Accelerating Research with AWS IoT

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Intro/Abstract here.

Background

The speed of designing synthetic routes and defining formulations for new drug substances can be limited by the rate at which the data becomes available for decision making. Much of the data is generated by offline laboratory experiments, which requires process sampling, subdividing, transporting and consequently time-consuming sample preparation prior to analysis, in addition to the time to analyze, interpret and report the results. An obvious path to accelerate sample measurements is to increase the number of analyses that can be performed in parallel by either increasing the staff or through automation. Alternatively, the entire process can be shortened by performing the analysis in-situ. This approach, referred to as Process Analytical Technology (PAT), has been used in the pharmaceutical industry for decades, but has been limited to monitoring a few key parameters, most commonly using spectroscopic tools. The advent of miniature, cheap electronics coupled with the Internet of Things (IoT) has opened the possibility of monitoring a wide range of parameters in real-time. The one obstacle that has inhibited the widespread adoption of IoT in the pharmaceutical industry is the lack of a secure, scalable and cost-effective platform that can be used to store, analyze and visualize the data. In this paper, we describe the development of a combination of on-premise and cloud-based IoT platform that can be used to monitor and analyze data from a wide range of sensors. The platform is designed to be scalable, secure and cost-effective, and is demonstrated by interfacing and controlling in real time three commonly used PAT sensors, such as:

1. Level sensor, for process safety applications (generating Boolean data type);
2. pH sensor (generating scalar data type);
3. UV spectrometer (generating array data type).

Architecture

The key to a successful IoT platform is the ability to scale to a large number of devices that can be readily implemented in various processes with minimal experience or training by the end user e.g.: "plug-n-play". This minimal training interface often requires developing custom in-house applications that make calibration, measurement and analysis simple and robust. Moreover, the IoT platform must handle the large amount of data generated by the sensors securely and cost-effectively. One way to achieve this goal is through the use of AWS IoT services and solutions, which allow to connect, collect, store and analyze IoT data for industrial workloads. See Figure 1.

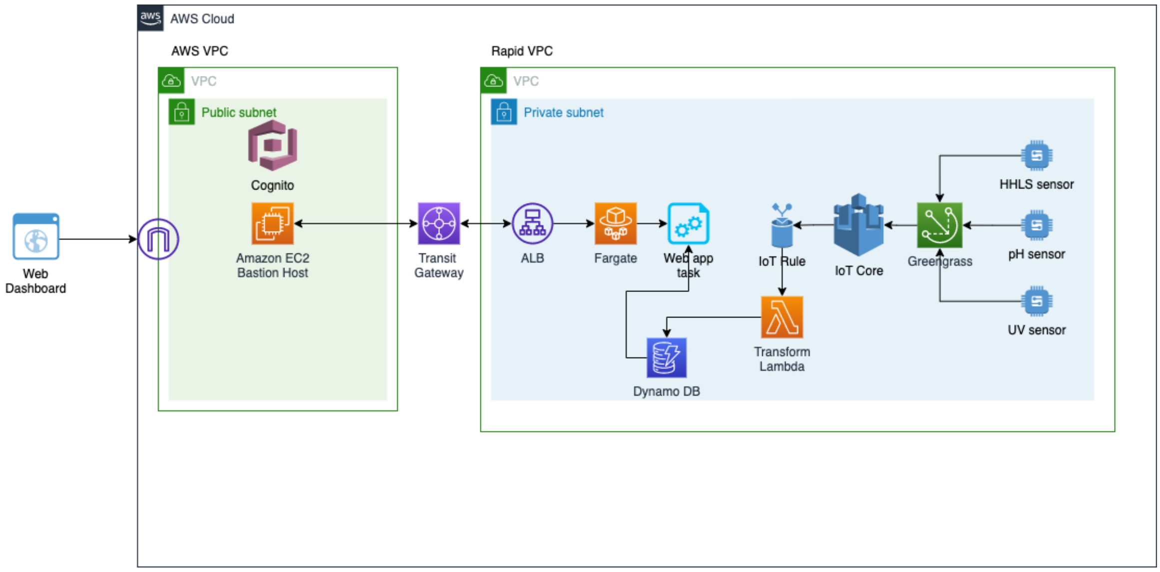

Figure 1: AWS IoT architecture at Pfizer.

