

Techniques for Optimizing Asset Analytics

Presented by: Nathaniel Adebayo

Agenda

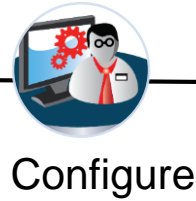
- Asset Analytics Overview
- Best Practices
 - Building expressions
 - Using Event Frames to capture critical events
 - Backfilling and Recalculations
 - Management
- Summary

Asset Analytics Overview

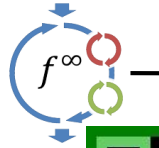
Asset Analytics

- 150+ built in functions
- Streaming calculations triggered by events or clock
- Output to PI Points for reporting and trending
- Create event frames and rollups
- Trigger notifications
- Supports templates, fully integrated into PI AF
- Backfill and Manual recalculation
- Auto-recalculation for late or out-of-order data

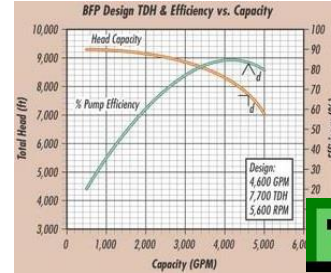
Workflow



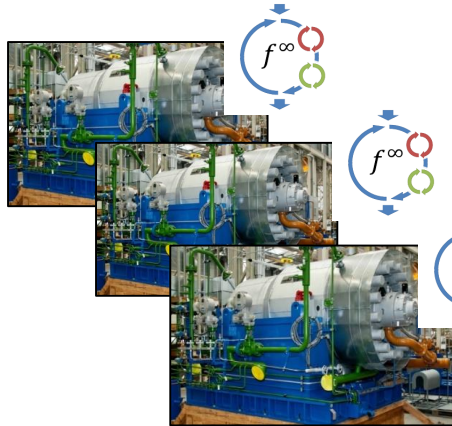
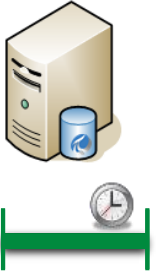
Configure



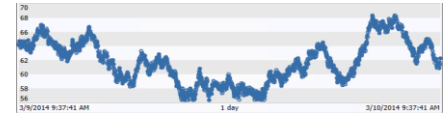
Test



Schedule



Backfill/Recalculate



A bit about Context...

The screenshot shows a software interface with two main panels. The left panel, titled 'Elements', displays a hierarchical tree structure of assets. The right panel, titled 'Unit #1', shows a detailed view of a specific unit with tabs for 'General', 'Child Elements', 'Attributes', 'Ports', and 'Analyses'. The 'Filter' tab is active, showing a list of attributes for the unit.

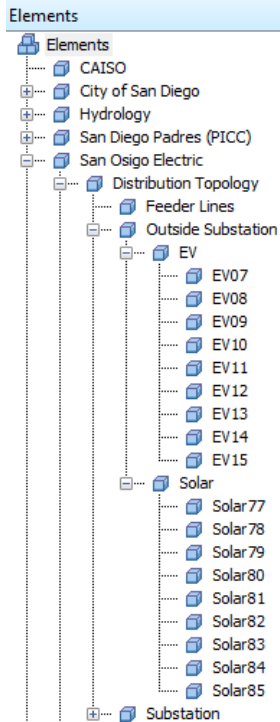
Name
Compressor Frame Vibration - High Limit
Compressor Make
Compressor Manufacturer Logo
Compressor Model
Compressor SN
Compressor Status
Compressor Suction Pressure - High Limit
Compressor Suction Pressure - Low Limit
Data Mode
Desired Intake Manifold Air Flow
DIAG_CIDFMI_AGG
Elapsed Time - Week to date
Emission Feedback Mode
Emission Feedback Status Description
ENG_A3_GAS_SHTOFF_CMD_IN
ENG_A3_START_CMD_IN

Typical use case:

I want to monitor and detect problems with my compressor, before they become catastrophic.

- AF models assets and processes
- Inputs (typically) come from the asset
- Analysis outputs are mapped on the asset

A bit about Context...

