



Microsoft Azure IoT Training

Starting at 09:00 AM



Glenn Colpaert

CTO – Zure Belgium

glenncolpaert@zure.com

- Azure MVP & Advisor
- Microsoft Certified Trainer
- Architect and assessor for several IoT and cloud projects across Belgium
- Professional experience with Azure since 2014
- Azug.BE Crewmember



Microsoft
Most Valuable
Professional



 @GlennColpaert

 github.com/GlennColpaert





Ghent, Belgium

Helsinki, Finland

100%

Azure since 2011

64

experts

14,2

experience avg.

4,6 / 5

customer satisfaction

4

Azure MVPs
+ 1 Regional Director

81

employee NPS



Gold Application Development
Gold Cloud Platform
Gold Data Analytics
Gold Data Platform
Gold DevOps
Gold Datacenter
Gold Application Integration



Microsoft®
Most Valuable
Professional

Microsoft
CERTIFIED
Trainer

Microsoft
Partner Advanced Specialization
Modernization of Web Application on Microsoft Azure

**WHO?
ARE
YOU?**



Agenda

DAY I

- Azure IoT Intro & Overview
- //BUILD Recap: What's new in Azure IoT
- Azure IoT Hub Concepts & Device Lifecycle
- Message Processing and Analytics with Azure

DAY II

- Message Processing and Analytics with Azure
- The future of IoT with Azure Digital Twins
- Introduction to Azure IoT Edge and Edge Modules
- Building an IoT Solution with Azure IoT Central

Training Days : 09:00 - 16:00

- 09:00 – 10:30 : Training
- 10:30 – 10:50 : Break
- 10:50 – 12:15 : Training
- 12:15 – 13:15 : Lunch
- 13:15 – 14:30 : Training
- 14:30 – 14:50 : Break
- 14:50 – 16:00 : Training

Demo's / Slides / ...

<https://zure.ly/iotworkshop>



Beacons

Quorum



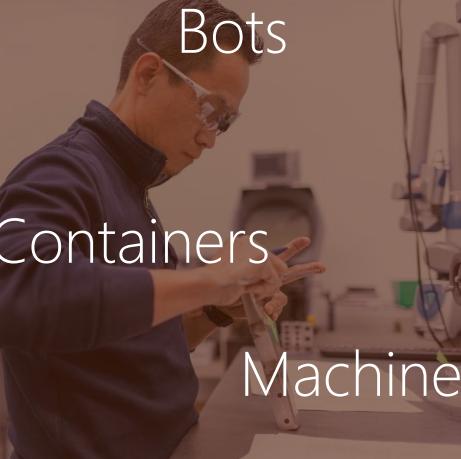
Digital twin
Artificial Intelligence

Microservices

Log telemetry



Mixed reality



Bots
Containers

Machine Learning



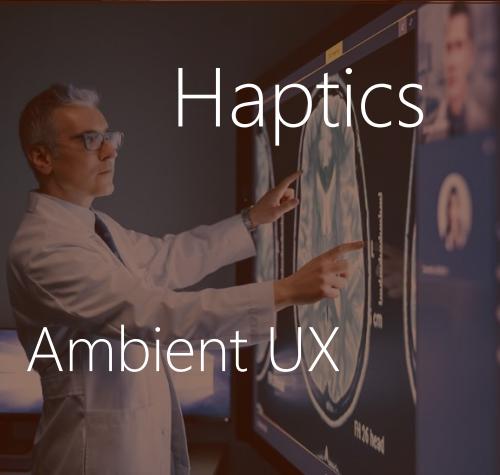
NoSQL

Serverless



Location-based authentication

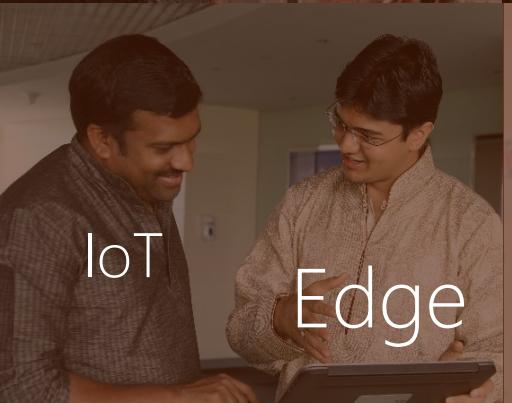
Hybrid cloud



Haptics

Ambient UX

Event driven
DevOps



IoT

Edge



Monitoring

Blockchain



GPU

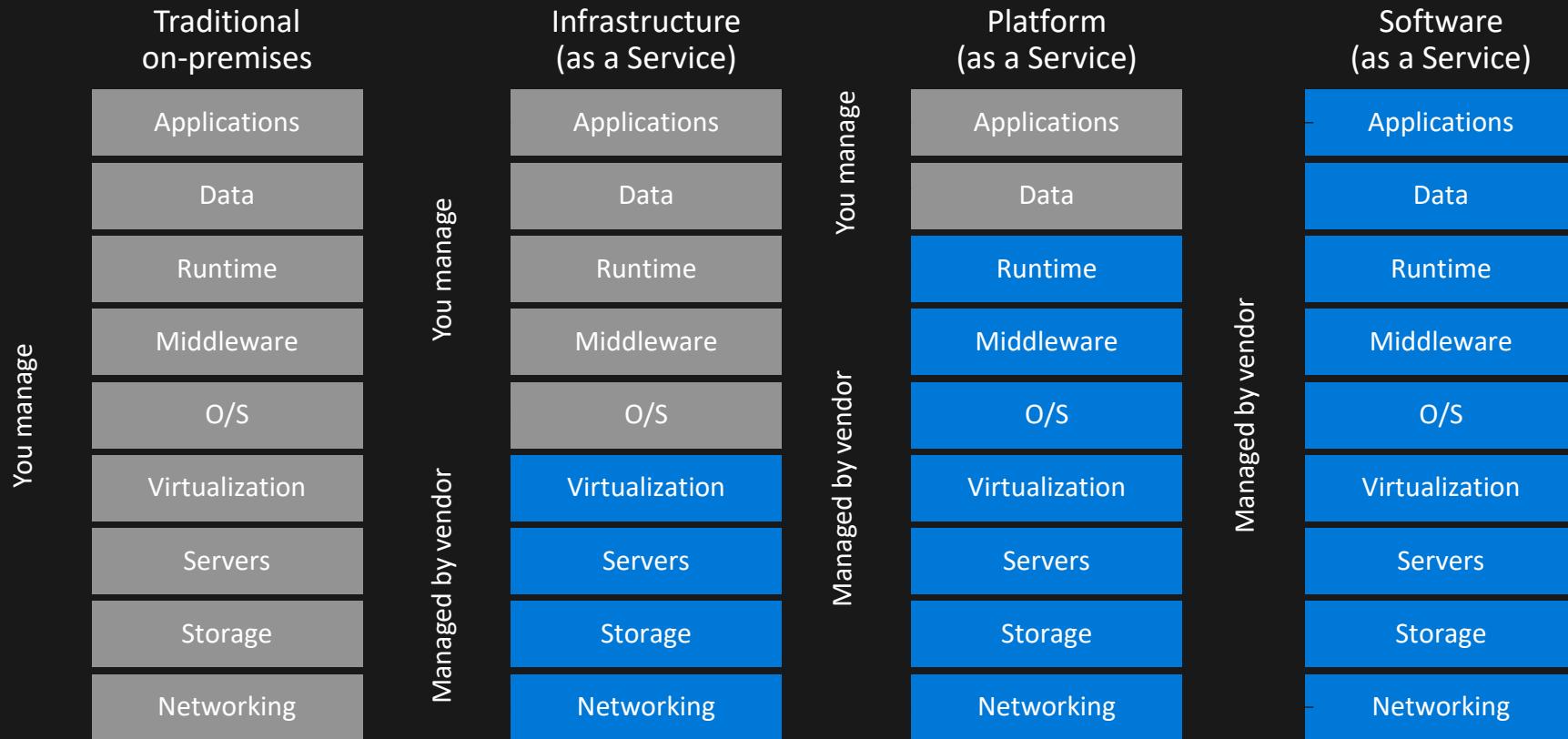
Big data



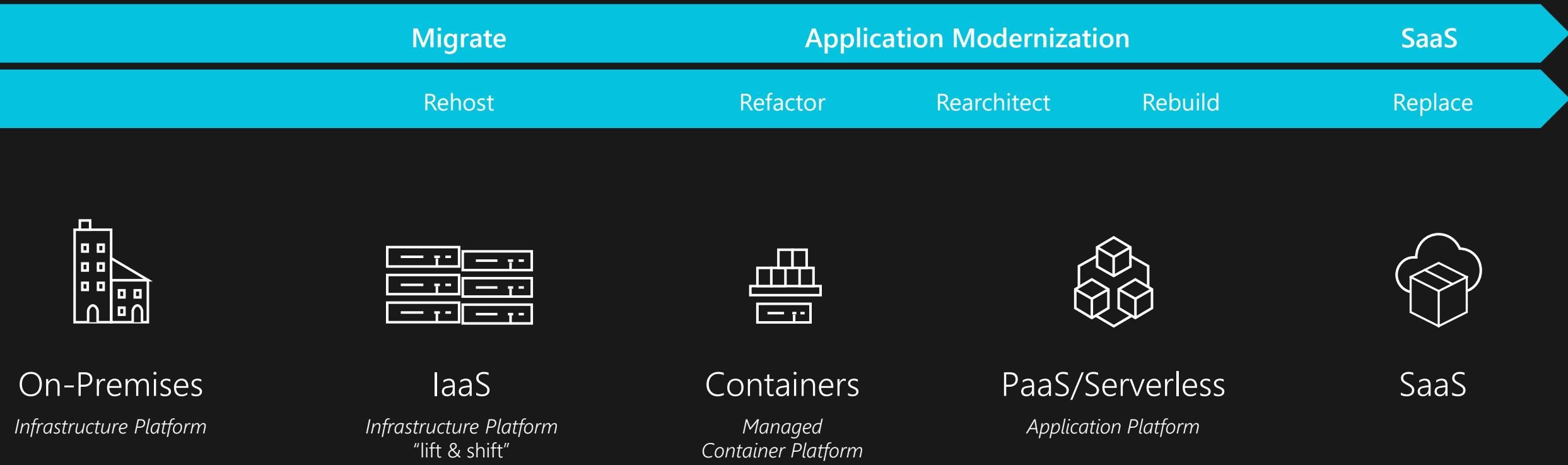
Threat Intelligence

Data privacy

Journey to the Cloud



Journey to the Cloud



AI + Machine Learning	Analytics	Compute	Databases	Development	Identity + Security	IoT + MR	Integration	Management + Governance	Media + Comms	Migration	Networking	Storage
Bot Service	Analysis Services	App Service	Apache Cassandra ML	App Configuration	Azure Active Directory	Azure Maps	API Management	Automation	Azure CDN	Azure Migrate	Application Gateway	Avere vFXT
Cognitive Search	Azure Purview	App Service (Linux)	Blockchain Service	Azure DevOps	Azure AD B2C	Azure Sphere	Azure API for FHIR	Azure Advisor	Communication Services	Data Box	Azure Bastion	Azure NetApp Files
Cognitive Services	Data Catalog	Azure Batch	Cosmos DB	Azure Spring Cloud	Azure AD DS	Digital Twins	Event Grid	Azure Arc	Media Services	DB Migration Service	Azure DNS	Azure Storage
Machine Learning	Data Explorer	Azure Functions	Database for MariaDB	Dev/Test Labs	Azure Defender	IoT Central	Logic Apps	Azure Automation	Site Recovery	Azure Firewall	Data Lake Storage	
Microsoft Genomics	Data Factory	Azure VMware Solutions	Database for MySQL	Lab Services	Azure Key Vault	IoT Edge	Notification Hubs	Azure Backup		Azure Front Door	Data Share	
Open Datasets	Data Lake Analytics	Cloud Services	Database for PostgreSQL	SignalR Service	Azure Sentinel	IoT Hub	Service Bus	Azure Blueprints		Azure Orbital	Managed Disks	
	Databricks	Container Instances	Redis Cache	Visual Studio App Center	DDoS Protection	Object Anchors		Azure Lighthouse		ExpressRoute	StorSimple	
	Event Hubs	Container Registry	SQL Database		Dedicated HSM	Remote Rendering		Azure Monitor		Load Balancer		
	HDInsight	CyberCloud	SQL Server Stretch DB		Information Protection	Spatial Anchors		Azure Policy		Network Watcher		
	Power BI Embedded	Dedicated Host			Security Center	Time Series Insights		Azure Portal		Private Link		
	Stream Analytics	Kubernetes Service						Cloud Shell		Route Server		
	Synapse Analytics	Service Fabric						Cost Management		Traffic Manager		
		Virtual Machines						Managed Apps		Virtual Network		
		VM Scale Sets						Scheduler		Virtual WAN		
		Windows Virt. Desktop								VPN Gateway		

<https://azurecharts.com/overview>



Azure IoT

Introduction and Overview

An IoT solution is all about data...

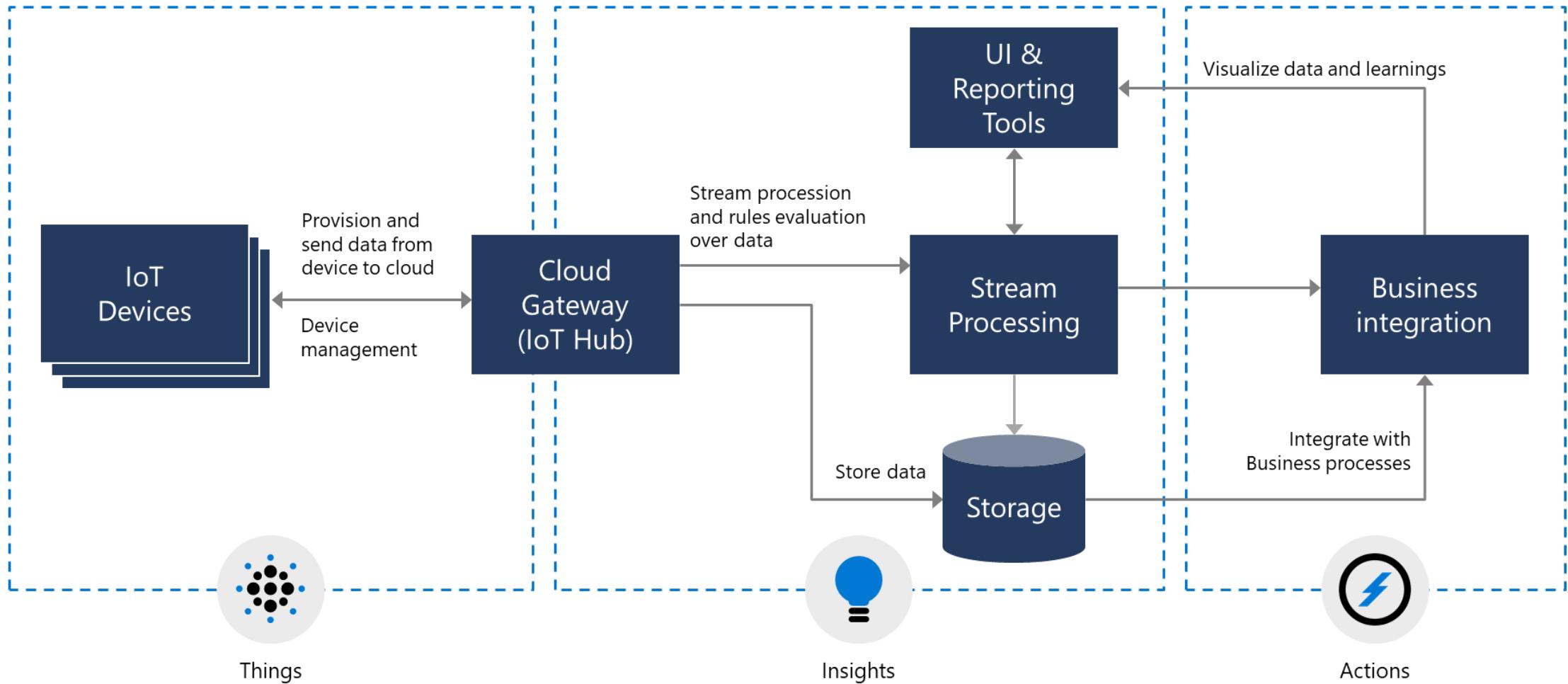


Things –
Generate Data

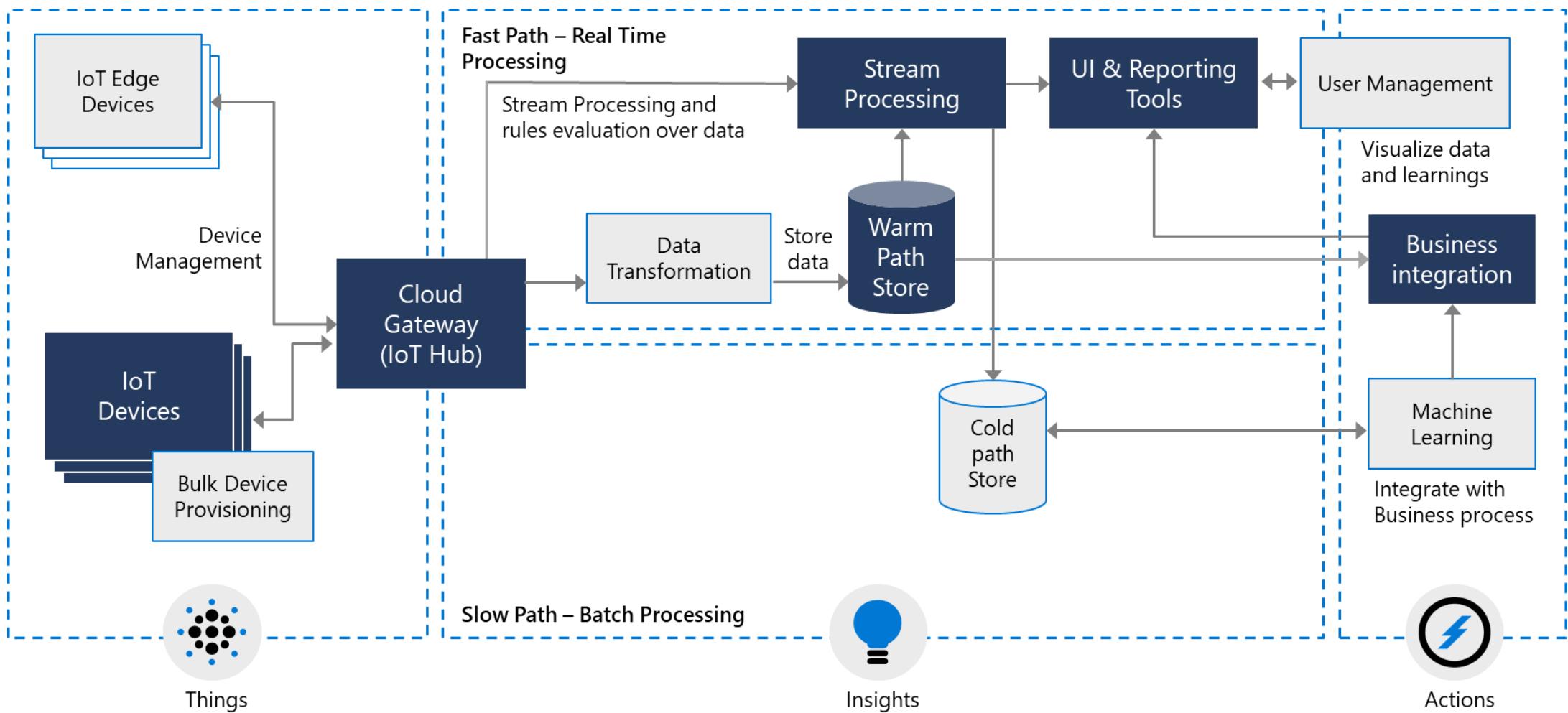
Insights –
Based on Data Generated

Actions –
Based on Insights

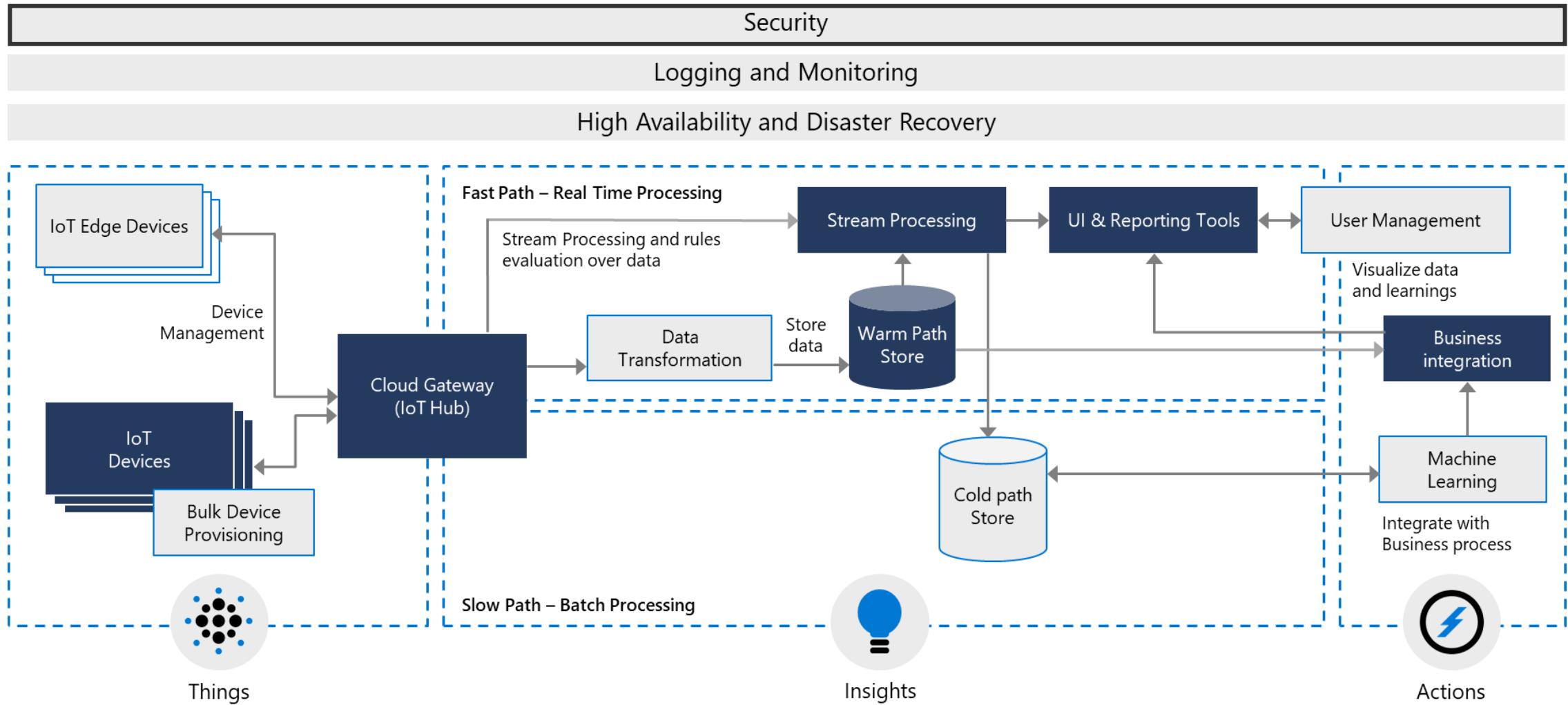
Core subsystems of an IoT Architecture



Optional subsystems of an IoT Architecture



Cross-cutting architectural needs



Azure Security Center for IoT



IoT Central application templates



Retail



Health



Energy



Government

IoT Solutions



Azure IoT Central – managed application platform



Reference Architecture and Accelerators(PaaS)



Dynamics Connected Field Service(SaaS)

Azure Services for IoT

Azure IoT Hub Device Provisioning Service
Azure Digital Twins
Azure Time series Insights
Azure Maps

Azure Stream Analytics
Azure Cosmos DB
Azure AI
Azure Cognitive Services
Azure ML
Azure Logic Apps

Azure Active Directory
Azure Monitor
Azure DevOps
Power BI
Azure Data Share
Azure Spatial Anchors

