

OPC UA Industrial Joining Technologies (IJT)

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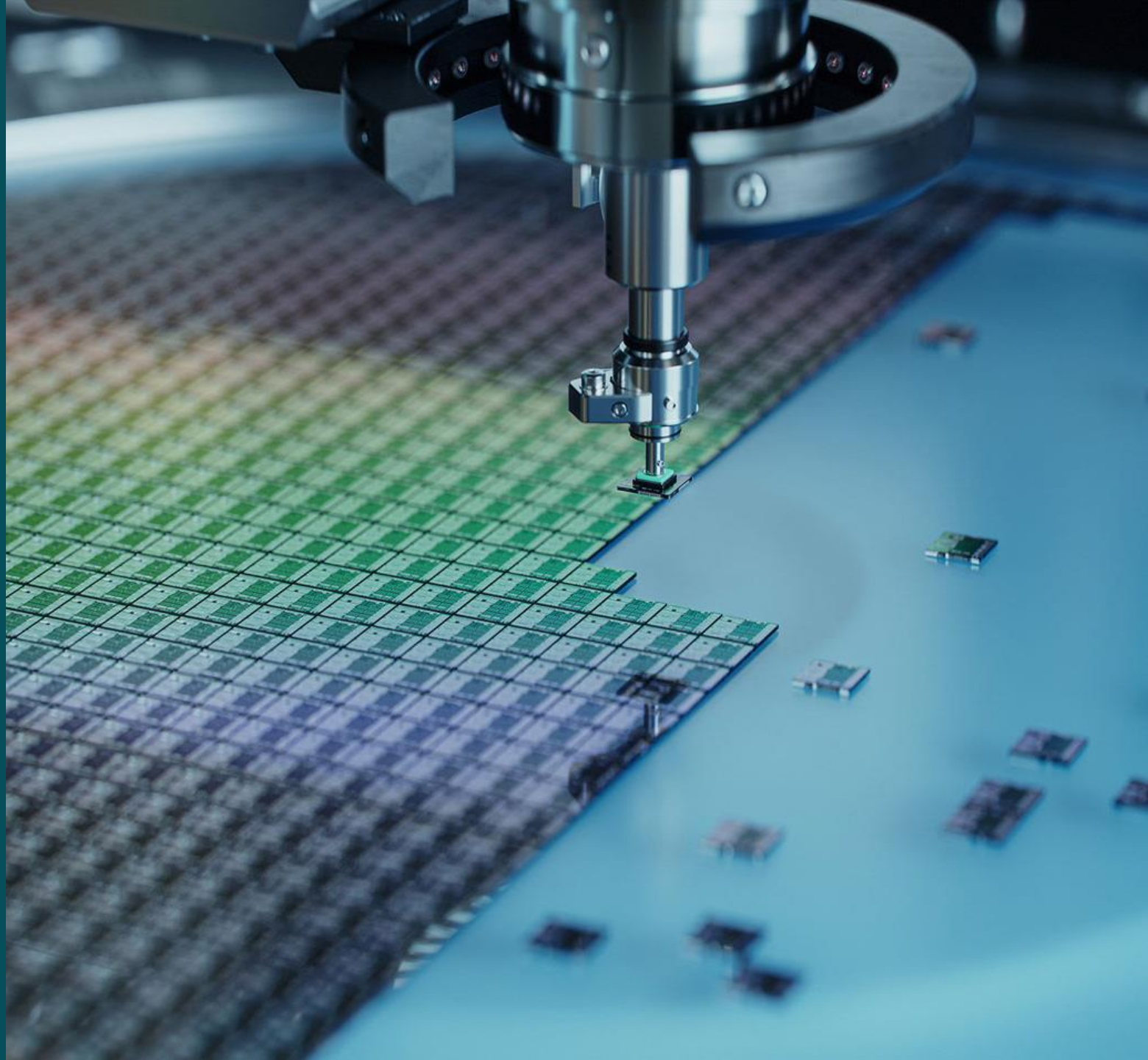
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Atlas Copco
Group



Agenda

- Introduction
 - Smart Integrated Assembly
 - Atlas Copco Communication
- Industrial Joining Technologies (IJT)
 - Overview
 - Use Cases
 - Technical Models
 - Demonstration
- Summary

Introduction – Atlas Copco

Smart Integrated Assembly – meeting the needs of modern assembly!

Smart Integrated Assembly



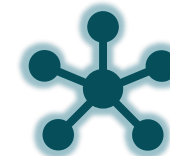
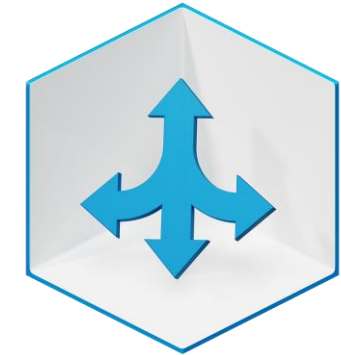
Needs



Key enablers



5G



OPC UA



Communication for Atlas Copco Tools today



Atlas Copco Open Protocol

a de facto standard

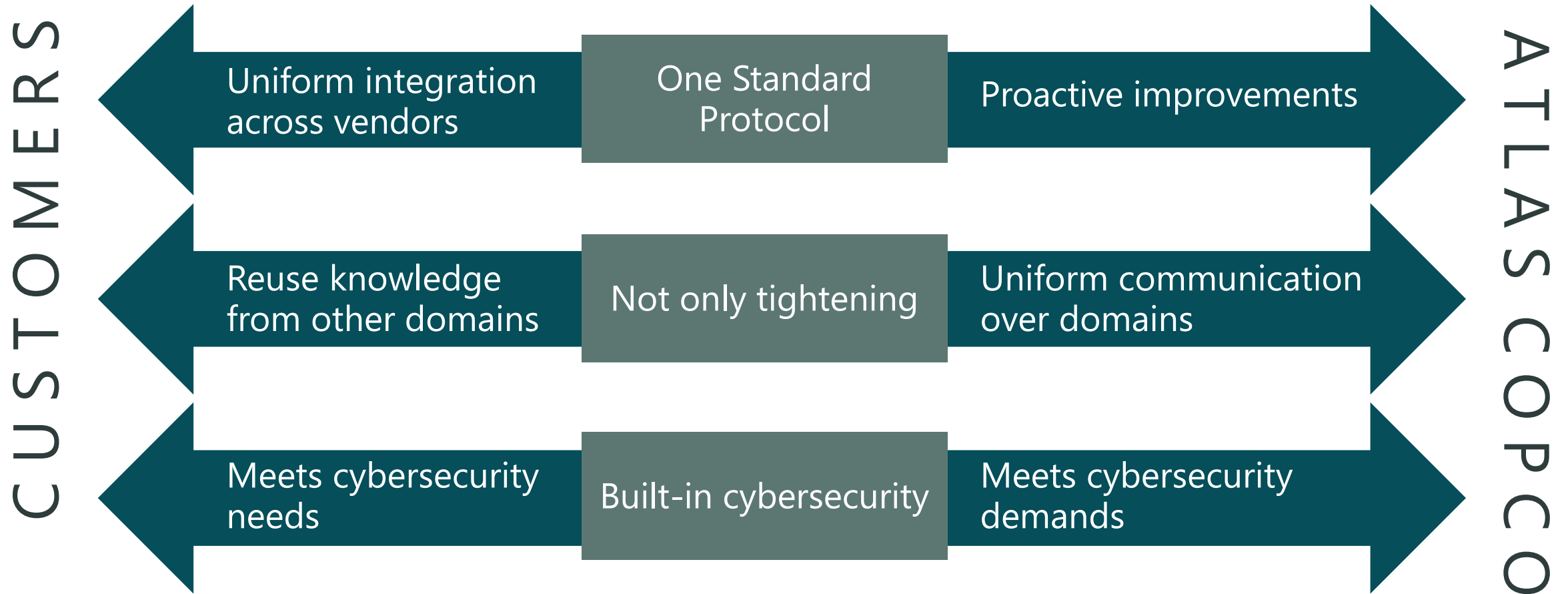
- Not a governed process – each vendor responsible for implementation.
- No cybersecurity measures.
- Specific to tightening.

