Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 28:
The NCID Defender
Bi-Weekly Update 4

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Scott Kevil-Yeager
Matthew Hebrado

Sponsor: Dr. Tod Cox
TA: Rohith Kumar

Project Summary

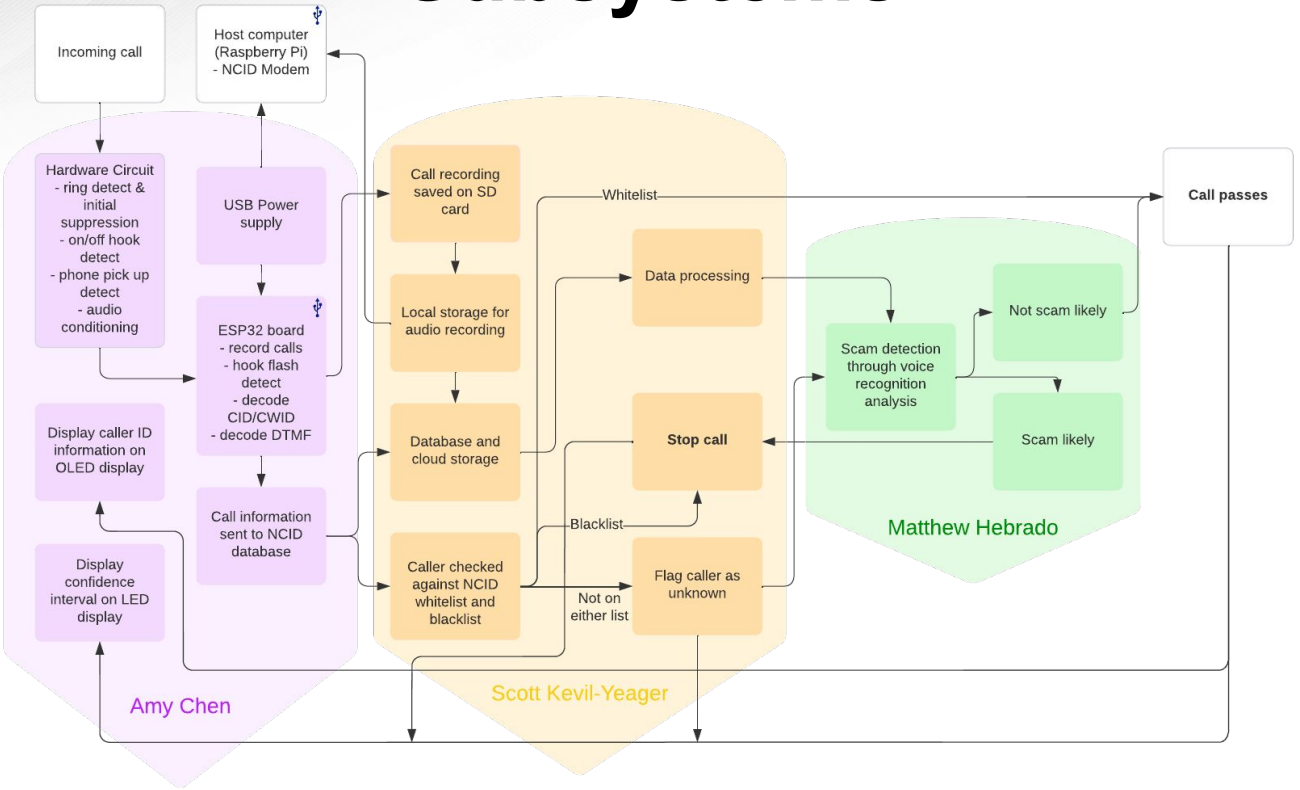
The Problem:

- $39.5 billion lost to phone scams
- Target: elderly American citizens
- Timeframe: can last for months

