34th Annual **INCOSE** international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

Erik Herzog, Jad El-Khoury, Eran Gery, Judith Crockford, Torbjörn Holm, Robert Nilsson, Stefan Albinsson, Andrii Berezovskyi, Tord Ringenhall

Enabling Digital Engineering with Federated PLM – Experiences from the Heliple-2 Project
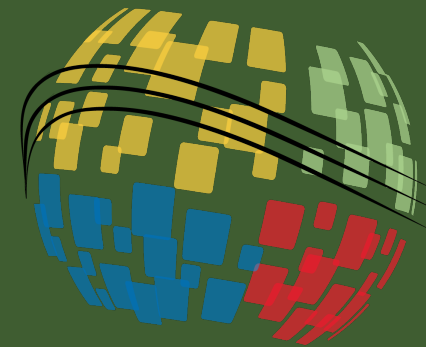
Saab Aeronautics – and our products

- Multiple parallel projects

- International operations and interoperability

- Exports

- International collaboration
  - Multi-site Development & Production

- More stringent international regulations

- Speed!
  - Product development
  - Enabling system

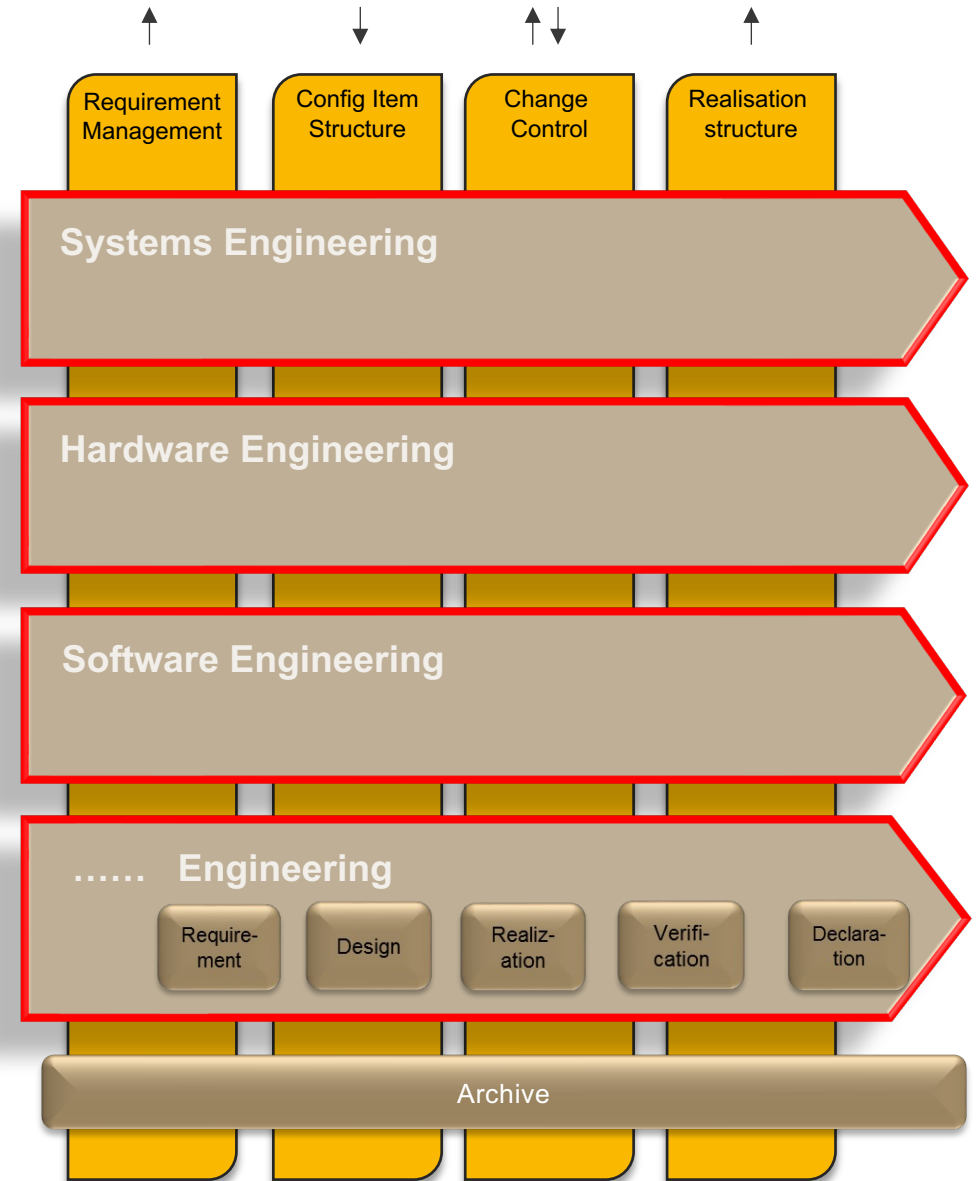Advanced and innovative digitalisation

Agenda

1. Enabling Digital Engineering with Federated PLM

2. Configuration management challenges

3. Implementation Experiences

4. Conclusions and next steps
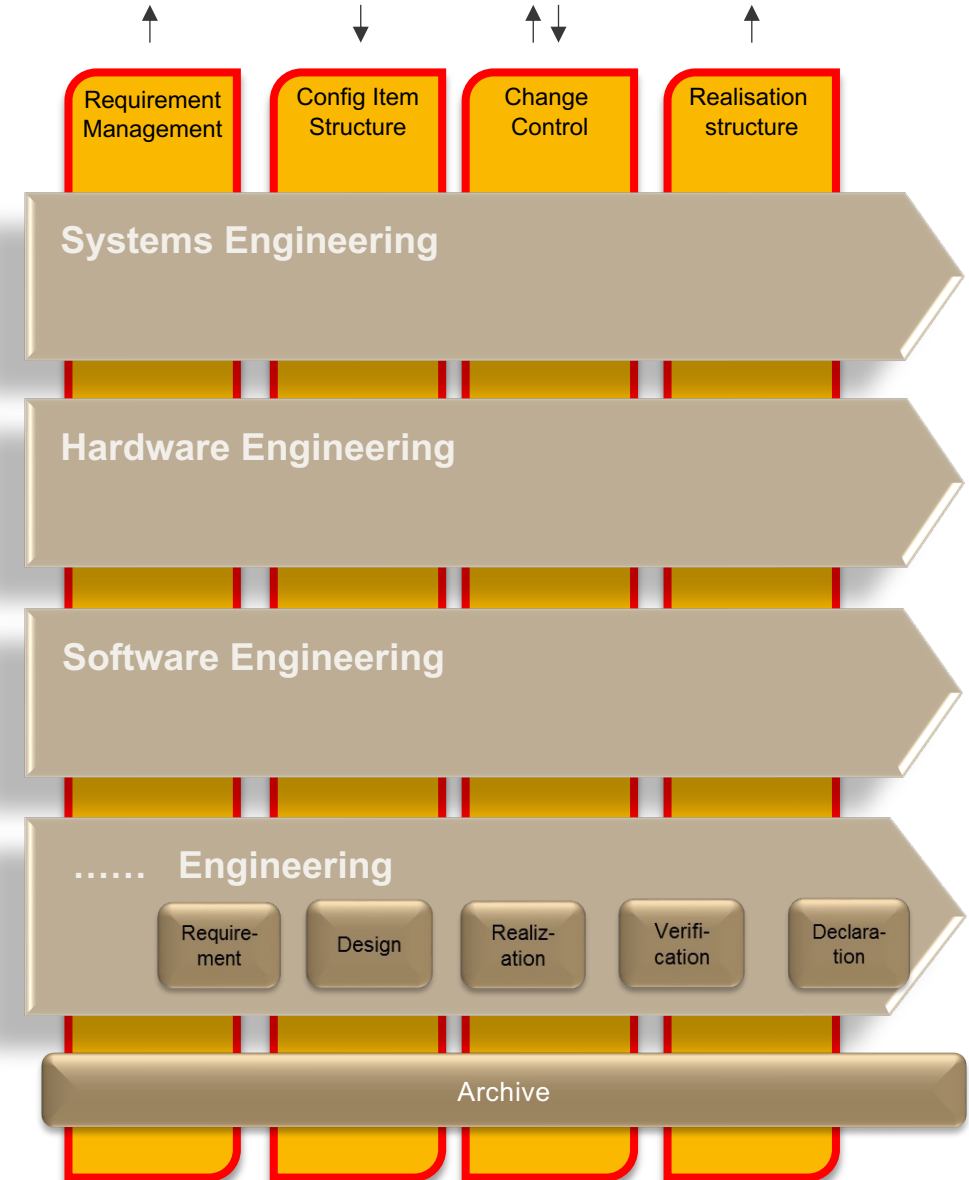
The Genesis PLM architecture

Modularity

- Optimise support for each engineering discipline
