

A I R O 5

How to build and manage your IoT project from PoC to production

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Mechanical Rock



The worlds most innovative Internet
Connected Toaster company

Why do people need a smart Toaster?

Prototype new project *Toasté* cheaply

Securely connect *Toasté(s)* back to Bread-office

Deploy thousands of *Toasté(s)* with ease



Capture toast metrics for improved toasting

Detect & React to unsafe toasting at the Edge

Secure *Toasté* fleet by detecting bad actors

Update *Toasté* firmware over the air

Why Toasté

- Checked **Crunchbase**
 - No one has done it!
- Our smart fridges should be able to talk to our toasters
- Better toast*

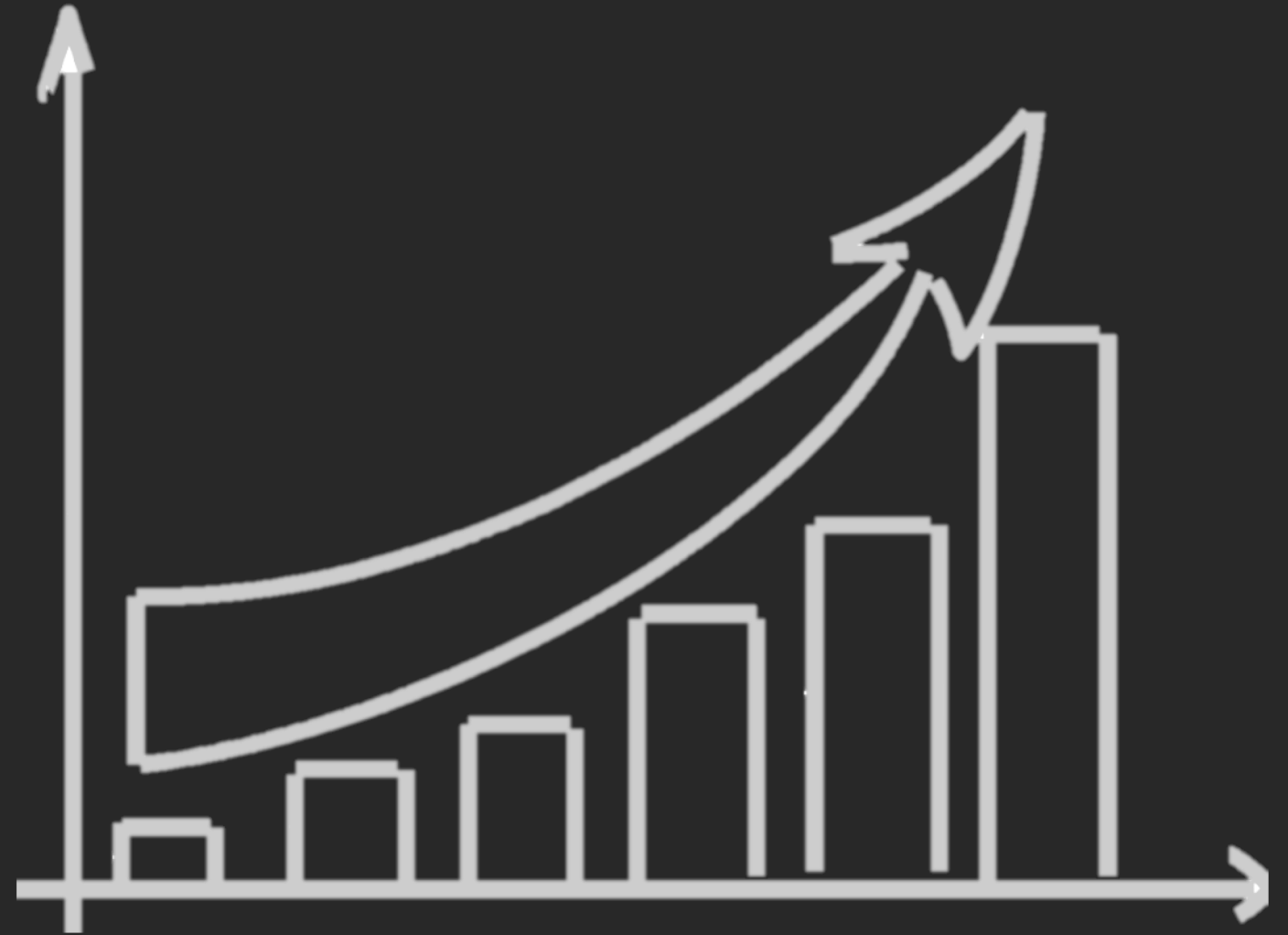


Fig. chart trending upwards

** no scientifically reviewed peer research to support this claim*

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Breadboard Prototype

Inputs/Outputs

- Sensors connectivity
 - GPIO pins
 - USB / Serial

Power

- 3, 5 or 12Volts?
- Battery
- Chargeability?



Compute

- Edge computation
- GPU or CPU loads?
- Camera processing

Connectivity

- WiFi
- LoRa

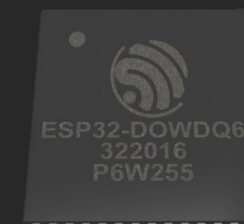
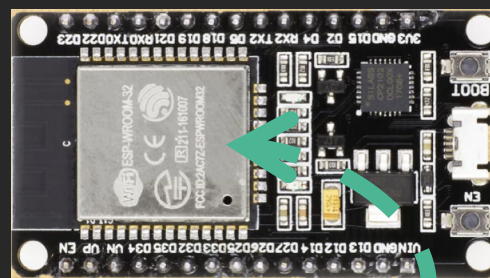
Choosing a Device

Consumer Microcontrollers

- Very cheap
- Open source communities
- Well supported by IoT platforms
 - AWS IoT / FreeRTOS

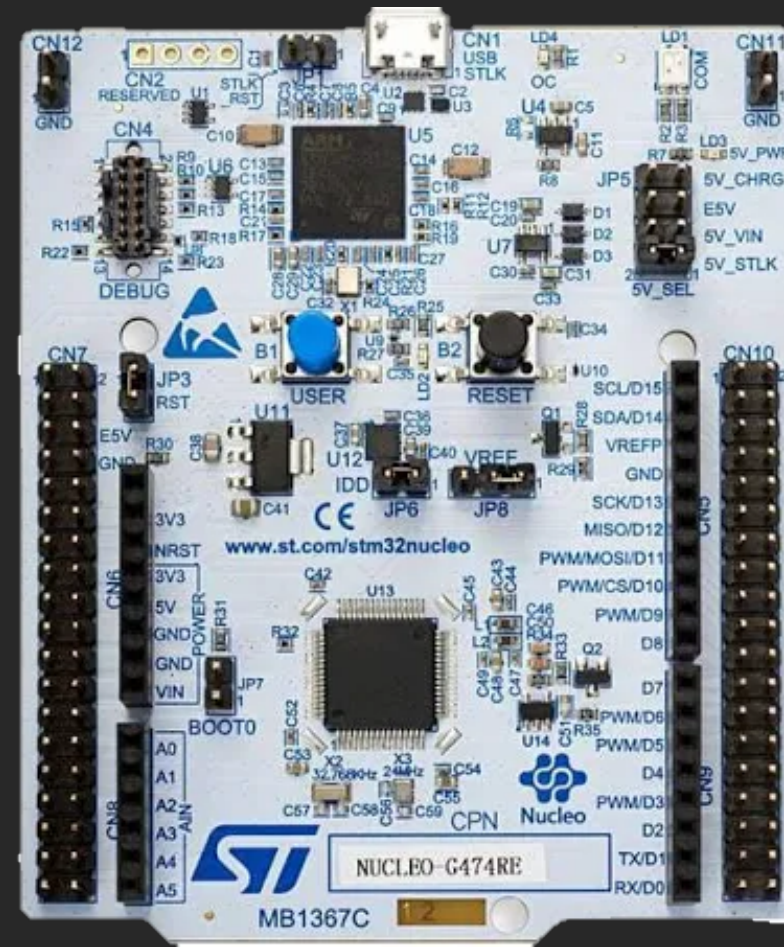
Fabricate your own

- Specific use-cases
- Suitable after problem is validated
- Usually to reduce power consumption



