INTEGRATING EXPERIMENTAL SENSORS INTO WAGGLE EDGE-COMPUTING PLATFORM

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ABSTRACT

- Waggle Infrastructure:
  - Utilizes a network of sensors to provide environmental information
  - Currently relays light, meteorological, chemical, and particulate data
- Project goals:
  - Integrate commercial off-the-shelf (COTS) water level, soil moisture, and airborne particulate matter sensors
  - Deploy and test the sensors
  - Determine applicability to the Waggle Platform


PLATFORMS

- Goal: interface sensors using Particle's Photon and Electron Internet of Things (IoT) modules, and Waggle sensor infrastructure
- Method of transmission: Photon → wireless network, Electron → cellular data, Waggle → wired, wireless, or cellular data
- Embedded communication protocols
  - I²C
  - UART
  - GPIO
  - A/D
- Photon and Electron firmware is programmed on the Particle IDE
- Data is either sent to a computer's serial port or sent to Particle's cloud

Photon   **Electron**
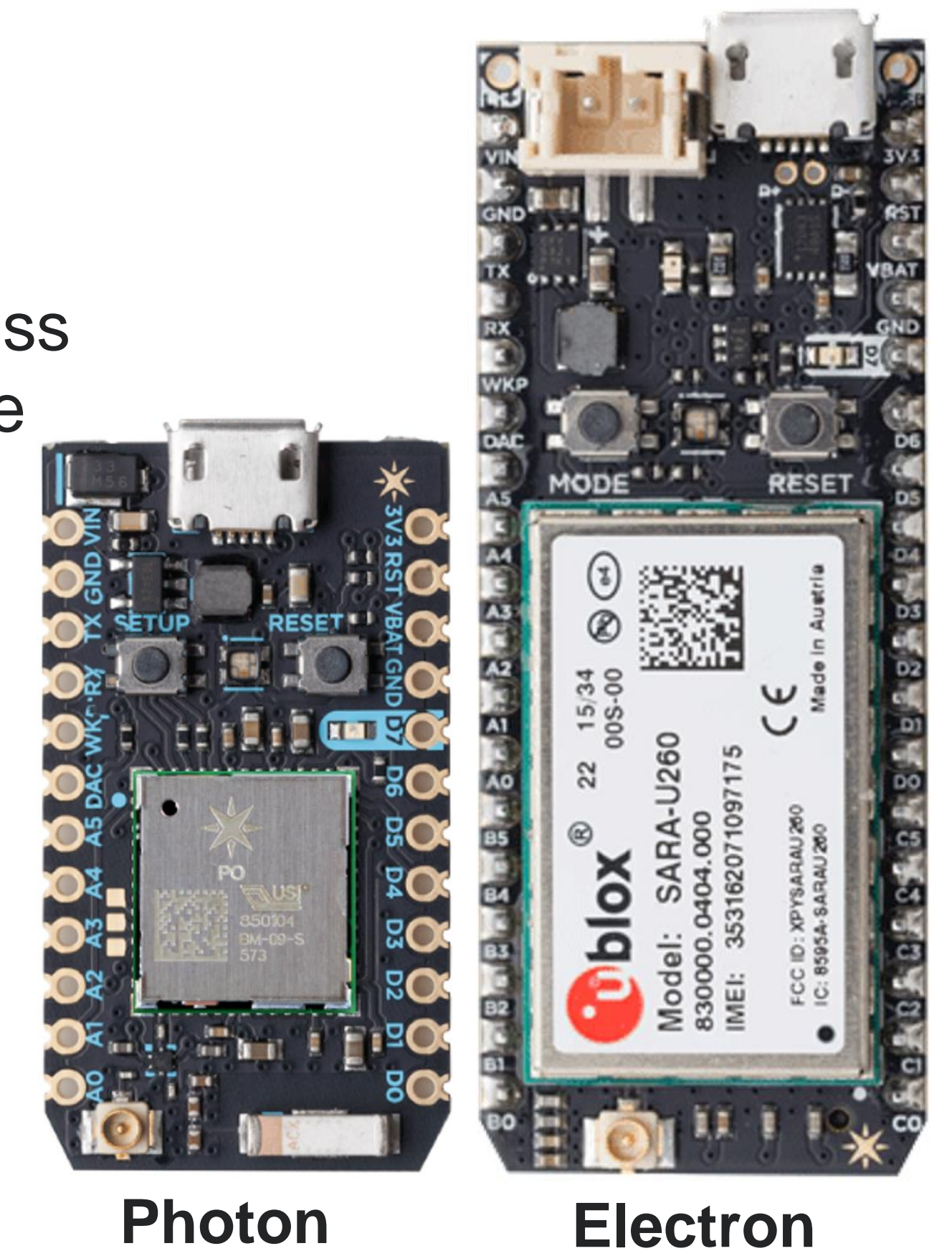
EVALUATED SENSORS

Water Level Sensors

- RobotDyn Sens-WaterLev and MH Water Sensor
- Type: analog
- Output of ADC starts at 0 and increases to 500 as water level rises
  - Completely dry: < 10
  - Submerged halfway: ~450
  - Completely submerged: ~500
- Water salinity can also affect the readings and may have to be considered
- Sensors are useful for flood detection in basements and understanding changes in water tables after it rains

