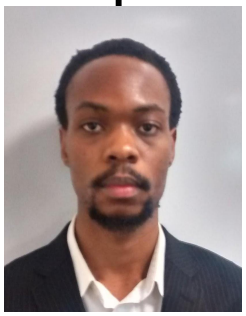
Midway Design Review

Sync-In
December 4, 2015

Sync-In

Ajwad Alam, EE
Amplifier

Joseph Bellve, EE
User Interface



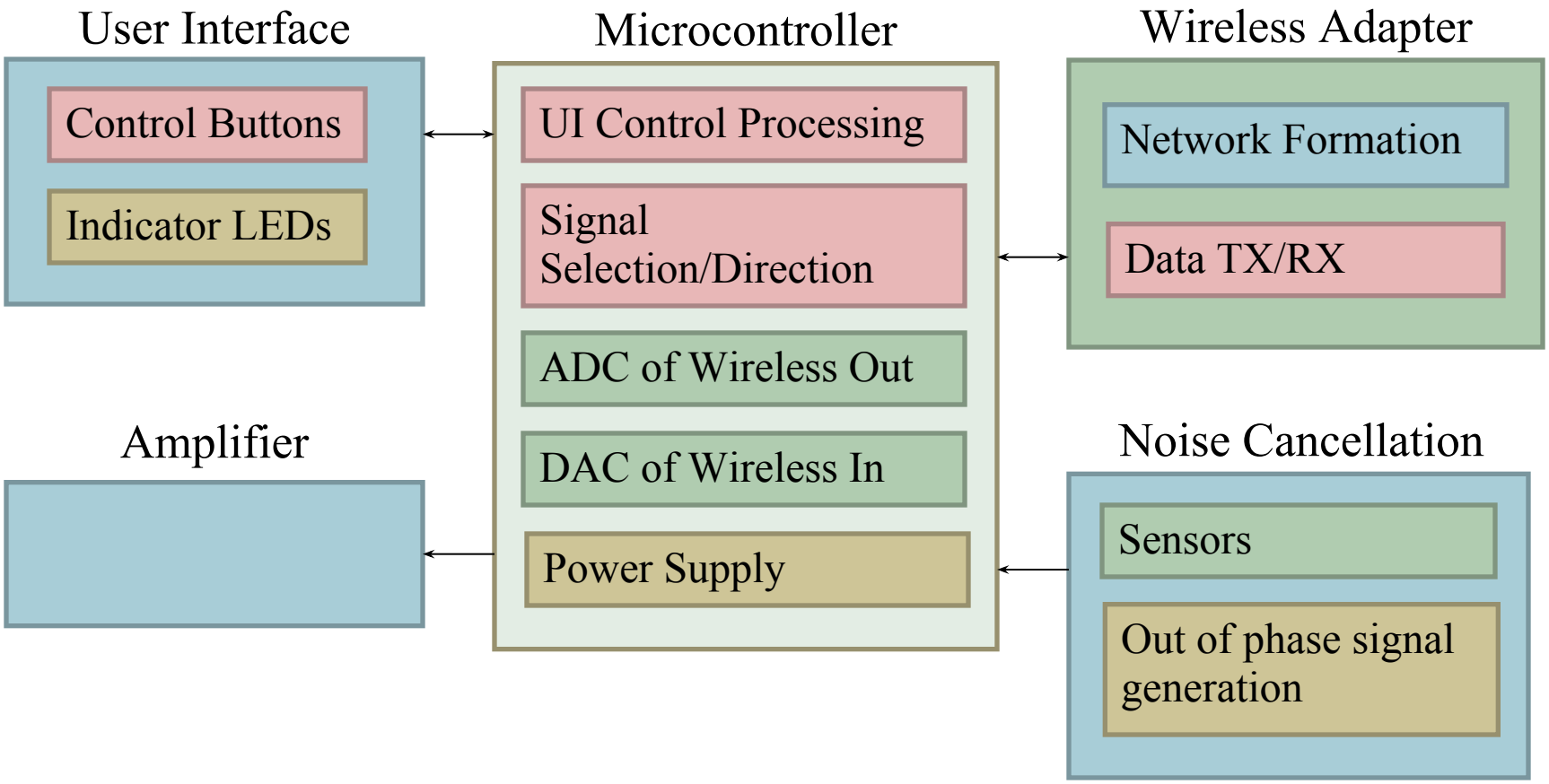
Levis Agaba, CSE
Tx/Rx

Carl Senecal, CSE
Network Formation

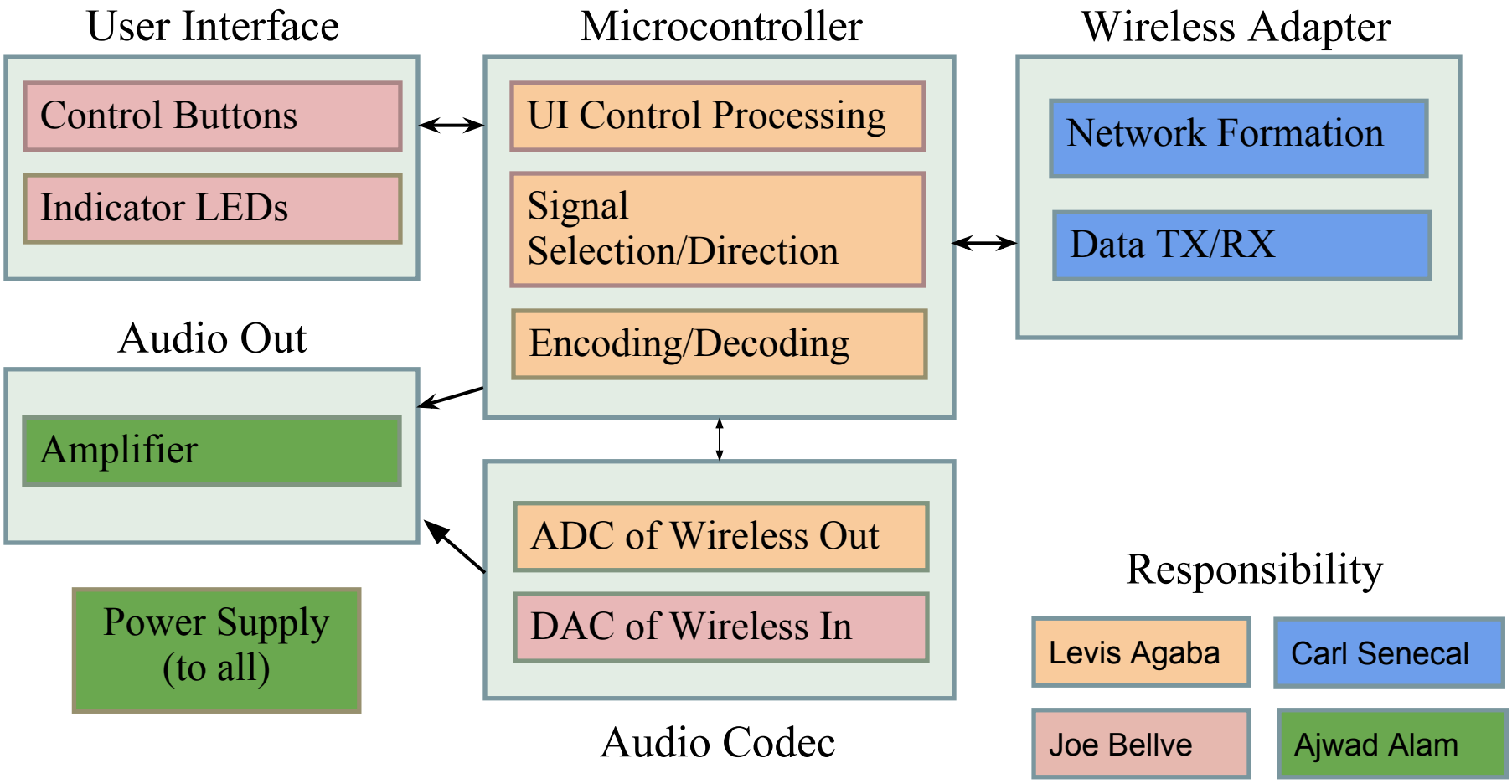
Sync-In Overview

- 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

Our Solution: Original Block Diagram



Revised Block Diagram



Overall System Requirements

Portability	▪ Containment within normal headset
Ease of Use	▪ Clear controls and indicators
