Microsoft

Azure

Azure IoT Workshop

Real-time asset tracking

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Azure IoT

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Agenda

Introducing the problem – Contoso Art Shipping

Typical IoT architecture

Hands-on labs

Going further

Follow along at: http://aka.ms/iot-workshop/asset-tracking

Introducing the problem

Monitoring of high-value parcels for international company Contoso Art Shipping

Problem statement (1/3)

Contoso's goods are getting tampered, ruined in transit

Increased customer dissatisfaction

Losing customers, revenue

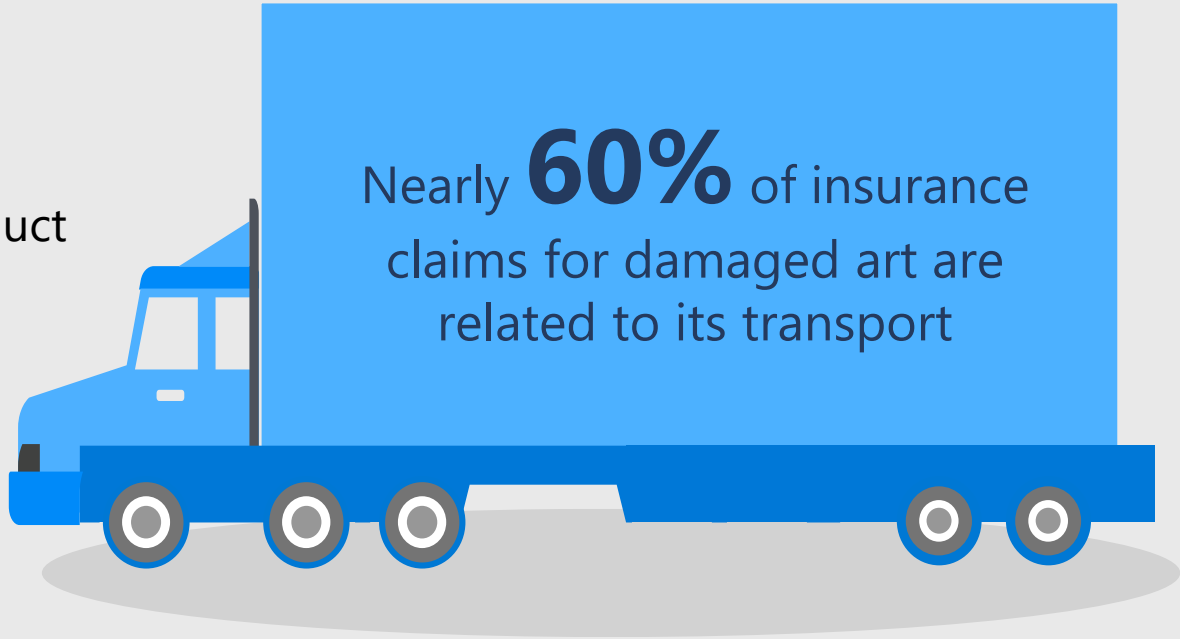
Increased insurance claims

High personnel costs to follow-up on claims

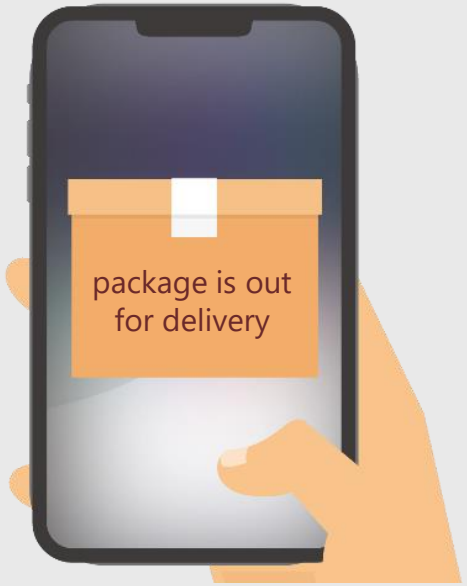
Problem statement (2/3)

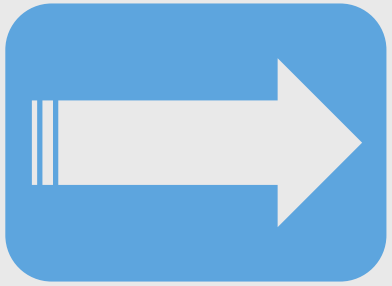
Contoso lacks ability to monitor

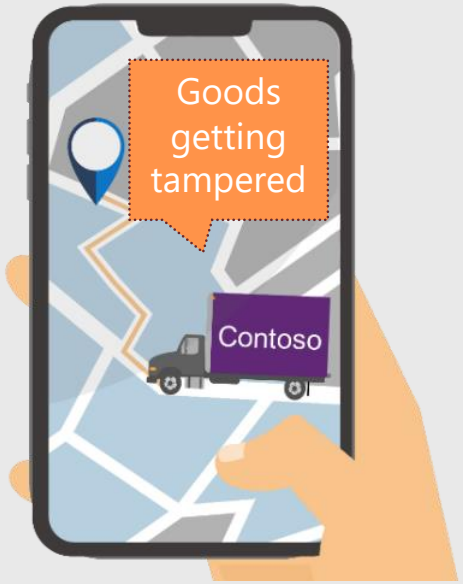
- Goods that are getting tampered with during transportation
- In-transit product condition
- Location of the parcels



Problem statement (3/3)







Contoso already has an ERP and mobile app in place for basic tracking information