Protocol Adapters

Unique to each customer

- Project developments according to specifications.
- Parallel solutions to similar issues.
- Costly to maintain.

OPC UA is mutually beneficial

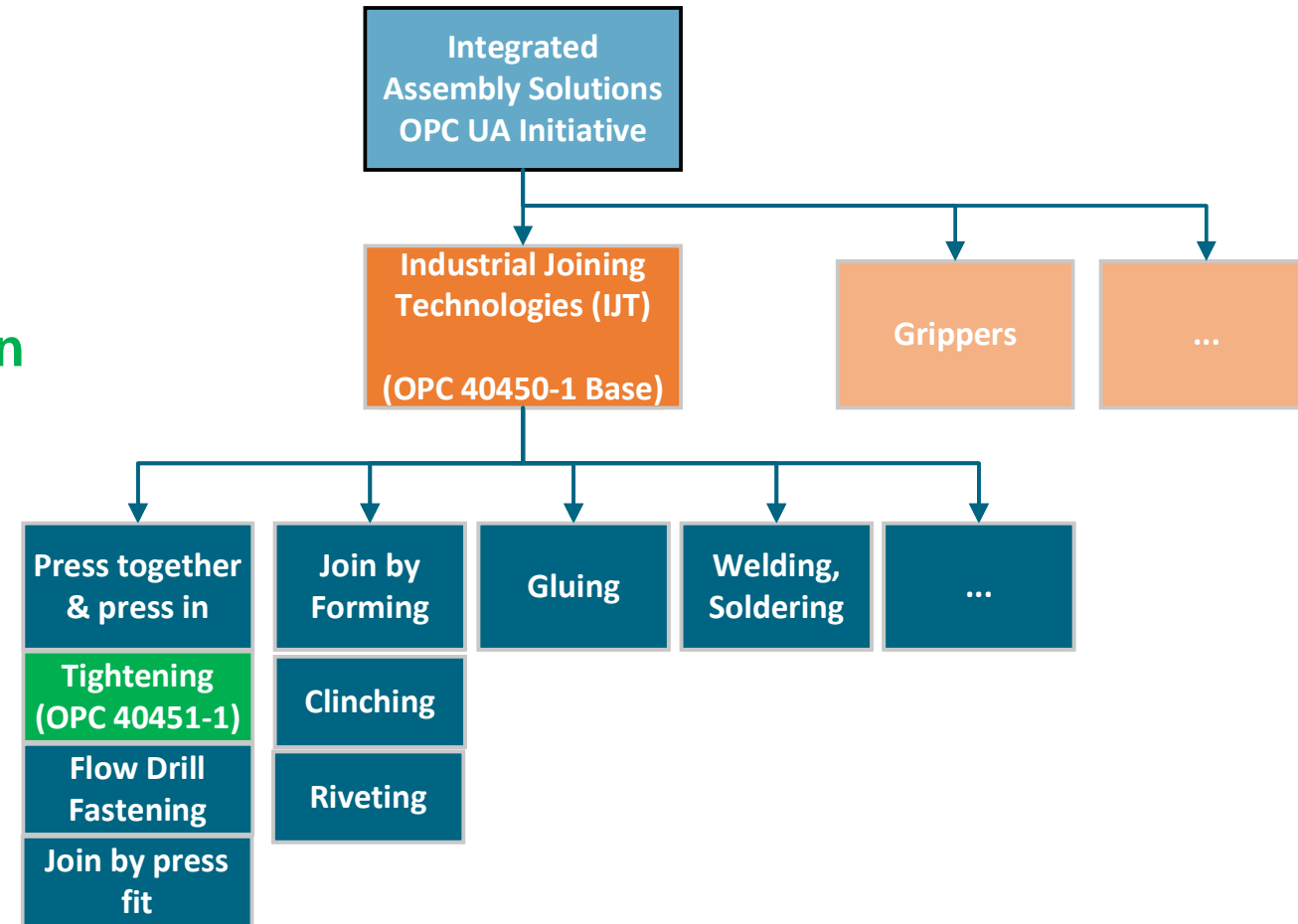


VDMA Industrial Joining Technologies (IJT)

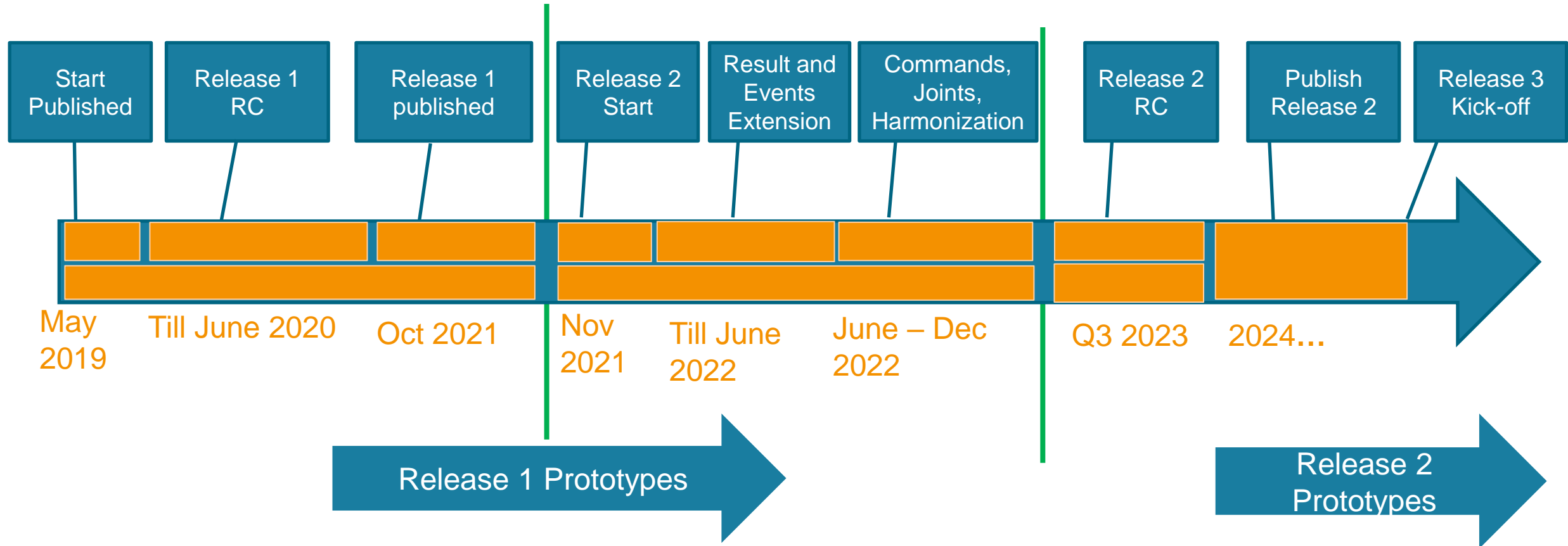
IJT Specification(s) Overview



- **OPC 40450-1** for Joining Systems **version 1.0**
 - Common elements of various joining technologies.
 - <http://opcfoundation.org/UA/IJT/Base/>
 - `Opc.Ua.Ijt.Base.NodeSet2.xml`
- **OPC 40451-1** for Tightening Systems **version 2.0**
 - **Version 1.0** was published in October 2021.
 - Moved common models to the base specification.
 - <http://opcfoundation.org/UA/IJT/Tightening/>
 - `Opc.Ua.Ijt.Tightening.NodeSet2.xml`



History and Milestones



IJT Working Group Members



IJT Use Cases

Use Cases Overview



Asset Management

Overview and Identification of physical assets in the given system.