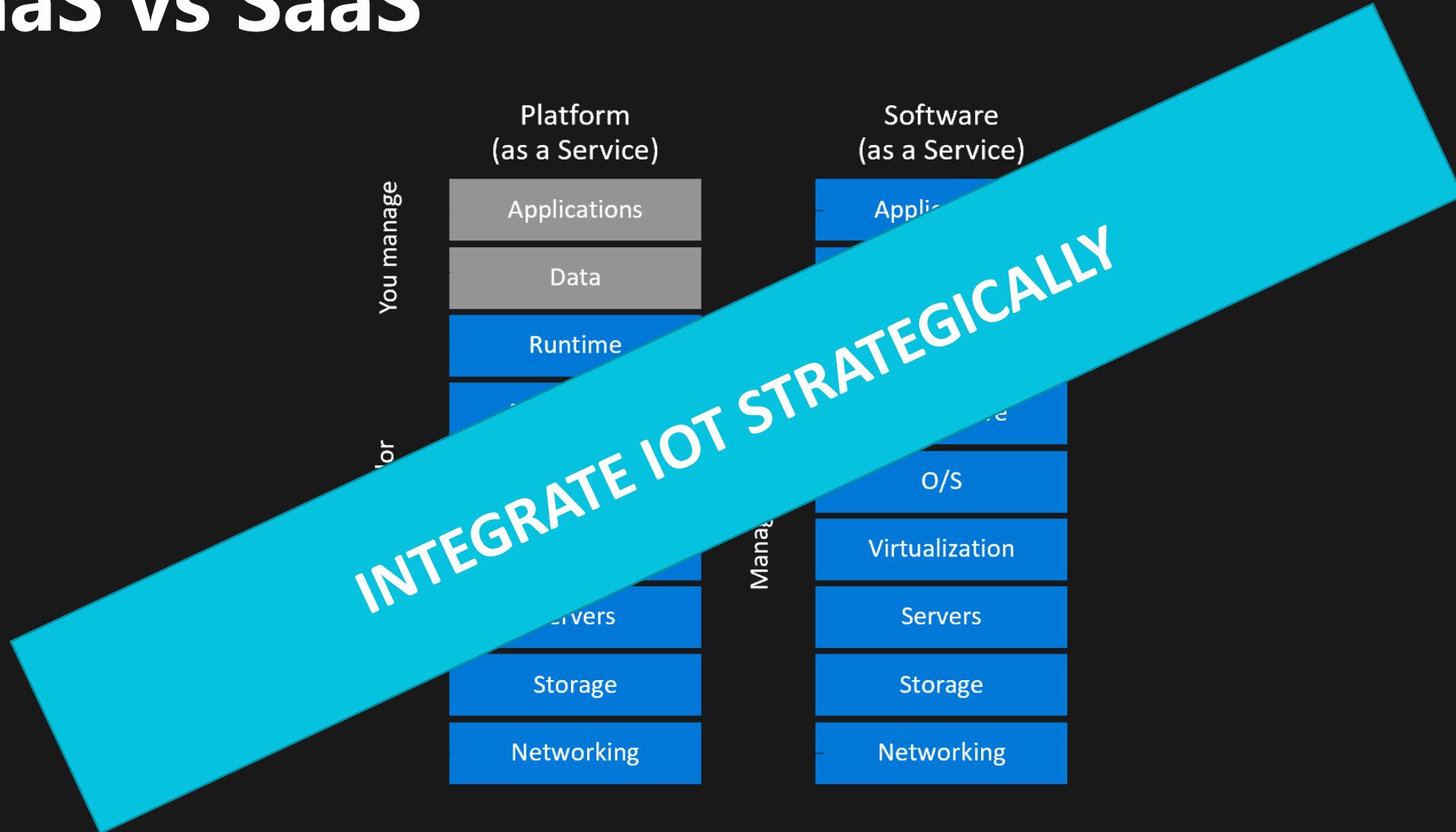
IoT and Edge Device Support

Azure Sphere
Azure IoT Device SDK
Azure IoT Edge
Azure Data Box Edge

Windows IoT
Azure Certified for IoT – Device Catalog
Azure Stream Analytics
Azure Storage

Azure ML
Azure SQL
Azure Functions
Azure Cognitive Services

PaaS vs SaaS



//BUILD Recap

What's new in Azure (IoT)

//BUILD book of news

<https://news.microsoft.com/build-2021-book-of-news/>

Microsoft's hybrid and on-premises strategy



Azure application services

Run your apps, anywhere



App
Service



Functions



Logic
Apps



API
Management



Event
Grid



Azure | On-premises | AWS | GCP



https://mybuild.microsoft.com/sessions/2debf_c2e-f0b3-4adf-bcec-d126930f806f?source=sessions

IoT Updates

- Azure IoT Edge
 - Hierarchies of IoT Edge Devices is now GA
- Azure IoT Edge for Linux on Windows
 - EFLOW is now GA
- Azure Digital Twins
 - Explorer available in Portal (Preview)

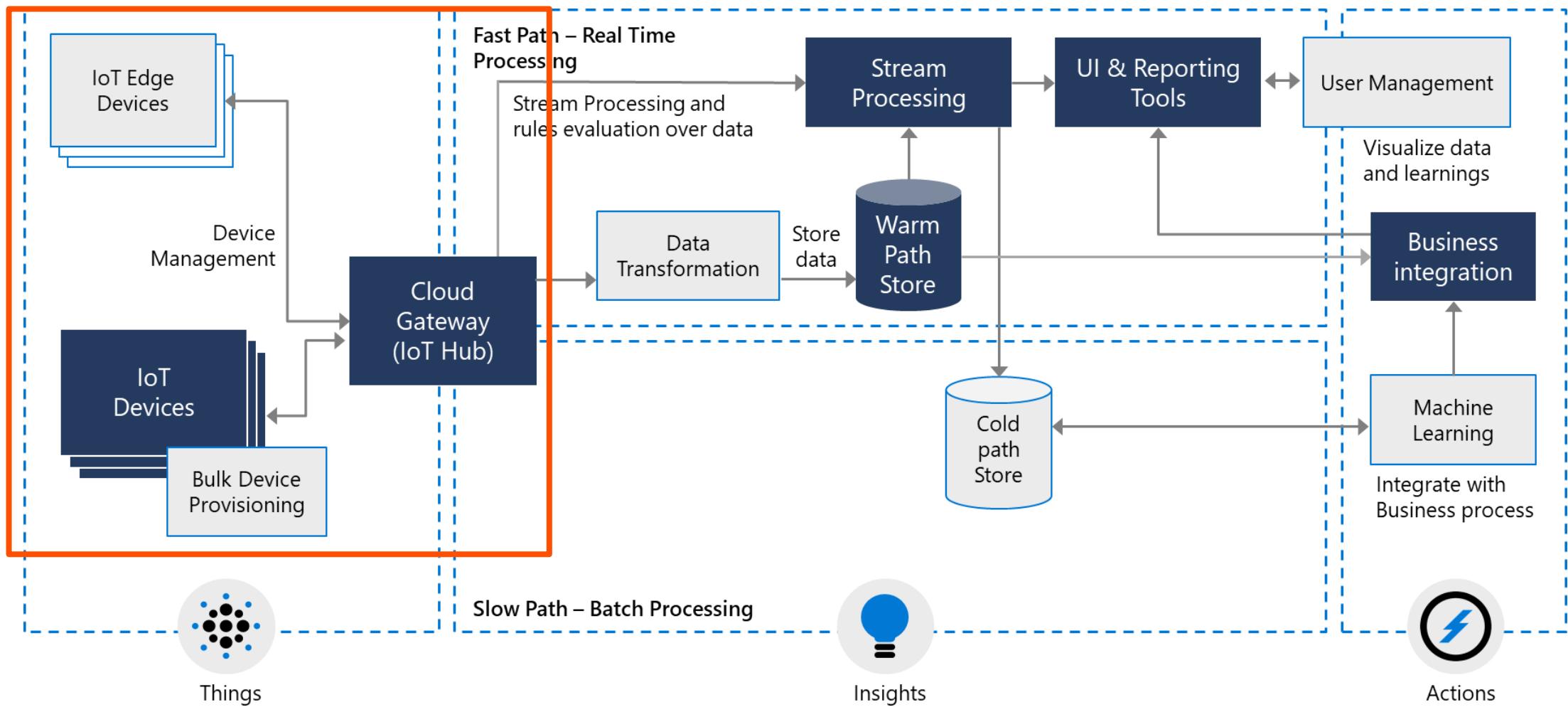
CosmosDB Updates

- Partial Document Update
- Cosmos DB Serverless is now GA
- Linux Emulator for CosmosDB
- Free tier is now expanded to 1000RU's
- Always Encrypted is now in Preview

IoT Hub

Azure IoT Hub Concepts & Device Lifecycle

IoT Architecture



IoT Hub

- Message Processing
- Message Routing
- Device Management
- Jobs and Queries
- Message Enrichments



IoT Hub



Enterprise scale and integration

Millions of devices
Multi-language, open source SDK
HTTPS/AMQP/MQTT
Send telemetry
Receive commands
Device management
Device twins
Queries and jobs



End-to-end

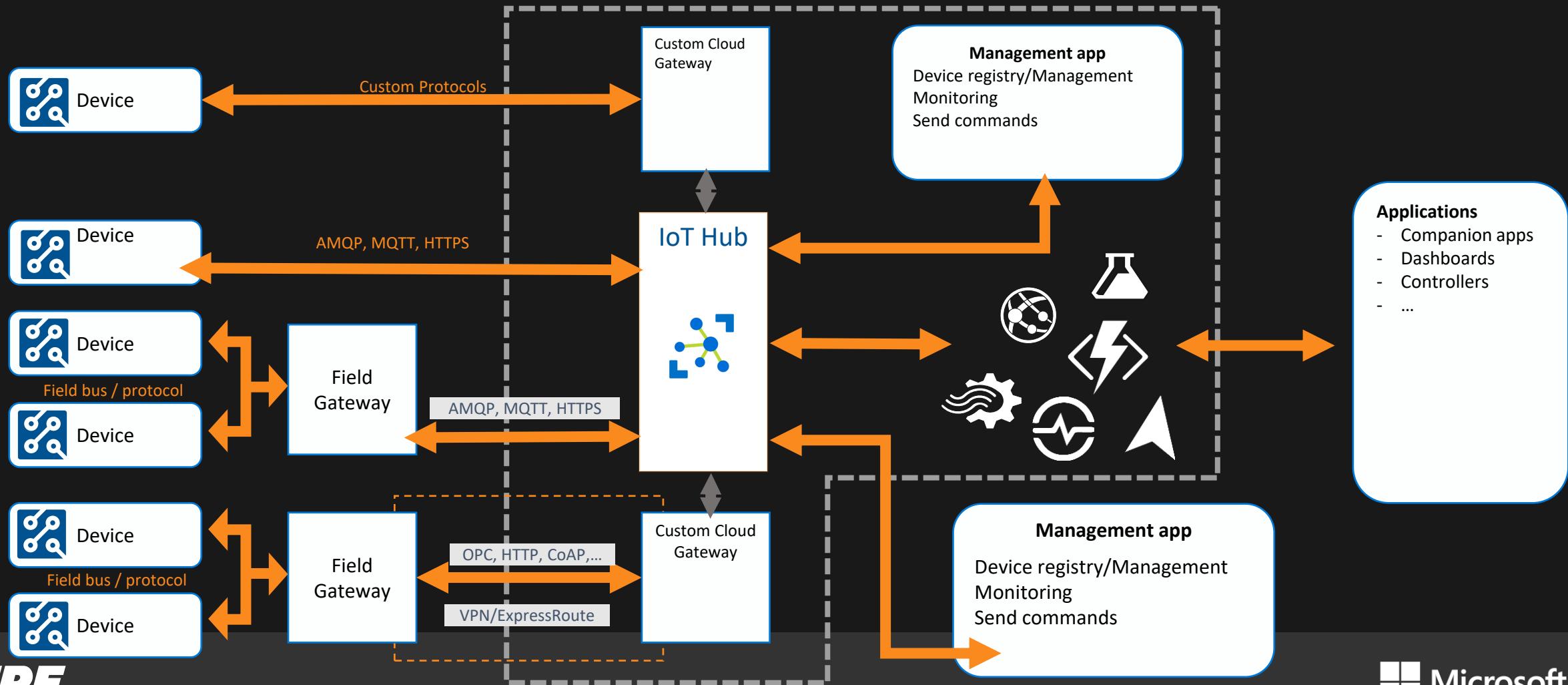
Billions of messages
Scale up and down
Declarative message routes
File upload
Web sockets and multiplexing
Azure monitor
Azure resource health
Configuration management security



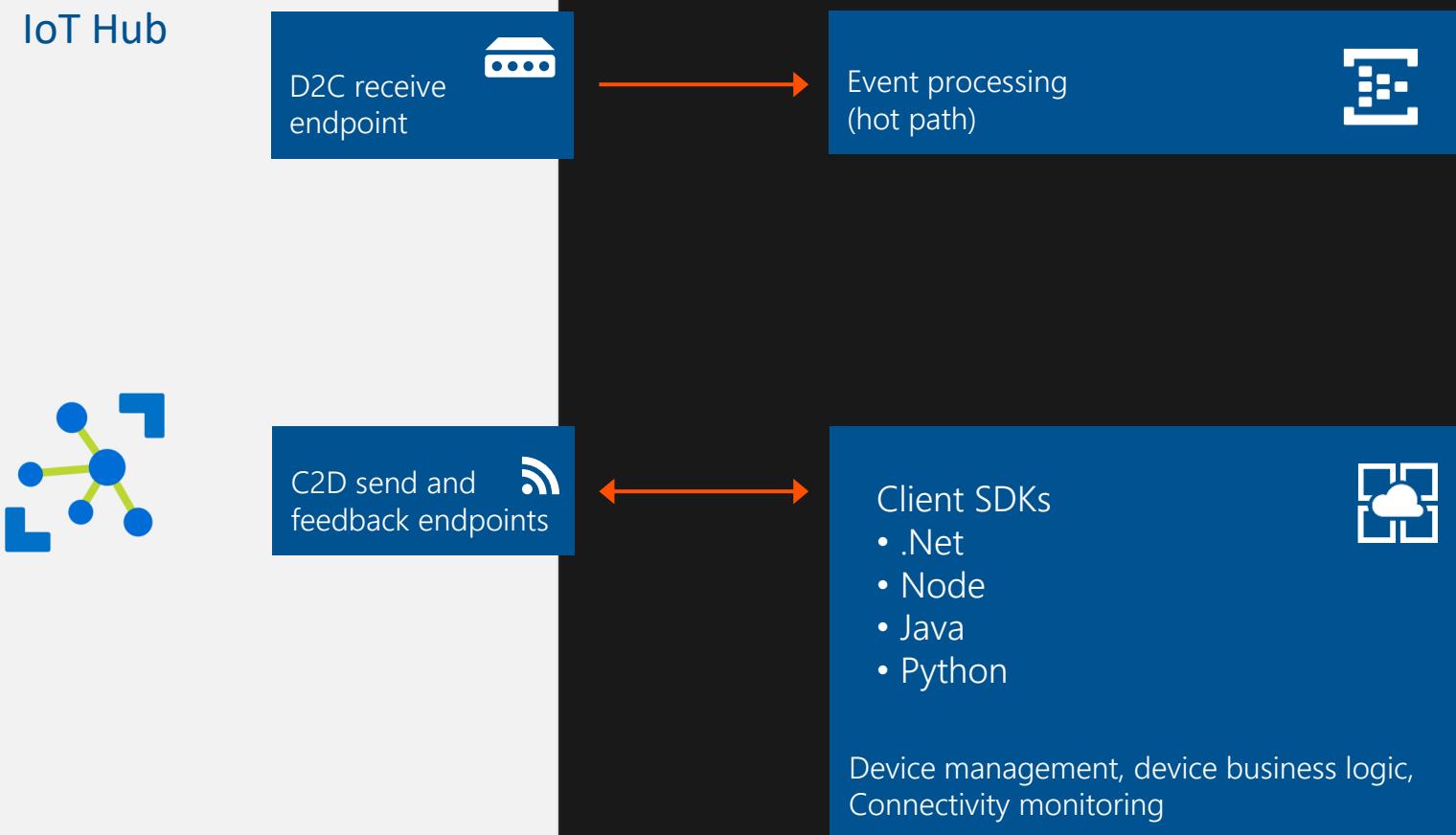
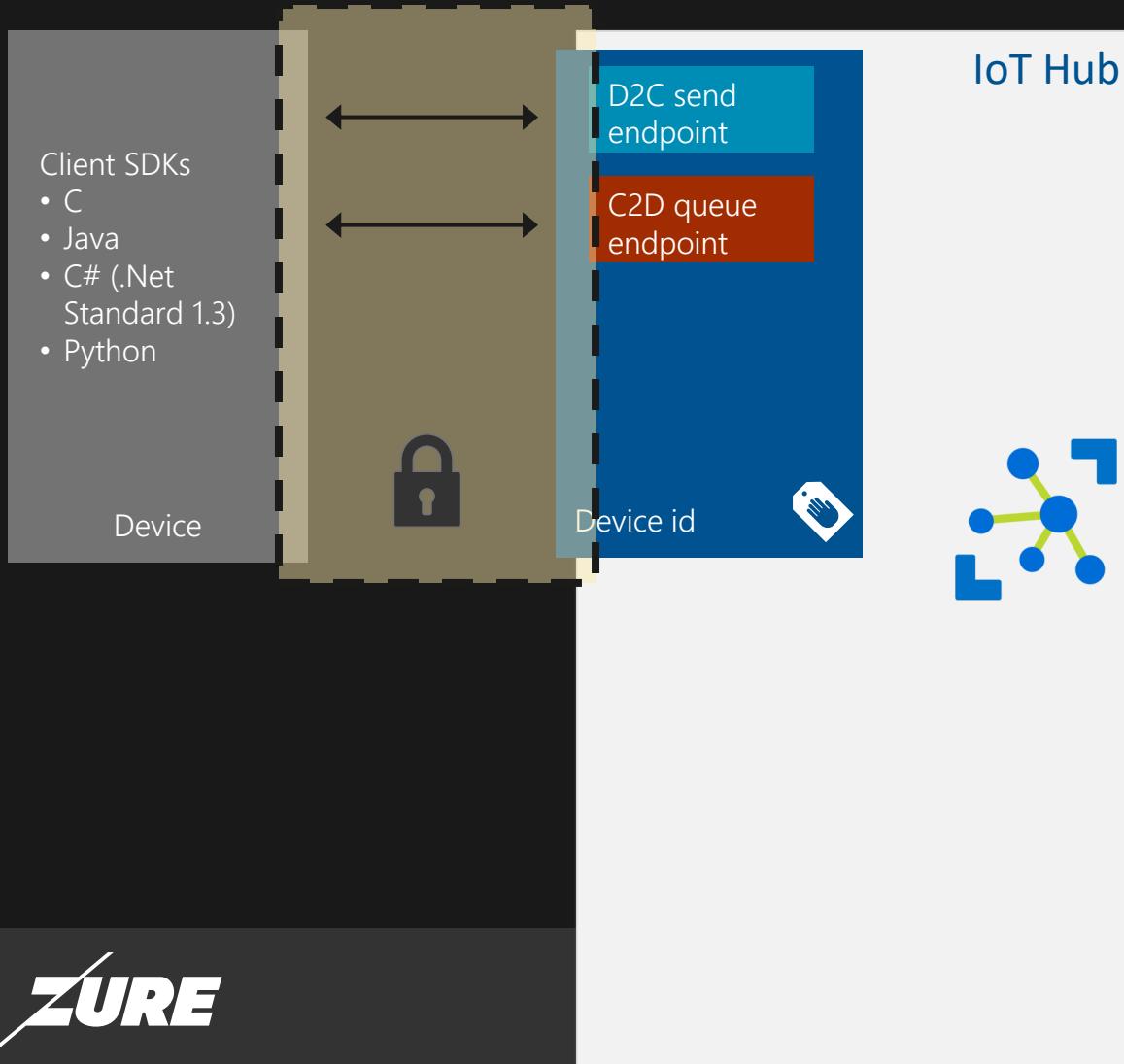
Bi-directional communication

Per device certificates
Per device enable/disable
TLS security
X.509 support
IP whitelisting/blacklisting
Shared access policies
Firmware/software updates

