Acknowledgments

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- Officer Sullivan, UMass Police Department
- Suzan Young, UMPD IT Coordinator
Agenda

- F.I.R.E System Requirements
- Use and Threat Models
- Block Diagrams
  - Previous
  - Updated
- MDR Deliverables
  - Proposed
  - Current

- Deliverables
  - Microphone Unit
  - Sensor Evaluation Module
  - PCB Preliminary Design
  - Camera Unit
F.I.R.E System Requirements

- Chest-mounted video camera connected to box on officer’s belt
- Sensor activated when officer removes weapon from duty belt
- Small, reliable, easy to use, emphasized by UMPD
Use Models

• Entering building
  • Camera automatically activated if officer draws weapon
  • Camera activated manually if situation potentially dangerous

• Traffic stop
  • Camera activated manually if situation potentially dangerous
  • Camera automatically activated if officer draws handcuffs

• Officer caught unaware (Ferguson)
  • No time to manually activate, camera automatically activated if officer draws weapon
  • Pre-record feature will detect why weapon was drawn
Threat Model

**Controlled:**
- Officer attempts to access the data
  - Data is encrypted - only accessible when downloaded to computer
- Officer doesn’t want/forgets to turn the camera on
  - Sensor array will activate it anyway
- Hacker attempts to steal data from servers
  - Data is encrypted
  - Tampered data loaded onto server
  - Data signed with key contained in camera

**Uncontrolled:**
- Local Memory Unit was ‘lost’/stolen (either by officer or attacker)
- Officer covered the camera
Previous Block Diagram
Updated Block Diagram

Police Station
Servers

Docking Station (Mini USB)

Video and Audio (compressed and encrypted)

Camera/Microphone

Video and Audio (raw)

Camera On Signal
Power

Local Memory Unit

NFC Readers (1 per holster)
NFC Reader Signal
NFC Tags (1 per weapon)

Power
Previous MDR Deliverables

- Prototype for RFID sensor array on officer duty belt
- Components of local memory unit connected via breadboard
- Camera unit functional and mounting option decided upon
- Software at the police station prototype
Updated MDR Deliverables

• Microphone record and playback demonstration
• Activation Sensors evaluation module demonstration
• Camera record and compression demonstration
• Preliminary PCB design and list of Local Memory Unit components for custom PCB
Microphone Unit components

- Microphone Preamp System
- ISD 4002/Arduino Subsystem
- Postamp Speaker subsystem

Team Member: Andrew Kelley (EE)
Microphone Unit schematic

Mic Preamp subsystem  ISD 4002 / Arduino Subsystem  Postamp Subsystem
Block Diagram

- **Police Station**
  - Servers
  - Video and Audio (compressed and encrypted)

- **Local Memory Unit**
  - Camera On
  - NFC Readers (1 per holster)
  - NFC Tags (1 per weapon)
  - Power

- **Docking Station (Mini USB)**
  - Video and Audio (compressed and encrypted)
  - Power

- **Camera/Microphone**
  - Video and Audio (raw)
  - Camera On Signal
  - Power
Sensor Evaluation Module

- NFC Reader 13.56 MHz
- Determine functionalities of TRF7970A transponder using provided GUI to create custom software
Evaluation Module GUI

Required Commands:
- Inventory (Code: 0x01)
- Stay Quiet (Code: 0x02)
- Select (Code: 0x25)

Optional Commands:
- Read Single Block (Code 0x20)
- Write Single Block (Code 0x21)
Low Power NFC Reader

- Samples then measures the time it takes for signal to decay
- Unable to implement yet because of incorrect cable to download firmware
Block Diagram

- **Police Station**
  - Servers
  - Video and Audio (compressed and encrypted)

- **Docking Station (Mini USB)**
  - Video and Audio (compressed and encrypted)

- **Local Memory Unit**
  - Camera On
  - Power
  - NFC Reader (1 per holster)
  - NFC Tags (1 per weapon)

- **Camera/Microphone**
  - Camera On Signal
  - Power
  - Video and Audio (raw)
Camera Unit

BeagleBone Black
- Camera Cape
- 1.26MP Camera Sensor
- Ultra-low-power

- Outputs data in YUV4:2:2 format
- Capable of 1280x720 at 30 fps (adjustable)
Camera Data Processing

RAW from Camera

<table>
<thead>
<tr>
<th>Data Rate</th>
<th>Beaglebone Black H.264 Encoding</th>
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<tbody>
<tr>
<td>14.648 MB/s</td>
<td></td>
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</table>

After encoding

<table>
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<tr>
<th>Quality Level</th>
<th>Data Rate</th>
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<tr>
<td>0 (best)</td>
<td>4.6523 MB/s</td>
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<tr>
<td>25</td>
<td>.05775 MB/s</td>
</tr>
<tr>
<td>51 (worst)</td>
<td>.003052 MB/s</td>
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Quality 51

Quality 25

Quality 0
End Point Storage / Software

- Police frowned upon cloud storage
- Will be creating an end point interface
  - Manage software / permissions on device
  - Ability to catalogue and tag videos
Block Diagram

- Police Station
  - Servers
  - Video and Audio (compressed and encrypted)
- Docking Station (Mini USB)
  - Power
- Camera on
  - Camera On Signal
  - Power
  - Video and Audio (compressed and encrypted)
  - NFC Readers (1 per holster)
  - NFC Reader Signal
  - NFC Tags (1 per weapon)
Custom PCB justification

- BeagleBone Black impractical both in terms of size and features
- Custom design allows for a smaller Local Memory Unit
- Power supply will be integrated (no built in solution for BeagleBone Black)

**Height of BBB (with all desired features) vs. Height of PCB**

```
2"

- Microphone
- CryptoCape
- Camera Cape
- BeagleBone Black
```

```
Custom PCB
```

0.5"
Local Memory Unit Specifics

 ✓ AM335x 1GHz ARM Cortex-A8 processor
 ✓ Mini HDMI Port
 ✓ MicroSDHC Port
 ✓ USB PC interface
 ✗ Encryption hardware
   • Atmel At24C32D
   • AES Algorithm with 128 – bit keys
 ✗ Battery
   • TPS65217CRSLT power management IC
   • 3.7V LiPo battery
 ✗ Microphone
   • ISD 4002 Record-Playback Device

- USB host
- DC Power Connector
- Cape Support
- Ethernet Port

Key

 ✓ On BBB
 ✗ Not on BBB
 − On BBB but Unneeded
Demonstrations and Questions