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OPC with MATLAB

Industrial Communication Toolbox

Hans-Petter Halvorsen

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Introduction

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Introduction

- In this Tutorial we will use **MATLAB** and the **Industrial Communication Toolbox** to communicate with different OPC Servers
- We will go through some examples where we use **OPC DA** and **OPC UA**

What do you need?

- OPC DA Server
  - E.g., “MatrikonOPC Simulation Server”, which is an OPC DA Demo/Test Server which you can download and use for free
- OPC UA Server
  - E.g., “OPC UA Server Simulator”, which is an OPC UA Demo/Test Server which you can download and use for free
- MATLAB
- Industrial Communication Toolkit

What is OPC?

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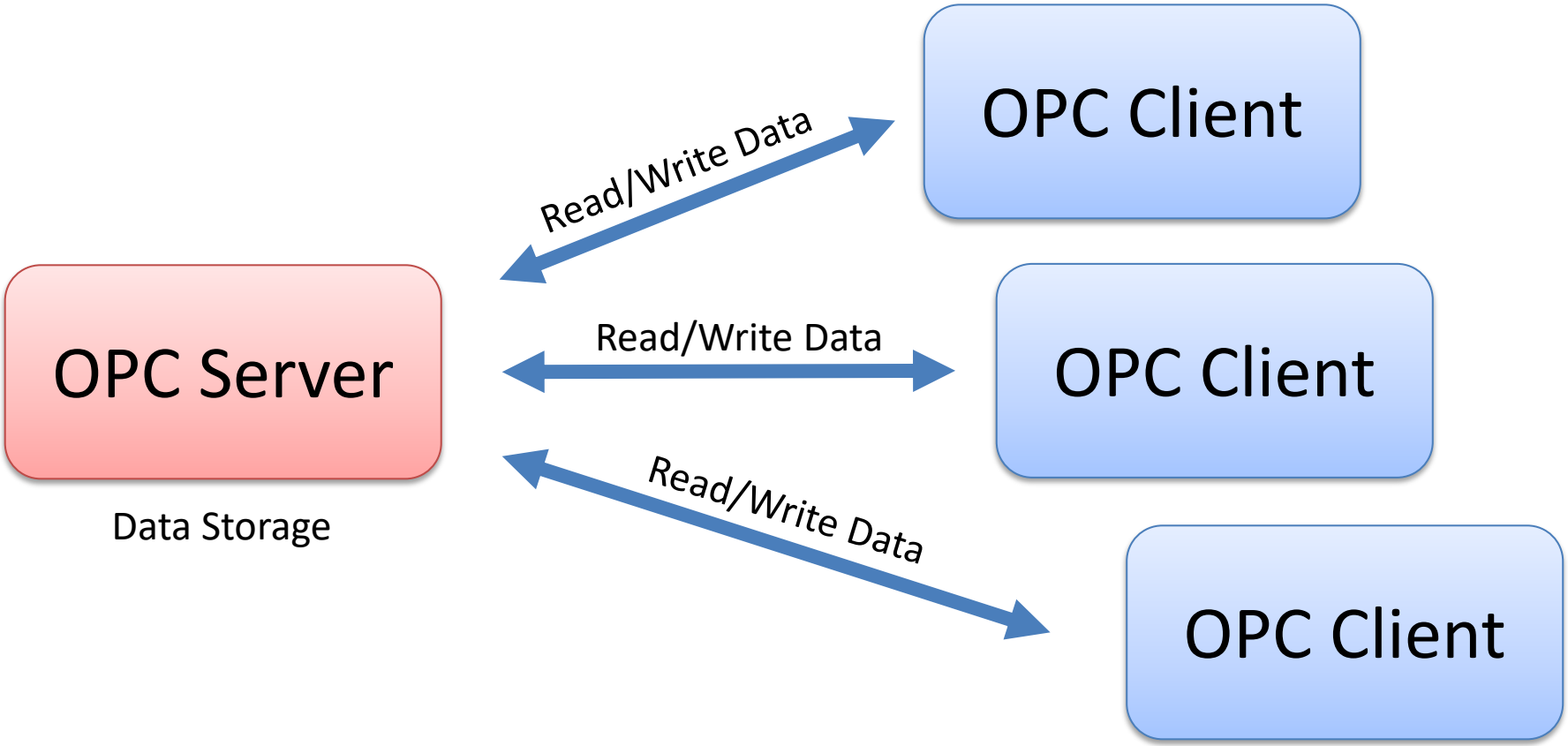
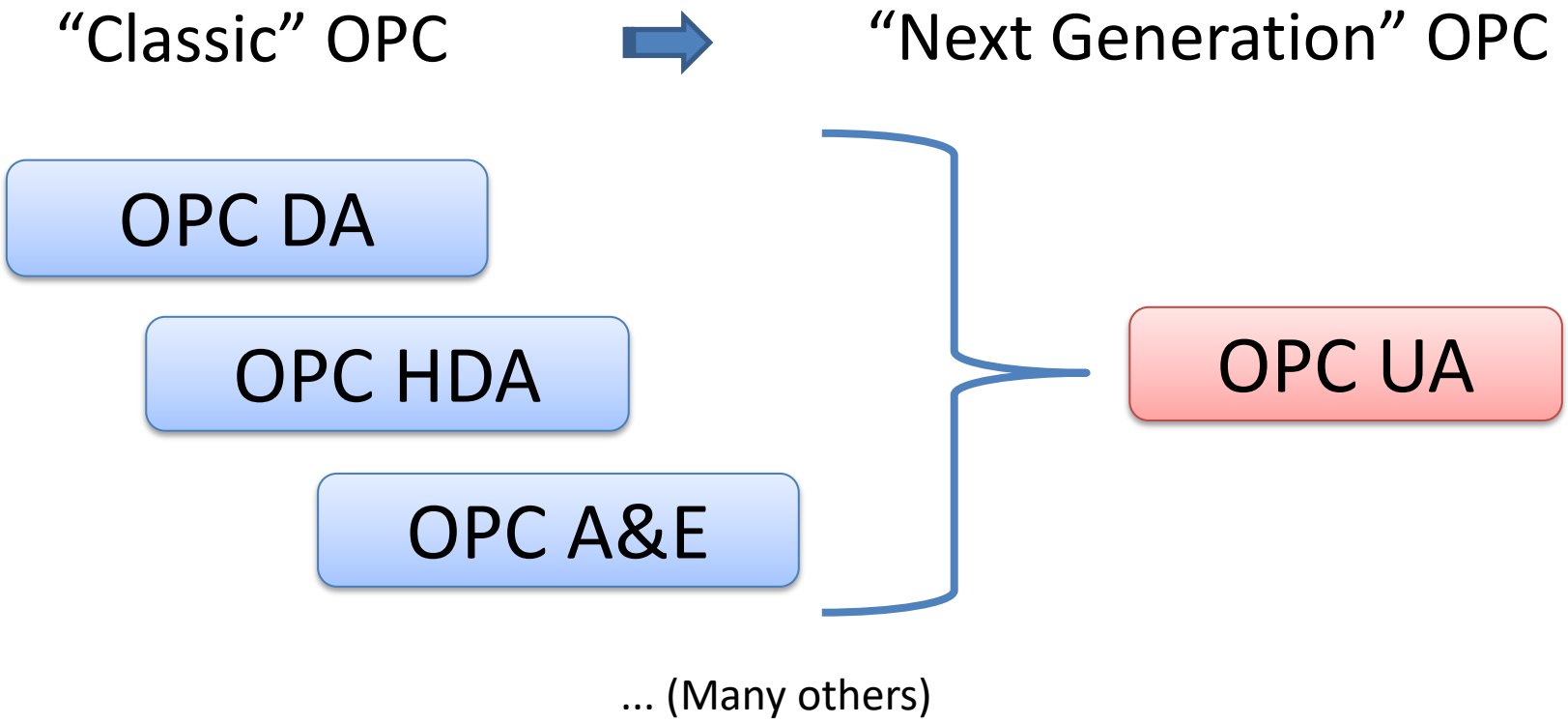
What is OPC?