Azure IoT Hub Scenario's

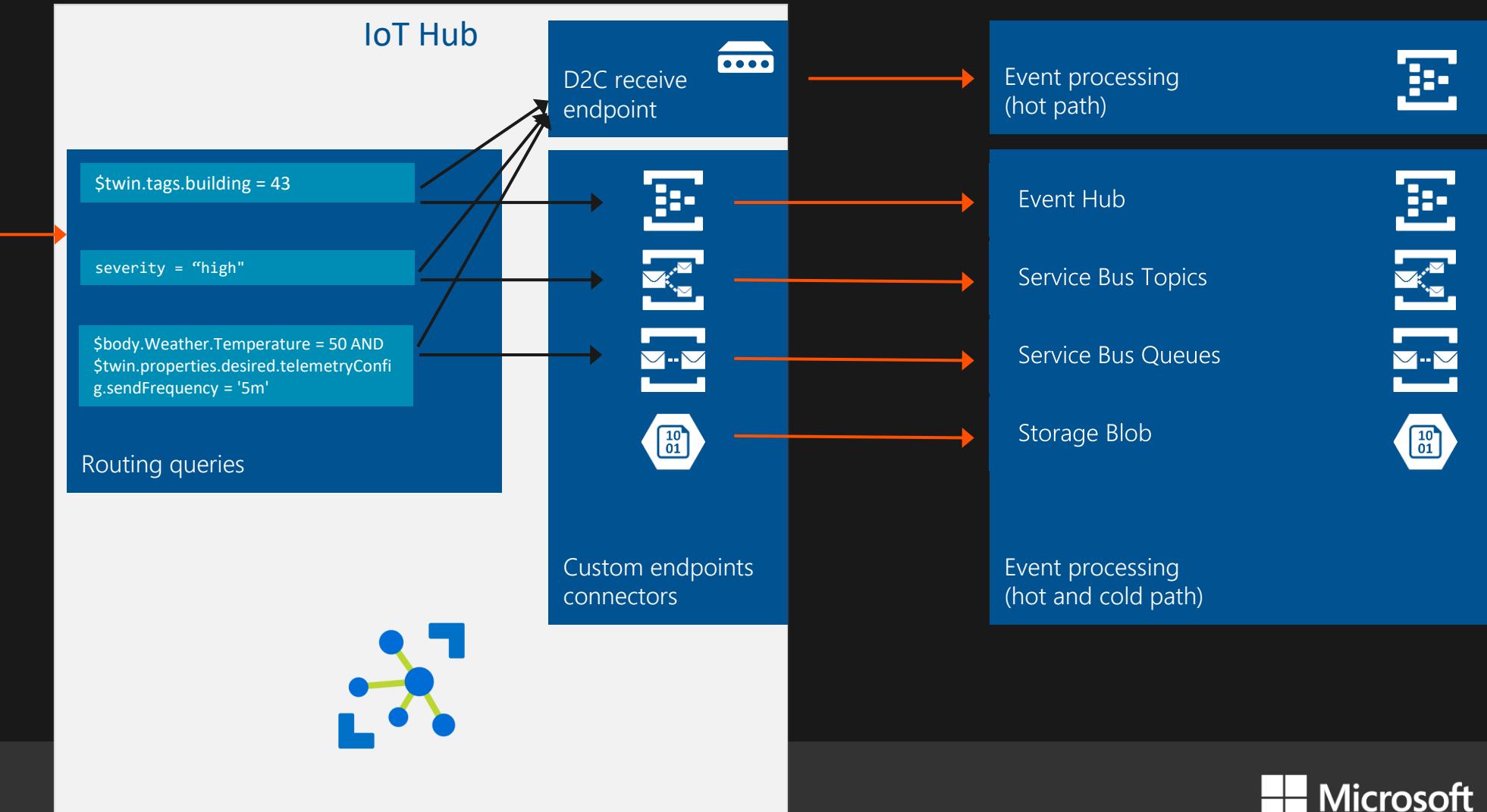


IoT Hub – Message Processing



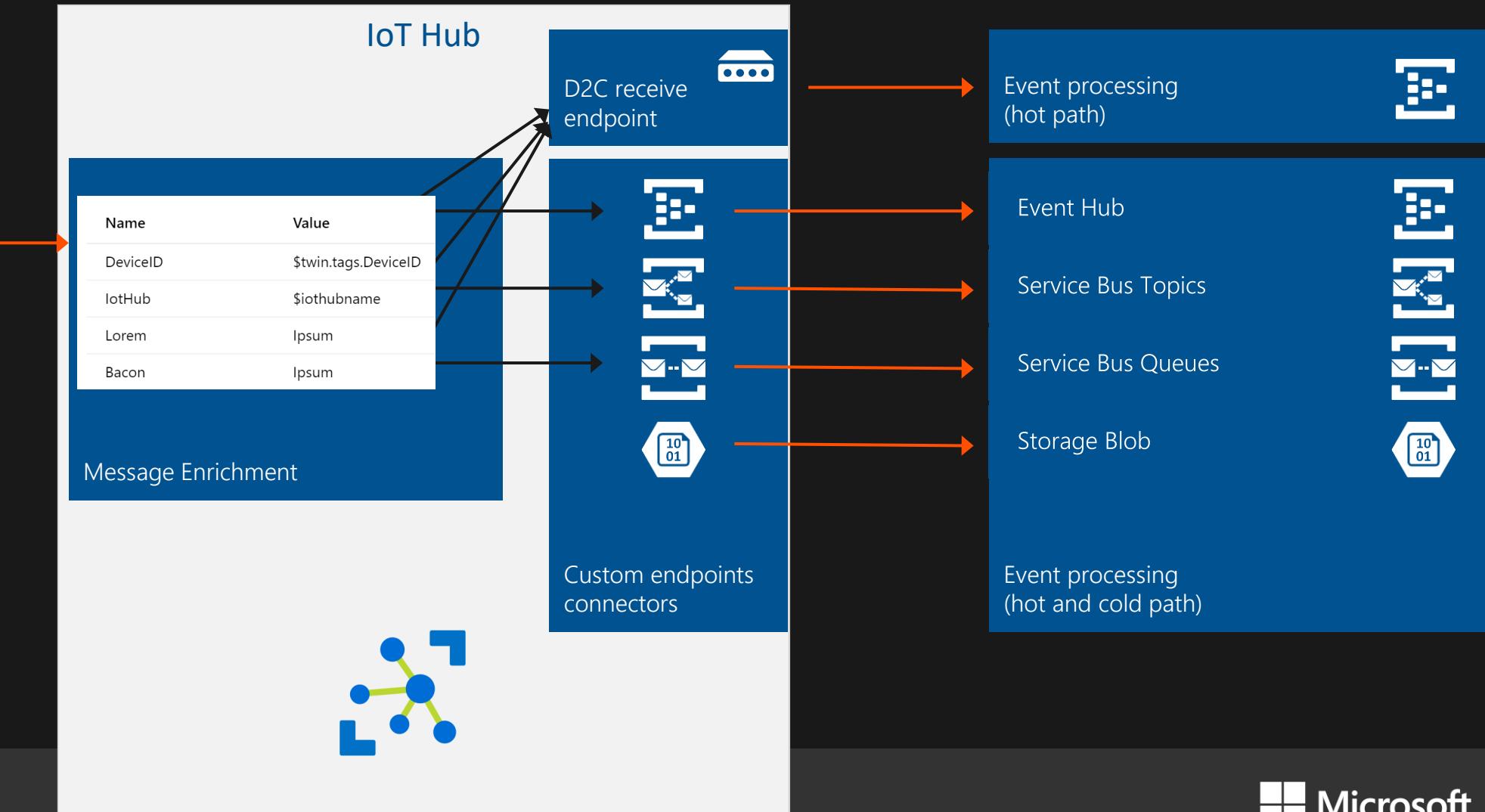
IoT Hub – Message Routing

```
Device to cloud message:  
"message": {  
  "systemProperties": {  
    "contentType": "application/json",  
    "contentEncoding": "utf-8",  
    "iothub-message-source":  
    "deviceMessages",  
    "iothub-enqueuedtime": "2017-05-  
08T18:55:31.8514657Z"},  
  "appProperties": {  
    "processingPath": "<optional>",  
    "verbose": "<optional>",  
    "severity": "<optional>",  
    "testDevice": "<optional>"  
  },  
  "body":  
  {"Weather": {"Temperature": 50}}  
}  
}  
  
Device Twin:  
{  
  "tags": {  
    "deploymentLocation": {  
      "building": "43",  
      "floor": "1"}  
  },  
  "properties": {  
    "desired": {  
      "telemetryConfig": {  
        "sendFrequency": "5m"},  
      "$metadata": {...},  
      "$version": 1  
    },  
    "reported": {  
      "telemetryConfig": {  
        "sendFrequency": "5m",  
        "status": "success"},  
      "batteryLevel": 55,  
      "$metadata": {...}  
    }  
  }  
}
```

