

Wireless Local Positioning System

- Project Overview
- Functional Description
- Hardware and Software Design
- Components and Interfaces
- Timing
- Extensions

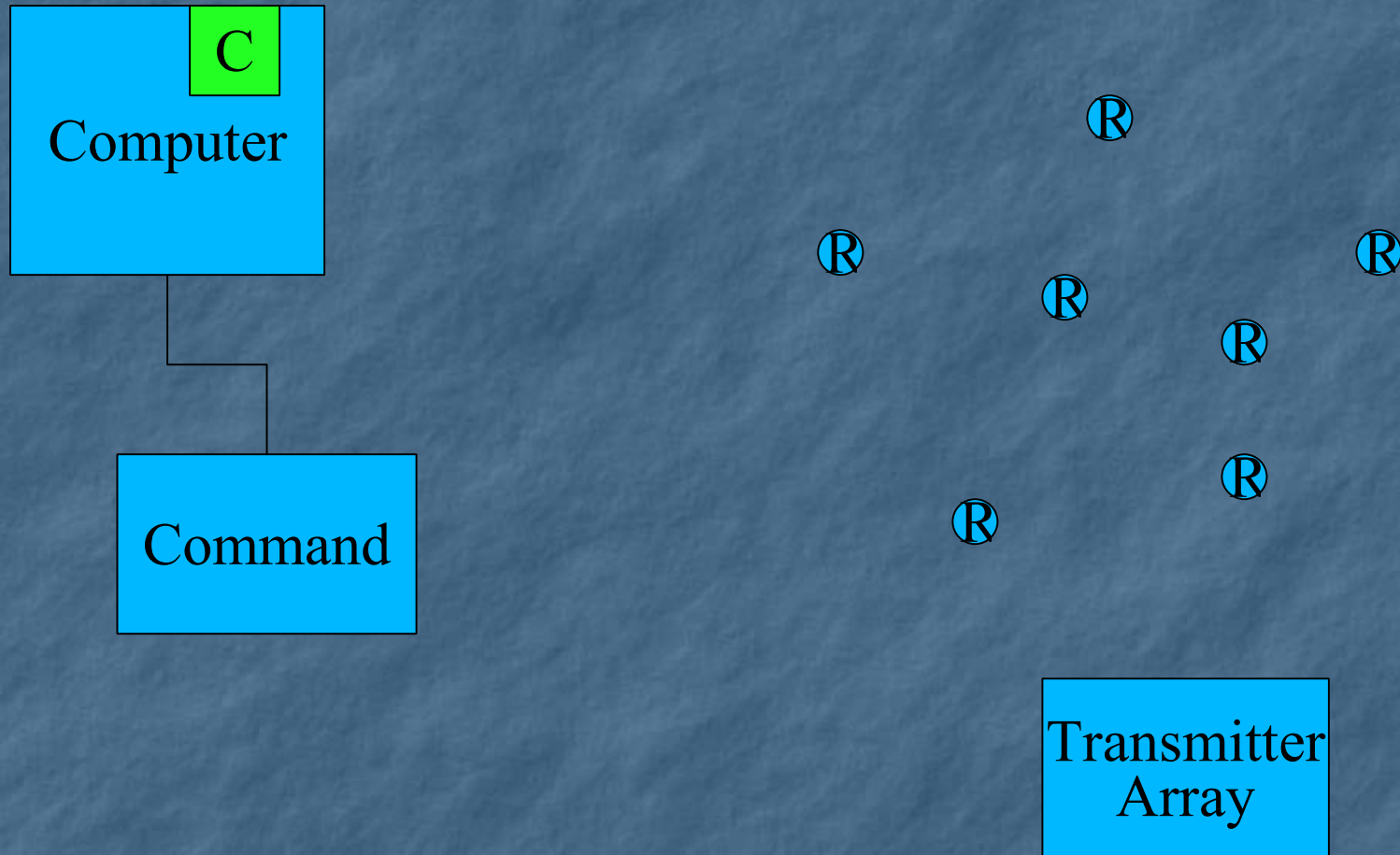
Project Overview

- Wirelessly senses positions of nodes relative to a transmitter array
- Uses ultrasonic signal delay from transmitters to receiver nodes to determine distances.
- Relays captured data to a personal computer.

