Visualizing PI System Data

November 2020
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1. PI SYSTEM BASICS

What is a PI System?

Learning Outcomes

After completing this topic, you should be able to:

- Define the components of a PI System.
- Draw a diagram of the architecture of a PI System.

The PI System

The PI System was originally developed by OSIsoft to collect Plant Information from PLC, DCS and SCADA systems. The PI System collects, stores, and manages time stamped data. This data may have timestamps in the past, current or future.

Components of a PI System are:

- Computers with a PI Interface collect data (known as points or tags) from a data source. These interface nodes get data from your data sources and send it to the Data Archive. This data may be collected from a variety of places, such as:
  - the plant, weather stations,
  - IT networks,
  - location data for trucks,
  - Telemetry from monitoring systems.

- Data is stored in the Data Archive in such a way as to make user retrieval as efficient as possible. The data is accessible to users in different ways: directly or via tools providing context.

- Accessing the data in context is provided by linking the data points to assets defined in an Asset Framework (AF) system.

- To visualize the data collected and stored, users use tools in the Visualization Suite:
  - PI Vision (browser-based graphs and symbols),
  - PI Datalink (a Windows based Excel add in),
This diagram shows the 3 main categories and components of a typical PI System:

Architecture of a PI System

The architecture varies from simple to complex; some customers may have only a single interface sending data to a single Data Archive. There are many more combinations and configurations of the PI software components, so make sure to ask your PI System administrator about how your infrastructure is laid out.
Here is a conceptual diagram as an example:

Quick Check

Having completed this topic, are you able to:

- Define the components of a PI System?
- Draw a diagram of the architecture of a PI System?

If you answered NO to any of these questions, ask your instructor for assistance.
Building Blocks of the PI System

LEARNING OUTCOMES

- Define the terms of Asset Framework (AF) and its components: elements and attributes.
- Define AF attribute types: static (none), PI Point, point array, formula, string builder, table lookup and Analysis.

What is an AF Element/Asset?

<table>
<thead>
<tr>
<th>Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
</tr>
<tr>
<td>Wind Farm</td>
</tr>
<tr>
<td>Northeast</td>
</tr>
<tr>
<td>New York</td>
</tr>
<tr>
<td>NY001</td>
</tr>
<tr>
<td>NY002</td>
</tr>
<tr>
<td>NY003</td>
</tr>
</tbody>
</table>

In Asset Framework, company locations, sites, processes and each piece of equipment is represented by an **Element**. Company **Assets** may be defined with an AF Element. The AF encourages organization of assets into a structure that makes it easier to find information.

A self-explanatory element structure for assets goes a long way to help users find the data they are seeking. With well-defined elements showing context for the assets, data can be located without the user needing to understand the technical details of each piece of equipment. The AF element structure assists in promoting a hierarchical and logical organization of assets.

What is an AF Attribute?

<table>
<thead>
<tr>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
</tr>
<tr>
<td>Anemometer</td>
</tr>
<tr>
<td>Wind Speed</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Farm Lifetime Production (Hours)</td>
</tr>
<tr>
<td>Farm Lifetime Production (KWh)</td>
</tr>
<tr>
<td>Lost Power</td>
</tr>
<tr>
<td>Power Production</td>
</tr>
</tbody>
</table>

Attributes represent a single property associated with an asset element. Attributes hold values that can represent:

- static information, such as the diameter of a tank
- a PI point stored in the Data Archive, such as the current temperature of the tank contents
- formulas
- values linked to tables in relational databases
- values held in internal AF tables
- values derived from AF analytics

**Note:** All relevant data about an asset is grouped together with AF Attributes on AF Elements. This allows users to build displays and reports that maintain a complete view of the company’s assets.
What is a PI Point?

A PI Point (sometimes referred to as a tag) is a unique storage point for data in the Data Archive. It is a single point of measurement and has a value with a timestamp, such as a temperature of 31.2 °C on 2019-Dec-24 23:59.

Point name

Points stored in the Data Archive each have a unique name. It is a common practice to name the PI Points based on Control Systems point names. Since the point is the name that identifies the point to users, a consistent point-naming convention should be used that is meaningful to people in your organization. Knowing the naming convention can be helpful in searching for points.

Try to determine what the following point may refer to:

**M03_E1P1_MOTDRV1202_RUNSTAT**

It refers to - Machine3 Enclosure 1 Panel 1 Motor Drive 1202 Run Status.

Is this intuitive? Probably not, unless you have spent time memorizing the equipment’s naming conventions.

Most of the time, the PI Points themselves are not going to be easy enough for users to work with; therefore, OSIsoft recommends developing your Asset Framework hierarchy to leverage the very “human friendly” nature of AF Attributes on AF Assets. Building an intuitive AF structure will make end users’ work much easier to accomplish.
LEARNING OUTCOMES

- Understand PI time expressions
- Explain the differences between fixed and reference times
- Use time offsets
- Understand the effect of DST on the retrieval of PI point data.

When searching for data in PI you will use a timestamp since most PI data is time series data and this data has a timestamp associated with it. We can use a special syntax, called PI time, to specify inputs for timestamps and time intervals in the PI client applications, for example PI Vision. PI time uses specific abbreviations and rules in building valid time expressions.

2.1 PI Time Expressions

In PI there are two ways to specify time:

**Fixed Time**: An expression that signifies a specific date and time. Used when you want to save a view of your PI System data for a specific time in history.

Example: A user is creating a report that investigates an equipment failure event which occurred on the 15th of April 2020 at 11 am, so the date expression may be written as 15-Apr-2020 11:00:00 AM

**Reference Time**: An expression that signifies a date and time relative to the current date and time. This may be used when you want to create a dynamic view of your data, which can be used to view data in real-time, or re-used on a periodic basis to create periodic reports.

Example: A user creates a report that summarizes weekly production totals. By using relative time expressions, the user will be able to re-use this report every week, so define a start date of “Monday”, meaning start the report from last Monday.

Both Fixed Time and Reference Time can be used with Time Offsets. Time Offsets may be used alone.
Fixed Time Syntax

A fixed time expression is an expression which includes a date, and optionally a time. When the time component is omitted, **Midnight** is assumed and it occurs at the beginning of the day, not the end.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-jan-88 12:34</td>
<td>12:34 p.m. on January 26, 1988</td>
</tr>
<tr>
<td>25-sep-19</td>
<td>00:00:00 (midnight) on September 25, 2019</td>
</tr>
</tbody>
</table>

The PI System interprets many different formats for fixed time. In the event of an ambiguous input, the Windows Region and Language settings of the computer where the PI client tool is installed take precedence.

Note the following:

<table>
<thead>
<tr>
<th>Expression</th>
<th>Region and Language Format</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/5/2020</td>
<td>English (United States)</td>
<td>00:00:00 (midnight) on January 5th 2020</td>
</tr>
<tr>
<td>1/5/2020</td>
<td>Rest of the world</td>
<td>00:00:00 (midnight) on May 1st 2020</td>
</tr>
</tbody>
</table>

Reference Time Syntax

A reference-time abbreviation represents a time relative to the current time.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Reference time</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>Now</td>
<td>Current time</td>
</tr>
<tr>
<td>t</td>
<td>today</td>
<td>00:00:00 (midnight) of the current day</td>
</tr>
<tr>
<td>y</td>
<td>yesterday</td>
<td>00:00:00 (midnight) of the previous day</td>
</tr>
<tr>
<td>fri</td>
<td>friday</td>
<td>00:00:00 (midnight) on the most recent Friday</td>
</tr>
<tr>
<td>may</td>
<td>may</td>
<td>00:00:00 (midnight) on the current day in May of the current year</td>
</tr>
<tr>
<td>apr-15</td>
<td>april-15</td>
<td>00:00:00 (midnight) on the 15th day of April in the current year</td>
</tr>
<tr>
<td>YYYY</td>
<td>Year</td>
<td>00:00:00 (midnight) on the current day and month in year YYYY</td>
</tr>
<tr>
<td>M-D or M/D</td>
<td>USA</td>
<td>00:00:00 (midnight) on the Dth day of month M in the current year</td>
</tr>
<tr>
<td>D-M, D/M</td>
<td>Rest of the world</td>
<td>00:00:00 (midnight) on the Dth day of month M in the current year</td>
</tr>
</tbody>
</table>
Visualizing PI System Data

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Reference time</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td></td>
<td>00:00:00 (midnight) on the 15th day of the current month</td>
</tr>
</tbody>
</table>

Use the first three letters as an abbreviation for any day of the week and any month of the year.

For example:

<table>
<thead>
<tr>
<th>Expression</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>thu</td>
<td>00:00:00 (midnight) on the most recent Thursday</td>
</tr>
<tr>
<td>apr</td>
<td>00:00:00 (midnight) on the current day in April of the current year</td>
</tr>
</tbody>
</table>

**Time Offset**

When specifying PI time use specific abbreviations that represent time units. These are used in constructing *Time Offsets* as in the table.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Time Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>second</td>
</tr>
<tr>
<td>m</td>
<td>minute</td>
</tr>
<tr>
<td>h</td>
<td>hour</td>
</tr>
<tr>
<td>d</td>
<td>day</td>
</tr>
<tr>
<td>mo</td>
<td>month</td>
</tr>
<tr>
<td>y</td>
<td>year</td>
</tr>
<tr>
<td>w</td>
<td>week</td>
</tr>
</tbody>
</table>

Specify the abbreviation, the full-time unit or the plural version of the time unit, such as *s, second, or seconds*. Time offset is any of the time units with a valid value and a + or – sign included, e.g. +8h.

Time offsets can be used alone in a time field or come with a fixed time or reference-time abbreviation.

**Time Offset Syntax**

**Reference Time or Fixed Time and Offset Expression**

When included with a reference-time abbreviation or with a fixed time, a time offset adds or subtracts from the specified time (indicated by either + or −) and a time unit with a value

<table>
<thead>
<tr>
<th>Expression</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>“-1h”</td>
<td>One hour ago</td>
</tr>
</tbody>
</table>
Time Offsets Used Alone

Entered alone in a time field, time offsets specify a time relative to an *implied* reference time. The implied reference time depends on the field where you enter the expression:

- For a start time, the reference time is the current clock time.
- For an end time, the reference time is the start time.
- For a single time stamp, the reference time is the current clock time.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>t+8h</td>
<td>08:00:00 (8:00 a.m.) today</td>
</tr>
<tr>
<td>y-8h</td>
<td>16:00:00 (4:00 p.m.) the day before yesterday</td>
</tr>
<tr>
<td>mon+14.5h</td>
<td>14:30:00 (2:30 p.m.) last Monday</td>
</tr>
<tr>
<td>sat-1m</td>
<td>23:59:00 (11:59 p.m.) last Friday</td>
</tr>
<tr>
<td>1-jan-20 – 1d</td>
<td>Midnight 31 December 2019</td>
</tr>
</tbody>
</table>
2.2 Rules to Remember

**Rule 1:** You can only include a single time offset in an expression. Including multiple offsets can lead to unpredictable results. For example, the following time expressions are not valid:

\[ *+1d+4h \]

\[ t-1d+12h \]

**Rule 2:** To define a time offset you must include a valid value with any time unit. Only for seconds, minutes, or hours, you can specify a fractional value. You cannot specify fractional values for other time units.

**Rule 3:** A fixed timestamp consists of the fields of Year, Month, Day and Time (hours, minutes and seconds). If any of these fields are not specified in the PI time expression, the following values will be assumed by default:

- If Time is not specified, then the default value would be Midnight.
- If Day is not specified, then the default value would be Current Day.
- If Month is not specified, then the default value would be Current Month.
- If Year is not specified, then the default value would be Current Year.
2.1.1 Exercise – PI Time

This solo or group exercise is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Activity Description

Part 1 – Determine the “real” dates and times indicated by the PI Times in the table below:

<table>
<thead>
<tr>
<th>Timestamp Input</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>* - 30m</td>
<td></td>
</tr>
<tr>
<td>y + 8h</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
</tr>
<tr>
<td>Thu</td>
<td></td>
</tr>
<tr>
<td>Tuesday – 2d</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
</tr>
<tr>
<td>y-2y</td>
<td></td>
</tr>
</tbody>
</table>

Part 2 – Express the following times in valid PI time expression:

<table>
<thead>
<tr>
<th>Timestamp Input</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today at 6:00 AM</td>
<td></td>
</tr>
<tr>
<td>Monday at 6:30 am</td>
<td></td>
</tr>
<tr>
<td>12 hours ago</td>
<td></td>
</tr>
<tr>
<td>The first day this month</td>
<td></td>
</tr>
<tr>
<td>The end of the week (Friday morning)</td>
<td></td>
</tr>
<tr>
<td>7:00 am yesterday</td>
<td></td>
</tr>
<tr>
<td>15 minutes ago</td>
<td></td>
</tr>
<tr>
<td>First of March</td>
<td></td>
</tr>
<tr>
<td>25th of September 2014</td>
<td></td>
</tr>
</tbody>
</table>

Part 3 – List at least 4 ways you can “PI Abbreviate” 8 am today.

✔ Quick Check

Having completed this topic, are you able to:
• Understand PI time expressions?
• Explain the differences between fixed and reference times?
• Use time offsets?

If you answered NO to any of these questions, ask your instructor for assistance.
3. COURSE SIMULATOR

Ideally this course uses data from your own site for the exercises. As this is not always possible this manual uses a fictitious manufacturing plant, OSIsoft Plant, for its exercise data. Initially this simple plant has two production lines; each line has one mixing tank and one storage tank.

The ‘It’s Not Real’ OSIsoft Plant

Each tank has different analogue process variables such as Internal and External Temperatures, Flow Rate, Pressure and Level; values continuously collected from devices in the Plant.

Other data associated with these tanks such as the manufacturer, model and installation date are stored in the maintenance sheets available on tables in an SQL Server. The information related to the material flowing in these tanks is also kept in tables on the plant’s SQL Servers. Despite the fact that these tables may be available in a relation database, this information cannot be easily integrated with the historical data stored in the Data Archive. To integrate the time series data with SQL based data, the Asset Framework with an asset hierarchy is utilised, bringing all the data and information into one place - the PI System.

A collection of PI Points has been built in the PI Data Archive for storing the process variable values along with their timestamps. The plant hierarchy in the PI Asset Framework brings all the important information and data into one place, as shown below.
Note: All tank points that have colon ":" belong to the "OSIsoft Plant" AF database; for example - "MXTK2:Flow Rate". All tank points that use dot "." belong to the "OSI Production Facility" AF database - which is only used for the Final Project; for example "MXTK2.Flow Rate".
4. APPLYING CONCEPTS

LEARNING OUTCOMES

- Look at live data using PI Vision
- Build a basic display in PI Vision

Now that you understand the terminology and concepts associated with the PI System, it’s time to start driving value from our client tools. Let’s demonstrate some of the concepts we discussed and create a display of live data in PI Vision.

4.1 PI Vision - Browser based displays

PI Vision is a web browser-based application that lets you retrieve, monitor, and analyze process information.

PI Vision allows users to:
- Search for and visualize time-series and other PI System data.
- Save displays for later use and further analysis.
- Reuse displays for multiple assets.
- Share displays with other members of a group or anyone with access to PI Vision.

PI Vision is supported by most modern browsers on a wide variety of computers, including tablets and phones running iOS or Android operating systems.

Learning Outcomes:
- Create a PI Vision display.
- Use PI Vision symbols
- Demo future data
- Explain the search mechanism.
- Explain how to change the time range of a display.

To start using PI Vision, navigate to the PI Vision application server set up by your administrator. In a default installation, the address is: https://webServer/PIVision where webServer is the name of the PI Vision web server, for example https://pisrv01/pivision.
Drill Down Through the Assets in Your Plant

Ok, you need to quickly and easily get insight into the operational data stored in your PI System. The 1st page displayed on the web server is the PI Vision homepage. Here you are able to view the thumbnails of ‘All Displays’ that you can access; displays that you create as well as those displays your colleagues create and share with others.