They would like to enable real-time tracking of shipments

Contoso Art Shipping's requirements

Track in real-time the physical location and condition of their parcels

Efficiently **store** this data so that it can be accessed and queried

Get **alerts** when abnormal conditions are detected…

… and **visualize** them on a map

Integrate with their existing business application

Scale from a very small deployment to something much bigger

… bonus points if they can be supported by great **developer tools** ☺

Architecture of an IoT solution

A More Realistic View…

Fault tolerance

Data storage

Deployment

Enterprise integration

Cloud-to-device commands

Business process integration

Cold path analytics

Device recovery

Solution scale

Operations monitoring

Cost management

Internationalization

High availability

Updating devices

Provisioning devices

Transport protocols

Device lifecycle

Warm path analytics

Things

Disaster recovery

Insights

Hot path analytics

Actions

Drivers

Device updates

Data ownership

< ---- End-to-End Security ---- >

On device analytics

Data visualization

Industry and government compliance

HW certification

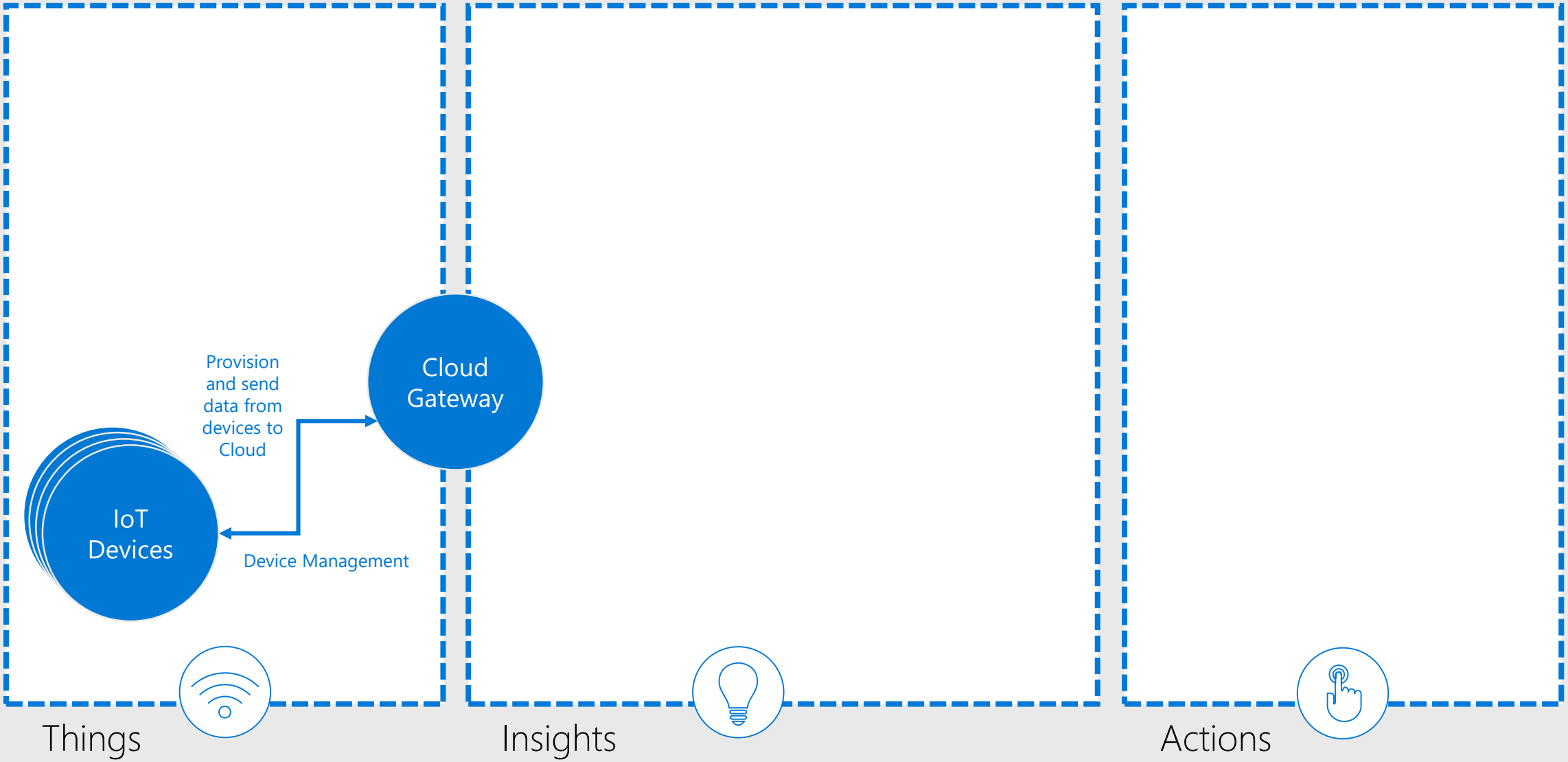
Manufacturing scale

Device commercialization

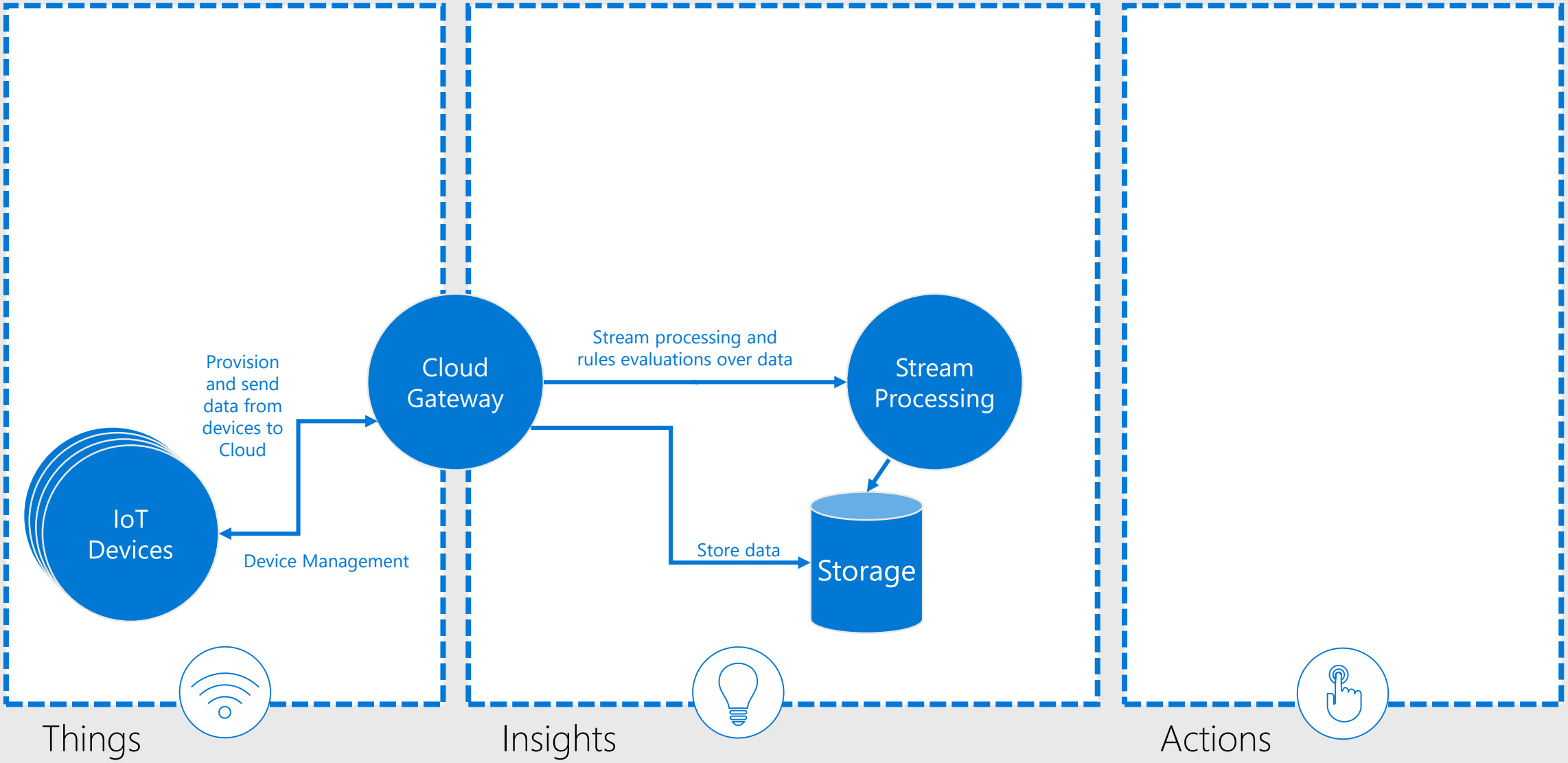
Securing data

… and why IoT needs simplifying

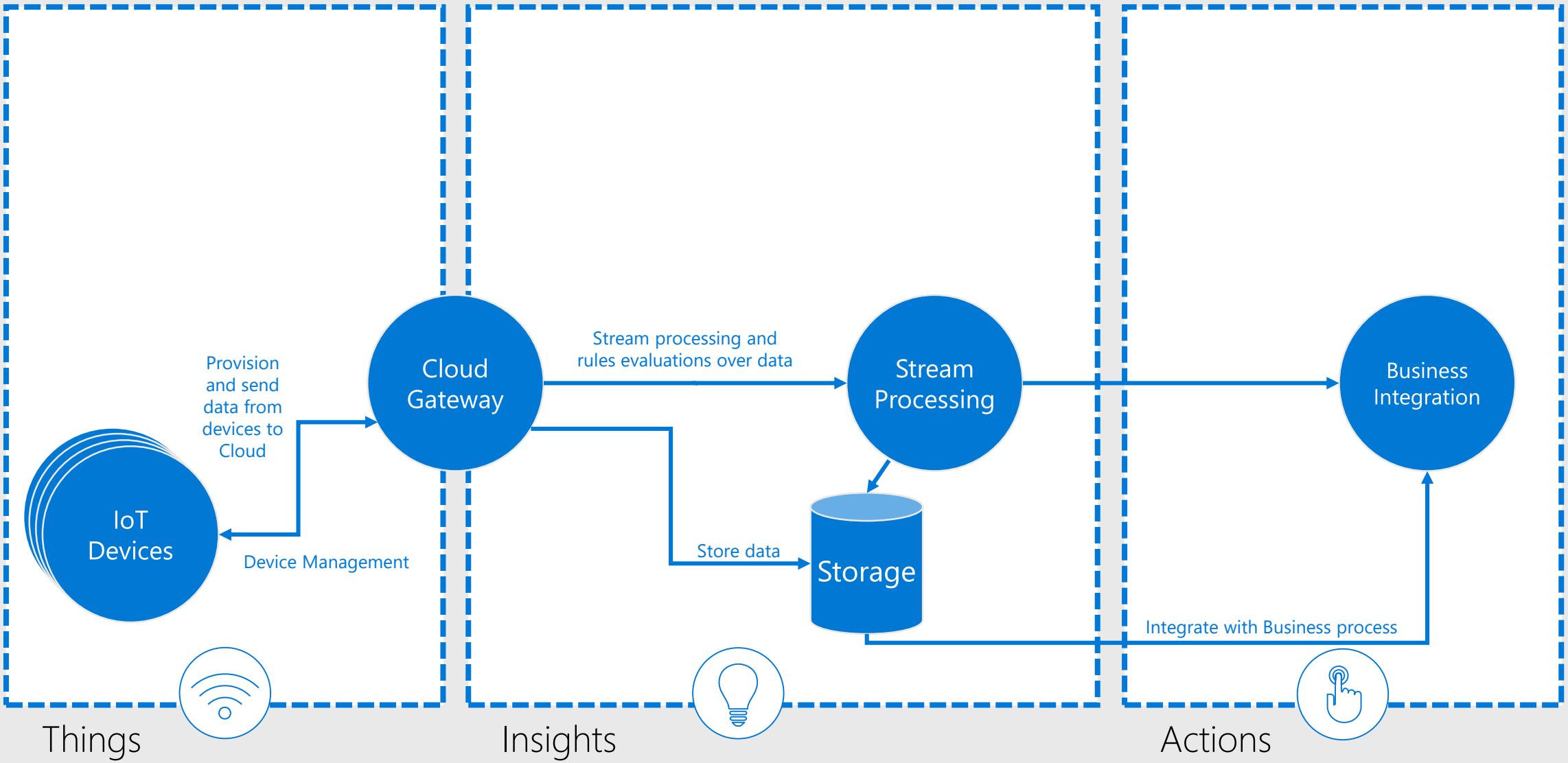
IoT Architecture



IoT Architecture



IoT Architecture



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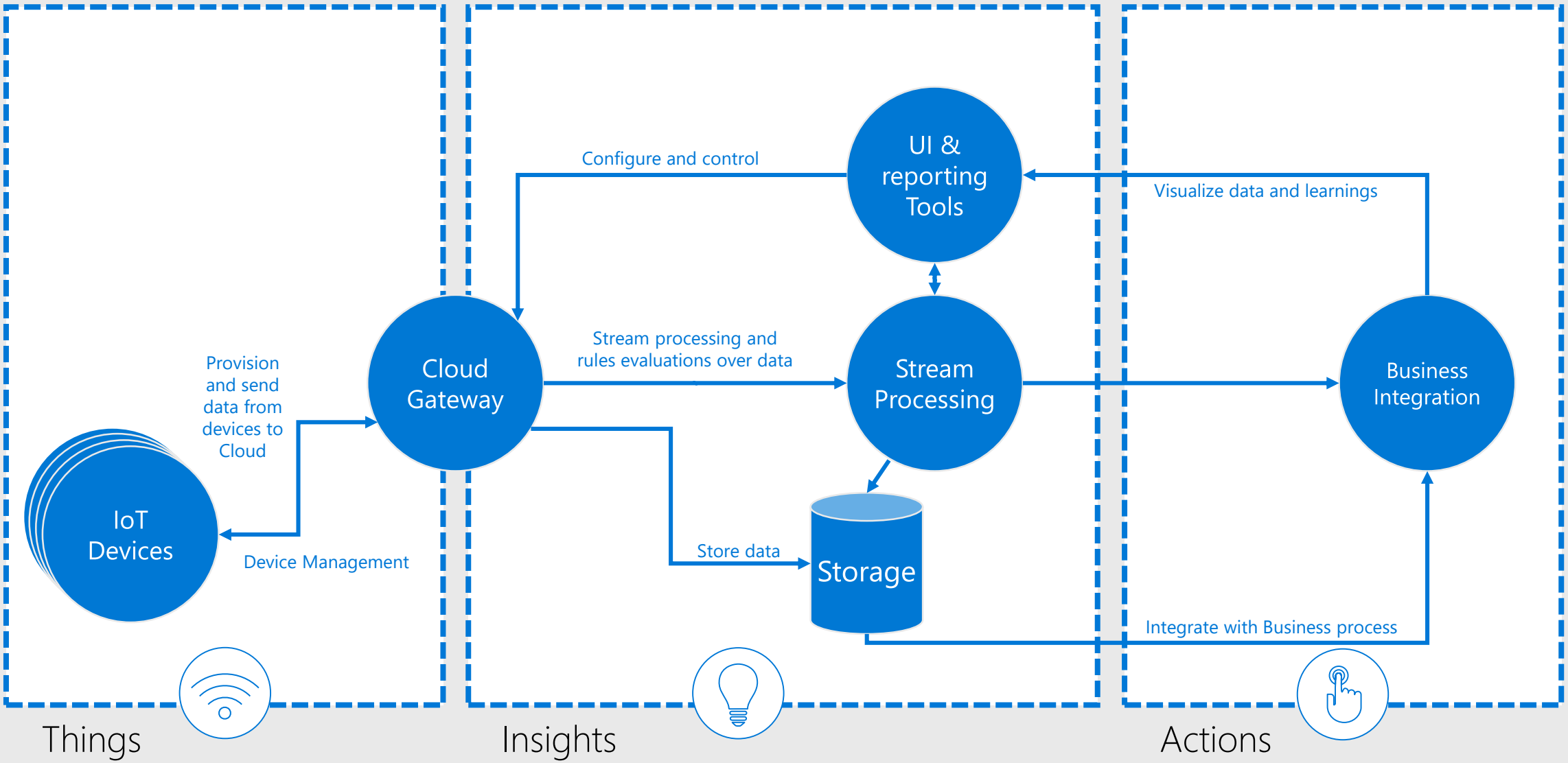


aka.ms/iot-workshop/asset-tracking

Hands-on lab

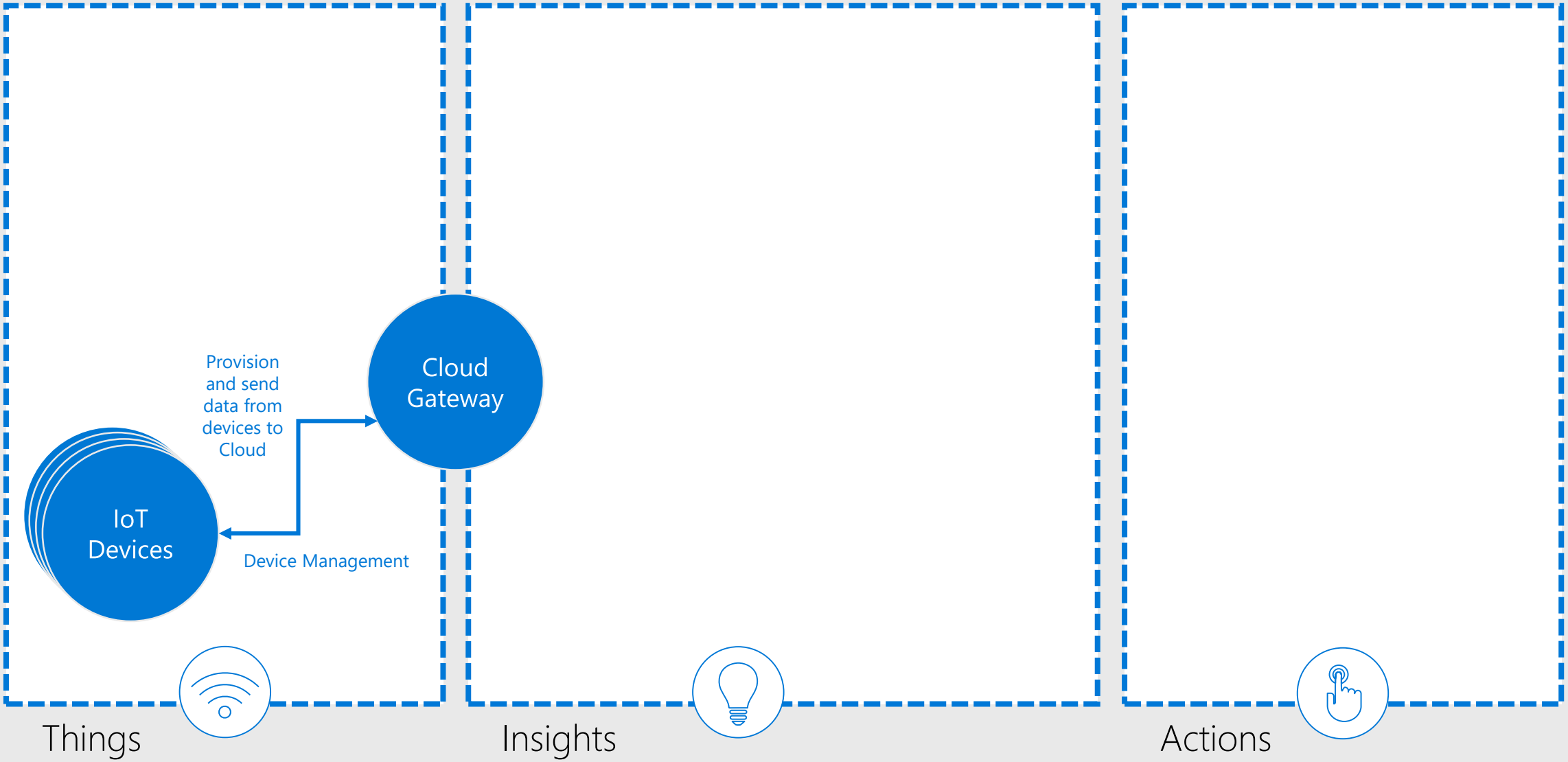
Step 1 – Connecting a device to Azure IoT

Track in real-time the physical location and condition of their parcels

Learning goals:

- How to setup the messaging infrastructure for connecting your IoT devices
- Understand basic security and device management concepts
- Explore IoT Plug-and-Play concepts
- Discover VS Code IoT extensions and Azure IoT Explorer

