



Utilizing the PI system as an Industrial Internet of Things (IIoT) platform for Laboratory Monitoring

The Lilly logo, featuring the word 'Lilly' in a red, cursive script font, centered within a white rectangular box.



- Founded in 1876 by Colonel Eli Lilly
- Global Headquarters located in Indianapolis, Indiana
- Pharmaceutical Company
- Introduced first commercially available Insulin product in 1923

Lilly

Lilly BioProcess R&D Facility

- Located in Indianapolis, Indiana
- 550,000 square feet facility dedicated to biologic pharmaceutical process development
- Small scale development to large scale clinical trial manufacturing onsite; setup to mimic a production facility



Utilizing the PI System as an Industrial Internet of Things Platform

Dead Batteries

- Utilizing the Connector for HART-IP to monitor battery life

Laboratory Monitoring

- Cost effective laboratory monitoring solution without a DCS or PLC
- Freezers, Refrigerators, Incubators

Utilizing the PI System as an Industrial Internet of Things Platform

- Effort started in 2014 and completed in 2018 to change from wired micro-PLC based system to a fully wireless Rosemount monitoring system
- Issue started to arise as wireless transmitters would either stop updating or disappear from network

Utilizing the PI System as an Industrial Internet of Things Platform

- Why were Wireless Transmitters disappearing or not updating?
 - Dead Batteries
- What does that mean?
 - No Laboratory Temperature monitoring = discarded samples = Opportunity Cost

Wireless Device Battery Health



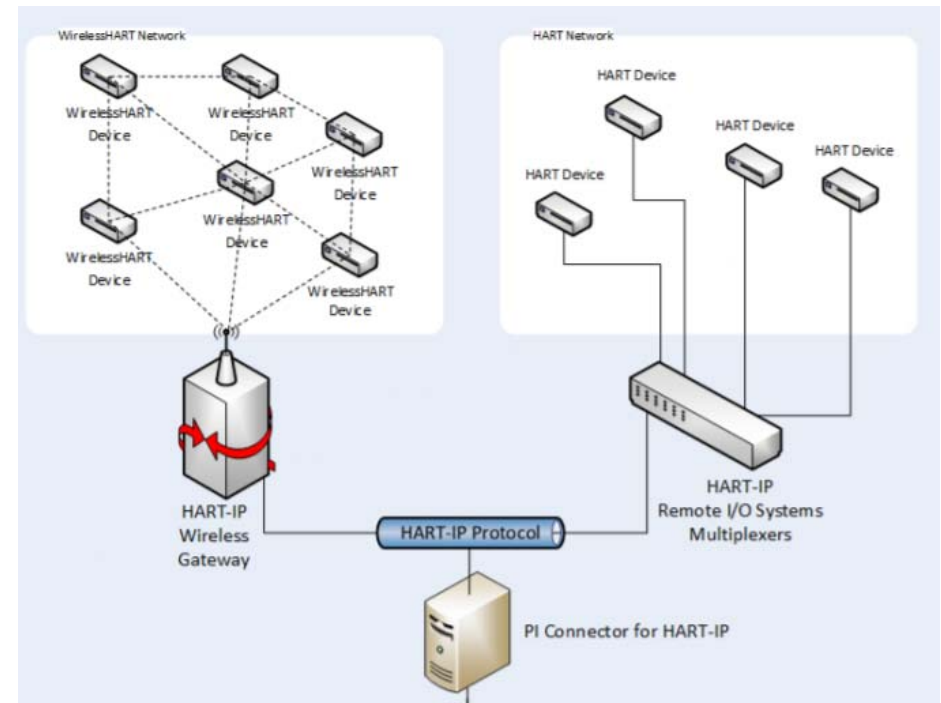
848T(pictured) does not have the battery life as one of HART variables that can be captured by DeltaV

Must be manually monitored by another Emerson program

Over 180 devices in the field

PI Connector for HARTIP

- Connector allows for capture of the battery data from the Rosemount Gateway
- Battery Life sent to the PI System

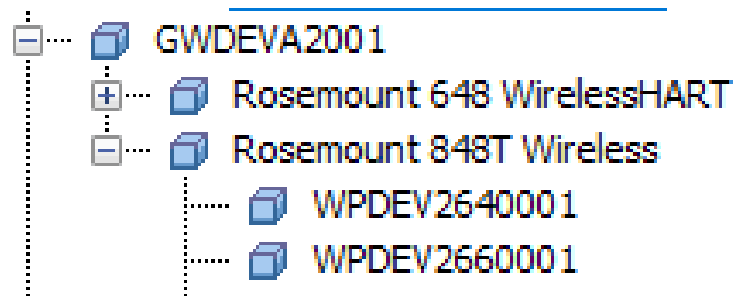


Wireless Device Battery Health- Asset Framework

Automatic
creation based
on gateway
and device
names



Battery Life in Asset Framework



 Battery Life	2049 d
 Battery Life Status	Good, Not Limited
 Cold Start	False

Analysis

Event Frames and Notifications

Battery has less than 30 days of life

The screenshot shows the 'Event Frame Template' configuration for 'Battery Life'. It includes a table with triggers and expressions:

Name	Expression
Start triggers	
BatteryLife	'Battery Life' < 30
End trigger	
EndTrigger	'Battery Life' > 40

Text or Email to change the battery

The screenshot shows the 'Notification Rule - Message - Battery Life' configuration. It includes a table with notification details:

Name	Is Default
Battery Life	Inherited
Global Default Email	

Notification

The screenshot shows the 'Notification' message preview for '362 CS Mode Low Battery'. It includes fields for Subject, Attachments, Device, Battery Life, Start Time, and End Time:

Subject: 362 CS Mode Low Battery

Attachments: +

Device: Long Tag:Value At Send Time

Battery Life: Battery Life:Value At Send Time

Start Time: Event Frame:Start Time

End Time: Event Frame:End Time

No Human Intervention Required

PI Vision – Battery Life

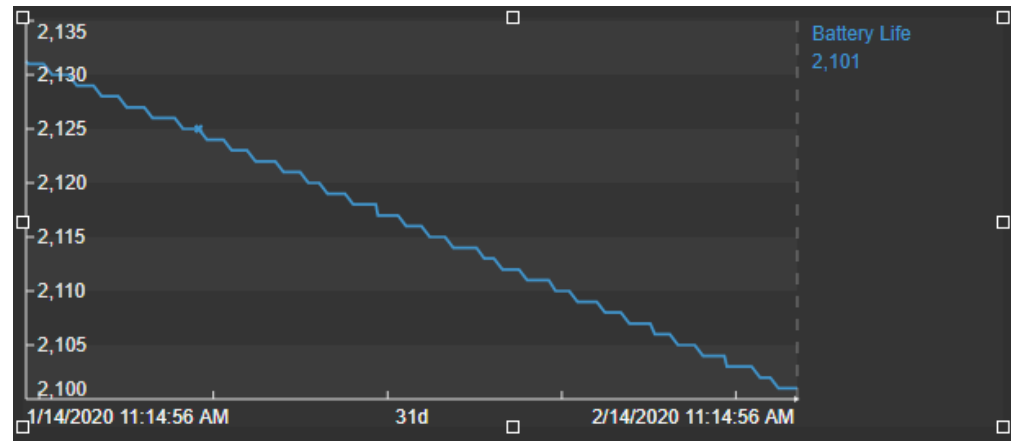
K362 Battery Life Overview Asset: WPDEV1640001+ ▼

Name	Value ▲	Description	Name	Value ▲	Description	Name	Value ▲	Description	Name	Value ▲	Description
WPDEV1740001 Battery Life	127	days	WPDEV2442001 Battery Life	83	days	WPDEV3040001 Battery Life	13	days	WPDEV4350001 Battery Life	128	days
WPDEV1320001 Battery Life	133	days	WPDEV2094006 Battery Life	124	days	AT-419A Battery Life	123	days	WPDEV4820001 Battery Life	130	days
WPDEV1350001 Battery Life	705	days	WPDEV2110001 Battery Life	124	days	WPDEV3442001 Battery Life	125	days	WPDEV4850002 Battery Life	131	days
WPDEV1110001 Battery Life	909	days	WPDEV2081001 Battery Life	125	days	WPDEV3110001 Battery Life	129	days	WPDEV4850003 Battery Life	131	days
WPDEV1320003 Battery Life	947	days	WPDEV4350001 Battery Life	126	days	WPDEV3820001 Battery Life	130	days	AT-4320A-1 Battery Life	133	days
WPDEV1320002 Battery Life	1,112	days	TT-503A Battery Life	128	days	WPDEV3442003 Battery Life	131	days	WPDEV4850004 Battery Life	192	days
WPDEV1330001 Battery Life	1,327	days	TT-505A Battery Life	128	days	WPDEV3540001 Battery Life	131	days	WPDEV4330001 Battery Life	309	days
WPDEV1130001 Battery Life	1,438	days	TT-504A Battery Life	129	days	WPDEV3830001 Battery Life	132	days	WPDEV4830001 Battery Life	468	days
WPDEV1330002 Battery Life	1,533	days	TT-508A Battery Life	129	days	WPDEV3420001 Battery Life	133	days	WPDEV4850001 Battery Life	489	days
WPDEV1350002 Battery Life	1,654	days	WPDEV2320001 Battery Life	132	days	WPDEV3830001 Battery Life	133	days	WPDEV4338001 Battery Life	515	days
WPDEV1640001 Battery Life	1,727	days	TT-502A Battery Life	133	days	WPDEV3830002 Battery Life	133	days	WPDEV4080001 Battery Life	813	days
WPDEV1840003 Battery Life	1,878	days	WPDEV2840001 Battery Life	1,000	days	WPDEV3830008 Battery Life	133	days	WPDEV4320002 Battery Life	844	days
WPDEV1840002 Battery Life	1,991	days	WPDEV2342001 Battery Life	1,058	days	WPDEV3442002 Battery Life	134	days	WPDEV4740001 Battery Life	782	days
WPDEV1740002 Battery Life	1,999	days	WPDEV2110002 Battery Life	1,127	days	WPDEV3423001 Battery Life	138	days	WPDEV4730001 Battery Life	1,117	days
WPDEV1720002 Battery Life	2,009	days	WPDEV2130001 Battery Life	1,283	days	WPDEV3830005 Battery Life	138	days	WPDEV4430001 Battery Life	1,176	days
WPDEV1042003 Battery Life	2,011	days	WPDEV2338001 Battery Life	1,298	days	WPDEV3850001 Battery Life	310	days	WPDEV4830002 Battery Life	1,219	days
WPDEV1350003 Battery Life	2,017	days	WPDEV2130005 Battery Life	1,305	days	WPDEV3830004 Battery Life	806	days	WPDEV4430002 Battery Life	1,220	days
WPDEV1042002 Battery Life	2,018	days	WPDEV2660001 Battery Life	1,311	days	WPDEV3830003 Battery Life	808	days	WPDEV4752001 Battery Life	1,251	days
WPDEV1440001 Battery Life	2,019	days	WPDEV2130004 Battery Life	1,318	days	WPDEV3090001 Battery Life	1,347	days	WPDEV4752002 Battery Life	1,251	days
WPDEV1840002 Battery Life	2,026	days	WPDEV2338002 Battery Life	1,382	days	WPDEV3122001 Battery Life	1,451	days	WPDEV4330002 Battery Life	1,397	days
WPDEV1840001 Battery Life	2,048	days	WPDEV2740001 Battery Life	1,426	days	WPDEV3090001 Battery Life	1,551	days	WPDEV4638002 Battery Life	1,525	days
WPDEV1720001 Battery Life	2,049	days	WPDEV2442002 Battery Life	1,451	days	WPDEV3435003 Battery Life	1,727	days	WPDEV4754001 Battery Life	1,875	days
WPDEV1110002 Battery Life	2,057	days	WPDEV2094001 Battery Life	1,576	days	WPDEV3435002 Battery Life	1,732	days	WPDEV4638001 Battery Life	1,890	days
WPDEV1130002 Battery Life	2,085	days	WPDEV2726001 Battery Life	1,581	days	WPDEV3435004 Battery Life	1,883	days	WPDEV4330003 Battery Life	1,892	days
WPDEV1130003 Battery Life	2,110	days	WPDEV2438001 Battery Life	1,630	days	WPDEV3040002 Battery Life	1,914	days	WPDEV4430003 Battery Life	1,953	days
WPDEV1320004 Battery Life	2,116	days	WPDEV2840001 Battery Life	1,666	days	WPDEV3040003 Battery Life	2,019	days	WPDEV4075001 Battery Life	1,990	days
WPDEV1740003 Battery Life	2,117	days	WPDEV2130006 Battery Life	1,676	days	WPDEV3320002 Battery Life	2,022	days	WPDEV4320005 Battery Life	1,993	days
WPDEV1330003 Battery Life	2,149	days	WPDEV2840002 Battery Life	1,705	days	WPDEV3090002 Battery Life	2,046	days	WPDEV4430005 Battery Life	2,003	days
WPDEV1320005 Battery Life	2,283	days	WPDEV2338003 Battery Life	1,805	days	WPDEV3820003 Battery Life	2,052	days	WPDEV4330004 Battery Life	2,007	days
WPDEV1050001 Battery Life	2,473	days	WPDEV204001 Battery Life	1,889	days	WPDEV3094002 Battery Life	2,063	days	WPDEV4040001 Battery Life	2,010	days
WPDEV1042001 Battery Life	2,904	days			WPDEV3423001 Battery Life	2,084	days				

