# Multipoint tracker via GPS and wireless communication

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# Device Purpose

- This device will be used in a variation of the game Paintball, i.e. Woodsball.
- Woodsball
  - Larger area to cover
  - More dense surroundings
  - Harder to keep track of teammates

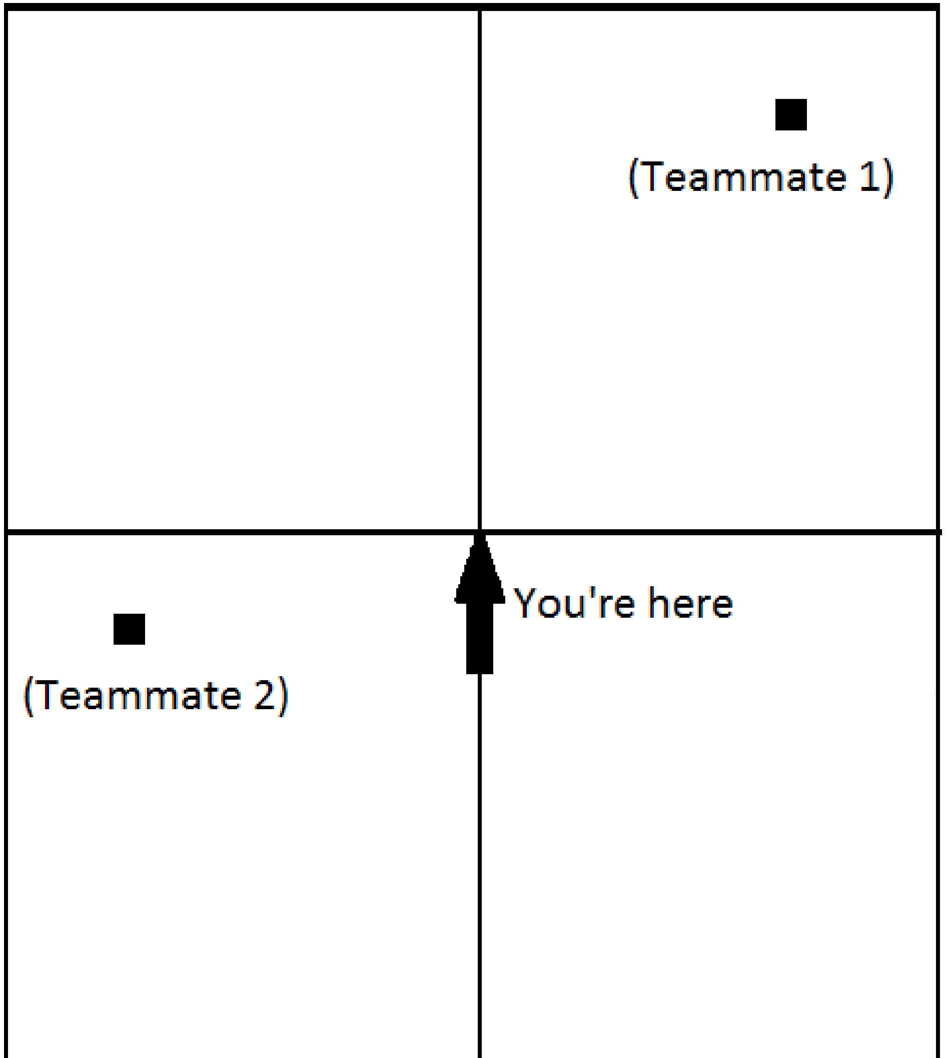
[2]

[1]

# Overview

- Device displays the position of other devices relative to its location.
- Acquires GPS information through a GPS module.
- Transmits its own coordinates through an RF transceiver, predesigned for point-to-multipoint communication.

