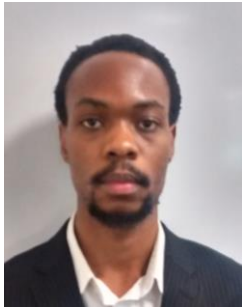# Final Project Review

Sync-In
April 14, 2016

Sync-In

Ajwad Alam, EE
Amplifier/Power

Joseph Bellve, EE
Housing/PCB

Levis Agaba, CSE
ADC/DAC

Carl Senecal, CSE
Networking/Integration

Agenda

- Project Overview

- Specifications

- FPR Deliverables

- Demo

Sync-In Overview

- Broadcast audio from one set of headphones to many in a local area via WiFi

- Independent of Internet connection or phone data plan

- Various applications

- Social – Bring together strangers in unfamiliar situations through music

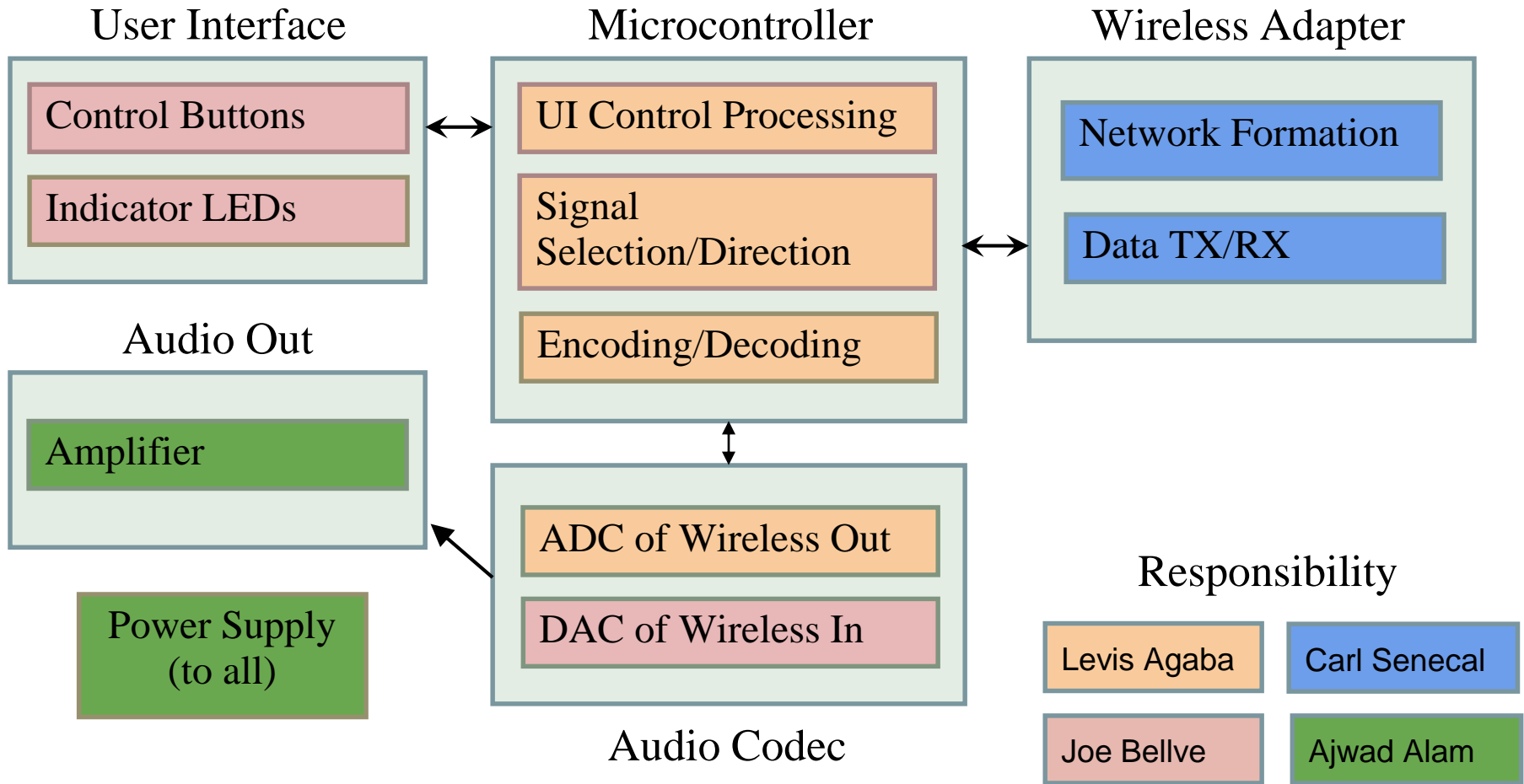- Conferences/Events – Broadcast translations in multiple languages

