

Modernizing PI SQL For The Future

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Your Speakers Today



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Why SQL for the PI System

- Simplest place to cross-pollinate actionable line-of-business (LOB) data with real-time data
- Enhancing Real Time Data with LOB data
- Enhancing LOB Data with RT
- Maximizes the resources you already have to complete data projects:
 - SQL Database Administrators
 - Web Developers
 - LOB App Developers

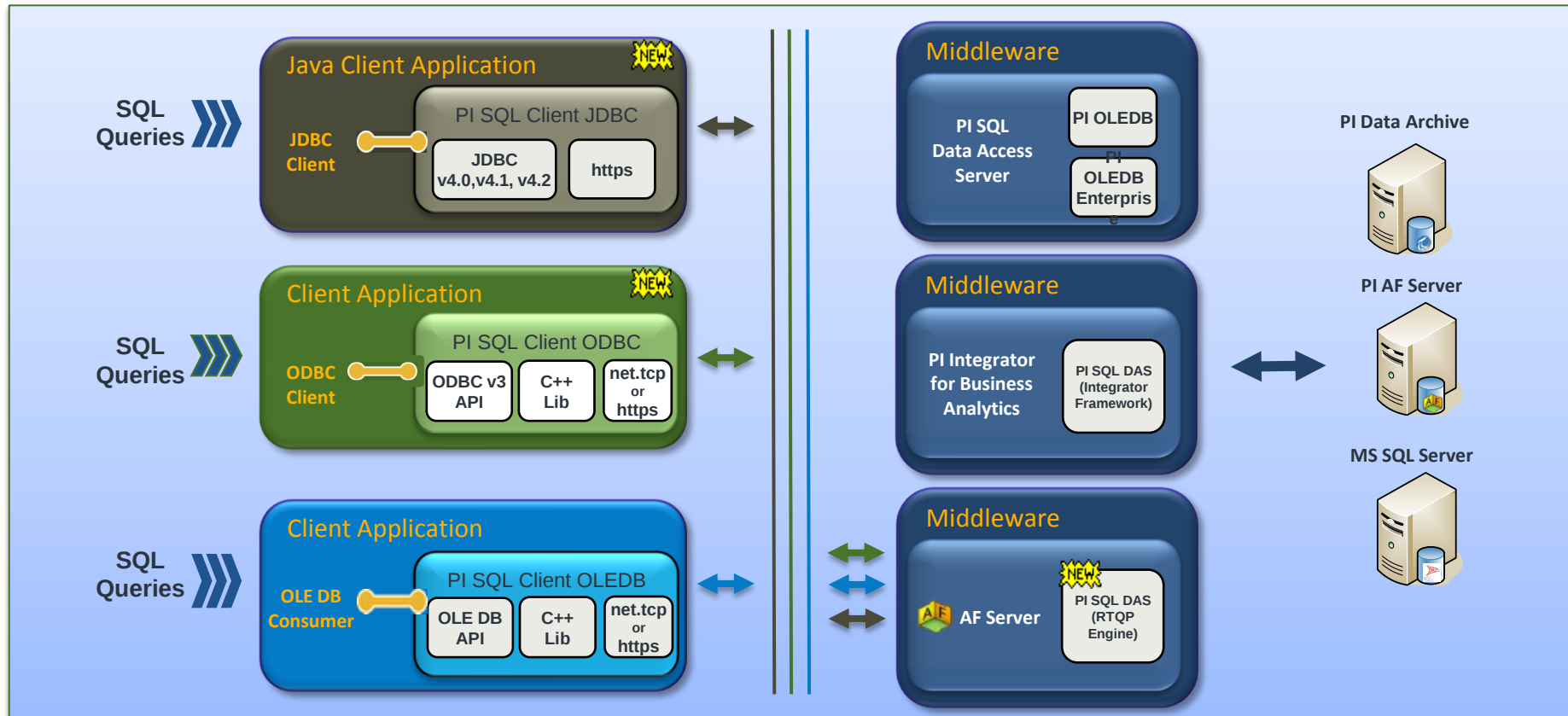
Why SQL for the PI System

- Some data will never live in SQL (streams)
- Some data will never live in the PI System (financial costing)
- We've optimized how we merge relational structures and their relationships to assets with streaming data in the PI System

