Introduction to Developing with the PI System

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Contents

About this course

Developer Technologies are designed to support the development of custom applications on top of the PI System, as well as the integration of PI System data with other applications and business systems. This course is designed for software developers new to the PI System who desire programmatic access to it. You will be introduced to various Developer Technologies that you can leverage in your custom application to interact with the PI System. At the end of the lab, you will walk away with knowledge of their basic capabilities and also know where to go if you want to dive deeper into them.

We hope you enjoy the module and please don't hesitate to get in touch with any comments or feedback.

By the end of this course you'll…

- Be able to make better decisions regarding the development of your custom application
- Have become familiar with the different PI Developer technologies (AF SDK, PI Web API, PI SQL Framework)
- Be able to describe the purpose of a PSA license and Application ID
- Have learnt more about PI Integrators, OSIsoft Cloud Services (OCS) and the Edge Data Store (EDS)
- Be aware of available resources and how to access them

Audience

This course is designed for developers, systems integrators and systems architects who are looking for an introduction on everything they need to develop solutions on the PI System.

Level: Introductory

Study time: 2 hours

This Course Includes...

- Videos, discussion opportunities and quizzes to help you learn the material
- A sharable certificate of completion

Prerequisites

- You can access our YouTube content.
- PDF Reader or equivalent is required to access the workbook and presentation provided.

Further information

- Once you register for a course, you will have access to the course materials 24/7 on this website.
- This is a self-paced course. Any questions or assistance needed about the material can be asked in this course's space in the OSIsoft PI Square community
- When you complete the examination at the end of the course, you will receive a certificate of completion which can be shared and directly posted on LinkedIn.
- For more information about our Online Courses please visit our FAQ page

You can audit the full video lecture content right now on the OSIsoft Learning YouTube Channel

- ## Lesson 1: Introduction to PI Developer Technologies

Learning outcomes

After completing this lesson, you will:

- Be more familiar with the types of PI Developer Technologies and understand the features and limitations of each.
- Be more knowledgeable on topics such as the PI System Access (PSA) license and the OSIsoft message format.

Introduction

PI Developer Technologies are designed to support the development of custom applications on top of the PI System, as well as the integration of PI System data with other applications and business systems such as Microsoft Office or SQL Server, Enterprise Resource Planning systems (ERPs), reporting and analytics platforms, web portals, or geospatial and maintenance systems among other things.

They cover a wide range of use cases in various environments, programming languages, operating systems, and infrastructures. This course covers an introduction to the different technologies in the family, including:

- AF SDK provides comprehensive, high performance, Windows based .NET programmatic access to the PI System. Other technologies in the family might use AF SDK calls internally.
- PI SQL Framework family of products exposes the data on a PI Server as if it were on a relational database. Here, we will be focusing on PI SQL client and RTQP.
- PI Web API exposes a REST API, enabling operating system and device independent programmatic access to the PI System.

Quick comparison of Dev. Technologies

In this section we provide a quick comparison of the advantages and limitations of each of the Development Technologies.

- AF SDK
  - Has the best performance of all PI Development Technologies.
  - More methods and options available than any other Technology.

- o Limited to Windows operating systems.
- PI SQL Framework
  - o Is compatible with other systems that use Structured Query Language (SQL).
  - o Has limited methods and options available compared with AF SDK (for example, setting security on assets and creating units of measure).
  - o Is limited to read-only PI AF access (but can create and write to tags on your PI System).
- PI Web API
  - o Operating system and programming language agnostic.
  - o Limited methods and options available compared with AF SDK.

Detailed comparison of Developer Technologies

Name	Type	PI Data Archive?	PI Asset Framework?	Example Use
PI AF SDK	.NET based SDK	RW	RW	Custom development
PI Web API	RESTful web service	RW	RW	Custom development, including mobile and non-Windows REST clients
PI SQL Client (RTQP)	Relational (SQL) – OLEDB, JDBC, ODBC Standards	R*	R	SQL clients, Microsoft SQL Server Linked Server, Java clients on Windows and Linux
PI OLEDB Enterprise	Relational (SQL) – OLEDB Standard	R*	R	SQL clients, Microsoft SQL Server Linked Server
PI OLEDB Provider	Relational (SQL) – OLEDB Standard	RW	-	Same as PI OLEDB Enterprise
PI JDBC Driver	Relational (SQL) – JDBC Standard	RW	R	Java clients on Windows and Linux
PI ODBC Driver	Relational (SQL) – ODBC Standard	RW	R	ODBC clients on Windows
PI OPC DA Server	OPC DA Standard	RW	-	OPC clients on Windows
PI OPC HDA Server	OPC HDA Standard	RW	-	OPC clients on Windows

- R: Read access
- RW: Read and Write access
  * through PI Point Data Reference Attributes

You might also like to have a look at this presentation from the Developer Track at the 2017 Users Conference in San Francisco: "[How to Pick the Right PI Developer Technology for Your Project](#)".

Licensing

PI Developer Technologies are freely available for download. However, this does not mean that the PI Developer Technologies are license-free. You need a PI System Access (PSA) license to deploy your applications. You might think of this as a run-time license. The PSA *runtime* license enables end users to access PI System data, including time series data in Data Archives and asset metadata in AF Servers, using any of the PI Developer Technologies.

Therefore, PSA is a license required when deploying a non-OSIsoft software program, application, or device that programmatically accesses data stored in the PI Server or supporting servers. Programmatic access of PI System data is possible through our Developer Technologies. Deprecated Developer Technologies may require additional licensing.