Specifications

Ease of Use	▪ Clear controls and indicators
Size	▪ Small enough to fit in headphone enclosure
Power	▪ Use as little power as possible; ideally 4-8 hours of battery life
Network	▪ Free WiFi network (no need for ISP or data plan)
Concurrent users	▪ Minimum 3 users (one broadcaster, two listeners)
Streaming Quality	▪ Minimum 192 kbps audio quality ▪ No noticeable drops/stuttering in playback ▪ Near-synchronous listening
Range	▪ 100 foot radius

Specifications

Ease of Use	🟢 Clear controls and indicators
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Range	🟢 100 foot radius

Block Diagram

User Interface

- Control Buttons
- Indicator LEDs

Microcontroller

- UI Control Processing
- Signal Selection/Direction
- Encoding/Decoding

Wireless Adapter

- Network Formation
- Data TX/RX

Audio Out

- Amplifier

Power Supply (to all)

Audio Codec

- ADC of Wireless Out
- DAC of Wireless In

Responsibility

Levis Agaba	Carl Senecal
Joe Bellve	Ajwad Alam

CDR Review

- Two-channel audio amplification

- Partially integrated mobile power supply

- One-to-one board communication and one-to-one group formation

- Audio communication between two boards

FPR Deliverables

| Deliverable	Responsible	Achieved	Comments
Multi-Person Groups	Carl	Yes	Transceiver Mode
Audio Broadcast	Carl	No	Tx/Rx functions incomplete; API problems
PCB Development	Joe	Yes	
Enclosure	Joe	Yes	Larger than planned
Power supply to all subsystems	AJ	Yes	
Audio Quality Improvement	Levis	Yes	192 kbps

Subsystem 1: User Interface

- Built the Housing in AutoCAD2016 Student edition

- 3D printed at Digital Media Lab in W.E.B. Du Bois Library

- Has two buttons which control the state.

- Has 3 LED's that notify the user of the current state.
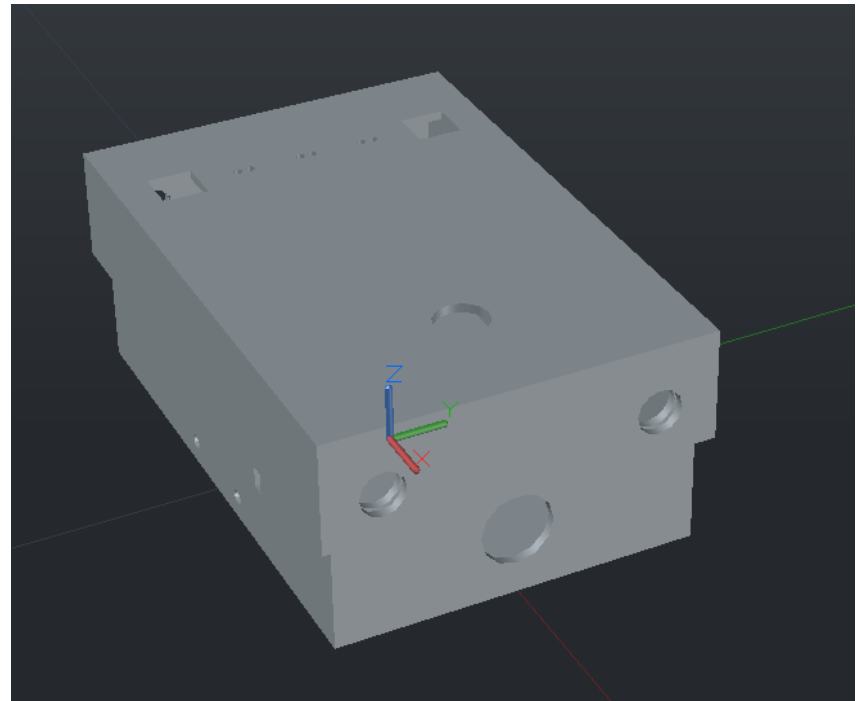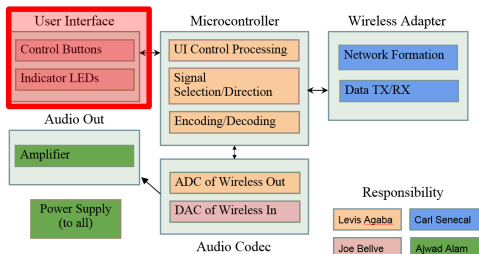
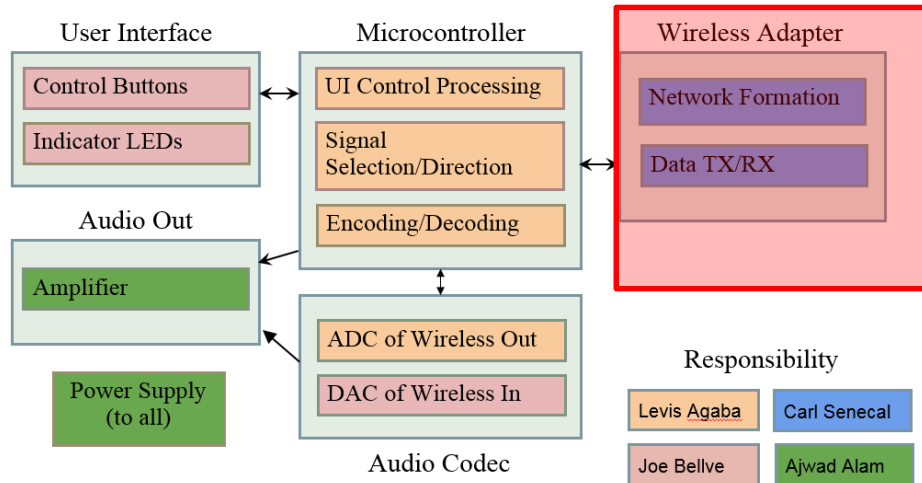# Printed Circuit Board

