



Microsoft IoT Hackster LIVE 2017
Azure IoT for the Enterprise Maker

Beyond the Device

Kent Stroker
Senior IoT/Cloud Consultant/Evangelist

Microsoft, PDS IoT Team
stkent@microsoft.com

Kent Stroker Bio

- Microsoft – Cloud/IoT Consultant and Evangelist
 - IBM – Open Source Analytics and Cloud Data Services Evangelist for IoT
 - Boeing – DBaaS Cloud Architect and Database Technical Lead
 - Raytheon, Dell, Mythics, Oracle – Database Architecture and Operations
 - Ran my own consultancy (twice); worked for many providers
- Worked with Azure, AWS, Bluemix, VMware, OpenStack
- First Computer Exposure - IBM Mainframe 360
- First PC and OS – DEC Rainbow and CP/M
- First Databases - IMS, PICK, Oracle v3, Dbase
- Rochester Institute of Technology
- US Navy Electronics Technician
- IoT/Tech Junkie and Foodie
 - Studied pastry and active in food science (think liquid nitrogen)...



Sponsors

- Microsoft
 - Kent Stroker, Speaker and IoT Evangelist
 - Support for Hackster.io
 - Renewed focus on enterprise maker community
- Hackster.io
 - Organizes these Live events
 - Coordinates with local user groups
- Show some love please...
 - Twitter
 - @Azure
 - @MictrosoftIoT
 - @Hackster.io
 - @kentstroker
 - Linkedin



Agenda

- Kick Off
- IoT Hub
 - Lab One – IoT Hub and Devices
- Persistence
 - Lab Two – Store to Database
- Visualization
 - Lab Three – Visualize data in a web application
- Wrap Up

House Etiquette Rules

- Silence ringer and turn off vibration on mobile phones
- It is fine to stand at back and sides of room
- Let us have one conversation
- There will be no planned breaks
 - So please plan on using restroom during lab time
- In an emergency
 - Please gather out front so we may get a head count and ensure everyone got out safely

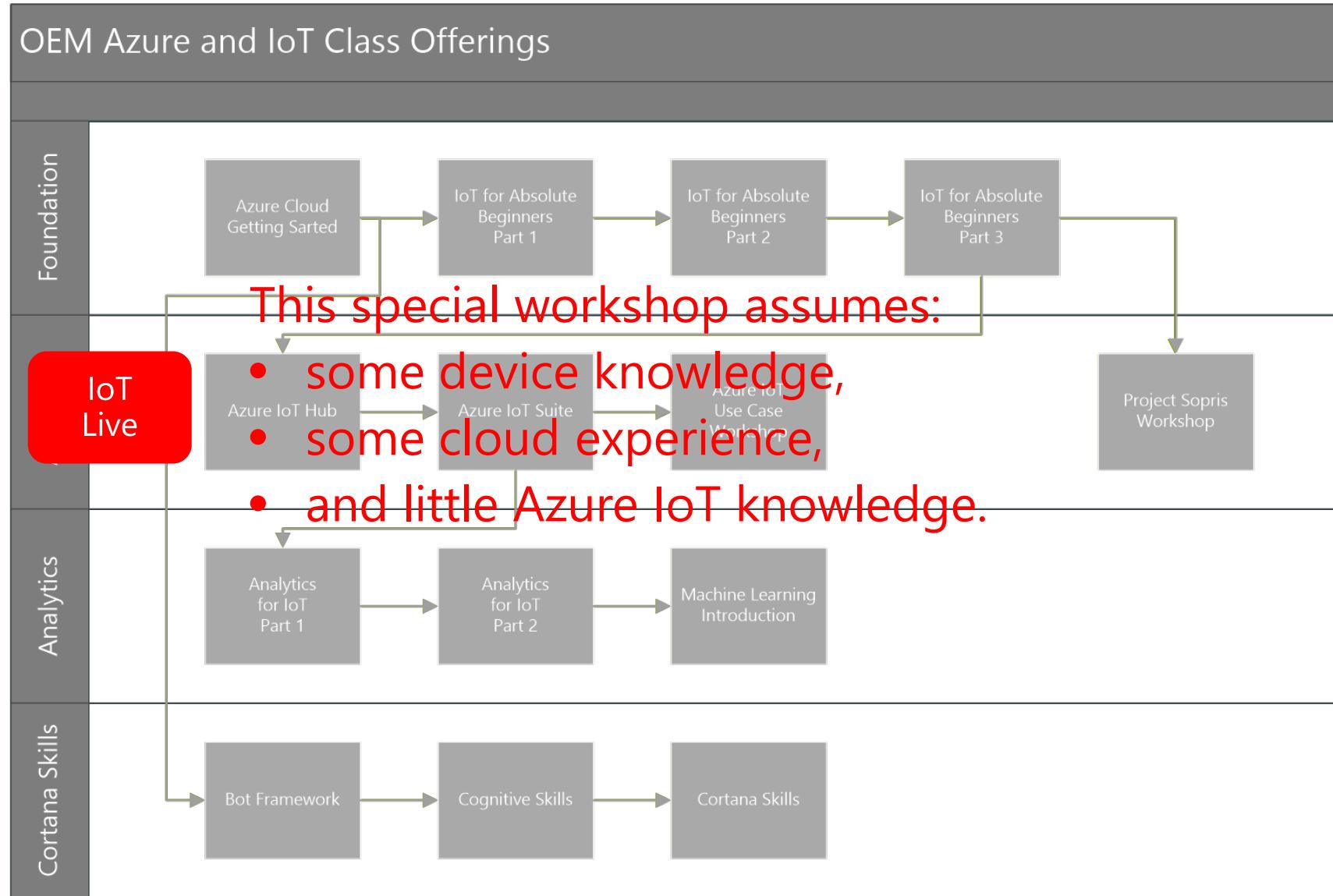
What You Will Work with Today

- Microsoft Azure
- Azure IoT Hub
 - Using simulated devices to drive data stream to the hub
- Azure Table Store
 - Key-Value/NoSQL storage/database for storing messages from the hub
- Microsoft Azure Storage Manager
- Azure Functions
 - Serverless computing, reactive trigger mechanism
- Azure Web Apps
 - Visualize data in a simple JavaScript web server
- Visual Studio 2017
 - Direct push code to Azure web services

Are you ready?

- Downloaded the GitHub lab materials?
 - <https://github.com/kentstroker>
- Laptop software installed?
- Got solid Wi-Fi connection?
- Azure account working?

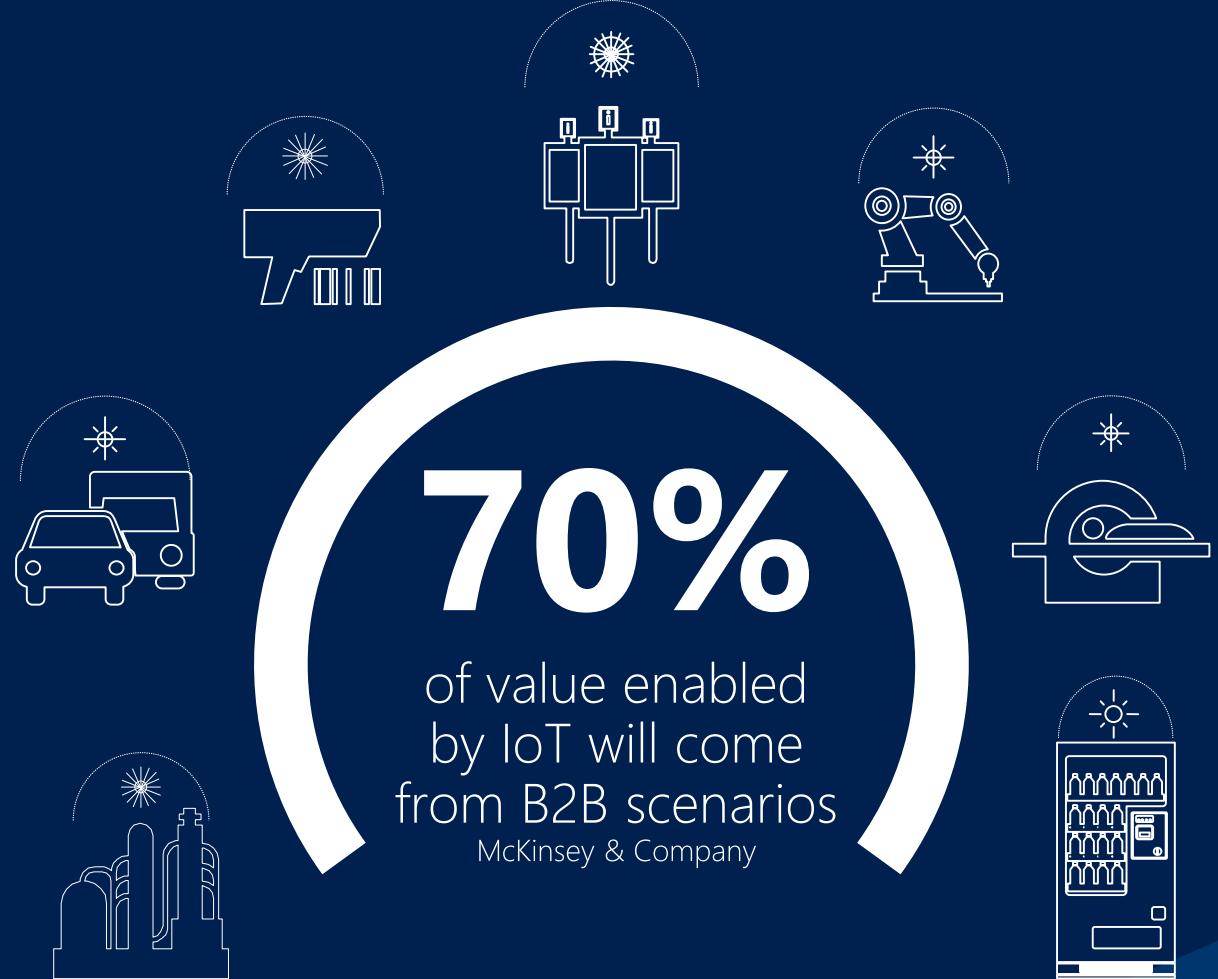
Microsoft IoT Workshops



What is the Internet of Things (IoT)?



Internet of Things Future

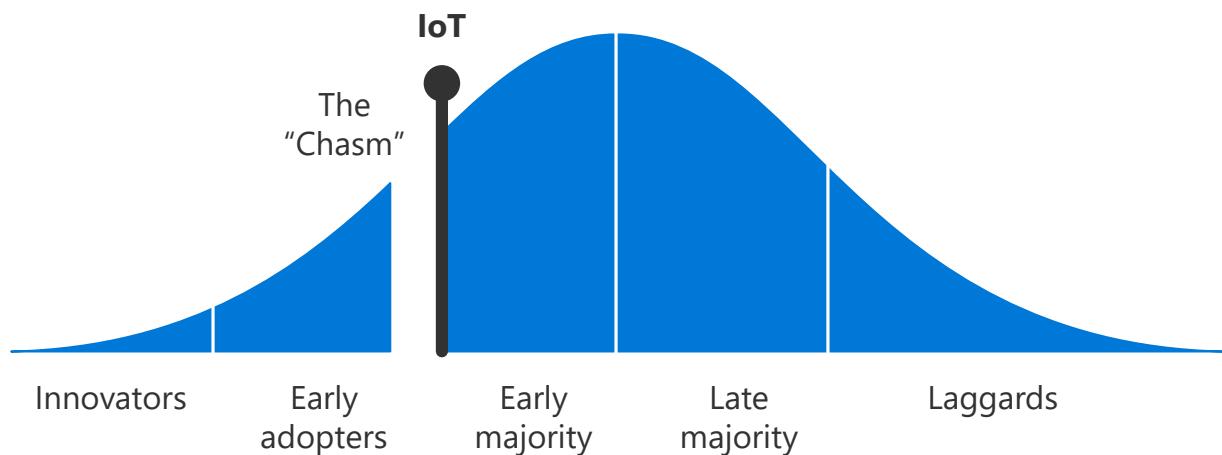


25 billion
Connected "things" by 2020
—Gartner

\$1.7 trillion
Market for IoT by 2020
—IDC

IoT means business model change

IoT is no longer just for early adopters



Change offers tremendous opportunity



\$130B

New monetization avenues due to IoT-related services



40%

Top 100 manufacturers will provide product-as-a-service by 2018



80%

Companies that increased revenue as a result of IoT implementation

What is the Cloud?

Cloud computing, also on-demand computing, is a kind of Internet-based computing that provides shared processing resources and data to computers and other devices on demand.

- Infrastructure as a Service
- Platform as a Service
- Software as a Service



Official Definition

NIST Publication 800-145

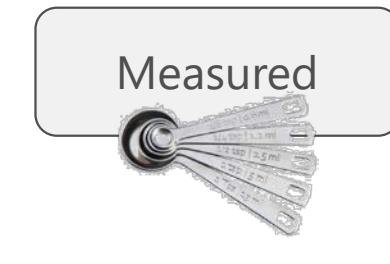
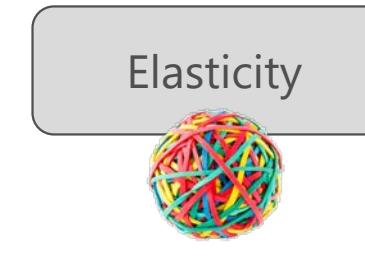
- **Essential Characteristics**
 - On-Demand Self-Service
 - Broad Network Access
 - Resource Pooling
 - Rapid Elasticity
 - Measured Service
- **Service Models**
 - Software as a Service (SaaS)
 - Platform as a Service (PaaS)
 - Infrastructure as a Service (IaaS)

- **Deployment Models**
 - Private Cloud
 - Public Cloud
 - Hybrid Cloud
 - Community Cloud



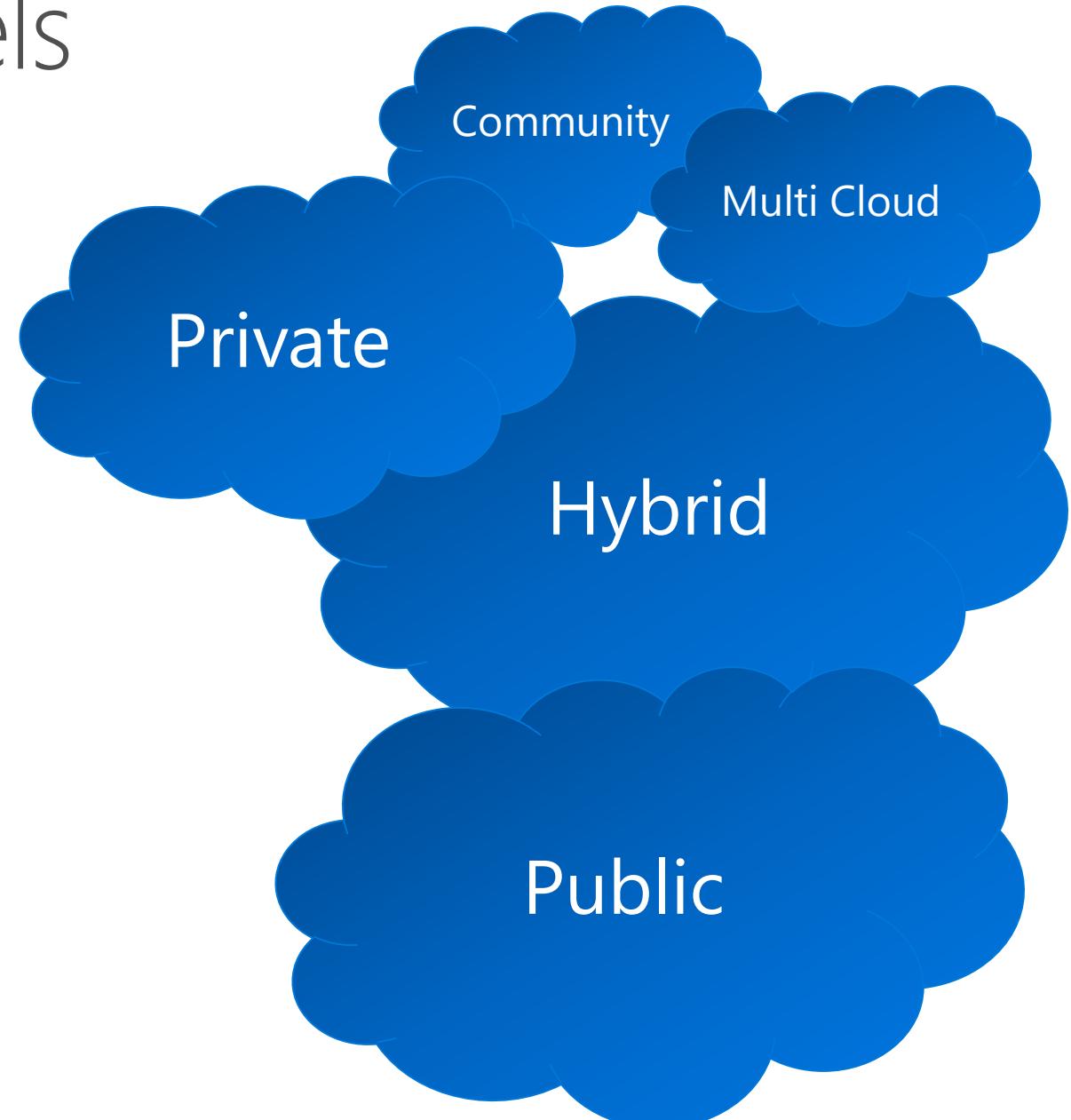
Essential Characteristics of Cloud

- On-Demand Self-Service
 - Ability to provision capabilities as without requiring human intervention
- Broad Network Access
 - Access is available over public or private network using different type of clients (e.g.,workstation, laptop, tablet, smartphone)
- Resource Pooling
 - Resources are pooled such as storage, processing, memory and bandwidth
- Rapid Elasticity
 - Resources may be scaled up or down elastically using automated process
- Measured Service
 - a metering capability at some level of abstraction appropriate to the service

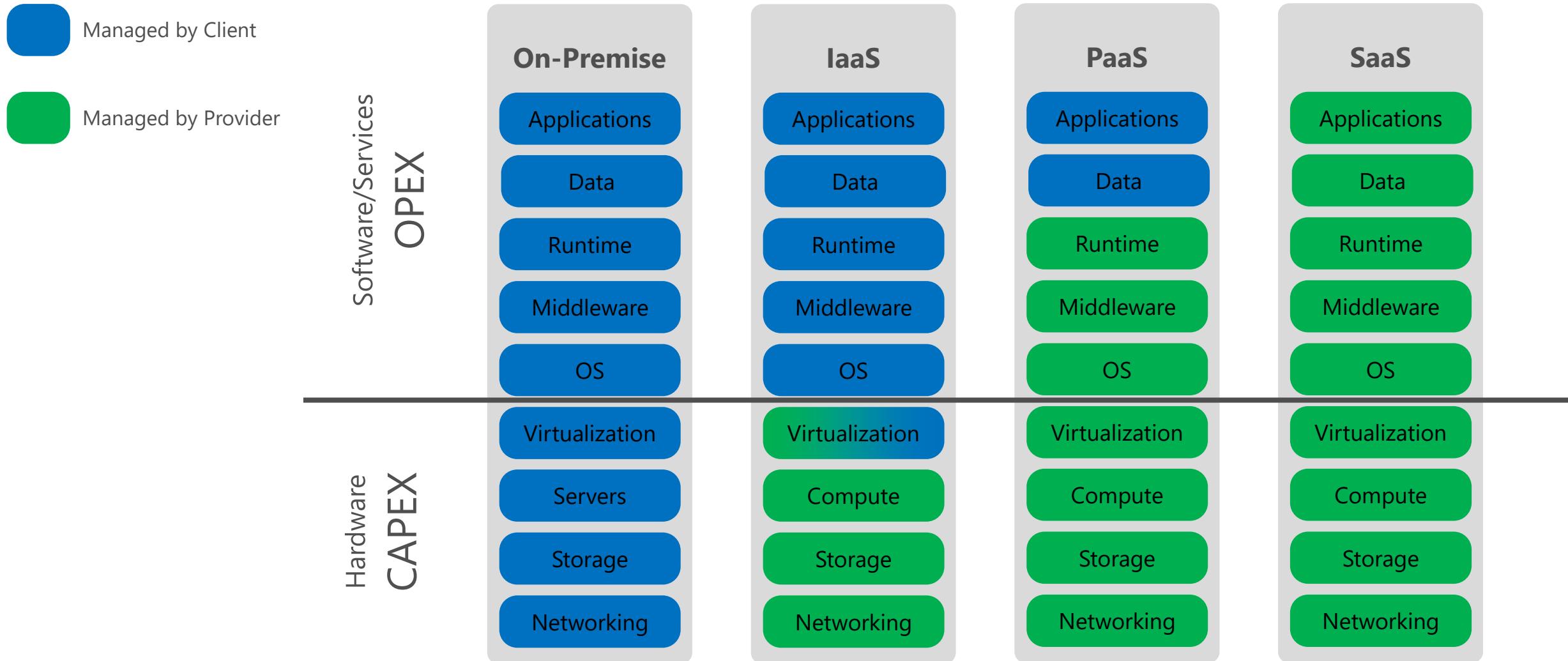


Cloud Deployment Models

- **Private Cloud**
 - A cloud dedicated for sole use and resides either on-premises or off-premises that is Client-managed or Provider-managed.
- **Public Cloud**
 - When the cloud is off-premises and resources may be shared between clients. Hundreds to thousands of clients with controls to enforce isolation between client's data and resources.
- **Hybrid Cloud**
 - A combination of Public and Private clouds.
- **Community Cloud**
 - Multi-tenant cloud shared by several organizations from a group. Health care and government favor using this cloud type.
- **Multi Cloud**



Who Does What?



Cloud explained using cake

- Cake IaaS
 - Buy a “cake provider”
 - Add extra things and work
- Cake Providers
 - Duncan Hines Cake Provider
 - Azure
 - Pillsbury Cake Provider
 - AWS
 - Betty Crocker Cake Provider
 - Google

**You still have to do all the work,
using your own tools and skill!**



Cloud explained using cake

- Cake IaaS + Frosting PaaS

- Already have the IaaS cake
 - You had to bake the cake
 - You have to frost the cake
- Just add Frosting PaaS
 - Already made, just use "as-is"



- Cake PaaS

- Purchase a pre-built cake
 - Bakery did "the work"
 - You have limited control
 - Must choose from a menu
- Cake AND Icing Template



Cloud explained using cake

- **Cake as a Service**

- Pay for only what you eat
 - 1 slice, 2 slice or more
- Full-service at the table
 - Plate, fork and napkin “framework”
- Fully integrated coffee
 - Optional other SaaS services are easy



Who is responsible for cake security?

- For a cake you baked (IaaS) or one you bought (PaaS), who is responsible for the safe guarding of the cake?



**The customer bears ultimate responsibility
for security, not the provider.**

Seriously, you gonna call Duncan Hines Help Line and expect them to replace the cake you baked and did not secure?!?

