CPSL
Cyber-Physical Systems Laboratory

Cloud Tutorial: AWS IoT

CSE 521S Fall,
Aug. 29, 2019
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Washington University in St.Louis

Pointers

- Amazon IoT
  - http://docs.aws.amazon.com/iot/latest/developerguide/what-is-aws-iot.html
- Raspberry Pi
  - https://www.raspberrypi.org/
- Resource list for course projects
  - http://cps.cse.wustl.edu/index.php/List_of_Projects
- Apply for $40 credits for Amazon AWS
  - https://aws.amazon.com/education/awseducate/apply/

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XaaS: Basics in Cloud Computing

Cloud Computing

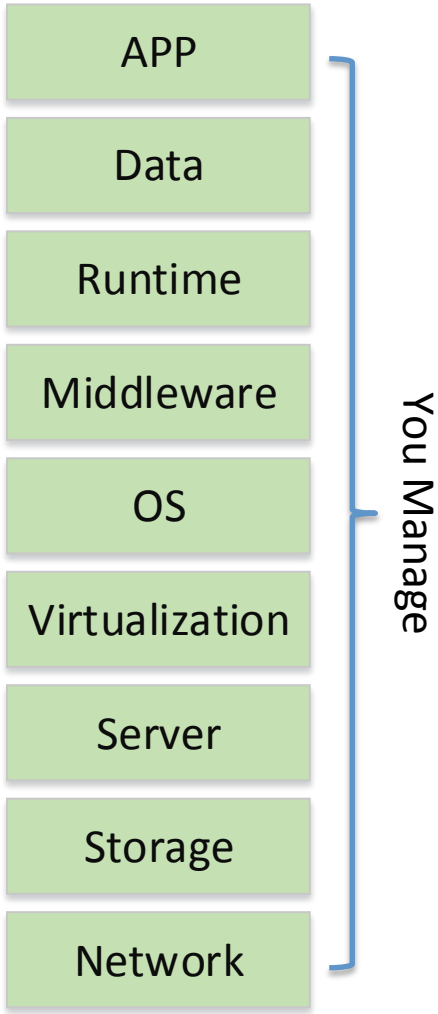
- Cloud computing provides **shared pool of configurable computing resource** to end users on demand
- Three service models
  - **IaaS (Infrastructure as a Service):** virtual machines, storage, network …

  - **PaaS (Platform as a Service):** execution runtime, middleware, web server, database, development tool …

  - **SaaS (Software as a Service):** email, virtual desktop, games …

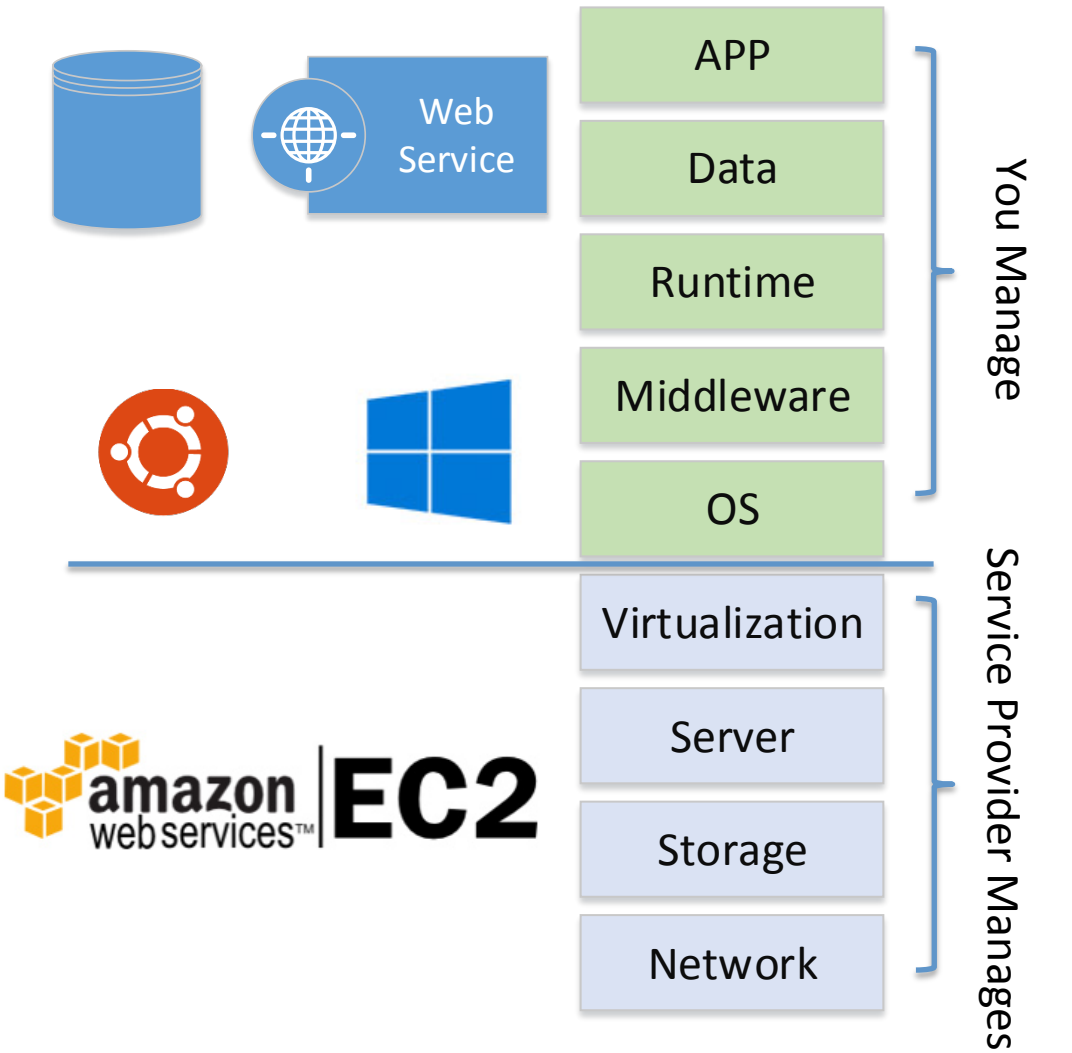
~~Cloud Services~~: On-premise Software

- Traditional
- installed and runs on personal computer
- You Manage and Deploy
  - Hardware
  - OS
  - Software
- Example
  - This presentation



Infrastructure as a Service (IaaS)

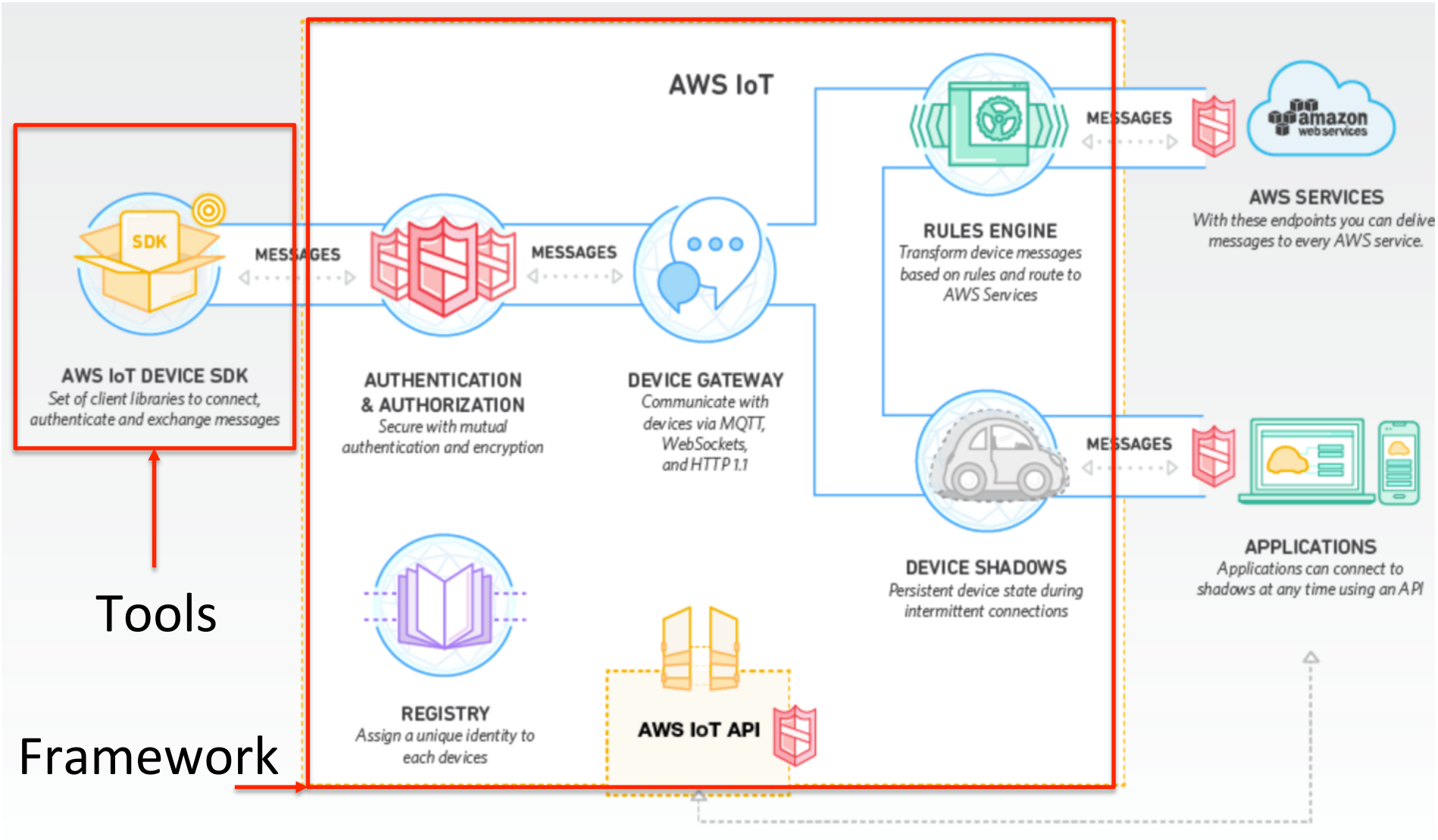
- IaaS
  - "physical server box"
  - Virtual Machine
    - Memory
    - Storage
    - CPU
    - Network
- Example
  - AWS EC2
  - AWS EFS
- Use case
  - Build up you VM cluster



Platform as a Service (PaaS)

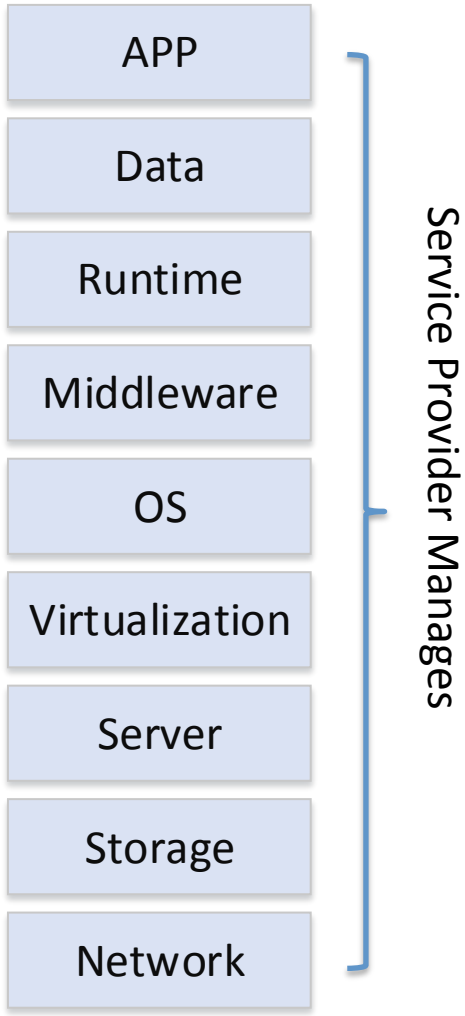
- PaaS
  - You get a framework
  - Host Application
  - Tools
- Example
  - AWS IoT
- Use case
  - Build up you're smart A/C controller

PaaS Example: Amazon IoT

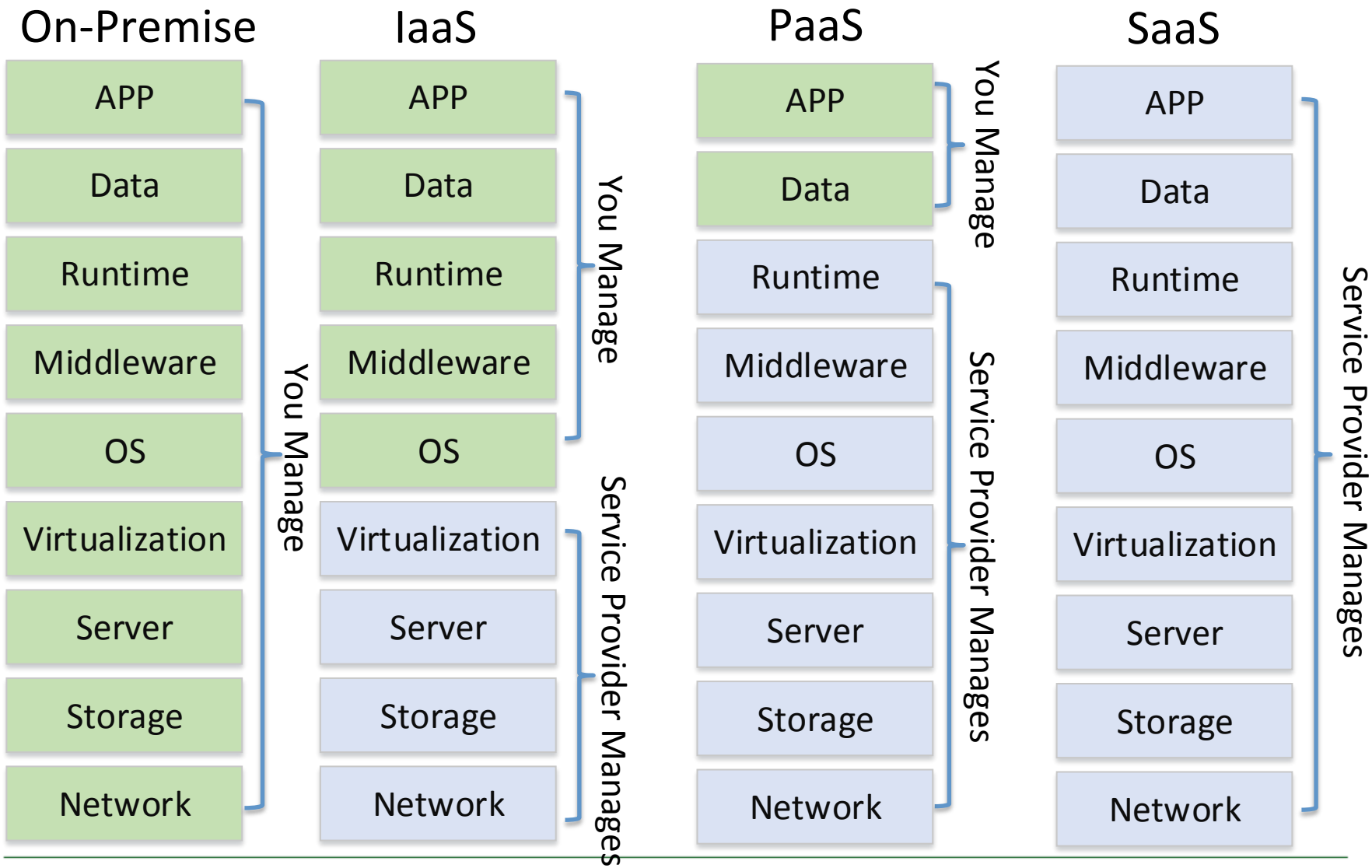


Software as a Service (SaaS)