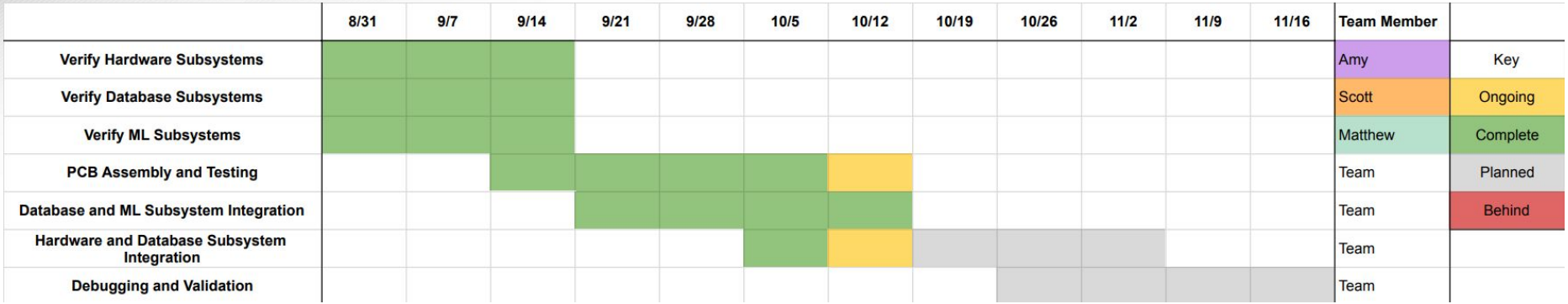
Our project:

- Voice signature matching
- Captures and records call data
- Integrates and augments NCID

Subsystems


Incoming call
Host computer (Raspberry Pi) - NCID Modem
Hardware Circuit - ring detect & initial suppression - on/off hook detect - phone pick up detect - audio conditioning
USB Power supply
ESP32 board - record calls - hook flash detect - decode CID/CWID - decode DTMF
Display caller ID information on OLED display
Call information sent to NCID database
Display confidence interval on LED display
Amy Chen
Call recording saved on SD card
Local storage for audio recording
Database and cloud storage
Caller checked against NCID whitelist and blacklist
Whitelist
Data processing
Stop call
Blacklist
Flag caller as unknown
Not on either list
Scott Kevil-Yeager
Call passes
Scam detection through voice recognition analysis
Not scam likely
Scam likely
Matthew Hebrado

Project Timeline



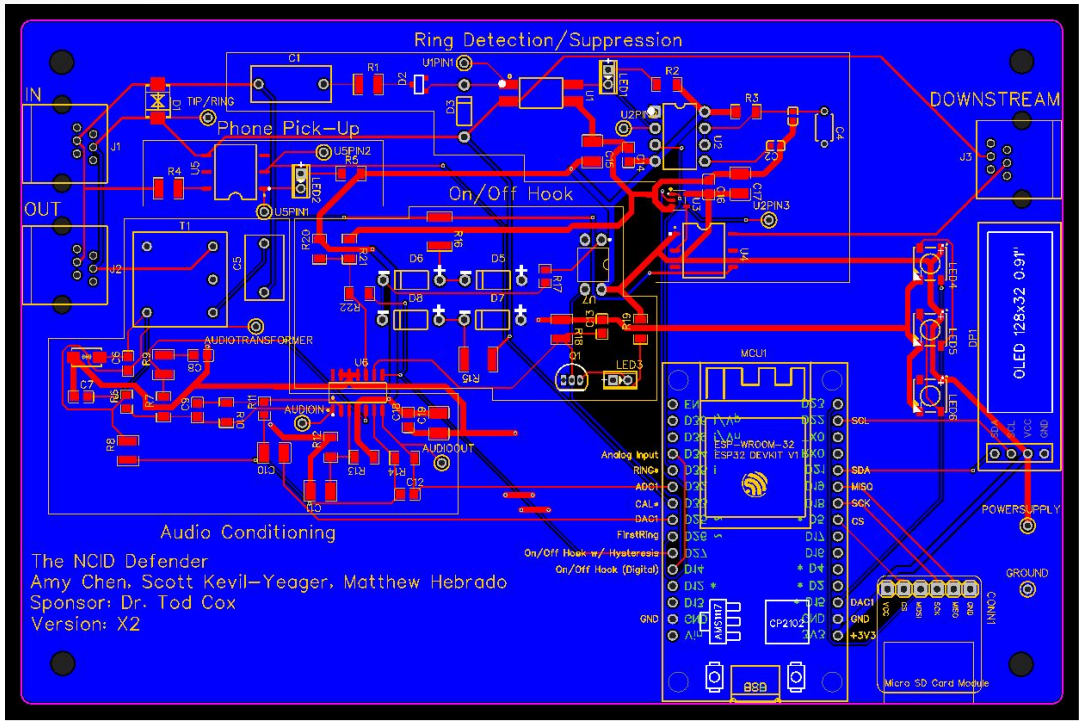
Hardware Subsystem

Amy Chen

Accomplishments since last presentation 30 hrs of effort	Ongoing progress/problems and plans until next presentation
• Ordered and received version X2 of PCB. • Successfully received a signal from the DAC pin to the output of audio conditioning circuit. (integration with Scott) • Added DTMF key detection to ESP32 code.	Ongoing progress: • Finish AFSK (CID/CWID) state machine code. • Add hook flash detection in ESP32 code. • Test 2nd PCB. • Continue integrating with Scott.