# What is Displayed




X(m) : Y(m)
+223 : +270
-225 : -030

Device1 : Device 2
012 : 013

Note: Diagram not to scale

# Components

## GPS module: Fastrax UP501

**Pros**:

- 22 channels (tracking)
- Built-in antenna
- Good Documentation
- 75mW typical power consumption
- Serial interface (9600 BAUD)
- Small size (22mm x 22mm x 8mm)
- $49.95 per module

**Cons**:

- 115mW consumption in satellite search phase
- Long acquisition period, sometimes no acquisition
- Requires 3.3V to 5V logic converter


[5]

# Components Cont.

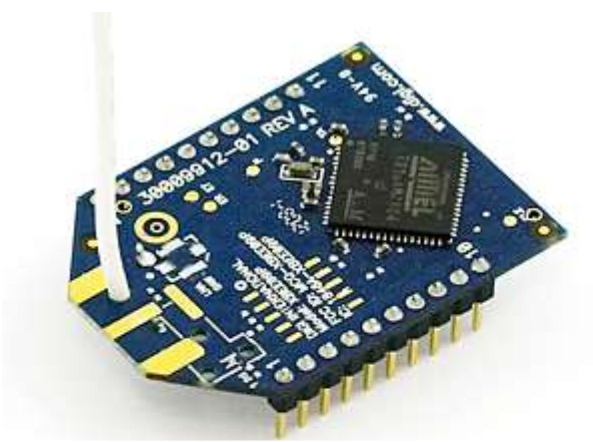
## RF radio: Xbee 900MHz

**Pros**:

- 1.8 mile range (Line-of-sight)
- Good documentation
- 900 MHz operating frequency
- Point-to-multipoint networking
- Serial Interface (9600 BAUD)
- $42.95 each

**Cons**:

- 450ft urban range
- 693mW Transmitting power consumption (3.3V x 210mA)
- Requires a breakout board for breadboarding
- Requires 3.3V to 5V logic converter



[3]

# Components Cont.

## LCD: Sparkfun Graphical LCD

**Pros**:

- 64x128 pixels
- LED backlight
- Control code online
- $19.95 per LCD

**Cons**:

- Parallel interface (14 pins)
- Operates at 5V, forcing the microcontroller to run at 5V
- Horrible documentation
- Code only had 2 font libraries

[4]

# Components Cont.

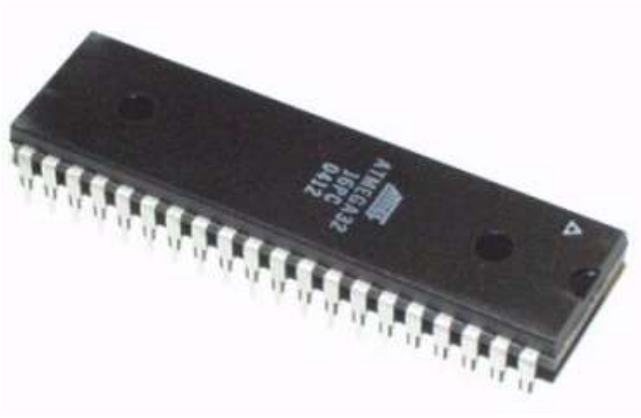
## Microcontroller: Atmel ATmega 324p

**Pros**:

- Low power (45mW at 5V)
- Two UART (SCI)
- 40 pins
- 8 MHz system clock freq.
- Good documentation
- $8.80 per chip

**Cons**:

- 8-bit microcontroller
- AVR GCC 4 and 5 are not the best compilers
- Does not run 9600 BAUD well on UART while system clock is at 1 MHz