- SaaS
  - You get a whole solution
- Example
  - Gmail
  - Dropbox
  - Office365
  - Stadia



XaaS: A Recap


On-Premise
IaaS
PaaS
SaaS
APP
Data
Runtime
Middleware
OS
Virtualization
Server
Storage
Network
You Manage
Service Provider Manages

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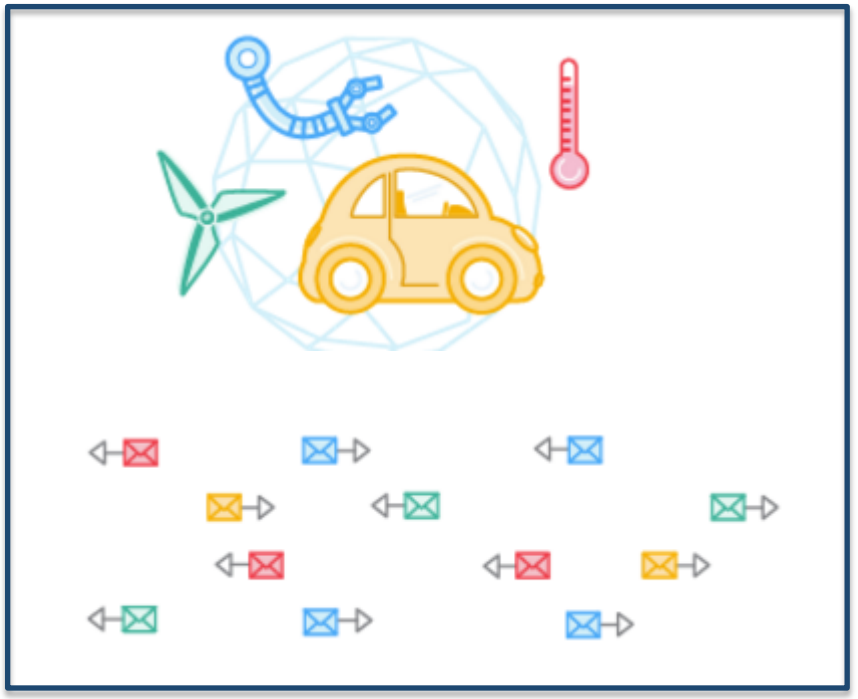
Tutorial: Hello! AWS IoT!!

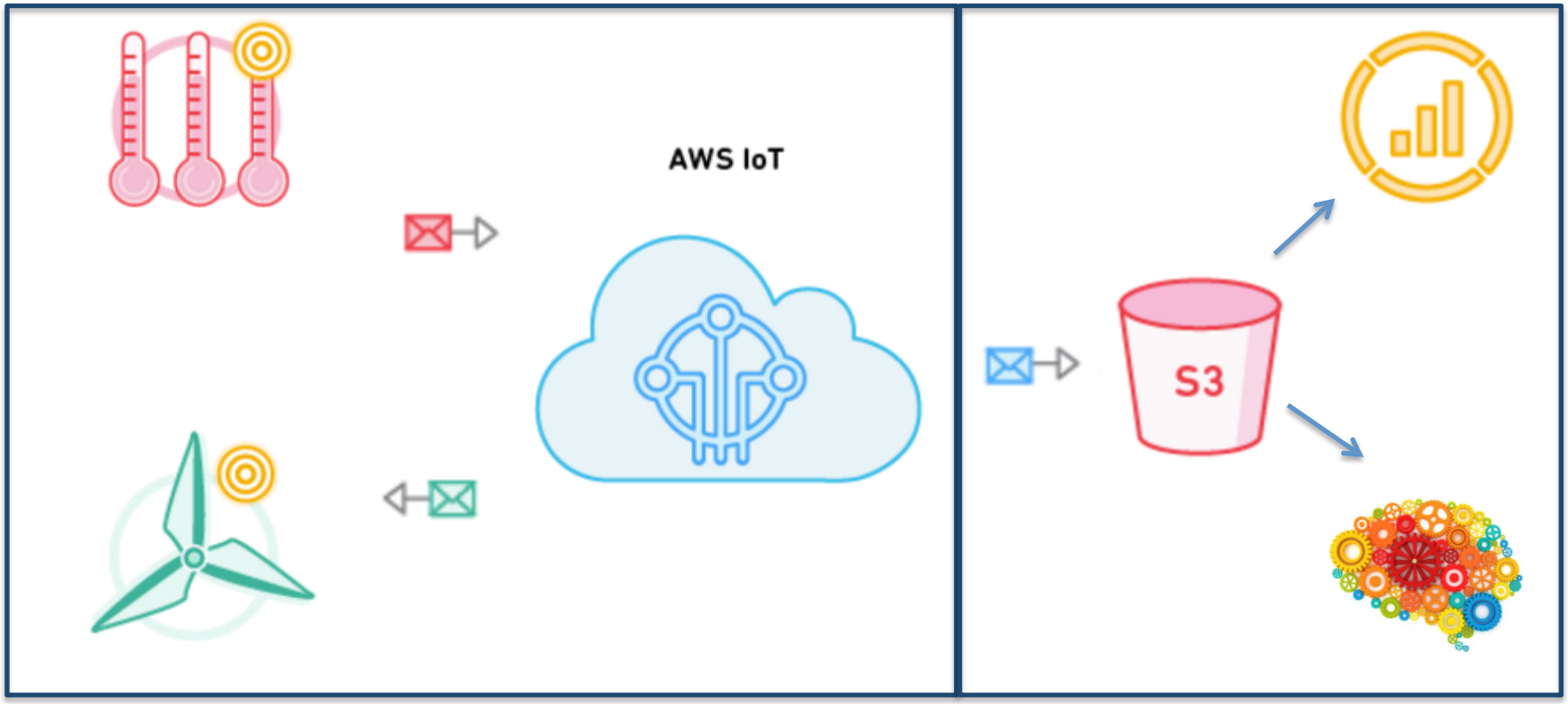
Internet-of-Things

- Things (Devices)
  - Many of them
    - Different Types
    - Isolated Systems
  - Data and Command
    - Sensing the world
    - Give Response
  - Challenge
    - United: Connected + Communication
    - Smart: Data Analytics + Strategy



Source: https://aws.amazon.com/iot-platform/
http://www.brain-smart.net/smart-brain-health-blog/page/2/#axzz4W4oSp8a6

Solution: AWS IoT

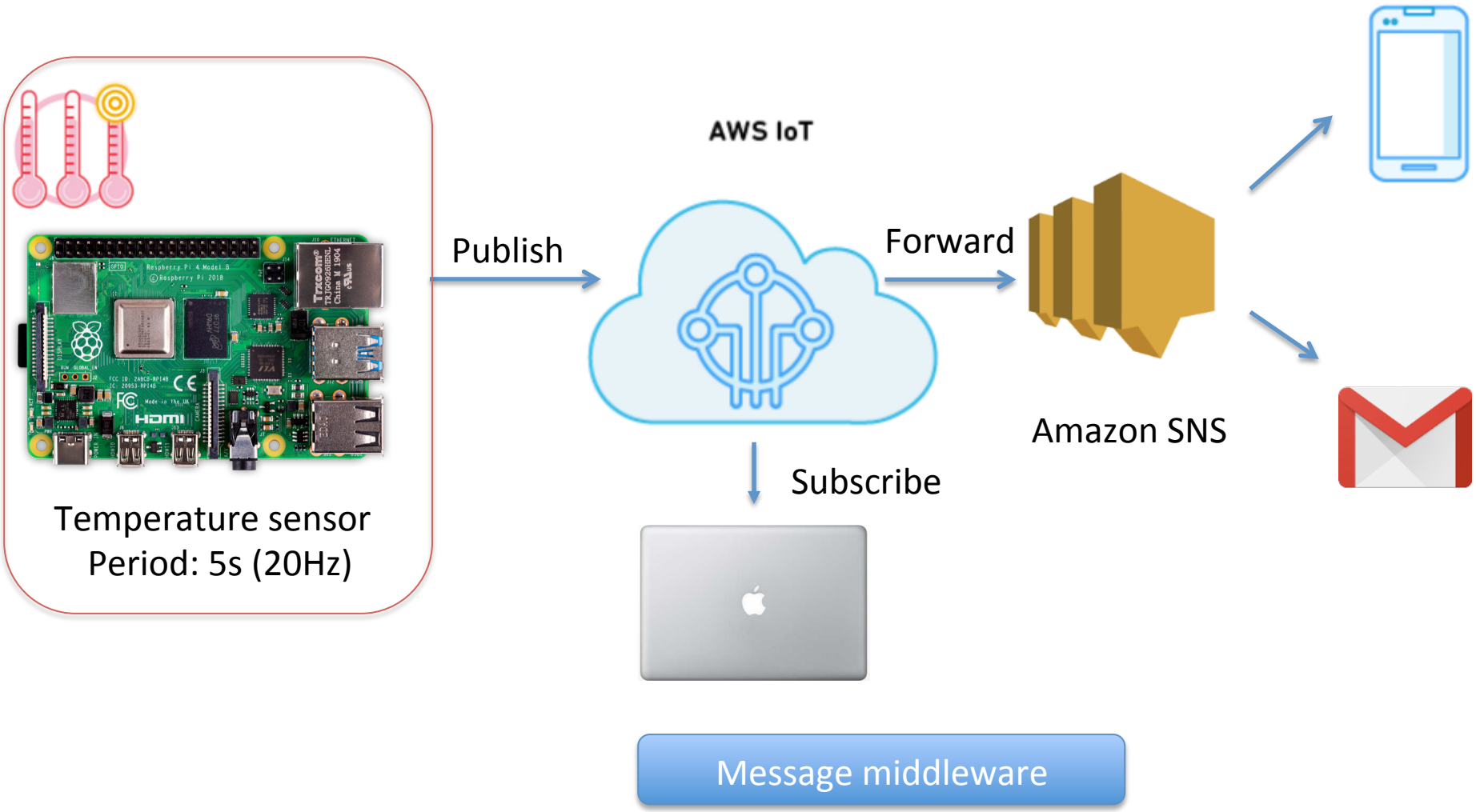


United: Connect + Communication

Stated: “Thing Shadow”

Smart: Other Cloud Service
Data Storage
Machine Learning

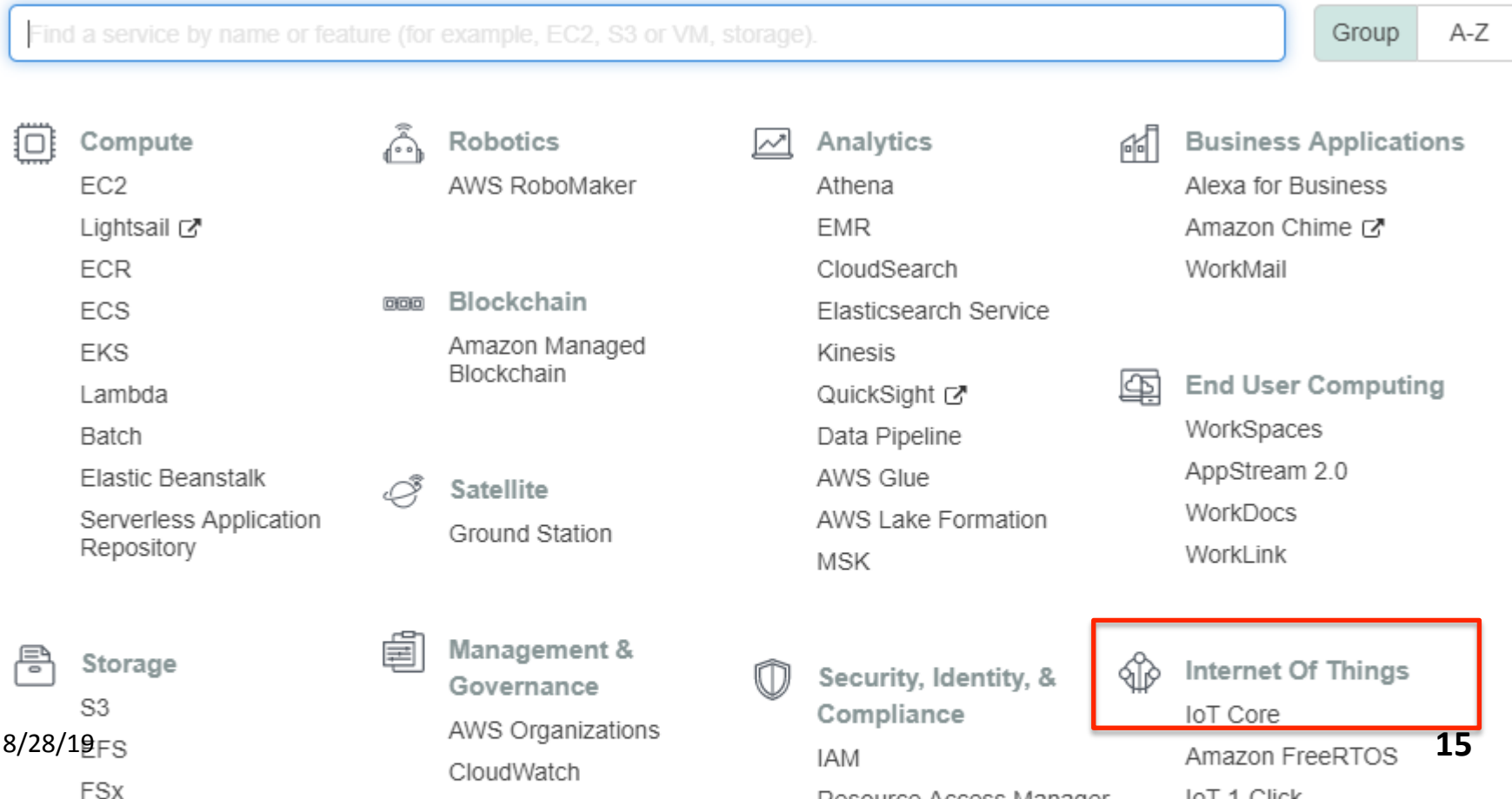
Tutorial: Hello AWS IoT!



