



Hybrid Cloud
IT Management



Student Lifecycle &
Success Management



Teaching &
Learning



Academic
Research

Jonelle Kreiner
GBB, SSP IoT
Public Sector

Connected Campus & School Experiences



The Internet of Things **isn't**
a technology revolution...

...IoT is a **business revolution**,
enabled by technology

Waves of innovation have enabled the rise of IoT

Cloud

Globally available, unlimited compute resources

IoT

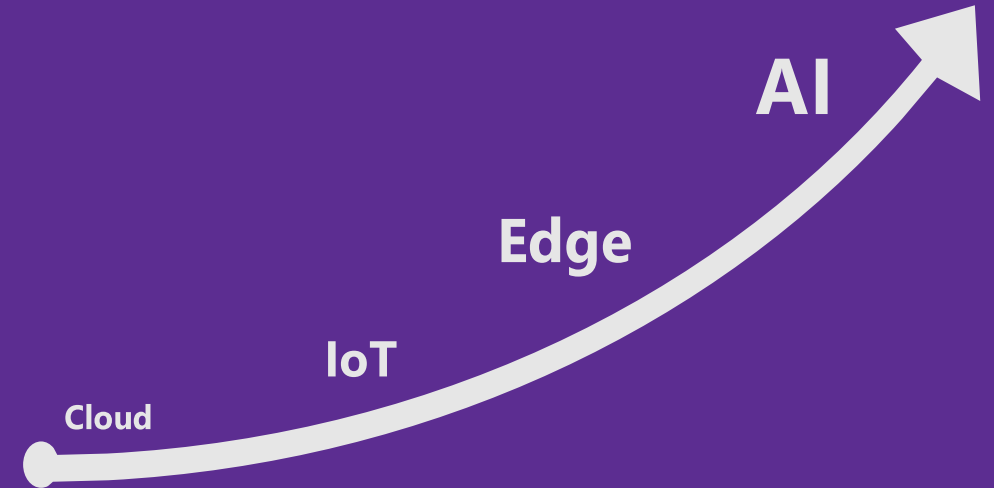
Harnessing signals from sensors and devices, managed centrally by the cloud

Edge

Intelligence offloaded from the cloud to IoT devices

AI

Breakthrough intelligence capabilities, in the cloud and on the edge



Azure IoT: Ready for the enterprise

Secure

End-to-end



From the endpoint, through the connection, to data, applications, and the cloud

Fast

Start in minutes



Preconfigured solutions for the most common IoT scenarios

Open

Connect anything



Any device, OS, data source, software, or service

Scalable

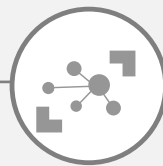
Grow effortlessly



Millions of devices, terabytes of data, on-premises, in the cloud, in the most regions worldwide



Things



Control



Insights



Action

From endpoint to insight to action, across the enterprise, and around the world



Recognized as a **leader in Business Intelligence and Analytics Platforms**
Recognized as a the **leading visionary for Internet of Things platforms**



Built on the **industry's leading cloud**



Hyper-Scale Azure footprint

38

Announced Azure regions worldwide

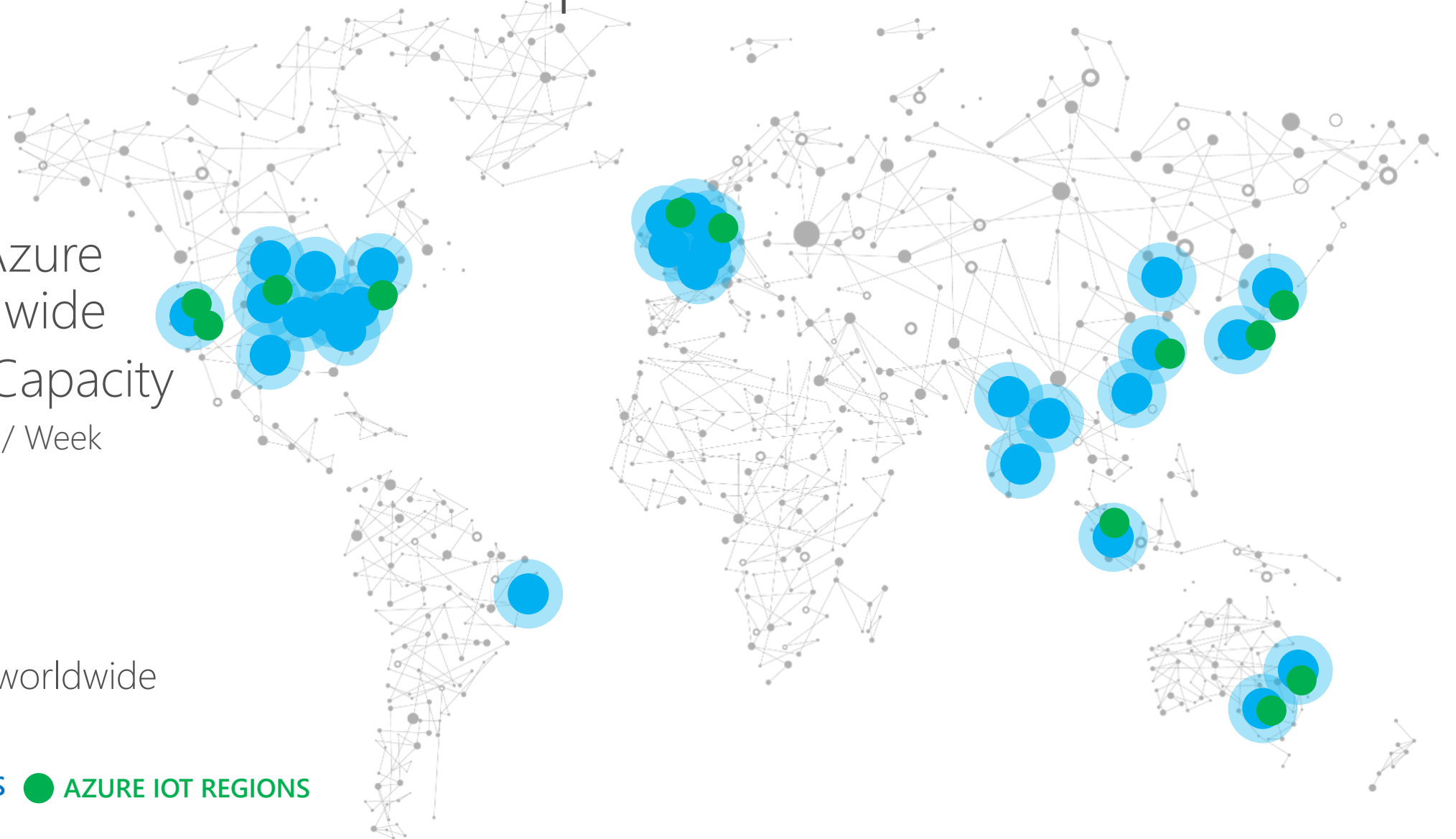
Hyper-Scale Capacity

3.5 Trillion Messages / Week

12

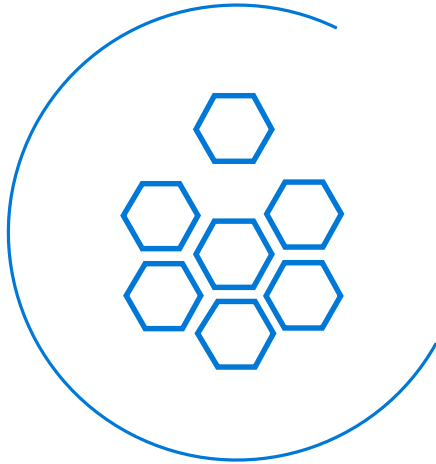
Azure IoT regions worldwide

 AZURE REGIONS  AZURE IOT REGIONS



We offer choice and flexibility to support the needs of all customers

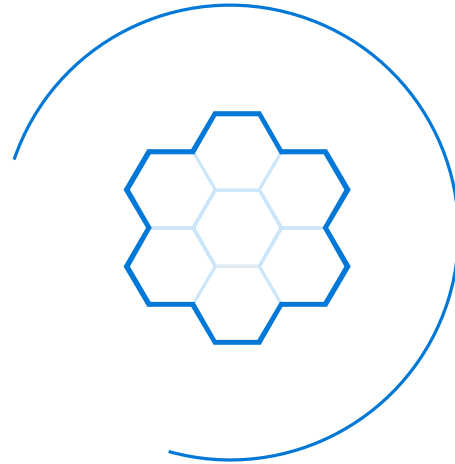
Build the right solution to meet your needs



Azure IoT Suite

Preconfigured solutions on a **customizable PaaS** to accelerate common scenarios

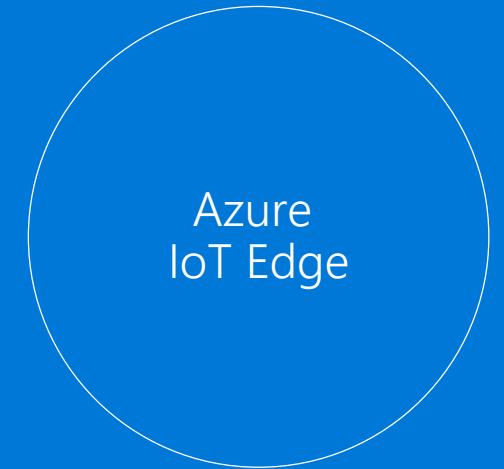
For when you need a lot of control over your IoT solution



Microsoft IoT Central

A **fully managed SaaS** solution for IoT

For when you need to get started quickly with minimal IoT experience



Local processing for IoT devices

Securely distribute cloud intelligence to IoT devices quickly and at scale by using a single edge runtime

