

SAN  $\rightsquigarrow$  SCADA, lessons from MODELSWARD'17

Refinement-Based and Model-Driven Development  
of Service-Oriented SCADA Applications  
from Models of Sensor and Actuator Networks

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**MDE** Model-Driven Engineering

**SAN** Sensor and Actuator Network

**SCADA** Supervisory Control And Data Acquisition

**WS** Web Service

**EE** Electric Engineering

**IT** Information Technology

**PV** Photo-Voltaic

**LED** Light-Emitting Diode

## FUSE-IT (ITEA2 Project)

- build a smart lighting demonstrator
  - PV panels, batteries, LED
  - luminosity and motion sensors
  - manually controlled switches
  - automatically controlled dimmers
- provide SCADA functionality to partners

## Issue: **SAN** and **SCADA** design at the same time

- EE team on SAN, IT team on SCADA
- SAN design continuously evolving
- MDE approach: orthogonal! relevant?

Publication at MODELSWARD'17

**1-step MDE:** SAN design  $\rightsquigarrow$  SCADA implementation

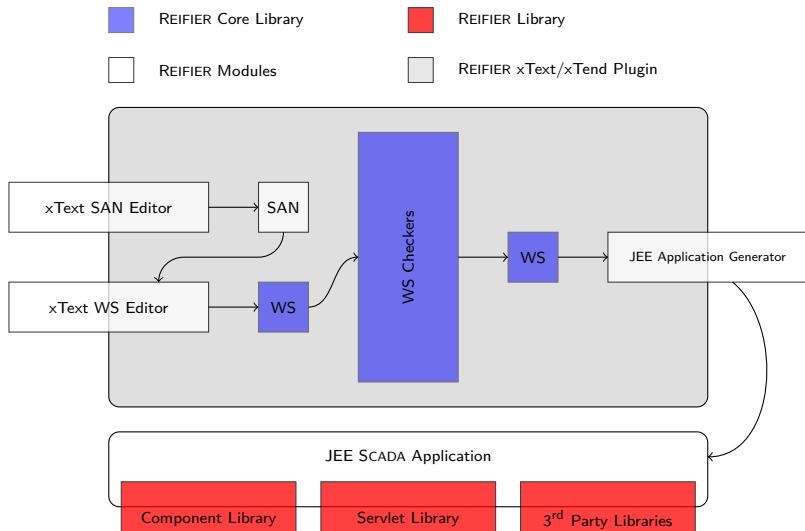
### Benefits

- ✓ SAN models  $\rightarrow$  WS for collecting/providing time-series
- ✓ SAN structure (places, instruments & devices)

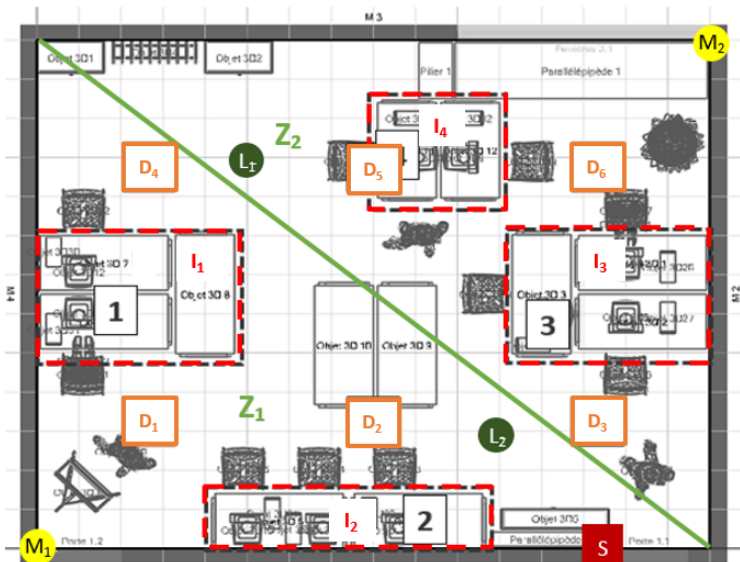
### Drawbacks

- ✗ dependency of WS model elements in SAN models
- ✗ SAN behaviour (processes)

**... Refinement-Based & Model-Driven SAN Engineering**



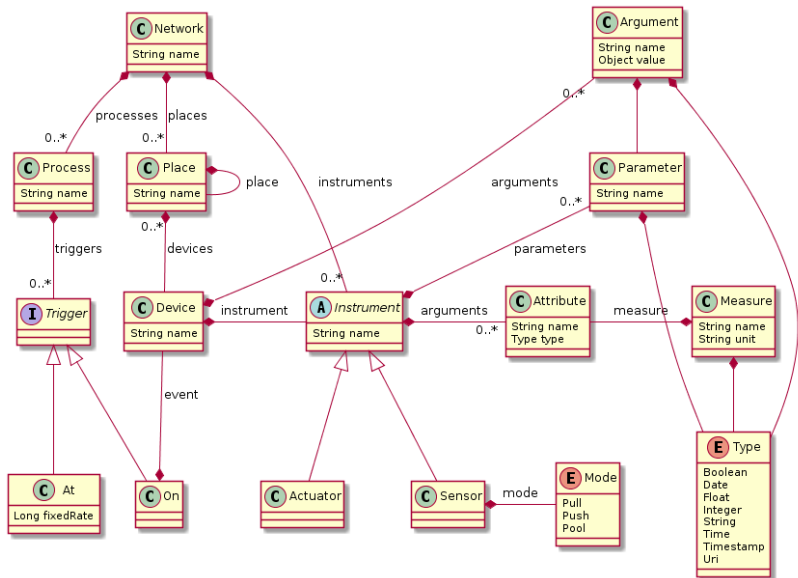
- 1 SAN MetaModel
- 2 WS MetaModel
- 3 SAN to WS Model Mapping

