T.A.A.G
Tamper Automated Alert Gadget
Final Presentation

Group 7
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Daniel Gibney CpE
Leaphar Castro EE

Funding
Dr. Yuan, Co-Director of MIST research center at UCF.
Motivation

With the ever expanding use of IoT sensor systems, the vulnerability of these systems must be evaluated. This project serves as a platform to demonstrate how IoT security can be implemented.
Concept

What is T.A.A.G?

• Senses motion and light
• Wi-Fi messages to mobile app
• Place on door, gun case, etc.

User Interface

Detector

Detectors

Plexiglass for Light Sensor

"Join System" Button

Tampering Detected
Item #43
My Cereal
Goals & Objectives

• Secure transmission of data between device and user
• Lightweight & compact
• Easy to use and set up
• Adjustable light and motion thresholds
• Long lasting battery life
• Allows for multiple detectors
# Requirement Specifications

<table>
<thead>
<tr>
<th>Parameter of interest</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery life</td>
<td>50 days or more with normal operation</td>
</tr>
<tr>
<td>Charging time</td>
<td>1 hour or less</td>
</tr>
<tr>
<td>Weight</td>
<td>50 grams or less</td>
</tr>
<tr>
<td>Dimensions</td>
<td>55 mm X 45 mm or less</td>
</tr>
<tr>
<td>Mobile application</td>
<td>Android mobile app</td>
</tr>
<tr>
<td>Notification</td>
<td>Given network connectivity detector sends notification to user when sensor thresholds are crossed - Provides low battery notification before battery is fully depleted</td>
</tr>
<tr>
<td>Security</td>
<td>Use of Https</td>
</tr>
<tr>
<td>Range of light sensing threshold</td>
<td>0 lux – 10,000 lux</td>
</tr>
<tr>
<td>Acceleration detection</td>
<td>Be able to detect a magnitude of 0.2g or greater in all directions</td>
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</tbody>
</table>
System Overview

3 major components:
Mobile application, web service, and detector
Work Distribution

- Aiman Salih:
  - Administrative tasks
  - Overall system
  - PCB design
- Daniel Gibney:
  - Overall system
  - Software system
- Leaphar Castro:
  - Power system
  - Hardware system
Detector Hardware System

- Accelerometer
- Light sensor
- Gas gauge
- LiPo Charger
- Battery
- Buck-Boost Converter
- JTAG Flash
- 5V USB
- MCU CC3200
- I2C SCL
- I2C SDA
- To 3.3V Rail
- Headers
Microcontroller

T.I. SimpleLink Wi-Fi CC3200 Internet-on-a-chip Wireless MCU module:

- Most compact solution
- Crypto engine

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Texas Instruments</th>
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<tbody>
<tr>
<td>Part model</td>
<td>CC3200mod</td>
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<tr>
<td>Price</td>
<td>$24.99</td>
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<td>Purchased from</td>
<td>Mouser</td>
</tr>
<tr>
<td>Pins</td>
<td>65 pins</td>
</tr>
<tr>
<td>Vin</td>
<td>3.3V</td>
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<tr>
<td>Dimensions</td>
<td>17.5 mm X 20.5 mm</td>
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</table>
Accelerometer

- Has a dedicated interrupt pin
- Uses the 3.3V rail
- Very compact dimensions

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Bosch</th>
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<tr>
<td>Part model</td>
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<td>Pins</td>
<td>12-pin LGA</td>
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<tr>
<td>Vin</td>
<td>3V Nom.</td>
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<tr>
<td>Dimensions</td>
<td>1.9 mm X 1.9 mm</td>
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</table>
Light Sensor

- Light responsivity down to 0.25 lux
- Offers I2C technology
- Operates on 3.3V rail

<table>
<thead>
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<th>TAOS</th>
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<tr>
<td>Part model</td>
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<tr>
<td>Pins</td>
<td>6 pins</td>
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<tr>
<td>Vin</td>
<td>3 V Nom.</td>
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<tr>
<td>Dimensions</td>
<td>2.9 mm X 1.7 mm</td>
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Power Flow

- Gas gauge
- Battery
- LiPo Charger
- Buck-Boost Converter
- 5V USB
- To 3.3V Rail
## Battery