IoT Architecture



IoT Hub and Device Provisioning Service

Azure IoT Hub

Bi-directional communication

Millions of Devices

Multi-language, open source SDKs

HTTPS/AMQPS/MQTTS

Send Telemetry

Receive Commands

Device Management

Device Twins

Queries & Jobs

Enterprise scale & integration

Billions of messages

Scale up and down

Declarative Message Routes

File Upload

WebSockets & Multiplexing

Azure Monitor

Azure Resource Health

Configuration Management

End-to-end security

Per Device Certificates

Per Device Enable/Disable

TLS Security

X.509 Support

IP Whitelisting/Blacklisting

Shared Access Polices

Firmware/Software Updates

Azure Security Center Support

Device Provisioning Service

IoT-scale automated provisioning

Zero-touch provisioning

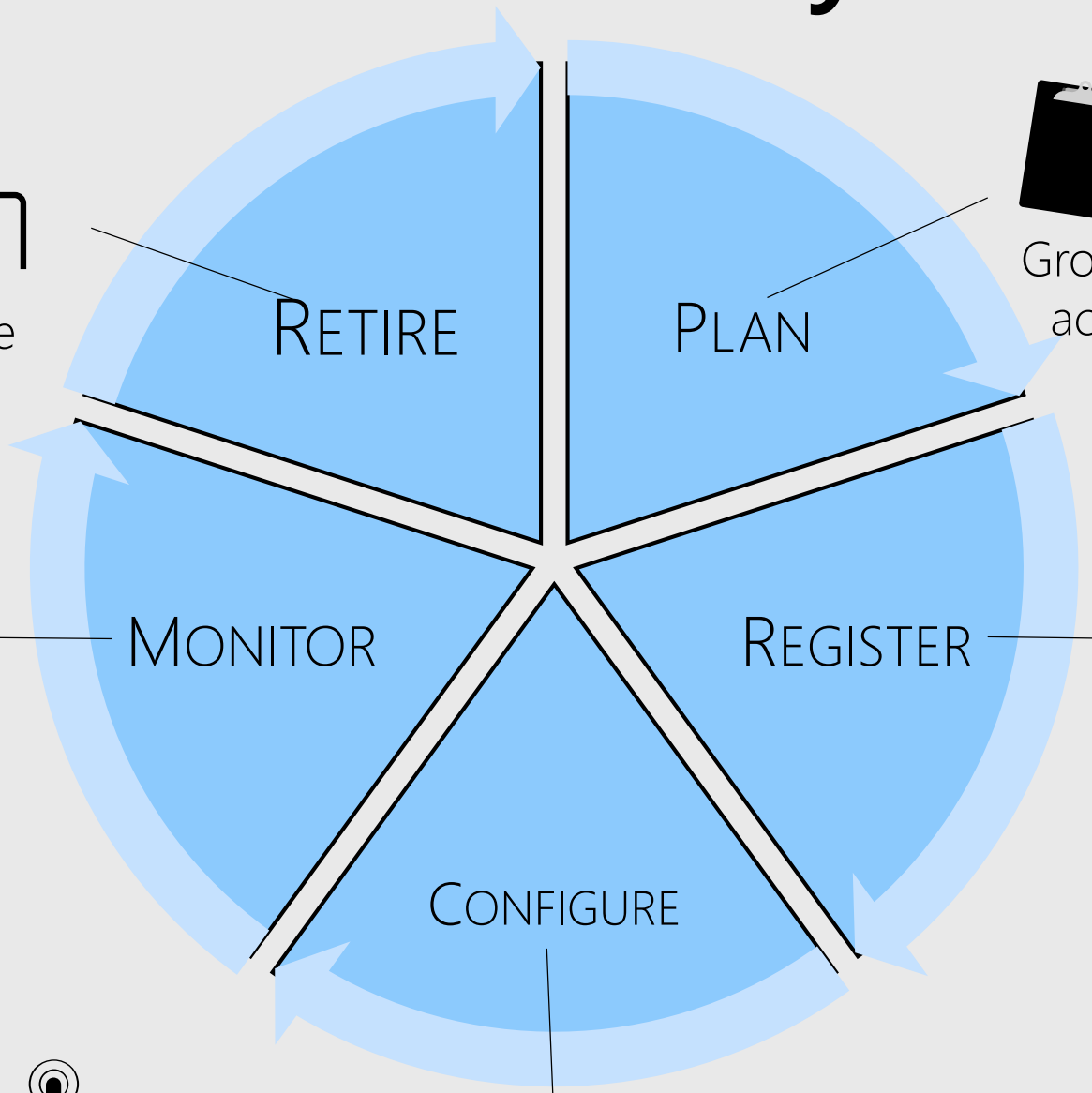
Centralize your provisioning workflow

Load balance across multiple IoT Hubs

Re-provisioning support

Supports TPM + X.509

IoT Device Lifecycle



Replace or decommission devices after failure, upgrade cycle or service lifetime

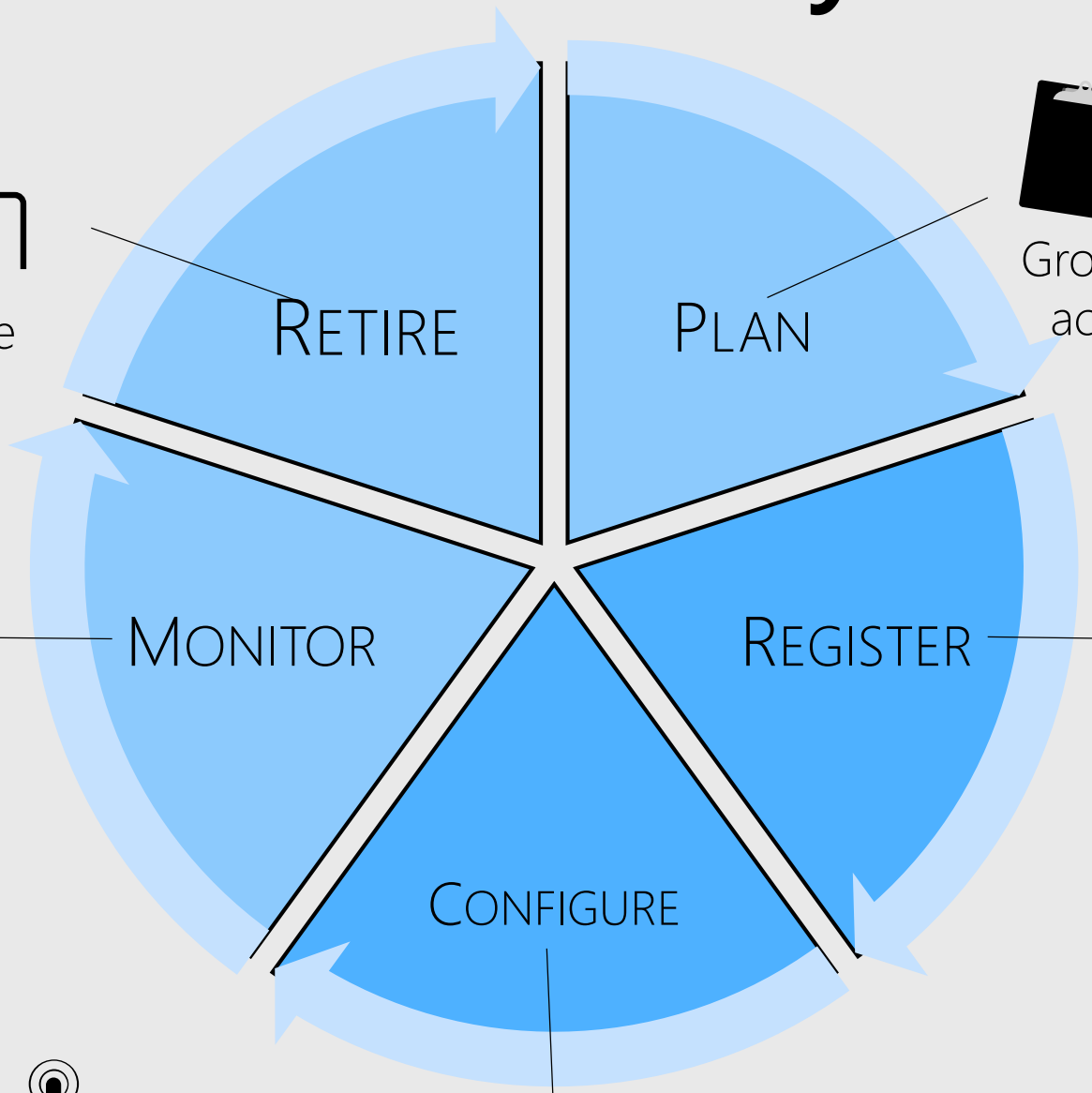
Group devices and control access according to your organization's needs

Monitor device inventory, health & security while providing proactive remediation of issues

Securely authenticate devices, on-board for management and provision for service

Provide updates, configuration & applications to assign the purpose of each device

IoT Device Lifecycle



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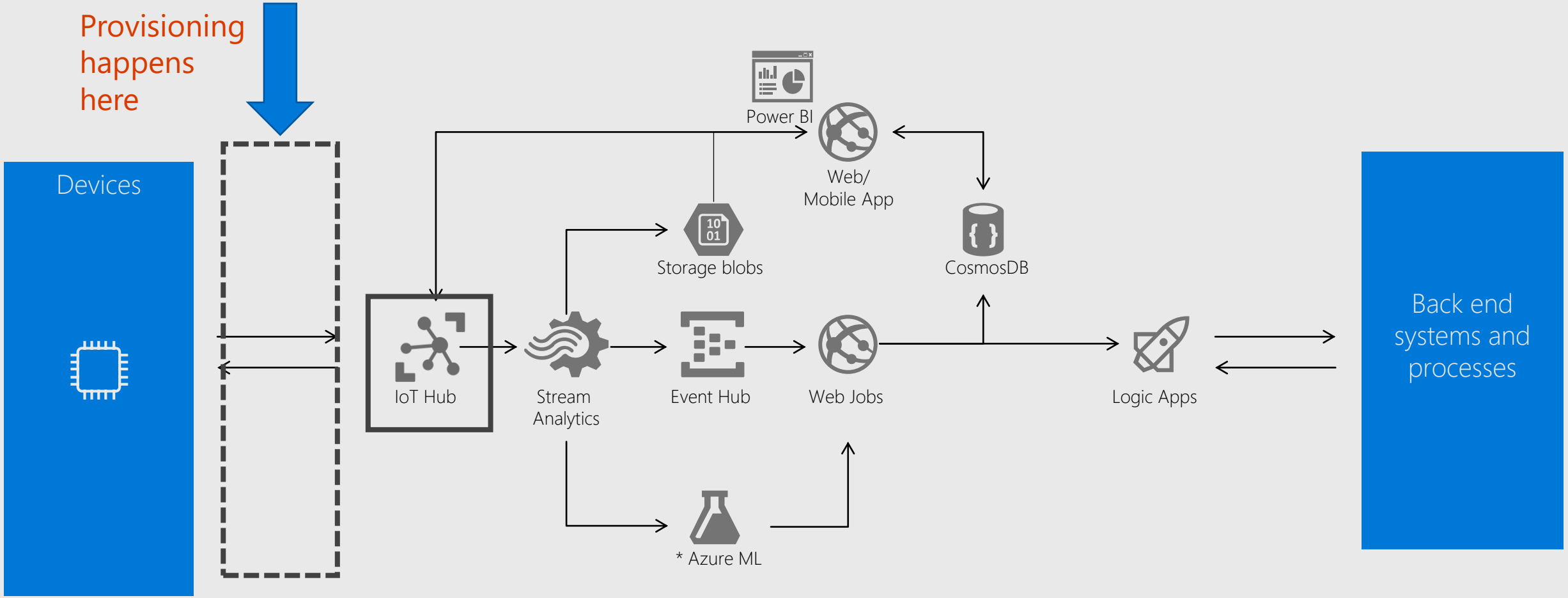
Quick orientation



What is provisioning?

Why provisioning is hard today

- Solutions must have per-device revocable access
- Provisioning is a manual process
- Initial configuration can become irrelevant between manufacturing and deployment
- Device supply chains are complex

Azure IoT Hub Device Provisioning Service

Simplify with zero touch provisioning

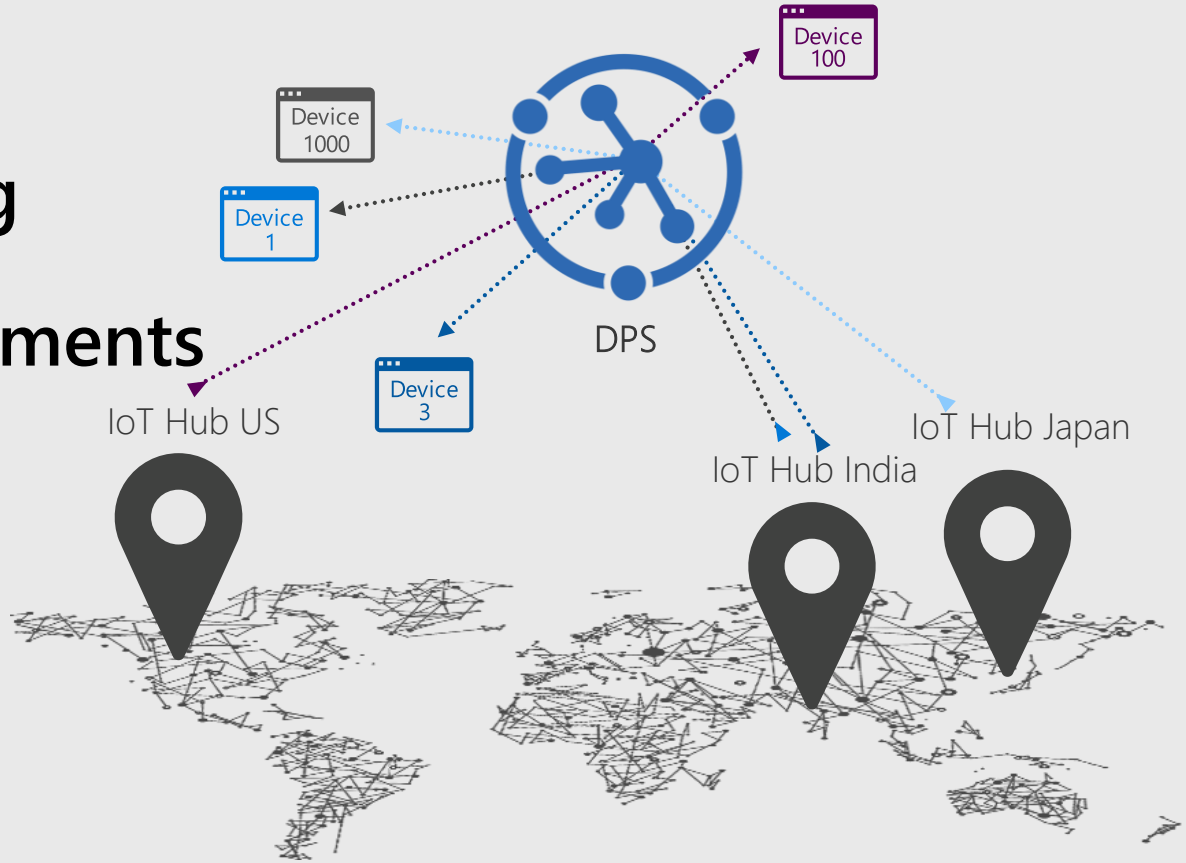
Minimize manual connection requirements

Cross-geo provisioning support

Multitenancy support

Enhanced security

For any device compatible with IoT Hub



DPS knows exactly which IoT Hub to connect and provision

Securely automate the provisioning process

Devices are automatically and securely connected to the IoT Hub service and provisioned with an initial configuration

Multitenancy support

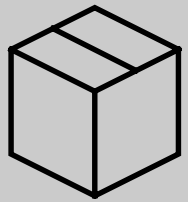
A single DPS can provide service for multiple IoT hubs (in multiple regions)

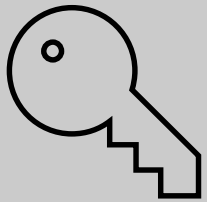
Flexible device assignment

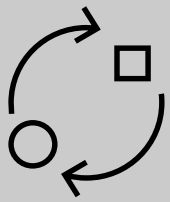
Customers provide rules and logic to assure the right device is attached to the right IoT solution (and associated IoT Hub)

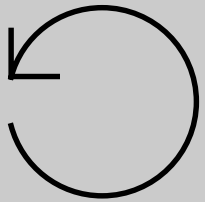
An IoT device's relationship to DPS

Initial setup	Retrieving a key	Rolling a key	Hard reset
Getting the device ready for the first time	For devices with limited or no key storage capabilities	Applicable only for devices which connect via a SAS token	When the device needs to be treated as new in-box

