

# Collaborative Mesh Networking

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Instructor: Rob Faludi  
Week 3

# Warmup

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- Digits

# Readings

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- Go over XBee Manual
  - 1.2 Specifications
  - 1.5 Pin Signals
  - 2.2 ADC and I/O Mode
  - 2.4 Addressing
  - 2.5.3 Sleep
  - 3.2 AT Command Table
  - 3.3 AT Commands
  - 3.4 API Mode

# Materials

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- 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

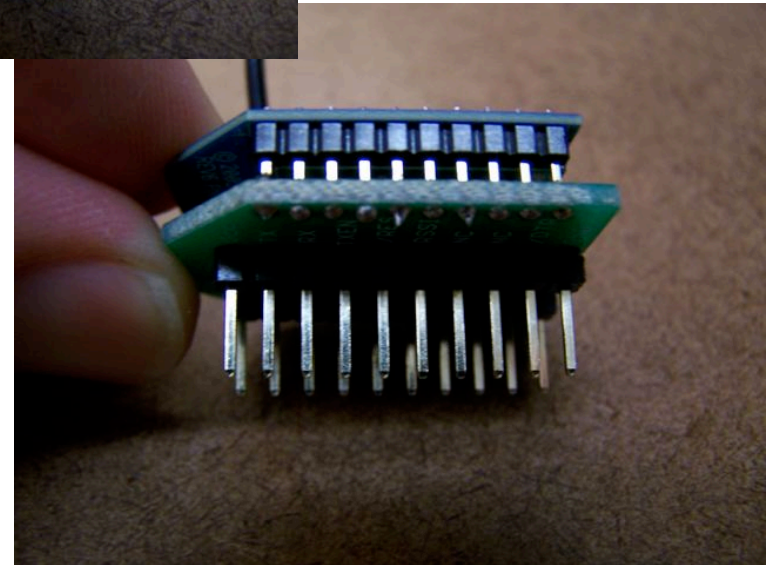
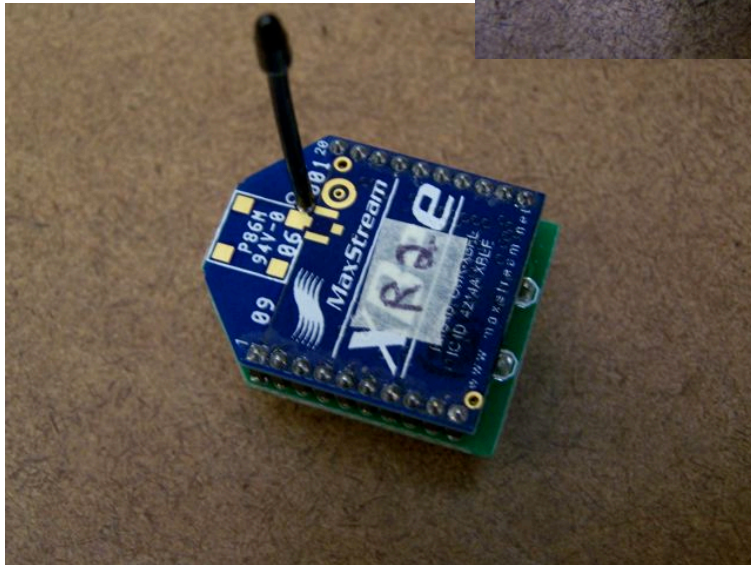
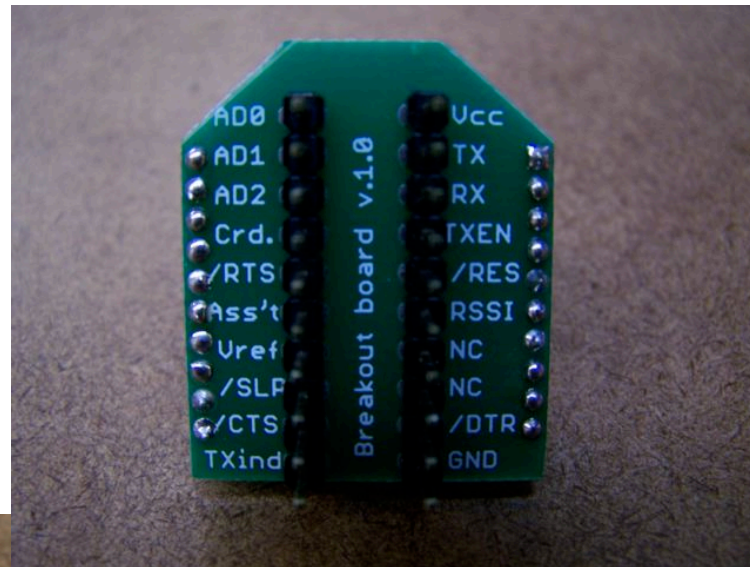
# Breakout Board Soldering