Elements of Azure IoT Suite

1. Connect and Manage Devices & Gateways



Preconfigured solutions



Devices & Gateway



Connect and control

2. Analyze streaming data



Real time analytics



Data visualization



Predictive analytics*

3. Integrate into business systems



Workflow integration



Push and broadcast notifications



ID and access management

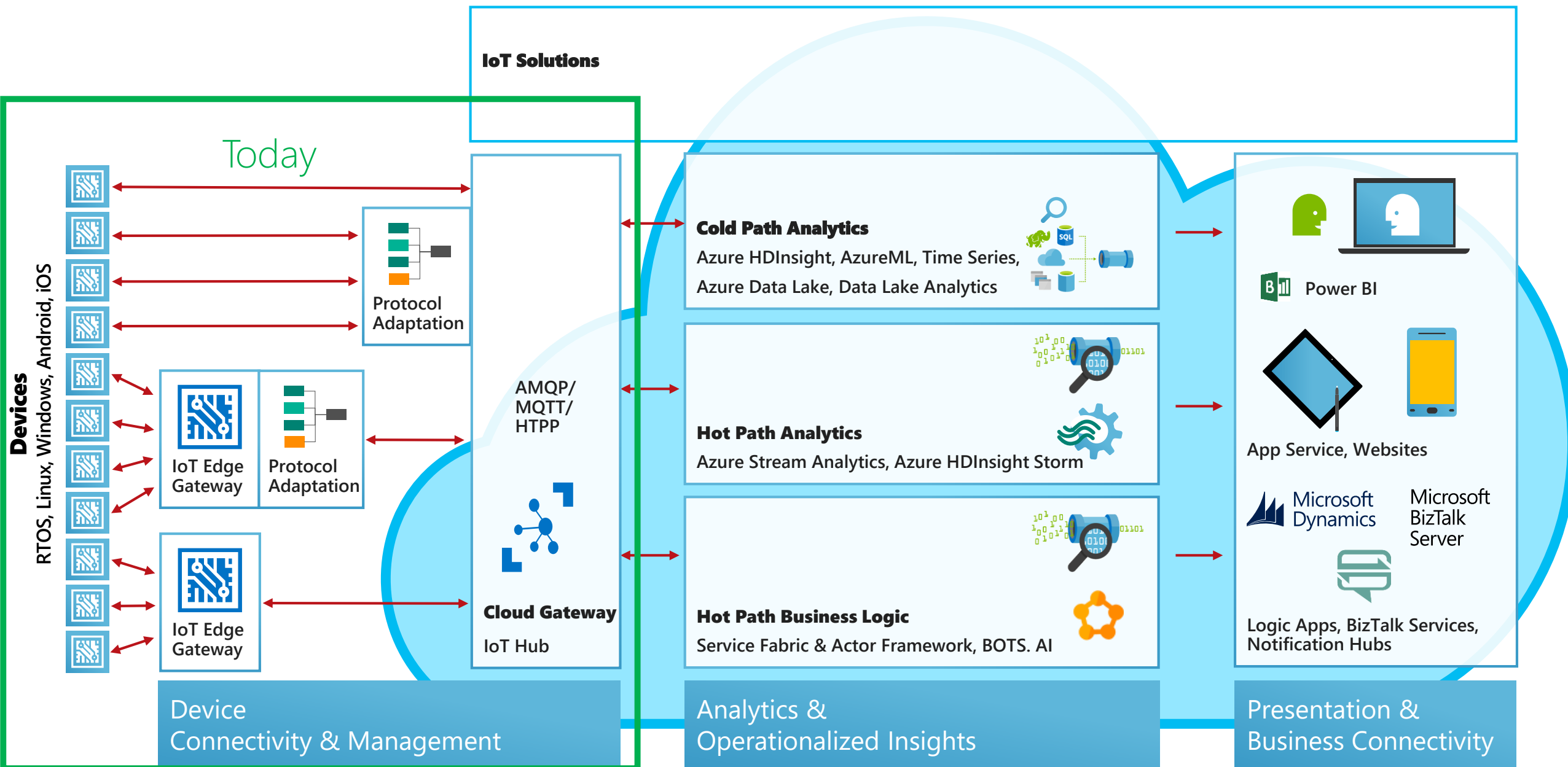
4. Secure IoT Infrastructure



5. Customize IoT Architecture

* Only applies to Predictive Maintenance

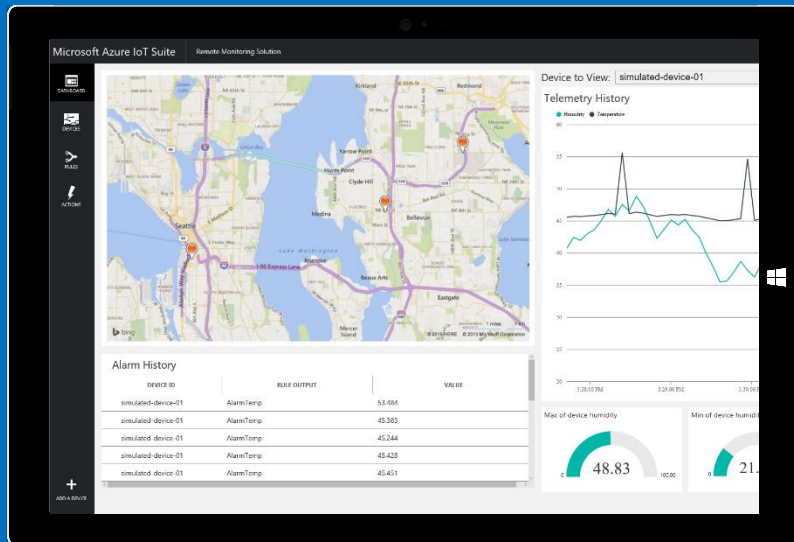
Azure IoT Solutions big picture



Preconfigured solutions

Remote Monitoring and Predictive Maintenance

Start quickly with preconfigured solutions



Get started in minutes

Modify existing rules and alerts

Add your devices and begin tailor to your needs

Finish with your Internet of Things application



Fine-tuned to specific assets and processes

Highly visual for your real-time operational data

Integrate with back-end systems

PCS: Remote Monitoring azureiotsuite.com

Microsoft Azure IoT Suite RMsolution ADMINISTRATOR [Sign Out](#)

DASHBOARD
DEVICES
RULES
ACTIONS
+
ADD A DEVICE

Device to View:

Telemetry History

● Humidity ● Temperature

TIME	DEVICE ID	RULE OUTPUT	VALUE
09/29/2015 9:22:25 AM	SampleDevice001_363	AlarmTemp	43.817
09/29/2015 9:22:25 AM	SampleDevice001_363	AlarmHumidity	22.588
09/29/2015 9:22:23 AM	SampleDevice001_363	AlarmTemp	42.933
09/29/2015 9:22:23 AM	SampleDevice001_363	AlarmHumidity	25.135

Max of device humidity: 20.70
Min of device humidity: 20.42
Average of device humidity: 24.38

PCS: Predictive Maintenance azureiotsuite.com

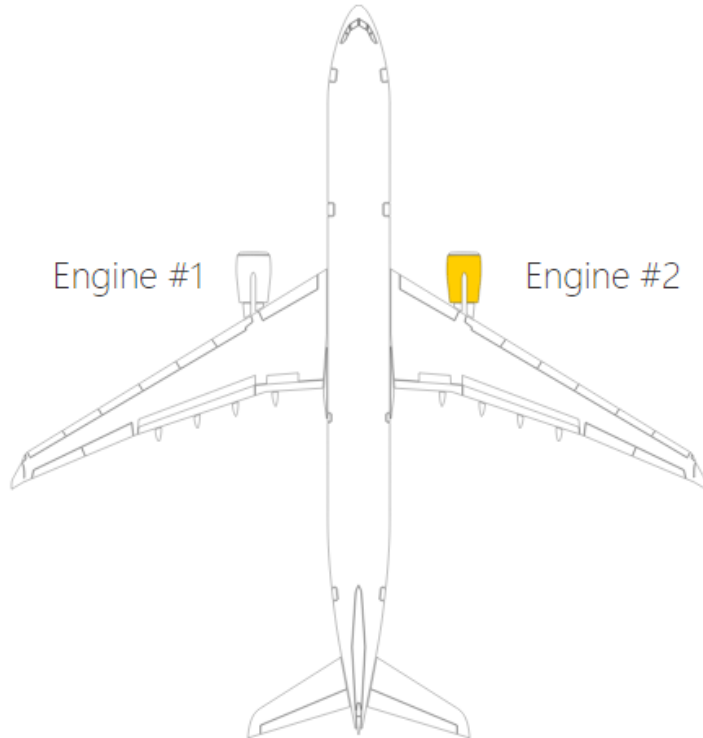
Microsoft Azure IoT Suite



DASHBOARD

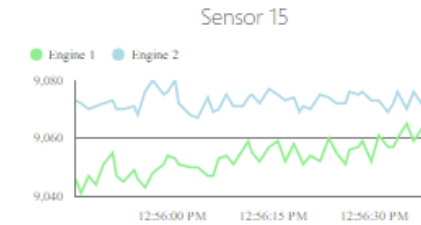
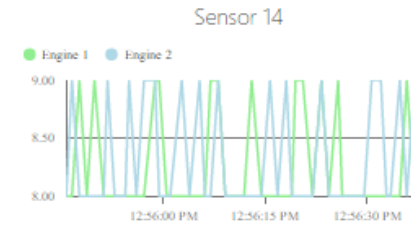
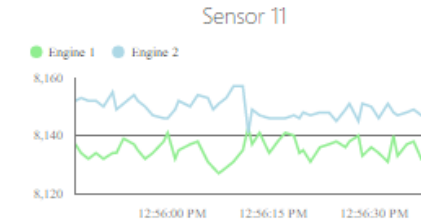
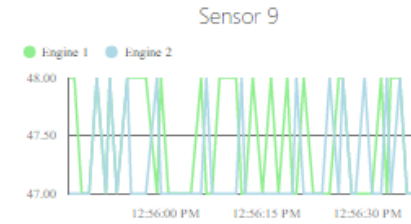
Aircraft map

