ASEM
A ROCKWELL AUTOMATION COMPANY

FactoryTalk

FactoryTalk Optix Technical Training

ASEM • APPLICATION SUPPORT ENGINEERS • 08/2025

Rockwell Automation
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Getting Started

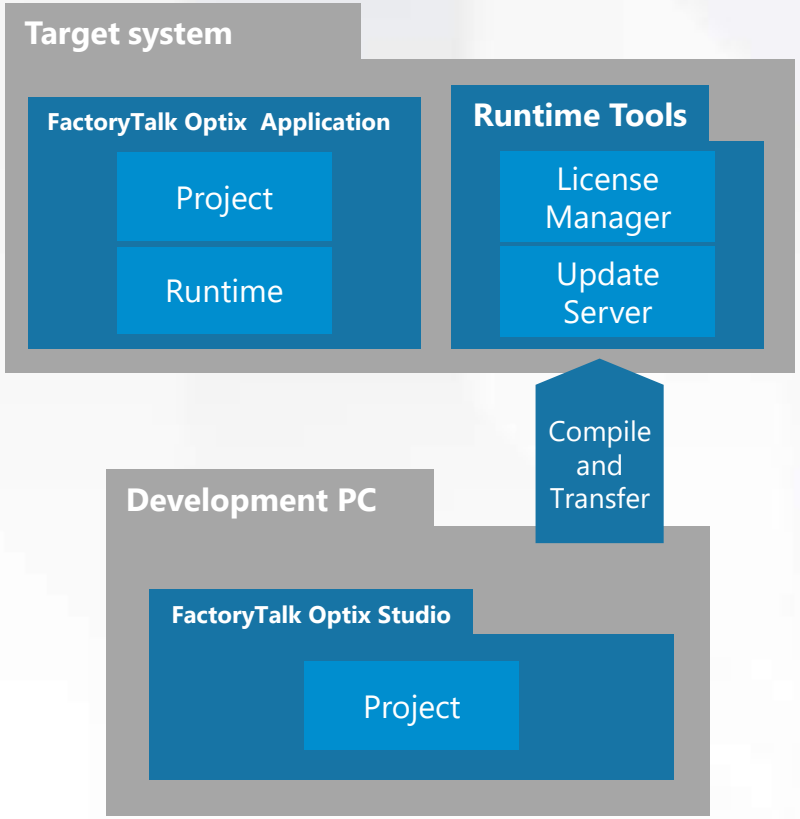
FactoryTalk
by ROCKWELL AUTOMATION

Architecture

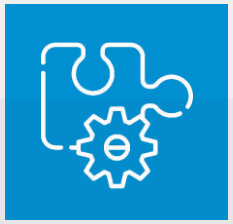
- **FactoryTalk Optix Studio** is the Integrated Development Environment (IDE) used to design and deploy HMI and IIOT applications

- **FactoryTalk Optix Application** is the compiled and "portable" application that combines the Project code and the Runtime executable for the Target (HMI or iPC)

- **Runtime Tools** is the set of tools that includes:
  - **Update Server**: Software to allow the deployment of applications from Studio to the target
  - **License Manager**: Software to manage the Runtime entitlements on the target device



FactoryTalk Optix key features

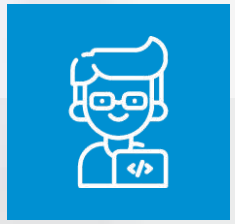


EXTENSIBILITY options

Natively OPC UA

Libraries

Scripting



DESIGN options

Object-oriented

Software As A Service

Version Control

GRAPHIC & DEPLOYMENT options

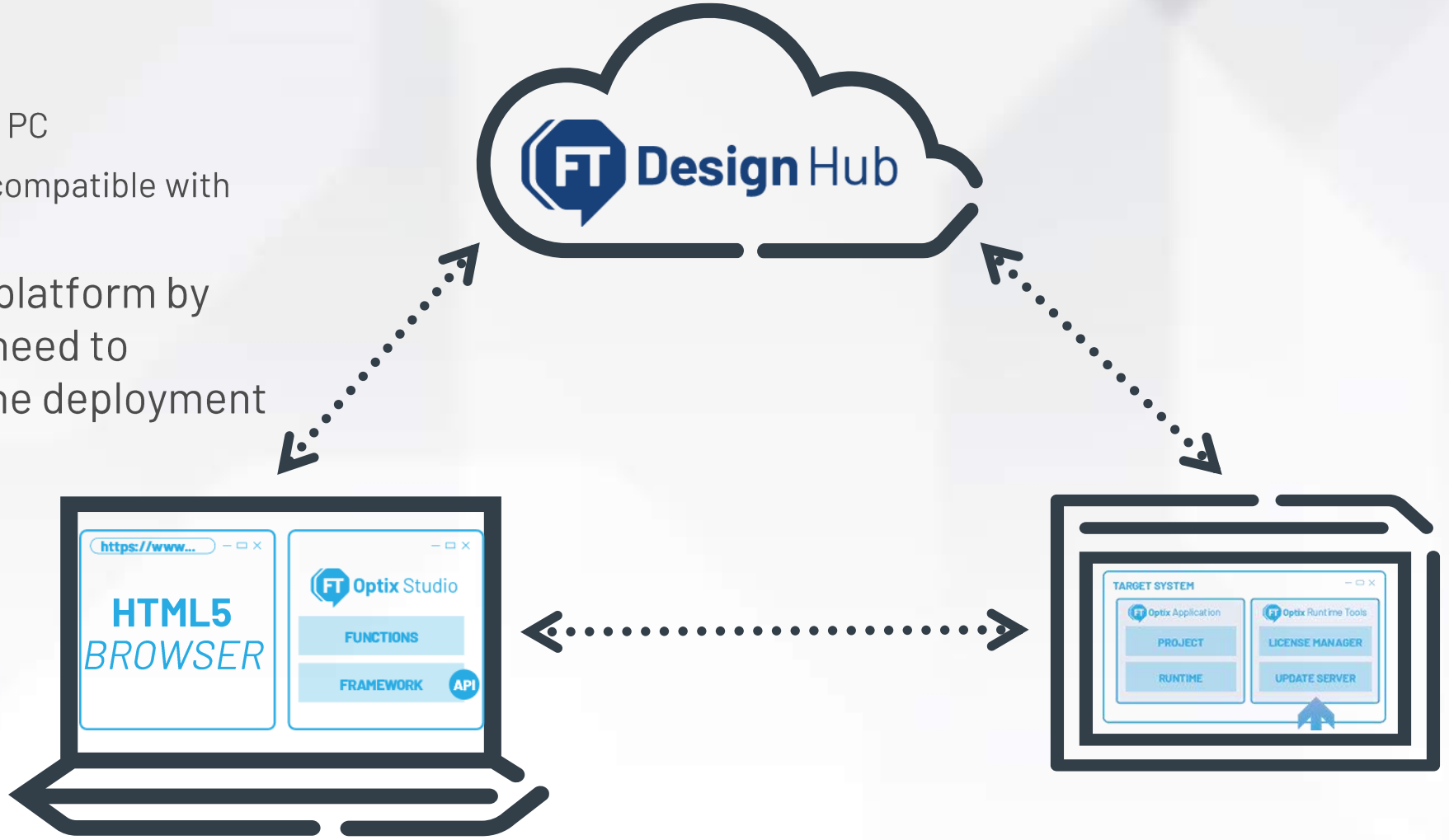
Cross-platform

Universal UI

Audit

FactoryTalk Optix Studio

- Available both
  - On premise: as a setup on local PC
  - As a service: a could instance compatible with any HTML5 browser
- All applications are cross-platform by design, the user does not need to choose or know which is the deployment target



FactoryTalk Optix Studio flavours

STANDARD

Installed on local PC

Design and Deploy application from your PC

No screens, tags, alarms or other Runtime features limitations

FREE

PRO

STANDARD capabilities plus...

Use the **Version Control** System (both on project and libraries) to enable multi-user **collaboration**

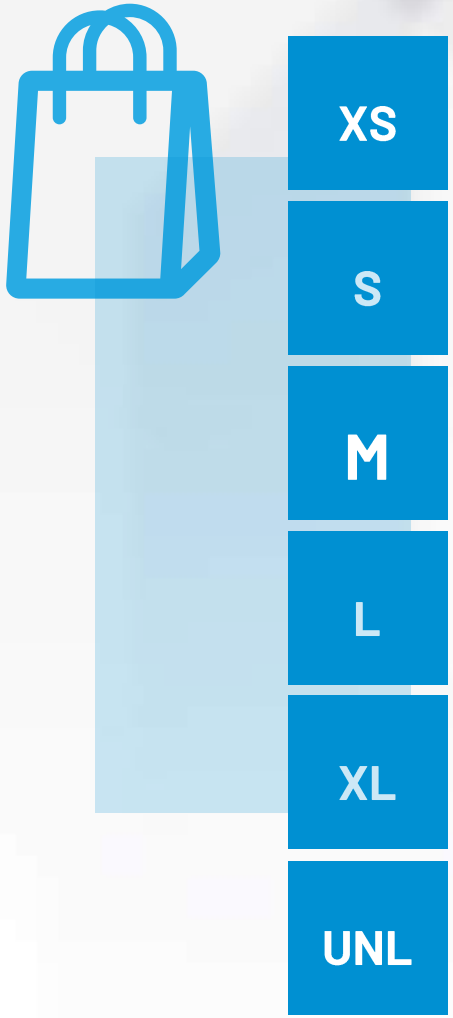
Design application using **web-based** Studio

Annual subscription per User

FactoryTalk Optix Runtime – Feature tokens overview

- Every **feature** used by the Runtime has a cost in **Tokens**
- License **size** defines the number of Tokens available

SIZE	RUNTIME FOR IPC
XS	5
S	8
M	11
L	15
XL	21
UNL	Unlimited



FactoryTalk Optix Runtime – Feature tokens example

SMALL HMI	
Native UI	1
Web UI (up to 1 clients)	1
Alarms + Alarms History	1
Data logger	1
Recipes	1
1x Comm Driver (multiple stations)	2
TOTAL	**7**

MEDIUM HMI	
Native UI	1
Web UI (up to 3 clients)	2
Alarms + Alarms History	1
Data logger	1
Retentivity	1
Recipes	1
OPC UA Server (1 client)	1
1x Comm Driver (multiple station)	2
TOTAL	**10**

Ready to start with FactoryTalk Optix?

- Just need to create a «My Rockwell» account then…
- Optix Studio STANDARD can be downloaded for free from https://compatibility.rockwellautomation.com/
- Optix Studio PRO is available as 90 Days Trial at https://home.cloud.rockwellautomation.com

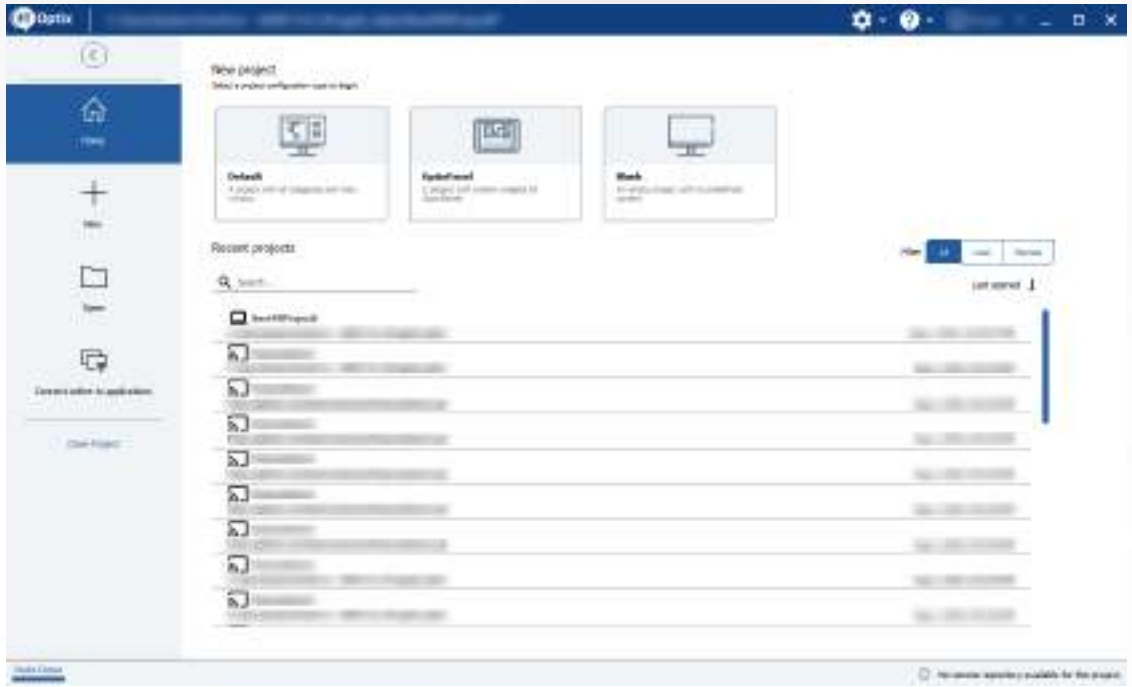
Be familiar with FactoryTalk Optix Studio

Development environment: new project wizard

Choose between

- Default: project with default folders/resource structure (recommended)
- OptixPanel: project with Optix Panel's dedicated widgets (network, screen settings, etc)
- Blank: empty project, without folders/resources structure (only if «advanced mode» is enabled)

Important: this selection does not limit in the deployment capabilities or available features



Project configuration

- Name, Location
- Use version control: allow the project versioning and collaboration between developers (GIT)
- Encrypt secrets: passwords are encrypted via a private key stored in the FactoryTalk HUB domain
- Default screens resolution (can be changed later)

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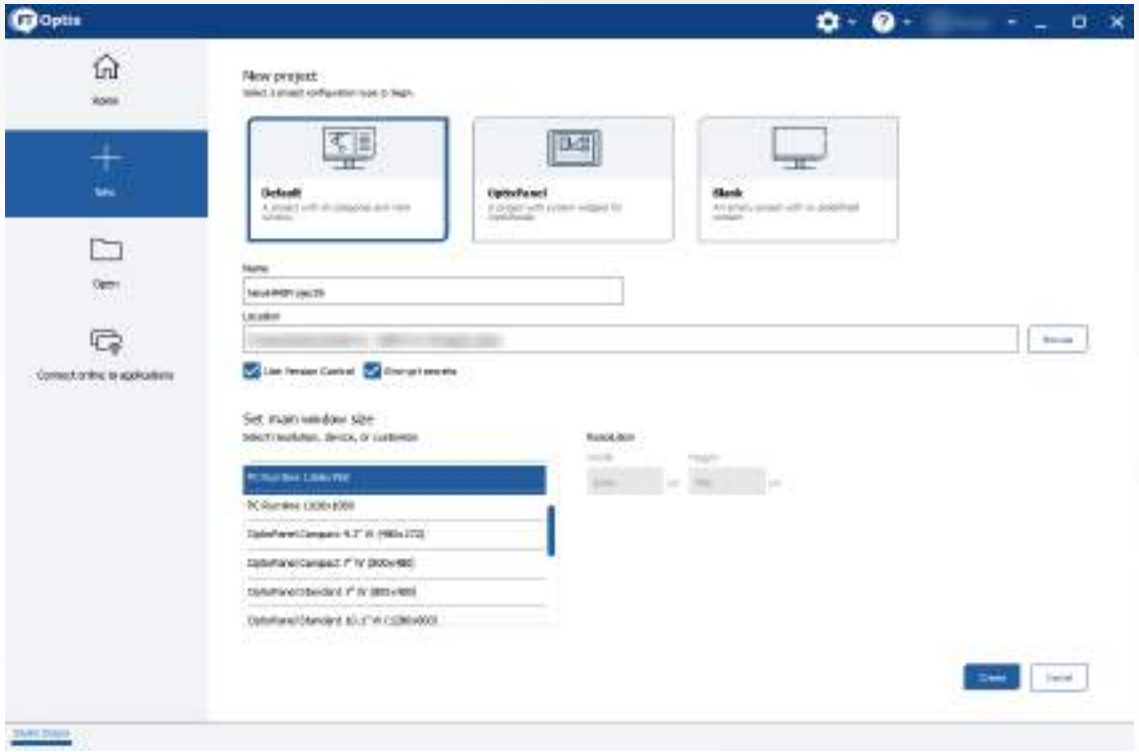

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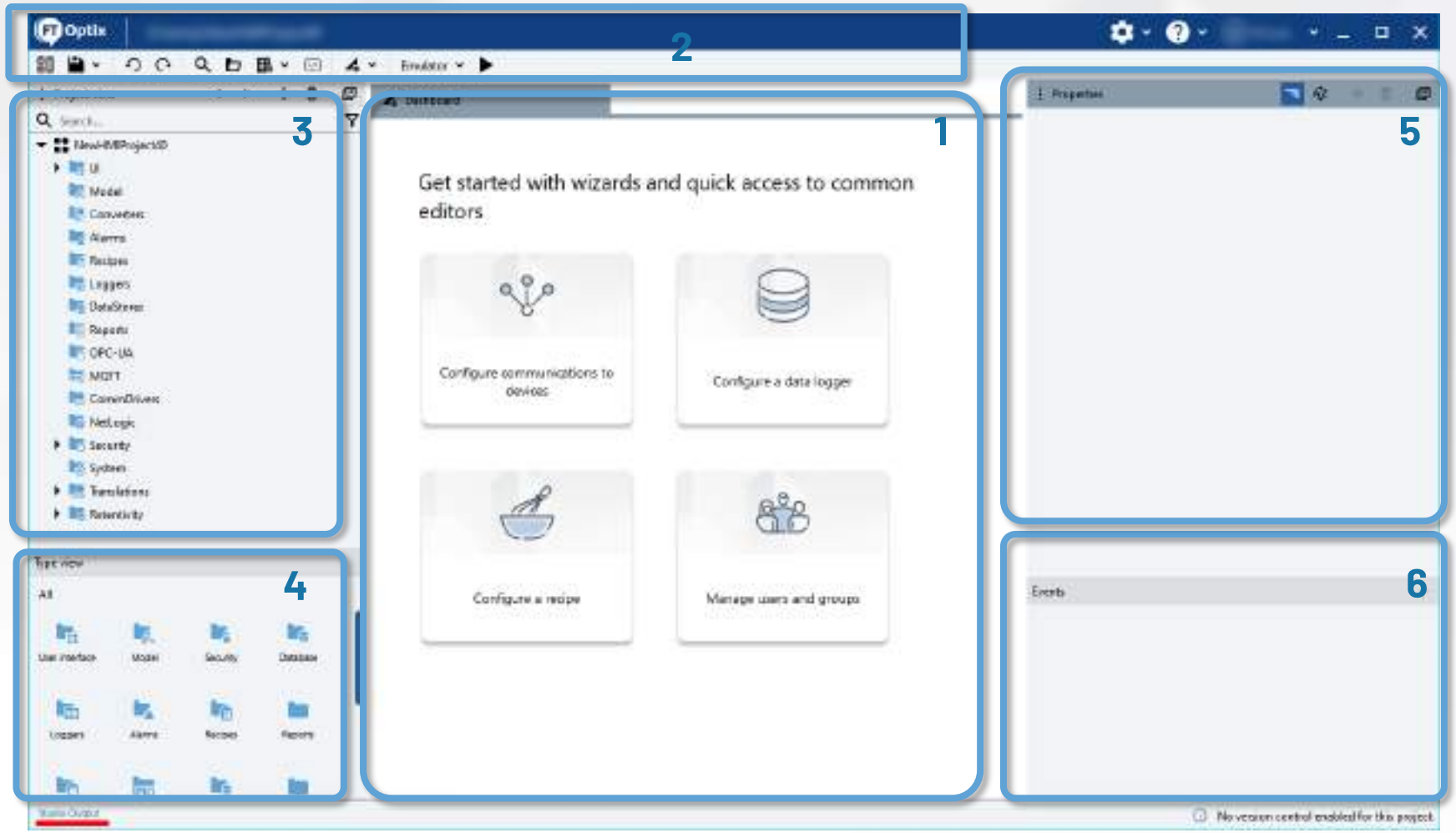
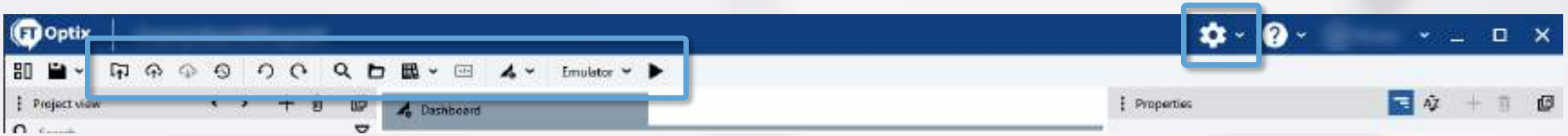
Development environment

1. Wizards
2. Main Toolbar
3. Project View panel
4. Types View panel
5. Properties panel
6. Events panel



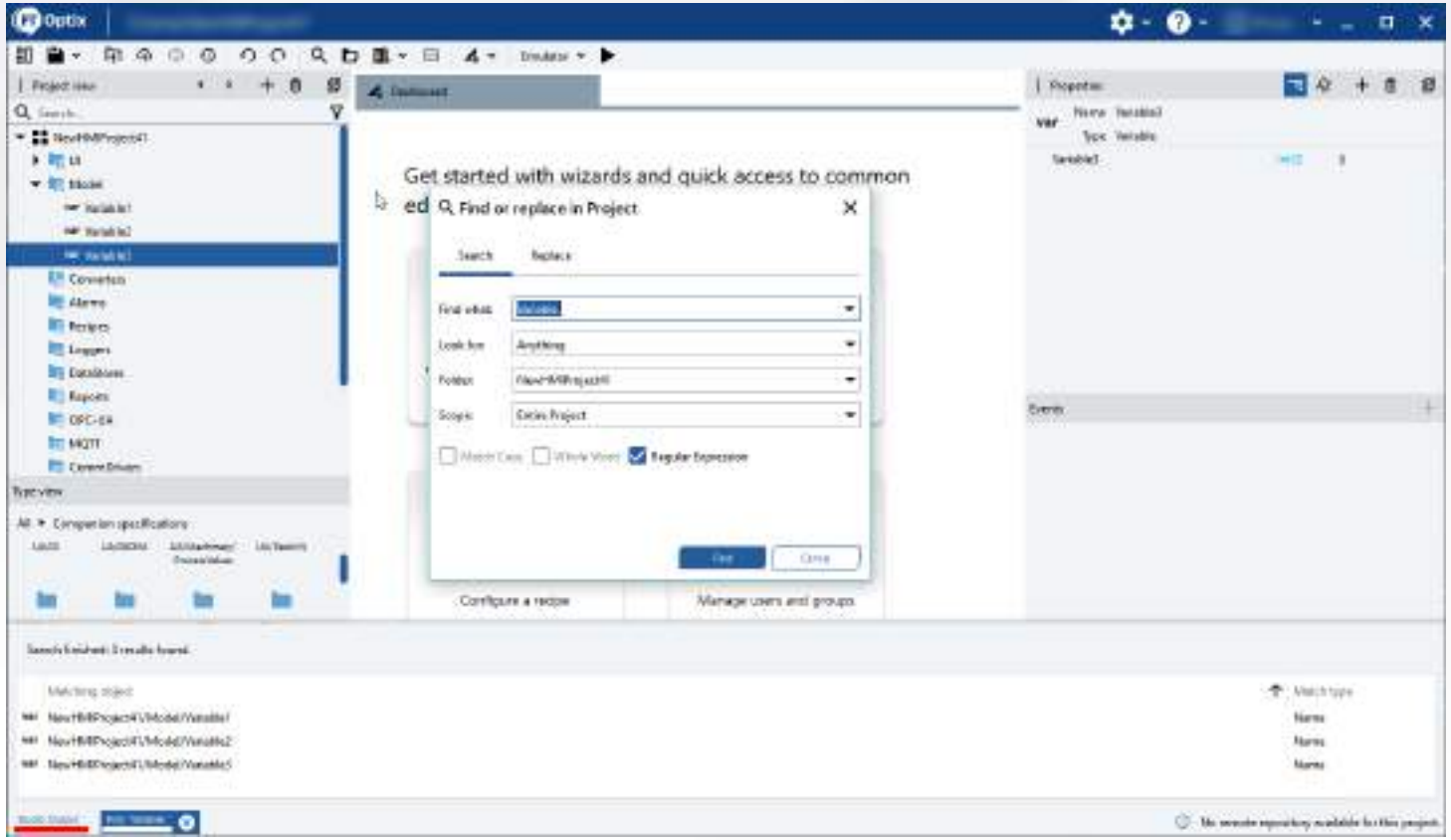
Main toolbar



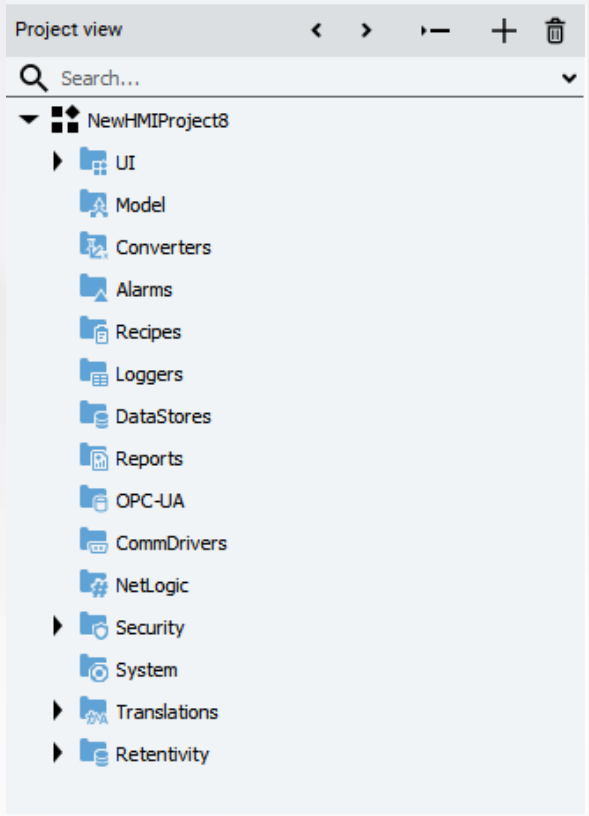
- **Collaboration:** Save & Commit/Push/Pull/History
- **Undo/Redo**
- **Global search**
- **Project Files**
- **Libraries** (`%UserProfile%\Documents\Rockwell Automation\FactoryTalk Optix\Libraries`)
- **NetSolution**
- **Wizards**
- **Deploy options:** Run the project within Emulator or transfer and run on a Target
- **Studio Options**

Main toolbar

- **Global Search:** helps finding elements anywhere in the project
  - Supports RegEx (using POSIX syntax, e.g: «.*» to search for any characters)
  - Can search in NetLogic, project tree and values
  - Output is returned in the a dedicated tab of the IDE
  - Supports replacing text and values



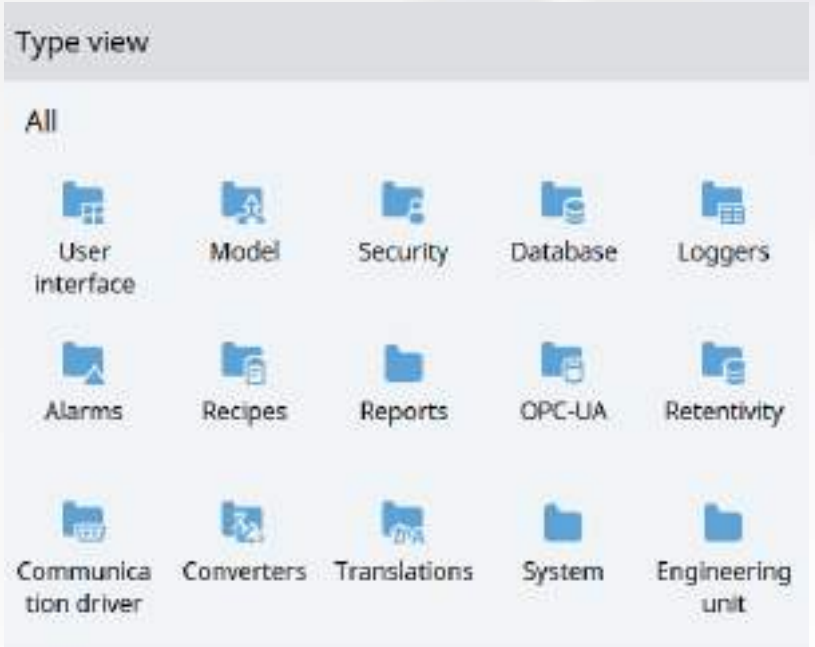
Project view



- The Project view shows, in a **typical tree architecture**, the project folders
- Folder structure constitutes the foundation of a project and are organized by type and functionality
- The Project view tree supports:
  - Context commands with the mouse (right-click)
  - Multiple selections
  - Drag&Drop
  - Copy/Paste
  - Search and filter
  - Detach
- Please, do not move or rename the default folders

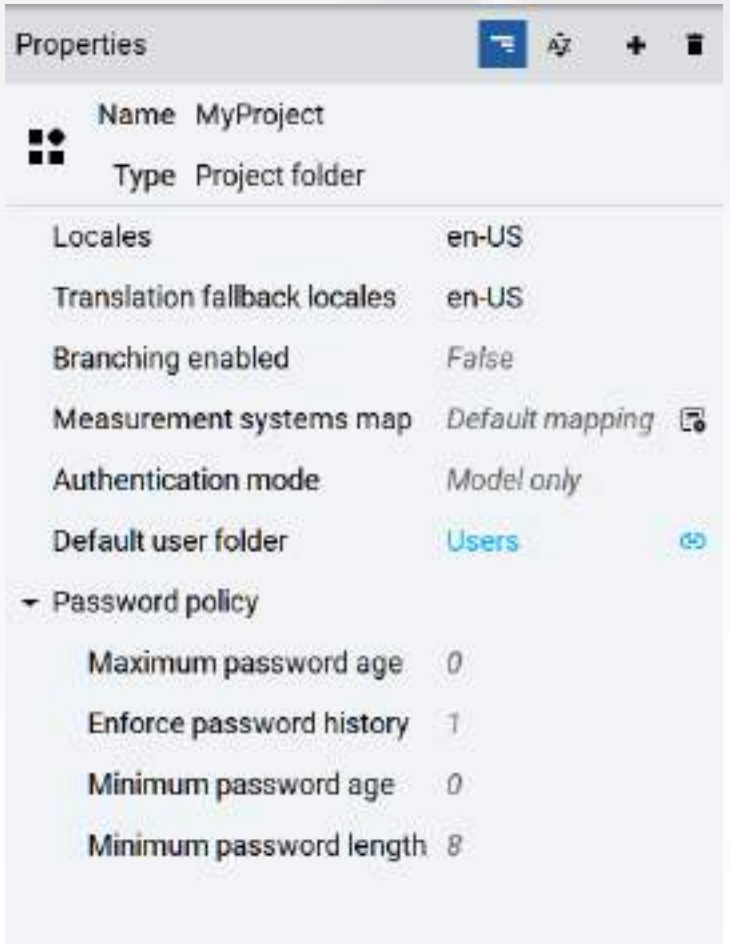
Type view

- Collection of **Native Types**, grouped in folders according to their purpose:
  - **Basic User Control**: to develop the User Interface
  - **Optix Types**: all the objects to be added to the project folders
  - **Companion specifications**: set of standard and custom types definition which are used to share information between different manufacturers (PackML, DI, TMC, etc)
- Object from Type view can be added into the project Tree by Drag&Drop
- Can be also the repository of **Custom Types**



Properties panel

- This pane shows properties of the selected node
  - Project
  - Resource
  - Objects
- Depending on the type of property, the editing can be done through:
  - Direct editing by typing
  - by Selecting the pencil icon
  - Drop-down menu
  - by Selecting the DynamicLink icon
- Can edit common properties of Multiple selections



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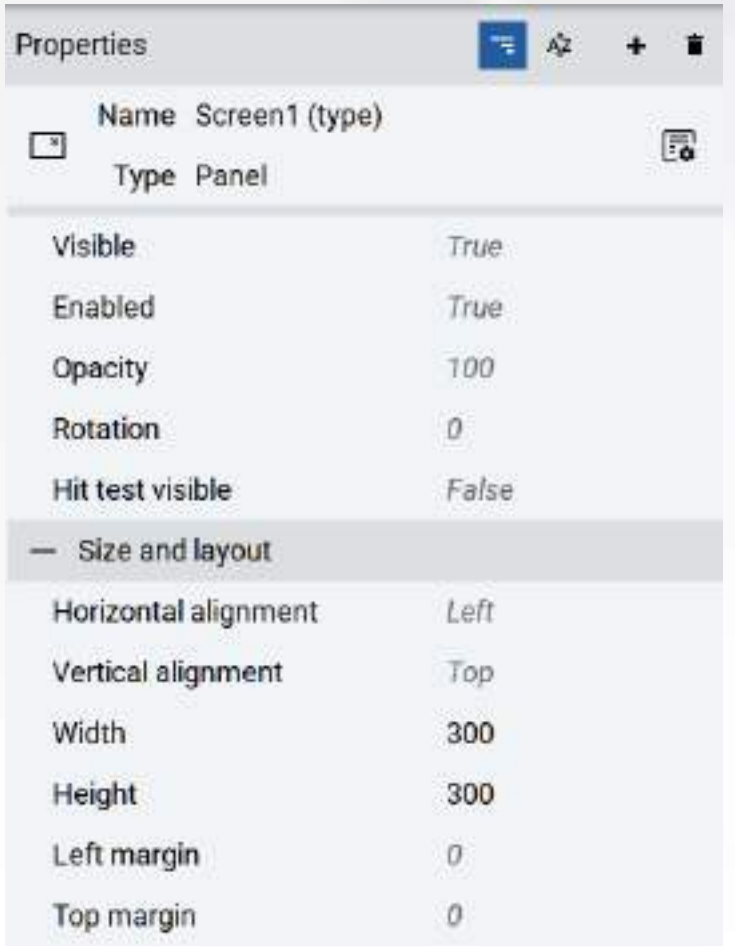

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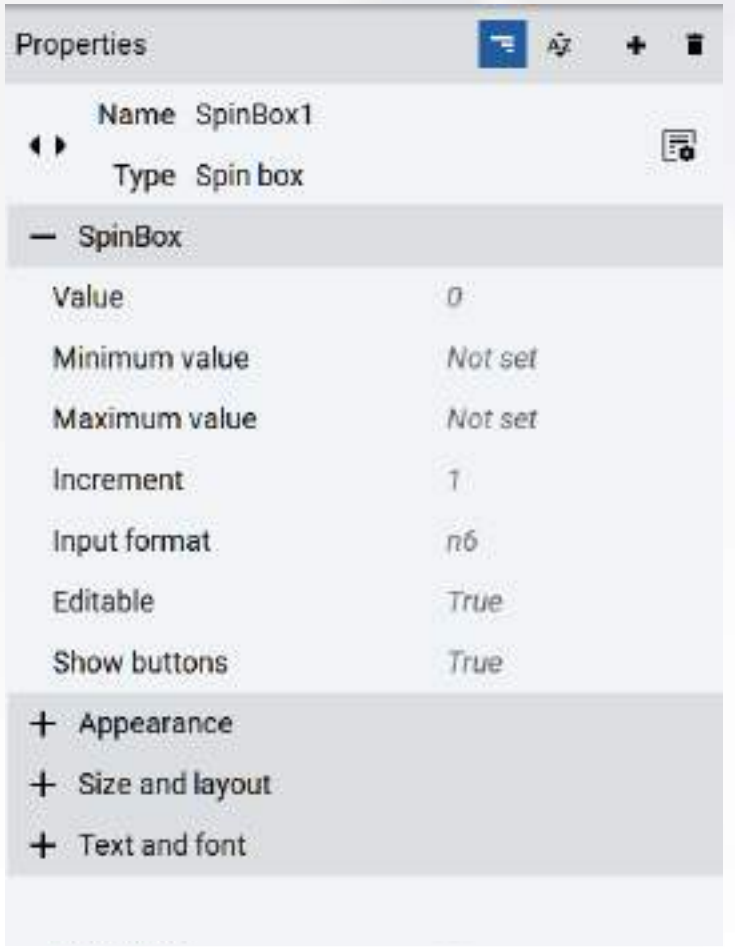
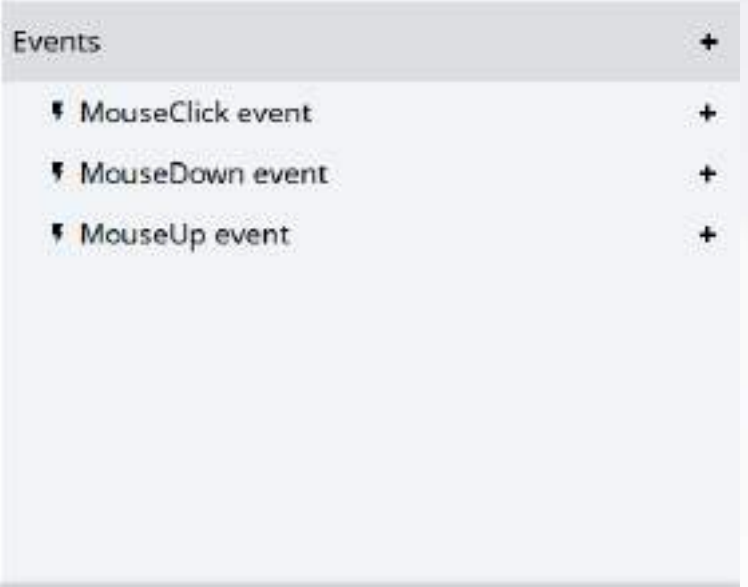
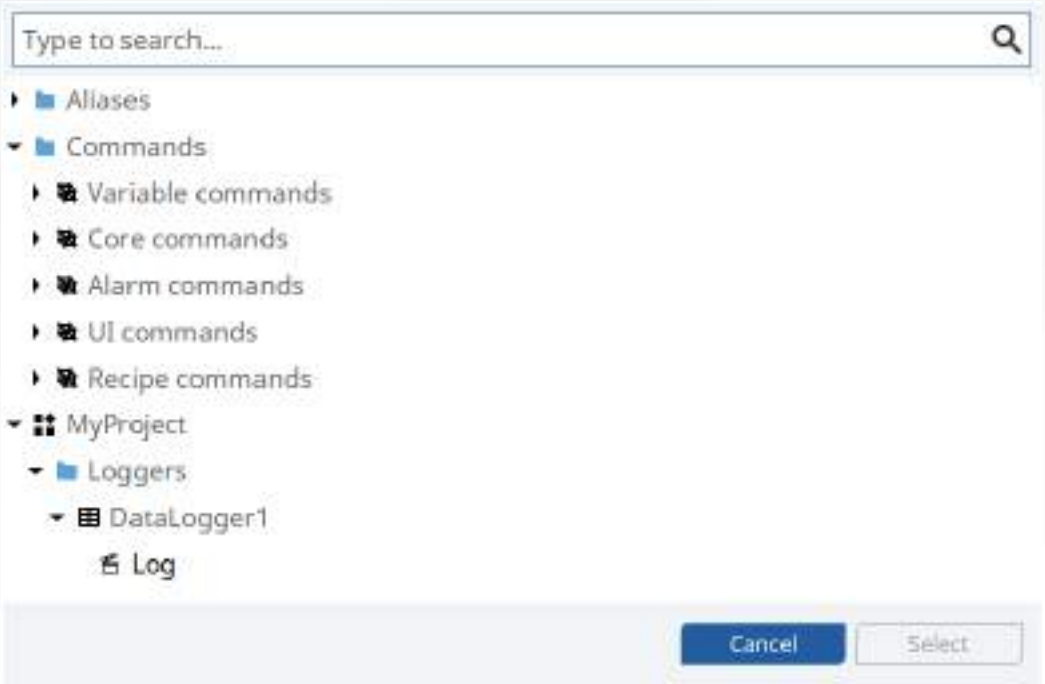


Events panel

- Used to configure Commands or Methods to be executed when events are triggered by the selected object
- Different objects have different events

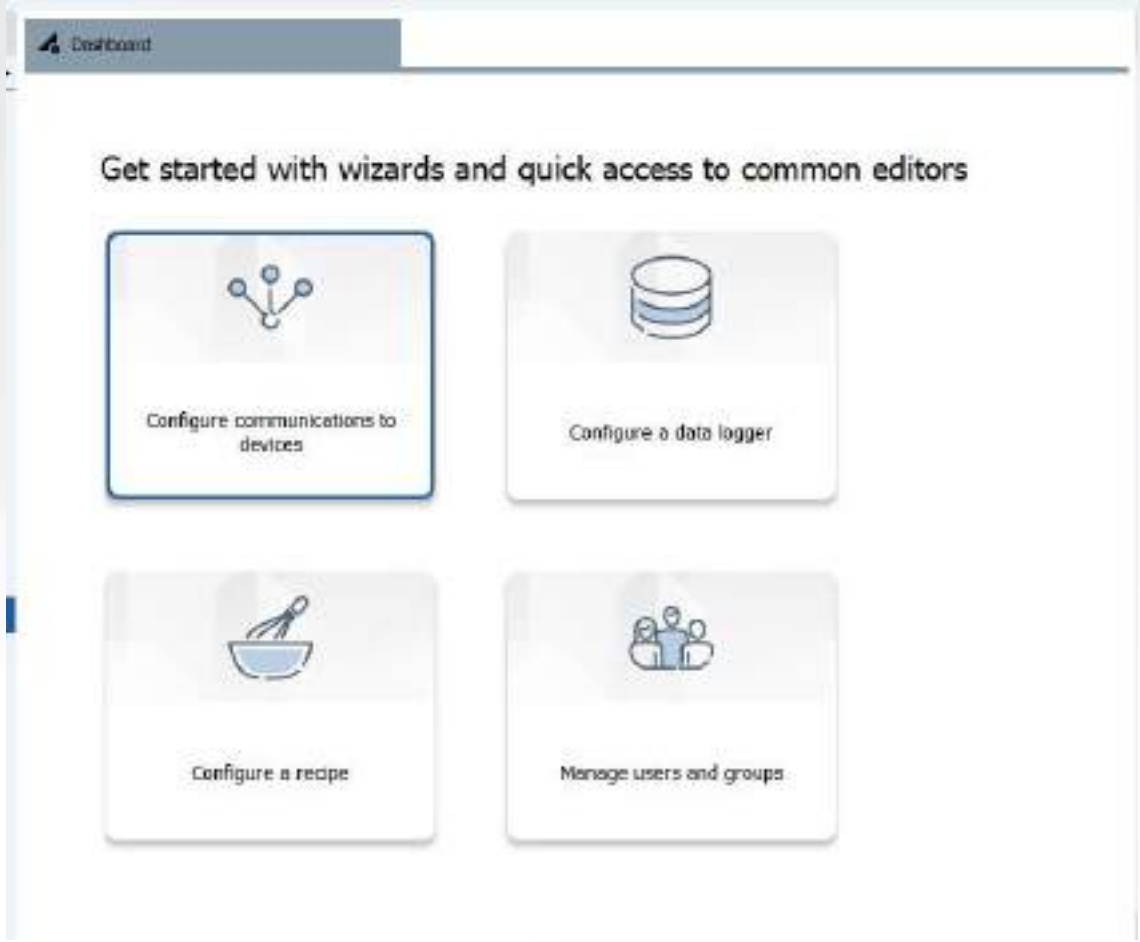




How to create a simple HMI project in few steps

Create a simple HMI project in few steps

1. Configure connected device



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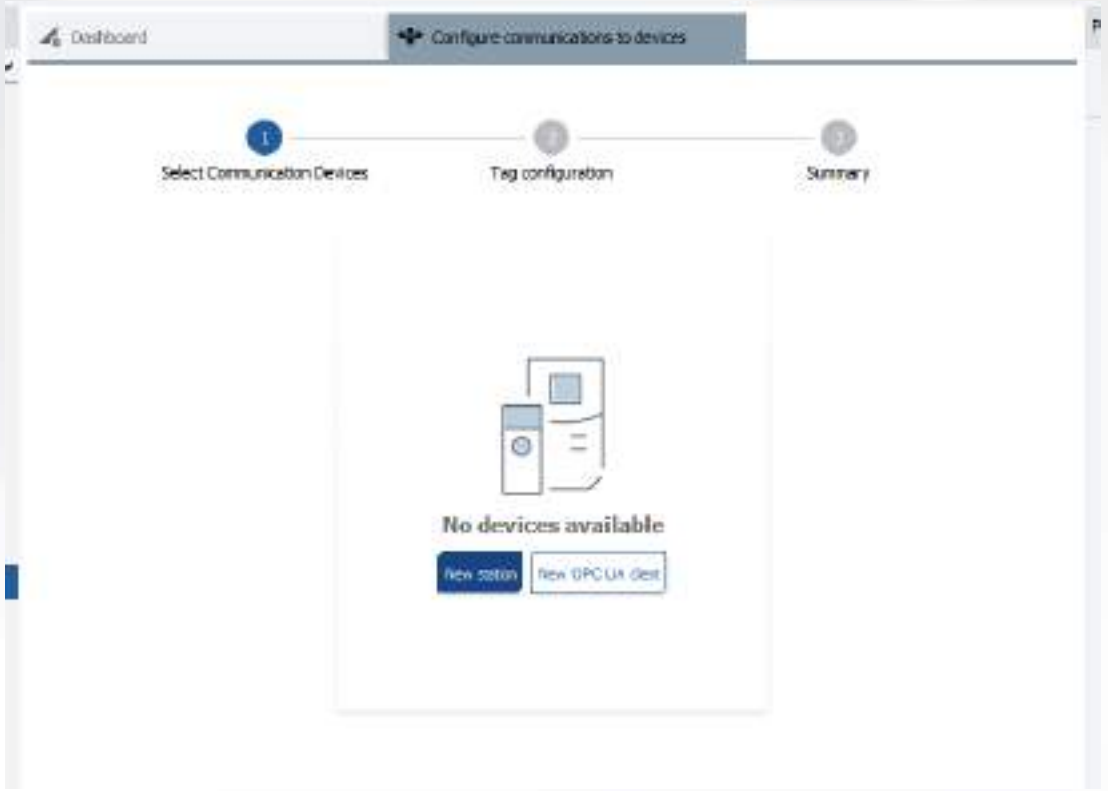

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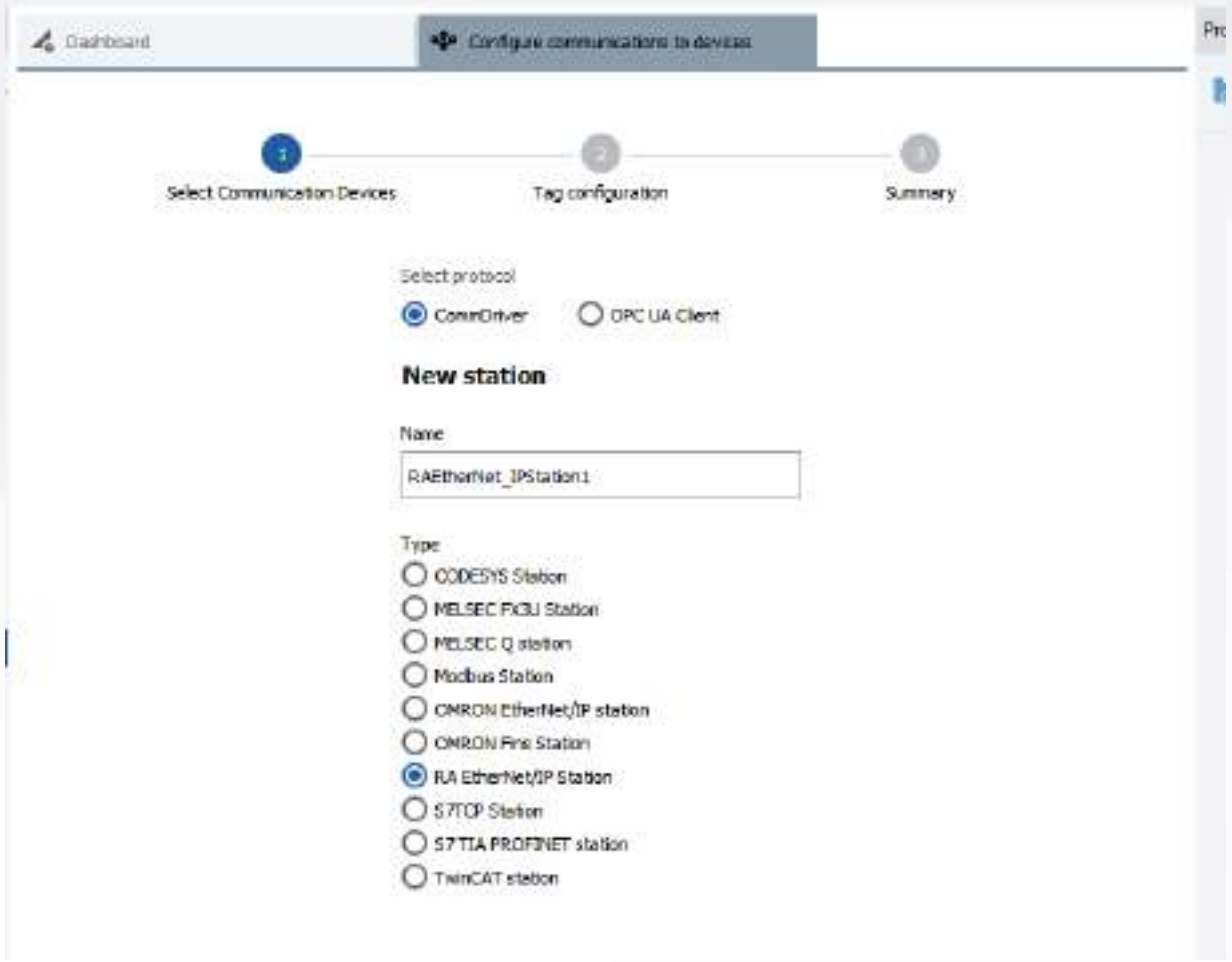

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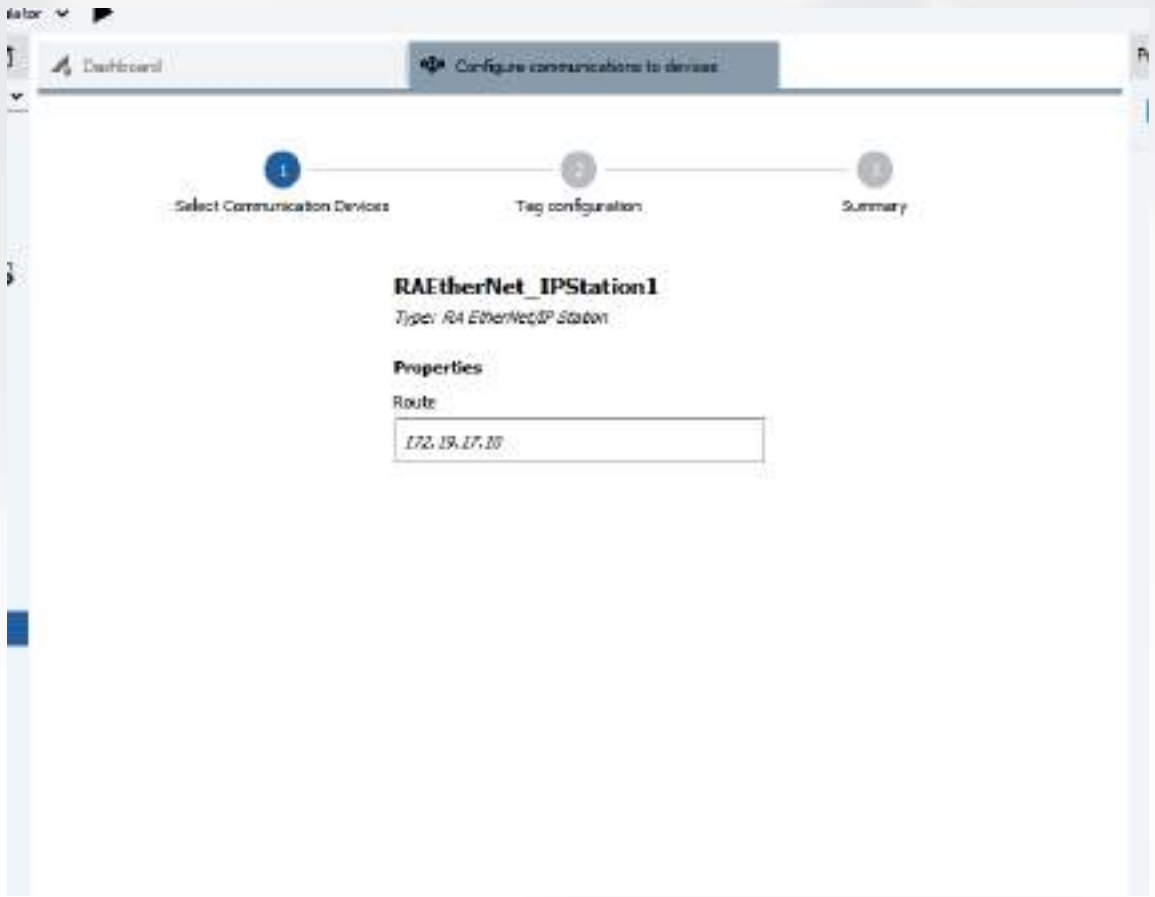

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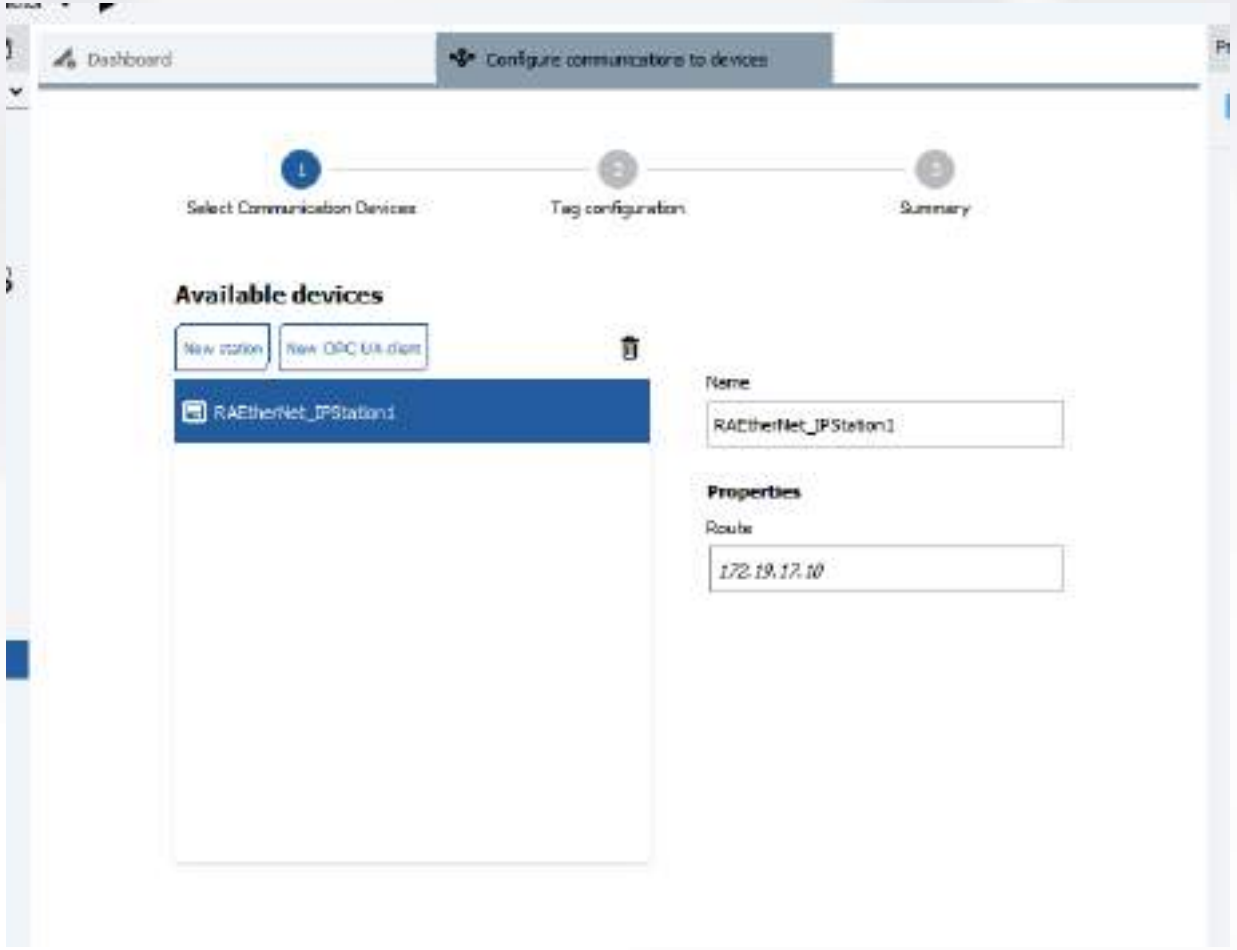

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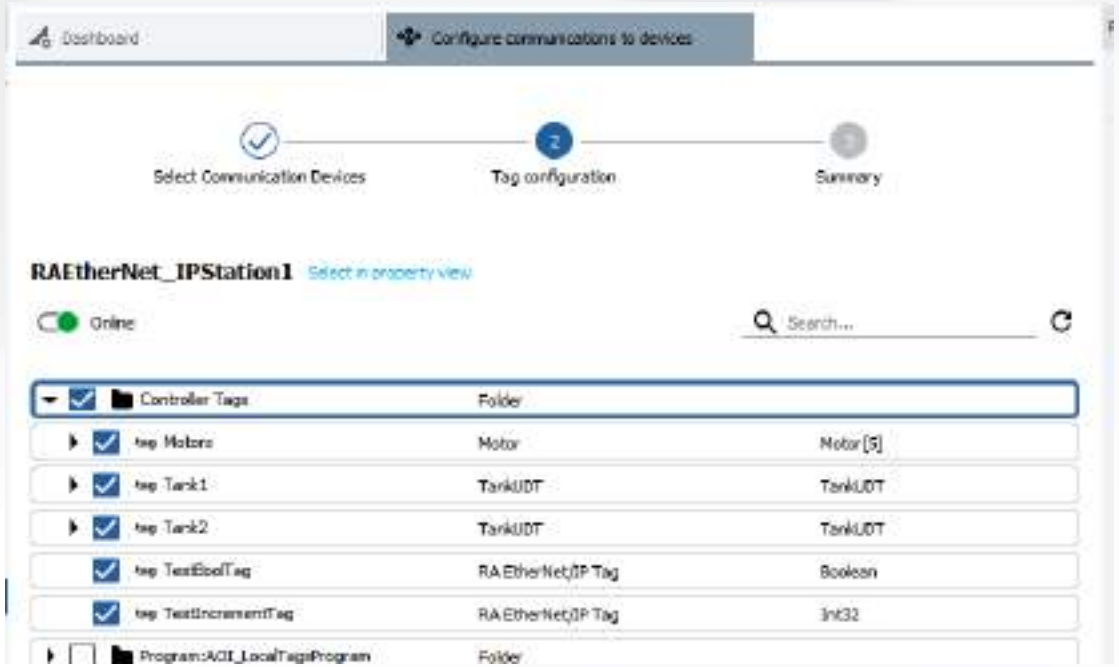
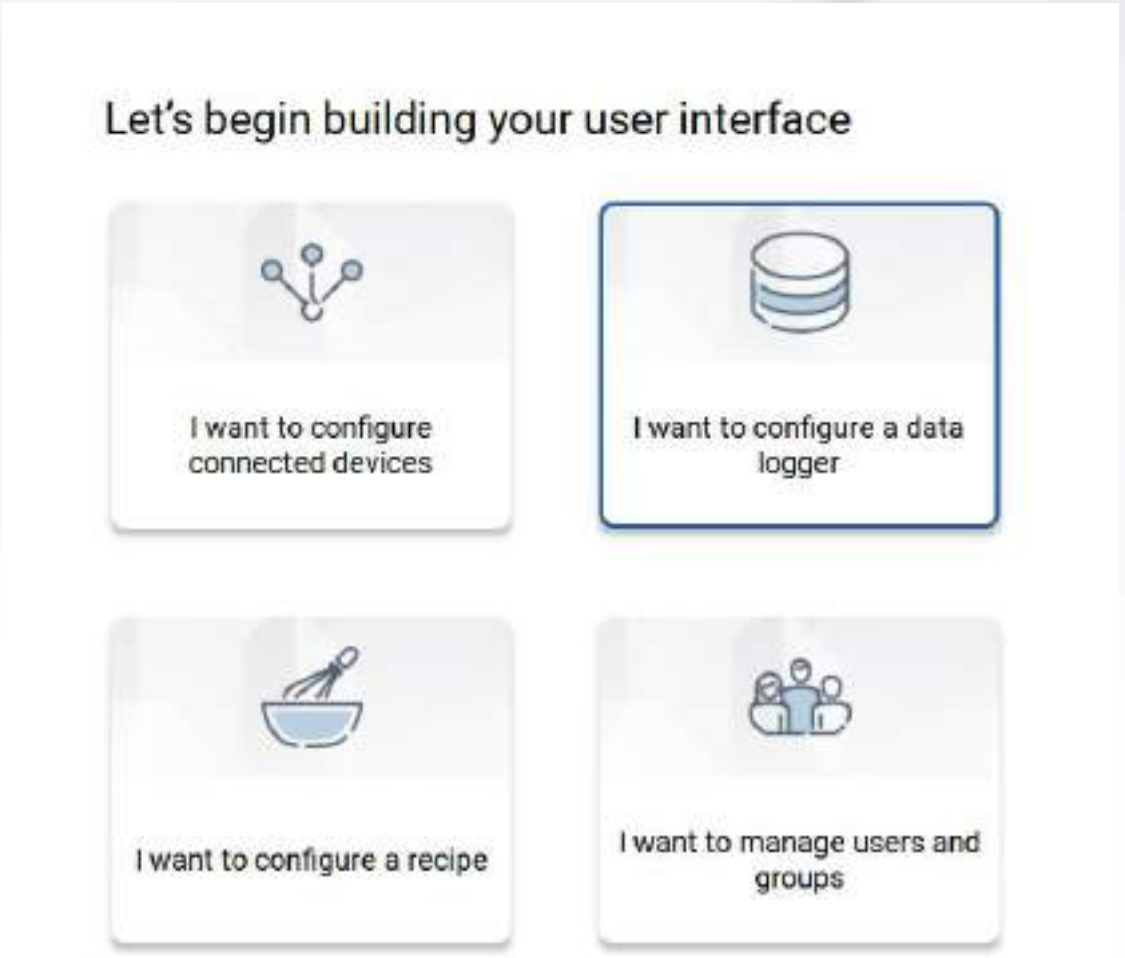


Create a simple HMI project in few steps

1. Configure connected device

Create a simple HMI project in few steps

2. Configure a datalogger



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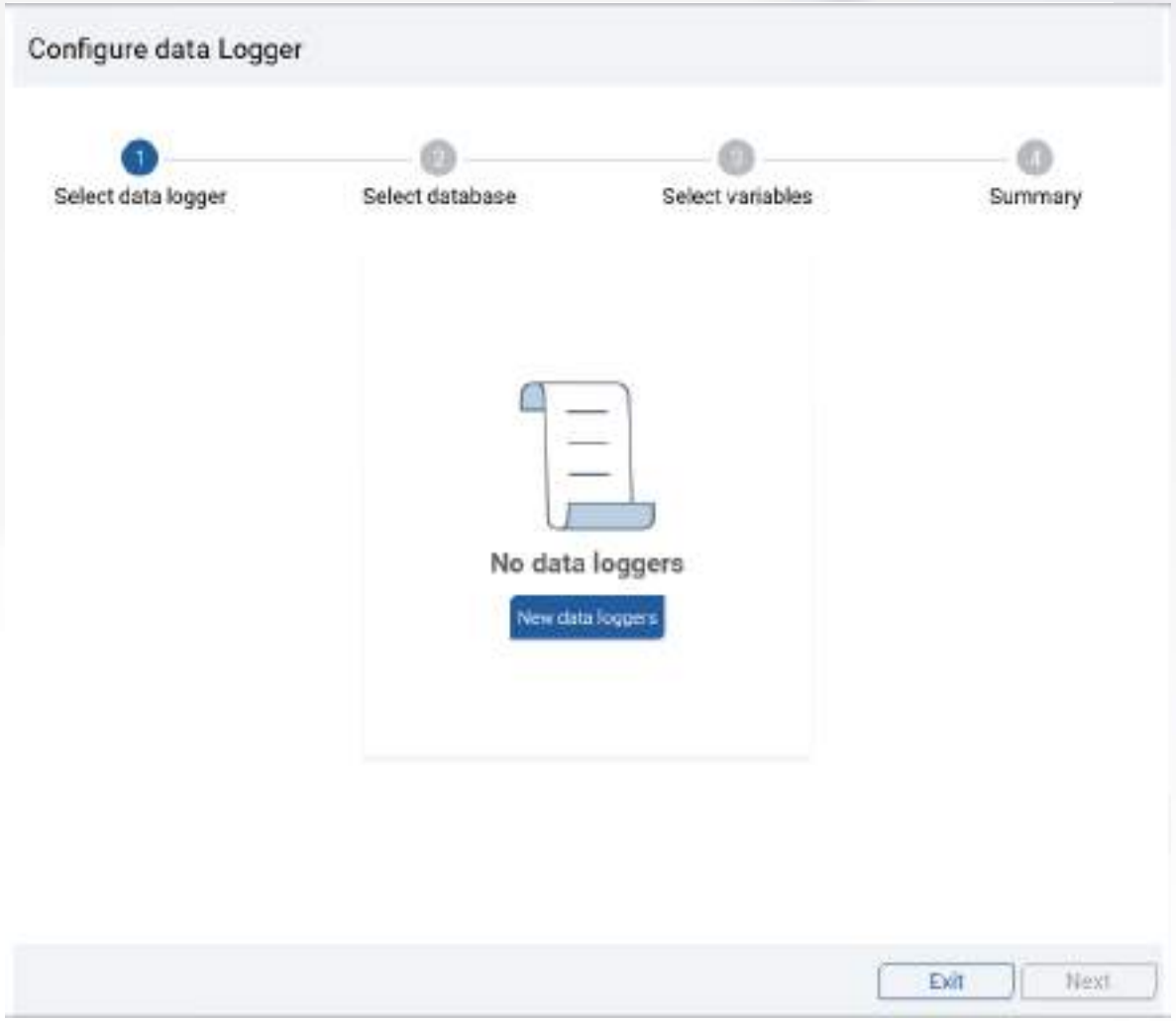

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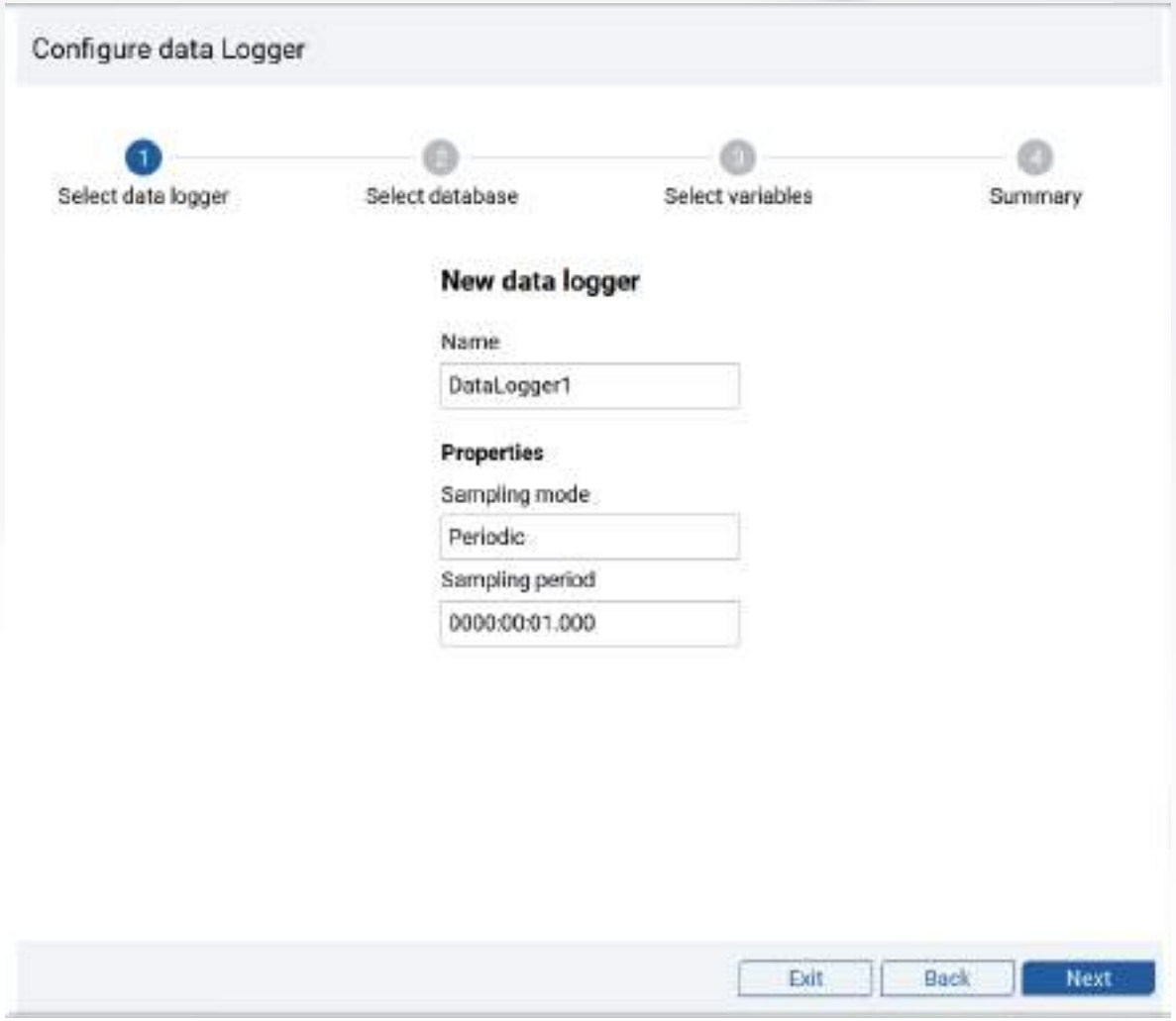

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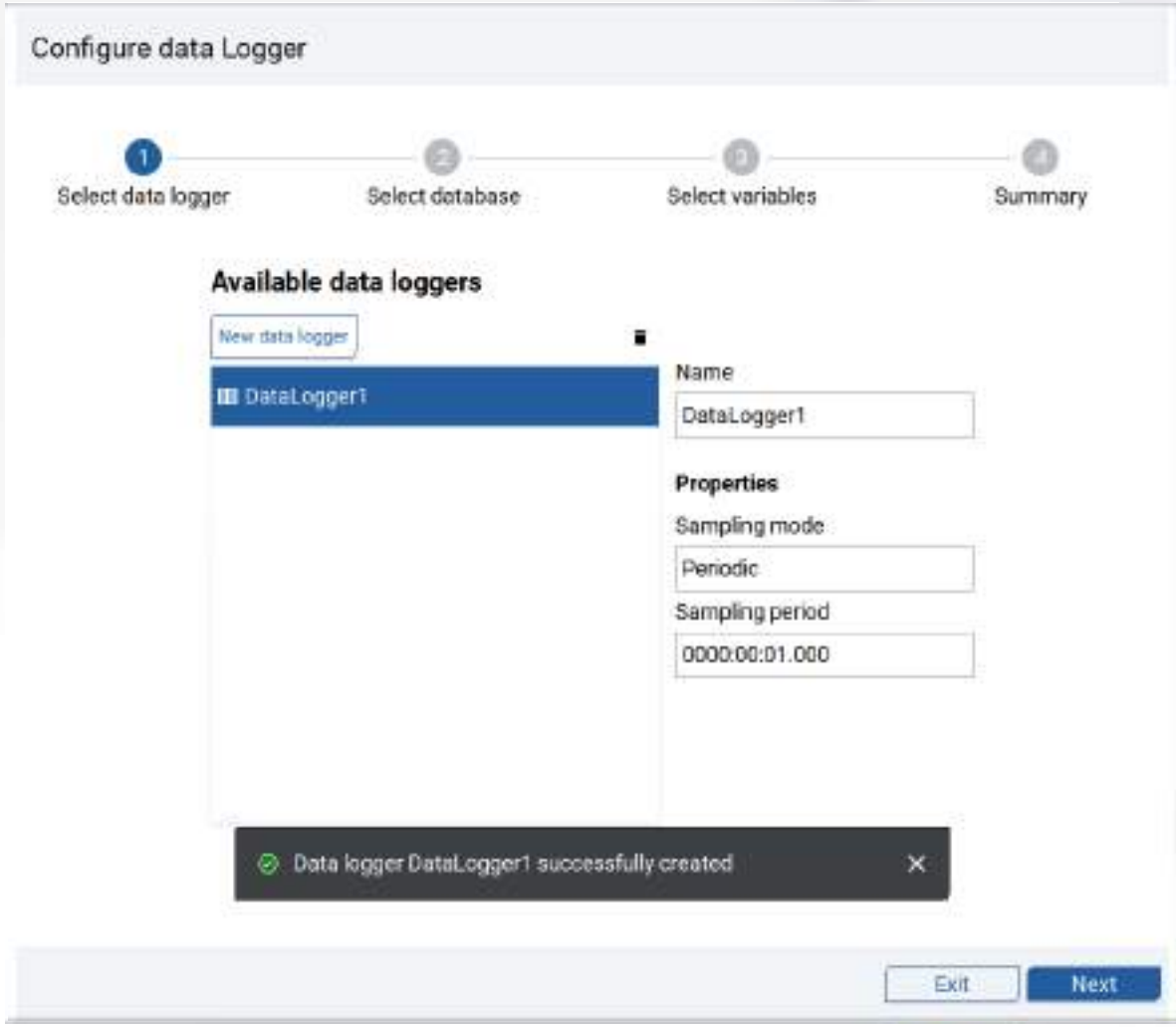

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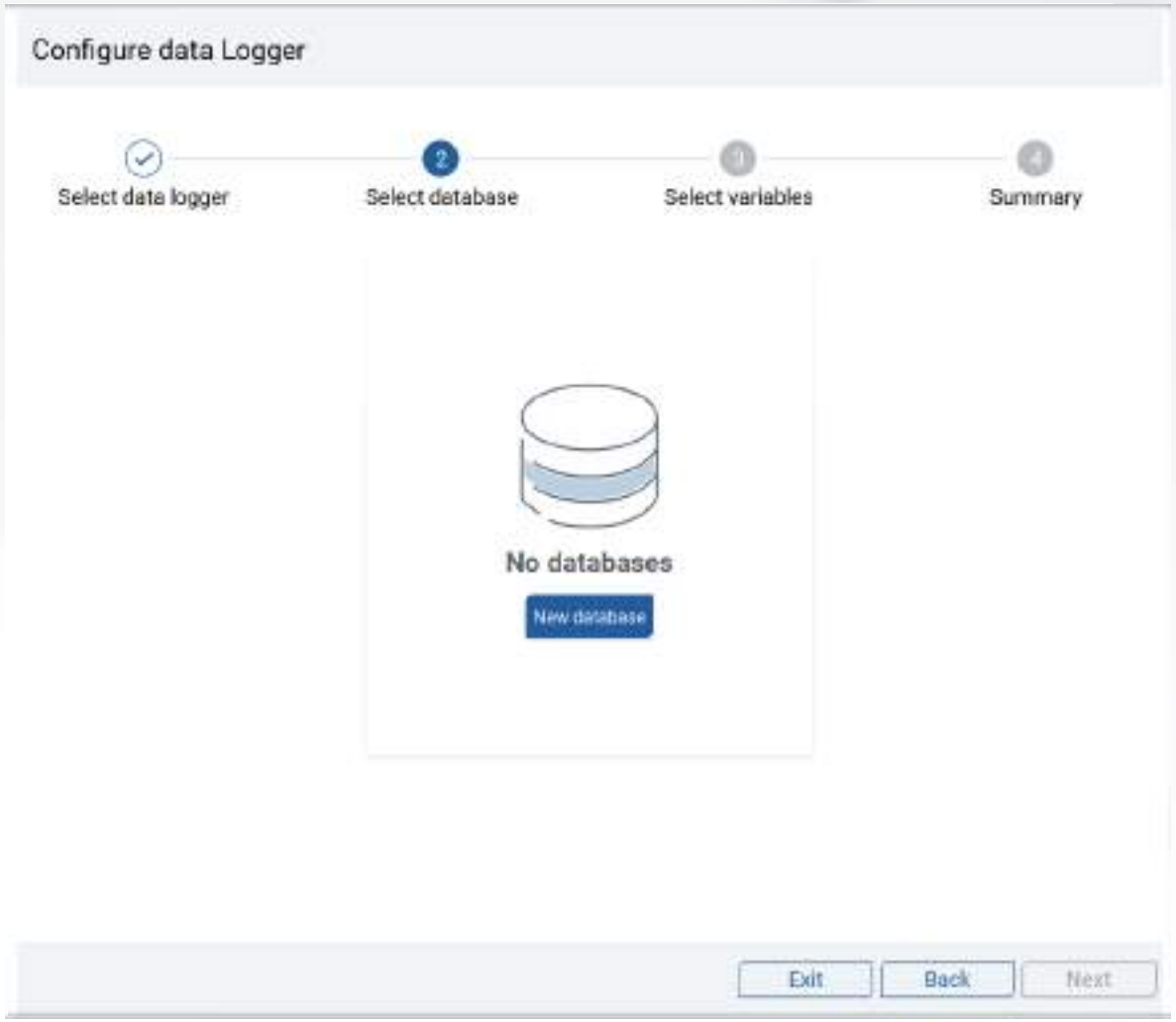

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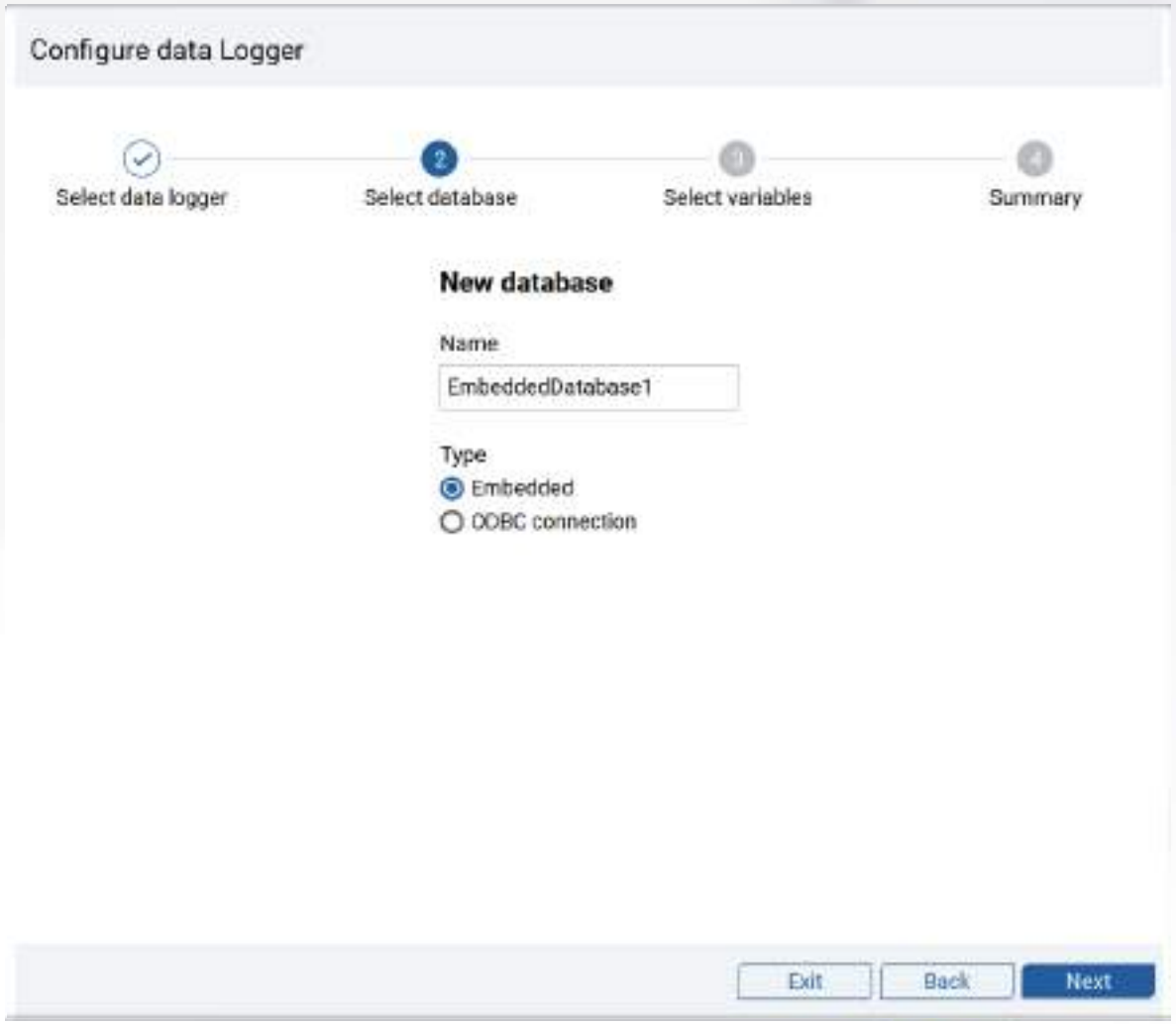
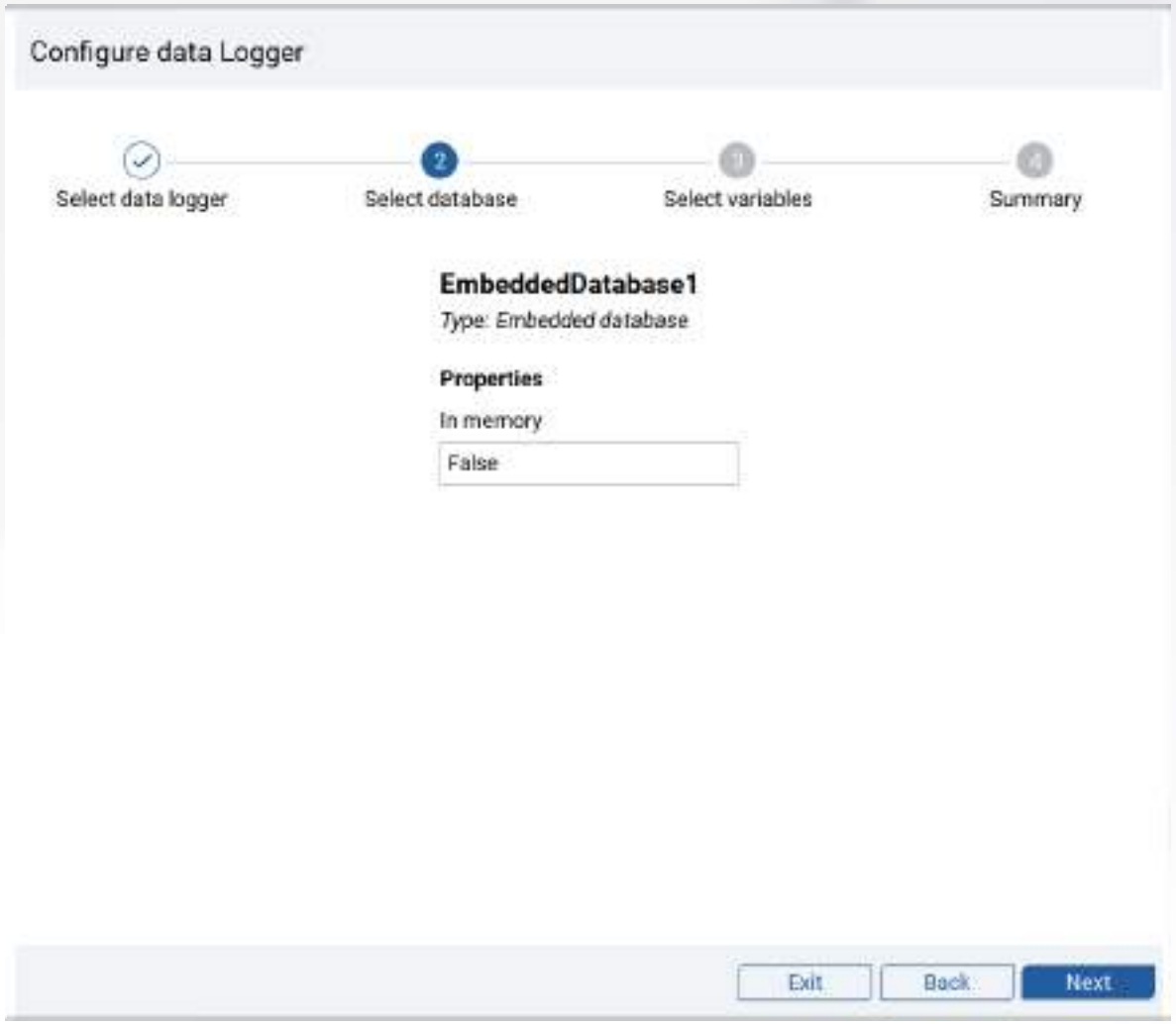


Create a simple HMI project in few steps

2. Configure a datalogger
   - In memory: data are put in RAM, content of the DB is lost if the application is restarted



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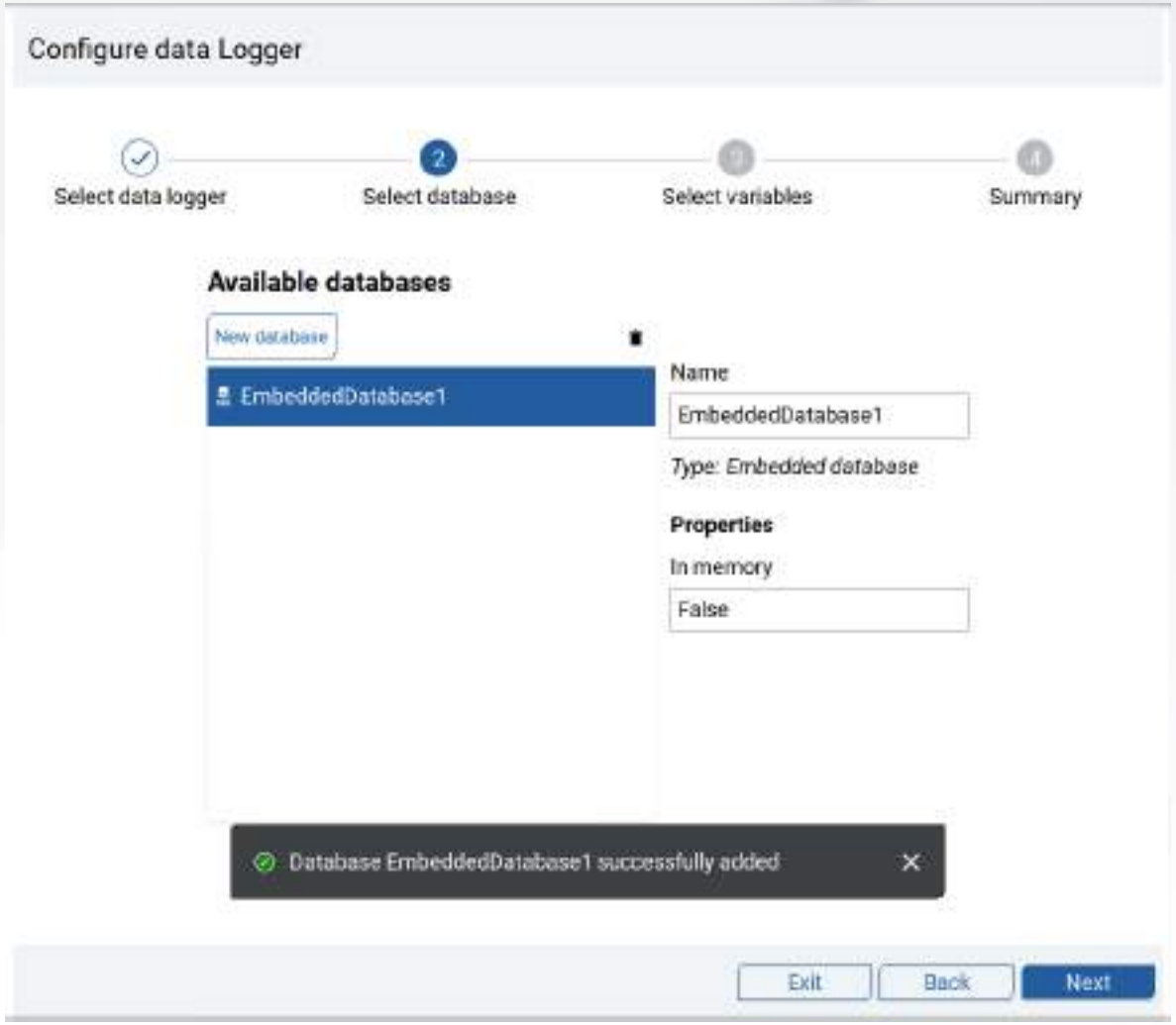

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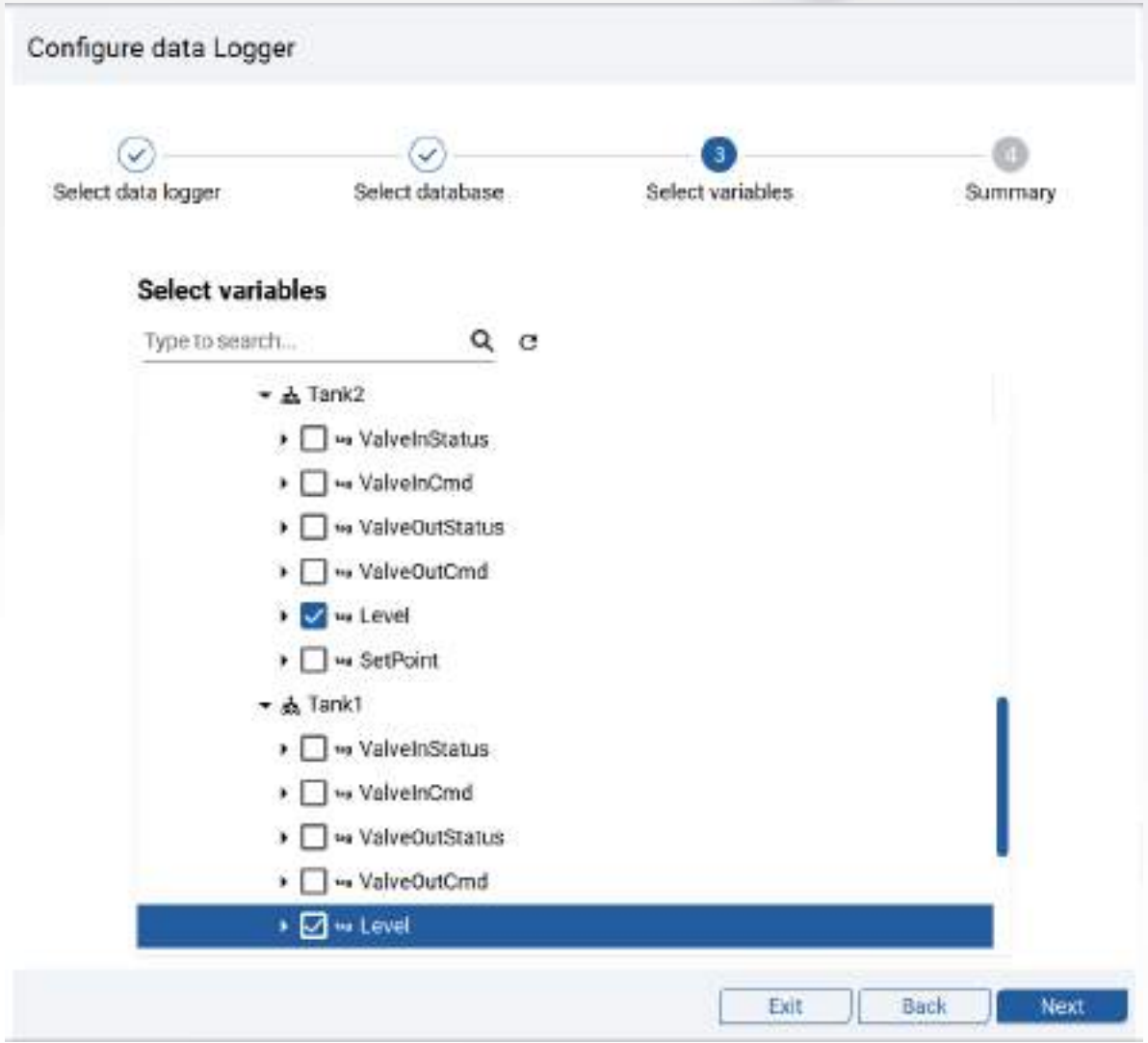

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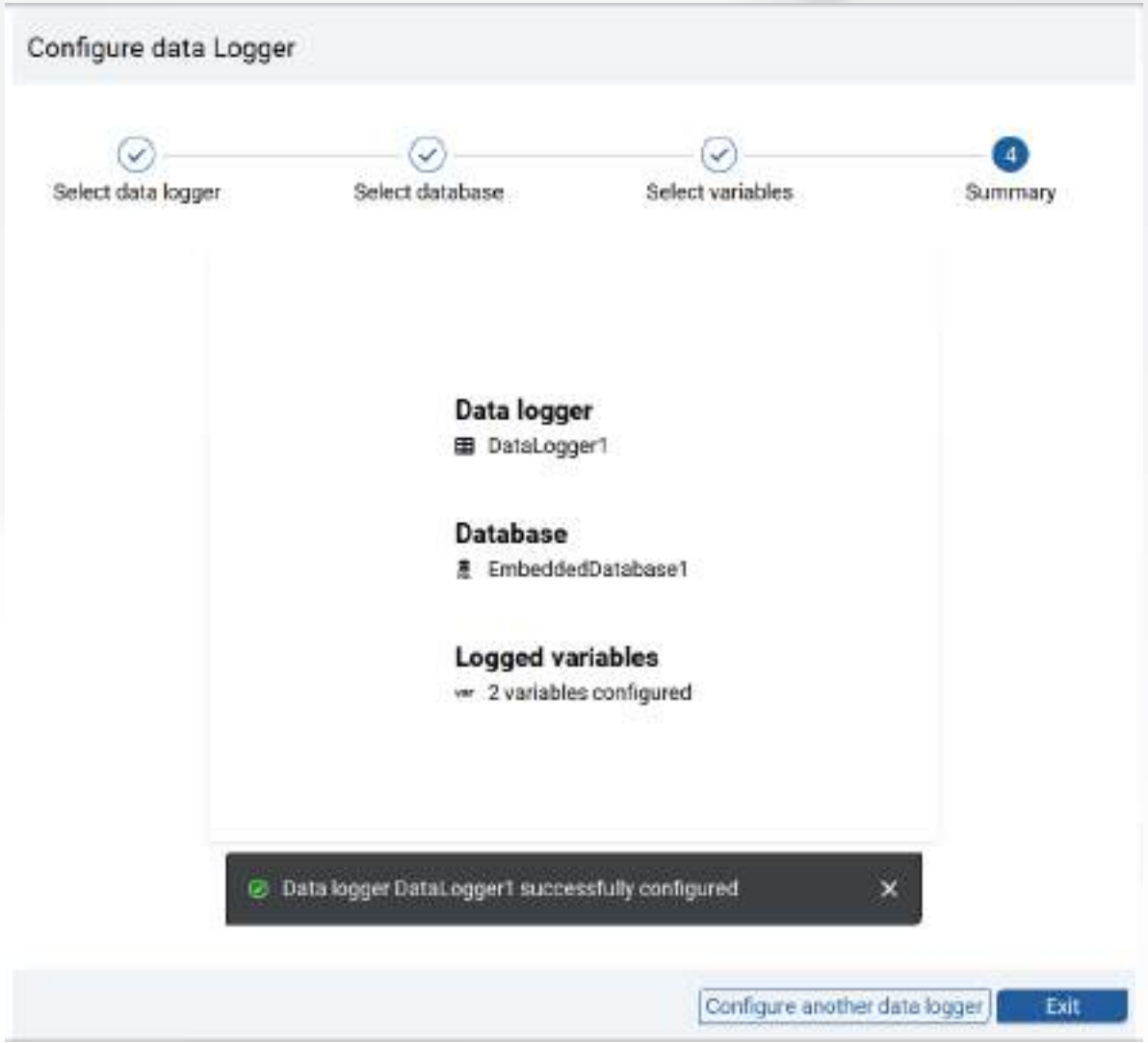
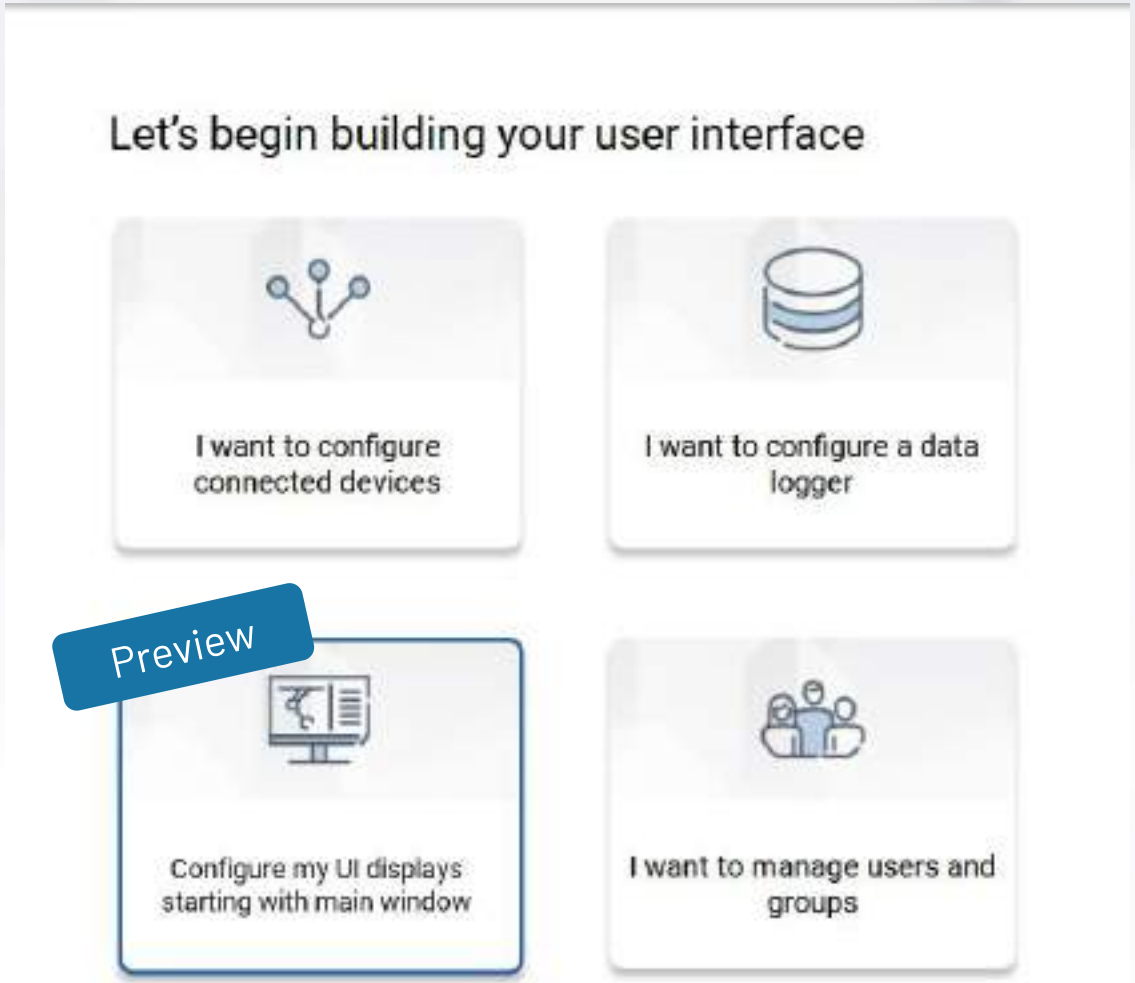


Create a simple HMI project in few steps

3. Configure the user interface



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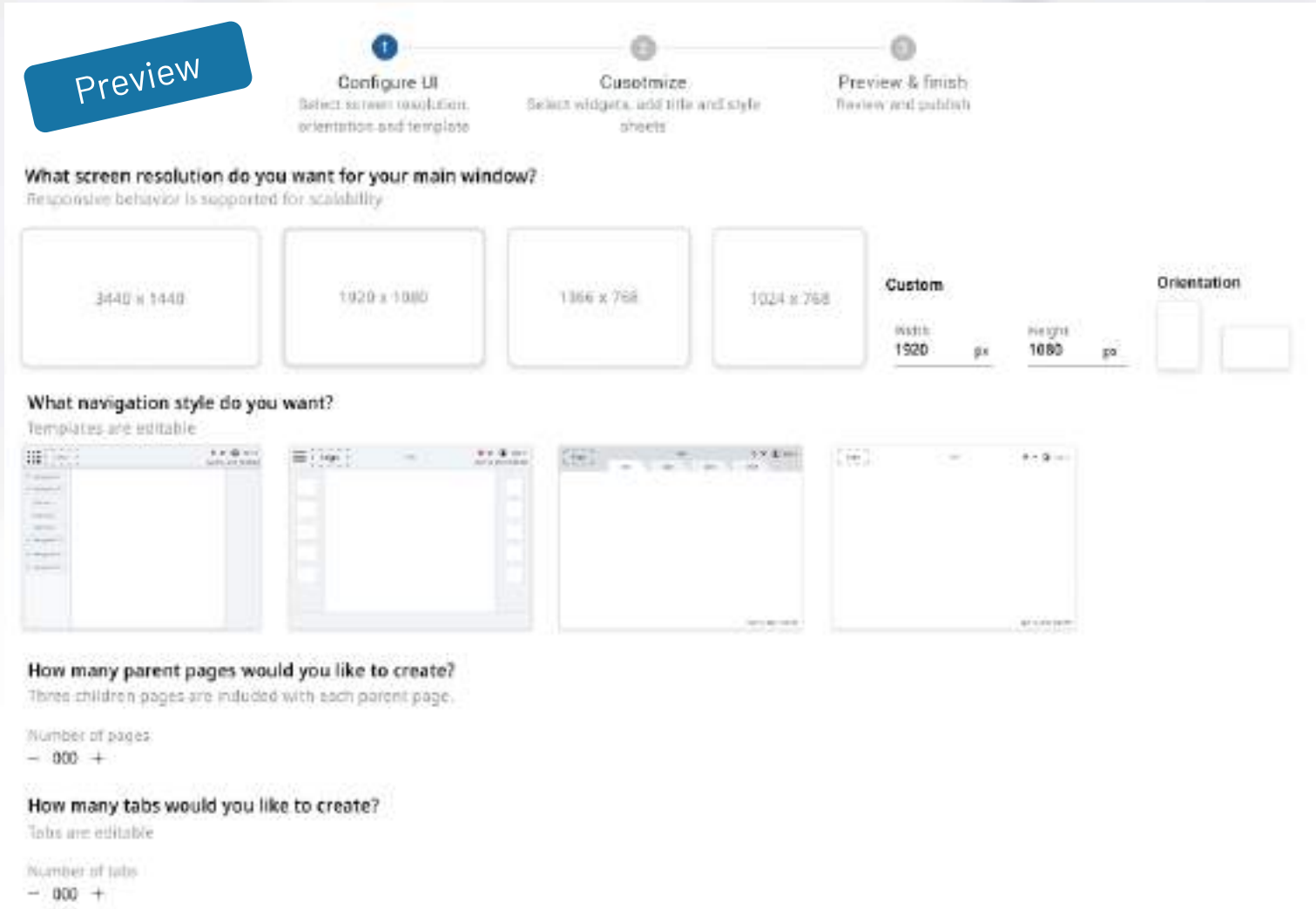

Web IDE

Web IDE using FactoryTalk Hub

- Sign in to FactoryTalk Hub
- Click on the FactoryTalk Optix tile
- Select which build to launch on Web IDE or continue with the last used version

Web IDE using FactoryTalk Hub

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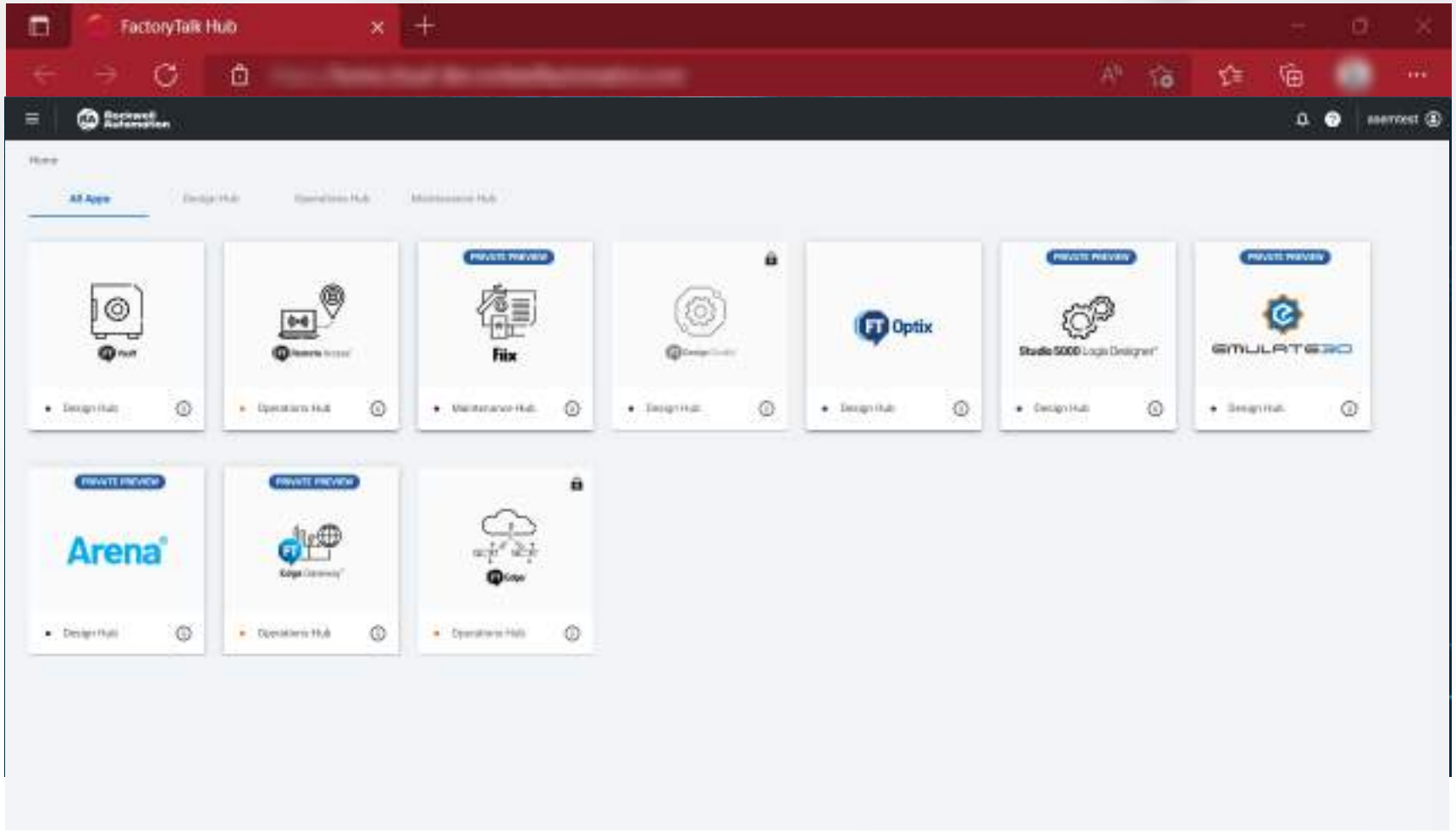

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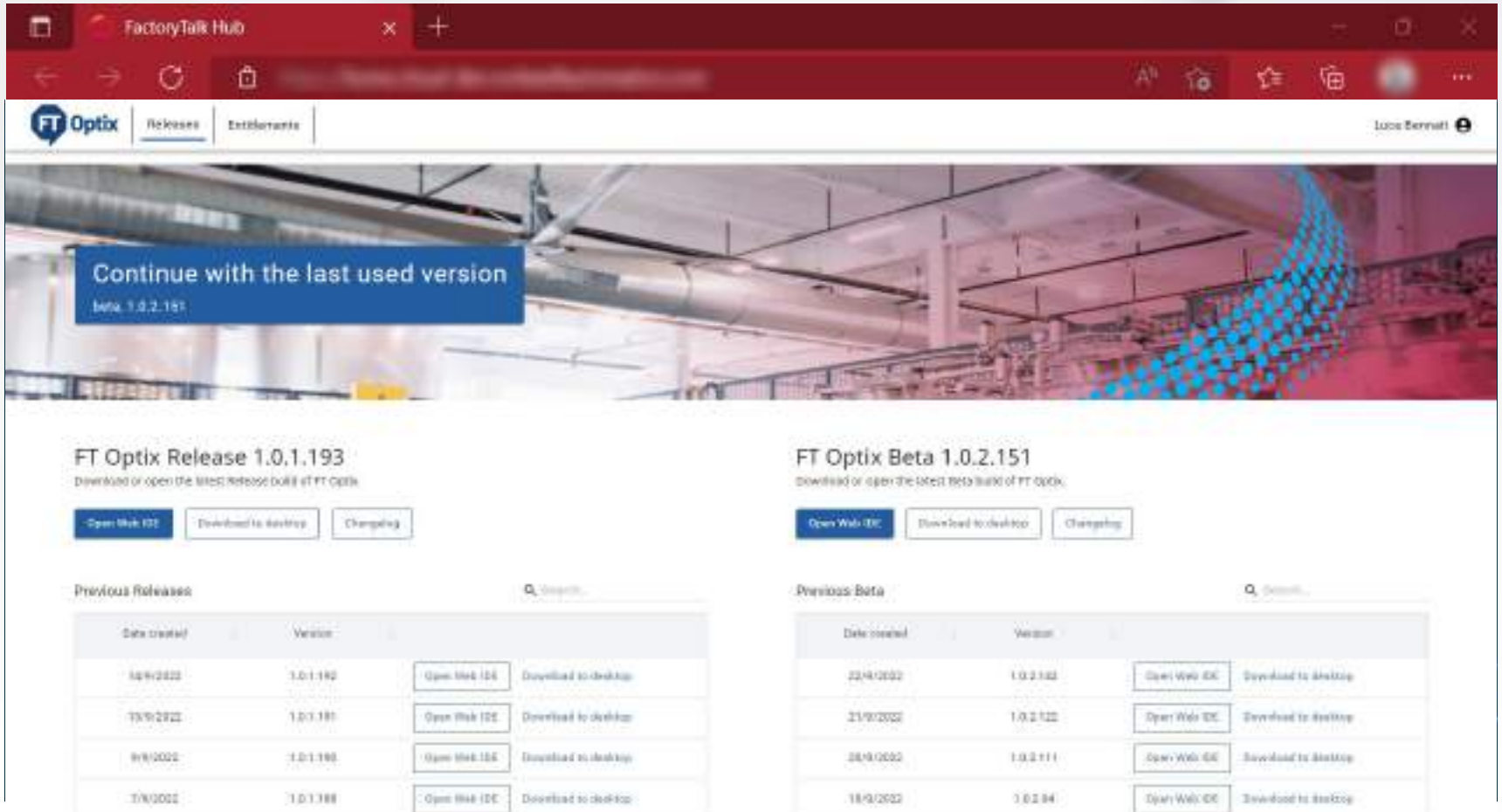

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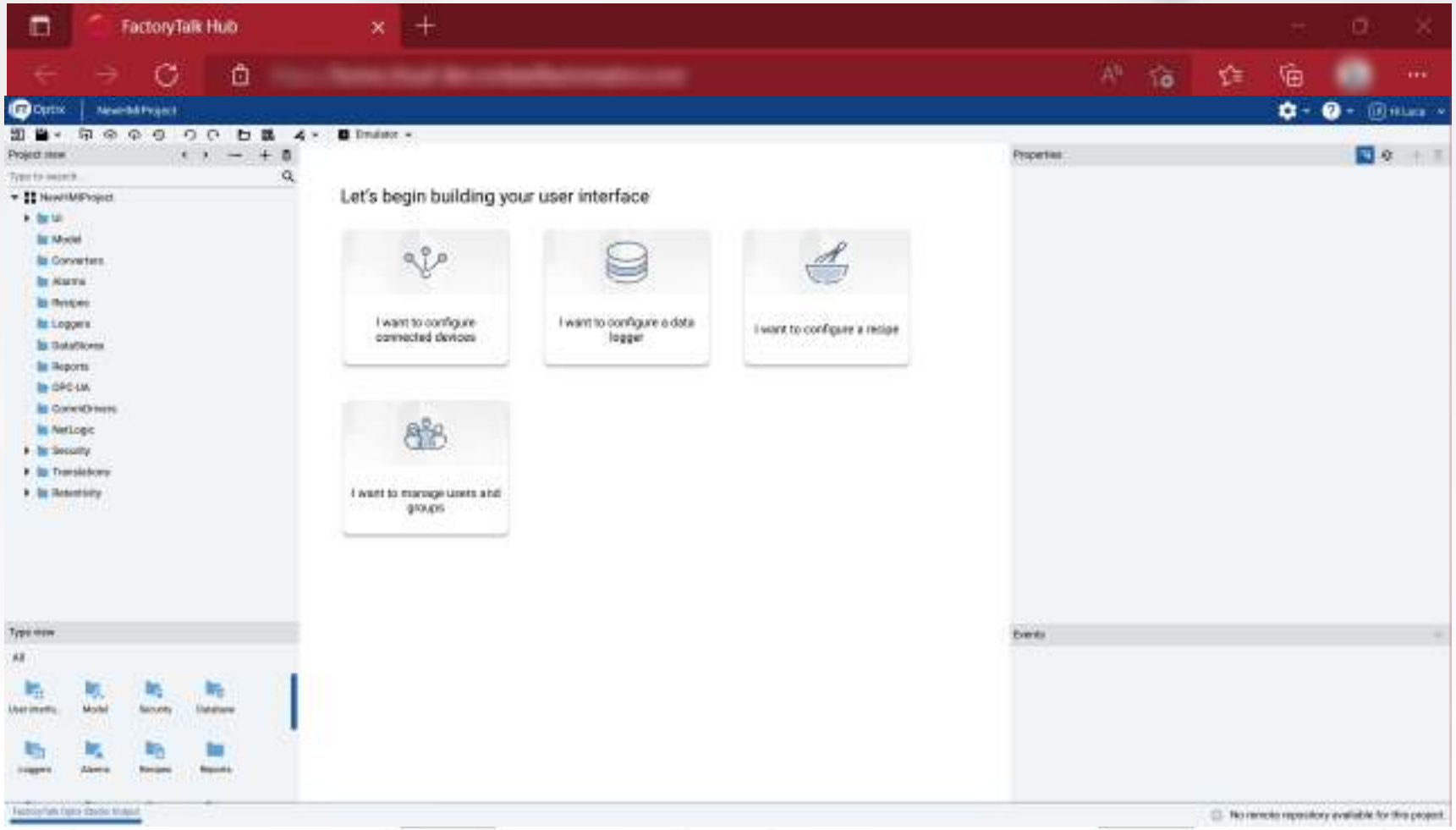


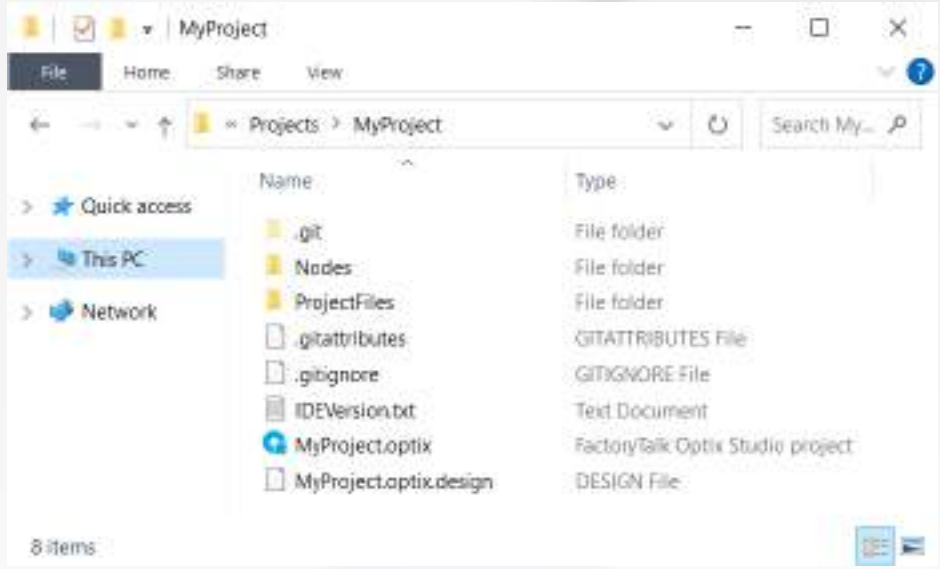
Project versions and components

Project compatibility and backup

- **Upgrade**:
  - Projects created with an old version of Studio **can be opened with later versions**
  - Studio automatically updates the project and all its modules to the current version
- **Downgrade**:
  - Projects created with newer versions of Studio **cannot be opened with older versions**
- **Backups**: `%localappdata%\Rockwell Automation\FactoryTalk Optix\FTOptixStudio\Backups\`
  - *Automatic*: contain the last three backups, performed when saving the project
  - *Upgrade*: performed when updating the project to make it compatible with a newer version
  - *Recovery*: performed when a corrupt project is opened, and repair is attempted

Project structure

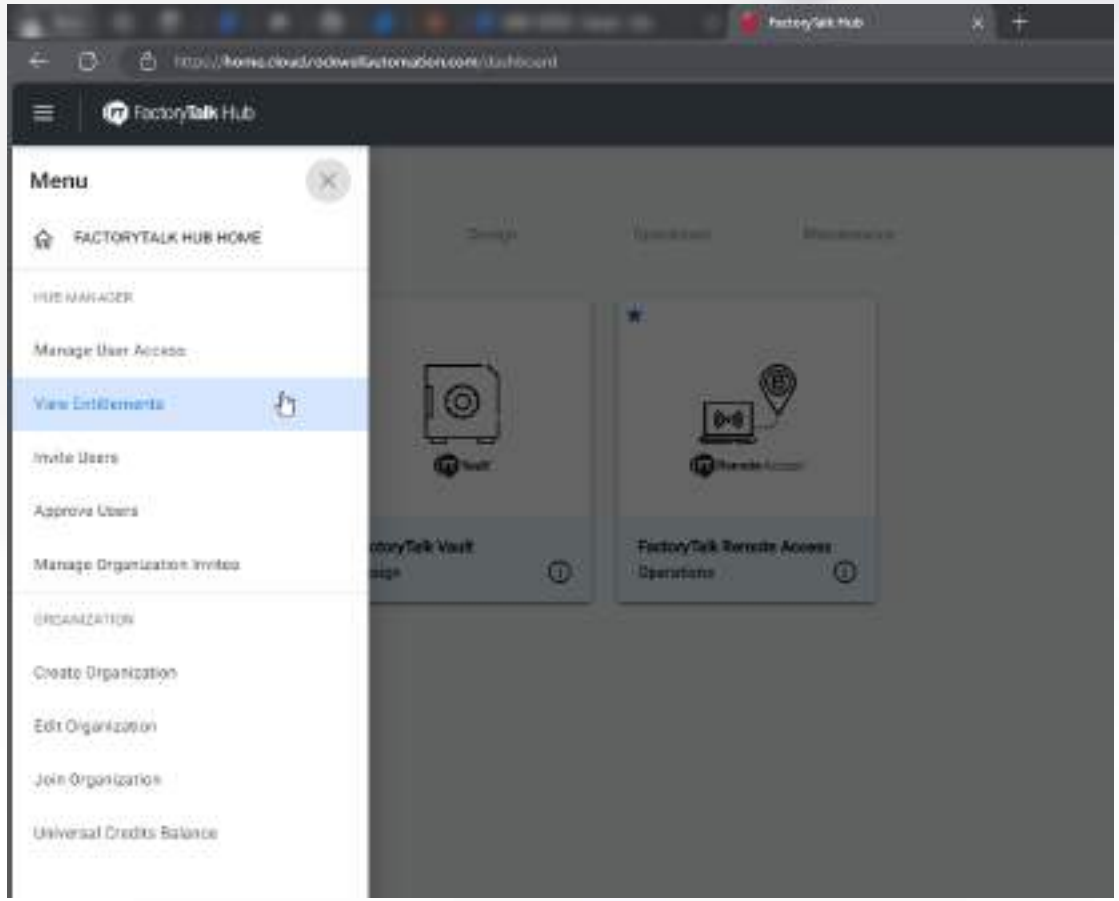
- Contents of the project folder
  - **.optix** file: information on the project's elements
  - **.optix.design** file: information on accessory elements only required at design time.
  - **Nodes** folder: contains a YAML file for each node that describes its related information model
  - **ProjectFiles** folder: containing all files used in the project, including images, fonts and documents.
    - NetSolution subfolder contains all files used to create customized C# scripts
    - PKI subfolder: Public Key Infrastructure folder, used to manage security certificates for OPC-UA



Factory Talk Optix Entitlements

FactoryTalk Optix Entitlements

- Licenses are called «Entitlements»
- Entitlements are assigned to the user that bought the license by accessing the «Entitlements» menu of FactoryTalk Hub
- Entitlements have to be assigned to a FactoryTalk Optix organization



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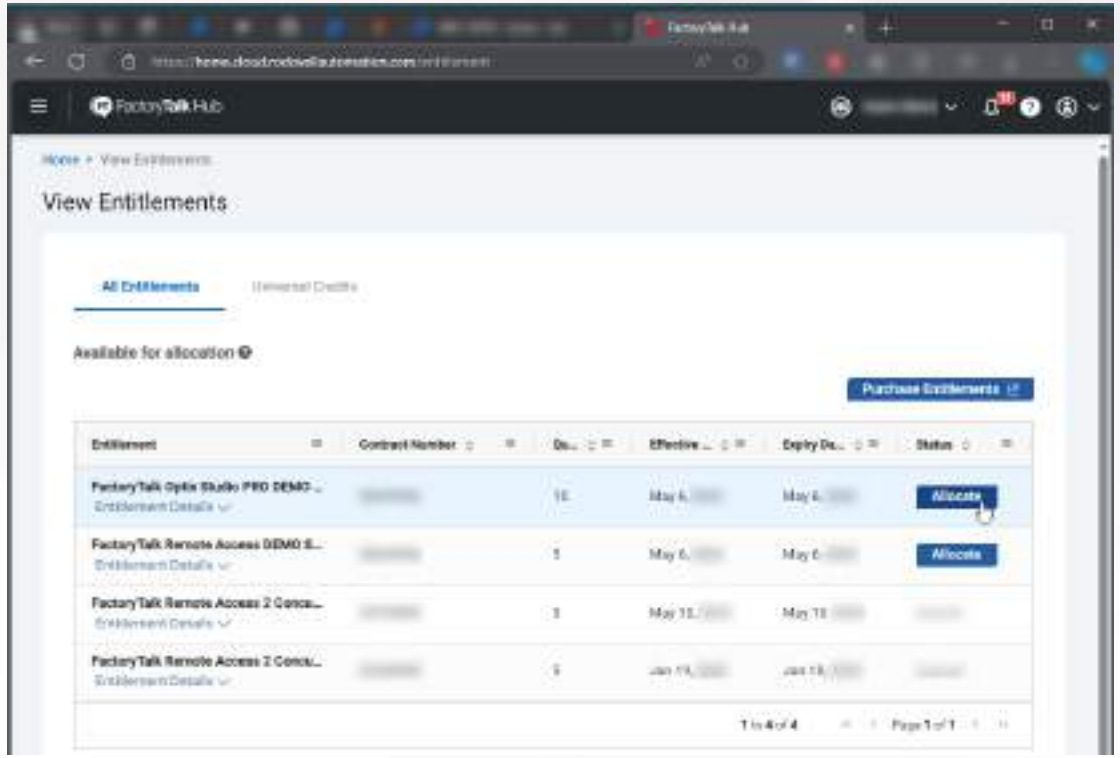

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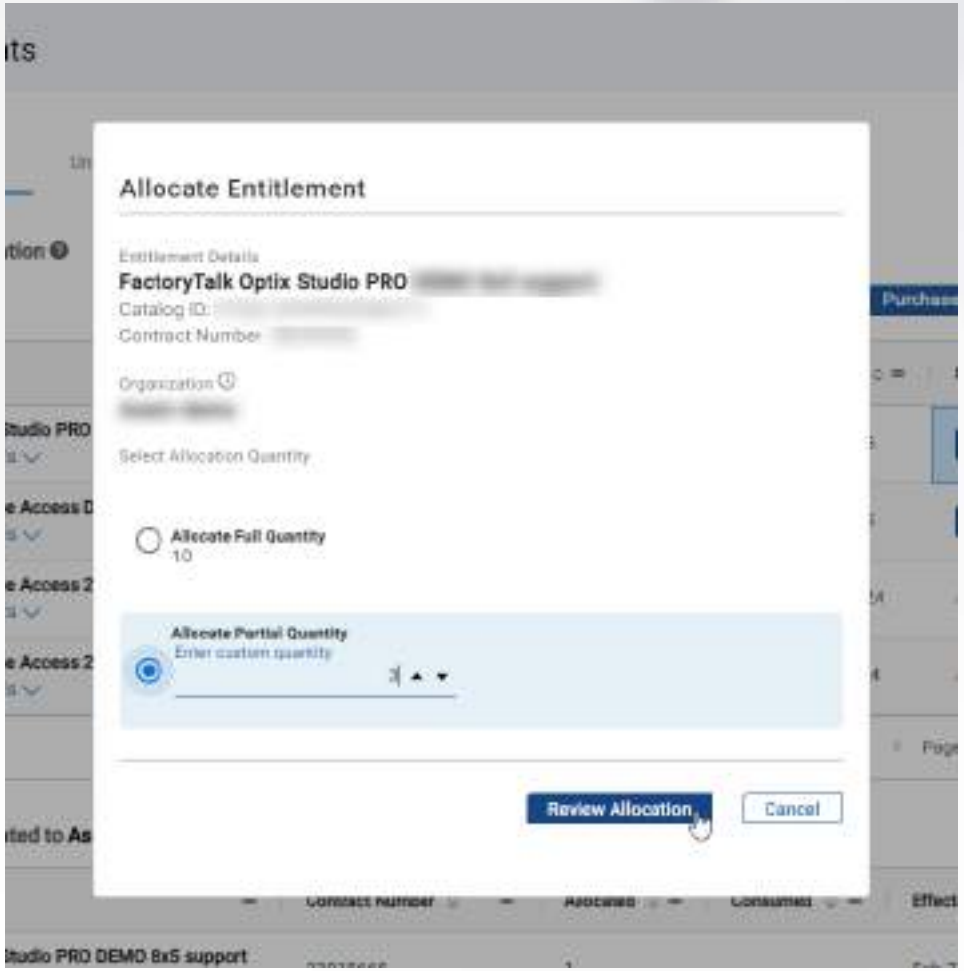

FactoryTalk Optix Studio Entitlements

- Users of an organization can self-assign any available Studio entitlement from FactoryTalk Optix web page
- Studio Entitlements can be released once they are not needed anymore and used by a different user in the same organization either from FactoryTalk Optix Studio or the web dashboard
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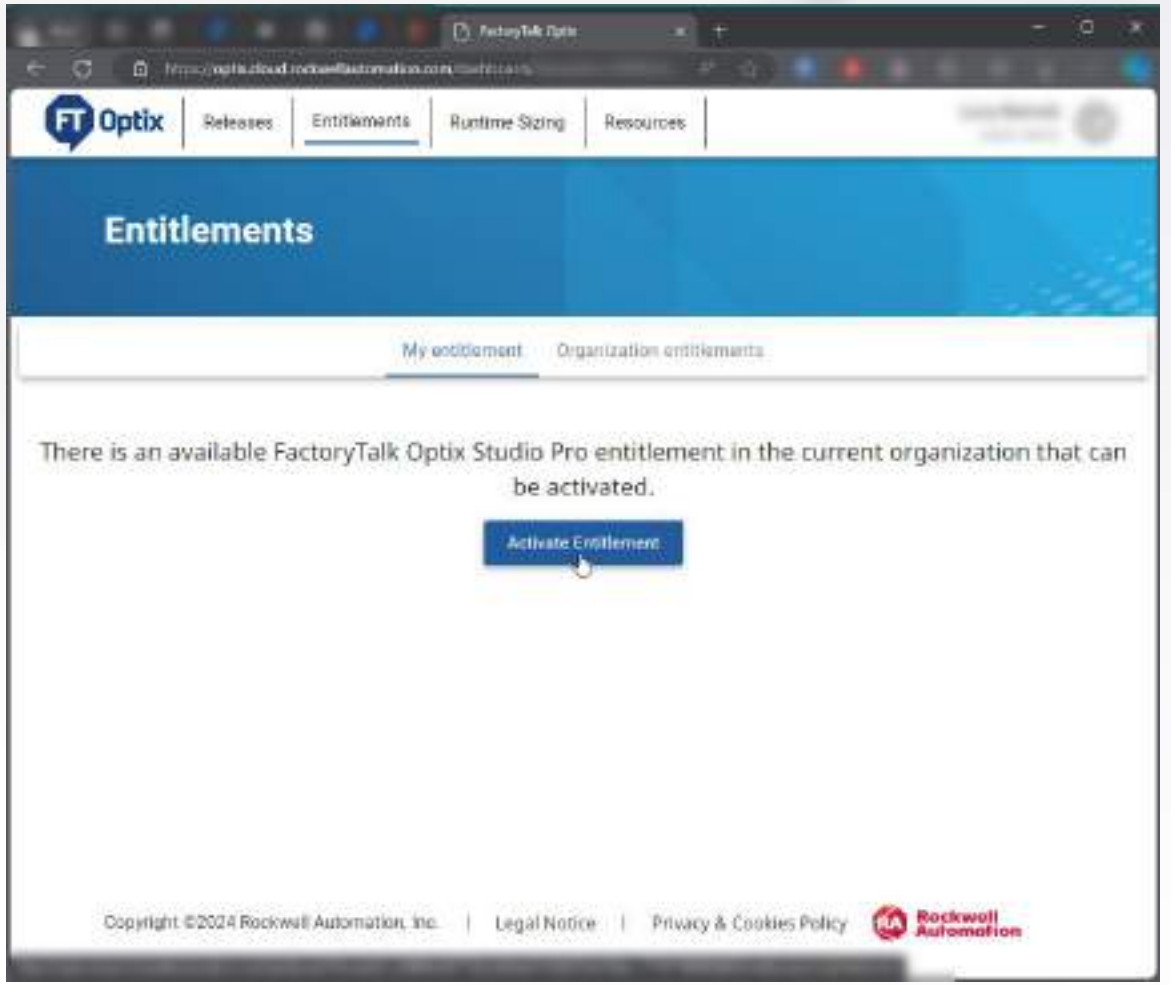

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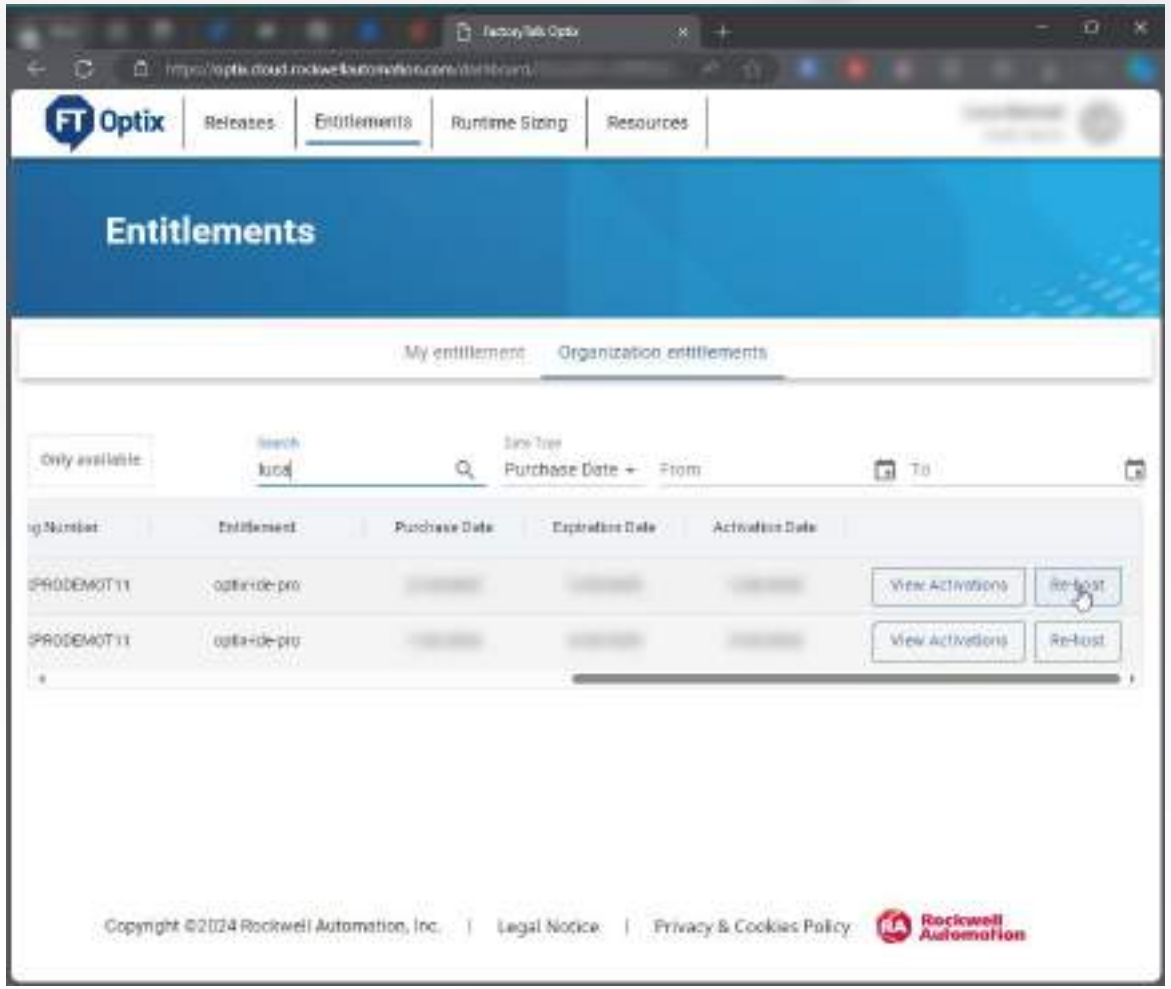

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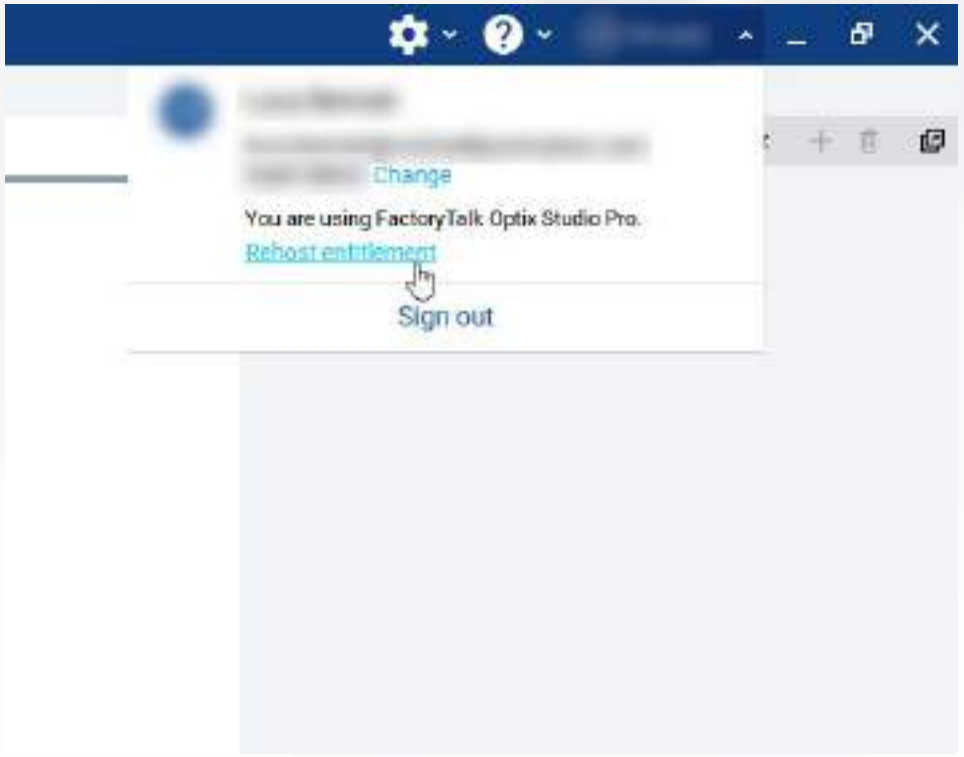
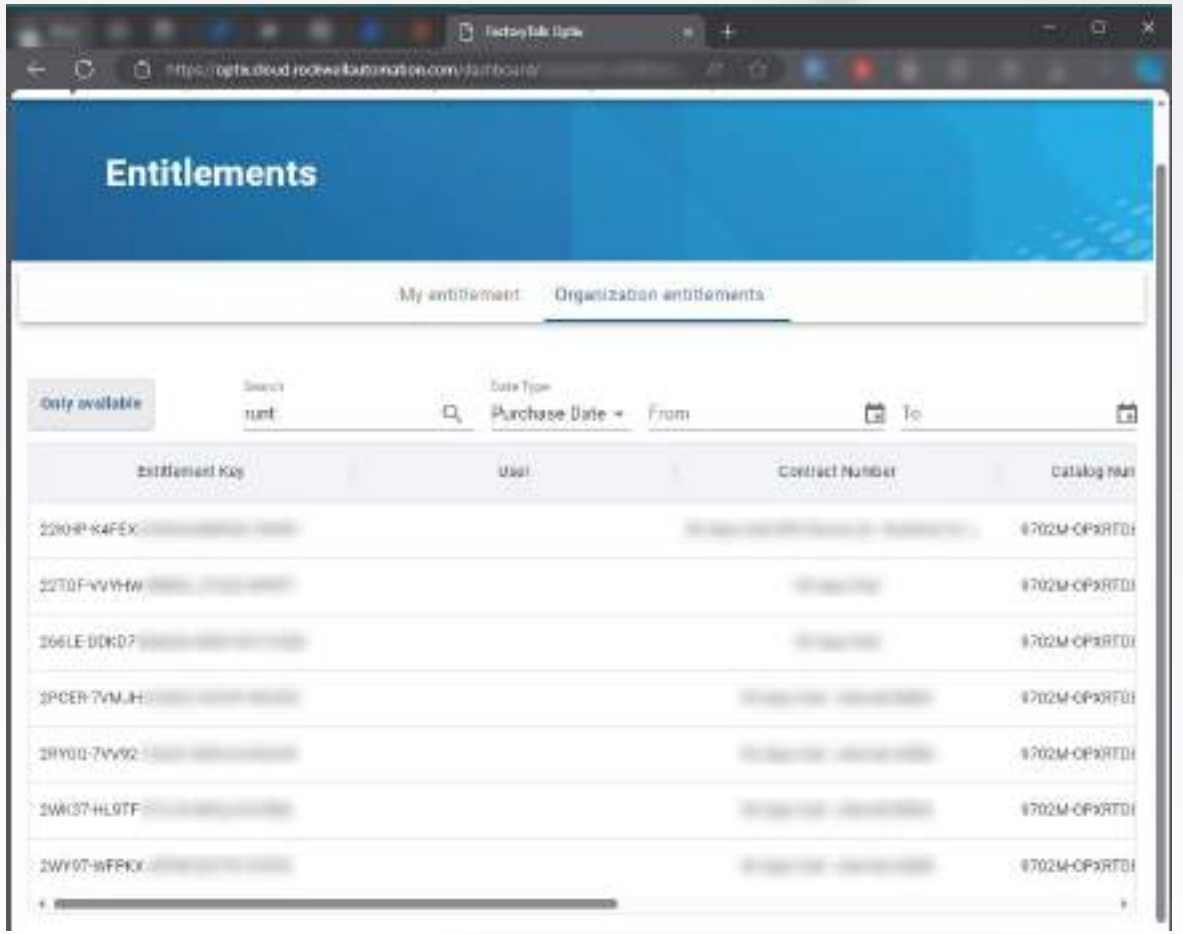


FactoryTalk Optix Runtime Entitlements

- Embedded devices comes with a preinstalled entitlements (size varies depending on the device)
- «Open» devices (like iPC) should be manually activated using the License Manager which is installed with the Runtime Tools
- Runtime licenses can be upgraded by buying a bigger size
  - Runtime licenses upgrade on Embedded devices (like OptixPanels) may be limited to specific sizes



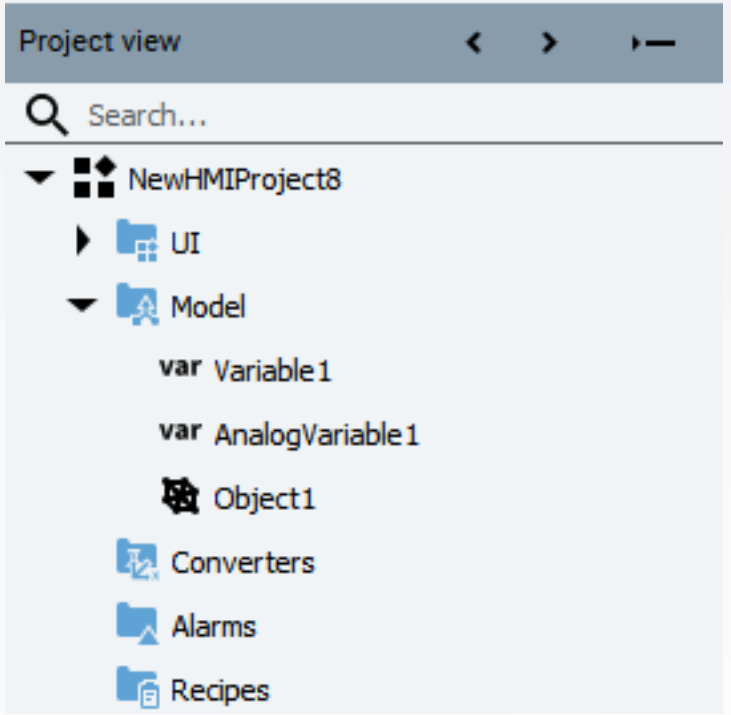
FactoryTalk Optix Entitlements

- A dedicated tutorial is available

Variables and tags

Model's variables

- What are the purposes of these Tags?
  - as "**internal variables**" used only on the HMI project (such as parameters or global variables)
  - as "**bridge**" between the Tag connected to the Comm Driver and the User Interface (such as using same UI for different PLC vendors)
- Under the "Model" node, it's possible to define different types of tags:
  - **Variable**: Standard Tag with desired data type
  - **Analog Variable**: Tag with Engineering Unit (used in combination with Measurement System)
  - **Object**: Structured Tag (a.k.a. User Defined Type)



Communication drivers

- Used to:
  - communicate with a PLC exchanging Tag values
  - import Tags from the PLC application (if supported by the protocol)

- To configure the communication,
  1. Add a Communication Driver object that represents the communication protocol. Some drivers (like Modbus) have a choice between serial and eth.
  2. Add one (or more) Station object that represents PLC and configure communication parameters

Communication driver	Online tags import	Offline tags import
Modbus driver		
MELSEC FX3U Driver		✓
S7TCP driver	✓*	✓
OMRON EtherNet/IP driver		✓
MELSEC Q driver		✓
S7 TIA PROFINET driver	✓	✓
OMRON Fins Driver		✓
CODESYS Driver	✓	✓
TwinCAT driver	✓	✓
Serial port		
RA EtherNet/IP Driver	✓	✓
Micro Controller Driver	✓	

Communication drivers

- Some drivers also supports runtime import of PLC Tags
  - A custom logic must be added to the project (NetLogic examples are available on GitHub)
  - Only supported for:
    - RA Ethernet/IP
    - Twincat
    - Siemens S7 TCP

```
[FTOptix.NetLogic.ExportMethod]
public static void ImportFromRAEthernetIP()
{
    Log.Info("RuntimeTagsImport.ImportFromRAEthernetIP", "Starting runtime tags import");

    var station = Project.Current.Get<FTOptix.RAEtherNetIP.Station>("CommDrivers/RAEtherNet_IPDriver1/RAEtherNet_IPStation1");

    // Call Browse method to retrieve data from PLC
    station.Browse(out var plcItems, out var prototypes);

    Log.Info("RuntimeTagsImport.ImportFromRAEthernetIP", "Fetched " + plcItems.Length + " tags structures from the PLC");

    // Filter tag to import by tag name
    var tagInstances = FilterTagsToImport(new List<string>() { "Controller Tags/Tank1/Level", "Controller Tags/Tank2/Level" }, plcItems);

    Log.Info("RuntimeTagsImport.ImportFromRAEthernetIP", "Importing " + tagInstances.Length + " tags");

    if (tagInstances.Length == 0)
    {
        Log.Warning("RuntimeTagsImport.ImportFromRAEthernetIP", "No tags to import. Returning.");
        return;
    }

    //Filter tag to import by prototypeId
    // var tagInstances = GetTagsOfType("MachineParameter", plcItems);

    station.Import(tagInstances, prototypes);
}
```

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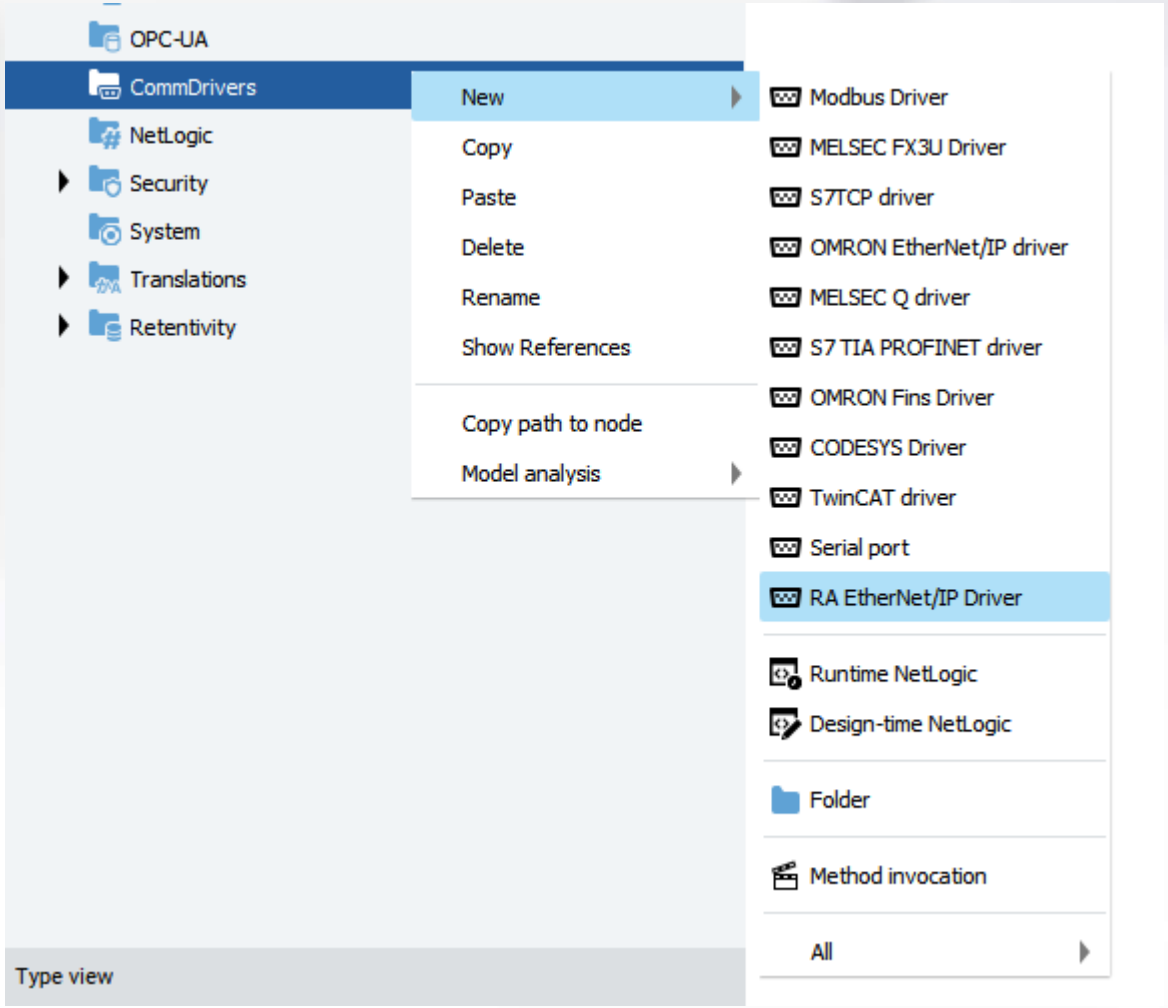

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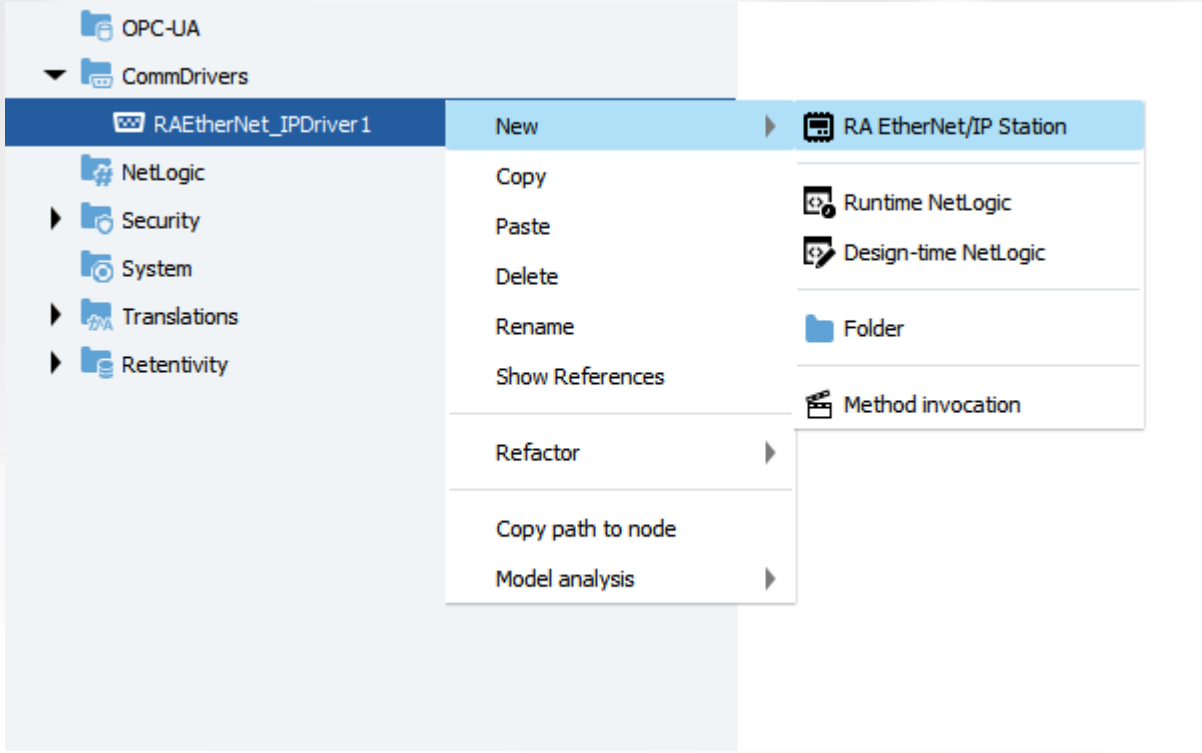

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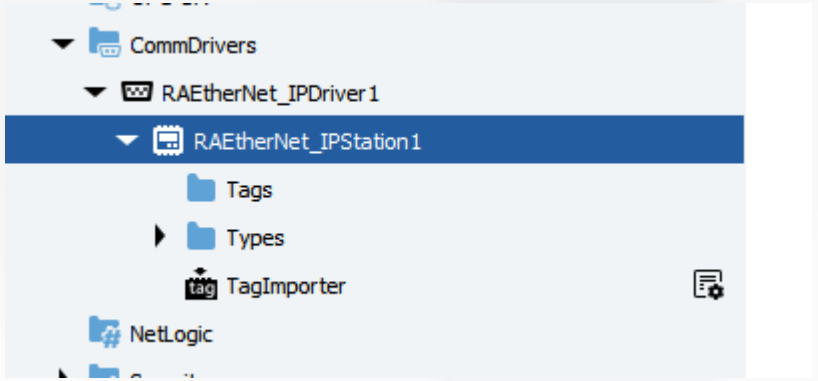

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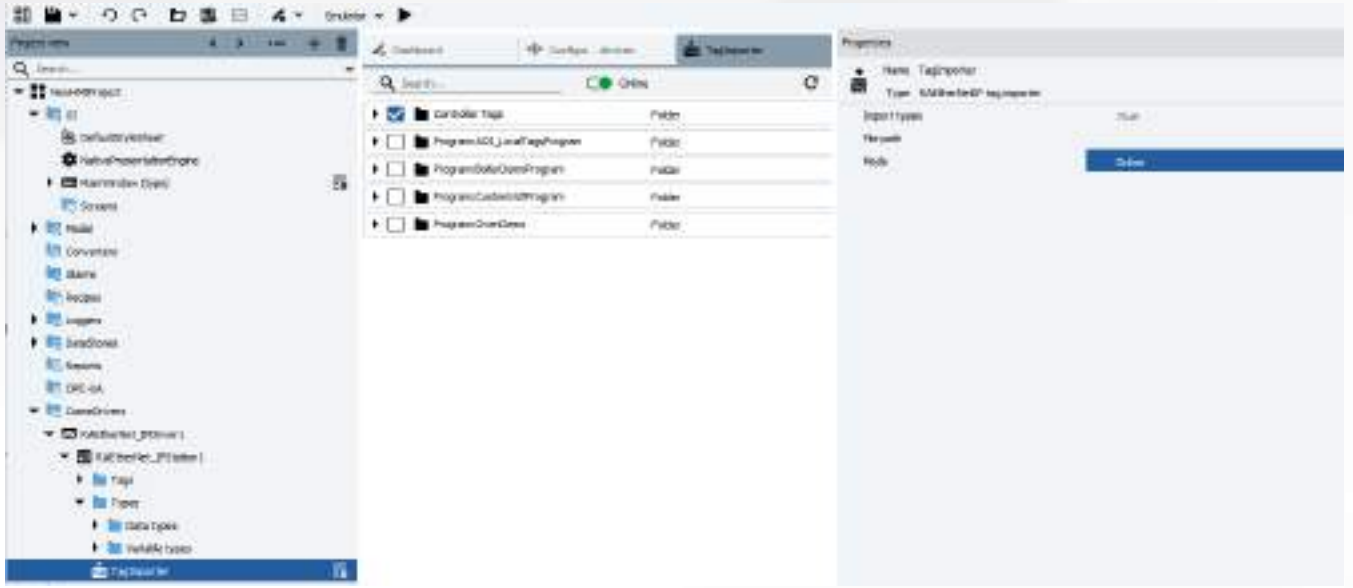
Add tags exchanged with plc: tag importer

