CS575 Assignment 1 – Build and Describe an Architecture for an IoT device

Background

There is a significant market to create novel Internet of Things (IoT) devices to solve a number of interesting problems. IoT devices, by design, are inexpensive, and designed to solve specific problems. The problem we will be addressing via design this term is bike theft, something that most people don't think about, but is a multi-billion dollar problem in the US. More than 95% of bikes stolen are never recovered. See the below figure for some background on this problem.
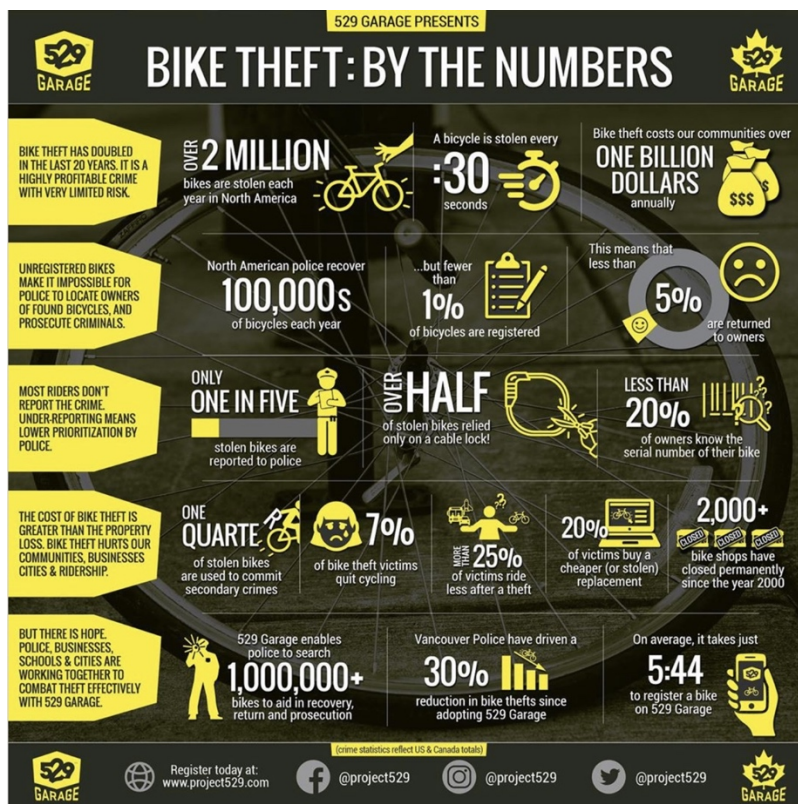

Figure 1: Bike Theft Facts

For this assignment you are conceptualize and create a high-level architecture description for a new product that helps people deal, and municipalities that want to start broader enforcement of the bicycle theft problem in a novel way.

Product Objectives

In order to address our goals we are going to undertake specifying product requirements and create an architecture description of an IoT device that can help people deal with bike theft. The three main components of our solution are shown below:

Bike Accessory   Mobile Application   Bluetooth Beacon Receiver

Figure 2: Product Components

The three components of the product include:

- **A bike accessory with a hidden / embedded Bluetooth beacon transmitter** (See figure 3 below). We will be using Bluetooth beacon technology given that transmitters are cheap ($<10), and can be powered on a single battery for about a year. Your goal is to pick an appropriate accessory where the Bluetooth beacon can be hidden, and possibly be recharged or replaced when the battery dies. Maybe in a water bottle holder, a light, handlebar grips, something else (be creative).
- **A mobile application.** When you first receive your bike accessary you will need to register it with the mobile application – every Bluetooth transmitter has a unique code. You can also use the mobile application to try to find the location of your bike or to report it as stolen. Both of these options register your unique beacon transmitter ID with a centralized database that is used by the beacon receivers.
- **An exterior hardened Bluetooth Beacon receiver.** Many cities and shore towns that have bike theft problems can be incented to install Bluetooth beacon receivers in strategic locations throughout their municipalities. The idea is that a Bluetooth beacon has a range of 70 to 450 meters or 230 to 1476 feet given they are low powered devices. By placing these inexpensive receivers strategically, they can detect if a stolen or missing bike comes into their range and report detection to the owner or the police.

Figure 3: Bluetooth Beacon Transmitter

The other unique aspect of this product is that it can use crowdsourcing to deal with bike theft. Every user running your mobile app can also participate as a Bluetooth beacon receiver, thus if somebody riding a stolen bike comes in the proximity of anybody running the app, the user of the app will be alerted that a stolen bike is nearby and be given the option of reporting their location and the identification of the bike to the owner and the police.

Technical Considerations
- The solution must be practical and implementable. I suggest using Bluetooth beacon receivers because they have a pretty good range and can support ultra-long battery life not requiring recharging. Feel free to investigate other technical solutions.
- User privacy – the solution must respect all parties privacy so that personal information such as location is not provided to law enforcement without explicit permission.

Non-Technical considerations
- Affordable – there are existing GPS-based solutions in the market to address this problem, but these solutions are not power friendly (need to recharge a battery weekly or even more frequently), and require monthly subscription costs given the GPS technology piggybacks on the cellular network. This may be the best solution for really expensive bikes, but is not an ideal product for everybody.

Assignment Objectives
You have 2 objectives for this assignment:
1. Spend some time learning about IoT devices in general and Bluetooth beaconing technology.
2. List / devise (and be creative) 2 additional features that this IoT solution must have to make it a viable product that somebody would want to purchase. I'm looking for enhancements to any of the product components (from Figure 2), most of the technical features have already been documented (low power, mobile app management)
3. Develop an architectural description of the system that shows how the architecture supports the features that you identified for the product. Your architecture description should include a high-level picture describing the architecture of the product and a writeup showing how the architecture supports the product feature requirements. You are free to pick the notation that you want to use from the ones we talk about in class (informal line and box, UML, C4) as I care more about your ability to communicate an architecture well versus using a specific notation.