**Water Sensor**

Sens-WaterLev
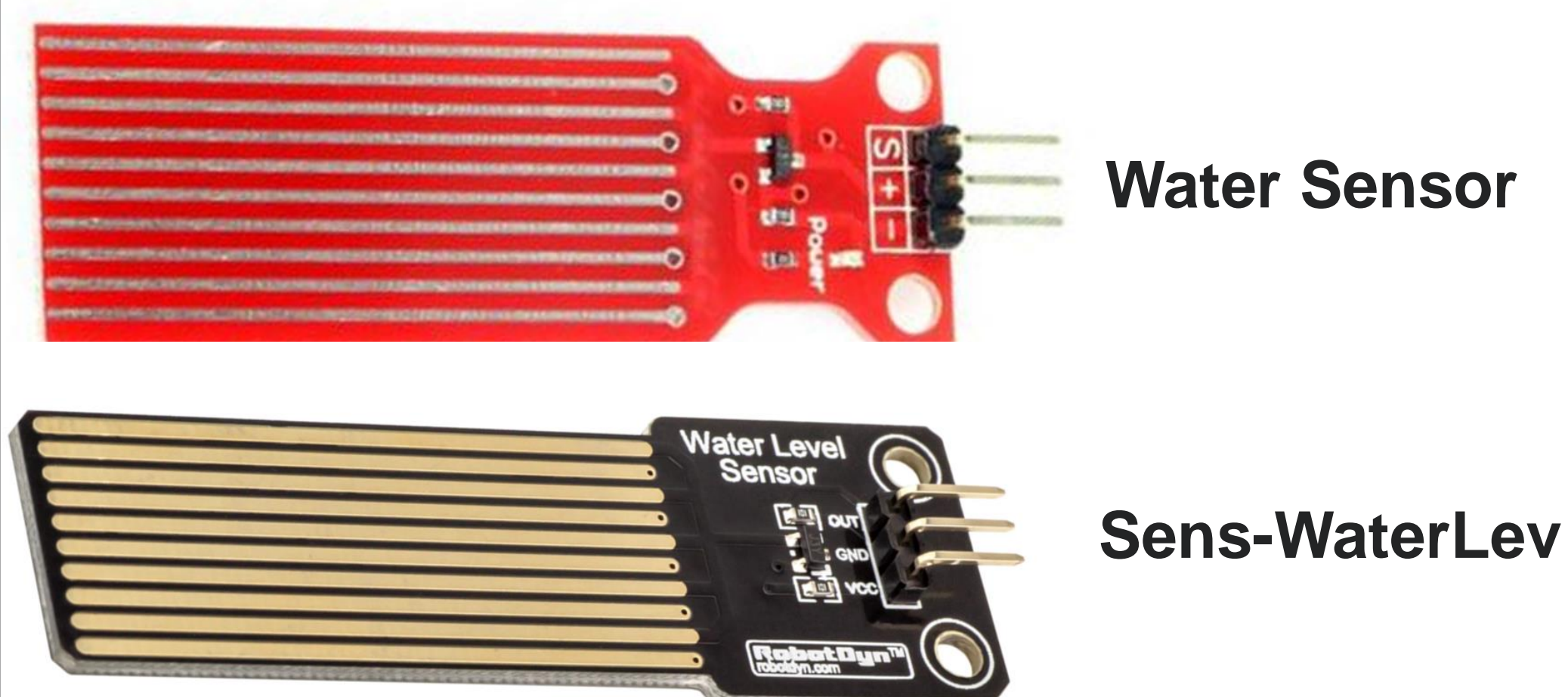
Particle Sensors

- Plantower PMS 7003 and PMS 3003
- Type: UART
- Operating Voltage: 4.95 – 5.05 V
- 7003 outputs 32 bytes, 3003 outputs 24 bytes
- Range of results: 0 – 500 µg/m³
- Detects fine particulate matter (width of particles < 2.5 microns)
- Can help prevent respiratory and heart conditions that stem from increased exposure to 2.5 particulate matter

**PMS 7003**   **PMS 3003**

Soil Moisture Sensors

- BSI InFlect Moisture Sensor
  - Type: analog
  - Outputs both measured relative humidity and resistance
  - Resistance increases as humidity increases
- YL-69 Soil Moisture Sensor
  - Type: analog/digital
  - Outputs an analog value that decreases as moisture increases
  - Outputs high digital signal if moisture crosses a predetermined threshold