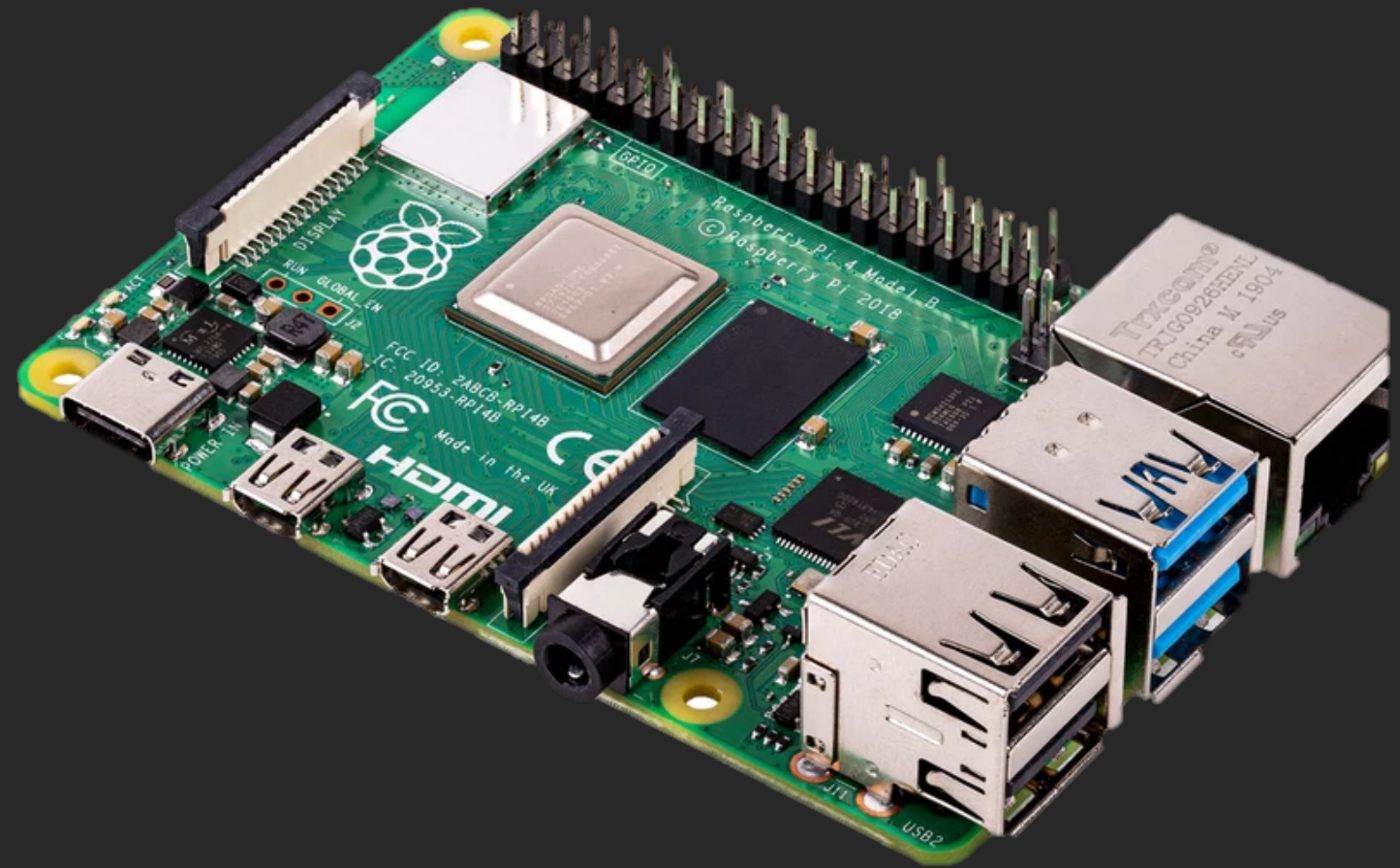
Choosing a Device – Embedded (Low-powered)

- Espressif
 - ESP32
- STMicroelectronics
 - STM32
- Nordic
 - nRF52840DK
- Arduino
 - MKR WiFi 1010



Choosing a Device – More Realtime Operation

- Raspberry Pi
 - Zero W, 3B+, 4
- Orange Pi
 - Zero LTS
- Banana Pi
 - M4
- BeagleBone Black



Choosing a Device – ML & Inference

- **NVIDIA**
 - Jetson NANO
 - TX2
- **Intel**
 - Movidius stick + Raspberry Pi
- **AWS**
 - DeepLens



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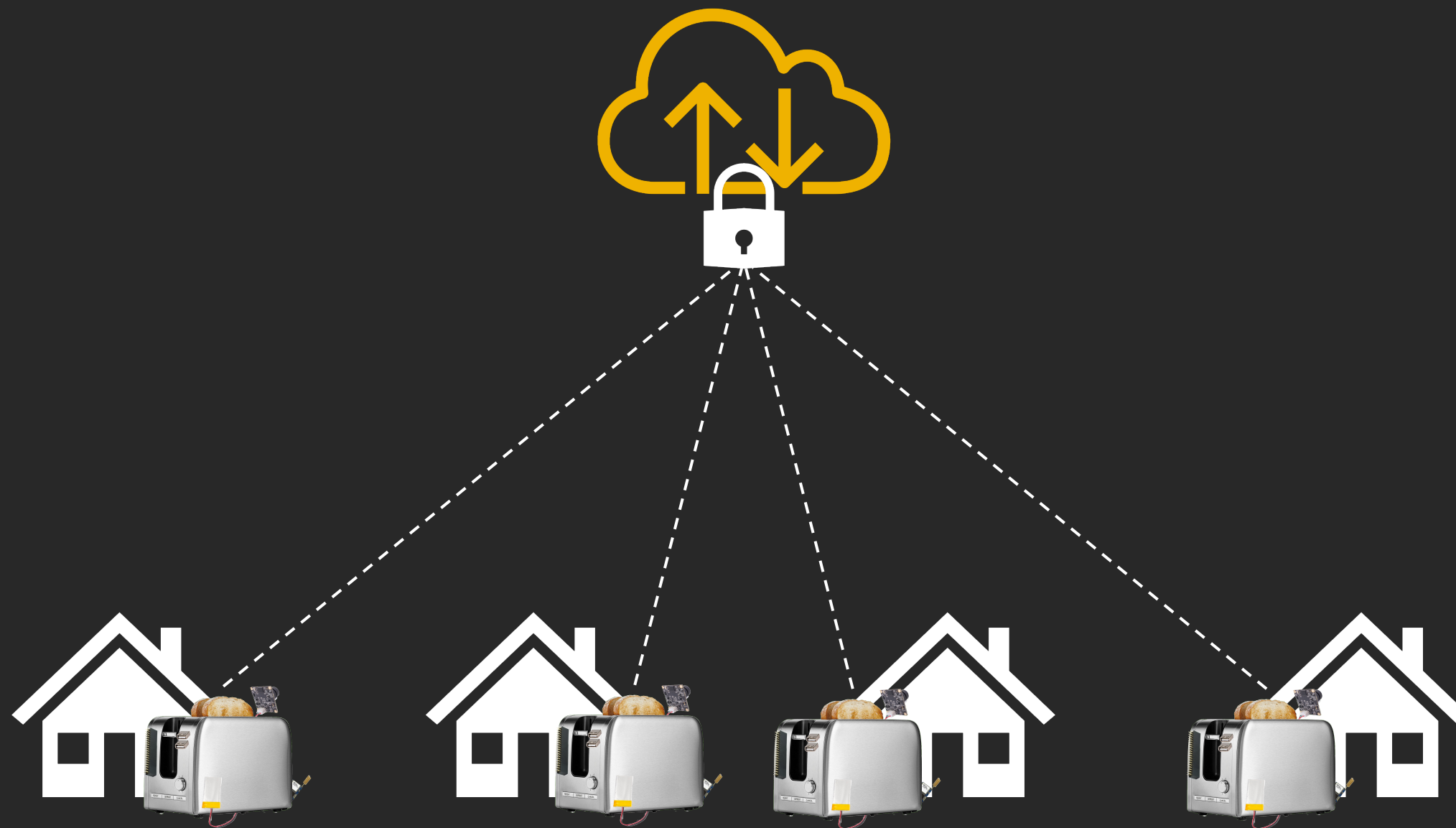
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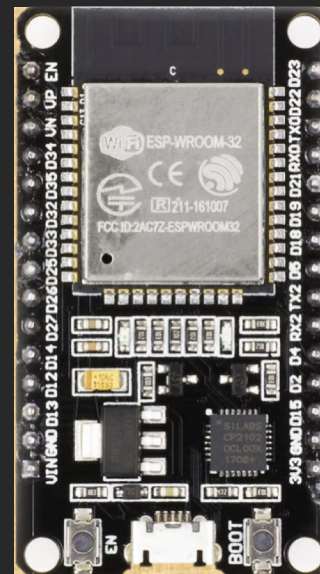


