STEP Semantics and the Arrowhead fPVN Knowledge Graph based Digital Twin

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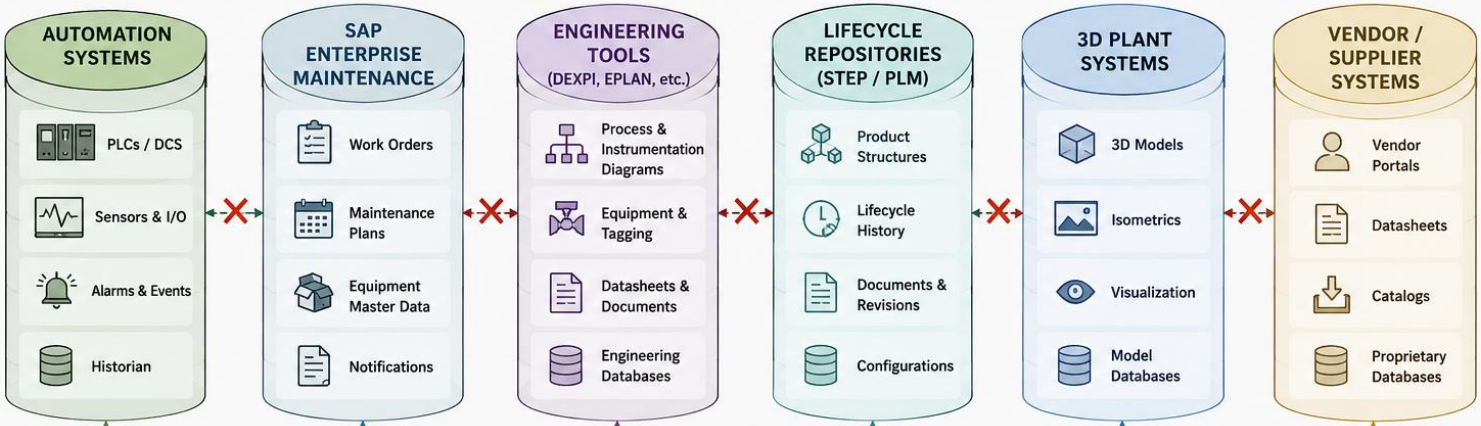
ARROWHEAD fPVN

FRAGMENTED INFORMATION LANDSCAPE

TRADITIONAL PROCESS PLANT ENVIRONMENTS

Isolation of Systems • Duplicate Data • Manual Interfaces • Lack of Context • Disconnected Workflows



KEY CHALLENGES

- Data duplication and inconsistency
- Siloed information
- Manual reconciliation and re-entry
- Limited visibility and traceability
- Slow decision making
- High operational risk