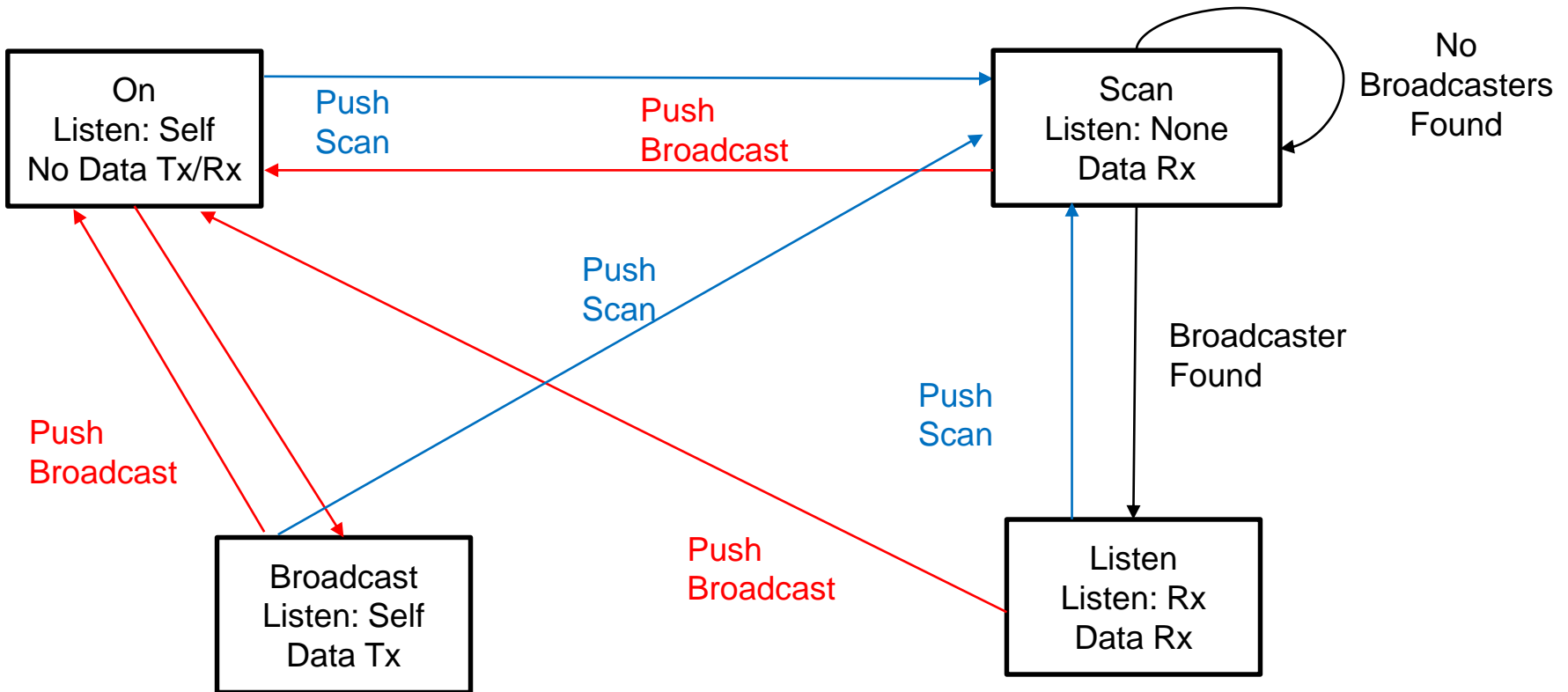- Built on Eagle

- Manufactured by OSH Park
