

**GUIDE**

# A Beginner's Guide to OPC

Version 2

FREQUENTLY ASKED QUESTIONS ABOUT OPC

By John Weber and Win Worrall

Our mission is to provide you with the right software package to solve your industrial operation challenges.



# A Beginner's Guide to OPC: Frequently Asked Questions about OPC

## Guide Version 2

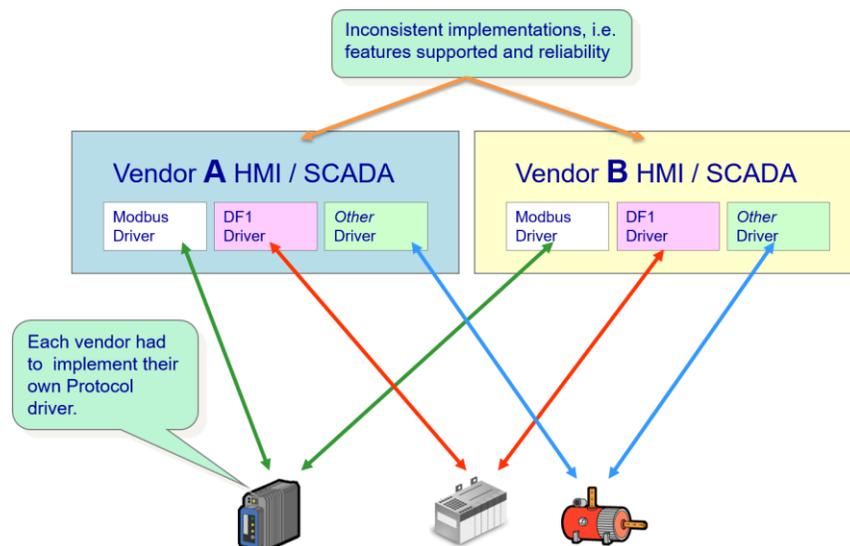
We've been working with the OPC software interoperability standards since 1996, and it's easy to forget that others who are new to this space often find the whole discussion around the OPC standard and all the different standards confusing.

John and I created this guide to help users that are new to the industrial automation space, also known as operations technology or OT, or just new to the software side of operations technology. We are approaching the subject based on some commonly asked questions that our team hears and in this Version 2 of the guide we have added questions that we have heard from you since our first guide was published.

## Why OPC?

Before we get into what the OPC acronym stands for it's important to understand at a high level the business problem it set out to solve.

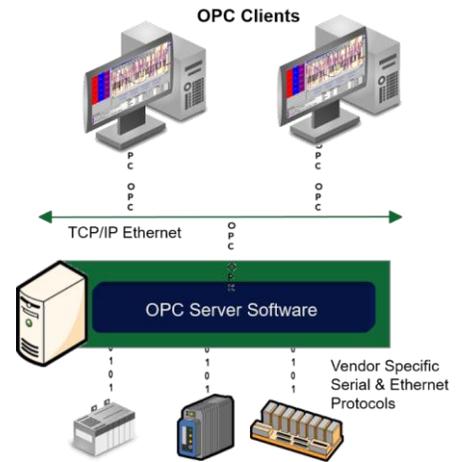
One of the common challenges in industrial operations is communications between different brands or manufacturers' control devices (PLC, DCS, Drives, RTUs, Smart Sensors)) and between those devices and software. While most control devices have methods of communication they don't all communicate using the same methods or protocols, and even if they both have the same serial or Ethernet wiring the difference in communication protocols prevents them from passing information. It's the same problem you have if someone calls you on the phone, but doesn't speak the same language. As humans we may be able to overcome a difference in dialect, machine communication has to be precise and exact. Small differences in addressing or data formatting can be enough variation to prevent sharing of critical information.



When a group of industrial automation vendors came together in 1995 and created the independent OPC Foundation, the most common problem in automation was connecting Windows based industrial software to PLCs and control systems. Each vendor of software had to write their own drivers to talk to all the different PLCs. Our world in automation was like printer drivers before Windows existed and came with standard printer drivers.

Users had limited choices and vendors trying to integrate with other vendor's hardware and software experienced frustration. Some vendors were using an early Windows technology called DDE but that had limitations.

The OPC standards changed all that as shown in this diagram by providing a standardized way to exchange real-time information between industrial automation software applications. That early standard was called OPC Data Access or OPC DA, and now has been adopted in used worldwide.