Shared Responsibilities for Cloud Computing

- Azure provides services that can help customers meet the security, privacy, and compliance needs.
- There are shared roles and responsibilities an organization needs to consider when selecting a cloud model, such as IaaS, PaaS, and SaaS
 - It is essential to explore how different cloud service models will affect cost, ease of use, privacy, security and compliance
 - **All too often customers mistakenly assume that after moving to the cloud their role in securing their data shifts most security and compliance responsibilities to the cloud provider.**

Responsibility	On-Prem	IaaS	PaaS	SaaS
Data classification & accountability	Cloud Customer	Cloud Customer	Cloud Customer	Cloud Customer
Client & end-point protection	Cloud Customer	Cloud Customer	Cloud Customer	Cloud Provider
Identity & access management	Cloud Customer	Cloud Customer	Cloud Provider	Cloud Provider
Application level controls	Cloud Customer	Cloud Customer	Cloud Provider	Cloud Provider
Network controls	Cloud Customer	Cloud Provider	Cloud Provider	Cloud Provider
Host infrastructure	Cloud Customer	Cloud Provider	Cloud Provider	Cloud Provider
Physical security	Cloud Customer	Cloud Provider	Cloud Provider	Cloud Provider

<https://aka.ms/sharedresponsibility>

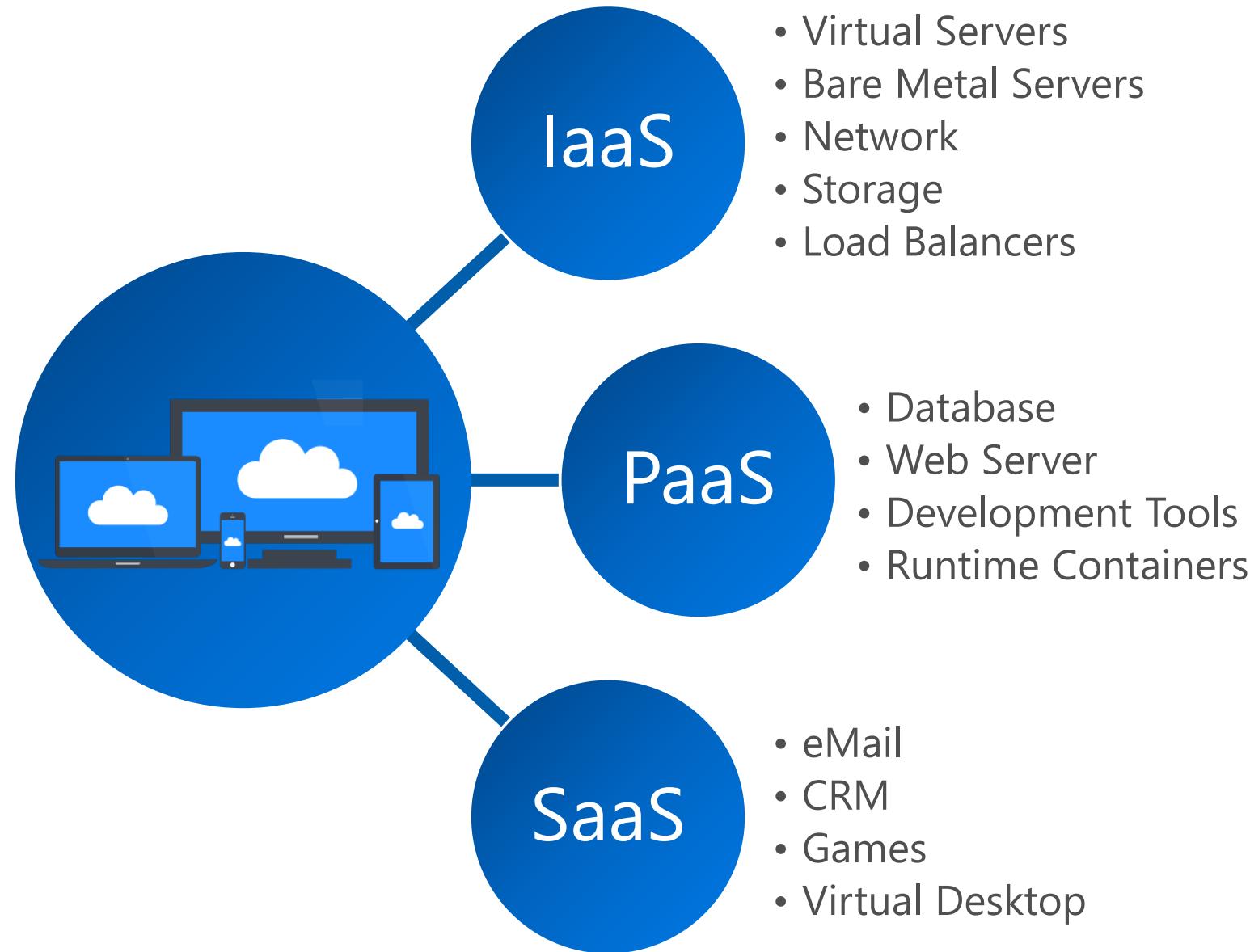
Azure Security and the Trust Center

- Most comprehensive compliance coverage of any cloud provider
 - More certifications than any other cloud provider
 - Industry leader for customer advocacy and privacy protection
 - Unique data residency guarantees

<https://azure.microsoft.com/en-us/support/trust-center/>

<https://www.microsoft.com/en-us/trustcenter>

Cloud Service Models



Microsoft Cloud

Office 365

Dynamics

Secure
Productive
Enterprise &
Operations
Management +
Security

Cortana
Intelligence
Suite

Azure

PRODUCTIVITY

BUSINESS
APPS

SECURITY &
MANAGEMENT

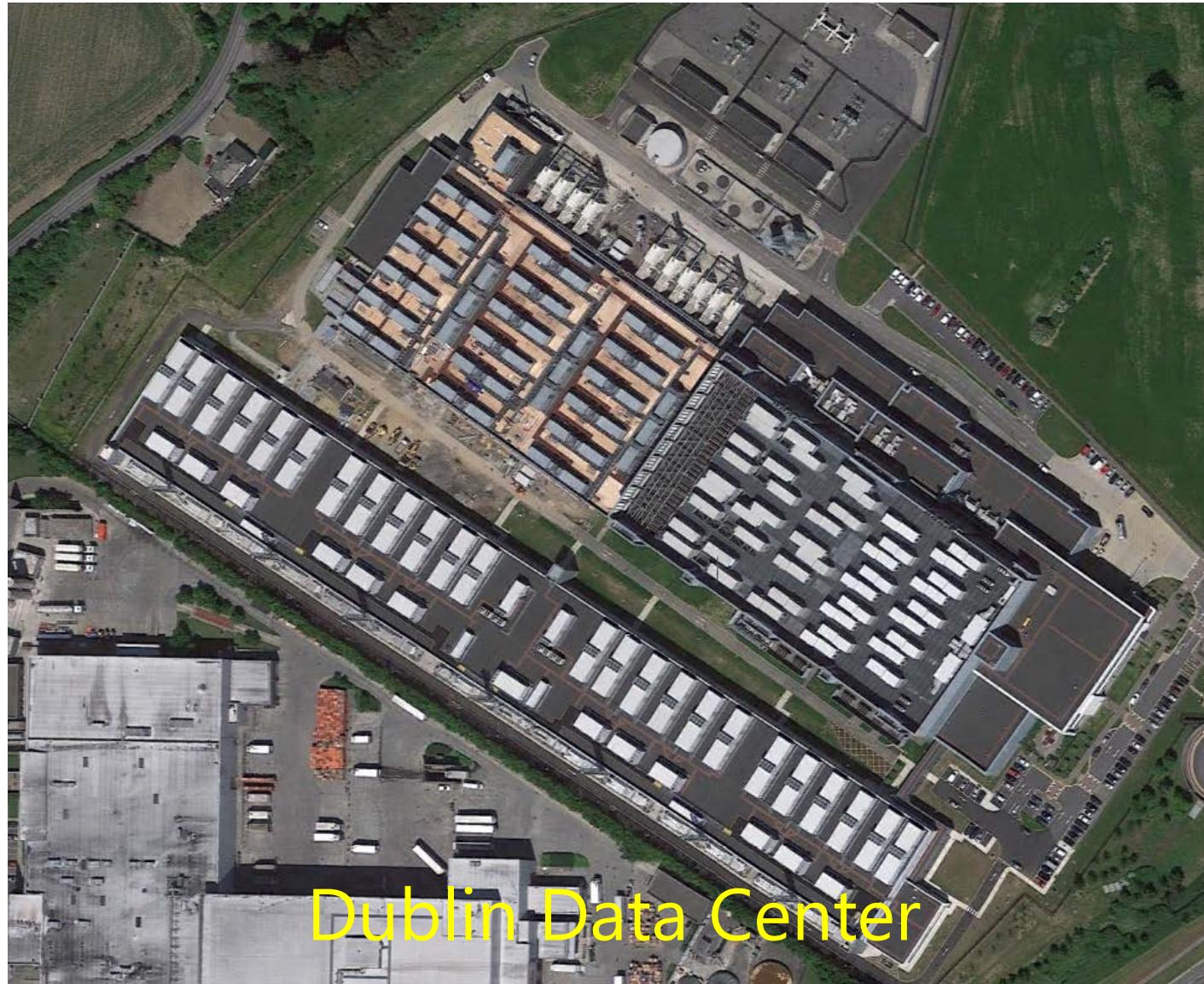
DATA &
INTELLIGENCE

APPLICATION
INNOVATION

Azure – Global View



Azure – Satellite View (53°19'28.7N, 6°27'17.2W)



Azure – Helicopter View



Azure – Street View



Azure – Inside Building View



Modular Containers



Servers



Network



A lot of Pipe



Some Cooling



Aux Power

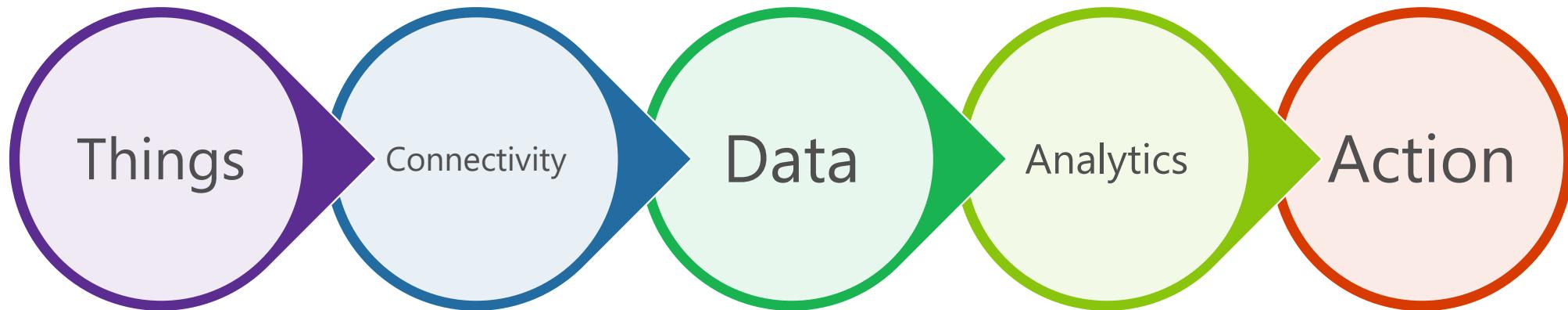
Exploring new delivery points



Azure – Portal View

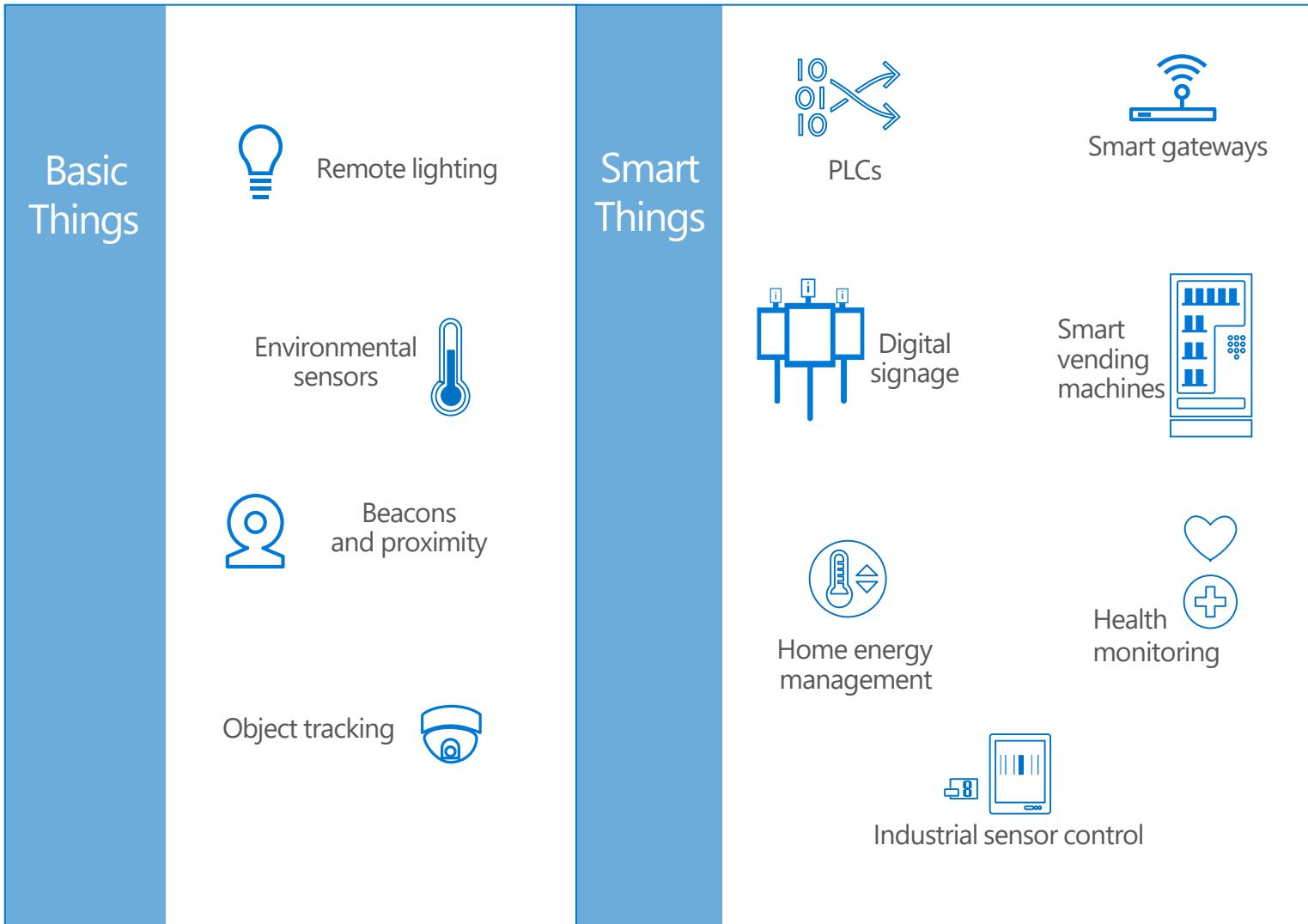
The screenshot shows the Microsoft Azure portal interface. The top navigation bar includes a back/forward button, refresh, search, and account information for stkent@microsoft.com. The main dashboard features a sidebar with a 'New' button and a list of services: Dashboard, All resources, Resource groups, App Services, SQL databases, SQL data warehouses, Azure Cosmos DB, Virtual machines, Load balancers, Storage accounts, Virtual networks, Azure Active Directory, Monitor, Advisor, Security Center, and Billing. The main content area displays 'All resources ALL SUBSCRIPTIONS' with a list of resources including stroksa01 (Storage account), stroker-iohub (IoT Hub), 611782westus2 (Storage account), yfid-cosmos-01 (Azure Cosmos DB account), yfid-public-sqldb-01 (SQL database), yfid-static-01-nsg (Network security group), yfid-static-01-ip (Public IP address), kentfunctiondemo (App Service), and SouthCentralUSPlan (App Service plan). Below this is an 'Azure Health MY RESOURCES' section showing a world map with green status indicators. To the right, there is a 'Quickstart tutorials' section with links to Windows Virtual Machines, Linux Virtual Machines, App Service, Functions, and SQL Database, along with a 'Marketplace' link.

Pillars of IoT

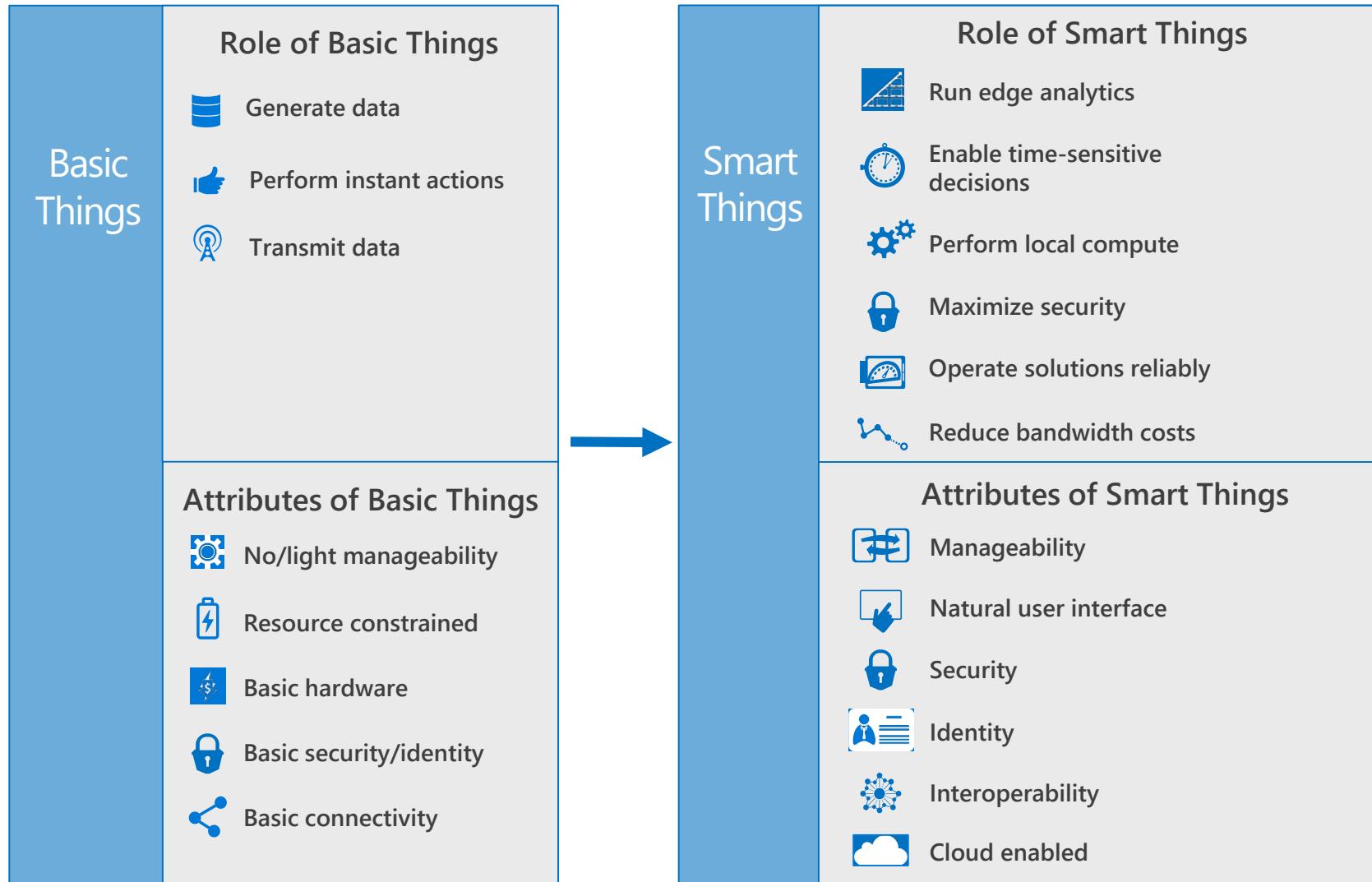


- The “Thing” is only 20% of the solution
 - Often, far too much emphasis and the “thing”, not the “solution”
 - If you’re not doing analytics; you’re not doing IoT
 - Device level engineers often miss the “big picture”
 - Success comes from device engineers working with back-end cloud architects, business analysts and data scientists

Things



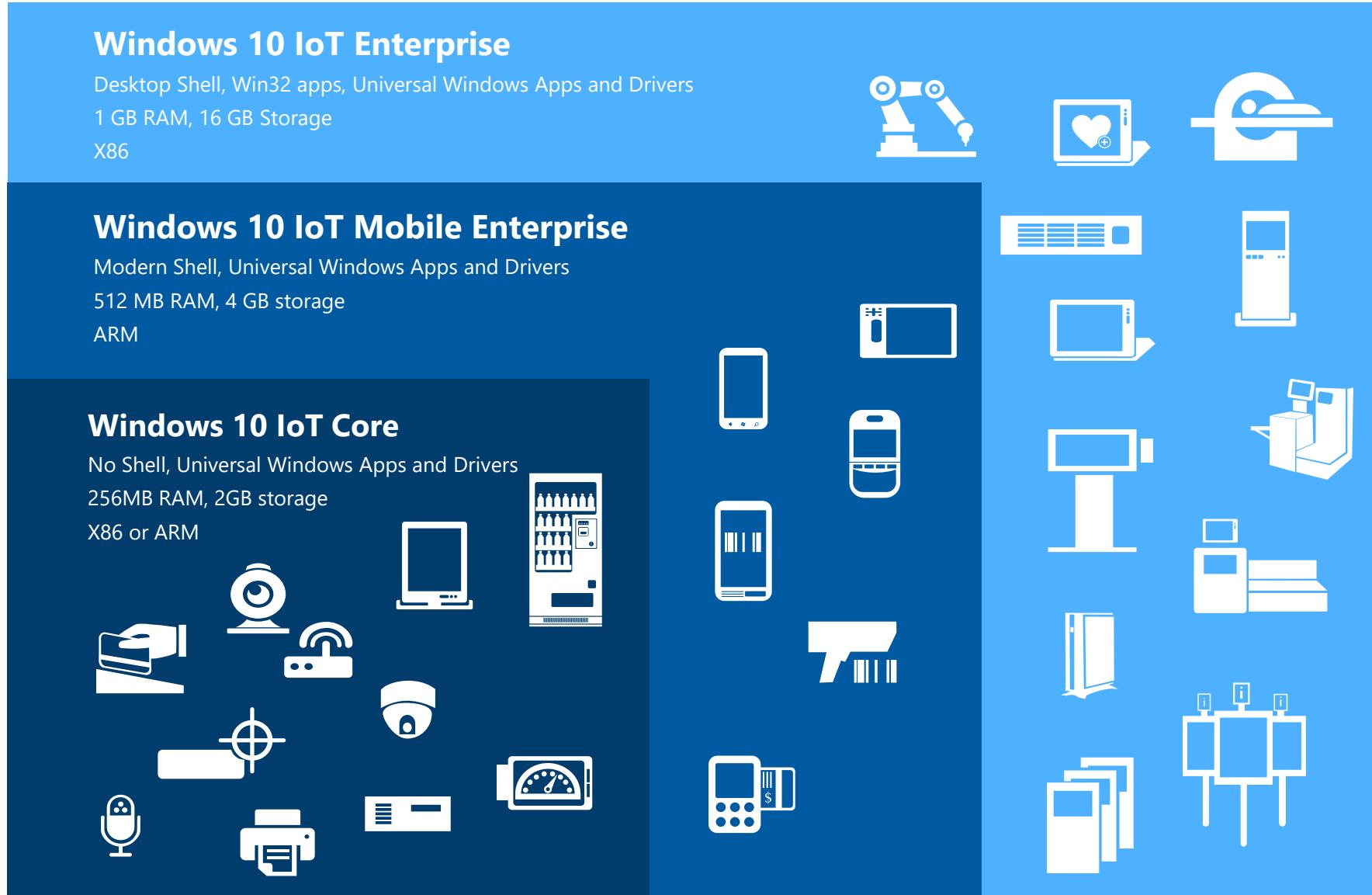
Smart Things Require Intelligence at the Edge



