BeatBeam

SDP 2015 PDR

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Brian Hickey, CSE

Duncan Smith-Freedman, EE

Team

Daniel Bond
(Fearless) Team Leader

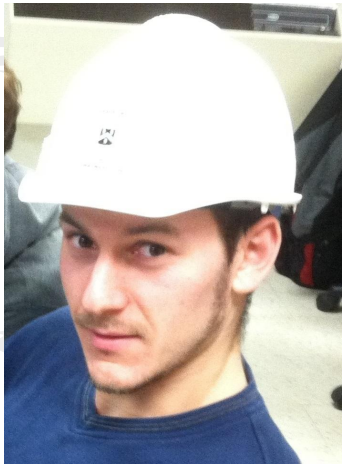
Board Interpretation, Musical Implementation

Brian Hickey

Networking, Wireless Connectivity

Duncan Smith-Freedman

Signal-to-Audio Interpreter, Physical Design, Power



Brandon Sprague

Project Description

- Simultaneous multiplayer music creation via a simple to use web application
- Central node housing multiple speakers, a wireless access point, and a web server
- LED light array for visual interpretation of music

Alternative Solutions

- Traditional Music Lessons
  - large time investment; doesn't cater to casual music creation
  - professional lessons are expensive
  - Instruments are expensive to buy/rent
- Garageband
  - cost-effective
  - potential for poor sounding music still tremendously high
  - steep learning curve
- Guitar Hero / Rock Band (rhythm video games)
  - Both series discontinued due to market saturation during late 2000s
  - Limited to on-disk setlists
  - Additional songs have minimum cost $1.99/song

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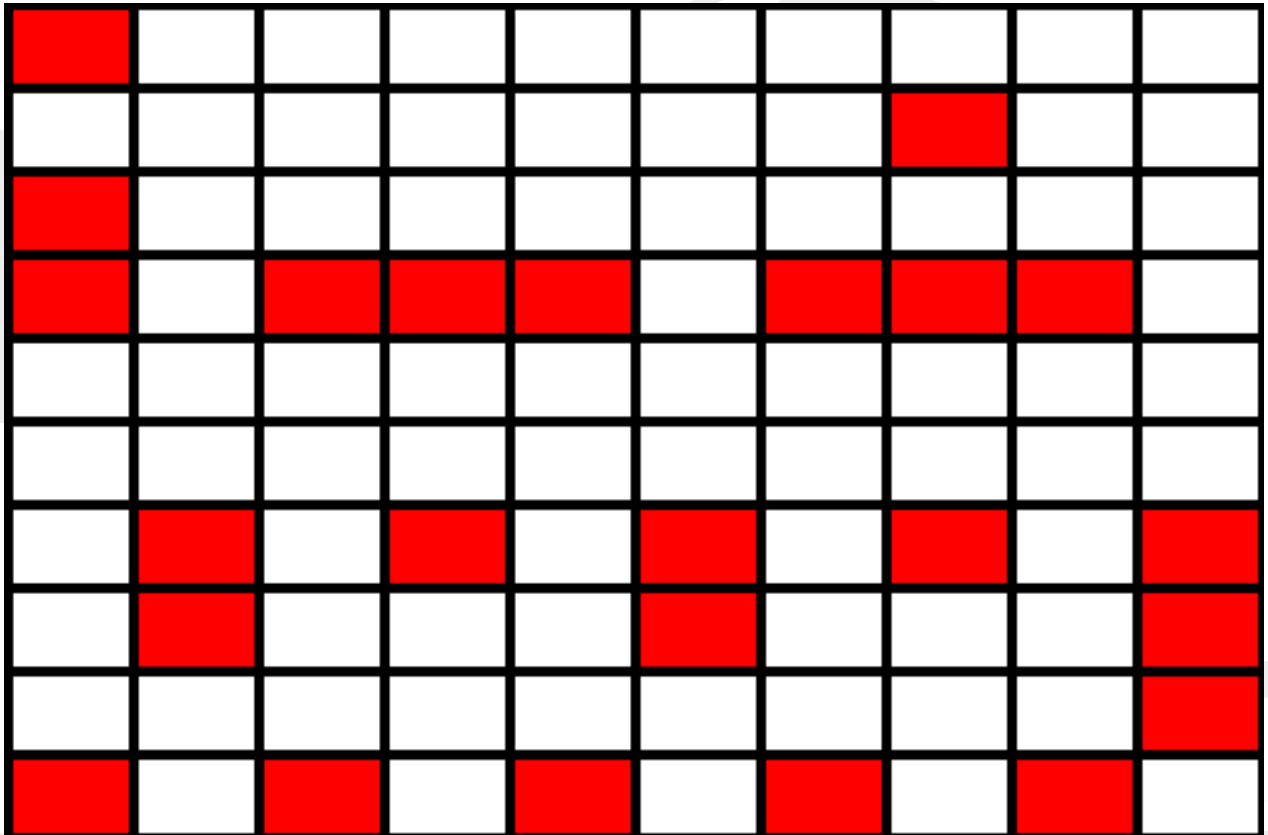
----------BeatBeam----------