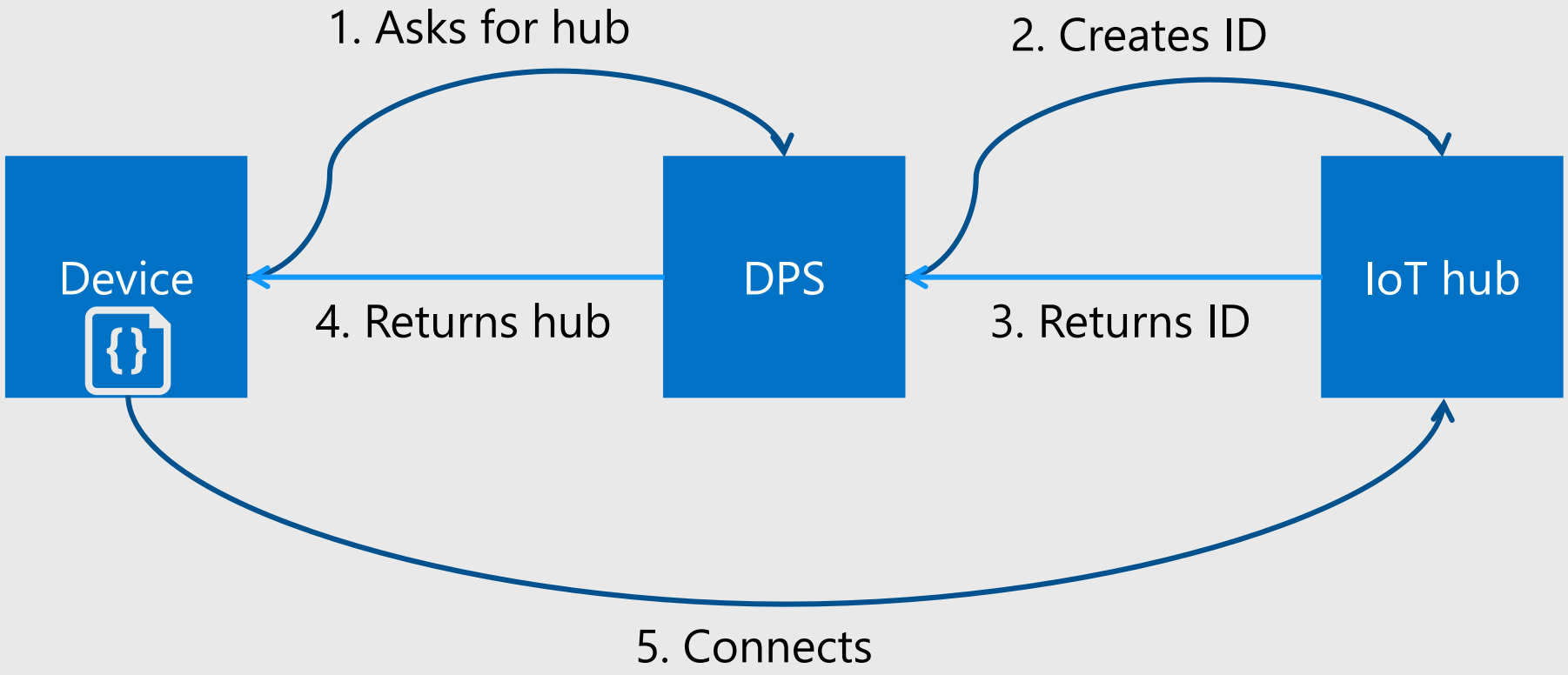




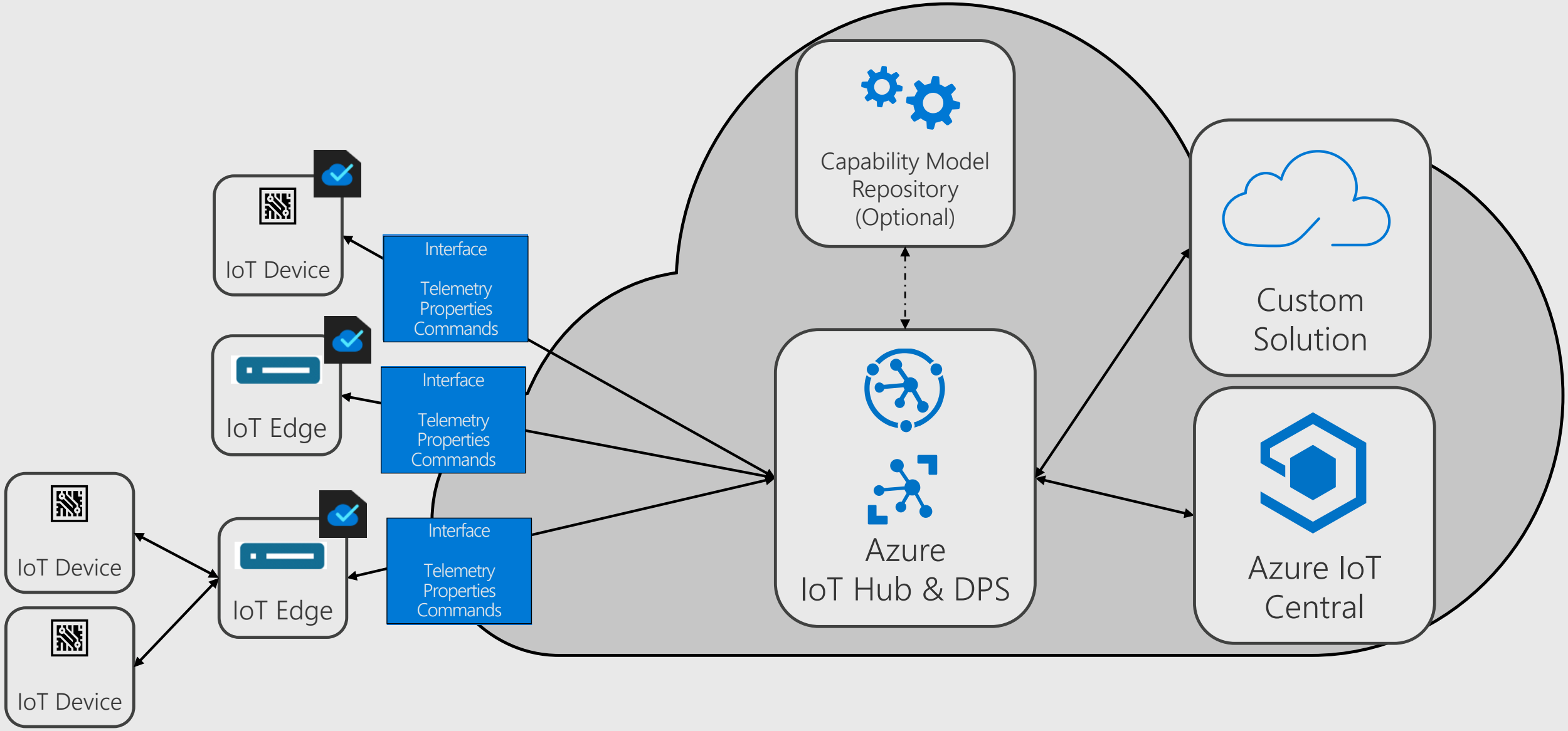




High level provisioning



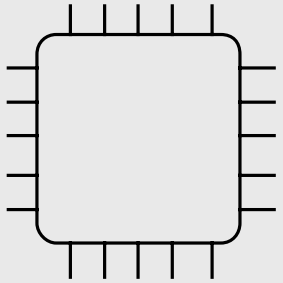
IoT Plug and Play In Platform Context



Where are capability models stored?

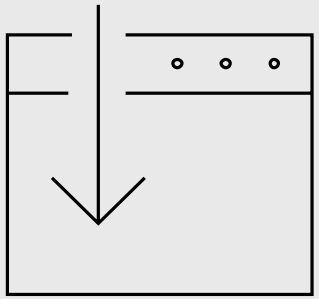
Device sends capability model ID and version expected for the solution to know

If unknown, the following are the model retrieval options for the solution:



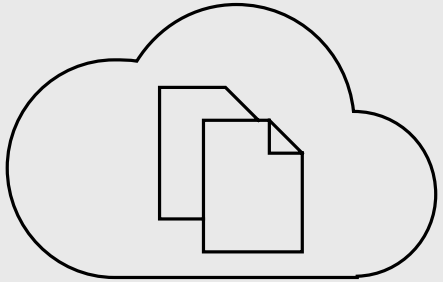
Device Sent

Stored and sent by the device to the solution. Quick and easy but device must be updated if model changes



URI Retrieval

Device sends a URI for retrieval from central location. Great for constrained devices, privacy or for simple on-premises deployments



Capability Model Repository

Can be pre-cached by Azure solutions. Includes publish-time validation/versioning and integration with Azure dev tooling

IoT Plug and Play Repository*

https://preview.catalog.azureiotsolutions.com

Capability model and interface workspace and publishing repository experience

Publishing integrated in VS Code and Azure CLI for both interfaces and capability models

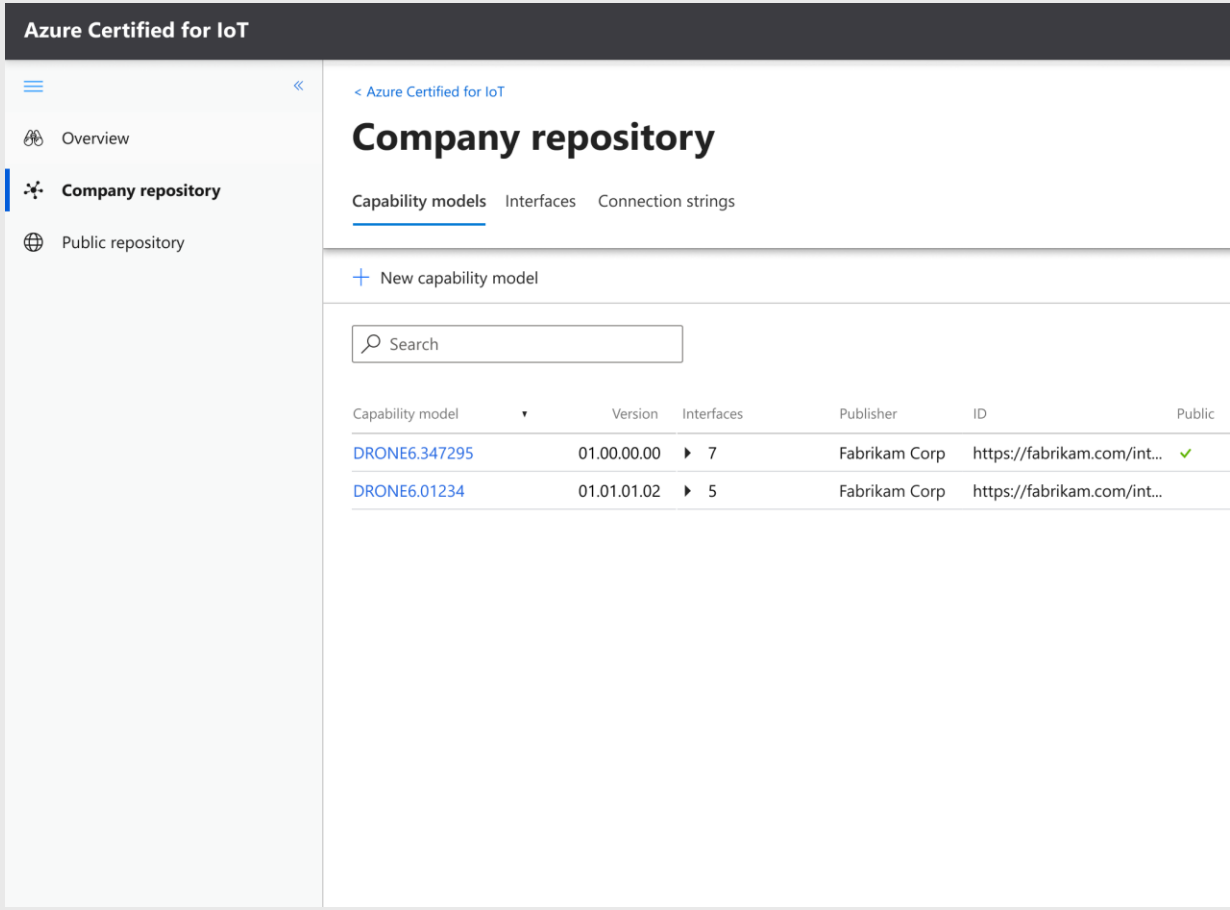
Automated validation, collision checks and versioning support

Search, filter, sort, view models & their graphs in model repository UX

Works out-of-the-box with any Azure IoT solution

Will be made available as an open-source project

Microsoft will also host a fully managed, multi-tenant instance for always up-to-date for Azure Certified devices; integrated into certification flow

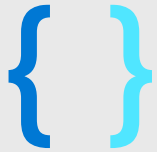


IMPORTANT: Model repository is never required for IoT Plug and Play

Capability Model Developer Tooling

Azure IoT Device & Service SDKs

Updated with IoT Plug and Play support for all languages

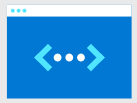


Azure IoT Device Workbench extension for Visual Studio Code

IntelliSense and validation for authoring models

Generate skeleton device code from capability models

Works with Microsoft model repository



Azure IoT CLI extension

Author / retrieve capability models & interfaces

Test device and service code

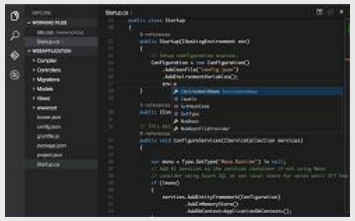
Azure IoT Explorer

Updated to allow discovery and examination of IoT Plug and Play devices

Azure IoT
Device Simulation

Partner Solutions &
Azure IoT Central

VS Code



Devices that just work out of the box with no code required

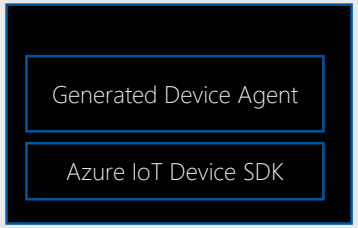
Easy to model device capabilities, easy to generate device software skeleton