Simulation in progress



Stop simulation

Sensor history



Remaining Useful Life (RUL)
IN DAYS

162
ENGINE #1

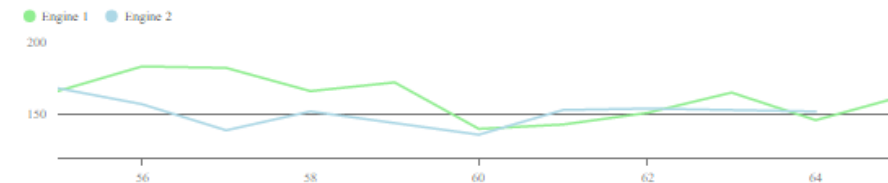
152 ⚠
ENGINE #2

Cycles
#

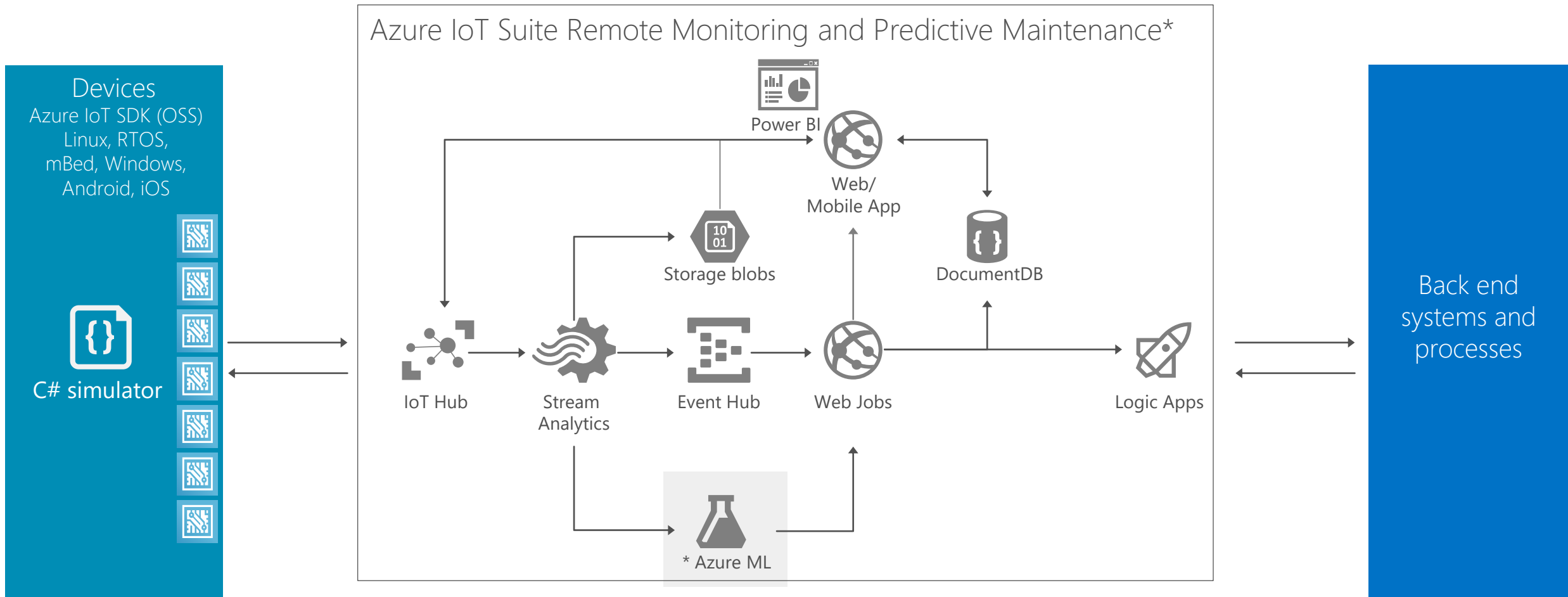
65
ENGINE #1

65
ENGINE #2

Remaining Useful Life (RUL) history
IN DAYS

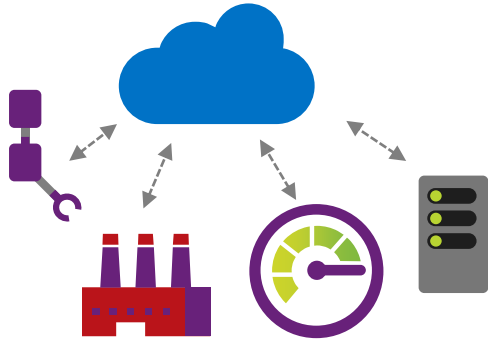


What is behind IoT Suite preconfigured solutions



* Machine Learning available with Predictive Maintenance only

Why the edge?

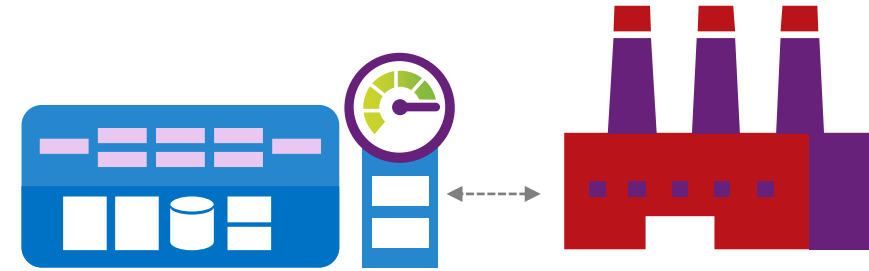


IoT in the Cloud

Remote monitoring and control

Merging remote data from across multiple IoT devices

Near 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

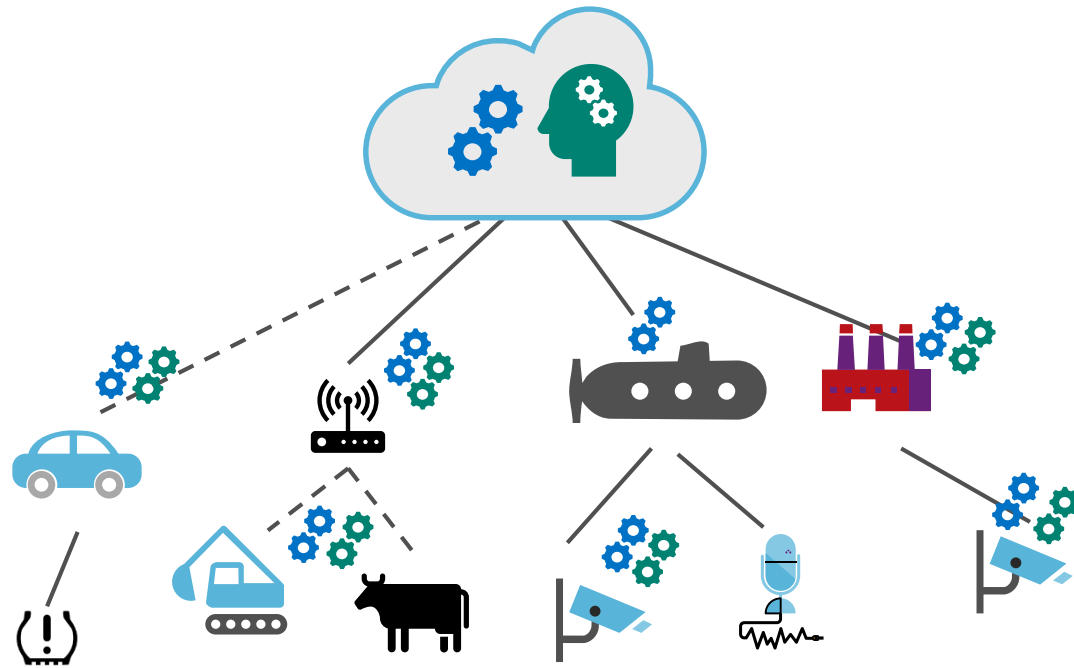
Public internet inherently unpredictable

Privacy of data and protection of IP

Life cycle management and configuration of edge device

 **Simple processing**
filtering, batching, compression

 **Complex processing**
Azure Stream Analytics, Cognitive Services



Enable any service (Microsoft or third party) to offload intelligence to edge devices

Compose these services in solutions spanning edge and cloud

Declarative configuration of Edge
Manage edge configuration, from provisioning to decommissioning, without touching the device

Coming Soon: Microsoft IoT Central



Device Connectivity & Management



Telemetry Ingestion and Command & Control



Monitoring Rules & Triggered Actions



User roles and permissions



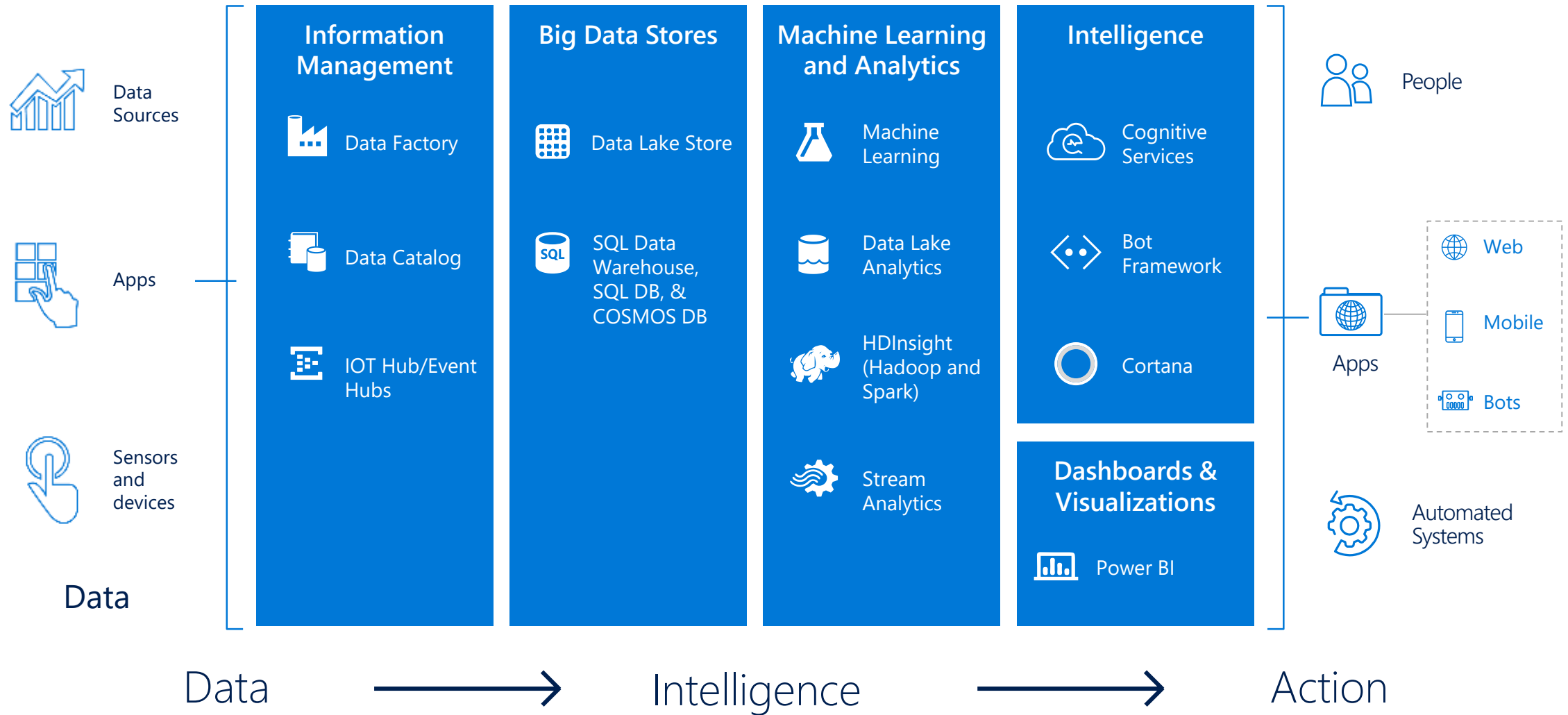
Dashboards, Visualization & Insights



Fully Hosted & Managed by Microsoft



Transform data into intelligent action



Microsoft Has a Comprehensive IoT and Analytics Offering

Azure IoT Suite and Cortana Intelligence Suite

Customer equipment and devices



COLLECT

data from building equipment and third-party sources

Azure IoT Hub

TRANSFORM

data into a standardized format



MANAGE

data as real-time streams and store as relational or non-relational datasets in highly-secure ISO-certified data centers

SQL, DW, HDInsight, Cosmos

Azure Machine Learning, Stream Analytics, AI



ANALYZE and PREDICT

with machine learning and custom queries and algorithms

Power BI & Hololens



VISUALIZE

through dashboards, reports, both in the office and while mobile

Azure IoT Hub



DECIDE and ACT

Using rules-based prioritization engines that help prioritize and monetize maintenance tasks

SAFETY &
SECURITY

BUILDINGS & ENERGY
EFFICIENCY

ACCESS, CONTROL &
PAYMENTS

CONNECTED
TRANSPORTATION

CONNECTED CAMPUS & SCHOOLS EXPERIENCES (CITYNEXT)

