

# NXP MICROCONTROLLER INNOVATION CLOUD CONNECTIVITY WITH AWS & LPC54018

JUNE 2018



PUBLIC



SECURE CONNECTIONS  
FOR A SMARTER WORLD



## AGENDA

- MCU Introduction
- Cloud Connectivity
  - Applications and challenges we're solving together
  - Introducing Amazon FreeRTOS & AWS IoT suite of services
- Connecting with LPC54018 based IoT module
- Demo
- Where to go, resources, get started!



# NXP 32-BIT MICROCONTROLLERS FOCUSING ON OUR ECOSYSTEM

1

## **Innovation**

Product, Technology,  
Solutions

2

**Low Cost  
SW, Tools & Boards**

3

**Quality &  
Longevity**

4

**Local  
Support**

5

**Partner  
Ecosystem**

# NXP 32-BIT MICROCONTROLLERS

## EXAMPLE CUSTOMER SEGMENTATION

### General Consumer



### USB Peripherals & Gaming



### Home & Building



### Industrial, Energy

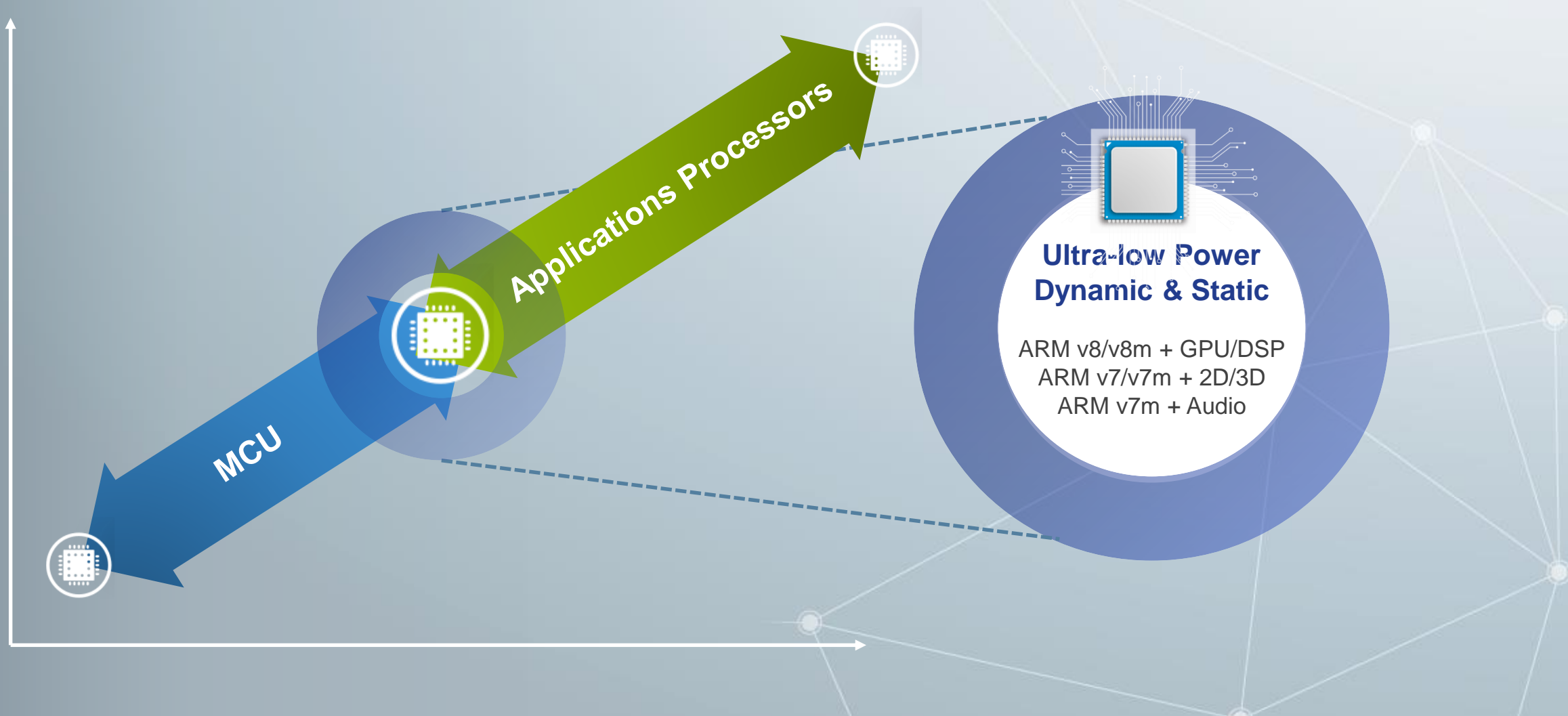


### General Embedded



# SCALABILITY OF EMBEDDED PROCESSING

## THE NEW NORMAL



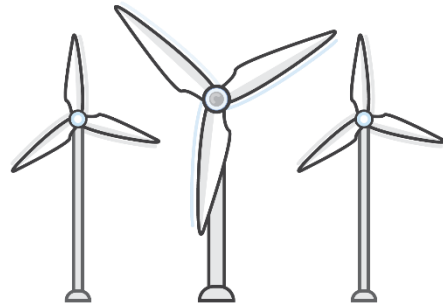
# CLOUD CONNECTIVITY AWS & NXP



# Verticals markets requiring Cloud Connectivity



Smart Home



Industrial



Automotive



Metering

# Market Observations

## Challenges

- Time to Market
- Software Complexity
- Development & Production Costs
- Operating Expense

## Themes

- Added consumer conveniences
- Real-time control
- Remote access & monitoring
- Exponential growth of IoT data
- Need for increased processing capabilities with inherent embedded security



# Amazon FreeRTOS

*IoT Operating System for Microcontrollers*

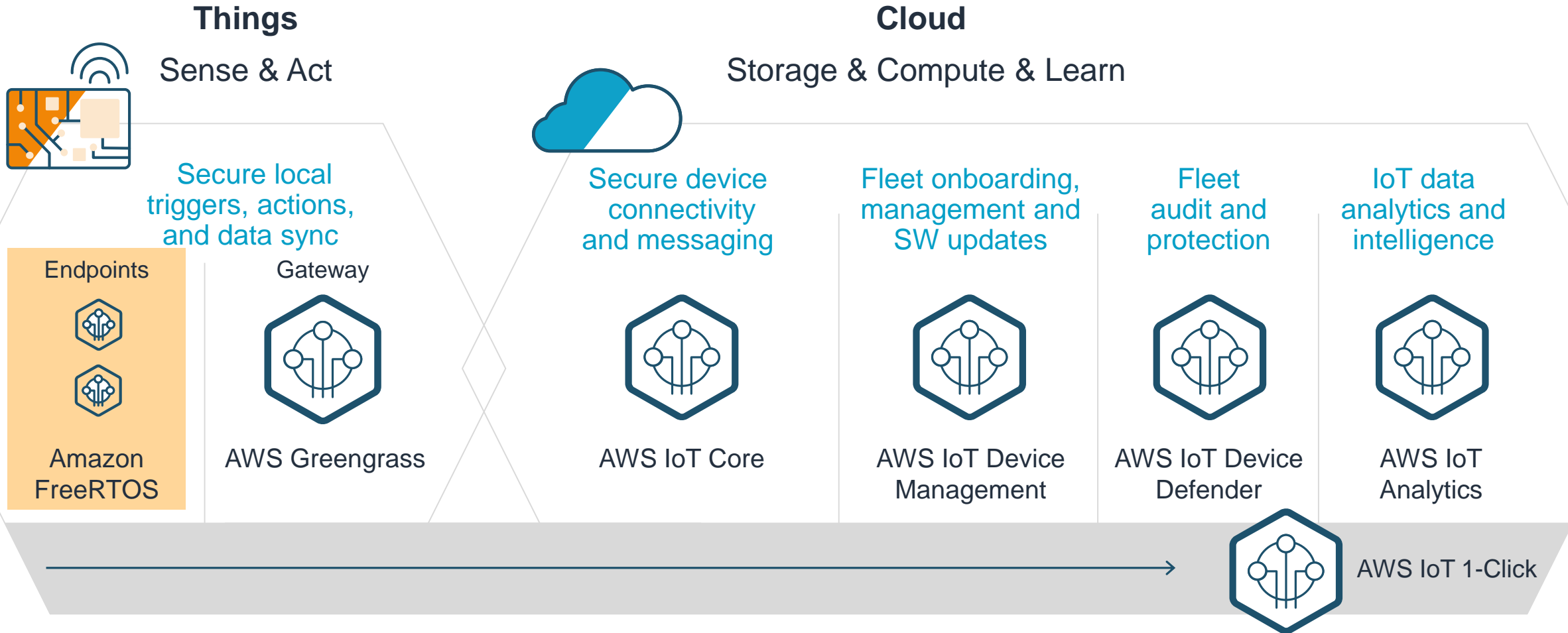
Extends the **FreeRTOS Kernel**  
with libraries for security and  
cloud & local connectivity