Hardware Subsystem

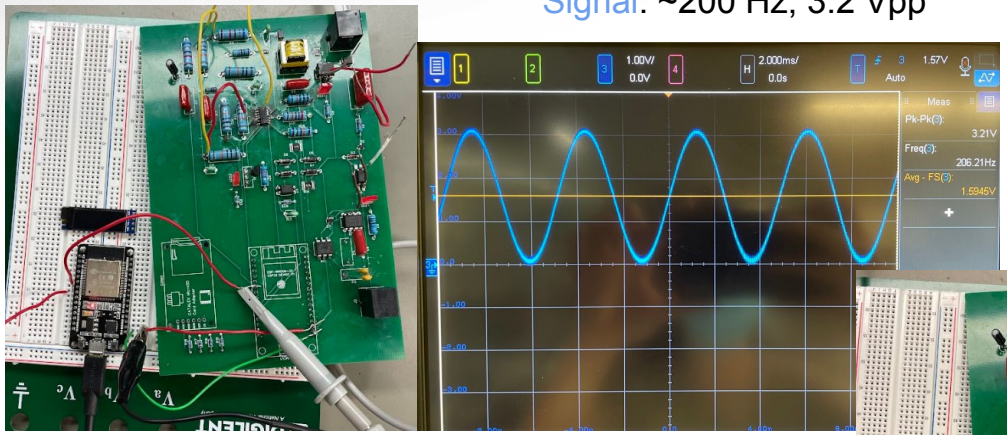
PCB Version X2



Hardware Subsystem

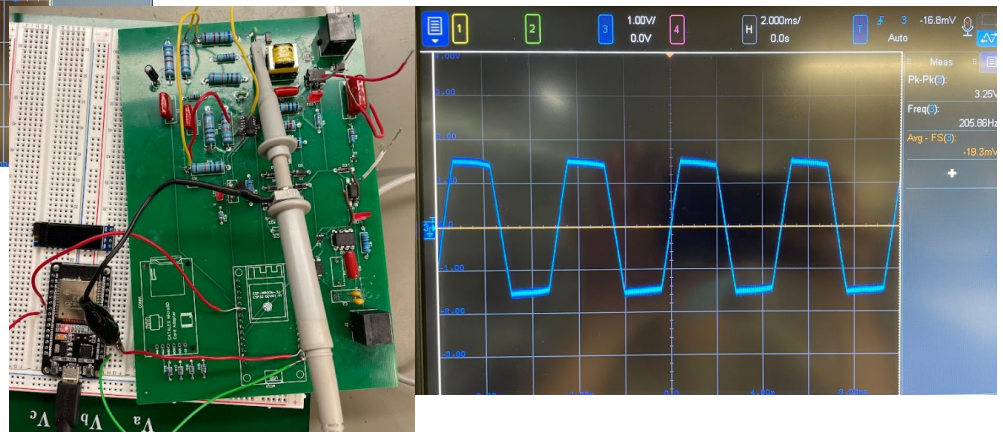
Integration with Scott

Signal: ~200 Hz, 3.2 Vpp



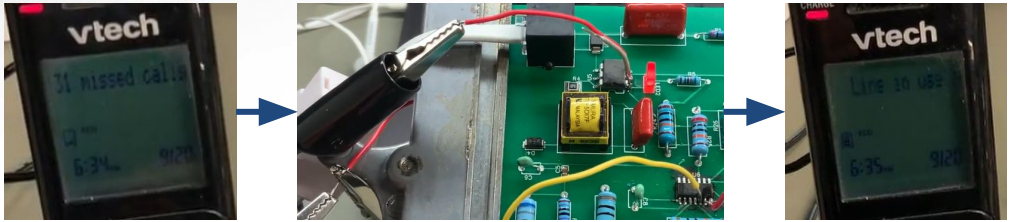
DAC Signal

Output from audio conditioning



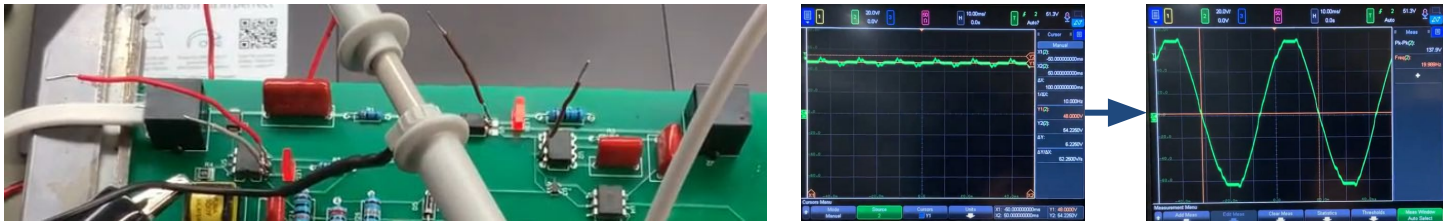
Hardware Subsystem

Phone Pick-up Subcircuit



LED2 lights up when phone pick up in detected -> line use to “in use”

Ring Detection/Suppression Subcircuit



LED1 lights up/flickers when ringing is detected

*Initial ring is suppressed when FirstRing pin on MCU is HIGH

