Operationalizing IoT Data

Presented by **Dave Roberts**
OSIsoft

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#OSIsoftUC

Talk Agenda

- Extending the Edges of the PI System
- Customer Use Case Example:
  - Achieving Predictive Analytics
- Putting it together in Geospatial Context
- Closing thoughts

Opening Thoughts

- The PI System has been used over 30 years to integrate data from Industrial Systems and create actionable information
- We're extending these capabilities in multiple directions:
  - Data Ingestion (PI Connectors) – leveraging IoT technologies to get closer to the edge directly connecting to Assets and Sensors
  - Delivery as a Service – Microsoft Azure
  - Open and Interoperable – Data Access
  - Analytics – Enabling Business Intelligence, Predictive Analytics, Machine Learning
  - Geospatial Context – Visualization in a Geospatially oriented world
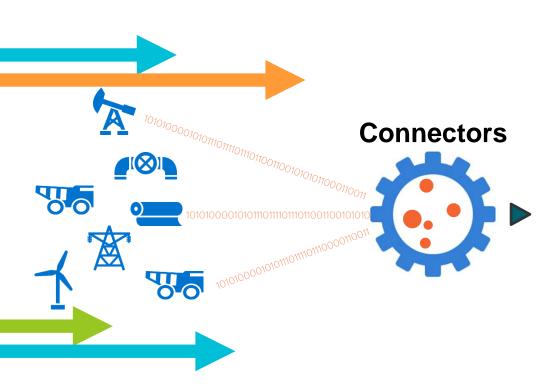
Deploying Connectors for IoT

PI Connectors

Connectors

- Data source is the system of record
- Data collected in terms of assets as defined by the data source
- Assets auto-created in PI AF
- Tags auto-created in PI Data Archive, linked to PI AF Elements
- Events collected and stored in Event Frames
- Easy to configure

See Chris Coen's Talk: Collect your Data in Context Using PI Connectors
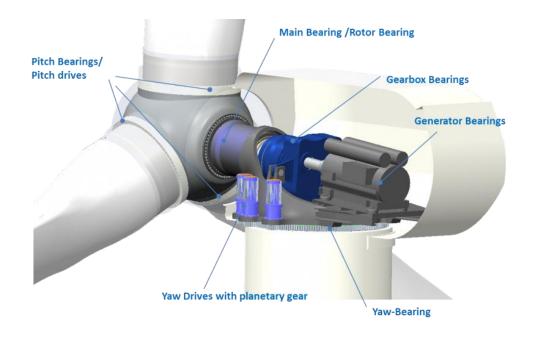*Thursday 3:30-4:00PM*

PI Connector	Market	Status
IPMI	Datacenters	✅
CygNet	Upstream Oil and Gas	✅
EtherNet/IP	High-speed discrete	✅
Kongsberg	Transportation	✅
HART-IP	Many. Wireless sensors	Beta
Wonderware Historian	Many	Beta
IEC 60870-5-104	T&D Substations	Beta
RTscada	T&D	Beta
BACnet	Facilities	Beta
WITSML	Upstream, drilling	Beta
Siemens Simatic PCS 7	Many	Beta
OPC UA	Many	Planned
DNP3 (in Cisco)	T&D	Planned
IEC 61850	Substations, wind generation, etc.	Planned
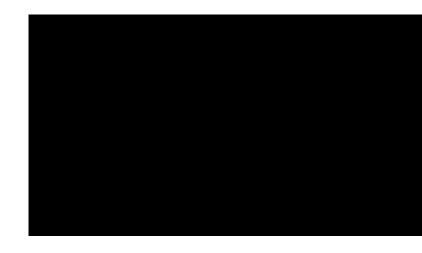
Proof of Concept Project

Connected Services: UpWind Solutions

Pitch Bearings/ Pitch drives

Main Bearing /Rotor Bearing

Gearbox Bearings

Generator Bearings

Yaw Drives with planetary gear

Yaw-Bearing

You don't want hear this coming from a tower!!!

