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Offload AI and analytics workloads to the edge

AGENDA

- Introduction: What is edge analytics?
- Edge Analytics Architecture
- Edge Computing and IoT Edge
- Azure IoT Edge-based edge analytics
- Azure IoT Edge Architecture Overview
- Azure IoT Edge Architecture in Depth
- Implementing Edge Analytics with Azure IoT Edge
- Azure ML and Cognitive Services on the edge
- Using edge analytics in the real world
- Demos

Introduction:
What is edge analytics?

What is edge analytics?

- Early computers
- The rise of the personal computer
- Peer-to-peer networks
- Cloud computing
- Edge computing
- Early IoT applications
- Edge analytics

History of Edge Analytics

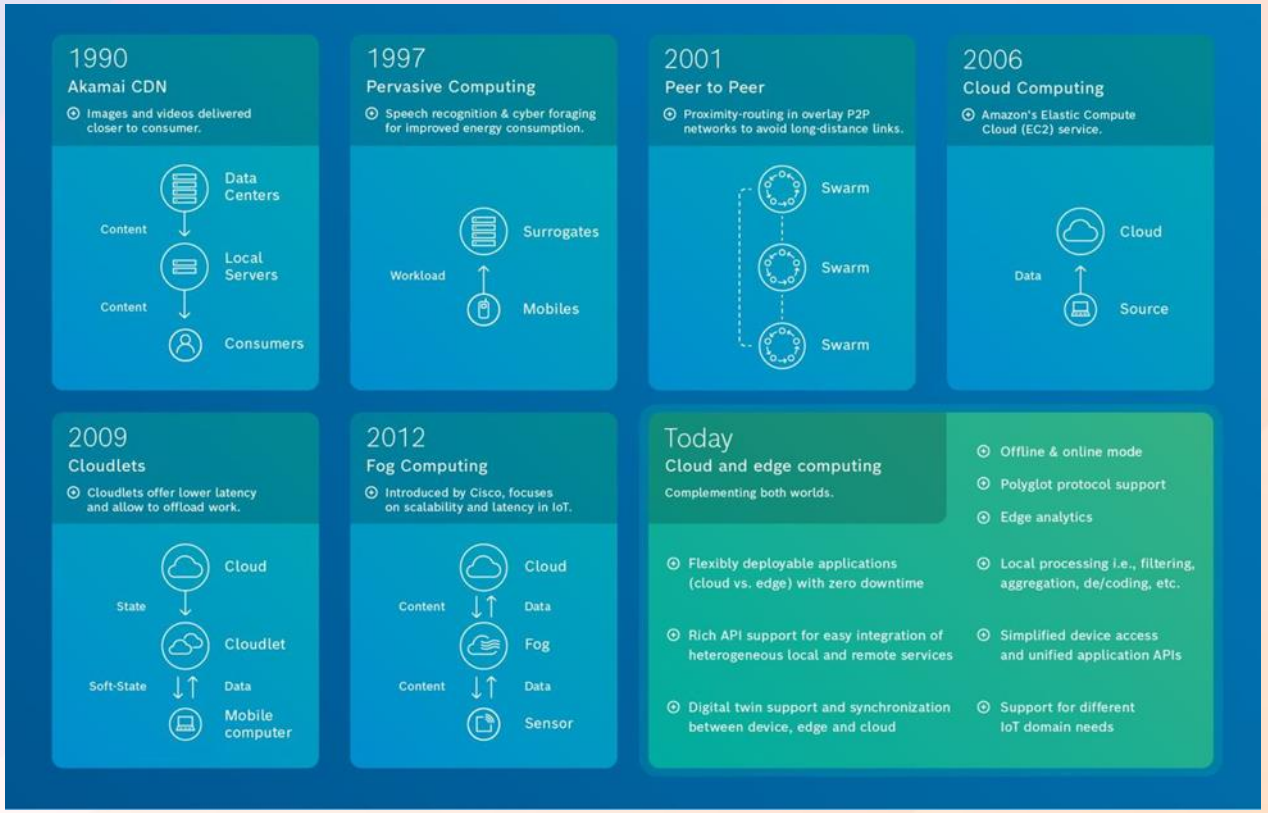


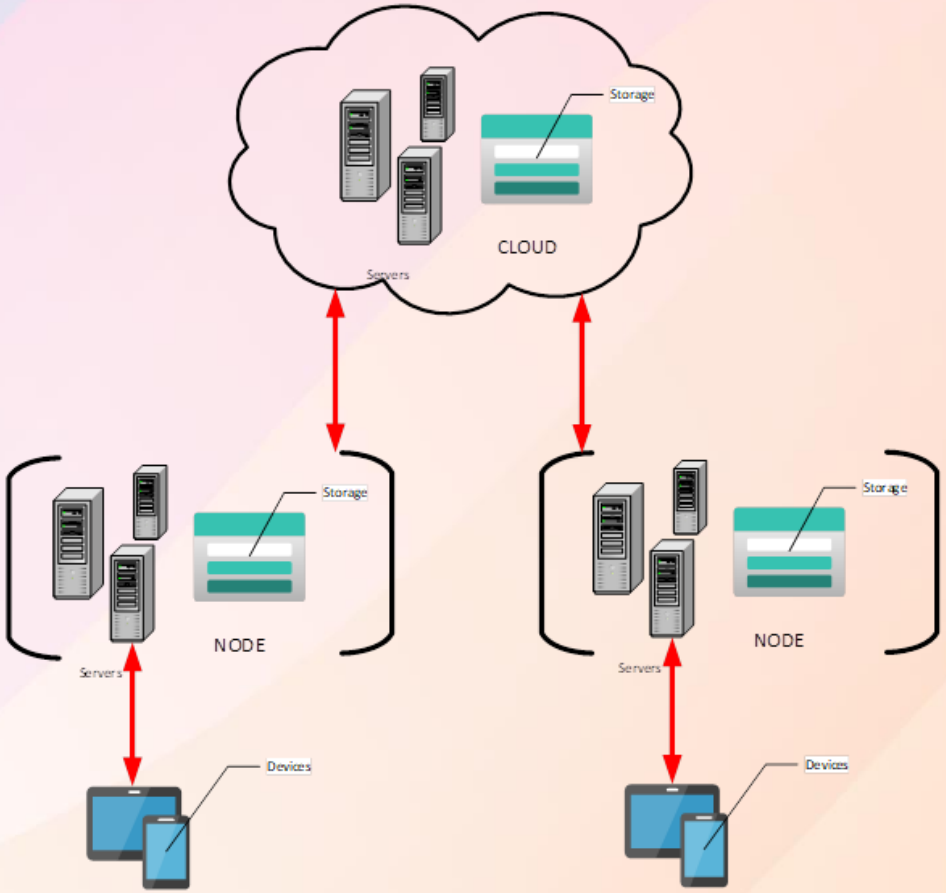
Figure 1.2 - The history of IoT Edge.

Understand Edge Computing concept

- Edge computing is a form of distributed computing whereby resources are copied from a remote location to a local one.

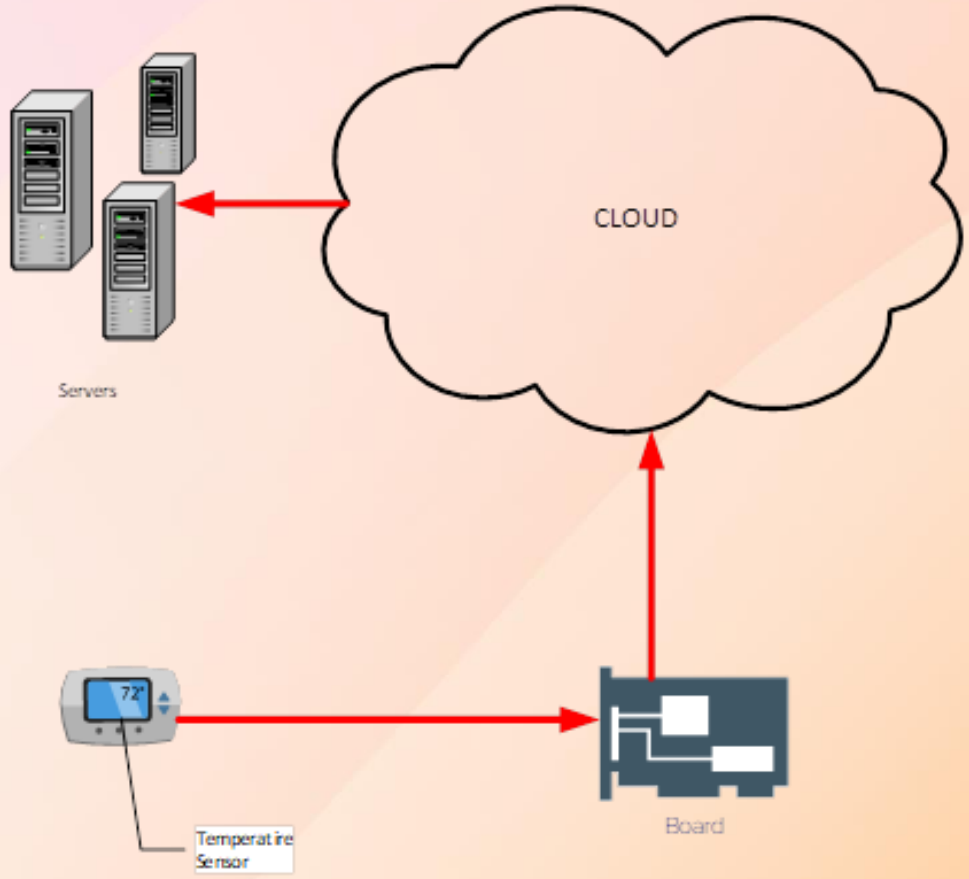
- Despite improvements to network technology, having nodes close to the location where data is generated is a methodology which is paid back due to the following three factors:
  - Privacy
  - Latency
  - Reliability

Edge computing



Edge analytics

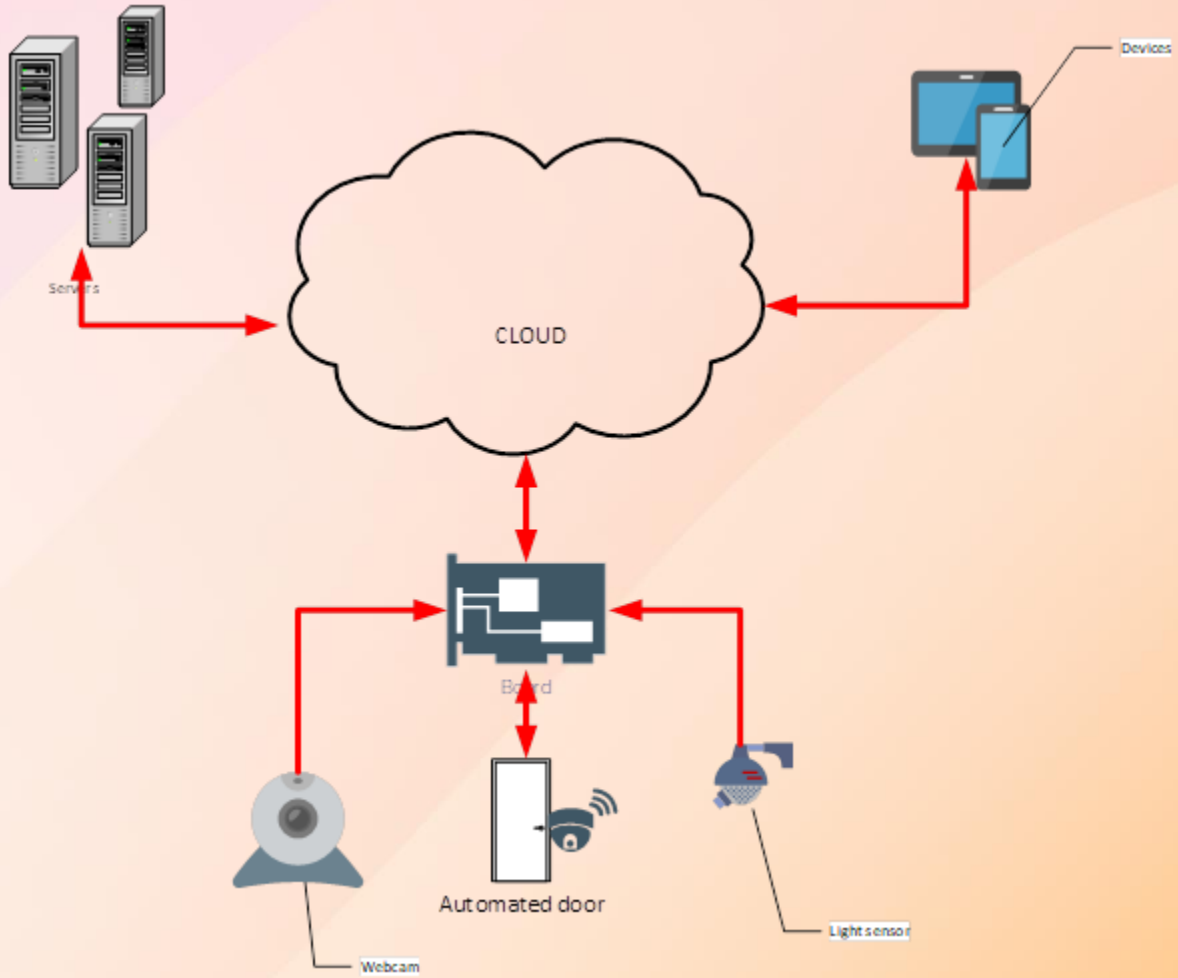
- Edge analytics removes some of the processing responsibilities from the internet-connected computer