Hardware Subsystem

On/Off Hook Detection Subcircuit

On hook, ringing

On hook, silence

Off hook detected

Off hook

Hook flash detected

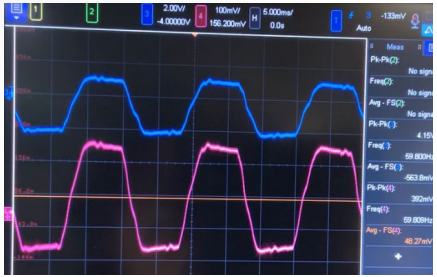
Off hook

On hook detected

Hardware Subsystem

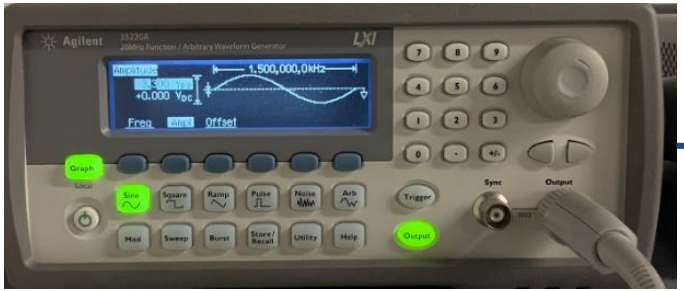
Audio Conditioning Subcircuit

Audio out from phone to ADC1 pin

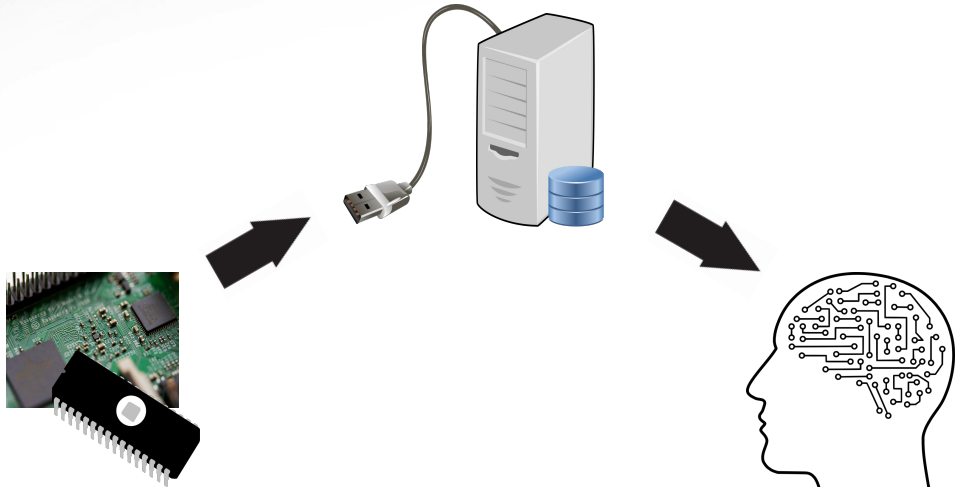


Blue: Phone
Purple: ADC1

Audio in from the DAC1 pin to phone



Database and Data Processing Subsystem Overview



The database and data processing subsystem acts as a bridge between the hardware and machine learning subsystems

