Agenda

Introducing the problem – Contoso Art Shipping

Typical IoT architecture

Hands-on labs

Going further

Follow along at: http://aka.ms/iot-workshop/asset-tracking
Introducing the problem
Monitoring of high-value parcels for international company Contoso Art Shipping
Contoso’s goods are getting tampered, ruined in transit

- Increased customer dissatisfaction
- Losing customers, revenue
- Increased insurance claims
- High personnel costs to follow-up on claims
Contoso lacks ability to monitor

Location of the parcels

In-transit product condition

Goods that are getting tampered with during transportation

Nearly 60% of insurance claims for damaged art are related to its transport

Problem statement (2/3)
Contoso already has an ERP and mobile app in place for basic tracking information. They would like to enable real-time tracking of shipments.
Contoso Art Shipping’s requirements

**Track** in real-time the physical location and condition of their parcels
Efficiently **store** this data so that it can be accessed and queried
Get **alerts** when abnormal conditions are detected...
... and **visualize** them on a map

**Integrate** with their existing business application

**Scale** from a very small deployment to something much bigger
... bonus points if they can be supported by great **developer tools** 😊
Architecture of an IoT solution

Things → Insights → Actions
A More Realistic View…

… and why IoT needs simplifying
Provision and send data from devices to Cloud

Device Management

IoT Devices → Cloud Gateway

Things

Insights

Actions
IoT Architecture

- **Things**: IoT Devices
- **Insights**: Cloud Gateway
  - Stream processing and rules evaluations over data
  - Provision and send data from devices to Cloud
- **Actions**: Stream Processing
  - Store data
  - Device Management
  - Storage
IoT Architecture

- **Things**: IoT Devices
  - Provision and send data from devices to Cloud
  - Device Management

- **Insights**: Cloud Gateway
  - Stream processing and rules evaluations over data

- **Actions**: Stream Processing
  - Store data
  - Integrate with Business process

- **Business Integration**
IoT Architecture

**Things**
- IoT Devices
  - Provision and send data from devices to Cloud
  - Device Management

**Insights**
- Cloud Gateway
  - Configure and control
  - Stream processing and rules evaluations over data
- Stream Processing
  - Store data
- UI & reporting Tools
  - Visualize data and learnings

**Actions**
- Business Integration
  - Integrate with Business process
aka.ms/iot-workshop/asset-tracking

Hands-on lab
Step 1 – Connecting a device to Azure IoT

Track in real-time the physical location and condition of their parcels

**Learning goals:**

- How to setup the messaging infrastructure for connecting your IoT devices
- Understand basic security and device management concepts
- Explore IoT Plug-and-Play concepts
- Discover VS Code IoT extensions and Azure IoT Explorer
Provision and send data from devices to Cloud Gateway.
IoT Hub and Device Provisioning Service

### Azure IoT Hub

- Bi-directional communication
  - Millions of Devices
  - Multi-language, open source SDKs
  - HTTPS/AMQPS/MQTTs
  - Send Telemetry
  - Receive Commands
  - Device Management
  - Device Twins
  - Queries & Jobs

- Enterprise scale & integration
  - Billions of messages
  - Scale up and down
  - Declarative Message Routes
  - File Upload
  - WebSockets & Multiplexing
  - Azure Monitor
  - Azure Resource Health
  - Configuration Management

- End-to-end security
  - Per Device Certificates
  - Per Device Enable/Disable
  - TLS Security
  - X.509 Support
  - IP Whitelisting/Blacklisting
  - Shared Access Polices
  - Firmware/Software Updates
  - Azure Security Center Support

### 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
IoT Device Lifecycle

- **PLAN**: Group devices and control access according to your organization's needs
- **REGISTER**: Securely authenticate devices, onboard for management and provision for service
- **MONITOR**: Monitor device inventory, health & security while providing proactive remediation of issues
- **CONFIGURE**: Provide updates, configuration & applications to assign the purpose of each device
- **RETIRE**: Replace or decommission devices after failure, upgrade cycle or service lifetime
IoT Device Lifecycle

- **Plan**: Group devices and control access according to your organization's needs
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Quick orientation

Provisioning happens here

Devices

IoT Hub

Stream Analytics

Event Hub

Web Jobs

Logic Apps

Storage blobs

CosmosDB

Web/ Mobile App

Power BI

" Azure ML
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
- Device supply chains are complex
Azure IoT Hub Device Provisioning Service

Simplify with zero touch provisioning

Minimize manual connection requirements

Cross-geo provisioning support

Multitenancy support

Enhanced security

For any device compatible with IoT Hub

DPS knows exactly which IoT Hub to connect and provision
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)
<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>
High level provisioning

1. Asks for hub
2. Creates ID
3. Returns ID
4. Returns hub
5. Connects
IoT Plug and Play In Platform Context

IoT Device

IoT Edge

IoT Device

IoT Edge

Interface
Telemetry Properties Commands

Azure IoT Hub & DPS

Custom Solution

Azure IoT Central

Capability Model Repository (Optional)
Where are capability models stored?

