Bluetooth Stereo Network

ECE 445 – Senior Design Lab
Final Presentation

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Objective

- Network of Bluetooth speakers
  - Play music to speaker closest to user
  - User’s device streams to central hub
Features

• Smooth handoff when moving between rooms

• No additional software needed on the phone

• Plug-n-play UX
System Overview
Old Hub
New Hub

USB micro-B

Power Supply

Analog In → BT Unit → UART → MCU
Old Speaker Adapter
New Speaker Adapter

USB micro-B

Power Supply

BT Unit

UART

MCU
## Requirements and Verification

### Requirements
1. MCU Interface
2. BT IC Interface
3. Receive RSSI values seen by speaker adapters on hub
4. Battery Charger Implemented

### Testing
1. Interface with BT IC via UART, observed using BP
2. Test A2DP connection with UE and analog audio playback
3. Observe RSSI data through BP and audio playback switching
4. Tested using oscilloscope current probes
Reqs + Verification Changes

- Removed all PurePath
- Moved battery charging onto BT block
- Removed superfluous analog ASICs
MCU Schematic
MCU PCB Layout
Bluetooth PCB Layout
Hub Construction
Speaker Adapter Construction
Functional Testing

- Developed UART interface test programs in C
  - Speak at binary packet levels

- Verified Bluetooth connectivity with UE like phones, computers

- Update BT IC configurations and observe settings change real-time with other BT enabled devices

- Successful system level testing with OTA audio playback
Component Testing

• Link-Budget Analysis
  – RX Power(dBm) = TX Power(dBm) + Gain(dB) - Loss(dB)
  – Loss = 20log_{10}(d) + 20log_{10}(f) - 147.55

• Incoming RSSI Data
  \0xBF\0x01\0x00\0x01\0x44\0xFE
  \0xBF\0x00\0x00\0x01\0x01\0xFF
  \0xBF\0x00\0x00\0x01\0x42\0xFF
  \0xBF\0x00\0x00\0x01\0x01\0xFF
  \0xBF\0x01\0x00\0x01\0x01\0xFE

• Confirmed battery charging via current measurement
Successes

**Hardware**
- Seamless handoff between speakers
- Avoids use of development boards (Arduino, LaunchPad...)
- Recovered "dead" BT IC
- Last minute switch to analog audio in hub

**Software**
- Inter-IC UART communication
- Automatically picks BT channel upon received RSSI value.
- Developed programs to interface with external HW
Design Challenges

**Hardware**
- Unreliable MSP programming
- Interfacing with PurePath IC
- 2-layer PCBs w/ no silkscreen
- Soldering analog components
- Importance of bypass caps

**Software**
- Poor Code Composer UX
- Optimized interrupt handling
- Changing baud rates causes issues
- RSSI collection timing
Recommendations

Hardware

• Integrated single PCB
• I²S between BT ICs on hub
• Discrete audio amplifier
• Integrated battery and exposed power controls
• Mechanical improvements
• Use a discrete antenna

Software

• Minimize 0.4s switching delay between speakers
• Optimize setup time
• Add/remove devices seamlessly
• Audio interface for device status
Budget & Marketing

- ~$40 of components per system block
  - Bluetooth chip is expensive
  - Sell hub + 2 speaker adapters for ~$200

- Existing products suggest strategy
  - Minimally tech-savvy customers
  - Living in apartments/small homes
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Appeal for “Design Award”
Questions?