IoT in Action – Technical Track

David Hsu
Cloud Solution Architect, Microsoft
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>
<tr>
<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>
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<tr>
<td>Search for data needed for root-cause analysis</td>
<td>Access comprehensive data immediately to perform root-cause analysis</td>
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1 | 2 | 3
Expand, change and scale easily

With fragmented solutions:

1. Solve storage on your own using capacity planning, capital purchases and on-going maintenance.
2. Connect new devices later after customizations and integration efforts are complete.
3. Take weeks or months to modify and extend systems with custom connections.

With IoT:

1. Exploit cloud solutions to scale instantly and pay for only what you need.
2. Connect new devices now with little or no configuration required.
3. Add to and extend systems faster by building on the extensible architecture.
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)

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<thead>
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<th>PaaS</th>
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<tr>
<td>Azure IoT Device SDK</td>
<td>Azure IoT Hub</td>
<td>Azure Stream Analytics</td>
<td>Azure HD Insight</td>
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<tr>
<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>Cosmos DB</td>
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<thead>
<tr>
<th>SaaS</th>
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<tbody>
<tr>
<td>Microsoft Flow</td>
<td>Azure Active Directory</td>
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<tr>
<td>Azure Logic Apps</td>
<td>Microsoft Power BI</td>
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<tr>
<td>Notification Hubs</td>
<td>Azure Monitor</td>
<td></td>
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<tr>
<td>Azure Websites</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 tailoring 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
- IoT Hub
- Orchestration

**Microservices**
- Cosmos DB
- Web App
- Active Directory
- Logic Apps
- Azure ML
- VM
- C# simulator

**Back end systems and processes**
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 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

 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 Policies
- Firmware/Software Updates
- Azure Security Center Support
Azure IoT Hub: IoT device lifecycle

- **Plan**: Group devices and control access according to your organization's needs.
- **Provision**: Securely authenticate devices, on-board for management and provision for service.
- **Configure**: Provide updates, configuration and applications to assign the purpose of each device.
- **Monitor**: Monitor device inventory, health, and security while providing proactive remediation of issues.
- **Retire**: Replace or decommission devices after failure, upgrade cycle or service lifetime.

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IoT in Action
Quick orientation

**Provisioning happens here**

- **Devices**
  - IoT Hub
  - Stream Analytics
  - Event Hub
  - Web Jobs
  - * Azure ML

- **Back end systems and processes**
  - Storage blobs
  - Cosmos DB
  - Web/ Mobile App
  - Logic Apps
  - Power BI

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**Microsoft**

IoT in Action
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 about 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

<table>
<thead>
<tr>
<th>Initial connection</th>
<th>Load balancing</th>
<th>Ownership based</th>
<th>Location based</th>
<th>Re-provisioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero-touch</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>
</tr>
</tbody>
</table>
An IoT device’s relationship to Device Provisioning Service

<table>
<thead>
<tr>
<th>Initial setup</th>
<th>Retrieving a key</th>
<th>Rolling a key</th>
<th>Hard reset</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>
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

Azure IoT Hub Device Provisioning Service

- IoT-scale automated provisioning
  - Zero-touch provisioning
  - Centralize your provisioning workflow
  - Load balance across multiple IoT Hubs
  - Re-provisioning support
  - Supports TPM + X.509
Jean-Sébastien Brunner
Principal Program Manager Lead, Microsoft
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*
Stream Analytics is relevant across industries

- Real-time Fraud Detection
- Streaming ETL
- Predictive Maintenance
- Call Center Analytics
- IT Infrastructure and Network Monitoring
- Customer Behavior Prediction
- Log Analytics
- Real-time Cross Sell Offers
- Fleet monitoring and Connected Cars
- Real-time Patient Monitoring
- Smart Grid
- Real-time Marketing
'000s of customers use Azure Stream Analytics
Real-time analytics pipeline

Stream Analytics on IoT Edge

Event production

Event Queuing & Stream Ingestion

Stream Analytics

Storage & Batch Analysis

Presentation & Action

Applications

Devices & Gateways

Stream Analytics on IoT Edge

IoT Hub

Event Hubs

Blobs

Reference Data

Machine Learning

Automation to kick-off workflows

Archiving for long term storage/batch analytics

Real-time dashboard

Power BI, Time Series Insight

Service Bus Topics/Queues -> Worker Role

Azure functions, Event Hubs

Data Lake, Cosmos DB, SQL DB/DW, ...