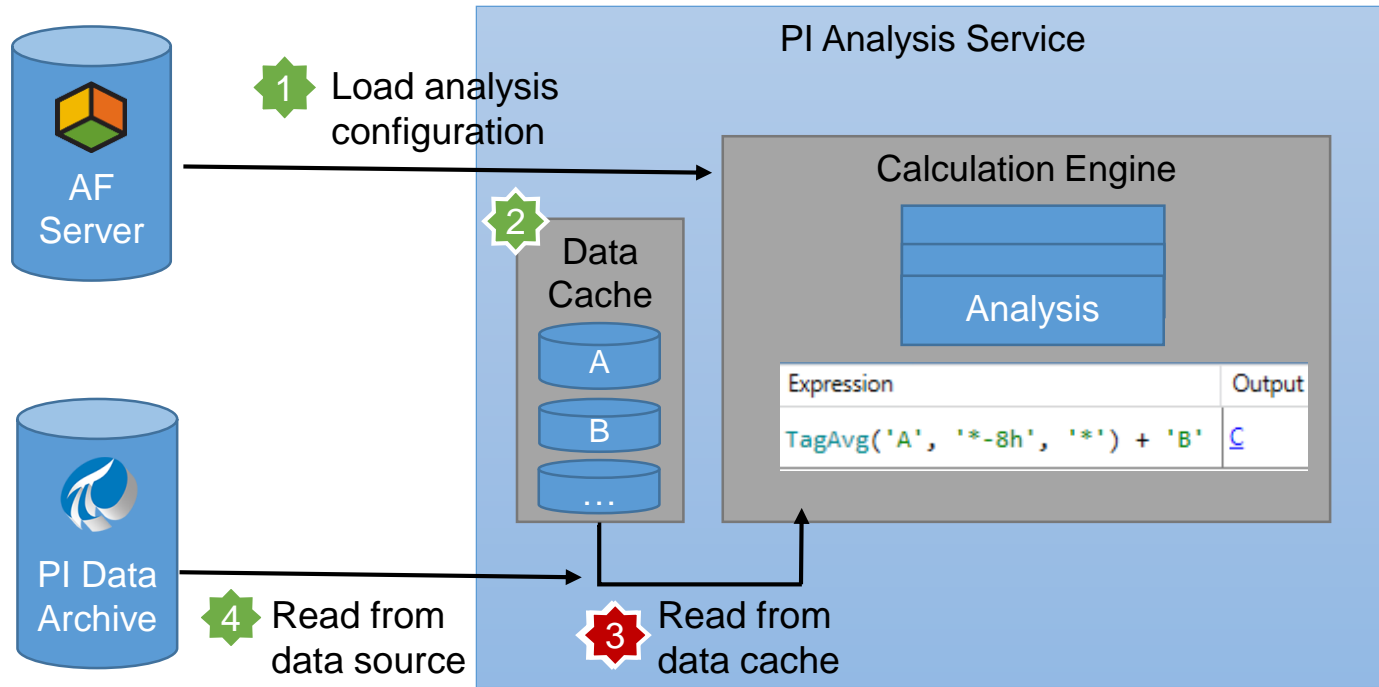


Typical use case:

I want to aggregate EV and Solar production for my substations.

- Inputs come from asset hierarchy
- Analysis outputs used in dashboards, CBM, KPIs & reports

PI Analysis Service - Overview



Design Tradeoffs

- Optimized for...
 - Streaming analytics use case
 - Real-time calculations take priority over recalculations
 - Easy configuration - no programming experience required
- Not suitable for...
 - Executing queries across really large number of attributes
 - Extracting large amounts of time series data
 - Ad-hoc calculations