In this section the focus is on working with the native PI Vision displays. Below is a typical home page for PI Vision.

To create a new display, click on ‘New Display’ and then start exploring the hierarchy of the OSIsoft Plant, which is already set up as an AF database for you.

Click on the chevron (arrow) to the right of ‘OSIsoft Plant’ to start inspecting.
Drill through your AF Asset hierarchy by clicking on the black arrows to find assets in the plant. Notice the hierarchy of assets displayed on the left.

Once you click on an asset of interest, say Storage Tank1, the Attributes list populates below the Assets’ list...

Click a symbol, then drag and drop an asset or attribute to the display area to create a display. You are then able to add other attributes or assets to this symbol.

Change the start time time

Change duration of display

Change the end

Shift backward in time

Set the display to end now
4.2 Explore PI Points, AF Attributes, and Related Assets in PI Vision

4.2.1 Directed Activity – Up close and personal with PI System Data through PI Vision

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section. Use your own data if you have access to such data.

Objectives
- Create components of a PI Vision display

Activity Description
You want to see the following critical measurements of Mixing Tank1 from your home computer!

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Display Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Radial Gauge</td>
</tr>
<tr>
<td>Level</td>
<td>Trend</td>
</tr>
<tr>
<td>Level_Forecast</td>
<td></td>
</tr>
<tr>
<td>External Temperature</td>
<td>Value</td>
</tr>
<tr>
<td>Product</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>Table</td>
</tr>
</tbody>
</table>

Approach

Step 1: Open your web browser to the PI Vision homepage

Step 2: Create a new display with

Step 3: Drill down through the hierarchy in AF Server PISRV1 and database OSIsoft Plant to determine the assets and their attributes.

Step 4: Drill down to Mixing Tank1. Select the Radial Gauge icon and drag the Pressure attribute to the display area to create the radial gauge.

Step 5: Select the Trend icon and drag the Level and Level_Forecast to create a trend. Right click and choose Format Trend, change the colours of the trend cursors.

Step 6: Change the end time of the display to ten minutes in the future from now. Change the start time of the display to the start of the work week (Monday at 8 am).

Step 7: Select the value icon and drag the External Temperature to create the value.

Step 8: Select the table icon and drag the Product and Density to the display area.
Step 9: Change the start time of the display to start yesterday at 8 in the morning.

Step 10: For fun - Add the Installation Date to the table; then remove it via the Configure Table... pop up.

4.2.2 Alternative Approach (PI Points ONLY)

Objectives
- Create the same PI Vision display using only PI Points (not with AF Attributes)

Activity Description
Your company has not set up an Asset Framework hierarchy (yet!). Create the same display you made before, but only use PI Points instead of the AF attributes. Thankfully, your colleague has identified the PI Points that you need to use in the dashboard and has filled in the below table for you:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>PI Point</th>
<th>Display Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing Tank1 Pressure</td>
<td>VPSD.OSIssoftPlant.PL1.MXTK1.Pressure</td>
<td>Radial Gauge</td>
</tr>
<tr>
<td>Level</td>
<td>VPSD.OSIssoftPlant.PL1.MXTK1.Level</td>
<td>Trend</td>
</tr>
<tr>
<td>Level_Forecast</td>
<td>VPSD.OSIssoftPlant.PL1.MXTK1.Level_Forecast</td>
<td>Value</td>
</tr>
<tr>
<td>External Temperature</td>
<td>VPSD.OSIssoftPlant.PL1.MXTK1.External Temperature</td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>BCS1717</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>4321 g/L</td>
<td>Table</td>
</tr>
</tbody>
</table>

Approach

Step 1: Open your web browser to the PI Vision homepage

Step 2: Create a new display with

Step 3: Find the PI Points by drilling into the Data Archive and search for the names listed in the table above.

Step 4: Select the Display Symbol, then drag and drop the PI Point onto your display.

Step 5: Repeat steps 3 and 4 for all measurements/symbols required.

Step 6: Product and Density are not from PI Points. Use text fields for these items.

Discussion Questions:
1. How likely is it that you will know (or be given) every PI Point name you need to work with?
2. Your boss sees your great work and says that MixingTank2 should have the same display, how do you build out another display for the second mixing tank?

3. Next week, you know that the products in your mixing tanks will change. How would you get this new information onto your display without the use of Asset Framework?
5. PI VISION

5.1 Recap of PI Vision

PI Vision is a web browser-based application that lets you retrieve, monitor, and analyse process information.

PI Vision allows:
- Searching for, and visualising time-series data and other PI System data.
- Saving displays for later use and further analysis.
- Reusing displays across multiple assets.
- Sharing displays with other members of a group, or anyone with access to PI Vision.

PI Vision is supported by most modern browsers on a wide variety of computers, including tablets and phones running iOS or Android operating systems.

Learning Outcomes:
- Create a PI Vision display.
- Use of PI Vision symbols
- Future data displays
- Explain PI Vision components
- Explain the search mechanism.
- List the dynamic and static symbols available.
- Configure symbols.
- Configure multi-state symbols.
- Explain how to change the time range of a display.
- Explain the options in the Design Mode toolbar.

To start using PI Vision, navigate to the PI Vision application server set up by your administrator. In a default installation, the address is: https://webServer/PIVision where webServer is the name of the PI Vision web server, for example https://pisrv01/pivision.
Keyboard shortcuts

PI Vision lets you use several keyboard shortcuts to accomplish your tasks faster.

Some useful shortcuts:

<table>
<thead>
<tr>
<th>Press</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL + C</td>
<td>Copy an object</td>
</tr>
<tr>
<td>CTRL + V</td>
<td>Paste an object</td>
</tr>
<tr>
<td>CTRL + X</td>
<td>Cut an object</td>
</tr>
<tr>
<td>DELETE or BACKSPACE</td>
<td>Delete an object</td>
</tr>
<tr>
<td>Arrow keys</td>
<td>Move an object</td>
</tr>
<tr>
<td>CTRL + Click</td>
<td>Select multiple objects</td>
</tr>
<tr>
<td>CTRL + A</td>
<td>Select all objects</td>
</tr>
<tr>
<td>SHIFT + Drag</td>
<td>Resize an object while maintaining its proportions</td>
</tr>
<tr>
<td>CTRL + Z</td>
<td>Undo an action</td>
</tr>
<tr>
<td>CTRL + Y</td>
<td>Redo an action</td>
</tr>
<tr>
<td>CTRL + S</td>
<td>Save a display</td>
</tr>
</tbody>
</table>

5.2 Introducing displays

The PI Vision home page lists thumbnails of displays that you can access. You can set the page to show groups of displays, such as favourite or recently used displays; you can also view displays stored in particular folders and you can search for displays with particular names or owners, or filter by keywords.

In addition to viewing displays from the home page, you can share, delete, and mark displays as favourites. And you can also create new displays.
5.2.1 Exercise – Exploring the Home Page

You are invited to watch what the instructor is doing or perform the same steps at the same time.

Let's start by exploring the home page.

Connect the bulleted items with the appropriate area of the home page.

- 1. New display button
- 2. A display thumbnail
- 3. Search box
- 4. Filter displays by keywords
- 5. Predefined groups
- 6. Folders
- 7. Shared display icon
- 8. Settings
- 9. Favourites
- 10. Display owner
PI Vision Symbols

The table below gives an explanation of PI Vision symbols. You can view your data as a trend, a value, a table, a vertical, horizontal, or radial gauge, an XY plot, or an asset comparison table.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Functionality</th>
<th>Number of Data Items Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trend</td>
<td>Trends show the value of one or more data items over a time period. Trends are typically used to display time series data, though they may also include non-time series data. When exiting Design mode, you can view trend cursors, pan across the time range, zoom in and out and hide traces. Right click to configure the value scale or remove traces.</td>
<td>Multiple</td>
</tr>
<tr>
<td>Value</td>
<td>Used to show data item value, at the end time of the display. It is shown as a number, time stamp, string, or digital state. Right click to format how the value is displayed or to add Multi-State.</td>
<td>Single</td>
</tr>
<tr>
<td>Table</td>
<td>The table symbol contains columns that include the name, value, description, and other summary data about a data item. These summary data values take their intervals from the display’s time range as defined in the time bar. Right click to configure table columns.</td>
<td>Multiple</td>
</tr>
<tr>
<td>Vertical Gauge</td>
<td>These three symbols are identical in every way, except their orientation. The zero and span of the symbol are from the PI point attributes. If the data item is an AF attribute of formula type, the minimum and maximum traits on the attribute are used. Right click to format the gauge or to add Multi-state.</td>
<td>Single</td>
</tr>
<tr>
<td>Horizontal Gauge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radial Gauge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XY Plot</td>
<td>An XY Plot shows a correlation between one or more paired sets of data. On an XY Plot (also called a scatter plot), the X scale shows possible values for one of the items in the pair and the Y scale shows the value of the other item in the pair.</td>
<td>Multiple</td>
</tr>
<tr>
<td>Asset Comparison Table</td>
<td>The asset comparison table symbol allows you to compare measurements from similar types of equipment by organizing your data by assets. Each asset is assigned its own row while columns contain the asset’s selected attributes.</td>
<td>Multiple</td>
</tr>
</tbody>
</table>
Arranging and adding to the PI Vision Display

The editing toolbar allows you to add shapes, text, or images, as well as arrange objects on the display. The table below describes some of the options available in the tool bar.

<table>
<thead>
<tr>
<th>Static Shapes</th>
<th>Static shapes add rectangles, circles, lines, arcs or polygons to the display. Right click to format the shape or add Multi-state.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>Add a line of text to the display. Add a hyperlink to the text and search for an existing display to link to. Right click to format the text or add Multi-state.</td>
</tr>
<tr>
<td>Image</td>
<td>Add an image to the display. Supports most file formats including JPG, TIF, GIF (Static and animated), BMP, and SVG. The maximum image size is 2 MB.</td>
</tr>
<tr>
<td>Arrange</td>
<td>To arrange multiple objects by aligning them or bringing one of them backward or forward, click the Arrange button on the editing toolbar. There are many options for arranging or aligning display objects, including sending an object forward or back, aligning multiple objects and distributing objects on the display.</td>
</tr>
</tbody>
</table>

Future data in PI Vision

Dynamic symbols support future data and do not require any special configuration. When a display range is set into the future, a trace for future data continues to show new values in a staircase pattern.

Trends that have a time range including time into the future show a “now” line. This line helps track where you are in time when panning into the future to see forecasted data.
5.2.2 Exercise – Exploring the Components of PI Vision Display Design

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Identify the location of the tools required to build a PI Vision display

Activity Description

Match the components of PI Vision, shown in the following screenshots, to their appropriate task. Do this by trial and error or with the help of the PI Vision User Guide which is accessible by clicking on ? at the top right corner.

Part 1 – In a Display I want to...

a. Draw a line _____
b. Copy selected symbol(s) _____
c. Add text to link to another display _____
d. Save the display _____
e. Arrange selected symbol(s) _____
f. Toggle Design mode _____
g. Insert a picture _____
h. Undo or redo last action _____
i. Paste a previously copied symbol _____
j. Delete selected symbol(s) _____
Part 2 – In a Display I want to…
   a. View the list of Attributes on an Element ______
   b. Search for a Data Item (AF Element, AF Attribute, or PI Point) ______
   c. Create a Trend with time series data ______
   d. See Event Frames associated with the data ______
   e. Insert an Asset Comparison Table ______
   f. Insert a Table ______
   g. Navigate through the AF hierarchy ______
   h. Insert a gauge ______
   i. Find a Graphic to add to the display ______
   j. Insert the current value of a Data Item ______

Part 3 – In a Display I want to…
   a. Change the duration of the display ______
   b. Set the end time of the display manually ______
   c. Change the start time of the display ______
   d. Set the display to end now ______
   e. Shift backward in time ______
Quick Check

Having completed this topic, are you able to:

- Create a PI Vision display?
- Use of PI Vision symbols?
- Explain PI Vision components?
- List the dynamic and static symbols available?
- Configure symbols?
- Explain how to change the time range of a display?
- Explain the options in the Design Mode toolbar?

If you answered NO to any of these questions, ask your instructor for assistance.
5.3 Searching for Data

Learning Outcomes

- Search for data in PI Vision.
- Add symbols to a display in bulk.

In PI Vision you can use the Search pane to locate data items in the PI System, such as PI Points and AF elements and attributes. You can also search for previously saved PI Vision displays. Ensure the search is being performed at the PI System level. The filter search query will attempt to find:

- PI points - *Example: VPSD*Flow
- AF elements - *Example: Mixing
- AF attributes - *Example: temp
- Description of a PI Point
- Description of an AF Attribute

Limit the scope of your search by drilling down to a specific Data Archive or into a specific AF Database and its subsequent element tree structure.

Keyword Search versus Phrase Search

PI Vision leverages the PI Indexed Search Crawler in order to improve the performance and scalability of searching and navigation. This is different to the search and navigation mechanism used in other Client tools such as PI System Explorer and PI DataLink. With the indexed search, results are returned by keywords rather than by phrases; this is similar to looking up something with Google or other modern search engines. Consequently, different results may be returned for the same query in PI Vision as compared to the other PI Client tools. This is particularly true of PI search queries which make use of wildcard characters such as ‘*’.

Note: The keywords search does NOT apply to the display title searches. The indexed search is only applied when searching for Data Items, which includes PI points, AF attributes, AF elements and their associated metadata. Display title search relies on phrase search and use of wildcards.
In order to better understand the difference between the phrase search and indexed keyword search in PI Vision, consider the following three examples of a data item (can be a PI point name or an AF element name). For ease of referral in the search results scenarios assign an imaginary data item ID number to each of these three data items:

<table>
<thead>
<tr>
<th>Data Item</th>
<th>ID#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing Tank1</td>
<td>1</td>
</tr>
<tr>
<td>Storage Tank1</td>
<td>2</td>
</tr>
<tr>
<td>Tank Volume</td>
<td>3</td>
</tr>
</tbody>
</table>

Based on these three data items, the following Indexed Keyword table will be considered for later search results:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Associated ID#</th>
</tr>
</thead>
<tbody>
<tr>
<td>mixing</td>
<td>1</td>
</tr>
<tr>
<td>tank1</td>
<td>1, 2</td>
</tr>
<tr>
<td>storage</td>
<td>2</td>
</tr>
<tr>
<td>volume</td>
<td>3</td>
</tr>
</tbody>
</table>

Below are a few examples of the search query and what their search results would be:

<table>
<thead>
<tr>
<th>Search Query</th>
<th>Associated Keywords</th>
<th>Search Results (ID#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank</td>
<td>Tank1, Volume</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Mix*Tank</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mix* *Tank</td>
<td>Mixing, tank1</td>
<td>1</td>
</tr>
<tr>
<td>tank1</td>
<td>Mixing, storage, tank1</td>
<td>1, 2</td>
</tr>
</tbody>
</table>

Note: PI Vision adds a * to the end of all searches so the first two rows of the table above would not really need a * at the end.
5.3.1 Directed Activity – Search in PI Vision

You are invited to watch what the instructor is doing or perform the same steps at the same time.

Objectives

• Search for PI Points and AF Attributes in PI Vision

Activity Description

Building a display in PI Vision starts with finding the data items in PI System. We want to build a display to include the Flow Rates of all tanks. We also want to see what other displays are built for the Mixing Tanks (assuming Mixing Tank1 or Mixing Tank2 is in the title of the display).

Approach

Step 1: Open PI Vision homepage and create a new display.

Step 2: Select the AF database named OSIsoft Plant.

