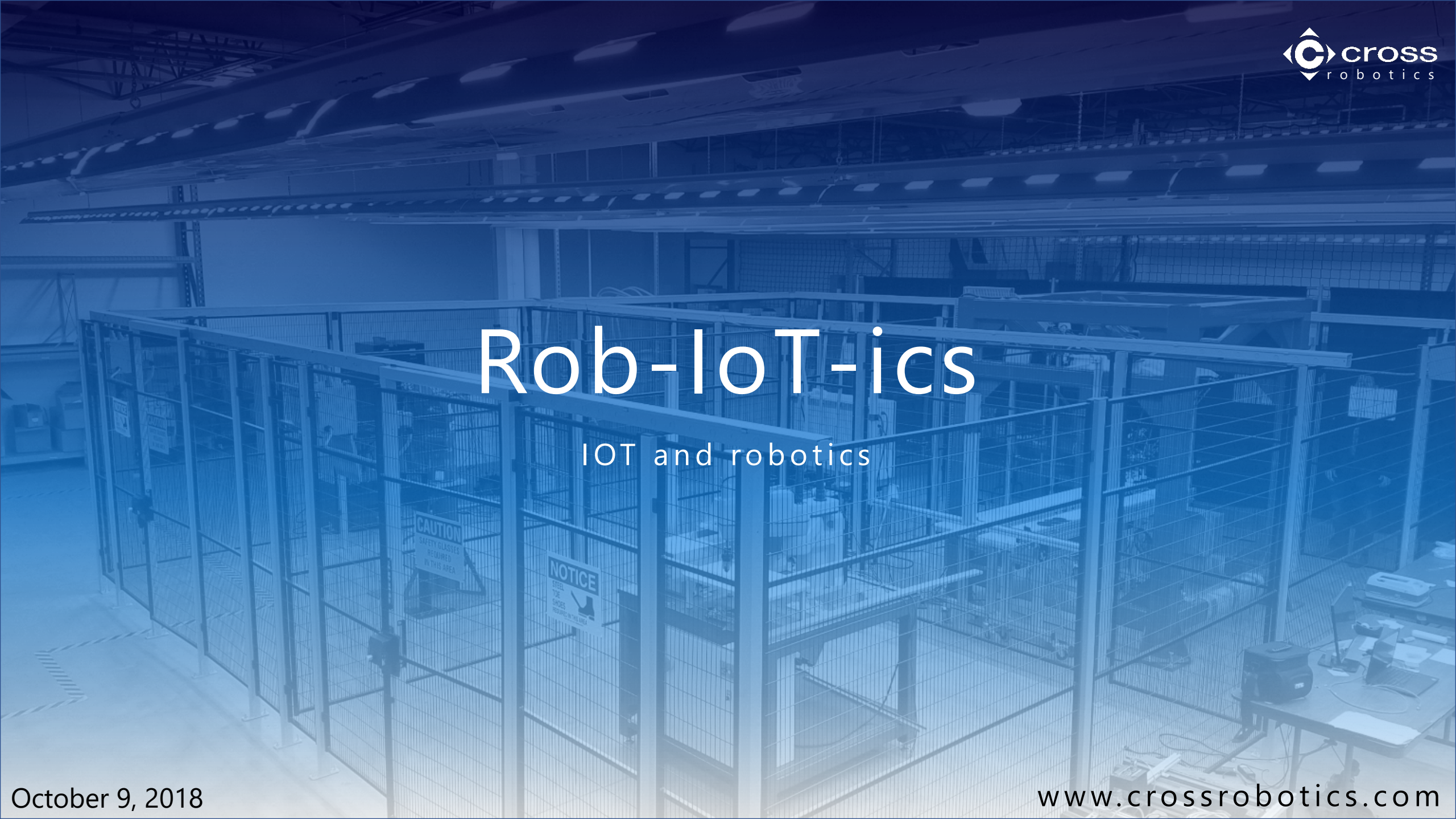


Rob-IoT-ics

IOT and robotics

October 9, 2018

www.crossrobotics.com

AGENDA

- What is the Internet of Things?
- Elements of IoT infrastructure
- How can IoT be applied to Robotics?
- Dipping your toes into IoT

