IoT in Action – Technical Track

Tim Zhan
IoT Solution Architect, CDS IoT Solutions
IoT Enables a Digital Feedback Loop
The benefits are profound

IoT enables a “digital feedback loop” that connects

- Customers
- Operations
- Products/Assets
- Employees

Our vision is to help businesses take advantage of the digital feedback loop
Digital Feedback Loop

A realtime connection enables new breakthrough levels of insights that in turn drive informed actions.
Respond and recover quickly

<table>
<thead>
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<th>With fragmented solutions</th>
<th>With IoT</th>
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</thead>
<tbody>
<tr>
<td>Maintain technicians onsite to determine and resolve issues</td>
<td>Access devices remotely to diagnose and resolve issues</td>
</tr>
<tr>
<td>Take days or weeks to reroute and reconfigure devices</td>
<td>Complete corrections within hours, including rerouting processes and reconfiguring machines</td>
</tr>
<tr>
<td>Search for data needed for root-cause analysis</td>
<td>Access comprehensive data immediately to perform root-cause analysis</td>
</tr>
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Expand, change and scale easily

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<th>With IoT</th>
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<tr>
<td>Solve storage on your own using capacity planning, capital purchases and ongoing maintenance</td>
<td>Exploit cloud solutions to scale instantly and pay for only what you need</td>
</tr>
<tr>
<td>Connect new devices later after customizations and integration efforts are complete</td>
<td>Connect new devices now with little or no configuration required</td>
</tr>
<tr>
<td>Take weeks or months to modify and extend systems with custom connections</td>
<td>Add to and extend systems faster by building on the extensible architecture</td>
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<tr>
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IoT in Action
Enabling the Digital Feedback Loop used to be challenging

Insights
- Fault tolerance
- Cloud-to-device commands
- Data storage
- Solution scale
- CI/CD
- Cold path analytics
- Hot path analytics
- Disaster recovery
- Operations monitoring
- Business process integration
- High availability
- Cost management
- Provisioning devices
- Warm path analytics
- Data ownership
- Data visualization
- Device updates
- Device lifecycle
- Transport protocols
- On device analytics
- Manufacturing scale
- Industry and government compliance
- End-to-End Security

Things
- Enterprise integration
- Device recovery
- Internationalization
- Security
- Drivers
- Device commercialization
- HW certification
- Securing data
- CI/CD

Actions
- Transport protocols
- Enterprise integration
- Device recovery
- Internationalization
- Security
- Drivers
- Device commercialization
- HW certification
- Securing data
- CI/CD

Enabling the Digital Feedback Loop used to be challenging.
Microsoft is simplifying IoT
Microsoft is simplifying IoT

- Easier to build secure, scalable solutions from device to cloud
- Easier to provision devices at scale
- Easier to secure devices at scale
- Easier to manage devices at scale
- Easier to find insights from your IoT devices
- Easier to run cloud services on devices
- Easier to benefit from IoT
The industry’s most agile, comprehensive, and secure portfolio

Solutions (PaaS)
- Azure IoT (PaaS)
  - Partner repeatable solutions
  - Azure IoT Solution Accelerators

Solutions (SaaS)
- Azure IoT Central
  - IoT SaaS
- Microsoft Dynamics
  - Connected Field Service

Technologies (PaaS)

<table>
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<th>Azure IoT Hub</th>
<th>Azure Stream Analytics</th>
<th>Azure HD Insight</th>
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<td>Azure IoT certified devices</td>
<td>IoT Hub Device Provisioning Service</td>
<td>Azure Time Series Insights</td>
<td>Azure Data Lake Analytics</td>
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<tr>
<td>Security Program for Azure IoT</td>
<td>Azure IoT Edge</td>
<td>Azure Machine Learning</td>
<td>Azure Data Lake</td>
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<tr>
<td>Windows 10 IoT</td>
<td></td>
<td>Cosmos DB</td>
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<th>Microsoft Flow</th>
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<td>Microsoft Power BI</td>
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Microsoft is simplifying IoT

**Azure IoT Solution Accelerators**
Preconfigured solutions for common IoT scenarios

**Azure IoT Central**
Fully managed IoT SaaS
No cloud solution expertise required

Built on the same Azure IoT Platform Services

Rich extensibility points in IoT Central
Continuum of support for IoT solution needs
**Azure IoT solution accelerators**

- End-to-end implementation
- Completely customizable
- Open-source microservices based architecture
- Device connectivity and management
- Dashboards, visualization, and insights
- Workflow automation and integration
- Command and control
- Preconfigured solutions

- Remote Monitoring
- Connected Factory
- Predictive Maintenance
- Device Simulation
Accelerate time to value

Start quickly for common IoT scenarios

Get started in minutes
Modify existing rules and alerts
Add your devices and begin tailor to your needs

Finish with your IoT application

Fine-tuned to specific assets and processes
Highly visual for your real-time operational data
Integrate with back-end systems
Components of a pre-configured solution

**Remote monitoring** | Predictive maintenance | Connected factory | Device simulation

**Devices**

- C# simulator

**Back end systems and processes**

- IoT Hub
- Web App
- Active Directory
- Cosmos DB
- Logic Apps
- Orchestrator
- VM
- Azure ML

**Microservices**
Azure IoT – Remote Monitoring Update

- Device Connectivity & Management
- Data Ingestion and Command & Control
- Stream Processing & Predictive Analytics
- Workflow Automation and Integration
- Dashboards and Visualization
- Preconfigured Solutions
  - Remote monitoring
  - Predictive maintenance
  - Connected factory
Azure IoT Central

Fully managed SaaS solution
No cloud expertise required
Built in security best practices
New extensibility features
Transparent and predictable per device pricing

Try today: http://azureiotcentral.com
Azure IoT Central empowers you to

**Get results fast**
Build production-grade applications in hours

Remove the management burden, operational cost, and overhead

Easily understand TCO with transparent and predictable per device pricing

**Grow and scale with ease, securely**
Enable IoT projects from small to large

Integrate with your existing business systems to execute workflows, such as field service support, alerts etc.