Best Practices

Building Expressions

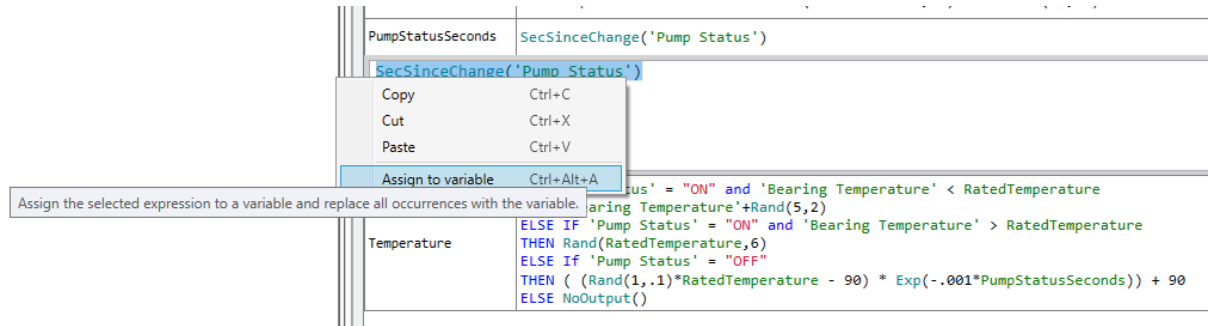
Use of variables

Add a new variable		Evaluate	
Name	Expression	Output Attribute	
RatedFlowRate	// Typical Flow Rate of the Pump 450	Map	⊗
RatedPressure	// Typical Pressure of the Pump 150	Map	⊗
RatedTemperature	// Typical Temperature of the Pump 170	Map	⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	Discharge Flow Rate	⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1, .2)	Suction Pressure	⊗
PumpStatusSeconds	SecSinceChange('Pump Status')	Map	⊗
Temperature	IF 'Pump Status' = "ON" and 'Bearing Temperature' < RatedTemperature THEN 'Bearing Temperature'+Rand(5,2) ELSE IF 'Pump Status' = "ON" and 'Bearing Temperature' > RatedTemperature THEN Rand(RatedTemperature,6) ELSE If 'Pump Status' = "OFF" THEN ((Rand(1,.1)*RatedTemperature - 90) * Exp(-.001*PumpStatusSeconds)) + 90 ELSE NoOutput()	Bearing Temperature	⊗

Building Expressions

Use of variables

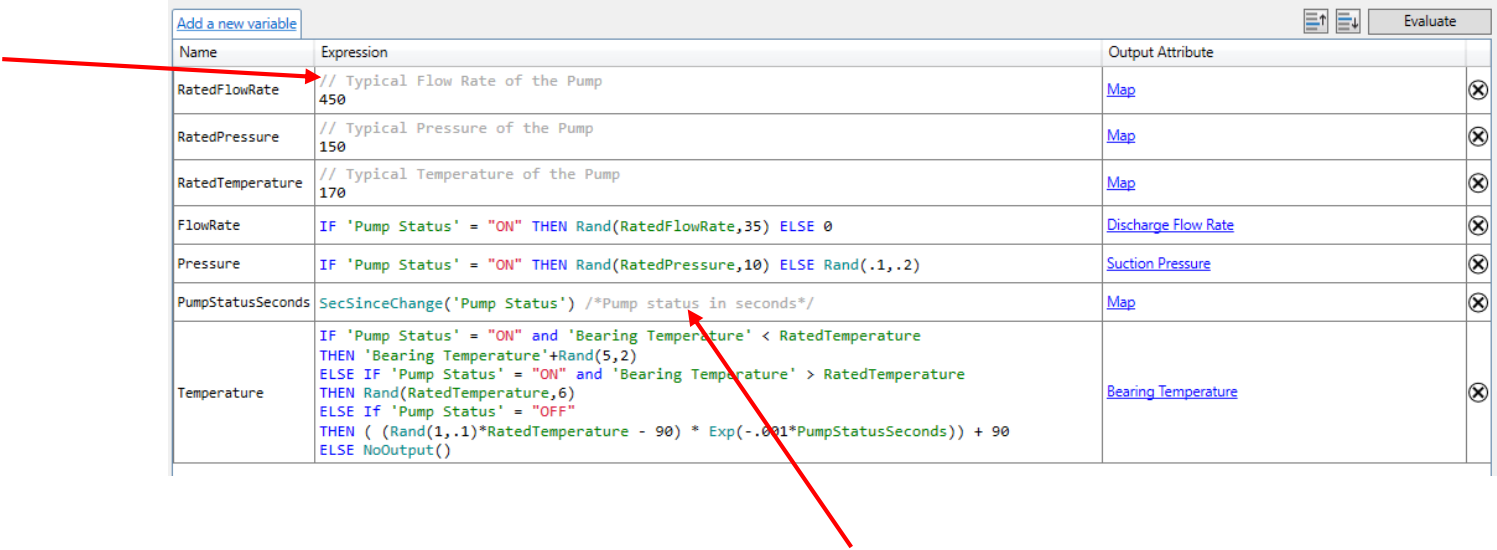
Easily assign variables to expressions, by highlighting and right-clicking on the highlighted text:



Building Expressions

Comments

Use of comments in expressions helps with readability:



Name	Expression	Output Attribute	
RatedFlowRate	// Typical Flow Rate of the Pump 450	Map	⊗
RatedPressure	// Typical Pressure of the Pump 150	Map	⊗
RatedTemperature	// Typical Temperature of the Pump 170	Map	⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	Discharge Flow Rate	⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1,.2)	Suction Pressure	⊗
PumpStatusSeconds	SecSinceChange('Pump Status') /*Pump status in seconds*/	Map	⊗
Temperature	IF 'Pump Status' = "ON" and 'Bearing Temperature' < RatedTemperature THEN 'Bearing Temperature'+Rand(5,2) ELSE IF 'Pump Status' = "ON" and 'Bearing Temperature' > RatedTemperature THEN Rand(RatedTemperature,6) ELSE If 'Pump Status' = "OFF" THEN ((Rand(1,.1)*RatedTemperature - 90) * Exp(-.001*PumpStatusSeconds)) + 90 ELSE NoOutput()	Bearing Temperature	⊗

Building Expressions

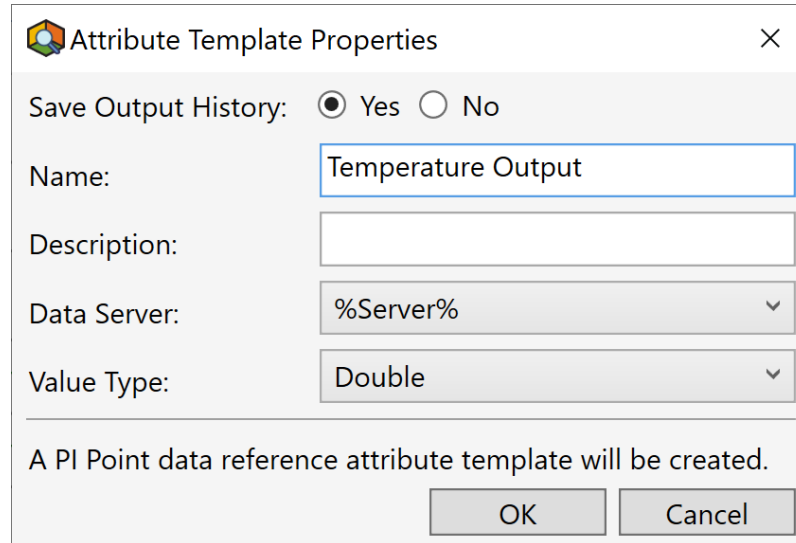
Exit early

If some expressions are not needed to be evaluated based on same conditions, the Exit() function can be used:

Name	Expression	Output Attribute	
RatedFlowRate	// Typical Flow Rate of the Pump 450	Map	⊗
RatedPressure	// Typical Pressure of the Pump 150	Map	⊗
RatedTemperature	// Typical Temperature of the Pump 170	Map	⊗
Validation	if (BadVal('Pump Status')) then Exit() else NoOutput()	Map	⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	Discharge Flow Rate	⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1,.2)	Suction Pressure	⊗
PumpStatusSeconds	SecSinceChange('Pump Status')	Map	⊗
Temperature	IF 'Pump Status' = "ON" and 'Bearing Temperature' < RatedTemperature THEN 'Bearing Temperature'+Rand(5,2) ELSE IF 'Pump Status' = "ON" and 'Bearing Temperature' > RatedTemperature THEN Rand(RatedTemperature,6) ELSE If 'Pump Status' = "OFF" THEN ((Rand(1,.1)*RatedTemperature - 90) * Exp(-.001*PumpStatusSeconds)) + 90 ELSE NoOutput()	Bearing Temperature	⊗

Historizing Data

Store data history into PI Points:



Attribute Template Properties

Save Output History: Yes No

Name:

Description:

Data Server:

Value Type:

A PI Point data reference attribute template will be created.