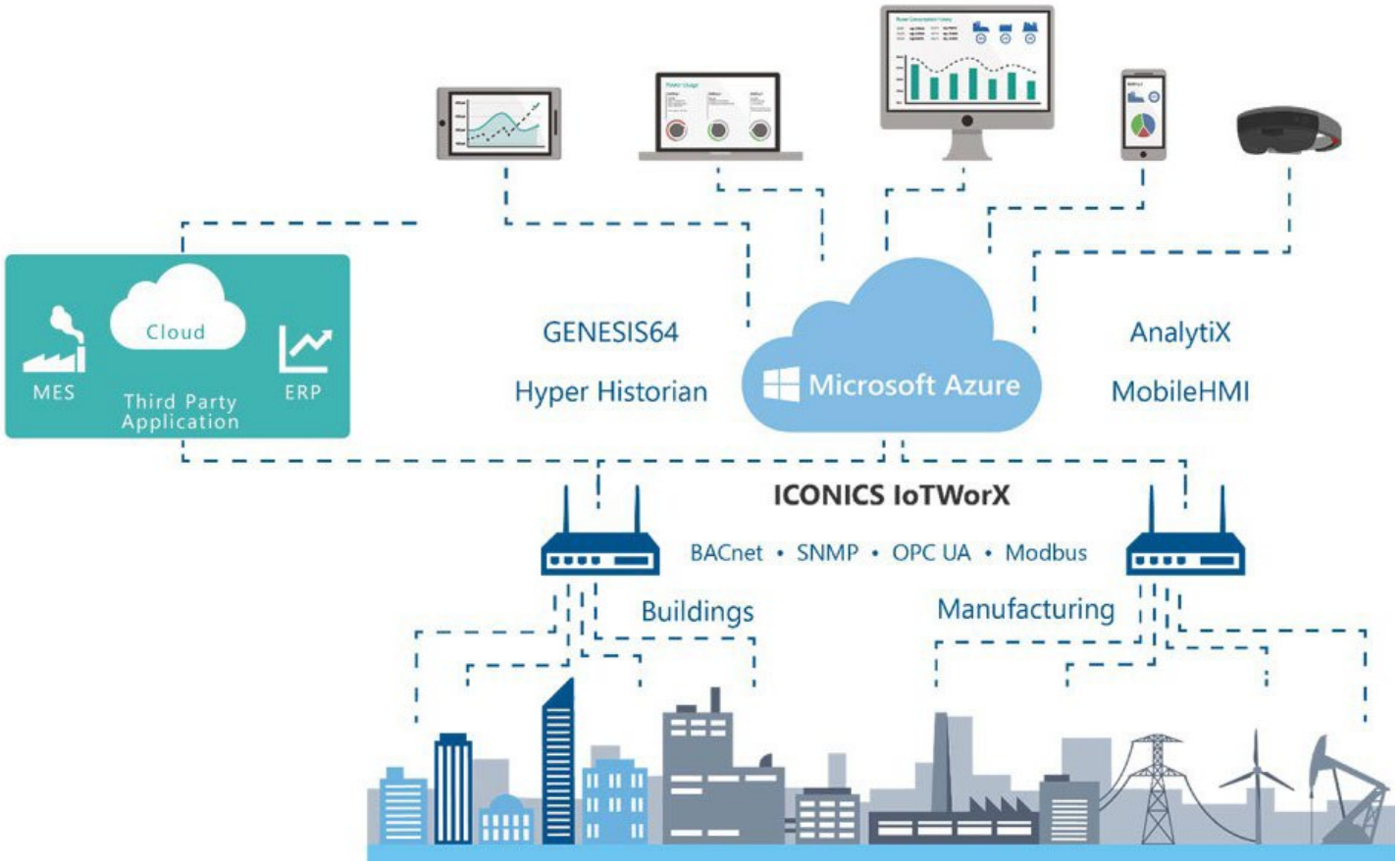
cross robotics

WHAT IS IoT?