Battery	▪ At least 4 hours of charge ▪ Rechargeable via a standard connector (USB)
Concurrent Use	▪ Minimum 3 users, ideally 10+
Range	▪ 100 foot radius for use on public transit
Network Operation	▪ No Internet connection ▪ Standard legal frequency
Streaming Quality	▪ Minimum 192 kbps audio quality ▪ No noticeable drops/stuttering in playback ▪ Near-synchronous listening

MDR Requirements

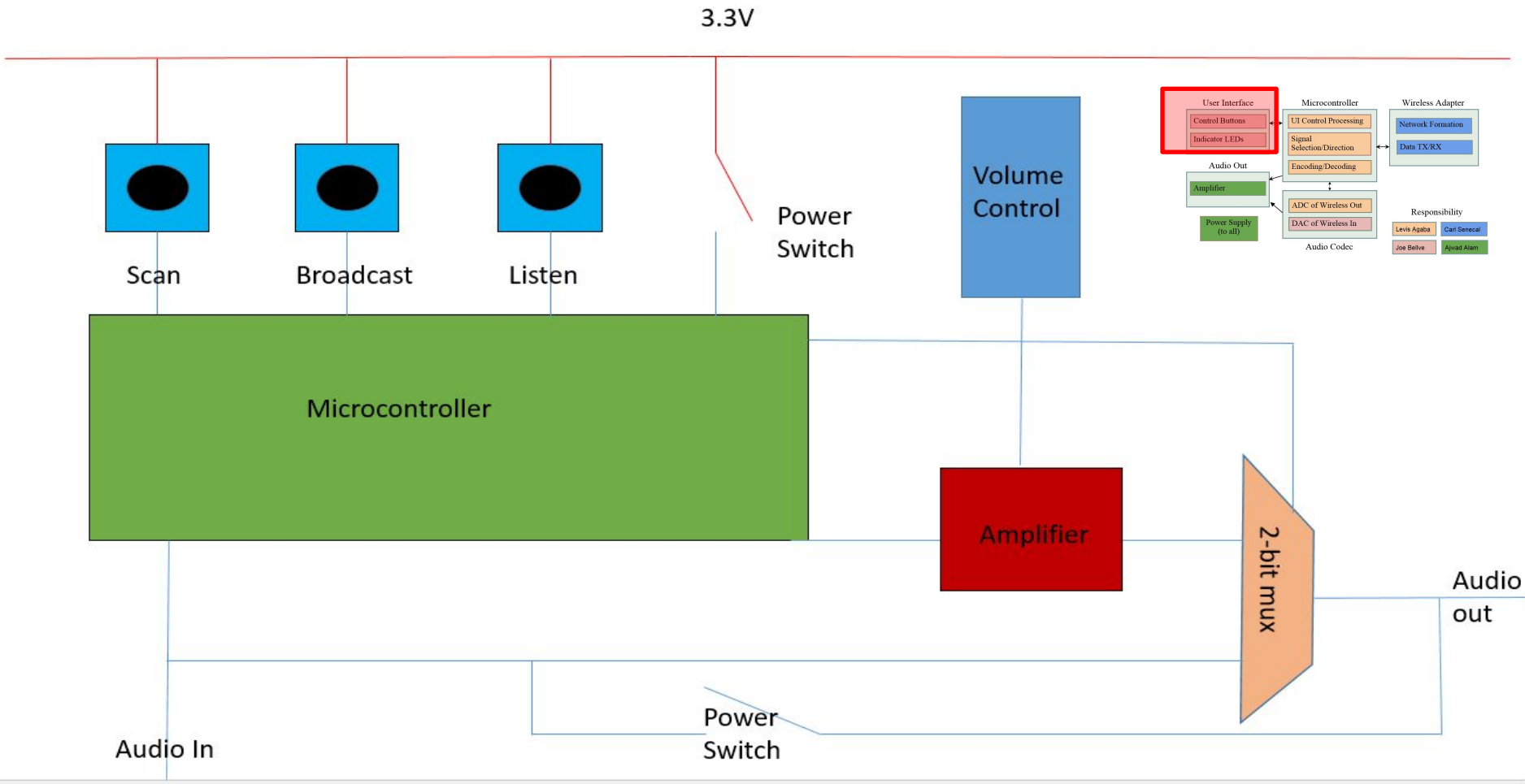
- Demonstrate persistent communication between two boards
- Demonstrate switch functionality
- Demonstrate amplifier with volume control functionality