MANUAL DATA TRANSFER & DISCONNECTED WORKFLOWS

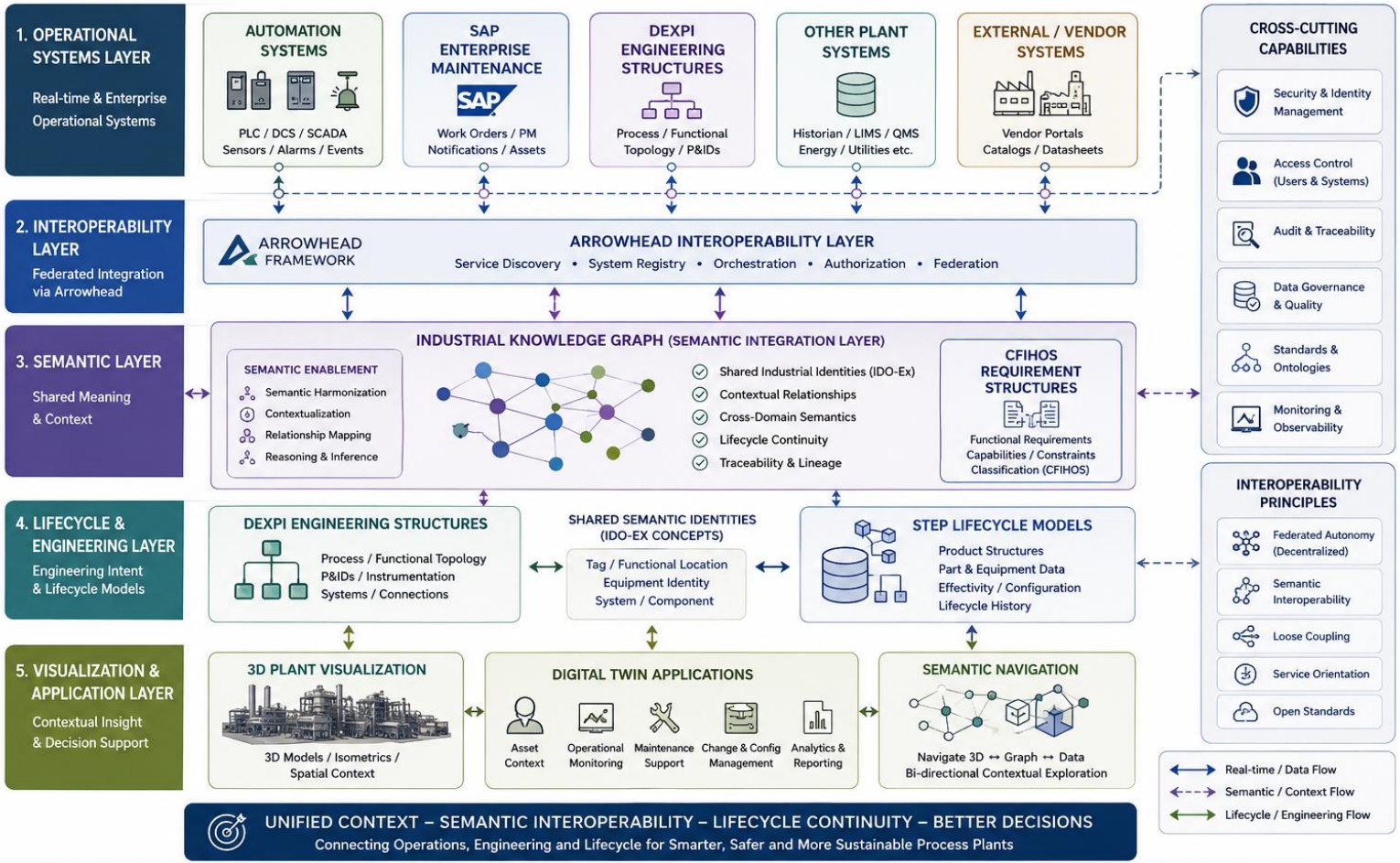
OUTCOMES

- Lack of real-time context
- Incomplete engineering knowledge
- Inefficient maintenance execution
- Poor lifecycle continuity
- Increased downtime and cost
- Limited ability for advanced analytics & AI

LACK OF CONTEXTUAL INTEROPERABILITY ACROSS THE PLANT LIFECYCLE

FEDERATED PROCESS PLANT DIGITAL TWIN ARCHITECTURE

Semantically Interoperable • Federated • Contextual • Lifecycle Connected



SEMANTIC ALIGNMENT BETWEEN DEXPI ENGINEERING STRUCTURES AND STEP LIFECYCLE MODELS

Connecting Functional Engineering Intent with Physical Lifecycle Realizations using Shared Tag Identities and IDO-Ex Concepts

DEXPI ENGINEERING STRUCTURES
Functional & Logical Perspective

Functional Topology (Example)

- FL-1001 Pumping System – Area 10
  - XV-101 Control Valve
  - P-100A Centrifugal Pump
    - M-100 Motor
    - PS-100 Power Supply
  - PI-101 Pressure Indicator

DEXPI Engineering Data

- P&IDs and Instrumentation
- Functional Locations
- Equipment & Instrument Tags
- Process Topology & Connections
- Engineering Attributes & Specifications

DEXPI Tag Example

Tag ID: P-100A
Description: Centrifugal Pump
Service: Steam Condensate
Location: Area 10
Engineering Spec: Pump Spec 123
Status: In Service

SEMANTIC ALIGNMENT LAYER
Shared Identities and IDO-Ex Concept Mapping

IDO-Ex (Industrial Digital Ontologies) — Core Industrial Concepts Used for Alignment

Tag	Functional Location	Equipment	System	Lifecycle State	Relationship
Unique identifier for engineering and assets	Represents function in the process	Physical item that realizes a function	Collection of related functions or equipment	State in the lifecycle	Semantic connection between things

Semantic Mapping using Shared Tag Identities

DEXPI Tag (Engineering)	IDO-Ex Concept	STEP Product / Asset (Lifecycle)
FL-1001	Functional Location	FL-1001
P-100A	Equipment	PU-100
M-100	Equipment	EM-100
PI-101	Equipment	PI-101
XV-101	Equipment	XV-101

Semantic Alignment Outcomes

- Shared identity across engineering and lifecycle
- Cross-domain traceability and context
- Lifecycle continuity and change impact analysis
- Consistent meaning and context (semantic)
- Elimination of data silos and duplication
- Enables advanced analytics and AI

STEP LIFECYCLE MODELS
Product & Asset Lifecycle Perspective

Product Structure (Example)

- FL-1001 Pumping System – Area 10
  - PU-100 Pump Unit
    - CP-100 Casing
    - IM-100 Impeller
  - EM-100 Electric Motor
  - PI-101 Pressure Indicator

STEP Lifecycle Data

- Product Structures (BOM)
- Parts & Components
- Effectivity & Configuration
- Lifecycle States & History
- Document & Change Management

STEP Product Example

Product ID: PU-100
Name: Pump Unit
Part of: FL-1001
Type: Rotating Equipment
Lifecycle State: Installed
Effectivity: 2021-06-11 – Present

SEMANTIC INTEROPERABILITY ENABLED

Engineering Context (DEXPI) ↔ Shared Semantic Layer (IDO-Ex Concepts & Relationships) ↔ Lifecycle Context (STEP)

Bidirectional Contextual Relationships and Traceability

KEY RELATIONSHIPS ENABLED

realizes	Functional realization (function → asset)
installedAt	Physical installation (asset → location)
partOf	Aggregation / Composition
replacedBy	Replacement chain
hasState	Lifecycle state association
linkedTo	Contextual association

BUSINESS & ENGINEERING VALUE

- Single Source of Truth across Engineering & Lifecycle
- Faster Engineering & Maintenance Decisions
- Impact Analysis & Change Management Across Lifecycle
- Improved Data Quality, Governance & Consistency
- Enables Advanced Analytics, AI & Digital Twin Apps