1st Floor 2nd Floor 3rd Floor 4th Floor

Wireless Device Battery Health

Changed from run to failure to preventative failure mode



Wireless Device Battery Health

Result:

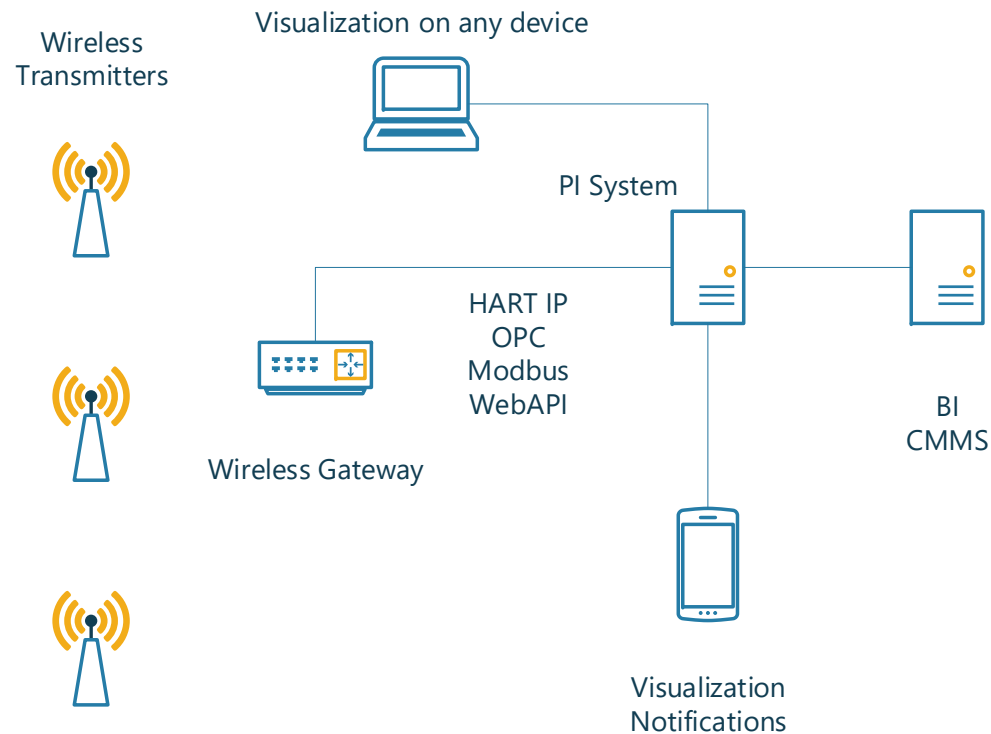
- Pre-implementation: Most battery replacements were at battery failure
- Post-implementation: Only 1 replacement at failure (device taken out of range of gateway)

Wireless Device Battery Health

If I can get the battery life directly to the PI System, what other information can the PI System receive from the gateway?



The PI System as an IIoT platform



Can I use the Rosemount System for monitoring without a DCS or PLC?

The PI System as an IIoT platform

Problem Statement:

- Small Lab needed to replace obsolete monitoring equipment
- Existing computer systems were all at their end of life and required an upgrade to the latest version
- Existing monitoring system was not meeting user's needs