Leverage industry leading security standards and data protection features to help keep you in control of your data

**Enterprise grade solution**
Built on the hyperscale and enterprise-grade services provided by Azure and IoT

Leverage the latest advances when you need them

Bring your connected product strategy to life by keeping your most critical data secure
Azure IoT Central

- Fully hosted and managed by Microsoft
- No cloud development expertise required
- Device connectivity and management
- Monitoring rules and triggered actions
- Extensibilities (Flow, Dynamics, Webhooks, etc.)
- Analytics, dashboards and visualization
- Risk-free trial with simplified pricing
Azure IoT Central

**Builders**
- Product Modeler
- Digital-twin Management
- Template Management
- Rules & Workflows

**Administrators**
- App Manager
- User Management
- Identity Management

**Operators**
- Intuitive discoverability
- Asset Visualizations
- Time-series Insights
- Device Management
Azure IoT Central: Demo
Microsoft is simplifying IoT

**Azure IoT Solution Accelerators**
Preconfigured solutions for common IoT scenarios
Remote Monitoring | Predictive Maintenance | Connected Factory

**Azure IoT Hub**
IoT cloud gateway, secure, bi-directional communication with billions of devices sending trillions of messages

**Azure IoT Central**
Fully managed IoT SaaS
No cloud solution expertise required
Azure IoT Hub

- Bi-directional communication
  - Millions of Devices
  - Multi-language, open source SDKs
  - HTTPS/AMQPS/MQTT
  - 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 Security Center Support
Replace or decommission devices after failure, upgrade cycle or service lifetime

Replace or decommission devices after failure, upgrade cycle or service lifetime

Group devices and control access according to your organization's needs

Provide updates, configuration and applications to assign the purpose of each device

Monitor device inventory, health, and security while providing proactive remediation of issues

Securely authenticate devices, on-board for management and provision for service

Azure IoT Hub: IoT device lifecycle
Quick orientation

Provisioning happens here

Devices

IoT Hub

Stream Analytics

Event Hub

Web Jobs

Logic Apps

* Azure ML

Power BI

Web/Mobile App

Storage blobs

DocumentDB

Back end systems and processes
What is provisioning?

Registration + Configuration = Provisioning
Why provisioning is hard today

- Solutions must have per-device revocable access
- Provisioning is a manual process
- Initial configuration can become irrelevant between manufacturing and deployment
- Mergers, acquisitions, and bankruptcies can orphan devices
- Device supply chains are complex
Let’s talk supply chain

Building devices is complicated

Most common supply chain: OEM → ODM → SI → customer

Updating manufacturing process is hard if not impossible

Supply chain problems
Producing certificates, injecting certificates, re-flashing devices, data ownership changes, etc.

Example: cars
Azure IoT Hub Device Provisioning Service

Register and provision devices with zero-touch in a secure and scalable way

- Simple “plug and play” provisioning
- Minimize manual connection requirements
- Enhanced security through HSM
- Global availability
Goals for device provisioning with Azure IoT

**Securely automate the provisioning process**
Devices are automatically and securely connected to the IoT Hub service and provisioned with an initial configuration.

**Multitenancy support**
A single DPS can provide service for multiple IoT hubs (in multiple regions).

**Flexible device assignment**
Customers provide rules and logic to assure the right device is attached to the right IoT solution (and associated IoT Hub).
A selection of scenarios

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<tr>
<th>Initial connection</th>
<th>Load balancing</th>
<th>Ownership based</th>
<th>Location based</th>
<th>Re-provisioning</th>
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<tr>
<td>Zero-touch provisioning to a single IoT solution</td>
<td>Across multiple hubs</td>
<td>Connecting devices to their owner’s IoT solution based on sales transaction data</td>
<td>Connecting a device to the IoT hub with the lowest latency</td>
<td>Based on a change in the device, e.g. change of ownership</td>
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### An IoT device’s relationship to Device Provisioning Service

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<tr>
<th>Initial setup</th>
<th>Retrieving a key</th>
<th>Rolling a key</th>
<th>Hard reset</th>
</tr>
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<tbody>
<tr>
<td>Getting the device ready for the first time</td>
<td>For devices with limited or no key storage capabilities</td>
<td>Applicable only for devices which connect via a SAS token</td>
<td>When the device needs to be treated as new in-box</td>
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### Azure IoT Hub

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<td>Zero-touch provisioning</td>
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<tr>
<td>Centralize your provisioning workflow</td>
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<tr>
<td>Load balance across multiple IoT Hubs</td>
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<tr>
<td>Re-provisioning support</td>
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<tr>
<td>Supports TPM + X.509</td>
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IoT Pattern: Gaining Insight

- Things
- Cloud Gateway
- Insights
- Actions

Azure IoT Hub

Azure Stream Analytics
Jie Su
Senior Program Manager, R&D Data Analytics
Unlocking Real-time Insights

Insights are Perishable
Window of opportunity is limited

Time to Insight is Critical
Reducing decision latency can unlock business value

You can now query Data in Motion
Real-time analytics pipeline

- Devices & Gateways
- Stream Analytics on IoT Edge
- Azure Stream Analytics
- Event Queuing & Stream Ingestion
- Stream Analytics
- Storage & Batch Analysis
- Presentation & Action

Flow Diagram:
- Event production
- Event Queuing & Stream Ingestion
- Stream Analytics
- Storage & Batch Analysis
- Presentation & Action
Stream Analytics - Key Differentiators

- **Ease of getting started**: Declarative SQL language
- **Developer Productivity**: Out of the box source/sink integrations
- **Intelligent Cloud & Edge**: Same query in the cloud and on the Edge
- **Lowest TCO PaaS Service**: Start at $0.11/hr; No cluster Provisioning
- **Mission critical reliability**: Financially backed Enterprise-grade SLA
1,915 lines of code with open source offering!

