

# Getting more out of Asset Analytics

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# Agenda

- Asset Analytics overview
- Best practices
  - Building expressions
  - Using Event Frames to capture critical events
  - Backfilling and recalculations
  - Management
- Summary

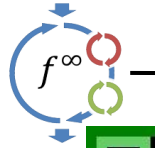
# Asset Analytics

- 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

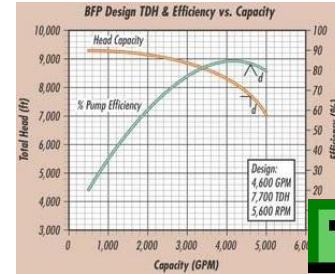
# Workflow



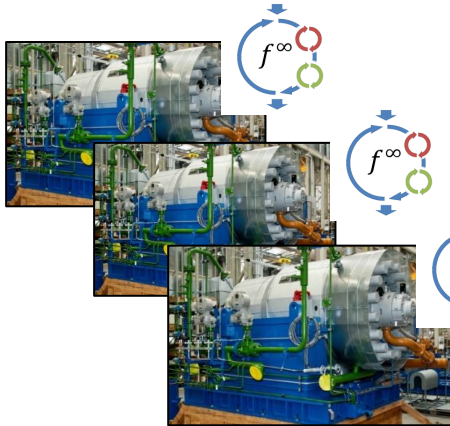
Configure



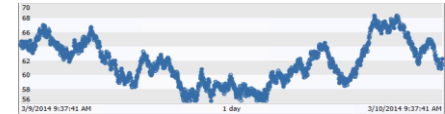
Test



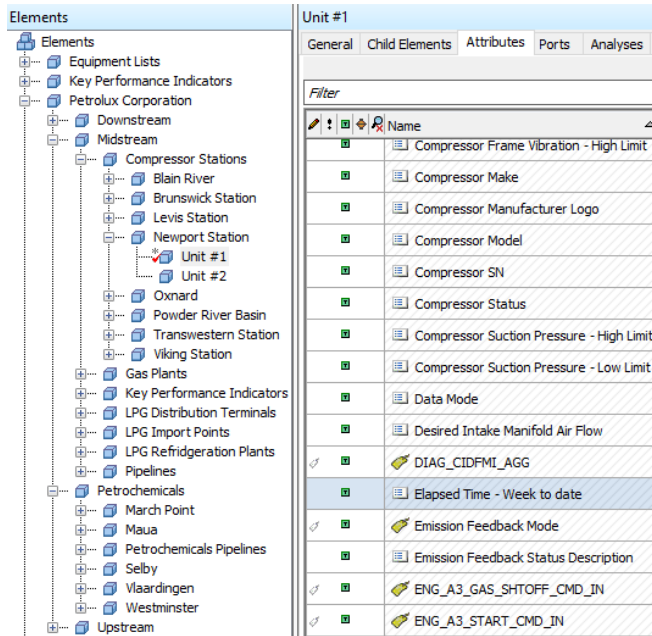
Schedule



Backfill/Recalculate



# A bit about Context...

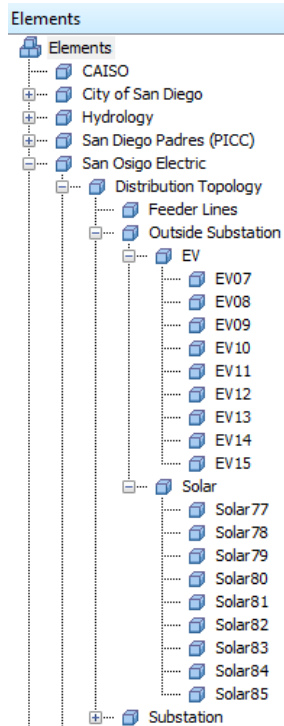


Typical use case:

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...