Previous Laboratory Monitoring System

Wired Lab Instruments



Electronic Chart Recorder



PI Server

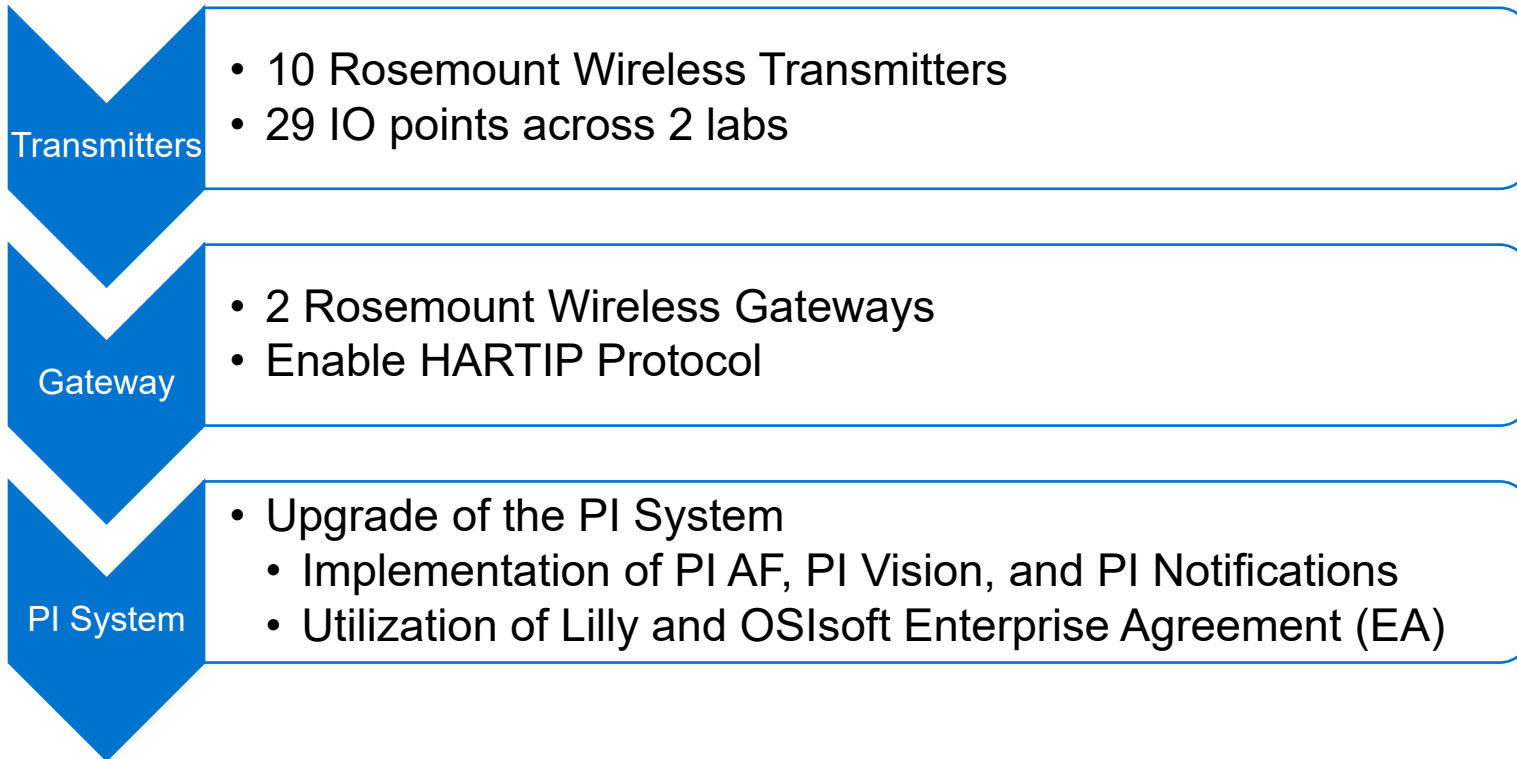


Notification System



Users

Project Scope



Wireless Monitoring Solution

Wireless Gateway

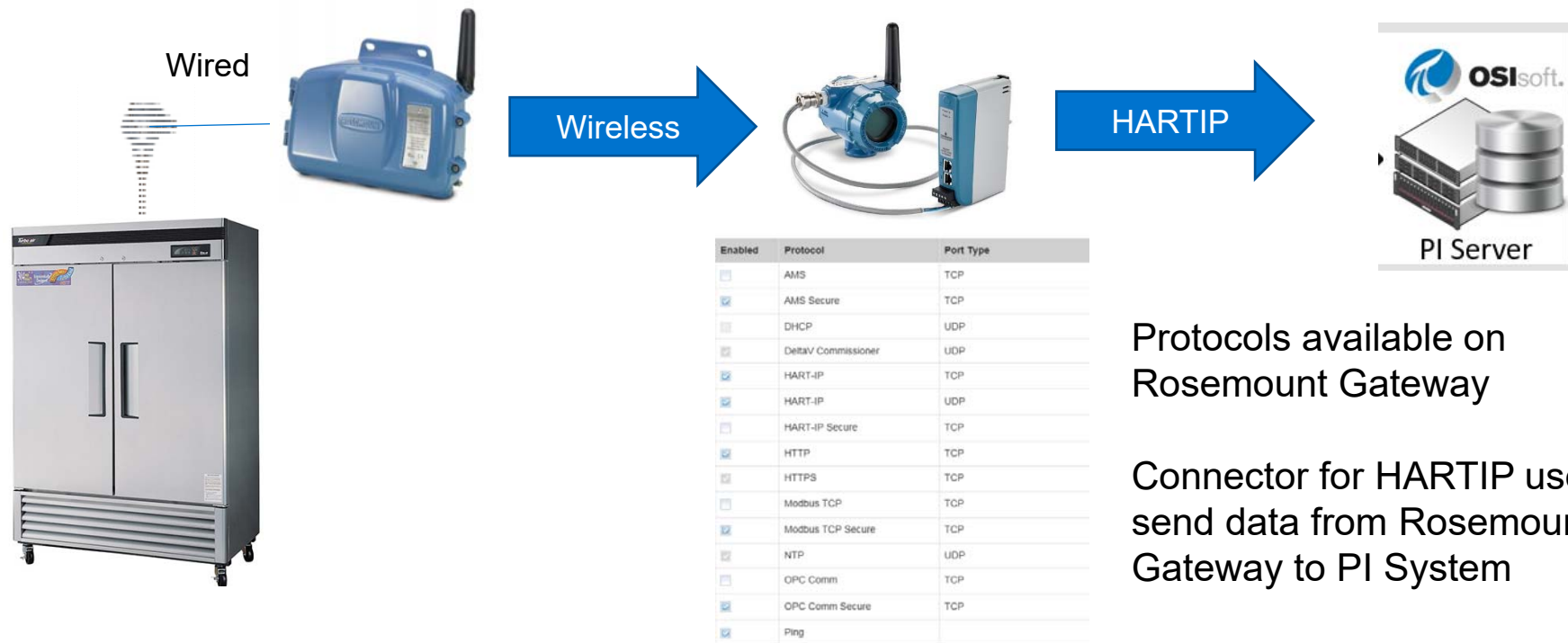


Antenna

848T Transmitter



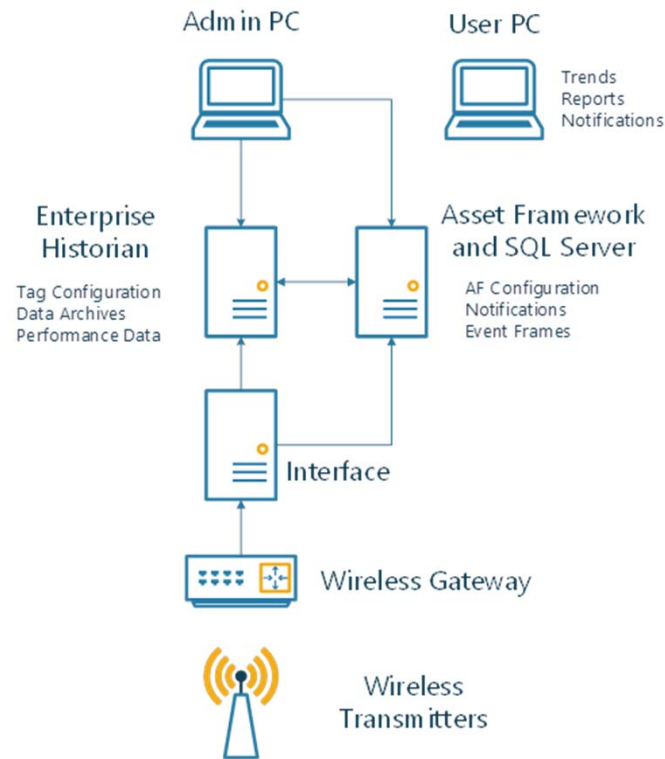
Data Flow from Lab Units to PI System



Protocols available on
Rosemount Gateway

Connector for HARTIP used to
send data from Rosemount
Gateway to PI System

Data Flow – No DCS or PLC



- One server for the Connector
- One Server for AF and SQL server
- One Server for the Data Archive
- Implemented in a firewalled environment