  - Maximise automation, as provided by the supplier
  - Minimise application family switching
- Bring together management and engineers in a single environment
  - E.g., Change management and Status reporting
- Ability to upgrade individual capabilities independent of others
- Redundant capabilities accepted
- Ability to replace environment without upsetting the complete PLM landscape

Traceability

- Need capability to ensure traceability and integrity of product data

- Traceability dimensions between engineering discipline environments
  - Requirements
  - Configuration item structure
  - Change management
  - Realization

- **Configuration Management** capability required for Requirements Traceability, Configuration item structure and Realization structure
  - Versions and baseline capability

- The OSLC standard offers the desired capabilities
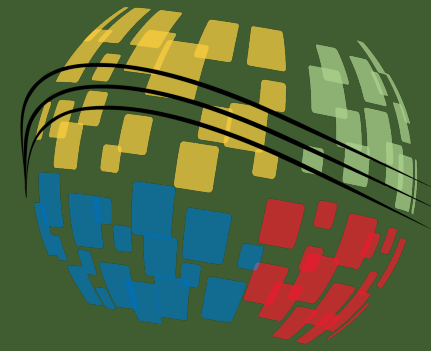 - Exploit for low cost and high quality integrations

| Requirement Management | Config Item Structure | Change Control | Realisation structure |