- Tag Importer
  - *Offline*: from an export file generated by PLC programming software
  - *Online*: reading tags directly from an online PLC (if supported by the comm driver)
- Remind!
  - the number of tags exchanged with PLC are not counted by the license manager



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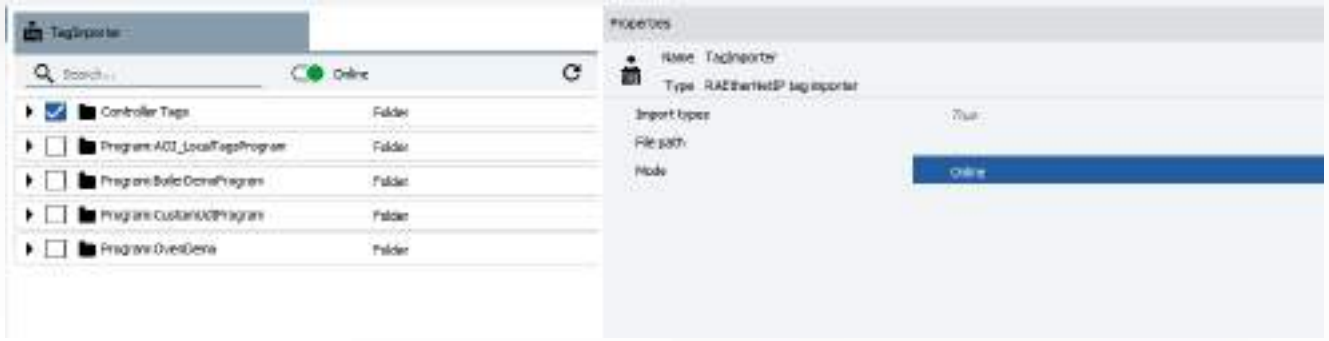
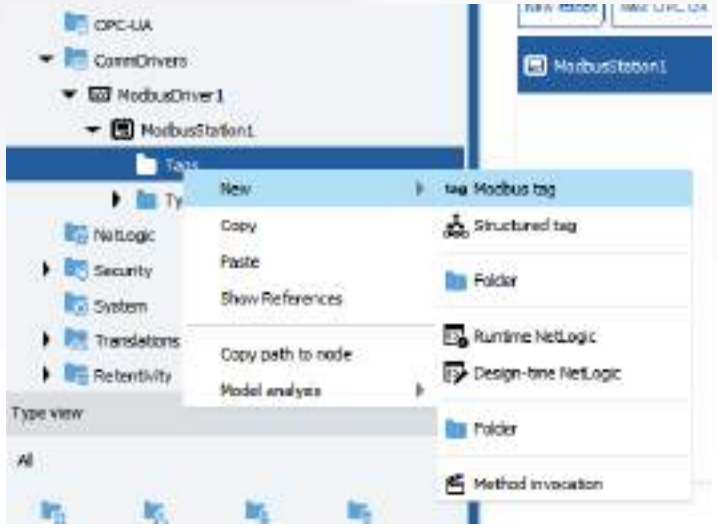


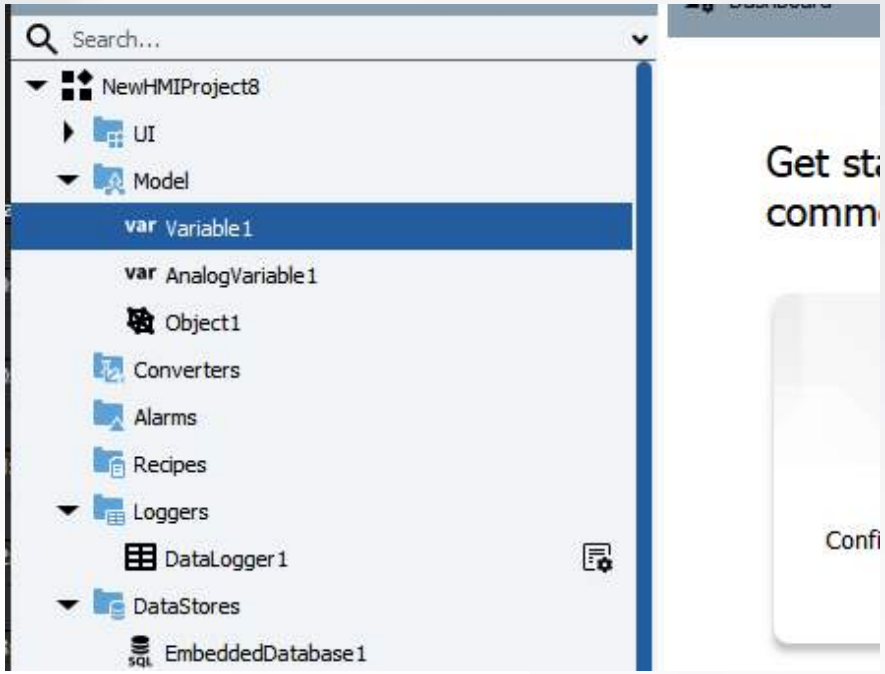
Add tags exchanged with plc: manually

- for Communication Drivers not using symbolic names (i.e. Modbus TCP)
- tags can be created “manually”
  - Right-click on the Tags node and select the "New Variable" command
  - on the Properties panel, configure the tag



Tag rename

- Tags can be renamed
  - Applies to Model's Tags
  - Applies to Tags exchanged with PLC created manually and also imported!
  - If the Tag is referenced by a resource that requires refactoring (example: a datalogger), a popup will appear automatically
  - If it has been imported, the Tag will be marked as "Renamed"



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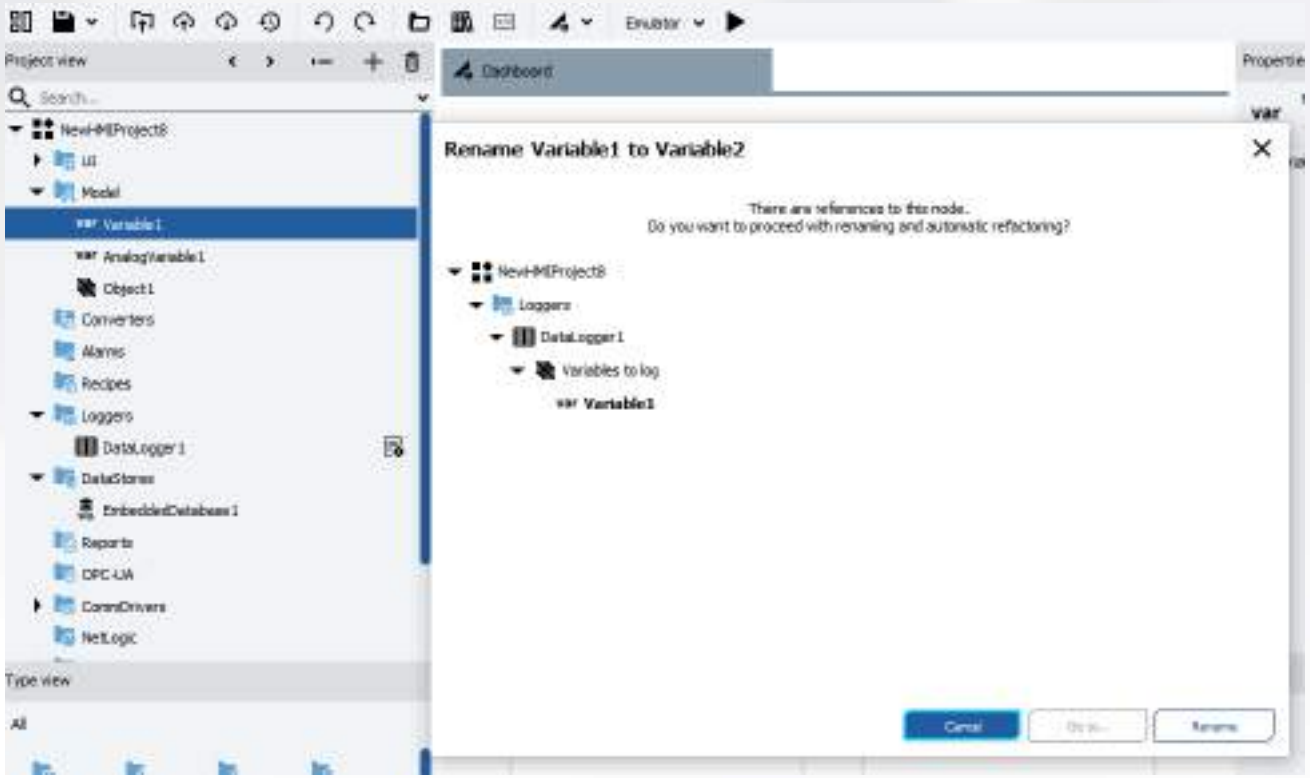
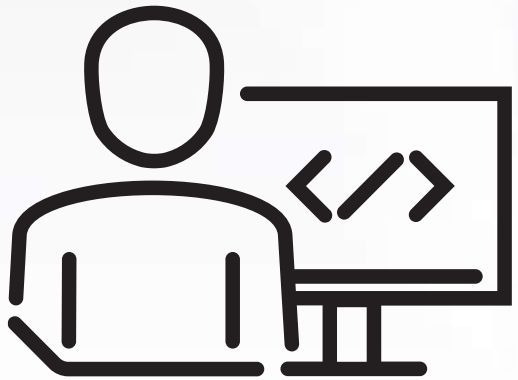


Hands-on session

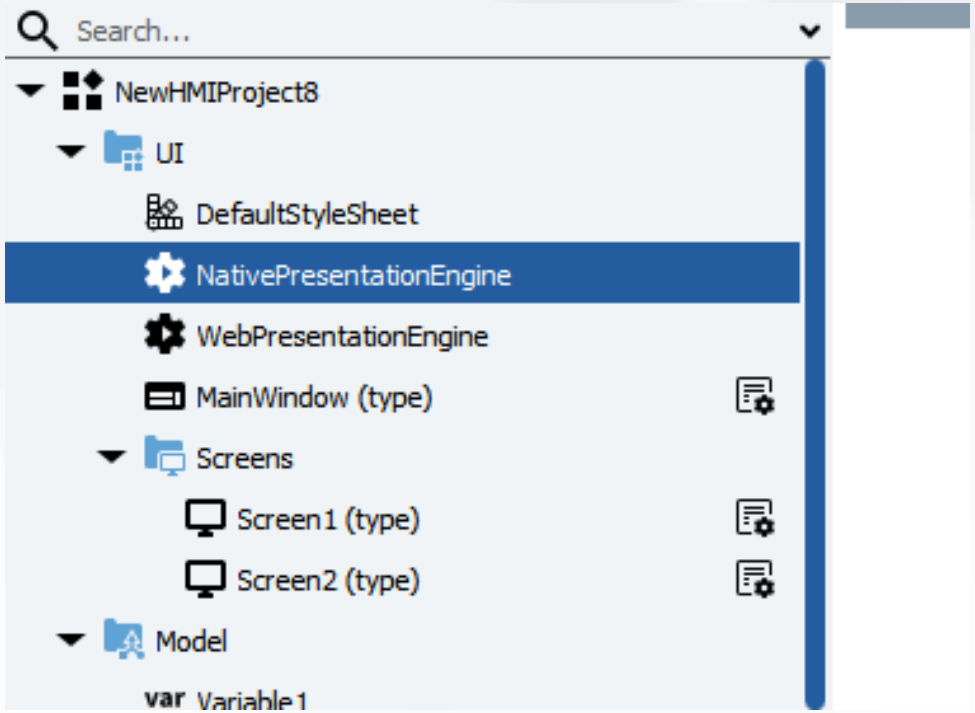
- Create some Model tags
- Add the RA Ethernet/IP communication driver
- Import tags from FactoryTalk Logix Echo



Develop the user interface

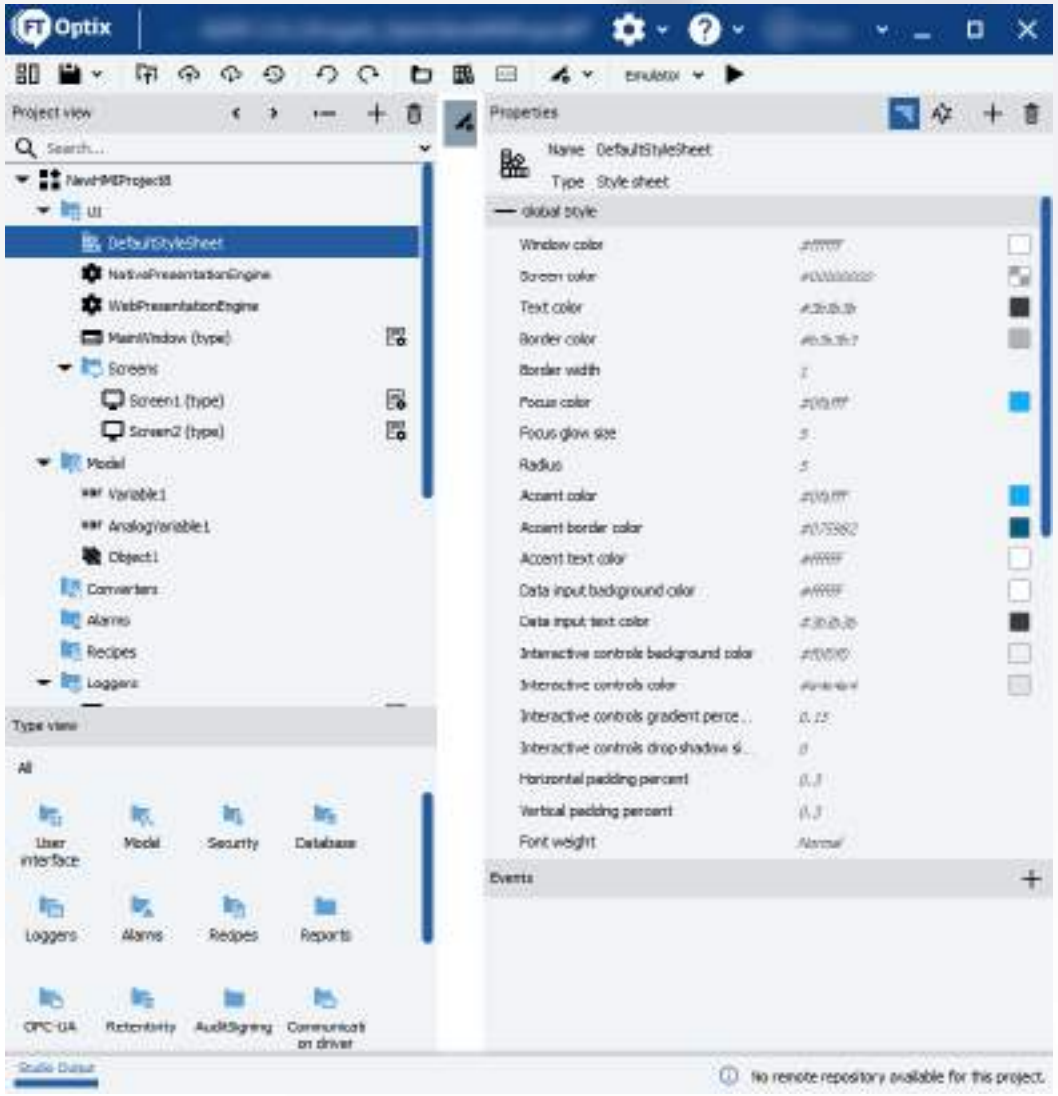
User interface (UI)

- Default Style Sheet
  - makes it possible to globally set some style properties of all graphical objects in the project
- Presentation Engine
  - **Native** Presentation Engine it's the object that create the user interface of the Application
  - **Web** Presentation Engine, it's the object that create the user interface for Web access
- Main Window
  - This object is the root container of graphical objects



Default style sheet

- Properties
  - Global Style: style properties in common with all objects (like radius)
  - Control Styles: style properties for a specific type of object (Button, Switch...)
- Multiple style sheets
  - into the same project can be defined multiple style sheets for example, to allow to switch between a light/dark interface at Runtime
- Template Libraries
  - contain some pre-defined and "ready to use" Style sheets



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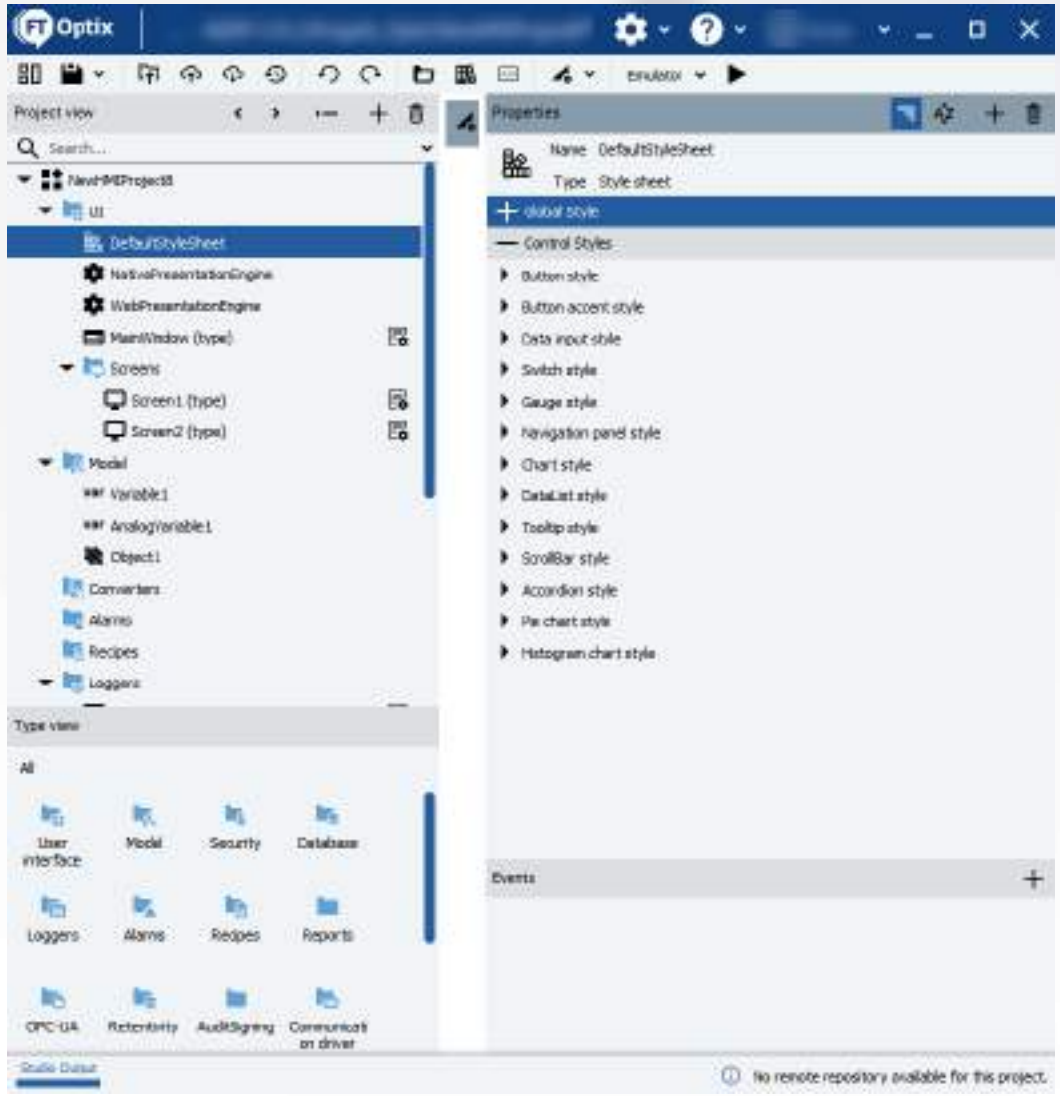
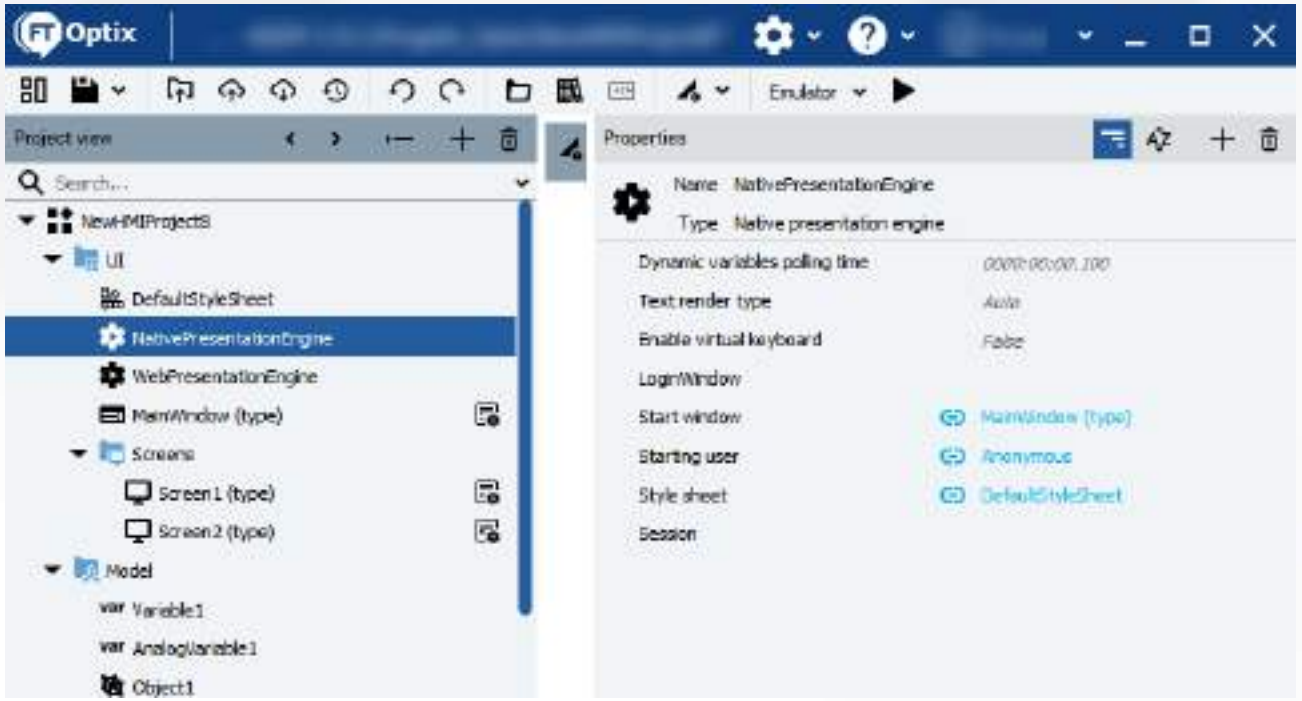


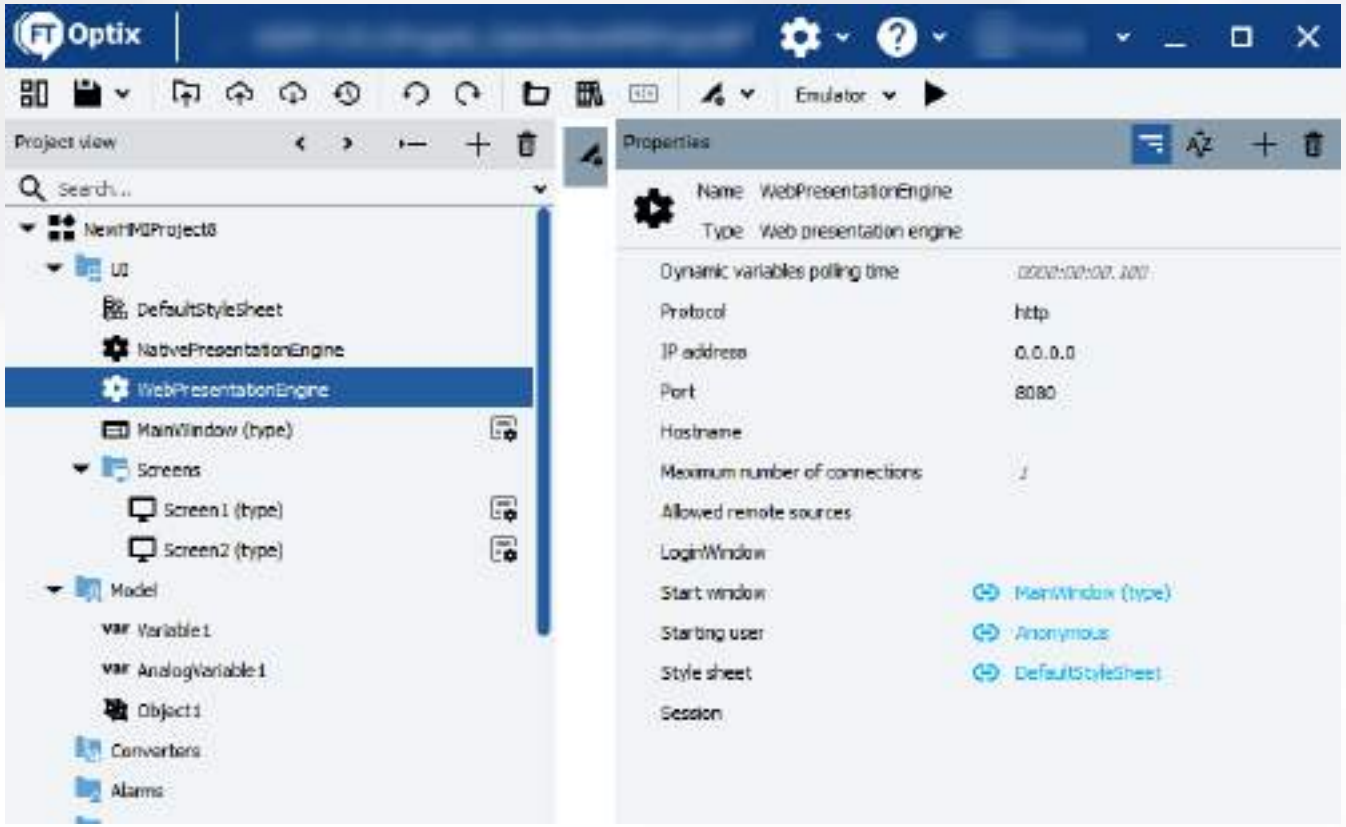
Native presentation engine

- Properties
  - Dynamic Variables polling time: used to refresh Tags used in Presentation Engine.
    NOTE: this will also set the polling time used by comm drivers (for active tags)
  - Start Window
  - Starting User
  - Style Sheet
  - Enable Virtual Keyboard



Web presentation engine

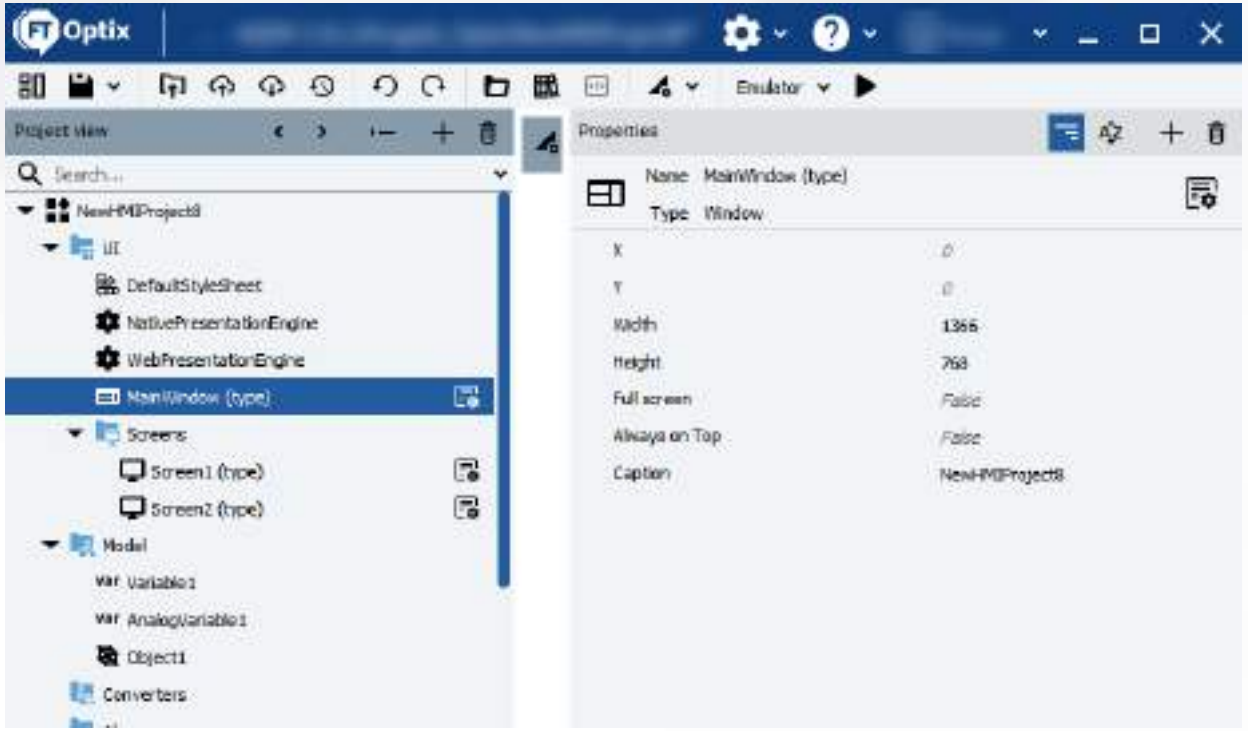
- Allow publishing the UI through the integrated Web Server
- Properties:
  - Start Window, Starting User, Style Sheet…
  - **Protocol**: http/https
  - **IP Address**: this will be the IP address used by Web Server 0.0.0.0 = listen on all addresses
  - **Port**: define the listening port
  - Hostname
  - Maximum Number of connections
  - Allowed remote sources: external sources that can be embedded (websites)



Main window

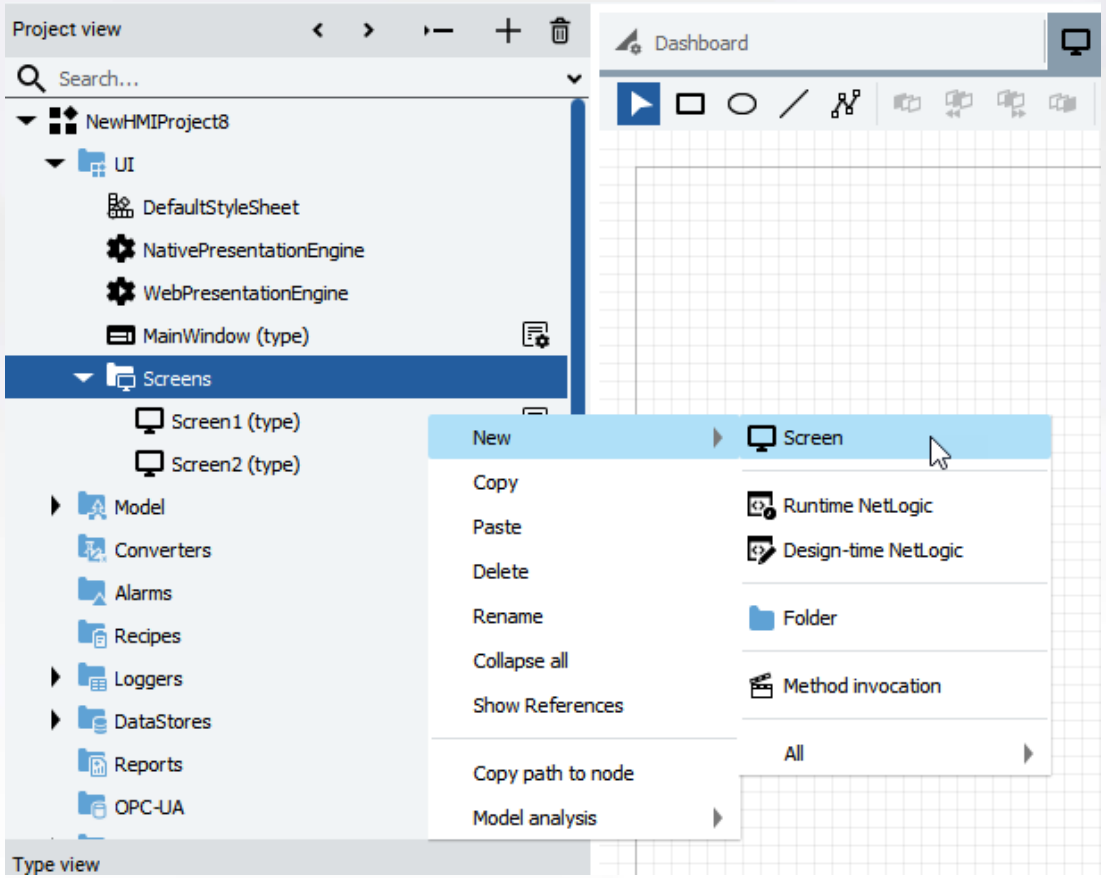
- Define the window where all graphical objects are showed
  - width/height: defines (manually) the size of the entire User Interface
  - Full Screen: set the size of UI equal to the current screen resolution hiding the title bar
  - Always on Top: force the window to be always on top of other applications
  - Caption: title of the window

- NOTE:
  - **Application is a single-window application**
  - Switching between a page to another will not close/open a window, but will only change its content (containers)



Screens

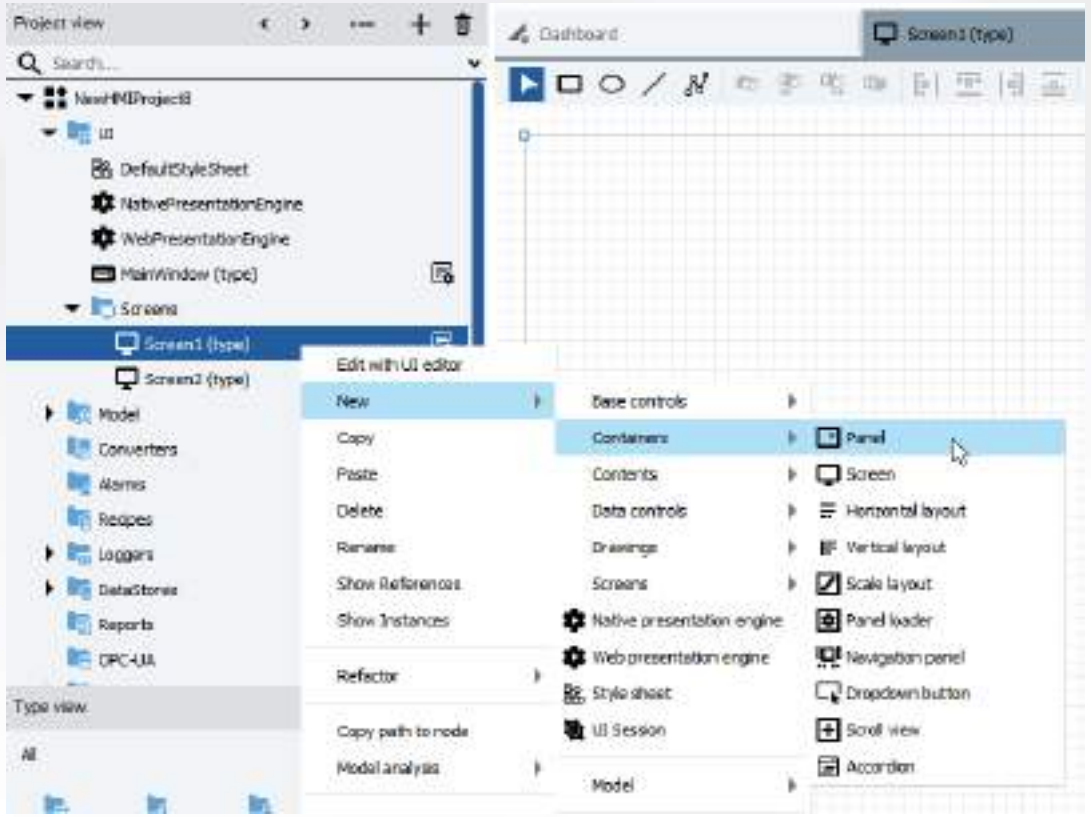
- Screens are the pages that are loaded to the running applications



- Screens sizes are stretched to the parent container (PanelLoader or NavigationPanel)
- Background can be customized with StyleSheet

Panels

- Panel is a Container that aggregates graphical objects (i.e. widgets)



- create a new Panel:
  - Right-click on the Page
  - select New > Containers > Panel
- Panels are transparent only
  - Can be used to group elements to trigger specific behaviors on all child components (like visibility, enablement, etc)

Navigation

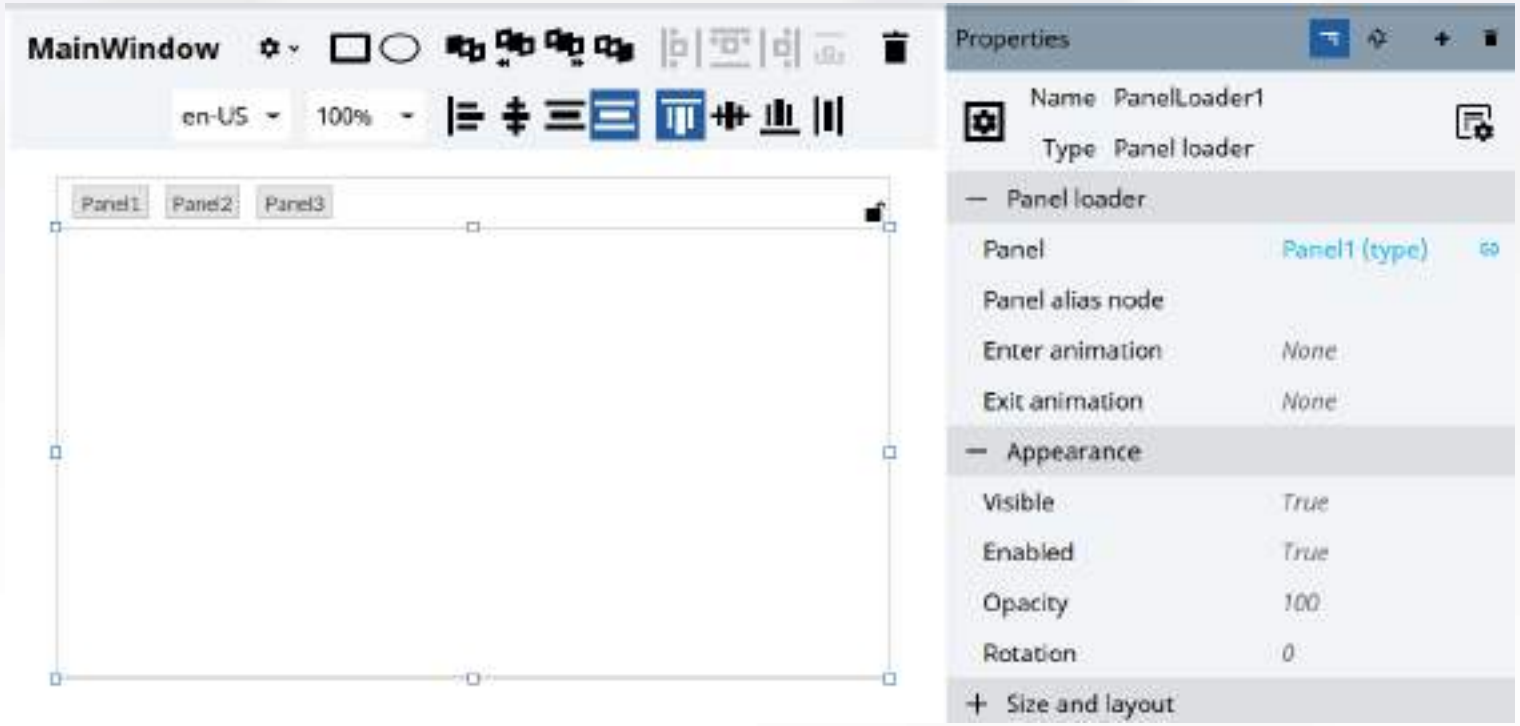
- Navigation can take place using two different ways

1. Panel Loader

- Container to display panels or screens
- "Change panel" method allow to load a different panel

2. Navigation Panel

- Container that automatically organizes Panels into navigable tabs.
- Just Drag&Drop Screens into the object
- Tabs can be hidden or disabled

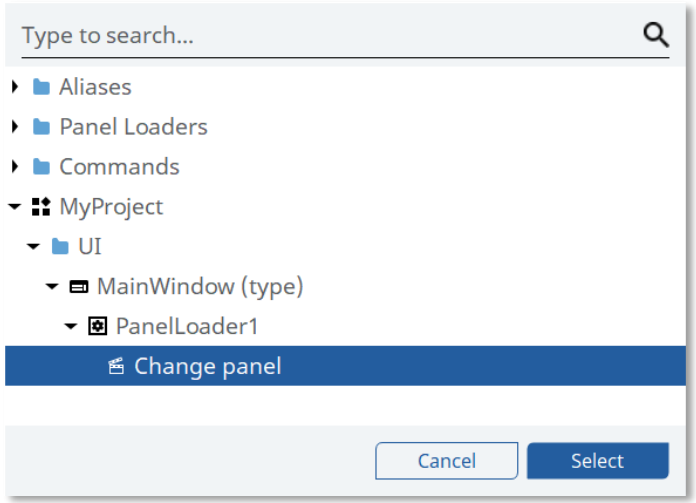


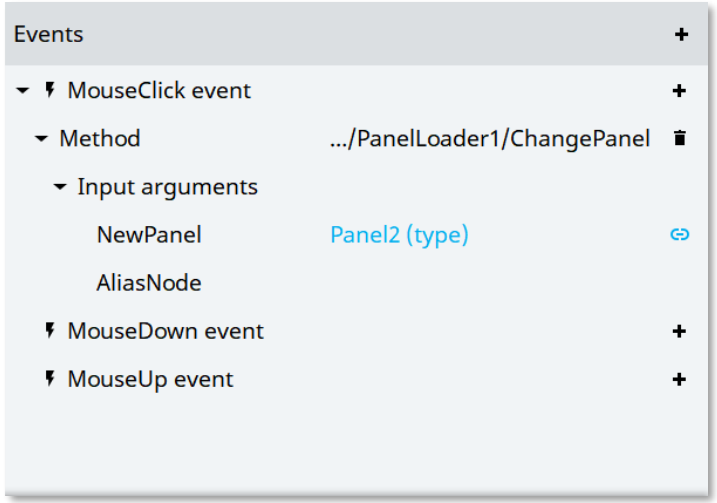
Navigation

- Navigation can take place using two different ways

1. Panel Loader

- Container to display panels or screens
- "Change panel" method allow to load a different panel





2. Navigation Panel

- Container that automatically organizes Panels into navigable tabs.
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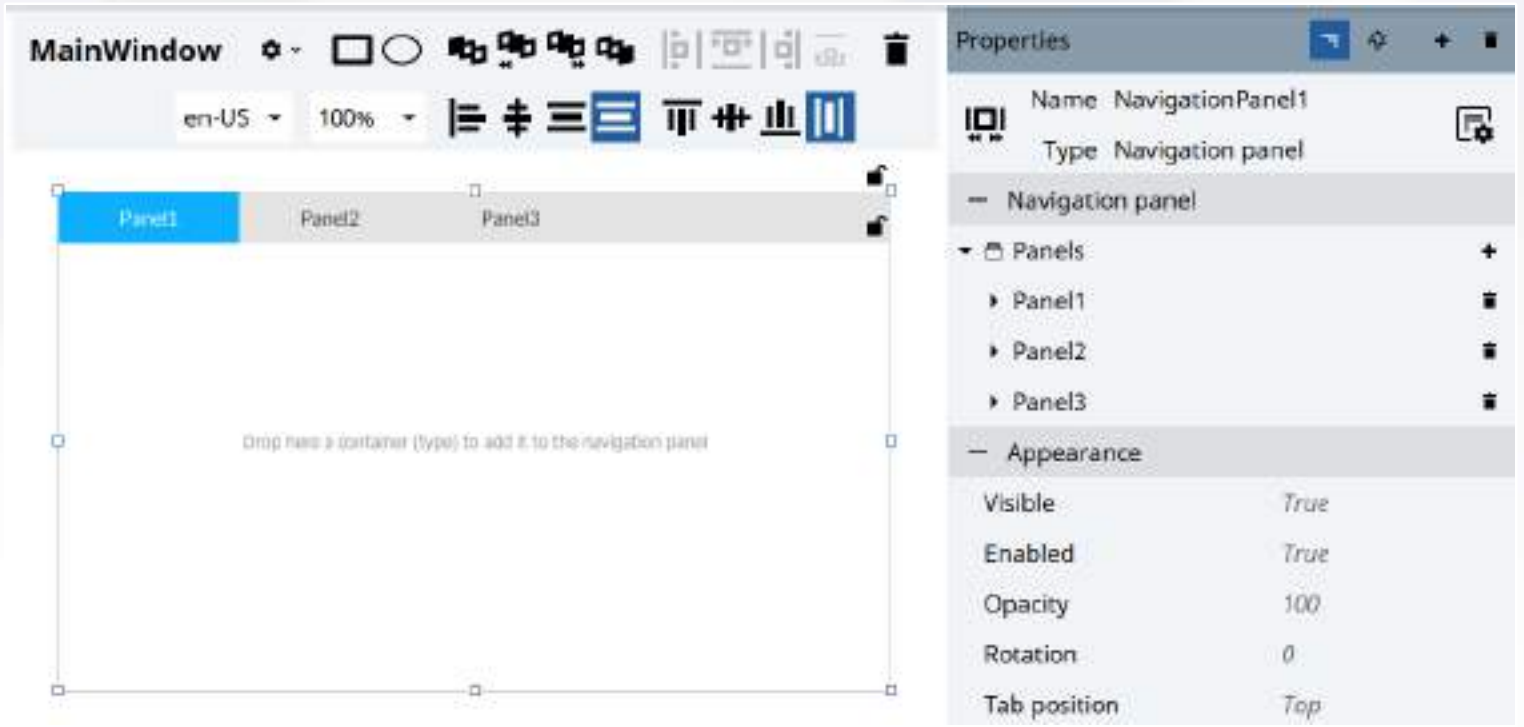
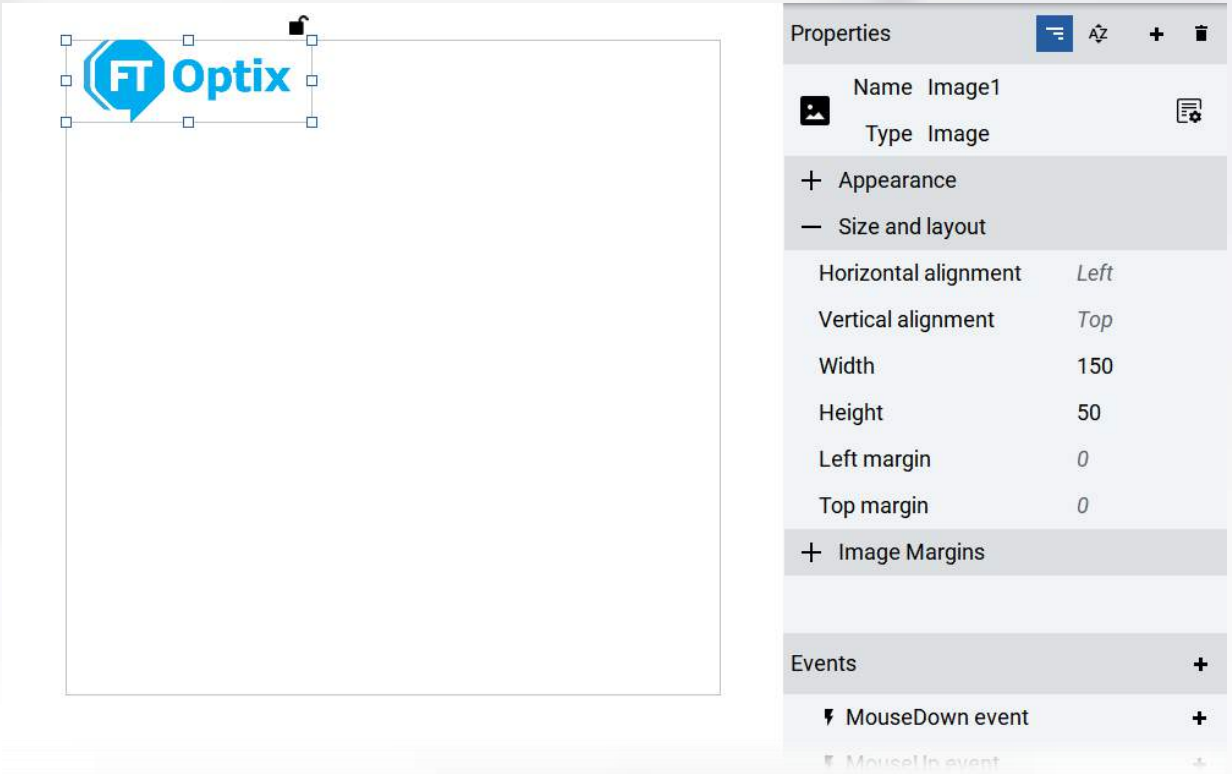


Responsive design

- This can be achieved by using the **relative positioning** of objects or **scaling** them to be bigger or smaller

1. **Alignment ***: manage the reference
   - Left/Right and Top/Bottom
   - Center
   - Stretch

2. **Margins**: manage the distance from the reference



- Horizontal Layout and Vertical Layout can be used for structured layouts

* Remember: to set Alignment on objects and also on all its containers: Panel, Navigation Panel...

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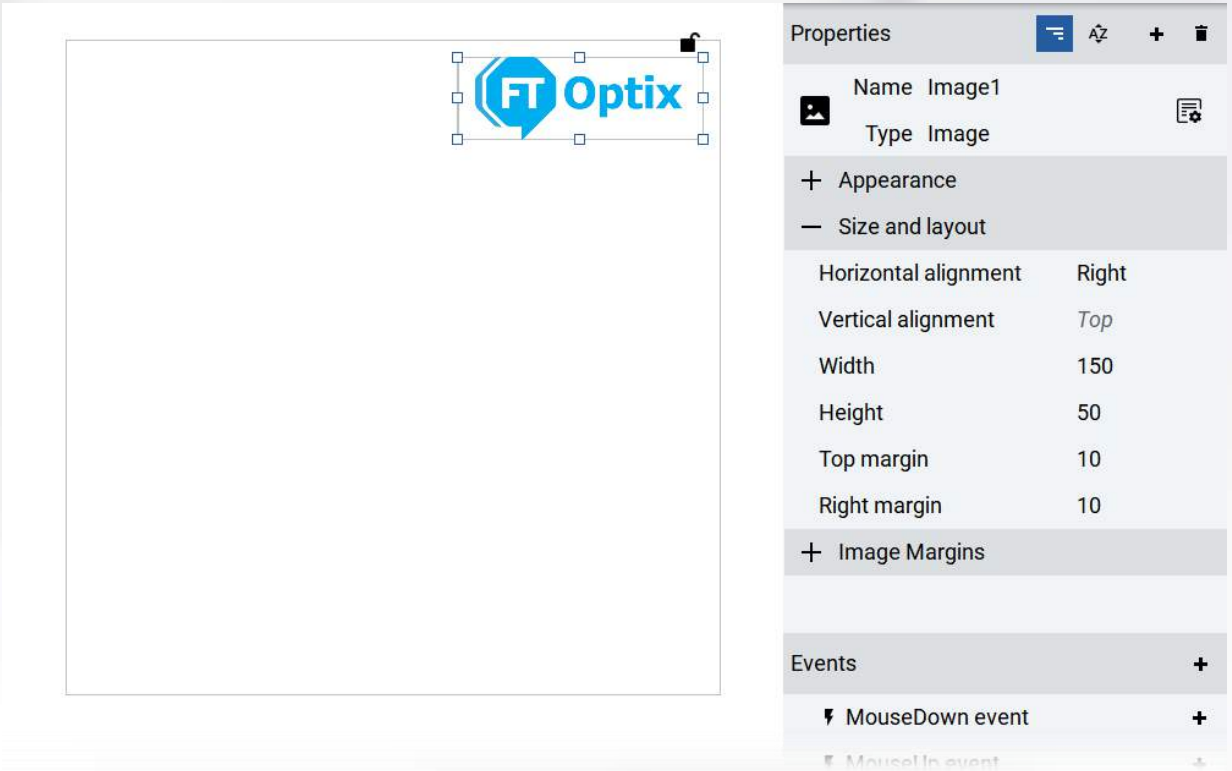

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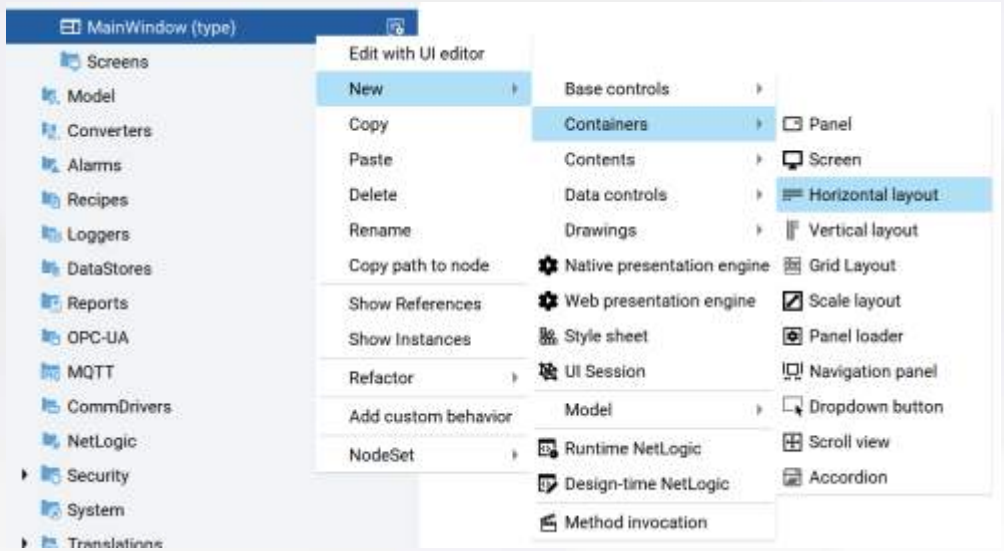
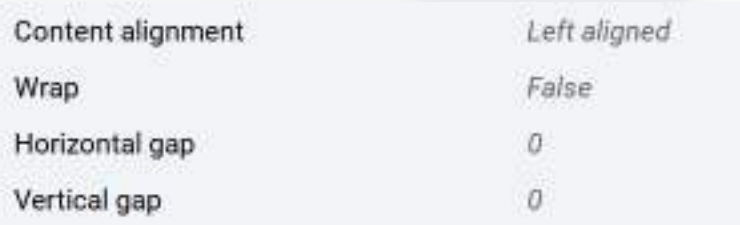
Horizontal Layout

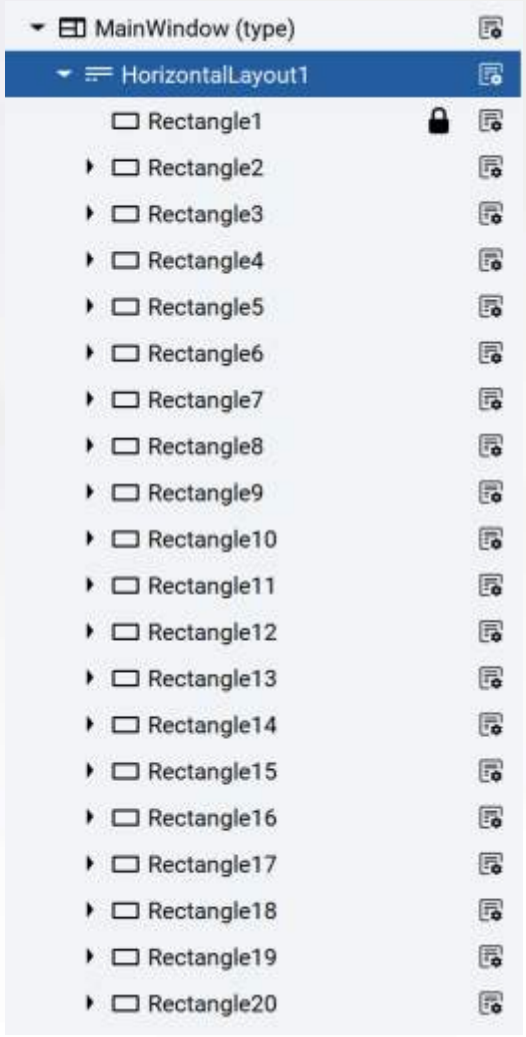
- Automatically lay out content horizontally inside a container

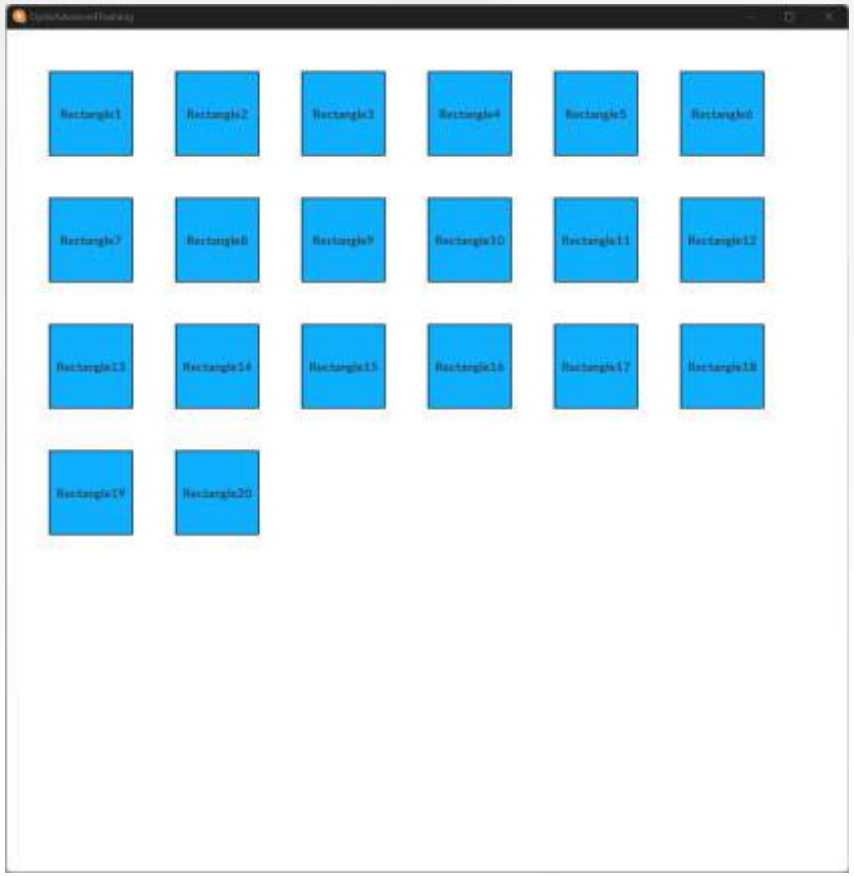




- Content alignment: Where to place content inside the container (Left aligned, Center aligned, Right aligned)
- Wrap: Start a new row when content exceeds the horizontal bounds of the container
- Horizontal gap: How much horizontal space between content
- Vertical gap: How much vertical space between content

Horizontal Layout

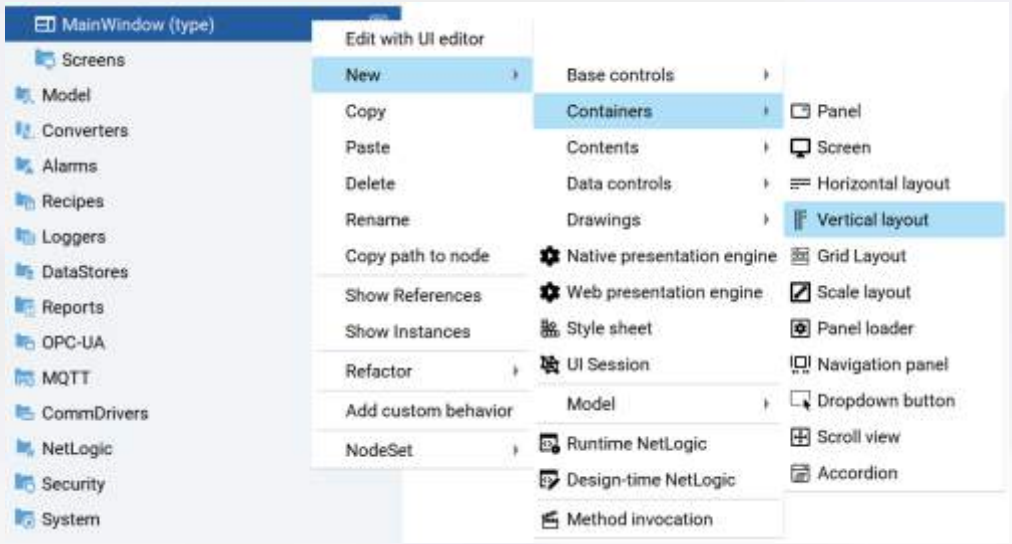




Horizontal Layout	
Content alignment	*Left aligned*
Wrap	True
Horizontal gap	50
Vertical gap	50
Appearance	
Visible	*True*
Enabled	*True*
Opacity	*100*
Rotation	*0*
Move target	*None*
Size and layout	
Horizontal alignment	Stretch
Vertical alignment	Stretch
Left margin	50
Top margin	50
Right margin	50
Bottom margin	50

Vertical Layout

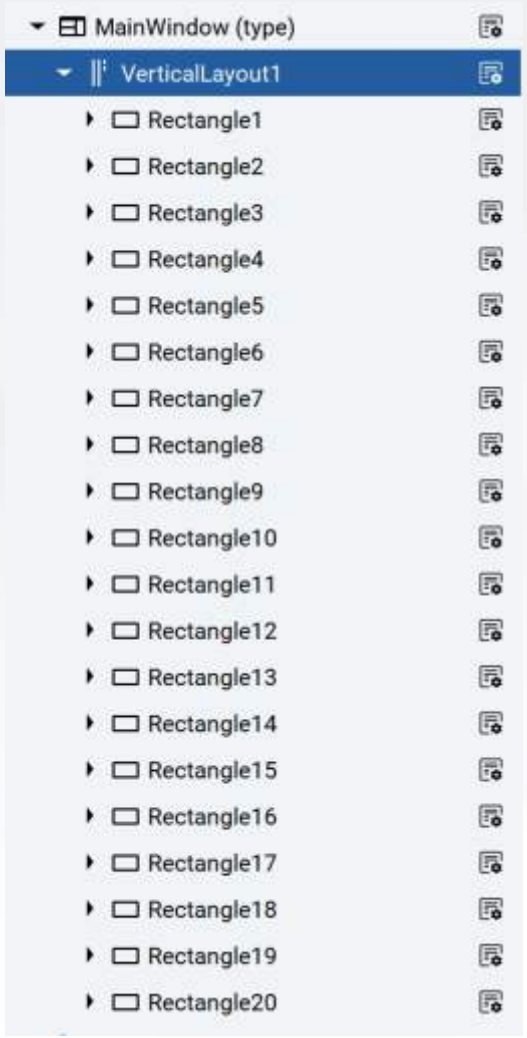
- Automatically lay out content vertically inside a container

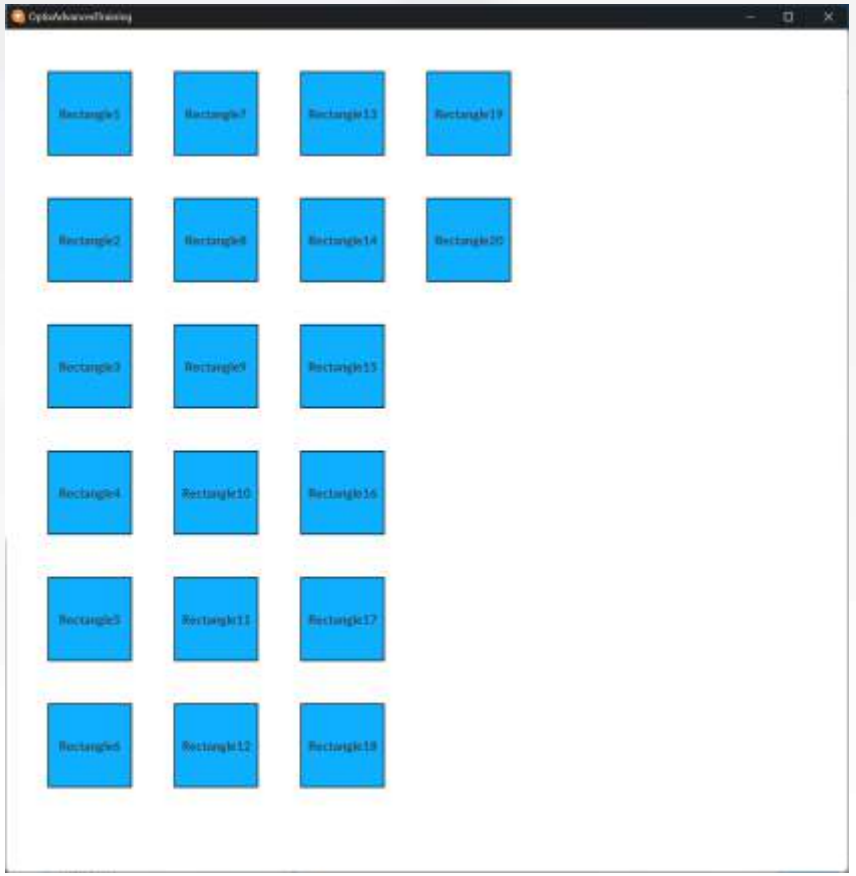


Content alignment	*Top aligned*
Wrap	*False*
Horizontal gap	*0*
Vertical gap	*0*

- Content alignment: Where to place content inside the container (Left aligned, Center aligned, Right aligned)
- Wrap: Start a new column when content exceeds the vertical bounds of the container
- Horizontal gap: How much horizontal space between content
- Vertical gap: How much vertical space between content

Vertical Layout

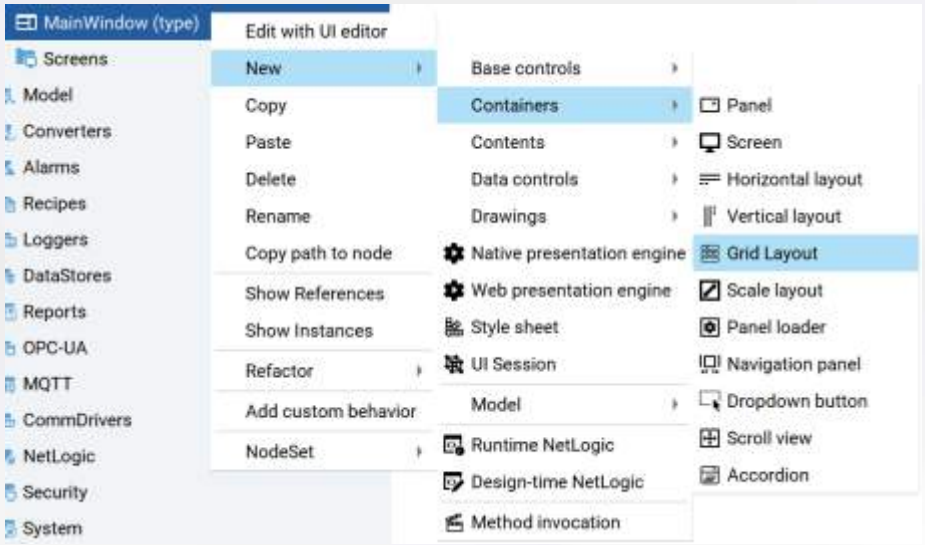




— Horizontal Layout	
Content alignment	*Top aligned*
Wrap	True
Horizontal gap	50
Vertical gap	50
— Appearance	
Visible	*True*
Enabled	*True*
Opacity	*100*
Rotation	*0*
Move target	*None*
— Size and layout	
Horizontal alignment	Stretch
Vertical alignment	Stretch
Left margin	50
Top margin	50
Right margin	50
Bottom margin	50

Grid Layout

- Automatically lay out content based on configured grid pattern



- Columns: Specify column width in units of static pixels or relative frame units (1fr = 1 unit, 2fr = 2 frame units)
- Rows: Specify column width in units of static pixels or relative frame units (1fr = 1 unit, 2fr = 2 frame units)
- Horizontal gap: Space between columns
- Vertical gap: Space between rows
- Items Horizontal Alignment: Column content alignment
- Items Vertical Alignment: Row content alignment

Grid Layout

- Grid Pattern Configuration

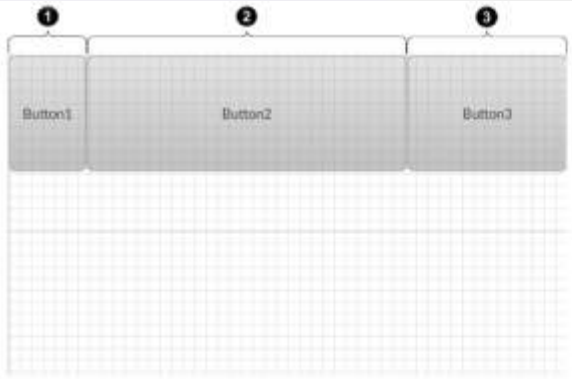
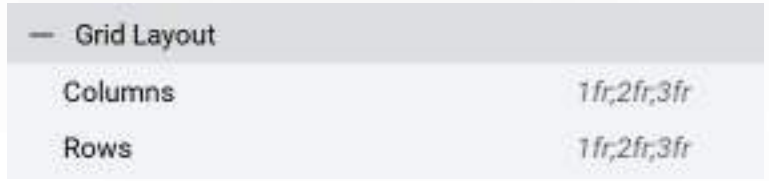


Table 1. Grid layout columns width explained

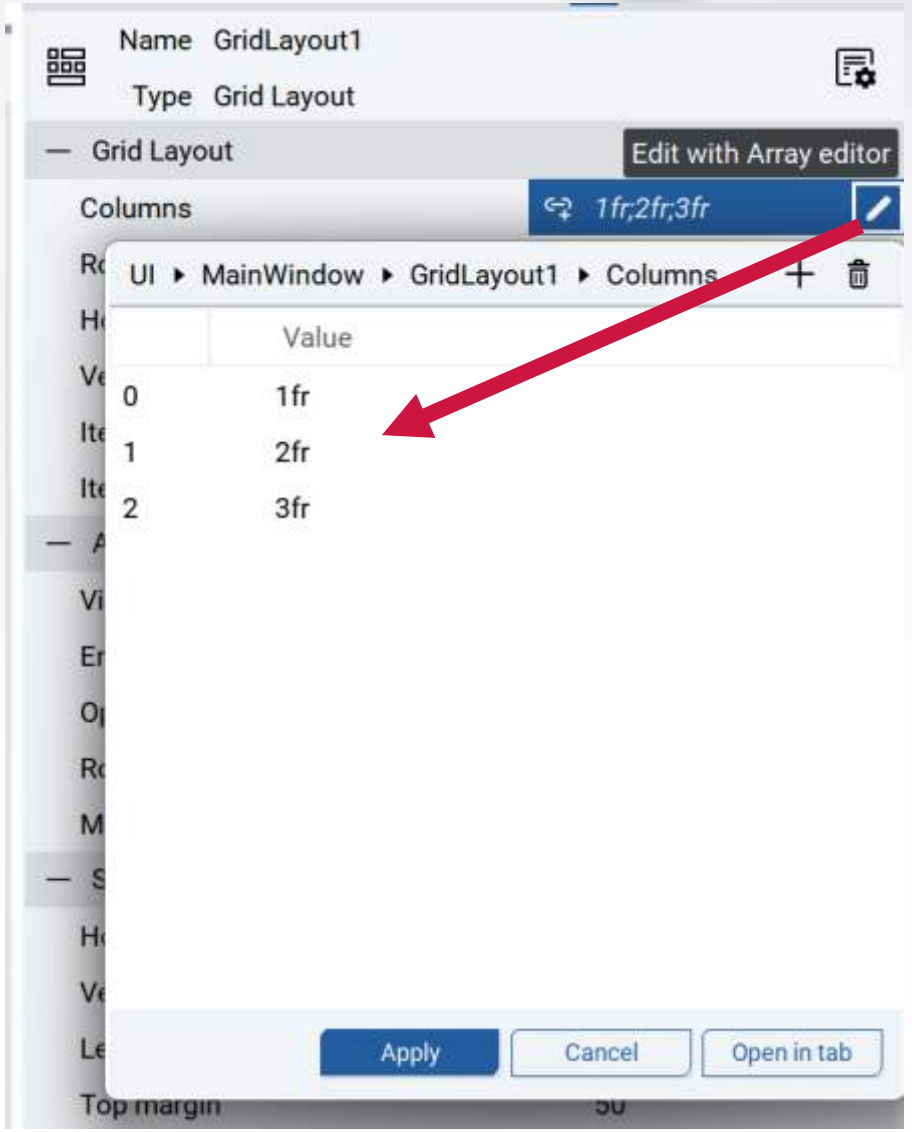
Callout	Unit	Value	Description
1	Pixels	100	Fixed width of 100px
2	Frames	2fr	2/3 of the remaining space
3	Frames	1fr	1/3 of the remaining space

- Columns and Rows are arrays of values dictating content behaviour
- Column and Row array values can be static pixels or dynamic at runtime using xfr notation
- Column and Row array values are separated by semicolon
- Example:
  - 3x3 grid
  - Column 1 = 1/6 of Grid Layout Width
  - Column 2 = 1/3 of Grid Layout Width
  - Column 3 = 1/2 of Grid Layout Width
  - Row 1 = 1/6 of Grid Layout Height
  - Row 2 = 1/3 of Grid Layout Height
  - Row 3 = 1/2 of Grid Layout Height

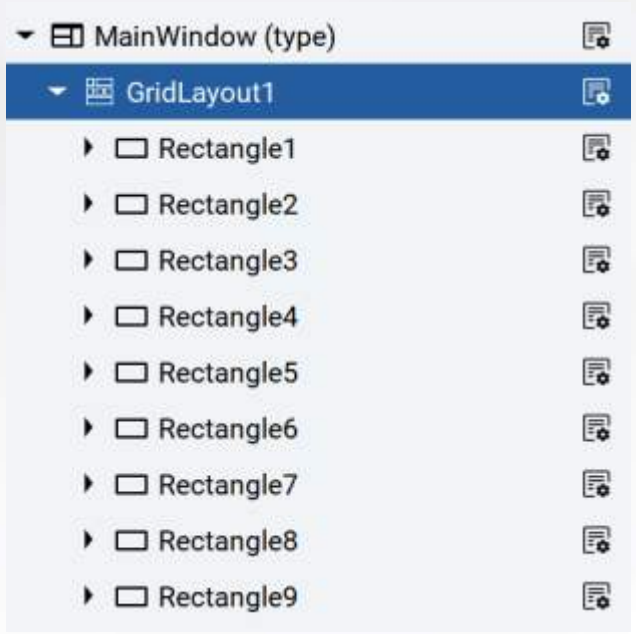


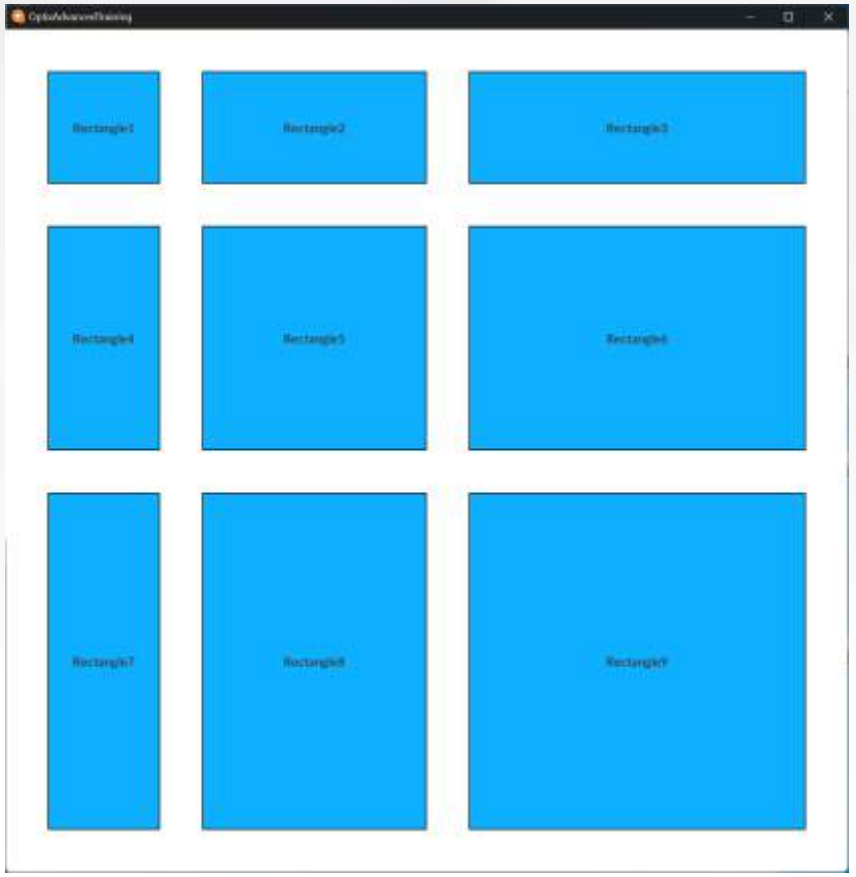
Grid Layout

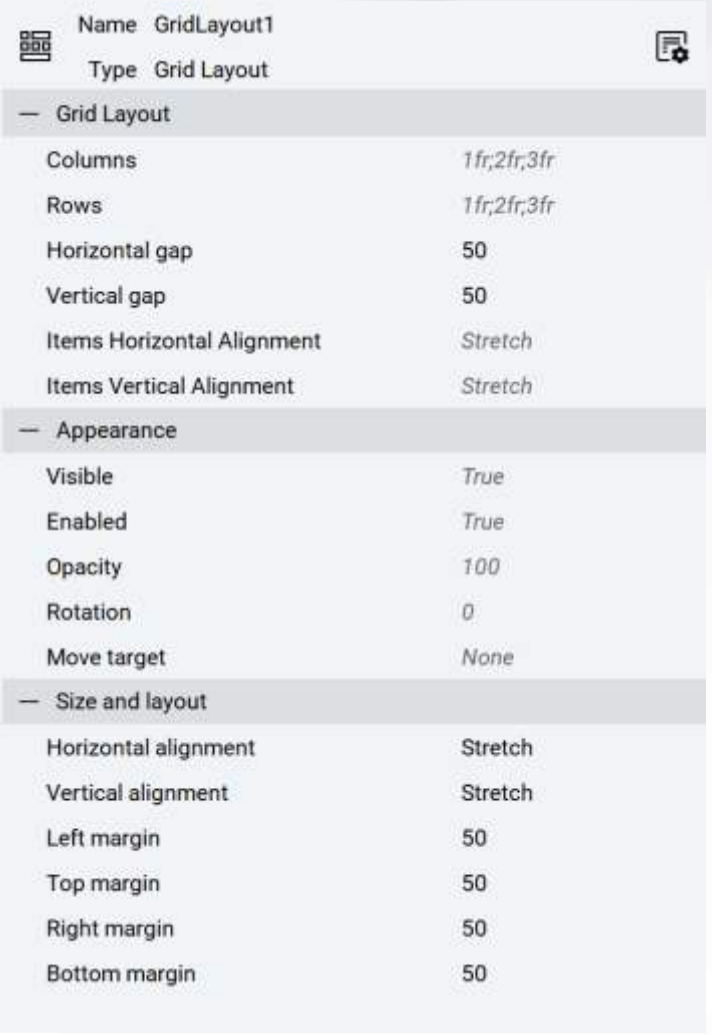
- Grid Pattern Configuration
  - Add / Delete Columns and Rows using the Edit (Pencil) button



Grid Layout

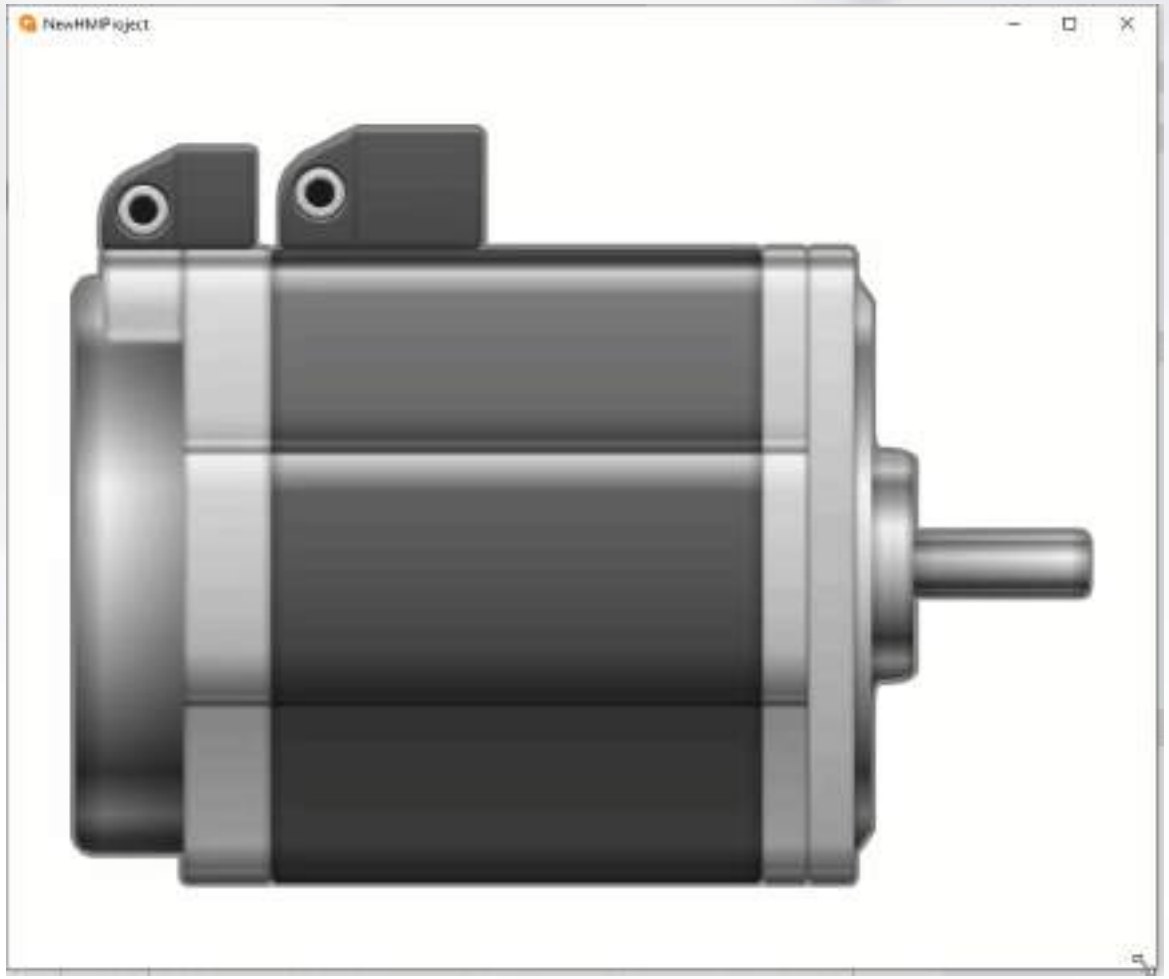

MainWindow (type)
GridLayout1
Rectangle1
Rectangle2
Rectangle3
Rectangle4
Rectangle5
Rectangle6
Rectangle7
Rectangle8
Rectangle9



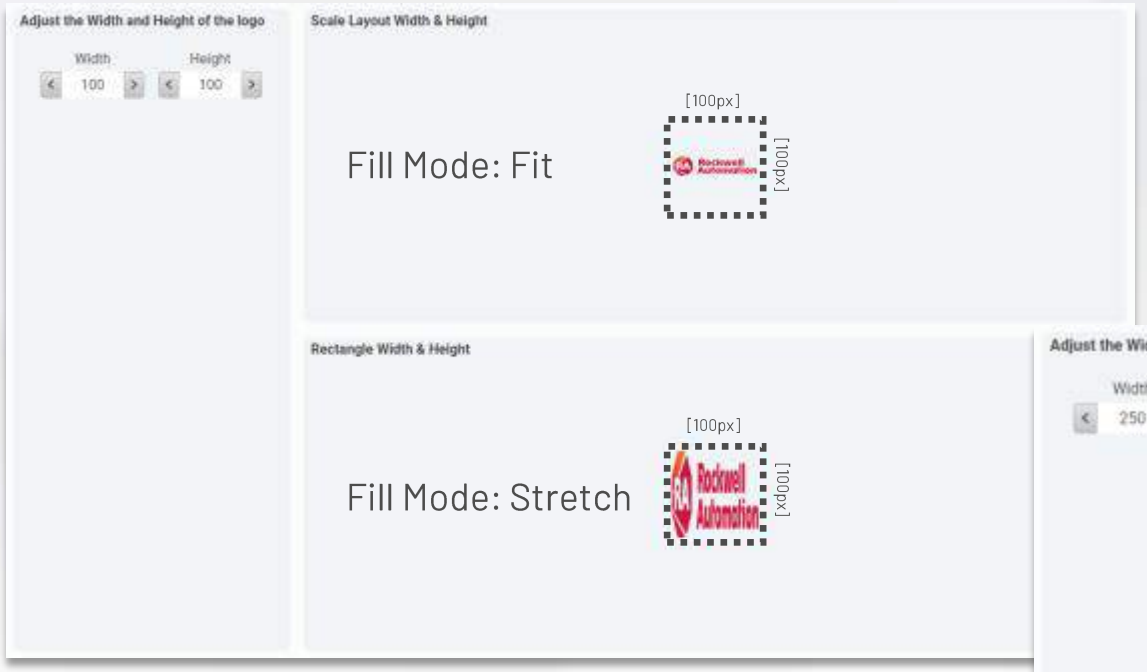

Name GridLayout1
Type Grid Layout
Grid Layout
Columns 1fr;2fr;3fr
Rows 1fr;2fr;3fr
Horizontal gap 50
Vertical gap 50
Items Horizontal Alignment Stretch
Items Vertical Alignment Stretch
Appearance
Visible True
Enabled True
Opacity 100
Rotation 0
Move target None
Size and layout
Horizontal alignment Stretch
Vertical alignment Stretch
Left margin 50
Top margin 50
Right margin 50
Bottom margin 50

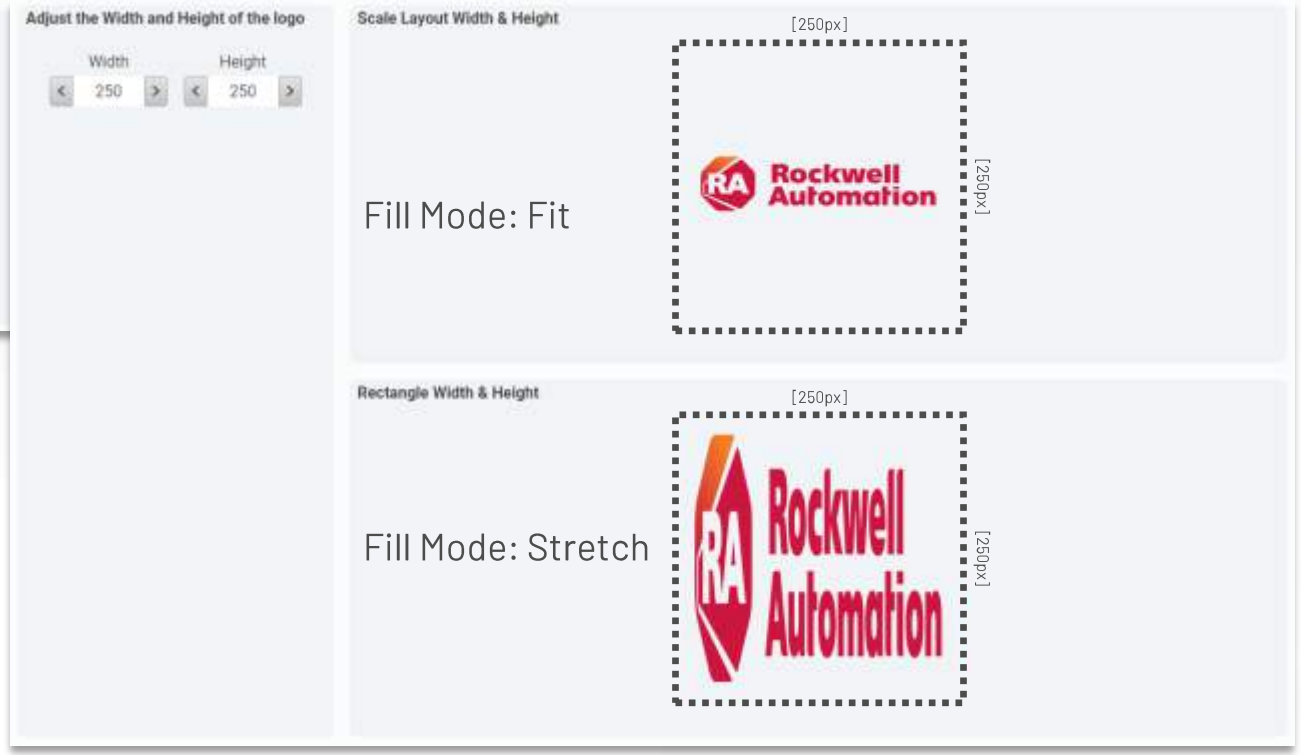
ScaleLayout

- Objects can be adapted to the size of the container using a **ScaleLayout**
- Scaling ratio can be set to:
  - Fit: original ratio is maintained, empty bars can appear around the element if the container's ratio is different from the object's ratio
  - Stretch: object is stretch to the container size, ratio is ignored, graphics may get distorted



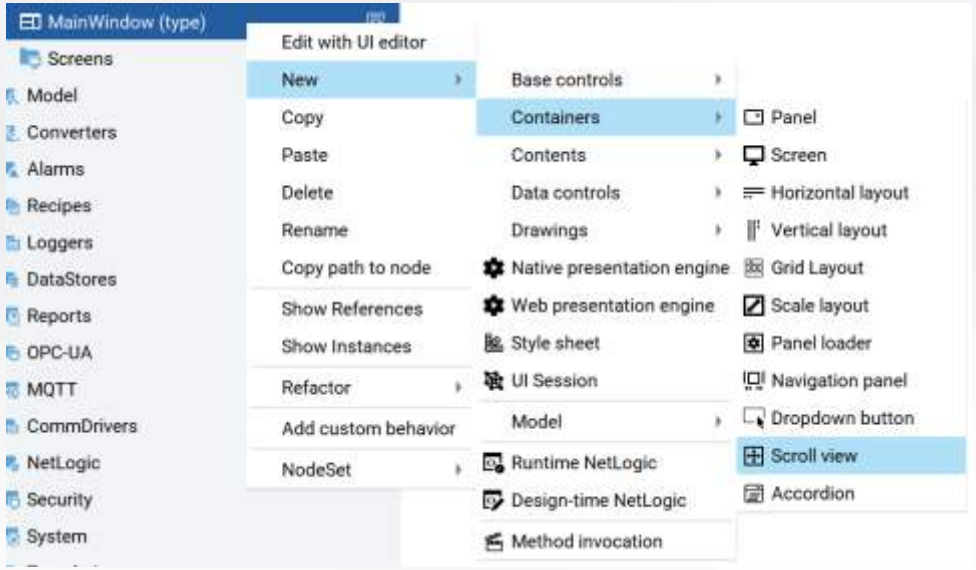
Scale Layout

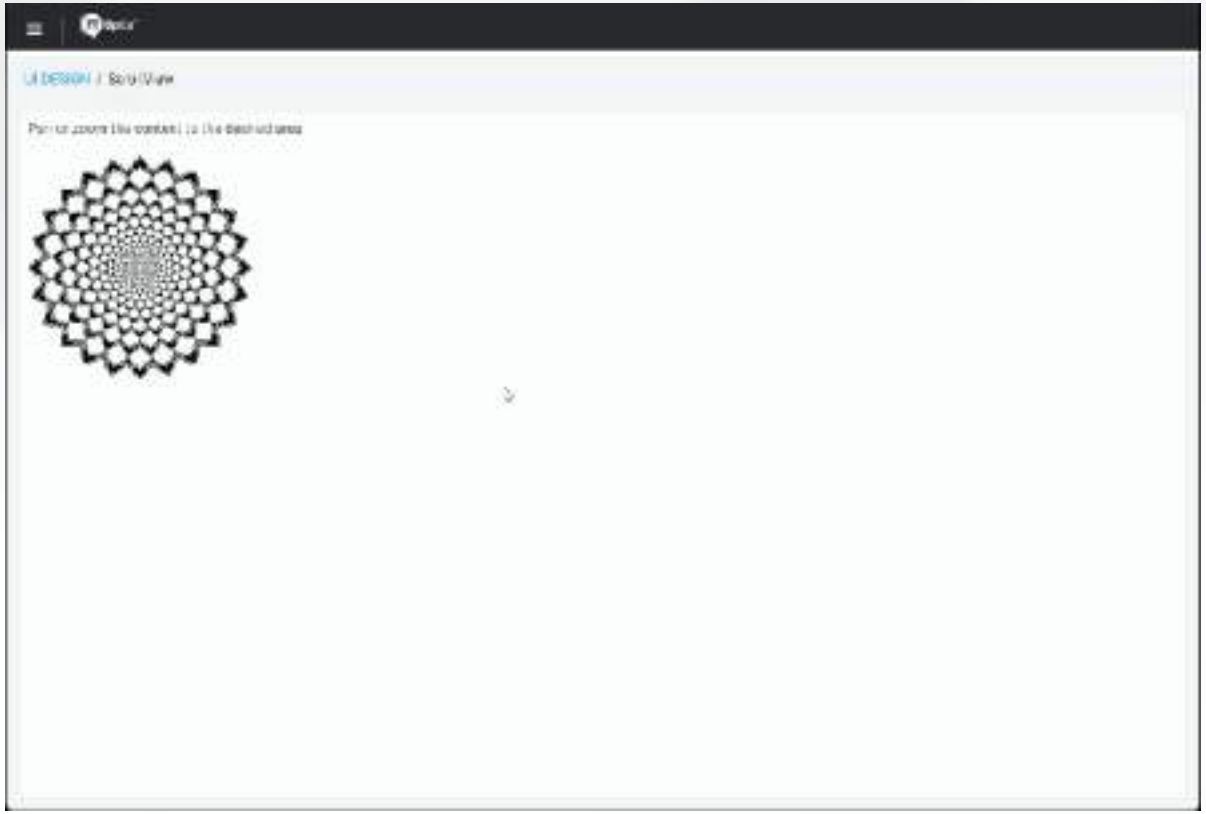




Scroll View

- Pan and Zoom on content
  - Zoom supported with Ctrl+Mouse Scroll or Multi-touch pinch





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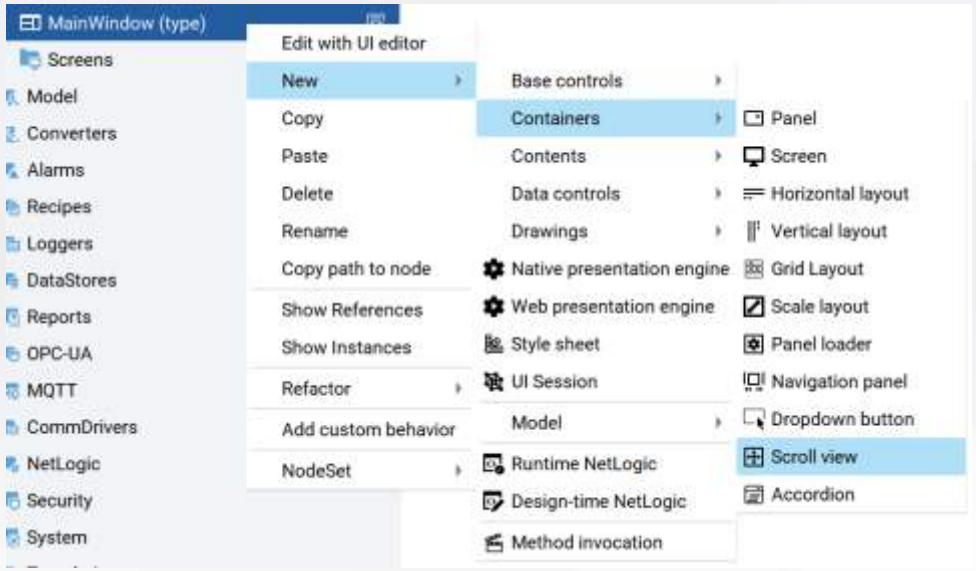
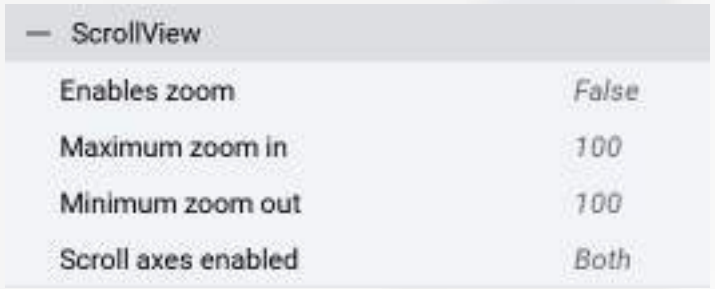
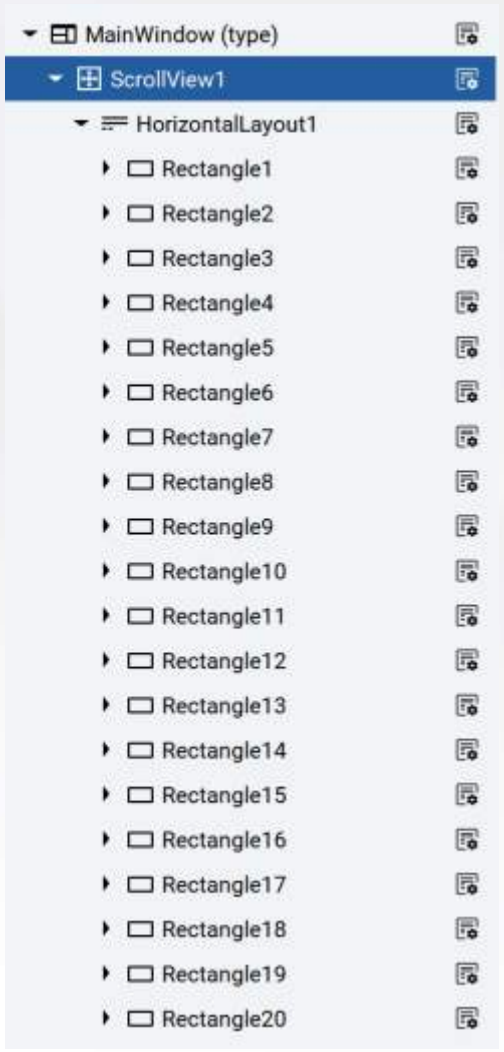




- Enables zoom: Turn on / off zoom capabilities
- Maximum / Minimum zoom in / out: Set zoom boundaries as a percentage
- Scroll axes enabled: Control scroll directions available (X Axis, Y Axis, Both)

Scroll View + Horizontal Layout (Wrapped)



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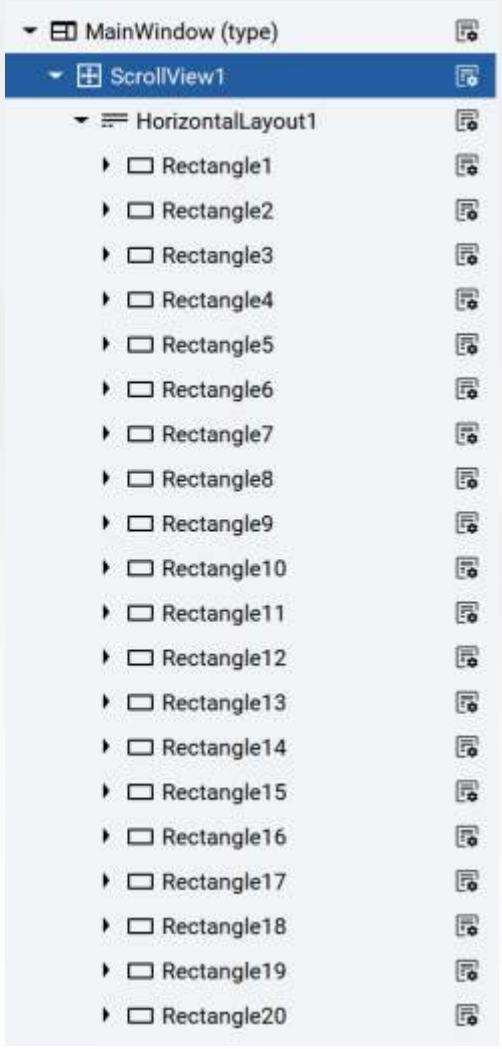
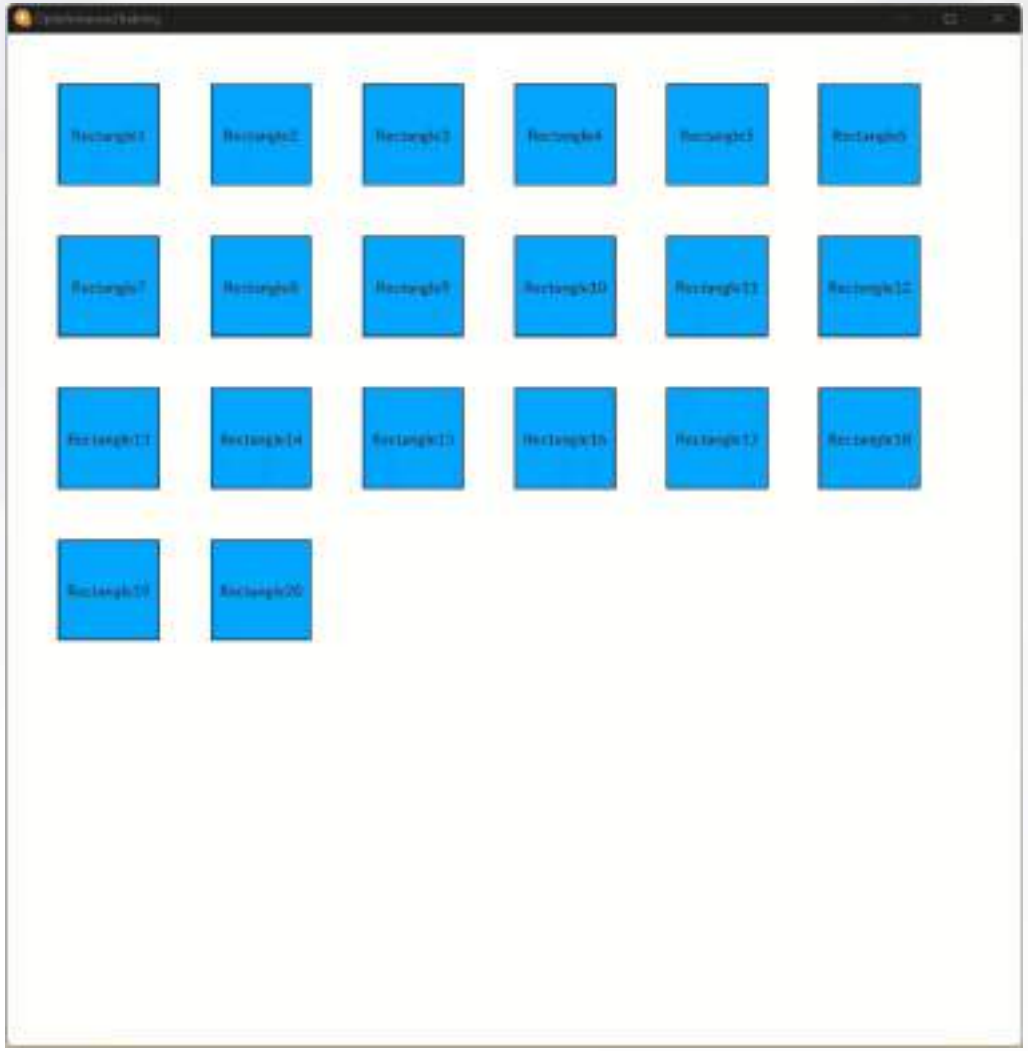
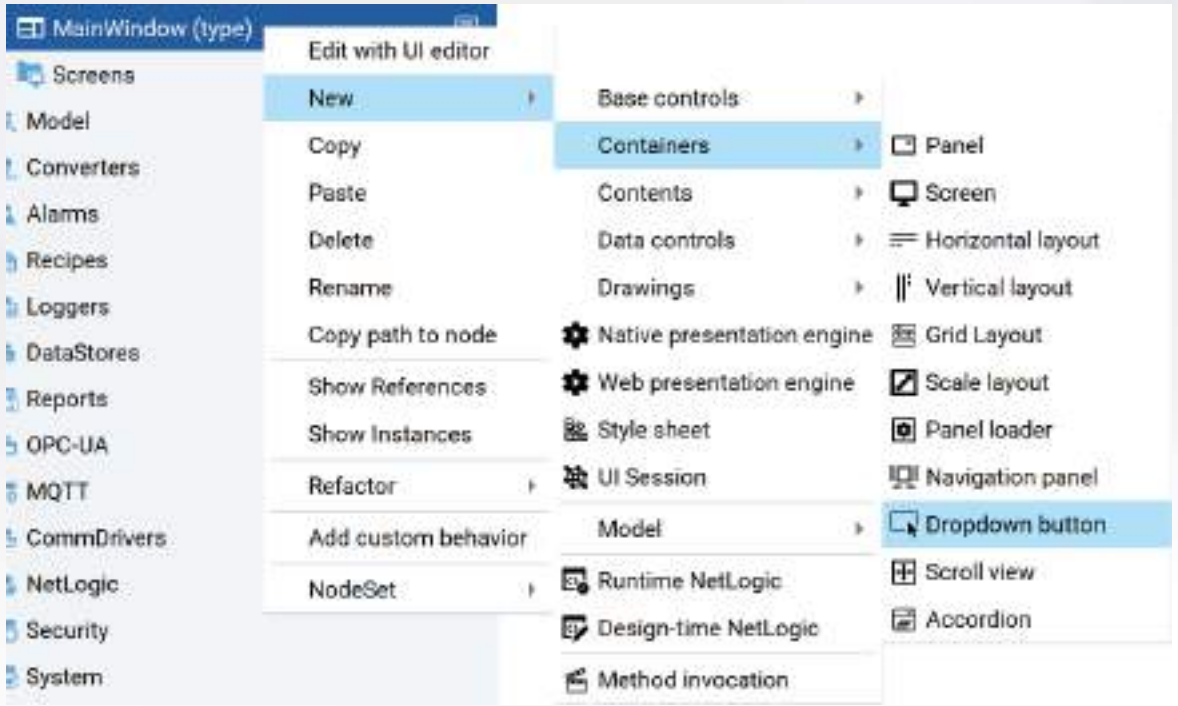
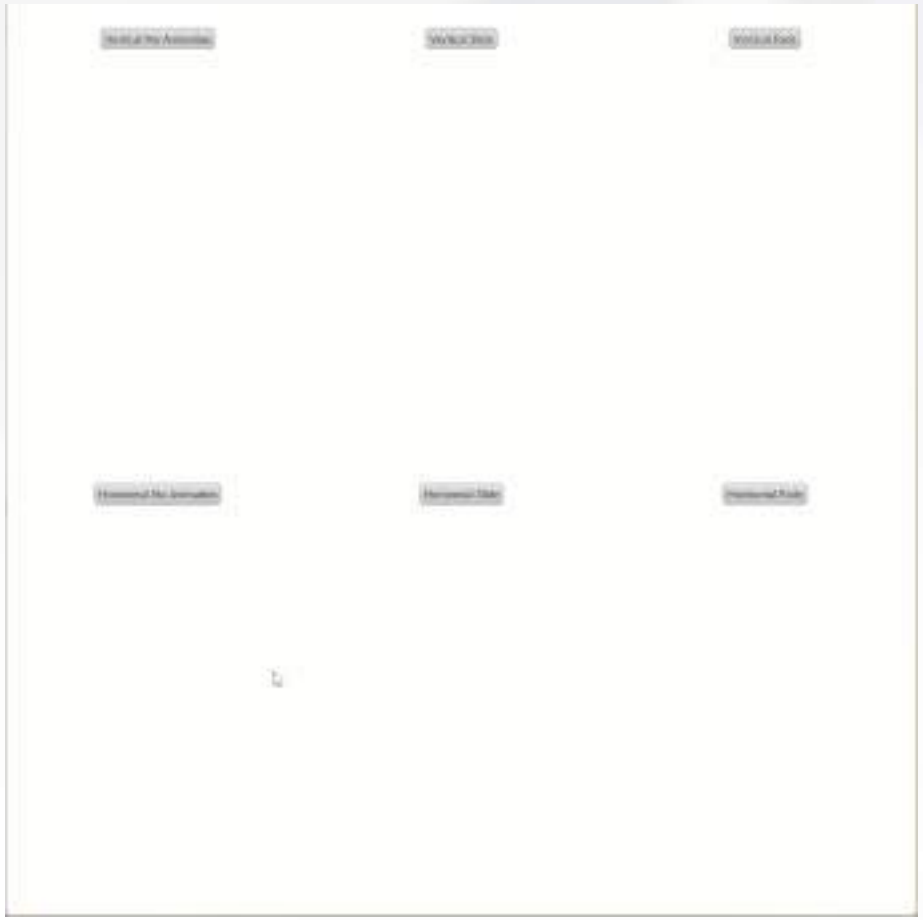




Dropdown button

- Present another container where clicked (i.e. Drop down menus or Faceplate-like functionality)





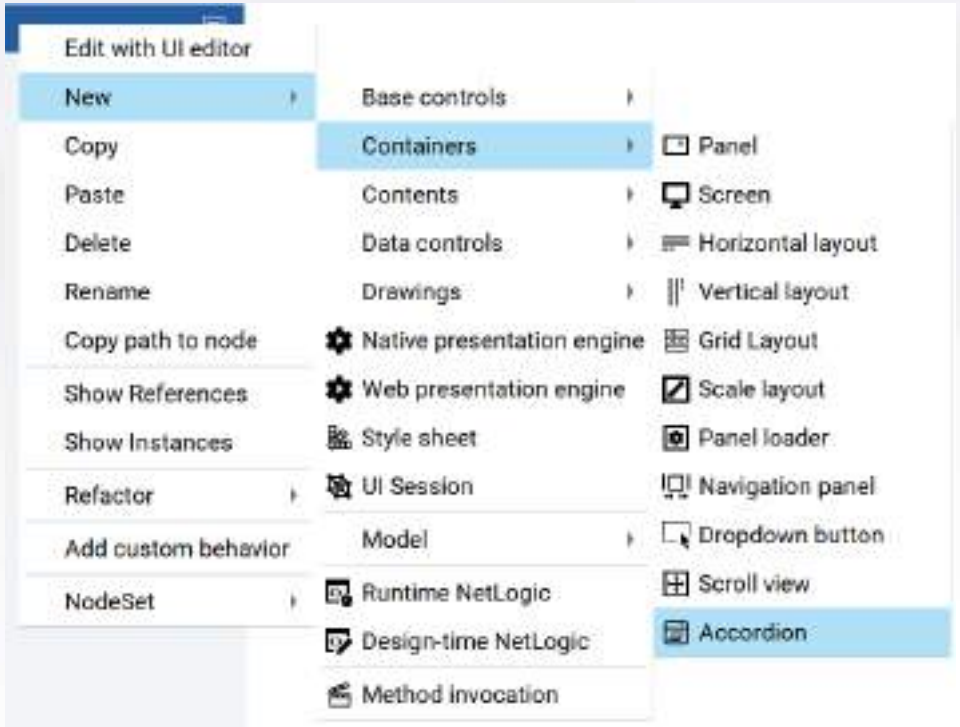
Dropdown button

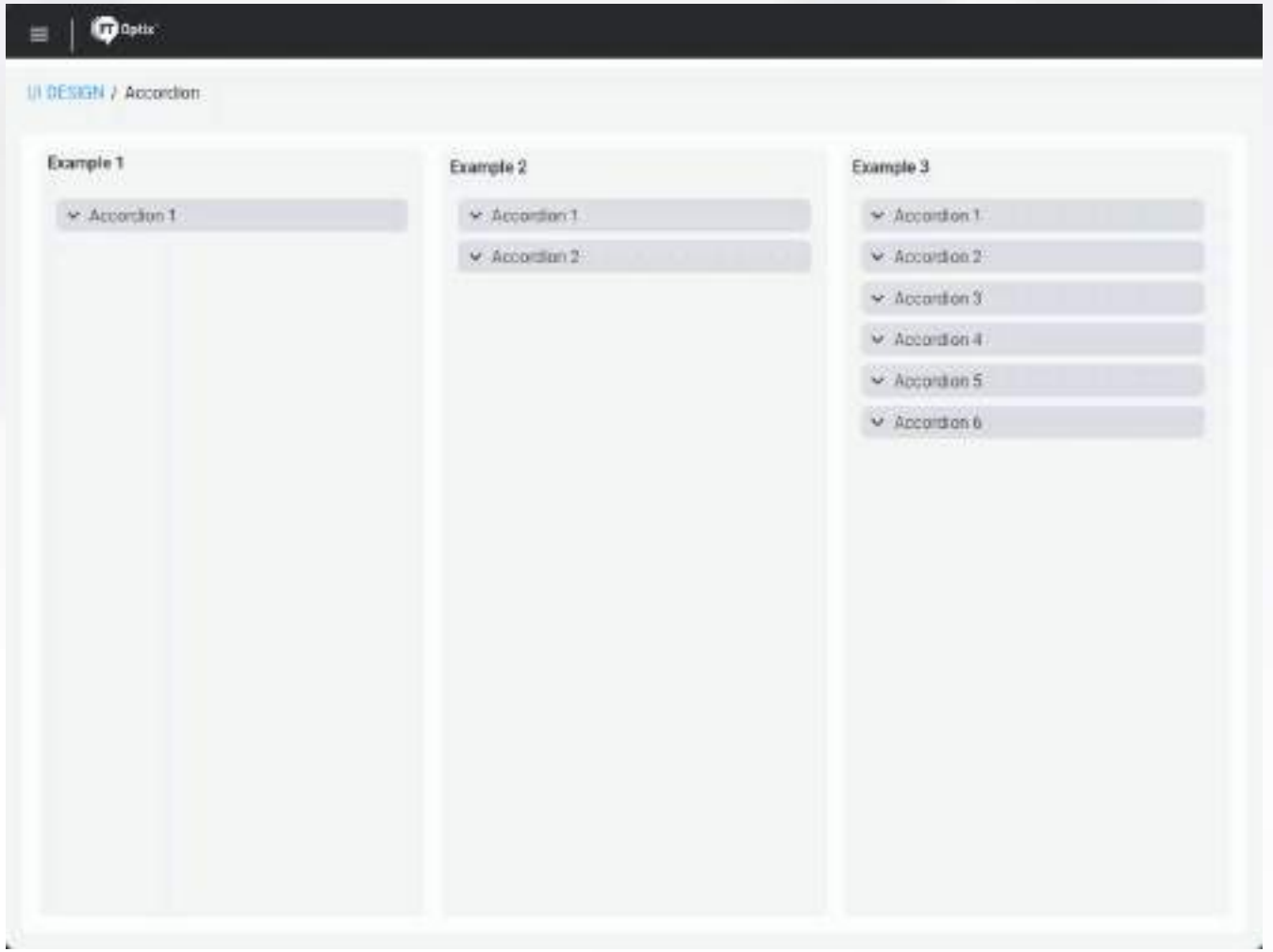
- Present another container where clicked (i.e. Drop down menus or Faceplate-like functionality)

- Panel: Panel to load on click
- Panel alias node: Aliases to pass to Panel
- Direction: Vertical or Horizontal
- Animation: None, Slide, Fade
- Close on Click inside / outside: Close panel behavior

Accordion

- Configurable Dropdown button with nesting capabilities





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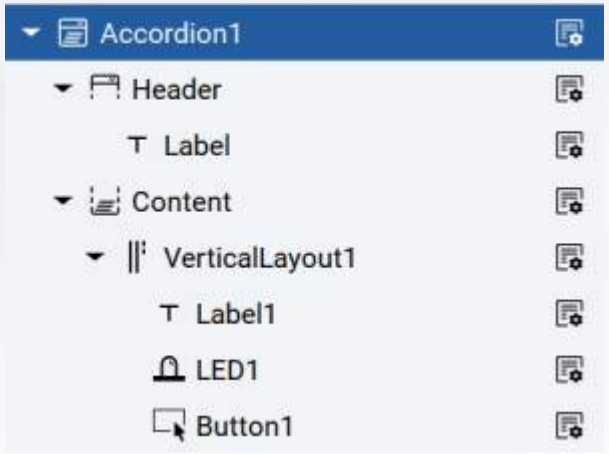
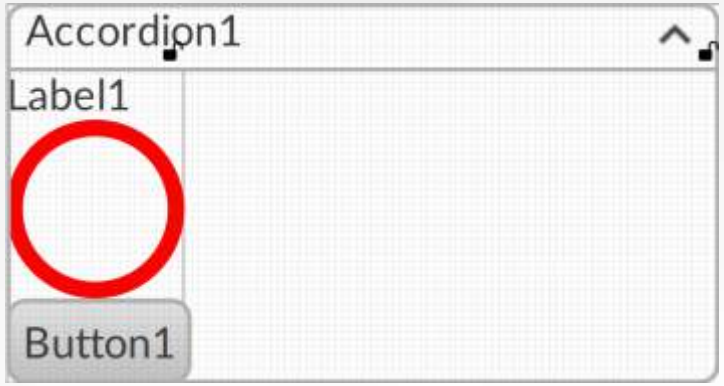
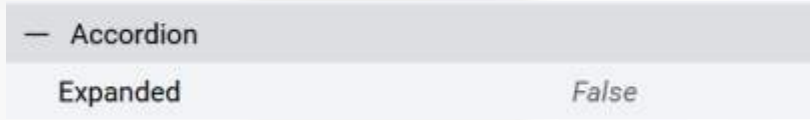




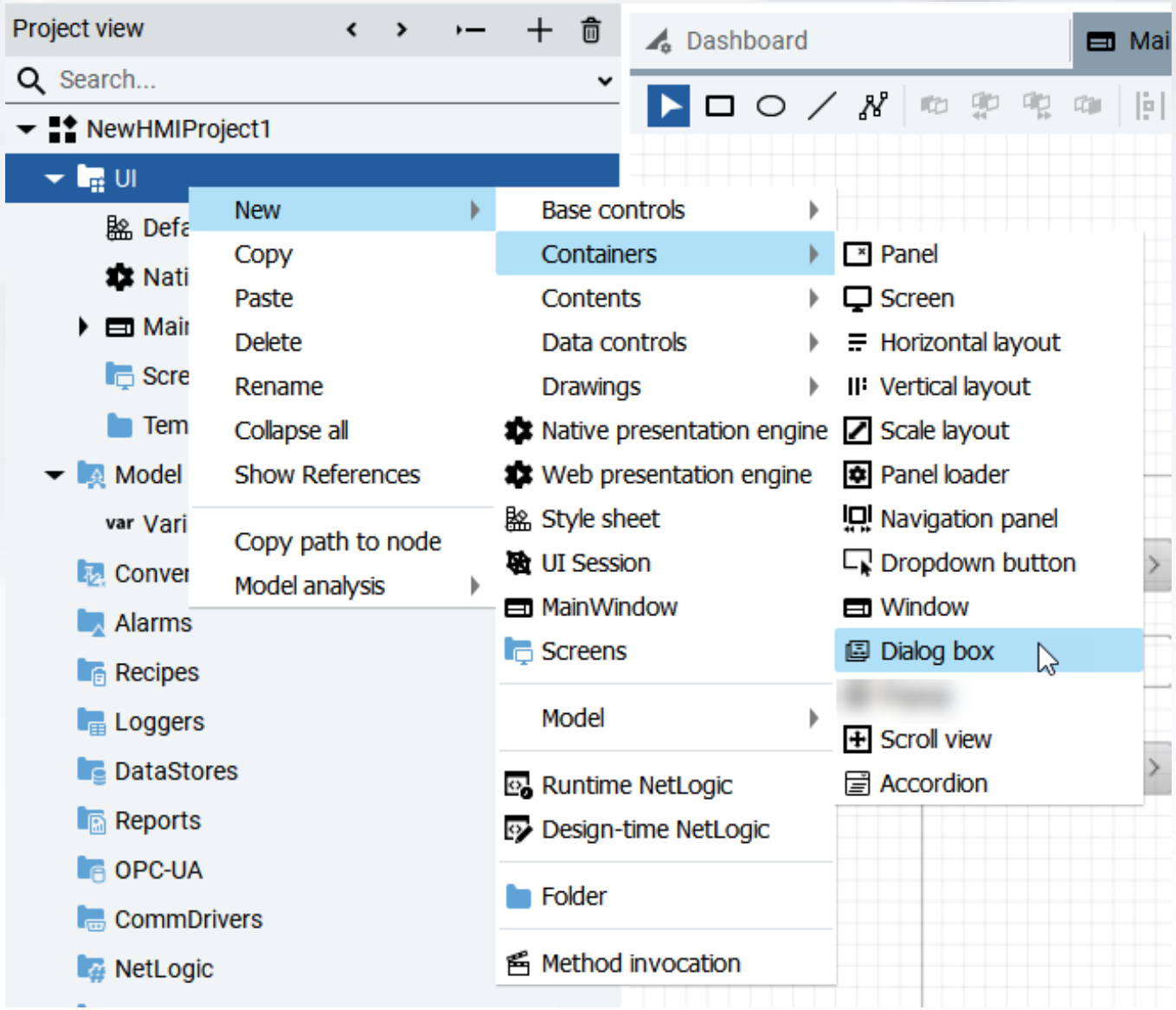


DialogBox

- Popup displays in Optix are called «DialogBox»
- DialogBox must be a type
- DialogBoxes are transparent by default

- **Note**: DialogBox does not open a new window on the device, it is a container on the highest Z-level of the MainWindow

- The «Close» method is exposed by the DialogBox itself



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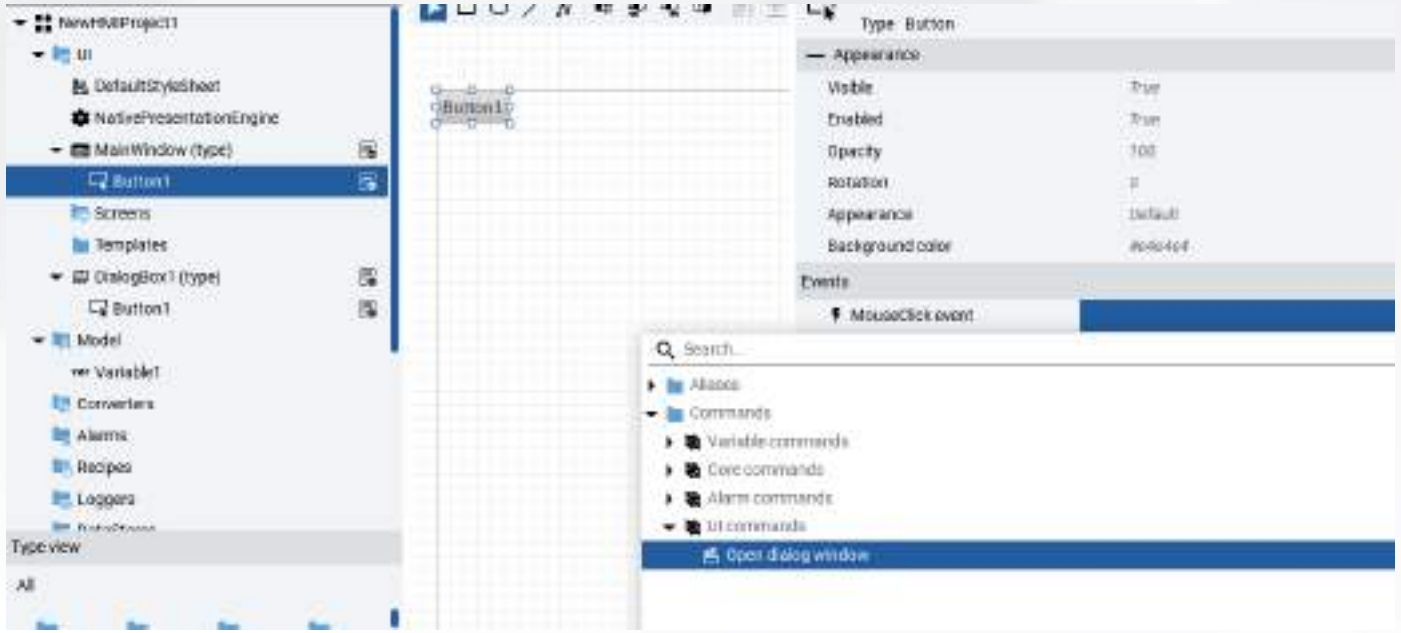
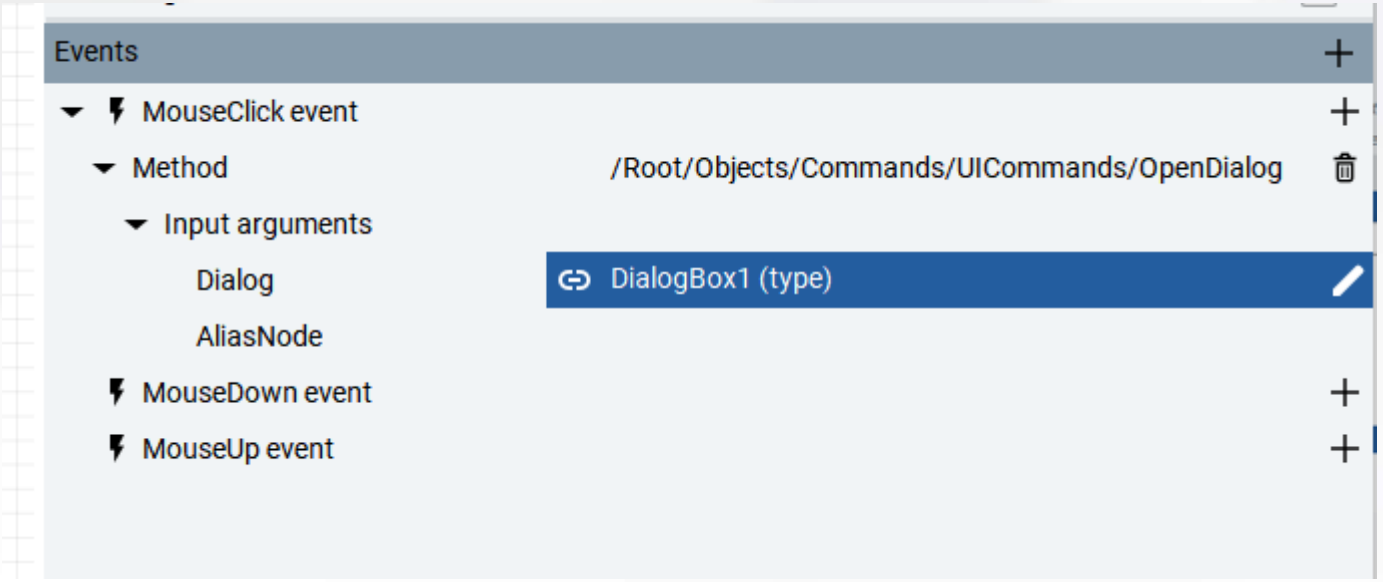


DialogBox

- Popup displays in Optix are called «DialogBox»
- DialogBox must be a type
- DialogBoxes are transparent by default



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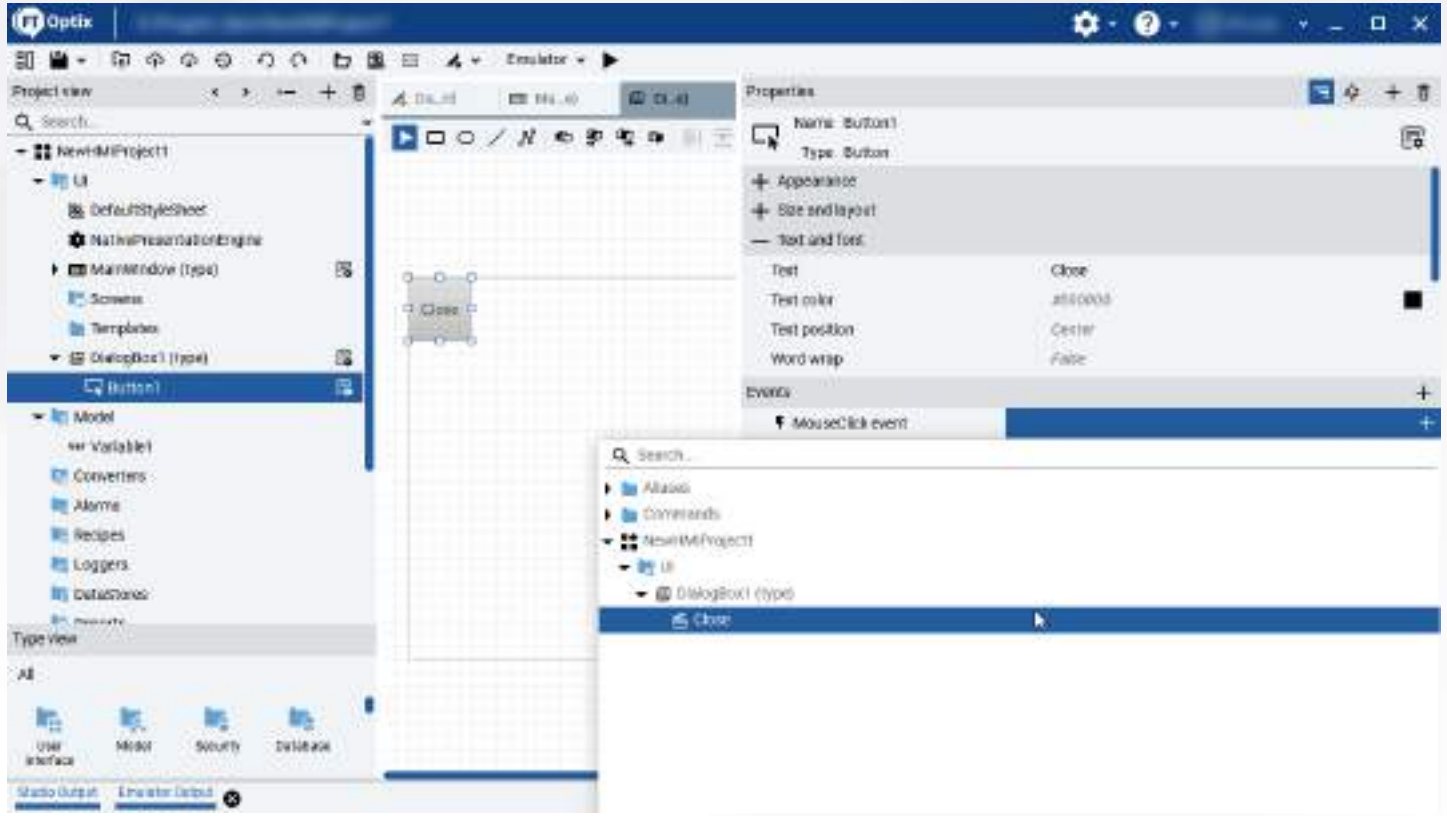
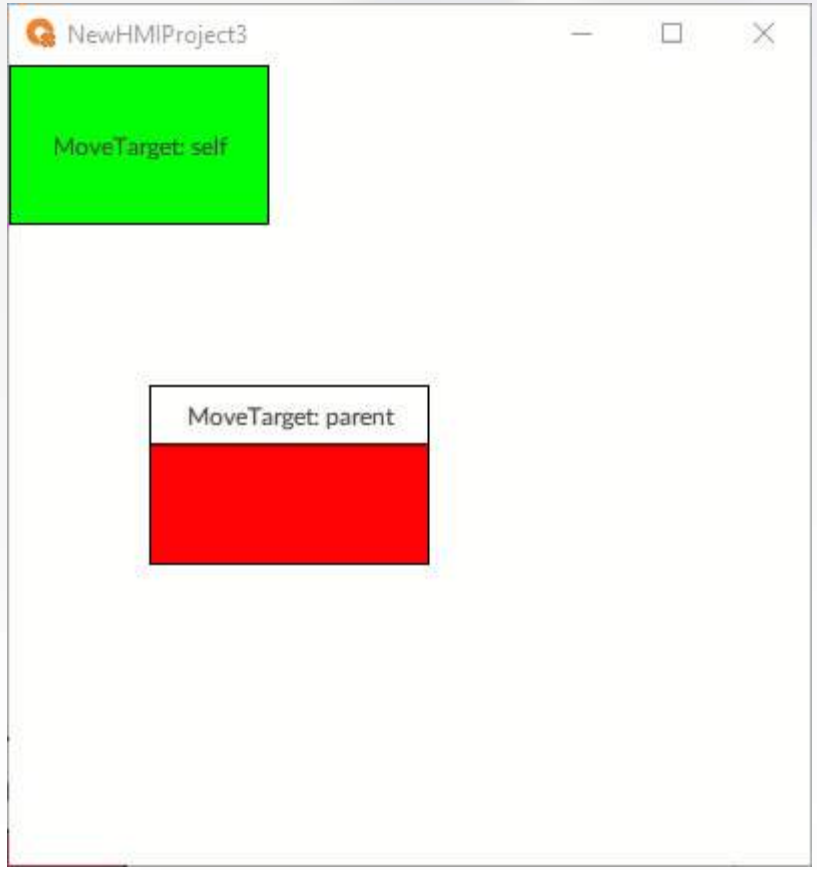


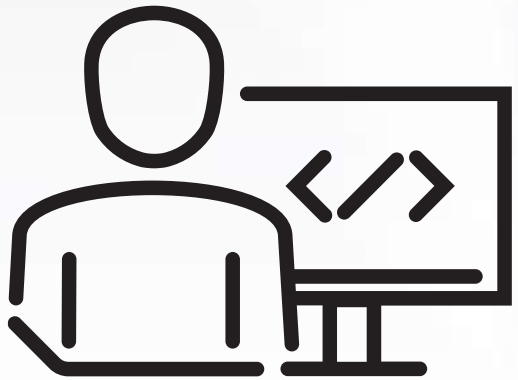
Move Target

- Elements can be moved on the screen with the MoveTarget property
  - Self -> Dragging the object will move the object itself (and its children)
  - Parent -> When selecting any of the parent objects, dragging the control will move the whole parent and all children (e.g: dragging the title bar moves the whole DialogBox)



Hands-on session

- Create a simple HMI with two or three screens and a Navigation Panel
- Add a web presentation engine
  and connect to the emulator using a browser
- Try to make the graphics responsive

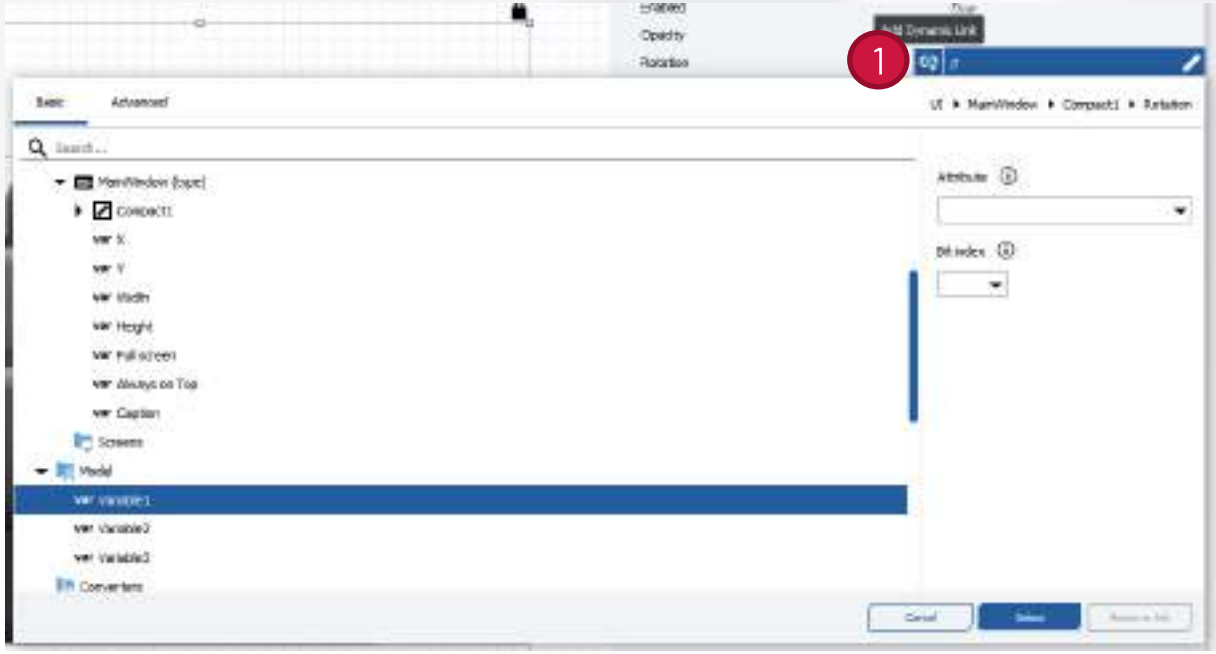


Dynamic links

Dynamic links

- Dynamic Link is a connection between two nodes
  - Property connected to a Variable
    absolute link = "Variable1"
  - Property connected to a Property of the same object
    relative link = "../Enabled"
  - Property connected to a Property of another object
    relative link = "../../Switch1/Checked"

- Can be created in different ways
  - Manual selection using the dynamic link window
  - Dragging the variable on a property
  - Dragging the variable on the graphical object
    in this case, Studio sets the dynamic link
    on the most suitable property, based on heuristics.



