Best Practices of Implementing Intelligent Edge Solutions with Azure IoT & AI

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Partner Devices and Solutions, Microsoft
IoT in the Cloud and on the Edge

**IoT in the Cloud**
- Remote monitoring and management
- Merging remote data from multiple IoT devices
- Infinite compute and storage to train machine learning and other advanced AI tools

**IoT on the Edge**
- Low latency tight control loops require near real-time response
- Protocol translation & data normalization
- Privacy of data and protection of IP

**Symmetry**
Azure IoT Edge

Move cloud and custom workloads to the edge, securely

Seamless deployment of AI and advanced analytics

Configure, update and monitor from the cloud

Compatible with popular operating systems

Code symmetry between cloud and edge for easy development and testing

Secure solution from chipset to cloud
IoT Pattern + Edge

- Things
- Insights
- Actions

- Azure IoT Hub
- Cloud Gateway
- Insights
- Actions
IoT Pattern

Offline Support!

- Indefinite offline operation after one-time sync with IoT Hub!
- Downstream IoT devices can connect to offline Edge device and queue messages for deferred cloud delivery - no code changes, just works!
- Edge + downstream devices can restart and reauthenticate when offline.
- Local Inter-device communication facilitated by Edge Runtime.
## Platform Support

### Tier1

**Generally Available**

<table>
<thead>
<tr>
<th>Operating System</th>
<th>AMD64</th>
<th>ARM32</th>
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</thead>
<tbody>
<tr>
<td>Raspbian-stretch</td>
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<tr>
<td>Ubuntu Server 16.04</td>
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<tr>
<td>Ubuntu Server 18.04</td>
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**Public Preview**

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<th>Operating System</th>
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<tr>
<td>Windows 10 IoT Core (April 2018 update)</td>
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<td>Windows 10 IoT Enterprise (April 2018 update)</td>
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<td>Windows 10 Server 1803</td>
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### Tier2

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<tbody>
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<td>Debian 9</td>
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<td>Yes</td>
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<tr>
<td>RHEL 7.5</td>
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<tr>
<td>Ubuntu 18.04</td>
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<td>Yes</td>
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<td>Wind River 8</td>
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<tr>
<td>Yocto</td>
<td>Yes</td>
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Concept

**Azure IoT Edge Runtime**

Installs and updates workloads on the device.

Maintains Azure IoT Edge security standards on the device.

Ensures that IoT Edge modules are always running.

Reports module health to the cloud for remote monitoring.

Facilitates communication between downstream leaf devices and the IoT Edge device.

Facilitates communication between modules on the IoT Edge device.

Facilitates communication between the IoT Edge device and the cloud.

IoT in Action
Concept

Routing

FROM <source> WHERE <condition> INTO <sink>

Sources – source of messages

/messages/modules/{mid}/outputs/{out1}

Condition – expression on messages properties/body

sensorType = “temp” and alert = true

Sinks – destination for messages (endpoints)

$upstream

brokeredEndpoint(“/modules/{mid}/inputs/{in1}”)

For example:

FROM /messages/modules/mod1/outputs/*
WHERE sensorType = “temp”
INTO brokeredEndpoint(“/modules/mod2/inputs/in1”)

Query Language
Concept

Device Management

- Power plant
- Elevators
- Smart meters
- Medical devices
- Buildings

**Device twin**
- Desired
- Reported
- Methods

**IoT Hub**
- Desired
- Reported
- Tags
- Methods

**Jobs**
Schedule and broadcast Device twin changes across large fleets
Azure IoT Edge Deployment

IoT Edge Device

Deployment Manifest

Azure IoT Hub

Docker container

Azure Machine Learning

Docker container

Azure Stream Analytics

Docker container

Azure Functions

Docker container

Azure Cognitive Services

Azure Container Service
Azure IoT Edge in action

1 – Edge device provisioned with right agents for scenario
2 – Select Edge node to deploy to
3 – Define modules on Edge node via device twin
4 – Define message routes for modules on edge node via device twin
5 – Define Module twins for module configurations (parameters)

Container based workloads
AI Services
Azure Functions
Azure Stream Analytics
Azure Machine Learning
Your own code using module SDK

Edge device with security requirements
Rich OS – Linux or Windows
Docker-compatible container management system
Defines a deployment that describes a set of modules as well as the target devices.

Configuration performed and status reported.

Hub communicates with all targeted devices to configure them with the desired modules.