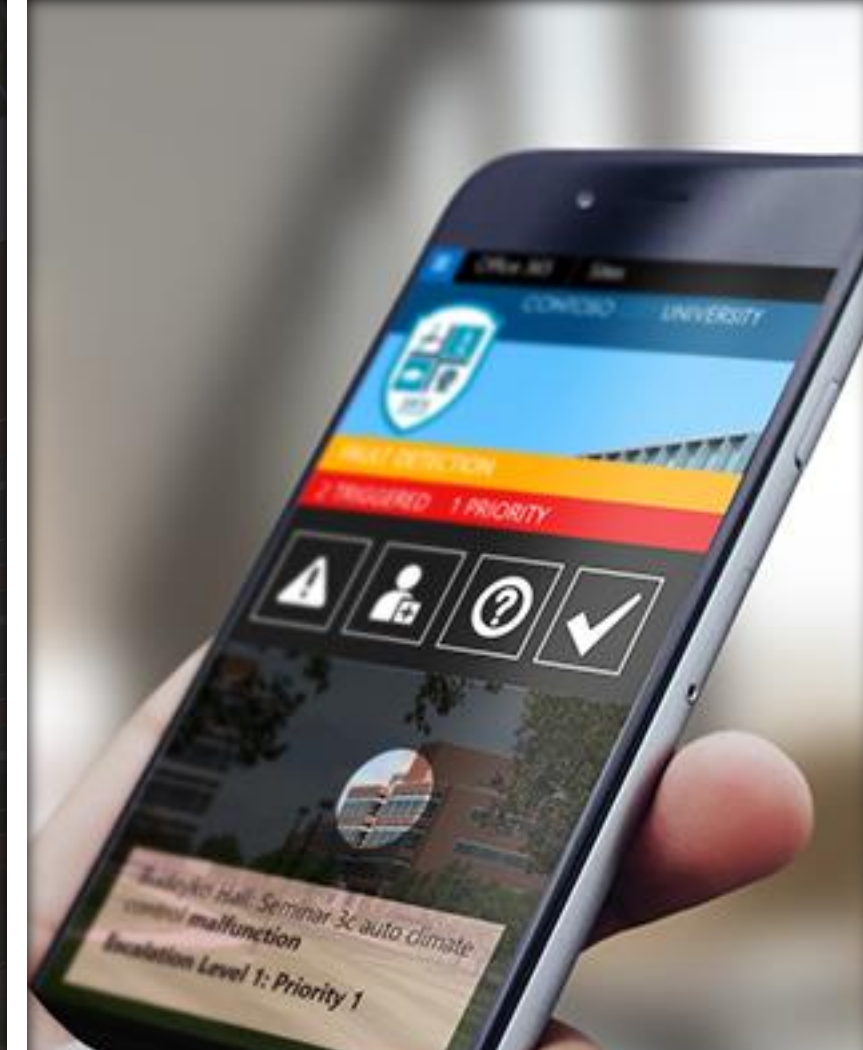
CONNECTED
HEALTH

STUDENT SUCCESS
ANALYTICS

STUDENT
EXPERIENCE



ENERGY USAGE



FAULT DETECTION



PREDICTIVE DATA

BUILDING ENERGY EFFICIENCY

With smart buildings, schools and university campuses can **save 10% or more** through facilities management & energy efficiency.



What does it mean to have Smart Buildings?

➔ Reduce energy consumption

➔ Fault detection

➔ Reduce minor disasters

➔ Save money

➔ Go green





Microsoft deployed this
solution in 2011
with our Partner ICONICS
using Azure



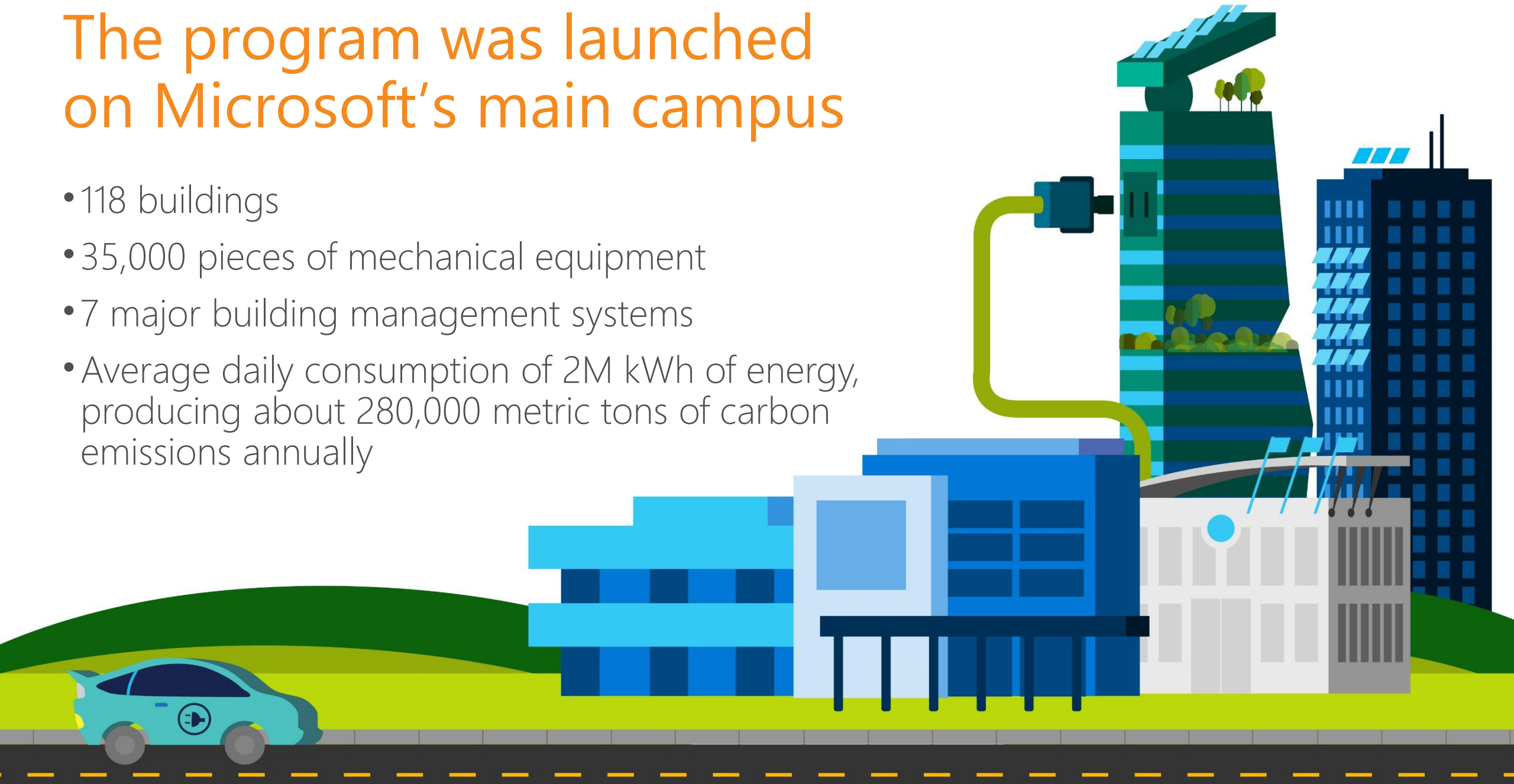


and the system
paid for itself
in 18 months



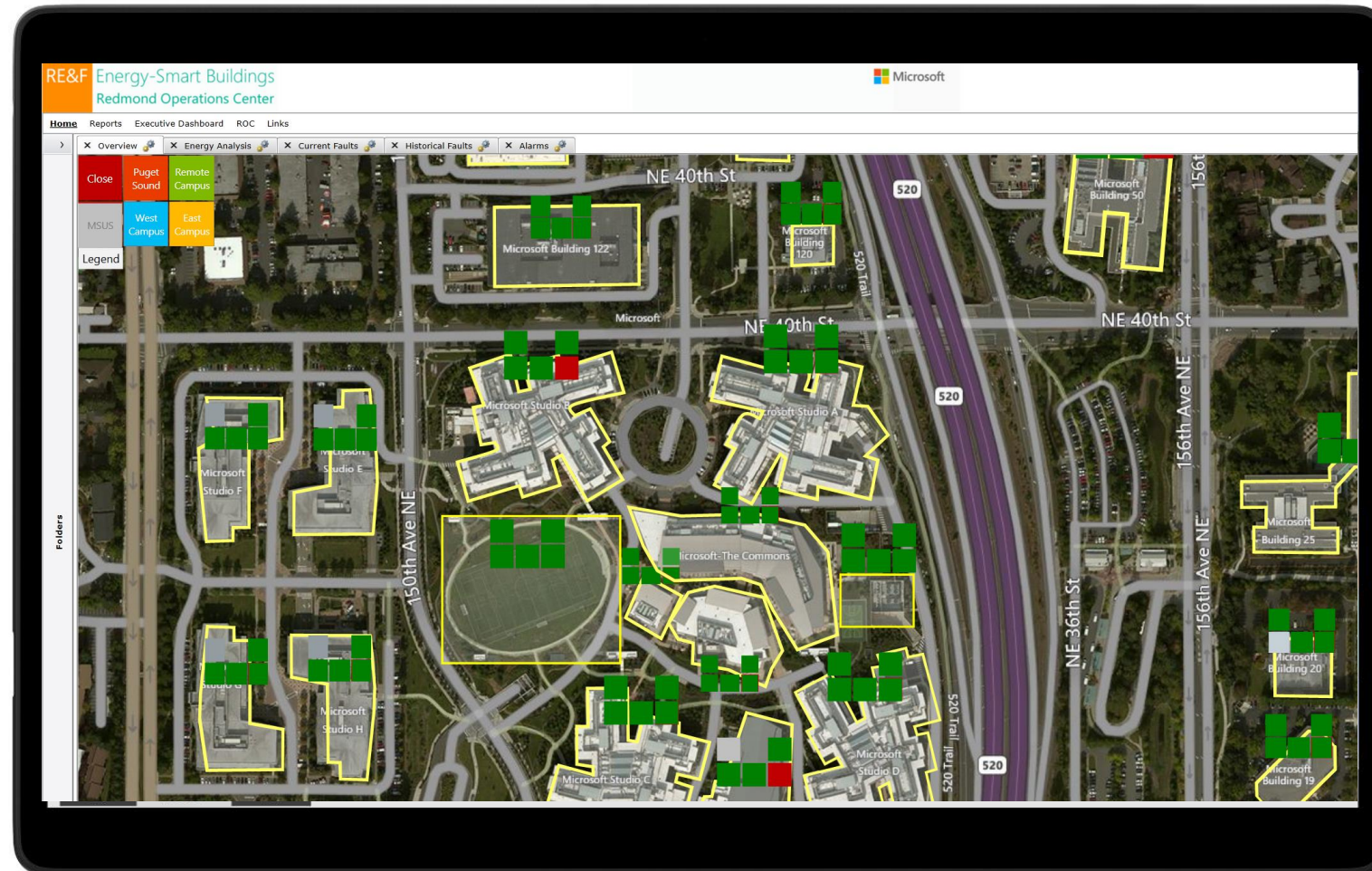
The program was launched on Microsoft's main campus

- 118 buildings
- 35,000 pieces of mechanical equipment
- 7 major building management systems
- Average daily consumption of 2M kWh of energy, producing about 280,000 metric tons of carbon emissions annually