Device Capability Model

JSON-LD Schema

Azure IoT Device Catalog
IoT Plug & Play Certified

IoT Plug and Play
Device Software



Easy to certify plug and play devices

Easy for customers and partners to find plug and play devices that just work

Easy to develop device software and ensure it just works with IoT solutions

IoT Hub, DPS, PnP

Step 1 – Hands-on

http://aka.ms/iot-workshop/asset-tracking

Setup IoT Hub and DPS

Configure asset tracking device

Explore capabilities thanks to PnP

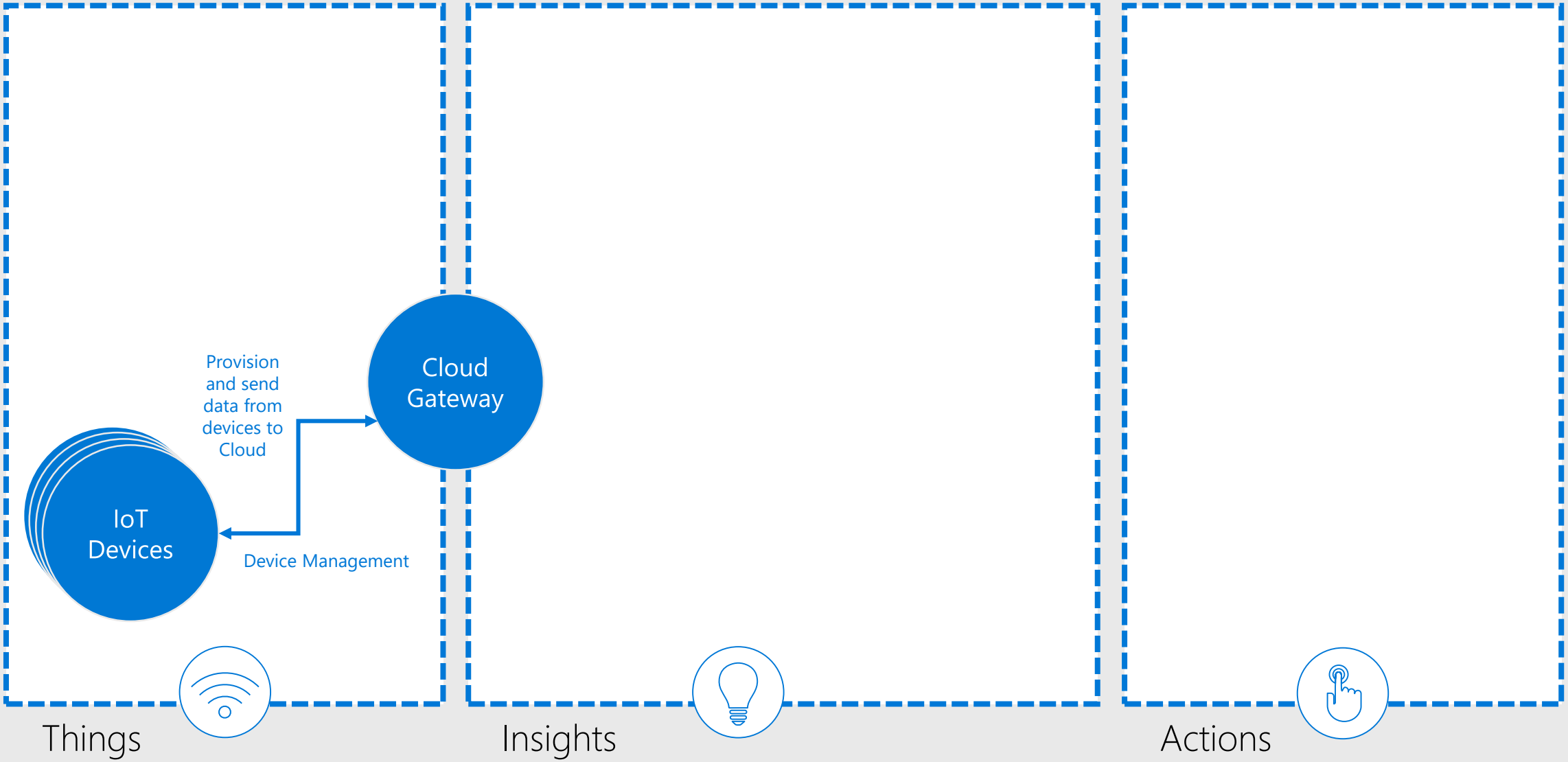
Step 2 – Setting up an IoT data pipeline

Efficiently store this data so that it can be accessed and queried

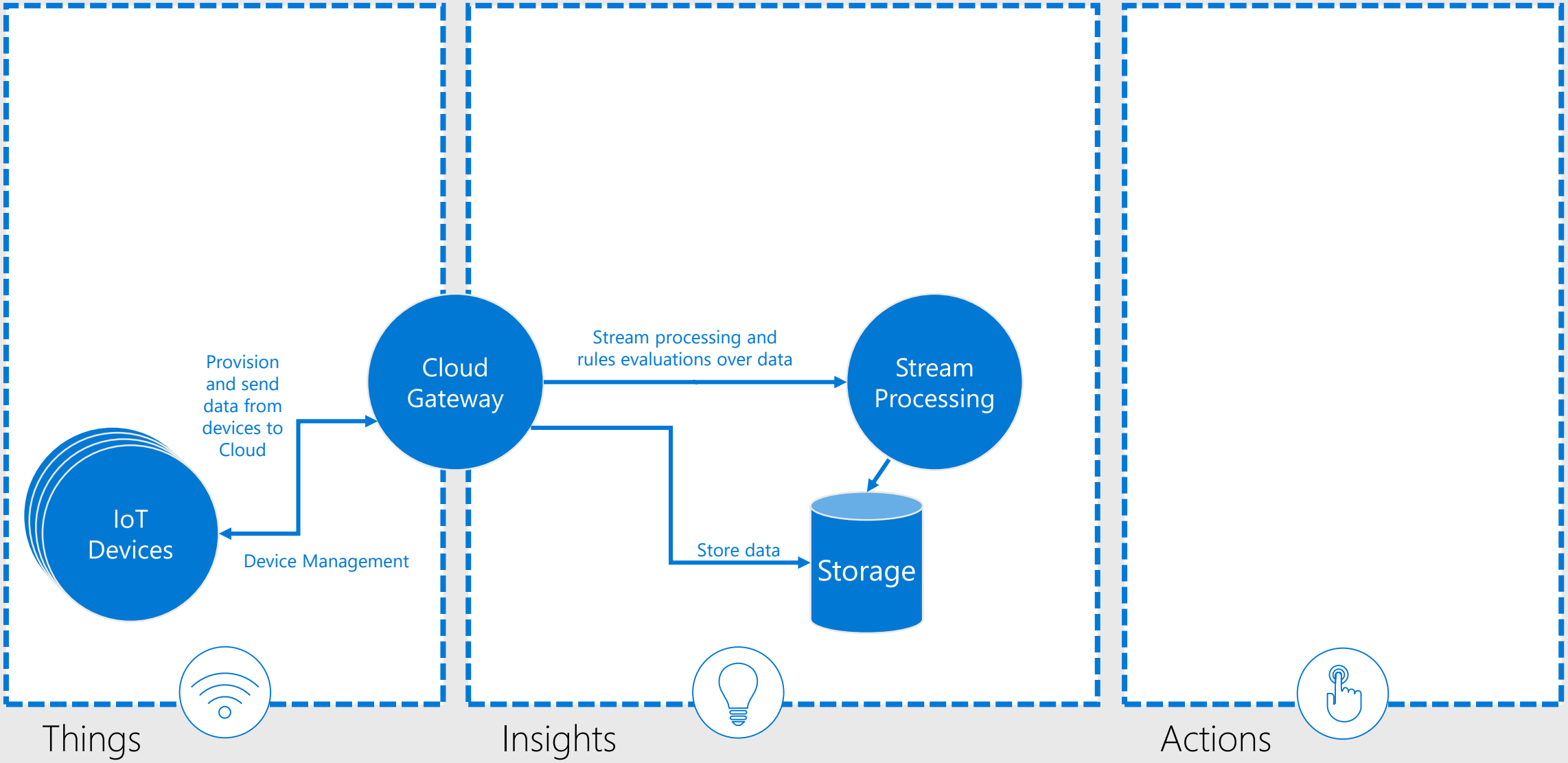
Learning goals:

- How to implement short-term and long-term retention using Azure Time Series Insights
- How to use TSI built-in data explorer to perform data analytics

IoT Architecture



IoT Architecture



What is Azure Time Series Insights

A Fully Managed Platform as a Service (PaaS) Solution Built for IoT

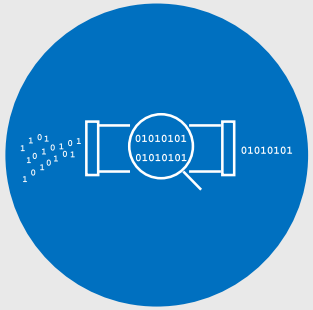
Fully managed, end-to-end PaaS solution to ingest, process, store, and query highly contextualized, time-series-optimized, IoT-scale data

Connect to a variety of data solutions using TSI's flexible data platform

Use rich analytics APIs and UX for ad-hoc exploration and operational intelligence

Use JavaScript control library for building custom analytics apps on the TSI platform

IoT Data Characteristics



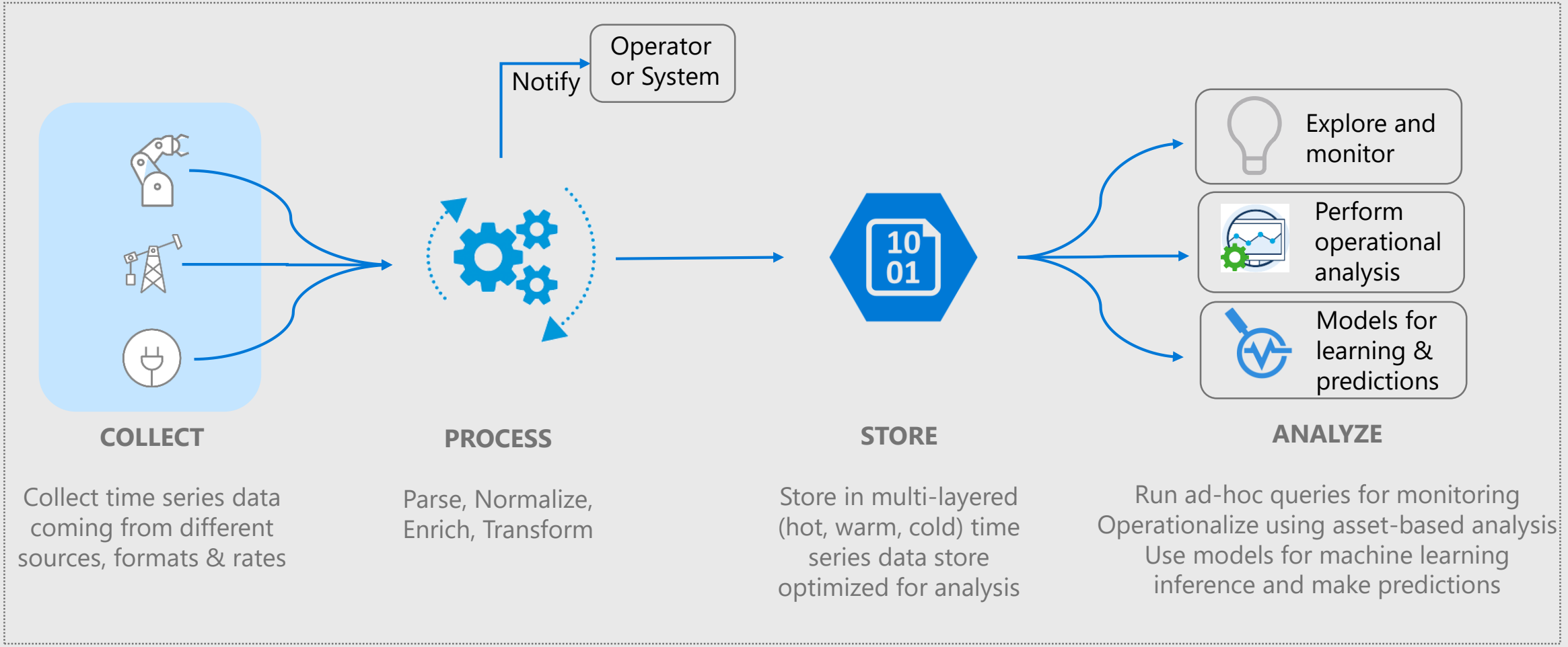
Lacks structural consistency

Needs contextualization

Often used with other data

Infinite retention

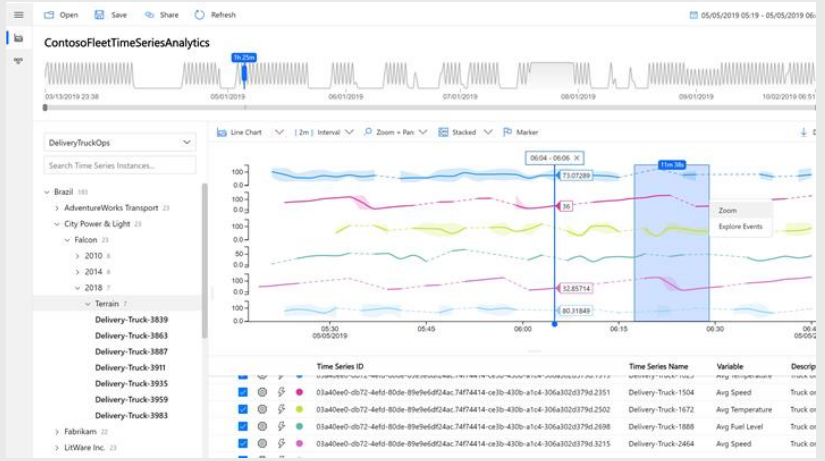
Canonical IoT Data Pipeline

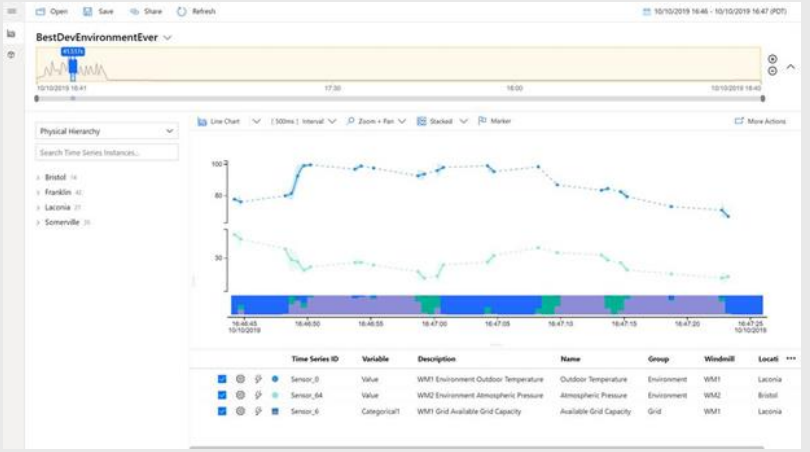


Azure Time Series Insights

NEW CAPABILITIES

- Multi layered storage with warm and cold analytics support providing customers with the option to route data for interactive analytics over short timespans and operational intelligence over decades of historical data
- Flexible data platform that allows customers to take data stored in open source Apache Parquet to other advanced data solutions such as Spark, Databricks, Jupyter for predictive maintenance, machine learning and AI
- Rich query APIs and user experience to support interpolation, scalar and aggregate functions, categorical variables, scatter plots, and time shifting between time series signals for in-depth analysis.
- Enterprise grade scale and performance at all layers of the solution to support customers' industrial IoT solution needs
- Rich extensibility through Power BI connector to enable customers to take their time series queries directly into Power BI for a unified BI and analytics view





Time Series Insights

Step 2 – Hands-on

http://aka.ms/iot-workshop/asset-tracking

Setup TSI environment

Setup event sources

Explore data

Step 3 – Anomaly detection

Getting alerts when abnormal conditions are detected

Learning goals:

- How to extract insights from real-time IoT Data using Azure Stream Analytics
- How to turn alerts into actions
- How to store alerts into Time Series Insights, alongside telemetry