Types of Things

- Non-OS Based
 - Arduino, NX4, SAMD and many more...
- OS-Based
 - Windows, Windows IoT Core, Linux and many more...
- Physical
 - All kinds of silicon and processors
- Simulated

Windows IoT Core



Azure Certified Devices

The Azure Certified for IoT device catalog is located at:

catalog.azureiotsuite.com

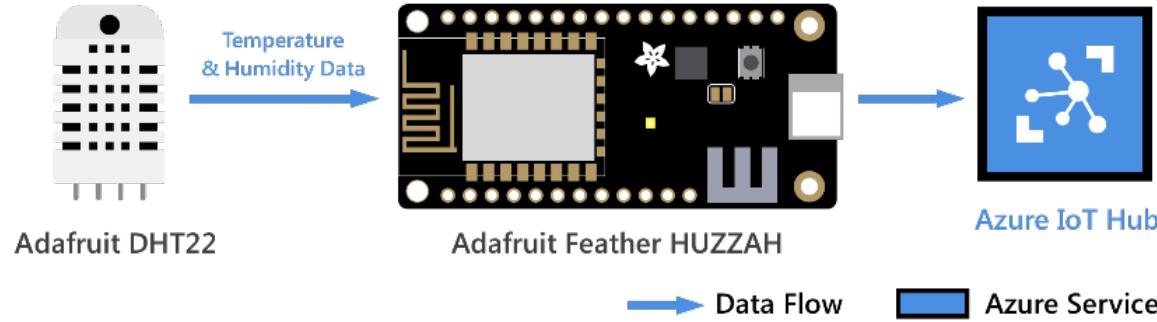


blogs.microsoft.com/iot/

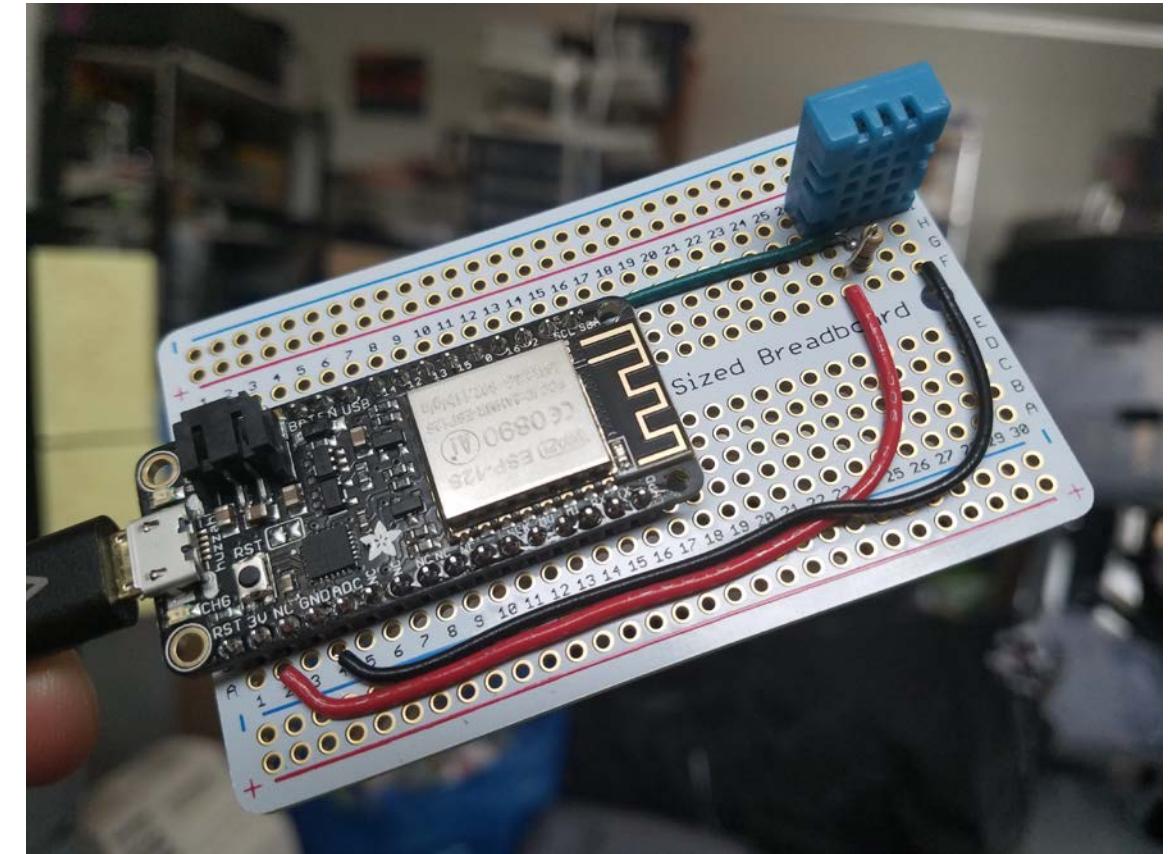
Devices for Todays Workshop

- Simulated devices
 - Laptop Based
 - Node.js application consoles
 - Web Based
 - Raspberry Pi Web Simulator
- Physical devices
 - Not in scope for today's workshop
 - Azure IoT Hub Getting Started has many cook book...
 - Raspberry Pi, Intel Edison, Adafruit HUZZAH, Adafruit Feather M0, Sparkfun ESP8266
 - Java, C, Python, Node.js, Arduino IDE
 - Students may wish to build a few devices and further explore Azure IoT bi-directional management and configuration

Adafruit Feather HUZZAH ESP8266

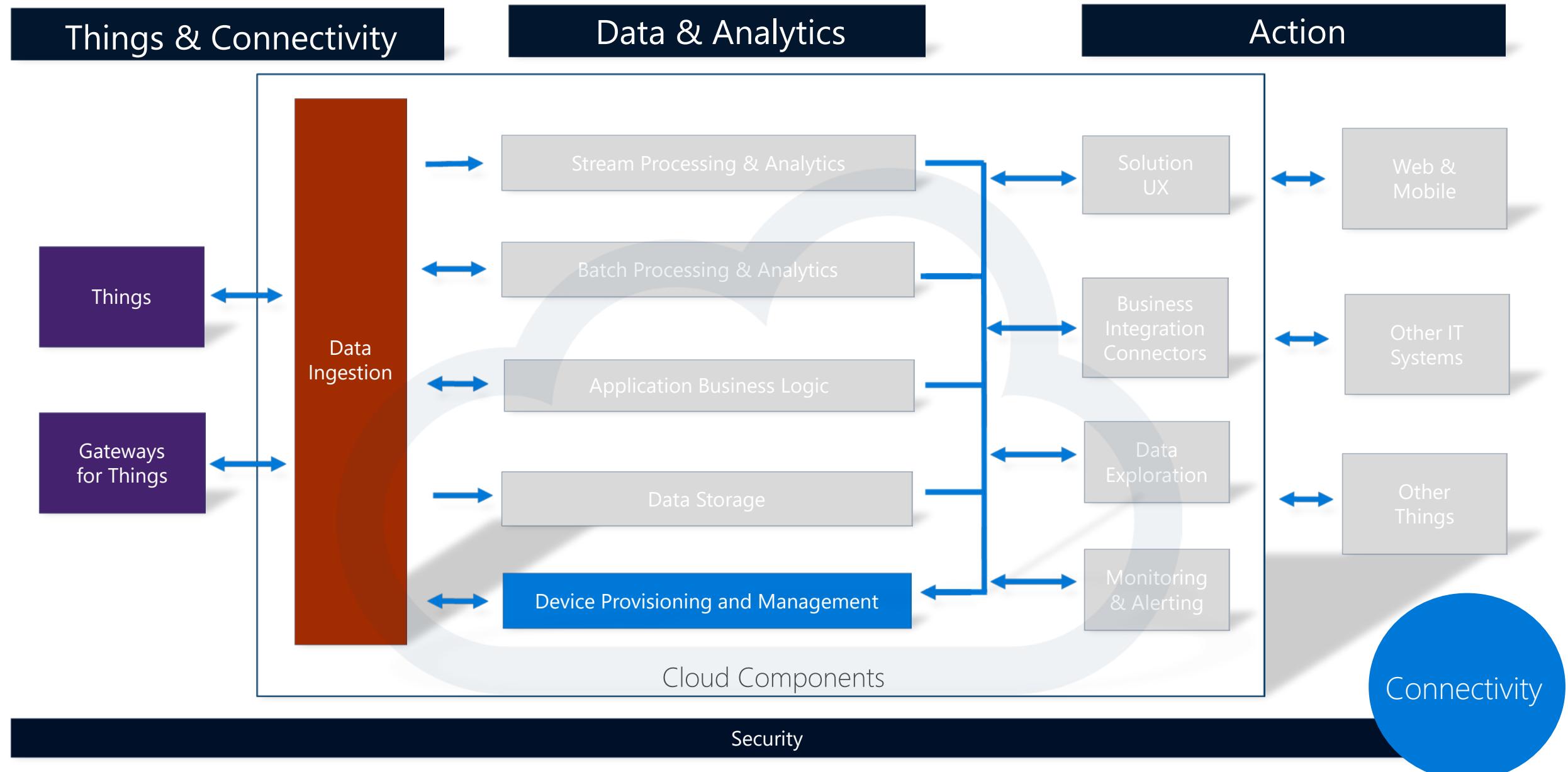


- **HUZZAH**
 - ESP32-based, 4MB, Wi-Fi and BLE
 - \$19.95
- **DHT11**
 - Temperature and Humidity
 - \$5.00



<https://docs.microsoft.com/en-us/azure/iot-hub/iot-hub-arduino-huzzah-esp8266-get-started>

IoT anatomy from the top down



Many aspects of device connectivity

Functionality

- Device-to-cloud telemetry,
- Cloud-to-device commands and notifications,
- File uploads/downloads



Security

- Device security,
- Cloud security,
- Channel security, ...



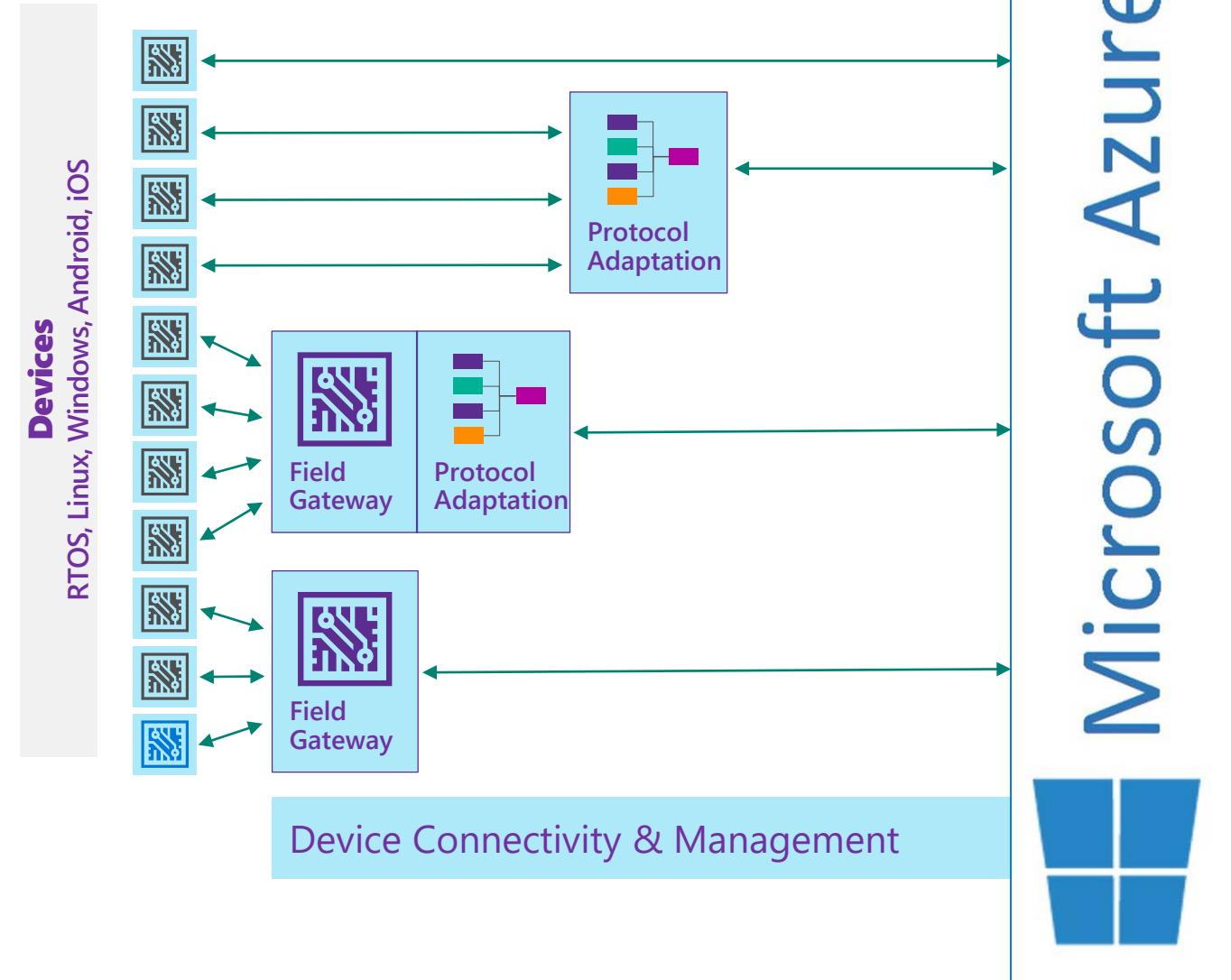
Monitoring

Identify malfunctioning devices when they cannot be reached directly

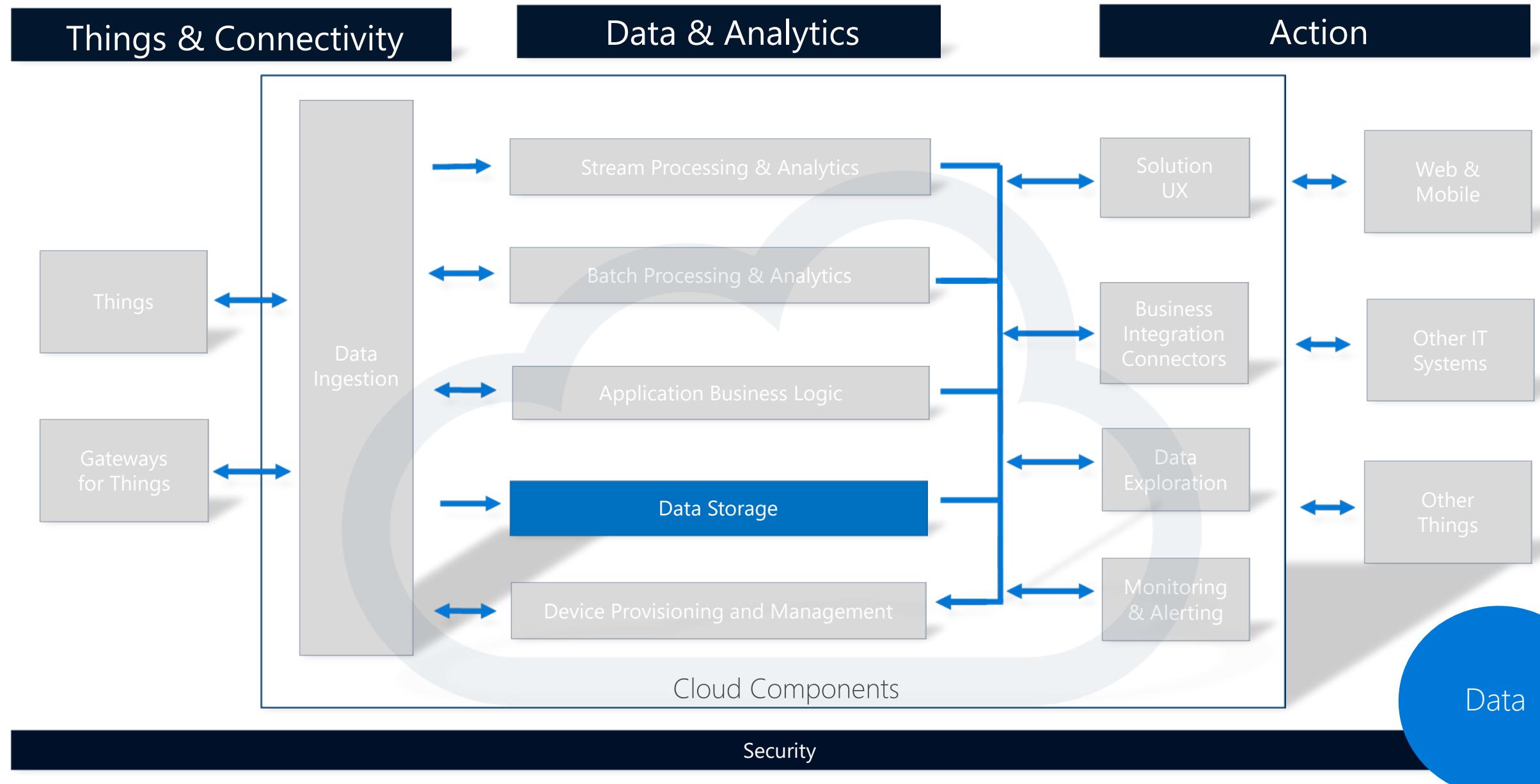


Reach and customization

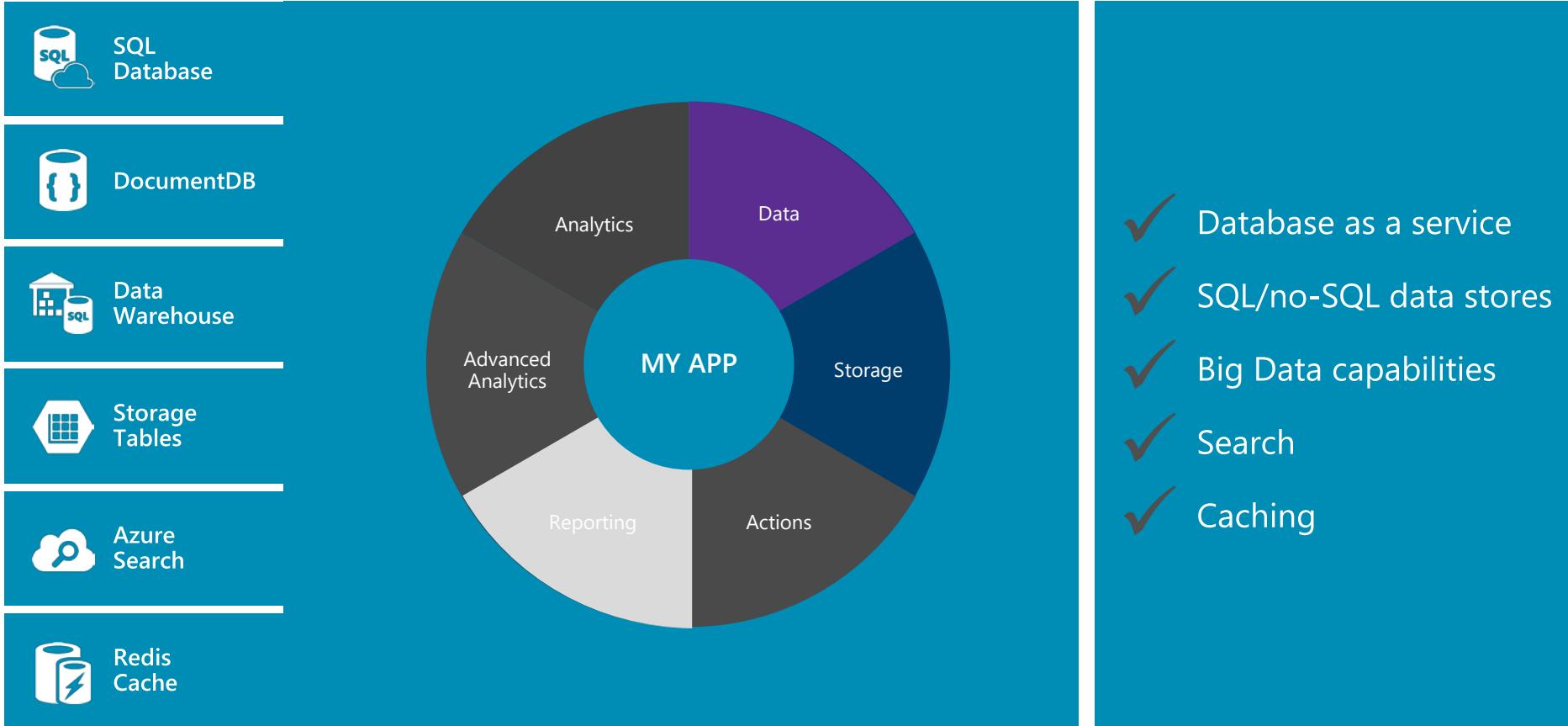
- RTOS/Linux/Windows/non-IP capable,
- Network/application protocols,
- Authentication schemes