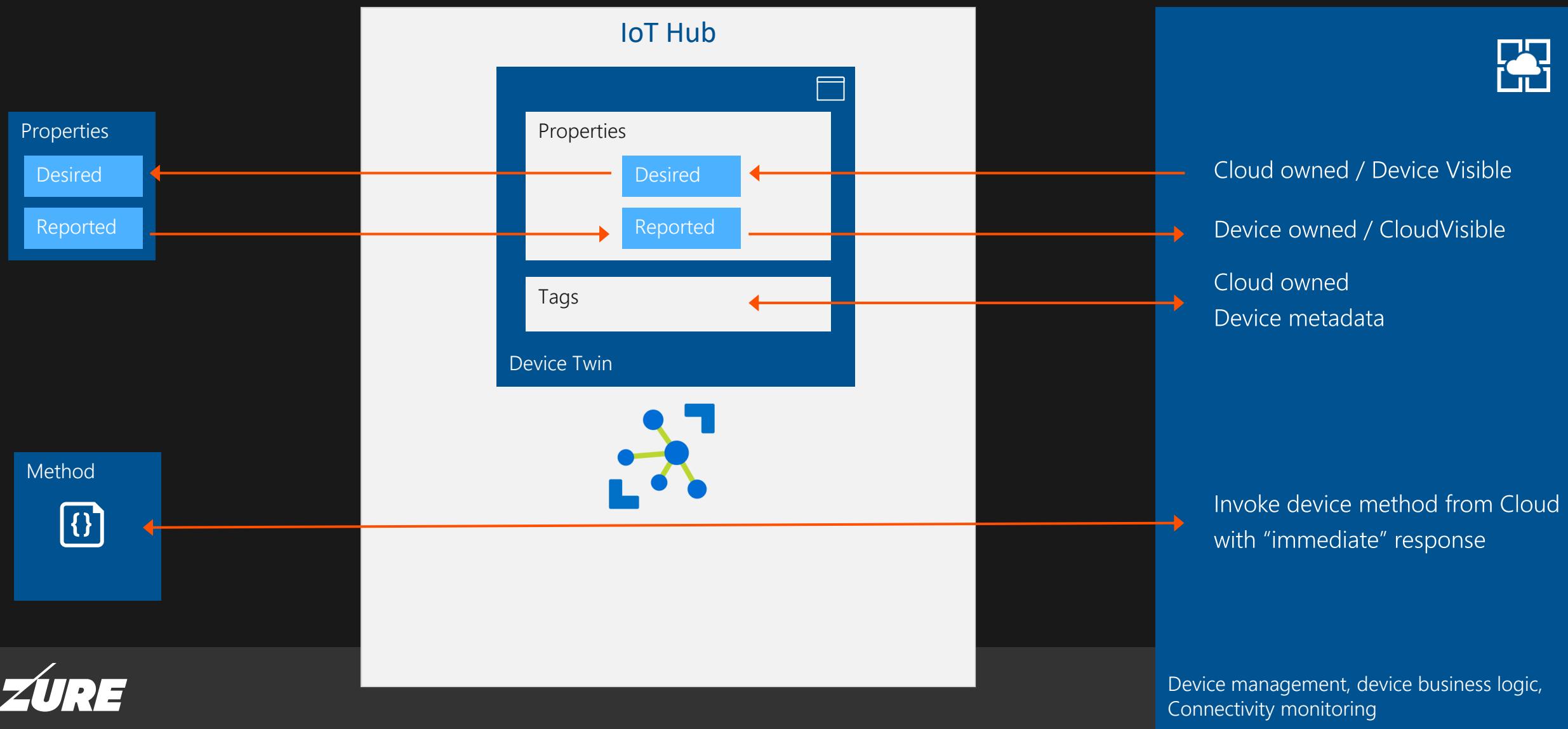


IoT Hub – Message Enrichments

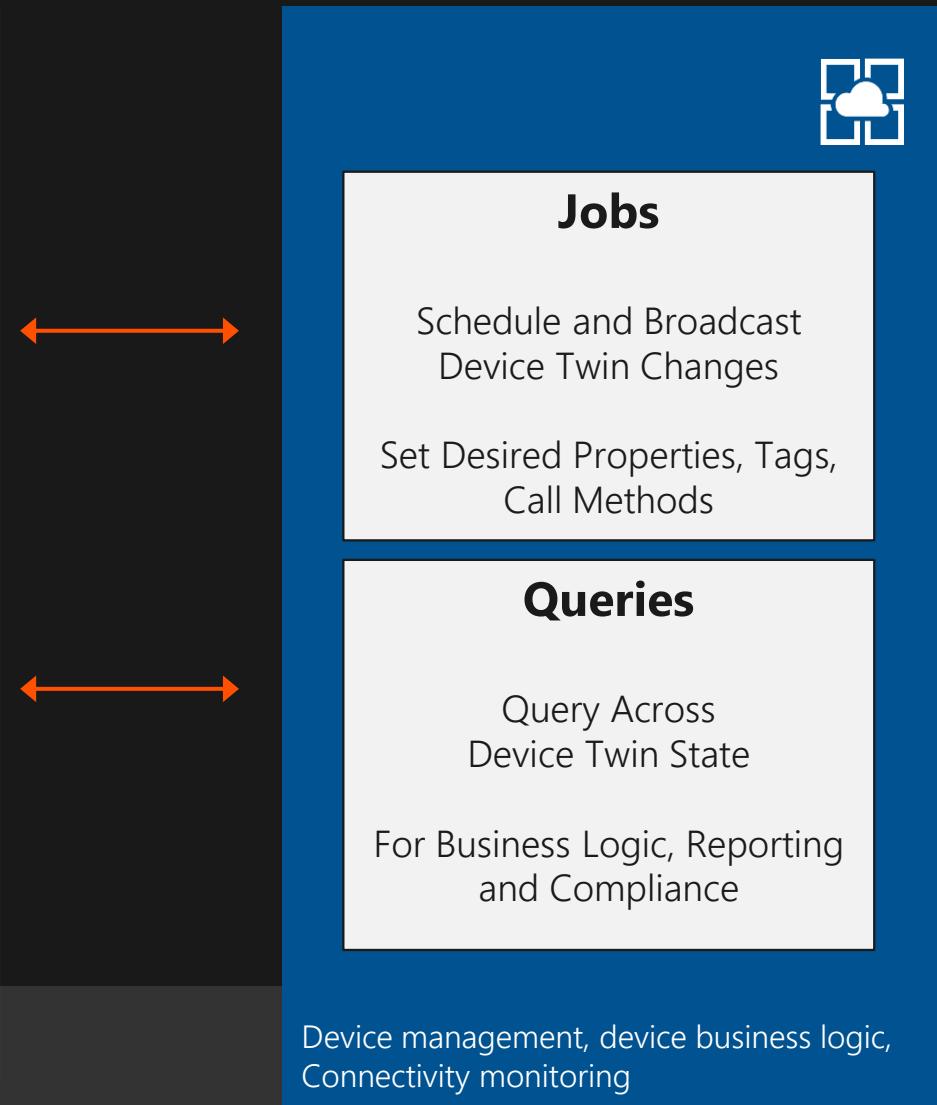
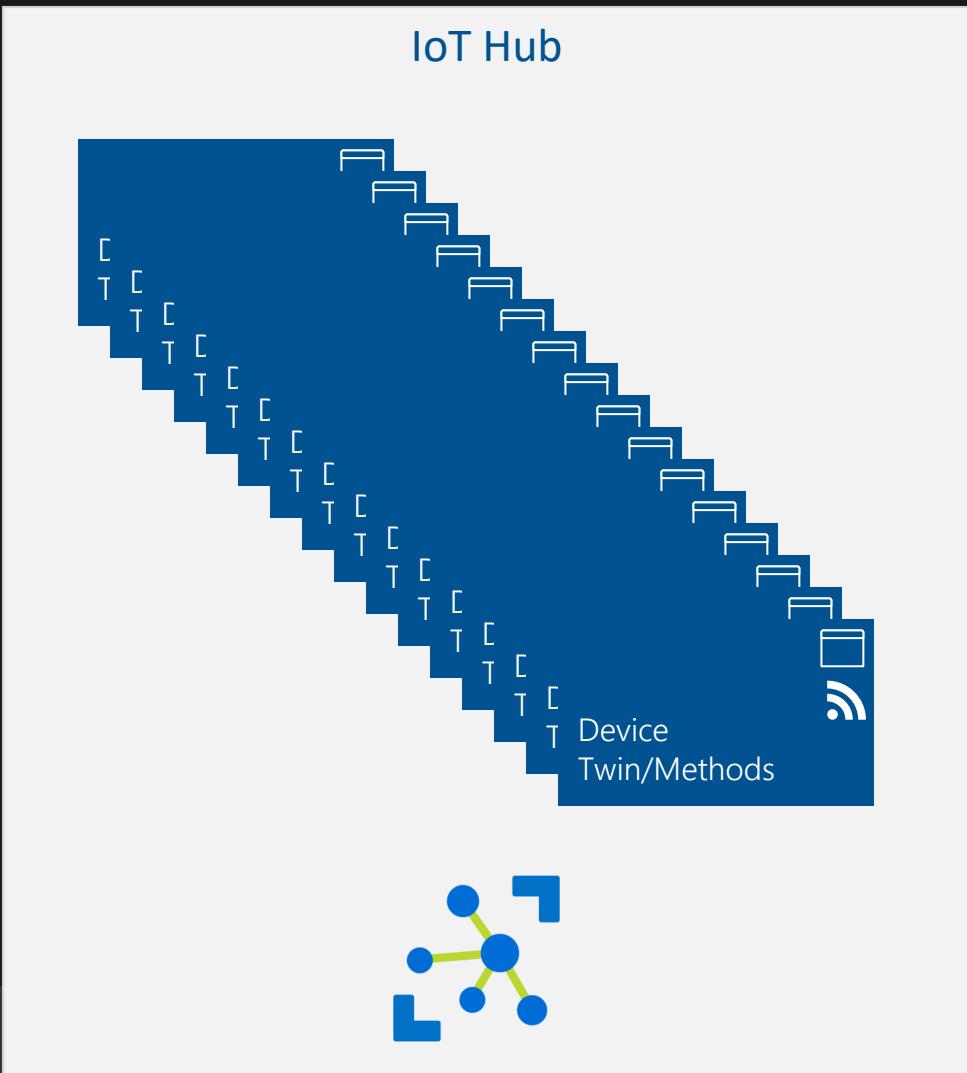
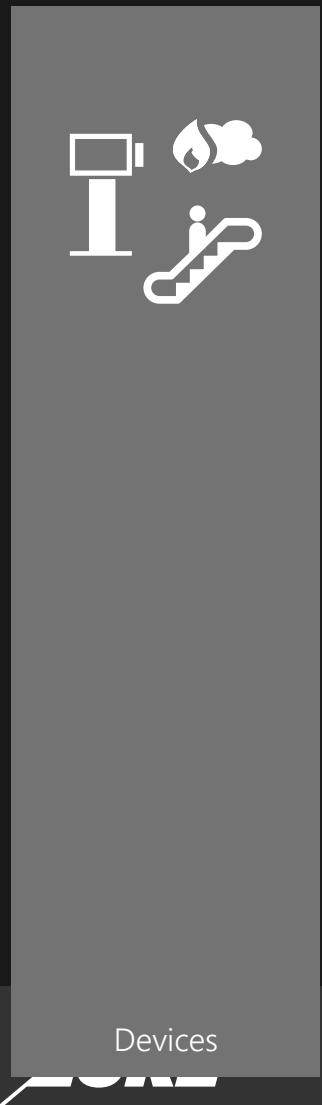
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  "appProperties": {  
    "processingPath": "<optional>",  
    "verbose": "<optional>",  
    "severity": "<optional>",  
    "testDevice": "<optional>"  
  },  
  "body":  
  {"Weather": {"Temperature": 50}}  
}  
}  
Device Twin:  
{  
  "tags": {  
    "deploymentLocation": {  
      "building": "43",  
      "floor": "1"}  
  },  
  "properties": {  
    "desired": {  
      "telemetryConfig": {  
        "sendFrequency": "5m"},  
      "$metadata": {...},  
      "$version": 1  
    },  
    "reported": {  
      "telemetryConfig": {  
        "sendFrequency": "5m",  
        "status": "success"},  
      "batteryLevel": 55,  
      "$metadata": {...}  
    }  
  }  
}
```



IoT Hub – Device Management



IoT Hub – Jobs and Queries



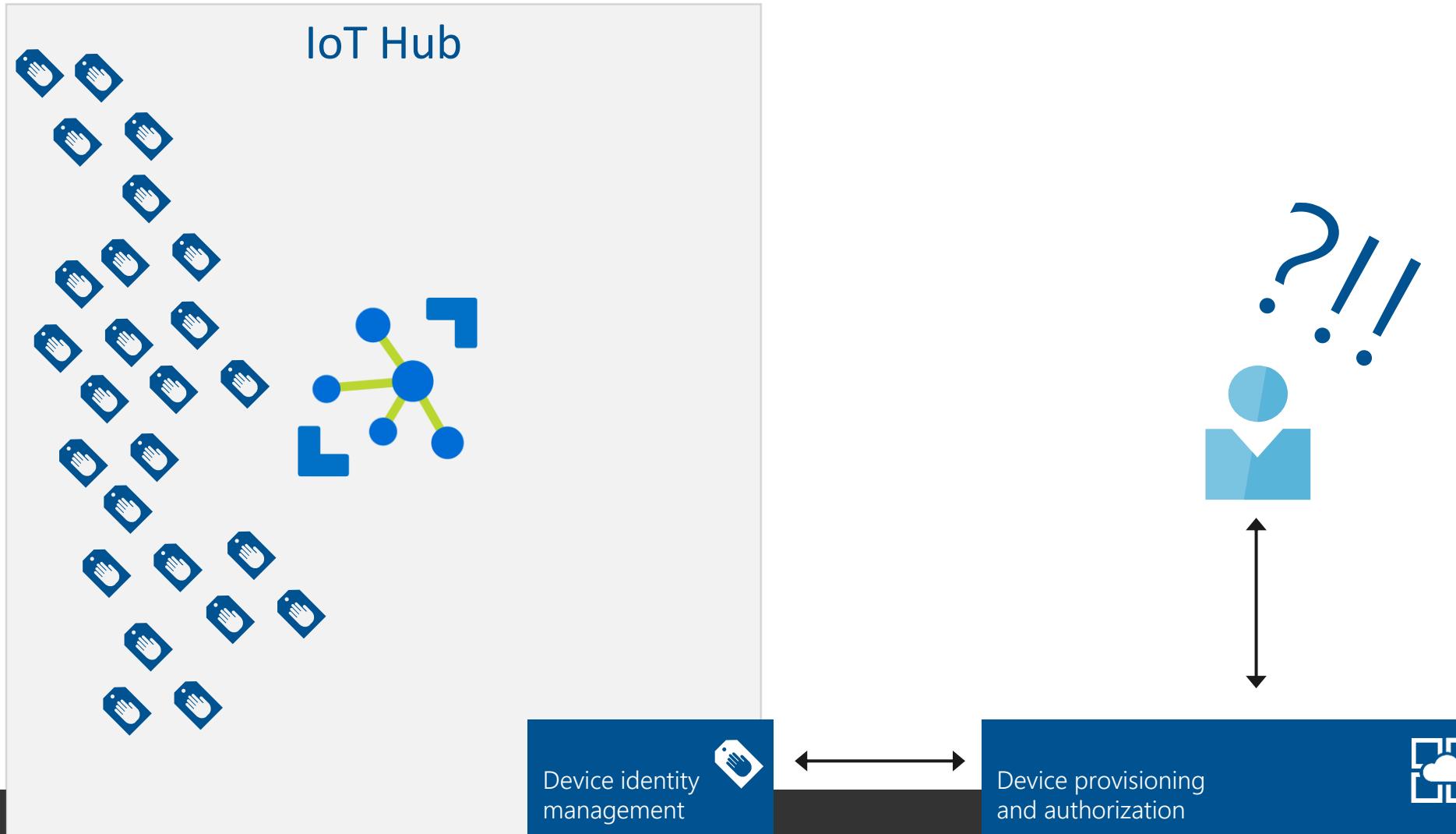
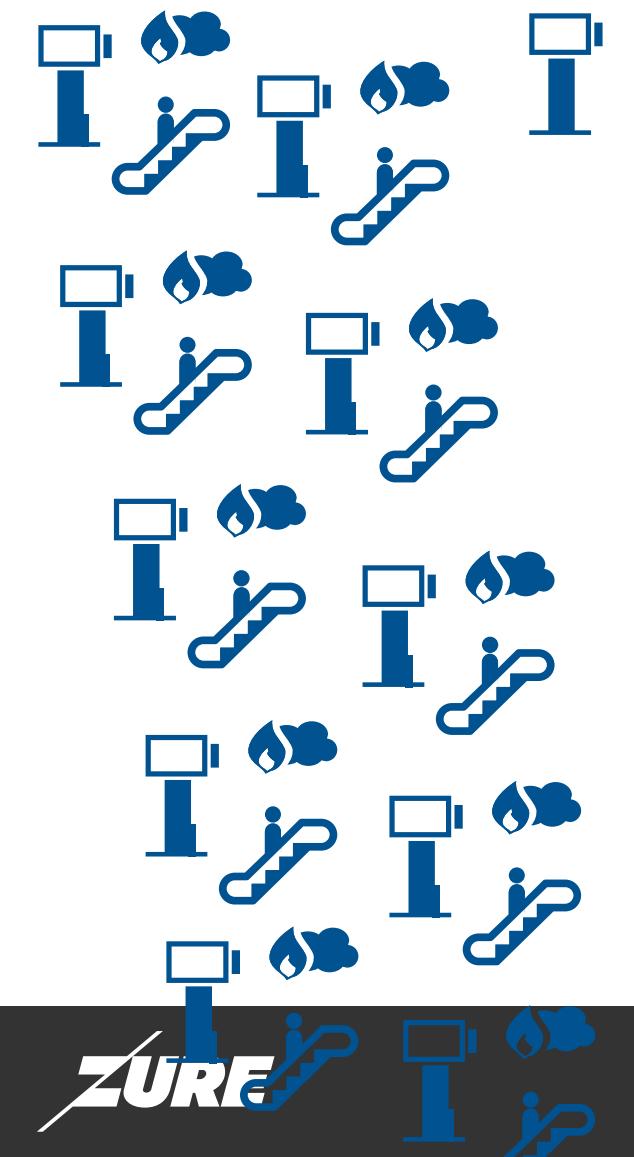
DEMO

IoT Hub Concepts

Device Provisioning

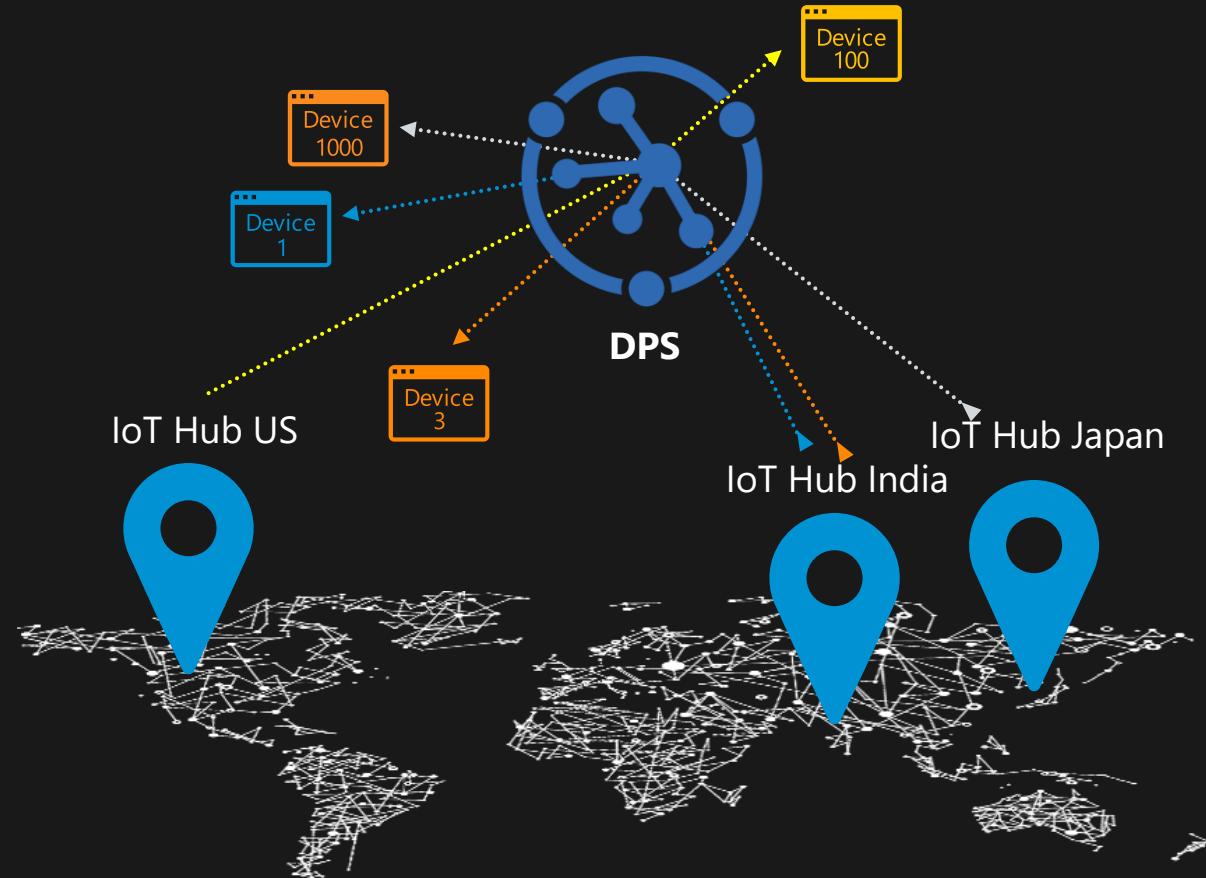
Processing and Analytics with Azure

Provision at Scale...

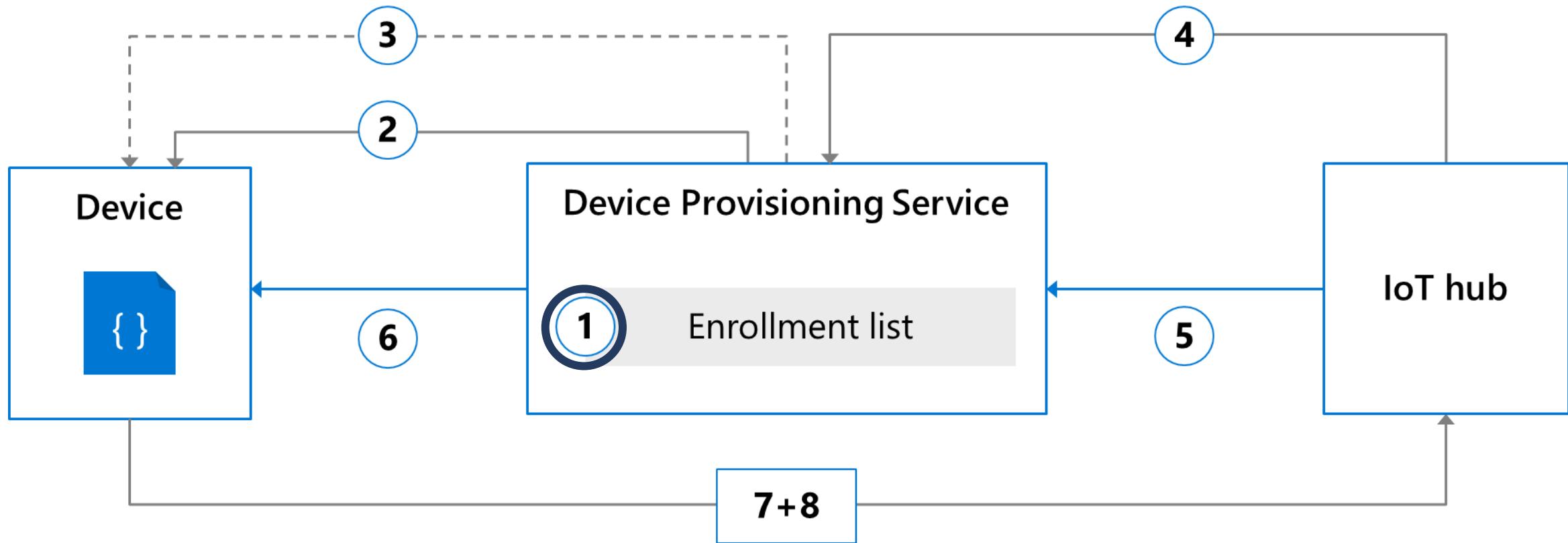


Device Provisioning Service

- Plug and play provisioning
- Multiple IoT Hub Support
- Rules and Logic
- Support for all Devices
- Support for transferring data



DPS knows exactly which IoT Hub to connect and provision

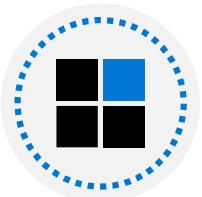


8. The device gets the enrollment information and performs the registration in the IoT hub.

Reprovisioning



