WHITE PAPER

Developing IoT Solutions with AWS IoT Platform

Internet of Things (IoT) is a widely-used industry buzzword offering significant transformation opportunities for businesses.

An IoT Platform is middleware software and considered as the “plumbing” of IoT. Multiple IoT Platform as a Service (PaaS) vendors offer it as a service, providing ready-to-use software components that can be customized to suit IoT applications with minimal effort.

AWS® IoT is considered as a leading IoT PaaS provider. We review the different AWS IoT services and how they can be used to develop IoT solutions.

THINXTREAM®

Introduction

Internet of Things (IoT) platform is the supporting software that connects devices, networks, and end-user applications. It enables IoT applications involving provisioning, connectivity, monitoring, and automation of connected devices from diverse sources.

Among the several IoT platforms in the market today, the one offered by AWS stands out due to its feature-rich portfolio and significant customer base. AWS IoT provides “Platform as a Service”, which enables billions of devices to securely interact with themselves as well as applications residing on cloud.

In this white paper, we analyze the different components and reference architecture of a typical IoT platform and how the AWS IoT platform realizes them through its managed services.

IoT Platform

An IoT platform is the key to the development of scalable and secure IoT solutions and services. For developers, an IoT Platform provides a ready-to-use scalable and secure platform, which can help in the faster development of IoT applications and the services underneath for connected devices.

Components

A true, end-to-end IoT platform consists of the following high-level building blocks.

- **Connectivity**: Provides one single software interface to collect data from diverse connected devices communicating different protocols and data formats.
- **Fleet Management**: Provides provisioning, configuration and software/firmware updates functionality on devices and edge gateways.
- **Storage**: Brings scalable storage, which can handle the volume, variety, velocity and veracity of billions of messages from connected devices.

- **Rule Processing**: Triggers actions against incoming messages based on configured rules. It can also route messages to configured destinations.
- **Analytics**: Derives insights from the IoT data-stream by doing a range of analytics from simple aggregation to predictive analytics, anomaly detection and other machine learning algorithms.
- **Visualization**: Provides tools to visualize IoT data in the form of various charts. This enables human operators to derive meaningful outcomes from patterns and trends.
- **External Interfaces**: Enables end-to-end operations of the IoT systems with business connectors that integrate the underlying functionality of the IoT platform tier with business functions including ERP, CRM, service lifecycle management, billing and payment, work planning and scheduling systems.
- **Development & Test Tools**: Provides stacks and libraries for interacting with the IoT platform to rapidly build prototypes and products.

Reference Architecture

A typical IoT architecture has several components that interact with each other to collect data from IoT devices, process them and store the data.

Devices communicate with the IoT infrastructure directly, if they are capable or via a field gateway commonly referred to as Gateway. A single gateway can collect data from one or more devices and securely send/receive data from the cloud IoT infrastructure.

A Device Gateway on the cloud side facilitates secured data communication between devices/gateways and cloud IoT servers. The Device Registry stores the device information and maintains the state and device data in it. Stream Processors ensure that large amount of input data is streamed to storage or to the analytics/machine learning engines.

Applications and different business systems can use the data available in the storage or processed by analytics and machine learning using application interfaces or business integrators to achieve different business goals.