PI Connector for HARTIP

Overview

Data Source List
Server List
Diagnostics

Overview

Connector details
Version 1.1.3.12

Status of the connector
Connector running as
✔ Connector is running - [Stop connector](#)

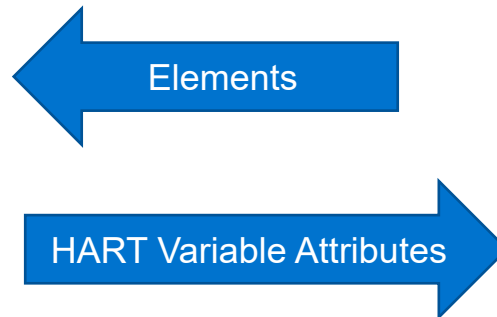
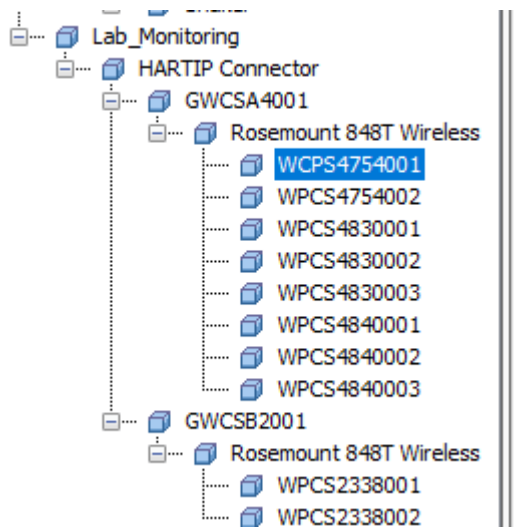
Data sources
✔ Lab_2330 Connected
✔ CS Mode Lab 4840 Connected
[Add or modify data sources](#)

Servers configured to receive data from the connector
✔ PI Data server : B362 CS PI
✔ PI Asset server : B362 CS AF
[Add or modify servers](#)

OSIsoft.

Asset Framework

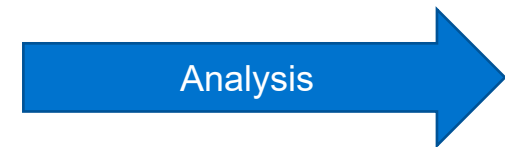
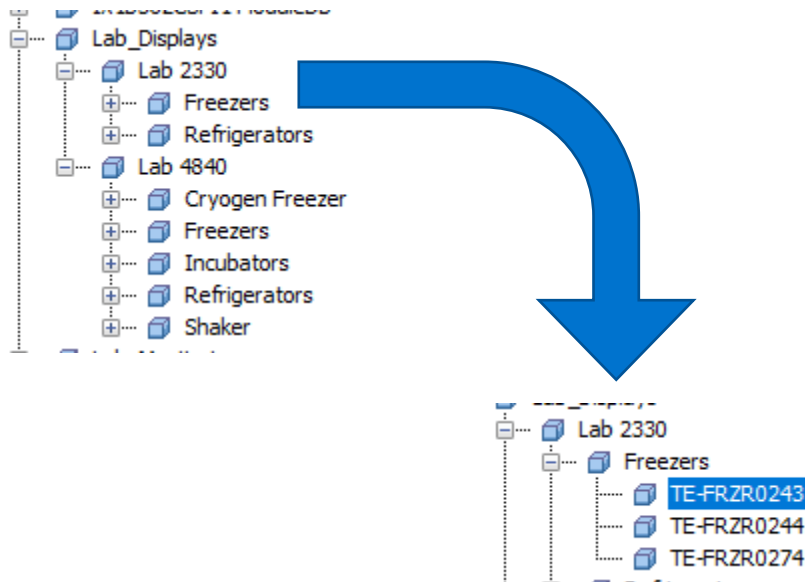
Asset Framework- HART Variables