@ApplicationAnnotation(name="WordCountDemo")
public class Application implements StreamingApplication {
    protected String fileName = "com/datatorrent/demos/wordcount/samplefile.txt";
    private Locality locality = null;

    @Override public void populateDAG(DAG dag, Configuration conf) {
        locality = Locality.CONTAINER_LOCAL;
        WordCountInputOperator input = dag.addOperator("wordinput", new WordCountInputOperator());
        input.setFileName(fileName);
        UniqueCounter<String> wordCount = dag.addOperator("count", new ……

Just 3 lines in Stream Analytics

SELECT Avg(Purchase), ScoreTollId, Count(*)
FROM GameDataStream
GROUP BY TumblingWindows(5, Minute), Score

Data Manipulation
- SELECT
- FROM
- WHERE
- HAVING
- GROUP BY
- CASE WHEN THEN
- ELSE
- INNER/LEFT OUTER
- JOIN
- UNION
- CROSS/OUTER APPLY
- CAST INTO
- ORDER BY

Date and Time
- DateName
- DatePart Day, Month, Year
- DateDiff
- DateTimeFromParts
- DateAdd

Temporal
- Lag
- IsFirst
- Last
- CollectTop

Windowing Extensions
- TumblingWindow
- HoppingWindow
- SlidingWindow

Aggregation
- SUM
- COUNT
- AVG
- MIN
- MAX
- STDEV
- STDEVP
- VAR
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- TopOne

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Scaling Extensions
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Geospatial
- CreatePoint
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- ST_INTERSECTS

Mathematical
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- EXP
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Advanced analytics and temporal processing

- Analyze any binary, Protobuf or Parquet data (on Edge now, Cloud in the future)
- Support for C# on Edge. More language support coming (Cloud and Azure IoT Edge)
- Built-In Geospatial analytics
- Select application/device time or ingest time
- Manage out of order events
- Join multiple streams on temporal windows
- Manage streams with multiple timelines (substreams) in same query independently
‘000s of customers use Azure Stream Analytics
A key part of Azure IoT Edge ecosystem
Main edge scenarios for ASA

- Low-latency command and control
- Limited connectivity to the cloud
- Limited bandwidth
- Compliance
Built-in ML models for Anomaly Detection on IoT Edge

Supports inline learning and real-time scoring

Easily invoked with simple function calls within query language

Requires no data scientist involvement

5 types of Anomalies Detected:
- Spikes and Dips
- Slow positive trend
- Slow negative trend
- Bi-Level change
Built-in function signatures for Anomaly Detection

\[\text{AnomalyDetection\_SpikeAndDip}(\text{<scalar\_expression>}, \text{<confidence>}, \text{<historySize>})\]
\[\text{OVER} (\text{[[PARTITION BY <partition key>]} \text{LIMIT DURATION(<unit>,<length>})] \text{WHEN boolean\_expression}])\]

\[\text{IsAnomaly}: \text{A bigint (0 or 1) indicating if the event was anomalous or not.}\]

\[\text{Score}: \text{A/D score (float) indicating how anomalous an event is.}\]
Azure Stream Analytics: Demo
Sign up for preview features at
http://aka.ms/ASAPreview1

Follow us on twitter
@AzureStreaming

Engage with us
askASA@microsoft.com
Intelligent Edge
Microsoft is simplifying IoT

**Azure IoT Solution Accelerators**
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**Azure IoT Hub**
IoT cloud gateway, secure, bi-directional communication with billions of devices sending trillions of messages

**Azure IoT Central**
Fully managed IoT SaaS
No cloud solution expertise required

**Azure IoT Edge**
Cloud consistent approach to deliver intelligent workloads closer to the action
Shift to the edge

Cloud
Globally available, unlimited compute resources

IoT
Harnessing signals from sensors and devices, managed centrally by the cloud

Edge
Intelligence offloaded from the cloud to IoT devices

AI
Breakthrough intelligence capabilities, in the cloud and on the edge
Challenges today create high barriers to entry

Cloud barriers

- High volume of data collection sources
- High cost of transporting data to the cloud
- Limits to real-time insights

Edge barriers

- High developer skillset for hardware, cloud, edge
- Custom code for everything = No standardization
- Manual set up and integration = Does not scale
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
Azure IoT Edge personas and tools

**Developer**
- Cloud development skills
- Familiar tools like VSCode
- Develop and test
- Continuously iterate

**Operator**
- Manage large fleets
- Stage and deploy at scale
- Stage and test
- Operational workflows with alerts
Enable AI and advanced services at the edge

Reduce IoT solution costs

Simplify IoT solution development

Cloud and edge code symmetry

Use programming tools and languages you know

Support for C, Java, .NET, Node.js and Python

Tackle bandwidth issues by pre-processing data

Minimize downtime by taking actions real-time

Leverage existing developer resources

AI Toolkit for Azure IoT Edge

Azure Machine Learning

Azure Stream Analytics

Azure Functions

Your own code

Cloud and edge code symmetry

Use programming tools and languages you know

Support for C, Java, .NET, Node.js and Python

Tackle bandwidth issues by pre-processing data

Minimize downtime by taking actions real-time

Leverage existing developer resources

AI Toolkit for Azure IoT Edge

Azure Machine Learning

Azure Stream Analytics

Azure Functions

Your own code
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
IoT Pattern + Edge

Azure IoT Hub

Things

Insights

Actions

Cloud Gateway

Insights

Actions

Microsoft

IoT in Action

IoT Hub

Insights

Actions
IoT Pattern

IoT Device

IoT Edge

Azure IoT Hub

Customer Solution

IoT in Action
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.
Concept

Module
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. The module instance is started by the IoT Edge runtime.