- *What are the terms of a PI System Access license?* Please refer to the [Usage and Service Terms Content](#) > Product Licensing > Product Usage Terms document for the most up-to-date terms of the PSA license.
- *Who should I contact regarding the PI System Access license?* If you have questions regarding licensing, contact your Customer Success Manager or Account Manager.

For the latest information on the PI System Access license review [this article](#) on the myOSIsoft customer portal.

List of deprecated PI Developer Technologies

PI SDK - The PI Software Development Kit (PI SDK) is a programming tool based on Microsoft's Component Object Model (COM) used to access PI Servers. Data Access Pack or PI System Access licenses are required to deploy custom PI SDK applications.

PI API - The PI API Provides a common programmer interface to PI Data Archive information, designed to span multiple hardware and software environments.

Data Access Pack or PI System Access licenses are required to deploy custom PI API applications.

PI Web Services - PI Web Services is a set of Simple Object Access Protocol (SOAP) services that exposes time series data in the PI System. This product is implemented using Microsoft Windows Communication Foundation (WCF). PI System Access licenses are required to deploy custom PI Web Services applications.

For a complete list, please visit the [Developer Technologies website](#).

OSIsoft Messaging Format

PI Interfaces and PI Connectors can be used to access and read data from many types of equipment and control systems. But what happens when you have a data source for which no interface or connector exists? One solution is to write an application that uses OMF to send the data to the PI System.

OMF enables you to send data into your PI System from sources that you would not otherwise be able to send data from. Those sources could include different platforms, different operating systems, and different devices - from server class devices to headless devices running embedded operating systems. OMF allows you to connect the pieces so that you have your data available, no matter where it originated.

The OSIsoft Message Format (OMF) defines a set of message headers and bodies that can be used to generate messages for ingestion into a compliant back-end system. OMF can be used to develop data acquisition applications on platforms and in languages for which there are no supported OSIsoft libraries.

OMF itself does not define or depend on any particular binary message protocol (HTTP, AMQP, Kafka, etc.) It is instead based on an abstract message type, where a message consists of a set of key / value pairs, called the headers, and a binary payload, called the body. OMF messages can thus be constructed using any message protocol that defines headers and bodies.

OMF messages fall into three categories:

- Type
- Container

- Data

Within each category, three types of actions can be specified: Create, Update, and Delete.

Each message bulks individual JSON objects into a JSON array. Within a given array, all objects must be of the same message type: Type, Container, or Data.

To achieve optimal throughput, bulking and compression of messages is recommended.

For more information:

- Live Library documentation – link
- OMF Docs - link

Learn More

- PI Developers club - link
  - o an online offering that provides resources for developing applications and solutions on the PI System. PI DevClub can be considered the next version of OSIsoft Virtual Campus and offers members-only and public features. PI DevClub is the gateway to get support, latest updates, and access to the developers' community.
  - o The member benefits of the club are listed in this FAQ.
- PI Developer Technologies (tech support) - link

- ## Lesson 2: AF SDK

Learning outcomes

After completing this lesson, you will:

- Be more familiar with AF SDK programmatic library.
- Know how to locate and search the AF SDK reference.
- Know how to locate and install the AF SDK.

Definition

If you need to develop your own application to interact with the PI System, you have a few options. The whole family of PI Developer Technologies is at your disposal. However, if you want to get the best performance out of your application, the AF SDK has the greatest potential - assuming you are developing and running the application in a Microsoft Windows environment.

The AF SDK is a Microsoft .NET based programmatic library that provides structured access to the variety of data stored in the OSIsoft PI System. This data includes:

- Assets and their properties and relationships
- Time Series data from the PI Data Archive and other sources
- Event frames that record and contextualize process events

The AF SDK provides a comprehensive, Windows based, programmatic interface to the PI System. It provides an object-oriented approach to interact with AF structures and data, as well as the PI Data Archive, directly. The AF SDK is designed for easy access from Microsoft .NET languages like Visual Basic .NET, C#, and Managed C++. The development machine and the machine that will eventually run any applications developed with AF SDK must have at least Microsoft .NET Framework 3.5 installed. However, for full use of all features we recommend using the AF SDK .NET 4.5 assemblies, which would require .NET 4.5 to be installed on both the development machine, and any other machines that will run your application.

Installation and rationale

Some reasons why you might choose to develop with the AF SDK:

- You can quickly build complex AF hierarchies. Many of our customers and partners prefer to build AF hierarchies this way, rather than using the PI Builder plugin to Microsoft Excel.
- You have the power to create rich and customized Windows client applications. Client applications such as PI Datalink are developed using the AF SDK and its predecessors.
- It is well suited to developing middleware applications sitting between the PI System and other systems. AF SDK gives you flexibility on how you want to integrate other systems with the PI System and allows you to do so in the most resource efficient way possible. It is also possible to automate element generation and/or synchronization between AF and other systems.