Open source under the MIT license

No requirement to use AWS



# AWS IoT Services Suite

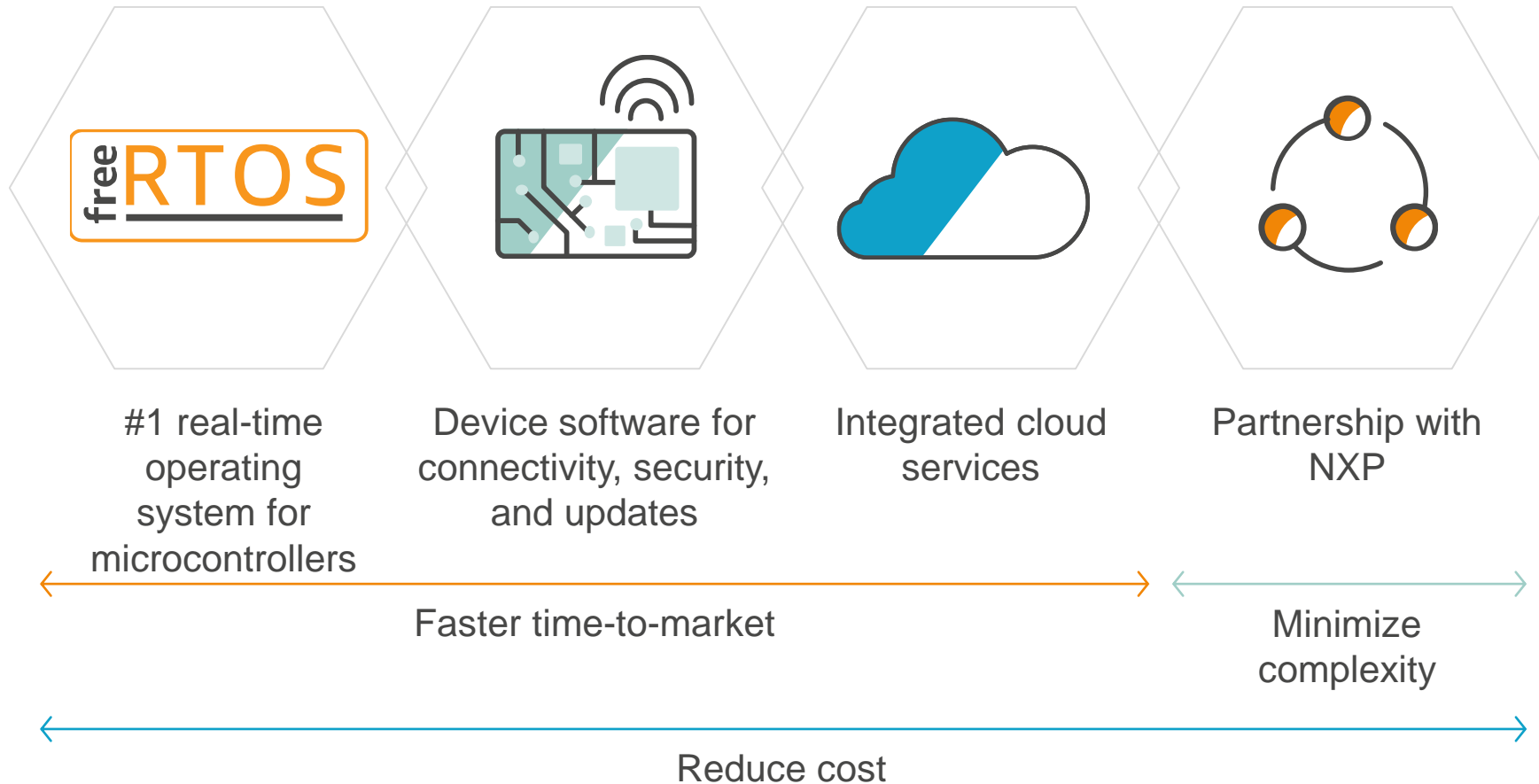


# Amazon FreeRTOS

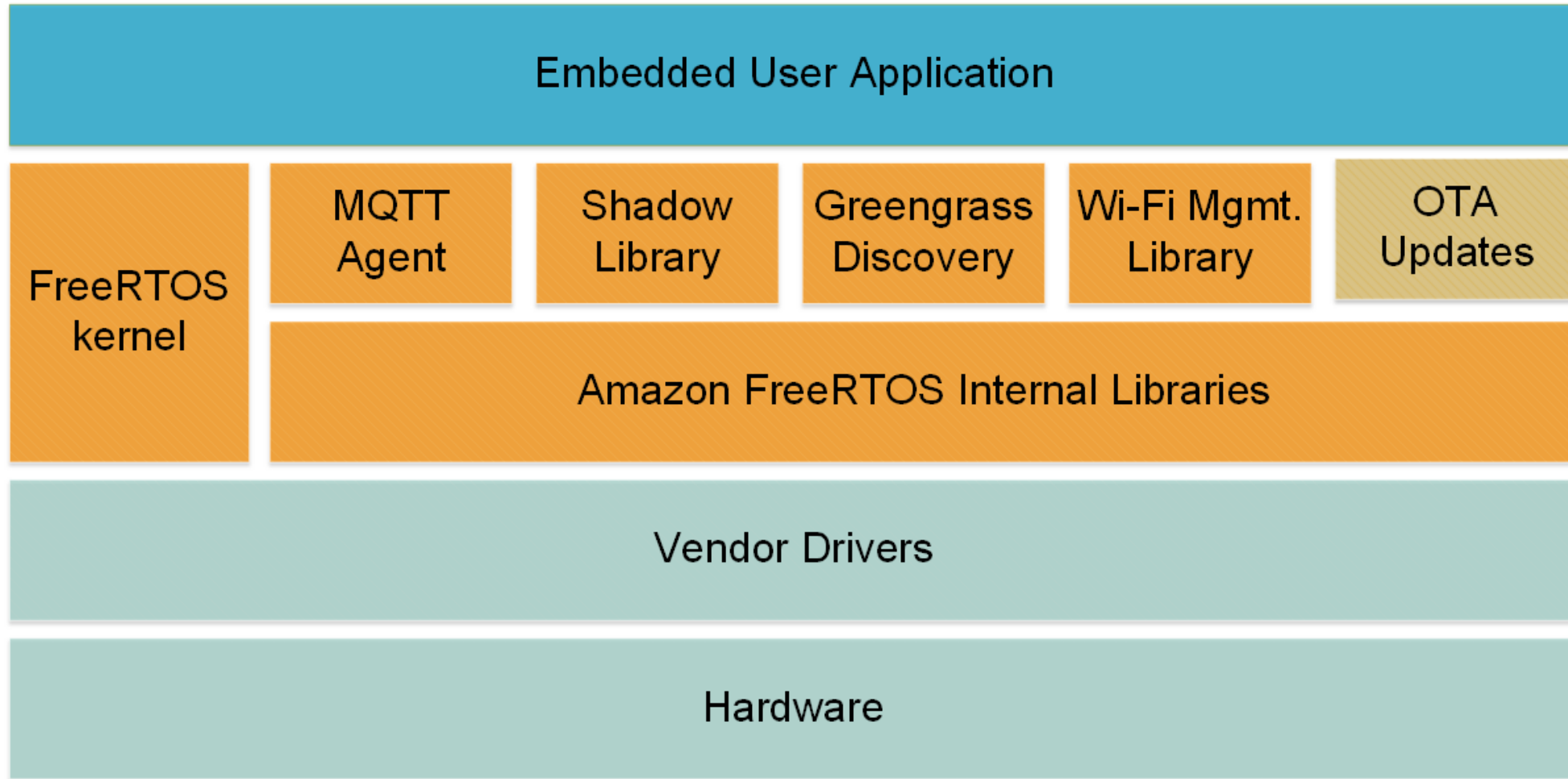
Amazon FreeRTOS is an IoT OS for microcontrollers that makes small, low powered edge devices easy to program, deploy, secure, connect, and maintain.



# Amazon FreeRTOS



# Modular architecture driving faster time to market



# Based on #1 Real-Time Operating System for Microcontrollers

- 15 years, trusted, and widely distributed
- 40+ supported architectures
- Broad ecosystem support
- Free and open source
- Introducing version 10
- MIT Open Source License
- Improved Inter-Process Communication (IPC) capabilities with stream and message buffers



# Amazon FreeRTOS: Local Connectivity Libraries

Connect with AWS Greengrass

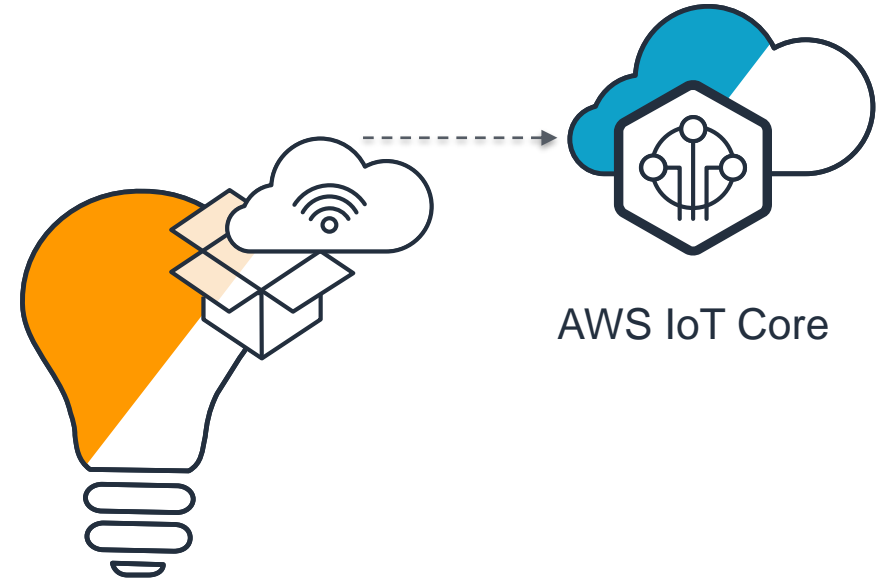
- Local communication with edge gateways and a Wi-Fi stack, including AWS Greengrass discovery support
- Wi-Fi management library implements an abstraction layer for Wi-Fi features such as setup, configuration, provisioning, security, and power management
- Continue communicating, collecting data, and taking actions without a cloud connection
- Support for many network topologies and use cases