Source: https://aws.amazon.com/iot-platform/

Get into AWS Manage Console

- Create your own AWS account
- Sign In IoT Manage Console
  - https://aws.**amazon**.com/**iot**/



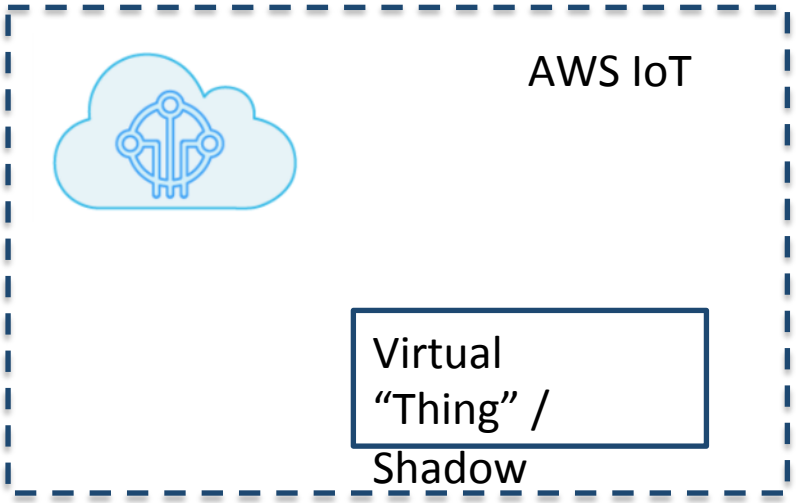
Step 1: Create a Virtual "Thing"

- A Thing in AWS IoT has a **"shadow"**
  - a JSON document that is used to **store and retrieve current state information for a device.**
    - **E.g.** Battery level, Connectivity, data

A "Dashboard" to show some info

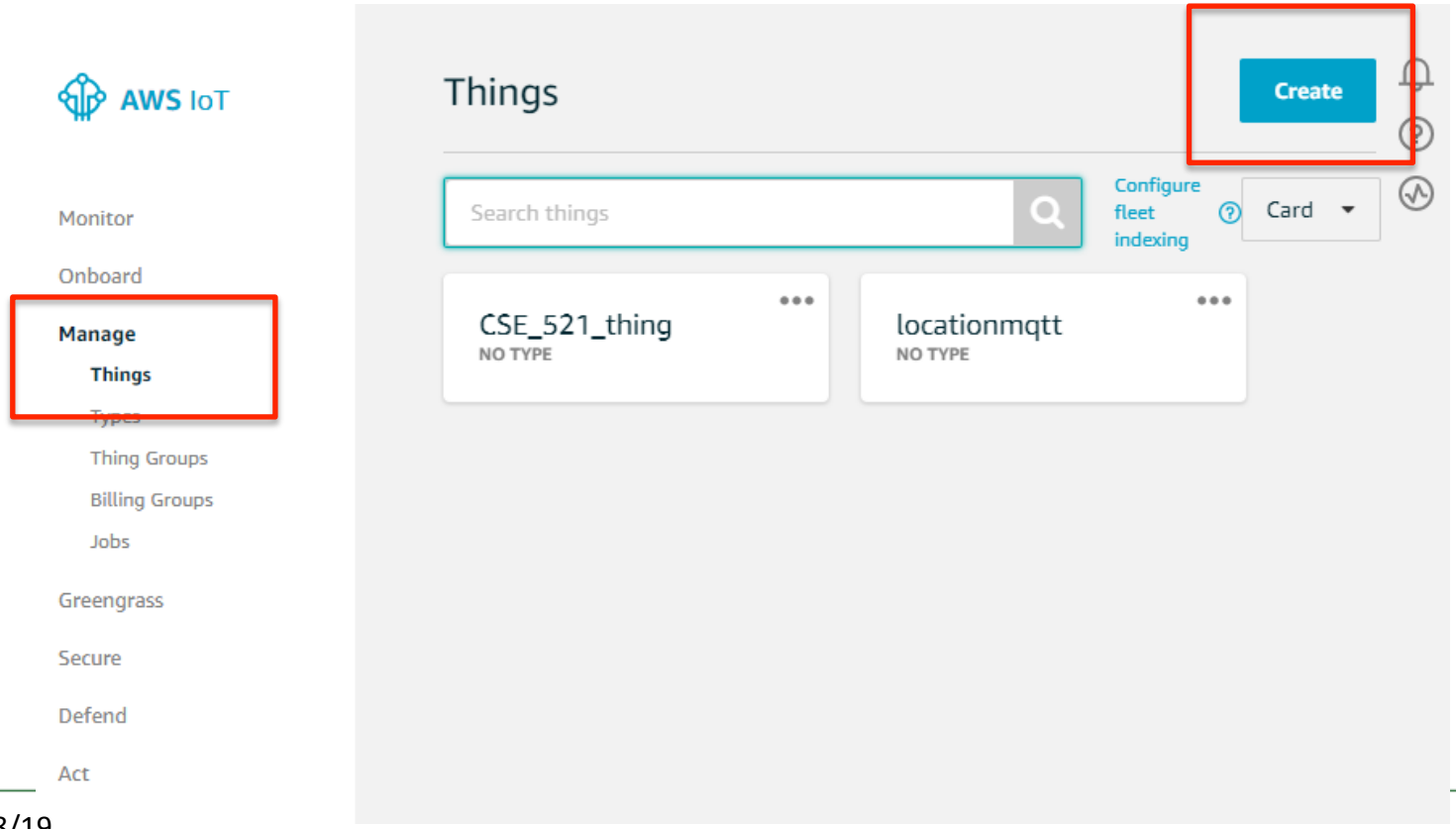
  - **Shadow is a special topic in AWS IoT**

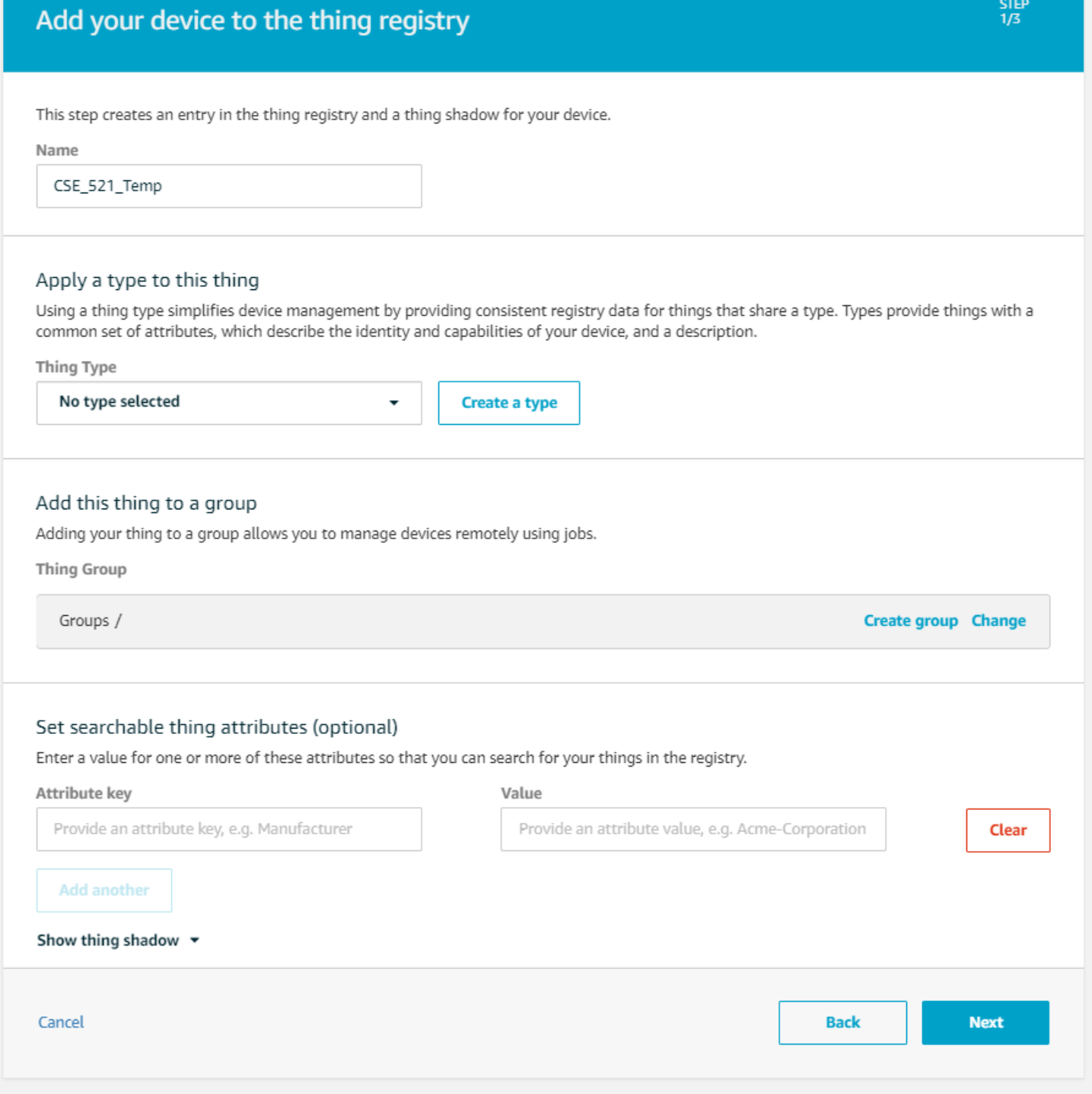
- **Certificates and policy**
  - **Authentication, Security**
  - **Permission and roles**

