

Performance evaluation of BaSyx based Asset Administration Shells for Industry 4.0 Applications

Christian Sauer and Holger Eichelberger

`{sauer,eichelberger}@sse.uni-hildesheim.de`

Software Systems Engineering
University of Hildesheim

`www.sse.uni-hildesheim.de`

Gefördert durch:



Bundesministerium
für Wirtschaft
und Energie

Content

1. Motivation	3
2. Background	4
3. Contribution	5
4. Approach	6
5. Experiment and Results	7
6. Conclusion	13
7. Future Work	14

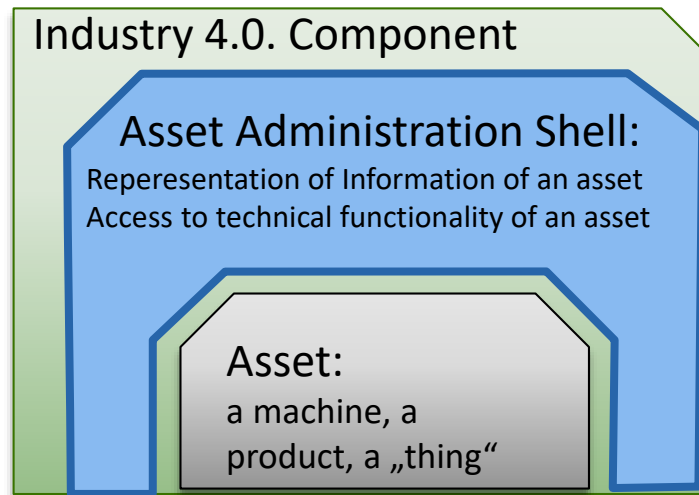
Motivation

- Interoperability and information exchange in IIoT/Industry 4.0.
- Currently several proprietary information models in different IIoT-platforms exist, increasing complexity and costs for IIoT/Industry 4.0 integration.
- Asset Administration Shell (AAS) is an upcoming information model standard for IIoT/Industry 4.0.
- BaSyx middleware for AAS: Exploring the capabilities and performance of BaSyx-based AAS, consideration for IIP-Ecosphere