SHARED TAG IDENTITY (EXAMPLE)

Tag: P-100A (DEXPI Tag) ↔ Product: PU-100 (STEP Product)

IDO-Ex Concept: Equipment (Same Meaning, Shared Identity)

PROCESS PLANT DIGITAL TWIN – BIDIRECTIONAL NAVIGATION

Connecting 3D Plant Context with Semantic Knowledge Graph

3D TO GRAPH
Select in 3D to explore semantic context

GRAPH TO 3D
Select in Graph to locate in 3D plant environment

3D PLANT VIEW

SELECTED ASSET SUMMARY

P-100A
Centrifugal Pump

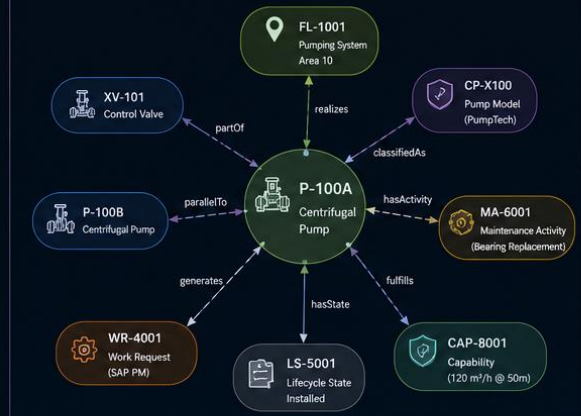
Tag (DEXPI)	P-100A
Functional Location	FL-1001
System	Pumping System
Area	Area 10
Status	In Service
Lifecycle State (STEP)	Installed
Manufacturer	PumpTech
Model	CP-X100
Serial No.	10001A
Installed On	2018-11-21
Effectivity	2018-11-21 – Present

QUICK ACTIONS

- Show Neighbors (3D)
- Show in Graph
- View Engineering Data
- View Lifecycle History
- Create Work Request
- Open in SAP PM

KNOWLEDGE GRAPH VIEW

All | Equipment | Systems | Functions | Locations | Documents



GRAPH LEGEND

- Functional Location
- Equipment
- Product / Asset
- Maintenance
- Work / Document
- Lifecycle
- Capability / Req.

RELATIONSHIPS

- realizes
- partOf
- parallelTo
- classifiedAs
- hasActivity
- generates
- hasState
- fulfills
- replacedBy
- linkedTo
- derivedFrom

NEIGHBORING ASSETS (3D)

XV-101 Control Valve	3.2 m	
P-100B Centrifugal Pump	5.6 m	
PI-101 Pressure Indicator	8.7 m	

Show all in 3D

LIFECYCLE HISTORY (STEP)

2015-03-15	2018-11-21	2021-06-10	2024-02-18
Manufactured	Installed	Maintenance (Overhaul)	Maintenance (Seal Replacement)

Effectivity: 2018-11-21 – Present (In Service)

ENGINEERING CONTEXT (DEXPI)

P&ID	P-101
Functional Spec	FS-1001
Equipment Spec	ES-1001
3D Model	P-100A.smc
Instrumentation	PI-101, TI-101

Open in Engineering System

REQUIREMENTS & CAPABILITIES

Requirement (CFIHOS)
REQ-7001
Maintain Flow Rate > 100 m³/h

Capability
CAP-8001
120 m³/h @ 50m Head

View all relationships

RELATED DOCUMENTS

- Datasheet_P-100A.pdf
- Maintenance_Manual.pdf
- Alignment_Procedure.pdf
- Work_Instructions.pdf
- Inspection_Report_2024.pdf

Show all documents

CONTEXTUAL UNDERSTANDING. SMARTER DECISIONS.

Seamlessly navigate between 3D plant context and semantic knowledge to explore relationships, analyze impact, and make better engineering and operational decisions.

PROCESS PLANT DIGITAL TWIN – LIFECYCLE REALIZATION HISTORY

Stable Functional Location – Multiple Physical Realizations Over Time

STABLE FUNCTIONAL LOCATION

FL-1001
Pumping System – Area 10

(Functional Intent)
Deliver process fluid from suction to discharge at required flow, head and reliability.

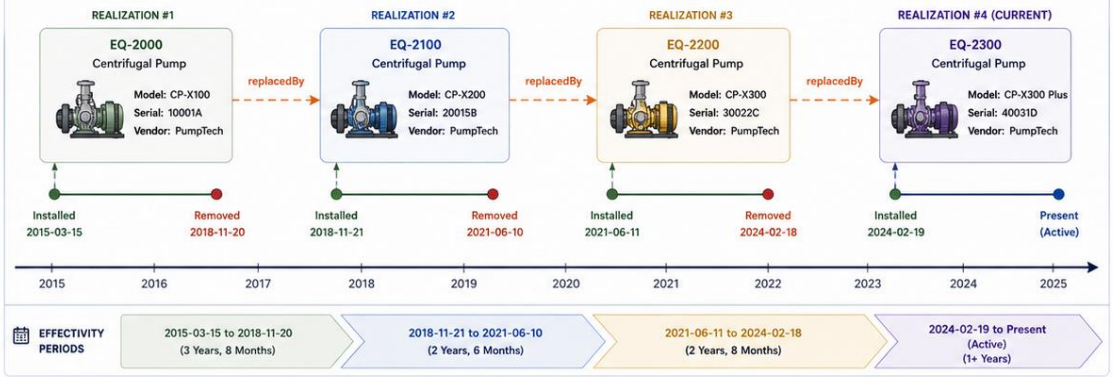
REALIZATION CHAIN

The functional location remains the same while physical equipment realizations change over time.