A BRIEF PRIMER

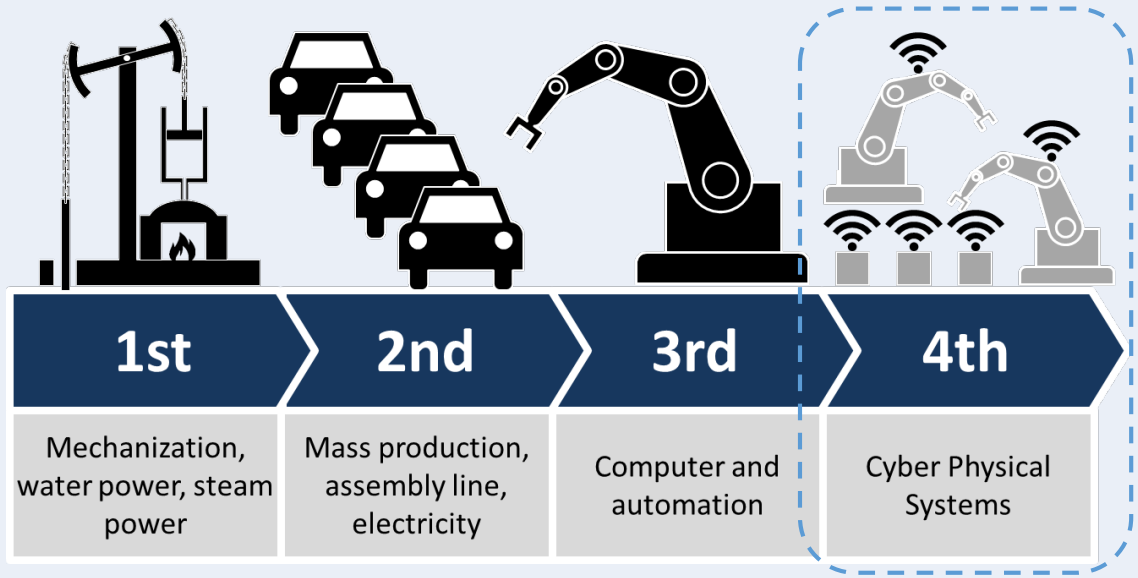
What is the Internet of Things?

- Collecting data
  - …that part isn't new or that difficult
  - SCADA systems have been around for years
- The hard parts:
  - Determining **where** and **how** to analyze the data based on available bandwidth, allowable latency, etc.
  - Getting information to the consumers of the information on any device



Terminology

IoT	Internet of Things	**IIoT**	Industrial Internet of Things
Industrie 4.0	German government's strategy "Smart Factory" 4 Design Principles of I4: • Interoperability • Information Transparency • Technical Assistance • Decentralized Decisions Intended to be a "revolution" in technology innovation		



cross robotics

Elements of IoT Infrastructure

The Cloud

- It's not a physical "thing"
- Network of remote servers connected and configured to operate as a single ecosystem (*Microsoft*)
- Information available to any device on the network
- Data storage/business analytics is less expensive with cloud solutions than internally hosted solutions
- Not about getting data into the cloud

Cloud Services

- Microsoft Azure
- Amazon Web Services
- IBM Cloud (formerly Bluemix/Softlayer)

LIVING ON THE EDGE

- The edge is the boundary between the local network and devices

- Serve as the connection between sensors/controllers/devices and the network

- A gateway is the boundary between the local network and the cloud

Types of Edge Devices

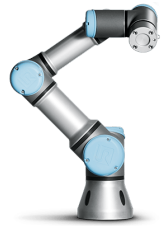
Thin	Intelligent	Actuated
• Bare minimum • Collect + communicate sensor info to gateway • Limited Programmability	• Sensing + communication • Also has simple Processing Capability • Reprogrammable • Major processing still happens on remote servers	• Intelligent device but also performs actions • **Static -** Simple Actions • **Dynamic -** Much more advanced operations

Temp Sensor

Accelerometer

Smart Electric Meter

Smart Thermostat (Static)