Simple edge analytics solution

Key benefits of edge analytics

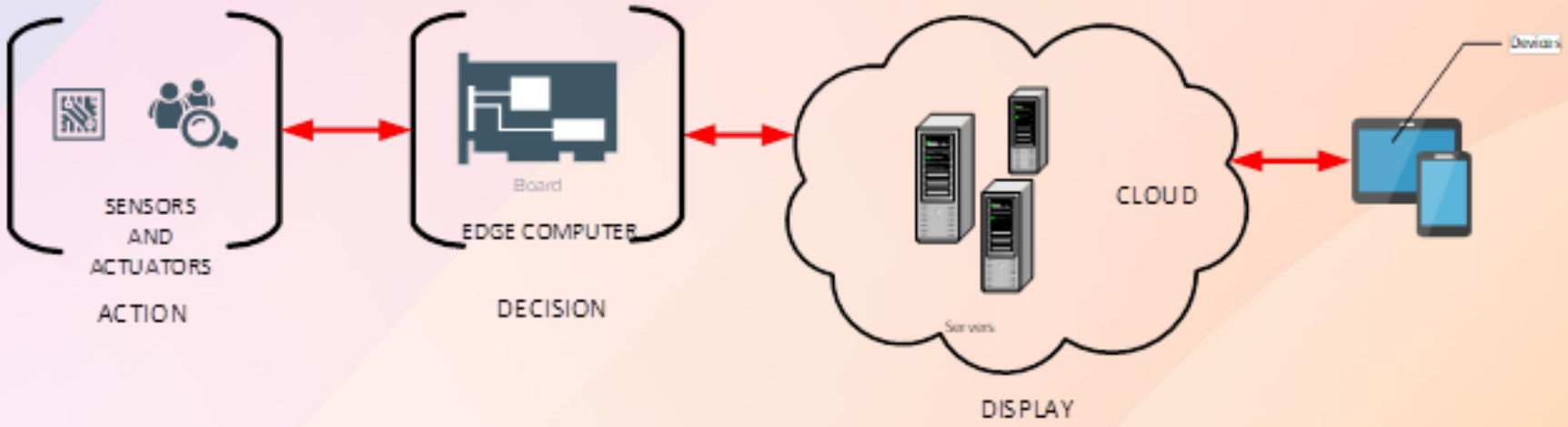
- Implementing edge analytics into our IoT design has advantages that outweigh the costs and complexity



Home automation edge analytics solution

Key benefits of edge analytics

- Privacy
- Latency
- Reliability

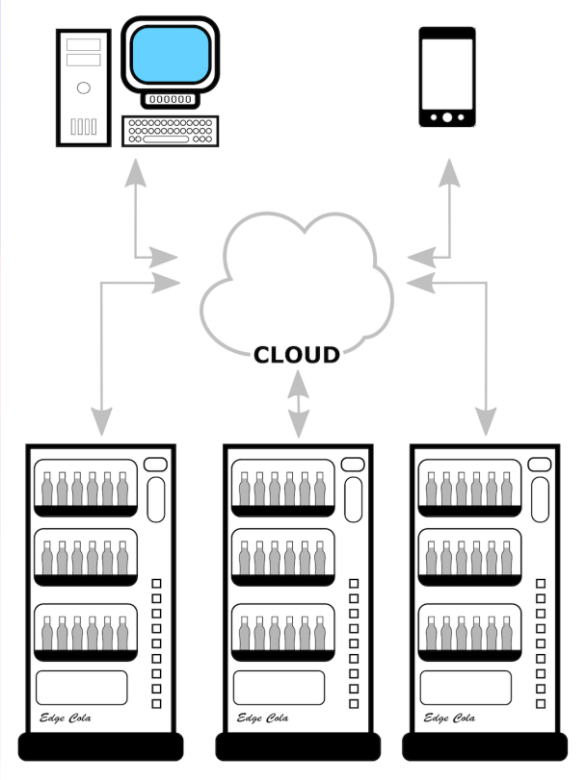


Sample edge analytics flow

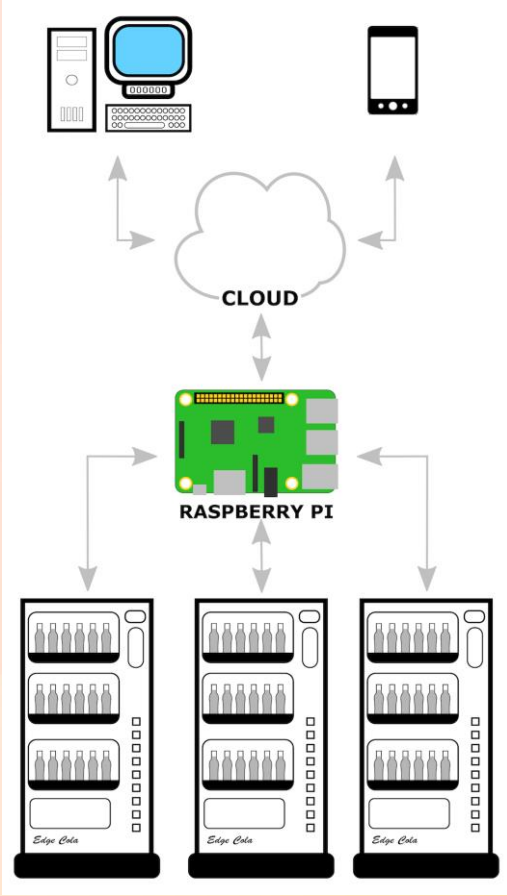
Edge Analytics Architecture

Traditional vs Edge IoT Solutions

- The standard IoT solution

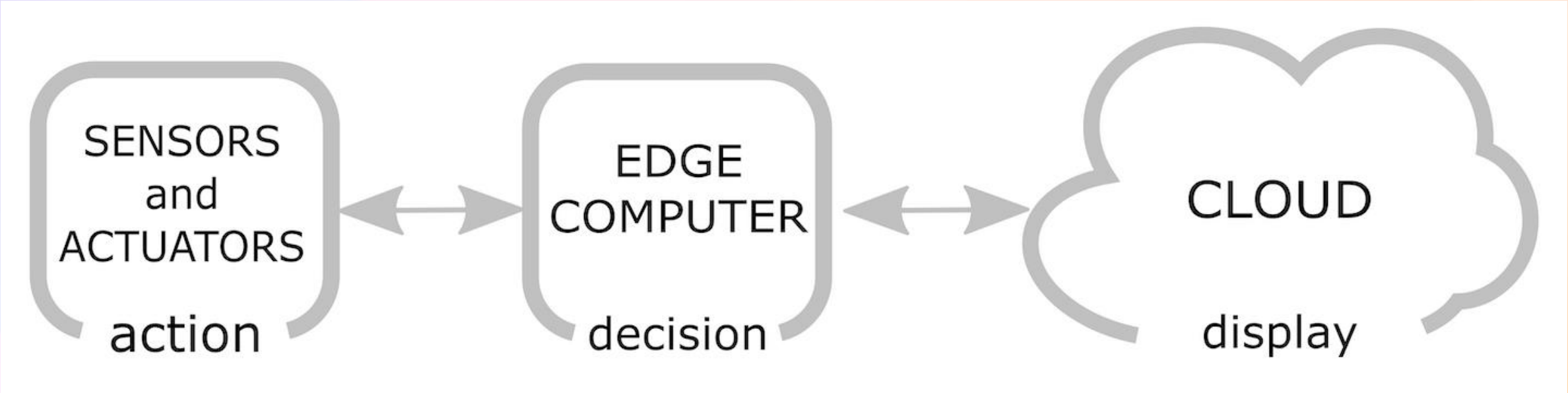


- Edge analytics-based IoT solution



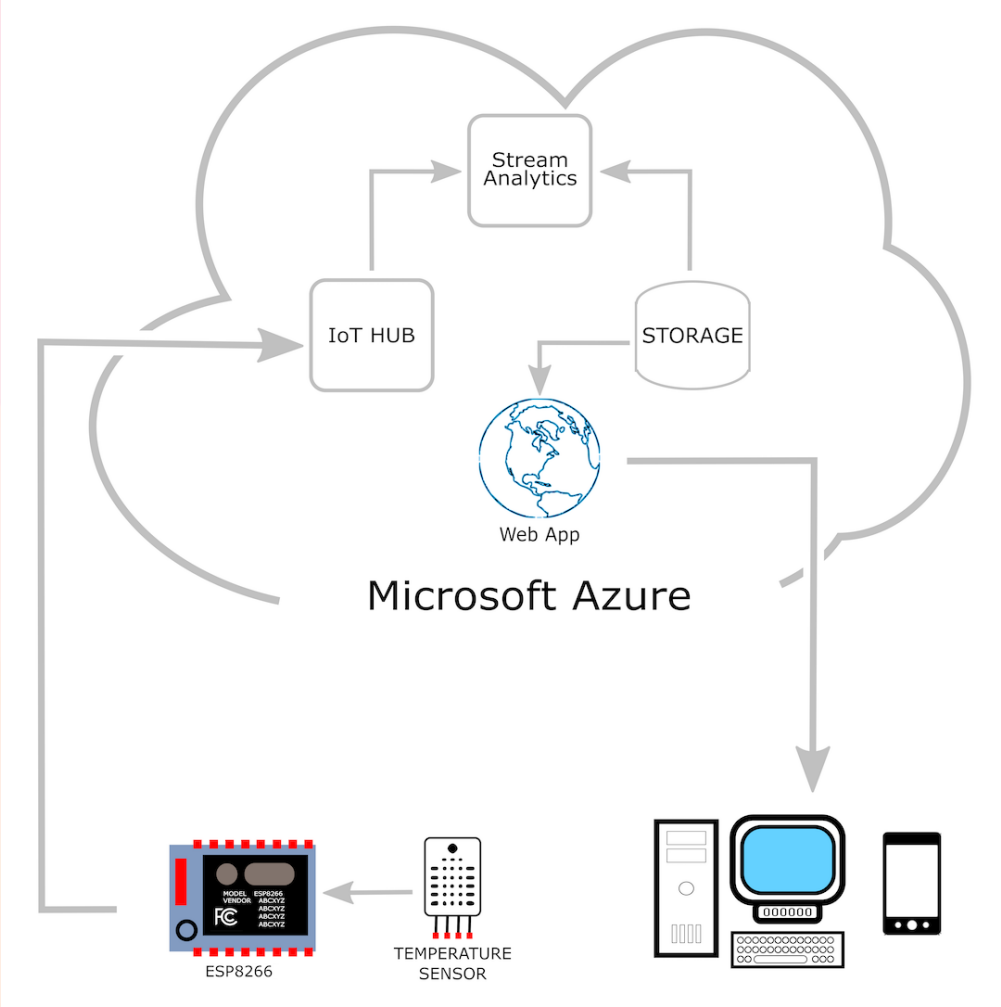
Basic edge analytics architecture

- A basic edge analytics application consists of three major components



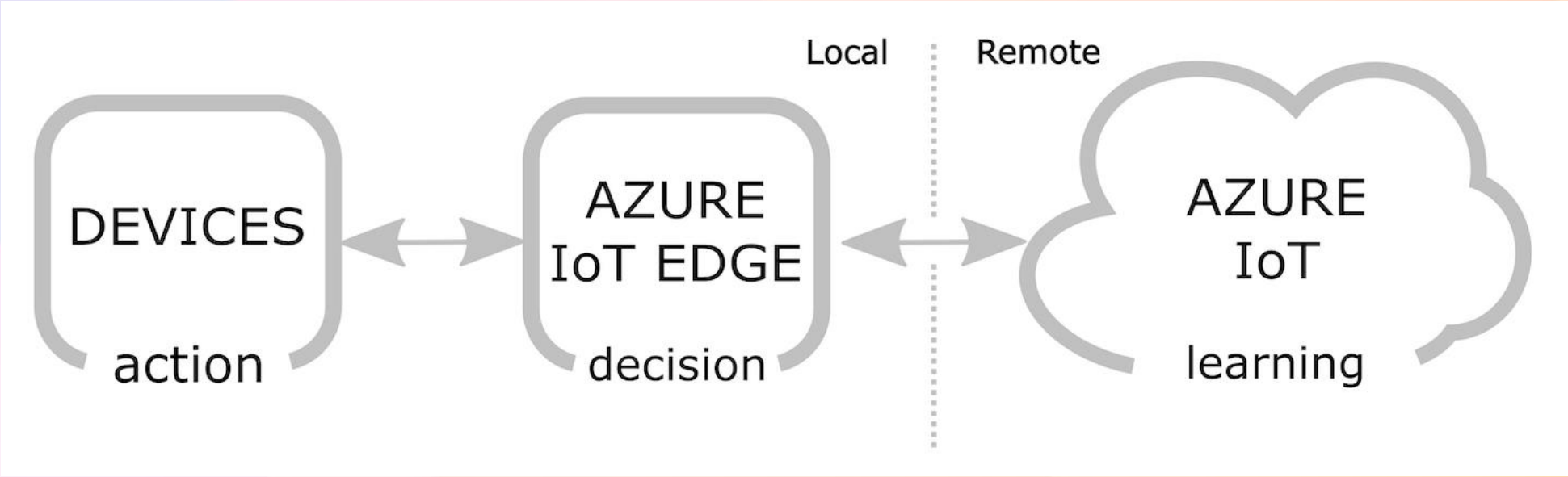
Azure IoT Edge-based edge analytics architecture