- OPC is a standard that defines the communication of data between devices from different manufactures
- OPC requires an **OPC Server** that communicates with one or more **OPC Clients**
- OPC allows “plug-and-play”, gives benefits as reduces installation time and the opportunity to choose products from different manufactures
- We have different OPC standards:
  - “Real-time” data (OPC DA),
  - Historical data (OPC HDA)
  - Alarm & Events data (OPC A&E)
  - etc.

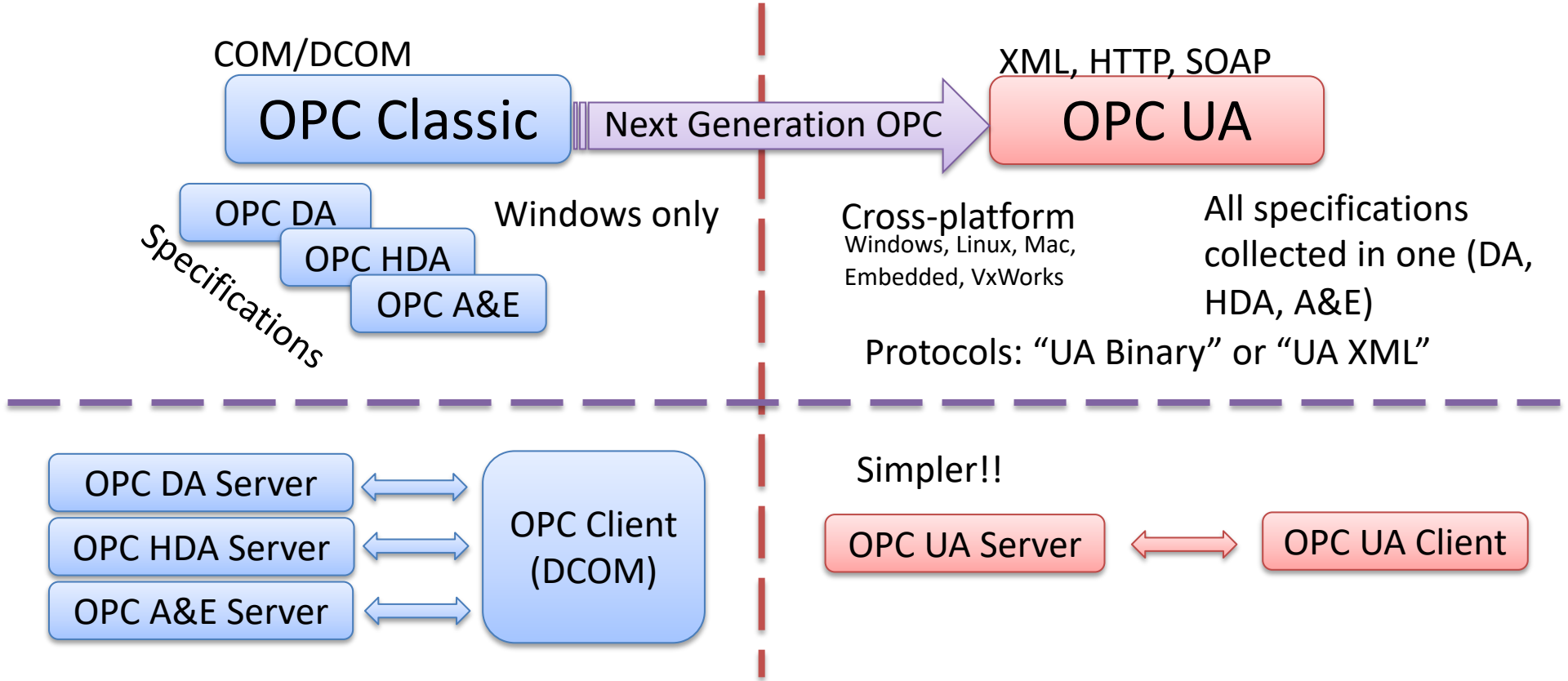
OPC Server and Clients



OPC Specifications



Next Generation OPC

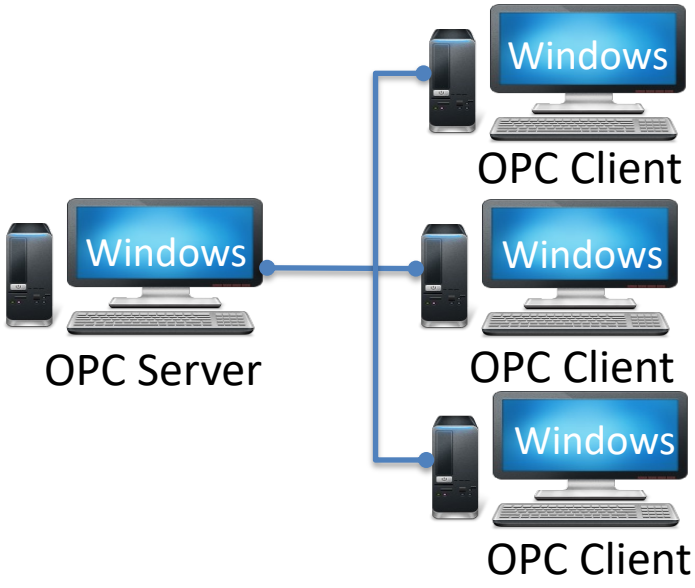


OPC UA

- UA – Unified Architecture
- The Next Generation OPC
- Cross Platform. “Classic” OPC works only for Windows
- Based on Modern Software/Network Architecture (No COM/DCOM problems!)
- It makes it easier to transmit and receive data in a modern data network/Internet

Classic OPC vs. OPC UA

Classic OPC (DCOM)



OPC UA

The server (or clients) can be an embedded system, LINUX, Windows, etc.

OPC UA Server

OPC UA Client

OPC UA Client

OPC UA Client

Classic OPC requires a Microsoft Windows operating system to implement COM/DCOM server functionality. By utilizing SOA and Web Services, **OPC UA is a platform-independent system** that eliminates the previous dependency on a Windows operating system. By utilizing SOAP/XML over HTTP, OPC UA can deploy on a variety of embedded systems regardless of whether the system is a general-purpose operating system, such as Windows, or a deterministic real-time operating system.

http://www.ni.com/white-paper/13843/en/

OPC with MATLAB

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OPC with MATLAB

- In order to use OPC with MATLAB you can use the "**Industrial Communication Toolbox**".
- The "Industrial Communication Toolbox" supports the following Protocols:
  - OPC, both OPC DA and OPC UA (previously "OPC Toolbox")
  - MQTT
  - Modbus
- **Note!** "Industrial Communication Toolbox" is a new Toolbox that is included in "MATLAB R2022a" and newer versions

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Industrial Communication Toolbox

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Industrial Communication Toolbox

- The Industrial Communication Toolbox supports:
  - OPC DA
  - OPC HDA
  - OPC UA
- Resources:
  - https://mathworks.com/products/industrial-communication.html
  - https://mathworks.com/help/icomm/data-reading-and-writing.html