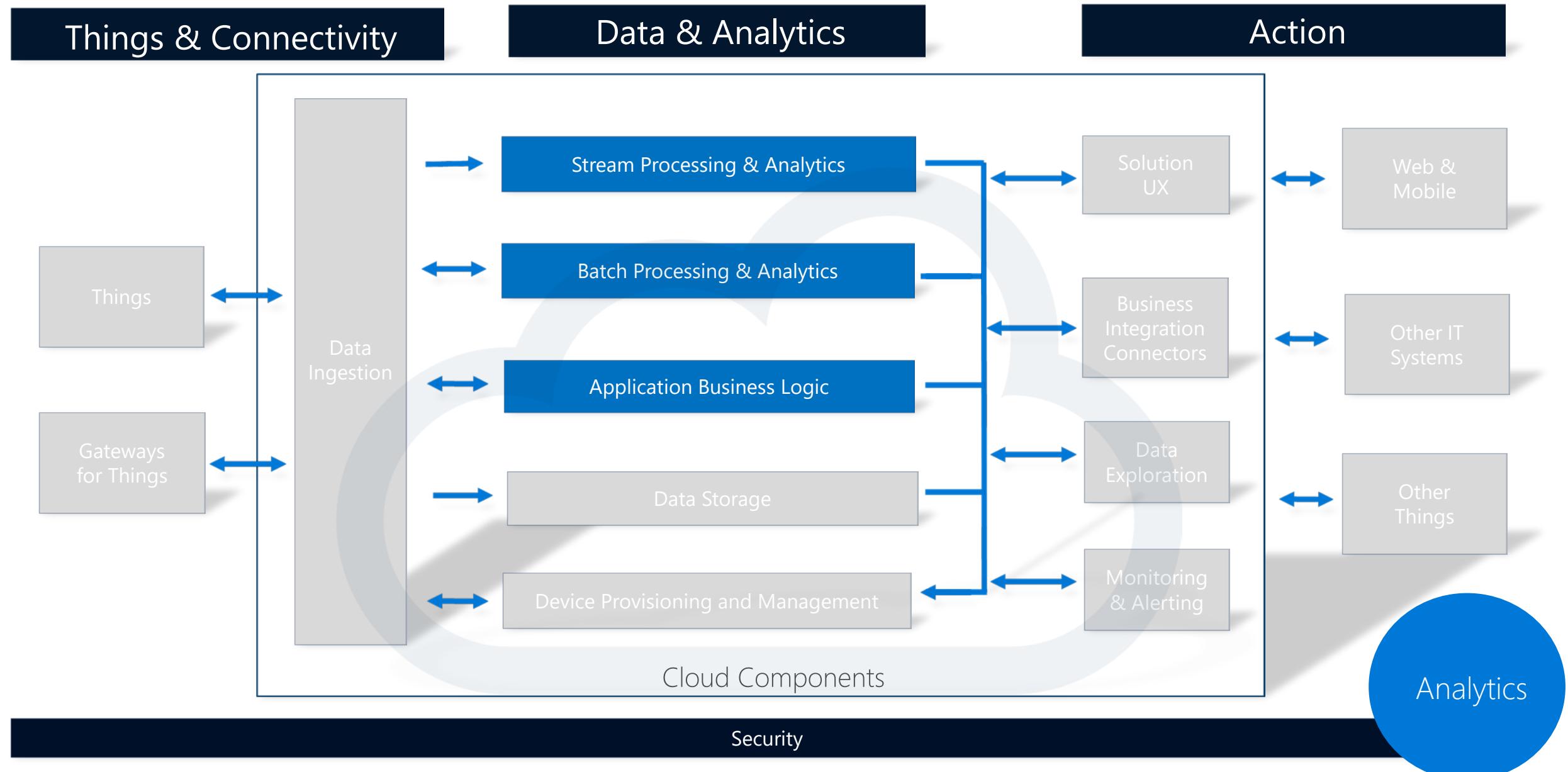
IoT anatomy from the top down



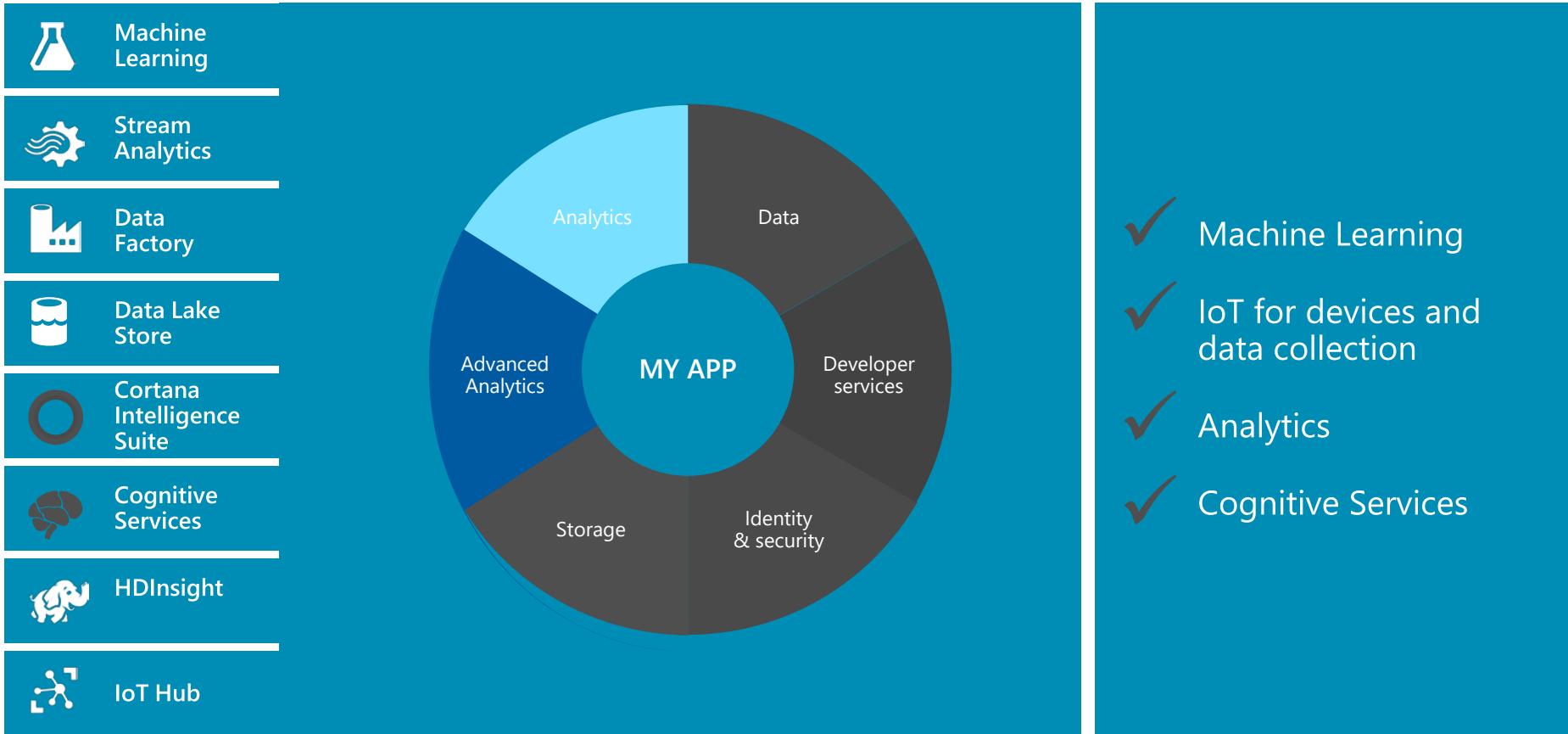
Data Storage



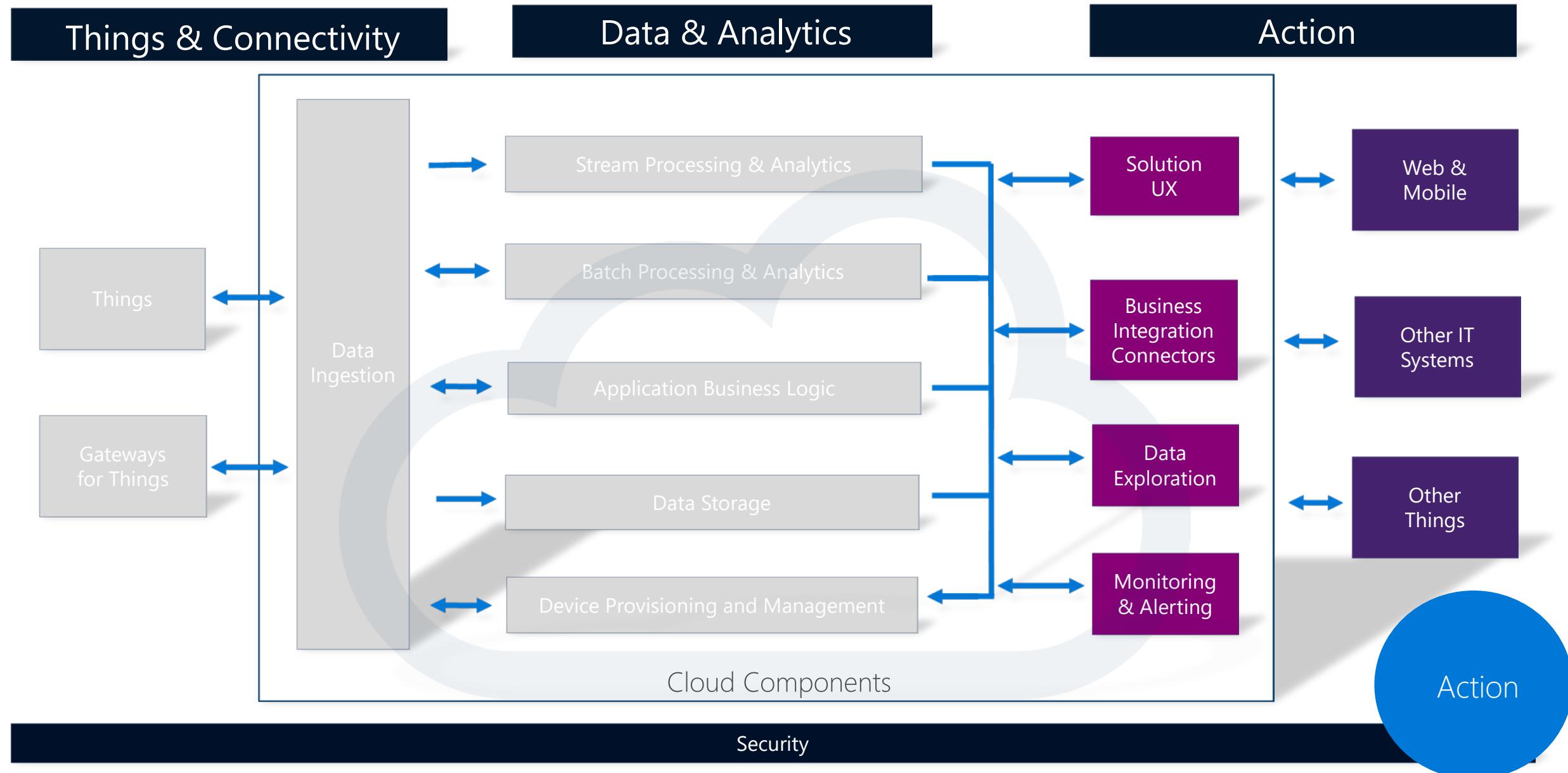
IoT anatomy from the top down



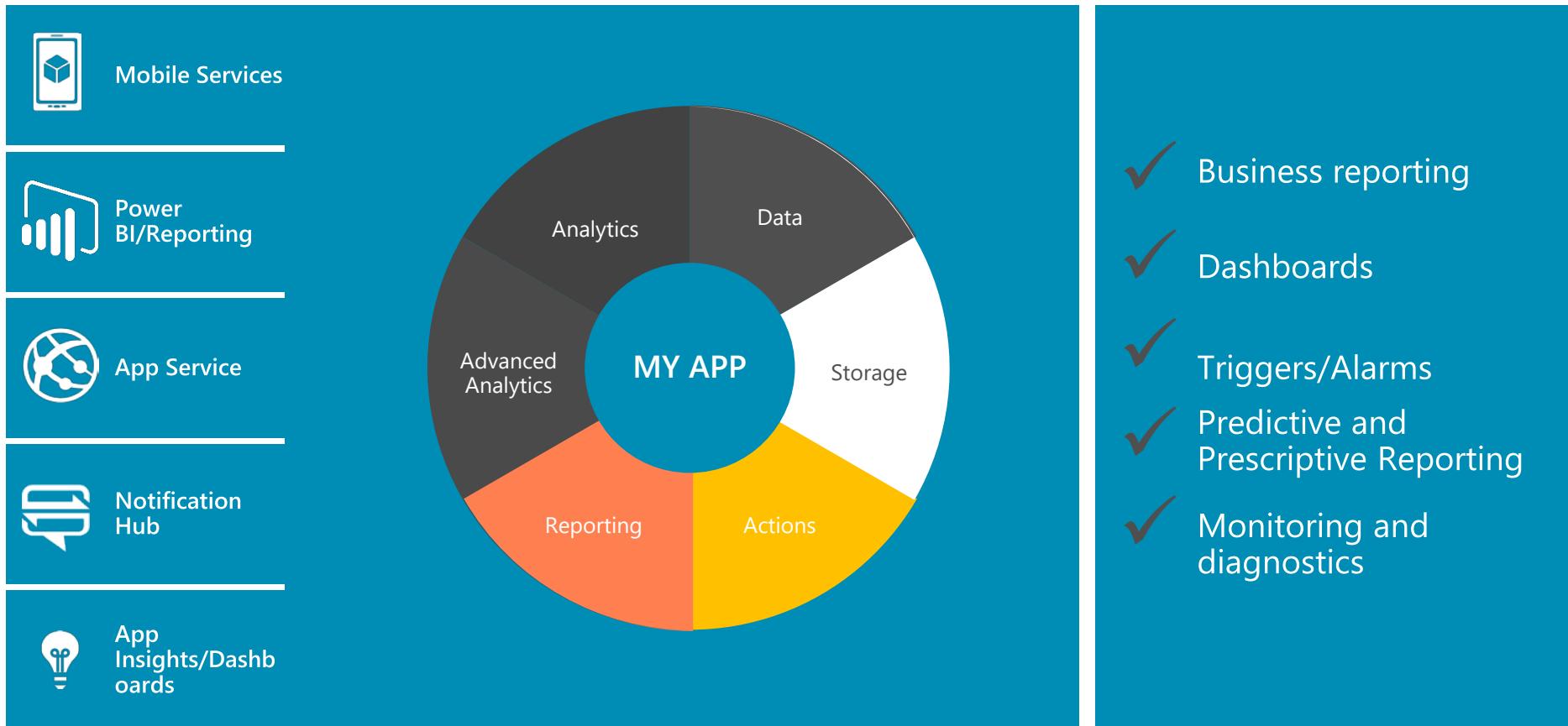
Analytics



IoT anatomy from the top down



Actions



Security Across All Pillars

Security

Securely connect millions of devices ...



Device Security

Device Provisioning and Authorization

Over a secure internet connection ...

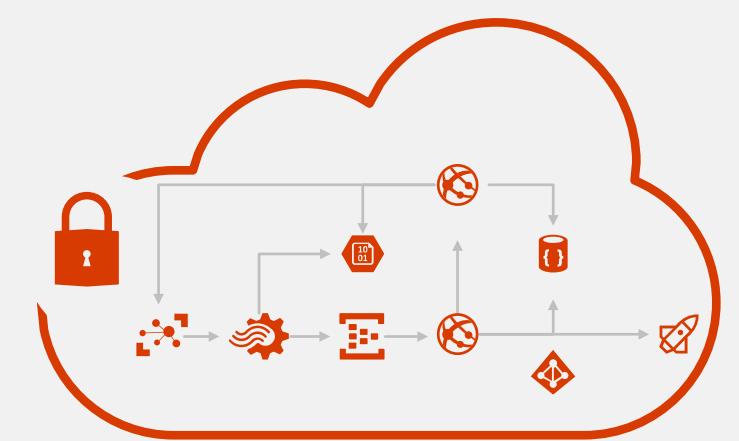


010101011010101
0101110100010111
1010101011001010

Connection Security

X.509/TLS-Based Handshake and Encryption

Cloud built with security from the ground up



Cloud Security

Security Center
Active Directory
Key Vault
Policy-Based Access Control

Azure IoT Hub

- Establish bi-directional communication
- Use familiar platforms and protocols
- Authenticate per-device for secure IoT solutions
- Manage IoT devices at scale
- Extend the cloud to the edge device



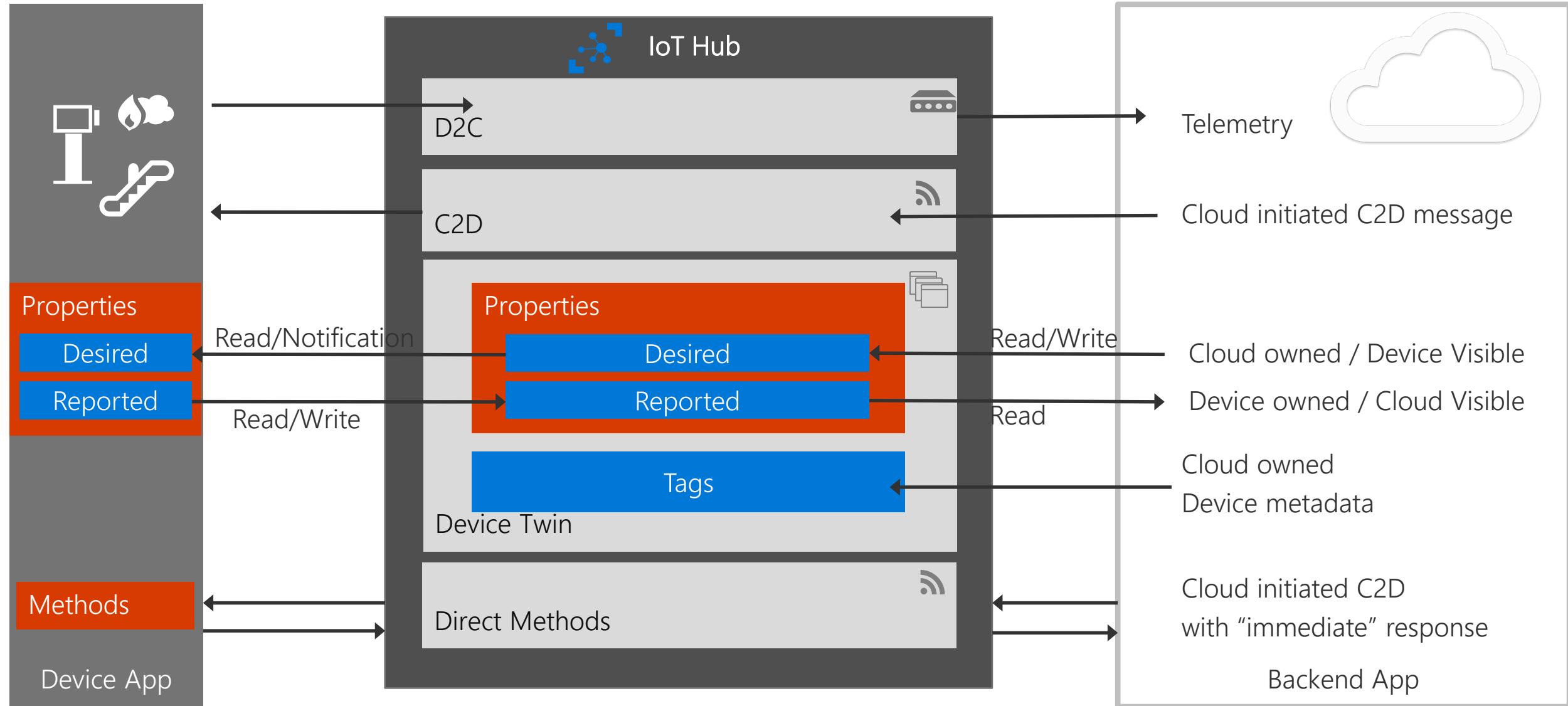
What is Azure IoT Hub?

- Device connectivity challenges
 - Are often embedded systems with no human operator.
 - Can be in remote locations, where physical access is expensive.
 - May only be reachable through the solution back end.
 - May have limited power and processing resources.
 - May have intermittent, slow, or expensive network connectivity.
 - May need to use proprietary, custom, or industry-specific application protocols.
 - Can be created using a large set of popular hardware and software platforms.

Why use Azure IoT Hub?

1. Device twins
 - Store, synchronize and query service metadata and status information
2. Per-device authentication and secure connectivity
 - Each device may have its own security key
3. Route device-to-cloud messages to Azure services based on declarative rules
 - No code ability route messages replacing pre-ingestion dispatchers
4. Monitoring of device connectivity operations
 - Detailed operation logs
5. An extensive set of device libraries
 - C/Linux, Windows, RTOS, IoT SDK, C#, Java, JavaScript
6. IoT protocols and extensibility
 - MQTT v3.1.1, HTTP 1.1 or AMQP 1.0 protocols
 - Can extend to customized protocols using Azure IoT Edge and gateways
7. Scale
 - Supports millions of simultaneously connected devices and millions of events per second

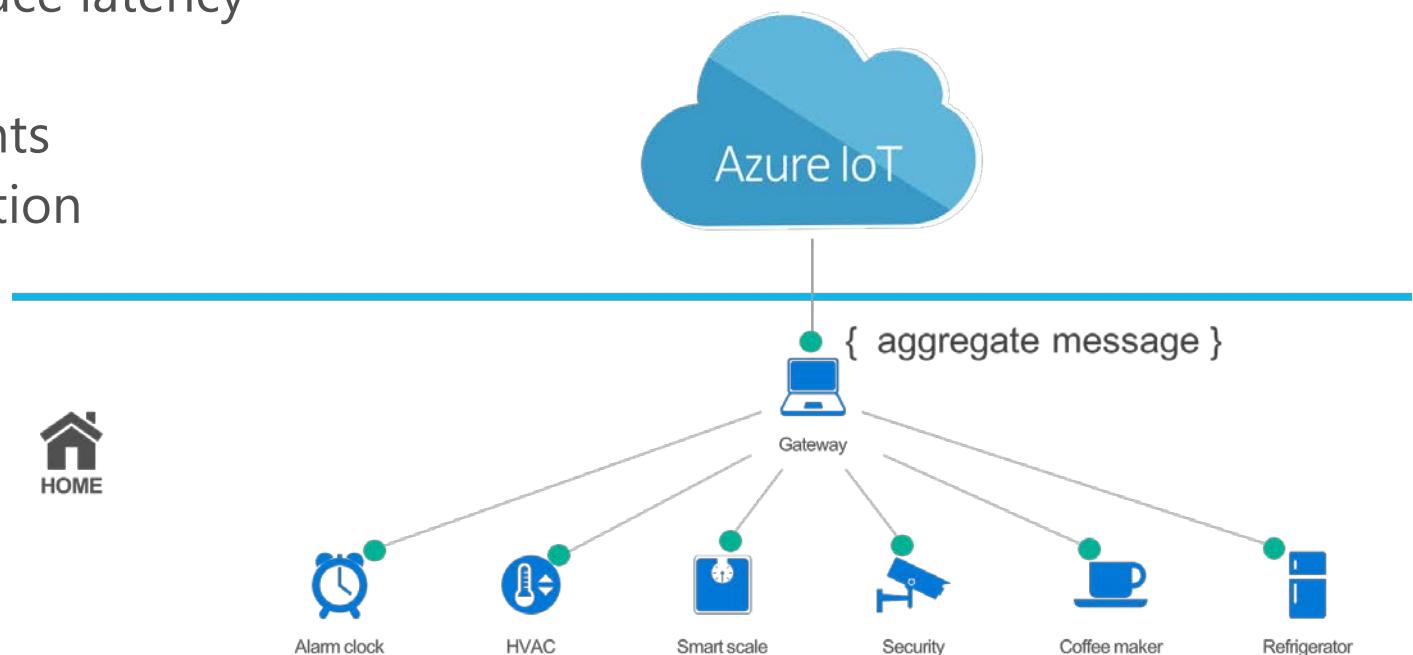
Manage through Device Twin and Methods



Gateways

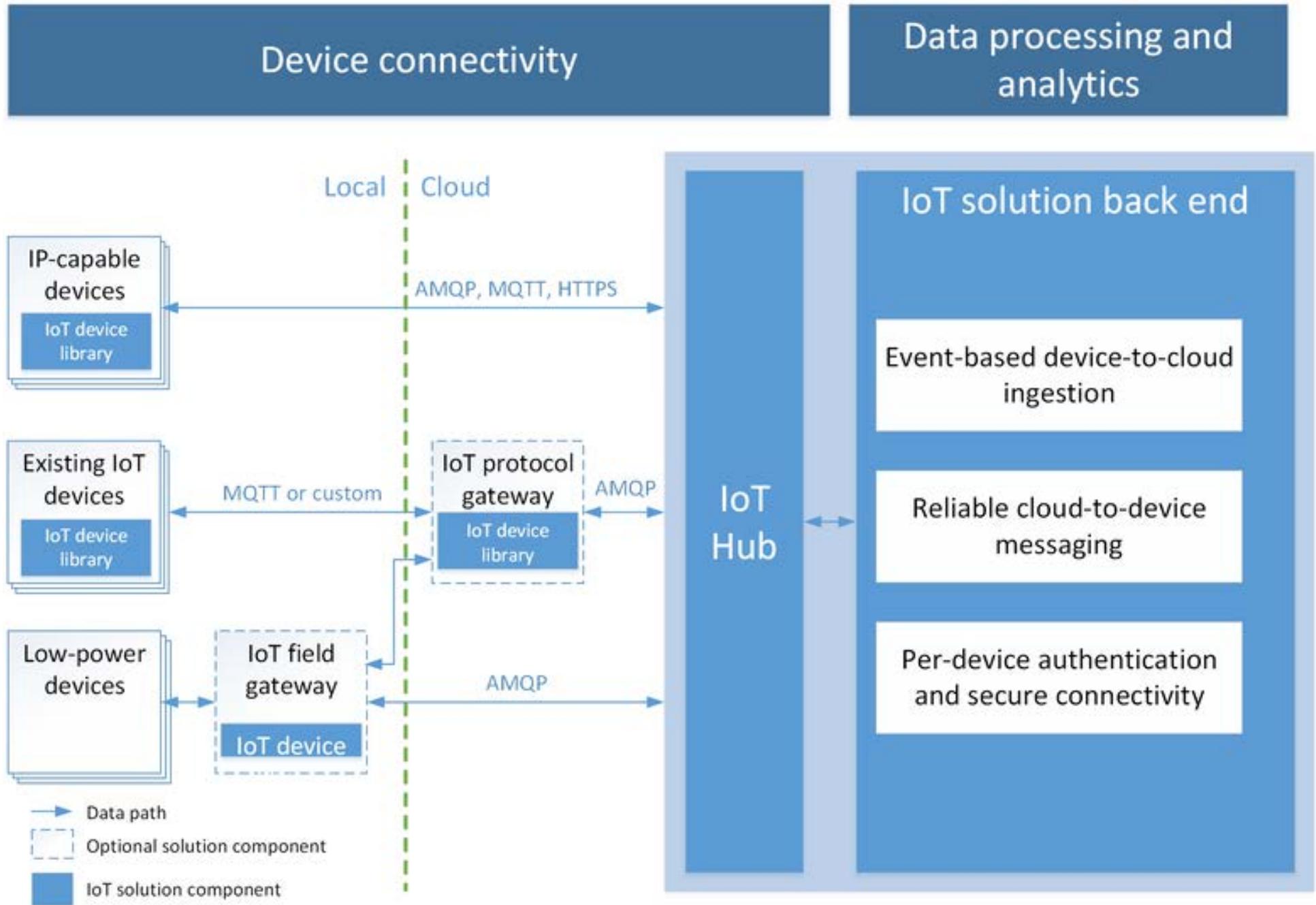
- Deployed locally with the devices

- Protocol gateway
 - Performs protocol translation (e.g. MQTT to AMQP)
- Field gateway
 - May run analytics on the edge
 - Make time-sensitive decisions to reduce latency
 - Provide device management services
 - Enforce security and privacy constraints
 - And it might also do protocol translation