Operator looks at twin for detailed status.
Azure Certified for IoT Device Catalog
Provides an easy way to discover cross-platform IoT device and starter kits for intended use case

More than 1000 certified hardware already listed on catalog.azureiotsolutions.com

Upcoming changes to device catalog website for improved discoverability and usability:
- Featuring best-in-class certified devices
- Ability to provide detail product description at glance
- Intuitive ways to search for the devices

Expansion of the existing program to support IoT Edge devices
New set of requirements for IoT Edge devices specifically

Existing certification for IoT devices remains intact

IoT Edge device certification certify against Azure IoT Edge functionality, device management and security

Hardware manufacturers can start submitting the IoT Edge devices for certification from partner dashboard

We are working with hardware manufacturers for certified IoT Edge devices

Send questions to iotcert@microsoft.com
Certified hardware for Azure IoT Edge

- Docker compatible container management system requires to be pre-installed
- Basic functionality of device management such as using device twin for reboot, FW/OS updates are required
- Optional requirements for additional security capabilities with 4 levels
- Devices can continue to run Azure IoT Edge. Microsoft is only certifying pre-installed Azure IoT Edge runtime

<table>
<thead>
<tr>
<th>Security Feature</th>
<th>Standard Feature</th>
<th>Secure Element</th>
<th>Secure Enclave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure Hardware Requirements</td>
<td>None</td>
<td>Standalone security processor e.g. TPM and secure elements.</td>
<td>Integrated security processor</td>
</tr>
<tr>
<td>Expectation</td>
<td>Edge base security processes</td>
<td>Secure hardware protection of storage and use of secrets e.g. keys</td>
<td>Secure Element feature plus protection of execution environment</td>
</tr>
<tr>
<td>Examples of Typical Transactions</td>
<td>All transactions in accordance with deployment risk assessment</td>
<td>- Authentication - Session key generation - Certificates processing</td>
<td>All Secure Element transactions plus: - Metering - Billing - Secure I/O - Secure Logging</td>
</tr>
<tr>
<td>Max Security Grading</td>
<td>Level 2</td>
<td>Level 4</td>
<td>Level 4</td>
</tr>
</tbody>
</table>

- **Grading**

<table>
<thead>
<tr>
<th>Grading</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
</table>
Advantech-EIS-D210

To fulfill customer requirements in equipment connectivity, data visualization, and predictive maintenance applications, Advantech offers the EIS-D210 Edge Intelligence Server, which is equipped with an Intel® Celeron® Processor N3350 and comes integrated with AWS Greengrass and Microsoft Azure IoT Edge, thus ensuring that IoT devices can respond quickly to local events. Interact with local resources, operate with intermittent connections, and minimize the cost of transmitting IoT data to the cloud.

UC-8112-ME-T with Azure IoT Edge

RISC-based communication-centric computing platform with 1 GHz CPU, 1 GB RAM, 2 Ethernet, 2 serial ports, USB port, SD Socket, pre-installed US LTE module and -40 to 70°C operating temperature with LTE module and Microsoft Azure IoT edge installed.

MyPi Industrial IoT Integrator Board

A Raspberry Pi Compute module based Industrial IoT Integrator board specifically designed for the Industrial IoT market. MyPi's architecture, components, O/S and feature set have all been chosen to provide you with maximum functionality and value for money. Utilises the Raspberry Pi Compute Module as its CPU section allowing users to leverage the most widely supported and easiest to use development platform available.
Control data through its lifecycle

<table>
<thead>
<tr>
<th>Existing</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>At rest</strong></td>
<td><strong>In use</strong></td>
</tr>
<tr>
<td>Encrypt inactive data when stored in blob storage, database, etc.</td>
<td>Protect/Encrypt data that is in use during computation</td>
</tr>
<tr>
<td><strong>Examples include:</strong></td>
<td><strong>Examples include:</strong></td>
</tr>
<tr>
<td>Azure Storage Service Encryption for Data at Rest</td>
<td>Trusted Execution Environments such as Intel SGX and VBS</td>
</tr>
<tr>
<td>SQL Server Transparent Database Encryption (TDE)</td>
<td>Homomorphic encryption</td>
</tr>
</tbody>
</table>

**In transit**
Encrypt data that is flowing between untrusted public or private networks

**Examples include:**
HTTPS
TLS
TEE Based Application Development

Node

User

App

Host Application 1

Host Application 2

TEE

Application Enclave 1

Code

Data

Application Enclave 2

Application Enclave 3

TA : Trusted Application

IoT in Action
Azure IoT Leverages the Protection of Trusted Execution Environments (TEE) Hardware from any Capable IoT Device