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In the [myOSIsoft customer portal](#), use the Products page search box to search for the PI Server Integrated Installation Kit. The installer includes components such as PI AF Server, PI Notifications Service, PI Analysis Service, and PI AF Client (includes AF SDK). For the most recent release, search in the Current Version tab; for all versions 2018 and later, search in the All Versions tab.
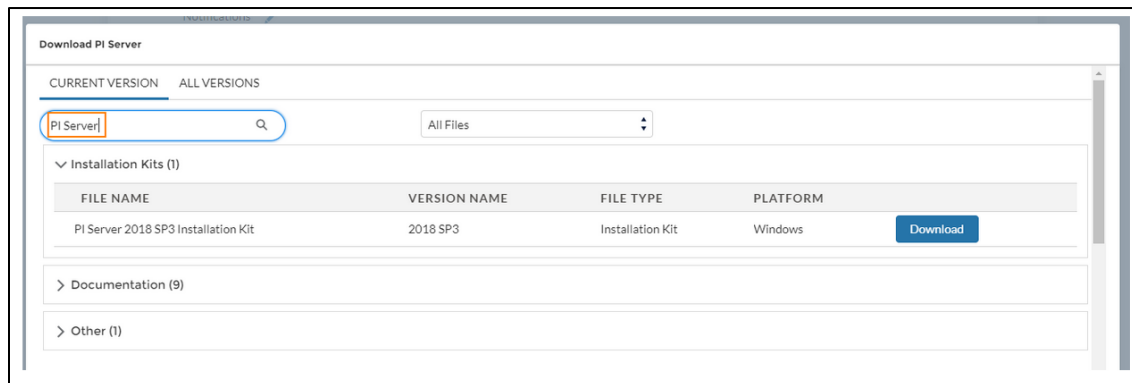
For more information on downloading the Asset Framework (AF) Server and PI System Explorer from the Customer Portal have a look at [this article](#).

Naming Conventions

Every time you write an application using the AF SDK, you are going to have to connect to an AF Server, or a Data Archive. The AF SDK is a little confusing when it comes to naming, because we have kept a lot of discontinued old names of products to preserve backwards compatibility. The Data Archive used to be called

a PI Server, and the AF Server used to be called a PI System. OSIsoft now use the words "PI Server" and "PI System" to describe groups of software; the PI Server now refers to our group of server products, while PI System refers to all products – clients, servers and development tools. For all intents and purposes:

Name in OSIsoft Documentation and Training	Name in AF SDK	Description
Data Archive	PIServer	A server application that stores high fidelity time-series asset data.
AF Server	PISystem	A server application that indexes and categorizes time-series, calculation, and relational asset data.
PI Server	-	A collective term given to all OSIsoft *non-client server* products and features. "The Data Archive and PI AF Server, along with a few others, make up the PI Server."
PI System	-	A collective term given to all OSIsoft products. "OSIsoft makes the PI System."

Exercise - Search the AF SDK Reference

An important resource when developing with the AF SDK is the AF SDK Reference on the PI Live Library. We will look at this reference and try to find some important methods. The steps to follow are:

1. Navigate to livelibrary.osisoft.com
2. Scroll down the page to "</> Developer Technologies" and select "AF SDK Reference". It takes you to a different site, hosting the full reference manual.
3. Search the manual for the following methods and write down what they do.
   - PISystem.Connect()

> o AFAttribute.GetValue()

> o AFAttribute.Data.UpdateValue ()

Learn More

- This [webpage](#) contains examples that demonstrate how to use the SDK.
- Take our online courses to learn more about AF SDK
  - o [Developing Applications with PI AF SDK](#)
    - Discover how easy it is to develop powerful AF SDK based applications; learn the basics of the programmatic access to the PI System using AF SDK
  - o [AF SDK Project Management Best Practices](#)
    - Get a taste of the AF SDK methodologies used by large global companies to manage their large-scale complex PI landscapes and get started on building a prototype application for managing multiple remote AF databases (AF templates).

- Lesson 3: PI SQL Framework

Learning outcomes

After completing this lesson, you will be:

- Be more familiar with PI SQL Framework.
- Able to describe PI SQL Client for RTQP and its features.
- Able to explain the purpose of PI SQL Data Access Server (PI SQL DAS).

Introduction

The PI SQL Framework is a category of PI System Access products that expose PI asset structures and time series data as if the PI Server were a relational database. That is, each exposes PI data (both real time and contextual) as tables available for access via SQL queries. These technologies are typically used when integrating the PI System with other systems that can import data in this format.

PI SQL Client for RTQP replaces the functionality of PI OLEDB Enterprise and is the recommended tool for new development projects.

In this course we are highlighting only the recommended technology to use when reading from the PI System using SQL technologies. If your organization is using an older technology, see the following video explaining the history and landscape of the PI SQL family of products, including all legacy products.

The only reason not to use RTQP are if you are not using AF or if you have an older version of PI. If you are using AF and your system supports RTQP you should use it.

The tables below show some a comparison between the technologies.

Query Parsing Engine	Pros	Cons
PI SQL Data Access Server (RTQP)	• Current path forward for PL SQL • More performant query optimizer • Denormalized/customizable schema • All endpoints decoupled from query engine • Simple/consistent Data Flow • Transpose Queries	• Query Engine is on AF Server • Read-only • No Access to MDB or Batch data
PI SQL Subsystem	• Compatible with 2.x ODBC • Query Engine not on client	• Deprecated • Query Engine is on PI Data Archive • Limited schema

PI OLEDB Provider	• Read/write • Direct access to PI Data Archive • Access to MDB and PI Batches • Simple schema • Backward compatible with PI SQL Subsystem queries	• No access to AF Server data • OLEDB endpoint coupled to query engine
PI OLEDB Enterprise	• Access to AF Server data including Event Frames • Highly Normalized • Transpose Queries	• Succeeded by RTQP • Read-only • Highly Normalized • No Access to MDB or PI Batches • Complex data flow • OLEDB endpoint coupled to query engine

These Developer Technologies are particularly useful when the PI System has a role to play in Reporting or Business Intelligence (BI) scenarios, where it must interact with other products or systems that communicate using Structured Query Language (SQL).