How is BeatBeam different?

- Collaborative and Continuous
  - Groups of people can simultaneously create music
- Universal Platforming
  - Accessible from any WiFi enabled device with web browser
- Makes a game out of music creation
  - Low barrier to entry, fun, addicting
- Immediate gratification
  - Hear and see the results of your efforts within seconds
- Small and lightweight
  - Easy to bring anywhere
- Easy to use interface

  Simple interface for touch devices and mouse users

Interface Prototype

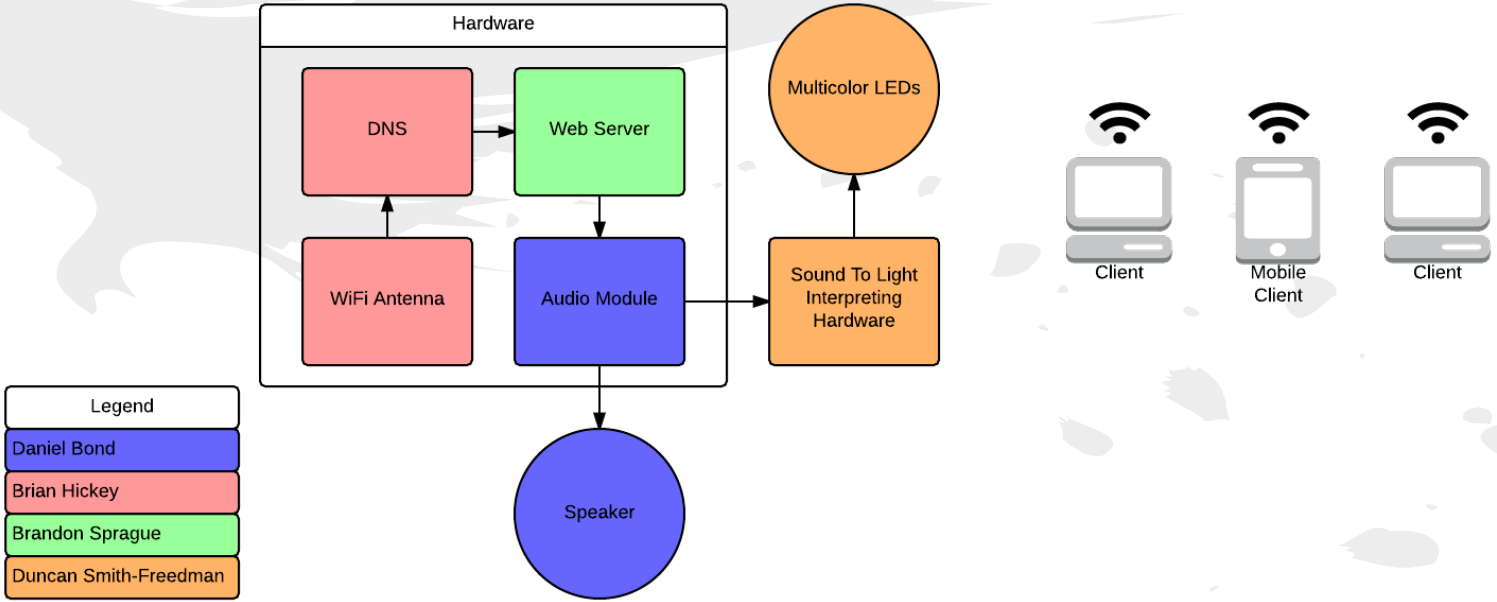


Significance and Societal Impacts

- Music creation has little, if any, moral implications

- Studies show music has positive neurological benefits such as improved memory and increased brain activity[1]