Reprovisioning – the process of associating a device with a different Azure IoT Hub



Reasons for reprovisioning devices:

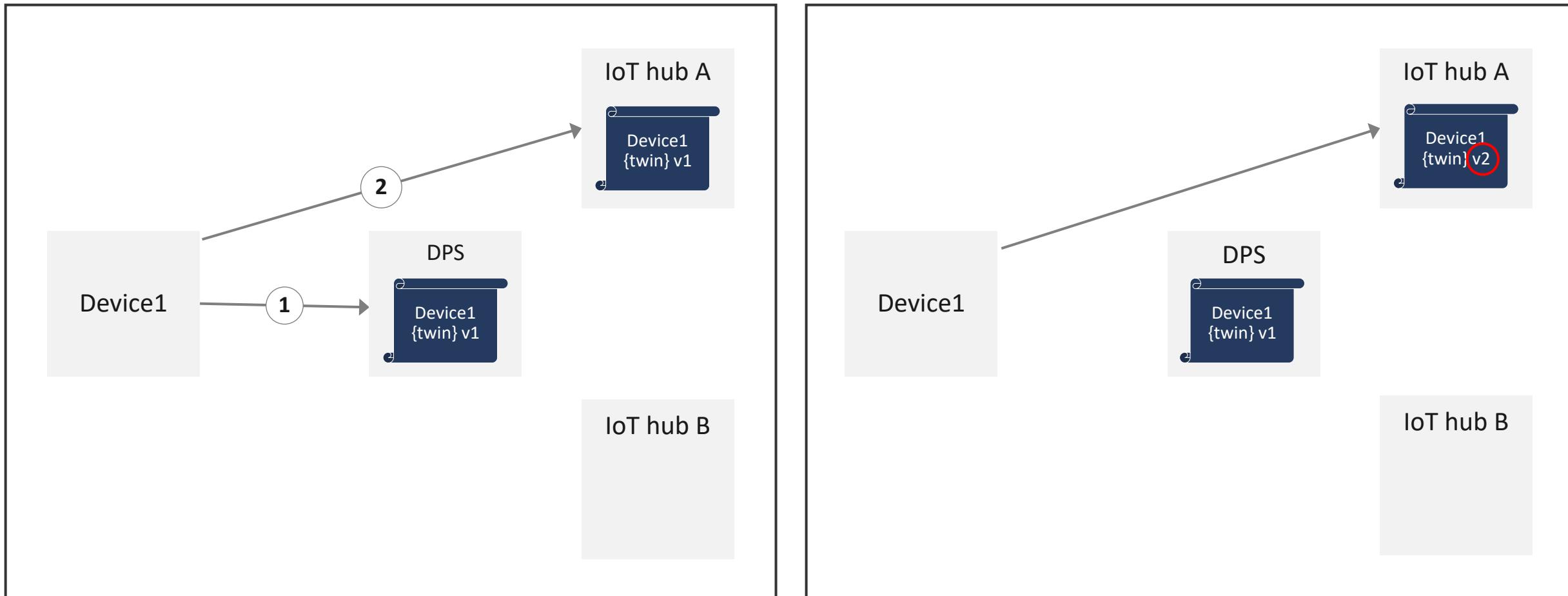
Geolocation/GeoLatency – a device is moved to a new location

Multi-tenancy – Different customer, customer site, etc.

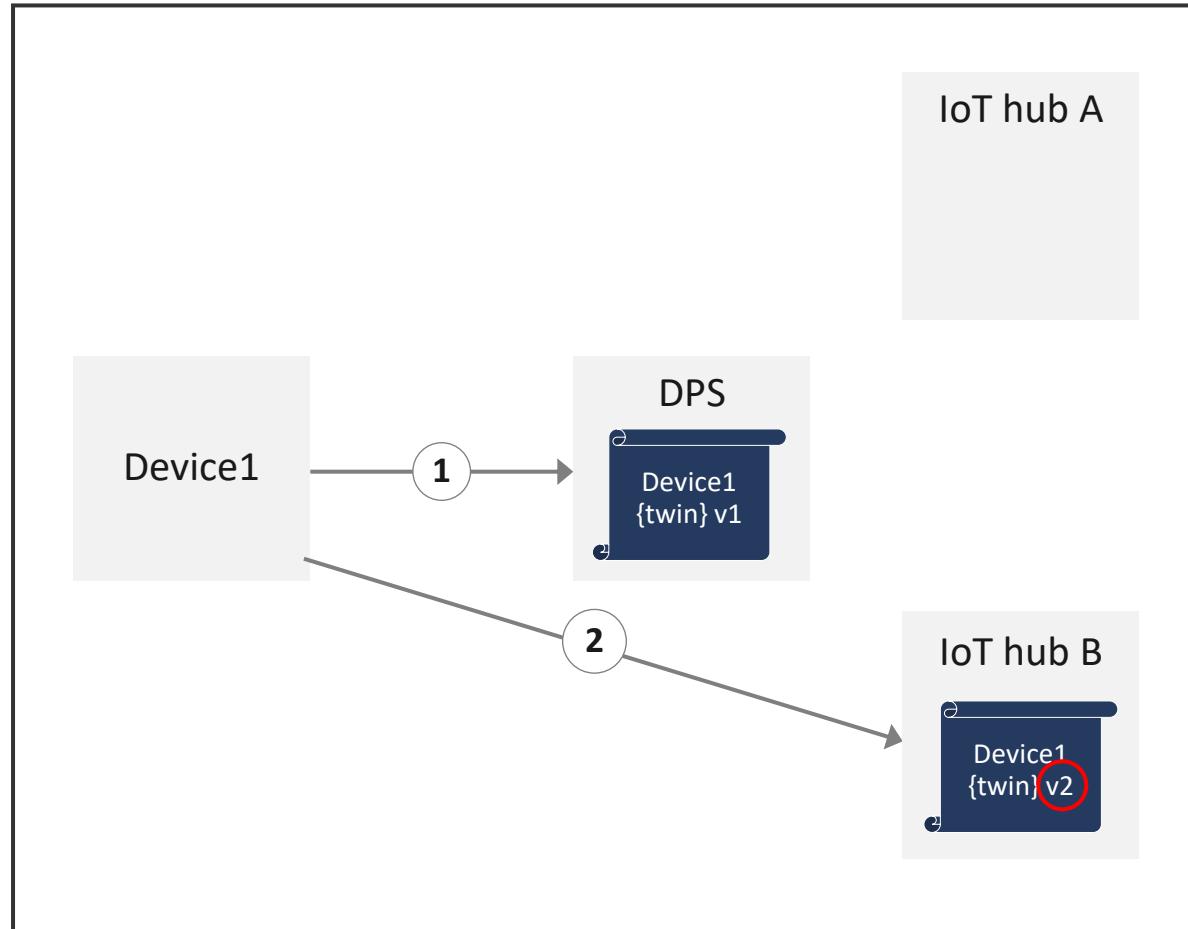
Solution change – choosing to move to a new solution, say with different back-end services connected

Quarantine – moving to an Azure IoT Hub that can fix the configuration or correct the compromise

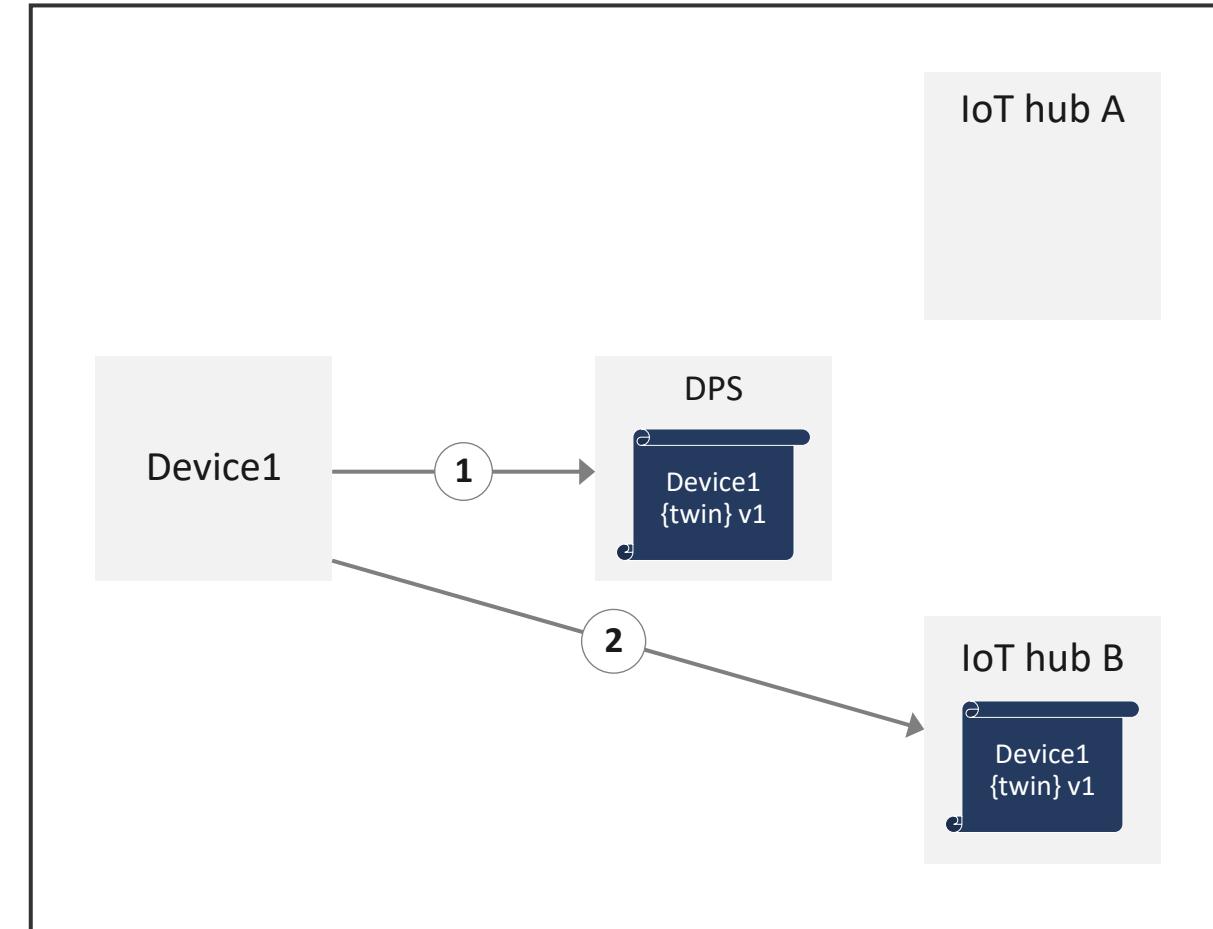
Provisioning with Device State



Provisioning with Device State



Reprovision and migrate data



Reprovision and reset to initial config

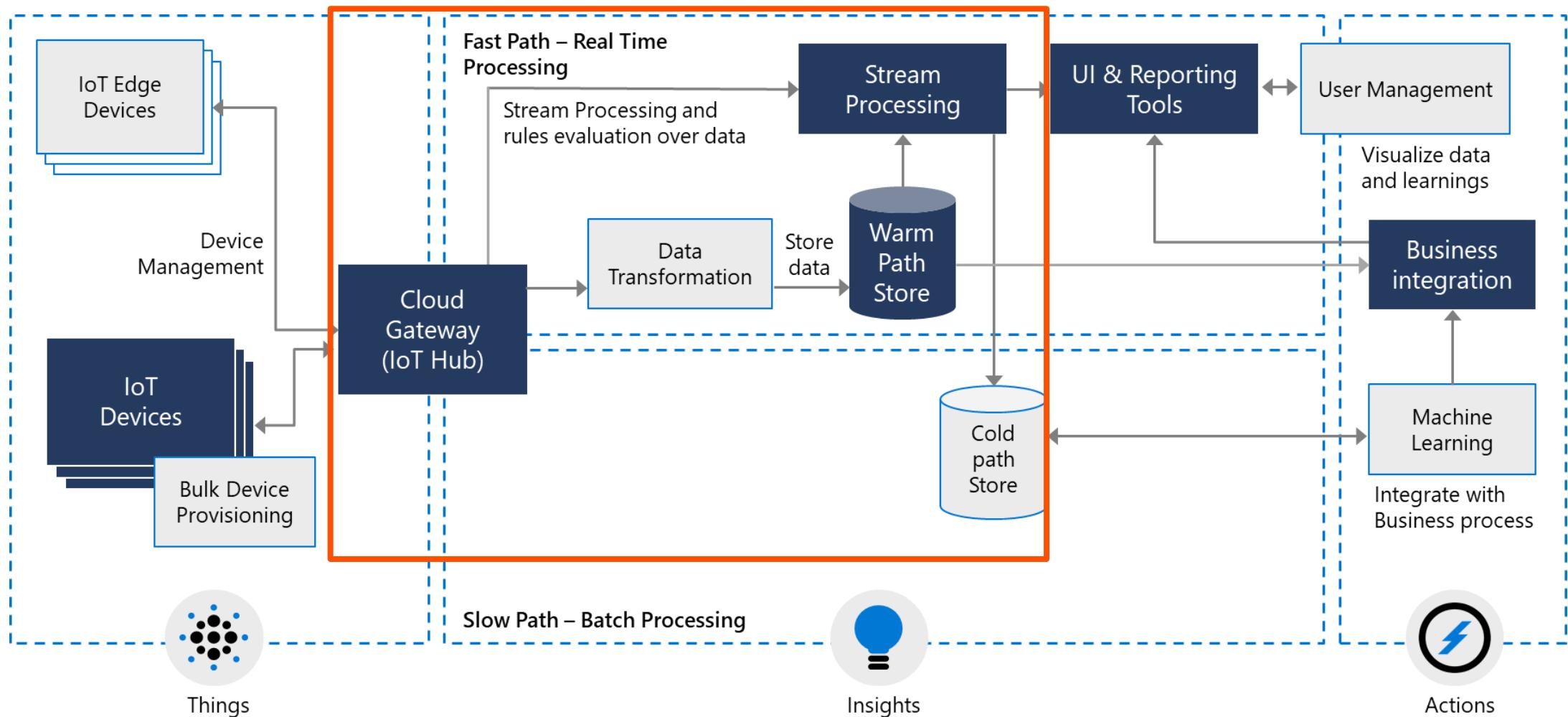
DEMO

Device Provisioning

Message Processing

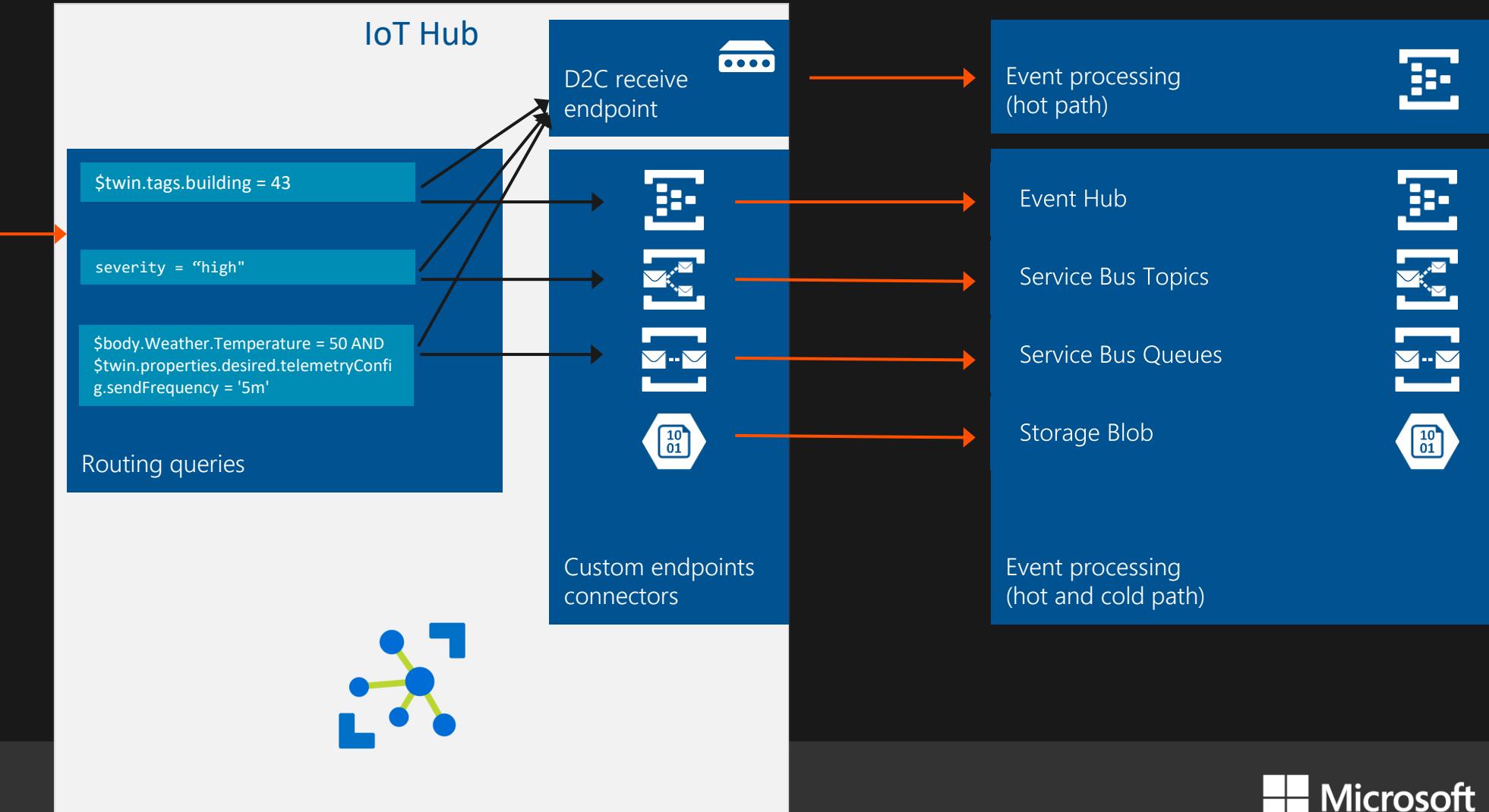
Processing and Analytics with Azure

IoT Architecture



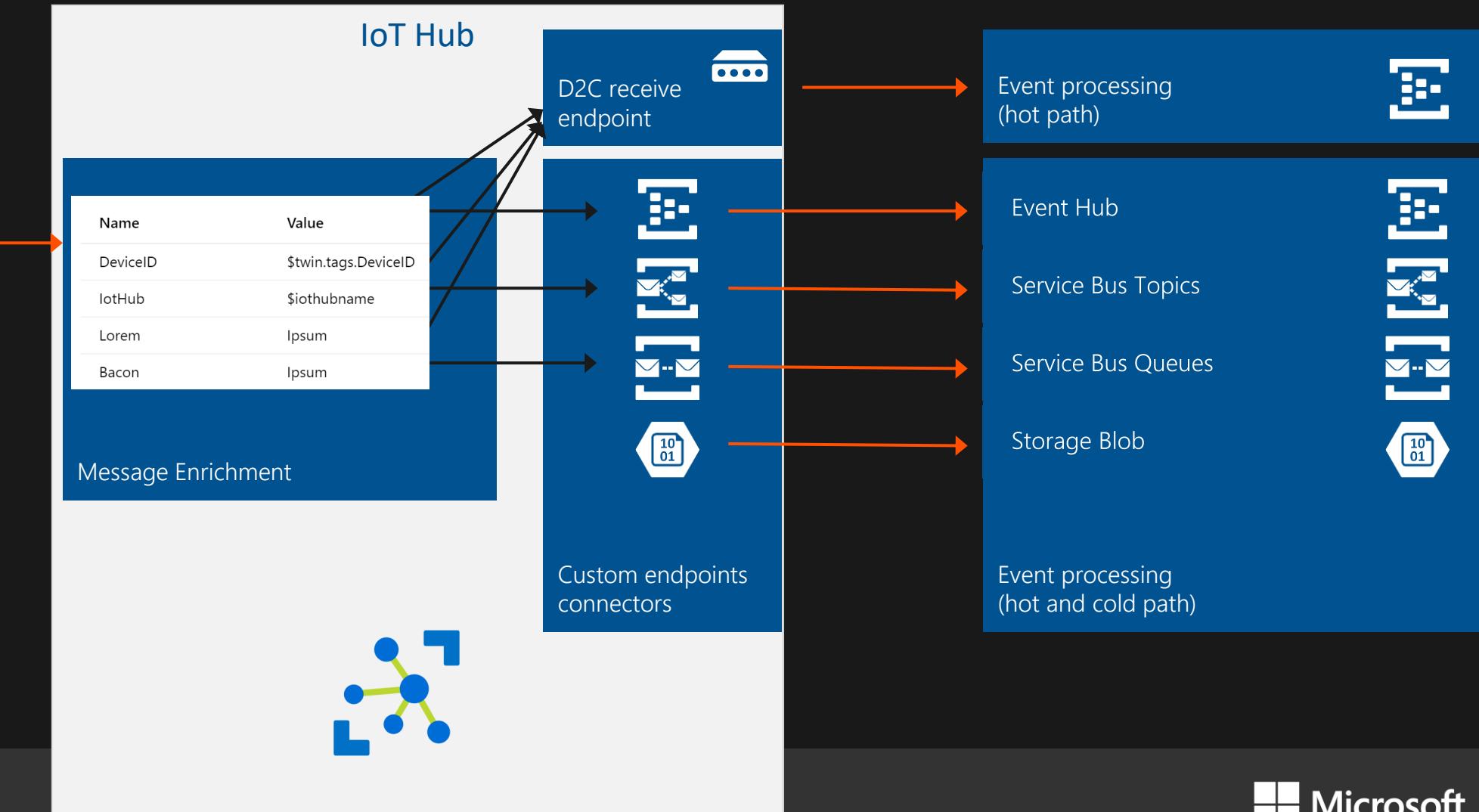
IoT Hub – Message Routing

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    "severity": "<optional>",  
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  },  
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}  
}  
  
Device Twin:  
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    "deploymentLocation": {  
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      "floor": "1"}  
  },  
  "properties": {  
    "desired": {  
      "telemetryConfig": {  
        "sendFrequency": "5m"},  
      "$metadata": {...},  
      "$version": 1  
    },  
    "reported": {  
      "telemetryConfig": {  
        "sendFrequency": "5m",  
        "status": "success"},  
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      "$metadata": {...}  
    }  
  }  
}
```