LIFECYCLE SUMMARY

- Total Realizations: 4
- First Installed: 2015-03-15
- Current Realization: EQ-2300
- In Service Since: 2024-02-19
- Total Operational Time: 9+ Years
- Replacements: 3
- Maintenance Events: 18

PHYSICAL REALIZATIONS OVER TIME



EFFECTIVITY PERIODS

2015-03-15 to 2018-11-20	2018-11-21 to 2021-06-10	2021-06-11 to 2024-02-18	2024-02-19 to Present
(3 Years, 8 Months)	(2 Years, 6 Months)	(2 Years, 8 Months)	(Active) (1+ Years)

MAINTENANCE TRANSITIONS (Key Events)

LIFECYCLE STATE HISTORY (STEP)

KEY / LEGEND

- Installation Event
- Removal Event
- Active / Present
- Replacement Chain
- Effectivity Period
- Maintenance Event
- Lifecycle State Transition

REALIZATION DETAILS

- All realizations are linked to the same Functional Location (FL-1001).
- Replacement chain provides full historical traceability.
- Each realization has its own lifecycle, maintenance, and performance history.
- Complete history supports engineering, compliance, and reliability analysis.

TRACEABILITY BENEFITS

- ✓ Long-term lifecycle continuity
- ✓ Full replacement history
- ✓ Maintenance & performance trend analysis
- ✓ Regulatory & audit compliance
- ✓ Better engineering decisions
- ✓ Future planning & risk mitigation

ONE FUNCTIONAL INTENT. MANY PHYSICAL REALIZATIONS. COMPLETE LIFECYCLE TRACEABILITY.
Enabling reliable operations, informed decisions, and continuous improvement across the asset lifecycle.

SEMANTIC ENGINEERING MATCHING IN PROCESS PLANT DIGITAL TWIN

CFIHOS-Based Functional Requirements ↔ Equipment Capability Models ↔ Vendor Alternatives

Semantic Evaluation • Engineering Constraints • Capability Matching • Maintenance Decision Support

1. FUNCTIONAL REQUIREMENTS (CFIHOS)

What the Process Needs to Achieve

CFIHOS Requirement Structure

REQ-7001 Maintain Process Fluid Flow

- REQ-7001.1 Provide Flow Capacity
  - Maintain Flow Rate: ≥ 100 m³/h
  - Operating Pressure: 10 – 25 bar(g)
  - Temperature Range: -10 – 120 °C
  - Availability: ≥ 98 %
- REQ-7001.2 Ensure Reliability
  - MTBF: ≥ 25,000 h
  - Redundancy: 1 (Standby)
  - Proof Test Interval: ≤ 12 months
- REQ-7001.3 Ensure Operability
  - Control Method: Automatic
  - Response Time: ≤ 5 s
  - Turndown: ≥ 10:1
- REQ-7001.4 Ensure Maintainability
  - MTTR: ≤ 8 h
  - Maintenance Access: Local
  - Spare Parts Availability: ≥ 95 %

CFIHOS Context

Process Area:	Area 10 – Crude Unit
Process Function:	Transfer Pumping
Criticality:	High
Design Basis:	Basis-2021-10
Reference Standards:	API 610, ISO 13709

2. EQUIPMENT CAPABILITY MODELS

What Equipment Can Do

Normalized Capability Model (Equipment Ontology)

Capacity | Pressure | Temperature | Reliability | Operability | Maintainability | Compliance

Capability Models (Examples)

CAP-PUMP-001
Centrifugal Pump API 610

Flow Rate	120 m³/h
Pressure	16 bar(g)
Temp. Range	-20 – 110 °C
Availability	97.5 %
MTBF	28,000 h
MTTR	6 h
Turndown	8:1
Control	VFD
States (STEP)	Installed

CAP-PUMP-002
Centrifugal Pump API 610

Flow Rate	150 m³/h
Pressure	25 bar(g)
Temp. Range	-30 – 120 °C
Availability	98.5 %
MTBF	35,000 h
MTTR	5 h
Turndown	10:1
Control	VFD
States (STEP)	Installed

CAP-PUMP-003
Centrifugal Pump API 610

Flow Rate	95 m³/h
Pressure	16 bar(g)
Temp. Range	-10 – 100 °C
Availability	95.0 %
MTBF	20,000 h
MTTR	8 h
Turndown	6:1
Control	On/Off
States (STEP)	Installed

Engineering Constraints

Piping Connection:	1S0# RF	Footprint Limit:	L ≤ 1200 mm
Suction Pressure Min:	1.5 bar(g)	Weight Limit:	≤ 800 kg
NPSH Available:	≥ 2.0 m	Ambient Temperature:	-20 – 50 °C
Material:	SS316	Hazardous Area:	Zone 1
Power Supply:	480 V, 60 Hz	SIL Requirement:	SIL 1

3. VENDOR ALTERNATIVES

Who Can Deliver & Maintain

Vendor / Manufacturer Solutions

A VEND-A PumpTech Solutions

Model:	PT-610-
Lead Time:	10 weeks
Warranty:	24 months
Service Network:	Global
Spares Availability:	97%

B VEND-B FlowPro Industries

Model:	FPX-150/25
Lead Time:	8 weeks
Warranty:	18 months
Service Network:	Regional
Spares Availability:	92%

C VEND-C GlobalPump Co.