Example:

Manufacturer, Serial number, Software Revision...



Condition Monitoring

Acquisition and processing of information that indicate the state of an asset over time.

Example:

Health status, temperature...



Result Management

Primary process output of the tightening operation.

Example:

Single Result, Batch Result, Job Result, Multi-spindle Result, etc.



Event Management

Various types of events with standard payload and filter criteria.

Example:

Tool Connected, Maintenance Events, etc.



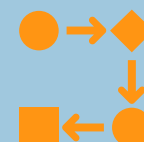
Commands

Asset Management
control mechanisms.

Joining Process
Management.

Example:

Select Program, Send Program, Enable Tool, etc.

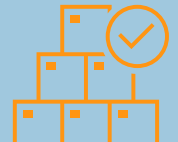


Joint Management

Provides joint data.

Example:

Joint with associated Programs, etc.



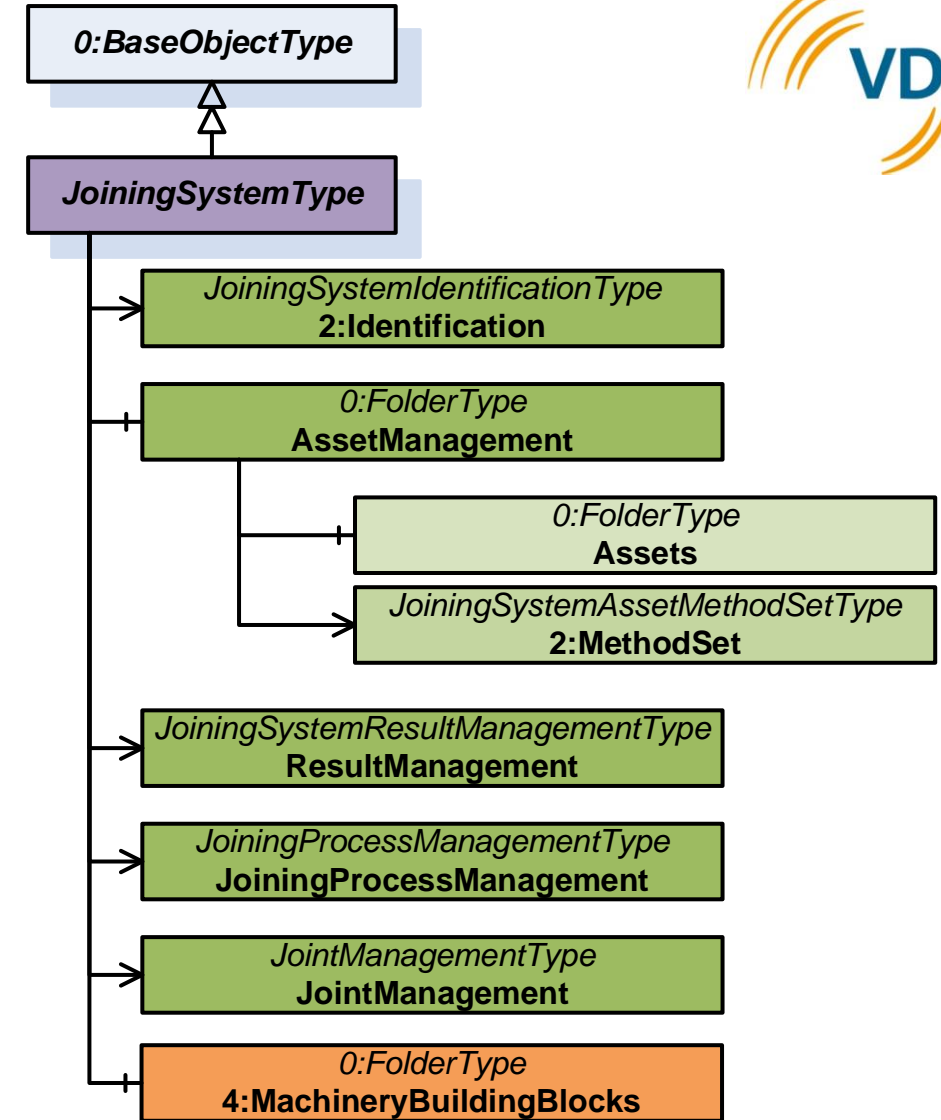
Technical Overview of Models

Joining System Overview

- Standard entry point for a joining system.
- Common interface for any joining system.
- Top-level structure with building blocks for the

use cases discussed such as:

- Asset Management
- Result Management
- Joining Process Management
- Joint Management
- ...



Asset Management

Asset Management Overview



- Definition of assets building blocks.
- Diverse systems – Flexible asset management model to build different systems.
 - Fixtured, Handheld, Pneumatic, Multi-Channel, Single Channel
- Reuse of Machinery Building Blocks and Asset Management Basics.
- Future Extensibility with the usage of Interfaces and Add-Ins instead of concrete types.