UpWind Solutions Use-Case: OSIsoft Connected Services

UpWind Insight™

Analytics · Reports · Big Data · Smart Tech

WIND FARM · IMPROVED PERFORMANCE

"The PI Connected Services approach allows UpWind to significantly expand our UpWind Insight capabilities services providing comprehensive predictive maintenance to extend the life of wind projects and increase turbine performance. This also allows UpWind to tap into an eco-sphere of partners that can provide value-add solutions to enable our customer services."

Dave Peachey – VP Technology & Engineering, UpWind Solutions

CHALLENGES

Manage multiple GW of wind, across diverse OEMs, asset owners and geographies. Customers' windfarms use PI.

Millions of data points per second

Unreliable sensors prevent critical faults and protective shutdowns

Expensive failures to bearings and generators happen

Business is predicated on turbine uptime – they get paid by the turbine

SOLUTION

1. PI Cloud Connections to Customers' Windfarms
2. PI Cloud Connections from Upwind Solutions to Analytics Partner PI Infrastructure
3. Partner applied algorithms to standardize (around IEC 61400-25 Standard), contextualize and trust the data
4. Azure Machine Learning to identify patterns in the data that led to predictive models of high confidence related to bearing failures
5. Tied predictive models to Microsoft PowerBI tools to prioritize decision-making
6. Provided future data and tools to SMEs at UpWind for further analytic querying

RESULTS

PI Connected Service Agreement aligns our customers, UpWind and OSIsoft business models

Early warning of failures has dramatic reduction in O&M costs and lost production

Higher *trust* of the sensor data underlying the analytics

Partner Demo
UpWind Solutions

ELEMENT ANALYTICS

We help critical industrial organizations uncover intelligence hiding in their production data.
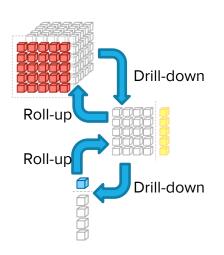
Sameer Kalwani, Head of Product at Element Analytics
sameer@elementanalytics.co

To develop predictive models, we need to standardize, contextualize and establish trust with UpWind's PI data
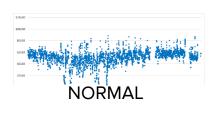
Standardize
roll-up, drill-down, slice and dice

