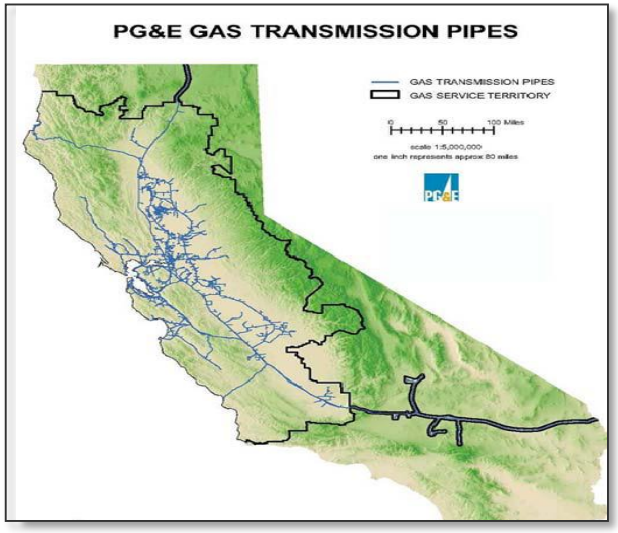


Predicting Over-Pressure in Gas Pipelines

Bryan Hennessy & Sergio Hernandez, PG&E

Andrew Pong & Jerry Vin, DST Controls

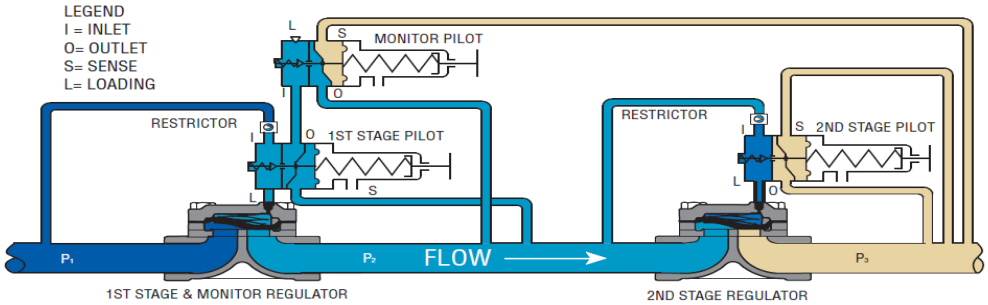
Pacific Gas & Electric

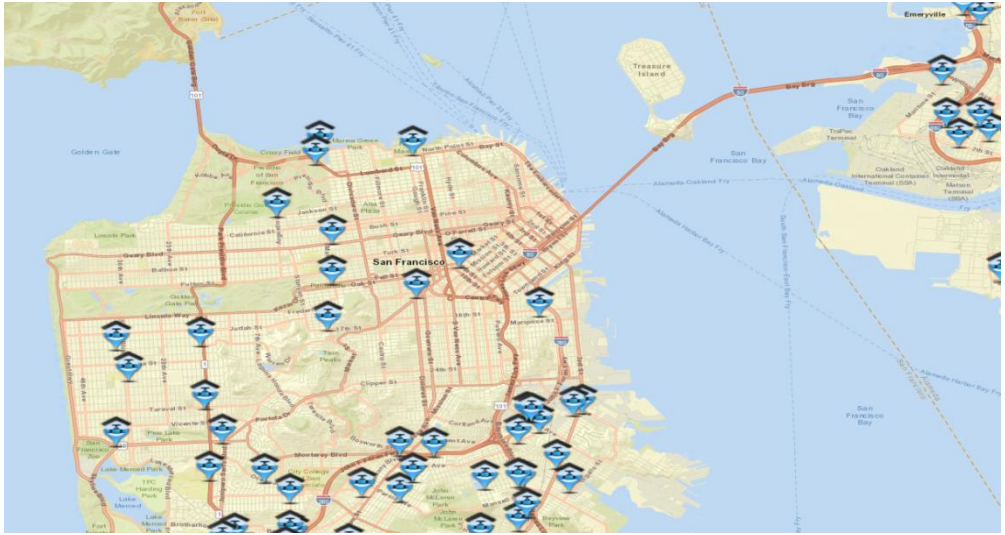
DST Controls

igenpatterns Collaborative Decision Engines

Gas Pressure Regulator Stations

- Step down pressure for customers downstream similar to an electric transformer
- We operate hundreds
- Risk of over-pressurizing downstream system if failure occurs





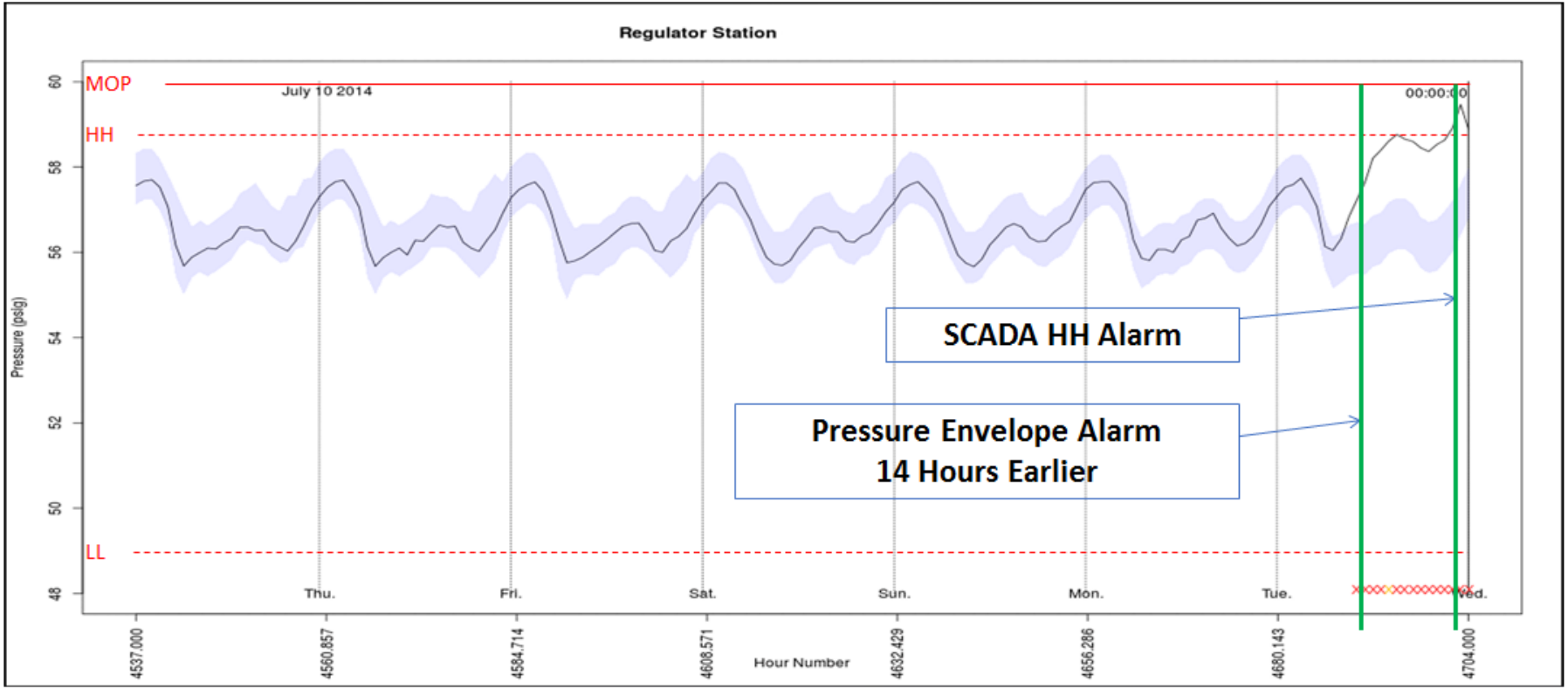
Predict Regulator Failures

- 16% of Over Pressure (OP)/near hit events show potential for early saves

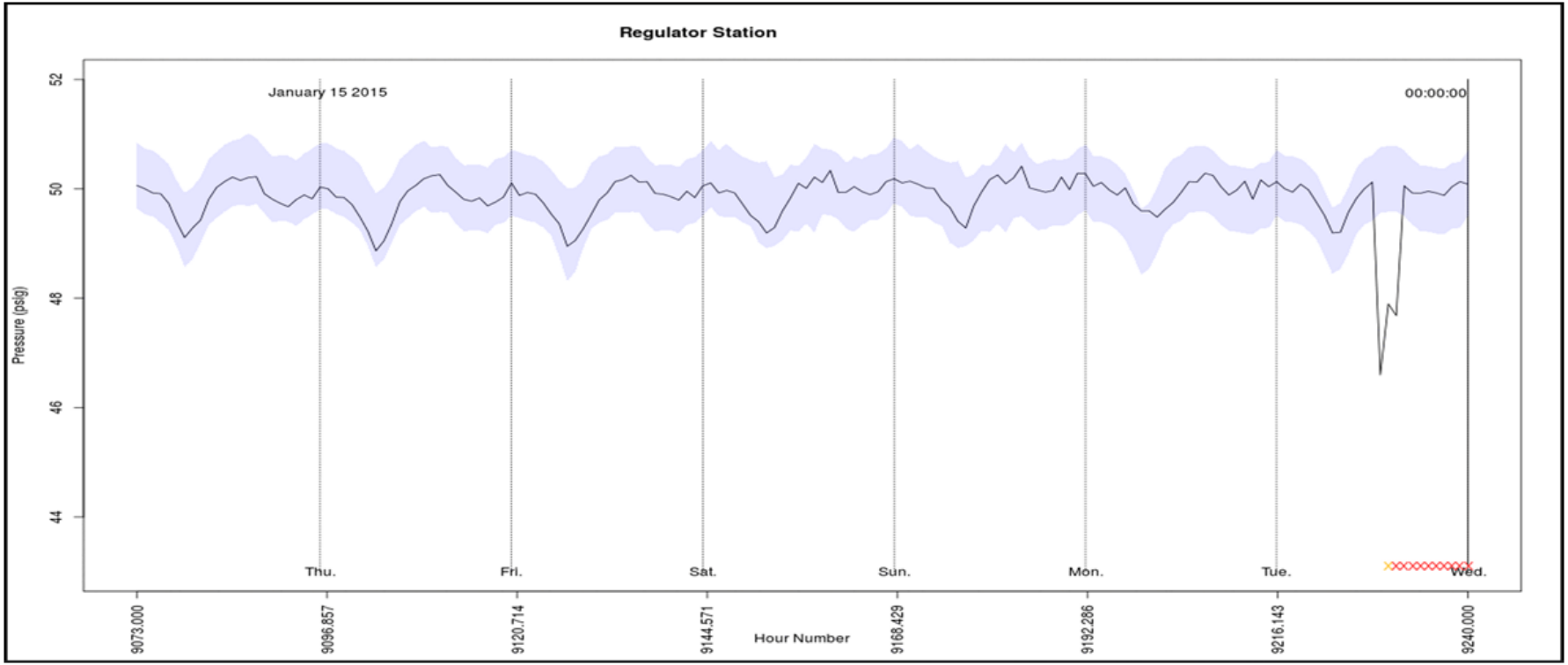
- We have 500 distribution regulator stations with downstream regulator pressures sensors, and another 2,000 coming online in the next 5 years. We have to depend on automated monitoring.