OPC DA Examples

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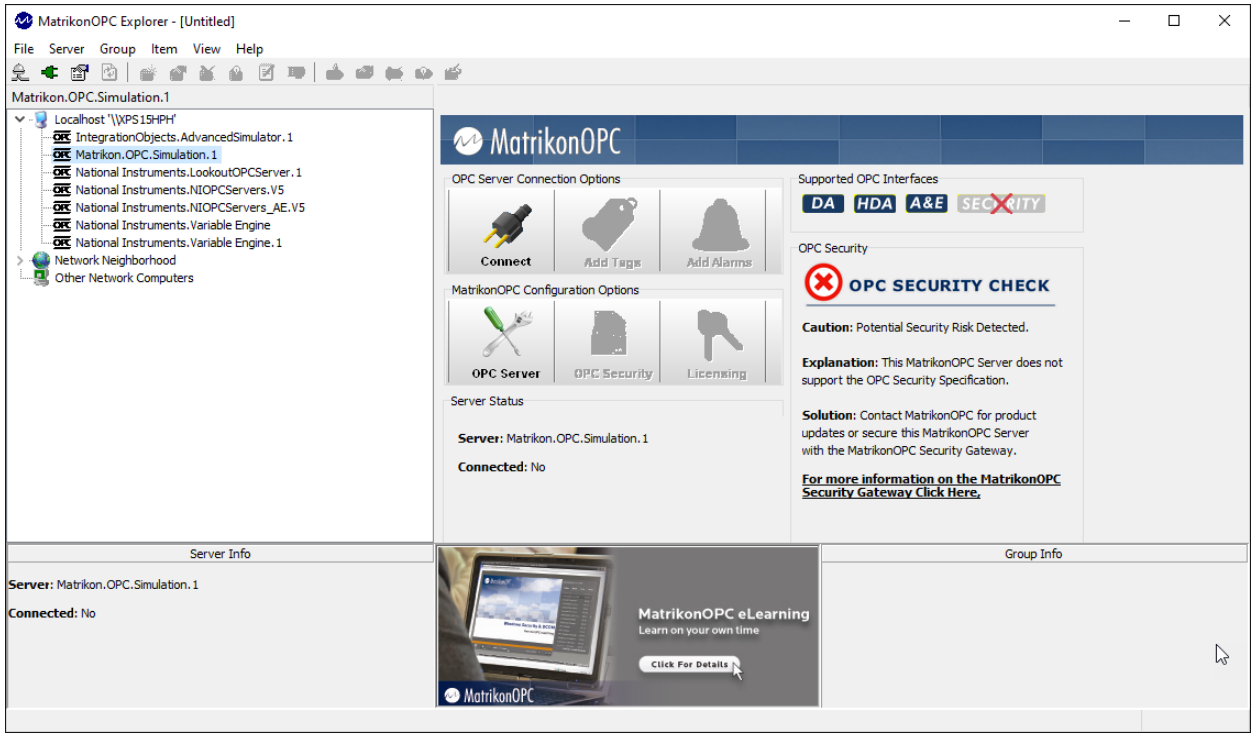
MatrikonOPC Simulation Server



MatrikonOPC Simulation Server is free and can be used for testing OPC DA

https://www.matrikonopc.com/products/opc-drivers/opc-simulation-server.aspx

OPC DA - Example 1

Basic Example that reads a single value from an OPC Server

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OPC DA - Example 1

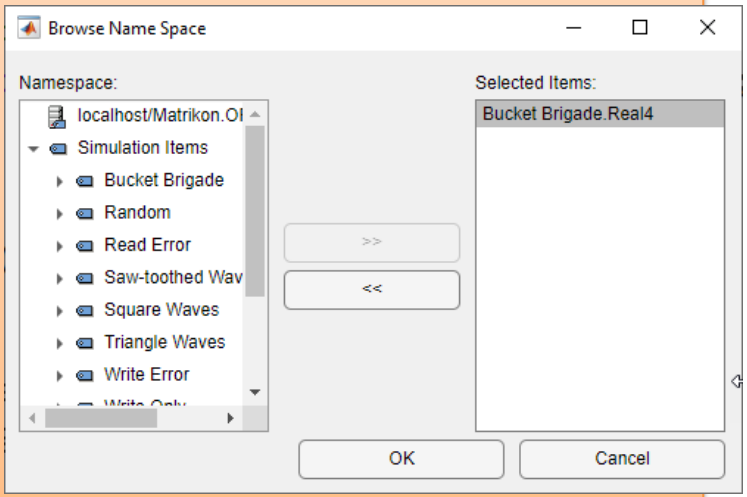
```
% Connect to OPC Server
da = opcda('localhost', 'Matrikon.OPC.Simulation.1');
connect(da);

% Create Group
grp = addgroup(da, 'DemoGroup');

%Add Tags
ItmList = {'Random.Real4'};
itm = additem(grp, ItmList);

% Retrieve Data
data = read(grp);
opcdata = data.Value

%Clean Up
disconnect(da)
delete(da)
```

This simple Example reads only one value from the OPC DA Server

OPC DA - Example 1b

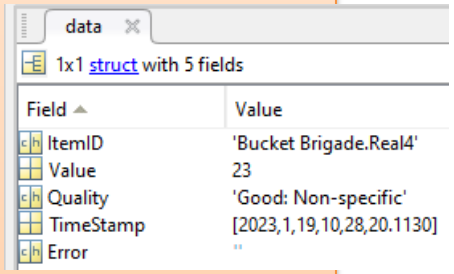
```
% Connect to OPC Server
da = opcda('localhost', 'Matrikon.OPC.Simulation.1');
connect(da);

% Create Group
grp = addgroup(da, 'DemoGroup');

%Add Tags
ItmList = browsenamespace(da);
itm = additem(grp, ItmList);

% Retrieve Data
data = read(grp);
opcdata = data.Value

%Clean Up
disconnect(da)
delete(da)
```

This Example makes it possible to select one or more OPC Tag from a pop-up window



OPC DA - Example 1c

```
% Connect to OPC Server
da = opcda('localhost', 'Matrikon.OPC.Simulation.1');
connect(da);

% Create Group
grp = addgroup(da, 'DemoGroup');

%Add Tags
ItmList = browsenamespace(da);
itm = additem(grp, ItmList);

% Retrieve Data
data = read(grp)
data.ItemID
data.Value
data.TimeStamp
data.Quality

%Clean Up
disconnect(da)
delete(da)
```



You can also get other information than the Value itself, like TimeStamp, Quality, etc.

OPC DA - Example 1d

```
% Connect to OPC Server
da = opcda('localhost', 'Matrikon.OPC.Simulation.1');
connect(da);

% Create Group
grp = addgroup(da, 'DemoGroup');

%Add Tags
ItmList = {'Bucket Brigade.Real4', 'Bucket Brigade.Real8'};
itm = additem(grp, ItmList);

% Retrieve Data
data = read(grp);
opcdata1 = data(1).Value
opcdata2 = data(2).Value

%Clean Up
disconnect(da)
delete(da)
```

Here we get data from 2 different OPC Tags

data

2x1 struct with 5 fields

Fields	ItemID	Value	Quality	TimeStamp	Error
1	'Bucket Brigade.Real4'	23	'Good: Non-specific'	[2023,1,19,10,28,20.1130]	[]
2	'Bucket Brigade.Real8'	19	'Good: Non-specific'	[2023,1,19,13,51,48.2450]	[]
3					

