IoT Reference Architecture

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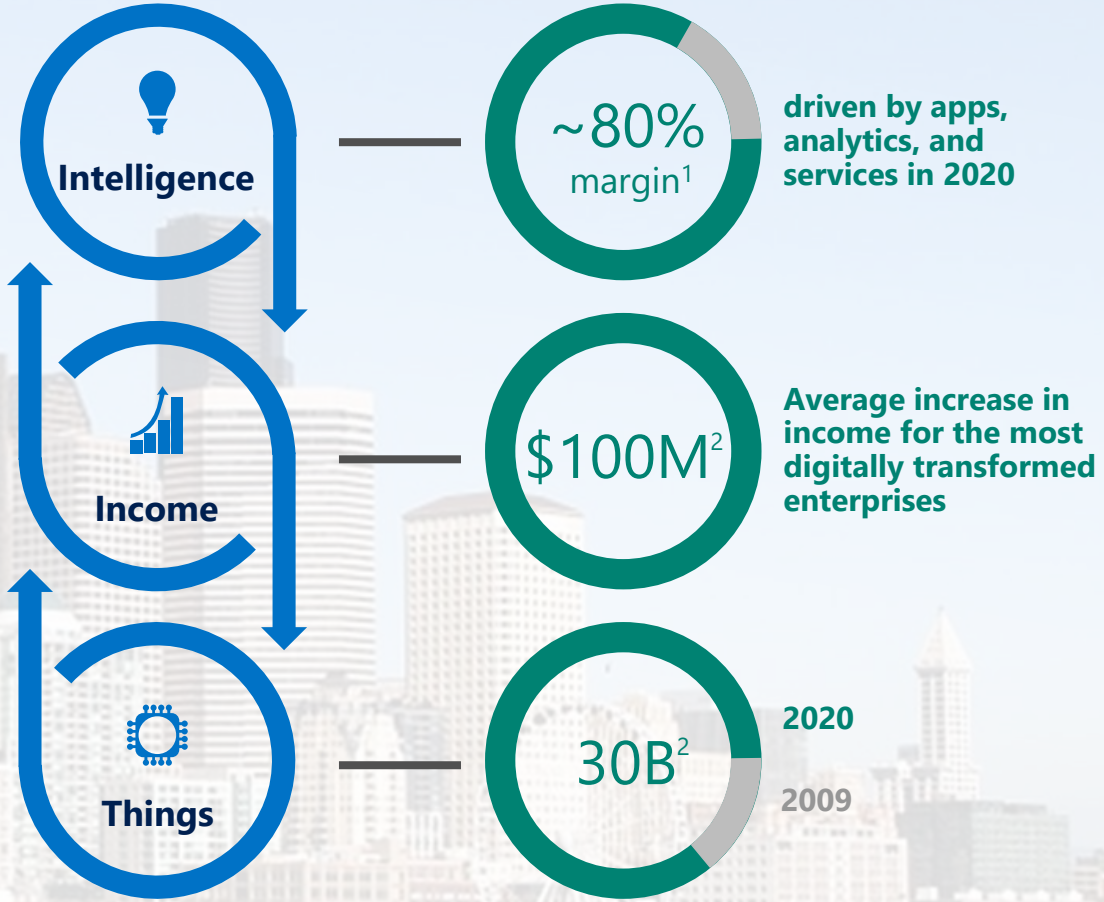
Kolding
June 12, 2018

Digital transformation is rapidly reshaping the landscape

"Every business will become a software business, build applications, use advanced analytics and provide SaaS services."

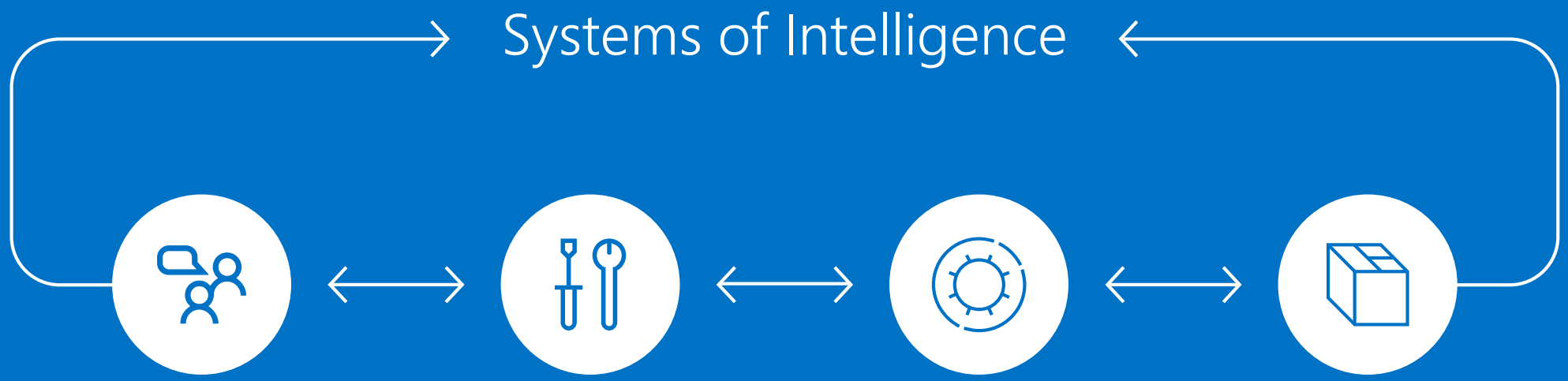
Satya Nadella



Sources:
[1]McKinsey, How IoT Can Support A Dynamic Maintenance Program, 2016
[2]IDC, 2016

IoT is a **business revolution** being fueled by technology

Digital Transformation

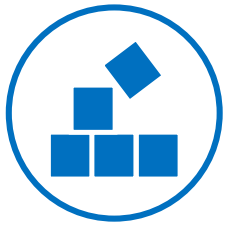


However…IoT projects can be complex

Difficult to maintain cohesive security

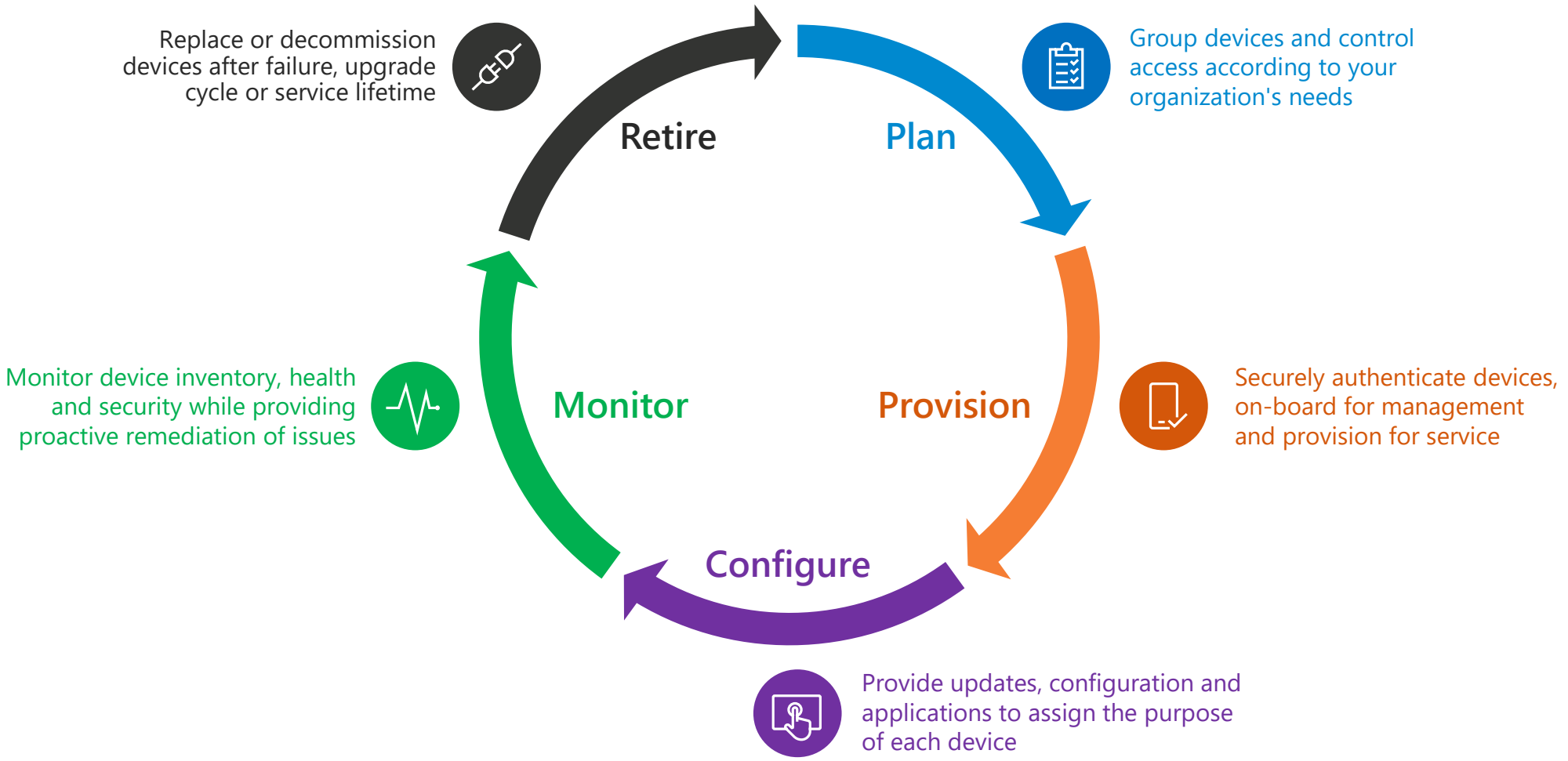
Time-consuming to get started

Incompatible with existing infrastructure



Challenging to scale over time

IoT Device Management Lifecycle



IoT solution Target & Microsoft positioning

- Consumer IoT?