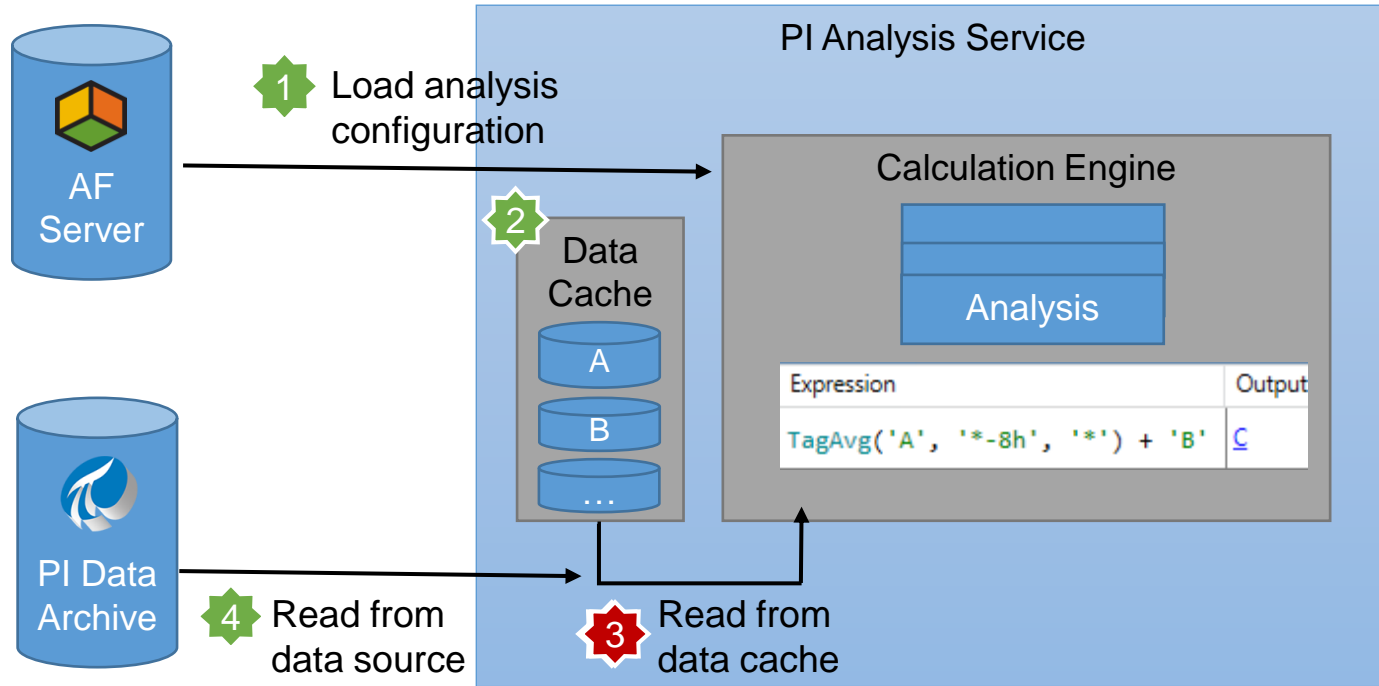


Typical use case:

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



# Building Expressions

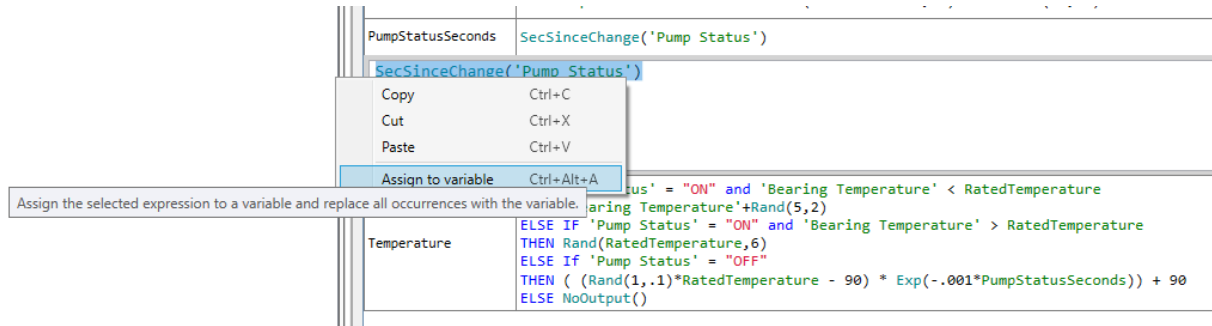
## Use of variables

Add a new variable				Evaluate	
Name	Expression	Output Attribute			
RatedFlowRate	// Typical Flow Rate of the Pump 450	<a href="#">Map</a>			⊗
RatedPressure	// Typical Pressure of the Pump 150	<a href="#">Map</a>			⊗
RatedTemperature	// Typical Temperature of the Pump 170	<a href="#">Map</a>			⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	<a href="#">Discharge Flow Rate</a>			⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1,.2)	<a href="#">Suction Pressure</a>			⊗
PumpStatusSeconds	SecSinceChange('Pump Status')	<a href="#">Map</a>			⊗
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()	<a href="#">Bearing Temperature</a>			⊗

# 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:

Add a new variable			Evaluate
Name	Expression	Output Attribute	
RatedFlowRate	// Typical Flow Rate of the Pump 450	<a href="#">Map</a>	⊗
RatedPressure	// Typical Pressure of the Pump 150	<a href="#">Map</a>	⊗
RatedTemperature	// Typical Temperature of the Pump 170	<a href="#">Map</a>	⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	<a href="#">Discharge Flow Rate</a>	⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1,.2)	<a href="#">Suction Pressure</a>	⊗
PumpStatusSeconds	SecSinceChange('Pump Status') /*Pump status in seconds*/	<a href="#">Map</a>	⊗
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()	<a href="#">Bearing Temperature</a>	⊗

# Building Expressions

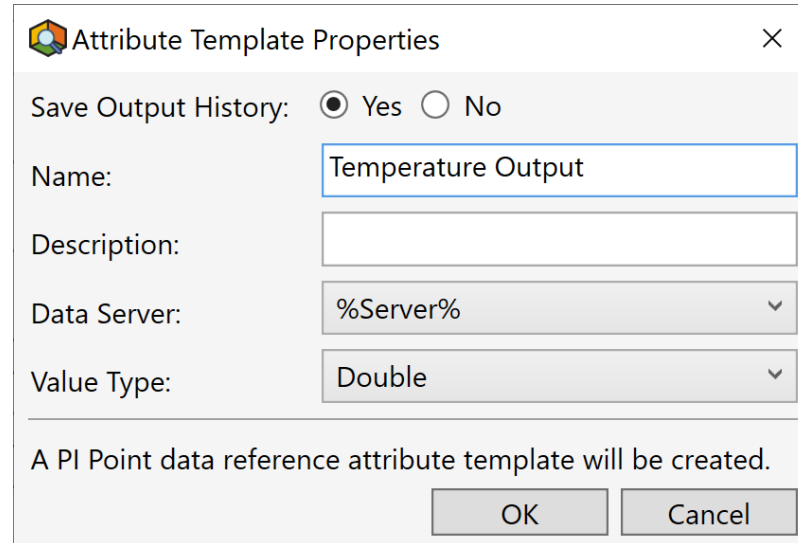
## Exit early

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

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	⊗
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:



The image shows a screenshot of the 'Attribute Template Properties' dialog box. The dialog has a title bar with a close button (X) and a small icon. Inside, there are several fields and controls:

- Save Output History:** A group box containing two radio buttons: 'Yes' (selected) and 'No'.
- Name:** A text input field containing 'Temperature Output'.
- Description:** An empty text input field.
- Data Server:** A dropdown menu showing '%Server%'.
- Value Type:** A dropdown menu showing 'Double'.
- Footer:** A message 'A PI Point data reference attribute template will be created.' and two buttons: 'OK' and 'Cancel'.

