Intelligent Edge and Intelligent Cloud

Tony Shakib
Azure IoT
IoT Enables a Digital Feedback Loop
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
Today companies have major gaps that prevent a digital feedback loop

1. Large portions of the business are not digitized
2. Data is siloed across different parts of the company
We’ve observed three primary stages in the IoT customer journey.

1. **Connect & Monitor**
   - Ability to gain real-time insights and improve business processes.

2. **Analyze & Improve**
   - Optimize usage of assets and/or deliver better products to customers.

3. **Transform & Expand**
   - Develop new business opportunities, increase profitability, create more compelling business models.

Customer Sophistication / Value Realized
Unlock the retail digital feedback loop

**Connected Shopper**
- Offline/Online Identity
- Loyalty, Marketing Engagement, Ecommerce

**Connected Store**
- Shopper, Associate
- Inventory Movement, Frictionless Checkout

**Connected Supplier**
- Sales Transactions, Inventory On-Shelf & On-Order

**Connected Payments**
- Blockchain Enabled Online/Offline Payments, Cloud POS

**Connected Fulfillment**
- Supply chain traceability
  - Factory to DC to Store and in-Transit, AI-driven warehouse

---

**INTELLIGENCE**

**RETAILER’S AZURE DATA LAKE COMMON DATA MODEL**

- Dynamics 365 for Retail
- Azure Search for Retail
- Bing Audience Intelligence (AIP)
- Blockchain
- Mixed Reality Apps
- IoT Edge & Azure Digital Twins
- Azure Hybrid cloud
- Data Share
  - Azure Data Catalog
- Data Share
  - Azure Hybrid cloud
Harnessing business intelligence in the retail space

Delight your customers with personalized experiences
Empower your workforce to provide differentiated customer experiences
Optimize your supply chain with intelligent operations
Transform your products and services

Digital assistant
- Shoe style XYZ
  - In-stock at Modern Store!
  - BUY NOW
  - SHOP
  - SIMILAR
  - CHAT

Intelligent Customer Service
- Product expert alert
  - It looks like Jane might need help
- CUSTOMER HISTORY
  - Women’s Clothing

Demand forecasting
- Proposed production based on forecasted trends
- High-performing attributes
- Recommendation: More blue, leather, and cross-body styles

Proposed production based on forecasted trends
- Blue leather cross-body
- Green clutch floral hand leather cross-body

Recommendation: More blue, leather, and cross-body styles

IoT in Action

Microsoft
Microsoft is a trusted partner that helps customers & partners benefit from IoT

Microsoft is investing 5 billion dollars in IoT over the next 4 years
What our customers are saying
The Hershey Company

Improving accuracy and efficiency with autonomous machinery

“If you take the difference there – you’re talking about saving tons of licorice.”

— Greg Lenhart III, Sr. Manager IS Disruptive Solutions and IoT, The Hershey Company
With this new understanding of the customer, Nordstrom is able to combine its contextual data with an understanding of intent and product interest to deliver personalized communications that optimize the next step in the customer journey.

— Shawn Englund, CEO, Footmarks
Microsoft is simplifying IoT
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

- 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
Microsoft IoT

*Intelligent Cloud*

- Azure IoT Central
- Azure IoT Solution Accelerators
- Azure IoT Platform Services

*Intelligent Edge*

- Azure IoT Edge
- Windows IoT
- Azure Sphere
Microsoft IoT

*Intelligent Cloud*

Azure IoT Central

- Azure IoT Solution Accelerators
- Azure IoT Platform Services

*Intelligent Edge*

- Azure IoT Edge
- Windows IoT
- Azure Sphere
Azure IoT Central
Fully managed IoT SaaS
No cloud solution expertise required

Azure IoT Solution Accelerators
Solution accelerators for customers with cloud solution expertise and the need to fully customize

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 & Reference Architecture

Accelerates custom solutions
Open source & fully customizable
Built on the Azure IoT Reference Architecture

https://azureiotsolutions.com

https://aka.ms/iotrefarchitecture
Azure Maps

Azure IoT Central & Azure IoT Solution Accelerators

Maps
The ability to fetch a visual rendition of map data

Map Control
A web control mechanism for developers to more easily integrate mapping capabilities into their applications

Routing
The ability to calculate a route from point A to B or n points, and receive step by step directions

Search and Geocoding
The ability to find places, addresses, businesses, POIs etc.