Joining System

Controller

Tool

Servo

Feeder

Battery

Software

Accessory

Memory
Device

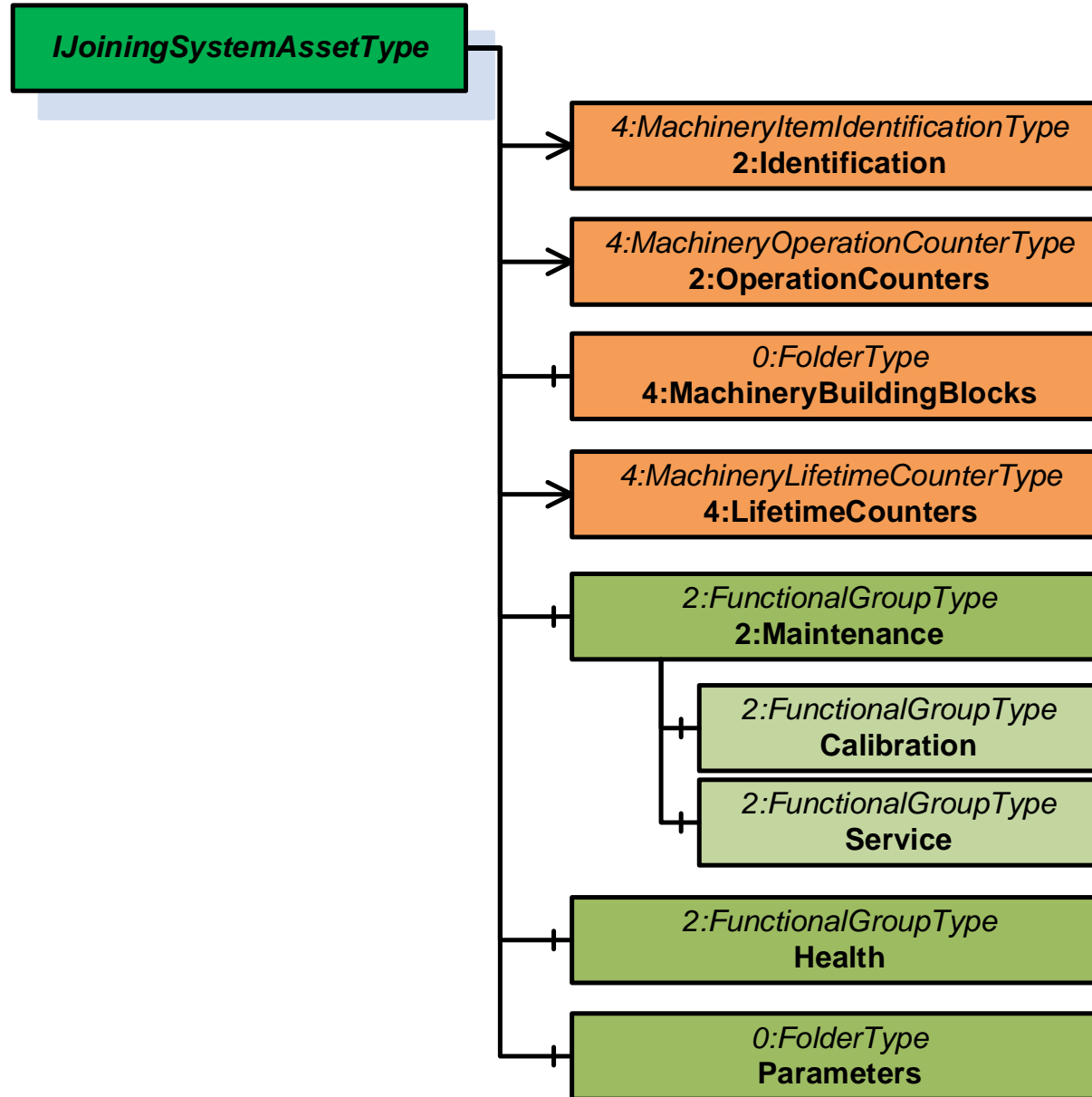
Cable

Power
Supply

Sub-
Component

Virtual
Station

Common Asset Data

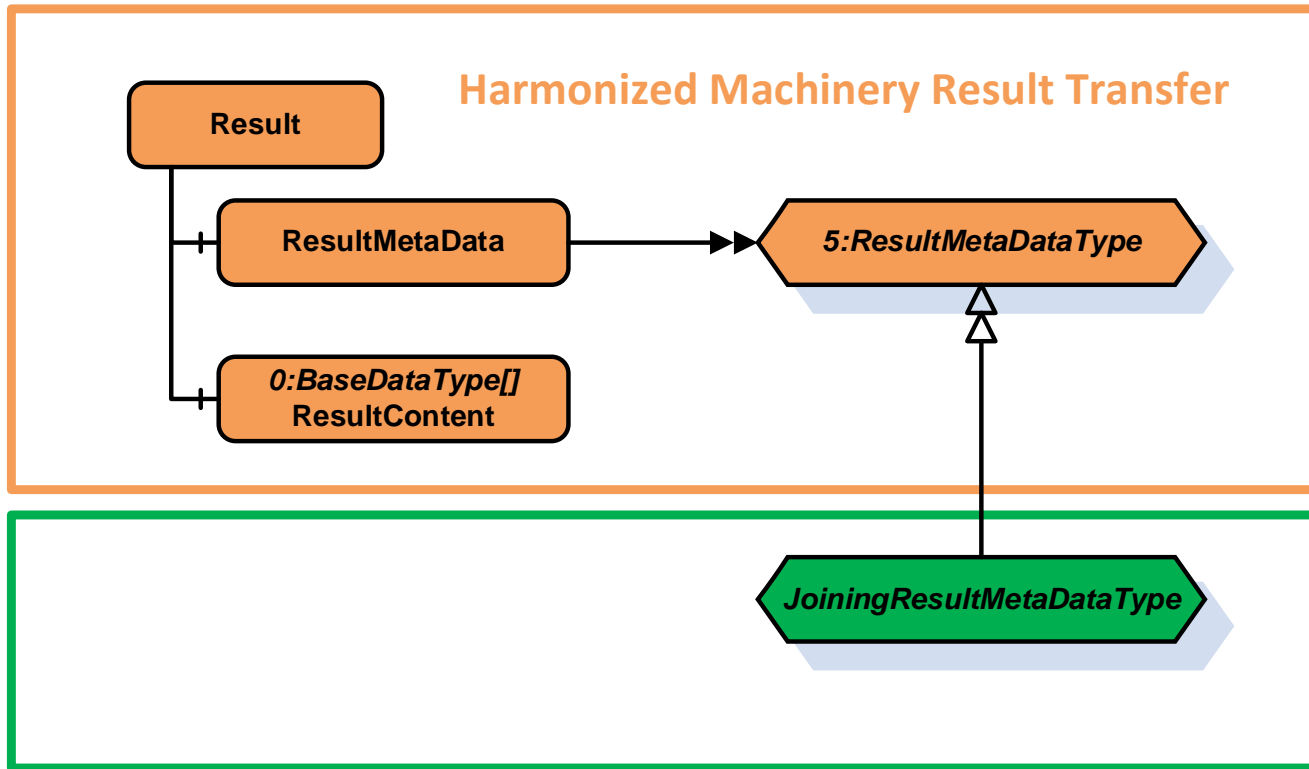


Result Management

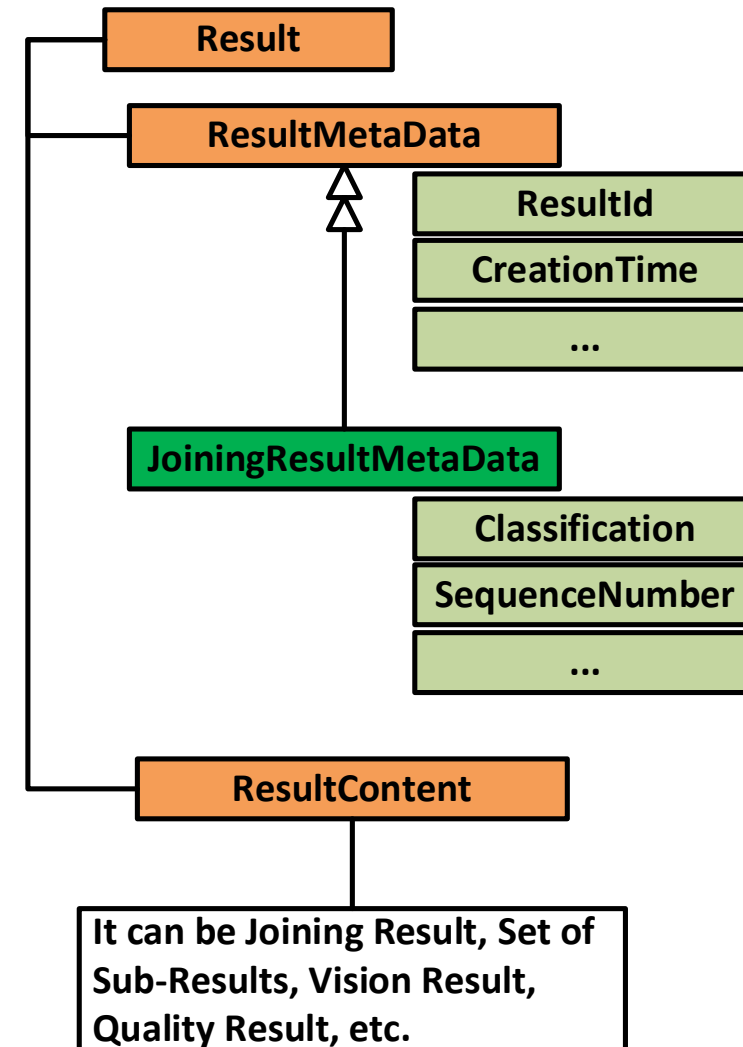
Result Overview



Structure



Example

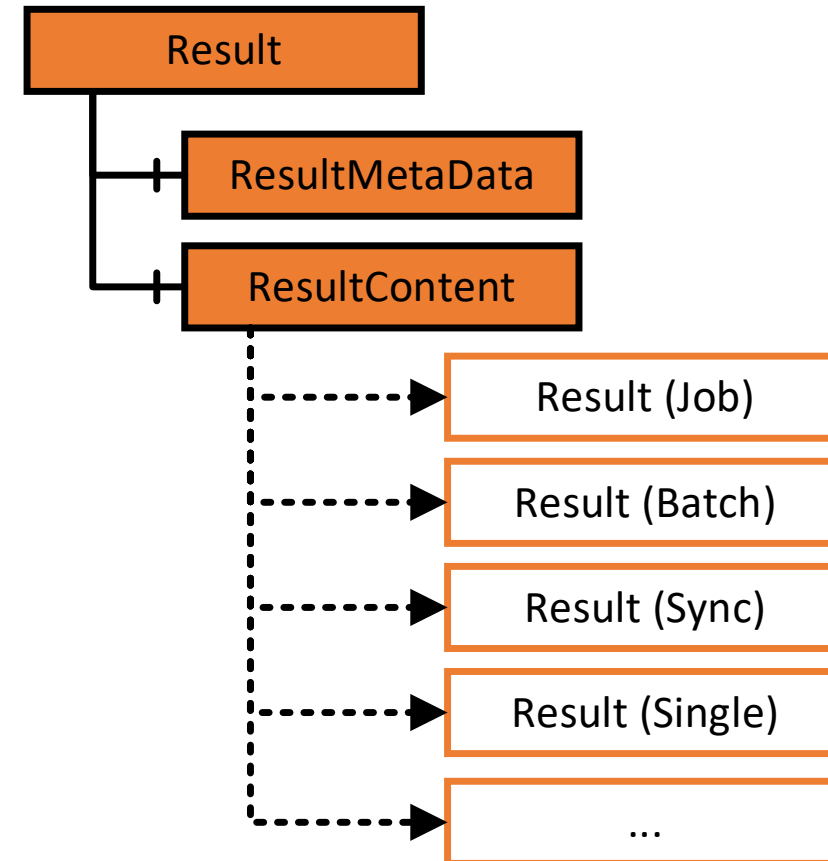


Result Classification – Multiple Use Cases



- Result
 - Common Joining Meta Data
- Result Content
 - Single Result
 - Batch Result
 - Job Result
 - Sync (Multi-spindle) Result
 - Stitching Result

