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.

Download the solution: KnowledgeGraphAttr.dbslnKnowledgeGraphAttr.dbsln (10.1.5b)

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's path** (which specific Tag the edge resolves to at startup). For ordinary equipment this is the tag itself, e.g. `Plant1/Tank_T1`.

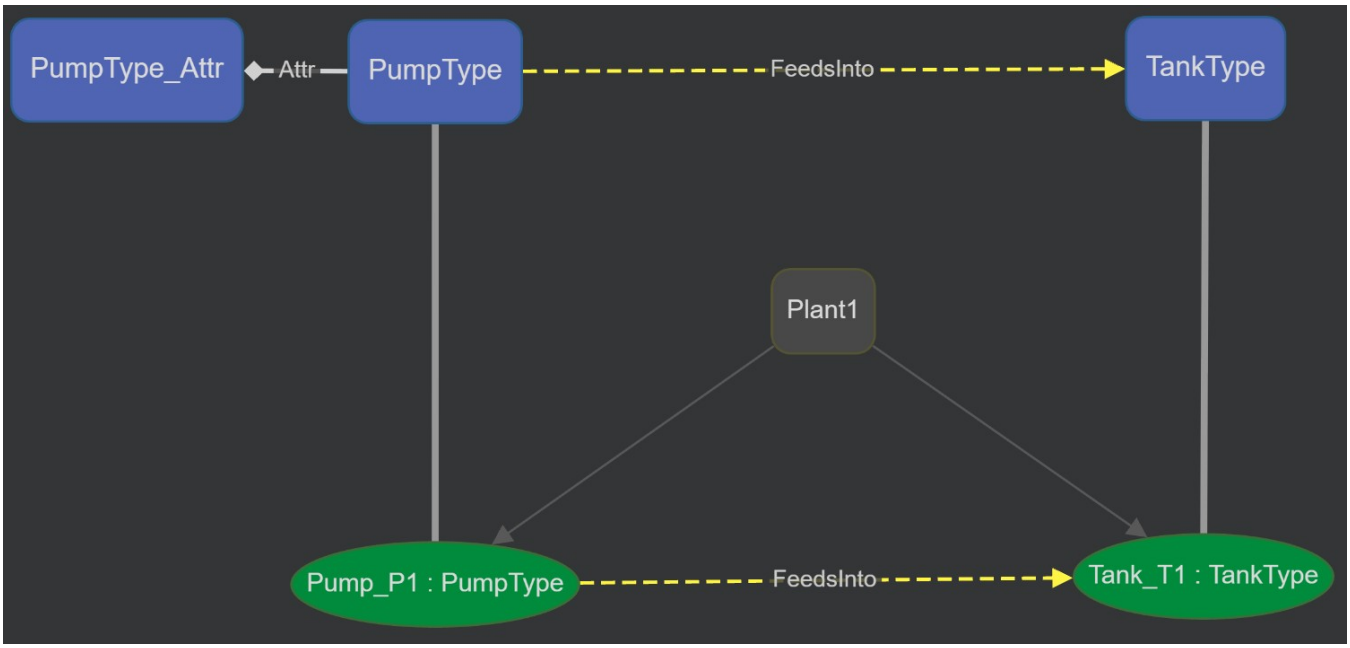
That's the whole mechanism. Steps 1 and 2 build the edge for the Pump Tank example. Step 3 adds the optional `/Attr` metadata sibling — a separate Tag carrying static design-sheet literals alongside the live equipment Tag.

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	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

Already done in "Step 1 - Create the UserTypes", this step is only for explanation. A Reference UDT member needs two fields to declare a graph edge. Set them in the member grid:

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.	`Plant1/Tank_T1`

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

> ⚠ **Which tag do you target?**
>
> A Reference points at the tag that carries the **target entity's identity**.
>
> - For ordinary equipment, that is the equipment tag itself — `Plant1/Tank_T1`. The Reference's **Parameters** type (`TankType`) must match the target tag's UserType (or a subclass), so the live `TankType` tag is the correct target.
> - Only when you use the ontology **dual-shape** — where an entity's identity lives on its `Attr` tag, typically imported from OWL/RDF — do you target that `Attr` tag (e.g. `Plant1/Tank_T1/Attr`). On export the trailing `Attr` leaf is dropped, so either way the OWL IRI reflects identity, not storage layout. See UNS Asset Tree Reference and Industrial Ontology Integration How-to.