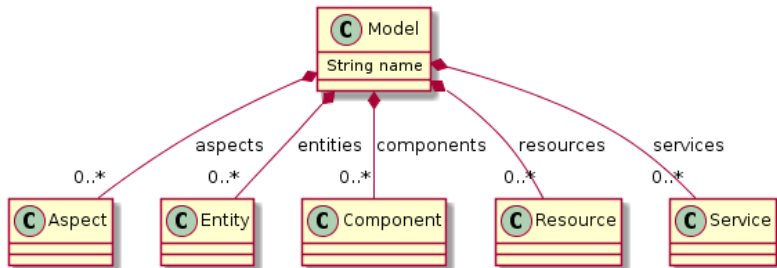


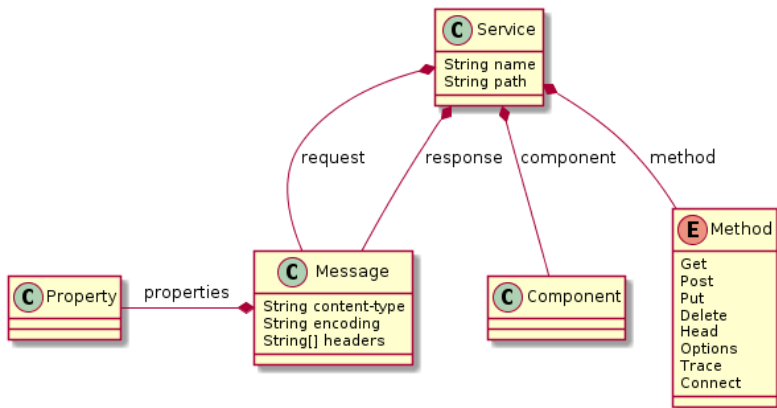
## Requirements

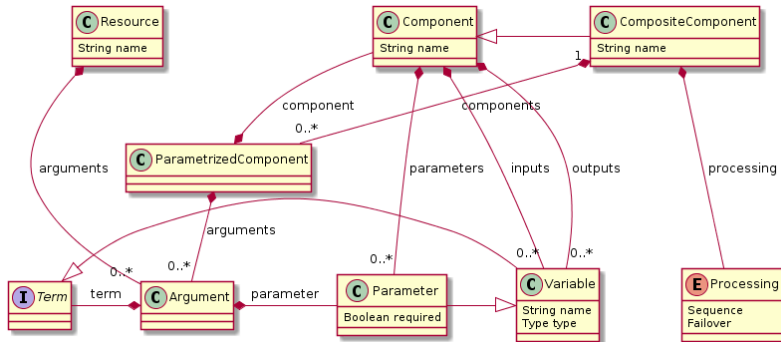
- Nested zones
- Instances of sensors and actuators located into a zone
- Types or models of instruments (sensors, actuators)
- Control command units
  - units of communication
    - retrieve/receive measurements from sensors
    - send commands to actuators
    - receive commands from users
  - units of computation
    - trigger computation on event
    - trigger computation at fixed rate

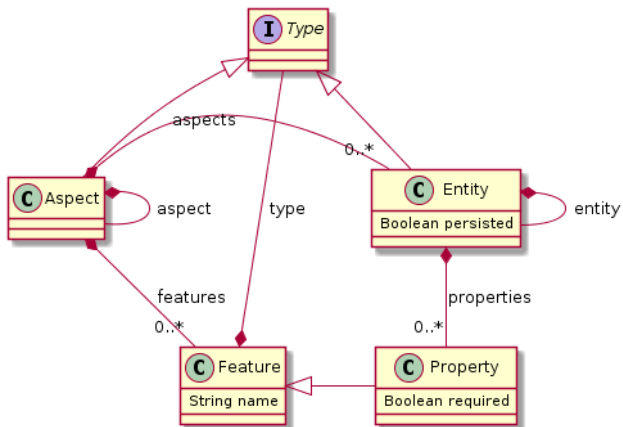




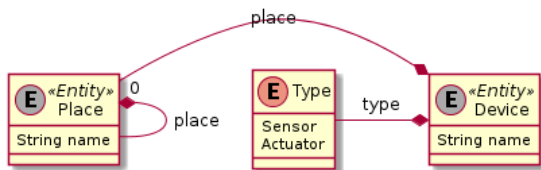








## Fixed Mapping



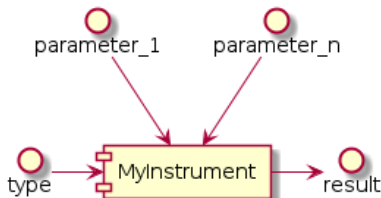
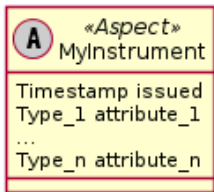
## Services

