sparkfun ELECTRONICS

XBee Wireless

Michelle Shorter

Radio Communication

- Electromagnetic Waves
- No medium required
- Modulation
- Well described mystery
- Wireless/Airwaves
- Inverse Square Law

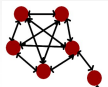
802.15.4

- Low Power
- Low bandwidth
- Addressing
- Affordable
- Small
- Standardized
- Popular

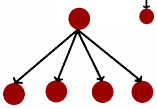
802.15.4 Configurations

- Single Peer

- Multi Peer



- Broadcast



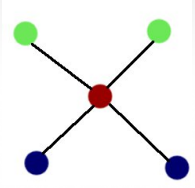
Zigbee

- Layer on top of 802.15.4
- Routing (pass messages on)
- Ad-hoc network creation
- Self-healing

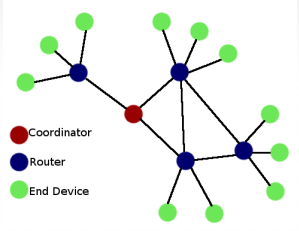
ZigBee Alliance

Zigbee Configurations

- Star



- Mesh



Antennas

- Chip

- Whip

- u.FL

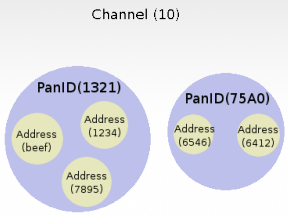
- RPSMA

Regular vs. Pro

- 1-2mW
- Smaller
- Shorter range (100m)
- Cheaper

- 50-60mW
- Longer
- Longer range (300m)
- More expensive

Addressing



Addressing

- Channels
- PAN
- 64-bit address
- High -0013A200 same for all XBees
- Low – each XBee has its own address
- 16-bit address (configurable on Series 1)

Coordinators

- Each network has 1 coordinator
- Coordinator selects channel and PAN ID
- Other devices then join the PAN
- Usually powered by something stable
- 16-bit address is always 0
- Assigns 16-bit address for the router and end devices

Routers

- Optional
- Often powered by something stable
- Can have as many as you want
- Issues a request on startup to find a coordinator/network it can join
- Can talk to any device
- If an end device is sleeping it stores its data
- Coordinator can act as a “super router”

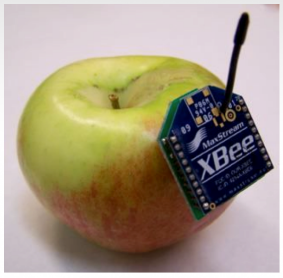
End Devices

- Optional
- Usually battery powered
- Can have as many as you want
- Issues a request on startup to find a network it can join and a parent device (router or coordinator)
- Can only communicate with its parent

Firmware

- Must upload with X-CTU (on Windows)
- AT firmware vs API firmware
- Coordinator, Router, End Device
- Other
- Each Firmware has different settings

Contrary to this picture X-CTU will not work on your Mac

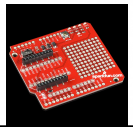


How to Hookup your XBee

- Breakout Board

- Xbee Explorer

- Xbee Explorer Regulated



- Xbee Shield

Terminal Windows

- X-CTU
- Hyperterm (doesn't come with Windows 7)
- Coolterm (Windows, Mac, Linux)
- Unix/Linux terminal window
- Plenty of others

9600-8-N-1

Getting into Command Mode

- +++ gets you into command mode
- 1 second delay on either side
- No <enter>
- Should get “OK” back
- Times out after 10 seconds

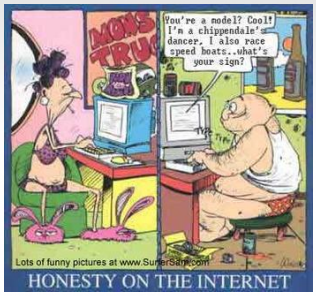
AT Commands

- AT – just returns an “OK”
- ATMY – 16- bit address (Series 1 only)
- ATDH – 64-bit destination address high bits
- ATDL – 64-bit destination address low bits
- ATID – PAN ID
- ATCN – end command mode
- ATRE – reset all settings
- ATWR – write settings to flash