A module identity is a piece of information (including security credentials) 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, including metadata, configurations, and conditions.

SDKs to develop custom modules in multiple languages (C#, C, Python, Java, Node.JS)
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

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

Device Management

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

Device twin

| Desired | Reported | Methods |

IoT Edge or device

IoT Hub

- Desired
- Reported
- Tags
- Methods

Query

Jobs

Schedule and broadcast Device twin changes across large fleets
## Principles and Goals

- Cross Platform (Linux, Windows, multiple architectures)
- Standardized Protocols
- Secure technology isolation from app developer
- Availability of technology

### Security

<table>
<thead>
<tr>
<th>Protected General Computing</th>
<th>Application execution with runtime integrity checking</th>
</tr>
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<tr>
<td>Secure Execution Environment</td>
<td>Privileged executions and systems resource access control</td>
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<tr>
<td>Secure Boot/Updates</td>
<td>Bootstrapping and recovery</td>
</tr>
<tr>
<td>Hardware Root of Trust</td>
<td>Trust anchor</td>
</tr>
</tbody>
</table>
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

IoT Edge

Hardware based root of trust
Local storage

Security Manager

Device Provisioning

Device Twin

Module Twin

Container Modules

IoT Hub

IoT Edge operator

IoT Device with IoT Device SDK

IoT Device (e.g. BLE)

Connects to Edge Hub (Owns a device twin)

Connects to BLE Module for protocol translation (configured via BLE Module twin)
Azure IoT Edge: New Capabilities

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.

Azure Marketplace support for 3rd party Edge functionality (modules)
Azure Blob Storage module
Visual Studio + Visual Studio Code Tooling
Azure DevOps & Jenkins CI/CD support
High Availability / Multi-Device Support in Development
Certified hardware for Azure IoT Edge

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
Azure IoT Edge
Ready for the enterprise
Intelligent Edge

Leveraging Artificial Intelligence & Machine Learning
AI, Machine Learning and Deep Learning

Artificial Intelligence

Machine Learning

Deep Learning

Deep learning advancements

- **96%**
  - RESNET vision test
  - 152 layers

- **5.1%**
  - Switchboard speech recognition test

- **88.493%**
  - SQuAD reading comprehension test

- **69.9%**
  - MT research system

Object recognition
- Human parity: 2016

Speech recognition
- Human parity: 2017

Machine reading comprehension
- Human parity: Jan 2018

Machine translation
- Human parity: March 2018
Microsoft AI Platform

Azure AI Services

**PRE-BUILT AI**
- Cognitive Services

**CONVERSATIONAL AI**
- Bot Services

**CUSTOM AI**
- Azure Machine Learning

**Coding & Management Tools**
- VS Tools for AI
- Azure ML Workbench
- Others (PyCharm, Jupyter Notebooks...)

**Deep Learning Frameworks**
- Cognitive Toolkit
- TensorFlow
- Caffe
- Others (Scikit-learn, MXNet, Keras, Chainer, Gluon...)

Azure Infrastructure

**AI ON DATA**
- Cosmos DB
- SQL DB
- SQL DW
- Data Lake
- Spark

**AI COMPUTE**
- DSVVM
- Batch AI
- ACS
- IoT Edge

- CPU, FPGA, GPU

IoT in Action

Microsoft
Azure AI services

Bot Service
Accelerated development for conversational AI.

Cognitive Services
Vision, speech, language, knowledge and search pre-trained services customizable for any scenario.

Azure Machine Learning
Experimentation and management services for creating AI models with productivity.
Microsoft Cognitive Services

**Vision**
From faces to feelings, allow your apps to understand images and video.

**Speech**
Hear and speak to your users by filtering noise, identifying speakers, and understanding intent.

**Language**
Process text and learn how to recognize what users want.

**Knowledge**
Tap into rich knowledge amassed from the web, academia, or your own data.

**Search**
Access billions of web pages, images, videos, and news with the power of Bing APIs.

**Labs**
An early look at emerging Cognitive Services technologies: discover, try and give feedback on new technologies before general availability.
Why Microsoft Cognitive Services?

**Easy**
- Roll your own with REST APIs
- Simple to add: just a few lines of code required

**Flexible**
- Integrate into the language and platform of your choice
- Breadth of offerings helps you find the right fit for your app
- Bring your own data for your custom experience

**Tested**
- Built by experts in their field from Microsoft Research, Bing, and Azure Machine Learning
- Quality documentation, sample code, and community support

Get a key, Build
Microsoft Cognitive Services

**Vision**
- Computer Vision
- Content Moderator
- Emotion
- Face
- Video Indexer
- Custom Vision Service

**Speech**
- Bing Speech
- Speaker Recognition
- Custom Speech Service

**Language**
- Bing Spell Check
- Linguistic Analysis
- Text Analytics
- Translator Text & Speech
- Web Language Model
- Language Understanding

**Knowledge**
- Academic Knowledge
- Entity Linking
- Knowledge Exploration
- Recommendations
- QnA Maker
- Custom Decision Service

**Search**
- Bing Autosuggest
- Bing Image Search
- Bing News Search
- Bing Video Search
- Bing Web Search
- Bing Entity Search
- Bing Custom Search

**Labs**
- Project Prague (gesture)
- Project Cuzco (events)
- Project Johannesburg (routing)
- Project Nanjing (isochrones)
- Project Abu Dhabi (distance matrix)
- Project Wollongong (location)
A variety of real-world applications