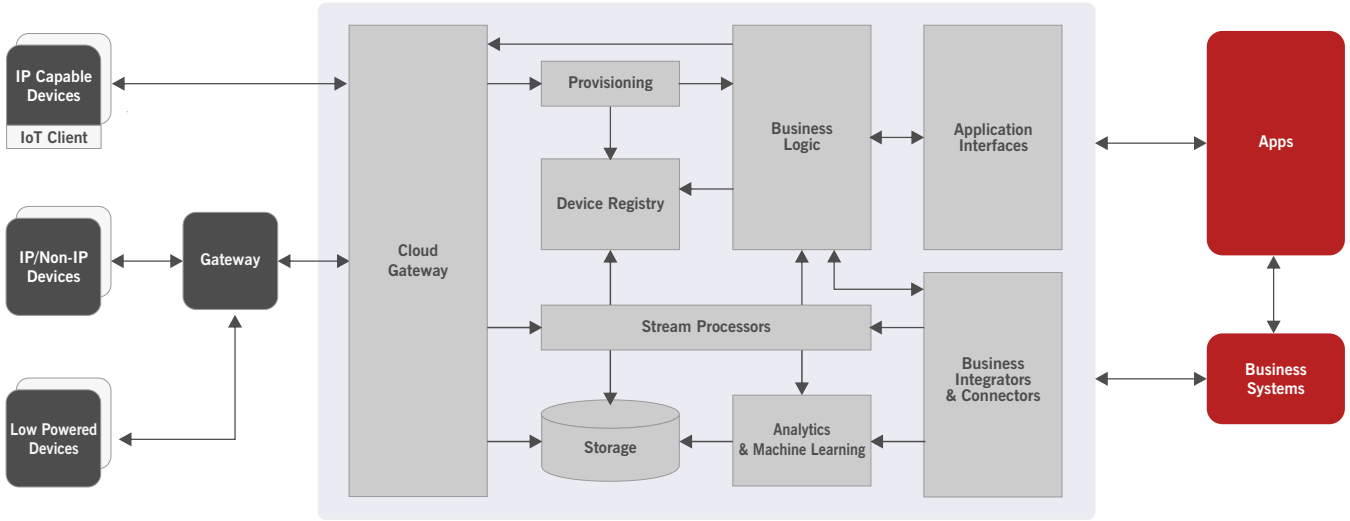

Figure 1. Typical IoT Reference Architecture

AWS IoT Platform

In October 2015 AWS announced the availability of its IoT platform. AWS described it “as a managed cloud platform that lets connected devices easily and securely interact with cloud applications and other devices”. AWS claimed that their IoT platform can scale to billions of devices and trillions of messages and can process and route those messages to AWS endpoints and to other devices reliably and securely.

Solution Components

The AWS IoT platform in its core includes a device gateway, a rule-based engine, a registry where you keep device properties such as location and also a feature that AWS calls Device Shadows, which lets one track data about devices when they are offline and sync it back with the system once they are back online.

Here, we review some of the features of key components of AWS IoT and their usage in IoT solutions.

AWS IoT Core: AWS IoT Core® provides secure and scalable bi-directional connectivity to all connected devices. It can receive, route, process and act on the messages from the devices. You can also develop and deploy applications that can talk to devices even when they are offline. These messages for offline devices are cached and delivered when they are back online. Messages received can be routed to AWS services like Amazon S3®, Amazon DynamoDB®, Amazon Kinesis® and AWS Lambda® using rules configured in SQL syntax. By writing custom logic in Lambda function, the application can trigger actions on devices.

AWS IoT Device Management: This enables configuring device types, onboarding and provisioning them in bulk. It maintains a registry of device information like authentication info, serial number, service tag, model, etc. In a separate data structure called AWS IoT Device Shadow, it maintains dynamic state information such as running state of the device, firmware, temperature, RPM, etc. It lets you query devices based on both static and dynamic attributes in real time. It provides service to diagnose and troubleshoot issues and perform OTA upgrades for either the entire fleet of devices or an individual device.

AWS IoT Device Defender®: This service continuously monitors devices fleet for any abnormal behaviour that might indicate a potential security issue and alerts a configured user. This could include excessive outbound traffic from the device, traffic to an unauthorized server, etc. On receiving an alert, the user can initiate a corrective action such as blocking the device, doing a security update, etc.

AWS IoT Events: AWS IoT Events® helps in easy evaluation of multiple sources of telemetry data to detect the state of processes, equipment or products quickly, send alarms or alerts to support teams, trigger actions and schedule maintenance.

AWS IoT SiteWise: AWS IoT SiteWise® helps to gather data reliably from multiple facilities, structure it, and make it accessible and understandable—without developing additional software. You can query information and metrics about equipment or processes across multiple facilities, so that it is readily available for applications.