Device sends capability model ID and version expected for the solution to know.
If unknown, the following are the model retrieval options for the solution:

**Device Sent**
- Stored and sent by the device to the solution.
- Quick and easy but device must be updated if model changes.

**URI Retrieval**
- Device sends a URI for retrieval from central location.
- Great for constrained devices, privacy or for simple on-premises deployments.

**Capability Model Repository**
- Can be pre-cached by Azure solutions.
- Includes publish-time validation/versioning and integration with Azure dev tooling.
IoT Plug and Play Repository*
https://preview.catalog.azureiotsolutions.com

Capability model and interface workspace and publishing repository experience

Publishing integrated in VS Code and Azure CLI for both interfaces and capability models

Automated validation, collision checks and versioning support

Search, filter, sort, view models & their graphs in model repository UX

Works out-of-the-box with any Azure IoT solution

Will be made available as an open-source project

Microsoft will also host a fully managed, multi-tenant instance for always up-to-date for Azure Certified devices; integrated into certification flow

*IMPORTANT: Model repository is never required for IoT Plug and Play
Capability
Model
Developer
Tooling

Azure IoT Device & Service SDKs
Updated with IoT Plug and Play support for all languages

Azure IoT Device Workbench extension for Visual Studio Code
IntelliSense and validation for authoring models
Generate skeleton device code from capability models
Works with Microsoft model repository

Azure IoT CLI extension
Author / retrieve capability models & interfaces
Test device and service code

Azure IoT Explorer
Updated to allow discovery and examination of IoT Plug and Play devices
Azure IoT Device SDK

Generated Device Agent

Easy to model device capabilities, easy to generate device software skeleton

Easy to certify plug and play devices

Easy for customers and partners to find plug and play devices that just work

Devices that just work out of the box with no code required

Azure IoT Device Catalog

IoT Plug & Play Certified

Easy to develop device software and ensure it just works with IoT solutions

Partner Solutions & Azure IoT Central

Device Capability Model

JSON-LD Schema

VS Code

IoT Plug and Play Device Software

Generated Device Agent

Azure IoT Device SDK
Step 1 – Hands-on
http://aka.ms/iot-workshop/asset-tracking

IoT Hub, DPS, PnP

Setup IoT Hub and DPS
Configure asset tracking device
Explore capabilities thanks to PnP
Step 2 – Setting up an IoT data pipeline

Efficiently store this data so that it can be accessed and queried

**Learning goals:**

- How to implement short-term and long-term retention using Azure Time Series Insights
- How to use TSI built-in data explorer to perform data analytics
Provision and send data from devices to Cloud.
Provision and send data from devices to Cloud

Stream processing and rules evaluations over data

Store data

IoT Architecture

Things

Insights

Actions
What is Azure Time Series Insights
A Fully Managed Platform as a Service (PaaS) Solution Built for IoT

- Fully managed, end-to-end PaaS solution to ingest, process, store, and query highly contextualized, time-series-optimized, IoT-scale data
- Connect to a variety of data solutions using TSI’s flexible data platform
- Use rich analytics APIs and UX for ad-hoc exploration and operational intelligence
- Use JavaScript control library for building custom analytics apps on the TSI platform
IoT Data Characteristics

- Lacks structural consistency
- Needs contextualization
- Often used with other data
- Infinite retention
Canonical IoT Data Pipeline

COLLECT
Collect time series data coming from different sources, formats & rates

PROCESS
Parse, Normalize, Enrich, Transform

STORE
Store in multi-layered (hot, warm, cold) time series data store optimized for analysis

ANALYZE
- Explore and monitor
- Perform operational analysis
- Models for learning & predictions
- Run ad-hoc queries for monitoring
- Operationalize using asset-based analysis
- Use models for machine learning inference and make predictions

Notify Operator or System
Azure Time Series Insights

NEW CAPABILITIES

✓ Multi layered storage with warm and cold analytics support providing customers with the option to route data for interactive analytics over short timespans and operational intelligence over decades of historical data.

✓ Flexible data platform that allows customers to take data stored in open source Apache Parquet to other advanced data solutions such as Spark, Databricks, Jupyter for predictive maintenance, machine learning and AI.

✓ Rich query APIs and user experience to support interpolation, scalar and aggregate functions, categorical variables, scatter plots, and time shifting between time series signals for in-depth analysis.

