Knowledge Graph How-to

Configure your solution's data foundation to build a knowledge graph

Wire typed graph relations between Tags using Reference members and StartValue, optionally enriched with the `/Attr` dual-shape pattern. The result is a UNS that doubles as a queryable knowledge graph — visualizable, AI-groundable, and round-trippable with industrial ontologies.

Version 10.1.5+

Scope of this page

This is a **step-by-step recipe**. It assumes you already understand UserTypes, Tags, and the Asset Tree from the Unified Namespace How-to. For the concepts and column reference, see UNS UserTypes Reference, UNS Tags Reference, and Industrial Ontology Integration How-to.

How the relation is made

In a knowledge graph, **nodes** are entities and **edges** are typed relations between them.
In FrameworX:

- Each **node** is a **Tag** — typically of a UserType.
- Each **edge** is a **UDT member declared with Type = Reference** on the source Tag's UserType. Two fields configure it:
  - **Parameters** — the **target UserType** (which kind of Tag the edge may land on).
  - **StartValue** — the **target Tag path**, written as `<path>/Attr` (which specific Tag the edge resolves to at startup).

  That's the whole mechanism. Steps 1 and 2 build the edge for the Pump Tank example. Step 3 adds the optional `/Attr` metadata sibling — a separate Tag carrying static design-sheet literals alongside the live equipment Tag.

The example

A two-equipment water-treatment line:

```
Plant1/Pump_P1   --(FeedsInto)-->   Plant1/Tank_T1
```

Pump_P1 fills Tank_T1. Each tag carries live process variables. You will add a typed graph relation between them and, optionally, a `/Attr` sibling carrying static metadata. End state: a runnable solution and a Knowledge Graph that renders the relation visually.

Prerequisites

- A solution open in the Designer with the Unified Namespace module visible.
- Familiarity with creating UserTypes and Tags — see Unified Namespace How-to.

Step 1 — Create the UserTypes

Two UDTs. The interesting member is `FeedsInto` on **PumpType**: declared with **Type = Reference**, it becomes the graph edge.

PumpType

Member	Type	Parameters	StartValue	Notes
Flow	Double			Live process value (m³/h)
Status	Text		stopped	Initial state at startup
FeedsInto	Reference	TankType	Plant1/Tank_T1/Attr	Typed pointer at the downstream Tank. See Step 2.

TankType

Member	Type	StartValue	Notes
Level	Double		Live process value (%)
Status	Text	idle	Initial state at startup

Create both via **Unified Namespace UserTypes New**, then add the members in the grid.

For the canonical member-column definitions (every column, every constraint), see UNS UserTypes Reference.

Step 2 — Wire the relation via StartValue

A Reference UDT member needs two fields to declare a graph edge:

Field	Purpose	Example value
Parameters	The **target UserType** — what kind of Tag this Reference is allowed to point at.	`TankType`
StartValue	The **target Tag path** the Reference resolves to at runtime startup. Use the `/Attr` envelope of the target.	`Plant1/Tank_T1/Attr`

In JSON form (for `write_objects` or copy-paste into a row):

Error rendering macro 'code': Invalid value specified for parameter 'com.atlassian.confluence.ext.code.render.InvalidValueException'

```
{
  "Name": "FeedsInto",
  "Type": "Reference",
  "Parameters": "TankType",
  "StartValue": "Plant1/Tank_T1/Attr"
}
```

When the runtime starts, every PumpType instance gets its `FeedsInto.Link` resolved to `Plant1/Tank_T1/Attr` automatically. The FrameworX object model now has a typed edge from `Pump_P1` to `Tank_T1`.

> **Target the /Attr envelope, not the naked tag**
>
> The canonical Reference target is the **target Tag's /Attr envelope** — for example `Reactor_R101/Attr`, not `Reactor_R101`. The `/Attr` suffix is stripped on RDF export so the OWL entity IRI reflects identity, not storage layout (see UNS Asset Tree Reference for the export contract). Pointing at the naked tag may still produce a working runtime edge, but the OWL round-trip will not match the documented convention.