  Quick Time to market - Connectivity and aftersales management

- Professional IoT?

  longer Time To market – management/update/TTL – current infrastructure integration

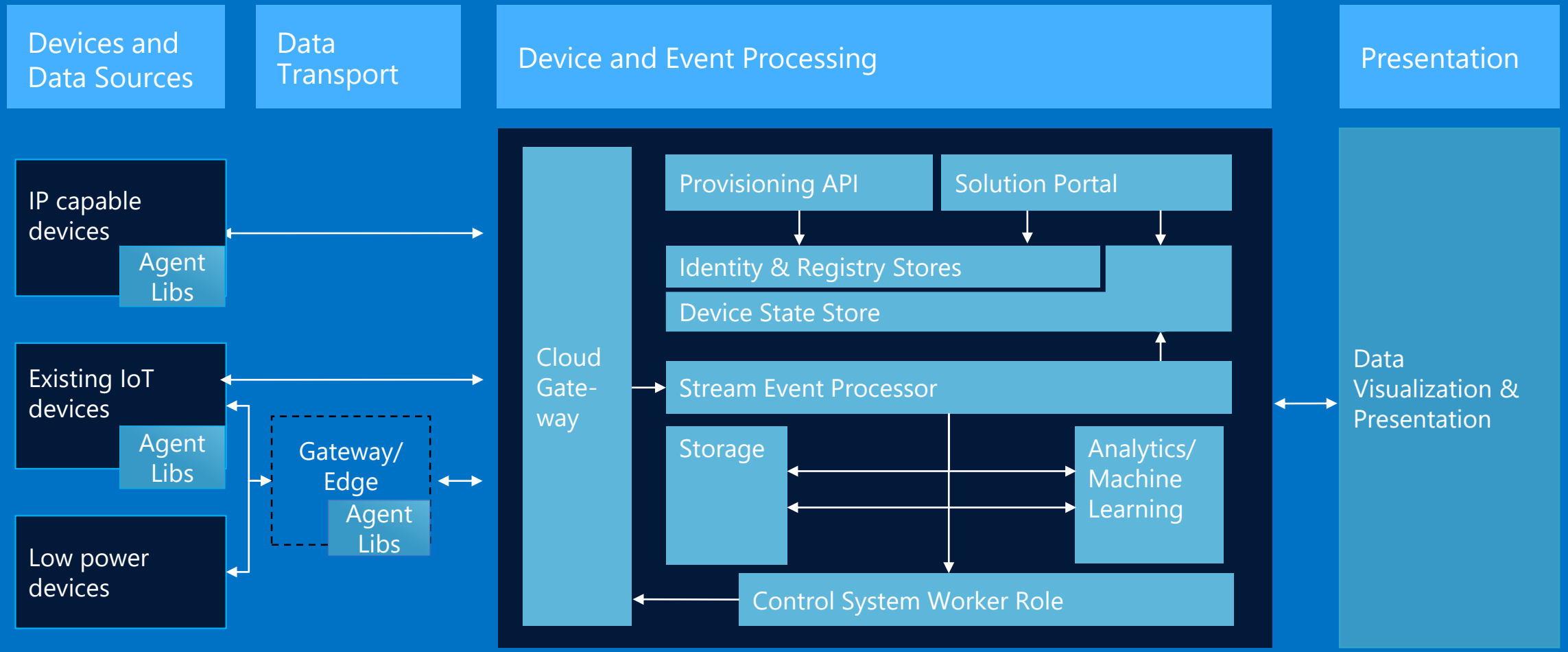
- IoT Devices?

  OS/RTOS/No OS Systems – HW – Suppliers - Apps

- IoT Cloud?

  Connectivity – Security/Compliance – Cloud Service planning and maintenance - service upgrade/evolution – Support - WebApps

Must to read:
Azure IoT Reference Architecture



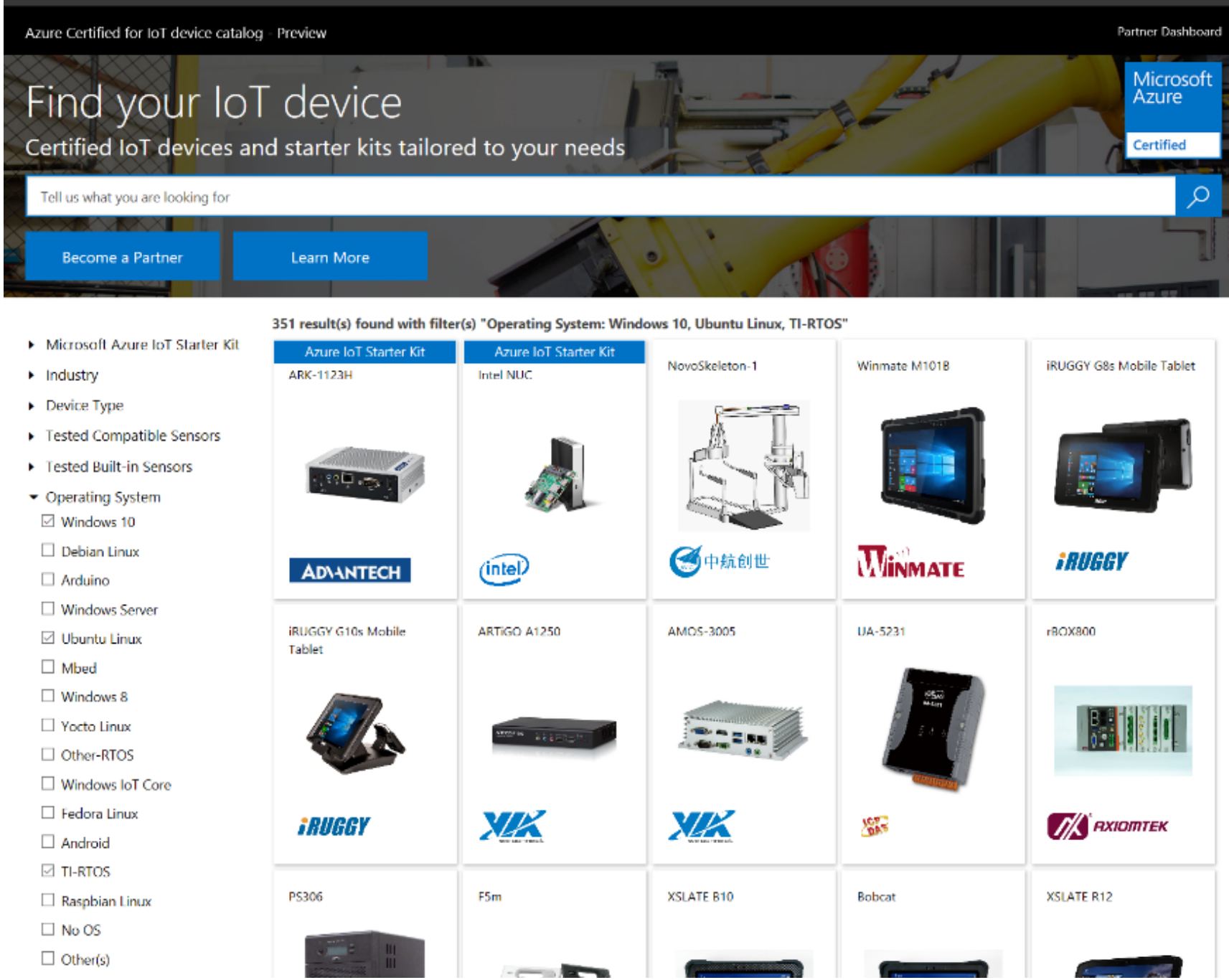
https://azure.microsoft.com/da-dk/updates/microsoft-azure-iot-reference-architecture-available/