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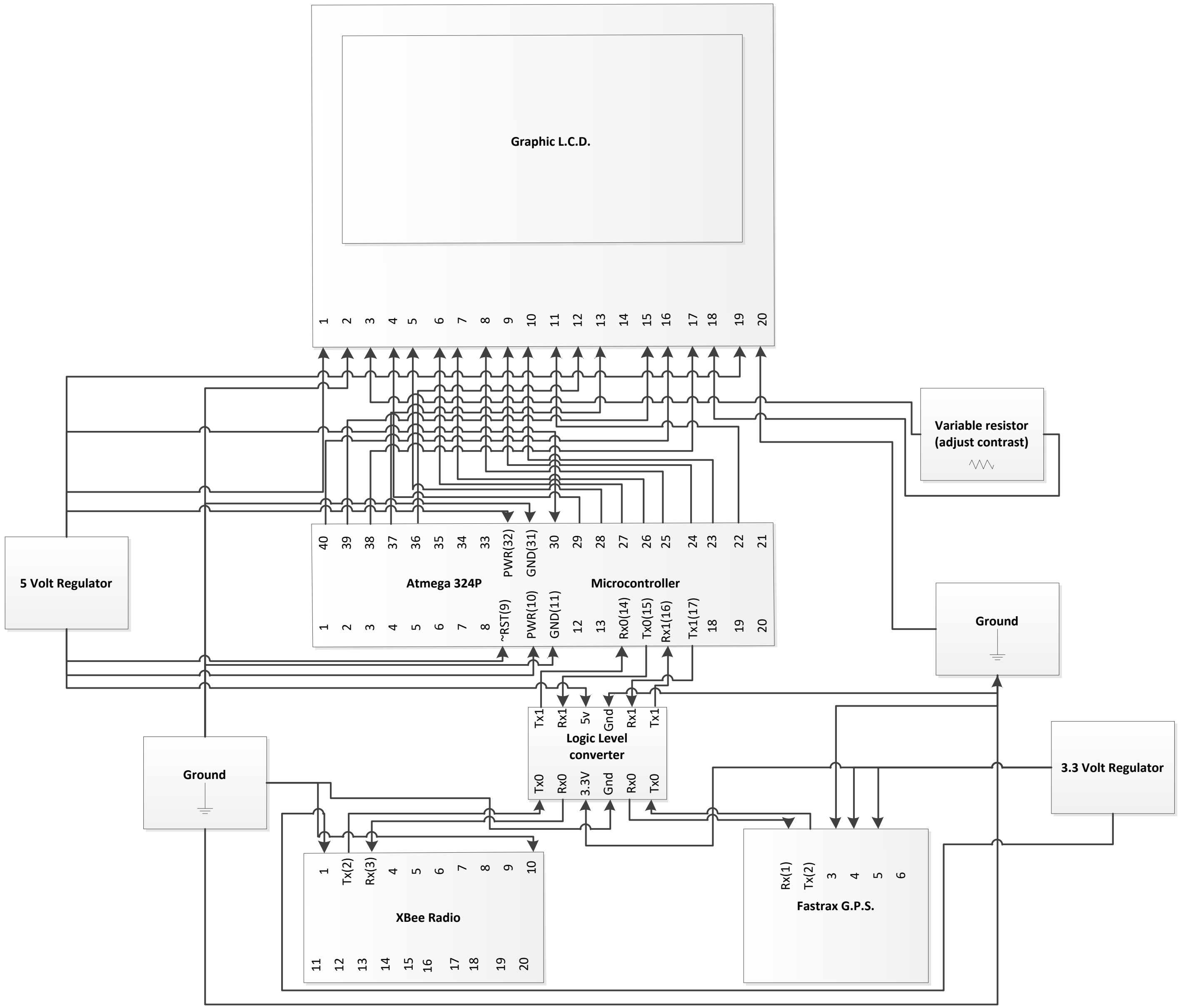
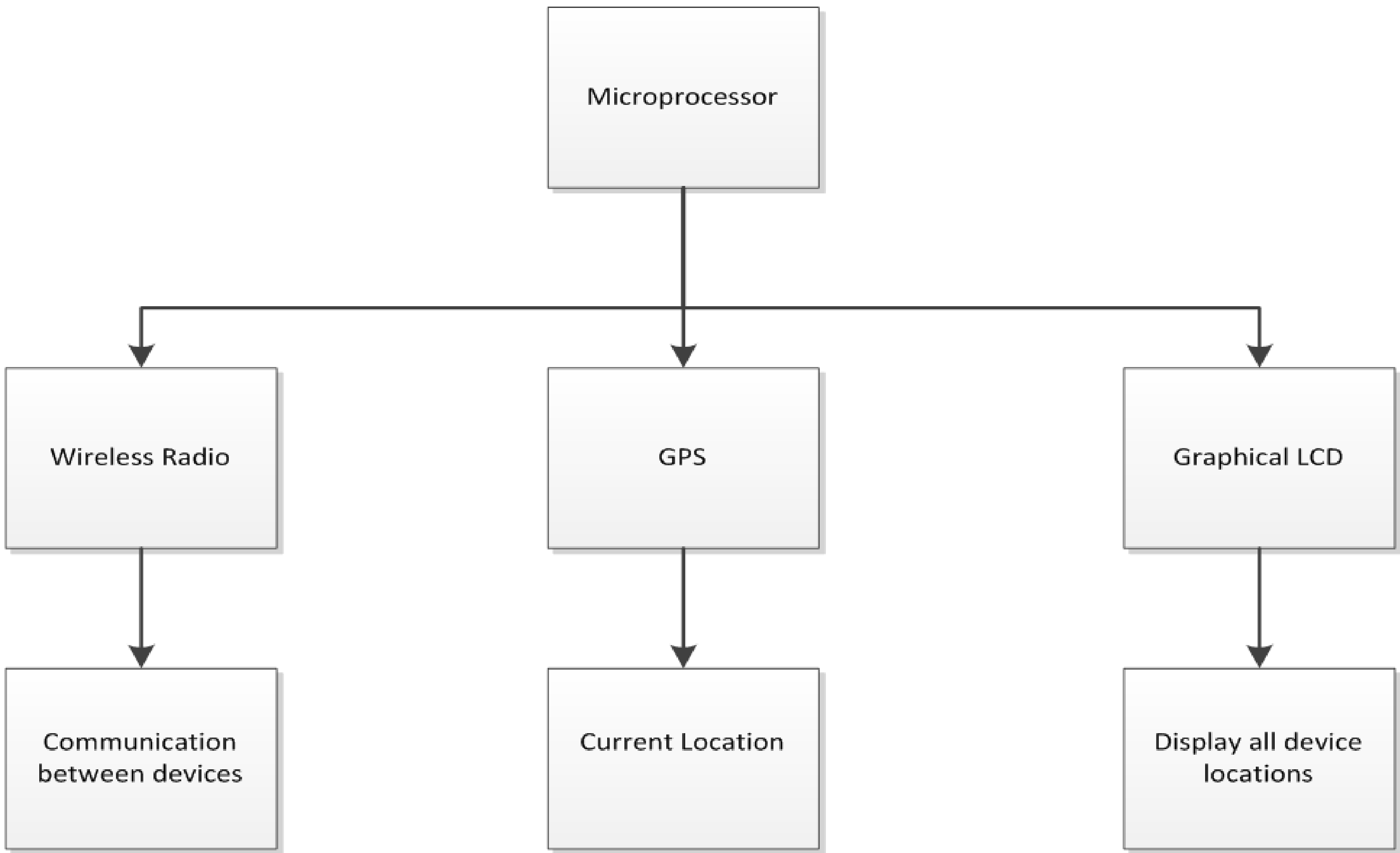