Drill-down

Roll-up

Roll-up

Drill-down

Contextualize
recognize sensor patterns

NORMAL
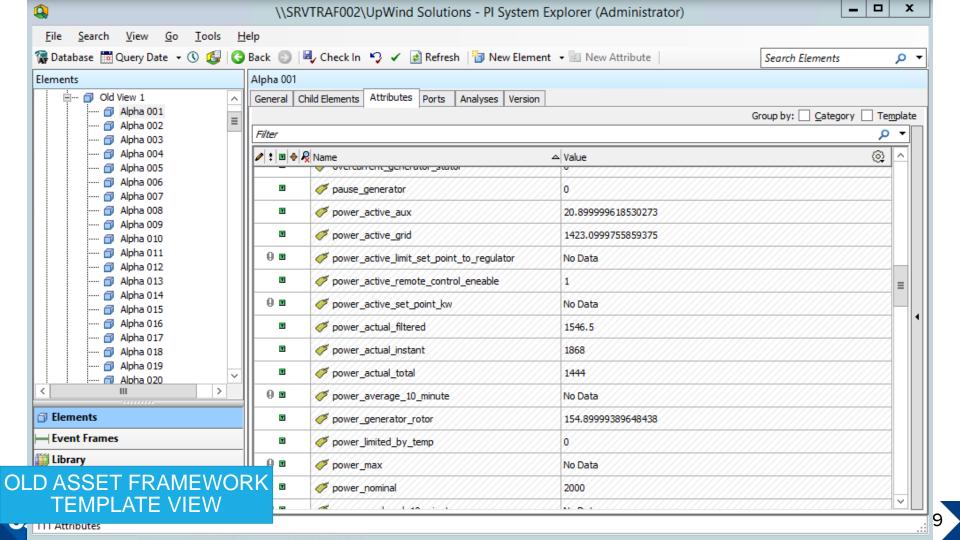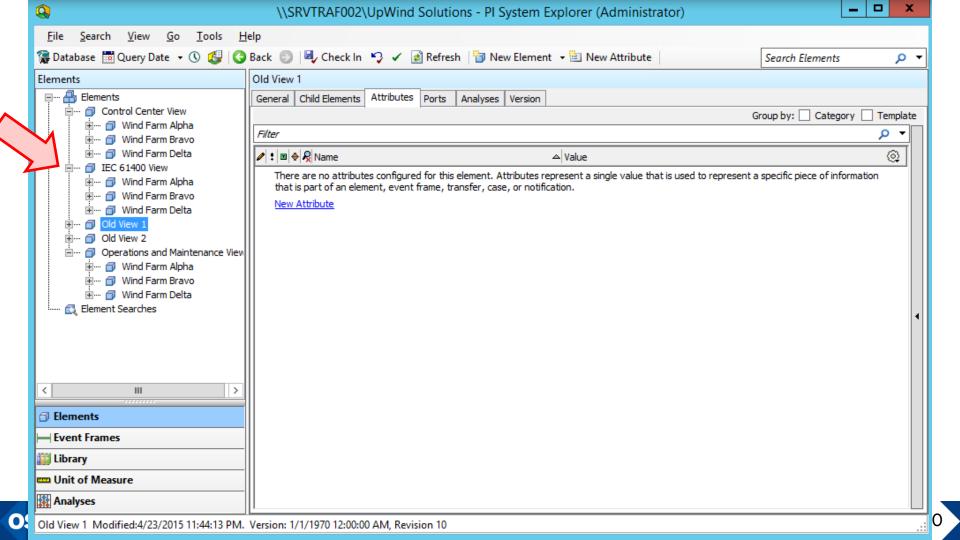
SENSOR FAILURE
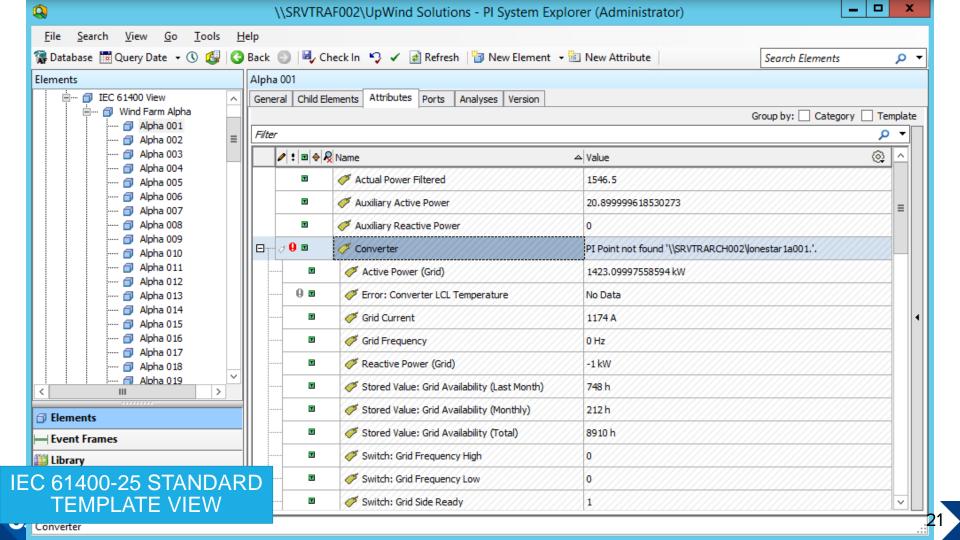
Trust
monitor for erroneous data