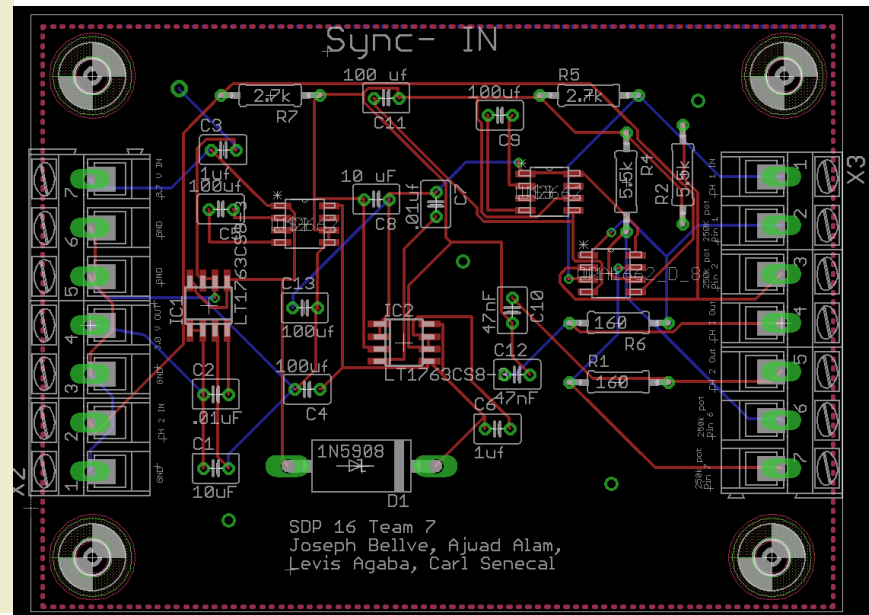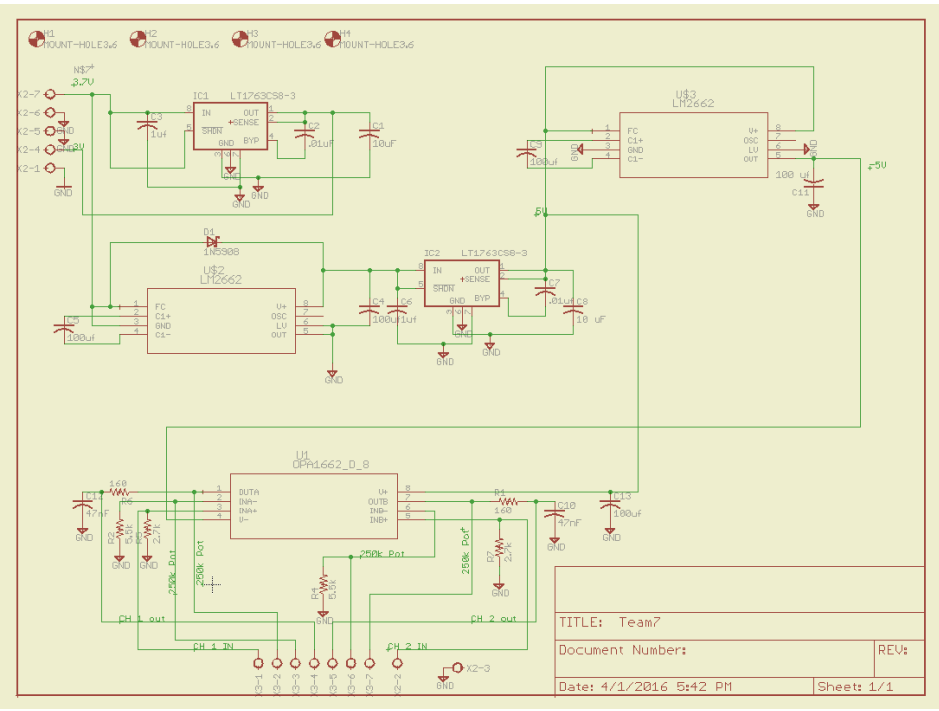
Subsystem 2: Networking