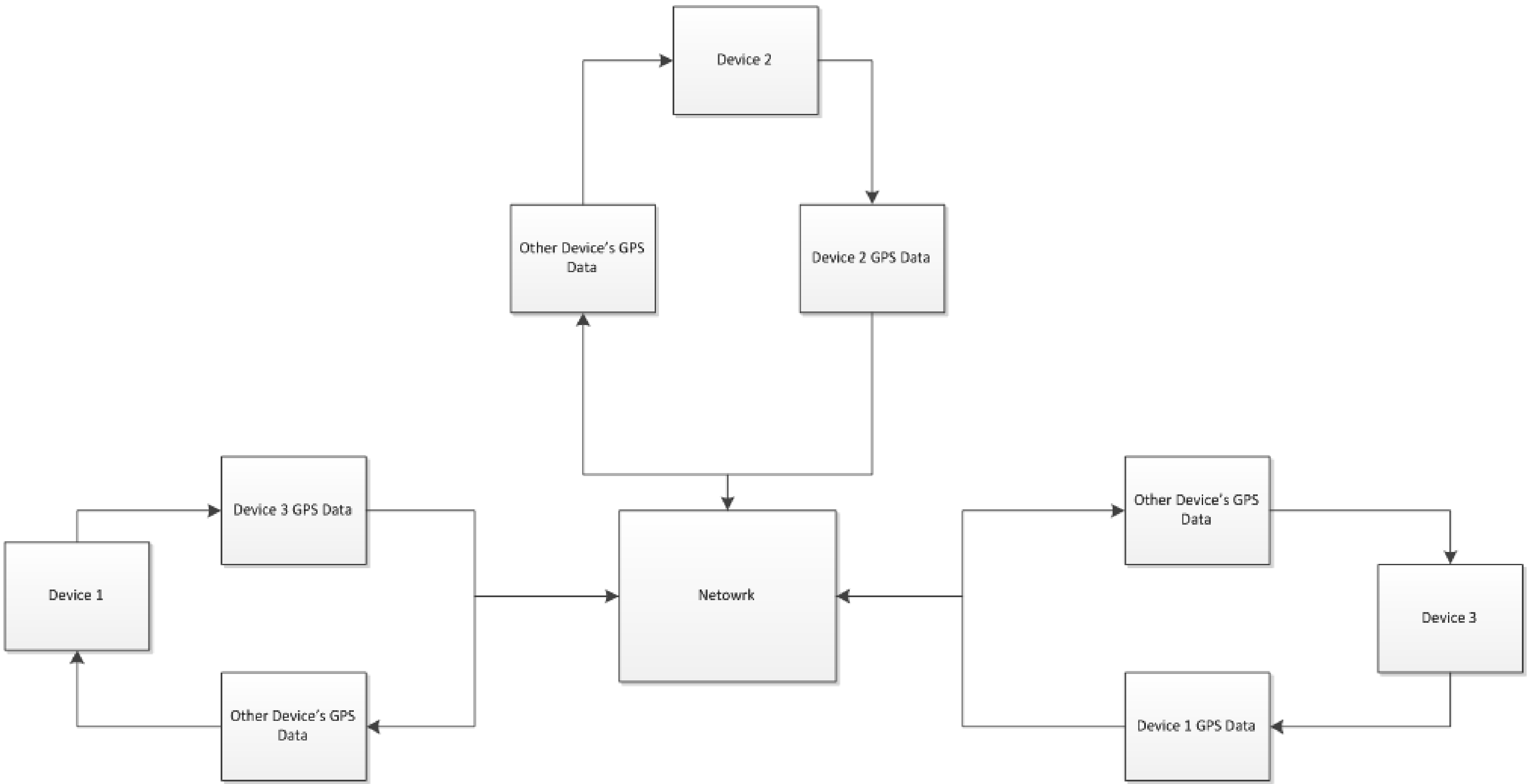
# Circuit Block diagram