In the years following 1995, OPC suppliers sprung up and user choice was finally available. A user could choose HMI from Vendor A and have easy connectivity to control hardware in their plant from Vendors B and C. They could share information between software applications provided those software applications supported the OPC standard.

## What does the OPC acronym stand for?



John: Ask a veteran of OPC this and they will laugh, because they know there have been many meanings! In classic engineering techie fashion, the original meaning was based on very software programmer speak: **OLE** for **Process Control**. OLE or Object Linking and Embedding, was a fundamental early building block of Windows that allowed applications to share complex information between them. I'll show my age here – I remember the first demos of Windows 3.0 where people were embedding Excel spreadsheets into Microsoft Word documents and how much of a big deal it was to update the spreadsheet, open Word, and the document updated. The original OPC standards derived from that technology and COM or the Windows Component Object Model.

Since then we've heard OPC stand for Open Productive Communications, but today the official OPC Foundation meaning is **Open Platform Communications**. The goal remains the same: Eliminate barriers and obstacles to interoperability between automation software and hardware platforms to give users a choice.

## What's the difference between an OPC client and OPC server?

Win: OPC clients request data and sometimes also want to write data. Servers respond to the requests of clients and provide data or accept their writes, if allowed. In the simplest form, that's it.

Think of an OPC Server like a protocol converter, OPC Servers talk to a device or devices using the specialized protocols of the devices, and then provide access to that data using the standardized formats defined by the OPC Classic and OPC UA specifications. Typically an OPC Server doesn't do anything until an OPC client request to read or write data. Some OPC servers can be configured to poll data from devices even in the absence of client requests. This is typically done to allow an OPC server to have current data in its internal cache and ready to go when a client requests it, but comes at the price of generating communications traffic that may not be required. Many OPC servers provide flexibility for the user to configure the behavior to suit their application needs.

## Why do I need OPC servers if my control hardware vendor says they support OPC?

Win: Welcome to the evolving world of OPC. When hardware suppliers say they support OPC, they often aren't meaning they have embedded an OPC server into their hardware directly. What they mean is that they have OPC server software that runs on a Windows based computer somewhere that talks to their hardware and exposes data using one or more of the OPC standards. Also for some hardware suppliers, there may be additional licensing fees to enable this OPC server functionality. It sounds better in marketing for them to just say "we support OPC", but we do hear often from users that they find this confusing. Always clarify what your vendor says.

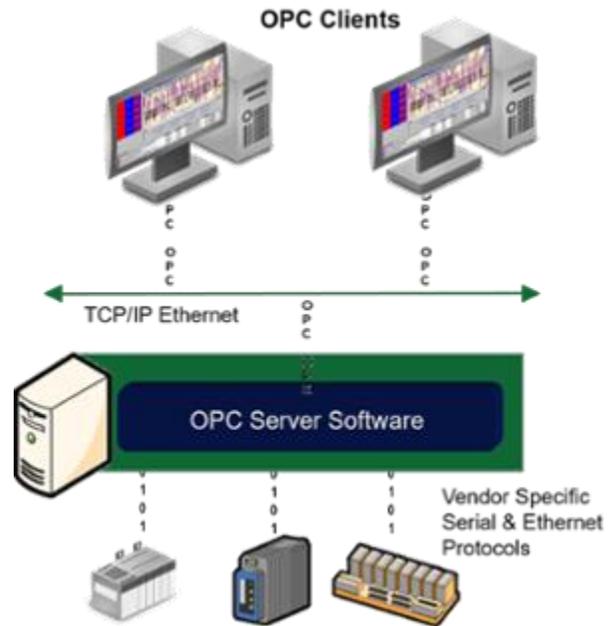
Now some vendors are beginning to leverage the multi-platform capabilities and embed OPC UA servers directly into their PLCs. This can be quite handy if your HMI or SCADA software supports OPC UA. If your client applications don't support OPC UA, there are [OPC Gateway applications](#) that can help you bridge from OPC UA to DA.

## Do OPC servers have to run on Server class computers and operating systems?

John: OPC servers do not need server class hardware or operating systems. Some vendors may require this for their specific implementations, but the OPC standards do not dictate this. OPC server software is often fairly lightweight and can easily co-exist with other software applications on a desktop PC. Check with your OPC server supplier for your specific application's requirements to be sure. Software Toolbox's products have a specification page on each product website area though we typically do not require server class hardware or operating systems for our OPC servers.