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Hunan Sounddon New Energy Co.</th>
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<tr>
<td>Part Model:</td>
<td>503562</td>
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<tr>
<td>Price:</td>
<td>$9.95</td>
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<tr>
<td>Purchased From:</td>
<td>Adafruit</td>
</tr>
<tr>
<td>Type:</td>
<td>Polymer Lithium-Ion</td>
</tr>
<tr>
<td>Connector:</td>
<td>2-pin JST- PH connector</td>
</tr>
<tr>
<td>Nominal Voltage:</td>
<td>3.75 V</td>
</tr>
<tr>
<td>Nominal Capacity:</td>
<td>1200 mAh / 4.5 Wh</td>
</tr>
<tr>
<td>Weight:</td>
<td>23 g</td>
</tr>
<tr>
<td>Dimensions:</td>
<td>34mm x 62mm x 5mm</td>
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</table>
Polymer Lithium-ion Battery

- Low maintenance battery
- Self-discharge rate compared to other available technologies fairly low in most cases less than half
- Little to no harm to the environment when disposed
- No special requirements for prolong battery life
- Energy Density when compared to other technologies is typical twice as good
- Protection circuit built in
- Specialty Cells
- Dimensions
- Lightweight
- Safe to use
- Easy to implement into design and system
- Load characteristics
- Rechargeable
- Potential for even higher densities
<table>
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<tr>
<th>Manufacturer</th>
<th>Microchip Technology</th>
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<td>Part Model:</td>
<td>Battery Management</td>
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<td>Purchased From:</td>
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<td>Product Type:</td>
<td>Charge Management</td>
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<tr>
<td>Connector:</td>
<td>20-pin</td>
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<tr>
<td>Output Voltage:</td>
<td>4.2 V</td>
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<tr>
<td>Output Current:</td>
<td>50mA to 1000mA</td>
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<td>Dimensions:</td>
<td>4mm x 4mm</td>
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LiPo Charger

- Simultaneously Power the system and charge the battery
- Integrated reverse discharge protection
- Versatile
- Automatic recharge
- Automatic end-of-charge control
- Power on status indicator
- Autonomous power source selection
- Low external component
- Small size
- Safety features
- Low battery Status indicator
# Gas Gauge - MAX17048

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Maxim Integrated</th>
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<tr>
<td>Product Model:</td>
<td>Battery Management</td>
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<td>Purchased From:</td>
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<td>Product Type:</td>
<td>Fuel Gauges</td>
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<td>Connector:</td>
<td>9-pin</td>
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<td>Output Voltage:</td>
<td>0.4 V</td>
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<td>Operating Voltage:</td>
<td>2.5 V to 4.5 V</td>
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<tr>
<td>Operating Current:</td>
<td>23 µA</td>
</tr>
<tr>
<td>Dimensions:</td>
<td>2 mm x 2 mm</td>
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</table>
Gas Gauge

- Algorithm based sensing
- No current sense resistors
- No learned battery cycles necessary
- Temperature compensation
- Autonomous detecting
- Accurate
- Voltage measurement improvement on battery insertion
- I2C communication
- Small size
- Programmable
- Reports on battery information
Voltage Regulation

- **Buck-boost topology (Webench).**
- **Vout = 3.3V**
- **Efficiency = 85%**
- **Cost = $1.79**
Development

T.I. CC320MOD LaunchPad
- Contains JTAG & Flash circuitry
- Useful hardware and software files

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Texas Instruments</th>
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<tr>
<td>Model</td>
<td>CC3200MODLAUNCHXL</td>
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<tr>
<td>Price</td>
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<tr>
<td>Purchased at</td>
<td>Mouser</td>
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Development

Battery Booster Pack

- Comes with LiPo battery
- Gave platform for hardware and software development

Manufacturer: Texas Instruments
Model: BOOSTXL-BATTPACK
Price: $19.99
Purchased at: Element 14
PCB Schematic
PCB Schematic
Final PCB Layout
Final PCB Layout
Detector Program Flow

Start up
- Initialization, Wait on smart link provisioning
  - Received settings
- Program sensors and timers for interrupts
  - Low power mode
    - Timer Int.
    - GPIO Int.
- Emit RESET notification
- Tamper Detection
  - Yes
    - Is button pushed?
      - No
        - Low power mode
        - Wait 30 seconds
      - Yes
        - Sensor enabled & lux changed?
          - Yes
            - Emit LIGHT notification
          - No
            - Sensor enabled & acceleration?
              - Yes
                - Emit MOTION notification
              - No
                - Set timer, disable GPIO Interrupt
  - No
    - Enable GPIO interrupt
      - Timer Int.
      - Low power mode
- Battery Check
  - Battery power low?
    - Yes
      - Emit BATTERY notification
    - No
Start-up Overview

TIME

Application start:
Request token (future calls are local)
Token
Login Screen:
Remove token from DB (for all users)
Create account/login
Store token for user
Web Service/Data base

Get user name & pw
Mobile Application

User fills in settings
Start Sync

Detector sync-screen:
provisioning
Acknowledge

Indicates to User sync complete

Settings/Username/Password (10 second window)
Light flashes

Detector

Google Cloud Message
Google Cloud Messaging

• **Application ID:**
  • App is registered with google by developer to obtain.
  • Shared amongst all instances of the application.
  • Hard coded into both mobile application and the web server.