> **StartValue scope in 10.1.5**
>
> **StartValue declared on the UDT member applies to every instance.** If two PumpType tags must feed different Tanks, you currently need per-instance overrides — and per-instance member StartValue is **not yet writable from the Tags grid in 10.1.5** (the UI write surface is in-flight; see UNS Asset Tree Reference troubleshooting). For single-instance examples and tutorial scenarios, the UDT-level StartValue used above is sufficient and is the simplest path. For multi-instance solutions today, set the per-instance StartValue via `write_objects` or `T.Eng.Project` until the UI catches up.

Step 3 — (Optional) Add the /Attr metadata sibling

The `/Attr` dual-shape pattern stores static, design-sheet-style metadata on a sibling tag — separate from the live equipment tag. The naked tag carries dynamic process variables; the `/Attr` sibling carries literals like Manufacturer, ModelNumber, InstallationDate.

When to use which shape:

Use case	Pattern
Plain process equipment, no descriptive metadata	Naked tag only
Conceptual containers (Enterprise, Site, Area) — folders, not equipment	`/Attr` only
Equipment + design-sheet metadata + ontology round-trip	Both (naked + `/Attr` siblings)

For Pump_P1 to carry both live process data AND nameplate metadata, declare a second UDT:

PumpType_Attr

Member	Type	StartValue	Notes
Manufacturer	Text	Grundfos	Static literal, never updated at runtime
ModelNumber	Text	CR-32-4	Static literal
MaxFlowRate	Double	50	Design rating (m³/h)

Then create a sibling Tag at `Plant1/Pump_P1/Attr` of type **PumpType_Attr** (see Step 4).

For the full dual-shape rationale and the OWL/RDF round-trip semantics, see Industrial Ontology Integration How-to — sections **"Two paradigms"** and **"FrameworX architecture and ontology alignment"**.

Step 4 — Create the instance Tags

In **Unified Namespace Asset Tree**, create the folder `Plant1` and add three tags inside it:

Tag path	Type	Notes
`Plant1/Pump_P1`	PumpType	Live pump
`Plant1/Pump_P1/Attr`	PumpType_Attr	Optional — static nameplate metadata (Step 3)
`Plant1/Tank_T1`	TankType	Live tank

Either:

- right-click the `Plant1` folder **New Tag**, set the **Type** to the UDT, OR
- paste a row into the **Tags** grid with the **Name** and **Type** columns set.

The Asset Tree auto-creates the folder hierarchy from the slashes in the tag path.

Step 5 — Verify in the runtime

Start the runtime (F5). With the configuration above, the FrameworX object model now exposes:

```
@Tag.Plant1/Pump_P1                     <- PumpType instance (live)
@Tag.Plant1/Pump_P1.Flow                <- Double, live
@Tag.Plant1/Pump_P1.Status              <- Text, live
@Tag.Plant1/Pump_P1.FeedsInto           <- Reference -> Tank_T1
@Tag.Plant1/Pump_P1.FeedsInto.Link      <- "Plant1/Tank_T1/Attr"

@Tag.Plant1/Pump_P1/Attr                <- PumpType_Attr instance (static, optional)
@Tag.Plant1/Pump_P1/Attr.Manufacturer   <- "Grundfos"

@Tag.Plant1/Tank_T1                     <- TankType instance (live)
@Tag.Plant1/Tank_T1.Level               <- Double, live
@Tag.Plant1/Tank_T1.Status              <- Text, live
```

Quick sanity check from a Script or the runtime monitor:

Confirm the Reference resolved at startup

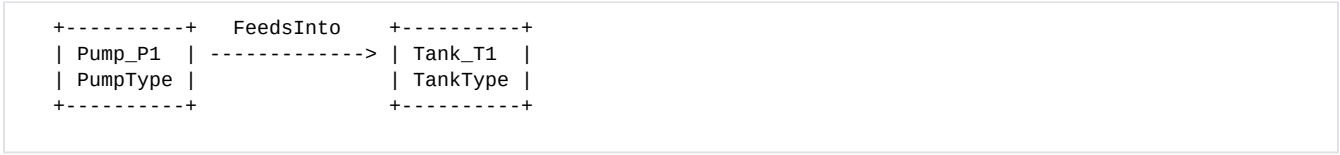
```
// Read the resolved target through the Reference
string target = @Tag.Plant1/Pump_P1.FeedsInto.Link;
// Expected: "Plant1/Tank_T1/Attr"

// Read a value of the target tag through the Reference
double level = @Tag.Plant1/Pump_P1.FeedsInto.Value;   // routed to Plant1/Tank_T1
```

For the full Reference-tag runtime semantics, see UNS Tags Reference **Reference Type**.