**Vision**
- What is in the image or video?

**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’

**Intelligent Image insights**
- Category: People; 5 faces
- Adult/Racy?: False/False
- Dominant colors
- Accent color

**Speech to text**
- Convert spoken audio to text
- Convert text to spoken audio
- Extract intent of user

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

**Automatic extraction of questions and answers**
- Now Playing
- 11/29/2016 Customer Call

**Intelligent web search**
- Information Communications
- Media Market News
- The Big Question: In-House or Outsourced Fraud Protection?
- How to Protect Your Business from Online Fraud this Holiday Season
Image-processing algorithms to smartly identify, caption, and moderate your pictures
Process and extract smart insights from videos

Customizable web service that learns to recognize specific content in imagery

Detect, identify, analyze, organize, tag faces in photos, and even recognize emotions

Machine-assisted moderation of text and images, augmented with human review tools

Customizable web service that learns to recognize specific content in imagery
Custom Vision

A customizable web service that learns to recognize specific content in imagery

Upload images
Upload your own labeled images, or use Custom Vision Service to quickly tag any unlabeled images

Train
Use your labeled images to teach Custom Vision Service the concepts you want it to learn

Evaluate
Use simple REST API calls to quickly tag images with your new custom computer vision model

Active learning
Images evaluated through your custom vision model become part of a feedback loop you can use to keep improving your classifier
Custom Vision

Customize
Design your own state-of-the-art models for unique use cases

Upload
Use labeled images to quickly train and update your models

Export
Run models on a device or as a Docker container with just one click

Get Started At: https://customvision.ai/
Custom Computer Vision : Demo
Intelligent Edge
Windows IoT

Fei Zhou
Sr. Software Engineer Lead
Partner Engineering - China
Microsoft is simplifying IoT

**Azure IoT Solution Accelerators**
Preconfigured solutions for common IoT scenarios
Remote Monitoring | Predictive Maintenance | Connected Factory

**Azure IoT Hub**
IoT cloud gateway, secure, bi-directional communication with billions of devices sending trillions of messages

**Azure IoT Central**
Fully managed IoT SaaS
No cloud solution expertise required

**Azure IoT Edge**
Cloud consistent approach to deliver intelligent workloads closer to the action

**Windows 10 IoT**
Build secure, powerful and manageable intelligent edge devices
Intelligent Edge for IoT – with Windows

Microsoft’s building blocks for Intelligent Edge
Best of breed

Connecting the Intelligent Edge and the Intelligent cloud
Best of both worlds

Why Windows 10 IoT with Azure
Simple and secure

What's new this fall with Windows
More intelligent
Microsoft’s building blocks for Intelligent Edge

Azure Sphere
- Cloud Security
- Secured MCU
- Secured OS

Azure IoT Edge
- Open Sourcing
- Azure IoT Edge Runtime
- Windows SDK and Commercial Drone Solutions

Windows IoT, Windows Server
- Intelligent security
- Faster time to market
- Smarter devices

Azure Stack, Azure Databox Edge
- On-premises, cloud consistent
Intelligent Edge scenarios

Bring intelligence to gateways at the edge
- Transparent gateway
- Protocol translation
- Identity translation

Intelligent compute to find insights at the edge
- Data sovereignty and Filtering
- Deploy event processing
- Machine Learning
- Image recognition
- Other high value Artificial Intelligence

Bring intelligence to local storage
- Blob Store
- SQL
- SQLite
Canonical Intelligent Edge roles

Pattern#1
- Data collection, protocol bridging
- ("Complex") IoT device

Pattern#2
- Data collection
- ("Simple") IoT device
- Protocol bridging, pre-processing/annotating
- IoT Gateway

Pattern#3
- Data collection
- (Either) IoT device
- Protocol bridging, pre-processing/annotating
- IoT Gateway
- Edge Server(s)
- Data buffering, Local reactive, predictive & cognitive analytics

Pattern#4
- Data collection
- (Either) IoT device
- Protocol bridging, pre-processing/annotating
- IoT Gateway
- Edge Server(s)
- Data buffering, Local reactive, predictive & cognitive analytics

Broad range of cloud-consistent PaaS services

Power of Intelligent Cloud

One or all these boxes are Optional*

MS product offerings
- Azure Sphere, Windows IoT Core & IoT Enterprise, Azure IoT Device SDK
- Azure IoT Edge, Windows IoT Core & Windows Enterprise Client
- Azure IoT Edge, Azure Databox Edge
- Windows Server
- Azure IoT Edge, Azure Databox Edge
- Windows Server
- Azure Stack
- Azure

Microsoft Intelligent Edge
Why Windows 10 IoT with Azure

Device-to-cloud platform for secure, simply manageable intelligent edge devices

**Azure ML + Azure IoT Edge + Windows AI**
Brings accelerated AI to your device

**Windows 10 IoT**
Secure, manageable, full-featured IoT OS with long-term support

**Windows 10 IoT Device Management**
Provided by Azure IoT Hub and enterprise device management

**Windows Update + Device Update Center**
Keeps devices secure, giving full control to the device maker

---

*Microsoft*
## Windows IoT Powers the Intelligent Edge

### Faster time to market

- Innovate and get to market faster with powerful Windows development tools and Azure integration.

### Intelligent security

- Protect devices, data, and identities with intelligent security, built in and up to date.

### Smarter devices

- Optimize your edge and cloud intelligence with devices that can do more.

**Complete platform**, enabling customers to focus on their unique value.

- Great Visual Studio **dev experience**
- The most comprehensive and best integrated **Azure IoT support**
- Extensive **Windows ecosystem** of hardware and software providers and integrators.