Traffic
The ability to show dynamic traffic and incident information

Time Zones
The ability to query for a time zone

Note: Additional services will be added to the offering in the future
Microsoft IoT

*Intelligent Cloud*
- Azure IoT Central
- Azure IoT Solution Accelerators
- Azure IoT Platform Services

*Intelligent Edge*
- Azure IoT Edge
- Windows IoT
- Azure Sphere
<table>
<thead>
<tr>
<th>Azure IoT Hub</th>
<th>Azure IoT Hub Device Provisioning Service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bi-directional communication</strong></td>
<td><strong>IoT-scale automated provisioning</strong></td>
</tr>
<tr>
<td>Millions of Devices</td>
<td>Zero-touch provisioning</td>
</tr>
<tr>
<td>Multi-language, open source SDKs</td>
<td>Centralize your provisioning workflow</td>
</tr>
<tr>
<td>HTTPS/AMQPS/MQTTs</td>
<td>Load balance across multiple IoT Hubs</td>
</tr>
<tr>
<td>Send Telemetry</td>
<td>Re-provisioning support</td>
</tr>
<tr>
<td>Receive Commands</td>
<td>Supports TPM + X.509</td>
</tr>
<tr>
<td>Device Management</td>
<td><strong>Enterprise scale &amp; integration</strong></td>
</tr>
<tr>
<td>Device Twins</td>
<td><strong>End-to-end security</strong></td>
</tr>
<tr>
<td>Queries &amp; Jobs</td>
<td>Per Device Certificate</td>
</tr>
<tr>
<td><strong>End-to-end security</strong></td>
<td>Per Device Enable/Disable</td>
</tr>
<tr>
<td>Per Device Certificate</td>
<td>TLS Security</td>
</tr>
<tr>
<td>Per Device Enable/Disable</td>
<td>X.509 Support</td>
</tr>
<tr>
<td>TLS Security</td>
<td>IP Whitelisting/Blacklisting</td>
</tr>
<tr>
<td>X.509 Support</td>
<td>Shared Access Policies</td>
</tr>
<tr>
<td>IP Whitelisting/Blacklisting</td>
<td>Firmware/Software Updates</td>
</tr>
<tr>
<td>Shared Access Policies</td>
<td>Azure Security Center Support</td>
</tr>
<tr>
<td>Firmware/Software Updates</td>
<td><strong>Configuration Management</strong></td>
</tr>
<tr>
<td>Azure Security Center Support</td>
<td><strong>IoT-scale automated provisioning</strong></td>
</tr>
<tr>
<td>Azure IoT Hub</td>
<td><strong>Device Provisioning Service</strong></td>
</tr>
<tr>
<td><strong>Device Provisioning Service</strong></td>
<td><strong>Device Management</strong></td>
</tr>
<tr>
<td><strong>Device Management</strong></td>
<td><strong>Device Twins</strong></td>
</tr>
<tr>
<td><strong>Device Twins</strong></td>
<td><strong>Queries &amp; Jobs</strong></td>
</tr>
<tr>
<td><strong>Queries &amp; Jobs</strong></td>
<td><strong>Device Management</strong></td>
</tr>
<tr>
<td><strong>Device Management</strong></td>
<td><strong>Device Twins</strong></td>
</tr>
<tr>
<td><strong>Device Twins</strong></td>
<td><strong>Queries &amp; Jobs</strong></td>
</tr>
<tr>
<td><strong>Queries &amp; Jobs</strong></td>
<td><strong>Device Management</strong></td>
</tr>
</tbody>
</table>
New Capabilities

**Azure IoT Hub**

**Automatic Device Management**
IoT Hub will automatically goal seek management operations as devices match standing queries.

**Advanced Message Routing**
Automatically route inbound device messages based on Device Twin properties.
New Azure portal configuration experience with unified navigation between message routes and custom endpoints.

**Android and Android Things Support**
In development and coming soon.

---

**Azure IoT Hub Device Provisioning Service**

**Increased limits**
25 CA certificates (up from 10)
500,000 enrollments, with more available if you contact support (up from 10,000)

**High availability**
Automatic failover to Azure geo-paired region in case of regional-wide disaster.

**Symmetric key attestation (Preview)**
Support for symmetric keys in both individual and group enrollments.

---

**Automatic re-provisioning (Preview)**
For device factory reset and migration scenarios.

**Enrollment-level device allocation policies (Preview)**
Assign distinct allocation policies to each enrollment; link multiple IoT Hubs to each policy.

**Custom provisioning logic (Preview)**
Trigger an Azure function to determine IoT Hub destination and initial configuration.
# Microsoft IoT

## Intelligent Cloud
- Azure IoT Central
- Azure IoT Solution Accelerators
- Azure IoT Platform Services

## Intelligent Edge
- Azure IoT Edge
- Windows IoT
- Azure Sphere
IoT Pattern + Edge

Azure IoT Edge

Azure IoT Hub

Cloud Gateway

Insights

Actions

Things

Insights

Actions

Microsoft
High Level Topology

IoT Device

IoT Edge

IoT Device

IoT Edge

IoT Device

Azure IoT Hub

Customer Solution
Azure IoT Edge Deployment

- IoT Edge Device
- Azure IoT Hub
- Azure Container Registry
- Deployment Manifest
- Azure Machine Learning
- Azure Cognitive Services
- Azure Event Grid
- Azure Functions
- Azure Stream Analytics
- Azure SQL Server
Azure IoT Edge Deployment + Azure IoT Hub Device Provisioning Service
Azure IoT Edge
Vision AI Developer Kit