How do we connect securely?



Connecting Securely – Device to Cloud

- x509 certificates
- Amazon managed certificate authority
- Permissions applied to policies



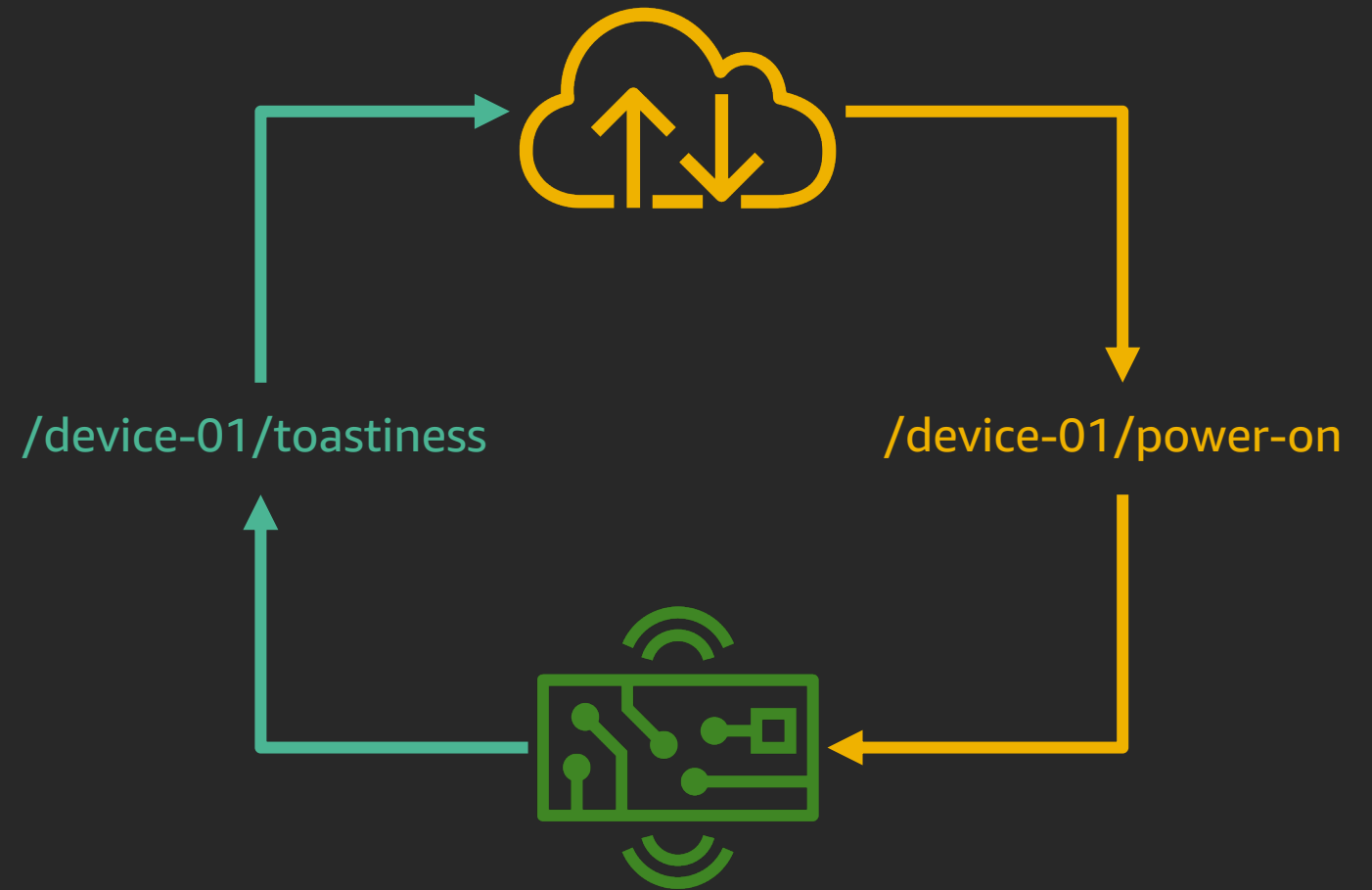
xxxxxxxxxx.iot.us-east-1.amazonaws.com



AWS IoT Core

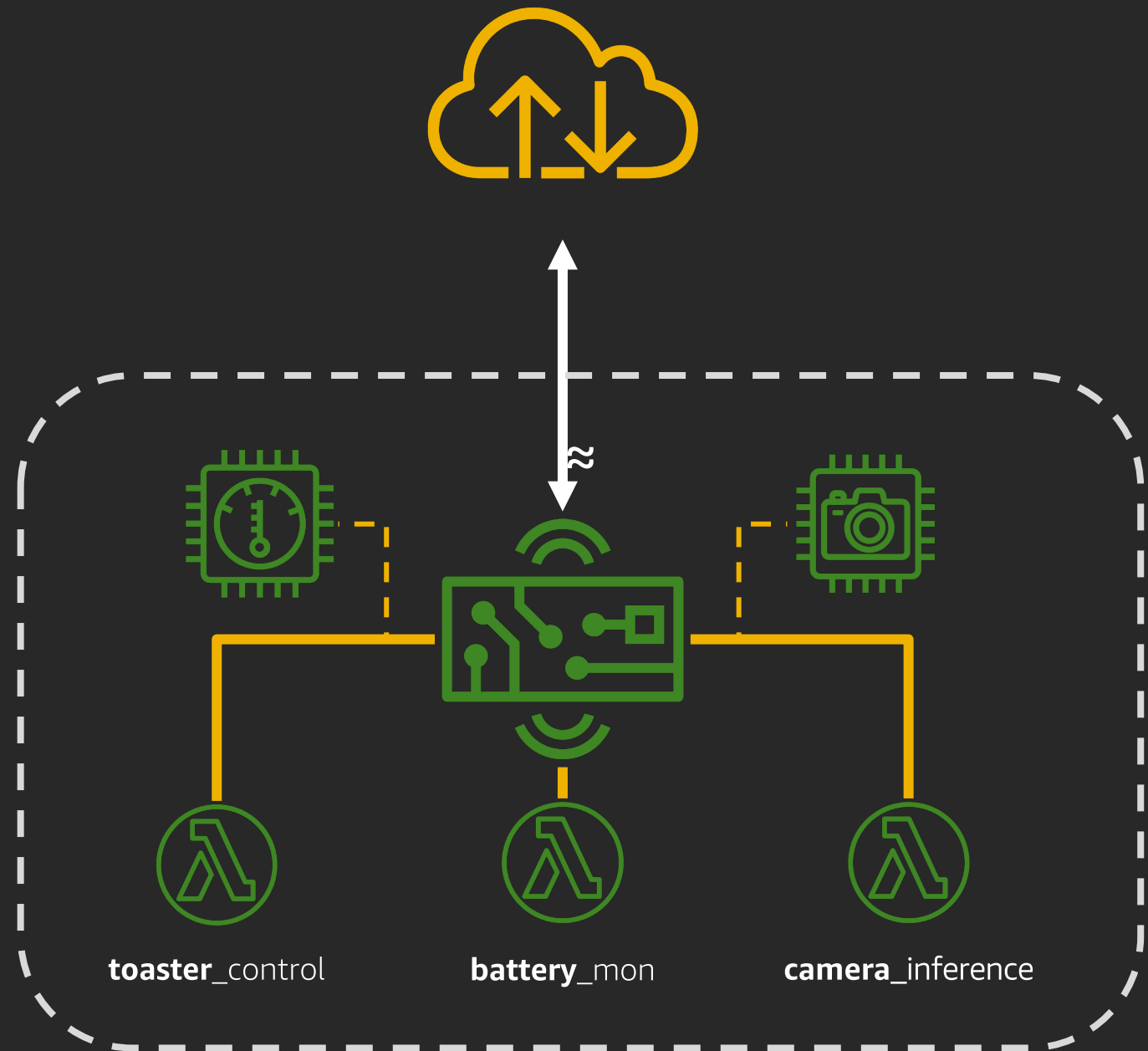
IoT Edge Devices vs **IoT Devices**

- Simple and easy
- IoT Device might only need to report a status
- Bi-directional communication over MQTT



IoT Edge Devices vs IoT Devices

- Sense and Actuate at the edge
- Only suitable for devices with Realtime operating systems
- Resilient to network outages



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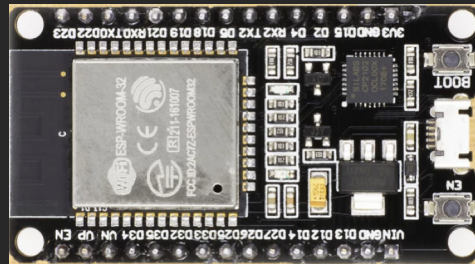
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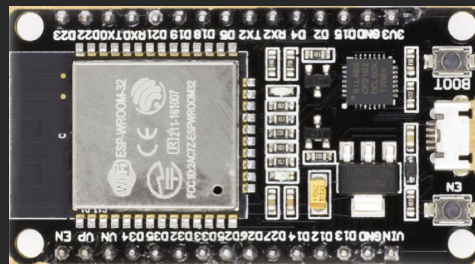
Standards are good
sometimes...