Subsystem 1: User Interface

- Requirements

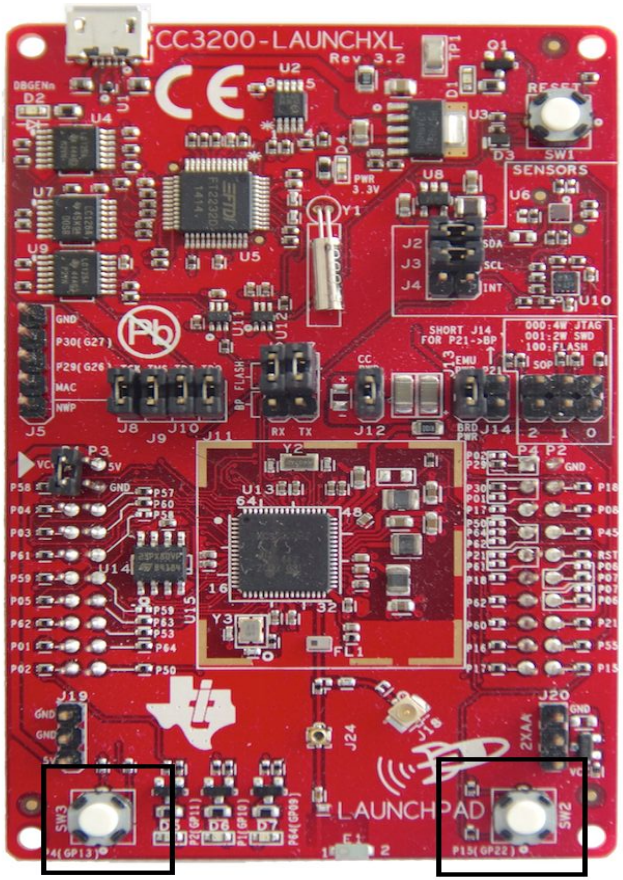
Ease of Use	▪ Clear controls and indicators
User control	▪ Allow the user to customize listening experience
Size	▪ Need to occupy a little footprint in terms of hardware space
Power	▪ Use as little power as possible to increase battery length
Analog Multiplexer	▪ Low input resistance <100Ω ▪ Voltage range between -1V and 1 V

User Interface: Detailed Block Diagram



User Interface

- The user interface implemented uses two buttons on the Microcontroller to switch the modes
- These buttons worked as a GPIO interrupt
- Triggered on the falling edge
- The buttons are also tied to pins, 2 and 15



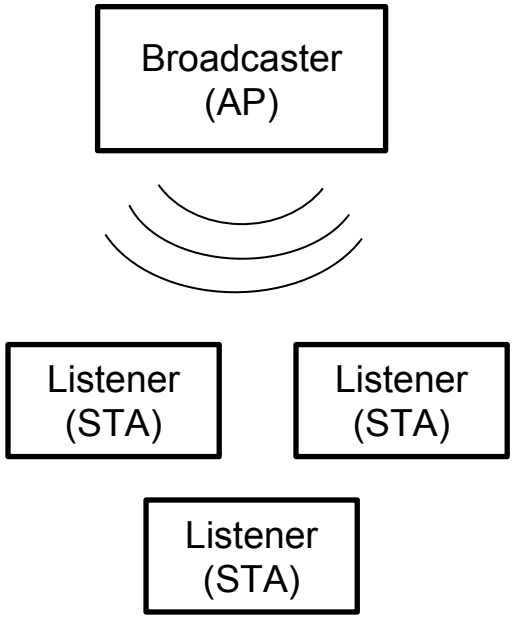
Subsystem 2: Networking

- Requirements:

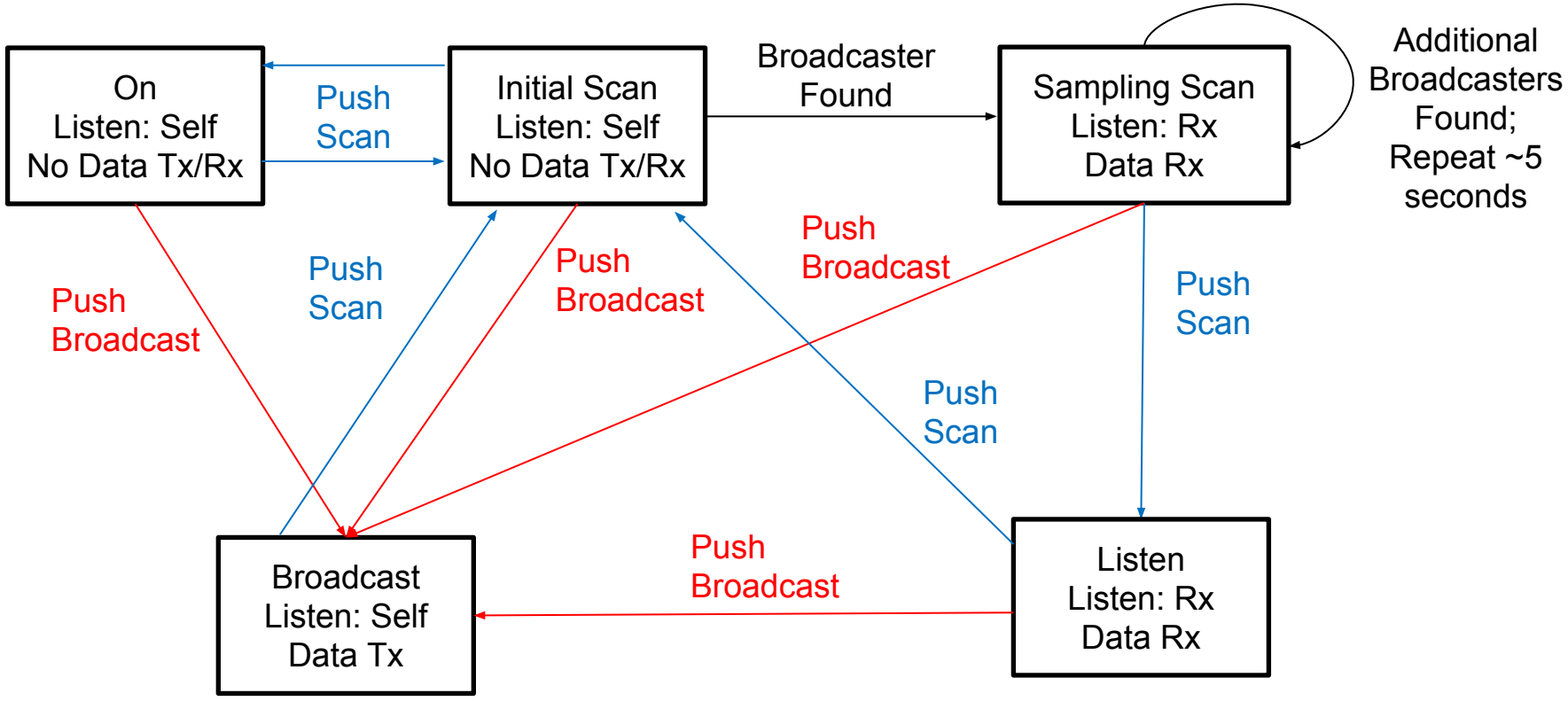
Concurrent Use	▪ Minimum 3 users, ideally 10+
Range	▪ 100 foot radius for use on public transit
Network Operation	▪ No Internet connection ▪ Standard legal frequency
Streaming Quality	▪ Minimum 192 kbps audio quality ▪ No noticeable drops/stuttering in playback ▪ Near-synchronous listening

Networking

- Initial attempt with WiFi Direct was unsuccessful due to device limitations and difficulty with API
- Networking is accomplished via WiFi Access Point/Station model
- Broadcaster acts as Access Point
- Listener acts as Station
- Listeners scan for SSIDs that match a particular pattern and attempt to connect
- Broadcasters accept any Listener
- Data transmission via UDP