Model:	GP-150/25
Lead Time:	12 weeks
Warranty:	12 months
Service Network:	Regional
Spares Availability:	85%

Vendor Capabilities (Semantic)

Manufacturing | Quality | Support | Lifecycle | Compliance

Semantic Alignment (IDO-Ex Concepts)

CFIHOS Concept	IDO-Ex Concept	Capability Concept
Flow Rate	Capacity	Flow Rate
Pressure	Pressure	Pressure
Temperature	Temperature	Temp- Range
Availability	Reliability	Availability
MTBF	Mean Time Between Failure	MTBF
MTTR	Mean Time To Repair	MTTR
...	...	...

4. SEMANTIC EVALUATION & CAPABILITY MATCHING

Requirement vs Capability Evaluation

Requirement (REQ-7001)	Weight	CAP-PUMP-001	CAP-PUMP-002	CAP-PUMP-003
Flow Rate ≥ 100 m³/h	20%	0.80	1.00	0.60
Pressure 10 – 25 bar(g)	20%	0.60	1.00	0.60
Temperature -10 – 120 °C	15%	0.85	1.00	0.80
Availability ≥ 98 %	15%	0.70	1.00	0.40
MTBF ≥ 25,000 h	10%	0.80	1.00	0.40
MTTR ≤ 8 h	10%	0.75	1.00	1.00
Turndown ≥ 10:1	5%	0.40	1.00	0.30
Constraints Compliance	5%	0.85	0.95	0.70
Weighted Match Score	**100%**	**0.73**	**0.99**	**0.53**

Semantic Reasons (Key Gaps / Strengths)

CAP-PUMP-001
- Pressure below max requirement
- Availability below target
- Turndown below requirement

CAP-PUMP-002
- All functional requirements met
- Best reliability and availability
- Compliant with all constraints

CAP-PUMP-003
- Flow rate below requirement
- Availability significantly below
- MTBF below requirement

5. MATCHING RESULTS (Ranked)

		Match Score	Confidence
1	**CAP-PUMP-002** Model: FPX-150/25 (Vendor B)	0.99	High
2	**CAP-PUMP-001** Model: PT-610-150/25 (Vendor A)	0.73	Medium
3	**CAP-PUMP-003** Model: GP-150/25 (Vendor C)	0.53	Low

Recommendation

Select CAP-PUMP-002 from Vendor B.

Best overall semantic match to functional requirements and constraints.

6. MAINTENANCE & ASSET DECISION SUPPORT

Risk Impact (Low Risk) | Lifecycle Cost (Lowest LCC) | Spares & Support (High Availability) | Maintainability (Best (MTTR S h)) | Downtime Impact (Minimized)

Decision Output

- Approved for Procurement
- Update Work Strategy
- Create / Update Functional Location Link
- Update Maintenance Plan

7. DIGITAL TWIN LIFECYCLE UPDATE

Update Selection (Functional ↔ Physical) → Update STEP Model (Asset Realization) → Update Knowledge Graph (Semantic Relationships) → Update SAP / EAM (Work & Asset Data) → Update 3D Context (IVsualization)