device-01



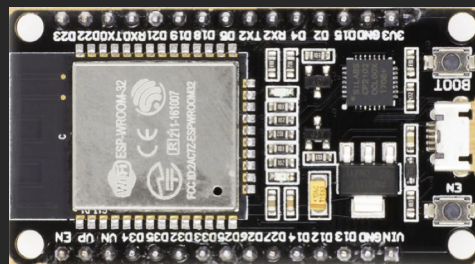
device-cert-01



Device-2



cert-device-2



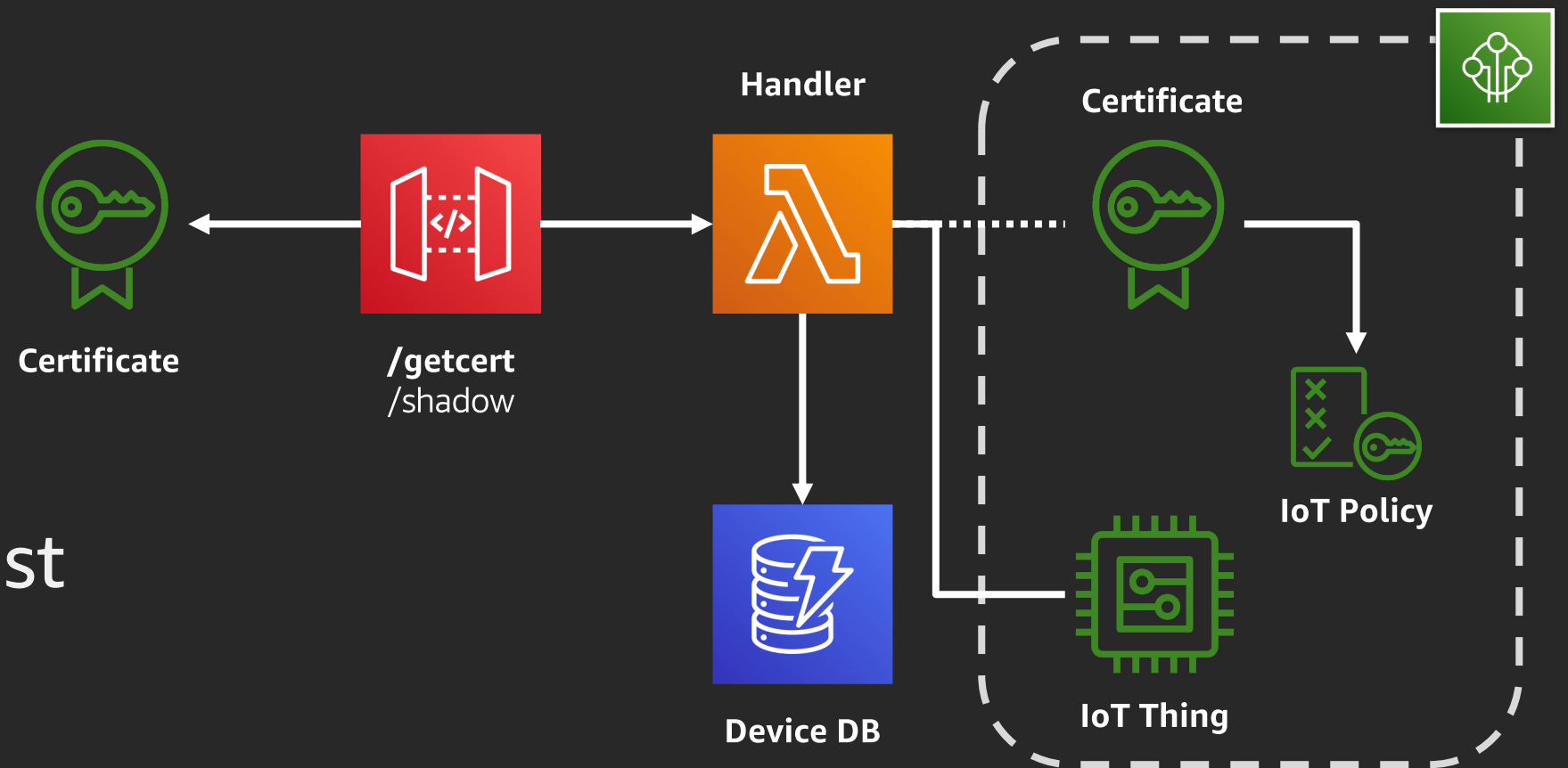
lot-test3



cert-three

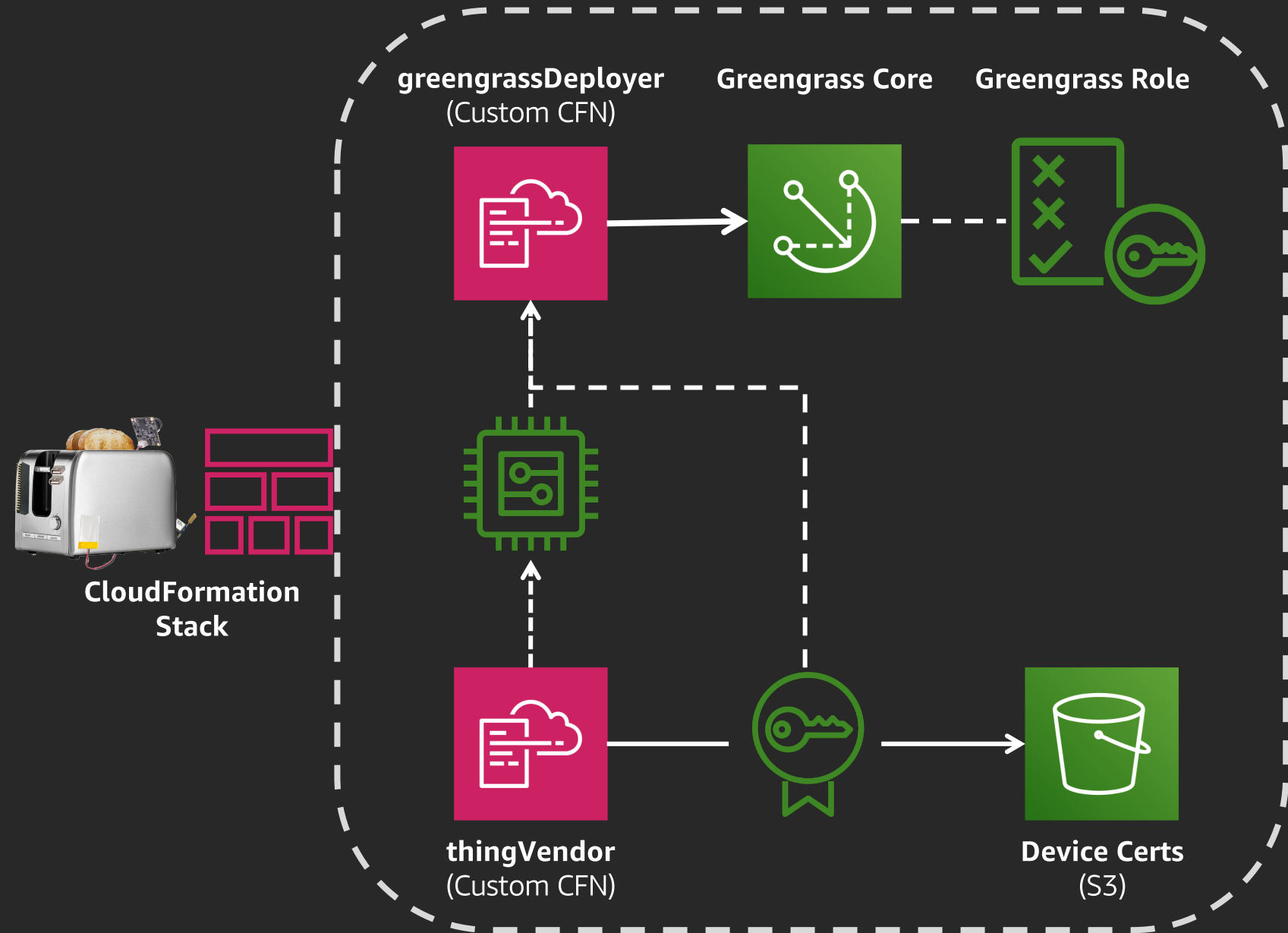
Certificate Vending Machine

- Create and manage
 - Certificates
 - Policies
 - Devices
- Scales well enough for most projects
- CloudFormation managed