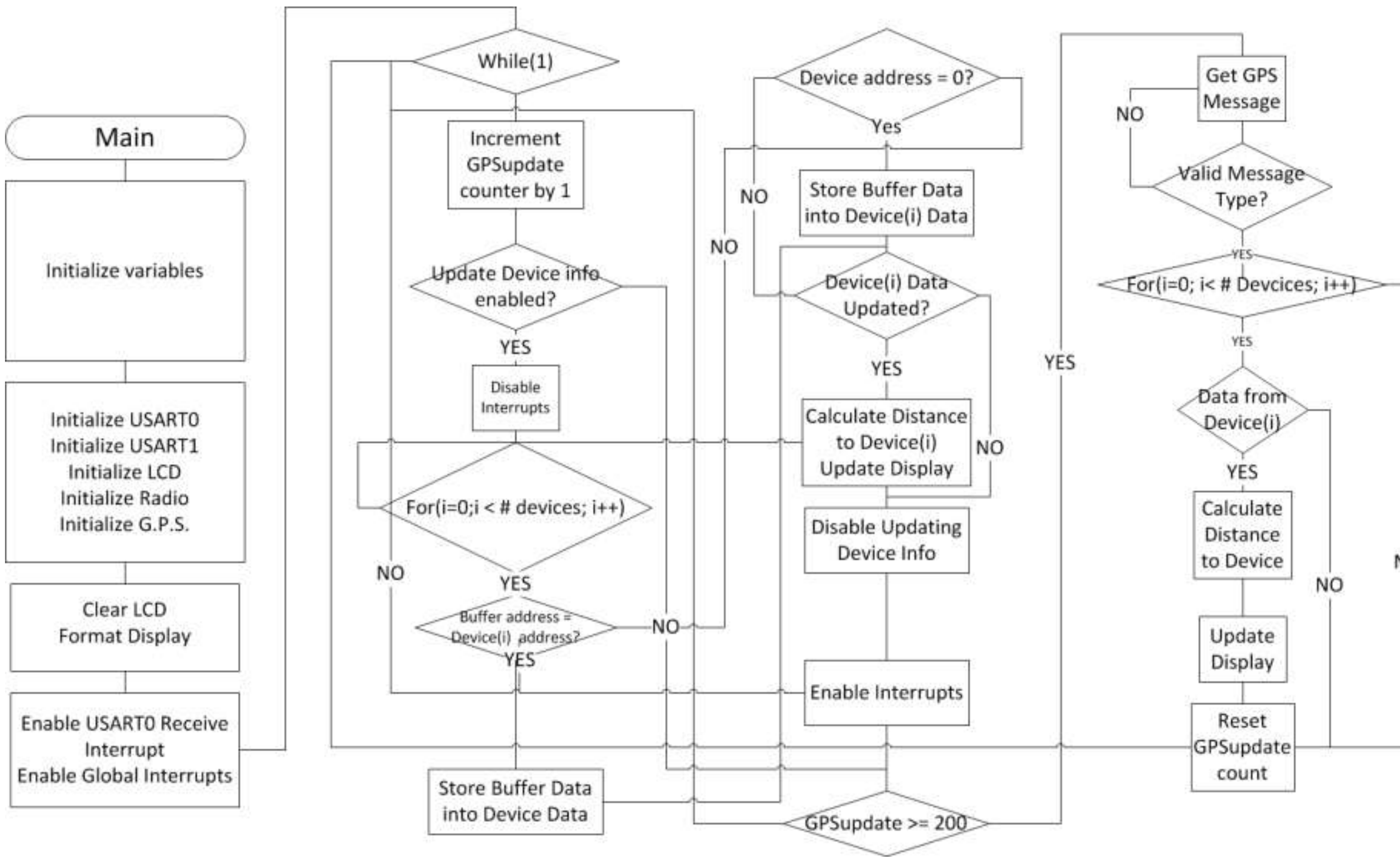
# Top Down Diagram



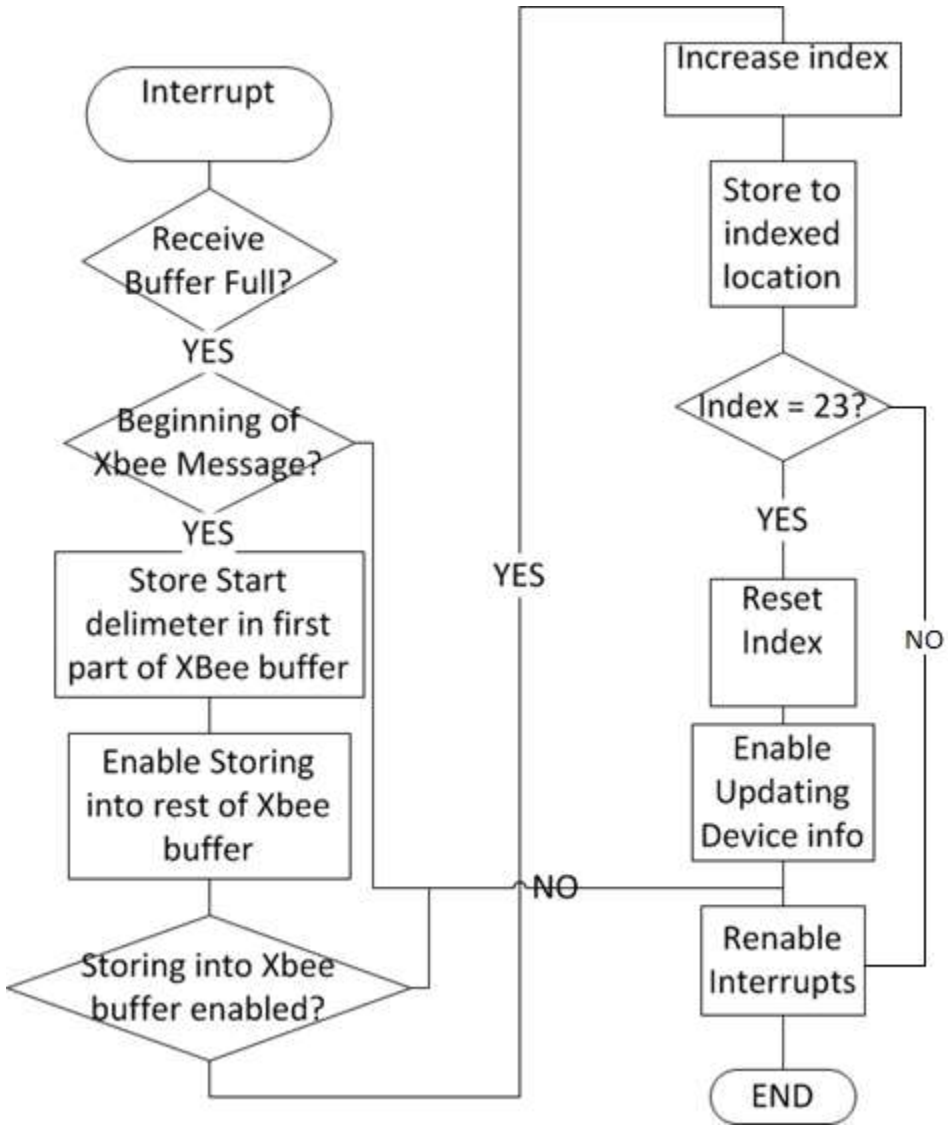
# Data Transfer Flow



# Main Program Flowchart



# Interrupt Subroutine



# Distance Calculation

- Equirectangular projection vs Haversine Formula
- Equirecntangular Formula
- $x = (lon_2 - lon_1)\cos((lat_1 + lat_2)/2)$
- $y = lat_2 - lat_1$
- $d = R * \sqrt{x^2 + y^2}$
- $lon2, lat2 : gps\ info\ from\ another\ device$
- $lon1, lat1 : device\ doing\ calculations$
- $R :\ mean\ radius\ of\ the\ earth$
- $d :\ direct\ distance\ between\ two\ points$

# Distance Calculation Cont'd

- Haversine Formula
- $a = sin^2(lat_2 - lat_1) + \cos(lat_1)*\cos(lat_2)*sin^2(lon_2 - lon_1)$
- $c = 2 * arctan2(\sqrt{a}, \sqrt{1 - a})$
- $d = R * c$
- $d : distance\ between\ two\ points$

# Distance Calculation Cont’d

- Equirectangular Projection
  - Pros
    - Easy computation
  - Cons
    - Not accurate for far distances
- Haversin Formula
  - Pros
    - Accurate for far and close distances
  - Cons
    - Computationally Complex

# Calculations Cont’d

| Lat1 | Lon1 | Lat2 | Lon2 | Haversine | Equirectangle | Error |
|---|---|---|---|---|---|---|
| 41°18’58” N | 105°34’58” W | 41°18’58” N | 105°34’59” W | 23.2 m 76.11 ft | 23.19m 76.09 ft | 0.04% |
| 41°18’58” N | 105°34’58” W | 42°18’58” N | 105°34’58” W | 111.2km 69.1 miles | 6371 km 3958 miles | 5629% |