- System supports full one-to-one communication

- Listeners can scan and choose between different transmitters

- Can broadcast (one-to-many) data, but not audio

State Diagram

Code

- **System Thread** Monitors for network events

- **I/O Event Thread** Watches for and processes button presses

- **Audio In Thread** Depending on state, forwards line in to a socket, places line in in the play buffer, or does nothing

- **Audio Out Thread** Depending on state, listens for audio data on a socket and places that data in the playback buffer or does nothing

- **Networking Thread** Configures board in Access Point or Station mode and handles network connection events

Code Flow

- Initialization: Board Setup, Pin Setup, UART Setup, Thread Creation (System, I/O Event, Audio In, Audio Out), Thread Launch

- Board loops back audio until a button is pressed

- Button Handler starts AP or STATION thread and sets flags for use by the Audio In and Audio Out threads according to a state machine

- AP/STATION thread configures soft AP with SSID, key, operating channel, transmission strength, connection policy, handles connection to AP, assigns IP addresses, creates socket for Audio Tx/RX, handles all network events like device connection and disconnection

Subsystem 2: Networking

- Challenges: API Limitations and Transmission Rates
- Broadcasting
  - CC3200 AP Mode Supports only 1 client at a time
  - Workarounds via IP addresses are not viable
    - Client needs to associate with AP before accepting packets
    - Cannot associate new clients at an AP without disassociating current client
  - Solution: Transceiver Mode
    - Bypasses Network & Link Layers
    - Requires re-implementing transmission and receive protocols and does not work with essential API functions
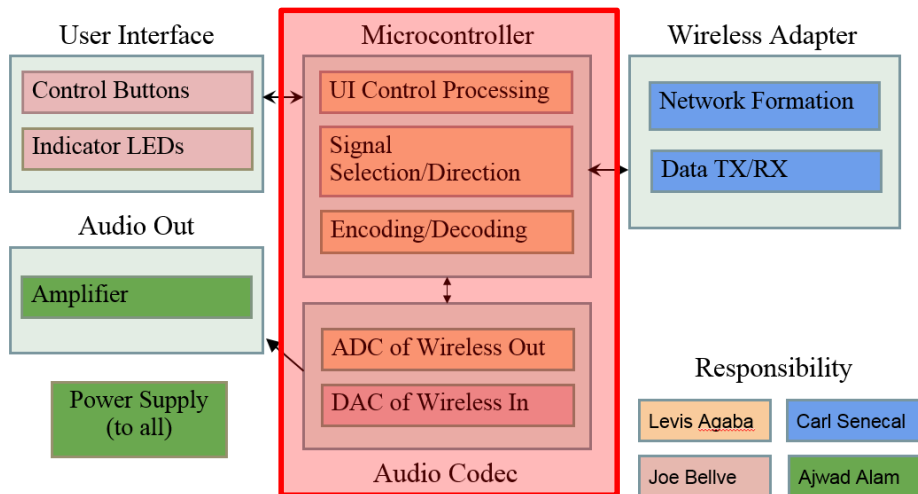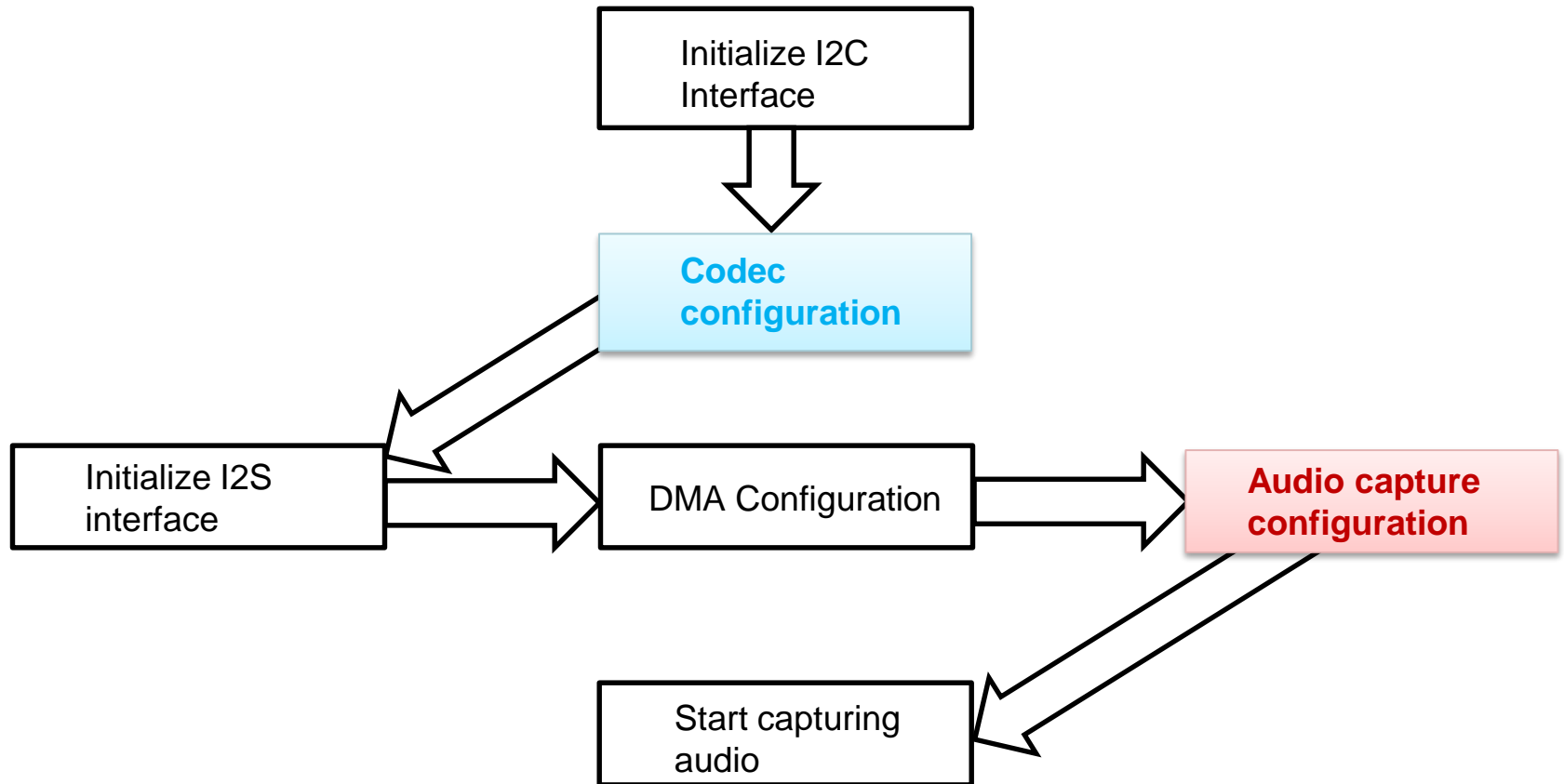
Subsystem 2: Networking

- Transceiver Mode
  - No collision protection
  - Need to filter packets manually
  - Many API functions do not work properly with raw sockets
    - Receiving packets to file is broken
  - Between buffering issues and noise, audio is mostly static, unrecognizable
  - Demo shows basic broadcast functionality with data only

- 16bit (Default) bit resolution (option to use 24bits)

- 44.1kHz sampling frequency (16kHz for decent quality)

- 48kHz sampling frequency at 16bit resolution

User Interface

| Control Buttons |
| Indicator LEDs |

Audio Out

| Amplifier |

| Power Supply (to all) |

Microcontroller

| UI Control Processing |
| Signal Selection/Direction |
| Encoding/Decoding |

| ADC of Wireless Out |
| DAC of Wireless In |

Audio Codec

Wireless Adapter

| Network Formation |
| Data TX/RX |

Responsibility

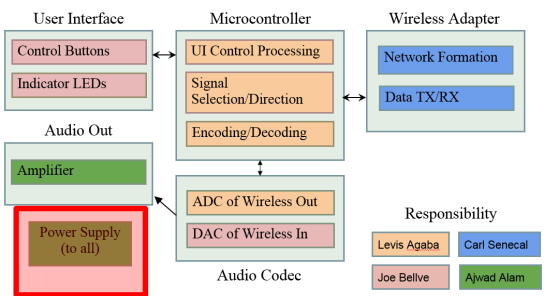| Levis Agaba | Carl Senecal |
| Joe Bellve | Ajwad Alam |