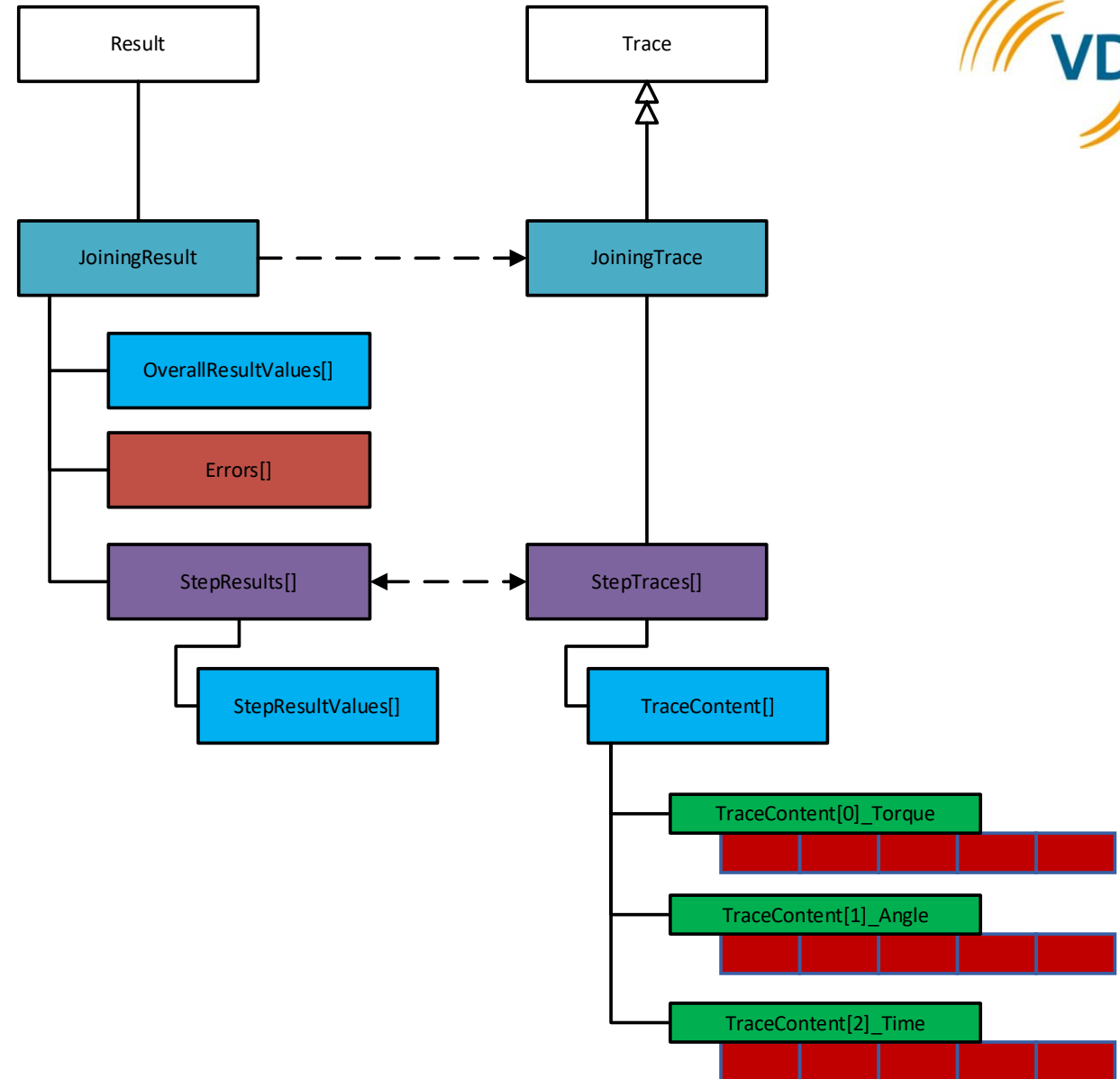
RESULT MODEL



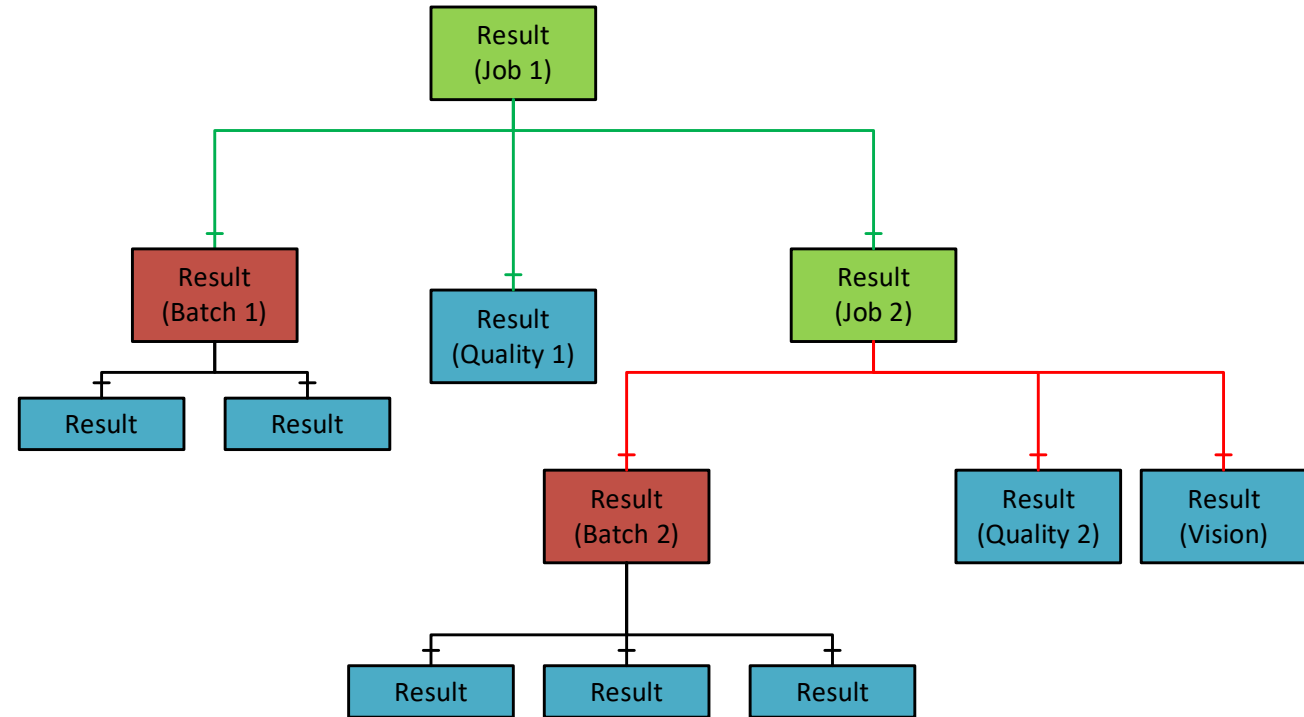
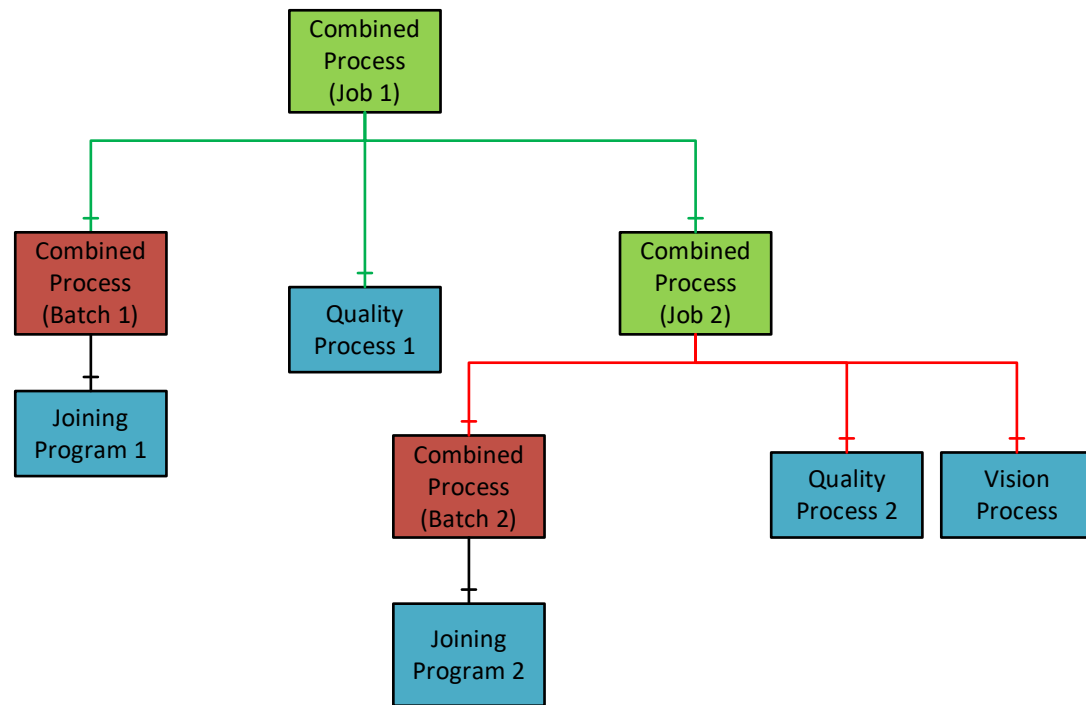
Single Joining Result Content



- Joining Result
 - Global values