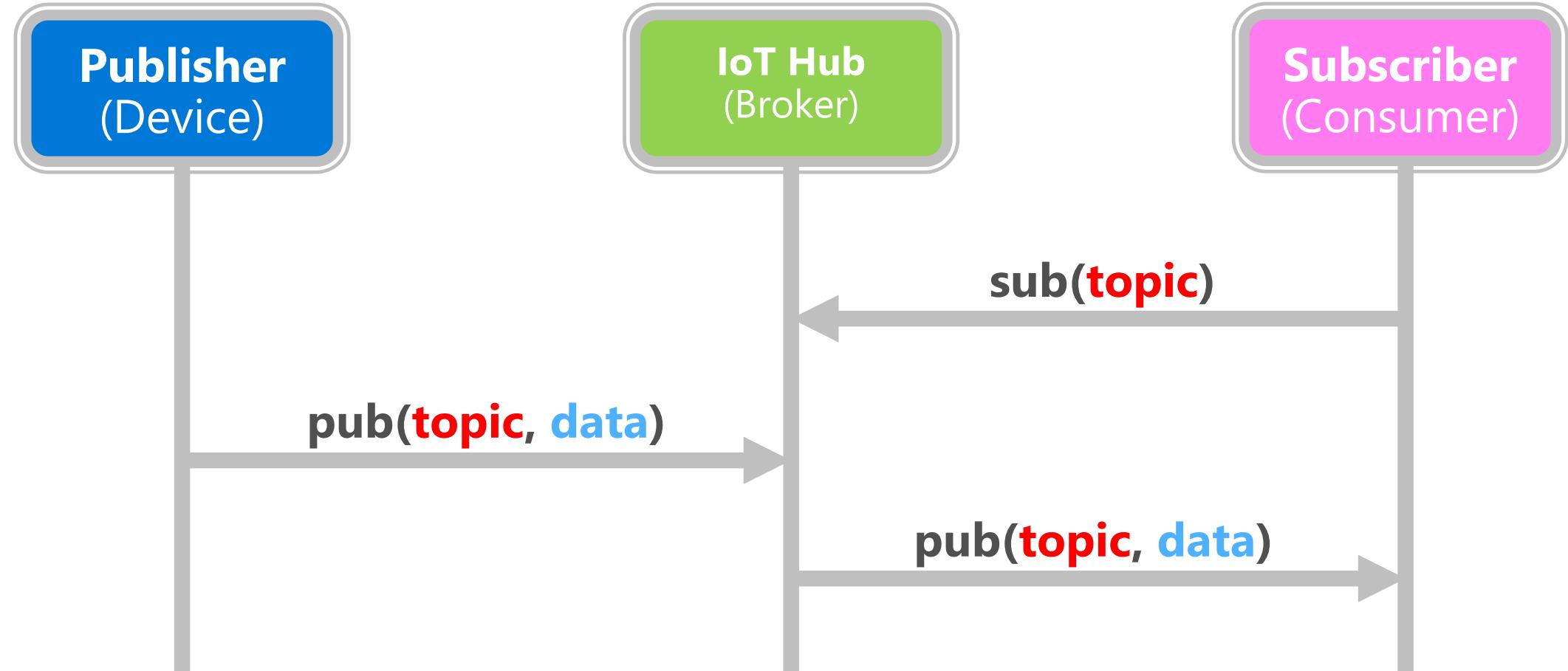


Industry protocols

- Process automation protocols (CIP, DC-BUS, EtherCAT)
- Industrial control system protocols (OPC, MTConnect)
- Building automation protocols (BACnet, KNX, X10)
- Power system automation protocols (DNP3)
- Automatic meter reading protocols (Zigbee, Modbus)
- Automobile / Vehicle protocol buses (CAN, MOST, VAN)



Publish and Subscribe Messaging



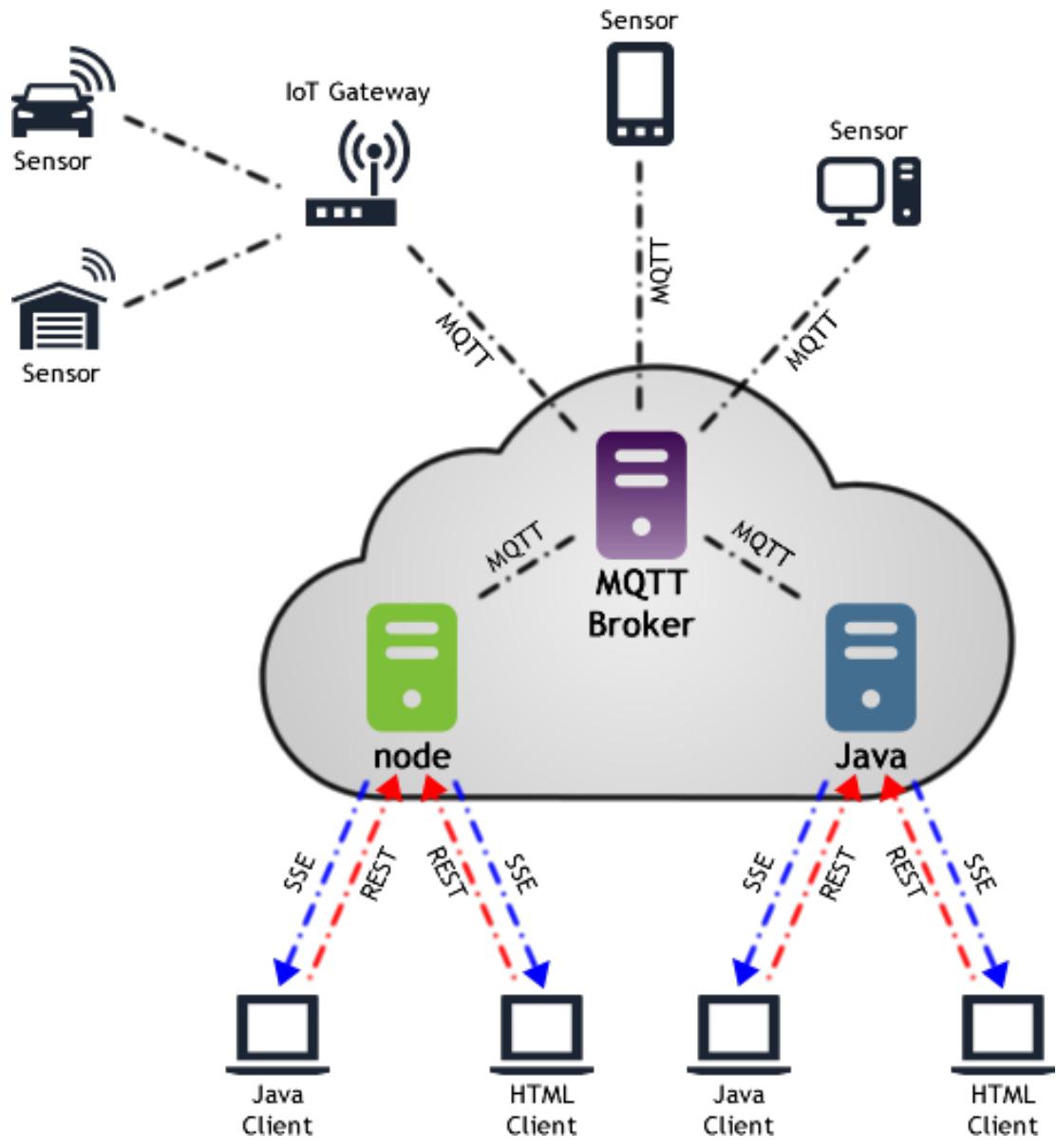
What is MQTT?

- Message Queue Telemetry Transport
- Machine-to-Machine (M2M)/"Internet of Things" (IoT)
 - Lightweight connectivity protocol for publish/subscribe messaging transport
 - Small code footprint, limited bandwidth, low power usage
 - Minimized packets and efficient distribution to multiple receivers
- MQTT v3.1.1 now an OASIS Standard
 - Invented by Dr. Andy Stanford-Clark (IBM) and Arlen Nipper (Eurotech)
 - MQ Telemetry Transport (ISO/IEC PRF 20922)
- MQTT Broker/Servers
 - IBM Websphere MQ Telemetry, Message Sight, Integration Bus
 - Mosquitto, Eclipse Paho, Europtech Everywhere Device Cloud, emqttd, Xively, Moquette, Yunab.io, m2m.io, RabbitMQ, Apache ActiveMQ, HiveMQ
- MQTT Client Methods
 - Connect, Disconnect, Subscribe, Unsubscribe, Publish



MQTT

- Open and Simple
- Quality of Service (QoS)
 - QoS 0 - At most Once
 - QoS 1 – At least Once
 - QoS 2 – Exactly Once (Best Choice)
- Provides secure messaging
 - TLS support, use X509 client certificates
- Scales to monstrous numbers
- Integrates many devices and apps
 - Device
 - Web servers
 - Application servers
- Reliability for mission critical apps
 - Assured delivery
 - Ensures deliverer despite network errors



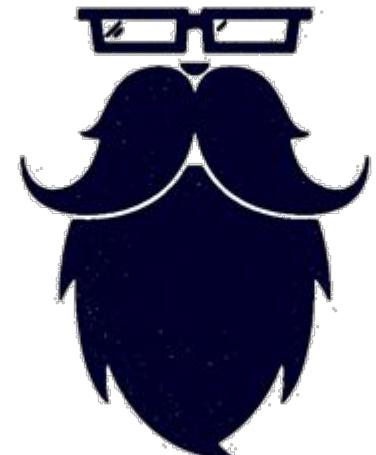
What is AMQP?

- Advanced Message Queuing Protocol
 - Open standard protocol for message-oriented middleware
 - Messaging for heterogeneous platforms, spanning multiple operating systems
 - Easily bundled into any computer as easy as TCP/IP, SMTP and HTTP
- AMQP 1.0 is now an OASIS Standard
 - Internal Standard ISO/IEC 19464, Developed in 2004
 - Combined with ISO 20022 (message dashboard) for increased value
- ISO 19464 is an enabler of Modular Government
- Base for other ISO standards; especially financial transactions
 - Business needs to exchange data between enterprises
 - AMQP directly addressed enterprise needs around security



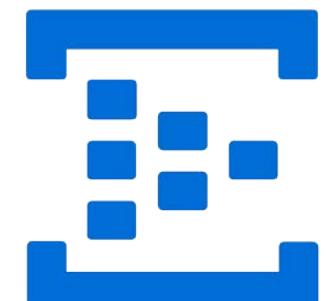
MQTT has some major gaps

- No queues (send and receiver must be up at the same time)
- No persistence / durability / archival or recovery
- No Java Message Service (JMS)
- No Windows Communication Foundation (WCF)
- No transactions for application server or XA integration
- No flow-control or selective acknowledgement (ACK) to stop app lock-ups
- No multiplexing for easy fire traversal
- No Kerberos or Active Directory



Other Azure Hubs

- [Azure Notification Hub](#)
 - For pushing notifications to mobile devices
- [Azure Service Bus](#)
 - For applications needing rich publish-subscribe backbone
- [Azure Event Hub](#)
 - Only enables event egress (device-to-cloud)
 - No device state information is stored
 - Supports AMQP, AMQP/Websockets and HTTP
 - Shared access policies only
 - Exposes only aggregate metrics
 - .NET, Java and C



Azure Event Hub

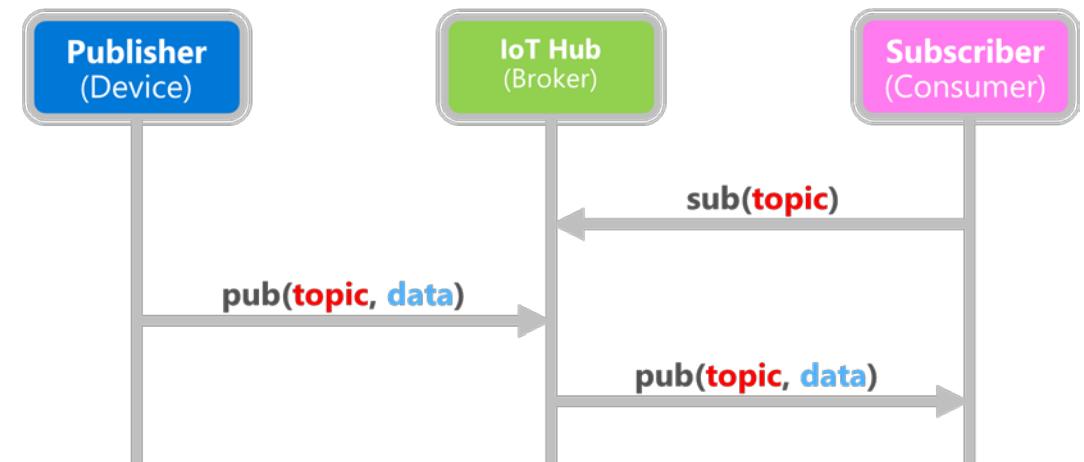
- Similar to an IoT Hub
 - Actually, Event-like hubs are used on the back-end of the IoT Hub...
- Summary
 - IoT Hub creates a device connectivity for device-to-cloud telemetry (ingress)
 - Event Hub is for event ingress at massive scale
 - Context is both for inter-datacenter and intra-datacenter scenarios
 - Missing many features that IoT Hub brings, but provides deeper device support

IoT Hub vs. Event Hub

Area	IoT Hub	Event Hubs
Communication patterns	Enables device-to-cloud and cloud-to-device messaging.	Only enables event ingress (usually considered for device-to-cloud scenarios).
Device protocol support	Supports AMQP, AMQP over WebSockets, MQTT, and HTTP/1. supports Azure IoT Protocol Gateway ,	Supports AMQP, AMQP over WebSockets, and HTTP/1.
Security	Provides per-device identity and revocable access control.	Event Hubs-wide shared access policies , with limited revocation support
Operations monitoring	subscribe to a rich set of device identity management and connectivity events	Exposes only aggregate metrics.
Scale	Is optimized to support millions of simultaneously connected devices.	up to 5,000 AMQP connections, as per Azure Service Bus quotas .
Device SDKs	Provides device SDKs for a large variety of platforms and languages.	Is supported on .NET, and C. Also provides AMQP and HTTP send interfaces.

Node.js - Simulated Device

- Runs as a Node.js jobs [on the laptop]
 - Simulated Device
 - **SimulatedDevice.js**, which connects to your IoT hub with the device identity created earlier and sends a telemetry message every 10 seconds
 - Message Reader
 - **ReadDeviceToCloudMessages.js**, which displays all the telemetry sent by your simulated device app, regardless of the device sending the data



Raspberry Pi Web Simulator

- Online device simulator
 - Written in Node.js
 - Temperature and Humidity
- Three areas in the web simulator
 - Assembly area - The default circuit is that a Pi connects with a BME280 sensor and an LED. The area is locked in preview version so currently you cannot do customization.
 - Coding area - An online code editor for you to code with Raspberry Pi. The default sample application helps to collect sensor data from BME280 sensor and sends to your Azure IoT Hub. The application is fully compatible with real Pi devices.
 - Integrated console window - It shows the output of your code. At the top of this window, there are three buttons.
 - Run - Run the application in the coding area.
 - Reset - Reset the coding area to the default sample application.
 - Fold/Expand - On the right side there is a button for you to fold/expand the console window.
- GitHub
 - <https://github.com/Azure-Samples/raspberry-pi-web-simulator>



iothub-explorer

Is a CLI tool that you run on a host computer to manage device identities in your IoT hub registry

It comes with management options that you can use to perform various tasks

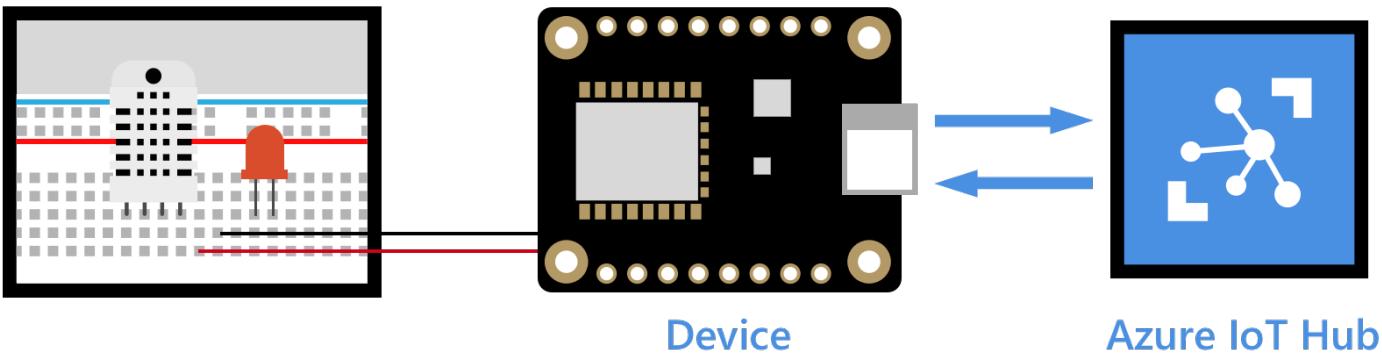
Connect to your IoT hub

Connect to your IoT hub by running the following command:

```
bash
```

```
iothub-explorer login <your IoT hub connection string>
```

Lab One – Azure IoT Hub



- Create an Azure Hub service
- Create two simulated devices
 - Node JS on your laptop
 - Raspberry PI Web Simulation
- Confirm data being sent to the IoT Hub
- Use iothub-explorer to manage devices

Lab Hints

- DO NOT follow the illustrations verbatim
- The elusive NEW button
- Stay focused on the product/service you're working with

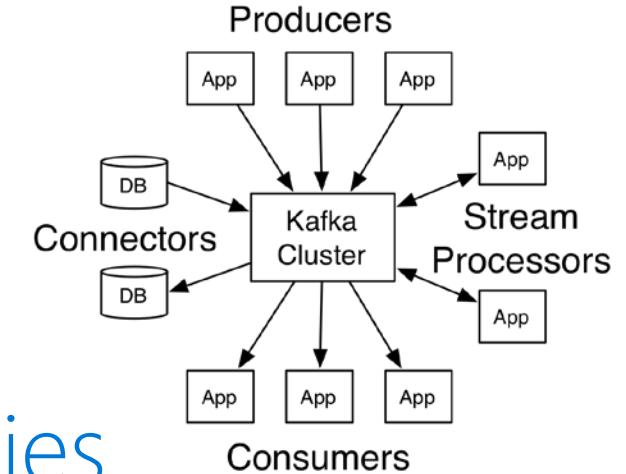
Lab One – Azure IoT Hub

Goal: Create an IoT Hub, Simulated Device and connect the two together

Duration: 45 Minutes

What about Apache Kafka?

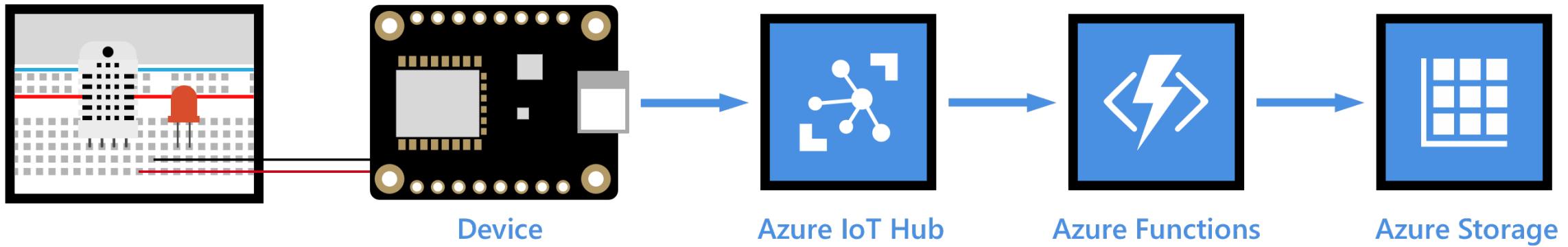
- Apache Kafka
 - Apache Kafka – ingestion layer similar to Azure IoT Hub
 - Both have very similar features and capabilities
 - Key differentiators
 - Managed Service or Do-It-Yourself
 - Kafka does not support AMQP
 - Kafka is Java only; IoT Hub supports many languages
 - DR is storage based in Azure; cluster based in Kafka (no geo, high latency)
 - HA is harder for Kafka while Azure IoT Hub makes it much easier
 - Kafka is not auto scalable, Azure IoT Hub
 - Kafka lacks ANY security; Azure IoT Hub is VERY secure



Cold and Hot Path Processing

- Cold
 - Data stored for later processing
 - Structured
 - SQL
 - Unstructured
 - NoSQL
 - BLOB
 - File
 - TXT, CSV
 - Batch
- Hot
 - Data processed in real-time
 - Reactive to device behavior
 - Streaming analytics
 - Live dashboards
 - Stream processing
 - Hadoop, Spark
 - Machine Learning
 - Predictive, Prescriptive analytics
 - Event-driven processing

Cold Processing/Storing Messages (Data)



Using your existing IoT Hub

- + Consumer Group
- + Azure Storage Account
- + Azure Function to take incoming messages
 - Pushes payload to Azure Table Store/Database

Azure Functions

- Serverless compute service that enables you to run code on-demand without having to explicitly provision or manage infrastructure
 - Small pieces of code, or "functions," in the cloud
 - Run a script or piece of code in response to a variety of events
- Serverless
 - No infrastructure, no provisioning; scaling up is easy and fast
- Accelerated Development
 - Write code, Click Run, Immediate Execution
- Bind into Services
 - Combine with Azure and external services (Box, DropBox, OneDrive, SendGrip and more)

IaaS > PaaS > SaaS

Need to run a JavaScript program each time a URL is visited.

