Artificial Lift Applications of the Internet of Things

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IoT as Defined by IT Professionals

From Wikipedia

- Internetworking of physical devices, buildings, vehicles and other items
- Embedded with electronics, sensors, actuators
- Network connectivity to collect and exchange data
- Allows object to be controlled remotely across existing network infrastructure
IoT as Defined by IT Professionals

Examples From Wikipedia

• Automobiles with built-in sensors
• Medical and Healthcare monitoring equipment
• Building and Home Automation
• Trending towards “autonomous control”, not just remote control
  – Provides better value than just reporting data
  – Uses intelligence, or rules-based decision making
Wellsite Automation and IoT

When will Apps make it to the oilfield?

Irrigation Caddy: Web Based Sprinkler Control System

Introduction
The Irrigation Caddy (IC) device is an Ethernet based irrigation control system. The system allows the user to control and schedule an irrigation system from any computer with a web browser. No special software or clients are required, just a Web Browser on a computer.

Web Enabled
The IrrigationCaddy is controlled from a web browser, whether the browser is in a computer, an iPhone, iPad, or any other web enabled device.

Burglar Alarm

Home Automation

Be there. Even when you’re not.

The EyezOn EVL-3EZ Internet Control Module

MAKE IT WEMO
YOUR HOME AT YOUR FINGERTIPS
WeMo is a family of simple and customizable products that allow you to control home electronics from anywhere.
Wellsite Automation and IoT

Who is the primary beneficiary of these applications?

- Better security and safety
- The Lease Operator

THE LEASE OPERATOR

- No more gate unlocking
- Better security and safety
IoT Reality to E&P Industry

By turning everyday production equipment into a “Smart Device”, the Lease Operator:

• Can remotely “check-in” on equipment
  – Just to monitor indicators of interest (webpage or APP)
  – When informed of an alarm via conventional Scada system
• Can change setpoints, control equipment operation
  – Using actionable webpage or APP
• Can reset alarms remotely, or remotely ESD well
  – Providing passwords are known, with record keeping
IoT Reality to E&P Industry

What about the production engineer?

• **IoT Devices communicate using Modbus TCP**
  – Conventional Scada programs pull data, or push data out
  – No different than communicating with RPC’s, EFM’s, etc

• **Offers the engineer ability to incorporate engineering calculations at the wellsite**
  – Create KPI’s for equipment using engineering principles
  – Create alarms or shutdowns based on calculated indicators
  – Control decisions can be made based on external data
    • Ex: Chemical pump rate adjusted based on well test data
What about the field supervisors and management?

- **IoT** takes operating by exception to a new level
- **Eliminates repetitive and mundane tasks through automation**
  - Low priority tasks get done that may other-wise be skipped
  - Personnel become trouble-shooters, and find new applications
  - Millennials thrive with this technology
- **Personnel assisted in troubleshooting by smart device**
  - Based upon “rules based decision making” from operator knowledge, likely problem causes are identified in advance
What about the perceived computer security issues?

• Don’t listen to the IT industry about needing a massive cloud-based system (Not proven!)

• Operators simply maintain private internet networks behind firewalls, never contacting the “cloud”

• Operators already have their own “cloud” full of data collected from existing Scada equipment
  – Keep data private
  – Share internal “cloud”, never outside internal network

• Restrict wellsite IoT devices to internal network
IoT Wellsite Examples

The below actual examples are a small fraction of the myriad of IoT possibilities:

• Pump Stroke Optimization Device
  – As described in SPE 181228, and at ALRDC SRP Workshops

• Compressor Panel IoT Device
  – Used to pull temperature and pressure data to improve conventional gas-lift compressor operation

• Electric Driven Gas-lift Compressor
  – Complete control via IoT enabled PLC (SPE 181773)

• VFD Cabinet Cooling Fan Control Device
  – Example of controlling even simple support devices
Pump Stroke Optimization Device

Improves operation of RPC’s for Horizontals

• Intercepts speed signal, providing alternate signal that increases pump fillage while decreasing pump slippage

• Monitored via webpage, hosting up to 8

• Scada picks up key data using Modbus TCP
Pump Stroke Optimization Device

Example of Webpage

• Gray buttons are actionable, giving history
• Blue fields show data for past 150 days
• Algorithm selection, PID gain, and setpoints also selectable providing passcode supplied
• Realtime motor frequency shown on bottom sliders
• No special software

Encln PSO Ver 5.10
Time: 20:42 MSE Ct=1
Max/Min Spd 59/11 HZ
Avg 6 Hr HZ: 25.8 HZ

MSE History MSE SetPt Upstroke Hz Downstrk Hz
Average Hz Accept Next 3 Days Prev 3 Days
Relearn Gain HZ/10 Alg T Value Future