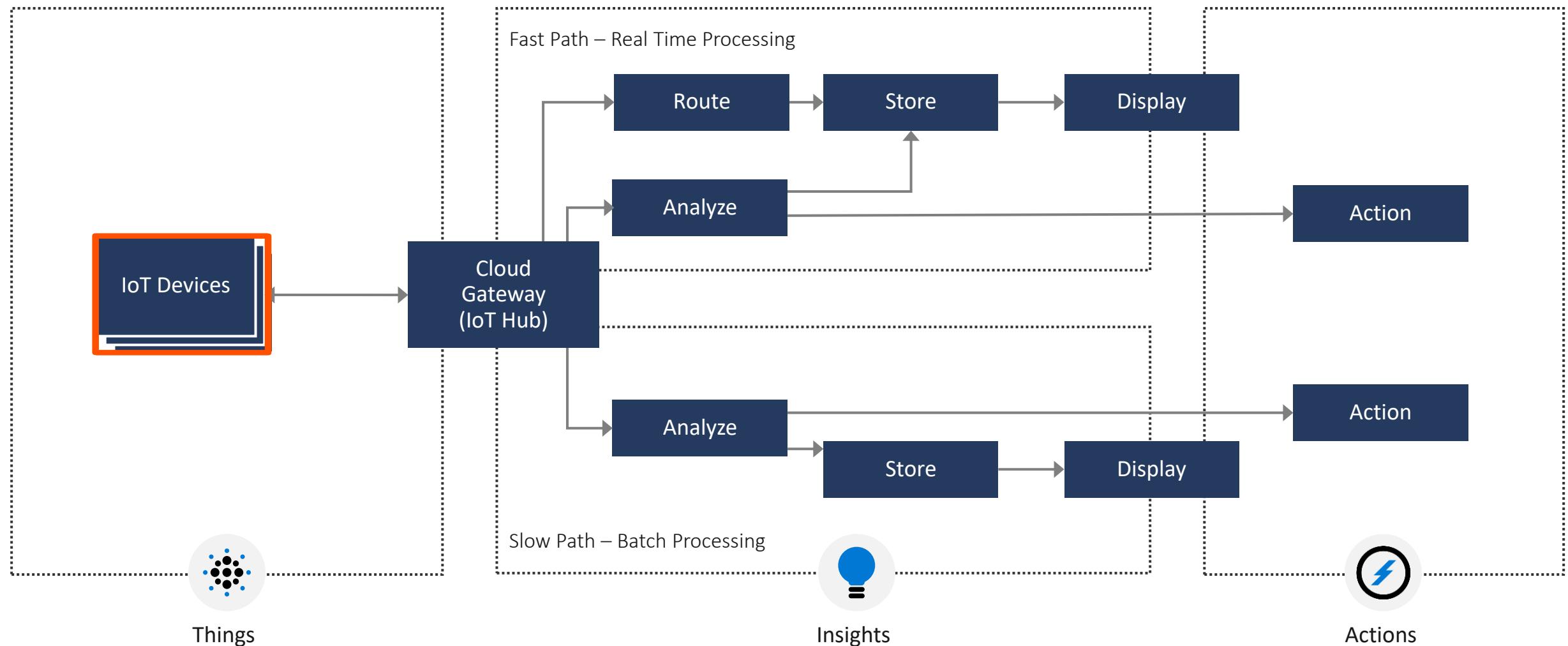


IoT Hub – Message Enrichments

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          }  
        }  
      }  
    }  
  }  
}
```



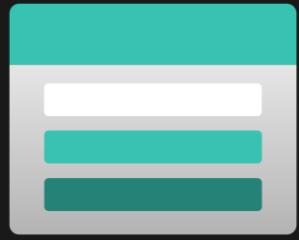
Lambda Architecture



DEMO

Message Routing

Common Storage options



Storage Accounts



Data Lake Gen2

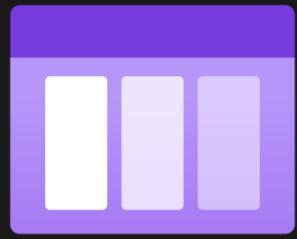


Cosmos DB

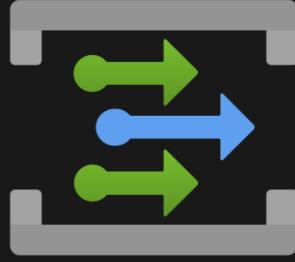


Azure SQL DB

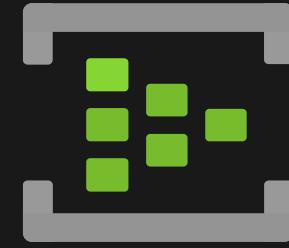
Common Messaging Options



Storage Queue



Event Grid



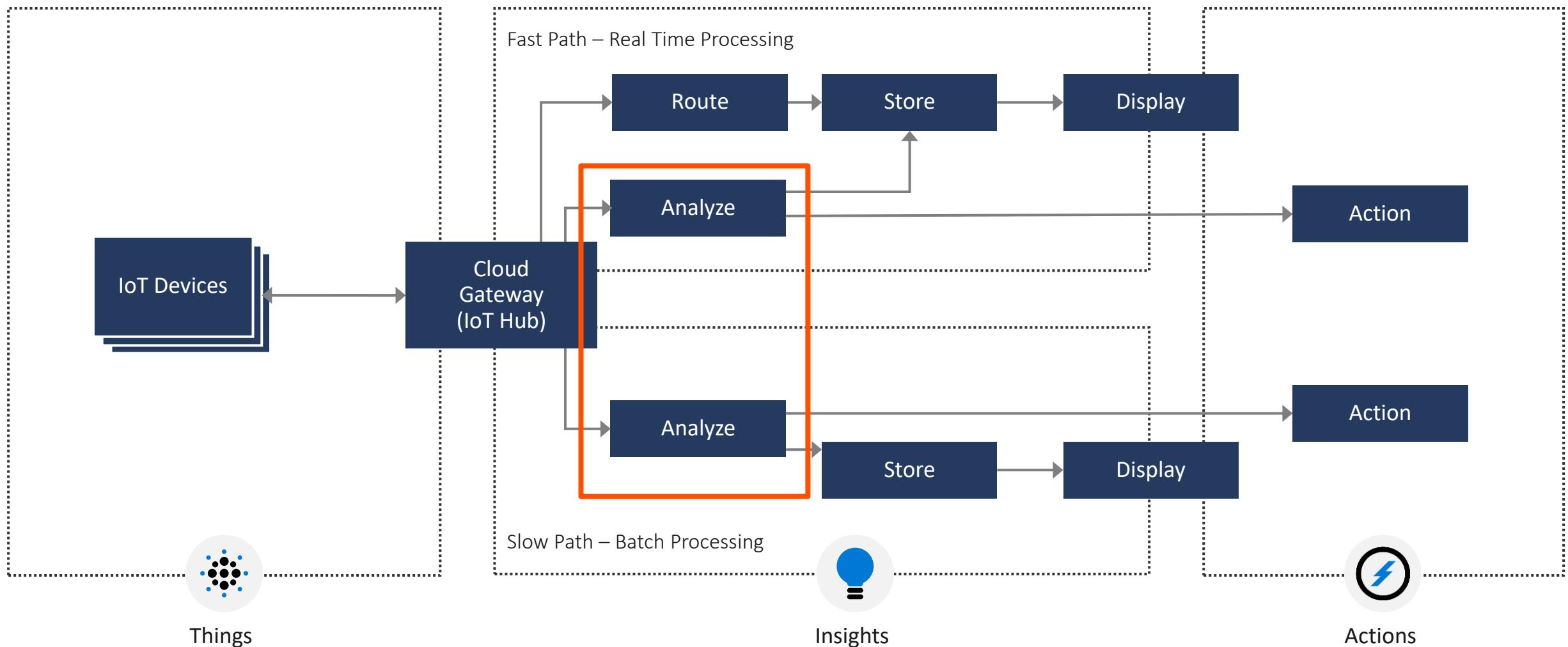
Event Hubs



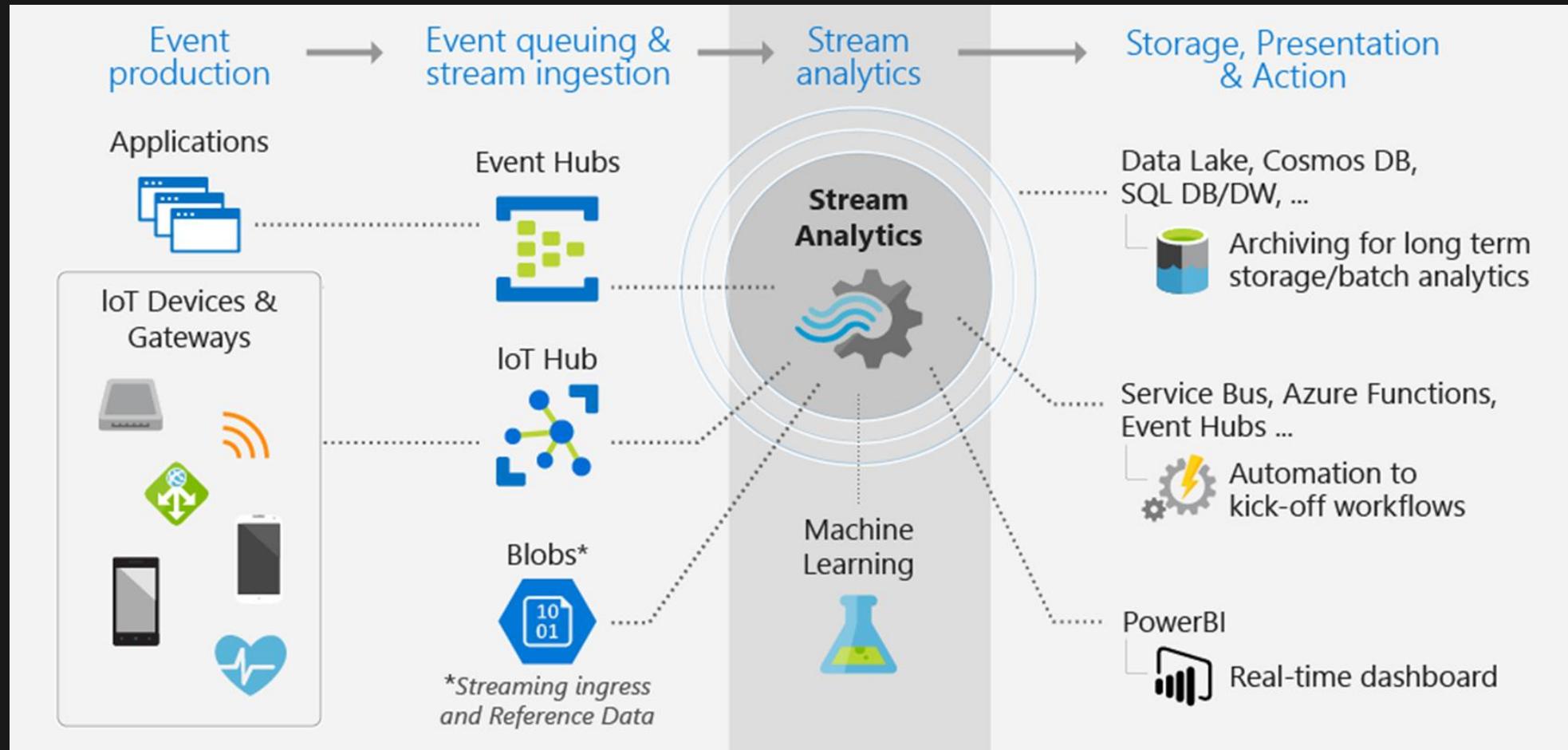
Service Bus

Requirement	Simple queuing	Eventing and PubSub	Big data streaming	Enterprise messaging
Product	Queue storage	Event Grid	Event Hubs	Service Bus
Supported advantages	<ul style="list-style-type: none"> Communication within an app Individual message Queue semantics / polling buffer Simple and easy to use Pay as you go 	<ul style="list-style-type: none"> Communication between apps / orgs Individual message Push semantics Filtering and routing Pay as you go Fan out 	<ul style="list-style-type: none"> Many messages in a Stream (think in MBs) Ease of use and operation Low cost Fan in Strict ordering Works with other tools 	<ul style="list-style-type: none"> Instantaneous consistency Strict ordering Java Messaging Service Non-repudiation and security Geo-replication and availability Rich features (such as deduplication and scheduling)
Weaknesses	<ul style="list-style-type: none"> Ordering of messaging Instantaneous consistency 	<ul style="list-style-type: none"> Ordering of messaging Instantaneous consistency 	<ul style="list-style-type: none"> Server-side cursor Only once 	<ul style="list-style-type: none"> Cost Simplicity
Type	Serverless	Serverless	Big data	Enterprise

Lambda Architecture



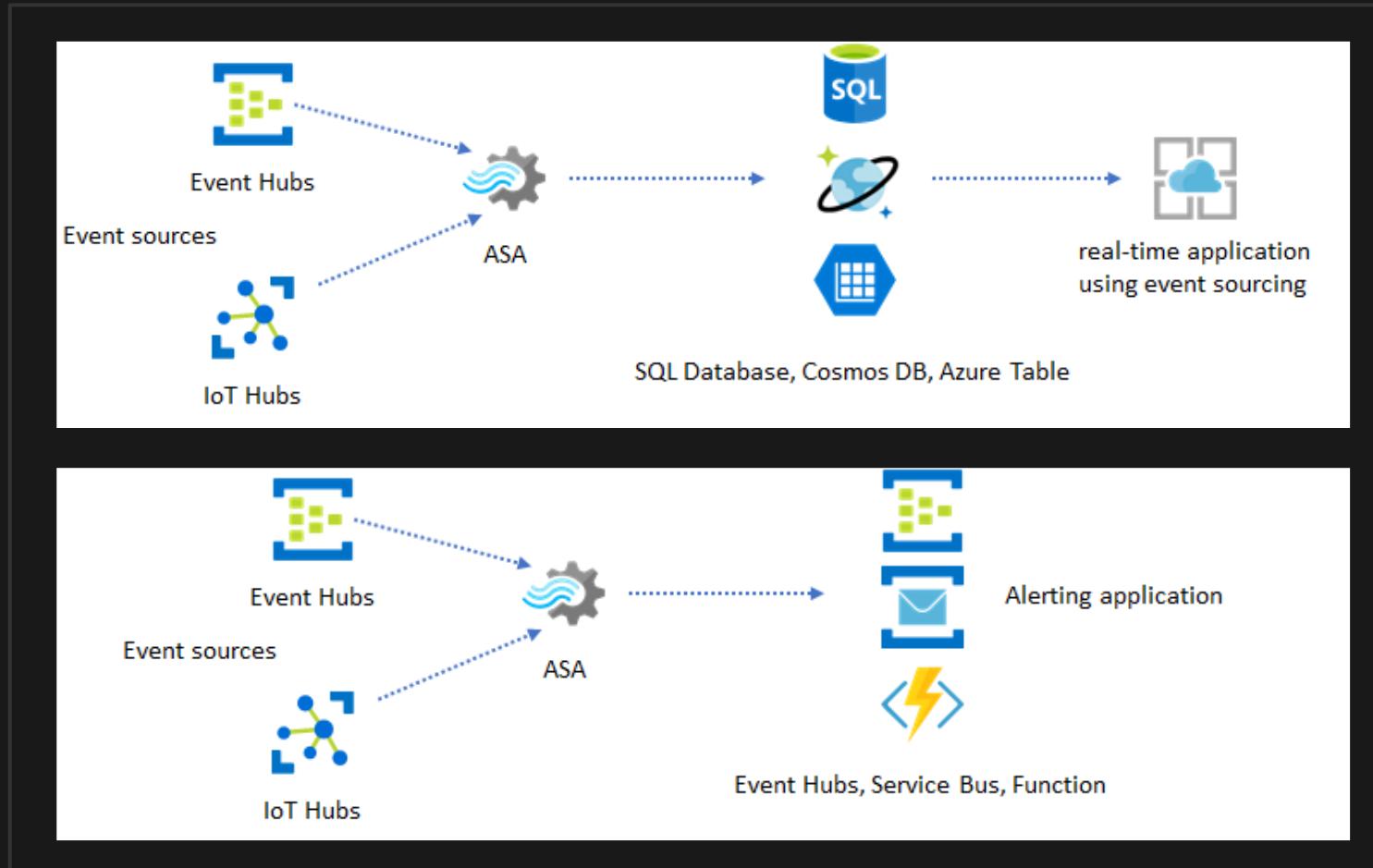
Stream Analytics



Stream Analytics

- Jobs
 - Input, query and output
- Inputs from Eventhubs, IoT Hubs or Storage
- Outputs to many targets, including storage, DataLake, ServiceBus, PowerBI...
- Recommended for
 - Analytics on Azure
 - Dashboard visualization
 - Real-time alerting
 - Basic ETL

Stream Analytics Patterns



Stream Analytics Patterns

- Windowing Functions
 - Tumbling
 - Hopping
 - Sliding
 - Session
- 'SQL Like Queries'
 - Group By
 - Average
 - Having
- Multiple Outputs

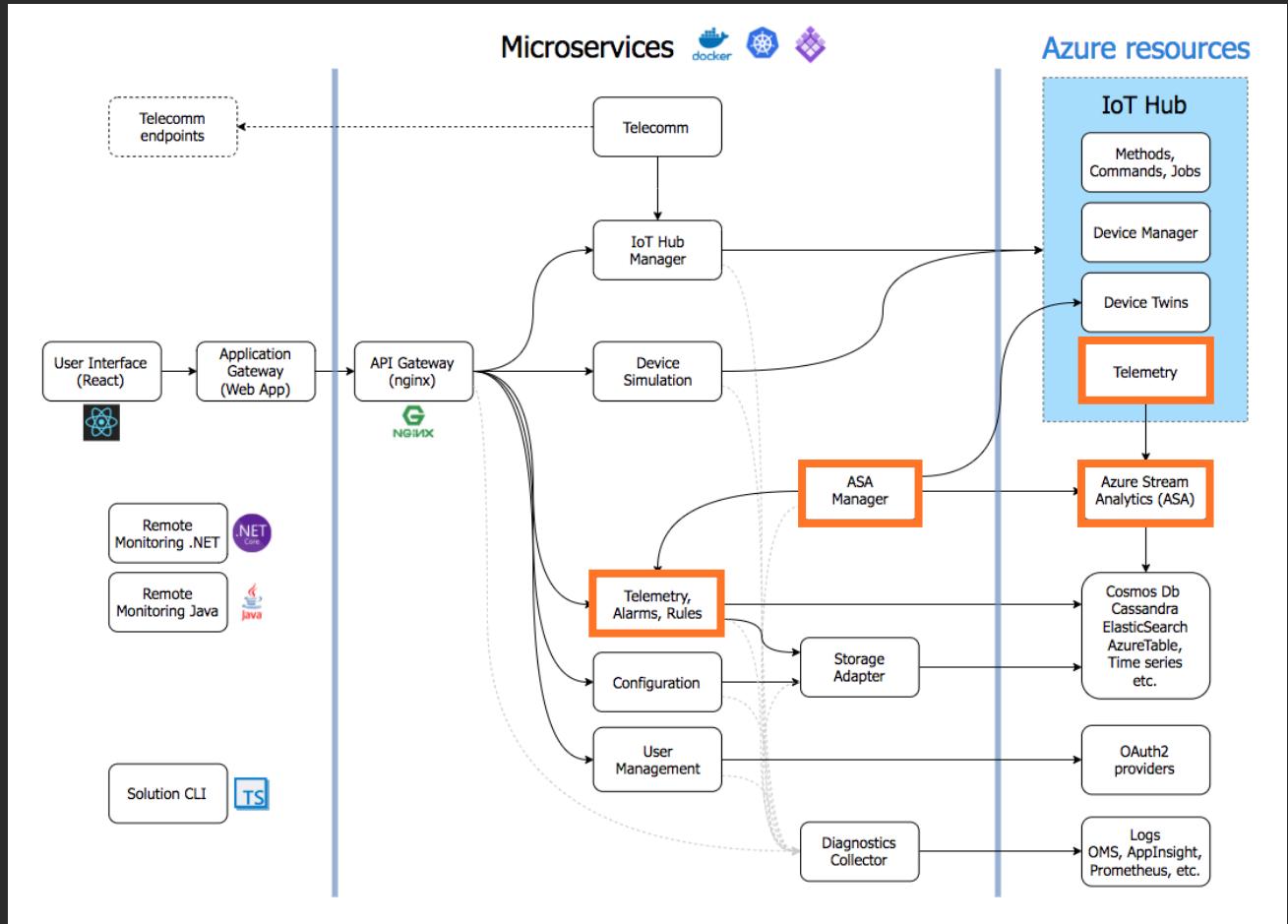
DEMO

Stream Analytics

AZURE IOT SOLUTIONS

REMOTE MONITORING

- Device Connectivity
- Data Processing and Analytics
- Presentation

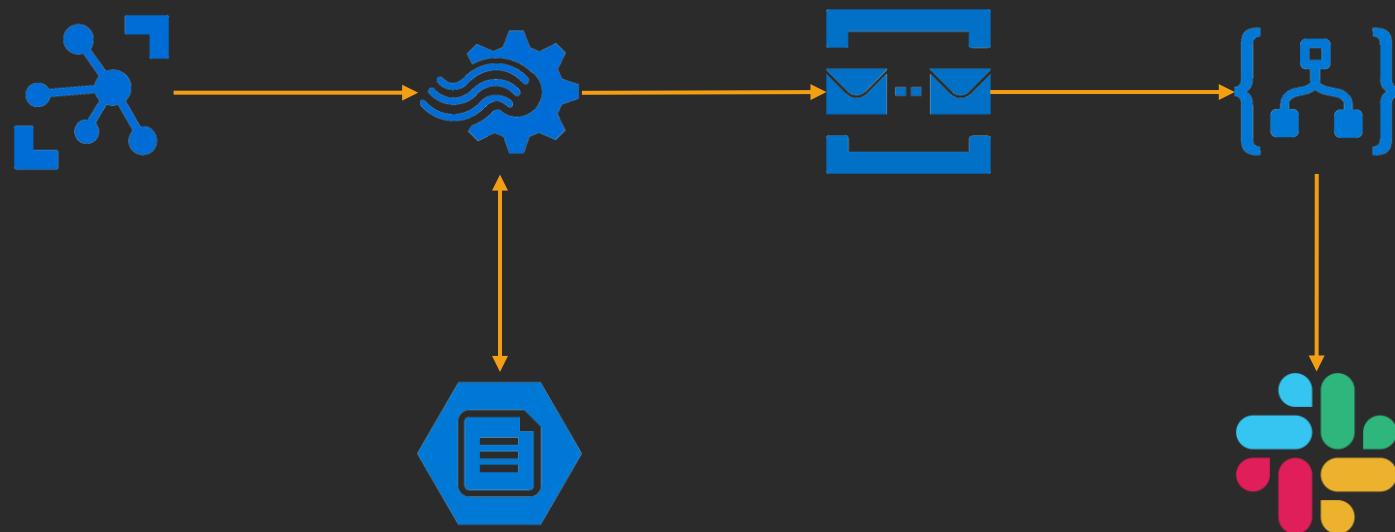


<https://docs.microsoft.com/en-us/azure/iot-accelerators/iot-accelerators-remote-monitoring-sample-walkthrough>

<https://github.com/Azure/remote-monitoring-services-dotnet>

<https://github.com/Azure/remote-monitoring-services-dotnet/tree/master/asa-manager>

DEMO: REMOTE MONITORING RULES ENGINE



A large, fluffy white cumulus cloud is centered against a dark, solid blue background.

Microsoft Azure IoT Training

Starting at 09:00 AM

Agenda

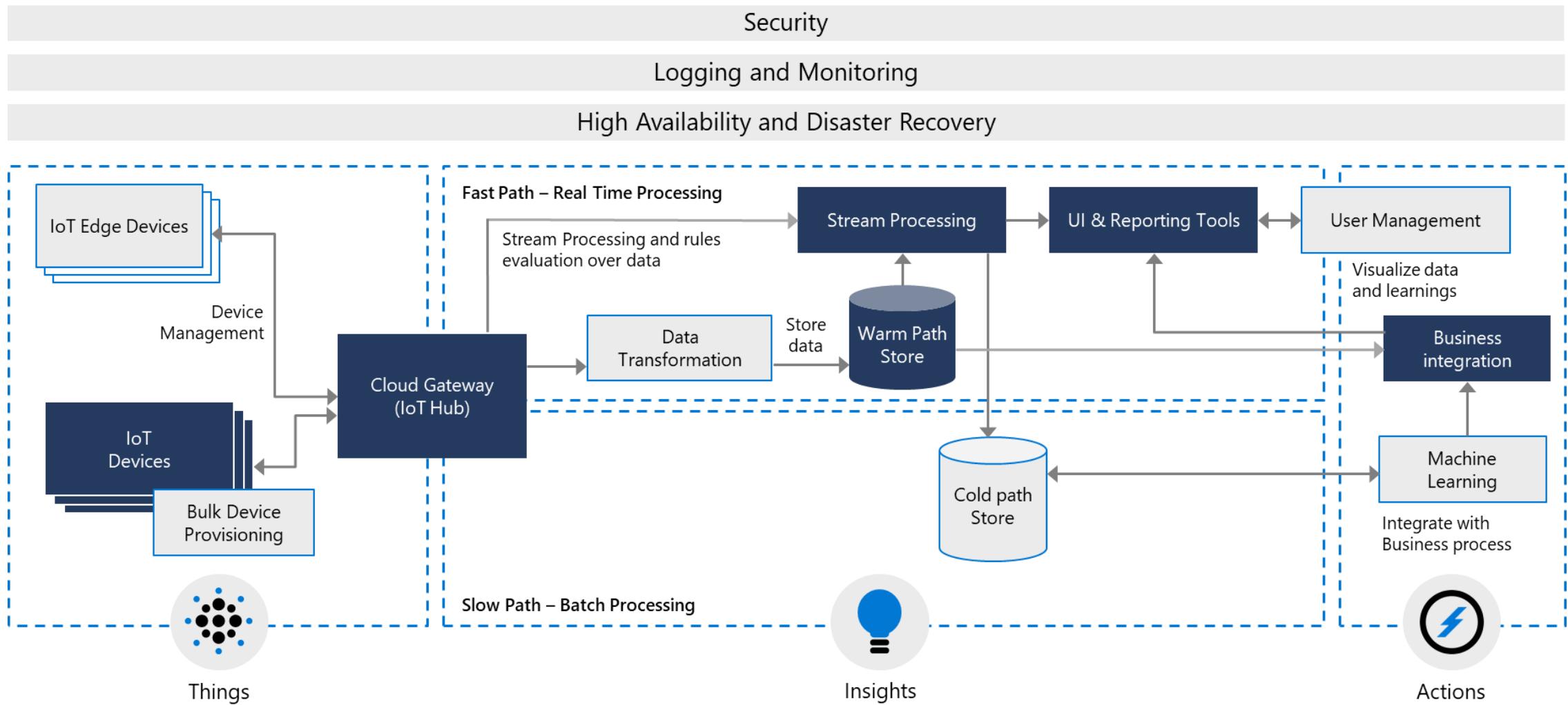
DAY I

- Azure IoT Intro & Overview
- //BUILD Recap: What's new in Azure IoT
- Azure IoT Hub Concepts & Device Lifecycle
- Message Processing and Analytics with Azure

DAY II

- Message Processing and Analytics with Azure
- The future of IoT with Azure Digital Twins
- Introduction to Azure IoT Edge and Edge Modules
- Building an IoT Solution with Azure IoT Central

Cross-cutting architectural needs



Azure Time Series Insights

Azure TSI

- IoT time-series data store
- Schema-less store
- Easy IoT Hub connection
- Store, query and visualize
- Near-real time
- Build Apps



Azure TSI

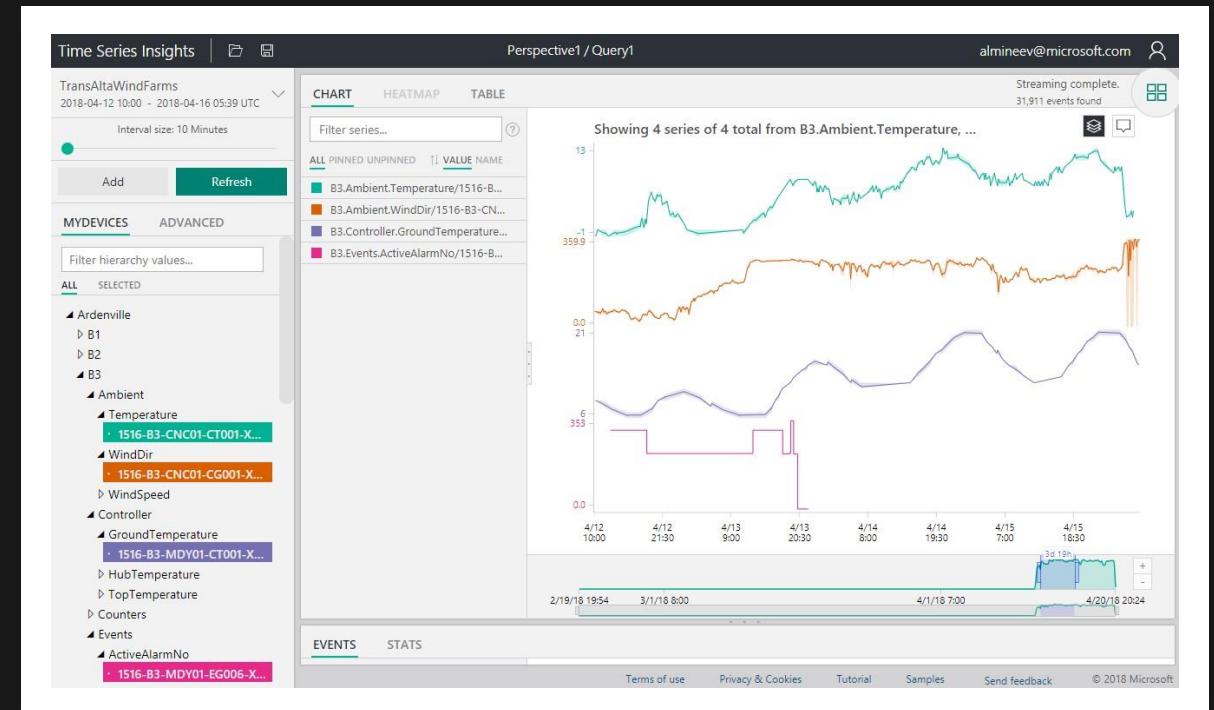
"Tag-based" user experience that makes it easy to group time series data into logical "things" and hierarchies of "things"

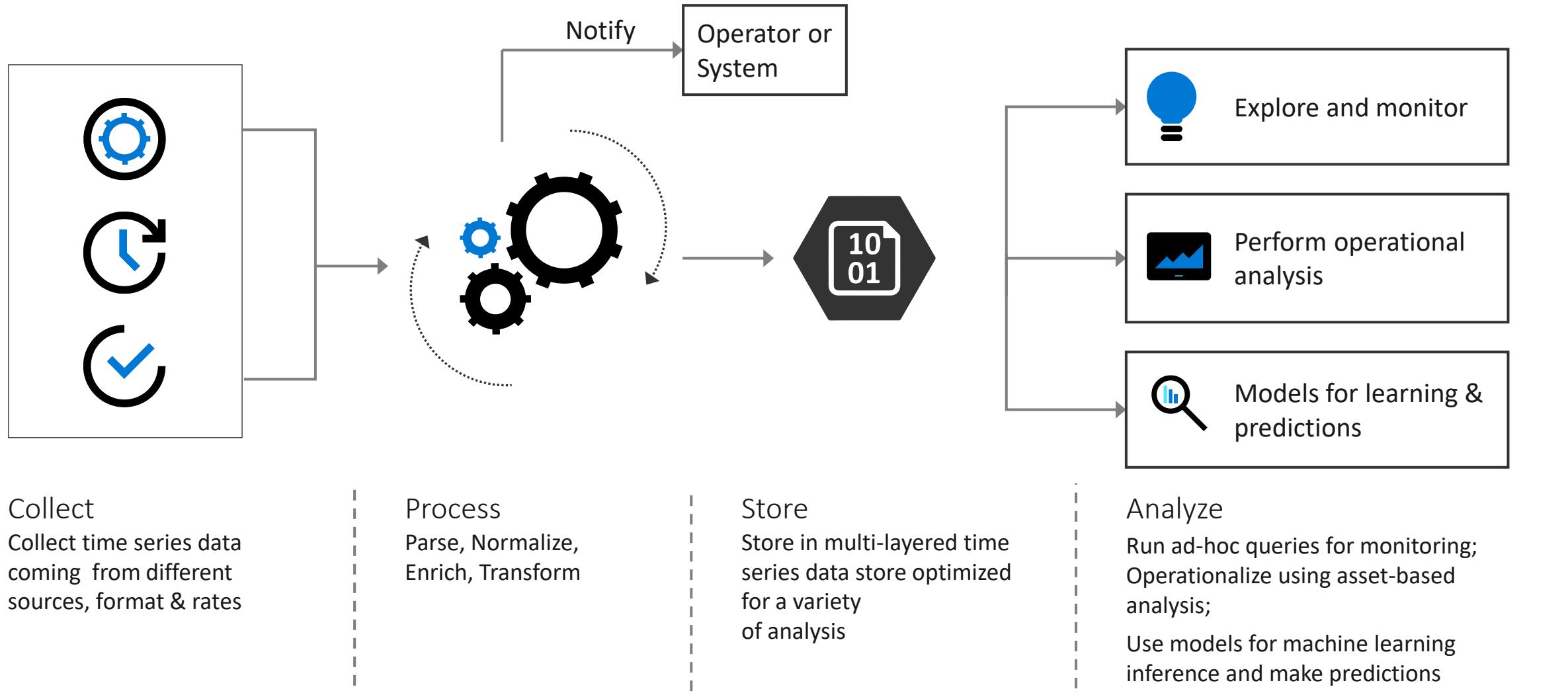
