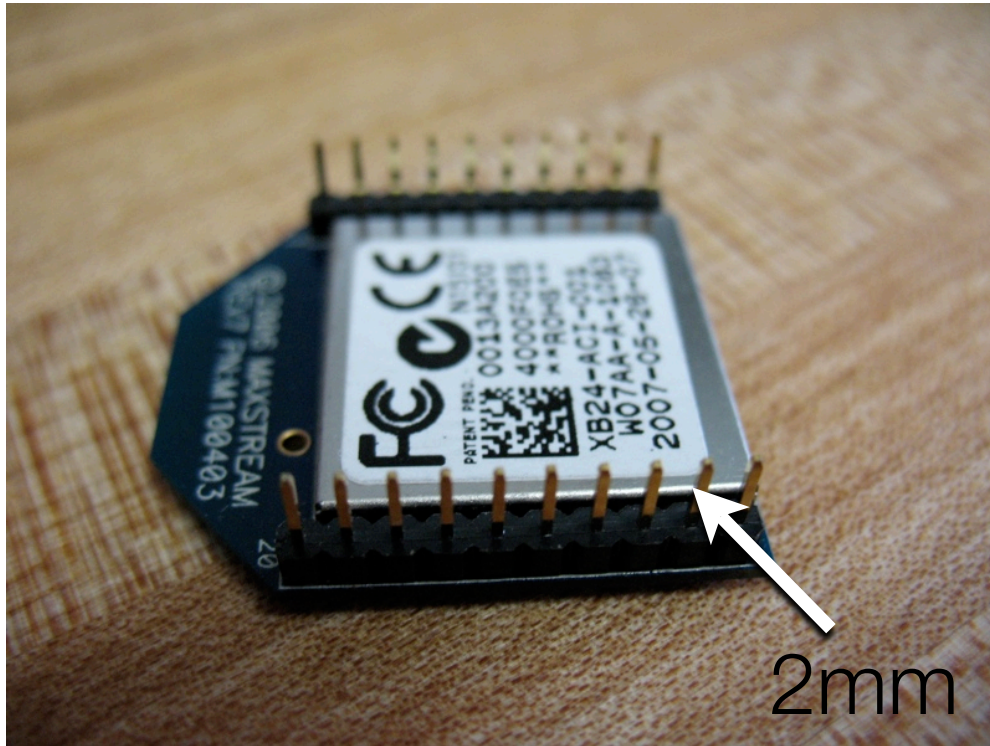
Soldering Breakout Boards: finished