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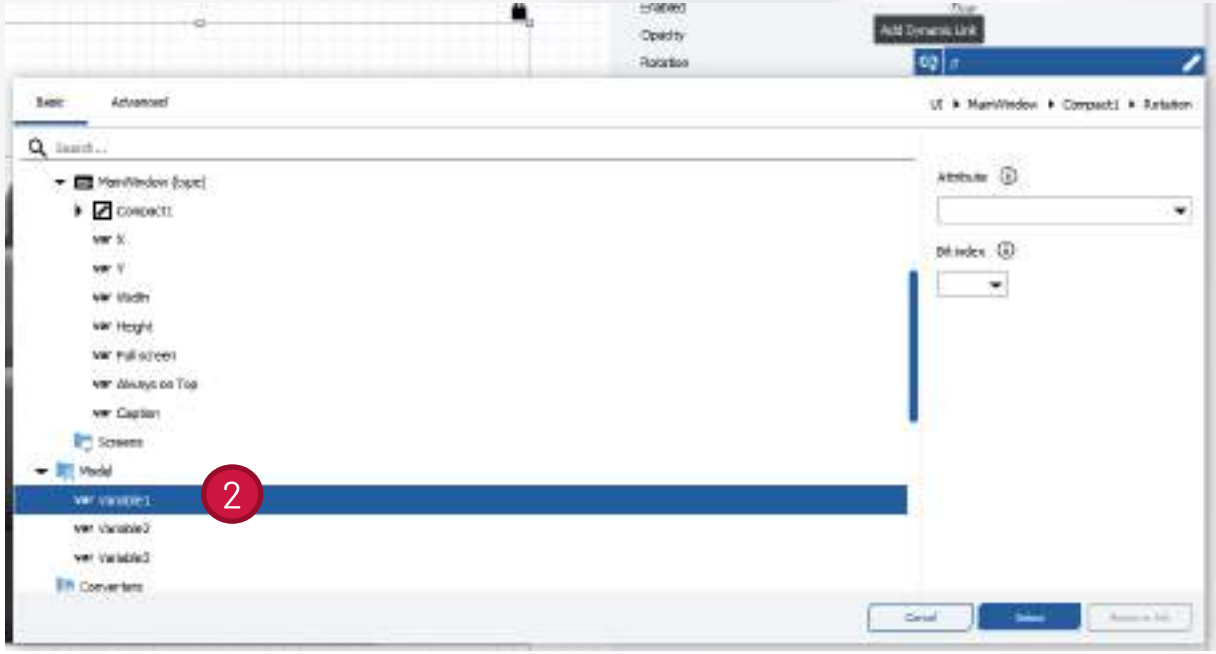

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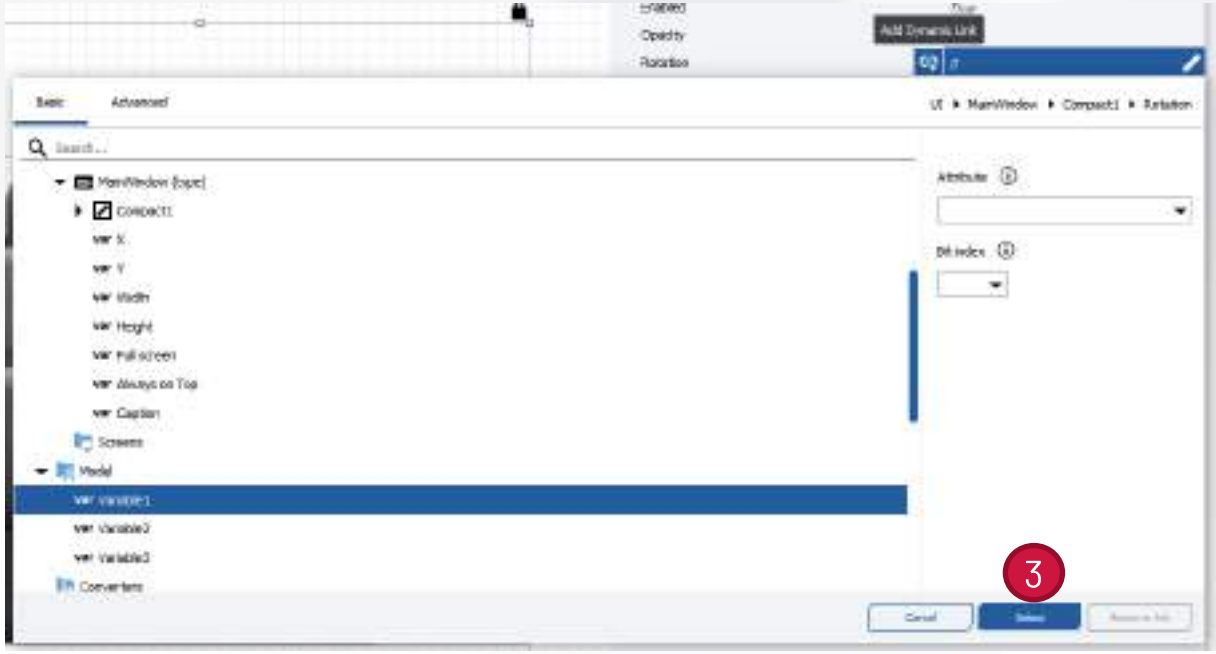

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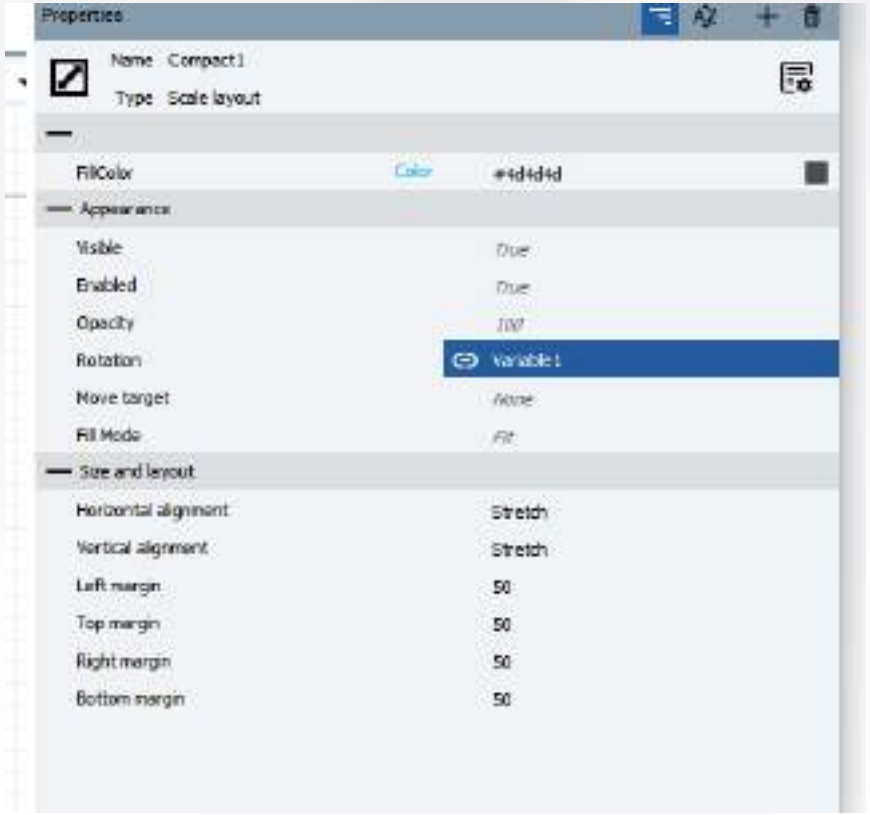

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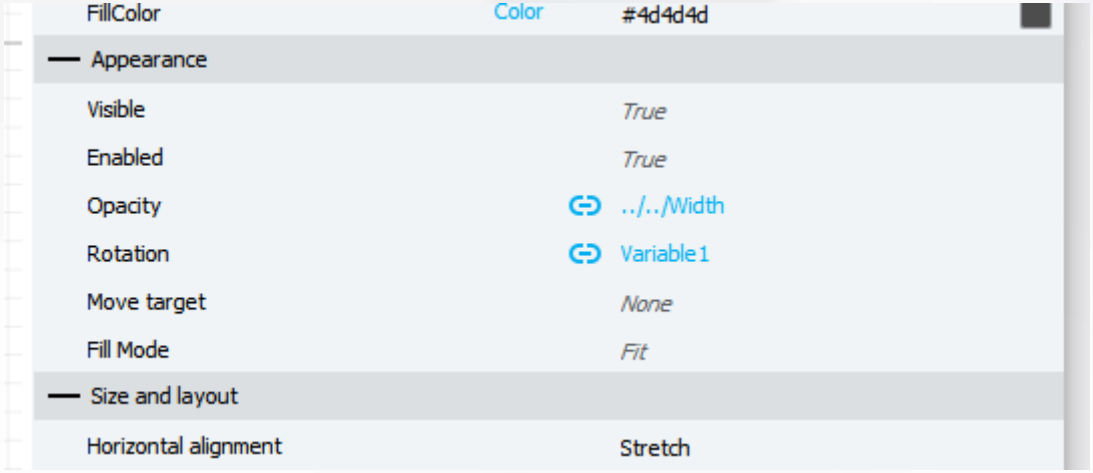
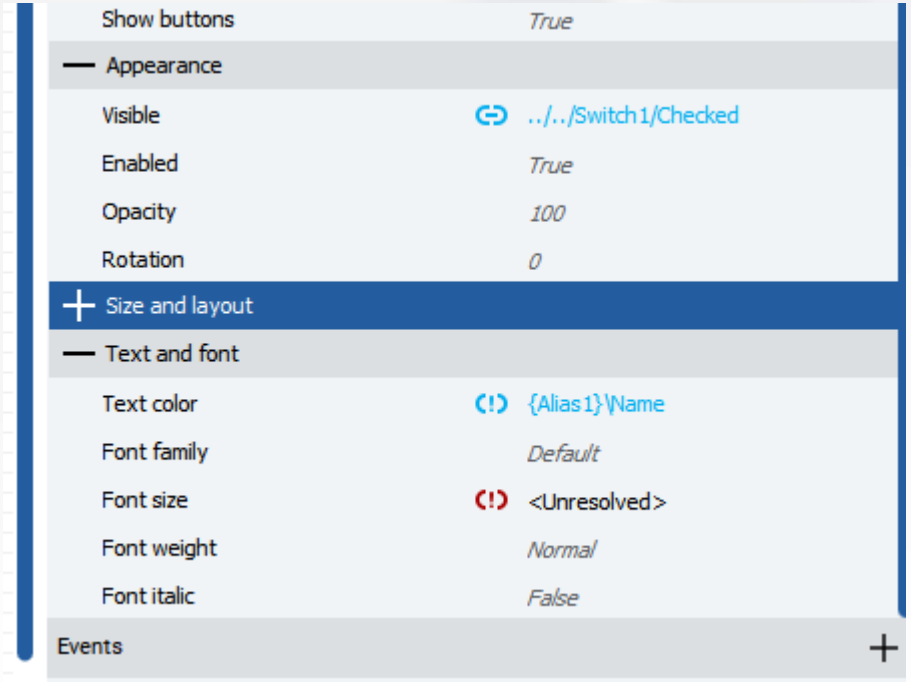


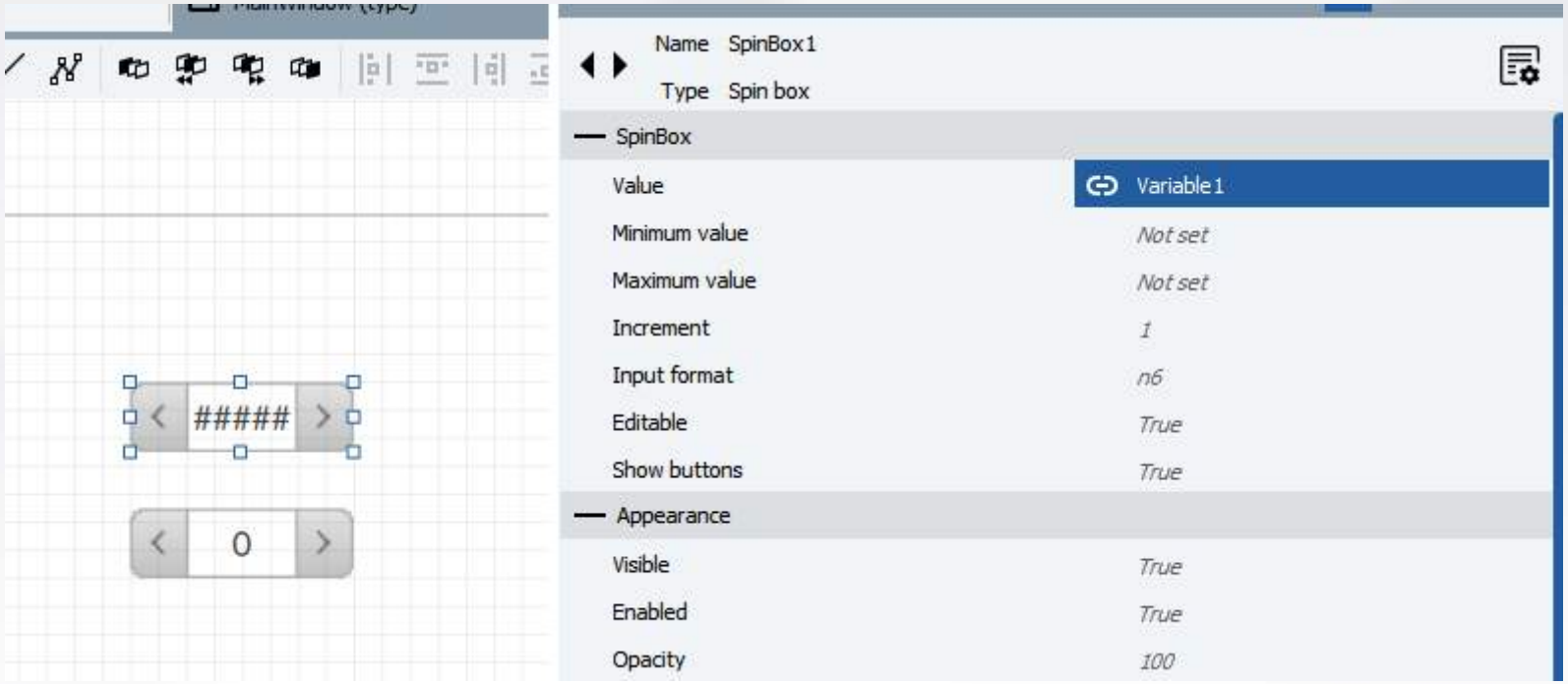
Dynamic links indicators

- Dynamic links can be
  - **Valid**: solid blue indicator, target variable is reachable
  - **Unknown**: blue exclamation mark, the target variable is not reachable at DesignTime (an Alias for example) but can be good at Runtime
  - **Unresolved**: the target variable does not exist, DynamicLink is most likely broken



Advanced dynamic links: indexing

- Variables can be indexed by using {0} placeholder



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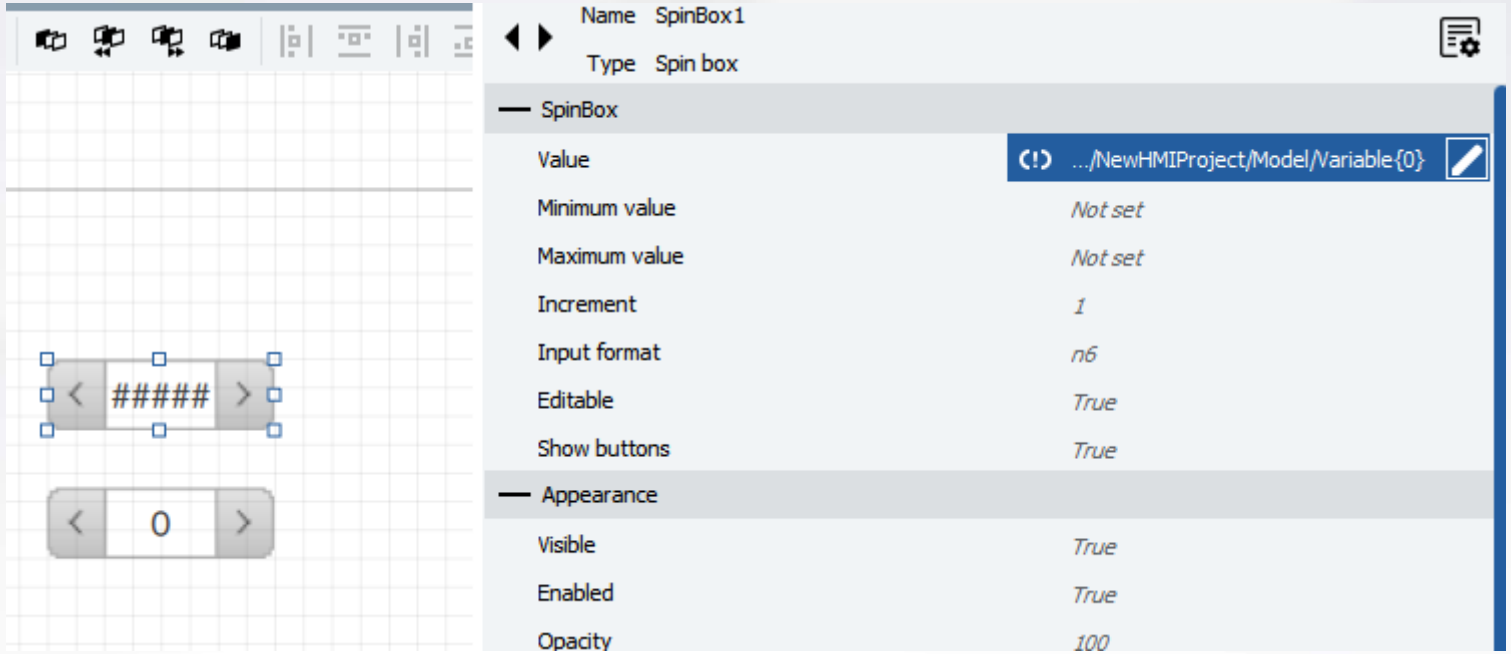

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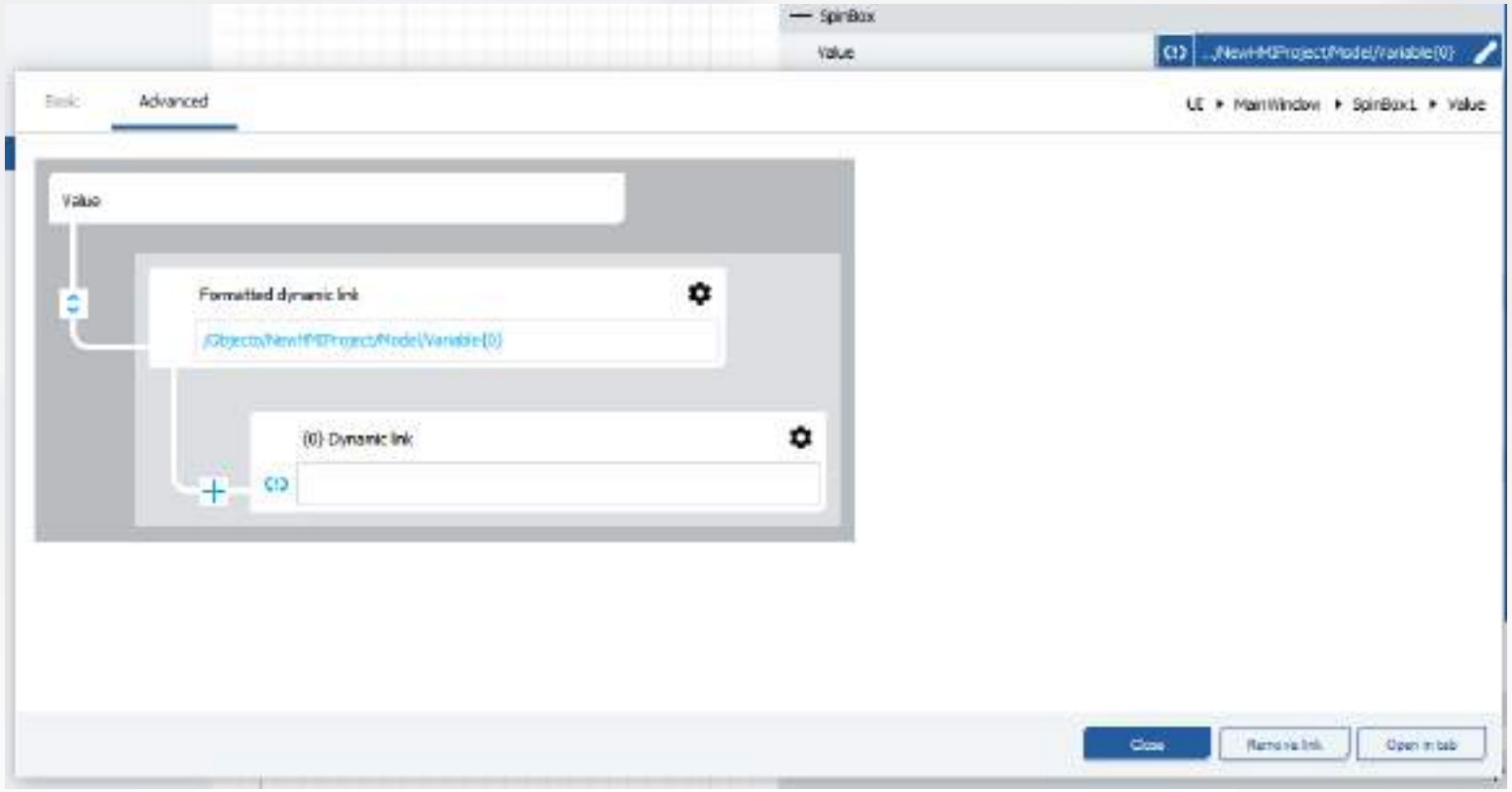

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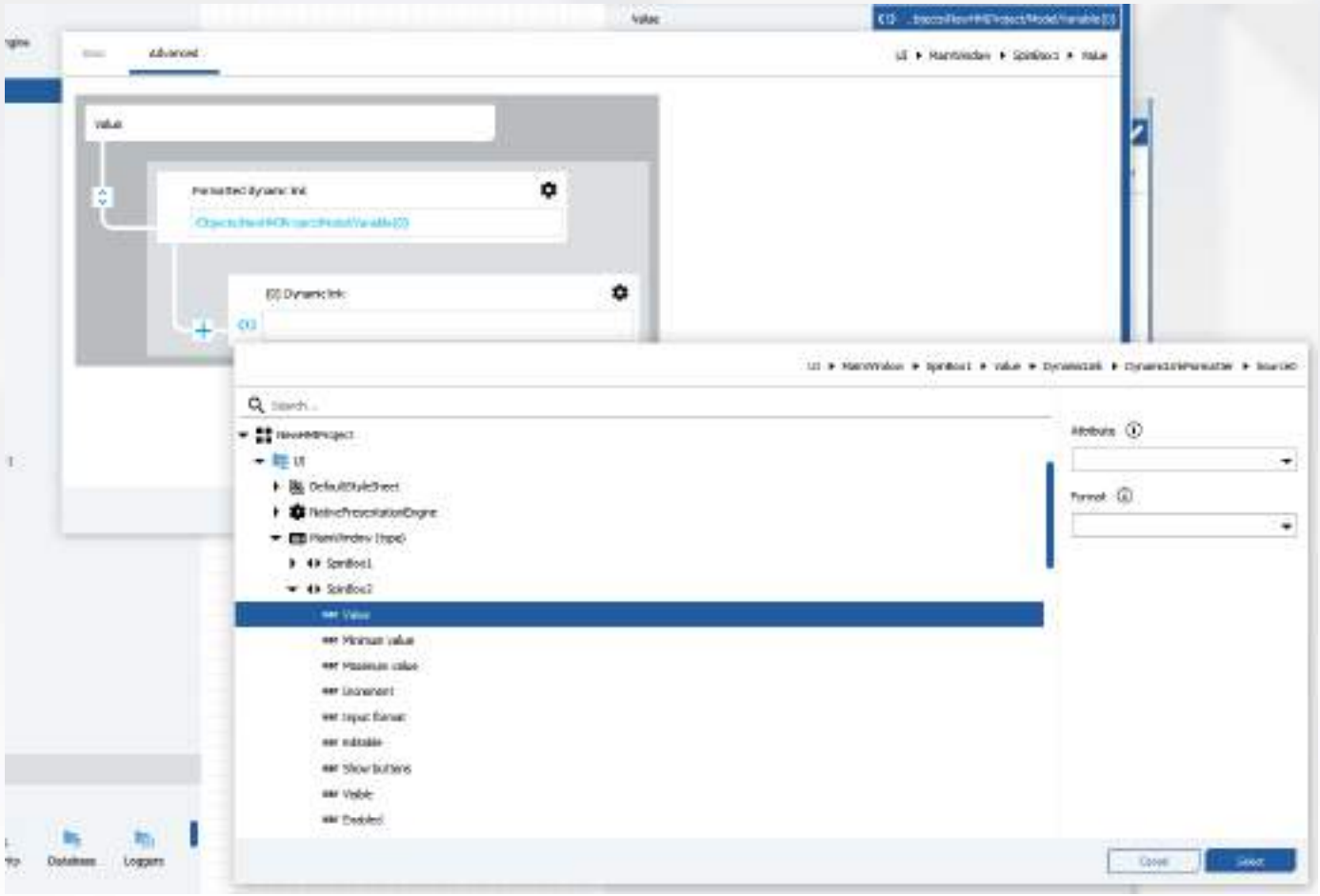
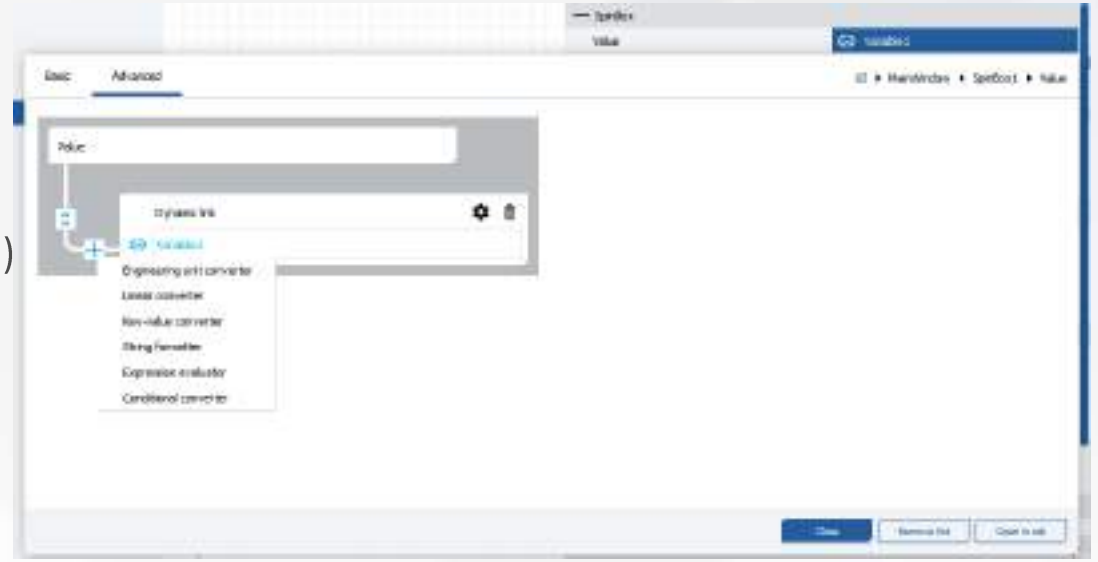


Advanced dynamic links: converters

- By [Advanced...] button on Dynamic Link window, the value of a Property can be set through a Converter
  - **Engineering Unit converter**: it's a linear conversion defined by Raw range (PLC) and Scaled range (HMI)
  - **Linear converter**: it's a linear conversion defined by equation $y = \mathbf{m}x + \mathbf{q}$
  - **Key-Value converter** *: converts the value of the source variable according to a table of key-value pairs.
  - **String formatter**: modify the format of a Numeric, Date/Time, String, SQL Query
  - **Expression evaluator**: performs arithmetic calculations with one or more input values
  - **Conditional converter:** writes two different values according to a boolean Condition DynamicLink



* Key-Value converter table can be exported to csv file and imported back, using a Template Library script

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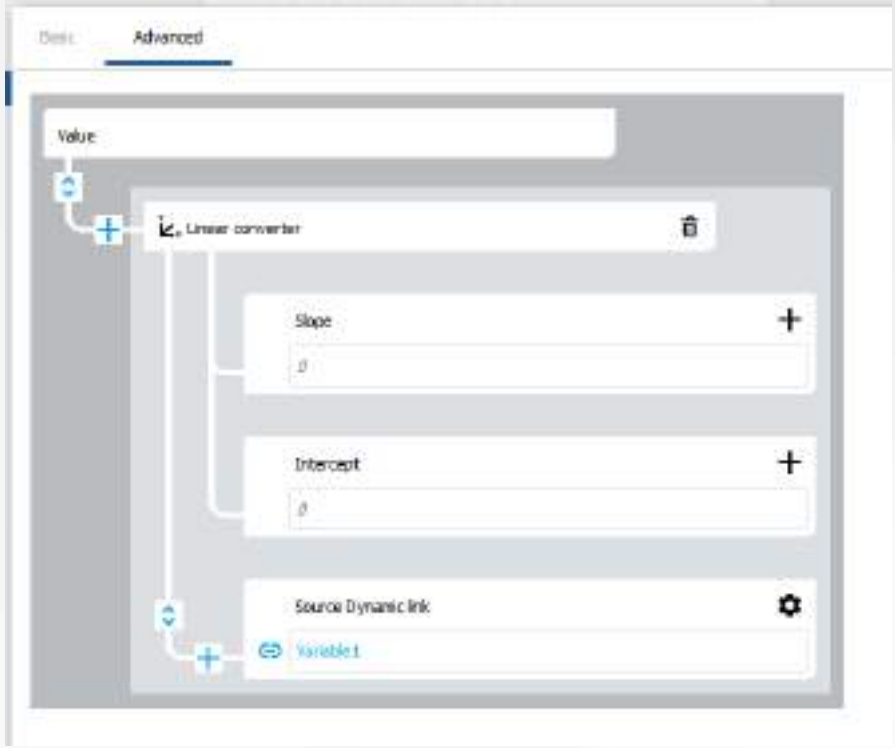

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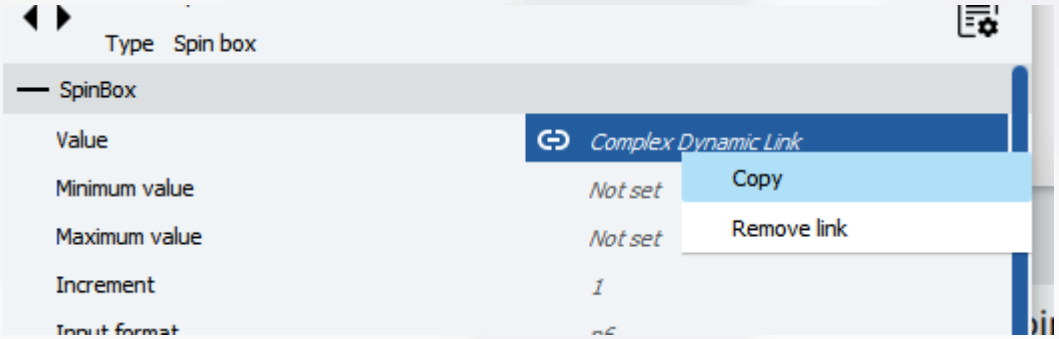
Advanced dynamic links: reusable converters

- Converters can be reused
  - Using **copy/paste**
    1. Copy the converter from the property with "*Complex Dynamic Link*"
    2. Paste to another property



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    1. Create a Converter into Converters node
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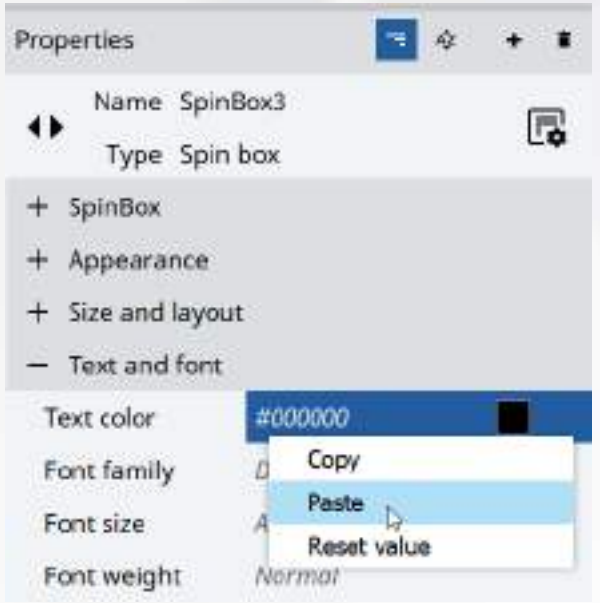

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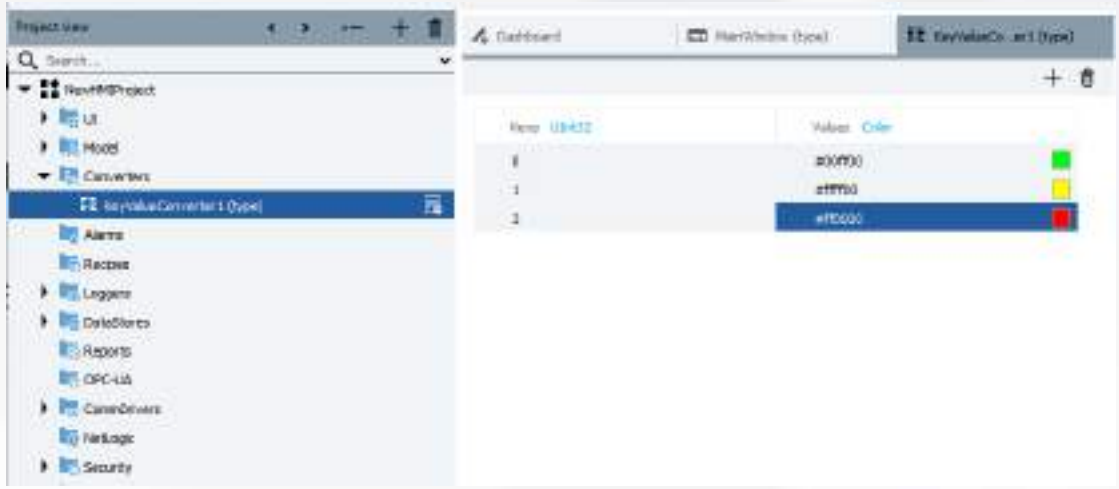

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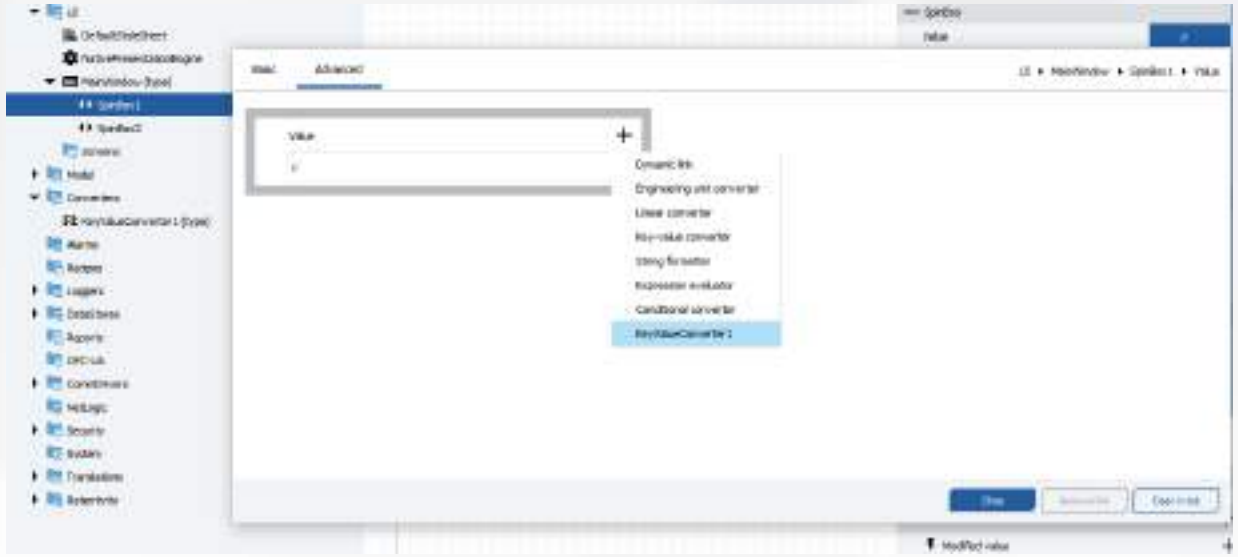

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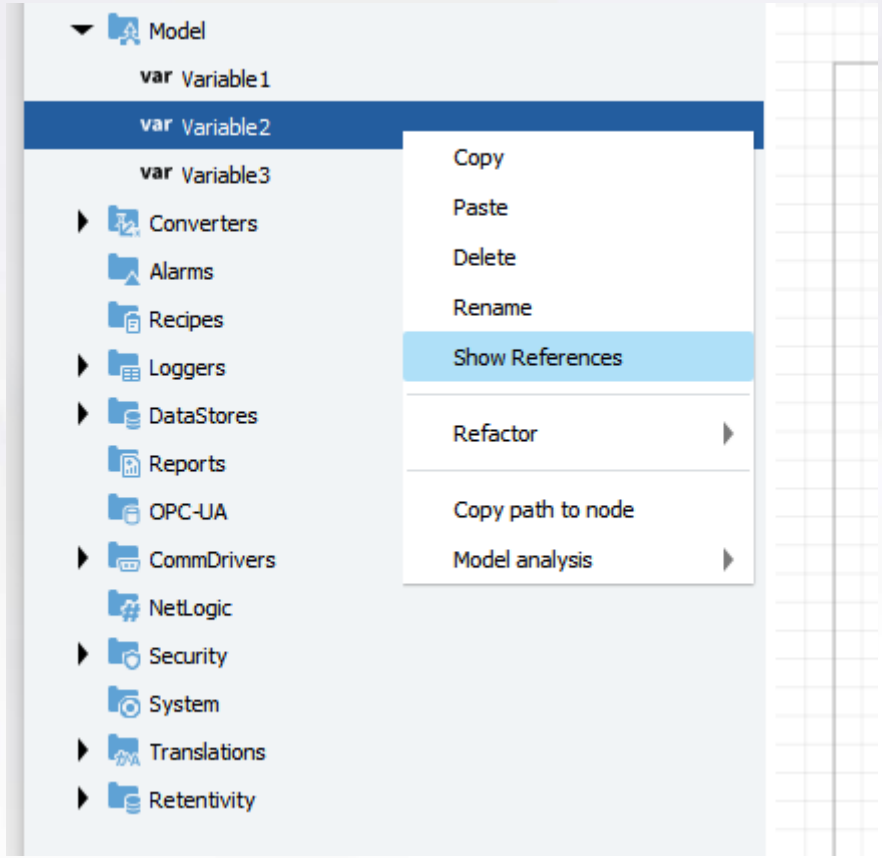

- Answer the question:

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- Can be used mainly for Tags, but also, for other objects like
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  - ...

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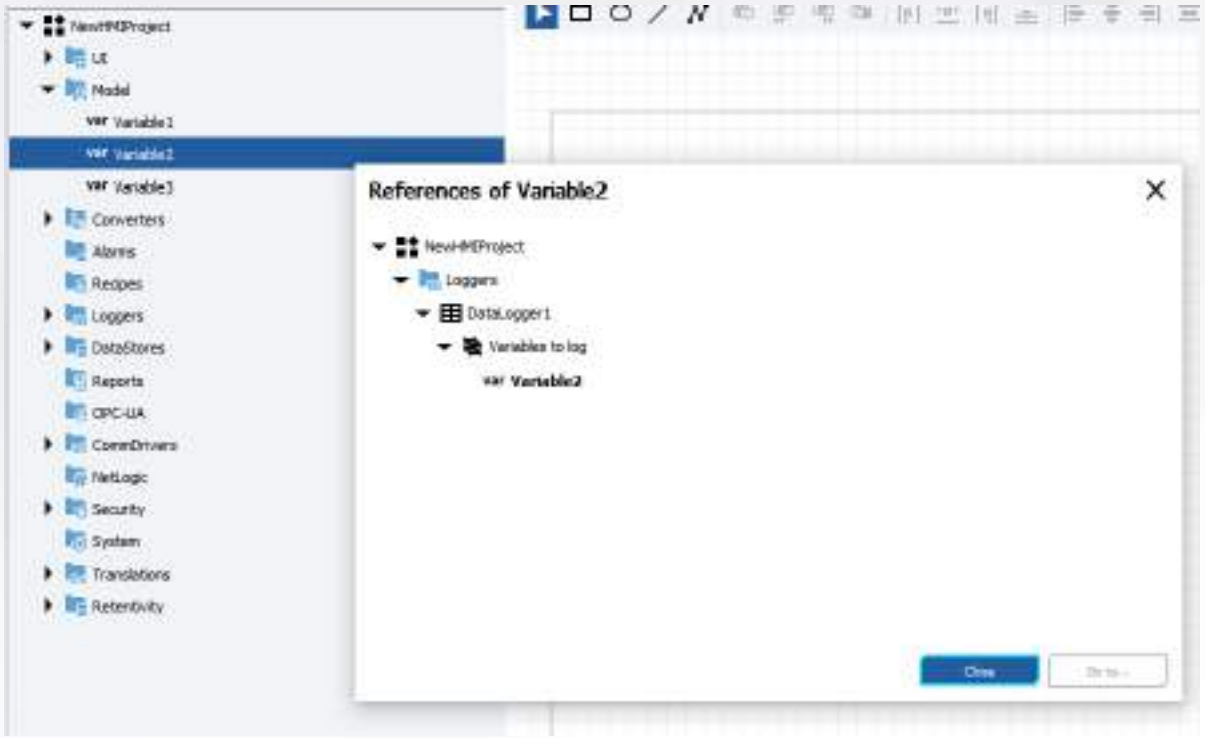

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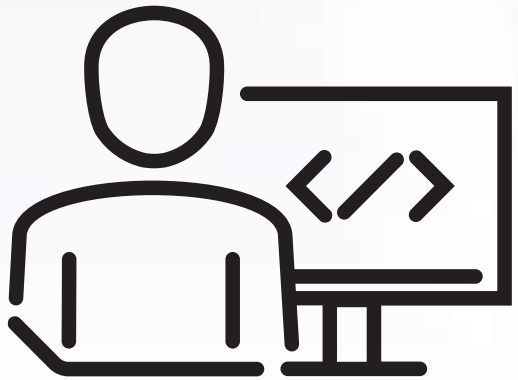
Hands-on session

- Define an "indexed dynamic link"
  to show the value of Variable1, Variable2, Variable3
  using a SpinBox

- Use a Key-Value converter to change the background color of a rectangle
  based on the value of a variable

- Use a Key-Value converter to change the string of a label
  based on the value of a variable

- Use a Linear convert to show a scaled value

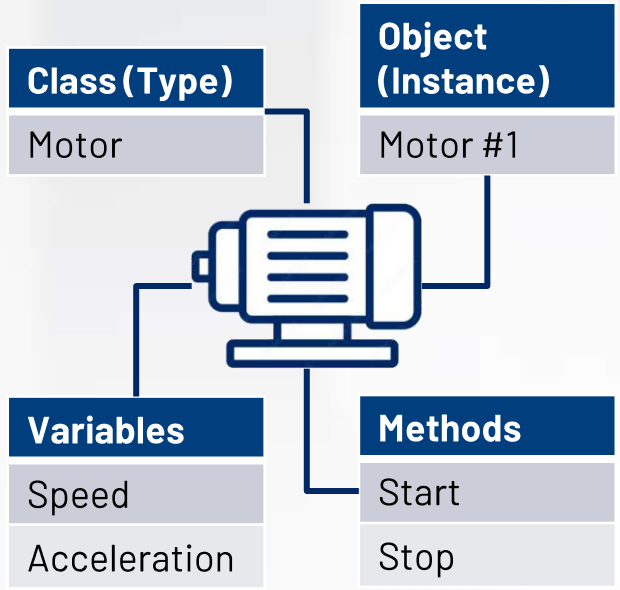


Work with reusable objects

Global objects, UDTs, Widgets

Object-oriented programming (OOP) paradigm

- Elements of OOP:
  - **Class:** as a core element, it's a collection of methods and variables and generally, it is regarded as a **type for instance**.
  - **Object:** as a basic element, it is regarded as an **instance** of a class

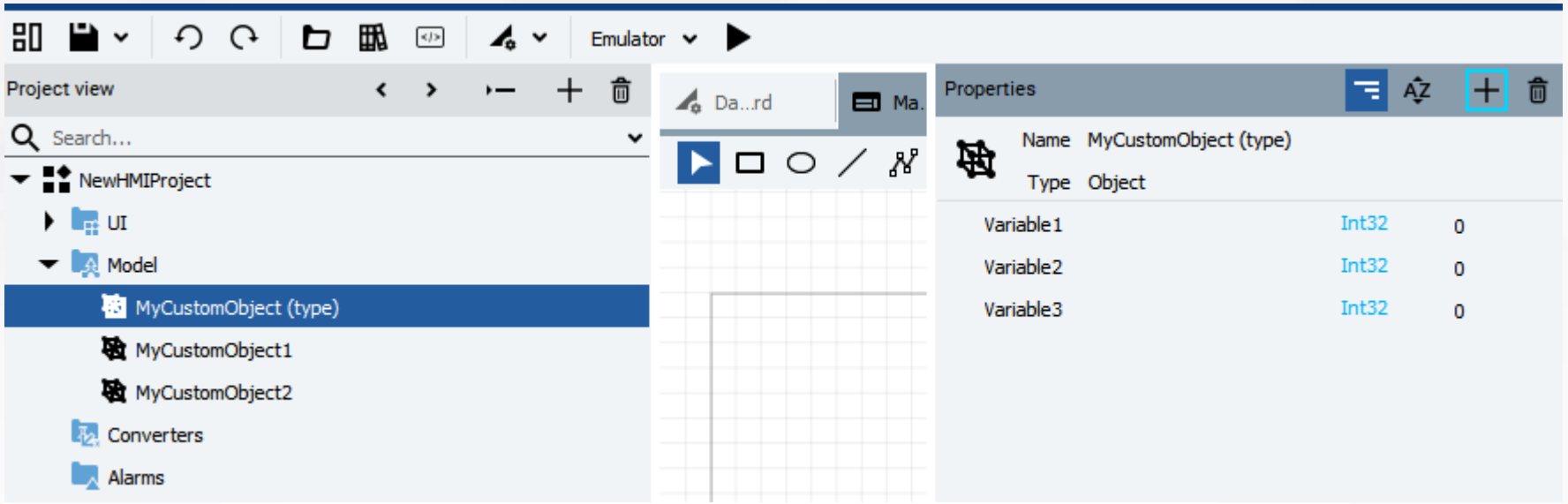


- Capabilities of OOP:
  - Encapsulation, Abstraction, Inheritance, Polymorphism

- Object-Oriented Programming in Optix means
  - **Native Types** already seen →
  - **Custom Types**

Custom types: reusable tags

- Object-Oriented Programming paradigm can be applied to Model Tags
  - “MyMotor (type)” = Class = Type
  - “MyMotor1”, “MyMotor2” = Instances



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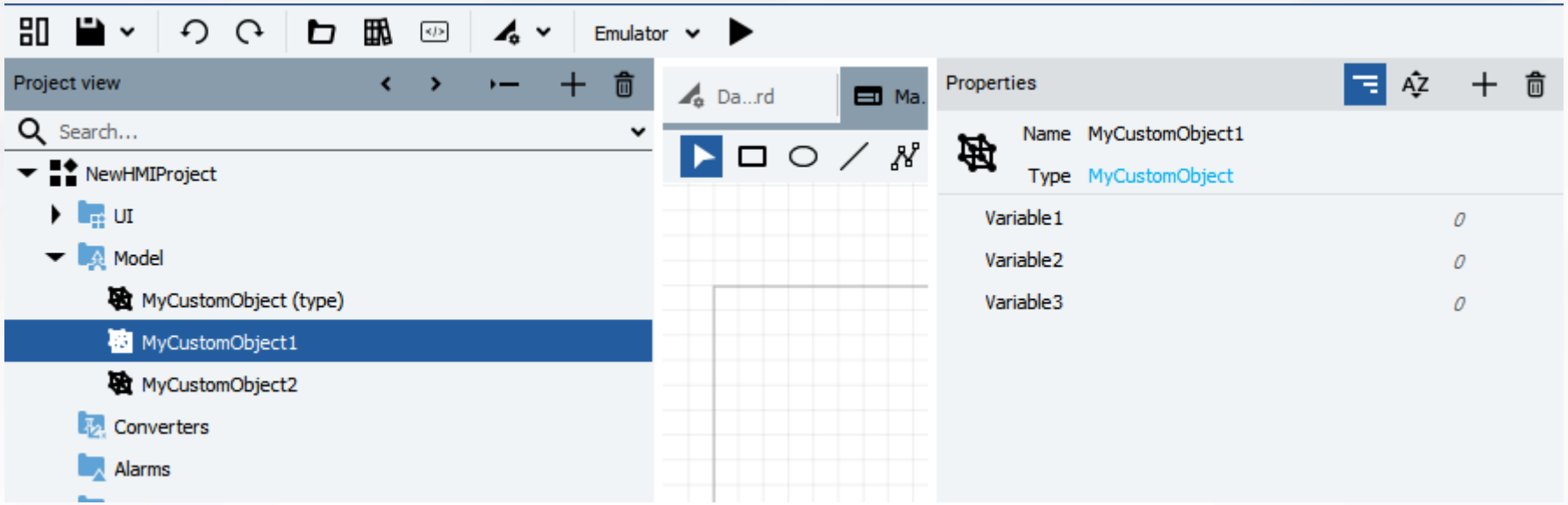
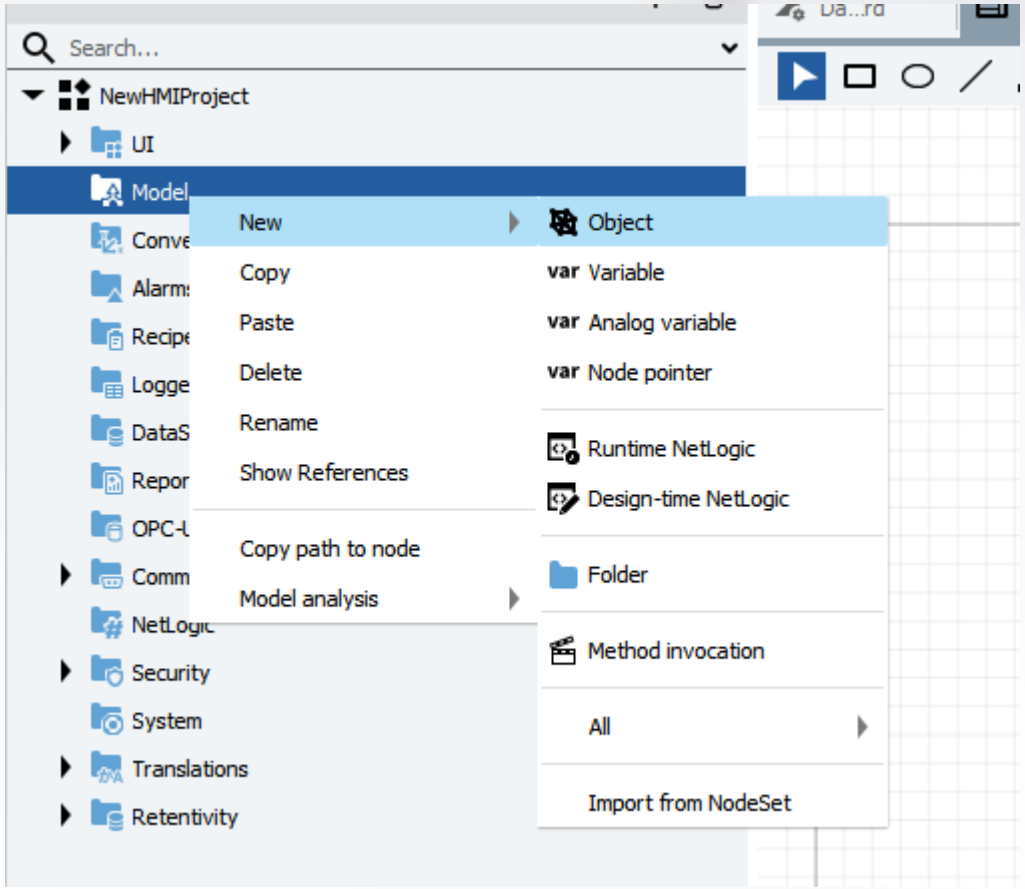


Custom types: reusable tags example

- Example: a Structured Tag into Model folder

- Created as a brand **new object** that becomes a **new type**

- How to make your object a Type:
  - Option 1: Drag&Drop into Types View panel
  - Option 2: in "Advanced Mode", Right click > Refactor > Transform instance to type



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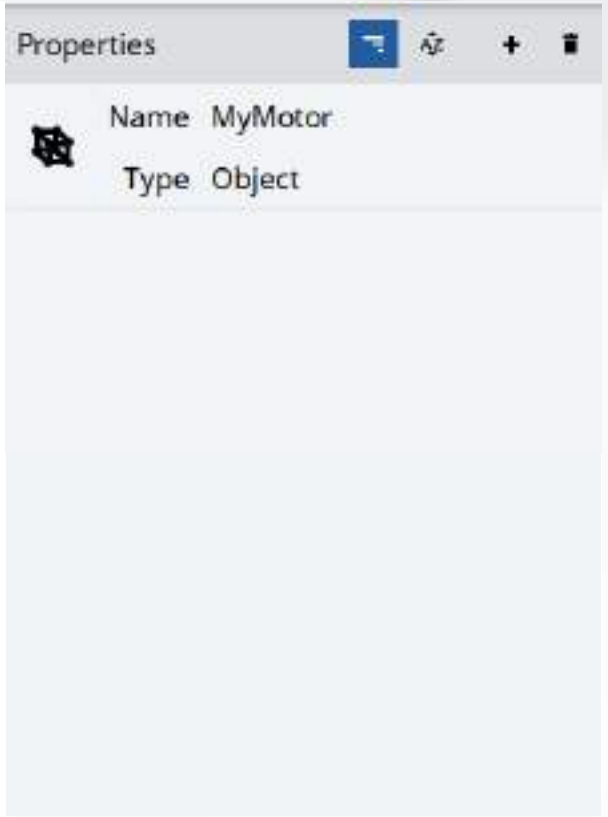

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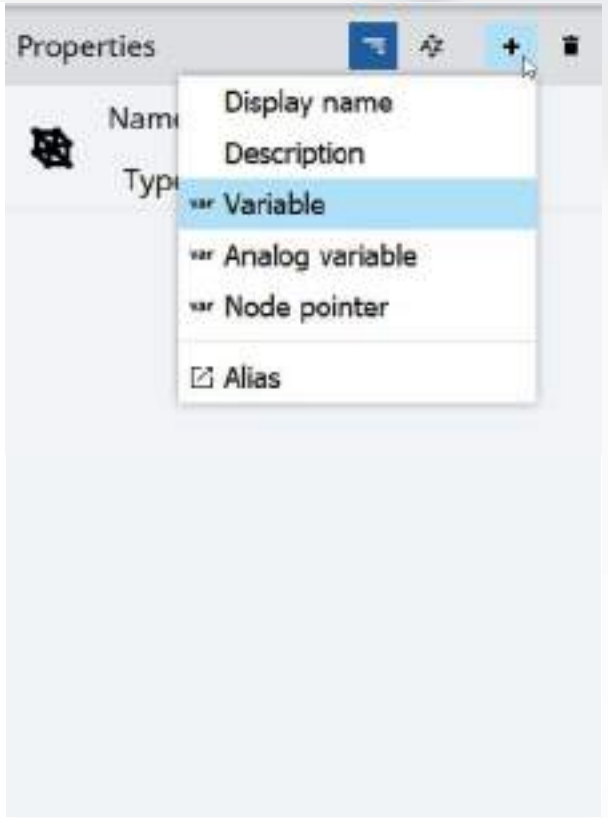

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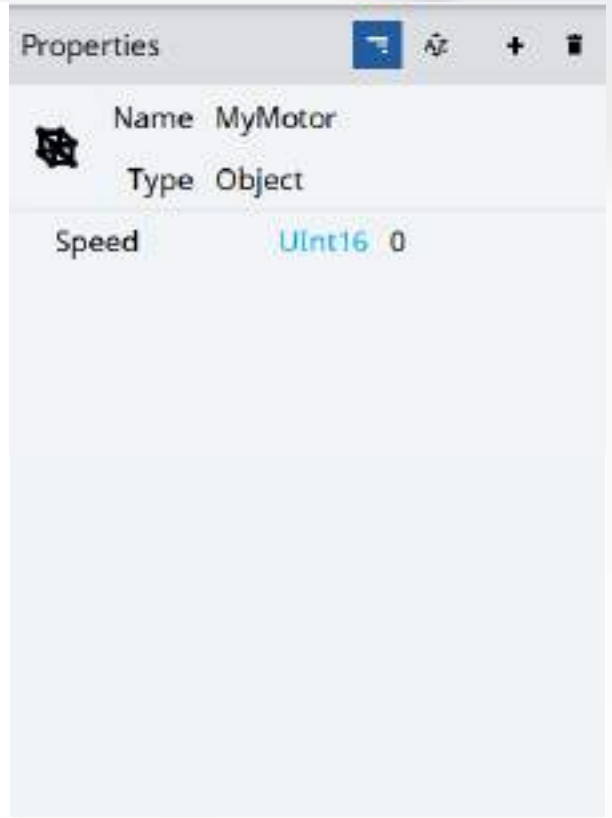

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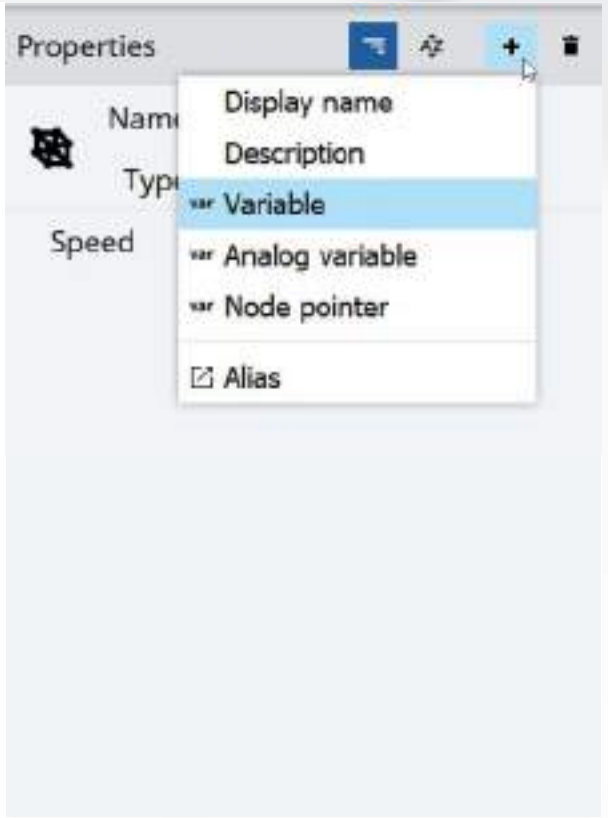

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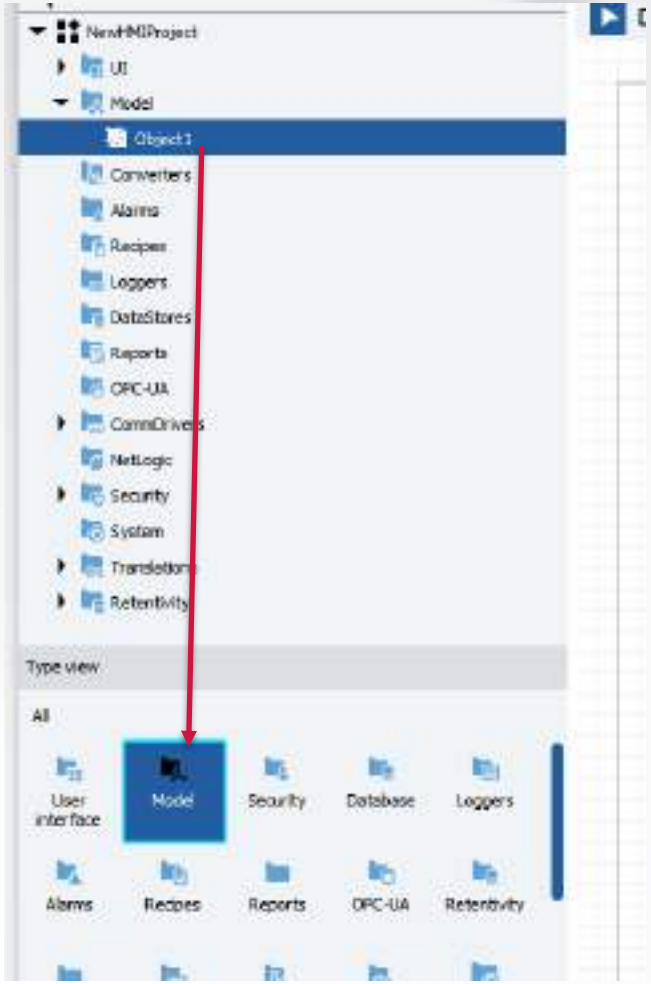

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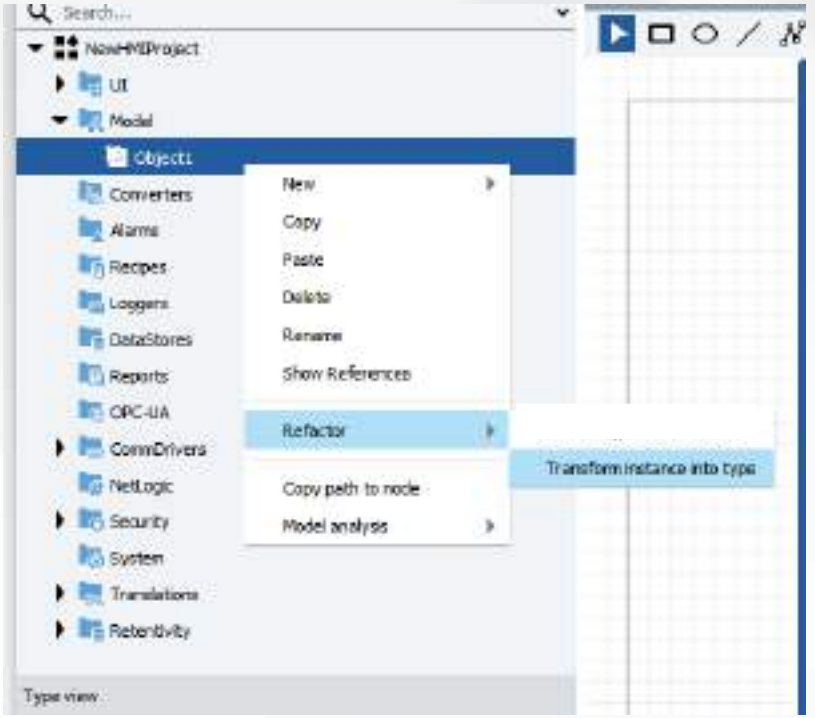

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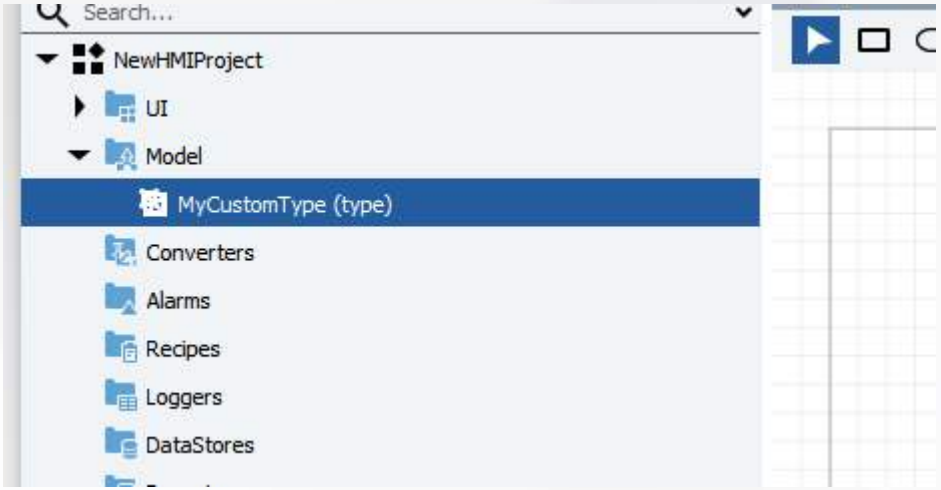

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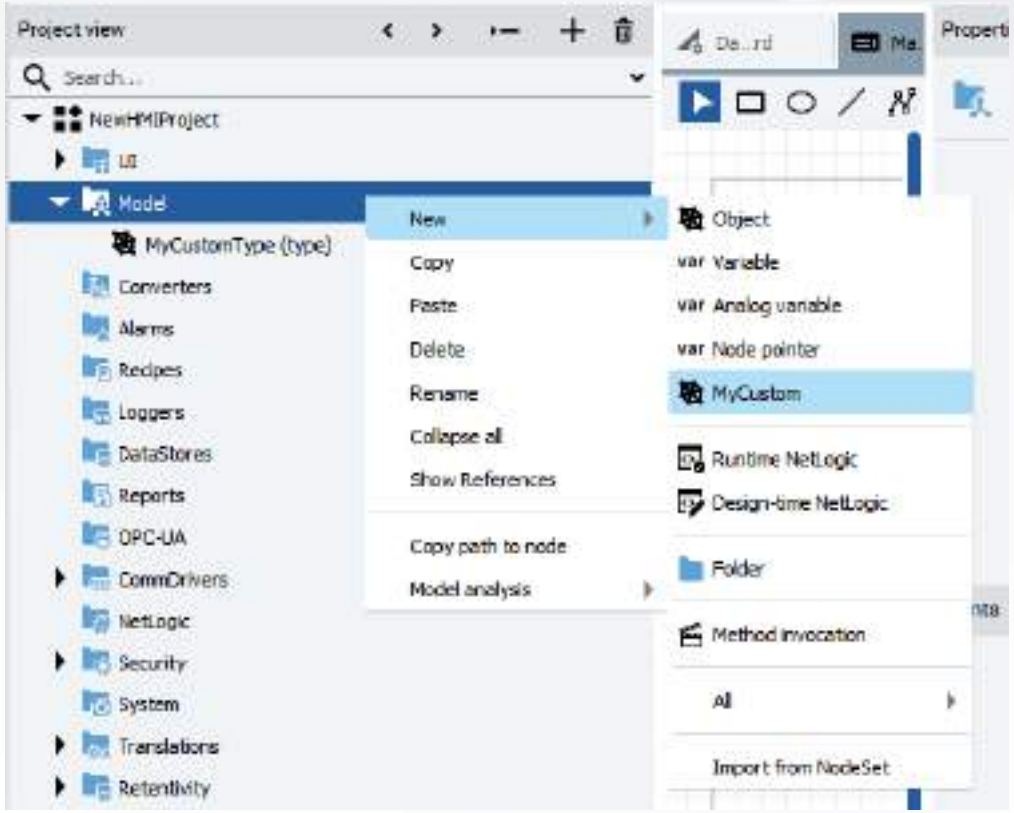

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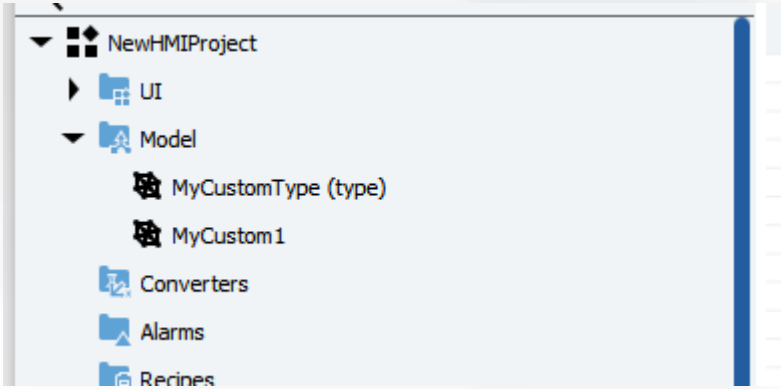

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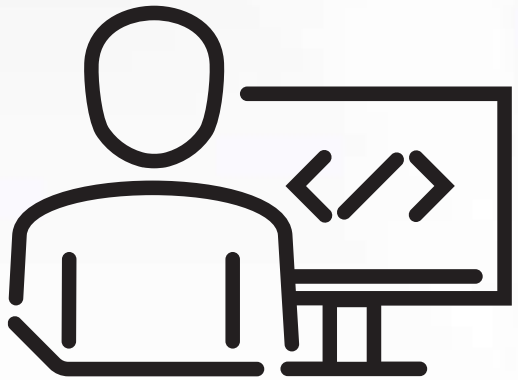
Hands-on session

- Create a Motor Type variable into the Model folder with these elements
  - Power (Float)
  - Speed (Int16)

- Create 3 instances of the Motor Type
  - Motor1, Motor2, Motor3…



Custom types: reusable graphics with a "local variable"

- Object-Oriented Programming paradigm can be also applied to Graphics
  - “Panel_with_BG (type)” = Class = Type
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- Reusable Graphics can be
  - Widgets
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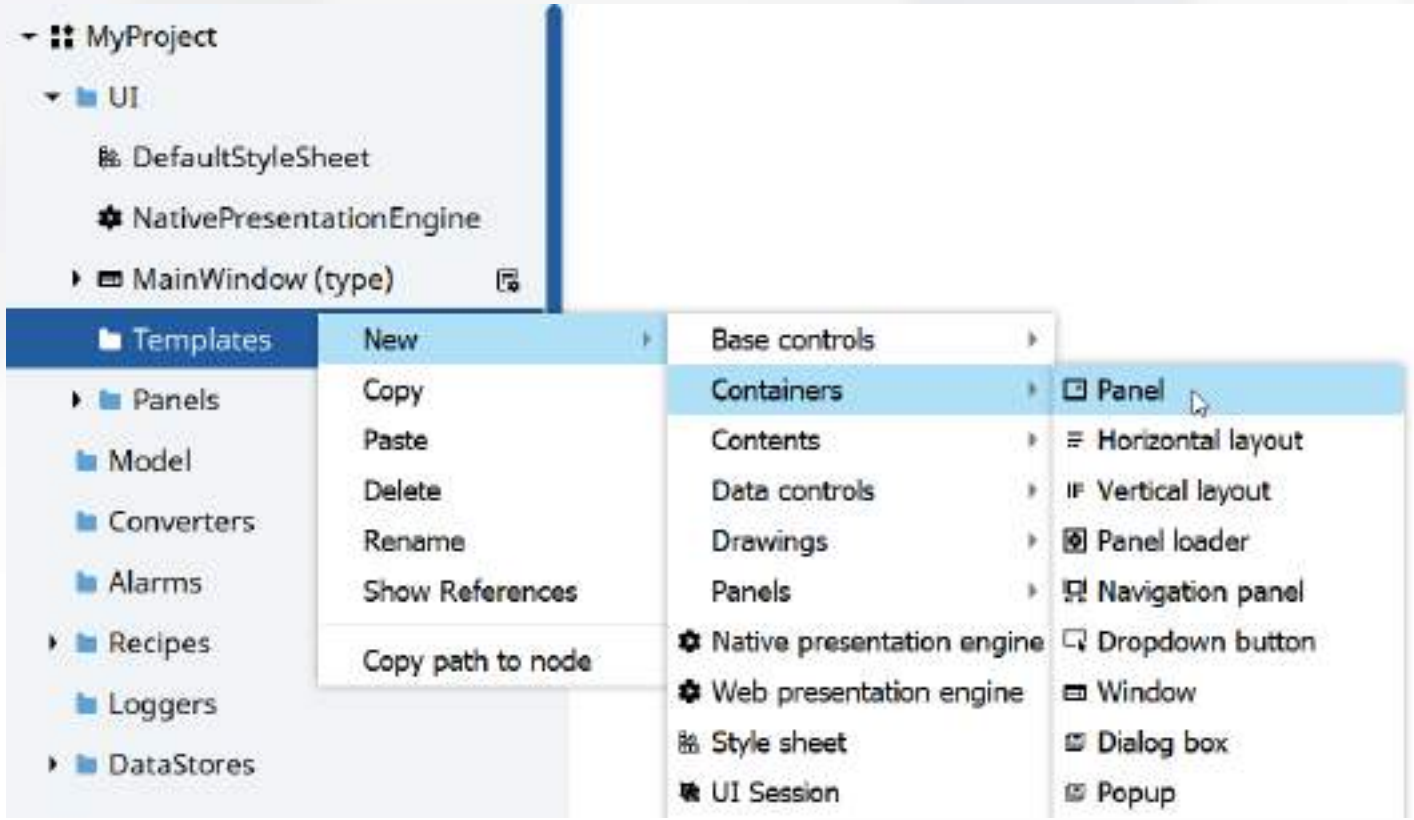
- Example: a customized Panel with a rectangle used to set the background color



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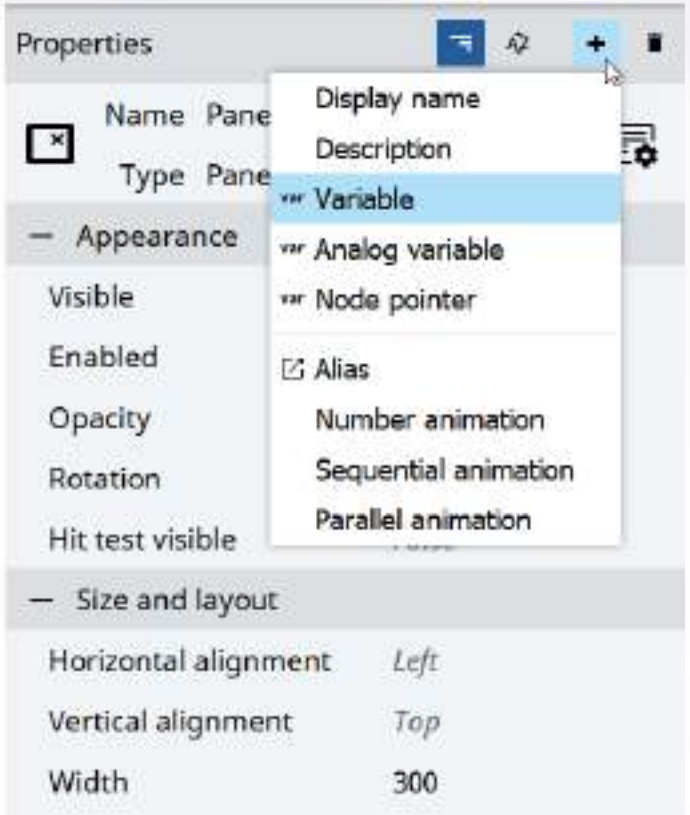

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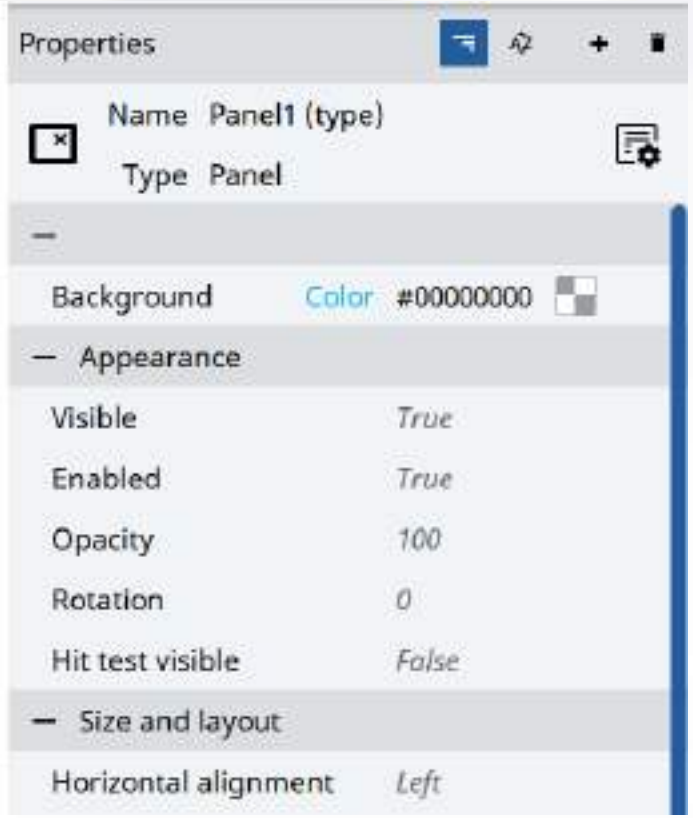

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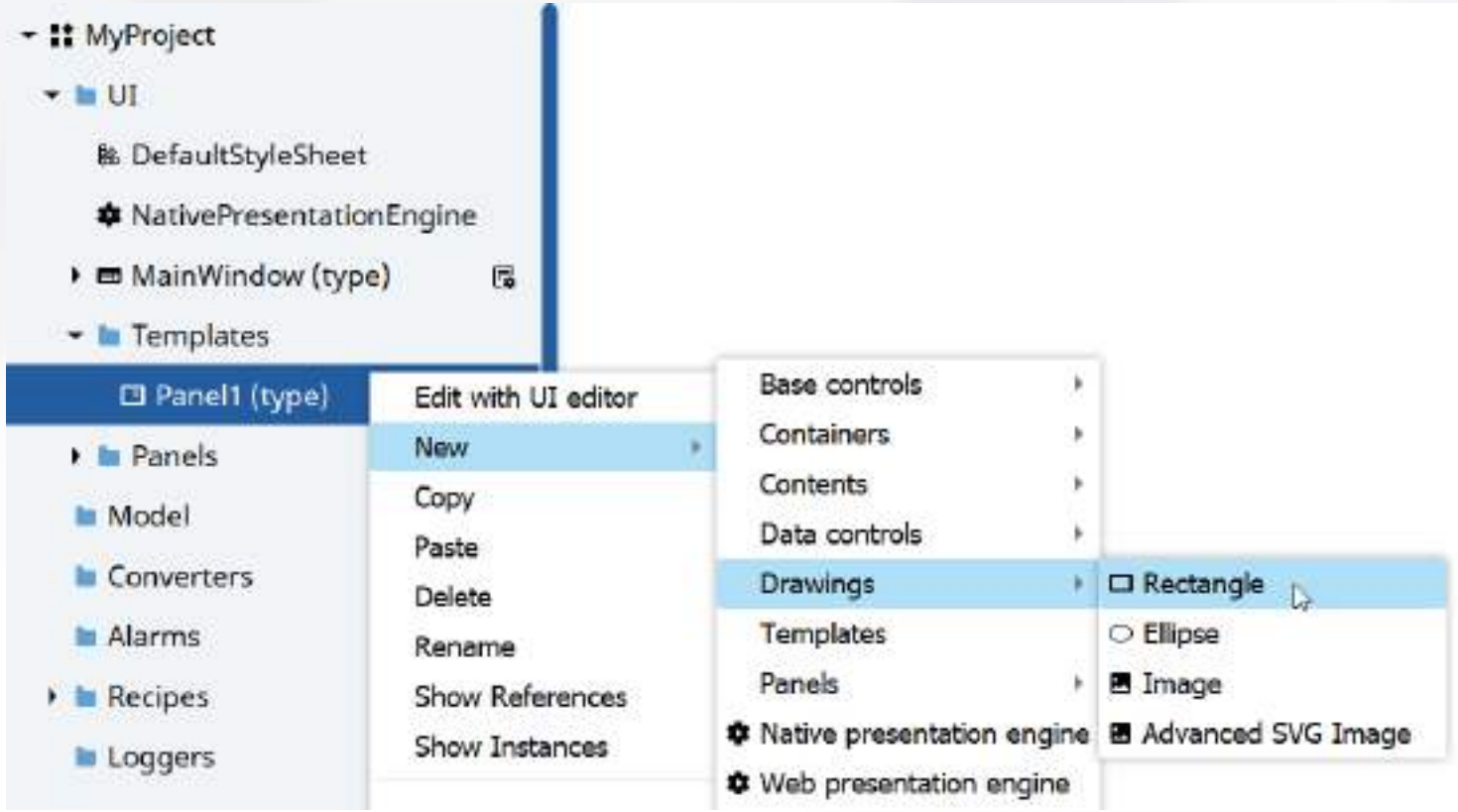

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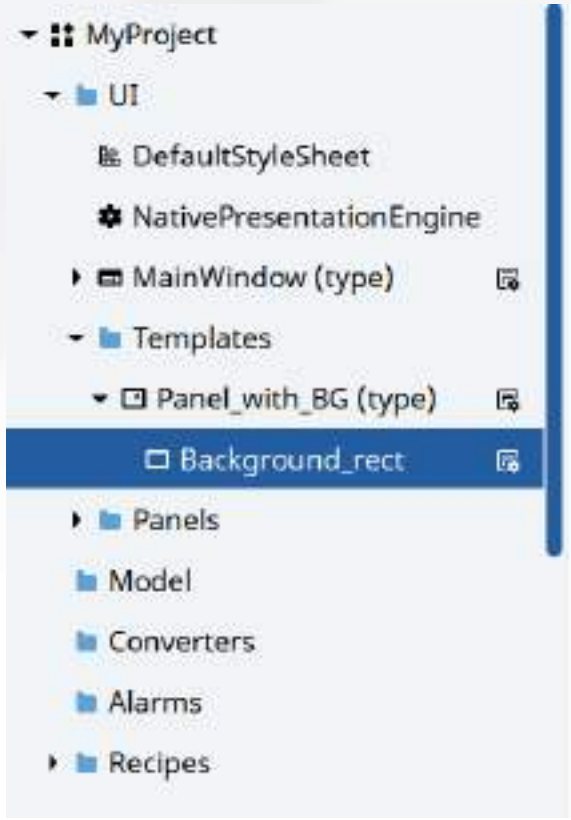

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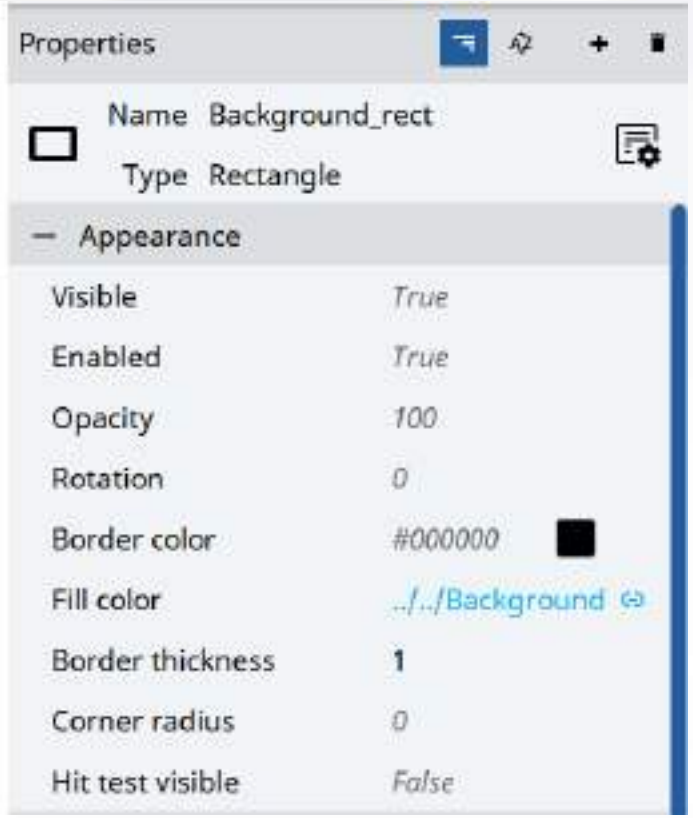

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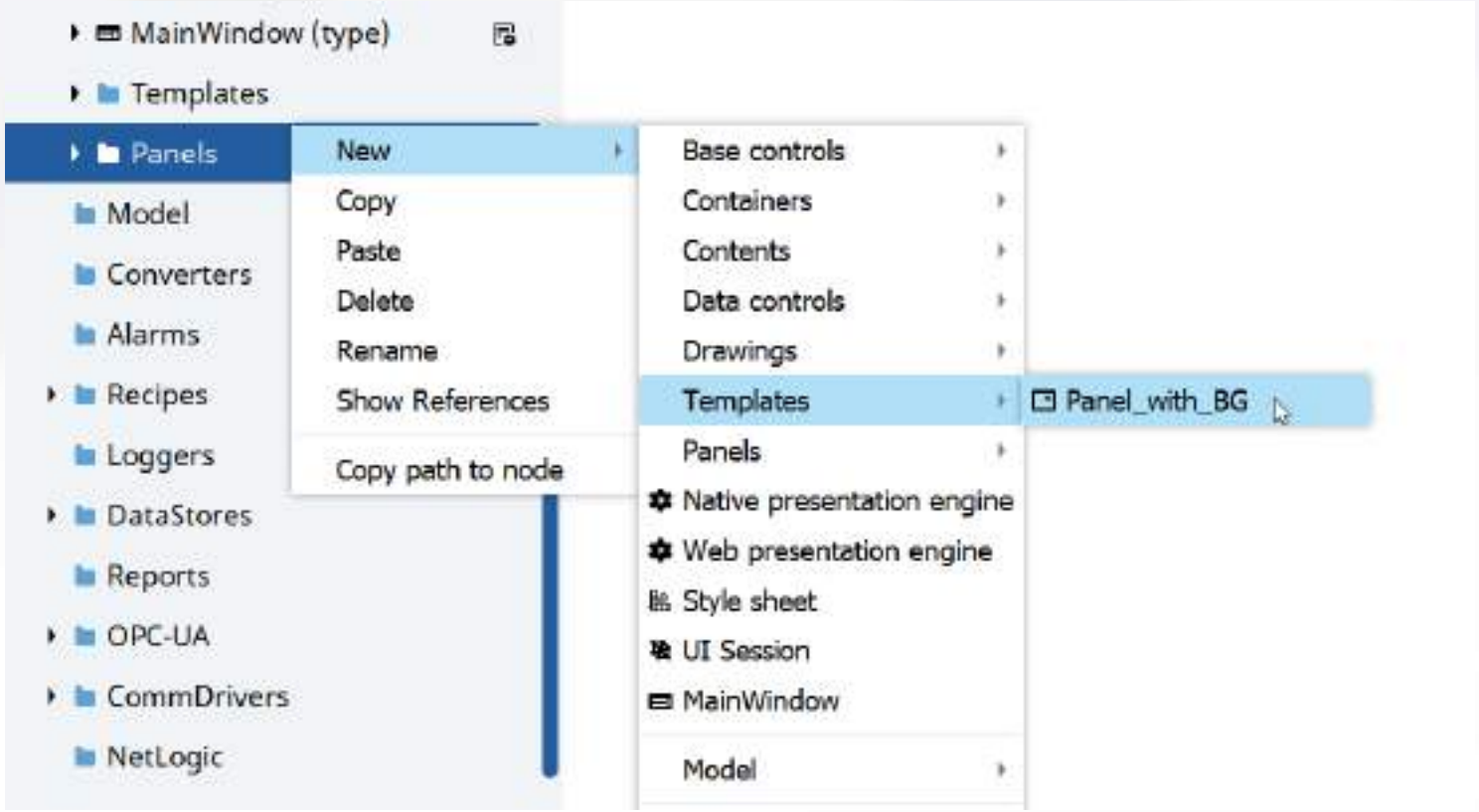
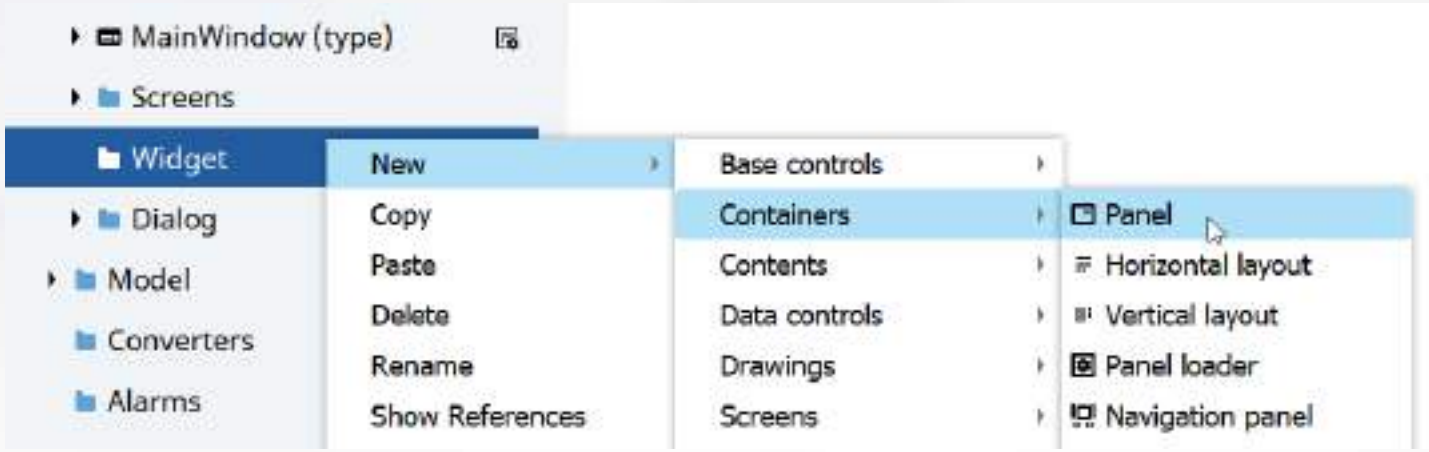


Custom types: reusable graphics with an alias

- Example: a motor widget that shows the values of different instances of the motor



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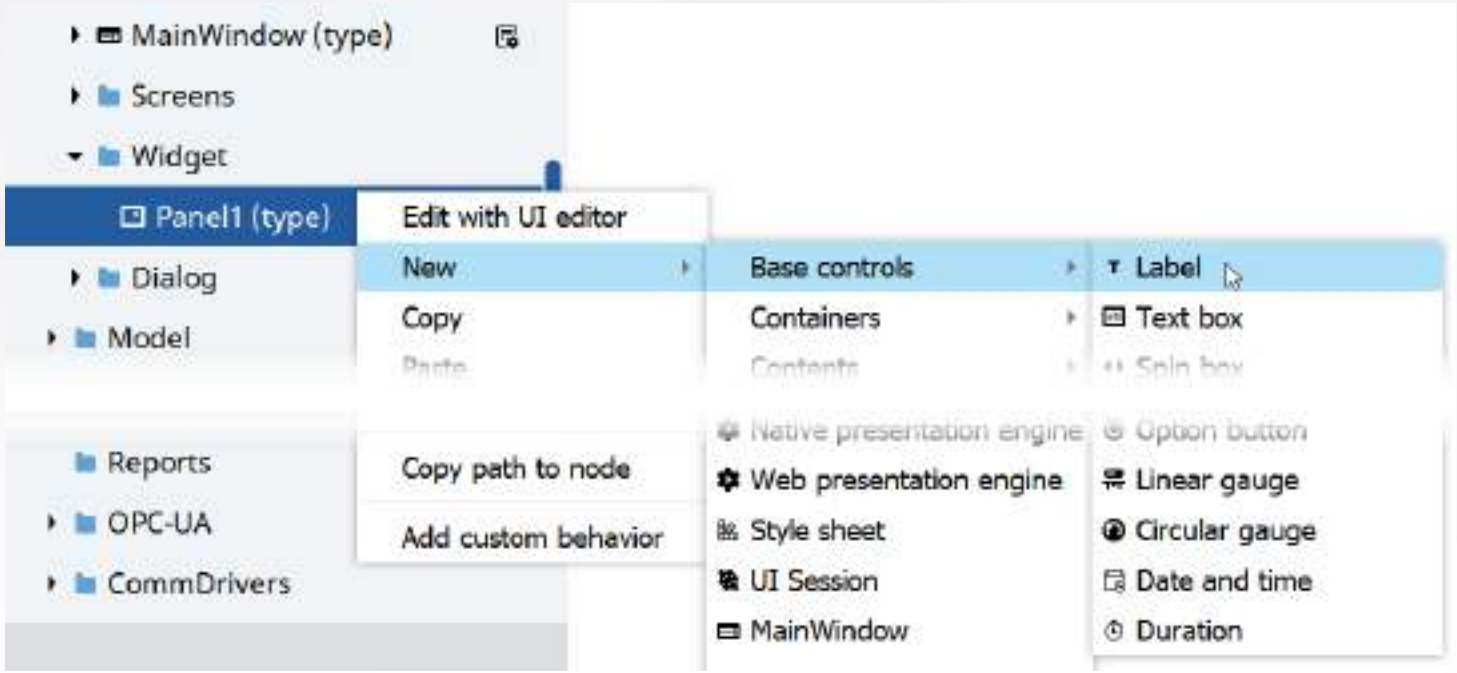

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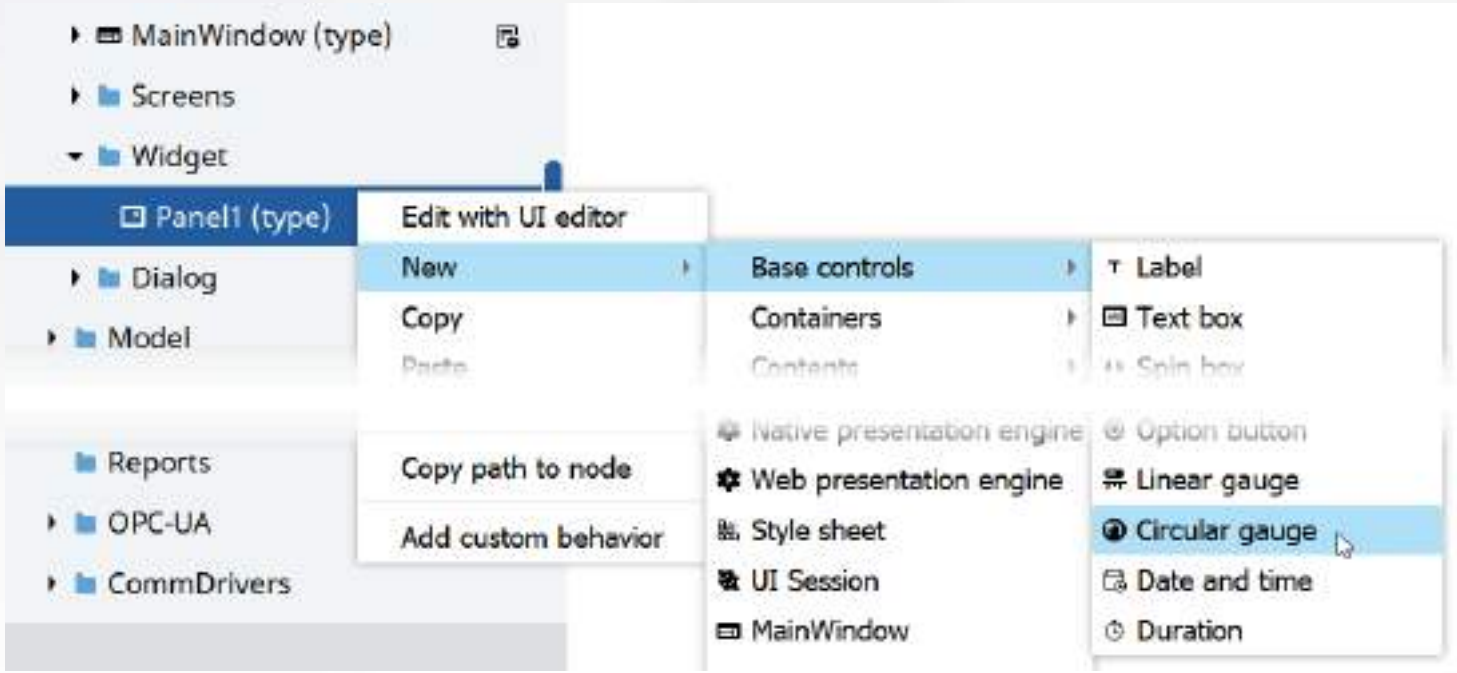

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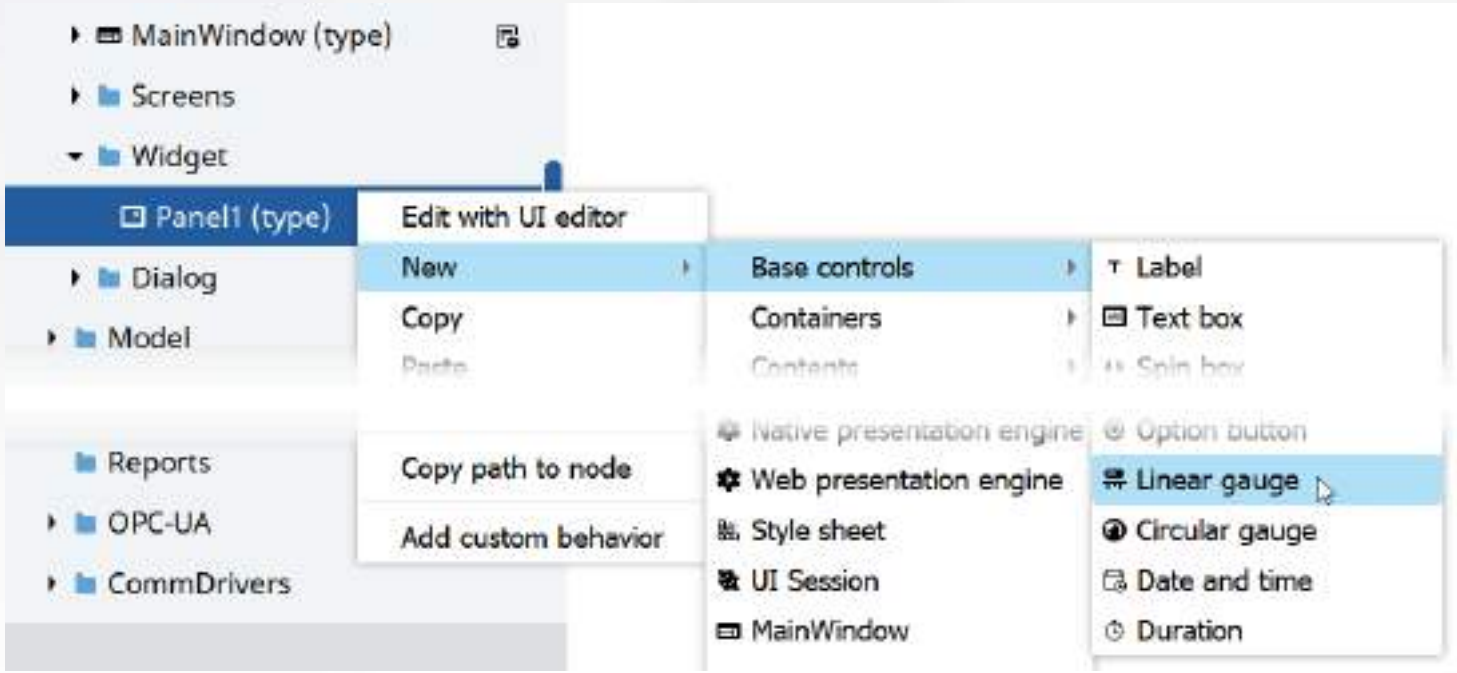

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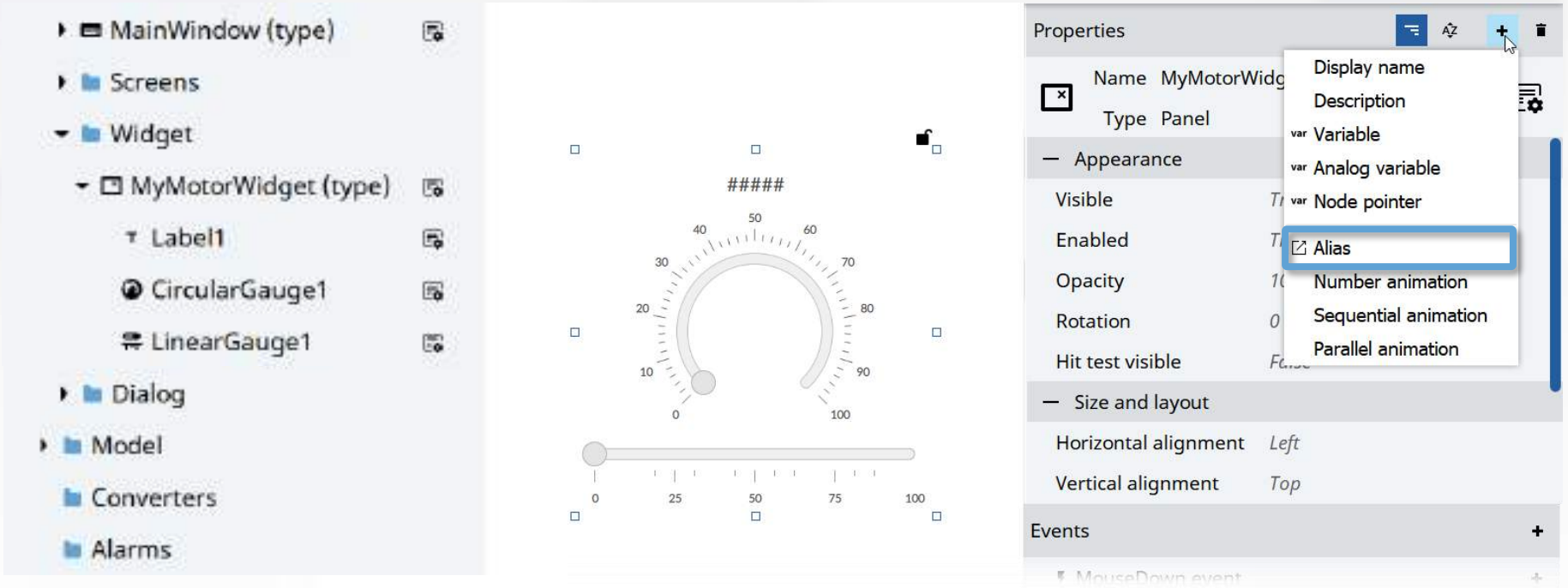

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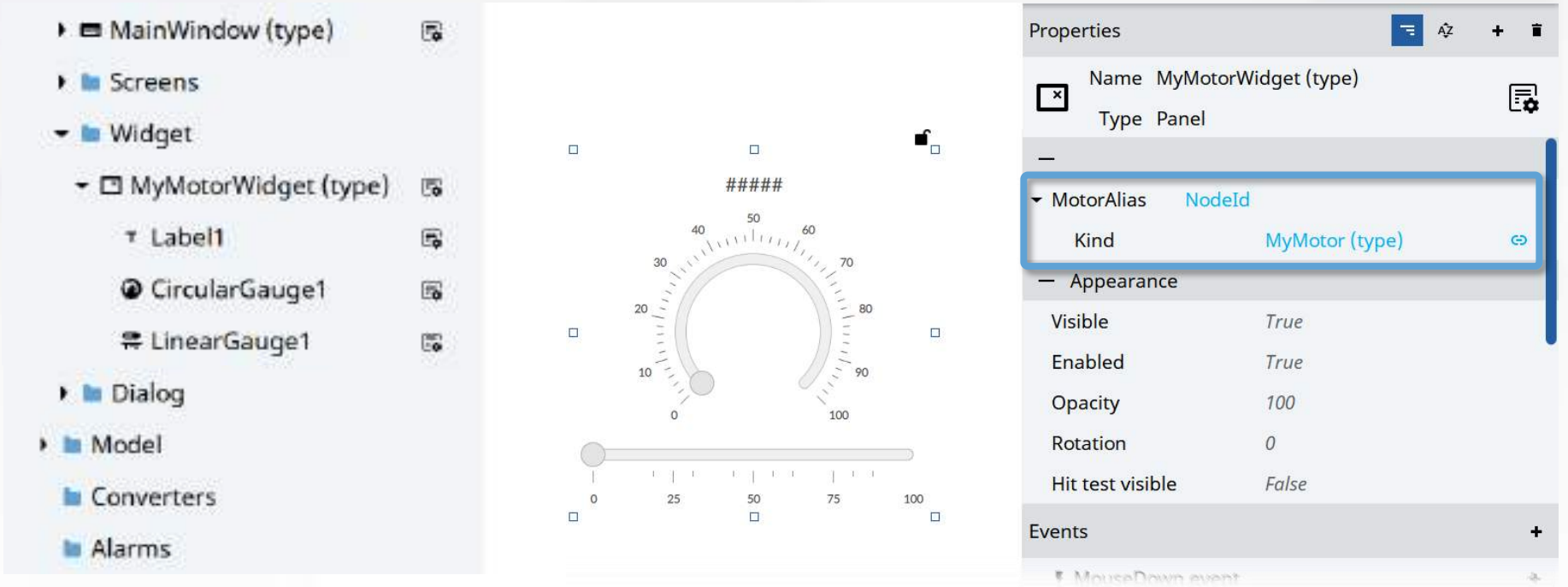

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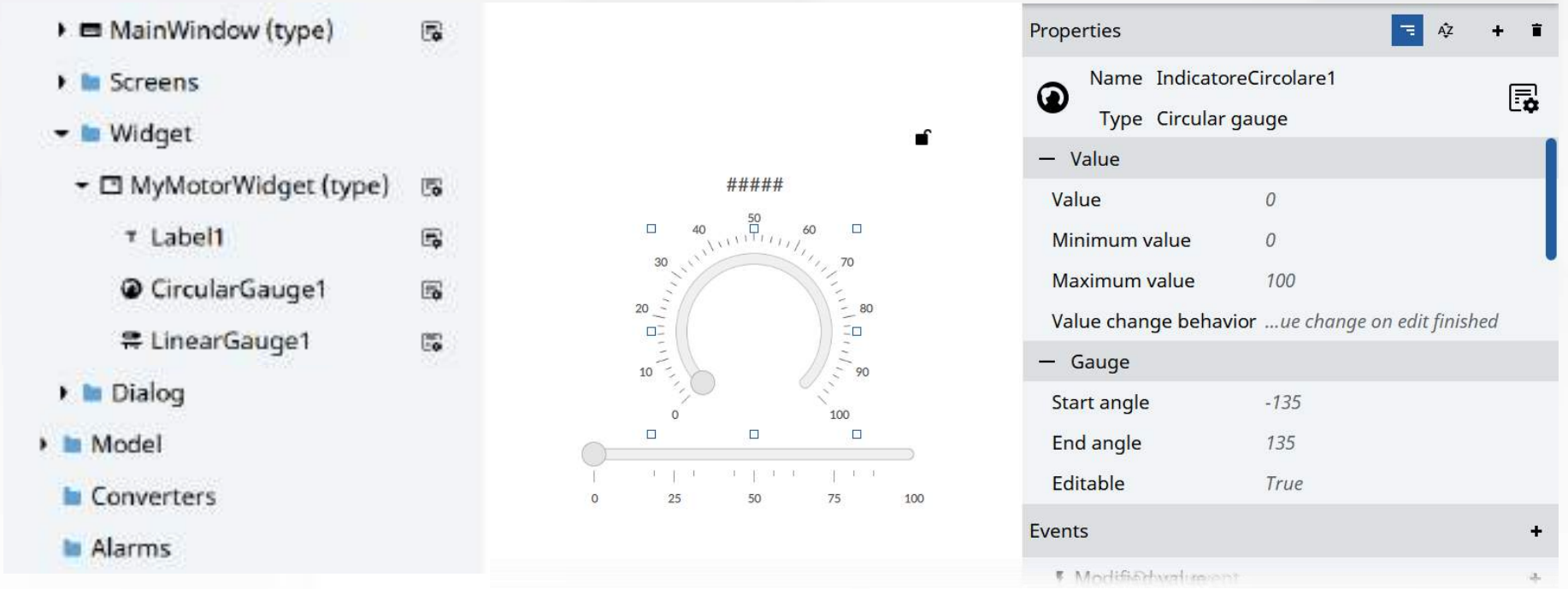

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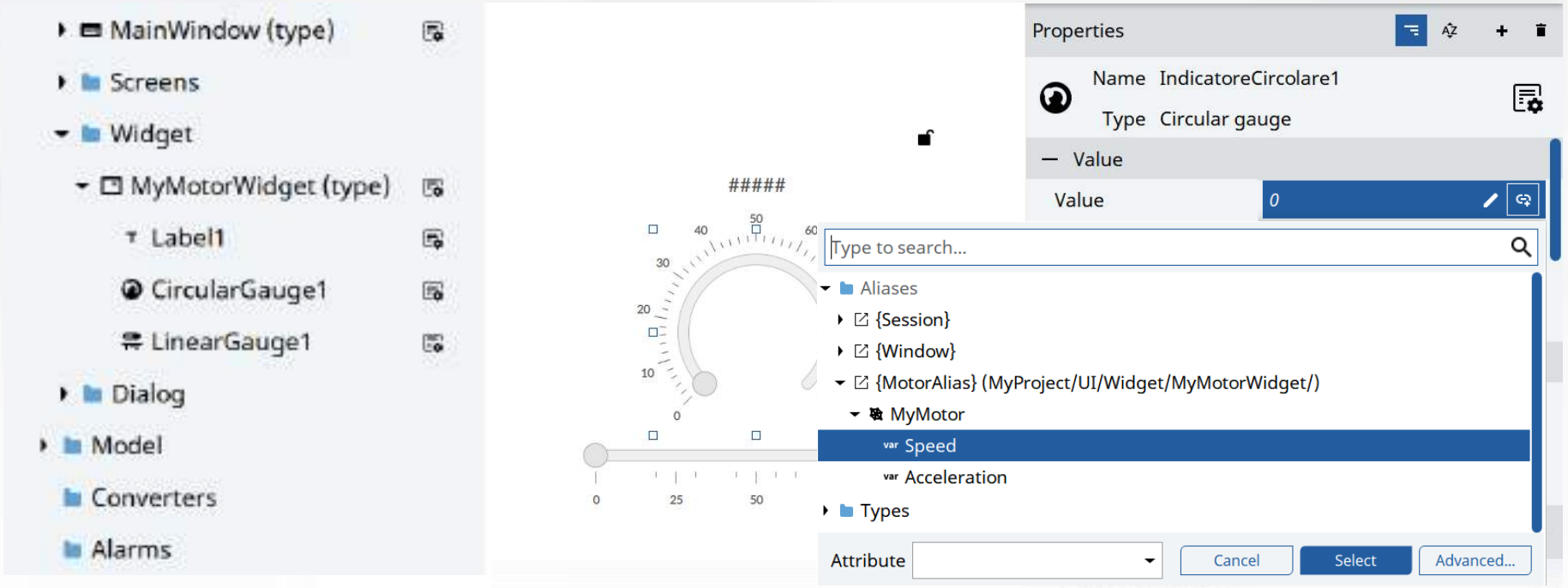

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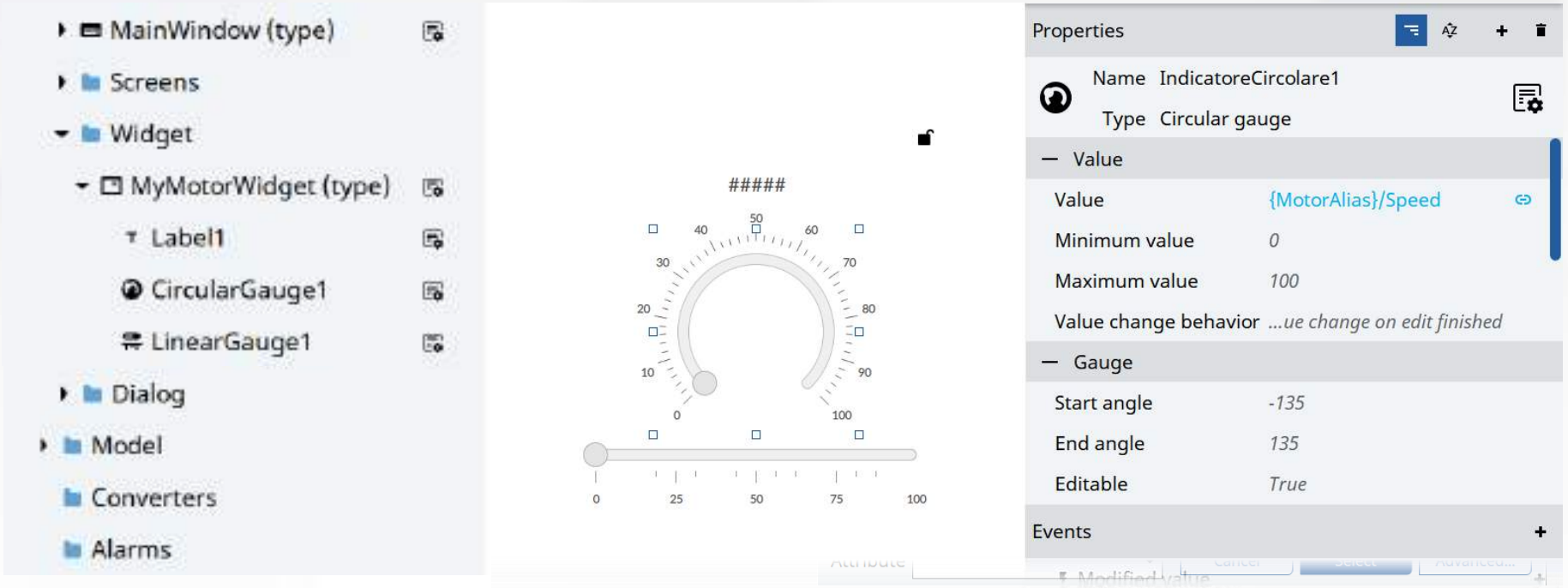

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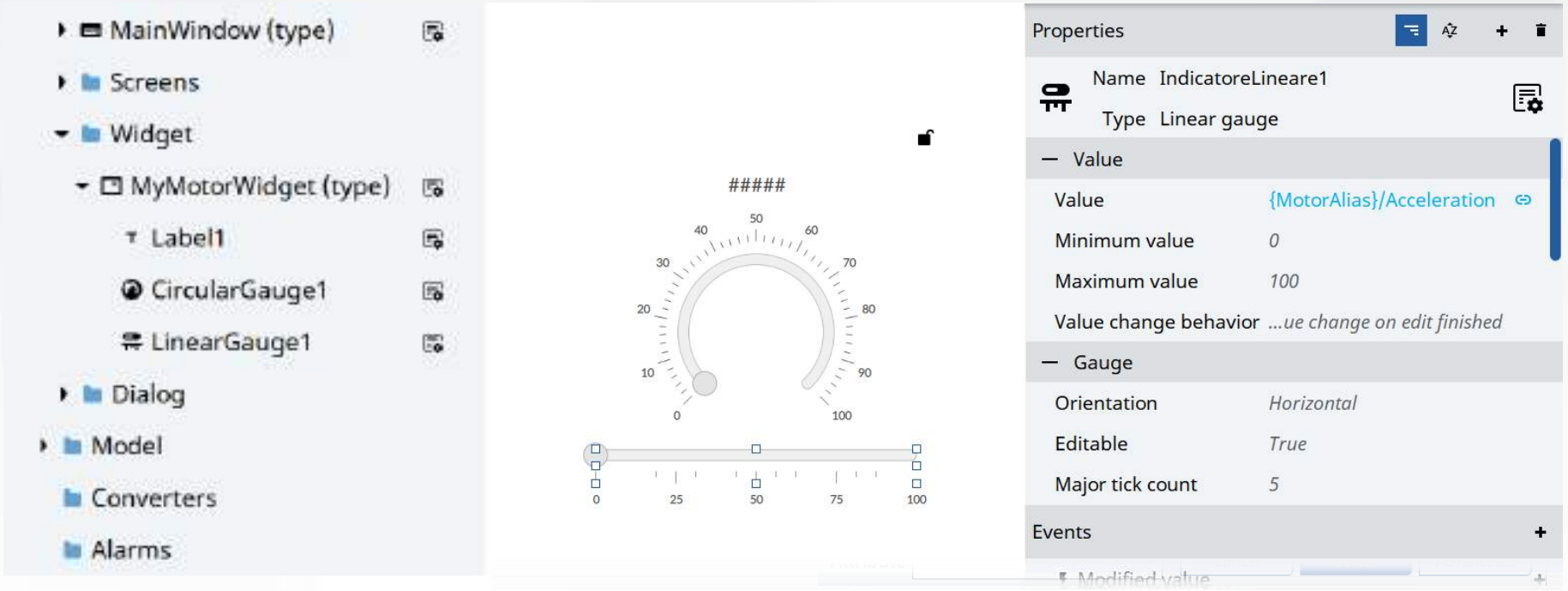

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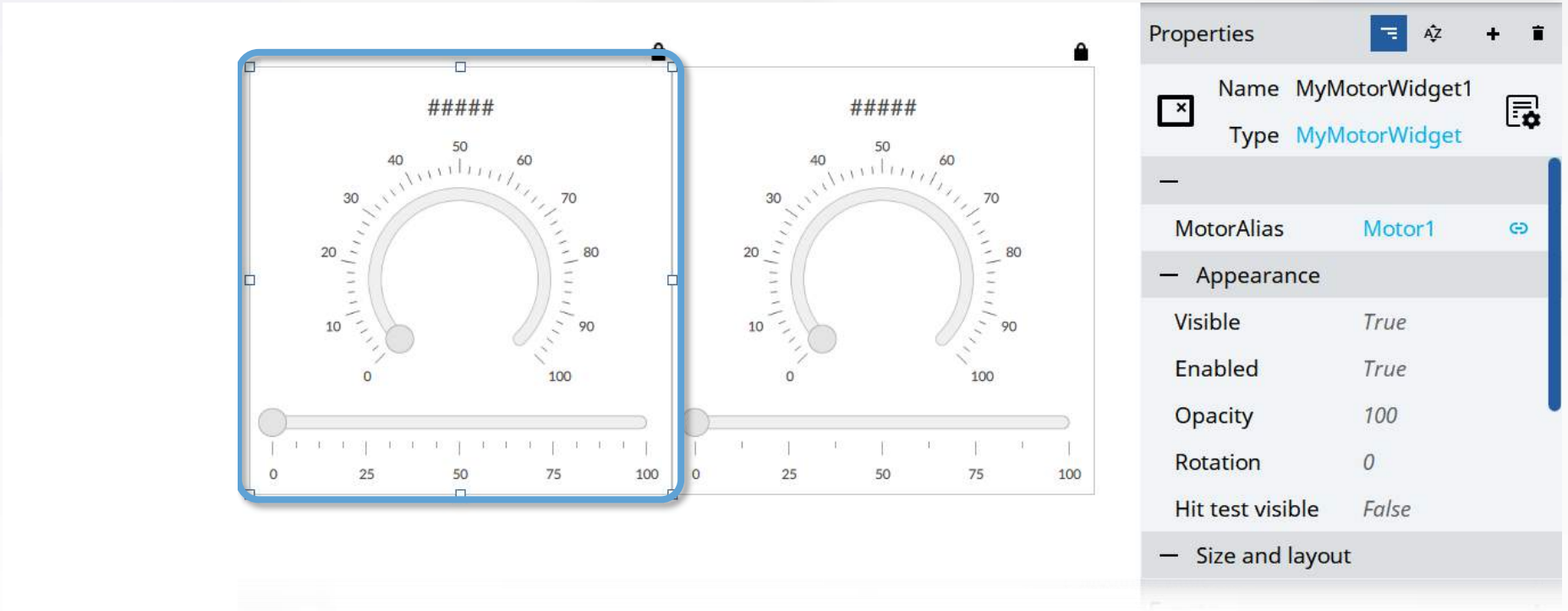

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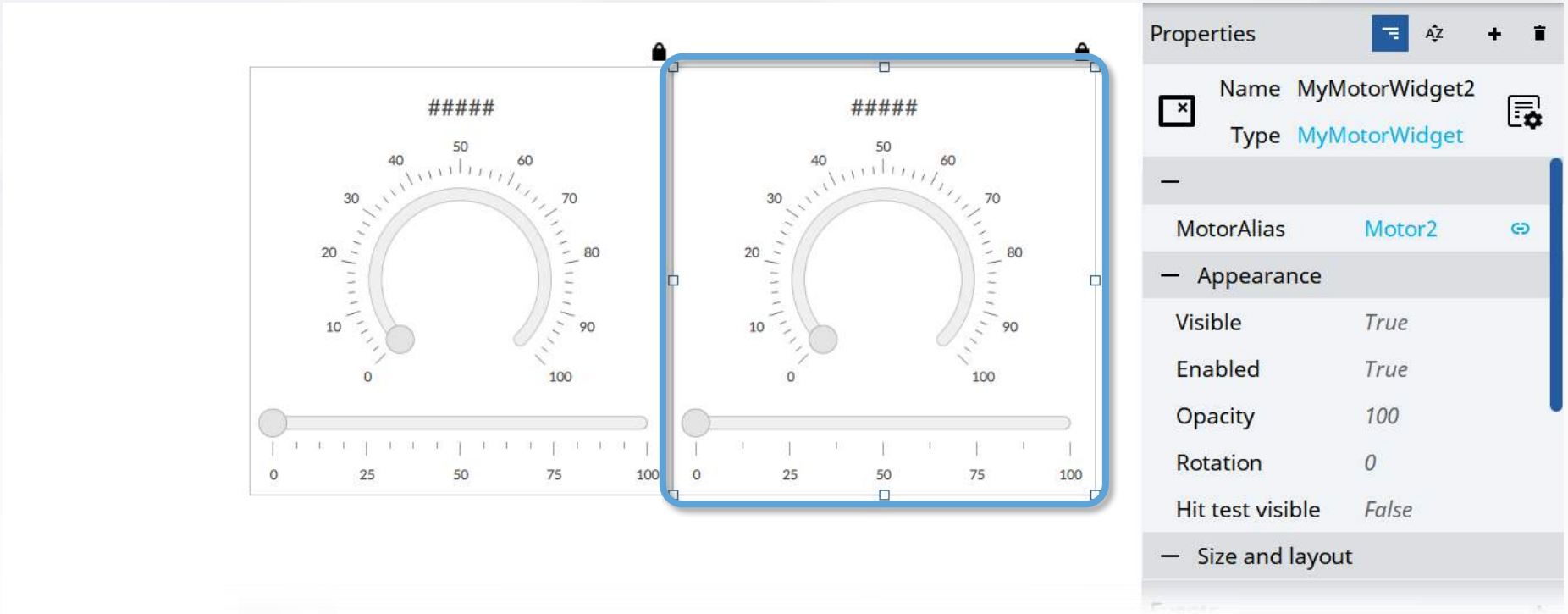
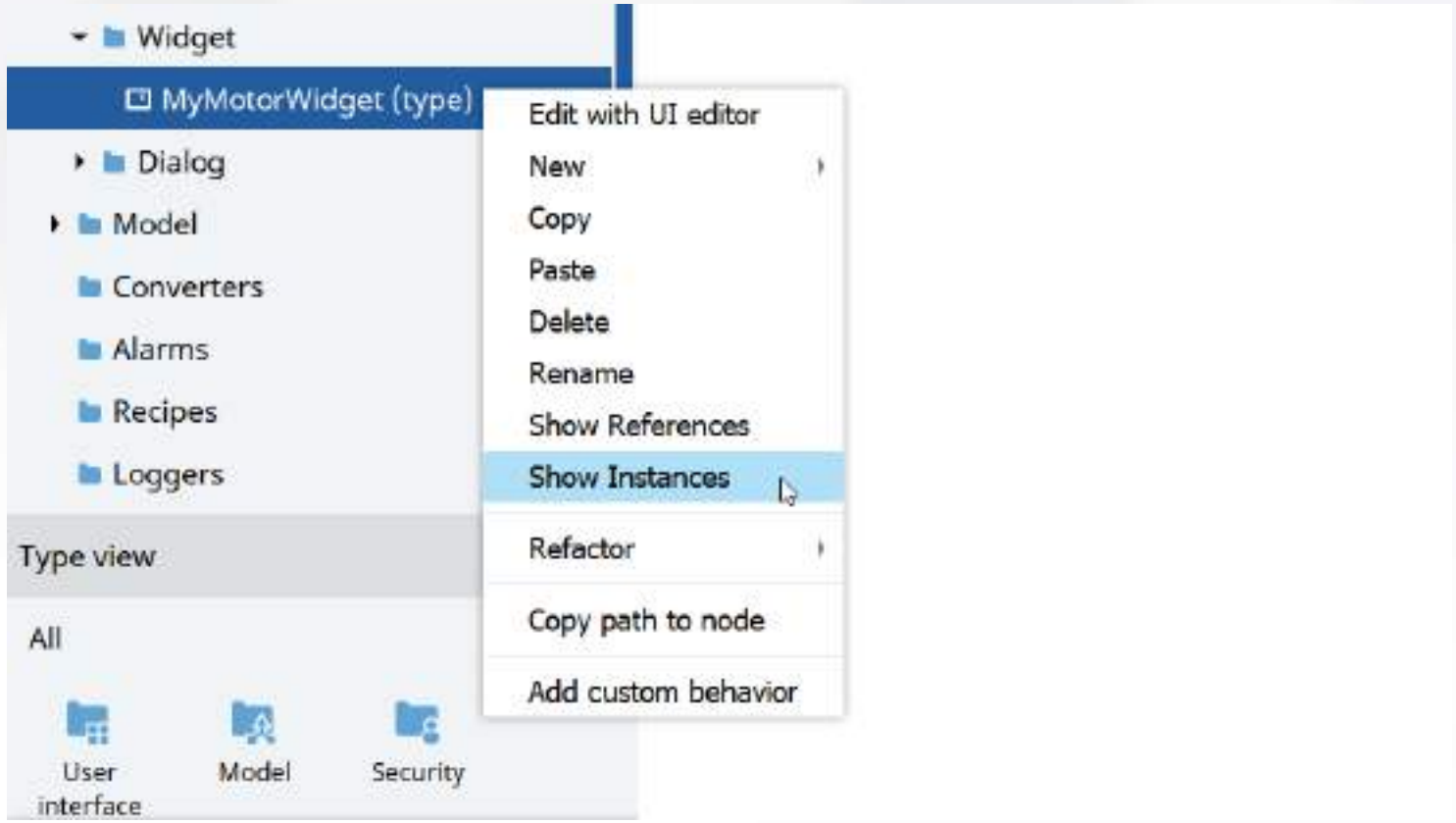


Custom types: show instances

- Answer the question: "**where are the instances of this type?**"

- Can be used to find instances of
  - Widgets,
  - Panels,
  - Tags (Structure)
  - "typed" Alarm
  - ...



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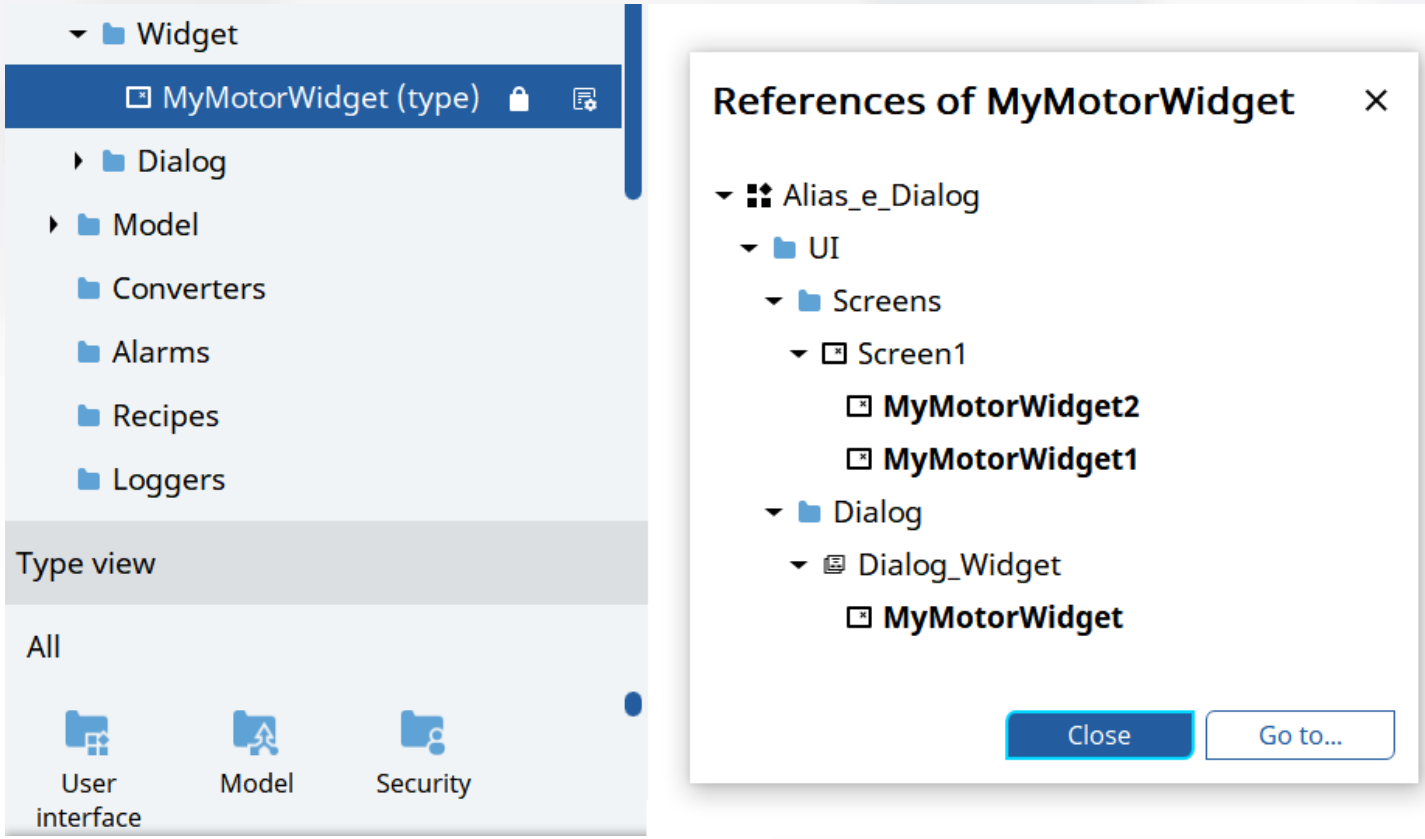
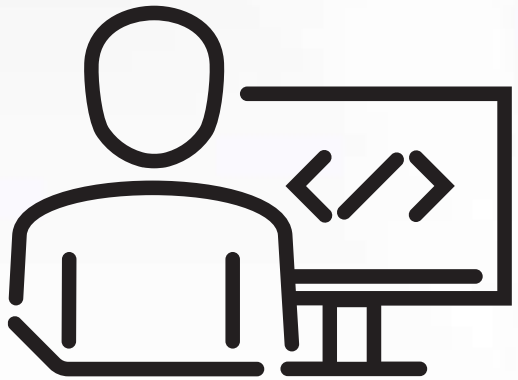


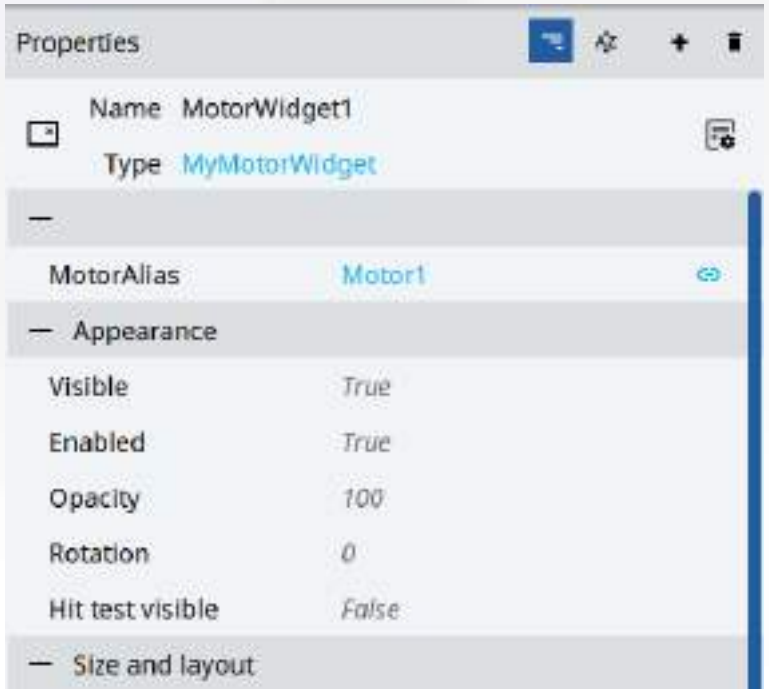
Hands-on session

- Create a widget called MotorWidget as a Type with an Alias to be used with the Motor variables
- Add 3 instances of the MotorWidget into a new Panel
- Specify, at design time, the alias on each MotorWidget instance associating to each Motor variable



Reusable graphics: set aliases using indexing

- Alias variables can be indexed like simple variables
- Allow to easily change the alias of a widget



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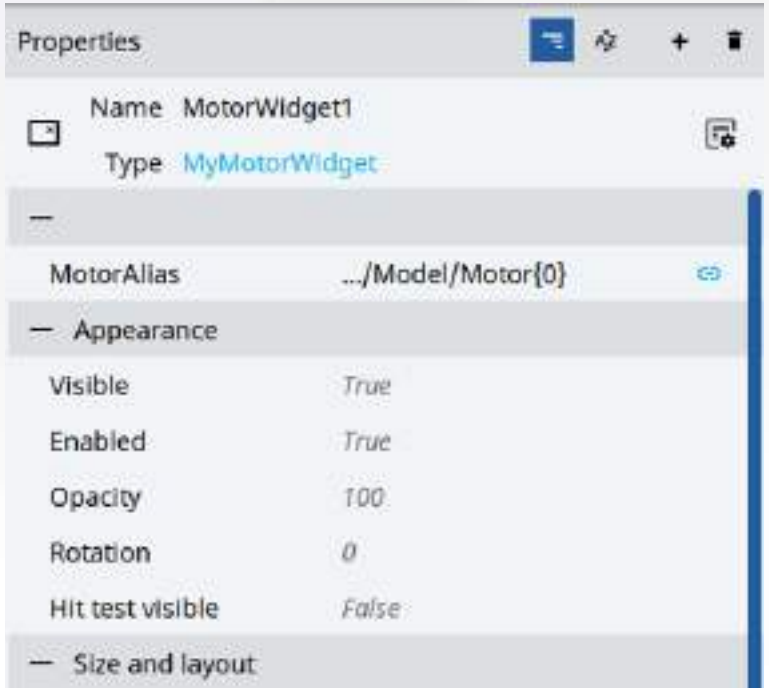

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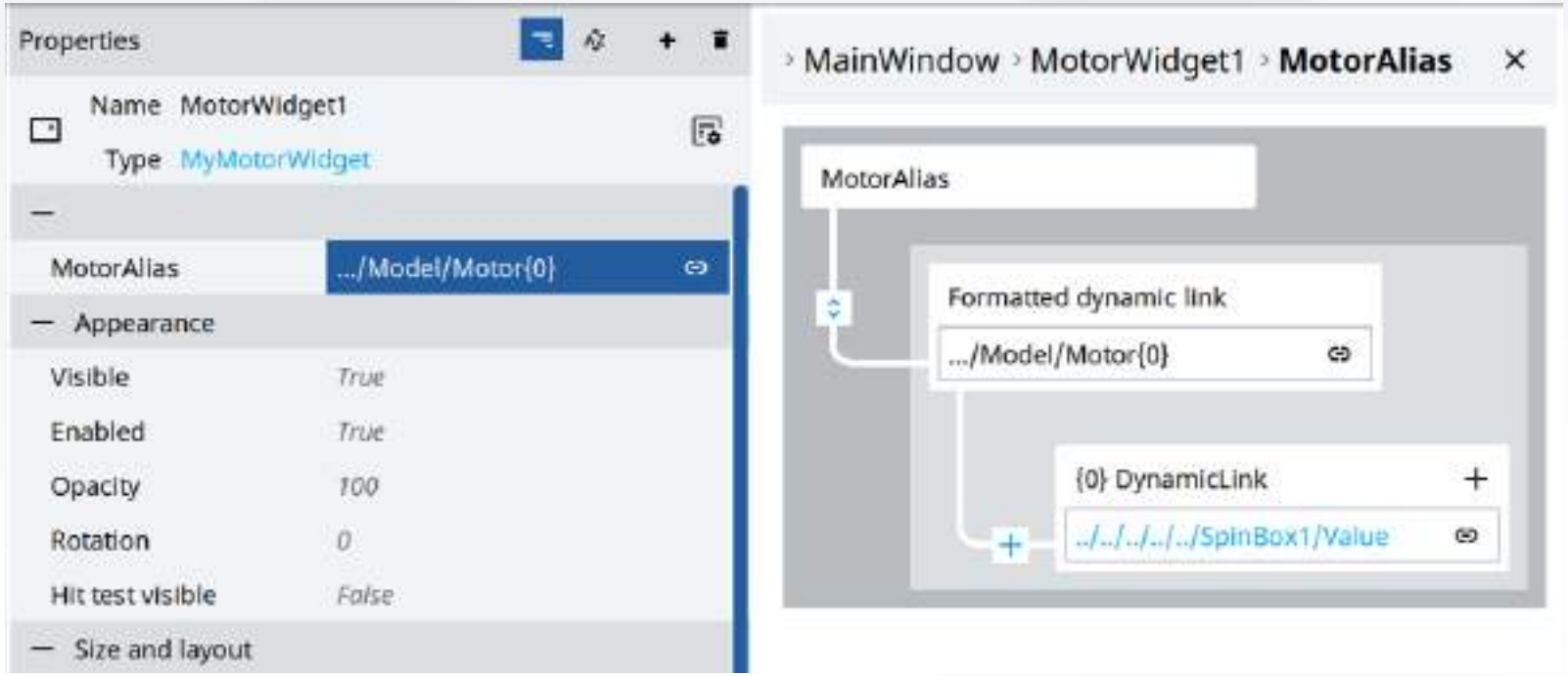
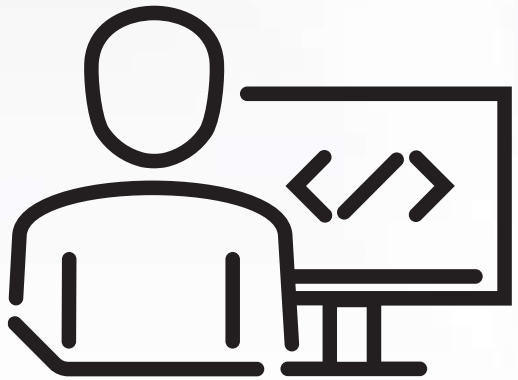


Hands-on session

- Add just only one instance of the MotorWidget into a new Panel
- add also a Switch object in the Panel
- use the "indexing" method to define the Alias on the MotorWidget instance, associating the index to the Switch value



Reusable graphics: set aliases at runtime

- For Dialog and Panels, the Alias at Runtime can be set on:
  - Open Dialog command
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  - Navigation Panel properties
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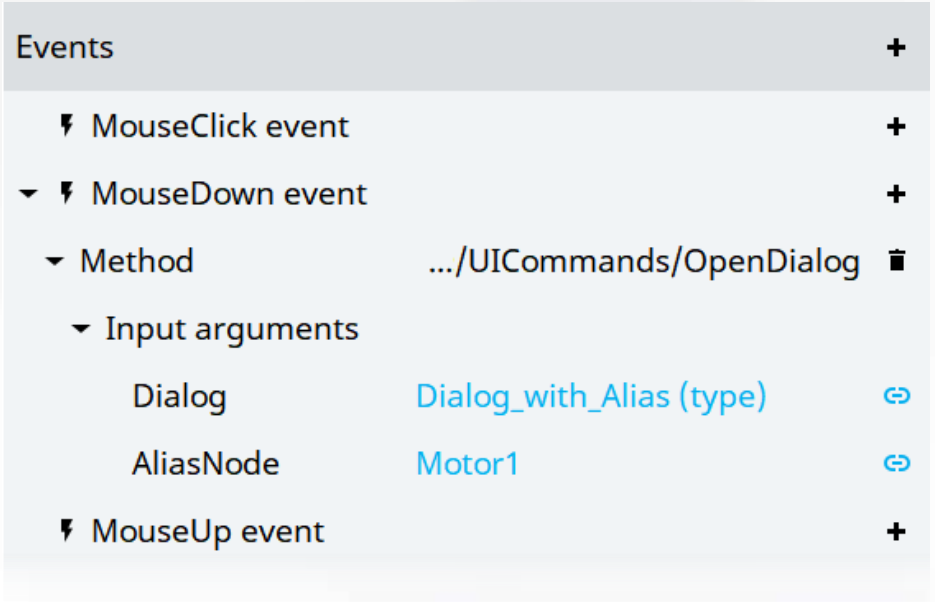

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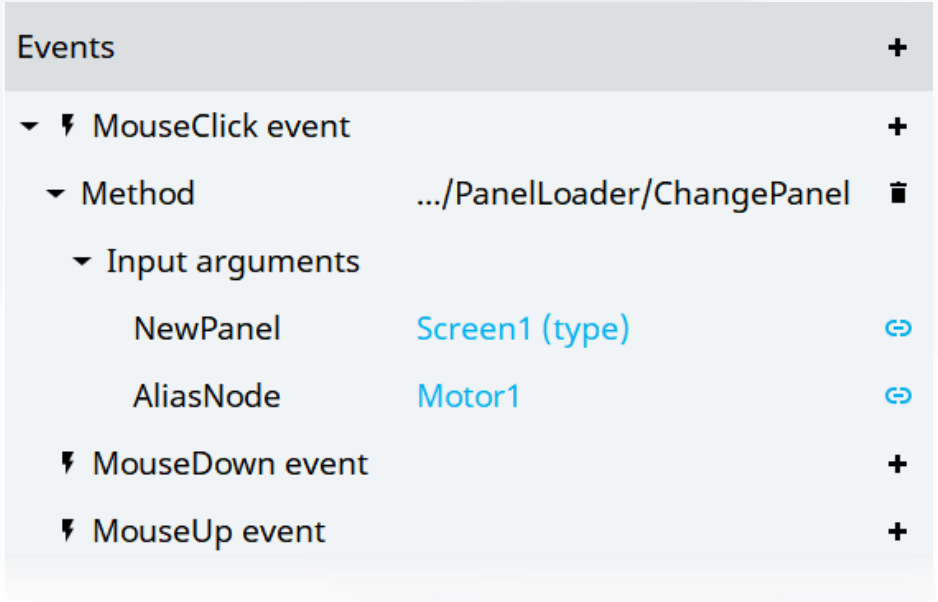

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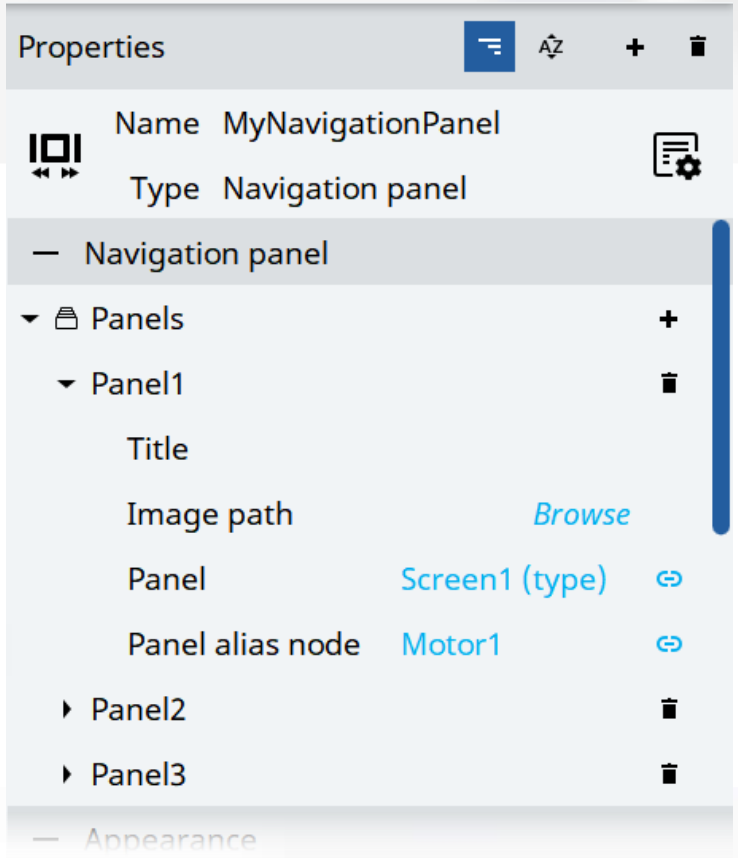

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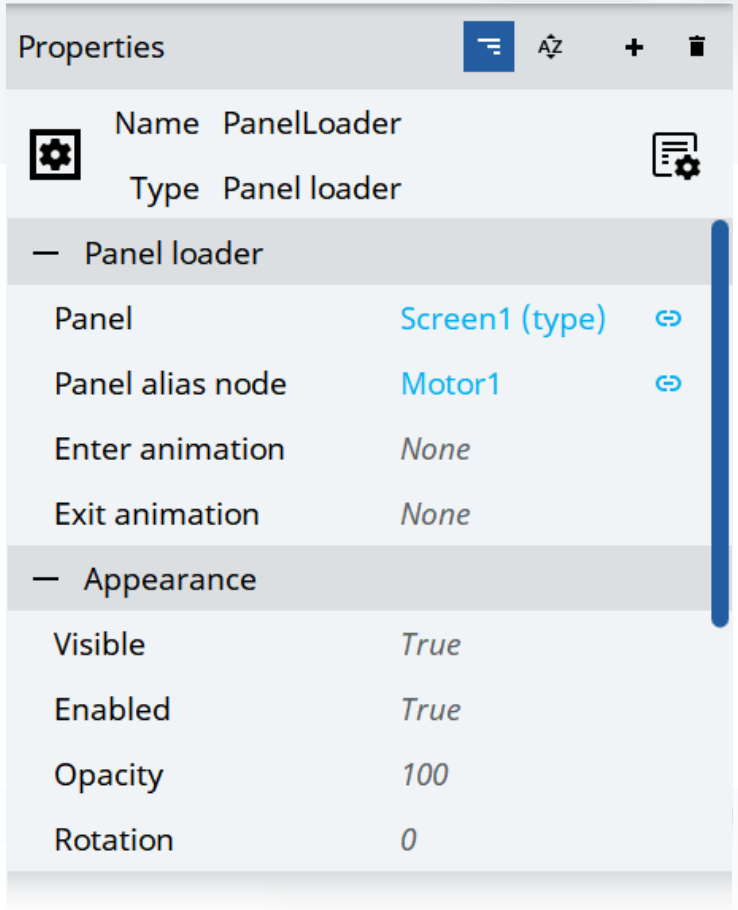
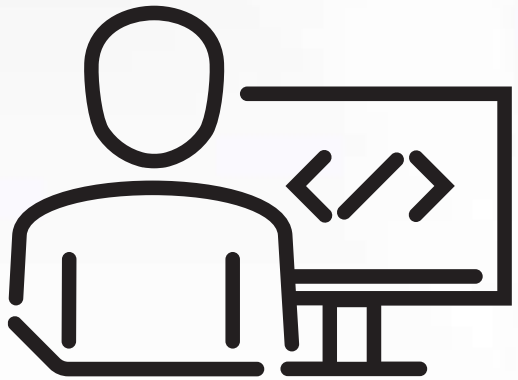


Hands-on session

- Add 3 Dropdown buttons (it's under the "container" group) into a new Panel

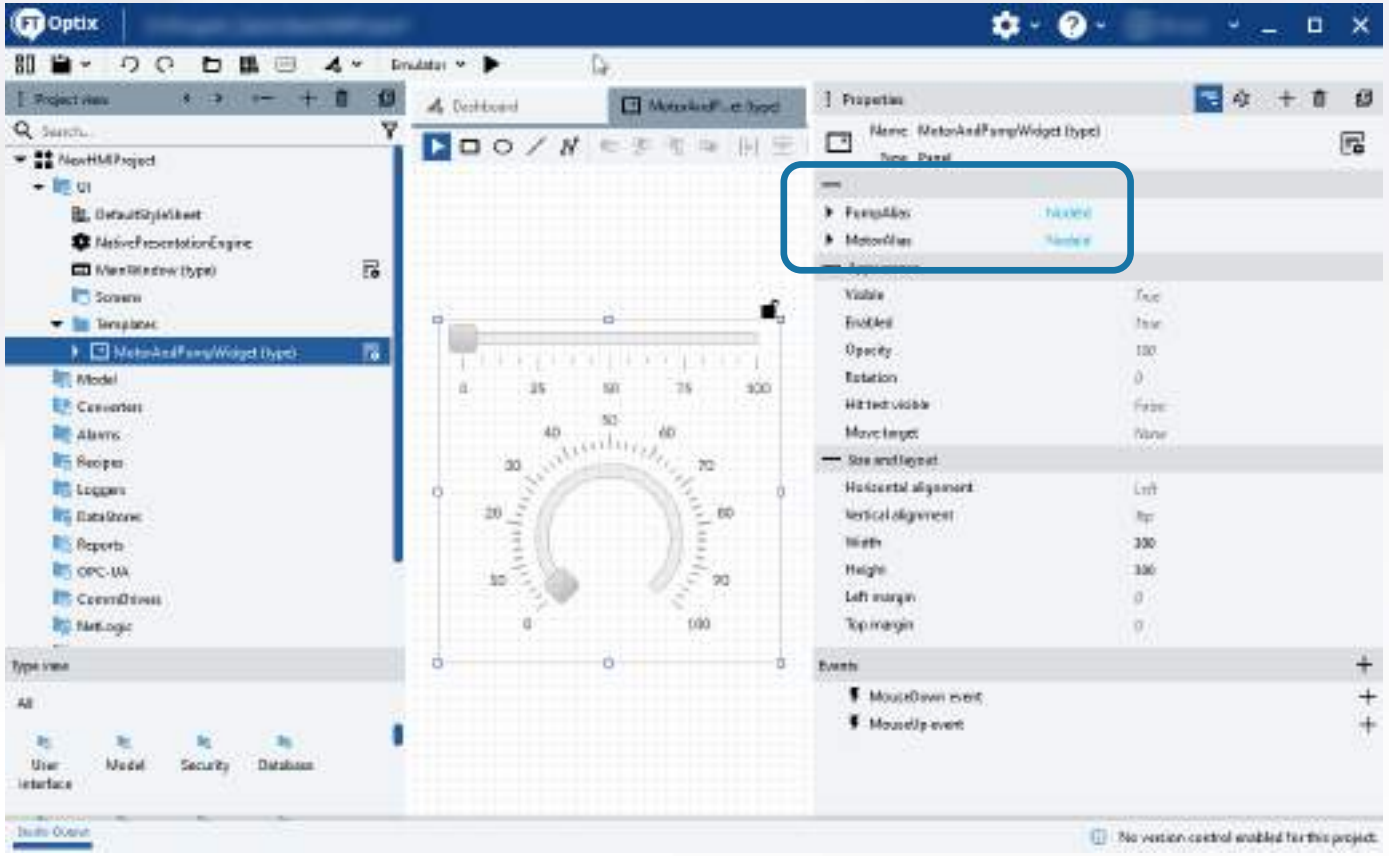
- Configure each button, with the following properties:
  - Panel = MotorWidget type
  - Panel alias node = the Alias of a Motor variable

- NOTE: you "probably" need to add a background to the MotorWidget type



Multiple aliases

- If multiple aliases are used in a type, the Aliases editor panel will come out when configuring the Alias Node property of a container loader



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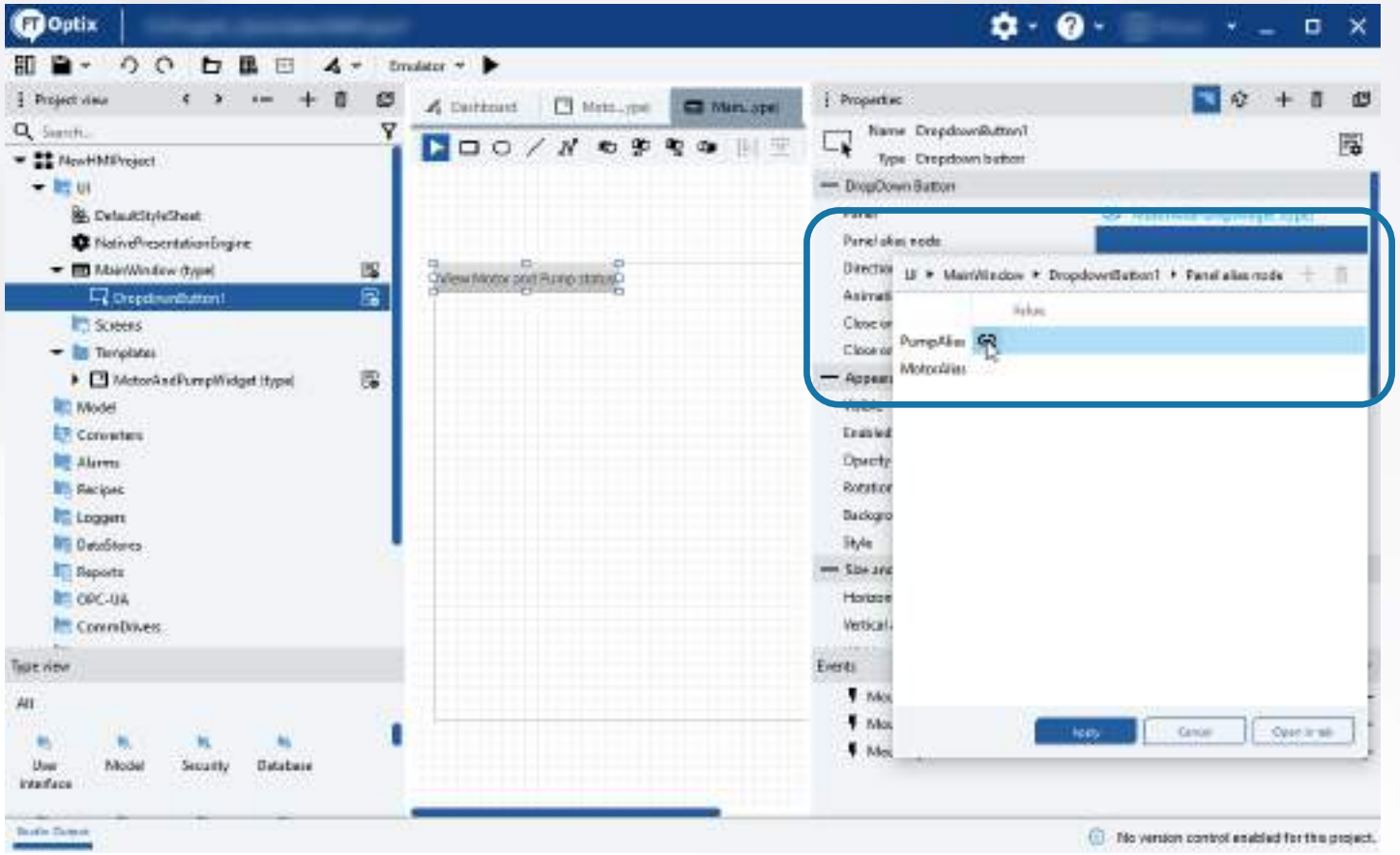
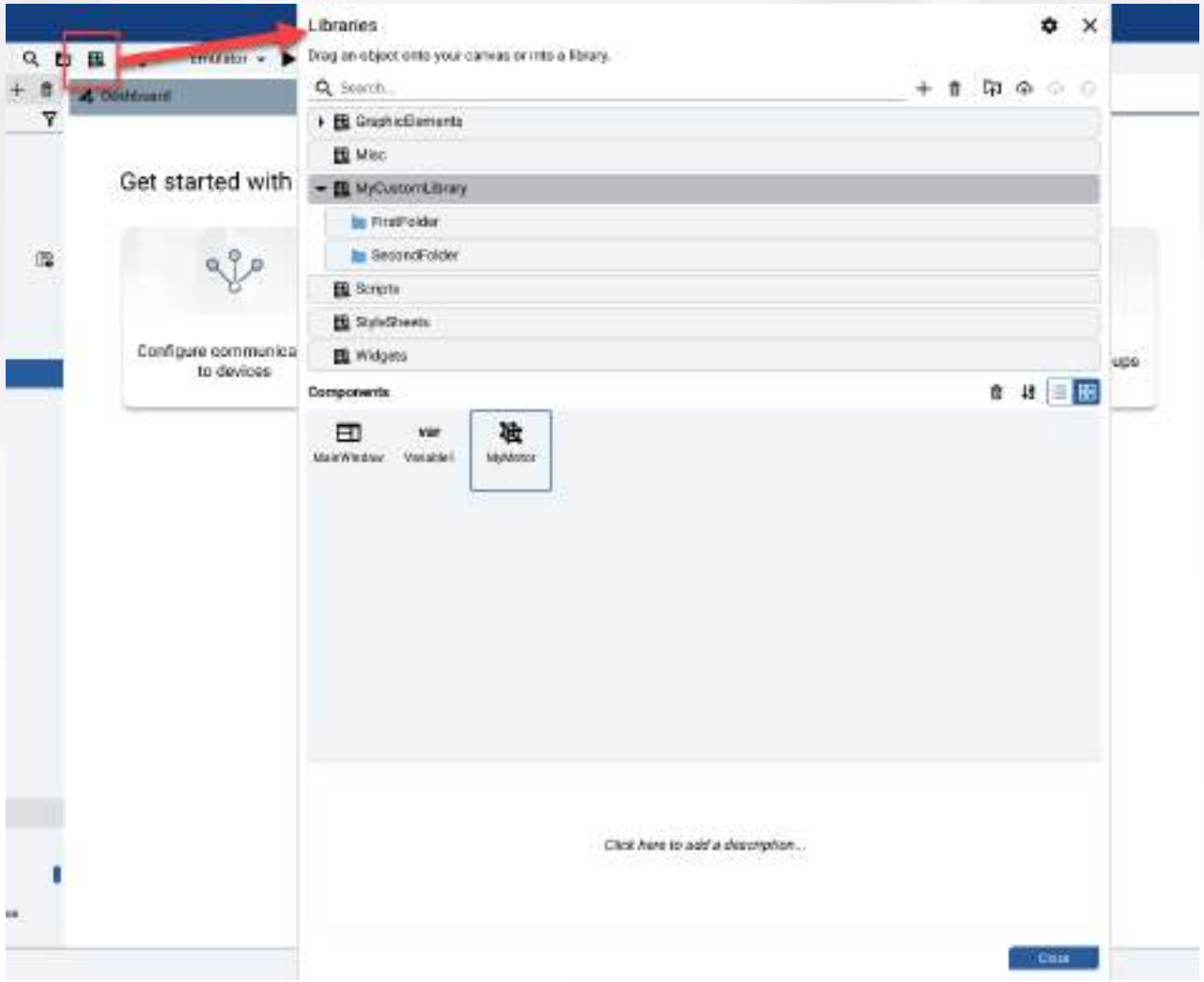


Template Library

Template Library

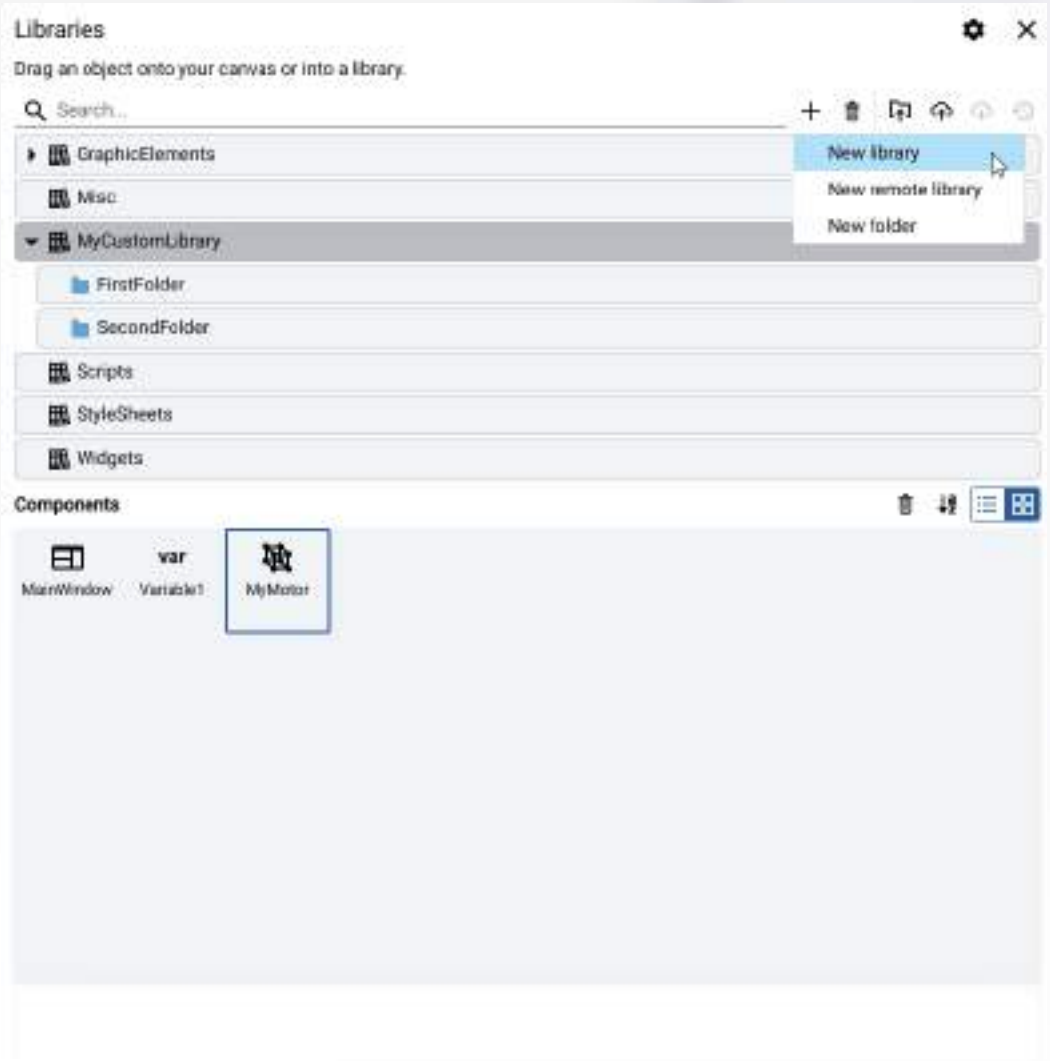
- FactoryTalk Optix contains a good number of default libraries
- Default libraries cannot be modified (read-only)
- User can create unlimited libraries
  - Each library can have multiple subfolders
  - Libraries can contain any kind of element
- Libraries are shared across projects
- Libraries can be versioned with GIT
- Custom libraries are saved in the Documents folder
  - `C:\Users\User\Documents\Rockwell Automation\FactoryTalk Optix\Libraries`



Template Library

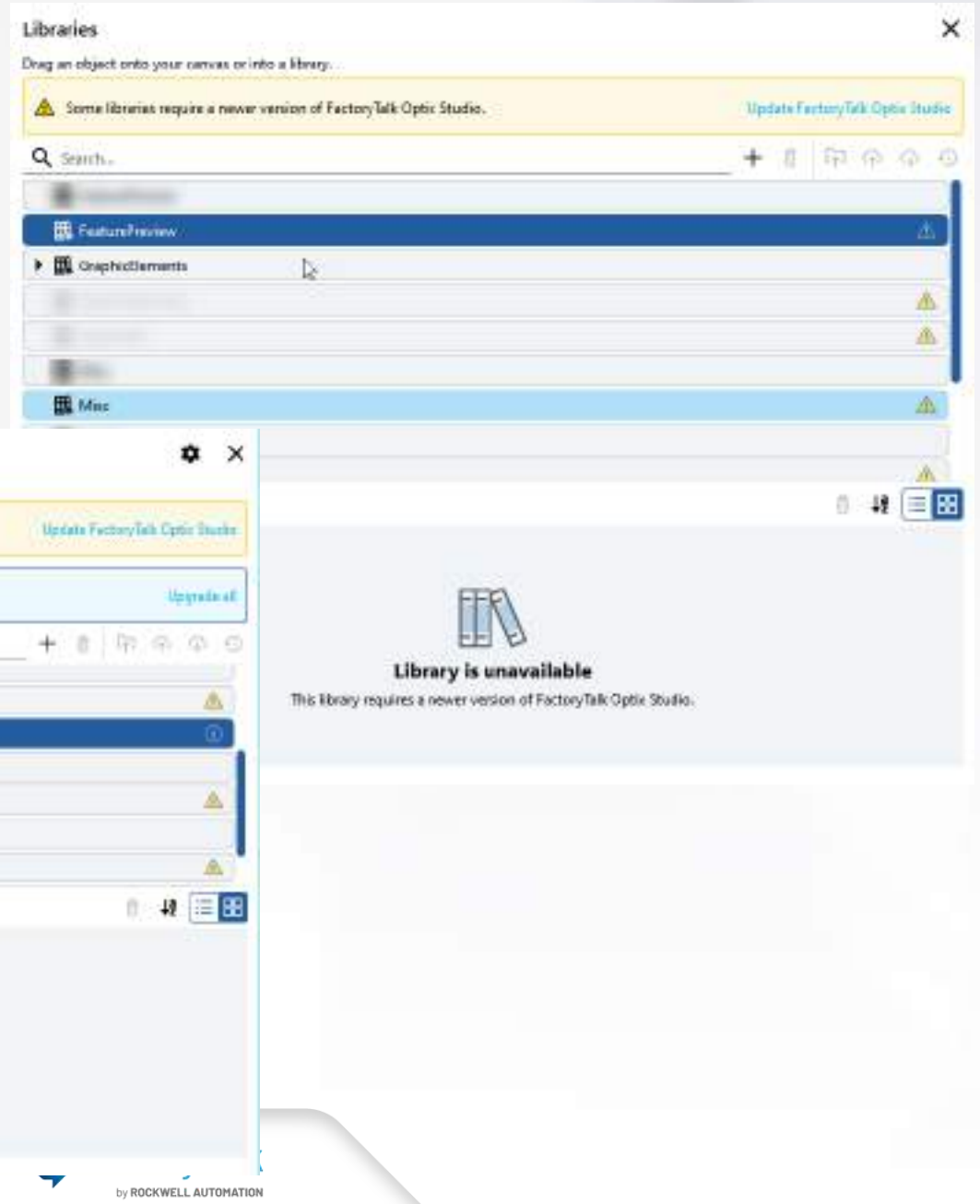
- **New library**: create a new local library
  - Any new library can be versioned bi using the dedicated buttons
- **New remote library**: pulls an existing library from a remote GIT provider
- **New folder**: create a subfolder in the selected library

- Version control history works for Template Library too (see the Version Control chapter)



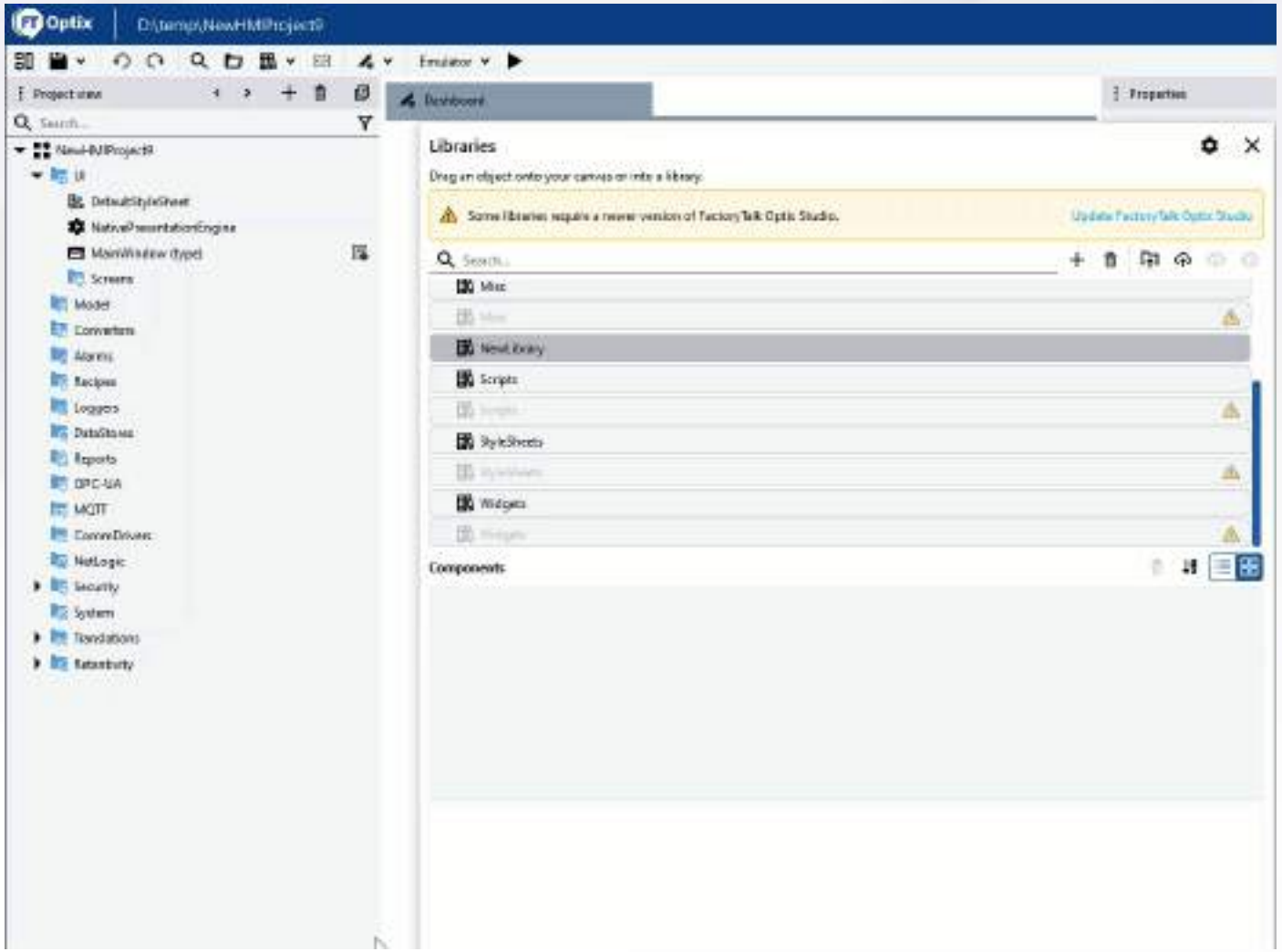
Template Library

- Libraries are only compatible with the same version of Optix that was used to create them
  - Libraries can be upgraded to a newer version if needed
  - Libraries cannot be downgraded