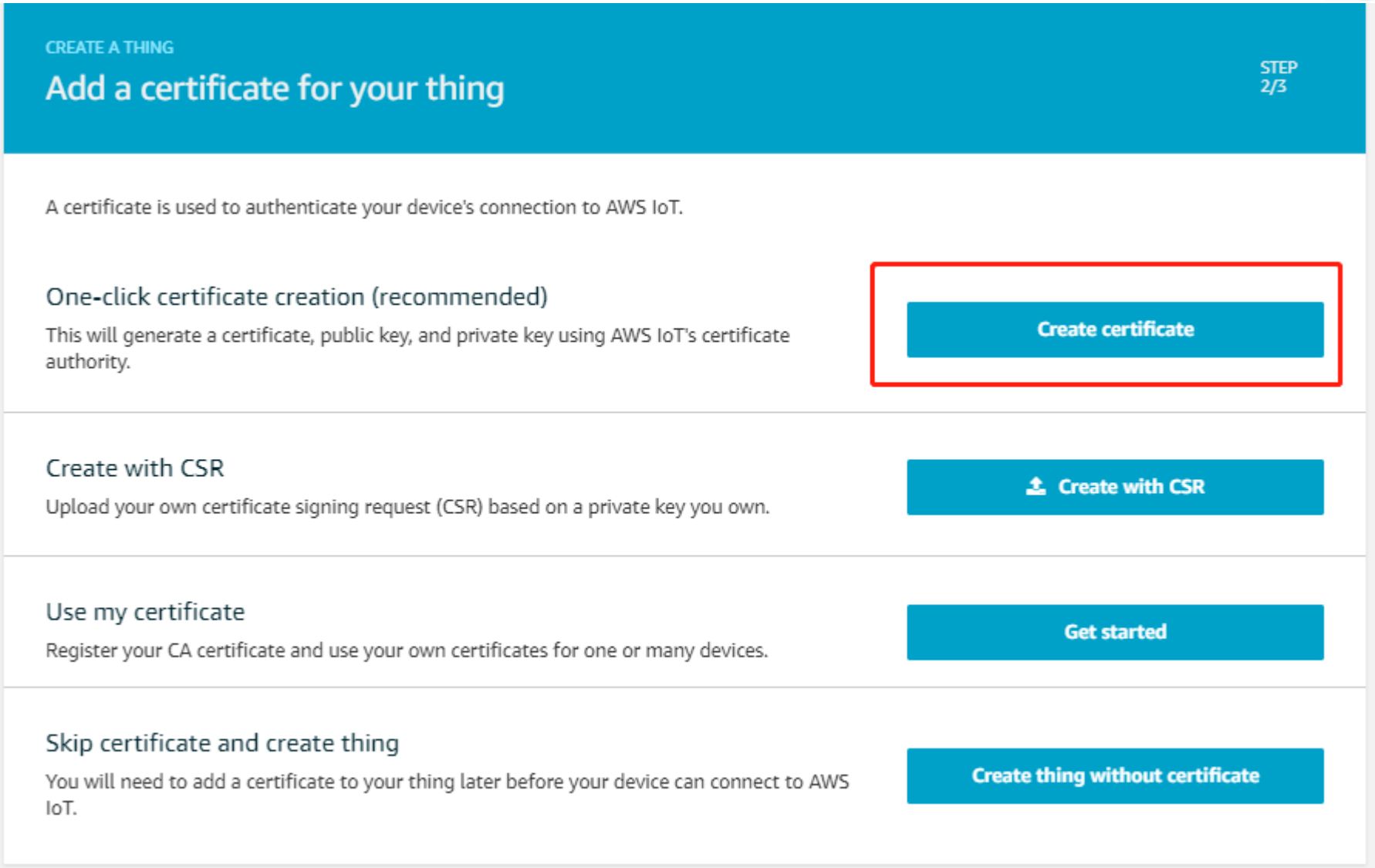


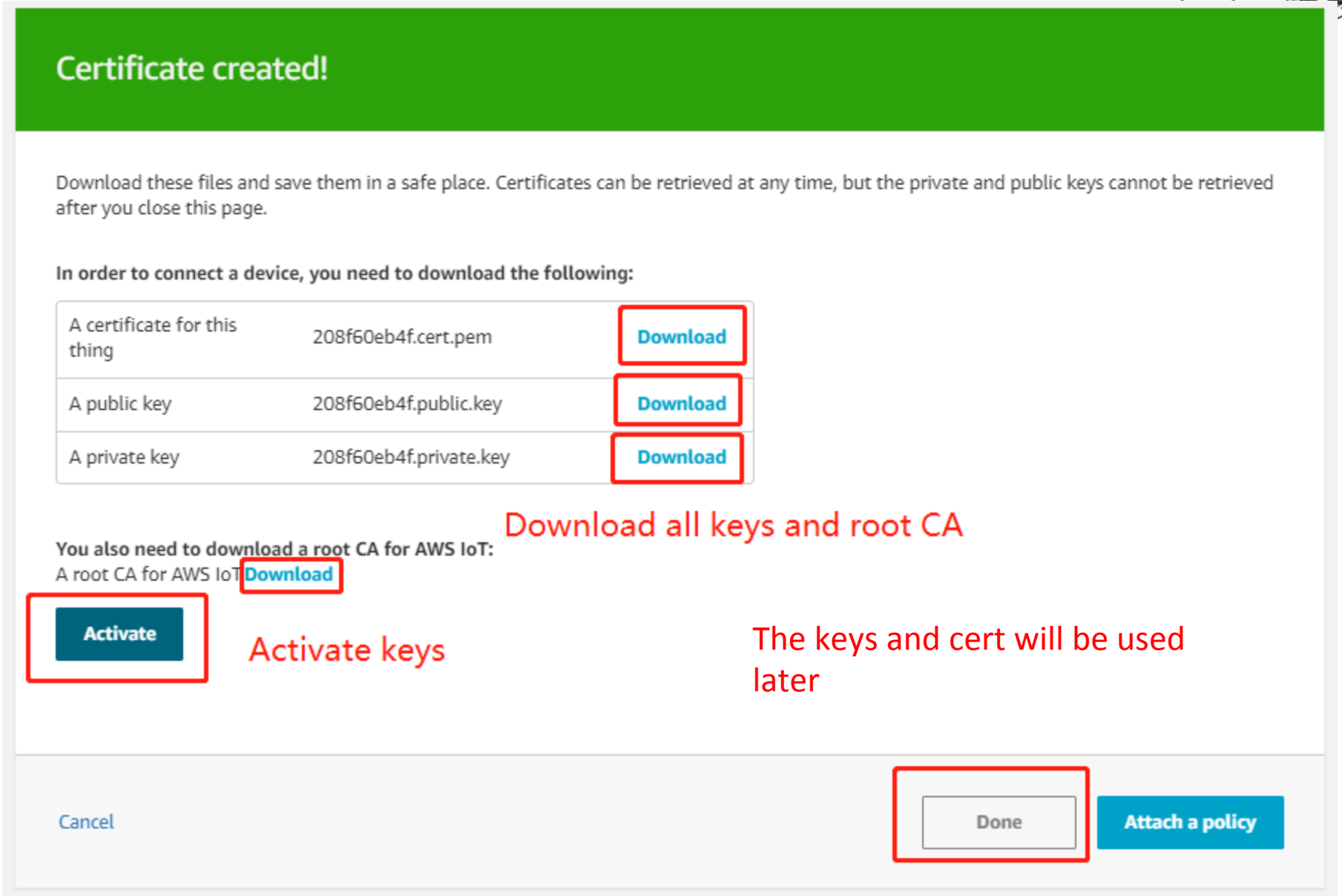
Create a thing

- 1. AWS IoT Menu
  - Things ➔ Create
- 2. Give a name



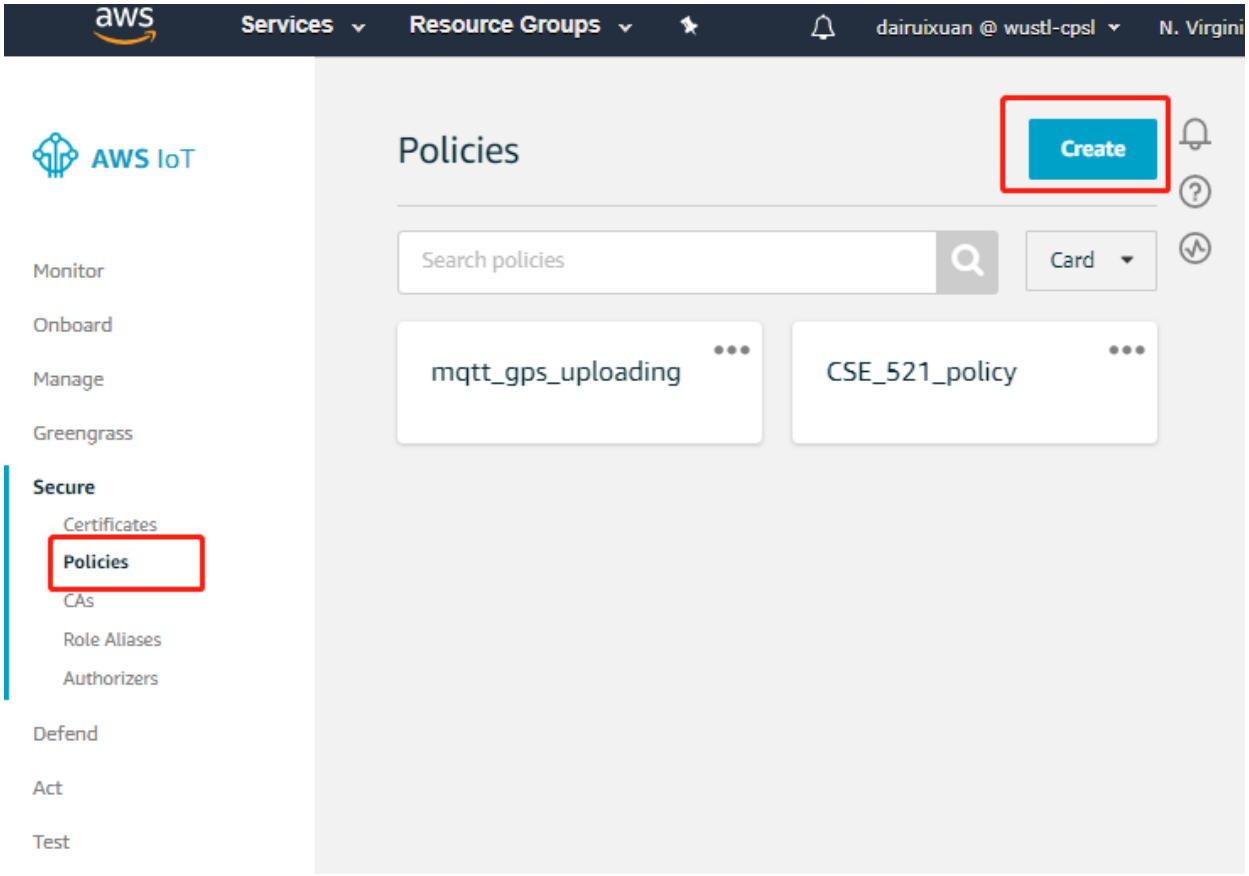

Add your device to the thing registry
STEP 1/3
This step creates an entry in the thing registry and a thing shadow for your device.
Name
CSE_521_Temp
Apply a type to this thing
Using a thing type simplifies device management by providing consistent registry data for things that share a type. Types provide things with a common set of attributes, which describe the identity and capabilities of your device, and a description.
Thing Type
No type selected
Create a type
Add this thing to a group
Adding your thing to a group allows you to manage devices remotely using jobs.
Thing Group
Groups /
Create group
Change
Set searchable thing attributes (optional)
Enter a value for one or more of these attributes so that you can search for your things in the registry.
Attribute key
Provide an attribute key, e.g. Manufacturer
Value
Provide an attribute value, e.g. Acme-Corporation
Clear
Add another
Show thing shadow
Cancel
Back
Next

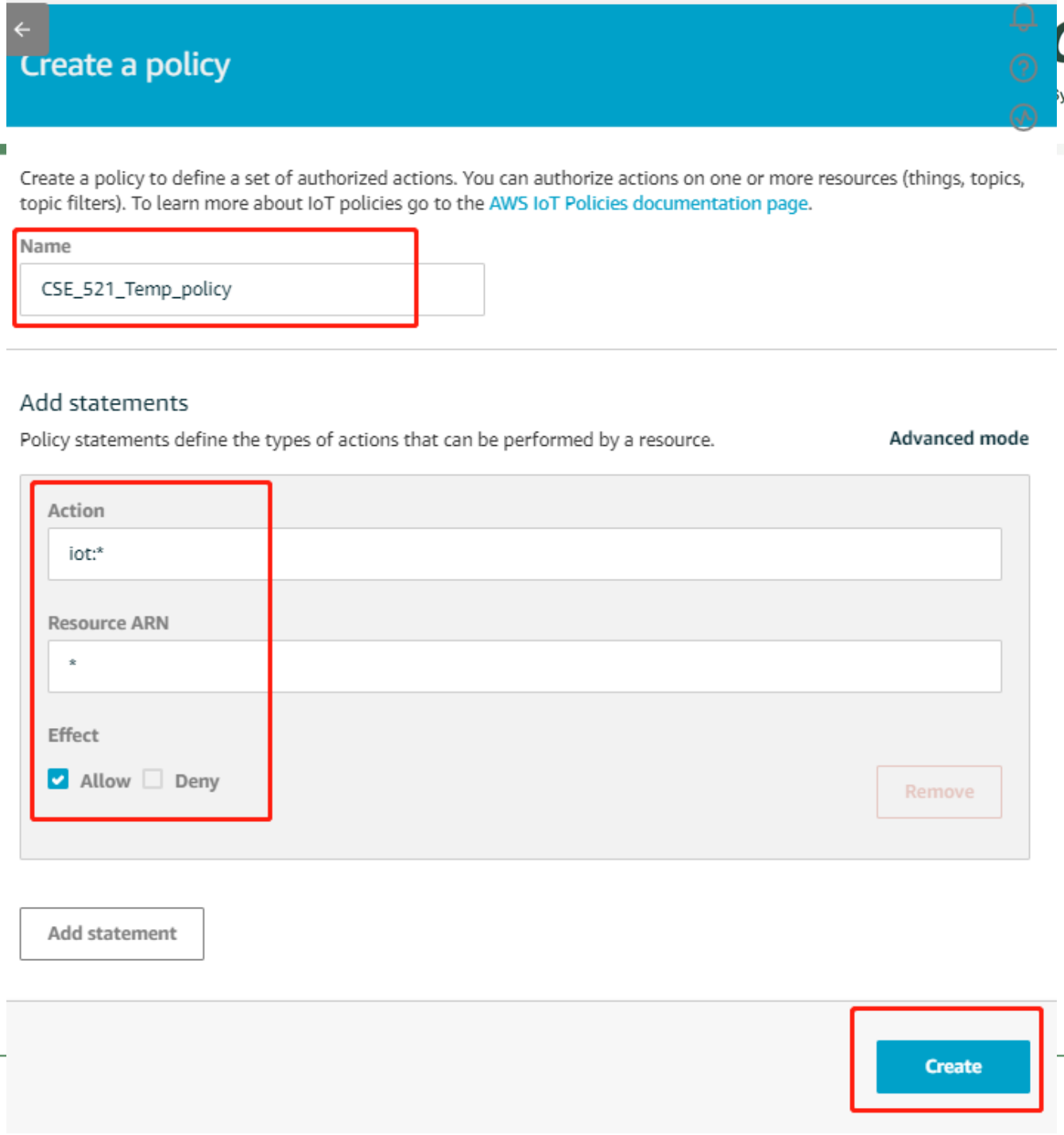

CREATE A THING
Add a certificate for your thing
STEP
2/3
A certificate is used to authenticate your device's connection to AWS IoT.
One-click certificate creation (recommended)
This will generate a certificate, public key, and private key using AWS IoT's certificate authority.
Create certificate
Create with CSR
Upload your own certificate signing request (CSR) based on a private key you own.
Create with CSR
Use my certificate
Register your CA certificate and use your own certificates for one or many devices.
Get started
Skip certificate and create thing
You will need to add a certificate to your thing later before your device can connect to AWS IoT.
Create thing without certificate