OP/Near Hit Events per year with Instrumentation	62
OP/Near hits per year that can be seen by eye more than 2 hours before the SCADA alarm	10 (16%)

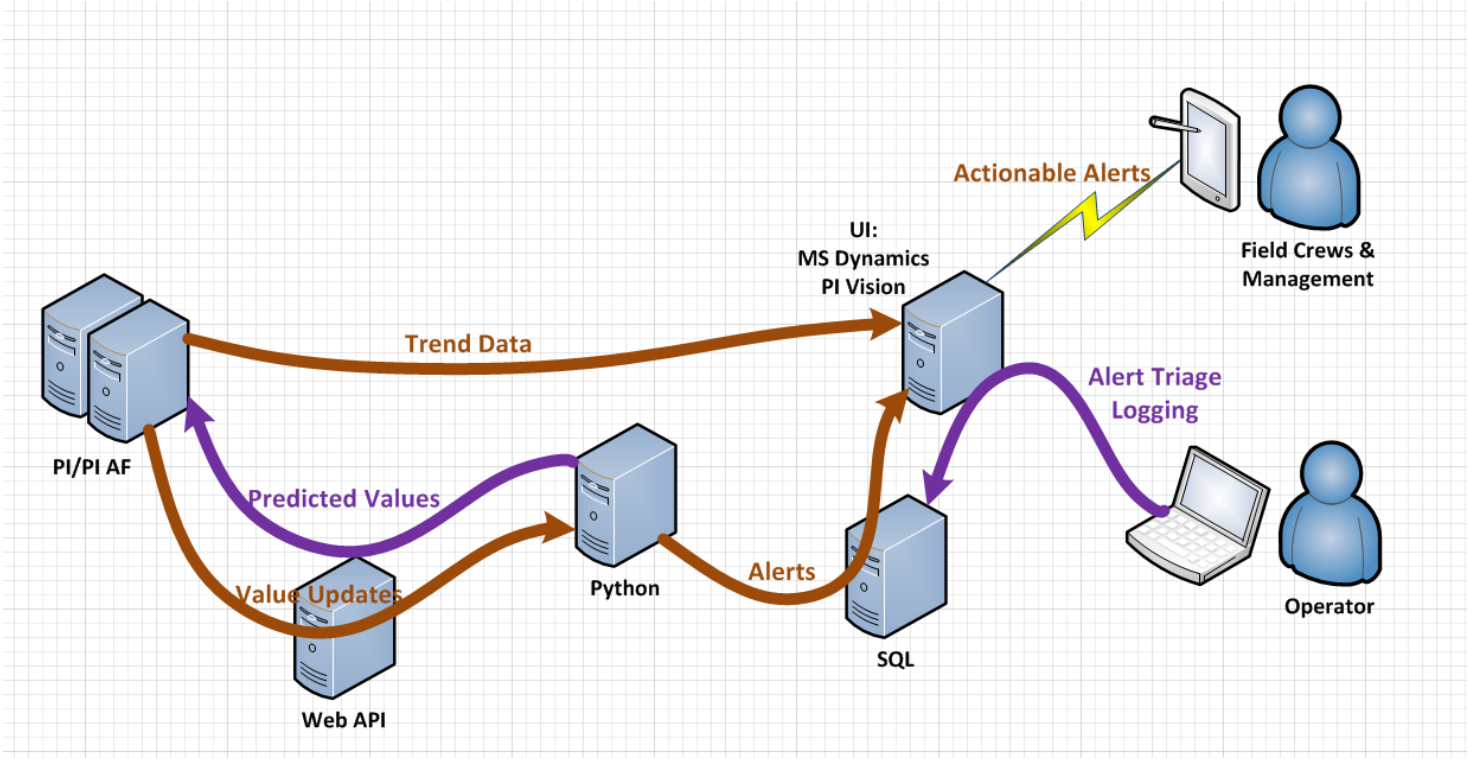
Alert Envelope Early Catch



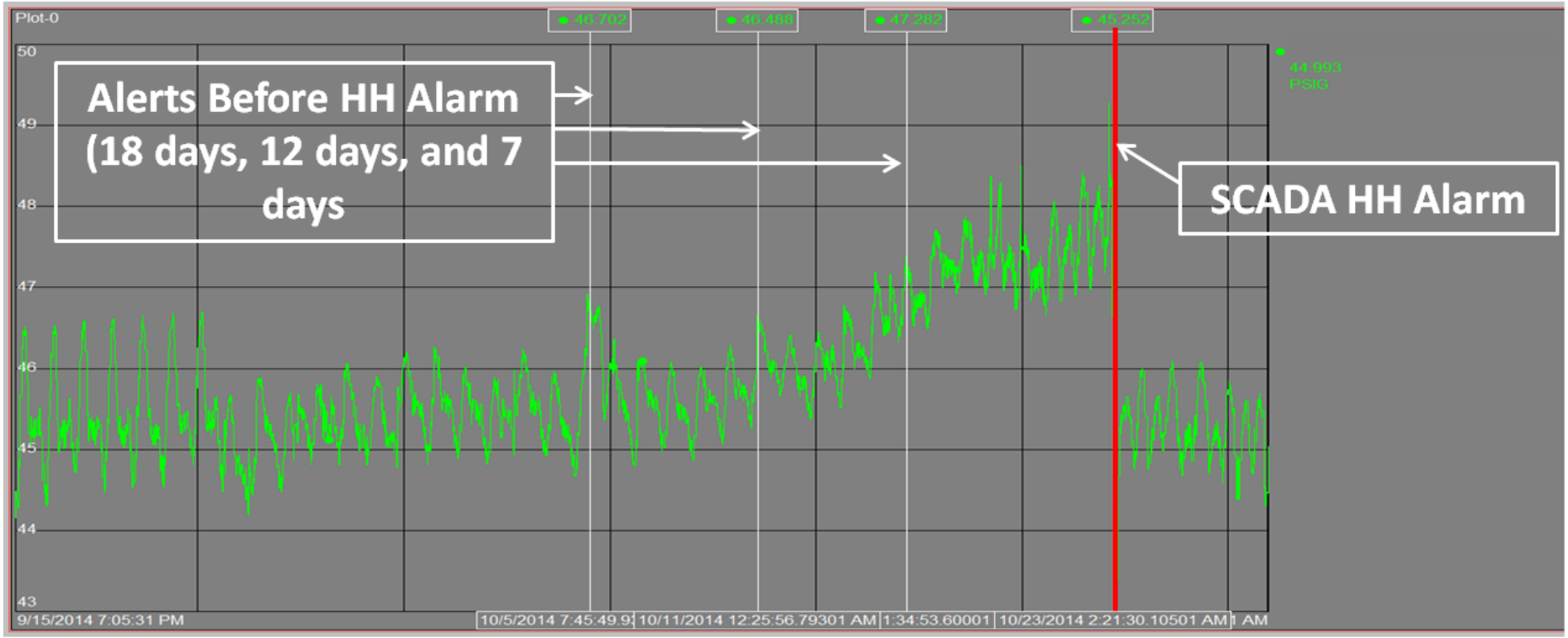
Finding New Potential Issues



System Components



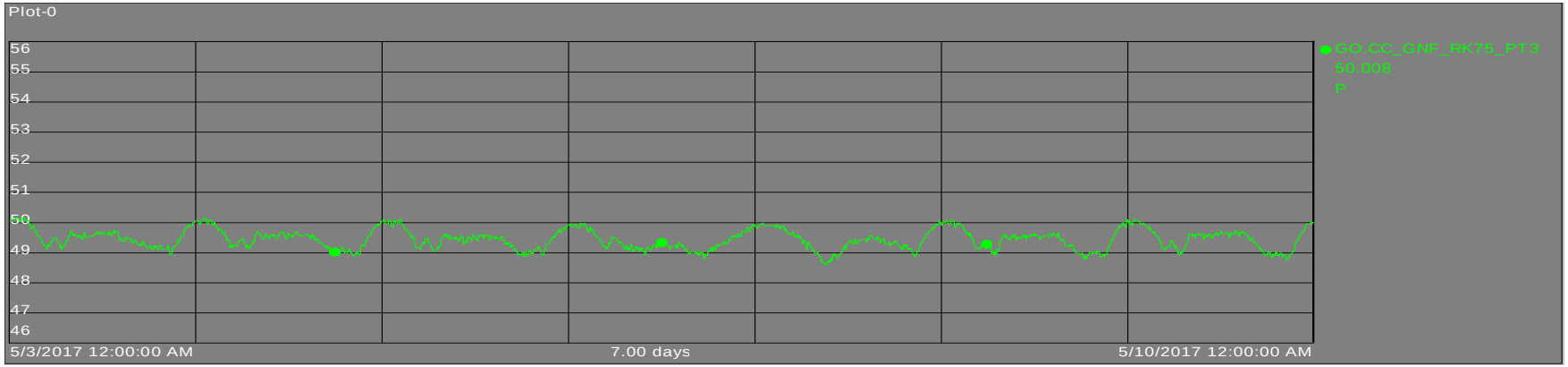
Ambiguity in Alert Response

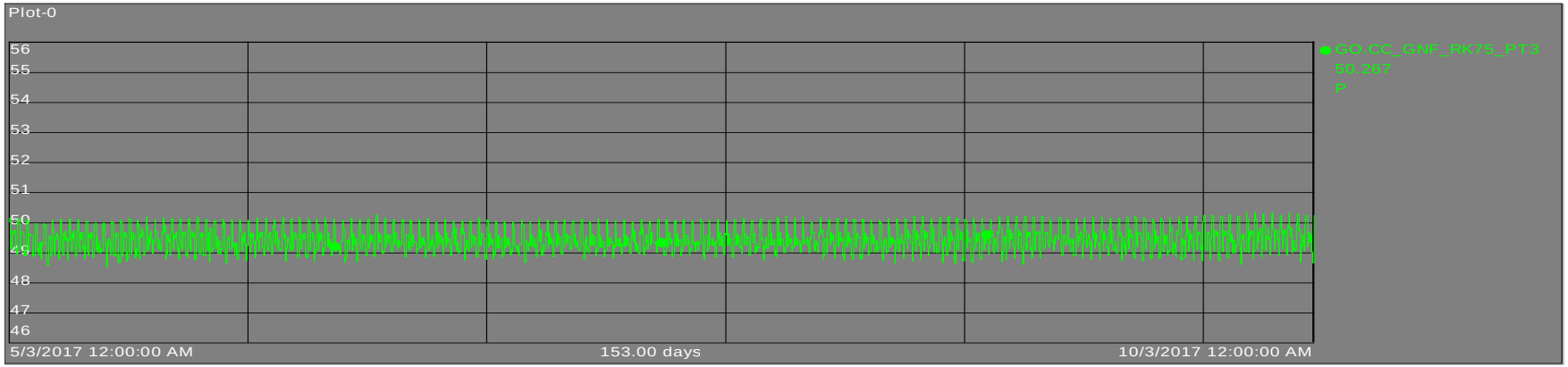


Algorithm Selection

consideration	Pros	Cons
Customized model parameters per station	Typically lower false alarm rate	Each model is trained and maintained independently, so there is a high initial and support cost
General model parameters for all stations	Can be run on our whole system with little input and minimal cost	Higher false alarm rate with costs to review and to possibly send additional field crews
Existing Commercial Products	Mature software with lots of features	Locked into a platform. One vendor had non standard hardware requirements
Open source	Not dependent on vendor to support	Less out of the box features
Existing Commercial Algorithms	Well known algorithm with proven success in other industries	Designed to look for single snap shots in time across many correlated variables. Doesn't consider time series shape. Pilot results were not finding the abnormal time series signatures. The results were similar to High and Low flat alarm settings in this application.

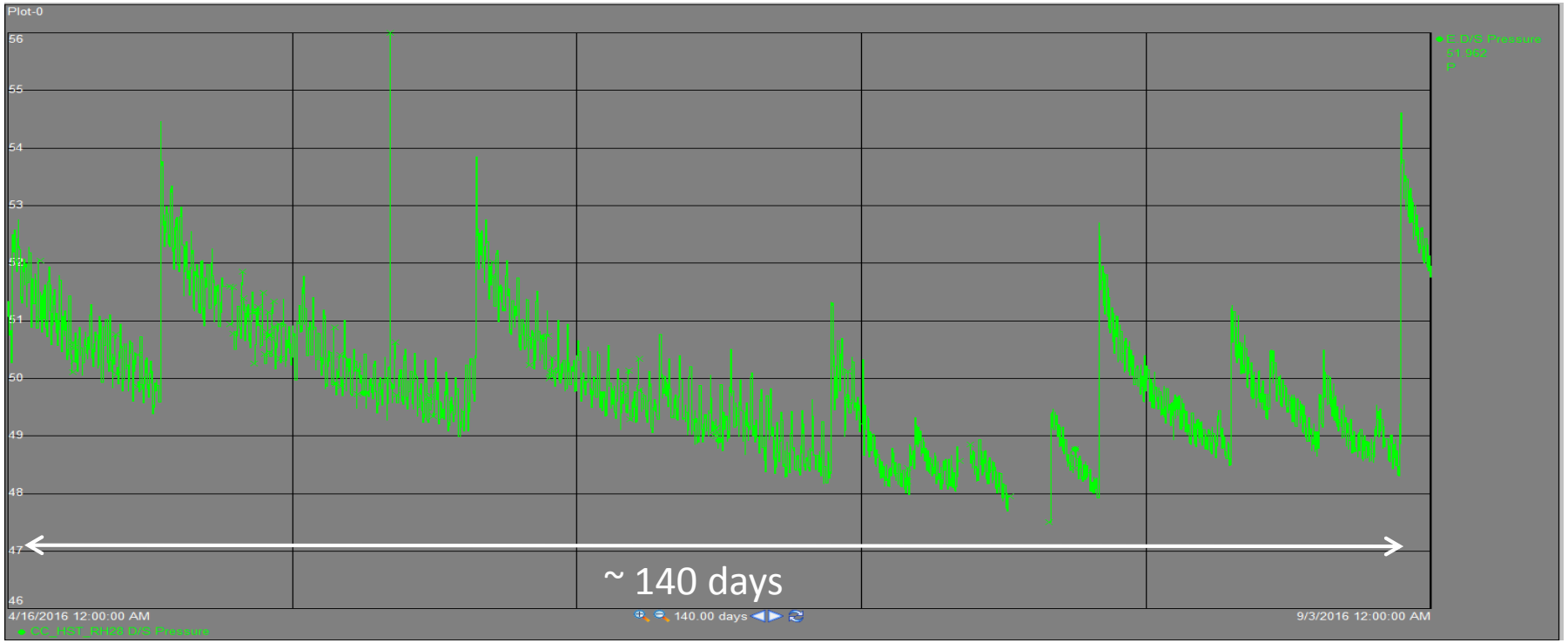
Pressure Downstream of Regulator Stations