IaaS

Create Azure VM
Install Node.js
Deploy Code

PaaS

Web App Service
Deploy Code

SaaS

Deploy Code



Economic Benefits

- Reduce business risk
- Pay only for what you utilize
- Always realize the current market price

Operational Benefits

- No refresh or migration hassles
- A fully managed service
- Wide range of products and tiers

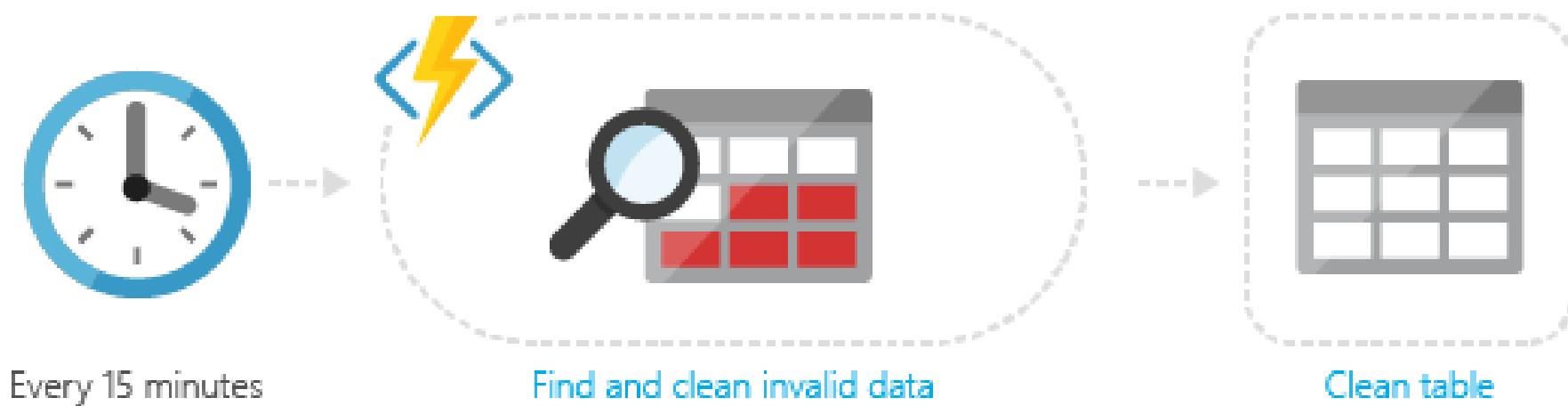
Azure Function - Common Scenarios

- Time-based processing
- Azure service event processing
- SaaS event processing
- Serverless web application architecture
- Serverless mobile back ends
- Real-time stream processing
- Real-time bot processing

Azure Functions - Scenario

- **Timer-based processing**

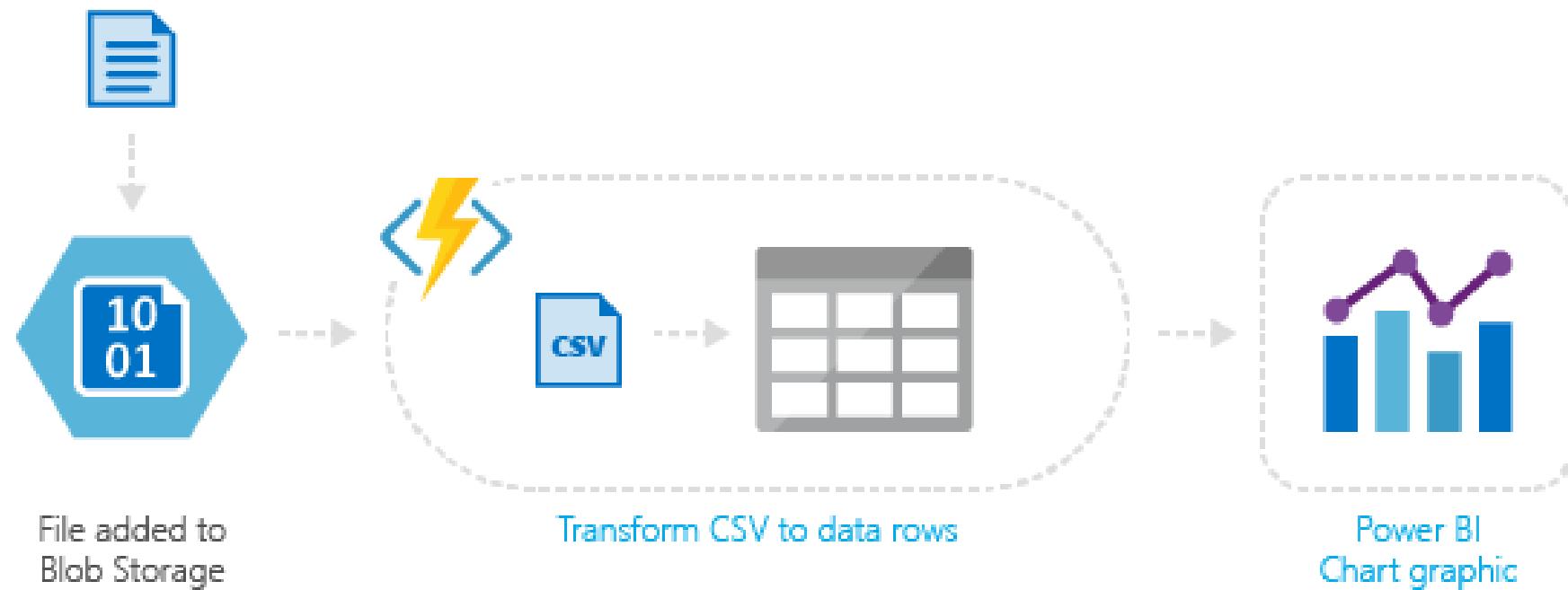
- Azure Functions supports an event based on a timer using cron job syntax.
- For example, execute code that runs every 15 minutes and clean up a database table based on custom business logic.



Azure Functions - Scenario

- Azure service event processing

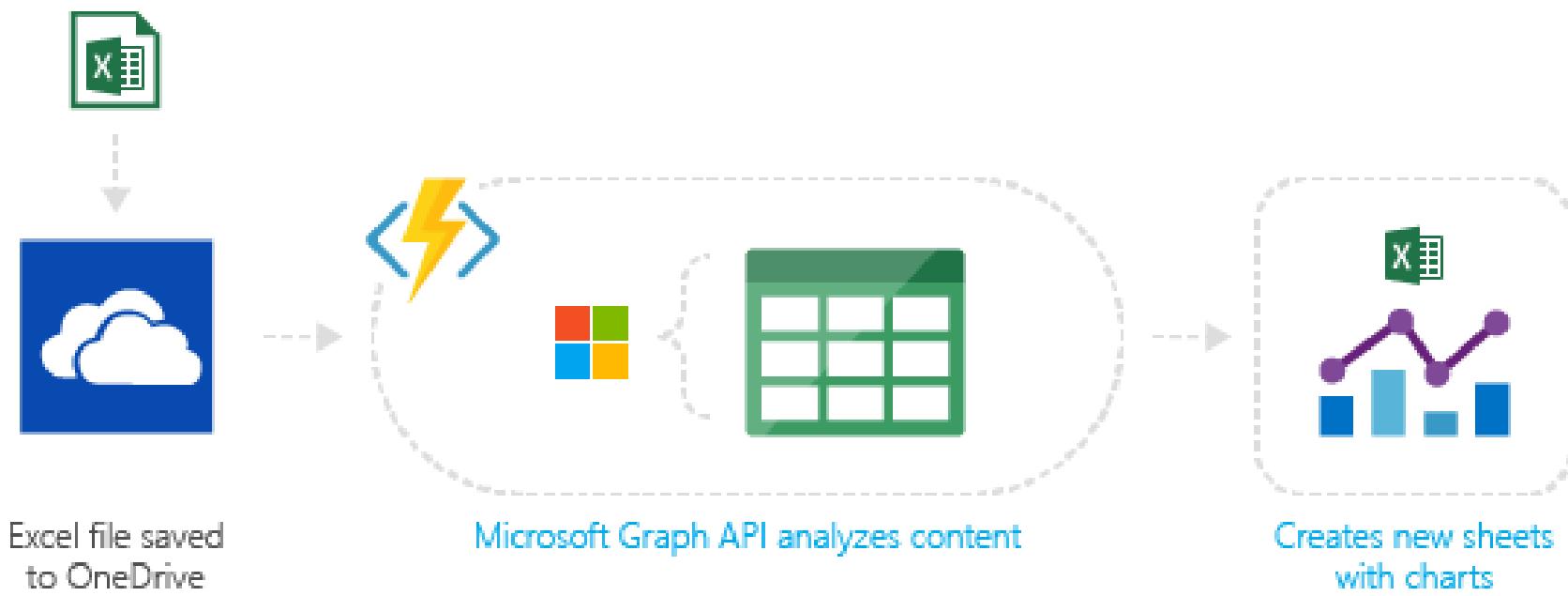
- Azure Functions supports triggering an event based on an activity in an Azure service.
- For example execute serverless code that reads newly discovered test log files in an Azure Blob storage container, and transform this into a row in an Azure SQL Database table.



Azure Functions - Scenario

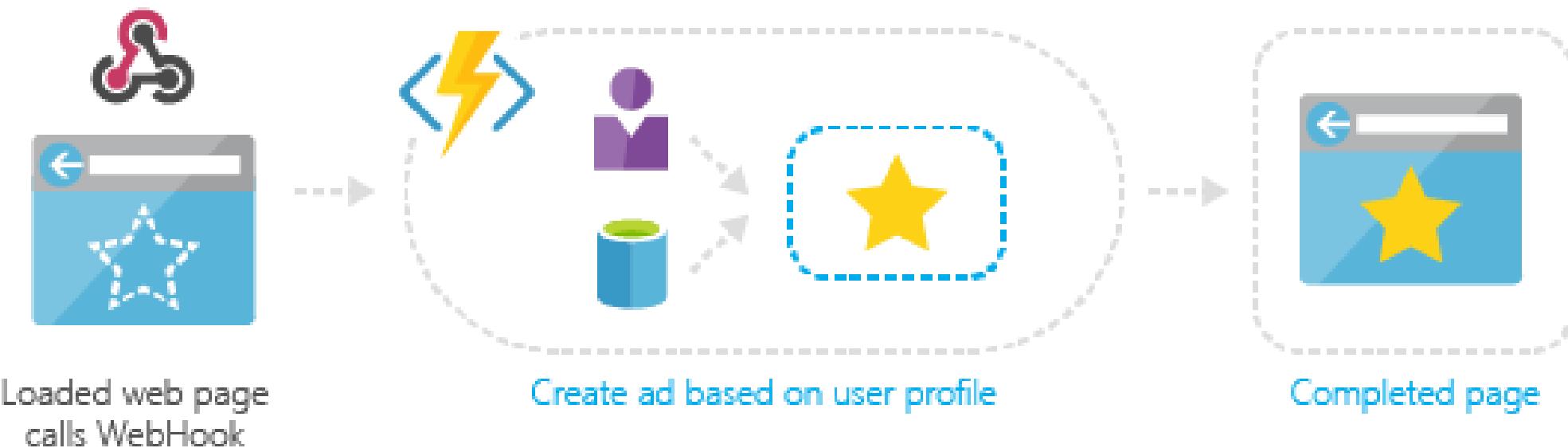
- SaaS event processing

- Azure Functions supports triggers based on activity in a SaaS service.
- For example, save a file in OneDrive, which triggers a function that uses the Microsoft Graph API to modify the spreadsheet, and creates additional charts and calculated data.



Azure Functions - Scenario

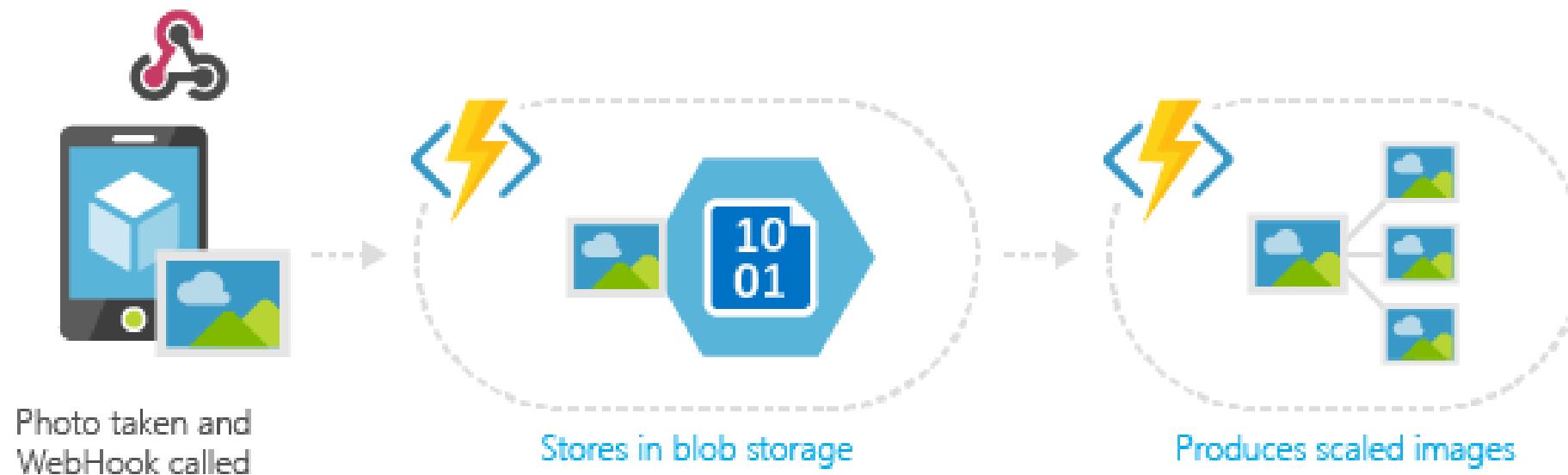
- Serverless web application architectures
 - Azure Functions can power a single-page app.
 - The app calls functions using the WebHook URL, saves user data, and decides what data to display.
 - Or, do simple customizations, such as changing ad targeting by calling a function and passing it user profile information.



Azure Functions - Scenario

- **Serverless mobile back ends**

- A mobile back end can be a set of HTTP APIs that are called from a mobile client using the WebHook URL.
- For example, a mobile application can capture an image, and then call an Azure Function to get an access token for uploading to blob storage. A second Azure Function is triggered by the blob upload and resizes the image to be mobile-friendly.



Azure Functions - Scenario

- Real-time bot messaging

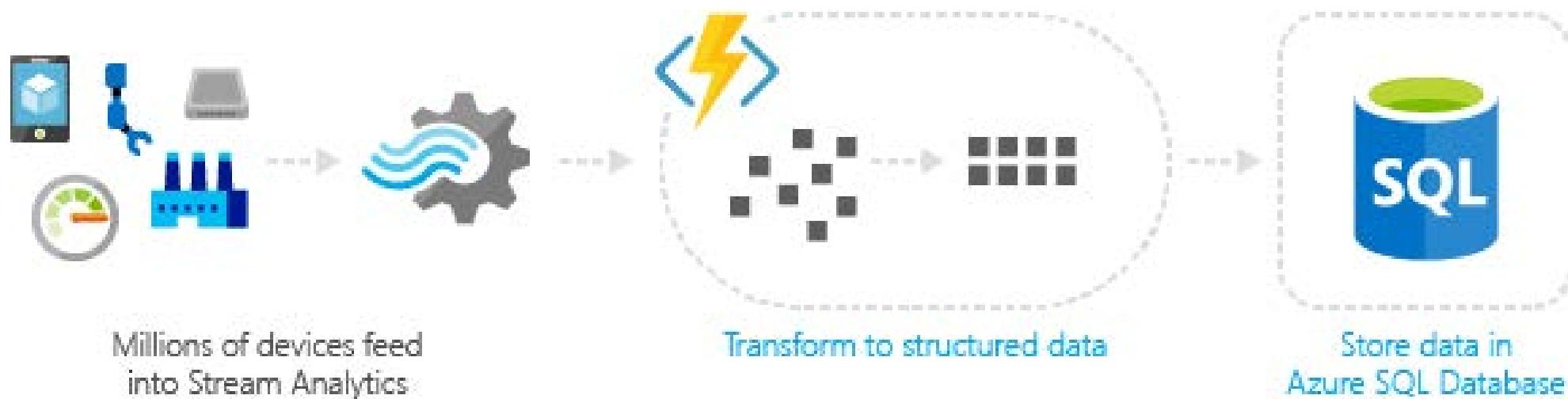
- Use Azure Functions to customize the behavior of a bot using a WebHook.
- For example, create an Azure Function that processes a message using Cortana Analytics and call this function using Microsoft Bot Framework.



Azure Functions - Scenario

- **Real-time stream processing**

- For example, Internet of Things (IoT) devices send messages to Azure Stream Analytics, which then calls an Azure Function to transform the message. This function processes the data and creates a new record in an Azure SQL database.



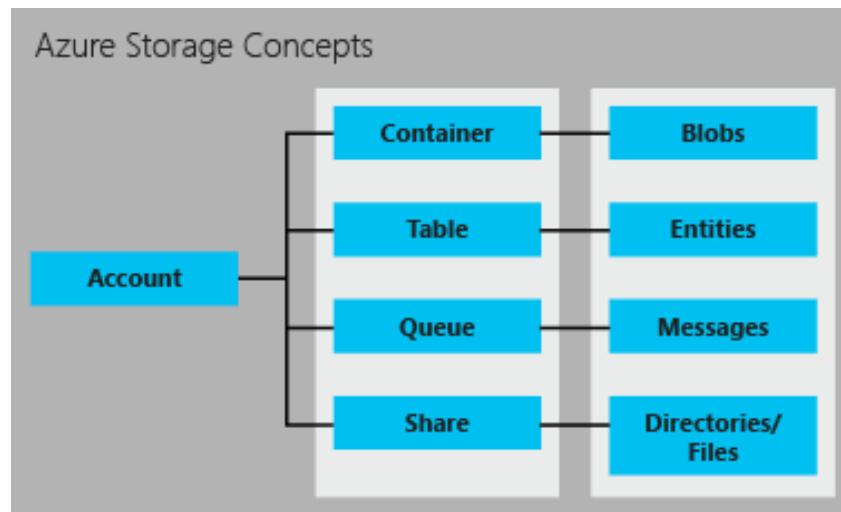
DEMO: Azure Function

Azure Storage

- Foundational Building Block of Azure
 - Azure Services: SQL Data Warehouse, HDInsight, Data Lake Store, Event Hubs, IoT Hubs...
 - Microsoft Services: Office 365, OneDrive, XBox, Skype...
- Hyper Scale
 - >110 Trillion Objects, >14 million transactions per second
- Open
 - REST API, Open sourced Client Libraries
 - .NET, Java, C++, Python, Node.js, iOS, Android, Xamarin and so forth
- Hybrid
 - Azure Stack in Windows Server 2016
 - Integration with Azure Services for hybrid connectivity (StorSimple, Backup, Site Recovery)
 - Integration with partner companies (EMC, NetApp, CommVault, Nasuni, Panzura...)

Azure Storage Account

- A general-purpose storage account gives you access to Azure Storage services such as Tables, Queues, Files, Blobs and Azure virtual machine disks under a single account.
 - A storage account is a globally unique entity within the storage system. The storage account is the parent namespace for the Table service, and is the basis for authentication.
 - You can create any number of tables within a given storage account, as long as each table is uniquely named.



Storage Account : stroksa01

File Share URL:

<https://stroksa01.file.core.windows.net/kentfunctiondemob1c5>

Table Store/Database URL:

<https://stroksa01.table.core.windows.net>

Azure Storage Services

IaaS



Storage



Virtual
machines



Networking

PaaS



Existing
frameworks



Web
and mobile



Microservices



Serverless
Compute

Disks

Persistent disks for Azure IaaS VMs

Premium Storage Disks option: SSD based, high IOPS, low latency

Files

Fully Managed File Shares in the Cloud

SMB and REST access
“Lift and shift” legacy apps

Objects

Highly scalable, REST based cloud object store

Block Blobs: Sequential file I/O
Cool Tier Available
Page Blobs: Random-write pattern data
Append Blobs

Tables

Massive auto-scaling NoSQL store

Dynamic scaling based on load
Scale to PBs of table data
Fast key/value lookups

Queues

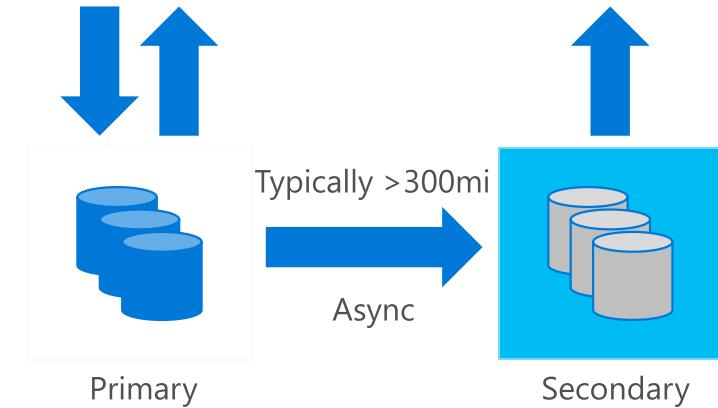
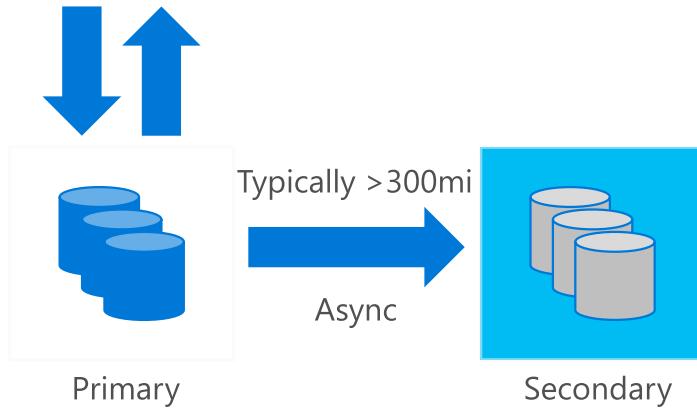
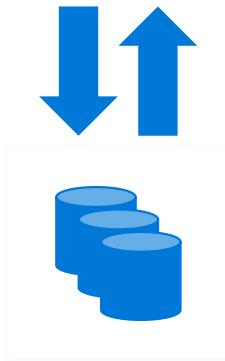
Reliable queues at scale for cloud services

Decouple and scale components
Message visibility
timeout and update message to protect against unreliable dequeuers

Built on a unified Distributed Storage System

Durability, Encryption at Rest, Strongly Consistent Replication, Fault Tolerance, Auto Load-Balancing

Azure Storage Durability



LRS

- 3 replicas, 1 region
- Protect against disk, node, rack failures
- Write is ack'd when all replicas are committed
- Superior to dual-parity RAID

GRS

- 6 replicas, 2 regions (3/region)
- Protects against major regional disasters
- Asynchronous to secondary

RA-GRS

- GRS + Read access to secondary
- Separate secondary endpoint
- RPO delay to secondary can be queried

Strong consistency, checksums/CRC and background scrubbing to preserve data integrity

Azure Tables

- Store petabytes of semi-structured data without manual sharding
- Perform OData-based queries
- Strong consistency
- High availability options
- Suited for these use cases
 - Web app user data
 - Address books
 - Device information
 - Other metadata