## I have multiple brands of devices, do I need multiple OPC Servers?

John: Maybe. It really depends on the device types and whether they are using the same device level protocol or, if different protocols, using protocols that are available in a single OPC server product. For example, if you have multiple flow meters that all use Modbus or can support Enron Modbus, then you could use a single OPC server. If you are using PLCs from different vendors, and maybe a flow metering package from another vendor, you likely will be dealing with different device level protocols. However, you may be able to obtain an [OPC server that has plug-in drivers](#) that may be licensed separately, but actually run in the same OPC server application. Implementations of this nature are common.



## How can 2 OPC servers talk to each other? How can two OPC clients talk to each other?

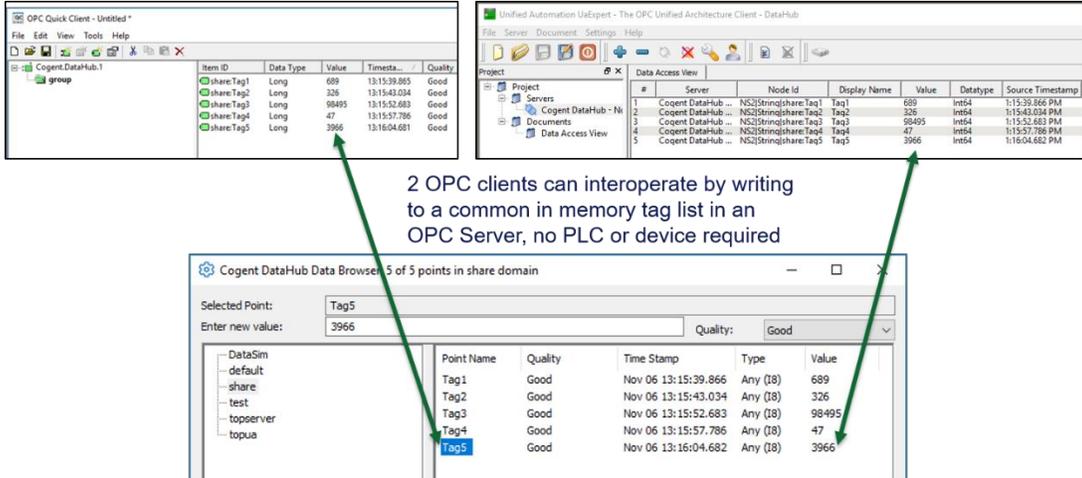
Win: In the OPC world, clients talk to servers. Servers talk to clients. The good news is there are ways for OPC servers to talk to other OPC servers and the same for OPC clients.

Why might two OPC servers need to communicate? Imagine you have PLC vendor A and PLC Vendor B and there is an OPC server communicating to each one using the two different PLC vendor's specific device protocols. You want to move data from PLC A to PLC B, which means the 2 different OPC Servers need to talk with each other. You can do this using OPC Bridging software applications. OPC Bridging software applications are OPC client applications that can connect to many different OPC servers and then allow you to map data movement between the two OPC servers, specifying direction, data transformations, etc. You can learn more about OPC bridging in our [OPC bridging blog post](#).



In the case of OPC clients talking to each other, the most common application would be two different SCADA or HMI software applications needing to exchange data. The first solution would be to see if the HMI or SCADA software supports an OPC Server interface in addition to being an OPC client. Many do, and if so then problem solved. The two

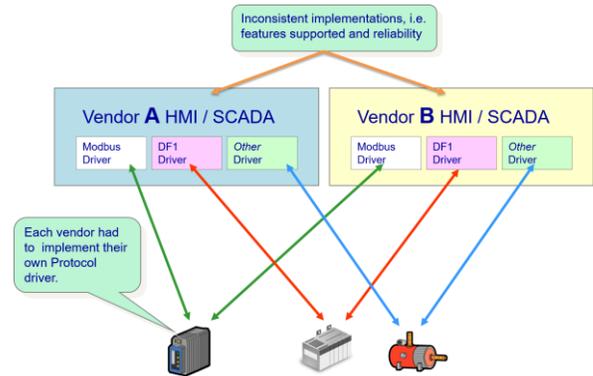
client applications talk to each other's OPC server interfaces using their OPC client interface. If not, and the clients are purely OPC DA, UA or DA and UA clients, then using an application such as the Cogent DataHub would be the solution. The Cogent DataHub can act as an OPC server with a tag list that you define and both OPC clients read/write to those common tags.