The ESP32 sends that data through serialized JSON packets to the host computer where it is decoded and audio data is sent to the database to be stored

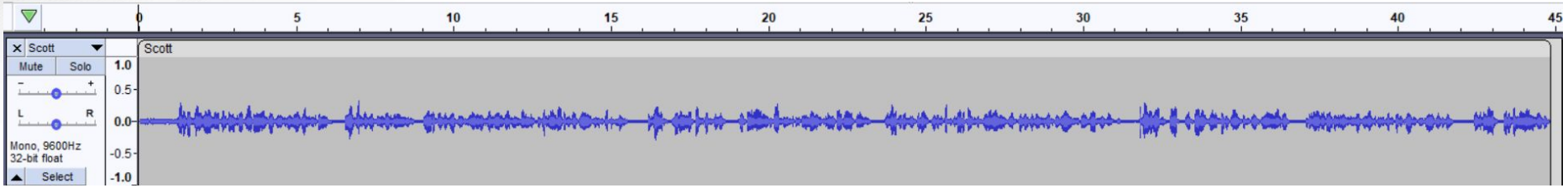
Database and Data Processing

Scott Kevil-Yeager

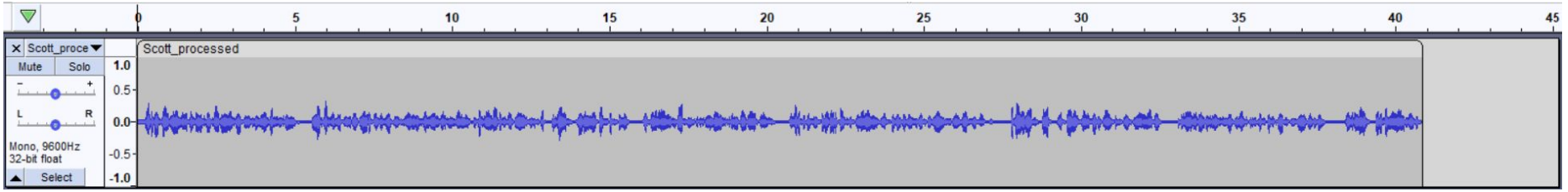
Accomplishments since previous presentation 16 hrs	Ongoing progress/problems and plans until next presentation
• Integration with Matthew • Fixing code incompatibility issues • Playing signals from DAC to board output • Re-writing code from last semester to improve processing times • Writing code to send messages to NCID using TCP-IP protocol • Continued working on integrating state machine	• Finishing state machine integration • Finishing NCID integration • Finishing ML subsystem integration • Test voice capture on a less noisy PCB • Continue commenting and documenting code for a README file at the end of the semester • Dynamically configurable settings • Handshake between host PC and ESP32 • Begin testing fully integrated systems

Database and Data Processing

Voice recordings through ESP32:



After removing silence:



Database and Data Processing

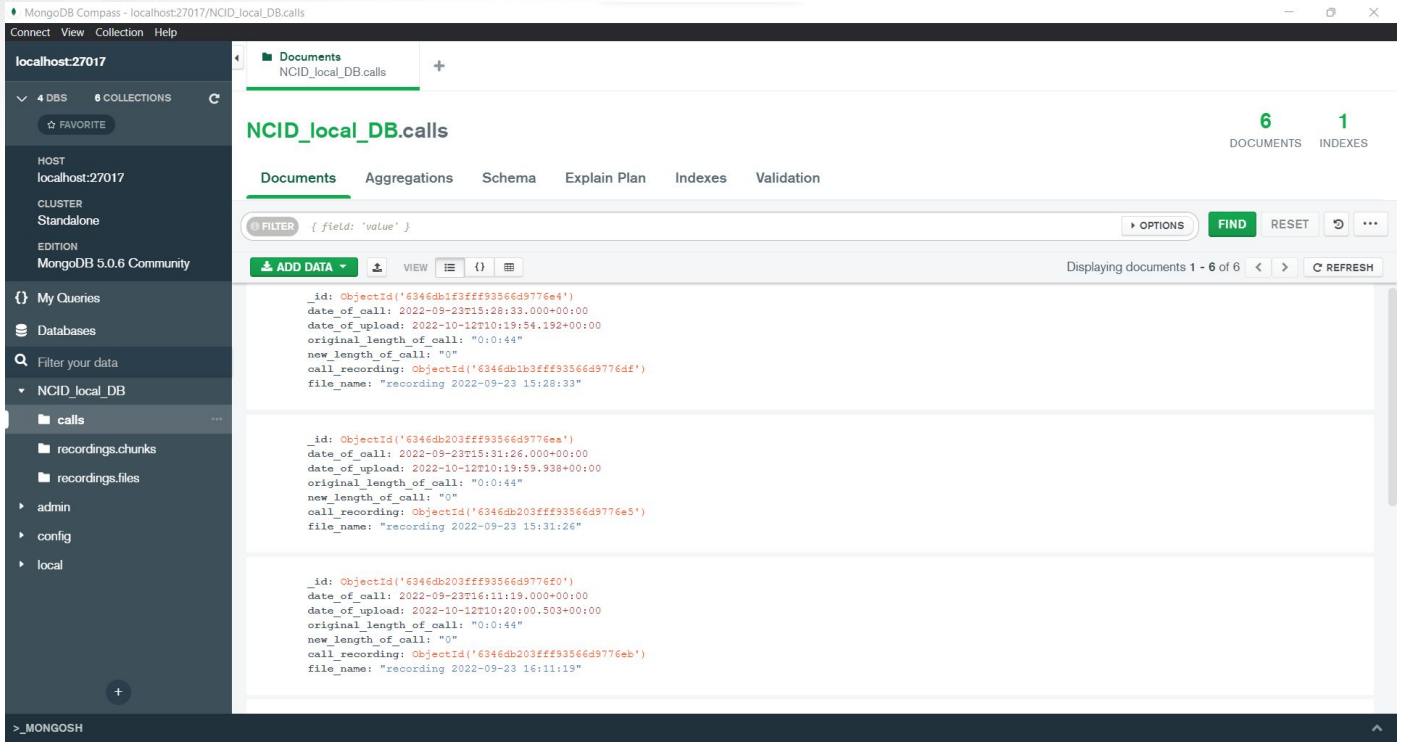
Future plans:

- Finalize integration with Matthew's subsystem and begin testing to ensure proper functionality
- Finalize integration with Amy's subsystem

Additional plans:

- Create NCID gateway test files for final release
- Continue commenting and documenting code for a README file at the end of the semester
- Dynamically configurable settings
- Handshake between host PC and ESP32
- Begin testing fully integrated systems

Database and Data Processing



Machine Learning

Matthew Hebrado

Accomplishments since previous presentation 15 hrs of effort	Ongoing progress/problems and plans until next presentation

• Continued integration with Scott
  ○ Files are going to be sent directly to each other's directories
• Converting any file type to .wav in python
• Adjusted file management for database interfacing
  ○ All test files go into one directory
	• Getting the percentages higher on the new dataset
	• Integrating with NCID gateway