Template Library

- **Add an element to the library**: drag and drop the element from the project to the Template Library
  - Additional dependencies or types are imported automatically
  - Each element can have a description
- **Import an element from the library**: drag and drop the element from the library to the project
  - Additional dependencies or types are imported automatically
- **Resolving conflicts**: when importing or exporting any element, if the same type already exist, conflict resolution is prompt to the user



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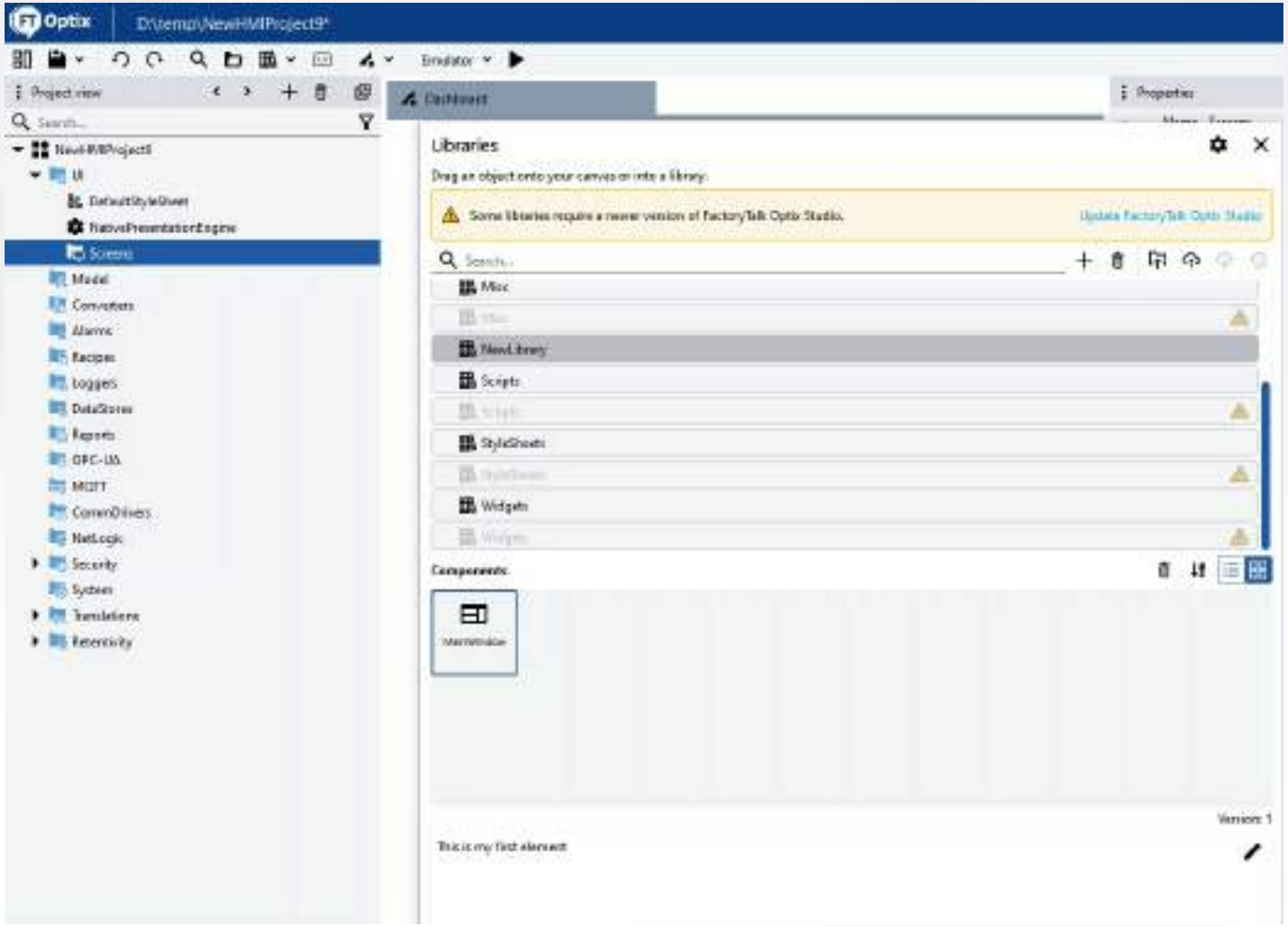

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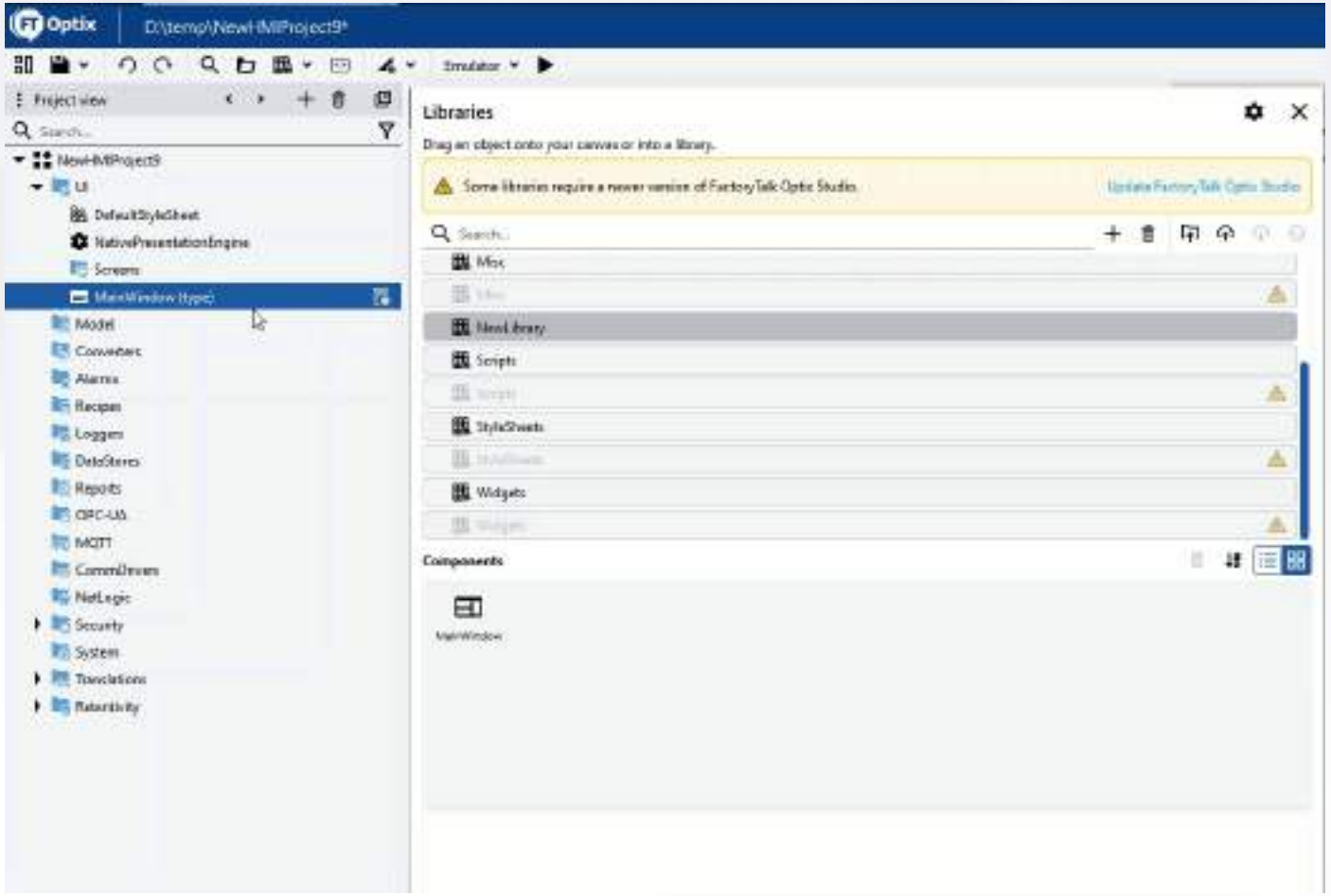
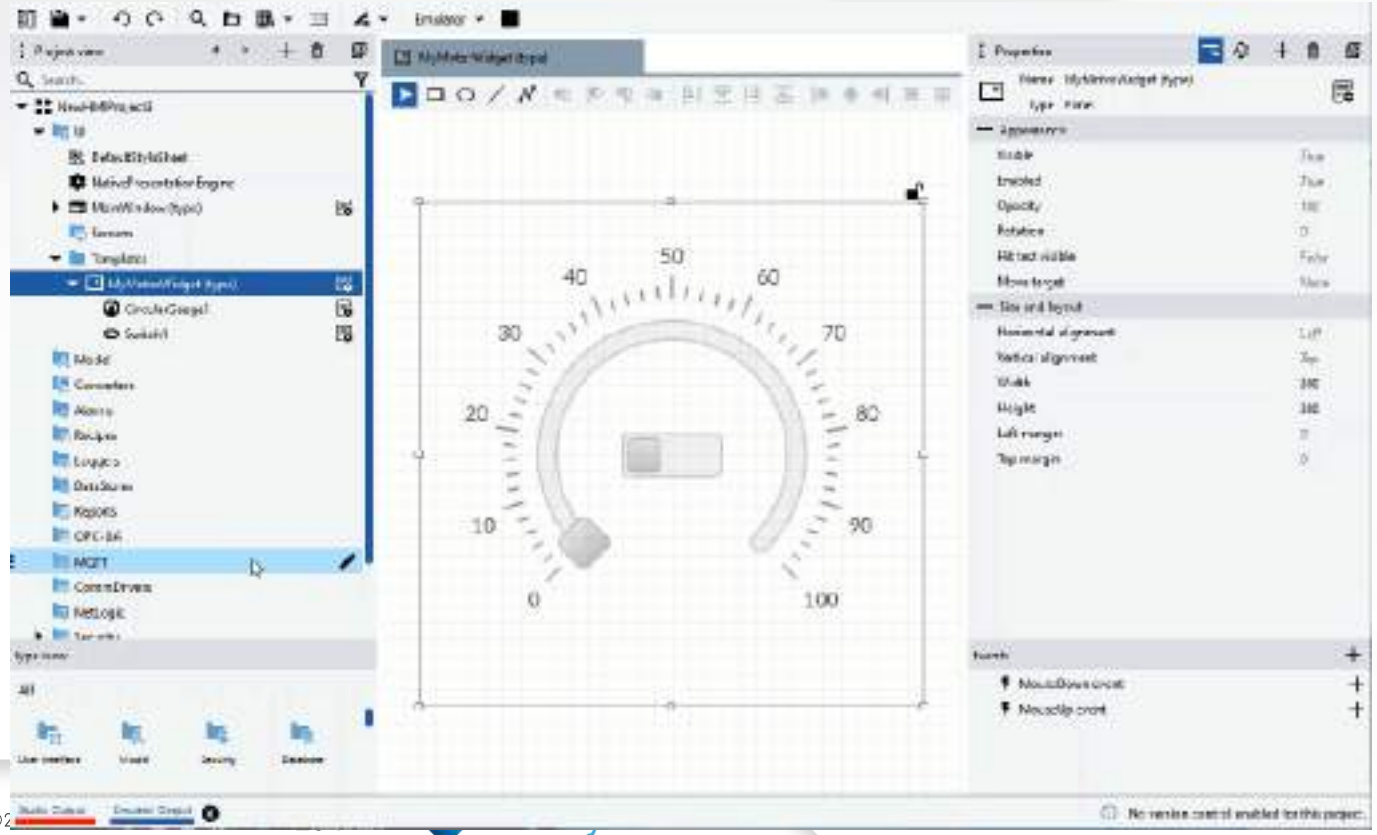


UI Objects Protection

UI Objects Protection

- UI Types can be protected to avoid accidental changes
  - Does not encrypt the content of the YAML file or prevents element manipulation from YAML source file
  - Does not encrypt the NetLogic in the UI Object (if any)
  - Used to avoid unauthorized changes of the children elements of an UI Type (e.g: sharing the object with colleagues)
  - Only works on UI Types

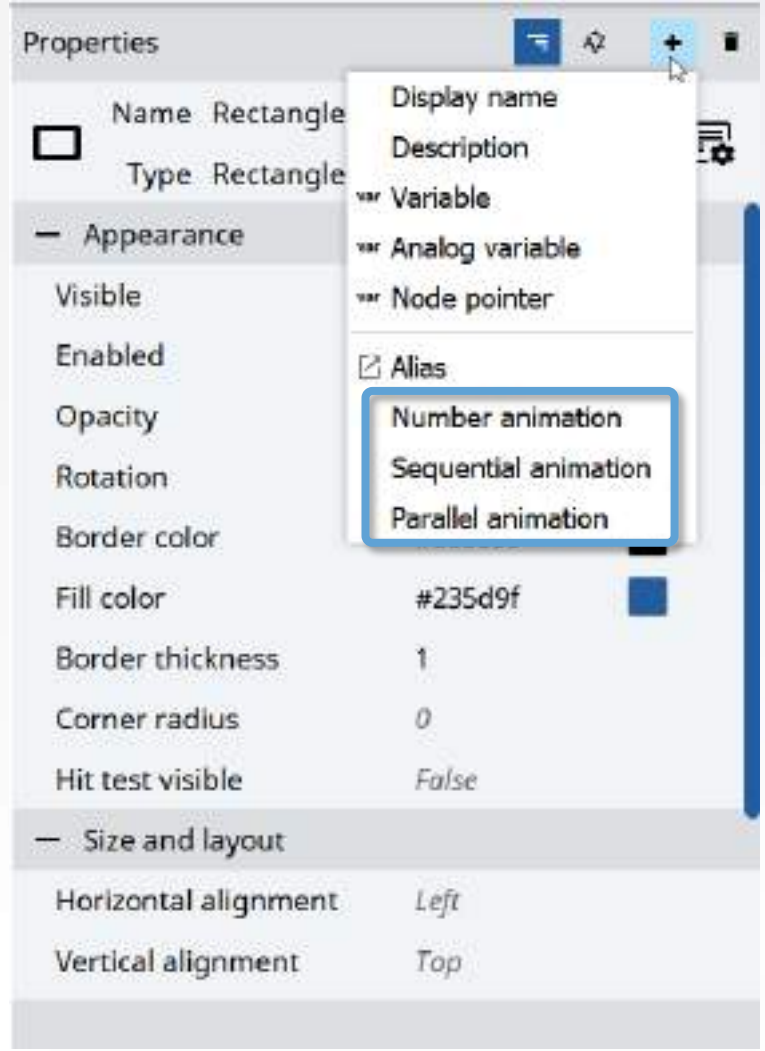


Animations

Animations

- Using Dynamic Links some basic animations can be defined as **just linking a Variable to a property**
  - Visibility, Enabling, Resizing, Change color…

- For **"eye-catching" Animations**:
  - Number animation: single animation
  - Sequential animation: container of animations executed in sequence
  - Parallel animation: container of animations executed in parallel (at the same time)
  - Animation of Behavior: allow to animate a property linked to a Variable



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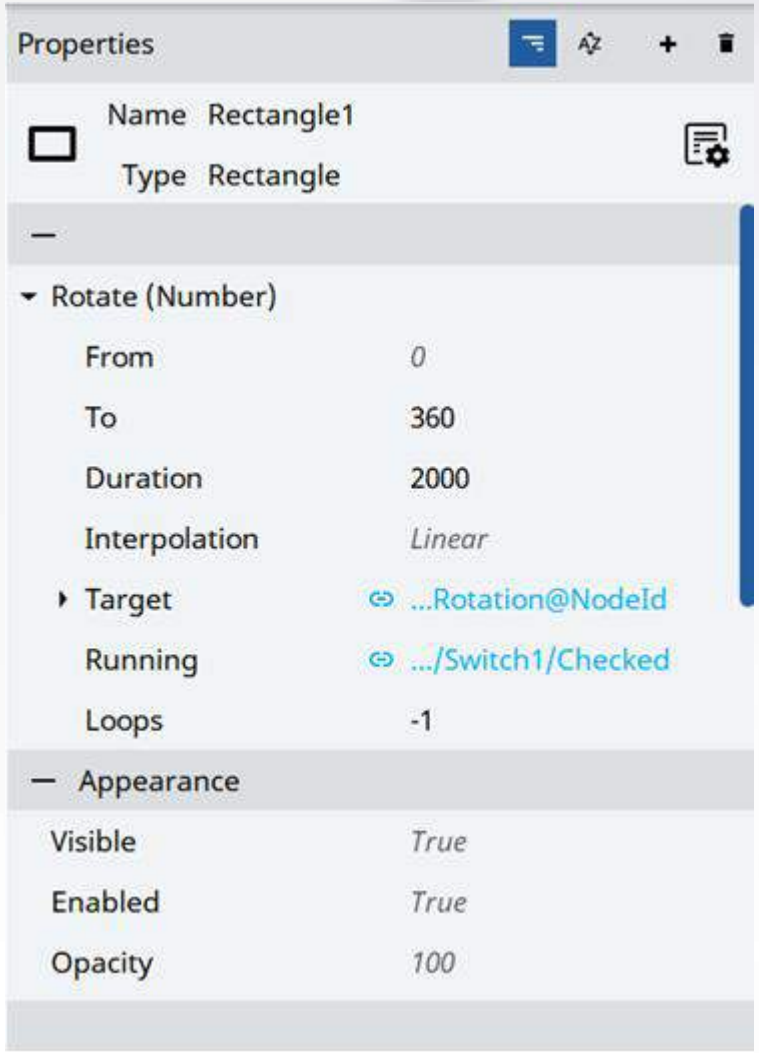

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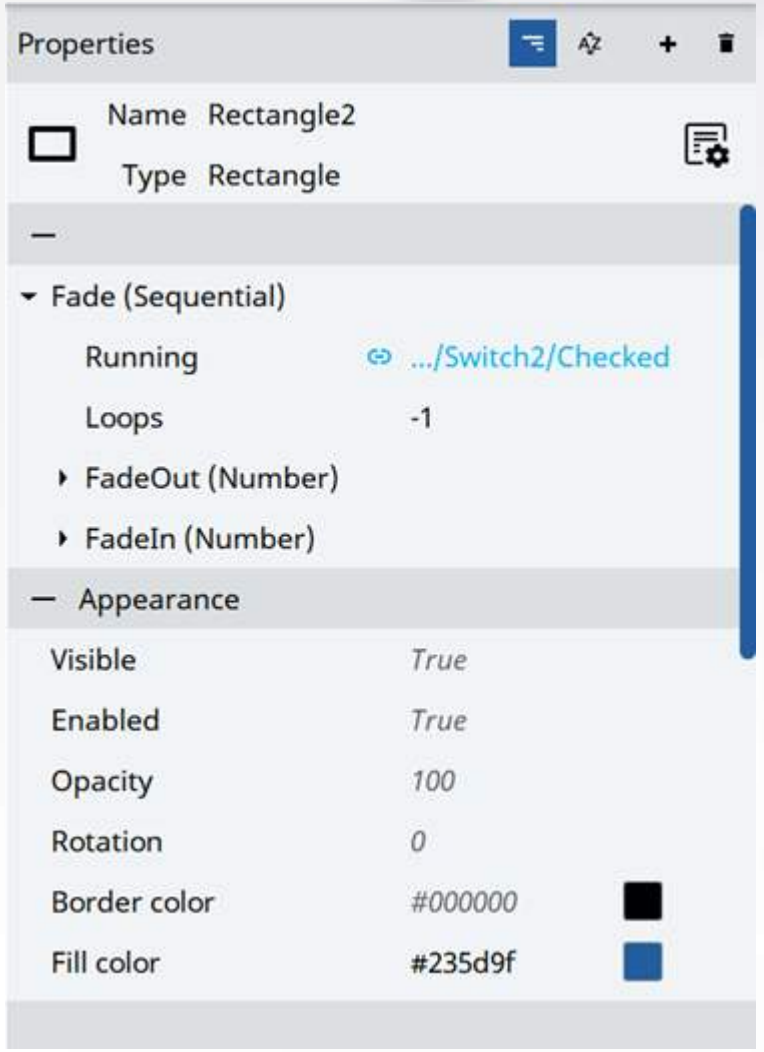

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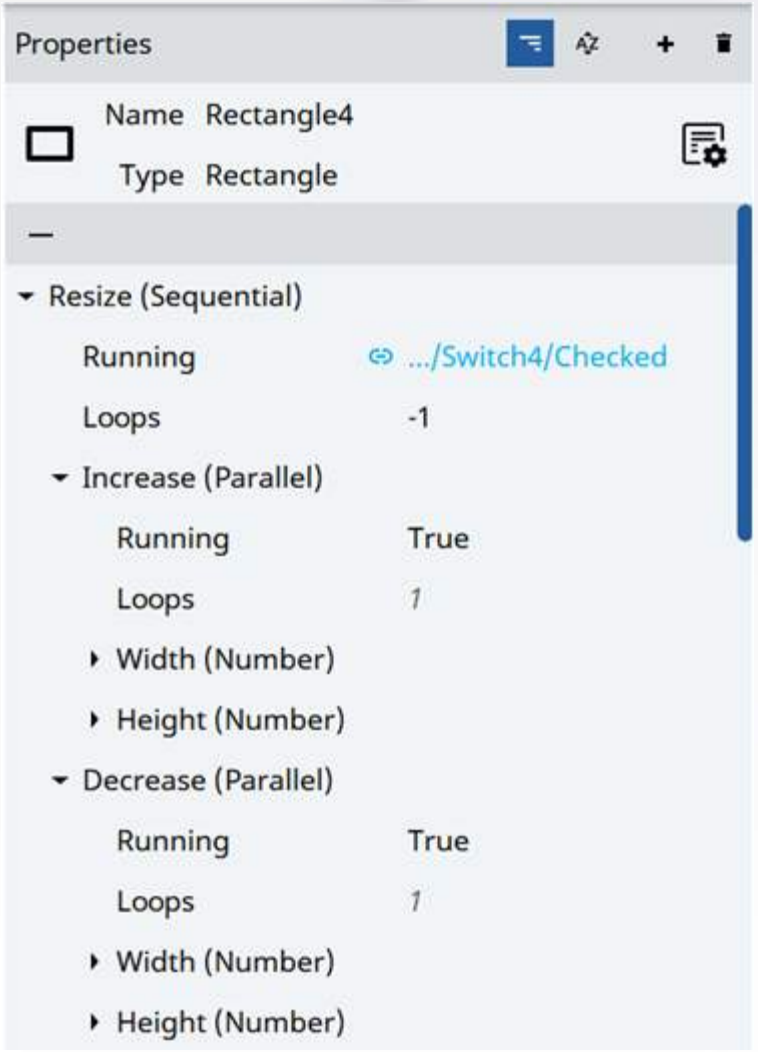

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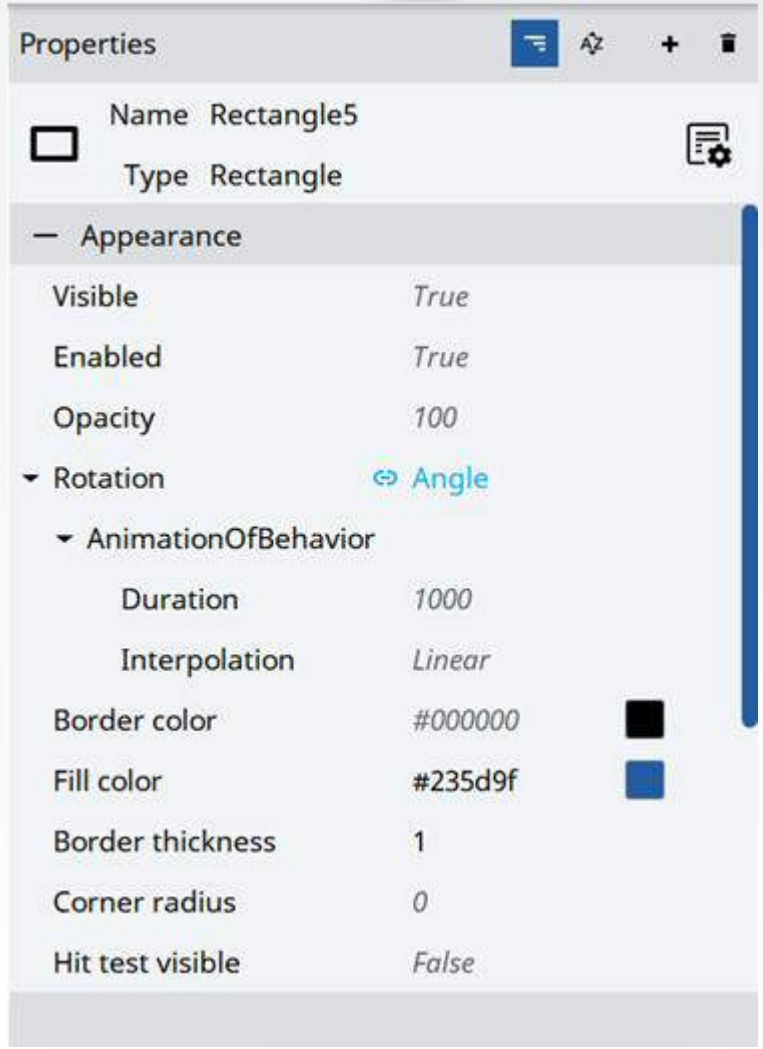
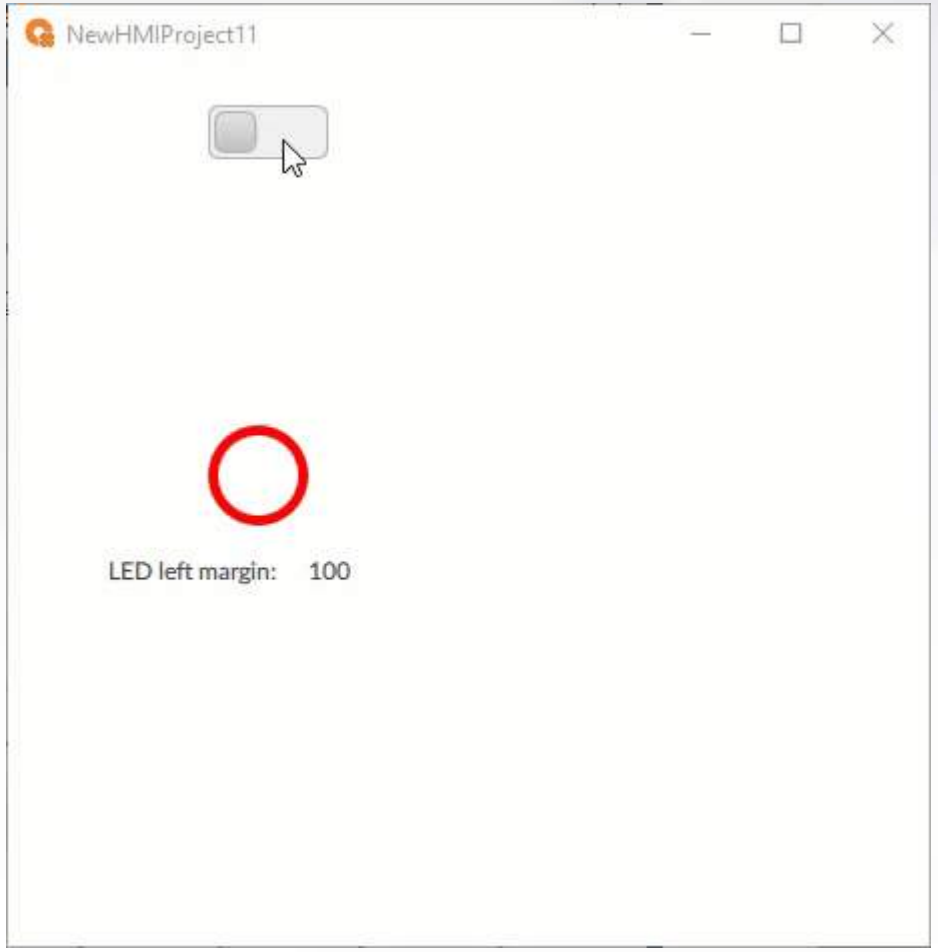


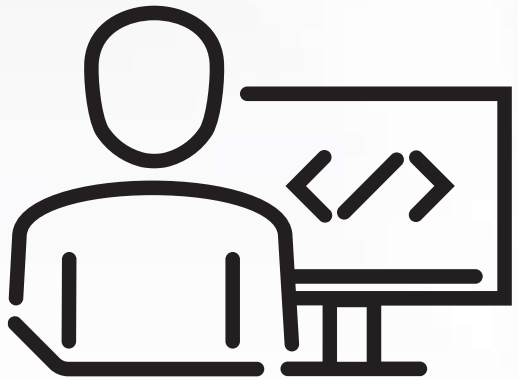
Things to remember

- Animations are just an “overlay” added before rendering to the variable
- The “real” value of the variable is left untouched



Hands-on session

- Add a Panel Loader object and add one or more buttons that call the method "Change Panel" to change the panel loaded
- Create a button object that calls the method "Open Dialog" to open a Dialog Box
- Define a Transitioned Event that executes a method like "Variable commands > Set Variable Value" or "Core commands > Close"

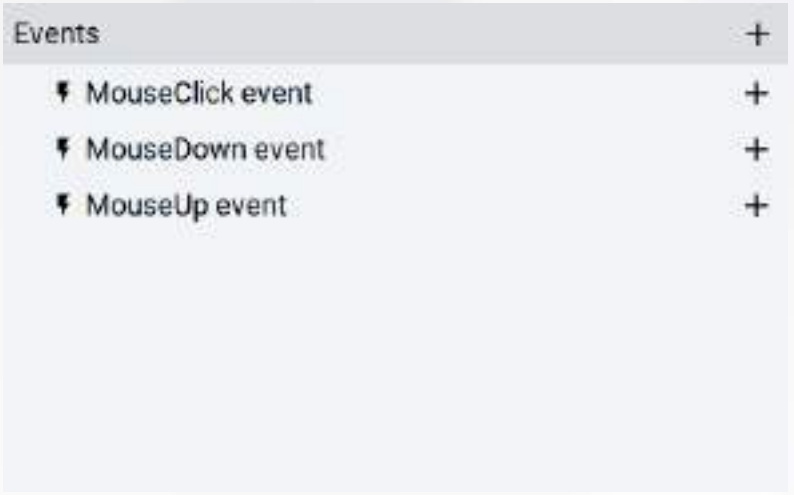


Events

Commands, methods and events

- Commands/Methods can be executed on Events triggered by objects

- Event Types:
  - **Native Event** (Event View): like "MouseClick", "MouseDown", "MouseUP" of a button
  - **Changed Event, Transitioned Event, Range Transitioned Event** (Property Panel): custom event



- Method Types:
  - Global Methods or **Commands**: like "Change User", or "Open Dialog"...
  - Local **Methods exposed by objects**: like "Log" of Datalogger, or "Refresh" of Datalogger viewer...

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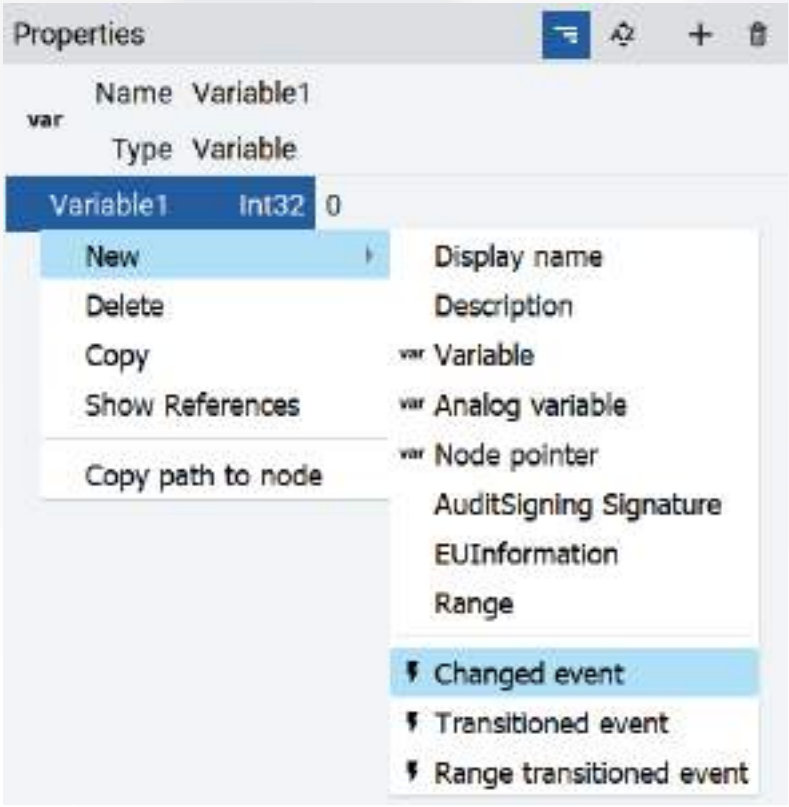

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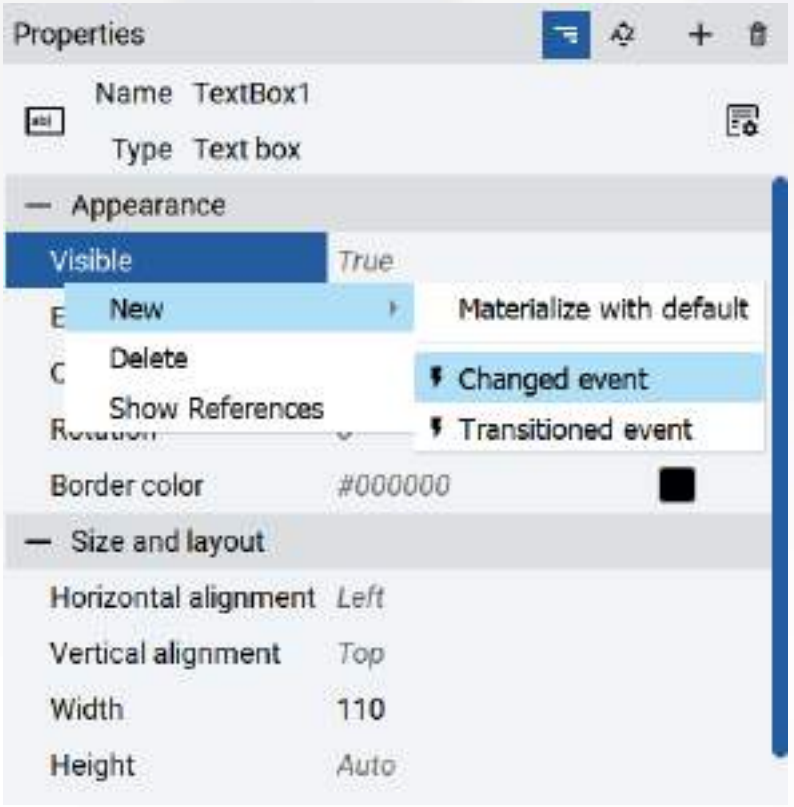
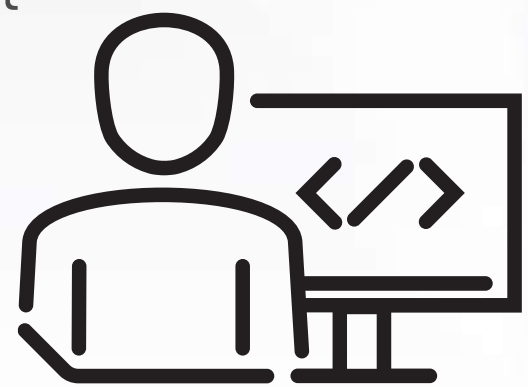


Hands-on session

- Create a button object that calls the method "Open Dialog" to open a Dialog Box

- Define a Transitioned Event that executes a method like "Variable commands > Set Variable Value" or "Core commands > Close“

- Define an event to display a ScreenSaver Screen after Idle Timeout
  - HINT: add the UISession object and assign Session in Presentation properties
  - Unzip Image file ra_logo.svg or use any image
    - C:\Program Files\Rockwell Automation\FactoryTalk Optix\Studio\Help\en\downloads

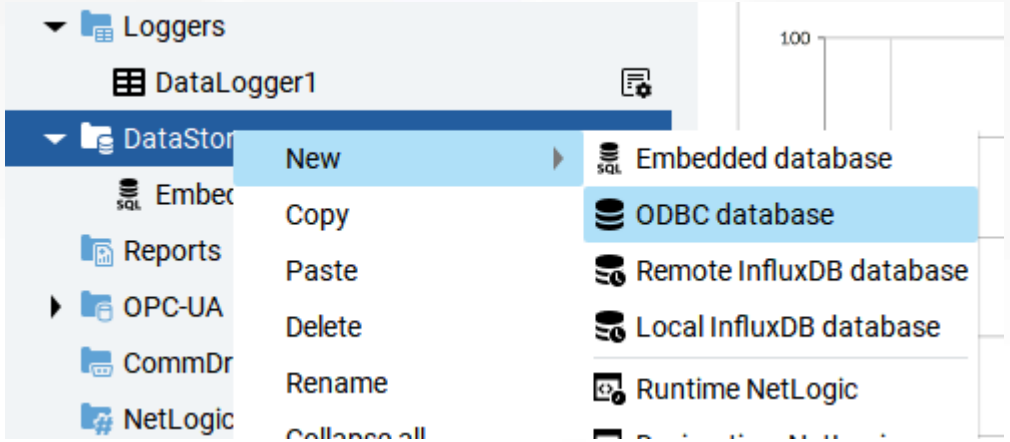


DataStores

DataStores

- A DataStore is a database connection
- Types of DataStores

  - **EmbeddedDatabase**: Records values of one or more variables at the same time
  - **ODBC database**: SQL based ODBC connection (SQL Server, MySQL or any derivative)
  - **Remote InfluxDB Database:** Remote PC Timeseries database connection (self-hosted)
  - **Local InfluxDB Connection:** Local PC Timeseries database connection (similar to an EmbeddedDatabase)



Working with Databases

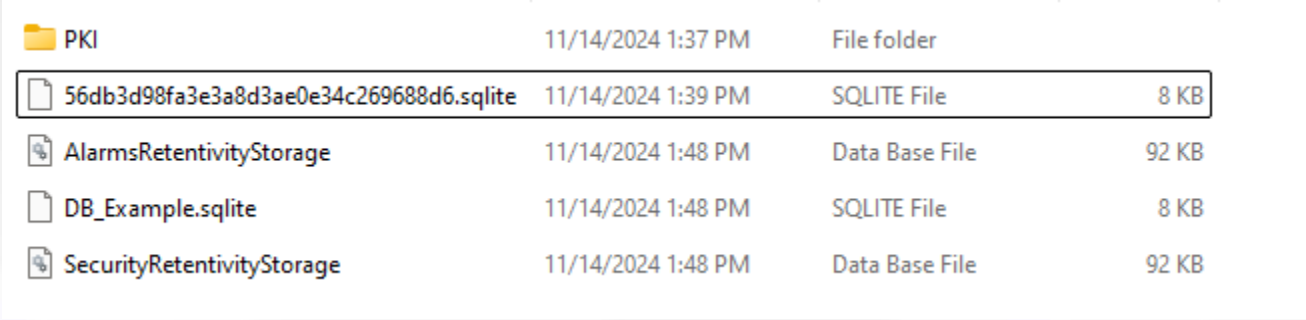
Objects that can exchange data with a datastore:

- ***Data grid*, *List box*, *Combo box*** and *Trend* objects
  query a table to display data at runtime
- *Data logger* and *Event logger* objects
  store data in a table
- *Recipe* object
  stores data in a table and execute a query to display data at runtime

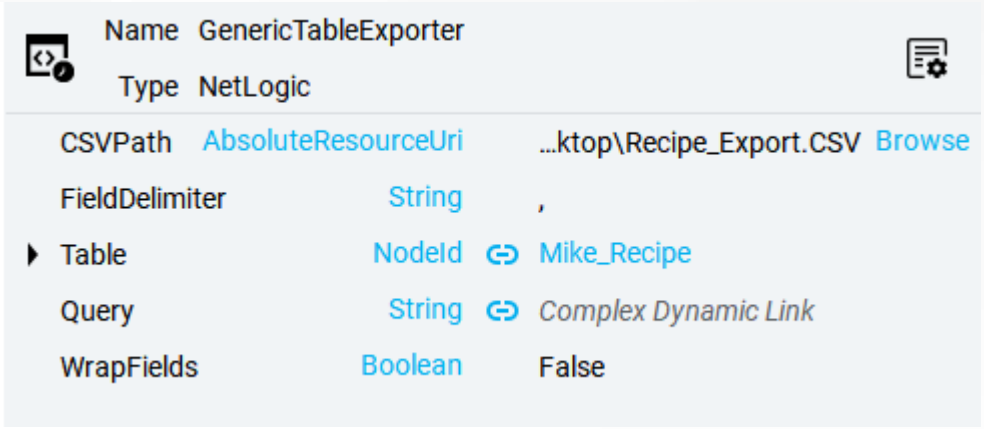
Working with databases Design-Time

- Emulator will create a copy of the project at runtime
- C:\Users\<USER>\AppData\Local\Rockwell Automation\FactoryTalk Optix\Emulator\Projects

- At Runtime the Embedded database is Locked.
- Path: `\ApplicationFiles\<DB Name>.sqlite`
- Can be manipulated with SQLite editors like SQLite Browsers, Dbeaver and more.



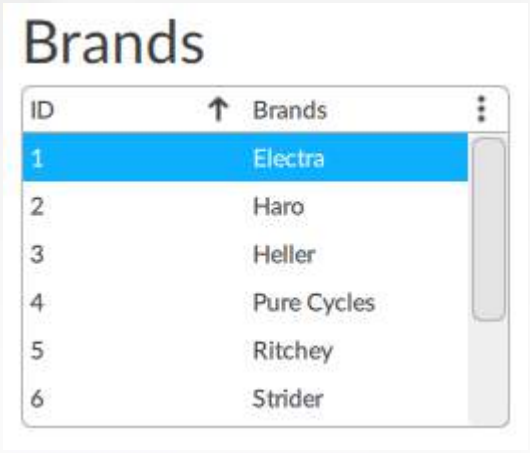
- Tables can be exported to CSV via script

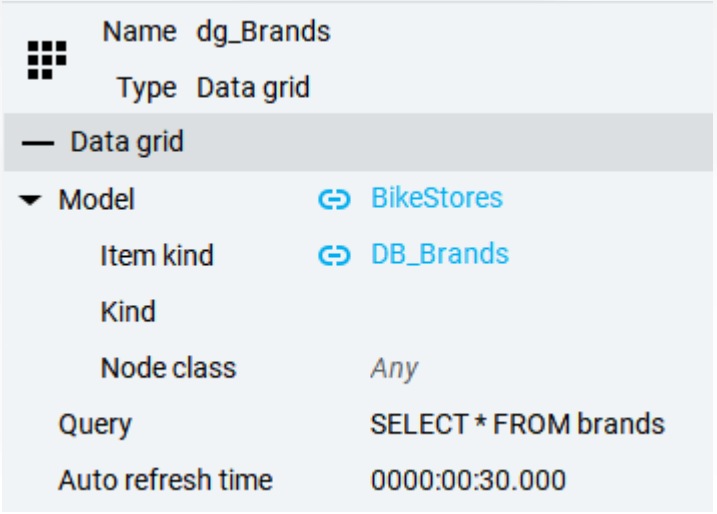


Data Grid, List Box and Combo Box

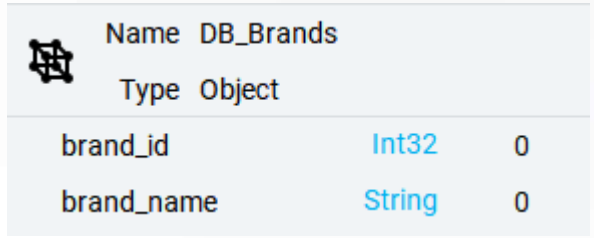
Data Grid is a tabular view of data at Runtime

Connect to Database, Folder of objects, structure, Enumeration

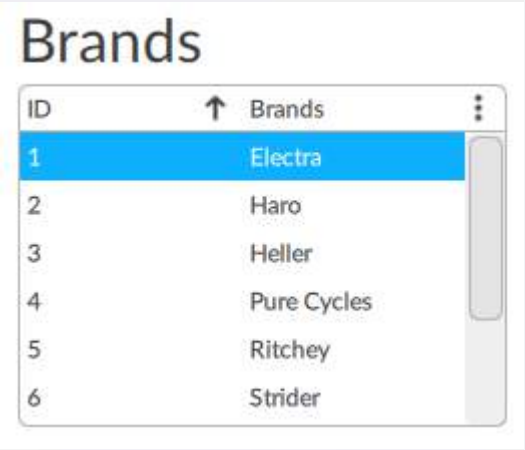


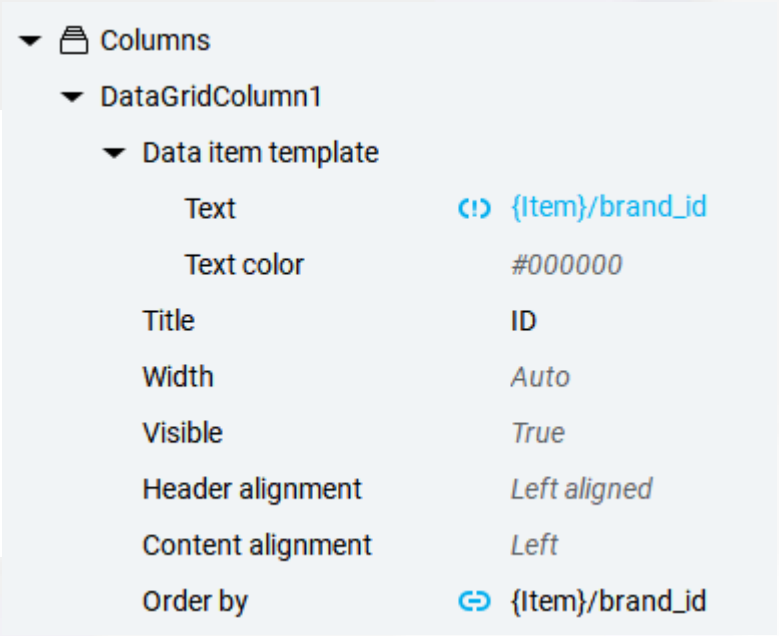


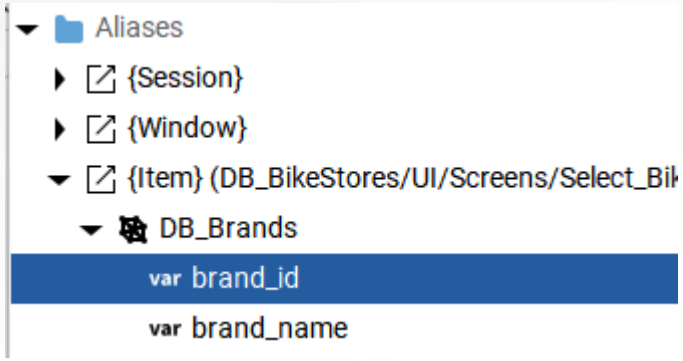
- Model – DataStore or Folder or object
- Item kind (optional) – Design time structure
- Query – SQLite syntax
- Auto refresh time – how often data is queried – can be triggered on demand



Data Grid - Columns





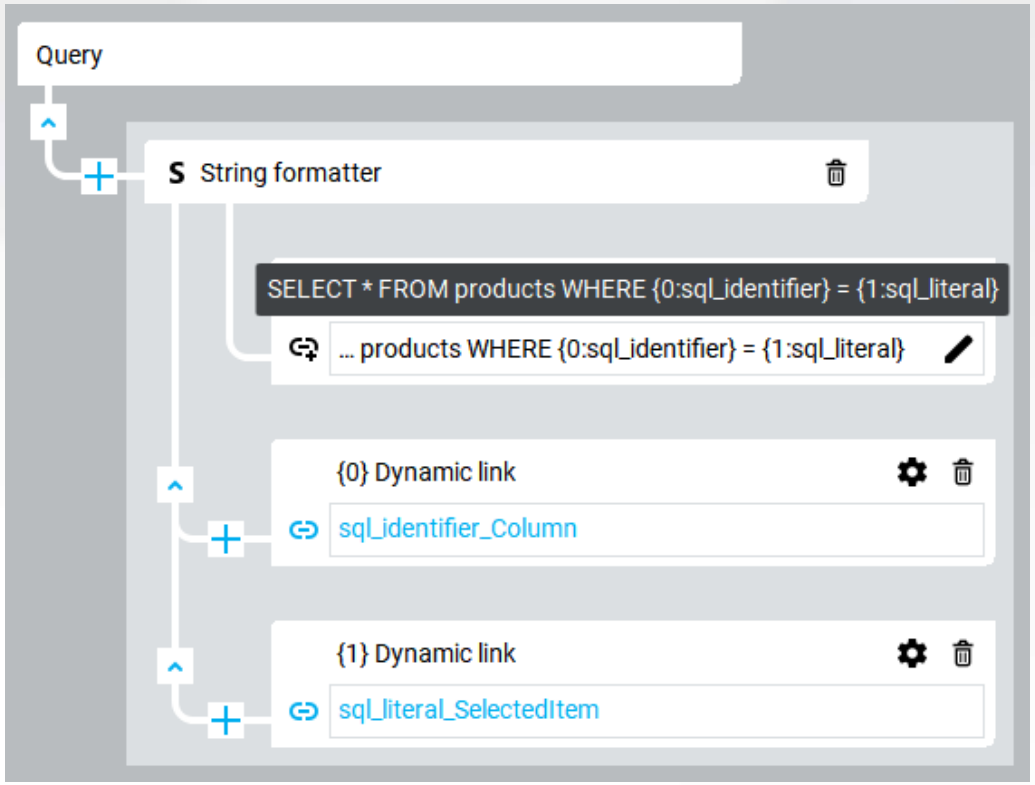


- Text – {Item}/ColumnName
  - For embedded Database
    - Browse into Aliases – {Item}/
    - Set Item kind to Datastore – Tables - columns
  - For ODBC Database
    - Browse into Aliases – {Item}/
    - Type in column name or create a model object for structure
- Title – Column label
- Query – SQLite syntax
- Order by – At least one column in DataGrid needs to be set

Database Queries

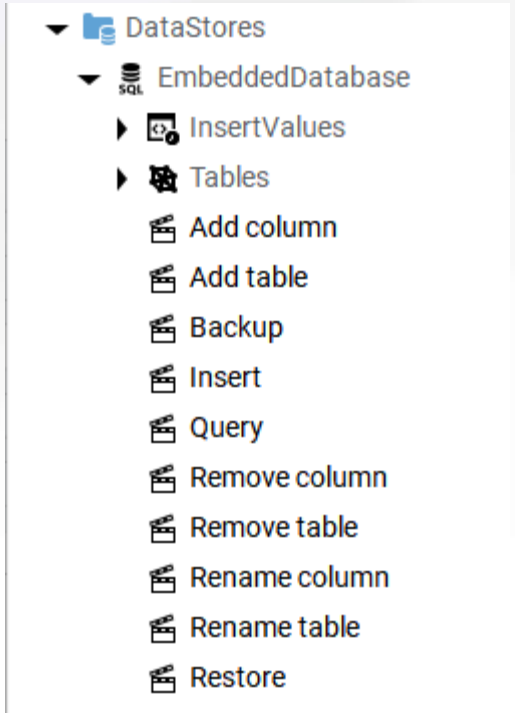
- Query – SQLite syntax supports a subset of statements such as:
- SELECT
- DELETE
- UPDATE
- CREATE and DROP
- JOIN
- Many more…

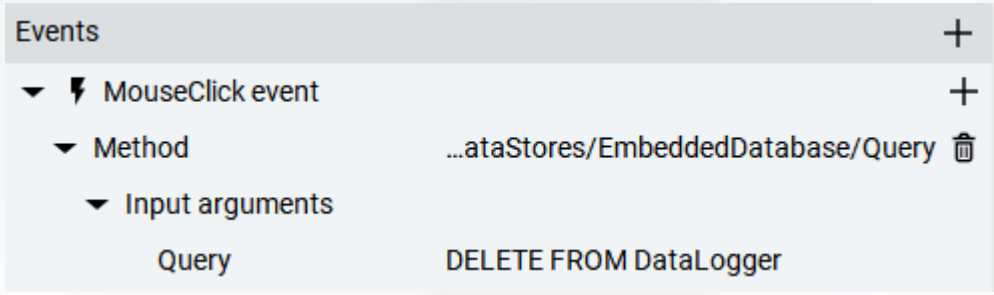
- When using the String formatter use placeholders
  - {0:sql_identifier} To define a column name for example
  - {1:sql_literal} To define a number for example

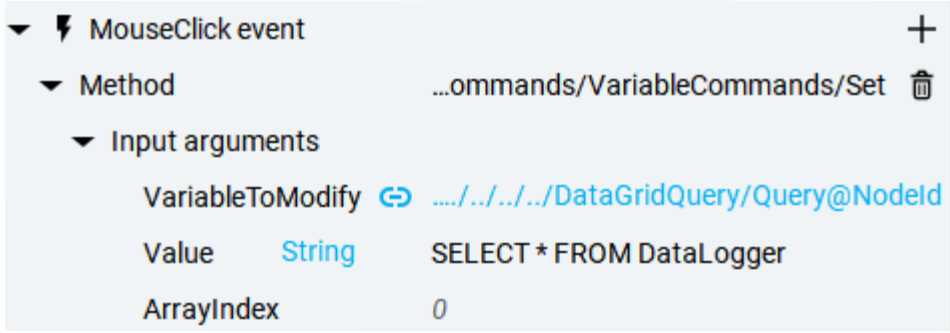


Database Queries

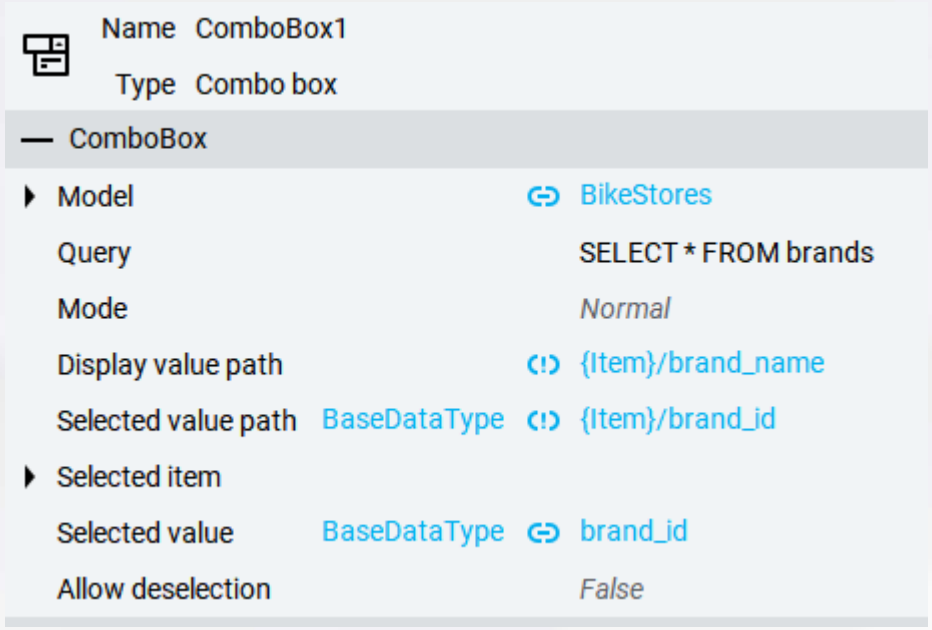
- There are 3 ways to Interact with a database
  1. Loggers
     - Data Logger or Event Logger can be set to “None” for OnDemand Writes or Periodic or OnChange
  2. SQL Methods
     - Use String Formatter to build query
  3. Scripts
     - See FeaturesDemo2 for examples







Combo box and List box



The most flexible of objects

Similar to DataGrid but has additional functions

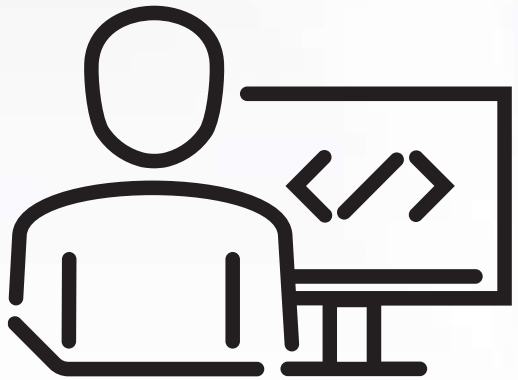
- **Model** – Datastore or Folder or Object
- **Query** – SQLite elect statement, use string formatter for advanced select
- **Mode** – Combo box – Normal, Search or Editable
- **Display Value Path** – Values to display
- **Selected Value Path** – Values to select
- **Selected Item** – NodeId of selected (nodeId is the unique ID reference)
- **Selected Value** – Value of selected

Queries limitations

- Support only for Standard SQL 2003 syntax
  - No support for specific dialects like SQL Server, MySQL or Flux
- List of supported clauses:
  - SQL queries
  - Influx database limitations

Hands-on session

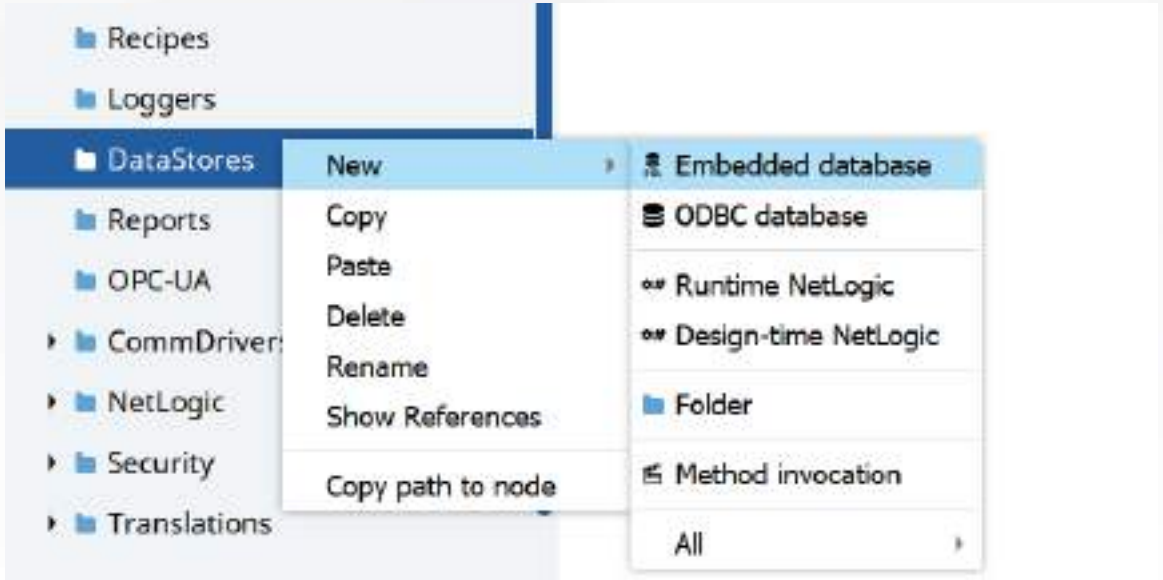
- Create a project with an EmbeddedDatabase and log some data
- Configure a DataGrid to show data from a DataBase
- Configure Combo box to filter by values
- Backup and Restore Embedded Database content



Save historical data with loggers

Loggers

- A logger is an object that records data and stores them in a database
- Types of logger
  - **Data logger**: Records values of one or more variables at the same time
  - **Event logger**: Records the properties of one or more events



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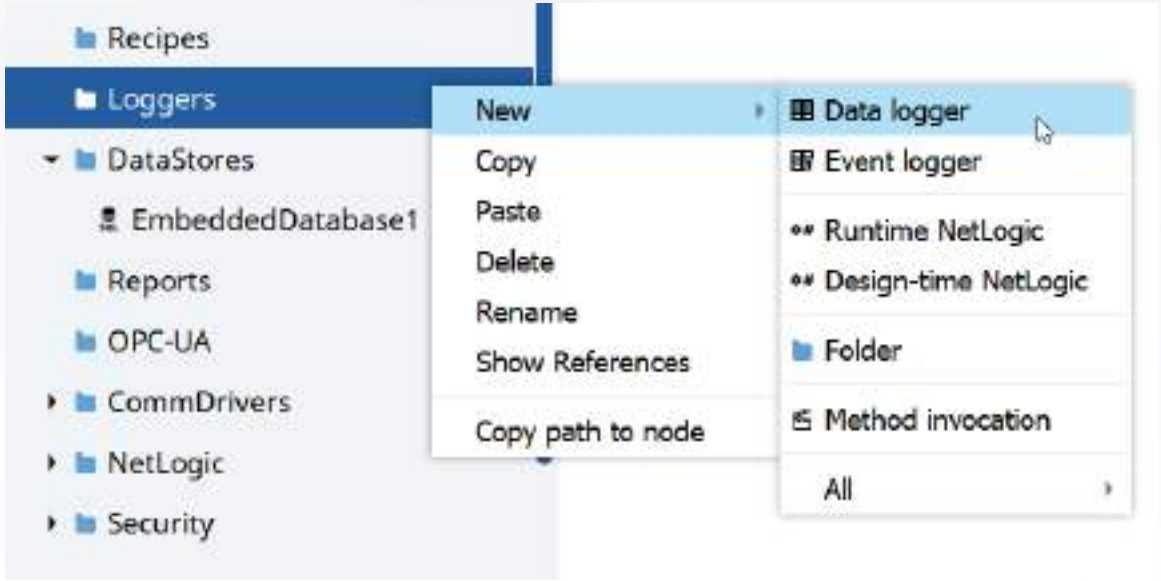
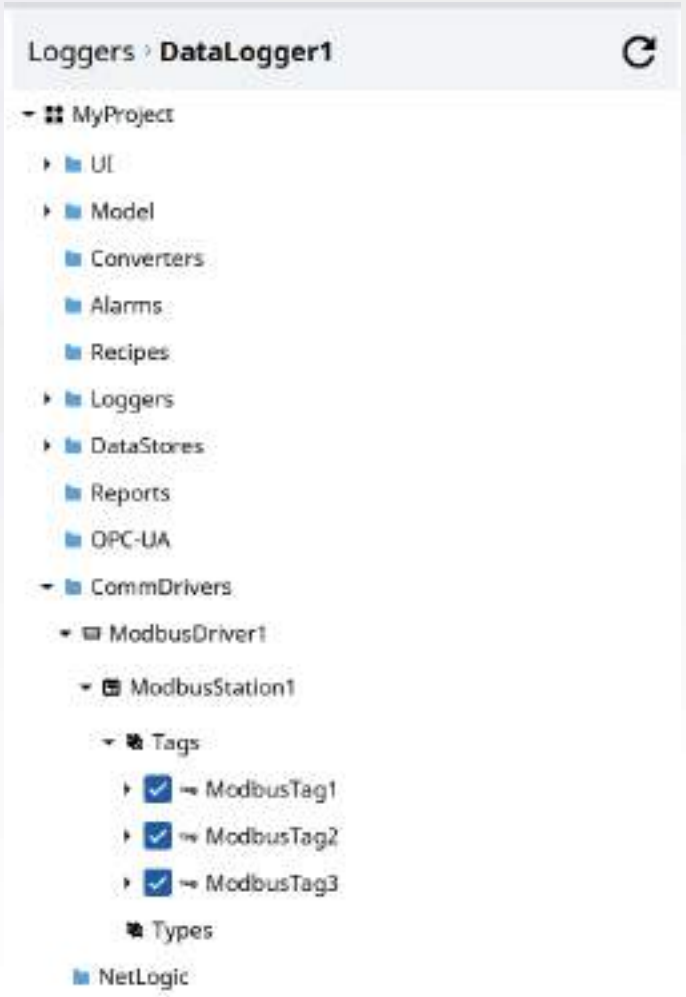


Data logger

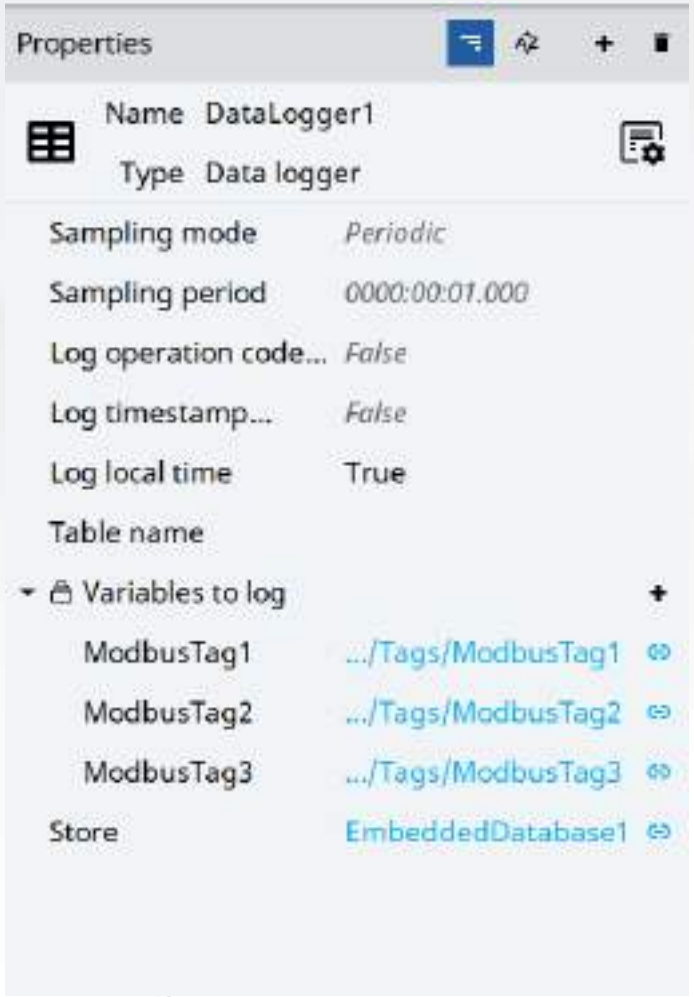


- At every sampling event the Datalogger create a new record into a table with the following structure:

Date/Time	Variable 1	Variable 2	...	Variable N
hh:mm:ss	value	value	...	value
hh:mm:ss	value	value	...	value

- Select Variables to record
  - Model tags, CommDrivers Tag, Objects properties...
- Configure Datalogger properties
  - Sampling Mode: Periodic/Change in Value
  - Sampling Period: dd:hh:mm:ss.fff
  - Table name (optional)
  - Store: DataStore used to save historical data

Data logger



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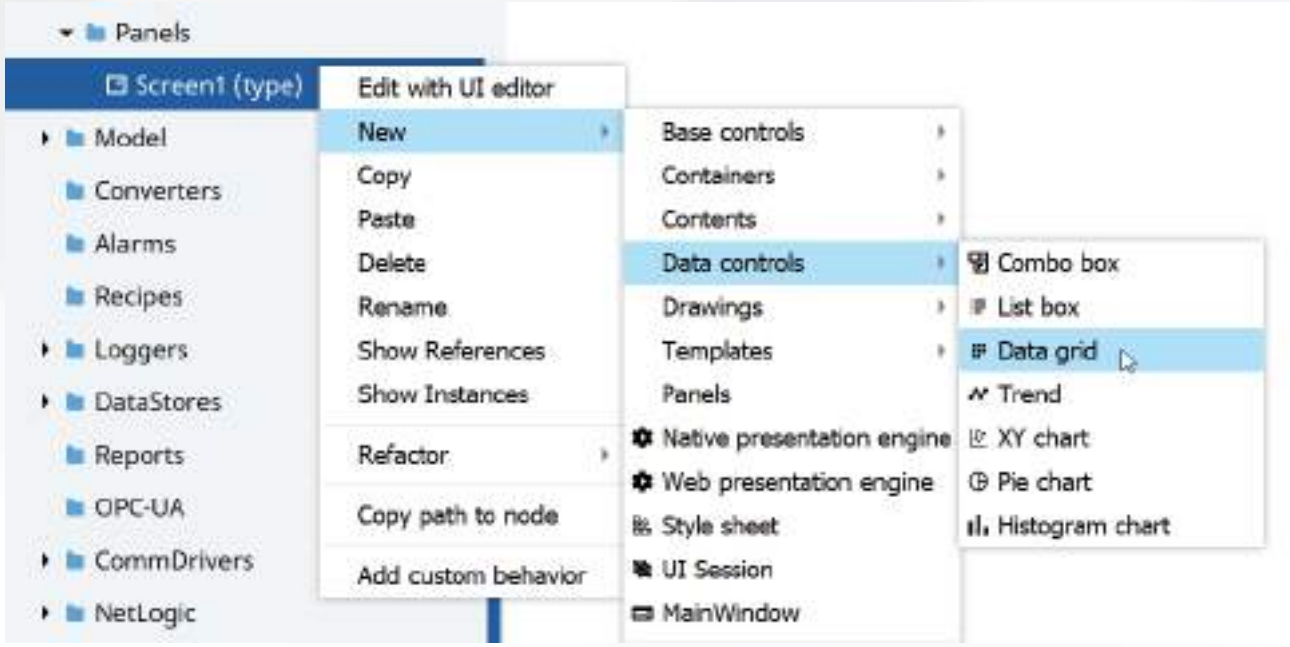
Data logger "viewer"

1. Add a "Data grid" object by New > Data controls > Data grid
2. Drag&Drop the Datalogger to the Data grid object

- The object can be customized through Properties pane
  - Query
  - Columns format
  - Sorting



- Export
  - Data logger can be exported using the script "Data Logger exporter" available into Template Library. This script can be associated with a button event

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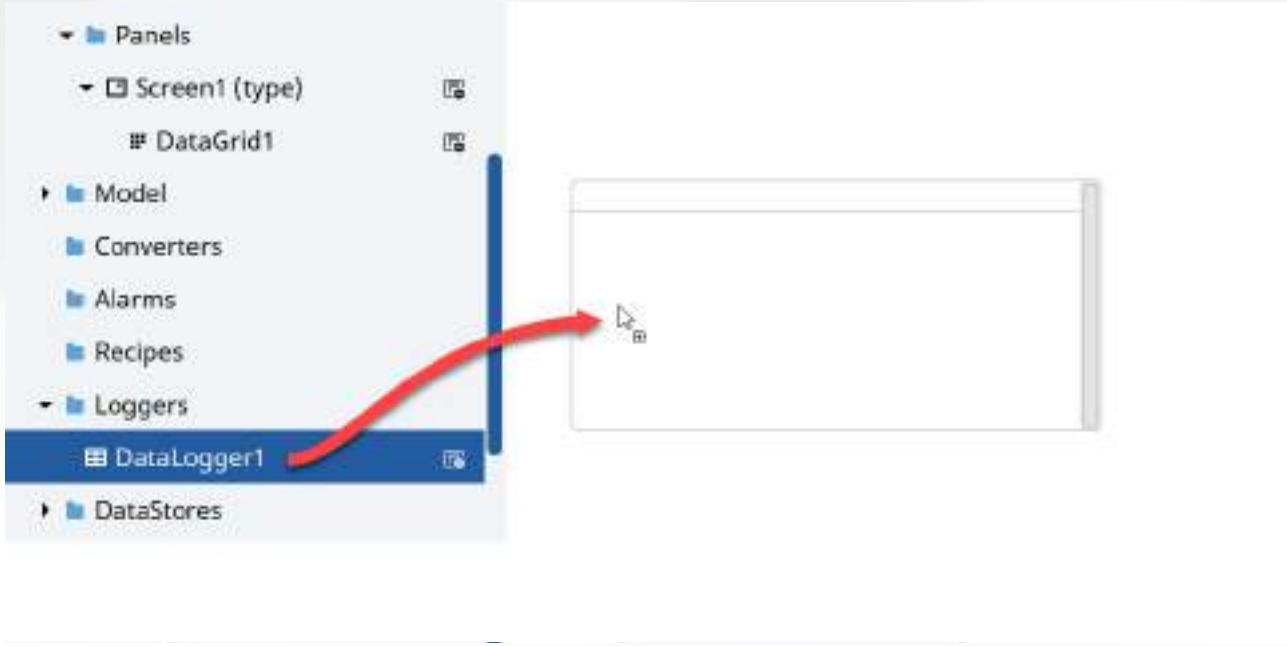

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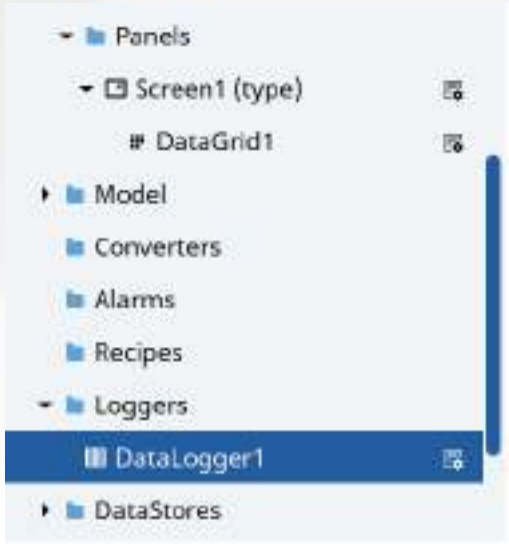
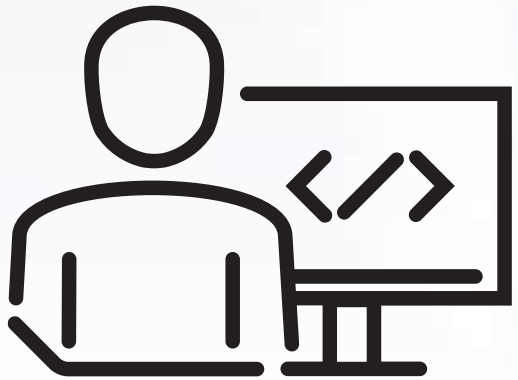


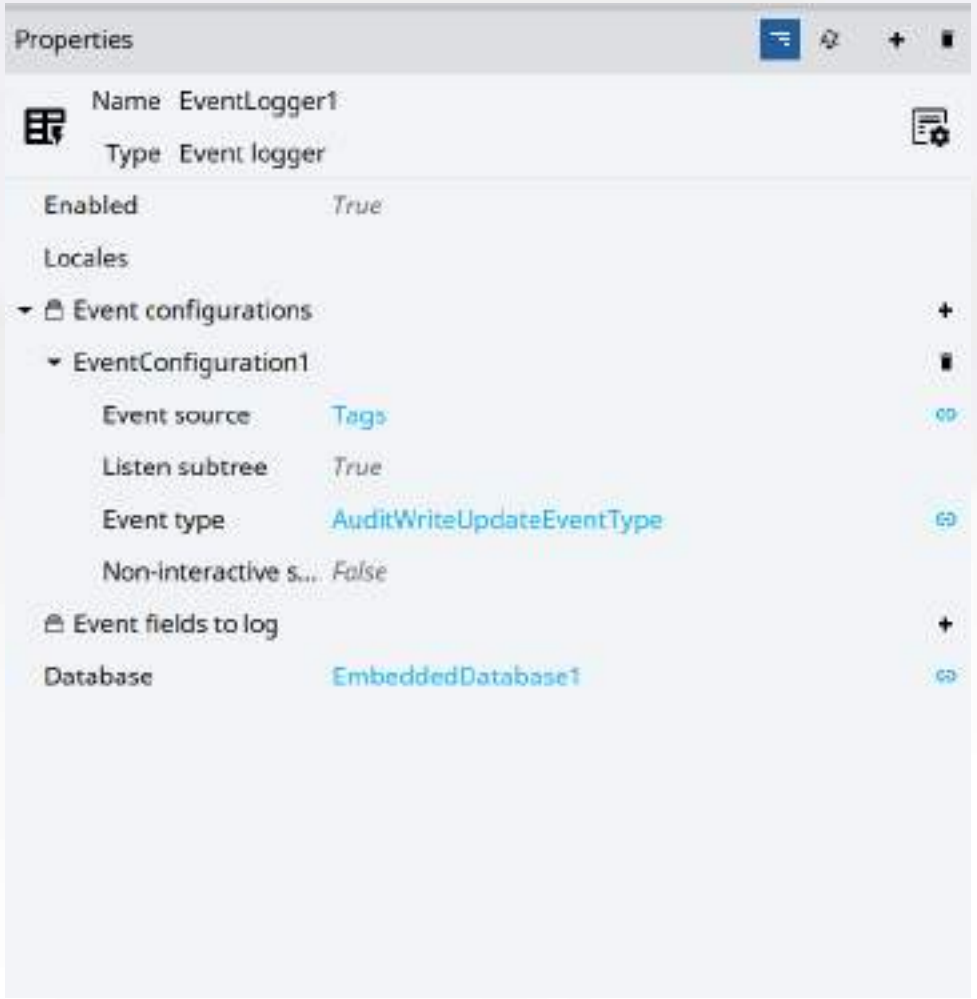
- Export
  - Data logger can be exported using the script "Data Logger exporter" available into Template Library. This script can be associated with a button event

Hands-on session

- Define a new Datalogger with a periodic sampling of 5 seconds
- Configure a Grid to show the datalogger table stored on the database
- Add a button to manually trigger a new record
- Add a button to refresh the grid
- Add a switch to start/stop the sampling



Event logger

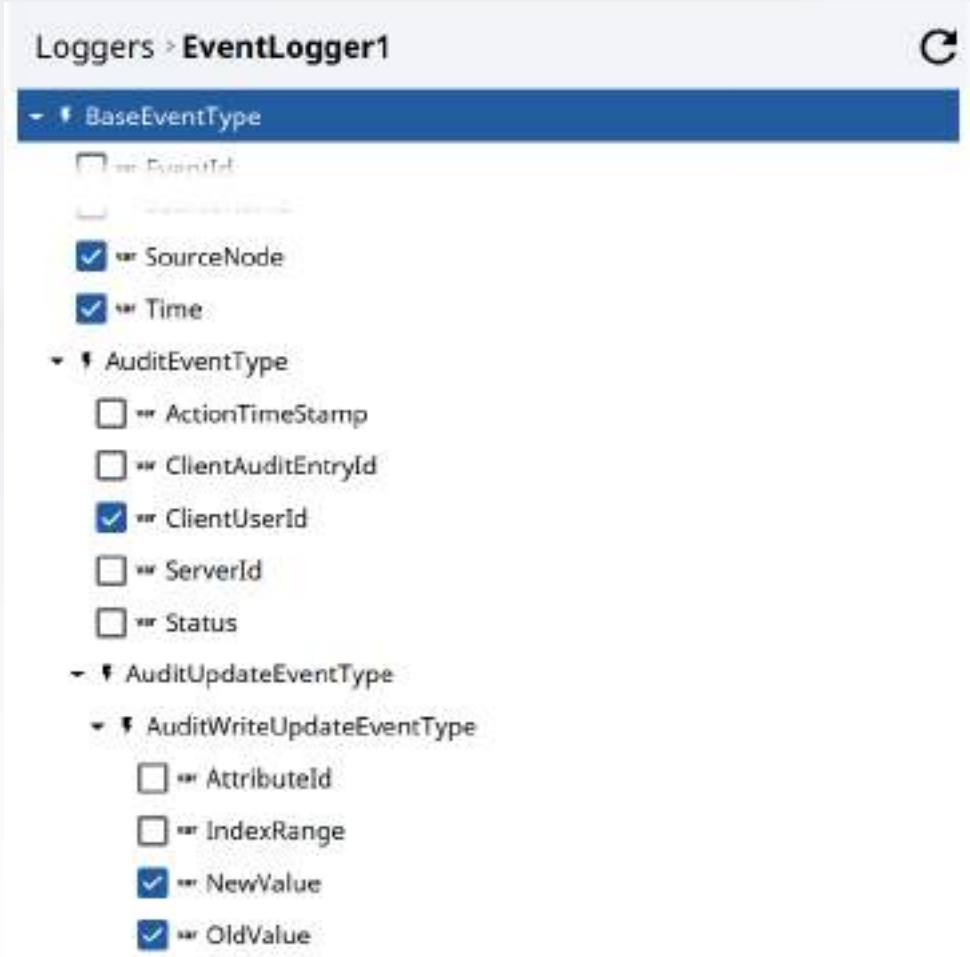


- At every event the Event Logger creates a new record into the table with structure defined into "Event fields to log"

Time	Client User ID	Source Node	Old Value	New Value
hh:mm:ss	Guest	Variable1	0	5
hh:mm:ss	Admin	Variable2	2	8

- Configure the Source and Event to log
- Select Event fields to log
- Define the Datastore

Event logger



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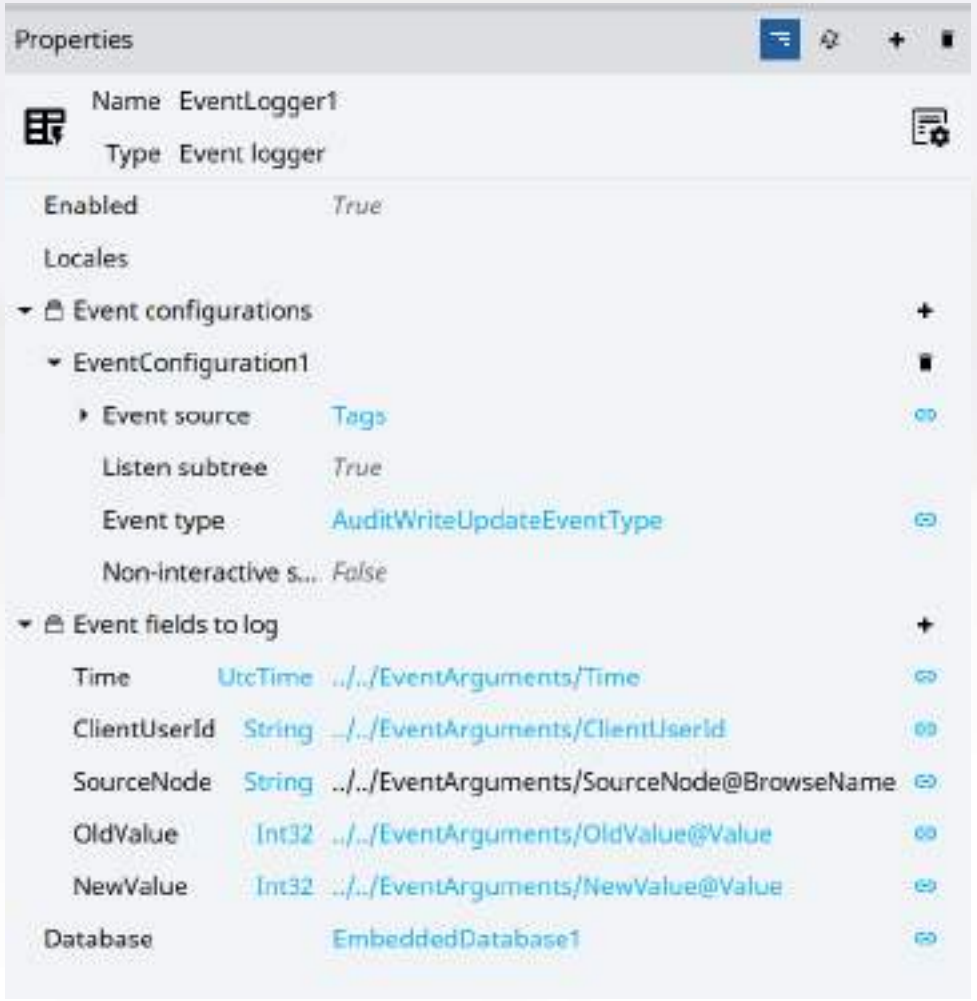
Event logger



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- Configure the Source and Event to log
- Select Event fields to log
- Define the Datastore

Event logger "viewer"

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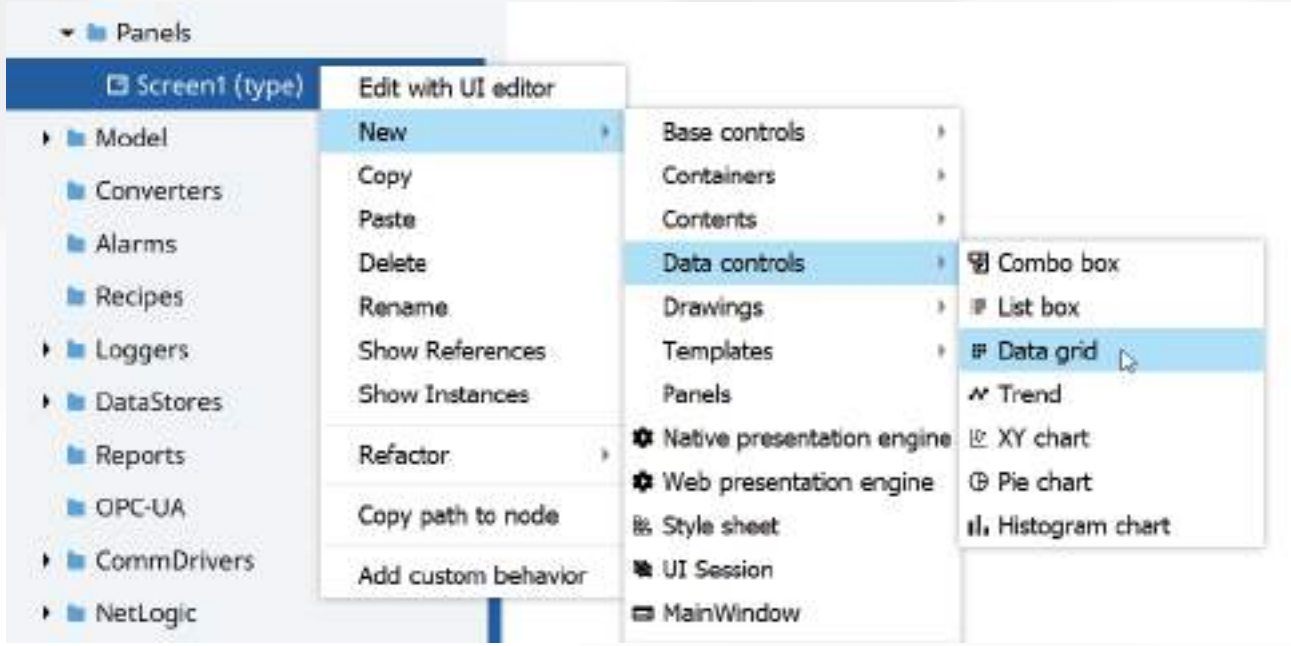

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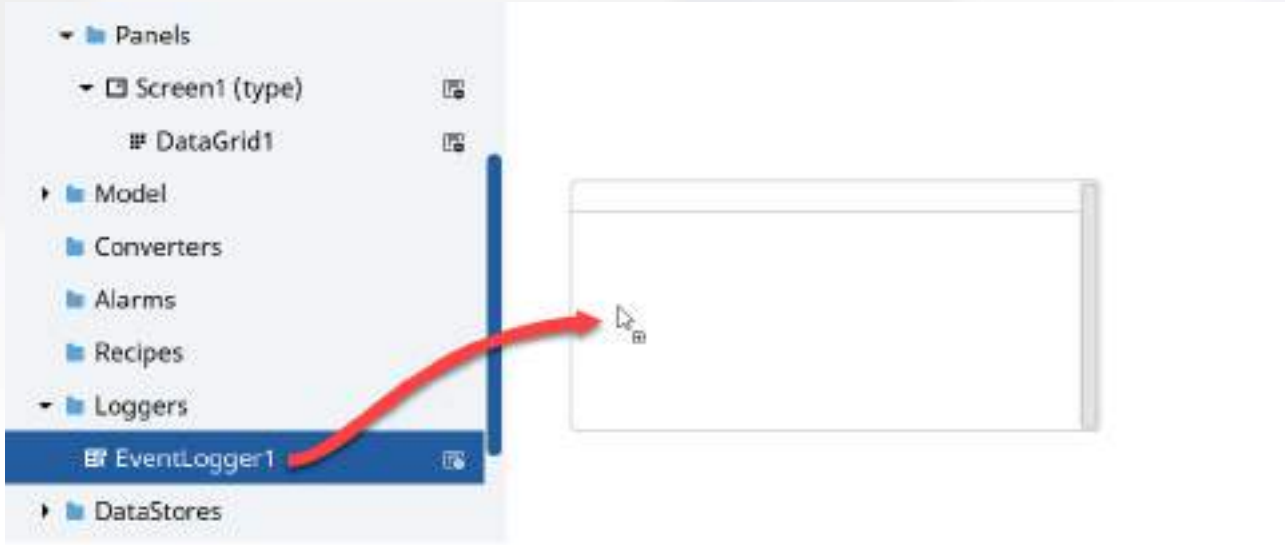

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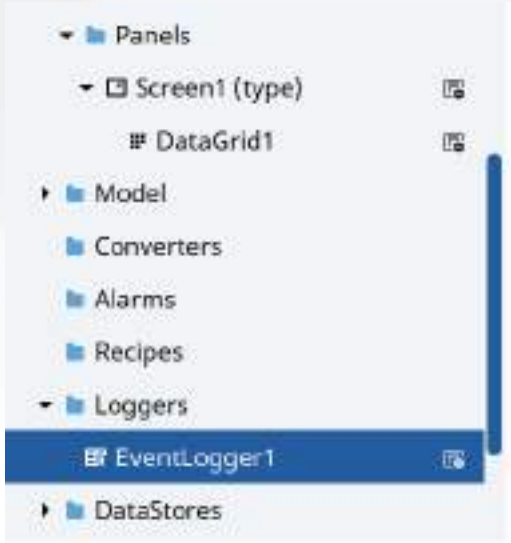
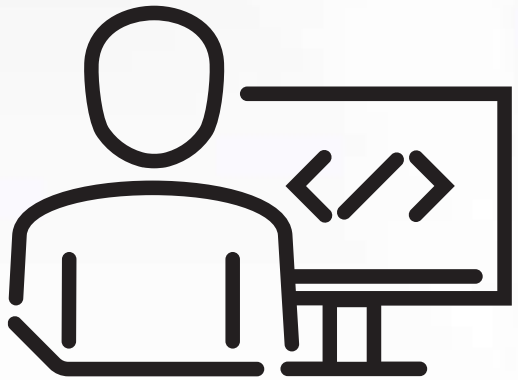


Hands-on session

- Configure an Event Logger to trace changes made to variables
- Add a Grid to show the Event Logger table
- Add a button to refresh the Grid



Represent data by Trends

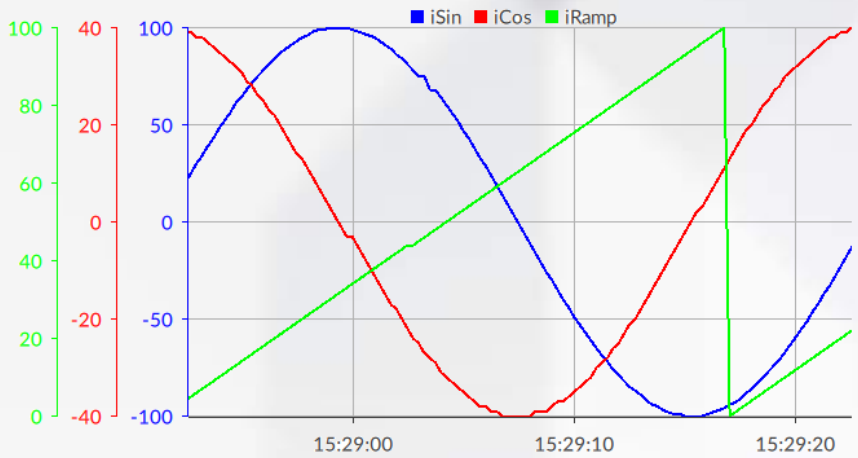
Real-time Trends

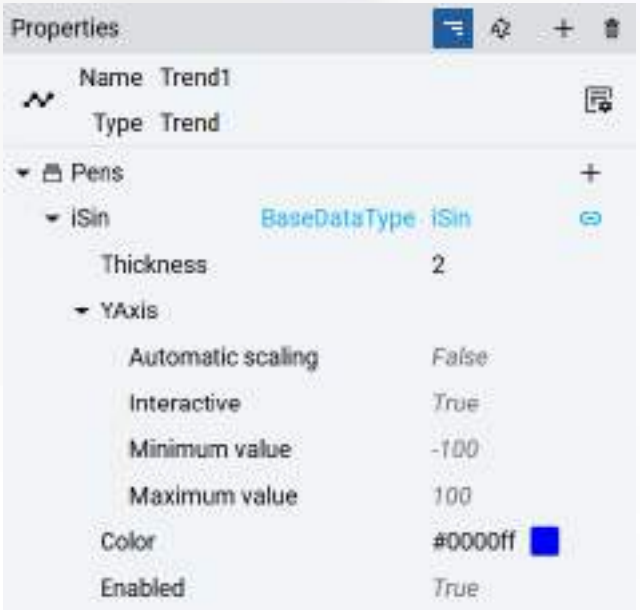
- Trend widget is available under the "Data Controls“ group

- Real-time Trend = data showed in the Trend window, will be purged on the exit

- To configure a Trend as a Real-time one, just link a Pen with a Variable

- Optionally, a Y-Axis for each Pen can be configured

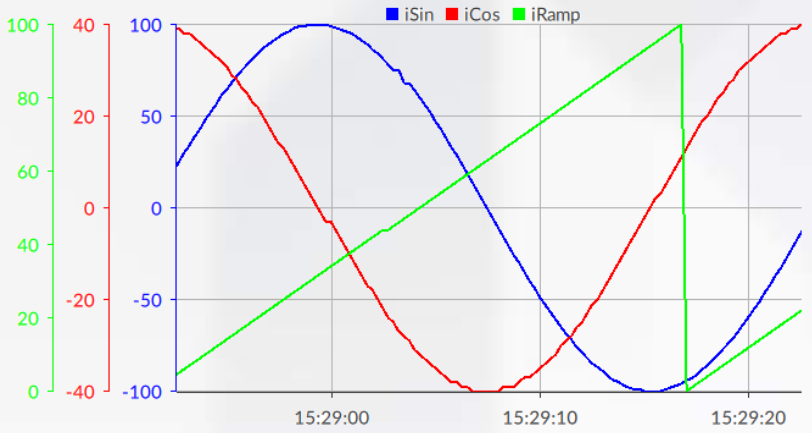


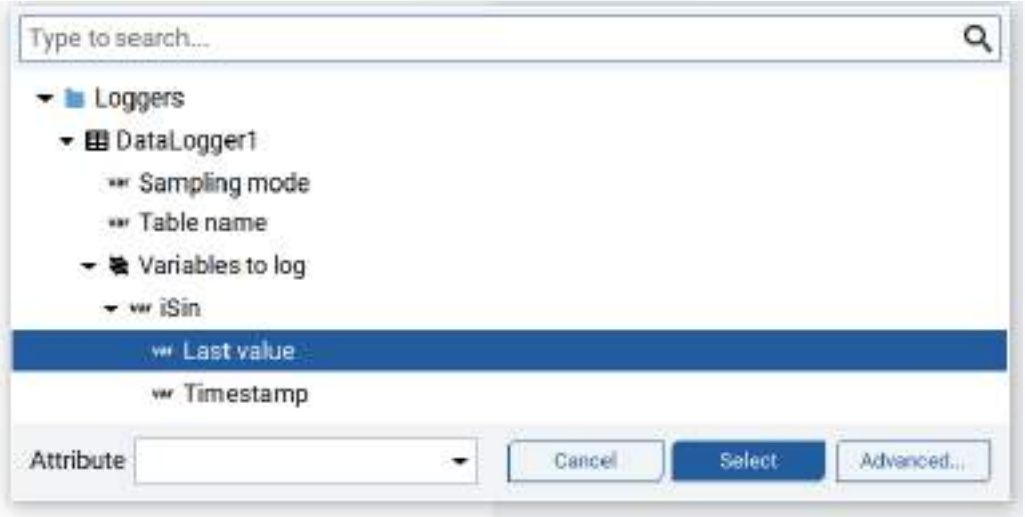


Historical Trends

- Historical Trends = when the Trend window is loaded, a query is executed to retrieve historical data

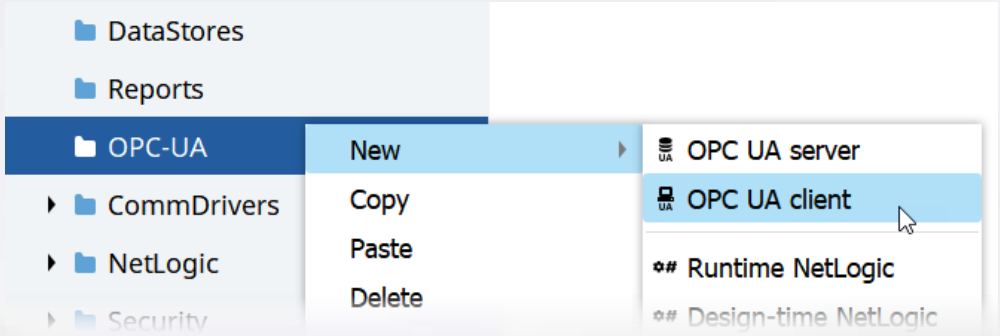
- To configure a Trend as an Historical one:
  - a DataLogger is needed to save historical data
  - Pens should be associated to DataLogger > Variables to Log > {name} > Last Value

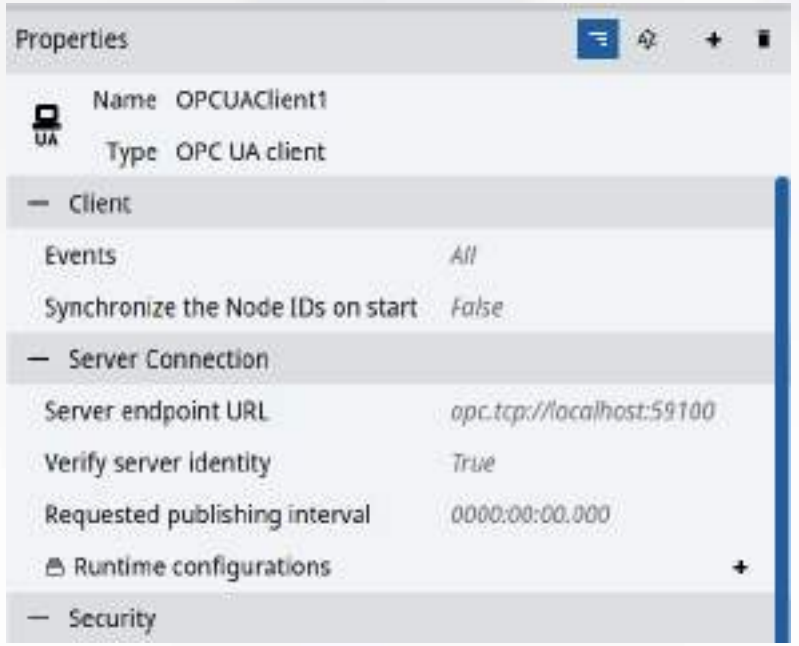




Exchange data via OPC-UA Client

OPC-UA Client: basic configuration

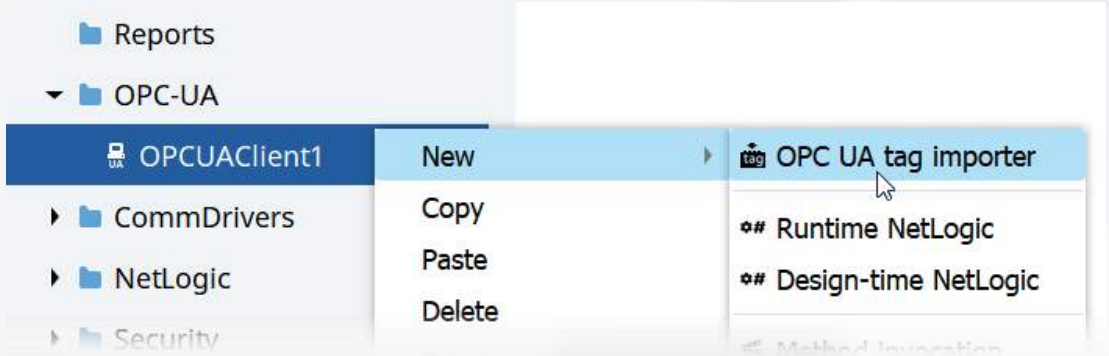


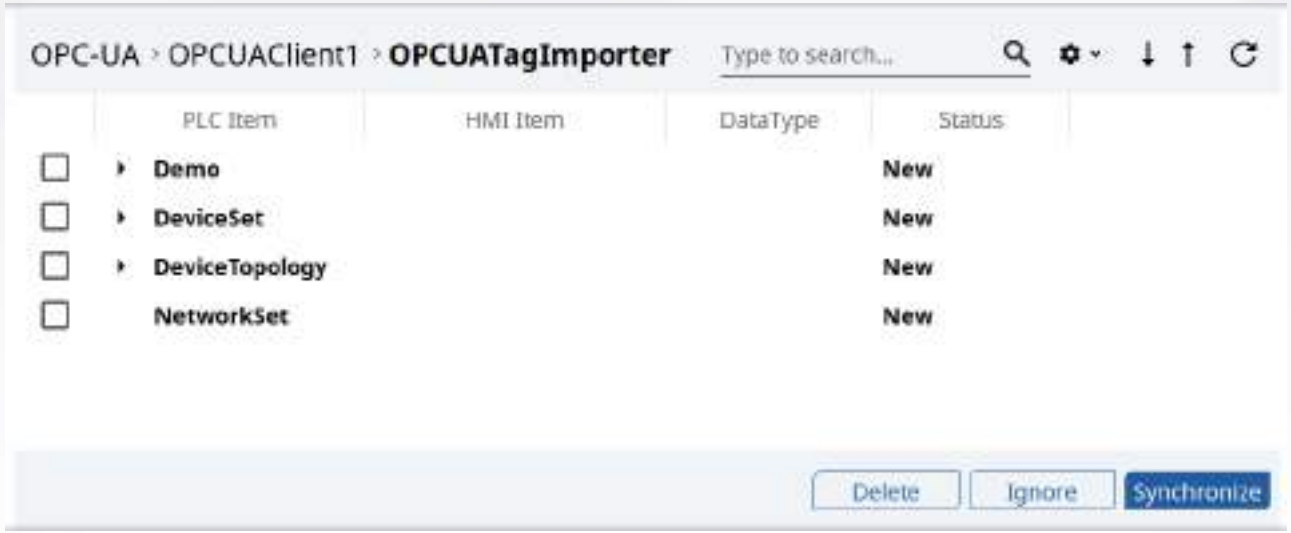


- *Events:* If not interested to read OPC-UA Server Events, set to None
- *Synchronize Node IDs on start:* In case node id of OPC-UA Server changes
- *Server Endpoint URL:* URL of OPC-UA Server to connect to
- *Requested publishing interval*: defines the rate that the OPC-UA Server returns data change notifications to the OPC UA client

OPC-UA Client: tag importer

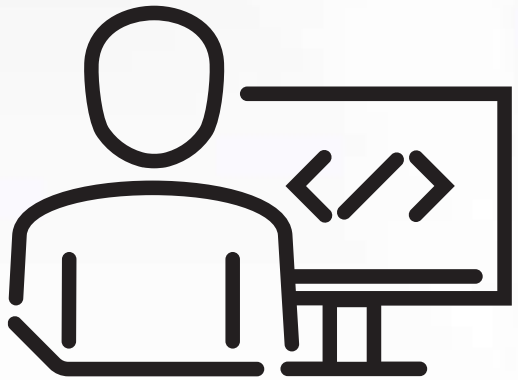
- Like any other Tag Importer
- Allow to import/synchronize tags exposed by an OPC-UA Server





Hands-on session

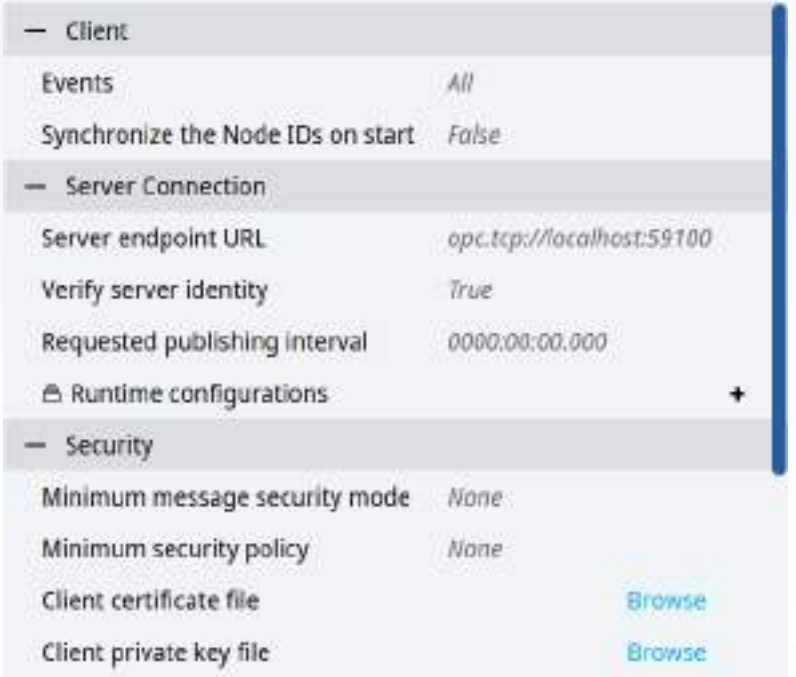
- Launch the OPC UA Server (UaAnsiCServer)
- Add the OPC UA Client node to the project and configure the server endpoint
- Open the OPC UA tag importer and import the folder "Demo > BoilerDemo"
- Into the UI:
  - attach the variable "FillLevel" to a Text box
  - attach the variable "Temperature" to a Text box
  - add a button that calls the method "Fill" setting the argument "SetPoint" as variable
  - add a button that calls the method "Heat" setting the argument "SetPoint" as variable



OPC-UA Client: security configuration

- *Verify server identity*
  if True, accept only CA-issued certificates
  if False, accept Self-signed certificates
- *Minimum message security mode*
  Security Profile: none, Sign, Sign+Encrypt
- *Minimum security policy*
- *Client Certificate File*
  "der" file stored in "…\ProjectFiles\PKI\Own\Client"
- *Client Private key file*
  ".pem" file stored in " …\ProjectFiles\PKI\Own\Client"

- Runtime, **will <u>NOT</u> automatically generate** a self-signed certificate for the Client so it's necessary to create one manually

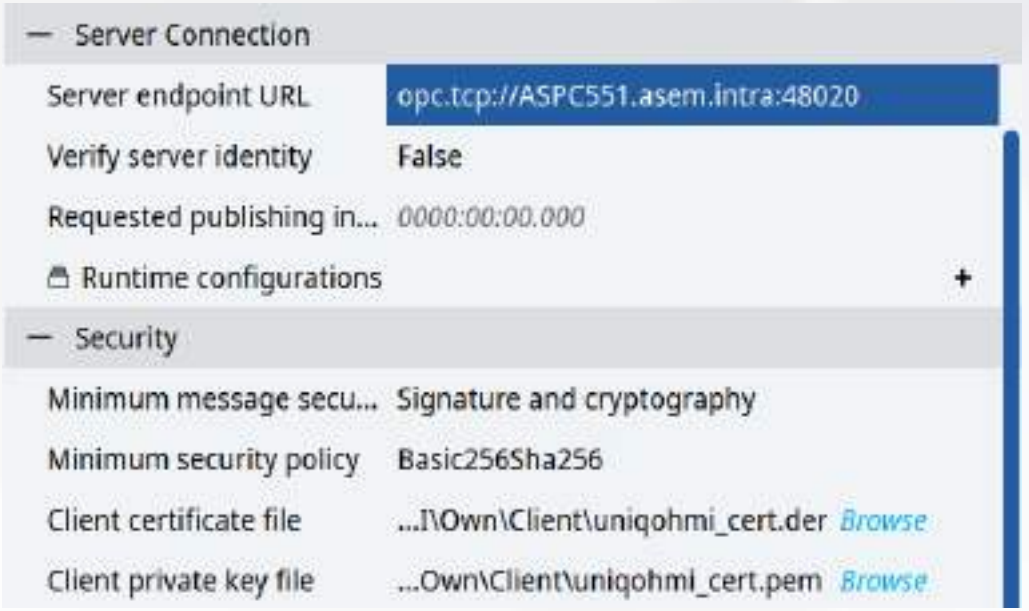


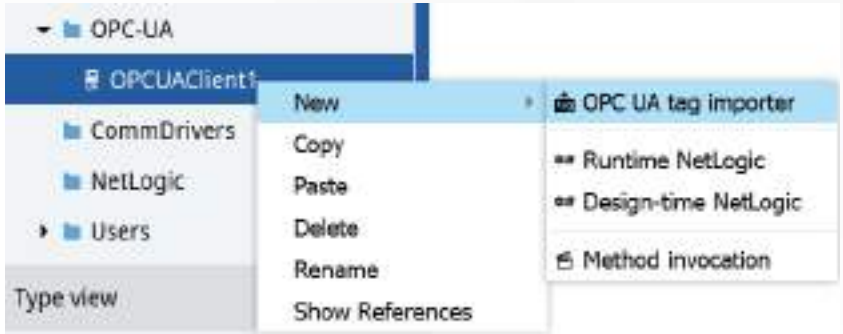
OPC-UA Client: connection using certificates

- Connection to a 3rd part OPC-UA Server

1. Configure OPC-UA Client Settings:
   - Server endpoint URL
   - Set "Verify server identity" to False
     if OPC-UA Server uses a self-signed certificate
   - Set Security Profile and Security Policy
   - Import self-signed Client Certificate file
     and Client Private Key file

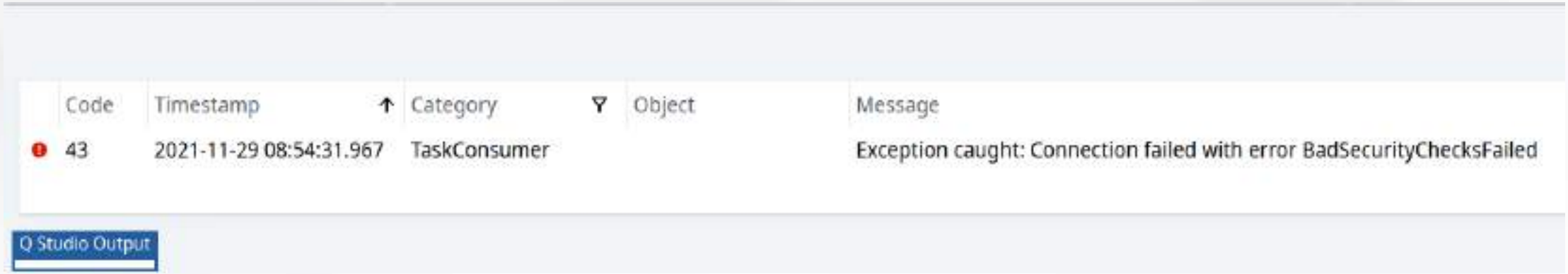
2. Import tags adding the object
   OPC UA tag importer





OPC-UA Client: connection using certificates

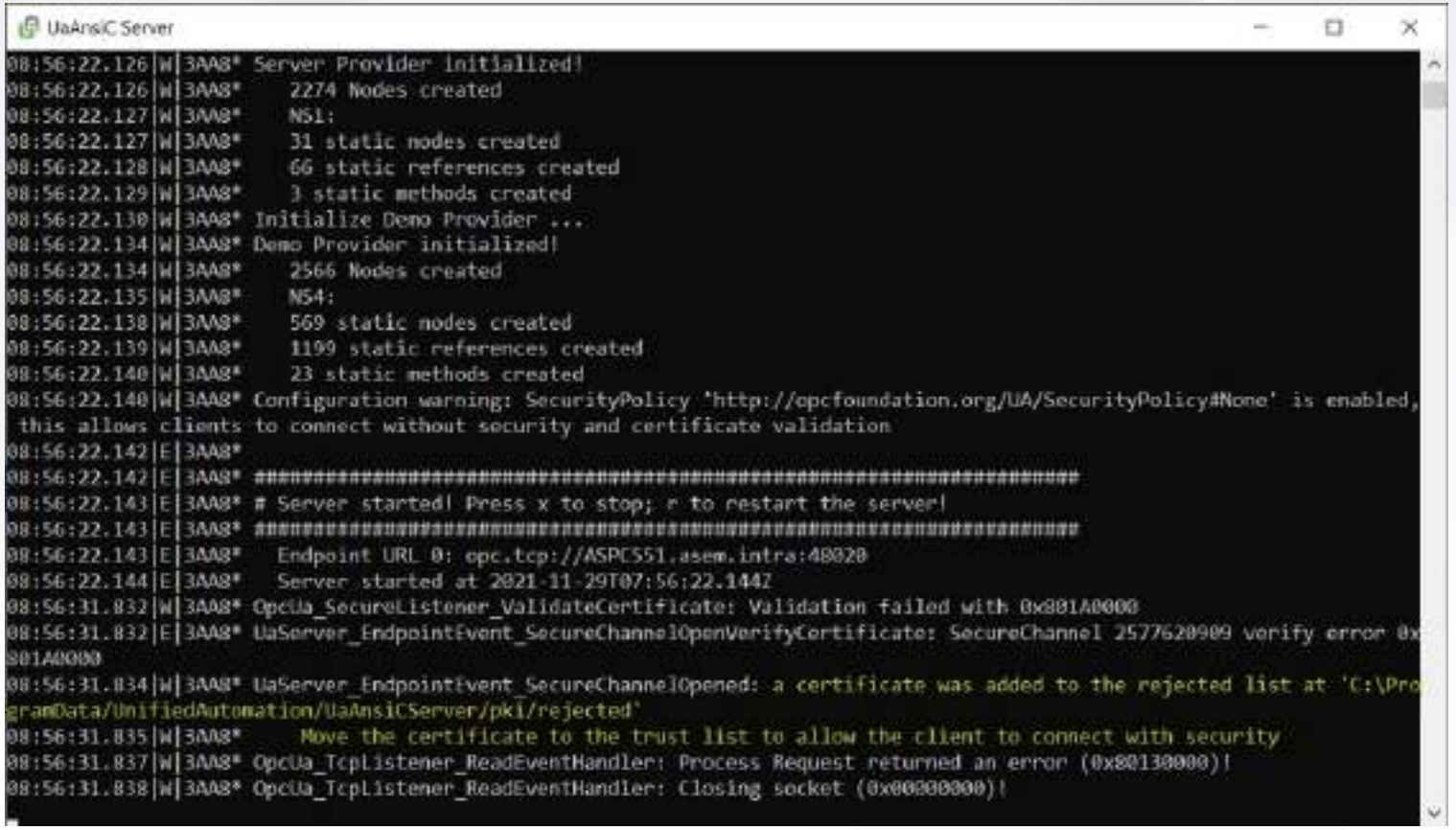
- OPC-UA Client sends his certificate to the Server,
  but in this case, the Server automatically set the certificate into the Rejected folder so "***BadSecurityChecksFailed***" is triggered



OPC-UA Client: connection using certificates

- In this case, we need to go to the OPC-UA Server and manually move the Client certificate from Rejected to Trusted folder

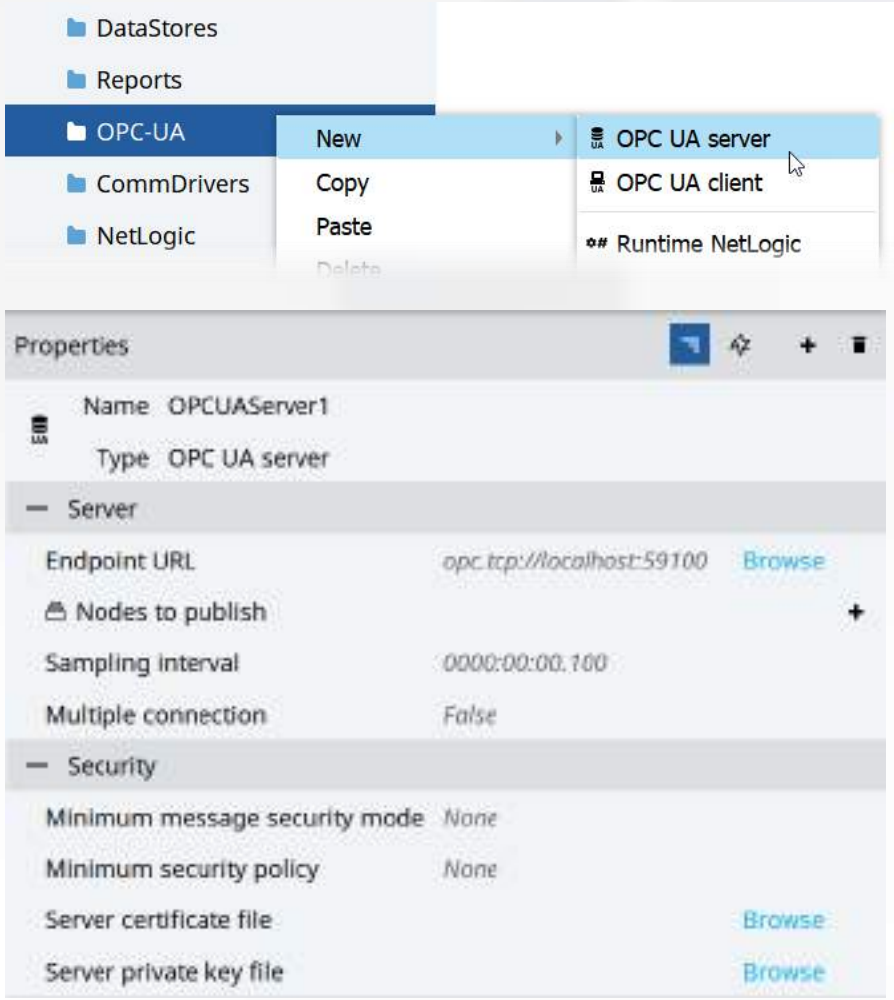
- After this operation, the Client will be able to connect to Server to Browse tag for import and exchange data.



Expose data as OPC-UA Server

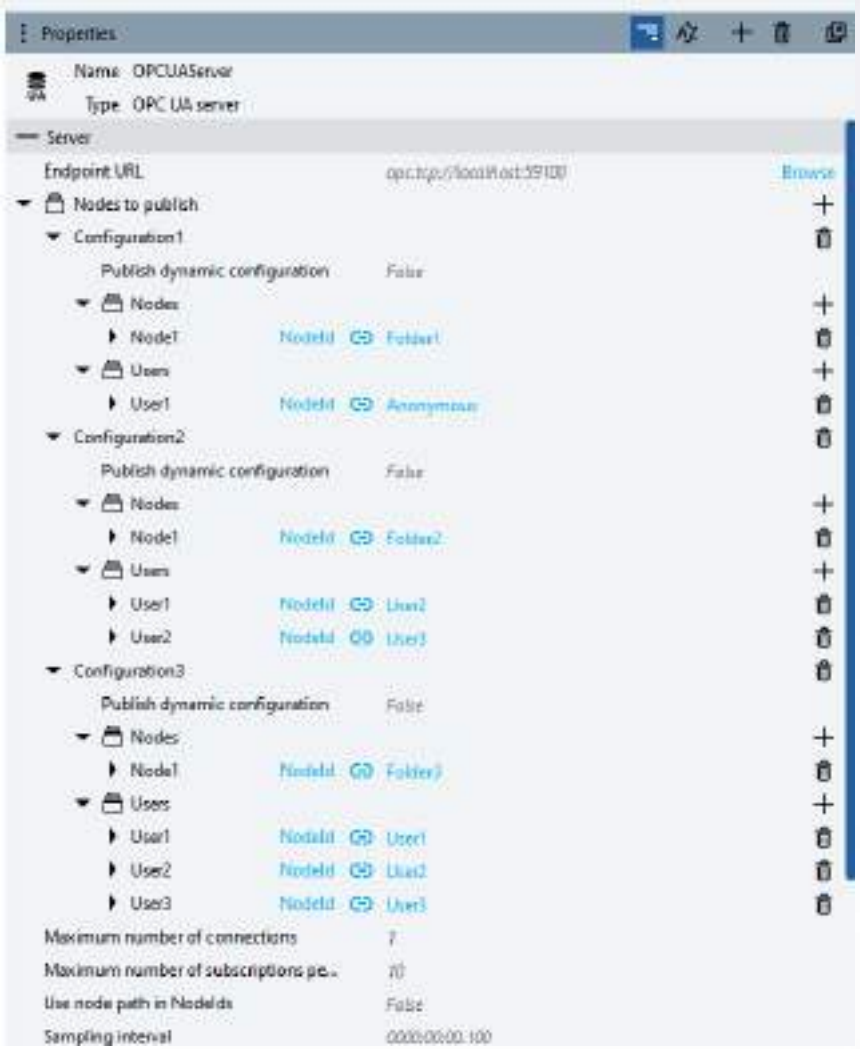
OPC-UA Server: basic configuration

- *Endpoint URL*
  - protocol, IP/hostname, port used by Server
- *Nodes to publish*
  - by default, the entire project will be published
- *Sampling Interval*
  - Defines a "best effort" cyclic rate that the Server uses to sample the item from its source.
    i.e. the Communication Driver tag polling rate
- *Multiple connections*
  - Allow multiple OPC-UA Clients to connect then OPC-UA Server cost 2 tokens instead of 1
- *Security settings*
  - See: Appendix: See the light about OPC-UA Security
  - See: Appendix: Using OPC-UA certificates
  - See: Appendix: Generating OPC-UA certificates



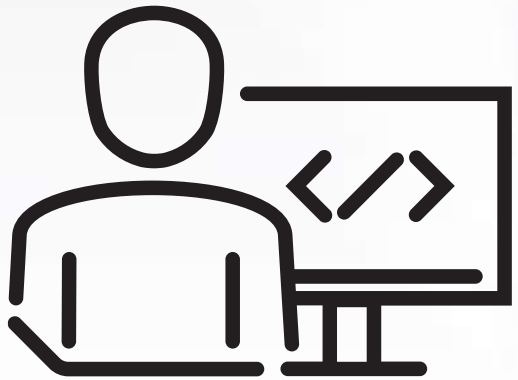
OPC-UA Server: Nodes to publish

- Specific users can be limited to specific nodes of the project
- When configuring a set of nodes to publish, a user entry must be provided (can be any project user or “Anonymous”)
- Multiple nodes can be assigned to multiple users
- Currently no way to set a node in “read-only” mode
- If no entry is created in the **Nodes to publish** collection, then the whole project is exposed via OPC-UA



Hands-on session

- Add the OPC UA Server node to the project
- Configure the OPC UA Server to expose the entire project
- Launch the Emulator
- Launch the OPC UA Client «UA Expert» and connect to the Emulator
- Browse some variables or call a method exposed like the "Log" method of a Datalogger



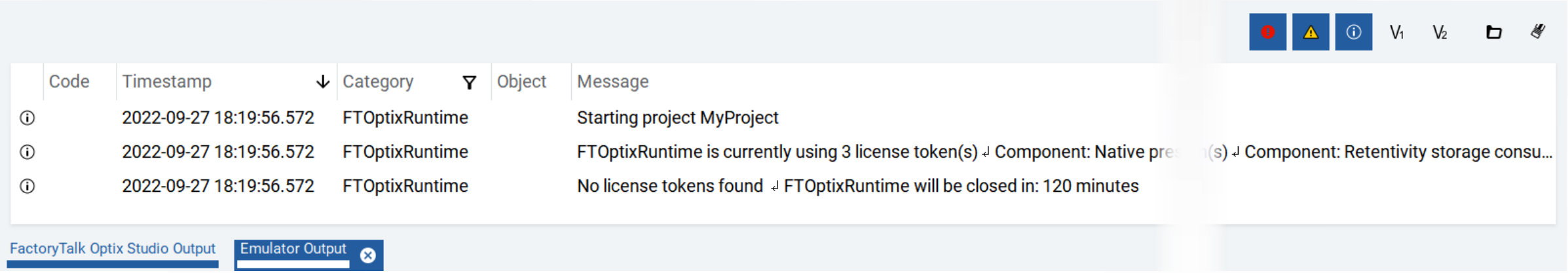
Project deployment

Execute the project with emulator

- Allow the execution of the project from Studio.

- Emulator folder: `%localappdata%\Rockwell Automation\FactoryTalk Optix\Emulator\`

- Emulator output is useful to check license token in use by the Runtime

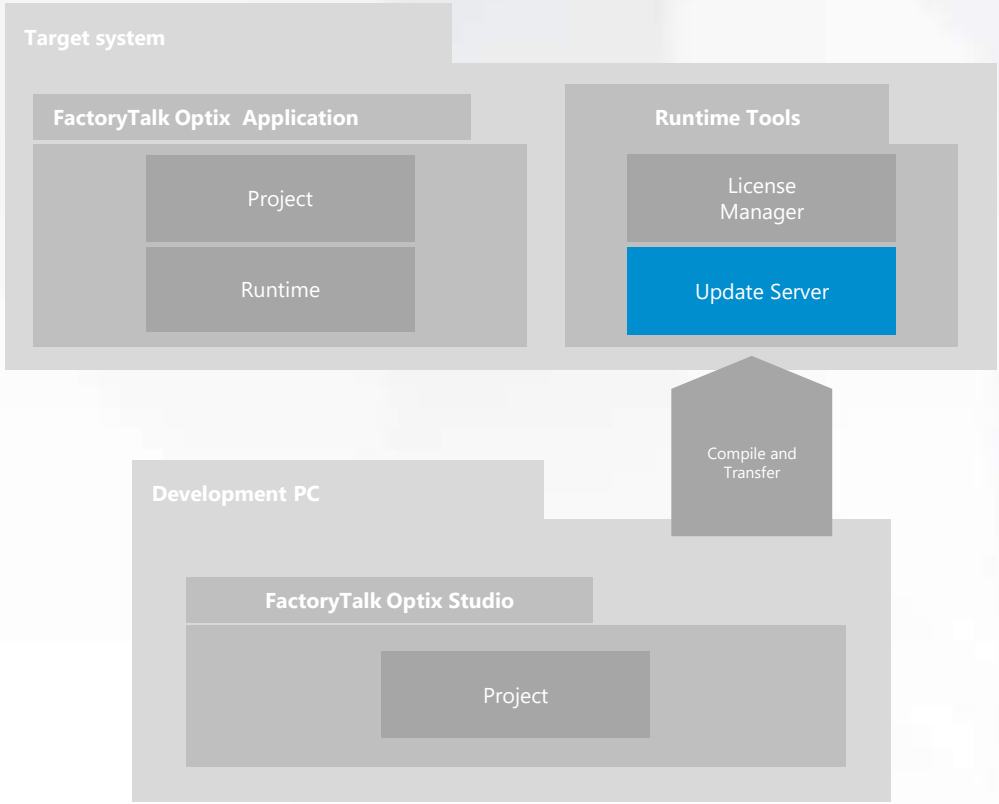


Transfer the project to local target

1. Target must have "Runtime Tools" installed and "Update Server" running

- **Optix Panel:** Runtime Tools are already installed in production and Update the Server running as a service

- **iPC:** Runtime Tools must be installed manually. Update Server will be installed as Service and set to automatically startup when Windows starts



Transfer the project to local target

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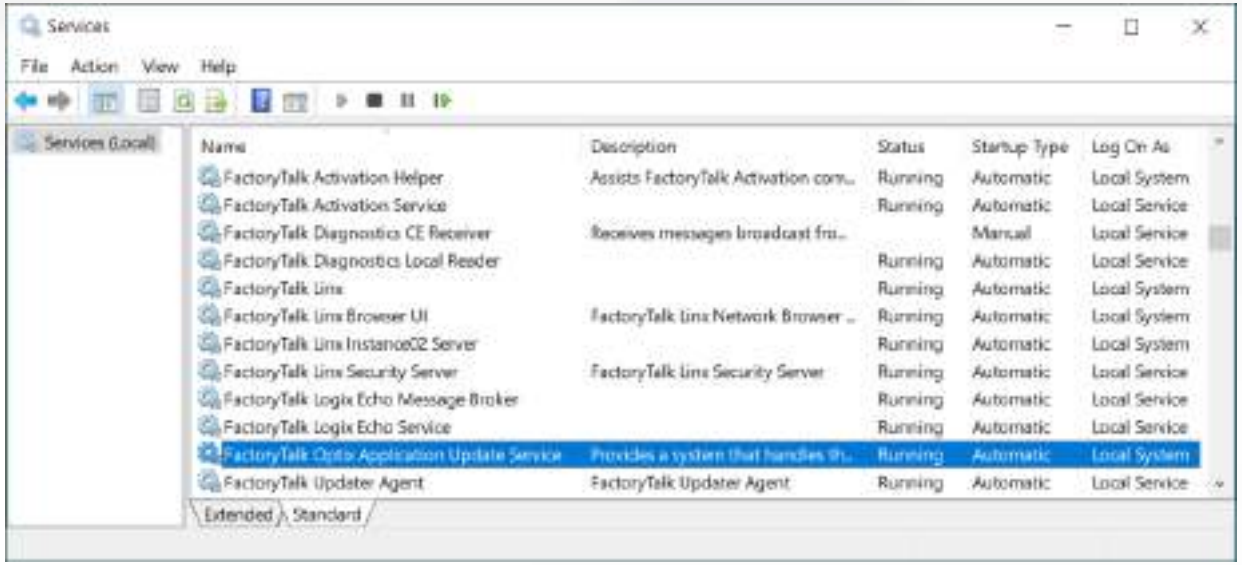
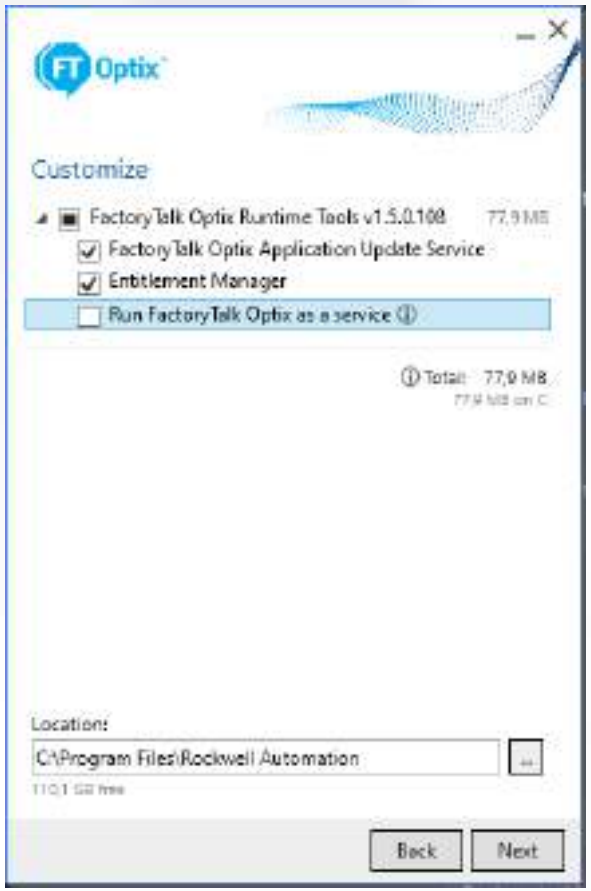
   - **Optix Panel:** Runtime Tools are already installed in production and Update the Server running as a service
   - **iPC:** Runtime Tools must be installed manually. Update Server will be installed as Service and set to automatically startup when Windows starts

- On **OptixPanels**, the UpdateServer is automatically upgraded by FactoryTalk Optix Studio if needed (downgrade not supported)
- On **iPC**, the UpdateServer can be upgraded or downgraded by the user as needed
- FactoryTalk Optix version must be **same or newer** version than the UpdateServer version (no backward compatibility)



Run the project as Windows service

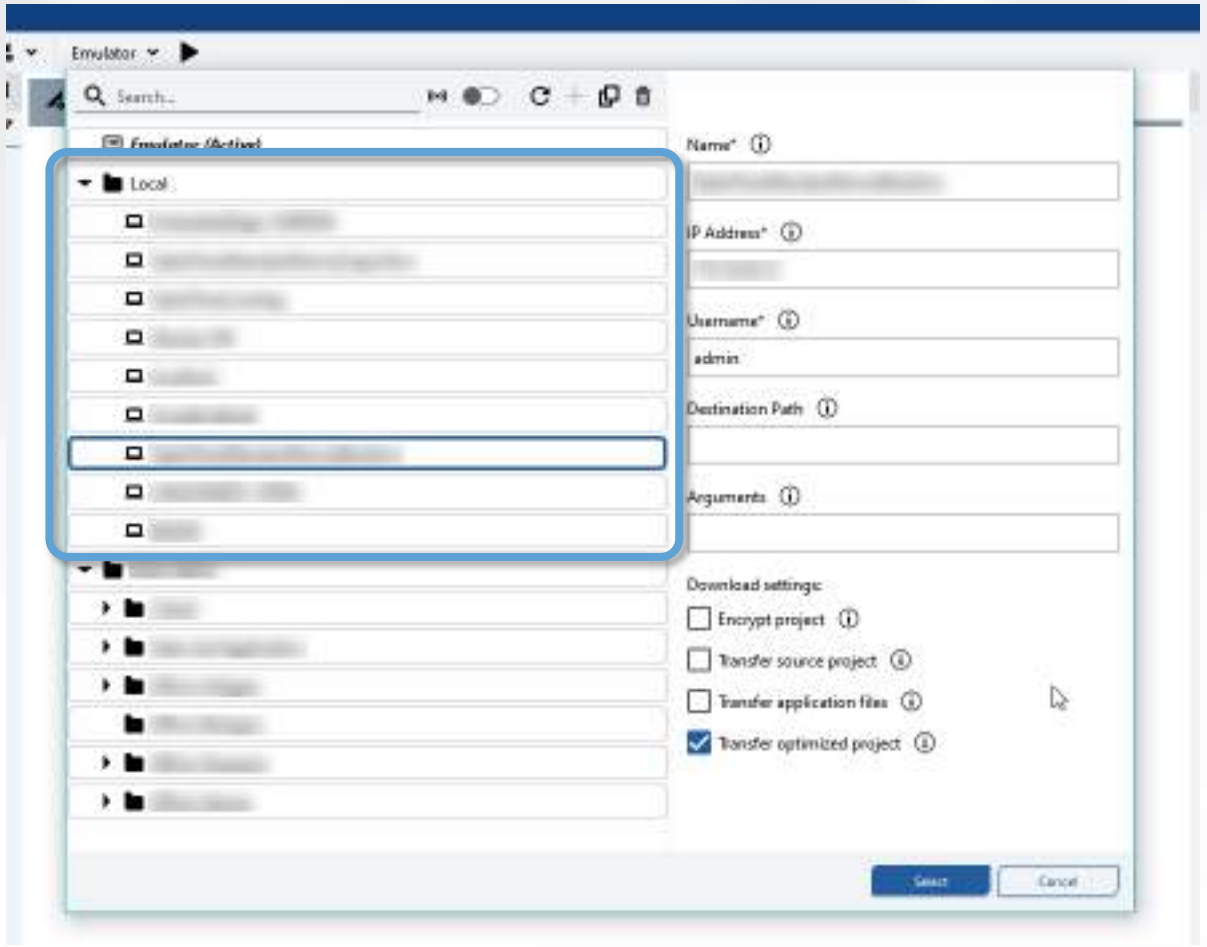
- Configure the RuntimeTools in Service mode during setup
  - Only available on Windows IPCs
  - Project cannot contain a NativePresentationEngine
  - WebPresentationEngine is allowed but not strictly needed
  - Useful when the application does not have any UI (data gateway) or when the user interface should only be accessed remotely



Transfer the project to local target

2. Configure Target device in Studio
   - Name,
   - IP Address,
   - Username,
     - for Optix Panels, it's the same admin user that access the System Manager
     - for iPC, it's a Windows user with rights to access OS folders
   - Destination Path: optional

3. Transfer from Studio to Target
   - set the Active path
   - click the Play button

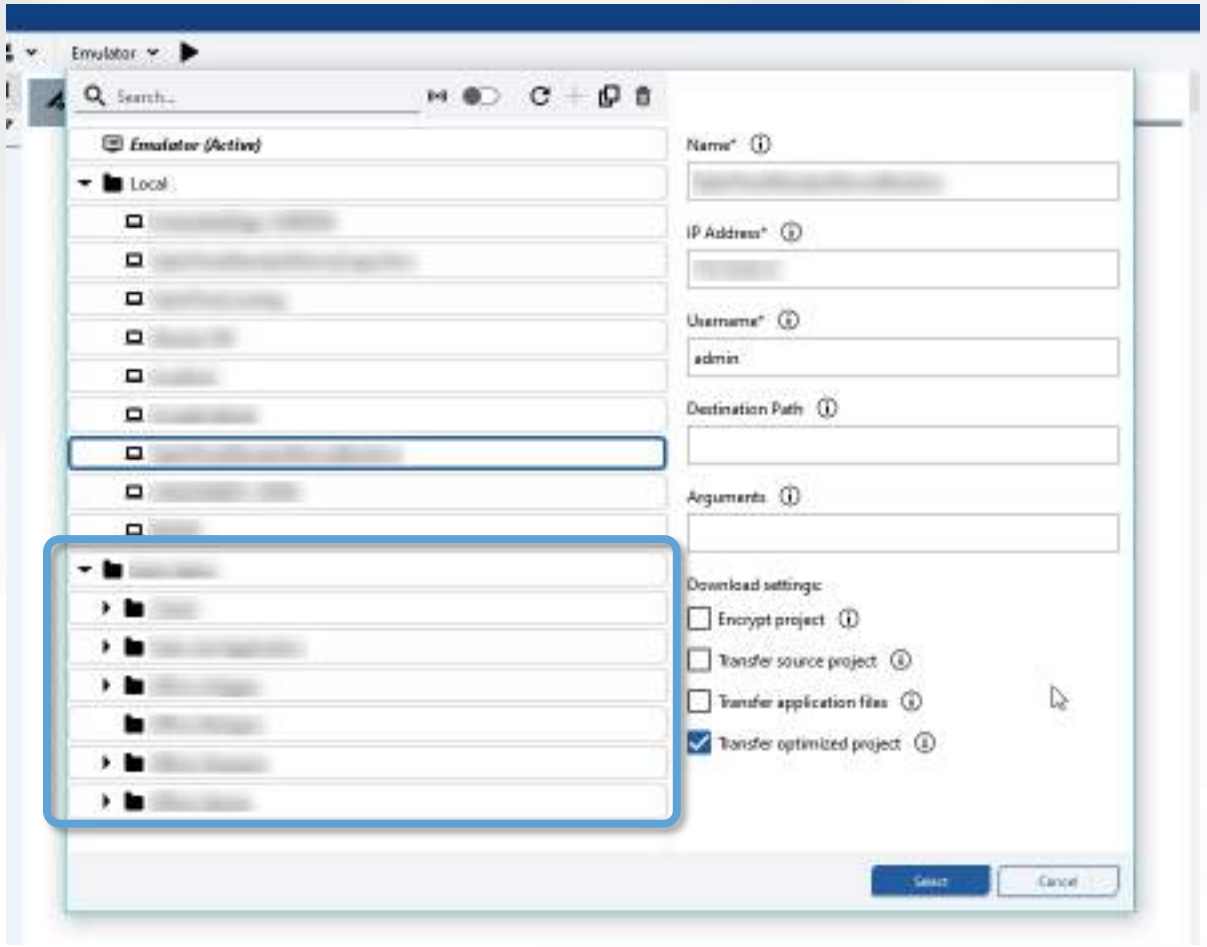


Transfer the project to remote target (FactoryTalk Remote Access)

- If you are signed in FactoryTalk Hub and you have also access to a FactoryTalk Remote Access domain

- FactoryTalk Optix Studio, lists the devices available through FactoryTalk Remote Access

- Then you will be able to:
  - activate a VPN connection to the device and transfer the project
  - open the FTRA screen mirroring feature (VNC-like)



Execute the project on target

4. Application is launched by Studio after download

- **HMI**: Application is also set to be executed automatically at HMI startup

- **iPC**: Application is also set to be automatically executed at Windows startup by using the shortcut of

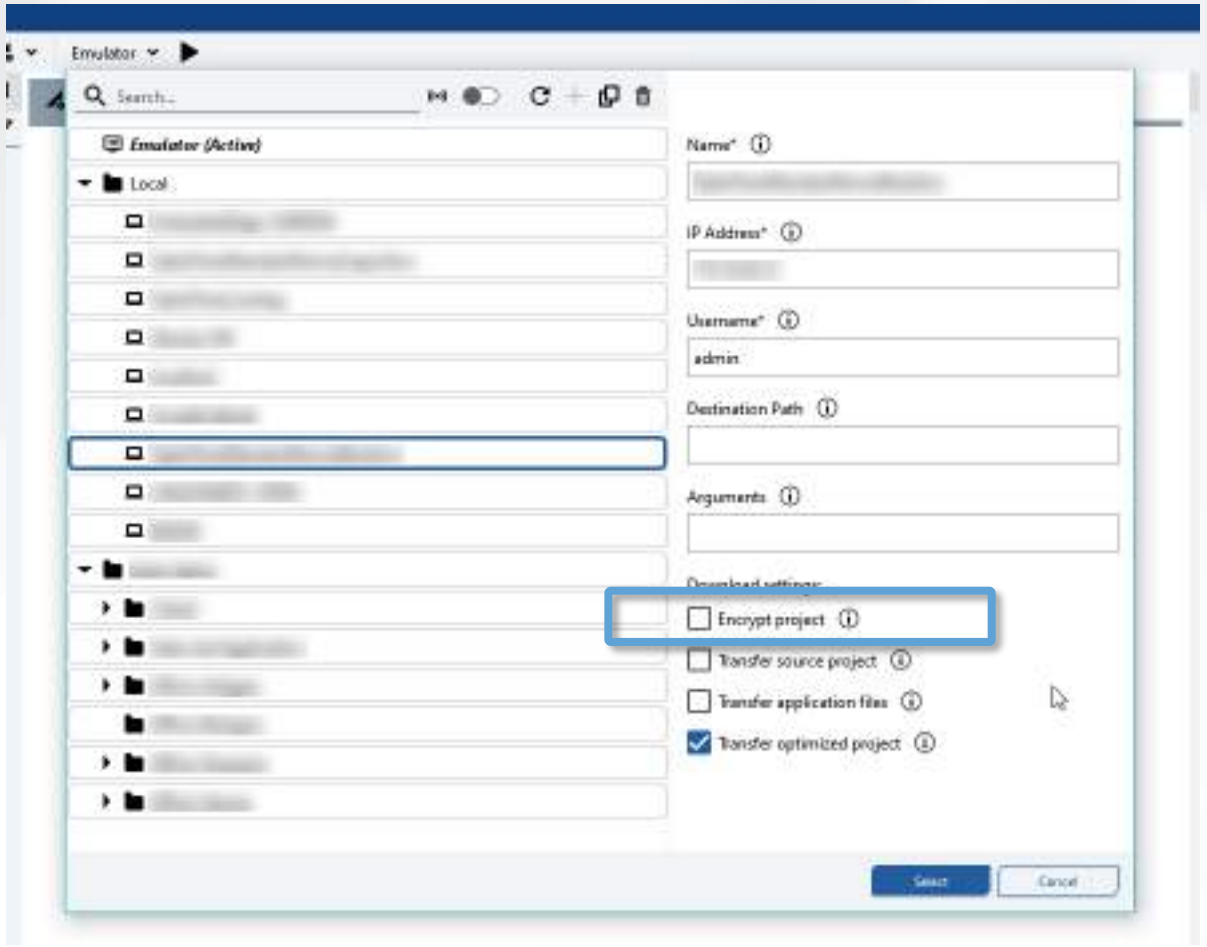
```
%localappdata%\Rockwell Automation\FactoryTalk
Optix\Application\FTOptixRuntime.exe
```

into:

```
shell:startup
```

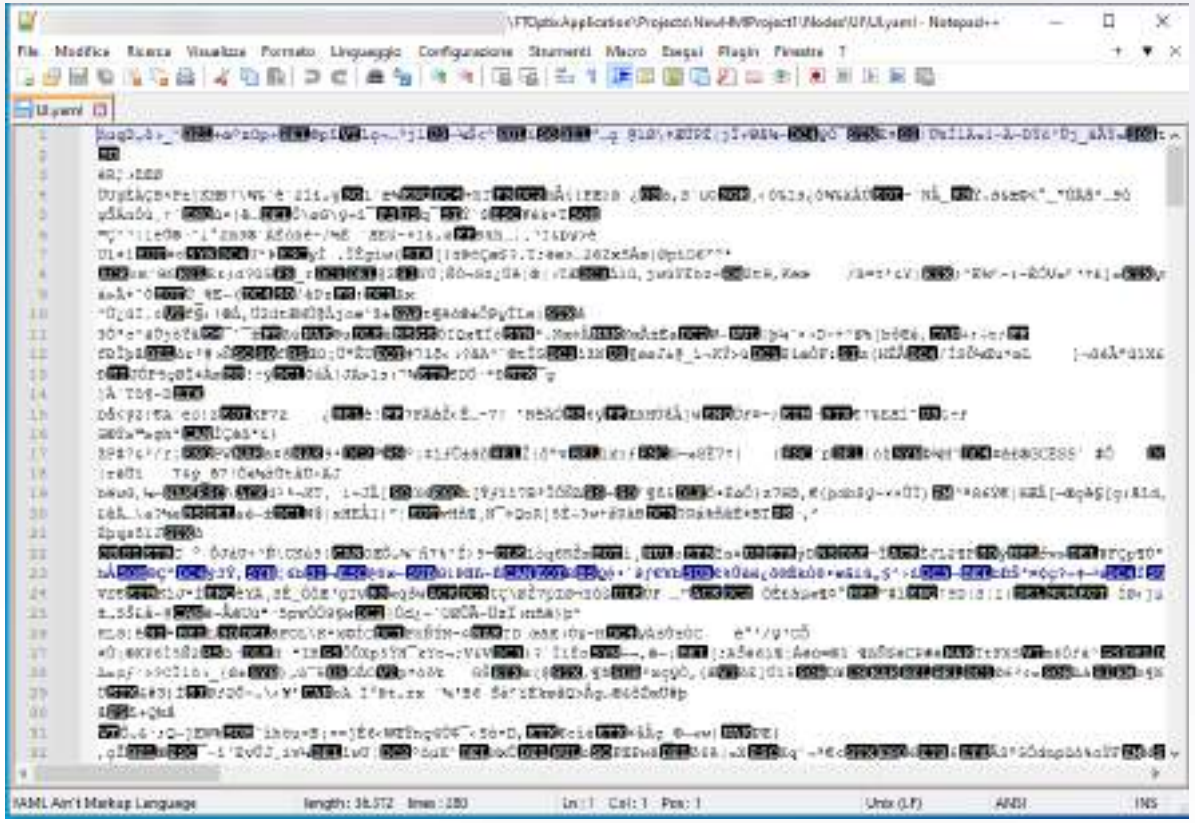
Deployment options

- Project can be encrypted with a hardware-based key
  - All YAML files will be fully encrypted using a unique and hardware-based encryption key
  - Once project is encrypted, it cannot be moved to a different PC or Panel (as the encryption is hardware based)
  - Project is encrypted and decrypted using the UpdateServer
    - Encryption is only supported when deploying the project from FactoryTalk Optix Studio
    - Project can be decrypted and uploaded (if source files are transferred) only by using the Update Server



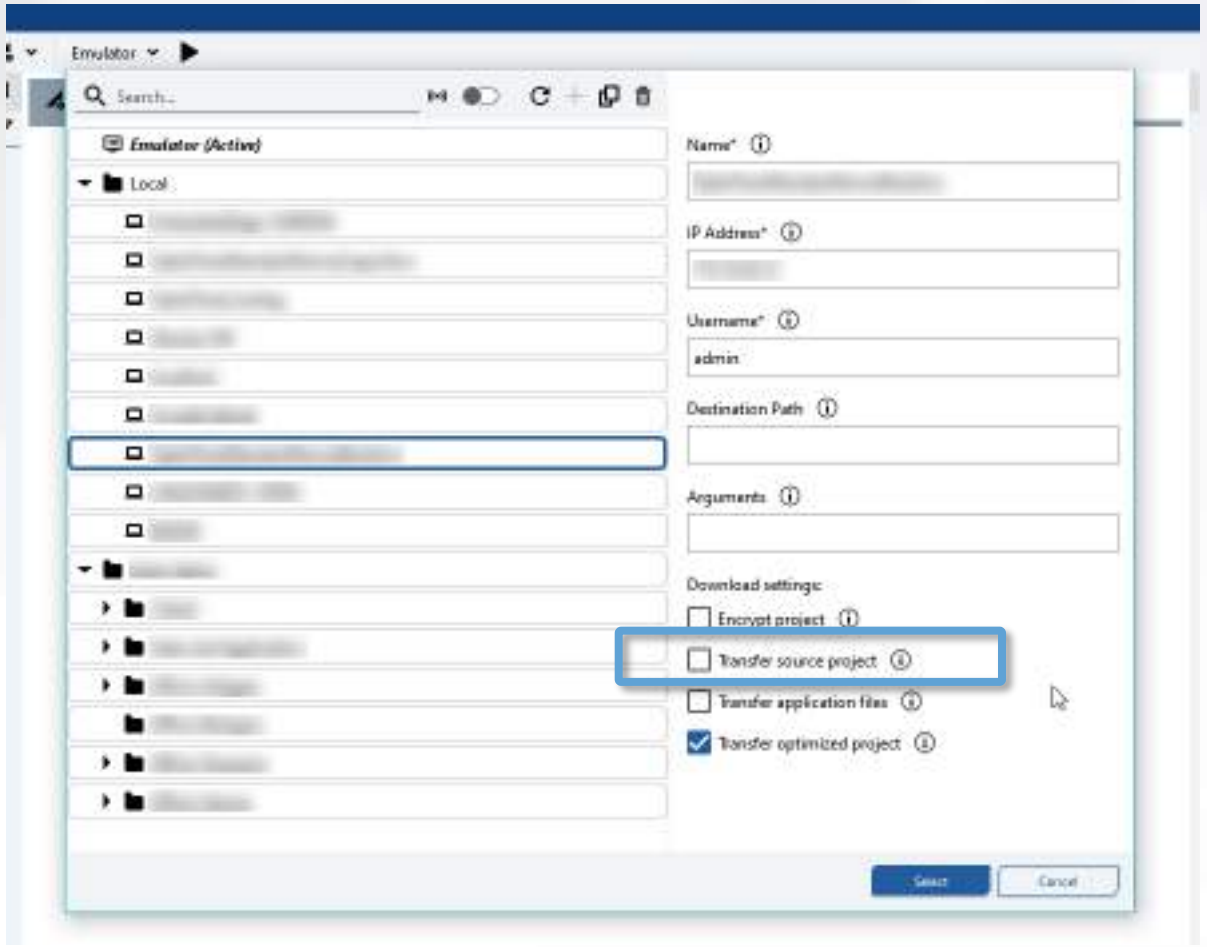
Deployment options

- Project can be encrypted with a hardware-based key
  - All YAML files will be fully encrypted using a unique and hardware-based encryption key
  - Once project is encrypted, it cannot be moved to a different PC or Panel (as the encryption is hardware based)
  - Project is encrypted and decrypted using the UpdateServer
    - Encryption is only supported when deploying the project from FactoryTalk Optix Studio
    - Project can be decrypted and uploaded (if source files are transferred) only by using the Update Server



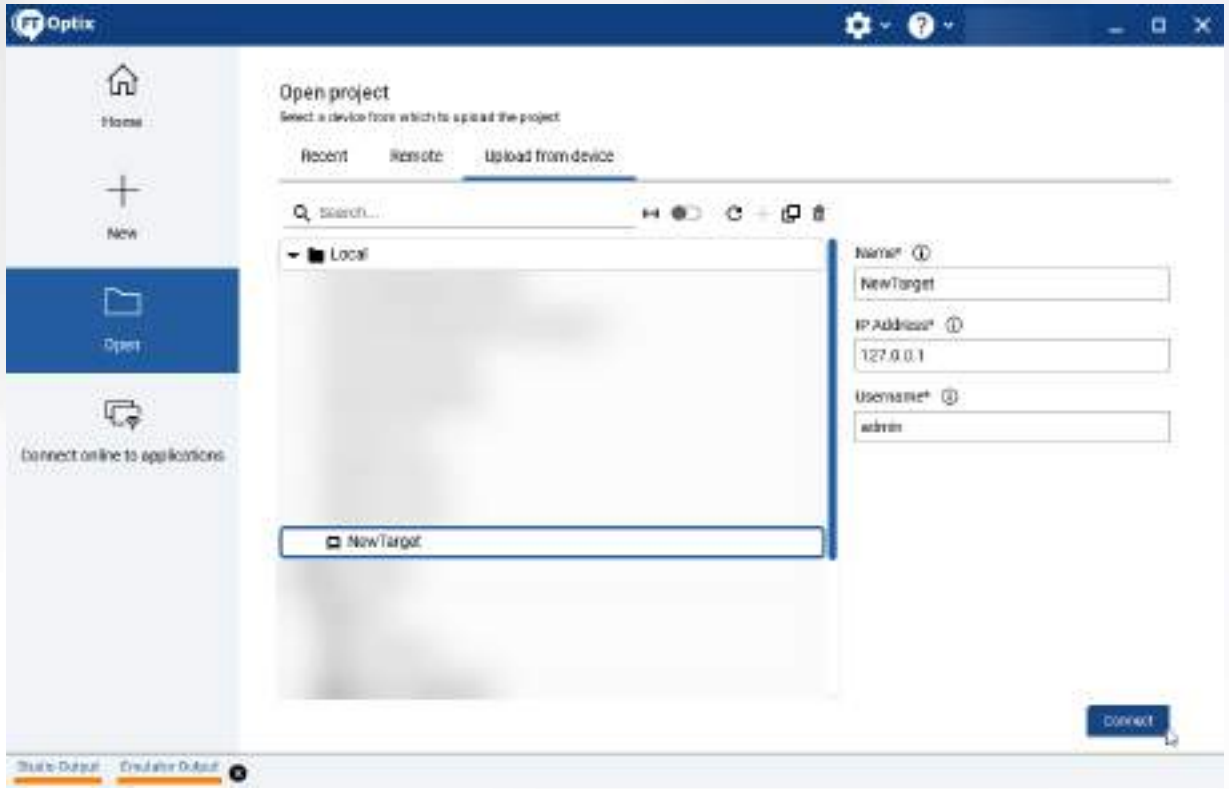
Deployment options

- Source code of the application can be deployed to the device
  - This allows the project to be uploaded from the target device if needed