In order to decide which one to use, you'll need to read the documentation of the software or device that you're using to read the data and see which standard it supports. For example, you could import data into a Microsoft SQL Server database with either ODBC or OLEDB as it supports these two standards, but you'd need to use JDBC to import data into an Oracle database unless you're using an additional wrapper.

PI SQL Data Access Server (RTQP)

The RTQP Engine is a new query engine with improved performance and scalability. The ER model is simplified, meaning that query complexity is reduced. It is a PI AF Server component and can only be installed on PI AF Server.

It's main features include:

- Exposes AF objects (Elements, Attributes, Event Frames) and associated data.
- Simplified schema to make writing queries easier.
- Custom schemas and functions.

- Many performance improvements over OLEDB Enterprise, including streaming of partially completed result sets.
- Time zone support.
- No AF SDK requirement on client machine.

Architecture

PI SQL Client OLEDB has been constructed to leverage PI SQL DAS (RTQP Engine) on PI AF Server for query execution. Because PI SQL DAS (RTQP Engine) is installed on the same server as PI AF Server, the client only requires a thin client that has no local dependency on larger components such as a query engine and AF SDK.

PI SQL DAS (RTQP Engine) provides secure network communication through Net.Tcp or HTTPS to the driver on the client side.
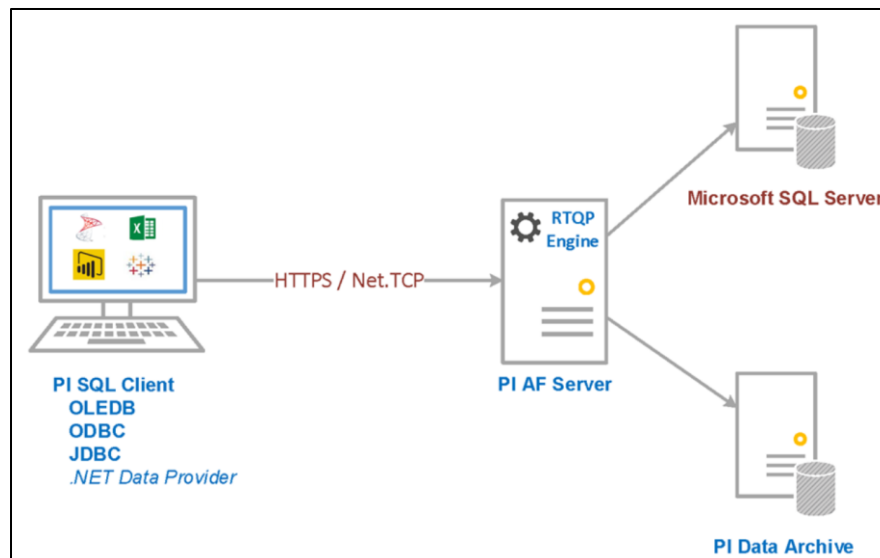
Install PI DAS (Data Access Server) for RTQP on the AF Machine through the PI Server 2018 install kit and install PI SQL Client via the stand alone PI SQL Client install kit on the desired client machine. This guide provides procedures for the installation and configuration of PI SQL DAS (RTQP Engine) on Windows operating systems. Users of this guide should be familiar with PI AF.

PI SQL Client

PI SQL Client is a set of lightweight providers that allow data access to the PI System through a relational schema and belongs to the OSIsoft Developer Technologies family of products. The PI SQL Data Access Server (RTQP Engine) is the server-side component that processes incoming queries from PI SQL Client connections.

Connections to the PI SQL Data Access Server (RTQP Engine) are made by client software that make use of the PI SQL Client family of drivers. This includes PI SQL Client OLEDB, PI SQL Client ODBC, and PI SQL Client JDBC.

The RTQP Engine via PI SQL Client became available in PI Server 2018 SP2 and is the successor to PI OLEDB Enterprise. The functionality is very similar to PI OLEDB Enterprise in that PI AF and the underlying tags can be queried using SQL statements. The main benefits over PI OLEDB Enterprise are better performance, simpler queries, and simplified software architecture.

PI SQL Commander

The PI SQL Client installation includes a test environment, which handles the OLE connection process and allows the user to execute queries and perform other tasks. This test environment is *PI SQL Commander Lite.*

PI SQL Commander is the user interface to assist with creating queries, transpose functions, and views against PI AF using PI SQL Client. This user interface also provides access to the legacy PI OLEDB Provider and PI OLEDB Enterprise providers.

PI SQL Commander Lite is an application to navigate a relational view of the PI System using SQL Queries that are exposed by PI ODBC. This can be used to create, edit, test, and save SQL queries of PI System data.

More information on the SQL commander is available in the Live Library.

Learn More

- Take our online courses to learn more about PI SQL Framework
    - Exposing PI Data with the PI SQL Framework
        - Learn the best way for your organization to integrate the PI System into applications built for relational databases.
    - Building PI SQL Queries for the Real-Time Query Processing Engine
        - Create optimized PI SQL Client queries and transform existing PI OLEDB Enterprise queries into PI SQL Client queries
- For information on Troubleshooting, User permissions, metadata and more, have a look at this article in the Live Library.
- Older technologies exist and may still be useful in specific situations. See this video for more information.

- ## Lesson 4: PI Web API

Learning outcomes

After completing this lesson, you will:

- Be more familiar with the PI Web API interface to the PI System.
- Know how to locate and search the PI Web API reference.
- Know how to locate and install the PI Web API install kit.
- Understand how we are using GitHub at OSIsoft.