Azure Tables

Key Value, high scale, auto-scaling NoSQL store

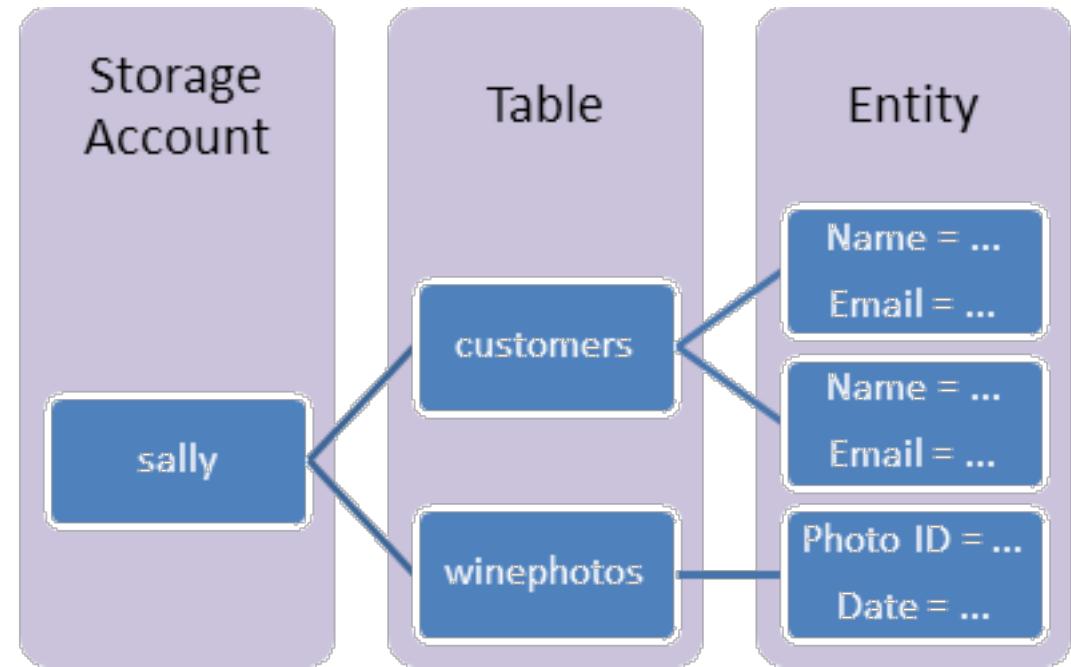
User, device and service metadata, structured data

- Schema-less entities with strong consistency
- No limits on number of table rows or table size
- Dynamic load balancing of table regions
- Best for Key/value lookups on partition key and row key
- Entity group transactions for atomic batching

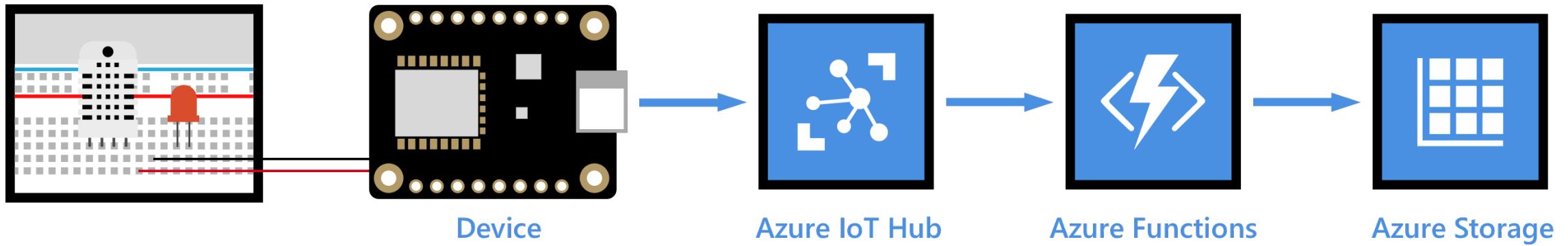


Table Service Concepts

- URL format: `http://<storage account>.table.core.windows.net/<table>`
- Storage Account: All access to Azure Storage is done through a storage account
- Table: A table is a collection of entities..
- Entity: An entity is a set of properties, similar to a database row. An entity can be up to 1MB in size.
- Properties: A property is a name-value pair. Each entity can include up to 252 properties to store data. Each entity also has 3 system properties that specify a partition key, a row key, and a timestamp. Entities with the same partition key can be queried more quickly, and inserted/updated in atomic operations. An entity's row key is its unique identifier within a partition.



Lab Two – Function and Table



Data Persistence (Cold)

1. Create a Azure Storage Account
2. Create an Azure Table Storage/Database
3. Add Azure IoT Hub Endpoint Consumer Group
4. Create an Azure Function App Service
5. Create an Azure Function
6. Confirm data is written to the Azure Table

Lab Two – Function and Table

Goal: Persist data to storage

Duration: 30 Minutes

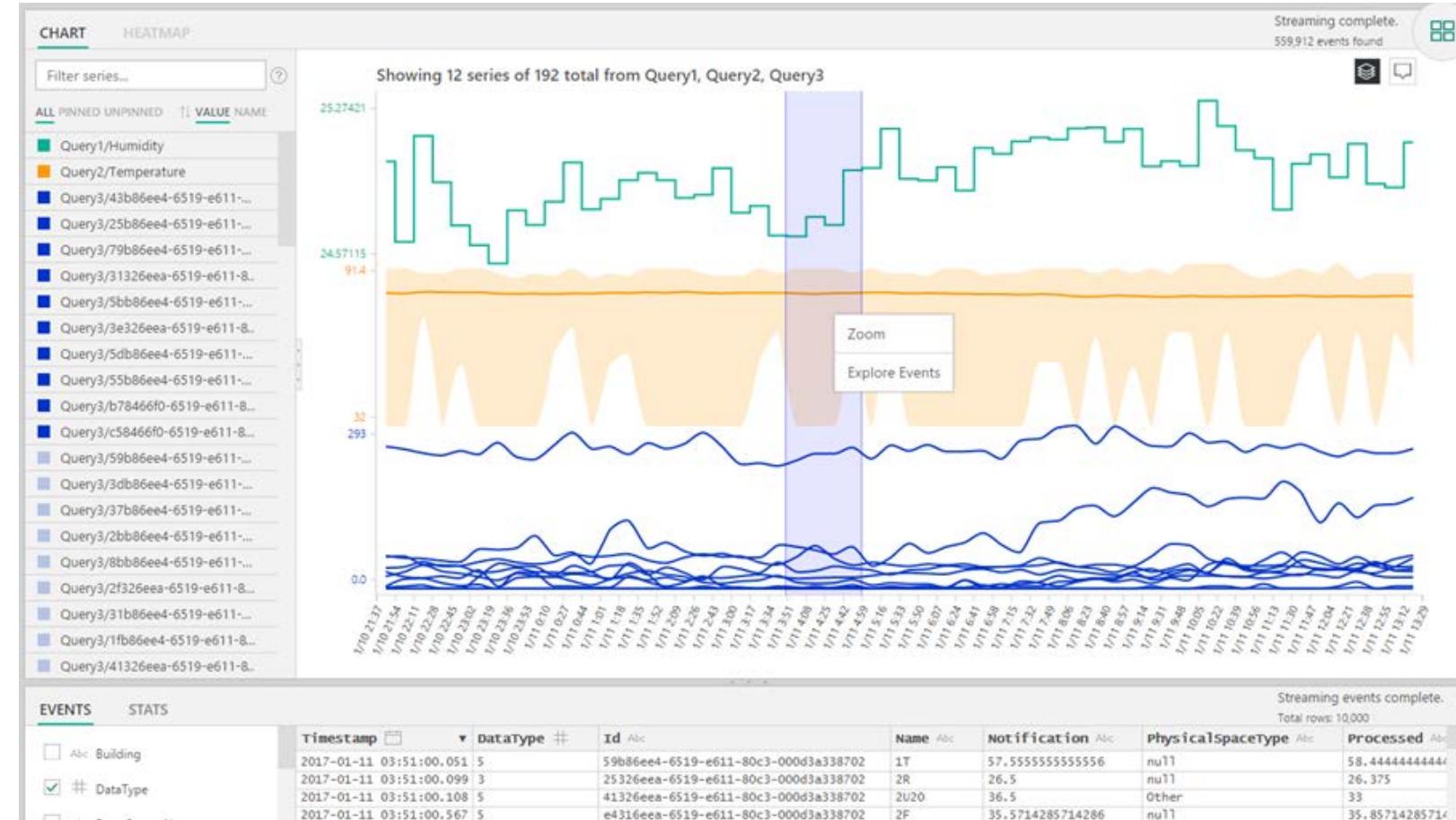
Azure Databases

- [SQL Database](#)
 - Managed relational SQL Database as a service
- [Azure Database for MySQL](#)
 - Managed MySQL database service for app developers
- [Azure Database for PostgreSQL](#)
 - Managed PostgreSQL database service for app developers
- [SQL Data Warehouse](#)
 - Elastic data warehouse as a service with enterprise-class features
- [SQL Server Stretch Database](#)
 - Dynamically stretch on-premises SQL Server databases to Azure
- [Azure Cosmos DB](#)
 - Globally distributed, multi-model database (SQL, NoSQL, MongoDB, and Graph)
- [Table Storage](#)
 - NoSQL key-value store using semi-structured datasets
- [Redis Cache](#)
 - Power applications with high-throughput, low-latency data access
- [Data Factory](#)
 - Orchestrate and manage data transformation and movement

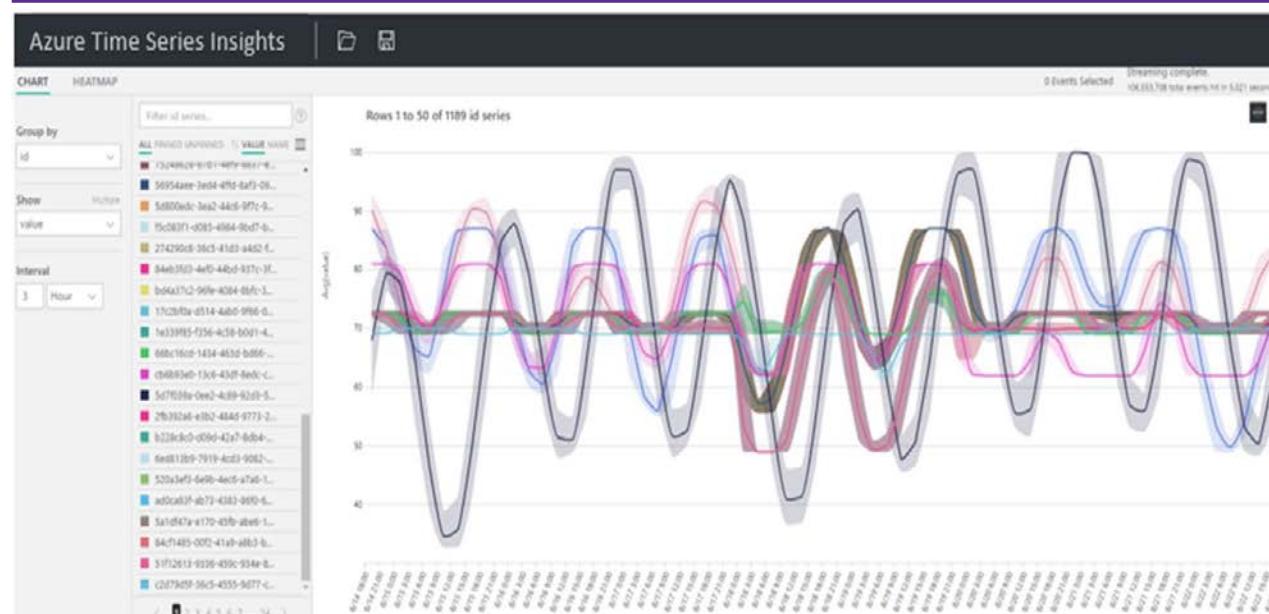
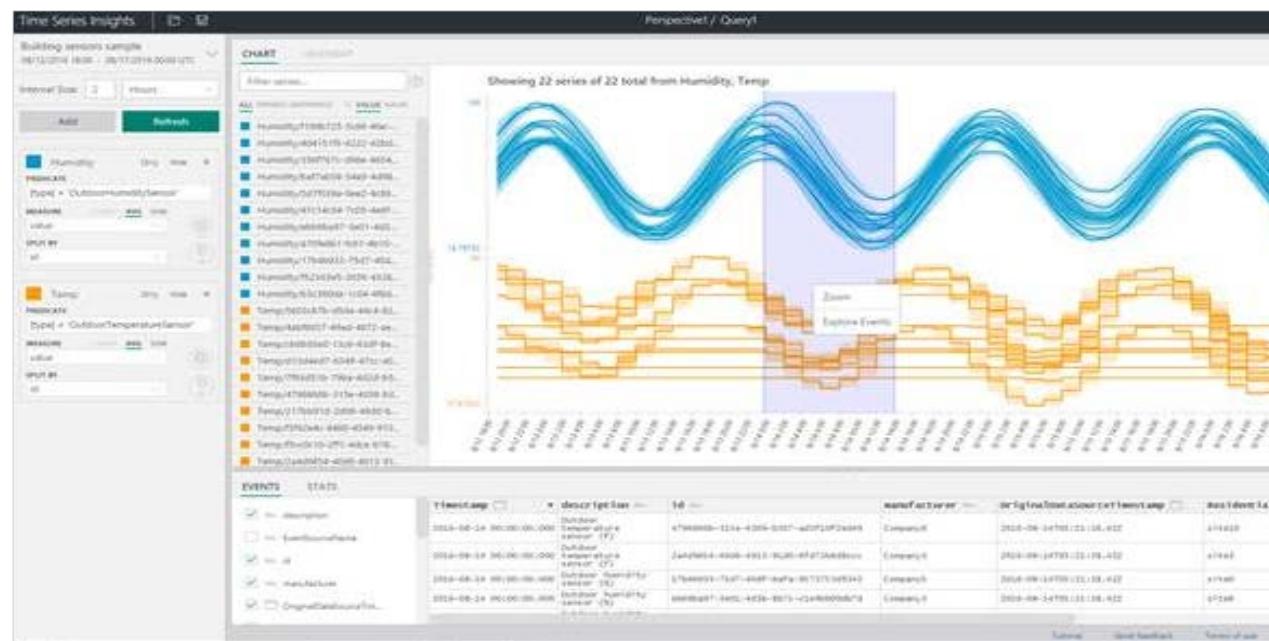
Azure Time Series Insights

Azure Time Series Insights is a fully managed analytics, storage, and visualization service that makes it incredibly simple to explore and analyze billions of events simultaneously.

- Get near real-time insights in seconds
- Start in seconds, scale in minutes
- Create a global view of your IoT-scale data
- Leverage the power of Time Series Insights in your Apps and Solutions



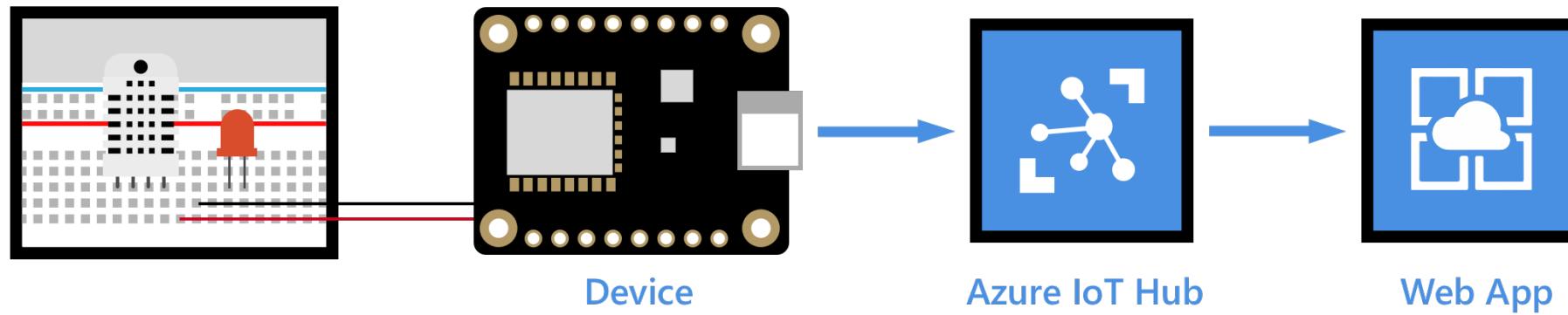
Powerful Analytics and Visualizations



Websites and apps

- Build standards-based web apps and APIs
 - .NET, Node.js, PHP, Python, and Java
- Rich gallery of pre-built APIs
 - like Office 365 and Salesforce
- Developer productivity
 - continuous integration using Visual Studio Team Services and GitHub
 - live-site debugging
- Enterprise grade
- Containers
- Global scale
 - provides availability and automatic scale on a global datacenter infrastructure
 - scale applications up or down on demand
 - get high availability within and across different geographical regions

Data Visualization with Web Applications



- + Web App
 - Deploy provided JavaScript code using Visual Studio

Lab Three – Visualize w/Web App

Goal: Create a web app to display the data from the table database

Duration: 30 Minutes

Want to keep going and do more?

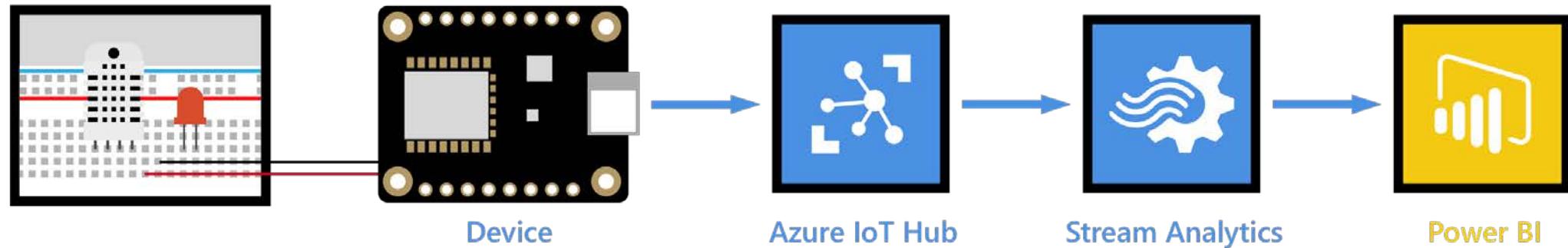
- **Leave your current environment in tact...**

- Go to this URL:

<https://docs.microsoft.com/en-us/azure/iot-hub/iot-hub-get-started>

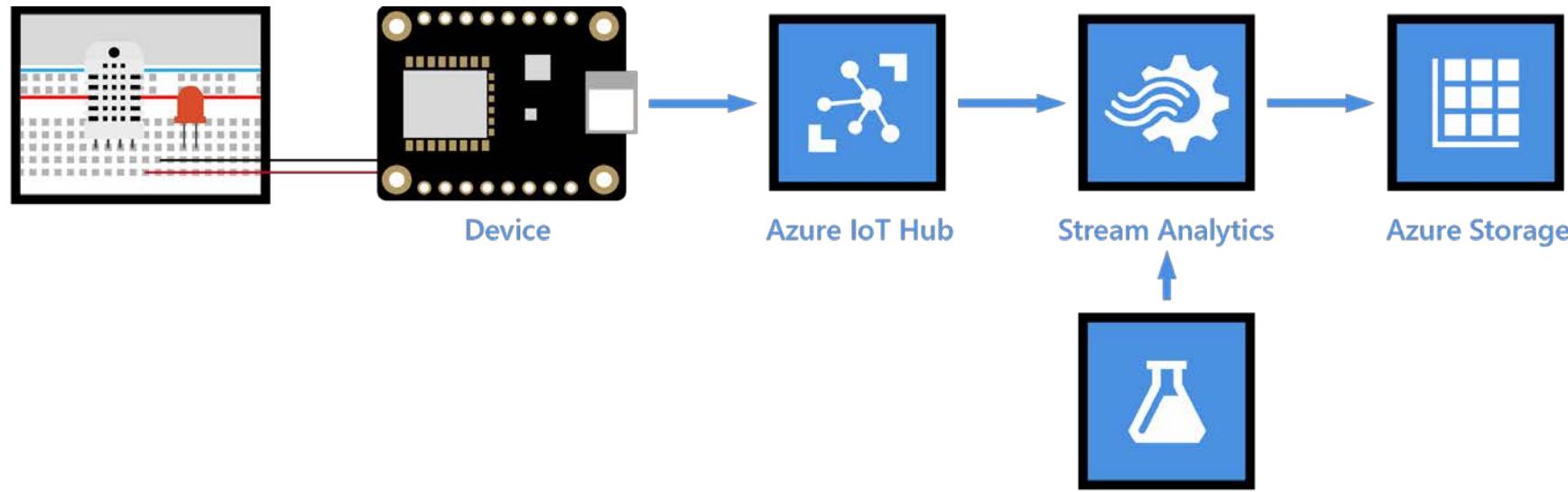
- Extended IoT Scenarios

Data Visualization in Power BI



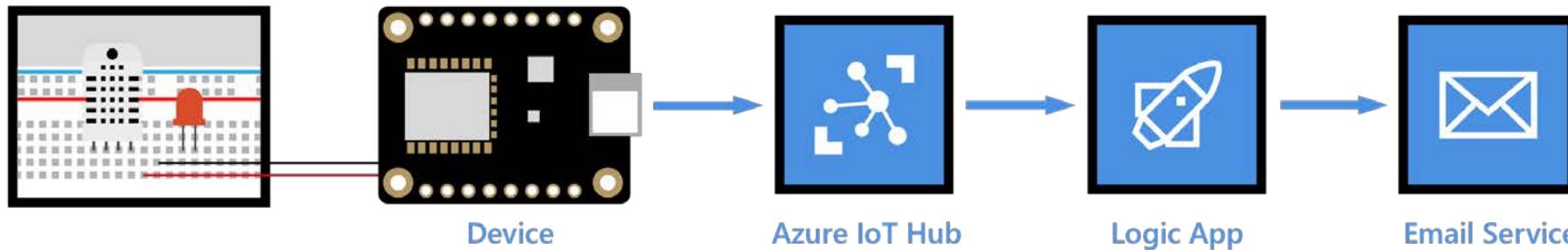
- Get your IoT hub ready for data access by adding a consumer group.
- Create, configure and run a Stream Analytics job for data transfer from your IoT hub to your Power BI account.
- Create and publish a Power BI report to visualize the data.

Azure Machine Learning



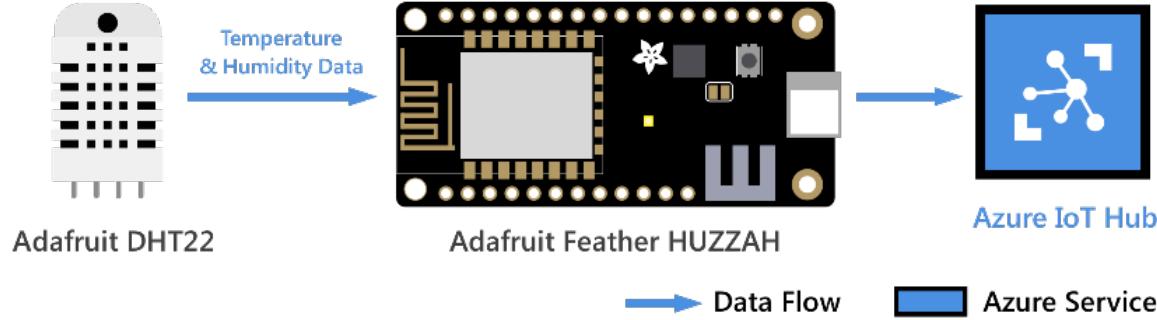
- Deploy the weather prediction model as a web service.
- Get your IoT hub ready for data access by adding a consumer group.
- Create a Stream Analytics job and configure the job to:
- Read temperature and humidity data from your IoT hub.
- Call the web service to get the rain chance.
- Save the result to an Azure blob storage.
- Use Microsoft Azure Storage Explorer to view the weather forecast.