Systems Engineering

Hardware Engineering

Software Engineering

...... **Engineering**

| Require-ment | Design | Realiz-ation | Verifi-cation | Declara-tion |

Archive

VINNOVA Advanced and innovative digitalisation

eurostep · IBM · KTH VETENSKAP OCH KONST · LYNXWORK · SAAB TECHNOLOGIES · SAAB · VOLVO

Evaluation criteria

Federated PLM – feasibility dimensions

- Technical feasibility
  - Does OSLC offer industrial strength solutions for integrating stand-alone PLM systems?
- Development efficiency
  - Does a federated PLM environment offer improved productivity potential in the short and long term compared to a monolithic, single supplier solution?
- Operational feasibility
  - Can a federated PLM environment be maintained over time?
- Realisation effectivity
  - Can OSLC interfaces be implemented and maintained at a reasonable cost?
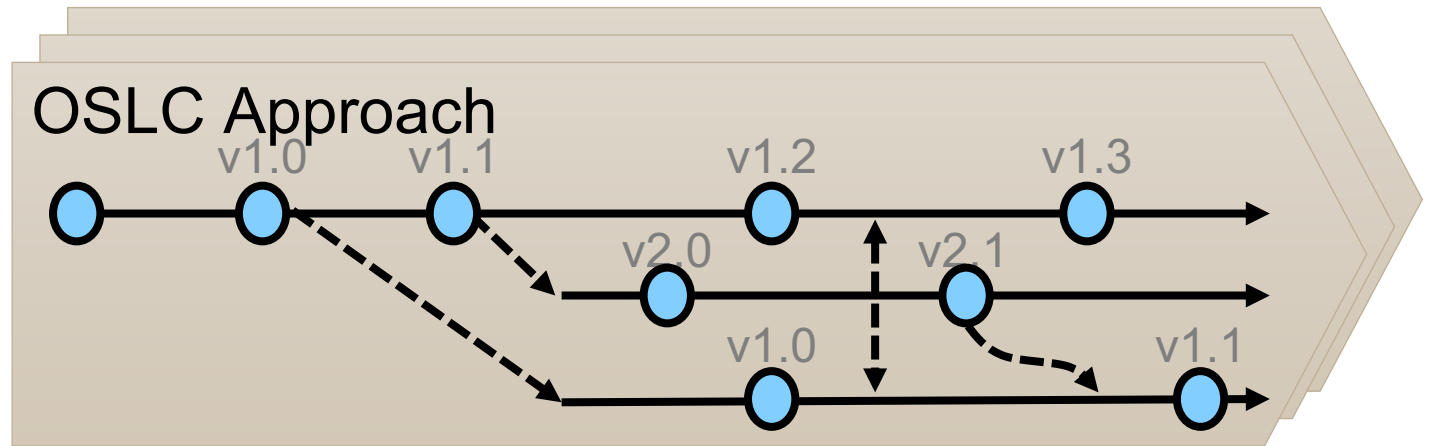
Configuration management challenges

OSLC Configuration management

Targeted lifecycle phases = Requirements & ALM
Explicit configurations
Baselines

Configuration Management : OSLC approach

OSLC Approach

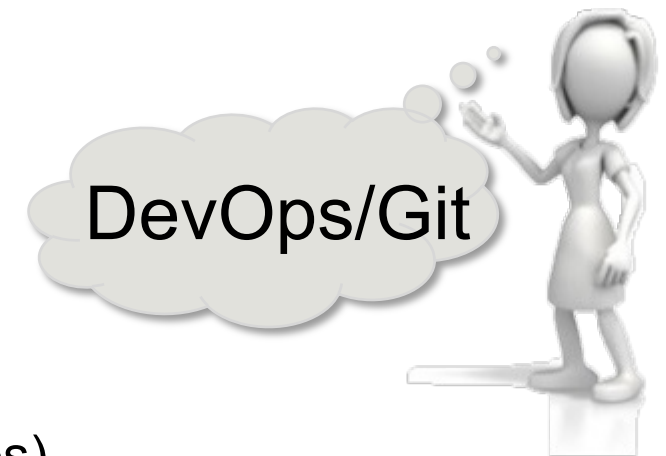v1.0   v1.1   v1.2   v1.3

v2.0   v2.1

v1.0   v1.1

Stream

- **Mutable** – for ongoing work
- Linking to latest artifacts
  - **implicit** - versions hidden
- **Merge** changes from other streams or baselines

Baseline ⬤

- A **frozen** record of a stream at a point in time
- Linking to artifacts at the time of freeze
- **Branch** into new streams

DevOps/Git

A stream (baseline) can be a contribution to other streams (baselines)

VINNOVA Advanced and innovative digitalisation   eurostep IBM KTH LYNXWORK SAAB SAAB VOLVO

STEP Configuration management

Targeted lifecycle phases = PLM to Asset management
Implicit configurations
Continuous
Planned & Actual

- Each carrier weighs **65,000** tonnes
- Each carrier is **280** metres in length
- The carriers will have a crew complement of **700**, increasing to **1,600** with a full complement of **40** F-35B aircraft
- The flight deck is 70 metres wide and 280 metres long – enough space for three football pitches
- Each carrier is made up of 17 million parts
- There are 364,000 metres of pipes inside each Ship

- **2.1M Occurrences**
- **150,000 unique parts**
- **165 ship systems**
- **3000 compartments**
- **Lifespan of 50 years**