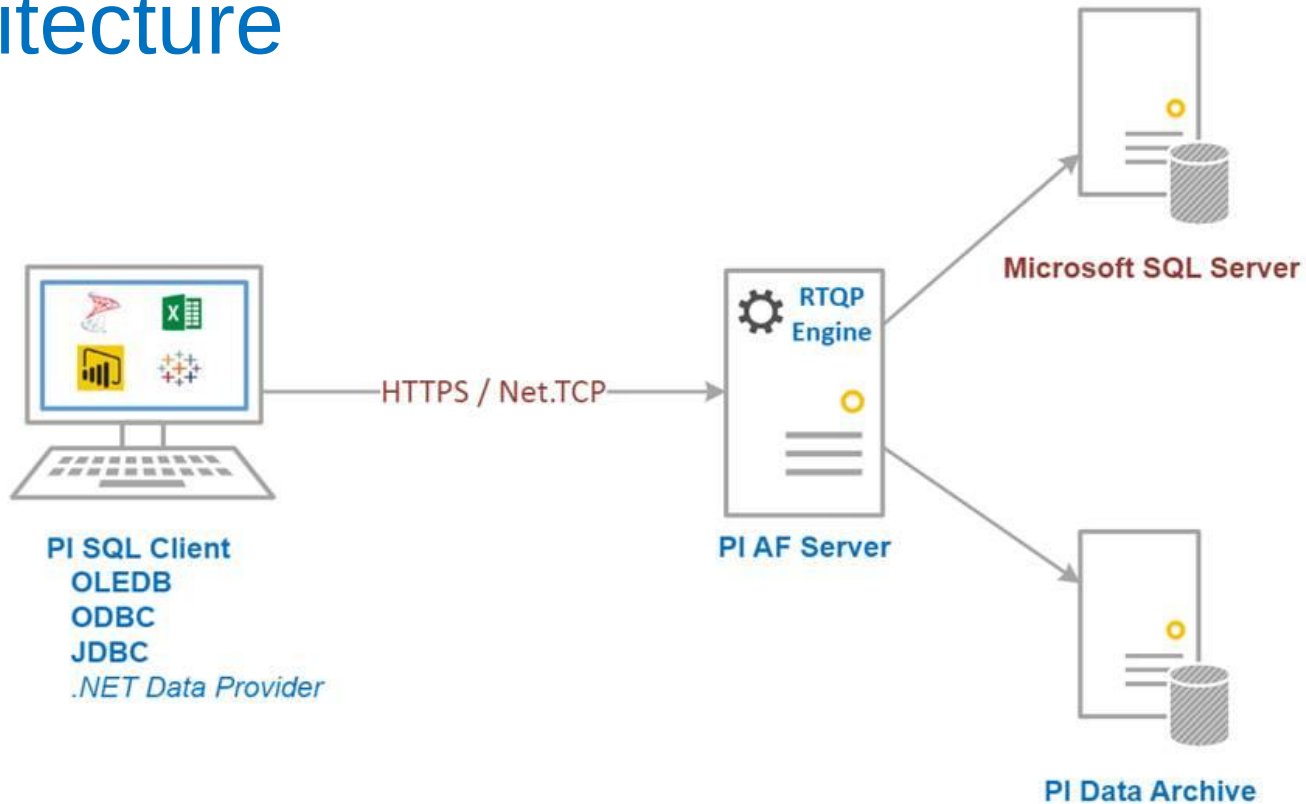
Next Generation Development Goals

- Performance and scalability
- Review data model
 - Reduce query complexity
 - What are top use cases (use customer feedback)
 - Address known issues (e.g. timestep data type, PI time literals)
- Infrastructure to support multiple standards and thin clients
- Works across WAN and different time zones
- Review security and authentication