- Microsoft Azure IoT
  - Able to utilize pre-written code, as well as have an infrastructure already set up



Microsoft Azure IoT Edge

- Azure IoT Edge is a form of distributed computing whereby Azure modules are copied to the physical edge device



Edge Computing and IoT Edge

What is IoT Edge?

Specific Edge Analytics System

- Run workloads at the edge.
- Reduce the bandwidth
- Clean and aggregate the data locally, and then only send the insights to the cloud
- The IoT Edge solution is a specific Edge analysis system that uses Edge analysis on the Internet of Things.

What is IoT Edge?

- Manage data to reduce costs
- Reliably operate in offline or intermittent mode
- Provide security for edge deployments
- Ensure privacy for IoT deployments
- Act as a gateway
- Availability of third-party modules

Core IoT Edge Features

- Complex event processing
- Machine learning and artificial intelligence models.
- Applications
- Offline support
- Data management


When to Use IoT Edge?

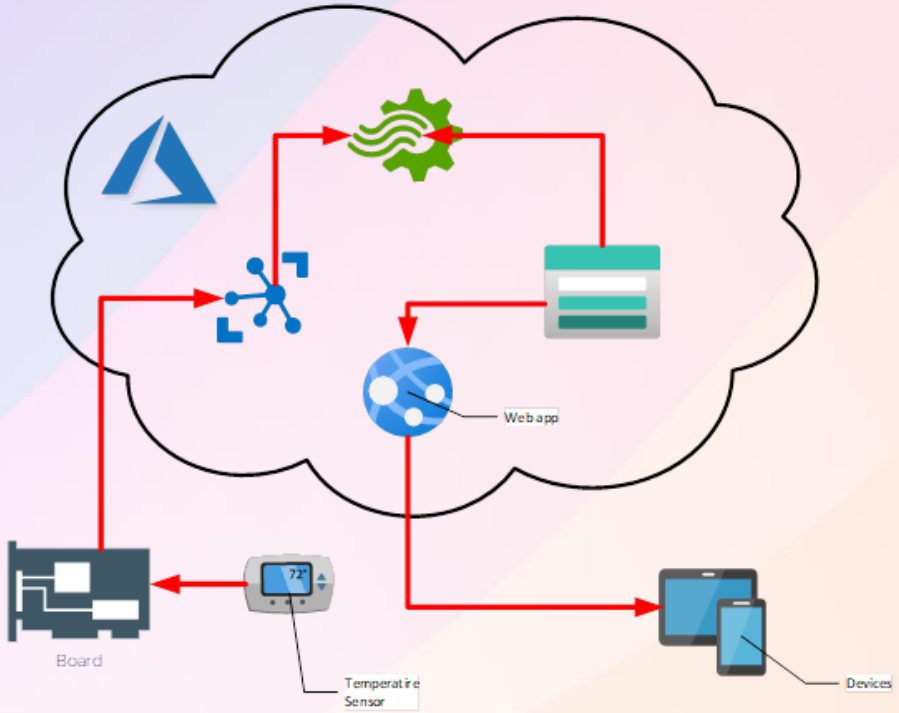
When to use IoT Edge

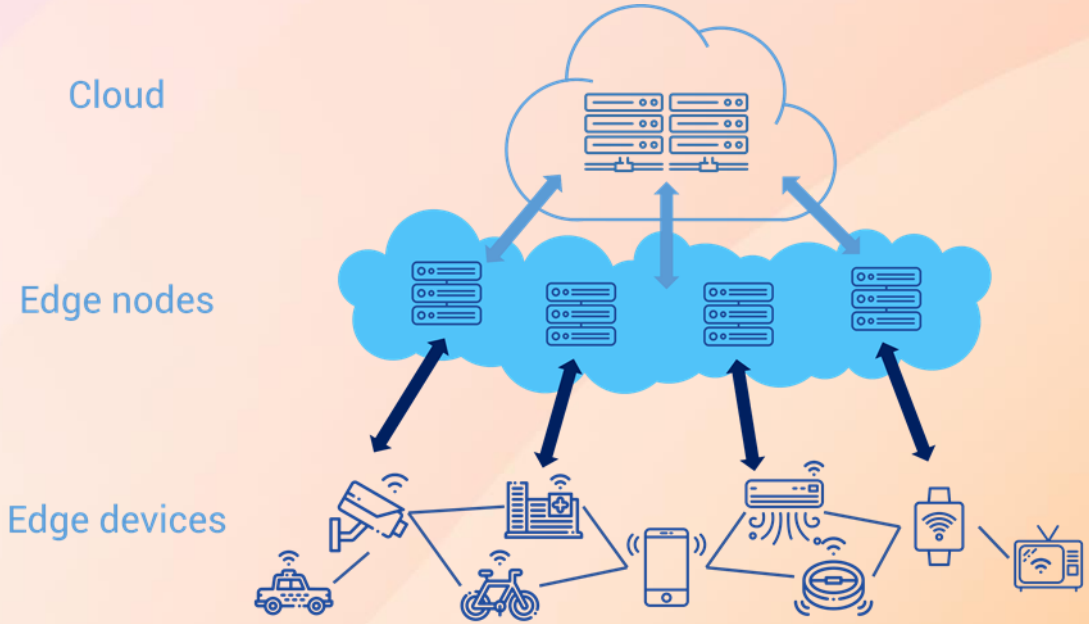
- Near real-time response to local changes
- Deploy and manage using Containers to IoT Edge devices
- Security for IoT Edge deployments
- Offline or intermittent mode operation
- AI and analytics workloads to the IoT Edge
- Optimize data costs
- Privacy for IoT Edge deployments

Azure IoT Edge-based edge analytics

Azure IoT Edge-based edge analytics

- Sample Azure IoT Edge Solution





Top Trends with IoT and Edge Device

- Low power connectivity
- Analytics on the edge
- Increased Security

Popular Edge Analytics platforms

- Microsoft Azure IoT Edge
- AWS IoT GreenGrass
- Cisco SmartAdvisor
- Dell Statistica
- HPE Edgeline
- IBM Watson IoT Edge Analytics
- Intel IoT Developer Kit
- Oracle Edge Analytics (OEA)
- PTC ThingWorx Analytics
- Streaming Lite by SAP HANA

Top IoT Edge analytics real use cases

- Autonomous vehicles
- Remote monitoring of assets in the oil and gas industry
- Smart grids
- Predictive maintenance
- In-hospital patient monitoring
- Virtualized radio networks and 5G
- Cloud gaming
- Content delivery
- Traffic management
- Smart homes
- Security Solutions
- Retail Advertising
- Smart Speakers
- Video Conferencing

Azure IoT Edge Architecture Overview

Azure IoT Edge Architecture Overview

- Azure Edge and Azure IoT Edge
- IoT Edge modules
- IoT Edge runtime
- Monitoring IoT Edge with IoT Edge cloud interface

Microsoft Azure IoT Edge in a nutshell

- Flows with Azure IoT Edge

Microsoft Azure IoT Edge main components

Azure IoT Edge is made up of three components

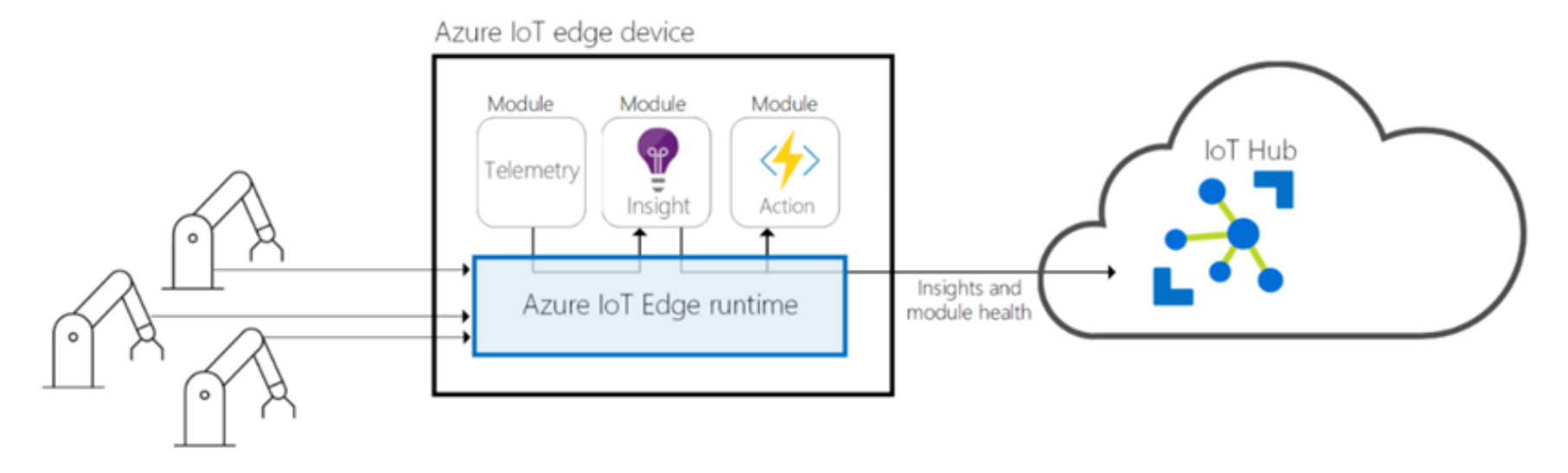
- IoT Edge modules
- IoT Edge runtime
- A cloud-based interface

IoT Edge modules

- Units of execution, implemented as Docker compatible containers, that run your business logic at the edge.
- Multiple modules can be configured to communicate with each other
- You can develop custom modules or package certain Azure services into modules that provide insights offline and at the edge.

IoT Edge runtime environment

The IoT Edge runtime provides the infrastructure to integrate the functionality of multiple IoT Edge modules and to deploy them onto IoT Edge devices.