Element Analytics Workbench

OLD ASSET FRAMEWORK TEMPLATE VIEW

IEC 61400-25 STANDARD TEMPLATE VIEW
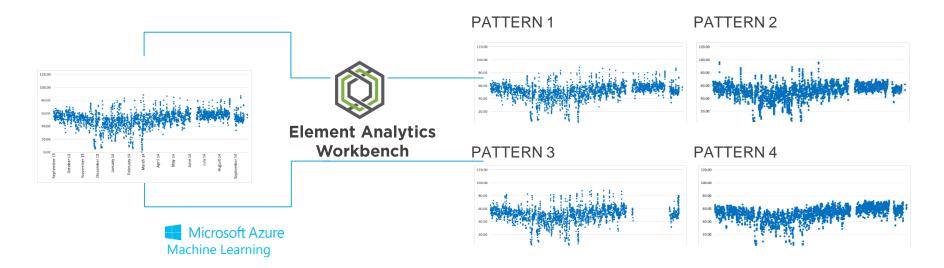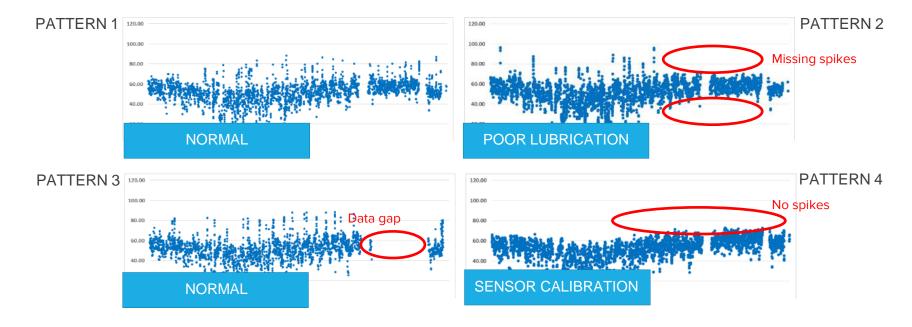
Step 2: Reliable Data via Automated Pattern Recognition

Fed engine with sensor data – identified patterns.

Element Analytics
Workbench

Microsoft Azure
Machine Learning

PATTERN 1

PATTERN 2

PATTERN 3

PATTERN 4
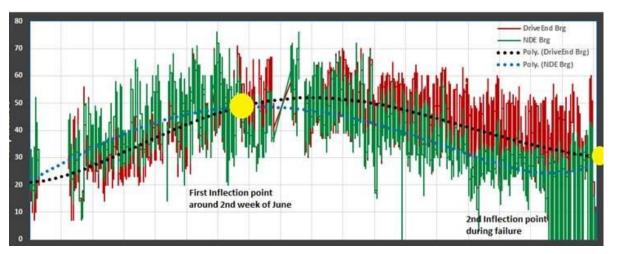
Step 2: Reliable Data via Automated Pattern Recognition

UpWind subject matter experts then identified each pattern

PATTERN 1 — NORMAL

PATTERN 2 — POOR LUBRICATION — Missing spikes

PATTERN 3 — NORMAL — Data gap

PATTERN 4 — SENSOR CALIBRATION — No spikes
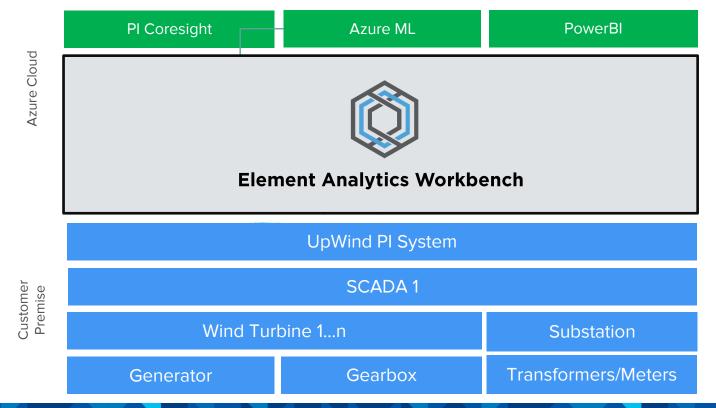
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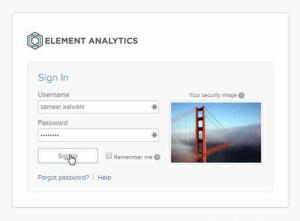
Repeated the process: Identified issues in the relationship between points

Identified sensor drift issues

Element Analytics' Workbench connects your PI System to modern data science tools