Interfacing the laboratory instruments

Each PAT laboratory instruments is connected to a hardware wrapper that aims to convert and exchange the control commands and data from its native protocol into a standard-based messaging protocol, MQTT. AWS provides native support for a managed MQTT broker, through its IoT Core service. Messaging structure is Sparkplug™ specification 1

Listing 1: Example of MQTT payload following Sparkplug™B.

```
{
  "timestamp": "1701199950000",
  "seq": 14,
  "metrics": [
    {
      "name": "status",
      "timestamp": "1701199950000",
      "dataType": "Uint32",
      "value": 0
    },
    {
      "name": "level_high",
      "timestamp": "1701199950000",
      "dataType": "Uint32",
      "value": 0
    }
  ]
}
```

Data visualization and instrument control

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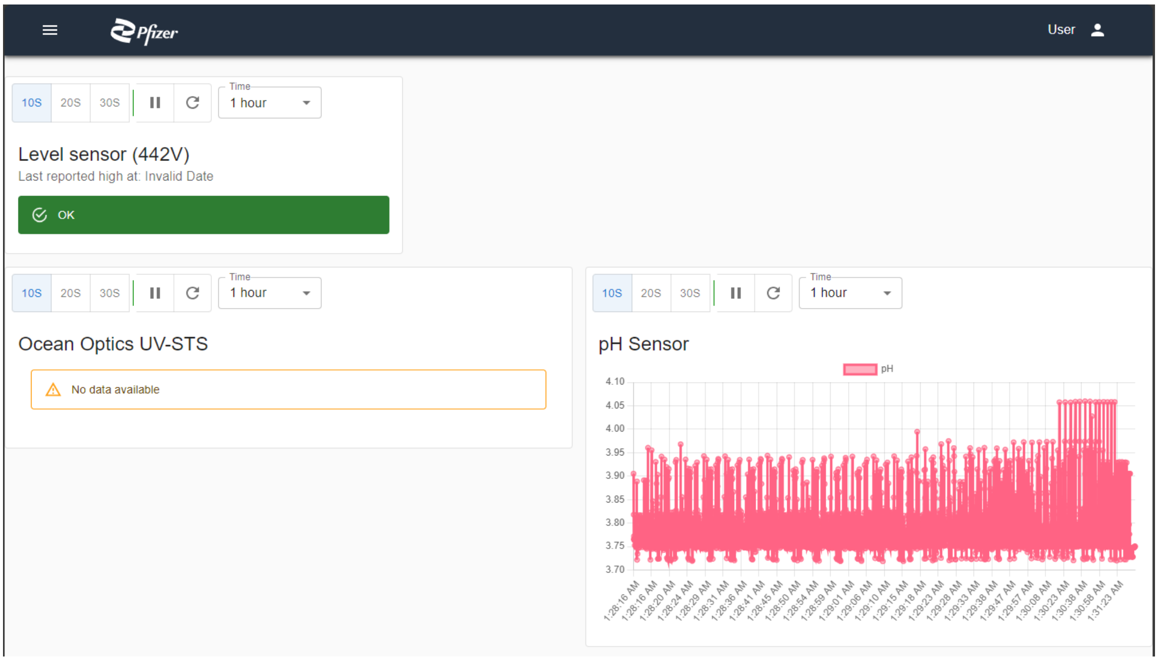

Figure 2: Data visualization web app dashboard.