- Up-to-date systems, with **services controlled by our partners and customers**
- **Secure solutions** from device to cloud with robust security built into the platform
- Support for the **latest security protocols**
- A **corporate wide team of security and privacy experts** focused on the platform

- **Broad hardware support**
- **Rich user interactions** with Natural User Interface (NUI) and world-sensing support
- Great support for containers, **Azure IoT Edge**
- Accelerated ML with **Windows AI platform**
Windows 10 IoT editions

Windows 10 IoT Core
Bringing the core of Windows to smart devices

Windows 10 IoT Enterprise
Bringing the full power of Windows to smart devices
# Windows 10 IoT edition comparison highlights

<table>
<thead>
<tr>
<th></th>
<th>Windows 10 IoT Core</th>
<th>Windows 10 IoT Enterprise*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User experience</strong></td>
<td>Single UWP app active in foreground at one time with supporting background apps &amp; services</td>
<td>Traditional Windows shell with advanced lockdown features</td>
</tr>
<tr>
<td><strong>Headless supported</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>App architecture supported</strong></td>
<td>UWP</td>
<td>UWP &amp; Win32</td>
</tr>
<tr>
<td><strong>Cortana</strong></td>
<td>Cortana SDK</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>Azure IoT DM, Intune, MDM &amp; DUC</td>
<td>Azure IoT DM, Intune, MDM &amp; traditional agent-based (e.g. SCCM)</td>
</tr>
<tr>
<td><strong>Device security technologies</strong></td>
<td>TPM, Secure Boot, BitLocker, Device Guard, Device Health Attestation</td>
<td>TPM, Secure Boot, BitLocker, Device Guard, Device Health Attestation, Windows Advanced Threat Protection</td>
</tr>
<tr>
<td><strong>CPU architecture support</strong></td>
<td>x86, x64 &amp; ARM</td>
<td>x86 &amp; x64</td>
</tr>
<tr>
<td><strong>System resources</strong></td>
<td>512MB RAM + 2GB storage</td>
<td>1GB RAM + 16GB storage**</td>
</tr>
<tr>
<td><strong>Licensing</strong></td>
<td>Online licensing terms agreement and embedded OEM agreements, subscription</td>
<td>Direct and indirect embedded OEM agreements</td>
</tr>
<tr>
<td><strong>Usage scenarios</strong></td>
<td>▪ Digital signage &amp; kiosks ▪ IoT gateway ▪ Manufacturing devices</td>
<td>▪ Digital signage &amp; kiosks ▪ IoT gateway ▪ Manufacturing devices ▪ Large medical devices ▪ Industry tablets ▪ POS, ATM</td>
</tr>
</tbody>
</table>
NXP + Windows 10 IoT Core now available

Windows 10 IoT Core on several i.MX6/7/8M SoCs
Hundreds of evaluations in progress
Unique security capabilities like trusted I/O
Public Preview NOW
Get started today – http://aka.ms/iotnxp

Aaeon PICO-IMX6
Advantech RSB-4411
Keith & Koep pConXS
SolidRun HummingBoard Edge
Kontron SMARC-sAMX6i
Geniatech SoM-iMX6Q
Geniatech SoM-iMX7D
VIA VAB-820
PHYTEC phyBOARD i.MX7-Zeta
Compulab IoT-Gate
Kontron SMARC-sAMX6i
Ka-Ro TX6
# Introducing Windows IoT Core Services for Windows 10 IoT Core

## Commercialize your project with enterprise-grade security and support

<table>
<thead>
<tr>
<th>Updates</th>
<th>Security</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take control of Windows updates with cloud-based <strong>IoT Core Device Update Center (DUC)</strong>&lt;br&gt;Manage updates for OS, apps, settings, and OEM-specific files from the cloud&lt;br&gt;Distributed over same global CDN used by Windows Update</td>
<td>Help ensure the safety of your network and devices with cloud-based <strong>Device Health Attestation (DHA)</strong>&lt;br&gt;Backed by the <strong>same security research team and validation process</strong> used by 500M Windows 10 devices&lt;br&gt;Leverage hardware and cloud services to provide tamper proofing and remote attestation of device health</td>
<td>Count on stable systems with <strong>10 years of LTSC (Long Term Servicing Channel) support</strong> with security updates only (no new features)&lt;br&gt;Access to monthly published Windows IoT Core packages&lt;br&gt;Official Microsoft Lifecycle Support statement - links to software license agreement&lt;br&gt;Access to monthly published Windows IoT Core packages for <strong>building fully patched images</strong> with OEM tools</td>
</tr>
</tbody>
</table>

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**IoT in Action**

![Microsoft Logo](https://example.com/logo.png)
Windows 10 IoT Enterprise: Assigned Access Overview
More manageable, more locked down

**Single app kiosk experience**
Restrict the user experience to a single universal windows application.

Examples:
- Digital signage
- Interactive display
- ATM, POS, Healthcare

**Multi-app kiosk experience**
Restrict the user experience to a curated set of applications.

Examples:
- Interactive kiosk
- Tablets used by store employees for business operation
Windows 10 IoT Long Term Support Silicon

Windows 10 IoT Enterprise

- AMD® 6th Generation Processors Series Ax-8xxx & E-Series Ex-8xxx & FX-870K
- AMD® 7th Generation Processors Series Ax-9xxx & E-Series Ex-9xxx & FX-9xxx
- AMD® Ryzen™ 3/5/7 1xxx
- AMD® Ryzen™ 3/5/7 2xxx
- AMD® G-Series, R-Series
- AMD® V1xxx
- 4th 5th 6th 7th 8th 9th Generation Intel® Core™ Processors
- Intel Xeon E3-xxxx v6
- Intel® Atom™ processor E3900 series
- Intel® Atom™ x5-E8000 Processor
- Intel® Atom™ x5-Z8350 Processor
- Intel® Atom™ Processor E3800 Product Family
- Intel® Pentium® and Celeron® Processor N and J Series

