Developing the connected world

how enterprise applications can talk to IoT devices
across Cisco wireless networks

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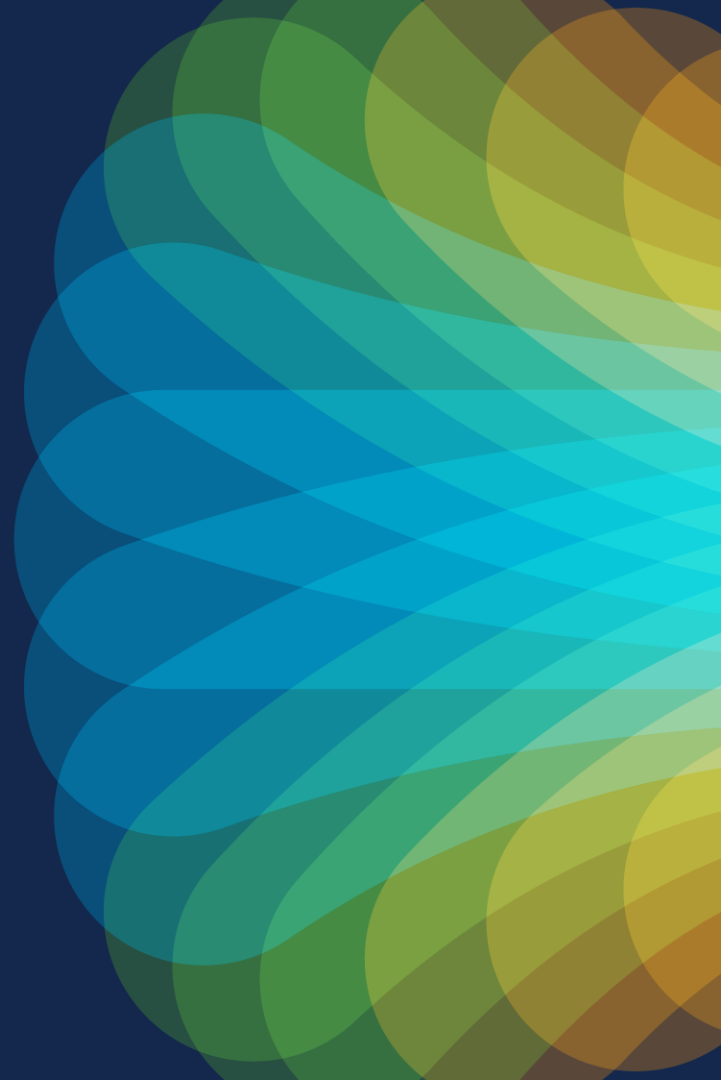
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DEVNET-2693

Agenda

- Enterprise IoT market & use cases

- IoT wireless in the enterprise

- Communicating to IoT devices leveraging Cisco Wireless
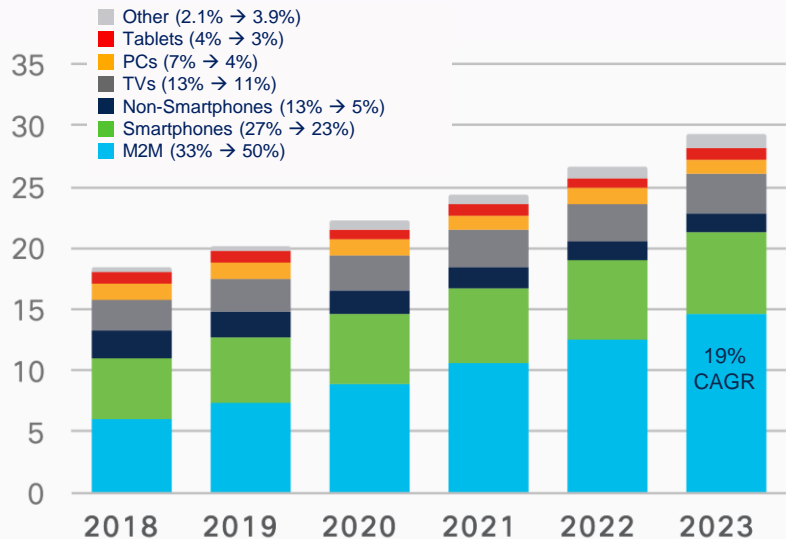
- IoT API demo

- Conclusion

We start with...

Enterprise IoT market
& use cases

CISCO *Live!*

IoT device growth in the enterprise

Devices connecting to the Internet

Legend:
- Other (2.1% → 3.9%)
- Tablets (4% → 3%)
- PCs (7% → 4%)
- TVs (13% → 11%)
- Non-Smartphones (13% → 5%)
- Smartphones (27% → 23%)
- M2M (33% → 50%)

Chart: stacked bar chart with years 2018, 2019, 2020, 2021, 2022, 2023. 2023 bar labeled "19% CAGR". Y-axis from 0 to 35.
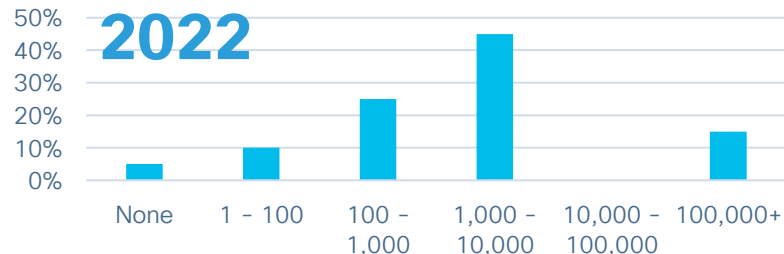
For the first time **in 2023, more than 50% of connections will be from IoT devices.** IoT devices are the only device type with an increasing share of total connected devices, with a **19% CAGR**
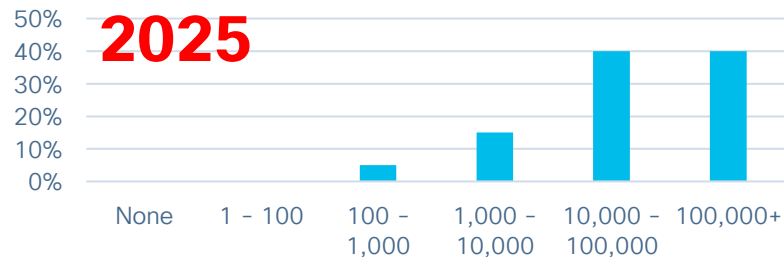
Source: Cisco Annual Internet Report (2018-2023)

Cisco Enterprise customer survey

Iot devices 2022

2022

Bar chart, Y-axis 0%–50%. Categories: None (~5%), 1 – 100 (~10%), 100 – 1,000 (~25%), 1,000 – 10,000 (~45%), 10,000 – 100,000 (0%), 100,000+ (~15%)

Iot devices 2025

2025

Bar chart, Y-axis 0%–50%. Categories: None (0%), 1 – 100 (0%), 100 – 1,000 (~5%), 1,000 – 10,000 (~15%), 10,000 – 100,000 (~40%), 100,000+ (~40%)
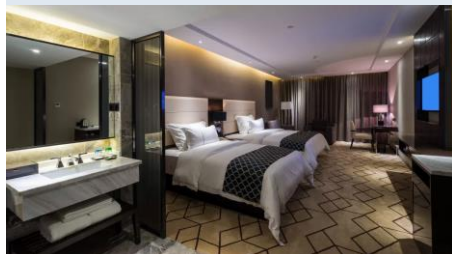
Many use cases, one infrastructure

Hospitality

Smart mirrors · Motorized Blinds · HVACs · Minibars · PoE TVs · Emergency Alert systems · IP phones · Lighting · Access points