# Amazon FreeRTOS: Cloud Connectivity Libraries

Connect with AWS IoT Core

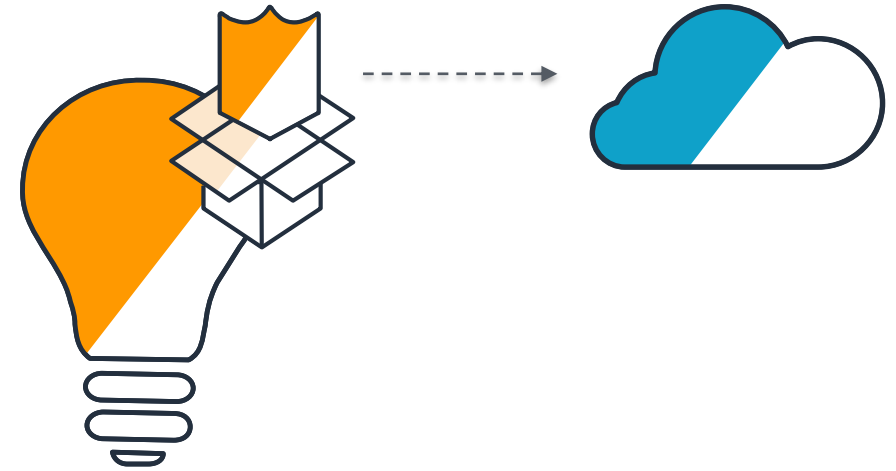
- MQTT Pub/Sub messaging
- Device Shadow support
- Take advantage of IoT Core benefits like IoT Device Management, scalable architecture, and pay as you go pricing
- Fastest way to get started on IoT microcontrollers





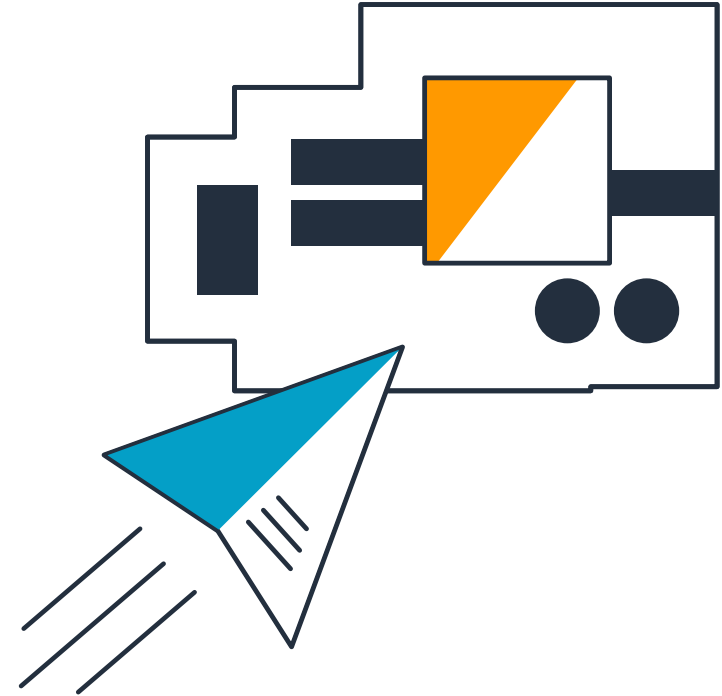
# Amazon FreeRTOS: Security Connectivity Libraries

- Secure sockets using TLS
- Mutual Certificate authentication
- PKCS#11 interface for key management
- No open network ports
- Only run trusted code
- Clear, modular implementation

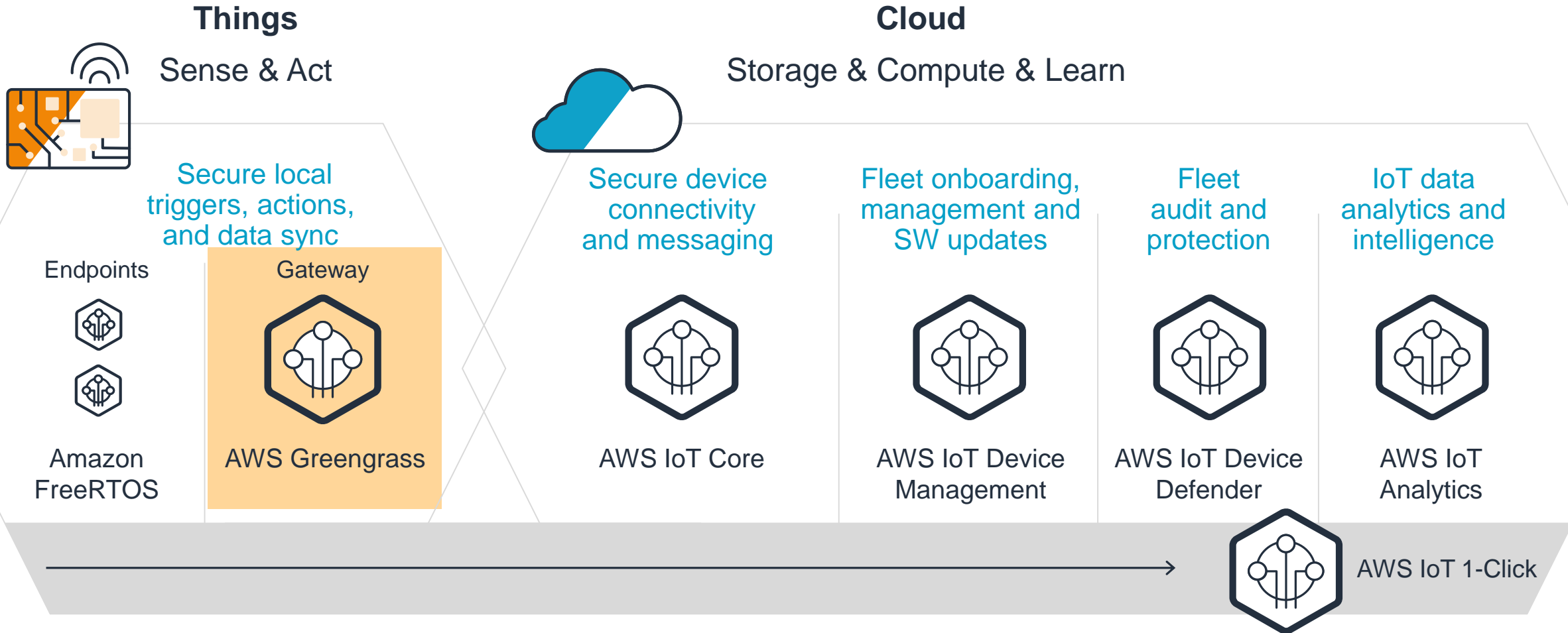


# Amazon FreeRTOS: Over-the-Air Firmware Updates <sup>Beta</sup>

- Use AWS IoT Device Management to assign updates to groups
- Code sign new firmware images
- Stream updates to your device over MQTT
- Validate signature on device
- APIs to control installation and reboot logic
- Simple to manage groups
- Control authorship and ensure devices only run trusted code
- Memory efficient updated client
- **Coming Soon!**



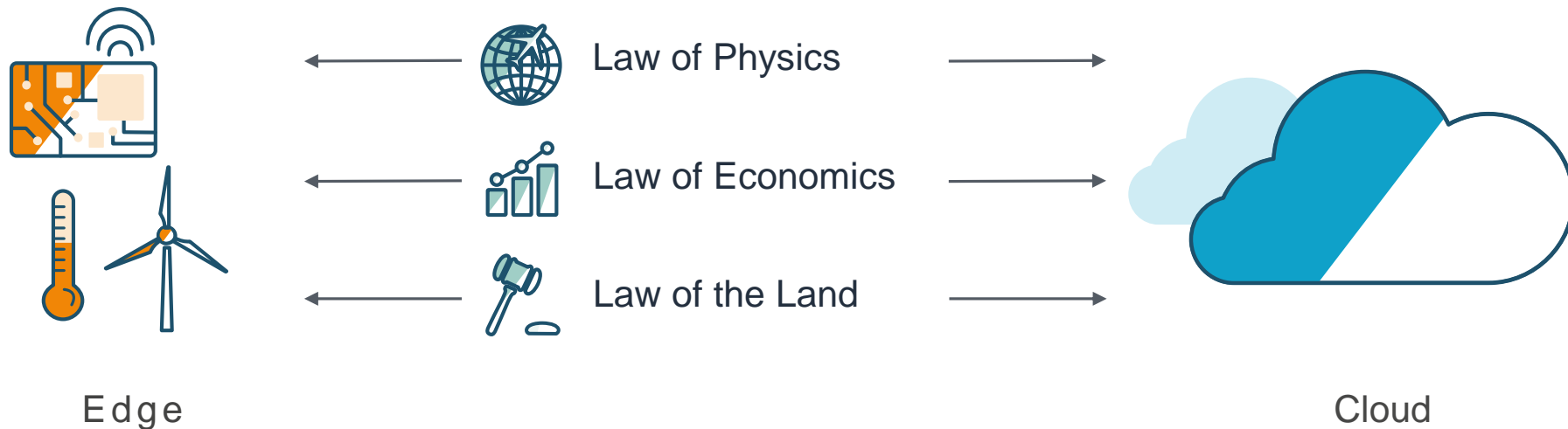
# AWS IoT Services Suite



# AWS Greengrass

## Extend AWS IoT to the Edge

AWS Greengrass extends AWS IoT onto your devices, so that they can act locally on the data they generate, while still taking advantage of the cloud.