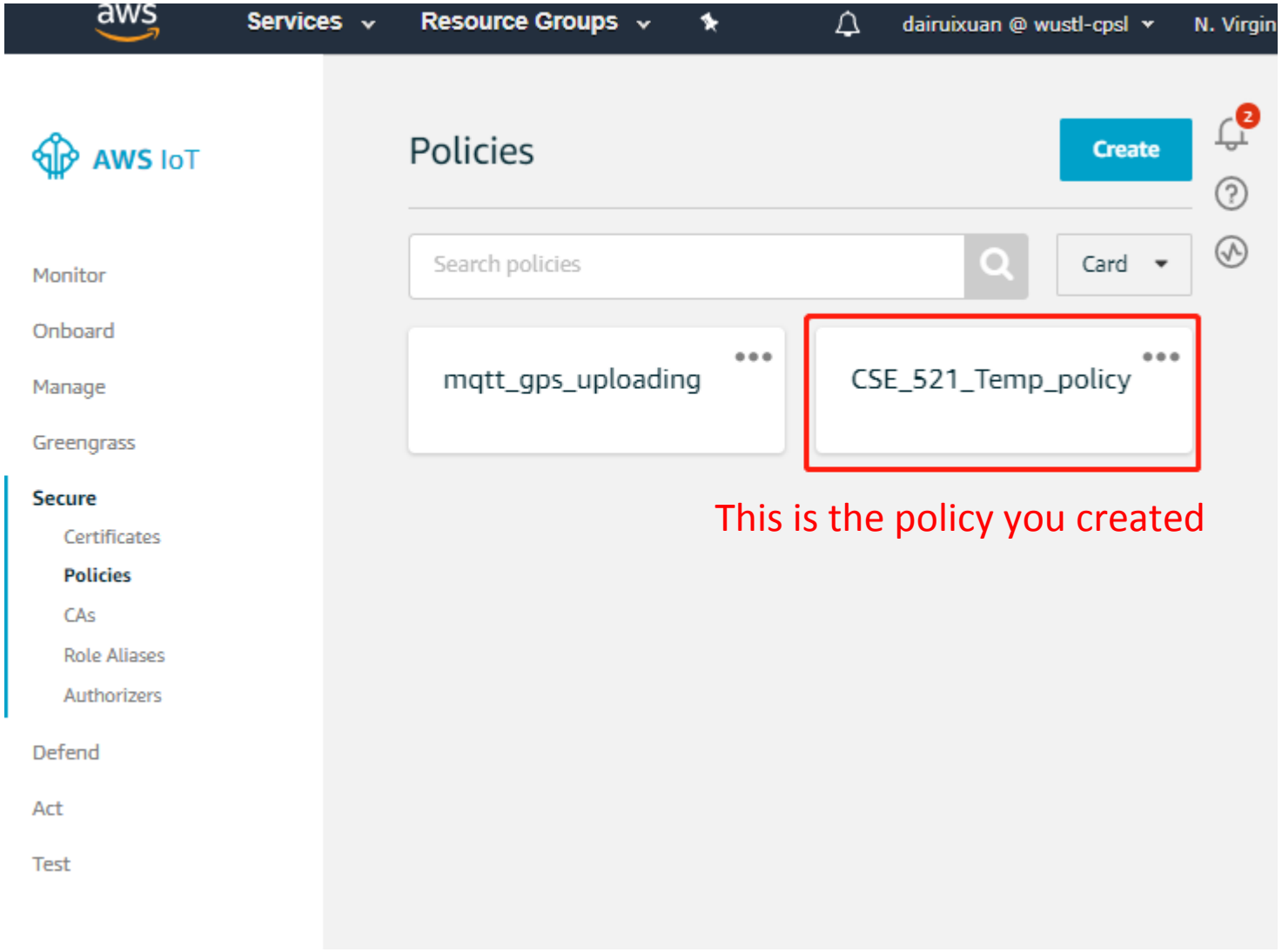

Certificate created!
Download these files and save them in a safe place. Certificates can be retrieved at any time, but the private and public keys cannot be retrieved after you close this page.
In order to connect a device, you need to download the following:
A certificate for this thing
208f60eb4f.cert.pem
Download
A public key
208f60eb4f.public.key
Download
A private key
208f60eb4f.private.key
Download
Download all keys and root CA
You also need to download a root CA for AWS IoT:
A root CA for AWS IoT Download
Activate
Activate keys
The keys and cert will be used later
Cancel
Done
Attach a policy

Create Policy

- A policy is attached to a key/cert
  - **It tells what this key/cert can do**

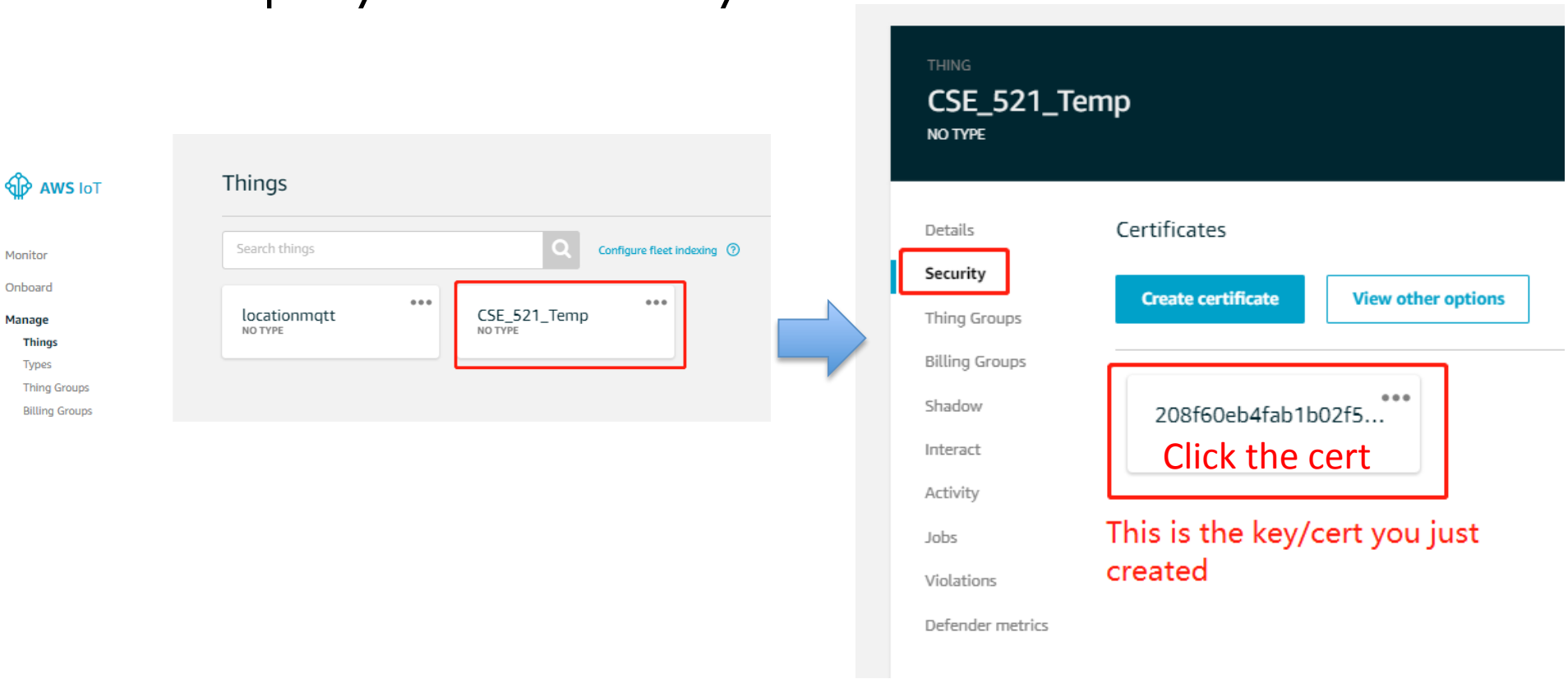


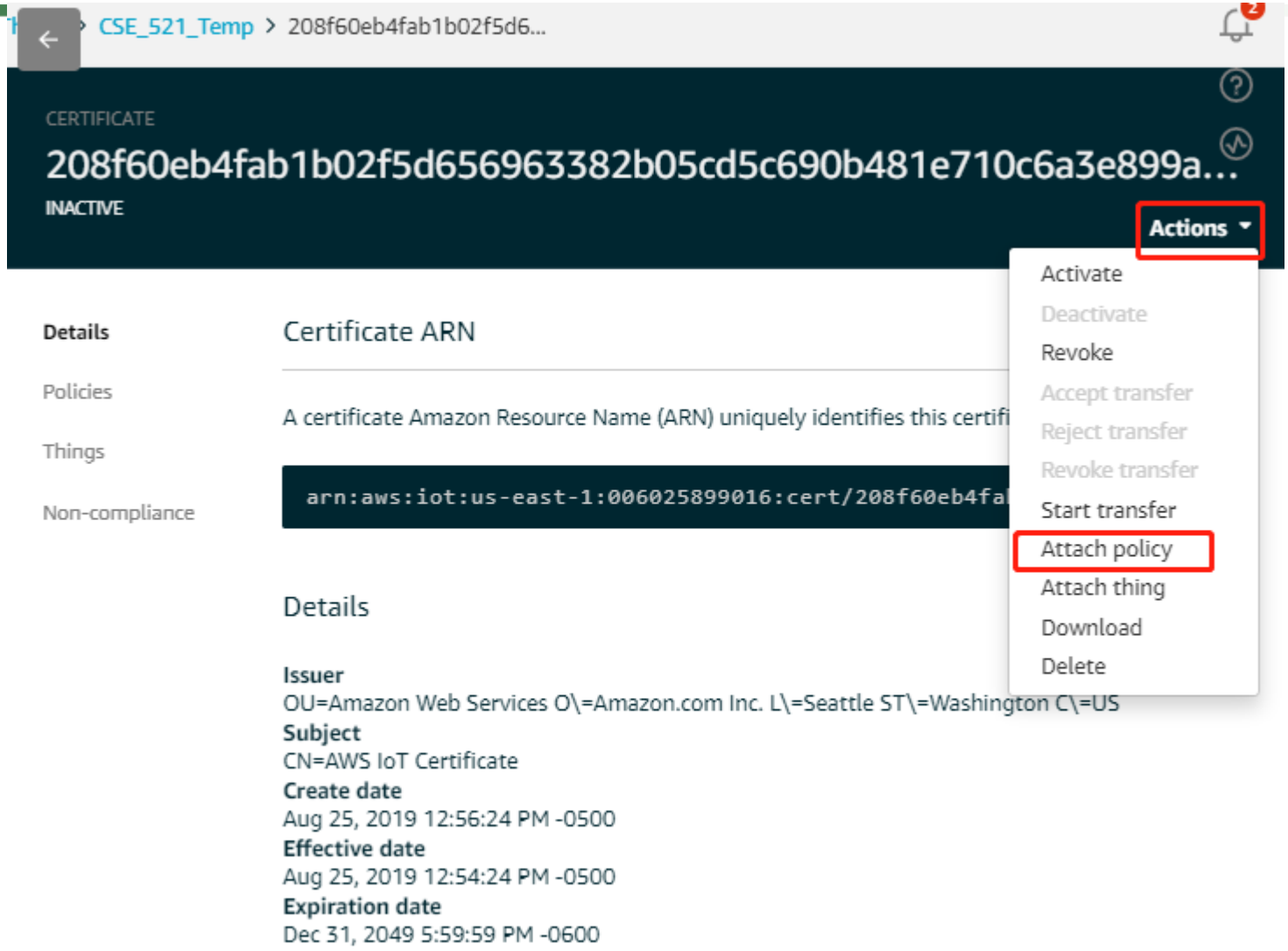

Create a policy
Create a policy to define a set of authorized actions. You can authorize actions on one or more resources (things, topics, topic filters). To learn more about IoT policies go to the AWS IoT Policies documentation page.
Name
CSE_521_Temp_policy
Add statements
Policy statements define the types of actions that can be performed by a resource.
Advanced mode
Action
iot:*
Resource ARN
*
Effect
Allow
Deny
Remove
Add statement
Create

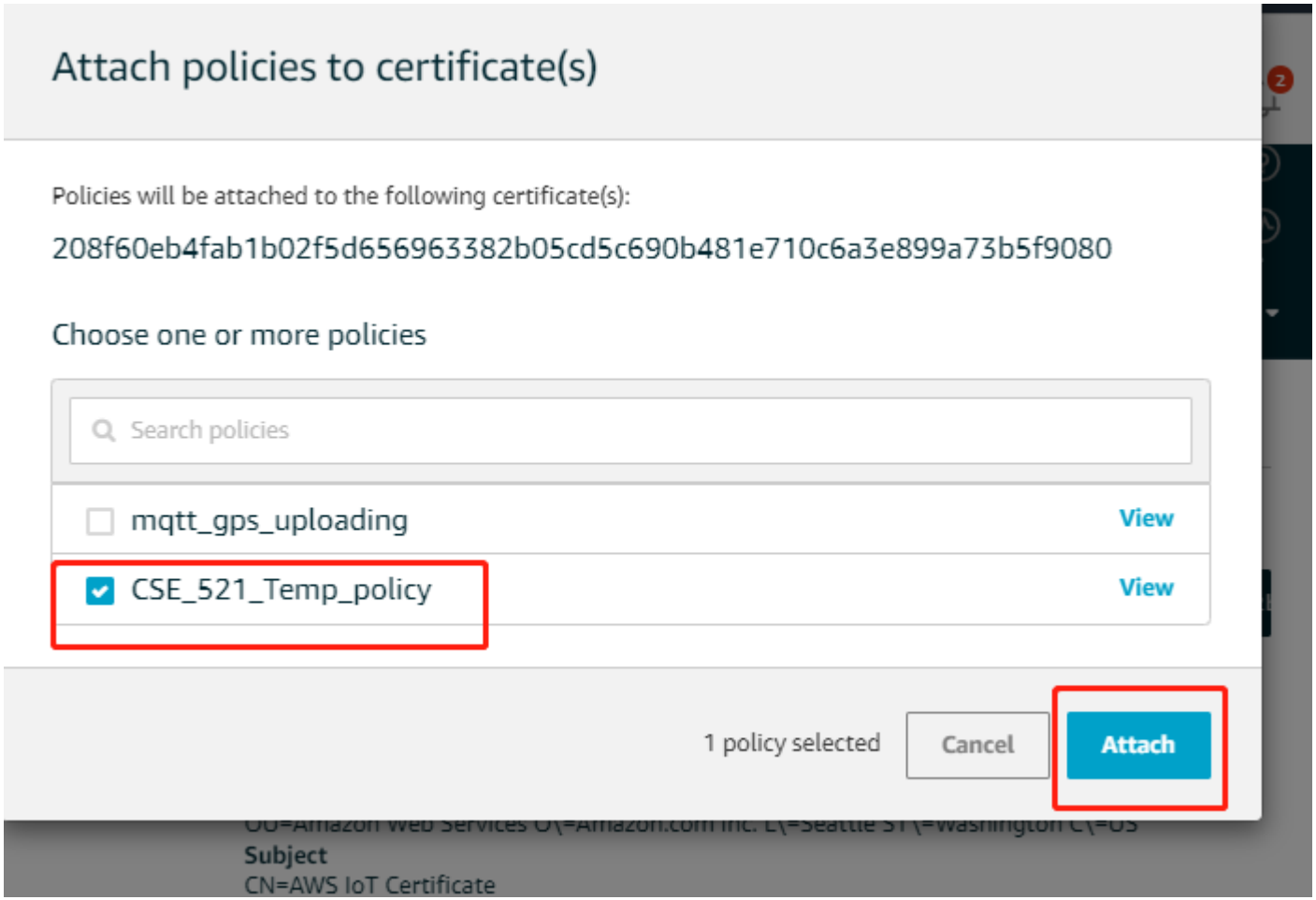

aws
Services
Resource Groups
dairuixuan @ wustl-cpsl
N. Virgin
AWS IoT
Monitor
Onboard
Manage
Greengrass
Secure
Certificates
Policies
CAs
Role Aliases
Authorizers
Defend
Act
Test
Policies
Create
Search policies
Card
mqtt_gps_uploading
CSE_521_Temp_policy
This is the policy you created