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OPC DA - Example 2

Basic Example that reads continuously from an OPC Server

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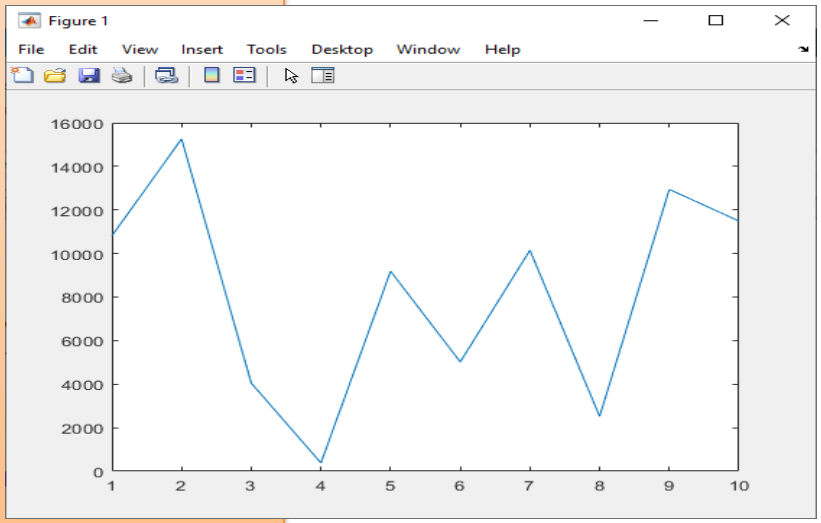
OPC DA - Example 2

```
% Connect to OPC Server
da = opcda('localhost', 'Matrikon.OPC.Simulation.1');
connect(da);

% Create Group
grp = addgroup(da, 'DemoGroup');

%Add Tags
ItmList = {'Random.Real8'};
itm = additem(grp, ItmList);

% Retrieve Data
N=10;
for i=1:N
   data = read(grp);
   opcdata(i) = data.Value;
   pause(10)
end

%Clean Up
disconnect(da)
delete(da)

%Present Data
plot(opcdata)
```

This simple Example reads values from a OPC DA Server.
This Examples reads N values using a For Loop



OPC DA - Example 3

Advanced Example that reads continuously from an OPC Server

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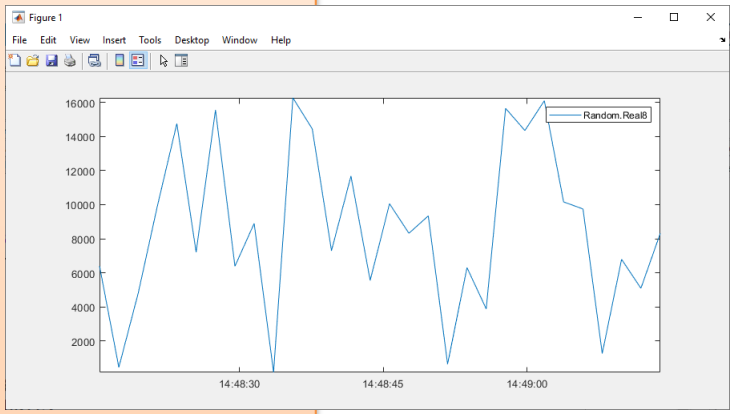
OPC DA - Example 3

```
% Connect to OPC Server
da = opcda('localhost', 'Matrikon.OPC.Simulation.1');
connect(da);

% Create Group
grp = addgroup(da, 'DemoGroup');
%Add Tags
itmIDs = {'Random.Real8'};
itm = additem(grp, itmIDs);

% Set Properties
logDuration = 60;
logRate = 2;
numRecords = ceil(logDuration./logRate);
grp.UpdateRate = logRate;
grp.RecordsToAcquire = numRecords;

% Acquire Data
start(grp);
wait(grp);

% Retrieve Data
[logIDs, logVal, logQual, logTime, logEvtTime] = getdata(grp, 'double');

% Plot Data
plot(logTime, logVal);
axis tight
datetick('x', 'keeplimits')
legend(logIDs);

%Clean Up
disconnect(da)
delete(da)
```



This simple Example uses some of the more advanced features in the MATLAB Industrial Communication Toolbox.
No For/While Loop needed!

OPC UA Examples

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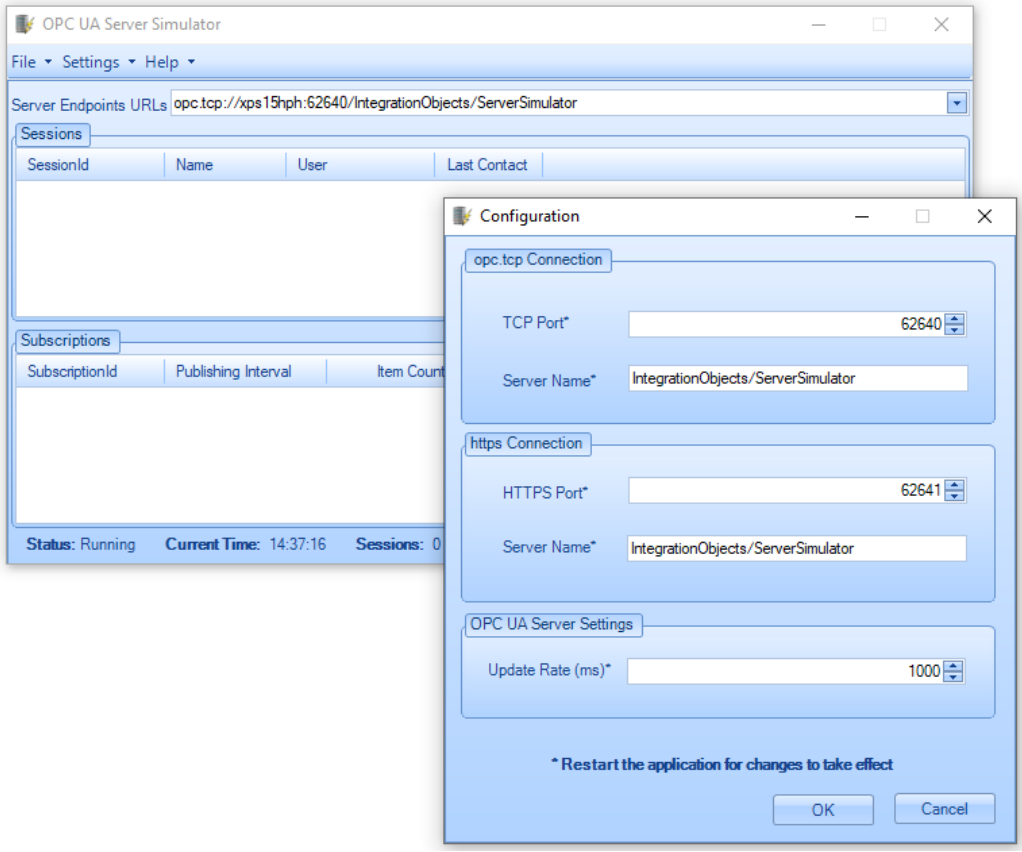
OPC UA Demo/Test Software

- OPC UA Server
  - E.g., “OPC UA Server Simulator” from “Integration Objects”, which is an OPC UA Demo/Test Server which you can download and use for free
- OPC UA Client
  - E.g., “OPC UA Client“ from “Integration Objects”, which is a free client tool that supports the main OPC Unified Architecture information models.