IoT Edge runtime environment

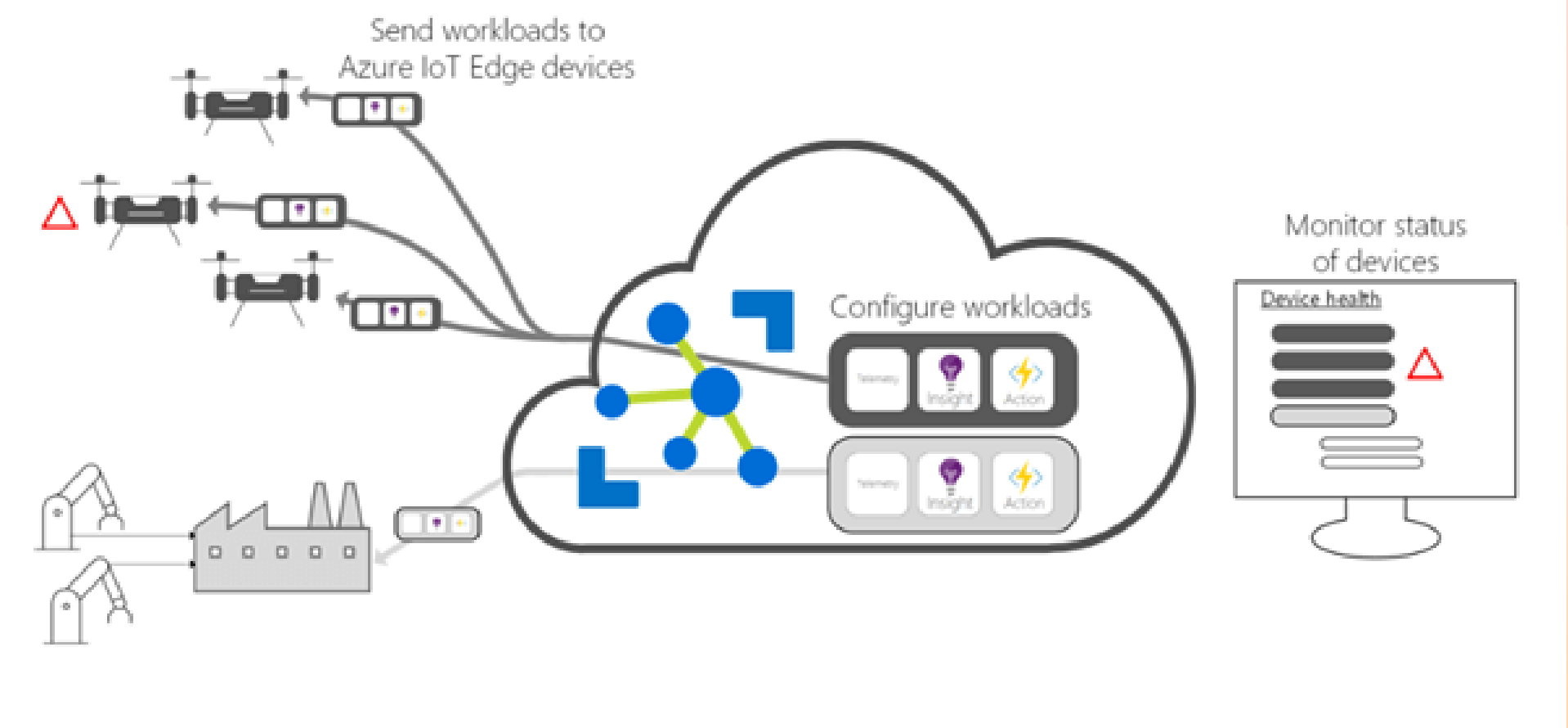
The IoT Edge runtime is responsible for the following functions on IoT Edge devices:

- Maintain Azure IoT Edge security standards on the device.
- Ensure that IoT Edge modules are always running.
- Report module health to the cloud for remote monitoring.
- Manage communication between downstream devices and IoT Edge devices.
- Manage communication between modules on the IoT Edge device.
- Manage communication between the IoT Edge device and the cloud.

IoT Edge cloud interface

- This interface allows you to remotely monitor and manage IoT Edge devices.
- Allow users to create and configure a workload to be run on a specific type of device
- Send a workload to a set of devices and monitor workloads running on devices in the field.
- Manage the software life cycle for IoT Edge devices

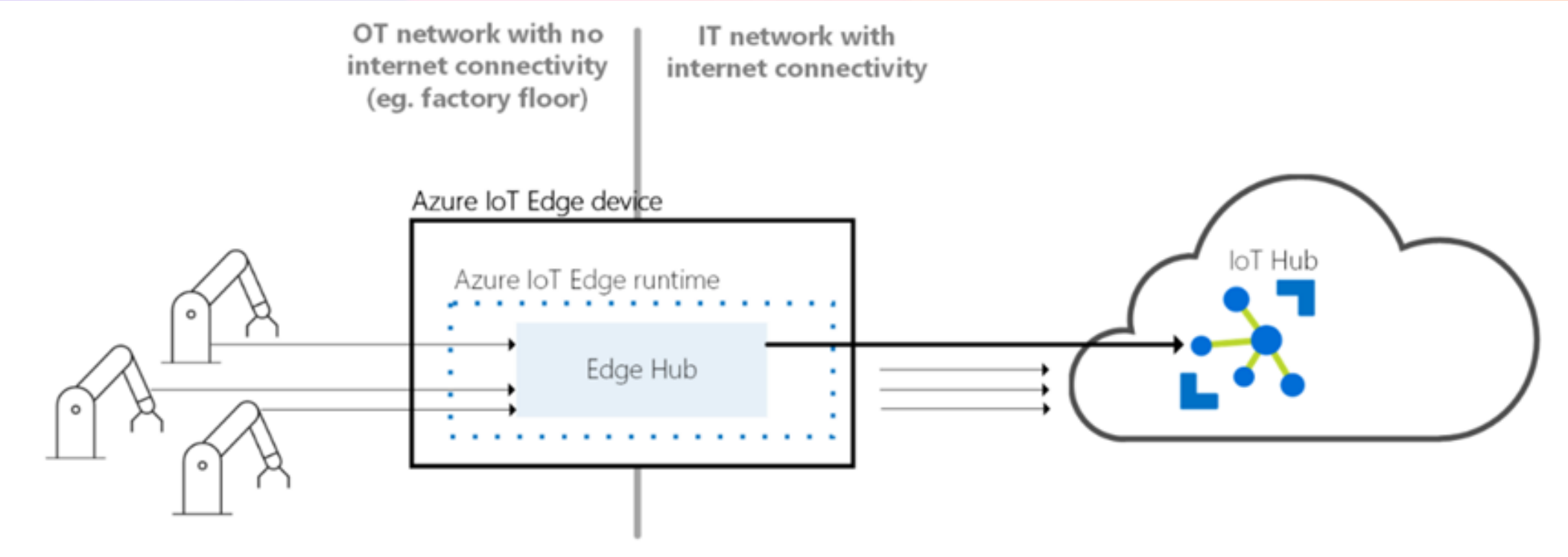
IoT Edge cloud interface



IoT Edge hub

- Acts as a local proxy for IoT Hub by exposing the same protocol endpoints as IoT Hub.
- Supports clients that connect using MQTT or AMQP
- Does not support clients that use HTTP.
- IoT Edge hub is not a full version of IoT Hub running locally
- Reduces the bandwidth your IoT Edge solution uses

IoT Edge hub


OT network with no internet connectivity (eg. factory floor)
IT network with internet connectivity
Azure IoT Edge device
Azure IoT Edge runtime
Edge Hub
IoT Hub

Building blocks of Azure IoT

The platform offers the following components:

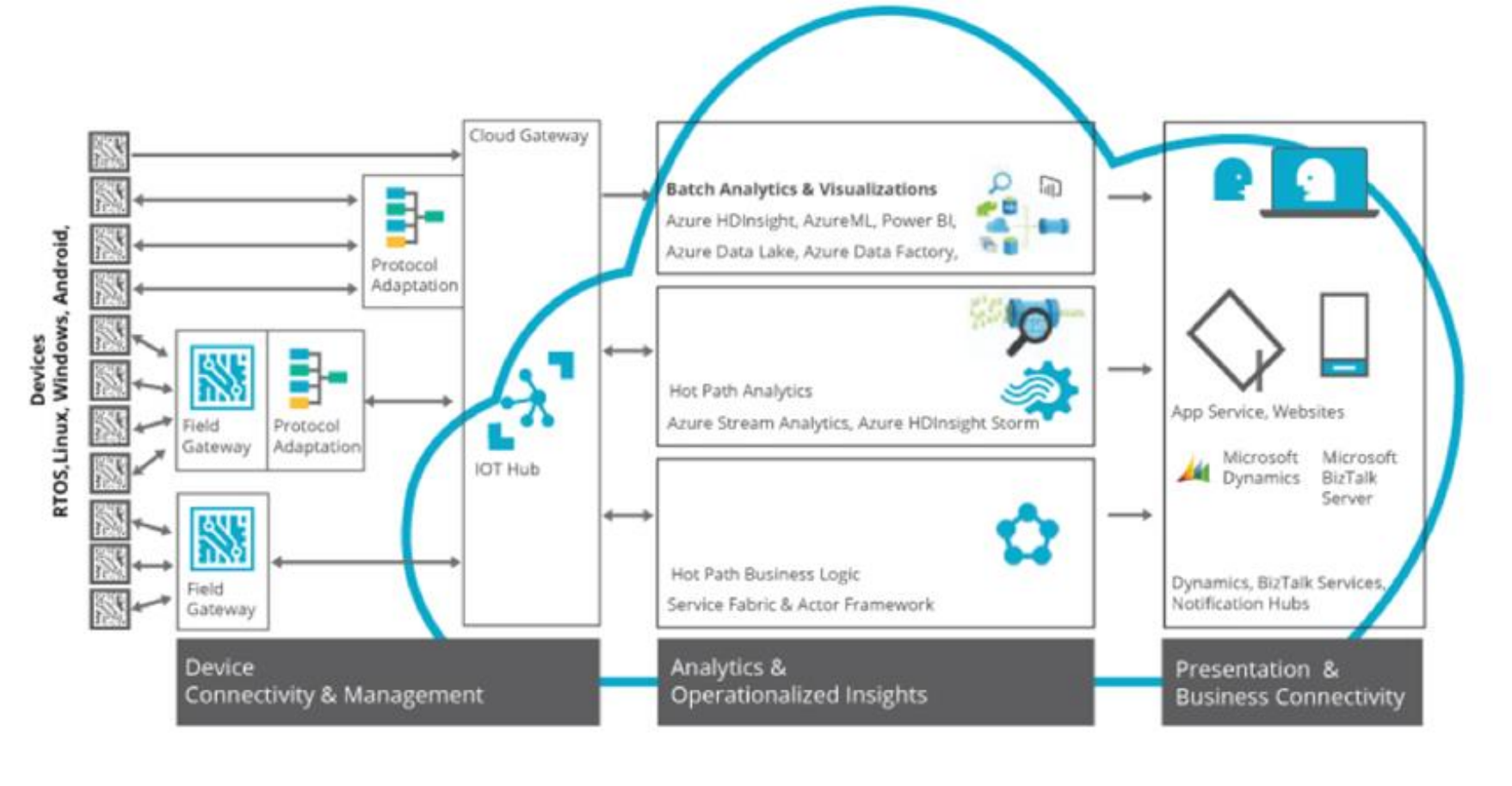
- IoT Hub — Device provisioning, management, control, and communication
- Event Hubs — Hight velocity data ingestion service
- Stream Analytics — Real-time query and processing of streams
- Blob Storage — Unstructured data store
- Cosmos DB — NoSQL database to store metadata
- Time Series Insights — A Time-series database for storing and querying sensor data

Building blocks of Azure IoT

The platform offers the following components:

- Azure Databricks / HDInsight — Real-time stream processing (Spark) and batch processing (Hadoop)
- Functions — Event-driven serverless computing model
- SQL Database — RDBMS to store structured data
- ML Studio — Web-based IDE to build and deploy ML models
- Power BI — Rich dashboard and visualization tool