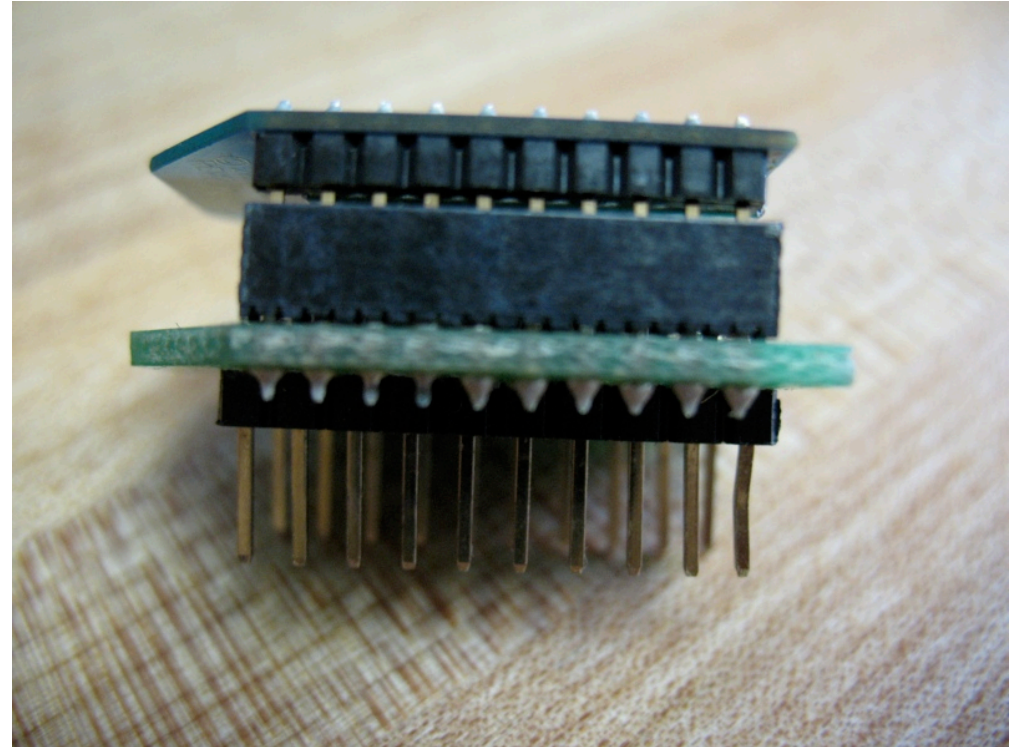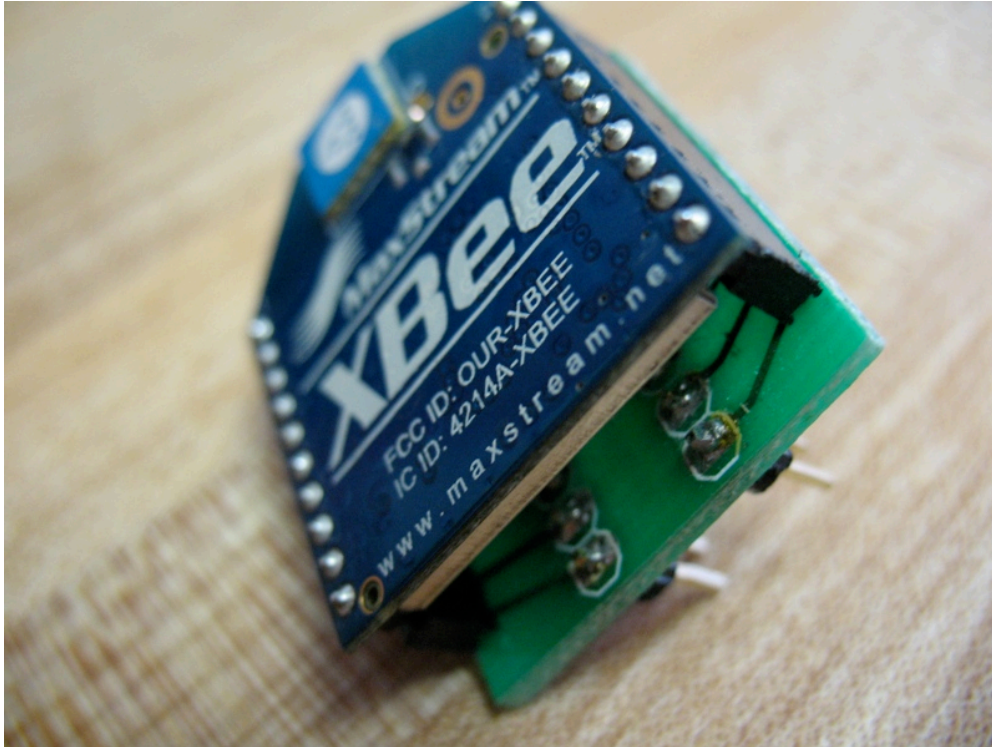