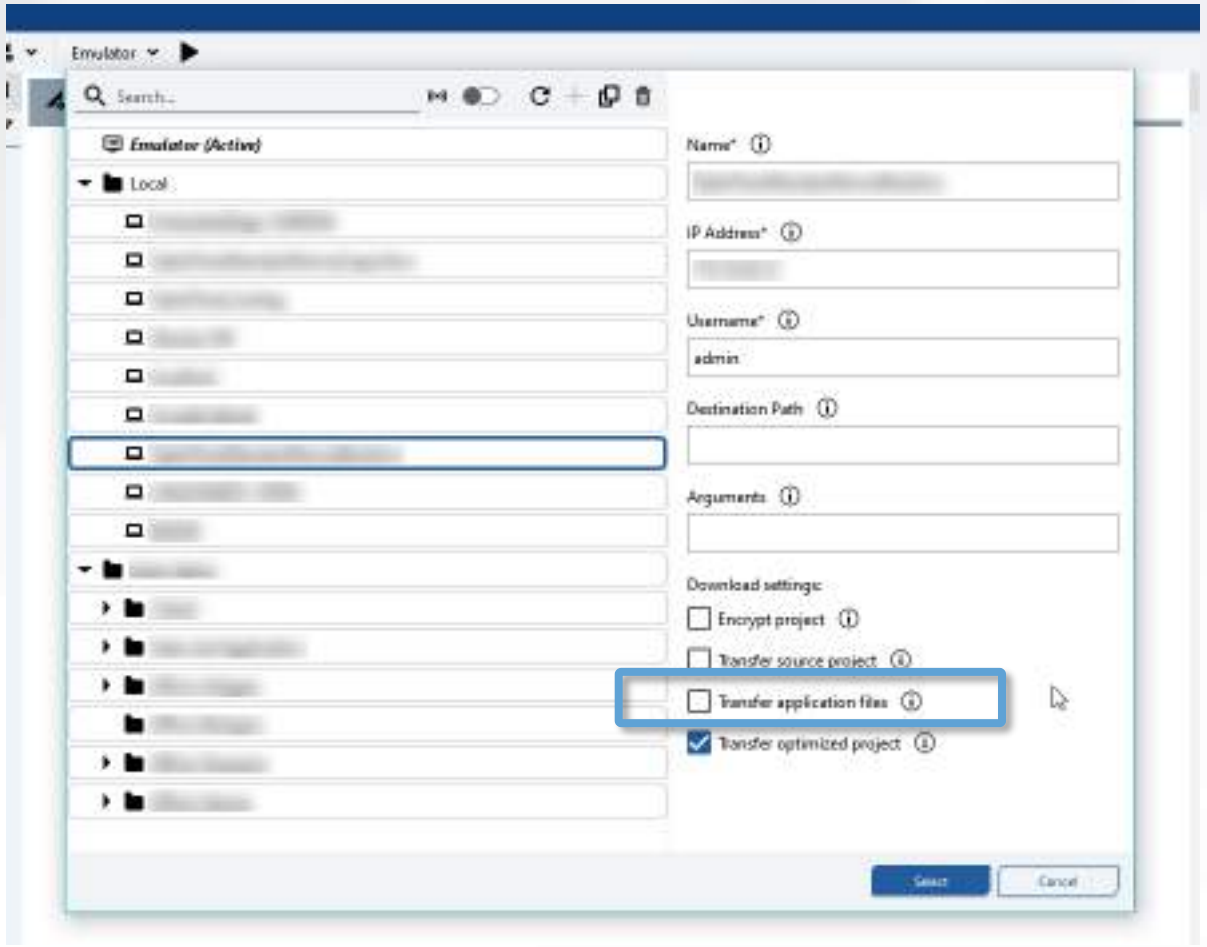
Deployment options

- Source code of the project can be transferred to the target device
  - All YAML files, resources and NetSolution will be transferred to the target device
  - If the project sources were transferred to the device, the project can be uploaded later from the device using the dedicated menu in the welcome screen of FactoryTalk Optix IDE



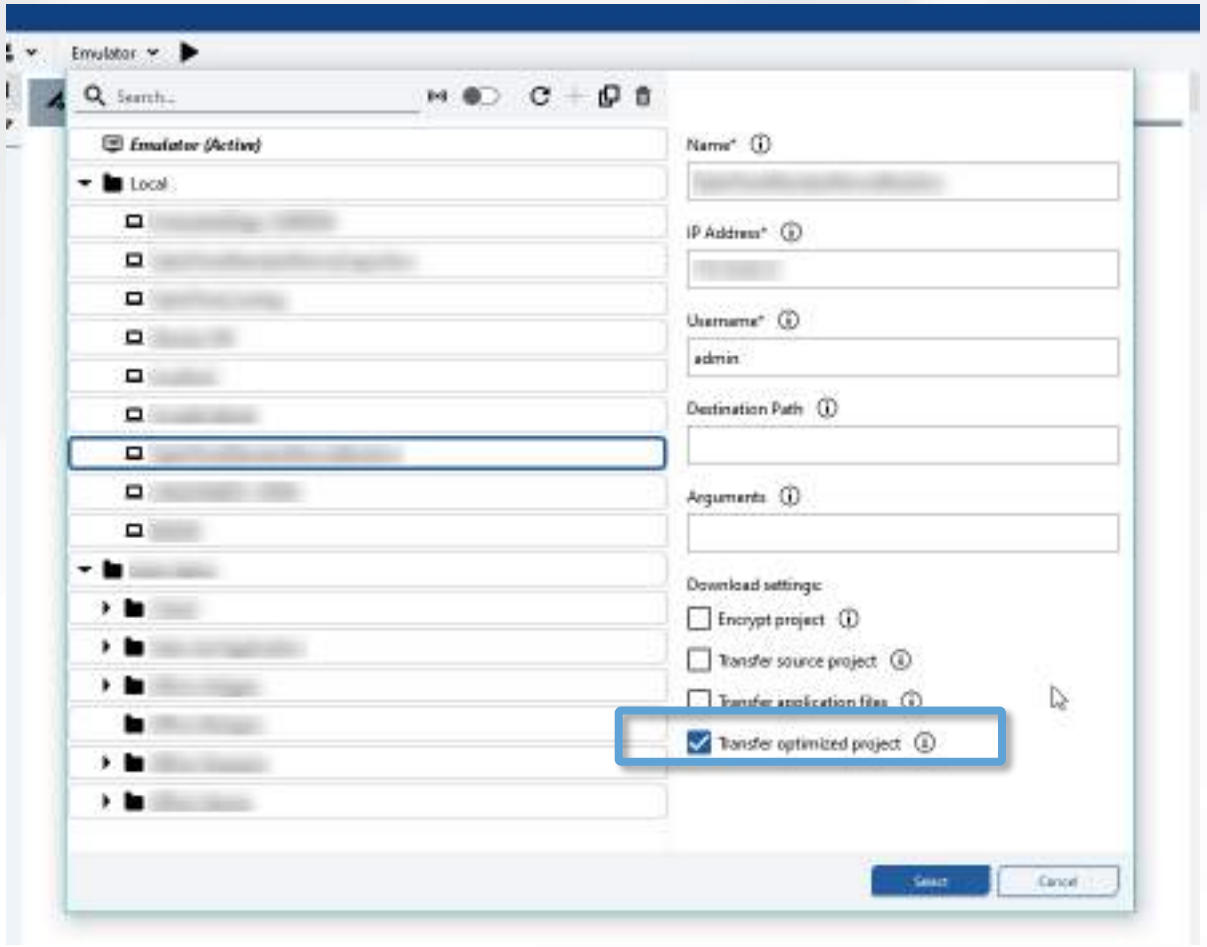
Deployment options

- Application files on the target device can be overwritten
  - When a project is uploaded from a device, the files in the ApplicationDir can be uploaded too, this includes: retentivity, users, database, etc.
  - Once the files were uploaded, they can be transferred to the same or a different device



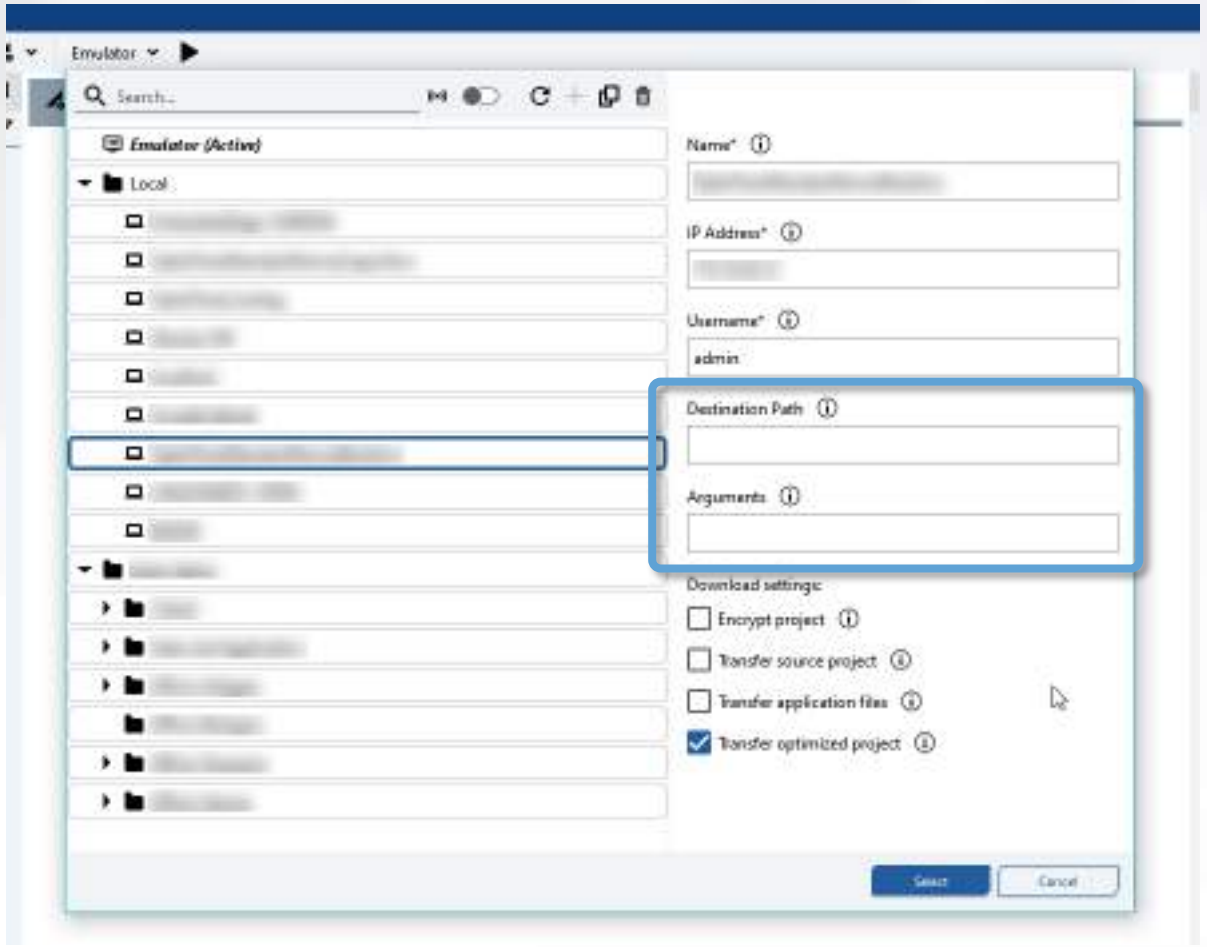
Deployment options

- Optimize the project before deployment
  - In some cases, a lot of tags were imported in the application even if not used in the application
  - The optimization process will move all imported tags from the YAML file to a dedicated binary repository where tags are retrieved only if needed.
  - This can significantly improve startup time and memory usage
  - Cannot be used if the OPC/UA server is exposing the PLC tags



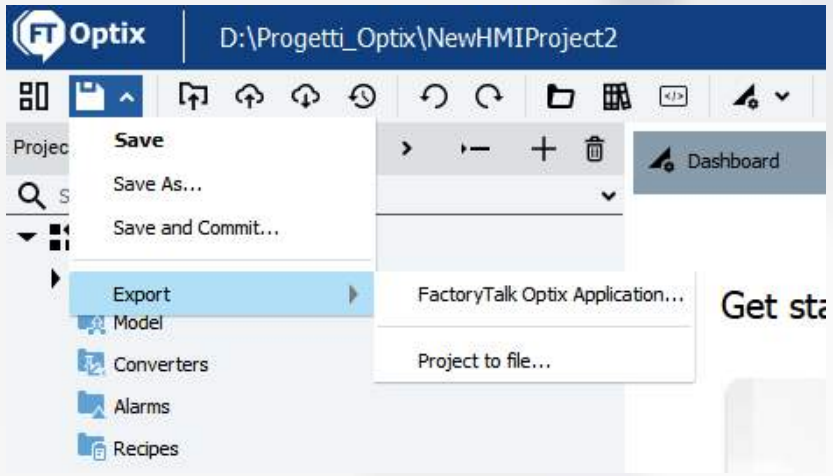
Additional parameters

- A specific path on the remote device can be specified
  - Only for Windows-based devices
  - The user being selected for deployment must have write access to such path
- Additional startup arguments can be added
  - Only used for debugging if requested by SW support or R&D team, should be always blank

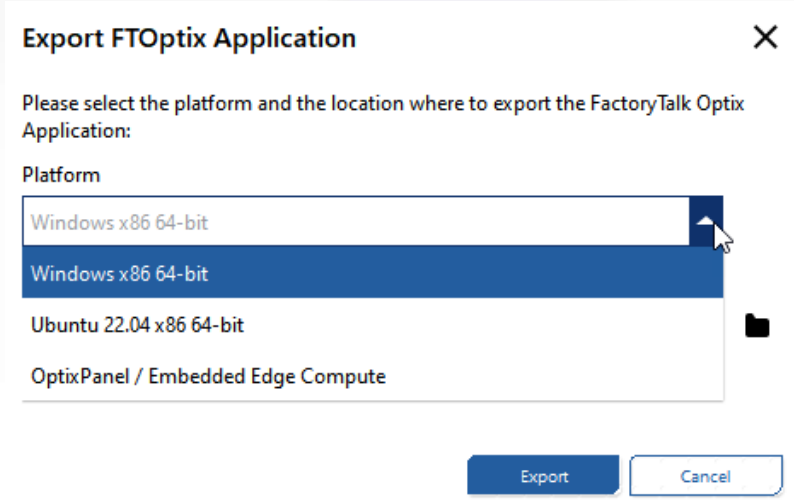


Transfer project to target manually

- Application can be transferred manually
  - "**Export FactoryTalk Optix Application**" : exports the (semi) compiled Application into a folder that needs to be manually transferred and executed on Target
  - No encryption can be enabled if exporting the application from this menu



Platform	HMI Model
Optix Panel	Optix Panel Standard or Compact
Windows (on x64 CPU)	iPC Windows
Ubuntu (on x64 CPU)	iPC Linux with Ubuntu 22



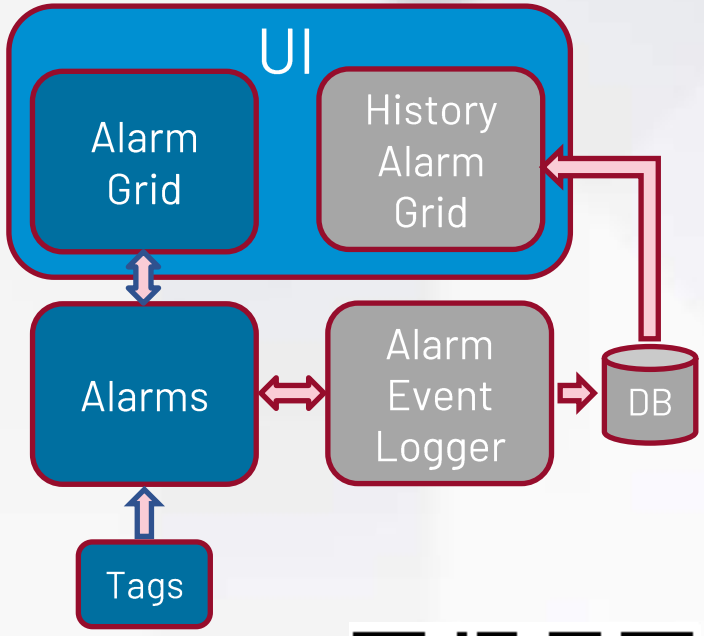
Manage alarms

Alarms

- Alarm functional module is used to define alarm events connected to Tags/Variables and manage them at runtime

- Active Alarms
  - just define alarms
  - drag&drop Alarm Grid widget from Template Library to UI

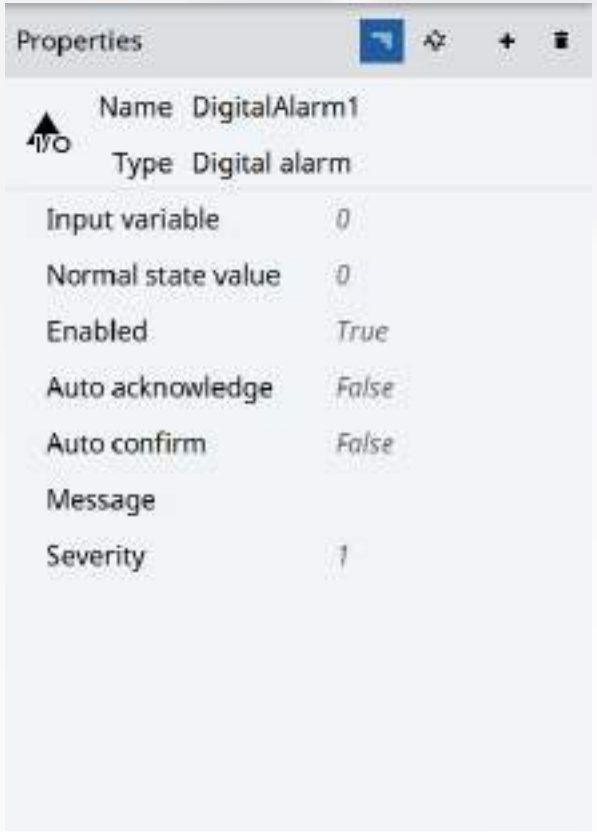
- History of Alarms
  - add a new datastore (Embedded database or ODBC)
  - drag&drop Alarm Event Logger object from Template Library, into Loggers node
  - drag&drop History Alarm Grid widget from Template Library to UI



OPC/UA Alarms specifications

Alarm types

- Types of alarms:
  - *Digital*: "two-state" alarm, typically used to monitor Boolean tags
  - *Level: an* alarm that activates when the monitored variable exceed the range "Low – High"
  - *Deviation:* alarms that activate when the monitored variable exceed the range defined by a Setpoint and Low/High deviation limit
  - *Rate of Change:* like Level Alarm but evaluated with specific polling time (i.e. to filter spurious spikes)



- Exclusive/Non-Exclusive (when all four limits are used)
  - Exclusive: exceeding High and High-high limits, only High-high alarms will be shown
  - Non-Exclusive: exceeding High and High-high limits, both alarms will be shown

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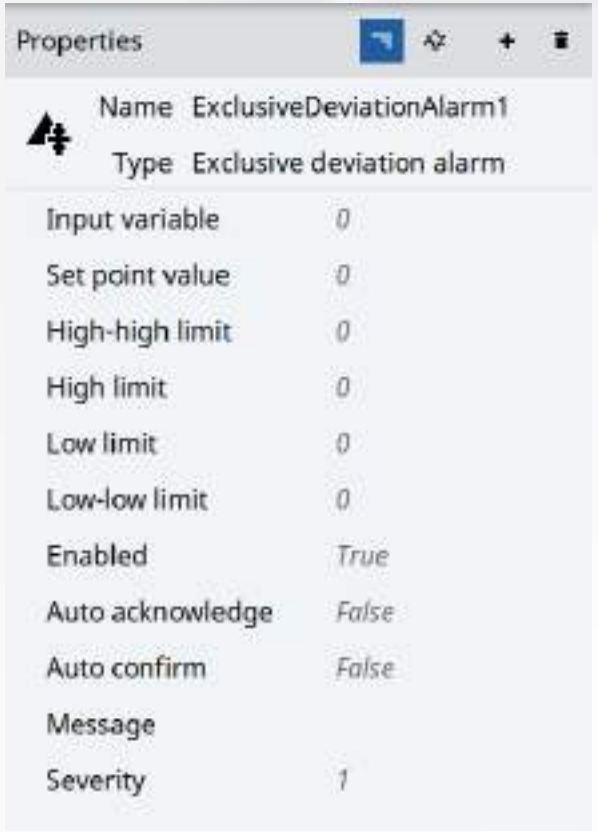

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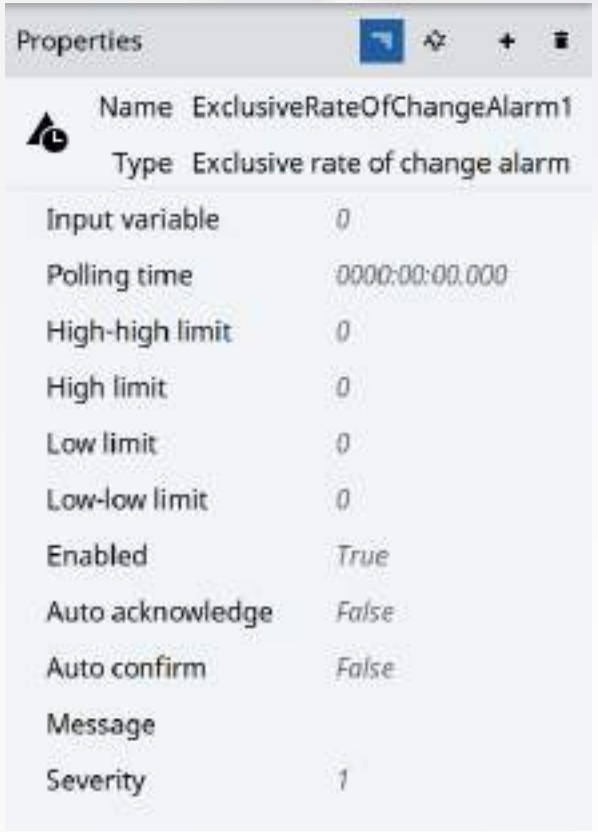

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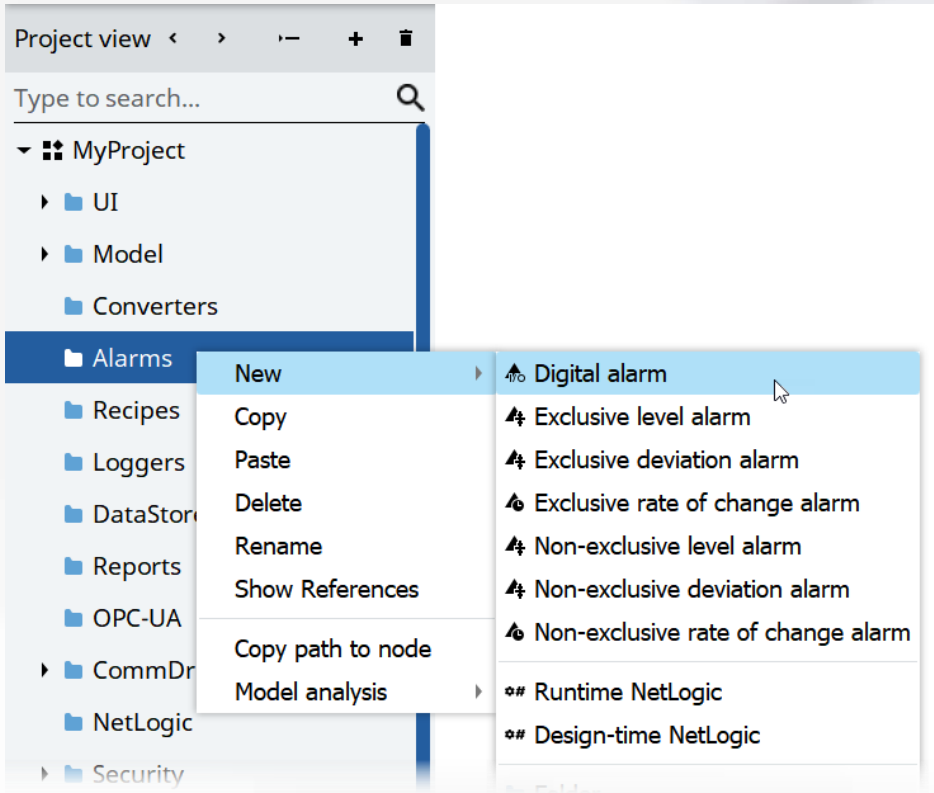
Alarm definition

- How to define alarms
  1. Choose the alarm type
  2. Configure Input Variable and properties

- For Tags where every bit bring alarm information
  1. Select the single tag
  2. Select the bit index



- Import/Export
  - Alarms Definition can be imported/exported to CSV file using a Template Library script (customizable as needed)
  - The path of the CSV file can be set to the current project fodler using the %PROJECTDIR% placeholder

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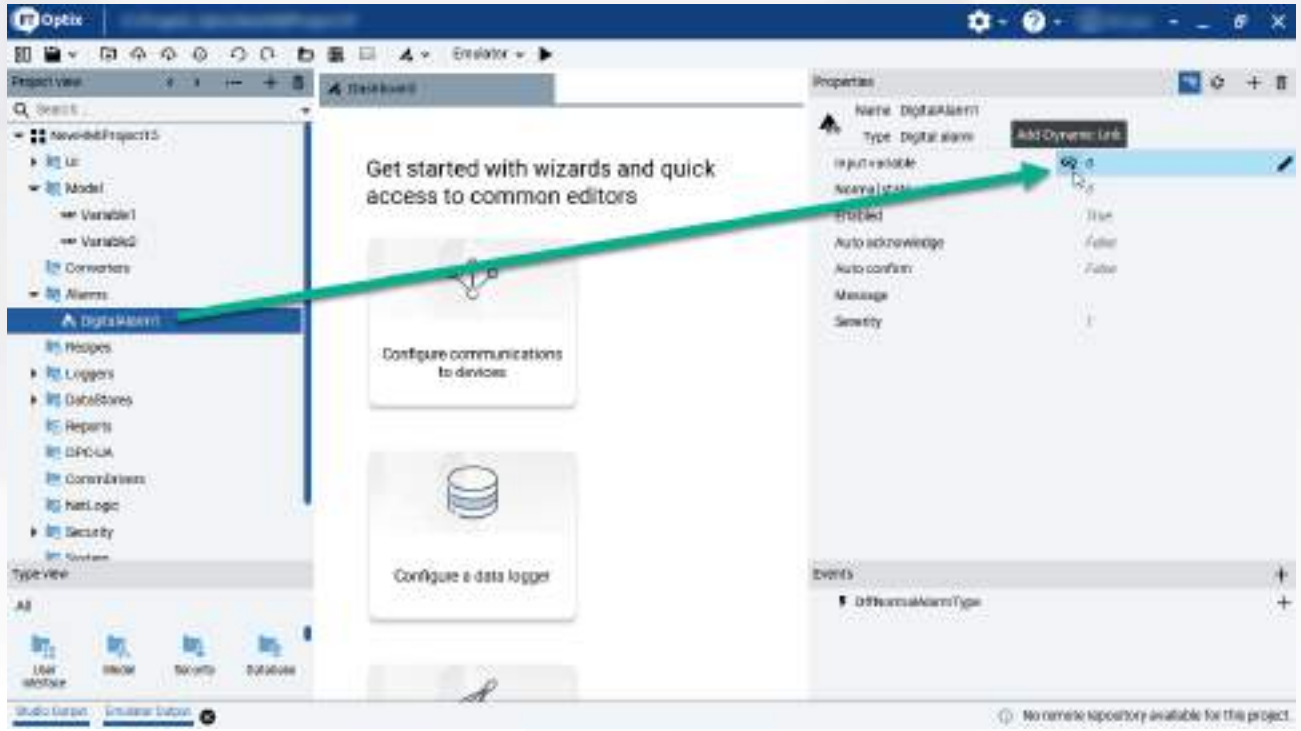

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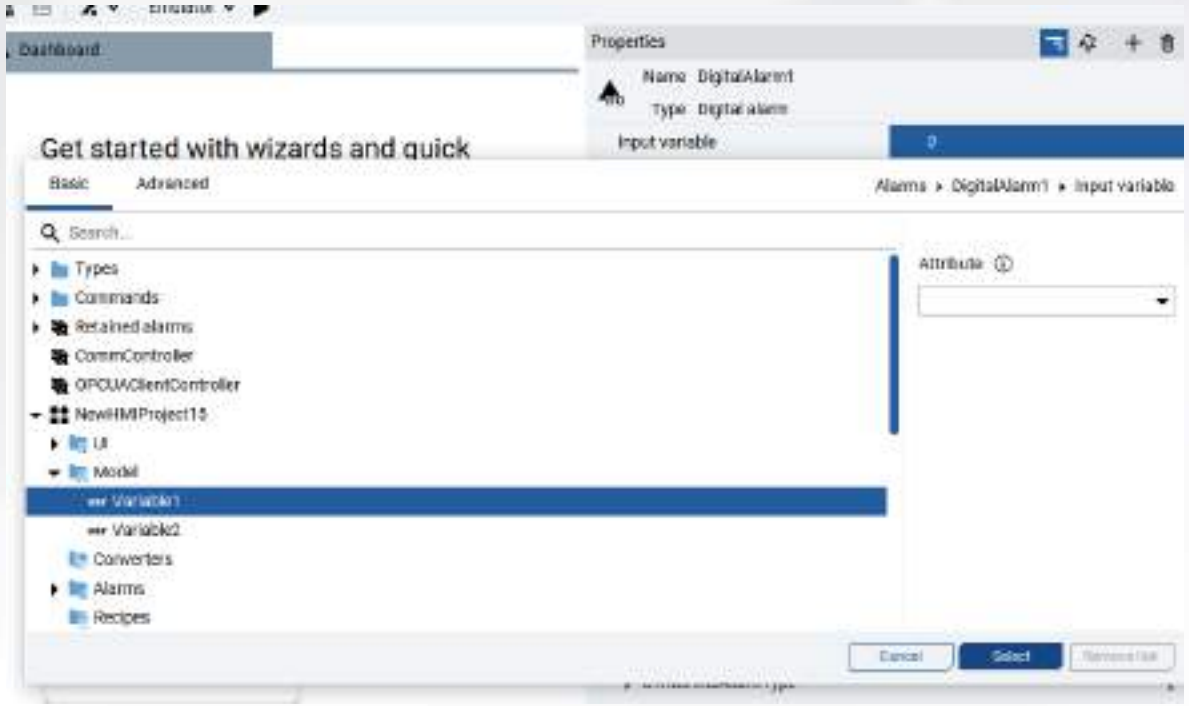

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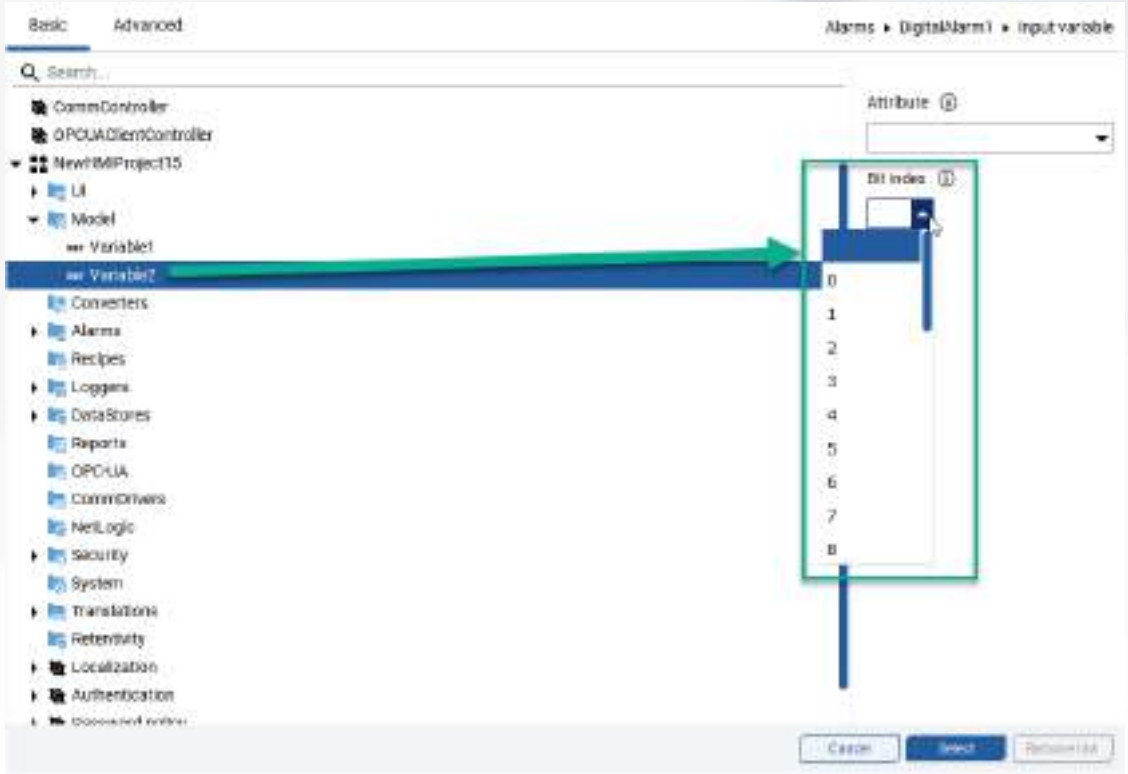

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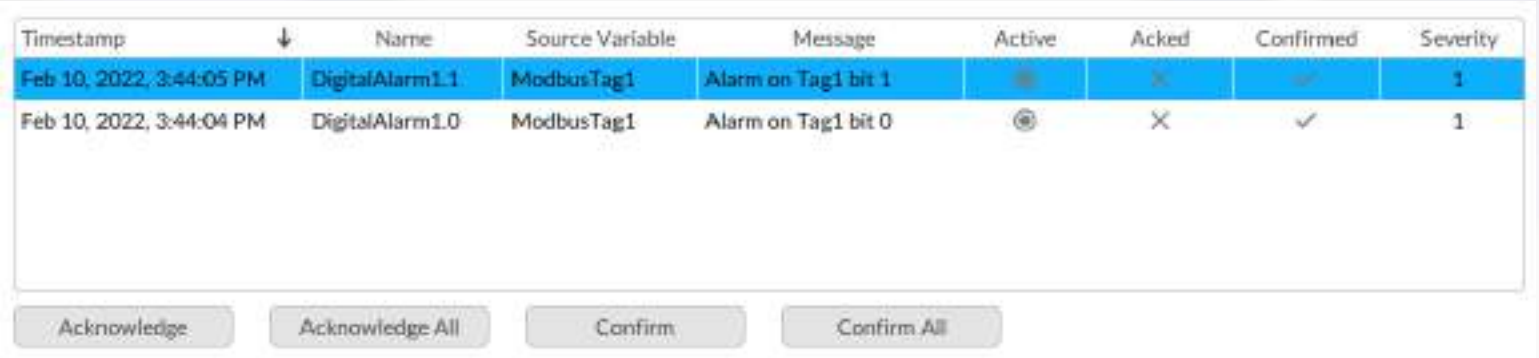
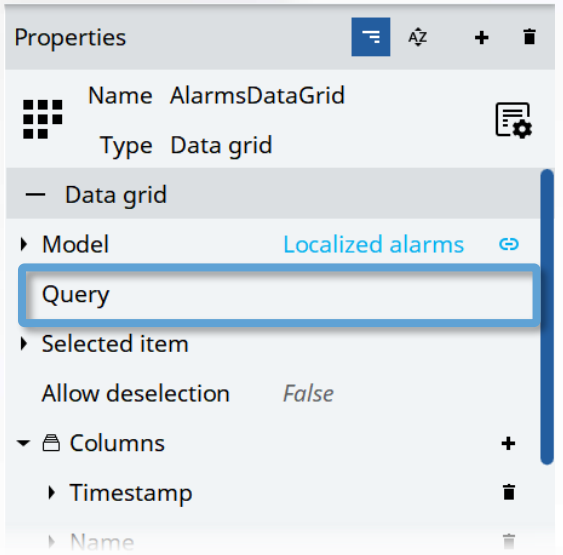
Show alarms

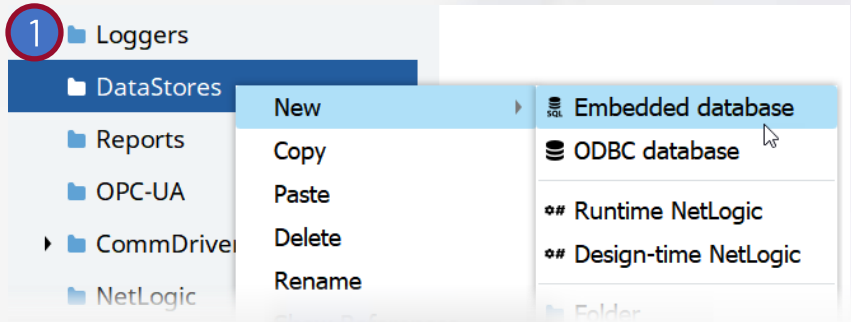
- Available Widgets
  - into Template Library
    - Alarm Grid,
    - Alarm Banner,
    - Alarm Icon
  - customizable
    - columns,
    - buttons,
    - the "Query" parameter allow to filter alarms of Alarm Grid
  - Support Messages in different languages
  - Supports different messages per each threshold of analog alarms





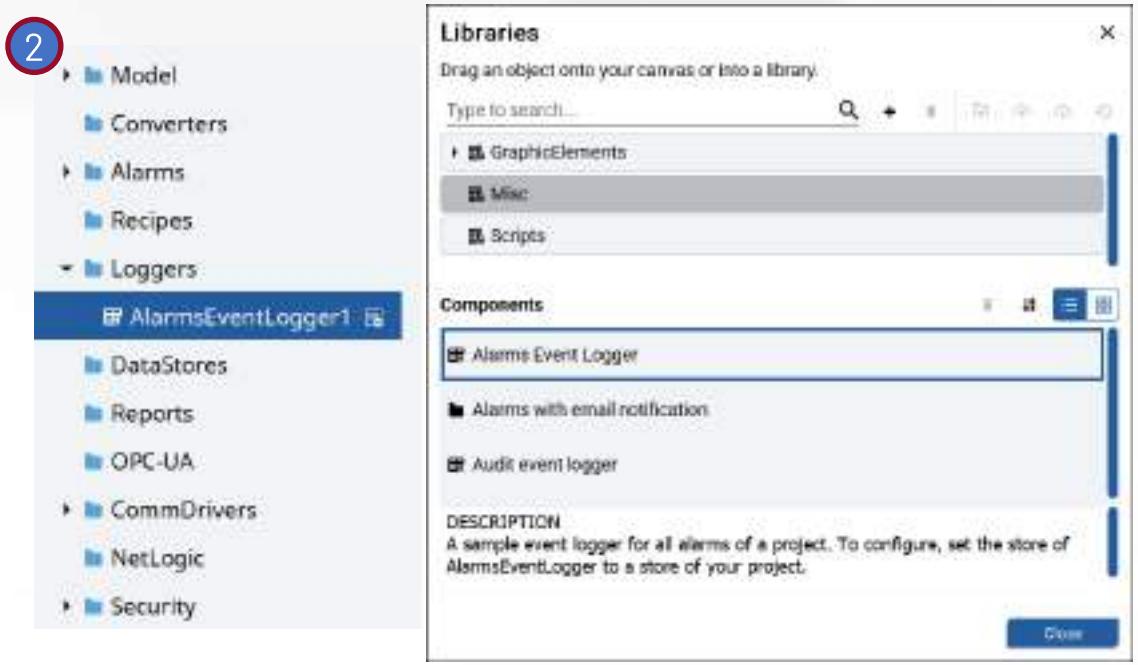
Show alarms history

- To record alarms history
  some additional resources are needed
  1. Datastore resource (if not already present)
  2. Alarm event logger (from Template Library)
     just drag&drop and configure datastore to be used



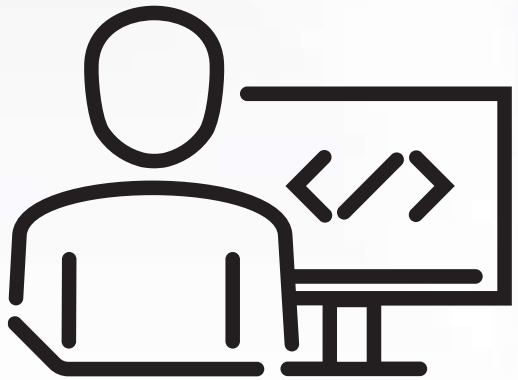
- Available Widgets
  - Alarm History grid
  - Alarm History grid with filter

- Export
  - Alarm History can be exported
    with script "Alarms History Exporter"
    available in Template Library



Hands-on session

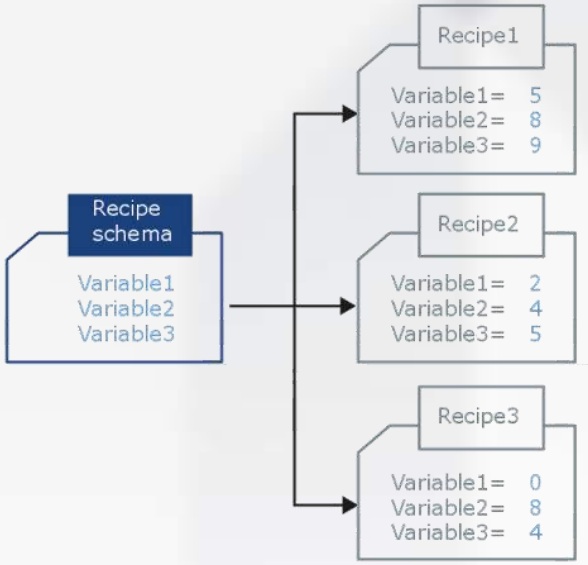
- Define some digital alarms configuring the input variables
- Add the Alarm Grid widget to see alarms at runtime with the emulator
- Add the Alarm Event Logger to log historical alarm events
- Add the Alarm History Grid widget to see historical

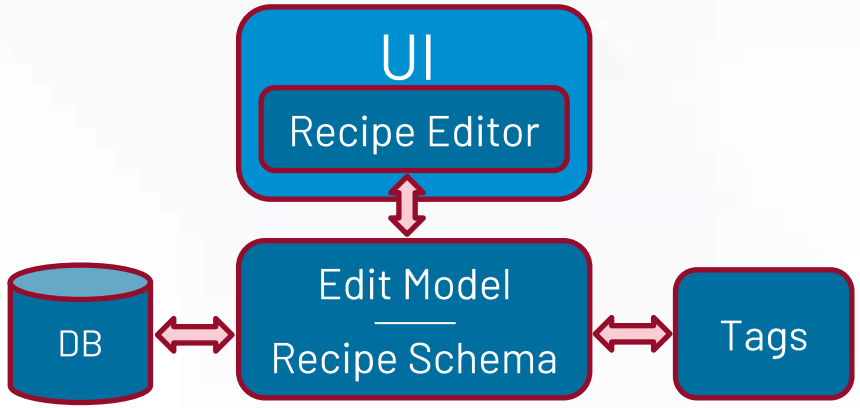


Recipes

Recipes

- Allows defining a group of values/set points stored in database archives (embedded or ODBC)
- in Studio
  - configure the Recipe Schema by defining datastore and selecting Tags
- in Runtime
  - User can create several recipes, by defining values manually or by reading values directly from PLC
  - User can store the recipe in the database for future use
  - User can retrieve the recipe from the database and transfer to the PLC





Configure a recipe schema

- Steps to configure Recipes

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2. Select the Datastore
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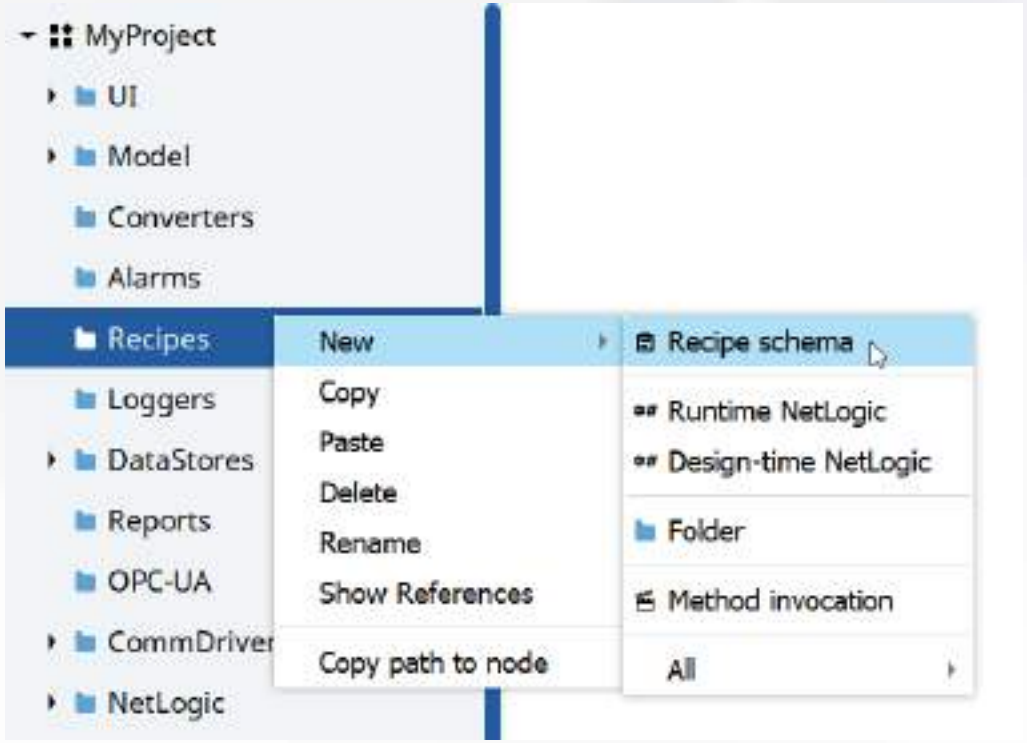
3. Configure the Target Node
   This is the project folder containing Variables that will be used in the Recipe Schema
   Example: Tags, Models...

4. Select which Variables add to the Schema then confirm with "Apply"



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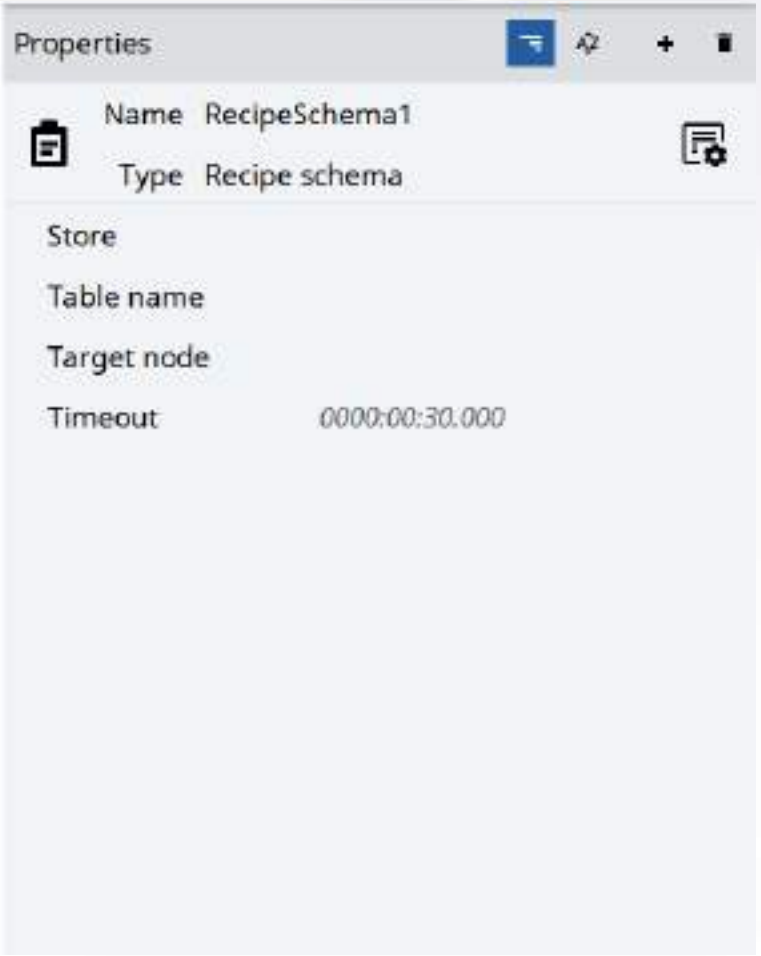

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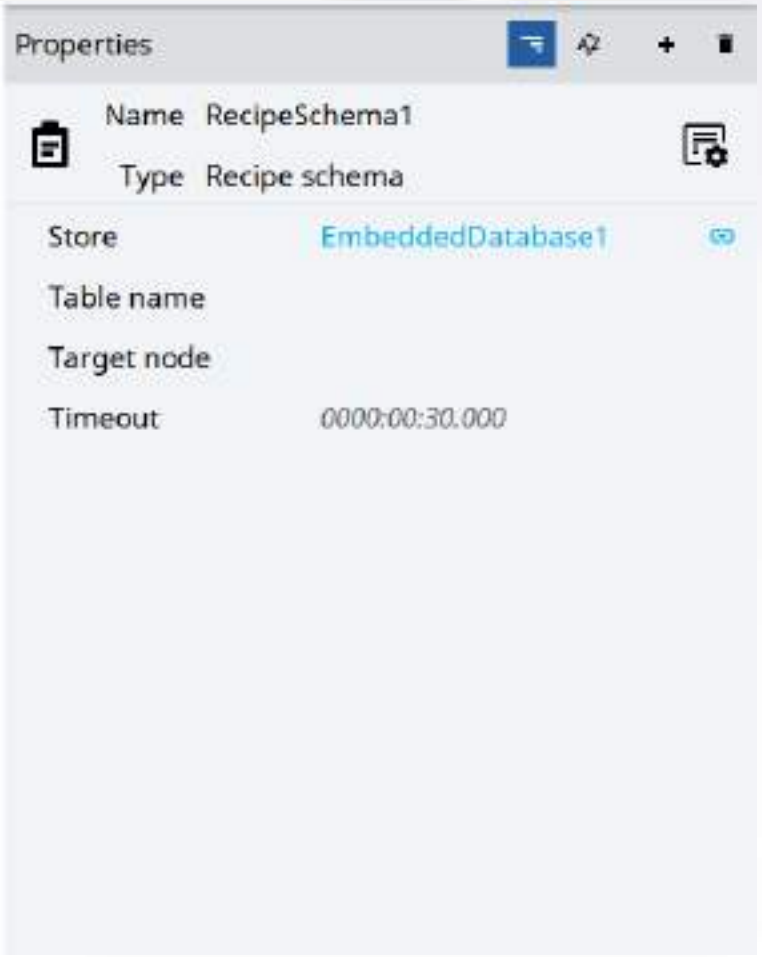

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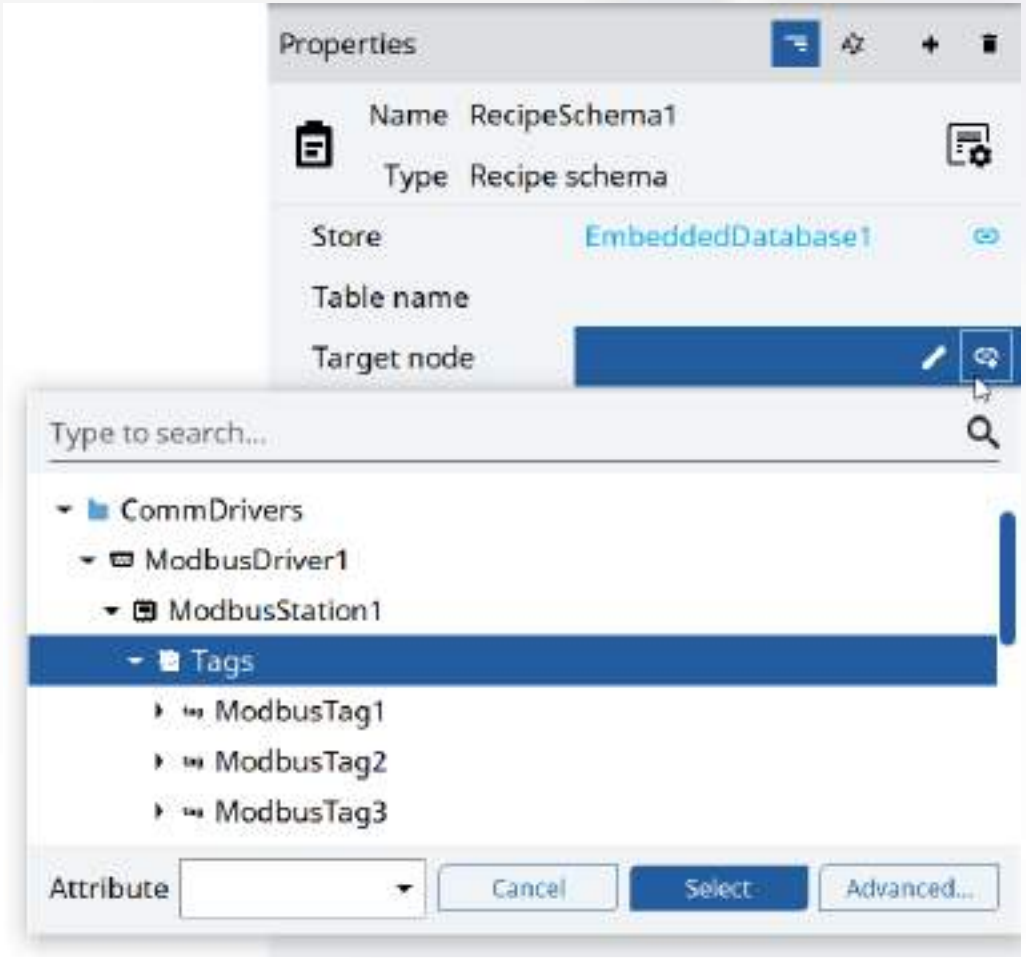

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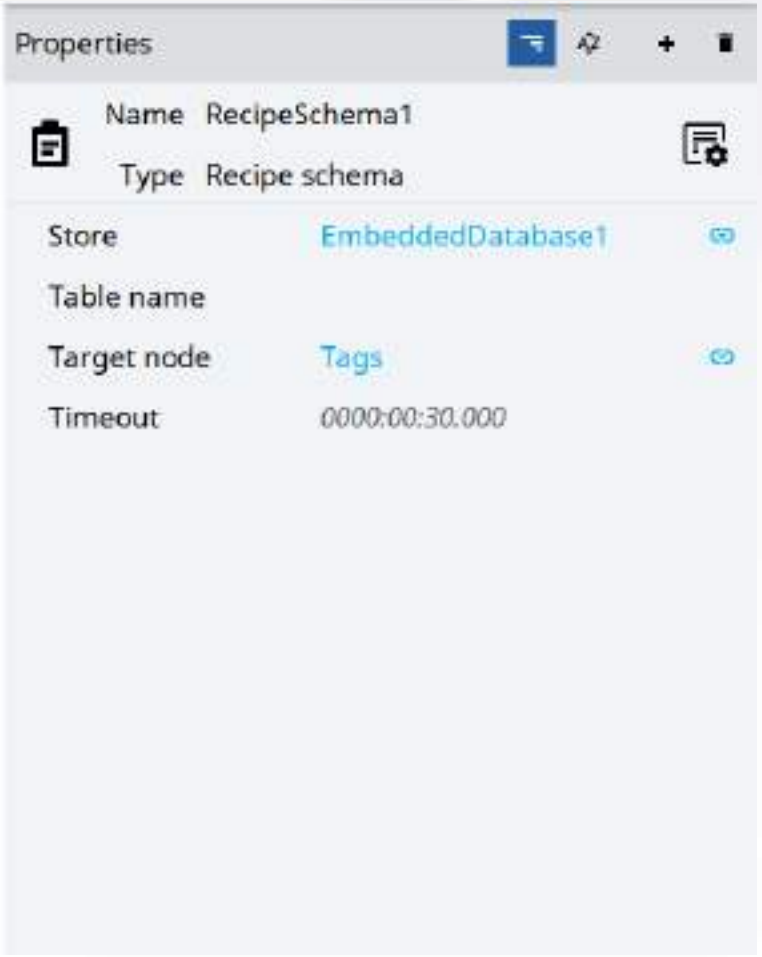

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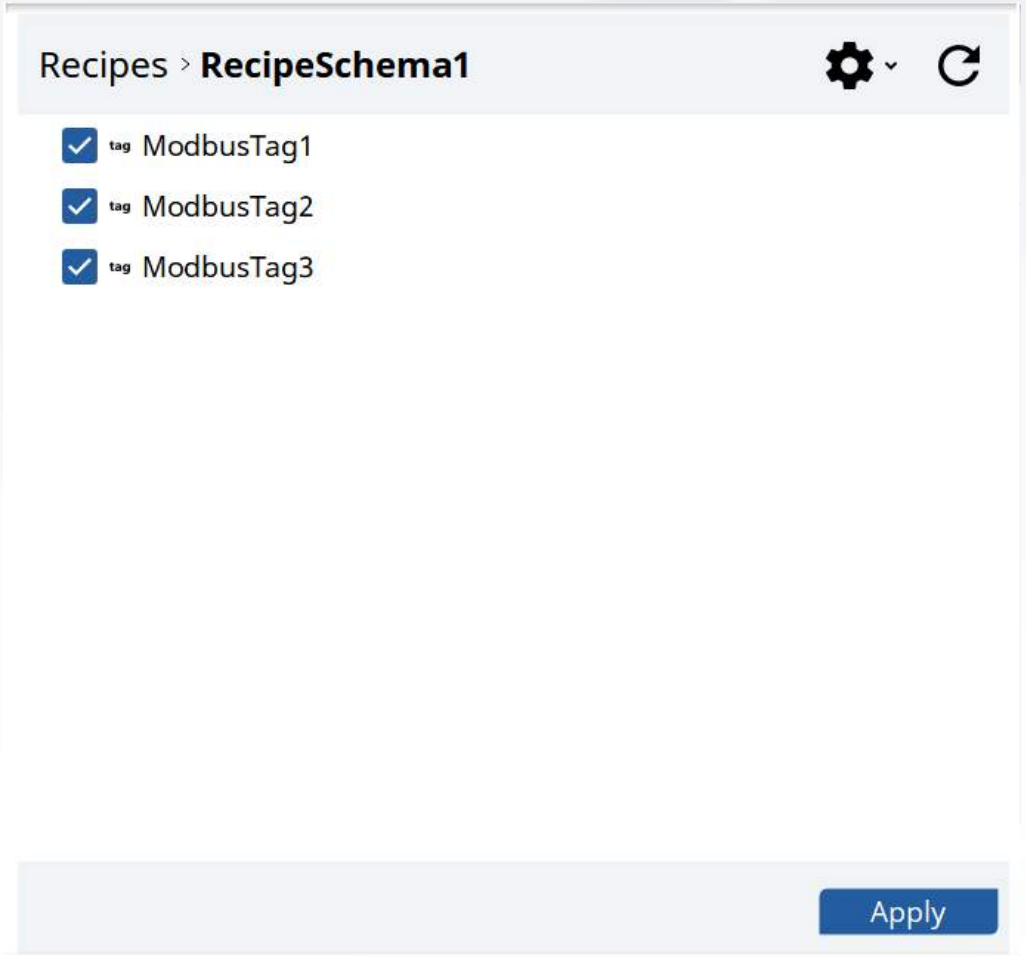

Recipe editor widget

- Steps to configure the Recipe Editor widget
  1. Drag&drop the widget from Template Library
  2. Into Property pane,
     select the recipe schema
  3. Right-click on the "RecipeEditorUISetup"
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- Widget:
  - Save: save/create the recipe into the database
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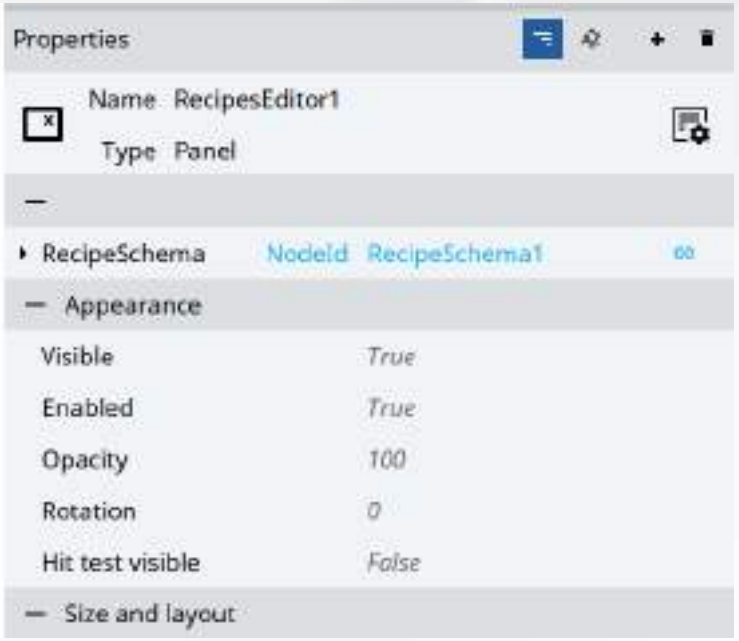

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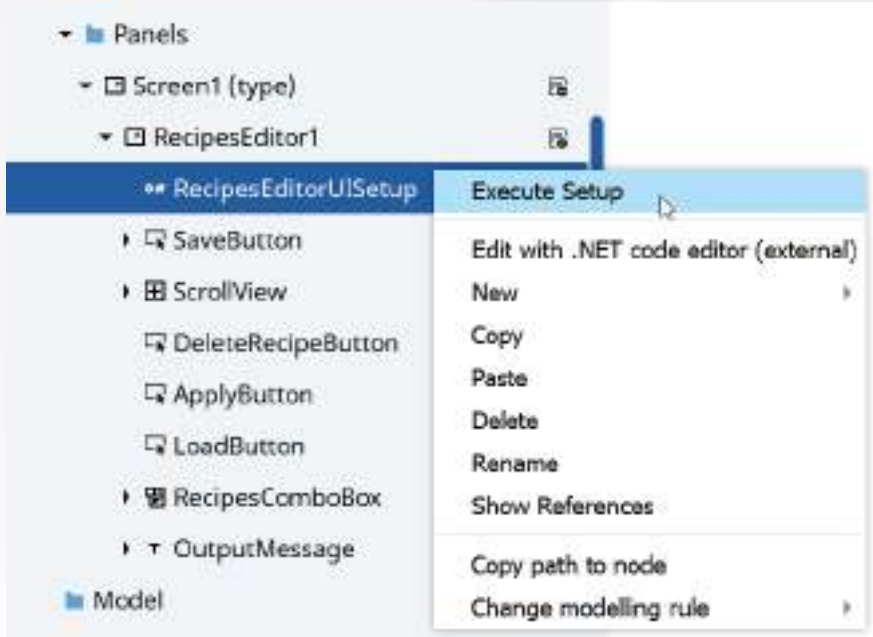

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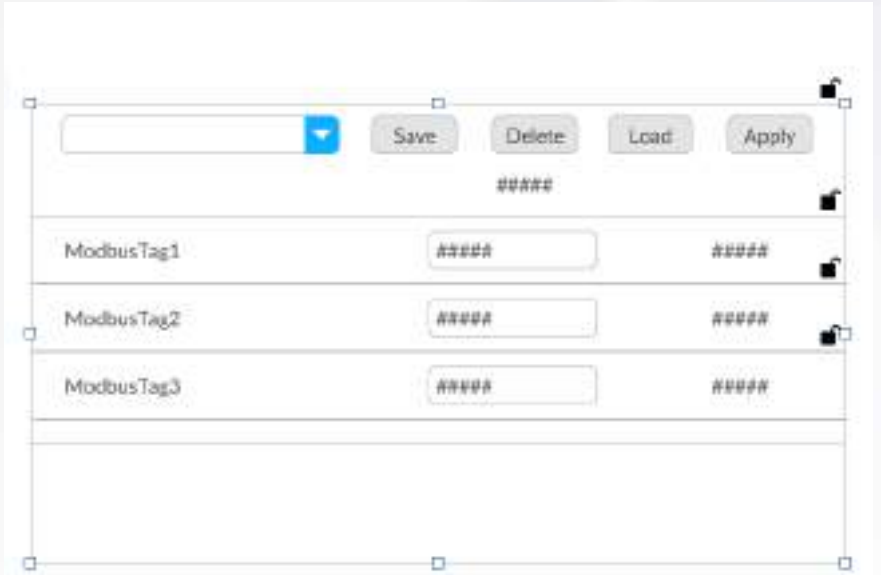

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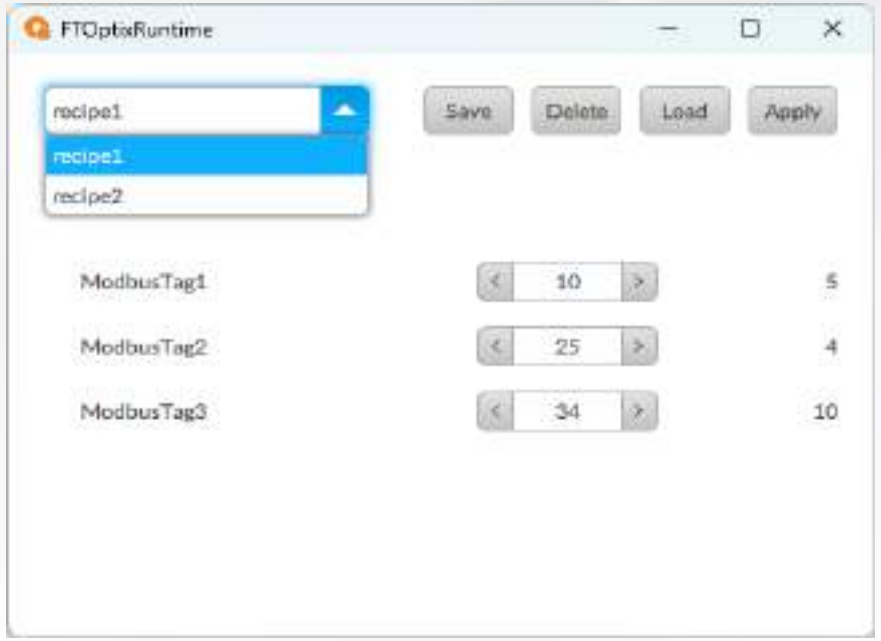

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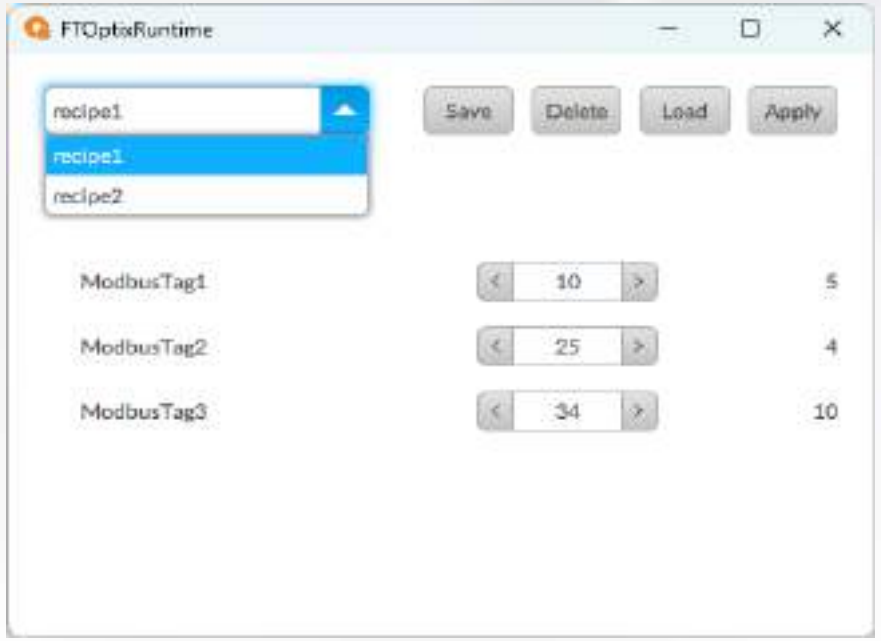
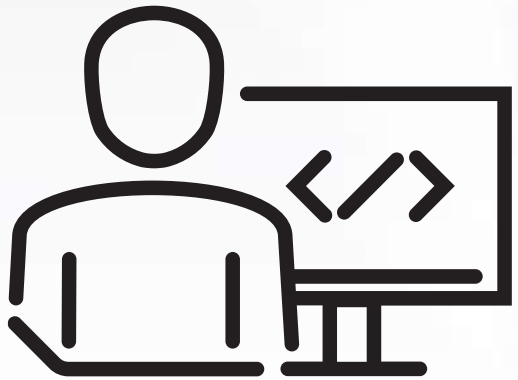


Hands-on session

- Create a recipe schema using tags coming from the communication driver
- Add the recipe widget to the project
- Execute the Recipe widget "setup"
- Play with the widget at runtime with Emulator

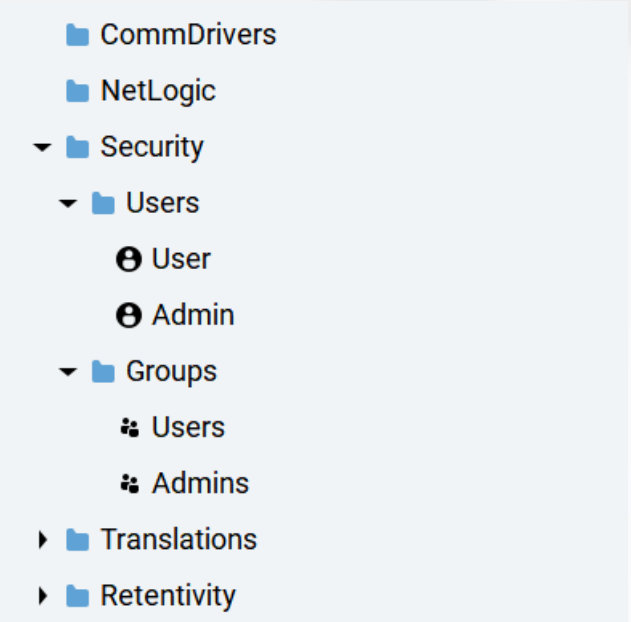


Configure users and groups

Users and groups

- Allow defining a level of Security for commands/UI objects

- Project Properties
  - Authentication Mode: Model = Project's users,
    Local = iPC Local users,
    Domain = Active Directory users
  - Default User Folder
  - Password Policy



- Presentation Engine properties
  - Login Window: on Web Presentation Engine only, allow to specify a Window that should contain a Login Form to be prompted at startup.
  - Starting user: "Anonymous" it's the user logged in at the startup (it's not visible in the Users folder)

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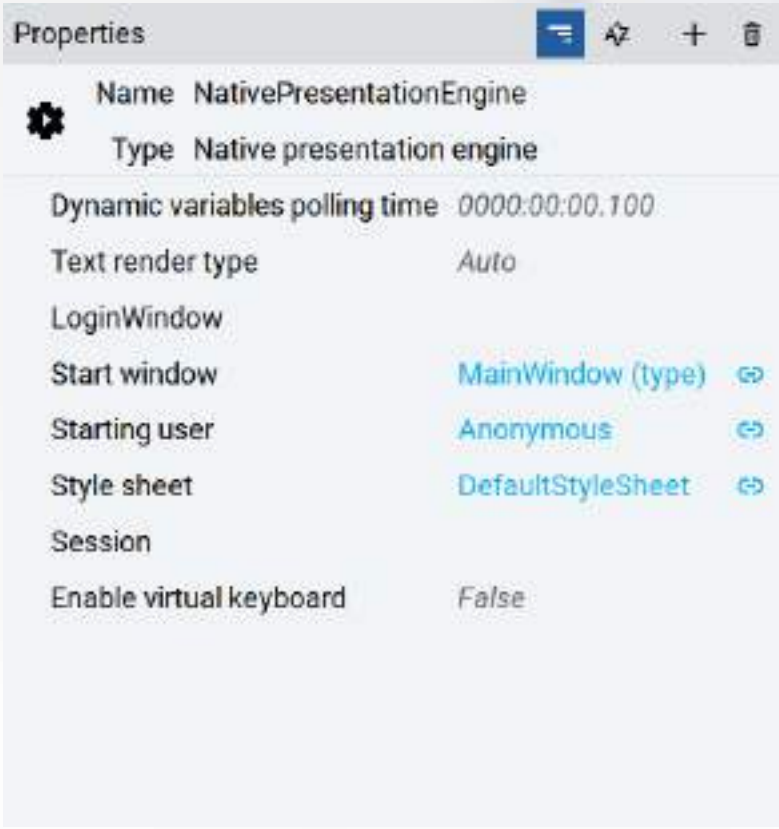

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- User/Group Creation:
  - Users and Groups can be created manually, by the right click on Users or Groups folders (except for Local/Domain users)
- User properties:
  - Password
  - LocaleIds: a combination of Regional Settings, Language and Measurement System
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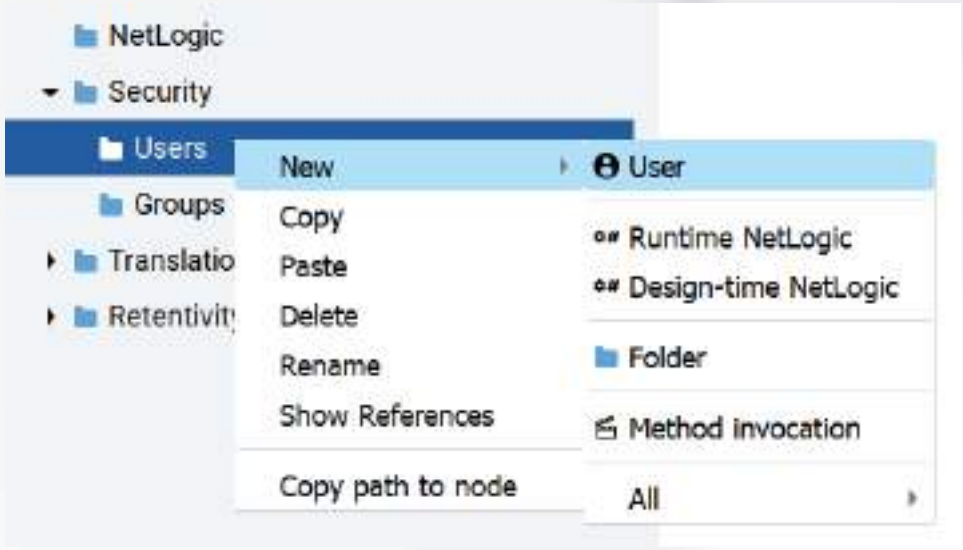

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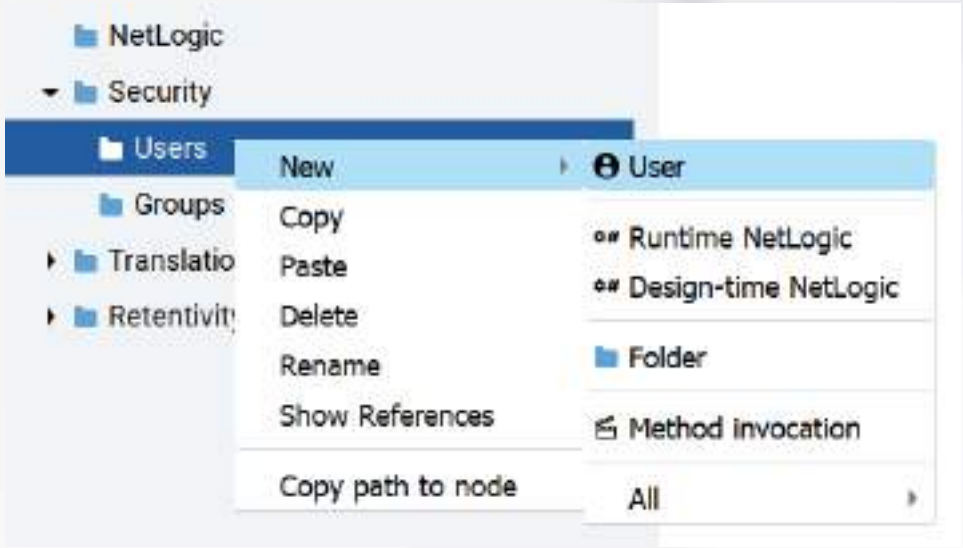
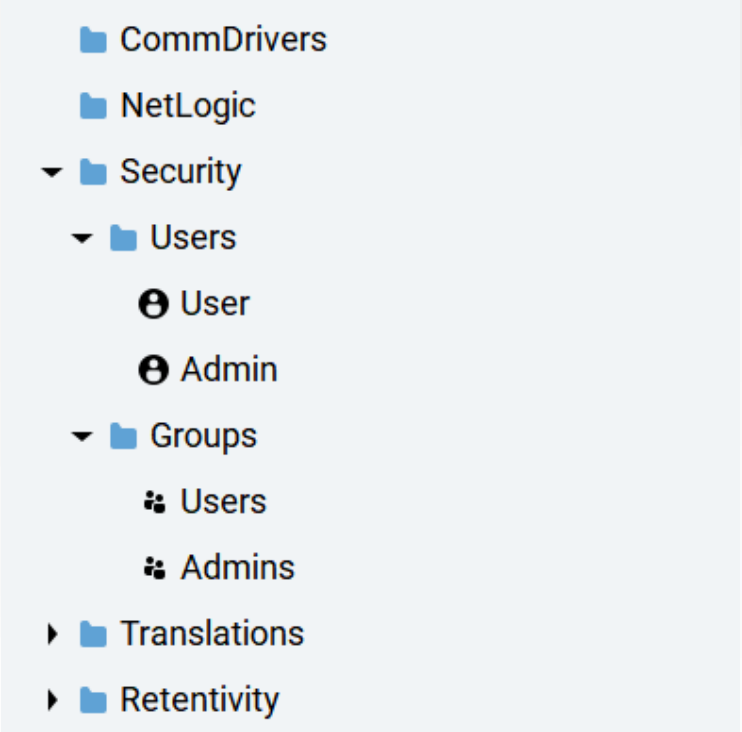


Assign users to groups (and viceversa)

- Assignment must be done through the wizard "manage users and groups"

- The wizard allows assigning users to groups but also groups to users



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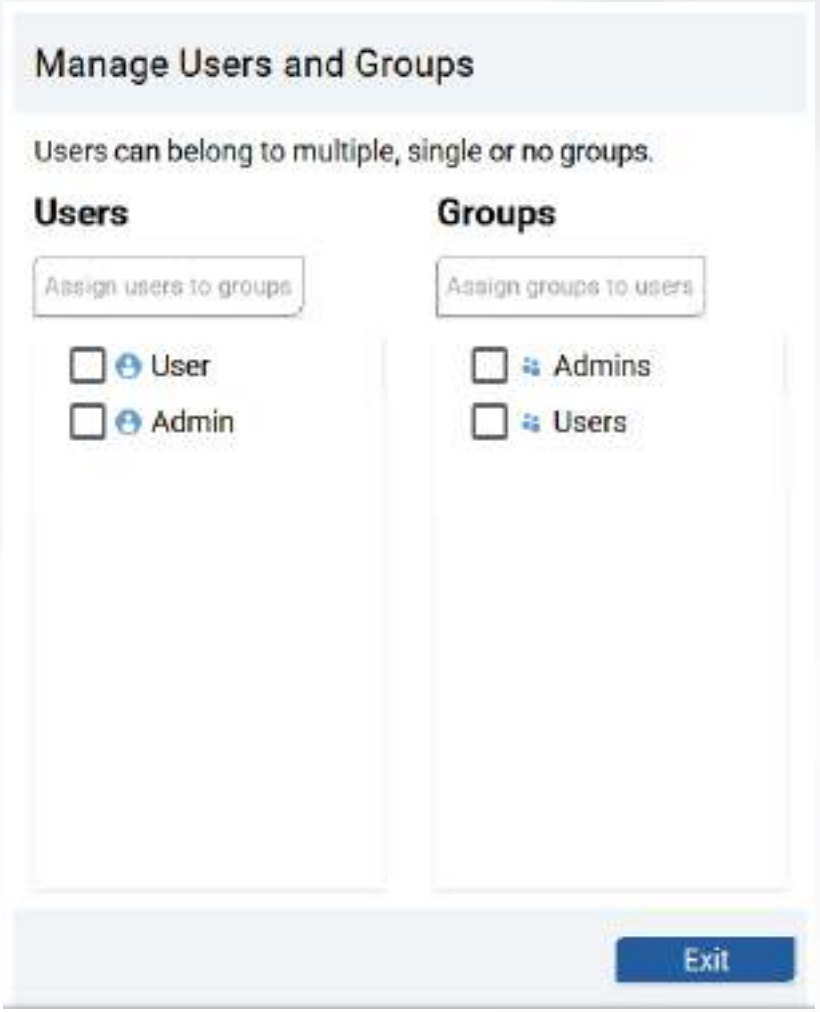

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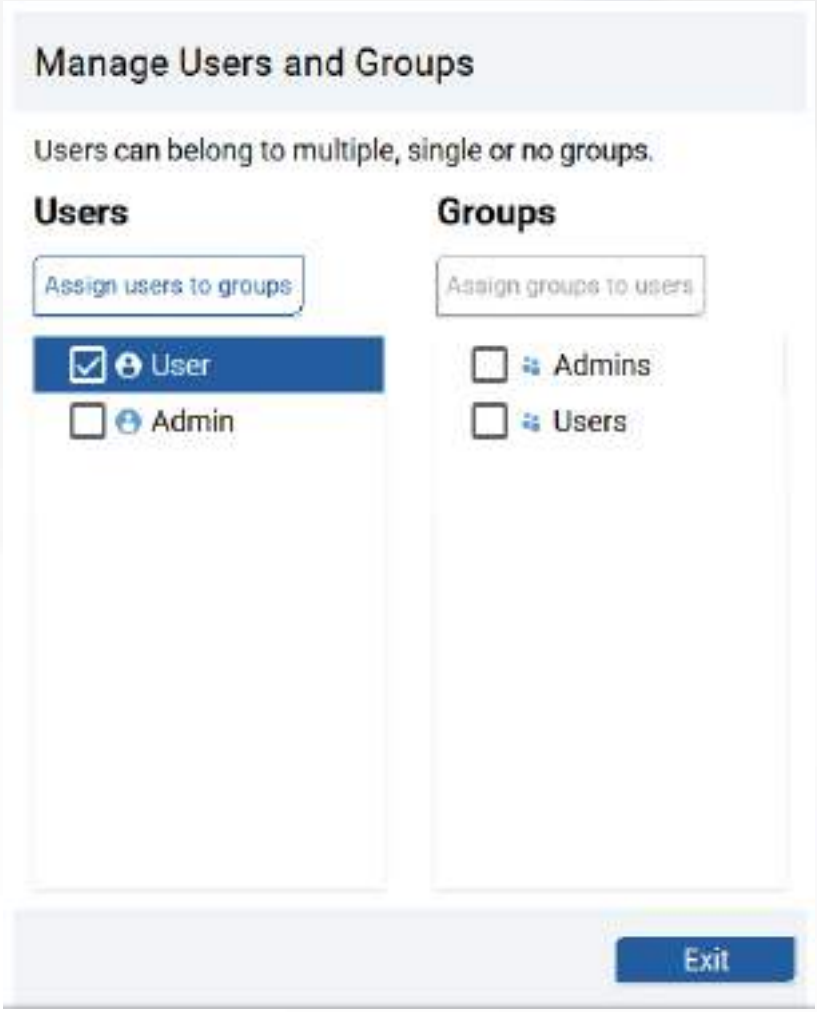

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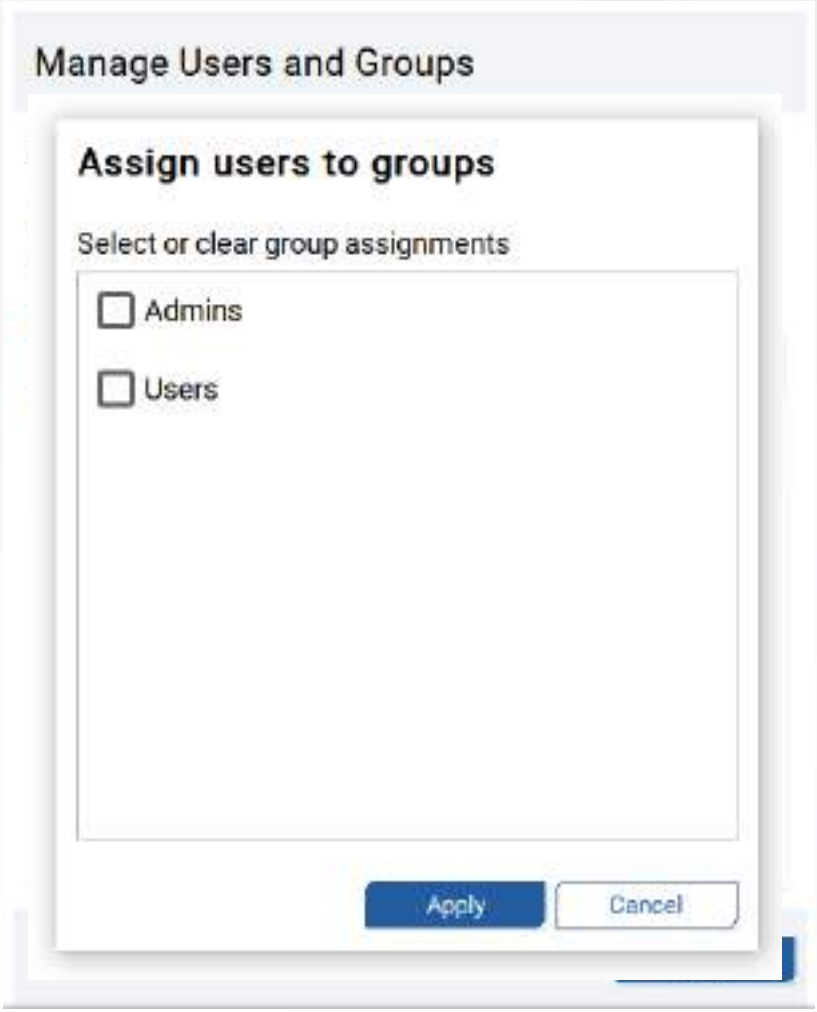

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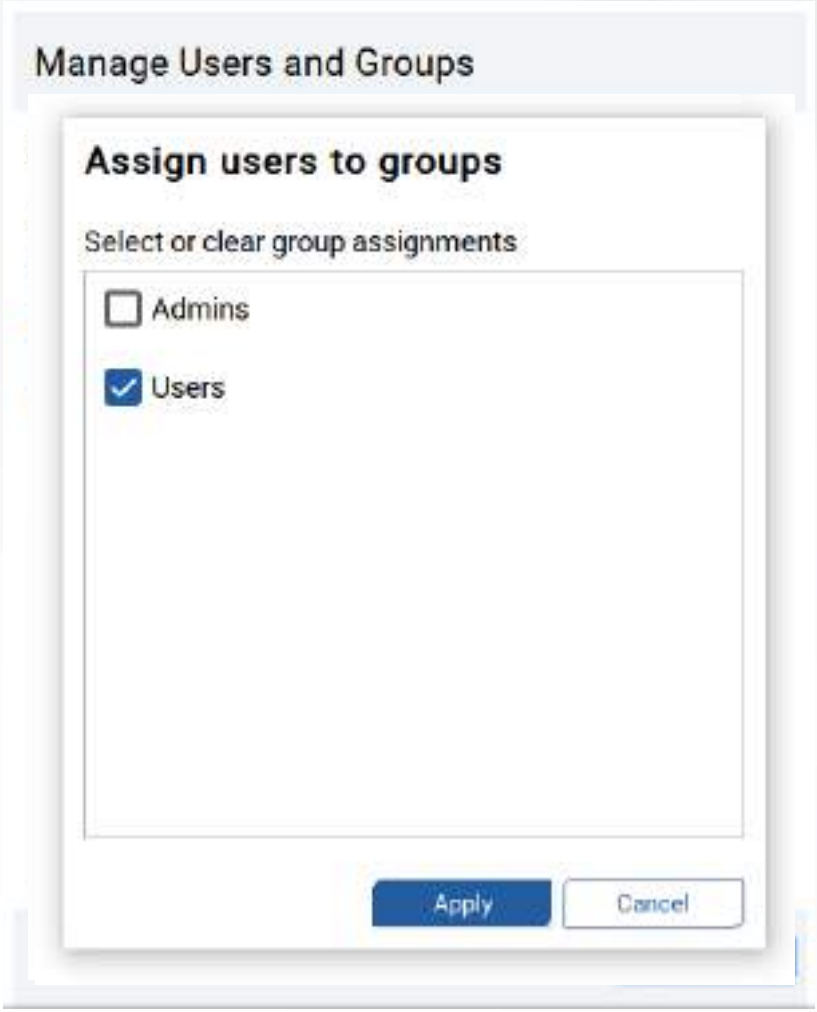

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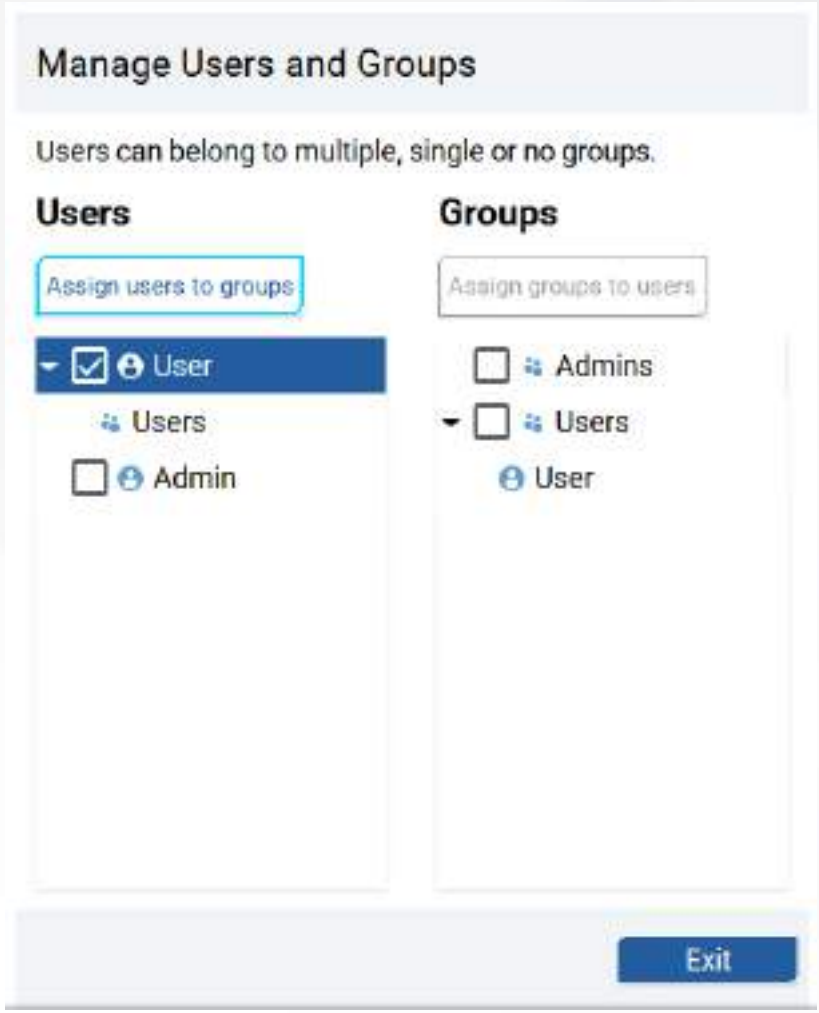

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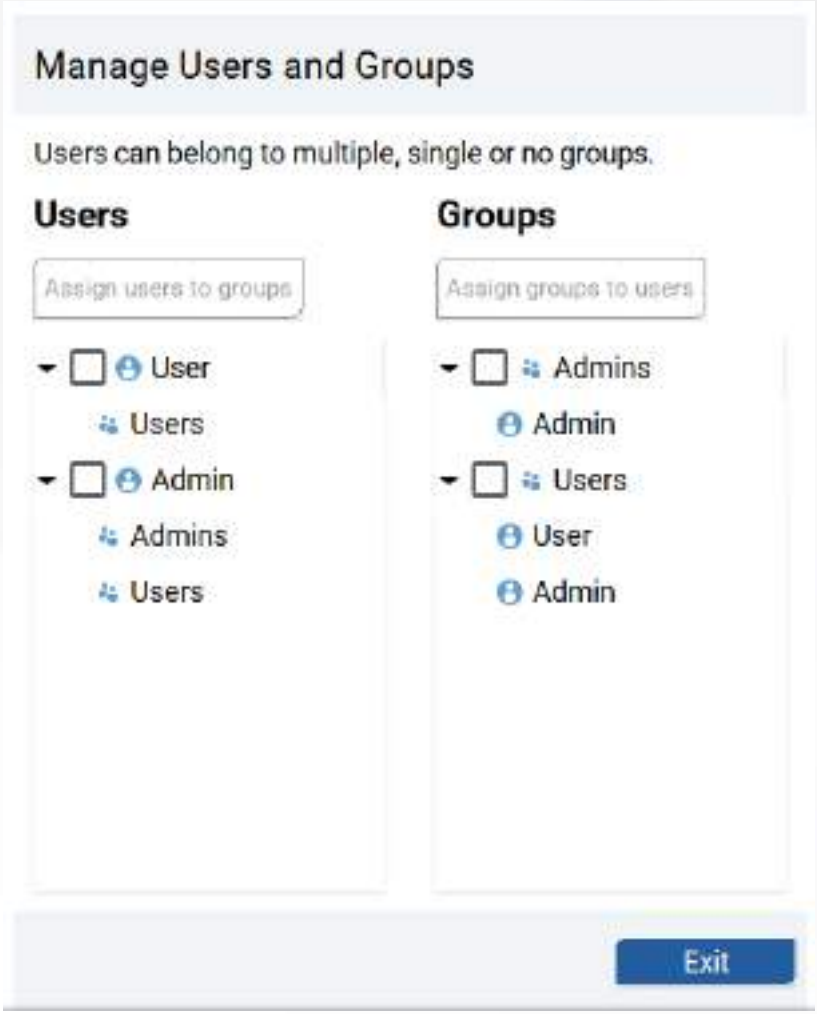
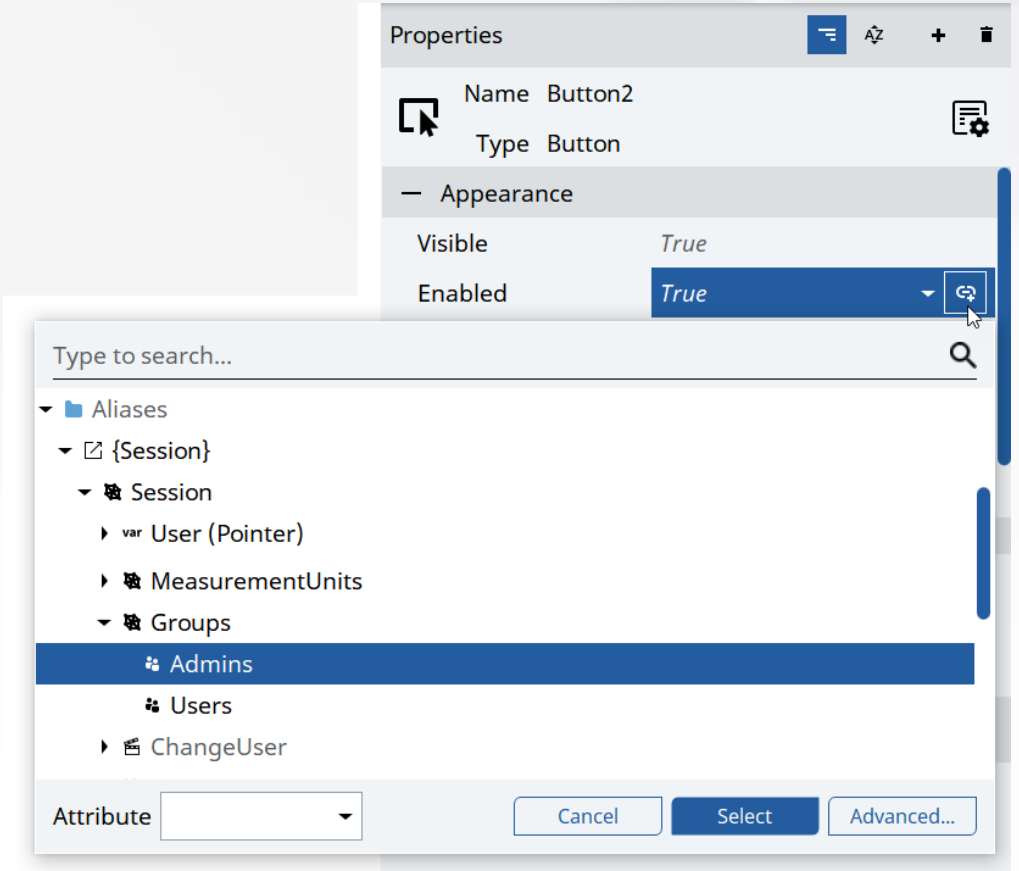


Define security into UI

- It's possible to make an object
  - "Visible/Invisible"
  - "Enabled/Disabled"
- just linking a Group to the needed property {Session} > Session > Groups > ...
- In this example "Button2" will be "Enabled" only for users of group "Admins"



Manage user access at runtime

- Login options
  - using the **widget "Login Form"** of Template Library.
    Widget comes as a folder that contains the "LoginForm"
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  - using the **method** "Aliases > {Session} > Session > Login"
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- Logout options
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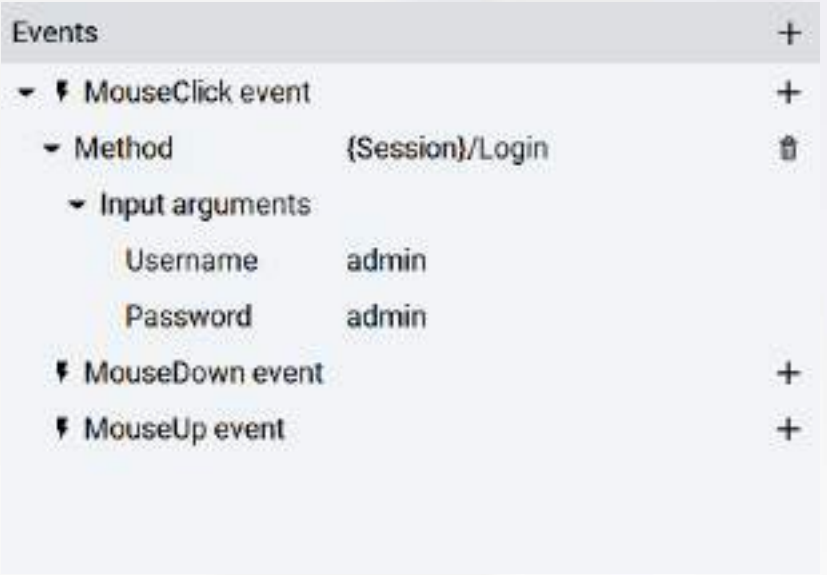

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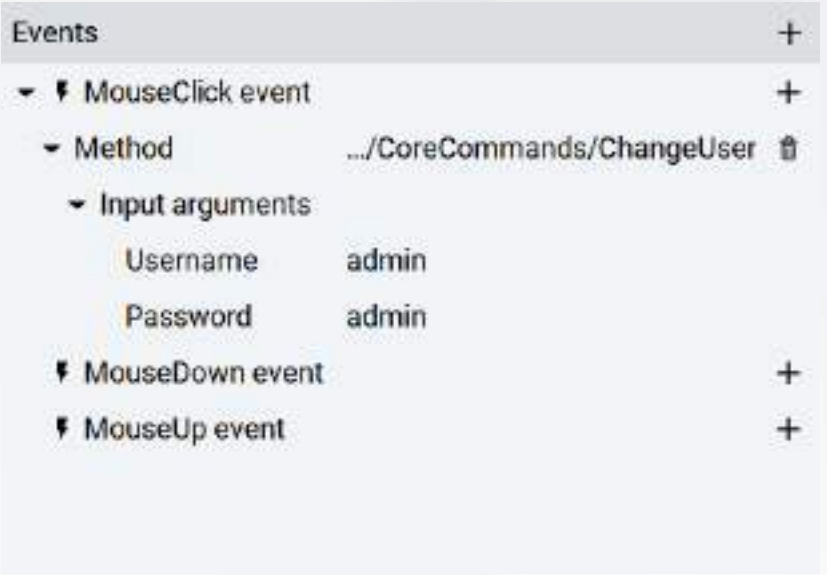
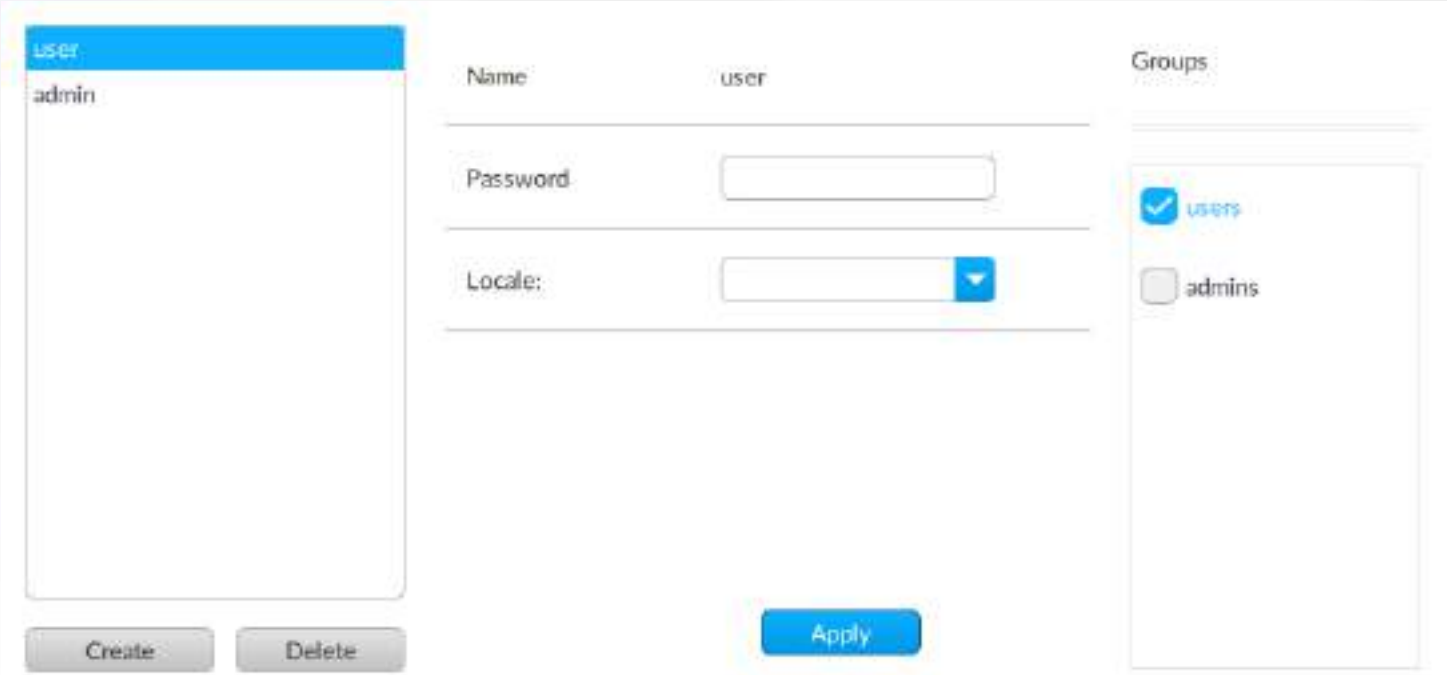


- Logout options
  - using the **method** "Aliases > {Session} > Session > Logout"
  - using an **UISession object** and use the IdleTimeoutEvent
    to call the method "UI Session > Logout" or "UI Session > Change User"
  - using the **script "Idle Timeout"** available in Template Library,
    place into the MainWindow and associate a "Logout" command

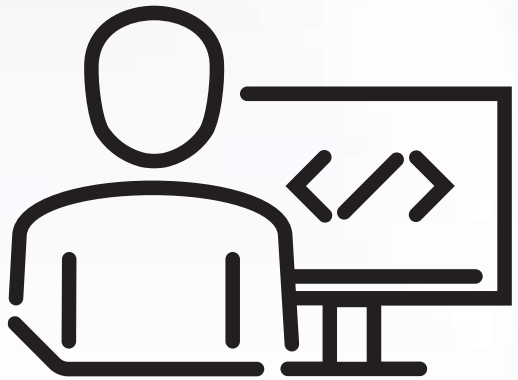
Edit users at runtime

- using the **widget "User Editor"** of Template Library
- Widget, comes as a folder that contains the "UserEditorOverview to be placed in a Panel
- It is required to link Users and Groups folder to the widget



Hands-on session

- Create a couple of different users, and groups and make "user – group" association
- Define security at some UI objects (Visibility/Enabling)
- Add the Login form to a Panel
- Optional: call the Login form from a dropdown button paying attention to the background…
- Try at runtime with different users

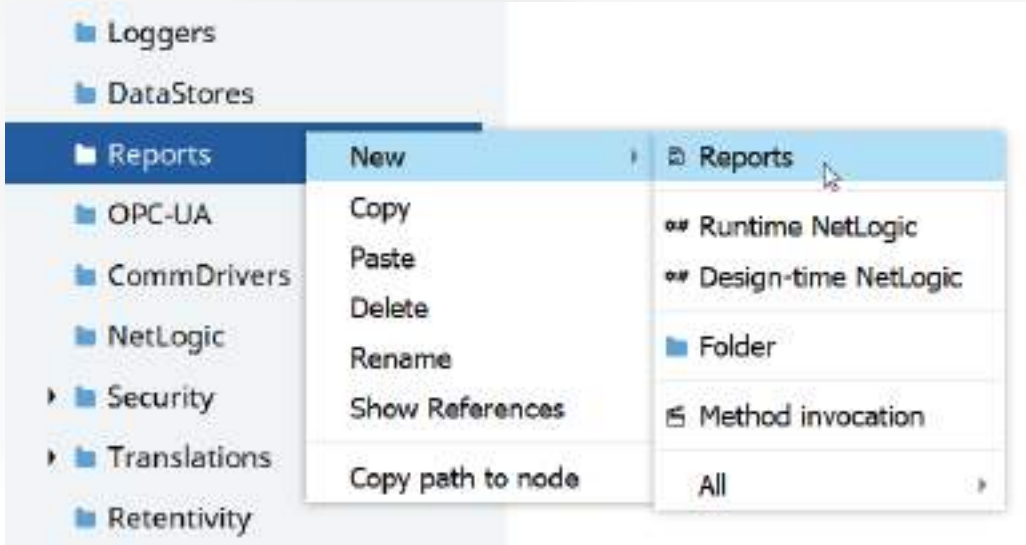


Configure Reports

Reports

- Design and generate reports in PDF format
- Data coming from FTOptixApplication and/or from a database

- Components:
  - StyleSheet
  - Header
  - Sections
  - Footer



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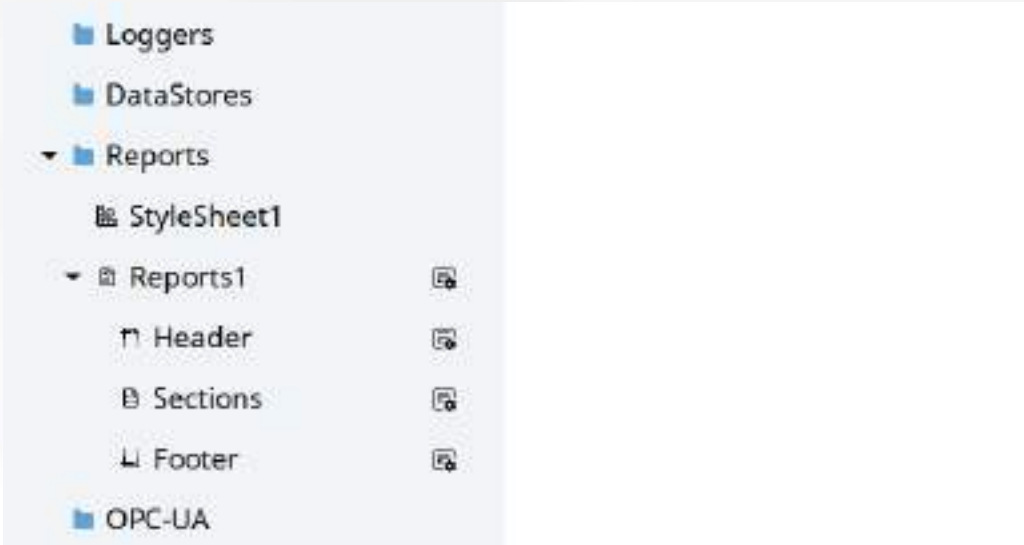
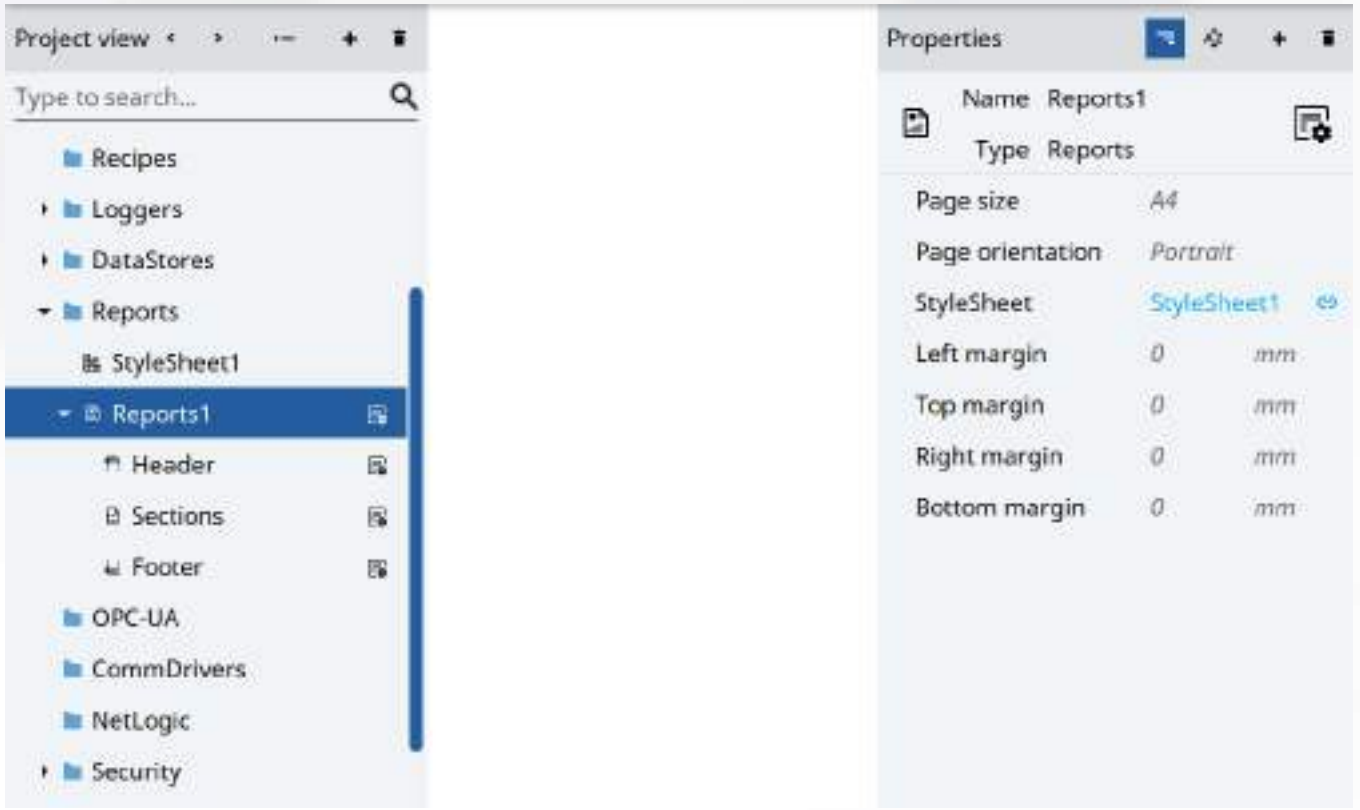


Report properties

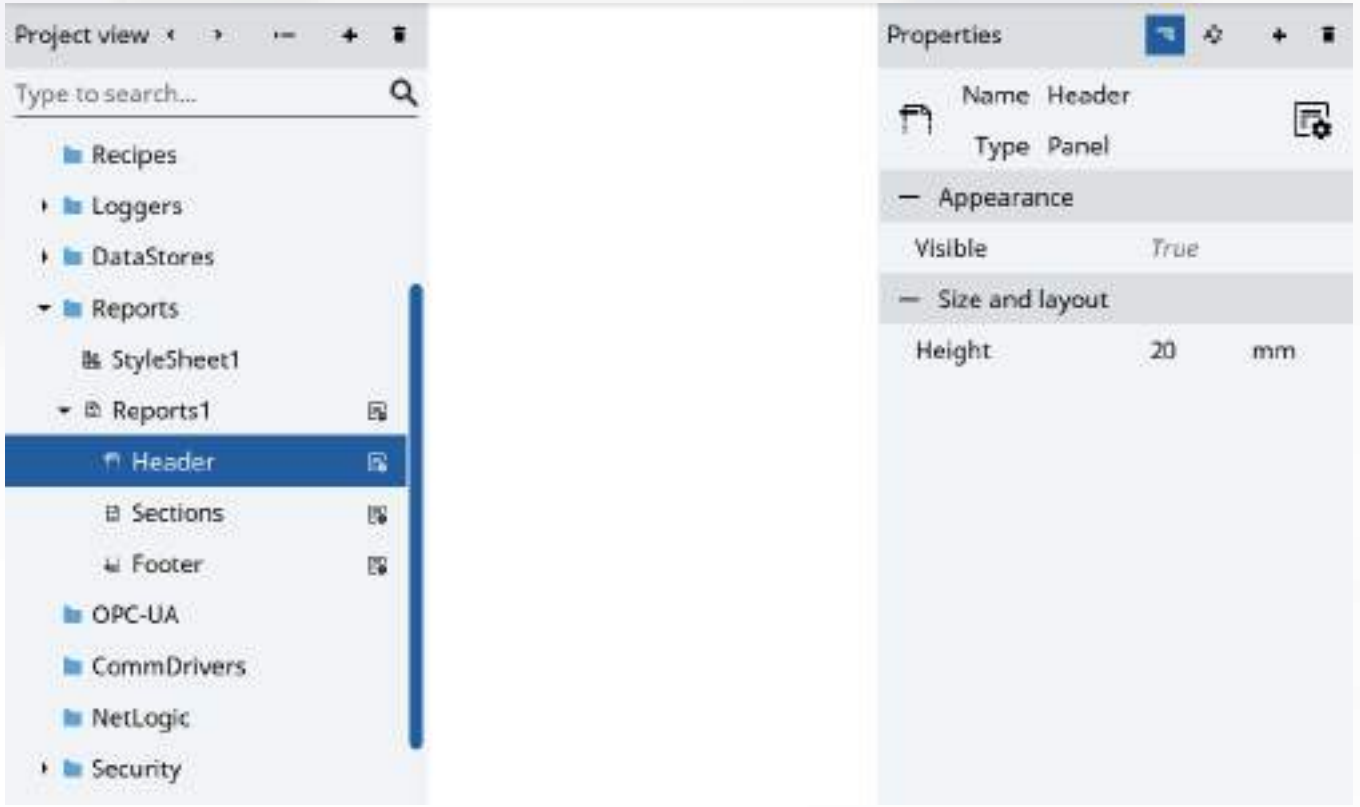
- Allow setting the report's global layout properties, which apply to all pages of the final PDF document

  - Page size,
  - Page orientation,
  - Style sheet used,
  - Page margins

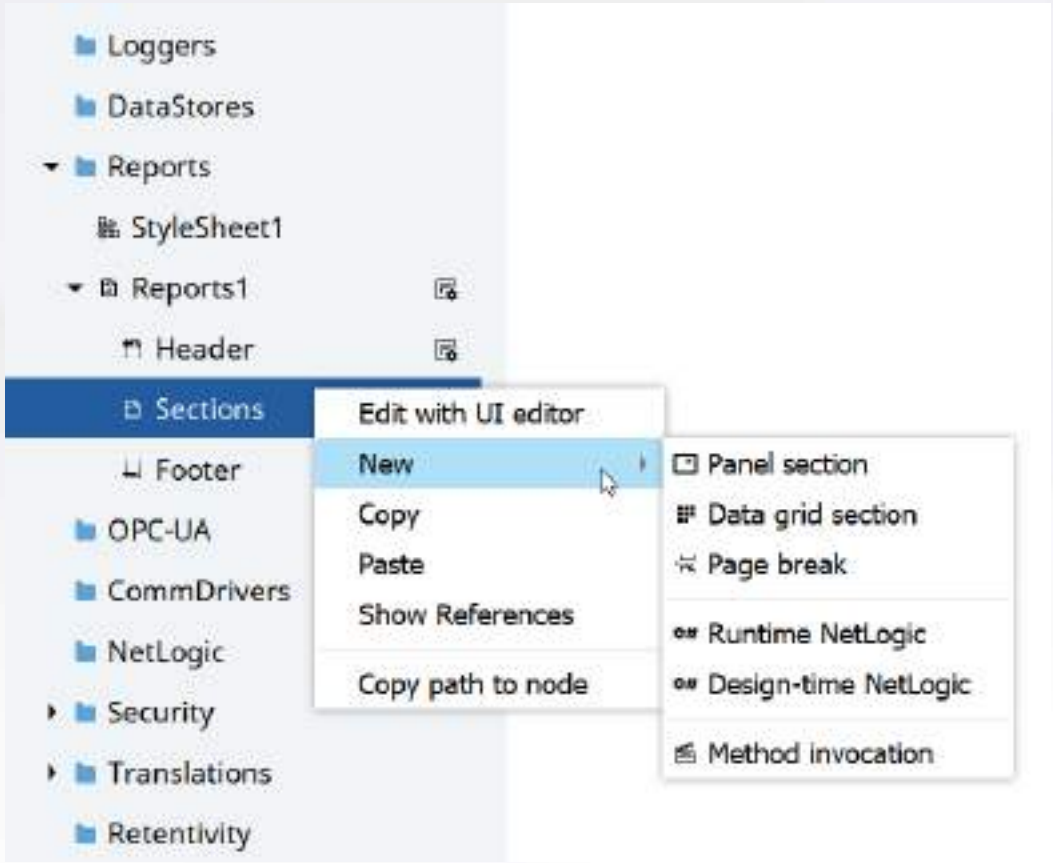


Report header and footer

- Header/Footer is content that appears at the top/bottom of a report page
- Properties:
  - Visible
  - Height



Report sections



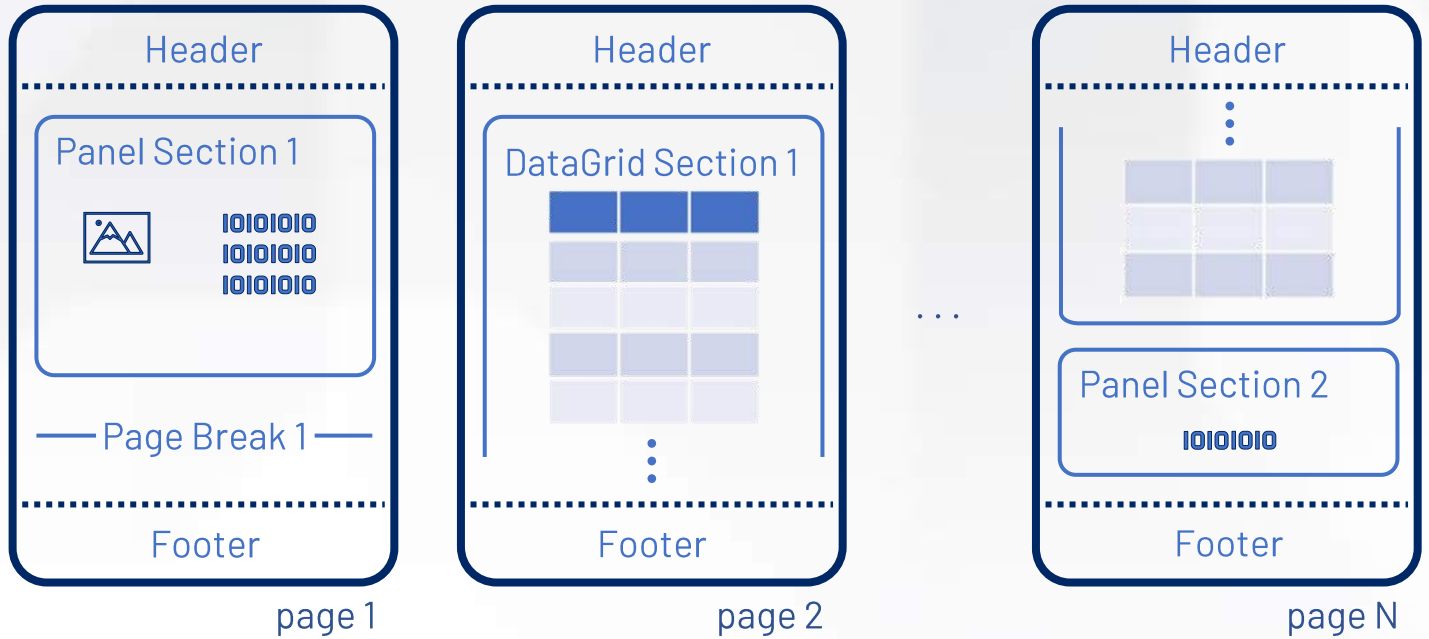
- **Panel**: container of graphical objects as Label, Rectangle, Panel, Image. Can be used to show variable values.

- **DataGrid**: container of data read from a database in table format.

  Can be used to show historical data collected by a Datalogger or Alarms.

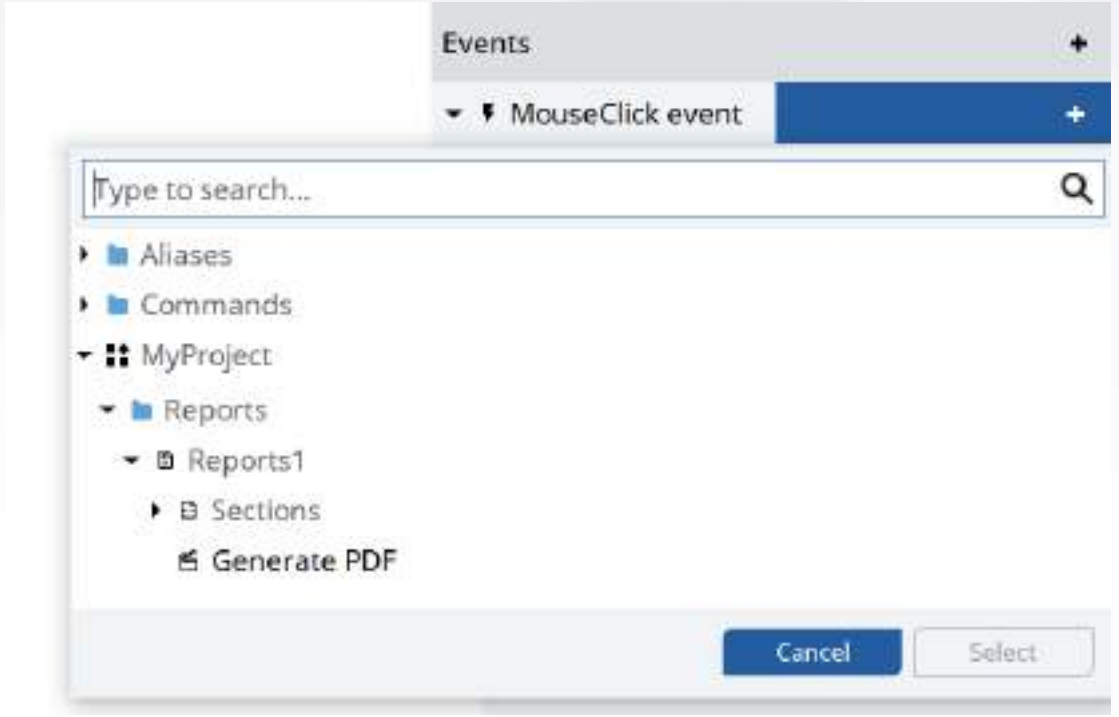
- **Page break**: placeholder that forces the report to continue to another page.

Report sections example



Generate report at runtime

- Report resource expose method "Generate PDF"
- Can be called for example on Mouse Click event
- Properties:
  - Output Path: the path of the PDF file
  - Locale Id (optional): language to be used inside report



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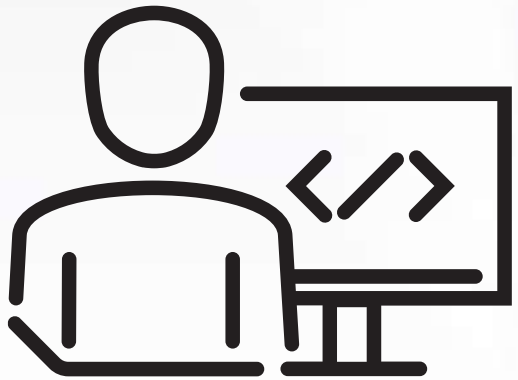
Output Path

Shortcut	Description
`%PROJECTDIR%`	A directory that contains files transferred at runtime (images, documents, and so on). Example: `C:\Users\UserName\Documents\Rockwell Automation\FactoryTalk Optix \ProjectName`
`%APPLICATIONDIR%`	A directory that contains objects used at runtime, including these objects: • Embedded database • Retentivity storage • Exported files
`%USBN%`, where *N* is a number associated with the USB device.	A path to a specific USB device connected to the target device.

Hands-on session

- Define a report that includes a Datagrid to show values from a datalogger table

- Add a button that calls the "Generate PDF" method



Set Locale, Languages and Measurement System

Localization

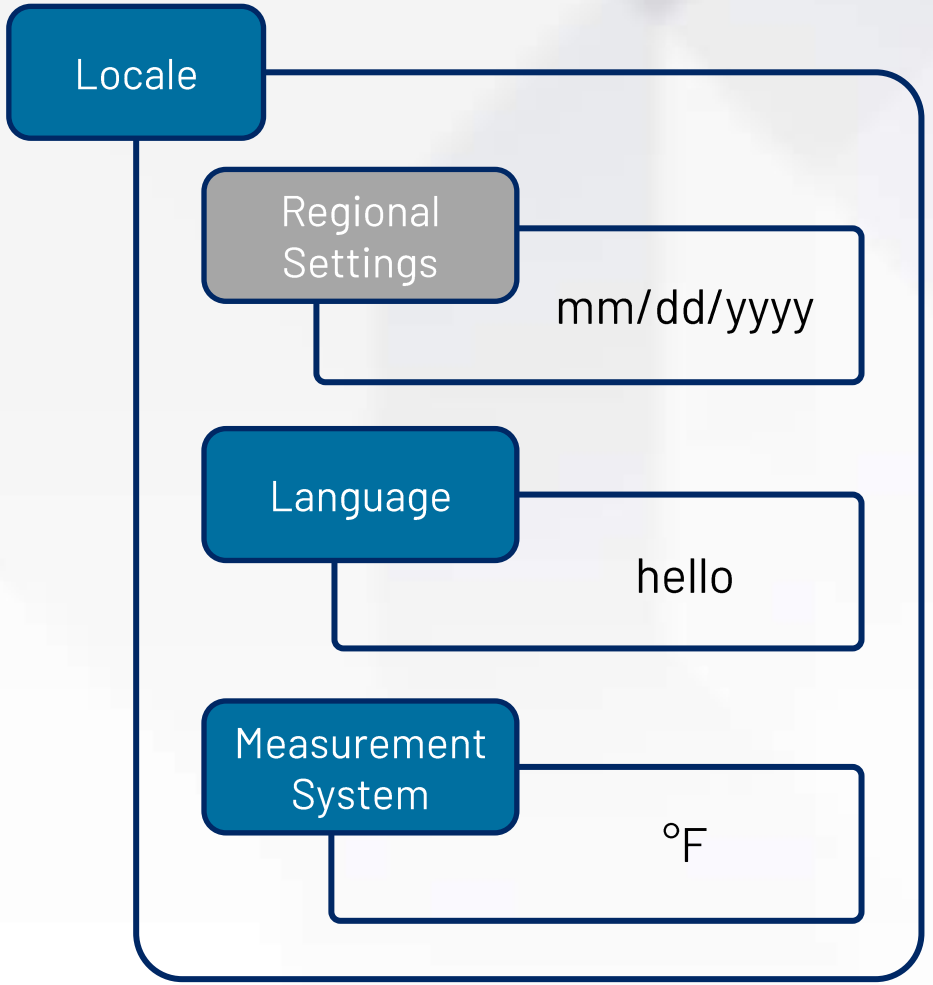
- a Locale is **a set of User Interface settings** based on country

Locale	en-US	it-IT
Regional Settings	mm/dd/yyyy … 10.5	dd/mm/yyyy … 10,5
Language/Translations	Hello	Ciao
Measurement System	°F	°C

- Locale, Language and Measurement System are **related to the Session**
  - A session is a Runtime context in which a user executes operations
  - Examples: a session of Native Presentation Engine can look different from a session of Web Presentation Engine.
    A session of User1 can look different from a session of User2

Locale

- Changing Locale will set altogether:
  - Regional Settings
  - Language
  - Measurement System
- How to change the Locale at Runtime
  - Method
    - Command > Variable commands > Set variable value
  - Variable to Modify
    - Aliases > {Session} > Session > ActualLocaleIds
  - Value
    - Select the Locale ISO code



- Language and Measurement System can be set independently from Locale

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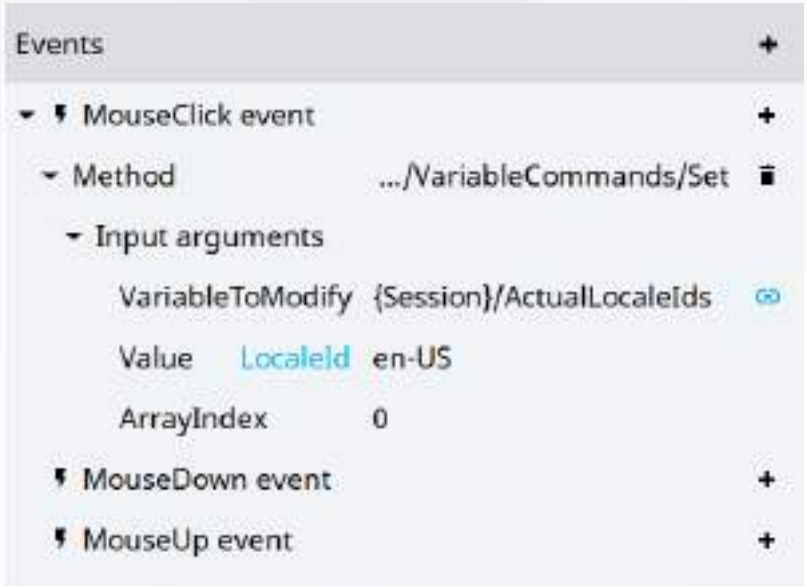


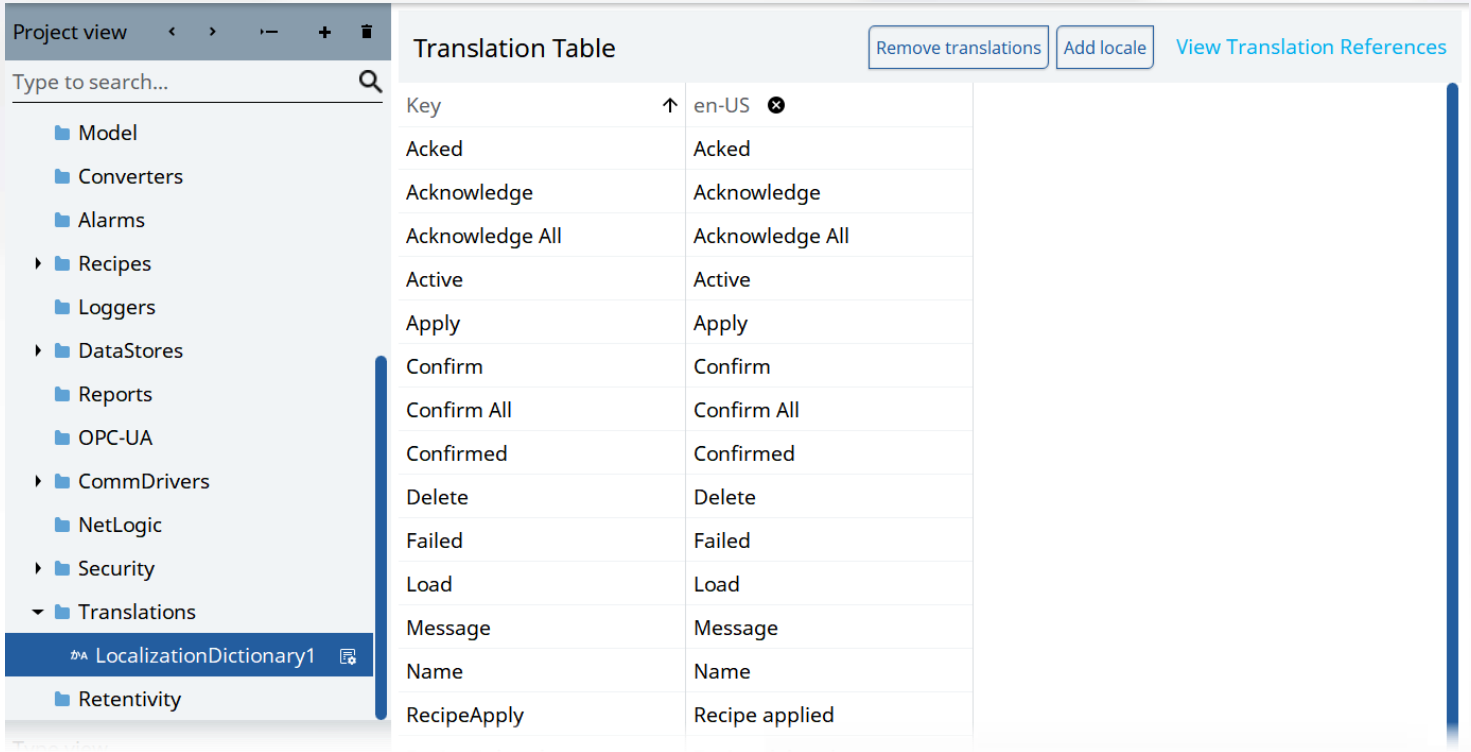
- Language and Measurement System can be set independently from Locale

Languages - Translations

- The translation editor makes it possible to translate strings used in multilingual projects

- **Translation Table**
  - shows the translation of strings (Keys) in different languages (Locales)

- **Translation Key References**
  - shows all strings of the project that can be synched with the Translation Table (to become a key)



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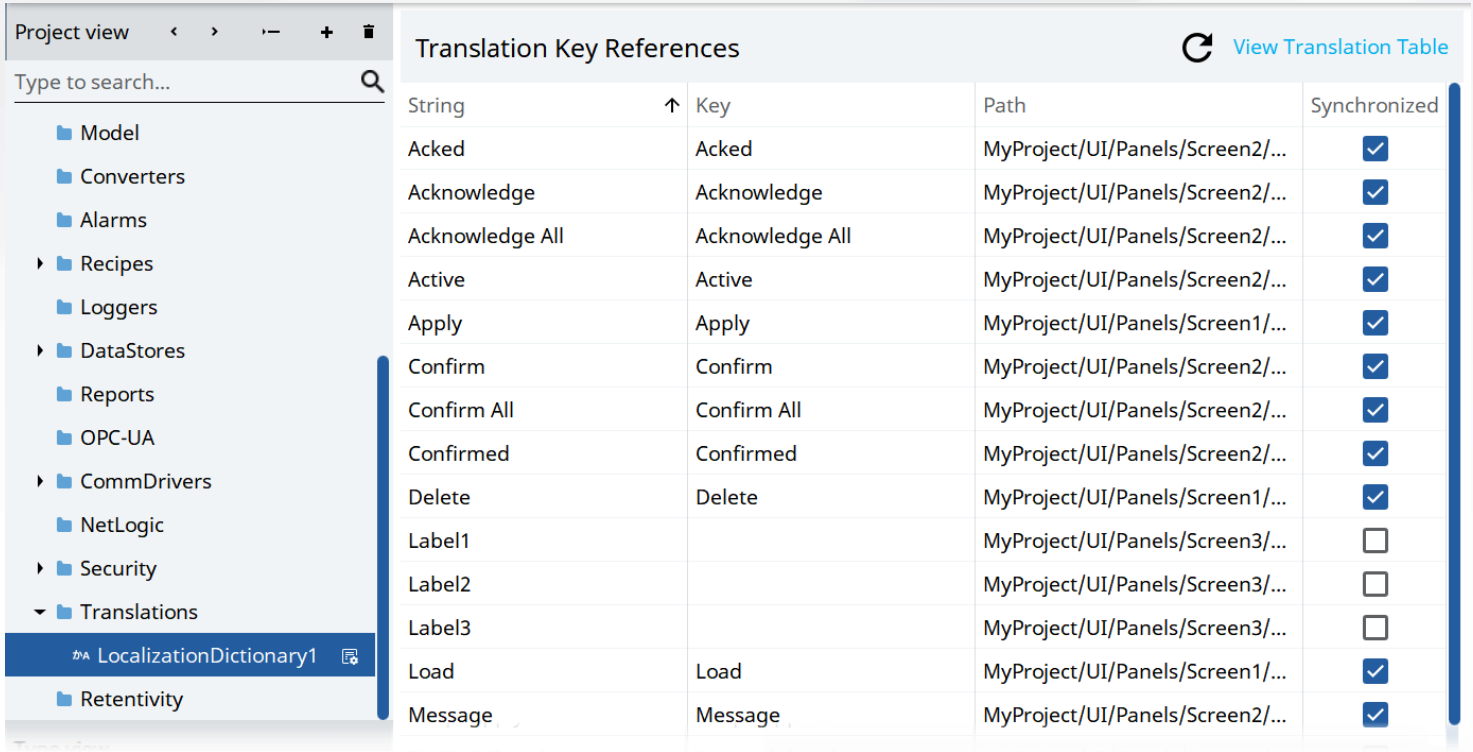
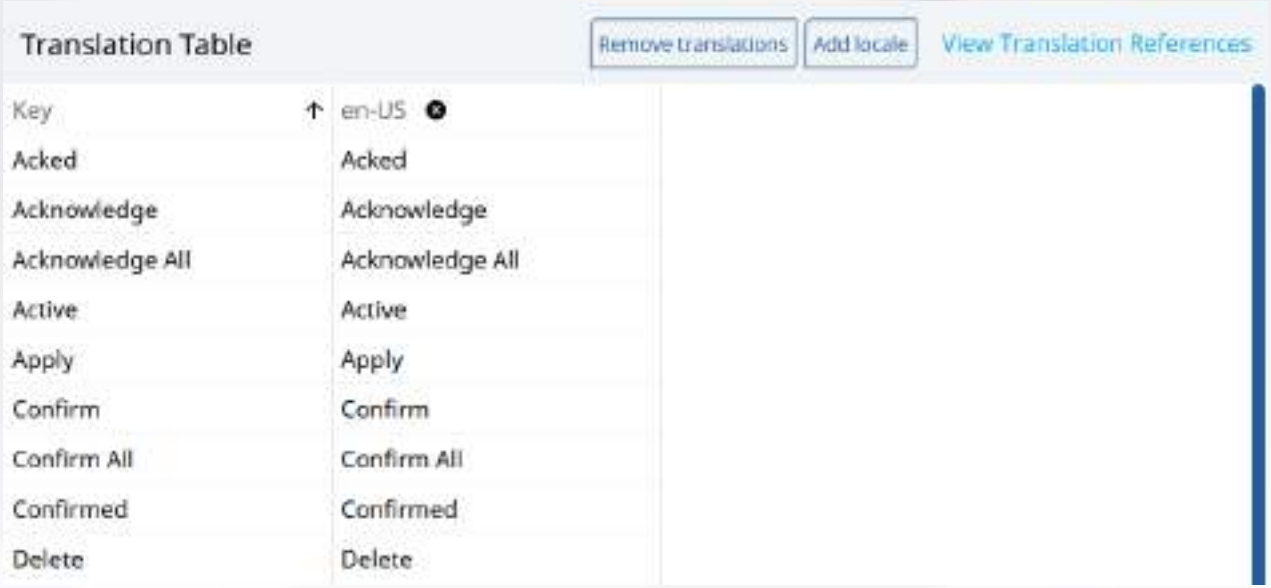


Translation table

- Remove Translations
  - to remove one or more keys from the table
- Add locale
  1. Click to add a new language
  2. Select the language in a standard Language-Country ISO code
  3. Confirm adding the new language to the Project properties
- View Translation Reference
  - switch to Key Reference table



- Import/Export
  - Translation Table can be exported and imported back using the "Translation Importer Exporter" script available in Template Library

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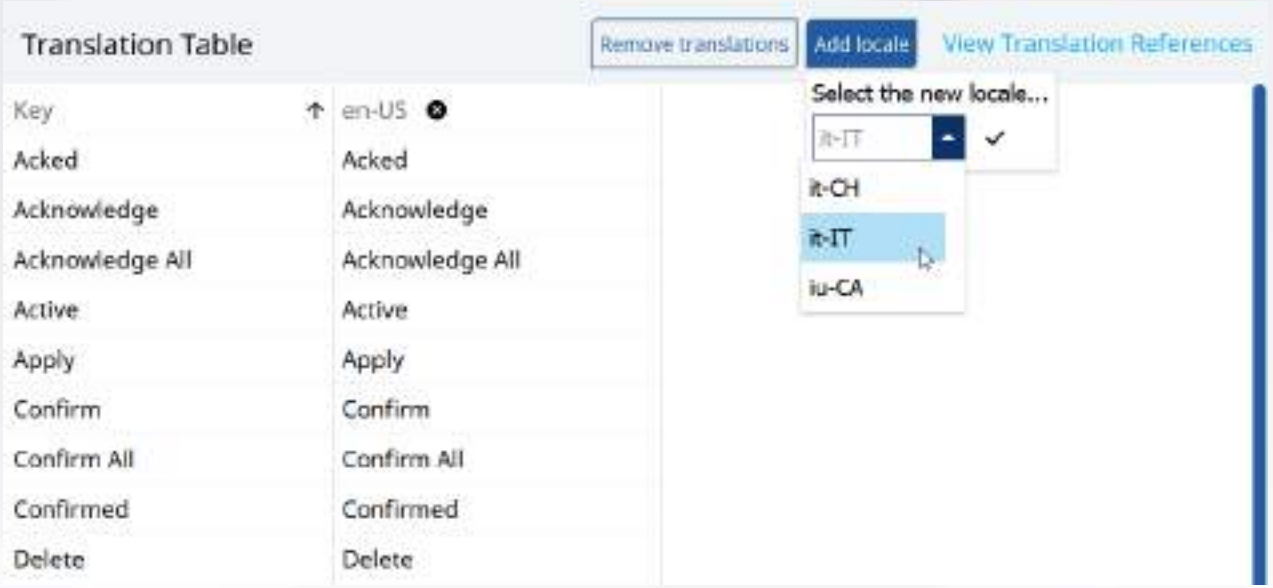

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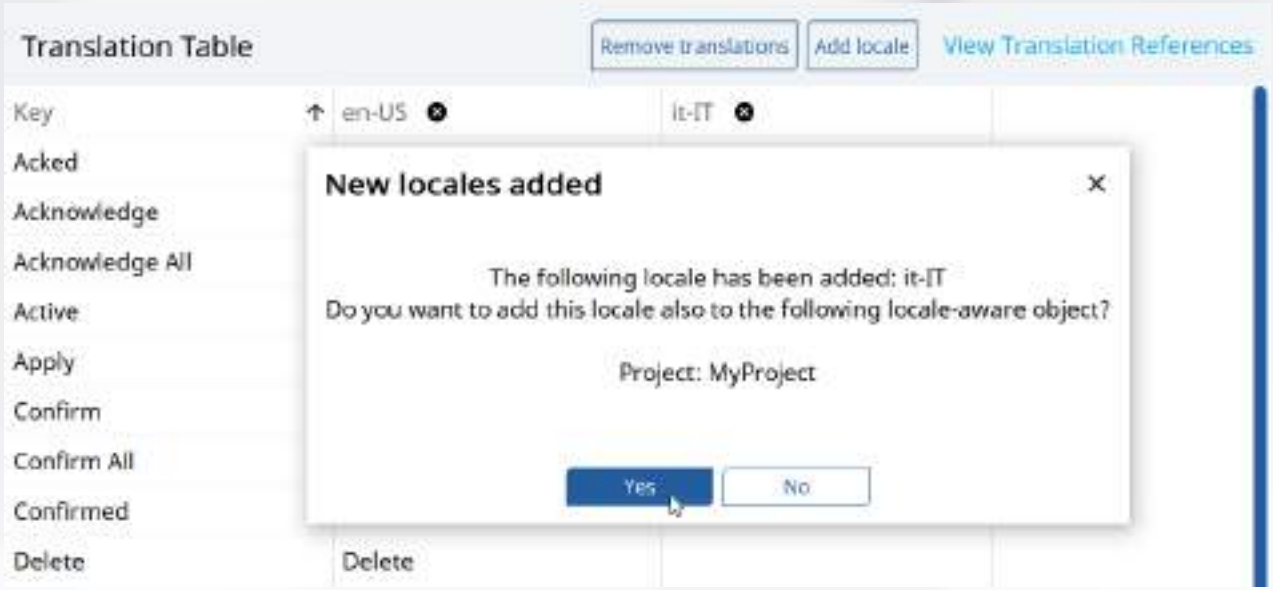

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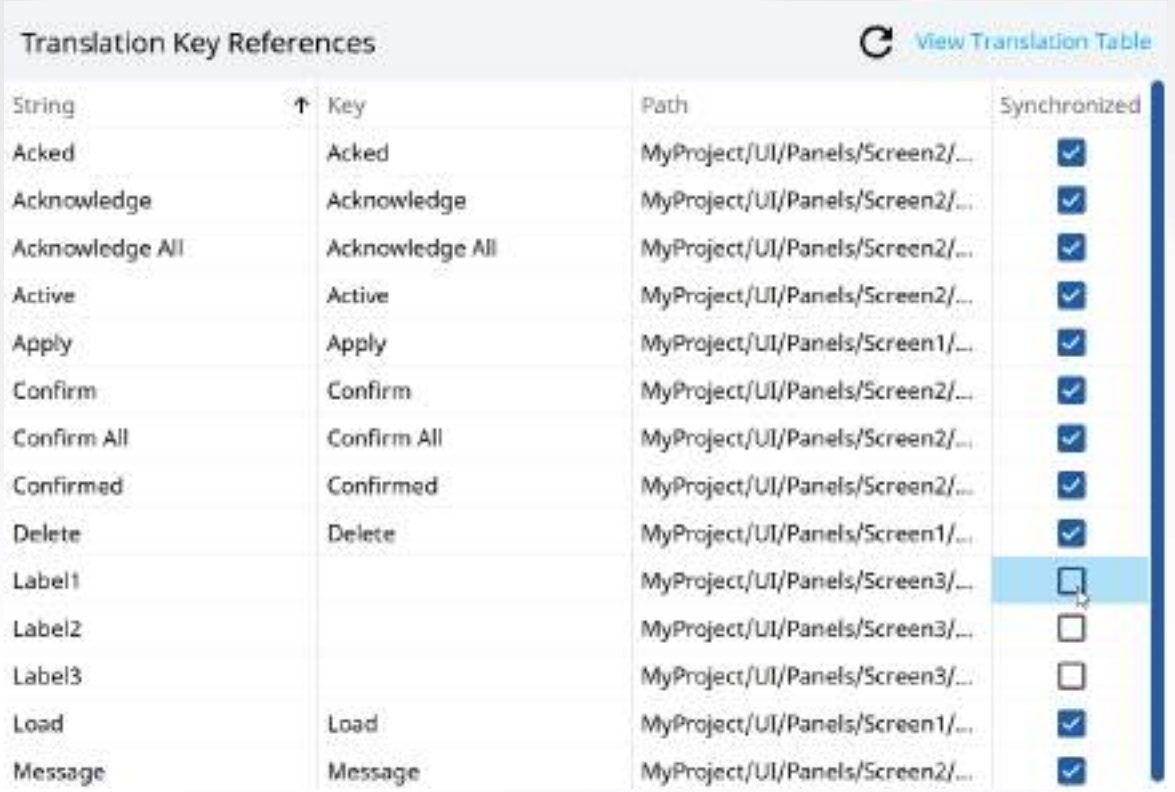
Translation key references

- Key Reference table
  - shows all strings of the project
- Setting "Synchronized" to true
  - creates a key into Translation Table with the same text
  - copy the key text into the default language (en-US)



String	Key	Path	Synchronized
Acked	Acked	MyProject/UI/Panels/Screen2/...	☑
Acknowledge	Acknowledge	MyProject/UI/Panels/Screen2/...	☑
Acknowledge All	Acknowledge All	MyProject/UI/Panels/Screen2/...	☑
Active	Active	MyProject/UI/Panels/Screen2/...	☑
Apply	Apply	MyProject/UI/Panels/Screen1/...	☑
Confirm	Confirm	MyProject/UI/Panels/Screen2/...	☑
Confirm All	Confirm All	MyProject/UI/Panels/Screen2/...	☑
Confirmed	Confirmed	MyProject/UI/Panels/Screen2/...	☑
Delete	Delete	MyProject/UI/Panels/Screen1/...	☑
Label1		MyProject/UI/Panels/Screen3/...	☐
Label2		MyProject/UI/Panels/Screen3/...	☐
Label3		MyProject/UI/Panels/Screen3/...	☐
Load	Load	MyProject/UI/Panels/Screen1/...	☑
Message	Message	MyProject/UI/Panels/Screen2/...	☑

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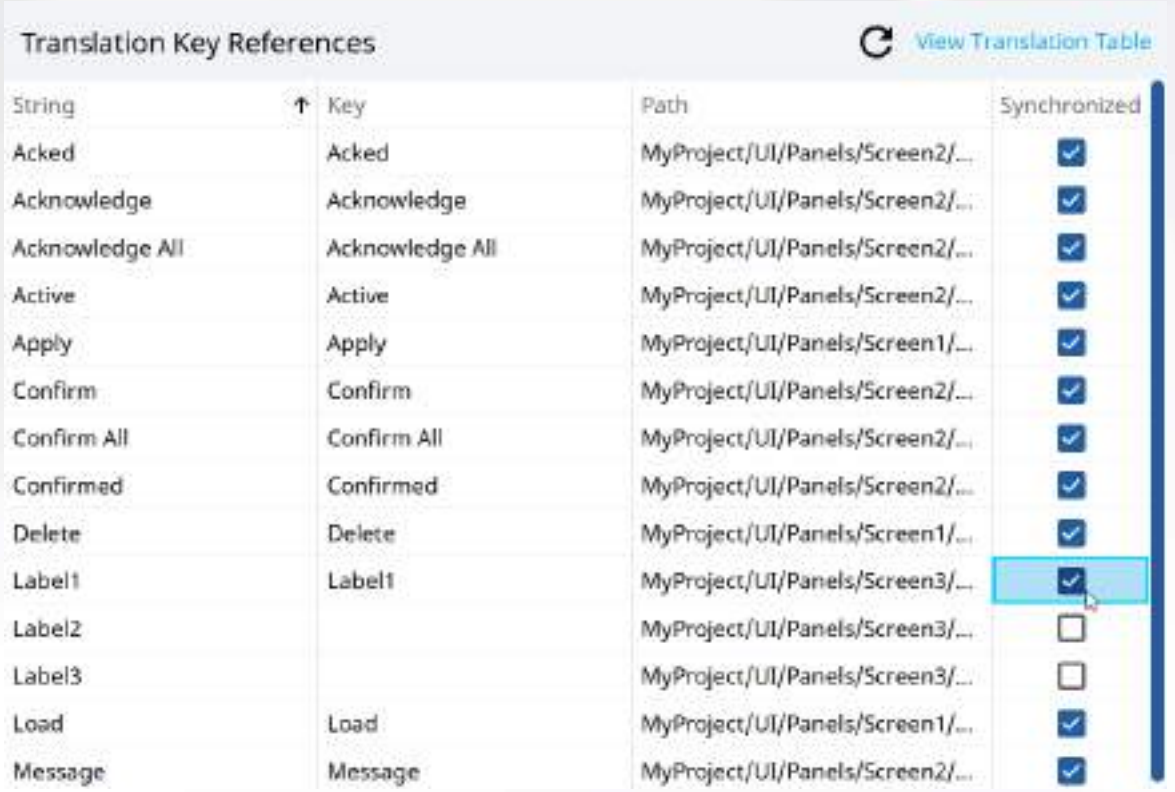