## Why so many standards? DA, A&E, HDA, UA – seems like alphabet soup?

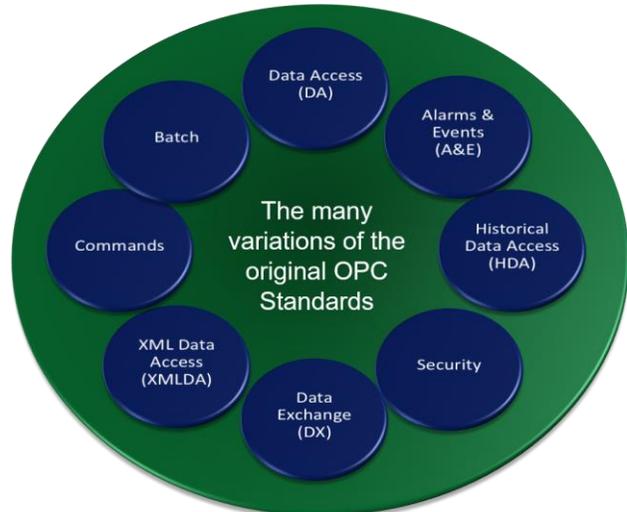
John: There are multiple standards because there are multiple software to software and software to hardware problems that the independent OPC Foundation set out to solve starting in 1995. Each standard addresses a different problem type.

Remember the original problem OPC set out to solve with OPC Data Access or OPC DA, which was control hardware to software communications as shown here.



The OPC DA standard defines function calls to read, write, and subscribe to data points like analog and digital values, integers, floats, strings, etc. There are no complex data structures, it's all about moving real time data effectively and openly.

We discuss the other 2 major original OPC standards next in this paper: OPC A&E and OPC HDA.



You may have also heard about OPC XML-DA, OPC Security, OPC commands, & OPC batch.

All of these were standards to address specific types of problems, but none were as widely adopted as OPC DA, A&E, and HDA.

As a collection, these original OPC standards are now known as OPC Classic. It may be “Classic” but to be clear, these standards are still widely used and implemented and there are millions of installed OPC Classic servers and clients in the world. Examples of OPC DA servers in the Software Toolbox offering include [TOP Server for Wonderware](#), [OmniServer](#), and [Cogent Datahub](#).

## What’s OPC A&E?

Win: The OPC Alarms & Events (OPC A&E) standard was created to provide a standardized method of exchanging information from systems that generate alarms or events with other applications. For example, a Distributed Control System (DCS) may generate alarms that are shown on operator consoles used by the DCS. The user may also have a callout or alarm notification system that needs to unify alarm data from multiple vendors systems. Prior to the OPC standard, the alarm callout or notification software would have to write and support drivers or interfaces to every different system and their custom interfaces.

The OPC A&E standard defined a common format to exchange that information. Alarms have the alarm type, limit, timestamp, value, possibly a string message, acknowledgment status and more, and all that information needs to remain together as a single “bundle” of information. OPC DA wasn’t designed to that. Below is an example of the types of information the OPC A&E standard allows to be shared in a single call between a client and server.

Point Name	Quality	Time Stamp	Type	Value
ASCDefinition	Good	Aug 18 08:03:40.554	String	Channel1_Device1_Tag1 > 5000
ASCDescription	Good	Aug 18 08:03:40.554	String	The HI_HI sub-condition for the HI_HI condition.
AckRequired	Good	Aug 18 08:03:40.554	BOOL	1
AcknowledgerID	Good	Aug 18 08:03:40.554	String	
ActiveSubCondition	Good	Aug 18 08:03:40.554	String	HI_HI
Comment	Good	Aug 18 08:03:24.076	String	
CondLastActive	Good	Aug 18 08:03:40.554	DATE	8/18/2017 12:03:41 PM
CondLastInactive	Good	Aug 18 08:03:24.082	DATE	8/18/2017 12:02:27 PM
EventCookie	Good	Aug 18 08:03:24.082	UI4	42828152
LastAckTime	Good	Aug 18 08:03:34.626	DATE	8/18/2017 12:03:35 PM
Quality	Good	Aug 18 08:03:24.082	I2	192
Severity	Good	Aug 18 08:03:34.626	I4	1
State	Good	Aug 18 08:03:40.554	I2	3
SubCondLastActive	Good	Aug 18 08:03:40.554	DATE	8/18/2017 12:03:41 PM
SubCondLastActiveFiletime	Good	Aug 18 08:03:40.554	String	133130380 30611482

OPC A&E provides the specialized function calls and data format for this data type. So when an OPC client says it supports A&E that means it supports these specialized function calls and data formats. In the Software Toolbox offering, the [Cogent DataHub](#)

can be an OPC A&E server and client, securely tunneling data between OPC A&E clients and servers across networks, routers, firewalls and between remote sites. The Cogent DataHub can also [convert OPC A&E to OPC DA or OPC UA](#).