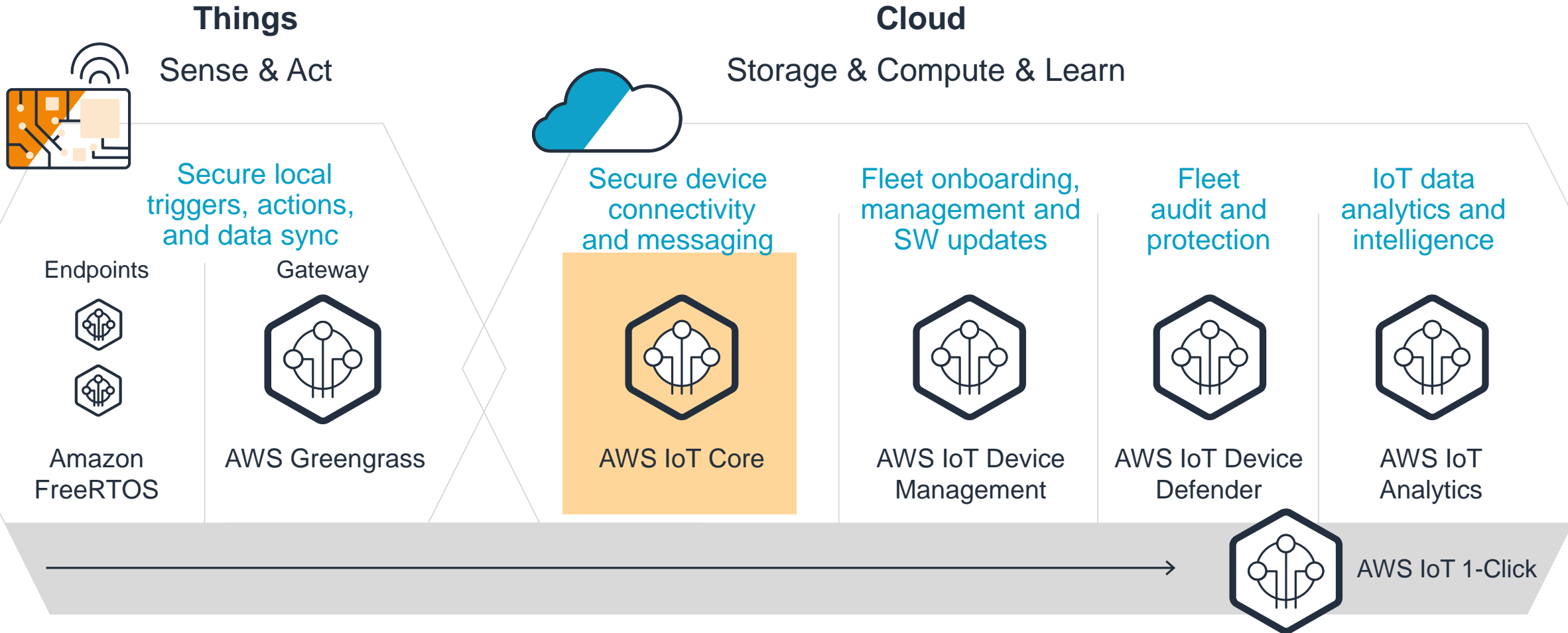


# AWS Greengrass

## Extend AWS IoT to the Edge



# AWS IoT Services Suite



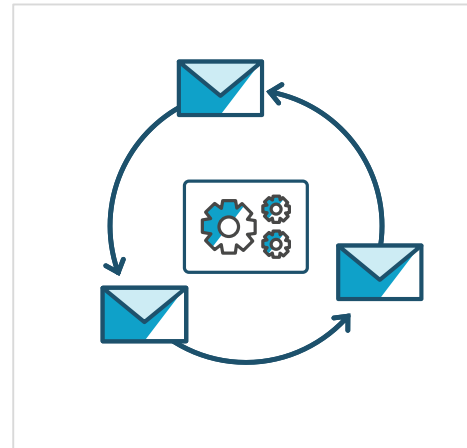
# AWS IoT Core

## Secure Device Connectivity and Messaging

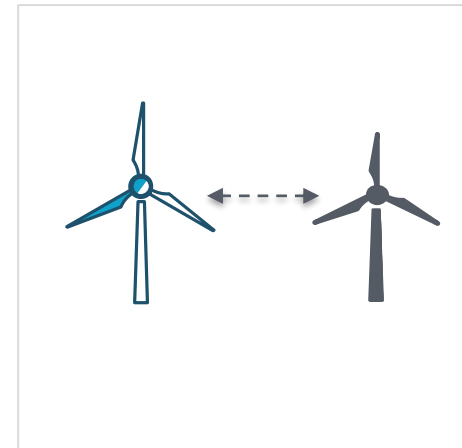
AWS IoT Core is a managed service that lets connected devices easily and securely interact with cloud applications and other devices.



To securely connect devices to the AWS cloud and other devices at scale



To route, process, and act upon data from connected devices



To enable applications to interact with devices even when they are offline



To fully integrate with other AWS service to reason on top of the data (Analytics, Databases, AI, etc.)

# Things management



CERTIFICATE  
17fd71c0919c74

ACTIVE

Actions

- Activate
- Deactivate
- Revoke
- Accept transfer
- Reject transfer
- Revoke transfer
- Start transfer
- Attach policy
- Attach thing
- Download
- Delete

**Details** Certificate ARN

Policies

Things

arn:aws:iot:us-east-1: :cert/ 5f21a

**Details**

**Issuer**  
OU=Amazon Web Services O\=Amazon.com Inc. L\=Seattle ST\=Washington C\=US

**Subject**  
CN=AWS IoT Certificate

**Create date**  
Jun 1, 2018 3:41:47 AM -0400

**Effective date**  
Jun 1, 2018 3:39:47 AM -0400

**Expiration date**  
Dec 31, 2049 6:59:59 PM -0500

Thing ARN Edit

A thing Amazon Resource Name uniquely identifies this thing.

arn:aws:iot:us-east-1: :thing/berlin

Type

Q Prototypes ...

1 Attributes

Attribute key	Value
Q Vendor	NXP



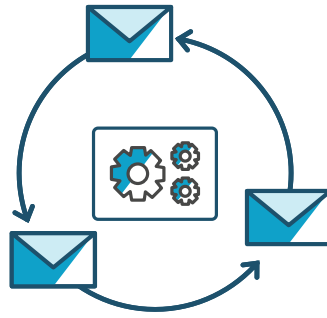
Policy

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "iot:Connect",
      "Resource": "arn:aws:iot:us-east-1:123456789012:*"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Publish",
      "Resource": "arn:aws:iot:us-east-1:123456789012:client/${iot:ClientId}"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Subscribe",
      "Resource": "arn:aws:iot:us-east-1:123456789012:*"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Receive",
      "Resource": "arn:aws:iot:us-east-1:123456789012:*"
    }
  ]
}
```





# Rules Engine



## Overview

### Description

Edit

No description

### Rule query statement

Edit

The source of the messages you want to process with this rule.