Sending Commands

- Just typing the AT command will give you the setting
- Typing the AT command followed by a value sets the value
- Commands use Hexadecimals
- Always Press Enter
  - >ATID 1111
  - OK
  - >ATID
  - 1111
  - >ATWR
  - OK

Chat Program



I/O Series 1 vs Series 2

- 8 Digital I/Os
- 7 Analog Inputs
- 2 Analog Outputs (PWM)
- Can't use these all at once
- Straight through I/Os
- Must use Vref

- 10 Digital I/Os
- 4 Analog inputs
- No Analog outputs
- Can't use these all at once
- I/O pins are 1.2V only

To use or not to use

- Saves space
- Save power
- Save weight
- Save money
- Reduce complication

- Limited I/Os
- No logic
- No analog output
- Added Complexity

I/O Commands

- ATD0...D7 configure pins 0-7
- ATP0...P1 configure pins 10,11
- ATIR set the sample rate (in ms)

- Always sends 1 sample per transmission
- Data is sent to destination address

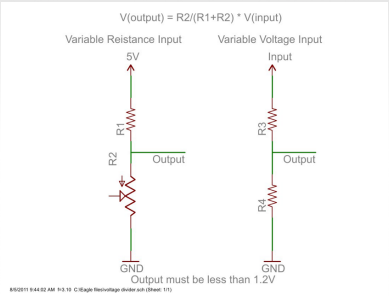
Commands for Series 1 Only

- ATIT samples before transmit (1 for Series 2, configurable for Series 1)
- ATIA – I/O addresses (who can play with my pins)

ATDx Command Options

- 0 - Disabled
- 1 – Built-in function (sometimes)
- 2 – Analog Input (sometimes)
- 3 – Digital Input
- 4 - Digital Output (low to start)
- 5 – Digital Output (high to start)

Voltage Divider



Serial Sensor Project

Why use a Microcontroller

- Local logic
- Fast prototyping
- I2C, PWM, SPI
- More I/Os
- Xbee Series 2 only allows 1 side of I/O

Arduino HW Serial vs NewSoftSerial

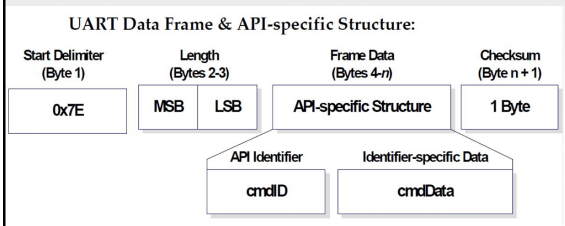
- 1 Serial port on Uno
- 4 Serial ports on Mega
- Connected to USB port

- Unlimited serial ports*
- Requires more processing power
- More likely to loose data
- Higher baud rates less likely to work
- *as many as the processor can handle

API Mode?

- Application Programing Interface
- For computers to talk to other computers
- Structured
- Predictable
- Reliable
- Frames of data
- Radio must be in API mode
- ATAP 1 for Series 1 (ATAP 0 to turn off)
- API firmware for Series 2

API Frame Data



Color Project

Gateways

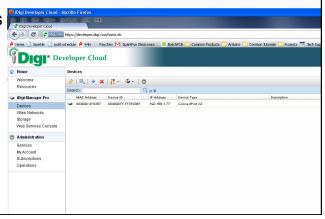
- Connect your Xbee to something else
- Bluetooth
- Ethernet
- Cell Modules
- WiFi
- RFID
- Many others

Digi's Connect Ports

- X8 – Ethernet, Wifi, Cell, USB, serial... $1000
- X5 – Satellite Radio, cell, WiFi, GPS... $1000
- X4 – Ethernet/Wifi, cell $700
- X3 – GSM/FPRS... $250
- X2 – Ethernet or WiFi
  - $100-$200
  - Sparkfun WRL-10569
    - (Ethernet version)
    - $140

iDigi

- Free account with up to 5 Connect Ports
- Remote access your connect port
  - Update firmware on other Xbees in the network
  - Firmware updates
  - Remote Reboot



X2 Example

Troubleshooting

- Only use 3.3V, more than 7 will release magic smoke
- Use decoupling capacitors with a voltage regulator
- TX->RX RX->TX
- Don't overwhelm them, try putting in a small delay

Questions?

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