Wiring
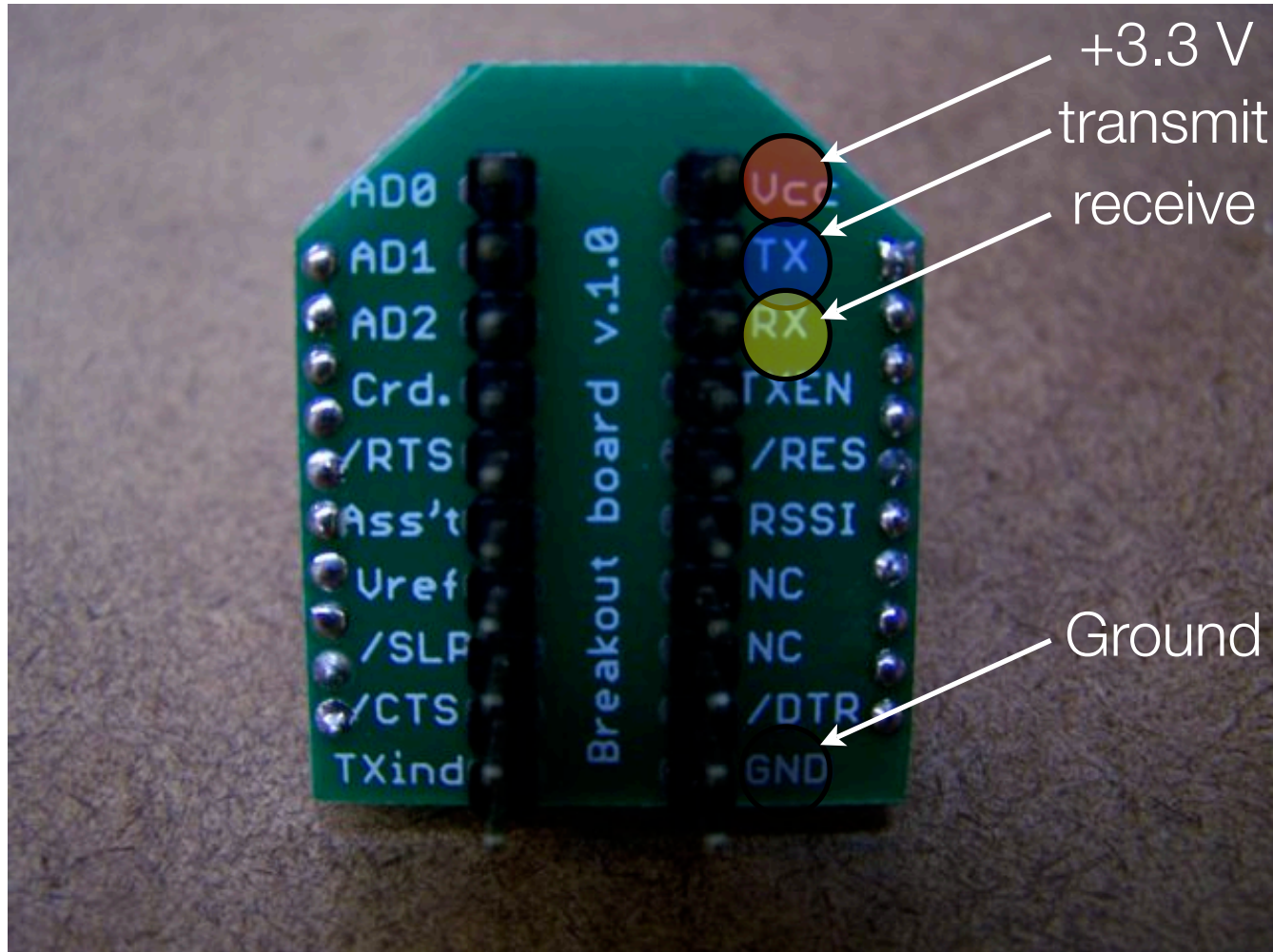
Remember!