✓ Enterprise grade scale and performance at all layers of the solution to support customers’ industrial IoT solution needs.

✓ Rich extensibility through Power BI connector to enable customers to take their time series queries directly into Power BI for a unified BI and analytics view.
Time Series Insights

Step 2 – Hands-on

http://aka.ms/iot-workshop/asset-tracking

- Setup TSI environment
- Setup event sources
- Explore data
Step 3 – Anomaly detection
Getting alerts when abnormal conditions are detected

Learning goals:

• How to extract insights from real-time IoT Data using Azure Stream Analytics
• How to turn alerts into actions
• How to store alerts into Time Series Insights, alongside telemetry
Azure Stream Analytics In a Nutshell
Unlocking Real-time Insights

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

Insights are Perishable
- Window of opportunity for insights to be actionable

Ask Questions to Data in Motion
- Can’t wait for data to get to rest before running computation
Real-time Stream Processing

Simple Event Processing
• Filter
• Transform
• Enrich
• Split
• Route

Event Stream Processing
• [Simple event processing] +
• Aggregate
• Rules

Complex Event Processing
• [Event Stream Processing] +
• Pattern detection
• Time windows
• Joins & correlations
## Scenario Examples

<table>
<thead>
<tr>
<th>Real-time Fraud Detection</th>
<th>Streaming ETL</th>
<th>Predictive Maintenance</th>
<th>Call Center Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Infrastructure and Network Monitoring</td>
<td>Customer Behavior Prediction</td>
<td>Log Analytics</td>
<td>Real-time Cross Sell Offers</td>
</tr>
<tr>
<td>Fleet monitoring and Connected Cars</td>
<td>Real-time Patient Monitoring</td>
<td>Smart Grid</td>
<td>Real-time Marketing</td>
</tr>
</tbody>
</table>

and many more…
Streaming Pipeline

- Event production
- Event Queuing & Stream Ingestion
- Stream Analytics
- Storage & Batch Analysis
- Presentation & Action

Applications
- IoT Hubs
- Event Hubs
- IoT Hubs
- Blobs
- Reference Data

Devices & Gateways

Archiving for long term storage/batch analytics
- Real-time dashboard
- Automation to kick-off workflows
- PowerBI
**Stream Analytics Query Language (SAQL)**

Declarative SQL like language to describe transformations

- Filters (“Where”)
- Projections (“Select”)
- Time-window and property-based aggregates (“Group By”)
- Time-shifted joins (specifying time bounds within which the joining events must occur)
- and all combinations thereof

### 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**

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

### Date and Time
- **DateTimeName**
- **DateTimePart**
- **Day**
- **Month**
- **Year**
- **DateDiff**
- **DateTimeFromParts**
- **DateAdd**

### Temporal
- **Lag**
- **IsFirst**
- **Last**
- **CollectTop**

### 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**

### Scaling Extensions
- **WITH**
- **PARTITION BY**
- **OVER**

### Windowing Extensions
- **TumblingWindow**
- **HoppingWindow**
- **SlidingWindow**
Stream Analytics Job

Users construct and deploy jobs to ASA

Job definition includes inputs, a query, and output

Inputs are from where the job reads the data stream

Query runs for perpetuity unless explicitly stopped and transforms the input stream

Output is where the job sends the job results to
Azure Stream Analytics

Step 3 – Hands-on

http://aka.ms/iot-workshop/asset-tracking

Setup ASA job
Create query to detect anomalies
Visualize anomalies in TSI
Step 4 – Map visualization

**Learning goals:**

- How to use Azure Maps web control
- How to combine Time Series Insights and Azure Maps web SDKs
- Advanced Azure Maps features, e.g heatmap
What is Azure Maps?

A collection of geospatial services for creating solutions that meet the requirements of enterprise customers in their line of business and consumer applications.

**Enterprise Ready**

- Enterprise Scale
- Global Availability
- Web and Mobile SDKs
- Integrated with other Azure Services
- Maps updated weekly
- Traffic data updated every minute

**Trusted Platform**

- Azure Security Complaint
- Azure Active Directory Tenancy
- GDPR (Azure Privacy) Compliant
- Accessibility, Usability, Globalization and Localization Compliant

**Competitive, Flexible Pricing**

- Generous free limits
- Access Azure Maps with any Azure subscription (trial, pay as you go, Enterprise Agreement)
- Multiple pricing tiers for your specific needs
- No upfront cost
- Only pay for what you use
Best of Breed Content Partnerships

**TOMTOM®**
- Maps
- Points of Interest
- Geocoding
- Routing
- Road networks
- Traffic

**moovit**
- Mobility Services
- Public Transit Networks
- Real-time Transit data
- Micro-mobility data

**AccuWeather**
- Current Weather
- Forecast Weather
- Weather along route

Updates from content partners made instantly available in Azure Maps!
A platform of geospatial APIs for the enterprise