InFlect Moisture Sensor   **YL-69**

IMPLEMENTATION

Particle Device

Firmware implemented in C

Python Subscriber
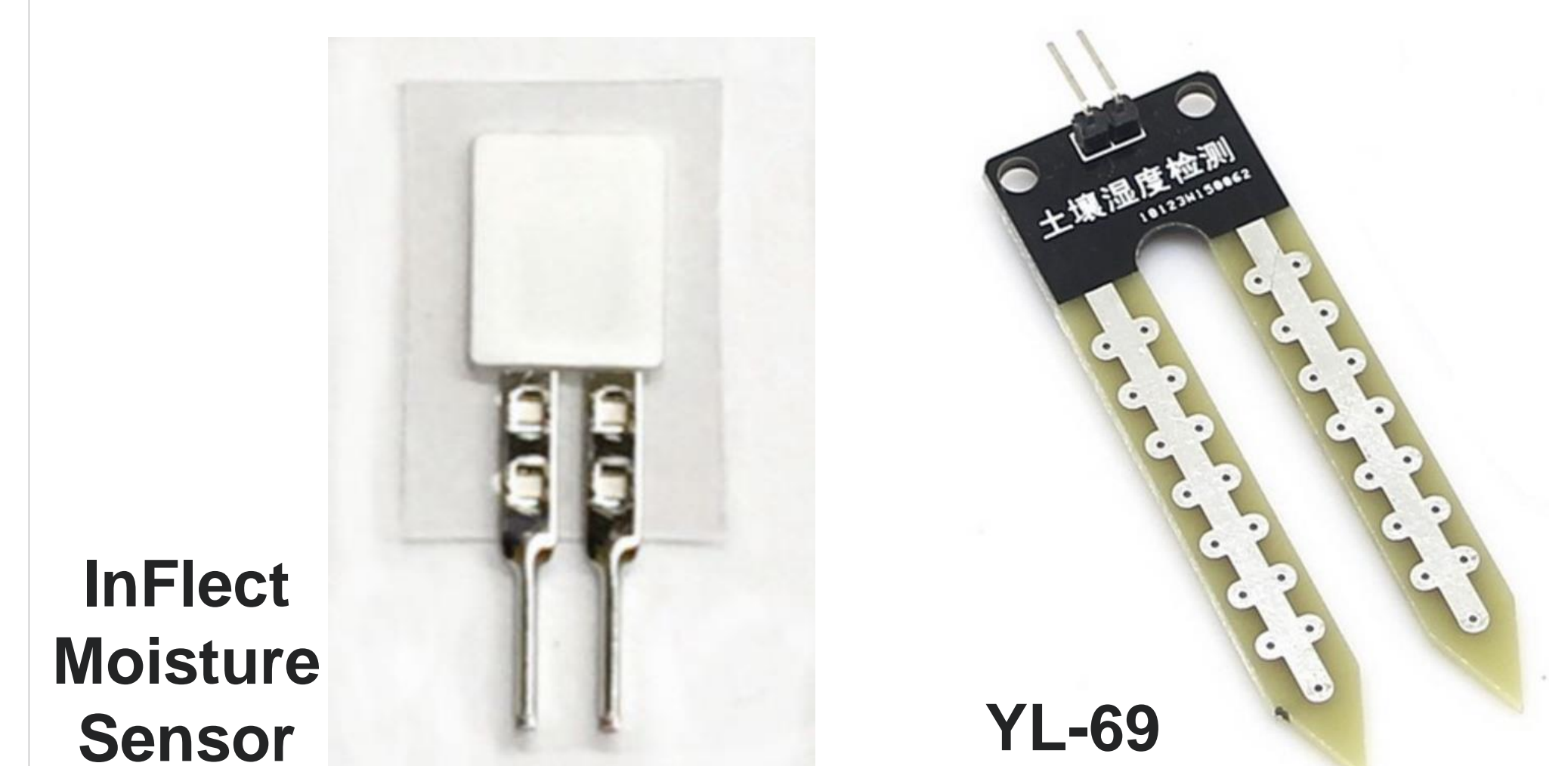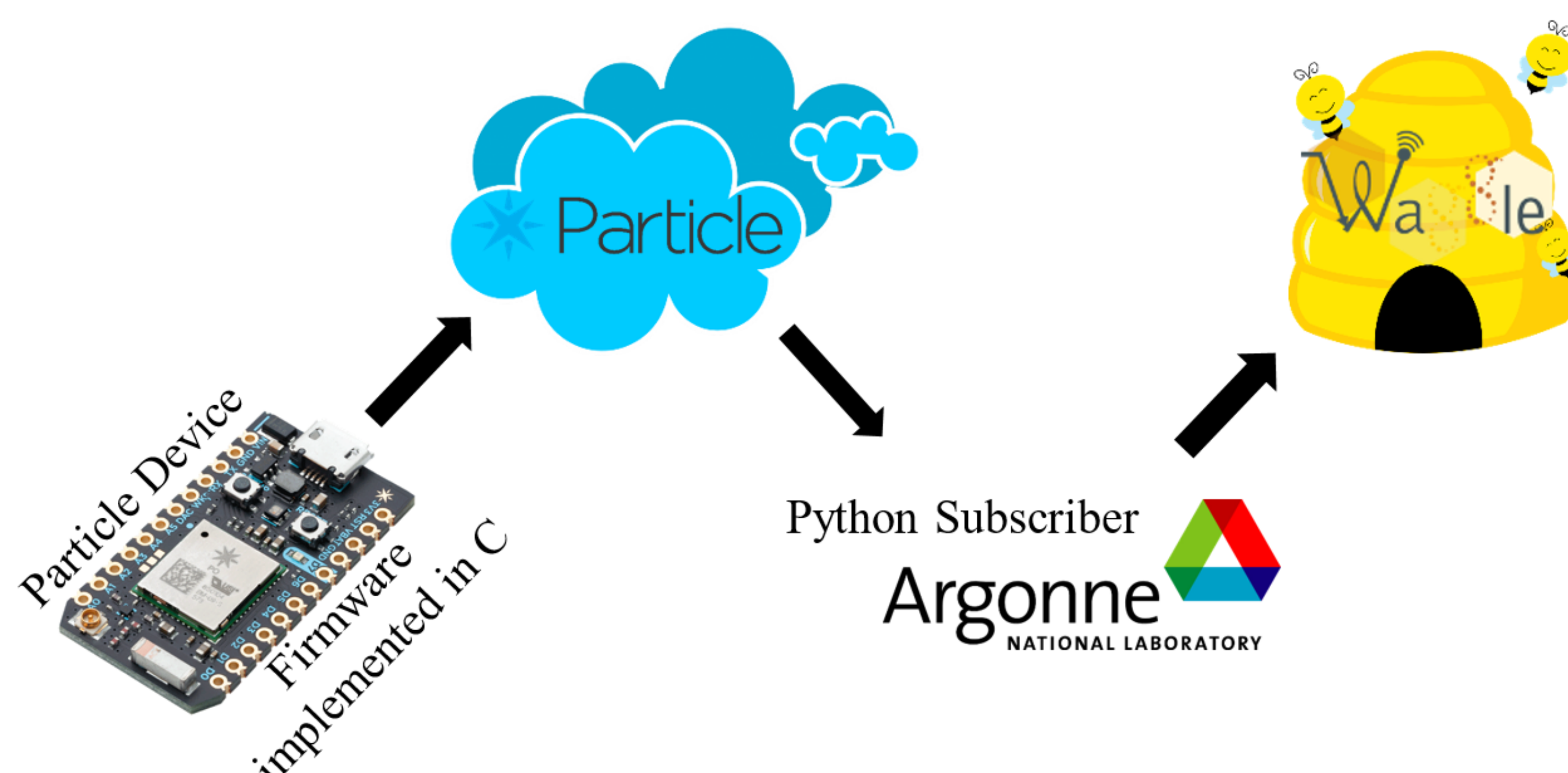
WORK TO BE PERFORMED