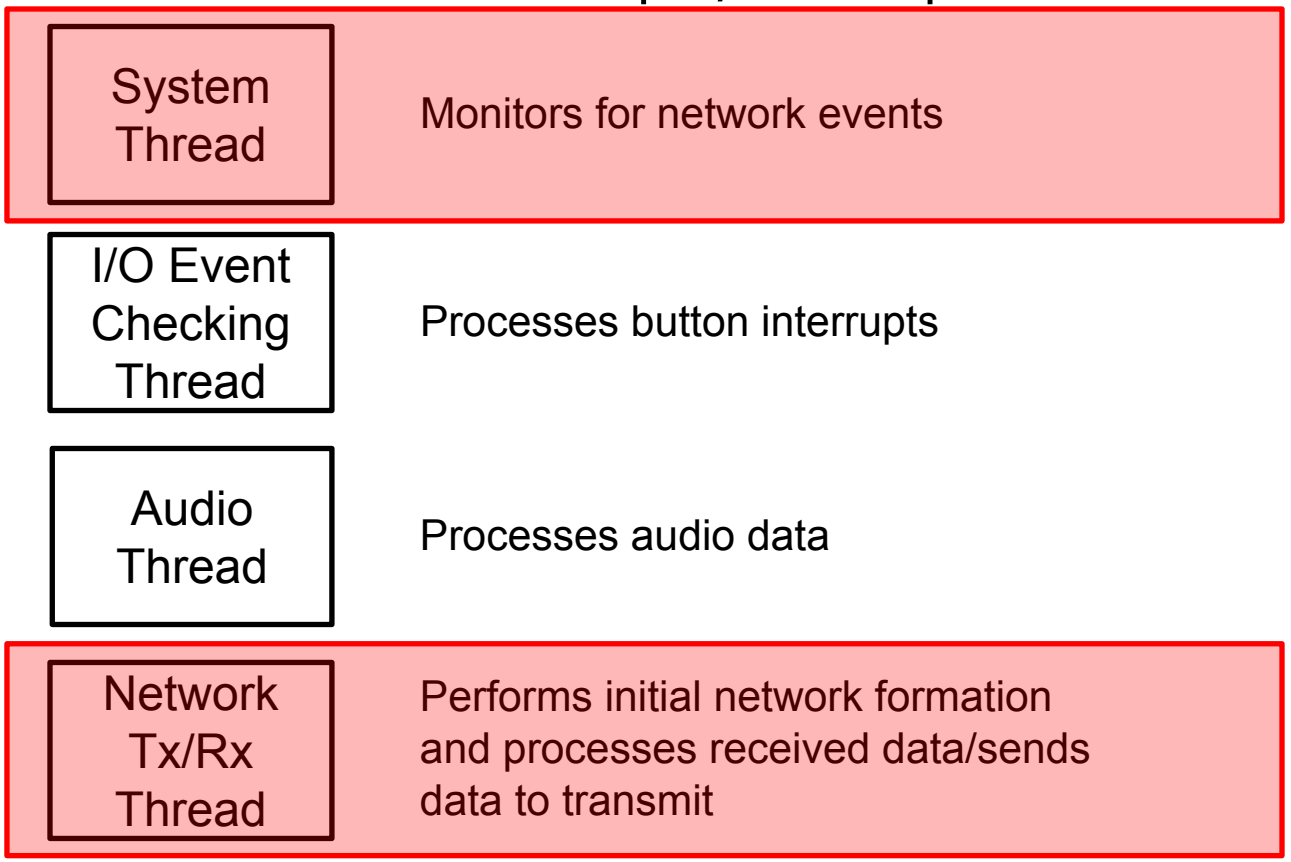


State Diagram

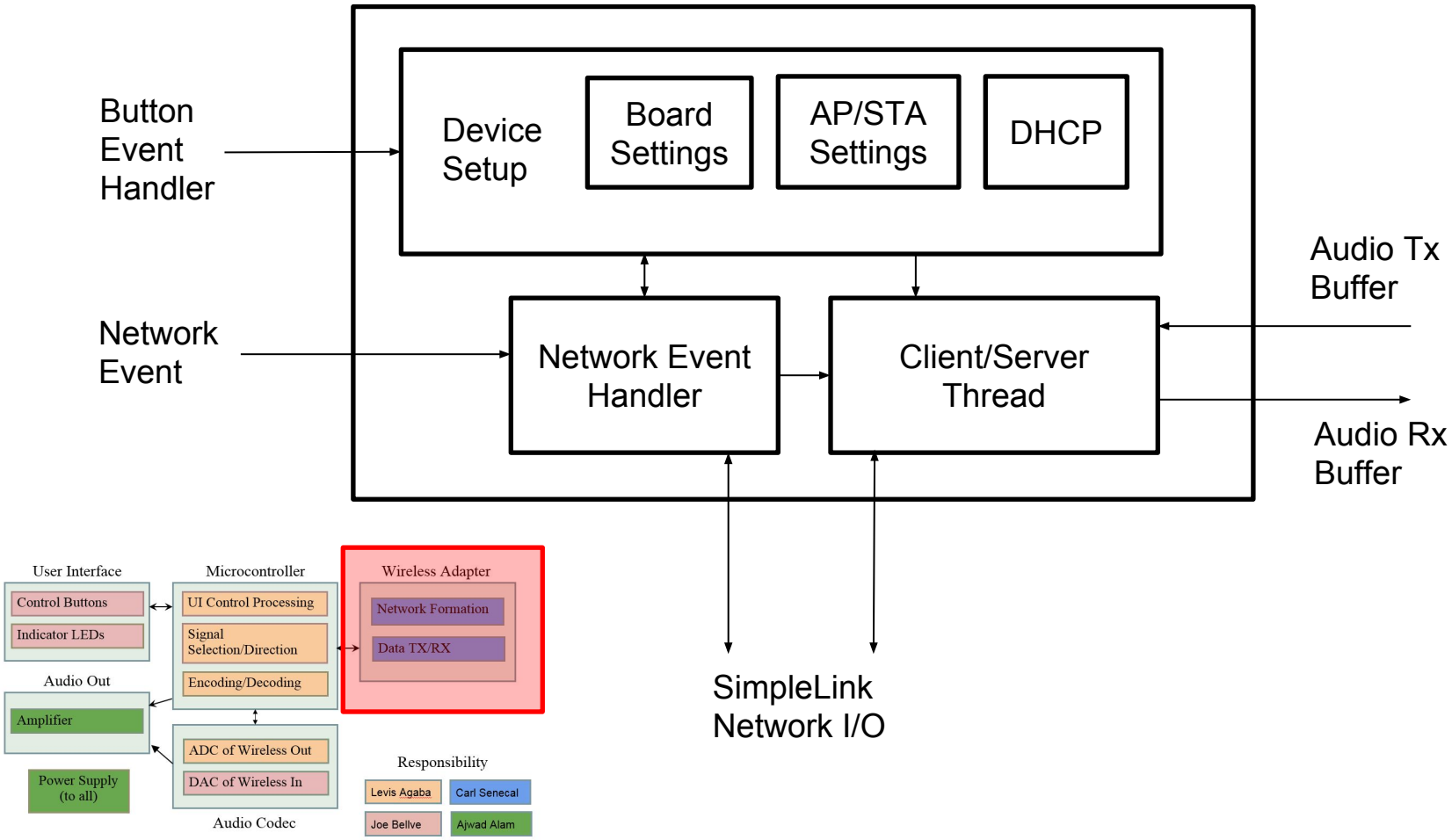


General Code Structure

- Concurrent threads and interrupts/interrupt handlers



Networking Block Diagram



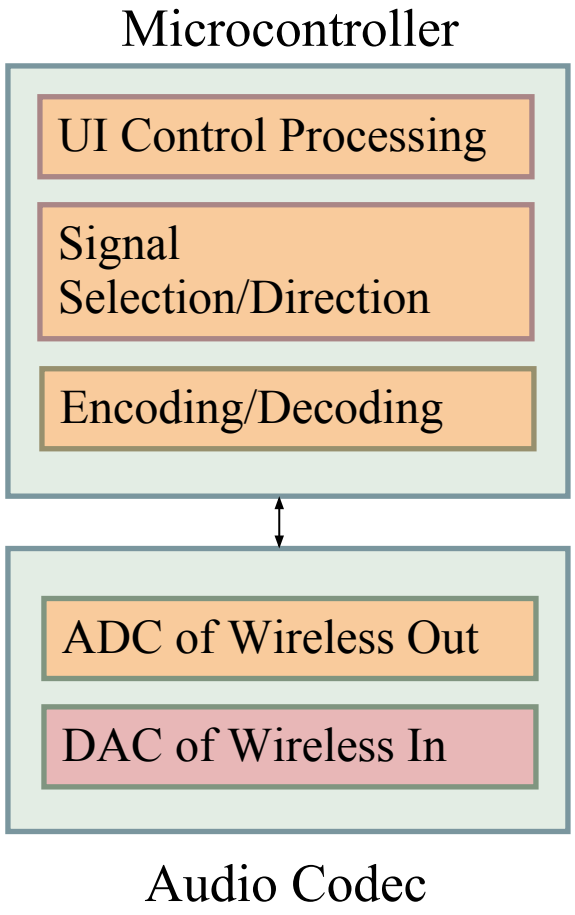
UI and Networking Demo

- MDR Requirement (UI): Working buttons
- MDR Requirement (Networking): Demonstrate communication between two boards
- Each board runs the same code (symmetric)
- One button starts broadcaster mode
- Second button starts receiver mode
- Use UART to type in a message to send
- UDP client sends messages to server 1000 times