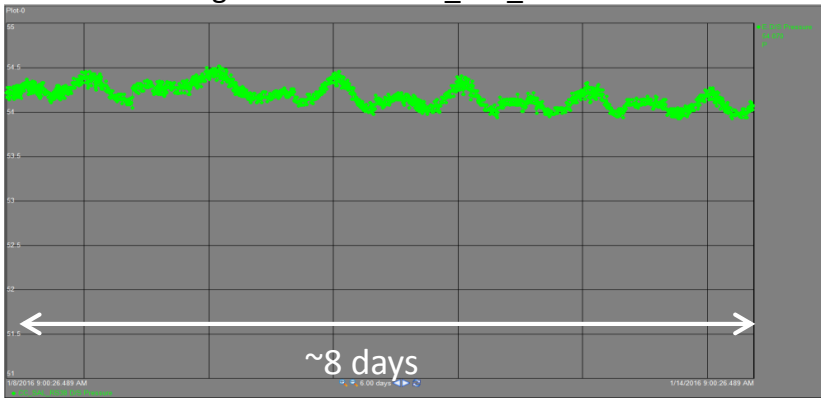
Anomaly or Normal Operations?

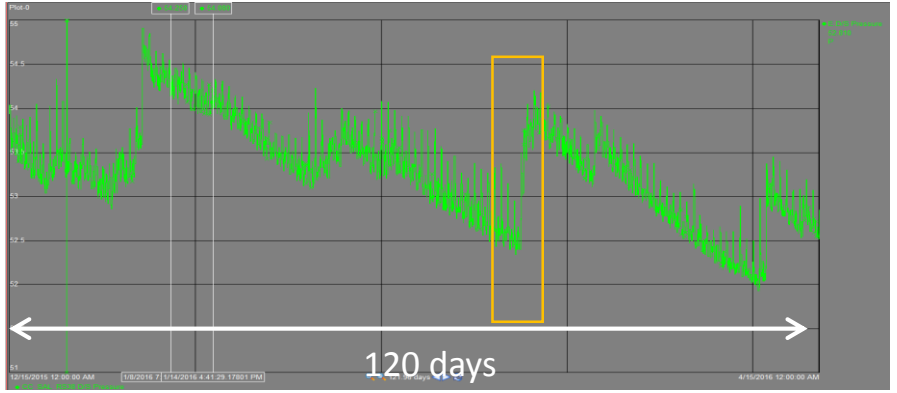
Downstream pressure [46 – 56 psig]



Downstream pressure [51-55 PSIG]

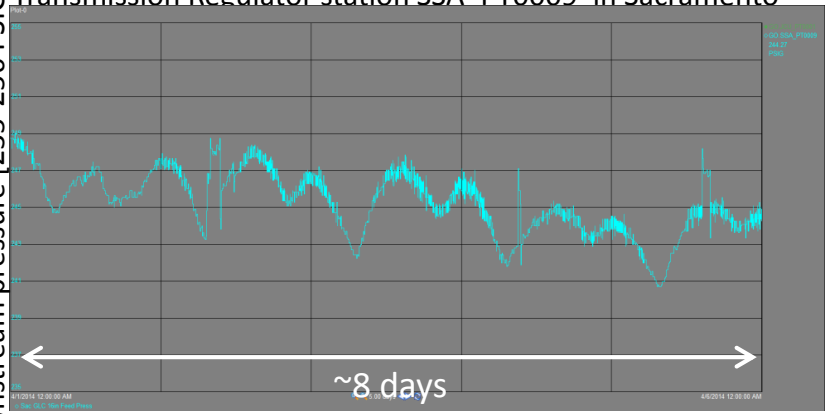
Distribution Regulator Station CC_SAL_S38 in Salinas

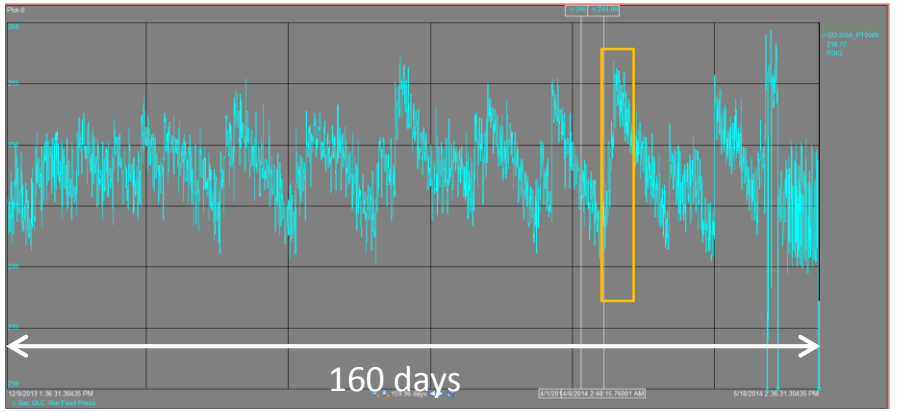




Downstream pressure [235-256 PSIG]

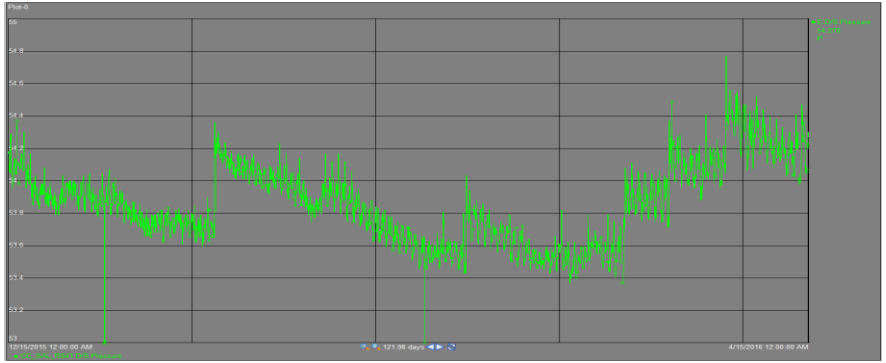
Transmission Regulator station SSA_PT0009 in Sacramento



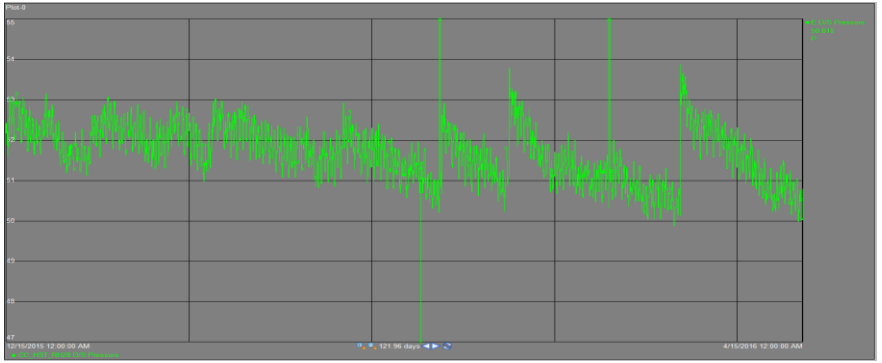


See Pattern Across System

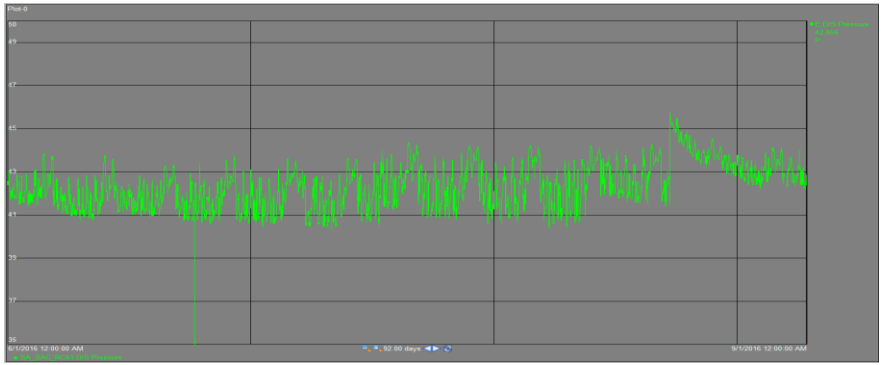
Salinas



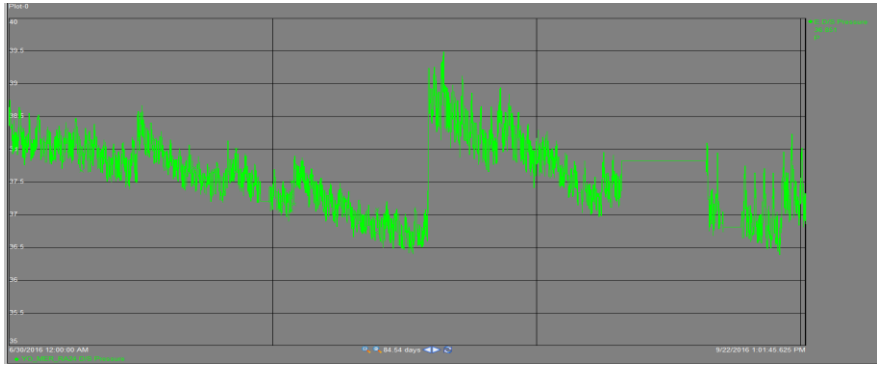
Hollister



Sacramento



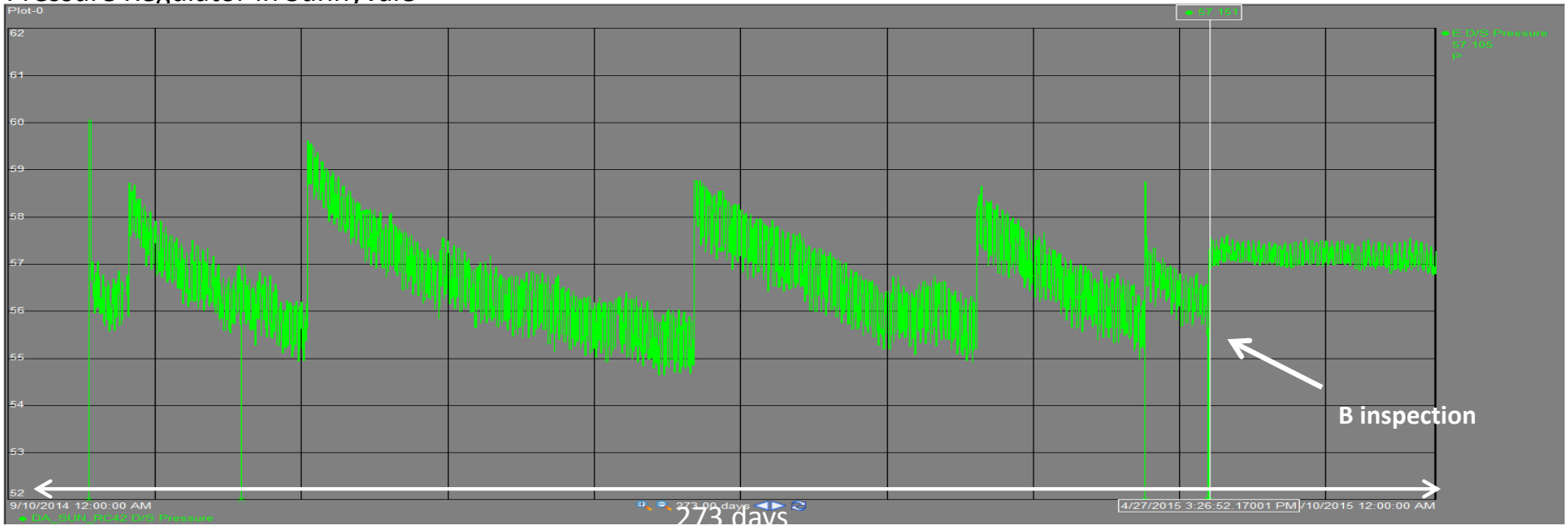
Merced



Distribution Regulator Station in Sunnyvale

- After inspection, pattern disappears
- Pattern due to an internal component in regulator station
- Nothing unusual noted in the maintenance record