```
SELECT hallsensor FROM 'lpc54018/demo' WHERE hallsensor > 4096
```

Using SQL version 2016-03-23

### Actions

Actions are what happens when a rule is triggered. [Learn more](#)



Store messages in an Amazon S3 bucket  
acmelambdas

Remove Edit >

Add action

### Error action

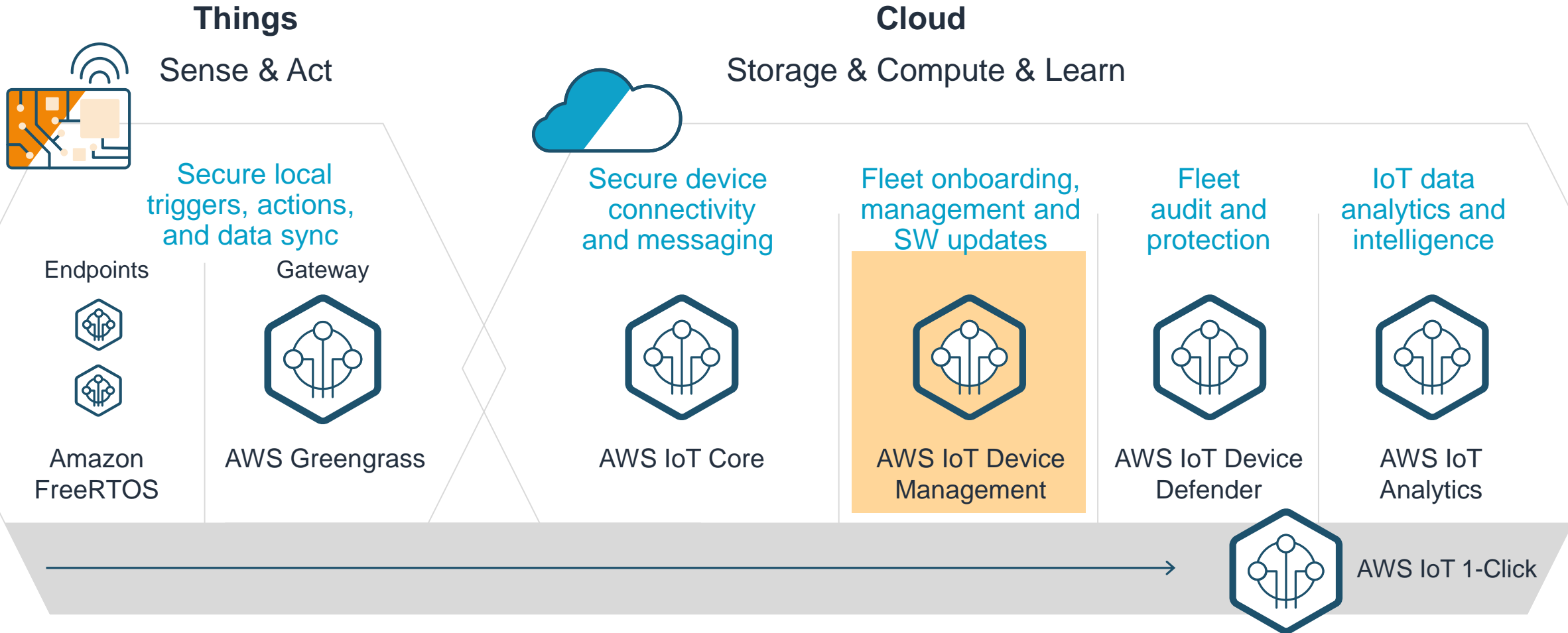
Optionally set an action that will be executed when something goes wrong with processing your rule.

Add action

Select an action.

- Insert a message into a DynamoDB table  
DYNAMODB
- Split message into multiple columns of a database table (DynamoDBv2)  
DYNAMOVBV2
- Invoke a Lambda function passing the message data  
LAMBDA
- Send a message as an SNS push notification  
SNS
- Send a message to an SQS queue  
SQS
- Sends messages to an Amazon Kinesis Stream  
AMAZON KINESIS
- Republish messages to an AWS IoT topic  
AWS IoT REPUBLISH
- Store messages in an Amazon S3 bucket  
S3
- Send messages to an Amazon Kinesis Firehose stream  
AMAZON KINESIS FIREHOSE
- Sends message data to CloudWatch  
CLOUDWATCH METRICS
- Change the state of a CloudWatch alarm  
CLOUDWATCH ALARMS
- Send messages to the Amazon Elasticsearch Service  
AMAZON ELASTICSEARCH
- Send message to a Salesforce IoT Input Stream  
SALESFORCE IOT
- Send message to an IoT Analytics Channel  
IOT ANALYTICS

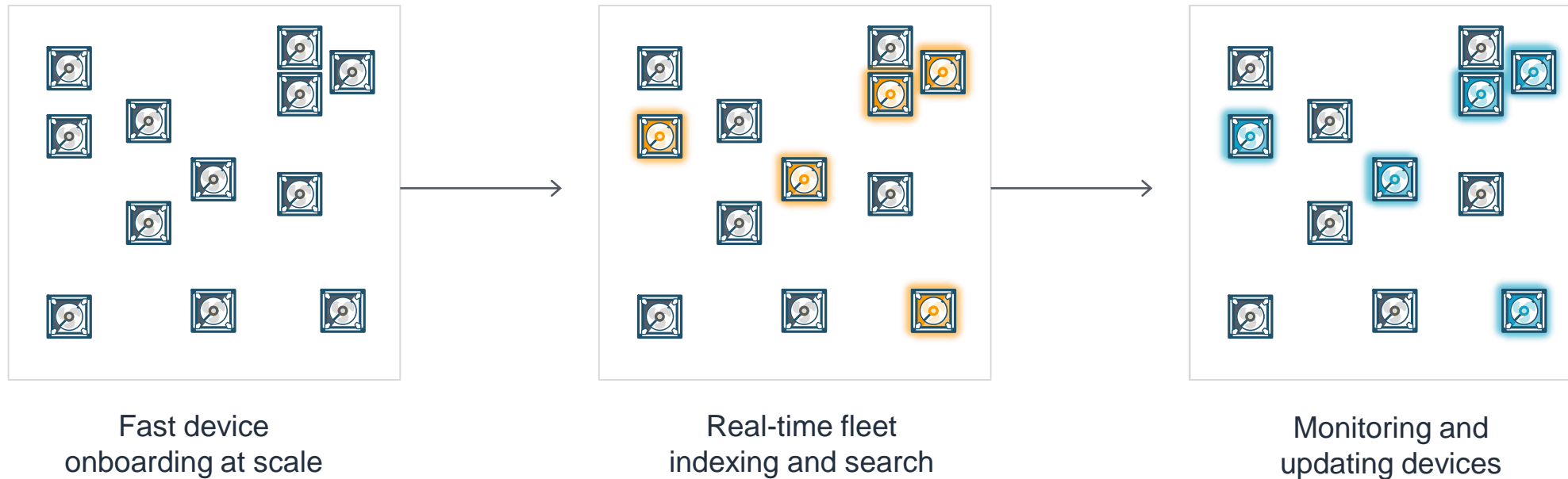
# AWS IoT Services Suite



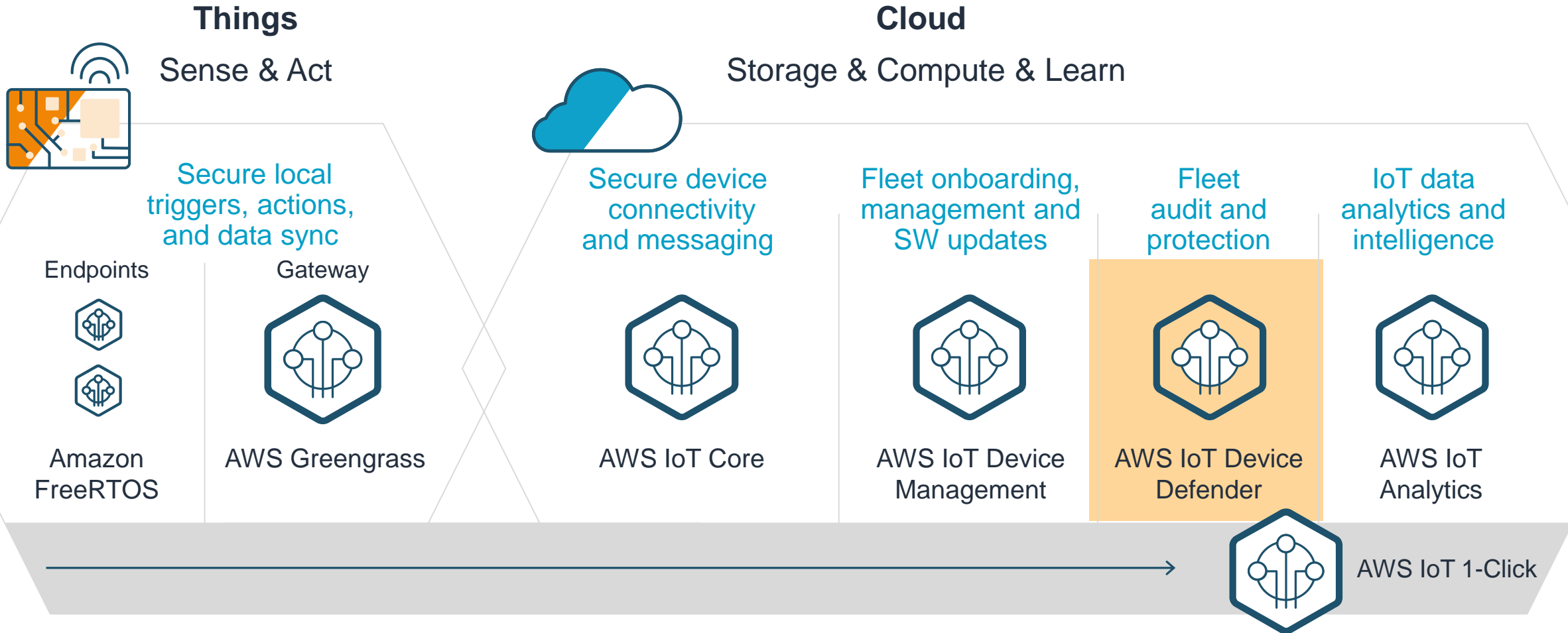
# AWS IoT Device Management

## Maintain Fleet Health

AWS IoT Device Management helps you onboard, organize, monitor, and remotely manage your growing number of connected devices.



# AWS IoT Services Suite

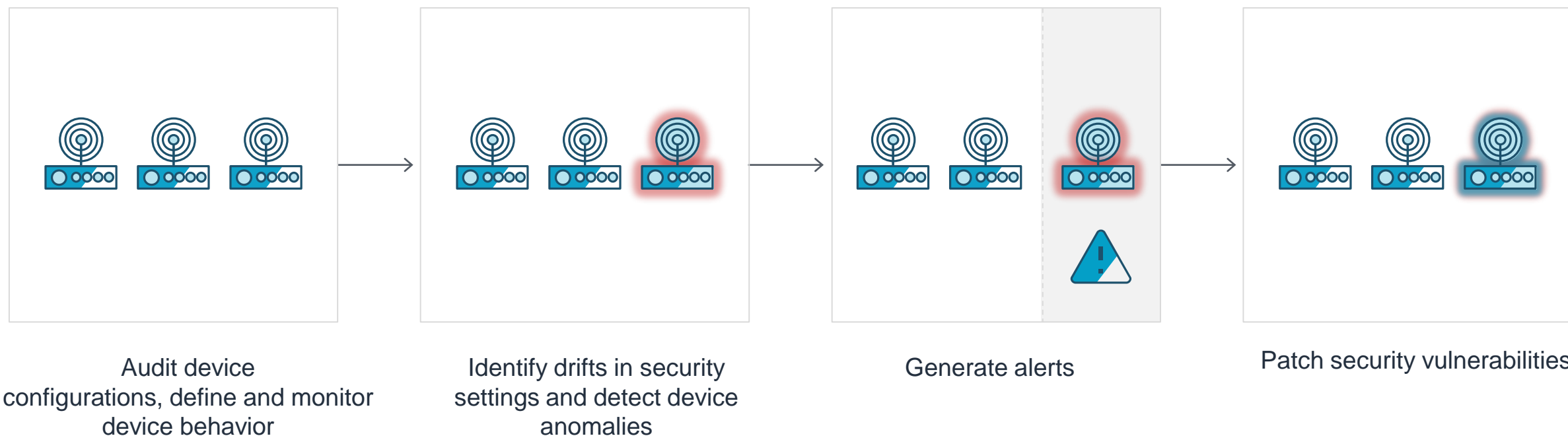


COMING  
SOON

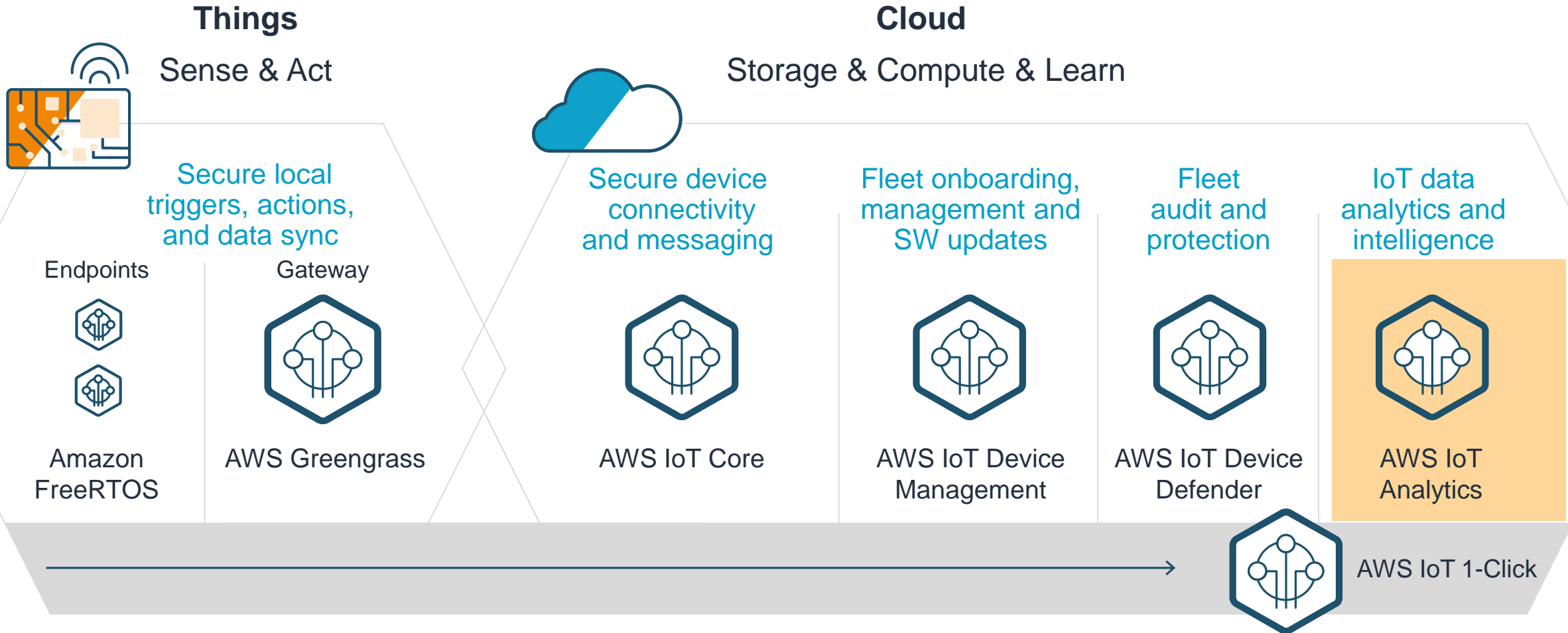
# AWS IoT Device Defender

## Keep Your Fleet Secure

AWS IoT Device Defender is a fully managed IoT security service that enables you to secure your fleet of connected devices on an ongoing basis.



# AWS IoT Services Suite

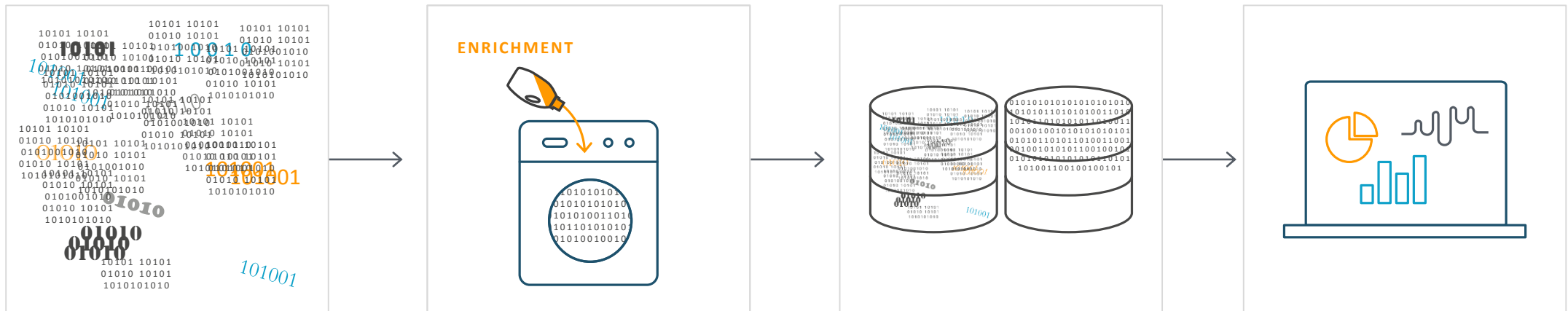




# AWS IoT Analytics

## Analytics for IoT Devices

AWS IoT Analytics is a service that processes, enriches, stores, analyzes, and visualizes IoT data for manufacturers and enterprises.



IoT data is noisy and contains gaps and false readings

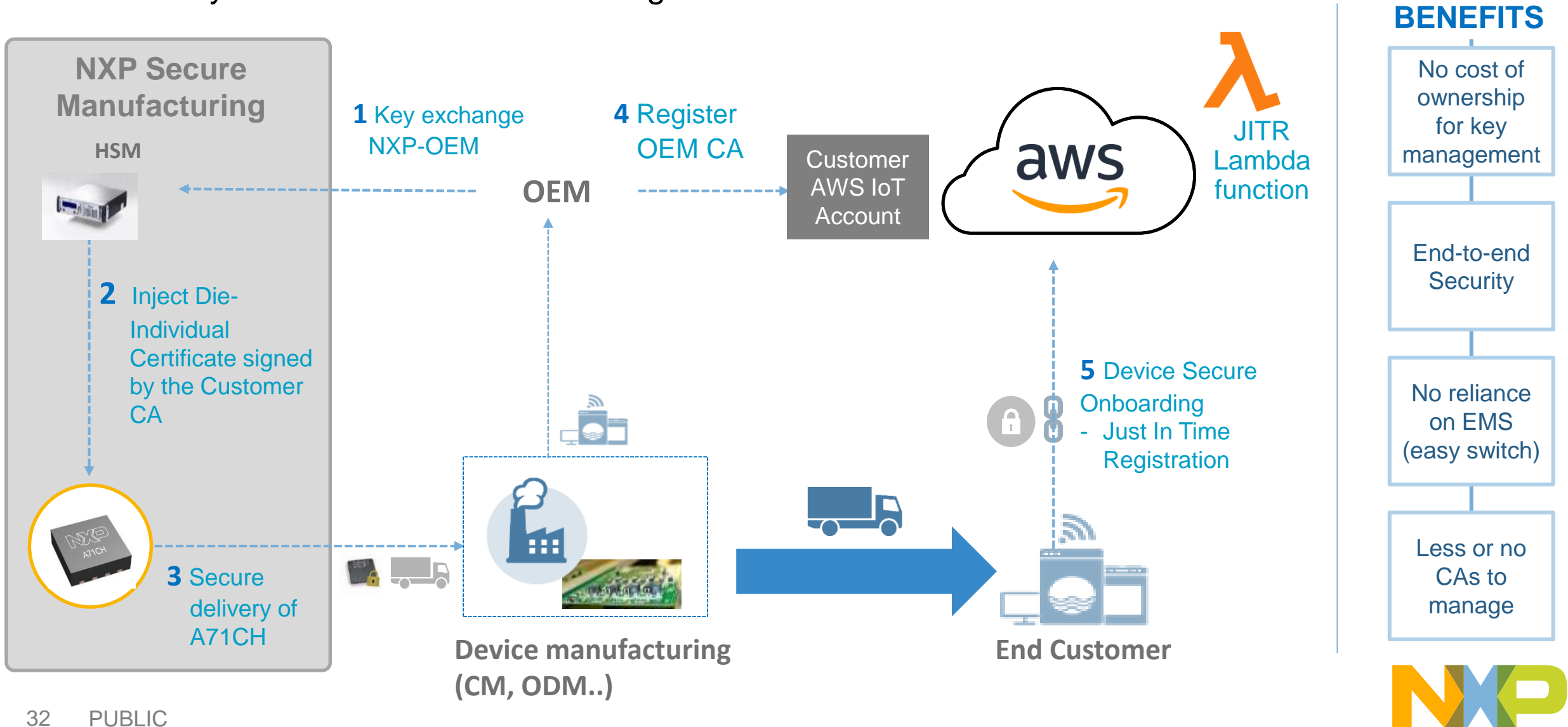
Filter, process, transform, and enrich your data

Store raw data and processed data

Ad-hoc queries or sophisticated IoT analytics and visualization

# NXP A71CH IC supports AWS Just In Time Registration flow

NXP Security IC for zero-touch onboarding to AWS