What to consider for building an IoT Solution

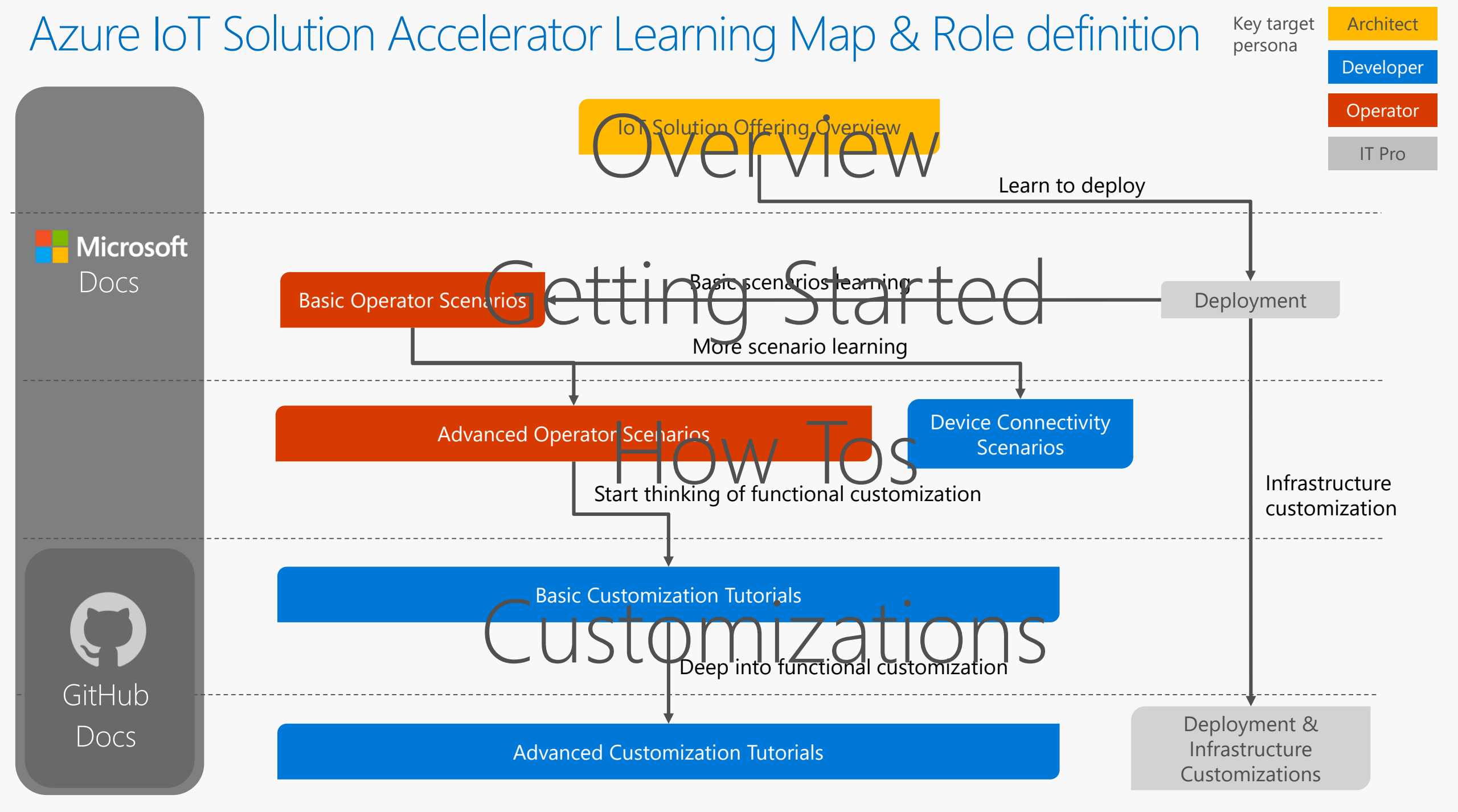
(after having read the Reference architecture!)

Microsoft Azure IoT Device Catalog

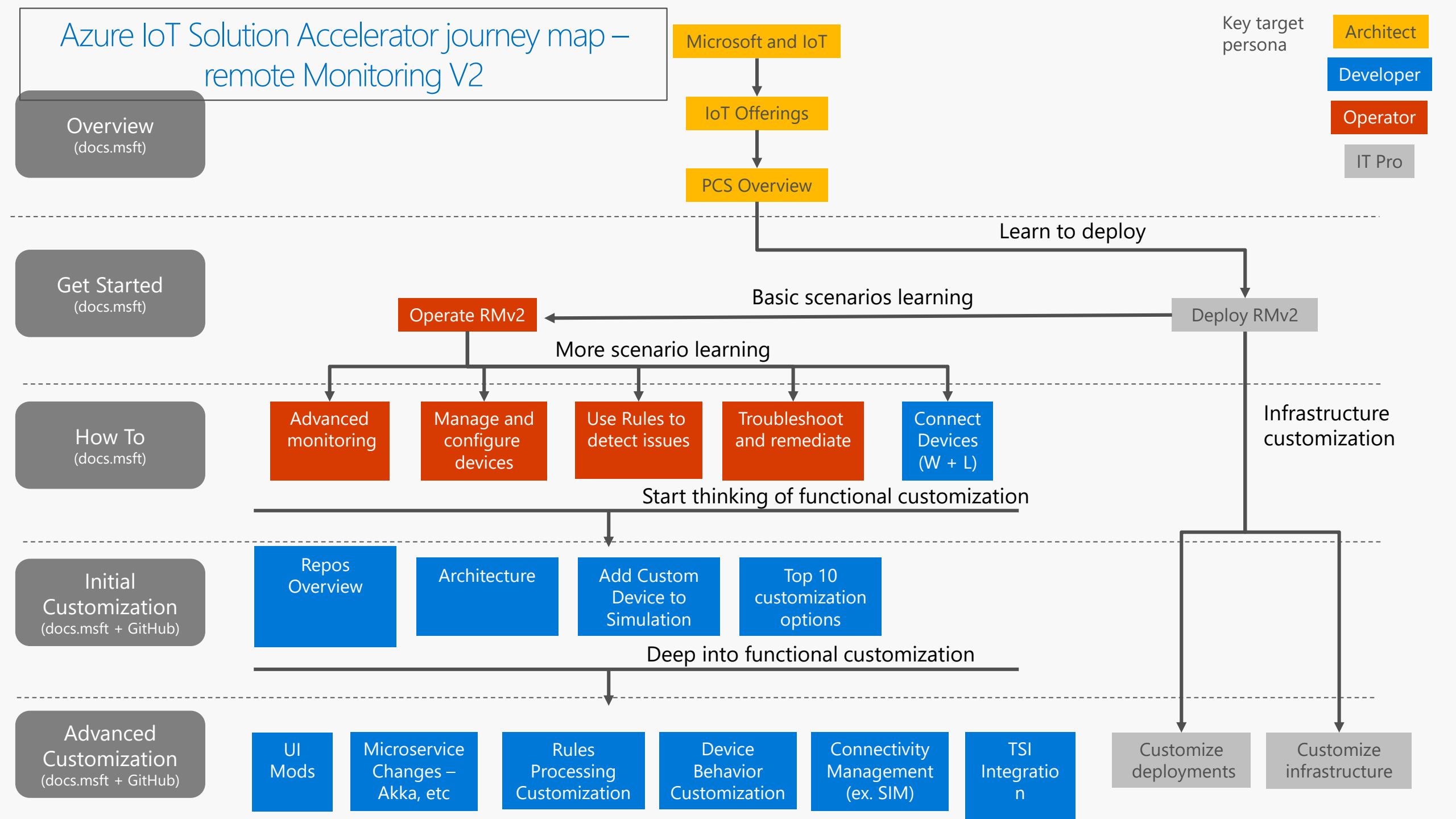
~580 certified devices
~200 partners
~250% growth YTD



Azure IoT Solution Accelerator Learning Map & Role definition



Azure IoT Solution Accelerator journey map – remote Monitoring V2



IoT architecture challenges

- Network and protocol
- Security, privacy, and trust
- Heterogeneity
- Device HW+SW
- Serialization and market
- Streaming throughput
- Cost
- Data volume
- Auto-discovery
- Legacy and fragmentation

IoT architecture characteristics/variables

- Message type
- Message speed
- Message frequency
- Device volume
- Message volume
- Connectivity level
- Data structure
- Communication direction

IoT real-life use cases and scenarios

Industry	Use case	Scenarios patterns
Manufacturing	Connected vehicle Food traceability Production asset mgmt Manufacturing operations Connected field service	Device connectivity and management Multi-protocol support Connect legacy devices without replacing existing infrastructure Remote monitoring Command and control Service customer equipment Edge computing Security and environmental monitoring Real-time analytics Data transformation and routing Predictive maintenance Role-based access control Alerts and notification Data visualization Integration with other business services Process atomic and batch data stream Manage intermittent-connected devices Data security from connectivity to storage Geo-availability
Consumer	Home security Smart appliances	
Government	Automated public transit Environmental monitoring detection Public infrastructure asset mgmt Public safety and emergency response	
Healthcare	Remote health monitoring Clinical care Personal wellness Connected medical device	
Retail	In-store consumer digital offer Personalized promotion	
Transportation	Air traffic monitoring Asset fleet management Freight monitoring	
Utility	Smart grid Smart building	


