

# Bringing Clouds Down to Earth: Modeling Arrowhead Deployments via Eclipse Vorto

Géza Kulcsár (IncQuery Labs)

Sven Erik Jeroschewski (Bosch.IO)

Kevin Olotu (Bosch.IO)

Johannes Kristan (Bosch.IO)

**Eclipse SAM IoT 2020**  
Security | AI | Modelling



# How to maintain overview on a cloud?

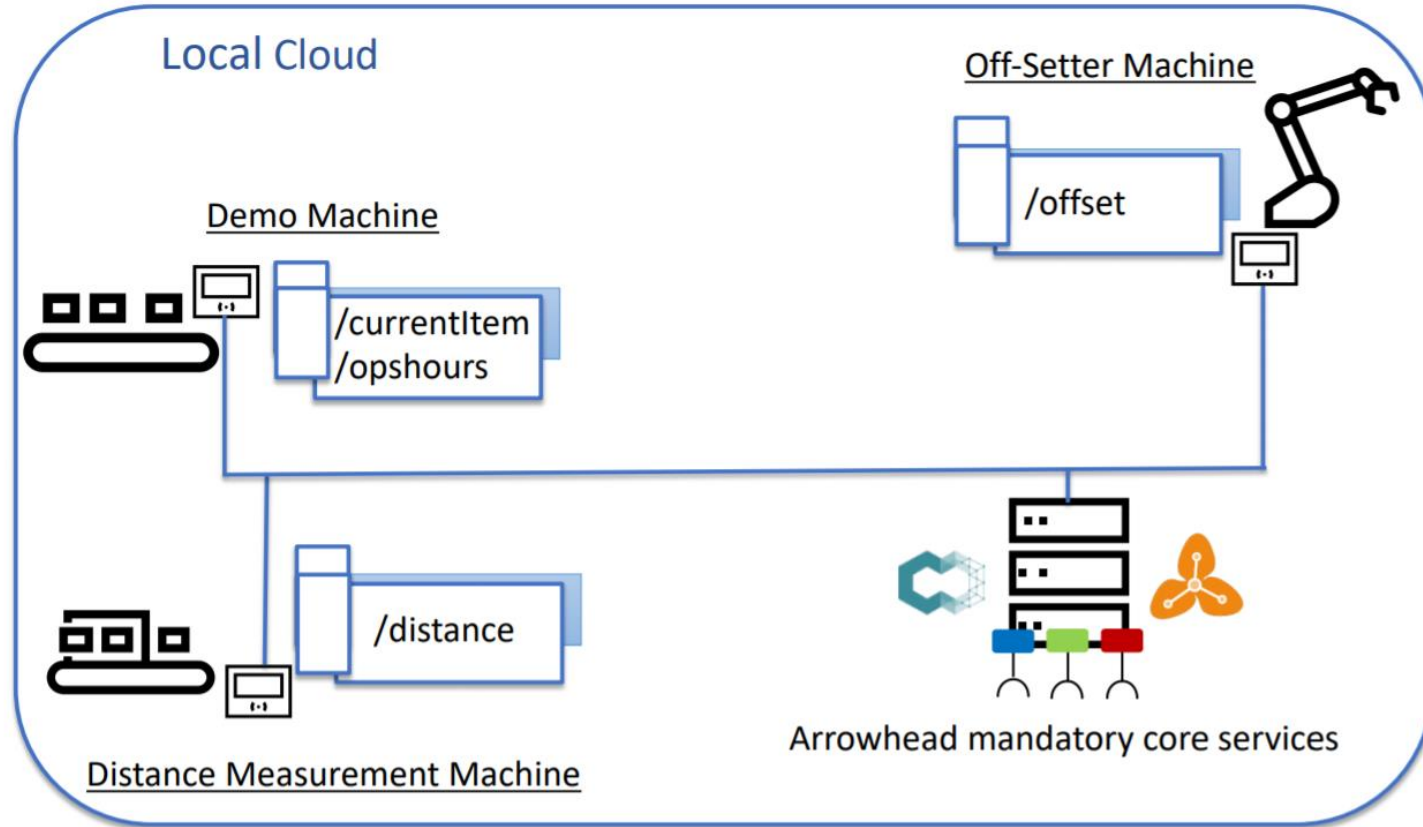


Source: <https://www.br.de/nachrichten/kultur/instagram-caspar-david-friedrich-natur-bilder-aesthetik-kunst,RrnPw2Q>

# The need for bringing clouds down to earth

1. **A high-level engineering design is up in the clouds, while its realization should be down here on earth**
  - One of the main challenges of IoT design is an adequate representation of *System-of-Systems* (SoS)
2. **Adding device models to the design representation allows for representing *real* (i.e., down-to-earth) connections between devices**
  - To be more precise, those are ideal connections between *digital twins*, the other central concept of industrial IoT

# Example: An “Arrowhead local cloud”



# System models: the SysML language

- **SysML is a wide-spread language and standard for systems modeling**
  - Currently established version: **1.6**, the release of version **2**, constituting a major update, is planned in 2021
- **Originally conceived for designing single, monolithic systems**
  - Emerging support for distributed and dynamic scenarios
- **Challenge: will SysML accomodate *System of Systems* (SoS)?**
- **SoSysML exploits one of the most powerful features, profiles for extending the language in a well-founded way**