In addition to data at rest and data in transit, now protect code and data when in use.
Azure IoT Edge Module in Azure Marketplace

Solution developers:
Discover certified pre-built modules
Integrate certified pre-built modules

Publishers:
Share your modules
Monetize your modules
Supports “free” and “bring your own license”
Industrial Use Case

- Prognosis Monitoring System
- Gateway + Data Acquisition Module
- Motor + Controller + Accelerometer
- Accelerometer
Industrial Use Case

Remote monitoring of equipment health
Fear of height? No problem because you can be behind your desk

Prepare the suppliers for maintenance way in advance
No more aching arms – you know exactly what went wrong and what needs to be brought along
Industrial Use Case

IT

OT

Azure IoT Edge device

Ingest  Format

Modbus

OPC Publisher

Azure IoT Edge Runtime
Therefore, we need to support both IT and OT’s works -

**OT – Operate and Optimize the edge module**

a) Need a more intuitive way to do configuration things
   a) Choose edge module type
   b) Decide instance of each module
   c) Set configuration
   d) Data routing
   e) UI design

b) No permission to operate Azure Portal to avoid service interrupt by incorrect operation.

**IT – Deploy and Manage the edge module**

a) Implement the edge module by taking requirement of OT
   a) Implementation of consistent data modeling
   b) Skill transfer to OT

b) Set initial value of configuration
   a) Edge module credentials
   b) Image url
   c) Create Container options
Industrial Use Case

Sensor:
- Accelerometer
- Ammeter
- Thermometer
- ...

CNC Controller

CNC

Ethernet

USB

BNC

DAQ

VimoNet

Intelligent Machine Box

Pre-install Azure IoT Edge & VMX software
- Support various commercial CNC controllers, PLC and DAQ.
- Move cloud analytics and custom workloads to device securely. Such as data normalization, ML Model, OEE engine...
- Perform anomaly detection on the device itself and respond to emergencies as quickly as possible.

Azure Market Place

For Customer
- One simple place to discover all the capabilities that can be deployed to an edge device.
- All the modules are certified for quality and scanned for security vulnerabilities.

For Service Provider
- Publicize and monetize your IP
- Bill anyone using the module securely, automatically, and without writing a bunch of sensitive billing logic.

Azure IoT Hub & Edge
- Seamless deployment of AI and advanced analytics from cloud to the edge
- Centralized configure, update and monitor from the cloud

IoT in Action
AI priority industry

- **Manufacturing**
  - Discrete Manufacturing
  - Chemicals and Agrochemicals
  - Energy

- **Retail**
  - Retail
  - Consumer Goods

- **Media + Communications**
  - Media and Entertainment
  - Telecommunications

- **Education**
  - Higher Education
  - Primary and secondary (K-12)
  - Libraries and museums

- **Health**
  - Health payer
  - Health provider
  - Pharmaceuticals

- **Financial Services**
  - Banking and Capital Markets
  - Insurance

- **Automotive**
  - Automotive suppliers
  - Automotive OEMs

- **Government**
  - National Government
  - Defense and Intelligence
  - Local Regional Government

**FY19 Industry Initiatives:**

*Recruit for AI solutions*
Azure is the best place for AI

- **Accelerate time to value** with agile tools and services
- **Innovate with AI everywhere** in the cloud, at edge and on-premises
- **Use any language, any development tool and any framework**
- **Benefit from industry leading security, privacy, compliance, transparency and AI ethics standards**

>90% of Fortune 500 companies use Microsoft Cloud
The AI development lifecycle

**INGEST**
- Data orchestration and monitoring

**STORE**
- Data lake and storage

**PREP & TRAIN**
- Hadoop/Spark/SQL and ML
  - On-prem
  - Cloud

**MODEL & SERVE**
- IoT

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Apps + insights

- Azure Machine Learning
Machine learning & AI portfolio
When to use what?

Build your own or consume pre-trained models?

Which experience do you want?