Program Flow

Audio Codec Specs

- Stereo Audio DAC with 100db SNR

- 4.1 mW Stereo 48ksps DAC Playback

- Stereo Audio ADC with 93 dB SNR

- 6.1mW Stereo 48ksps ADC Record

- Support Sample ADC sample rate 8kHz to 192kHz

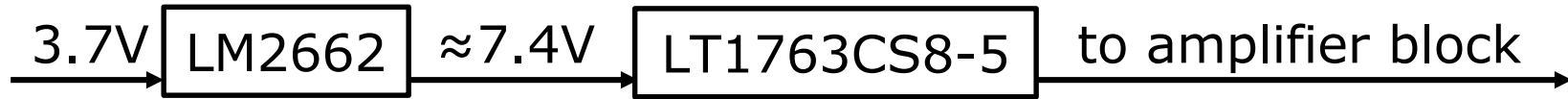- DAC supports data rates form 8kHz to 192 kHz

Subsystem 4: Power Supply

- **Lithium Polymer Ion**

    3.7V, 2500mAh

    Powers amplifier, MCU & codec

    Fed to voltage regulators
    -LT1763CS8-3 (3V)
    -LT1763CS8-5 (5V)

- **5V generation is done in two steps**

PKCELL LP785060
3.7V2500mAh

LT1763CS8-3   LT1763CS8-5

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Wireless Adapter
- Network Formation
- Data TX/RX

Responsibility
- Levis Agaba
- Carl Senecal
- Joe Bellve
- Ajwad Alam

Subsystem 4: Power Supply

- 5V Generation

$$3.7V \rightarrow \boxed{\text{LM2662}} \rightarrow \approx 7.4V \rightarrow \boxed{\text{LT1763CS8-5}} \rightarrow \text{to amplifier block}$$
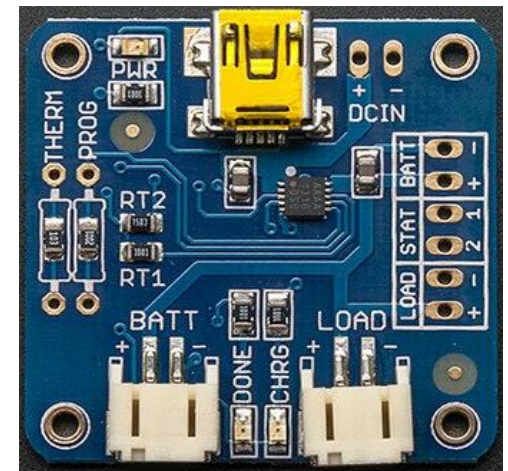
- Charging circuit from Adafruit

  5V input via mini-B USB connector

  Default charge current ≈ 500mA

  Duration for full charge ≈ 5 hours

Cost Analysis

item	qty	unit price	total cost
boosters	3	$ 29.00	$ 87.00
batteries	3	$ 15.00	$ 45.00
headphones	3	$ 15.99	$ 47.97
launchpads	3	$ 29.99	$ 89.97
pcb	3	$ 10.00	$ 168.00
capacitors	39	$ 1.70	$ 66.30
resistors	18	$ 0.15	$ 2.70
audio cables	3	$ 3.00	$ 9.00
potentiometers	3	$ 3.99	$ 11.97
opamp	3	$ 2.10	$ 6.30
battery charger	3	$ 12.50	$ 37.50
lm2662	6	$ 2.52	$ 15.12
voltage regulators	6	$ 2.30	$ 13.80
totals			$ 600.63

Demo

- Part 1: Video of Broadcast Communication

  - One board broadcasts data to two others on the same channel

  - One-to-many communication

  - Video

Demo

- Part 2: Three parties that can act as listeners or transmitters

- Unicast

  - Listener board tunes to first transmitter

- Channel changing

  - Listener board tunes to second transmitter

- Role changing

  - Listener board changes to transmitting, transmitter changes to listening

RED = Scan/Active Listener Mode

BLUE = Loopback

GREEN = Broadcast Mode

Thank You

Questions?