Semantic Interoperability — Common Meaning Across Domains

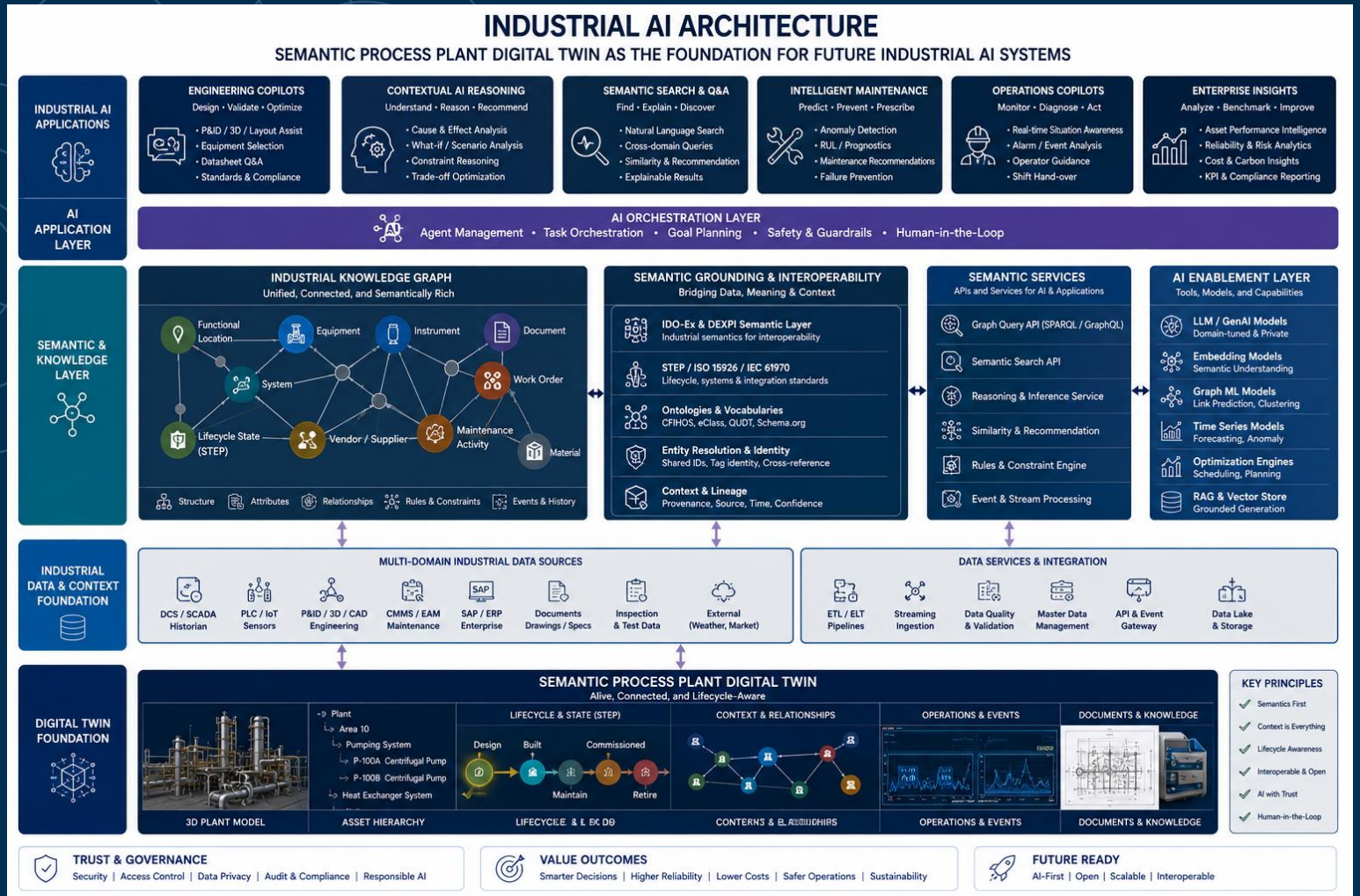
Traceability — Requirements → Assets → Operations

Better Engineering Decisions — Data-Driven & Transparent

Lifecycle Continuity — From Design to Operations

Lower Risk & Cost — Right Asset, Right Time

Legend: Excellent | Good | Fair | Poor

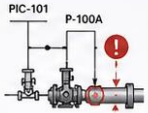

INDUSTRIAL AI ARCHITECTURE
SEMANTIC PROCESS PLANT DIGITAL TWIN AS THE FOUNDATION FOR FUTURE INDUSTRIAL AI SYSTEMS
INDUSTRIAL AI APPLICATIONS
ENGINEERING COPILOTS
Design • Validate • Optimize
• P&ID / 3D / Layout Assist
• Equipment Selection
• Datasheet Q&A
• Standards & Compliance
CONTEXTUAL AI REASONING
Understand • Reason • Recommend
• Cause & Effect Analysis
• What-if / Scenario Analysis
• Constraint Reasoning
• Trade-off Optimization
SEMANTIC SEARCH & Q&A
Find • Explain • Discover
• Natural Language Search
• Cross-domain Queries
• Similarity & Recommendation
• Explainable Results
INTELLIGENT MAINTENANCE
Predict • Prevent • Prescribe
• Anomaly Detection
• RUL / Prognostics
• Maintenance Recommendations
• Failure Prevention
OPERATIONS COPILOTS
Monitor • Diagnose • Act
• Real-time Situation Awareness
• Alarm / Event Analysis
• Operator Guidance
• Shift Hand-over
ENTERPRISE INSIGHTS
Analyze • Benchmark • Improve
• Asset Performance Intelligence
• Reliability & Risk Analytics
• Cost & Carbon Insights
• KPI & Compliance Reporting
AI APPLICATION LAYER
AI ORCHESTRATION LAYER
Agent Management • Task Orchestration • Goal Planning • Safety & Guardrails • Human-in-the-Loop
SEMANTIC & KNOWLEDGE LAYER
INDUSTRIAL KNOWLEDGE GRAPH
Unified, Connected, and Semantically Rich
Functional Location
Equipment
Instrument
Document
System
Work Order
Lifecycle State (STEP)
Vendor / Supplier
Maintenance Activity
Material
Structure
Attributes
Relationships
Rules & Constraints
Events & History
SEMANTIC GROUNDING & INTEROPERABILITY
Bridging Data, Meaning & Context
IDO-Ex & DEXPI Semantic Layer
Industrial semantics for interoperability
STEP / ISO 15926 / IEC 61970
Lifecycle, systems & integration standards
Ontologies & Vocabularies
CFIHOS, eClass, QUDT, Schema.org
Entity Resolution & Identity
Shared IDs, Tag identity, Cross-reference
Context & Lineage
Provenance, Source, Time, Confidence
SEMANTIC SERVICES
APIs and Services for AI & Applications
Graph Query API (SPARQL / GraphQL)
Semantic Search API
Reasoning & Inference Service
Similarity & Recommendation
Rules & Constraint Engine
Event & Stream Processing
AI ENABLEMENT LAYER
Tools, Models, and Capabilities
LLM / GenAI Models
Domain-tuned & Private
Embedding Models
Semantic Understanding
Graph ML Models
Link Prediction, Clustering
Time Series Models
Forecasting, Anomaly
Optimization Engines
Scheduling, Planning
RAG & Vector Store
Grounded Generation
INDUSTRIAL DATA & CONTEXT FOUNDATION
MULTI-DOMAIN INDUSTRIAL DATA SOURCES
DCS / SCADA Historian
PLC / IoT Sensors
P&ID / 3D / CAD Engineering
CMMS / EAM Maintenance
SAP / ERP Enterprise
Documents Drawings / Specs
Inspection & Test Data
External (Weather, Market)
DATA SERVICES & INTEGRATION
ETL / ELT Pipelines
Streaming Ingestion
Data Quality & Validation
Master Data Management
API & Event Gateway
Data Lake & Storage
DIGITAL TWIN FOUNDATION
SEMANTIC PROCESS PLANT DIGITAL TWIN
Alive, Connected, and Lifecycle-Aware
3D PLANT MODEL
ASSET HIERARCHY
Plant
Area 10
Pumping System
P-100A Centrifugal Pump
P-100B Centrifugal Pump
Heat Exchanger System
LIFECYCLE & STATE (STEP)
Design
Built
Commissioned
Maintain
Retire
CONTEXT & RELATIONSHIPS
OPERATIONS & EVENTS
DOCUMENTS & KNOWLEDGE
KEY PRINCIPLES
Semantics First
Context is Everything
Lifecycle Awareness
Interoperable & Open
AI with Trust
Human-in-the-Loop
TRUST & GOVERNANCE
Security | Access Control | Data Privacy | Audit & Compliance | Responsible AI
VALUE OUTCOMES
Smarter Decisions | Higher Reliability | Lower Costs | Safer Operations | Sustainability
FUTURE READY
AI-First | Open | Scalable | Interoperable