ZEROTECH
CAN TELEMATICS
LIEBHERR
BMW
Steelcase
GRUNDFOS
fathym
Schneider Electric
NAV CANADA
MATTEL
WEKA
RENAULT NISSAN
GOJO
Ford
innovate
ABB
ABT RAAMS
ABUS
aegex
ATF SERVICES
avatarion
CITIZENSERVICES
AvePoint
AXELERATE
BAX ENERGY
Beijer automotive
Transport for London
BLUE DYNAMICS
BLUE FROG
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CAN TELEMATICS
CardioDiagnostics
careinnovations
CARNEGIE MELLON UNIVERSITY
CHIPING
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evoqua
FINNING
FUSE THRU
GAA
Geratriz
GTI
甘来 | Born for Smart Vending
HERSHEY
Homebase
Honeywell
INDENTIVE
iNGENU
JABIL
Jcble
Johnson Controls
King WAY
KONGSBERG
KUKA
LG CNS
LG Electronics
IOMOTE
Ville d'Ottignies-Louvain-la-Neuve
MARS drinks
medapp
Mondelēz International
MoveInSync
NORTH AMERICAN EAGLE
NAV CANADA
新希望六和 NEW HOPE LIUHE
NEXCOM The Intelligent Systems
origis
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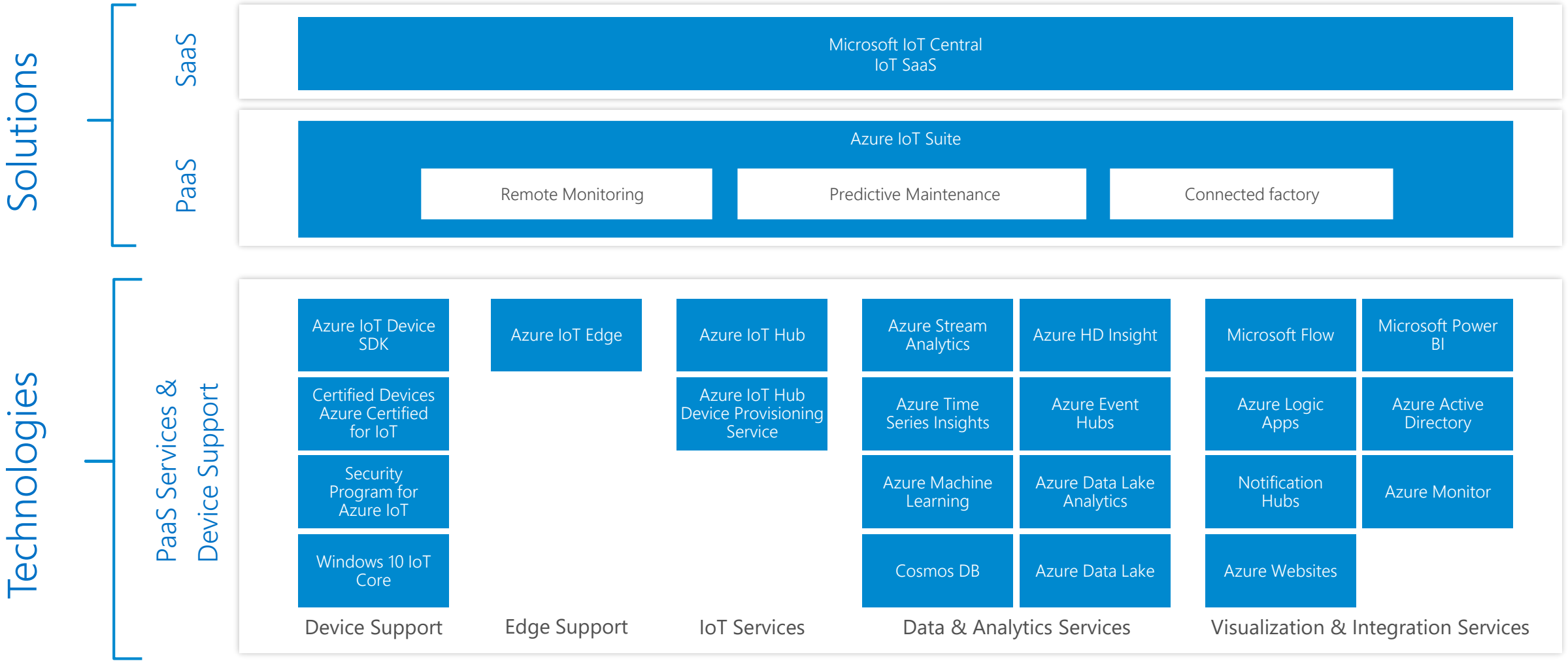
P97 networks
Plas.md
POLITECNICO MILANO 1863
powel
PRODATA mobility Brasil
Proxfinity.
quorum
RAC
realbox
Roche
RockStep
Rockwell Automation
Rolls-Royce
SAMSUNG
SANDVIK Coromant
saxa
Scomi Scomi Engineering
sensoria
SERAKU
SFE
SkyAlert
SLAC
SOLONGHT
Soup Stock Tokyo
STOCKROSE
takasolutions
targetbase
TechnoKom
TEXA
THE YIELD
thermoplan
things expert
thyssenkrupp
TRANSNET
ZPMC
tofugear
weka health solutions
Tetra Pak
WWW.ZIONCHINA.COM

Re-Defining Internet of Things

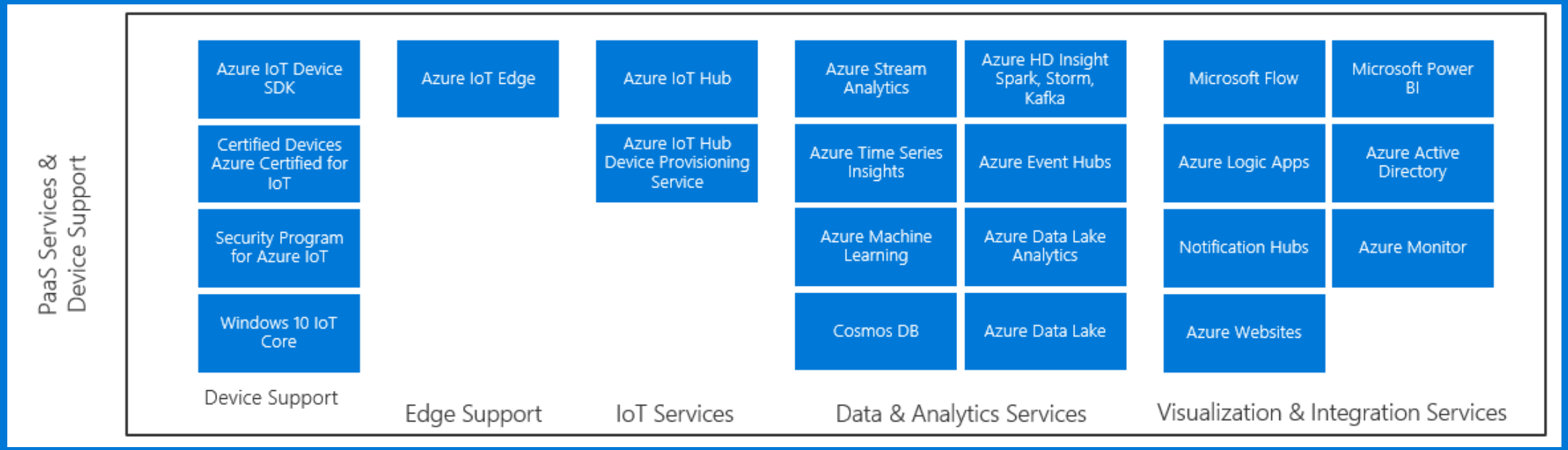
Comprehensive set of capabilities for IoT solutions



Microsoft

Azure IoT Services

(a.k.a. Lego® Building blocks)