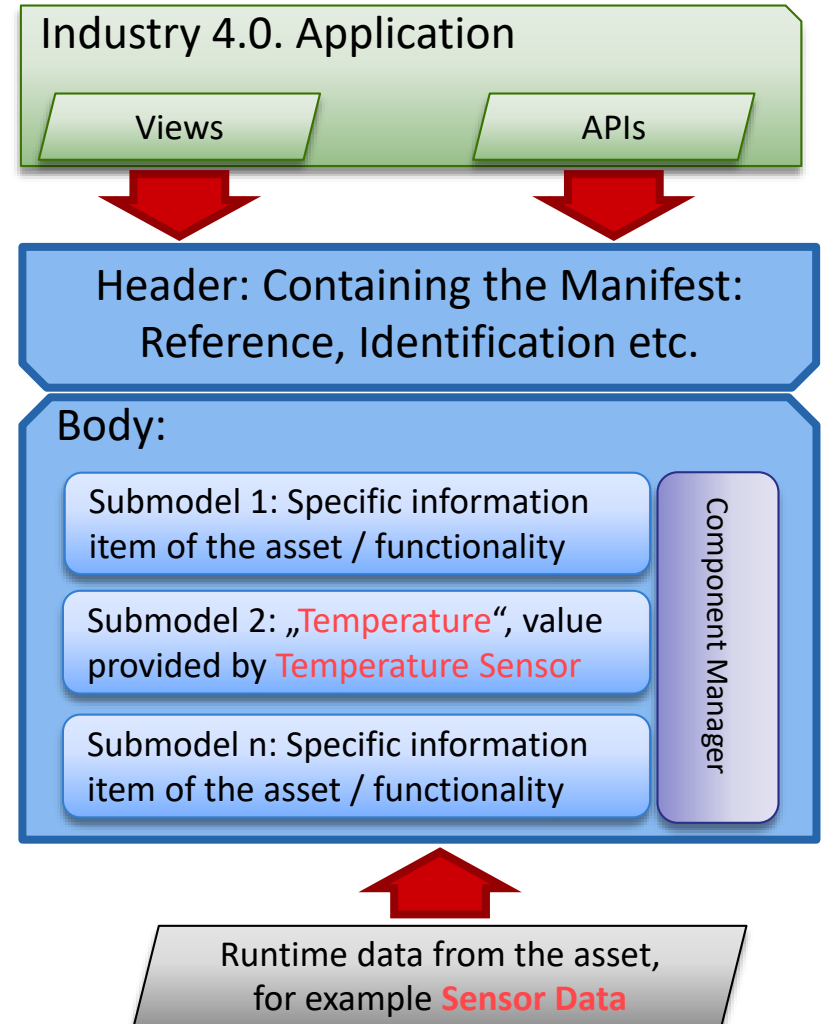


Background

Asset Administration Shell: Purpose and structure



=



Based on Source: ZVEI

Contribution

- We present an evaluation of the performance scalability of BaSyx-based AAS
- Evaluated BaSyx-based AAS:
 - Local AAS
 - Network-connected AAS
 - Scale between 1 and 100 AAS
 - Scale between 10 to 1000 AAS submodels

Evaluation of the performance scalability of BaSyx-based AAS

Based the initial examples of local and network- connected AAS from BaSyx we created 4 Experiments:

- 2 Experiments to evaluate local AAS:
 - 1 local AAS with 10 to 1000 sensor-submodels
 - 100 local AAS with 10 to 1000 sensor-submodels each
- 2 Experiments to evaluate network-connected AAS:
 - 1 network-connected AAS with 10 to 1000 sensor-submodels
 - 100 network-connected AAS with 10 to 1000 sensor-submodels each

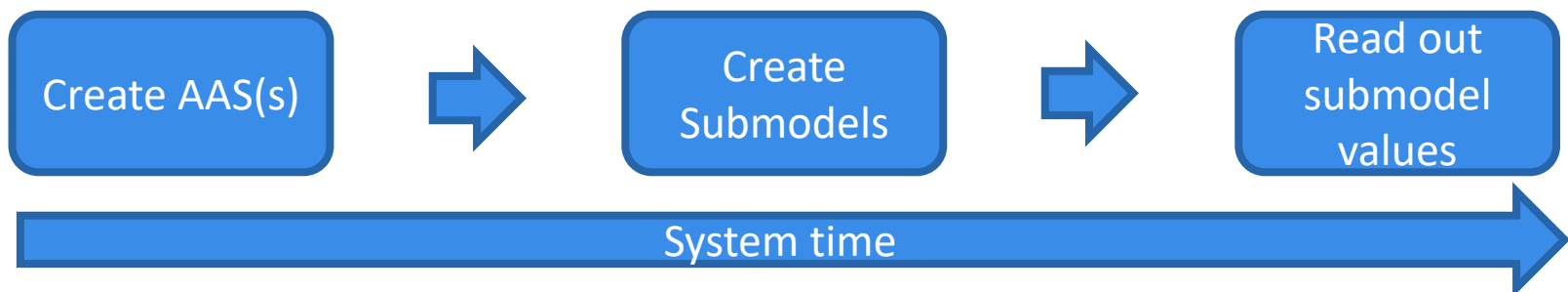
Experiment and Results

- BaSyx state at January 2022
- Standard PC with an Intel(R) Core(TM) i7-8665U CPU 1.90GHz and 32 GB RAM
- OS: Windows 10 professional
- Eclipse IDE for Enterprise Java and Web Developers, version 2022-06 (4.24.0)
- Java Development Kit (JDK) version 15
- Apache-Tomcat Server version 9.0
- Compensated for fluctuations by performing each measurement 10 times