Campus Dashboard

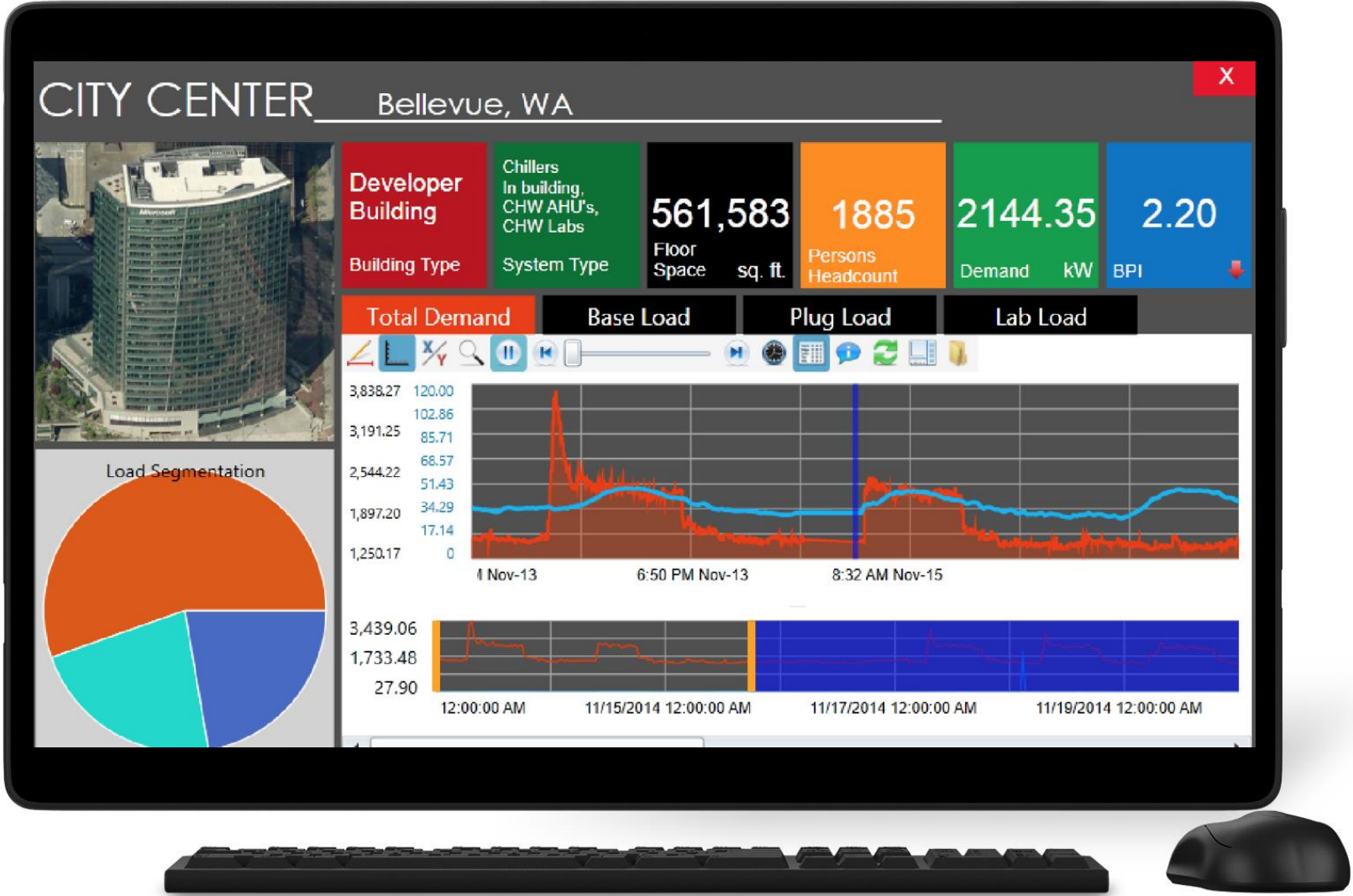
Created by ICONICS using Azure, Microsoft's Cloud Offering



Snapshot of Building's Energy Usage



Peak Load



Fault Prioritization and Savings

Overview Energy Analysis Current Faults Historical Faults Alarms

36 Faults

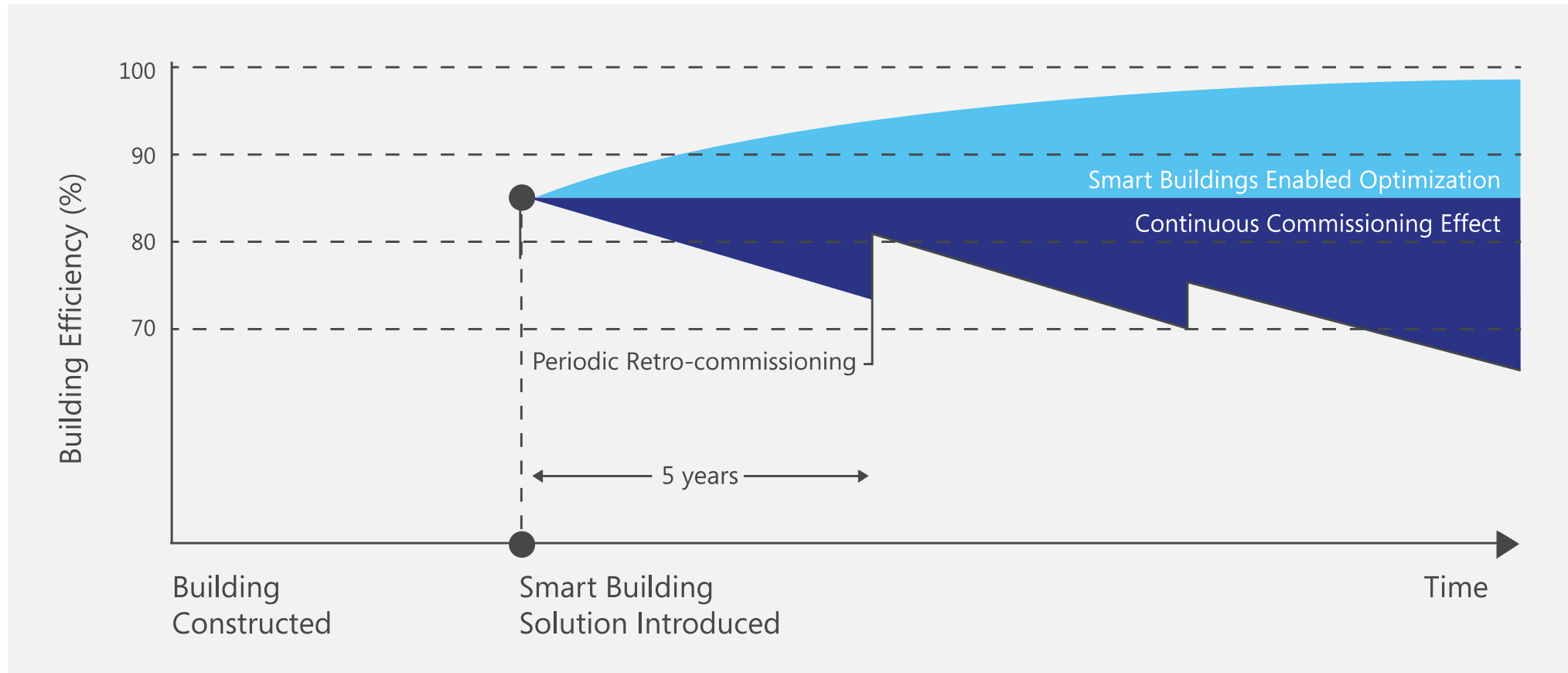
Prio 1 Prio 2 **Prio 3** Prio 4 Prio 5

Date / Time	Tag	Prio	Fault Savings
2/5/2015 1:22	92 Lab 4255 Damper Stuck Closed	3	\$1,299
2/5/2015 7:54	92 Lab 2453 CCV Leaking	3	\$1,067
2/5/2015 3:01	92 Room 3312 CCV Leaking	3	\$707
2/5/2015 2:57	92 Lab 5453 Damper Stuck Closed	3	\$246
2/5/2015 6:14	92 Room 4255 Unnecessary Mechanical Cooling	3	\$198
2/5/2015 2:33	92 CHW High DP Setpoint	3	\$120

Day Month Year

Learning and Prediction Over Time

The old way of optimizing facilities involves camping out in one building at a time for a period of weeks, tuning and fixing equipment. Efficiency peaks after this process but declines as the team moves on to other buildings, often not returning for a period of years.





In 4 years, the system has saved Microsoft \$4.5M (10%)

In 10 years, it is trending towards approximately \$100M (18%) in energy savings since deployment.

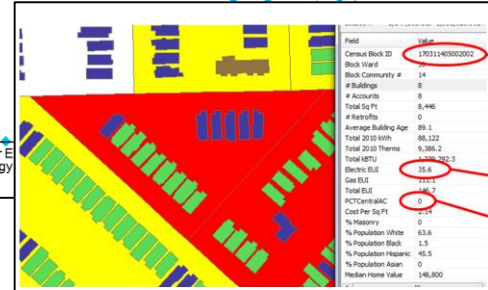
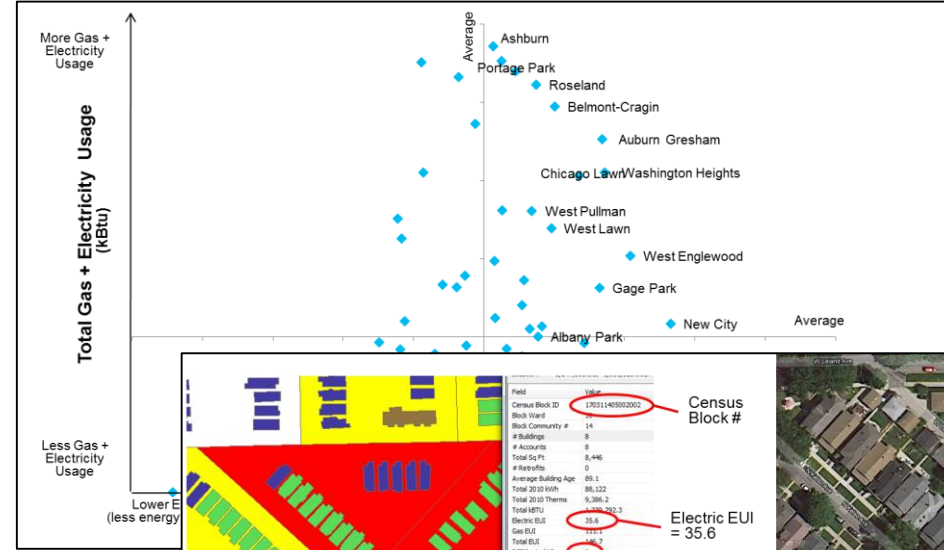


Bringing ENERGY EFFICIENCY

to buildings in Chicago

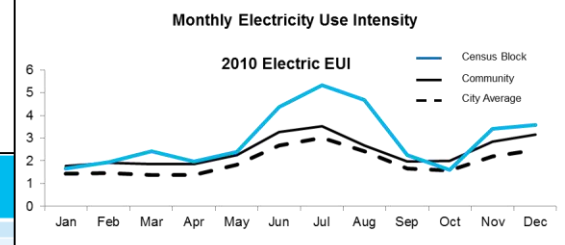
Accenture created advanced analytical tools to help guide Chicago's energy-efficiency efforts. By combining actual electricity and natural gas usage with building characteristics and demographics, Microsoft partner Accenture delivered a full picture of energy consumption and a precise analysis of **opportunities for energy-efficiency** improvements that can deliver **annual energy savings of over \$170MM.**