Qualcomm

Order now: https://visionaidevkit.com/
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**
Microsoft IoT

**Intelligent Cloud**
- Azure IoT Central
- Azure IoT Solution Accelerators
- Azure IoT Platform Services

**Intelligent Edge**
- Azure IoT Edge
- Windows IoT
- Azure Sphere
Windows IoT editions

### Windows 10 IoT Core
- 400 MHz x86, x64 or ARM CPU
- 256MB RAM (512MB with display)
- 2 GB storage

### Windows 10 IoT Enterprise
- 1GHz x86 or x64 CPU
- 1 GB RAM (2 GB for 64-bit)
- 16 GB Storage (20 GB for 64-bit)

### Windows Server IoT 2019
- 1.4GHz x64 CPU
- 512 MB RAM (2 GB for desktop)
- 32GB Storage

**Small-footprint smart edge devices**
- Familiar Windows security, tools, apps and manageability
- Universal Windows Platform (UWP) app experience
- Optimized for devices with and without displays
- No OS-shell UX
- No operating system royalty, Windows 10 IoT Core Services subscription available

**Powerful smart devices**
- A rich user experience with Win32 and UWP apps
- Same deployment, manageability and servicing as desktops
- Familiar interface with lockdown features to control user experience
- Identical to Windows 10 Enterprise, but sold through the OEM channel instead of volume licensing

**Advanced data analysis and storage**
- Enhanced security capabilities
- Unique hybrid platform – Integrate your on-premise and cloud infrastructures
- Improved container support with Azure IoT Edge management
- CAL-less option available

For details see [https://docs.microsoft.com/windows-hardware/design/minimum/minimum-hardware-requirements-overview](https://docs.microsoft.com/windows-hardware/design/minimum/minimum-hardware-requirements-overview)
Introducing Windows 10 IoT Core Services

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
Microsoft IoT

*Intelligent Cloud*
- Azure IoT Central
- Azure IoT Solution Accelerators
- Azure IoT Platform Services

*Intelligent Edge*
- Azure IoT Edge
- Windows IoT
- Azure Sphere
Microcontrollers (MCUs) low-cost, single chip computers

9 BILLION new MCU devices built and deployed every year
Fewer than 1% of MCUs are connected today.
Radio
2.4GHz WiFi

MCU
192Mhz Cortex-M4
256KB SRAM
1MB NOR FLASH
GPIO, I2C, I2S, etc.
RTOS (no kernel)
How does a consumer know the compressor in their fridge needs to be replaced?

Option 1
Melted ice cream

Option 2
Predictive maintenance

Connected devices create profoundly better customer experiences.
Opportunity  |  Risk
What happens when you connect a device to the internet?
“Ransomware attacks will target more IoT devices in 2018”

“Huge IoT botnet may be used for Ukraine attack”

“When smart gadgets spy on you: Your home life is less private than you think”

“Industrial IoT to equip new era of corporate intruders coming in through devices”

“Security experts warn of dangers of connected home devices”

“Hacking these IoT baby monitors is child’s play, researchers reveal”

“Hackers infect 500,000 consumer routers all over the world with malware”

“Your smart fridge may kill you: The dark side of IoT”

“The Lurking Danger of Medical Device Hackers”

“Why the KRACK Wi-Fi mess will take decades to clean up”
Everyday devices are used to launch an attack that takes down the internet for a day

100k devices

Exploited a well known weakness

No early detection, no remote update
Attackers gain access to casino database through fish tank

Entry point was a connected thermometer

Once in, other vulnerabilities were exploited

Gained access to high-roller database
No manufacturer wants to make insecure devices

From: Hackers
To: Consumer
Subject: Your Fridge

We control your fridge.
Send us $5 in bitcoin or else...

Terrorists Ignite Thousands of House Fires with Hacked Stoves

IoT in Action
You’ll try to keep the hackers out of your device.