Healthcare

Patient room control · Paging systems · Smart lighting · Emergency signs · Patient smart card readers · Bio medical devices · Patient monitoring

Retail

Price tag readers · Emergency alert systems · UHD 4K product displays · Checkout registers · BLE Access points · Surveillance cameras · People counting sensors

Connected Building

Access points · Motorized Blinds · IP Phones · Integrated Work Spaces · Occupancy Sensors · Lighting · Video Endpoints · HVAC · Surveillance cameras

A common building infrastructure delivering power and data connectivity to sensors and devices

Enterprise IoT wireless

Communicating with IoT Smart Objects

- IoT devices and smart objects can connect using a myriad of protocols that do not directly "talk" to one another

- The protocol of choice depends on the environment (indoor, outdoor), the range, the amount of data to transmit...
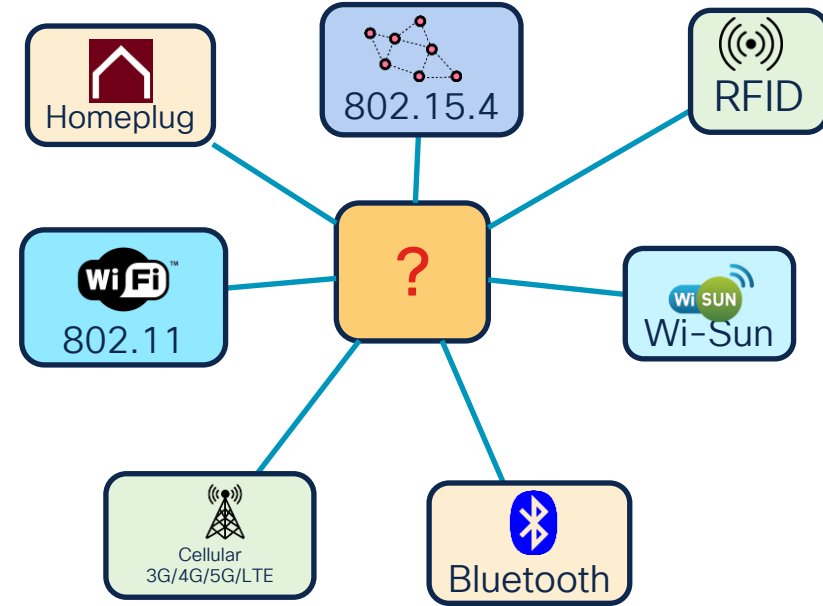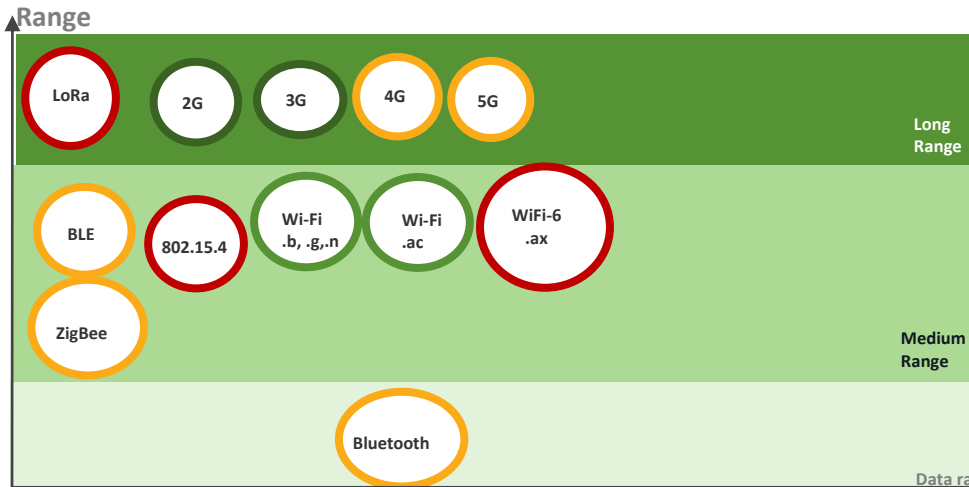
Wi-Fi as an IoT technology

Traditional Wi-Fi was not IoT-friendly

- Range: 100 meters / 300 feet
- Pros:
  - High throughput if needed
  - "Large" number of clients if needed
  - Any home has Wi-Fi
- Cons:
  - Sessions required
  - Keepalives needed
    - Not optimal for battery-powered devices
    - IoT prefers simple modulation to complex and high throughput

Wi-Fi 6 and later is IoT-friendly

2MHz RU, 375 kbps

time

Dual Sub-Carrier Modulation (DCM)

Subcarriers

Frequency
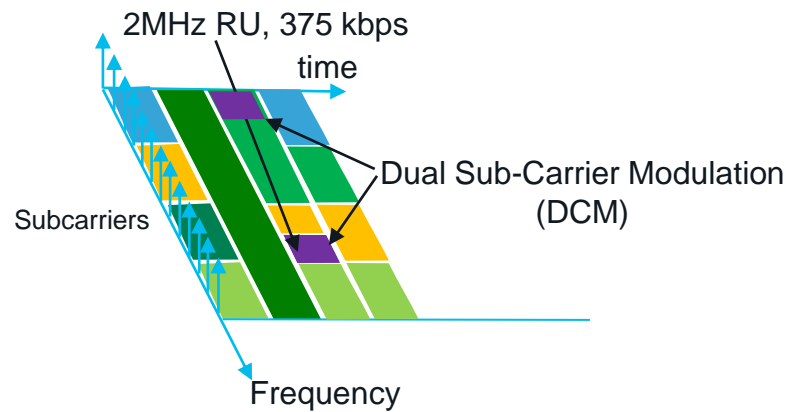
- ✓ Target Wake Time (TWT)
- ✓ Long Sleep allowed (up to 5 years)
- ✓ Longer preamble
- ✓ Longer Guard Intervals

Bluetooth vs. BLE

Secondary

Secondary

Secondary

Data

Sychronization

Listening

Primary

Physical Channel

Secondary

Secondary

Listening

Standard Bluetooth

Advertiser

Advertiser

Initiator

Scanner

BLE
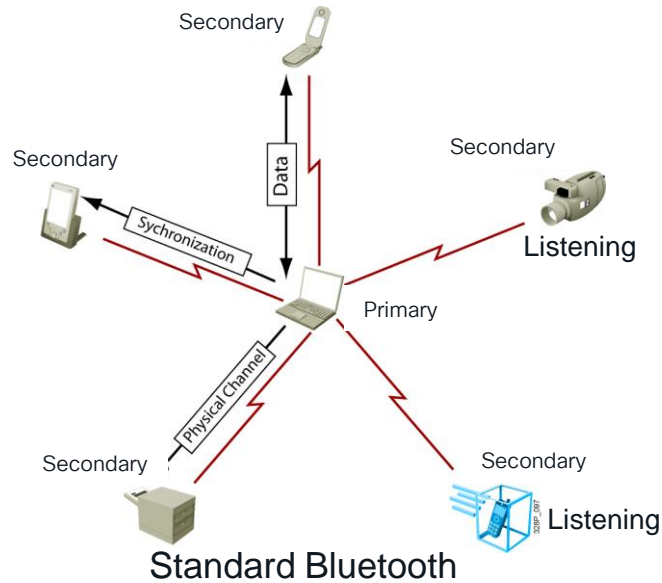
Short range (PAN), short / bursty sessions, low density
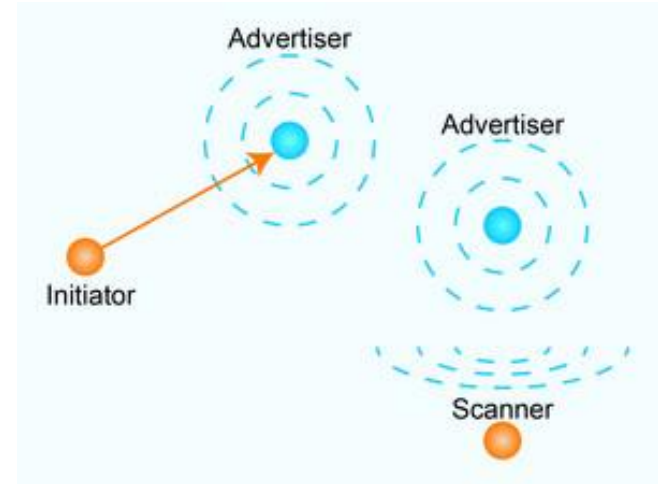
BT 4.0 (2010) adds Bluetooth Low Energy:
longer battery life, longer range