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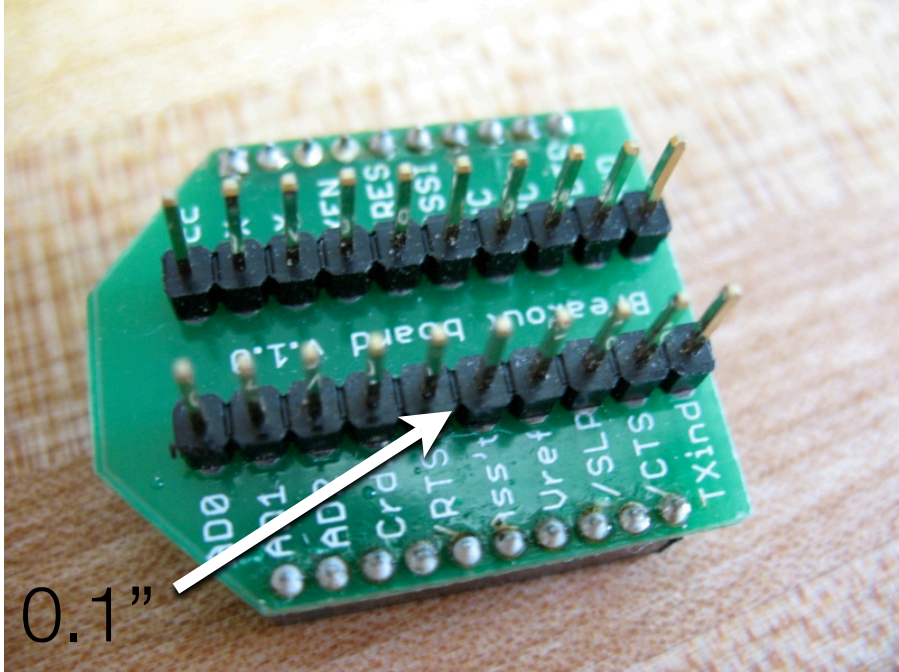
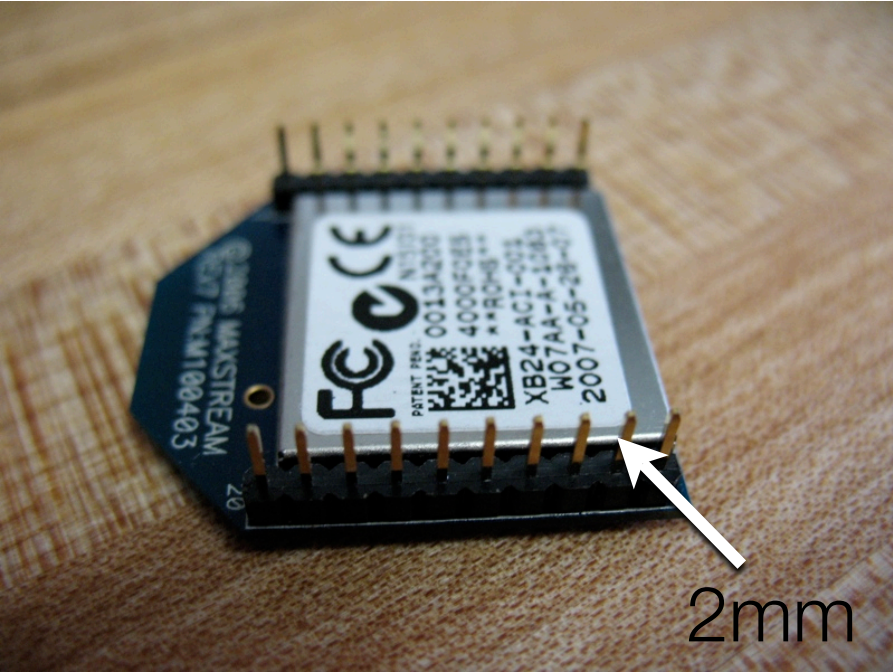
- Why breakout boards
- Why headers
- Good solder / bad solder
- Desoldering

