Requirements Specification

Senior Design Project 317, Fall 2017 - Spring 2018, CMSC 451/452

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Initial Proposal:  
Proposed Deliverables: This project will build a network of iBeacon tags that will help people locate their lost or stolen items. iBeacon tags will be attached or stick to people’s belongings and will communicate to the smartphone app (iOS+Android) regularly (over Bluetooth Low Energy (BLE)) and maintain the information about the presence of the item with tag attached. When the tag is out of the range of the owner’s smartphone (lost/stolen), a nearby smartphone of another user in the network will be able to detect this tag through the app and let the owner know it's detected location through server.

The app will have user mode and manager (public safety officer) mode. In user mode, the user will only see its connections with the tags attached to his items and once one is lost will receive alert. The user will also be recommended potential locations of the lost item based on last connection with it and the locations covered by other users. In manager mode, the location of all tags will be mapped and best paths to patrol to locate the lost item will be drawn based on the current locations covered. In collaboration with VCU police, the faculty advisor will help students to reach a community of users on campus and test the proposed system and app. Different scenarios will be evaluated. There will be stable tags deployed in certain spots of the campus to increase monitored area. Indoor areas especially will be considered for such stable tags to compensate the low GPS efficiency. The logs of the app will also be analyzed to develop and integrate prediction based smart mechanisms to the system to increase efficiency. A workshop/conference publication will be ultimate goal. Students will also be encouraged and guided to make their app available in app store and earn money.

Deliverables and Specifications:

The project will produce iOS and Android apps with the following features:

* Pair Bluetooth Low Energy (BLE) tag to the phone to define a tag-owner relationship.
* Phone passively observe BLE tag in the vicinity, logging last observation of a given tag with the GPS location of the observation.
  + This observation should be done in a battery-efficient way.
* To address the situation that an owner loses a tagged object, the phone will respond by providing the location of the last observation.
  + Additional recent observations may be provided as needed to make the recovery process robust to GPS imprecision and other errors.
* Crowdsourcing: A network will be established such that all users/owners may passively observe the BLE tags of other users, logging the last known location.  
  Upon request to the network, a user may receive the last observed location of their own tag.

Security:

* + Users should only be able to request and access information regarding their owned tags.
  + The encryption methods of the paper *Techu: Open and Privacy-Preserving Crowdsourced GPS for the Masses* should be implemented where practical, to help preserve privacy and security of users and their tagged items.
  + Where practical, given the possibly centralized features requested, aspects of the decentralized design described in *Techu: Open and Privacy-Preserving Crowdsourced GPS for the Masses* should be incorporated.
* Admin View: So that campus police can help students to find and recover their lost tagged items, the app should provide a map of the campus detailing the last reported observations in a given area.
  + The method of visualization should allow officers to identify an efficient route about campus which will allow them to observe relatively unobserved areas.
  + This map and information should only be available to authorized users, as specified by a whitelist.
* Static Receivers: A method for identifying particular, university-provided, observers (possibly built out of inexpensive hardware such as a Raspberry Pi) will be included, allowing these devices observations to include additional, location-aware information.  
  For example, given the limitation of GPS, an average user’s observations will be ignorant of the floor level in a building. But, we may fix a receiver on the 3rd floor of a building, aware of its location and able to specify the location of any observations it reports.
  + When providing last known observations and locations to users, results should be prioritized to include the reports of static receivers and their additional information when practical.
* ~~Initially, users should be able to log-on using Google accounts, and their profiles should be paired with their owned tags and with permissions (such as are they an admin/police officer).~~ (Modified 9/26)
  + Users should be able to log on using Google accounts.  
    Permissions (i.e. admin/police mode) should be associated with their accounts.
  + *If time permits*: Profiles will be paired with owned tags and keys, transferring upon sign-in.
* The app and network should be robust to challenges such as GPS imprecision, users not connected to the internet, etc.
* Initially, the apps should work with the Estimote BLE tags.

Example of Acceptable Prototype and Demonstration of Functionality:

* Prototype apps for iOS and Android.
* Several users each with several paired tags.
* Demonstration of Admin view.
* Demonstration of pairing a device to a tag, identifying that tag as lost, and the reported observations both from the owner’s phone and from other users in the network.
* Demonstration of additional information provided by static receivers.

Additional Goals and/or Features to be Implemented, Time Permitting:

* Following an initial prototype, we may meet with VCU PD to identify additional features which would be useful.
* Integrate the VCU login system to authenticate users with their university accounts.
* Make our app’s network able to accept BLE tags from other manufactures, allowing users to use their existing hardware.
* Purchase a batch of custom BLE tags to start a beta- style rollout on VCU’s campus.
* Explore the possibility of academic publication of our results.
* Ability to handle multiple campuses (database)
* Improve system for managing authorized admin users.
* Users can see high risk areas