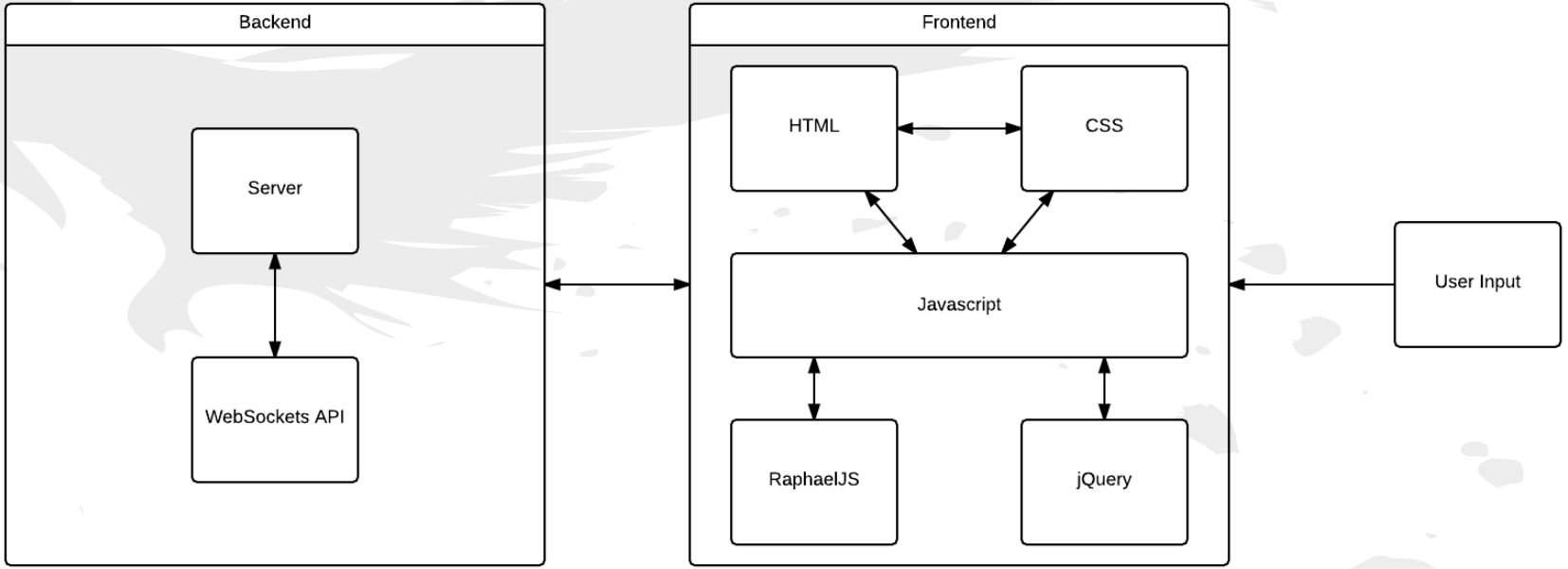
Block Diagrams, High level View



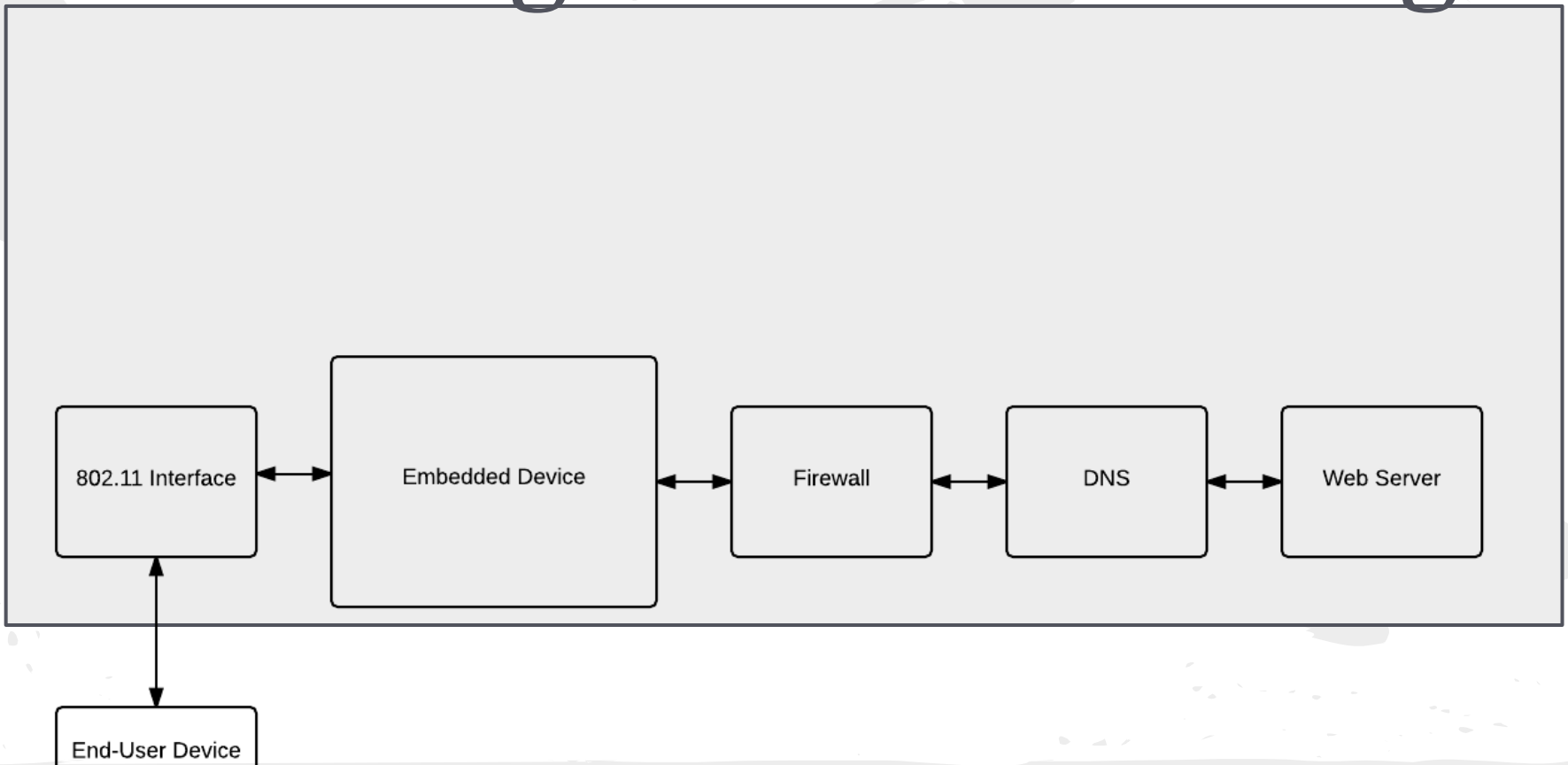
Distribution of Tasks

- **Brandon Sprague -** Design and development of required web-based software interface(s) including multiplayer functionality
- **Brian Hickey** - All networking components, including establishing of reliable client/server connection over 802.11, QoS, routing, DNS
- **Daniel Bond** - Sound generation, note/chord composition from game board state, abstraction of music theory from the end user
- **Duncan Smith-Freedman** - Audio signal processing, PCB design (If needed), 3D design, modeling, and printing, power