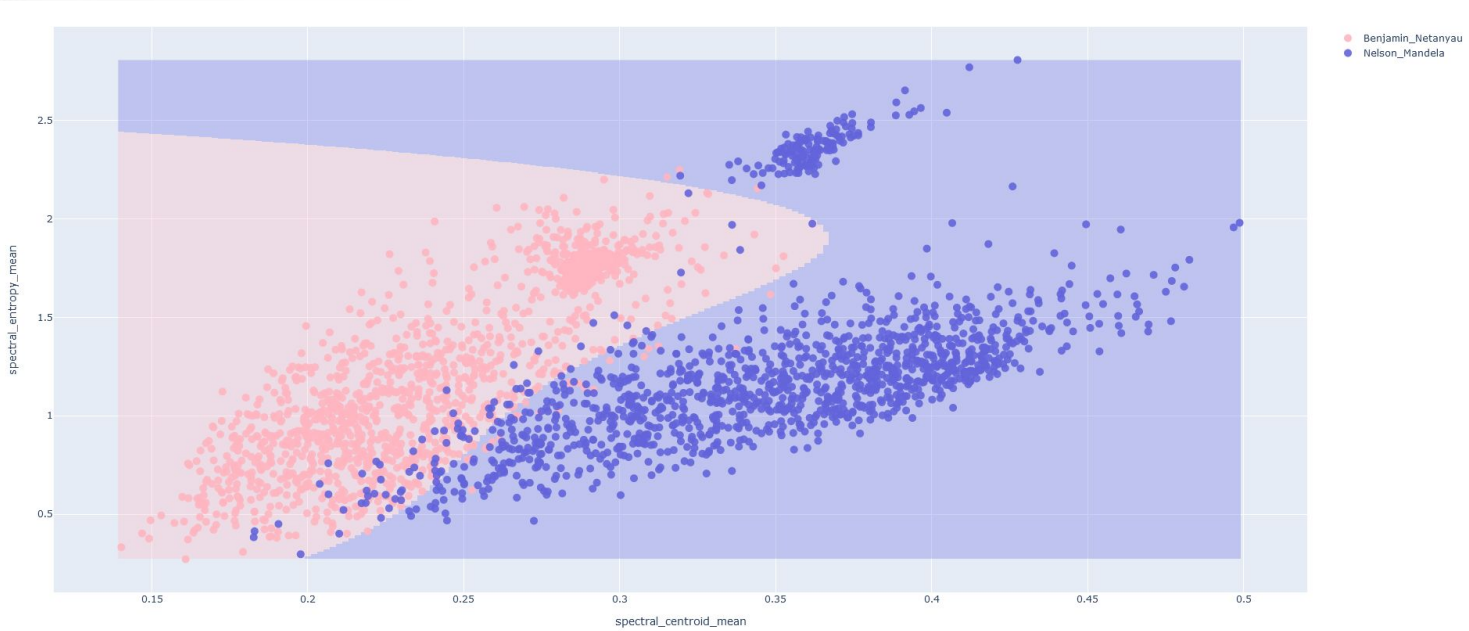
Machine Learning

Figure 1: Testing on new audio files

```
Calculating Averages:
A:  41
M:  59
S:  53
Testing Amy's Files:  85.1219512195122
Testing Matthew's Files:  58.83050847457627
Testing Scott's Files:  31.79245283018868
```

Machine Learning

Figure 1: Graph of feature extractions on two speakers



Parts Ordering Status

Name	Status	Name	Status
820nF	Received	604Ω	Received
100nF	Received	620Ω	Received
4.7uF	Received	470Ω	Received
100pF	Received	100kΩ	Received
0.33uF	Received	68kΩ	Received
MicroSD Card Adapter	Received	43kΩ	Received
TISP4350H3BJR-S	Received	10kΩ	Received
BZX84B33VLYT116	Received	4.7MΩ	Received
1N4148	Received	40.2KΩ	Received
SMAJ5.0CA-E3/61	Received	3.3kΩ	Received
1N4004-T	Received	100kΩ	Received
0.91_OLED_128x32	Received	200kΩ	Received
DS1133-S60BPX	Received	TTC-5017F	Received
TJ-L257FGHRMFCSFLC2R-A5	Received	LTV-817S-TA1	Received
WS2812C/W	Received	LMC555N	Received
IRF530PBF	Received	SN74LV1T08DBVR	Received
ESP-WROOM-32 DEVKIT V1	Received	PLA192STR	Received
22KΩ	Received	PC817X3NSZ9F	Received
1KΩ	Received	LMV824M/TR	Received
10.7KΩ	Received	PCB	Received

Execution Plan

	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9	11/16	Team Member	
Status Update 1													Team	Key
Design PCB													Amy	Ongoing
Order PCB													Amy	Complete
Generate an SVM													Matthew	Planned
Train and test SVM on known dataset													Matthew	Behind
Local storage receives recordings													Scott	
Test and run code on Raspberry Pi													Matthew	
Outline C Code for state machine													Amy	
Test display code on ESP32													Amy	
Fix code to account for unknown voices													Matthew	
Status Update 2													Team	
Train and test SVM on unfamiliar dataset													Matthew	
Writing code for state machine													Amy	
Create filesystem for storing all known callers (white/blacklist)													Matthew	
Generate accurate voice mappings from test data to known data													Matthew	
Test PCB													Amy	
Edit and order 2nd PCB													Amy	
Integrate state machine code and database data transfer code													Scott	
ESP32 Captures incoming FSK encoded CID													Scott	
Interface with Database													Matthew	

Execution Plan (cont.)