Deployment target

What engine(s) do you want to use?
Development Flow of AML

1. Use estimated value to create a web service that computes the area of a circle
2. Load the workspace, retrieve the latest run
3. Use saved a file containing the pi value into run history. Register that file as a model
4. Create a scoring script that consists of two parts: an init method that loads the model, and a run method that gets invoked
5. Specify the library dependencies of your scoring script as conda.yml file.
6. Deploy the web service on Azure Container Instance
7. Try out the web service by passing in data as json-formatted request
Model Management – Inferencing Target
Examples of real-world AI Applications

**Vision**
- What is in the image or video?
  - People; 5 faces

**Speech**
- Give me directions to the nearest local branch.

**Language**
- Play today’s customer call recording.

**Knowledge**
- QnA Pair of this site?

**Search**
- Search for ‘fraud prevention.’

### Computer Vision
- Category: People; 5 faces
- Adult/Racy?: False/False
- Dominant colors: RGB
- Accent color:

### Speech service
- Convert spoken audio to text
- Convert text to spoken audio
- Extract intent of user

### Natural Language Processing
- Intent: PlayCall
- Content: Customer#
- DateTime: date: today

### Language Understanding
- Now Playing
- 11/29/2016 Customer Call

### Knowledge
- QnA Maker

### Search
- Bing News Search

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**Customer Relationship Management – 5 Key Trends for 2014 CRM**
- Oct 28, 2015 – Here are five key trends in 2014 that would help marketers in rolling... Offsite, marketers are looking at customer lifecycle management (CLM)

**Predictive Customer Lifecycle Management (CLM)**
- The purpose of Customer Life-cycle Management (CLM) is to maximize both customer retention and... Predictive trend analysis provides business visibility.

**Trends 2016: The Future of Customer Service**
- Jan 5, 2016 – The top 10 customer service trends for 2016 that... North American Consumer

**Language Around Customer Lifestyles in the Banking Industry**
- Michael heads fraud prevention tool. Online and mobile shopping are expected to continue growing.
Cognitive Services Containers
Give your apps a human side

- Run Cognitive Services on-premises and at the edge
- High throughput / low latency
- Control over model updates
- Portable architecture
Train a new LUIS App

1. Export for container
2. Move file to input mount
3. Run container with input mount
4. Query container
5. Import endpoint logs from output mount
6. Review endpoint utterances
Deploy LUIS container on Edge and Test it!
Try to recognize Face from your Edge device
Try it out! Detect a face in image at Edge side
# Types of AI Agents

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Retail</th>
<th>Finance</th>
<th>Insurance</th>
<th>Telecoms</th>
<th>Government</th>
<th>Automotive</th>
<th>Manufacturing</th>
<th>Healthcare</th>
<th>Media</th>
<th>Events</th>
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</table>
MIRDC MCAP IoT ML Platform

Common Automation Platform
- Smart Manufacturing accessible to SMB
- Expand sale and reduce maintenance cost
- Hybrid Cloud for Easy Adoption
- Edge for small sized company
- SaaS and PaaS dual models
- Semi-government Status for fast customer reach
- Fast drive digital transformation to member companies via common automation platform

Fast Tech Transfer
- Rapid tech transfer to large account/member company
- Azure multi-tenant SaaS
Intelligent Factory Solution

Field Sensor and Devices
- PLC
- QA system
- SQC
- File system
- Production management

Intelligent Edge Layer
- Edge computing
  - Real time analytics
  - Offline scenario support
  - Data cache and upload resume
- Sensor integration
- Factory controller
- Telemetry data input

Intelligent Service and Visualization

Big Data Layer
- Training/Validation Data
- Cloud Gateway IoT Hub
- Azure SQL

AI Stack (Edge)
- Modbus module
- Yield rate ML module
- PLS integration

* ML pipeline, continuing data input and training to increase precision

Offline Storage

Production root cause analysis
- Azure ML Service
- AI dashboard Power BI
- Training Compute
**THINGS**

- Devices / sensors
- Field Gateway (Sensor aggregation)
- Device Controller

**INSIGHTS**

- Cloud Gateway and Spatial service
- Cloud Gateway
  - 1. Device provision management
  - 2. Remote monitoring
  - 3. Device control
- Spatial Service
  - 1. Spatial relation service
  - 2. Multi-tenancy
  - 3. Object model
  - 4. Access control
- Big Data on Cloud
  - Intelligent Service
    - Vision
    - Speech
    - Language
    - Search
    - AzureML
  - Knowledge base (Rule Editor)
  - Azure IoT Central
  - Azure SQL
  - Azure Stream Analytics
  - Azure Time Series Insights

**ACTIONS**

- Manage
  - 1. Energy Analysis
  - 2. Fault detection & diag.
  - 3. Energy knowledge base, expert system
  - 4. People care assistance
  - 5. Indoor navigation
- Business Integration
  - Connect to Business Processes
- Dashboard
  - Power BI
  - App Service
  - Web Apps (Spatial relation display)
  - Indoor Map
Thank you