OPC UA Server Simulator

https://integrationobjects.com/sioth-opc/sioth-opc-unified-architecture/opc-ua-server-simulator/

OPC UA Server Simulator

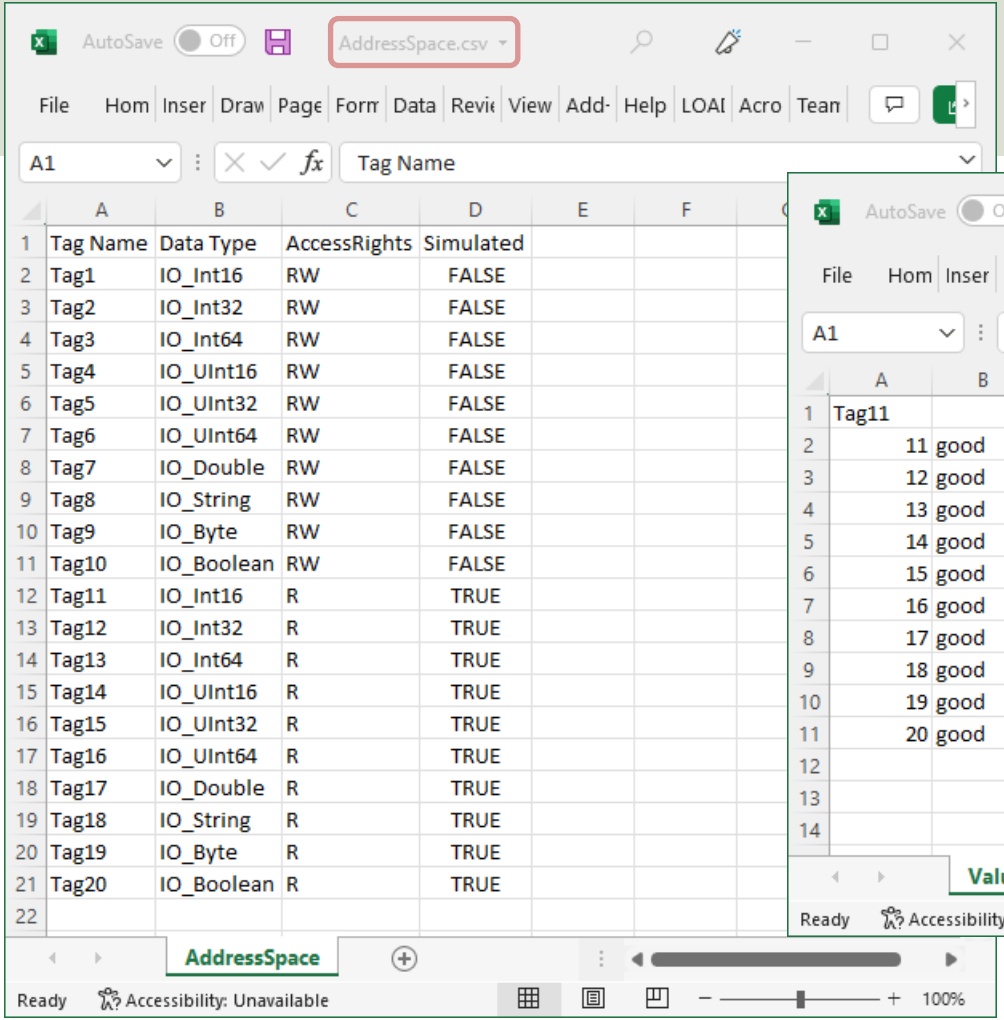


For the OPC UA Part we will use the “OPC UA Server Simulator”, which is an OPC UA Demo/Test Server which you can download and use for free

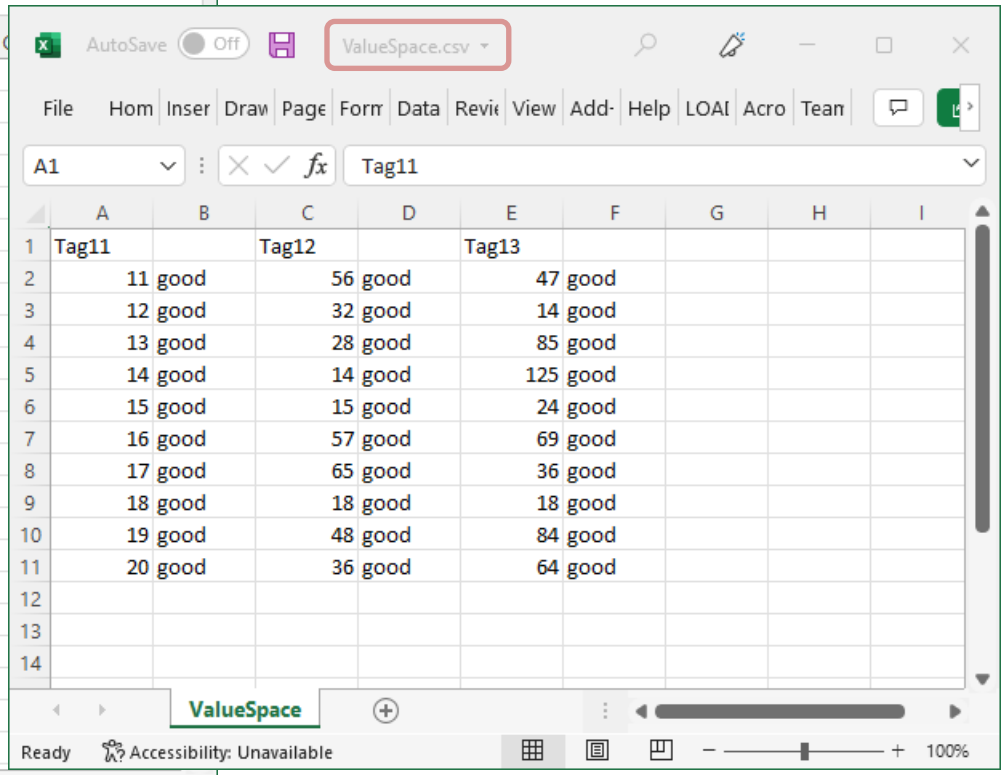
OPC UA Server Simulator

The “OPC UA Server Simulator” uses 2 CSV simulation files:

- “**AddressSpace.csv**” used to build the address space of the OPC UA Server.
- “**ValueSpace.csv**” used to simulate the data values of the OPC UA items.
- Those two files are located at the following path: X:\Program Files (x86)\Integration Objects\Integration Objects' OPC UA Server Simulator\OPC UA Server Simulator\DATA



	A	B	C	D
1	Tag Name	Data Type	AccessRights	Simulated
2	Tag1	IO_Int16	RW	FALSE
3	Tag2	IO_Int32	RW	FALSE
4	Tag3	IO_Int64	RW	FALSE
5	Tag4	IO_UInt16	RW	FALSE
6	Tag5	IO_UInt32	RW	FALSE
7	Tag6	IO_UInt64	RW	FALSE
8	Tag7	IO_Double	RW	FALSE
9	Tag8	IO_String	RW	FALSE
10	Tag9	IO_Byte	RW	FALSE
11	Tag10	IO_Boolean	RW	FALSE
12	Tag11	IO_Int16	R	TRUE
13	Tag12	IO_Int32	R	TRUE
14	Tag13	IO_Int64	R	TRUE
15	Tag14	IO_UInt16	R	TRUE
16	Tag15	IO_UInt32	R	TRUE
17	Tag16	IO_UInt64	R	TRUE
18	Tag17	IO_Double	R	TRUE
19	Tag18	IO_String	R	TRUE
20	Tag19	IO_Byte	R	TRUE
21	Tag20	IO_Boolean	R	TRUE
22				