Microsoft

Azure Stream Analytics In a Nutshell

Unlocking Real-time Insights

Time to Insight is Critical

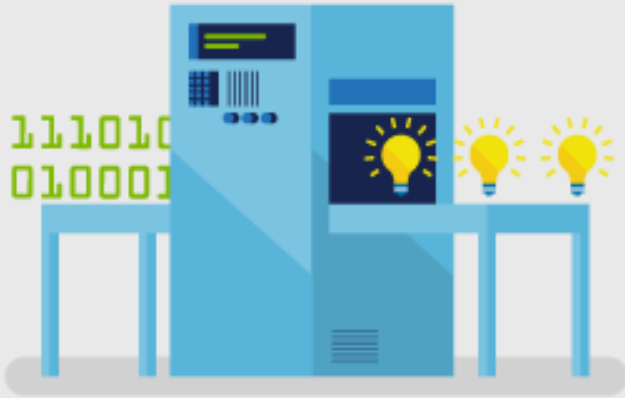
- Reducing decision latency can unlock business value

Insights are Perishable

- Window of opportunity for insights to be actionable

Ask Questions to Data in Motion

- Can’t wait for data to get to rest before running computation



Real-time Stream Processing

Simple Event Processing

- Filter
- Transform
- Enrich
- Split
- Route

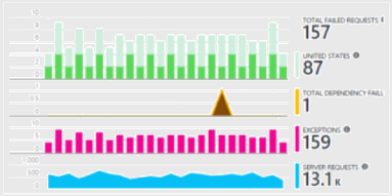
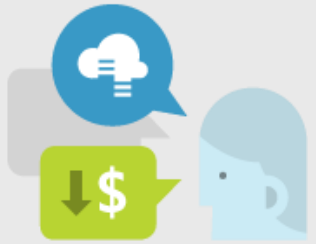
Event Stream Processing

- [Simple event processing] +
- Aggregate
- Rules

Complex Event Processing

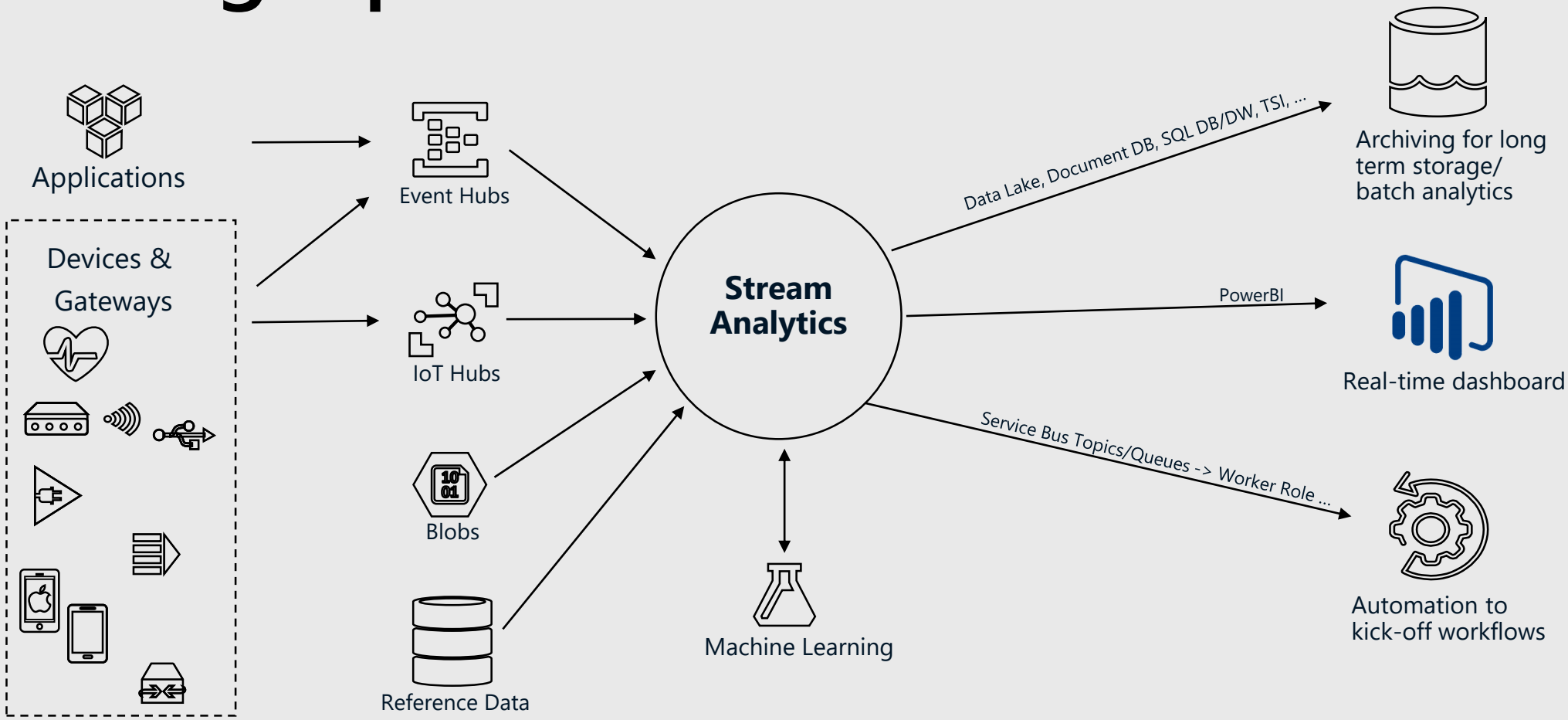
- [Event Stream Processing] +
- Pattern detection
- Time windows
- Joins & correlations

Scenario Examples

Real-time Fraud Detection 	Streaming ETL 	Predictive Maintenance 	Call Center Analytics 
IT Infrastructure and Network Monitoring 	Customer Behavior Prediction 	Log Analytics 	Real-time Cross Sell Offers 
Fleet monitoring and Connected Cars 	Real-time Patient Monitoring 	Smart Grid 	Real-time Marketing 

and many more...

Streaming Pipeline



Event production ⇨ Event Queuing & Stream Ingestion ⇨ Stream Analytics ⇔ Storage & Batch Analysis ⇨ Presentation & Action

Stream Analytics Query Language (SAQL)

Declarative SQL like language to describe transformations

- Filters (“Where”)
- Projections (“Select”)
- Time-window and property-based aggregates (“Group By”)
- Time-shifted joins (specifying time bounds within which the joining events must occur)
- and all combinations thereof

Data Manipulation

```
SELECT
FROM
WHERE
HAVING
GROUP BY
CASE WHEN THEN ELSE
INNER/LEFT OUTER JOIN
UNION
CROSS/OUTER APPLY
CAST INTO
ORDER BY ASC, DSC
```

Aggregation

```
SUM
COUNT
AVG
MIN
MAX
STDEV
STDEVP
VAR
VARP
TopOne
```

Date and Time

```
DateName
DatePart Day, Month, Year
DateDiff
DateTimeFromParts
DateAdd
```

Temporal

```
Lag
IsFirst
Last
CollectTop
```

Windowing Extensions

```
TumblingWindow
HoppingWindow
SlidingWindow
```

Scaling Extensions

```
WITH
PARTITION BY
OVER
```

String

```
Len
Concat
CharIndex
Substring
Lower, Upper
PatIndex
```

Mathematical

```
ABS
CEILING
EXP
FLOOR
POWER
SIGN
SQUARE
SQRT
```

Geospatial (preview)

```
CreatePoint
CreatePolygon
CreateLineString
ST_DISTANCE
ST_WITHIN
ST_OVERLAPS
ST_INTERSECTS
```

Stream Analytics Job

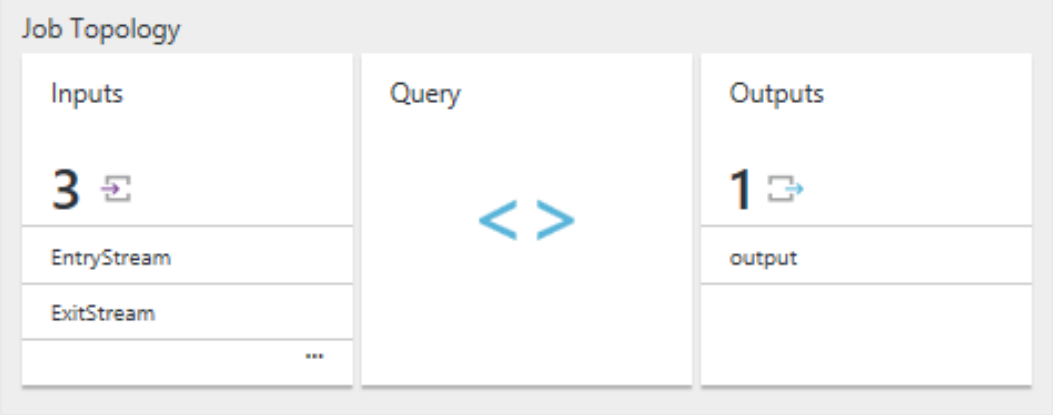
Users construct and deploy jobs to ASA

Job definition includes inputs, a query, and output

Inputs are from where the job reads the data stream

Query runs for perpetuity unless explicitly stopped and transforms the input stream

Output is where the job sends the job results to



Azure Stream Analytics

Step 3 – Hands-on

http://aka.ms/iot-workshop/asset-tracking

Setup ASA job

Create query to detect anomalies

Visualize anomalies in TSI

Step 4 – Map visualization

Learning goals:

- How to use Azure Maps web control
- How to combine Time Series Insights and Azure Maps web SDKs
- Advanced Azure Maps features, e.g heatmap


Azure Maps
Overview
Microsoft
©2019 TomTom Improve this map

What is Azure Maps?

A collection of geospatial services for creating solutions that meet the requirements of enterprise customers in their line of business and consumer applications.

Enterprise Ready

- ✓Enterprise Scale
- ✓Global Availability
- ✓Web and Mobile SDKs
- ✓Integrated with other Azure Services
- ✓Maps updated weekly
- ✓Traffic data updated every minute

Trusted Platform

- ✓Azure Security Complaint
- ✓Azure Active Directory Tenancy
- ✓GDPR {Azure Privacy} Compliant
- ✓Accessibility, Usability, Globalization and Localization Compliant

Competitive, Flexible Pricing

- ✓Generous free limits
- ✓Access Azure Maps with any Azure subscription (trial, pay as you go, Enterprise Agreement)
- ✓Multiple pricing tiers for your specific needs
- ✓No upfront cost
- ✓Only pay for what you use

Best of Breed Content Partnerships

AzureMaps

TOMTOM

Maps
Points of Interest
Geocoding
Routing
Road networks
Traffic

moovit

Mobility Services
Public Transit Networks
Real-time Transit data
Micro-mobility data

AccuWeather

Current Weather
Forecast Weather
Weather along route

Updates from content partners made instantly available in Azure Maps!

A platform of geospatial APIs for the enterprise

AzureMaps

Maps
Render maps and satellite imagery across many geographies in several styles

SDKs
Web and Android SDKs to integrate Azure Maps into applications

Routing
Multi-algorithmic routing, batch routing and matrix routing

Search
Find addresses, points of interest, landmarks, using a multitude of search algorithms or in batch

Spatial Operations
Create Geofences, measure great circle distance, closest point and point in polygon

Traffic
Real-time traffic flow and incident detail, measuring distance to back or front of the line

Time Zones
Obtain time zone and current time information from any location

Geolocation
Query for the location of an IP address

Mobility
(Public Transit)
Get real time intelligence on public transit services

Data Storage
Host your private map data in Azure Maps

NEW

capabilities

Weather services
Historical, Current and Predicted Weather Services with Radar and Satellite maps

Power BI integration
Integration with Power BI w/ rich data service and more powerful capabilities

Gov Cloud support
Azure Maps services availability through Azure Government Cloud

Microsoft's messaging: Azure Maps/Bing Maps

The following is the official Microsoft messaging regarding Bing and Azure maps:

Microsoft customers have a rich choice of options from which to source location and mapping data. Our guidance on which service to choose reflects the preference and status of a customer's implementation of location data. For those enterprise customers already using (or looking to use) Azure, we would recommend they use Azure Maps. Similarly, we'd recommend customers who have a preference for TomTom mapping data to also turn to Azure Maps. For existing Bing Maps for Enterprise customers, if your current services are meeting your needs, we encourage you to stay on your existing service. All customers should work with their Microsoft team to determine which of the services will best serve the individual customer requirements for production grade, fully deployable services

Azure Maps

Step 4 – Hands-on

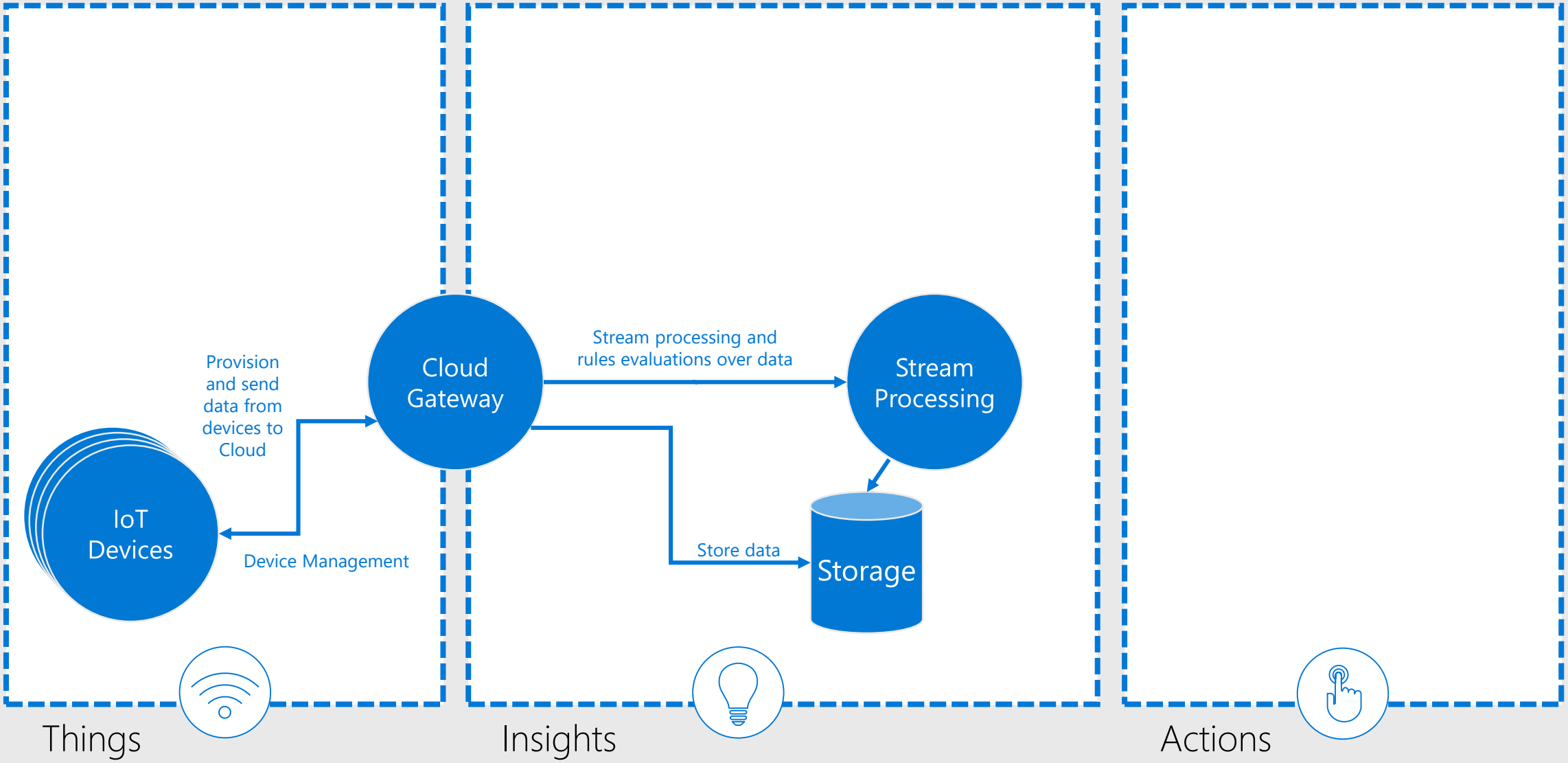
http://aka.ms/iot-workshop/asset-tracking