# NXP'S LPC54018 MCU & MCUXpresso SDK



# NXP's MCUXpresso Software & Tools Ecosystem



SUPPORT

## MCUXpresso SDK Builder

The MCUXpresso SDK brings open source drivers, middleware, and reference example applications to speed your software development. Customize and download an SDK specific to your processor or evaluation board selections.

Select Development Board

Access My SDK Dashboard



OVERVIEW

SOFTWARE AND TOOLS

DEVELOPER RESOURCES



### MCUXpresso SDK

An open-source software development kit (SDK) built specifically for your processor and evaluation board selections.

[Learn More >](#)



### MCUXpresso IDE

An easy-to-use integrated development environment (IDE) for creating, building, debugging, and optimizing your application.

[Learn More >](#)



### MCUXpresso Config Tools

A comprehensive suite of system configuration tools, including pins, clocks, SDK builder and more.

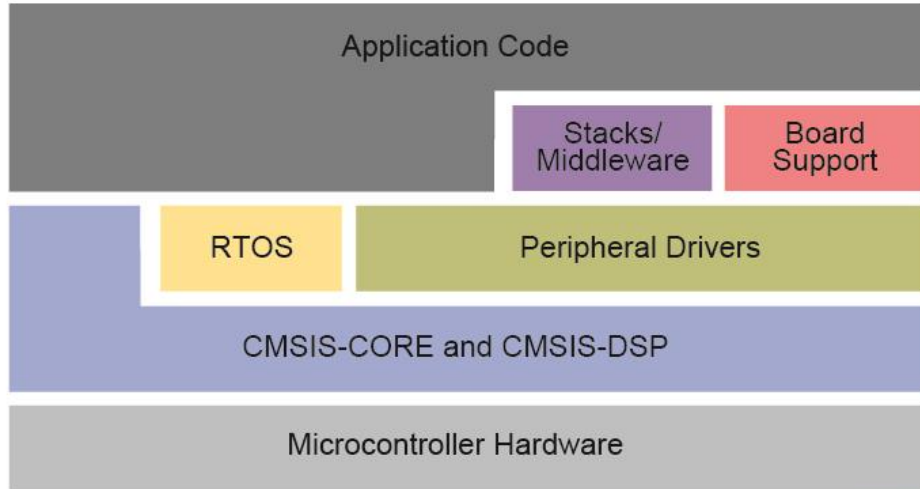
[Learn More >](#)



# MCUXpresso SDK



The software framework and reference for Kinetis & LPC MCU application development



## Product Features

### Architecture:

- CMSIS-CORE compatible
- Single driver for each peripheral
- Transactional APIs w/ optional DMA support for communication peripherals

### Integrated RTOS:

- FreeRTOS v9
- Amazon FreeRTOS v10
- RTOS-native driver wrappers

### Integrated Stacks and Middleware:

- Amazon FreeRTOS Security & Connectivity Libraries
- USB Host, Device and OTG
- QCA WiFi Stacks
- USB Type-C Power Delivery Stack
- lwIP, FatFS
- Crypto acceleration plus wolfSSL & mbedTLS
- SD and eMMC card support

### Reference Software:

- Peripheral driver usage examples
- Application demos
- AmazonFreeRTOS / AWS demos
- FreeRTOS usage demos

### License:

- BSD 3-clause for startup, drivers, USB stack

### Project file support included:

- MCUXpresso IDE
- IAR®, ARM® Keil®, GCC w/ Cmake

### Quality

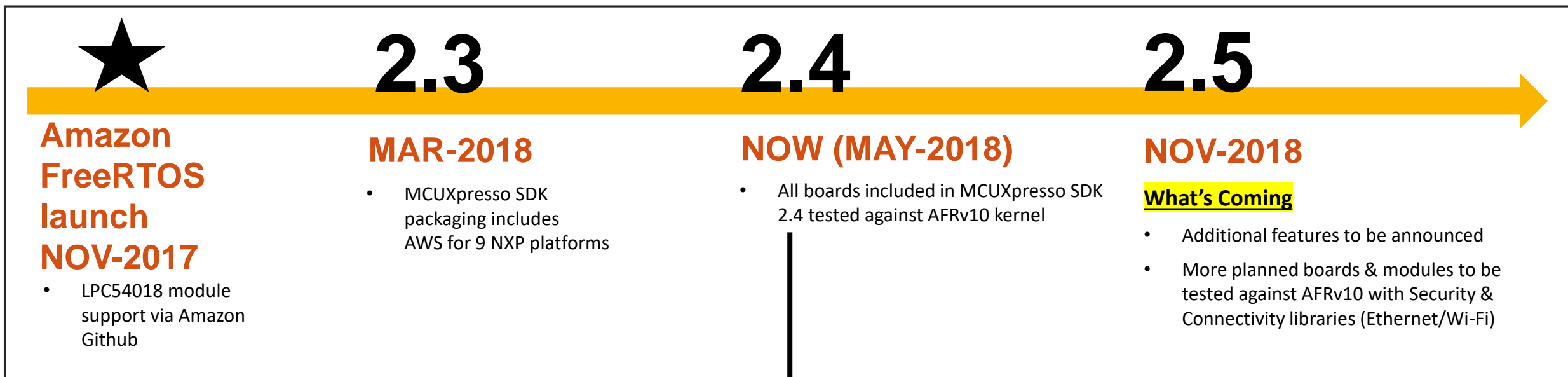
- Production-grade software
- MISRA 2004 compliance
- Checked with Coverity® static analysis tools



Open Source Initiative



# NXP's MCUXpresso SDK Release Plan with Amazon FreeRTOS



## NXP compatibility matrix | Hardware tested by NXP

- LPC54018 IoT Module w/ GT1216 (Wi-Fi)
- LPCXpresso54018 (Ethernet & Wi-Fi)
- LPCXpresso54608 (Ethernet & Wi-Fi)
- LPCXpresso54618 (Ethernet & Wi-Fi)
- LPCXpresso54628 (Ethernet & Wi-Fi)
- EVKB-IMXRT1050 (Ethernet & Wi-Fi)
- FRDM-K64F (Ethernet & Wi-Fi)
- FRDM-K66F (Ethernet)
- FRDM-K82F (Wi-Fi)