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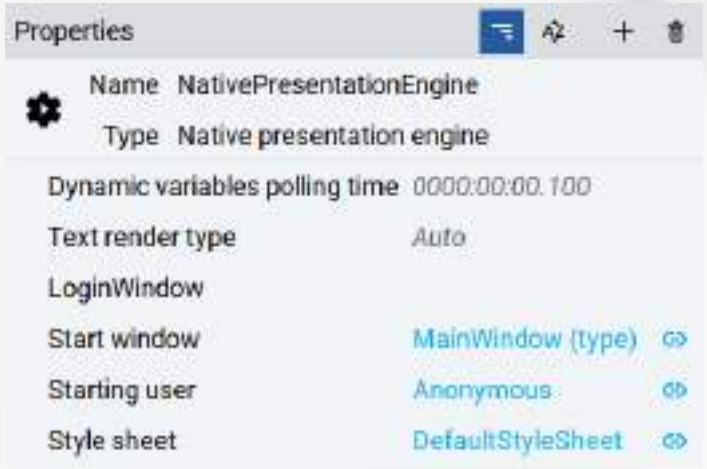
Acknowledge All	Acknowledge All	MyProject/UI/Panels/Screen2/...	☑
Active	Active	MyProject/UI/Panels/Screen2/...	☑
Apply	Apply	MyProject/UI/Panels/Screen1/...	☑
Confirm	Confirm	MyProject/UI/Panels/Screen2/...	☑
Confirm All	Confirm All	MyProject/UI/Panels/Screen2/...	☑
Confirmed	Confirmed	MyProject/UI/Panels/Screen2/...	☑
Delete	Delete	MyProject/UI/Panels/Screen1/...	☑
Label1	Label1	MyProject/UI/Panels/Screen3/...	☑
Label2		MyProject/UI/Panels/Screen3/...	☐
Label3		MyProject/UI/Panels/Screen3/...	☐
Load	Load	MyProject/UI/Panels/Screen1/...	☑
Message	Message	MyProject/UI/Panels/Screen2/...	☑

Translation usage

- Two ways to set the "starting" language:
  1. Language or Locale Id of the "Starting user"
  2. First language listed in the "Locales" project property



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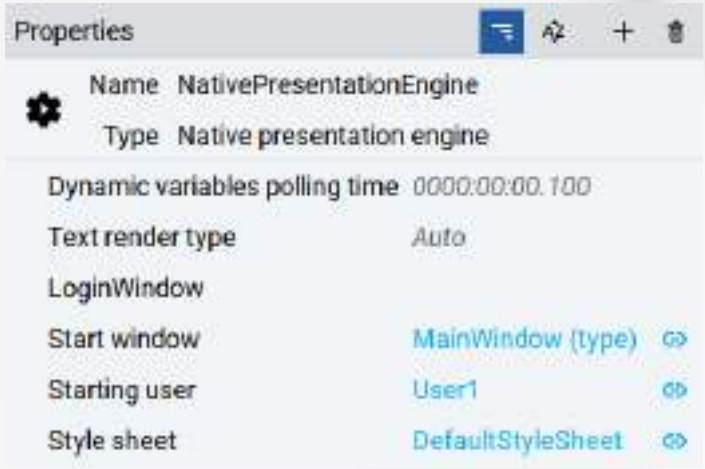

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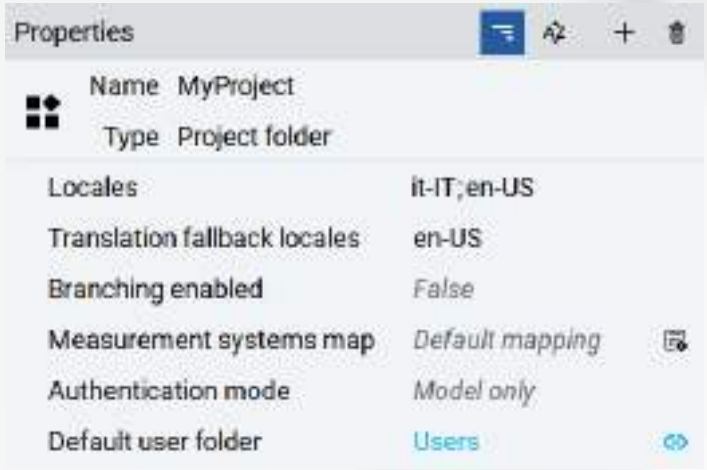

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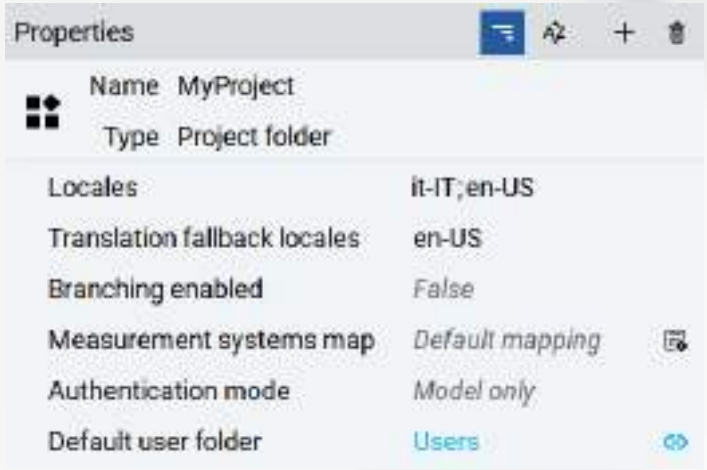

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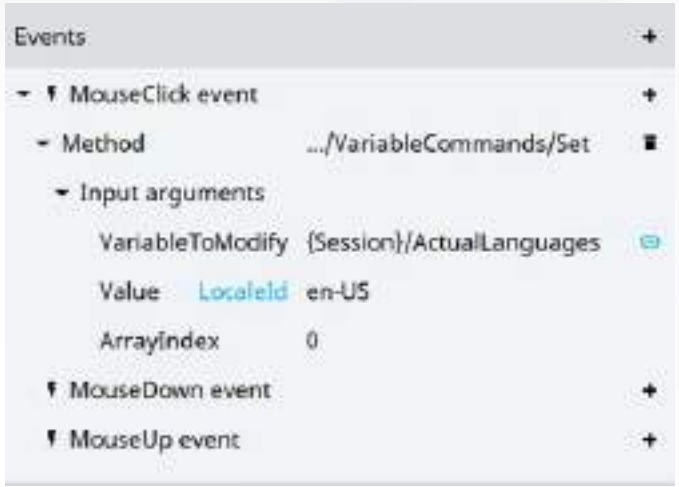
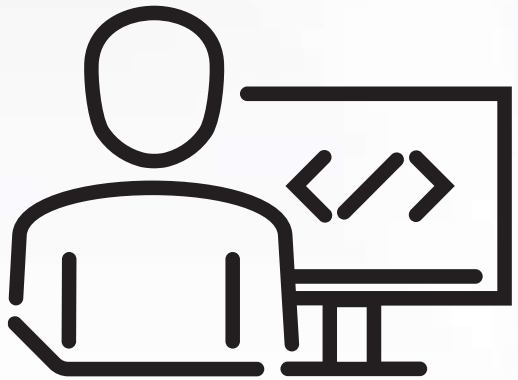


Hands-on session

- Use some strings to label objects around the project
- Import strings into the Translation Table using the Key Reference Table then edit the translation manually
- Change the language at Runtime with the Emulator
- Optionally
  - try to export the Translation table,
  - modify with an external editor,
  - import back in Optix Studio



Measurement system

- Choose between:
  - International System of Units (SI)
  - US Customary measurement system
  - British Imperial units
- is enough to set the Unit of Measure on the Variable, then at Runtime, the conversion will be automatically applied depending on the Measurement System chosen

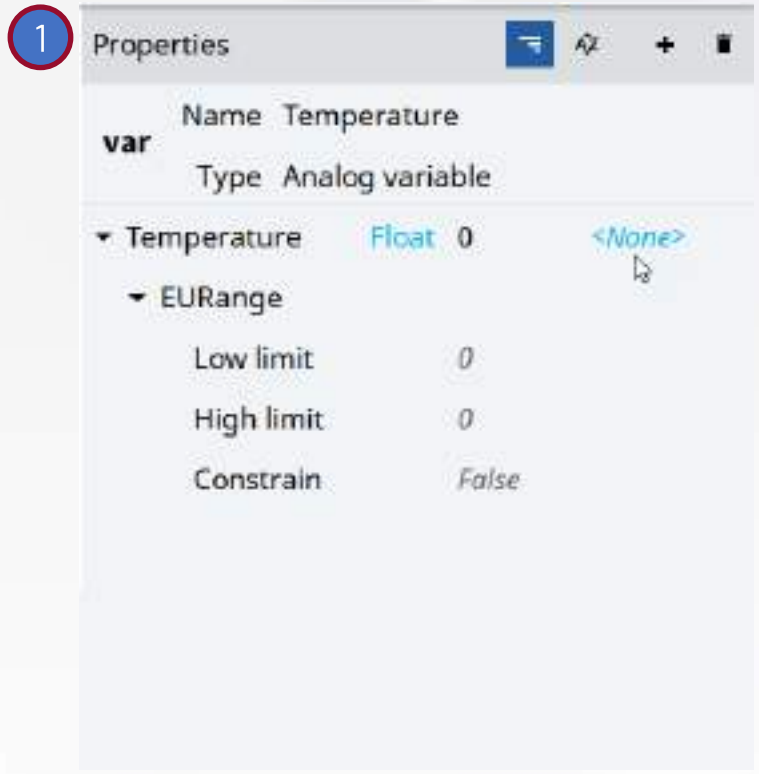
liter / quart

°C / °F

meter / yard

Localize an Analog Variable

1. Define a new Analog Variable with Engineering Unit into the Model folder
2. Add an Analog Variable to the object
3. Into the object's Analog Variable set an Advanced Dynamic Link using "Binding mode between Source and Parent engineering unit"
4. Link the object's value to the object's Analog Variable



- Unit of measure can be defined directly within a Comm.Driver Tag as well

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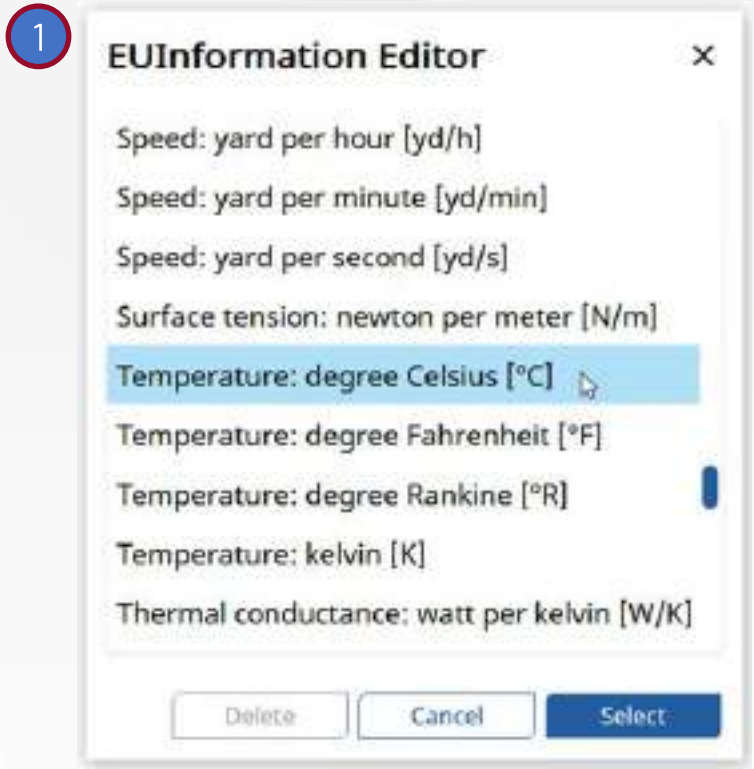

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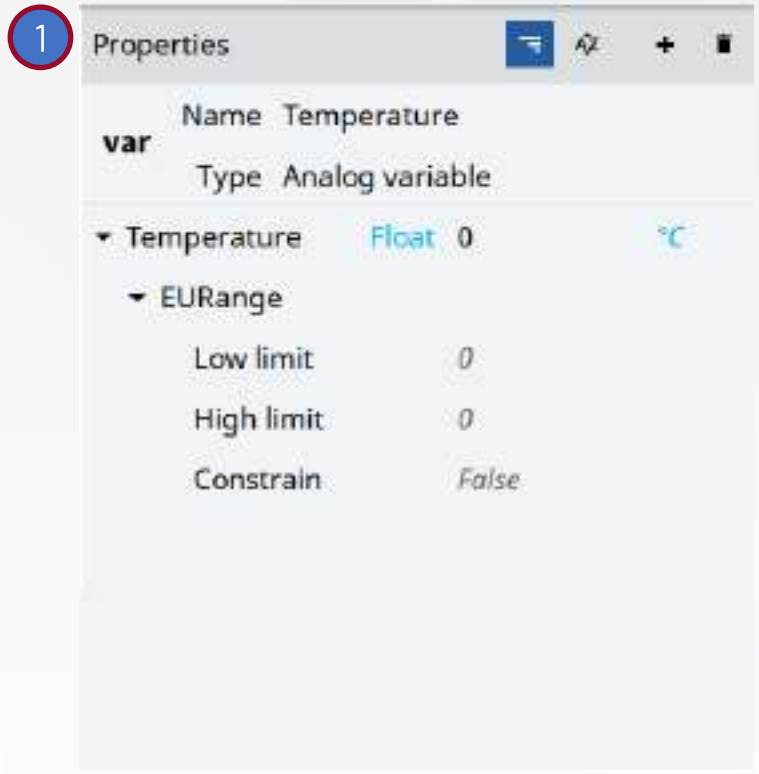
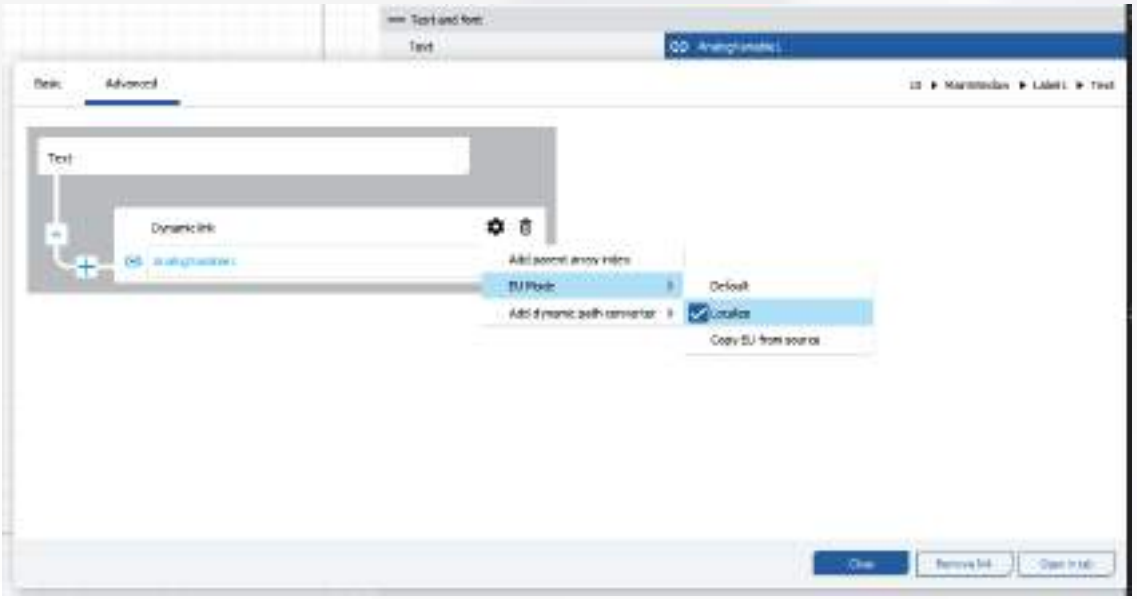


Localize an Analog Variable

1. Define a new Analog Variable with Engineering Unit into the Model folder
2. Add an Analog Variable to the object
3. Into the object's Analog Variable set an Advanced Dynamic Link using "Binding mode between Source and Parent engineering unit"
4. Link the object's value to the object's Analog Variable

- Unit of measure can be defined directly within a Comm.Driver Tag as well



Display and localize the Engineering Unit

1. Add a label to the screen and create a DynamicLink from the Analog Variable to the Text property of the label
2. Open the DynamicLink popup, expand the Analog Variable and select Engineering Unit > Display Name
3. Reopen the DynamicLink popup, move to the Advanced tab and localize the Engineering Unit

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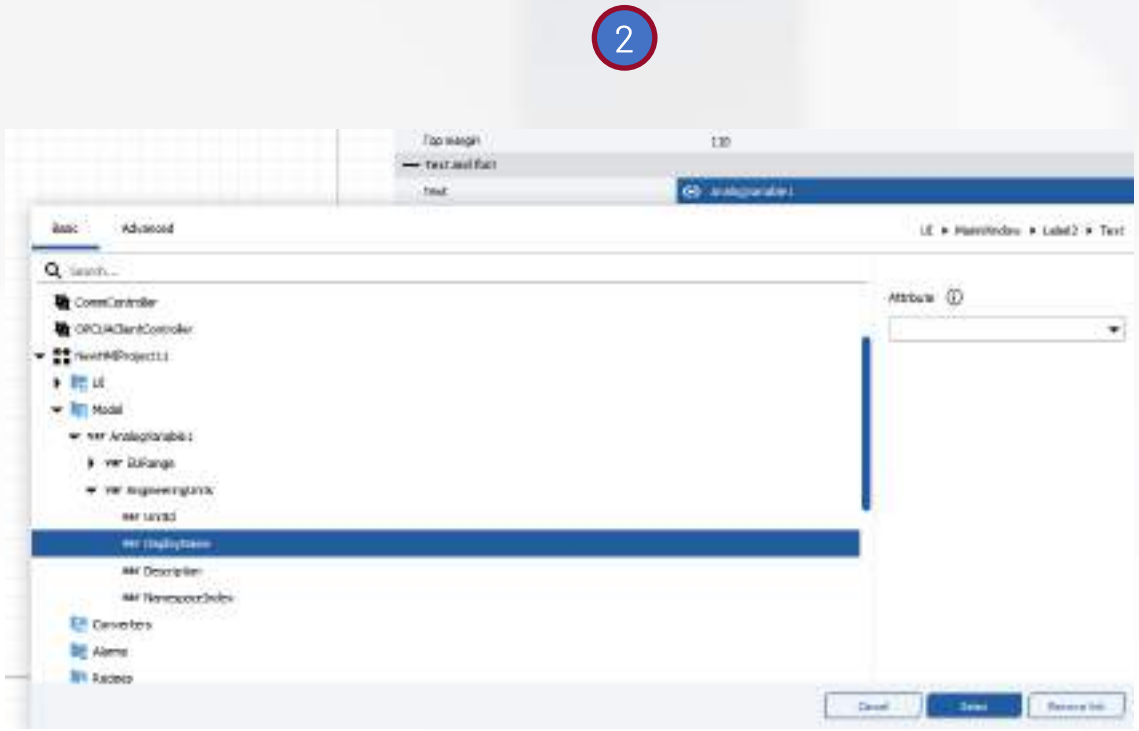

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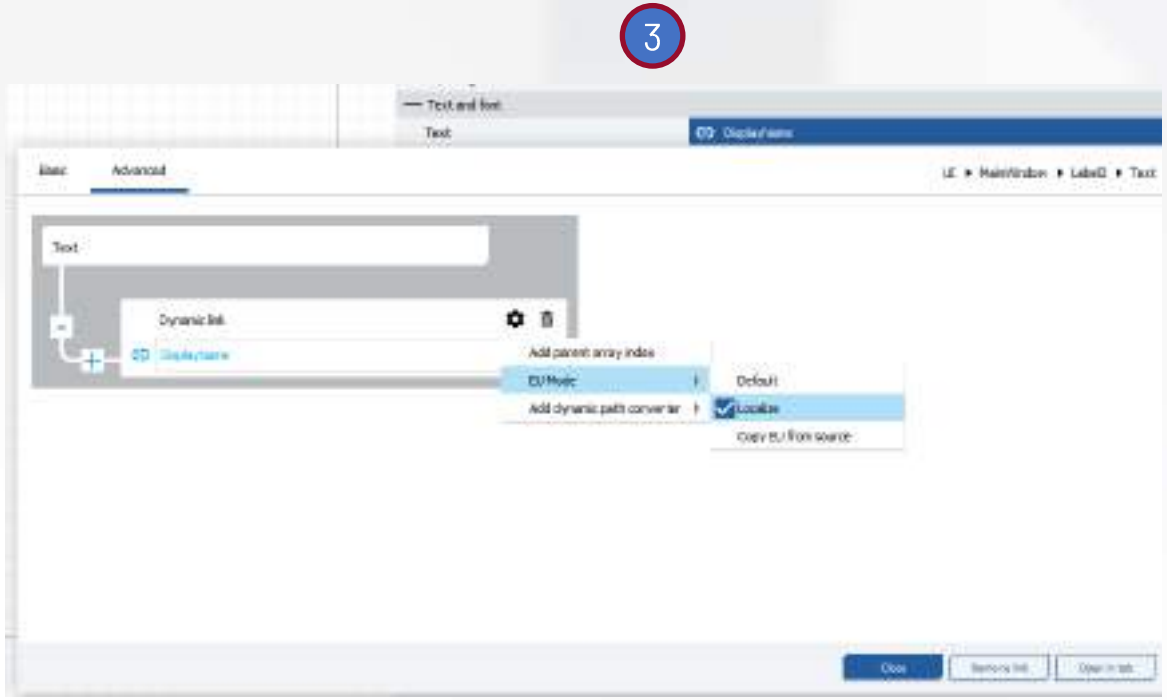
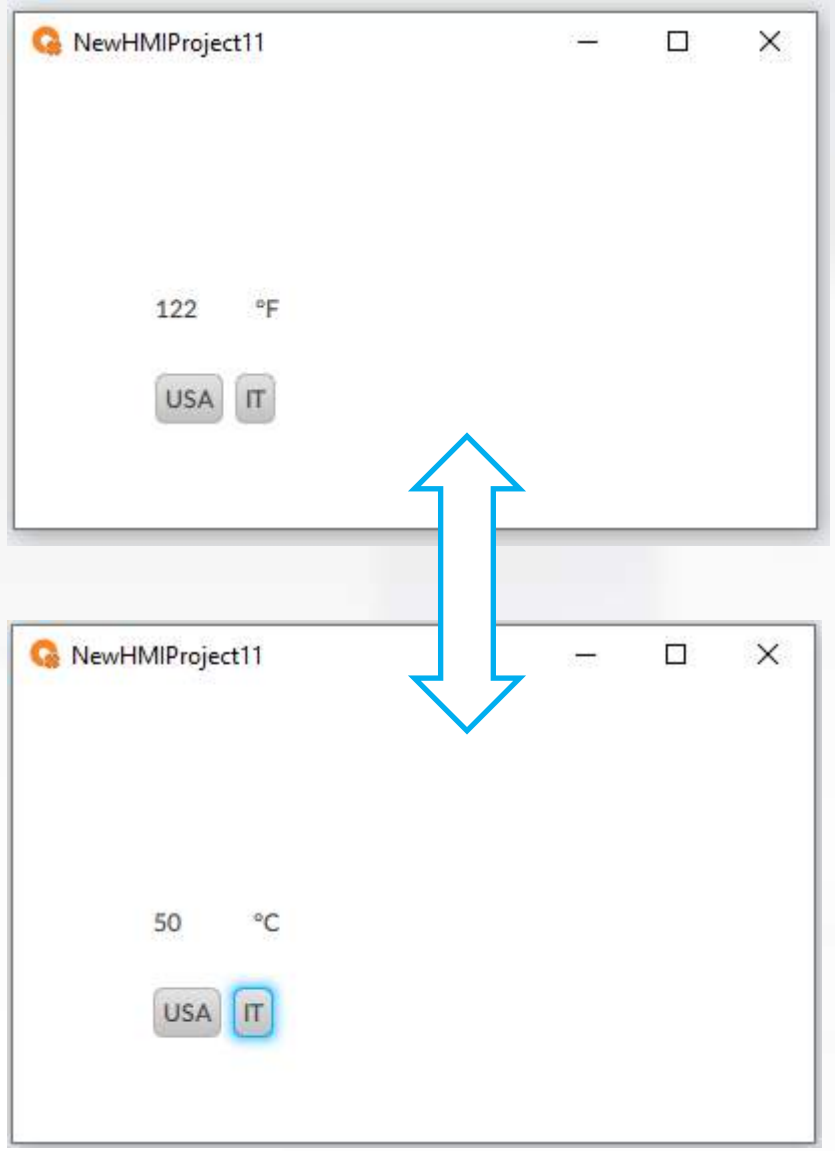


Test the conversion

1. Add two buttons to change the Measurement System
2. Execute the runtime and check the conversion

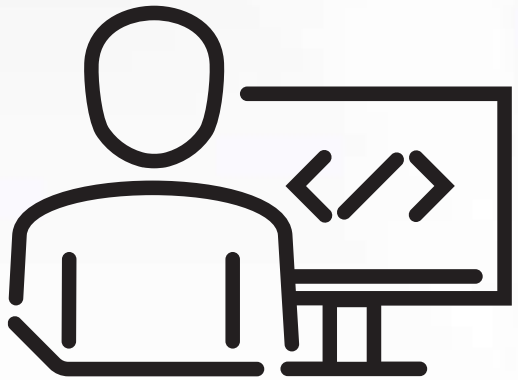


Set a measurement system

- How to change the Measurement System at Runtime
  - Method
    - Command > Variable commands > Set variable value
  - Variable To Modify
    - Aliases > {Session} > Session > ActualMeasurementSystem
  - Value
    - Select one of the available Measurement Systems

Hands-on session

- Set one or more Units of Measure to one or more variables
- Add a button to change
  the Measurement System (or the Locale)
- Check the conversion is applied



Develop using version control and collaboration

Version control and Collaboration

- **Version Control**
  - used for keeping track of incrementally-different versions
  - work also locally (offline)

- **Collaboration**
  - distributed version control
  - form of version control in which the full history, is mirrored on every developer's computer
  - enables automatic management of merges,
  - does not rely on a single location for backups
  - Git is a distributed version control system
  - GitHub is an Internet hosting service using Git

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Version control: save and commit locally

- Save and Commit,
  allow saving the project
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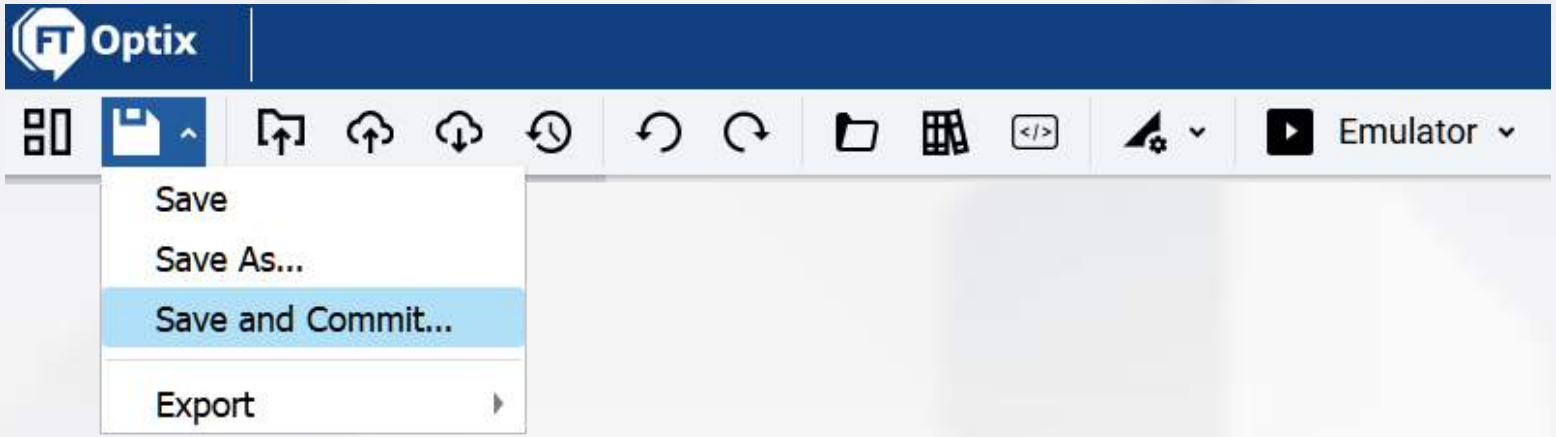

- Works "Local"

- Ideal for those who work alone
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- No more needs to make zip files named v1, v2...

- The history button show differences,
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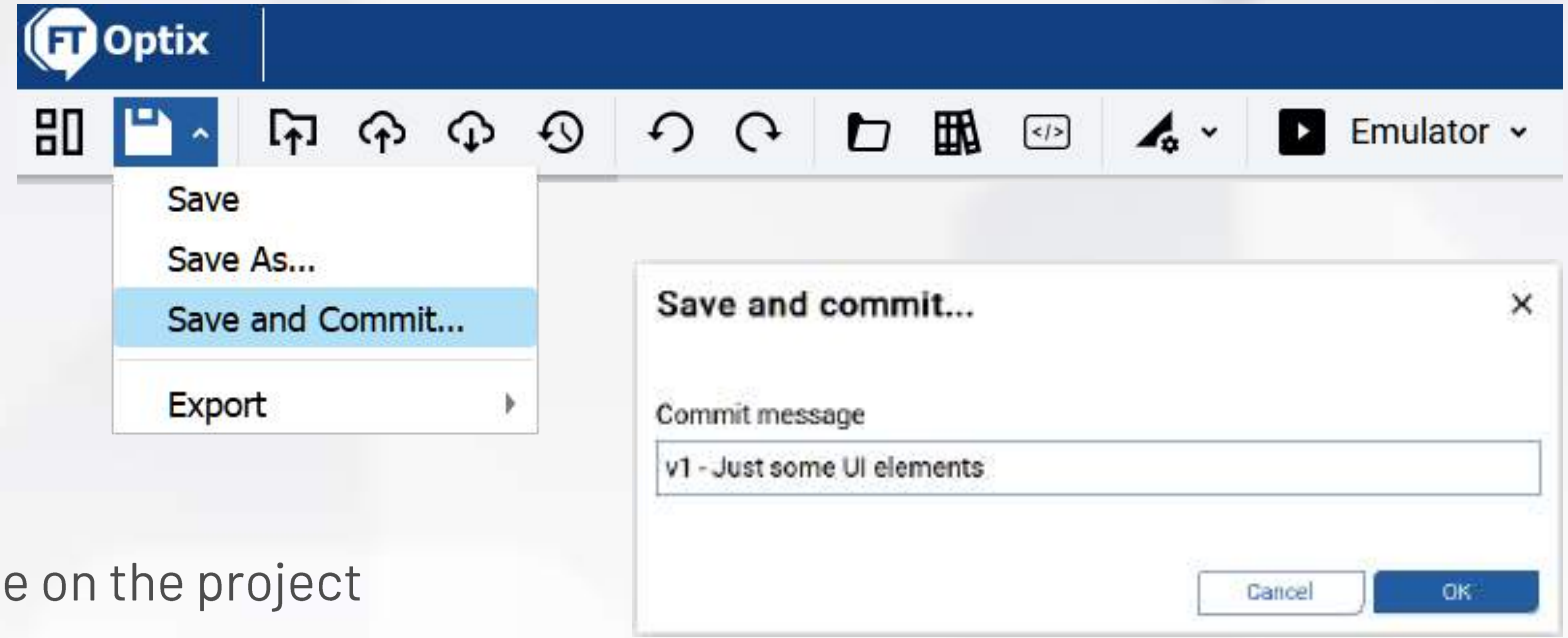

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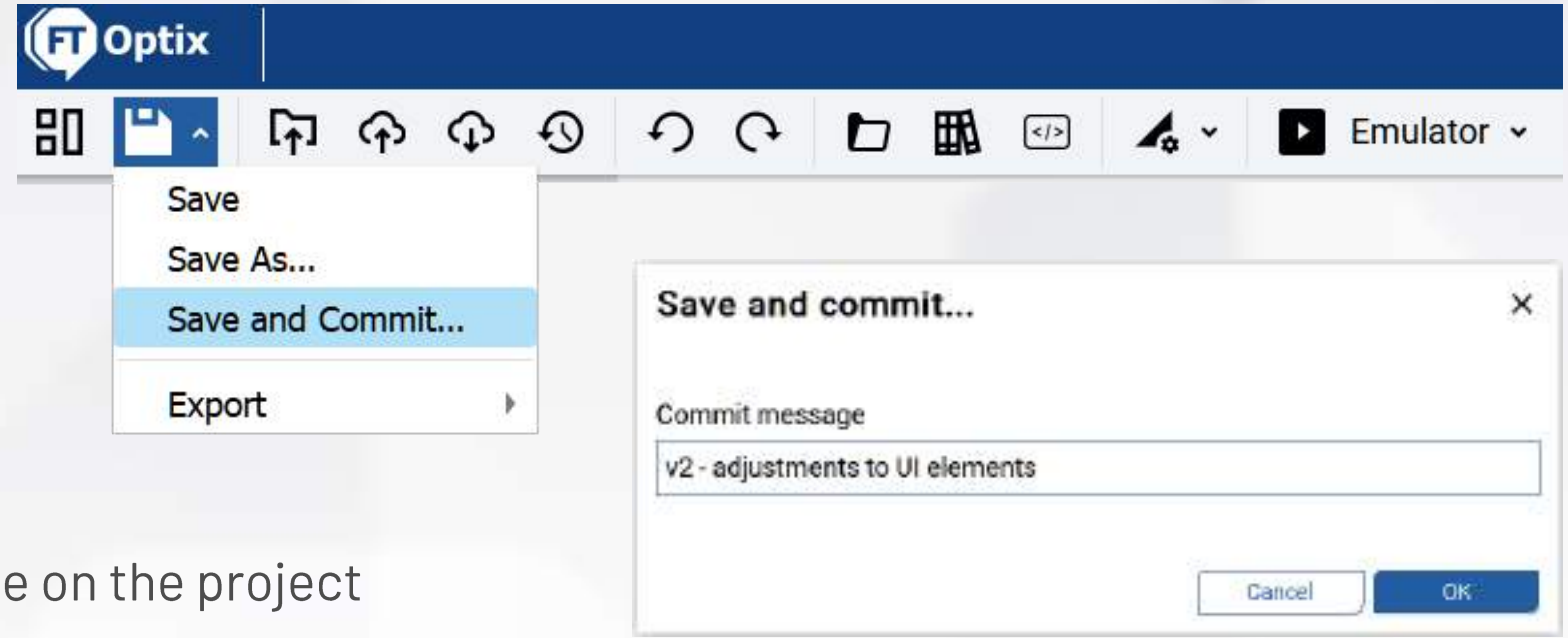

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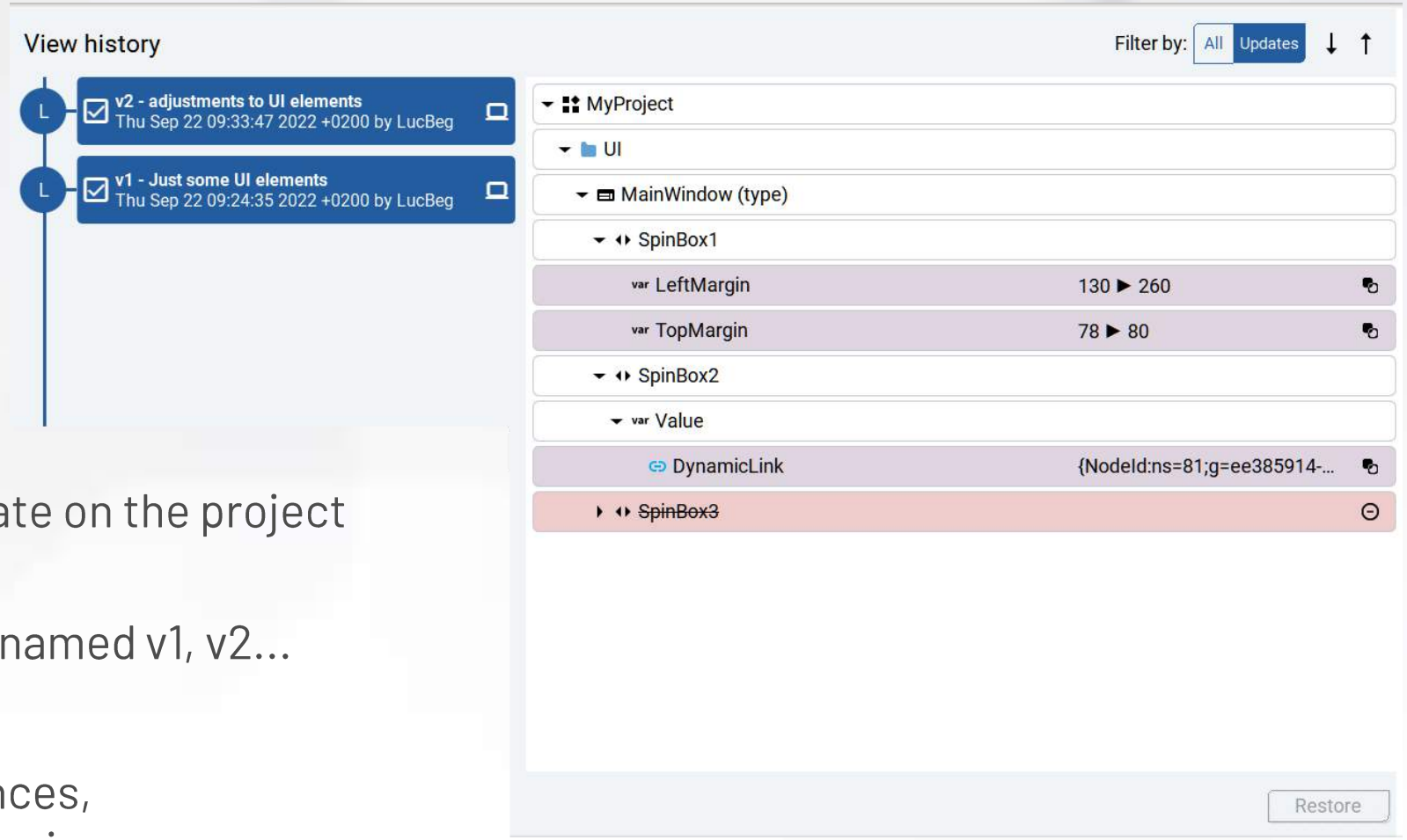

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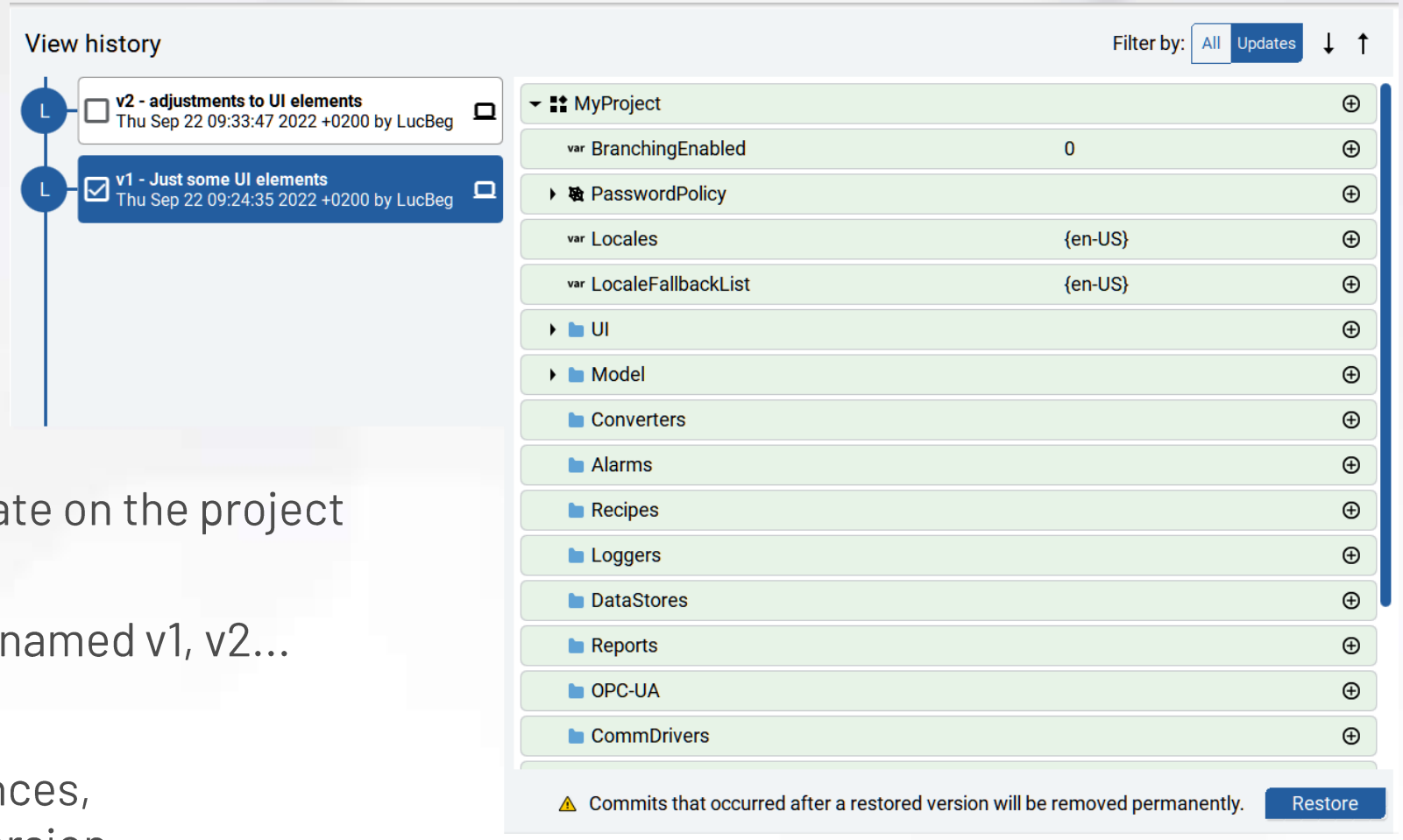
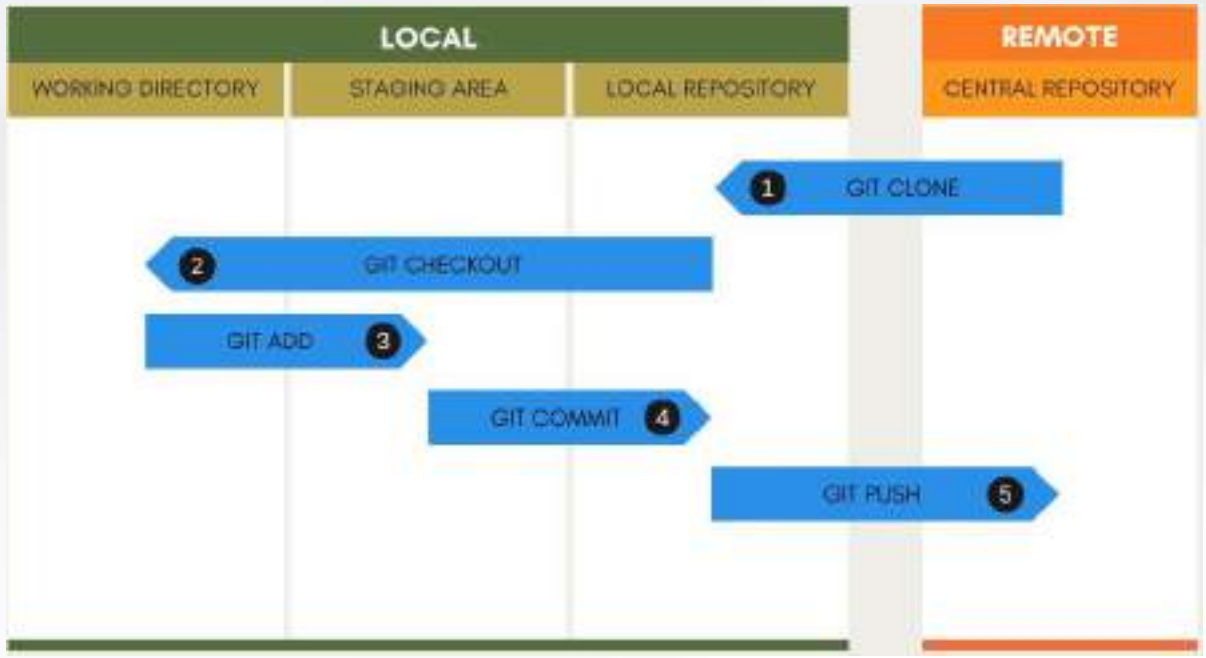
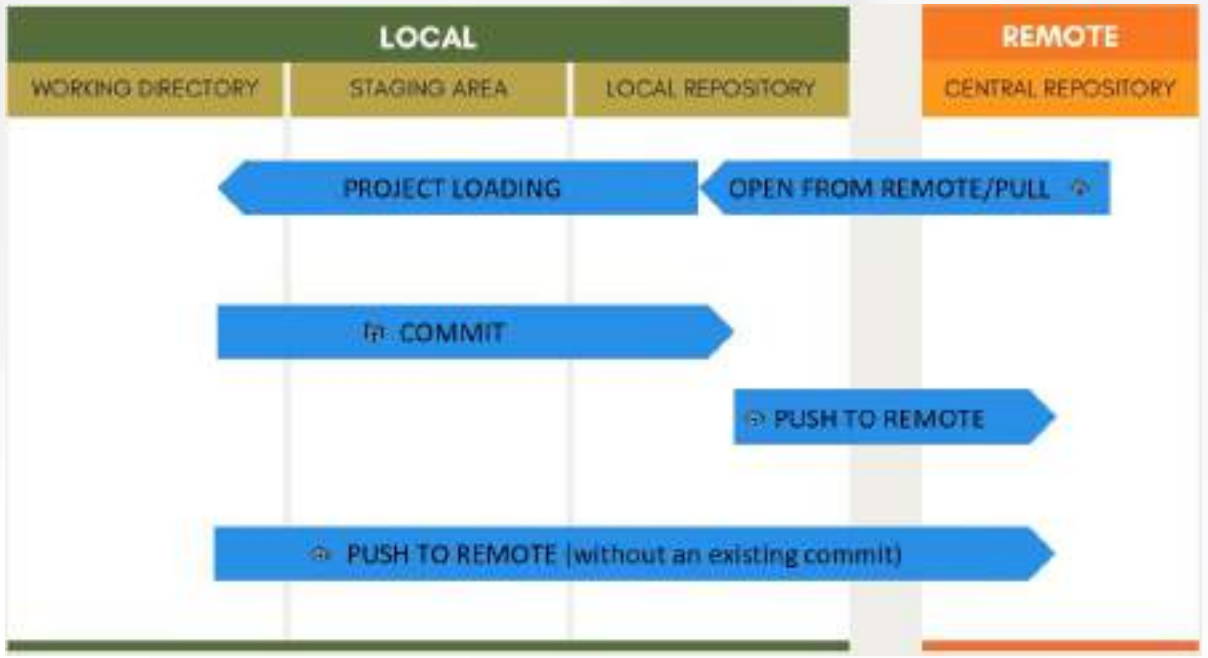


GIT workflow vs. Optix workflow

GIT Workflow



Optix Workflow



- Optix «hides» the GIT commands to improve the user experience
- User does not need to know anything about GIT commands and workflow

Collaboration tips

- Always configure/verify the GitHub access from Studio options

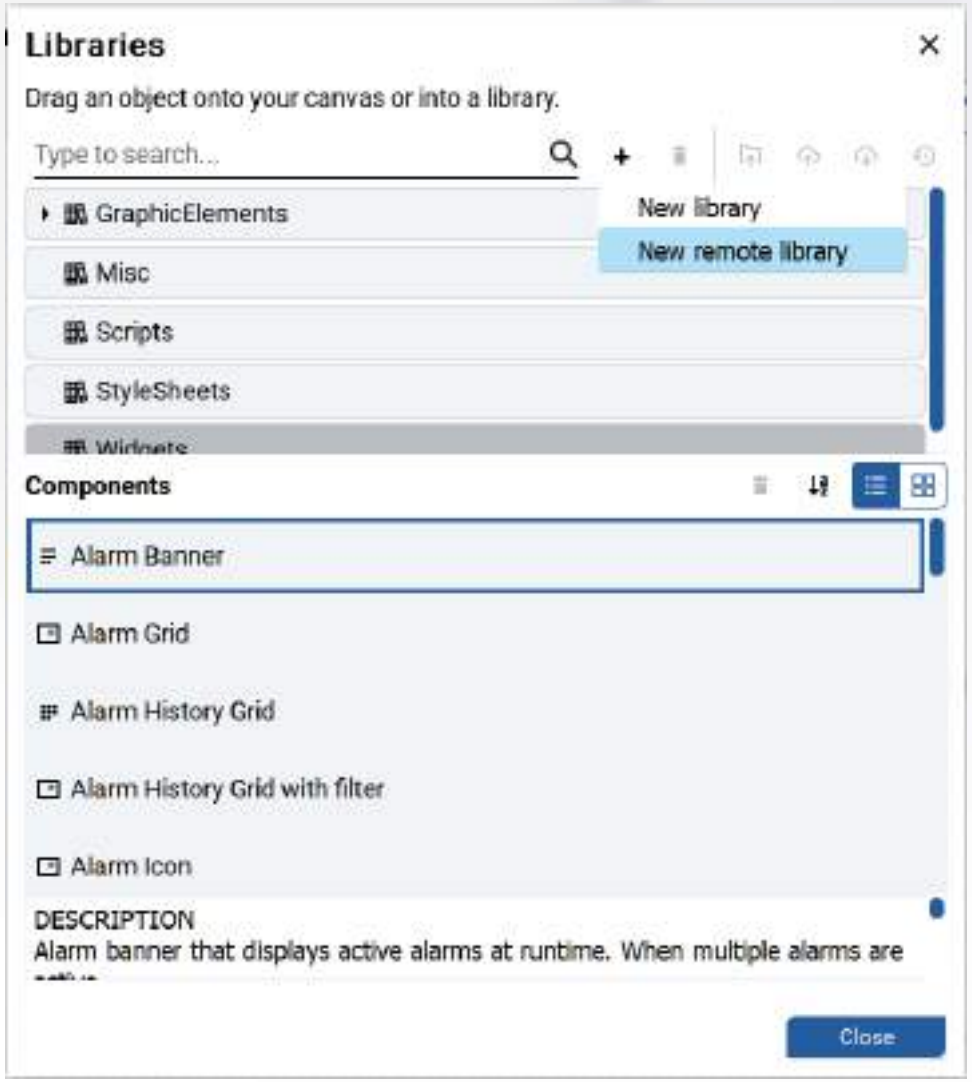
- General Git-related tips
  - Repository name **MUST** have the same name of Optix project
  - Some git providers does not allow non-alphanumerical characters
  - You can set the repository to be Private, then share with colleagues

Sharing libraries using Version Control

- a Custom Library can be shared exaclty the same as the projects

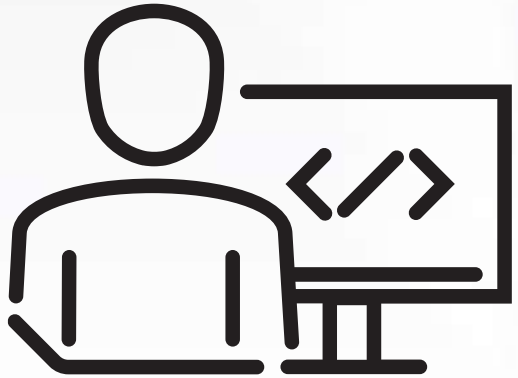
- a Shared Library is useful when the company has built his own graphical or widget library in the way all projects reuse the same basic components

- Libraries does not offer back compatibility, once somebody from the collaborators upgrades a library, everybody must upgrade the IDE to use it (same as projects)



Hands-on session

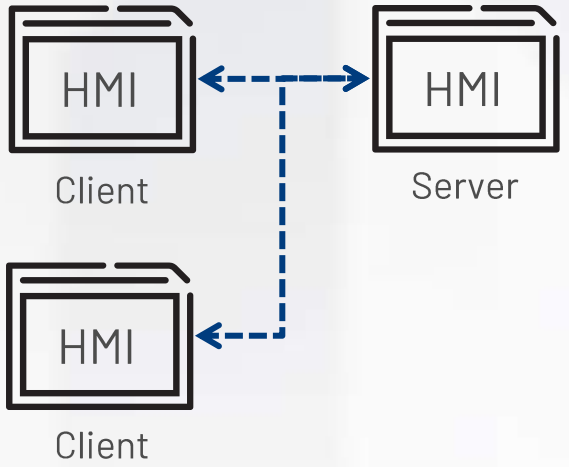
- Execute some Save and commit
- Explore the version history
- Try to restore to a previous state



Define client-server architectures via OPC-UA

Define client-server architectures via OPC-UA

- Thanks to the Full-featured OPC-UA architecture of FactoryTalk Optix It's possible to define client-server architectures



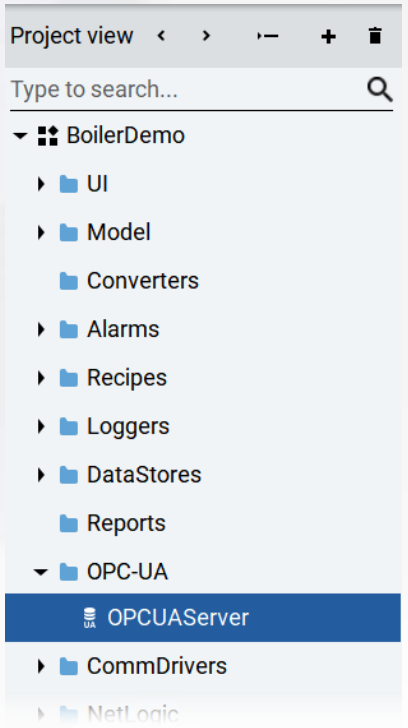
- Clients will have access to:
  - Variables
  - Methods
  - Alarms and Historical Alarms
  - Datalogger and Eventlogger
  - Recipes

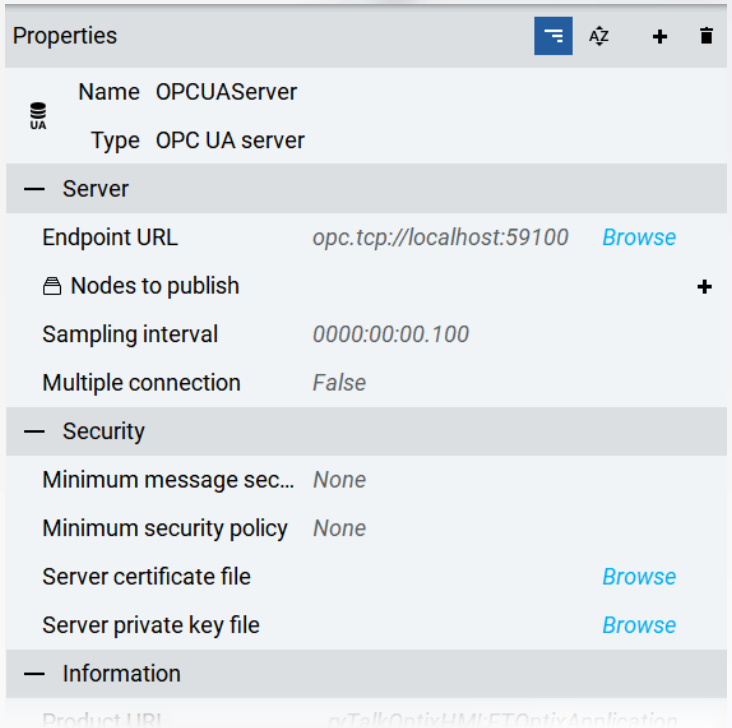
- Client: HMI project with OPC-UA Client (Full OPC-UA Client = 3 tokens)

- Server: HMI project with OPC-UA Server (1 client = 1 token, 2 o more clients = 3 tokens)

Configure the server

- On the HMI project,
  that is going to act as a Server,
  add the OPCUAServer node
- Endpoint can be manually changed
- Also Nodes to publish
  can be manually defined



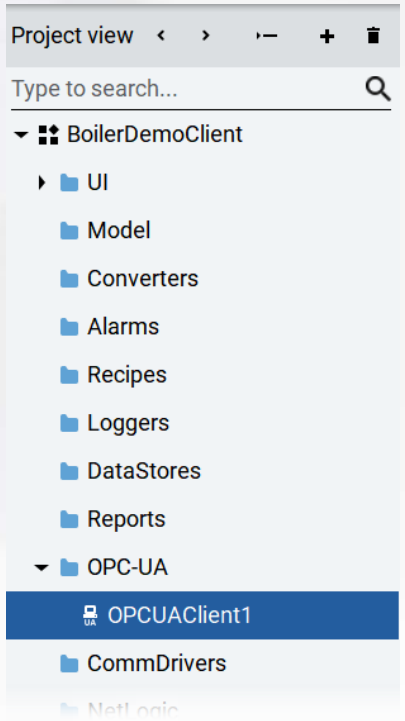


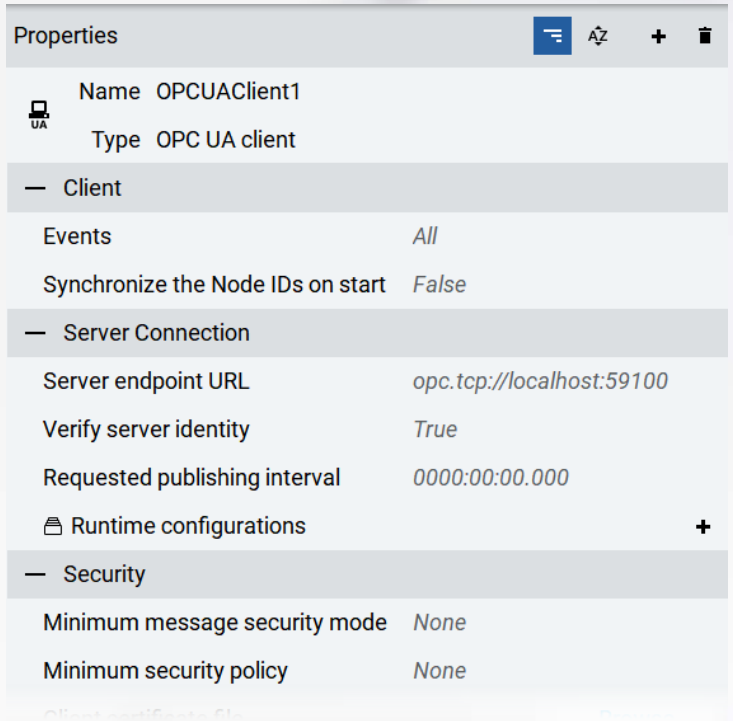
Configure the client

- On the HMI project,
  that is going to act as a Client,
  add the OPCUAClient node

- Server endpoint must be the
  one defined into the Server project

- Events property should be set to "All"
  to be able to attach to Methods,
  Alarms, Loggers...



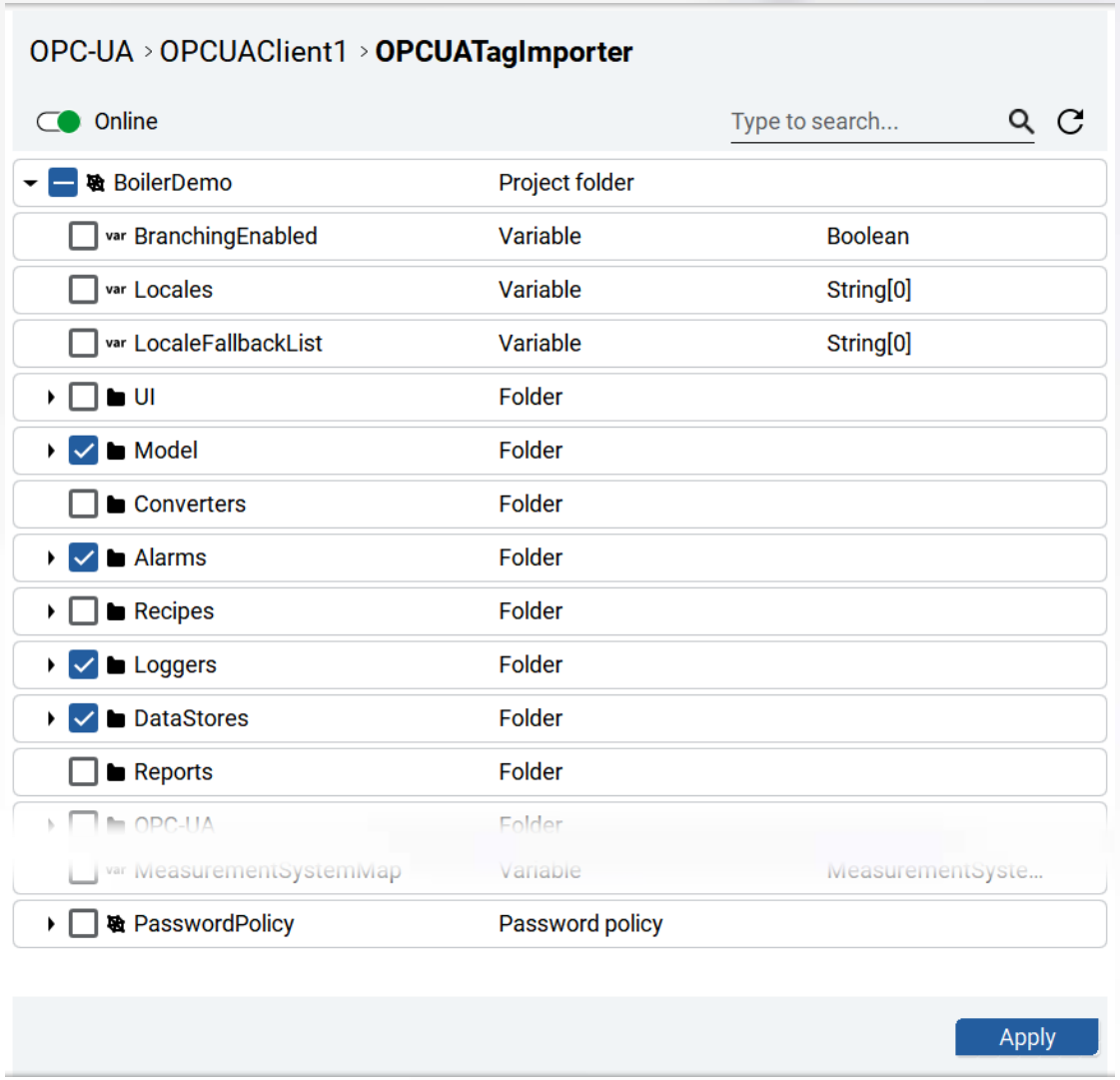


Configure the client

- Using the OPCUA Tag importer, it's possible to import not only variables but also objects!

- For example, select the entire folders Model, Alarms, Loggers and DataStores

- Elements like Alarms, Datalogger and AlarmsEventLogger can be used as they were part of the Client project



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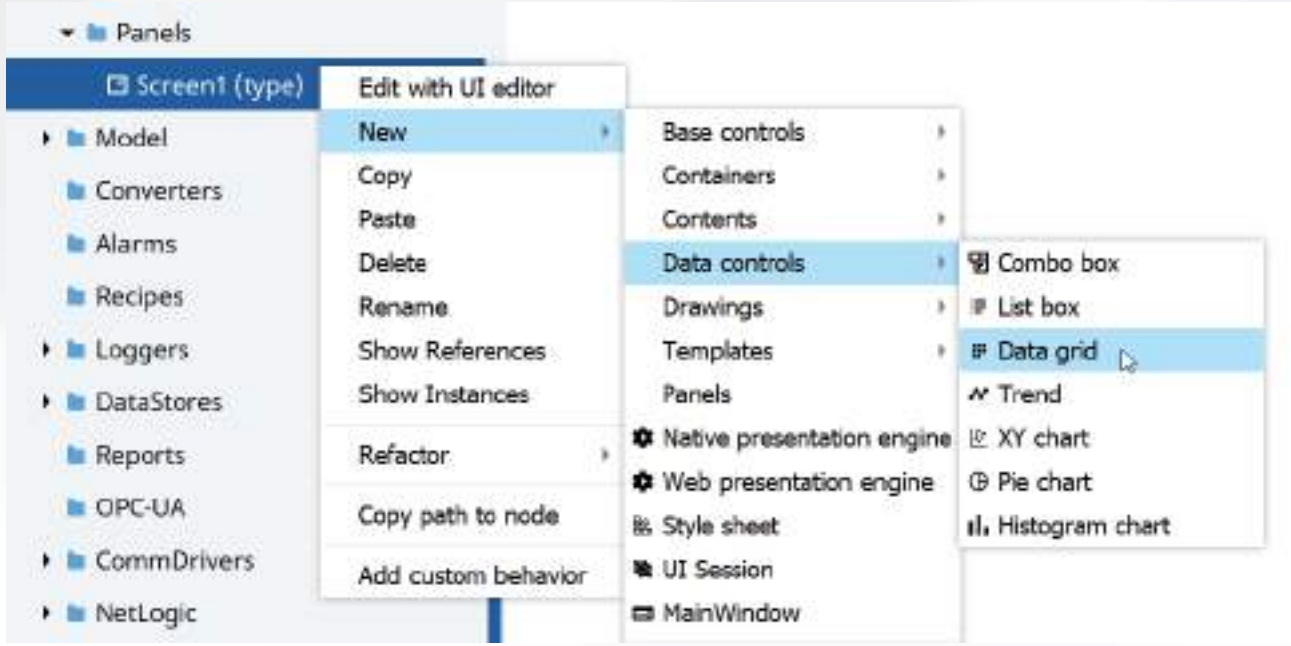

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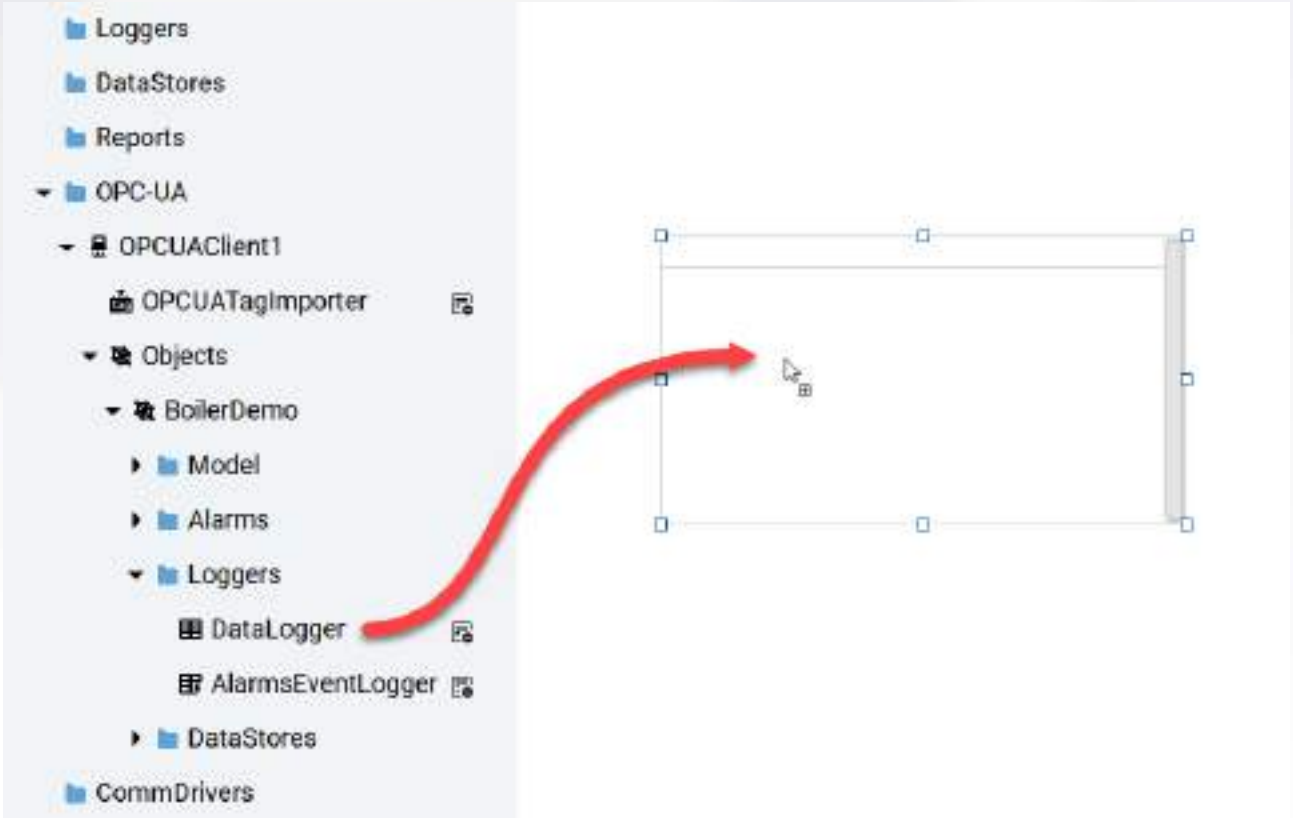

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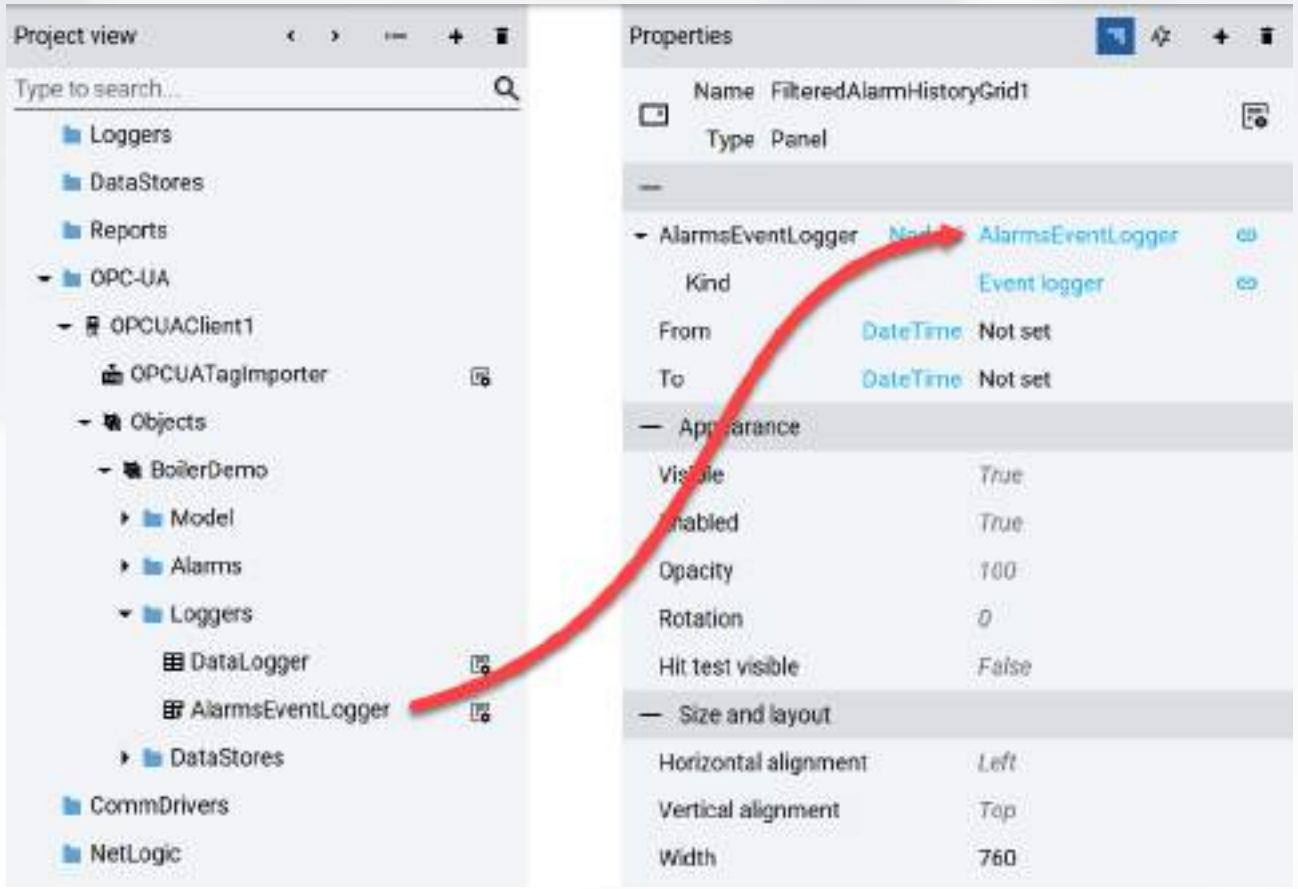
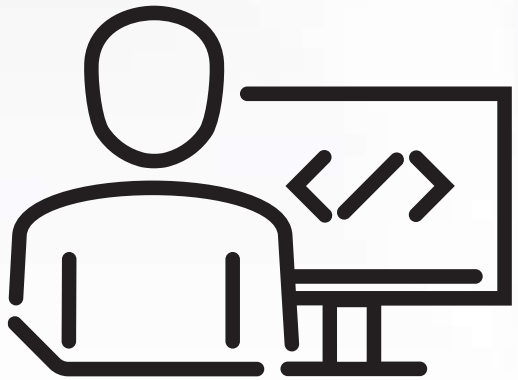


Hands-on session

- Use the BoilerDemo project as Server
- Create a new project that acts as a Client
- Try to visualize and manage the Server's Alarms, Alarm History and Datalogger from the Client project



Domain authentication

Domain authentication

- Login can be forwarded to external services
  - Active Directory
  - LDAP with SSL (no LDAPS)
  - Oauth 2.0 (only with PKCE and JWKD endpoint)
- Need to configure the authentication server properties
  - Type
  - Address
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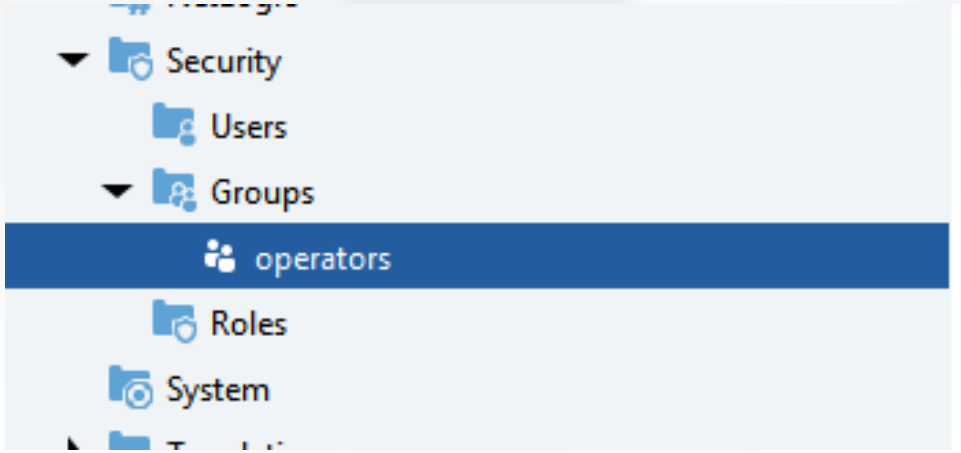
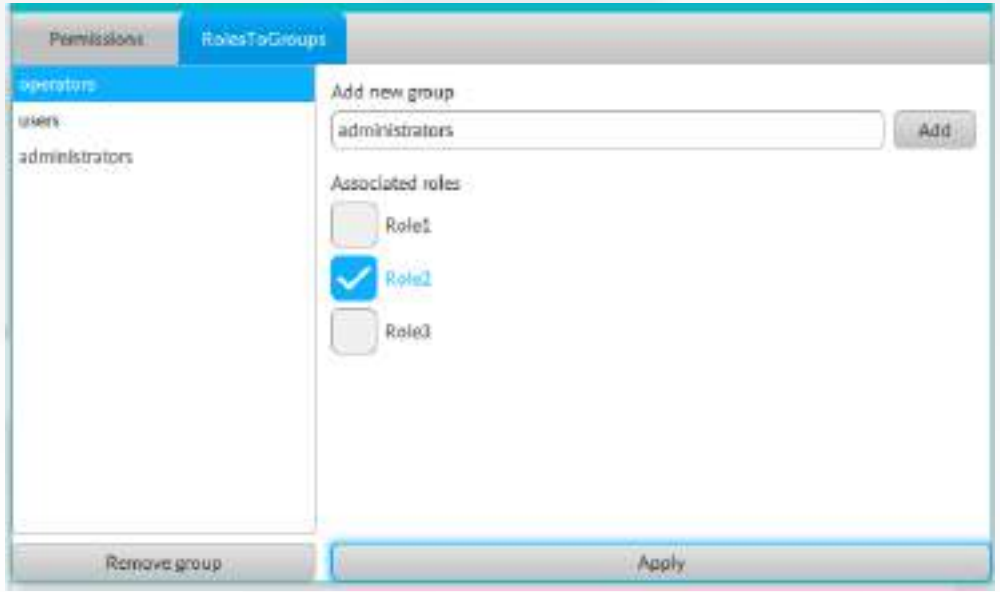
Domain authentication

- No need to create local users
  - If the authentication is validated by the server, a local user is automatically added to the project
- Login is always validated by the authentication server
  - No password caching can be done
  - Cannot login if the authentication server is unreachable
- FactoryTalk Optix groups are automatically mapped to the authentication server groups
  - Designer must have the list of groups in advance
  - When logging to the authentication server, the list of groups where the users belongs is returned, a mapping to the Optix user with the same name is performed automatically
  - For example, if “user1” is part of the “operators” group on the authentication server, all controls linked to the local “operators” group will be accessible



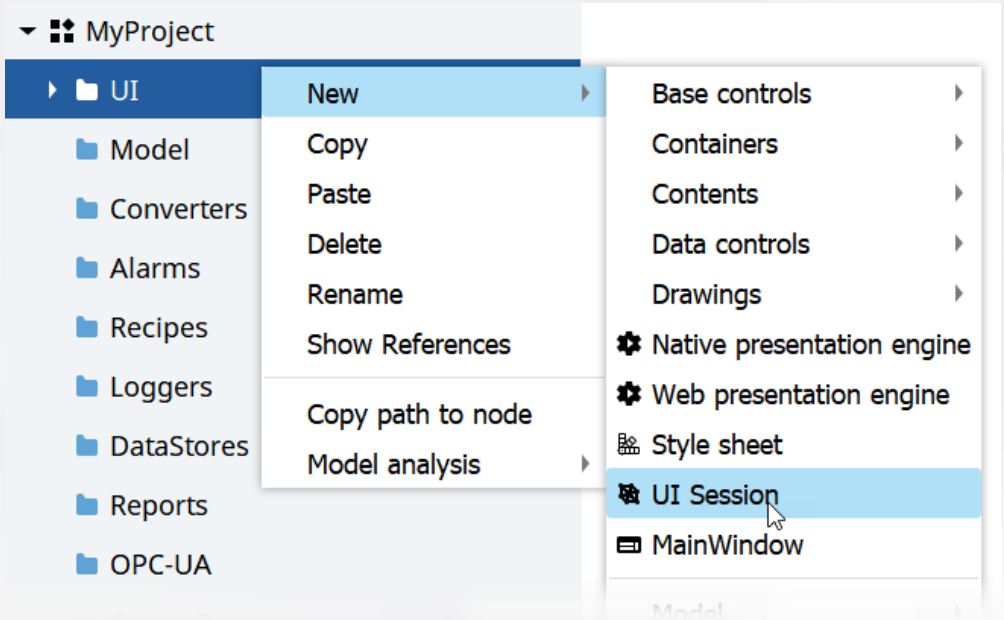
Domain authentication

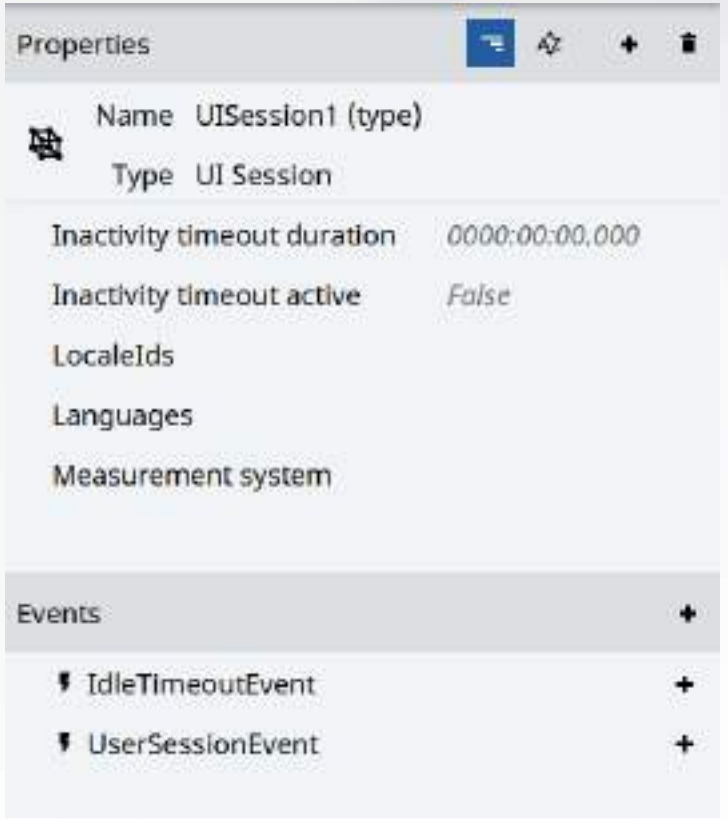
- If the designer does not have a list of the groups from the authentication server, roles can be used
  - All UI controls are tied to the Roles defined in the FactoryTalk Optix application
  - Groups can be created at runtime, then each group can be assigned to one or more roles during after deploying the project
- Full example is available in the GitHub organization
  - Optix_Sample_AssignRolesToGroupsAtRuntime: How to assiciate Active Directory groups to FactoryTalk Optix roles at runtime



Define UI Session and Session variables

UI Session





- UI Session allows defining a custom Session to be used on Native or Web presentation engine

- Allow customizing: Inactivity Timeout, Locale, Language and Measurement System

Session variables vs others

- Model/Comm. Driver variables
  - belongs to the Project context
  - display the same value regardless of sessions or panels
- Panel variables
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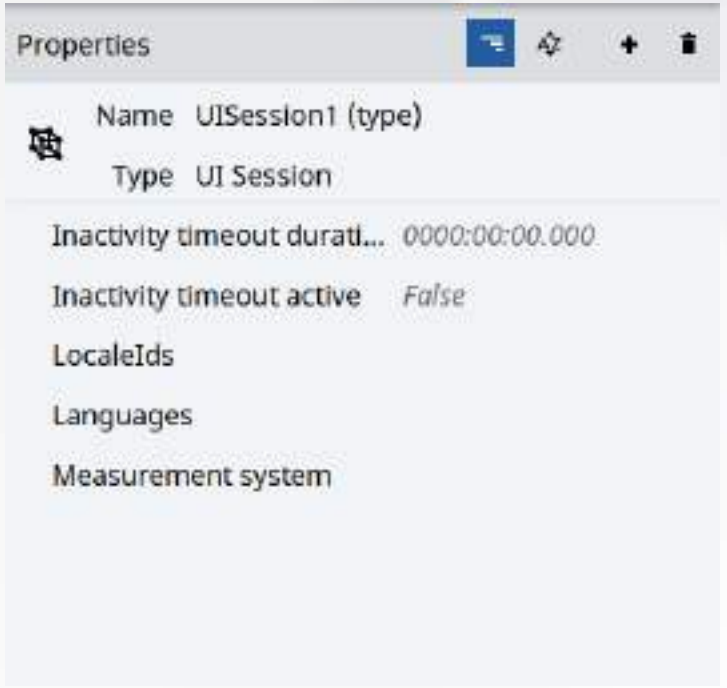

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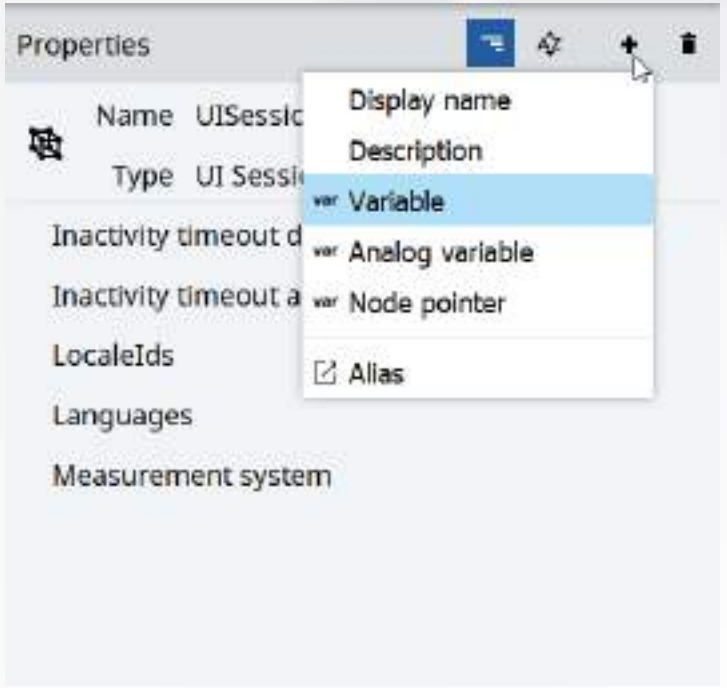

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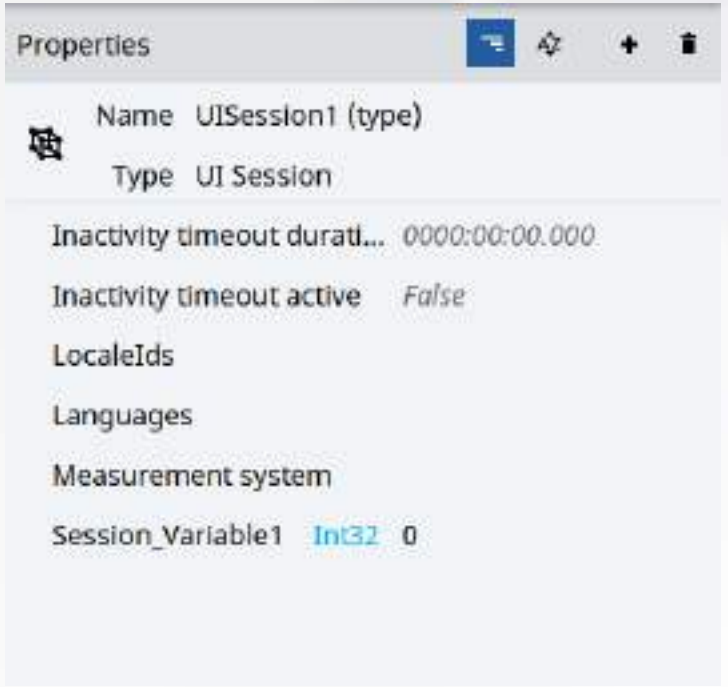
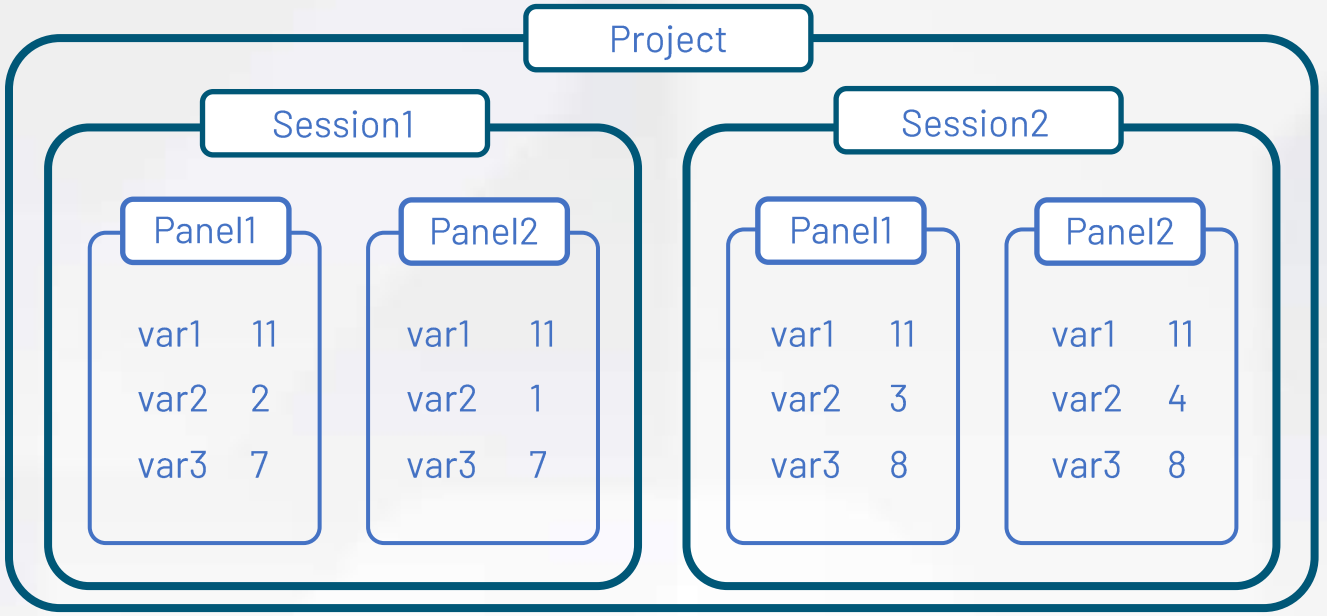


Session variables example



var1 = Model variable

var2 = Panel variable

var3 = Session variable

- Examples of different UI Sessions
  - Example1: one Session active on Native Presentation Engine, and another Session on the Web Presentation Engine
  - Example2: two browsers connected to the same Web Presentation Engine

Work with NetLogic scripts

.NET

- **What is .NET?**
  - .NET is a free, open-source development platform
- **What is .NET Standard?**
  - .NET Standard is an API specification that lets you develop class libraries for multiple implementations of .NET
- **What are .NET Framework, Mono and .NET Core?**
  - They are formally known as *implementations* of .NET Standard
  - .NET Framework is the original implementation of .NET (runs only on Windows)
  - Mono is used when a small runtime is required (formerly used by UNIQO)
  - .NET Core is the latest implementation and runs on any platform (used by OPTIX)
- **What is C#?**
  - it's one of the programming languages supported by .NET
- **What .NET version does Optix support?**
  - Depends on the FT Optix version, check requirements in the Install Guide
  - Additional packages or libraries must be compatible with the specific .NET version (NuGet packages for example)

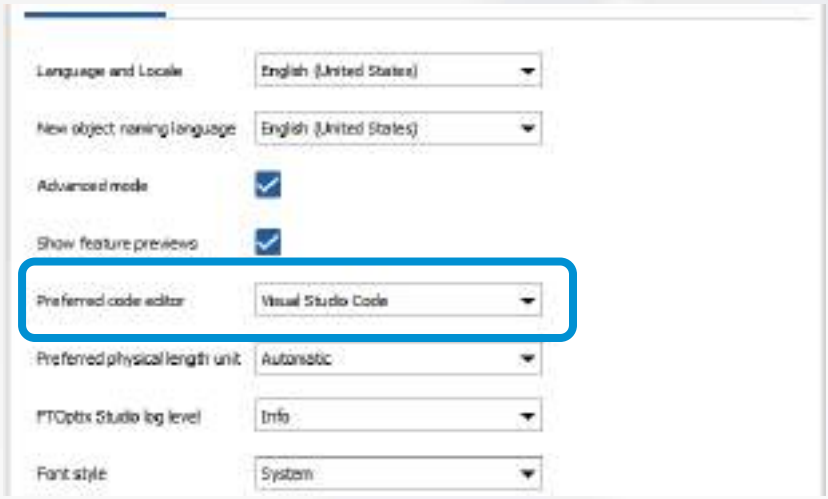
Optix 1.5+

Optix 1.4

Version	Start Date	End Date
.NET 8 LTS	Nov 14, 2023	2026
.NET 7	Nov 8, 2022	May 14, 2024
.NET 6.0 LTS	Nov 8, 2021	Nov 12, 2024
.NET 5.0	Nov 10, 2020	May 10, 2022
.NET 3.1 LTS	Dec 3, 2019	Dec 13, 2022
.NET 3.0	Sep 23, 2019	Mar 3, 2020
.NET 2.2	Dec 4, 2018	Dec 23, 2019
.NET 2.1 LTS	May 30, 2018	Aug 21, 2021
.NET 2.0	Aug 14, 2017	Oct 1, 2018
.NET 1.1	Nov 16, 2016	Jun 27, 2019
.NET 1.0	Jun 27, 2016	Jun 27, 2019

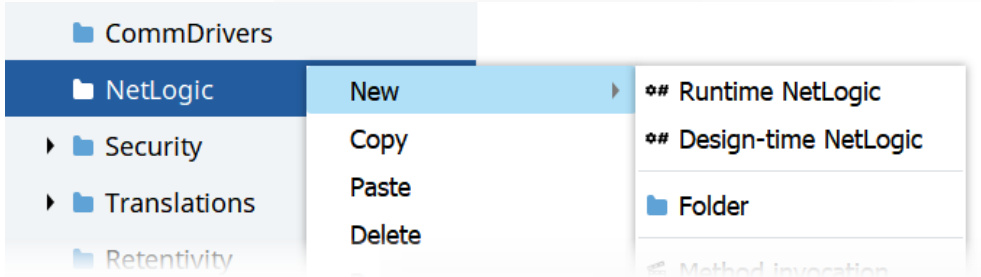
NetLogic

- It's an object that contains **C#** code compatible with the .NET version used by the current release of FactoryTalk Optix



- Supported NetLogic Editors:
  - Microsoft Visual Studio Code (Download)
    - C# Extension needs to be installed
  - Microsoft Visual Studio 2022 (no previous versions)

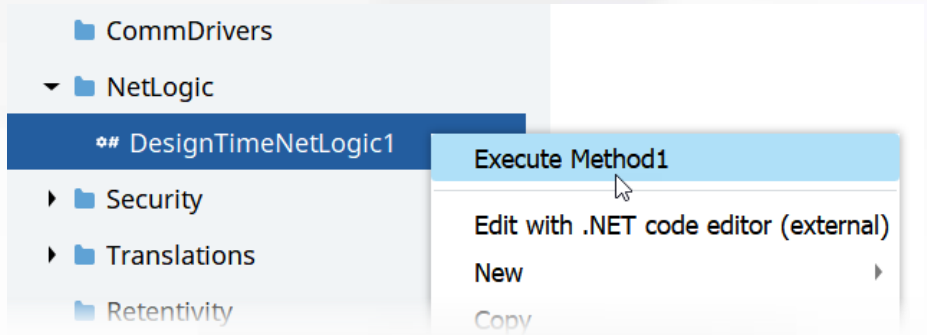
- Types of NetLogic:
  - **Runtime**: to be executed at Runtime
  - **Design-time**: to be executed in IDE



Design-time NetLogic

- **Where** can be placed?
  - Anywhere!
    But usually stay in NetLogic folder
- **When** is the method executed?
  - When the "exported method"
    is executed/called from Studio
- Notes on `[ExportMethod]`:
  - Allow exposing the method outside the script
  - Must be used before every method
    that need to be exposed
  - Exported methods, must be «`public`»
  - Methods must be void, output are passed as
    arguments using the «`out`» modifier

```
public class DesignTimeNetLogic1 : BaseNetLogic
{
    [ExportMethod]
    public void Method1()
    {
        // Insert code to be executed by the method
    }
}
```



Design-time NetLogic: create simple variables

```
[ExportMethod]
public void CreateSimpleVariables()
{
    var myFolder = Project.Current.Get<Folder>("Model/Variables");
    if (myFolder!=null)
    {
        myFolder.Delete();
    }
    myFolder = InformationModel.Make<Folder>("Variables");
    for (int i=1; i<=3; i++)
    {
        var myVar = InformationModel.MakeVariable("Variable" + i, OpcUa.DataTypes.UInt16);
        myFolder.Add(myVar);
    }
    Project.Current.Get("Model").Add(myFolder);
}
```

Delete the folder (if any)

TIP: Optix uses some custom APIs to create and manage project elements of any kind.
Do not use the `var myVar = new IUAVariable();` syntax from plain C# as it will not work, it will only create an useless blank class

TIP: When creating multiple elements under the same parent folder, a best practice is to create the container, add the element and finally add the container to the project. This will avoid executing multiple calls to the FactoryTalk Optix information model

Design-time NetLogic: create simple variables APIs overview

```
[ExportMethod]
public void CreateSimpleVariables()
{
    var myFolder = Project.Current.Get<Folder>("Model/Variables");
    if (myFolder!=null)
    {
        myFolder.Delete();
    }
    myFolder = InformationModel.Make<Folder>("Variables");
    for (int i=1; i<=3; i++)
    {
        var myVar = InformationModel.MakeVariable("Variable" + i, OpcUa.DataTypes.UInt16);
        myFolder.Add(myVar);
    }
    Project.Current.Get("Model").Add(myFolder);
}
```

Map this C# method to an equivalent OPCUA method

Retrieve the element of type "Folder" at the path "Model/Variables"

From the root of the current project

Delete the folder (if any)

Create an object of type "Folder" called "Variables"

Elements are in C# code only

Create a new variable called "VariableX" of type UINT16

The Optix class to create project elements

Add the variable to the folder

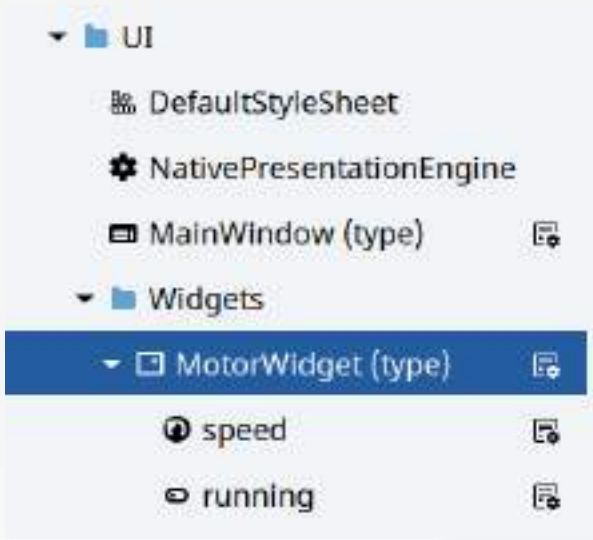
Add the folder containing all the variables from the C# code to the project

Design-time NetLogic: create Motor Type and instances

```
[ExportMethod]
public void CreateMotorType()
{
    // Create an UAObject and call it MotorType
    var motorType = InformationModel.MakeObjectType("MotorType");
    // Create some properties for the motor object
    var speed = InformationModel.MakeVariable("Speed", OpcUa.DataTypes.UInt16);
    var running = InformationModel.MakeVariable("Running", OpcUa.DataTypes.Boolean);
    // Attach the properties of the motor to the motor object
    motorType.Add(speed);
    motorType.Add(running);
    // Attach the motor type (with the child properties) to the project
    Project.Current.Get("Model").Add(motorType);
}

[ExportMethod]
public void CreateMotorInstances()
{
    // Create a new folder
    var motorInstancesFolder = InformationModel.Make<Folder>("MotorInstances");
    // Create some motors and add them to the new folder
    for (int i = 1; i <= 3; i++)
    {
        var motorType = Project.Current.Get("Model/MotorType");
        var motorInstance = InformationModel.MakeObject("Motor" + i, motorType.NodeId);
        motorInstancesFolder.Add(motorInstance);
    }
    // Attach the folder (with the motors) to the current project
    Project.Current.Get("Model").Add(motorInstancesFolder);
}
```

Design-time NetLogic: create widget instances

```
[ExportMethod]
    public void CreateMotorWidgetInstances()
    {
        // NOTE: the "MotorWidget" type with "MotorAlias" alias,
        // must be already available at UI/Widgets

        for (int i = 1; i <= 3; i++)
        {
            var motorWidgetType = Project.Current.Get("UI/Widgets/MotorWidget");
            var motorWidgetInstance = InformationModel.MakeObject("MotorWidget" + i, motorWidgetType.NodeId);
            motorWidgetInstance.SetAlias("MotorAlias", Project.Current.Get("Model/MotorInstances/Motor" + i));
            ((Panel)motorWidgetInstance).LeftMargin = ((Panel)motorWidgetInstance).Width + 50) * (i - 1);
            Project.Current.Get("UI/MainWindow").Add(motorWidgetInstance);
        }
    }
```

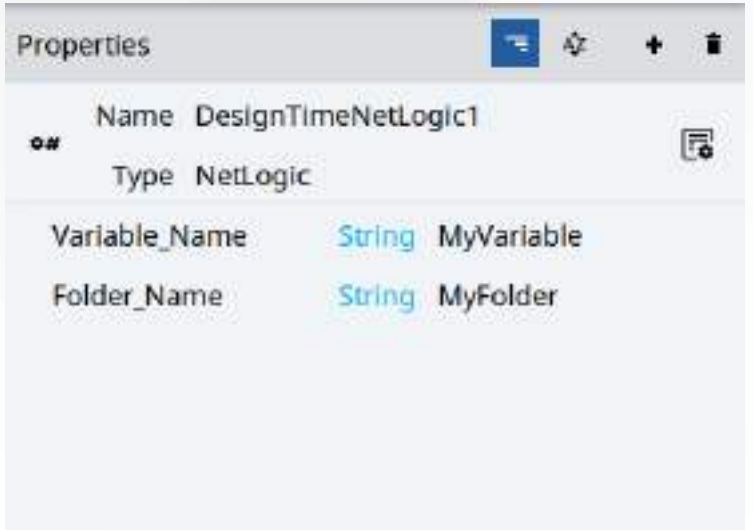


Cast to Panel is needed as the MakeObject would return a generic OPC-UA Object which does not contain the margin properties

Design-time NetLogic: script parameters

- Variables added to the NetLogic object behaves like script parameters
- Value of these variables can be read using LogicObject.GetVariable("{variable}").Value

```
[ExportMethod]
 public void ReadParameters()
 {
     string varName = LogicObject.GetVariable("Variable_Name").Value;
     string folderName = LogicObject.GetVariable("Folder_Name").Value;
     Log.Info(LogicObject.BrowseName,"Variable_Name = " + varName);
     Log.Info(LogicObject.BrowseName,"Folder_Name = " + folderName);
 }
```

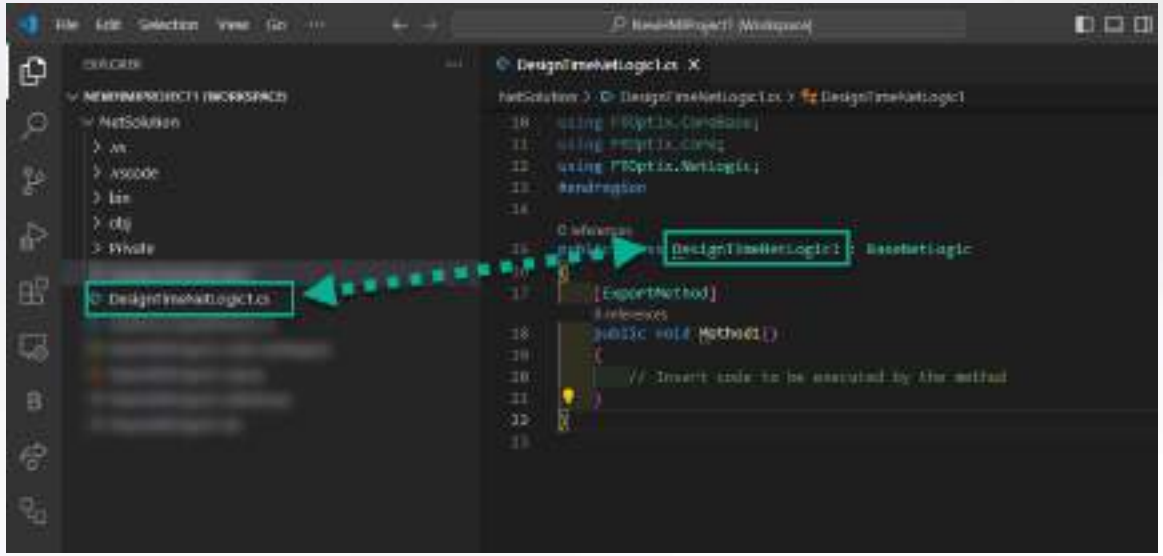


Access node path

- Using `Log.Node(IUANode);` a string is returned containing the project path to such node

```
var myNode = Project.Current.Get(“Model/Variable1”);
var nodePath = Log.Node(myNode); // returns /Objects/Model/Variable1
```

NetLogic don'ts !



1. NetLogic class name must be the same of the NetLogic object name

   - **Don't change the name from the source code!**
   - Rename it from Studio instead!

2. NetLogic objects are also browsable from the NetSolution

   - **Don't delete a NetLogic from the solution!**
   - Remove it from Studio instead!

Cast vs Type parameter

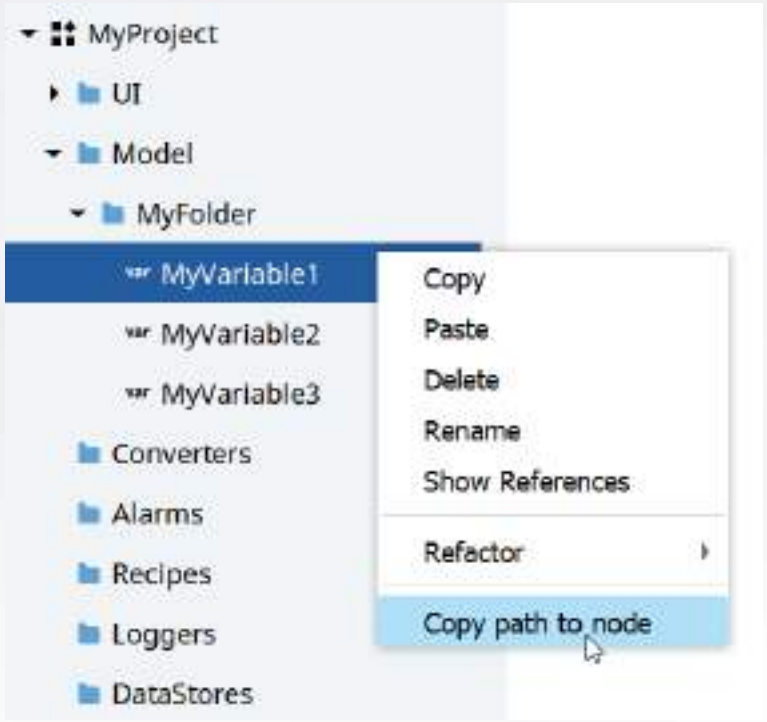
- Use of a "**type parameter**"
  - Type parameter can be used with "generic methods" that allows using different types
  - A generic method can be called either without an argument or by specifying the type of argument within angle brackets
  - Returns `null` if `MyFolder` is not an instance of `Folder`

```
var myfolder = Project.Current.Get<Folder>("Model\MyFolder");
```

- Use of a "**cast**"
  - a cast is an explicit conversion
  - To perform a cast, specify the type that you are casting to in parentheses in front of the value or variable to be converted.
  - Throws `InvalidCastException` if `MyFolder` cannot be assigned to `Folder` type

```
var myfolder = (Folder)Project.Current.Get("Model\MyFolder");
```

Copy path to node



- Can be useful when using absolute addressing with `Project.Current.Get`
- Provides the absolute path of the node to clipboard

```
"MyProject/Model/MyFolder/MyVariable1"
```

```
Project.Current.GetVariable("Model/MyFolder/MyVariable1");
```

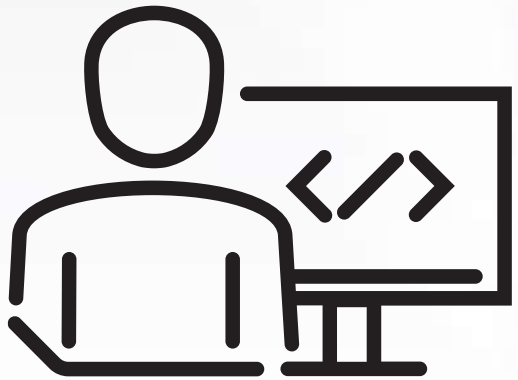
- NOTE: remember to remove the project name

NetLogic(s) FAQ

- Can I add ActiveX controls to my FactoryTalk Optix application?
  - No, you can't add ActiveX to FactoryTalk Optix, this is due to safety concerns (deprecated technology)
- I have my custom WPF application, can I embedd it into FactoryTalk Optix?
  - No, graphics can only come from FactoryTalk Optix UI, there's no chance to embed other applications
  - If the custom application exposes a HTML interface, the WebBrowser object can be used
- Can I use any NuGet package in my FactoryTalk Optix application?
  - Yes, if they are compatible with the .NET version used in FactoryTalk Optix
  - Yes, if they are cross-platform capable (compiler target must be **AnyCPU**)
  - Exceptions are:
    - Windows Forms (WPF and derivates are not cross-platform and cannot be used)
    - Microsoft.SQL (customers should use ODBC connector instead) → Limitation was removed in Optix 1.6.X
- Any limitations in a DesignTime script?
  - There is no way to access value of PLC tags (CommDriver only exist at Runtime)
  - There is no way to interact with ODBC connectors, EmbeddedDatabase or InfluxDB using Optix modules

Hands-on session

- Write one or more Design-Time script
- See what happens if multiple variables are created with the same name

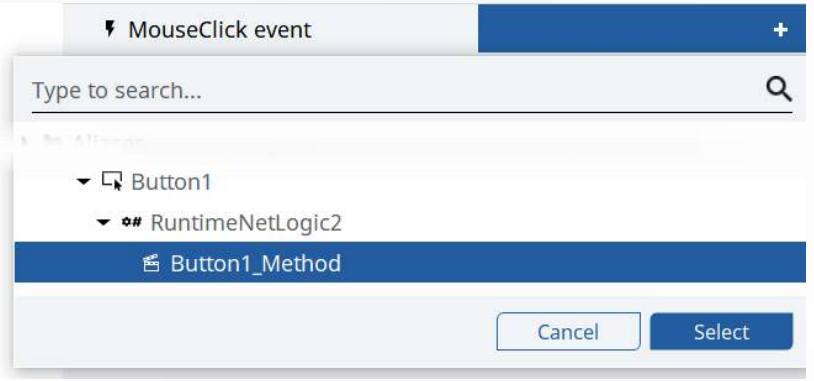


Runtime Netlogic

- **Where** can it be placed?
  - into the NetLogic folder
  - into the Main Window
  - into a Panel
  - into a graphical object (like a Button)

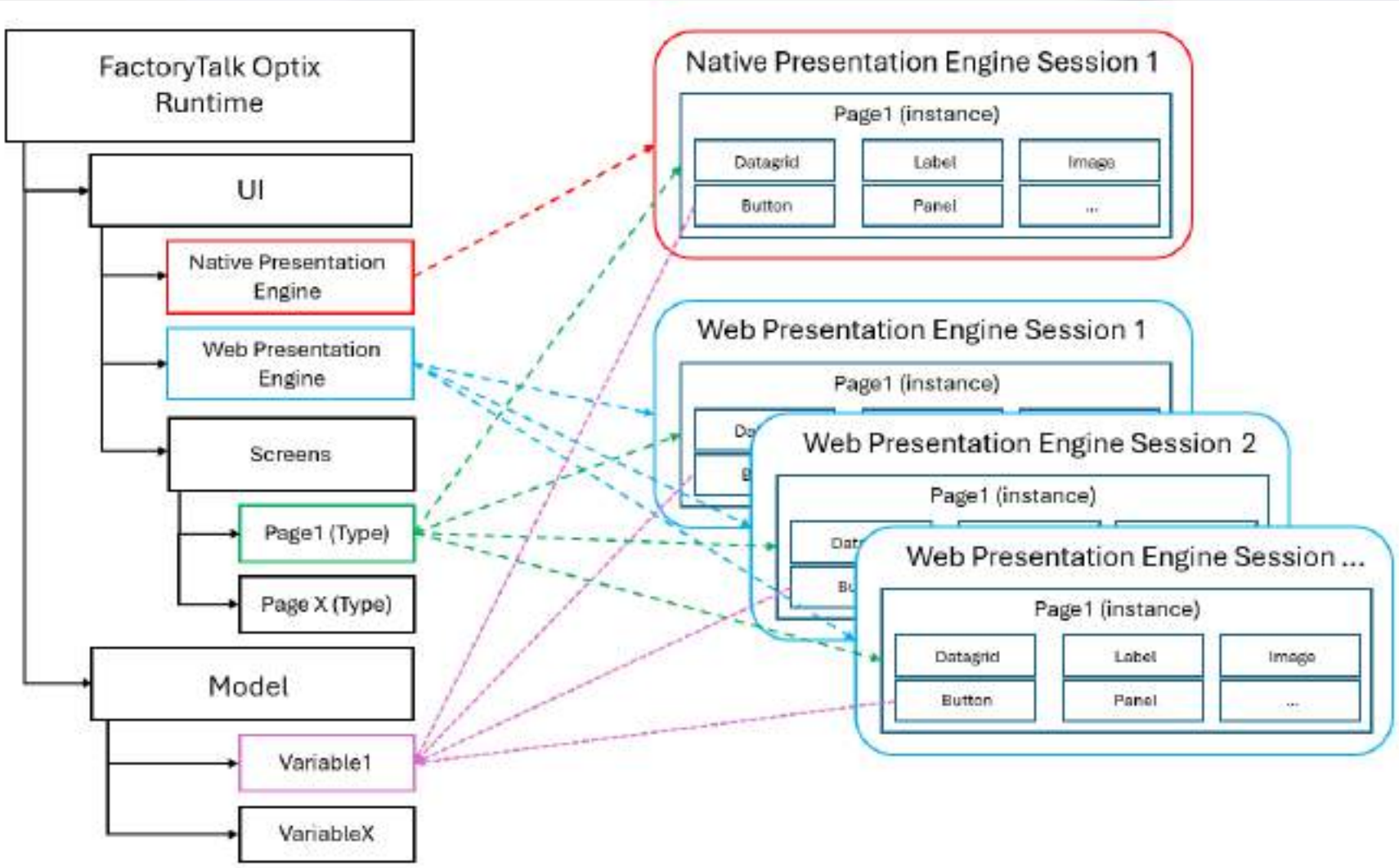
- **When** are the methods executed?
  - *Start*: automatically executed when the node that contain the NetLogic is created/opened
  - *Stop*: automatically executed when the node that contain the NetLogic is destroyed/closed
  - *Exported Method*: executed when called by an Event

```
public class RuntimeNetLogic1 : BaseNetLogic
{
    public override void Start()
    {
        // code executed when the logic is started
    }

    public override void Stop()
    {
        // code executed when the logic is stopped
    }

    [ExportMethod]
    public void Button1_Method()
    {
        // code executed by the method
    }
}
```



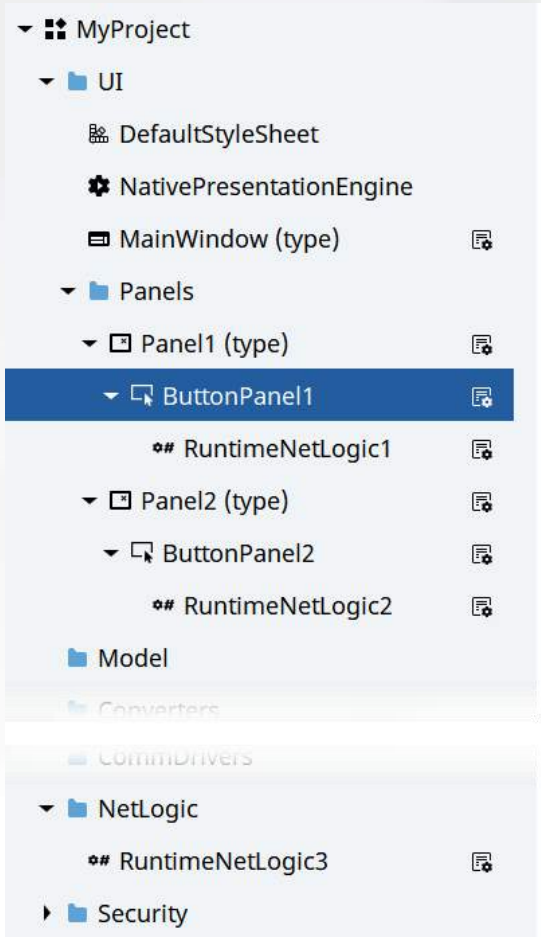
Runtime NetLogic: scope

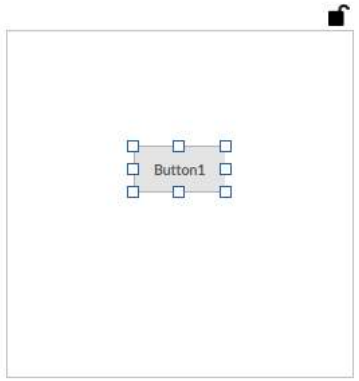
- Every session of the Runtime will create an instance of the UI type that was designed (session)
- Elements of a session can only interact with elements from the same session or global scope
- Elements from a global scope cannot interact with elements of a specific session

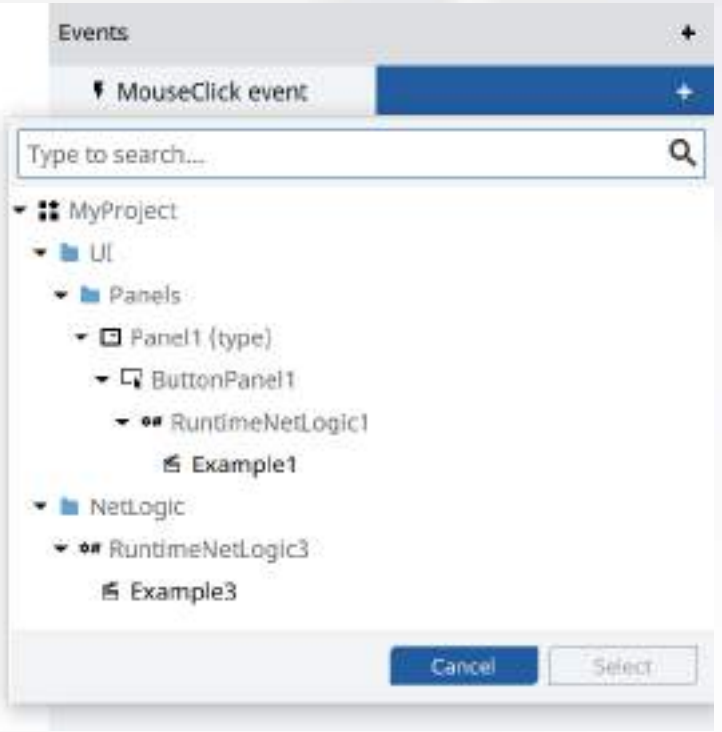


Runtime NetLogic: scope

- Button1 of Panel1 cannot access to method exposed by RuntimeNetLogic2 because is related to Panel2 (different type and different scope).
- Panel2 and therefore RuntimeNetLogic2 do not exists when Button1 is loaded
- Dynamic links from a global scope (model variables or PLC tags) cannot point to objects from a session scope

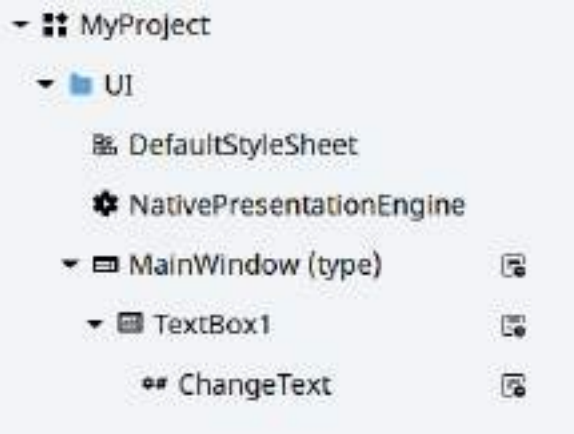






Runtime NetLogic: usage of "owner"

```
public class ChangeText : BaseNetLogic
{
    [ExportMethod]
    public void ChangeTextRelativePath()
    {
        // WORKING AT RUNTIME!
        Owner.GetVariable("Text").Value = "Text changed using Owner";
    }

    [ExportMethod]
    public void ChangeTextAbsolutePath()
    {
        // NOT WORKING AT RUNTIME!
        Project.Current.Get<TextBox>("UI/MainWindow/TextBox1").Text = "Text changed using Project.Current";
    }
}
```



	Project.Current...	Owner...
Type of path	Absolute	Relative
Runtime usage	can be used to refer nodes **outside the UI** *	**must be used** to refer nodes **inside the UI** *

* This is due to the UI Sessions, dynamically created at Runtime

Runtime NetLogic: read/write variables value


```
[ExportMethod]
public void Sum()
{
    var addend1 = (Int32)Project.Current.GetVariable("Model/Variable1").Value;
    var addend2 = (Int32)Project.Current.GetVariable("Model/Variable2").Value;
    Project.Current.GetVariable("Model/Variable3").Value = addend1 + addend2;
}
```

Runtime NetLogic: subscribe to VariableChange event

```
private IUAVariable addend1;
private IUAVariable addend2;

public override void Start()
{
    addend1 = Project.Current.GetVariable("Model/Variable1");
    addend2 = Project.Current.GetVariable("Model/Variable2");
    addend1.VariableChange += addend1_VariableChange;
    addend2.VariableChange += addend2_VariableChange;
}

private void addend1_VariableChange(object sender, VariableChangeEventArgs e)
{
    Project.Current.GetVariable("Model/Variable3").Value = (Int32)e.NewValue + (Int32)addend2.Value;
}

private void addend2_VariableChange(object sender, VariableChangeEventArgs e)
{
    Project.Current.GetVariable("Model/Variable3").Value = (Int32)addend1.Value + (Int32)e.NewValue;
}

public override void Stop()
{
    addend1.VariableChange -= addend1_VariableChange;
    addend2.VariableChange -= addend2_VariableChange;
}
```

This example executes the Sum when an addend changes, without the need to click the Button

Runtime NetLogic: set a variable always in use

```
private IUAVariable addend1;
private IUAVariable addend2;
private RemoteVariableSynchronizer variableSynchronizer;

public override void Start()
{
    addend1 = Project.Current.GetVariable("Model/Variable1");
    addend2 = Project.Current.GetVariable("Model/Variable2");
    addend1.VariableChange += addend1_VariableChange;
    addend2.VariableChange += addend2_VariableChange;

    variableSynchronizer = new RemoteVariableSynchronizer();
    variableSynchronizer.Add(addend1);
    variableSynchronizer.Add(addend2);
}

private void addend1_VariableChange(object sender, VariableChangeEventArgs e)
{
    Project.Current.GetVariable("Model/Variable3").Value = (Int16)e.NewValue + (Int16)addend2.Value;
}

private void addend2_VariableChange(object sender, VariableChangeEventArgs e)
{
    Project.Current.GetVariable("Model/Variable3").Value = (Int16)addend1.Value + (Int16)e.NewValue;
}
```

Starting from the previous example, here Variable1 and Variable2 are associated with Modbus registers, but they are not in use (because not linked to any object on page) so they need to be added to a RemoteVariableSynchronizer

Runtime NetLogic: execute code in asynchronous mode *

```
public override void Start()
{
    variable1 = Project.Current.GetVariable("Model/Variable1");
    myPeriodicTask = new PeriodicTask(IncrementVariable, 250, LogicObject);
    myPeriodicTask.Start();
    dCounter = 0;
}

private void IncrementVariable(PeriodicTask task)
{
    dCounter = dCounter + 0.05;
    variable1.Value = 50 + Math.Sin(dCounter) * 50;
}

public override void Stop()
{
    myPeriodicTask.Dispose();
}

private PeriodicTask myPeriodicTask;
private IUAVariable variable1;
private double dCounter;
```

* The asynchronous classes available are:

PeriodicTask to create a task that executes code at regular time intervals.

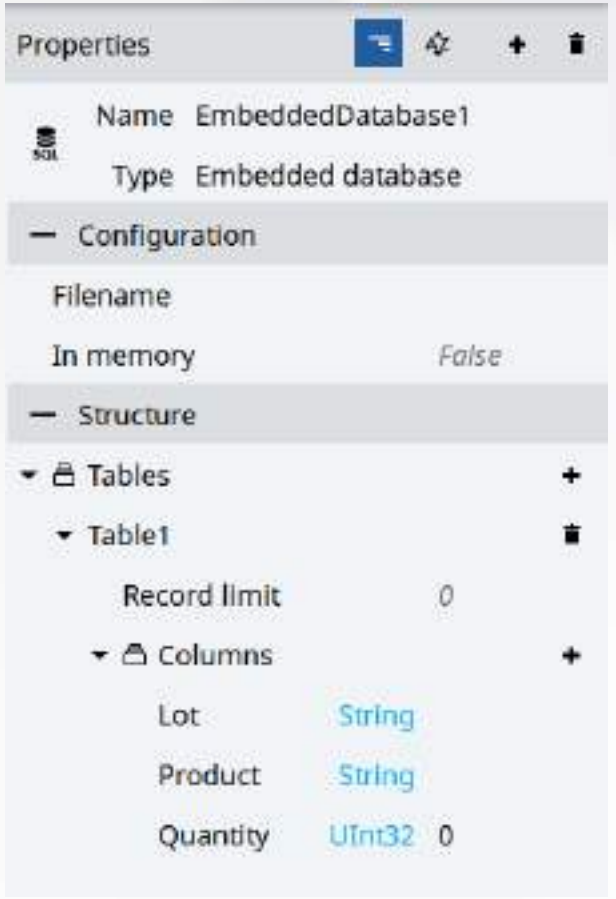
DelayedTask to create a task that executes code after a time delay.

LongRunningTask to create tasks that require significant time and/or CPU resources.

The default “async” methods in C# cannot be used to access project nodes (to avoid concurrency issues), use the FactoryTalk Optix classes from above instead

Runtime NetLogic: execute DB query

```
private Store myStore;
private Table myTable;
private object[,] resultSet;
private string[] header;

public override void Start()
{
    myStore = Project.Current.Get<Store>("DataStores/EmbeddedDatabase1");
    myTable = myStore.Tables.Get<Table>("Table1");
}

[ExportMethod]
public void Insert(string Lot, string Prod, uint Quantity)
{
    object[,] rawValues = new object [1,3];     // insert 1 row with 3 columns
    rawValues[0,0] = Lot;
    rawValues[0,1] = Prod;
    rawValues[0,2] = Quantity;

    string[] columns = new string[3] {"Lot","Product","Quantity"};
    myTable.Insert(columns,rawValues);
}
```



Runtime NetLogic: execute DB query

```
[ExportMethod]
public void Delete(string Lot)
{
    myStore.Query($"DELETE FROM Table1 WHERE Lot='{Lot}'", out header, out resultSet);
}

[ExportMethod]
public void Update(string Lot, uint Quantity)
{
    myStore.Query($"UPDATE Table1 SET Quantity='{Quantity}' WHERE Lot='{Lot}'", out header, out resultSet);
}

[ExportMethod]
public void Select(string Lot)
{
    myStore.Query($"SELECT Product, QUantity FROM Table1 WHERE Lot='{Lot}'", out header, out resultSet);
    for (int i = 0; i < resultSet.GetLength(0); i++)
    {
     Log.Info(LogicObject.BrowseName, $"Product = '{resultSet[i,0]}' - Quantity = '{resultSet[i,1]}'");
    }
}
```

NetLogic: look at some library scripts

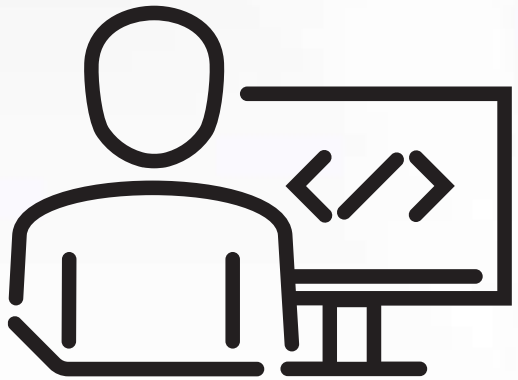
- MQTT push-agent (Runtime)
- FTP Client/Server (Runtime)
- ClockLogic (Runtime)
- Import/Export Alarm (Design-time)
- Import/Export Translations (Design-time)

Most Design-time scripts from TemplateLibrary can be modified to be used at Runtime too!

Hands-on session

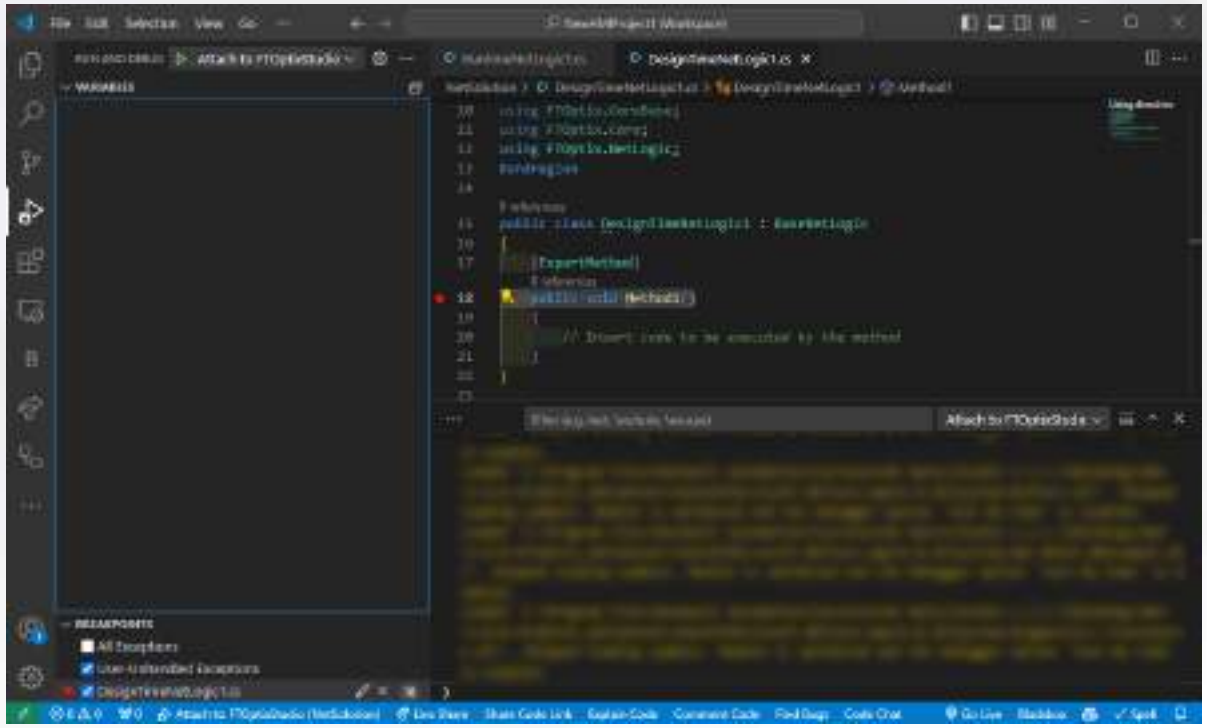
- Write one or more Runtime script

- See what happens when adding an element to a page using `Project.Current()` vs. `Owner.Get()`



Debugging NetLogic scripts

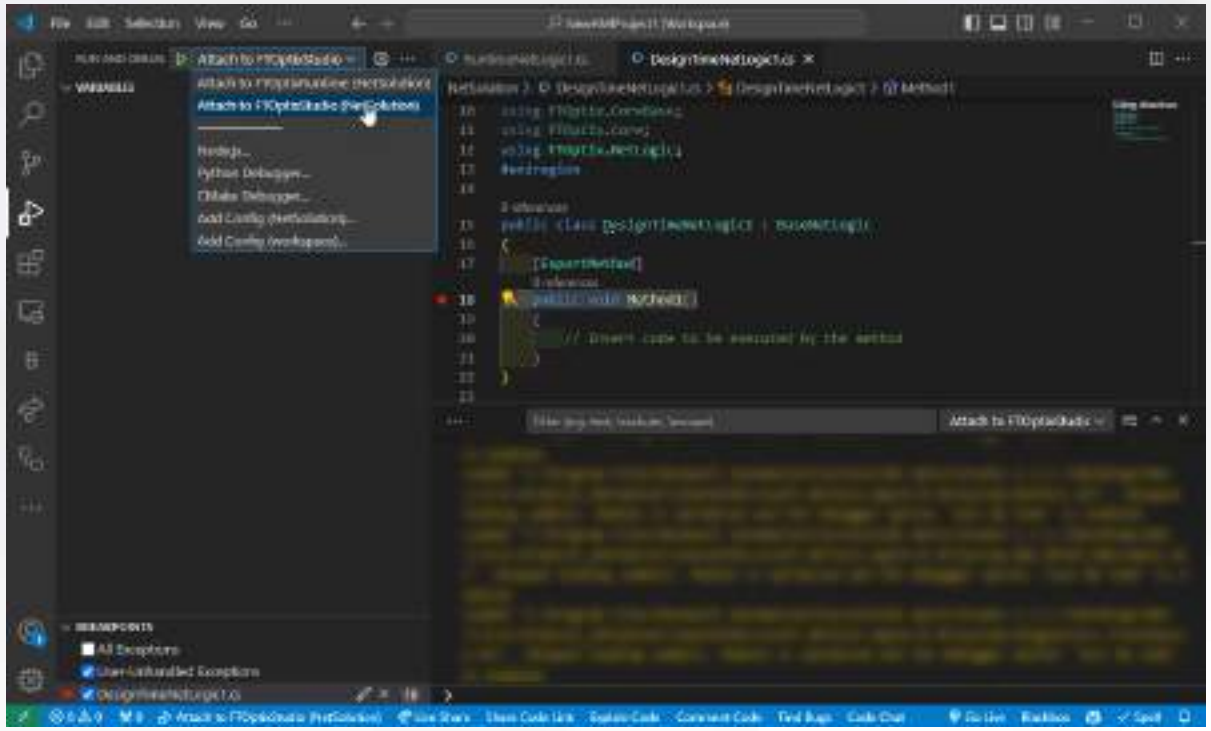
Debug with Visual Studio Code



- Set a breakpoint by clicking to the left of the row number (a red dot will appear)
- Select
  - Attach to FTOptixStudio for Design time NetLogic
  - Attach to FTOptixRuntime for Runtime NetLogic
- Click "Run and Debug" on the left toolbar or hit F5 on the keyboard
- Execute the script from FactoryTalk Optix Studio or FactoryTalk Optix Runtime
- Execute step-by-step
  - Step Over (F10)
  - Step Into (F11)

Due to a bug of the C# Extension of VSCode, versions of the plugin between 2.4.4 and 2.34.10 may not work when debugging Designtime NetLogic, please upgrade or downgrade as needed.

Debug with Visual Studio Code



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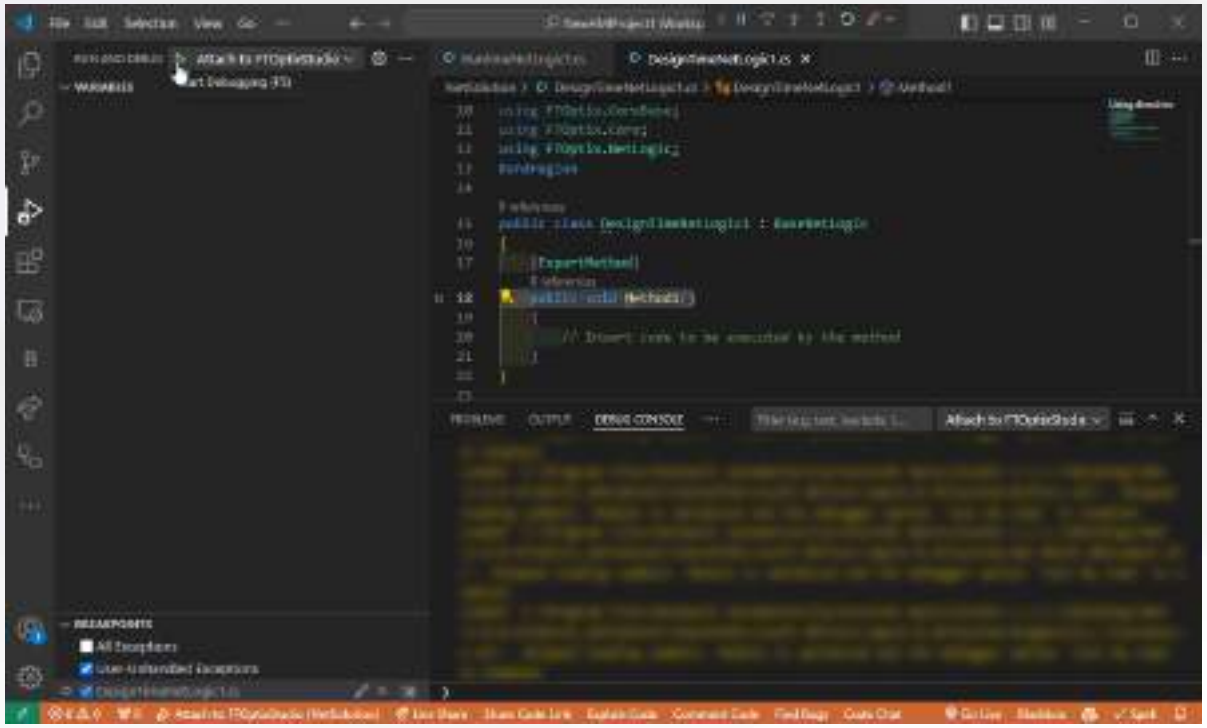

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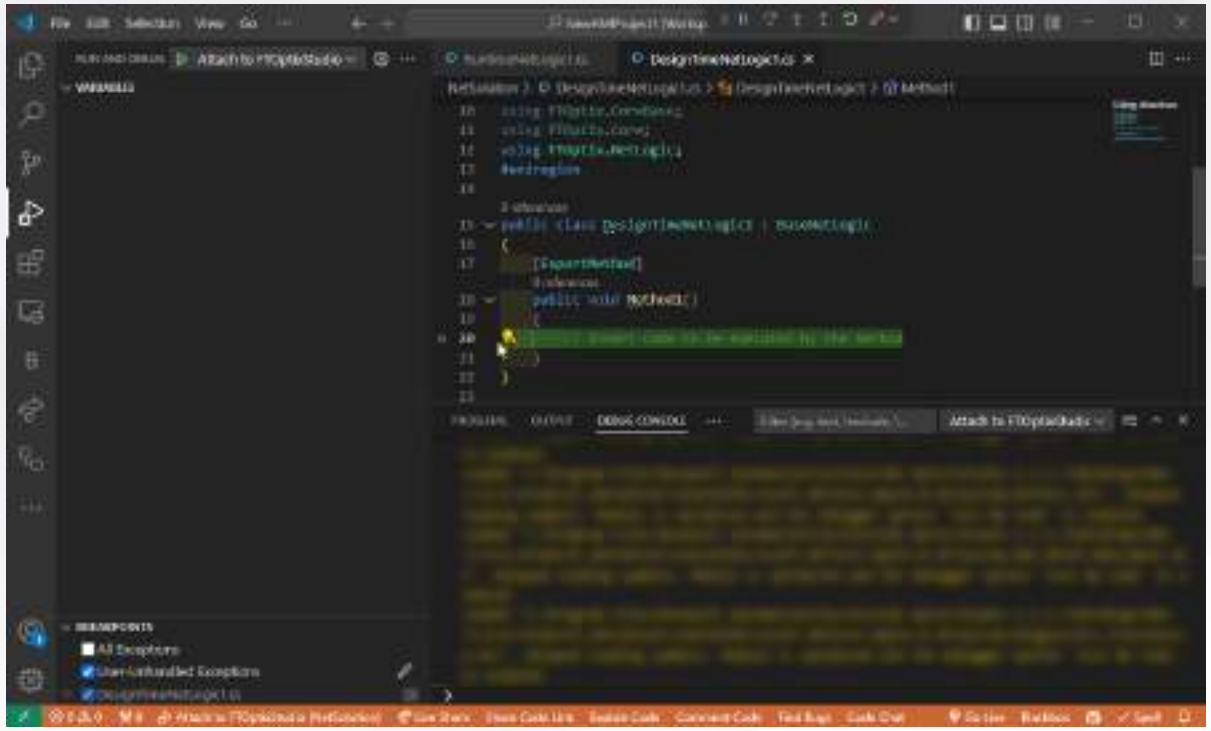

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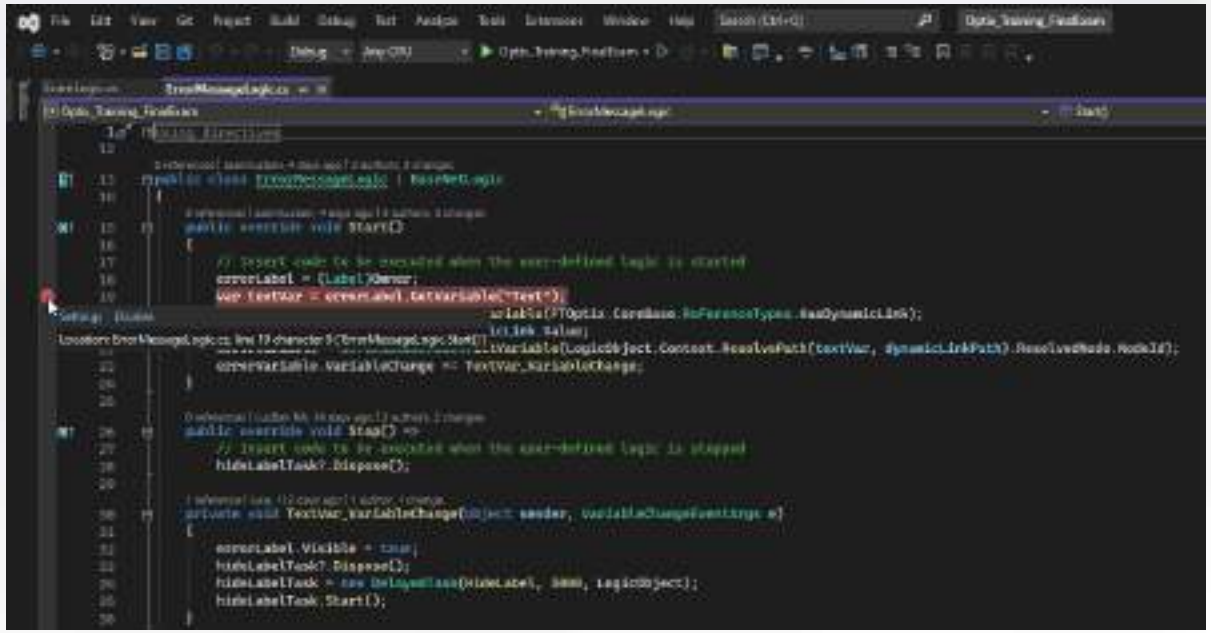
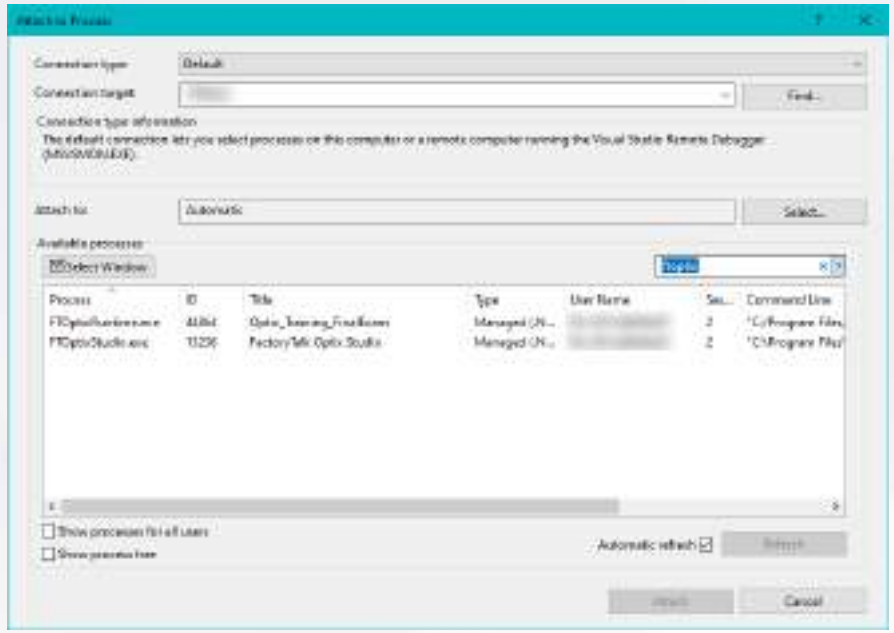
Debug with Visual Studio 2022



- Open the .NET Solution with VS
- Select the `.cs` file to debug
- Set a breakpoint by clicking on the left column of the code editor
- DesignTime NetLogic:
  - From the Debug menu, select «Attach to process»
  - Select FTOptixStudio from the menu
  - Click «Attach»
  - Execute the DesignTime method
- RunTime NetLogic
  - From the Debug menu select «Attach to process»
  - Select FactoryTalkOptixRuntime from the menu
  - Click «Attach»
  - Execute the RunTime method

Debug with Visual Studio 2022



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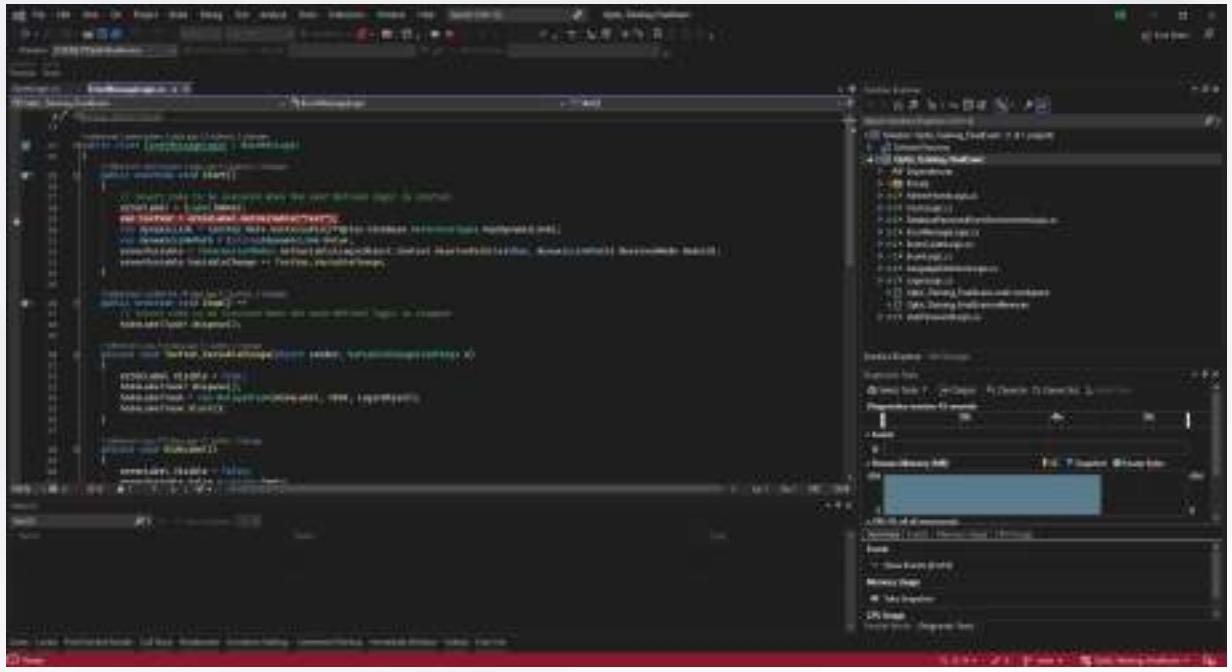

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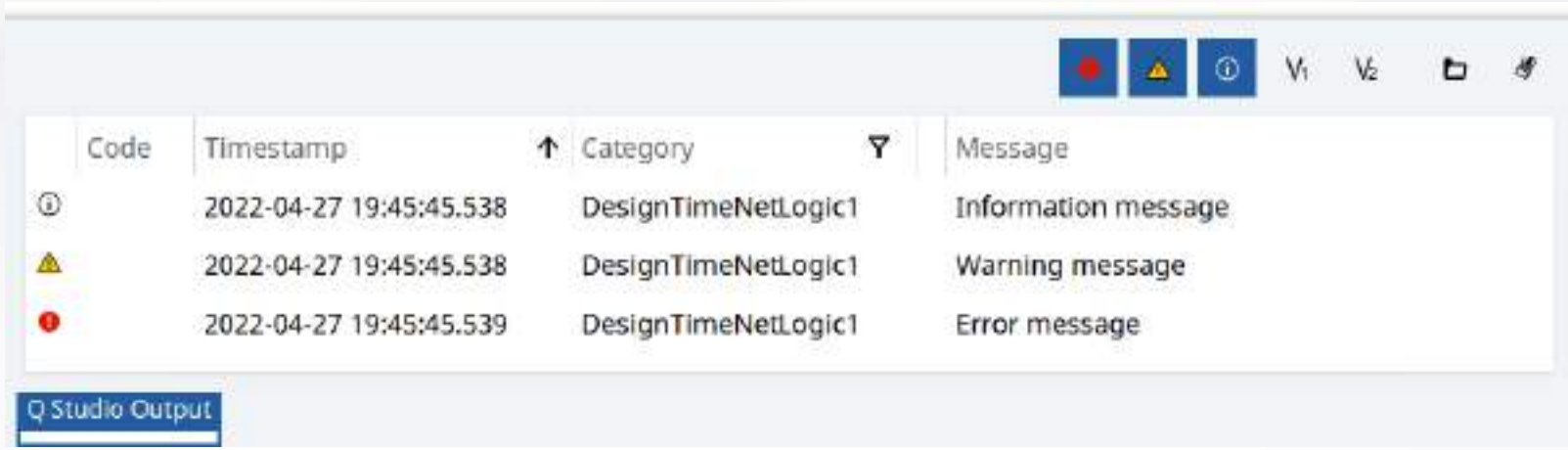
- RunTime NetLogic
  - From the Debug menu select «Attach to process»
  - Select FactoryTalkOptixRuntime from the menu
  - Click «Attach»
  - Execute the RunTime method

Debug by logging to output

- `Log.Info(LogicObject.BrowseName,"Information message");`
- `Log.Warning(LogicObject.BrowseName,"Warning message");`
- `Log.Error(LogicObject.BrowseName,"Error message");`



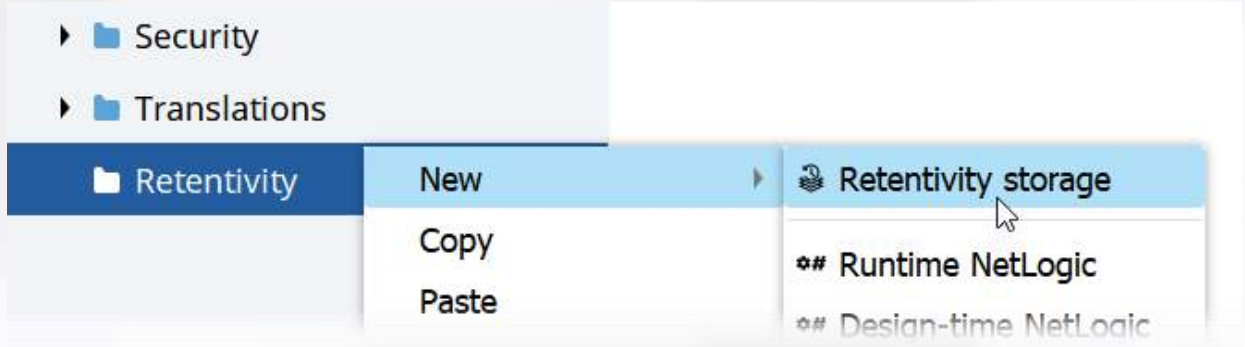
Why to debug?