## What's OPC HDA?

John: The OPC Historical Data Access (OPC HDA) standard solves the problem of providing a standardized way to read data from Process Historians. We often hear people say that they think OPC HDA defines how the data is stored in the historian database. Actually it does not. OPC HDA is about allowing interoperability between client applications that do trending, analysis, and reporting on data from wide range of Process Historian applications on the market. Each Process Historian has their own client tools that often connect using a private interface into their Process Historian. OPC HDA opens the door for users to use a mix of vendors for these types of applications.

A historical data recordset will consist of a variety of data samples with the timestamps for those samples, retrieved at the request of a client application to "Give me all the values for Tag1, Tag2, Tag3, etc for the time range of the last 2 hours". Like OPC A&E, the OPC HDA standards provide specialized function calls and data formats to pass these blocks of information between software applications.

The screenshot displays the Flow software interface. On the left, a 'Data Source Preview' window shows two time-series plots: a blue ramp function and a red random function. A blue arrow labeled 'OPC HDA' points from these plots to a 'Configuration (Connected to Runtime)' window on the right. This window shows a table of data points with columns for Value, Quality, and Timestamp (local time).

Value	Quality	Timestamp (local time)
164.75	Good	2017-11-06 at 14:57:57.166
165.75	Good	2017-11-06 at 14:57:56.166
166.5	Good	2017-11-06 at 14:57:55.166
167.25	Good	2017-11-06 at 14:57:54.166
168	Good	2017-11-06 at 14:57:53.166
168.75	Good	2017-11-06 at 14:57:52.166
169.75	Good	2017-11-06 at 14:57:51.166
170.5	Good	2017-11-06 at 14:57:50.166
171.25	Good	2017-11-06 at 14:57:49.166
172	Good	2017-11-06 at 14:57:48.166

Below the table, the text 'OPC HDA Server logging data once a second' is displayed. At the bottom of the configuration window, there is a link: 'Click here to configure value display settings'.

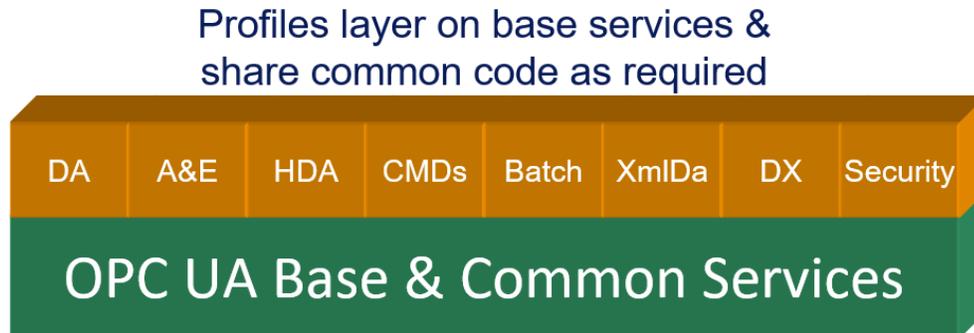
In the Software Toolbox offerings, [Flow](#) can connect to multiple Process Historians using OPC HDA as well as databases, Information Platform for industrial reporting and operational analysis. [Dream Report](#) can also connect to OPC HDA and many other data sources to produce a wide range of reports.

## Why OPC UA?

John: The OPC Unified Architecture (OPC UA) seeks to take what was learned over the first 10-15 years of OPC and remove duplication in code and interfaces that were

obstacles to adopting multiple parts of the standard, and expand the uses of OPC into other applications.

With the OPC Classic interfaces, developers had to include foundational OPC code over and over again for the different interfaces standards. Now they can use a unified code-base and implement whatever profiles they need. So the classic OPC standards became OPC UA Profiles and an OPC UA server or client describes itself based on what profiles it supports such as OPC UA DA profile, A&E profile, HDA profile, etc.



The most popular benefit of OPC UA is that it can be used across operating system platforms, communicates using a single TCP/IP port, offers SSL encryption, and allows for security rights control to the tag level based on user credentials, provided the OPC client and server have implemented all the required facets.

