CLOUD PLATFORMS FOR THE INTERNET OF THINGS: HOW DO THEY STACK UP?

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About Me!

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• Networked Embedded Software Lab, PoliMi
• Internet of Things Enthusiast
• First timer at an Open Source event
Goals for this talk

- Why do we need Cloud Platforms for Internet of Things?
- What are some of the cloud platforms out there?
- What are the parameters we use to analyze these platforms?
- How do we choose a platform in a use-case scenario?
- Do open source platforms really stand out?
Outline:

INTRODUCTION TO IOT AND CLOUD PLATFORMS
MOTIVATION FOR THE TALK
ARCHITECTURAL DESIGN CHOICES
PARAMETERS FOR COMPARING CLOUD PLATFORMS
INSIGHT INTO SOME CLOUD PLATFORMS
USE CASE SCENARIO
COMPARING THE PLATFORMS
CONCLUSION
IoT: Growing Bigger, Getting Smaller
Evolution of the Internet of Things
Motivation for Cloud Platforms in IoT

• Large number of connected devices, how to store the data?
• Difficulty to process large sets of data locally
• Base Station storage and processing limited
• Lack of remote access to the data
• Need for Cloud Platforms to address these issues
The Downside?

- Storing and extracting data from the cloud incurs delay
- Data Center might be geographically remote
- Delay can be quite significant for sensing-actuation applications
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The IoT Architecture

Sensors and Actuators

Gateway

Cloud Platforms
Where do I come in?

- Circo Massimo requires regular maintenance and monitoring
- Archaeologists from Univ. of Trieste are monitoring the site
- They wanted to improve their monitoring with the ‘Internet of Things’
What did they need?

- Data from the sensors deployed on site
- Being able to visualize the data for a given period
- To be able to show the data to others
- Get statistical measures on the data on given periods
What does a Cloud Platform for IoT offer?

- Storage
- Processing
- Remote Access
Optionally!

Visualization

Libraries for IoT devices

#include

Triggers

A

B
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Architecture: Gateway Based

nodeID = 1

nodeID = 2

nodeID = 3

All Nodes

Cloud Platform

‘Things’

Gateway
Architecture: Bypassing the Gateway

nodeID=1
nodeID=2
nodeID=3

‘Things’

Cloud Platform
Architecture:

**Gateway-based**

- Energy efficient for the devices
- Cloud platform agnostic to device-gateway communications
- Cloud platform sees fewer devices
- Granularity compromised
- Gateway single point of failure

**Bypassing the Gateway**

- Granularity of data sustained
- Easier management of the network from the cloud
- Higher energy consumption for devices
- Variable latency for devices
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How to judge the Cloud Platforms?

• Protocol used
• Type of service (X-aaS)
• Openness of the platform
• Libraries for platforms

• Cost
• Authorization Policies
• Privacy of data
Protocols Used

• Request Response Model
  • Constrained Application Protocol (CoAP)
  • Hyper Text Transfer Protocol (HTTP)
  • Example: Xively, SenseIoT, Thingspeak, IBM IoT, Amazon AWS IoT

Hey, it’s -11°C, I’m freezing

Cloud Endpoint
‘storedata.here.com’

Hey, it’s -11°C, I’m freezing

How is Pi doing?

Cool, got that!

Freezing!

Gateway

User/Application
Protocols Used

- **Message Passing Model**
  - Advanced Message Queuing Protocol (AMQP)
  - Message Queuing Telemetry Transport (MQTT)
- Example: Amazon AWS, Microsoft Azure IoT, IBM IoT, SicsthSense

Let’s talk about the weather in Berlin, it’s pleasant!

Really? That’s nice

You wanted to know about Berlin? It’s pleasant

Message Publisher

Message Broker

Temperature/Berlin

Message Subscriber
Openness of Platforms

- **Closed Platforms:**
  - Most commercial platforms are closed
  - The platforms are hosted by the company themselves
  - Services are paid and limited by the prices for the services
    - Example: Amazon AWS, Azure IoT, IBM IoT

- **Open Source Platforms:**
  - The platforms are available for contribution from the community
  - Can be locally hosted on own hardware
    - Example: Sparkfun, SicsthSense, Parse
Type of Service Offered (X-aaS)

• **Platform as a Service (PaaS)**
  • Service offers a platform that can be used for development
  • Parse, Xively, Phant, Amazon AWS, Azure IoT, IBM IoT, Sparkfun, Ubidots

• **Software as a Service (SaaS)**
  • Service offers a software which is being hosted remotely
  • Element Blue, Devicify

• **Infrastructure as a Service (IaaS)**
  • The service offers storage, hardware, server, as well as software
  • IoTSens, offering IaaS for smart cities
Cost

Number of messages (AWS IoT, SenseIoT)

Number of devices (IBM Watson IoT)

Storage (Azure)

Visualization (Ubidots)
Authorization

User name and Password (SenseIoT)

Authorization Certificates (AWS IoT)

API Keys (Xively)

ACL | Device 1 | Device 2
---|---|---
Resource 1 | ✔ | ✔
Resource 2 | ❌ | ✔
Libraries

- Makes cloud platforms easier to use
- Offers various utilities and methods to access the cloud platform
- Offered in various languages and device platforms