- Debugger is a powerful tool to understand what's happening to the project
  - Helps to understand why some «weird» errors appear, like «Object not set to an instance of an object» (when trying to access a variable that does not exist) or «Unhandled exception»
- When debugging some logic in the Start method of a RunTime NetLogic multiple options are available
  - Add the «ExportMethod» modifier to the Start method and use a button to call it
  - Use a NavigationPanel or PanelLoader to first connect to the debugger and then load the page containing the script
- If you get «The break point will not currently be hit» please check for:
  - Make sure you attached to the right process
  - Make sure the .NET solution compiles
  - Make sure you saved the project both on VS/VSCode and FactoryTalk Optix
  - Make sure the code in the FactoryTalk Optix Runtime is the latest (restart the runtime if needed)
- Remote debugging is also available via SSH on iPC
  - Cannot be used on closed systems (like OptixPanel) where SSH is not available

Use Retentivity

Retentivity usage

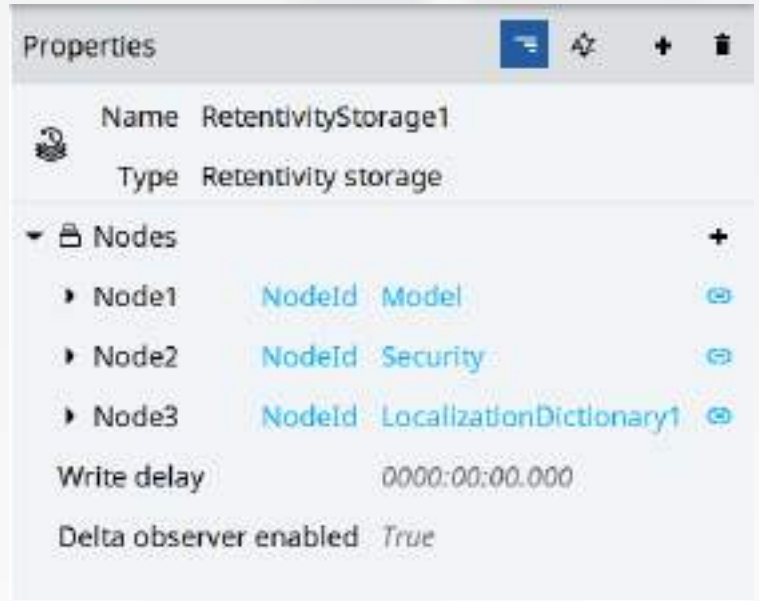
- Provide storage of changes made at Runtime
- Retentivity applies to:
  - **Variables**,
  - **Users**,
  - **Dictionary of Translations**,
  - or every node of the project



- Every Retentivity storage object is related to an embedded database

Retentivity properties and location

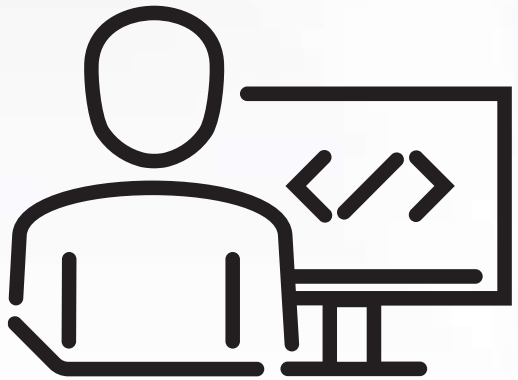
- Properties
  - **Nodes**: Folder/node of the project to be retained.
    It's possible to define several nodes on the same Retentivity Storage, or create separated storage
  - **Write delay**: define how often to save into the database
    Zero means values are saved as soon as a change is detected
  - **Delta observer enabled**: allow to enable/disable the Retentivity



- Location:
  - Database file can be found in the ApplicationFiles folder of FTOptixApplication
  - Example: `%localappdata%\Rockwell Automation\FactoryTalk Optix\Emulator\Projects\<ProjectName>\ApplicationFiles`

Hands-on session

- Add retentivity storage to the project
- Add a project's node to the retentivity (like the Model folder)
- Verify that changes made on Model's variable are reteined

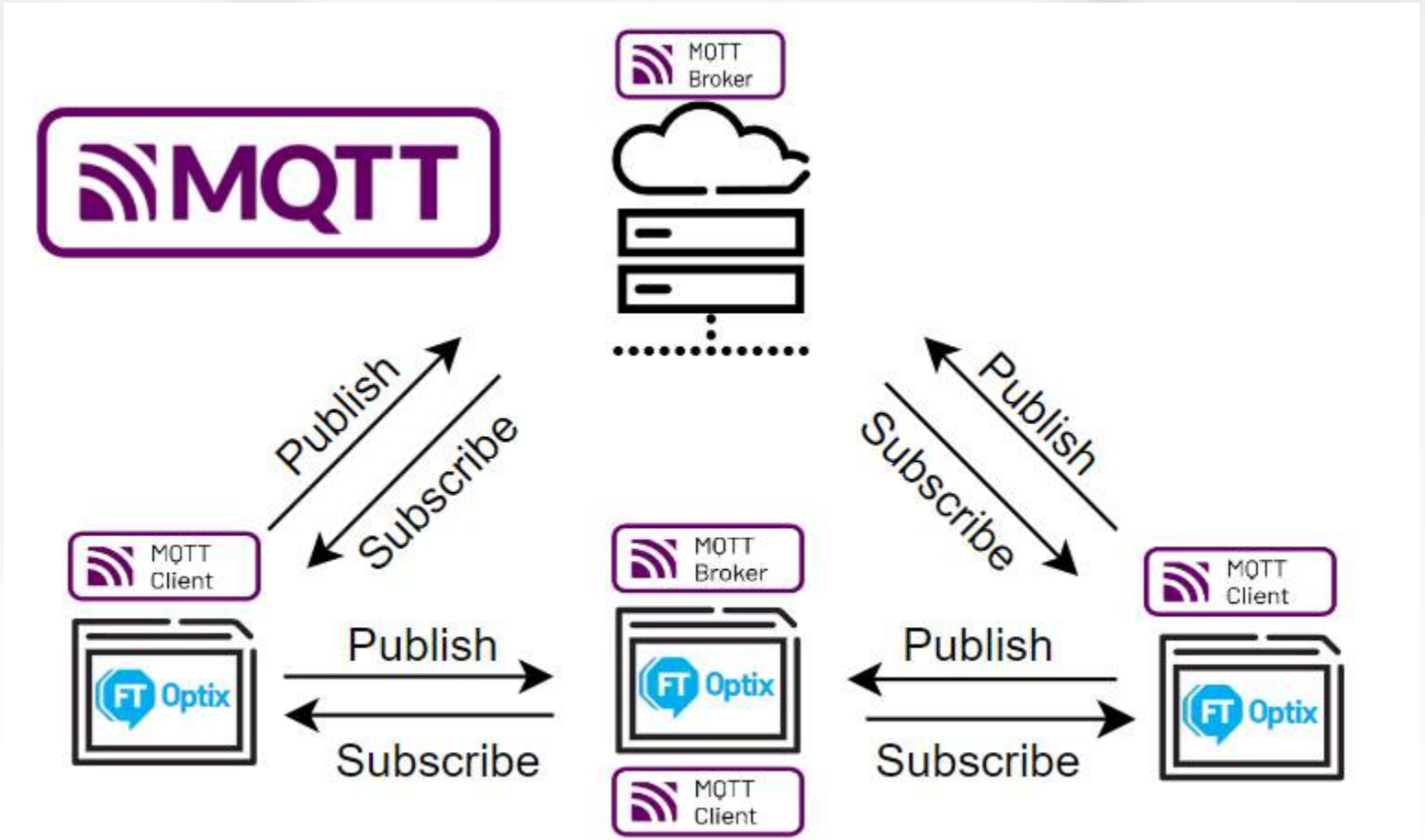


MQTT

FactoryTalk by ROCKWELL AUTOMATION

Basic configuration

- **MQTT Broker**: The central server that routes messages between clients in the publish/subscribe model.
- **MQTT Client**: Interacts with the broker to send or receive messages.
  - **Publisher**: A client that sends messages to a specific topic on the broker.
  - **Subscriber**: A client that listens to topics and receives messages from the broker.



MQTT broker

General Configuration

Listener port: The port on which the MQTT broker listens for incoming client connections (default: 8883 for secure communication using SSL/TLS).

Max connections: The maximum number of simultaneous client connections that the broker can handle (e.g., 25).

Max QoS: The highest Quality of Service level supported by the broker:

0: At most once (fire-and-forget).

1: At least once (acknowledged delivery).

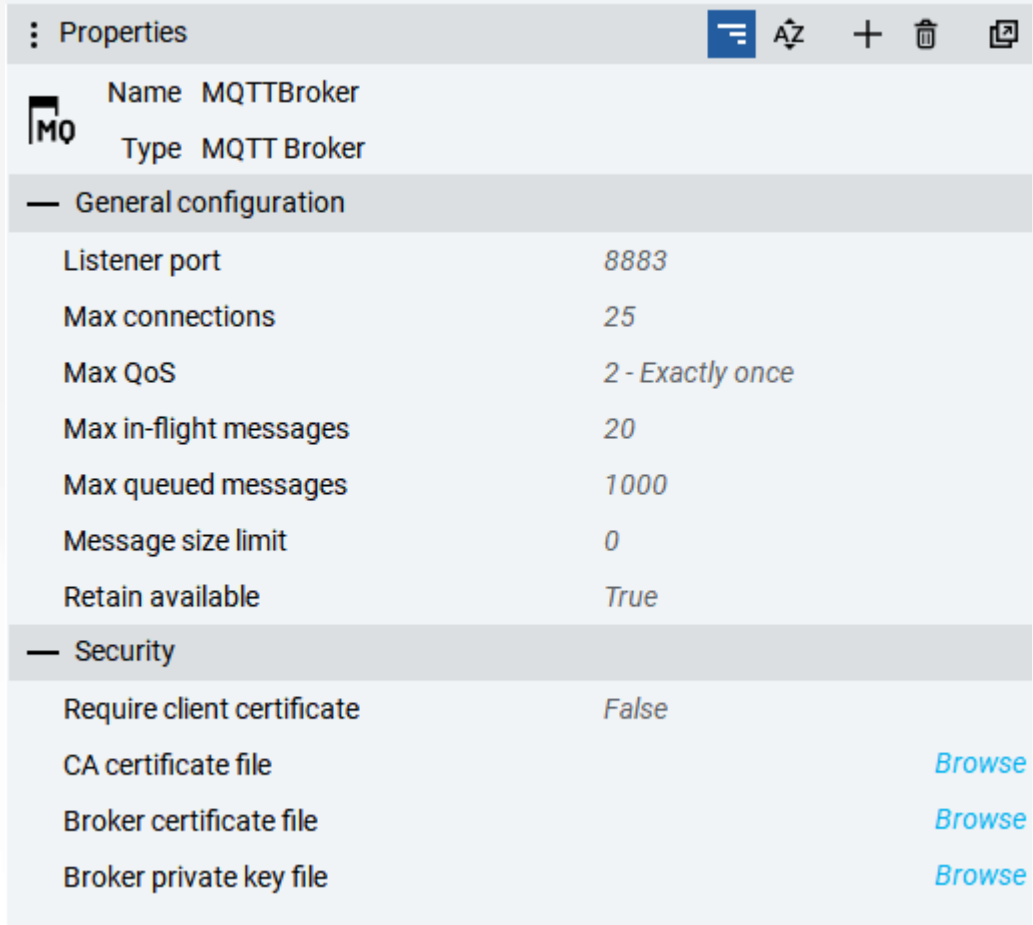
2: Exactly once (guaranteed delivery).

Max in-flight messages: The maximum number of unacknowledged messages per client that the broker allows to remain "in flight."

Max queued messages: The maximum number of messages that can be queued for offline clients.

Message size limit: The maximum size (in bytes) of a single MQTT message. A value of 0 indicates no limit.

Retain available: Indicates whether the broker supports retained messages. Retained messages store the last published message for a topic and send it to new subscribers.



MQTT broker

Security

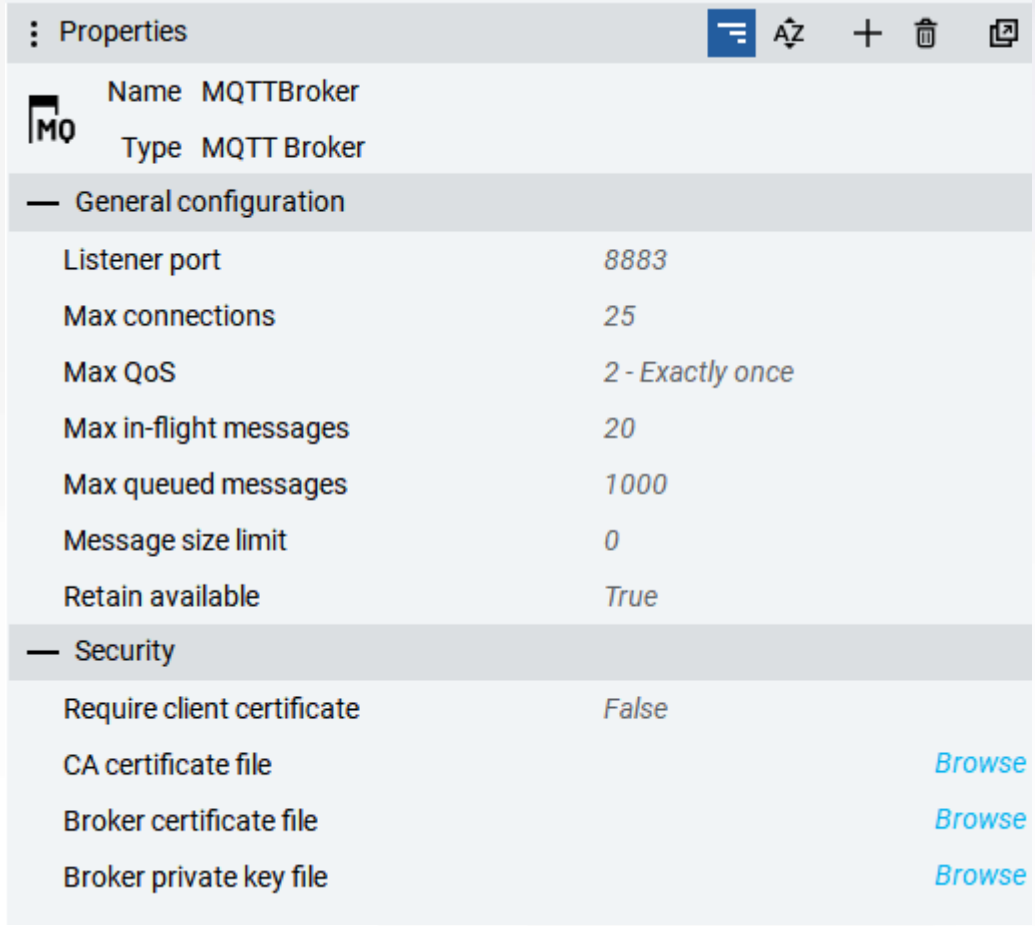
Require client certificate: Determines whether clients must provide a certificate for mutual TLS authentication (True or False).

CA certificate file: The path to the Certificate Authority (CA) certificate file, used to verify the authenticity of client certificates.

Broker certificate file: The path to the broker's SSL/TLS certificate file, used to encrypt communication.

Broker private key file: The path to the private key file corresponding to the broker's SSL/TLS certificate, used for secure communication.

This setup is typical for a secure and configurable MQTT broker deployment, ensuring flexibility and security.



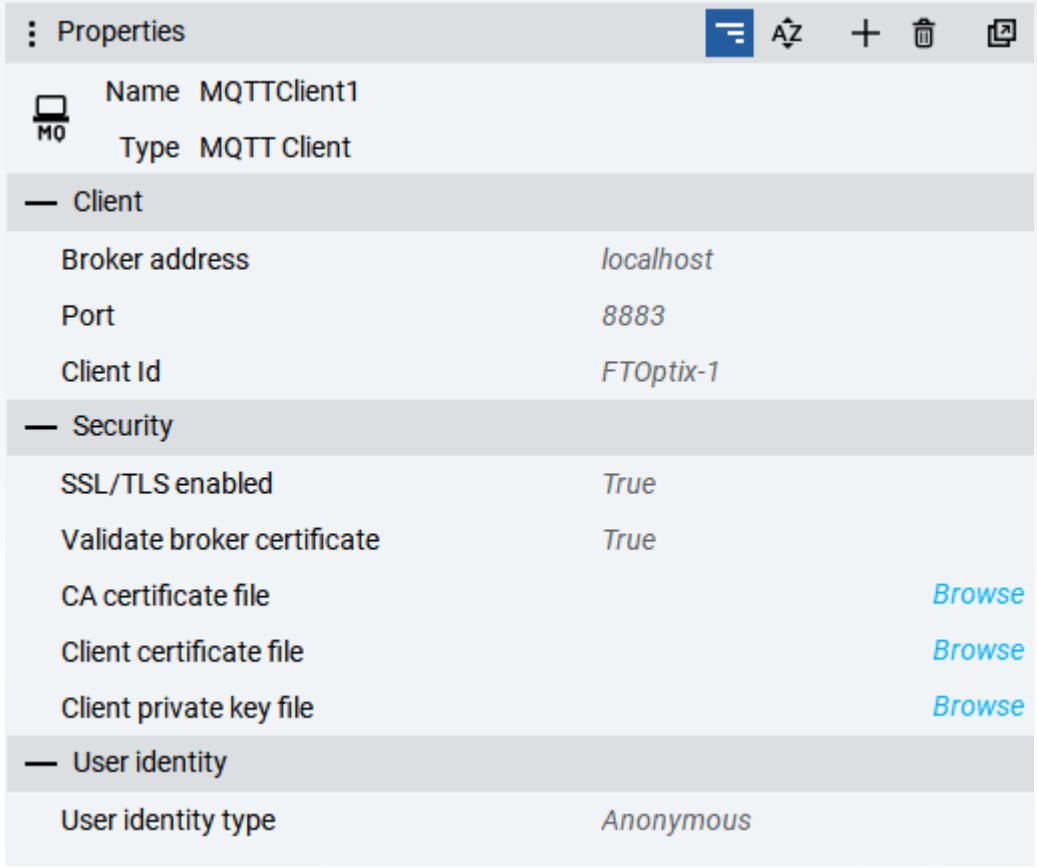
MQTT Client

Client

Broker address: The address of the broker to connect to.

Port: Communication port number.

ClientID: The Client identifier that is unique on the server.



MQTT Client

Security

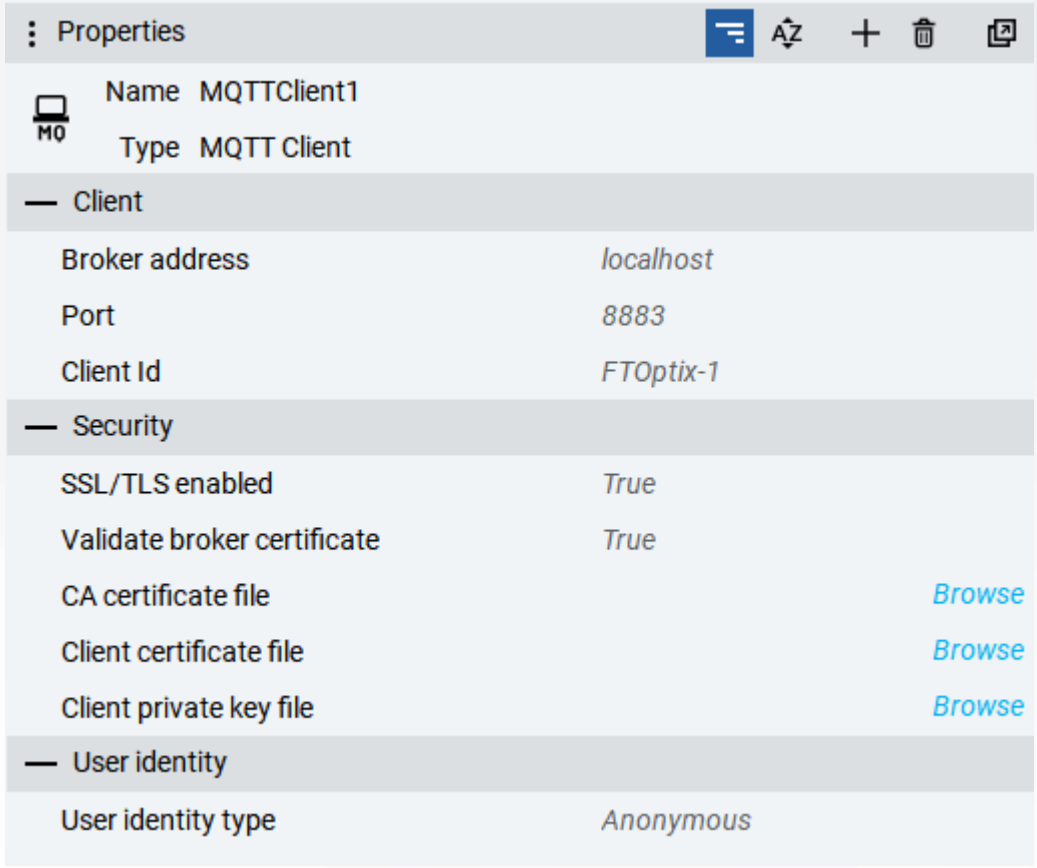
SSL/TLS Enabled: Enabling secure connection between FT Optix MQTT Client and MQTT Broker. Once activated 'mqqts' protocol is being used.

Validate broker certificate: Activates/deactivates validation process of MQTT broker certificate. During the SSL certificate verification process, the FT Optix MQTT client checks the digital signature of the broker certificate to ensure that it has been issued by a trusted certificate authority (CA). The client also verifies that the certificate has not expired.

CA certificate file: A Certificate Authority certificate that has signed the server certificate on the MQTT Broker. It is required once SSL/TLS is activated to establish secure connection with the broker. It must be found in \FactoryTalk Optix\Projects\ProjectName\ProjectFiles\PKI\Own\Certs folder.

Client certificate file: FT Optix MQTT Client certificate. A client certificate identifies the client just like the server certificate identifies the server. If this property stays empty only broker certificate is user for authentication. It must be found in \FactoryTalk Optix\Projects\ProjectName\ProjectFiles\PKI\Own\Certs folder.

Client private key file: FT Optix MQTT Client private key. It must be found in \FactoryTalk Optix\Projects\ProjectName\ProjectFiles\PKI\Own\Certs folder.

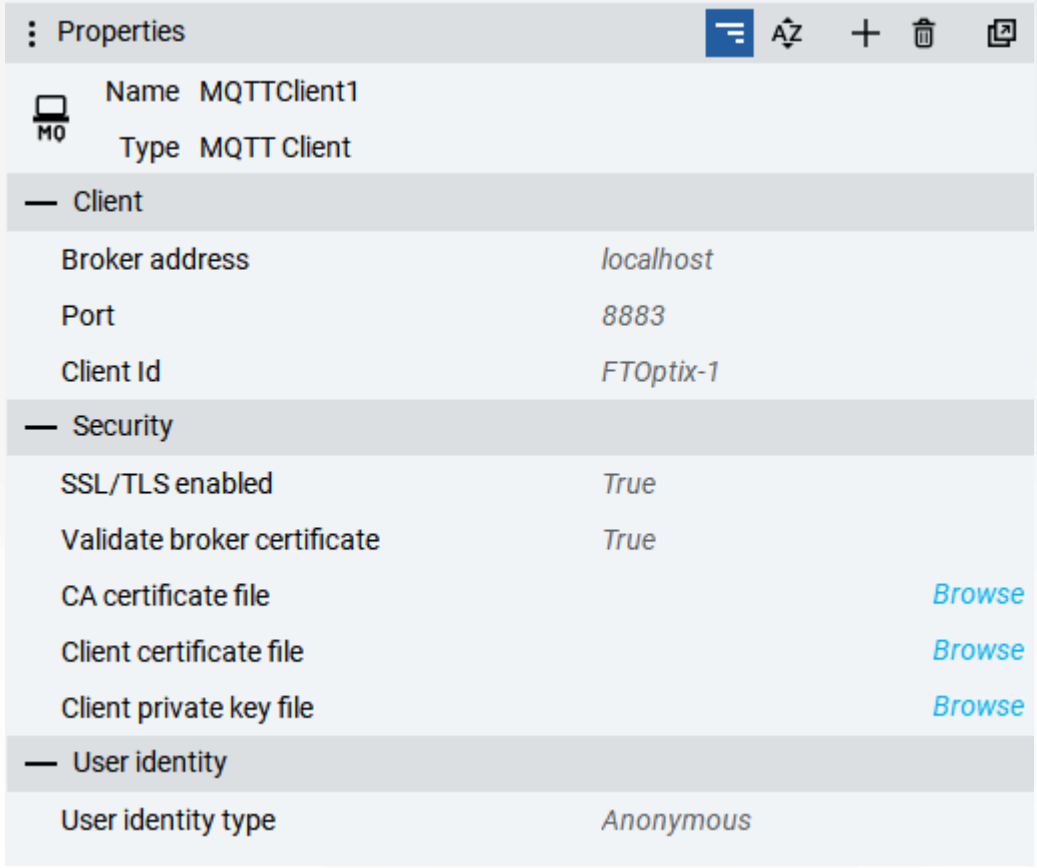


MQTT Client

User identity

User Identity type: Specify user when accessing the MQTT Broker:

- Anonymous (default) - No login is performed, access the server as Anonymous user
- Username/Password - Specify a username and password combination for logon.



MQTT Client/Publisher

Sampling mode:

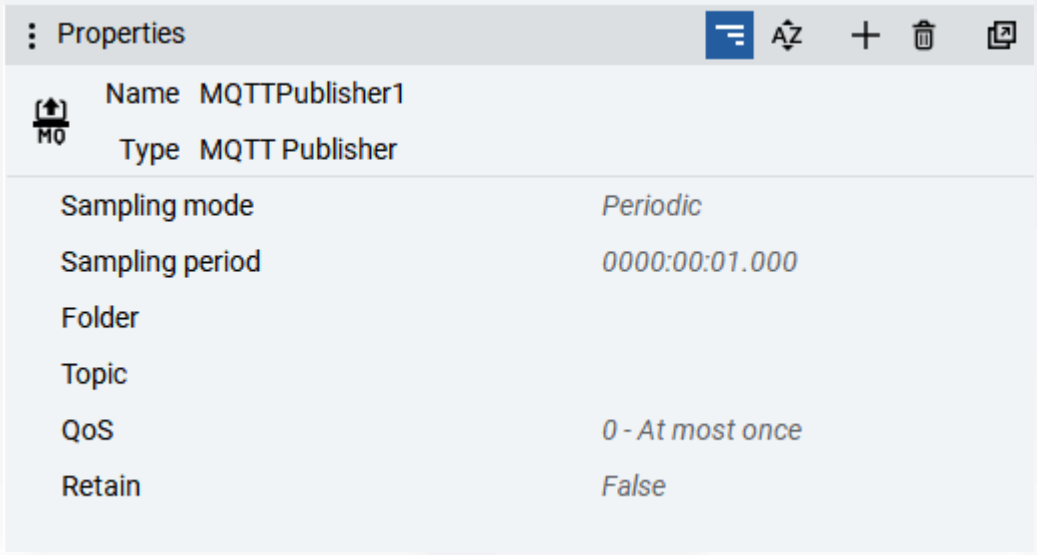
- **None**. Automatic recording is disabled, can record by invoking the Sample method;
- **Periodic**. At regular intervals records the values of all the selected variables;
- **Change in value**. At regular intervals records only the values of the selected variables that have changed with respect to the previous sampling.

Sampling period: Interval in hours, with millisecond precision, between one sampling and the next, in the Periodic mode.

Pooling time: Interval in hours, with millisecond precision, between one sampling and the next, in the Value change mode.

Folder: This folder contains variables whose values will be sent to the broker. The Folder node must be a global object and cannot be a session-based object.

Topic: Defines MQTT topic on which we are sending/publishing data. (Topic is required. Once topic is empty Publisher will generate warrning message during first publish. RT will not stop and other mqtt functions will keep working, only this specific Publisher will be stopped.)



MQTT Client/Publisher

QoS: MQTT Quality of Service (QoS), defines the guarantee of delivery for a specific message (0, 1, 2).

0 – At most once (May lose messages).

1 – At least once (Guarantees the message delivery but potentially duplicate messages).

2 – Exactly once (Ensures messages are delivered exactly once without duplication).

Retain: Retain message on the topic even after read

True - Enables Retain functionality

False - Disables Retain functionality

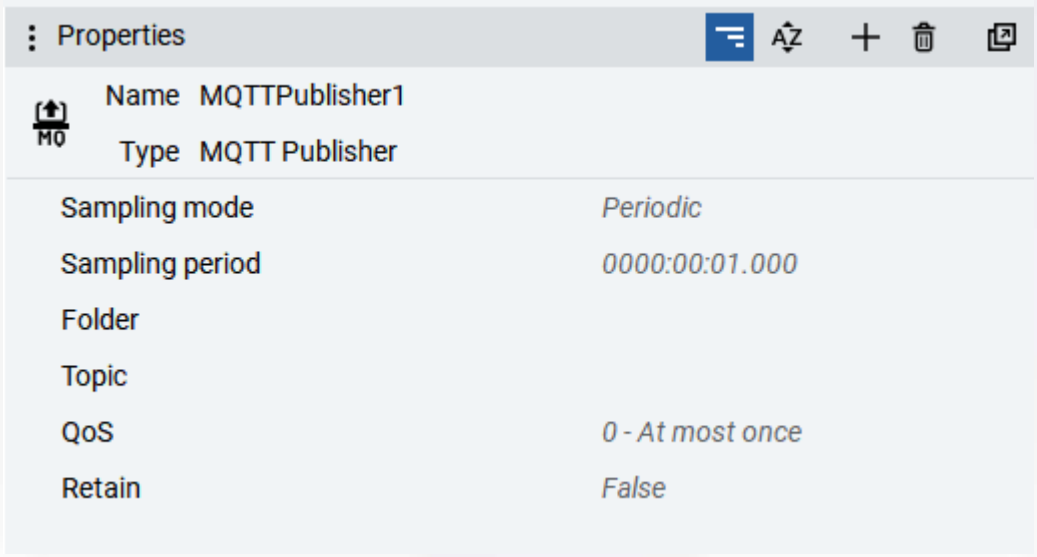
MQTT Client/Subscriber

Folder: This folder node contains variables on which the Subscriber will copy the values read from the broker.

Topic: A single topic on a Broker to subscribe. Topic is required.

QoS: MQTT Quality of Service (QoS), defines the guarantee of delivery for a specific message (0, 1, 2).

- **0 – At most once** (May lose messages).
- **1 – At least once** (Guarantees the message delivery but potentially duplicate messages).
- **2 – Exactly once** (Ensures messages are delivered exactly once without duplication).



Current Limitations

Supported Data Types:

- The publish/subscribe mechanism currently supports **only scalar variables**.
- Structures (UDTs), folders, or other complex data types are **not supported**.

Custom Payloads:

- It is not possible to configure a custom payload for MQTT messages currently.
- Workaround: use the Publish method and provide a valid payload

Sparkplug B:

- Not supported yet.

MQTT Token usage

Basic Concept of the License

1. **MQTT Clients without a Broker (pointing to localhost):**
   - Each client that connects to its local broker (localhost) consumes 1 token each.
   - If you have n clients, the total cost will be n tokens.
2. **MQTT Clients with a Central Broker:**
   - If you configure a central broker and all clients connect to it:
     - The clients do not consume tokens.
     - Only the broker consumes 1 token, regardless of the number of connected clients.
3. **MQTT Clients with Different Brokers:**
   - If the clients connect to different brokers (e.g., Broker A, Broker B, etc.):
     - Each broker consumes 1 token.
     - If there are n different brokers, the total cost will be n tokens, regardless of the number of clients connected to each broker.

MQTT Utilities

MQTT Official website: MQTT – The Standard for IoT Messaging

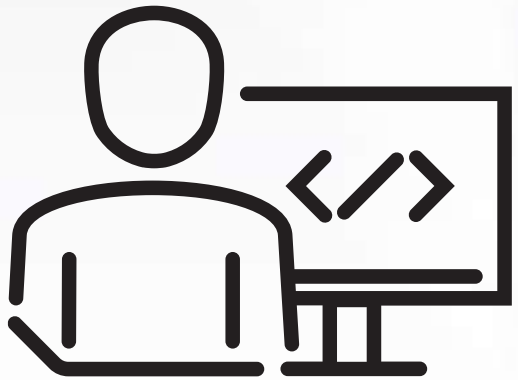
MQTT 5 Standard: MQTT Version 5.0

This tool helps us to connect to a broker and to subscribe to a specific topic, checking all the packets sent. It also allows us to publish to a topic.

MQTTX: Your All-in-one MQTT Client Toolbox

Hands-on session

- Define an MQTT Broker: Set up the MQTT broker to act as the central hub for communication.
  - Key configurations to cover:
    - Listener port (e.g., 1883 for standard or 8883 for SSL/TLS).
    - Retained messages (optional, if applicable to your example).
    - Max connections (adjust as needed based on class size).
- Define an MQTT Client: introduce the concept of an MQTT client, explaining its dual roles as a Publisher and Subscriber.
  - Publisher: configure the client to publish updates to a specific topic (e.g., sensor/temperature).
  - Create a variable that triggers a message when its value changes.
  - Subscriber: Configure the client to subscribe to the same topic (sensor/temperature) and react to updates published by the Publisher.
- Key learning points: Ensure the topic names match exactly (case-sensitive).
- Create Variables that Synchronize via MQTT: Demonstrate how to bind variables to MQTT topics in the software or platform being used.
- Example: create a "source" variable (e.g., temperature) that updates periodically or based on variable change. Create a "target" variable (e.g., displayTemperature) that listens for updates via MQTT and synchronizes automatically. Ensure the variable changes are observable in real-time.
- Test the configuration: Publish a value change (e.g., simulate a sensor reading update). Verify that the subscriber's variable updates automatically when the publisher sends data.



REST APIs

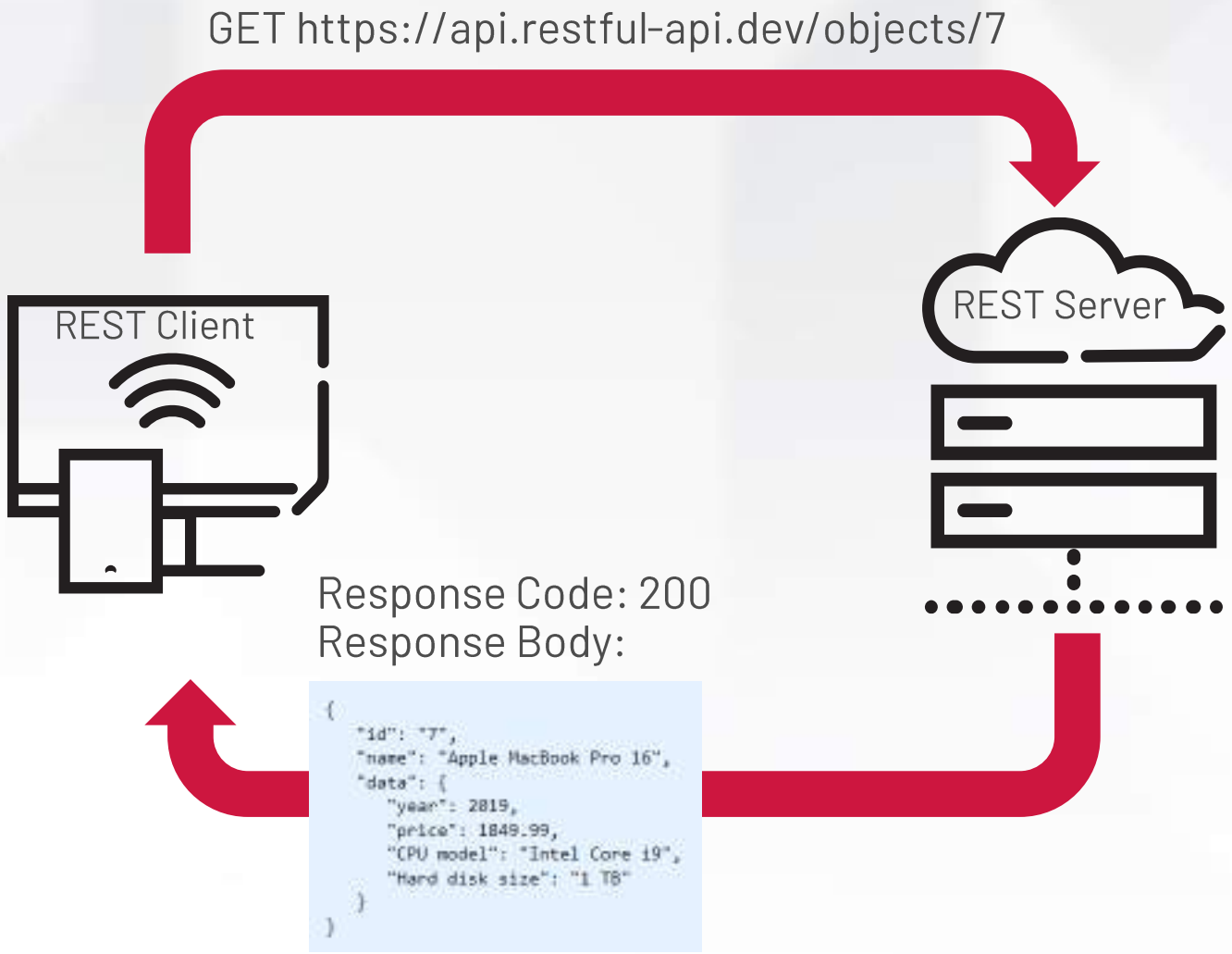
REST APIs – Intro to REST

- REST: Representational State Transfer
- Most commonly used protocol for interacting with Web Services
- Protocol uses HTTP / HTTPS methods as the delivery mechanism
- Example Web Services:
  - Google Search (Search the web)
  - Google Maps (Get directions)
  - National Weather Service (Get weather conditions)
  - Twilio (Send Email / Text)
  - Yahoo Finance (Get stock information)
  - SAP (Get business data)
  - ...

REST APIs – HTTP Methods / Response

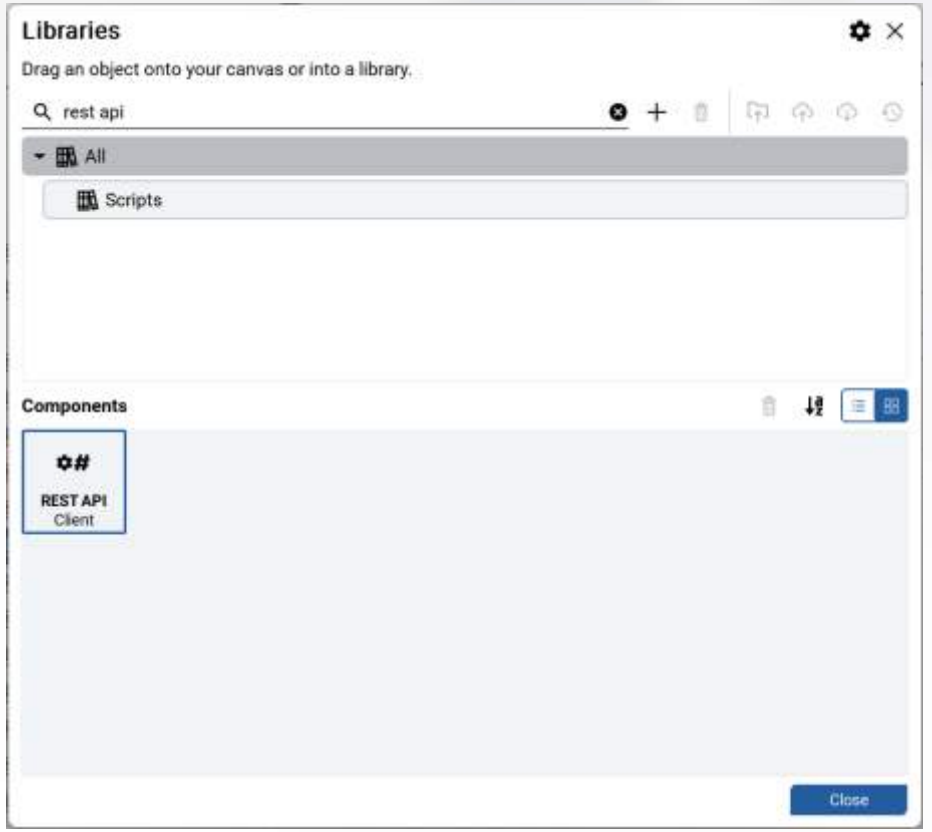
- CRUD: CREATE, READ, UPDATE, DELETE
- HTTP CRUD Methods
  - CREATE: **POST**
  - READ: **GET**
  - UPDATE: **PUT**
  - DELETE: **DELETE**

- HTTP Response:
  - Status Code Integer
    - 200: OK
    - 404: Not Found
    - ...
  - Response Body
    - Typically JSON format



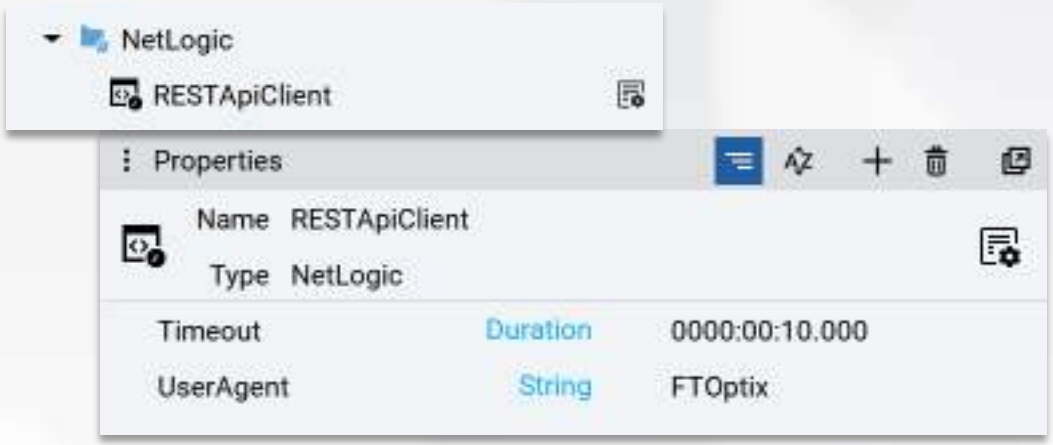
REST APIs – Implementing in Optix

- Prebuilt NetLogic script in Optix Scripts Library
- 'REST API Client' Script supported HTTP methods:
  - **GET**
  - **POST**
  - **PUT**



REST APIs – Import / Configure RESTApiClient

- Add RESTApiClient to Project
- Configure:
  - Timeout: Defaults to 10s
  - UserAgent: User defined string for client identification. Most REST web services consider this optional. Default: “FTOptix”



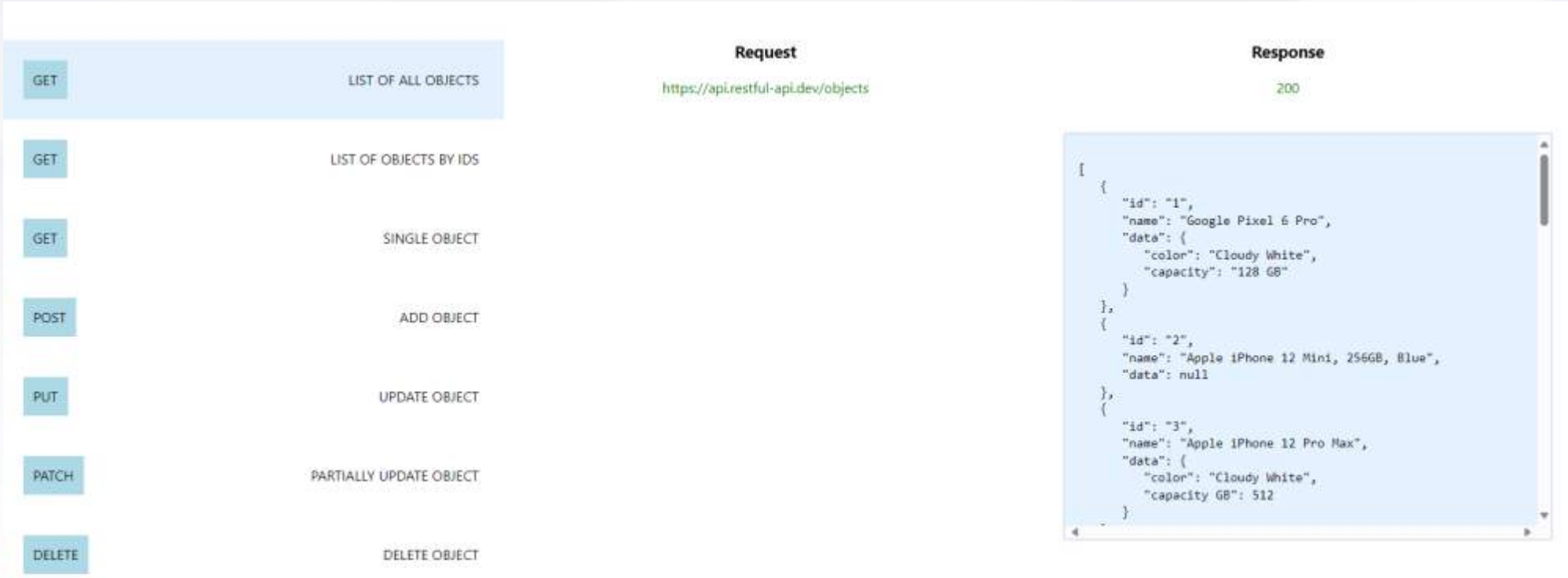
REST APIs – RESTApiClient NetLogic Exploration

- Three Methods available: Get, Post, Put
- Get contains 3 input parameters:
  - apiURL
  - queryString
  - bearerToken
- Post and Put contain 4 input parameters:
  - apiURL
  - requestBody
  - bearerToken
  - contentType
- Each Method contains 'out' parameters with the Response Code (code) and Response Body (response)

```
[ExportMethod]
public void Get(string apiUrl, string queryString, string bearerToken, out string response, out int code)
{
    TimeSpan timeout = TimeSpan.FromMilliseconds(GetTimeout());
    UriBuilder uriBuilder = new UriBuilder(apiUrl);
    uriBuilder.Query = queryString;

    var requestMessage = BuildMessage(HttpMethod.Get, uriBuilder.Uri, "", bearerToken, "");
    var requestTask = PerformRequest(requestMessage, timeout);
    var httpResponse = requestTask.Result;

    (response, code) = (httpResponse.Payload, httpResponse.Code);
}

[ExportMethod]
public void Post(string apiUrl, string requestBody, string bearerToken, string contentType, out string response, out int code)
{
    TimeSpan timeout = TimeSpan.FromMilliseconds(GetTimeout());
    UriBuilder uriBuilder = new UriBuilder(apiUrl);

    var requestMessage = BuildMessage(HttpMethod.Post, uriBuilder.Uri, requestBody, bearerToken, contentType);
    var requestTask = PerformRequest(requestMessage, timeout);
    var httpResponse = requestTask.Result;

    (response, code) = (httpResponse.Payload, httpResponse.Code);
}

[ExportMethod]
public void Put(string apiUrl, string requestBody, string bearerToken, string contentType, out string response, out int code)
{
    TimeSpan timeout = TimeSpan.FromMilliseconds(GetTimeout());
    UriBuilder uriBuilder = new UriBuilder(apiUrl);

    var requestMessage = BuildMessage(HttpMethod.Put, uriBuilder.Uri, requestBody, bearerToken, contentType);
    var requestTask = PerformRequest(requestMessage, timeout);
    var httpResponse = requestTask.Result;

    (response, code) = (httpResponse.Payload, httpResponse.Code);
}
```

REST APIs – GET Example (Get a list of all objects)

- Get contains 3 input parameters:
  - apiURL: “https://api.restful-api.dev/objects”
  - queryString: NULL (No Parameters)
  - bearerToken: NULL (No Security)



*https://restful-api.dev

REST APIs – GET Example (Get a list of all objects)

- Get contains 3 input parameters:
  - apiURL: "https://api.restful-api.dev/objects"
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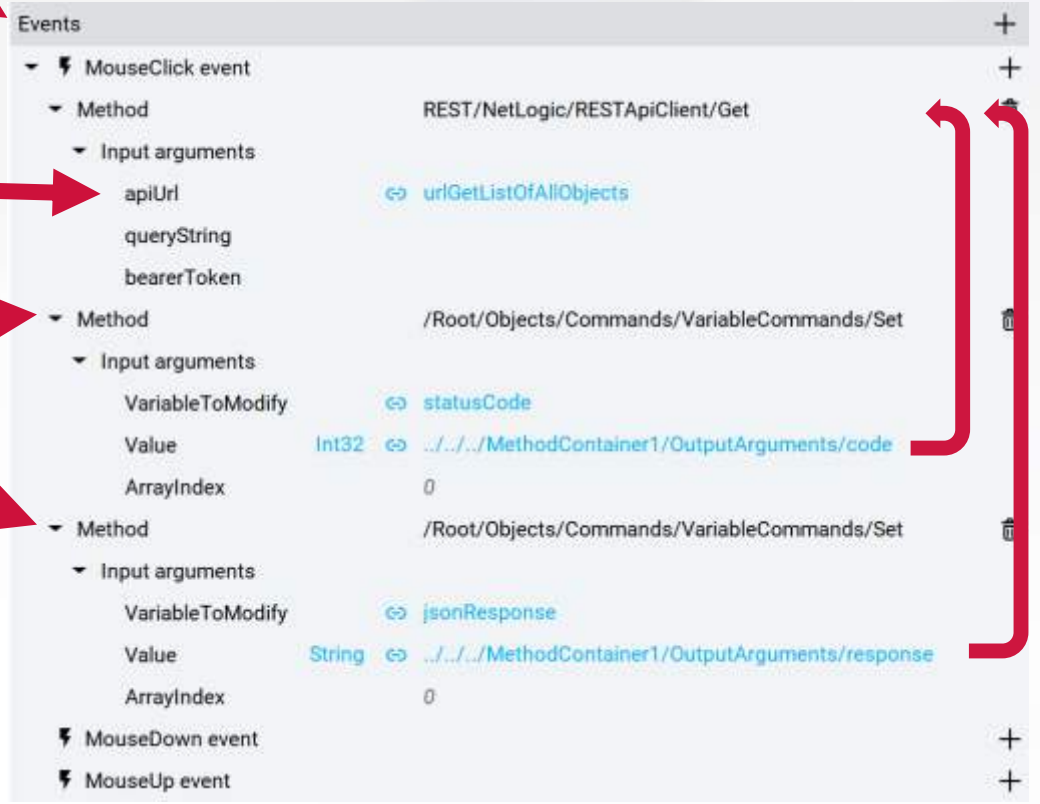
1. Call the RESTApiClient/Get method with 'apiURL' set.
2. Use VariableCommands/Set to gather the RESApiClient/Get Output Parameters



REST APIs – GET Example (Get a list of specific objects)

- Get contains 3 input parameters:
  - apiURL: “https://api.restful-api.dev/objects”
  - queryString: “id=3&id=5&id=10” (everything after “?” in request URL)
  - bearerToken: NULL (No Security)

*https://restful-api.dev

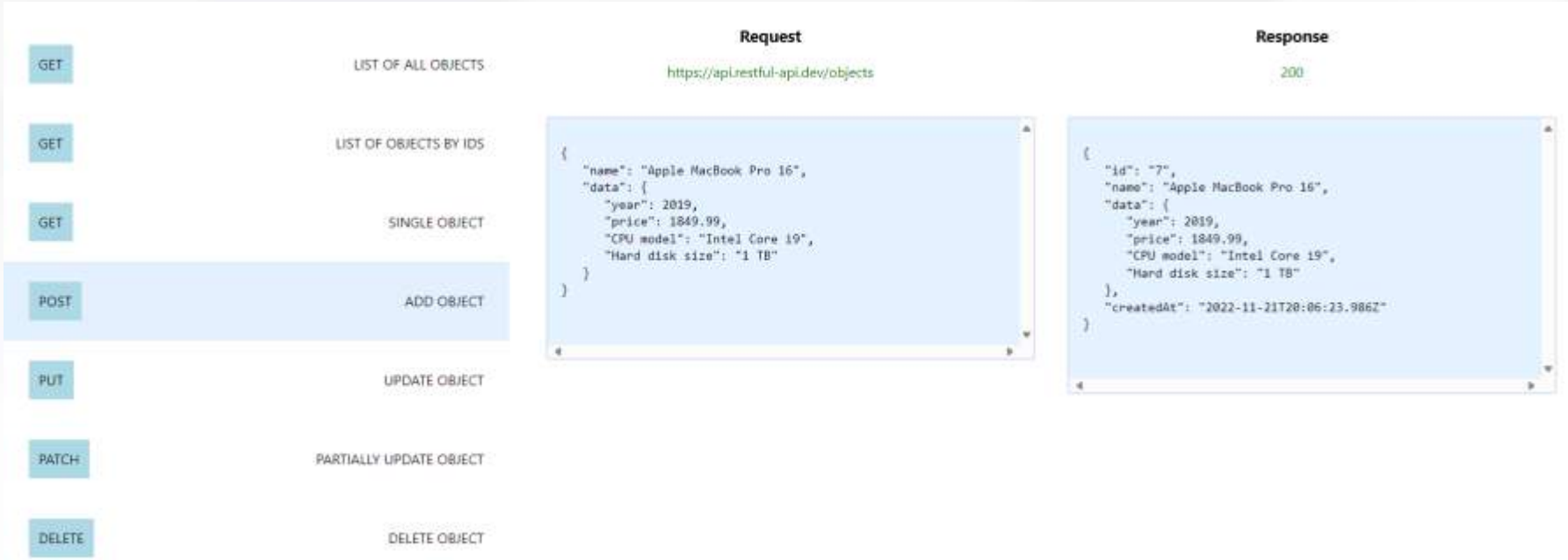
REST APIs – GET Example (Get a list of specific objects)

- Get contains 3 input parameters:
  - apiURL: "https://api.restful-api.dev/objects"
  - queryString: "id=3&id=5&id=10" (everything after "?" in request URL)
  - bearerToken: NULL (No Security)

1. Call the RESTApiClient/Get method with 'apiURL' and 'queryString' set.
2. Use VariableCommands/Set to gather the RESApiClient/Get Output Parameters

REST APIs – POST Example (Add new object)

- POST contains 4 input parameters:
  - apiURL: “https://api.restful-api.dev/objects”
  - requestBody: “{ "name": "Apple MacBook Pro 16", "data": { "year": 2019, "price": 1849.99, "CPU model": "Intel Core i9", "Hard disk size": "1 TB" } }”
  - bearerToken: NULL (No Security)
  - contentType: “application/json” (See Media type – Wikipedia for other content-type examples)



*https://restful-api.dev

REST APIs – POST Example (Add new object)

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  - bearerToken: NULL (No Security)
  - contentType: “application/json” (See Media type – Wikipedia for other content-type examples)

1. Call the RESTApiClient/Post method with ‘apiURL’, ‘requestBody’, and contentType set.
2. Use VariableCommands/Set to gather the RESApiClient/Post Output Parameters

REST APIs – PUT Example (Update object)

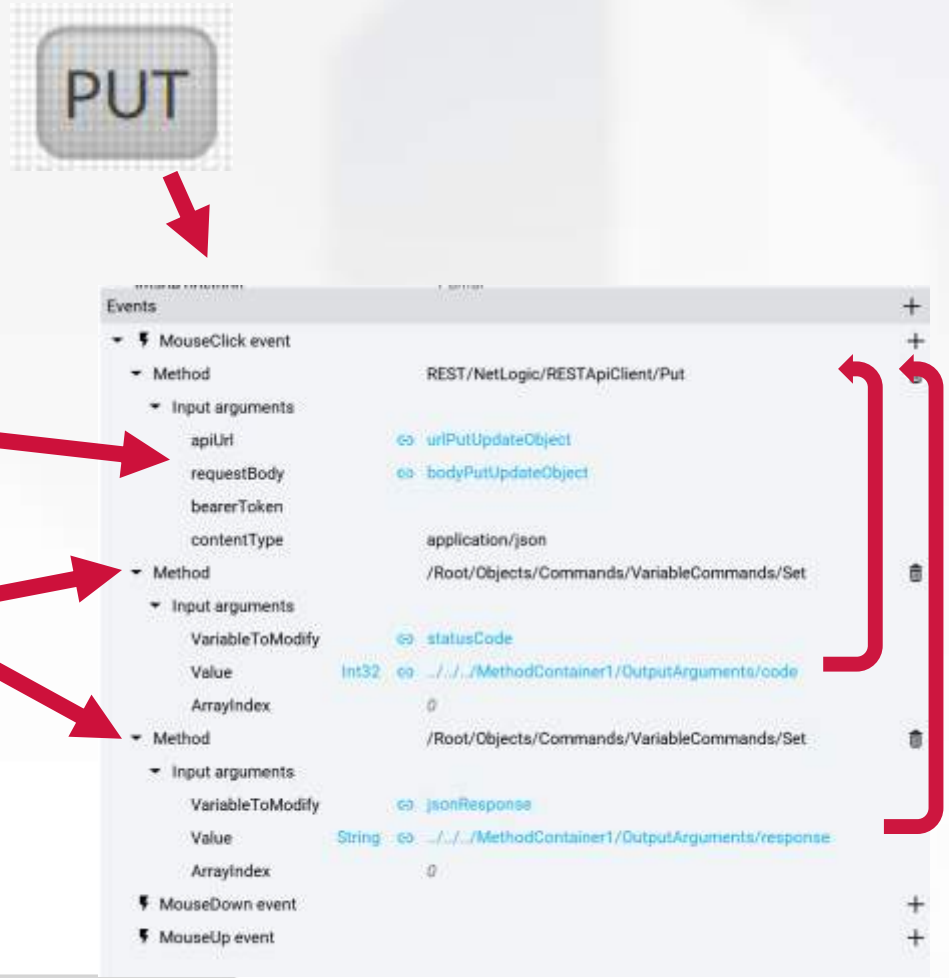
- PUT contains 4 input parameters:
  - apiURL: “https://api.restful-api.dev/objects/7”
  - requestBody: “{ "name": "Apple MacBook Pro 16", "data": { "year": 2019, "price": 2049.99, "CPU model": "Intel Core i9", "Hard disk size": "1 TB", "color": "silver" } }”
  - bearerToken: NULL (No Security)
  - contentType: “application/json” (See Media type – Wikipedia for other content-type examples)

*https://restful-api.dev

REST APIs – PUT Example (Update object)

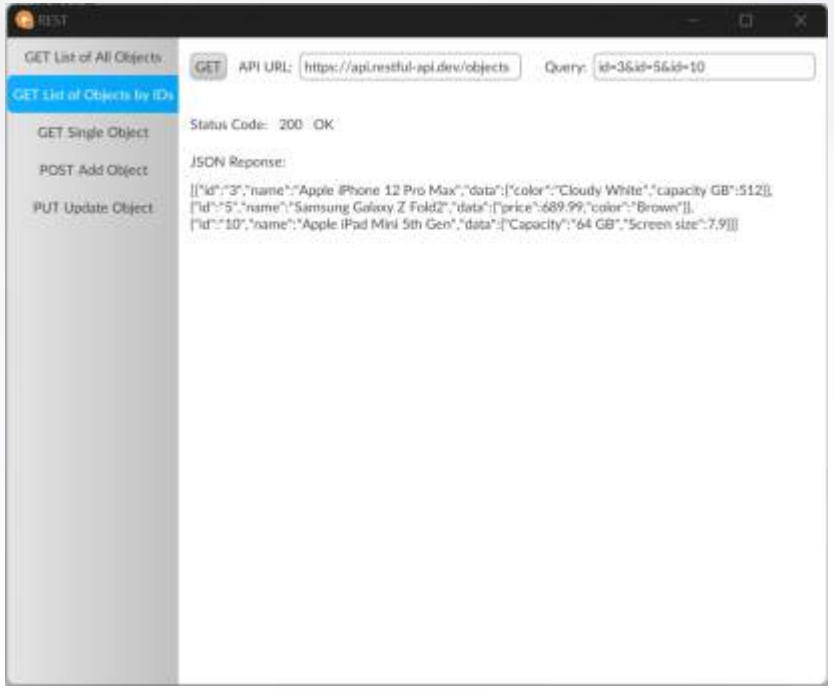
- PUT contains 4 input parameters:
  - apiURL: “https://api.restful-api.dev/objects/7”
  - requestBody: “{ "name": "Apple MacBook Pro 16", "data": { "year": 2019, "price": 2049.99, "CPU model": "Intel Core i9", "Hard disk size": "1 TB", "color": "silver" } }”
  - bearerToken: NULL (No Security)
  - contentType: “application/json” (See Media type – Wikipedia for other content-type examples)

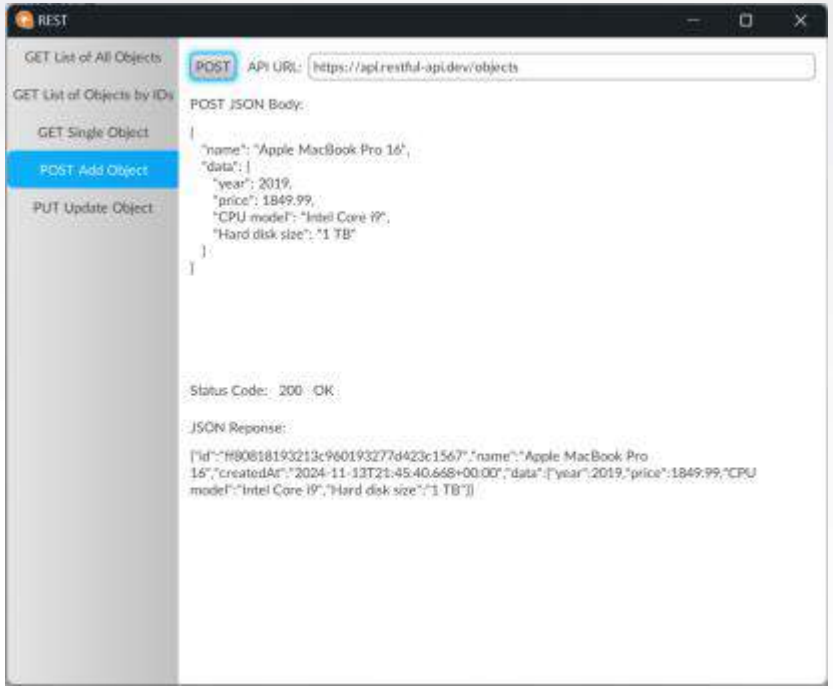
1. Call the RESTApiClient/Put method with ‘apiURL’, ‘requestBody’, and contentType set.
2. Use VariableCommands/Set to gather the RESApiClient/Put Output Parameters

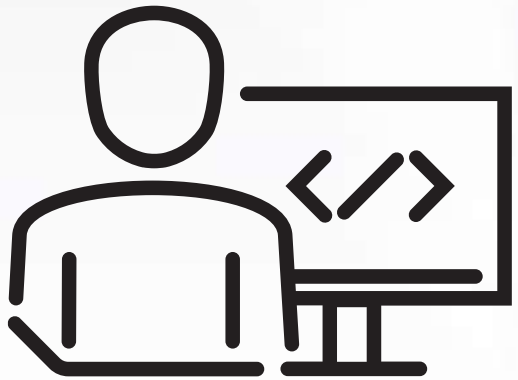


Hands-on session

- Open D01_01 REST_Start
- Add RESTAPIClient NetLogic from Library
- Create method calls on premade GET, POST, and PUT push buttons to complete their associated tasks against the RESTAPIClient NetLogic







Appendix – API Key vs Bearer Token

- Many Public REST APIs require an API Key and or Bearer Token for access
- API Keys are used for Application Authorization
- Bearer Tokens are used for User Authorization
- More Detail here: Why and when to use API keys | Cloud Endpoints with OpenAPI | Google Cloud

Appendix – Optix as REST Web Service

- FactoryTalk-Optix/REST_WEB_WS_Server: Sample of hosting a REST, WEB and Web Socket Server in Optix

Features

- All-in-one object to host WEB Server, REST Server, and Web Sockets in FTOptix
- Currently, no TLS is supported, but maybe in the future
- Provided as sample code
- When you use a REST Server, you will need to adjust the C# code to deal with all the different resources (Endpoints) of the server.
- If used as a Web Socket, there is a variable “Message” which is updated automatically.

Optix Runtime on Docker containers

Optix Runtime on Docker containers

- Optix supports running on x86_64 Ubuntu 22.04 devices
- Creating a container with Ubuntu 22.04 LTS allows the Update Server to be installed in the container
- Two ways to create containers:
  - Container with FactoryTalk Optix Update Server: the Runtime can be downloaded from the IDE to the container
  - Container with the FactoryTalk Optix Runtime: the exported Linux binaries are packed to a Docker container

Optix Runtime on Docker containers

- Procedure overview:
  1. Create base container with Ubuntu 22.04
  2. Install required libraries and dependencies
  3. Copy the FactoryTalk Optix Application Update Service installer
  4. Install the Update Service process
  5. Set the Update Service as entrypoint for the container
  6. Deploy the container

Full procedure with links and images

Optix Runtime on Docker containers

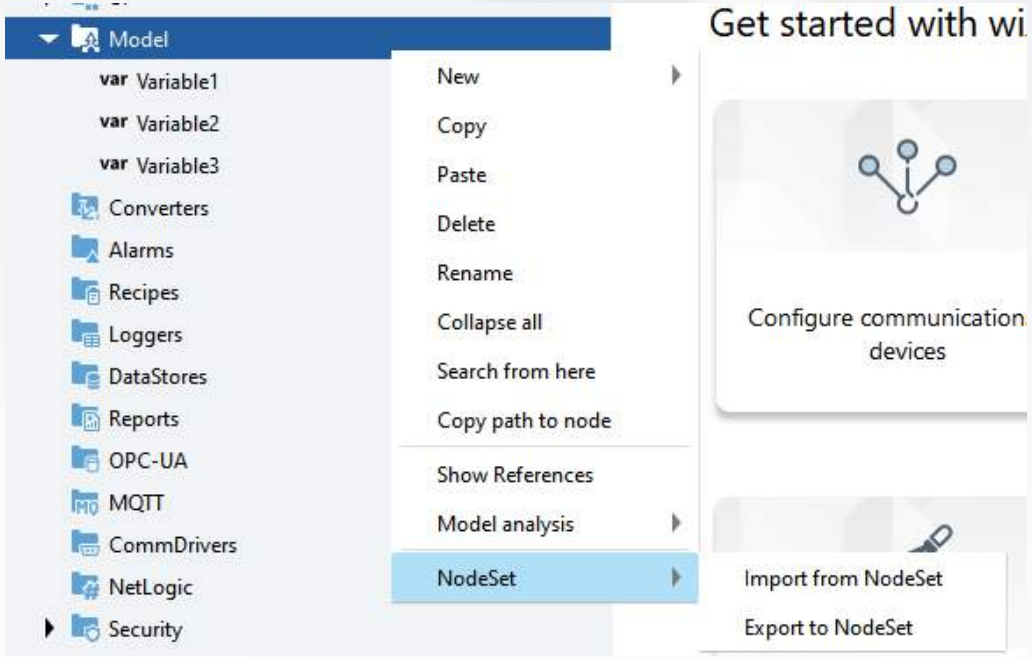
- Limitations:
  - Cannot use Native Presentation Engine
  - Containers can be licensed only if permanently connected to the internet
    - No offline licensing mechanism (as per V1.6)
    - License is verified to the Rockwell infrastructure every 30 mins
    - Entitlement number is passed as Environment variable to the container
  - No support for arm64 devices (Raspberry Pi, etc)
  - Update Server cannot be upgraded from the IDE
    - A new container must be rebuilt

OPC-UA NodeSet

FactoryTalk by ROCKWELL AUTOMATION

OPC-UA NodeSet

- A NodeSet is an XML file which describes a set of OPC-UA elements
- Can be used to:
  - Replicate a portion of the project tree
  - Import a set of tags from an OPC-UA server (offline import)
  - Perform bulk changes on project elements



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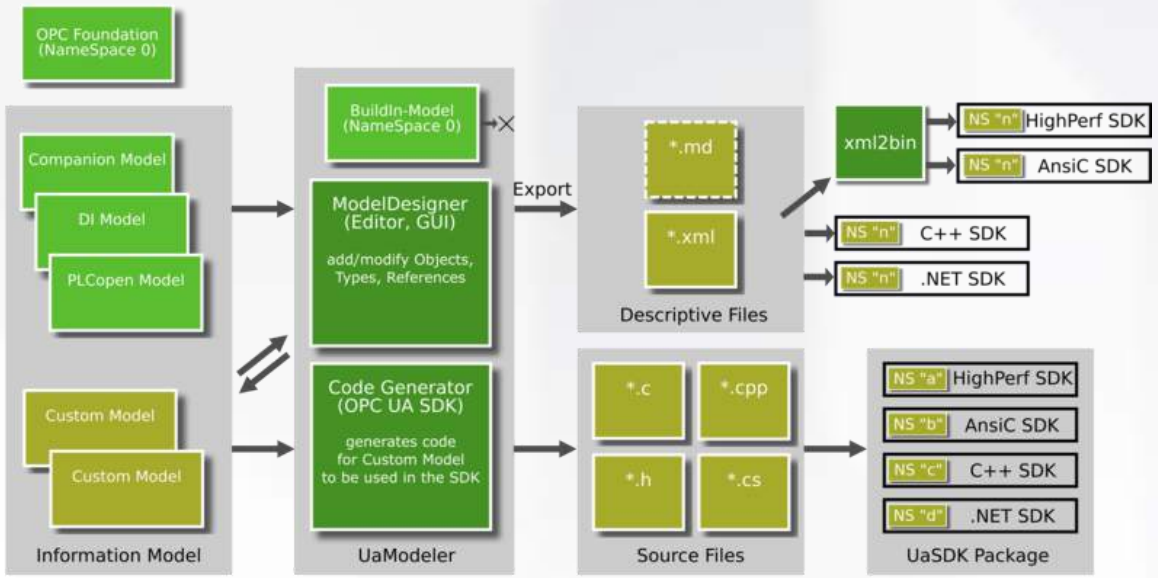
OPC-UA NodeSet

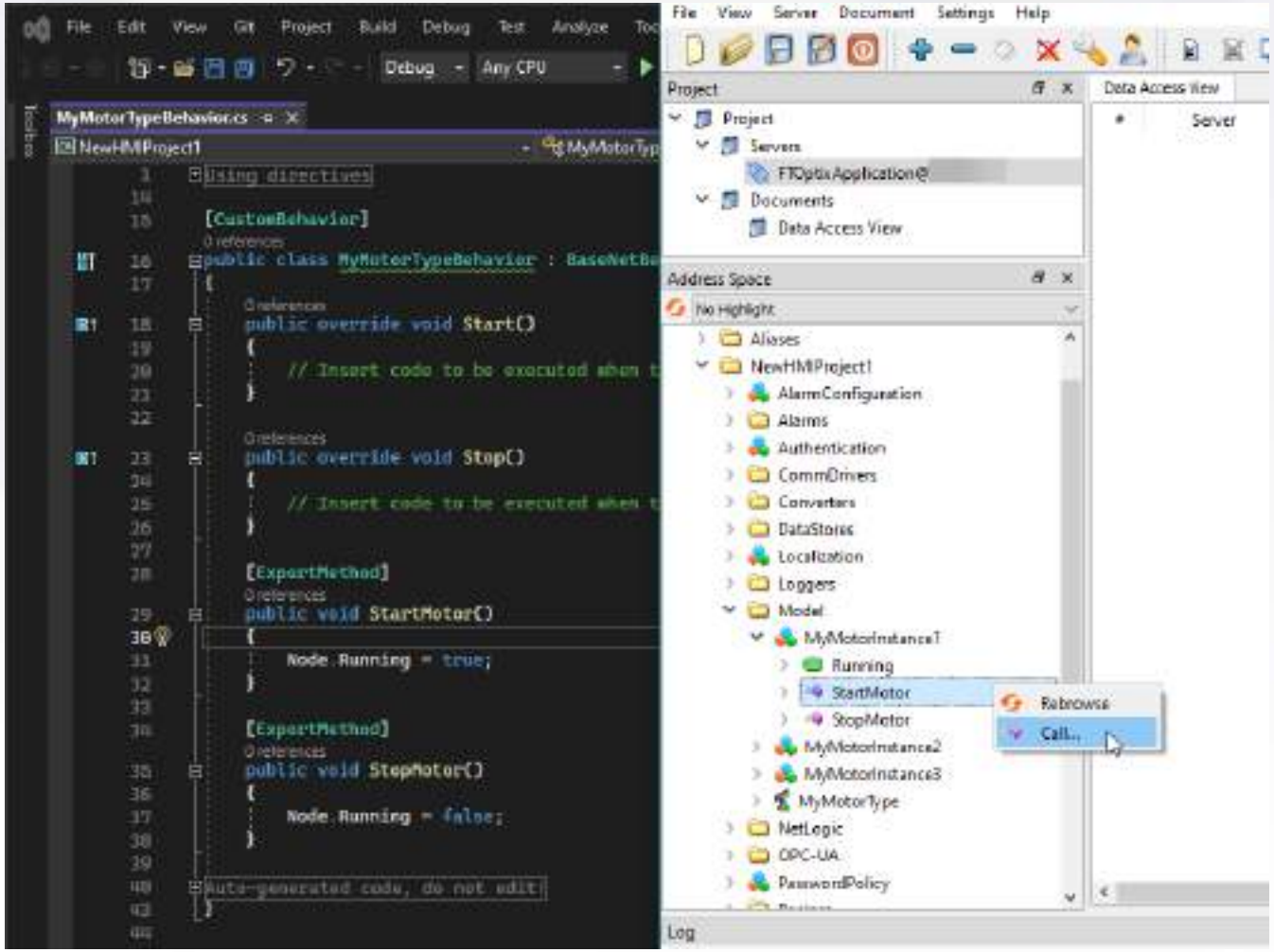
- NodeSet can be created with a variety of tools like UaModeler from the OPC Foundation
- Most third-parties software can generate NodeSet files



OPC-UA Custom Behavior

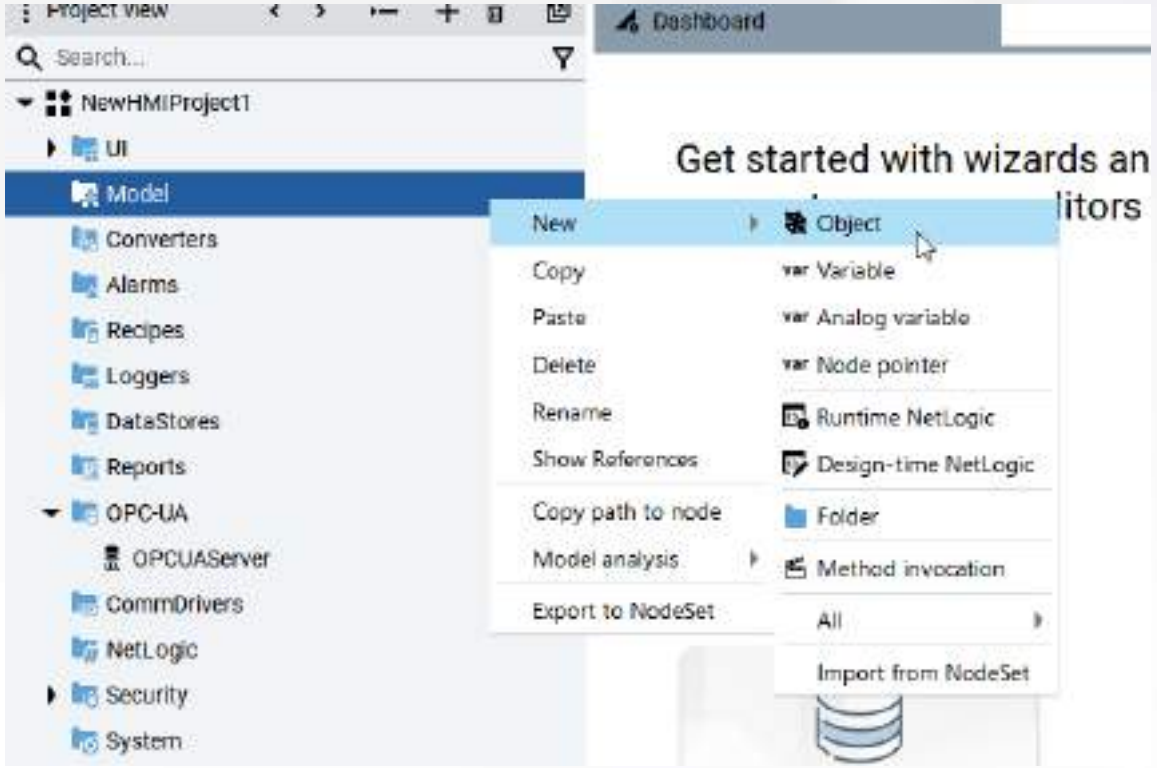
OPC-UA Custom Behavior

- When creating custom OPC-UA Object Types in FactoryTalk Optix, some methods can be exposed via OPC-UA to be called from a client
- Custom behaviors can only be added to IUAObject types
- Instances will inherit all the exposed methods
- Methods must return void, output shall be passed via the out modifier of method's arguments
- Properties of the IUAObject can be accessed using the «node» syntax



Creating an IUAObject with a custom behavior

- Create new IUAObject
- Add properties to the object
- Convert object to object type
- Right click the object type to add the custom behavior
- Double click the object type to open the code editor and configure the methods



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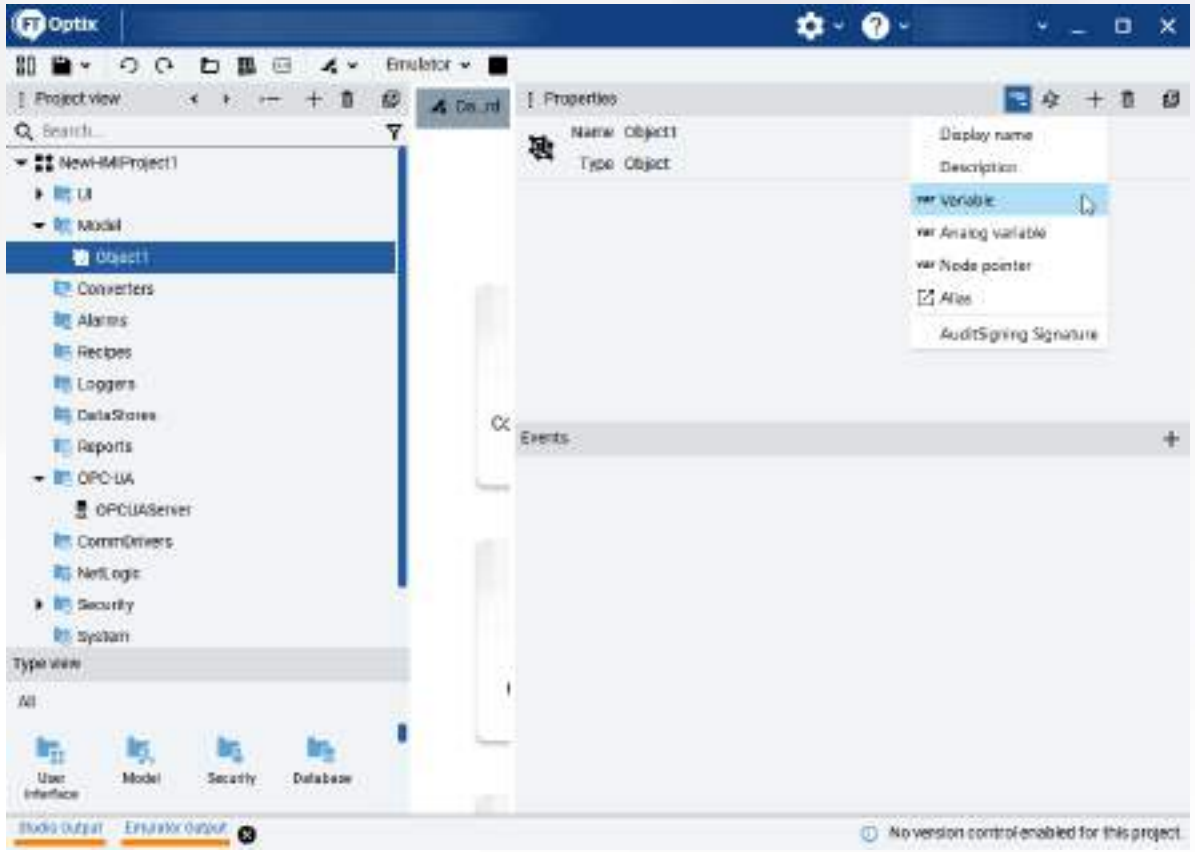

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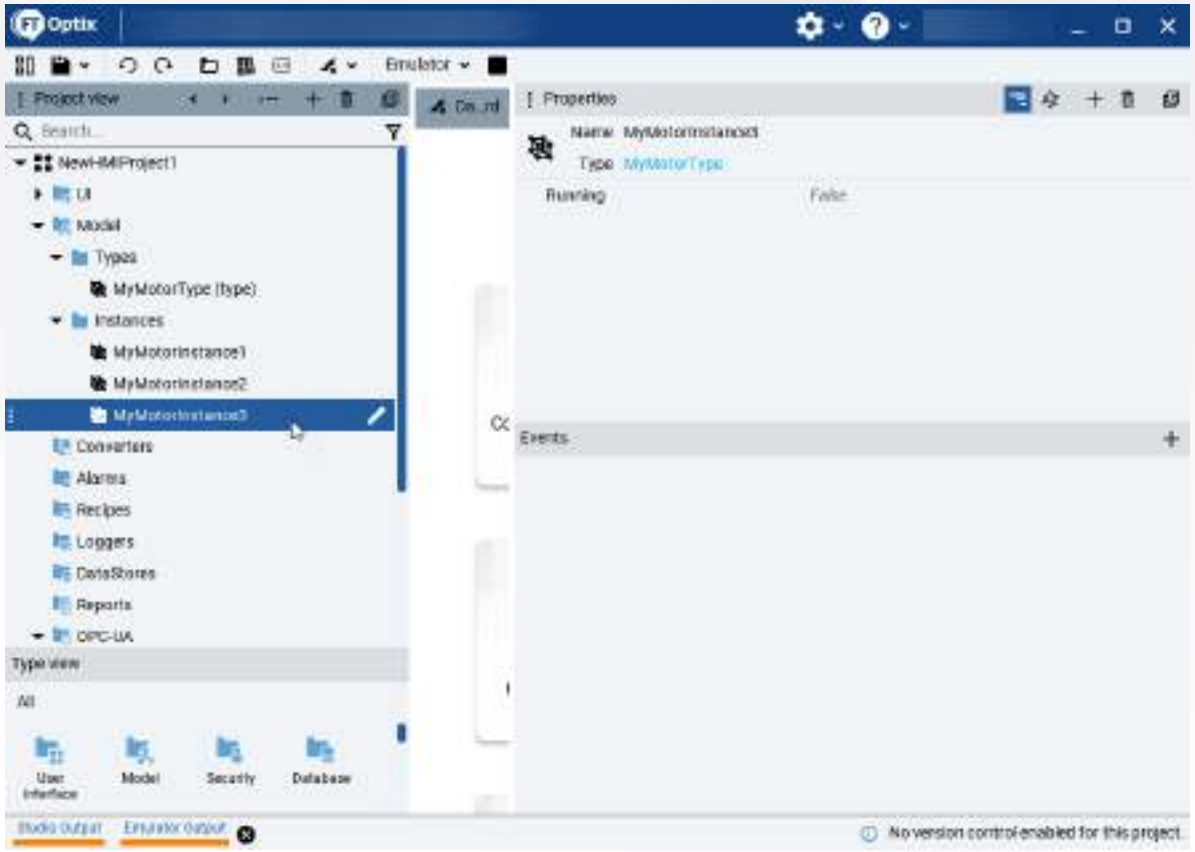

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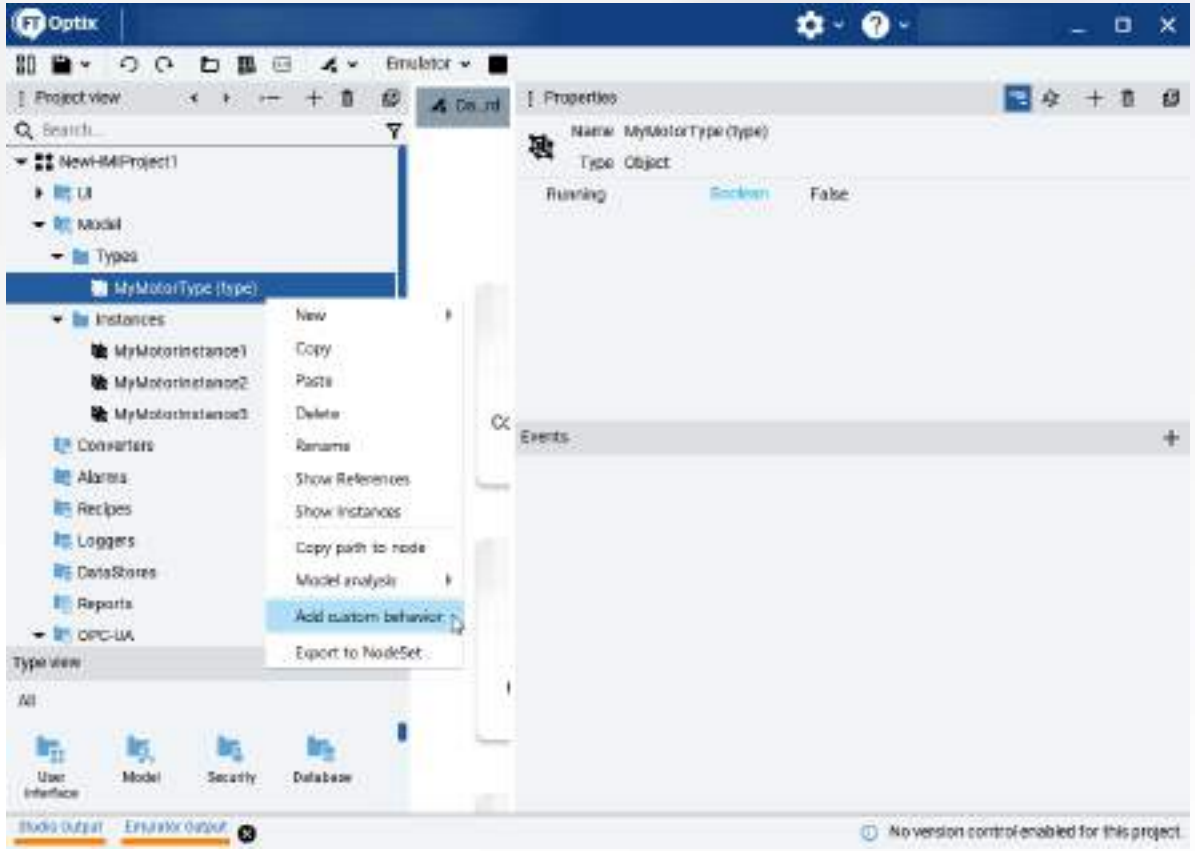

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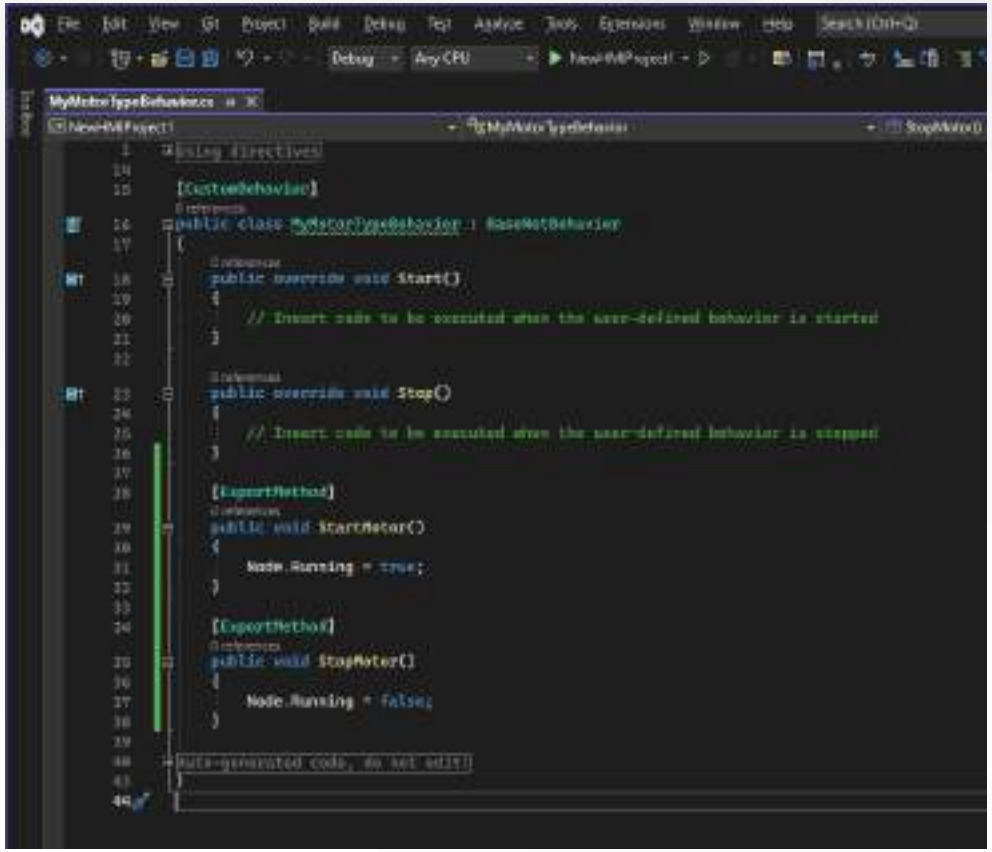
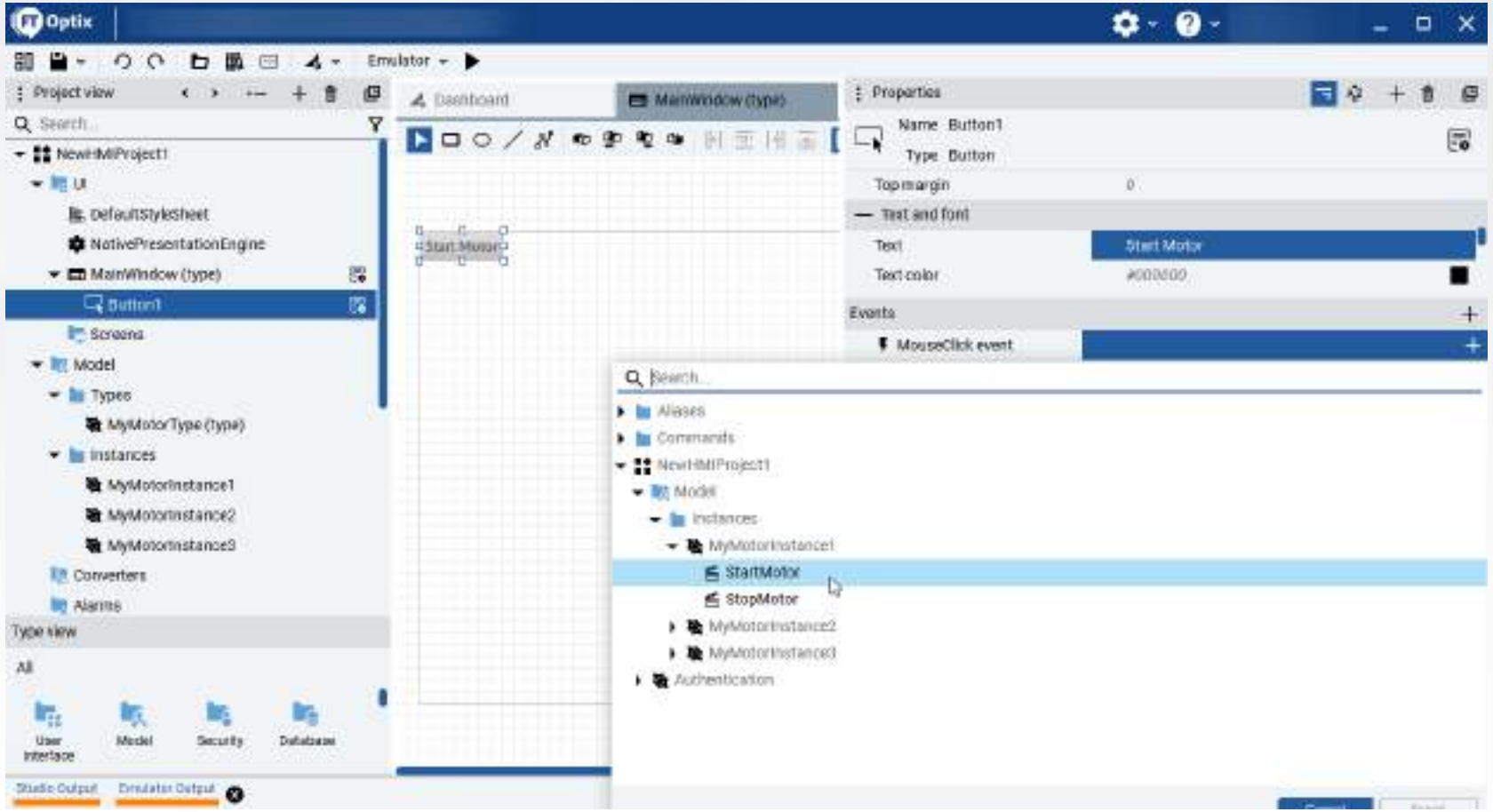


Usage of a custom behavior

- Custom behaviors can be used to call methods via OPC-UA
- Custom behaviors can be used to call methods from FactoryTalk Optix UI Controls or events



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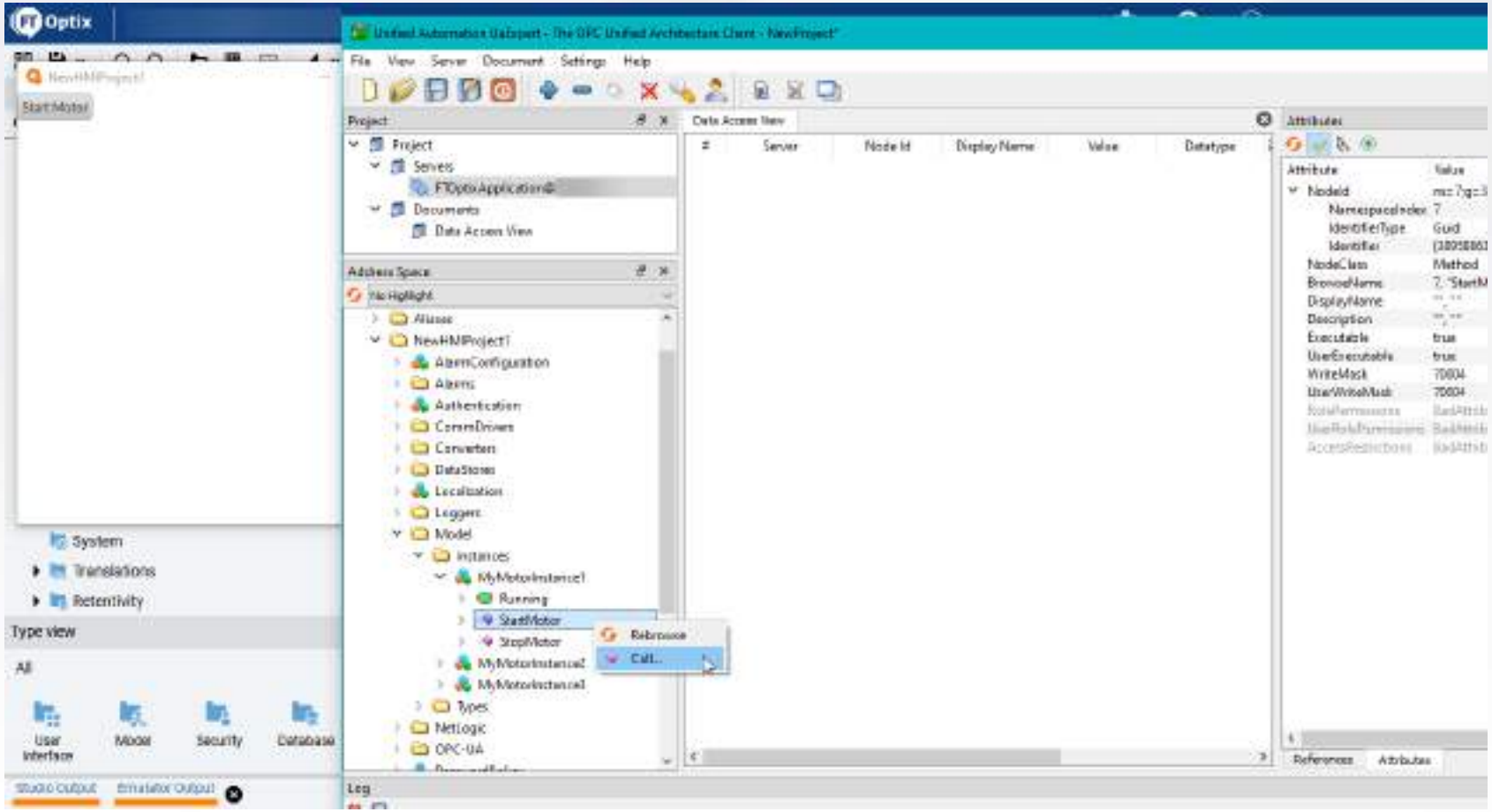
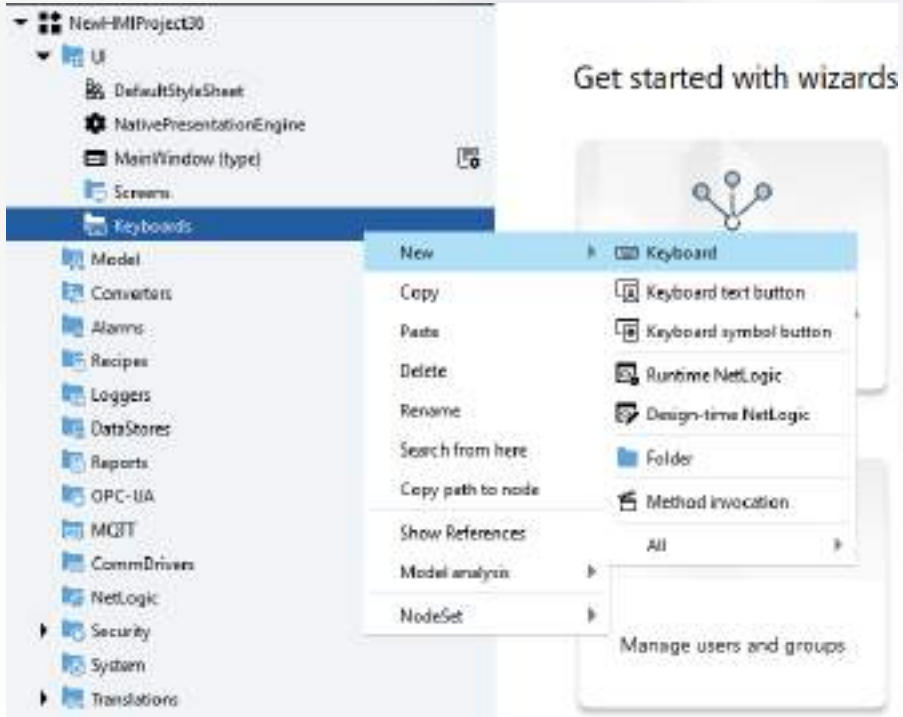


Custom keyboards

Custom keyboards

- Allows overriding the default Qt keyboard
- Allows creating custom logics before data is passed to the field
- Works both on Native UI and Web UI
- Can be fully customized
  - Custom layouts
  - Custom keys for characters
  - Custom keys for actions or symbols



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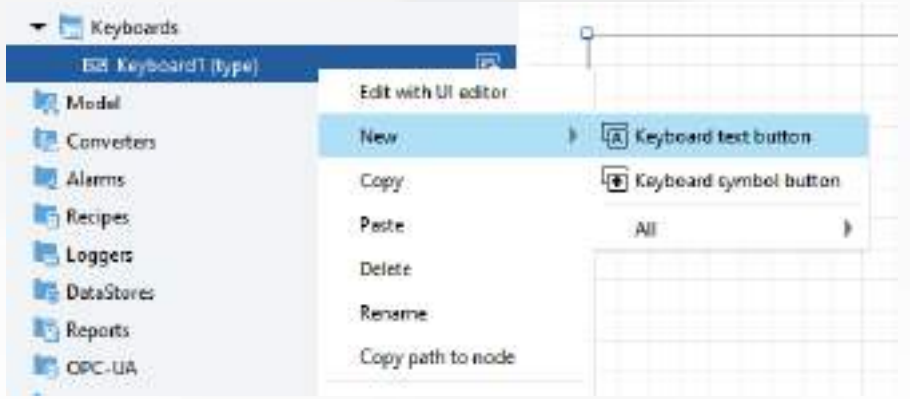

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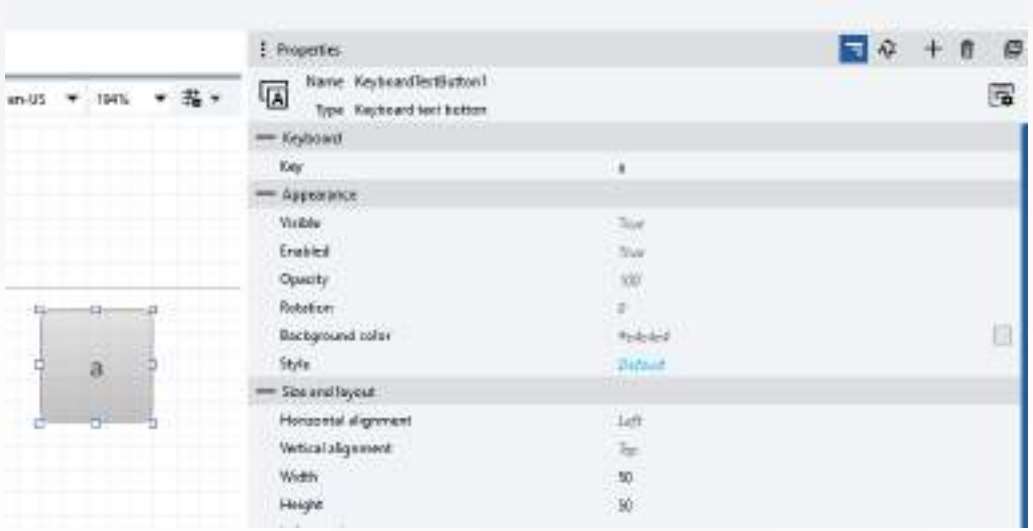

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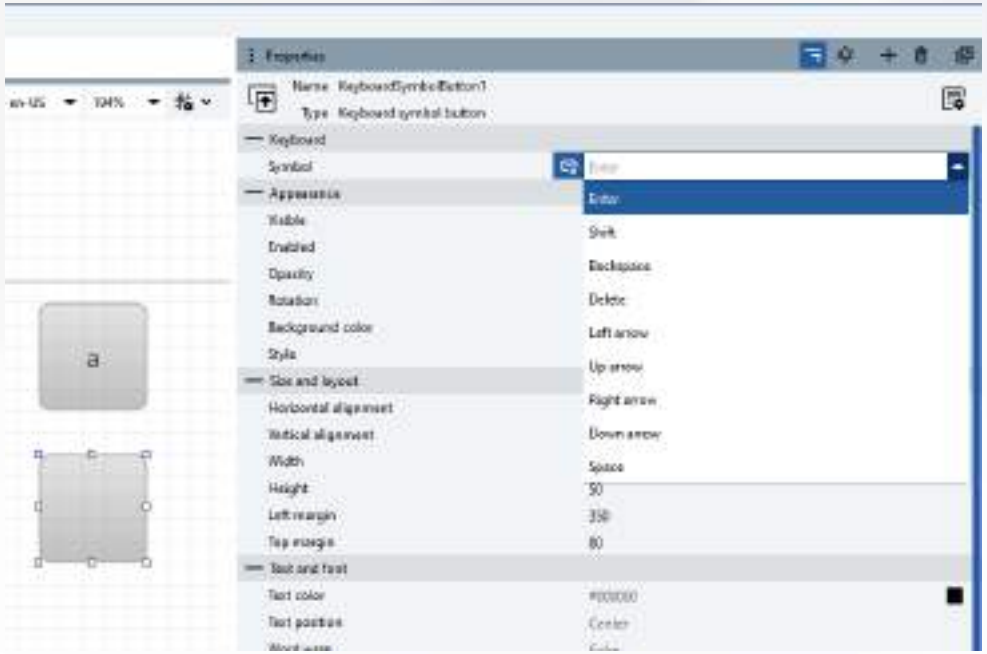
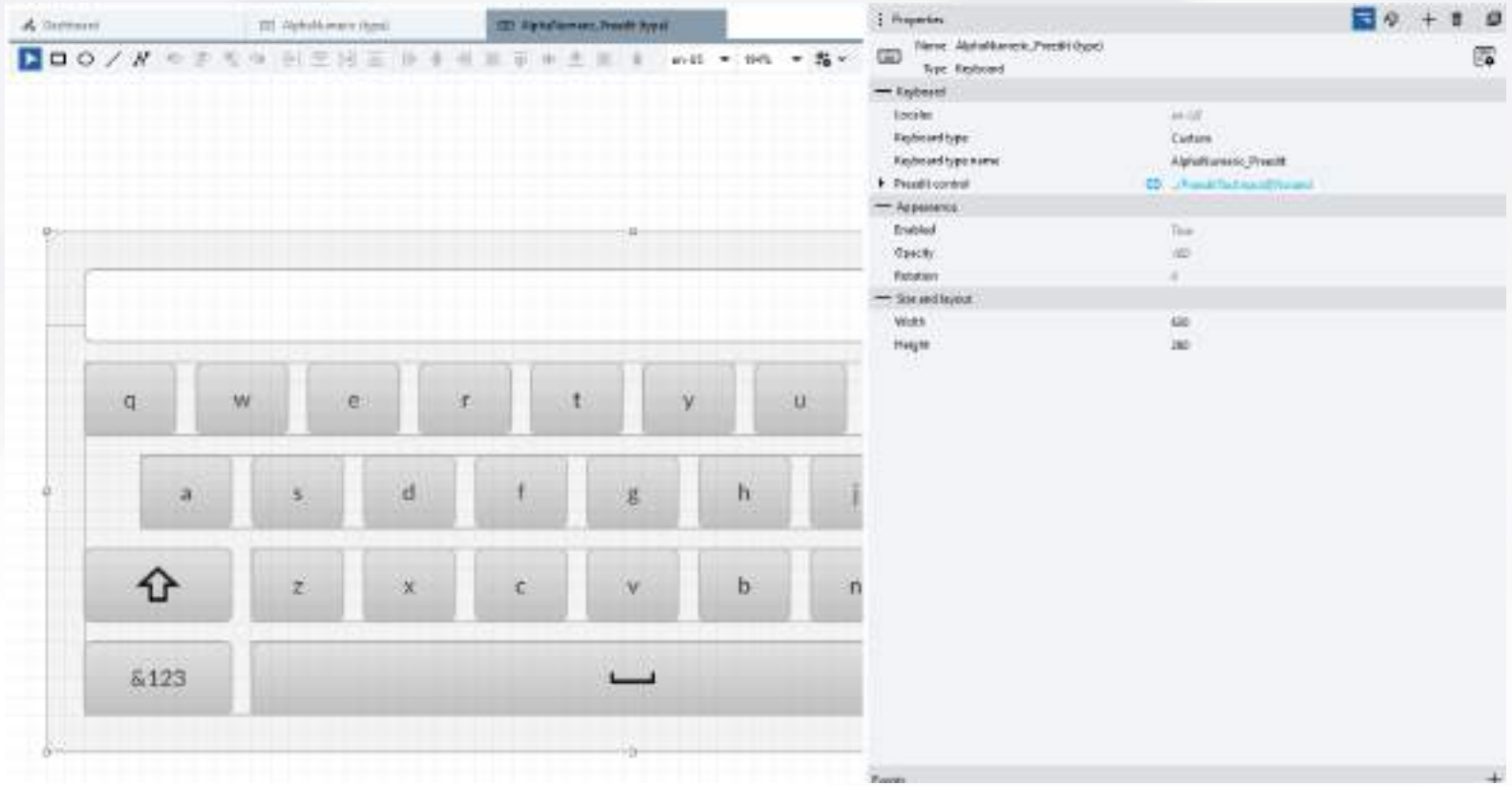


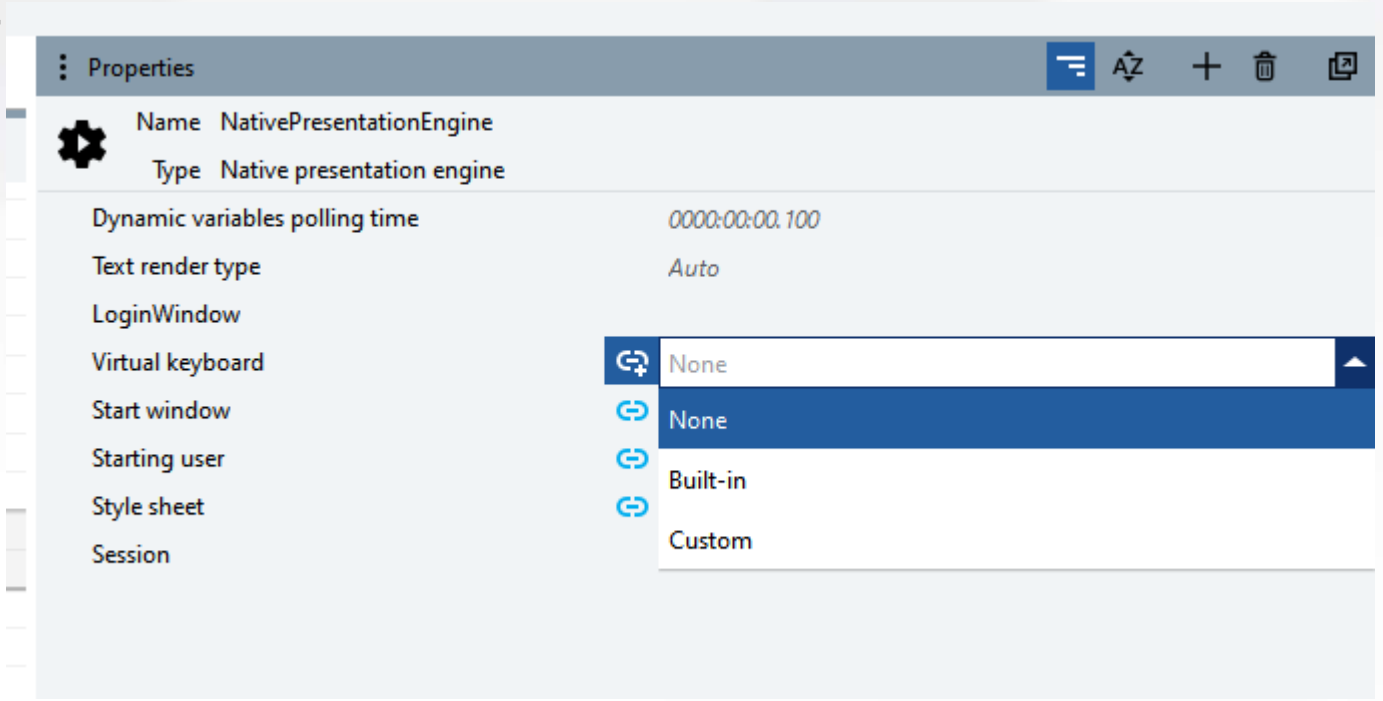
Custom keyboards

- A control (TextBox) can be added as preedit interface
  - Useful to double check the value before sending it to the field
  - Useful to create custom logic to the value (length check, RegEx, etc)



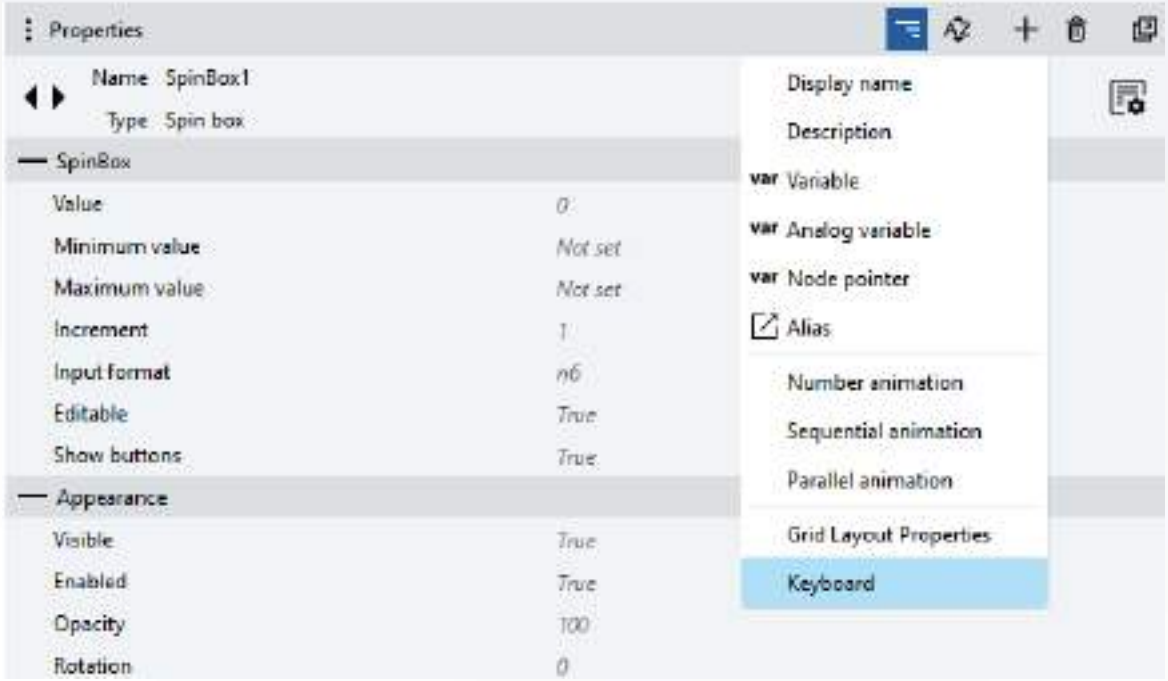
Custom keyboards

- Keyboard selection is done at the Presentation Engine level
  - Built-in: default Qt keyabord
  - Custom: the custom keyboard for that control type



Custom keyboards

- Different UI controls can trigger different keyboards
  - Need to add the attached property “Keyboard” to the control
  - Configure the specific keyboard to be invoked
  - If no custom attached property is added, the default custom keyboard for that kind of control (numeric or alphanumeric) is triggered



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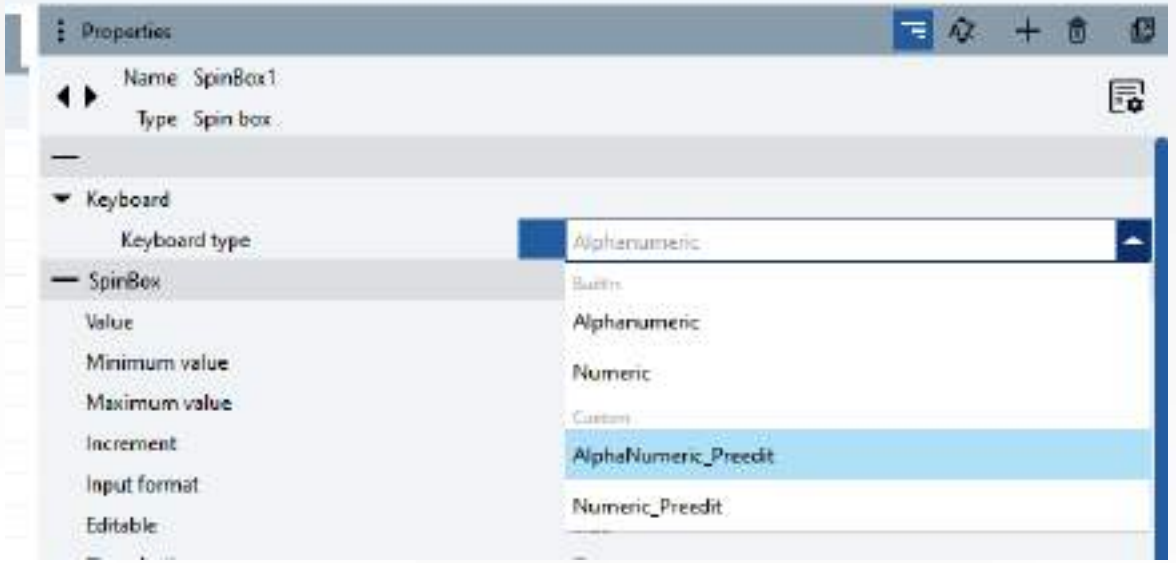
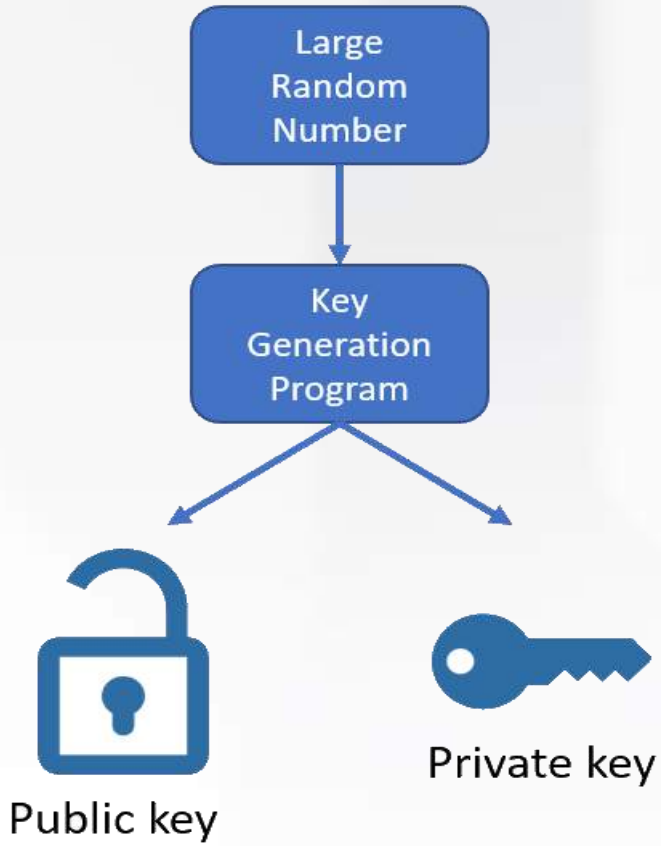


Appendix: see the light about OPC-UA Security

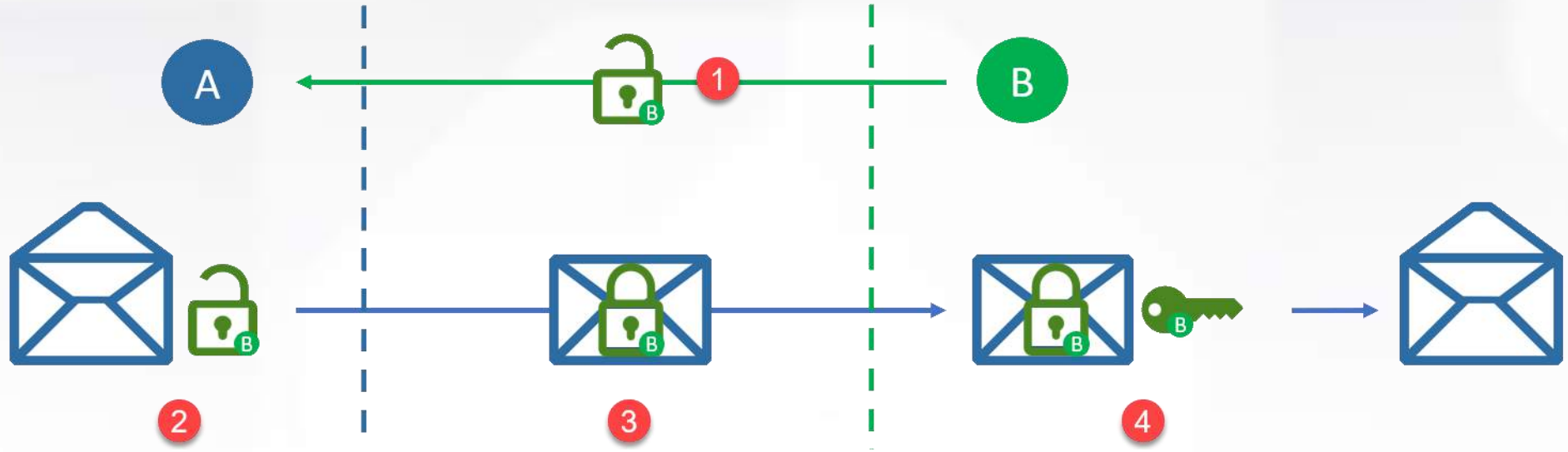
Asymmetric cryptography

- is a cryptographic system that **uses pairs of keys**
- each pair consists of a **public key** and a **private key**
- the generation of such key pairs depends on cryptographic algorithms



How does encryption work ?

1. Alice asks and receives Bob's padlock (Public Key exchange)
2. Alice uses the padlock to close the letter
3. Alice sends the locked letter to Bob
4. When Bob receives the letter, he can open it with his key (Private Key) of which he is the only owner.



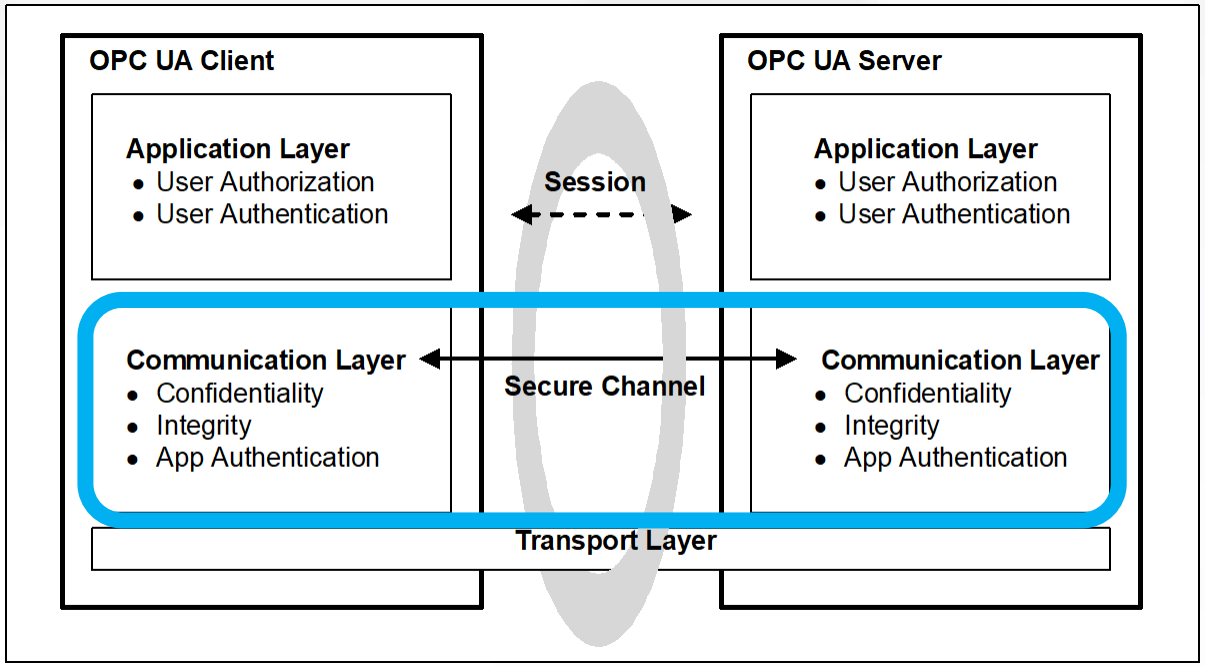
How does encryption apply to OPC-UA?

- When the OPC-UA Client connects to the OPC-UA Server:

1. X.509 Certificates are exchanged so a **Secure Channel** is established

   Certificates used here are called "*Application Instance Certificates*"

   These are the certificates exchanged when establishing a secure communication between OPC-UA Client and Server



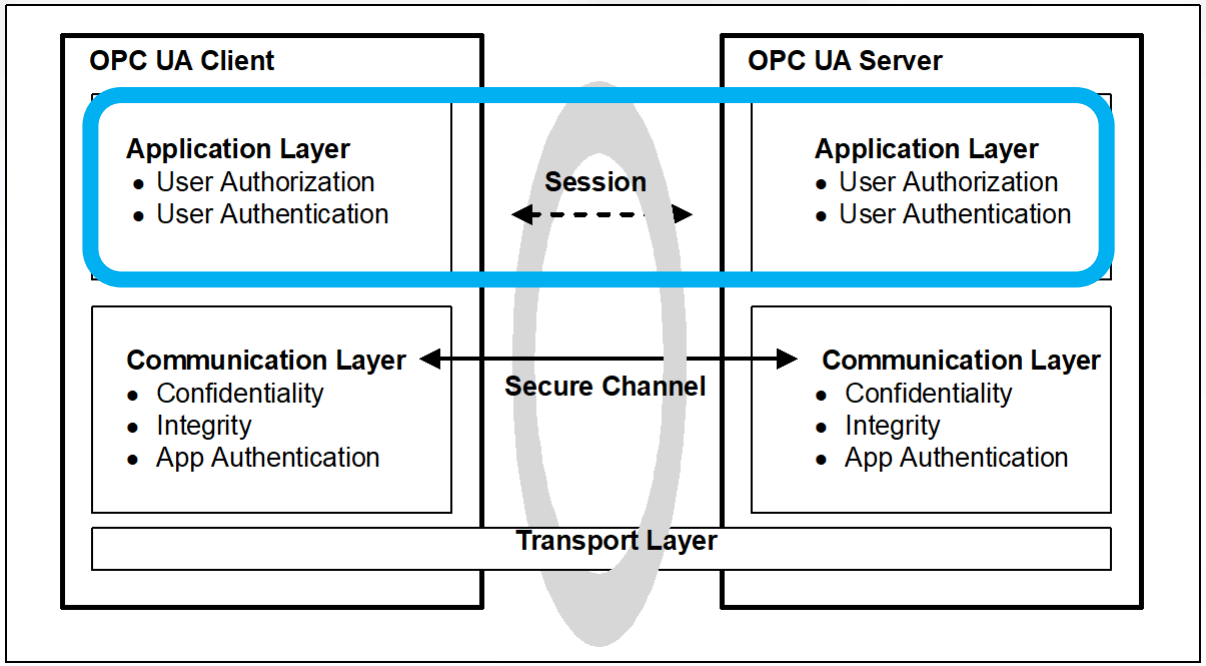
How does encryption apply to OPC UA?

2. Over the Secure Channel, a "**Session**" at "Application Layer" is defined.

   Here is where the OPC-UA Client application and OPC-UA Server application transmit information, settings, and commands.

   at Application Layer
   there is the User Authentication
   and User Authorization

   - *anonymous,*
   - *username/password*
   - *X.509 Certificate*
     (User Instance Certificate)



Secure channel security

- Secure Channel security = Security Profile + Security Policy

Security Profiles	Description
None	No security
Sign	The sender uses his private key to digitally sign the data. The receiver verifies whether the data comes from the expected sender using the sender's public key
Sign+Encrypt	In addition to Sign, the sender encrypt data using receiver's public key

Security Policies (length of the key and the algo)
None
Basic256Sha256
Aes128-Sha256-RsaOaep
Aes256-Sha256-RsaPss

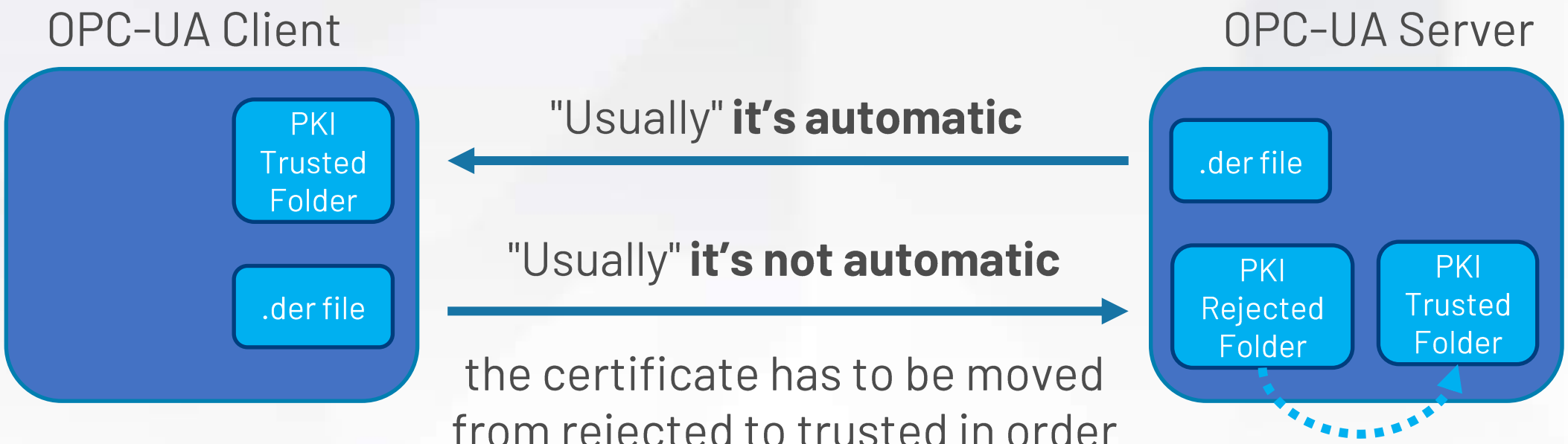
PKI and X.509 Certificates

- Public Key Infrastructure (PKI)
  - is a system for the creation, storage, and distribution of digital certificates

- X.509
  - is a standard defining the format of public key certificates

- In OPC-UA:
  - "**.der**" is the certificate file containing **public key**,
  - "**.pem**" is the **private key** file

OPC-UA certificate exchange



Generating OPC-UA certificates

Generating OPC-UA certificates

- Certificates are generated by authorities
  - Authorities are special entities, trusted by a number of users/clients that can **validate a certificate** and inform all users/clients that a certificate is valid and can be trusted
- Authorities (CA) can be public or local
  - Public authorities are well-known and trusteed organizations that can sign and validate certificates (almost) worldwide. Example include **DigiCert**, **Let's Encrypt**, **Comodo** and many more.
  - Private authorities are trusted services that can sign and validate certificates in a local (confined) environment. An example of a private authority can be the IT department of a company
- All certificates must be signed by an authority
  - After a certificate is generated, **an authority must sign it**
  - The certificate authority provides to all users/clients a notice with the list of valid and signed certificates
  - After a certificate is signed by an authority, all users/clients performing the handshake with the public key and the thumbprint of a signed certificate can be sure that nothing was tampered, and the connection can be established.
  - If the certificate is signed by an untrusted CA, it is rejected by default and the user is warned about potential risks.

Creating a self-signed certificate from FactoryTalk Optix Studio

- From the dropdown of the **Settings** menu, select **Create certificate**
- Fill-in all the details in the certificate creation form
- Select the certificate name
- Select the output folder
- Click **Create** to generate the certificates

- **Certificates created with FactoryTalk Optix Studio are self-signed and must be trusted manually by the clients**

Creating a self-signed certificate from FactoryTalk Optix Studio

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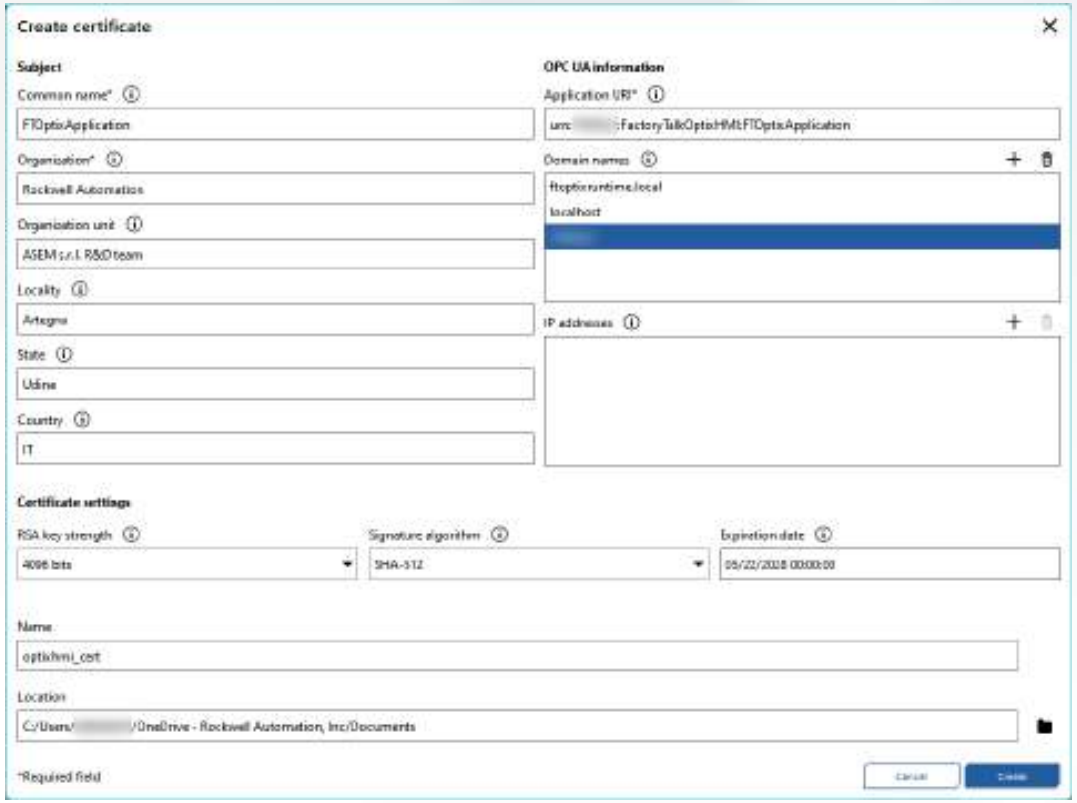

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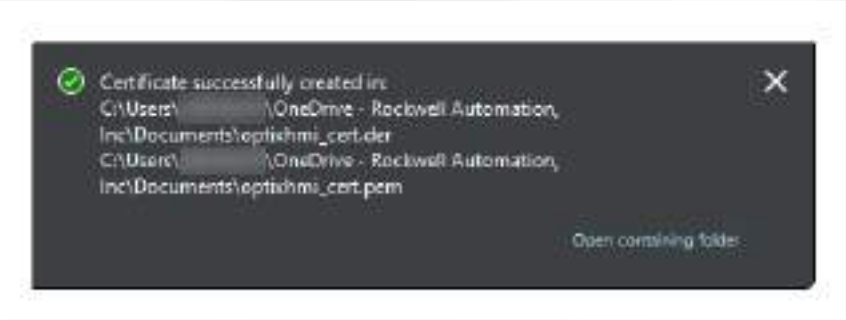
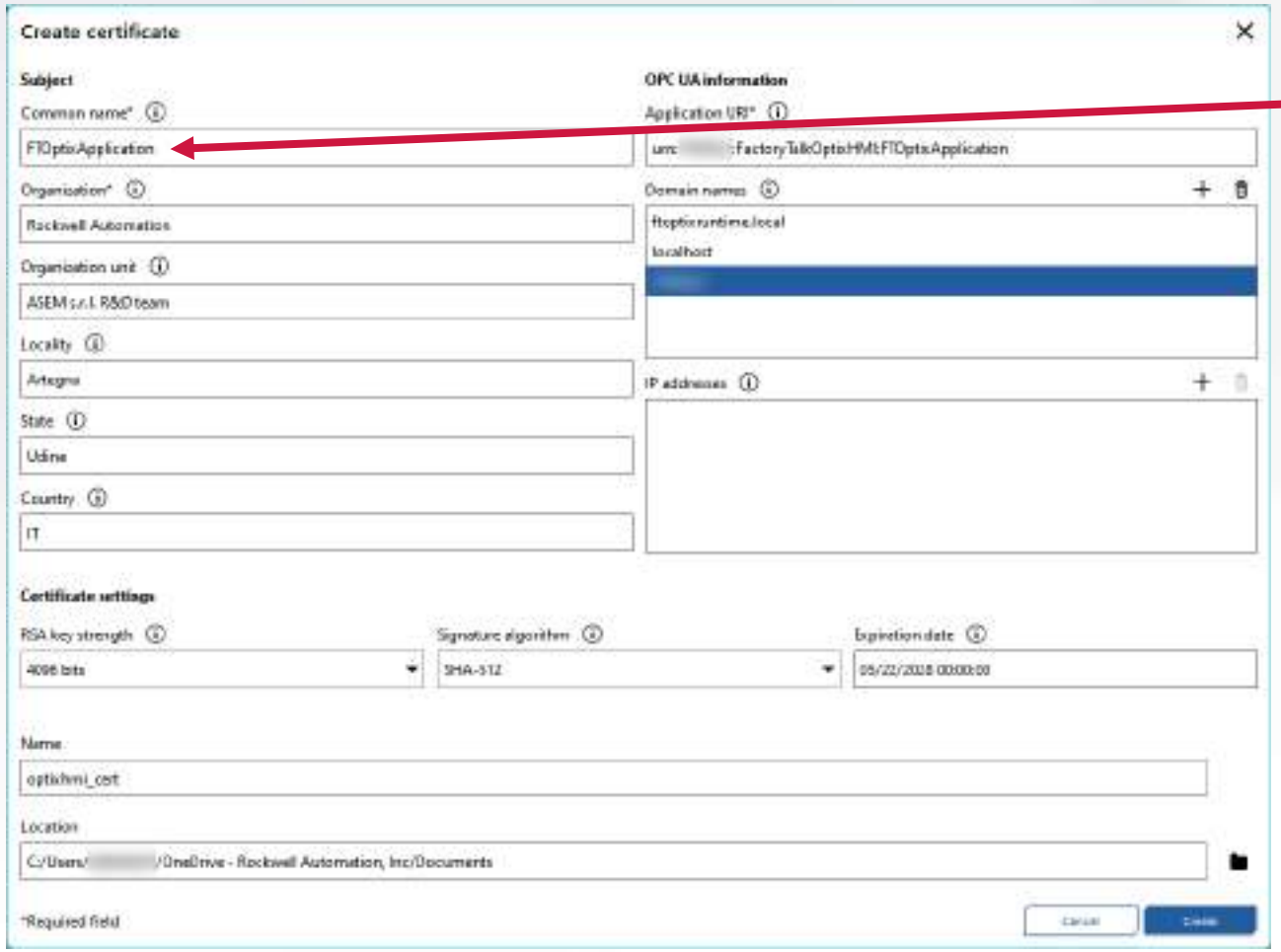
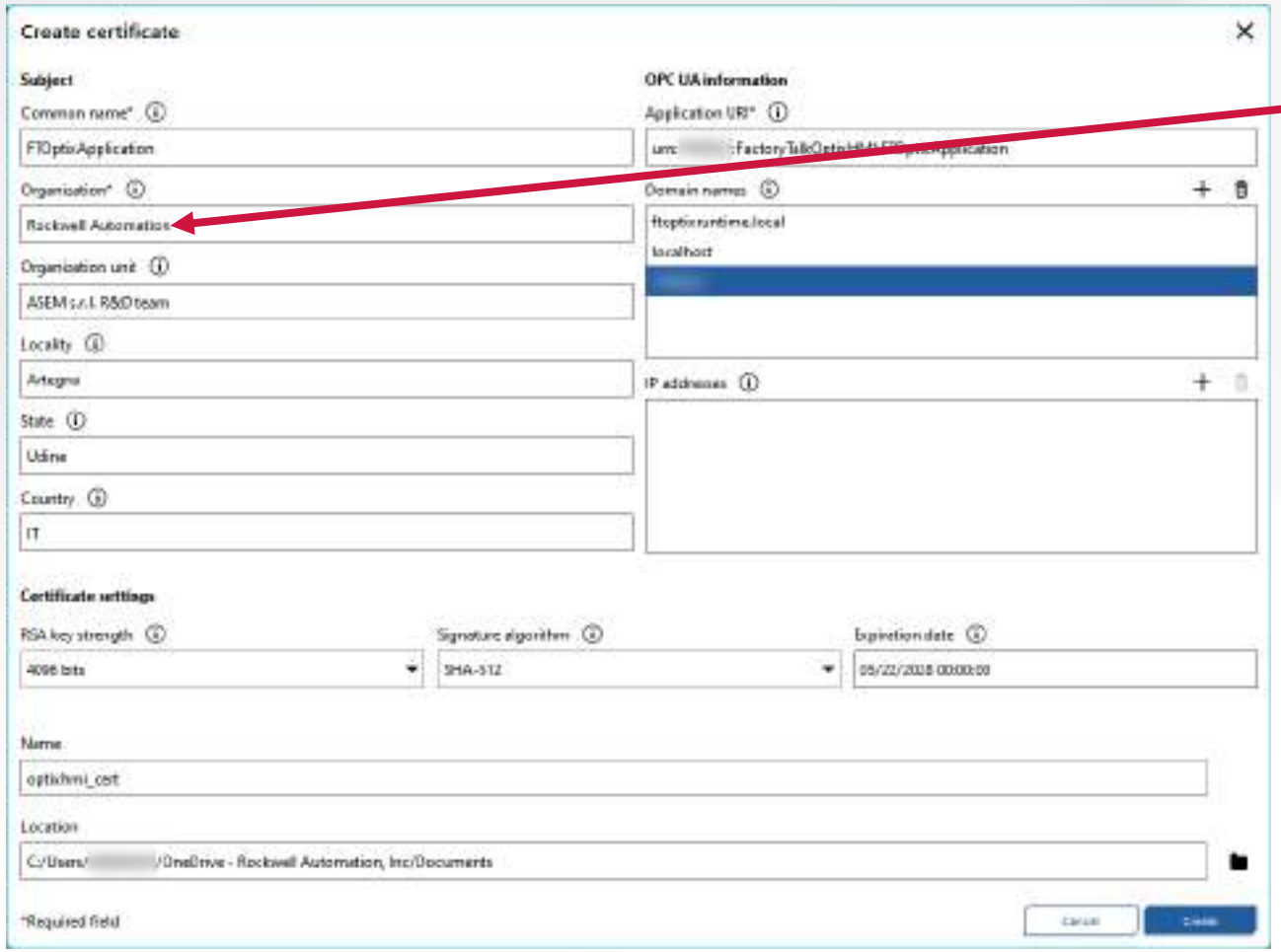


How to fill the self-signed certificate generation fields



Common name: name of the OPC-UA application. By default, in FactoryTalk Optix, this is always “FTOptixApplication”

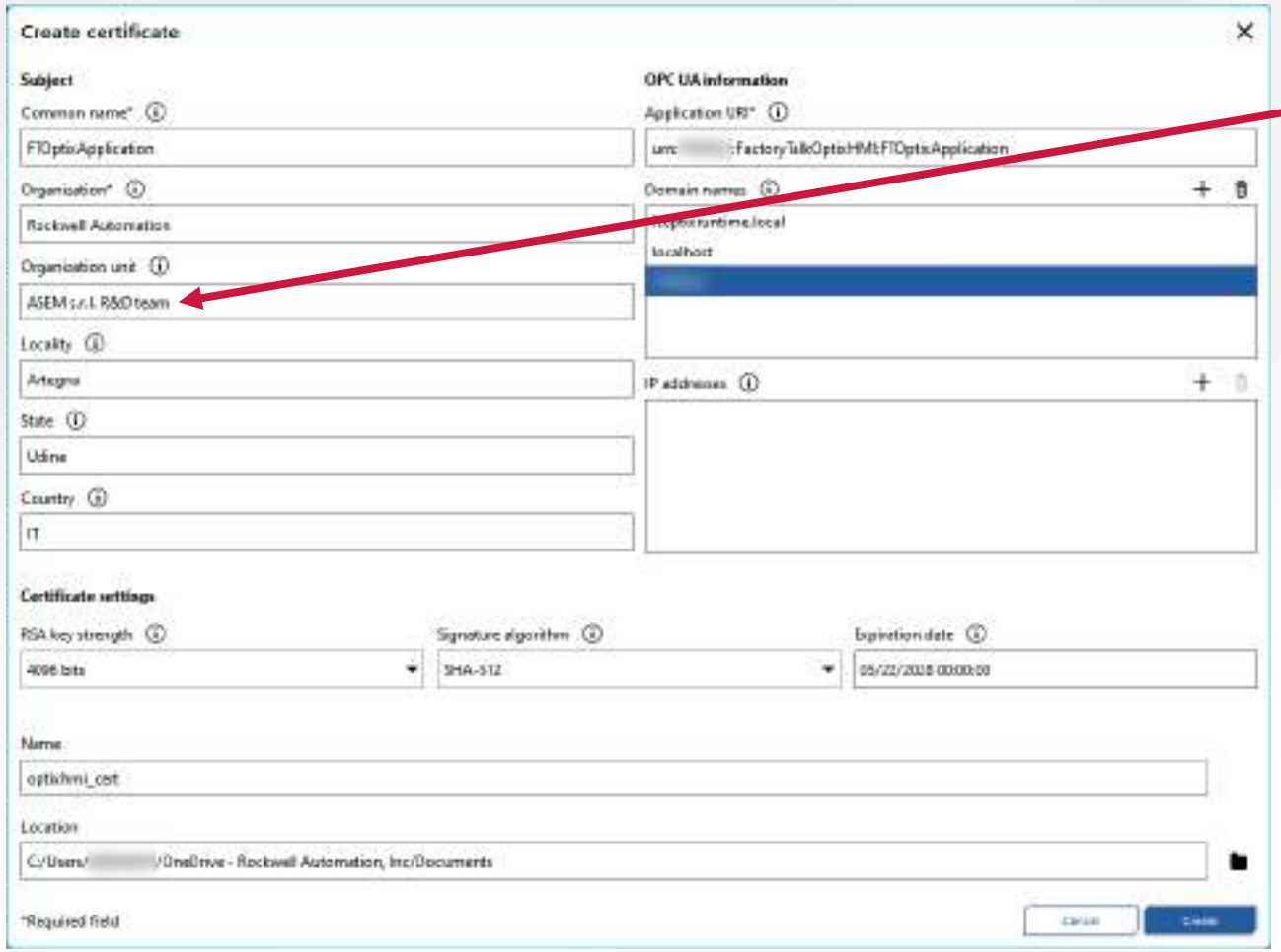
How to fill the self-signed certificate generation fields



Organization: registration name of the company responsible for the certificate.

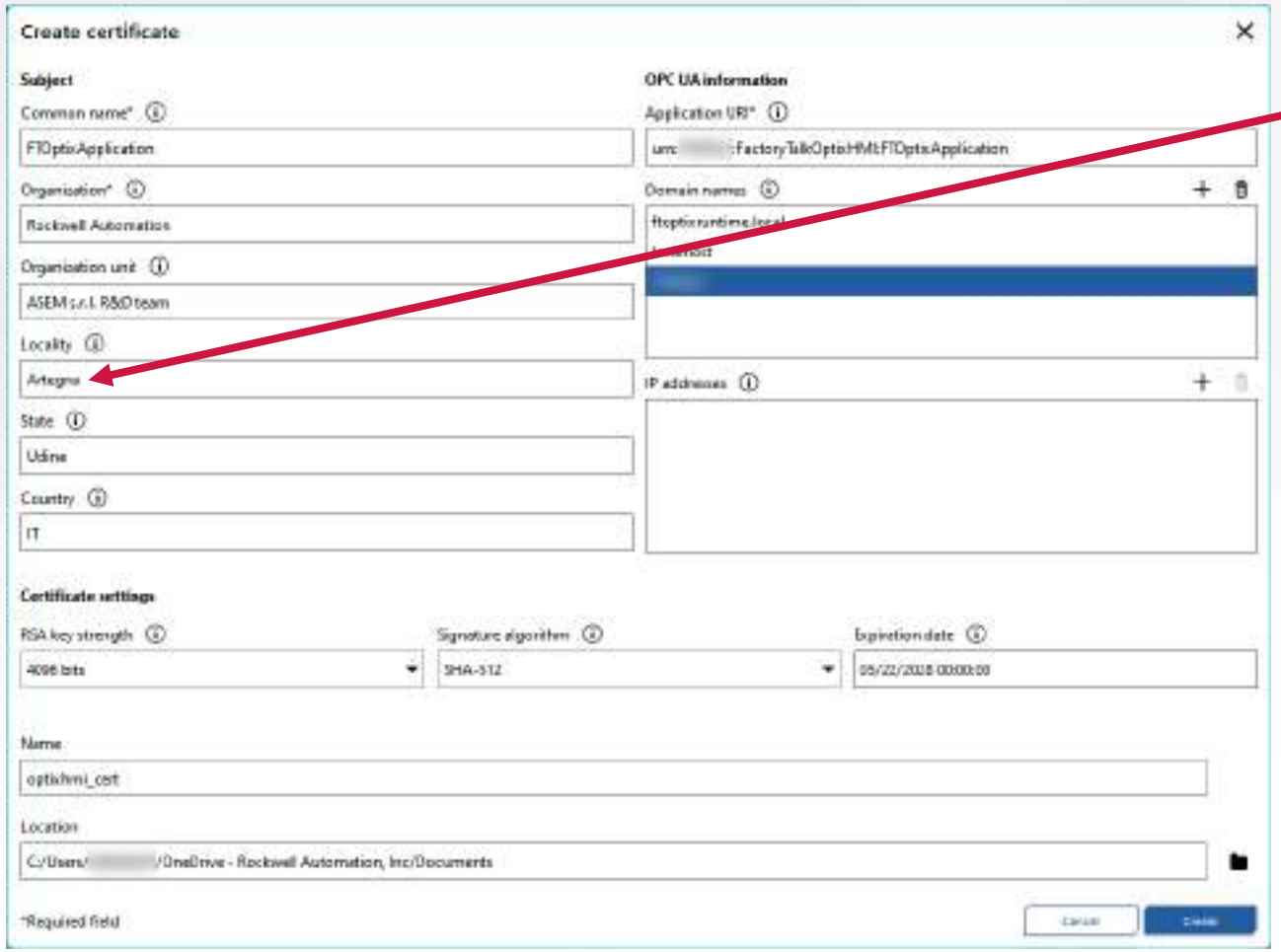
Do not use abbreviations or non-alphanumerical characters.

How to fill the self-signed certificate generation fields



Organization unit: local unit, office or group responsible for the certificate inside the Organization

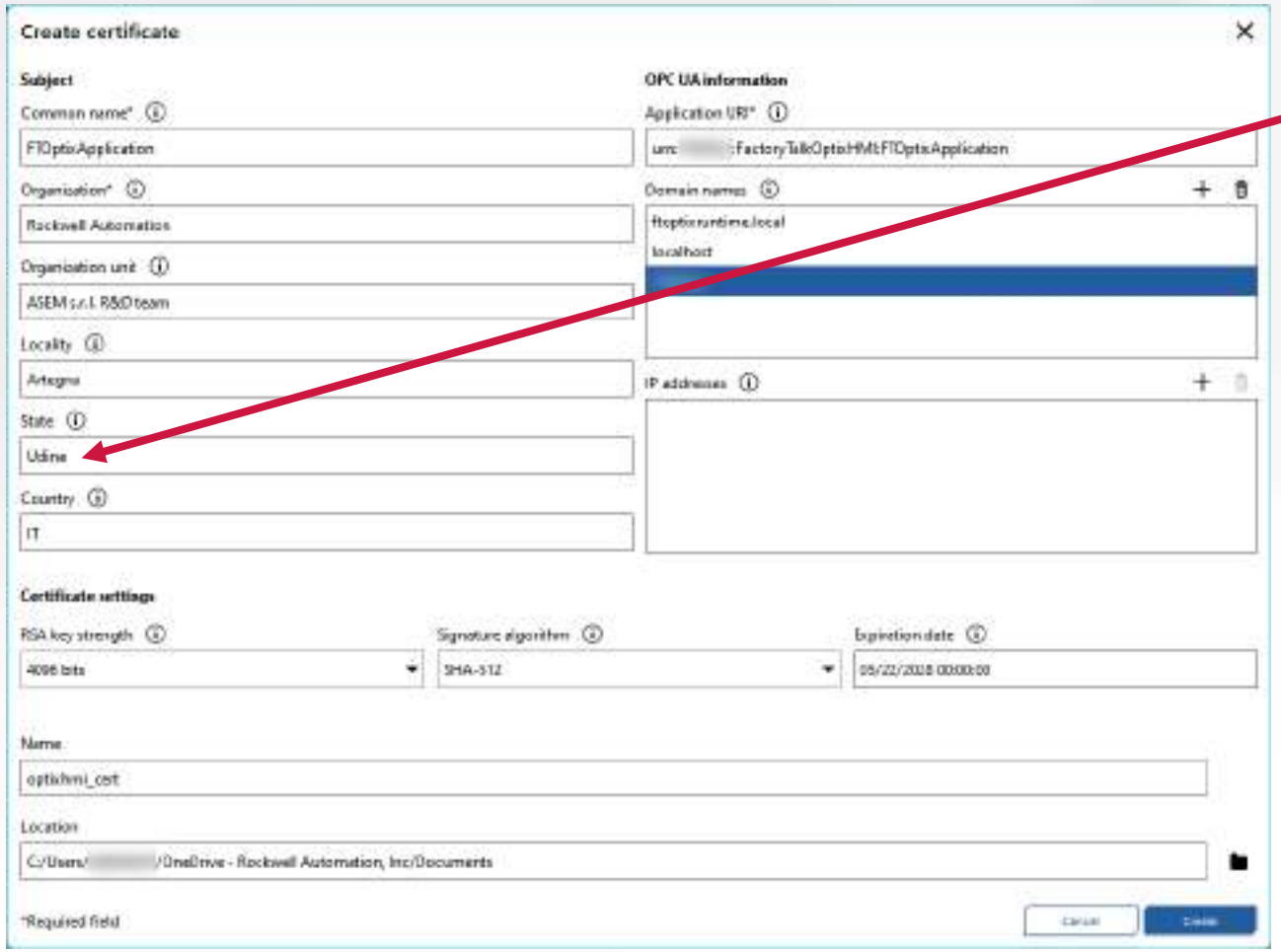
How to fill the self-signed certificate generation fields



Locality: hometown of the Organization (or the Organization unit).

Must be the proper town name as specified in the postal address. Do not use abbreviations.

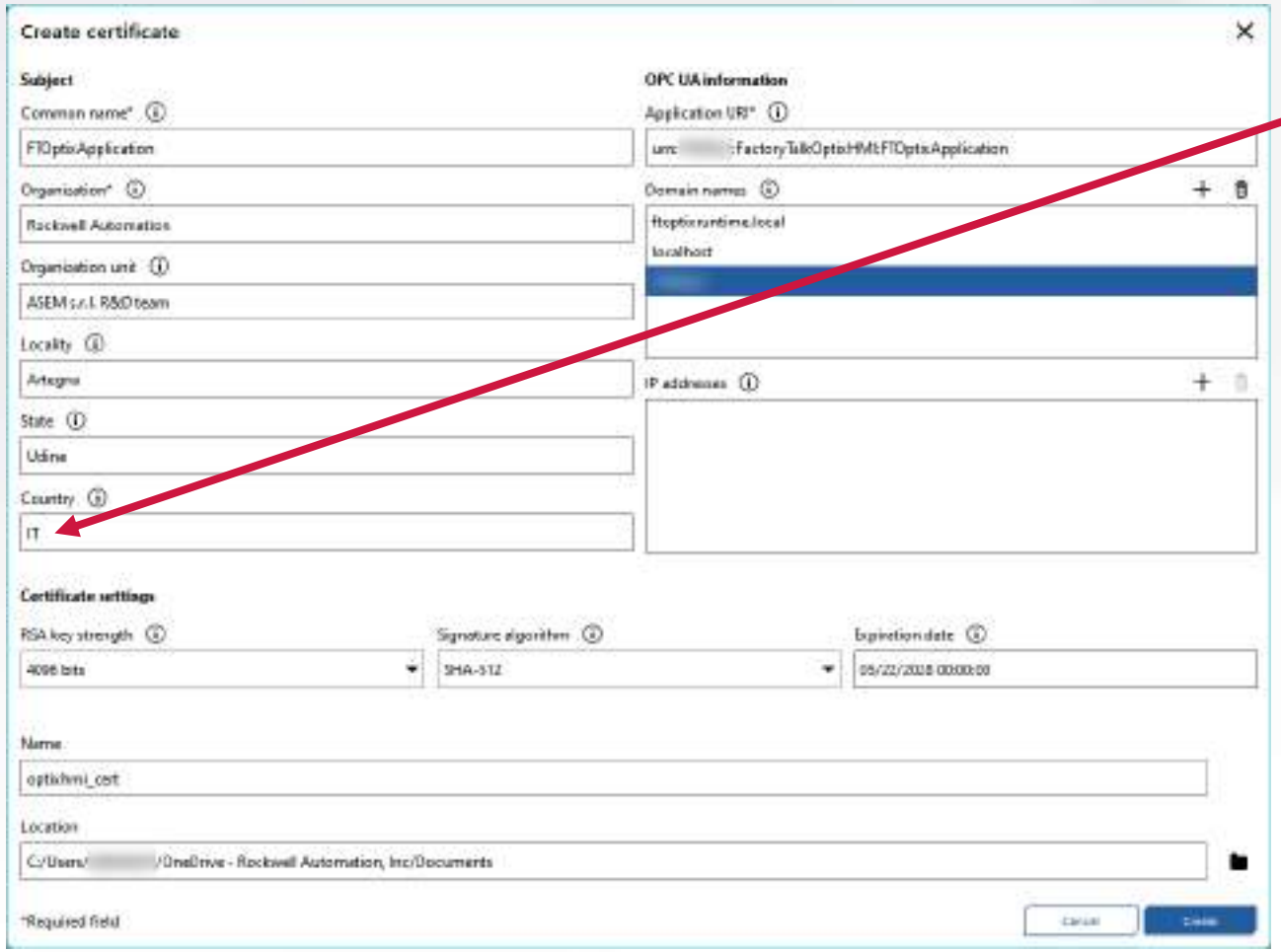
How to fill the self-signed certificate generation fields



State: geographical area where the Organization (or Organization unit) is located.