Business reports with Power BI integration

Predictive analytics with Azure Machine Learning integration

Data analysis with Jupyter and Apache Zeppelin notebook integration

Advanced analytics with Azure Databricks, Apache Hadoop and Apache Spark integration





DEMO

Time Series Insights

Azure IoT Edge

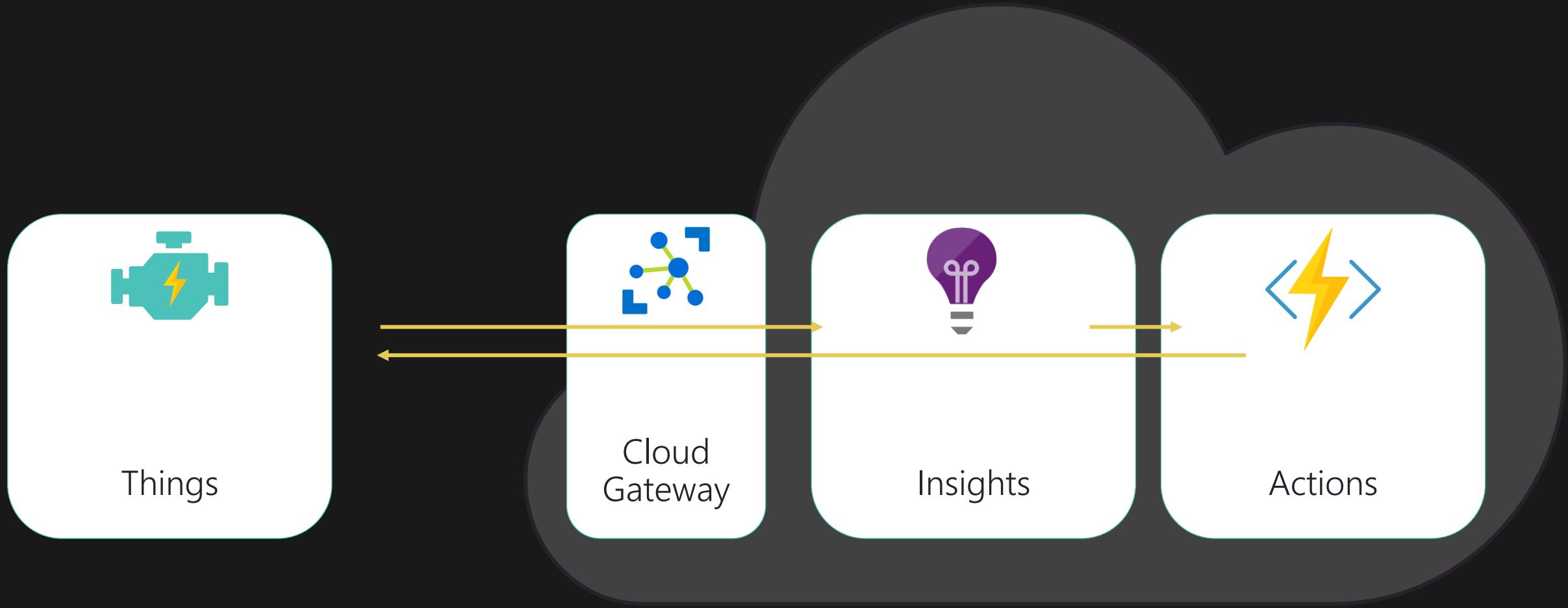
Introduction to Azure IoT Edge and Edge Modules



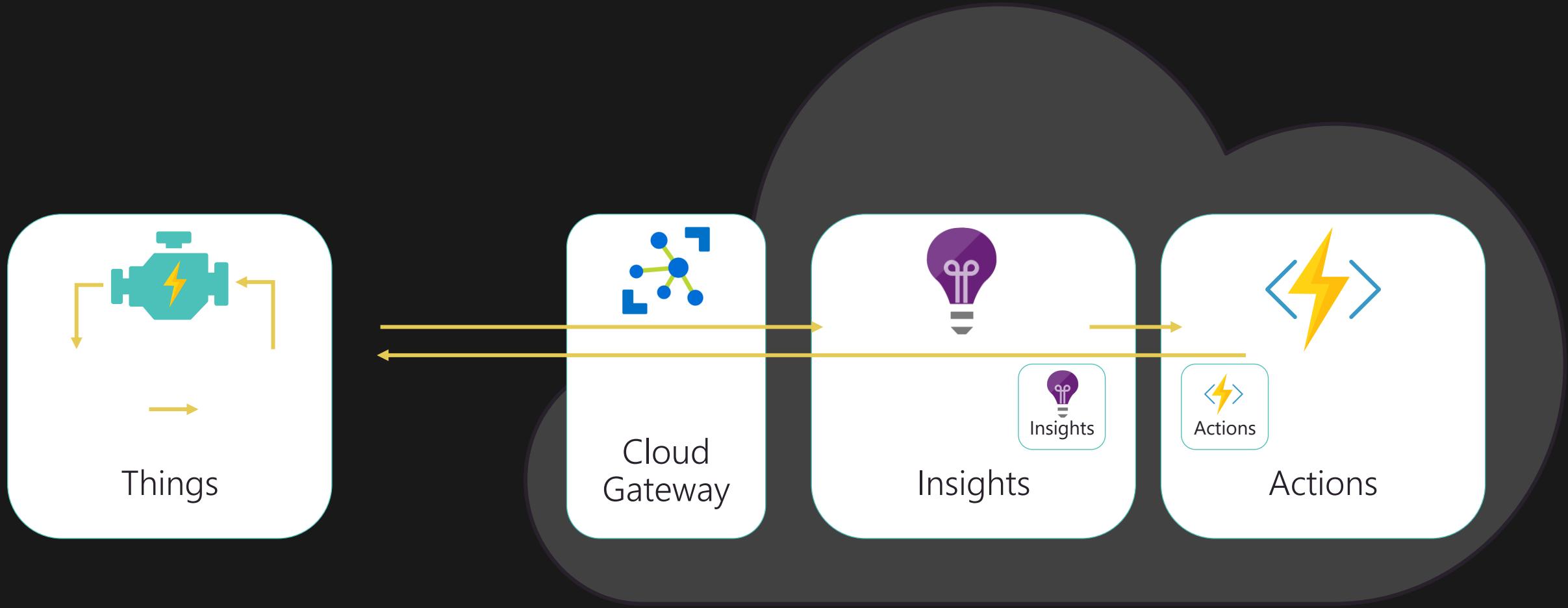
A large cargo ship, the "GOLDEN ENERGY", is shown sailing on the ocean at sunset. The sky is a gradient of orange and pink, and the water reflects this light. The ship is positioned in the center of the frame, moving from left to right.

CLOUD CAPABILITIES ON THE EDGE ARE KEY

IoT Pattern



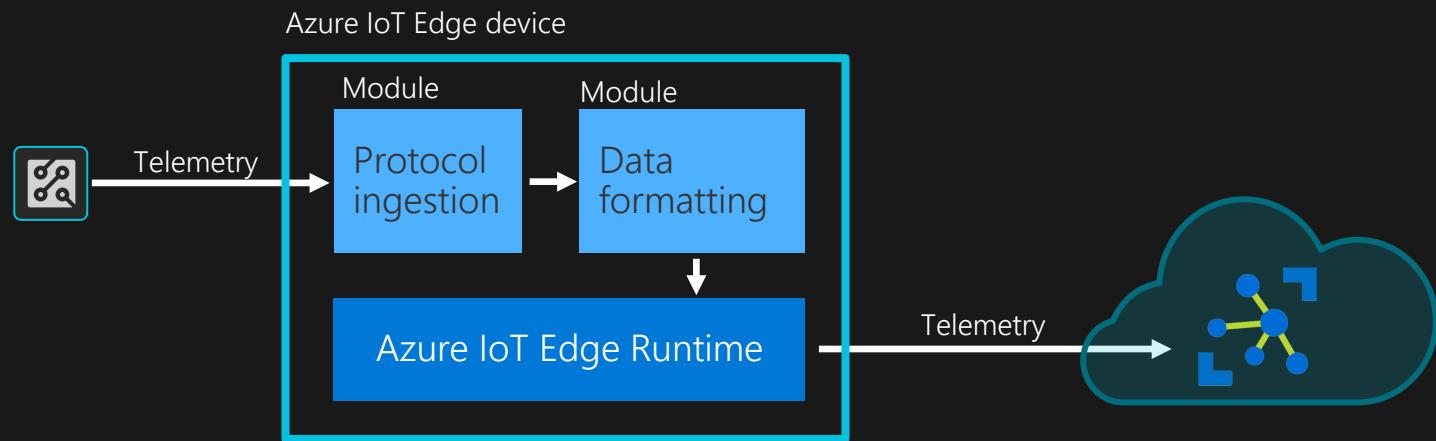
IoT Pattern + Edge



IoT in the Cloud and on the Edge

- Remote monitoring
- Remote management
- Merge data from multiple IoT Devices
- Infinite compute and storage
- Machine learning and other advanced AI Tools
- Offline operations
- Data privacy
- Data pre-processing (video)
- Low latency
- Near real time response
- Protocol translation and data normalization

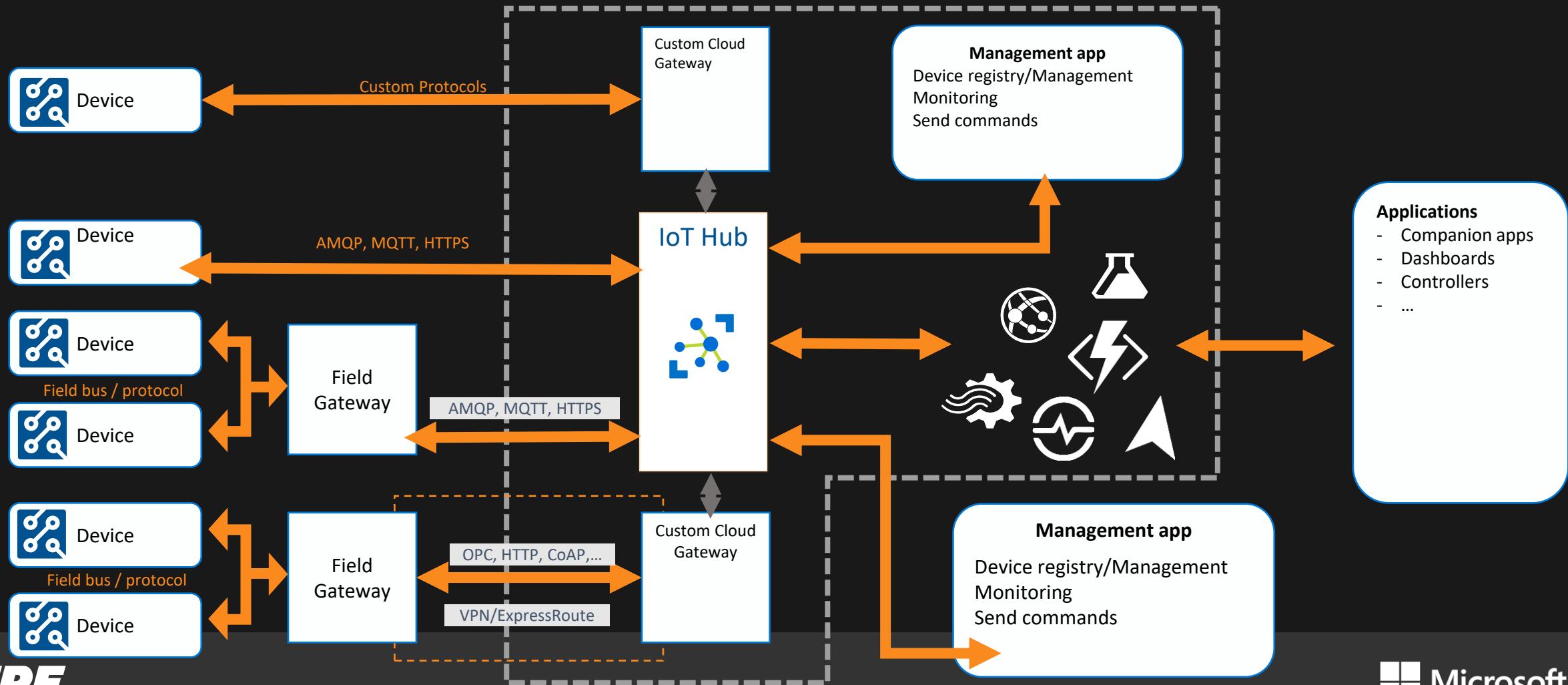
Azure IoT Edge



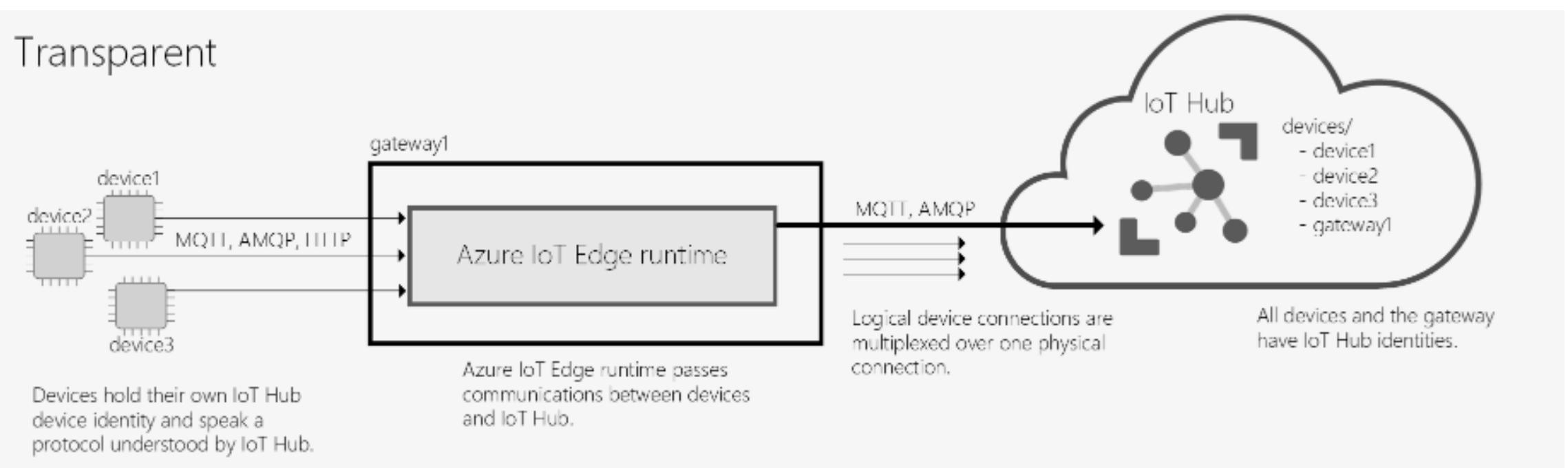
Azure IoT Edge

Gateway Patterns

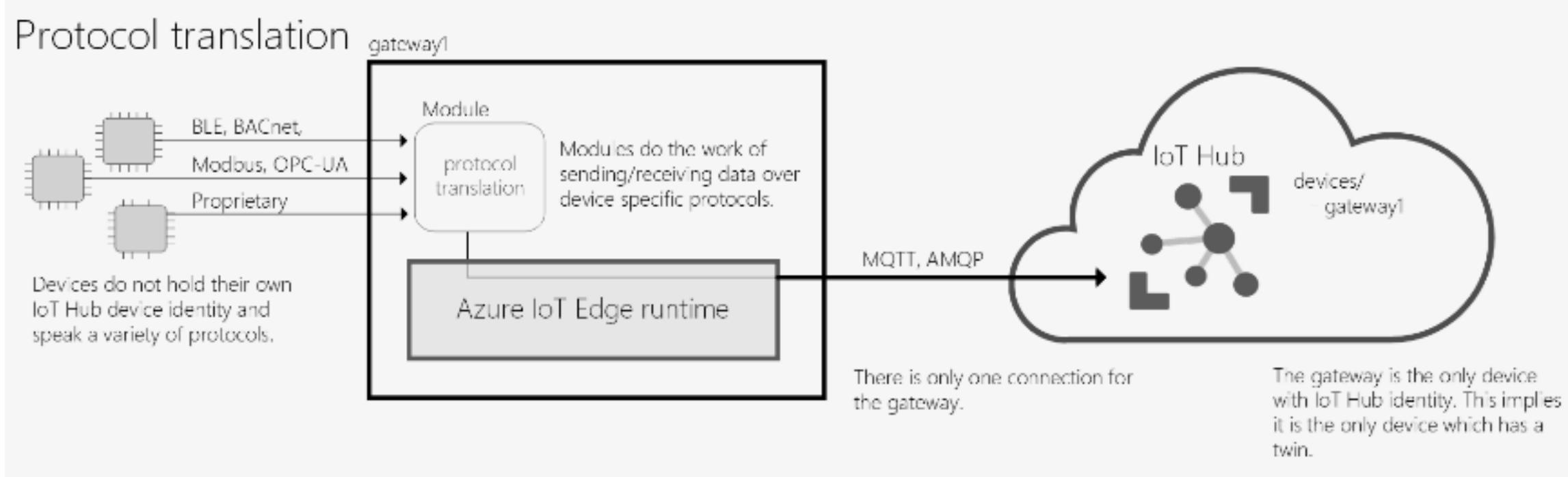
Azure IoT Hub Scenario's



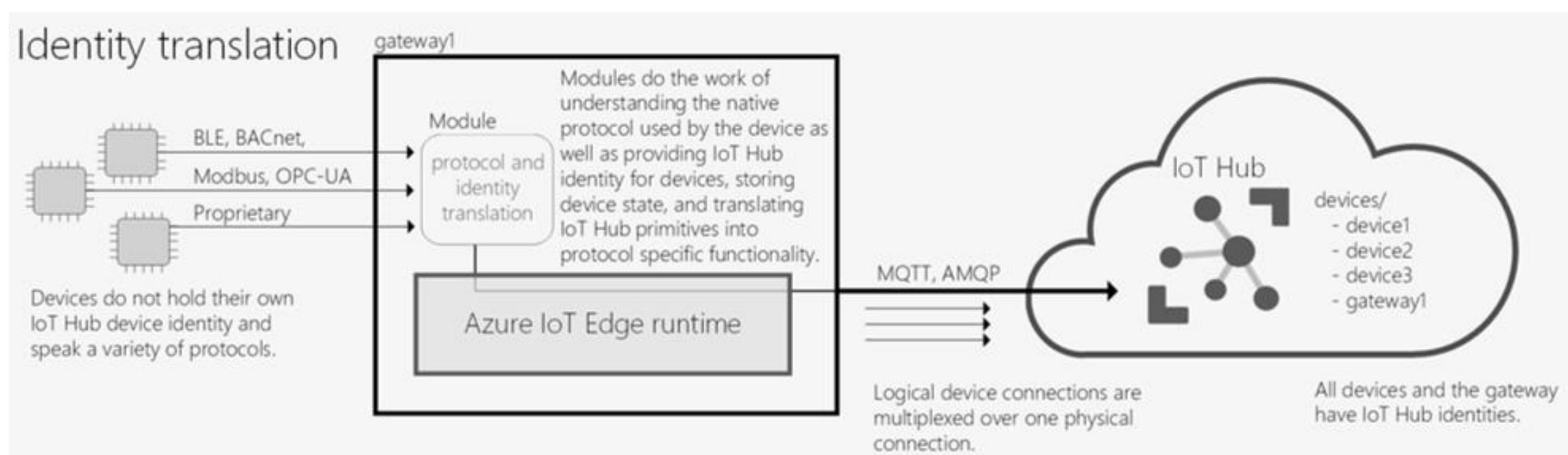
Transparent Gateway



Protocol Translation



Identity Translation



Pattern Comparison

	Transparent gateway	Protocol translation	Identity translation
Identities stored in the IoT Hub identity registry	Identities of all connected devices	Only the identity of the gateway device	Identities of all connected devices
Device twin	Each connected device has its own device twin	Only the gateway has a device and module twins	Each connected device has its own device twin
Direct methods and cloud-to-device messages	The cloud can address each connected device individually	The cloud can only address the gateway device	The cloud can address each connected device individually
IoT Hub throttles and quotas	Apply to each device	Apply to the gateway device	Apply to each device

DEMO

Azure IoT Edge

Azure Digital Twins

The future of IoT



TODAY
Connected Assets



EMERGING
Connected Environments



FUTURE
Connected Ecosystems





Azure Digital Twins

Creating next gen IoT solutions
that model the real world.

- Open Modeling Language
- Live Execution Environment
- Input from IoT and Business Systems
- Output to Time Series Insights, Storage & Analytics

Open Modelling Language

- “Digital Twins Definition Language”
- Describe your digital twin via
 - Properties
 - Telemetry
 - Components
 - Relationships
- Create a graph via relationships
- Digital Twins Definition Language is aligned with
 - IoT Plug and Play
 - Time Series Insights data model

Live Execution Environment

- Twin Instances and Relationships for a Graph of the environment
- Visualization possible via the “Azure Digital Twin Explorer”
- Eventing & Data processing system via external compute
- Query API
- Input via IoT Hub & other data sources

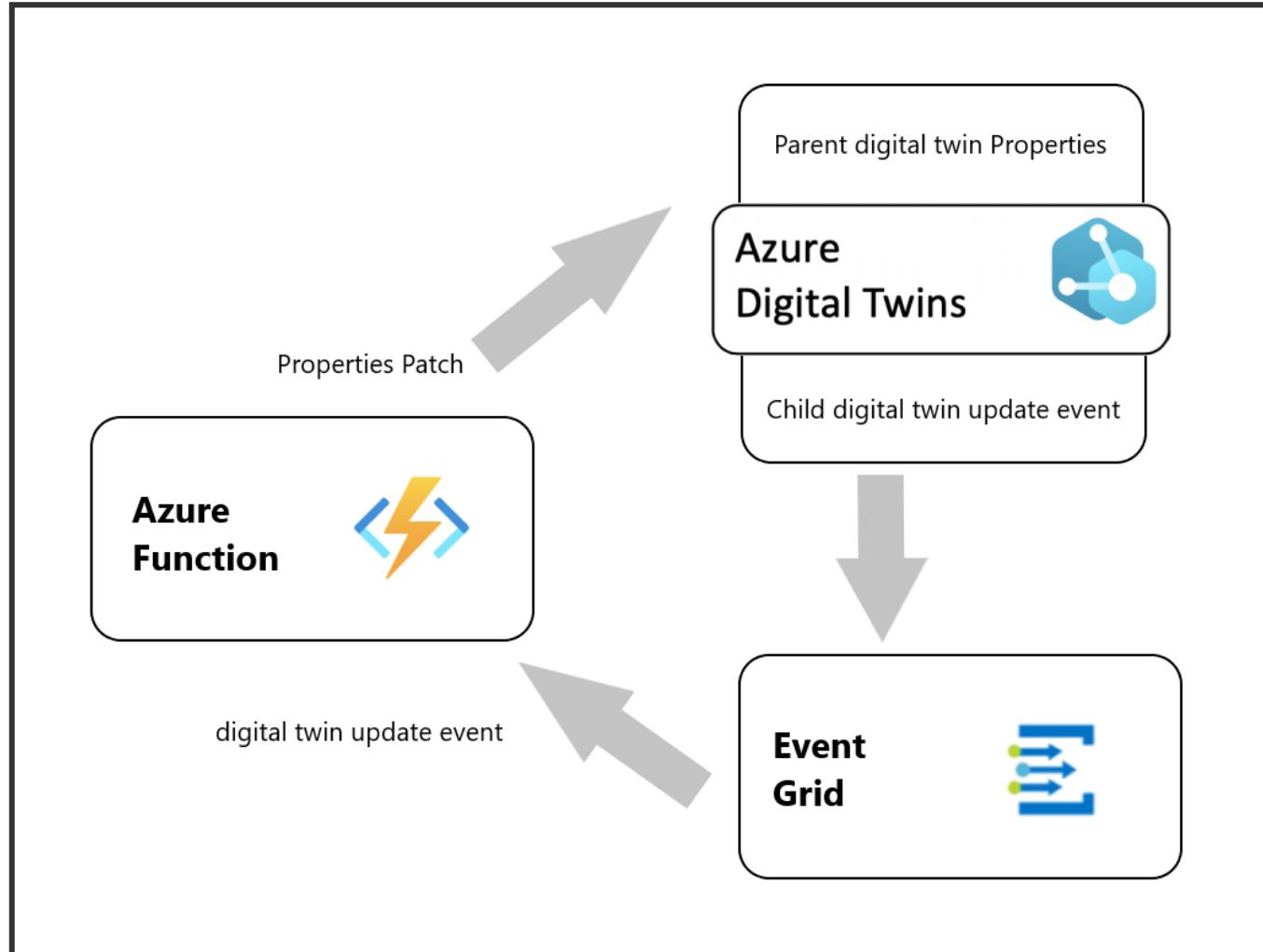
Storage and Analytics

- Routes via EventHub, EventGrid or Service Bus
- Routes & Endpoints allow for different scenarios
 - Store data in Azure Data Lake
 - Connect to Logic Apps
 - Connect to Time Series Insights for historical series of nodes

ADT uses digital twin change notification events as a trigger to route data to an ADT endpoint.

An Event Grid endpoint is used to transfer the digital twin change notification message, such as a twin update, to an Azure Function.

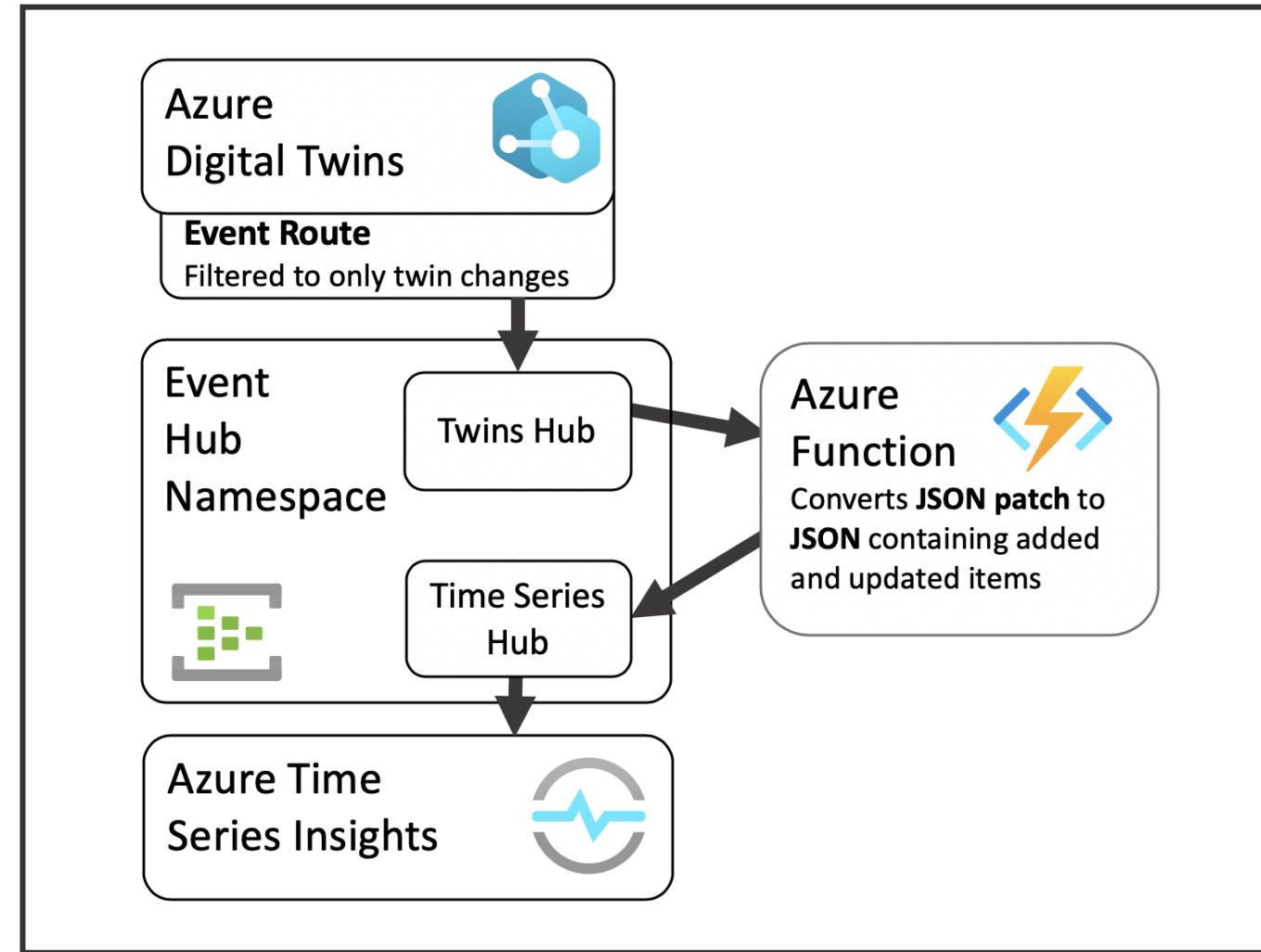
An Azure Function extracts data from the notification header and body and uses that data to get additional information from ADT, such as finding a parent digital twin. The function then performs the required action.