AWS IoT Things Graph: AWS IoT Things Graph® provides reusable models representing devices

and Web services. It bridges differences in low-level details such as communication protocols and proprietary interfaces. Using IoT Things Graph, IoT applications can be created by combining models using a visual interface.

AWS IoT Greengrass: AWS IoT Greengrass® is a software stack that enables local computing and data caching in a secure way. With this, IoT devices can respond quickly to local events, operate with unreliable network connections, and also selectively send critical data to the cloud and in the process save cost. Advanced functionality such as AWS Lambda, AWS ML can be deployed on the Greengrass enabled device for local intelligence.

FreeRTOS: AWS also provides a free, open-source FreeRTOS® for low power devices, which can talk directly to AWS Cloud as well as through Field Gateways running AWS Greengrass. It also provides services such as safe custody of security credentials and transport layer encryption.

AWS IoT Analytics: AWS IoT Analytics® provides actionable insights from large volumes of IoT data. Like in a typical data pipeline, AWS provides services for filtering, transforming, enriching,

storing and analyzing the IoT data. Users can use familiar SQL style queries and visualize the outcome using Amazon Quicksight®. AWS also provides sophisticated Big Data platforms such as Amazon EMR® and Amazon ML® services on top of this data.

AWS IoT Device SDK: The AWS IoT Device SDK helps to connect devices easily and quickly to AWS IoT Core. With the SDK, devices can connect, authenticate, and send/receive messages using the MQTT, HTTP, or WebSockets protocols. Developers can use languages such as C, C++, Java®, JavaScript™ and Python® to write IoT modules on devices. It provides open-source libraries, developer guides with samples, and porting guides to help build innovative IoT solutions on varied hardware.

Solution Architecture

AWS IoT provides a complete ecosystem for IoT and provides multitude of services for stream processing, storage, analytics and machine learning.