Greengrass Vending

- Slightly more involved
- Device is vended
 - Then attached to Greengrass Core
- Automatically cleans up
 - Certificates
 - Devices
 - Roles



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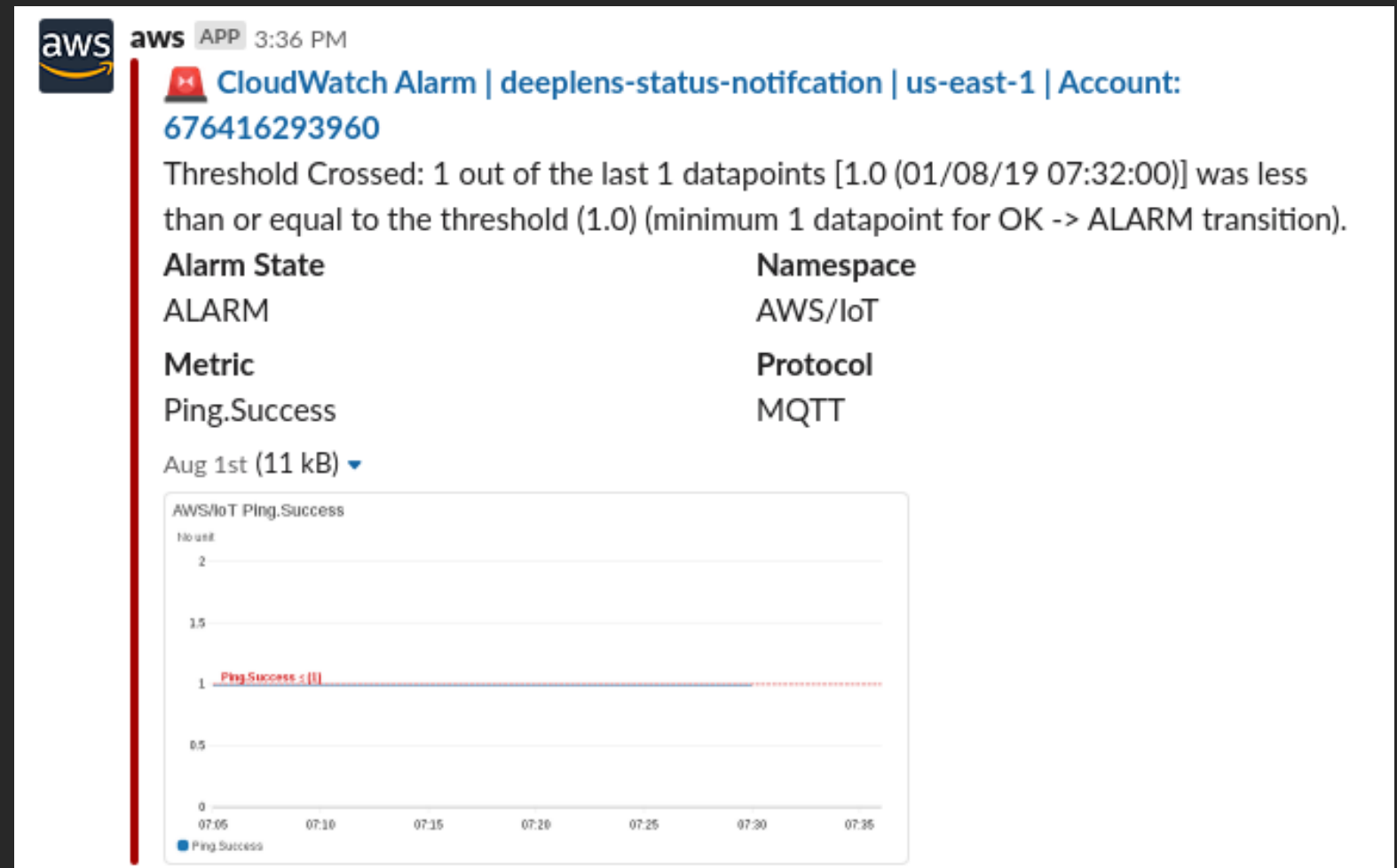
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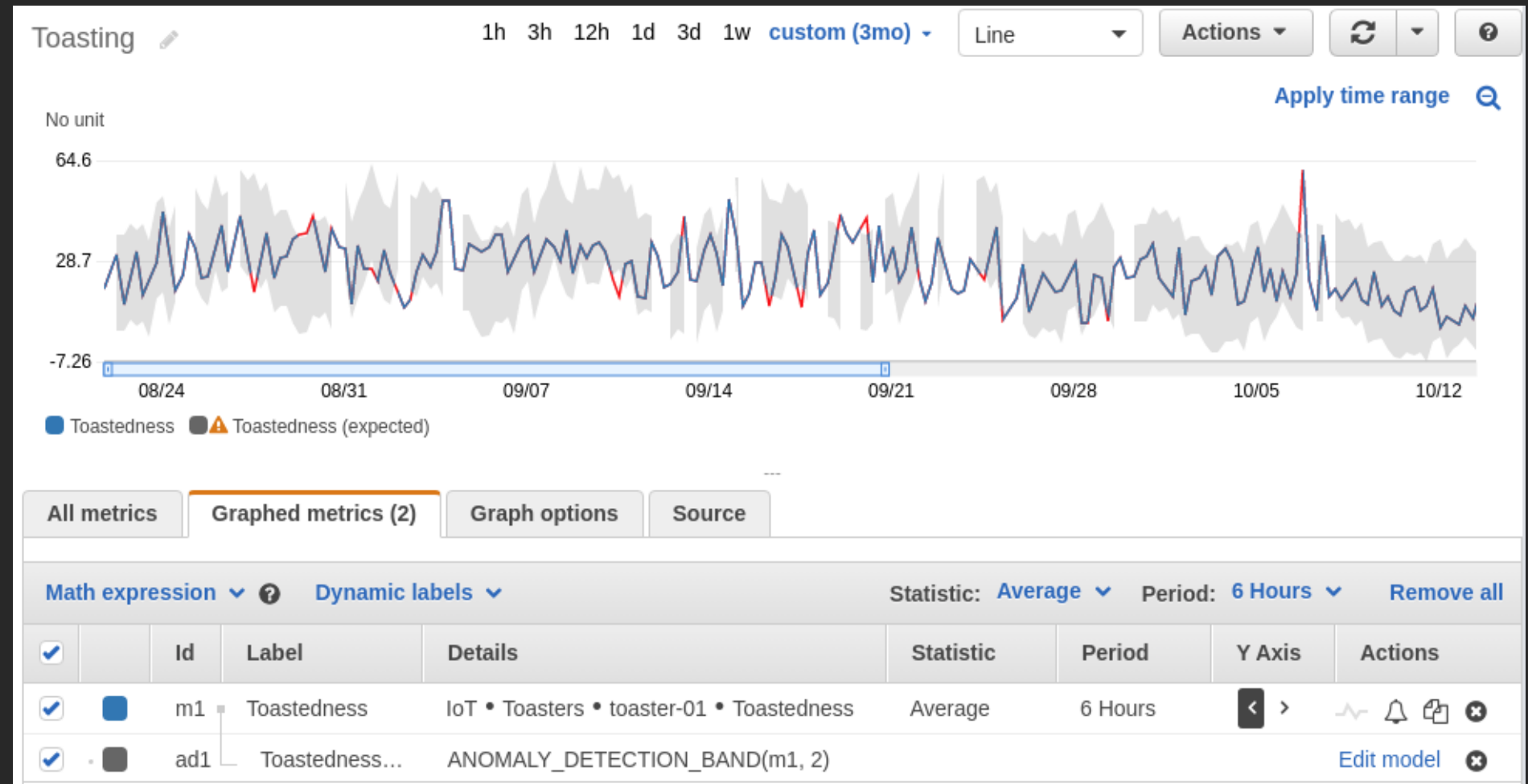
Blanket CloudWatch Alerting