Attach Policy

- Attach Policy to the key/cert
  - A policy tells what this key/cert can do

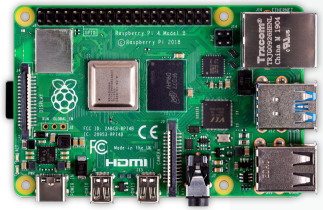


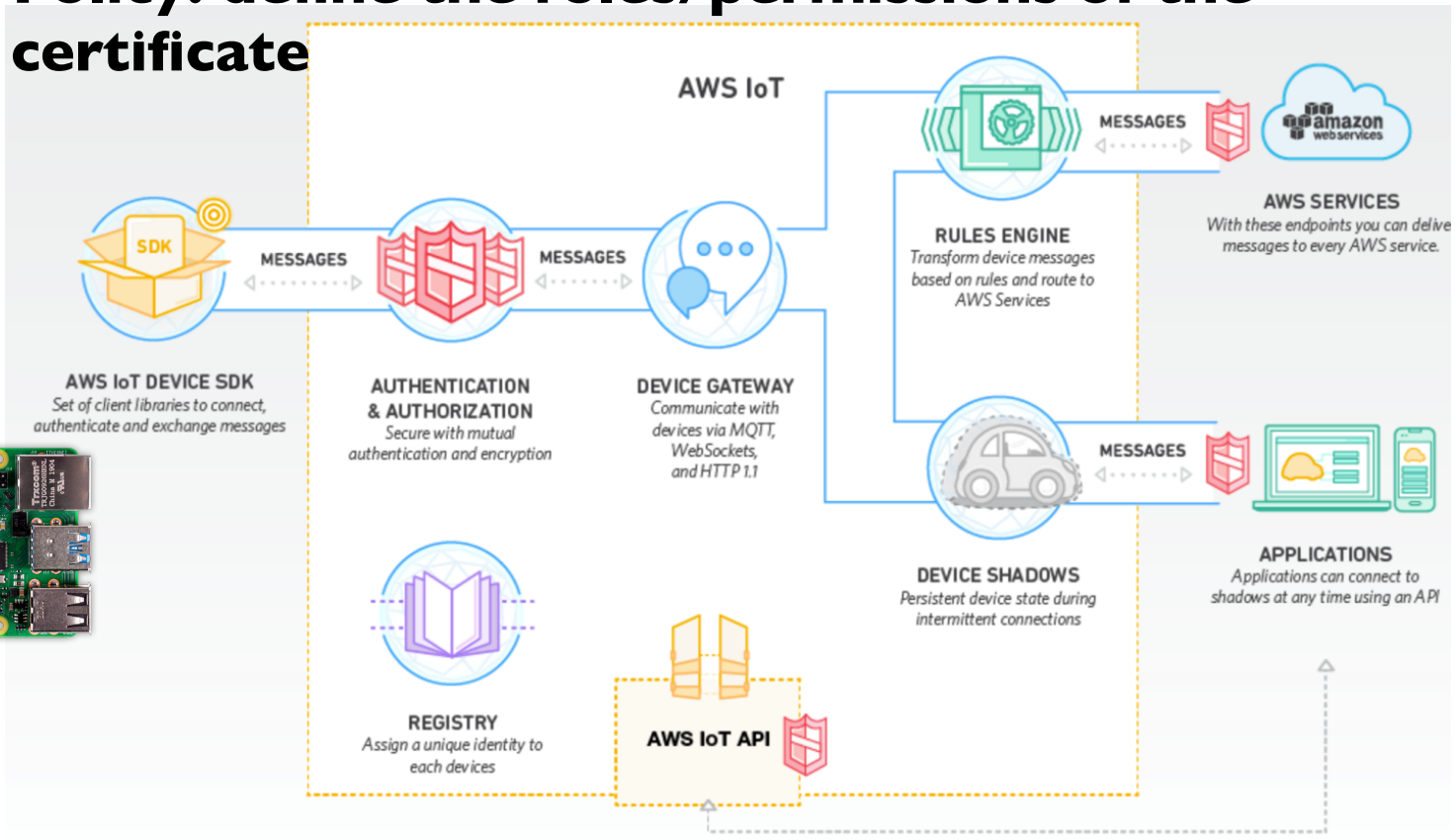

CSE_521_Temp > 208f60eb4fab1b02f5d6...
CERTIFICATE
208f60eb4fab1b02f5d656963382b05cd5c690b481e710c6a3e899a...
INACTIVE
Actions
Activate
Deactivate
Revoke
Accept transfer
Reject transfer
Revoke transfer
Start transfer
Attach policy
Attach thing
Download
Delete
Details
Policies
Things
Non-compliance
Certificate ARN
A certificate Amazon Resource Name (ARN) uniquely identifies this certifi
arn:aws:iot:us-east-1:006025899016:cert/208f60eb4fa
Details
Issuer
OU=Amazon Web Services O\=Amazon.com Inc. L\=Seattle ST\=Washington C\=US
Subject
CN=AWS IoT Certificate
Create date
Aug 25, 2019 12:56:24 PM -0500
Effective date
Aug 25, 2019 12:54:24 PM -0500
Expiration date
Dec 31, 2049 5:59:59 PM -0600


Attach policies to certificate(s)
Policies will be attached to the following certificate(s):
208f60eb4fab1b02f5d656963382b05cd5c690b481e710c6a3e899a73b5f9080
Choose one or more policies
Search policies
mqtt_gps_uploading
View
CSE_521_Temp_policy
View
1 policy selected
Cancel
Attach
Subject
CN=AWS IoT Certificate

AWS Things Summary

- **Shadow: Store/retrieve some information**
- **Certificate: authenticate the device**
- **Policy: define the roles/permissions of the certificate**





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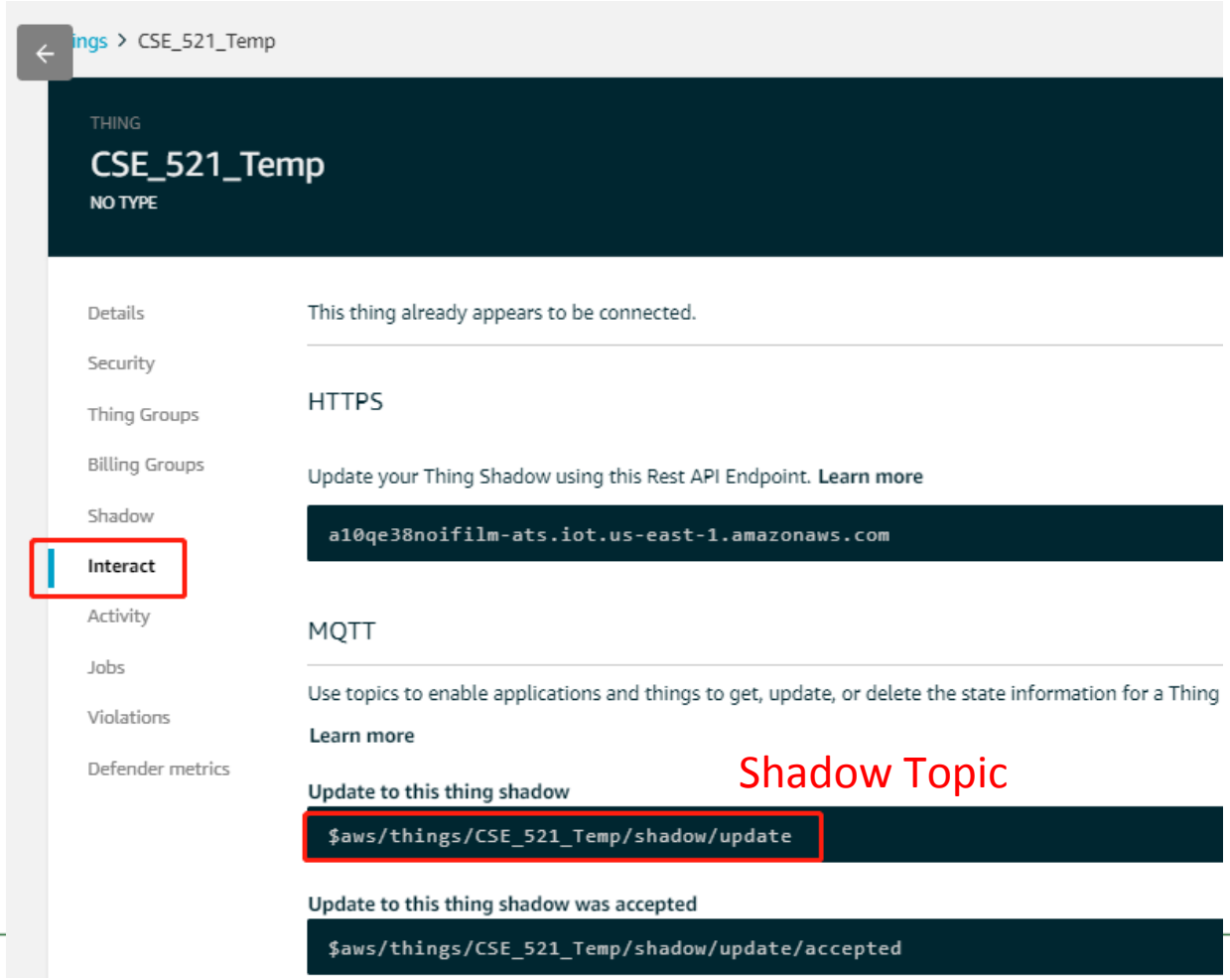
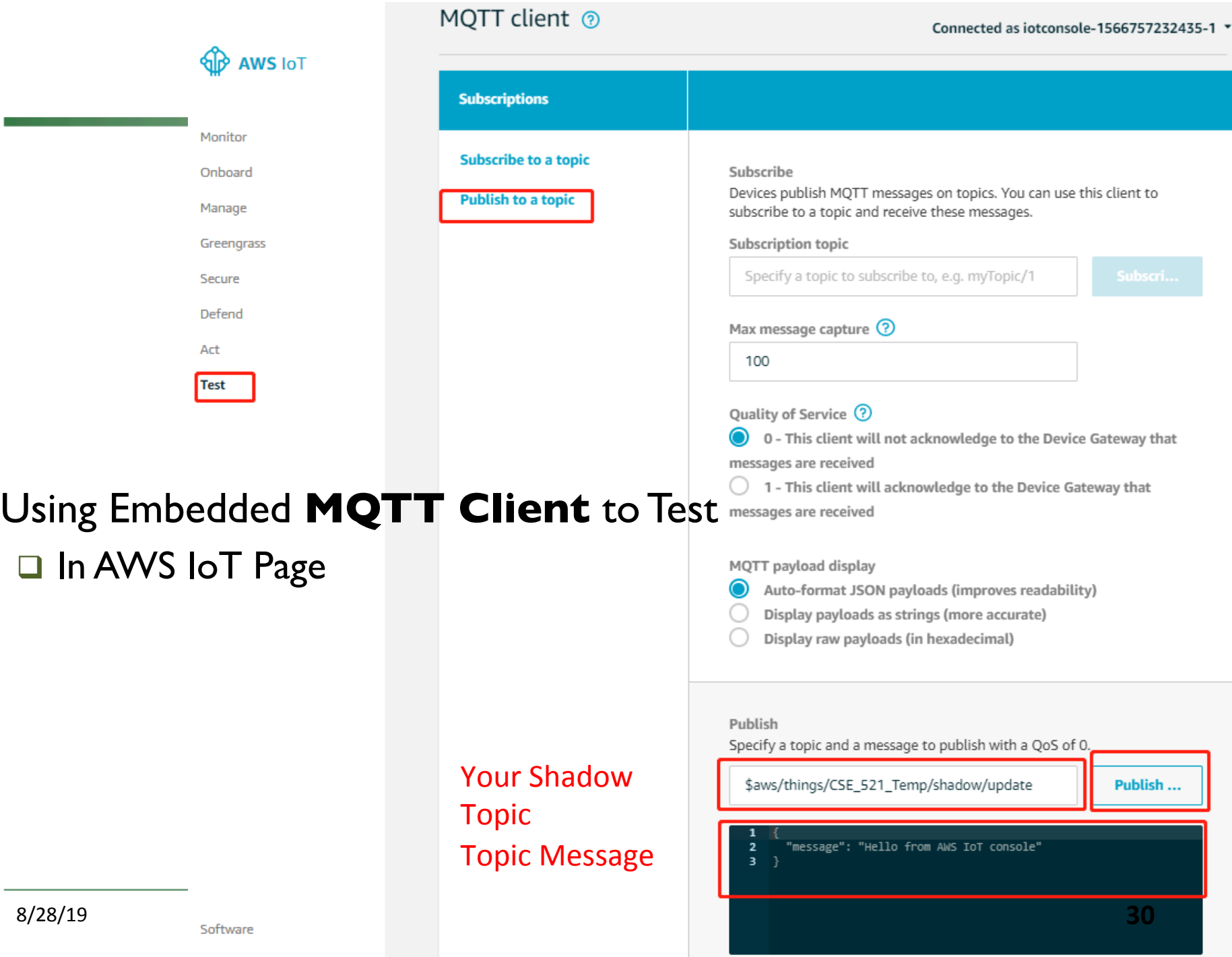
Let's test it online!