Experiment and Results

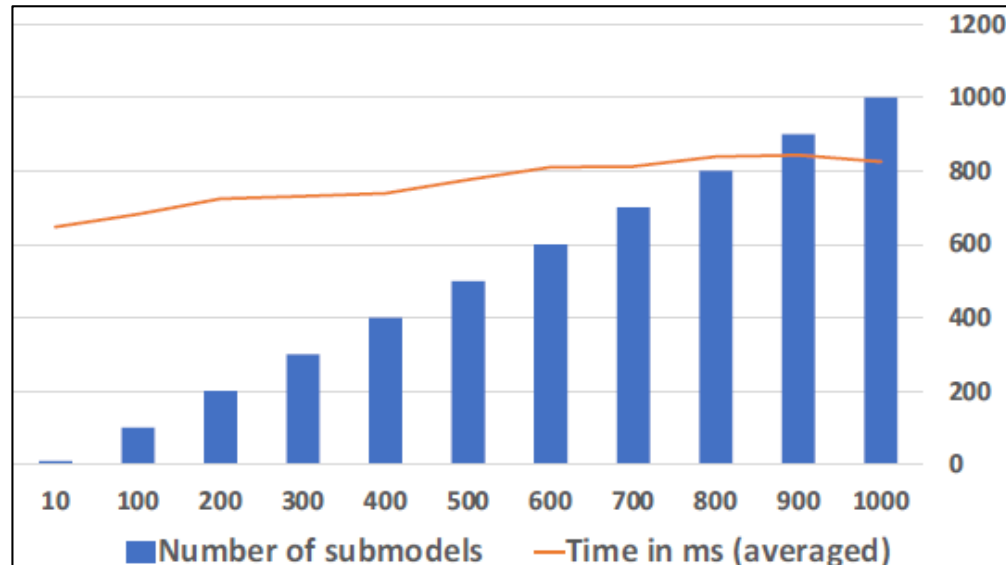
Experiments procedure:

- Measure system time to create first 1 then 100 AAS and their subsequent 10 to 1000 sensor-submodels.
- Always 11 iterations, start: 10 sensor-submodels, then 10 iterations from 100 to 1000 sensor-submodels.
- The measurement was as follows:



Experiment and Results

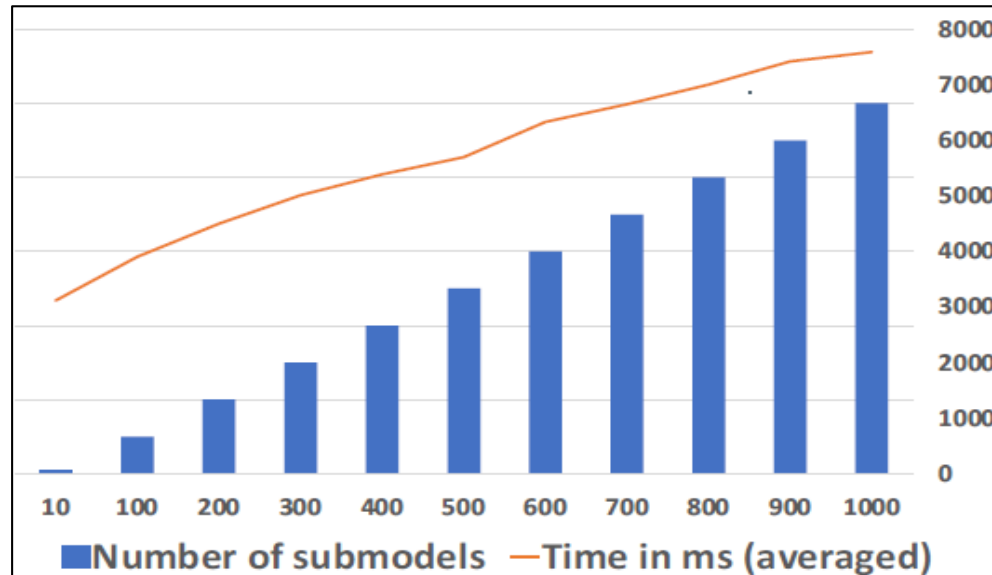
E1: 1 local AAS with 10 to 1000 sensor-submodels



- Time for generation 1 AAS and subsequently increasing number of sensor-submodels stayed level.
- Scaling the number of sensor-submodels for a single AAS had no significant performance impact.