Setup Azure Maps subscription

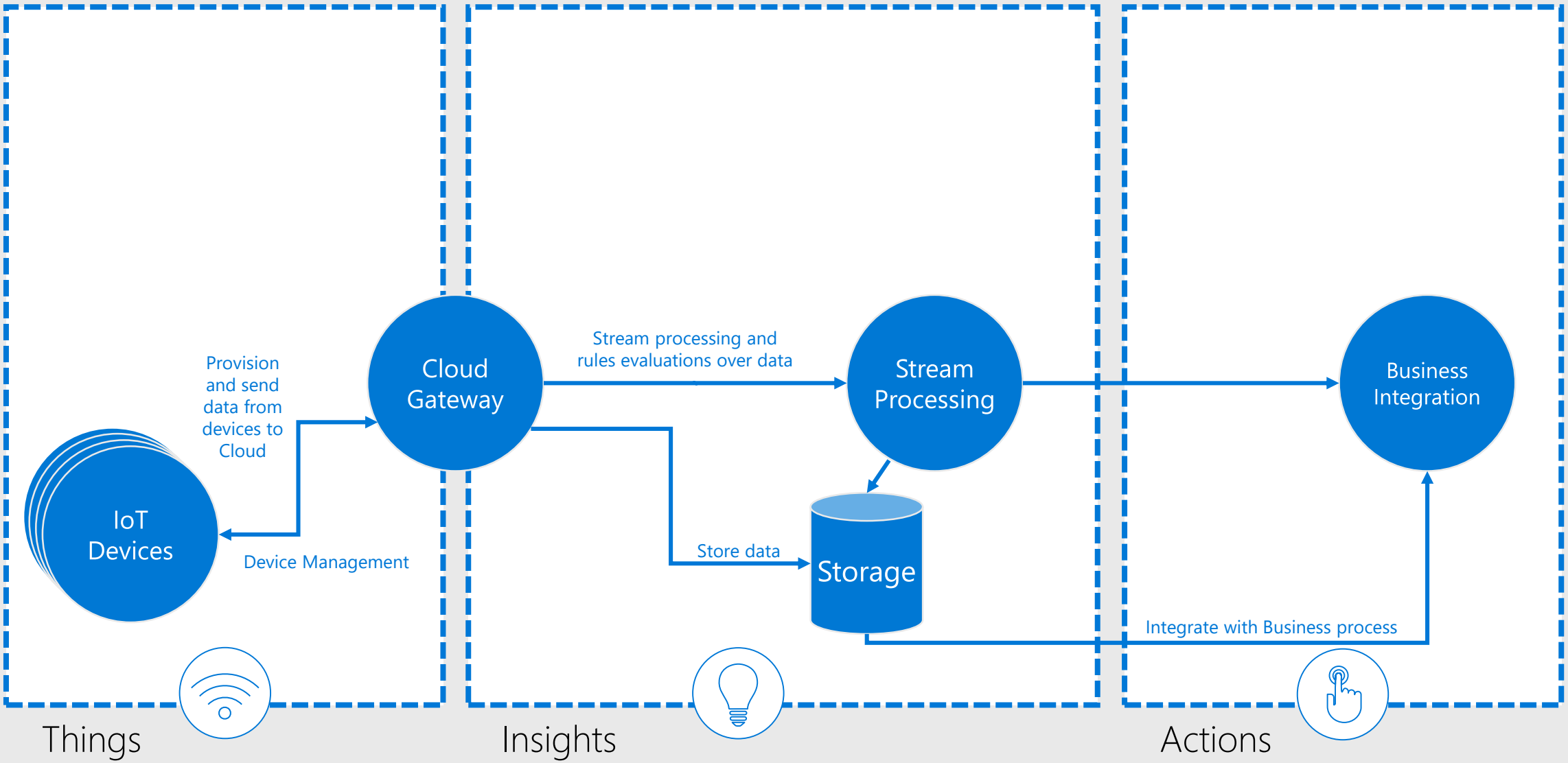
Use Azure Maps and TSI SDK

Explore Azure Maps REST API

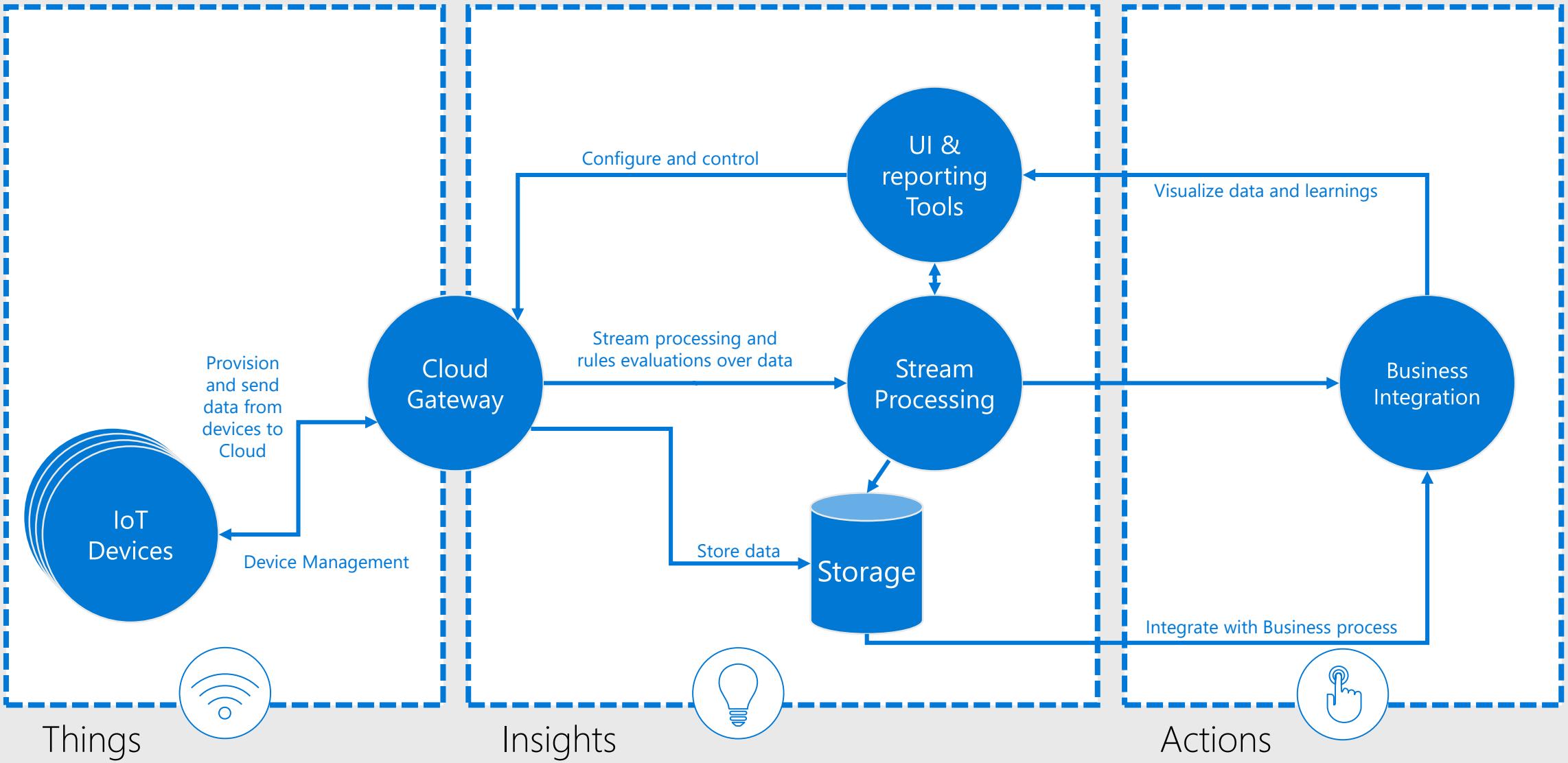
IoT Architecture



IoT Architecture



IoT Architecture



Logics Apps, Power Apps

Step 5 – Live Demo

Refine Stream Analytics job

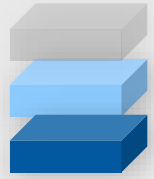
LogicApps workflow

PowerApps and CDS integration

IoT Central

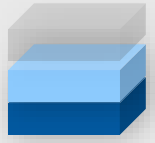
A fully managed IoT application platform

- Highly secure
- Enterprise-grade
- Predictable pricing
- Industry-focused



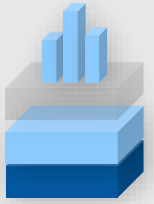
Get connected

Connect IoT devices to the cloud faster than any other platform.



Stay connected

Reconfigure and update devices with centralized device management.



Transform

Bridge the gap with connectors and extensibility APIs.

What is an IoT Central application template?

App templates are tools to help solution builders kickstart their IoT solution development

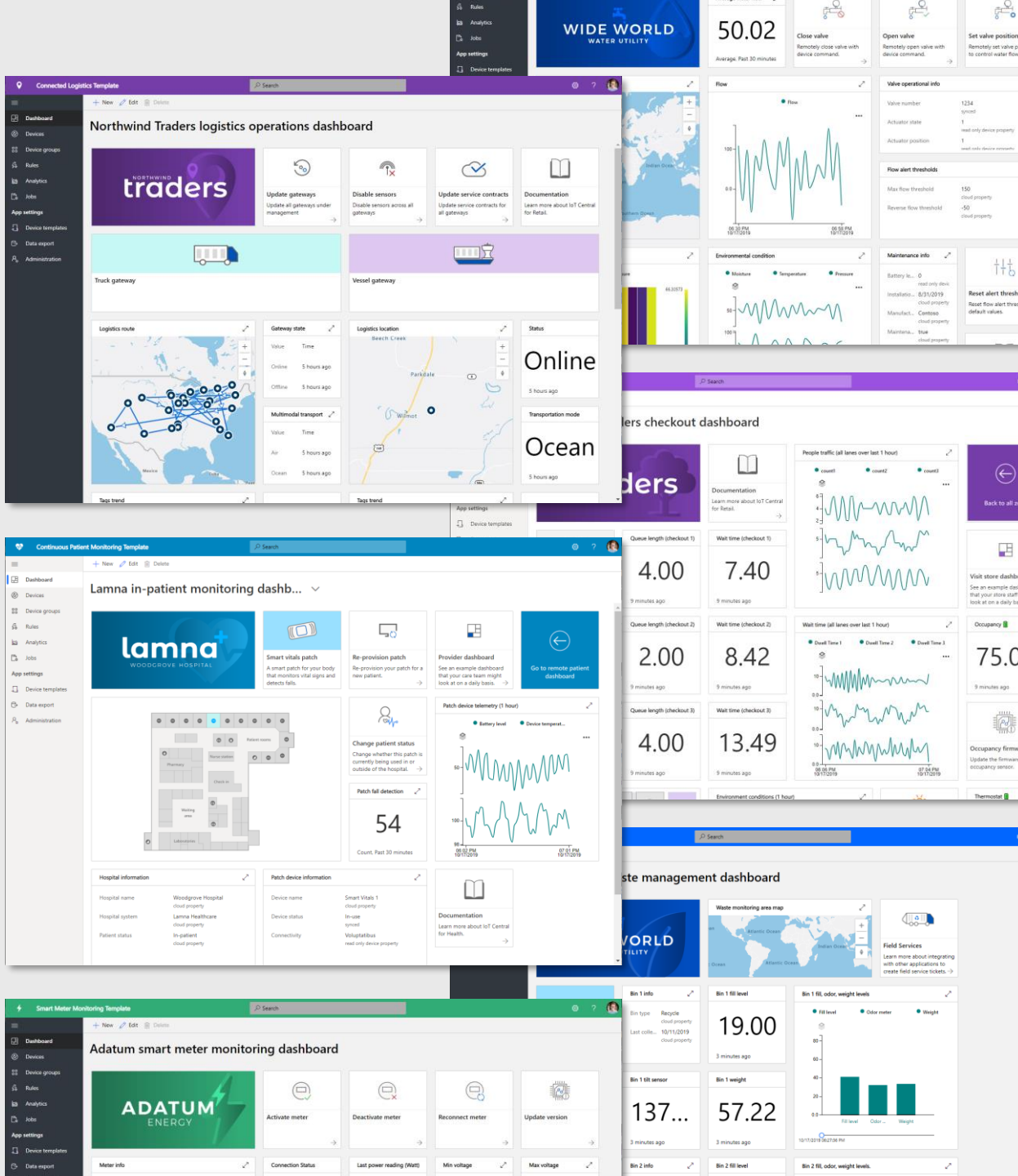
They consist of:

- Sample operator dashboards
- Sample device templates
- Simulated devices
- Pre-configured rules and jobs
- Rich documentation including tutorials

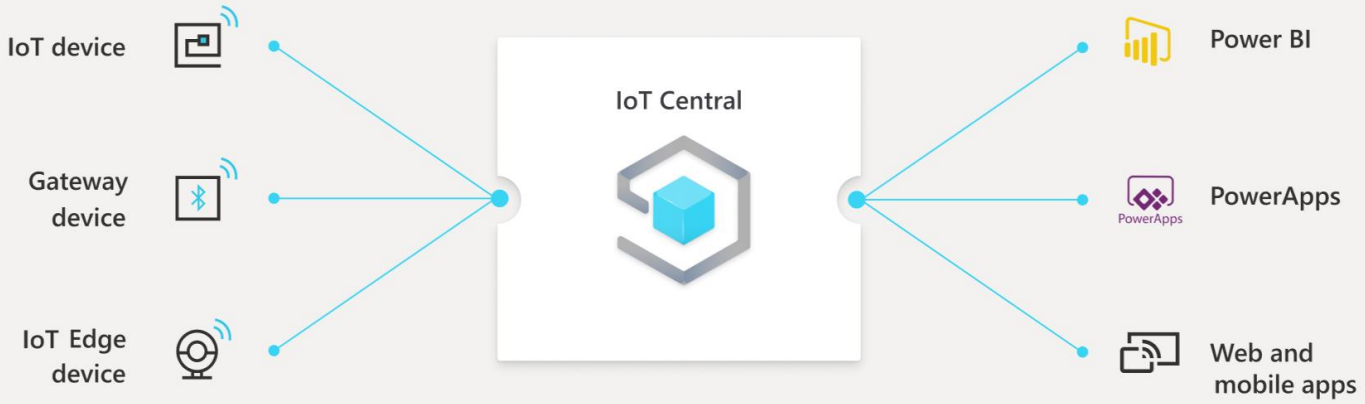
Brand templates using the white labeling feature

Sell to customers directly or through AppSource

Your brand, your SaaS



How do I build with IoT Central?