Looking to the future, because OPC UA had to support the more complex data structures of Alarms & Events and Historical Data, it was a logical extension to allow for support of just about any complex data model and provide mechanisms for the implementation of other complex data models for other standards to use OPC UA as the transport.

Software Toolbox offerings using OPC UA include [TOP Server for Wonderware](#), [Omniserver](#), [Cogent DataHub](#), [OPC Data Client](#), [OPC Data Logger](#) and [SLIK-DA for UA](#).

### Can OPC UA talk to OPC DA and vice versa?

Win: OPC UA and OPC DA can't talk directly, but there are [OPC Gateway applications](#) that can share data in a single or bi-directional configuration between the 2 standards.



This is useful when you have existing systems that you need to integrate with OPC UA but you aren't able to or ready to upgrade all the software in your systems. Simple gateway applications make the transition possible.

## My OPC Server doesn't support UA yet but my OPC client does, what do I do?

John: We hear this a lot, and in the end it's really the same as the previous question. We also hear the question reversed as "My OPC client supports OPC DA only but it needs to talk to an OPC UA server". The solution to both scenarios is the same. You need an [OPC gateway application](#) that can convert from OPC DA to UA at both the client and the server level.

Some people also call this an OPC wrapper or OPC UA wrapper, or OPC DA wrapper. They key is that you need a solution that is fast, easily configured, and supports the necessary OPC UA security features that you plan to use.

## Can OPC DA 2 and DA 3 clients and servers talk to each other?

John: If you've been around OPC long enough you may have heard that there were 3 versions of OPC DA – Version 1, 2, and 3. The most widely implemented standard is OPC DA 2.x. We don't see many OPC DA 1.x servers or clients any more but they do exist. OPC DA 3.x was the first step towards OPC UA in that it added some additional functionality to the DA function set to handle sampling of data and controlling of what constitutes changed data, but it was not widely adopted in client or server applications.

Many OPC clients, if they support OPC DA 3.x, they will support 2.x, and they might support OPC 1.x. Bottom line the client application has to support one of the versions of the OPC DA standard that the server offers. But what if the client doesn't?

If you find you need integrate between OPC DA 2 and DA 3 clients and servers and either your OPC client or server is missing the support you need, the [Cogent DataHub](#) supports OPC DA 2, OPC DA3, and OPC UA and can be an OPC Client and Server and would be a good solution.

If you happen to have an OPC DA 1.x client or server and need to integrate it with OPC DA 2, 3 or even OPC UA, the [TOP Server OPC Client Driver](#) would be a good solution.



## What are OPC Data Quality and Timestamps all about?

Win: Before OPC, when your HMI or SCADA software went to read data with its built in drivers, it either got data or it didn't. If you didn't get data you had no good way to know the last time you did get data. There was no in between.

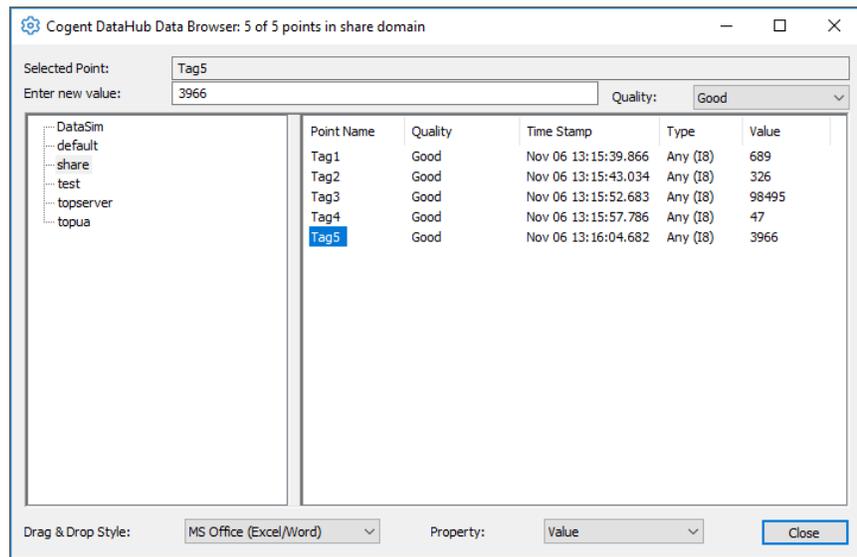
With OPC servers, they cache, or hold onto the last value that they read from the devices. They also timestamp the data in their cache, typically using the time the value was read from the device by the OPC server.