Networking: Future Expansion

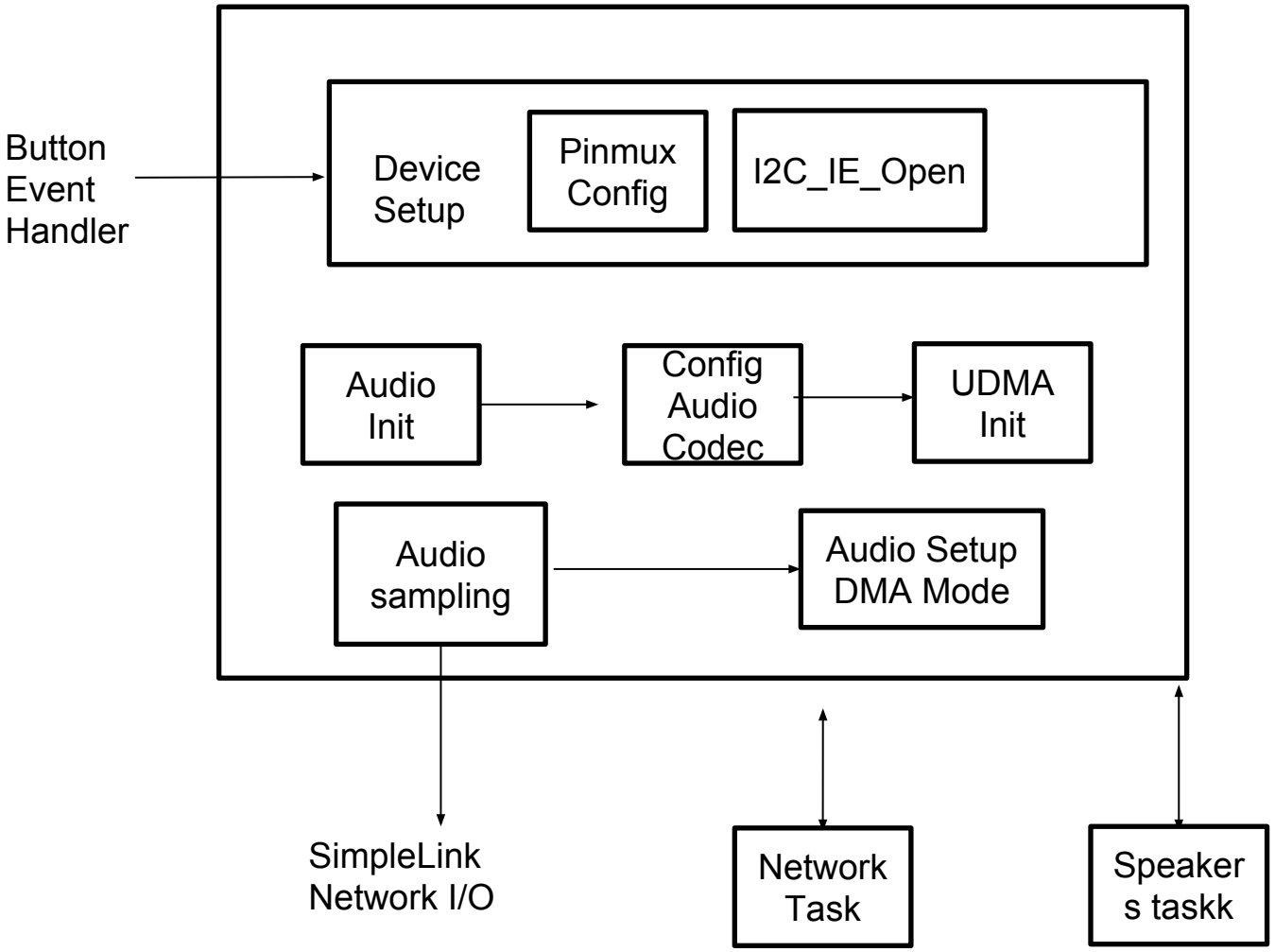
- Multiple listeners associated with a single access point
- Use of Broadcast/Multicast to allow for multiple listeners on the same broadcaster
- Standardization of access point naming and connection procedure

Subsystem 3: MCU/Signal Processing



- Requirements: Process audio at 192kbps
- Handles signal selection (line in vs. received audio)
- Acts as intermediary between received data buffers and audio out

Subsystem 3: Block Diagram



DAC

- 100dB signal to noise ratio
- 48 kHz sampling, 24 bits
- PCM format
- Requires ~1.2 Mbps transfer rate for audio signal
- THD: 0.005% ADC, 0.007% DAC

Subsystem 4: Amplification

- Requirements:
  - Low power
  - Low noise
  - High slew rate [≥ 2.56 V/μs]
  - Small size [SMD Package]
- Accomplished:
  - High frequency hiss minimized
  - Good replication of audio signal