 - Step Results
 - Errors
 - Traces



Combined Results – Job Result Example



Event Management

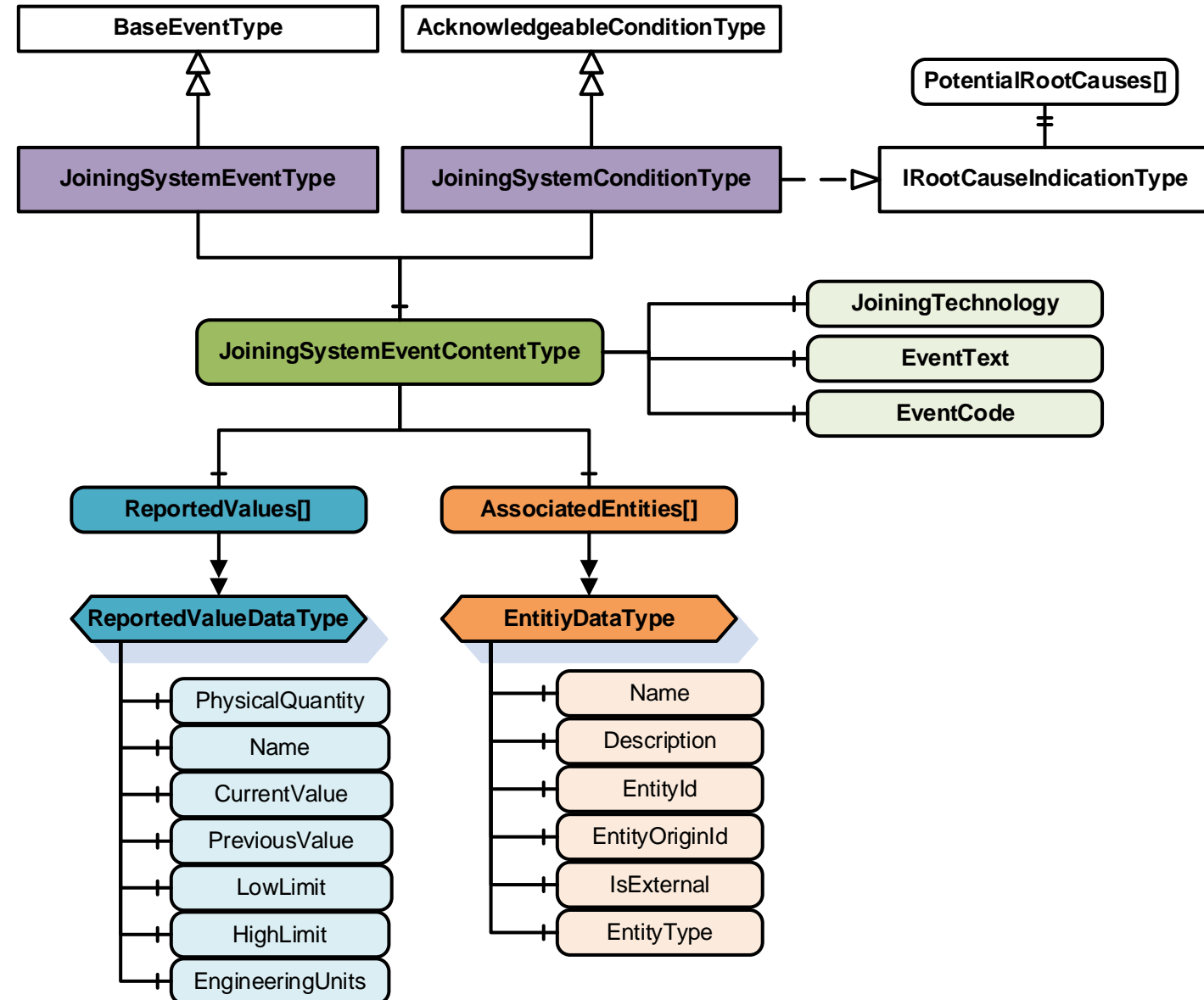
Event and Condition with **standard payload** from a joining system.