Azure IoT Hub

Bi-directional communication

Millions of Devices

Multi-language, open source SDKs

HTTPS/AMQPS/MQTTS

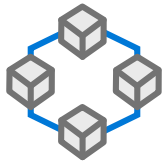
Send Telemetry

Receive Commands

Device Management

Device Twins

Queries & Jobs



Enterprise scale & integration

Billions of messages

Scale up and down

Declarative Message Routes

File Upload

WebSockets & Multiplexing

Azure Monitor

Azure Resource Health

Configuration Management

End-to-End Security

Per Device Certificates

Per Device Enable/Disable

TLS Security

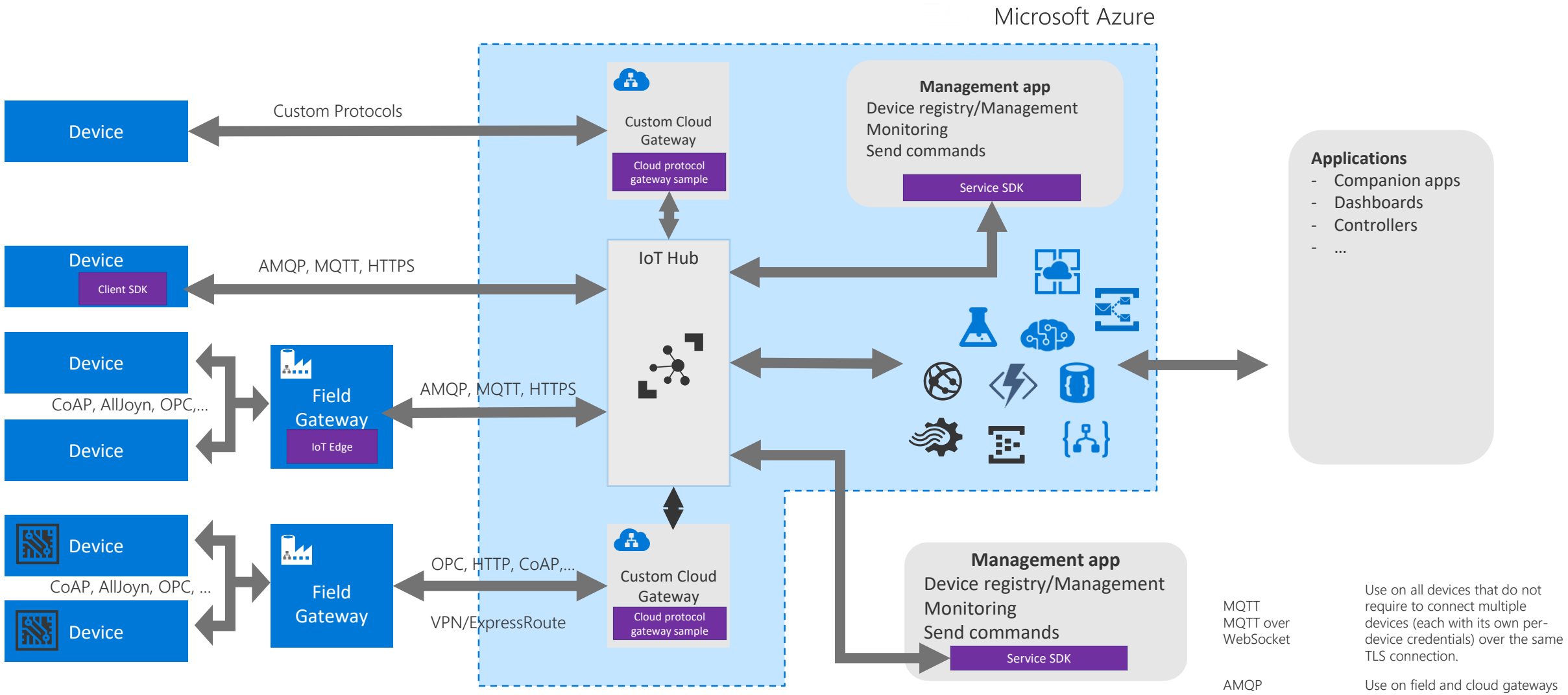
X.509 Support

IP Whitelisting/Blacklisting

Shared Access Polices

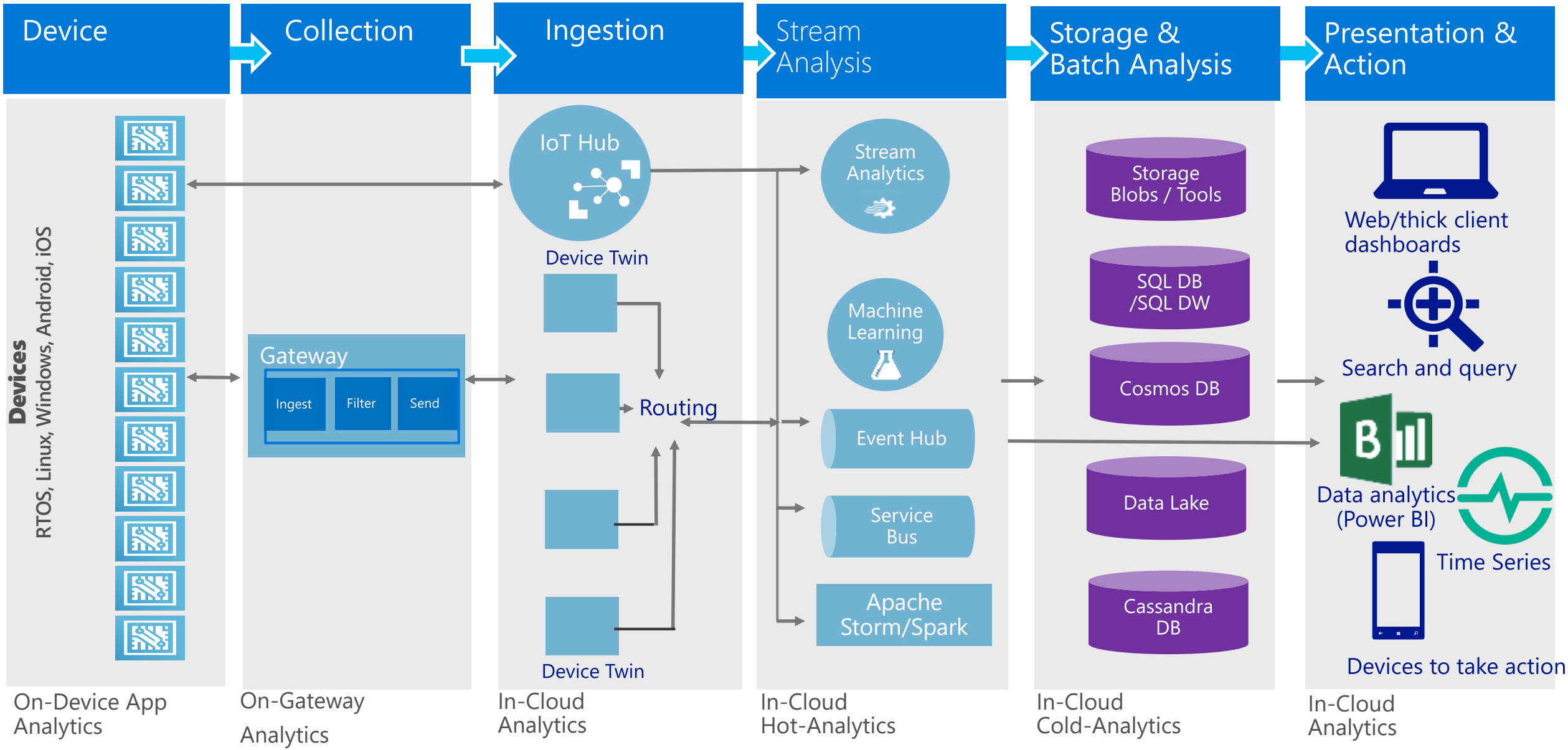
Firmware/Software Updates

Azure IoT Hub



MQTT MQTT over WebSocket	Use on all devices that do not require to connect multiple devices (each with its own per-device credentials) over the same TLS connection.
AMQP AMQP over WebSocket	Use on field and cloud gateways to take advantage of connection multiplexing across devices.
HTTPS	Use for devices that cannot support other protocols.

Azure IoT Analytics Patterns



IoT HUB – offering and features

IoT HUB Basic & Standard

Features

IOT CAPABILITY	IOT HUB STANDARD TIER	IOT HUB BASIC TIER
Device-to-cloud messaging	✓	✓
Protocols: HTTPS, AMQP, AMQP over websockets	✓	✓
Protocols: MQTT, MQTT over websockets	✓	✓
Per-device identity	✓	✓
File upload from devices	✓	✓
Device Provisioning Service	✓	✓
Cloud-to-device messaging	✓	
Device twin and device management	✓	
IoT Edge	✓	