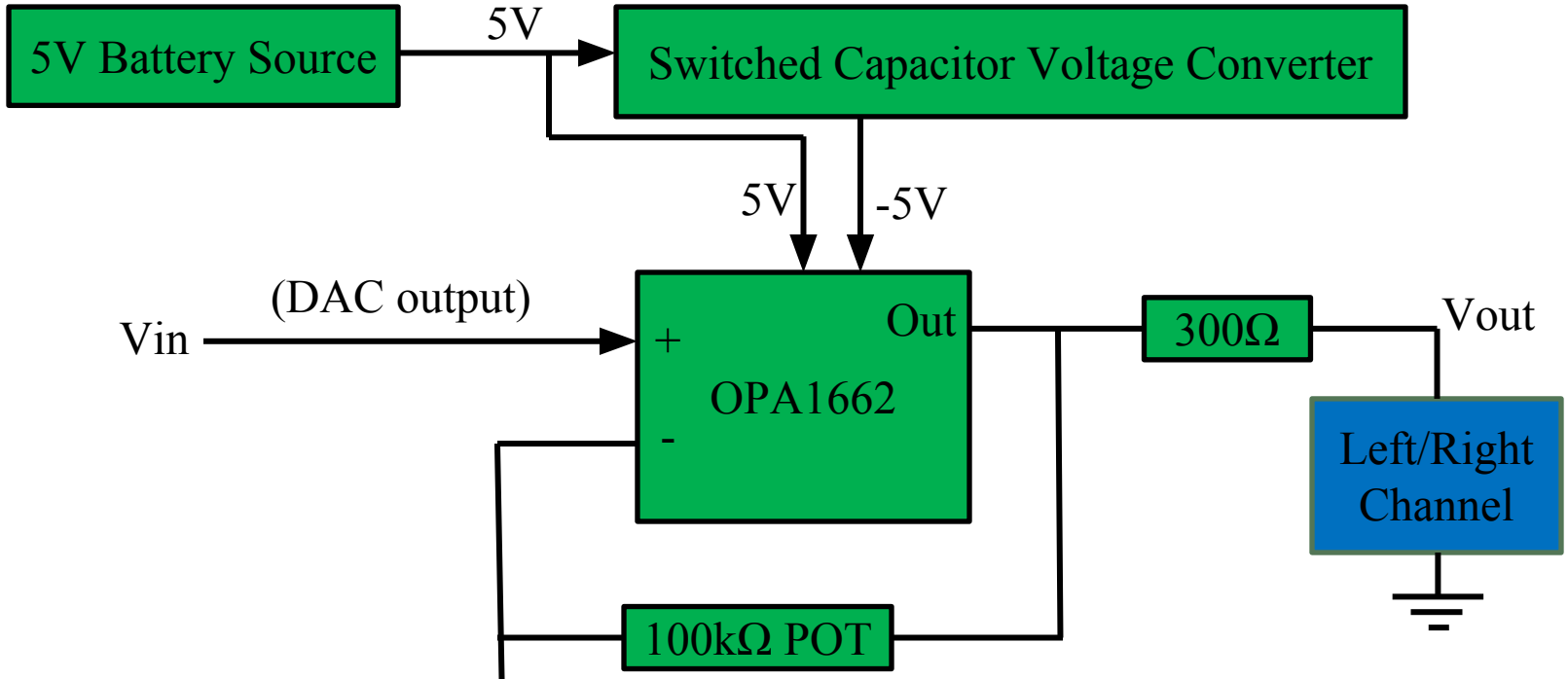
OPA1662

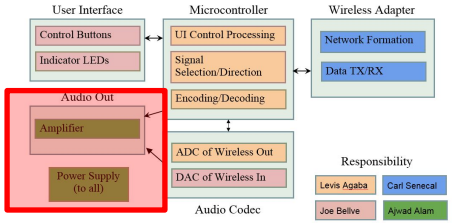
Low Distortion: 0.00006% at 1 kHz
THD+N → -124 dB
Slew rate = 17 V/μs

LM2662

Provides -5V to op-amp
Ripple of ≈ 100mV (AC)

Amplification Block Diagram





Test headphones impedance = 16Ω
Min. Vout = 0.05Vin
Max. Vout = 2.58Vin

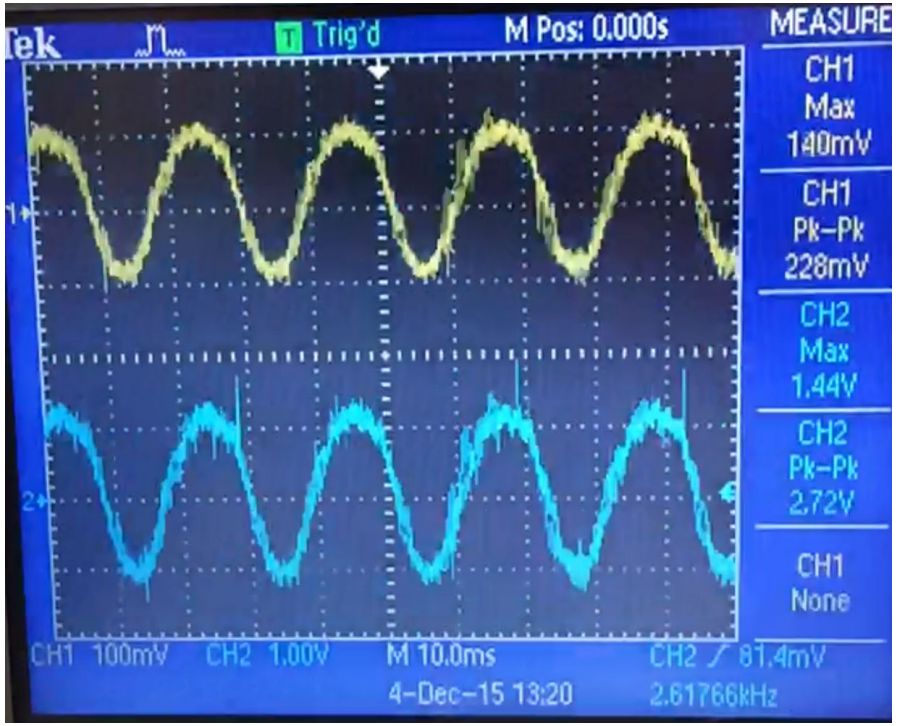
Test Results

Channel 1: Input audio signal

Channel 2: Amplified audio signal

Challenge:

Tradeoff between gain and noise



Cost Analysis

Parts	Quantity	shipping costs	price	price for all
CC3200 Wireless MCU	3	$6.25	$12.00	$36.00
Rechargeable batteries	3	$6.25	$9.90	$29.70
Monoprice headphones	3	$6.25	$17.98	$53.94
Resistors	6.	$2.00	$0.15	$0.90
Capacitors	9	$2.00	$0.30	$2.70
Potentiometers	3	$2.00	$0.72	$2.16
Opamp	2	$2.00	$1.78	$5.34
CC3200AUDBOOST	3	$6.25	$29.00	$87.00
Switch capacitor voltage convertor	3	$2.00	$2.38	$7.14
Voltage regulator 3.3v	3	$2.00	$1.95	$5.85
Switches and buttons	12	$2.00	$3.50	$42.00
Totals		$39.00	$79.66	$228.60