Washington University in St. Louis

Basic Interact: Publish to the "Shadow"

- Get your "Shadow"
  - In your Thing Page





- Using Embedded **MQTT Client** to Test
  - In AWS IoT Page

Your Shadow Topic

Topic Message

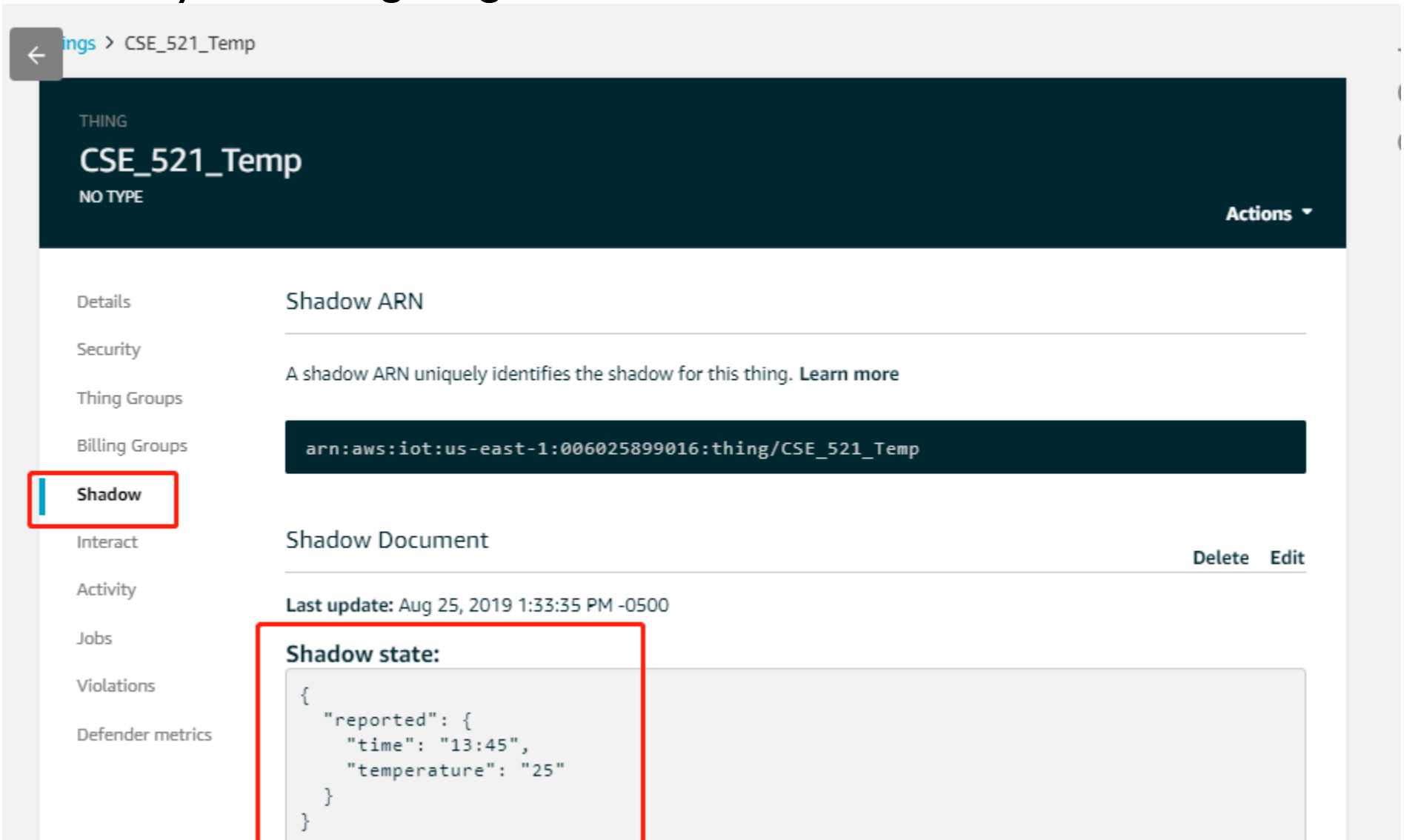
Shadow Message

```
{  "state": {
          "reported":{
             "time":"13:45",
             "temperature":"25"}
             },
  "message": "Hello from AWS IoT console"}
```

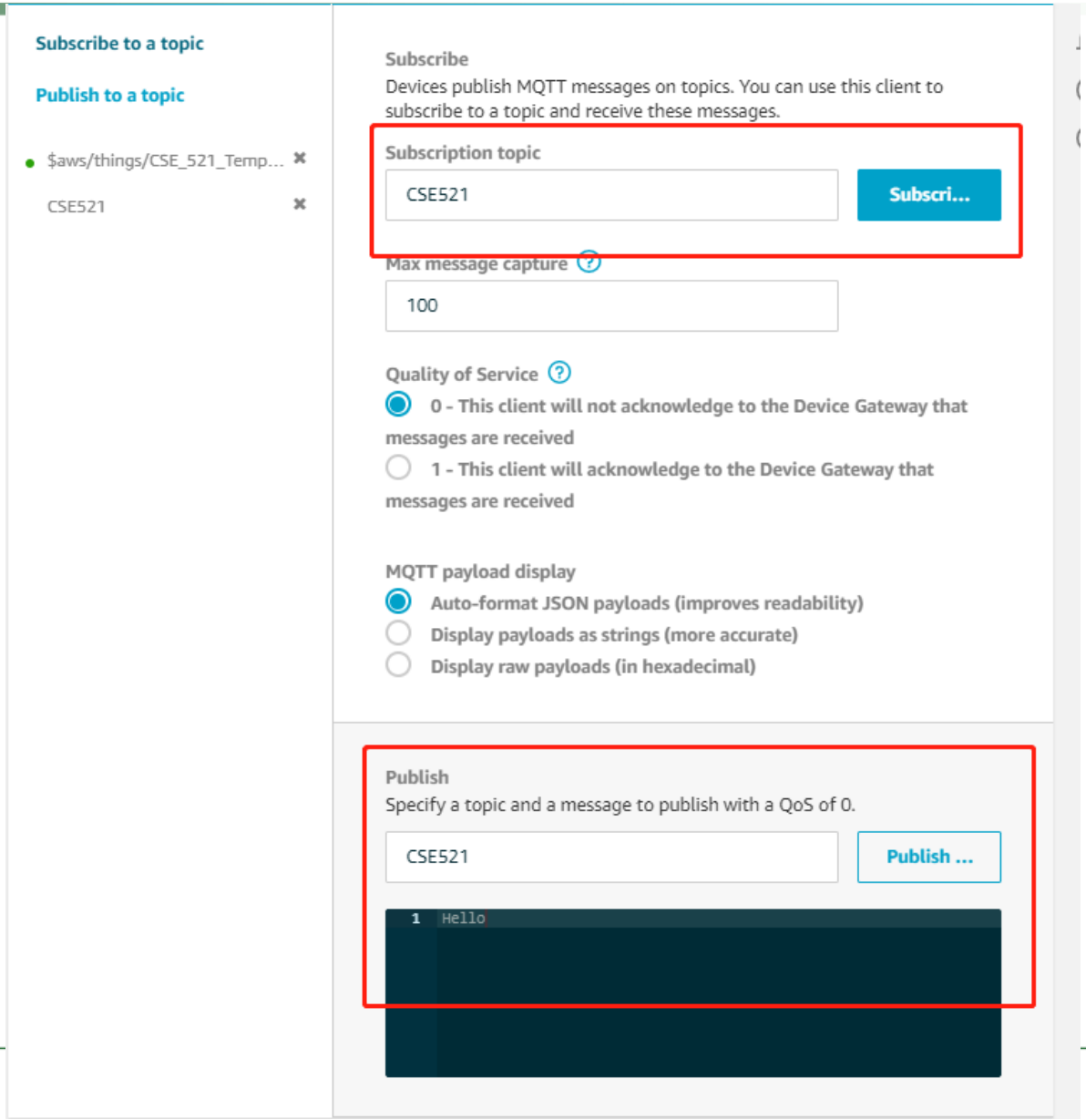
A Shadow Message is a JSON object.
Shadow message has strict formats.
Please see
https://docs.aws.amazon.com/iot/latest/developerguide/device-shadow-document-syntax.html

Update Shadow

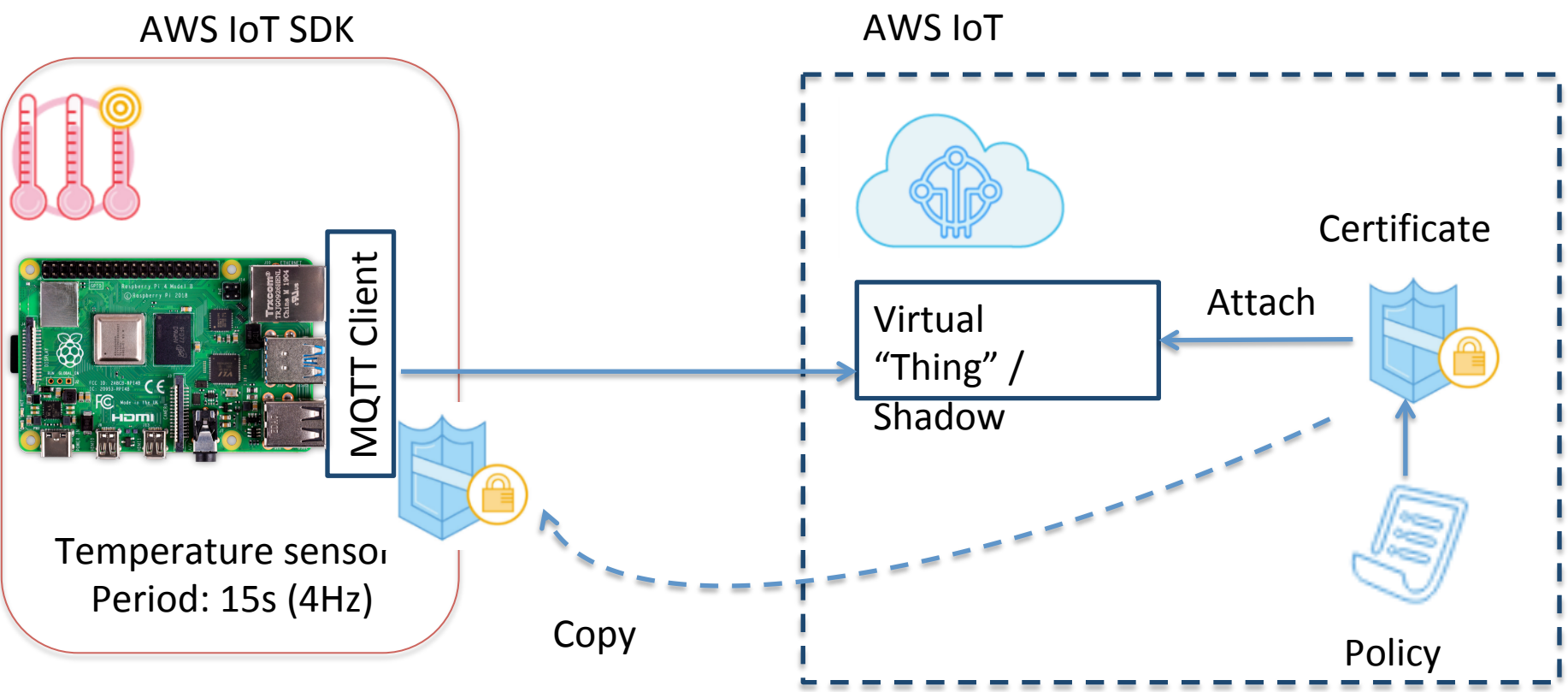
- In your "Thing" Page



Basic Interact: Subscribe/Publish



Step 2: Connect a “Physical” Device



Connect your Device

- Copy certificates to your **physical things**
  - Note: through **scp** utility
  - Downloaded before!