Last 6 Hours 0 Hours 37 - 42 0
Hours 7 - 12 0 Hours 43 - 48 0
Hours 13 - 18 0 Hours 49 - 54 0
Hours 19 - 24 0 Hours 55 - 60 0
Hours 25 - 30 0 Hours 61 - 66 0
Hours 31 - 36 0 Hours 67 - 72 0
Setpt / Value 0 PassCode 0

Current Hz 51
PSO Up&Dn 52
[0.70]
Compressor Panel IoT Device

Communicates with older yet reliable hardware using Modbus RTU via RS-485 (Murphy Centurion for example)

- Retrieves realtime temperature and pressure data
- Compares cooler outlet temperatures to webpage based setpoints
- Controls air motors that position cooler louvers to maintain elevated gas discharge temperatures
  - Preventing any hydrocarbon condensation in cooler tubes
  - Maintaining 150 degree temp at compressor discharge
  - Eliminates methanol injection, improves compressor runtime
  - Helps mitigate paraffin
Compressor Panel IoT Device
Compressor Panel IoT Device

Controlled via webpage, hosting up to 8 at a time

- Shows cooler outlet temps and setpoints
- Shows air motor pressures and setpoints
- Calc / compares theoretical discharge temps versus actual
- Actionable gray buttons can change setpoints, calibrate sensors and air motors (using a passcode for security)
Electric Driven Gas-Lift Compressor
Electric Driven Gas-Lift Compressor

Two stage electric driven design utilizes IoT enabled PLC

- Traditional compressor control panel eliminated
- PLC had enough I/O to handle in base form
- Webpage used to display operating data, change setpoints, and reset shutdowns (using Passcode)
- Versatile PLC easily communicates with operators Scada system via Modbus TCP
- Floating point math allows calculation of many diagnostic indicators based on engineering principles
- Other diagnostics based on rules-based decision making simplify trouble-shooting
Control Panel Simplicity

• On-Off switch with integral green run light

• Reset switch with integral red shutdown light

• Buzzer to announce startup, but will also announce shutdowns if webpage not accessible

• Auto restarts on ESD or low suction pressure without blowing down
Supplied thermostat caused severe cycling

- Installed IoT enabled PLC and thermistor
- PLC turns fan on at 120F, and off at 104
- Temp setpoints can be set on webpage
- Cycling no longer an issue (PLC counts)
VFD Cabinet Cooling Fan Control Device
VFD Cabinet Cooling Fan Control Device

VFD Cabinet maker had installed two fans, four times more ventilation than VFD manufacturer needed

• Some safety factor okay, but is this common???

• One fan disconnected and blocked off for future utility

• Thermostat had about a 3 degree deadband, causing severe cycling. PLC uses 16 degree deadband

• PLC alarms on excessive cabinet temperature

• PLC measures total fan runtime and number of starts
  – Collected by operators Scada system for trending analysis
  – Predicts air filter replacement
IoT Enabled PLC Selection

There are hundreds of hardware offerings, each with differing I/O, software support, communication abilities, and computing power. Where do we start?

- Remote oilfield environments dictate the need for a PLC that is reliable, and will communicate with existing Scada systems
  - Suggest sourcing a PLC that is IoT enabled
  - Do not advise trying new IoT hardware to do the job of a PLC
- Ability for higher math functions is required to perform engineering calculations and create diagnostic indicators
IoT Enabled PLC Selection

For these projects, a PLC brand that comprised not only normal ladder logic, but also Basic programming for control and math subroutines was chosen (8.2”L x 4.5”W)
IoT Enabled PLC Selection

For the simpler VFD cabinet fan project, their smallest product that had limited IO, but still hosted webpages and Basic programming was chosen (3.34”L x 2.84”W)
Conclusions

The purpose of this presentation was to educate operators on how the Internet of Things can be utilized to improve their operations

• The four examples scratch the surface of possible applications.

• IoT applications in these four examples did not involve communicating with the “Cloud”, only with the operators existing Scada system

• Advanced math capabilities and program complexity allows for engineering calculations that improve equipment operations, as well as create KPI’s and other valuable diagnostic indicators
Comments

• Webpages instead of local control panels or even HMI’s were accepted by the younger field workforce

• Having a degree of field experience, computer programming experience, and ladder logic experience may be an engineering career enhancing skill given IoT

• Internet connectivity at the wellsite level is becoming increasingly common among operators
  - As IoT applications prove their value, not having internet at the wellsite could be rare by 2020, except for stripper wells

• Operators, engineers, and field supervisors should all be able to do their jobs better with IoT enabled devices
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