But, what will you do if they get in?
Security is foundational
It must be built in from the beginning.
The 7 properties of highly secured devices

1. Hardware Root of Trust
2. Defense in Depth
3. Small Trusted Computing Base
4. Dynamic Compartments
5. Certificate-Based Authentication
6. Failure Reporting
7. Renewable Security

https://aka.ms/7properties
Some properties depend only on hardware support

Hardware Root of Trust

Unforgeable cryptographic keys generated and protected by hardware

- Hardware to protect Device Identity
- Hardware to Secure Boot
- Hardware to attest System Integrity
Some properties depend on hardware and software

**Dynamic Compartments**

Internal barriers limit the reach of any single failure

- Hardware to Create Barriers
- Software to Create Compartments
Renewable Security

Device security renewed to overcome evolving threats

- Cloud to Provide Updates
- Software to Apply Updates
- Hardware to Prevent Rollbacks
Meeting these seven properties is difficult and costly

- Design and build a holistic solution
- Recognize and mitigate emerging threats
- Distribute and apply updates on a global scale
Azure Sphere is an end-to-end solution for securing MCU powered devices
Azure Sphere Certified MCUs from silicon partners, with built-in Microsoft security technology provide connectivity and a dependable hardware root of trust.
The Azure Sphere Operating System

a four-layer defense in depth OS with ongoing updates

creates a secured platform for IoT experiences.
The Azure Sphere Security Service guards every Azure Sphere device; it *brokers trust* for device-to-device and device-to-cloud communication, detects emerging threats, and renews device security.
Azure Sphere is Open.
Three components. One low price. No subscription fees.

An Azure Sphere certified MCU

The Azure Sphere OS with ongoing on-device OS updates

The Azure Sphere Security Service with ongoing on-device security updates
Microsoft has modernized MCU development with Azure Sphere, Visual Studio, and Azure DevOps

Simplify development
Focus your device development effort on the value you want to create

Streamline debugging
Experience interactive, context-aware debugging across device and cloud

Collaborate across your team
Apply tool-assisted collaboration across your entire development organization
SECURITY
Peace of mind

PRODUCTIVITY
Faster time to market

OPPORTUNITY
The future is now
Get Started with Azure Sphere Today!

Now available
• Azure Sphere development kits from Seeed studios

Public preview availability
• Azure Sphere OS
• Azure Sphere Security Service
• Visual Studio tools for Azure Sphere

Try today: http://www.azure-sphere.com
New IoT Offerings
Integrating IoT into your IT security is challenging

**Diverse devices**
Numerous devices with diverse OSes make management difficult

**New threats**
IoT threats and defenses against them are evolving

**Cloud and Device**
IoT security requires monitoring thousands of devices on one side and cloud services on the other
Azure Security Center
IoT Support
Azure Security Center
Extending Azure Security to IoT
Azure Security Center
Extending Azure Security to IoT
Azure Security Center
Extending Azure Security to IoT

Comprehensive visibility into security posture and state of your **Azure IoT Solution – from Devices to Applications**

End-to-end analysis of the security posture. Actionable **Recommendations to reduce attack surface**

Real-time monitoring and analysis of security relevant events. Actionable **Alerts to timely respond to any potential compromises**
The Evolution of IoT
The Evolution of IoT

Early IoT solutions were based on lists of devices connected to Azure and monitoring them or predicting their maintenance needs.

We are seeing the beginning of a new trend in IoT solutions.

Customers want to model a physical environment first, and then keep the model up to date with IoT data.

We’re finding this is a more natural approach for building IoT solutions.
Digital Twins
A History of Digital Twins

**Information mirroring** model

- Powerful modeling and analysis
- R&D and engineering focus

**Simulation and 3D printing**

- Digital design, virtual assembly, and simulation
- 3D printing mainstream

**Connected IoT assets**

- Unified physical and virtual data
- Rapid feedback across design, manufacturing, and operations

**Model any physical environment**

- Humans and device collaboration
- Spatial awareness and intelligence
- Mixed Reality experience

---

*Dr. Michael Grieves and John Vickers – University of Michigan*
Digital Twins: Fusing physical and digital

**Physical World**
- Devices
  - Data
  - Control
  - Measure
  - Insight, Optimization
- Operations
  - Remote Monitoring
  - Fault Detection
  - Predictive Maintenance

**Digital World**
- Spaces
  - Data
  - Control
  - Measure
  - Insight, Optimization
- Insights
  - Occupancy & Utilization
  - Workplace Advisor
  - Workplace Analytics
- People
  - Data
  - Control
  - Measure
  - Assistance, Task Completion
- Experiences
  - Tenant Apps
  - Employee Productivity, Comfort, Satisfaction
  - Indoor Mapping, Location, Wayfinding
  - Mixed Reality & Cognition
Azure Digital Twins
Build next generation IoT solutions with Azure Digital Twins

Virtually represent the physical world with a digital twin that **models the relationships between people, places and devices.**

Leverage predefined and **extensible Twin Object Models** to build contextually-aware solutions uniquely attuned to your industry domain.

**Automate actions in a space with custom functions** that send events and/or notifications to endpoints based on incoming telemetry.

Securely replicate solutions across multiple tenants through **built-in multi- and nested-tenancy.**
Azure Digital Twins in Action
1000’s of Azure IoT certified devices from hundreds of partners today
Thank you!