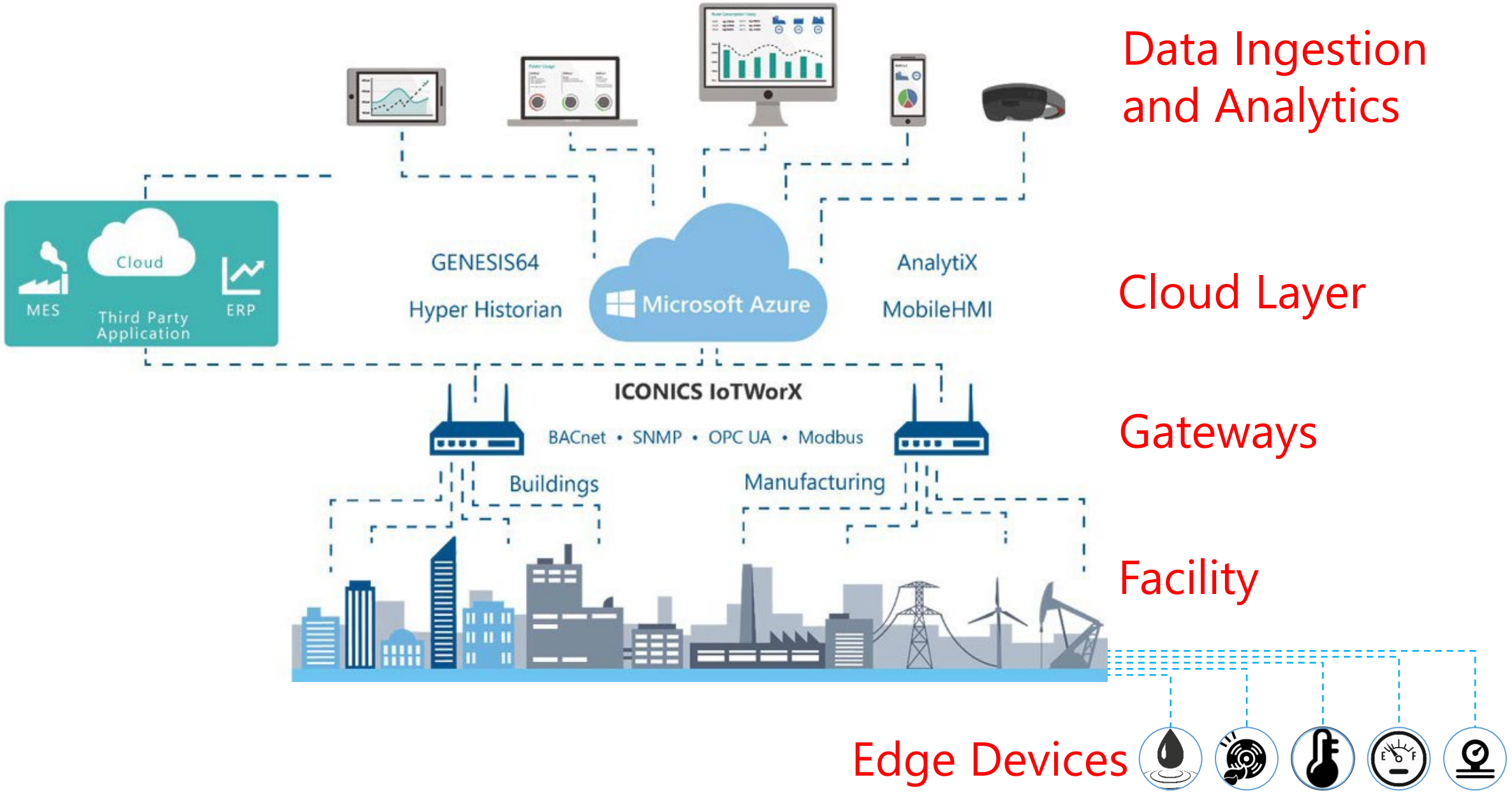
Robot (Dynamic)

Protocols

- "Basket of Remotes" problem
- Balance between capability, power draw, and bandwidth
- A few new protocols have been adopted by the automation industry

MQ Telemetry Transport (MQTT)	Advanced Messaging Queuing Protocol (AMQP)	JavaScript Object Notation (JSON)
• Works on top of TCP/IP protocol	• Works on top of TCP/IP protocol	• Often combined with HTTP
• Designed to be very lightweight	• More rich in features than MQTT	• Relatively lightweight and object-oriented
• Constrained Devices	• Fine-grained queuing control	• Flexible and can be used to implement higher level functionality
• Low-Bandwidth/Unreliable Networks		• Client/Server
• No Queuing Functionality		
• Low power draw, light on bandwidth		
• MQTT-SN – specifically for machine comms		