Introduction

In a world that is increasingly an "Internet of Things", it is becoming more and more important to integrate systems of different functions and standards with each other. The PI Web API makes it easy to integrate the PI System with non-Windows systems such as smartphones, UNIX servers or other network-connected devices. It gives rich, cross-platform access to the PI System from any application that can send and receive HTTPS. Adding a PI Web API Server to a PI System will enable client access to the PI Server via a RESTful interface.

Under normal operation, a client makes HTTPS calls to the PI Web API Service. The PI Web API Service gets the data needed from the PI Data Archive and AF servers, and returns the data in the form of JSON to the requesting client.

A common task that you may need to perform when programming against the PI System is to search for objects that match specific criteria. The PI Web API provides 3 ways to execute search actions within the PI Web API:

1) Traditional endpoints with filters

2) Using the Search controller

3) Using Query methods that utilize the AFSearch classes in AF SDK

The AFSearch methods provide significant advantages over the other two search types.

For example, searching via the Search controller is generally fast but requires much more setup and configuration. Each AF database or PI Data Archive that is going to be searched must be configured to be crawled by the PI Web API Search Crawler, which creates index files for each server. This introduces more potential

problems and administrative burden. For many applications, the AFSearch endpoints are similarly performant and the more robust option.

PI Web API installation

PI Web API is available for installation through the standalone PI Web API install kit.

In the myOSIsoft customer portal, use the Products page search box to search for the PI Web API Installation Kit. For more information have a look at the article on "How do I download PI Web API from the Customer Portal?"

There is also an article on Live Library on how to "Install PI Web API".

Exercise - Explore PI Web API Reference

Open a web browser to the PI Live Library. Scroll down to "Developer Technologies" and select "PI Web API Reference". The Controllers section lists the top-level endpoints provided by the service. Each controller's detail page provides links to the methods exposed by the controller. Go through the following questions:

1. Which PI Web API controller would you use for seeing the names and properties of child elements of a given element in your AF database?

2. What does the "Stream" controller do?

3. You are designing an application that requires the results of time-weighted averages of a few different data streams. You can get the results of a summary calculation like this with PI Web API. Which controller would you use?

4. Your application needs to be able to write back to an AF Attribute. Which controller would you use to accomplish this?

Using GitHub with PI

GitHub is a version control web platform, widely used by the open-source community, allowing like-minded users to borrow and contribute to other user projects.

OSIsoft has a GitHub site with sample applications located on this page. The OSIsoft samples are introductory, language-specific examples of programming against OSIsoft technologies. They are intended as instructional samples only. This site has examples that utilize PI Web API from various languages/frameworks. These projects implement some basic functionality and are a good place to start if you are curious what an application could look like in one of the provided languages.

This code is intended as a sample and not production level code and is provided as-is. Any use of this code outside of the sample is not supported and at your own risk. For more information, see our Ethical Disclosure Policy.

Learn More

- PI Web API in [Live Library](#)
- Take our online courses to learn more: [Using PI Web API from Beginner to Advanced](#)
  - Learn how to retrieve and manipulate time series data, asset information and event frames using PI Web API.
- [VIDEO] [Getting cOMFortable with PI Web API](#)
  - With today's computing power and the low cost of sensors, no data should be out of the reach of your PI System. When dealing with large amounts of critical data, it is important that our data ingress is performant and reliable. This video goes over the best practices of deploying an OMF application at the edge, using the PI Web API's OMF Data Ingress Services.

- ## Lesson 5: PI Integrators

Learning outcomes

After completing this lesson, you will:

- Be more familiar with PI Integrators in general and have taken a deep dive into our most popular options: PI Integrators for Business Analytics and Esri ArcGIS.
- Have gained a high-level understanding of the PI Integrator Architecture and Installation Process.
- Be aware of possible resource and documentation locations for further study.

Introduction

PI Integrators provide decision-ready PI Data to external systems, offering Information Technology/Operational Technology integration. PI Integrators are user-configurable products that mitigate the need for extensive custom solutions.

In this lesson we will take a closer look at two of the most popular PI Integrators: i) for Business Analytics and ii) for Esri ArcGIS.

Other PI Integrators include:

- PI Integrator for Microsoft Azure - presents PI System data, context, and events perfectly suited for Advanced Analytics with Cortana Intelligence and Power BI for reporting, visualization, and analytics.
- PI Integrator for SAP Hana - combines PI System data with SAP Hana so you can combine and analyze your sensor-based, time series, data from the PI Server with the high-performance analytics of SAP Hana.

## PI Integrator for Business Analytics

PI Integrator for Business Analytics transforms PI System data into a decision-ready format that can be consumed by business intelligence (BI) tools, such as Microsoft Power BI, Tableau, Tibco Spotfire, and QlikView. With BI tools, you can run retrospective analyses on large sets of your real-time PI System data. Such analyses make operational behaviors and patterns visible, so you can identify dependencies and correlations between different aspects of your operations.

The PI Integrator for Business Analytics gathers AF attribute data, filters it based on the criteria entered by the user in the Integrator's browser-based User Interface (UI) and publishes the data to an external data store (e.g. Microsoft SQL Server, Apache Hadoop). PI Integrator for Business Analytics is designed to help users transform time series data from the PI System into a data set that is easily consumed by Business Intelligence (BI) tools. PI Integrator for Business Analytics works directly with PI AF (not the PI Data Archive) when creating the search criteria for views. Therefore, a good AF structure is vital to using the PI Integrator.