 [Learn more](#)



Opportunities

- Window A/C control or replacement?
- Baseload electricity reductions?
 - Lighting
 - Appliances
 - Plugload
- Convert electric heat?
- Awareness and education
- Collaboration with *Hanul Family Center* (CEDA Energy Action Network)



Solution Zone								
All: Loop								
Commercial: Hotels/Motels								
Commercial: Hospitals		117	57	\$47.3	\$9.5	20%	\$32.3	
Commercial: Colleges/University		117	23	\$41.2	\$8.2	20%	\$28.1	
Single Family: Far Southwest	Ashburn, Auburn Gresham, Wash. Heights, Roseland, West Pullman	24	111	\$87.8	\$7.3	8%	\$10.2	
Single Family: Southwest	West Englewood, Chicago Lawn, West Lawn	24	117	\$39	\$4.9	13%	\$12.7	
Single Family: Near Southwest	New City, Gage Park	24	126	\$17.3	\$3.0	17%	\$11.4	
Single Family: Albany Park		29	104	\$8.3	\$0.6	7%	\$0.8	
Single Family: Portage Park		24	103	\$21.5	\$0.5	3%	\$0.3	
Single Family: Belmont Cragin		24	113	\$18.6	\$1.7	9%	\$3.1	
MF (< 7 units): Near Downtown	Near South Side, Near North Side	28	120	\$4.1	\$0.8	20%	\$2.8	
MF (7+ units): South Lakefront	Kenwood, Douglas, South Shore	9	79	\$6.6	\$1.3	19%	\$3.9	
MF (< 7 units): Rogers Park		30	86	\$8.7	\$1.2	14%	\$2.6	
MF (7+ units): Rogers Park		15	68	\$6.6	\$0.9	14%	\$2.0	
MF (7+ units): Roseland		20	101	\$1	\$0.2	20%	\$0.7	
MF (7+ units): Far West Side	North Lawndale, East Garfield Park	18	77	\$1.2	\$0.2	20%	\$0.8	
MF (< 7 units): Riverdale		33	106	\$0.6	\$0.1	20%	\$0.4	
All: Municipal		61	57	\$312.3	\$49.4	15.8%	\$128.2	
				TOTAL	\$1,049.3	\$175.4	16.7%	\$531.8



Enhanced Building and Energy management for a school

Arlington primary school's energy management was transformed by cloud-based insights with a solution from Microsoft partner ICONICS. They **reduced energy usage, increased equipment lifespan, and sped problem detection by 15%**. As soon as the fault detection system was turned on, it revealed the school's new chiller was running constantly, cycling every five minutes even at night to keep the school within a needlessly narrow, half-degree temperature range.

 [Learn more](#)

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Applying MACHINE LEARNING to save energy

Carnegie Mellon University wanted to reduce energy usage and cut carbon emissions. The university leveraged the PI system from Microsoft partner OSIsoft in combination with Azure HDInsight and Power BI for better fault detection, diagnosis, and more efficient operations. They were able to detect equipment failures sooner and **achieved a 30% reduction in energy costs.**

 [Learn more](#)

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Demos

Azure Gallery (<https://gallery.cortanaintelligence.com/>)

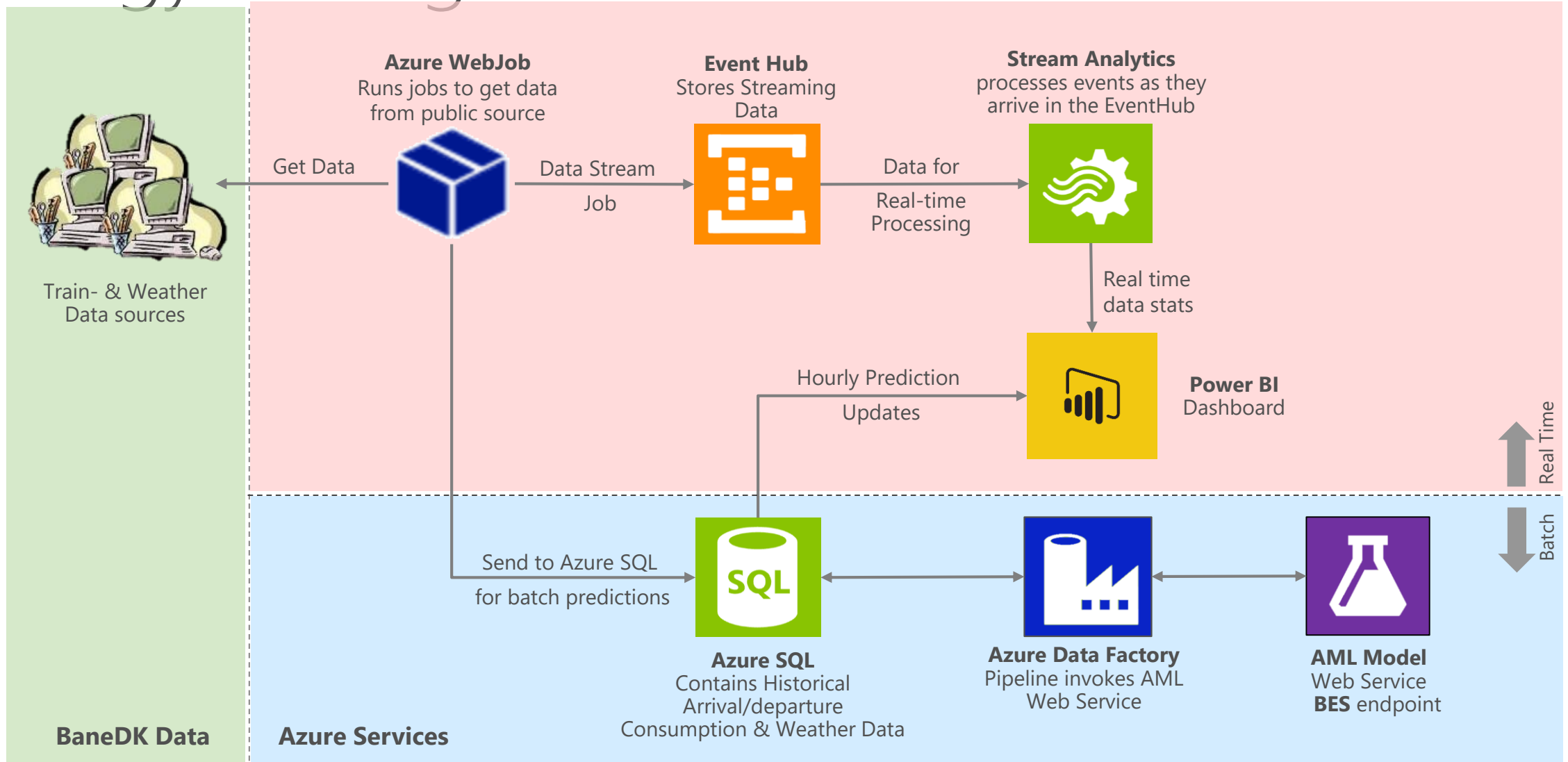
Azure Trial (https://azure.microsoft.com/en-us/free/?v=17.39&WT.srch=1&WT.mc_id=AID559320_SEM_i0yGeVjc&Inkd=Bin_g_Azure_Brand)

IOT Device Catalogue (<https://catalog.azureiotsuite.com/>)

Cognitive Services (<https://azure.microsoft.com/en-us/services/cognitive-services/directory/vision/>)

Azure Marketplace (<https://azuremarketplace.microsoft.com/en-us/marketplace/>)

Energy Management Architecture



Azure Machine Learning

The screenshot displays the Azure Machine Learning Studio interface. On the left is a navigation pane with a search bar and a list of modules: Saved Datasets, Data Format Conversions, Data Input and Output, Data Transformation, Feature Selection, Machine Learning, OpenCV Library Modules, Python Language Modules, R Language Modules, Statistical Functions, Text Analytics, Web Service, and Deprecated. The main workspace shows a workflow titled "EnergyDemandForecast-24hr-withT" which is "Finished running". The workflow consists of the following modules: 1. Reader (Get demand and temperature data from SQL), 2. Execute R Script (Data cleaning & feature engineering), 3. Two parallel Execute R Script modules (Data for training and Data for forecasting), 4. Boosted Decision Tree Regr... (Machine Learning model), 5. Train Model, 6. Score Model (Make forecast), 7. Execute R Script (Select the column we need), and 8. Writer (Write forecast data to SQL). The bottom of the workspace has a toolbar with icons for zooming, full screen, and a dropdown menu with options: Predictive Web Service [Recommended], Deploy Web Service, SET UP WEB SERVICE, and PUBLISH TO GALLERY. On the right, the Properties pane is open for the "Reader" module, showing configuration for an Azure SQL Database connection. The database name is "EnergyForecastSQLDatabase" and the server user account name is "energydemouser". A "Quick Help" section at the bottom of the Properties pane provides instructions on loading data from various sources.

EnergyDemandForecast-24hr-withT Finished running ✓

Search experiment items

- Saved Datasets
- Data Format Conversions
- Data Input and Output
- Data Transformation
- Feature Selection
- Machine Learning
- OpenCV Library Modules
- Python Language Modules
- R Language Modules
- Statistical Functions
- Text Analytics
- Web Service
- Deprecated

Reader
Get demand and temperature data from SQL

Execute R Script
Data cleaning & feature engineering

Execute R Script
Data for training

Execute R Script
Data for forecasting

Boosted Decision Tree Regr...