Step 3: Try the following combinations of search queries (for Flow Rate) and see how it changes the search results
   a. Flow
   b. F*Rate
   c. F* Rate

Step 4: Try the following combinations of search queries (for Mixing Tank) and see how it changes the search results
   a. Mixing Tank
   b. *Mixing tank
   c. *mix*tank
5.6.1 Exercise – Monitoring All Vital Measurements

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will coach you if you need assistance during the activity. **Use your own data if you have access to such data**

Objectives

- Search for data in PI Vision.
- Add symbols to a display in bulk.

Activity Description

You are interested in building a PI Vision display that shows all the vital measurements of the four tanks of OSIsoft plant in one place, for the past 4 hours until the next 15 minutes.

Approach

**Step 1**: Build a PI Vision display including the following symbols for the key measurements of each of the four tanks:

<table>
<thead>
<tr>
<th>For both Mixing Tank1 and Storage Tank1</th>
<th>Measurement</th>
<th>Display Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal and external temperatures</td>
<td>A single Trend</td>
</tr>
<tr>
<td></td>
<td>Levels and Level_Forecasts</td>
<td>A single Trend</td>
</tr>
<tr>
<td></td>
<td>Products</td>
<td>Table</td>
</tr>
<tr>
<td></td>
<td>Asset Names</td>
<td>Values</td>
</tr>
</tbody>
</table>

| Production Area                        | Asset Name                               | Values         |
| Production Lines                       | Asset Names                              | Values         |

**Step 2**: Repeat the procedure for Production Line2

**Step 3**: Add shapes and images to complete the display (perform a quick Google search to find some images if needed)

**Step 4**: Change the start and end time of the display to the desired values mentioned above.

**Step 5**: Save your display as `<your initials>_Production Area Dashboard`

An example of what the display might look like is shown below. There are many possible solutions – yours does not have to mirror it!
Quick Check
Having completed this topic, are you able to:

- Search for data in PI Vision?
- Add symbols to a display?

If you answered NO to any of these questions, ask your instructor for assistance.
5.4 Features of PI Vision Displays

Learning Outcomes:

- Add Graphics to the PI Vision display
- Add Multi-State behaviour in PI Vision
- Create a Collection
- Create an Asset Comparison Table

Reusing Displays for Multiple Assets

PI Vision automatically finds and shows all the assets that are related to the existing assets in a display. You can switch to these related assets to reuse displays. These related assets are assets that are built upon a common template.

Swapping the related assets is achieved by choosing the Switch Asset drop-down list and choosing a related asset from the list.
To configure which assets appear in the asset list and other context settings, click **Configure asset context switching**. This will be examined in a later exercise.

### Multi-State Behaviour

Multi-states behaviour allows objects on the display to alter their colour based on dynamic data values. Specific colours are assigned to ranges of values, corresponding to process states. When the value of a multi-state object enters the assigned range, its colour will alter to indicate a change of state. Many display objects can be configured as multi-state symbols - text, graphics, values, gauges.

To add Multi-state behaviour to a Value or Gauge symbol, right-click the symbol and select **Add Multi-State**. The attribute inside your symbol will now act as a trigger that will be associated with the multi-state behaviour. If desired, the active attribute can be removed and replaced with a different attribute (example, your level gauge can have a multi-state based on whether a valve is open or closed).

To configure multi-state behaviour, right-click on the object and select **Configure Multi-State**. To trigger the multi-state...
with an alternate data item, find the item in the search results and drag it inside the top area of the Multi-State pane.

By default, the Multi-State pane contains five regular states, each assigned a different colour. The Bad data state indicates when your value is either out of range or contains no data. The Bad data state can only be configured by a PI administrator, but any user can change its colour. To modify the colour of any state, click on it to open the colour palette. In the colour palette, you can also select Blink to call attention to the symbol. You can change the maximum value for any state in the value field. To add a new state, enter a maximum value in the empty top field and click Add. To remove a state, click X next to it.

To uncouple the attribute from the multi-state, click on the trash can icon at the top of the Multi-State pane.

Notice that you cannot change the Multi-State limits for Mixing Tank 1|Pressure

If the AF attribute has assigned Limits, then multi-state will use the limits defined in AF and the user will not be able to change them. The user will only be able to change the colours associated with each state. Pressure has been configured with AF Limits which are child attributes with the corresponding limits property.
Graphics Library

A large selection of graphics is available in the Graphic Library pane. The graphics are organized inside stencils belonging to a wide range of categories and industries. Many of the graphics have characteristics such as colour, fill type, orientation, or background, which can be modified.

To open the Graphic Library pane, click on the Graphic Library tab, located below the Events tab.

Open the folder with the desired graphic, then drag it across to your display. Formatting the graphic depends on the nature of the graphic. Be creative, have a go yourself!
5.4.1 Directed Activity – Graphics and Multi-State Behaviour in PI Vision

You are invited to watch what the instructor is doing or perform the same steps at the same time.

Objectives

- Add Graphics to the PI Vision display
- Add Multi-State behaviour

Activity Description

You want a dashboard that displays information about a tank and have symbols change colour depending on the value.

Approach

**Step 1:** Click New Display

**Step 2:** Open the Graphics Library view on the left-hand side graphic from the Flow Meters group. Click on a meter then right click on the drawing area and drag a rectangle on the display to create the symbol. Resize at will.

**Step 3:** Click on the Value symbol at the top of the Assets pane.

**Step 4:** In the Assets pane navigate to OSIsoft Plant – Production Area.

**Step 5:** In the search box type ‘flow’ and click on the search icon.

**Step 6:** Select the Flow Rate for Mixing Tank1 and drag near the flow meter.

**Step 7:** Right-click on the flow meter and choose Add Multi-State… Drag the Flow Rate from the Assets pane to the Multi State pane. You can alter the different state values or just click back in the drawing area; the value will now be Multi-state.

**Step 8:** Right click the value symbol and select Format Value. Click Visibility and change Label to ‘Flow Rate’ in the drop down. Change Text Alignment to Center.

**Step 9:** Add a Radial Gauge for Flow Rate overlaid on the meter graphic, resize as appropriate and make Multi-State.

**Step 10:** Add a Tank graphic and open Multi-State… Find the External Temperature and drag and drop it onto the Multi-State Attribute pane.
Step 11: Change the state maximum values, Set the top state to blink by opening the colour palette and selecting Blink

Step 12: Add a Value symbol at the top of the display for the Asset Name of tank you are working on. In Format Value / Visibility untick the Label, Units, Timestamp.

Step 13: Save the display as <your initials>_Tank Display

You might finish up with something like this:
Collections

Collections allow you to find and see all assets of the same type on the current display. With collections, you can choose one or more data symbols and automatically find and view their related assets and attributes on the same display, without having to search for each asset separately.

If, for example, there are ten tanks in one plant based on the same PI AF template. You can view the attributes of tank 1 and then convert them into a collection that shows those attributes for all ten tanks at the same time.

By changing the collection search criteria, you can then customize your collection to see only those assets whose parameters fall within a desired range or which are in a specific state. The collection will update automatically as the parameters or state of the assets changes.
5.4.2 Directed Activity – PI Vision Collections

You are invited to watch what the instructor is doing or perform the same steps at the same time.

Objectives

- Create a Collection

Activity Description

**Step 1**: Using the display from your last exercise, select all the symbols, right click, and select *Convert to Collection*.

**Step 2**: Resize the collection canvas so the collection covers as much area as possible.

**Step 3**: Right click on the new collection and choose Edit Collection Criteria…

  a. Expand *Search Root* and enter **Production Area**; select the *Return All Descendants* checkbox

  ![Screenshot of Search Root and Production Area]

  b. Expand the *Asset Type* and add an *Asset Attribute*. Set the Flow Rate > 100

  ![Screenshot of Asset Type and Asset Attribute]

This has the effect of showing only those tanks where the Flow Rate > 100.
5.4.3 Directed Activity – Create a Collection of Asset Tables

You are invited to watch what the instructor is doing or have a go yourself.

Objectives

- Use an asset comparison table to compare measurements and other process information by organizing data by asset.

Activity Description

**Step 1:** Click New Display

**Step 2:** Select the Asset Table symbol.

**Step 3:** Select an asset (e.g. Mixing Tank2) and drag onto the work area.

**Step 4:** Use the slider bar on the right to examine the data.

**Step 5:** Convert to a collection as was done in the previous exercise.

**Step 6:** Modify the Collection to change the appearance of the table. Click on Configure Table. Untick Description, Maximum and Minimum. Click on the door symbol on the upper right-hand side to exit.

**Step 7:** Right Click on the collection and select Edit Collection Criteria, changing Search Root to Production Area, and tick Return All Descendants.

**Step 8:** Change the time of the display and see the entire display update dynamically.
5.4.4 Exercise – Create a Dynamic Dashboard to Monitor Your Tanks

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity. *Use your own data if you have access to such data.*

Objectives

- Create a PI Vision dashboard using dynamic symbols.
- Use the collection feature

Activity Description

You need a dashboard that shows the key pieces of information for our tanks. The operator would like to see only tanks that are overheated at any given time. They also need a summary table that lists the installation dates and asset locations for all their tanks.

Approach

**Step 1:** Build a PI Vision display including the following symbols, utilizing the Collection symbol:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Display Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Name</td>
<td>Value</td>
</tr>
<tr>
<td>Tank</td>
<td>Graphic</td>
</tr>
<tr>
<td>External Temperature</td>
<td>Value (Multi-State Use default values but change colours)</td>
</tr>
<tr>
<td>Internal Temperature</td>
<td>Gauge</td>
</tr>
<tr>
<td>Internal Temperature</td>
<td>Trend</td>
</tr>
<tr>
<td>External Temperature</td>
<td></td>
</tr>
<tr>
<td>Installation Date</td>
<td>Asset Comparison Table</td>
</tr>
<tr>
<td>Asset Location</td>
<td></td>
</tr>
</tbody>
</table>

**Step 2:** Edit Collection Criteria to only show overheated tanks (Internal Temperature > 150°C), add an Asset Attribute to the Asset Type.

a. How many tanks were overheated at 8am today? ____________

b. How many tanks were overheated at noon yesterday? ____________

**Step 3:** Save your display as *<your initials>_Tank Temperature Dashboard*

**Bonus:** Modify the collection to include more graphics and a multi-state symbol such as a gauge for the pressure.
An example is shown on the next page.
5.4.5 Exercise – Monitoring the Mixing Tanks’ Key Performance Indicators

This activity is designed to maximize learning in a specific topic area. Your instructor will help you if you need assistance during the activity. *Use your own data if you have access to such data*

**Objectives**

- Create a PI Vision dashboard using dynamic symbols.
- Add Multi-State behaviour to symbols
- Reuse the PI Vision dashboard for multiple Assets

**Activity Description**

You would like to view details of each tank in your Production Area. With your large knowledge in PI Vision, you know that we don’t need to create a new display for each Tank. We can easily use the Asset Swap functionality so that we only need to build one display and then re-use it for each tank.

**Approach**

**Step 1:** Build a PI Vision display including the following symbols:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Display Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Name</td>
<td>Value</td>
</tr>
<tr>
<td>Asset Location</td>
<td>Value</td>
</tr>
<tr>
<td>Internal Temperature</td>
<td>Value (Multi-State)</td>
</tr>
<tr>
<td>External Temperature</td>
<td>Value (Multi-State)</td>
</tr>
<tr>
<td>Installation Date</td>
<td>Value</td>
</tr>
<tr>
<td>Internal Temperature</td>
<td>Table</td>
</tr>
<tr>
<td>External Temperature</td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td></td>
</tr>
<tr>
<td>Level_Forecast</td>
<td>• Trend</td>
</tr>
<tr>
<td></td>
<td>• XY Plot (10 minute interval)</td>
</tr>
<tr>
<td>Percentage Full</td>
<td>Vertical Gauge (Multi-State)</td>
</tr>
<tr>
<td>Pressure</td>
<td>Radial Gauge (Multi-State)</td>
</tr>
<tr>
<td>Product</td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>Table</td>
</tr>
<tr>
<td>Density</td>
<td></td>
</tr>
</tbody>
</table>
a. What is the Maximum **External Temperature** for **Mixing Tank1** over the last 12 hours? ______________

b. What is the Minimum **Internal Temperature** for **Mixing Tank1** over the last 12 hours? ______________

(Hint: Tables in PI Vision have columns for the maximum and minimum values).

**Step 2**: Add shapes and images to the display

**Step 3**: Go to [Configure asset context switching](#) in the asset drop-down list and select *Show search results*. Set the Search Root to **Production Area|Production Line2**.

**Step 4**: Reuse the same display to monitor the other mixing tank

a. What is the Maximum **External Temperature** for **Mixing Tank2** over the last 12 hours? ______________

b. What is the Minimum **Internal Temperature** for **Storage Tank2** over the last 12 hours? ______________

**Step 5**: Update the asset context switching to *Show assets of the same type*.

**Step 6**: Save the display as `<your initials>_Tank Details`

**Bonus**: Create navigation links from the previous exercise (Dashboard with Collections) to this display. Ensure each collection member and each row of the table navigates to this display with the proper context. We will cover navigation in more detail after this exercise.

An example solution is below. This is only an example, there are many possible solutions!
Quick Check

Having completed this topic, are you able to:

- add Graphics to the PI Vision display?
- add Multi-State behaviour in PI Vision?
- create a Collection?
- create an Asset Comparison Table?
- configure a multi-state symbol?

If you answered NO to any of these questions, ask your instructor for assistance.
5.5 PI Vision Additional Features

Learning Outcomes:
- Adding Navigation links
- Display URL parameters
- Ad hoc displays

Add Navigation Links to PI Vision Symbols

You can assign a hyperlink to any symbol, shape, or image on your display. The hyperlink can point to another PI Vision display or to an external website. Once you add a hyperlink, you can navigate from that hyperlink to your linked display or website. There is the option to have the linked display automatically match the asset and time context of the original display containing the hyperlink.

You may also add a hyperlink directly to the display by choosing the Text icon and then clicking anywhere in the display. The text menu opens. Select ‘Sync text to navigation’ link to enter a URL.

PI Vision URL Parameters

You can use a URL to open PI Vision displays programatically from other applications.

You can use the URL to:
- Create a temporary display that shows a single trend populated with specified data items; the URL can also specify a time range for the display. This is called an Ad Hoc display.
- Specify a display time range.
- Specify kiosk mode to open a display with limited interactivity.
- Configure an existing display to use other assets that share the same AF template.
• Set the time zone for a display so that users see data in the time zone you specify, rather than in the time zone of their client machine.
• Hide the toolbar or time bar, or both, in a display.
• Prevent automatic redirection for users of PI Vision on mobile devices

Rules for adding a URL Parameter:

**Rule 1:** Separate query string parameters from the preceding base URL with a question mark (?).
**Rule 2:** Separate each query string parameter with an ampersand (&).

Below are some commonly used URL parameters:

**StartTime=<PI Time> and EndTime=<PI Time>**
Specify the start and end time of the display. Any valid PI Time format is acceptable.
Example:
http://PISRV01/PIVision/#/Displays/339/MyDisplay?StartTime=-1h&EndTime=*  

**Mode=Kiosk**
Specify kiosk mode to open a display with limited interactivity.
Example:
http://PISRV01PIVision/#/Displays/339/MyDisplay?mode=kiosk  

**HideToolbar and HideTimebar**
Hide the toolbar or toolbar from the display
Example:
http://PISRV01/PIVision/#/Displays/339/MyDisplay?HideToolbar
http://PISRV01/PIVision/#/Displays/339/MyDisplay?HideTimebar
You can combine these parameters with other URL parameters. Example:
http://PISRV01/PIVision/#/Displays/339/MyDisplay?mode=kiosk&HideToolbar&HideTimebar

For more information, see “URL parameters for controlling the presentation of displays” in *PI Vision Installation and Administration Guide.*
5.5.1 Directed Activity – Using URL Parameters and Hyperlinks

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives
- Use URL Parameters to create links to PI Vision displays

Activity Description
Early this morning the operations team reported that there was an issue from noon yesterday until midnight today with Mixing Tank1. They need to look at the data for this time period.