Messages/day and costs

Basic tier

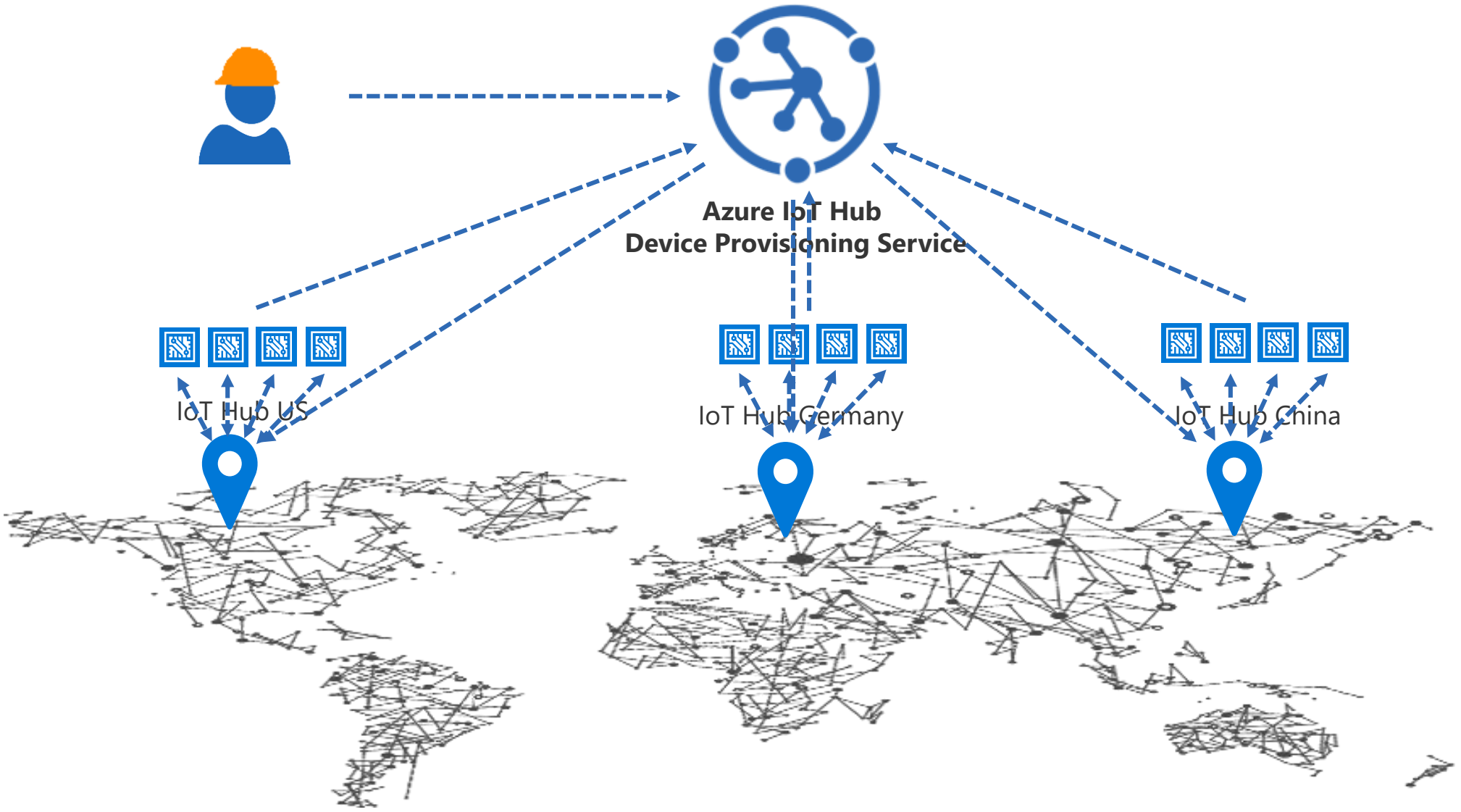
EDITION TYPE	PRICE PER UNIT (PER MONTH)	TOTAL NUMBER OF MESSAGES/DAY PER UNIT	MESSAGE METER SIZE
B1	$10	400,000	4 KB
B2	$50	6,000,000	4 KB
B3	$500	300,000,000	4 KB

Standard tier

EDITION TYPE	PRICE PER UNIT (PER MONTH)	TOTAL NUMBER OF MESSAGES/DAY PER UNIT	MESSAGE METER SIZE
Free	Free	8,000	0.5 KB
S1	$25	400,000	4 KB
S2	$250	6,000,000	4 KB
S3	$2,500	300,000,000	4 KB

Provisioning Challenges

Azure IoT Hub Device Provisioning Service



Available: Azure IoT Hub Device Provisioning Service

Global availability

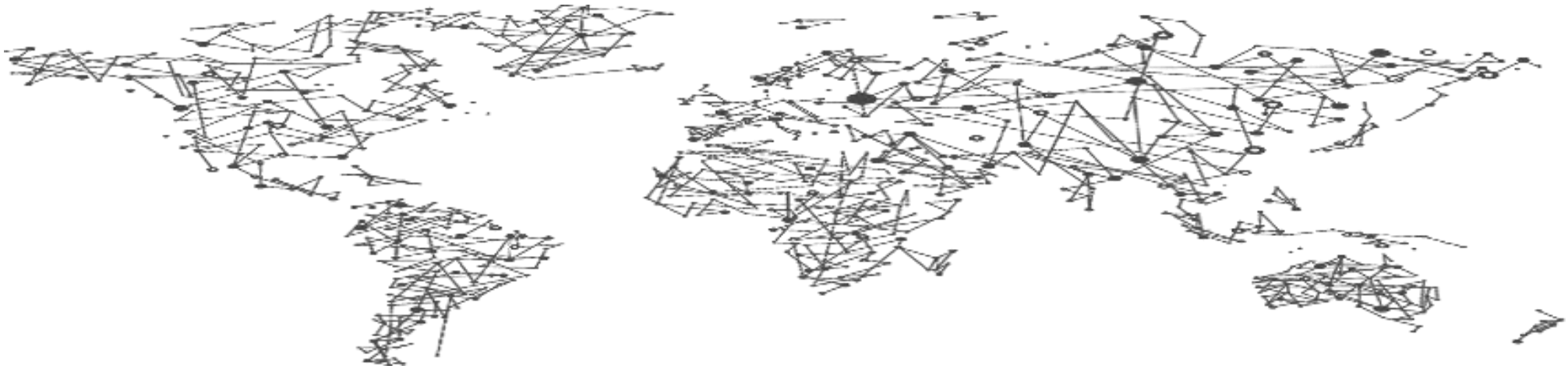
Simplify with “plug and play” provisioning

Minimize manual connection requirements

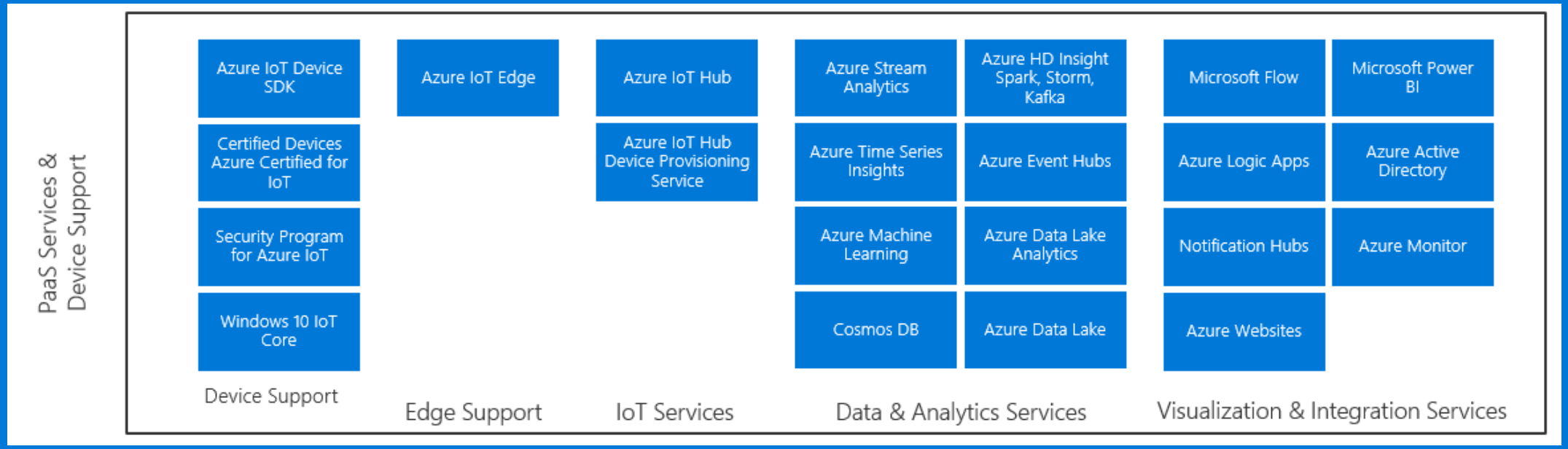
Enhanced security through Hardware Security Modules (HSM)

Works in harmony with Azure IoT Hub

Azure IoT Hub
Device Provisioning Service



Azure IoT Edge
(a.k.a. Lego® Building blocks “on premise”)



Azure IoT Edge

Secure

Provides a secure connection to the Azure IoT Edge, update software/firmware/configuration remotely, collect state and telemetry and monitor security of the device

Cloud managed

Enables rich management of Azure IoT Edge from Azure provide a complete solution instead of just an SDK

Cross-platform

Enables Azure IoT Edge to target the most popular edge operating systems, such as Windows and Linux