Conclusions

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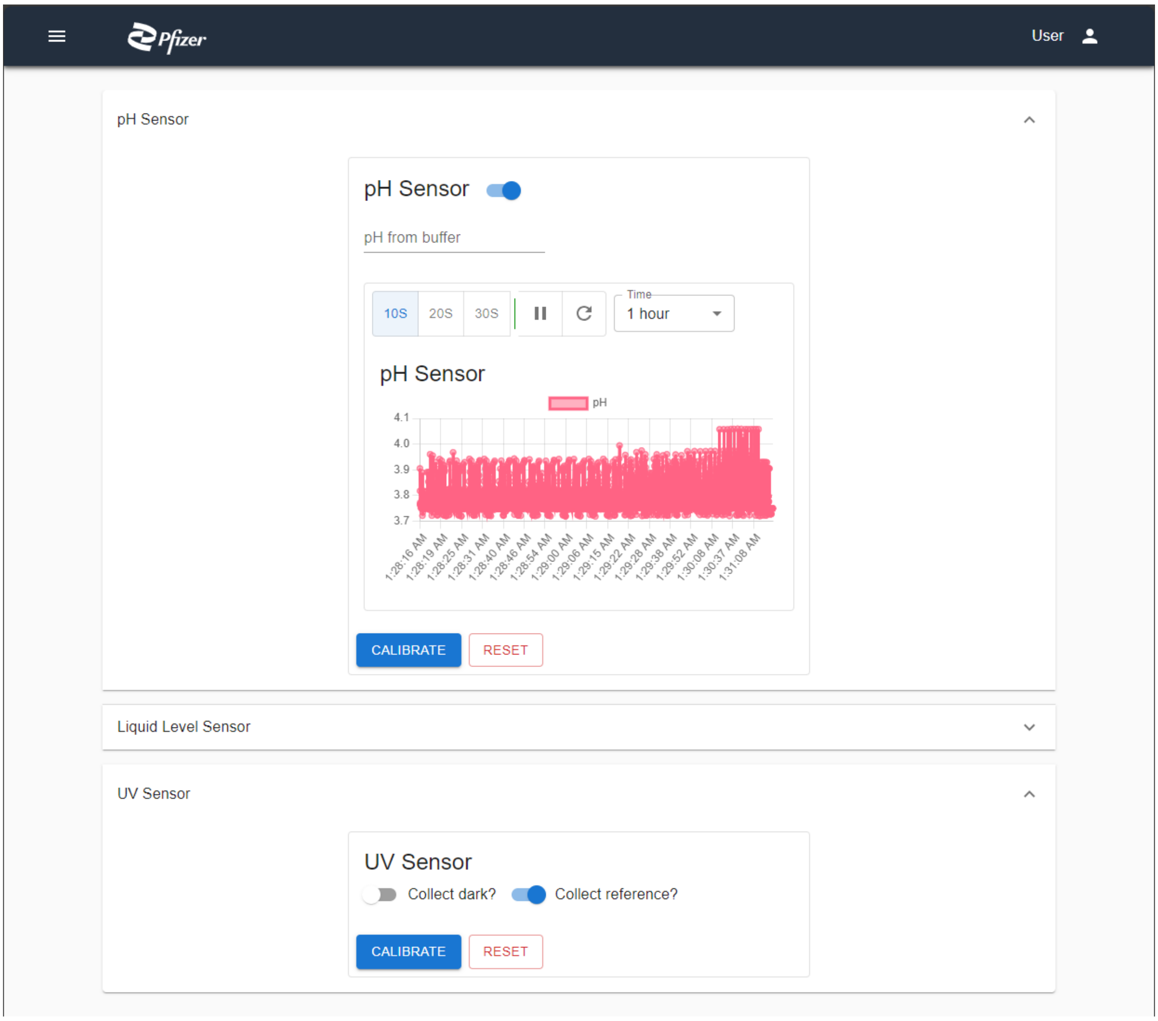

Figure 3: Instrument calibration panel withing webapp.