Approach
- **Step 7**: Open your `<your initials>_Tank Temperature Dashboard` display.
- **Step 8**: Enter Design mode and right-click and choose Modify Collection.
- **Step 9**: Right click on the Tank Graphic and choose Add Navigation Link...
- **Step 10**: Leave the Action as Open hyperlink to another page and click the Search for displays… link. Search for your `<your initials>_Tank Details` display
- **Step 11**: Save your display.
- **Step 12**: Test the link.
- **Step 13**: Make the display read only by placing it in Kiosk mode. Append `?mode=Kiosk` to the end of the URL.
5.5.2 Exercise – Navigating Between PI Vision Displays

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Create a link from your overview dashboard to a more detailed display.

Activity Description

You would like to quickly link from your Production Area Dashboard display to your Tank Dashboard display.

Approach

**Step 1** : Add Navigation Links to the Asset Name values on the Production Area Dashboard to the Tank Details

**Step 2** : Save your display then test your links.

**Step 3** : Add Text symbols to the Tank Details display that navigate back to the Production Area Dashboard and the Tank Temperature Dashboard.

Bonus

**Step 4** : Create an Asset Comparison Table on the Tank Details page that can change the context of the current display

**Step 5** : Save your display and test each link
Ad hoc Displays

You have created your dashboard, but your team would like to select a few different items from the displays and do some additional analysis when they investigate specific issues. If they identify something of interest, they would like to be able to share their findings by saving the display. Let’s use the ad hoc display functionality!

5.5.3 Directed Activity – Demonstrating Ad Hoc Analysis

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section

Objectives

- Create an ad hoc display

Activity Description

- You want to compare the external temperatures of all the tanks in the plant.

Approach:

1. Open any of your displays with multiple tank variables or use the Plant Process Variables display.
2. Select the external temperature of Mixing tank 1 and click Replace Ad Hoc trend.

   ![Show Ad Hoc]

   This will start a new ad Hoc display.

3. Toggle off the Summary Table.
4. Close the Ad Hoc Workspace by clicking the Hide button.
5. Back on the original display change the asset to Mixing Tank 2 and click on the external temperature. Notice the Ad Hoc icon has a ‘+’ sign. Click it and you are back to the Ad Hoc display with the added temperature. Alternatively, you can go to the Attributes pane, right click any attribute and select ‘Add Data Item to Ad Hoc’.
6. Add the other 2 external temperatures. Your Ad Hoc display now has all the data items you selected.
7. Click anywhere in the trend, then click again somewhere else to demonstrate multiple trend cursors.
8. Click on the Convert button to place the Ad Hoc Workspace contents into an Editor Display that can be permanently saved and shared:

9. Click Save As icon and give your display a name starting with your initials. You can now share.

✔ Quick Check

Having completed this topic, are you able to:

- Add a Navigation links?
- Use display URL parameters?
- Create ad hoc displays?

If you answered NO to any of these questions, ask your instructor for assistance.
Using Calculations in a Display

Learning Outcomes:

- Understanding PI Vision Calculations
- Using the Calculation Editor

Displays in PI Vision can utilize simple calculations on the fly and use the results to analyze data in real time. This includes the use of summary calculations like Min, Max, and Avg and simple calculations that use basic mathematical operators such as +, -, *, and / on data within the display. Use calculations on PI Vision symbols and configurations that support data items. These calculations use Performance Equation syntax.

5.5.4 Directed Activity – Create a calculation

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section

Objectives

- Create and use a calculation

Activity Description

- Add the mixing tank flows to get a resultant flow

Approach:

Find the points:

![Image of PI Vision symbol and configuration](image-url)
To define your calculation…

a. On the left side of the screen, click Calculations \( \text{Calculations} \) and then click Add Calculation \( \text{Add Calculation} \).

The Calculation Editor window opens.

b. Give the new calculation a Name and a Description.

Note: Your calculation Name needs to be unique for the current display. You may reuse a Calculation Name on different displays.
c. Define the calculation by dragging PI points from here:

onto the editor panel.
Note: You can only use PI Points from one Data Archive in a single Calculation.

d. Configure your Expression to calculate the data. You can create your own function or expression. These expressions can include point variables with mathematical and logical operations. See Built-in performance equation functions for additional information.

Examples

- ‘VPSD.OSIsoftPlant.PL1.STTK1.Flow Rate’ * 2
- (‘cdt158’+‘sinusoid’)/2
- log(‘cdt158’)
- (‘sinusoid’)/tagspan(‘sinusoid’)

e. Test your expression for the data available at the current time by clicking Preview.
f. Click Advanced Options to further configure the calculation.

g. Configure the Time Interval for the calculation. By default, this is set to Auto, but you can choose a Custom Time Interval if needed.

When setting the Time Interval to Auto:

- Set the Total Conversion Factor for the calculation; this only applies to the Total summary Column.
- Click Stepped Plot if you would like this calculation to display with stepped data.
- Click Save to finish configuring your calculation.

When setting the Time Interval to Custom:

- Set the Calc Interval for the calculation. The Calc Interval is the time range for which the data calculation is performed.
- Set the Sync Time for the calculation. The Sync Time is the time of day (in 24-hour format) from which Calc Intervals are counted.
Visualizing PI System Data

- Set the Total Conversion Factor for the calculation. The Total Conversion Factor is used as a time basis for time-weighted totals and only applies to the Total summary Column.
- Click Stepped Plot if you would like this calculation to display with stepped data.
- Click Save to finish configuring your calculation.

Example of Calc Intervals and Sync Time defined for a calculation:

- Calc Interval: 10m
- Sync Time: 00:00:00 (default)

The calculated value for each interval is plotted at the start of the interval. Since the Sync Time is set as 00:00:00, the start of the interval begins at the top of the hour. Since the Calc Interval is 10m, every 10 minutes, a new value is plotted. In this example, there will be a new plotted value at the following time stamps (among many more):

- 1:00:00
- 1:10:00
- 1:20:00
- 1:30:00
- 1:40:00
- 1:50:00

Save and give your display a name starting with your initials.

After adding the original points to the trend and some dial gauges your display may look like this:
See Using Calculations for more information.

✅ Quick Check

- Do you understand PI Vision Calculations?
- Can you use the Calculation Editor?

If you answered NO to any of these questions, ask your instructor for assistance.

Multiple Time Contexts for Trends

It is possible for trends in a display to have different time ranges that are not tied to the default display time bar.

5.5.5 Exercise – Displaying trends with different times
This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives
- Create trends with different time ranges

Activity Description
You would like to display an 8 hour trend, a 24 hour trend and a 7 day trend on the same display.

Approach

Step 1: Select the trend symbol, then a data point and drag on to the display area. If the time range down the bottom of the display is 8h this will be your 8-hour trend. If not, then set the time range to 8h.

Step 2: Drag the same point on the display in another trend. Right click the trend and select Configure Trend option.

Step 3: Open up Time Range and select Duration and Offset. Make the Duration 24 hour and offset 0. This will give a trend with the same end time as the previous trend but with a start time 24 hours previously.

Step 4: Create another trend, this time with the start 7 days previous.

You should have a display like this:
Step 5: Create another display with 3 trends. This time make the end times all different.

Save and give your display a name starting with your initials.
While you are right clicking on symbols use your display to investigate the following:

Symbol Enhancements
- Outside Scales on Trend: Display the Y-axis value scale outside of the trend plot area to improve data visibility.
- Configurable Grid Style on Trend: Use two additional grid styles for blank grid and horizontal/vertical gridlines.
- Data Markers on Trend: Use newly added trace styles to see data markers for recorded values on your trend and configure the marker visibility and shape for each trace.
- Plot Title on Trend: Specify custom plot titles for each trend symbol on a display.
• Labelling: Add element name, attribute name, description, or custom text as labels for trend, value, vertical gauge, horizontal gauge, and radial gauge symbols.

• Additional Multi-State Capabilities: Use new multi-state capabilities to hide symbol visibility and change value symbol text color using gauges.

See the information in the Live Library on configuring trends.
5.6 Managing PI Vision Displays

Learning Outcomes:

- Organise displays
- Change who can see a display

Manage Role-Based User Access Level

Your PI Vision Administrator can give users different level of access by assigning and managing user roles on the PI Vision Administration website. PI Vision provides two access roles based on PI AF identities:

- **Publisher**: users have full access to the application and can save displays.
- **Explorer**: users have access to the application but cannot save or share displays. An Explorer can still export data from a display.

For more information, see “Manage role-based user access level” in *PI Vision Installation and Administration Guide*.

PI Vision Homepage

In the homepage of PI Vision, you can View and Search All Displays that you have access to, Filter displays by Labels, or navigate logical groups to find displays. These groups are listed below:

- **ALL DISPLAYS**: lists all public and private displays
- **FAVORITES**: filters the thumbnails to show only favourites (starred displays)
- **MY DISPLAYS**: shows all displays that you have created.
- **RECENT**: PI Vision automatically remembers displays that you used within the last seven days.
- **FOLDER HOME**: shows the folders that your administrator has configured for you to access PI ProcessBook displays. Below this option, the list of folders for accessing PI ProcessBook displays will be listed. In the example shown in the screenshot, on the right, this folder is named “PI ProcessBook Displays”.

You can navigate to PI Vision Homepage from any display by clicking on the upper left corner.
Organizing PI Vision Displays

PI Vision offers new options for organization of displays to provide a quicker way of finding displays of interest.

- **Search All Displays**: Displays are searchable by name or owner.
- **Favourites**: You can mark displays as "favourites" by clicking the star icon 🌟. Favourites are a user-specific property.
- **Keywords**: You can apply keywords to displays to categorize them. The keywords can be viewed in a keyword cloud by selecting "Filter by Keywords." Within the keyword cloud, the keywords are sorted alphabetically, and their size is determined by their relative frequency. Keywords applied by one user are visible to the rest of the users.
- **You can add a keyword by clicking the Display Settings icon 🔄 and typing in the keyword in the Keywords box. Once you start typing the keyword, the matching available keywords become available in a list, as shown in the following screenshot.

Editing PI Vision Displays

Some of the editing options are available from the PI Vision homepage and some from the PI Vision display itself.

From the homepage, clicking on the Display Settings icon 🔄 you will see the following options:

- **Keyword**: You can enter text in the Keywords field and use a semicolon (;) to separate multiple keywords.
- **Display Owner**: You can make anyone else in your organization the owner of any display. (Only visible to the Administrators)
- **Delete Display**: Currently, you can only delete displays that you created in PI Vision, and not the PI ProcessBook displays.
- **Share with**: As the creator of a display you can keep these displays private, or to share them with other users in your organization.
The groups displayed in the Shared with section are AF Identities, only the AF Identities that a user is a part of will display except for Administrators which is a share option for any user.

As a user you can create a display that you use to home in on a set of data and then quickly and easily share that display with others across your organization. You can also send the URL for a shared display in an email or instant message to someone else in your organization for them to see as a public display. By default, all PI ProcessBook displays are automatically shared with World. You can also give team members WRITE permission for a display, allowing collaboration on the creation and maintenance of displays with your team, in case you want the day off.
5.6.1 Exercise – Manage and share your PI Vision Displays

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Work with different options available in managing PI Vision displays

Activity Description

Your corporate PI Vision homepage has a long list of displays shared by others. You also have a lot of wonderful displays that you would like to share with your team members. You want to make the management of your displays and displays of your interest easy and label your displays in a way that your team members can find them easily.

Approach

Earlier, you built a PI Vision display, <your initials>_Tank Details. Find it from the homepage by searching for it.

Step 1: Share your display with everyone (World), so that everyone else can view it. If your user ID ends in an odd number (ex. Student05) then also share your display with Operators. If your user ID ends in an even number (ex. Student08) then also share your display with Engineers.

Step 2: Add the keyword of VPSD to it (stands for Visualizing PI System Data)

Step 3: Choose 2 or 3 colours (Red, Orange, Yellow, Green, Blue, or Purple) and add those as keywords. Be sure to separate keywords with a semicolon (;).

Step 4: Find all the displays that have the label of VPSD or that match one of the colours you chose. Pick your favourites and add them to your favourites list.

Quick Check

Can you:

- organise displays?
- change who can see a display?
If you answered NO to either of these questions, ask your instructor for assistance.
5.7 Analysing and Comparing Related Events

Learning Outcomes

- Retrieving Events
- Finding Related Events
- Comparing Events
- ‘Pinning’ Events

Find Related Events

PI Vision enables you to view and analyse PI data during the time range of an event. For example, you may want to examine the performance of an asset during an operator shift or compare the data for several assets during a downtime period.

To view events, open the Events tab on the left side. Here you will find events related to your process, the colour to the left of each event indicates its severity. By default, the time range of the display and the context of the symbols in the display determine which events are shown in the Events list. To discover additional events, modify the time range or choose Edit Search Criteria. When editing the search criteria, there are a number of filtering options to find the Event Frames you are looking for, as shown at left.

Select an event to find its Data Items (event attributes) and its start and end time.
By right clicking on an event, you can choose **Apply Range** apply the event’s time range to the display.
5.7.1 Directed Activity – Find Events

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives

- Display Events based on Search criteria.

Activity Description

- The process engineer has set up Downtime tracking using AF Event Frames. An Event is created when the tank level drops below 10% full. You have been asked to provide details on how much production was lost in the last event.

Approach:

Step 1: Select New Display
Step 2: Select Events

![PI Vision Interface]

Step 3: Select Edit search Criteria
Step 4: Set Database dropdown to OSIsoft Plant
Step 5: Under Asset Name select ANY, then click APPLY

What is the last value for Lost Production? (Hint: the event highest in the list is the last one)

________________

When did it occur? ______________

What was the Reason Code? ______________

How many minutes did the Event last for? ______________
Get Event Details

Choosing *Event Details* will create a trend and table information about the event, click an item to add it to trend. On the right, will also see the Actions and Comments associated with an event. If you have access to do so, you can add a new comment to the Event Frame and ‘Acknowledge’ it. The access is controlled in PI System Explorer with the Annotate permission.
5.7.2 Exercise – Event Details

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Display the Event details

Task Description

- You have been asked to provide more details about the event including:
  - % Full for the beginning and end of the event
  - Event duration
  - Reason Code at the start of the event
  - Tank status at the beginning and end of the Event.

Approach:

**Step 1:** Right click the Event and select *Event Details.*

You might have a display like this:
Step 2: Acknowledge the event with the Green Acknowledge button in the top right-hand corner. Why might you do this?

Step 3: Click the top two graph symbols. What happened?

Step 4: Slide down to the bottom of the details and click the graph icon next to Pressure.

Step 5: Overlay the Flow Rate trend in this graph.

Step 6: Fill in the table:

| % Full for the beginning and end of the event |  |
| Event duration |  |
| Reason Code at the start of the event |  |
| Tank status at the beginning and end of the event |  |
Visualizing PI System Data

Compare Similar Events by Name or Type

Choosing Compare Similar Events will open a list of similar events with overlaid trends and a Gantt chart. You can hide events or highlight an event in the overlay trends. Additionally, you can drag more attributes to the display area to create more overlay trends.

Delete the trends displayed.

Click on Mixing Tank chevron and drag flow rate and pressure attributes to graph area. Click on any of the events in the Gantt chart. What does the length of bar in the Gantt chart represent? ____________

Save your display to <your initials>_tank events
Pinning Events

Once you created an event comparison screen, you can pin events from the search results as your reference event. Pinned events are your benchmark events that remain at the top of the Events pane even after you perform new event searches. Once you no longer want an event to be pinned at the top of the pane, you can remove it from the Pinned events list.

5.7.3 Exercise – Pinning an Event

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Pin an Event

Task Description

While investigating these tank events you noticed that the shortest event is the event against which you can compare all other events. You want to highlight so you can easily compare this event against others.