Azure Cloud

| PI Coresight | Azure ML | PowerBI |

Element Analytics Workbench

Customer Premise

UpWind PI System

SCADA 1

| Wind Turbine 1...n | Substation |

| Generator | Gearbox | Transformers/Meters |

UpWind Solutions: A Summary

1. Took existing data, and connected it to the Element Analytics Workbench
2. Applied algorithms to standardize, contextualize and trust the data
3. Used Machine Learning to identify patterns in the data that led to predictive models with precise confidence intervals
4. Tied predictive models to BI tools to prioritize decision-making
5. Provided data and tools to SMEs at UpWind for further analytic querying

GEO-SPATIAL CONTEXT

The Location of Things
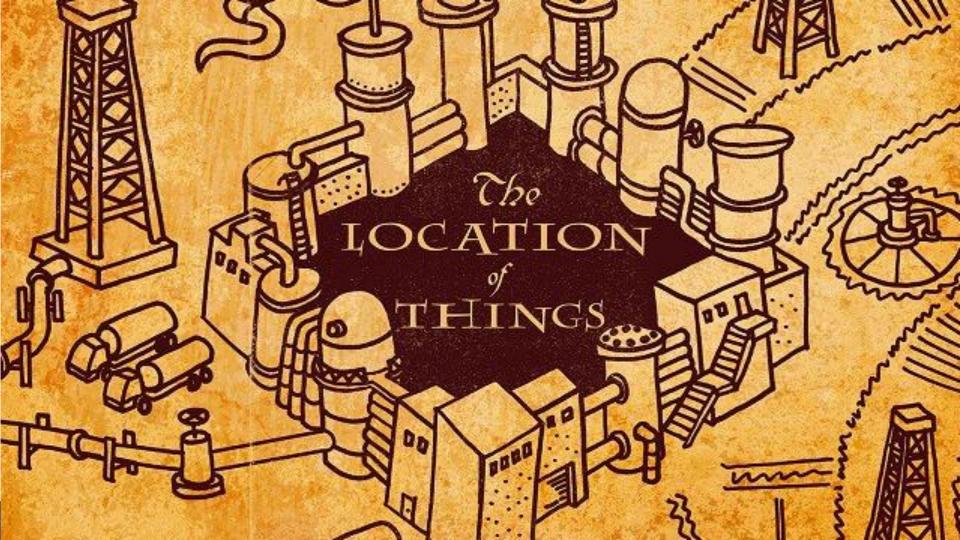
50,000,000,000

Connected devices by 2020*
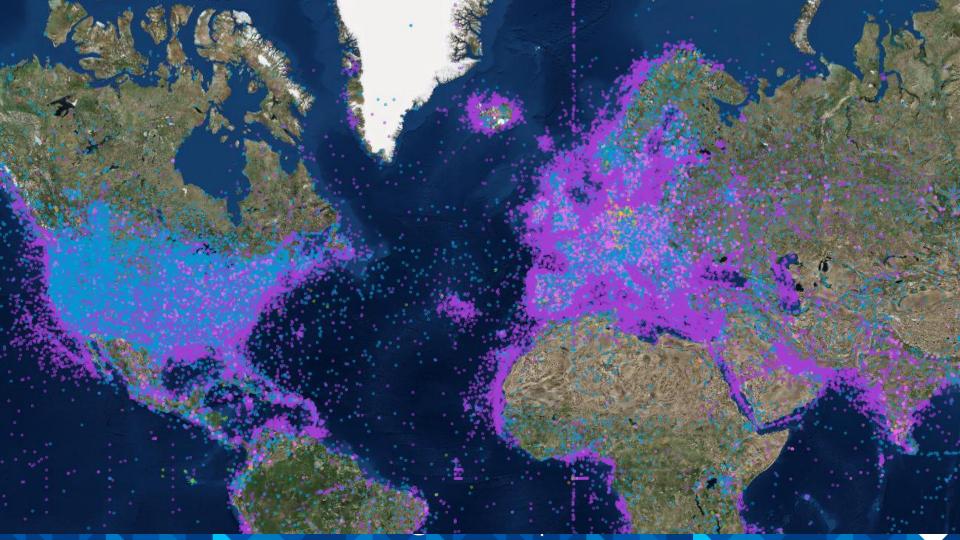
869

Devices per square mile of land mass, globally

Devices

- Smart Meters
- Thermostats
- Security systems
- Smartphones
- Appliances
- Trucks
- Trains
- Tracking dots