Pressure Regulator in Sunnyvale

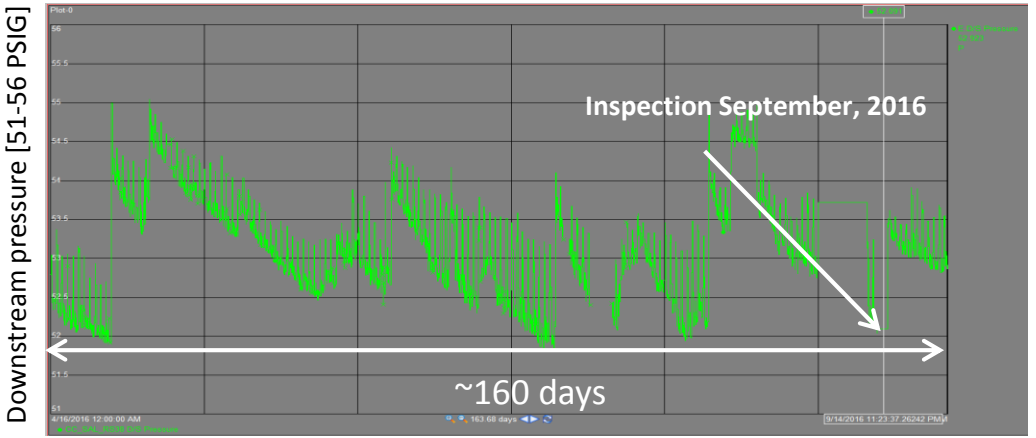


Before Inspection

- Station was chosen from current pressure trend
- No lock-up due to Sulfur build-up was expected before trip

During Inspection

- Regulator did not lock-up so it had to be rebuilt

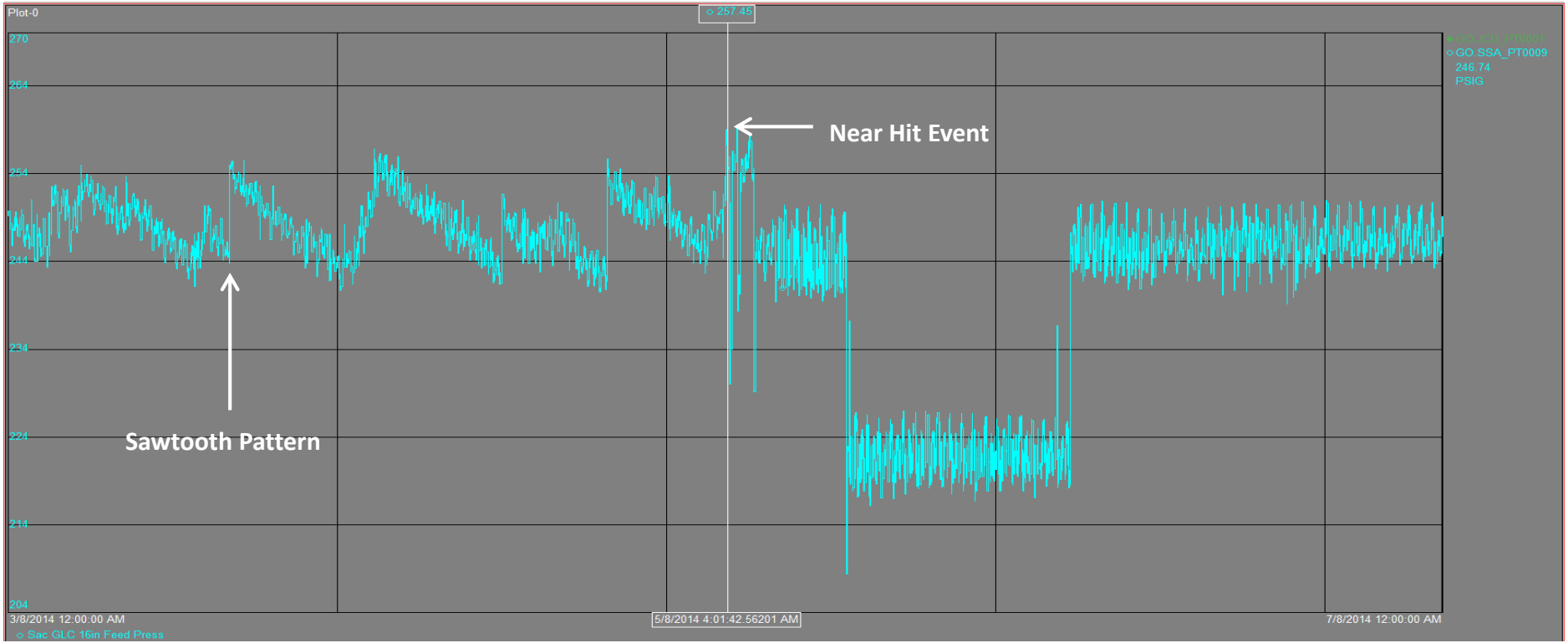


Is this pattern important?

- Sawtooth pattern was present in overpressure events that were caused by sulfur build-up
- Unfortunately, not all stations had instrumentation installed at time of incident

OP/Near Hit?	Gas Event # / CAP ID #	CITECT Point Name	Point Description / Location	Division	Date	Max Value	MAOP Value	Pressure Difference	Percent over MOP	Primary Event Category
OP	2490	RUN_PT0002	Union-Sta 6 Inch Out Press	North Coast	01/12/2011 02:46	194.7	167	27.7	16.6%	Equipment - Sulfur
OP	2600	JCU_PT0001	Church & Monterey Inlet Press	San Jose	04/18/2011 16:44	343.6	335	8.6	2.6%	Equipment - Sulfur
OP	AIR#	JCU_PT0001	Church & Monterey Inlet Press	San Jose	04/20/2011 21:49	311.9	307	4.9	1.6%	Equipment - Sulfur
OP	154277	N/A	DFM 0615-01, Sacramento	Sacramento	11/21/2012 00:00	435.0	425	10.0	2.4%	Equipment - Sulfur
OP	150462	Chart	Sacramento - DR A30 Madison Ave/ San Juan Avenue	Sacramento	01/18/2013 03:00	51.5	50	1.5	3.0%	Equipment - Sulfur
Near Hit	7003730	SSA_PT0009	Sacramento GLC	Sacramento	5/8/14	259.011	260	-0.989	-0.003803846	Equipment - Sulfur
Near Hit	7006488	SA_SAC_RA44_PT3	Roseville Road	Sacramento	10/22/14	49.28	50	-0.72	-1.4%	Equipment - Sulfur
Near Hit	7006929	YO_ATW_S027_PT1	Atwater (ERX)	Yosemite	11/7/14	44.25	45	-0.75	-1.7%	Equipment - Sulfur
Near Hit	7007337	SA_WDL_S044	Brown St (ERX)	Sacramento	12/3/14	48.08	50	-1.9	-3.8%	Equipment - Sulfur

Transmission Regulator Station in Sacramento SSA_PT0009



OSIsoft – Python Connector *"OSIsoftPy"*

Data Retrieval Features

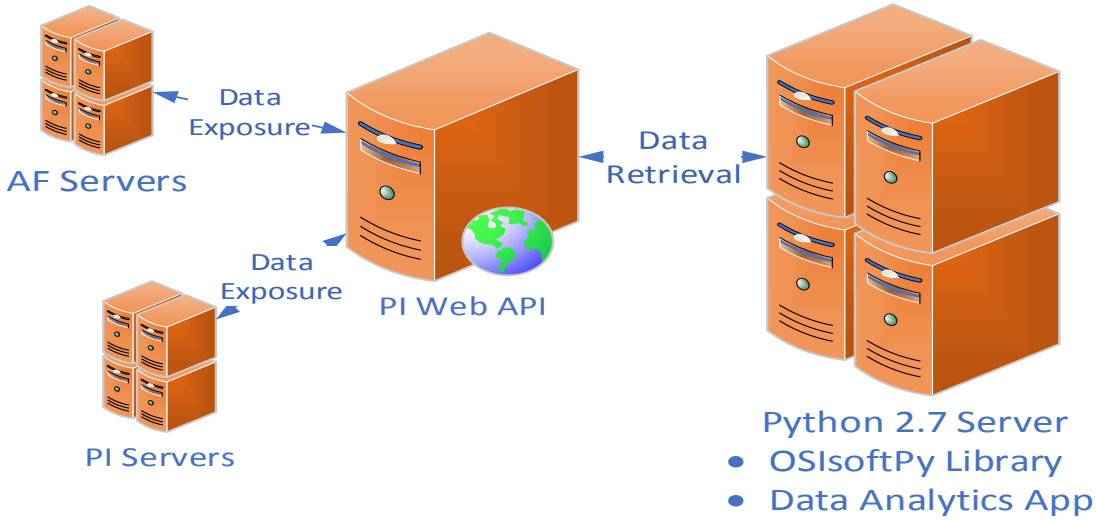
Read PI points

Current, interpolated, plot, recorded, summary, and end values

Write PI Points

Monitor PI points for updates

Reading from AF attributes



OSIsoftPy Architecture

- Python issues https requests to PI Web API
- Single command requests many PI Points
- Written as a library
- Warning:
  Kerberos authentication
  - Microsoft Active Directory requires PI Web API server confias a Service Principal Name

Code Sample

```
# Import library
import osisoftpy

# Authenticate
webapi =
osisoftpy.webapi('https://dev.dstcontrols.com/
piwebapi/')

# Get points
point_list = webapi.points(query='name:SINU*')
point_list2 = webapi.points(query='name:CDT*')
for individual_point in point_list2:
    point_list.append(individual_point)

# Read latest value
for individual_point in point_list:
    valueobj = individual_point.current()
    print('Latest value of {} is {} at time
{}'.format(individual_point.name,
valueobj.value, valueobj.timestamp))
```

Predicting Over-Pressure in Gas Pipelines

PG&E is trying to reduce gas over pressure events

CHALLENGE

Overpressure is a serious issue in gas pipelines

- Understanding normal vs abnormal behavior from pressure regulators

SOLUTION

Can detect a potential overpressure incident days before using machine learning

- PI Web API with DST Python connector
- Learning algorithm from EigenPatterns
- PI vision and Microsoft Dynamics UI

RESULTS

Move from react and respond to predictive and proactive response

- Notified hours or days before SCADA system alarms
- %5 of alarms caught in advance
- One additional alarm per day per hundred stations monitored

Merci

谢谢

Danke

Спасибо

Gracias

Thank You

감사합니다

ありがとう

Grazie

Obrigado

SIGMAFINE®

OSIsoft. OEM PARTNER

Hunt® REFINING COMPANY

Improving Data Quality, Inventory & Material Movement Management, & Refinery Yield with Sigmafine Embedded PI AF

Tyler Cohen – Yield Accounting Engineer

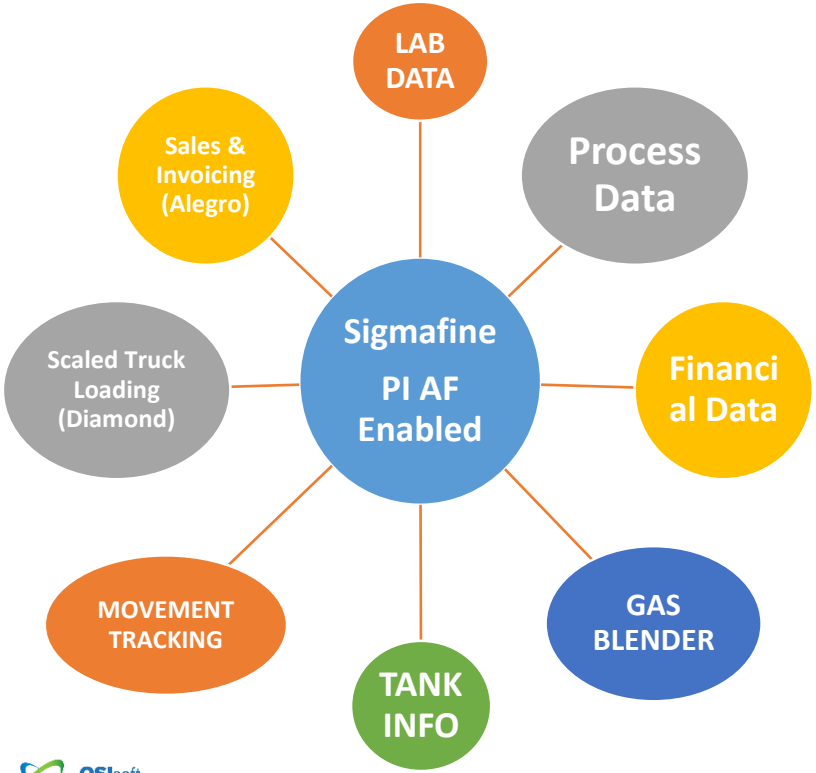
About Hunt Refining Company

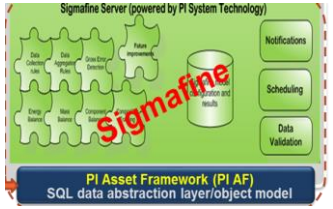
Hunt Refining Company is a **privately held petroleum refiner** headquartered in Tuscaloosa, Alabama. The company markets asphalt, transportation fuels, light oils and other refinery products predominantly in the southeastern United States