Approach:

In your display from the previous exercise right-click the event in the Events pane corresponding to the shortest event on the Gantt chart and click Pin Event. The pinned event appears at the top of the pane in the Pinned section and have yellow legend marker next to them.

After you pin an event, you can perform the following operations:

- To highlight the pinned event on the Overlay Trend, select the event in the Events pane.
- To add another pinned event, right-click that event and click Pin Event.
- To save the pinned event, save the event comparison display by clicking the Save button.

To unpin your pinned event, right-click it and click Unpin Event.

The next page has an example.
Quick Check

Having completed this topic, are you able to:

- Retrieve Events?
- Finding Related Events?
- Compare Events?
- ‘Pin’ Events?

If you answered NO to either of these questions, ask your instructor for assistance.
6. PI DATALINK: BUILDING REPORTS

6.1 PI DataLink Introduction

Learning Outcomes:

- Why use PI DataLink?
- Common terms.

PI DataLink is an OSIsoft add-in for Microsoft Excel. It lets you retrieve information from your PI System directly onto a worksheet. Combined with the computational, graphic, and formatting capabilities of Microsoft Excel, PI DataLink is a powerful tool for gathering, monitoring, analysing, and reporting PI System data.

For more information see "Introduction" in PI DataLink User Guide

PI DataLink has different functions for extracting PI System data into Excel. It is important to understand the following nomenclature when working with PI DataLink and its data retrieval functions.

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data item</td>
<td>A PI Point name or AF attribute name, for which the PI DataLink function returns property values.</td>
</tr>
</tbody>
</table>
| Root path     | The common path to specified data items within PI System. It is optional for PI DataLink functions. Valid entries include:  
                   - Data Archive name if the data item is a PI Point.  
                   - AF server and database if the data item is an AF attribute. For a data item of AF Attribute, root path can also include the name of parent elements.  
                   - Blank if the data item is on the default Data Archive or the default AF Server and default database.                                                                                   |
| Output cell   | The worksheet cell where the function writes the result.                                                                                                                                               |
If you select a cell before you open the function task pane, PI DataLink inserts the selected cell into the output cell field.

Quick Check

- Why would you want to use DataLink?
- What is a Root path?

If you are unsure of the answer to these questions, ask your instructor for assistance.
6.2 Finding Data

Learning Outcomes

- Demonstrate searching for PI Points
- Demonstrate the different ways of finding element and element attributes within the PI Asset Framework (AF) hierarchy.

PI DataLink offers two ways to search for data items:

1. Search tool
2. Asset Filter Search function (this will be covered in a later section)

Search for Data Items

On first use, the tool starts at the Home node, which shows all the Data Archives and AF servers listed in Connection Manager. You must limit the search to a single Data Archive or single AF server, and can limit the search further to a single database on an AF server, and then to specific elements and parent attributes.

When your search scope is a Data Archive, the top search field is applied to the PI Point Name, only. Set the fields under Filters to specify any additional criteria the retrieved PI Points must match. You can use wildcard characters to augment your search.
When your scope is an AF Server or Database, the top search field is applied to AF Attribute name as well as the name, description and categories of the parent element.

You can change columns displayed in the results pane by right clicking a column name in the results pane and selecting which column you would like to be displayed.
6.2.1 Directed Activity – Searching in PI DataLink

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section. Use your own data if you have access to such data.

Objectives
- Perform a search for PI Points and AF Attributes in PI DataLink

Activity Description
We will need to demonstrate how to use the search functionalities.

Approach
Step 1: Open Microsoft Excel.
Step 2: On the PI DataLink ribbon, select Search.
Step 3: Select a Data Archive
   a. Search for *temper*
   b. Select an item and then OK.
Step 4: Select the AF Server
   a. Search for flow*
   b. Choose all items in the list.
Step 5: Select OK

Quick Check
- Can you demonstrate searching for PI Points?
- Can you demonstrate the different ways of finding element and element attributes within the PI Asset Framework (AF) hierarchy?
If you answered NO to either of these questions, ask your instructor for assistance.
6.3 Functions Returning Data.

With PI DataLink functions, you can query any Data Archive or AF server, apply calculations to retrieved results and return values to worksheet cells. These functions return results in function arrays, which you can recalculate to update values as needed.

<table>
<thead>
<tr>
<th>Query Category</th>
<th>Function Name</th>
<th>What It Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single value</td>
<td>Current Value</td>
<td>The current or most recent value of a Data Item</td>
</tr>
<tr>
<td></td>
<td>Archive Value</td>
<td>Value of a Data Item at a specified time stamp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computed value of a performance equation at a specified time stamp</td>
</tr>
<tr>
<td>Multiple value</td>
<td>Compressed Data</td>
<td>All the values of a Data Item for a specified time period</td>
</tr>
<tr>
<td></td>
<td>Sampled Data</td>
<td>A specific number of Data Item values beginning at a certain time</td>
</tr>
<tr>
<td></td>
<td>Timed Data</td>
<td>Evenly spaced, interpolated values for a Data Item over a regular interval</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evenly spaced, interpolated values of a performance equation over a regular interval</td>
</tr>
<tr>
<td></td>
<td>Calculated Data</td>
<td>Actual or interpolated sample values for a Data Item at specified time stamps</td>
</tr>
<tr>
<td></td>
<td>Time Filtered</td>
<td>The amount of time that a performance equation evaluates to true during a specified time period</td>
</tr>
</tbody>
</table>

For more information see “PI DataLink Functions” in PI DataLink User Guide
6.4 Single Value Queries

Learning Outcomes

- Retrieve a current value for a data item
- Retrieve an archived value for a data item
- Describe the different retrieval modes
- Retrieve data item attributes

Quick Steps to Get Started

Most of the functions in PI DataLink can be done using these simple steps

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Select the Target cell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data/Information will be inserted below and to the right of the target cell</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Choose the Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Search/Snapshot Value or any other function</td>
</tr>
</tbody>
</table>

| Step 3 | Fill out the required parameters, or use cell references to make later editing easier |

Obtain a Current Value

For the Current Value function no timestamp is required, as it is always assumed to be NOW (* in PI time or =NOW() in Excel time).

You can retrieve PI data from any PI System currently connected to your client machine. You must specify:

- **Data item(s)**
  - Can specify 1 or more, explicitly or via a cell reference

- **Output cell**
  - Any data currently in this cell will be replaced.
The result of this query will be the most current value and timestamp of the data item specified.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>06-Jan-20 05:18:51</td>
</tr>
</tbody>
</table>

**Note:** Current Value is a volatile function: the function recalculates and updates values whenever Excel calculates or recalculates any cell in the worksheet. To force an immediate recalculation, press F9. [http://www.youtube.com/watch?v=98vxlhsR_M](http://www.youtube.com/watch?v=98vxlhsR_M)
Obtain an Archive Value

The other PI DataLink function that returns a single value is the Archive Value. This function retrieves an archived value at a specific timestamp.

You specify:
- Data item(s)
  - 1 or more
- Time stamp
  - Excel Time Format or
  - PI Time Format

The result being:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>06-Jan-20 04:22:38</td>
</tr>
</tbody>
</table>
6.4.1 Directed Activity – Single Value Query

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section. Use your own data if you have access to such data.

Objectives
- Perform Single Value Queries in PI DataLink

Activity Description
We would like to prepare a report that shows the current value of External Temperature, Pressure and Flow Rate of Mixing Tank2. You are also interested in knowing the value of these measurements at 7 am yesterday.

If you have access to your own data

Approach

Part 1 – Get Current Values

Step 1: Open Excel and in cell A1 type Current Values as a heading.
Step 2: Click on cell A2. Select Current Value function.
Step 3: Click on the magnifying glass next to Data Item(s) box.
Step 4: Search for the External Temperature of Mixing Tank2.
Step 5: Select Time at Left and click OK.
Step 6: Repeat these steps for Pressure and Flow Rate in cells A3 and A4, respectively.

Part 2 – Add Archive Values

Step 1: In cell C1 type Archive Values as a heading.
Step 2: Click on cell C2. Select Archive Value function.
Step 3: Click on the magnifying glass next to Data Item(s) box.
Step 4: Search for the External Temperature of Mixing Tank2.
Step 5: Type Y+7h in the Time stamp box. What time stamp will be retrieved? __________
Step 6: Select Time at Left and click OK.
Step 7: Repeat these steps for Pressure and Flow Rate in cells C3 and C4, respectively.

Part 3 – Do you think this is an efficient way to search for the data item every time a value is retrieved?
6.4.2 Directed Activity – Single Value Query Using Cell Reference

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section. Use your own data if you have access to such data.

Objectives
- Perform Single Value Queries in PI DataLink

Activity Description
You would like to include the current value of External Temperature of Mixing Tank1 in your daily report. You are also interested in the value of this tank’s Internal Temperature at 7 am today.

Approach
Part 1 – Build a Template

**Step 1:** Open Excel and click on cell A2. Click on **Search**.

**Step 2:** Select the AF Database of OSIsoft Plant. Type Ext*Temp* in the search box and click ‘Enter’. The External Temperature of all four tanks should show up on the search results list.

**Step 3:** Select the external temperature of Mixing Tank1 and click **OK**.

**Step 4:** In cell B1 type **Current Value**. In cell D1 type **Archive Value** as headings.

**Step 5:** In cell A4 type **Timestamp**, in B4 type **t+7h**. What time do you expect to see? __________

**Step 6:** Your report template will look similar to this:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(\text{\textbackslash P\textbackslash S\textbackslash R\textbackslash V\textbackslash 1\textbackslash O\textbackslash S\textbackslash I\textbackslash S\textbackslash O\textbackslash F\textbackslash P\textbackslash l\textbackslash a\textbackslash n\textbackslash t\textbackslash a\textbackslash n\textbackslash d\textbackslash 1\textbackslash</td>
<td>External Temperature</td>
<td>Current Value</td>
<td>Archive Value</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>\text{Production Area\textbackslash Production Line1\textbackslash Mixing Tank1})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Timestamp</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>t+7h</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part 2 – Query PI Data

**Step 1:** Select cell B2 (this will be your Output cell). Click on **Current Value** function.

**Step 2:** Refer to cell A2 in the **Data Item** field and select **Time at left**. Click OK.

**Step 3:** Select cell D2 (this will be your Output cell). Click on **Archive Value** function.

**Step 4:** Refer to cell A2 in the **Data Item** field. In the **Time stamp** field refer to cell B4. Do not change any of the other options. Select **Time at left** and click OK.
6.4.3 Exercise – Temperature at a Glance

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity. *Use your own data if you have access to suitable data.*

**Objectives**

- Extract values and attributes from the PI System using the following functions:
  - Current value.
  - Archive value.

**Activity Description**

You would like to include the current value of the External Temperature of all Tanks in your daily report. You are also interested in knowing the value of the tanks’ Internal Temperature at midnight.

**Approach**

**Step 1**: Open the file *PI_DataLink-Exercises.xlsx*.

**Step 2**: Save it as `<your initials>_PI_DataLink-Exercises.xlsx` then work on sheet *Temperature at a Glance* and fill in data into all of the fields.

**Step 3**: Use the **Current Value** and **Archive Value** queries to fill in the template. We should base our PI DataLink queries on cell references whenever possible.
Retrieval Mode

When bringing the archive value to our report, we saw that a timestamp needs to be specified and the archived value will be retrieved for that timestamp. There may or may not be a value archived at the specified timestamp; how does PI DataLink decide just what data is retrieved?

You can decide the data retrieval behaviour by selecting different options from the **Retrieval Mode** drop down list. The default option is **Auto**. Different modes will retrieve the value differently, as listed in the following table:

<table>
<thead>
<tr>
<th>Retrieval Mode</th>
<th>Data retrieval behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>(Default) Interpolates at the exact timestamp provided, unless the data item is a step point, which would retrieve the previous value.</td>
</tr>
<tr>
<td>Interpolated</td>
<td>Always interpolates at the exact timestamp provided.</td>
</tr>
<tr>
<td>Previous, Next</td>
<td>Retrieves the previous or next compressed event from the timestamp specified. If a compressed event does exist at the exact timestamp, it is retrieved.</td>
</tr>
<tr>
<td>Previous Only, Next Only</td>
<td>Same as Previous, Next, except it will ignore any event at the exact timestamp specified.</td>
</tr>
<tr>
<td>Exact Time</td>
<td>Retrieves the value if and only if an archived value exists at that exact timestamp (down to the second).</td>
</tr>
</tbody>
</table>

The graph and table below exemplify the different retrieval modes.
The next graph shows the difference between Auto and Interpolated for a step point and an analogue point.

<table>
<thead>
<tr>
<th>Retrieval Mode</th>
<th>Timestamp</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpolated</td>
<td>13:00:00</td>
<td>1.8</td>
</tr>
<tr>
<td>Previous</td>
<td>12:30:00</td>
<td>2.5</td>
</tr>
<tr>
<td>Next</td>
<td>13:30:00</td>
<td>1</td>
</tr>
<tr>
<td>Exact</td>
<td>No events found.</td>
<td>No events found.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Auto</th>
<th>Interpolated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step OFF (Rate point)</td>
<td>13:00:00 - 2</td>
<td>13:00:00 - 2</td>
</tr>
<tr>
<td>Step ON</td>
<td><strong>12:30:00 – 2.8</strong></td>
<td>13:00:00 – 2.8</td>
</tr>
</tbody>
</table>
6.4.4 Exercise – Activity Report

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity. Use your own data if you have access to such data.

Objective

- Extract values and attributes from the PI System using the following functions:
  - Current value.
  - Archive value.

Activity Description

Your manager needs a report they can open each afternoon to see the current values of KPI’s for Mixing Tank2, which are:

- External Temperature
- Internal Temperature
- Level
- Flow Rate

Your manager needs to see the KPIs values at midnight today. Not trusting this new “PI Thing” your manager wants to see archive values around midnight as well as be able to type in a timestamp and see if there is an archive value at an exact time.

Approach

**Step 1:**
Open `<your initials>_PI_DataLink-Exercises.xlsx` then work on sheet Activity Report and fill in the data in all fields.

**Step 2:**
Use the Current Value and Archive Value queries to fill in a template.

✔ Quick Check

Can you:
- retrieve a current value?
- retrieve an archived value?
- describe the different retrieval modes?
- retrieve data item attributes?
If you answered NO to any of these questions, ask your instructor for assistance.

### 6.5 Multiple Value Queries

#### Learning Outcomes

- Retrieve compressed data for a point.
- Retrieve sampled data for a point.
- Retrieve timed data for a point.

There are three types of queries that return multiple values.

<table>
<thead>
<tr>
<th>Compressed Data</th>
<th>Actual archived data and is more properly termed Archived data, as not all data may be compressed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampled Data</td>
<td>Evenly spaced interpolated data</td>
</tr>
<tr>
<td>Timed Data</td>
<td>Interpolates events to match existing timestamps</td>
</tr>
</tbody>
</table>

Below is a graph of Compressed Data compared to Sampled Data. The Compressed Data function returns all the data that had been archived for the data item of interest. Time intervals between the compressed data values are uneven and depends on when the data was received and archived by the PI System.

You may need to know the value of a data item at specific timestamps, for example at the beginning of every shift. Or you may need to compare the values of two different data items and having unevenly spaced time intervals would not be that helpful. In these cases, using the Sampled Data function is helpful in creating a PI DataLink report.
Retrieving Compressed Data

The **Compressed Data** function retrieves the actual archived data from the Data Archive. You must specify:

- **Data item(s)**
  - Can specify 1 or more

- **Output cell**
  - Any data currently in this cell will be replaced

- **Start Time** and **End Time**.

**Note**: If you switch the timestamps for **Start** and **End Times**, the data will be returned in reverse order.

There are several optional checkboxes that will affect what is displayed, none of which are selected by default:

- **Hide count**: When this box is unchecked, the top line of your results will return the number of events found within that time range. When this box is checked, this count is not displayed and only the results are shown.