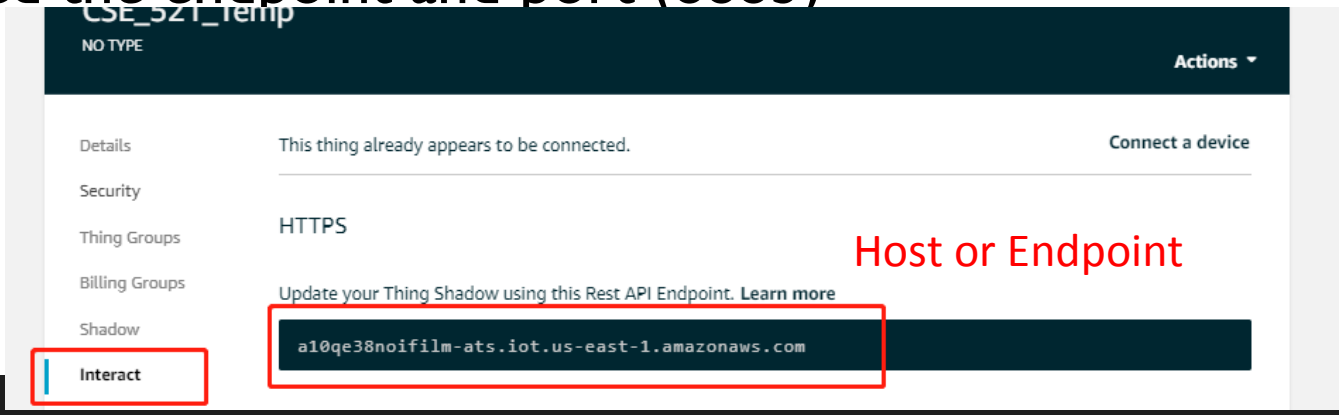
- Choose your **AWS SDK** (support MQTT)
  - Node JS
  - Python (pip install AWSIoTPythonSDK)
  - Java
  - …
- Set up your client with SDK and the certificates

Some Notes

- 1. Copy the certificates/keys

```
[ec2-user@ip-172-31-92-213 temp_demo]$
[ec2-user@ip-172-31-92-213 temp_demo]$
[ec2-user@ip-172-31-92-213 temp_demo]$ ls
aws-iot-device-sdk-python  demo.py                          root-CA.crt
CSE_521_Temp.cert.pem      e556be14fc-certificate.pem.crt   start.sh
CSE_521_Temp.private.key   e556be14fc-private.pem.key
CSE_521_Temp.public.key    e556be14fc-public.pem.key
[ec2-user@ip-172-31-92-213 temp_demo]$
```

- 2. You will need the endpoint and port (8883)



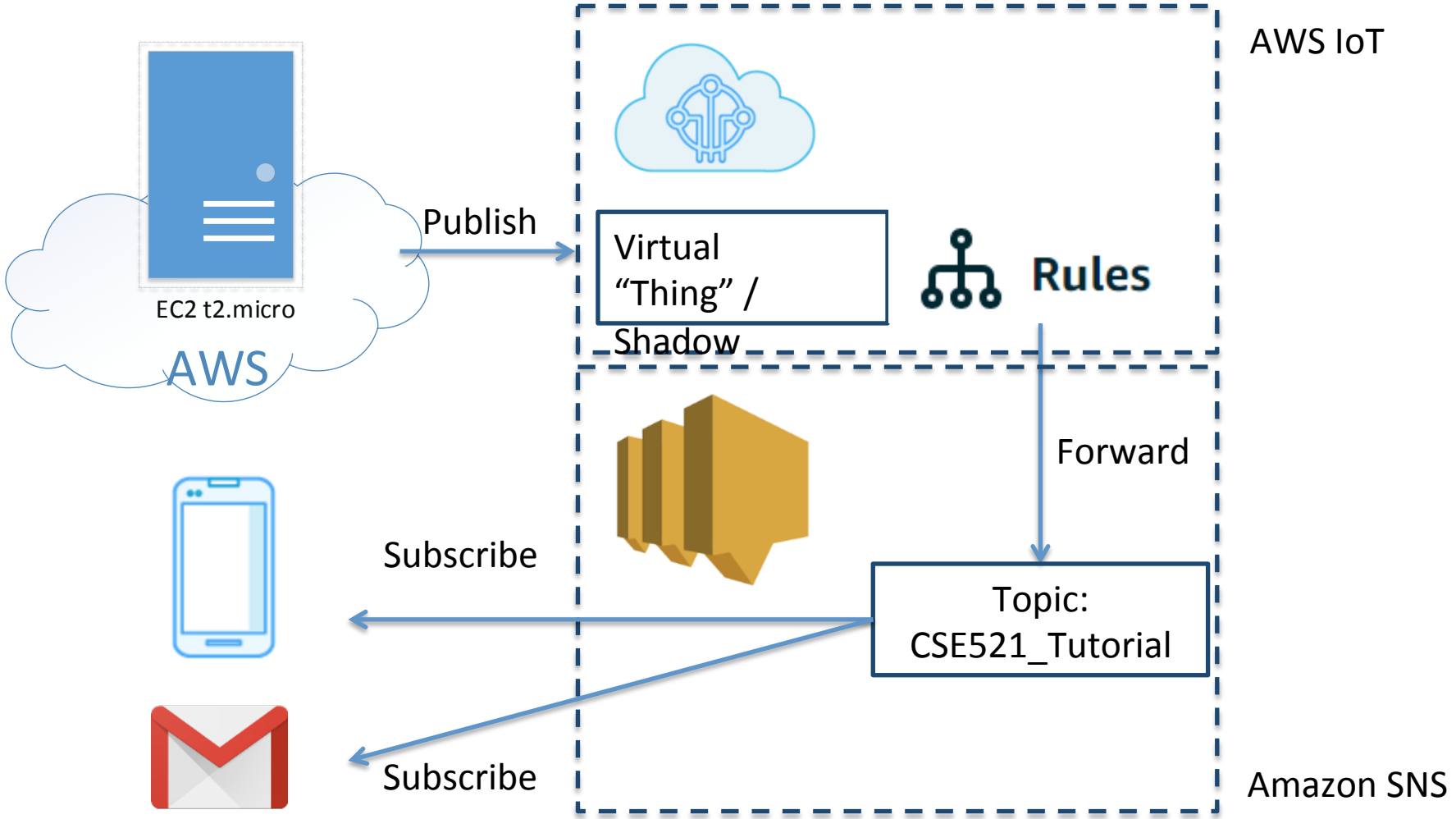

```
host = "a10qe38noifilm-ats.iot.us-east-1.amazonaws.com" # Your thing's endpoint. See tutorial slides
rootCAPath = "root-CA.crt"
certificatePath = "e556be14fc-certificate.pem.crt"
privateKeyPath = "e556be14fc-private.pem.key"
port = 8883
clientId = "CSE521_temp"
topic = "$aws/things/CSE_521_Temp/shadow/update" # Shadow topic of your Thing
```

SDK and Demo Codes

- https://github.com/aws/aws-iot-device-sdk-python
- https://github.com/aws/aws-iot-device-sdk-python/blob/master/samples/basicPubSub/basicPubSub.py

More: Rule Engine, Link with SNS services

- Simple Notification Service



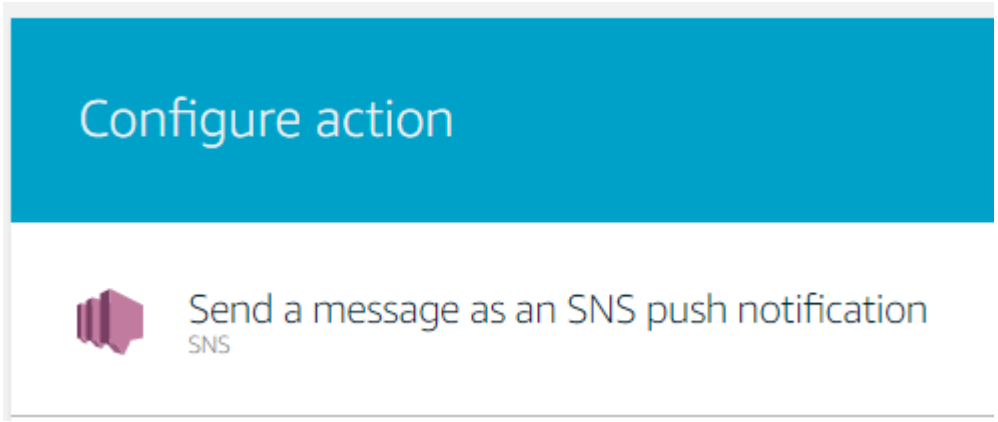
Create a Rule in Amazon IoT

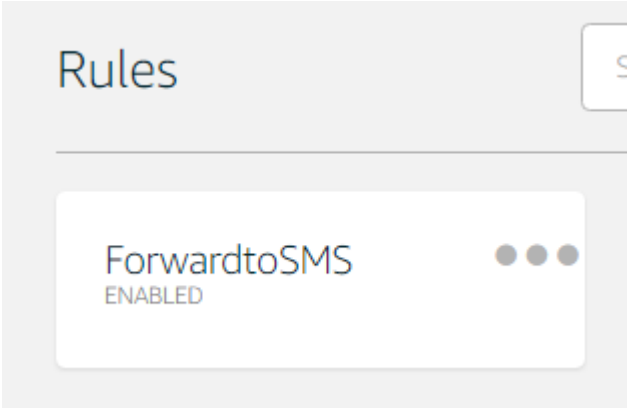
- Add a query to filter your inteseting topic (event)

Rule query statement

```
SELECT * FROM '$aws/things/RaspberryPi/shadow/update/accepted'
```

- Add an Action:
  - Forward this message to SNS
  - Specify Dest ARN
  - Enable Rule





Notification on SMS & Email

AWS Notification Message

Inbox x

520Tutor no-reply@sns.amazona 3:11 PM (28 minutes ago)

to me

{"state":{"reported":{"Value":45}},"metadata":{"reported":{"Value":{"timestamp":1503951070}}},"version":134,"timestamp":1503951070}

--

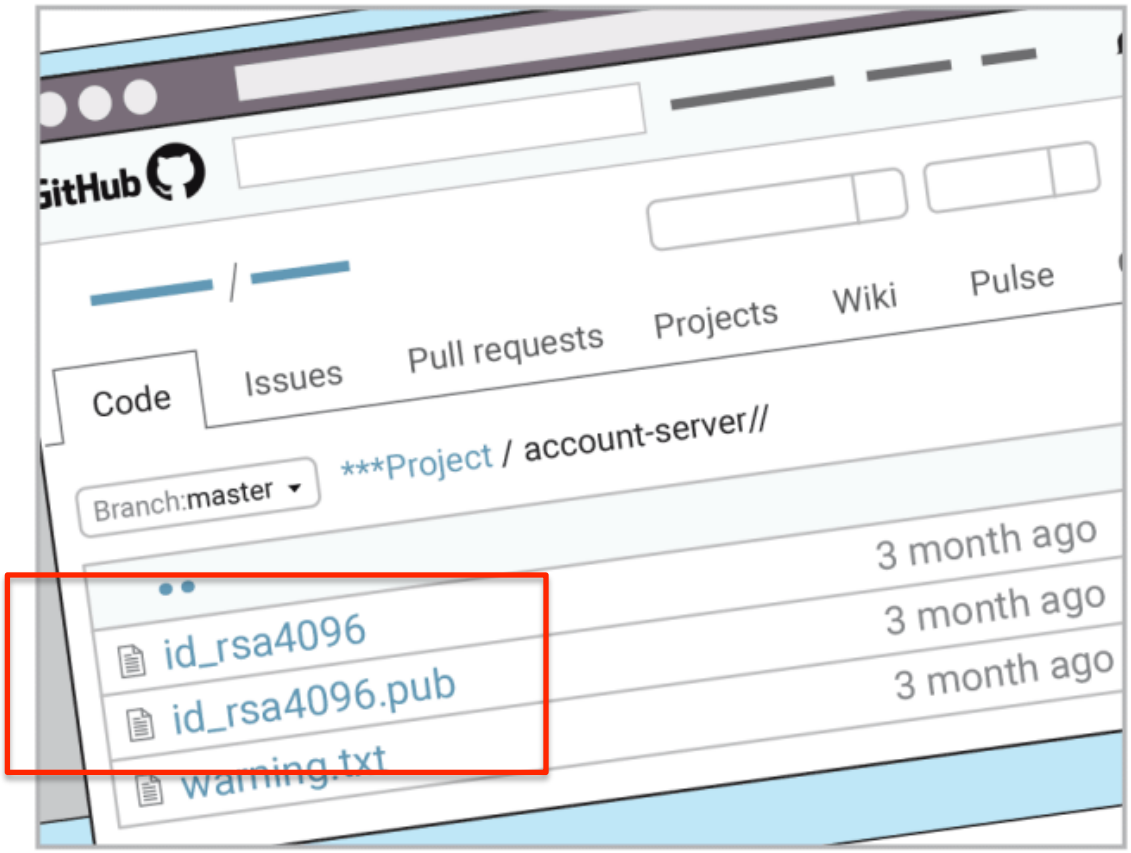
If you wish to stop receiving notifications from this topic, please click or visit the link below to unsubscribe:
https://sns.us-west-2.amazonaws.com/unsubscribe.html?SubscriptionArn=arn:aws:sns:us-west-2:401317363811:CSE520S_Tutorial:00c54352-7d1a-4c09-9cc1-15aed3c395e3&Endpoint=naroahlee@gmail.com

Please do not reply directly to this email. If you have any questions or comments regarding this email, please contact us at
https://aws.amazon.com/support

One More Thing: Account Security

- DON'T UPLOAD YOUR KEY PUBLICLY!!!

Time to Open Source!



Source: WeChat Subscriptions: 西乔《神秘的程序员们 39》 Geek Life Chpt 39.

What if… $50,000 AWS Bill!

CPSL Cyber-Physical Systems Laboratory

Quora | Ask or Search Quora | Ask Question

Fraud | Amazon Web Services | Amazon.com (product) | Hackers | +3

My AWS account was hacked and I have a $50,000 bill, how can I reduce the amount I need to pay?

For years, my bill was never above $350/month on my single AWS instance. Then over the weekend someone got hold of my private key and launched hundreds of instances and racked up a $50,000 bill before I found out about it on Tuesday. Amazon had sent a warning by email at $15,000 saying they had found our key posted publicly, but I didn't see it. Naturally, this is a devastating amount of money to pay. I'm not saying I shouldn't pay anything, but this just a crazy amount in context. Amazon knew the account was compromised, that is why they sent an email, they knew the account history and I had only spent $213 the previous month. I almost feel they deliberately let it ride to try to earn more money. Does anyone have any experience with this sort of problem?

Source: https://www.quora.com/My-AWS-account-was-hacked-and-I-have-a-50-000-bill-how-can-I-reduce-the-amount-I-need-to-pay

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Cyber-Physical Systems Laboratory

Thanks!

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Aug. 29, 2019

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