> ⚠ **Per-instance override — the usual way (recommended)**
>
> StartValue set on the UDT member is the **default for every instance** of that UserType — all PumpType tags point at the same target. In most solutions you instead set the target **per instance**, two ways:
>
> - **From the Asset Tree** — open **Unified Namespace Asset Tree**, right-click the Reference member on the tag, choose **Properties**, and pick the tag it points to.
> - **From the Tags grid** — open **Unified Namespace Tags**, select the tag, then under **Symbol and Properties Mapping Edit Properties of member** select the Reference member, click the **gear** icon, and pick the tag it points to.
>
> The per-instance value **overlays** the type default for that instance only; other instances still fall back to the UDT-level default. The configured target appears in the Asset Tree next to the Reference member, shown as `: <target>`.

Step 3 — (Optional) Add the Attr metadata tag

> ⓘ **What is Attr?**
>
> `Attr` is just a normal Tag — usually of a UserType — that holds static information describing the entity it belongs to, whether that's a folder (Plant, Site, Area) or a piece of equipment. The name `Attr` is a convention we recommend for keeping your Unified Namespace organized, and you can use it at any level of the Asset Tree.

In this example we add `Attr` to the equipment — the pump's nameplate. The `Attr` dual-shape stores static, design-sheet-style metadata on a separate tag named `Attr`, sitting next to the live equipment tag. The live tag carries dynamic process variables; the `Attr` tag carries fixed literals like Manufacturer, ModelNumber, InstallationDate.

When to use which shape:

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

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

PumpType_Attr

Member	Type	StartValue	Notes
Manufacturer	Text	Acme Pumps	Fictional vendor — static literal
ModelNumber	Text	AP-3000	Fictional model — static literal
MaxFlowRate	Double	50	Design rating (m³/h)

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

> ⓘ **Containers (Plant, Site, Area) use the same Attr — standing alone**
>
> A folder like `Plant1` carries no metadata of its own. To give the plant an identity and description, add a single `Plant1/Attr` tag — for example of a `SiteType` UDT with Description, Location, and ISA-95 level. There is no live `Plant1` tag: a container isn't equipment, so it has `Attr` **only**. The same holds one level up for a Site or Enterprise folder.

How this maps to OWL

On RDF/OWL export the pieces map like this: each **UserType** becomes an OWL **class**; a **Reference** member becomes an **owl:ObjectProperty** (its **Parameters** type is the range); a scalar member (Double, Text, …) becomes an **owl:DatatypeProperty**; each **Tag** becomes a **NamedIndividual**. The ISA-95 / ISA-88 levels — Enterprise, Site, Area, Batch — are **folders**; the folder's `Attr` tag becomes that level's individual, and folder nesting emits containment edges (`hasChild`, or the policy's ordered `ContainmentPredicates`). The trailing `Attr` leaf is dropped on export so every IRI reflects identity. For the full mapping and the predicate policy, see Industrial Ontology Integration How-to and RDF Triples and the IOF.

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 — carries the FeedsInto edge
`Plant1/Pump_P1/Attr`	PumpType_Attr	Optional — static nameplate metadata (Step 3) (this will be a member inside of "PumpType_Attr" UserTypes)
`Plant1/Tank_T1`	TankType	Live tank

Either right-click the `Plant1` folder **New Tag** and set the **Type** to the UDT, or paste rows 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.

The resulting Asset Tree:

```
Plant1
+-- Pump_P1
|   +-- Attr
|   |   +-- (T) Manufacturer
|   |   +-- (D) MaxFlowRate
|   |   `-- (T) ModelNumber
|   +-- (R) FeedsInto   : Plant1/Tank_T1
|   +-- (D) Flow
|   `-- (T) Status      : stopped
`-- Tank_T1
    +-- (D) Level       : idle
    `-- (T) Status
```

Step 5 — 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:

```
+----------+   FeedsInto    +----------+
| Pump_P1  | -------------> | Tank_T1  |
| PumpType |                | TankType |
+----------+                +----------+
```

You now have the complete loop: typed UserTypes, a Reference edge, live instance tags, optional `Attr` metadata, and a rendered Knowledge Graph. For control configuration depth — render modes, source regenerators, HTML5 / OpenSilver parity, design-time preview — see KnowledgeGraph Control Reference.

What this enables

Once the UNS carries Reference edges (and, optionally, `Attr` metadata tags), 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 trailing `Attr` leaf is dropped 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), `StartValue` is the path of an existing Tag, and the target's UserType matches `Parameters` (or a subclass). 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. That is expected — UDT-level StartValue is the shared default. To point one instance elsewhere, set the Reference target on that specific tag; the per-instance value overlays the type default for that instance only. See UNS Asset Tree Reference troubleshooting.

OWL round-trip drops the relation. If you used the ontology dual-shape, the Reference must target the identity-bearing node — the `Attr` tag. The exporter drops the trailing `Attr` leaf so the OWL IRI is clean. For plain equipment with no `Attr` tag, target the equipment tag itself. See 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.
- 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...