- **Show time stamps**: This checkbox determines if only the point values are returned, or if the corresponding timestamp is also retrieved.
• **Show Value Attributes** and **Show Annotations**: will return additional fields if there are any annotations or quality bits associated with the compressed events within the time range specified.

• **Column** and **Row**: This pair of radio buttons determine if the results are returned in columns or rows.

• The **Number of Values** option for this query behaves similarly, but rather than a specific time range, you will specify a **Start Time** and the **Number of Values** that you would like to retrieve. You can also check the box to have this go backwards, rather than forwards in time.
Obtaining Sampled Data

**Sampled Data** retrieves evenly spaced interpolated values from the archive. You specify:

- **Data item(s)**
  - Can specify 1 or more

- **Output cell**
  - Any data currently in this cell will be replaced

- **Start Time** and **End Time**.

- **Time Interval**
  - Used to divide the time range into discreet intervals.

Timed Data

The Timed Data function retrieves interpolated events to match existing timestamps. These timestamps are already in your spreadsheet and may be as a result of a related data item query.

The **Data item**, **Retrieval mode**, and **Output cell** need to be specified. In this case, the times used to retrieve events will be a range of cells containing timestamps. This is typically done by querying one point for events, and then using those timestamps to find the values for other, related points. The graph below shows an example of the External Temperature for Mixing Tank1 queried for Compressed data, then going to Mixing Tank2 and getting the Compressed Data then the Timed Data matched to Mixing Tank1 External temperature timestamps.
6.5.1 Directed Activity – Archived, Sampled and Timed Data Functions

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives

- Retrieve archive data with the different multiple value functions

Activity Description

You would like to analyse the archived values of the External Temperature of Mixing Tank1 in your daily report for the first two hours of every day. You would also like to see this temperature value every 10 minutes during these two hours.

You are also interested in doing a comparison between Mixing Tank1 and Mixing Tank2 at the timestamps where there is a value archived for external temperature of Mixing Tank1.

Approach

Part 1 – Build a Template

- **Step 1**: In Excel, create a Template for your report by typing Data Item, Start Time, End Time and Time Interval in cells A1, A3, A4 and B5, respectively.

- **Step 2**: Using Search, find the attribute External Temperature for Mixing Tank1 and Mixing Tank2 and place them in cells B1 and B2, respectively.

- **Step 3**: Type the Start Time of T (in cell B3), End Time of T+2h (in cell B4) and time interval of 10m (in cell B5).

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data Item</td>
</tr>
<tr>
<td>2</td>
<td>Start Time</td>
</tr>
<tr>
<td>3</td>
<td>End Time</td>
</tr>
<tr>
<td>4</td>
<td>Time Interval</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mixing Tank 1</td>
</tr>
<tr>
<td></td>
<td>Mixing Tank 2</td>
</tr>
<tr>
<td>C</td>
<td>Compressed</td>
</tr>
<tr>
<td>D</td>
<td>Sampled</td>
</tr>
<tr>
<td>E</td>
<td>Compressed</td>
</tr>
<tr>
<td>F</td>
<td>Sampled</td>
</tr>
</tbody>
</table>

Part 2 – Query PI Data

- **Step 1**: Obtain the compressed data for Mixing Tank1 External Temperature and list it in cell C3.

- **Step 2**: Do the same for Mixing Tank2 in cell G3.

- **Step 3**: Obtain the sampled data for Mixing Tank1 External Temperature in cell E3.
Step 4: Comparing the timestamps of the compressed data for the two mixing tanks you notice they are not the same so the comparison can’t be accurately done. To have a better comparison, use Timed Data function and get the External Temperature of Mixing Tank2 at the timestamps in Column C.

6.5.2 Exercise – Tank Analysis Report

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity. Use your own data if you have access to suitable data.

Objective
- Extract values and attributes from the PI System using the following functions:
  - Compressed Data.
  - Sampled Data.

Activity Description
Show the archived values of the Pressure of the two Mixing Tanks listed in your daily report for the past 24 hours. When retrieving the raw archived data for this process variable, you prefer to see one value each hour for the past 24 hrs.

You will use this report to do some analysis on this critical process variable of the mixing tanks.

Approach
Step 1: Spend a few minutes and fill out the following table:

<table>
<thead>
<tr>
<th>Data Item</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Time</td>
<td></td>
</tr>
<tr>
<td>End Time</td>
<td></td>
</tr>
<tr>
<td>Time Interval</td>
<td></td>
</tr>
</tbody>
</table>

Step 2: Open <your initials>_PI_DataLink-Exercises.xlsx then work on sheet Tank Analysis Report and fill in data for all of the fields.

Step 3: We will use the Compressed Data and Sampled Data queries to fill in a template.

Bonus 1
Using Excel functions, modify your report such that you get one value at the top of each hour for the past 24 hours.

**Bonus 2**

The Excel Insert tab in the **Sparklines** section has several options to show lines and columns as well as additional options to format the axes and colors.

To use this functionality, first select the cell where you want to place the Sparkline. Then choose the Sparkline type. For Data Range, select the cells with the data (just select the values, not the timestamps). Verify your output cell and choose OK. The result is a small trend of your data, with an assumption of evenly spaced values over time.
6.5.3 Directed Activity – Multiple Value Queries

Instructor led class discussion

Objectives
- Determine the best multiple value query for the job

Activity Description
You have just built a report to analyse the values of external and internal temperatures of all mixing tanks in your plant for the past 24 hours.

Approach

Part 1
Do you think the report you built is efficient? Since the same analysis would be done on the values retrieved for the internal and external temperatures of each of the mixing tanks, do you think your report can be built in a better way?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Part 2
What would you do if there were 50 mixing tanks in your plant and you needed to repeat the same process for each of them?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Quick Check
- Can you:
  - Retrieve compressed data for a point?
6.6 Element Relative PI DataLink Reports

Learning Outcomes

- Create Asset reports based on AF element templates
- Use Filters to search for Assets.

PI DataLink promotes the reusability of PI DataLink reports and the creation of Element Relative PI DataLink Reports.

This functionality is provided via Search.

You will need to:

- Set the Root path length to the mark before Name Only
- Insert root paths in: Drop-down list

resulting in:

<table>
<thead>
<tr>
<th>\PISRV01\OSisoft Plant\Production Area\Production Line1\Mixing Tank1</th>
<th>\PISRV01\OSisoft Plant\Production Area\Production Line1\Mixing Tank1</th>
</tr>
</thead>
<tbody>
<tr>
<td>\PISRV01\OSisoft Plant\Production Area\Production Line1\Storage Tank1</td>
<td>\PISRV01\OSisoft Plant\Production Area\Production Line1\Mixing Tank1</td>
</tr>
<tr>
<td>\PISRV01\OSisoft Plant\Production Area\Production Line2\Mixing Tank2</td>
<td>\PISRV01\OSisoft Plant\Production Area\Production Line2\Storage Tank2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>External Temperature</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>External Temperature</td>
<td>Average</td>
</tr>
<tr>
<td>Flow Rate</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td></td>
</tr>
</tbody>
</table>
Search for Assets by Filtering

The Element Relative search functionality is provided in PI DataLink through the Asset Filter search option. The Asset Filter is helpful for searching the AF database for elements and filtering the returned elements by the attribute values. Note that you must select an element template to filter elements if using attribute values.

The Asset Filter Search function returns assets that meet specified filter criteria. The returned assets can be used in the worksheet as a function array which can update automatically, or as static values.

The filter criteria include:

- Element name
- Element template
- Element category
- Element description
- Value of attributes

Using the Asset Filter, you will have the option of returning the search results in a Drop-down list which would be used in building reusable reports.

Note: The Asset Filter option provides more options in filtering different assets and attributes when creating an Element Relative Report. However, it requires a template for filtering the related assets. [http://www.youtube.com/watch?v=bUOW1yBlnk](http://www.youtube.com/watch?v=bUOW1yBlnk)
6.6.1 Directed Activity – Element Relative PI DataLink Reports

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section. Use your own data if you have access to suitable data.

Objectives
- Create an element relative PI DataLink report

Activity Description
You want to create a report to review the internal and external temperatures for all of the tanks.

Approach
We will follow two approaches in creating this report. The first approach is to use the Search functionality while the second approach is to use the Asset Filter functionality.

Method 1: Using Search

Step 1: Choose cell A1 in Excel

Step 2: Select the AF Server > OSIsoft Plant > Production Area in Search.

Step 3: Search for *TEMP*
You will notice that the results include all the attributes because their parent elements are based on the template named “Generic Tank Template”.

Step 4: Repeat the search for *TEMPER*

Step 5: Select all eight (8) results using the <Shift> Click (or individually with Ctrl Click).

Step 6: Use the Root path length slider set to the mark before Name Only.

Step 7: Set ‘Insert root paths in:’ to Drop-down list.

Step 8: Choose cell B2 and select the Current Value function.

Step 9: Select the cells for Data item(s) and Root Path.

Step 10: Now the Tank path can be modified with the drop-down list.
Method 2: Using Asset Filter

Step 1: Add a new sheet.
   a. Choose cell A2.

Important When working with Asset Filter and selecting the Drop-down list, the drop-down list will appear in the cell above your Output cell. The selected Output cell is where the selected attributes will start being listed.

Step 2: Click on Asset Filter from the Search section.

Step 3: Under the Root path specify the path to the Production Area Element in the form of \PISRV01\OSIsoft Plant.

Step 4: Under the Element template, select “Generic Tank Template”.

Step 5: Under the Attributes to display, select External Temperature and Internal Temperature.

Step 6: Select Drop-down list.

Step 7: Click Apply.
6.6.2 Exercise – Operational Start Up

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity. Use your own data if you have access to suitable data.

Objective
- Retrieve data using the Compressed Data and Sampled Data functions.

Activity Description
You want to determine if there is any deviation between start-up of operations for today compared to yesterday, during the same period of time. Four tanks exist on your plant and you want to be able to build and reuse a single report for both tanks.

- Your daily shift starts at 6:30 am and the critical start up time is the first 2 hours after the start up.
- Gather the values for the external temperature for this period of time for today and yesterday
- Compare the two by calculating the ratio of the two days' values (ideally, the ratio should stay as close as possible to 1).

Approach
Step 1: Spend a few minutes to fill out the following table:

<table>
<thead>
<tr>
<th>Root Path</th>
<th>Data Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yesterday’s Start Time</td>
</tr>
<tr>
<td></td>
<td>Yesterday’s End Time</td>
</tr>
<tr>
<td></td>
<td>Today’s Start Time</td>
</tr>
<tr>
<td></td>
<td>Today’s End Time</td>
</tr>
<tr>
<td></td>
<td>Time Interval</td>
</tr>
<tr>
<td></td>
<td>Excel function for Comparison (ratio)</td>
</tr>
</tbody>
</table>

4 Minutes

Step 2: You will use the template provided in sheet Operational Start Up of the file <your initials>_PI_DataLink-Exercises.xlsx.

Step 3: Use both PI DataLink functions of Compressed and Sampled data in retrieving the values and doing the comparison.

Step 4: Which PI DataLink function, do you think, would be more suitable for the purpose of comparison of yesterday’s and today’s values?
Quick Check

- Can you create Asset based reports?
- Can you use Filters to search for Assets?

If you answered NO to either of these questions, ask your instructor for assistance.
6.7 Excel Arrays in PI DataLink

Learning outcomes

- Identify when it is necessary to resize an array.
- List the ways to resize and edit an array.

Resizing an Excel Array

When using the PI DataLink product, end users may see this message below:

The Multiple Value functions just discussed actually return an array of values and timestamps. This array cannot be modified cell by cell, but the entire array can be modified. These values can change in size based on the point used, the time range specified, and exception and compression settings. Therefore, it can be necessary to resize the array.

If too many values are returned, you will receive the message “Resize to show all values” at the bottom of the array.

The easiest way to resize an array is to right click anywhere in the array, and choose Recalculate (Resize) Function.

For more information see "Array Management" in PI DataLink User Guide.

☑️ Quick Check
Understand? If not consult your friendly instructor.
6.8 Units of Measure and Descriptions as Context in Reports

It is possible to add Units of Measure (UOM) and Descriptions to reports. Doing so will add more context to consumers. It is possible to retrieve these attributes, and any other attributes, for a data item using the Properties function.

Different Properties will be shown depending on the Data Item listed. For both PI Points and AF Attributes, the Units of Measure are shown as UOM in PI DataLink Properties list.
6.9 More PI DataLink Functions

Learning Outcomes

- Obtain calculated values.
- Obtain filtered values.
- Understand Conversion factors.

In the previous chapters, we used different PI DataLink functions to access the raw data stored in PI Server. However, you may not be interested in bringing all the raw data but instead apply calculations on these raw values as they are retrieved from PI Server.

PI DataLink offers two ways to bring in calculated values:

1. Use different predefined calculation modes in PI DataLink as part of the Calculated Data function.
2. Use custom expressions in defining your desired calculation. The syntax used in these calculations is the same as Performance Equations syntax which is explained later.

Calculated Data

The Calculated Data function returns a single calculated value or evenly spaced calculated values for a PI Point or an AF Attribute. Calculation modes are:

- Total
- Minimum
- Maximum
- Standard deviation
- Range
- Average
- Count
- Mean

These summary calculations provide statistical information for data over a specified time period.

Selecting the Data Item radio button of the Calculated Data Function, you will see most of the fields are similar to the other PI DataLink functions you have already worked with.

Some of the fields specific to this function are:

- **Time interval**: An optional field. If used, it allows the behaviour to be similar to the Sampled Data function and the calculations will be done for the evenly spaced time intervals.
- **Calculation mode**: The available modes are the ones listed above.
- **Show percent good**: Checking this option displays the percentage of good data for the calculation time range. You can use this to determine if you want use data that may not be 100% ‘good’.
Note: A Bad value for PI System is defined as any of the digital states from the System Digital State Set in the Data Archive. Examples are I/O Timeout, No Data, Shutdown, No Sample, Intf Shut and Arc Off-line. It makes no inferences about the Quality of the data in the plant.

- **Conversion Factor**: If the calculation mode is set to **Total**, the conversion factor may need to be changed to a number other than 1.

  For time-weighted total calculations, use the Conversion Factor calculator. From the dropdown make a selection based on the units of measure of the process variable. The required conversion factor number will then be calculated and placed in the Conversion factor field.

  When you click on the calculator icon next to the Conversion factor entry field you will get a popup that lets you select the appropriate conversion factor:
6.9.1 Directed Activity – Calculated Data

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives
- Use the calculated data function in PI DataLink

Activity Description
We want to practice how to use Calculated Data and obtain the Average, Maximum and Minimum of Flow Rate for Mixing Tank1 for the period of past two hours and for the past one day.

Approach

Step 1: In Excel create a template with
a. **Root Path**: `\PISRV01\OSIsoft Plant\Production Area\Production Line1\Mixing Tank1`
   b. **Data Item**: Flow Rate
   c. **Start Time**: *
   d. **End Time**: *-2h

Step 2: Obtain the Average, Maximum and Minimum of Flow Rate for this tank and for the past one day.

Step 3: Change the End Time to *-1d to see the PI Server recalculate these values.
Calculating Total and the Conversion Factor

The conversion factor is a multiplier used to change a number from one unit of measure to another.

Ex: 1000 g per kg, 2.54 cm per inch, 24 hours per day, 1440 minutes per day

Since the Data Archive is not aware of engineering units, it assumes that rate points are in terms of units per day. Typically, this assumption is inaccurate as many points are measured in terms of units per second, units per minute, or units per hour. When using the Total function in Calculated Data, a conversion factor must be used to correct PI's assumption that the data is in units per day. The conversion factor is equal to 1.0 when the source data are in units per day.