High level schema of Azure IoT



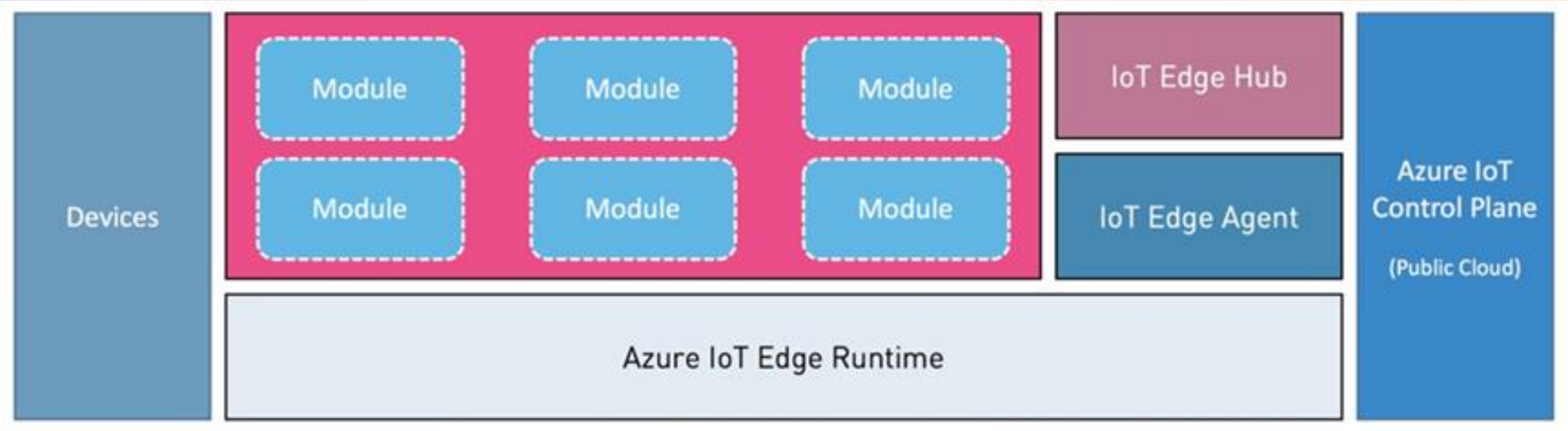
Azure IoT Edge Architecture in Depth

Azure IoT Edge Architecture

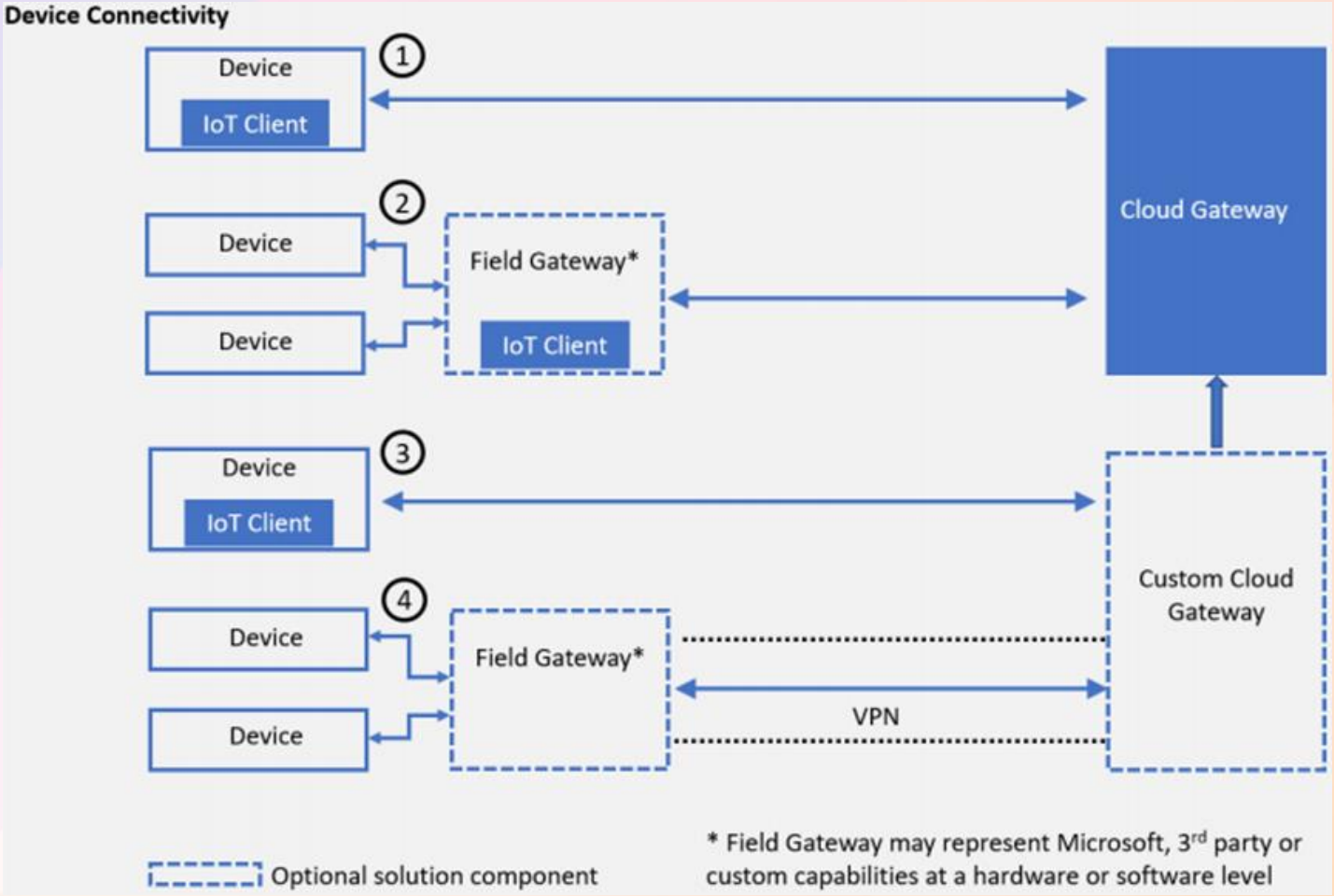
- Azure IoT Edge is designed to be extremely modular and extensible
- It is built on top of Moby: an open-source framework that powers Docker
- Devices can be registered only during the initial onboarding process after which are remotely managed from the public cloud
- Edge devices are considered as IoT devices that are capable of running additional services

Azure IoT Edge Architecture

- Schematic representation of Azure IoT Edge

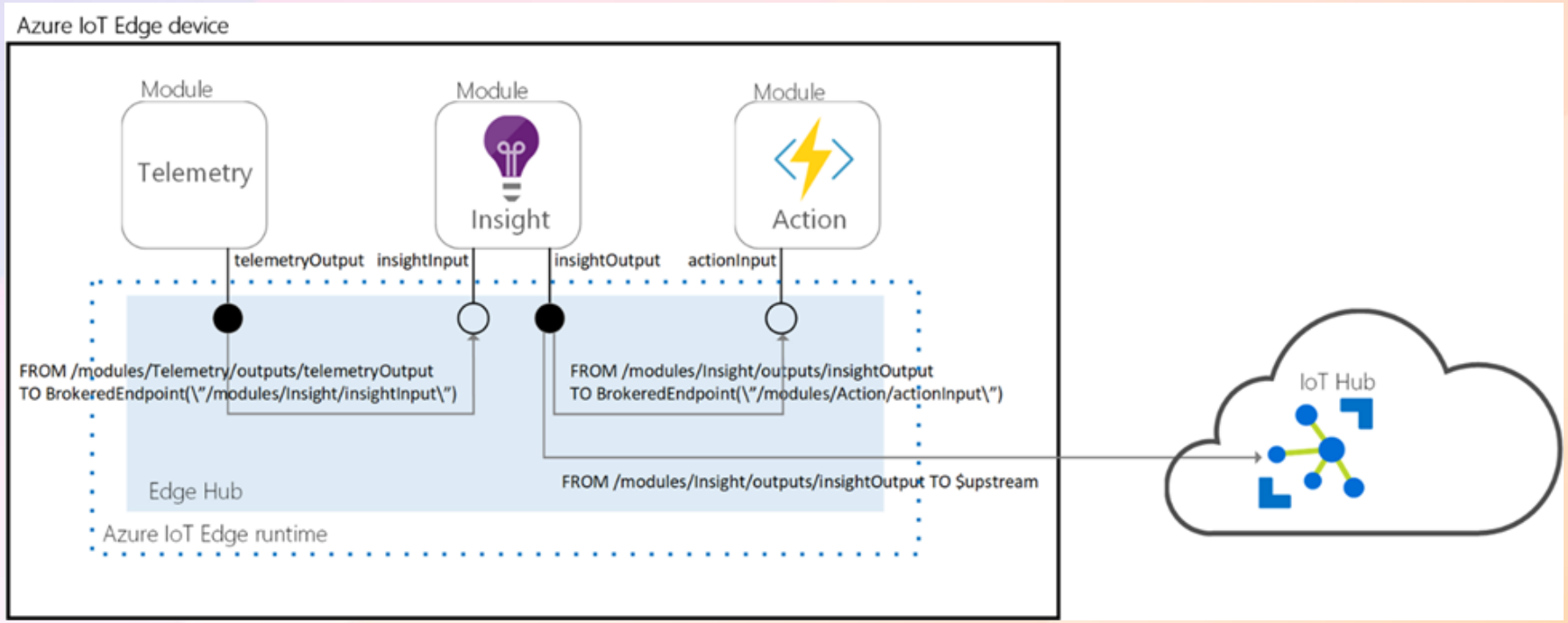


Azure IoT Reference Architecture say about Edge Computing



Communication between Azure IoT Edge modules

IoT Edge hub facilitates module to module communication.



IoT Edge Hub: Module Communications

IoT Edge agent

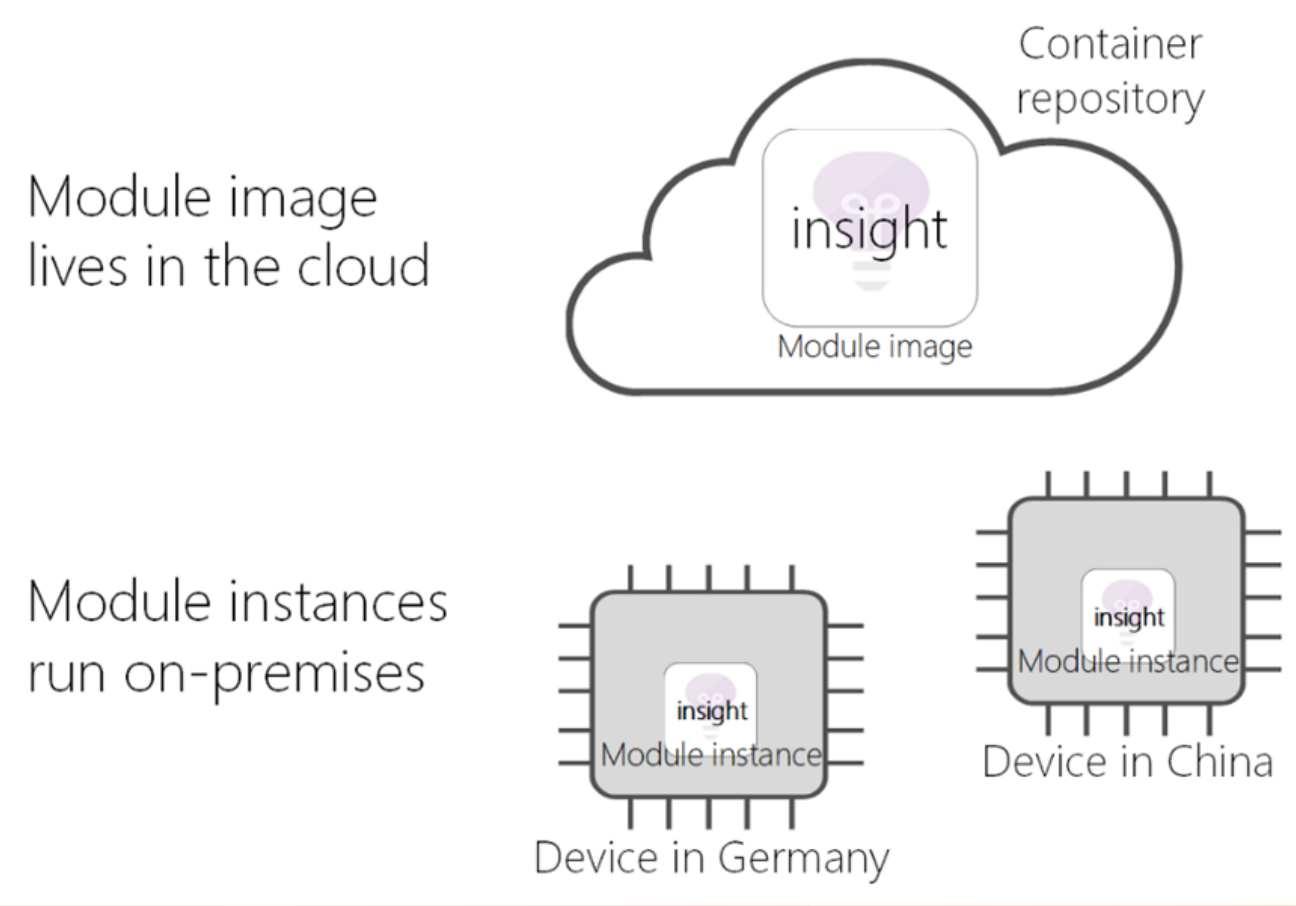
- Dedicated to instantiating modules, ensuring that they continue to work properly, and reporting the status of the modules back to IoT Hub.
- Important IoT Edge agent properties:
  - settings.image
  - settings.createOptions
  - Status
  - restartPolicy
  - imagePullPolicy

Azure IoT Edge Modules

- A module image is a package containing the software that defines a module
- A module instance is the specific unit of computation running the module image on an IoT Edge device.
- A module identity is a piece of information stored in IoT Hub, that is associated to each module instance
- A module twin is a JSON document stored in IoT Hub, that contains state information for a module instance.