- Use only +3.3 Volts. The regulator usually has a different pin arrangement: G-O-I

- Always use decoupling capacitors. The radios often don't work without them.

- You can't send infinitely fast. Try putting a 10ms delay into your loop.

- XBee TX goes to Arduino RX and vice versa.

- Arduino can run on 3.3 Volts

Instructions

- <u>Making Things Talk</u> by Tom Igoe

- XBee Practical Example: Paired communication between two microcontrollers. Includes building, wiring and code for PIC and Arduino

Serial Terminal Programs

- Processing: http://rob.faludi.com/teaching/cmn/code/XBee_Analog_Duplex_Sender.pde

- Z-Term: http://homepage.mac.com/dalverson/zterm/

- HyperTerm: Windows Start Menu, Accessories, Communication

- screen: Terminal program on the Mac (or Linux)

- X-CTU: http://rob.faludi.com/teaching/cmn/code/XBee_Terminal.pde

- plenty of others

Baud, Bits and Parity

- Setting different baud rates: 9600

- Data bits: 8

- Stop bits: 1

- Parity: None

- Flow control: none for now...

Data Mode vs. Command Mode

- Idle Mode, transmit and receive data

- Command Mode, talk to the XBee itself

  - +++   "*Yo, XBee*"

  - AT   "*Attention!*" (Hayes command set)
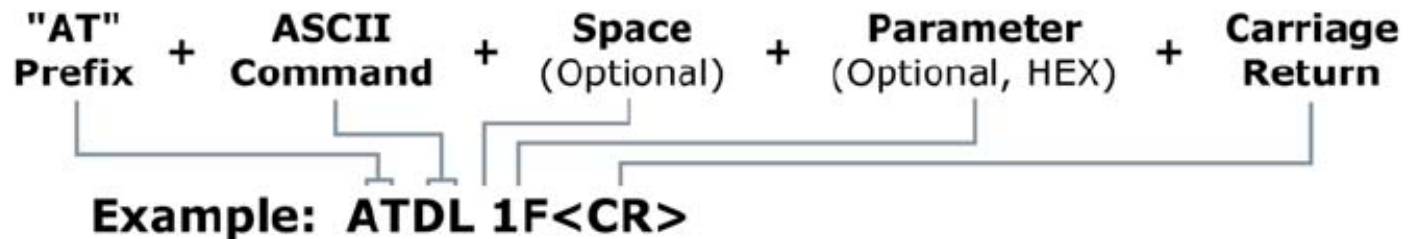
Some AT Commands

- AT -> OK

- ATMY -> my address

- ATDH, ATDL -> destination address hi/lo

- ATID -> personal area network ID

- ATCN -> end command mode

Addressing In-Depth

- SL, SH: fixed serial number address

- MY: configured local 16 bit address

- DH, DL: destination address low and high

- ID: Personal Area Network ID

- Broadcast FFFF

- Broadcast PAN FFFF

AT Command Format

Figure 2-08. Syntax for sending AT Commands

"AT" Prefix + **ASCII Command** + **Space** (Optional) + **Parameter** (Optional, HEX) + **Carriage Return**

Example: ATDL 1F\<CR>

Method 1 (One line per command)

Send AT Command	**System Response**
+++	OK \<CR> (Enter into Command Mode)
ATDL \<Enter>	{current value} \<CR> (Read Destination Address Low)
ATDL1A0D \<Enter>	OK \<CR> (Modify Destination Address Low)
ATWR \<Enter>	OK \<CR> (Write to non-volatile memory)
ATCN \<Enter>	OK \<CR> (Exit Command Mode)

Method 2 (Multiple commands on one line)

Send AT Command	**System Response**
+++	OK \<CR> (Enter into Command Mode)
ATDL \<Enter>	{current value} \<CR> (Read Destination Address Low)
ATDL1A0D,WR,CN \<Enter>	OK, OK, OK \<CR> (Command execution is triggered upon each instance of the comma)

API Mode

- Powerful, steeper learning curve

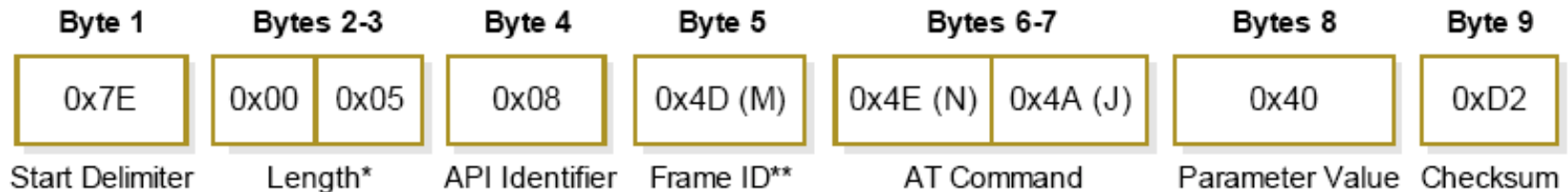- Data wrapped together with commands, addressing and status information

API Mode Format

Figure 4-01. UART Data Frame Structure:

Start Delimiter (Byte 1)	Length (Bytes 2-3)		Frame Data (Bytes 4-n)	Checksum (Byte n + 1)
0x7E	MSB	LSB	API-specific Structure	1 Byte

MSB = Most Significant Byte, LSB = Least Significant Byte

Any data received prior to the start delimiter is silently discarded. If the frame is not received correctly or if the checksum fails, the module will reply with a module status frame indicating the nature of the failure.

Figure 4-07. Example: API frames when modifying the NJ parameter value of the module.

Byte 1	Bytes 2-3		Byte 4	Byte 5	Bytes 6-7		Bytes 8	Byte 9
0x7E	0x00	0x05	0x08	0x4D (M)	0x4E (N)	0x4A (J)	0x40	0xD2
Start Delimiter	Length*		API Identifier	Frame ID**	AT Command		Parameter Value	Checksum

* Length [Bytes] = API Identifier + Frame ID + AT Command + Parameter Value

** "M" value was arbitrarily selected.

*ATNJ = node join

Readings and Assignments

- Readings

  - XBee User Manual

  - Making Things Talk, pages 192 - 206.

Schedule Office Hours or Lab Hours

- Friday afternoon in lab?