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PhD Activities 2019/2020

PON R&I 2014-2020

Phd student in Systems, Energy, Computer and Telecommunication Engineering – XXXIII cycle

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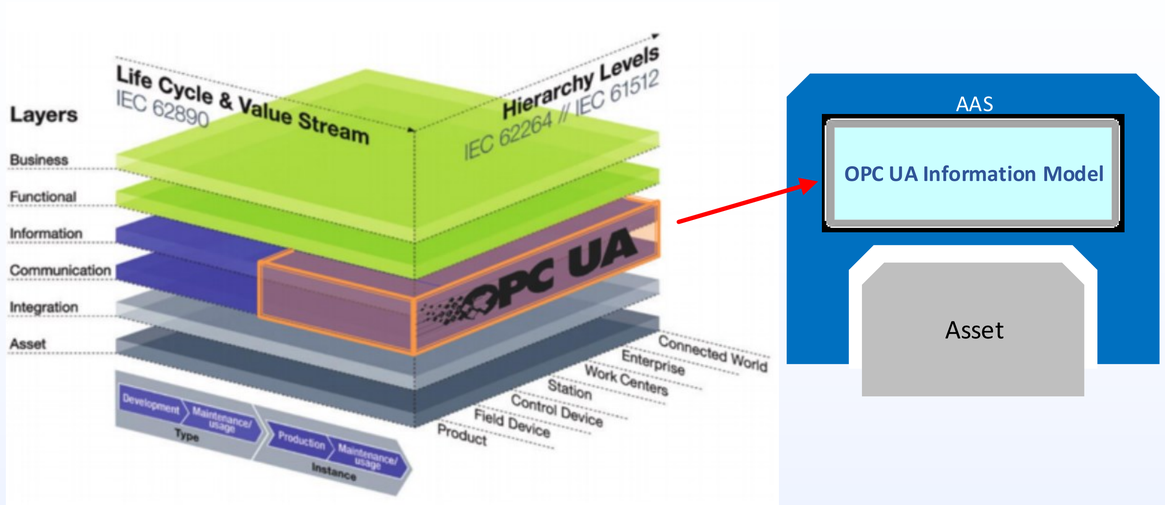
PhD Brainstorming day - 9 October 2018, University of Catania

Industry 4.0 Asset Administration Shell using OPC UA



Reference Architecture Model for Industrie 4.0 (RAMI4.0) defines the Asset Administration Shell (AAS) as the corner stone of the interoperability between application managing manufacturing systems. In particular, an Asset Administration Shell:

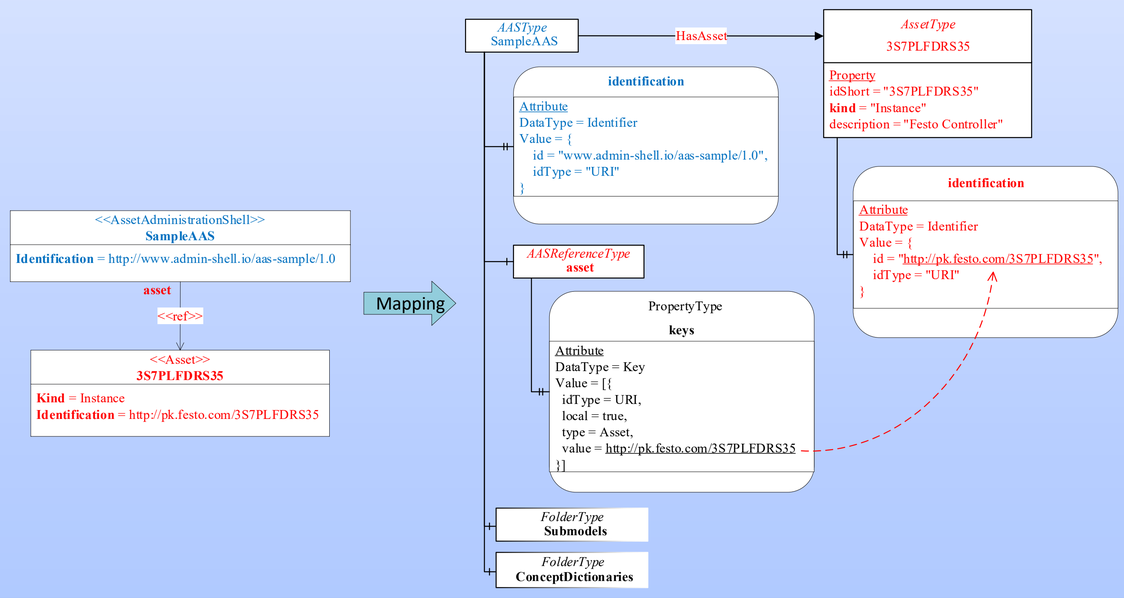
- contains all **information, data and artifacts** related to an asset in a structured manner for its whole life cycle.
- allows assets to cooperate between each other by means of **standardised interfaces and services**.