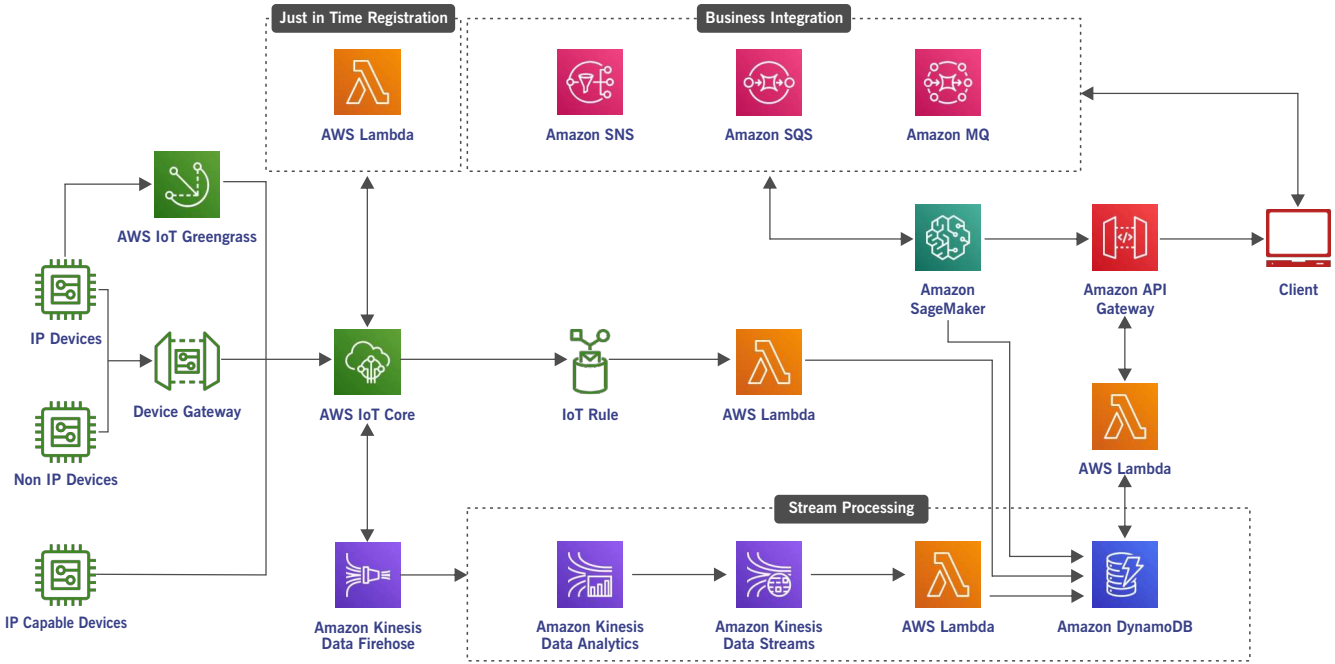

Figure 2. AWS IoT Solution Architecture

The typical solution architecture in Figure 2 shows how different AWS IoT services can be used together to achieve a full-fledged IoT application that collects data from devices stores, analyses and applies machine learning.

In a typical solution implementation, the IoT Device SDK is used to enable IP devices to connect to the AWS IoT service, while AWS Greengrass or a custom Gateway is used to connect non-connected device(s) or a group of connected devices to the AWS IoT service.

The AWS IoT device gateway authenticates and authorizes device messages and stores state of the devices in AWS IoT Device Shadow and Registry. The AWS IoT Rules Engine is used to apply appropriate rules and forward the messages to the AWS serverless Lambda computing. Amazon Kinesis Firehose® is leveraged to encrypt and compress the data in a suitable format for storage in Amazon Dynamo DB, while Amazon Sagemaker® enables machine learning on the telemetry data and inference outputs to be stored in the database.

External applications connect to the AWS IoT solution via REST APIs exposed in API Gateway, which authorizes access to compute Lambdas. AWS AppFlow® helps in integrating different business systems.

As can be seen, AWS IoT offers comprehensive tools to build IoT applications that can start simple and grow in functionality and scale.

Pricing

Like other AWS services, the AWS IoT platform too is metered on the basis of a pay-per-use model. For instance, for basic IoT functionality, prices are based on the number of messages published to AWS IoT (Publishing Cost), and the number of messages delivered by AWS IoT to devices or applications (Delivery Cost). AWS, however, does not charge for delivering to certain AWS services like Amazon S3, Amazon DynamoDB, Amazon Kinesis and AWS Lambda.

Typical AWS IoT pricing is computed based on the following factors.

- **Connectivity**: Total time devices are connected to AWS IoT Core. This is metered in minutes.
- **Messaging**: Messaging is metered by the number of messages transmitted between the devices and AWS IoT Core.
- **Device Shadow & Registry**: AWS IoT Device Shadow and Registry is metered by the number of read and write operation on Device Shadow or Registry data.
- **Rules Engine**: AWS IoT Rules Engine use is metered for the number of times a rule is triggered and number of actions executed within each rule.

Conclusion

IoT comes with its own challenges of scale, diversity, connectivity, privacy, security and regulatory compliance. There are many IoT platforms which promise to deliver easily customizable software components as “Platform as a Service” to solve these challenges. These pay-per-use platforms enable the quick implementation of low-cost proof of concept IoT solutions without writing code and extension to production quality and scalable solutions, which can connect to millions of devices.

AWS IoT is considered as a leader in IoT PaaS space and offers a gamut of pay per use services for building powerful IoT solutions.

As an IoT services provider, Thinxtream has delivered quality IoT solutions based on AWS IoT. By leveraging the IoT expertise built over a decade, Thinxtream ensures cost-effective, quality and timely delivery of IoT solutions.

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Thinxtream Technologies is a global software company with a portfolio of innovative software platforms, components, solutions, patents, competences and services for Internet of Things (IoT) across several industry verticals and applications, successfully enabling leading customers, including Fortune 500 companies, meet their application, product and business goals.

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