<table>
<thead>
<tr>
<th>Actual Engineering Unit of the Rate Point</th>
<th>Engineering Unit Assumed by Data Archive</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>units / day</td>
<td>units / day</td>
<td>1</td>
</tr>
<tr>
<td>units / hour</td>
<td>units / day</td>
<td>24</td>
</tr>
<tr>
<td>units / minute</td>
<td>units / day</td>
<td>1440</td>
</tr>
<tr>
<td>units / second</td>
<td>units / day</td>
<td>86400</td>
</tr>
</tbody>
</table>

**Example:** Flow rate is measure in litres per minute (l/m) and stored in the Data Archive. We are interested in calculating total litres for an 8 hour period. Shown in the following illustration, flow rate is:

- 3 l/m for 3 minutes
- 5 l/m for 2 minutes
- 1 l/m for 3 minutes

Total flow, is the area below the flow rate line (the area of the three rectangles added up).
flow rate l/m

PI assumes this measurement to be units/day
The expected total flow would, therefore, be:

\[(3 \text{ l/m x 3 min}) + (5 \text{ l/m x 2 min}) + (1 \text{ l/m x 3 min}) = 22 \text{ litres}\]

Data Archive, however, assumes the unit of measure of the flow rate is gallons per day. Without applying the conversion factor, the total flow calculated by Data Archive is returned as:

\[(3 \text{ litres per day x 3 min x 1 day/1440 min}) + (5 \text{ litres per day x 2 min x 1 day/1440 min}) + (1 \text{ litre per day x 3 min x 1 day/1440 min}) = 0.01528 \text{ litres}\]

The total computed by the Data Archive must be multiplied by the conversion factor of 1440 to get 22 litres:

\[0.01528 \text{ litres x 1440} = 22 \text{ litres}\]

When the calculation mode is **Total** and part of the archived data within the range is bad, the reported value is equal to the calculated total value divided by the fraction of the time period with good archived data. This data normalization is equivalent to the assumption that for the bad data time range, the point value takes on the average value of the entire range. However, this assumption may not be valid when a large fraction of the time range contains bad data. Therefore, we recommend that you always look at the **percent good** value before using the calculation result.

For more information see "Calculated Data" in *PI DataLink User Guide*
6.9.2 Directed Activity – Calculating the Total

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives

- Calculate the Total value using the Calculated Data function

Activity Description

We want to calculate the total Flow and the Average Flow Rate of Mixing Tank1 for yesterday. To know what conversion factor to use, we need to bring the UOM of Flow Rate for Mixing Tank1.

Approach

Step 1: In Excel create a template with

a. Root Path: \PISRV01\OSIIsoft Plant\Production Area\Production Line1\Mixing Tank1
b. Data Item: Flow Rate
c. Start Time: Y
d. End Time: T

Step 2: Add a cell to your report template titled UOM and get this value for Flow Rate using Properties.

Step 3: Add a cell to your report template titled Conversion Factor and write the appropriate value there.

Step 4: Calculate the Average

Step 5: Calculate the Total of Flow for the time range (don’t forget the Conversion Factor!)

Step 6: Add the percent good.

<table>
<thead>
<tr>
<th>Data item</th>
<th>Root path</th>
<th>average</th>
<th>total</th>
<th>% good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Rate</td>
<td>\PISRV01\OSIIsoft Plant\Production Area\Production Line1\Mixing Tank1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UOM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL conversion factor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.9.3 Exercise – Production Summaries

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objective

- Extract calculated values using the Calculated Data function.

Activity Description

As the production manager, you want to create a report showing last week’s production statistics. You want to display the following for the production from each day of the past week:

- Total
- Average
- Maximum

You also want to do the same calculations for the entire week.

Approach

Step 1: On the PI Server, the production is the sum of the productions from the two production lines and is stored as an attribute named Production under the element of Production Area. It is defined as the sum of the flows of the two Mixing Tanks in litres per minute.

Step 2: Spend a few minutes and fill out the following table:

<table>
<thead>
<tr>
<th>Root Path</th>
<th>Data item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Start time:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End time:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time interval:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UOM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Step 3: You will use the template provided in sheet Production Summaries of the file <your initials>_PI_DataLink-Exercises.xlsx. Use the values of your table in the provided template.
Note:

When working with the weekly total, do not use the time interval. Only use it for the daily total (hint).

Be sure to show the Start Time for the daily Calculations.

The percent good field is located to the right of an aggregate calculation, so use with the Maximum.

Quick Check

Can you:

- Obtain calculated values?
- Obtain filtered values?
- Understand Conversion factors?

If you answered NO to any of these questions, ask your instructor for assistance.
6.10 Using Time Filtered Data in a Preventative Maintenance Example

Learning Outcomes

- Using the Time Filtered Function

Time Filtered Data

You have a Pump and would like to implement a Preventative Maintenance program. Firstly, you need to determine the period that the pump was running. These total hours can then be checked against the replacement period as indicated in the pump manufacturer’s datasheet; every 10,000 hours, for example.

If you have a PI Point recording the status of the pump (when it is ON or OFF) you can report your Preventative Maintenance program by using the **Time Filtered** function. This function returns the amount of time that a performance equation evaluates to true during a specified time period.

You need to specify the following fields for this function:

- **Expression(s)**
  - Can specify 1 or more and it would follow the Performance Equation format. Data items permitted in expressions are:
    - PI points
    - AF attributes that store data references to PI points
    - AF attributes that store constant values

- **Start Time** and **End Time**.

- **Time Unit**
  - i.e. The pump was running for 5 seconds/minutes/hours/days
6.10.1 Directed Activity – Controller State

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives
- Extract Time Filtered data in PI DataLink

Activity Description
We want to determine the amount of time a controller has been in the CASCADE state. The controller is a digital point, named CDM158, and has five (5) discrete states. We are only concerned with the CASCADE state at this time.

Approach

Step 1: In Excel create a label for the output cell **Time in Cascade mode (hours)**.

Step 2: Choose an empty output cell.
   a. Select the **Time Filtered** function.

Step 3: Use the following values for different fields:
   a. Expression(s): ‘CDM158’ = “CASCADE”
   b. Start Time: T-3d
   c. End Time: T
   d. Time Units: Hours

![Image of Excel spreadsheet showing Time Filtered function with values for CDM158, T-3d, and T, and a result of 36.257 hours.

[Image of Excel spreadsheet showing Time Filtered function with values for CDM158, T-3d, and T, and a result of 36.257 hours.]
6.10.2 Directed Activity – Mixing Tank Level Control

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives

- Use an expression in the Time Filtered function

Activity Description

Mixing tank1 level going above 7 is an indication of malfunctioning of the pump. In our analysis report, we want to find out for how many hours the pump was malfunctioning during yesterday.

Approach

Step 1: In Excel create a report template similar to the screenshot at the end of the activity.

Step 2: Select cell B1 and search for the Mixing Tank1 Level attribute.

Step 3: Modify the expression and apply the PE syntax rules to ‘level’>7

Important Note: The first ‘ in an Excel cell is used to signify that the cell content is text and that no Excel formulas should be interpreted. To include an expression in a cell, you need to put a ‘ at the beginning of the expression.

Step 4: Complete the report template with these values:

a. Start Time: T
b. End Time: Y
c. Time Units: Hours

Step 5: Select the Time Filtered function and use the output cell as B6.

![Excel screenshot showing the expression "Level" > 7]
6.10.3 Exercise – Condition Based Inspection

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objective

- Calculate the operating time with the Time Filtered function.

Activity Description

The pumps on our mixing and storage tanks need to be visually inspected every 4 months only if they have been running for over 2,000 hours. As the person in charge of the Preventative Maintenance program, you want to know the operating time for the pumps on the tanks.

A PI Point does not exist to determine if the pump is ON or OFF, but the pump only runs when the tank Level is greater than 1.2. Find the amount of time the pumps on each of the tanks have been running for the past 4 months and find out if any of the pumps need to be inspected.

Approach

You will use the template provided in sheet Condition Based Inspection of the file <your initials>_PI_DataLink-Exercises.xlsx. Get the total Operating Time of the pumps associated with tanks.

Step 1: Use Asset Filter Search to bring the list of Assets without any attribute.

   a. Specify the appropriate Root Path and Element Template in the search dialogue box and without selecting any attributes, click Ok.

Step 2: Use Time Filtered function to calculate the number of hours each pump was running.
Quick Check

- Can you use the Time Filtered function?
  If NO, then ask your instructor for assistance.
6.11 Filtered Data Using Custom Expressions

Learning Outcomes

- Using Filtered expressions

When using different PI DataLink functions, we noticed an optional field of **Filter Expression**.

![Filter expression (optional)]

This option is available for the functions of:

- Compressed Data
- Sampled Data
- Calculated data

PI DataLink applies the filter expression to the raw data retrieved and only the values that make the specified expression **True**, would be included. Therefore, for the two functions of Compressed Data and Sampled Data, only the values that make the specified filter expression True would be listed in the output cell. For the Calculated Data function, only the raw values that make the filter expression True, would be considered in the calculations. With the use of Filter Expression, an option of **Mark as filtered** becomes available for the Compressed and Sampled Data functions; if the Mark as filtered option is selected, a **Filtered** status is returned for each group of values that does not satisfy the filter expression.

The Filter Expression is a performance equation and follows the formatting rules discussed in the previous section.

**Note:** When using a cell reference for your Filter Expression, be sure that if the Filter Expression begins with a timestamp or point name that you use two single quotes. The first single quote is used in Excel to identify a text string, rather than a value, and will not be seen by the filter expression. Another option is to enclose the entire filter expression in parenthesis, in which case the extra single quote is not needed.

For more information see the “Expressions” section in the *PI DataLink User Guide*. 
Excel Conditional Formatting

This topic is not specific to PI DataLink, but the **Conditional Formatting** found in Microsoft Excel can give your PI DataLink reports a great perspective. It is useful for visually comparing values extracted from PI. **Conditional Formatting** is found in the **Home Ribbon** in the **Styles** section. You can use this functionality to provide highlighted maxima or minima, bar graph backgrounds, and many other visual cues about the data being displayed.

To use this functionality, first highlight the group of cells you wish to format. Then click on the **Conditional Formatting** button and choose a group and rule. For the **Highlight Cells Rules** and **Top/Bottom Rules**, you will see a preview of the formatting once you configure the appropriate limits. For **Data Bars, Colour Scales** and **Icon Sets**, simply hover the mouse over each preconfigured option to preview its effect on the cells you selected. Click the desired rule to select it.

If none of the preconfigured rules suit your needs, you can configure additional rules using **Conditional Formatting > New Rule**. Multiple rules can be applied in configurable order using **Conditional Formatting > Manage Rules**.

**Note:** The **MS Excel TODAY()** function returns the serial number of the current date. The serial number is the date-time code used by Microsoft Excel for date and time calculations. Microsoft Excel stores dates as whole number of days starting at 1900. Dates and times are values and therefore can be added, subtracted, and included in other calculations.

**Syntax:**

```
=TOODAY()
```

**Example:**

```
=(TODAY() - 10 + 16/24) is today minus 10 days at 4 PM
```
6.11.1 Directed Activity – Filtered Data Value Queries

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives
- Apply a filter expression to the values retrieved using Compressed Data function

Activity Description
Retrieve data using the Compressed Data function and filter out all values below 150 because they are irrelevant to our report.

Approach

Part 1

Step 1: In Excel create a sheet with
- Data Item: CDT158
- Start Time: T
- End Time: T-1d
- Filter Expression: “CDT158’ > 150

Step 2: Retrieve the Compressed Data and verify there are no values less than 150.

Step 3: Values below 150 are unnecessary and we would not need to include them on our report.

Part 2

Step 1: On a new sheet, create a sheet with
- Tank: \PISRV01\OSIssoft Plant\Production Area\Production Line1\Mixing Tank1
- Process Variable: External Temperature
- Start Time: T
- End Time: T-1d
- Filter Expression: “External Temperature’ > 200

Step 2: Retrieve the Compressed Data and verify there are no values less than 200; the filter expression removed them.
6.11.2 Exercise – Production Level Report

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Use the Filter Expression option of the Sampled Data function to constrain the values that are extracted.

Activity Description

As a quality control manager, you want to examine the level of product in Mixing Tank1. Since this is an analogue point, it is better to perform a Sampled Data query rather than a Compressed Data query.

You want to build a report for the level yesterday over 10-minute intervals. The report filters out mean tank levels, which is defined as a level between 4 and 6.

Approach

Step 1: Spend a few minutes and fill out the following table:

<table>
<thead>
<tr>
<th>Root Path</th>
<th>Data Item</th>
<th>Start Time</th>
<th>End Time</th>
<th>Interval</th>
<th>Upper Limit</th>
<th>Lower Limit</th>
<th>Filter Expression</th>
</tr>
</thead>
</table>

Step 2: You will use the template provided in sheet Production Level Report of the file <your initials>_PI_DataLink-Exercises.xlsx.

Note: Are you familiar with the Excel function of CONCATENATE?
Quick Check

Having completed this topic:

- Do you understand the use of Filtered Expressions?

If you answered NO, ask your instructor for assistance.
6.12 Event-related Features of PI DataLink

Learning Outcomes

- Understanding the Event Explore and Compare

Explore and Compare PI Events

PI DataLink allows browsing and comparing PI Events within Microsoft Excel.

These two Events functions return events that meet specified criteria in an AF database.

- **Explore Events**: this function returns one event per row and nests children events under parent events. This function is useful to show child events under a parent event while preserving the hierarchy structure.

- **Compare Events**: this function returns one event per row but can return attributes from related events in that same row. Specifically, to facilitate event comparison, the function can return attributes from child events or parent events in the same row as the returned event. This function is useful to flatten the hierarchy to show a particular child event that is common for each parent event.
6.12.1 Directed Activity – Monitoring downtime events

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives
- Retrieve Event Frames in PI DataLink

Activity Description
Operations manager needs a report that lists the amount of time that the tanks at your site had been down due to mechanical issues (and not due to scheduled maintenance). Learn how to use event frames data in excel reports.

Approach

Step 1: In Excel select an Output cell

Step 2: Select Explore from the Events tab

Step 3: Make the following selections:
  a. Database: \PISRV01\OSIsoft Plant
  b. Event name: *
  c. Search start: *-1d
  d. Search end: *
  e. Event template: Downtime
  f. Element name: *

Step 4: Expand the More search options section. On the Attribute value filters select the “Reason Code” for the Attribute:
  a. Reason Code = mechanical

Step 5: From Columns to display select Event name, Start time, End time, Duration, Primary element, Maximum External Temperature, Maximum Internal Temperature, Reason Code and Temperature Difference.
Step 6: Click Ok.
6.12.2 Directed Exercise – Analysing downtime events

You are invited to watch what the instructor is doing. If you know Pivot Charts, have a go yourself.

Objectives

- Analyse Event Frames retrieved from PI DataLink using PivotChart and PivotTable

Activity Description

The operations manager now needs a report that shows which downtime reason is most prevalent and a comparison showing which tanks are the most problematic. He also would like to see information about the total production loss from the tanks.

Approach

Step 1: Use the template provided in sheets Downtime Raw Data and Evaluating Tank Downtime of the file <your initials>_PI_DataLink-Exercises.xlsx.

Step 2: Open the Downtime Raw Data Tab Select cell A7 as your Output cell

Step 3: Select the Compare from the Events tab

Step 4: Make the following selections:

Step 5: Database:

- Event name: *
- Search start: *-1d
- Search end: *
- Event template: Downtime
- Element name: *

Step 6: From Columns to display select:

- Event name, Start time, End time, Duration, Event Template,
- Primary element, Event Duration, Maximum External Temperature,
Step 7: Click Ok.

Step 8: Open the Evaluating Tank Downtime sheet.

Step 9: Select the PivotTable under Comparing Reason Codes, then, from the Analyse tab, select Refresh

Step 10: Select the PivotTable under Comparing Tanks, then, from the Analyse tab, select Refresh

Step 11: Which Reason Code caused the most production loss overall?