Azure Stream Analytics
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
Less code = More developer productivity

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;
        WordCountInputType 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 ASC, DSC

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

Temporal
- Lag
- IsFirst
- Last
- CollectTop

Windowing Extensions
- TumblingWindow
- HoppingWindow
- SlidingWindow

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

Scaling Extensions
- WITH
- PARTITION BY
- OVER

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

String
- Len
- Concat
- CharIndex
- Substring
- Lower, Upper
- PatIndex

Mathematical
- ABS
- CEILING
- EXP
- FLOOR
- POWER
- SIGN
- SQUARE
- SQRT

Geospatial (preview)
- CreatePoint
- CreatePolygon
- CreateLineString
- ST_DISTANCE
- ST_WITHIN
- ST_OVERLAPS
- ST_INTERSECTS
Advanced time Management made easy

• **Low latency in-memory engine**
• At least once delivery: events are never lost!
• Ability to join different streams of data, or streams and data at rest (time-versioned table join)
• Provides **advanced time management out-of-the-box**
  • Choose between global unique timeline, or multiple device timelines (substreams)
  • Configure out-of-order and late-arrival policy
  • Exactly once processing: provides full repeatability
Real-time Geospatial Analytics Scenarios

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>Connected Car</td>
<td>Geofencing</td>
</tr>
<tr>
<td>Asset Tracking</td>
<td>Connected</td>
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<tr>
<td></td>
<td>Manufacturing</td>
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<tr>
<td>Fleet Management</td>
<td>Facilities</td>
</tr>
<tr>
<td></td>
<td>Management</td>
</tr>
</tbody>
</table>
Geospatial Functions

Integrated in our SQL Language

CreatePoint
CreatePolygon
CreateLineString

ST_DISTANCE
ST_WITHIN
ST_OVERLAPS
ST_INTERSECTS

Using GeoJSON

Using WGS84 (reference coordinate system used by the Global Positioning System).

Generate an event when gas station is less than 50 km from the car

```sql
SELECT Cars.Location, Station.Location
FROM Cars c
JOIN Station s ON ST_DISTANCE(c.Location, s.Location) < 50 * 1000
```
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

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

AnomalyDetection_SpikeAndDip(
    <scalar_expression>,
    <confidence>,
    <historySize>)
OVER
    ([PARTITION BY <partition key>]
    LIMIT DURATION(<unit>,<length>)
    [WHEN
    boolean_expression])

AnomalyDetection_ChangePoint(
    <scalar_expression>,
    <confidence>,
    <historySize>)
OVER
    ([PARTITION BY <partition key>]
    LIMIT DURATION(<unit>, <length>)
    [WHEN
    boolean_expression])

Output schema

IsAnomaly: A bigint (0 or 1) indicating if the event was anomalous or not.
Score: A/D score (float) indicating how anomalous an event is.
Perform real-time scoring on streaming data
Anomaly Detection and Sentiment Analysis are common use cases

Function calls from the query
Azure ML can publish web endpoints for operationalized ML models
Azure Stream Analytics binds custom function names to such web endpoints

SELECT text, sentiment(text) AS score
FROM myStream
C# custom code

- Run .net standard code inside your streaming pipeline
- No additional I/O: efficient in-memory processing
- Can reuse existing projects or libraries
- Authoring experience in Visual Studio
- Available today in preview on ASA on IoT Edge
Azure Stream Analytics: Demo
More info on our webpage:
www.azure.com/sa

Follow us on twitter
@AzureStreaming

Engage with us
askASA@microsoft.com
Intelligent Edge
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

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**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

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AI Toolkit for Azure IoT Edge

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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

- Things
- Insights
- Actions

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

IoT Device

IoT Edge

Azure IoT Hub

Customer Solution
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>
Schedule and broadcast Device twin changes across large fleets.
## Security

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

### Protected General Computing
- Application execution with runtime integrity checking

### Secure Execution Environment
- Privileged executions and systems resource access control

### Secure Boot/Updates
- Bootstrapping and recovery

### Hardware Root of Trust
- Trust anchor
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)

IoT Edge

Edge device with security requirements
- Rich OS – Linux or Windows
- Docker-compatible container management system

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

IoT Hub

Module Twin

Device Twin

Container Modules

IoT Device with IoT Device SDK

Connects to Edge Hub (Owns a device twin)

IoT Device (e.g. BLE)

Connects to BLE Module for protocol translation (configured via BLE Module twin)

Device Twin

Secure Boot

Secure Storage

Hardware based root of trust

Security Manager

Device Provisioning

Edge runtime

Container Module

Container Module

Container Module

Container Module

Local storage

IoT Edge operator

1

2

3

4

5

- Define modules on Edge node via device twin
- Define message routes for modules on edge node via device twin
- Define Module twins for module configurations (parameters)
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
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**
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 API 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
A variety of real-world applications

<table>
<thead>
<tr>
<th>Computer Vision</th>
<th>Speech Service</th>
<th>Language Understanding</th>
<th>Knowledge</th>
<th>Search</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vision</strong></td>
<td><strong>Speech</strong></td>
<td><strong>Language</strong></td>
<td><strong>Knowledge</strong></td>
<td><strong>Search</strong></td>
</tr>
<tr>
<td>What is in the image or video?</td>
<td>Give me directions to the nearest local branch</td>
<td>Play today’s customer call recording</td>
<td>QnA Pair of this site?</td>
<td>Search for ‘fraud prevention’</td>
</tr>
</tbody>
</table>