OPC Quality is a way for OPC Servers to tell OPC clients more about the value they are providing. The way this is done is by passing a number along with the value and timestamp. In OPC speak we call this VQT or "Value, Quality, Timestamp". The OPC quality number is really determined by setting bits within a word, and that results in different values. A value of 192 means "Good" quality, which means the last time the OPC server polled the device it was able to successfully get data, so the OPC client can trust that value. A value of 0 will mean Bad Quality and typically means that there was a communications failure between the OPC server and the device it is polling. There are a whole range of other values that the OPC server can use to indicate why the quality is bad, but they are not widely implemented. We have a [detailed application note](#) that shows more of the common OPC quality values.

What matters the most is that OPC client applications typically can be configured to cause a change in how they show values to the user on an operator screen, or in a historical database, so that people know not to trust that value and they know why.

## What about Devices that store events and send data in batches with timestamps?

Some devices store a timestamp for when the data last changed, and can pass that to the OPC server using the device specific communications protocol. If the device supports that and the OPC server supports it, device timestamps can be used. Examples of Software Toolbox products that support device timestamps for protocols that support the functionality include TOP Server [DNP](#), [IEC 61850](#), and [IEC 60870](#) drivers.



Sometimes we hear from users that have applications where they need to source timestamps from one place and data from another and combine them. They aren't often, but when we run into those we help with the Cogent DataHub as we can use [its scripting engine](#) to control the source of data and timestamp separately.

## I need to share data between a control system and a metering package or between 2 different control systems that have OPC servers

John: What you need in this case is an [OPC Bridge application](#). An OPC Bridge application is a product that is an OPC client, and thus can talk to OPC DA and OPC UA servers, and has functionality to allow you to:

- Create mappings between tags in each control system through a visual user interface
- Define whether data flows one direction or both directions between the systems
- Define changes such as scaling to be applied to the data values if required
- Bridge to non-OPC data sources or destinations, if required, for your application
- Bridge between different OPC data sources, including OPC UA to OPC DA and vice versa



## Where should my OPC servers be placed in my network security model?

John: This could probably be a whole paper, as there are so many considerations, but we have heard this one a lot since the first edition, so let's look at it here.

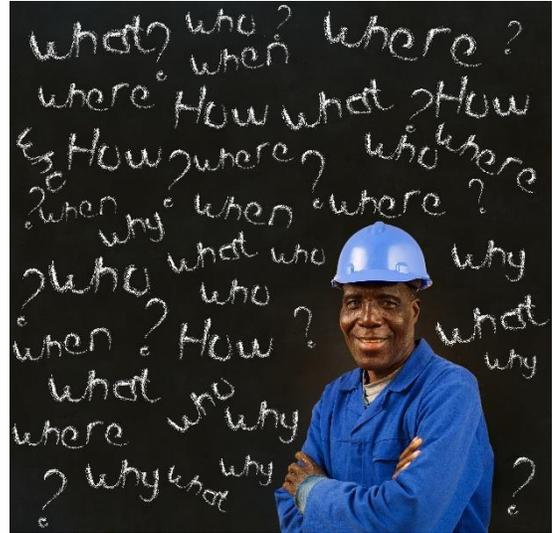


First, remember when we say OPC servers, we're talking about the software, not necessarily the hardware they are running on. Often those "hardware" servers are virtual these days, and the choice of location of those servers needs to involve a discussion with your IT department, OT team, and cybersecurity team.

The answer to the question is really "it depends", and there are too many possible combinations of factors and scenarios to discuss here in a responsible fashion so, instead, we'll point out some of what you should consider, and provide a couple of examples.

Factors to consider include but are not limited to:

- Who needs the data from the OPC servers and where are those applications running? Are they on the public internet? Are they in a business layer? A DMZ layer in the network? Or are they in a totally isolated Automation layer?
- Do different data sets have different user needs and, thus, access is needed at multiple layers?
- How often do they need the data?
- Is some of the data read only and some read/write?
- How critical is the security of the data?
- What are your corporate IT standards?