- Infrastructure
- Public transit
- Light bulbs
- TVs
- Printers
- Parking spots
- Apparel
- Packages

- Beds
- Personal fitness devices
- Watches
- Webcams
- Sports equipment
- Shipping containers
- Weather stations

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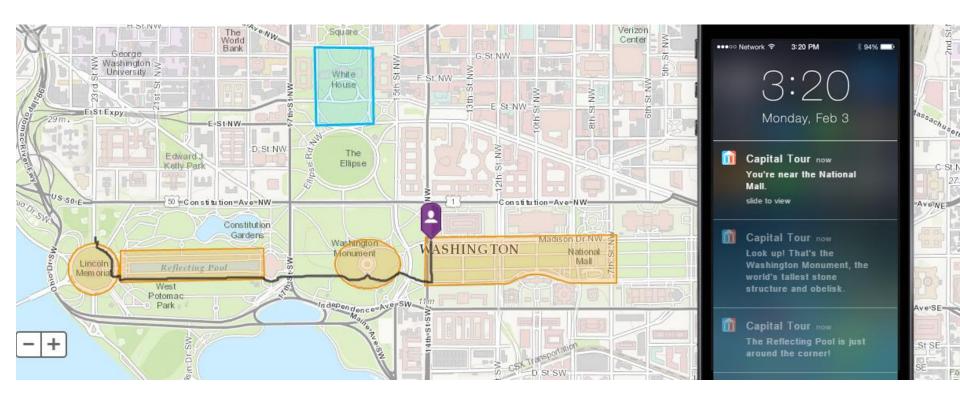
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Location as Interaction

Smartphones Can Now Detect Earthquakes and Give You Time To Run

A crowdsourced GPS network could send a crucial few seconds of notice in the many countries that don't have early warning systems set up.
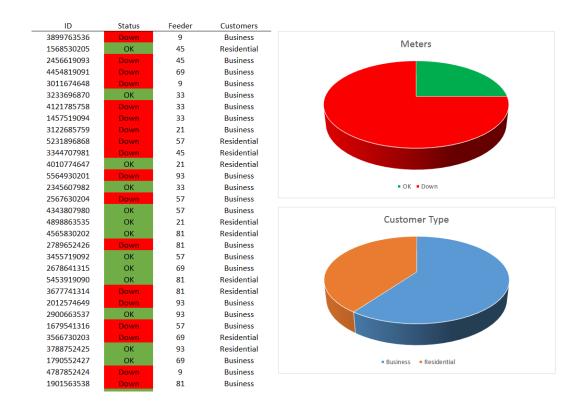
When a rare 5.9 earthquake struck Virginia a few years ago, some people in New York City heard about it on Twitter seconds before the actual rumbling reached them.

Now a group of researchers has proposed a better way to use smartphones to provide earthquake warnings, giving affected locations a crucial few seconds to get to positions of safety.

The Internet of Things with ArcGIS

The Internet of Things (IoT) offers cable providers exciting new revenue opportunities. But IoT also imposes unique network management challenges. Esri's location platform helps monitor and manage the IoT data and your networks. So you can monetize business opportunities. Esri's industry-leading technology integrates location intelligence into your critical business decisions – from capital prioritization to better customer satisfaction – so you gain a competitive advantage. Operational dashboards help you visual trends and gain new insights to compete for new customers and deliver superior customer experiences.

esri

Legend

◢ Work

◢ Home

◢ Car

◢ Drive Time (5min)

◢ Drive Time (10min)