Bluetooth vs. BLE

- With Bluetooth, the primary connects to the secondary and maintains the connection (energy greedy, but allows for things like VoIP)

- With BLE, the primary detects the secondary's announce, and (if interested) connects, retrieves data, and closes the connection (few milliseconds, energy efficient, but no real-time support: built for small data chunks exchanges)

Advertisment: I can send the user pulse

Hey! Your pulse is 93 ☺

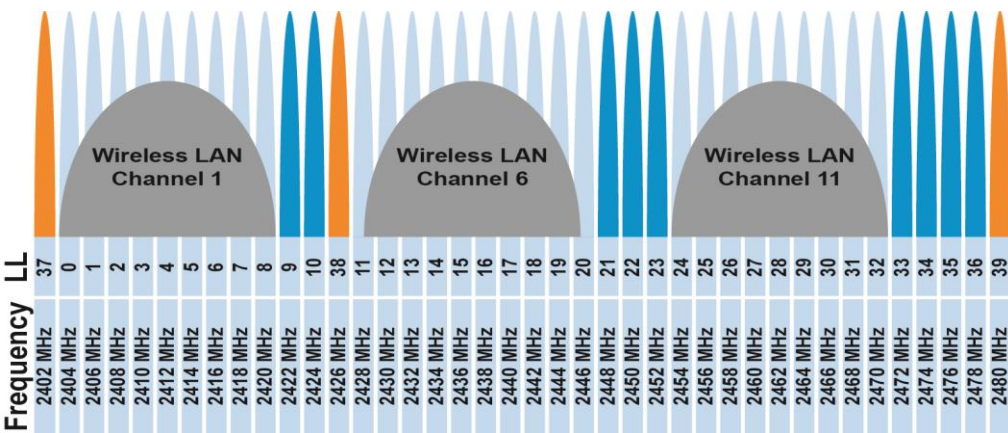Connect & discover services

Read pulse value

Pulse = 93

Disconnect

BLE & Wi-Fi coexistence in 2.4Ghz

- BLE is built to be Wi-Fi friendly
  - Announce messages are sent on non-Wi-Fi channels
  - If you just read the announces, no impact on Wi-Fi. If you connect to exchange more, Wi-Fi is impacted (40 x 2 MHz channels instead of 80 x 1 MHz channels with standard Bluetooth)

Feature	Standard Bluetooth	BLE
Max range (theoretical)	< 100m	< 100 m
Data rate	1 – 3 Mbps	1 Mbps
Throughput	0.7 – 2.1 Mbps	0.27 Mbps
Time to send data	100 ms	6 ms
Power consumption	1 W as reference	0.01 to 0.5 W
Peak current consumption	<30 mA	< 15 mA

IEEE 802.15.4

"Low Rate WPANs":

- ✓ Based on low data rate communications
- ✓ Scalable and self maintained
- ✓ Enable low power and cost operation
- ✓ Combines scheduled and contention-based schemes
- ✓ Works in 2.4 GHz (ISM) band, and sub-1GHz (longer range)
- • Examples: Zigbee, Thread, WiSUN

| IEEE 802.11 Wireless LAN (WLAN) | WiFi 802.11a/b/g/n/ac/ax 802.11ah (sub-GHz) |

IEEE 802.15 Personal Area Network (PAN)	802.15.1 Bluetooth
	802.15.4 Low Rate WPAN (2003-2006-2011-2015-2020)
IEEE 802.16 Wireless Broadband Access	802.15.6 Body Area Networking
IEEE 802.22 Wireless Regional Area Networks	802.15.7 Visible Light Communications

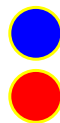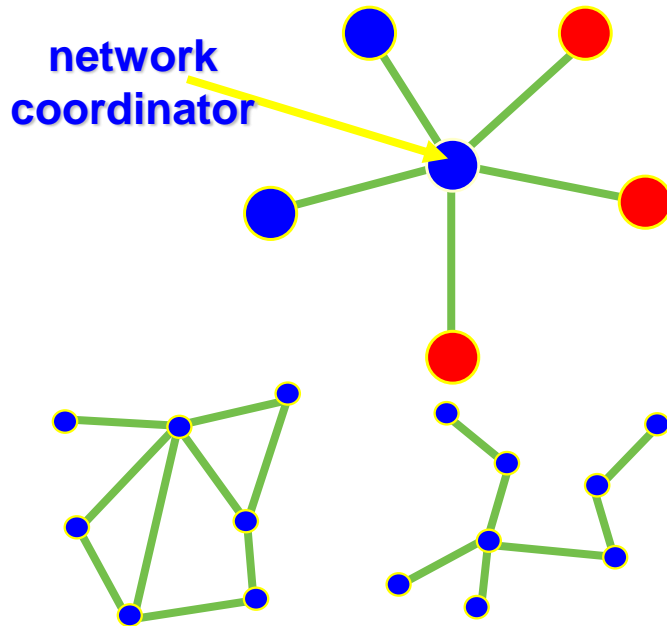CISCO *Live!*
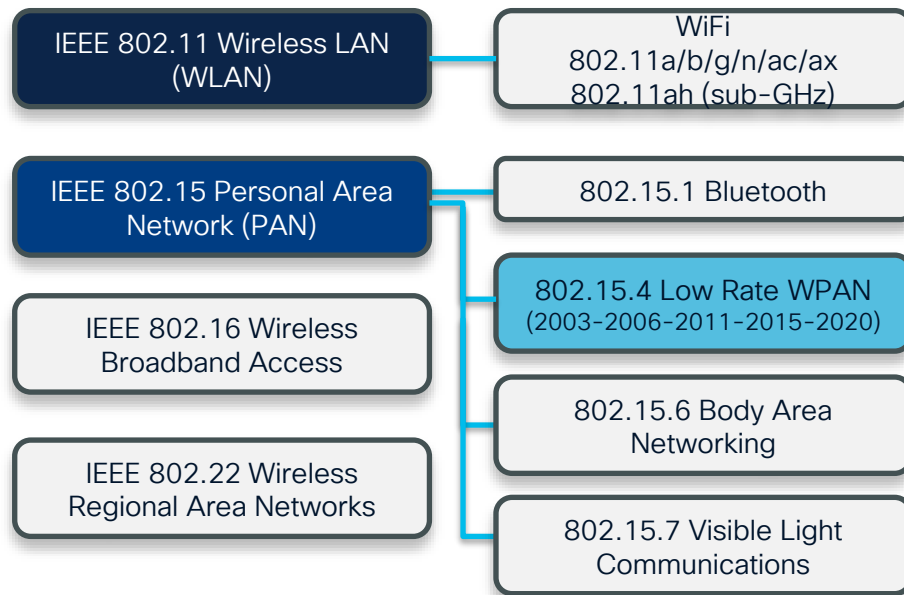
802.15.4 Mesh – FFD vs. RFD

- Full function device (FFD)
  - Any topology
  - Network coordinator capable
  - Talks to any other device