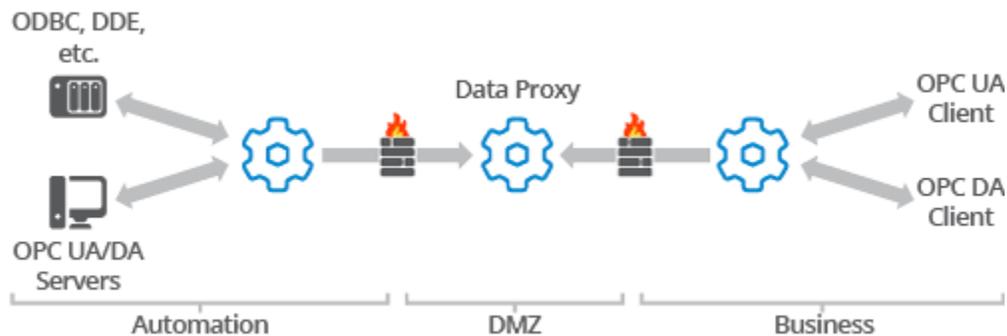


Have some considerations to add, [we'd love to hear from you](#).

To be sure, there are more factors, but most conversations we have start there. More and more we are seeing the need to be able to share data securely, rapidly, with more and more parties, which presents a cybersecurity challenge. There are [unique tools available](#) to share data without having to open inbound firewall ports, and without significantly sacrificing performance.

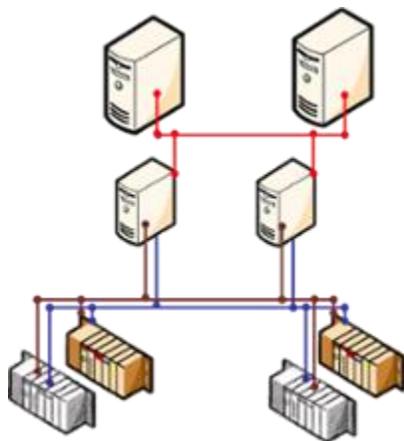


Probably the most common scenario we see is to place the OPC servers in the Automation Layer of a network, as close to the data source as possible, to insure performance and to make data available rapidly to other applications that reside in the Automation layer. Then, using [tools for tunneling](#), including OPC UA, data is taken to a DMZ layer and then up to the business layer, with the DMZ providing the necessary filtering and isolation.



We also are asked this question in the context of the [Perdue enterprise reference architecture](#) and the layers 0 to 4. We sometimes also are asked the question in the context of the Perdue ICS model. The answer unfortunately is still “it depends”. Typically, we see the OPC servers residing at Level 2 or Level 3 in the Perdue Enterprise model and, in the Security Cell/Area Zone, level 1 or level 2, in the Perdue security model. What matters most is that you involve all the relevant stakeholders and their needs in your decision.

## I need redundancy in my OPC system, how do I do that?



This is another deep topic, with lots of questions before there are answers. First, you must define what you mean by redundancy as, taken to deep extremes, it can apply to every component of the system that touches the OPC server or that the OPC server depends upon. We’ve written about this topic at length, so we suggest you read about the [OPC redundancy considerations](#) you need to keep in mind when defining what redundancy means to you.

The most common scenario we hear about is people wanting to have redundant OPC servers, specifically OPC UA servers with the growing adoption of OPC UA. Some HMI/SCADA client applications will have redundancy switching and monitoring of OPC data source health built into the product, so first check there. If they don’t then you’ll need an OPC redundancy switching tool. This is another area we’ve written about in more detail that you can [read about here](#).

## Do you have more questions? Ask us!

John and I view this document as a living document so we hope to hear from you with your questions so that we can continue to enhance and improve this resource for people that are new to the operations technology space.

[Click here to send us your questions](#). We look forward to helping you.

## About the Authors

### Win Worrall

Win studied software engineering and has been working at Software Toolbox since 2007. Win started out in product support and has worked with hundreds of users around the world with about every product in Software Toolbox’s mix. Win’s unique mix of development experience combined with hands-on client experience enables him to deliver value to his clients. Win currently is responsible for product management of the Cogent DataHub offering within Software Toolbox’s range of products and is part of the company leadership team with various other responsibilities.



## John Weber

John founded Software Toolbox in 1996 after 6 years with GE Fanuc automation and CIMTEC, a large high tech automation products distributor. He started out in technical support at GE Fanuc and has worked with users in about every industry through a variety of roles. That experience developed a passion for customer experience that is a key part of Software Toolbox's vision to provide a total product experience that will empower users to maximize their results. John is very active in many parts of Software Toolbox's business and enjoys the opportunity to help others learn about this space.





888 665 3678 TOLL FREE  
+1 704 849 2773 GLOBAL  
Charlotte, NC USA GLOBAL HQ  
[www.softwaretoolbox.com](http://www.softwaretoolbox.com) WEB

Our mission is to provide you with the right software package to solve your industrial operation challenges.