- Setup common CloudWatch Metric rules
- Publish to IM clients using AWS Chatbot
- *Verbose when there are a lot of devices*



Custom Metrics

- Publish your own custom metrics
- Anomaly detection out of the box
- Optimize your toasting time.



IoT Logging

- Very helpful to enable while developing
 - Change to INFO is designed
- While in production, enable ERROR level verbosity
- IoT Logging v2.0 is out
 - Events delivered in JSON format

Logs ENABLED

You can enable AWS IoT to log helpful information to CloudWatch Logs. As messages from your devices pass through the message broker and the rules engine, AWS IoT logs process events which can be helpful in troubleshooting.

Role

AWSIoTCloudWatchLoggingServiceRole

Level of verbosity

Error

[Edit](#)

```
{
  "timestamp": "2019-11-22 12:33:46.382",
  "logLevel": "ERROR",
  "traceId": "4d7bde79-0c72-cc34-20b4-8b0183d2a3b6",
  "accountId": "277790246569",
  "status": "Failure",
  "eventType": "GetThingShadow",
  "protocol": "HTTP",
  "deviceShadowName": "lila",
  "details": "No shadow exists with name: 'toaster-01'"
}
```

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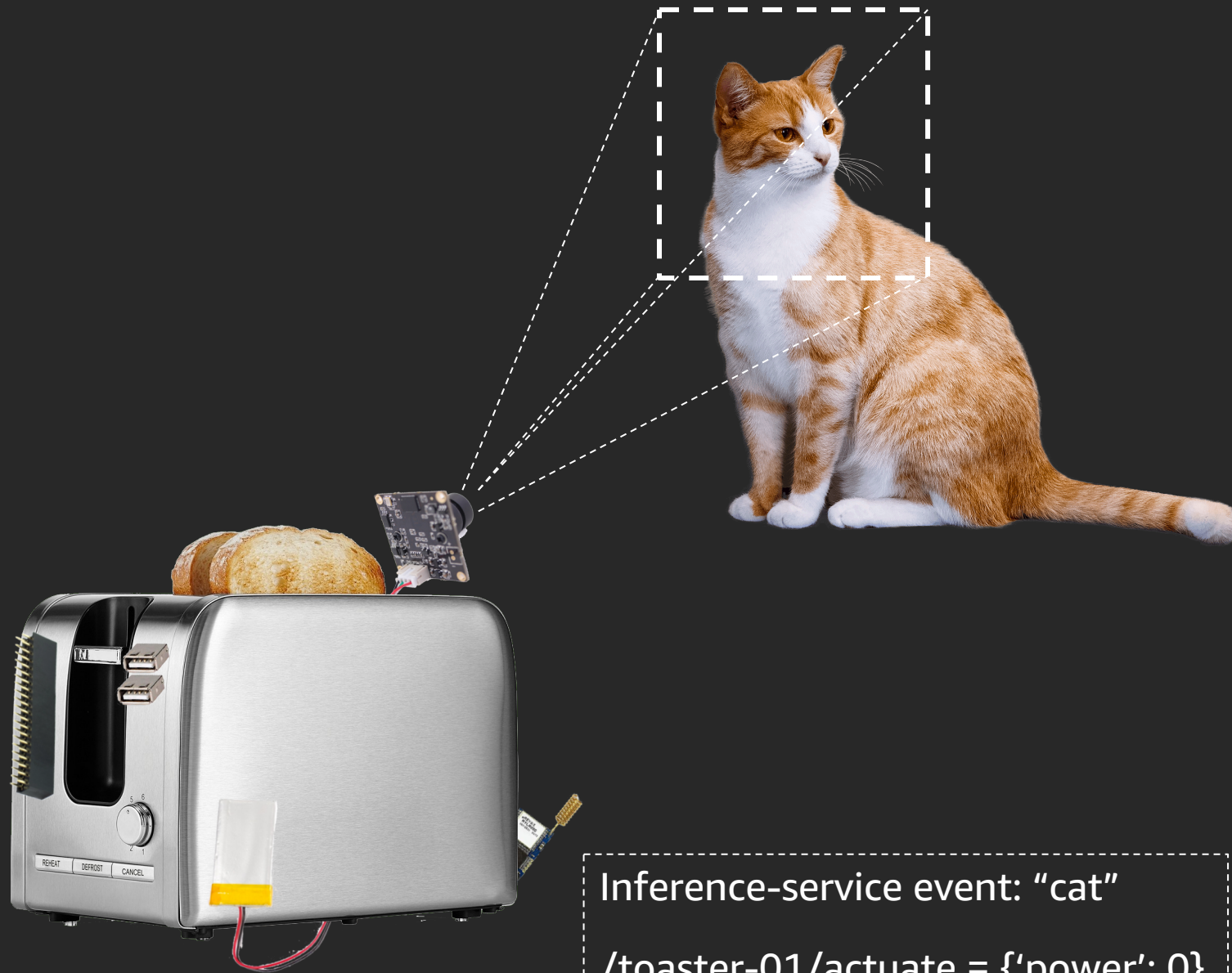
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Image Classification via Greengrass Connector



Inference-service event: "cat"
/toaster-01/actuate = {'power': 0}

ML Image Classification ARMv7 [Learn more](#)

Image classification inference service (Arm v7).