Timeline and CDR Deliverables

---CDR----------

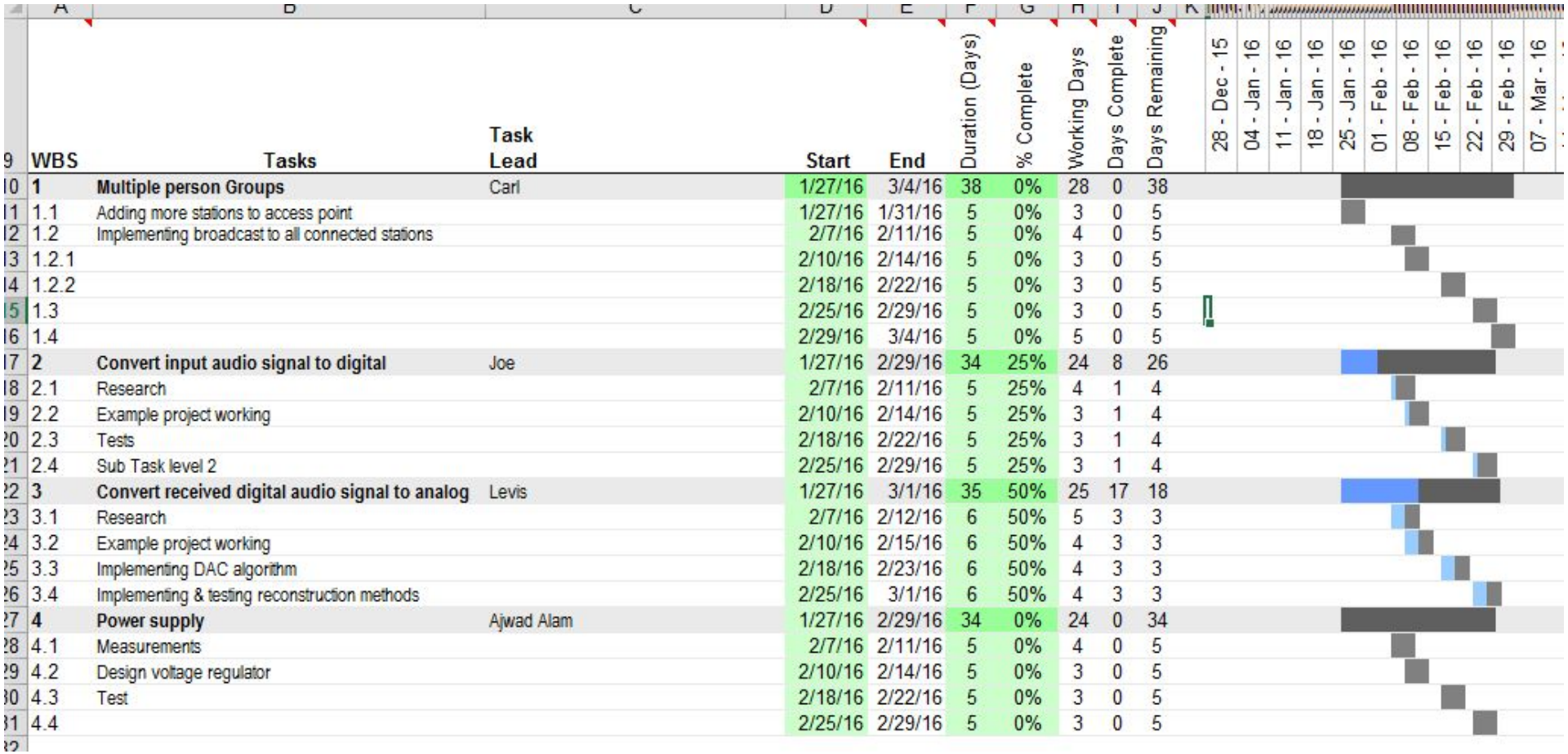
- Multiple person groups and multicast - Carl
- Convert input analog audio signal to digital - Joe
- Convert received digital audio signal to analog - Levis
- Power supply to other subsystems & analysis - AJ

---FDR----------

- Integration
- PCB design
- Housing within Headphones

Gant Chart

WBS	Tasks	Task Lead	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	**Multiple person Groups**	Carl	1/27/16	3/4/16	38	0%	28	0	38
1.1	Adding more stations to access point		1/27/16	1/31/16	5	0%	3	0	5
1.2	Implementing broadcast to all connected stations		2/7/16	2/11/16	5	0%	4	0	5
1.2.1			2/10/16	2/14/16	5	0%	3	0	5
1.2.2			2/18/16	2/22/16	5	0%	3	0	5
1.3			2/25/16	2/29/16	5	0%	3	0	5
1.4			2/29/16	3/4/16	5	0%	5	0	5
2	**Convert input audio signal to digital**	Joe	1/27/16	2/29/16	34	25%	24	8	26
2.1	Research		2/7/16	2/11/16	5	25%	4	1	4
2.2	Example project working		2/10/16	2/14/16	5	25%	3	1	4
2.3	Tests		2/18/16	2/22/16	5	25%	3	1	4
2.4	Sub Task level 2		2/25/16	2/29/16	5	25%	3	1	4
3	**Convert received digital audio signal to analog**	Levis	1/27/16	3/1/16	35	50%	25	17	18
3.1	Research		2/7/16	2/12/16	6	50%	5	3	3
3.2	Example project working		2/10/16	2/15/16	6	50%	4	3	3
3.3	Implementing DAC algorithm		2/18/16	2/23/16	6	50%	4	3	3
3.4	Implementing & testing reconstruction methods		2/25/16	3/1/16	6	50%	4	3	3
4	**Power supply**	Ajwad Alam	1/27/16	2/29/16	34	0%	24	0	34
4.1	Measurements		2/7/16	2/11/16	5	0%	4	0	5
4.2	Design voltage regulator		2/10/16	2/14/16	5	0%	3	0	5
4.3	Test		2/18/16	2/22/16	5	0%	3	0	5
4.4			2/25/16	2/29/16	5	0%	3	0	5



Thank You

Questions?