PI SQL Client Architecture



Architecture

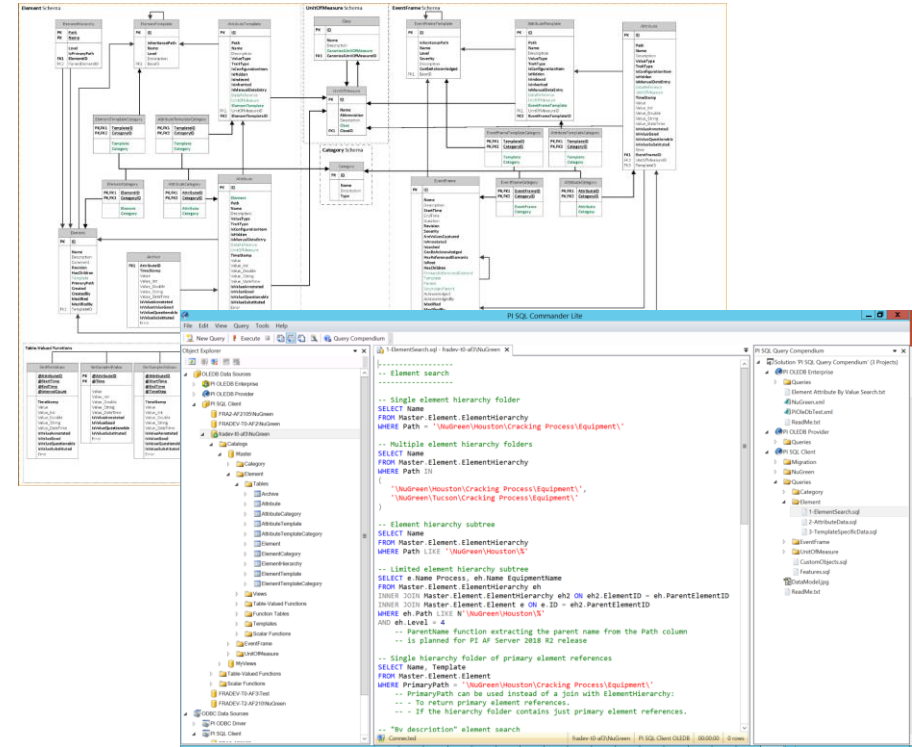


RTQP Engine – A Learned Technology

- **Deployment**
- **Working with different internal data sources**
- **Issue of Data References**
- **Memory Management / Intermediate Results**
- **Optimization**
- **Streaming**
- **Security**

RTQP Engine: Data Model

- Entity-Relationship Model
- Connection = AF Database
- Master Catalog
- Elements and Event Frames
- Attributes and Data
- Categories and Templates
- Template based Table-Valued Functions (*New!*)
- Denormalization
- Navigation Columns
- Multiple Value columns



Simplified Queries

Denormalization



A screenshot of a database table schema for 'Element'. The table has the following columns: ID (Guid, not null), Name (String(2000), not null), Description (String(2000), null), Comment (String(2000), null), Revision (Int32, not null), HasChildren (Boolean, not null), PrimaryPath (String(2000), not null), Template (String(2000), null), Created (DateTime, not null), CreatedBy (String(2000), not null), Modified (DateTime, not null), ModifiedBy (String(2000), not null), and TemplateID (Guid, null). The 'PrimaryPath' and 'Template' columns are highlighted with a red box.

Column	Type	Nullable
ID	Guid	not null
Name	String(2000)	not null
Description	String(2000)	null
Comment	String(2000)	null
Revision	Int32	not null
HasChildren	Boolean	not null
PrimaryPath	String(2000)	not null
Template	String(2000)	null
Created	DateTime	not null
CreatedBy	String(2000)	not null
Modified	DateTime	not null
ModifiedBy	String(2000)	not null
TemplateID	Guid	null