The options opened up by these protocols is why edge gateways are being promoted


Data Ingestion and Analytics
Cloud Layer
Gateways
Facility
Edge Devices
Cloud
MES
Third Party Application
ERP
GENESIS64
Hyper Historian
Microsoft Azure
AnalytiX
MobileHMI
ICONICS IoTWorX
BACnet • SNMP • OPC UA • Modbus
Buildings
Manufacturing

Two Main Uses in Manufacturing

- Production Optimization
  - Using device interconnectivity, data collection & analysis to collect process information
  - Increase throughput
  - Identify opportunities to tune processes

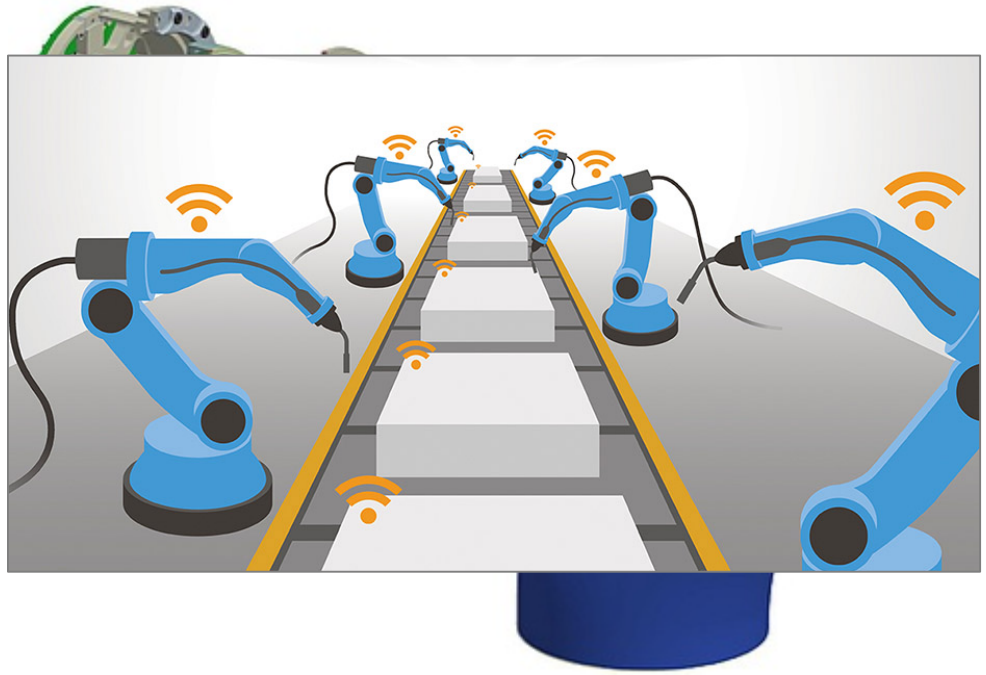
- Diagnostics/Preventative Maintenance
  - Collect robot sensor data and notify when readings trend out of normal
  - Convert required downtime from unplanned to planned

IoT and Robotics

A Brief Overview

Multi-Layered Systems

- A deployed robot is a system of smaller devices (servos, encoders, sensors, etc.)
- Manufacturing environments can contain a collection of robots, which form a higher-level system
- Most robots are capable of acting as gateway devices



~~Fake Smarts~~ Artificial Intelligence

- Machine Learning is an iterative process, needs datasets
- The gathering and pre-processing of huge amounts of process data is making ML more and more feasible