- Reduced function device (RFD)
  - Limited to star topology
  - Cannot become a network coordinator
  - Talks only to a network coordinator
  - Very simple implementation

network coordinator

Full Function Device (FFD)

Reduced Function Device (RFD)
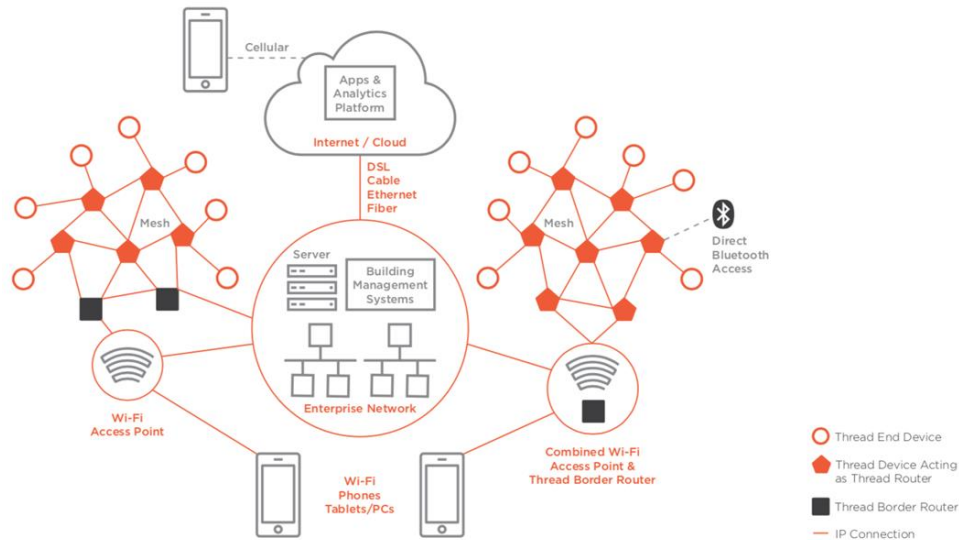
Communications Flow

Zigbee & Thread

- ZigBee and Thread leverage IEEE 802.15.4 MAC and PHY
- Both are driven by the same industry-level alliance (csa-iot) that push the protocol development forward and certify products out in the market.
  - Thread leverages IPv6 natively
- Longer term, Thread is expected to replace ZigBee
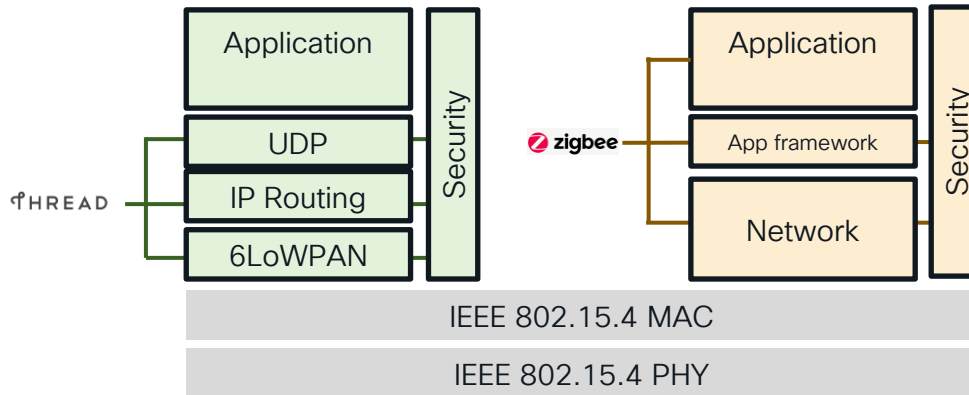
Thread & Matter

Thread:

- Built on 802.15.4 (Cisco AP HW supports 802.15.4) Forms a mesh
- Needs a 'border gateway'
- On top of Thread transport, several protocols can be carried (DALI, KNX, Matter,...)

THREAD IN A SMART HOME WITH MATTER DEVICES
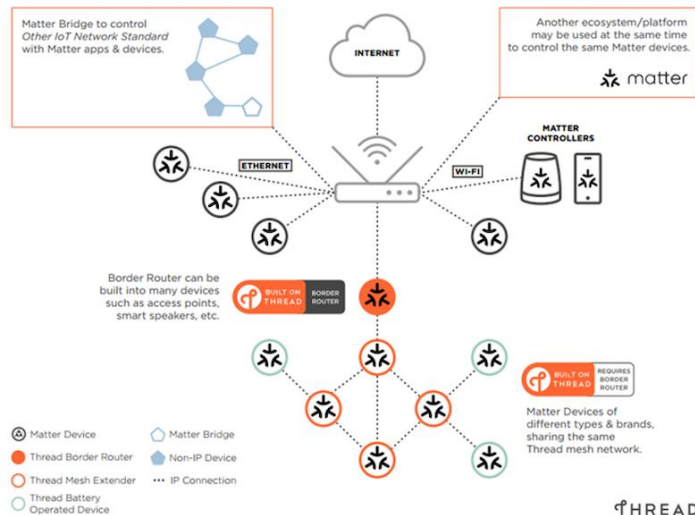
Matter:

- IoT application protocol on top of Thread or Wi-Fi
- Requires IPv6 support
- Carries commands between compatible devices
- Can use bridges to translate to other protocols

Communicating with IoT devices using Cisco Wireless Infrastructure

Communicating with non-IP IoT Things

Operations on low-power devices typically use a few simple operations:

- Connection management

- Read/write data

- Streaming telemetry

tell me the temperature (read, 'get')

turn HVAC off (write, 'put')

update firmware, etc.

save new profile (write, 'post')

delete profile (write, 'delete')

68 F / 20 C

9:21 AM
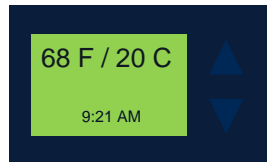
Streaming Telemetry with Message Brokers:
Pubs and Subs

- Messaging almost always goes through a broker

- Clients Subscribe to topics to publish and receive messages

- Broker receives messages from clients and forwards to interested subscribers (e.g. analytics engines, Big Data system, etc.)

Message Broker
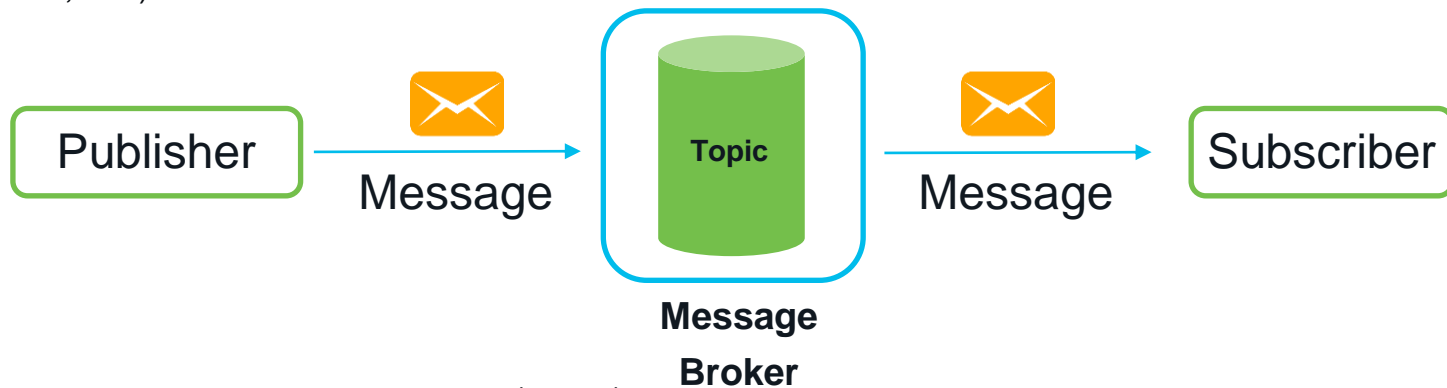
- Message Queue Telemetry Transport (MQTT)