- Integrate and test the YHDC SCT013-030 current sensor
  - To be placed around sump pump power cords as an alternative flood detector
- Integrate and test a tipping bucket rain gauge
- Integrate the soil moisture, particle, water level, current, and rain sensors into the Waggle edge-computing platform.

SCT013-030 Current Sensor

Argonne NATIONAL LABORATORY

Abstract

Waggle is an attentive sensing platform that brings together physically distributed Internet-enabled sensing and computing devices, and a cloud-enabled storage, control, and data dissemination infrastructure. The Array of Things (AoT) project uses Waggle platform to support urban-scale, interdisciplinary research and development by employing a network of sensors to provide environmental data about the city of Chicago. Currently, AoT nodes record information on conditions including light intensity, particulate matter, chemicals in the air, and the meteorological parameters of their surroundings. In an effort to expand the breadth of information available through the Waggle platform, we have integrated and tested new commercially off-the-shelf water level, soil moisture, and airborne particulate matter sensors. These devices are connected to one of two commercially available Internet of Things modules, the Photon and the Electron, which, respectively, send information to the Particle cloud over wireless networks and cellular data. A subscriber client pulls the sensors' data off the cloud and directs it towards the Waggle infrastructure. In the coming weeks, we will analyze the data collected thus far, deploy and test a current sensor and rain gauge, and ultimately work towards integrating the new sensors into the Waggle system.