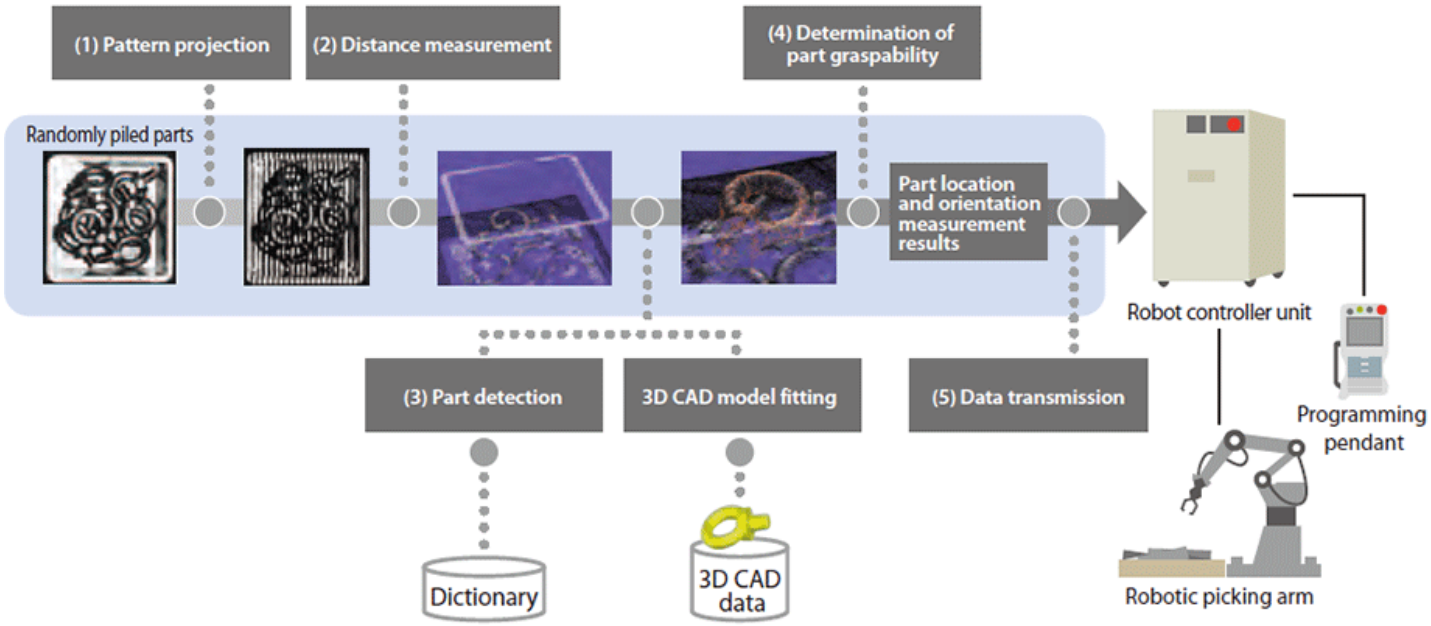
```
        }

        if (playerHealth > 20) {
            playerHealth = 20;  //caps player hp at 20
            hpDisplay.sprite = currentHP [0];

        } else if (playerHealth < 20 && playerHealth >= 19) {
            hpDisplay.sprite = currentHP [1];
        } else if (playerHealth < 19 && playerHealth >= 18) {
            hpDisplay.sprite = currentHP [2];
        } else if (playerHealth < 18 && playerHealth >= 17) {
            hpDisplay.sprite = currentHP [3];
        } else if (playerHealth < 17 && playerHealth >= 16) {
            hpDisplay.sprite = currentHP [4];
        } else if (playerHealth < 16 && playerHealth >= 15) {
            hpDisplay.sprite = currentHP [5];
        } else if (playerHealth < 15 && playerHealth >= 14) {
            hpDisplay.sprite = currentHP [6];
        } else if (playerHealth < 14 && playerHealth >= 13) {
            hpDisplay.sprite = currentHP [7];
        } else if (playerHealth < 13 && playerHealth >= 12) {
            hpDisplay.sprite = currentHP [8];
        } else if (playerHealth < 12 && playerHealth >= 11) {
            hpDisplay.sprite = currentHP [9];
        } else if (playerHealth < 11 && playerHealth >= 10) {
            hpDisplay.sprite = currentHP [10];
        } else if (playerHealth < 10 && playerHealth >= 9) {
            hpDisplay.sprite = currentHP [11];
        } else if (playerHealth < 9 && playerHealth >= 8) {
            hpDisplay.sprite = currentHP [12];
        } else if (playerHealth < 8 && playerHealth >= 7) {
            hpDisplay.sprite = currentHP [13];
        } else if (playerHealth < 7 && playerHealth >= 6) {
            hpDisplay.sprite = currentHP [14];
        } else if (playerHealth < 6 && playerHealth >= 5) {
            hpDisplay.sprite = currentHP [15];
        } else if (playerHealth < 5 && playerHealth >= 4) {
            hpDisplay.sprite = currentHP [16];
        } else if (playerHealth < 4 && playerHealth >= 3) {
            hpDisplay.sprite = currentHP [17];
        } else if (playerHealth < 3 && playerHealth >= 2) {
```