Windows 10 IoT Core

- Broadcom® 2836 (Raspberry Pi 2)
- Broadcom® 2837 (Raspberry Pi 3)
- Intel® Atom™ processor E3900 series
- Intel® Atom™ x5-E8000 Processor
- Intel® Atom™ x5-Z8350 Processor
- Intel® Atom™ Processor E3800 Product Family
- Intel® Pentium® and Celeron® Processor N and J Series
- NXP® i.MX 6QuadPlus, 6Quad, 6DualPlus, 6Dual, 6DualLite
- NXP® i.MX 6SoloX, 6SoloLite, 6ULL
- NXP® i.MX 7Solo
- NXP® i.MX 7ULP
- NXP® i.MX 8M Family
- Qualcomm® Snapdragon™ 410E
Windows Server as Intelligent Edge OS

High availability
High security
Machine Learning
Windows Admin Center
• Completed integrated with Azure
• System Insights
Azure IoT Edge
• Azure Blob Storage on the Edge accelerates edge-local processing like local video analytics
• SQL, SQLite
Edge Hyper Converged Infrastructure (HCI)
## Windows as Intelligent Edge OS

**Commercialize your project with enterprise-grade security and support**

<table>
<thead>
<tr>
<th>Windows 10 IoT Core</th>
<th>Windows 10 IoT Enterprise</th>
<th>Windows Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ SoC: Intel, Raspberry Pi, Qualcomm, NXP</td>
<td>▪ SoC: Intel, AMD</td>
<td>▪ SoC: Intel, AMD</td>
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<tr>
<td>▪ Small footprint: 512MB RAM+2G storage</td>
<td>▪ Windows 10 IoT Enterprise LTSC 1809</td>
<td>▪ Windows Server 2019</td>
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<td>▪ IoT Core Services</td>
<td>▪ Lockdown</td>
<td>▪ Windows Admin Center</td>
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<td>▪ ▪ DUC</td>
<td>▪ ▪ assigned access</td>
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<tr>
<td>▪ ▪ LTSC</td>
<td>▪ ▪ Security</td>
<td>▪ ▪ Azure backup</td>
</tr>
<tr>
<td>▪ Security</td>
<td>▪ ▪ Machine Learning</td>
<td>▪ Security</td>
</tr>
<tr>
<td>▪ Machine Learning</td>
<td>▪ ▪ Azure IoT Edge</td>
<td>▪ Machine Learning</td>
</tr>
<tr>
<td>▪ Azure IoT Edge</td>
<td></td>
<td>▪ High Availability</td>
</tr>
</tbody>
</table>

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*IoT in Action*
Intelligent Edge

Hybrid Cloud
Microsoft is simplifying IoT

Azure IoT Solution Accelerators
Preconfigured solutions for common IoT scenarios
Remote Monitoring | Predictive Maintenance | Connected Factory

Azure IoT Hub
IoT cloud gateway, secure, bi-directional communication with billions of devices sending trillions of messages

Windows 10 IoT
Build secure, powerful and manageable intelligent edge devices

Azure IoT Central
Fully managed IoT SaaS
No cloud solution expertise required

Azure IoT Edge
Cloud consistent approach to deliver intelligent workloads closer to the action

Azure Stack
Only Consistent Hybrid Cloud
Microsoft Azure: Only consistent hybrid cloud

- Azure Active Directory
- Azure management and security
- Azure data services
- Azure services

- Common Identity
- Integrated Management and Security
- Consistent Data Platform
- Unified Development and DevOps

- Active Directory
- On-premises infrastructure
- SQL Server
- Azure Stack
Azure Stack is an extension of Azure

Only consistent hybrid cloud platform
54 Azure regions
More than AWS & Google combined
Hybrid use cases: Azure and Azure Stack

- Edge and disconnected solutions
- Cloud applications to meet varied regulations
- Cloud application model on-premises
Azure Stack promise

Consistent application development

Azure services available on-premises

Integrated delivery experience
Azure Capabilities on Azure Stack

- Virtual machines (VM), VM scale sets
- Containers
- Networking
- Storage
- Key Vault
- Azure App Service
- Azure Functions
- Azure Marketplace

- Rapid deployment with scaling on demand
- Linux and Windows Server containers
- Virtual network, load balancer, VPN gateway
- Blobs, tables, queues
- Securely protect application keys and secrets
- Web and API apps
- Serverless Computing
- Ready to go Apps from the Azure Marketplace

*See roadmap slides & Azure Roadmap for upcoming investments*
One Azure ecosystem

Work with the tools and technologies you want across Azure and Azure Stack

Goal: Applications and services that are certified for Azure work on Azure Stack
Extending geographic reach for Azure services

Domain, industry, and regulatory expertise

Managing and operating Azure Stack on your behalf

Realizing Azure services everywhere with Managed Service Provider solutions
Azure, Azure Stack, IoT Edge, and IoT

**Azure**
- Available in Azure Regions
- Full functionality

**Azure Stack**
- Azure Services & Management on-prem
- Managed by Azure or Locally

**Azure IoT Edge**
- Deploy and manage cloud services
- Managed by Azure or Azure Stack

**Windows IoT, Linux**
- Azure IoT Edge runs on Windows and Linux

**Azure IoT Device SDK**
- Multi-device, multi-language, multi-OS
- iOS, Android, Windows, Linux

**Azure Sphere**
- Peerless security for MCU devices
- Connect directly to Azure or via Azure IoT Edge

**Azure Sphere OS**
- Linux Kernel that modernizes MCU devices
Getting Started

IoT Reference Architectures
Azure IoT reference architecture

Core Subsystems

- **IoT Devices**: Provision and send data from device to cloud
  - Device Management

- **Cloud Gateway (IoT Hub)**
  - Stream processing and rules evaluation over data

- **Stream Processing**
  - Store data

- **UI & Reporting Tools**
  - Visualize data and learnings

- **Business Integration**
  - Integrate with business processes

**Things**: Provision and send data from device to cloud

**Insights**: Stream processing and rules evaluation over data

**Actions**: Visualize data and learnings
IoT Reference Architecture

The latest Azure IoT cloud native recommended architecture and latest technology implementation recommendations.