# Working with Multiple Values

Retrieve and filter data in your calculations:

Add a new variable						Evaluate	
Name	Expression	Value at Evaluation	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 &gt; 110)</code>	[114.48 °F, ..., 1	[114.48 °F, ..., 1	Map			⊗
BearingTemperatureDayNew	<code>MapData(BearingTemperatureDay, if \$val &lt; 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

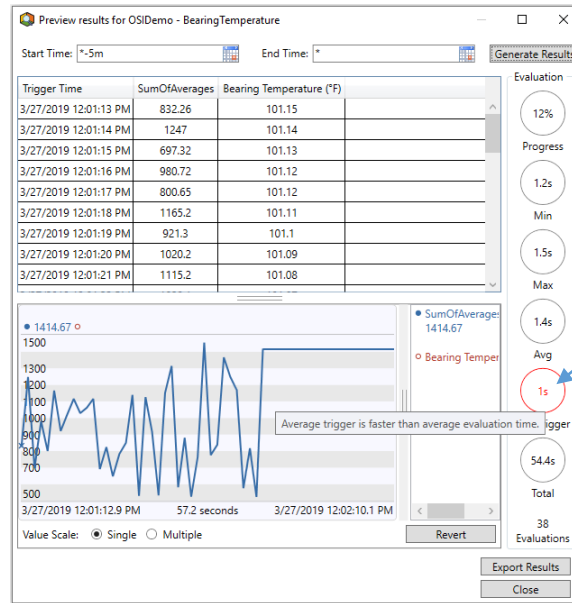
Perform an Evaluate to identify possible issues during configuration:

Add a new variable					Evaluate
Name	Expression	Value at Evaluation	Value at Last Trigger	Output Attribute	
RatedFlowRate	// Typical Flow Rate of the Pump 450	450	450	<a href="#">Map</a>	⊗
RatedPressure	// Typical Pressure of the Pump 150	150	150	<a href="#">Map</a>	⊗
RatedTemperature	// Typical Temperature of the Pump 170	170	170	<a href="#">Map</a>	⊗
Validation	if (BadVal('Pump Status')) then Exit() else NoOutput()	-	-	<a href="#">Map</a>	⊗
FlowRate	IF 'Pump Status' = "ON" THEN Rand(RatedFlowRate,35) ELSE 0	464.22	455.14	<a href="#">Discharge Flow Rate</a>	⊗
Pressure	IF 'Pump Status' = "ON" THEN Rand(RatedPressure,10) ELSE Rand(.1,.2)	152.84	150.91	<a href="#">Suction Pressure</a>	⊗
PumpStatusSeconds	SecSinceChange('Pump Status')	14542 s	14400 s	<a href="#">Map</a>	⊗
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	<a href="#">Bearing Temperature</a>	⊗
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

Add... Evaluate

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

# Event Frames and Notifications

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

Element3

General Child Elements Attributes Ports Analyses Notification Rules Version

	Name	Criteria
Notification Rule	Name = OSIDEMO*	

Trigger

A notification will be triggered when an **event frame** is created that satisfies all of these criteria.

Referenced Element = Element3    Name = OSIDEMO\*

[View/Edit Trigger](#)

# Bulk Operations

**Management**

Choose a type

- ☒ Analyses
- ☐ Notification Rules

Analysis Searches

+ X

All

Enabled

Disabled

FD-Elements

**Analyses**

56 total analyses selected (56 on this page)