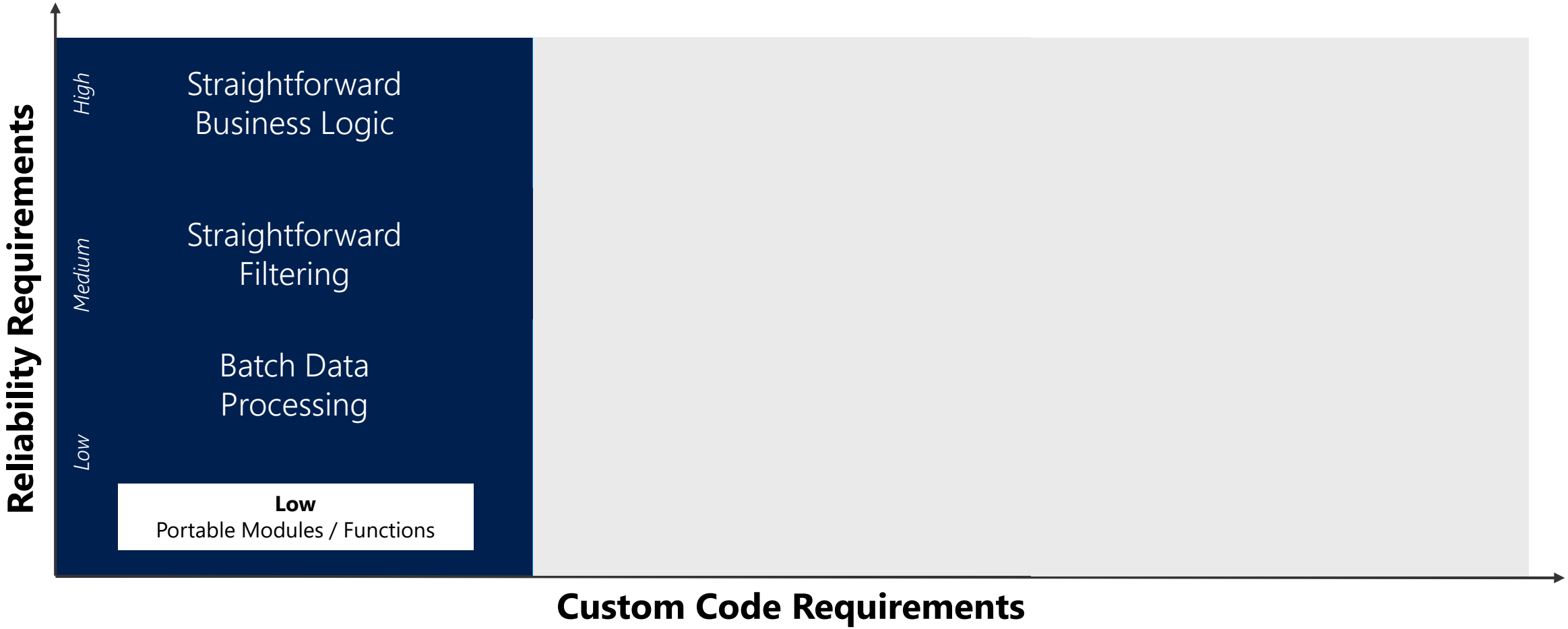
Portable

Enables Dev/Test of edge workloads in the cloud with later deployment to the edge as part of a continuous integration / continuous deployment pipeline

Extensible

Enables seamless deployment of advanced capabilities such as AI from Microsoft, and any third party, today and tomorrow

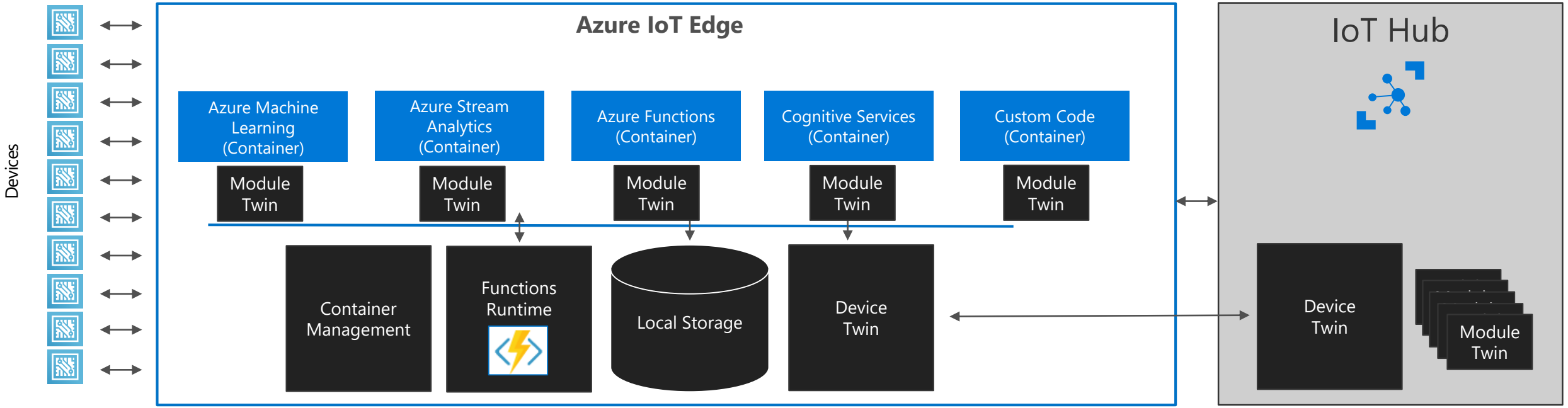
Edge Processing Scenarios & Requirements



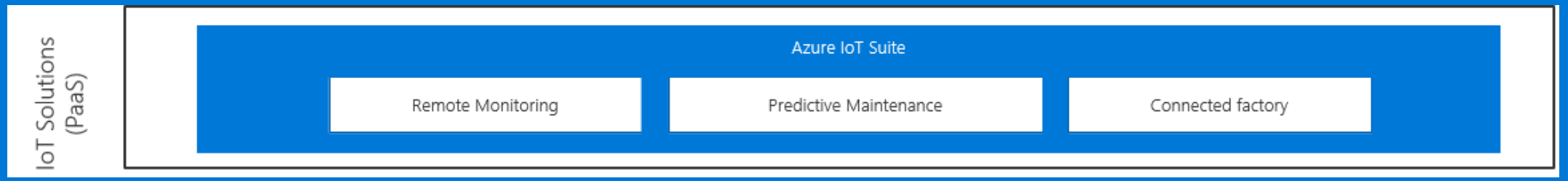
Azure IoT Edge

- Container based modules
- Azure Functions
- Azure Stream Analytics
- Azure Machine Learning
- Cognitive Services

- Offline / Synchronized Device Twins
- Local Storage
- Cloud Management & Deployment
- High Availability / Fault Tolerance
- Cloud Dev/Test Support



Azure IoT Solution Accelerators



What you get with a solution accelerators

https://www.azureiotsolutions.com/Accelerators

Remote Monitoring

Connect and monitor your devices to analyze untapped data and improve business outcomes by automating processes.

Try Now

Overview

Demo

Deployment guide

Connected Factory

Accelerate your journey to Industrie 4.0 – connect, monitor and control industrial devices for insights using OPC UA to drive operational productivity and profitability.

Try Now

Overview

Demo

Deployment guide

Predictive Maintenance

Anticipate maintenance needs and avoid unscheduled downtime by connecting and monitoring your devices for predictive maintenance.

Try Now

Overview

Demo

Deployment guide

Device Simulation

Streamline your IoT solution development by using simulated IoT devices to both build and test your solution throughout the software development lifecycle.

Try Now

Overview

Deployment guide

Azure IoT Central

a.k.a. Assembled and Glued Lego® Building blocks

Azure IoT Central

Connects assets in the field

Transforms data into a deeper understanding

Turns insight into action without sacrificing ease of use

Working with **Azure IoT Central** offers significant **advantages**

Comprehensive portfolio

Only hyperscale cloud vendor to offer SaaS, PaaS, and hybrid options for IoT, and a commitment to continual innovation

