

## 1. Transfer Mechanism

Date: 2023-09-13

### Status

Accepted

### Context

A transfer mechanism is needed to enable reliable, flexible, and fast state transfer..

### Decision

Open Platform Communications Unified Architecture (OPC UA) will be used to provide a middleware for transferring state quickly and reliably. OPC UA is designed for monitoring industrial devices from workstations, but was lately extended to also support fast, deterministic controller-to-field device communication. OPC UA includes a client/server protocol on top of TCP/IP, as well as a publish/subscribe mechanism on top of UDP. OPC UA address spaces may hold both configuration and sensor data. The Open Process Automation Forum (OPCAF) has identified OPC UA as the core communication mechanism in future open and interoperable industrial control systems. Controllers and certain field devices shall be equipped with OPC UA clients and servers, while legacy field buses shall be integrated via OPC UA gateways.

### Consequences

The only downside is OPC UA is niche protocol. Less open source libraries will support OPC UA. Fewer developers and engineers will know the protocol. More custom code will need to be written and less off the shelf support will be expected.

## 2. Serialization Mechanism

Date: 2023-09-13

### Status

Accepted

### Context

A way to store the state and memory structure before the state is transferred is needed.

## **Decision**

Binary large objects (BLOB) will be used to transfer the application state. A BLOB allows to abstract the internal application memory structure, which is important as the internal memory state structure might be vendor-specific. Hence, using a BLOB instead of structured data, allows to keep the interface of the state transfer service stable for different virtual PLCs. Additionally, it gives the ability to use data compression techniques or encryption

## **Consequences**

Storing data as BLOBs may result in reduced data integrity because there are no constraints or validations applied to the binary data. Structured data can have rules and constraints to maintain data consistency.

# **3. State Transfer Service as K8s Extension**

Date: 2023-09-13

## **Status**

Accepted

## **Context**

A state transfer service is needed to implement the OPC UA client and Virtual PLC Controller.

## **Decision**

A K8 operator (Virtual PLC Operator) running in a pod will be the state transfer service.

## **Consequences**

There is not out of the box K8 operator for this task. A custom pod will need to be developed with OPC UA, open62541, and a webserver.

# **4. Container Virtualization**

Date: 2023-09-13

## **Status**

Accepted

## **Context**

A way to deploy these virtual PLCs is needed.

## **Decision**

We will use containers in the form of Kubernetes pods to orchestrate instances and components which handle the compute and networking needed for the virtual PLC engines and state transfer service.

## **Consequences**

An decrease in perforance in terms of jitter is possible with Docker/Kubernetes pods. SWAP limitations are a concern in embedded environments.