Step 6 — Visualize with the Knowledge Graph control

1. Open **Unified Namespace Asset Tree**. Click the **Knowledge Graph** button at the top of the tree. This regenerates `SolutionSettings.KnowledgeGraphSource` from the current UDT + Tag + relation state.
2. Open or create a Display. From the **Components Panel Charts**, drop **Knowledge Graph** onto the canvas.
3. In the control's **Properties** panel:
    - Bind **Selected node path** to a Tag of type Text (for example `Tag.UI.SelectedNodePath`). The control writes the clicked node's full UNS path (dot notation, e.g. `Plant1.Tank_T1`) into that Tag.
    - Bind **Selected node type** to a Tag of type Text (for example `Tag.UI.SelectedNodeType`). The control writes the clicked node's UserType name (e.g. `TankType`) into that Tag.
4. Run the Display. Clicking a node updates the two bound Tags. Wire those Tags to a ChildDisplay source, a Trend Chart, or any other control to drive type-aware drill-down.

The expected render for this example:



For control configuration depth — render modes, source regenerators, HTML5 / OpenSilver parity, design-time preview semantics — see KnowledgeGraph Control Reference.

What this enables

Once the UNS carries Reference edges (and, optionally, `/Attr` metadata siblings), the same three building blocks — Reference members, StartValue, dual-shape — unlock four capabilities:

- **Visualize** the plant graph with the Knowledge Graph Display control (Step 6).
- **Ground AI queries** — the Local AI assistant walks Reference edges to answer questions like *"what feeds into this tank?"* or *"trace upstream of Pump_P1"*.
- **Export to RDF / OWL / JSON-LD / Turtle / N-Triples** — see Export your UNS to RDF/OWL/GraphDB. The `/Attr` suffix is stripped on export so OWL entity IRIs match the source ontology.
- **Re-import enriched ontologies** from external authoring tools via Industrial Ontology Integration How-to, with the `SourceIri` column providing the join key for diff and overlay.

Troubleshooting

Reference member shows no value at runtime. Confirm `Parameters` is set to the target UserType name (case-sensitive) and `StartValue` is the path of an existing Tag. The target must exist when the runtime starts; references to missing tags resolve to `null`.

Knowledge Graph control shows no edges. Click the **Knowledge Graph** button on the Asset Tree to regenerate `KnowledgeGraphSource`, or invoke `TK.GenerateUnsVisual()` from a Script. Edits to UDTs or Tags only refresh the source on the next regeneration; auto-refresh applies on subsequent renders.

Multiple PumpType instances all feed the same Tank. UDT-level StartValue applies to every instance. Per-instance override via the Tags grid is in-flight in 10.1.5 — set per-instance StartValue via `write_objects` (DesignerMCP) or `T.Eng.Project` (Engineering API) until the UI surface ships. See UNS Asset Tree Reference troubleshooting for the current status.

OWL round-trip drops the relation. The Reference target must point at the `/Attr` envelope (`Tank_T1/Attr`, not `Tank_T1`). The exporter strips the `/Attr` suffix on the way out so the OWL IRI is clean; an export that targets the naked tag will not match the round-trip contract documented in Industrial Ontology Integration How-to.

See also

- Unified Namespace How-to — basic UNS configuration (prerequisite).
- UNS UserTypes Reference — UDT member-column definitions.
- UNS Tags Reference — Reference Type runtime semantics; ontology columns (`Labels`, `SourceIri`, `Attributes`).
- UNS Asset Tree Reference — dual-shape folder layout; per-instance StartValue status.
- Industrial Ontology Integration How-to — standards coverage; the "Two paradigms" section.
- KnowledgeGraph Control Reference — control properties, source regenerators, render modes.
- Local AI — AI grounding on the UNS graph.
- LocalAI KnowledgeGraph Demo — reference solution exercising every column.
- RDF Triples and the Industrial Ontology Foundry (IOF) — the triples model behind the round-trip.

In this section...