- For our purposes the error at the distances we are operating at there is little to no error
- Haversine is not as accurate at close distances as Equirectangle projection

# Future Improvements

- Better LCD screen
- Better batteries
- Better GPS module
- Look into power saving techniques
- Add an electronic compass

# Special Thanks

- The NASA Space Consortium for funding our project.
- Dr. Cameron Wright, Dr. Steven Barrett, Dr. Stanislaw Legowski, Victor Bershinsky, George Janack for their help
- Electrical Engineering department staff for their aid.

# Image Citations

[1] (n.d.). In *Black Water Recon Paintball is Tallahassee and Quincy Florida's Premier Woodsball and Scenario Paintball Field*. Retrieved September 18, 2011, from http://bwrpaintball.innovative-websolutions.com/images/us.jpg

[2] What is Paintball? - Full Line of Paintball (n.d.). In *AirSplat.com*. Retrieved September 18, 2011, from http://www.airsplat.com/ScenarioPaintball.htm

[3] *Xbee pro 900 wire antenna* . (n.d.). Retrieved from http://www.sparkfun.com/products/9097

[4] *Graphic lcd 128x64 stn led backlight* . (n.d.). Retrieved from http://www.sparkfun.com/products/710

[5] *66 Channel UP-501 GPS Receiver* . (n.d.). Retrieved from http://www.sparkfun.com/products/10702

[6] *Avr 40 pin 16mhz 32k 8a/d - atmega32* . (n.d.). Retrieved from http://www.sparkfun.com/products/209

# Questions?