OK Cancel

Working with Multiple Values

Retrieve and filter data in your calculations:

Name	Expression	Value at Evaluatio	Value at Last Trigg	Output At	
BearingTemperature20	<code>RecordedValuesByCount('Bearing Temperature', '*', 20)</code>	[93.889 °F, ..., 1]	[93.889 °F, ..., 1]	Map	⊗
BearingTemperatureDay	<code>RecordedValues('Bearing Temperature', 't', '*')</code>	[109.93 °F, ..., 9]	[109.93 °F, ..., 9]	Map	⊗
BearingTemperatureFiltered	<code>FilterData(BearingTemperature_20, \$val > 110)</code>	[114.48 °F, ..., 1]	[114.48 °F, ..., 1]	Map	⊗
BearingTemperatureDayNew	<code>MapData(BearingTemperatureDay, if \$val < 100 then 100 else \$val)</code>	[109.93 °F, ..., 1]	[109.93 °F, ..., 1]	Map	⊗
BearingTemperatureDayNewMin	<code>Min(BearingTemperatureDayNew)</code>	100 °F	100 °F	Map	⊗
BearingTemperatureDayNewMax	<code>Max(BearingTemperatureDayNew)</code>	175.52 °F	175.52 °F	Map	⊗

Templates

- Provide manageability, consistency and governance
- Use templates for any repetitive work or for future extensions.
- A modification to the template is applied to all analyses from that template.
- Searching and filtering in UI is also easier with templates.
- More performant.

Evaluate

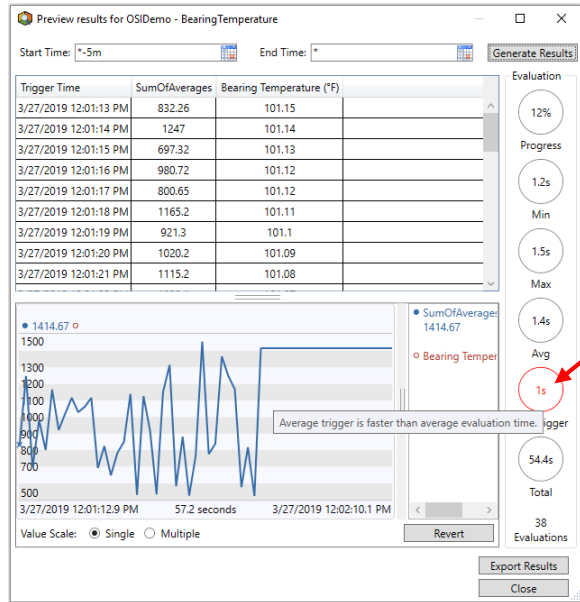
Perform an Evaluate to identify possible issues during configuration:

Name	Expression	Value at Evaluation	Value at Last Trigg	Output Attribute	
RatedFlowRate	// Typical Flow Rate of the Pump 450	450	450	Map	⊗
RatedPressure	// Typical Pressure of the Pump 150	150	150	Map	⊗
RatedTemperature	// Typical Temperature of the Pump 170	170	170	Map	⊗
Validation	if (BadVal('Pump Status')) then Exit() else NoOutput()	-	-	Map	⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	464.22	455.14	Discharge Flow Rate	⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1,.2)	152.84	150.91	Suction Pressure	⊗
PumpStatusSeconds	SecSinceChange('Pump Status')	14542 s	14400 s	Map	⊗
Temperature	IF 'Pump Status' = "ON" and 'Bearing Temperature' < RatedTemperature THEN 'Bearing Temperature'+Rand(5,2) ELSE IF 'Pump Status' = "ON" and 'Bearing Temperature' > RatedTemperature THEN Rand(RatedTemperature,6) ELSE IF 'Pump Status' = "OFF" THEN ((Rand(1,.1)*RatedTemperature - 90) * Exp(-.001*PumpStatusSeconds)) ELSE NoOutput()	170.03	170.03	Bearing Temperature	⊗

Evaluation Time: 3/19/2019 2:02:21 PM Last Trigger Time: 3/19/2019 2:00:00 PM Elapsed Evaluation Time: 3.3ms

Preview

Preview calculation before checking in:



Expensive Functions

- Some functions such as summary functions (TagAvg etc.) might require a lot of data in the past to perform a calculation.
- Optimizations can be made by using a smaller range or evaluating less often if the range is larger.
- Compression on PI points can also help with density of data.

Event Frames and Notifications

- Utilize Event Frames to capture events.
- Good for reports, comparisons and tracking.