Functional Description

- Wireless Position Measurement System
 - Highly accurate (>2 cm accuracy)
 - Short range (<3 m)
 - Small nodes ($<1'$ X $1'$ X $1'$)
 - Universal Serial Bus interface to transfer data to a computer

Functional Description: Top View



Design: Command Module

- Is combination microcontroller/zigbee node
- Has USB data link to Computer
- Controls the transmitter array and receivers
 - Handles adding nodes to the system
 - Tells transmitter array which transmitter to fire, and when
 - Tells receiver nodes when to start their delay timer
 - Polls receiver nodes for measured delay
- Runs network software for above, as well as drive a serial I/O connection through the USB to the computer.

Design: Transmitter Array

- Controlled by single microcontroller with zigbee.
- Has a set ultrasonic transmitters (as few as 3 but may be up to 8) located in strategic positions for triangulation.
- Software on microcontroller follows command module's directions and sends signal to appropriate transmitter.

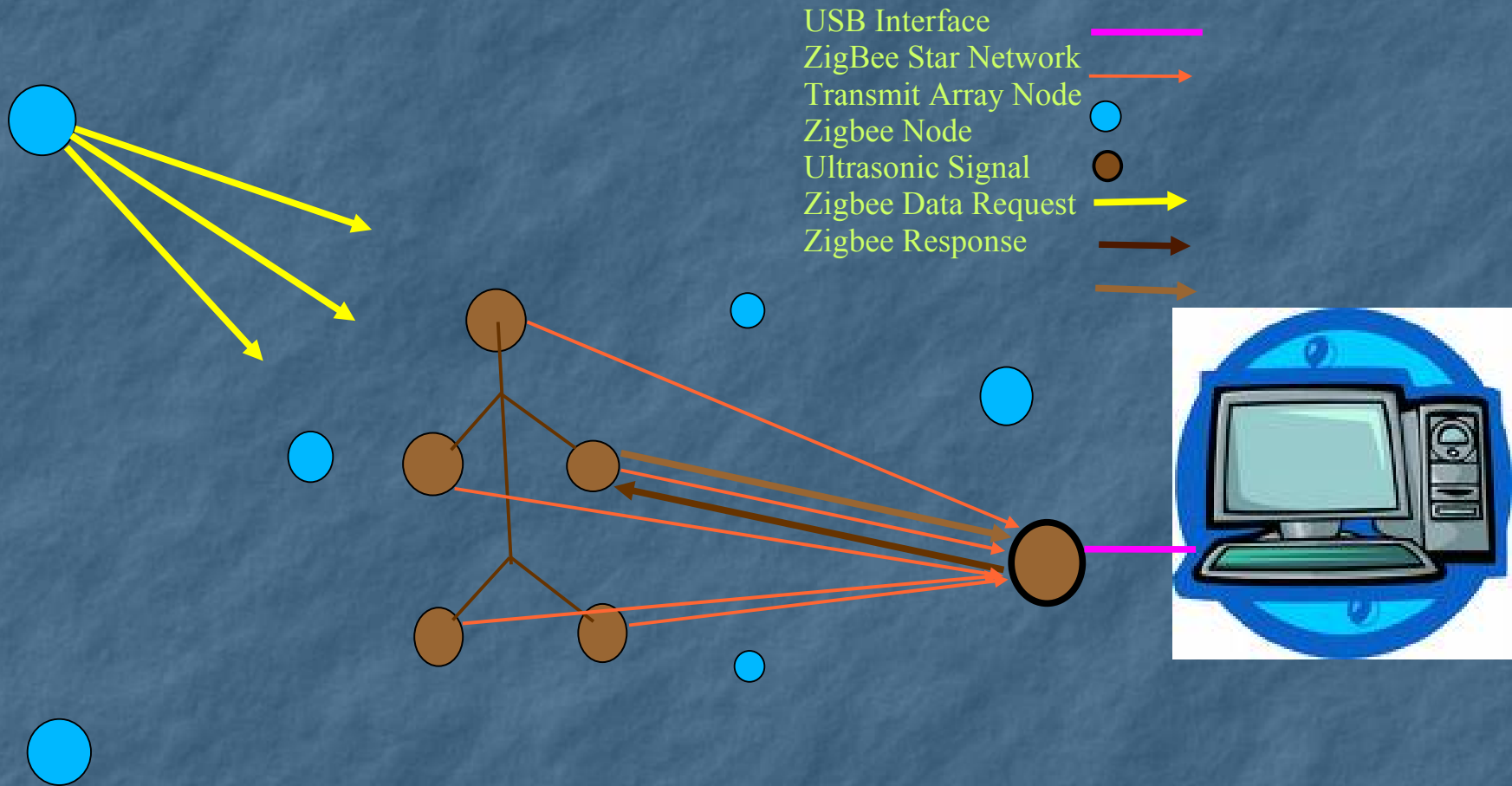
Design: Receivers

- Small, simple microcontroller/zigbee setup with ultrasound receiving hardware.
- Software to connect and interface with command module.
- Listens for transmission from transmitter array
- Records time stamp for transmitter
- Relays this data for each transmitter when asked by Command module.

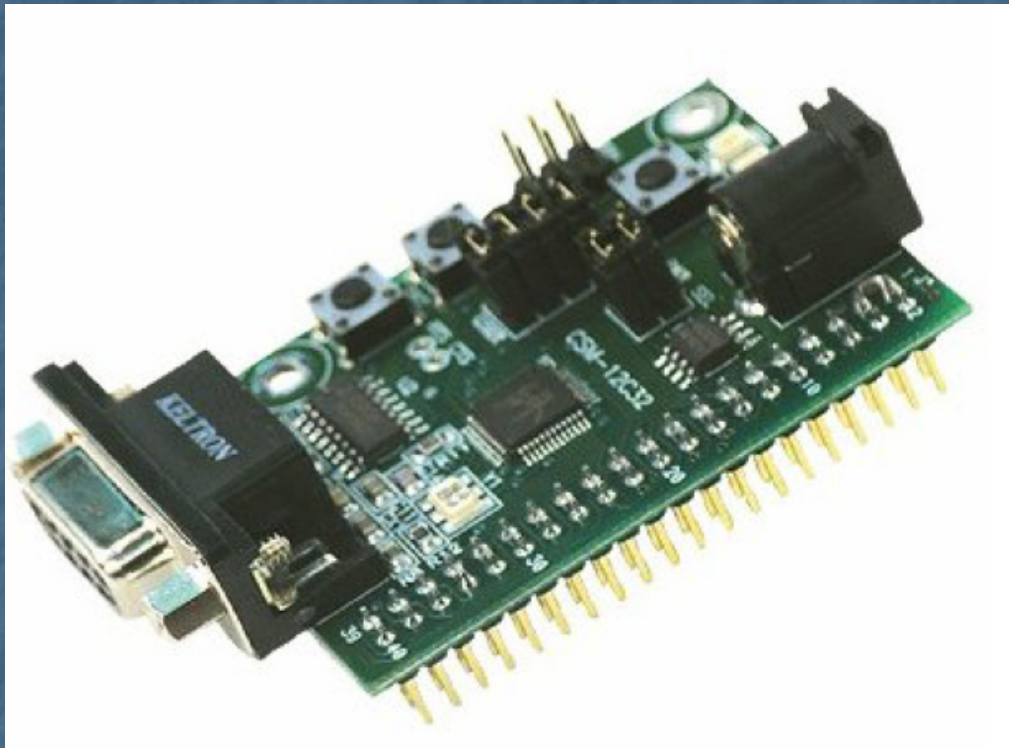
Design: Computer Software

- Drivers come with USB part or written by us if not.
- Program, or interface to a program, to demonstrate system
- Program Sophistication determined by time