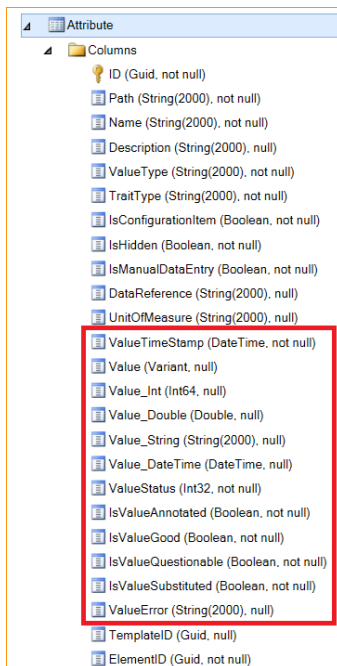
```
SELECT eh.Path + eh.Name Element, et.Name Template
FROM NuGreen.Asset.Element e
LEFT OUTER JOIN NuGreen.Asset.ElementTemplate et
    ON et.ID = e.ElementTemplateID
INNER JOIN NuGreen.Asset.ElementHierarchy eh
    ON eh.ElementID = e.ID
WHERE et.Name IN ('Boiler', 'Heater')
```



```
SELECT e.PrimaryPath + e.Name, e.Template
FROM Master.Element.Element e
WHERE e.Template IN ('Boiler', 'Heater')
```

Simplified Queries

Extention



Attribute
ID (Guid, not null)
Path (String(2000), not null)
Name (String(2000), not null)
Description (String(2000), null)
ValueType (String(2000), not null)
TraitType (String(2000), not null)
IsConfigurationItem (Boolean, not null)
IsHidden (Boolean, not null)
IsManualDataEntry (Boolean, not null)
DataReference (String(2000), null)
UnitOfMeasure (String(2000), null)
ValueTimeStamp (DateTime, not null)
Value (Variant, null)
Value_Int (Int64, null)
Value_Double (Double, null)
Value_String (String(2000), null)
Value_DateTime (DateTime, null)
ValueStatus (Int32, not null)
IsValueAnnotated (Boolean, not null)
IsValueGood (Boolean, not null)
IsValueQuestionable (Boolean, not null)
IsValueSubstituted (Boolean, not null)
ValueError (String(2000), null)
TemplateID (Guid, null)
ElementID (Guid, not null)

```
SELECT eh.Path + eh.Name Element, et.Name Template, ea.Name Attribute, s.Time, s.Value
FROM NuGreen.Asset.Element e
LEFT OUTER JOIN NuGreen.Asset.ElementTemplate et ON et.ID = e.ElementTemplateID
INNER JOIN NuGreen.Asset.ElementHierarchy eh ON e.ID = eh.ElementID
INNER JOIN NuGreen.Asset.ElementAttribute ea ON eh.ElementID = ea.ElementID
INNER JOIN NuGreen.Data.Snapshot s ON ea.ID = s.ElementAttributeID
WHERE et.Name IN ('Boiler', 'Heater')
AND eh.Path = N'\NuGreen\Houston\Cracking Process\Equipment\'
ORDER BY 1
```



```
SELECT e.PrimaryPath + e.Name Element, e.Template, ea.Name Attribute,
ea.ValueTimeStamp, ea.Value
FROM Master.Element.Element e
INNER JOIN Master.Element.Attribute ea ON e.ID = ea.ElementID
WHERE e.Template IN ('Boiler', 'Heater')
AND e.PrimaryPath = N'\NuGreen\Houston\Cracking Process\Equipment\'
ORDER BY 1
```