Train Model

Score Model
Make forecast

Execute R Script
Select the column we need

Writer
Write forecast data to SQL

Properties

Reader

Data source
Azure SQL Database

Database server name
ghdb7wg5iw.database.windows.net

Database name
EnergyForecastSQLDatabase

Server user account name
energydemouser

Server user account password
●●●●●●●●

Accept any server certificate (insecure)

Database query

```
1 select b.localTime as TimeStamp, b.PTID, a.HourAvgL
2 (select * from DemandHistoryHourly
3 where convert(varchar(10),TimeStamp,110)>=convert(v
4 and PTID=61761) a
5 right join
```

Quick Help

Load data from sources such as the Web, Azure SQL database, Azure table, Hive table, or Windows Azure BLOB storage

Predictive Web Service [Recommended]

Deploy Web Service

SET UP WEB SERVICE

PUBLISH TO GALLERY

NEW

RUN HISTORY

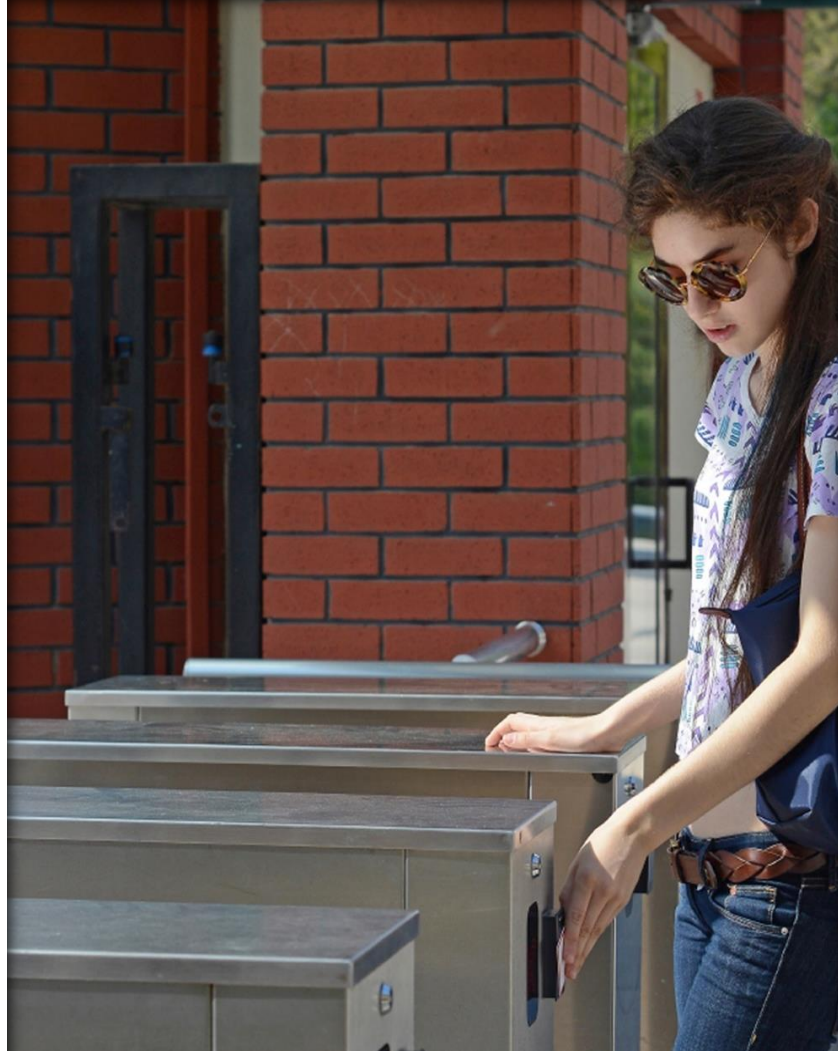
SAVE

DISCARD CHANGES

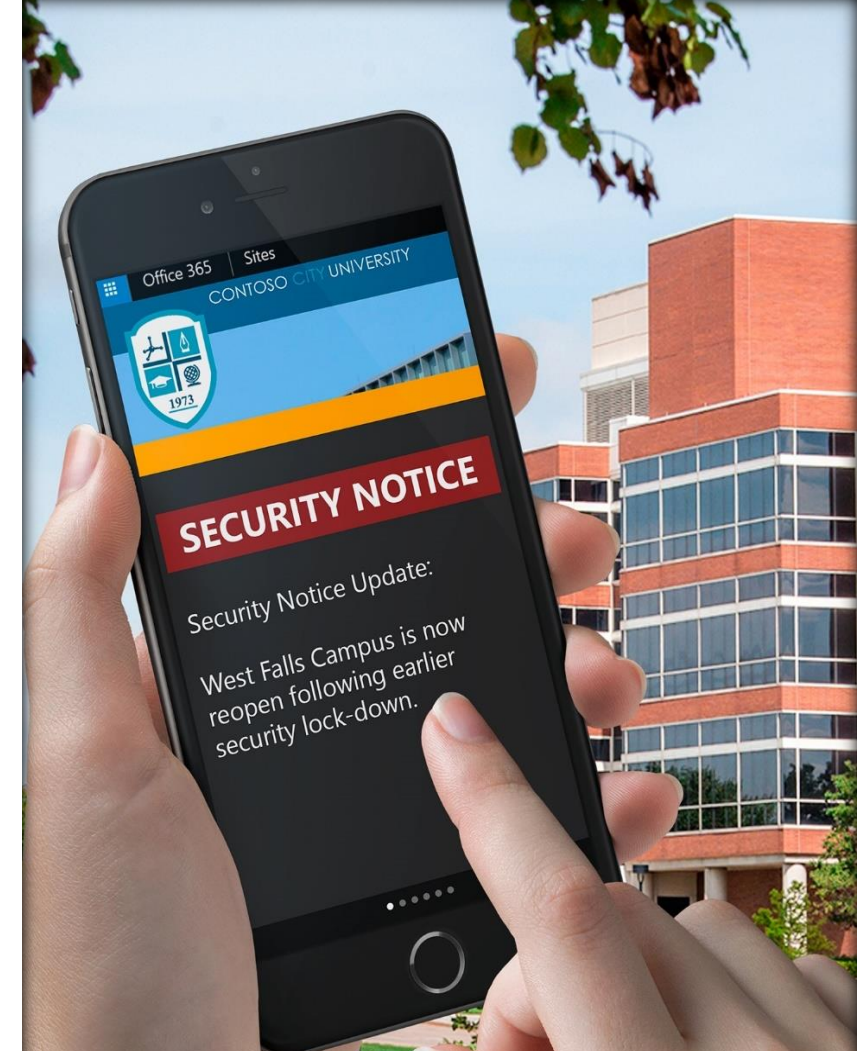
RUN



SMART CAMERAS



ACCESS CONTROL



EMERGENCIES

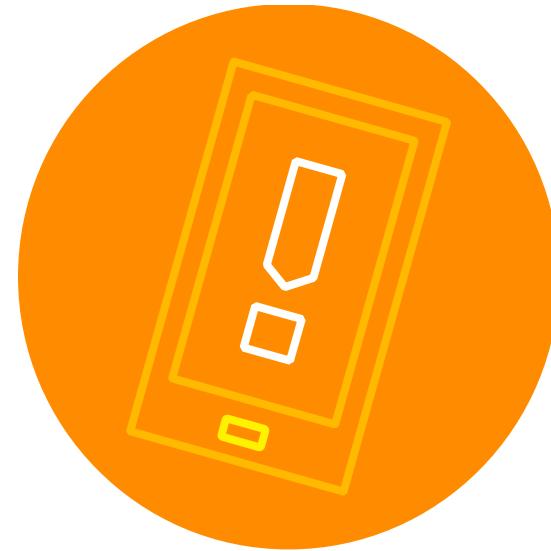
SAFETY AND SECURITY

Apply realtime analytics



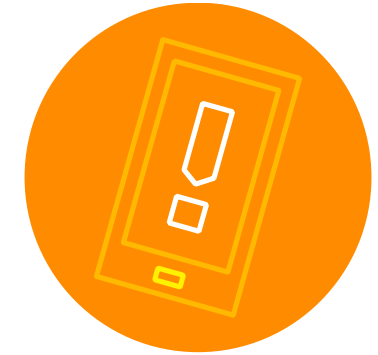
Emergency Notifications

- Create an alert for emergency situations including school evacuations and weather related school closings
- Rapidly deliver emergency alerts to all students, staff, faculty, and even parents instantly during these emergency situations
- Allow community members to check-in to confirm their safety or pinpoint problems with geolocation



Summon Help

- GPS-connected panic button phone apps and hardware



Quick Dispatch

- When an incident is reported, the system automatically finds the closest and most qualified person to respond.



Access Control

- Ensure the right people have access to the right spaces at the right times.
- Classrooms, academic buildings, dorms, labs, offices, equipment storage, and more
- No need for changing out lock cores

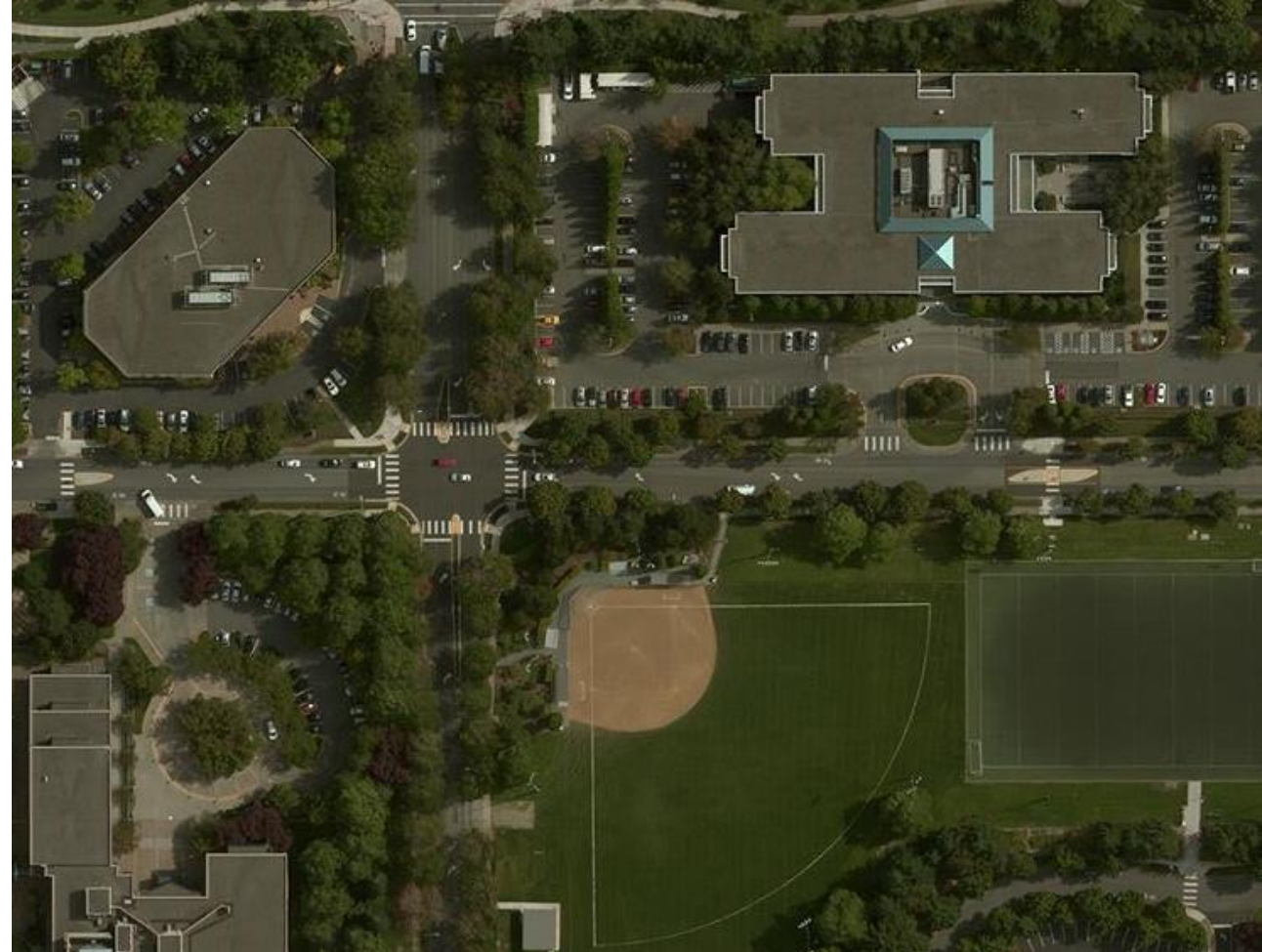


Reducing RESPONSE TIMES at the University of Puerto Rico

The University of Puerto Rico at Humacao was experiencing a spike in crime on campus. To ensure student safety, Microsoft partner INVID developed an emergency response app that allows students to **report incidents, pinpoints their location, and dispatches the nearest security officer**, reducing response times significantly.