Architecture and Components

PI Integrator for Business Analytics has three basic components. The user interacts through the UI with each of these components:

- PI Integrator Framework - the master Windows Service for the PI Integrator
    - Runs the Web UI - Self-hosted application server used to access the PI Integrator
    - Coordinates view scheduling and controls which Worker Node publishes each view
- PI Integrator Worker Node(s) - Windows service that handles publication jobs.
    - Up to 5 worker nodes can be added to help distribute jobs (note that each additional worker node adds RAM and CPU requirements).
- PI Integrator Sync - Windows Service that watches for changes to PI tag data and AF objects, and for views that support this, automatically updates supported targets with changed data. See Live Library for "How published data gets updated" for information on which views support automatic updates.
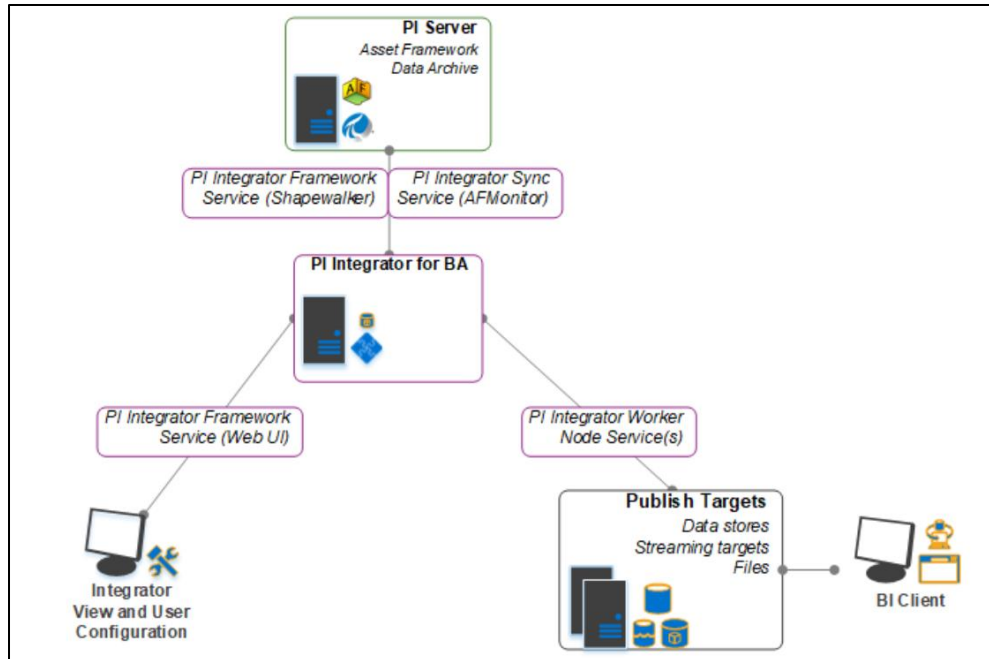
Download and Installation

Have a look at this link for information on downloading PI Integrators from the Customer Portal. There are three phases to PI Integrator installation.

- o Phase 1: Prepare for installation
    - This phase ensures that you have the appropriate access and permissions to the components that interact with PI Integrator for Business Analytics: PI AF server, PI Data Archive, and Microsoft SQL Server. These prerequisites must be in place before you run the installation kit for PI Integrator for Business Analytics.
- o Phase 2: Install PI Integrator for Business Analytics
    - In this phase, you install PI Integrator for Business Analytics, specifying the PI AF server and Microsoft SQL Server. New PI Integrator databases are created on the Microsoft SQL Server for PI Integrator for Business Analytics.
- o Phase 3: Verify the installation
    - This phase verifies that the PI Integrator for Business Analytics services have started and are running.

For more details on the installation phases have a look at this Live Library article.

For topics such as Licensing, Output Streams, Product Documentation, Releases and Configuration please refer to [this article](#).

PI Integrator for Esri ArcGIS

PI Integrator for Esri ArcGIS 2017 SP1 allows you to expose your PI System data in a real-time geographical context using the Esri ArcGIS platform. It gathers AF attribute data combined with geographical information (either from PI or by joining to an existing Esri Feature Layer with geometry) about the corresponding assets and publishes it to the Esri ArcGIS platform for use in maps and geospatial analyses. The Integrator can serve real-time PI data streams to the Esri ArcGIS GeoEvent server, which enables geospatial analysis, or real-time and (starting in the 2017 release) historical data directly to Esri platforms for customers to host and view GIS content: ArcGIS Enterprise with Portal for ArcGIS (on-premises) or ArcGIS Online (cloud).