# XBee with Breakout Board (pre-female header era)

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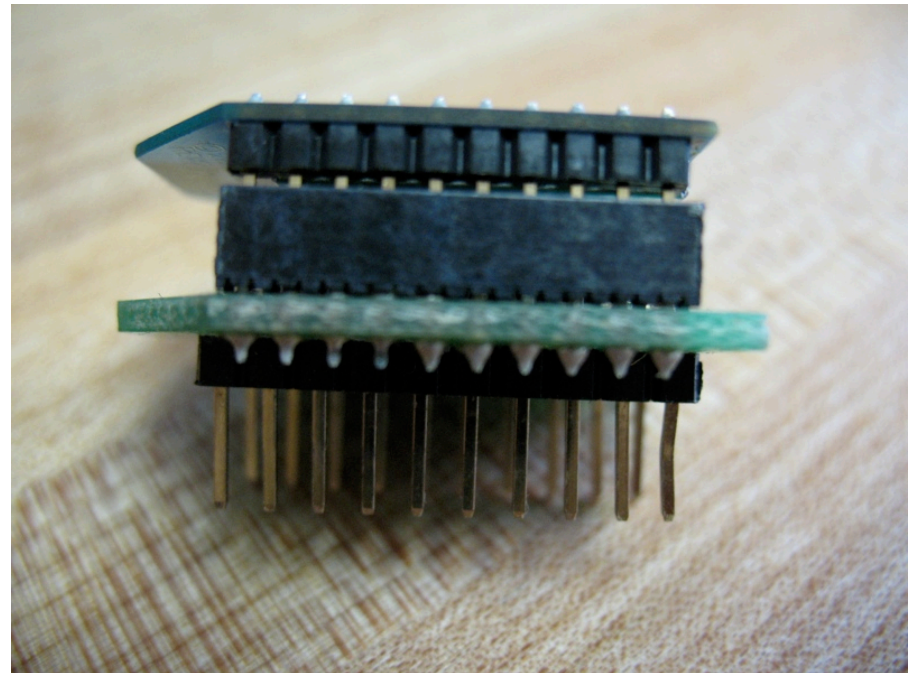
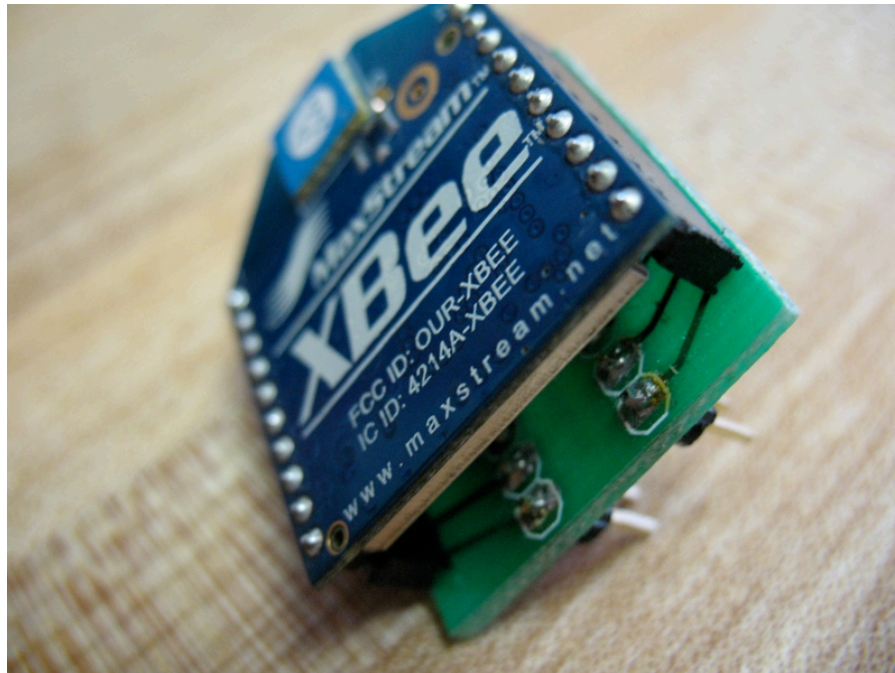
# Soldering Breakout Boards: pin spacing