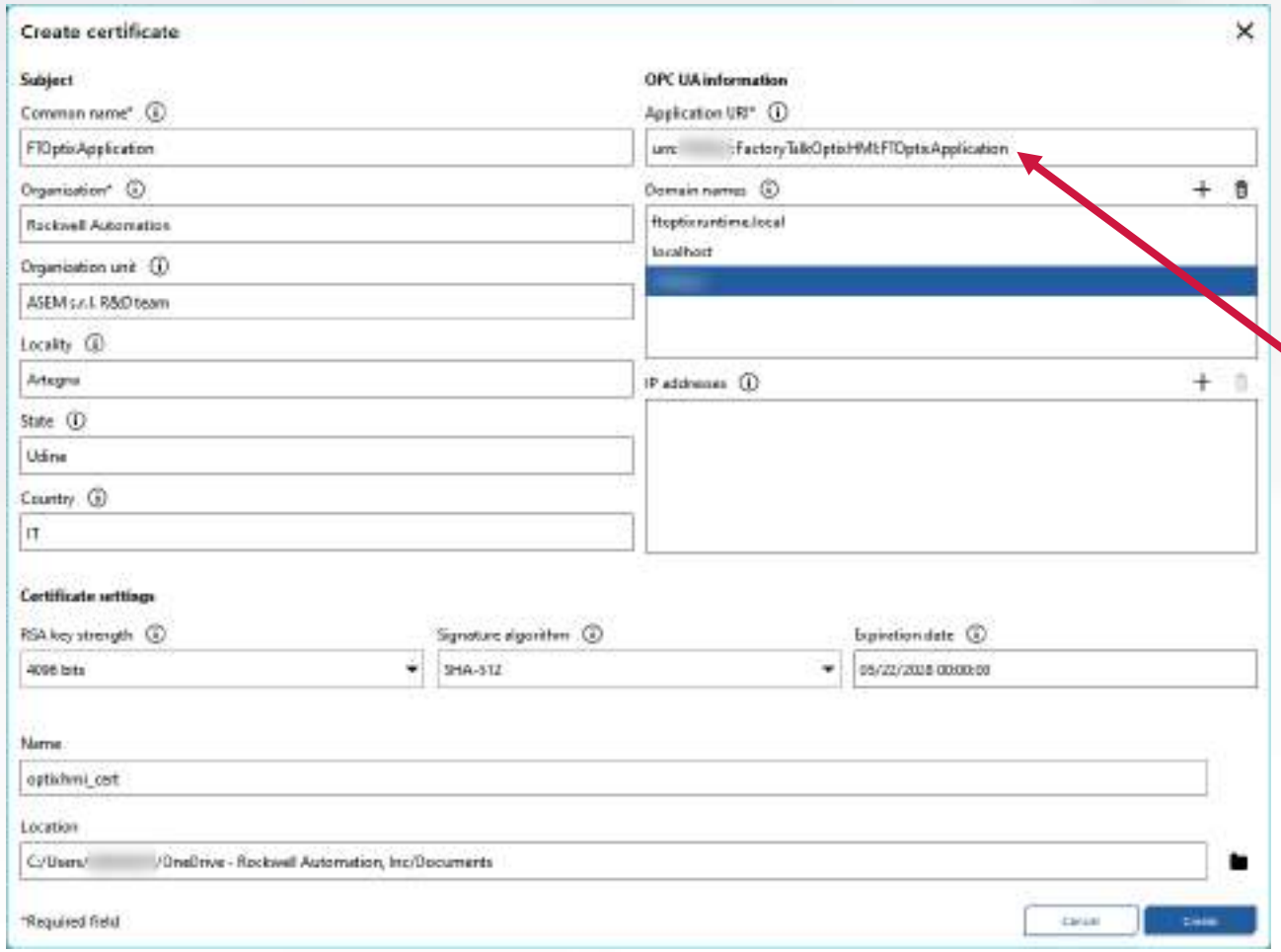
This can be an US state or a province.

How to fill the self-signed certificate generation fields



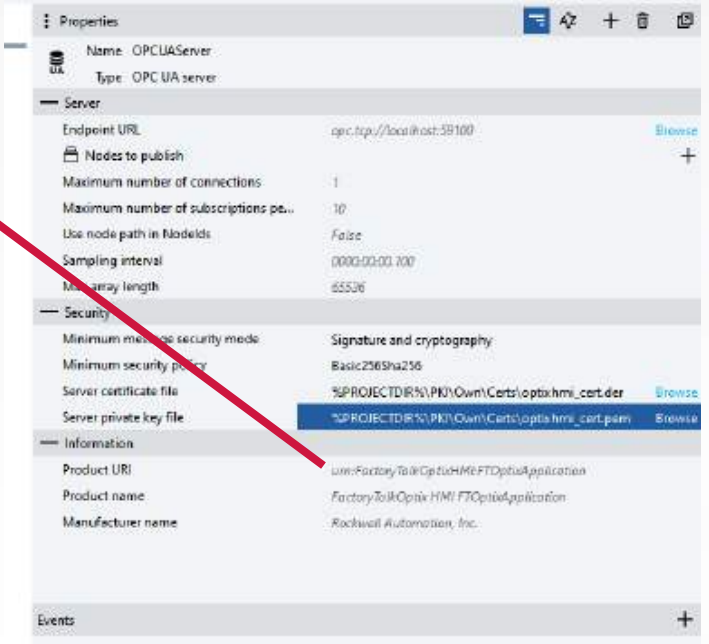
Country: Two-letters ISO-3166 country code where the Organization (or Organization unit) is located.

How to fill the self-signed certificate generation fields



Application URI: the unique identifier for the project on a specific machine.

In FactoryTalk Optix, this must be the same as the Product URI in the server configuration



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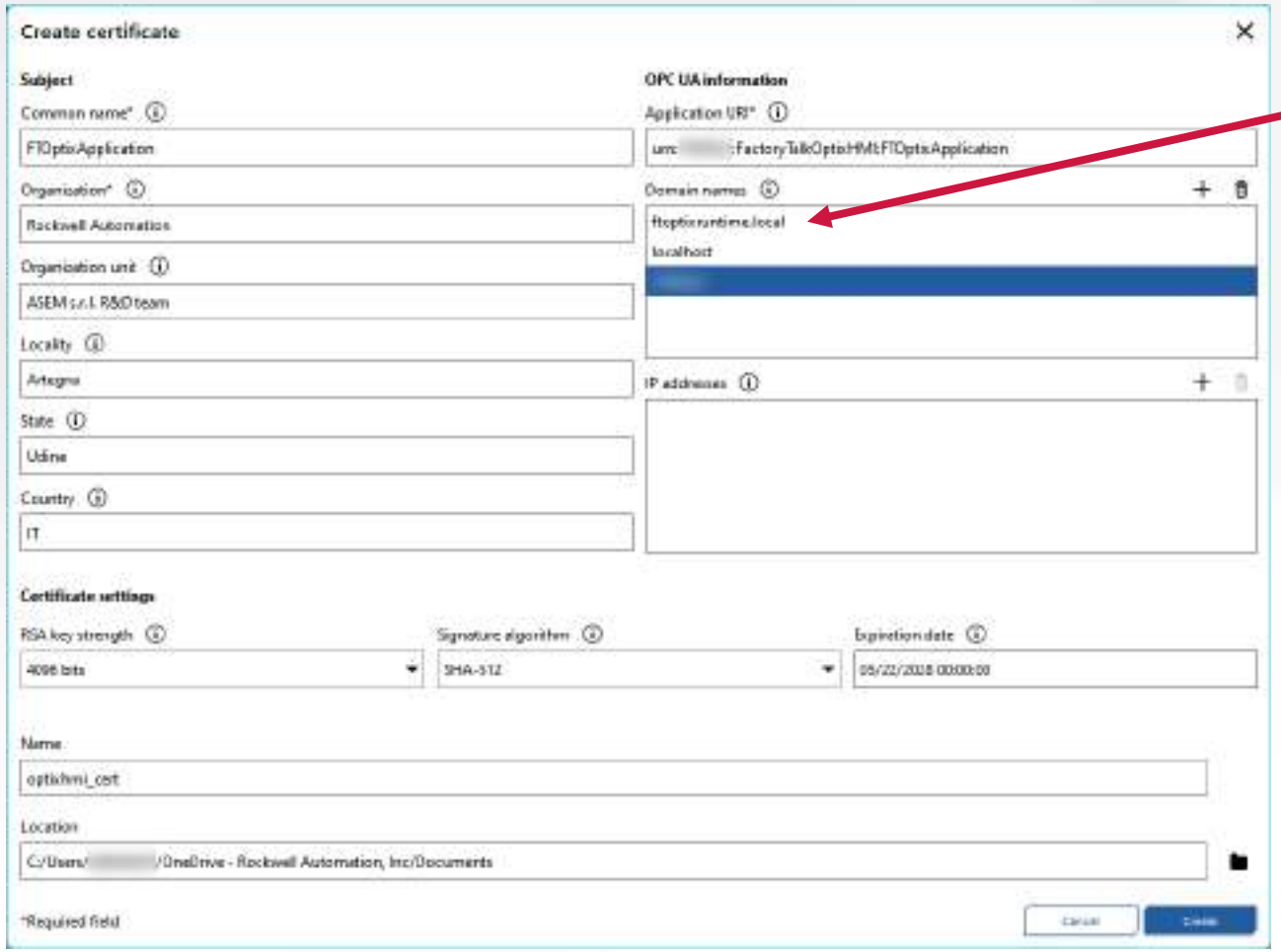
How to fill the self-signed certificate generation fields

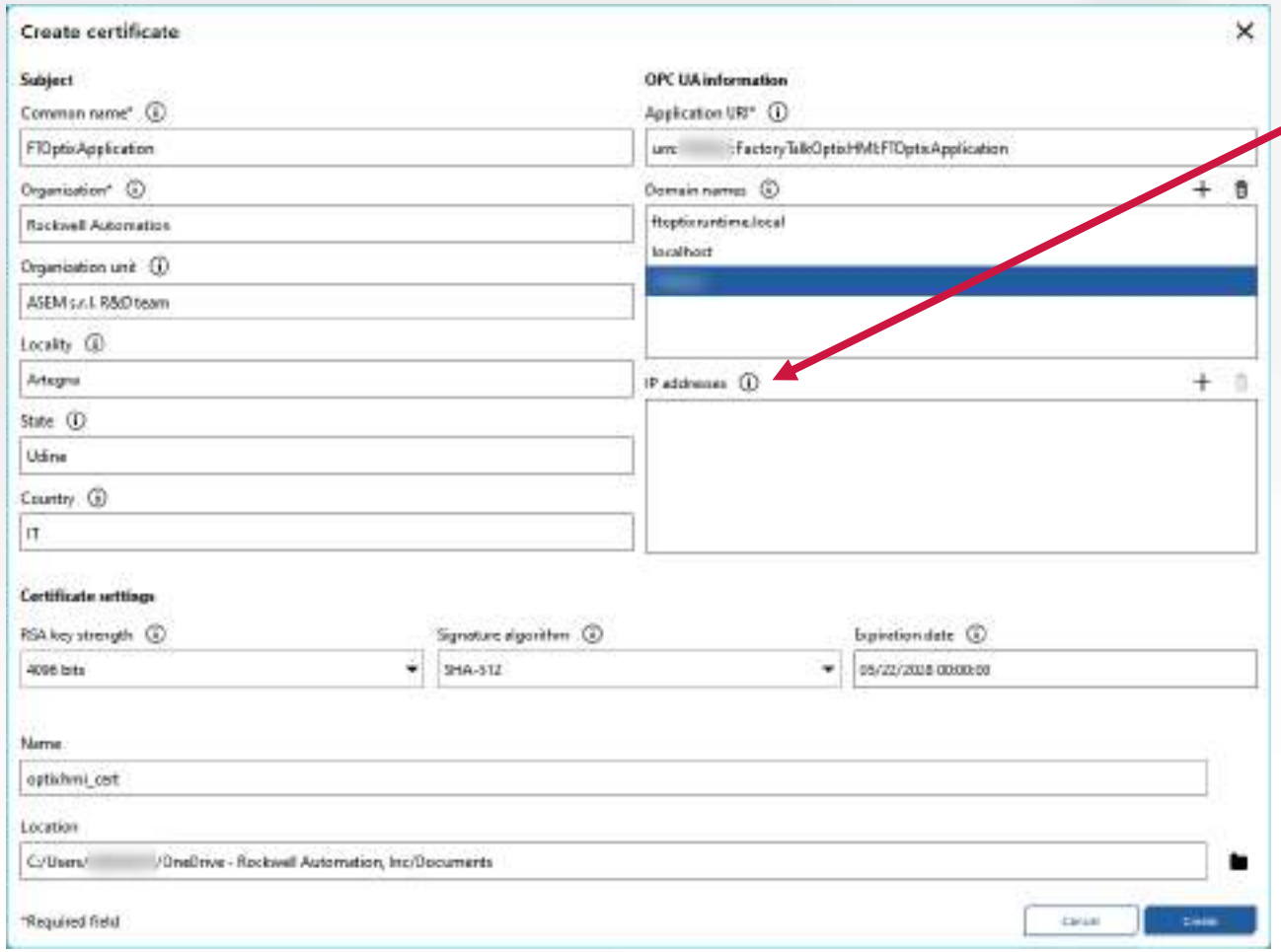


Domain names: a list of domain names that can be used to access the machine.

This field contains a list of URLs (like myapplication.example.com) or Active Directory name for the host machine.

This field should contain all the available domains used to access the host machine either locally or remotely.

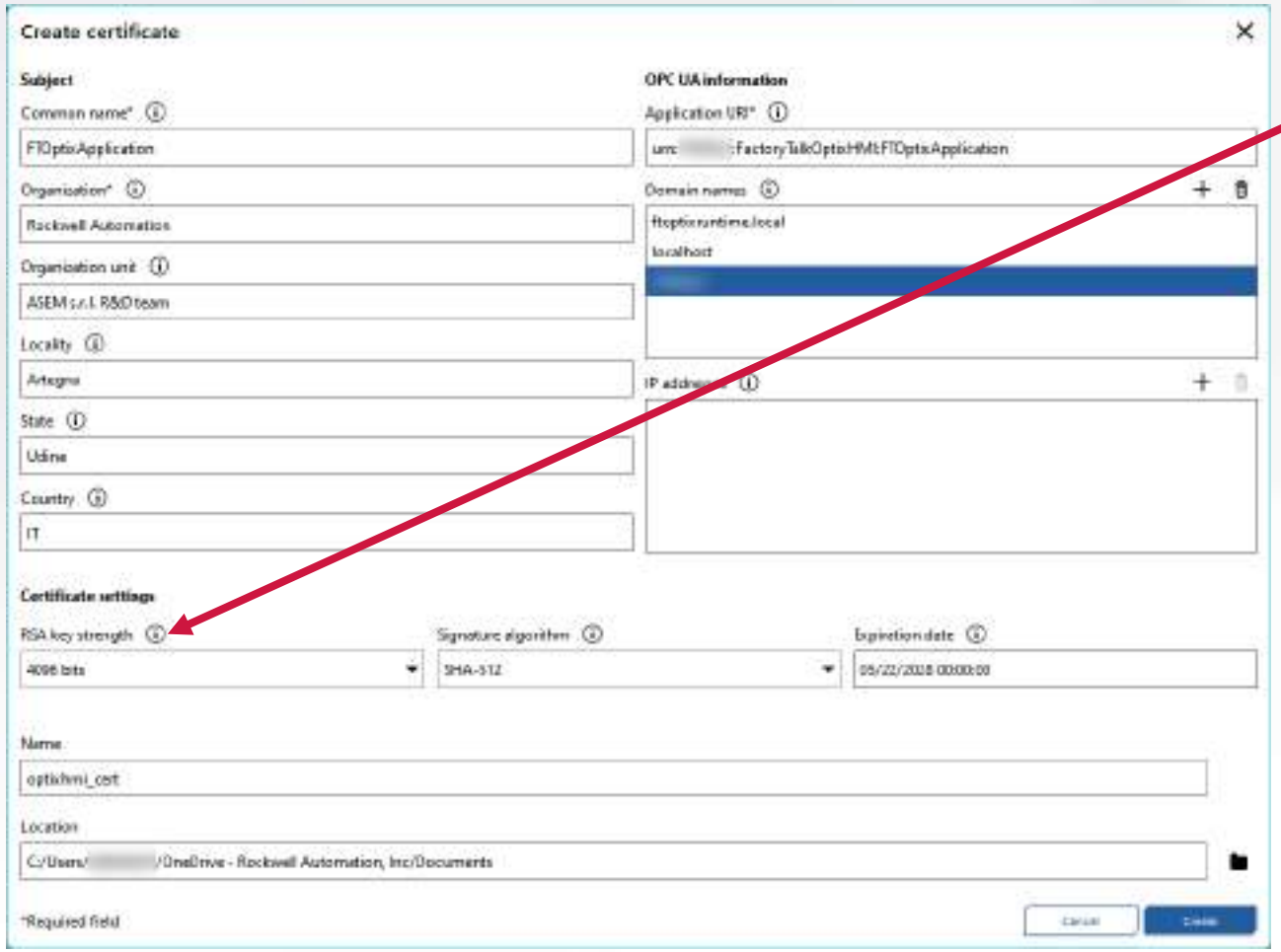
How to fill the self-signed certificate generation fields



IP address: a list of IP addresses that can be used to access the machine.

This field is optional and should not be used in normal condition as the certificate would be invalidated if the IP address changes.

How to fill the self-signed certificate generation fields

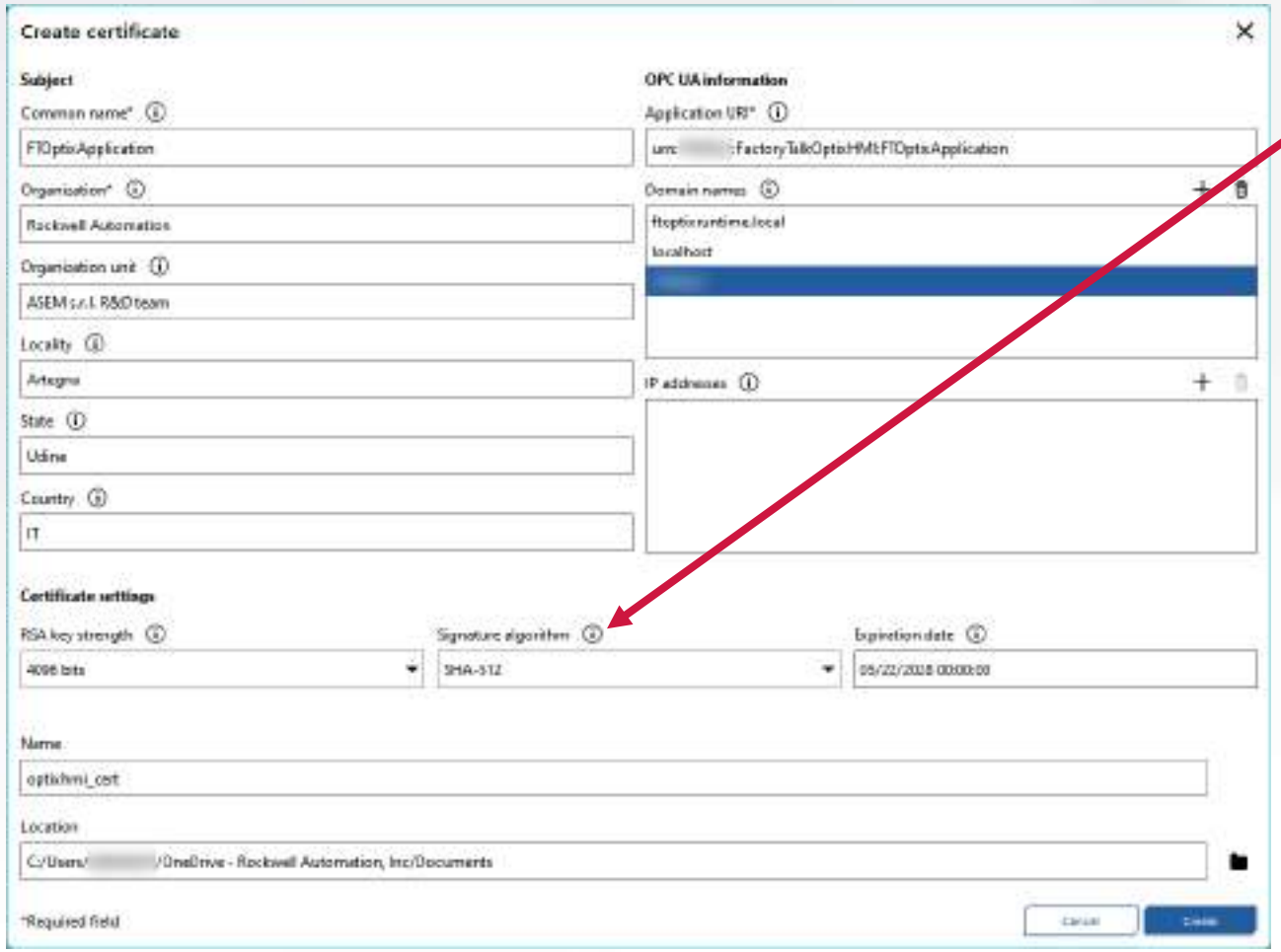


RSA key strength: length in bits of the RSA key.

Longer keys are more secure, but need more computing resources to be processed.

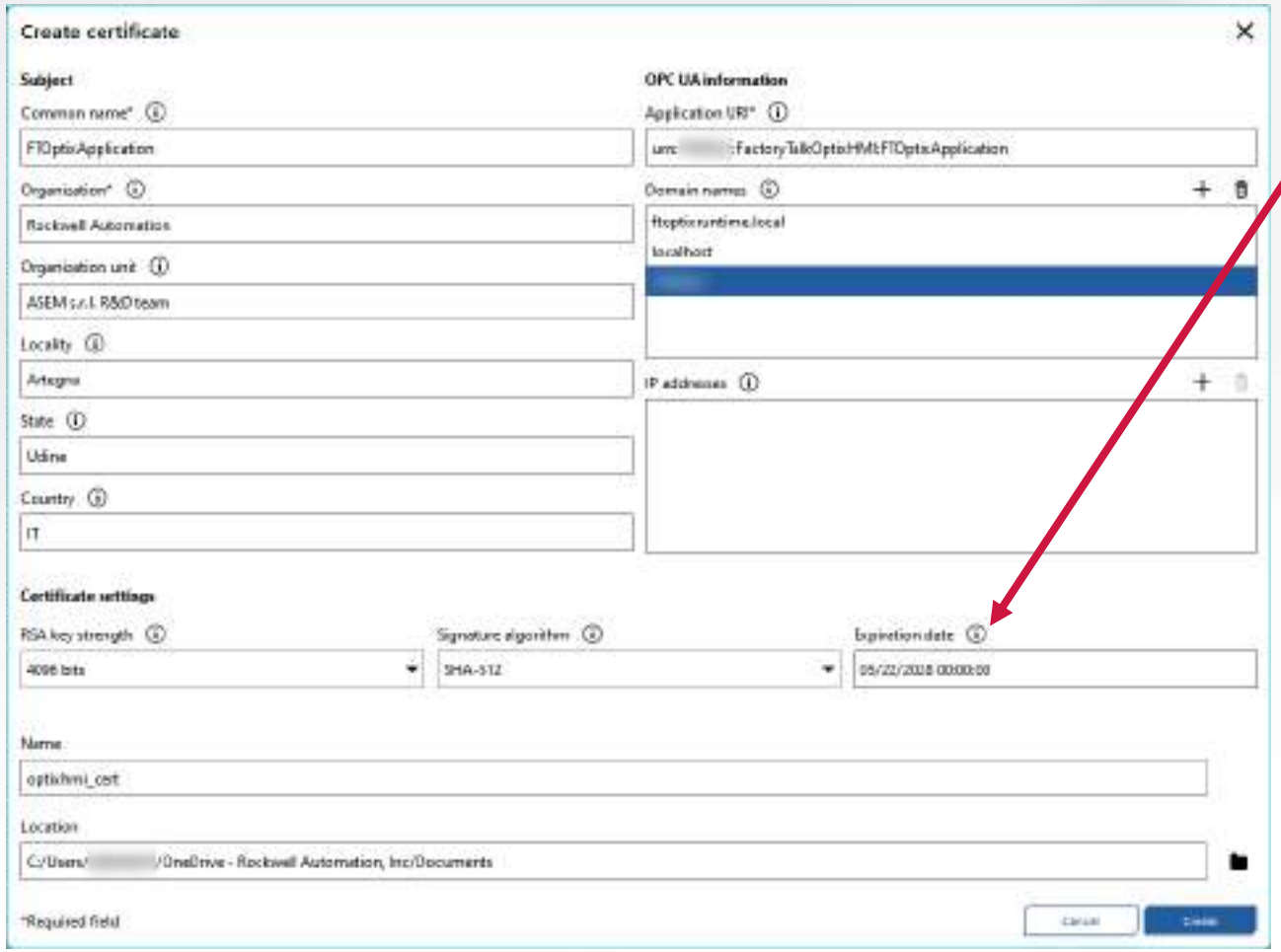
It is preferrable to choose the highest value that does not impact on the host hardware.

How to fill the self-signed certificate generation fields



Signature algorithm: algorithm used by the devices to sign the data using these certificates.

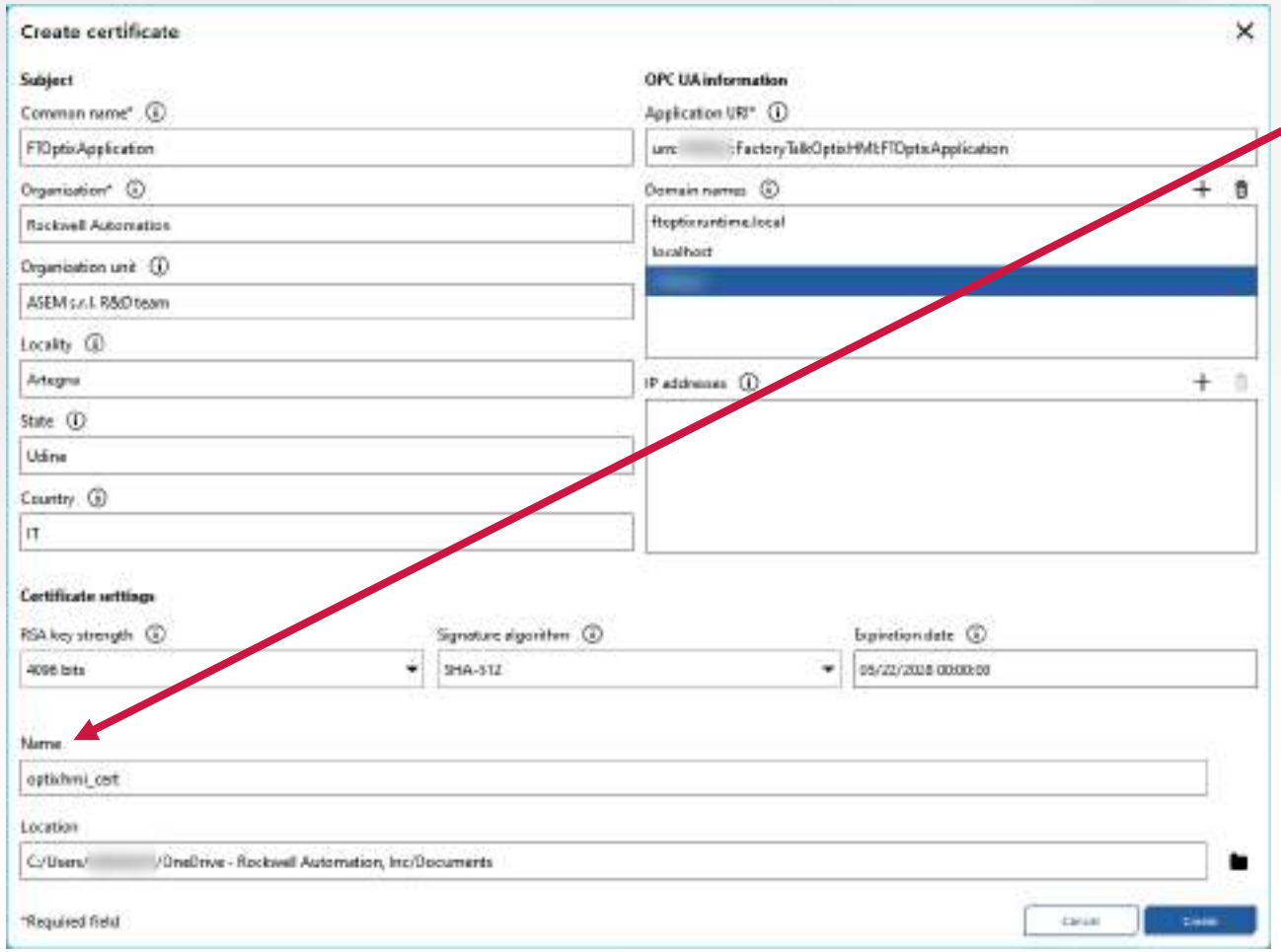
How to fill the self-signed certificate generation fields



Expiration date: how long the certificate will be valid before a new certificate should be requested/generated.

Longer times means less maintenance but are more prone to tampering, hijacking or identity thefts (as the certificate remains the same for longer time, increasing attack surface).

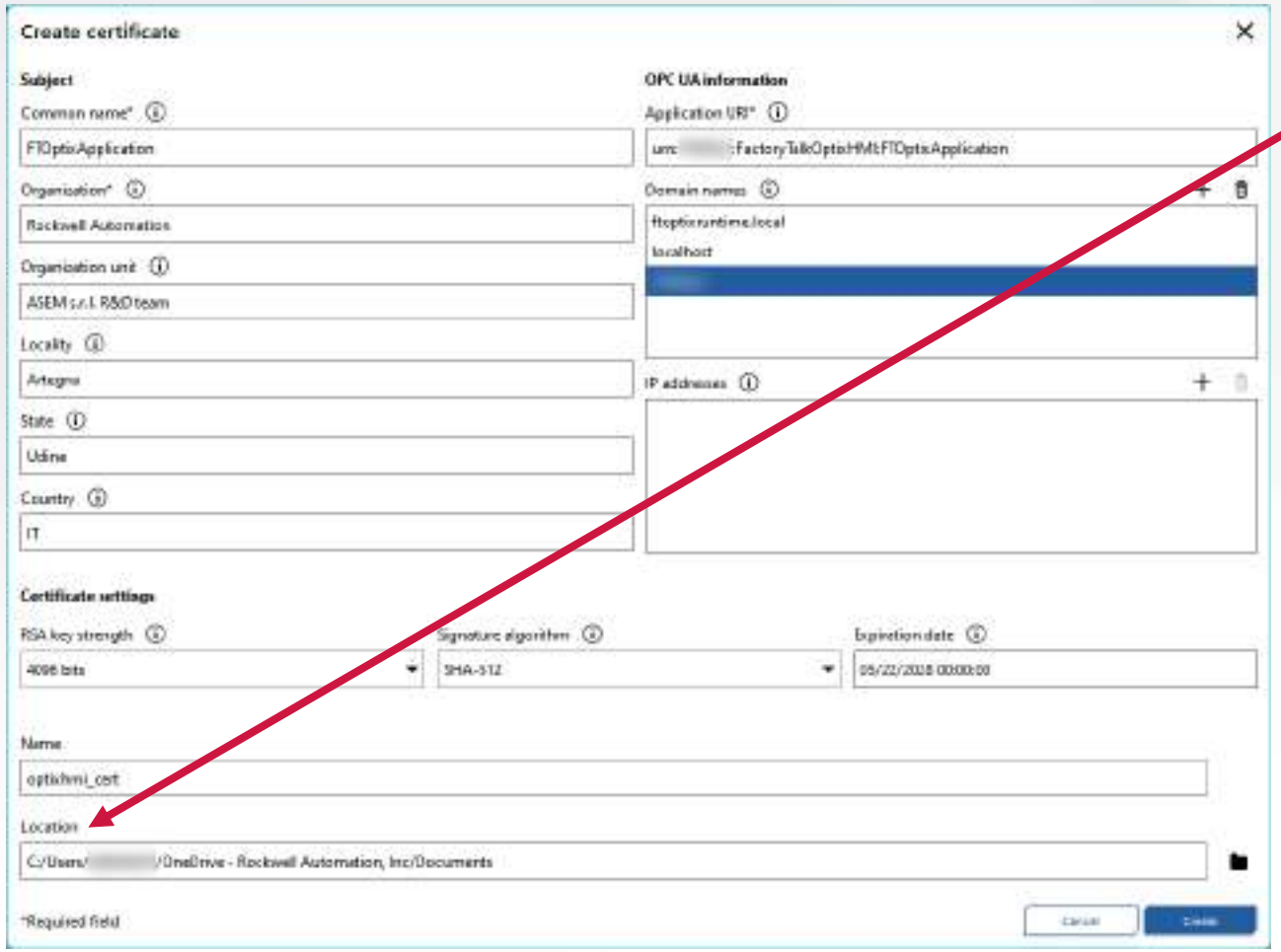
How to fill the self-signed certificate generation fields



Name: name of the output certificate.

Can be any valid file name.

How to fill the self-signed certificate generation fields



Location: where to store the generated certificate.

Can be any valid path.

Creating a self-signed certificate with OpenSSL

- Generate a Private Key
- Create a Certificate Signing Request (CSR)
  - Fill in all the details in the command line (refer to the procedure using Factory Optix to fill the fields)
- Generate the self-signed certificate
- Convert private key to a “pem” file
- Extract the public key and convert it to a “der” file

```
# Generate the private key
openssl genrsa -out private.key 2048
# Create the certificate sign request
openssl req -new -key private.key -out request.csr
# Generate the self-signed certificate
openssl x509 -req -days 365 -in request.csr -signkey private.key -out certificate.crt
# Convert the private key to a .pem file
openssl rsa -in private.key -out private.pem
# Extract the public key from the generated key
openssl rsa -in private.key -pubout -out public.pem
# Convert the public key to a .der file
openssl rsa -pubin -in public.pem -outform der -out public.der
```

Creating a CA-trusted certificate with OpenSSL

- Choose a Certificate Authority
  - Many online providers are available, some for free, some other require a fee
- Generate a Private Key
- Create a Certificate Signing Request (CSR)
  - Fill in all the details in the command line (refer to the procedure using Factory Optix to fill the fields)
- Send the CSR file to the Certificate Authority
  - Depending on the Certificate Authority, additional validations or checks might be needed
  - Depending on the Certificate Authority, the returned file might need to be converted to the “pem” and “der” files

```
# Generate the private key
openssl genrsa -out private.key 2048
# Create the certificate sign request
openssl req -new -key private.key -out request.csr
# Now send the generated certificate signing request file to the CA
# to proceed with the signing process.
```

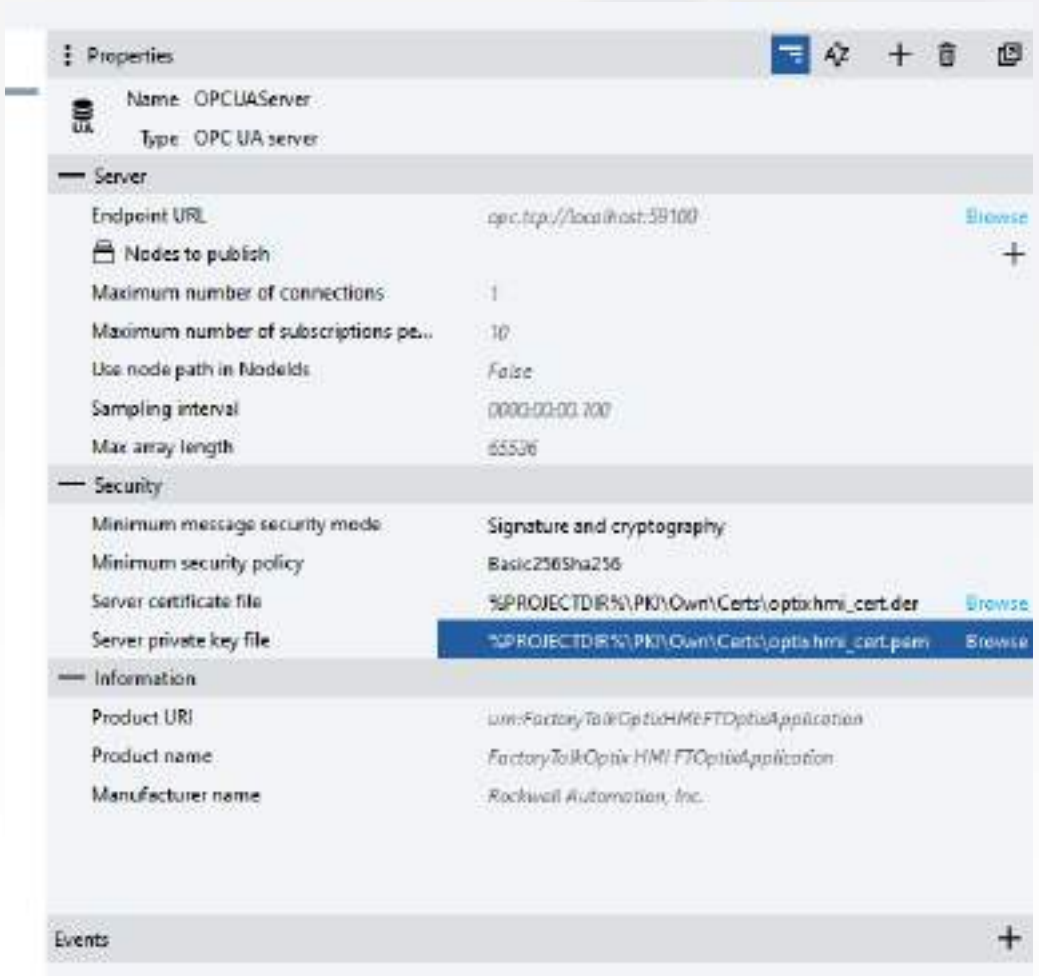
Using OPC-UA certificates

Things to know about OPC-UA certificates

- A FactoryTalk Optix OPC-UA server always uses certificates to perform some actions, this depends on the server configuration on the "Minimum message security mode":
  - None → Certificates are only used by the client to login to the server
  - Signature only → Certificates are used to sign messages, but content of messages is not encrypted
  - Signature and cryptography → Certificates are used to sign messages and to encrypt the content of the message
- Even if the "Minimum message security mode" is set to "None", certificates are still required to complete the login process
- In addition to the security mode, the server can also allow only specific encryption algorithms to be used by the connected clients
- FactoryTalk Optix automatically creates a self-signed certificate for testing purposes, **the automatically created self-signed certificate should never be used in a production environment**
  - Certificates should be issued by a trusted authority
  - FactoryTalk Optix Studio includes a dedicated tool to generate custom self-signed certificates if needed

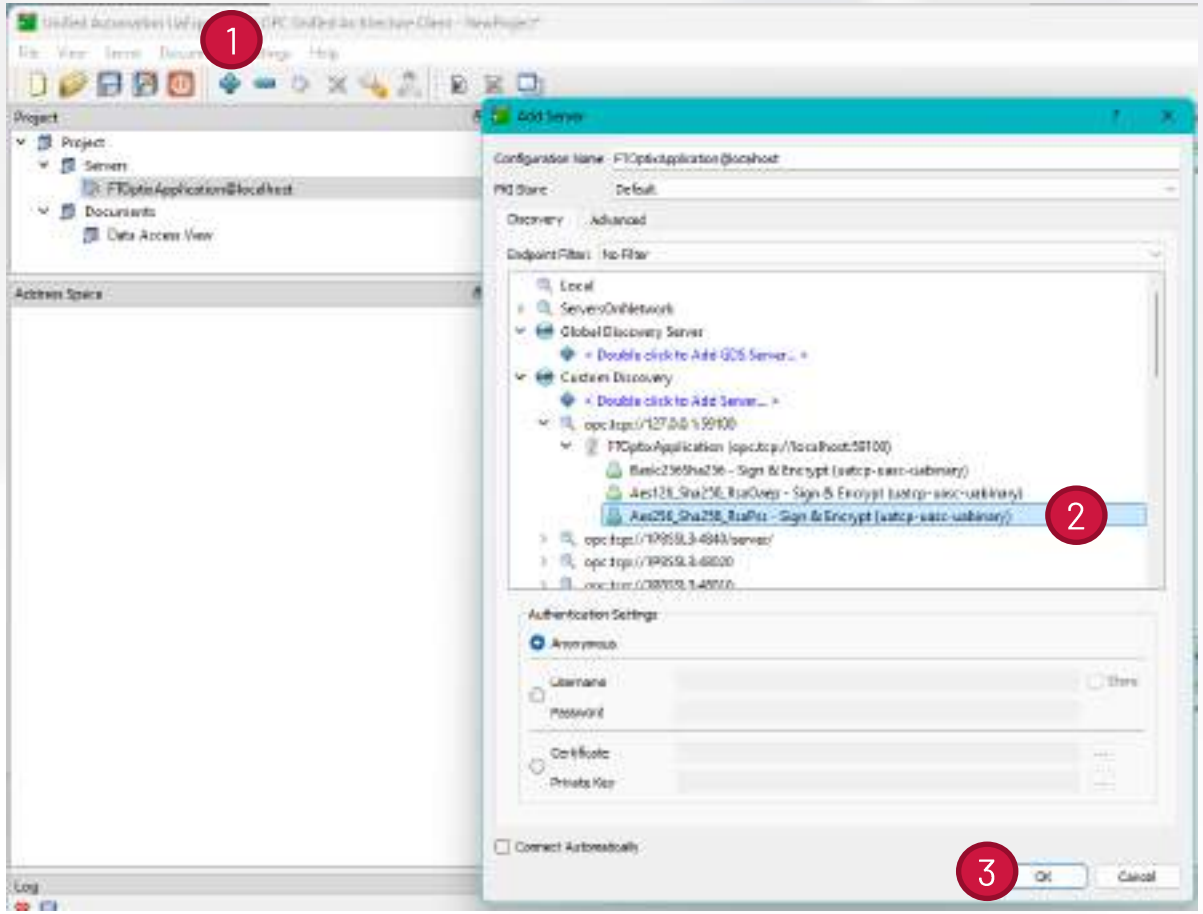
Using a custom certificate in the OPC-UA server

- To apply custom certificates to an OPC-UA server, simply import them in the project and set the relevant properties in the server configuration:
  - Server certificate file: public key of the certificate (“der” format)
  - Server private key file: private key of the certificate (“pem” format)
- Additional settings can be used to enforce a minimum-security policy for connected clients
  - This allows forcing stronger encryption and signing algorithm for all connected clients



Connecting to an OPC-UA server using custom certificates

- If the server is forcing clients to use certificates, when browsing the available servers, no unsecure connections are now listed
- Select the required sign and encryption protocol to be used
- If a self-signed certificate was used, the client will prompt the user to accept or reject the server certificate
- After trusting the certificate, the client can now attempt a connection
- FactoryTalk Optix will reject the client certificate by default, which needs to be trusted manually by moving it to the Trusted folder



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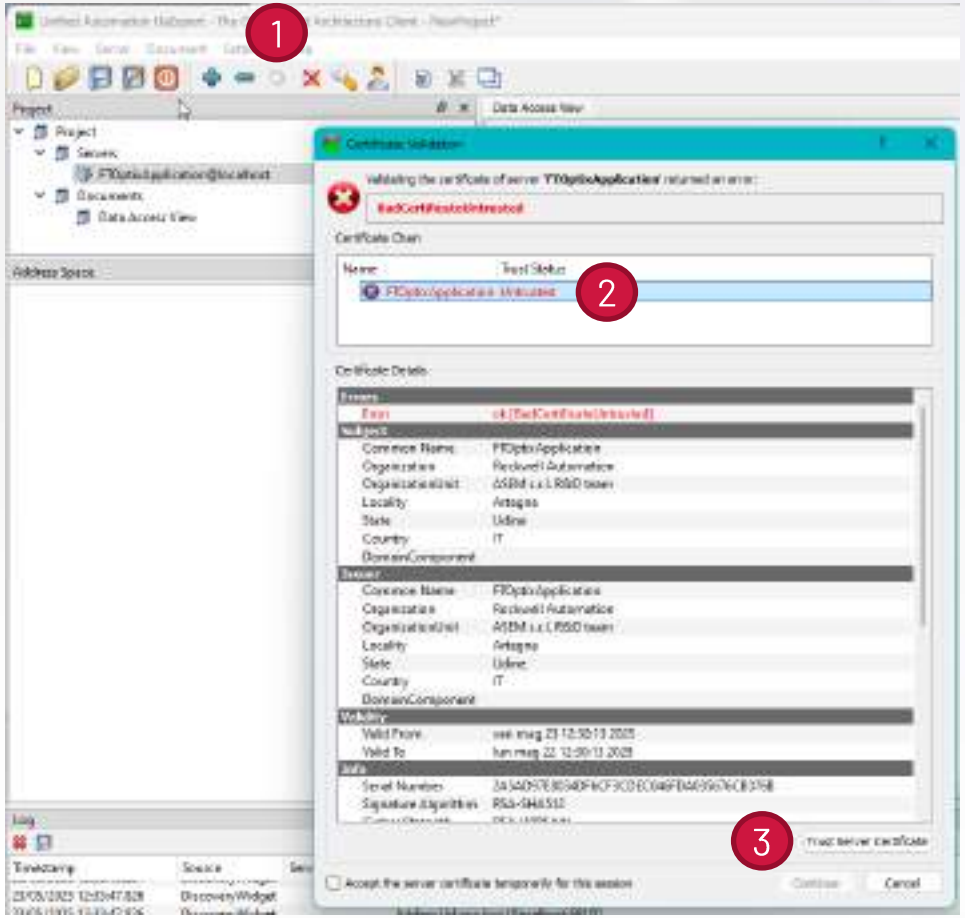

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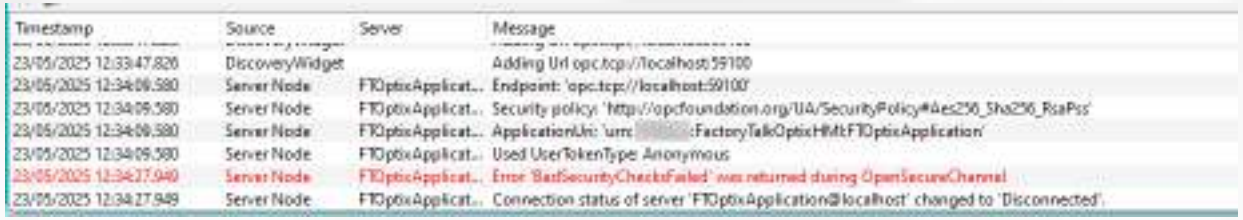

Timestamp	Source	Server	Message
23/05/2025 12:33:47.826	DiscoveryWidget		Adding Url opc.tcp://localhost:59100
23/05/2025 12:34:09.580	Server Node	FTOptixApplicat...	Endpoint: 'opc.tcp://localhost:59100'
23/05/2025 12:34:09.580	Server Node	FTOptixApplicat...	Security policy: 'http://opcfoundation.org/UA/SecurityPolicy#Aes256_Sha256_RsaPss'
23/05/2025 12:34:09.580	Server Node	FTOptixApplicat...	ApplicationUri: 'urn:[redacted]:FactoryTalkOptixHMI:FTOptixApplication'
23/05/2025 12:34:09.580	Server Node	FTOptixApplicat...	Used UserTokenType: Anonymous
23/05/2025 12:34:27.949	Server Node	FTOptixApplicat...	Error 'BadSecurityChecksFailed' was returned during OpenSecureChannel
23/05/2025 12:34:27.949	Server Node	FTOptixApplicat...	Connection status of server 'FTOptixApplication@localhost' changed to 'Disconnected'.

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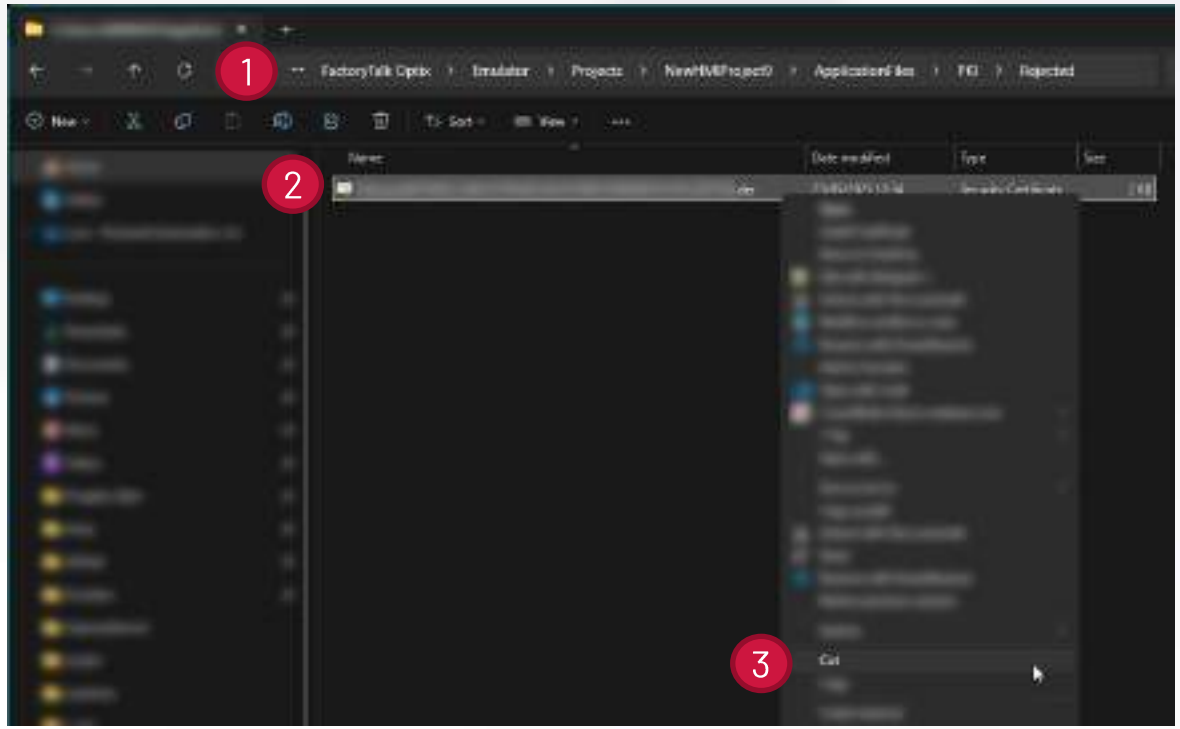

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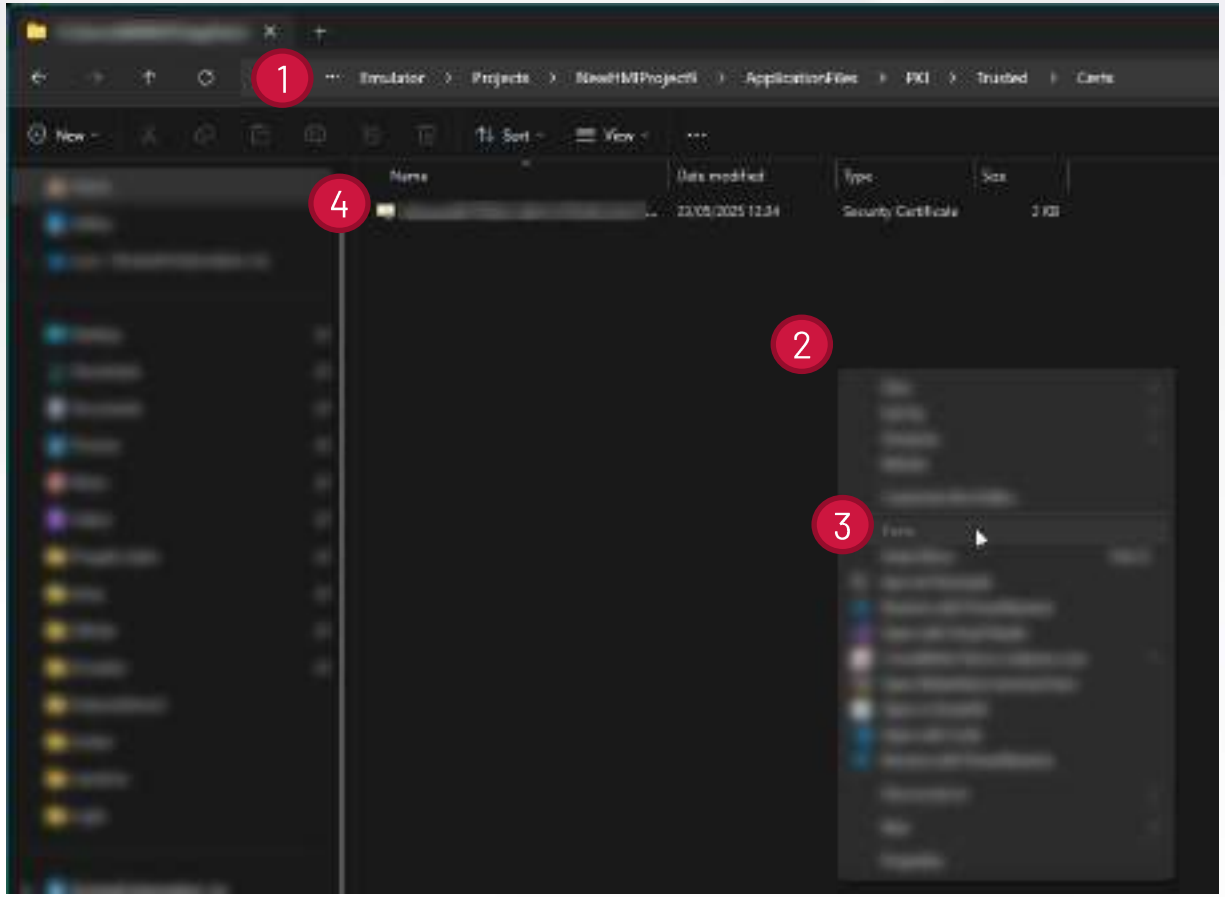

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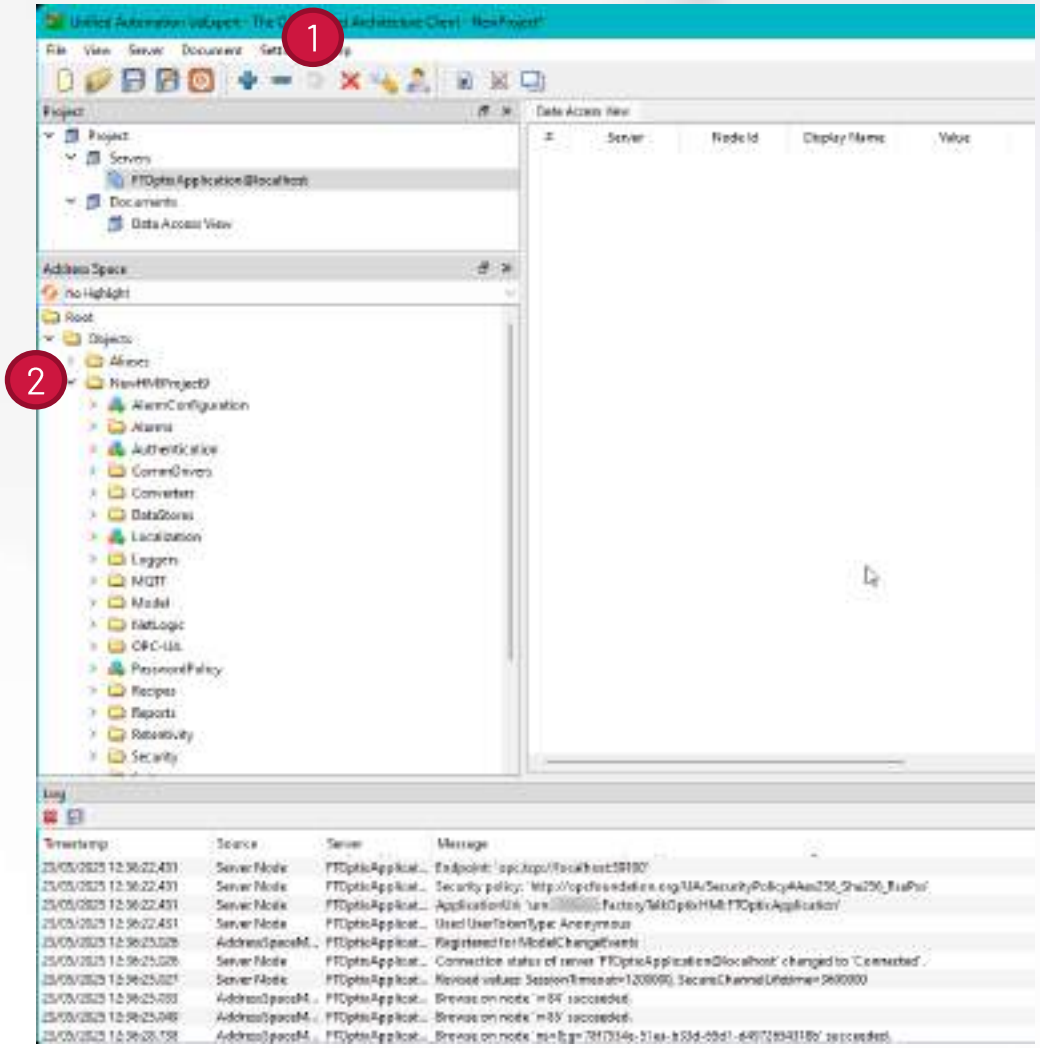


Return parameters from NetLogic methods

Return parameters from NetLogic methods

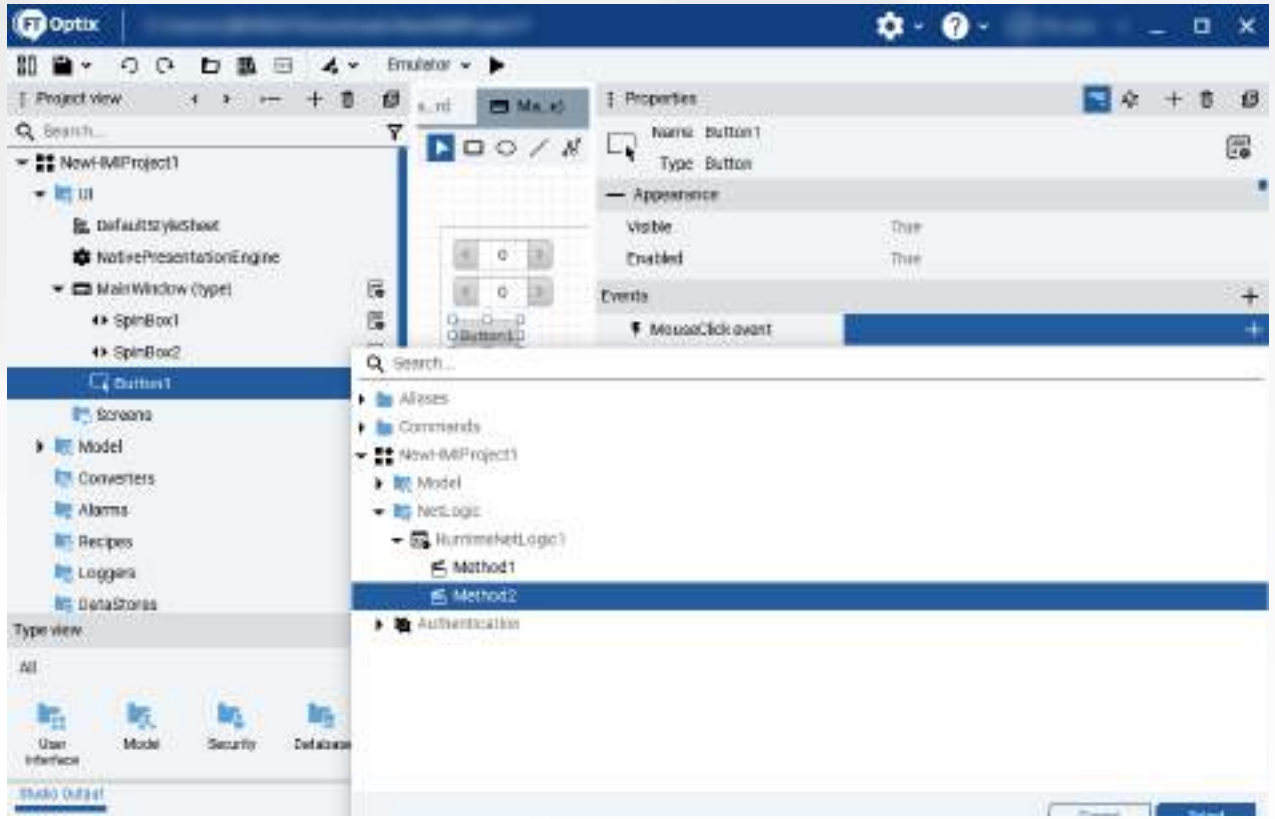
- All methods to be used in FactoryTalk Optix must be void (returning nothing)
- Parameters can be returned by using the «out» modifier in the arguments list

```
// This one will not work, returned value is discarded
[ExportMethod]
public int Method1(int a, int b) {
    return a + b;
}

// This one will work, returned value can be used
[ExportMethod]
public void Method2(int a, int b, out int c) {
    c = a + b;
}
```

Return parameters from NetLogic methods

- On any method that can trigger an event, call the method exposed by the NetLogic
- Configure the input parameters (if any)
- Add a second method invocation
- Use a SetVariableValue to get the output value from the MethodContainer1 and set it to a different variable (or property)



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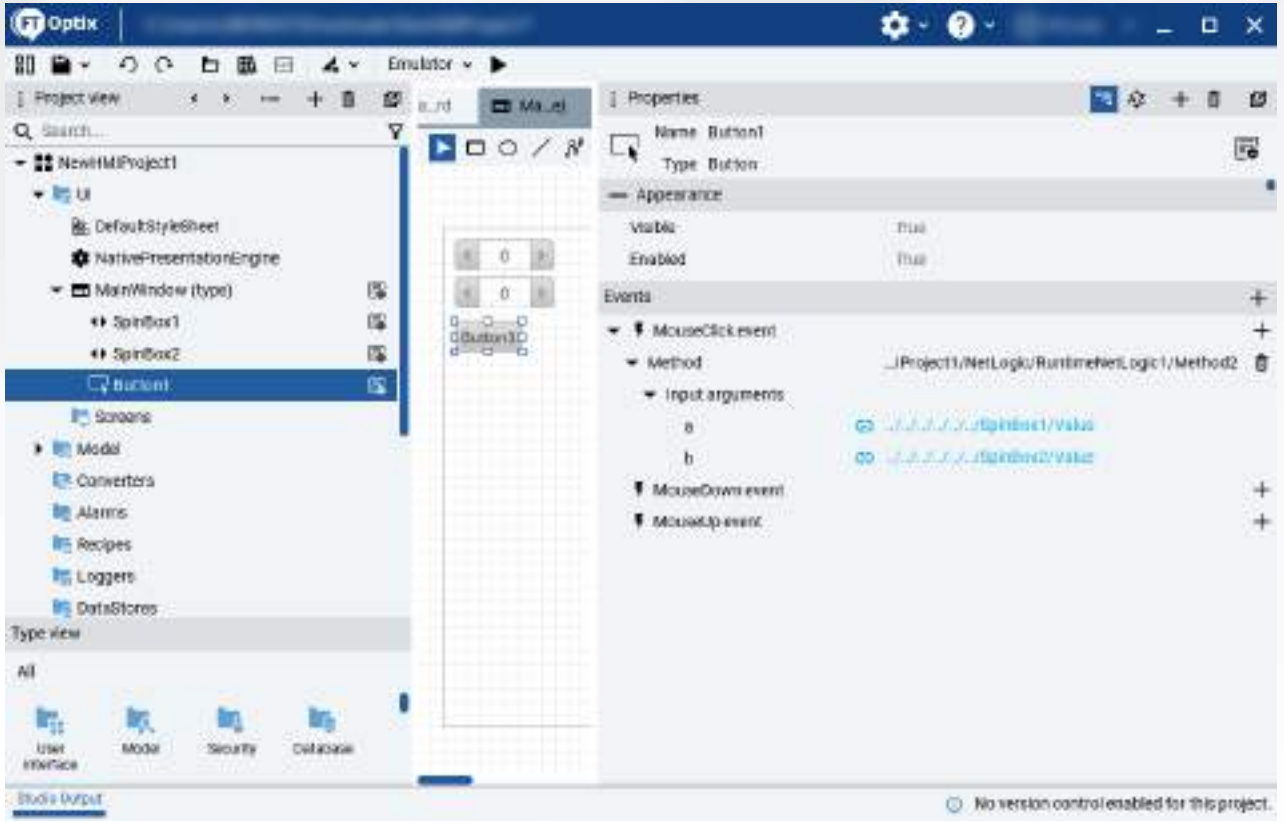

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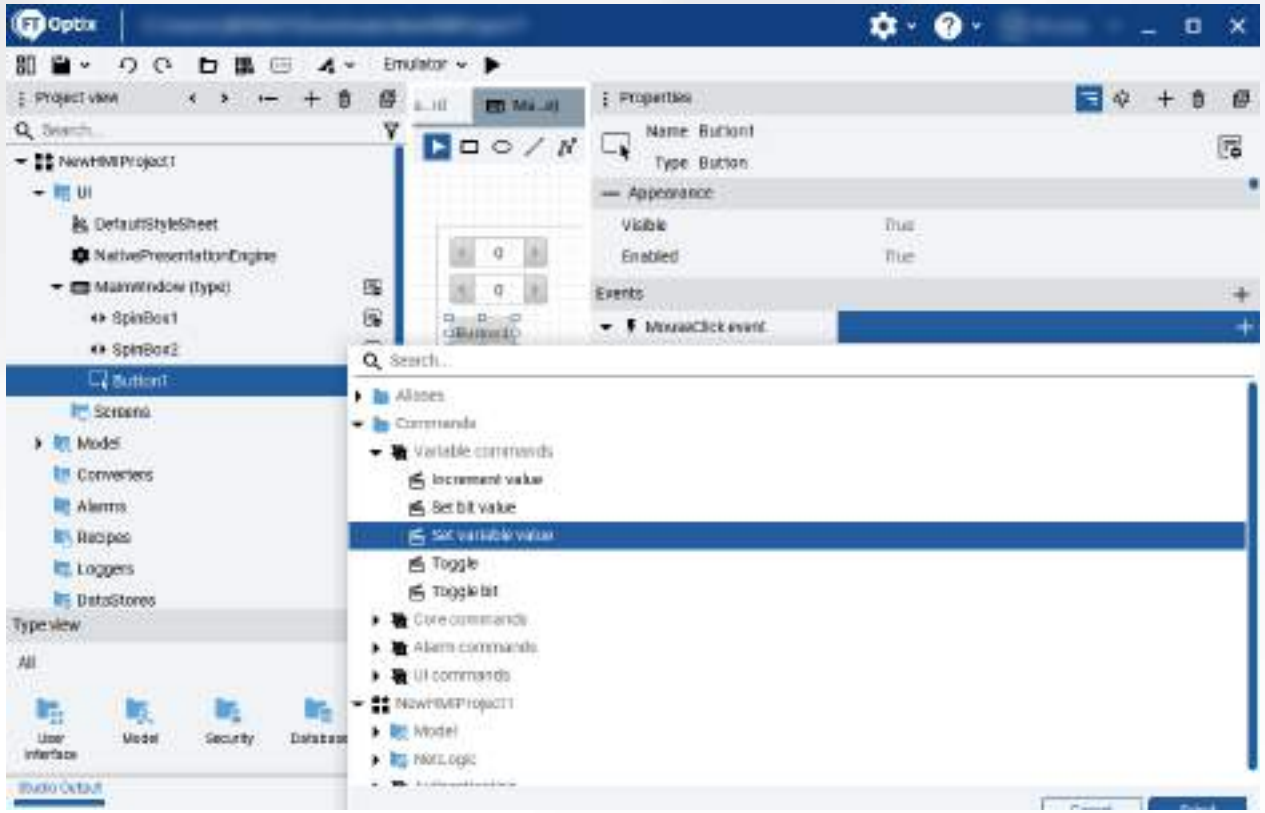

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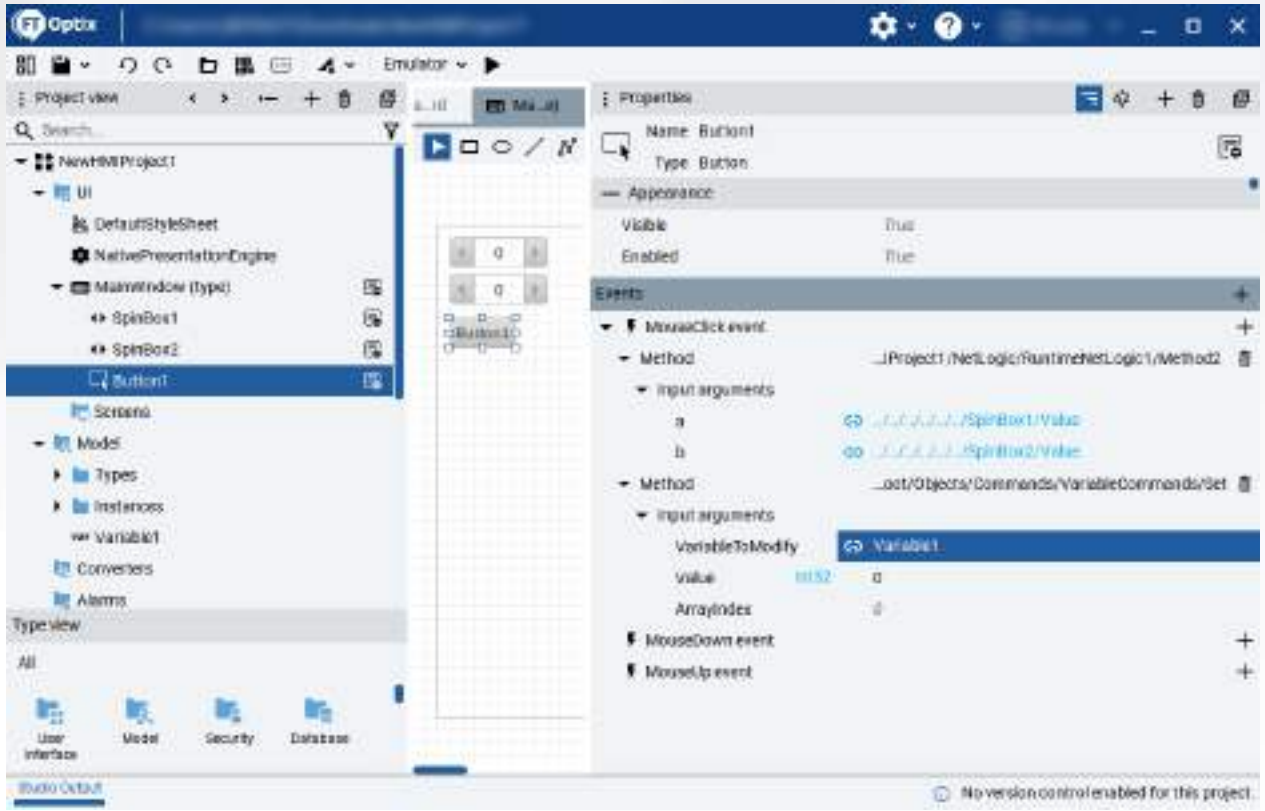

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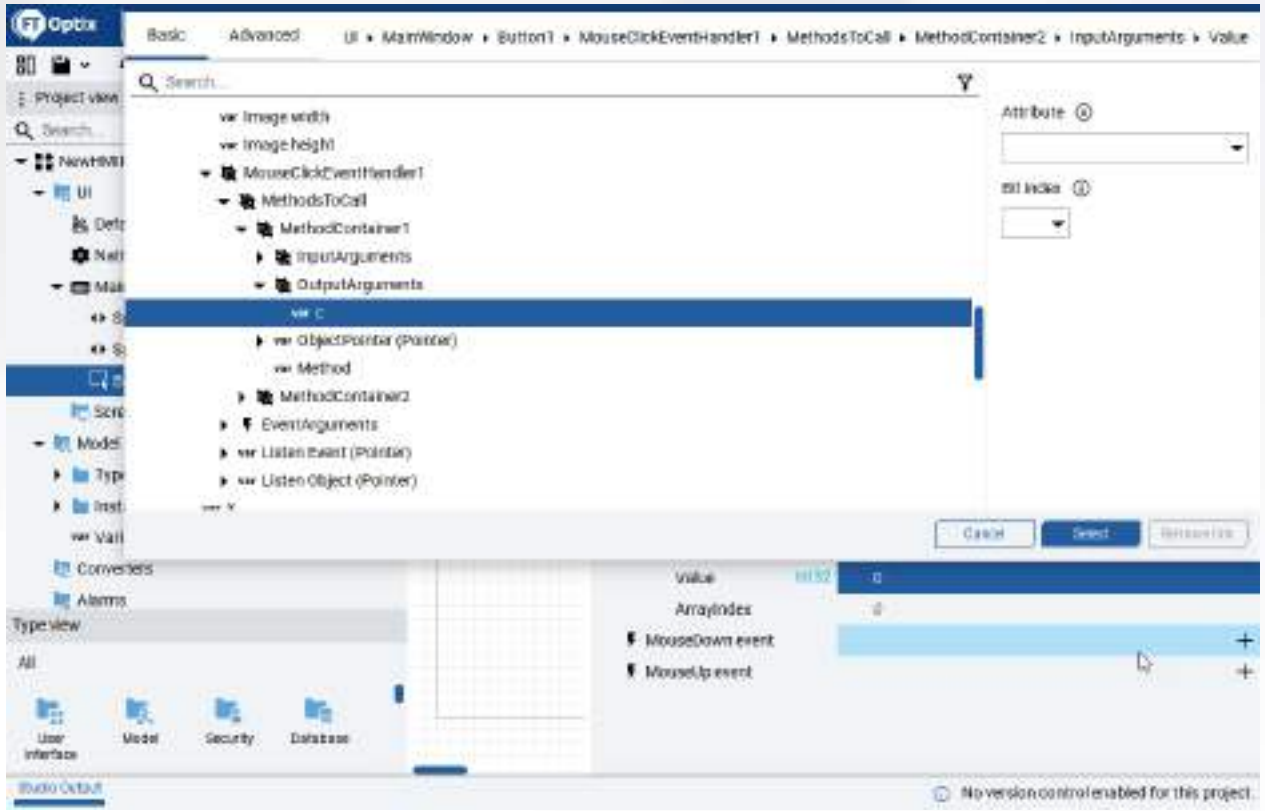
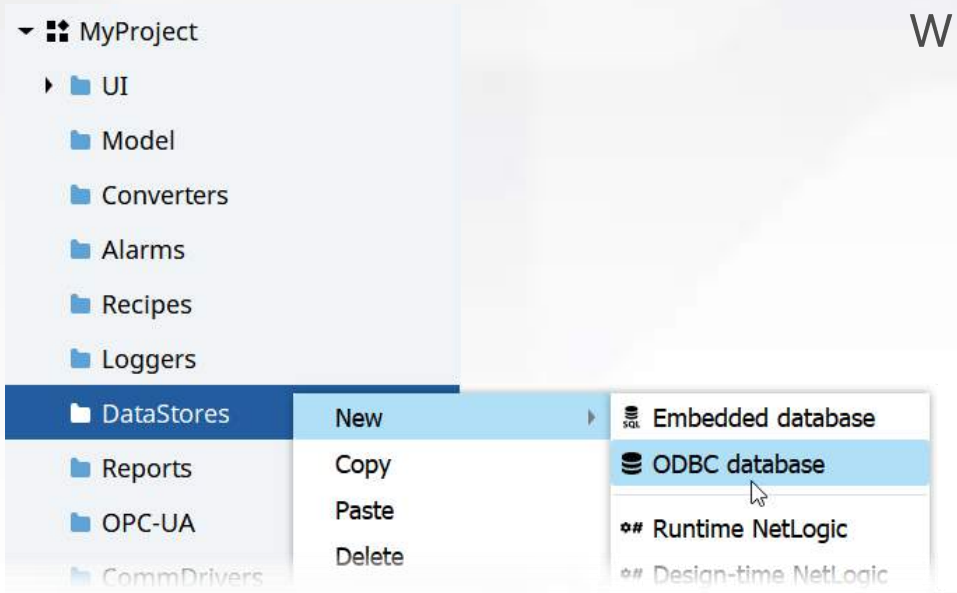


Connect to an External Database

ODBC Database

- It's used to query/populate a relational database external to the FTOptixApplication
- Supported DBMS:
  - SQL Server or SQL Server Express 2012 (or higher)
  - MySQL Server

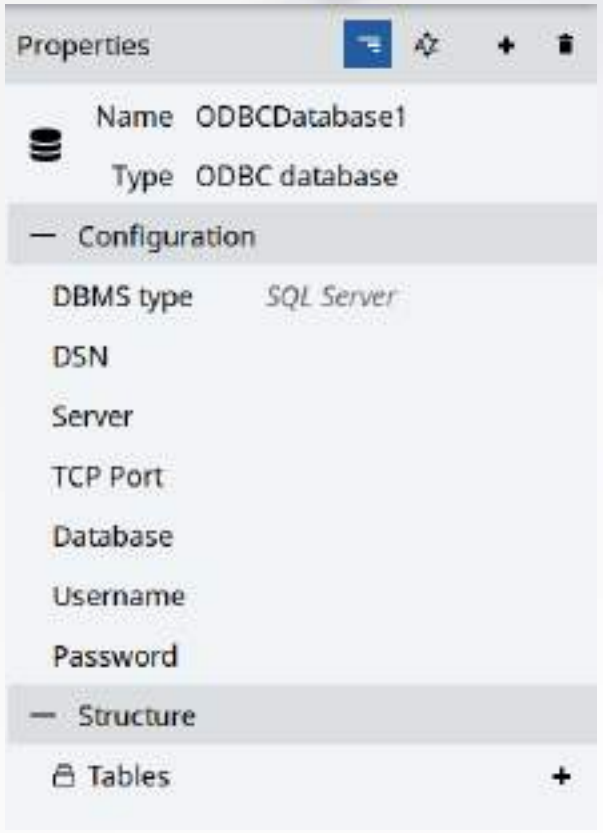


- Objects that can exchange data with an ODBC database:
  - *Data grid*, *List box*, *Combo box* and *Trend* objects
    query a table to display data at runtime
  - *Data logger* and *Event logger* objects
    store data in a table
  - *Recipe* object
    stores data in a table and execute a query to display data at runtime

ODBC Database

- *DBMS type:* SQL Express or MySQL
- *DSN (optional):* only in case ODBC is used
- *Server:* can be IP Address, Hostname or "Hostname\Instance Name"
- *TCP Port (optional):* to be used if the port is different from the default
- *Database*: Name of the database

  NOTE: database must be created manually
- *Username/Password*: credential of the user, used to read/write into database tables



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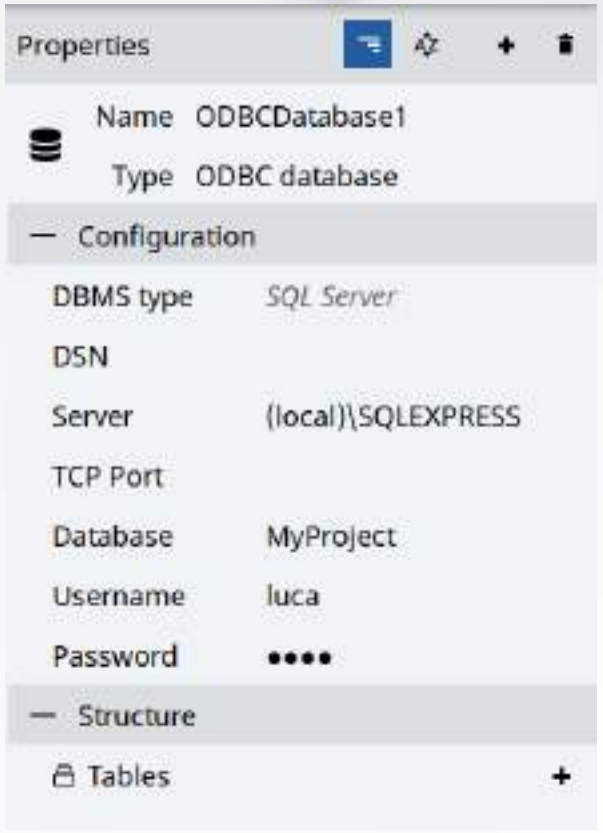
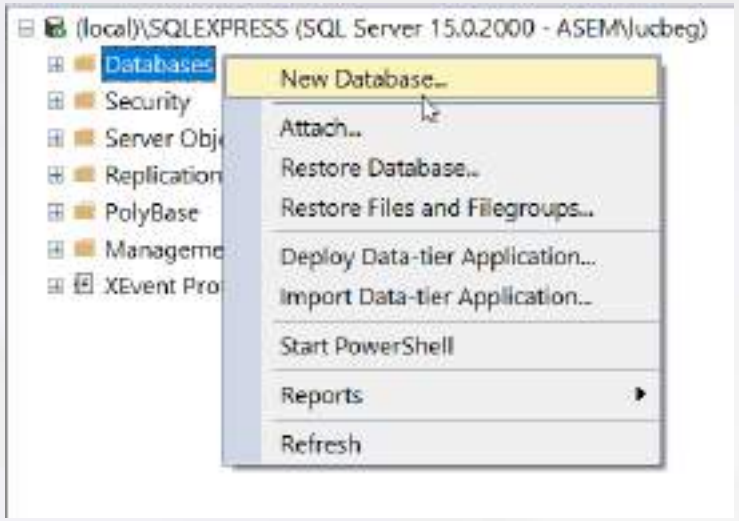
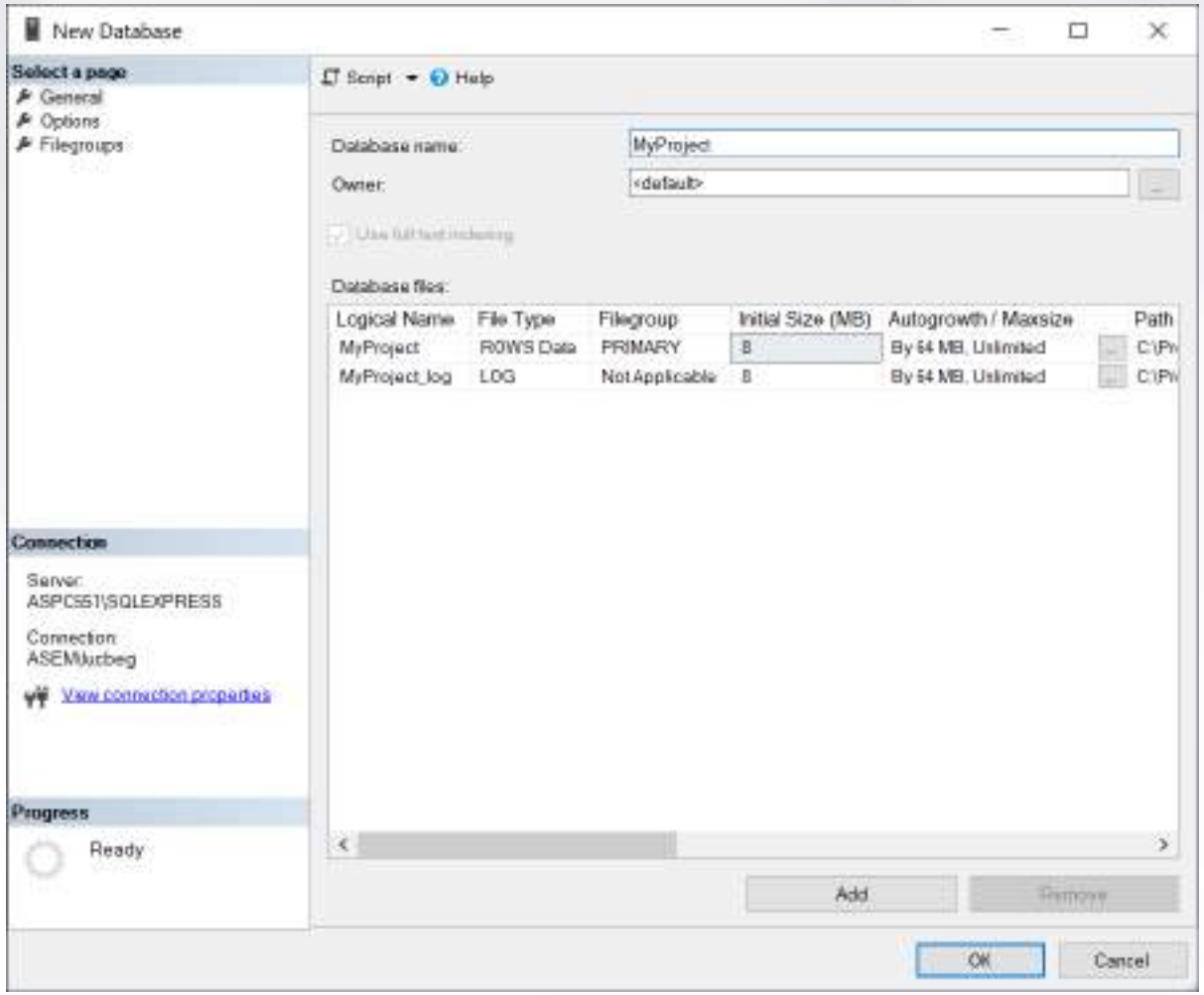


SQL Server: create database via SQL Server Management Studio





- Is suggested to create the database before the creation of the user

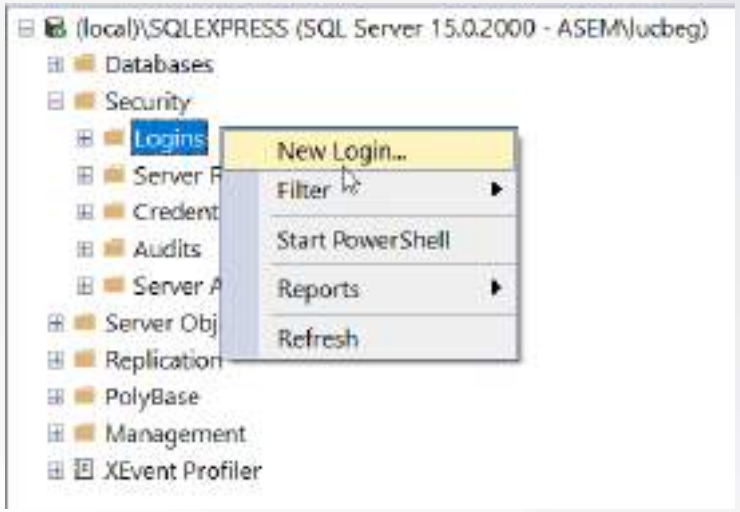
- To create a database
  Databases > New Database...
  and is enough to provide the name

SQL Server: create user via SQL Server Management Studio

1. Security > Logins > New Login...

2. Once created a User, it's necessary to assign a role for the needed database

3. User Mapping > Database > db_ownwer



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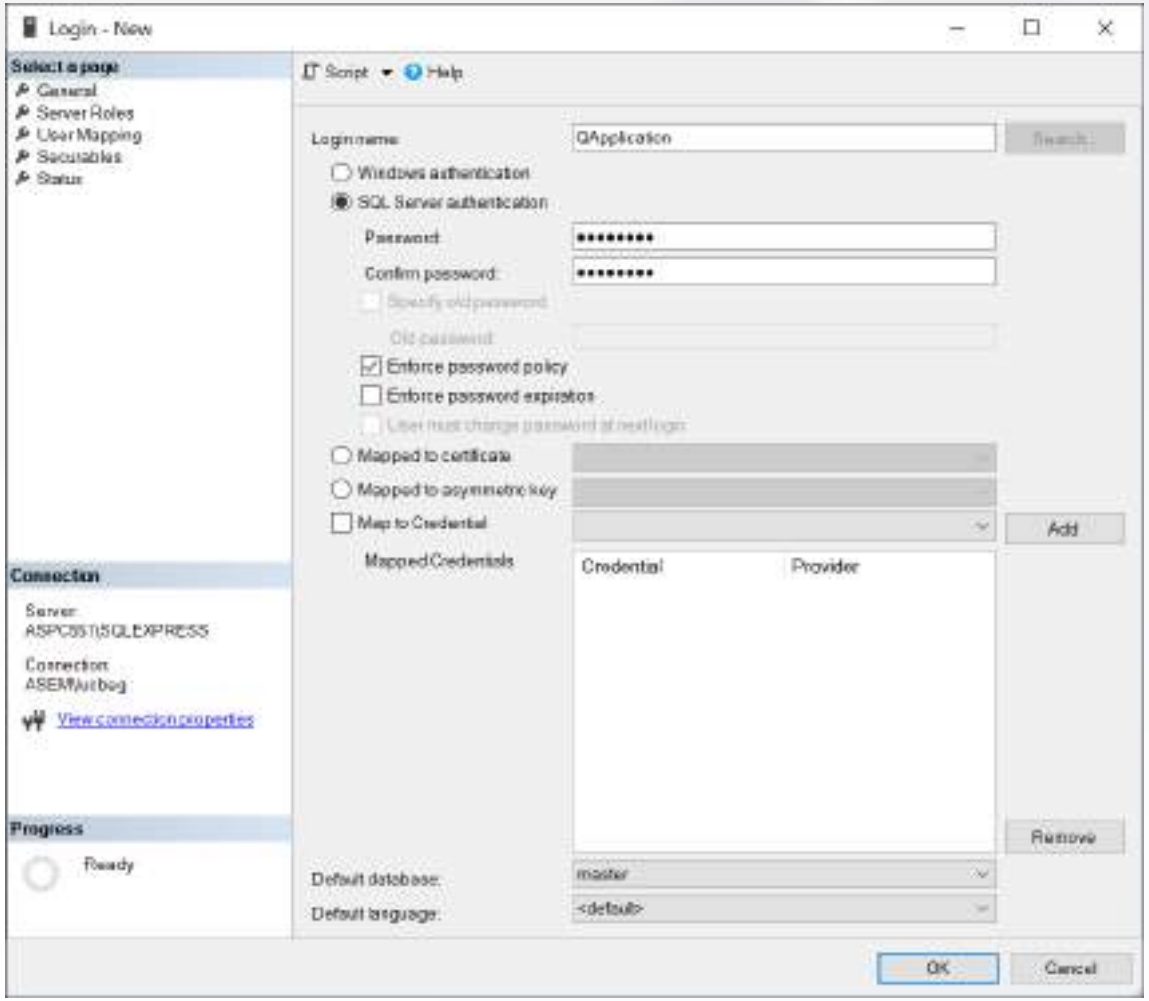

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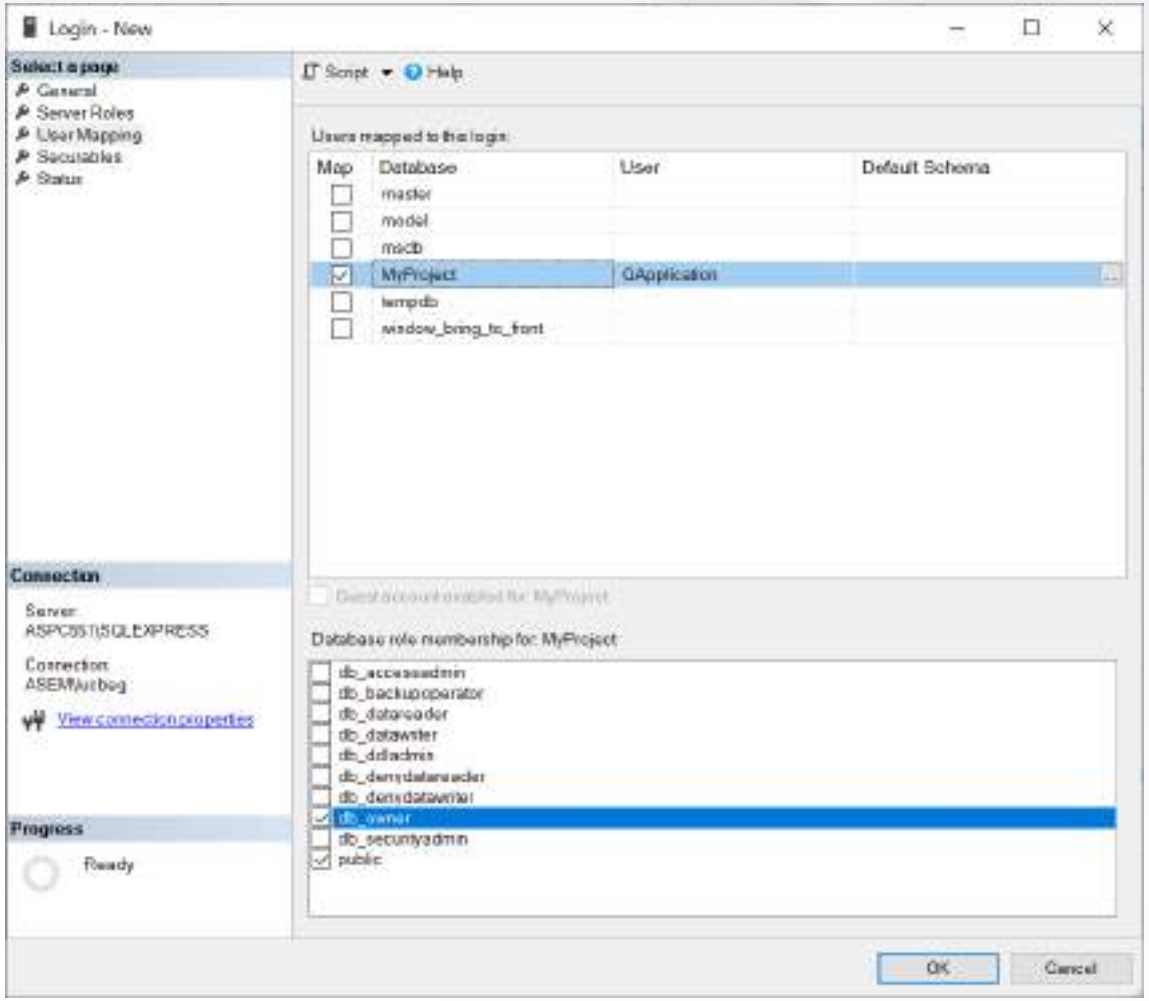

Usage of ODBC Data Source (optional)

- To configure a DSN
  use "ODBC Data Sources (64-bit)"

- ODBC Driver supported:
  - SQL Server
  - MySQL ANSI
  - MySQL Unicode

- Key settings:
  - DSN Name: defined into ODBC DSN,
    must be the same in FactoryTalk Optix Studio
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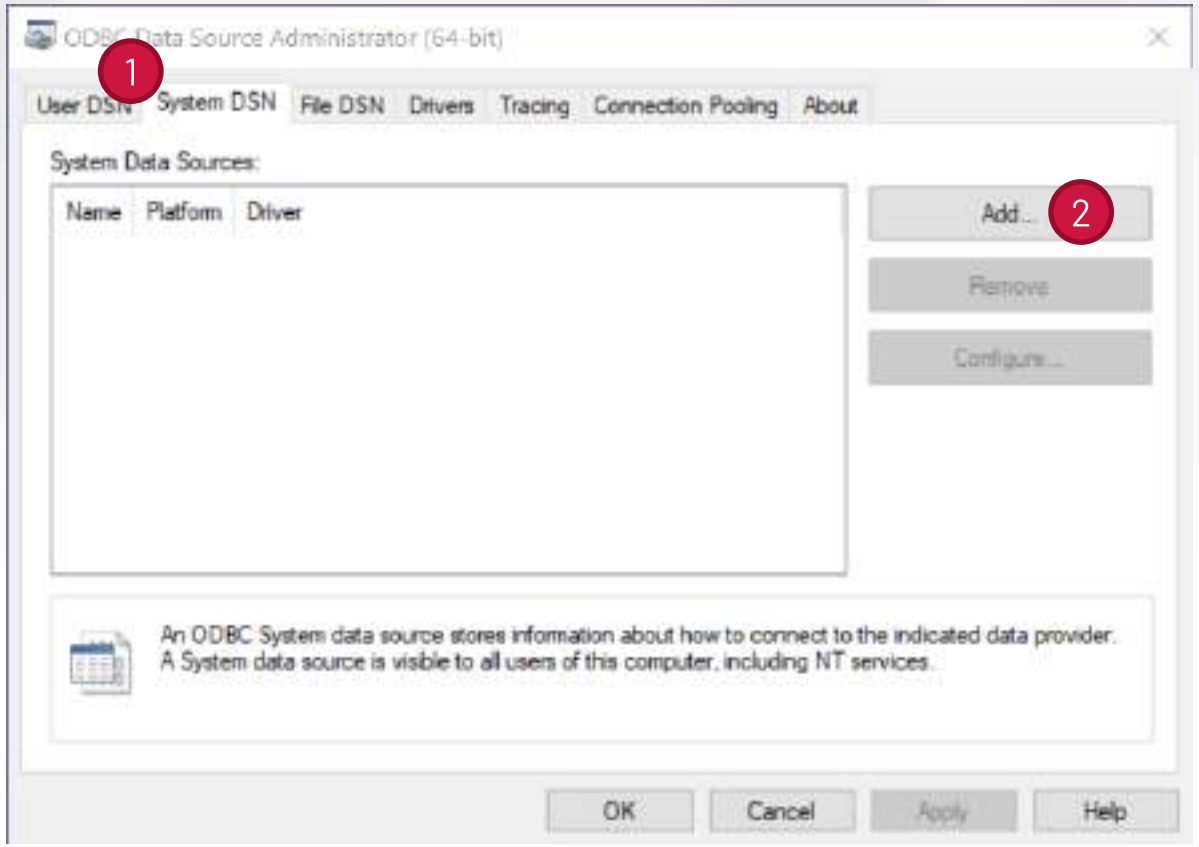

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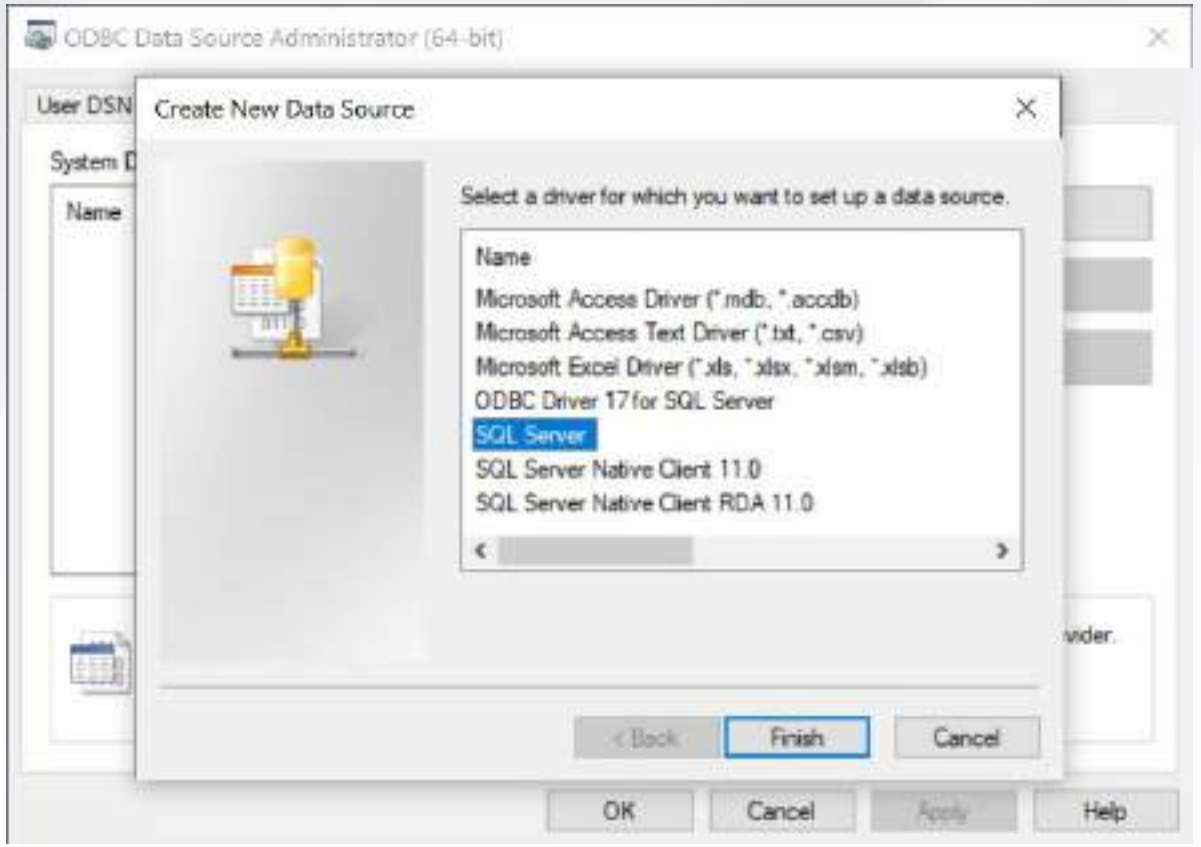

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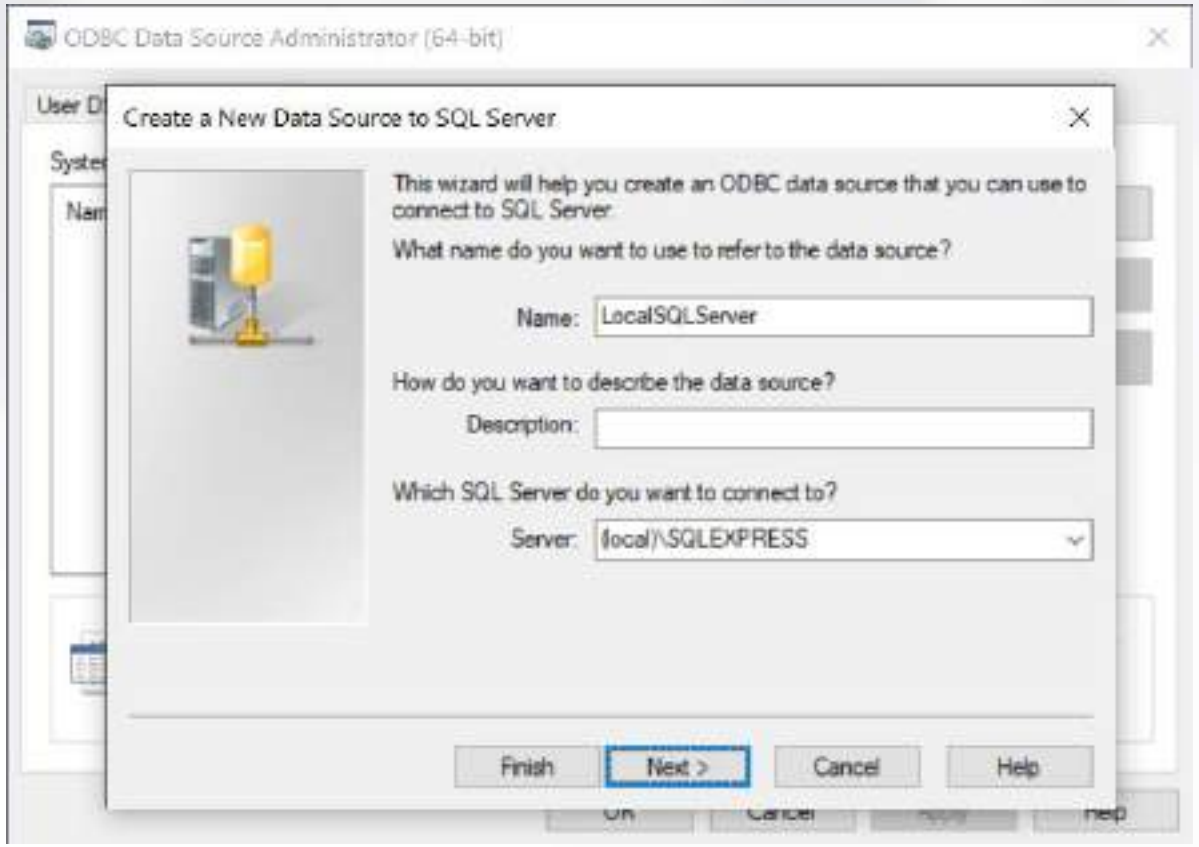

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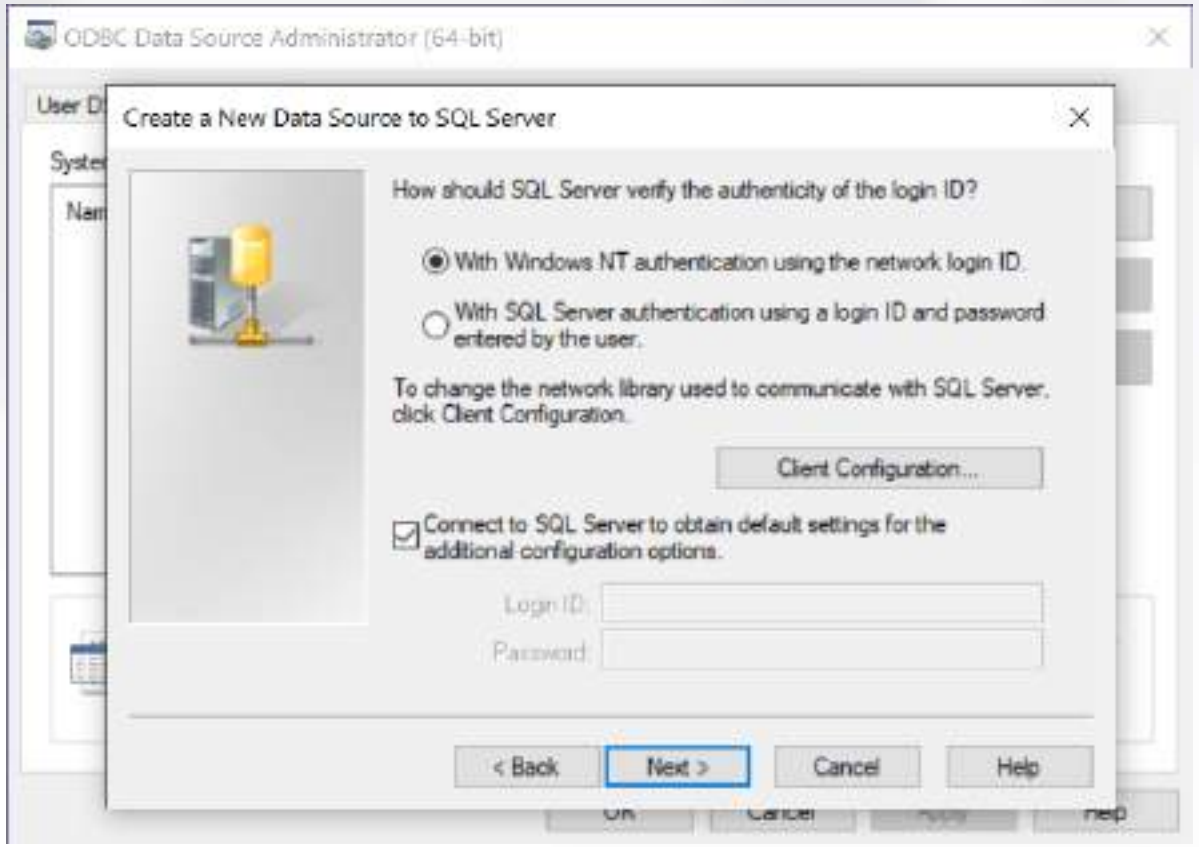

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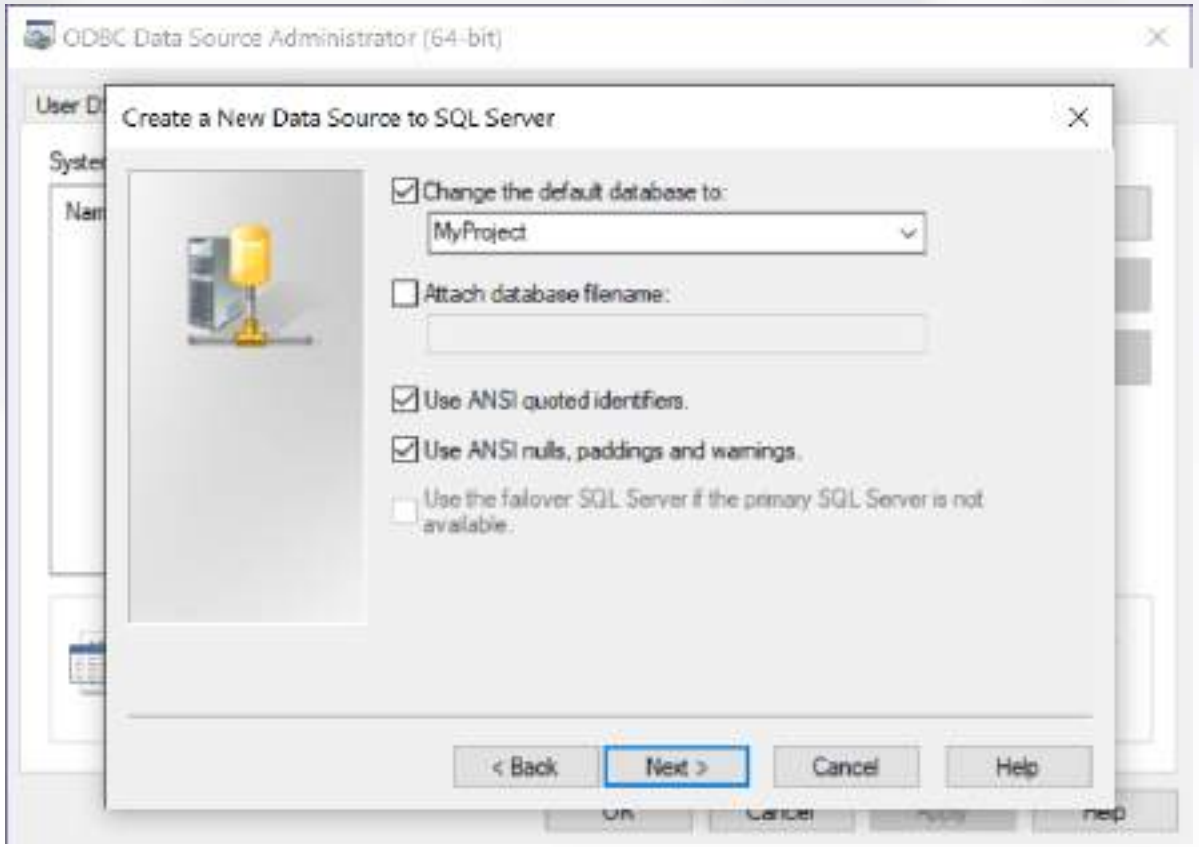

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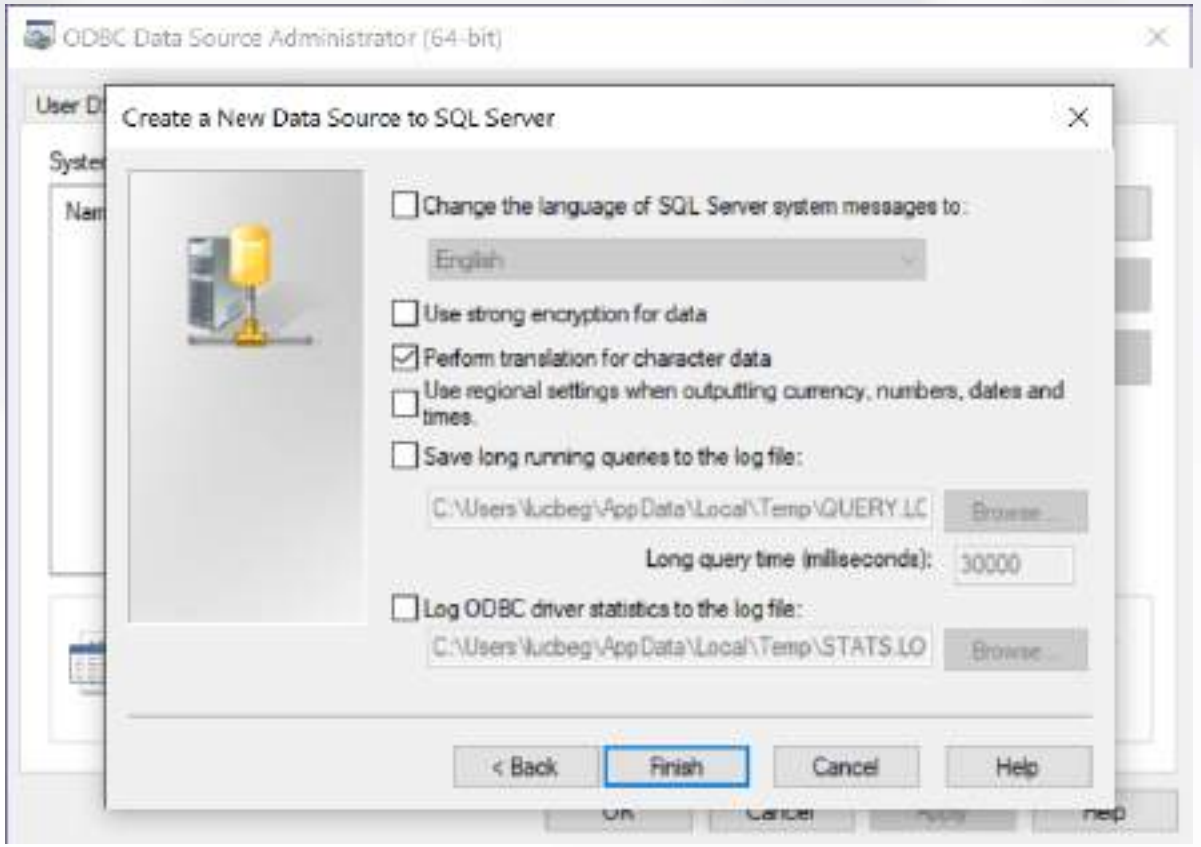

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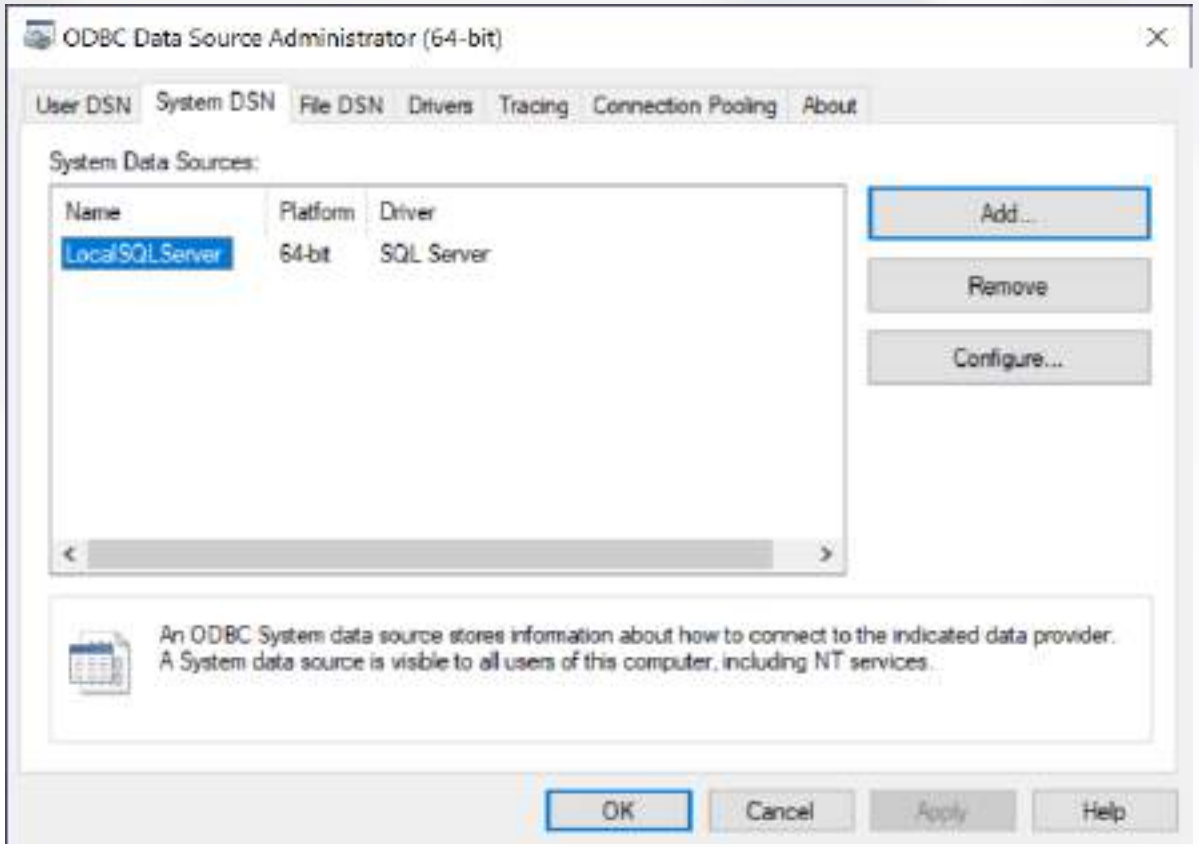

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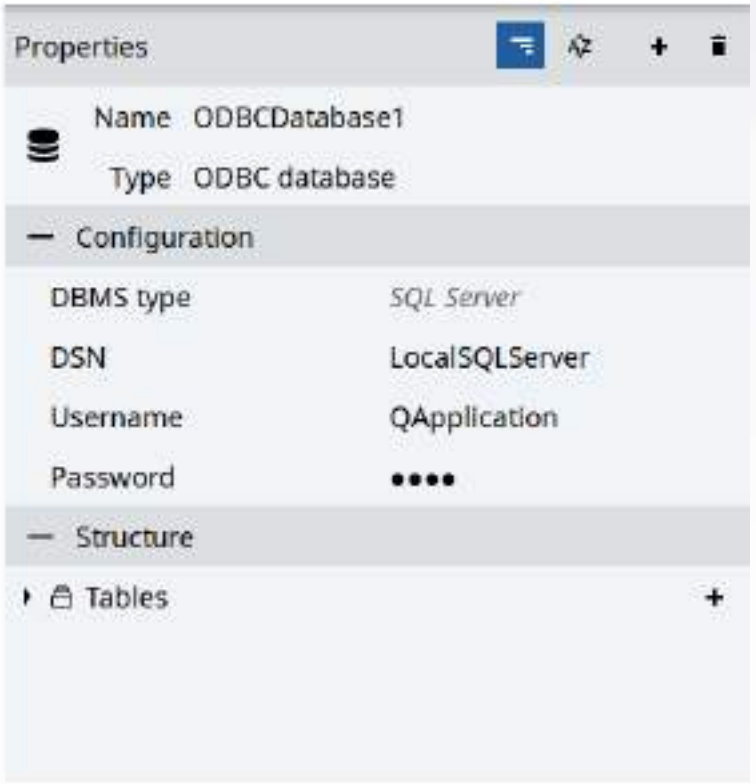


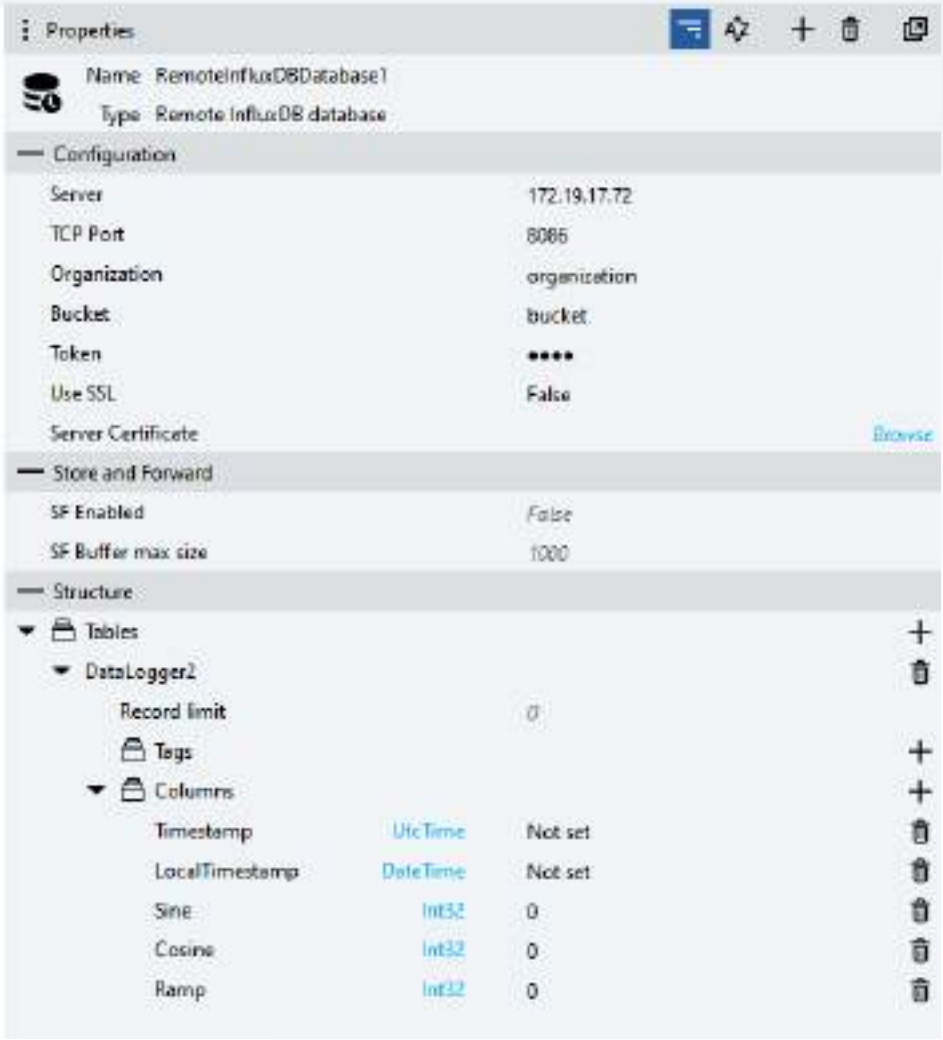
Connect to an External InfluxDB instance

Sample InfluxDB server using Docker

```
services:
  influxdb:
    image: influxdb:latest
    container_name: influxdb
    ports:
      - '8086:8086’ # Port to set in the Optix project
    volumes:
      - influxdb-storage:/var/lib/influxdb2
    restart: unless-stopped
    environment:
      - DOCKER_INFLUXDB_INIT_MODE=setup
      - DOCKER_INFLUXDB_INIT_USERNAME=admin
      - DOCKER_INFLUXDB_INIT_PASSWORD=admin_pass
      - DOCKER_INFLUXDB_INIT_ORG=organization # Name of the organization to set in the Optix project
      - DOCKER_INFLUXDB_INIT_BUCKET=bucket # Name of the bucket to set in the Optix project
      - DOCKER_INFLUXDB_INIT_RETENTION=4w # How long to retain data
      - DOCKER_INFLUXDB_INIT_ADMIN_TOKEN=MyVeryLongAndS3cr3tTok3nToWriteD4t4 # Access token to set in the Optix project
volumes:
  influxdb-storage:
```

Remote InfluxDB configuration

- Configure the connection parameters to reach the InfluxDB instance
- Usage of SSL is recommended
  - Certificate can be exported from the InfluxDB server and loaded in the Optix application
- Tables and columns are only required if inserting new data (same as ODBC)



Configuration example

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    image: influxdb:latest
    container_name: influxdb
    ports:
      - '8086:8086'
    volumes:
      - influxdb-storage:/var/lib/influxdb2
    restart: unless-stopped
    environment:
      - DOCKER_INFLUXDB_INIT_MODE=setup
      - DOCKER_INFLUXDB_INIT_USERNAME=admin
      - DOCKER_INFLUXDB_INIT_PASSWORD=admin_pass
      - DOCKER_INFLUXDB_INIT_ORG=organization
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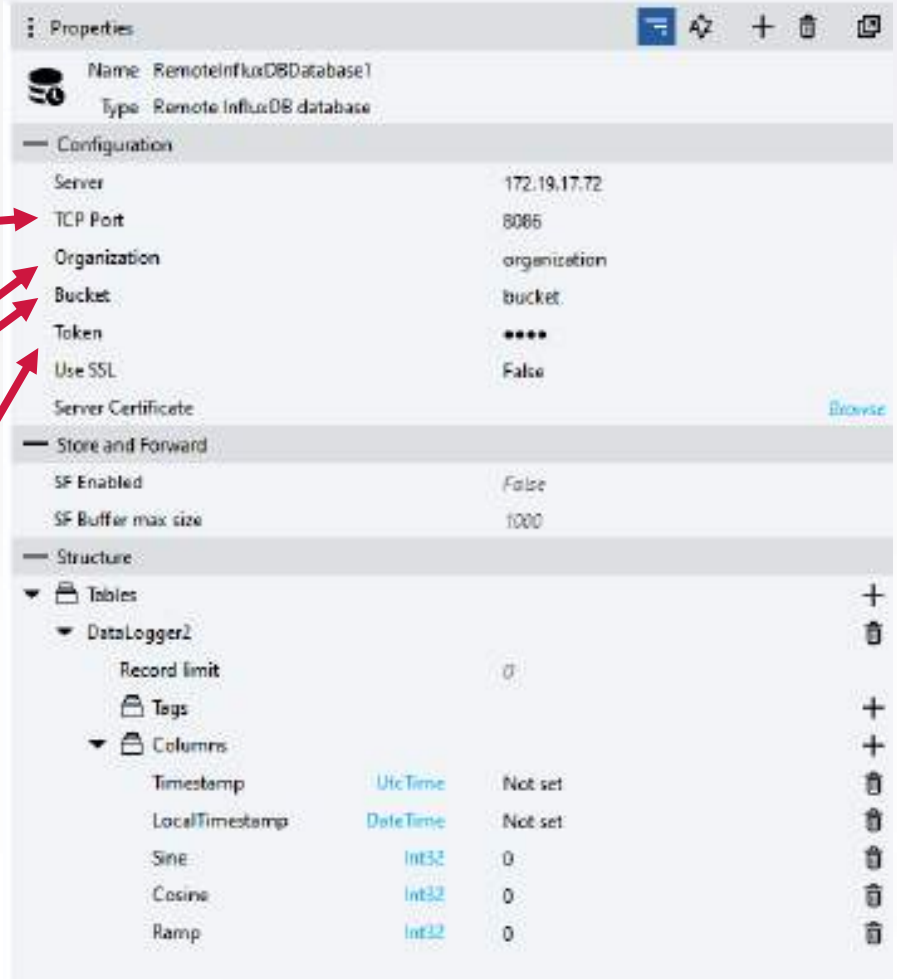
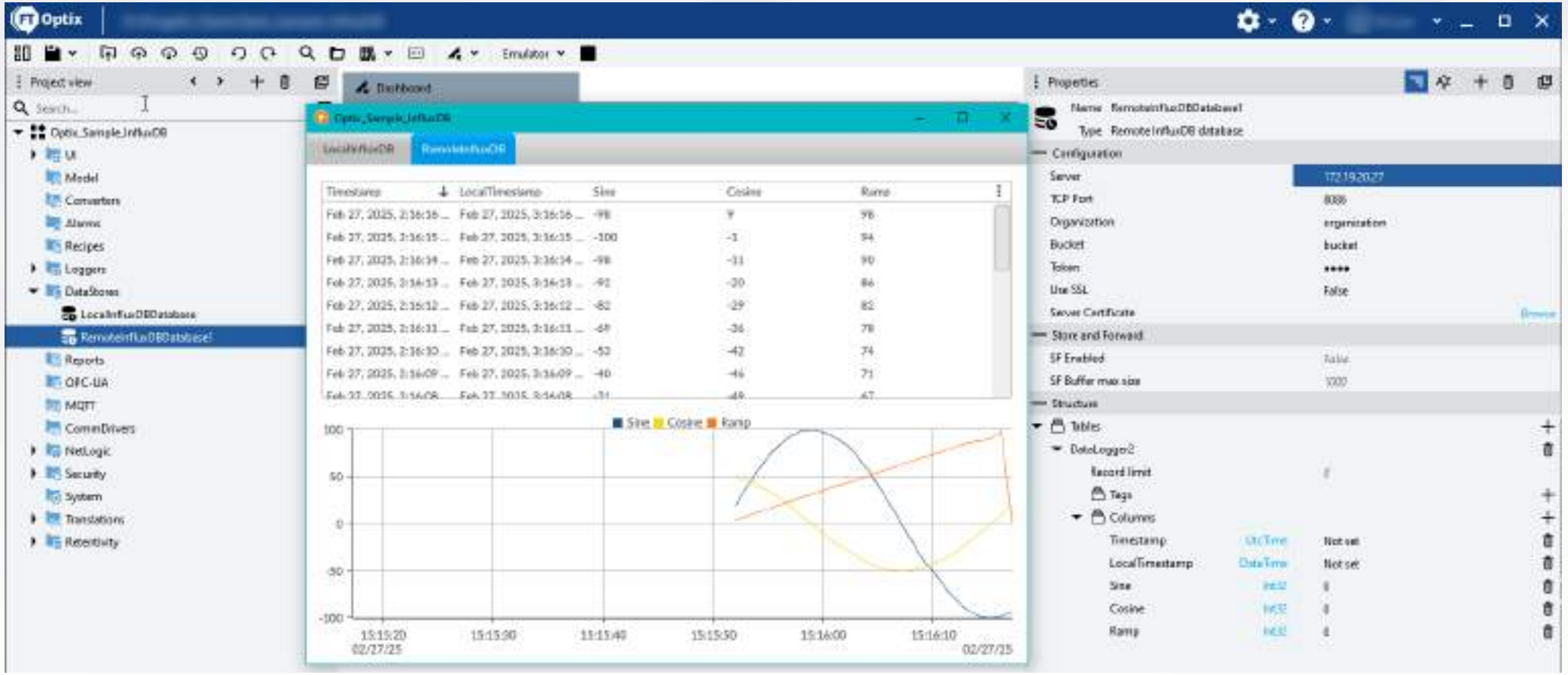


Configuration example



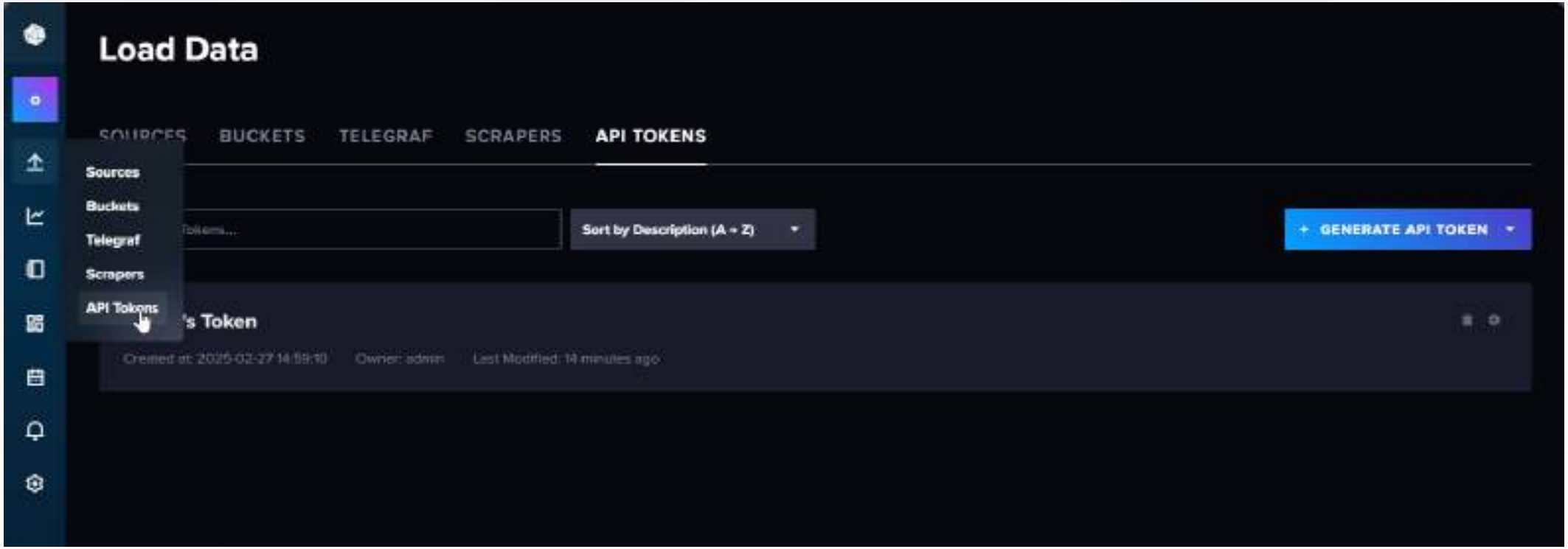
FactoryTalk by ROCKWELL AUTOMATION

InfluxDB limitations

- No support for Flux query language
- Limited set of queries (see InfluxDB documentation in Optix help)
- Recipes cannot be used with an InfluxDB store

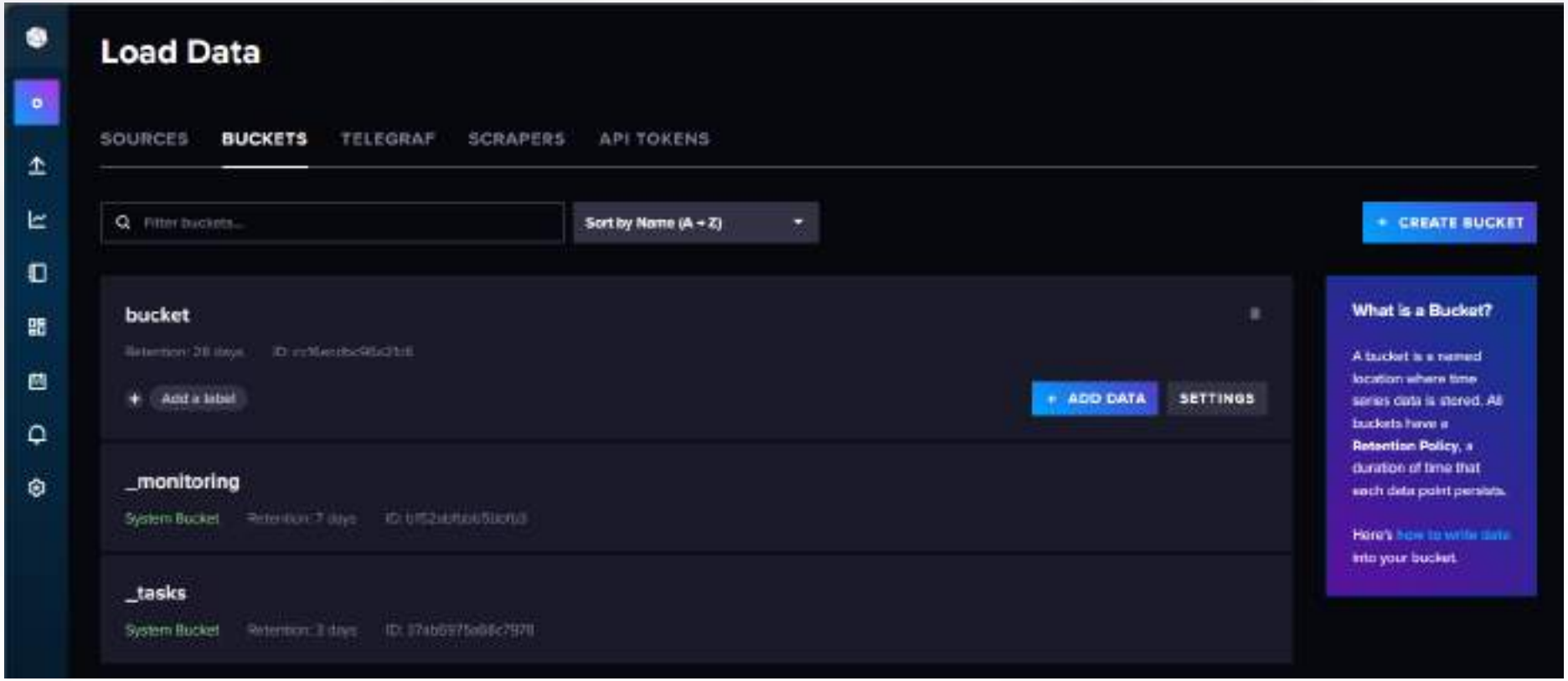
Creating a new token

- Access tokens are created from the InfluxDB web interface



Creating or configuring a bucket

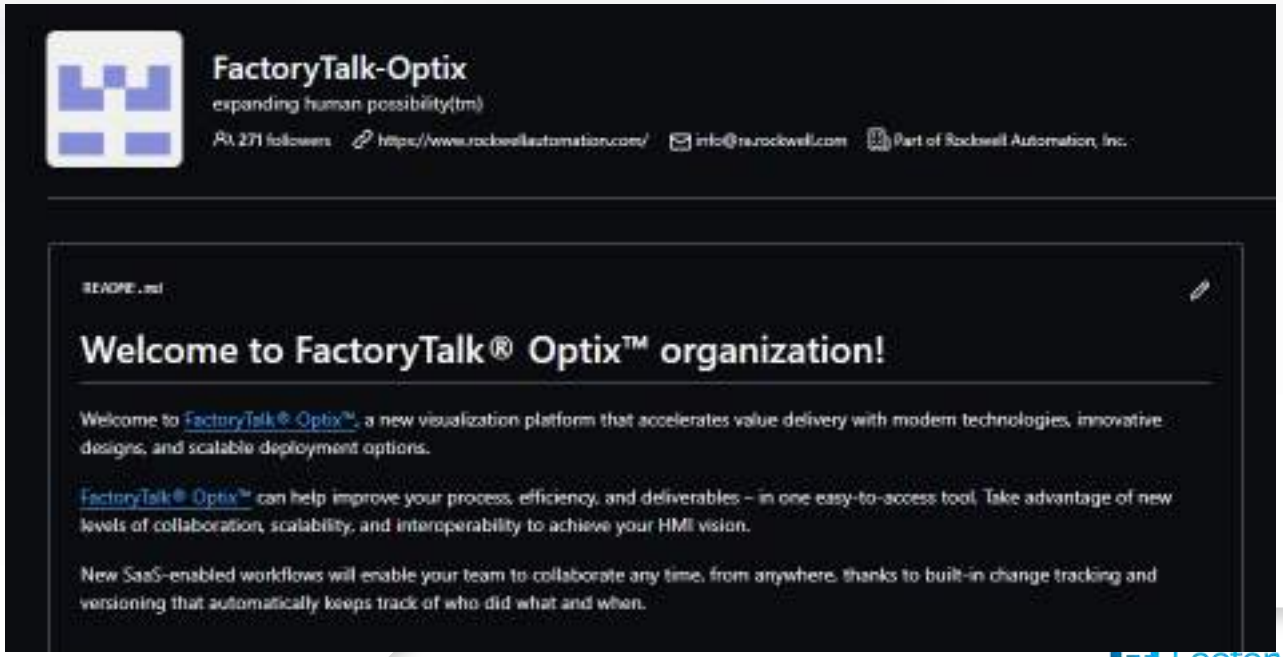
- Buckets, retention and user access are configured using the InfluxDB web interface



Additional resources

FactoryTalk Optix GitHub organization

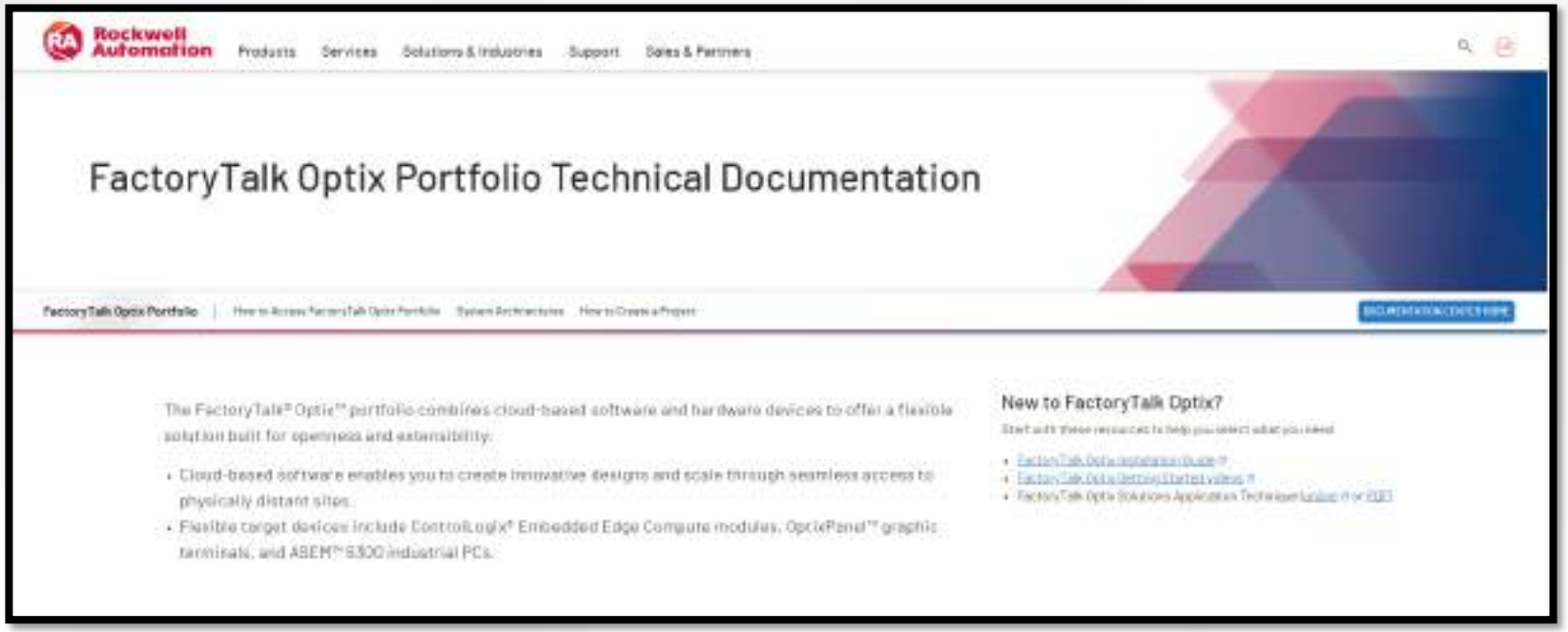
- Contains a big list of projects with a lot of features that can be studied and reused in custom projects
- Contains a lot of sample projects
- Contains a NetLogic CheatSheet with a lot of useful snippets



FactoryTalk-Optix (github.com)

FactoryTalk Optix landing page

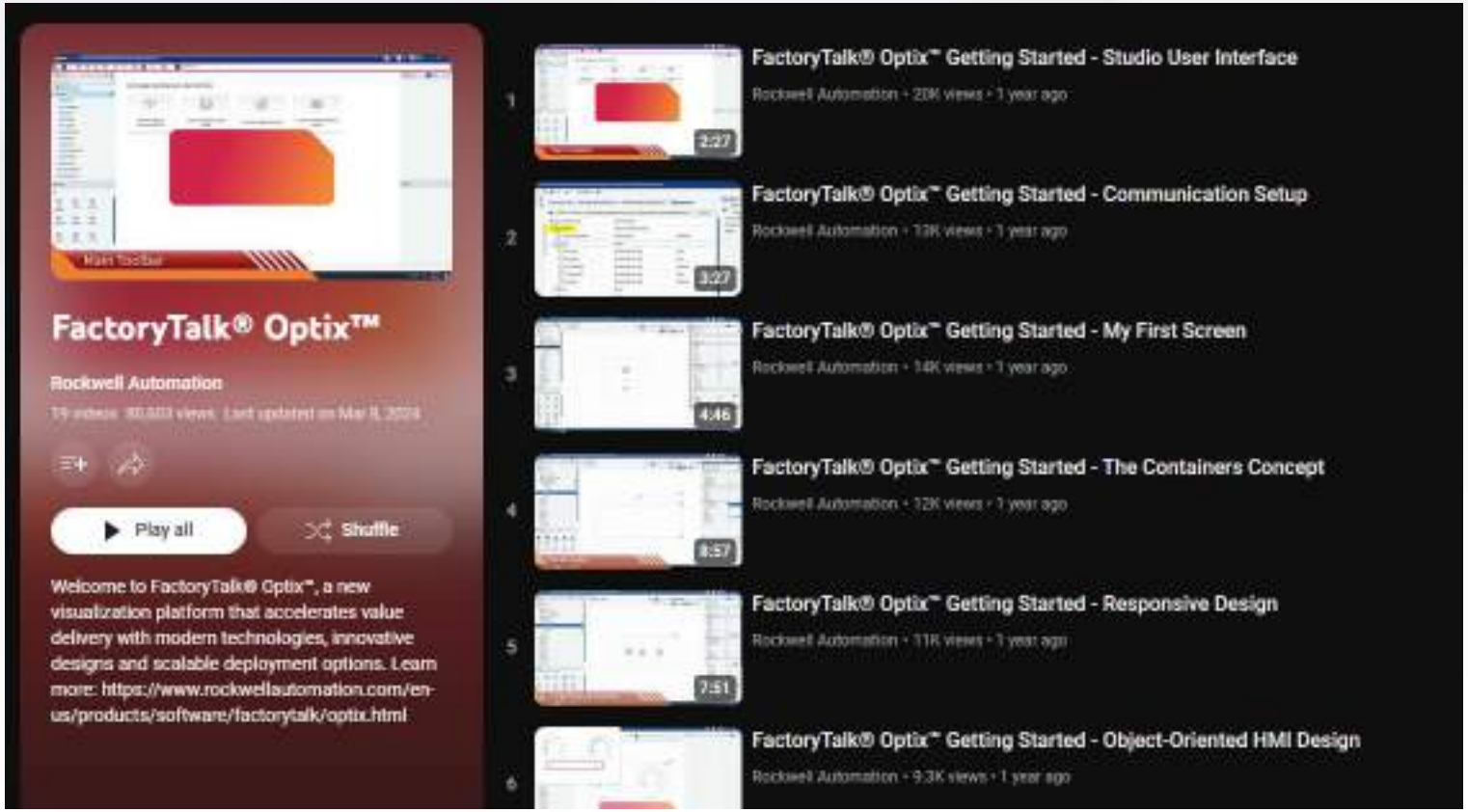
- Contains all the FactoryTalk Optix related resources (help, install guide, release notes, etc)
- Constantly updated



FactoryTalk Optix Portfolio Technical Documentation | Rockwell Automation

FactoryTalk Optix YouTube channel

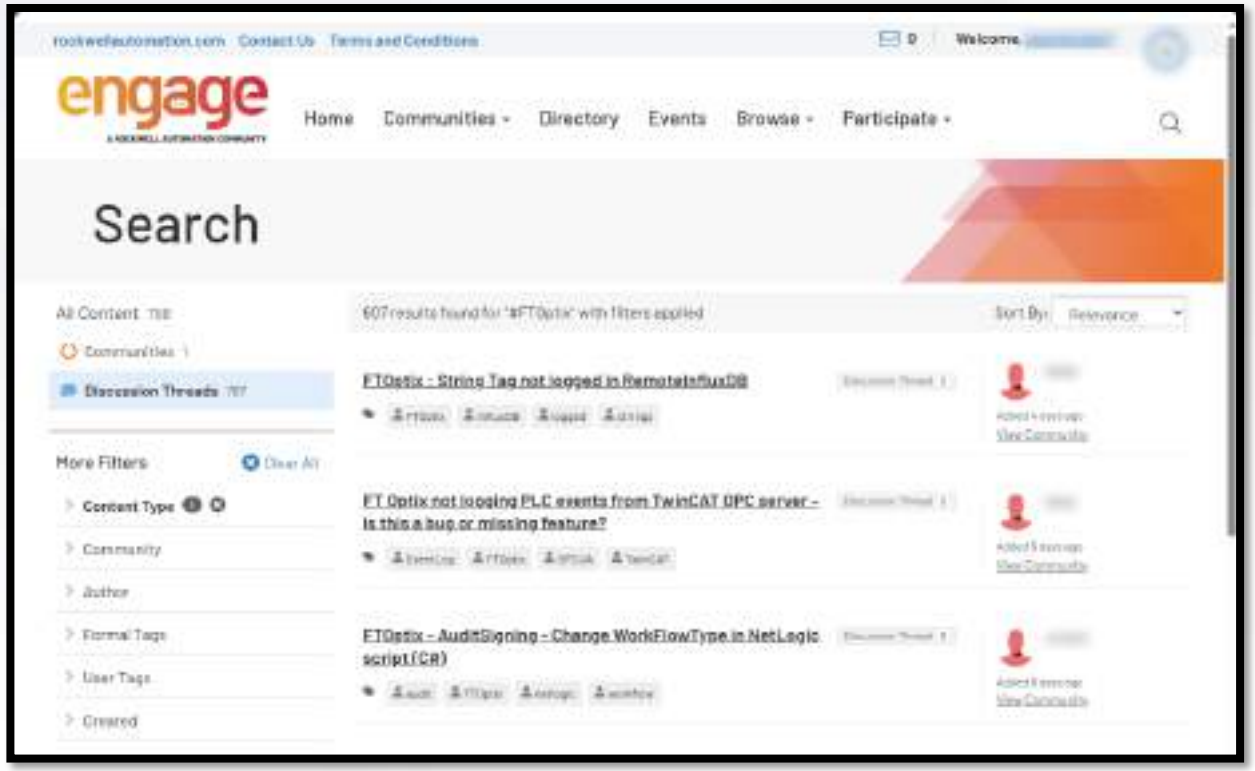
- Contains videos on how to build your first project (check the playlists tab)



Rockwell Automation - YouTube

FactoryTalk Optix forum

- Used by customers and colleagues to exchange informations



Search - Engage, A Rockwell Automation Community

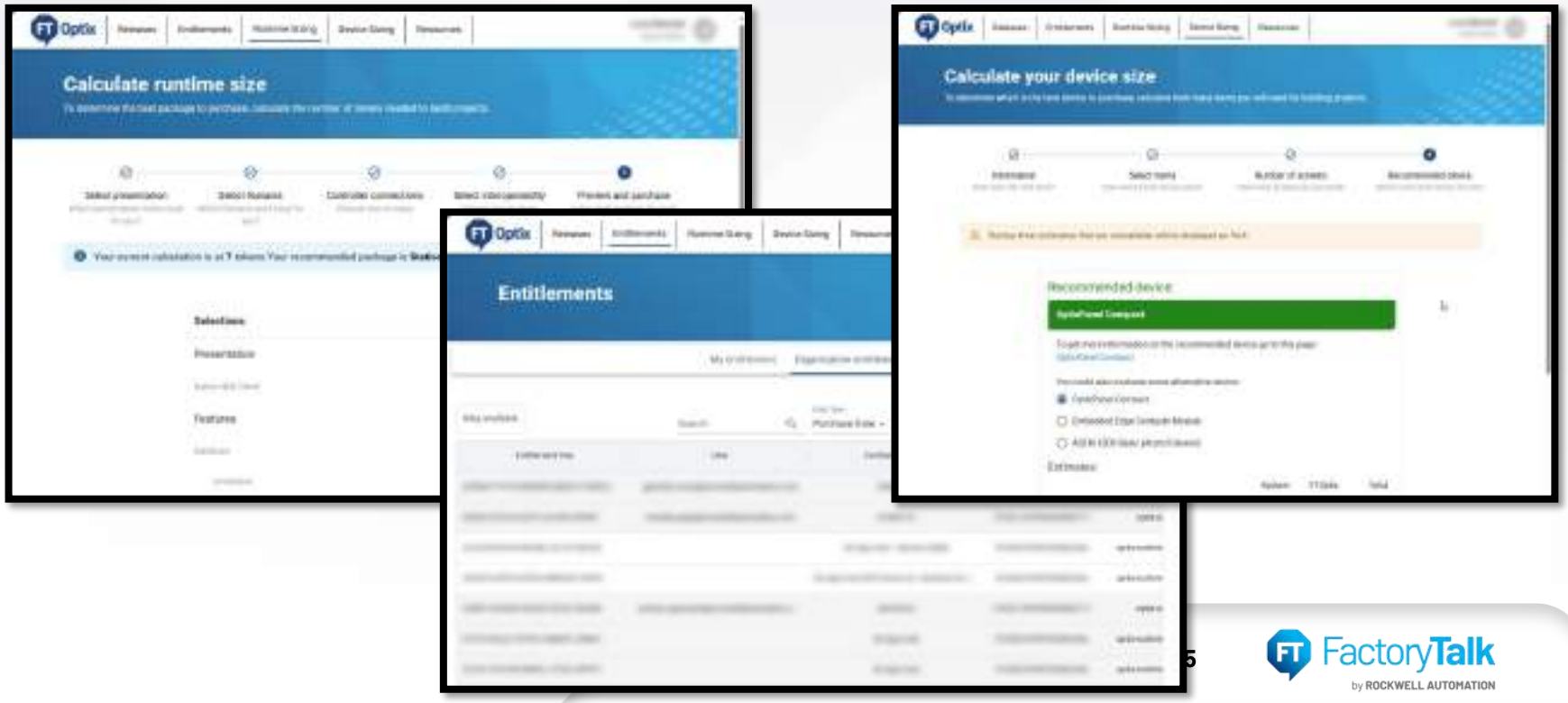
FactoryTalk Hub

- Contains all the releases of FactoryTalk Optix
  - Contains additional resources like RuntimeTools
  - Used to access the WebIDE
- Contains some interactive demos

FactoryTalk Hub

FactoryTalk Hub

- Used to view, manage and activate FactoryTalk Optix licenses
- Contains some useful tools
  - Runtime License size calculator (which license is needed to run the project)
  - Device sizing calculator (which device is recommended to run the project)



FactoryTalk Hub

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THANK YOU!

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