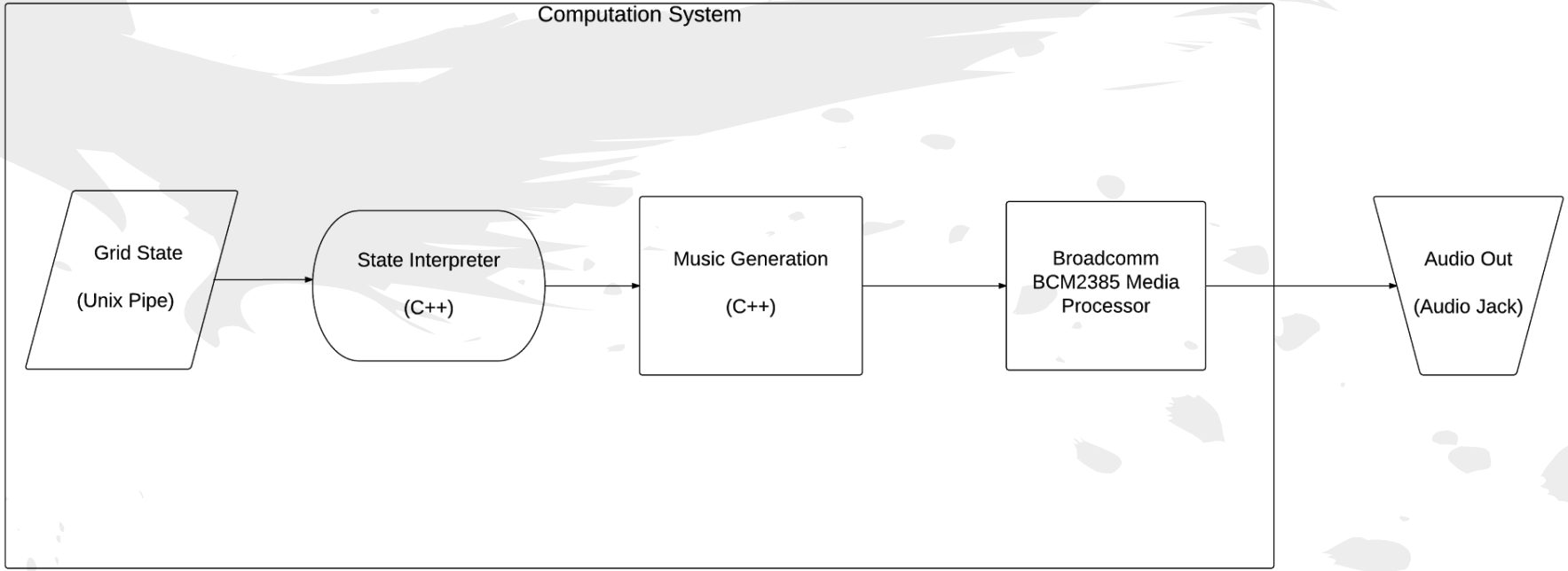
Block Diagram - Web Server



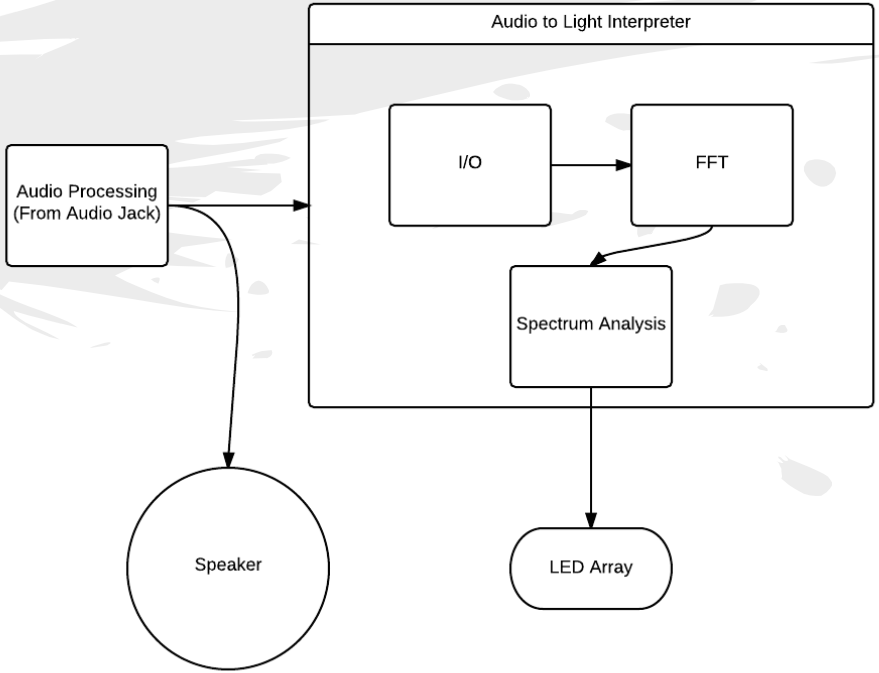
Block Diagram - Networking



Block Diagram - Music Generation Module



Block Diagram - Audio to Light Interpreter



Hardware

- ARM M4 Cortex - High performance (72 MHz), low power (8-157 uW/MHz), low cost, ability to perform FFT necessary for DSP

- Raspberry Pi - Barebones Linux machine with 700 MHz CPU, audio out, can act as a WiFi access point

Why is Raspberry Pi Sensible?

- Inexpensive, large developer community
- Supports running an OS (Arch Linux)
  - File System, DNS, Web Server
- Strong interface support (802.11, 802.15)
- Multiple programming language support
- Audio Processing Capability

Hardware Alternatives

- Arduino and derivatives
  - Can’t support web server or WiFi routing
  - No audio processing
  - Limited library support

- HummingBoard/Intel Edison
  - Too expensive ($100 - $200), more powerful than requirements deem necessary, unnecessary modules

- Make dedicated hardware for each module
  - Infeasible and unnecessary

Security

- Customizable nature of wireless interface allows for security across all layers to be tightly controlled and customized
- Device won't have WAN connection which eliminates threats occurring outside local radio range (802.11)
- Minimal quantity of data sent wirelessly (limited to music control signals over WebSockets) allows bidirectional communication to be both specific and limited in nature, all other data blocked
- Chroot jail, ports locked down

Requirements

- Users with no prior musical experience will be able to make pleasing music more than 90% of the time
- Groups of at least 20 people will be able to concurrently create music
- <25 ms delay for syncing game state across clients

MDR Deliverables

1. Functioning, secure client-server wireless interface
2. Operational grid state interpreter and music generation module
3. 3D printed electronic housing prototype
4. LED array that responds accurately to distinct frequency ranges
5. Online web-interface with live-updating display

Potential Resources

- Audio Engineer
  - Previously worked for Blue Man Group
  - Sound mixing/song creating
- Craig Colorusso
  - “Sun Boxes” Art Installation
  - Audio Engineer

References

1. Brown, Laura. "The Benefits of Music Education." *PBS*. 10 Jan. 2012. Web. 29 Sept. 2014

Q&A Session