RTQP Engine: Custom Objects

- Views
- Custom Table-Valued Functions
- Function Tables
for Table-Valued Functions
- Custom Functions

```
-- Create a custom catalog
CREATE CATALOG Test

-- Create a custom schema
CREATE SCHEMA Test.Test

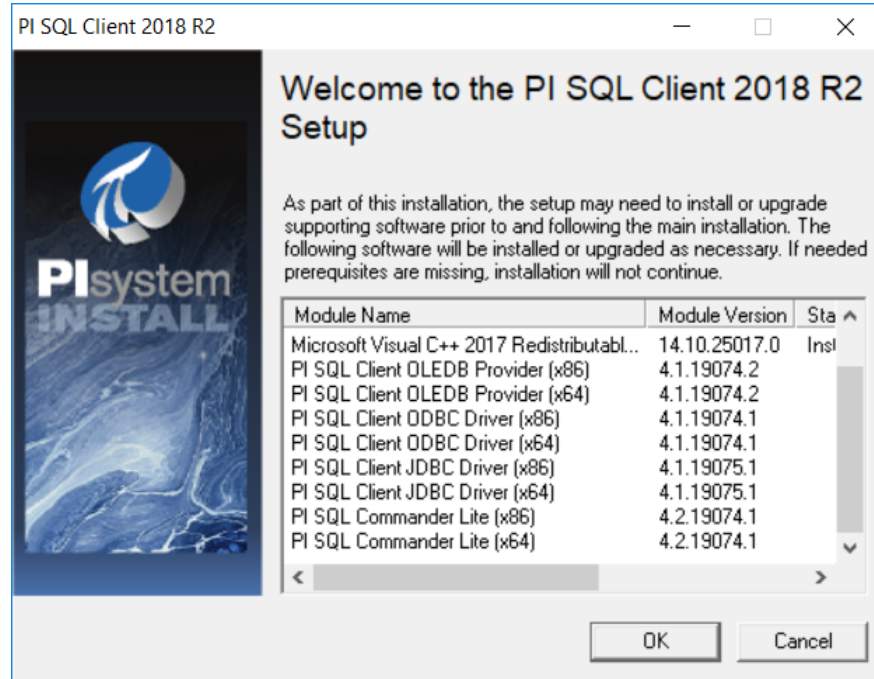
-- Create a custom view
CREATE VIEW Test.Test.HoustonElement
AS
SELECT *
FROM Master.Element.Element
WHERE PrimaryPath LIKE '\NuGreen\Houston\%'

-- Create a custom table-valued function as a parameterized query
-- (all parameters must be used in WHERE clause column equalities)
CREATE FUNCTION Test.Test.YesterdayEventFrame(@Unit String)
AS
SELECT ef.Name, ef.StartTime, ef.Duration, sv.Value ProcessFeedrate
FROM Master.EventFrame.EventFrame ef
INNER JOIN Master.Element.Attribute a ON a.ElementID = ef.PrimaryReferencedElementID
CROSS APPLY Master.Element.GetSampledValue(a.ID, ef.EndTime) sv
WHERE ef.PrimaryReferencedElement = @Unit
AND a.Name = 'Process Feedrate'
```

SQL Clients

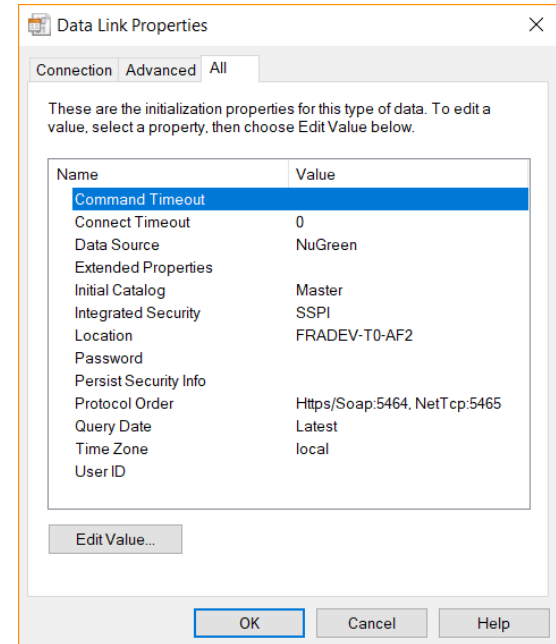
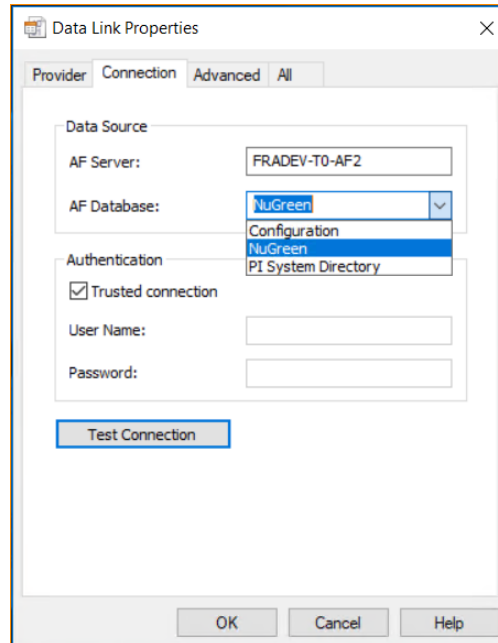
PI SQL Client 2018 R2

