Overview

• A Tale of Two Turbines
• Why IoT?
• IoT Roadblocks
• How do we get there?
• Connecting the physical & digital worlds
A Tale of Two Turbines

- 20 years ago wind turbines were controlled at the site manually
- Before duck curve was a problem
- Today need to curtail production before price drops to negative
- Inefficient & prone to failure
California’s Green Grid

• Up to 19% of California's energy from renewable sources
  – Solar, hydroelectric, wind
• There are some drawbacks
  – Not always available or needed
• Grid requires a constant transmission at 60 Hz
  – Careful management required
  – Avoid blackouts and brownouts
Demand Fluctuates

- Too much electricity on the grid during the day
- As People return home from work they turn on appliances, TVs & AC
- Sun goes down, natural gas power plants spin up
Imagine this scenario

- 3:00 a.m. remote wind farm in California
- Cold desert hills with turbines installed 20 years ago
- The “dark ages” - No WWW, WiFi, cloud or big data
- Turbines have no intelligence
- Designed to be controlled from the PHYSICAL WORLD (Green ON, Red OFF buttons)
But these turbines are different

- Sensor gateway connects turbines’ physical control system to Internet
- Digital world can peer into physical world
- Check website for spot price, start or stop?
- Automatic/ Autonomous
Intelligent Turbines

- Built-in logic and intelligence
- Input from real world: wind speed, time of day
- Sets outputs, changes turbine blade pitch
- Maximizes profit automatically
- Reports data to the cloud for predictive maintenance
- Schedules its own service calls & replacement part orders
The REAL Internet of Things

- Things autonomously monitoring digital world
- Determining when to take action in the real world
- Based on big data they generate
- Analyzed in the cloud they’re now connected to
Why IoT?

- Data is an asset to the enterprise
- Acquisition/Analysis of data in real time
- Better business decisions
  - Lower Costs
  - Increased Profits
- Rapid acceleration of insight into business processes
The Big Opportunity

- Bridge physical & digital worlds
- Billions of physical “things” already installed
- Not connected...yet
- Sensors, relays, circuits and transmitters
- Cloud-enable unconnected “things”
IoT Needs Data

- IoT consumes data
- No connectivity
- How do we connect?
- Two very different groups must work together
- Bridge the OT / IT Gap
- Different cultures
- Different objectives
- Different Technology
Operational Technology (OT)

- The Physical World
- Voltage and current
- Wires connected to drives and motors
- Relays, sensors and circuits
- Automation & controls engineers
- Electricians, facility managers
- Application-specific proprietary technology
- Harsh environment
Information Technology (IT)

• The Digital World
• Technology improves/adopted faster
• All users have PCs and mobile device with Ethernet or WiFi
• Based on open standards
• Designed for intercommunication of systems - moving data
• Web servers, databases, PC’s, Mobile devices
OT / IT Gap

**IT Digital World**
- Latest technology
- Frequent technology changes
- Open technology
- JavaScript, MQTT, Node.js
- Low cost PIs, PCs
- Electrical theory
- Bits and bytes
- TCP/IP, HTTP/S, REST

**OT Physical World**
- Old HW & SW, reliable
- Risk averse
- Application-specific technology
- Ladder logic, function block
- Long-life high-cost hardware
- Voltage and current
- Serial, Ethernet/IP, Modbus, BACnet
OT / IT Convergence

• Solution to bridge the gap:
  – Physical world language of voltage & current
  – IA world of application-specific protocols, Ethernet/IP, BACnet, Modbus
  – IoT protocols and languages, REST, JavaScript
Convergence

- Good business decisions are based on good data
- Real time information compared to historical information
- Is equipment about to fail?
- Is production line about to stop?
- Will shipments be made?
- Will the business get paid?
The Big Data (Problem)

- “Things” generate exabytes of data from the physical world
- Problem: garbage & erroneous data, insufficient infrastructure
- Solution: Analyze & Process data at the edge
SCADA...What?

- Mission critical & life threatening applications
- Supervisory Control And Data Acquisition required
- Still need local supervisory control - what if the internet crashes?
- “Things” shouldn’t ask the IoT if they should put out a fire.
- Run control program & keep operations running until internet is restored
- Local data buffering
Why not use a PI?

• The edge is a vicious and frightening place
• Extremely hot or cold, rugged environment
• High voltage, not GPIO
• I/O Channel isolation, EMI Resistance
Solving the Problem

• Industrially hardened interface
  – Bridges the gap
  – Translates into languages of IoT
• Industrial spec
• Physical I/O
• IoT Communication & programming capabilities
• Node.JS, JavaScript, HTTP, RESTful APIs