  - Intended to be a publish-subscribe based "lightweight" messaging protocol for IoT and M2M

  - Sensor publishes information (MQTT Publisher)

  - The application that needs to receive the information can be set as the MQTT subscriber

Solving Silofication through standardization

Proprietary stovepipes

App 1   App 2   App 3   App 4

App — AP Gateway — Device (×4)

← → Onboarding: developed for home or personal area networks
← → Control: Proprietary per app/device
← → Telemetry/data: Proprietary per app/device

Apps and devices are developed hand in hand with network 'gateways', typically 1 app – 1 stack

Heavy lift for partners and Cisco Engineering

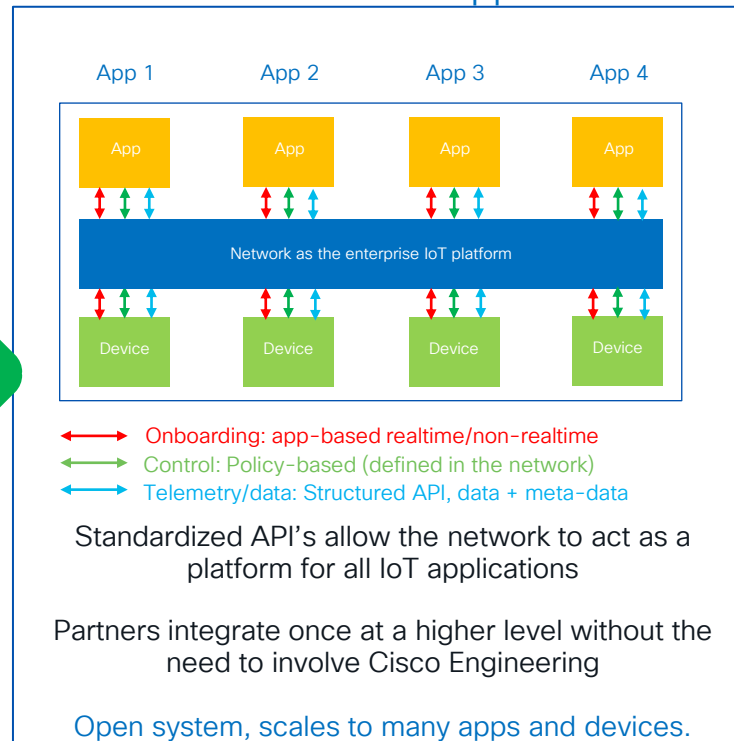Closed system, does not scale beyond a couple apps.

From → **To**

Standards-based approach

App 1   App 2   App 3   App 4

App (×4) — Network as the enterprise IoT platform — Device (×4)

← → Onboarding: app-based realtime/non-realtime
← → Control: Policy-based (defined in the network)
← → Telemetry/data: Structured API, data + meta-data

Standardized API's allow the network to act as a platform for all IoT applications

Partners integrate once at a higher level without the need to involve Cisco Engineering

Open system, scales to many apps and devices.

Standardizing APIs:

Accelerating use case deployment

Enterprise Network

BLE

Thread

Wi-Fi

Zigbee

…

Gateway

Common APIs across radio technologies enables streamlined and accelerated integration

Provisioning (SCIM)

Device Control (NIPC)
(REST or MQTT)

Device Telemetry (MQTT)

Onboarding

Device Control

Data Receiver

Application

CRUD
Create, Update, Delete devices

Connection
Data
Registration

Broadcasts
Streaming data
Connection state

System for Cross-Domain Identity Management (SCIM)

SCIM: https://datatracker.ietf.org/wg/scim/documents/
Device Model: https://datatracker.ietf.org/doc/html/draft-shahzad-scim-device-model-05

Core Schema
— User
— Group
— Device
    — Connectivity extensions
        — BLE
        — Zigbee
        — Thread
        — Wi-Fi
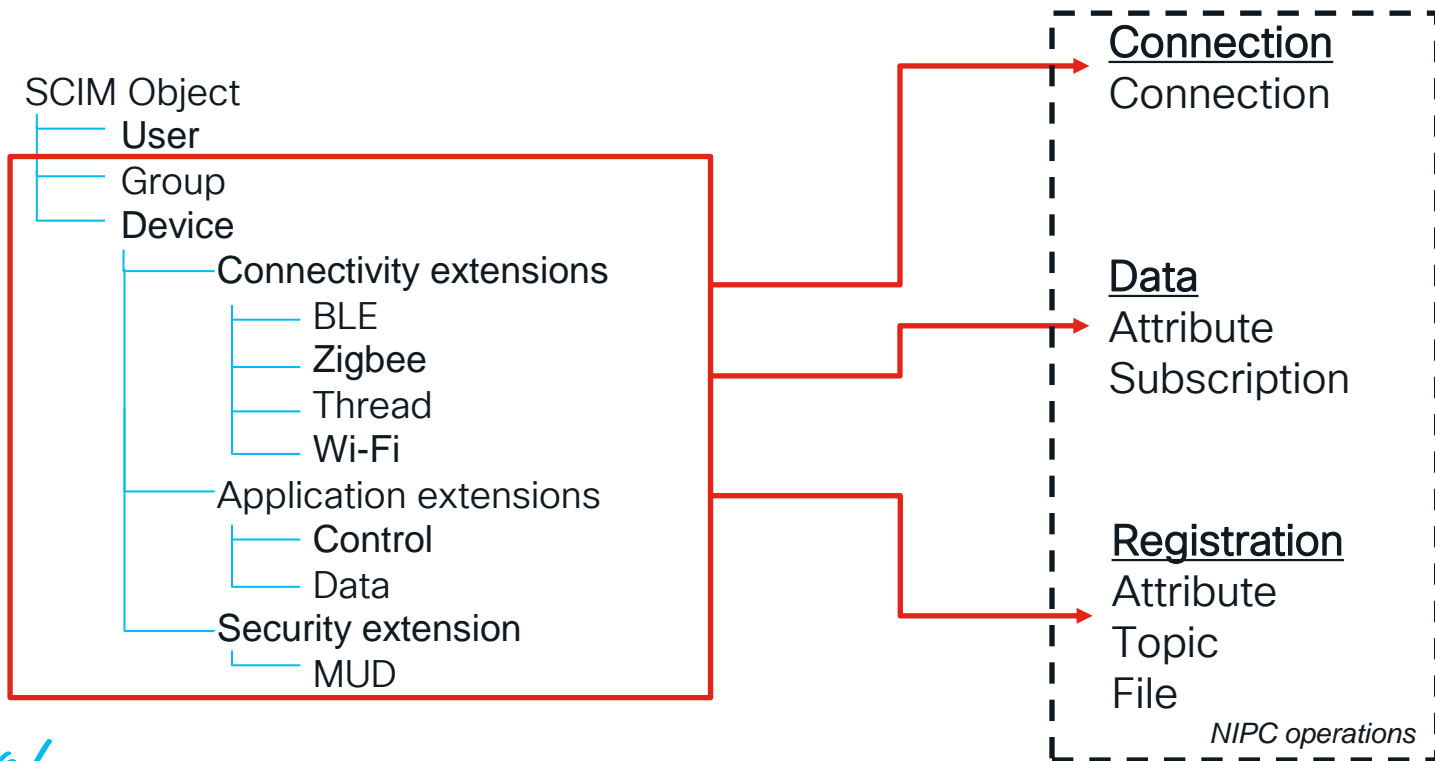   — Application extensions
        — Control
        — Data
— Security extension
    — MUD

new

Non IP Control (NIPC)