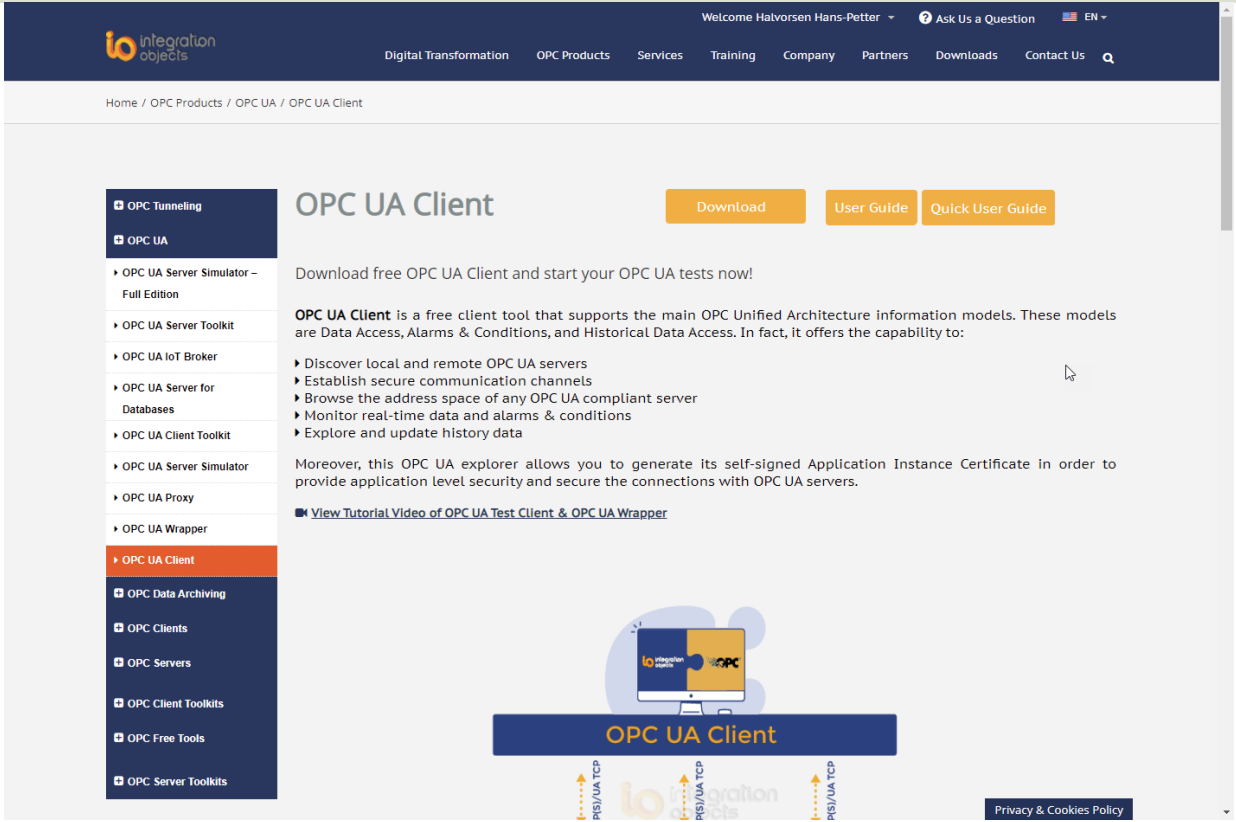


	A		B	C	D	E	F
1	Tag11			Tag12		Tag13	
2	11	good		56	good	47	good
3	12	good		32	good	14	good
4	13	good		28	good	85	good
5	14	good		14	good	125	good
6	15	good		15	good	24	good
7	16	good		57	good	69	good
8	17	good		65	good	36	good
9	18	good		18	good	18	good
10	19	good		48	good	84	good
11	20	good		36	good	64	good
12							
13							
14							

OPC UA Client

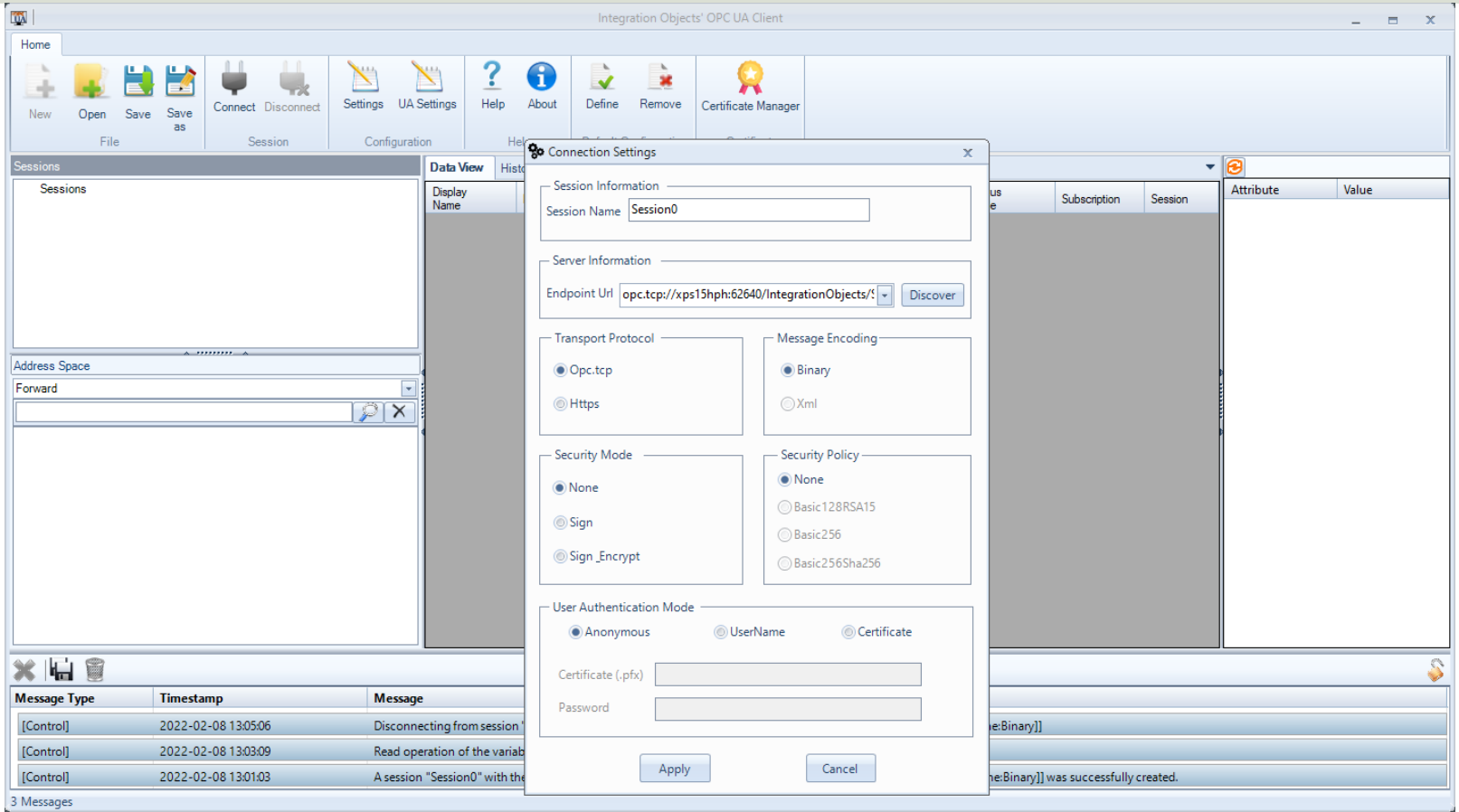
- “OPC UA Client” is a free OPC client tool that supports the main OPC Unified Architecture information models.
- These models are Data Access, Alarms & Conditions, and Historical Data Access
- Handy to use to test OPC communication
- https://integrationobjects.com/sioth-opc/sioth-opc-unified-architecture/opc-ua-client/