Provides:

- Overview of the IoT space
- Recommended subsystem factoring for solutions
- Prescriptive technology recommendations per subsystem
- Proven production ready architecture
- Proven technology implementation choices
- Recommendations for scaling systems
- Reference architecture implementations such as Remote Monitoring and Connected Factory.

https://aka.ms/iotrefarchitecture
Call to Action
Azure: IoT for every business

Accelerate your IoT journey

Build on the most comprehensive IoT portfolio & ecosystem

Work with a trusted IoT leader
Key Expectations of the day

Learn
Grow
Connect
ESP32 in Azure IoT practice

Scott Liu
Software Engineer
Partner Engineering - China
Agenda

• ESP32-Azure board
• Azure IoT workbench for Visual studio code
• Azure IoT central
• Connect ESP32-Azure board with Azure IoT central
• Connect ESP32-lyraT board with Azure speech
ESP32-Azure board

- ESP32-WROVER (Espressif)
- CP2102N USB2UART Bridge
- MicroUSB or Li-ion power supply
- Sensors:
  - Motion sensor
  - Magnetometer
  - Ambient light sensor
  - Barometer
  - Humidity and temperature sensor
- OLED, 128 x 64
- MicroSD card
- 2 buttons
- 2 LEDs
Azure IoT workbench for Visual Studio Code

IoT Workbench aims to support multiple popular IoT development boards and kits. It currently supports:

- ESP32
- MXChip IoT DevKit
- teXXmo IoT button
- Raspberry Pi

Features:
- Create New Project
- Provision Azure Service
- Example Gallery
Azure IoT Central

Fully managed SaaS solution
No cloud expertise required
Built in security best practices
New extensibility features
Transparent and predictable per device pricing
Azure IoT Central

- Fully hosted and managed by Microsoft
- No cloud development expertise required
- Device connectivity and management
- Monitoring rules and triggered actions
- Extensibilities (Flow, Dynamics, Webhooks, etc.)
- Analytics, dashboards and visualization
- Risk-free trial with simplified pricing
Connect ESP32-Azure board with Azure IoT Central
What you need

• An esp32-azure-board kit

• An active Azure subscription. If you do not have one, you can register via one of these two methods:
  ▪ Activate a free 30-day trial Microsoft Azure account.
  ▪ Claim your Azure credit if you are MSDN or Visual Studio subscriber.
Features implemented

• Telemetry data sent for all onboard sensors
• LED status of network, Azure IoT send events
• Display temperature and humidity on screen
• Reported twin property dice number is sent when shaking the device (uses accelerometer sensor data)
• Cloud to device messages (supports sending a message to display on the screen, press button to go back humiture screen)
• Desired twin property to turn on a fan at a defined speed and temperature (Need to connect a L298N DC motor control)
• Direct twin method calls to turn on and off a fan (Need to connect a L298N DC motor control)
Open the project folder

Start VS Code

- Start Visual Studio Code.
- Make sure Azure IoT Workbench is installed.
- Connect ESP32-azure-kit to your PC.

Open IoT Workbench Examples
Build and upload the device code

- Open the command palette and select IoT Workbench: Device, then select Device Upload.

- VS Code then starts verifying and uploading the code to your DevKit.
IoT central dashboard

Show highlighted sensor data on IoT central dashboard
IoT central measurement

Show all onboard sensor data on IoT central measurement
Send message to device

Message
Send message to device
Hello world

Run

Sent at 07:20 9/28/2018 (UTC)
Shaking device to simulate a dice
Turn on/off a fan using command
Auto turn on/off fan using sensor

<table>
<thead>
<tr>
<th>Fan Speed (RPM)</th>
<th>Temperature Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

- synced since 105 minutes ago
Connect ESP32-lyraT board with Azure speech
ESP32-LyraT board

ESP32-LyraT is an open-source development board for Espressif Systems’ Audio Development Framework (ADF). It is designed for smart speakers and smart-home applications. The dev board consists of the ESP32-WROVER module, a Micro SD card, expansion interfaces, touch buttons and several function keys.
# Azure Speech Services

<table>
<thead>
<tr>
<th>Speech to Text – Converts spoken audio to text for intuitive interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easily add real-time speech-to-text conversion to your applications for cases like voice commands, real-time transcriptions, or call center log analysis.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Speech Translation</th>
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<tbody>
<tr>
<td>Give your app real-time speech translation capabilities in any of the supported languages and receive either a text or speech translation back.</td>
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</table>

<table>
<thead>
<tr>
<th>Text to Speech – Give natural voice to your apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build smart apps and services that speak to users naturally with the Text to Speech service. Convert text to audio in near real time, tailor to change the speed of speech, pitch, volume, and more.</td>
</tr>
</tbody>
</table>
Azure translator with ESP32-LyraT board
## Call to Action

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be Curious</td>
<td>Be curious and start thinking about “What if my company …..”</td>
</tr>
<tr>
<td>Visit</td>
<td>Visit the Expo Hall here at IoT in Action</td>
</tr>
<tr>
<td>Get Inspired</td>
<td>Talk to partners and get inspired</td>
</tr>
<tr>
<td>Network</td>
<td>Use the IoT Matchmaking opportunity to connect with partners and other attendees</td>
</tr>
<tr>
<td>Don’t wait</td>
<td>Connect your button and other devices to an IoT Central solution</td>
</tr>
<tr>
<td>Start Now</td>
<td>Start with Azure IoT Central or a Solution Accelerator</td>
</tr>
<tr>
<td>Learn</td>
<td>Visit <a href="http://aka.ms/IoTSchool">http://aka.ms/IoTSchool</a> to learn more</td>
</tr>
</tbody>
</table>
Thank you!
Thank you