BlueDentist
Project Summary

Develop a portable, wideband SDR module that utilizes a GPU for digital signal processing

Develop firmware and software to monitor and analyze Bluetooth signals
Team

Jeff Longo
Hardware Design
Jetson integration
High-speed design
MCU firmware

Chris Chan
Hardware Design
MCU integration
Power management design
Jetson adaptation

Griffin Danninger
Software Design
Driver configuration
Algorithm optimization
Software testing

Zach Battles
Software Design
Thread building
Algorithm design
Library integration
Bluetooth Spectrum

- Spread spectrum frequency hopping on 79 channels
- 48-bit unique addresses
- Device announces presence when in discoverable mode

BlueDentist identifies and records all activity when Bluetooth device is not in discoverable mode
Application – Analyze Bluetooth RF Signals
BlueDentist Implementation
NVIDIA Jetson & high-speed peripherals:
- PCI Express
  - XTRX Software-defined radio
  - 1TB SSD
- HDMI
- USB 3.0
- Gigabit Ethernet

STM32 Board Supervisor Microcontroller:
- Power up sequencing
- Power management
Hardware Schematic
Hardware Schematic
Hardware Circuit Board Layout

- **High Density**
  - 8 layers
  - 7” by 7” size

- **High Speed**
  - Custom board stackup
  - Impedance control
  - Matched lengths

- **High Power**
  - 65 Watts
  - Thermal considerations
Finished Hardware
Software Flow Chart

- **ISM24**
  - Master program controls capture, decoding, and monitoring

- **Capture Thread**
  - Collects samples and buffers frames for analysis

- **Analysis Thread**
  - Channelizes and calculates power level for each frame

- **Noise Estimation Thread**
  - Establishes noise floor for filtering

- **Bluetooth Decode Thread**
  - Obtains Access Codes
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Data Collection

- Monitor 2.4 GHz band for bursts of activity
- Process activity above the noise threshold

(0 MHz at 2.425 GHz)
Bluetooth Decoding

- Channelize the frame
- Demodulate each channel
- Frequency Modulate Squelch each signal
- Identify sync words and extract lower address parts (LAP) from access codes

From the Bluetooth Core Specification
Bluetooth Monitoring

- Identify access codes in 2.4GHz band activity
- Highlight activity of specified target devices
- Record full packet data for later inspection
Demo Session
Software Design Challenges Faced

- Driver library integration/debugging
- Multithreading
- CUDA optimization
- XTRX tuning
- Noise threshold parameters
Project Summary / Milestones

- Designed, assembled and tested BlueDentist Module
  - XTRX Software Defined Radio
  - NVIDIA Jetson Xavier SOM
  - STM32 MCU, Power Supplies, & I/O

- Developed software to perform RF scan, collect & analyze RF data and display Bluetooth signal parameters

- Received congratulations and thank you email from sponsor
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