- No AF SDK dependency
- ODBC added
- JDBC added



Connection and Connection Options

- AF Database names can be browsed when **PI Web API Core Services** are configured
- Time Zone support
- Query Date



PI SQL Client: OLE DB Provider

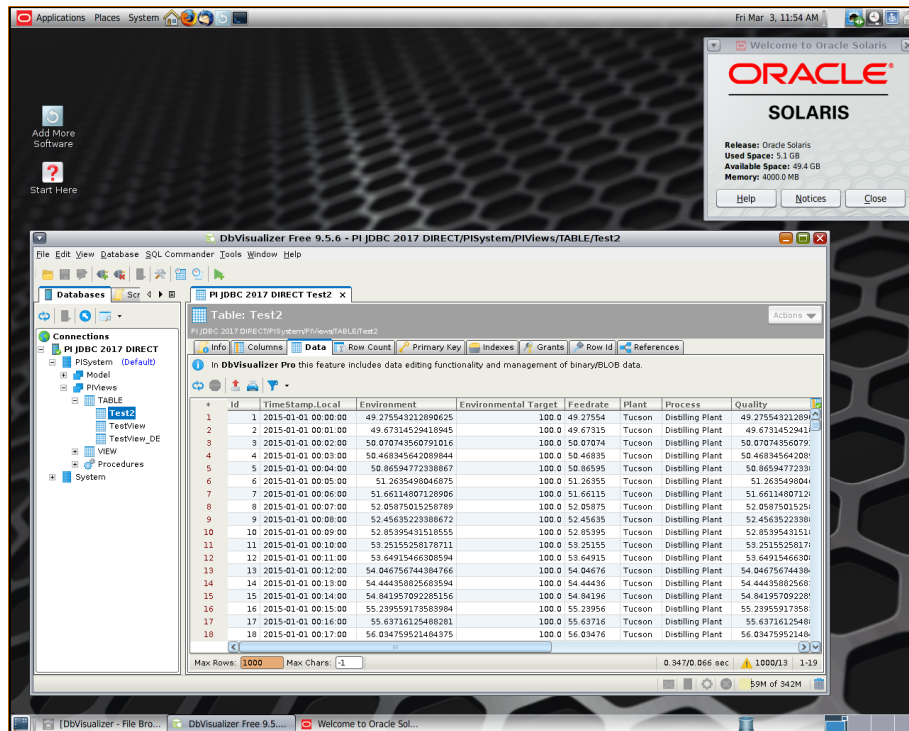
- SQL Server integration (SSRS, SSIS, etc.)
- BizTalk
- SAP Crystal Reports
- ADO.NET, ASP.NET

PI SQL Client: ODBC Driver

- Oracle integration
- BI Tools, e.g. Tibco, Spotfire, Power BI
- Crystal Reports
- ADO.NET, ASP.NET

PI SQL Client: JDBC Driver

- Pure Java
- Https only



PI SQL Client: PI SQL Commander

- Browse Data Model and Functions
- Compendium
- Code/keyboard pre-completion (it might also be known as IntelliSense™®☺)

Sample Queries and Performance

The screenshot displays the PI SQL Commander Lite interface. On the left is the Object Explorer showing a tree of data sources under 'OLEDB Data Sources' and 'PI OLEDB Provider'. The main window shows two queries and their results.