NIPC: https://datatracker.ietf.org/doc/html/draft-brinckman-nipc/

SCIM Object
- User
- Group
- Device
  - Connectivity extensions
    - BLE
    - Zigbee
    - Thread
    - Wi-Fi
  - Application extensions
    - Control
    - Data
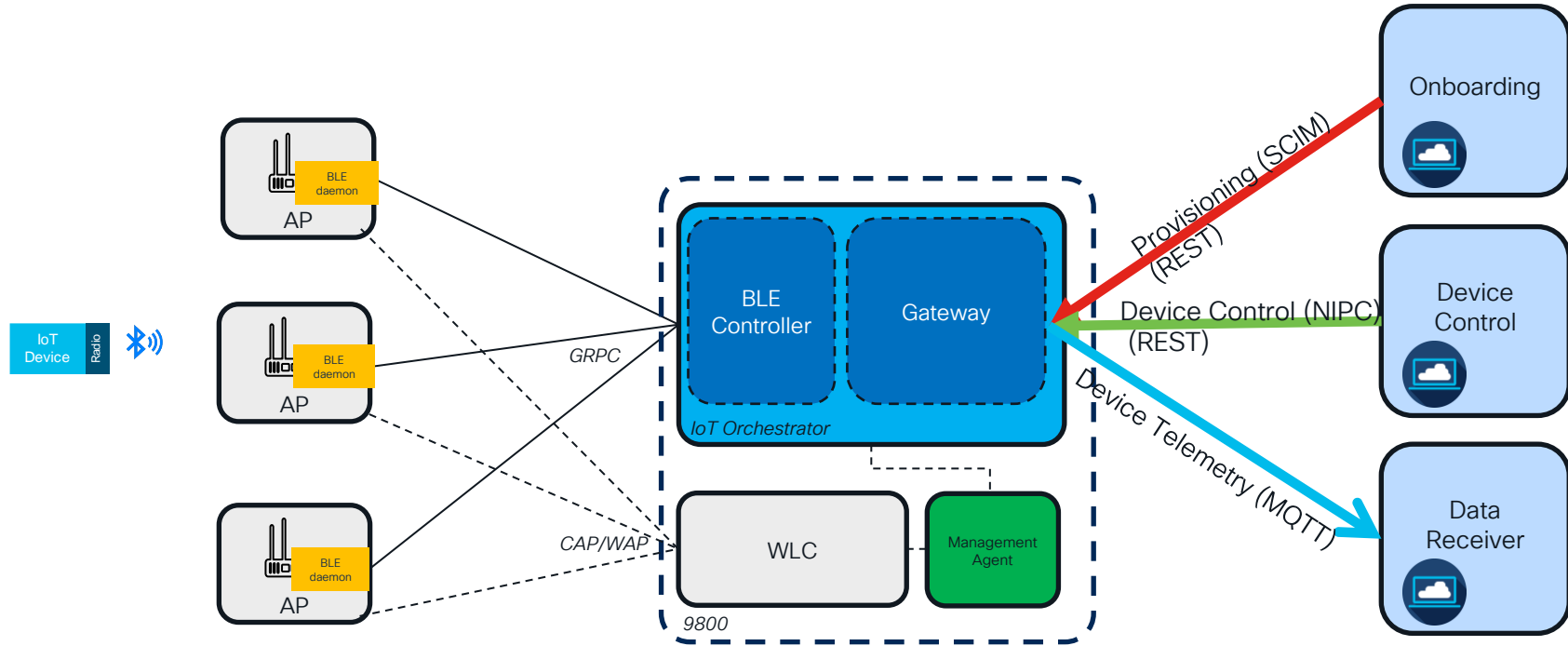 - Security extension
    - MUD

Connection
Connection

Data
Attribute
Subscription

Registration
Attribute
Topic
File

NIPC operations

IoT orchestrator on Catalyst 9800 WLC:
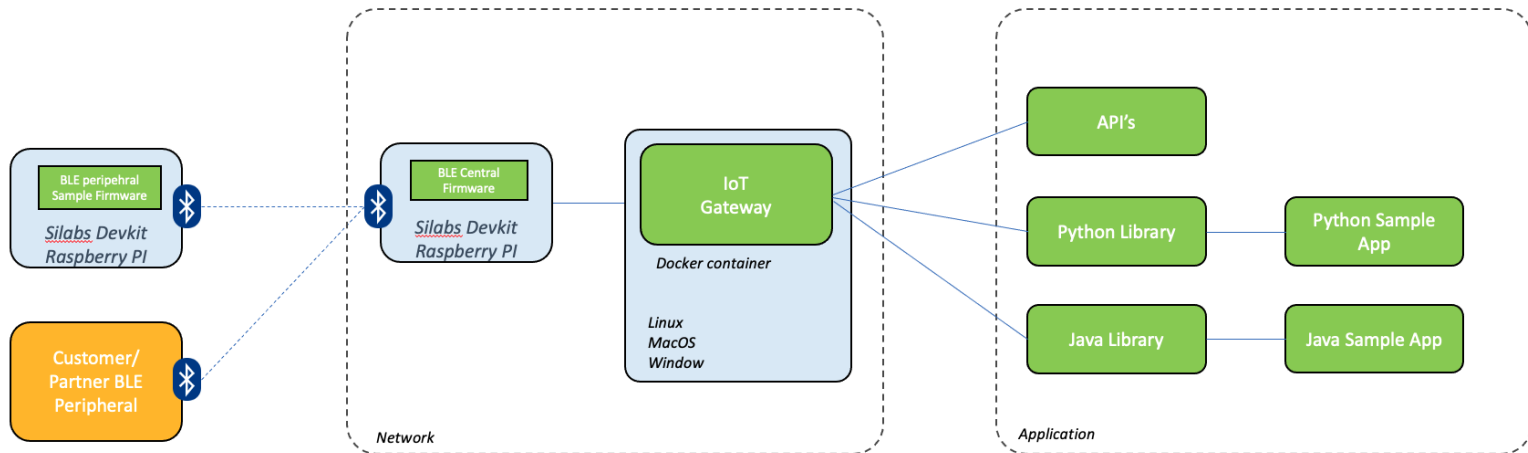*Delivering on IoT onboarding & connectivity*

Open Source

Goal: Any developer with a laptop and raspberry PI can develop an IoT application that runs on an Enterprise network