# Soldering Breakout Boards: finished

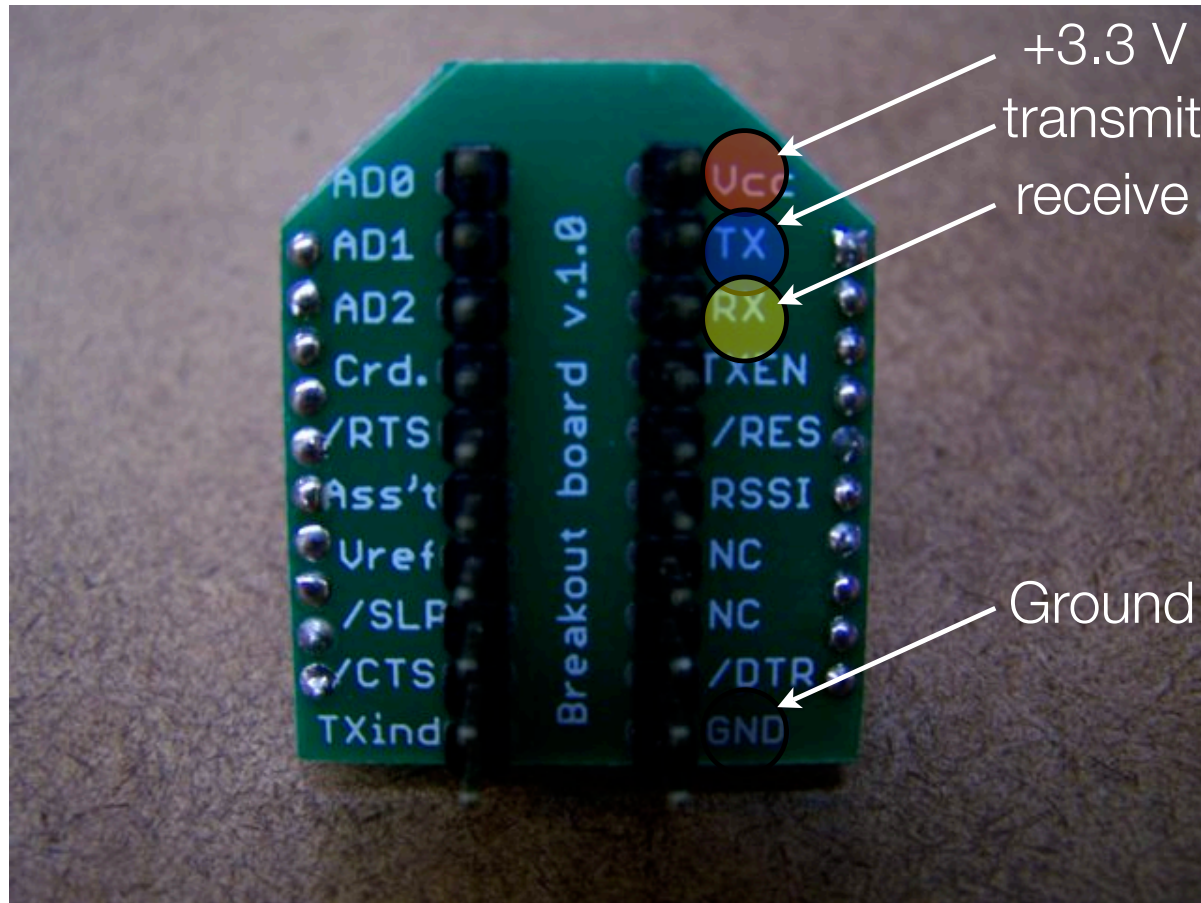
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# Wiring

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# Remember!

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- 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 (so can PIC)

# Instructions

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- XBee Practical Example: Paired communication between two microcontrollers. Includes building, wiring and code for PIC and Arduino
  - [Making Things Talk](#) by Tom Igoe

# Serial Terminal Programs

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- Z-Term: <http://homepage.mac.com/dalverson/zterm/>
- HyperTerm: Windows Start Menu, Accessories, Communication
- screen: Terminal program on the Mac (or Linux)
- Processing: [http://rob.faludi.com/teaching/cmn/code/XBee\\_Analog\\_Duplex\\_Sender.pde](http://rob.faludi.com/teaching/cmn/code/XBee_Analog_Duplex_Sender.pde)
- X-CTU: [http://rob.faludi.com/teaching/cmn/code/XBee\\_Terminal.pde](http://rob.faludi.com/teaching/cmn/code/XBee_Terminal.pde)
- plenty of others

# Baud, Bits and Parity

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- Setting different baud rates: 9600
- Data bits: 8
- Stop bits: 1
- Parity: None
- Flow control: none for now...