The proposal consists in adopting OPC UA as reference technology to expose all data in the AASs. Administration Shells can be serialized (XML, JSON) and packeged (.aasx) so they can be exchanged and used in development and production phases by different partners in a value-chain network.

Mapping AAS metamodel in OPC UA

A consistent mapping between the metamodel of the serialized AAS and OPC UA Information Model is needed to create an OPC UA Server representing real AASs. Our proposal defines mapping rules and new OPC UA ObjectType and ReferenceTypes in order to maintain the same internal structure and relationships of the AAS.

Inconsistencies between models are completely covered in our proposal, e.g. template mechanism in metamodel is converted in aggregation of Object instances in the Information Model.



Seamless OPC UA-based AAS deploy

With a consistent Information Model it was possible to define a tool (AAS CLI) able to parse an XML-serialized AAS and automatically deploy an OPC UA Server containing the AAS in its AddressSpace. This process is done in a seamless way, without human intervention.

This very important proof of concept shows how is possible exchange static AASs between partners and make them accessible on-site by means of the ServiceSets provided by OPC UA. Furthermore, configuration data inside Submodels of the AAS can be used to create connections between OPC UA and real process variables.

XML-Serialized AAS

```
<aas:assetAdministrationShell>
    <aas:identification idType="URI">www.admin-shell.io/aas-sample/1/0</aas:identification>
    <aas:administration>
      <aas:version>1</aas:version>
      <aas:revision>0</aas:revision>
    </aas:administration>
    <aas:assetRef>
      <aas:keys>
        <aas:key type="Asset" local="false" idType="URI">http://pk.festo.com/3s7plfdrs35</aas:key>
      </aas:keys>
    </aas:assetRef>
    <aas:submodelRefs>
      <aas:submodelRef>
        <aas:keys>
          <aas:key type="Submodel" local="true" idType="URI">http://www.zvei.de/demo/submodel/12345679</aas:key>
        </aas:keys>
      </aas:submodelRef>
    </aas:submodelRefs>
    <aas:views>
      <aas:view>
        <aas:idShort>SampleView</aas:idShort>
        <aas:containedElements>
          <aas:containedElementRef>
            <aas:keys>
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              <aas:key type="Property" local="true" idType="idShort">rotationSpeed</aas:key>
            </aas:keys>
          </aas:containedElementRef>
        </aas:containedElements>
      </aas:view>
    </aas:views>
    <aas:conceptDictionaries>
      <aas:conceptDictionary>
        <aas:idShort>SampleDic</aas:idShort>
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            </aas:keys>
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          <aas:conceptDescriptionRef>
            <aas:keys>
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            </aas:keys>
          </aas:conceptDescriptionRef>
        </aas:conceptDescriptionRefs>
      </aas:conceptDictionary>
    </aas:conceptDictionaries>
</aas:assetAdministrationShell>
```
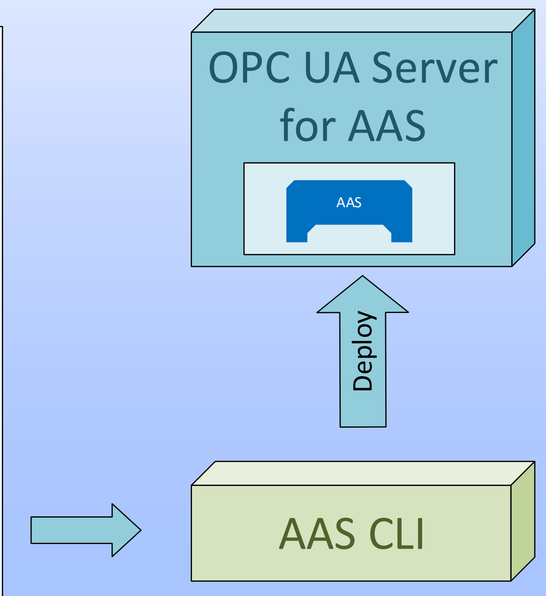