# Eclipse Arrowhead Vorto

- Eclipse Arrowhead (aka the Arrowhead Framework) is a software platform for operating *dynamic industrial SoS installations*, but without the “earthly details”
- As a recent addition, SoSysML has been proposed as a design-time extension for *designing digital twin models*
- Observation: Eclipse Vorto is an established *device digital twin modeling* approach

# Eclipse Vorto - Tooling

Open Source Project for Semantic Modelling of Digital Twins and their Capabilities

Vorto consists of

- Vortolang: Domain Specific Language to describe Digital Twins
- Repository: Create, manage and distribute models (<https://vorto.eclipse.org>)
- Plugins: Transform Vorto models into something else (source code, request template, other representations)
- Telemetry Payload Mapping: Map the data sent by a device using a mapping specification based on a Vorto model



# Eclipse Vorto - Vortolang

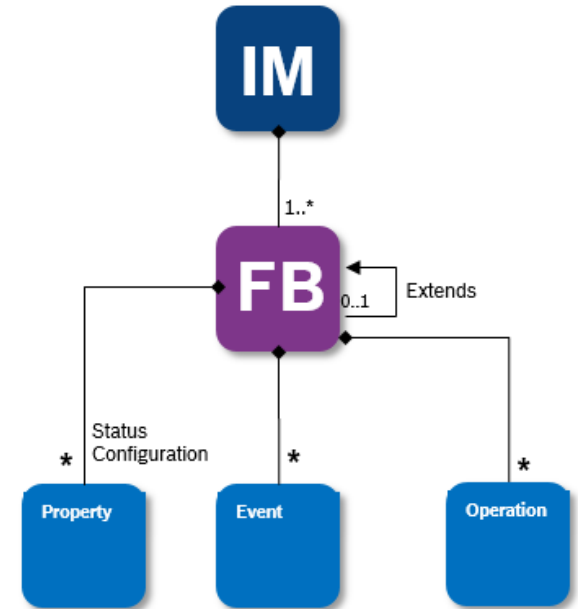
Information Model: describes a digital twin and it's capabilities

Function Block: describes the capabilities that are implemented by the digital twin

- Properties of a Function Block are:
  - Status: describes properties, read-only
  - Configuration: describes properties, read-write
  - Event: describes events emitted by the device
  - Operation: describes a function that can be invoked on the device

Data type: describes complex data types or enumerations that can be assigned to Function Block properties

Mapping: describes platform- / implementation-specific information





# Integration: Eclipse ♥ MagicDraw!

System model authoring  
and integration



Vorto: Device  
modeling



INCQUERYLABS



VIATRA

Underlying model  
handling engine



# Summary and future work

System modeling

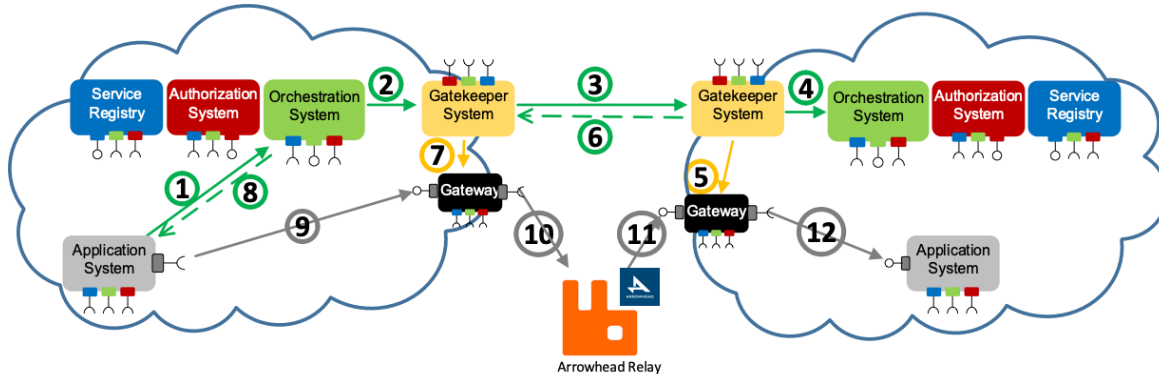


Device modeling



Teamwork Cloud

Eclipse Arrowhead: a comprehensive industrial IoT integration platform



SPONSORED BY THE



Federal Ministry  
of Education  
and Research



PROGRAM  
FINANCED FROM  
THE NRDI FUND

# Thank you for your attention!

The research has received funding from the EU ECSEL JU under the H2020 Framework Programme, JU grant nr. 826452 (Arrowhead Tools project, <https://www.arrowhead.eu>) and from the partners' national funding authorities.

Project no. 2019-2.1.3-NEMZ\\_ECSEL-2019-00003 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the 2019-2.1.3-NEMZ\\_ECSEL funding scheme.

Project no. 16ESE0367 has been implemented with the support from the Federal Ministry of Education and Research of Germany.