Client Devices

Server Applications
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Amazon: AWS IoT

- Platform hosted by Amazon, offers subscription to services
- Multiple protocol options offered: MQTT, HTTP, Web Sockets
- Offers data aggregation from the devices
- For processing and storing data, additional modules are required
- Data reception can be used as a trigger to these modules
Amazon: AWS IoT

• Additional Modules:
  • AWS Lambda: Adding cloud code to triggers
  • DynamoDB: NoSQL database for storage
  • CloudWatch: For monitoring the services
  • S3: Storing the data in files

• Modules entail additional costs based on usage
Sparkfun (Phant)

- Open Source Data logging platform for IoT
- Source code available for hosting
- Also hosted on data.sparkfun.com, free to use
- REST API based interaction model
- Data published to data-streams accessible by API
Sparkfun: Where does it differ?

- In development stages
  - Data published to data.sparkfun.com is open
  - Can be accessed by anyone with the URL
  - Tradeoff: Does it matter for your specific application?

- Limits on number of requests
  - 100 log requests for 15 minutes
  - Not limited by costs, but a parametric limit set by the platform
**Parse: Open to the World**

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**Migrating an Existing Parse App**

The Parse hosted service will be retired on January 28, 2017. If you are planning to migrate an app, you need to begin work as soon as possible.

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**RECOMMENDED TIMELINE**

1. April 28, 2016
   Data migrated to a self-hosted MongoDB.

   Finish setting up your self-hosted Parse Server and release a new app pointing to it.

3. January 28, 2017
   Parse shutdown.
What does Parse offer?

• Open source server is offered for cloning and hosting
• Based on REST API, communication based on objects
• Open source libraries for embedded devices and other data sources
• Libraries offered in C, Python, JavaScript, Java, .NET
Parse: How does it stand out?

- **Cloud Code**
  - Functions on Parse Cloud, can be invoked remotely
  - Can be leveraged to create WebHooks and Triggers

- **Live Query**
  - Subscription based model for getting updates on objects
  - Flexibility to set cache and websocket timeouts

- **Offers the option to send push notifications to clients**
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Use Case: Circo Massimo
The Deployment:

- LDR Sensor
- Temperature Sensor
- CO2 Sensor
- Soil Temperature Sensor
- Humidity Sensor
- Libelium Mote
- 802.15.4
- Serial
- Libelium Gateway
- Raspberry Pi
- WiFi
Deployment:
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Connecting to the Cloud: Parse

- Locally hosted on a server
- Data gathered over REST API and JavaScript SDK
- Visualization: Use Cloud Code to send data to Freeboard
- Visualization of data in the form of widgets
- Basic statistical operations: Implemented on Cloud Code
- Sharing the data: Share the dashboard for particular sensor
Connecting to the Cloud: Sparkfun

- Data sent from the gateway to the datastreams over HTTP
- Data stored in the form of JSON Objects
- Statistical Operations: Can be done by querying the stream
- Data Visualization using Google Charts Library
- Sharing the Data: Can be achieved by using PUBLIC_KEY
- Only Read access on datastreams using PUBLIC_KEY
Connecting to the Cloud: Amazon

• Connect to Amazon’s endpoint for IoT devices
• Data gathered over MQTT and Python
• Action based on message received:
  • Insert to Database (DynamoDB) using AWS Lambda
  • Visualize data using AWS Cloud Watch
• Basic statistical operations: Scripts on AWS Lambda
• Visualization with Amazon QuickSight (in future!)
• Cost becomes a major factor: Pay per usage
### Comparing these platforms:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Amazon (AWS IoT)</th>
<th>Parse Platform</th>
<th>Sparkfun (Phant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosted by organization?</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Can be locally hosted?</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Protocol Used</td>
<td>MQTT</td>
<td>HTTP (REST)</td>
<td>HTTP (REST)</td>
</tr>
<tr>
<td>Installation Cost (Hosting)</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Usage Cost</td>
<td>As Per Use</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Libraries</td>
<td>CLOSED</td>
<td>OPEN-SOURCE</td>
<td>OPEN-SOURCE</td>
</tr>
<tr>
<td>Modify Platform</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Cloud Code</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
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Why go for Open Source?

• **Cost**
  - Only pay for hosting the server
  - Estimation of total cost easier
  - No price driven limits for number of messages/devices

• **More control**
  - Fine tune platform parameters according to requirements

• **Flexibility**
  - Want to change something you don’t like?
  - Contribute and improve the platform

• **Simplicity**: Connect the modules and voila!
Closed platforms: When to use?

- Tradeoff between operational and setup cost
- In certain cases, setup cost > operational cost
  - Sparse data generation, handled in free tier
- Complex operations on data, requires complex modules
- Stringent data privacy and authorization measures
- Lack of expertise to setup an open source platform
Conclusion:

• Choosing a platform is not an easy task, there are many available

• Narrow down requirements, ask the right questions!
  • What kind of protocol suits my use case?
  • How frequently do I need to send messages to the platform?
  • How much storage do I need?

• Open source platforms offer flexibility and simplicity
  • Catch: I have to host it myself!

• Is it worth paying for a commercial/closed platform for my requirements?
• There is no single answer to these questions, there are always tradeoffs!
SUGGESTIONS AND QUESTIONS!

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