The Internet of Things

Fort Pierce

Home Security

Current Status

Your Home is Currently **Alarmed**

Home Lighting

Current Status

The Lights in your home are Currently **Off**

Home Heating and Cooling

Current Status

The AC in your Home is Currently **Off**

Current Home Temperature: **84 Degrees**

*Hurricane Risk & Weather Outlook

ZOOM − +   ZOOM − +

Location as Organization

ID	Status	Feeder	Customers
3899763536	Down	9	Business
1568530205	OK	45	Residential
2456619093	Down	45	Business
4454819091	Down	69	Business
3011674648	Down	9	Business
3233696870	OK	33	Business
4121785758	Down	33	Business
1457519094	Down	33	Business
3122685759	Down	21	Business
5231896868	Down	57	Residential
3344707981	Down	45	Residential
4010774647	OK	21	Residential
5564930201	Down	93	Business
2345607982	OK	33	Business
2567630204	Down	57	Business
4343807980	OK	57	Business
4898863535	OK	21	Residential
4565830202	OK	81	Residential
2789652426	Down	81	Business
3455719092	OK	57	Business
2678641315	OK	69	Business
5453919090	OK	81	Residential
3677741314	Down	81	Residential
2012574649	Down	93	Business
2900663537	OK	93	Business
1679541316	Down	57	Business
3566730203	Down	69	Residential
3788752425	OK	93	Residential
1790552427	OK	69	Business
4787852424	Down	9	Business
1901563538	Down	81	Business

Meters

- OK ■ Down

Customer Type

- Business ■ Residential

"Everything is related to everything else, but near things are more related than distant things"

-Tobler's First Law of Geography

Meters

❌ **2303 Offline**

Transformers

❌ **450 Offline**

Substations

❌ **1 Offline**

Cell Sites

❌ **3 Offline**

Electric Distribution and Wireless Network

Place or Address

Critical Customers without Service

- Critical Customer at 1600 S. 3rd Street
  Service Location Type: **Detached single-unit housing**

- Critical Customer at 1600 S. 3rd Street
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- Critical Customer at 1700 S 23rd Street
  Service Location Type: **Other**

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Offline Service location Type

Service Location Type	Count
Detached single-unit housing	904
Other	25
Movable dwelling	15
Attached Multi-unit housing	14
Semi-detached dwellings	13
Commerical building	12
Attached Single-unit housing	7
Educational building	7
Government building	3

ZOOM

POWERED BY esri

Meters ↗

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0   200   400   600   800   1000   1200

ZOOM — +

Meters

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ZOOM

What can you do with IoT?

Condition-based maintenance   Production improvements

Situational awareness   **Employee safety**   Crew dispatch

Common operating picture   **Risk mitigation**

Lease management   Asset performance   Waste reduction

Workforce collaboration   Operation costs

Emergency response   Financial investments   Asset acquisition planning

Predictive measures   Proactive planning   **Regulation requirements**

New opportunities   Efficient supply chain

Storm response   Timely stakeholder communications

How can you leverage the IoT?

Putting it all together....

Closing Thoughts:
10 Relevant Lessons for Broader IoT (R)Evolution

1. Your PI system was and is built to be at the heart of your data collection and analysis for the IoT.

2. IoT roll-out will result in proliferation of cheap distributed sensing and orders of magnitude more data.

3. New Data needs to fit in to a model to forecast behavior. AF is built for this.

4. Reliability of predictions will only be as good as the reliability of data feeding in to them.

5. Cheap sensors are not going to be 100% reliable forever.

6. Data engineering can take significant time and resource, but is very important and shouldn't stop customers from moving forward with projects. Outsiders can help here.

7. Standardization will lead to repeatability – the more comparable assets are in your organization, the better your forecasts will be. Machine Learning is better with more, similar data.

8. Highly powerful tools that have been developed for clickstream analysis, fraud detection, cybersecurity and genome sequencing are now coming to Process Industries, and becoming more intuitive and economic every day.

9. IoT data will be more democratic than SCADA data. Can be shared with SMEs and across businesses if desired.

10. **Value of the IoT is not technology, but new value propositions and potential revenue streams that open up to customers.**

IoT - what are you doing, how can we help?

- Curious about your IoT story
  - Data sources and collection methods
    - Sensor, device, gateway, ...
  - Data path
    - Sensor to cloud to ... ; device to on-premise to ... ; ...
  - What are you doing with the data
- Email us: iot-m2m@osisoft.com
  - Time permitting discussions during the UC
    - Suggest date(s)/time(s)

Questions

Please wait for the **microphone** before asking your questions

State your
name & company

THANK YOU