BAE SYSTEMS

© Eurostep | 5

-eurostep-
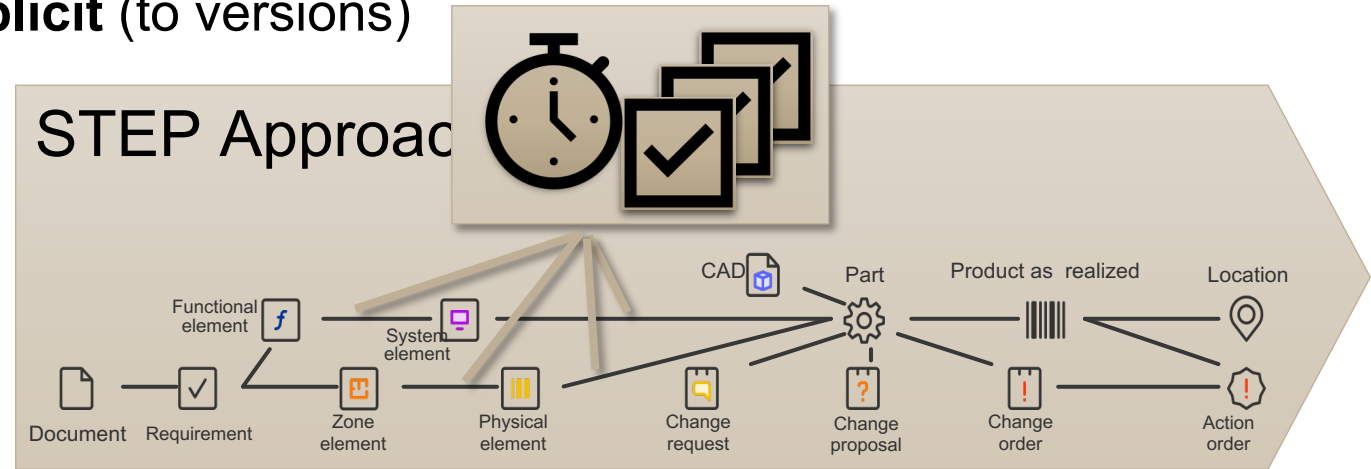
Configuration Management : STEP approach

Links can be **implicit** ("latest") **or explicit** (to versions)

Date effectivity ⏱
- Every **link** and **property**:
  - start date, and optional end

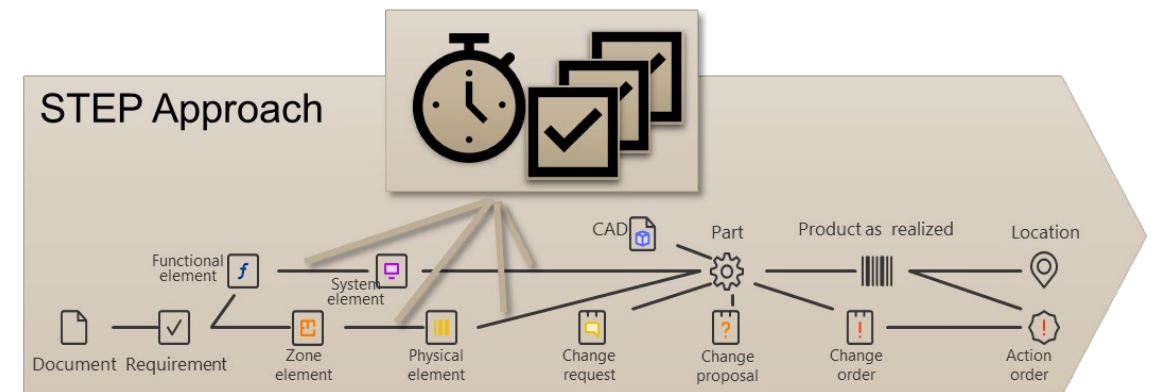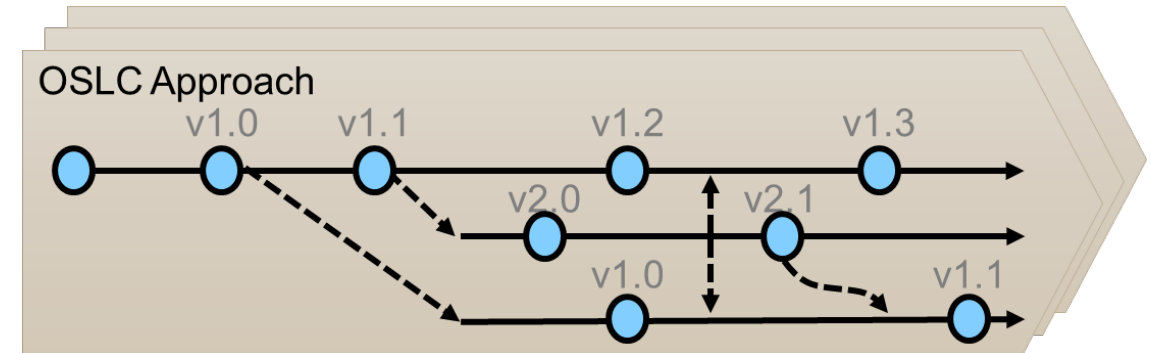Object effectivity (applicability) ☑

- Every **artifact and link** can have effectivity in relation to other artifacts, with conditions (no effectivity = always applicable)
- These can <u>also</u> have date effectivity

Now, or at any time in past, can **filter** to get the structured artifacts.