Networked Robotics

Allows higher-level tasks and optimization to be done by linking robots to outside analytics



- Google Self-Driving Cars
  - Pull information from the cloud (maps, images)
- Columbia Grasp Dataset (research)
  - Large dataset of precomputed grasps on 3D Models
- Canon Bin Picking Camera Dictionary
  - Stores point cloud and CAD data on external PC
  - Drastically reduces cycle time on complex parts

cross robotics

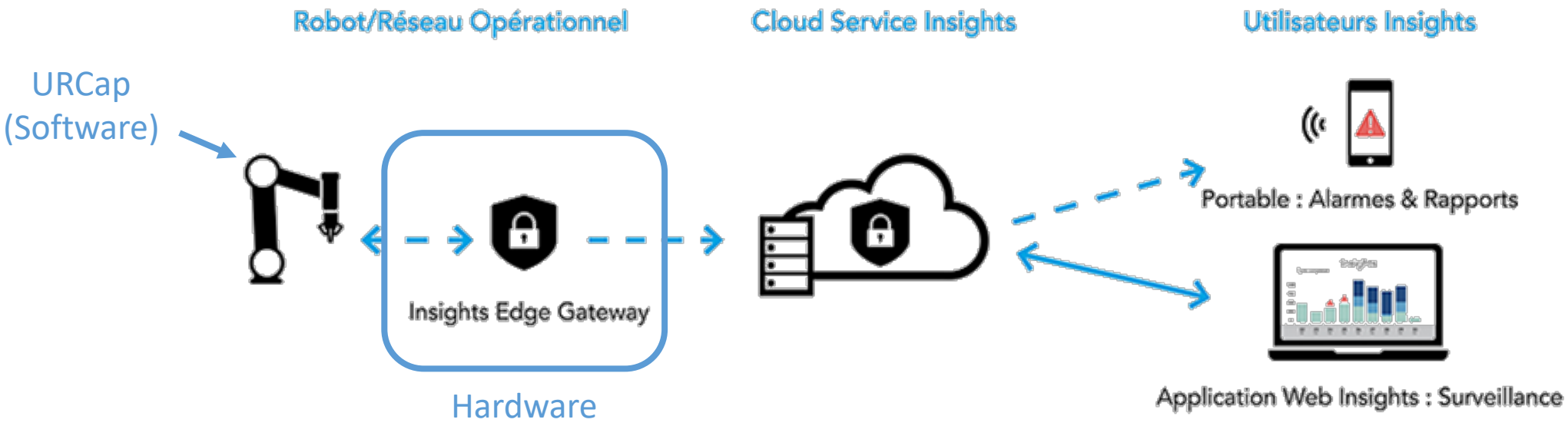
Some Options

Products to dip your toes into IoT

Robotiq Insights for UR

CLOUD-BASED MONITORING

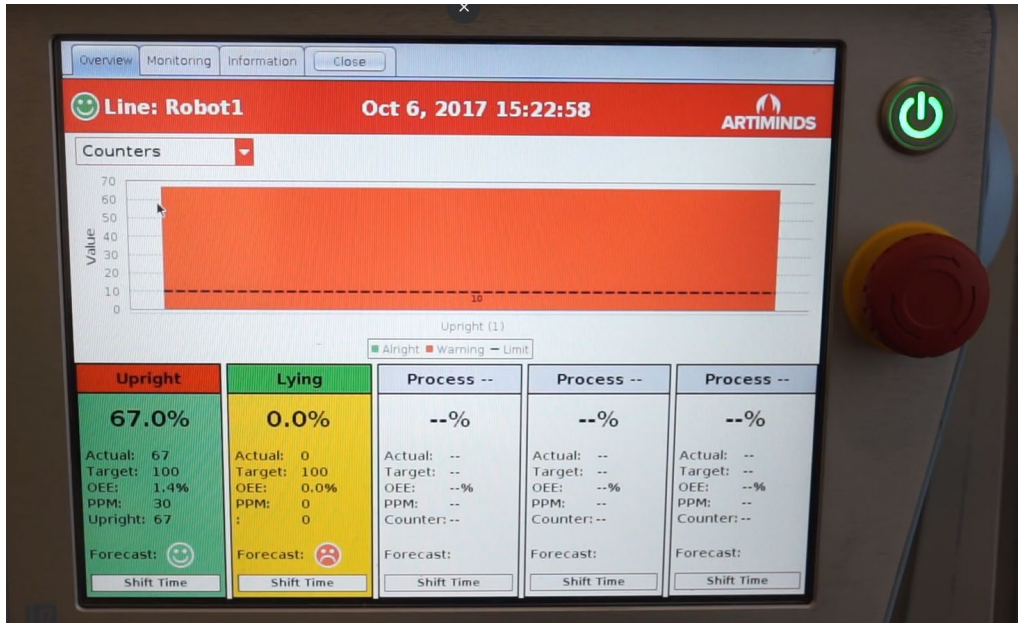
- Performance timeline and KPI reporting
- Hardware + Software solution at the robot level