### Wi-Fi modules used for NXP base board testing,

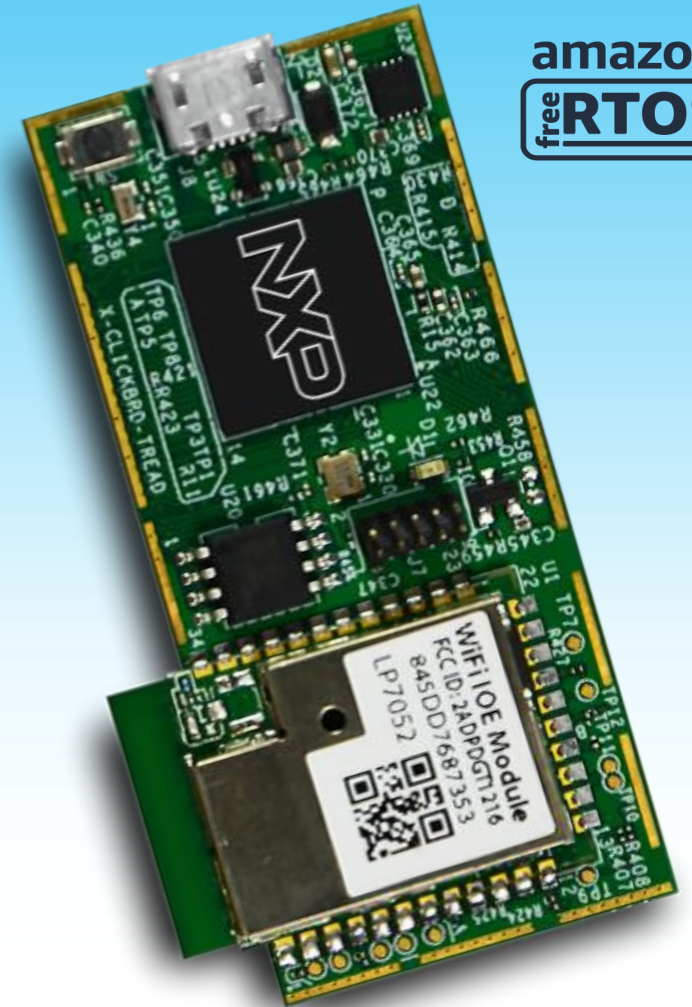
- Longsys GT202 (available from Arrow Electronics)
- Coming Soon: **Silex QCA4004 Module** (with a MikroE Click Board/Arduino Shield)

### Other Wi-Fi modules,

- Customer can port to another module by using MCUXpresso SDK's LWIP stack

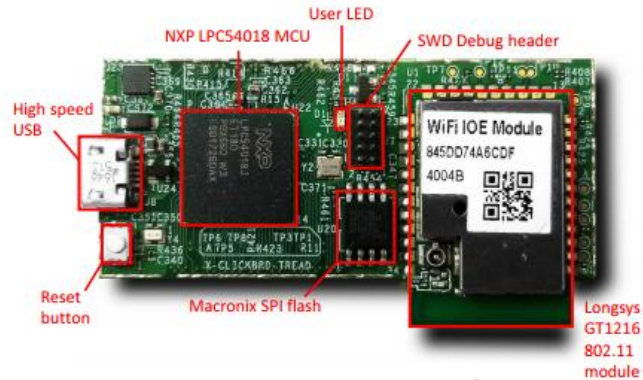
# NXP's LPC54018 IoT Module

- **High-performance CPU with large SRAM**
  - 180MHz Cortex-M4 & 360KB SRAM
- **Ultimate in low-cost memory expansion**
- **Rich integration of communication interfaces**
- **Options for embedded security & root of trust**
- **Flexible package options, including LQFP100**
- **Accelerate time to market**
  - NXP's MCUXpresso developer ecosystem
  - Amazon FreeRTOS Qualified
  - Tutorials & Demos



# Amazon FreeRTOS Qualified NXP Solution | IoT Modules

## LPC54018 IOT MODULE



**Available Now (\$35)**

- MCU** Arm Cortex-M4 core running up to 180 MHz with 360 KByte on-chip SRAM
- Memory** On-board 16 MB Macronix Quad SPI NOR Flash
- Radio** Longsys GT1216 Wi-Fi (IEEE 802.11b/g/n) module based on Qualcomm QCA4004, with internal antenna
- Debug** Required debug probes from SEGGER, NXP's LPC-Link2 and P&E Micro or an NXP's IoT Baseboard

## OPTIONAL BASEBOARDS

Full featured version



**Available Now (\$149)**

Mini baseboard



**Available June 2018 (\$35)**

**MORE MODULES LAUNCHING IN 2018**

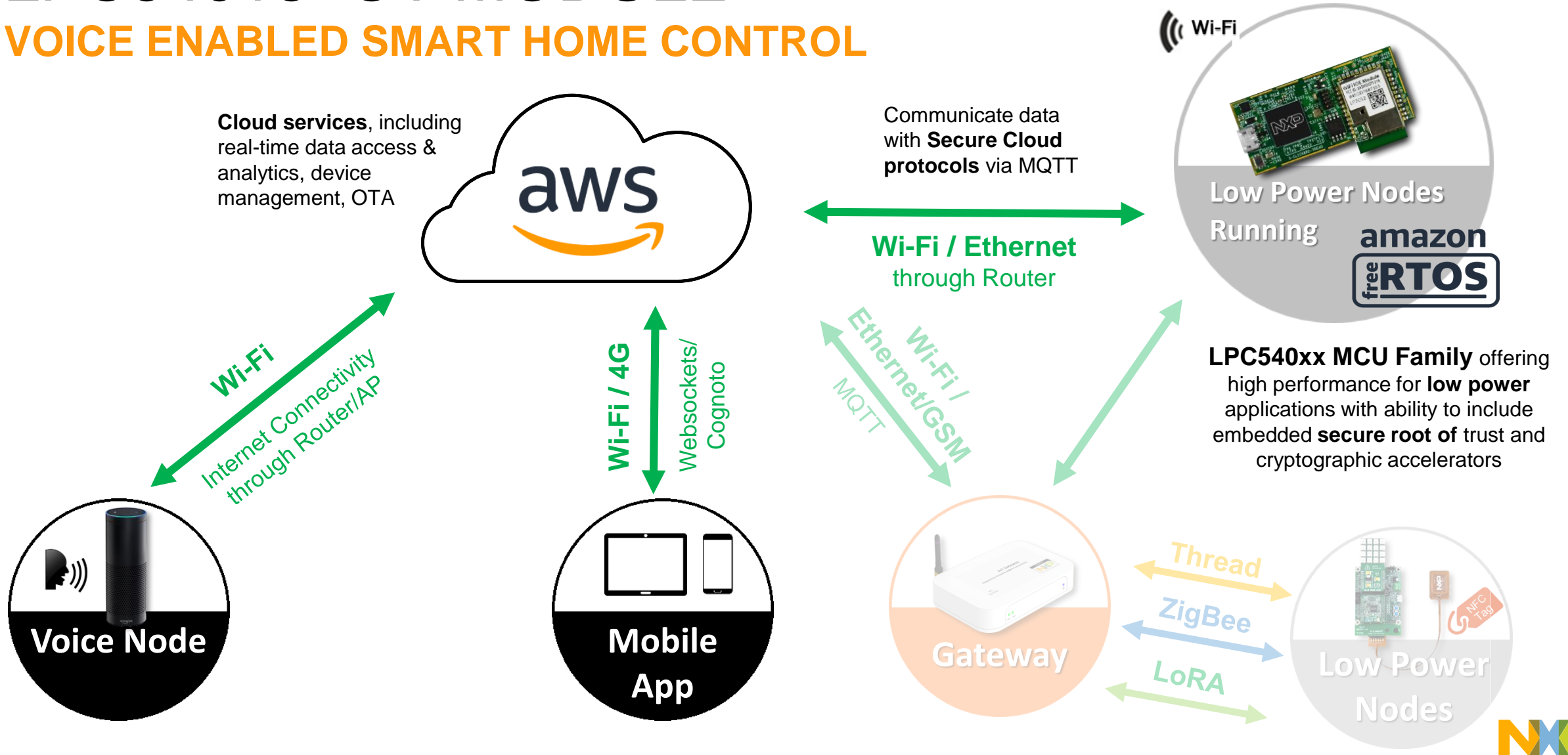
DEMO





# AMAZON FREERTOS LPC54018 IOT MODULE

## VOICE ENABLED SMART HOME CONTROL





# AMAZON FREERTOS LPC54018 IOT MODULE

## VOICE ENABLED SMART HOME CONTROL



Developed by the engineering team from Bluewind and leveraging NXP's MCUXpresso SDK & Amazon FreeRTOS

<https://github.com/bluewind-embedded-systems/aws-nxp-lpc54018-demo>



For example,  
**Smart Home Automation & Control (i.e lighting)**



*Alexa, what is the IoT module temperature?*

*Alexa, turn on my IoT module light.*



Leveraging the integrated temperature sensor and on-board user LED



# AMAZON FREERTOS LPC54018 IOT MODULE DISPLAY DRIVEN SMART HOME CONTROL

Demonstrating smart home automation & control with LPC54018 IoT Module with associated baseboard and integrated 4.3" touch display and an Android app



Sources planned for release July 2018



# RESOURCES



# AWS Resources

- **Getting Started with the LPC54018 IoT Module**
  - [https://docs.aws.amazon.com/freertos/latest/userguide/getting\\_started\\_nxp.html](https://docs.aws.amazon.com/freertos/latest/userguide/getting_started_nxp.html)