Step 12: Which Reason Code caused the most production loss for the Storage tanks?

Step 13: Which Tank has caused the most production loss?

Quick Check

- Do you now understand the Event Explore & Compare functions?

If you answered NO ask your instructor for assistance.
6.13 Functions using an Expression

Learning Outcomes

- Use an Expression instead of a Data Item
- Understand why Expressions are provided.

As we saw earlier, some PI DataLink functions accept either a data item or an expression as input. These functions have Data item and Expression options at the top of the task pane. So far, we only worked with the Data Item option. In PI DataLink, expressions are performance equations that you can use to incorporate mathematical operations and calculations based on PI System data items.

PI DataLink functions that can use Expressions (as well as Data Item) include:

- Archive Value function
- Sampled Data function
- Timed Data function

PI Expressions behave much the same way that PI PE do. They follow the same expression syntax and can use one or many of the following Data items:

- PI points
- AF attributes that store data references to PI points
- AF attributes that store constant values

The benefit to PI Expressions is that they only calculate on demand. However, the downside is that, unlike PI PE, there is no history of these calculations stored on the PI Server, so it is more difficult to see historical trends.

How is Calculated Data Function Different from PI Expressions?

One difference between PI Calculated Data and PI Expressions is shown in an example below. The PI Calculated Data computes the maximum of the point over each 1-day period for the last 7 days. The PI Expression shown computes the maximum of the Sampled Data of point for the most recent 8 hours of every 1-day period, for the last 7 days.
The format for the PI Expression is: \texttt{TagMax('TagName','*-8h','*')}
Just like the PI Calculated Data, it would be configured with a start time of *-7d, an end time of *, and an interval of 1 day (1d). Keep in mind that the ‘*’ in the expression does not always go to the current time of the machine, the ‘*’ in this case is represented by the right side of the 8-hour bar below. If the PI expression was changed to TagMax('tag', '+-1d', '*'), the results of the PI Calculated Data and the PI Expression would be identical. However, the PI Expression will contain an extra interval at the start time of the expression when compared directly with PI Calculated Data.
6.13.1 Directed Activity – Expression Queries

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives

- Use Performance Equations in PI DataLink

Activity Description

We showed how we would be able to see the values of the Flow Rate of Mixing Tank2 for the past one day at the top of each hour, using Sampled Data function.

Here, instead of bringing the raw values of the flow rate, we are interested in getting the difference between the flow rate value and its average for the past day, and have it included in our Excel report.

Note: For simplicity, we will use PI Points in this example. You would be able to do this exercise using the AF Attribute and the Concatenate function in Excel for building the expression.

Approach

Step 1: Open Microsoft Excel.

Step 2: Create a Template with:

- **Start Time**: y
- **End Time**: t
- **Time Interval**: 1h
- **Expression**: TagVal('VPSD.OSIsoftPlant.PL2.MXTK2:Flow Rate') - TagAvg('VPSD.OSIsoftPlant.PL2.MXTK2:Flow Rate', '*-24h','*')

Step 3: Use *Sampled Data* function and use *Expression* in retrieving the data

Step 4: 

![Excel template screenshot](image-url)
6.13.2 Exercise – Material Balance Report

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Use Performance Equations in PI DataLink

Activity Description

Two products, named Product A and Product B are being mixed in a tank, as shown in the following schematic.

The flow of Product A is stored in a PI Point named \texttt{VPSD.OSIsoftPlant.PL1.MXTK1:Flow Rate}

and the flow of Product B is stored in a PI Point named \texttt{VPSD.OSIsoftPlant.PL1.MXTK2:Flow Rate}.

You are interested in including the Percentage of Product A in the mix, as it is a critical indicator. There is no PI Point storing this value and you need to calculate it.

You are building this report for the past 7 days and would like to list this percentage for the period of every 2 hours.

Approach

Step 1: Develop the expression for calculating the Percentage of Product A in the resulting mix.

Step 2: Spend a few minutes and fill out the following table:

<table>
<thead>
<tr>
<th>Expression</th>
<th>Start Time</th>
<th>End Time</th>
<th>Time Interval</th>
</tr>
</thead>
</table>

Step 3: You will use the template provided in sheet \textit{Material Balance Report} of the file \texttt{<your initials>_PI_DataLink-Exercises.xlsx}. 
Step 4: How would you change the expression if one of the two Products was not flowing and the associated point was showing a bad value of “Shutdown”? (Hint: If Then Else)

✔ Quick Check

- Can you use an Expression?
- Do you understand why Expressions are provided?

If you answered NO to either of these questions, ask your instructor for assistance.
7. FINAL EXERCISE

Now that you have the Visualization tools in your toolkit, it is time to put them to work. Your plant is so successful it has expanded and has a new database. It is now called the **OSI Production Facility**, or you may be using your own company assets if you have access to them. Your task is to create new displays and reports for the production engineers.

**Learning Outcomes**

- Demonstrate Familiarity of the OSIsoft Visualization tools

**7.1 Global Recap Exercise**

This solo activity is designed to maximize learning in a specific topic area. Your instructor is available to assist if you need assistance during the activity.

**Objectives**

- Demonstrate understanding of the fundamentals of the PI System technology
- Access data in the PI System
- Demonstrate the use of PI Vision and PI DataLink client applications

**Activity Description**

The production facility has grown beyond company’s wildest expectations resulting in an upgrade to a bigger plant. The old displays and reports are no longer acceptable. You have been asked to completely redesign the displays and reports from the previous environment.

Design a set of dashboards, displays and reports using the skills learned in this class. Creativity is highly encouraged. This is intended as a fun, open-ended exercise, and a friendly competition to wrap up the class. Feel free to work in small teams or alone. At the end of the session, all groups will give a brief presentation of their displays.

Work will be graded on:

1. Conveying your understanding of as many skills/concepts as possible.
2. Use of all the products, including PI DataLink and PI Vision.
3. Creativity in your design.
4. Your presentation to the class.

You may use any aspects of PI DataLink, and PI Vision discussed in class. This is open book, so feel free to consult the workbook as well as relevant documentation (all the relevant user guides are available in your learning environment). You are encouraged, but not required, to use all three products in your final design.
**Approach**

**Step 1:** In the PI client tools - PI Vision and PI Datalink - set the database to OSI Production Facility.

**Step 2:** Explore the AF Structure to see the data available. *If you are using your own PI System, take note of the data surrounding your job role or your ideal business use case.*

**Step 3:** Build displays using the tools studied in this course to show potential solutions for the business case you chose. Below are some of the things you need to implement.

**PI Vision**
- Build a display with Tables, Trends, Values and Gauges
- The **use of collections is a must**, incorporating all production lines.
- Re-use displays for similar assets and add text, images, links, and multi-state behaviour to enrich your PI Vision Display.
- Create a pinned Event Frame representing an ideal run. Remember - pinned events are benchmark events that remain at the top of the Events panel.
- Share the display, add keywords to sort displays and find your favourite displays.
- Display your knowledge of multiple time contexts within a display.
- Demonstrate the use of PI Vision calculations.

**PI DataLink**
- Display Current Values and archived data for PI Points and AF Attributes
- Calculate totals, averages, and other statistical values for your data
- Report on Event Frames, particularly regarding Downtime & Lost Production
- Re-use reports for multiple assets using drop-down lists

Share your displays and reports with the class, explaining how each fulfils the business case (or your own use case).

Additionally show how what you have learned, will help you when you return to your normal role.
8. OSISoft Supporting You

Learning Outcomes

- Show the OSIsoft Learning Platform
- Explore the OSIsoft Learning YouTube Channel
- Introduce PI Square and the Customer Portal

Learning Platform @ learning.osisoft.com

The best place to learn more about the PI System is through the OSIsoft Learning platform. We have curated our online courses, instructor-led training, and hands-on labs in an easy to browse website, so you can keep learning about the PI System long after PI World concludes.

The platform is separated into learning paths, and for beginners, we suggest the User path.

PI System Learning Made Easy

An OSIsoft Learning experience built for you!

VISIT LEARNING.OSISOFT.COM

Online Courses

Take a few minutes to click into the different learning paths and see the types of online courses offered for:

- Users – who need to see the data in real time or build reports with PI System data.
- Administrators – who keep the data flowing and support end users. These courses dive into the backend components of the PI System.
- Developers – who write code to interact with the PI System programmatically.
• Power Users – who are adept with the basics of the PI System and can boost their organization’s efforts through building an enhanced Asset Framework structure.

Our online courses cover a wide range of topics and are on-demand. When you sign up for an online course, you will immediately gain access to the course material for 30 days along with a Training Cloud Environment for you to practice the concepts discussed in the course.

You can also purchase a Training Cloud Environment separately from the courses if you want a place to explore the PI System outside of your company’s production environment; however, we recommend using your own development system whenever possible to create meaningful results with your company’s data as you learn from our online materials.

**Classroom Courses**

If you prefer a classroom setting, you will want to check out our instructor-led Classroom Courses. We have several training centers around the world for you to visit, so pick a location that is convenient for you (or combine some PI education with a vacation)!

To browse the available training centers and courses, follow these steps:

1. Click on “All Content”
2. Use the filter on the left to select “Classroom” under “Content Type”
3. Expand the “Location” category to browse our training centers
4. View the available courses offered at your selected location
   a. Some training locations offer course taught in languages other than English, feel free to use the “Language” filter to further refine your course options.
5. Click on the course that matches your interest and follow through registration

If you want to view the course calendar, you can click on the calendar icon in the All Content page.

**OSIsoft Learning YouTube Channel @ youtube.com/OSIsoftLearning**

Visit our YouTube Channel to *Learn about the PI System by watching any of our 1000+ free videos on You Tube!*  

Playlists for various topics are available to help guide you through your training topic of choice from start to finish.
8.1 Exercise – Search the OSIsoft Learning Channel

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Find a video on the OSIsoft YouTube Learning Channel to learn about a topic not covered in the Visualizing PI System Data Course
- Demo accessibility features and playback settings in YouTube

Activity Description

You want to learn how to navigate a PI Vision display and make use of Ad-Hoc trending functionality.

Approach

**Step 1**: Use a web browser to navigate to YouTube.com

**Step 2**: Search for the OSIsoft Learning Channel

**Step 3**: Run a search to find a video about migrating PI ProcessBook displays to PI Vision, sample search: “PI Vision” or “ad hoc trending” or search for any other topic of interest to you.

**Step 4**: A video covering the utility is “PI ProcessBook to PI Vision Migration Utility”

**Step 5**: Turn on the Subtitles by clicking on the 

**Step 6**: Change the quality of the video by clicking on the Settings icon

**Step 7**: While in Settings, choose Subtitles and notice that you can have Google auto-translate to the language of your choice AND you can submit subtitles in other languages for the OSIsoft YouTube team to review

**Step 8**: To get notified when OSIsoft releases new videos, make sure to and click on the bell icon for updates
8.2 Directed Exercise – Find a playlist on YouTube

You are invited to watch what the instructor is doing or perform the same steps at the same time to explore the different concepts presented in this chapter or section.

Objectives

- Search the OSIsoft YouTube Learning Channel for a playlist that interests you
- Use the playlist links to share structured content with your colleagues

Activity Description

You want to learn as much about a product as possible, or you want to audit an online course for free.

Approach

Step 1: Use a web browser to navigate to YouTube.com

Step 2: Search for the OSIsoft Learning Channel.

Step 3: Identify several playlists on the channel’s “Home” tab.

Step 4: Click on the PI Vision Playlist.

Note the playlist sidebar on the right side of the page. Now you can click into several related videos.

Step 5: Share the URL for the video with a colleague by selecting the entire URL on your page. If you use the share button on the video, it does not share the entire playlist.

Step 6: Go back to the OSIsoft Learning channel homepage by clicking on the channel icon below the video player.
Step 7: Scroll down until you see the section titled “Audit our Online Courses” and click on the title.

Step 8: Take note of all the free online course videos that you can view and share after PI World with your team!

Follow up: What are 2 ways you can find playlists on the OSIsoft Learning YouTube Channel?

myosisoft.com and the Customer Portal @ customers.osisoft.com

The myosisoft.com website has many tutorials on how to support related activities as well as quick links to take you to commonly used support pages:

OSIsoft Customer Portal Hints

- How to Get an OSIsoft Customer Portal Login
- How to Create a New Case
- How to Download Products and Generate Licenses
- How to Search for Articles
- How to Manage Users

From the Customer Portal, you can also:

- Download any PI product your company is licensed for using.
- View the PI System Roadmap to get information about the most current releases and what new features and products are on the horizon.
- Login and view your open and previously closed Support Cases or create a new one.
- Search through our Knowledge Base to try and troubleshoot any issues you may be having by referring to the rich collection of available KB Articles.

Here are the general phone number and email address for the OSIsoft Technical Support:

Phone: +1 510 297-5828 in North America
E-mail: techsupport@osisoft.com

24 Hour Telephone Support

Support may be provided in languages other than English in certain centres based on availability of attendants. If you select a local language option, we will make best efforts to connect you with an available Technical Support Engineer with that language skill. If no local language tech support engineer is available to assist you, you will be routed to the first available attendant.

Before you contact Technical Support, it is helpful to have certain information readily available. OSIsoft technical support engineers will ask:

- name of the product
Visualizing PI System Data

- version number
- the time that the difficulty started
- the computer platform (CPU type, operating system, and version number)

**PI Square – The online PI System Community @ pisquare.osisoft.com**

PI Square is OSIsoft’s community where you can get Technical Support for your questions, access the PI Developers Club (PI DevClub) for your coding projects, and connect to PI Systems users worldwide to get more value out of your PI System.

The PI Square community has places you go to collaborate, called Spaces. These spaces are generally named for a specific topic or purpose. Each space can contain multiple types of content, including discussions, documents, blog posts, polls, and more. Currently, PI Square has the following four spaces:

- **All Things PI** - A general forum where OSIsoft Technical Support will keep watch to help answer questions and contribute to discussions. Use the product-specific spaces like PI Server or PI Visualization to find relevant content for whatever your needs may be.

- **PI Developers Club** - Here we have tools and support for developers to create applications for the PI System.

- **Learn PI** - Our hub for students to interact and learn from each other while they pursue certificates in our on-demand online courses.

- **PI Square Groups** – Join a group that speaks to your specific industry’s needs and learn from others in your field of their recommended best practices for projects on your horizon.
8.3 Exercise – Navigating PI Square

This solo or group activity is designed to maximize learning in a specific topic area. Your instructor will have instructions and will coach you if you need assistance during the activity.

Objectives

- Create a PI Square SSO Account and find answers about Visualization topics
- Discover the online course forums

Approach – Part 1

**Step 1:** Using a web browser, navigate to the PI Square website:
[https://pisquare.osisoft.com](https://pisquare.osisoft.com)

**Step 2:** Log in to the PI Square community
   - If you don’t have an OSIsoft SSO account, create one now. You’ll use the same account for PI Square, the OSIsoft Learning platform, and the Customer Portal.

**Step 3:** Search for a post for each of the topics:
   - Future Data in PI DataLink | URL Parameters in PI Vision

**Step 4:** Read through past posts, comment, or ask your own question.

Approach – Part 2

**Step 5:** Navigate to the “Learn PI” space either by clicking on Spaces>Learn PI in the page header, or by clicking on “Online Courses” from the homepage.

**Step 6:** Click on “Visualizing PI System Data with PI Vision” under the “User” learning path, and explore the questions posed and the answers given by the community for our on-demand Online Courses.

Further Questions?

For questions about Licensing you can find your account manager listed at [http://www.osisoft.com/](http://www.osisoft.com/) > Contact Us

For questions about existing Support Issues, contact technical support or visit [my.osisoft.com](http://my.osisoft.com).

For questions about unresolved training issues, contact your instructor or email learning@osisoft.com.

For all other questions, please contact our Customer Service group via email at customerservice@osisoft.com.