Interfaces



Components

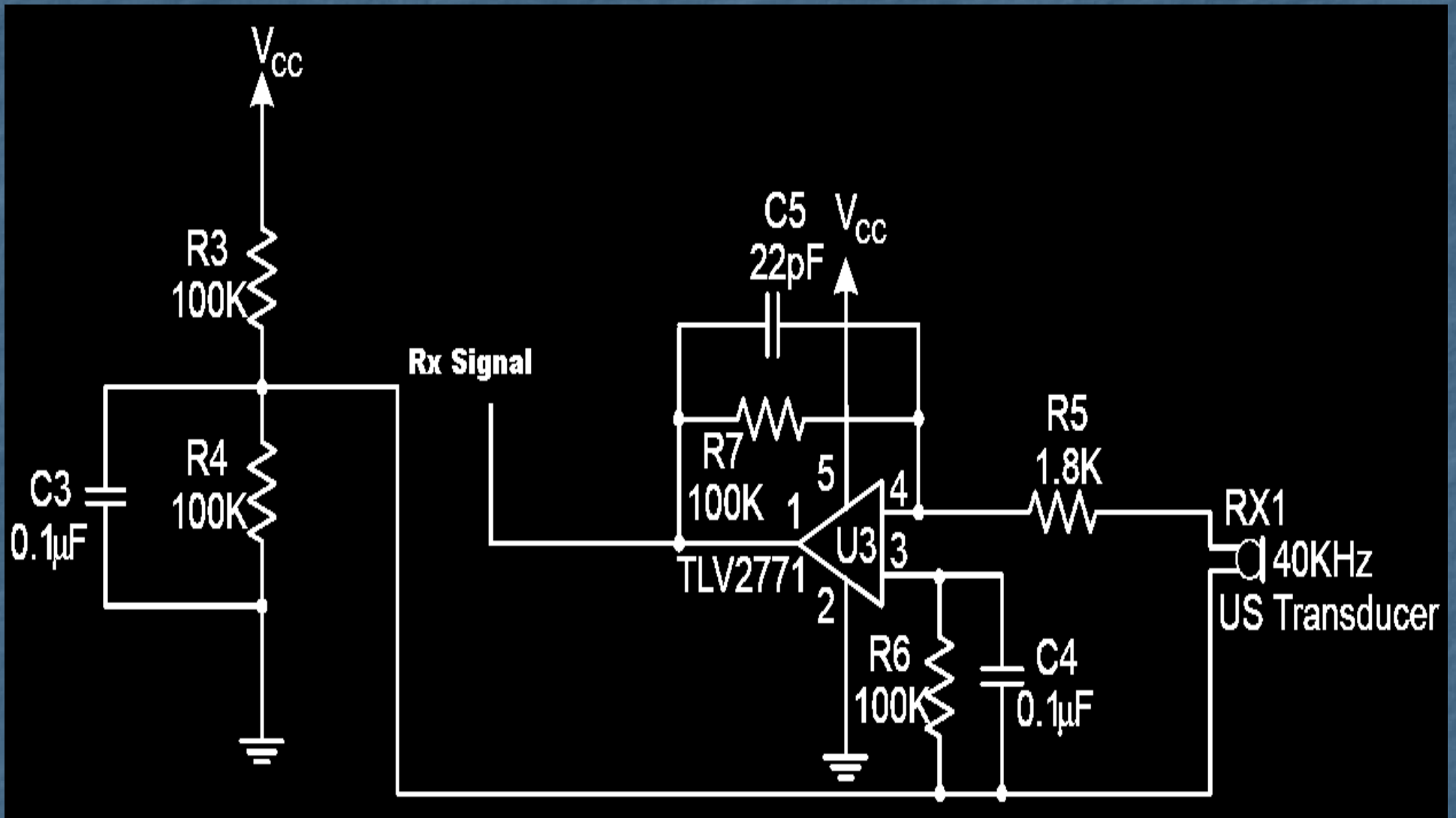


Components: Receiver Nodes

- Zigbee Nodes
 - Freescale MC13213 (Transceiver/Microcontroller)
 - Freescale 802.15.4 MAC Software
 - 16 Mhz Oscillator Crystal Package
 - RF Antenna
 - Piezoelectric Ultrasound Transducer
 - Op-Amp/Miscellaneous components for signal filtering.