Scope:
- Sample apps
- Java & Python libraries
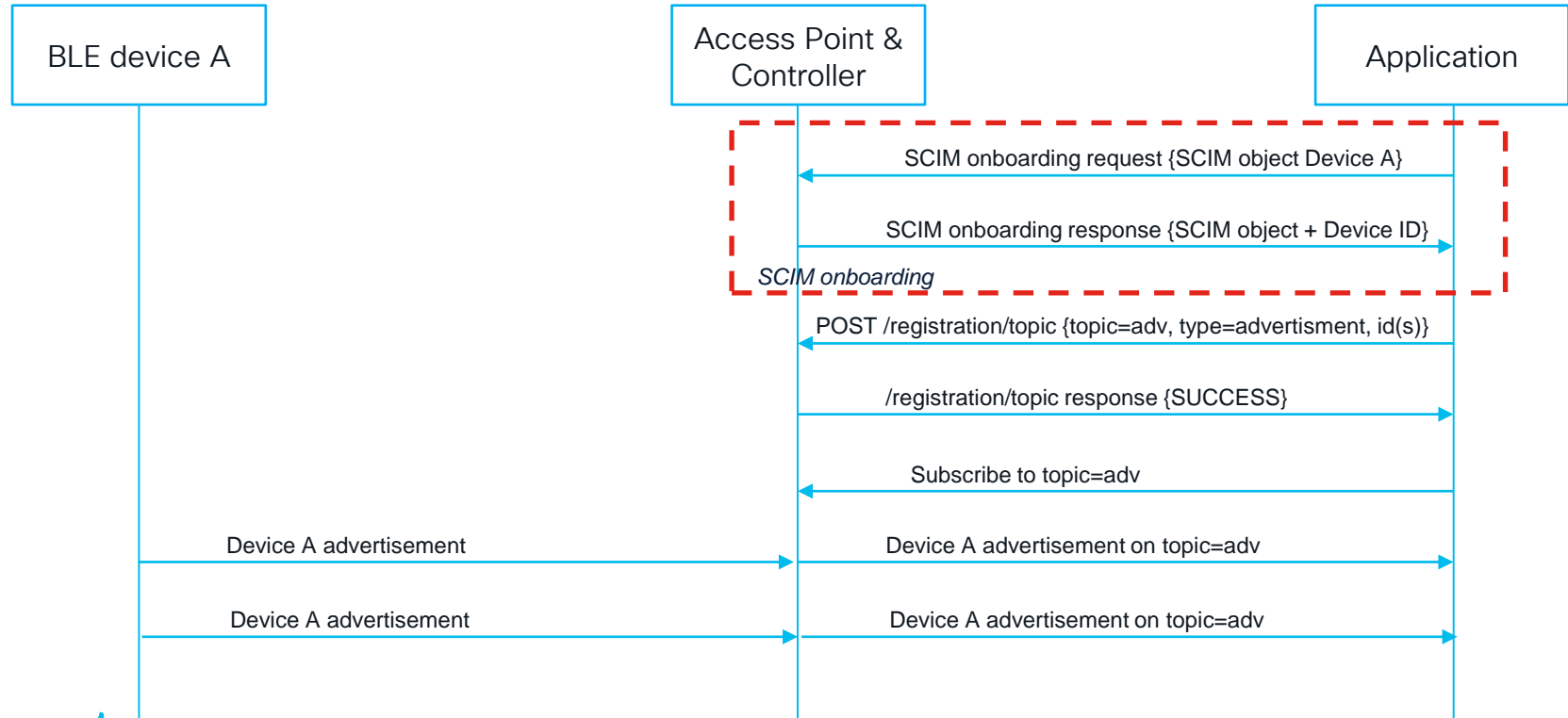- Network simulator
- Sample device firmware
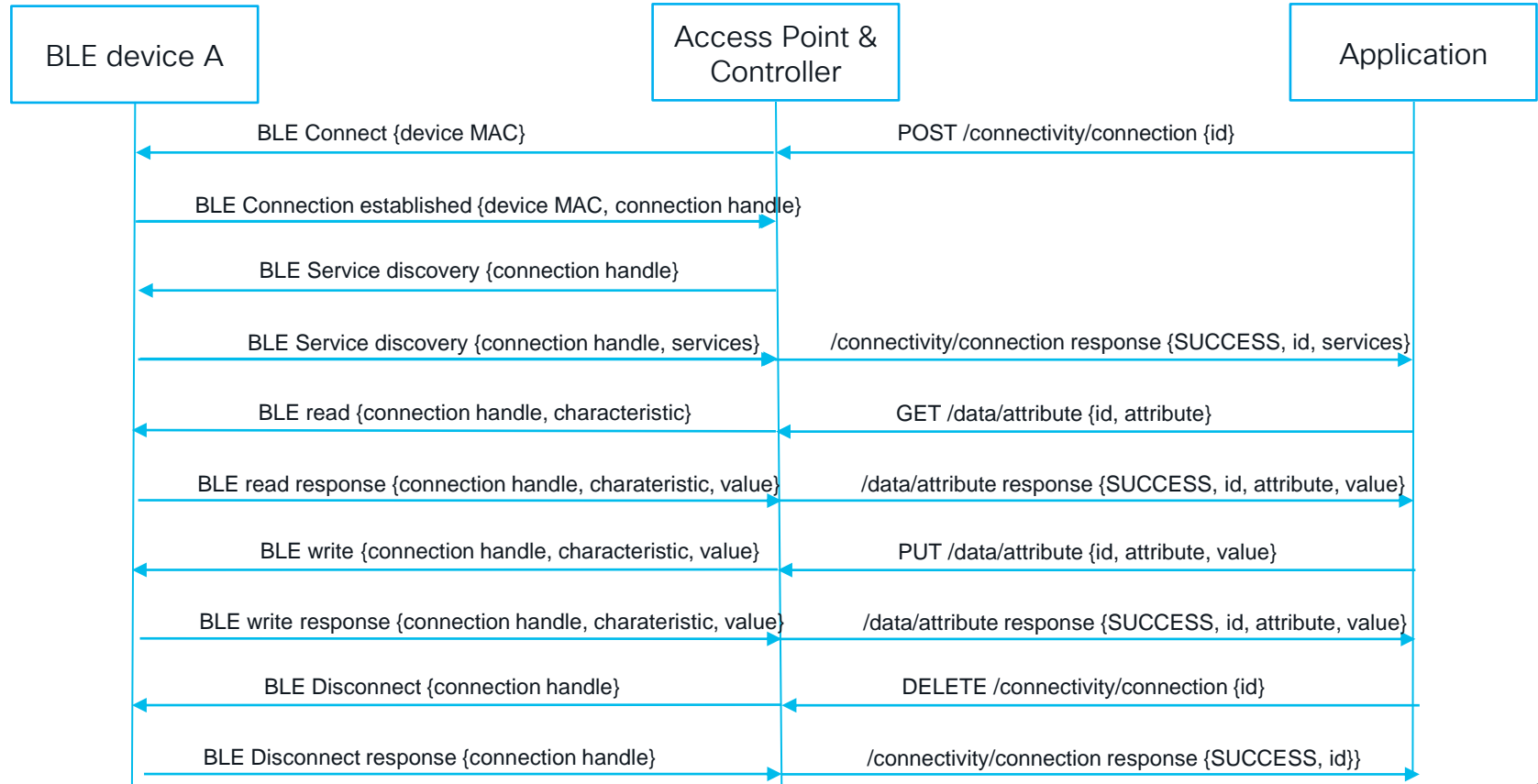
Status: Released v1 in Oct 2023, supporting BLE

Demo

1) Asset tracking application: Listen to broadcasts from a device to determine its whereabouts