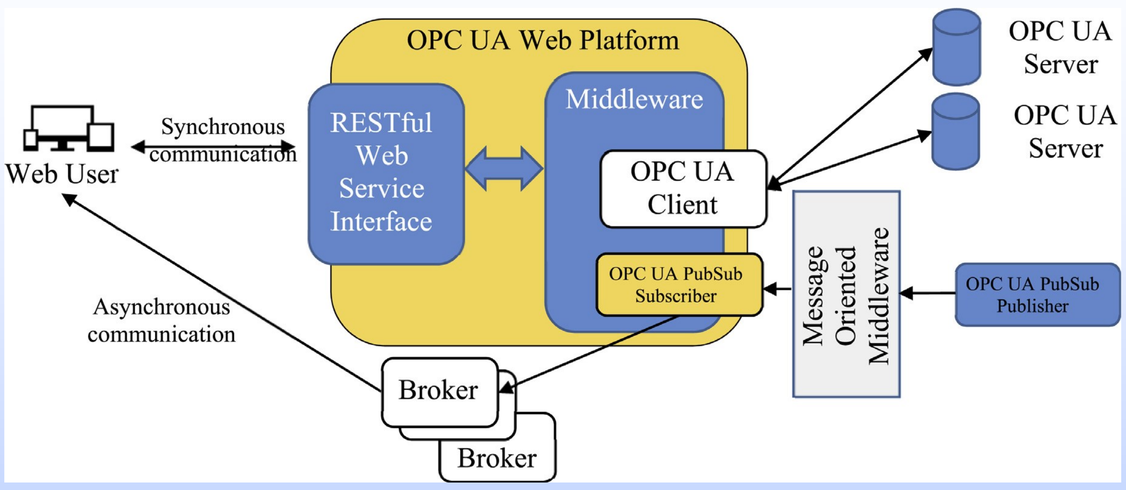
Publications

Cavalieri S, Mulè S, Salafia M G (2018). ***OPC UA-based Asset Administration Shell***. Proceedings of IECON 2019, IEEE 45th Annual Conference of the Industrial Electronics Society , 14-17 October 2019, Lisbon (Portugal).

Cavalieri S, Salafia M G (2018). ***OPC UA-based Information Model for the Asset Administration Shell in Industry 4.0.*** *"IEEE Access" Journal* **

**Submitted and under review

Enhance interoperability in Industry 4.0 using OPC UA and Web technologies



OPC UA Web Platform allows devices not compliant with the OPC UA technology to access data inside an OPC UA Server using simple web technologies. IoT technologies like MQTT and SignalR are adopted for M2M communication in a Publisher-Subscriber fashion.

Features of the Platform

- **Secure Access:** Authentication by means of JWT
- **Stateless communication:** No Session management in the interaction with the Platform
- **Address Space Browsing:** explore multiple OPC UA Address Spaces.
- **Node reading:** read the state of an OPC UA Node
- **Node writing:** write the value of an OPC UA Variable
- **Monitoring:** used to monitor the change in the value of an OPC UA Variable
- **No OPC UA Knowledge required:** constrained device can access OPC UA Information without being OPC UA-compliant

Publications

Cavalieri S, Di Stefano D, Salafia M G, Scroppo M S (2017). *Integration of OPC UA into a Web-based Platform to enhance interoperability*. Proceedings of ISIE 2017, 26th IEEE International Symposium on Industrial Electronics, 19-21 June 2017, Edinburgh (Scotland, UK)

Cavalieri S, Di Stefano D, Salafia M G, Scroppo M S (2017). *A Web-based Platform for OPC UA integration in IIoT environment*. Proceedings of ETFA 2017, 22nd IEEE International Conference on Emerging Technologies And Factory Automation September 12-15, 2017, Limassol (Cyprus)

Cavalieri S, Di Stefano D, Salafia M G, Scroppo M S (2017). *OPC UA integration into the Web.* Proceedings of IECON 2017, 43rd Annual Conference of the IEEE Industrial Electronics Society, October 29 - November 1 2017, Beijing (China)

Cavalieri S, Salafia M G, Scroppo M S (2018). *Integrating OPC UA with Web Technologies to Enhance Interoperability.* "Computer Standards and Interface" Journal