Query2.sql - FRADEV-T2-AF210*

```
SELECT top 3000 e.Name, sSP.ValueStr "Service Point", sY.ValueDbl "Y", sX.ValueDbl "X"
FROM Element e
INNER JOIN ElementAttribute eaSP ON eaSP.ElementID = e.ID
INNER JOIN ElementAttribute eaX ON eaX.ElementID = e.ID
INNER JOIN ElementAttribute eaY ON eaY.ElementID = e.ID
INNER JOIN Data.Snapshot sSP ON sSP.ElementAttributeID = eaSP.ID
INNER JOIN Data.Snapshot sX ON sX.ElementAttributeID = eaX.ID
INNER JOIN Data.Snapshot sY ON sY.ElementAttributeID = eaY.ID
INNER JOIN ElementTemplate et ON et.ID = e.ElementTemplateID
WHERE eaSP.Name = 'ServicePointID'
AND eaX.Name = 'X'
AND eaY.Name = 'Y'
AND sX.ValueDbl BETWEEN 2210000. AND 2220000.
AND sY.ValueDbl > 390000. AND sY.ValueDbl < 400000.
AND et.Name = 'SilverSpringMeter'
ORDER BY Y DESC, Name -- North to South
```

Results:

	Name	Service Point	Y	X
1	SilverSpring_NP_ab00dd10027f	SPE_ab00dd10027f	399999.364297941	2213255.1212611
2	SilverSpring_NP_ab00dd100040	SPE_ab00dd100040	399998.395467848	2213695.82871303
3	SilverSpring_NP_ab00dd1002b4	SPE_ab00dd1002b4	399995.923031852	2215560.89486477

Query executed successfully FRADEV-T2-AF210 (AF Server) 00:00:05.228 2121 rows

Query3.sql - FRADEV-T2-AF210(PIFD24L*

```
SELECT top 3000 e.Name, eaSP.Value_String "Service Point", eaY.Value_Double "Y", eaX.Value_Double "X"
FROM Element e
INNER JOIN ElementAttribute eaSP ON eaSP.ElementID = e.ID
INNER JOIN ElementAttribute eaX ON eaX.ElementID = e.ID
INNER JOIN ElementAttribute eaY ON eaY.ElementID = e.ID
WHERE eaSP.Name = 'ServicePointID'
AND eaX.Name = 'X'
AND eaY.Name = 'Y'
AND eaX.Value_Double BETWEEN 2210000. AND 2220000.
AND eaY.Value_Double > 390000. AND eaY.Value_Double < 400000.
AND e.Template = 'SilverSpringMeter'
ORDER BY Y DESC, Name -- North to South
```

Results:

	Name	Service Point	Y	X
1	SilverSpring_NP_ab00dd10027f	SPE_ab00dd10027f	399999.364297941	2213255.1212611
2	SilverSpring_NP_ab00dd100040	SPE_ab00dd100040	399998.395467848	2213695.82871303
3	SilverSpring_NP_ab00dd1002b4	SPE_ab00dd1002b4	399995.923031852	2215560.89486477
4	SilverSpring_NP_ab00dd10013e	SPE_ab00dd10013e	399992.44567661	2215416.38399895
5	SilverSpring_NP_ab00dd1002e9	SPE_ab00dd1002e9	399992.336096764	2215277.20087835

Query executed successfully FRADEV-T2-AF210(PIFD24L (PI System) 00:00:02.119 2121 rows

Future

- Locale property:
 - e.g. '01-Dec-2019' vs N'01-Dez-2019'
- Data Archive tables (PI tags vs AF attributes)
- INSERT/UPDATE/DELETE event frames
- INSERT/UPDATE/DELETE tags/attribute values

DEMO

Microsoft SQL Server – PI SQL Client Remote Connection

Linked Server Properties - PISERVER_TEST

Select a page

- General
- Security
- Server Options

Script Help

Linked server: PISERVER_TEST

Server type:

☐ SQL Server

☒ Other data source

Provider: PI SQL Client

Product name:

Data source: NuGreen

Provider string: Integrated Security=SSPI

Location: CLSAF

Catalog: Master

Connection

Server: CLSAF

Connection: OSI\csawyer

[View connection properties](#)

Progress

Ready

OK Cancel

Questions?

Please wait for
the **microphone**

State your
name & company



Please remember

TO DOWNLOAD
APP, SEARCH
OSISOFT