Refineries:

Tuscaloosa, AL
Sandersville, MS

Leverage of Sigmafine (Embedded PI AF) to improve:

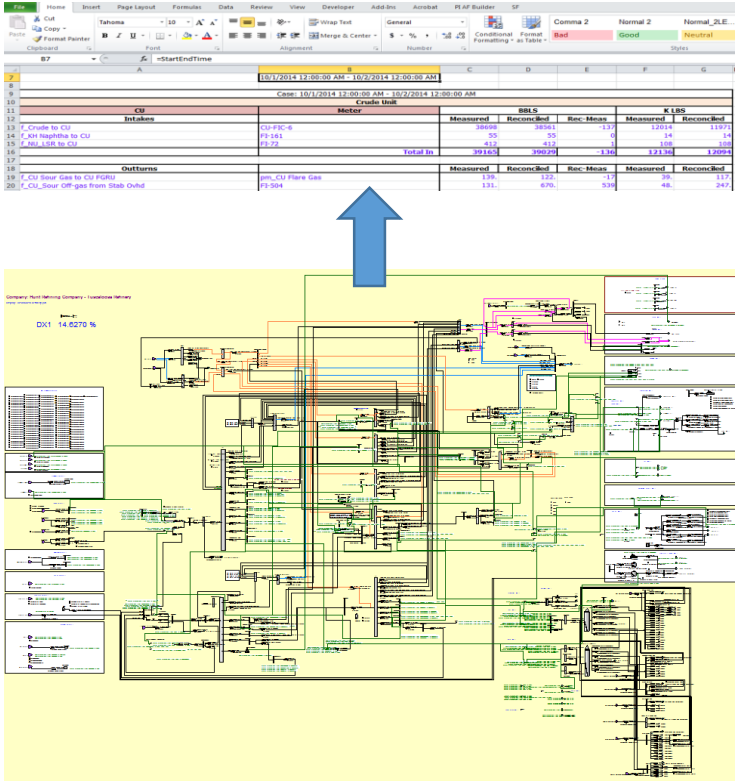




- Data Quality
- Data/System integration
- Integrated Movement Management
- Plant Production & Yield Accounting
- Inventory Balancing
- Refinery Performance

Sigmafine Model Enables Foundational Areas

- Process Data Quality – meter level
- Inventory Balancing
- Production accounting
- Refinery material balances
- Individual process units material balances
- Detection of measurement errors
- Non-measured flows calculation
- Material losses accounting



Improving Yield & Refinery Performance Using Sigmafine & PI AF

Hunt Refining

The main objective was to measure overall refinery performance on a more frequent basis and to improve reporting capabilities and data access to validate individual unit and meter performance.

CHALLENGE

Different systems having their own version of the “truth”

- Difficult to compare and validate overlapped information
- Systems working independently with no synergy to optimize the operation of the refinery

SOLUTION

The seamless integration was accomplished by the use of AF and Pimsoft Integration Framework, which integrates and transforms data from Hunt’s systems.

- AF as a centralized business logic layer
- AF-based Pimsoft’s Integration Framework
- Sigmafine mass balance modules

RESULTS

Accurate information about how the refinery is performing.

- Monitor meters, units, processes & overall refinery performance on a daily basis.
- Improved Reporting

Improving Yield and Refinery Performance Using AF

- **Tyler Cohen**
- tcohen@huntrefining.com
- Speaker's Title
- Hunt Refining

Questions

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

State your **name & company**

Please remember to…

Complete the Online Survey for this session

PI System
Fast Implementation & Analytics POC

PI Asset Framework enables business users to create value through analytics capabilities : the power to succeed and the right to fail, very quickly, without irreversible consequences

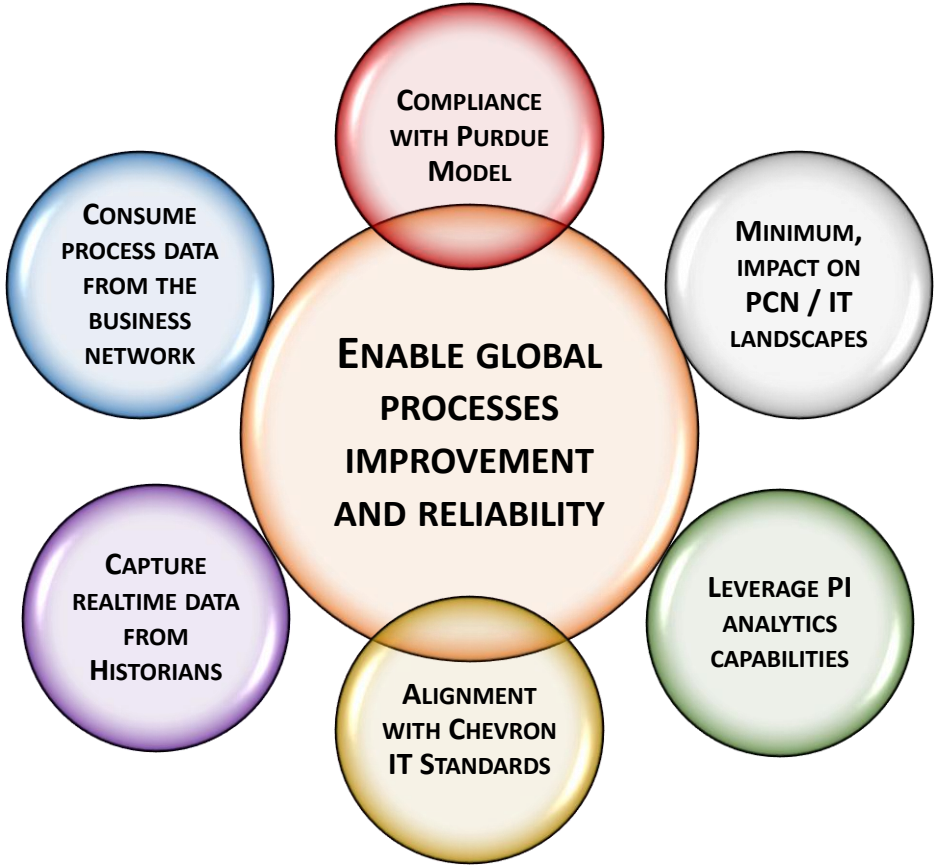
David Chatel - Project Manager – Chevron Oronite

Conference Theme & Keywords

OPPORTUNITY

- The OSI PI System has been a Chevron standard solution for **more than 15 years** with proven success stories.
- Chevron Downstream & Chemicals stream engaged a Manufacturing Data Foundation project.
- In 2017, Chevron Oronite Gonfreville Plant (France) was selected to run a **PI Proof of Concept**
  - Gonfreville plant benefits of robust SCADA system but with **quite limited analytics capabilities**
  - Each Oronite manufacturing plant has its own SCADA system **without process data aggregation layer**
- Execute this proof of concept in a **Sprint / Agile** approach while letting users practice products

OBJECTIVES



Chevron Oronite Global Manufacturing Organization

Oak Point Plant
Belle Chasse, Louisiana USA

Gonfreville Plant
Gonfreville, France

World Class Plants
Regional Plants
Joint Venture Plants

Omaezaki Plant
Omaezaki, Japan

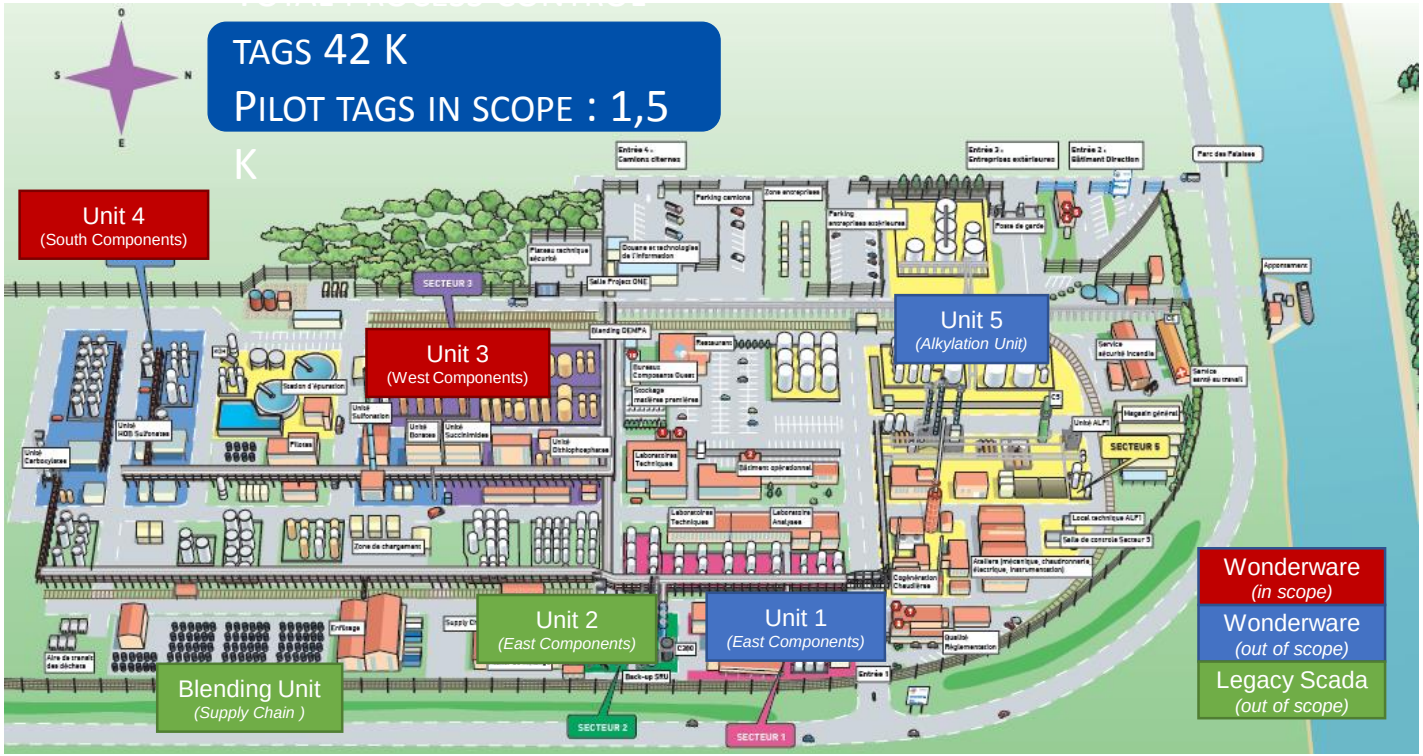
DAYS
BATCH PROCESSING
HETEROGENOUS SCADA

