Command and Control: Scalable Infrastructure for Dynamic IOT Device
Reconfiguration and Management

Nishant Jain

January 26th, 2017

Yale Computer Science Department

CPSC 490 Proposal — Directed by Prof. Y. Richard Yang

In Collaboration with Shreyas Tirumala

Introduction:
The Internet of Things (IOT) encompasses a vast array of devices that enable various household appliances to be networked. Because of IOT device heterogeneity, reconfiguration of these devices presents a challenge to current systems infrastructure. Furthermore, due to the expected growth in the number of deployed IOT devices over the next few years, there is a need for scalable infrastructure that can manage and control a cloud of IOT devices. We are attempting to develop a platform for the dynamic reconfiguration of such devices through live over-the-air updates to running code on IOT devices.

Proposed Architecture:
The project can be divided into two main components: The first is the creation of a scalable networked controller system that can register new IOT devices to transmit and receive data from them. The second is the creation of a methodology for re-programming functions within the IOT device. Together, these components create a complete system for commanding and controlling a vast cloud of IOT devices from a centralized platform. I will be collaborating with Shreyas Tirumala on building this system.

The controller will employ existing paradigms in the field of distributed systems, such as sharding and replication, to create a service that can scale to vast numbers of IOT devices. The controller itself will consist of a set of controller nodes, each of which is responsible for a set of IOT devices, thereby partitioning all of the IOT devices in the system. Nodes will be responsible
for keeping track of the characteristics of certain devices and being able to connect to them over a network. This is so that new program components can be transmitted by a client managing the controller to IOT devices on the network. For the purpose of this project, we will focus on wi-fi enabled IOT devices. To add additional guarantees such as high availability, we may implement replication of controller nodes and other general protocols from the field distributed systems. My focus for the semester will be on the creation and testing of this systems infrastructure.

The second component will be the creation of a methodology to reprogram functions on the IOT devices themselves. Currently, many IOT devices have simple functions that run in endless loops to perform certain logical tasks based on sensory triggers. We currently envision creating a framework to transmit programs to IOT devices so that they can be updated during runtime itself without terminating the running program. This would allow customization at the function-level for these devices. We plan to first experiment with Python since it is an interpreted language; this is because we hypothesize that binaries created in compiled languages may be more difficult to edit during runtime. I will be collaborating with Shreyas Tirumala on this component.

Our projects together will be composed to create a proof of concept of the system that should enable us to demonstrate the feasibility of scalable IOT device reconfiguration through a centralized networked platform.

**Project Deliverables:**

1. A Proof-of-concept of the system that demonstrates the ability to connect to a set of IOT devices and communicate with them.
2. An oral or written report that describes the design, process, and results of our work.

**Division of Work:**
The project involves the development and testing of a rather large distributed system. There will be considerable reading and coding to be done on the two components of 1) engineering the distributed controller system and 2) designing the methodology for re-programming the IOT
devices. My component of the project will focus on engineering the scalable controller system that can register IOT devices. To that end, I will be focusing on reading the latest in systems literature. I will also help Shreyas Tirumala with conceptualization and implementation of the reconfiguration methodology.

**Timeline:**

- **January 30th-February 10th**
  - Gather any infrastructure or materials that I may require and conduct background reading on the latest methods/research
- **February 10th-February 24th**
  - Plan the specifics of the system in consultation with our advisor, Professor Yang
- **February 24th-April 7th**
  - Create a proof-of-concept of the design by implementing it in code.
- **April 7th-April 21st**
  - Perform tests to measure the performance of the system. Write report and make modifications to system as necessary.
- **April 21st - May 10th**
  - Buffer time for any additional modifications/work.