Version: 2

Author: Greengrass Connectors Team

ARN: arn:aws:greengrass:us-east-1::connectors/ImageClassificationARMv7/versions/2

Minimum supported GGC version: 1.9.3

SageMaker job ARN resource

The machine learning resource that points to the trained model.

```
arn:aws:sagemaker:us-east-1:123456789012:jobs/cat-detector
```

More Greengrass Connectors

- Modules to perform common edge tasks
- Recommended:
 - Device Defender
 - CloudWatch Metrics
- CloudFormation supported
 - Easy to deploy to large groups of devices

| | | | |
|-----------------------|-------------------------|------------|----------------------------|
| <input type="radio"/> | CloudWatch Metrics | Version: 2 | Learn more |
| <input type="radio"/> | Device Defender | Version: 2 | Learn more |
| <input type="radio"/> | Iot Analytics | Version: 2 | Learn more |
| <input type="radio"/> | Kinesis Firehose | Version: 3 | Learn more |
| <input type="radio"/> | ML Feedback | Version: 1 | Learn more |
| <input type="radio"/> | ML Image Classification | Version: 1 | Learn more |
| <input type="radio"/> | ML Image Classification | Version: 1 | Learn more |

Serial Stream [Learn more](#)

Reads and writes to a serial port on the core device.

Version: 2

Author: Greengrass Connectors Team

ARN: arn:aws:greengrass:us-east-1::/connectors/SerialStream/versions/2

Minimum supported GGC version: 1.7.0

Serial port resource

The local device resource that represents the physical serial port.

Baud Rate

The baud rate of the serial connection.

Polling read interval (optional)

The interval (in seconds) between each polling operation. Required for Polling-Read mode. Must be between 1 and 999.

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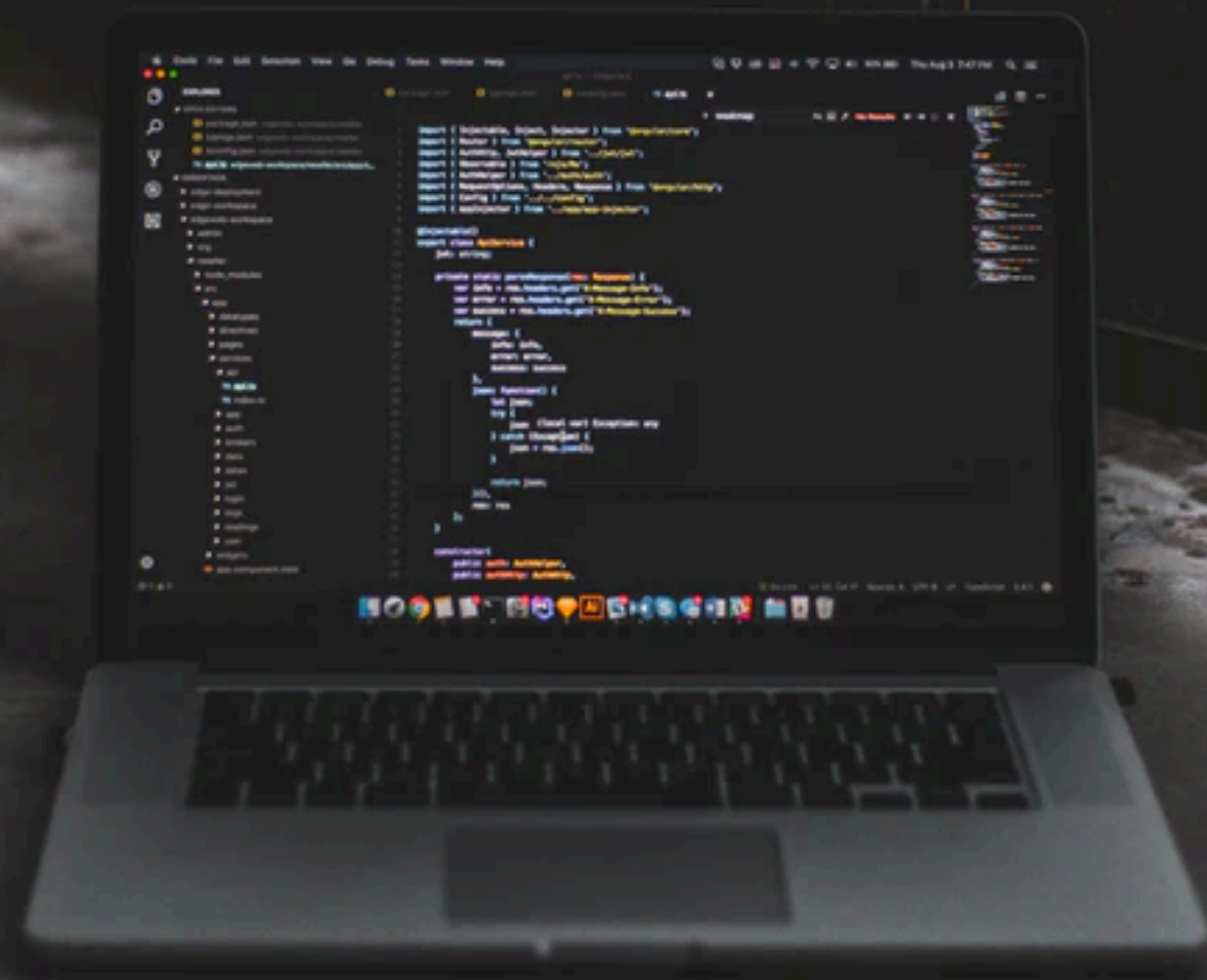


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Device Defender – Security Profiles

- Define **GOOD** and **BAD** behaviors
- Custom to your business cases
- Profiles can be like guardrails

DataExfiltrationCheck

Alerts on a possible data exfiltration attempt on devices

▼ Behaviors (2)

| Name | Description | Action |
|--------------------|---------------------------------------------------------------------------------------------------------------|--------|
| PacketExfiltration | Packets out greater than or equal to p99 in 5 minutes with datapoints to Alarm: 3, and datapoints to Clear: 3 | Add |
| CIDRExfiltration | Destination IPs not in CIDR set 123.243.24.247/32 with datapoints to Alarm: 1, and datapoints to Clear: 1 | Add |

▼ Additional Metrics to retain (6)

| Metric | Action |
|---------------------|--------|
| Connection attempts | Add |
| Destination IPs | Add |