Experiment and Results

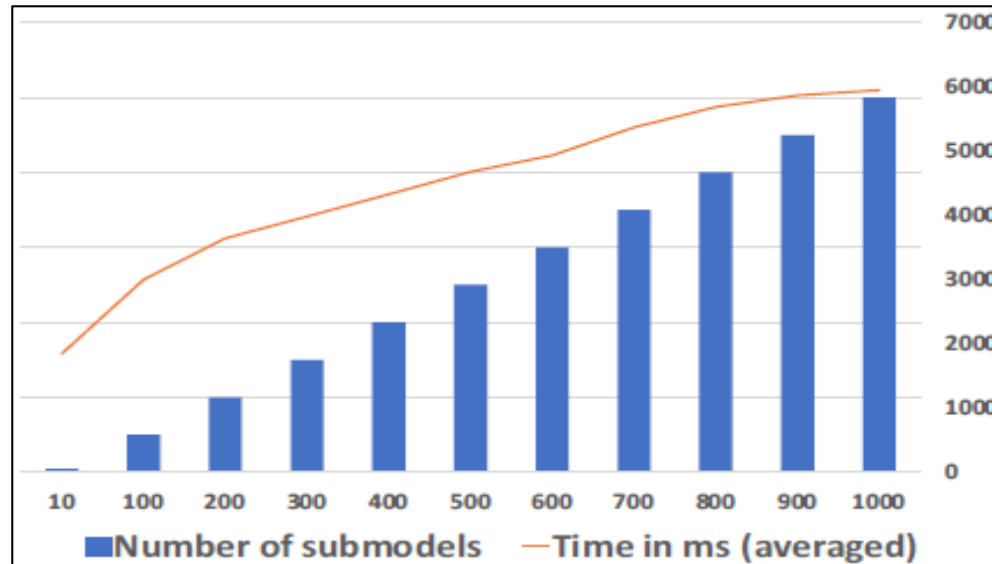
E2: 100 local AAS with 10 to 1000 sensor-submodels each



- Time for generation of 100 AAS and subsequently increasing number of sensor-submodels increased, as expected.
- Scaling the number of sensor-submodels showed an almost linear increase, up to 100000 sensor-submodels

Experiment and Results

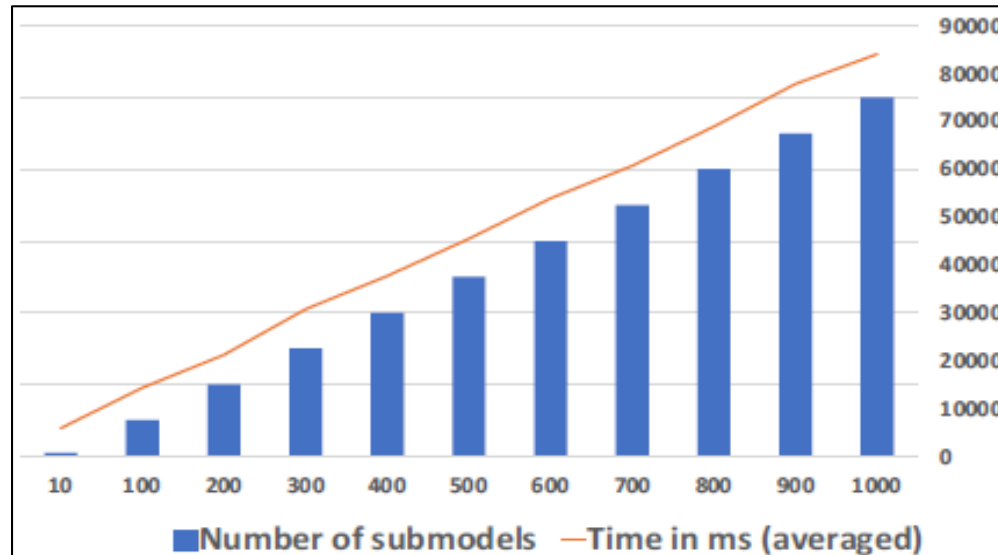
E3: 1 network-connected AAS with 10 to 1000 sensor-submodels



- Significant increase in effort for network-connected AAS
- Increase in effort prominent within the first 400 AAS
- More linear increase in effort past 400 AAS, similar to experiment 2

Experiment and Results

E4: 100 network-connected AAS 10 to 1000 sensor-submodels each



- 100-fold increase in scale: 100 network-connected AAS
- Scaling the number of sensor-submodels in the networked environment showed a very clear linear increase in effort.

Conclusion

Based on our experimental results we conclude that:

- The use of BaSyx-based AAS, passive as well as active AAS, scales well, even in larger numbers
- The application of BaSyx-based AAS is well suited for the anticipated industrial-scale dimensions of using AAS
- The application of BaSyx is very accessible
- Limitation:
 - We used a limited set of artificial experiments
 - We excluded deleting AAS or submodels
- Zenodo Link <https://zenodo.org/deposit/7180716>

Future Work

- Explore the scalability of realworld AAS implemented with BaSyx, instead of artificial example AAS
- Explore the performance of BaSyx-based AAS within the IIP-Ecosphere platform
- Further performance evaluations of active AAS features



IIP-Ecosphere

Next Level Ecosystem for
Intelligent Industrial Production