IoT Edge module images and instance

- Module images and container instances



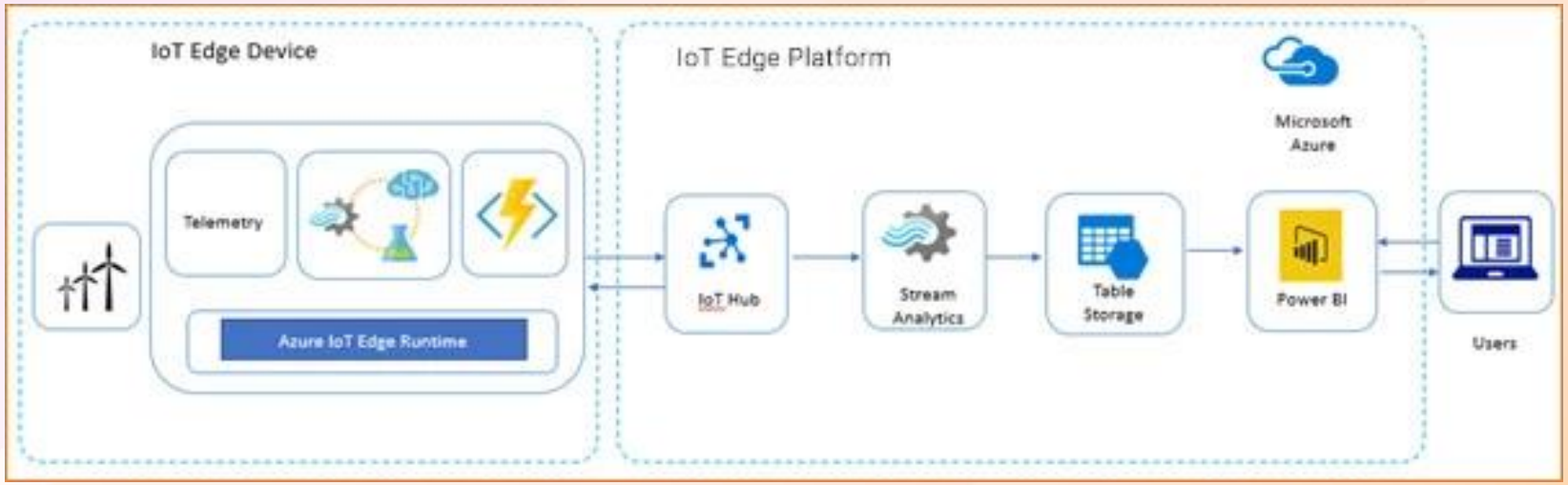
Implementing Edge Analytics with Azure IoT Edge

When to consider Azure IoT Edge

- Reduced cost
- Near real-time response
- Offline operations
- Device Security
- Protocol Translation
- Simplified Development process

How IoT Edge works:

- Azure IoT Hub has built-in support for Edge Platform and devices. It has 3 components
  - Azure Edge Runtime
  - Edge Modules
  - Cloud Interface



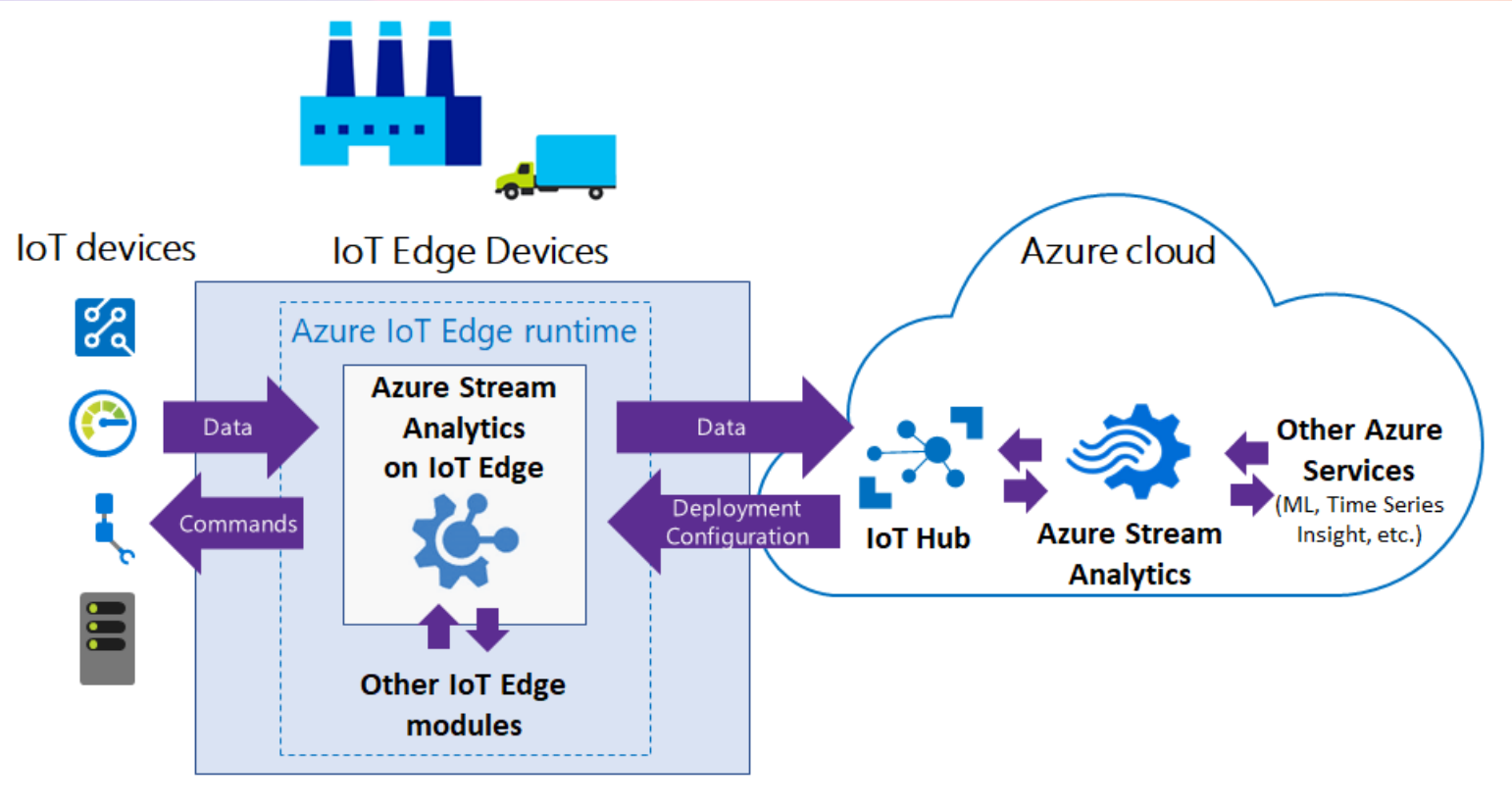
How to implement IoT Edge Strategy

Primary considerations to build best practices for your IoT Edge Platform.

- Edge Device
- Device Registration
- Module Development, Deployment & Upgrades
- Security

Azure Stream Analytics on IoT Edge

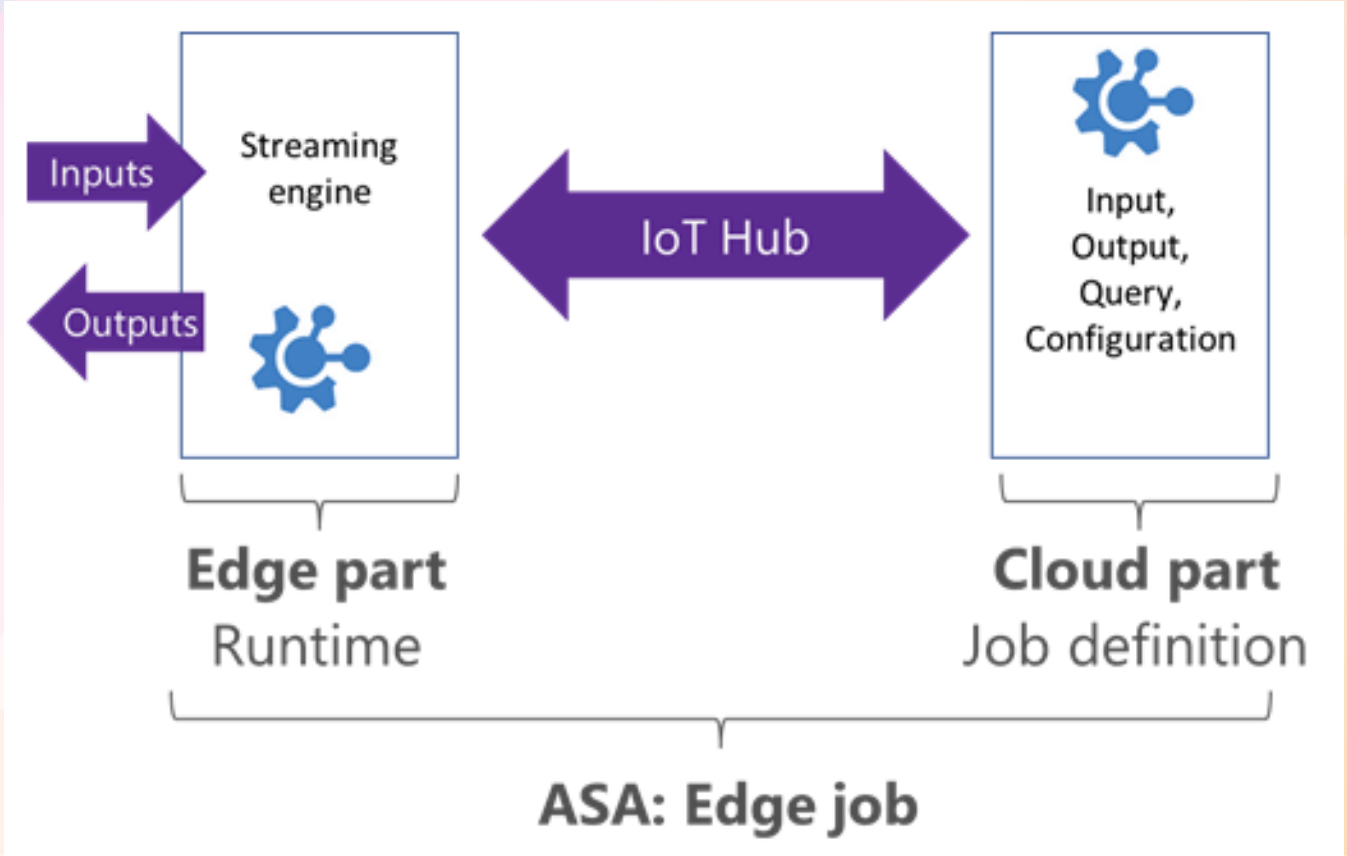
Common scenarios



- Low-latency command and control
- Limited connectivity to the cloud
- Limited bandwidth

Edge jobs in Azure Stream Analytics

- A cloud part that is responsible for the job definition
- A module running on your IoT devices



Edge job limitations

- User-defined functions (UDF) in JavaScript. UDF are available in C# for IoT Edge jobs (preview).
- User-defined aggregates (UDA).
- Azure ML functions.
- AVRO format for input/output. At this time, only CSV and JSON are supported.
- The following SQL operators:
  - PARTITION BY
  - GetMetadataPropertyValue
- Late arrival policy