2) Environmental sensor: Read temperature and humidity from a device
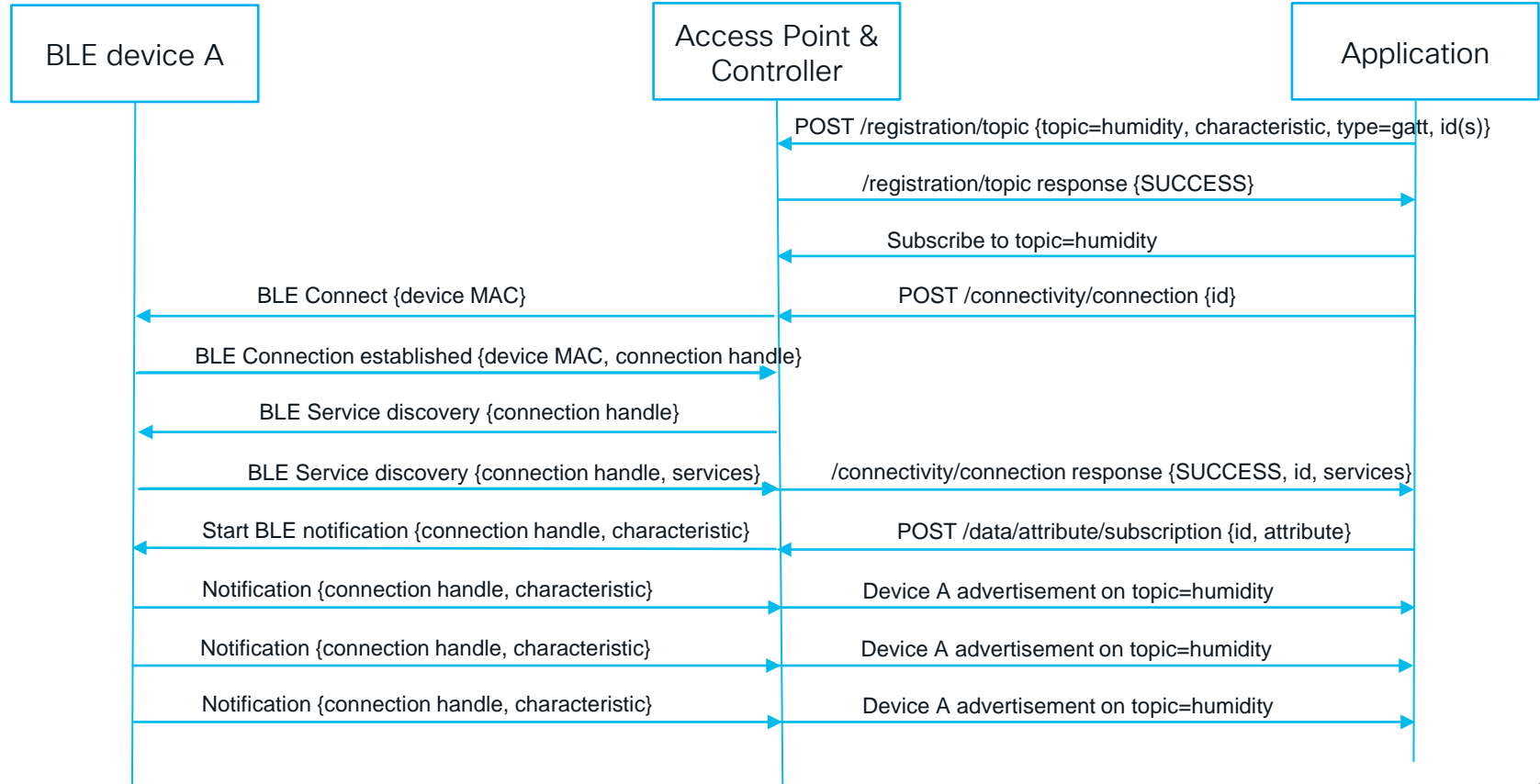
3) Environmental sensor: Stream environmental data

Asset tracking :
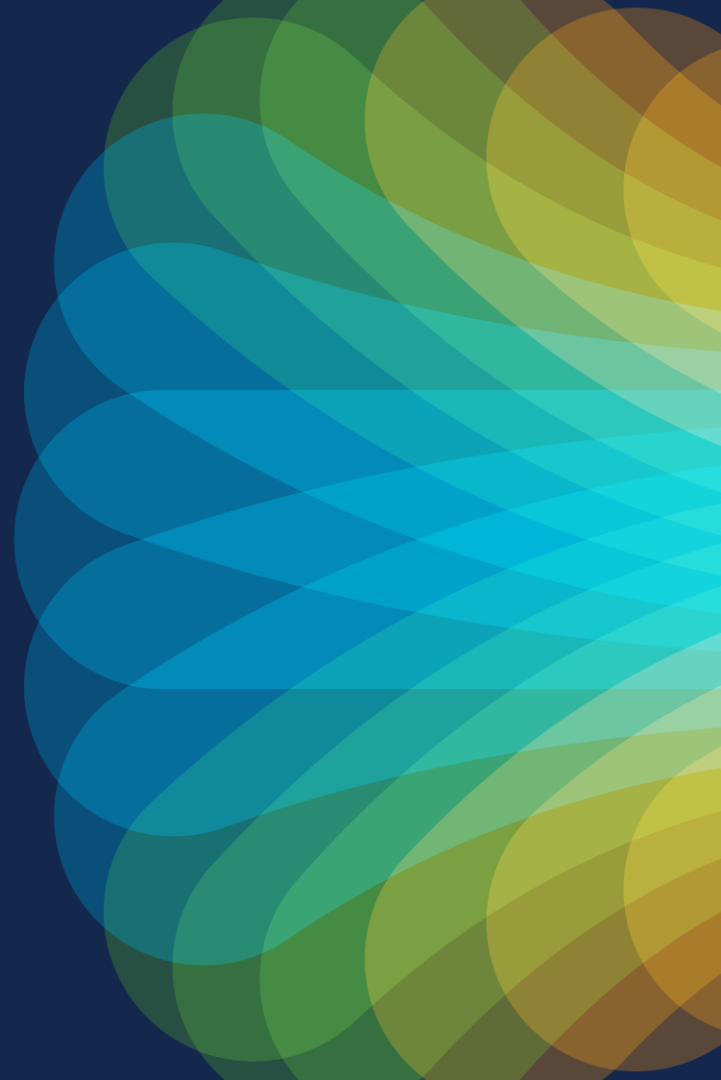# BLE Advertisement (broadcast) from BLE device

Environmental sensor:
Attribute read/write from BLE device

BLE device A	Access Point & Controller	Application

BLE Connect {device MAC} · POST /connectivity/connection {id}

BLE Connection established {device MAC, connection handle}

BLE Service discovery {connection handle}

BLE Service discovery {connection handle, services} · /connectivity/connection response {SUCCESS, id, services}

BLE read {connection handle, characteristic} · GET /data/attribute {id, attribute}

BLE read response {connection handle, charateristic, value} · /data/attribute response {SUCCESS, id, attribute, value}

BLE write {connection handle, characteristic, value} · PUT /data/attribute {id, attribute, value}

BLE write response {connection handle, charateristic, value} · /data/attribute response {SUCCESS, id, attribute, value}

BLE Disconnect {connection handle} · DELETE /connectivity/connection {id}

BLE Disconnect response {connection handle} · /connectivity/connection response {SUCCESS, id}}

Environmental sensor: Streaming data from BLE device

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Conclusion

Conclusion: IoT in Enterprise made easy!

- Contact us for more information or a Trial:

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    srsekar@cisco.com

- Try out the Open Source:

https://github.com/iot-onboarding/tiedie

- Read up on the standards:
  - SCIM: https://datatracker.ietf.org/wg/scim/documents/
  - SCIM Device Model: https://datatracker.ietf.org/doc/html/draft-shahzad-scim-device-model-05
  - NIPC: https://datatracker.ietf.org/doc/html/draft-brinckman-nipc/

Webex App

Questions?

Use the Webex App to chat with the speaker after the session

How

1. Find this session in the Cisco Events Mobile App

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4. Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until February 23, 2024.

https://ciscolive.ciscoevents.com/ciscolivebot/#DEVNET-2693
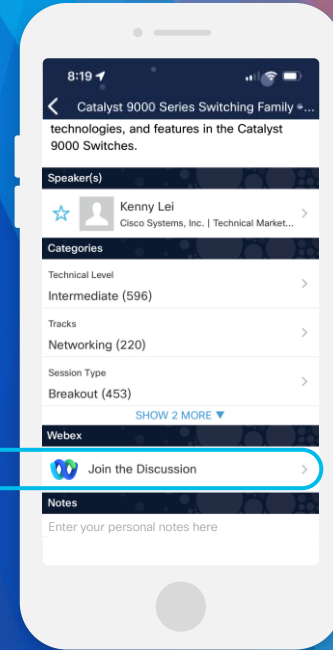
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Thank you

Cisco Live!

Let's go