Industry-leading security and privacy

From endpoint and connection through to data and the cloud

Open platform

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

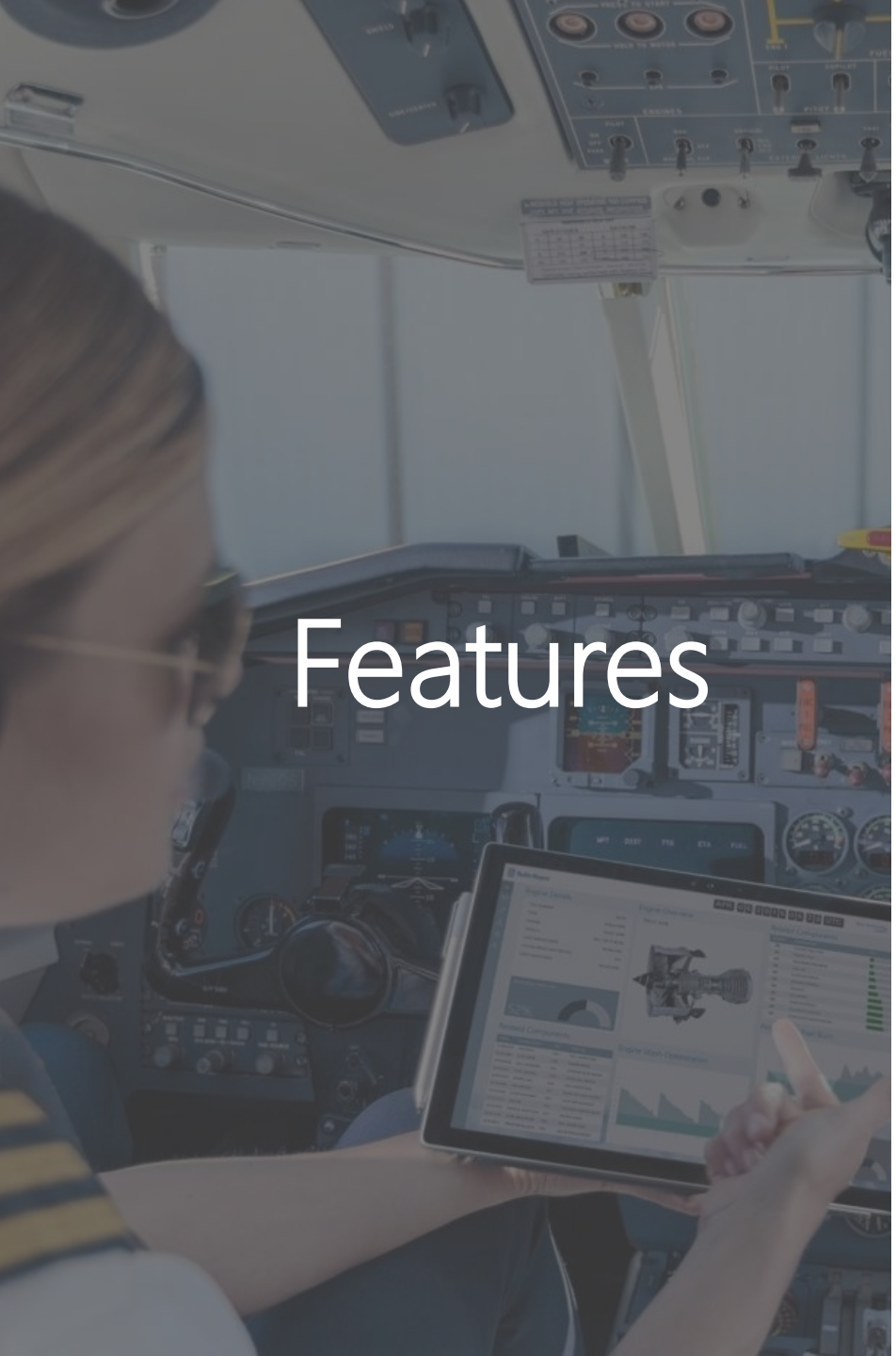
Extensive partner ecosystem

Industry leaders ready to collaborate with your business

Large-scale SaaS experience

Experience of running and managing powerful, user-friendly, scalable solutions used by millions of users worldwide

Microsoft



Features

Connectivity Hub & Telemetry ingestion

Connects a variety of devices to the cloud through an open platform

Device management

Enables understanding, control, and optimization of investments

Analytics & dashboards

Provide simple and consumable reports and visualizations for any platform

Rules engine

Real time data processing

Time-series insights

Identify trends among millions of IoT events

Digital twin management

Enables actionable insights through modeling and simulation

User and identity management

Delivers customized levels of permissions across users and protect from unauthorized access

What else I should think about?

Driving Security Innovation: 7 Properties of Device Security

- Well understood security principles and practices
- Device security rooted in hardware, but guarded with secure, evolving software
- https://www.microsoft.com/en-us/research/project/sopris/

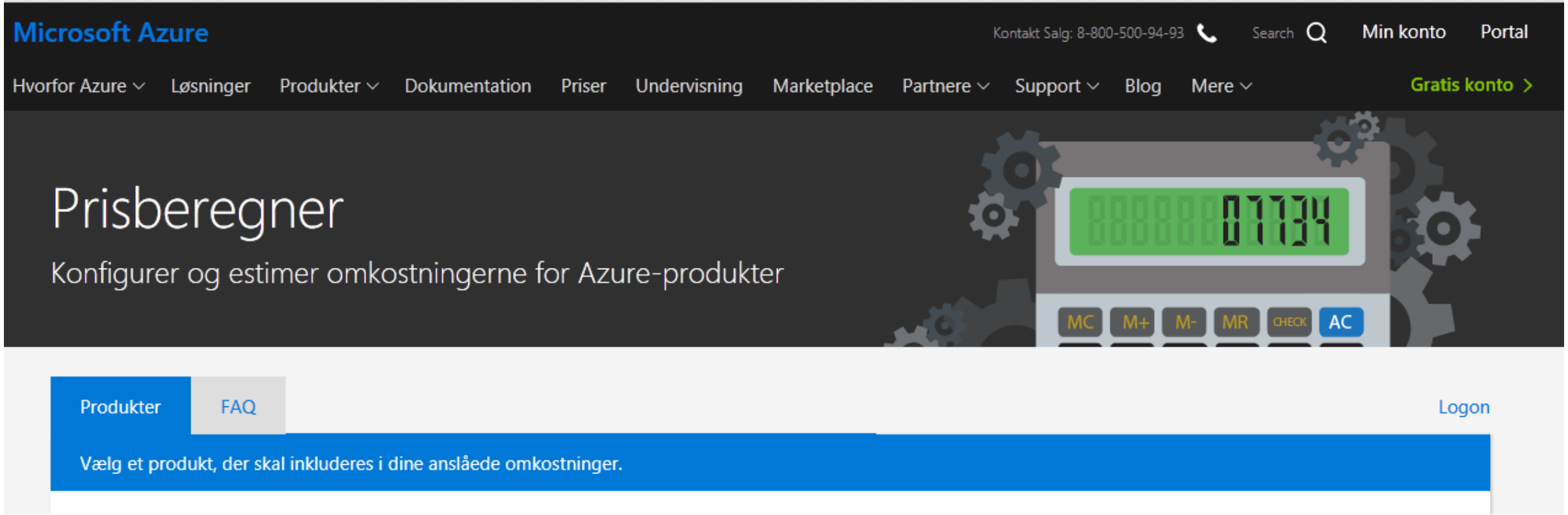
Property	Hardware-based Root of Trust	Small Trusted Computing Base	Defense in Depth	Compartmentalization	Certificate-based Authentication	Renewable Security	Failure Reporting
							
Key Questions	Does the device have a unique, unforgeable identity that is inseparable from the hardware?	Is most of the device's software outside the device's trusted computing base?	Is the device still protected if the security of one layer of device software is breached?	Does a failure in one component of the device require a reboot of the entire device to return to operation?	Does the device use certificates instead of passwords for authentication?	Is the device's software updated automatically?	Does the device report failures to its manufacturer?

Long Range Connectivity (in no specific order)

Technology	Available	Low Power	Lock-in?	Band	Notes
2/3G Cellular	Yes	-	Mobile Operator	GSM 900, GSM 1800, UMTS 900, UMTS 2100	
4G Cellular LTE	Limited in Rural Areas	-	Mobile Operator	LTE 800, LTE 900, LTE 1800, LTE 2100, LTE 2600	50-100ms Latency
ADSL	Yes	-	Telco		
Fiber	Yes	-	Telco		
ExpressRoute	Yes	-	ER Partner		
LoRaWAN	Yes	Yes	Open	868/933 MHz Whitespace	1-249 Bytes/Message
Sigfox	Yes	Yes	Sigfox	868/933 MHz Whitespace	12 Bytes/Message 144 times per day
NB-IOT/LTE-M/Cat-M1	Very Limited (Test Networks)	Yes	Mobile Operator	In-Band, Guard Band of LTE (4G)	1.6s-10s Latency *
5G	Future (2022)	-	Mobile Operator	28, 38, and 60 GHz	5ms+ Latency, 3x base station density compared to 3G
Satellite	Yes	-	Operator (Iridium, Inmarsat, LightSquared, Thuraya)	1525-1661 MHz	Extreme Costs, Indoor use not possible

Azure Calculation referral point

https://azure.microsoft.com/da-dk/pricing/calculator/



- Unless your company is, as instance, a LSP (licensing Solution Partner) and/or a CSP (Cloud Solution Provider), use this service as referral point to get an “idea” on possible costs.
- Be careful: depending on Customer contracts, costs may vary - refer to an official reseller to understand final Azure subscription costs

General Architecture Considerations - Summary

- Use PaaS and SaaS components as much as possible
- Architect for:
  - Performance
  - Cost
  - SLA
  - High Availability
  - Service Regional Availability
  - Scalability (Scale Sets)
  - Use the least number of Service Components
  - Data Sovereignty/Regional Data Requirements/GDPR
  - Monitoring
  - DevOps

IoT Implementation Success – Overall suggestions

Do

- Secure senior business sponsorship
- Focus on business requirements
- Start small, think big (MVP)
- Build multi-disciplinary teams
- Engage the right experience
- Keep security central in all you do
- Use agile development processes
- Design for flexibility and change
- Take a ecosystem approach to IoT

Do not

- Confuse data with insights
- Build a solution for all your needs
- Over-pivot on the technology
- Focus on future requirements
- Develop your own IoT infrastructure
- See middleware as the IoT solution
- Think connectivity is not a problem
- Underestimate the importance of quality sensors
- Forget that IoT is devices (HW) and software

Microsoft Learnings from Real Customer cases; 10 reasons why your IoT project will fail, Derek du Preez;
https://diginomica.com/2017/09/13/10-reasons-iot-project-will-fail/
The dos and don'ts of IoT, Jon Reed;
https://diginomica.com/2016/06/09/the-dos-and-donts-of-iot-a-customer-panel-shares-internet-of-things-progress/

Microsoft

Mange tak!

(Thank you!)