Runtime and hardware requirements

- Stream Analytics and Azure IoT Edge use Docker containers

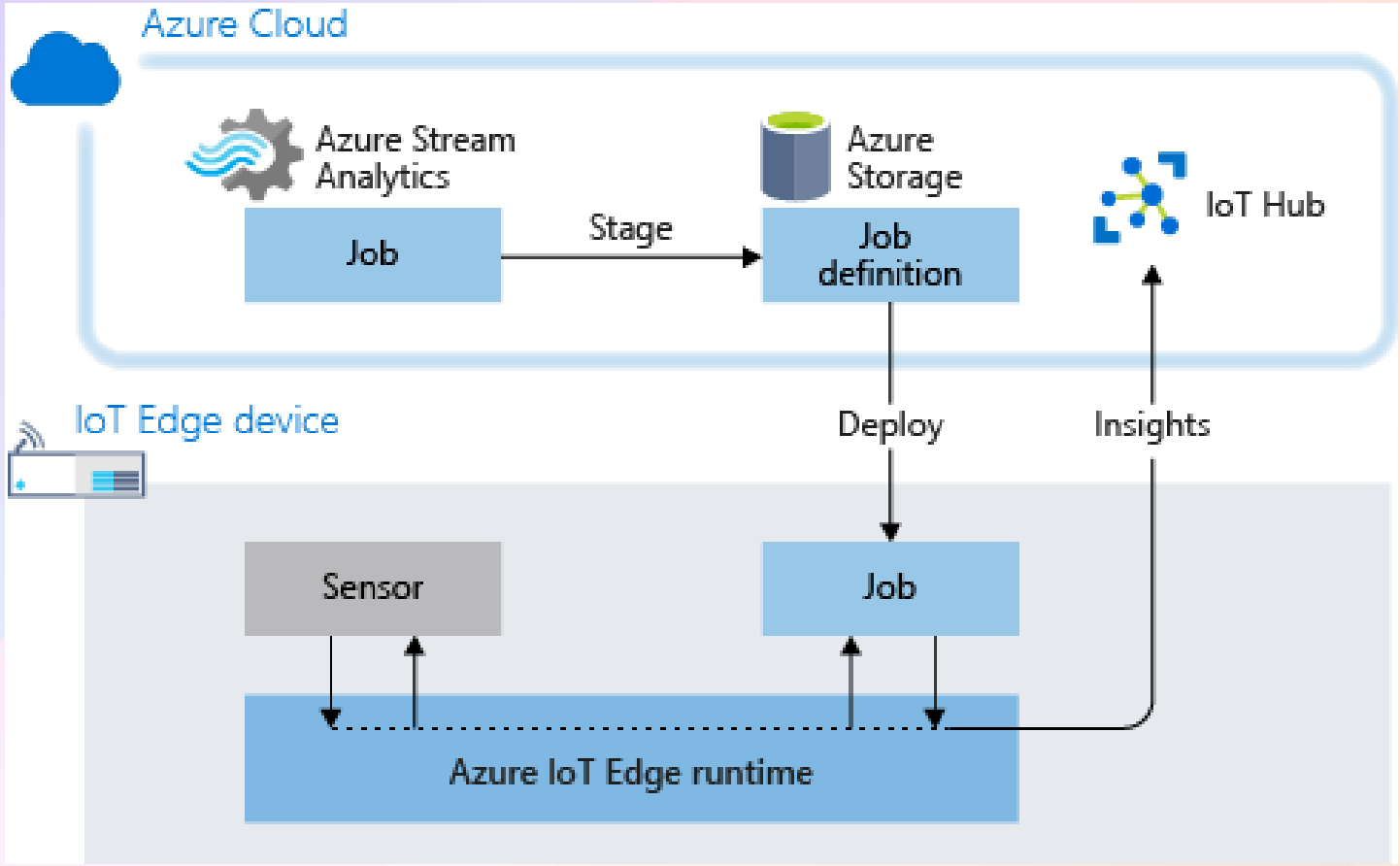
- Stream Analytics on IoT Edge is made available as Windows and Linux images, running on both x86-64 or ARM (Advanced RISC Machines) architectures.

Input and output

- Supported stream input types are:
  - Edge Hub
  - Event Hub
  - IoT Hub

- Supported stream output types are:
  - Edge Hub
  - SQL Database
  - Event Hub
  - Blob Storage/ADLS Gen2

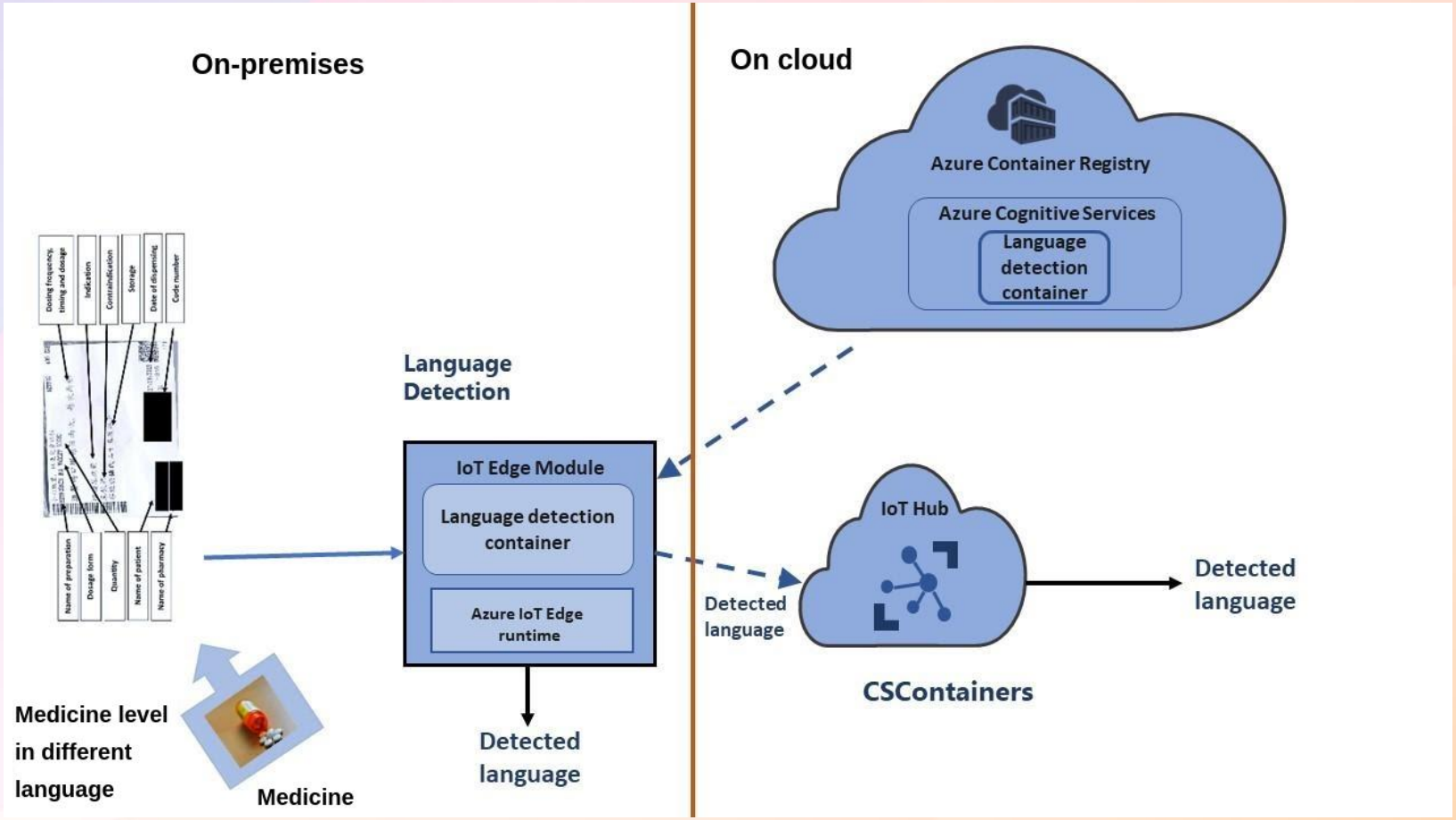
Deploy Azure Stream Analytics as an IoT Edge module



- Create an Azure Stream Analytics job to process data on the edge.
- Connect the new Azure Stream Analytics job with other IoT Edge modules.
- Deploy the Azure Stream Analytics job to an IoT Edge device from the Azure portal.