Take Action

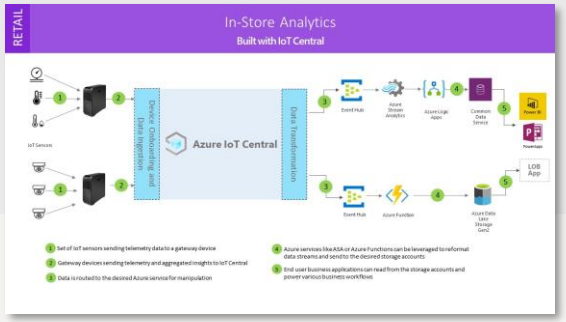
- No-code/Low-code actions with Microsoft Flow and Logic Apps

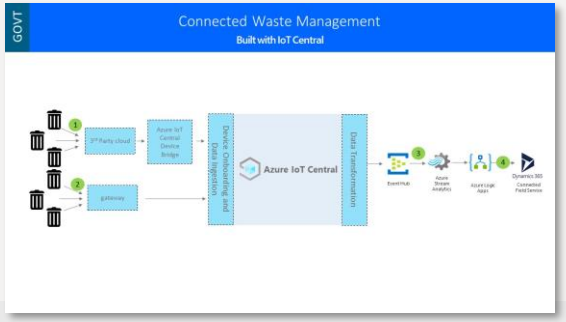
Integrate IoT Insights

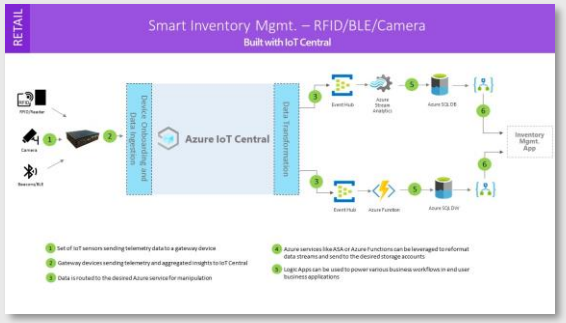
- Continuous IoT data routing through Event Hub and Service Bus
  - Build data pipelines using the breadth of Azure Services

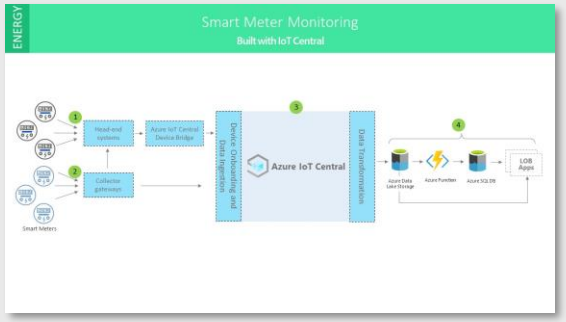
Build Solutions

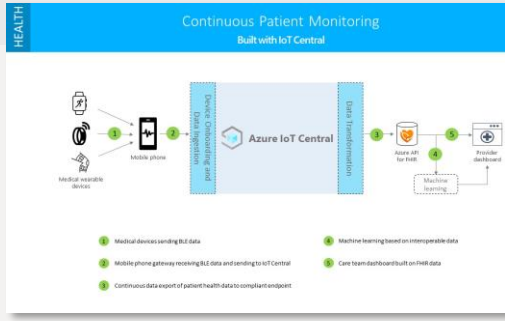
- IoT Central public APIs for device modeling, provisioning, lifecycle management, operations (updating/commanding), and data querying

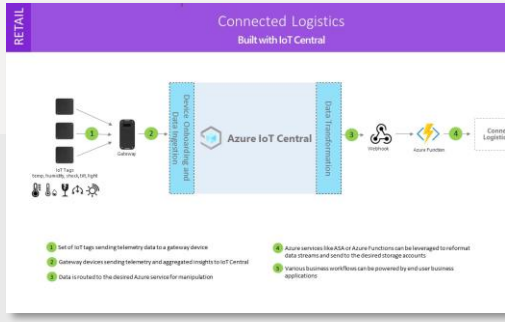


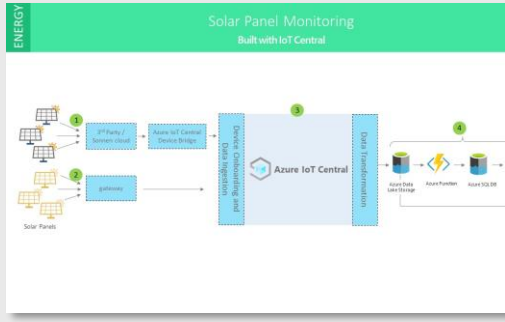












Going further

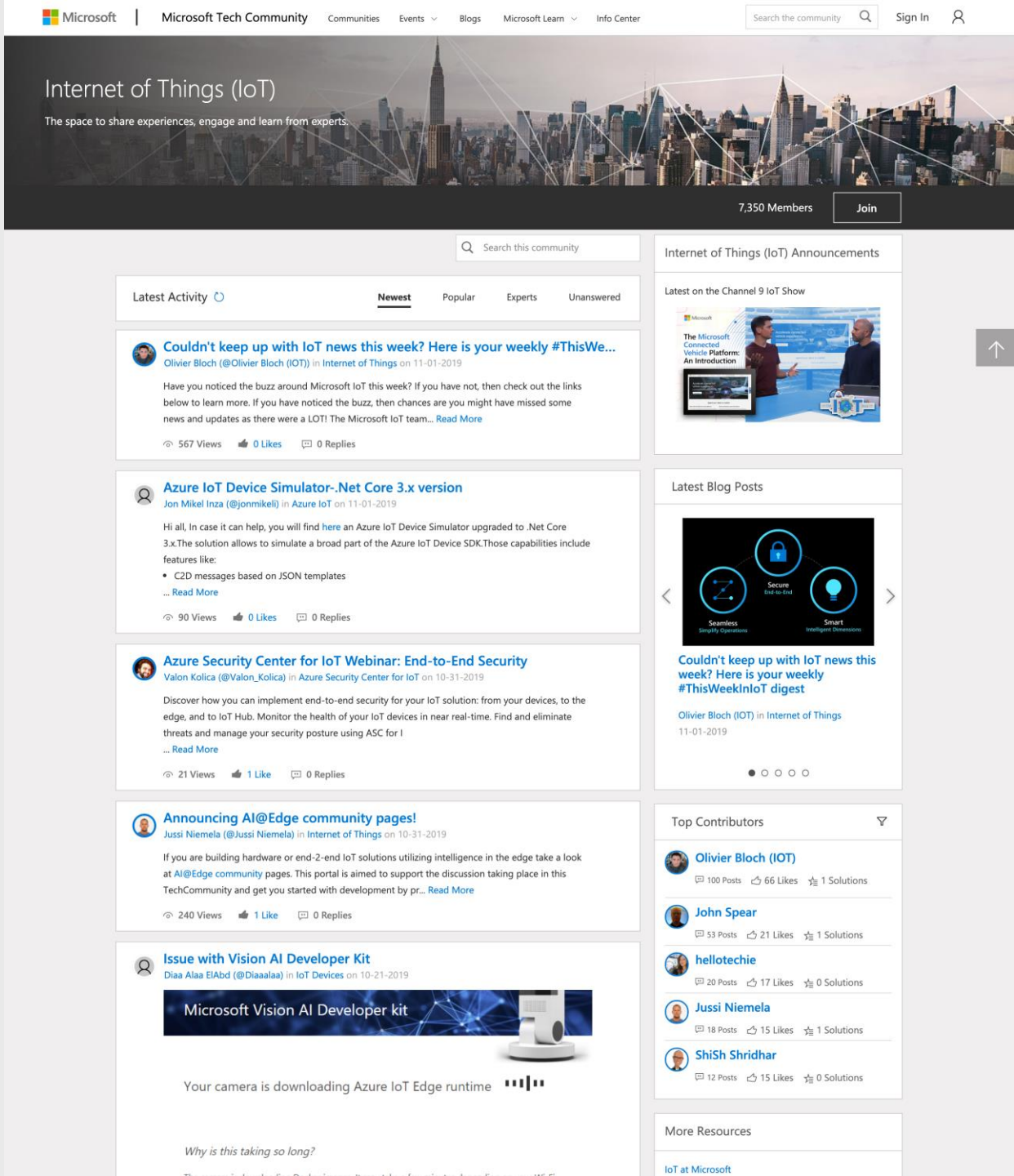
IoT Tech Community

aka.ms/iottechcommunity

Blog posts

News & Announcements

Weekly recap



IoT Show

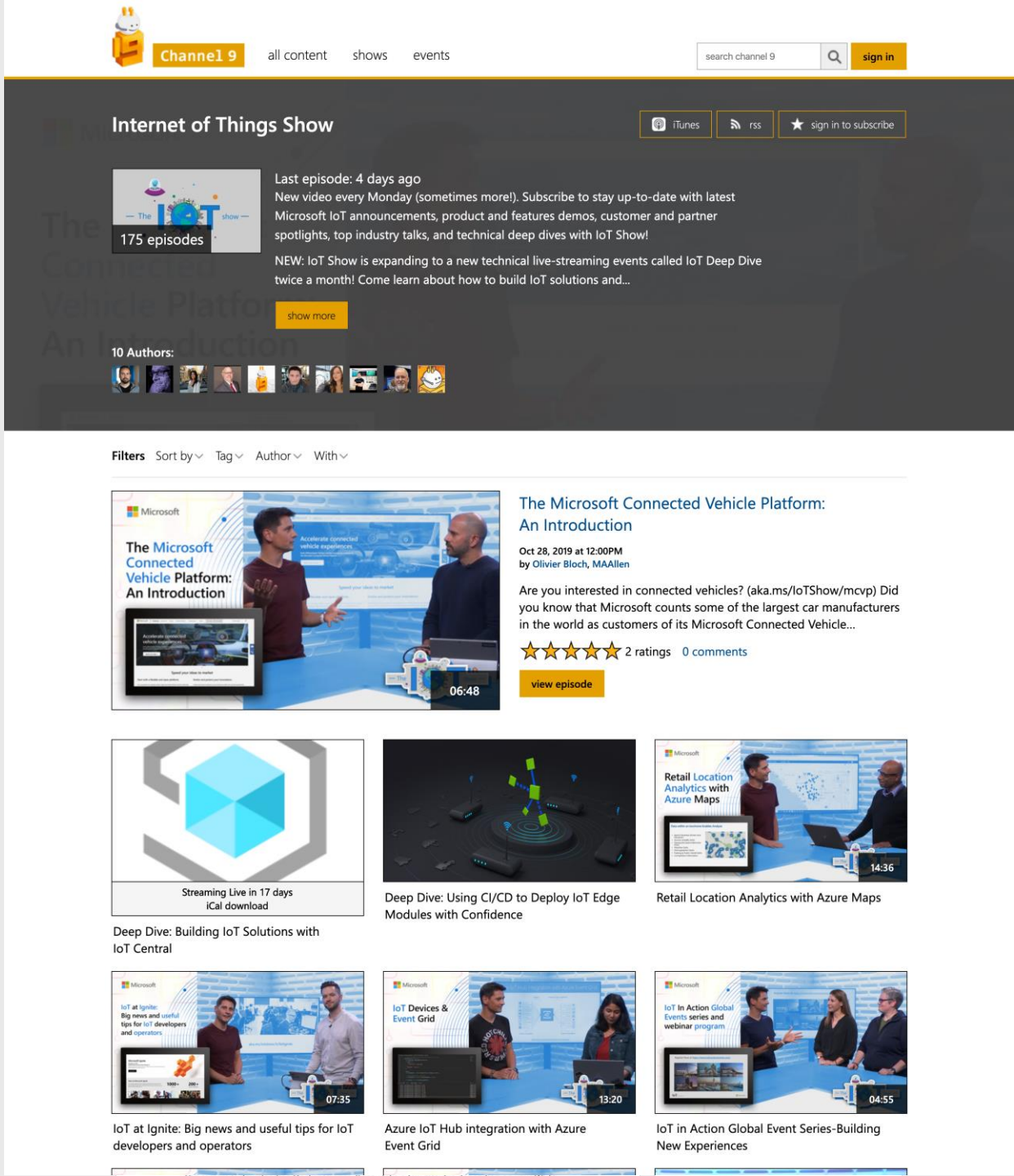
aka.ms/iotshow

Announcements

Tech talks & Deep Dives

Demos

Customer & Partner spotlights

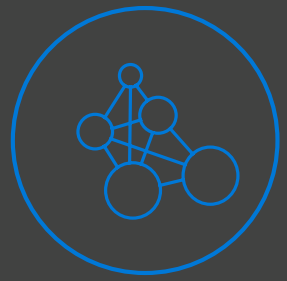


Azure IoT Reference Architecture

Foundational

A foundational guide for how to build native cloud IoT solutions.

Make your subsystems independently scalable, maintainable, and deployable.



Comprehensive

Provides component descriptions and tech recommendations.

Adjust for your skillset and solution.

Reliable

Helps you start from patterns that have worked with other partners

https://aka.ms/iotrefarchitecture

Would you like to provide feedback? Do you have an idea or suggestion based on your experience with IoT? We would love to hear it! email AzureIoTRefArcVoice@microsoft.com