Name	2/4/2019 11:00:33 AM	[43.04:34:05.2807465]	3/19/2019 4:34:38 PM	Duration	Start Time	End Time	De
OSIDEMO_Rig18 Rotary Drilling 2019-02-04 11:00:33.000				19:8:00:24	2/4/2019 11:00:33 AM	2/23/2019 7:00:57 PM	
OSIDEMO_Rig2 Rotary Drilling 2019-02-10 03:00:09.000				10:10:00:30	2/10/2019 3:00:09 AM	2/20/2019 1:00:39 PM	
OSIDEMO_Rig1 Rotary Drilling 2019-02-13 14:00:42.000				11:3:00:09	2/13/2019 2:00:42 PM	2/24/2019 5:00:51 PM	
OSIDEMO_Rig3 Rotary Drilling 2019-02-13 23:01:09.000				18:19:59:48	2/13/2019 11:01:09 PM	3/4/2019 7:00:57 PM	
OSIDEMO_Rig7 Rotary Drilling 2019-02-17 00:00:00.000				4:19:00:57	2/17/2019 12:00:00 AM	2/21/2019 7:00:57 PM	

- Capture data points at the close of event frame.

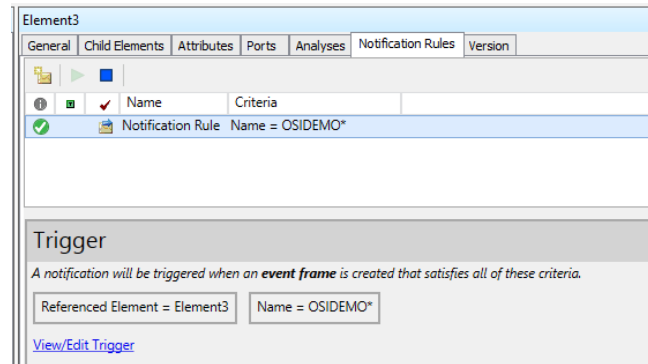
Generation Mode: Explicit Trigger Event Frame Template: Drilling Stage

Name	Expression	True for	Severity	Output Attribute	
Start triggers					
StartTrigger	'Well State' = "Drilling"	Set (optional)	None		
End trigger					
EndTrigger	'Well State' = "Completing"				⊗
Outputs at close					
Output1	TagAvg('Flow In Rate', EventFrame("StartTime"), EventFrame("EndTime"))			AverageFlowInRate	⊗

A red arrow points to the 'Output1' row in the 'Outputs at close' section.

Event Frames and Notifications

- Get notified when an event starts and/or ends.



Bulk Operations

Management

Choose a type

- Analyses
- Notification Rules

Analysis Searches

+ X

- All
- Enabled
- Disabled
- FD-Elements**

Elements

Event Frames

Library

Unit of Measure

Model Analyses

Management

Analyses

56 total analyses selected (56 on this page) 1 - 56 of 56

✓	Status	Element	Name	Template
✓	🟢	Assets/FD888	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD777	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD666	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD555	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD111	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD333	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD222	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	🟢	Assets/FD888	Current Calculations	Current Calculations
✓	🟢	Assets/FD777	Current Calculations	Current Calculations
✓	🟢	Assets/FD666	Current Calculations	Current Calculations
✓	🟢	Assets/FD555	Current Calculations	Current Calculations
✓	🟢	Assets/FD111	Current Calculations	Current Calculations
✓	🟢	Assets/FD333	Current Calculations	Current Calculations
✓	🟢	Assets/FD222	Current Calculations	Current Calculations
✓	🟢	Assets/FD888	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD777	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD666	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD555	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD111	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD333	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD222	OSIDemo_SimulatedData	OSIDemo_SimulatedData
✓	🟢	Assets/FD888	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟢	Assets/FD777	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟢	Assets/FD666	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟢	Assets/FD555	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟢	Assets/FD333	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟢	Assets/FD222	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟢	Assets/FD111	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	🟡	Assets/FD888	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟡	Assets/FD777	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟡	Assets/FD666	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟡	Assets/FD555	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟡	Assets/FD333	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟡	Assets/FD222	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟡	Assets/FD111	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	🟢	Assets/FD888	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Low
✓	🟢	Assets/FD777	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Low
✓	🟢	Assets/FD666	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Low
✓	🟢	Assets/FD555	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Low
✓	🟢	Assets/FD333	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Low

Operations

[Enable](#) | [Disable](#) selected analyses

[Enable](#) | [Disable](#) automatic recalculation for selected analyses

[Queue](#) | [Cancel](#) backfilling or recalculation for selected analyses

Pending Operations

No pending operations

Recalculation/Backfilling

- Real-time vs Recalculation: Independent workers.
- Recalculate dependent analyses:

Backfilling or recalculation for Analysis Template

Start Time: *-1d

End Time: *

What should we do with existing data?