Components: Receiver Nodes

Ultrasonic Receiver Schematic

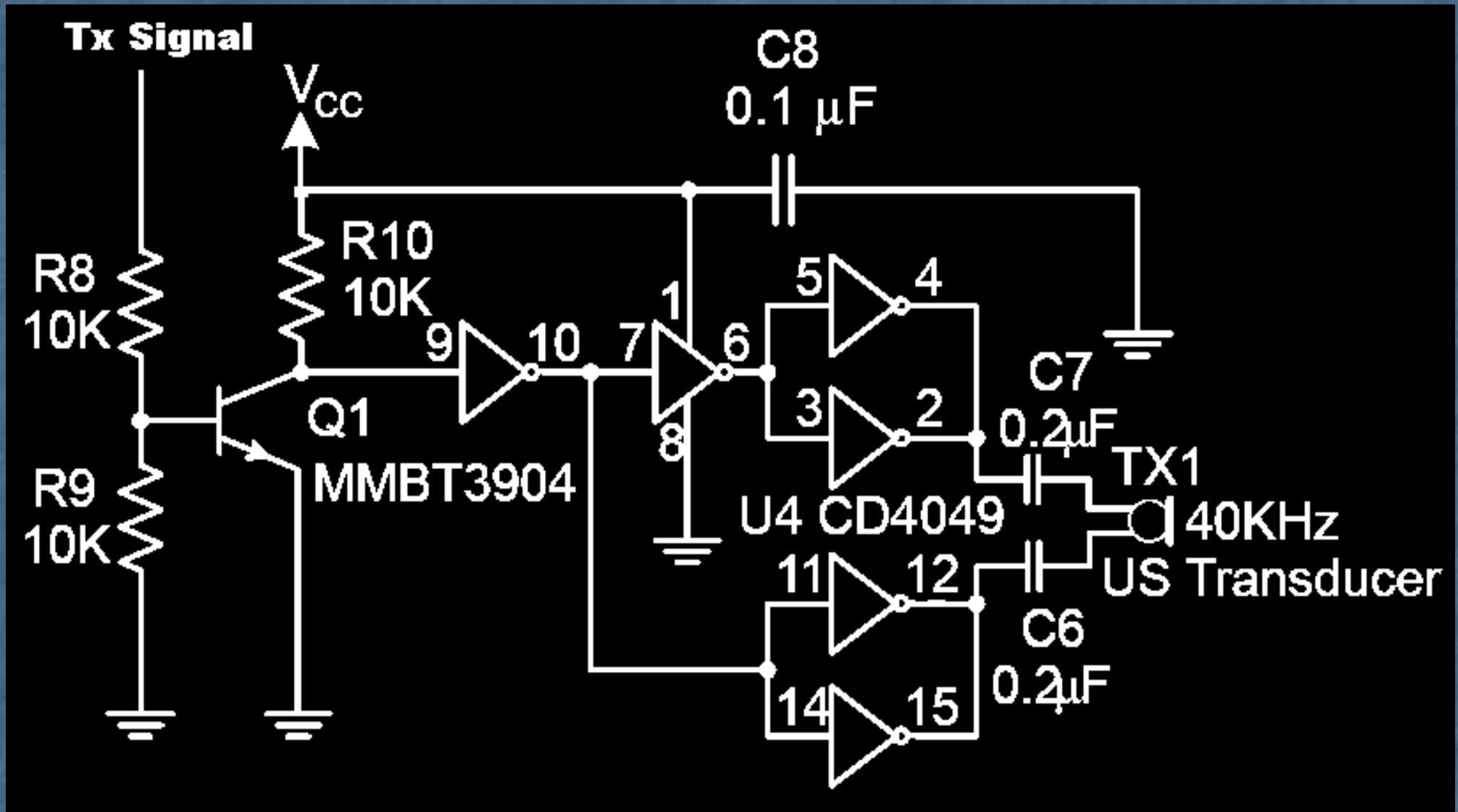


Components: Transmitter Array

- Transmitter Array Nodes
 - MC13213 (Transceiver/Microcontroller)
 - Oscillator Crystal Package
 - Antenna
 - Piezoelectric Ultrasound Transducers
 - Inverter Packages/Misc. Components