OPC UA Client

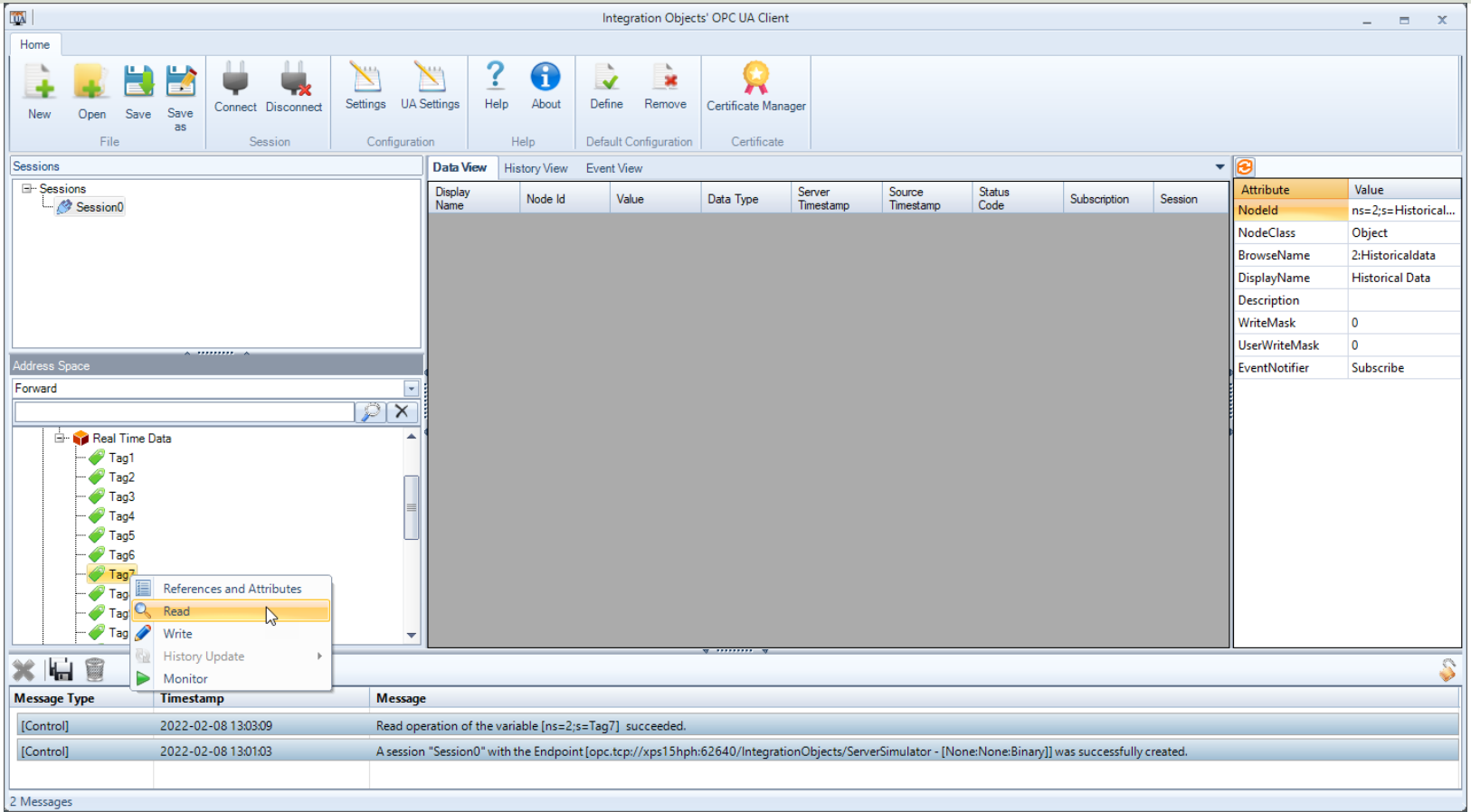


https://integrationobjects.com/sioth-opc/sioth-opc-unified-architecture/opc-ua-client/

OPC UA Client



OPC UA Client



OPC UA - Example 4

OPC UA Server Simulator – Read Data

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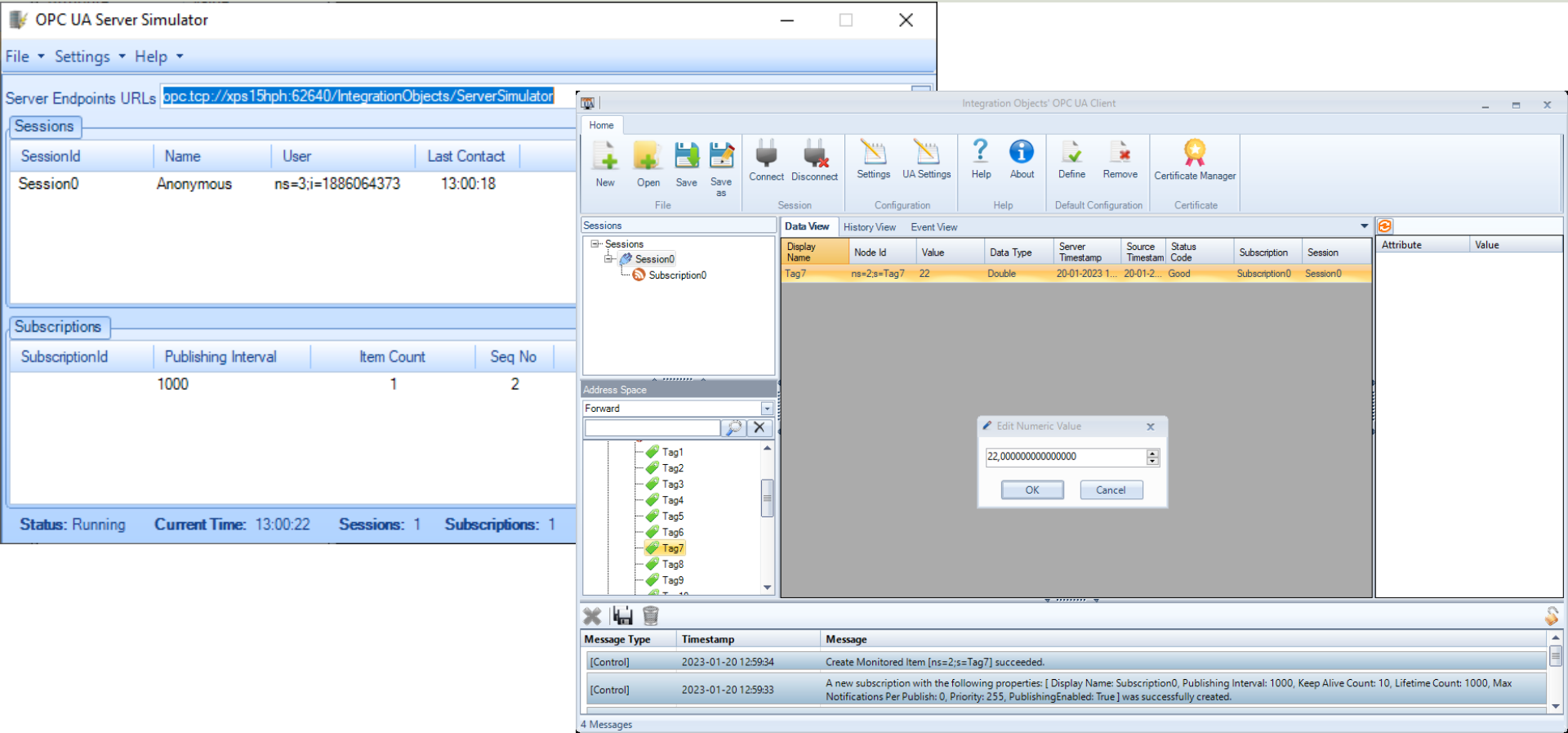
MATLAB OPC UA - Functions

Read Data

1. Locate Your OPC UA Server
```
serverList = opcuaserverinfo('localhost')
```
2. Create an OPC UA Client
```
uaClient = opcua('localhost', port)
```
3. Connect to the Server
```
connect(uaClient)
```
4. Browse OPC UA Server Namespace
```
serverNodes = browseNamespace(uaClient)
```
5. Read Current Values from the OPC UA Server
```
[val,ts,qual] = readValue(uaClient,serverNodes)
```
6. Disconnect
```
disconnect(uaClient)
```