The latest version features time-enabled mapping, allowing ArcGIS clients to access and display historical PI System data. You can now view data stored at any time in the PI System in addition to streaming current data. It also adds support for Integrated Windows Authentication (IWA), one of the web-tier authentication schemes in Esri's Portal for ArcGIS.
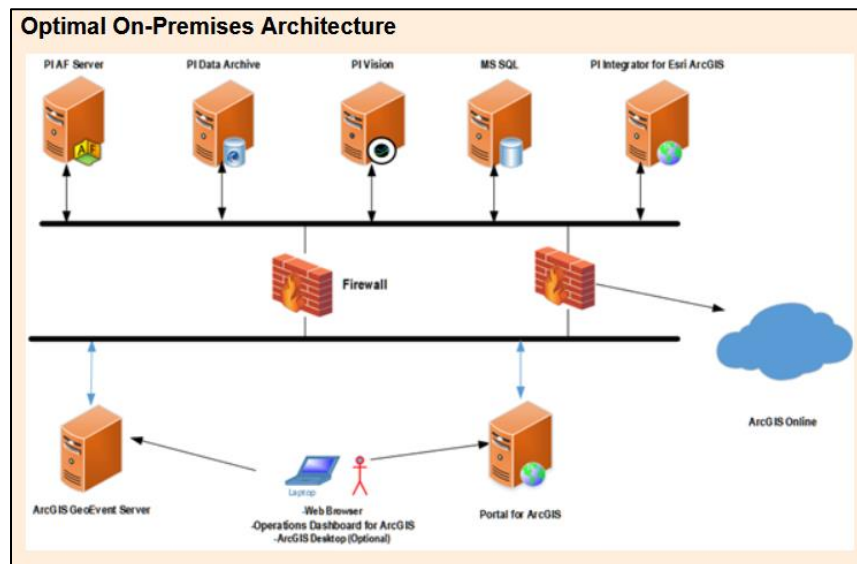
Download and Installation

Have a look at [this link](#) for information on downloading PI Integrators from the Customer Portal.

The PI Integrator for Esri ArcGIS installation process comprises three phases. The phases are:

- Phase 1: Prepare to install PI Integrator for Esri ArcGIS.
    - Proper configuration is required when installing PI Integrator for Esri ArcGIS. Ensure you have all of the system requirements in place before installing.
- Phase 2: Install PI Integrator for Esri ArcGIS.
    - You must install PI Integrator for Esri ArcGIS on a computer that has access to a Microsoft SQL Server. PI Integrator for Esri ArcGIS may authenticate with the SQL Server either using Windows Authentication or legacy SQL Authentication. During installation, you will have the opportunity to validate the connection and authentication.
- Phase 3: Administrator configuration.
    - While logged on as a system administrator, you must perform a few configuration tasks before users can access the system.

For more details on the installation phases have a look at this [Live Library article](#).

For topics such as GeoEvent-enabled Layers, Time-enabled Layers, Licensing and Data security please refer to [this article](#).

Learn More

- Live Library links:
    - [PI Integrator for Business Analytics](#)
    - [PI Integrator for Esri ArcGIS](#)
- [PI Integrators Tech Support page](#)
- BI Reporting with PI Integrator for Business Analytics - online course focused on analyzing PI System data using Power BI and PI Integrator for Business Analytics. We will build upon your existing application knowledge with hands-on activities to help you transform data into information.
- Videos
    - [Insight: PI Integrators and OSIsoft Cloud Services for time-series Data Science Enablement -](#) OSIsoft continues to invest in technology for better enabling data science and advanced analytics. For most

analytics projects, there is no magic "X marks the spot", but there are many possible paths to success.

- PI Integrator for Esri ArcGIS Architecture Map of Data Flow- High Level - The PI Integrator for Esri ArcGIS is the OSIsoft product that enables real-time geographic data visualization by connecting your PI System with the Esri ArcGIS platform. This video explains the major pieces in the data flow between these two systems by drawing a high-level architecture map. Learn what feature services and layers are, the role of the ArcGIS GeoEvent Processor in pushing real-time data to the feature services, and how the PI Integrator for Esri ArcGIS connects the GeoEvent Processor to the PI System data and can be used to create the map layers.

- Lesson 6: OCS and EDS

Learning outcomes

After completing this lesson, you will:

- Be more familiar with both OSIsoft Cloud Services and Edge Data store
- Know where to get more information to expand your understanding and skills.

OSIsoft Cloud Services (OCS)

Introduction

Industrial digitalization and globalization are generating more data and new opportunities to leverage data. Data that can be shared and used to power new applications that deliver increased operational efficiency and support new business models. At the same time the cloud offers a scalable, elastic, and centralized environment to aggregate data for reporting, advanced analytics, and third-party applications. OSIsoft's Cloud Services are designed to meet today's digital transformation needs by connecting in real-time data from PI Systems, to people, analytics and applications for enterprises and communities to realize the value of their data.

What is it?

OCS is a cloud-native platform built for historical, real-time and future/forecasted operational data. OCS complements existing on-premises PI systems and enables users to easily define, visualize, query and shape data sets required for data science.

More information

- https://www.osisoft.com/Solutions/OSIsoft-Cloud-Services/
- OSIsoft Cloud Services portal: cloud.osisoft.com
  - This your gateway to learning about Cloud Services features. You will find detailed API documentation as well as sample code to help you interact programmatically with your data using the Cloud Services API.
  - In the OCS portal you can:
    - View OSIsoft Cloud Services API documentation
    - Explore working code samples provided in multiple programming languages
    - View the OSIsoft Cloud Services service blog
- Enabling Enterprise-wide Data Science with OCS Dataviews
  - In this course, you will gain hands-on experience with a new OSIsoft software product, OSIsoft Cloud Services (OCS): analyze & visualize data in OCS, add metadata & create Data Views in OCS, access OCS data in a Jupyter Notebook via Python, filter & prepare data from OCS for machine learning and more.
- OSIsoft Cloud Services (YouTube playlist)
- OCS for Developers (webinar)

Edge Data Store (EDS)