ADT streams data to downstream services by routing events through an Event Hubs Namespace

The Event Hubs Namespace will include an Event Hub that receives events from ADT and an Event Hub that feeds events to the downstream service. An Azure Function is used to prepare message data and apply event formatting that is appropriate for the downstream service

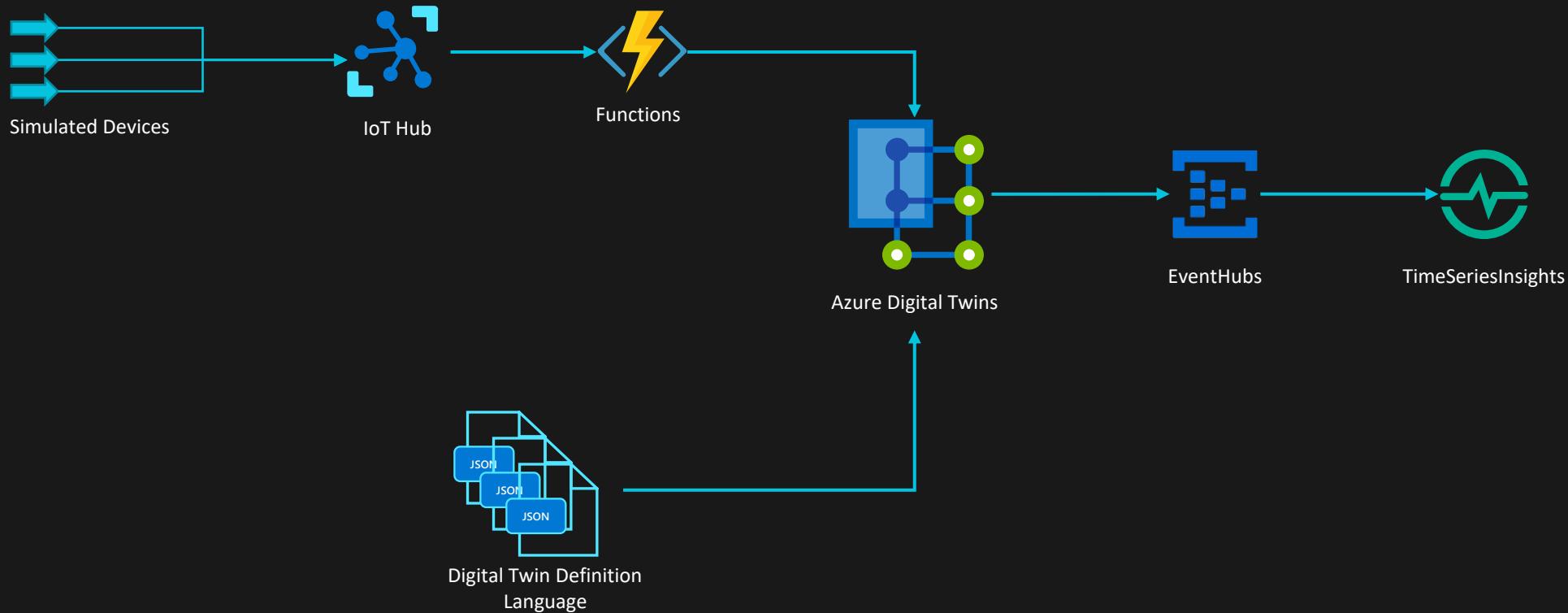
A downstream service, such as Time Series Insights, consumes the events from the second Event Hub



DEMO

Azure Digital Twins

DEMO

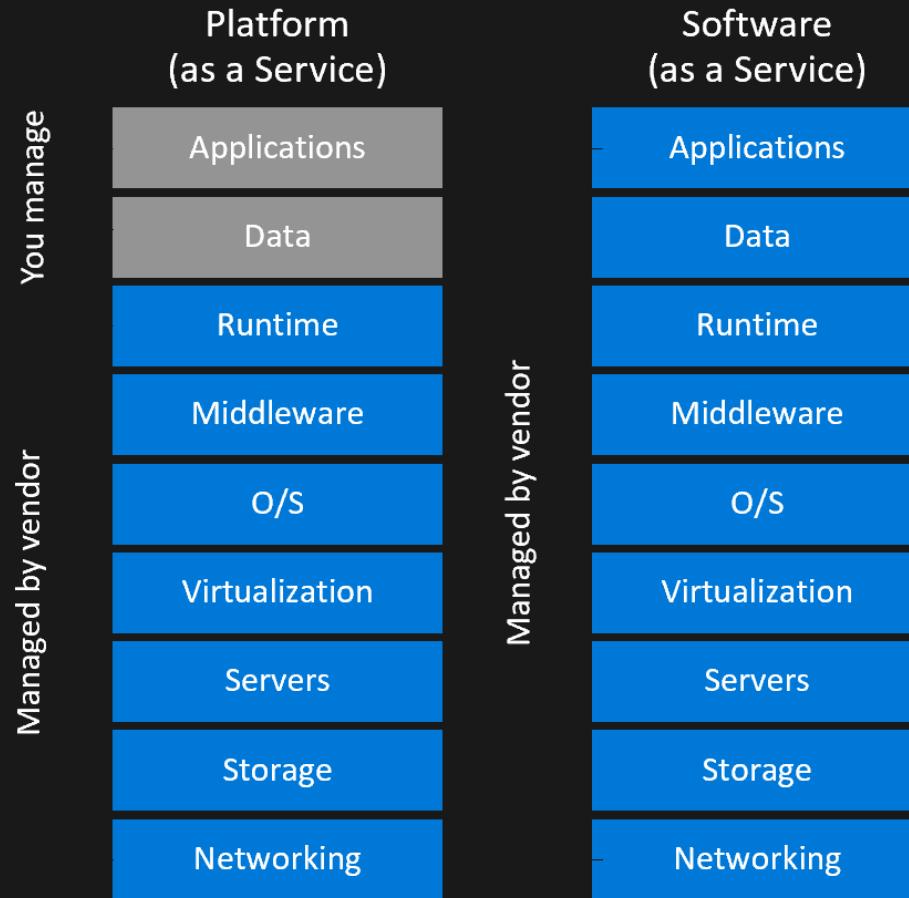


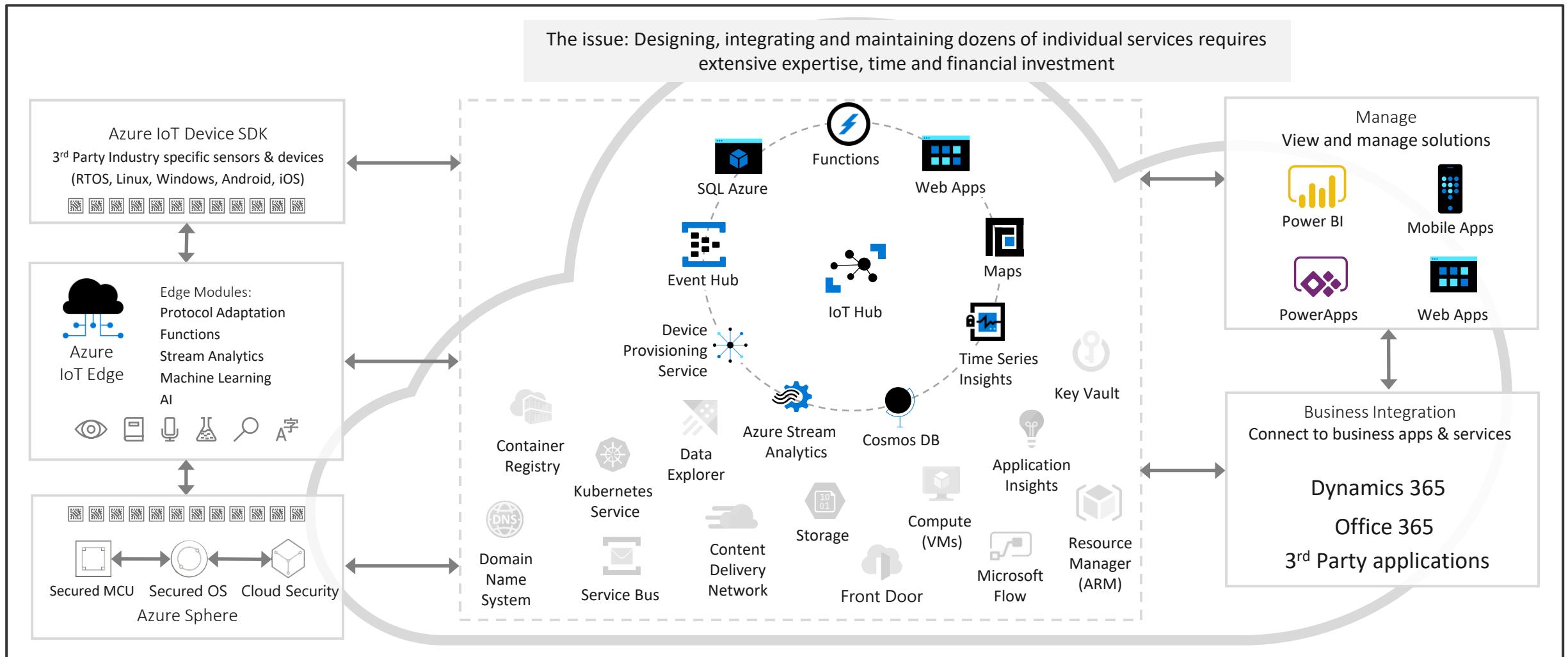
Azure IoT Central

Building IoT Solutions with Azure IoT Central



Your options for building IoT Solutions

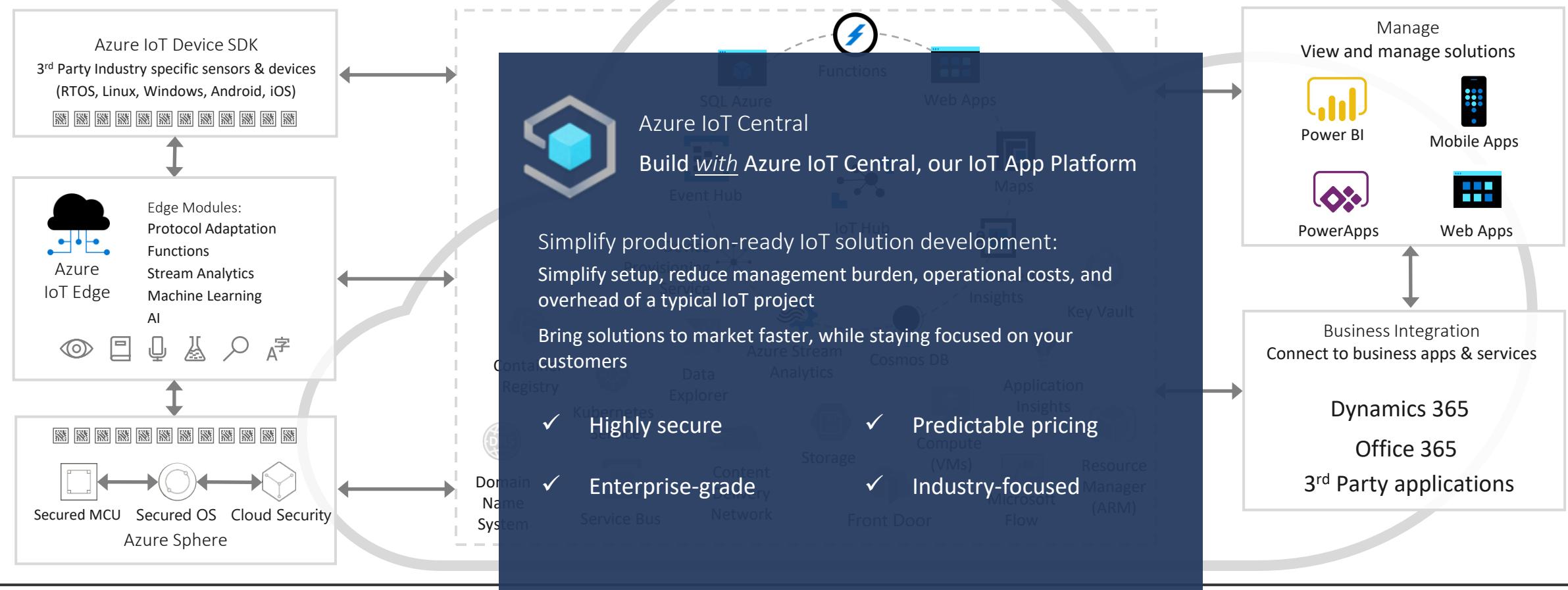




Azure Security Center for IoT

- Integrated view for CISO & SecOps personas to review enterprise security posture, including IoT solutions
- Holistic view of IoT solution security posture for DevOps and IoT solution managers to review and manage day to day security status

The issue: Designing, integrating and maintaining dozens of individual services requires extensive expertise, time and financial investment



Azure Security
Center for IoT

- Integrated view for CISO & SecOps personas to review enterprise security posture, including IoT solutions
- Holistic view of IoT solution security posture for DevOps and IoT solution managers to review and manage day to day security status

Azure IoT Central

A fully managed IoT app platform that reduces the burden of building and maintaining IoT solutions

✓ 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

Azure IoT Central



App templates
for Industry
Verticals



White labeling
your SaaS – your
brand



Azure IoT Edge
support



API
support



IoT Plug and
Play support



New 2-tiered
pricing model

First 2 devices included
(tiered message rates apply)



free

Tier 1

5,000 messages/month/device



additional devices: \$0.40 (USD) ea.

Tier 2

30,000 messages/month/device



additional devices: \$0.70 (USD) ea.

IoT Central Concepts



Connecting Devices:

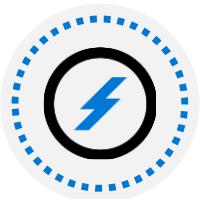
Connect a single device

Connect devices at scale using SAS/X.509

Connect without registering devices

Individual enrolment-based device connectivity

Device Status



Data:

Continuous data export

Full message data

Near-real time for Event Hubs and Service Bus

IoT Central Concepts



Device templates – blueprints for a device:

Device capability model – telemetry, properties, and commands for the device

Cloud properties – IoT Central properties not shared with the device

Customizations – allow overriding some of the capability model for an individual device such as property names

Rules – monitoring workflows and actions



Dashboards:

Enable operators to visualize devices

Includes charts and metrics

DEMO

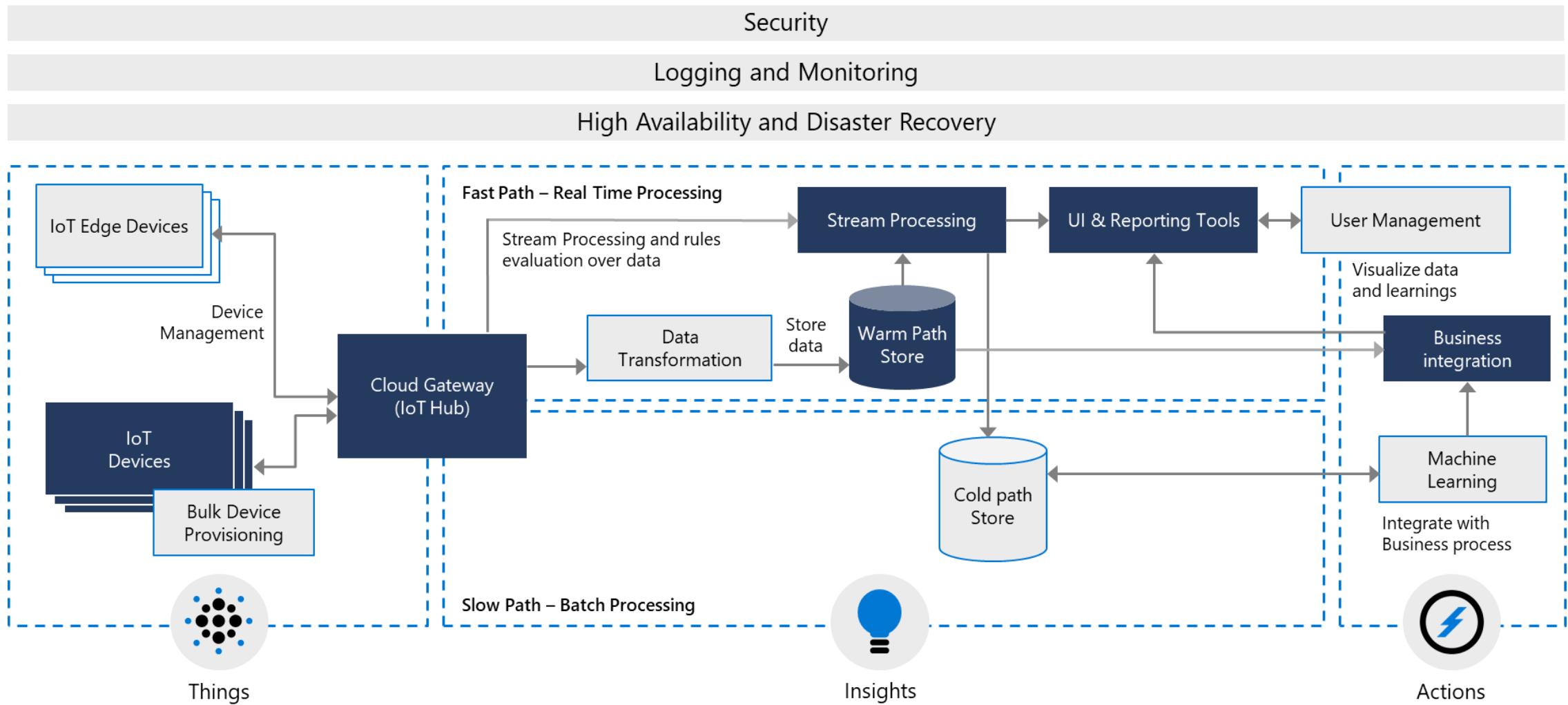
Azure IoT Central

<https://apps.azureiotcentral.com/>

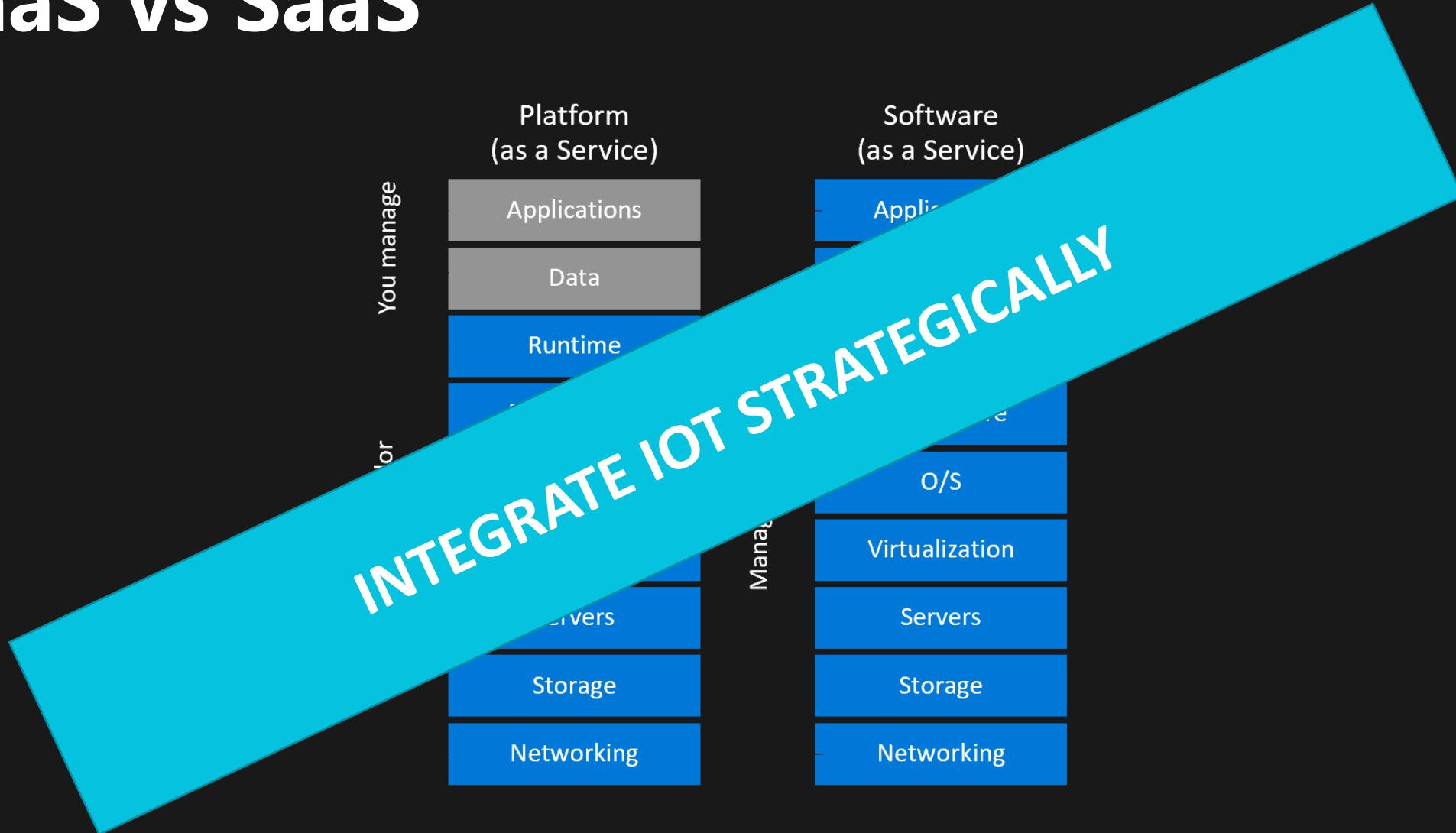
RECAP

So what did we learn the last 2 days...

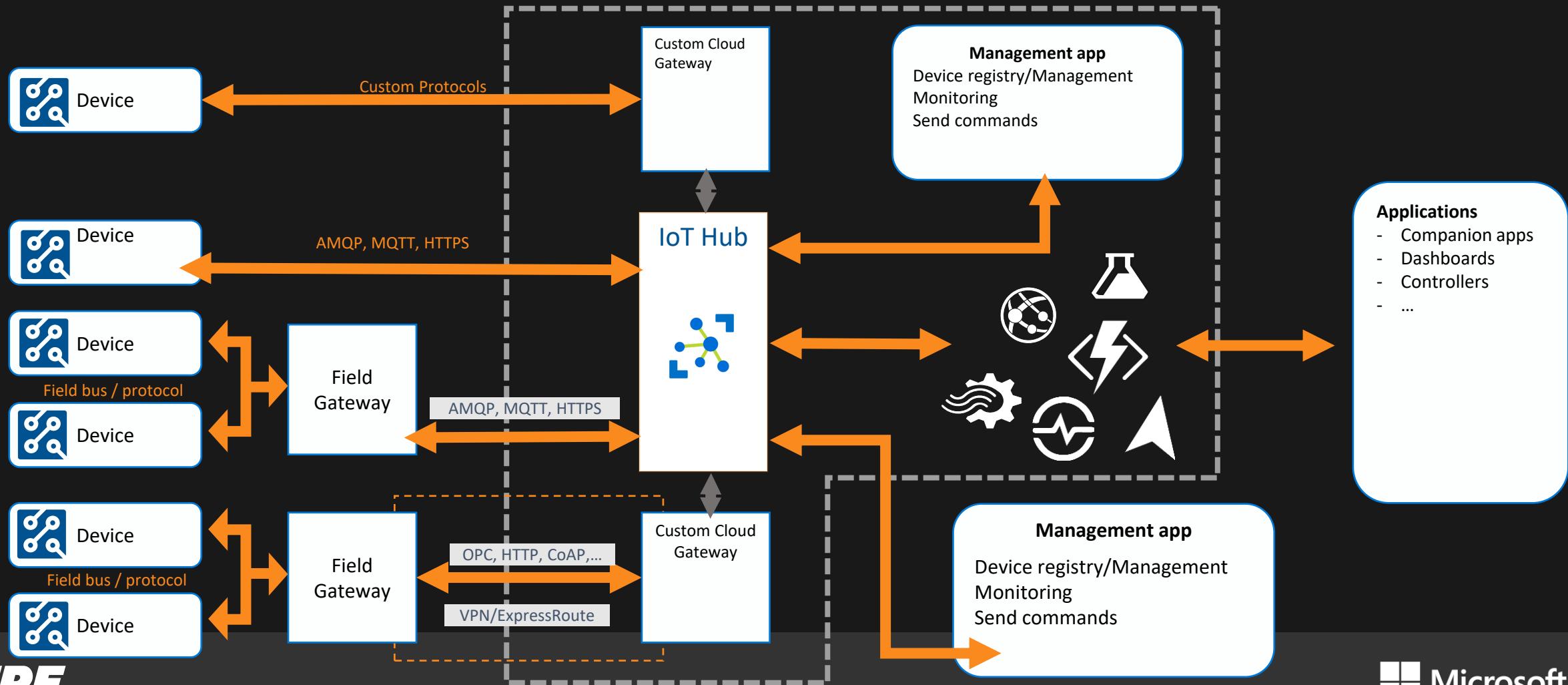
Cross-cutting architectural needs



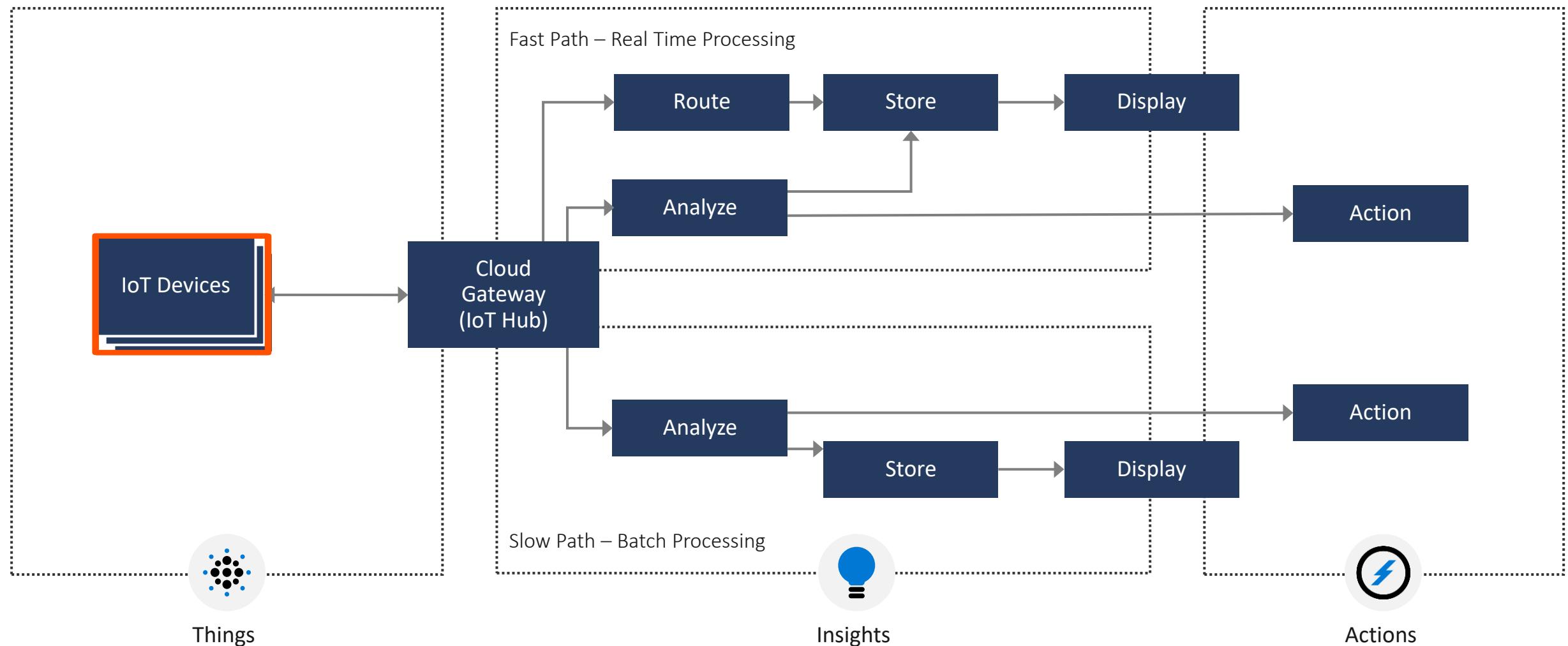
PaaS vs SaaS



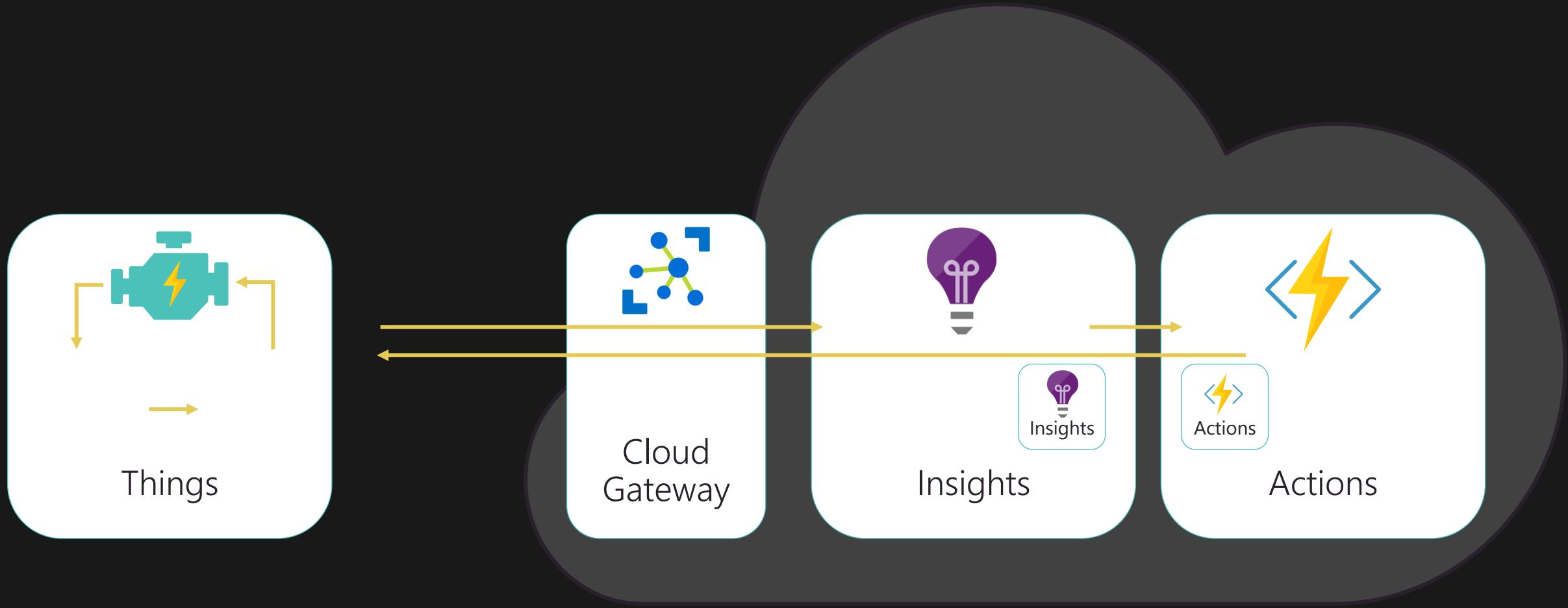
Azure IoT Hub Scenario's



Lambda Architecture



IoT Pattern + Edge





TODAY
Connected Assets



EMERGING
Connected Environments



FUTURE
Connected Ecosystems



Survey Time 😊

<https://zure.ly/msftiottrainingsurvey>



Glenn Colpaert

Questions after the training?
Reach out, happy to help!

glenncolpaert@zure.com



Microsoft®
Most Valuable
Professional



@GlennColpaert



github.com/GlennColpaert

The logo consists of the word "ZURE" in a bold, white, sans-serif font. A diagonal white line starts from the top left of the letter "Z" and extends towards the top right, passing through the top of the letter "U".

ZURE