	PV	-163.15960693359375
	Is Not Configuration Item	Good, Not Limited
	QV	74.777359008789063
	QV Status	Good, Not Limited
	Software Revision Level	1
	Standardized Status 0	0
	Standardized Status 1	0
	Standardized Status 2	0
	Standardized Status 3	0
	SubDevice Index	7
	SV	74.850746154785156
	SV Status	Good, Not Limited
	Tag	4754001
	TV	-168.90130615234375
	TV Status	Good, Not Limited
	Unique Address	2653 3EB635

Asset Framework- PI Vision Friendly

Templates based on Lab Unit Type



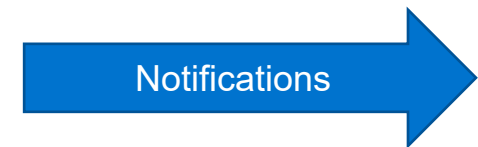
Filter	
Name	Value
Freezer Temperature	-77.1899719238281 °C

Asset Framework- Event Frame Generation

Generate Event Frame for out of range Temperature on Lab Unit Type

The screenshot shows a software interface for configuring an event frame. At the top, a title bar reads '-70 Degree Freezer Temperature Monitoring'. Below it, a section labeled 'Event Frame Template:' has 'Freezer Monitoring' selected. A table with two columns, 'Name' and 'Expression', defines the triggers. Under 'Start triggers', there are two entries: 'Low Temperature' with the expression `'Freezer Temperature' < -85.0` and 'High Temperature' with the expression `'Freezer Temperature' > -65.0`. Under 'End trigger', there is one entry: 'EndTrigger' with the expression `'Freezer Temperature' >= -85.0 AND 'Freezer Temperature' <= -65.0`.

Name	Expression
Start triggers	
Low Temperature	<code>'Freezer Temperature' < -85.0</code>
High Temperature	<code>'Freezer Temperature' > -65.0</code>
End trigger	
EndTrigger	<code>'Freezer Temperature' >= -85.0 AND 'Freezer Temperature' <= -65.0</code>



Asset Framework- Notifications

Notify Lab personnel and allow acknowledgement

-70 Freezer Notification - Trigger Criteria

Criteria Mode: ☒ Analysis ☐ Event Frame Search

A notification will be triggered when an event frame that matches all of these criteria is created by the selected analysis.

Referenced Element: Lab_Displays\Lab 2330\Freezer\TE-FRZR0243

> Analysis: -70 Degree Freezer Temperature Monitoring

Attribute Value: Add attribute criteria

Options:

Resend Interval: 0 Seconds

Non-repetition Interval: 0 Seconds

☒ Event Frame can be acknowledged

Choose when to be notified if child event frames are created for multiple trigger conditions:

- ☒ When the severity is higher than any previously true trigger condition
- ☐ When the severity is higher than the previous true trigger condition
- ☐ When any trigger condition is true

362CSPINotifications@lilly.com

To Kevin Ray Baker

Retention Policy Inbox (60 days)

Room: B362 Lab 4840 Discrete Notification

Unit: XS-348AA

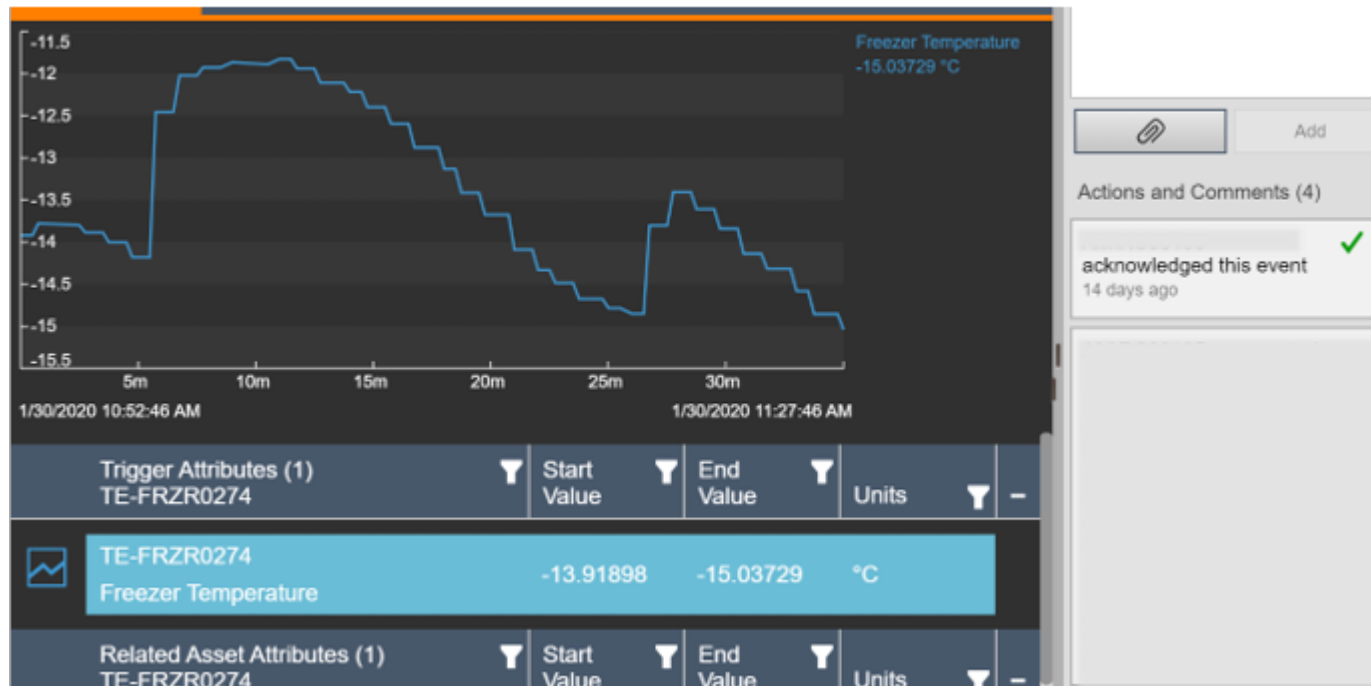
Start Time of Alarm: 2/14/2020 3:43 AM

End Time of Alarm: 12/31/9999 11:59 PM

[Incubator Discrete](#)