# Data Mode vs. Command Mode

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- Idle Mode, transmit and receive data
- Command Mode, talk to the XBee itself
  - +++      "*Yo, XBee*"
  - AT      "*Attention!*" (Hayes command set)



# Some AT Commands

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- AT -> OK
- ATMY -> my address
- ATDH, ATDL -> destination address hi/lo
- ATID -> personal area network ID
- ATCN -> end command mode

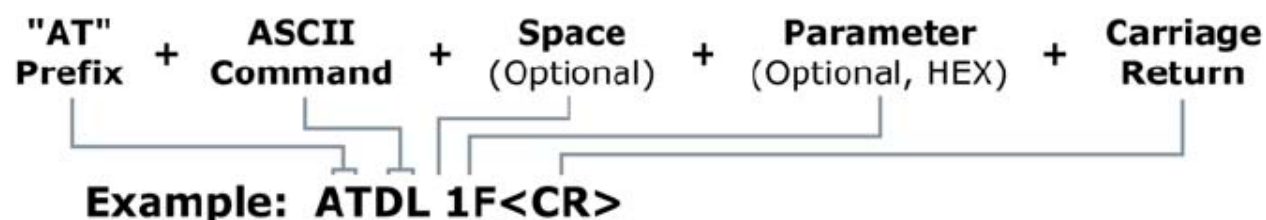
# Addressing In-Depth

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- 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



## Method 1 (One line per command)

### Send AT Command

```
+++  
ATDL <Enter>  
ATDL1A0D <Enter>  
ATWR <Enter>  
ATCN <Enter>
```

### System Response

```
OK <CR> (Enter into Command Mode)  
{current value} <CR> (Read Destination Address Low)  
OK <CR> (Modify Destination Address Low)  
OK <CR> (Write to non-volatile memory)  
OK <CR> (Exit Command Mode)
```

## Method 2 (Multiple commands on one line)

### Send AT Command

```
+++  
ATDL <Enter>  
ATDL1A0D,WR,CN <Enter>
```

### System Response

```
OK <CR> (Enter into Command Mode)  
{current value} <CR> (Read Destination Address Low)  
OK, OK, OK <CR> (Command execution is triggered upon  
each instance of the comma)
```

# API Mode

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- Powerful, steeper learning curve
- Data wrapped together with commands, addressing and status information

# API Mode Format

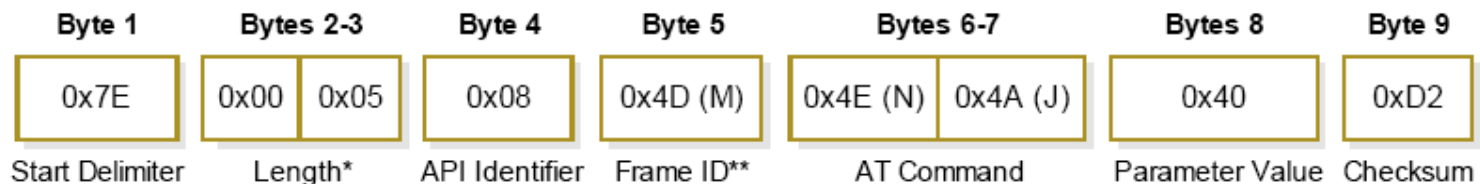
Figure 4-01. UART Data Frame Structure:



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.



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

\*\* "M" value was arbitrarily selected.

\*ATNJ = node join

Example:  
Blink that Light



# Readings and Assignments

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- The Internet of Things: [http://rob.faludi.com/teaching/cmn/readings/Nature Everything Everywhere 2006.pdf](http://rob.faludi.com/teaching/cmn/readings/Nature_Everything_Everywhere_2006.pdf)
- Vehicle Warning System Tried: <http://news.bbc.co.uk/2/hi/technology/6461831.stm>
- 'Smart dust' to explore planets: <http://news.bbc.co.uk/2/low/science/nature/6566317.stm>

# Schedule Workshop

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- Saturday noon in 406?
- Other good times?