Components: Transmitter Array

Ultrasonic Transmitter Schematic



Components: Command Module

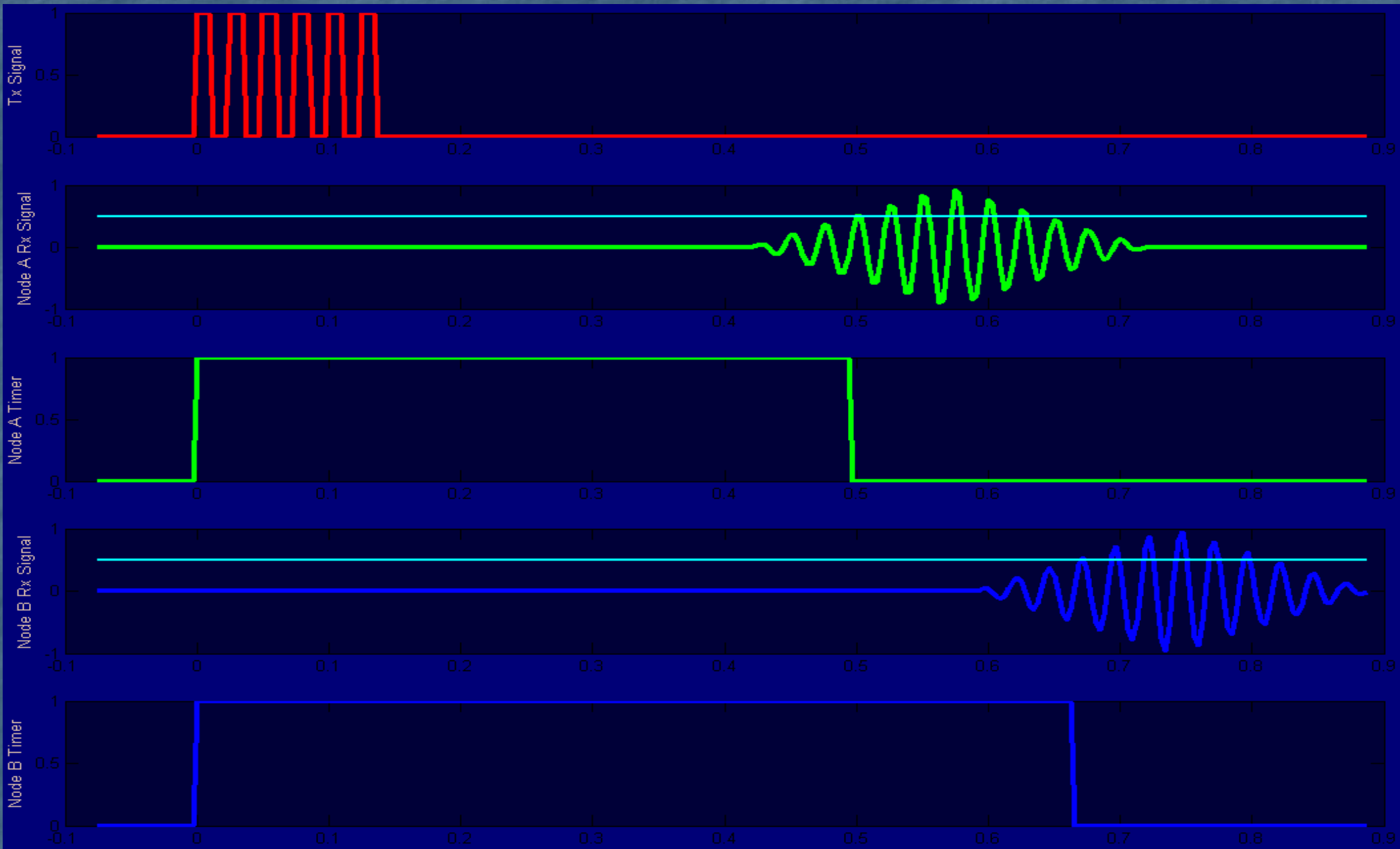
- ZigBee Node (same as Receiver Nodes w/o ultrasound)
- USB Interface
 - USBMULTILINKBDME
(Microcontroller Programmer/Debugger)

Timing

- Command Module sends out signals which cause Transmitter n to begin an ultrasonic pulse and all of the Receiver Nodes to start their delay timers.
- Pulse travels through the air at $\simeq 30$ cm/ms, reaching Receiver nodes at various times.
- Signal filter takes a few cycles to resonate up to amplitude of predefined threshold.
- Signal triggers input capture, causing each Receiver node to record the current time delay.

Timing

Example Signals



Applications

- Baseline:
 - “Wei” style controller used to position/move an object in a 3d application
- Stretch
 - 3D brush/pen
 - “Tinker-top” set up of nodes to build physical model to animate characters in a 3D modeling program
 - Full suit of nodes used to control a video game character

Hardware Stretch

- Add additional transmitter array to get better positions
- Add better processor to Command Module to translate data to x,y,z coordinates before sending to computer
- Add accelerometer to nodes, so they can notify Command Module of change instead of having to be polled
- more...

Ideal Final Product