Maua Plant
Sao Paulo, Brazil

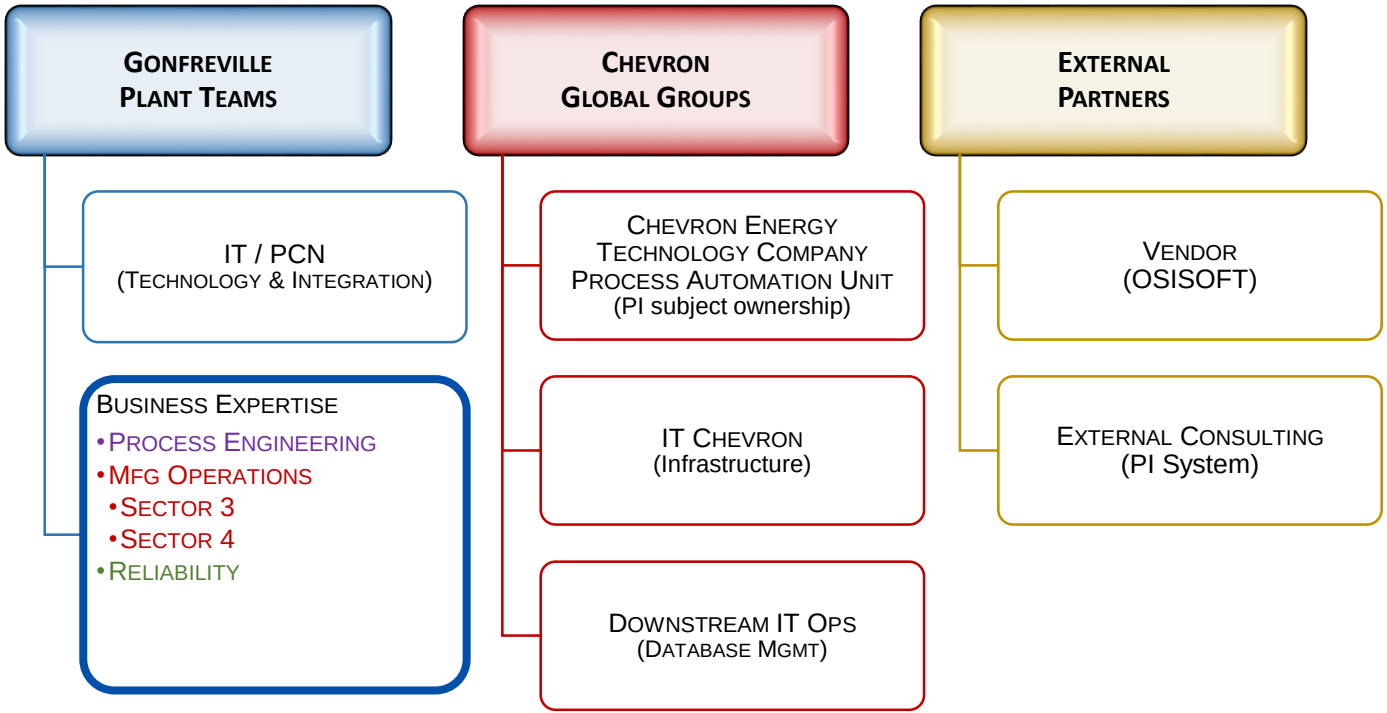
Chennai Plant
Chennai, India

Singapore Plant
Jurong Island, Singapore

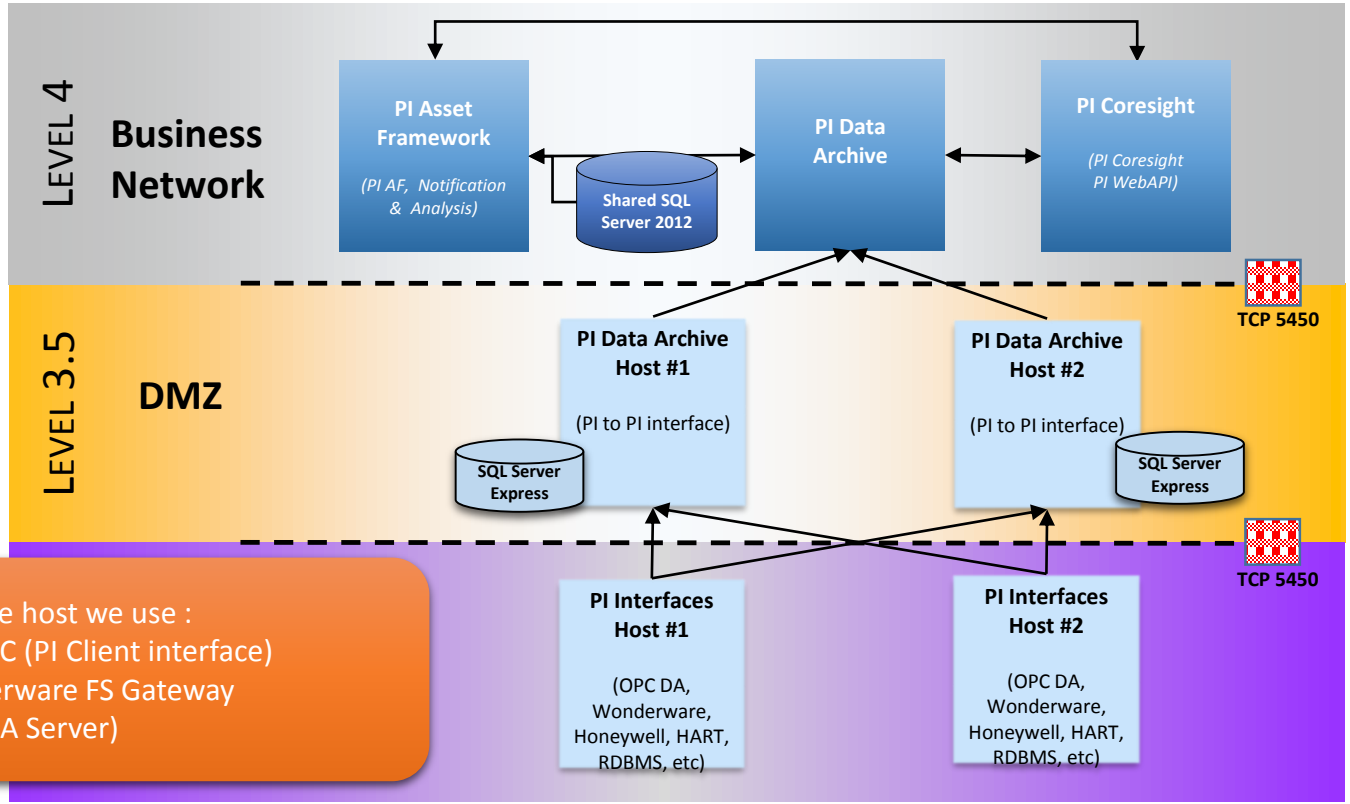
GONFREVILLE PLANT LAYOUT



Pilot Organization



Standard Technical Architecture - Purdue Model View



STANDARD CHEVRON IT VIRTUAL SERVER

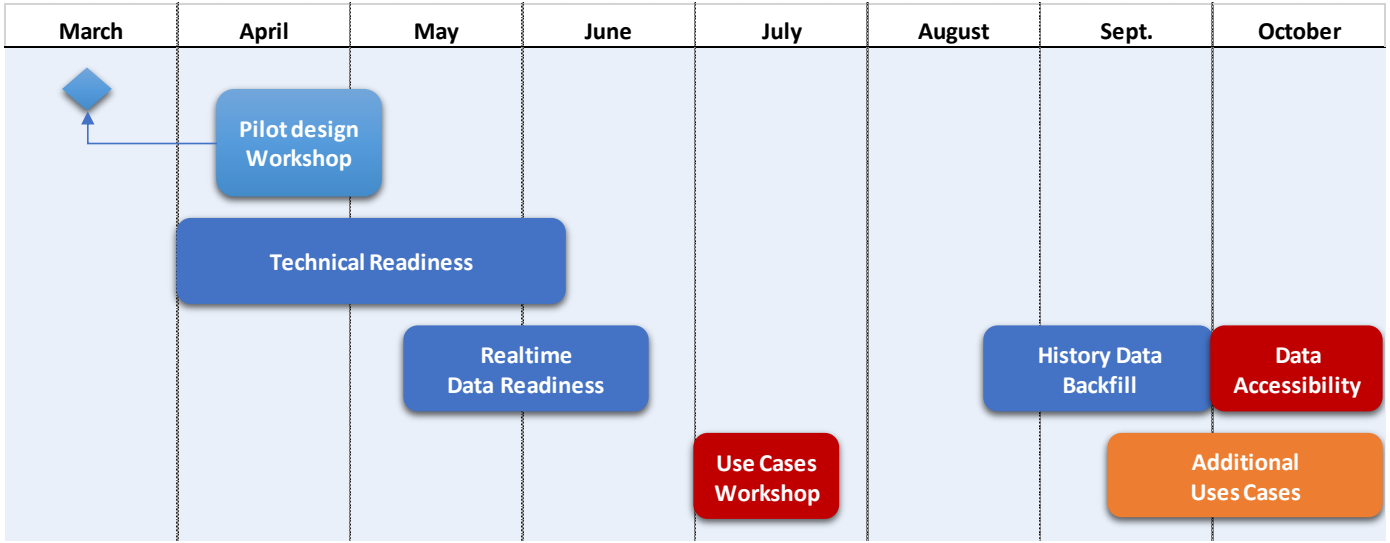
NON STANDARD CHEVRON IT VIRTUAL SERVER

On the same host we use :

- ICU OPC (PI Client interface)
- Wonderware FS Gateway (OPC DA Server)

Build time = 10 weeks

PROOF OF CONCEPT - GENERAL SCHEDULE



- Technical integration went very well and smoothly with zero impact on PCN / IT infrastructure and application landscapes.
- Chevron Process Automation Unit high expertise on PI made products implementation quite efficient.
- 11 K tags were loaded from our Wonderware platform instead of the initial 1,5K with fewer effort (thanks to PI Builder)
- We met our major milestone which was the held of a workshop
- Efforts : Business (180 hours) – IT Ops / PCN – (40 hours) – PM (350 hours)

AF TAGS & HIERARCHY BUILDOUT

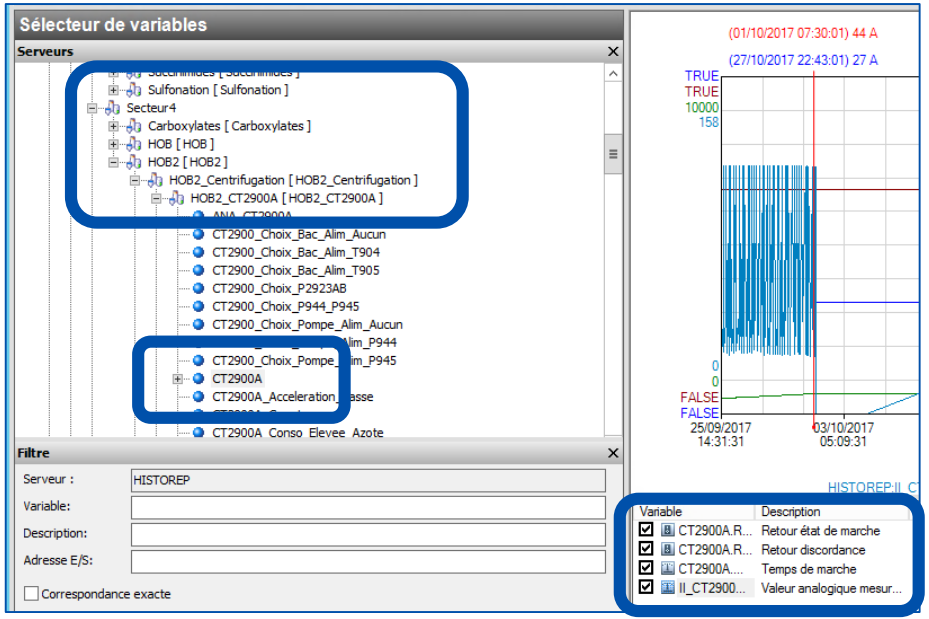
Wonderware comes with data visualization tools (Trend, Query and Workbook), familiar to business users, that enable crawling within a logical hierarchy to retrieve time series values.
Each tag is associated to a hierarchical node

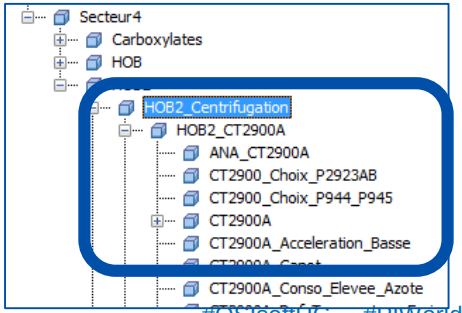
1. First goal was to **export tags** “flat” list for registration in PI Data Archive(s) and population with PI ICU (OPC)
2. Second objective was to **recreate** this entire **hierarchy** in Asset Framework and, by extension, in PI Coresight
3. **Third goal was to create element templates with appropriate attributes**
4. Third objective was to **map** tags with hierarchical structure

Data export and load phases were successfully achieved using :