 [Learn more](#)

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Increasing COORDINATION between agencies in Singapore

The Safe City Solution, created by Microsoft partner Accenture, integrates advanced analytics into existing systems and sensors owned by different agencies in order to **maximize situational awareness, streamline operations and enhance response** to a wide spectrum of safety and security concerns.

 [Learn more](#)

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Mitigating SAFETY

Threats in New York

The New York Police Department (NYPD) had to be up-to-date with the latest crime prevention and counterterrorism technology capabilities.

They worked with Microsoft to develop the Domain Awareness System. This system **aggregates and analyzes public safety data in real time**, providing investigators and analysts with a comprehensive view of potential threats and criminal activity.

The Domain Awareness System has helped the NYPD improve its response time and even prevent crimes.

 [Learn more](#)



 @MSFTCityNext [Microsoft.com/CityNext](https://www.microsoft.com/CityNext)



Responding FASTER to Emergency Situations

In Madrid, Spain, the city's emergency services was using an obsolete technology platform that couldn't classify different types of emergency calls or scale to track emergency vehicles.

The city implemented the GEMMA emergency management system by Atos, a Microsoft CityNext partner. The system integrates the management of the city's different emergency response infrastructures and provides interoperability across its various response agencies.

The has helped **reduce response times and enabled first responders to better prioritize** life-threatening emergencies.

 [Learn more](#)

Atos

 @MSFTCityNext Microsoft.com/CityNext



COMBINING DATASETS

Improve Student Success with Data from Other Campus Systems



Examples

Student Engagement

Use Access Control or Parking data to estimate student engagement as an early warning factor for performance

Effect of the Environment on Learning

Use Facilities data such as CO2 levels, temperature, and noise level to see environmental effects on learning

CO2 Levels in Classrooms

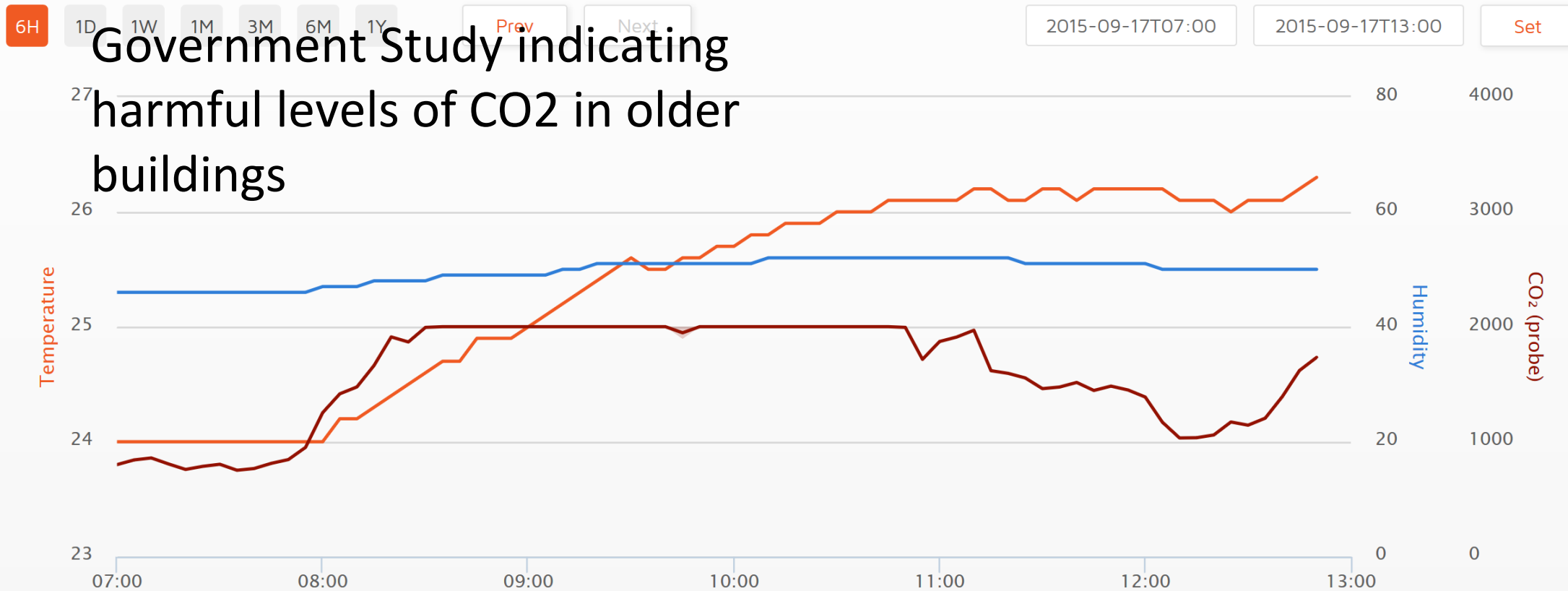


Graphs

Gateway Fløj A - Vallensbæk Skole: [Sensor - Lokale 53](#) / [Sensor - Lokale 48](#)

Gateway Fløj I - Vallensbæk Skole: [Sensor - Lokale 02](#)

Sensor - Lokale 48, 17'th September - 17'th September 2015



Government Study indicating harmful levels of CO2 in older buildings

lokale

lokale,



John.SocialClub (Running) - Microsoft Visual Studio

File Edit View Project Build Debug Team Tools Architecture

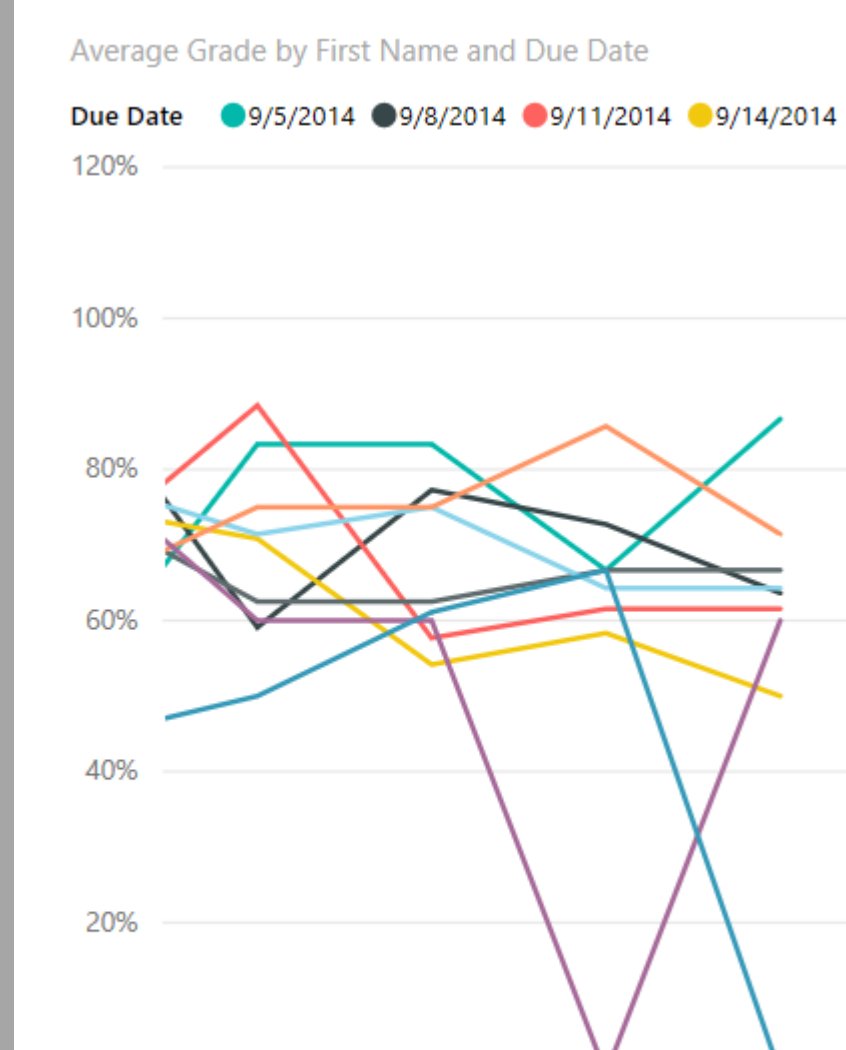
Debug Mixed Platform Continue

```
Program.cs # 1 x
John.SocialClub.Desktop John.SocialClub.Desktop.Progra Ma
using System;
using System.Collections.Generic;
using System.Linq;
using System.Windows.Forms;

namespace John.SocialClub.Desktop
{
    0 references
    static class Program
    {
        /// <summary>
        /// The main entry point for the application
        /// </summary>
        [STAThread]
        0 references
        static void Main()
        {
            Application.EnableVisualStyles();
            Application.SetCompatibleTextRenderingDe
            Application.Run(new Login());
        }
    }
}
```

Locals

Name	Value
------	-------



CLOUD COMPUTING

DATA ANALYTICS

IOT

MACHINE LEARNING

Curriculum Integration

Empowering Future Leaders With Data Science

The business school **integrated data analytics and Machine Learning into the curriculum** in order to give students real world experience and help them develop skills that will help them be successful employees.

"...the biggest impact of Azure Machine Learning is that it gives students a sense that they're connecting to the real world, and that's very powerful." –Dr. Florian Zettelmeyer, Director

 [Learn more](#)



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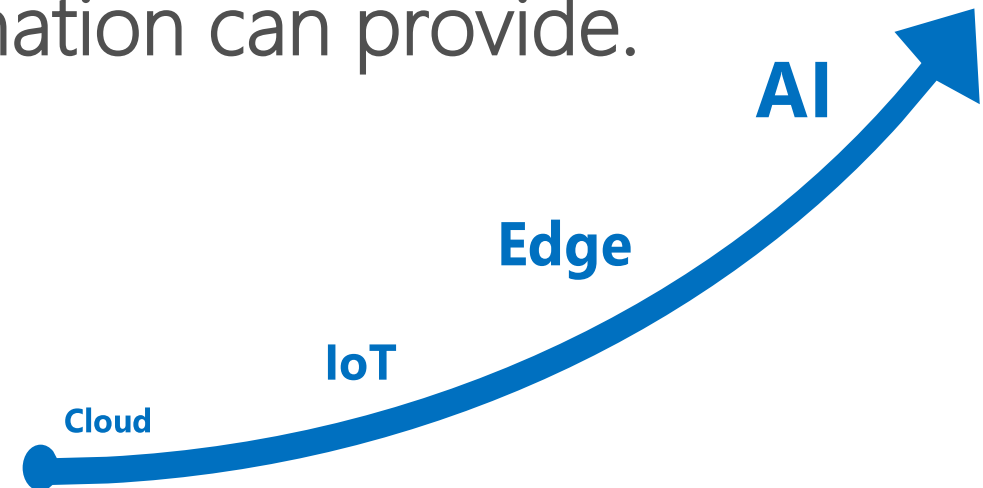


Conclusion

We are building the Future of Intelligent Business.

Connecting the Physical World to the Digital World.

Enabling all Companies to Realize the True Value that Digital Transformation can provide.





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