Leave existing data and fill in gaps

Permanently delete existing data and recalculate

Recalculate dependent analyses

Recalculation time range for dependent analyses may get expanded depending on analysis configuration.

Ready to recalculate from 3/17/2019 2:51:56 PM to 3/18/2019 2:51:56 PM

Start Cancel

Operations

[Enable](#) | [Disable](#) selected analyses

[Enable](#) | [Disable](#) automatic recalculation for selected analyses

[Queue](#) | [Cancel](#) backfilling or recalculation for selected analyses

Start *-1d

End *

What should we do with existing data?

Leave existing data and fill in gaps

Permanently delete existing data and recalculate

Recalculate dependent analyses

Recalculation time range for dependent analyses may get expanded depending on analysis configuration.

Queue

Recalculation will permanently delete all the data within the time range. For event frames this will result in loss of annotations and acknowledgements.

Auto-Recalculation

- Enable auto-recalculation when:
 - Out of order data is expected and
 - It is required to recalculate past data.
- Don't enable auto-recalculation when:
 - Past data shouldn't be modified
 - Past data from dependent calculations shouldn't be modified.

Change Management

- Consider setting up Dev or Test environment
 - Allows for experimentation while developing calculations
 - Many engineers could be writing calculations
 - Frequent changes can cause some churn for the production system
 - Easier to isolate issues

High Availability

- PI Analysis Service supports failover using Windows Server Failover Clustering (WSFC)
- Use buffering for writing PI Point outputs (PI Buffer Subsystem)

More Resources

- Incorporate Event Frames into Your Operations (up next!)
- PI Square (Asset Analytics Best Practices)
<https://pisquare.osisoft.com>

High Availability

- PI Analysis Service supports failover using Windows Server Failover Clustering (WSFC)
- Use buffering for writing PI Point outputs (PI Buffer Subsystem)

Summary

Summary

1. Use variables
2. Use comments
3. Use the Exit() function
4. Save analysis output data to PI Points
5. Build Analytics on a template
6. Avoid expensive, frequently evaluated queries using summary functions such as TagAvg()



Nathaniel Adebayo
Systems Engineer
OSIsoft LLC
nadebayo@osisoft.com

Questions?

Please wait for
the **microphone**

State your
name & company



Please remember

TO DOWNLOAD
APP, SEARCH
OSISOFT



謝謝 KEA LEBOHA
 TAPADH LEIBH 고맙습니다
 БАЯРЛАЛАА MISAOTRA ANAO
 DZIĘKUJĘ CI NGIYABONGA TEŞEKKÜR EDERIM GRACIES OBRIGADO شكرا SALAMAT
 DANKON TANK TAPADH LEAT
 KÖSZÖNÖM DANKIE TERIMA KASIH GRACIES
 СПАСИБО
 PAKMET CIZGE
 GO RAIBH MAITH AGAT
 БЛАГОДАРЯ GRACIAS MAHADSANID
 TI БЛАГОДАРАМ
 TAK DANKE MAHADSANID
 RAHMAT MERCI
 HATUR NUHUN
 GRAZZI ПAKKA PĒR
 PAXMAT САГА
 CẢM ƠN BẠN
 WAZVIITA
 FALEMINDERIT
 TI БЛАГОДАРАМ СИПОС
 EΥΧΑΡΙΣΤΩ GRATIAS TIBI
 AČIŪ SALAMAT MAHALO IĀ 'ŌE TAKK SKALDU HA
 ありがとうございます
 SIPAS JI WERE TERIMA KASIH
 UA TSAUG RAU KOJ
 TI БЛАГОДАРАМ СИПОС
 MULȚUMESC
 HVALA FAAFETAI
 ESKERRIK ASKO
 HVALA ХВАЛА ВАМ
 TEŞEKKÜR EDERIM
 GRAZIE
 DI OU MÈSI
 ĎAKUJEM
 MATUR NUWUN



OSIsoft.

PIWorld

THANK YOU