- Wonderware client tools
- Extensive use of PI Builder
- Some Excel formulas make data consistency easier
- SQL queries and VBA to export and modelize hierarchy

ELAPSE TIME : 2 WEEKS





AF Elements Templates

Wonderware is an **object-oriented** SCADA development and deployment platform

It uses **templates of objects** that be can derived to create a new element / assets like in PI AF. Each template can come with multiple attributes

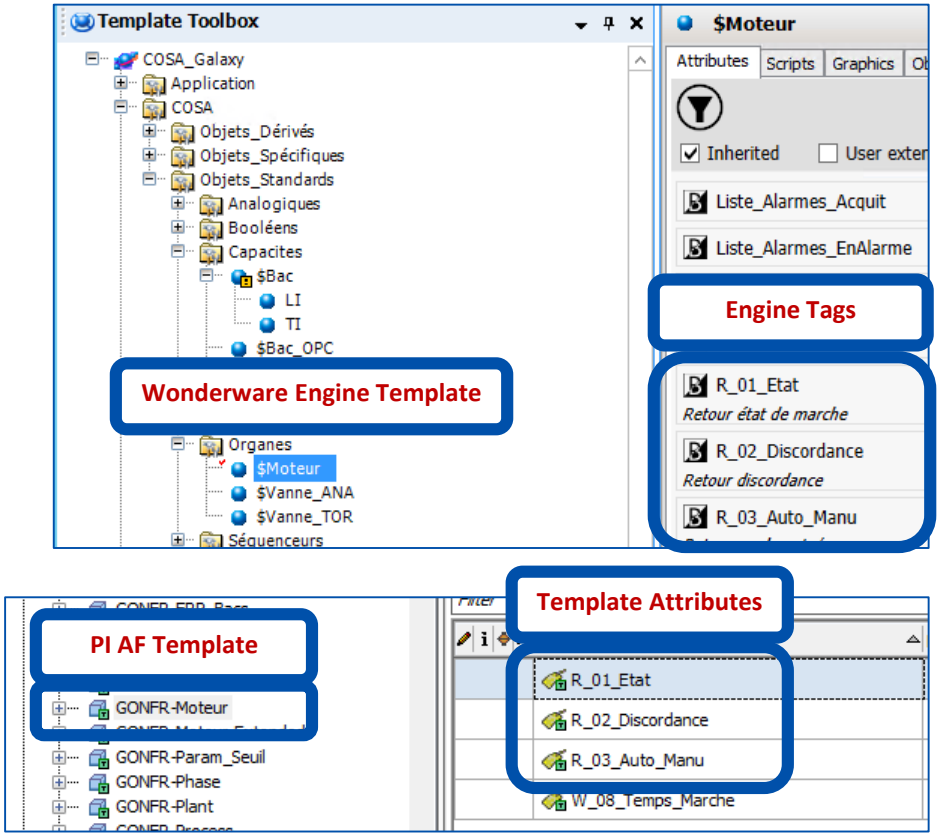
This best practice makes the creation of new equipment / attributes consistently managed.

Every individual Wonderware templates

1. Has been exported
2. Has been created in PI Explorer using PI Builder

Ultimately, mapping between templates and hierarchical node has been exported as well.

Elapse time : 1 week

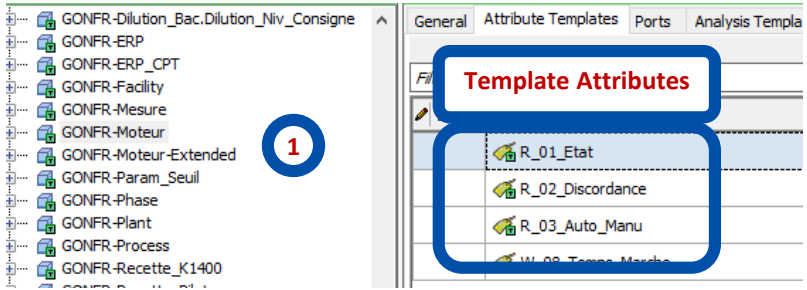


AF Elements & Templates Mapping

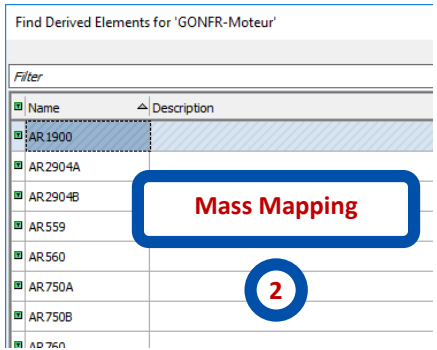
One of the objective was NOT to create all tags in PI AF.
Every template comes with the tag address named in a generic way

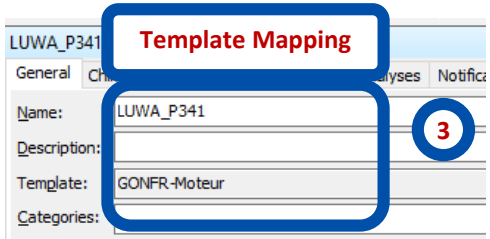
\\%Server%\%Element%.%Attribute%

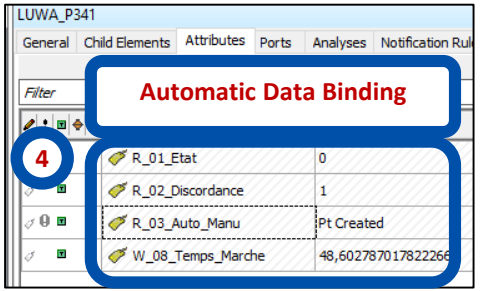
Last step consisted in mapping every PI AF element with the corresponding PI AF template which was achieved as well with PI Builder.



Elapse time : 1 week







PUMP USE CASE (ANALYSIS)

Requirement

- Reliability engineers have identified a key pump in a particular Manufacturing unit
- This pump operates well but is unique and is a key component in the process
- Engineers wish to be notified of an abnormal situation **before reaching a critical state**.
  This situation is the combination of :
  1. The pump flow rate must exceed a configurable value
  2. This excessive situation must persist during a configurable amount of time
  3. Once those conditions are met a notification email will be sent to a list of recipients

Process Data

- A PI Point exists in PI AF and hosts Wonderware Historian pump flow rate tag
- A configuration item is required to store minimum flow rate limit
- A configuration item is required to store minimum duration (excess persistence)
- A new PI Point will be used to store analysis calculation results

Conditions

- Pump has to be in an active state

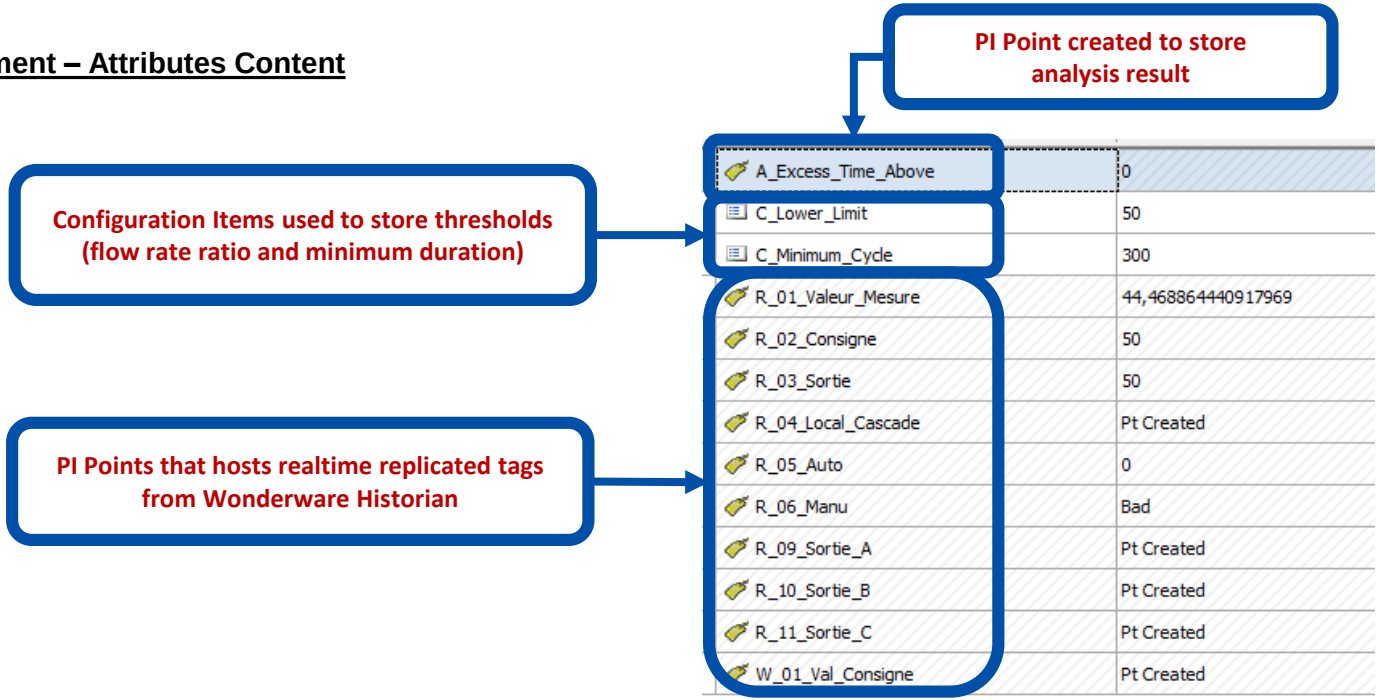
ELAPSE TIME : 2 DAYS

PUMP USE CASE (ANALYSIS)

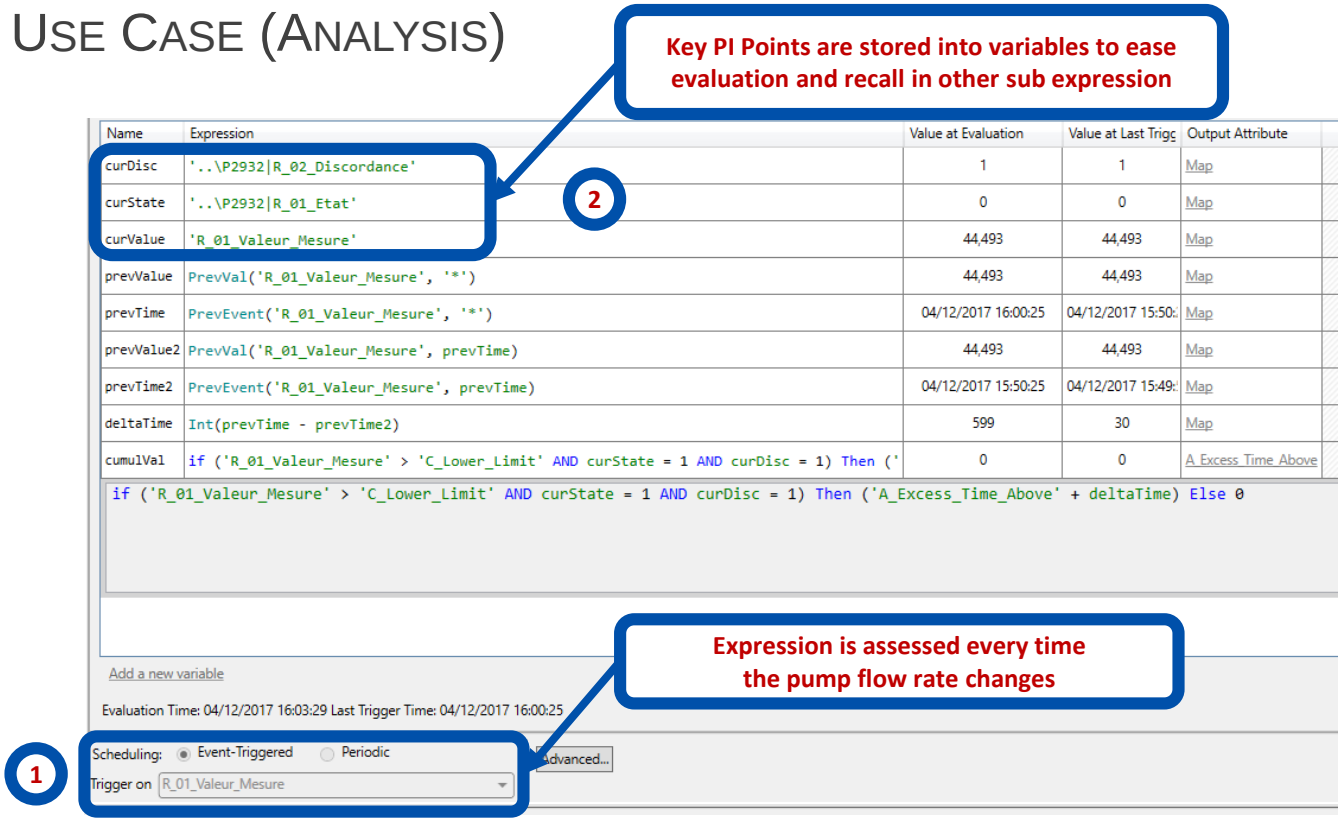
Logical Built

1. An expression was built to detect excess cumulated time and store duration (expressed in seconds) in a dedicated PI Point
2. An Event Frame triggers a notification to a list of recipients, only once after having exceeded the configurable duration