PROCESS PLANT DIGITAL TWIN – END-TO-END OPERATIONAL WORKFLOW

From Fault Detection to Lifecycle Update

1 FAULT DETECTION (Automation)

Event Detected in Control System



Event Details

Tag: P-100A
Centrifugal Pump
High Vibration Alarm
Time: 2024-05-10 08:15
Severity: High

Source: DCS / SCADA (Real-time Data)

2 WORK REQUEST CREATION (SAP)

Automatic / Manual Work Request

Work Request

WR-4001
Description: High vibration on P-100A
Priority: High
Status: Created
Reported By: System

System: SAP PM (Enterprise Maintenance)

3 KNOWLEDGE GRAPH SYNCHRONIZATION

Semantic Update & Context Linking

KG Actions

- ✓ Event Ingested
- ✓ Assets Linked
- ✓ Relationships Updated
- ✓ Context Enriched
- ✓ State Updated

System: Knowledge Graph (Semantic Layer)

4 3D CONTEXTUALIZATION & NAVIGATION

Visualize in 3D Plant Environment

3D Context

Asset Highlighted
Neighboring Systems
P&IDs & Lines
Accessibility & Location
Live Data Overlay

System: 3D Plant Model (Visualization Layer)

5 LIFECYCLE ANALYSIS & HISTORY

Understand Asset History & Realization

P-100A (Centrifugal Pump)

- EQ-2000
  2015-03-15 to 2018-11-20
  (Installed)
- EQ-2100
  2018-11-21 to 2021-06-10
  (Replaced)
- EQ-2200
  2021-06-11 to Present
  (Current)

Lifecycle State (STEP)

Installed
Effectivity: 2021-06-11 – Present

System: STEP / Lifecycle (Lifecycle Layer)

6 REQUIREMENT & CAPABILITY MATCHING

Find Suitable Solution Options

Requirement (CFIHOS)

REQ-7001
Maintain Flow Rate
> 100 m³/h

Matching Capabilities

- CAP-8001
  Pump Capacity 120 m³/h @ 50m — 98%
- CAP-8002
  Pump Capacity 110 m³/h @ 45m — 85%
- CAP-8003
  Pump Capacity 90 m³/h @ 40m — 65%

System: Requirements & Capabilities (Semantic)

7 MAINTENANCE EXECUTION

Perform Work & Record Execution

Maintenance Activity

MA-6001
Type: Bearing Replacement
Technician: Team A
Start: 2024-05-10 10:30
End: 2024-05-10 14:45
Status: Completed

System: Maintenance Execution (SAP PM)

8 DIGITAL TWIN UPDATE & LIFECYCLE SYNCHRONIZATION

Close the Loop & Keep Twin in Sync

Updates Performed

- ✓ Asset State Updated
- ✓ Event Closed
- ✓ Lifecycle State Confirmed
- ✓ History Recorded
- ✓ Knowledge Graph Updated
- ✓ 3D Model Refreshed

System: Digital Twin (All Layers)