**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

**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
Vision

Computer Vision
Distill actionable information from images

Video Indexer
Process and extract smart insights from videos

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

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

Custom Vision
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
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
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
- Data buffering, Local reactive, predictive & cognitive analytics
- Edge Server(s)

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

One or all these boxes are Optional*

Power of Intelligent Cloud

Microsoft Intelligent Edge

Broad range of cloud-consistent PaaS services

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

**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

**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&lt;br&gt;▪ IoT gateway&lt;br&gt;▪ Manufacturing devices</td>
<td>▪ Digital signage &amp; kiosks&lt;br&gt;▪ IoT gateway&lt;br&gt;▪ Manufacturing devices&lt;br&gt;▪ Small medical devices&lt;br&gt;▪ Wearables&lt;br&gt;▪ Smart building&lt;br&gt;▪ Large medical devices&lt;br&gt;▪ Industry tablets&lt;br&gt;▪ 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
Get started today – [http://aka.ms/iotnxp](http://aka.ms/iotnxp)

Aaeon PICO-IMX6
Advantech RSB-4411
SolidRun HummingBoard Edge
Geniatech SoM-iMX6Q
Kontron SMARC-sAMX6i
Compulab IoT-Gate
VIA VAB-820
PHYTEC phyBOARD i.MX7-Zeta
Geniatech SoM-iMX7D
Ka-Ro TX6

Keith & Koep pConXS
Introducing Windows IoT Core Services for Windows 10 IoT Core

Commercialize your project with enterprise-grade security and support

**Updates**
- Take control of Windows updates with cloud-based IoT Core Device Update Center (DUC)
- Manage updates for OS, apps, settings, and OEM-specific files from the cloud
- Distributed over same global CDN used by Windows Update

**Security**
- Help ensure the safety of your network and devices with cloud-based Device Health Attestation (DHA)
- Backed by the same security research team and validation process used by 500M Windows 10 devices
- Leverage hardware and cloud services to provide tamper proofing and remote attestation of device health

**Support**
- Count on stable systems with 10 years of LTSC (Long Term Servicing Channel) support with security updates only (no new features) Access to monthly published Windows IoT Core packages
- Official Microsoft Lifecycle Support statement - links to software license agreement
- Access to monthly published Windows IoT Core packages for building fully patched images with OEM tools
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, <strong>NXP</strong></td>
<td>SoC: Intel, AMD</td>
<td>SoC: Intel, AMD</td>
</tr>
<tr>
<td>Small footprint: 512MB RAM+2G storage</td>
<td>Windows 10 IoT Enterprise <strong>LTSC</strong> 1809</td>
<td><strong>Windows Server 2019</strong></td>
</tr>
<tr>
<td>IoT Core Services</td>
<td>Lockdown</td>
<td><strong>Windows Admin Center</strong></td>
</tr>
<tr>
<td>▪ DUC</td>
<td>▪ assigned access</td>
<td>▪ System insights</td>
</tr>
<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>
<tr>
<td></td>
<td></td>
<td>▪ Hyper Converged Infrastructure (HCI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Azure IoT Edge</td>
</tr>
</tbody>
</table>
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
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
Customers

Edge and disconnected solutions

Cloud applications to meet varied regulations

Cloud application model on-premises
Use Azure Stack for:
- Real-time latency requirements
- Connectivity issues
- Local data processing

Use Azure for aggregate analytics and big data modelling

Common application logic across both, connected, or disconnected

Edge and disconnected solutions
Develop and deploy global application in Azure

Optionally deploy to Azure Stack to handle customer preferences for regulations:

- Government
- Industry
- Region

No changes to application

Cloud applications to meet varied regulations
Apply modern architectures to on-premises apps not yet ready for cloud

- PaaS
- Serverless computing
- Microservices and containers

Move to Azure without code changes

Consistent programming model, skills, and processes
Azure Stack promise

Consistent application development

Azure services available on-premises

Integrated delivery experience
<table>
<thead>
<tr>
<th>Azure Capabilities on Azure Stack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual machines (VM), VM scale sets</td>
</tr>
<tr>
<td>Containers</td>
</tr>
<tr>
<td>Networking</td>
</tr>
<tr>
<td>Storage</td>
</tr>
<tr>
<td>Key Vault</td>
</tr>
<tr>
<td>Azure App Service</td>
</tr>
<tr>
<td>Azure Functions</td>
</tr>
<tr>
<td>Azure Marketplace</td>
</tr>
</tbody>
</table>

- 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
- 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
- **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**

**Insights**

**Actions**
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
# Call to Action

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

Learn
Grow
Connect
Thank you