Maps
Render maps and satellite imagery across many geographies in several styles

SDKs
Web and Android SDKs to integrate Azure Maps into applications

Routing
Multi-algorithmic routing, batch routing and matrix routing

Search
Find addresses, points of interest, landmarks, using a multitude of search algorithms or in batch

Spatial Operations
Create Geofences, measure great circle distance, closest point and point in polygon

Traffic
Real-time traffic flow and incident detail, measuring distance to back or front of the line

Time Zones
Obtain time zone and current time information from any location

Geolocation
Query for the location of an IP address

Mobility (Public Transit)
Get real time intelligence on public transit services

Data Storage
Host your private map data in Azure Maps

Weather services
Historical, Current and Predicted Weather Services with Radar and Satellite maps

Power BI integration
Integration with Power BI w/ rich data service and more powerful capabilities

Gov Cloud support
Azure Maps services availability through Azure Government Cloud

NEW capabilities
Microsoft’s messaging: Azure Maps/Bing Maps

The following is the official Microsoft messaging regarding Bing and Azure maps:

Microsoft customers have a rich choice of options from which to source location and mapping data. Our guidance on which service to choose reflects the preference and status of a customer’s implementation of location data. For those enterprise customers already using (or looking to use) Azure, we would recommend they use Azure Maps. Similarly, we’d recommend customers who have a preference for TomTom mapping data to also turn to Azure Maps. For existing Bing Maps for Enterprise customers, if your current services are meeting your needs, we encourage you to stay on your existing service. All customers should work with their Microsoft team to determine which of the services will best serve the individual customer requirements for production grade, fully deployable services.
Azure Maps

Step 4 – Hands-on

http://aka.ms/iot-workshop/asset-tracking

Setup Azure Maps subscription
Use Azure Maps and TSI SDK
Explore Azure Maps REST API
Things Insights Actions

- **IoT Devices**: Provision and send data from devices to Cloud
- **Cloud Gateway**: Stream processing and rules evaluations over data
- **Stream Processing**: Store data
- **Storage**: Device Management

**IoT Architecture**
IoT Architecture

- **Things**: IoT Devices
- **Insights**: Cloud Gateway, Stream Processing, Storage
- **Actions**: Business Integration

Provision and send data from devices to Cloud

Stream processing and rules evaluations over data

Integrate with Business process

Device Management

Store data
Things

Insights

Actions

Provision and send data from devices to Cloud

Device Management

Store data

Integrate with Business process

Configure and control

Stream processing and rules evaluations over data

Visualize data and learnings

UI & reporting Tools

Stream Processing

Storage
Logics Apps, Power Apps

Step 5 – Live Demo

- Refine Stream Analytics job
- LogicApps workflow
- PowerApps and CDS integration
IoT Central
A fully managed IoT application platform

- Highly secure
- Enterprise-grade
- Predictable pricing
- Industry-focused

Get connected
Connect IoT devices to the cloud faster than any other platform.

Stay connected
Reconfigure and update devices with centralized device management.

Transform
Bridge the gap with connectors and extensibility APIs.
What is an IoT Central application template?

App templates are tools to help solution builders kickstart their IoT solution development.

They consist of:
- Sample operator dashboards
- Sample device templates
- Simulated devices
- Pre-configured rules and jobs
- Rich documentation including tutorials

Brand templates using the white labeling feature

Sell to customers directly or through AppSource
Your brand, your SaaS
How do I build with IoT Central?

Take Action
- **No-code/Low-code actions** with Microsoft Flow and Logic Apps

Integrate IoT Insights
- **Continuous IoT data routing** through Event Hub and Service Bus
  - Build data pipelines using the breadth of Azure Services

Build Solutions
- **IoT Central public APIs** for device modeling, provisioning, lifecycle management, operations (updating/commanding), and data querying
Going further
IoT Tech Community
aka.ms/iottechcommunity

Blog posts

News & Announcements

Weekly recap
IoT Show
aka.ms/iotshow

Announcements
Tech talks & Deep Dives
Demos
Customer & Partner spotlights
Azure IoT Reference Architecture

Foundational

A foundational guide for how to build native cloud IoT solutions. Make your subsystems independently scalable, maintainable, and deployable.

Comprehensive

Provides component descriptions and tech recommendations. Adjust for your skillset and solution.

Reliable

Helps you start from patterns that have worked with other partners.

https://aka.ms/iotrefarchitecture

Would you like to provide feedback? Do you have an idea or suggestion based on your experience with IoT? We would love to hear it! email AzureIoTRefArcVoice@microsoft.com