- **Amazon FreeRTOS Github**
  - <https://github.com/aws/amazon-freertos>
- **Commercial support:** aws-iot-commercial-nxp@amazon.com
- **Technical support:** aws-iot-technical-nxp@amazon.com

# NXP Resources

## Getting Started with LPC54018 based IoT Module

OM40007: LPC54018 IoT Module for the LPC540xx family of MCUs

OVERVIEW GETTING STARTED DOCUMENTATION SOFTWARE & TOOLS BUY/PARAMETRICS TRAINING & SUPPORT

1. Get Software 2. AWS IoT 3. Build, Run 4. Learn

Jump To

1.1 Choose a development path.  
1.2 Jump Start Your Design with the MCUXpresso SDK!  
1.3 Install Your Toolchain

Quick Reference

- Chip Documents
- Board Information
- Software
- Support

1.1 Choose a development path.

OR

NXP MCUXpresso Software Development Kit (SDK) with Amazon FreeRTOS + Integrated Development Environment (IDE)

Amazon Web Services + Amazon FreeRTOS + IAR Embedded Workbench from aws.amazon.com

1.2 Jump Start Your Design with the MCUXpresso SDK!

The MCUXpresso SDK is complimentary and includes full source code under a permissive open-source license for all hardware abstraction and peripheral driver software.

Click below to download a pre-configured SDK release for the IoT module:

SDK

### NXP's MCUXpresso SDK Developer Ecosystem

- Access our **MCUXpresso SDK Builder** to configure and download your own LPC54018 specific package with the latest Amazon FreeRTOS (*the latest Amazon FreeRTOS kernel updates to be included*)
- Get started with our free **MCUXpresso integrated development environment (IDE)** for creating, building, debugging and optimizing your application. Supported partner IDE options include IAR, Keil.
- Leverage our comprehensive suite of system **configuration tools, including pins, clocks, and more** to ensure your development is made easy.
- Community support at <https://community.nxp.com>



Recommended Design House for LPC54018 IoT Module  
& NXP Certified Partner





# Upcoming Technical Sessions | Join Us

## TRAINING & EVENTS



### Online Training

- ✓ **June 12<sup>th</sup> Webinar**  
**Webinar:** Amazon FreeRTOS basics with LPC54018
- ✓ **June 19<sup>th</sup> Webinar**  
**Webinar:** Advanced Amazon FreeRTOS features with LPC54018, like Device Shadowing



### Industry Events

- ✓ **June 13<sup>th</sup> FTF Connects**  
**Santa Clara:** Learn how to get connected to AWS with LPC54018

**Further regional events coming in 2018**



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FOR A SMARTER WORLD**