- **Event**

- Simple transient information sent from the underlying system.
- Fire and forget from the sender's perspective.

- **Condition**

- Have a State associated.
- Can be acknowledged by the client.



Condition Classes

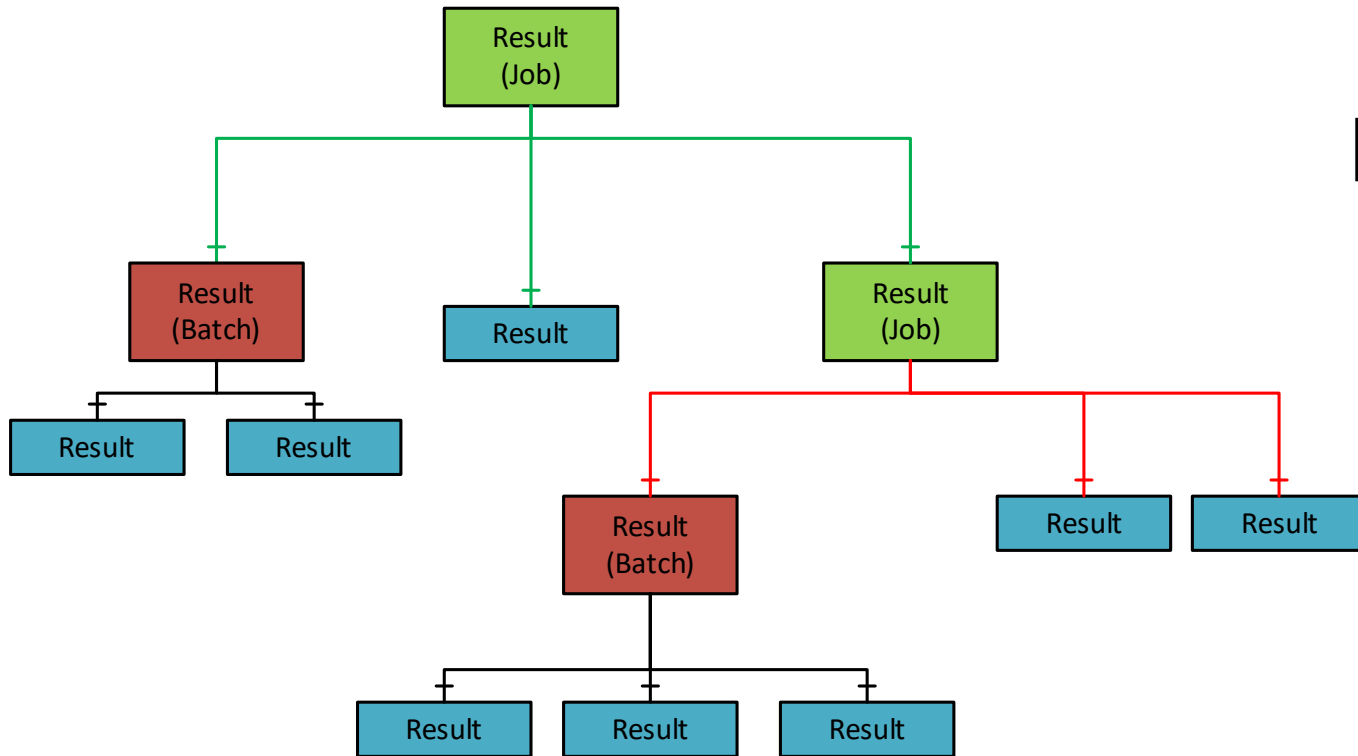
- **Condition Classes**
 - Reuse from base specifications.
- **Condition Sub Classes**
 - Defined in the IJT Working Group.
- **Example 1: Tool Disconnected**
 - **ConditionClass** = SystemConditionClass
 - **ConditionSubClass** = AssetDisconnectedConditionClass
- **Example 2: The tool is out of range from the station.**
 - **ConditionClass** = SystemConditionClass
 - **ConditionSubClass** = LocationOutOfZone
- **Example 3: Software Expired**
 - **ConditionClass** = SystemConditionClass
 - **ConditionSubClass[0]** = SoftwareConditionClass
 - **ConditionSubClass[1]** = ExpiredConditionClass

Condition Classes in Base Specifications	Condition Classes in IJT Specification(s)
OPC UA Base	
BaseConditionClass	AssetConnectedConditionClass
ProcessConditionClass	AssetDisconnectedConditionClass
MaintenanceConditionClass	AssetEnabledConditionClass
SystemConditionClass	AssetDisabledConditionClass
SafetyConditionClass	ThresholdViolationConditionClass
HighlyManagedAlarmConditionClass	ThresholdViolationResolvedConditionClass
TrainingConditionClass	JoiningSystemUserLoggedInConditionClass
StatisticalConditionClass	JoiningSystemUserLoggedOutConditionClass
TestingConditionClass	LocationInRangeConditionClass
Asset Management Basics	
ConnectionFailureConditionClass	AssetLocationConditionClass
OverTemperatureConditionClass	DataValidationFailureConditionClass
CalibrationDueConditionClass	InputValidationFailureConditionClass
SelfTestFailureConditionClass	ConfigurationChangeConditionClass
FlashUpdateInProgressConditionClass	ErrorConditionClass
FlashUpdatedFailedConditionClass	SoftwareConditionClass
BadConfigurationConditionClass	HardwareConditionClass
OutOfResourcesConditionClass	CertificateConditionClass
OutOfMemoryConditionClass	LicenseConditionClass
InspectionConditionClass	MissingEntityConditionClass
ExternalCheckConditionClass	ExpiredEntityConditionClass
ServicingConditionClass	InvalidEntityConditionClass
ImprovementConditionClass	IncompatibleEntityConditionClass
RepairConditionClass	AcceptedEntityConditionClass
	RejectedEntityConditionClass
	AddedEntityConditionClass
	UpdatedEntityConditionClass
	RemovedEntityConditionClass
	ReceivedEntityConditionClass

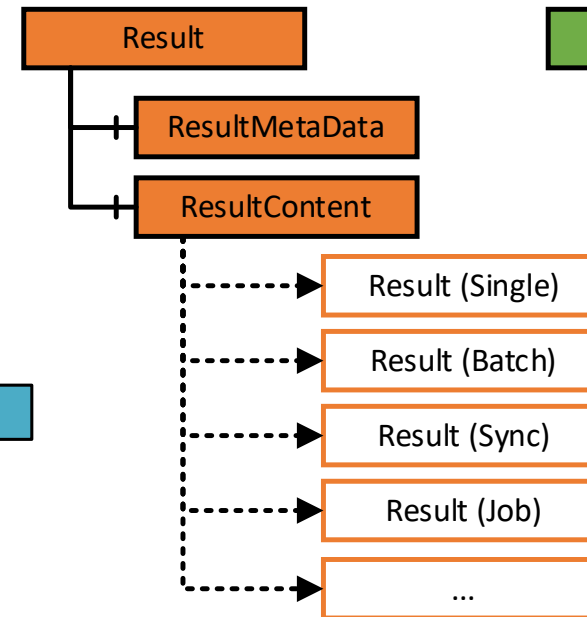
Joining Process Management

Joining Process

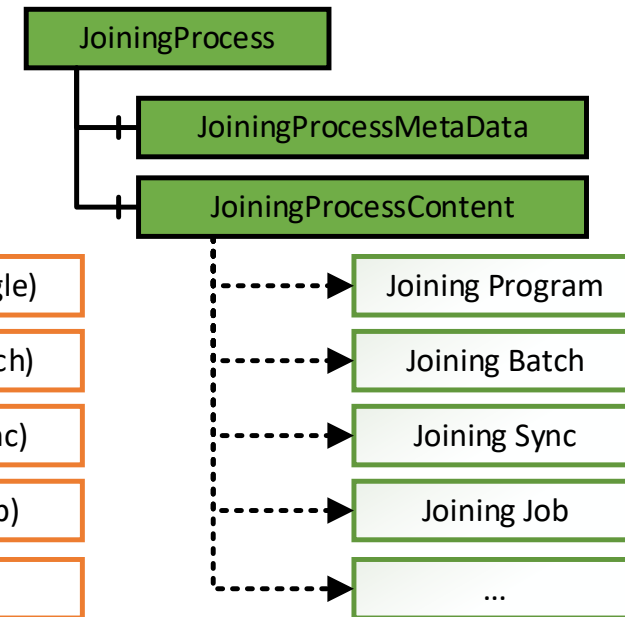
- Generic container for any type of Joining Process.
 - **Examples:** Joining Program, Joining Batch, Joining Job, etc.
- A concrete definition of the process is vendor-specific.
- The specification defines the interface to access the required processes.