- Free and Advanced versions
- Production monitoring
- SMS Alerts



Artiminds +Monitoring

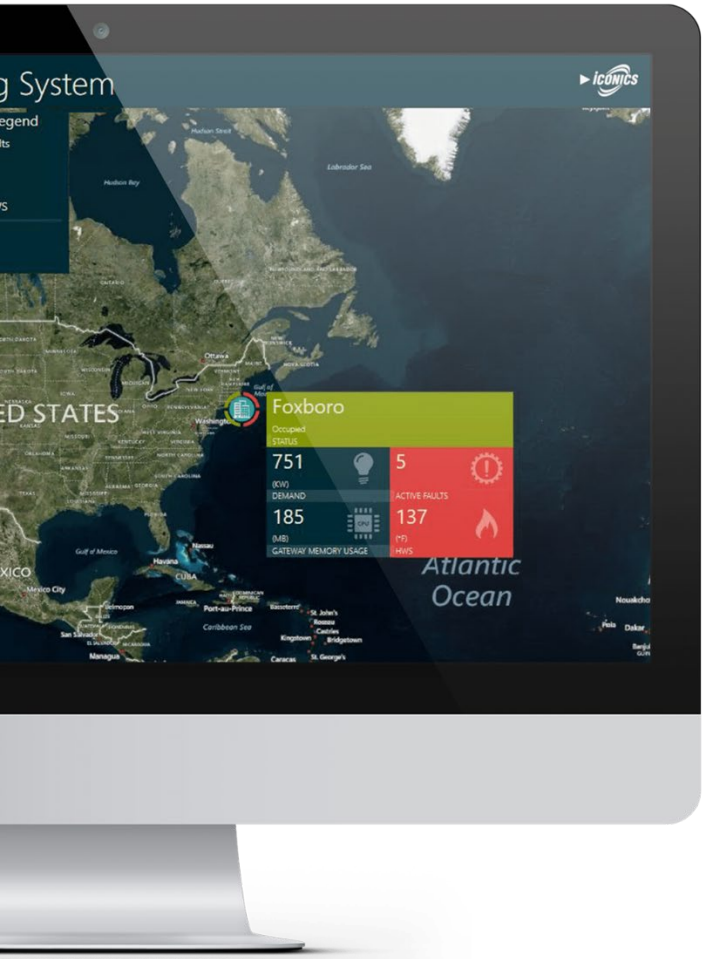
MONITORING ON LOCAL SERVERS

- Subprocess monitoring
- Turn your UR teach pendant into a HUD
- No cloud infrastructure required
- Network output via standard interfaces



ICONICS IoTWorX

SOFTWARE SOLUTION FOR ANY EDGE DEVICE



- Onboard analytics for Edge Devices
  - Minimizes latency
  - Cloud Communications
  - Real-time visualization
- Works with third-party gateways
- Can integrate with Microsoft Azure Machine Learning platform
- Remote Monitoring and Control

THANK YOU

WWW.CROSSROBOTICS.COM

MANAN BANERJEE

(704) 723-2036

manan.banerjee@crossco.com