	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9	11/16	Team Member	
Status Update 4													Team	Key
Test 2nd PCB													Amy	Ongoing
Integrate with Database													Amy	Complete
Send SVM out to database/onto host machine													Matthew	Planned
Miscellaneous integration													Team	Behind
Integration Checks from ML Subsystem													Matthew	
Status Update 5													Team	
Final Validation													Team	
Final Design Presentation													Team	
Final System Demo													Team	
Virtual Project Showcase Video													Team	
Final Report													Team	

Validation Plan

Test	Detail	Data	Status	Responsible Student
Device powers on	Turns on Raspberry Pi and ESP32	Turns on	Complete	Amy Chen
Display powers on	Displays caller ID information		Complete	Amy Chen
Ring detect	LED1 lights up when detection occurs	48 V DC to sine wave	Complete	Amy Chen
Ring suppress	Initial ring is suppressed		Complete	Amy Chen
Phone pick up	LED2 lights up	LED lights up when CAL* is grounded	Complete	Amy Chen
Audio Conditioning Out	Phone audio to ADC1 pin		Complete	Amy Chen
Audio Conditioning In	DAC1 pin to audio		Complete	Amy Chen
Detect off-hook/on-hook	LED3 lights up when detection occurs		WIP	Amy Chen
Detect hook flash on ESP32	Detect hook flash in firmware		WIP	Amy Chen
Decode CID/CWID on ESP32	Decode CID/CWID information in firmware		WIP	Amy Chen
Decode DTMF and FSK on ESP32	Decode DTMF and FSK in firmware	Code written, not tested	WIP	Amy Chen
OLED program	Code for OLED display		Complete	Amy Chen
WS2812B program	Code for LED light		Complete	Amy Chen
Control WS2812B	Test code on LED light		Complete	Amy Chen
Retrieve file from database	The file will be in the given or created directory that the user has input		Complete	Scott Kevil-Yeager
UI works as expected, allowing users to input test folder directories	UI works as expected, allowing users to input test folder directories		Complete	Scott Kevil-Yeager
Upload folder	Files in given directory will be counted, processed, named, and uploaded to the database automatically		Complete	Scott Kevil-Yeager
Listen to recording	Properly allows the playback of recording audio through the host machine, this assumes that the host machine will have a speaker		Complete	Scott Kevil-Yeager
Error checking	If a folder directory or file directory is incorrectly given then a message is given and the user is prompted for another input		Complete	Scott Kevil-Yeager
Delete recording in database	Given a valid name the function removes a single entry from the database		Complete	Scott Kevil-Yeager
Delete local recording	If a folder path and file name are given then the function will delete the local file		Complete	Scott Kevil-Yeager
pyAudioAnalysis	Removes periods of silence in recordings to reduce file size		Complete	Scott Kevil-Yeager
Local storage receives recordings			Complete	Scott Kevil-Yeager

Validation Plan (cont.)

Test	Detail	Data	Status	Responsible Student
Local storage receives recordings			Complete	Scott Kevil-Yeager
ESP32 Captures incoming FSK encoded CID			WIP	Scott Kevil-Yeager
Write state machine for possible states			WIP	Scott Kevil-Yeager
Handset properly records through ESP32			WIP	Scott Kevil-Yeager
Integrate with ML subsystem			WIP	Scott Kevil-Yeager
Integrate with NCID			WIP	Scott Kevil-Yeager
feature extraction on a wav file	uses pAA to do feature extraction on a wav file and prints the names of all features extracted	log of all features extracted from a given wav file	Complete	Matthew Hebrado
genereate files used to train SVM	take a source file and split it into 1 sec intervals	several wav files are produced that are 1 sec long	Complete	Matthew Hebrado
graph feature comparisons	based on the feature extraction graph is generated that displays a comparison of the two speakers		Complete	Matthew Hebrado
create SVM classification file	does feature extraction on all files in a directory and creates SVM file		Complete	Matthew Hebrado
run tests/predictions from known speakers		~80% accuracy accross the board	Complete	Matthew Hebrado
run tests/predictions from unknown speakers			WIP	Matthew Hebrado
code runs on pi		svms are generated and output is printed	Complete	Matthew Hebrado
send file to database			WIP	Matthew Hebrado
recieve file from database			WIP	Matthew Hebrado

Thank You!

Additional Data

Added in case the professor asked for additional information about a subsystem, and placed at the end to avoid cluttering preceding slides