STEP Approach

Functional element *f* · System element · Zone element · Physical element · CAD · Part · Product as realized · Location

Document · Requirement · Change request · Change proposal · Change order · Action order

OSLC inviting STEP to play (read only)

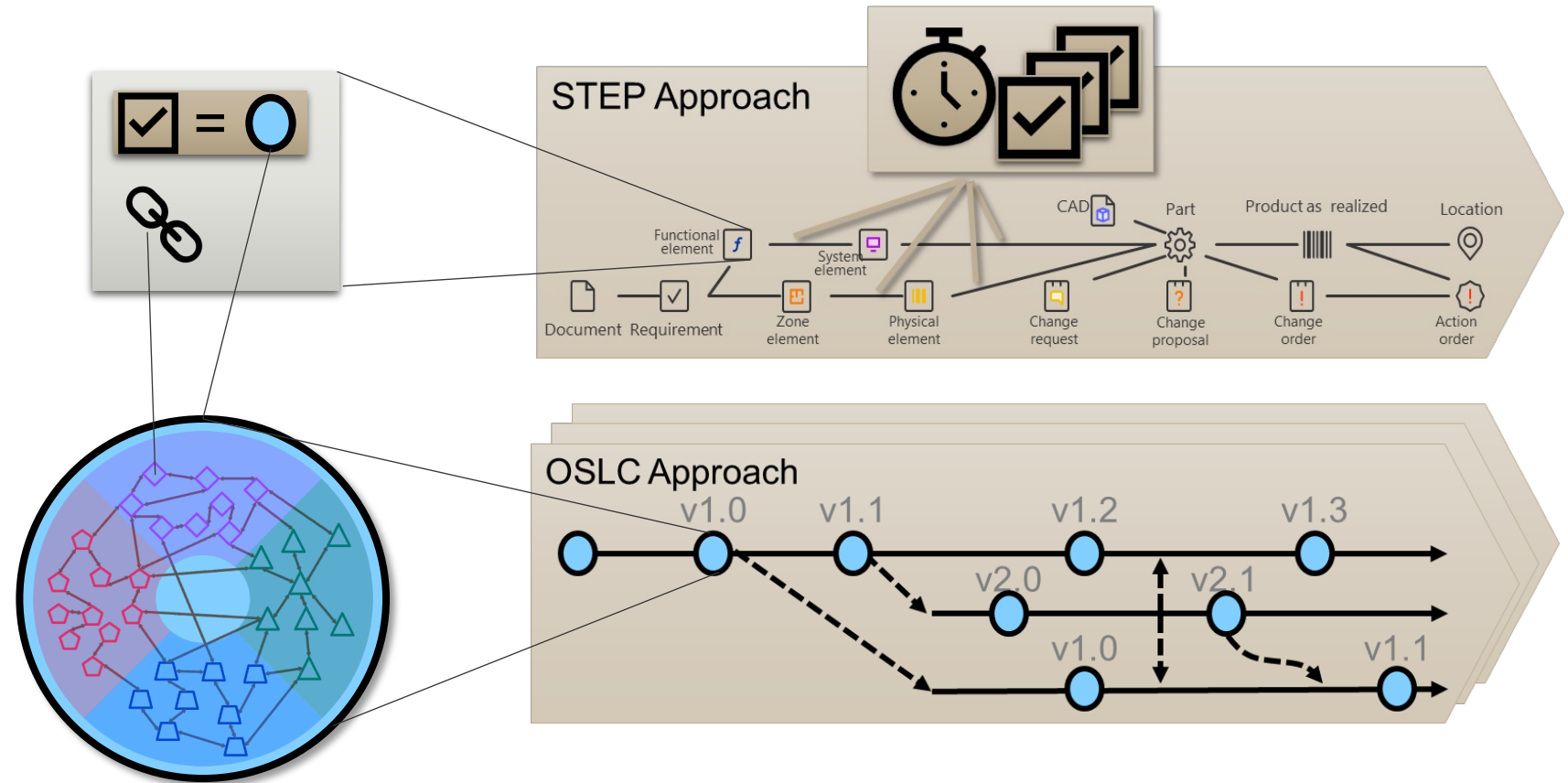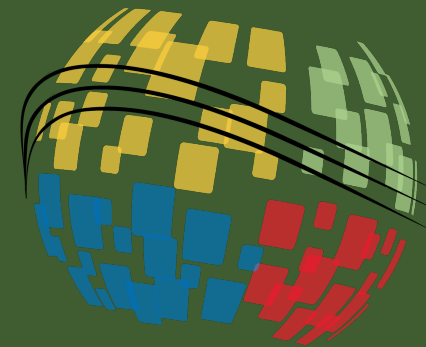| OSLC	Equivalent in STEP
Stream →	A set of object-effectivity, (with any conditions). Time = now Filter to get structure/view
Baseline ●	A set of object effectivity, (with any conditions) Time = freeze time of baselin Filter to get structure/view

OSLC Approach

v1.0 v1.1 v1.2 v1.3

v2.0 v2.1

v1.0 v1.1

STEP Approach

Functional element

System element

Document Requirement

Zone element

Physical element

Change request

Change proposal

CAD Part Product as realized Location

Change order

Action order

STEP inviting OSLC to play (read only)

STEP PLM resource
with object effectivity

OSLC resource URI
+
OSLC Configuration

STEP Approach

OSLC Approach

Response from OSLC:

- Configuration = baseline → fixed version
- Configuration = stream → latest version