Congnitive Services on IoT Edge

Cognitive Services on the Edge Scenarios

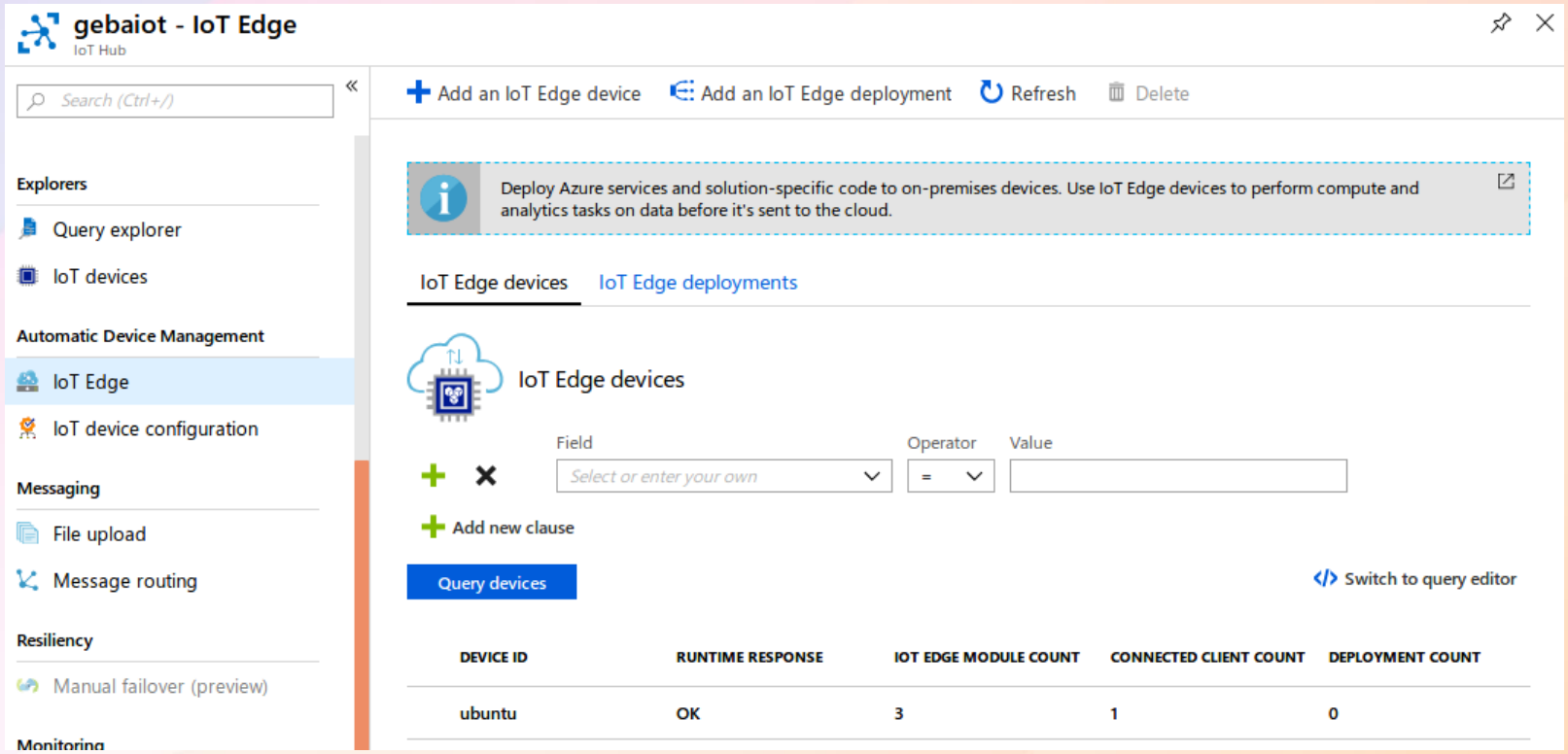


Deploy a cognitive service to an IoT Edge device

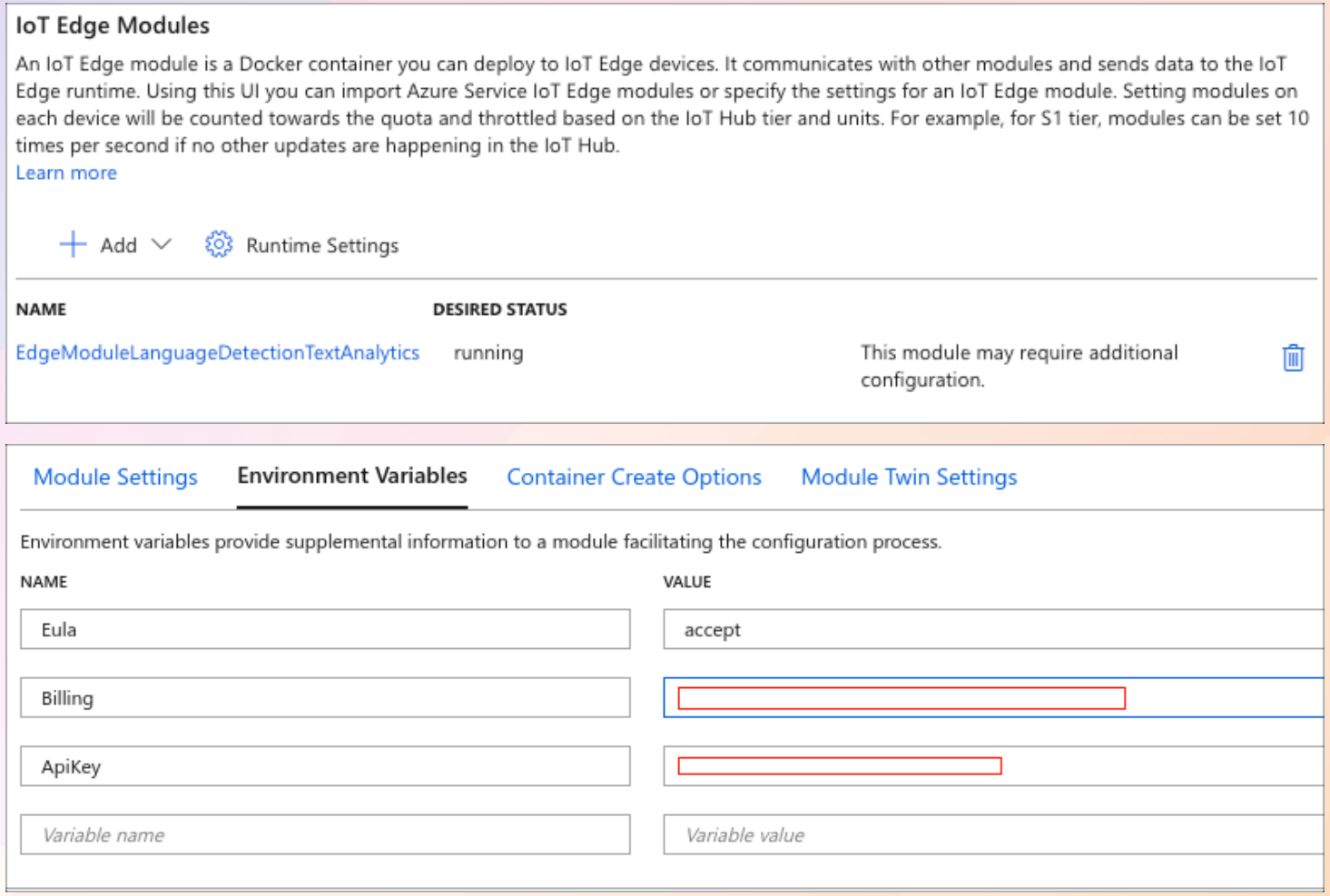
- Create a cognitive service in the cloud
- Configure the Azure Cognitive Services API to the Language Detection containerized module
- Retrieve the API key and endpoint
- Deploy the module to the edge device.

Deploying Azure Cognitive Services Containers with IoT Edge

- IoT Edge Configuration

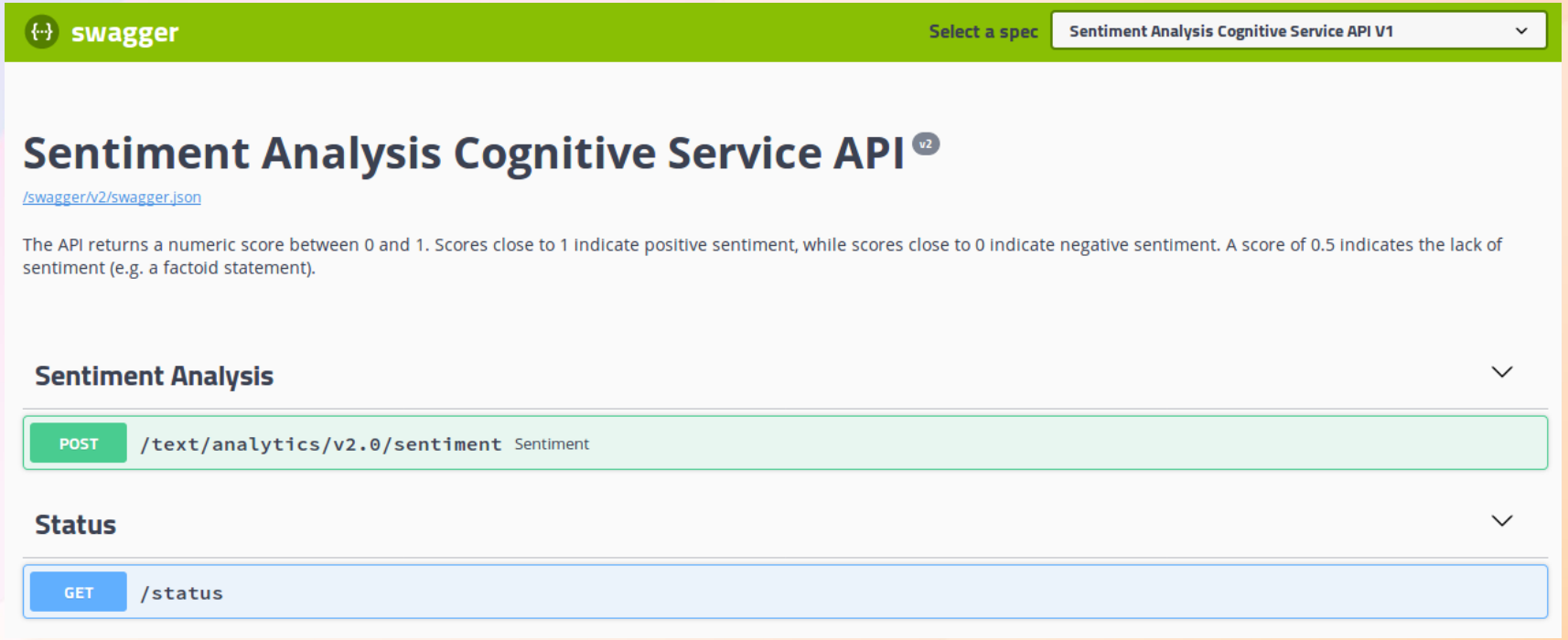


Deploy the Language Detection module to the edge



Testing Azure Cognitive Services Containers with IoT Edge

- Testing the Sentiment Analysis container
  - Go to http://localhost:5000/swagger to see the available endpoints.
  - Open Sentiment Analysis to try out a sample



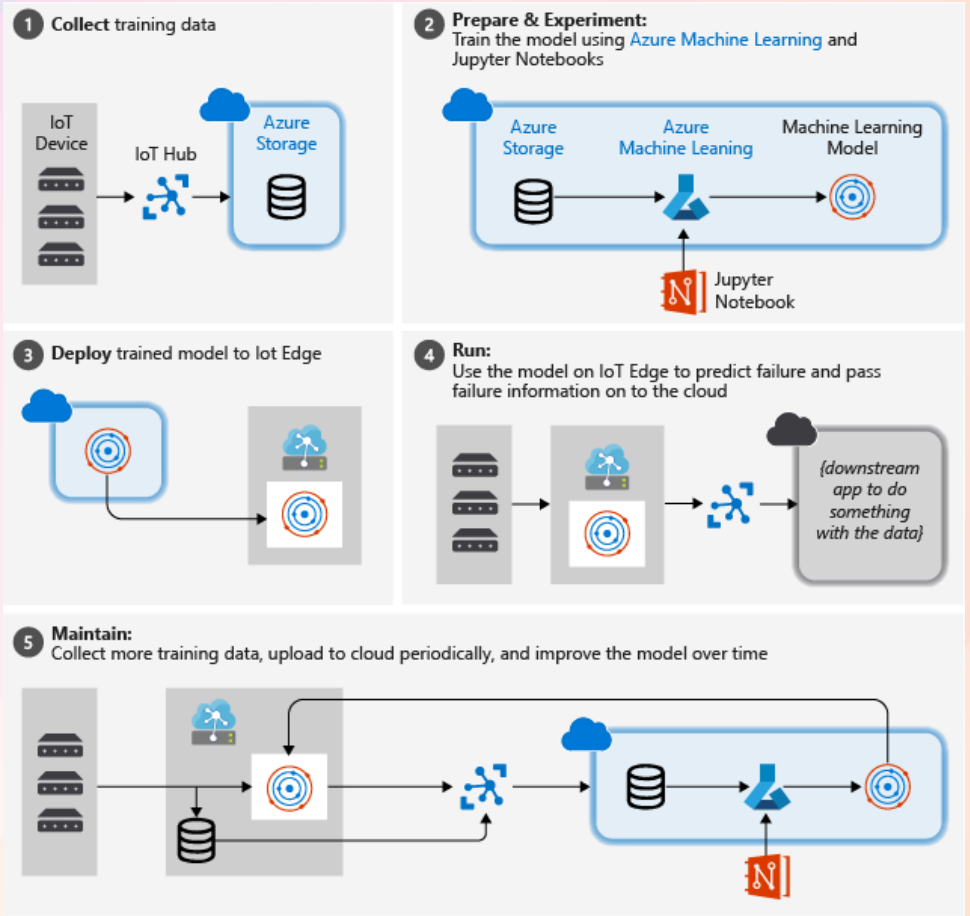
Azure Machine Learning as an IoT Edge module

Deploy Azure Machine Learning as an IoT Edge module

You can use IoT Edge modules to deploy code that implements your business logic directly to your IoT Edge devices

- Create an Azure Machine Learning module.
- Push a module container to an Azure container registry.
- Deploy an Azure Machine Learning module to your IoT Edge device.
- View generated data.

An end-to-end solution using Azure Machine Learning and IoT Edge



Using edge analytics in the real world

Edge analytics in the real world

- Mars Drinks
  - The American company Mars Drinks, keeping their vending machines fully stocked is very important for retaining customers
  - Mars Drinks rolled out a Microsoft Azure IoT Edge solution for just that purpose.
  - Using data analyzed from the vending machines, a service route may be planned or modified based on individual machine inventory.

Edge analytics in the real world

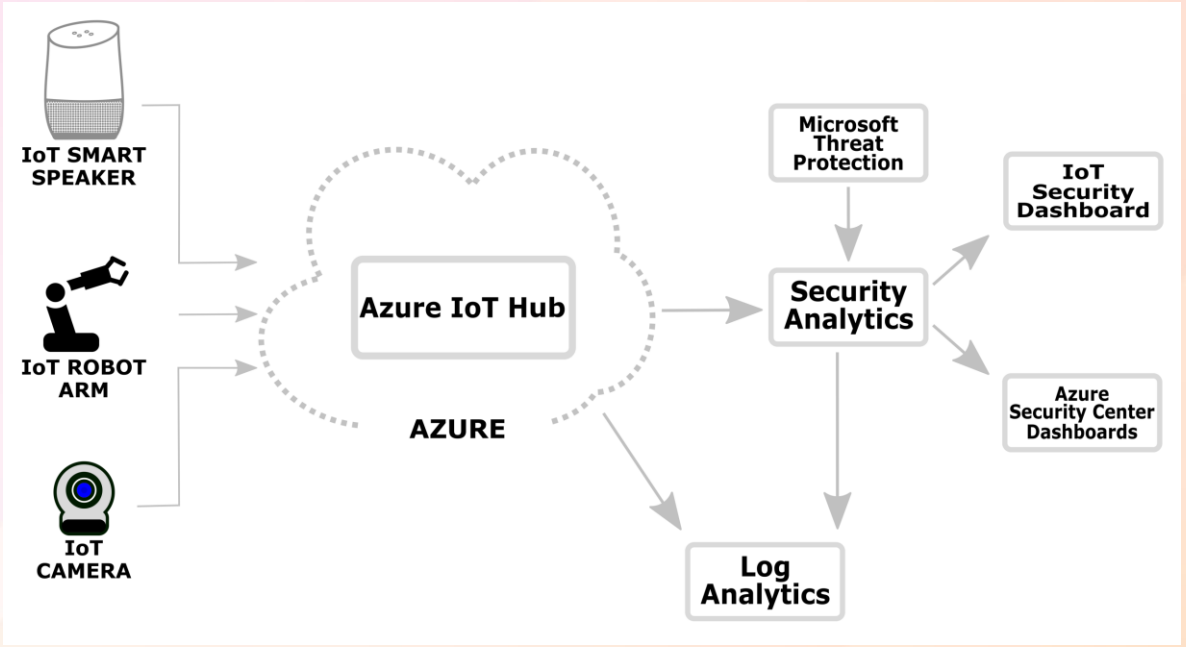
- Mars Drinks
  - Historical weather information collected by the Azure platform helps Mars Drinks in designing their menu options. Menu options may be modified to reflect consumption patterns, based on the analysis
  - Azure IoT Edge and related cloud services have helped Mars Drinks become a data-driven company focused on the needs of the consumer

Security and Privacy in an Edge Analytics

- An overview of the Internet-of-Things security
- Types of attacks against our edge analytics applications
- Protecting our edge analytics applications
- Monitoring and auditing our edge analytics application

Azure Defender for IoT.
(Azure Security Center for IoT)

- Edge analytics applications that use Azure can use Azure Defender for IoT.



Taking an audit of edge analytics devices

- Validate the existence of all the devices that are used
- Ensure that documentation exists for each device
- Verify that architecture diagrams exist and are up to date
- Ensure that log files are generated for devices
- Ensure that configuration files are present and up to date
- Verify that each device has the latest software or firmware patches
- Ensure that the response plans for the event of an application failure are up to date


Demos

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