Remote Monitoring

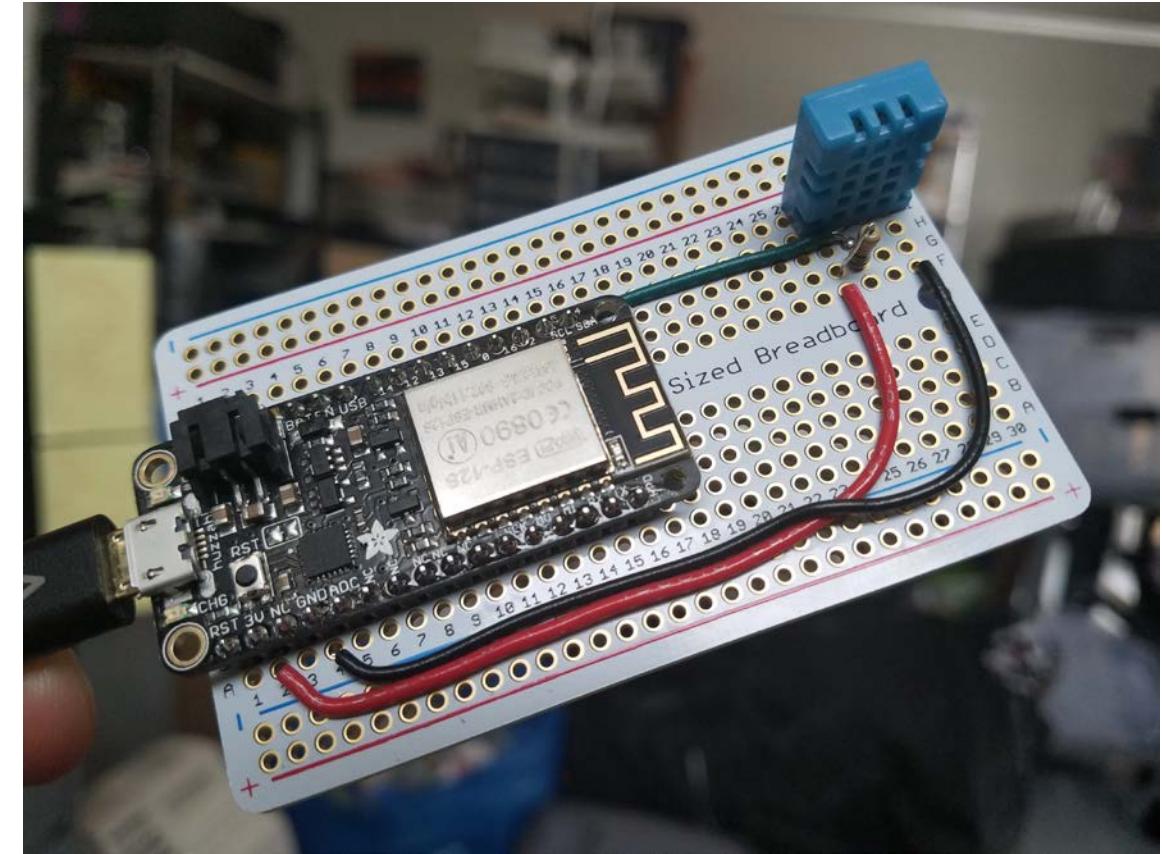


- Create a service bus namespace and add a queue to it.
- Add an endpoint and a routing rule to your IoT hub.
- Create, configure, and test a logic app.

Make a physical device



- Adafruit.com
 - Adafruit Feather HUZZAH (#2821) - \$16.95
 - Half-size Breadboard (#64) - \$5.00
 - DHT11 (#386) - \$5.00
- Bit of wire and soldering



<https://docs.microsoft.com/en-us/azure/iot-hub/iot-hub-arduino-huzzah-esp8266-get-started>

Microsoft Azure IoT services

Devices	Device Connectivity	Storage	Analytics	Presentation & Action
	Event Hub	SQL Database	Machine Learning	App Service
	IoT Hub	Table/Blob Storage	Stream Analytics	Power BI
	Service Bus	DocumentDB	HDInsight	Notification Hubs
	External Data Sources	3 rd party Databases	Data Factory	Mobile Services
			Data Lake	BizTalk Services

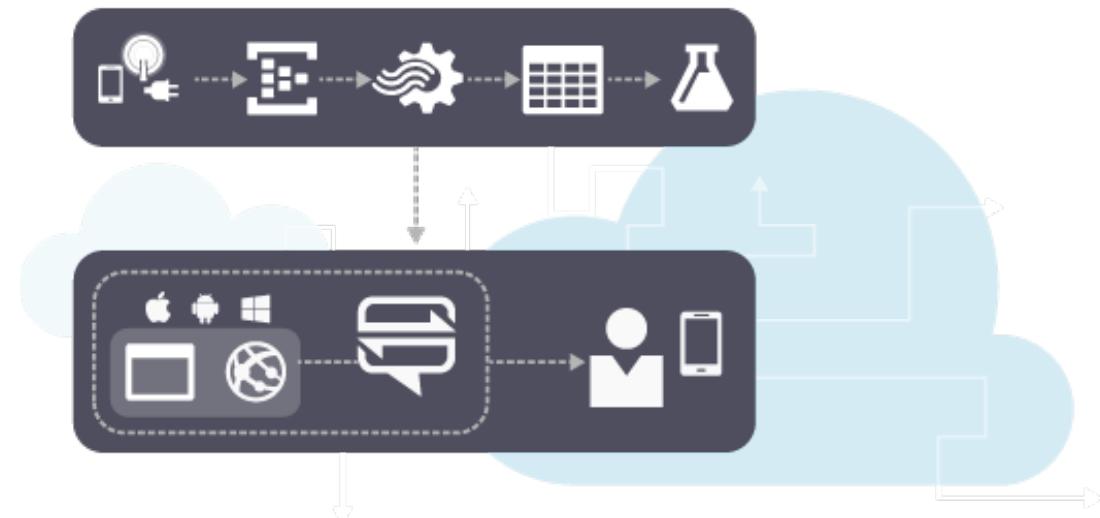
Introducing Microsoft Azure IoT Suite

Capture and analyze untapped data to improve business results

- Get started quickly with preconfigured solution
- Tailor preconfigured solutions to meet your needs
- Enhance the security of your IoT solutions
- Support a broad set of operating systems and protocols
- Easily connect millions of devices
- Analyze and visualize large quantities of operational data
- Integrate with your existing systems and applications
- Scale from proof of concept to broad deployment
- Connect and monitor your factory industrial devices

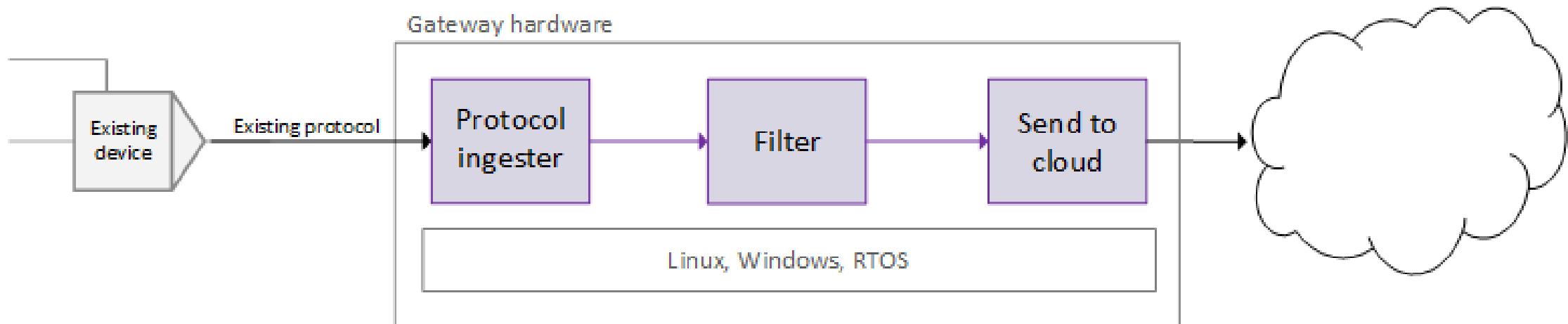
Popular solutions

- Remote monitoring
- Predictive maintenance
- Connected factory



Azure IoT Edge (Preview)

- Use existing devices, using existing protocols
- On-premises gateway
 - performs protocol adaptation which allows the device to send data to the cloud
 - it also filters the data so that only the most important information is uploaded



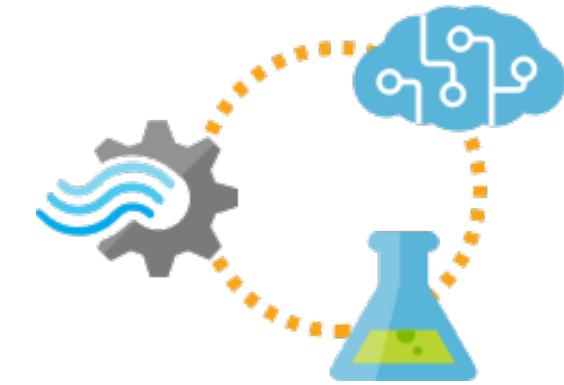
Connect your existing devices which speak their existing protocols without making expensive changes to them.

Create a module pipeline which accomplishes your specific scenario.

Only send necessary data to the cloud for further analytics, dashboarding, or storage.

Azure IoT Edge (Preview)

- Extend cloud intelligence to edge devices
 - Run artificial intelligence at the edge
 - Perform edge analytics
 - Deploy IoT solutions from cloud to edge
 - Manage devices centrally from the cloud
 - Operate with offline and intermittent connectivity
 - Enable real-time decisions
 - Connect new and legacy devices
 - Reduce bandwidth costs

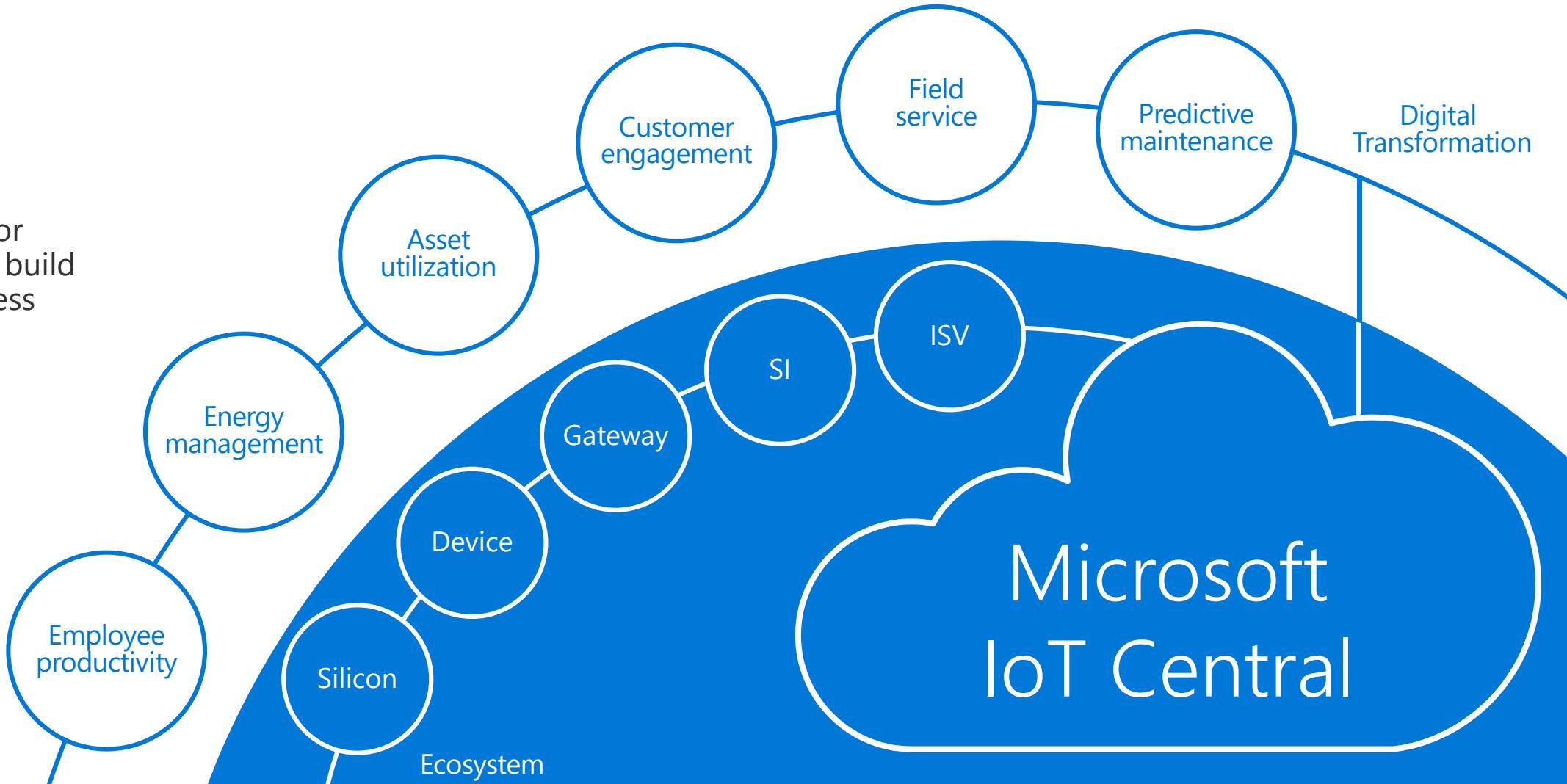


Introducing Microsoft IoT Central

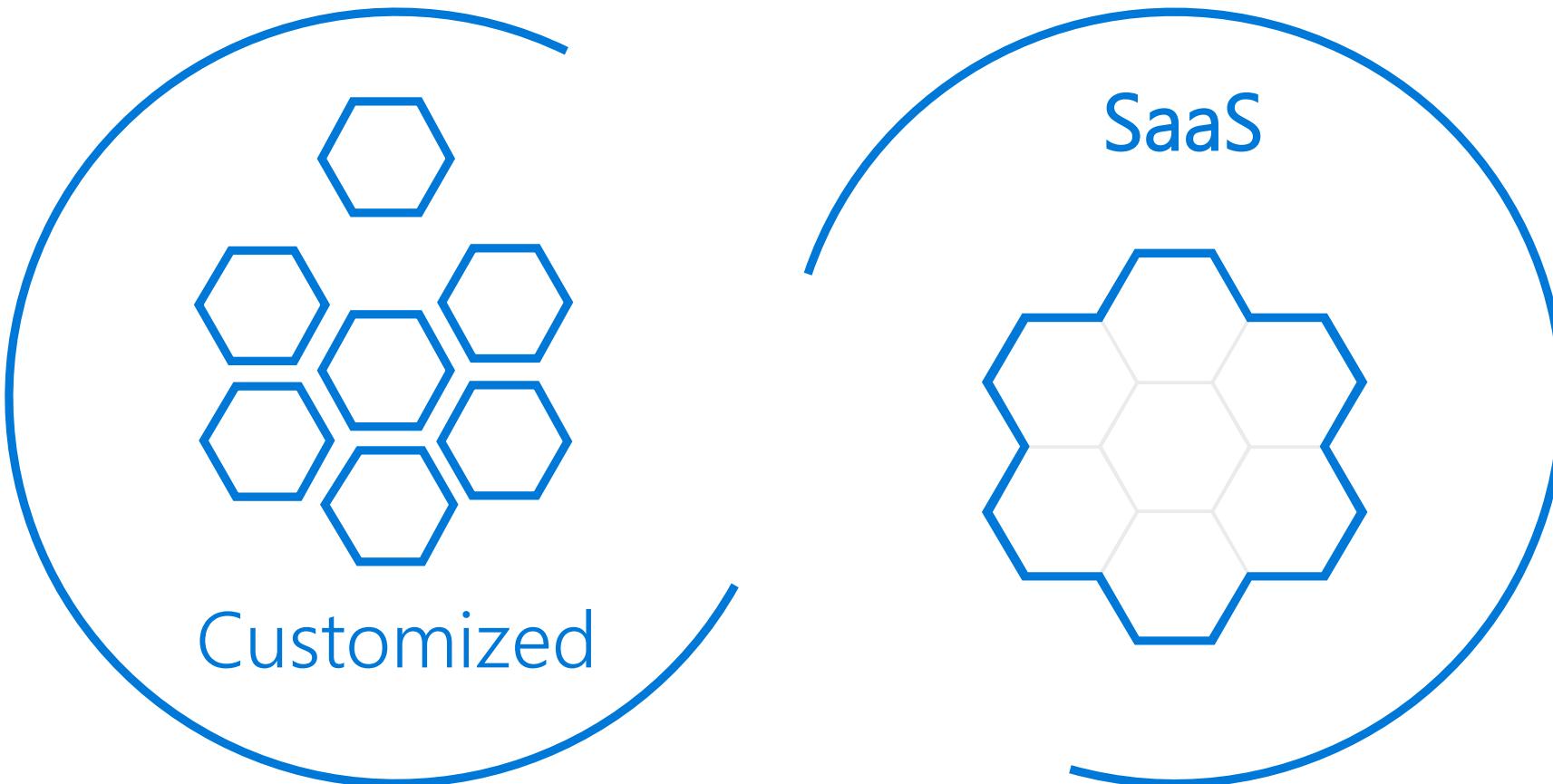
Accessible
for everyone

The focus point for
the ecosystem to build
IoT related business

The foundation
for your digital
transformation



There's more than one approach





Break down barriers for IoT



Fully managed SaaS solution

Reduce solution development and management burden

Complete solution for your connected products – capture, analyze, and act

Codeless experience for modeling your products



**Push new
boundaries with
dynamic business
opportunities**



Digital models to speed innovation

Employ a flexible, scalable solution that adapts to your needs and processes

Make dynamic changes to add new models or simulate what-if scenarios

Capture insights with built-in visualization for operational trends and problem analysis



**Leverage proven
technology &
ecosystem**



Rely on a commitment to IoT

Leverage proven technologies

Stay in control of your data

Achieve your business goals with rapidly
innovating products

Project Sopris

- Academic research project
 - Modified MT7687
 - Research team exploring the goal of securing the vast number of low cost internet connected devices coming online
 - “The Seven Properties of Highly Secure Devices”
 - Hardware-based Root of Trust
 - Small Trusted Computing Base
 - Defense in Depth
 - Compartmentalization
 - Certificate-based Authentication
 - Renewable Security
 - Failure Reporting
- Security Challenge
 - 30 Days and no verified exploits, yet (started March 2017)
 - Increasing the bounty payout. Stay tuned...
 - We’re looking for the first confirmed vulnerabilities in this prototype device
 - Security experts face the challenge and vie for \$100,000 in prizes

Partner with Microsoft for significant advantages



Industry-leading security

From endpoint and connection through to data and the cloud



Open platform

Any device, OS, data source, software, or service



Comprehensive portfolio

Only mega-scale cloud vendor to offer SaaS and PaaS for IoT, and a commitment to continual innovation



Extensive partner ecosystem

Industry leaders ready to collaborate with your business



Large-scale SaaS experience

Prepared to deliver powerful, user-friendly solutions

GitHub and Azure IoT

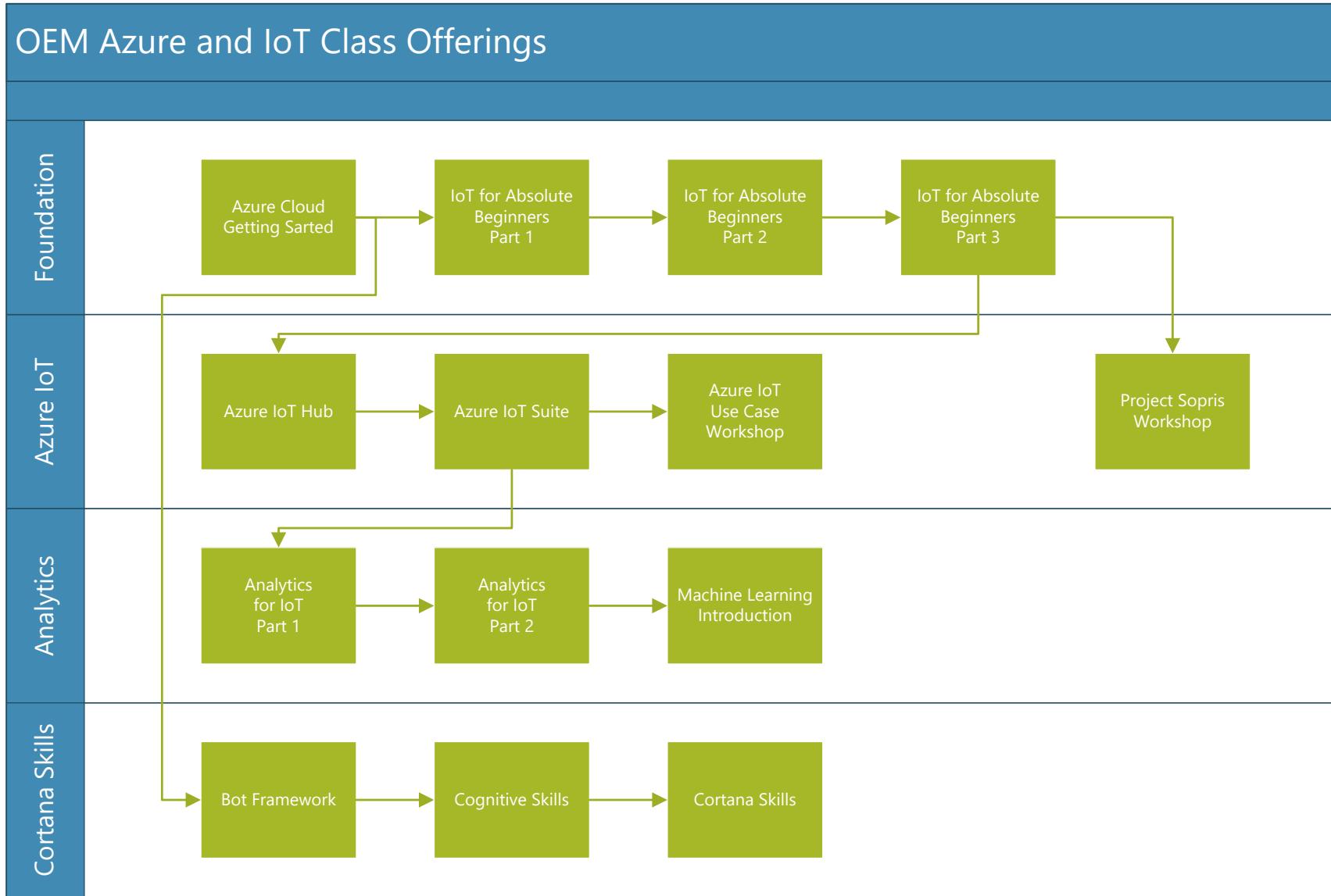
- <https://github.com/Azure>
- <https://github.com/Azure-Samples>
- <https://github.com/Azure/azure-quickstart-templates>



Favorite Places

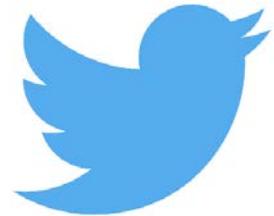
www.microsoft.com/en-us/internet-of-things/

Future Hackster/Microsoft IoT Workshops



Next Steps for Education

- Azure IoT Sites
 - <https://docs.microsoft.com/en-us/azure/>
- Power BI Sites
 - <https://powerbi.microsoft.com/en-us/>
- Microsoft Virtual Academy
 - mva.microsoft.com
- Other education services
 - Edx.org – 35 courses, 3 programs
 - An IoT program is coming



@Azure
@MicrosoftIoT
@Hackster.io
@kentstroker



Keep Learning!