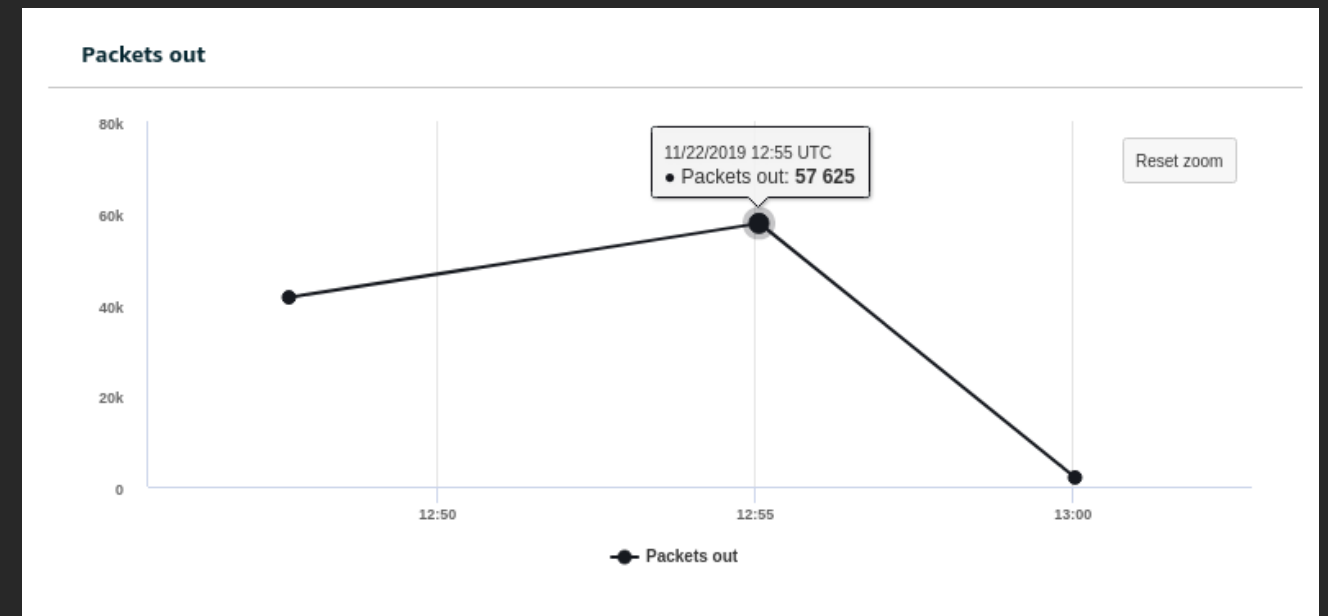
Device Defender – Security Profile (Results)

| Event ▾ | State | Thing name | Security profile | Behavior ? | Transition value ? |
|-------------------------------|-----------------|------------|-----------------------|--------------------|--------------------|
| Nov 22, 2019 9:05:02 PM +0800 | ● Alarm cleared | toaster-01 | DataExfiltrationCheck | PacketExfiltration | 276757 packet(s) |
| Nov 22, 2019 9:00:02 PM +0800 | ● In alarm | toaster-01 | DataExfiltrationCheck | PacketExfiltration | 1993 packet(s) |

Destination IPs ▾ Last 24 hours ▾

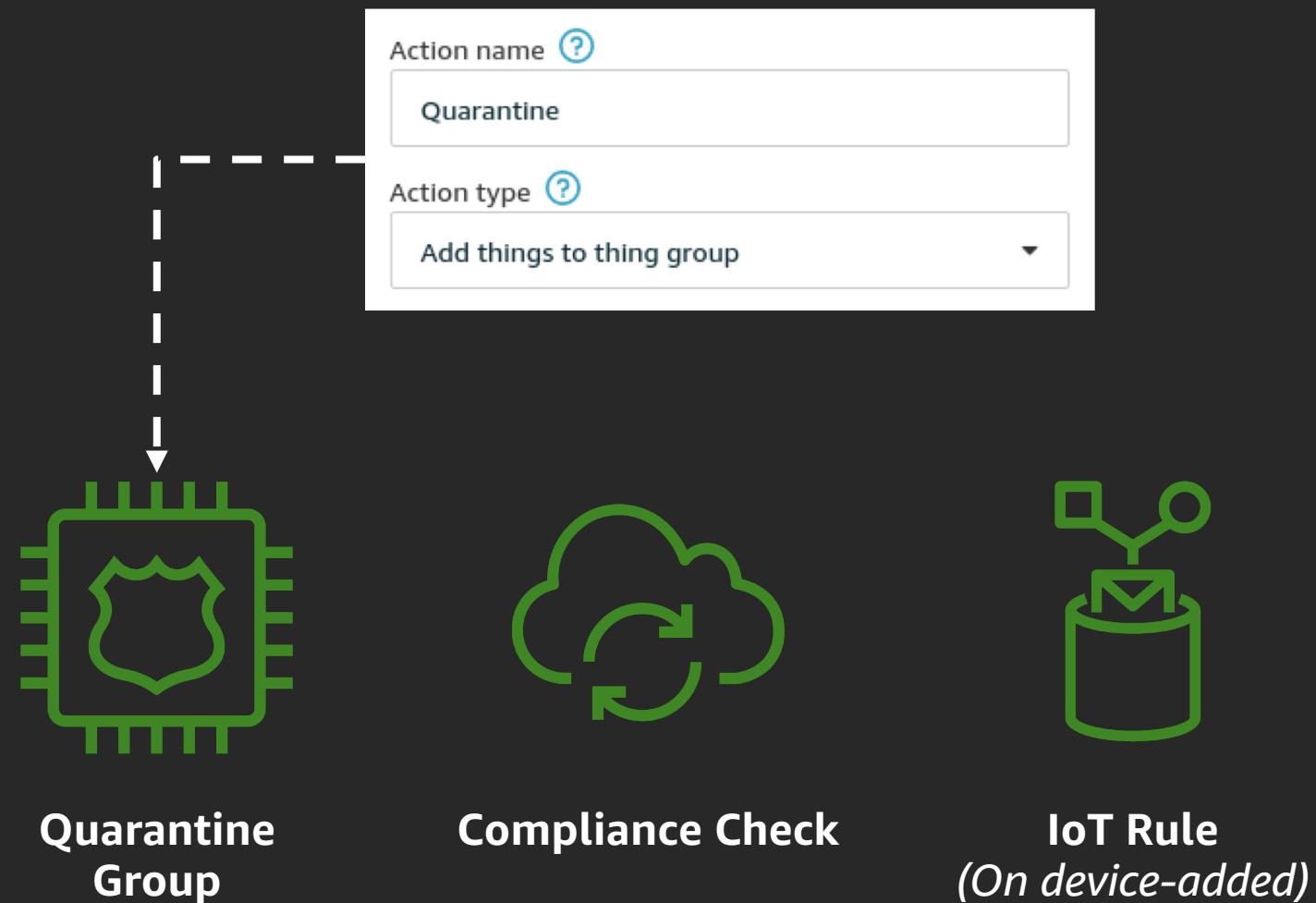
Destination IPs

| Timestamp | Metric Value |
|-------------------------------|---------------------------------------------------------|
| Nov 22, 2019 9:00:02 PM +0800 | 192.168.188.40, 35.153.28.249, 127.0.0.1 |
| Nov 22, 2019 8:55:03 PM +0800 | 35.153.28.249, 192.168.188.40, 52.54.149.10 |
| Nov 22, 2019 8:47:39 PM +0800 | 192.168.188.40, 34.197.173.244, 127.0.0.1, 54.239.25.71 |



Device Defender – Mitigation Actions

- Automated actions for compliance failures
- Automatically performs:
 - Remove policy permissions
 - Rotate certificates
 - Send notifications



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Over the Air (OTA) Updates

- Leverages IoT Jobs
 - Greengrass Core
 - AWS FreeRTOS
- Update process can be automated
- Target *Things group* to update thousands at a time

```
aws greengrass create-software-update-job \  
--region ${AWS_REGION} \  
--update-targets-architecture x86_64 \  
--update-targets arn:aws:iot:${REGION}:${ACCOUNT}:thing/${THING} \  
--update-targets-operating-system ubuntu \  
--software-to-update core \  
--update-agent-log-level DEBUG \  
--s3-url-signer-role ${greengrassUpdateRoleArn}
```

Last updated Nov 21, 2019 8:12:05 PM +0800 [All Statuses](#) [Refresh](#)

| | | | | | | | |
|-------------|---------------------|----------------|-------------|----------------|---------------|---------------|--------------|
| 1 Queued | 0 In progress | 0 Timed out | 0 Failed | 0 Succeeded | 0 Rejected | 0 Canceled | 0 Removed |
|-------------|---------------------|----------------|-------------|----------------|---------------|---------------|--------------|

| Resource | Last updated | Status | |
|--------------|-------------------------------|--------|-----|
| > toaster-01 | Nov 21, 2019 8:11:21 PM +0800 | Queued | ... |

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Thank you!

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