Implementation Experiences

Early Experiences

OSLC Specification

- OSLC Core – useful capabilities

- OSLC Domains

  - Scope aims at ALM

  - Many optional properties

  - imprecise/incomplete documentation

- Freely available

OSLC Development

- Requires competence of many technologies

  - W3C RDF https://www.w3.org/RDF/

  - Web development

  - Browser security issues

  - Authentication

  - …

- Eclipse Lyo Project

  - Useful test clients and servers

  - Good support for Java

  - Open Source

- Little or no support for non-java development

Development Needs

OSLC Specification

Specify new or extend existing OSLC domains
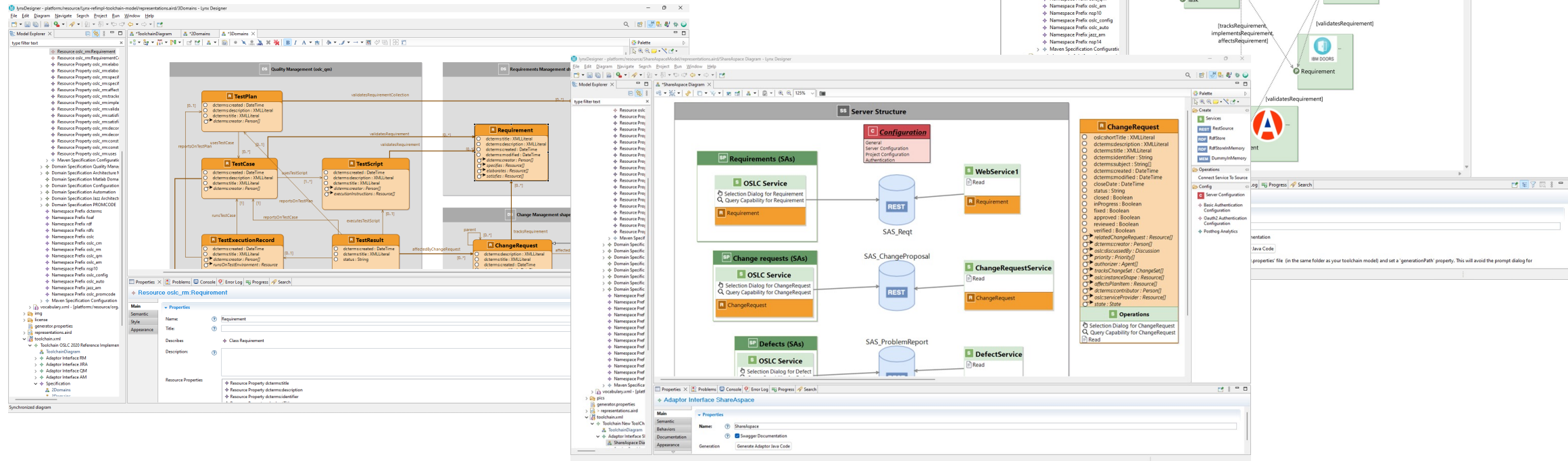
OSLC Development

Support in handling the underlying technologies

- Focus on your domain and application

LynxDesigner

A solution for the lifecycle management of a Federated Engineering Environment

1. Information models

2. Application interfaces

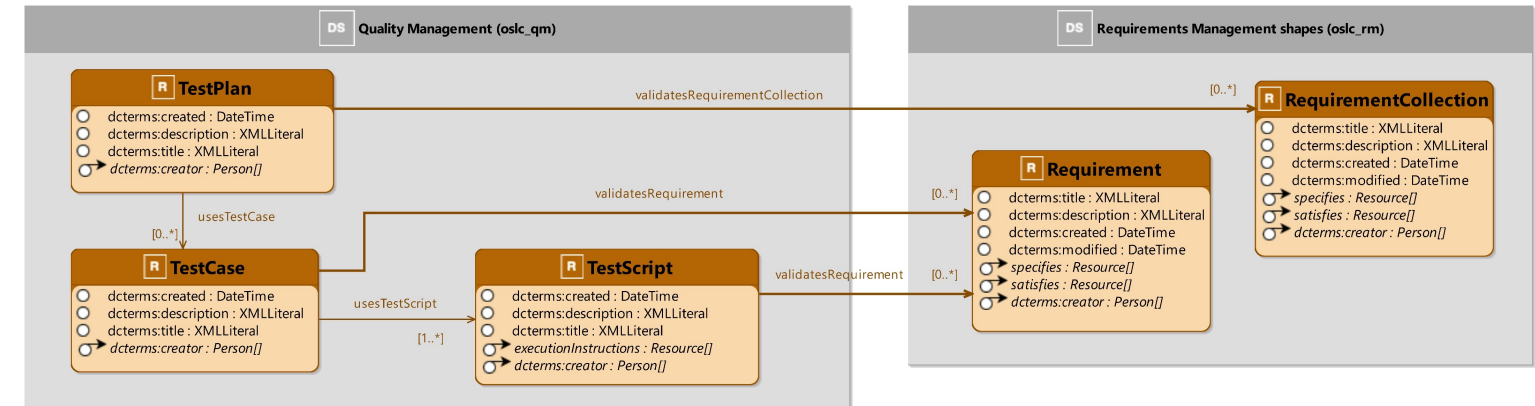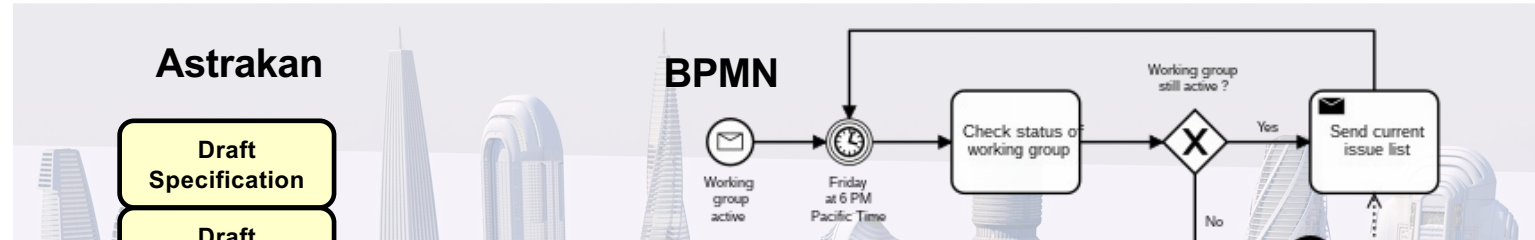3. Overall architecture