OPC UA Server Simulator

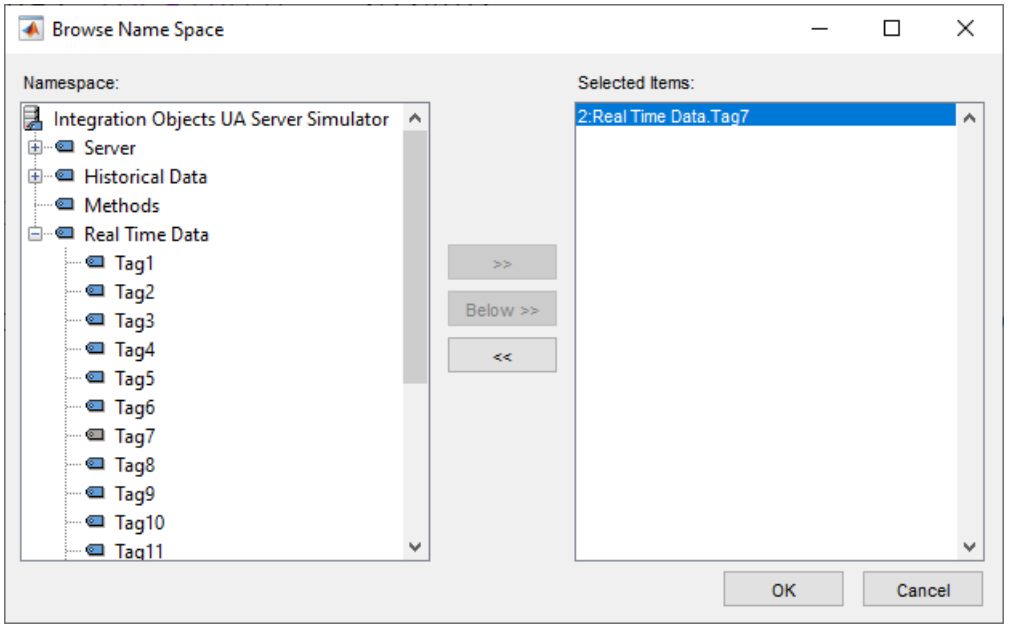


OPC UA - Example 4

Read Data

```
clear, clc

uaClient = opcua('localhost', 62640)

connect(uaClient)

serverNodes = browseNamespace(uaClient)

[val,ts,qual] = readValue(uaClient,serverNodes)

disconnect(uaClient);
```

OPC UA Server Simulator



Command Window

```
value =

    22


timestamp =

  datetime

    20-Jan-2023 13:01:44


quality =

OPC UA Quality ID:
    Good
```

OPC UA - Example 4b

```
clear, clc

uaClient = opcua('localhost', 62640)

connect(uaClient)
topNodes = uaClient.Namespace
serverChildren = topNodes(4).Children
findNode = findNodeByName(topNodes,'Tag7', '-once')

opcNode = opcuanode(2,'Tag7',uaClient)
[value,timestamp,quality] = readValue(uaClient,opcNode)

disconnect(uaClient);
```

Read Data

Here you don't need to select the Tag from the "Browse Name Space" window every time

OPC UA - Example 5

OPC UA Server Simulator – Write Data

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MATLAB OPC UA - Functions

Write Data

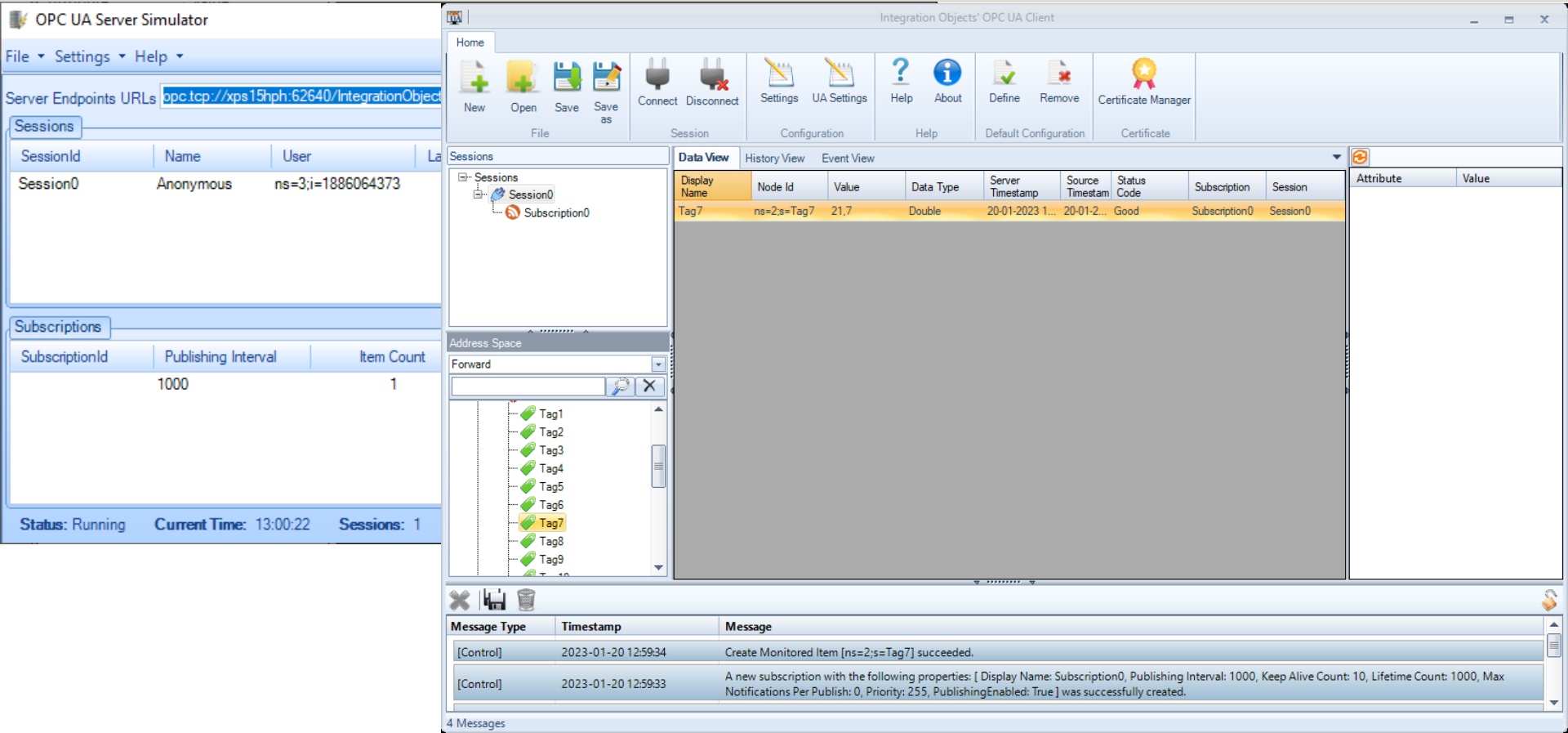
1. Locate Your OPC UA Server
```
serverList = opcuaserverinfo('localhost')
```
2. Create an OPC UA Client
```
uaClient = opcua('localhost', port)
```
3. Connect to the Server
```
connect(uaClient)
```
4. Browse OPC UA Server Namespace
```
serverNodes = browseNamespace(uaClient)
```
5. Write Current Values to the OPC UA Server
```
newValue = 22.5
writeValue(uaClient, serverNodes, newValue);
```
6. Disconnect
```
disconnect(uaClient)
```

OPC UA - Example 5

```
clear, clc

uaClient = opcua('localhost', 62640)

connect(uaClient)

serverNodes = browseNamespace(uaClient)

newValue = 21.7;
writeValue(uaClient, serverNodes, newValue);

[value,timestamp,quality] = readValue(uaClient,serverNodes)

disconnect(uaClient);
```

Write Data

OPC UA Server Simulator



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