Introduction

EDS augments the PI System and OCS by collecting and storing data in situations where deploying a full system is impractical. It can collect data that is beyond the reach of automation systems, in unreliable network conditions, and in environments too rough for traditional computers. Edge Data Store can run almost anywhere you can install a sensor, such as beam pumps, mining trucks, windmills, etc.
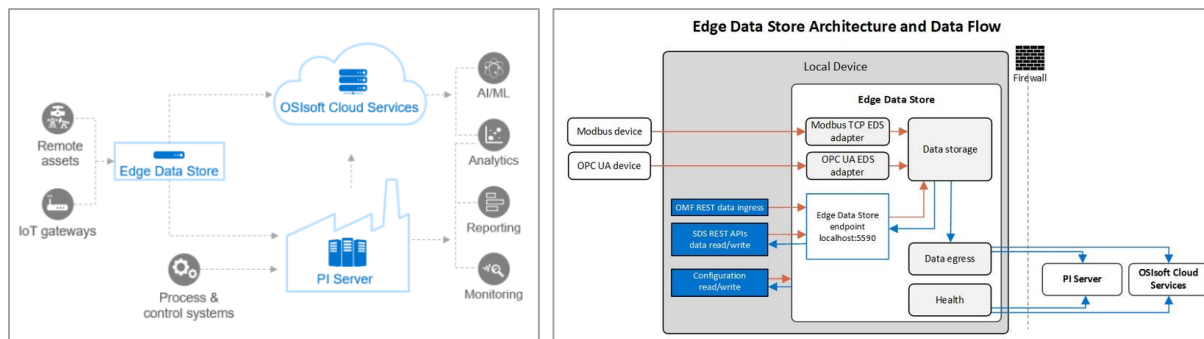
What is it?

EDS is a lightweight data collection and storage application designed to capture data at the edge of networks for historical storage and analysis. It runs on small, rugged devices or embedded in existing industrial hardware, and is designed to be resilient and require minimal installation and administration.

EDS collects data using any of the following methods:

- Built-in OPC UA connectivity
- Built-in Modbus TCP connectivity
- Custom application using OSIsoft Message Format (OMF)
- Custom application using REST API

Once collected, the data is stored locally in configurable data storage within EDS, until it can be sent to permanent storage in a PI System or in OSIsoft Cloud Services through periodic egress. The data can also be read from local storage by custom applications using REST APIs.

More information

- Link to GitHub page (https://osisoft.github.io/Edge-Data-Store-Docs/V1/) which includes: design, performance and security considerations , quick start guides and configuration options.
- Blog post: Easy as PI: Edge Data Store
- Video: What is an Edge to Cloud IIoT Solution for Remote Asset Monitoring using Smart Sensors?
    - Listen to Mikhail Koloskov from IPCOS say why they chose EDS for their edge analytics application for Oil & Gas. OSIsoft's Chris Felts describes the history of EDS and how it is related to the PI System.
- Video: Edge Data Store - Applications delivered at the Edge
    - In this presentation, we will cover what the Edge DS is and how we envision customers will use it at the Edge of networks. We show you how you can create local user applications directly from data stored in Edge DS. Finally, we will show you how to use Edge DS to extend applications from the Edge to the Enterprise or the Cloud.

- Next Steps and FAQ

FAQ

- Should I use the Developer Technologies to send data to another PI System?
  - We offer better solutions for that:
    - PI System Connector
    - PI to PI Interface
    - Differences between PI to PI and the PI System Connector
- Should I use the Developer Technologies to send data to Esri ArcGIS, SAP Hana or Business Analytics Tools?
  - We offer better solutions for that:
    - PI Integrators
- What is the "PI OPC DA/HDA Server?"
  - This is an old product that has been replaced by two new products:
    - PI OPC DA Server
    - PI OPC HDA Server
- Do we have a "PI OPC UA Server?"
  - Not yet: Feedback item is in User Voice
- What is the PI SQL Data Access Server (PI SQL DAS)?
  - A component of the PI SQL Framework. There are three editions:
    - PI SQL DAS (RTQP): Real Time Query Processing Engine for the PI SQL Client
    - PI SQL DAS (OLEDB): Connects ODBC/JDBC Drivers to the OLEDB Providers
    - PI SQL DAS (PI Integrator Framework): Used by the PI Integrators
- Is the PI SQL Framework a product?
  - No. The PI SQL Framework is a group of products:
    - PI SQL Client (OLEDB, ODBC, JDBC)
    - PI OLEDB Provider
    - PI ODBC Driver
    - PI JDBC Driver

Next steps

Thank you for taking this introductory module on Developer Technologies. We recommend you continue along the "Developer" learning path by following courses appropriate to the developer technology you have chosen for your project.

Take our online courses to learn more:

- PI AF SDK

- o [Developing Applications with PI AF SDK](#) - Discover how easy it is to develop powerful AF SDK based applications; learn the basics of the programmatic access to the PI System using AF SDK
  - o [AF SDK Project Management Best Practices](#) - Get a taste of the AF SDK methodologies used by large global companies to manage their large-scale complex PI landscapes and get started on building a prototype application for managing multiple remote AF databases (AF templates).
- PI SQL Framework
  - o [Exposing PI Data with the PI SQL Framework](#) - Learn the best way for your organization to integrate the PI System into applications built for relational databases.
  - o [Building PI SQL Queries for the Real-Time Query Processing Engine](#) - Create optimized PI SQL Client queries and transform existing PI OLEDB Enterprise queries into PI SQL Client queries
- PI Web API
  - o [Using PI Web API from Beginner to Advance](#) - Learn how to retrieve and manipulate time series data, asset information and event frames using PI Web API.

Alternatively, get familiar with basic Data Science concepts and techniques, by going through the steps of a Data Science project example in our "[Introduction to Data Science for PI System Professionals](#)" course.

You can find the complete list of courses for the "Developer" learning path [here](#).