**/places** (GET) :  $\emptyset \rightarrow \text{list}(\text{Place})$

**/places** (POST) : **Place**  $\rightarrow \text{list}(\text{Place})$

**/devices** (POST) : **Place**  $\rightarrow \text{list}(\text{Device})$

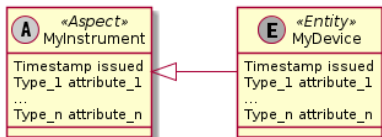
## Mapping of SAN Instruments MyInstrument



## Conditions

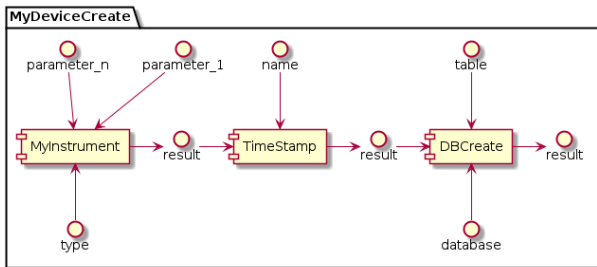
- $\text{type} \in \text{Type}$
- $\text{result} \in \text{type}$

## Mapping of SAN Devices MyDevice of MyInstrument





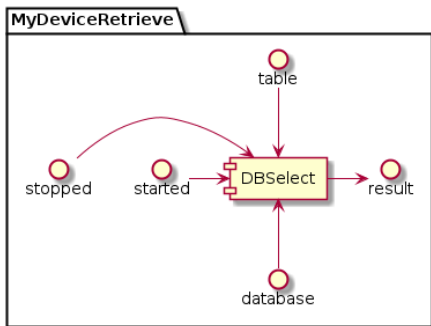
## Mapping of SAN Devices MyDevice of MyInstrument



## Settings

- name = issued
- table = MyDevice

## Mapping of SAN Devices MyDevice of MyInstrument

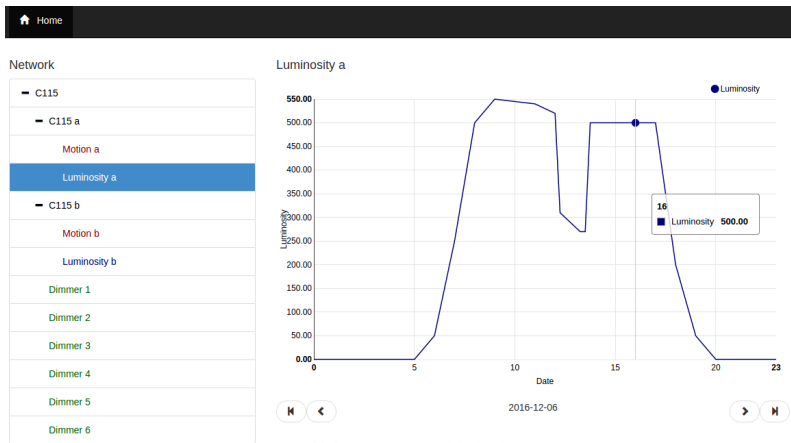


### Settings

- table = MyDevice

## Mapping of SAN Devices MyDevice of MyInstrument

`/mydevice/list` (POST) :  $\text{Timestamp}^2 \rightarrow \text{list}(\text{MyInstrument})$



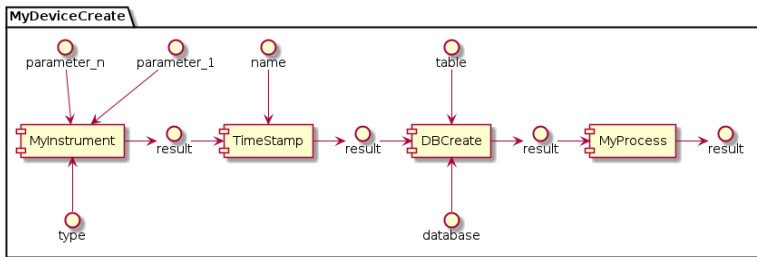
## Mapping of SAN Devices MyDevice of MyInstrument Services or Activities based on MyDevice.mode

**/mydevice/push** (POST) : MyInstrument  $\rightarrow$   $\emptyset$

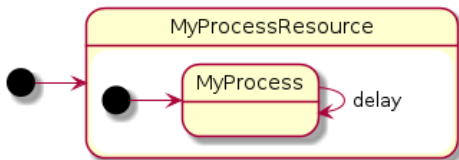
**/mydevice/pull** (NONE) :  $\emptyset \rightarrow$  (MyInstrument)  $\rightarrow$   $\emptyset$

**/mydevice/pool** (LOOP) :

## Mapping of SAN Process MyProcess on event MyDevice



## Mapping of SAN Process MyProcess at fixed rate delay



**Thank you!**