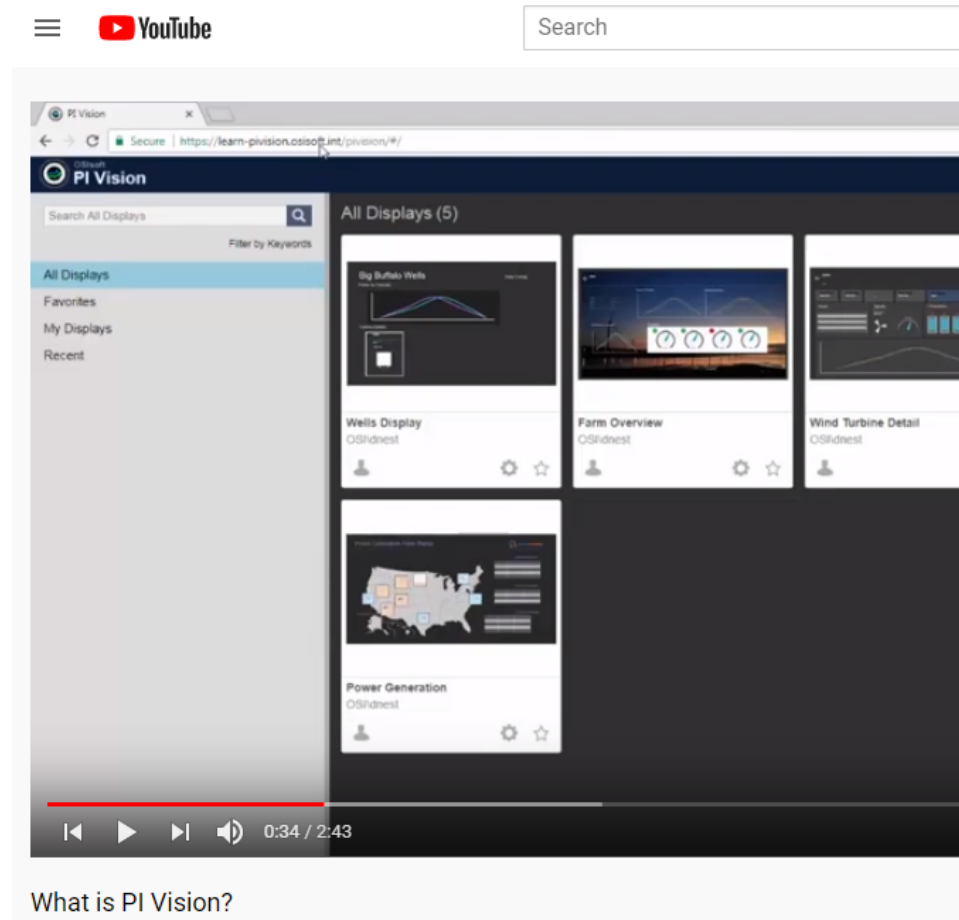
[Cryogen Discrete](#)

Event Frame Acknowledgement



User Training

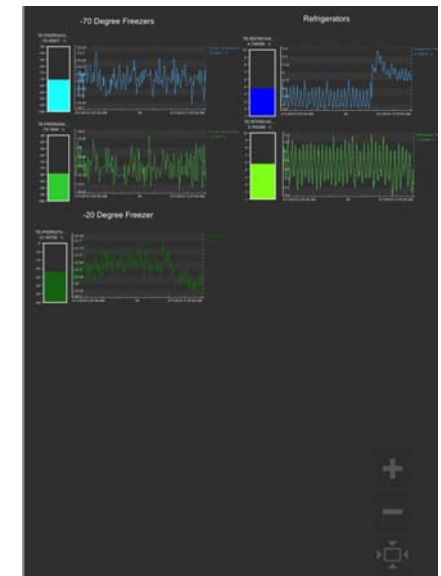
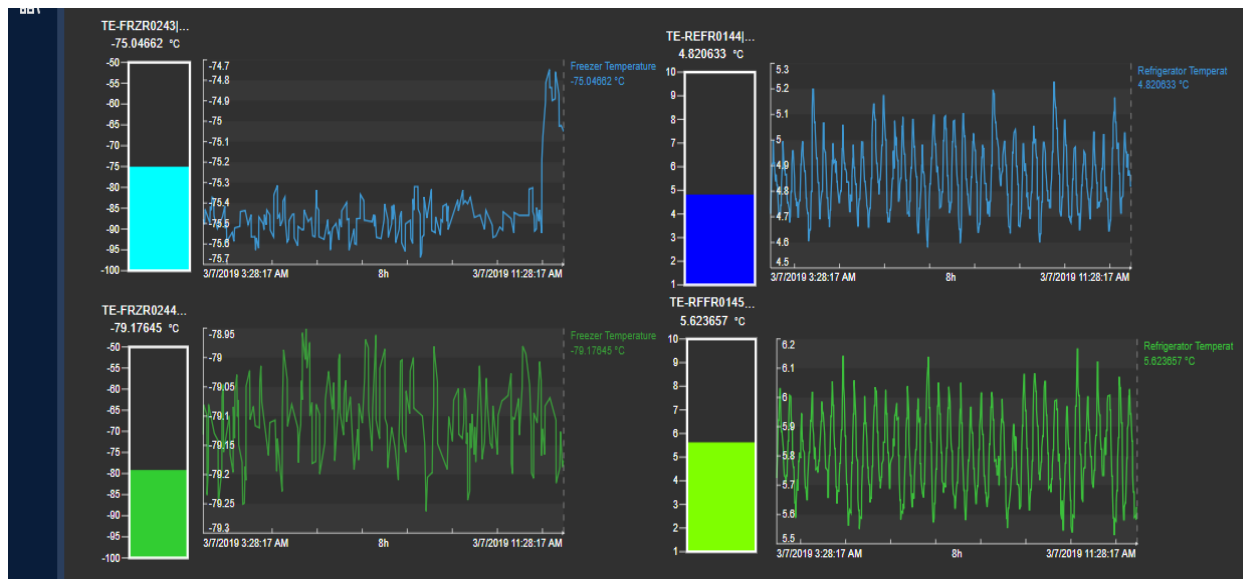
- OSIsoft YouTube Channel
- Grant users access upon request