1 - 56 of 56

✓	Status	Element	Name	Template
✓	✓	f\ Assets\FD888	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD777	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD666	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD555	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD111	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD333	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD222	Average Power - 15 Minutes	Average Power - 15 Minutes
✓	✓	f\ Assets\FD888	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD777	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD666	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD555	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD111	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD333	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD222	Current Calculations	Current Calculations
✓	✓	f\ Assets\FD888	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD777	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD666	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD555	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD111	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD333	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD222	OSIdemo_SimulatedData	OSIdemo_SimulatedData
✓	✓	f\ Assets\FD888	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD777	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD666	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD555	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD333	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD222	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD111	OSIdemo_SimulatedData_Power	OSIdemo_SimulatedData_Power
✓	✓	f\ Assets\FD888	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD777	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD666	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD555	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD333	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD222	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD111	Voltage Phase Limit Violation High	Voltage Phase Limit Violation Hig
✓	✓	f\ Assets\FD888	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Lov
✓	✓	f\ Assets\FD777	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Lov
✓	✓	f\ Assets\FD666	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Lov
✓	✓	f\ Assets\FD555	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Lov
✓	✓	f\ Assets\FD333	Voltage Phase Limit Violation Low	Voltage Phase Limit Violation Lov

**Operations**

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

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

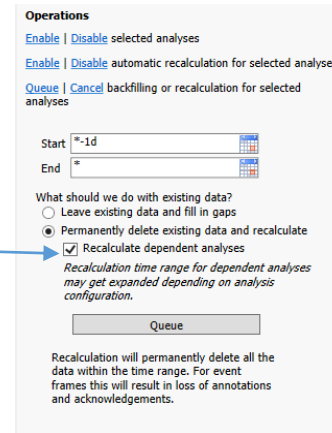
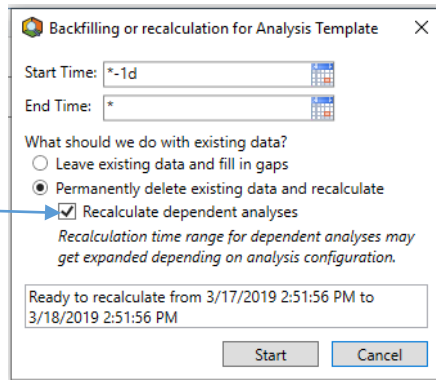
[Queue](#) | [Cancel](#) backfilling or recalculation for selected analyses

**Pending Operations**

No pending operations

# Recalculation/Backfilling

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



# 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.

# Auto-backfilling

- Enable Auto-backfilling to fill gaps automatically between service restarts.
- Analyses are queued for backfilling at start of service.



# 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

- Contextualize: Rolling out Asset Framework (PI World 2019, Day 3 Best Practices)
- PI Square



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# Questions?

Please wait for  
the **microphone**

State your  
**name & company**



# Please remember

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謝謝 KEA LEBONA  
TAPADH LEIBH 고맙습니다  
BAЯPЛAЛAА MISAOTRA ANAO  
DZIĘKUJĘ CI NGIYABONGA TEŞEKKÜR EDERIM GRACIES  
OBRIGADO شڪرا SALAMAT  
DANKON TANK TAPADH LEAT  
DANKIE TERIMA KASIH  
KÖSZÖNÖM  
СПАСИБО  
PAKMET CIZGE  
GO RAIBH MAITH AGAT  
БЛАГОДАРЯ GRACIAS  
ТИ БЛАГОДАРАМ  
MAHADSANID  
TAK DANKE  
RAHMAT  
HATUR NUHUN  
MERCİ  
CẢM ƠN BẠN  
WAZVIITA  
FALEMINDERIT  
DANK JE  
ΕΥΧΑΡΙΣΤΩ GRATIAS TIBI  
AČIŲ SALAMAT MAHALO IĀ 'OE TAKK SKALDU HA  
GRAZZI PAKKA PĒR  
PAXMAT CAĞA  
SIPAS JI WERE TERIMA KASIH  
UA TSAUG RAU KOJ  
ТИ БЛАГОДАРАМ  
СИПОС  
MULTUMESC  
FAAFETAİ  
ESKERRIK ASKO  
HVALA ХВАЛА ВАМ  
TEŞEKKÜR EDERIM  
HVALA  
DZЯKYI  
DI OU MÈSI  
ĐAKUJEM  
MATUR NUWUN