Information Models

Conceptual Model

- Identifies and organizes business concepts
- Explains meaning to people
- In the collective minds of the organisation

Information Model

- Enterprise catch-all cross-domain terms
- Reflects artifacts delivered to/from process activities
- Platform independent
- Provides requirements on the IT-systems
- Reflect resources delivered to/from applications
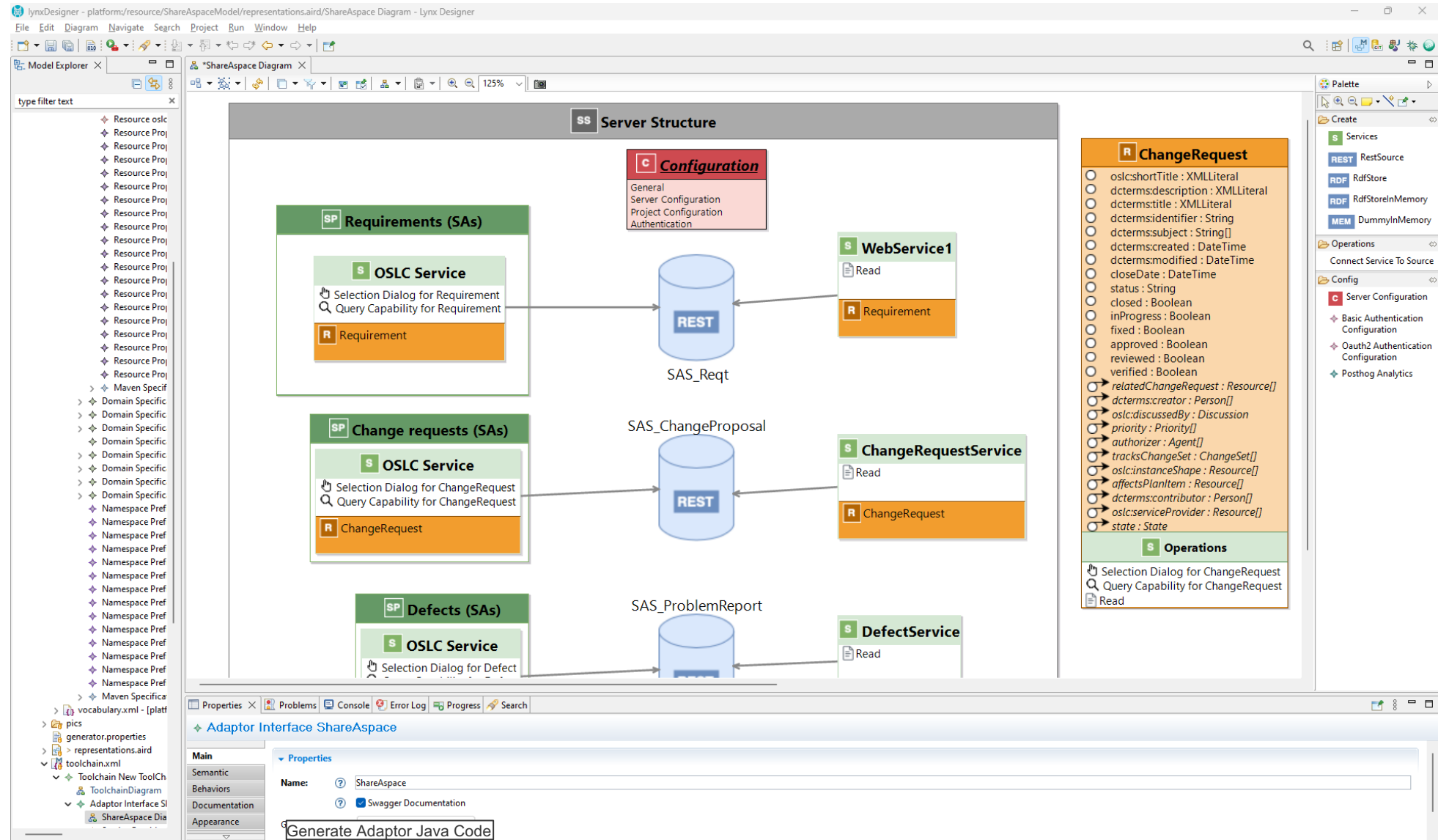- platform independent; yet more exact specification

Data Model

- Persistent in individual applications

Application Interface

Application Interface

Development Experiences

- ShareAspace configurable open architecture makes it easy to use a LynxDesigner adapter

- Effort
  - Hands-on training (~4 hours) – established basic (single service) ShareAspace Adapter
  - After 6 months "business consultant" could add new services in a few hours

- Skills
  - Basic adapter needs minimal code development skills.
  - Crossing CM paradigms needed more experienced code development skills

Heliple-2: Contributions

- **Federated PLM – feasibility dimensions**
  - Technical feasibility
    - Does OSLC offer industrial strength solutions for integrating stand-alone PLM systems?
  - Development efficiency
    - Does a federated PLM environment offer improved productivity potential in the short and long term compared to a monolithic, single supplier solution?
  - Operational feasibility
    - Can a federated PLM environment be maintained over time?
  - Realisation effectivity
    - Can OSLC interfaces be implemented and maintained at a reasonable cost?