PI Element – Attributes Content



Pump Use Case (Analysis)



Pump Use Case (Analysis)

3. Special functions are used to retrieve
- PI Points values and timestamps
- For the last and penultima pump flow rate
Then the difference between the 2 timestamps is converted into an integer to enable use in formulas

3

Name	Expression			
curDisc	'..\P2932\R_02_Discordance'			
curState	'..\P2932\R_01_Etat'	0	0	Map
curValue	'R_01_Valeur_Mesure'	44,493	44,493	Map
prevValue	PrevVal('R_01_Valeur_Mesure', '*')	44,493	44,493	Map
prevTime	PrevEvent('R_01_Valeur_Mesure', '*')	04/12/2017 16:00:25	04/12/2017 15:5	Map
prevValue2	PrevVal('R_01_Valeur_Mesure', prevTime)	44,493	44,493	Map
prevTime2	PrevEvent('R_01_Valeur_Mesure', prevTime)	04/12/2017 15:50:25	04/12/2017 15:4	Map
deltaTime	Int(prevTime - prevTime2)	599	30	Map
cumulVal	if ('R_01_Valeur_Mesure' > 'C_Lower_Limit' AND curState = 1 AND curDisc = 1) Then ('	0	0	A_Excess_Time_Above

```
if ('R_01_Valeur_Mesure' > 'C_Lower_Limit' AND curState = 1 AND curDisc = 1) Then ('A_Excess_Time_Above' + deltaTime) Else 0
```

4

4. The result of expression will populate a dedicated output PI Point
is nothing but a simple IF THEN ELSE
IF Pump flow rate exceeds configurable limit
AND discordance AND pump status are both positive
THEN time difference between past and penultima PI Points will be added to the aggregated value
ELSE 0 (will be written as an output to reset the counter)

PUMP USE CASE (ANALYSIS)

3. Special functions are used to retrieve
- PI Points values and timestamps
- For the last and penultima pump flow rate
Then the difference between the 2 timestamps is converted into an integer to enable use in formulas

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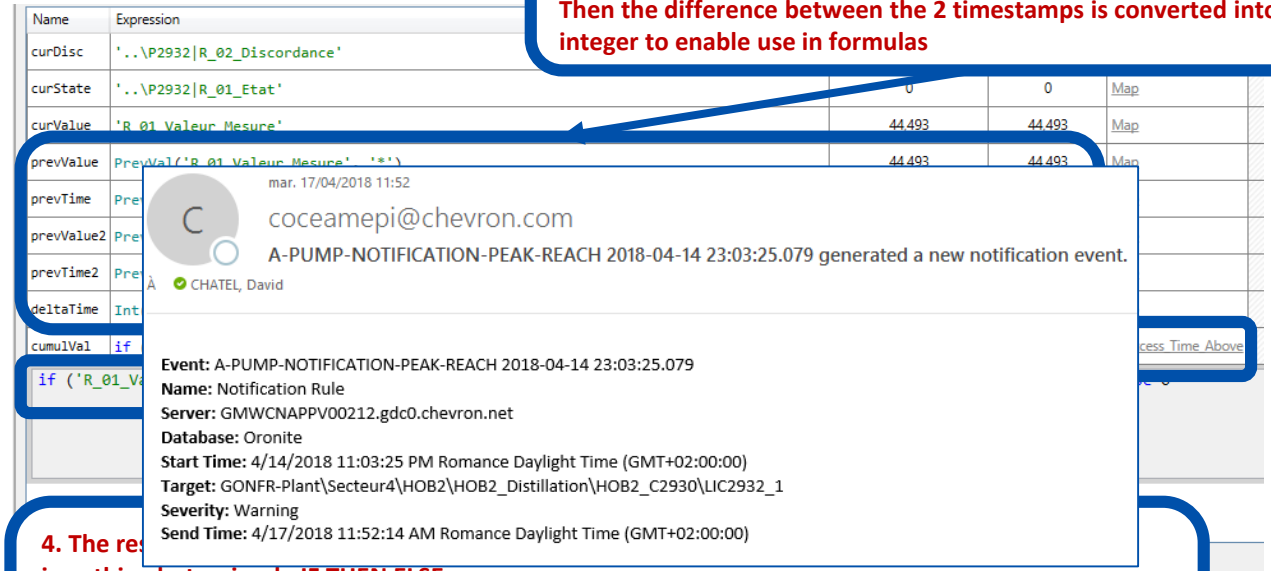

4

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IF Pump flow rate exceeds configurable limit
AND discordance AND pump status are both positive
THEN time difference between past and penultima PI Points will be added to the aggregated value
ELSE 0 (will be written as an output to reset the counter)

Centrifuge Use Case (Analysis)

Context

- Centrifuges play a key role in our processes
- Among multiple parameters, vibration rate is a very reliable indicator of asset health
- Data scale is quite reduced (expressed in millimeters) and makes abnormal state hard to see to the naked eye on a classic trend screen…and it will be very often **after the facts**

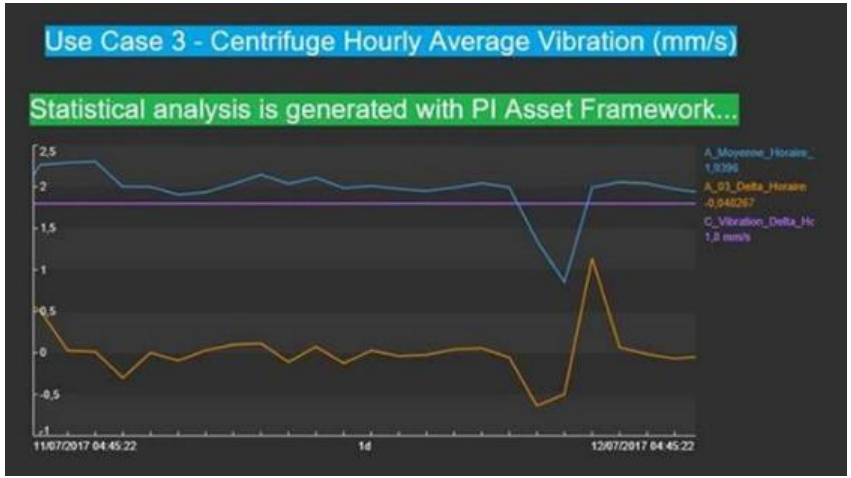
Objective

- **Anticipate progressive negative deviations** that are impossible to monitor in real time

Requirement

1. Create a common logic to all centrifuges (embedded in an element template)
2. Provide ability to configure vibration threshold on a per asset basis
3. Notify Reliability team after every reach of maximum limit

CENTRIFUGE USE CASE (ANALYSIS)



Analysis came with :

1. The calculation of an hourly vibration average rate
2. Compared with penultima hourly vibration average rate
3. The calculation of difference between the 2 past averages
4. This delta is compared with a threshold configurable by business experts
5. And the sent of a notification when delta excesses threshold

ELAPSE TIME : 1 DAY

ZINC PHASES DETECTION (EVENT FRAMES)

Context

- AF enables detection of events through the Event Frames feature
- Chevron had few opportunities to exploit this (recent) feature and Oronite wishes to identify easily batch processes
- Current situation is a manual processing of thousands of records pulled out from historian that take

Achievements

- Process engineers documented processes phases and steps in quite a synthetic document
- Efficient preparation work made execution simple

In **2 days** business users have been able to create “event frames” to detect successfully all 5 phases of the process

3 – DISTILLATION		
WFE		
V116	Stop	FIC1116.R_01_Valeur_Mesure<500
	Recycling	FIC1116.R_01_Valeur_Mesure>500 **AND** XV1117_1.R_01_Etat=TRUE
	Producing	FIC1116.R_01_Valeur_Mesure>500 **AND** XV1117_2.R_01_Etat=TRUE
V226	Stop	FIC1226.R_01_Valeur_Mesure<500
	Recycling	FIC1226.R_01_Valeur_Mesure>500 **AND** XV1226_1.R_01_Etat=TRUE
	Producing	FIC1226.R_01_Valeur_Mesure>500 **AND** XV1226_2.R_01_Etat=TRUE
V1216	Stop	FIC1216.R_01_Valeur_Mesure<500
	Recycling	FIC1216.R_01_Valeur_Mesure>500 **AND** XV1218_1.R_01_Etat=TRUE
	Producing	FIC1216.R_01_Valeur_Mesure>500 **AND** XV1218_2.R_01_Etat=TRUE

1-ACID

1 sequencer
Start and stop conditions easy to identify

→

2-NEUTRAL (DEGAZING)

2 asynchronous sub-phases
2 sequencers
Start and stop conditions easy to identify

→

2-NEUTRAL (NEUTRAL)

- 2 sub-phases
- 2 sequencers
- Only one has to be active to confirm process execution

→

3-DISTILLATION

3 tanks
- Only one has to be active to confirm process execution

→

4-FILTRATION

1 sequencer
Start and stop conditions easy to identify

ZINC PHASES DETECTION (SAMPLE OUTPUTS)

ACID PHASE

Name	10/04/2018 2... [6.18:13:04.7995598] 17/04/2018 1...	Duration	Start Time	End Time
EventFrames[ZINC-1-ACID-PHASE 2018-04-11 18:5...		140,2 Hours	11/04/2018 18:58:50.053	17/04/2018 15:08:14.866

NEUTRAL PHASE

EventFrames[ZINC-3-DISTILLATION-REPOS 2018-0...		2,4 Hours	12/04/2018 14:08:10.03	12/04/2018 16:30:40.016
EventFrames[ZINC-3-DISTILLATION-PHASE 2018-0...		27,4 Hours	12/04/2018 16:30:40.016	13/04/2018 19:54:10.069
EventFrames[ZINC-3-DISTILLATION-REPOS 2018-0...		0 Hours	13/04/2018 19:54:10.069	13/04/2018 19:54:40.085
EventFrames[ZINC-3-DISTILLATION-PHASE 2018-0...		0,2 Hours	13/04/2018 19:54:40.085	13/04/2018 20:05:10.004
EventFrames[ZINC-3-DISTILLATION-REPOS 2018-0...		86,6 Hours	13/04/2018 20:05:10.004	17/04/2018 10:42:10.008
EventFrames[ZINC-3-DISTILLATION-REPOS 2018-0...		4,5 Hours	17/04/2018 10:42:10.008	

FILTRATION PHASE

EventFrames[ZINC-4-FILTRATION-PHASE 2018-04-...		7,4 Hours	11/04/201
EventFrames[ZINC-4-FILTRATION-PHASE 2018-04-...		7,1 Hours	12/04/201
EventFrames[ZINC-4-FILTRATION-PHASE 2018-04-...		6,5 Hours	12/04/201
EventFrames[ZINC-4-FILTRATION-PHASE 2018-04-...		5,8 Hours	12/04/201
EventFrames[ZINC-4-FILTRATION-PHASE 2018-04-...		6,3 Hours	13/04/201
EventFrames[ZINC-4-FILTRATION-PHASE 2018-04-...		6,7 Hours	13/04/201

TAKEAWAY MESSAGES

1. PI Asset Framework is an ideal platform to apply **Agile methodology principles.**

2. Event Frame feature is by design **easy to use** and reveals data as they've never been seen before and **reduces drastically effort** required to identify batches, durations, etc.

3. Building an efficient analysis has **much greater** chances to succeed **only if** consistent time is dedicated with business users to understand data series, what they mean, conditions, triggers, and expected results.

4. Leverage **extensively** the Backfill/Recalculate feature on Analysis and Event Frames to control analysis consistency against past data before making logic live.

Speaker

- **David Chatel**
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- IT Project Manager
- Chevron Oronite

Questions

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

State your **name & company**

Please remember to…

Complete the Online Survey for this session

Merci

谢谢

Danke

Спасибо

Gracias

Thank You

감사합니다

ありがとう

Grazie

Obrigado

Optional: Click to add a takeaway you wish the audience to leave with.