• **Token: Tied to particular physical device.**
  • Gotten at initial application start-up, stored for reuse. Communicated to detector during sync process.
  • Stored in database for sending notifications.
Communication between System Components (except provisioning and mDNS)

• POST requests over https
• Data is exclusively formatted in JSON
• Example:

```json
{
  "name" : "a@b.com",
  "password" : "12345",
  "detector" : "cereal",
  "message" : "cereal tasted"
}
```
The Web Service - Google makes it easy

- A total of 6 URI are used. (/logIn, /createAccount, /deleteAccount, /logTamper, /displayLog, /storeGCMToken, /deleteGCMToken)
- Google Cloud Messaging is a separate service.
Web Service Program Design – Python using Flask

• Program design is a set of functions which get called when a particular URI is requested.

• Contents of JSON are parsed and helper functions are used to access and update the database.

• Very little, to no, iteration used
• Actual password is not stored in database, rather irreversible hash of password is stored.
• Row added to table from login screen on mobile application (create account).
• Row can be deleted from login on mobile application (delete account).
• Table checked for username and password hash match on login.
Database - Tampering

- User name must exist in the database, and password hash must agree, before tamper gets stored in the database.
Database - Tokens

- User name must exist in the database, and password hash must agree, before the token can be stored.
- Unlimited number of tokens per user allows the user to get notifications on unlimited number of devices.
- What if users are sharing a device, and one user force stops the application? Will the device receive notifications for both users? – This is why tokens are removed on start up.

### Table

```
mysql> DESCRIBE GCMTokens;
+----------------+------------+----------+------------+-------------+---------+
| Field          | Type       | Null    | Key        | Default     | Extra   |
+----------------+------------+----------+------------+-------------+---------+
| name           | varchar(255) | YES      |            | NULL        |         |
| token          | varchar(500) | YES      |            | NULL        |         |
```

Provisioning – TI Smart-Config

- Best seen here as a black box that gets the CC3200 on the Wi-Fi network.
- It communicates Wi-Fi ssid and passkey to CC3200 using packet lengths.
- Smart-Config libraries continue the process connecting the CC3200 to Wi-Fi network.
- ISSUE – DOES NOT SUPPORT ADDITIONAL FIELDS TO TRANSMITT SETTINGS DATA!
mDNS and DNS-SD

- Multicast DNS resolves host names to IP addresses
- Used with DNS Service Discovery it allows one device to look for a service advertised with a particular name.
- Service advertises port, service type, and a text field.
- This text field is used here to transmit additional information from the mobile app to the detector.
- `<light-settings>_<motion-settings>_<detector-name>_<user-name>_<password>`
- Then service is deregistered
A Tampering

TIME

Interrupt awakens detector from hibernation

Detector

/logTamper
POST

Web Service / Data base

Check username and password
For each token stored in GCMToken
Where name = username

POST

... Store tamper in Tamper table

Google Cloud Message

POST

... Mobile Application (multiple devices)

Notification appears on devices
Manufacturing

• PCB was printed with OshPark.
• Parts were assembled with Quality Manufacturing Services in Lake Mary, FL.
• Casing was designed and laser cut at the UCF TI innovation lab.
Testing

- Testing light sensitivity in different ambient settings.
- Motion testing.
- Network connectivity testing.
- Case drop testing.
- Regulator voltage.
- Tested reverse battery testing.
Light Testing

• Live sensor readings.

• Used to determine the best threshold settings
Motion Testing

- Accelerometer sampling for determining slope thresholds

Threshold Low value acceleration = .375 g
Threshold Medium value acceleration = .5 g
Threshold High value acceleration = .725 g
Battery Testing

- To assure maximize battery functionality, multiple test will be ran on the battery to figure the overall performance. In order to verify the battery will not fail during normal operations.

- Charge time: about 1 hr.
- No interrupts: 37 days
- Stuck at start up: 1 day
- Normal operation: 37 days

- General Performance
- Environmental Testing
- Mechanical Testing
- Safety testing
Battery Testing
Battery Testing
Budget

- Amount spent by purchase:

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Date</th>
<th>Price</th>
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<tbody>
<tr>
<td>Adafruit</td>
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<td>Banggood</td>
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<td>Newark</td>
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<td>Lowes</td>
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<tr>
<td>Google Cloud Service</td>
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Total $498.78

Budget $700

Remaining $201.22
Questions?