Advanced and innovative digitalisation

The need for standards

- Needs:
  - Ability to link across tool boundaries
  - Ability to exchange product data
  - Ability reason about product properties managed in different environments
  - Ability to build simulations with contributions from heterogeneous sources

- Needs can only be met if end-users drive standards development

Advanced and innovative digitalisation

Join us!

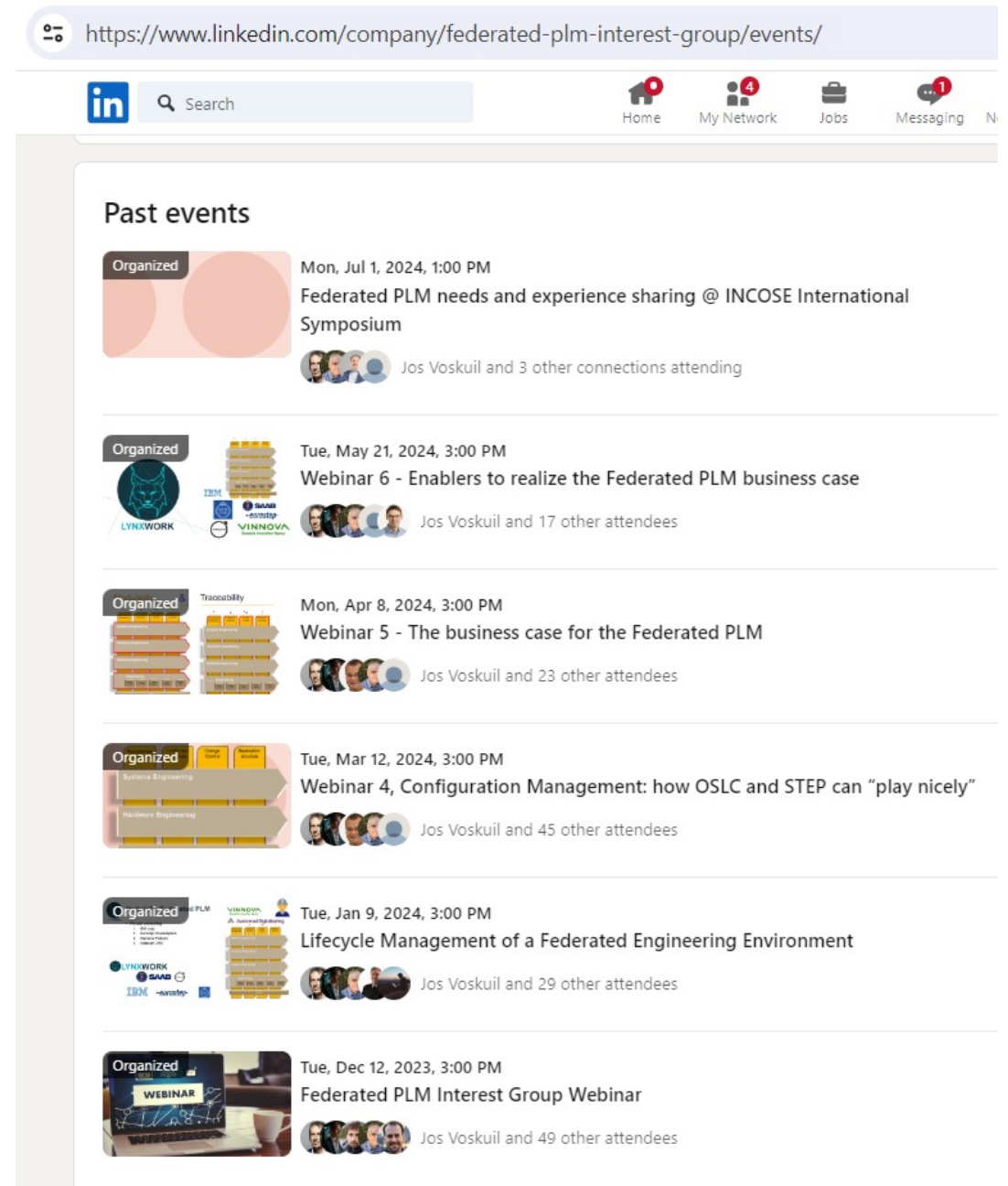https://www.linkedin.com/company/federated-plm-interest-group

Past events

Organized — Mon, Jul 1, 2024, 1:00 PM
Federated PLM needs and experience sharing @ INCOSE International Symposium
Jos Voskuil and 3 other connections attending

Organized — Tue, May 21, 2024, 3:00 PM
Webinar 6 - Enablers to realize the Federated PLM business case
Jos Voskuil and 17 other attendees

Organized — Mon, Apr 8, 2024, 3:00 PM
Webinar 5 - The business case for the Federated PLM
Jos Voskuil and 23 other attendees

Organized — Tue, Mar 12, 2024, 3:00 PM
Webinar 4, Configuration Management: how OSLC and STEP can "play nicely"
Jos Voskuil and 45 other attendees

Organized — Tue, Jan 9, 2024, 3:00 PM
Lifecycle Management of a Federated Engineering Environment
Jos Voskuil and 29 other attendees

Organized — Tue, Dec 12, 2023, 3:00 PM
Federated PLM Interest Group Webinar
Jos Voskuil and 49 other attendees

25

VINNOVA Advanced and innovative digitalisation

34th Annual **INCOSE**
international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024