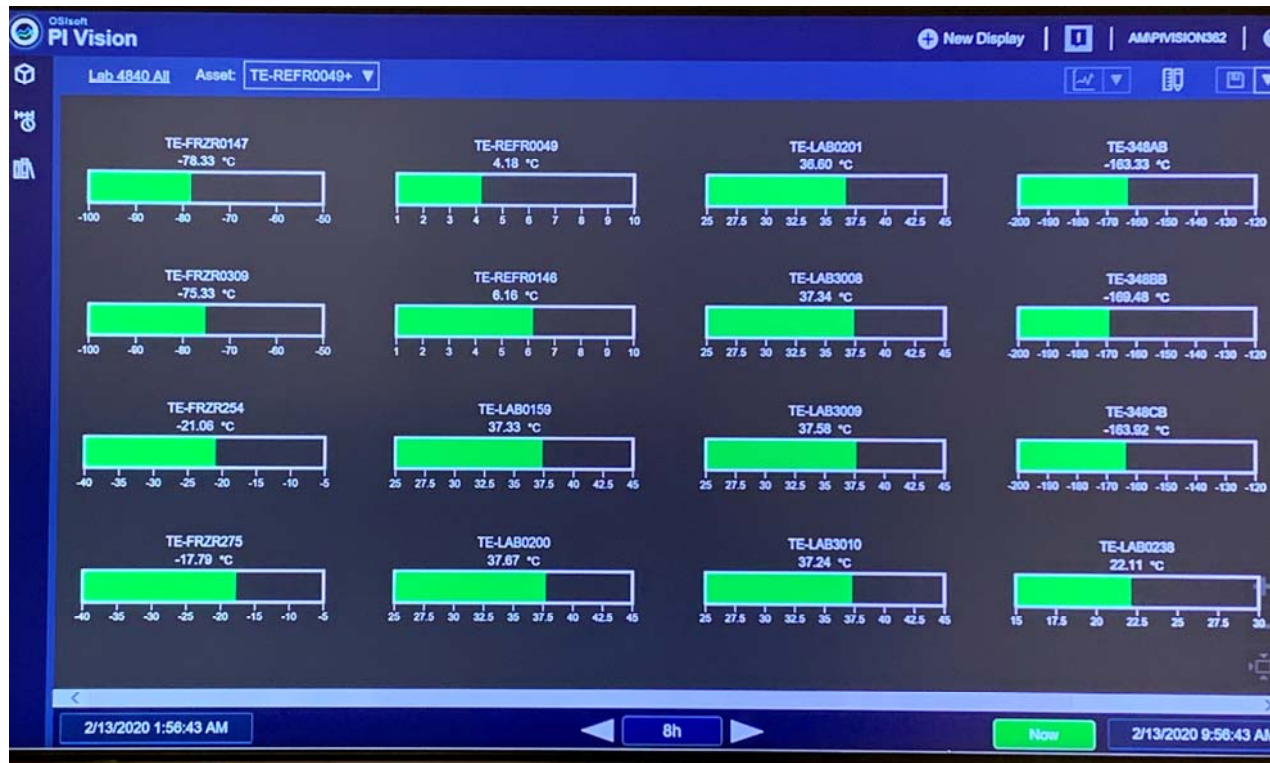
PI Vision Displays- Refrigerator and Freezer Monitoring

Computer

Smartphone



User Created PI Vision Display- 42" TV monitor



IIoT Implementation Results

- Users have data easily accessible to them from the PI system (smartphone, tablet, laptops)
- Notifications are sent for out of range data and low battery life
- Implementation cost was decreased significantly with wireless implementation
 - ~\$2k per IO point

Expansion

Replicated to another lab within the same building- completed in half the time of first

Wireless Pressure Monitoring Cart with SUB- 2 day implementation

Another Lilly site is utilizing the same architecture with vibration monitoring

Project to monitor lab scale TFF in-progress (Replacement of Chart recorders/ flash drives)

Future

Other IoT Sensors

- Trialing other less expensive brands of monitoring devices
- Monitor new variables
 - Power on critical equipment

Maintenance System Integration



Utilizing PI System as an IIoT Platform



CHALLENGES

- Current monitoring system not meeting customer needs
- Computer Systems at their end of life requiring action

SOLUTION

- Utilizing the PI System, Connector, and PI Vision a new cost effective monitoring system was implemented

BENEFITS

- PI System is more user friendly, meets user needs
- Cost Effective Solution
- System is easily scalable as needs change



“The new monitoring system is more robust. The biggest benefit is the alarms are now more reliable. The emails generated for an alarm have all the detail needed to determine how to respond to the email. The link in the email to PI Vision is very convenient to quickly see the data. There is not a big learning curve to use PI Vision. It is very easy to view events to acknowledge the alarm and to document a comment concerning the alarm.” – Lab Owner



“This system allows us to deliver in hours what used to take days to weeks.” - Engineer

Speaker



Kevin Baker
Automation Engineer
Eli Lilly and Company
bakerke@lilly.com



THE OHIO STATE
UNIVERSITY