RESULT MODEL



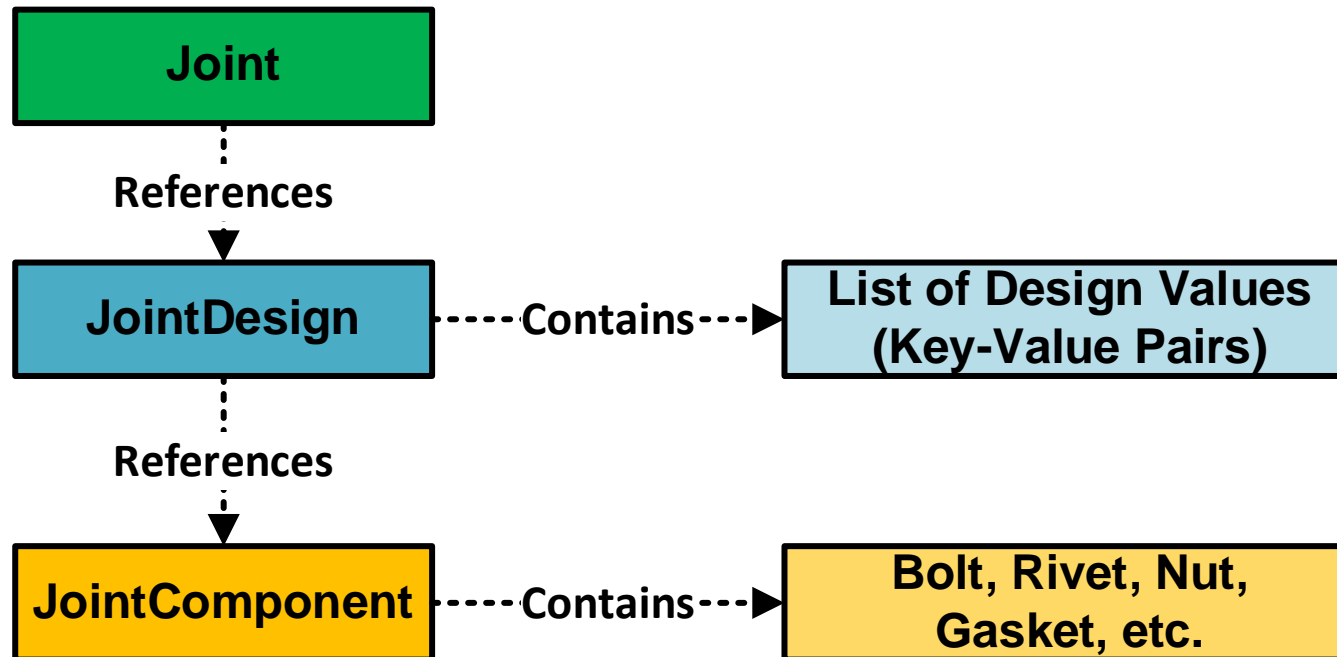
JOINING PROCESS MODEL



Joint Management

Joint Management

- **Use Case:** The user could send information on **what** type of joint needs to be done instead of **how** the joining operation should be executed.
- Definition of Bolt, Rivet is vendor-specific.



Joining System Method List (Commands)

Joining System Method List

Note: Result Management Methods are reused from **Machinery - Result Transfer**.

Asset Management	Result Management	Joining Process Management	Joint Management
SetCalibration	GetLatestResult	SendJoiningProcess	SendJoint
EnableAsset	GetResultById	GetJoiningProcess	SendJointDesign
DisconnectAsset	GetResultIdListFiltered	GetJoiningProcessList	SendJointComponent
RebootAsset	ReleaseResultHandle	GetJoiningProcessRevisionList	GetJointList
SendFeedback		SetJoiningProcessMapping	GetJointRevisionList
GetFeedbackFileList		SelectJoiningProcess	GetJointDesignList
SetOfflineTimer		DeselectJoiningProcess	GetJointComponentList
SetTime		IncrementJoiningProcessCounter	GetJoint
SendIOSignals		DecrementJoiningProcessCounter	GetJointDesign
GetIOSignals		SetJoiningProcessCounter	GetJointComponent
SendIdentifiers		SetJoiningProcessSize	SelectJoint
SendTextIdentifiers		ResetJoiningProcess	DeleteJoint
GetIdentifiers		AbortJoiningProcess	DeleteJointDesign
ResetIdentifiers		StartJoiningProcess	DeleteJointComponent
ExecuteOperation		StartSelectedJoining	
GetErrorInformation		DeleteJoiningProcess	

IJT Profiles Overview

IJT Certification Overview

- OPC UA Specifications define a set of rules that are needed for a product to be certified.
 - It is done using the definition of Conformance Units, Facets and Profiles.
- The following image provides an overview of profiles defined in IJT specifications.

CU/Facet	Facet/Profile
Joining System Base	Basic Joining System Facet
Result Server Facet	
Asset Management Assets Server Facet	
Basic Joining System Facet	General Joining System Facet
Joining Result Server Facet	
Trace Server Facet	
Identifiers Methods Server Facet	
Event Management Server Facet	
Joining Process Base Server Facet	
Result Content	
Result Internal Identifiers	
Result External Identifiers	
Method Input Argument	

Independent Selectable Features
RESULTS
Batch Result Server Facet
Sync Result Server Facet
Job Result
Partial Consolidated Result
Self Contained Consolidated Result
Consolidated Result with references
Result Value FINAL Tag
ASSET METHODS
Asset Connection Server Facet
Enable Tool Server Facet
JOINTS
Joint Server Facet
Joint Design Server Facet
Joint Component Server Facet
JOINING PROCESS
General Process Operations Server Facet
Sequential Process Operations Server Facet
Start Joining Process
MISC.
Engineering Units

References



- **Overview of OPC Foundation and OPC UA**
 - <https://opcfoundation.org/about/opc-technologies/opc-ua/>
- **OPC UA and IJT Overview**
 - <https://opcfoundation.org/markets-collaboration/IJT/>
- **OPC UA IJT Group Presentation:**
 - Refer to the **OPC UA IJT Group Presentation.pdf/pptx**.
 - https://github.com/umati/UA-for-Industrial-Joining-Technologies/tree/main/IJT_Documents
- **Specifications/Online Reference**
 - **Joining:** <https://reference.opcfoundation.org/IJT/Base/v100/docs/>
 - **Tightening:** <https://reference.opcfoundation.org/IJT/Tightening/v200/docs/>
- **OPC UA IJT Prototypes/Reference Implementations**
 - <https://github.com/umati/UA-for-Industrial-Joining-Technologies>

Demonstration

Summary

- Atlas Copco Smart Integrated Assembly Overview
- Role of OPC UA and Standards in the ecosystem
- Industrial Joining Technologies (IJT) Overview
- IJT Working Group Status
- Demonstration