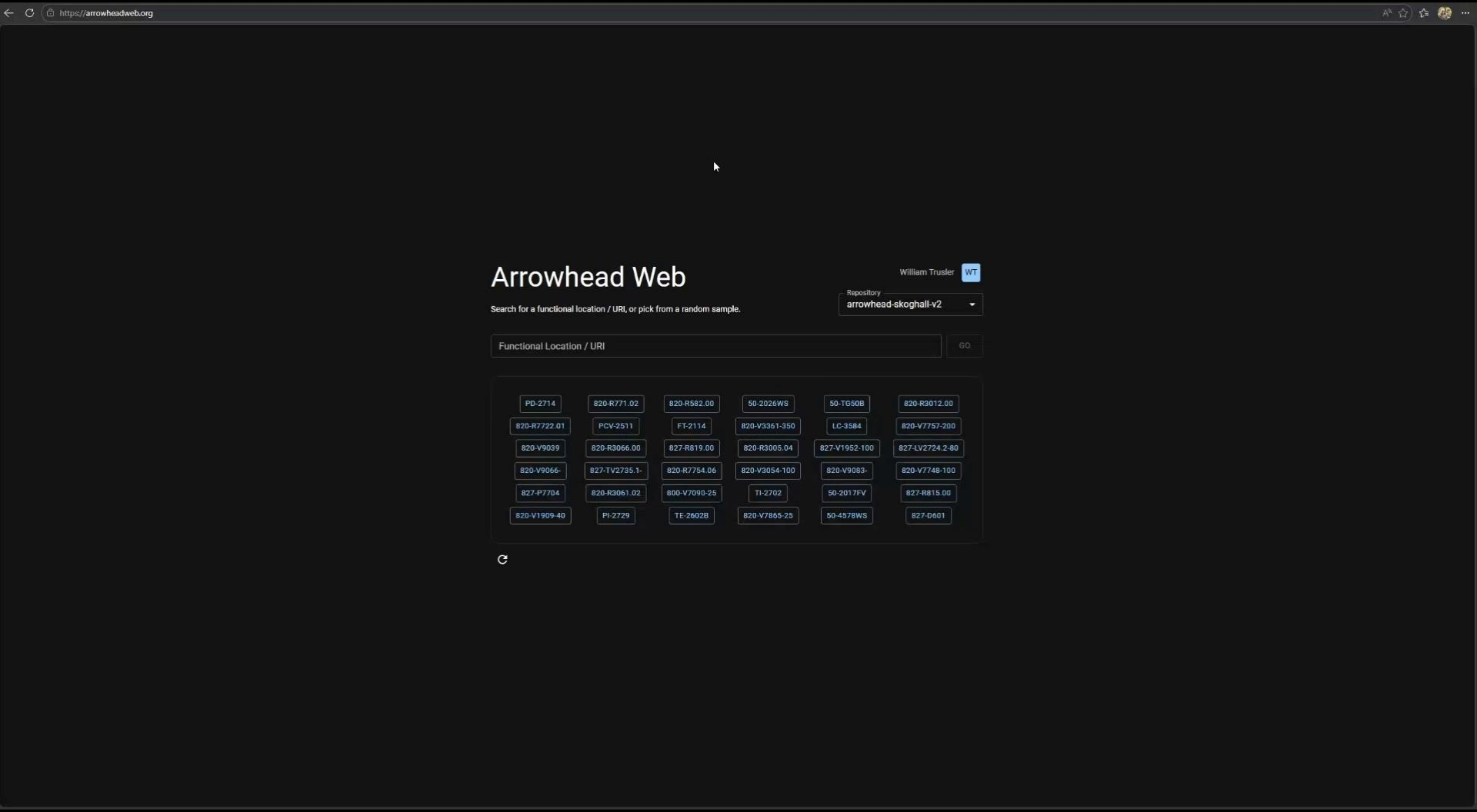
DIGITAL TWIN FOUNDATION (Cross-Domain Semantic Integration)

- Automation Systems (DCS / SCADA / Historian)
- Engineering Data (DEXPI / P&ID / CAE)
- Knowledge Graph (Semantic Layer)
- Lifecycle Data (STEP / Product Models)
- Enterprise Systems (SAP / EAM)
- Requirements & Capabilities (CFIHOS / IDO-Ex)

Bidirectional Data Flow & Semantic Interoperability (Arrowhead)

BUSINESS & OPERATIONAL VALUE

- Faster Fault Response & Resolution
- Improved Asset Availability
- Lifecycle Continuity & Traceability
- Better Engineering Decisions
- Reduced Downtime & Costs
- Regulatory Compliance & Auditability
- Data-Driven Continuous Improvement


https://arrowheadweb.org
Arrowhead Web
William Trusler
WT
Repository
arrowhead-skoghall-v2
Search for a functional location / URI, or pick from a random sample.
Functional Location / URI
GO
PD-2714
820-R771.02
820-R582.00
50-2026WS
50-TG50B
820-R3012.00
820-R7722.01
PCV-2511
FT-2114
820-V3361-350
LC-3584
820-V7757-200
820-V9039
820-R3066.00
827-R819.00
820-R3005.04
827-V1952-100
827-LV2724.2-80
820-V9066-
827-TV2735.1-
820-R7754.06
820-V3054-100
820-V9083-
820-V7748-100
827-P7704
820-R3061.02
800-V7090-25
TI-2702
50-2017FV
827-R815.00
820-V1909-40
PI-2729
TE-2602B
820-V7865-25
50-4578WS
827-D601

Key take-aways

- Semantic interoperability
- Lifecycle traceability
- Open standards
- IT/OT integration
- Reusable knowledge graphs
- Foundation for scalable Digital Twins
- Foundation for engineering AI applications through structured semantic data and interoperable knowledge graphs