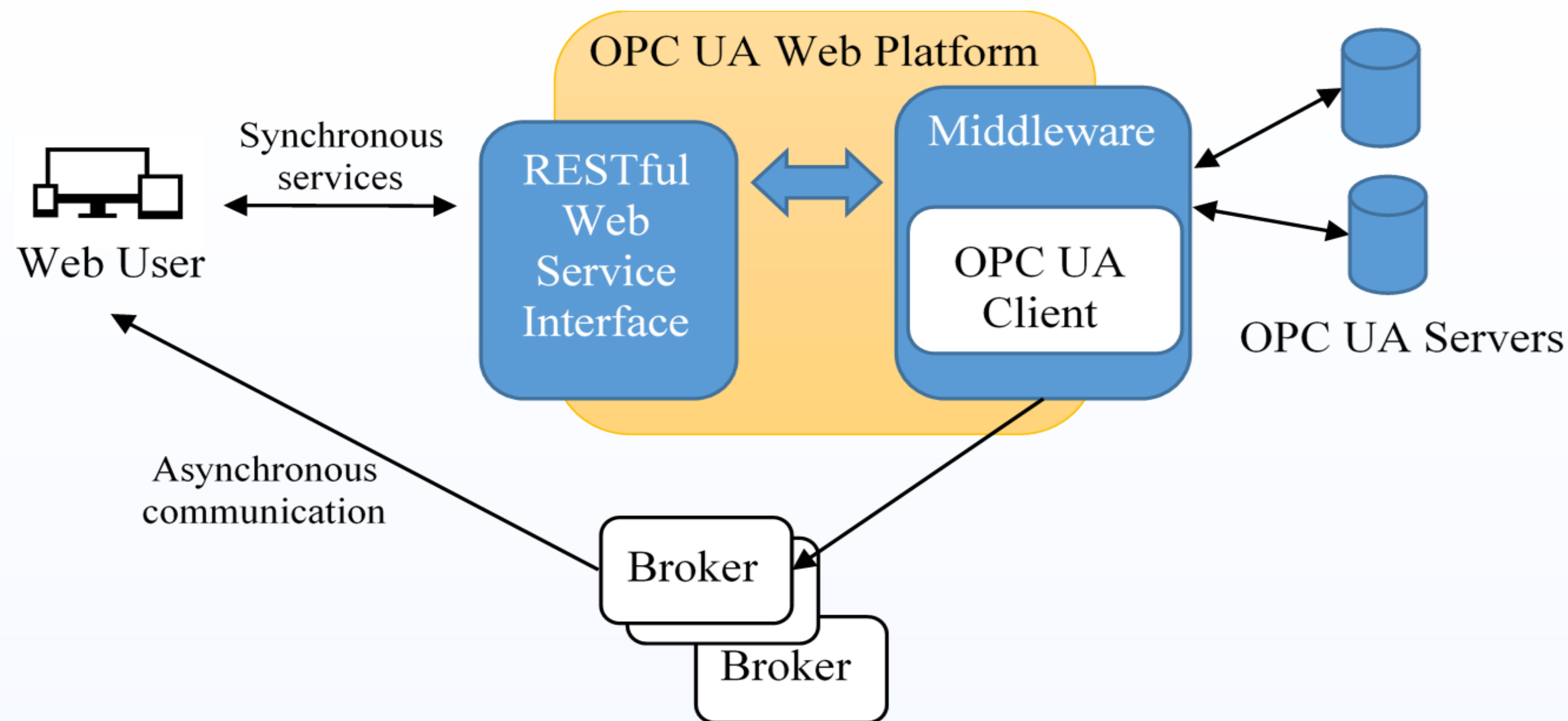


Enhancing Interoperability in Industry 4.0

The objective of the research is the investigation about the enhancement of interoperability in Industry 4.0, IoT and IIoT and to propose some improvements based on OPC UA. In particular, two proposal has been provided:

- **OPC UA Web Platform:** a proposal of Network Interoperability opening OPC UA to the Web. The proposal is based on the definition of a RESTful web platform able to offer access to OPC UA Servers.
- **Mapping between OPC UA and OCF:** a proposal of Syntactical Interoperability based on the integration of OPC UA and IIoT World through a bidirectional mapping between OPC UA Information Model and OCF Resource Model.

OPC UA Web Platform



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

Service	RESTful Resource	HTTP Method	Description
Authentication	/authenticate	POST	Return the authentication token
Read Root	/data-sets/{dataset-id}/nodes/	GET	Returns the entry point of a given data set
Read Node	/data-sets/{dataset-id}/nodes/{node-id}	GET	Returns the state of a given Node
Write Value	/data-sets/{dataset-id}/nodes/{node-id}	POST	Update the value of a given Node (only for a Variable)
Start Monitor	/data-sets/{dataset-id}/monitor	POST	Start monitoring the value of variable nodes
Stop Monitor	/data-sets/{dataset-id}/stop-monitor	POST	Stop monitoring monitored node

OPC UA Web Platform has been implemented and the relevant source code is available on GitHub [<https://github.com/OPCUAUniCT/OPCUAWebPlatformUniCT>]

OPC UA Web Platform Publications

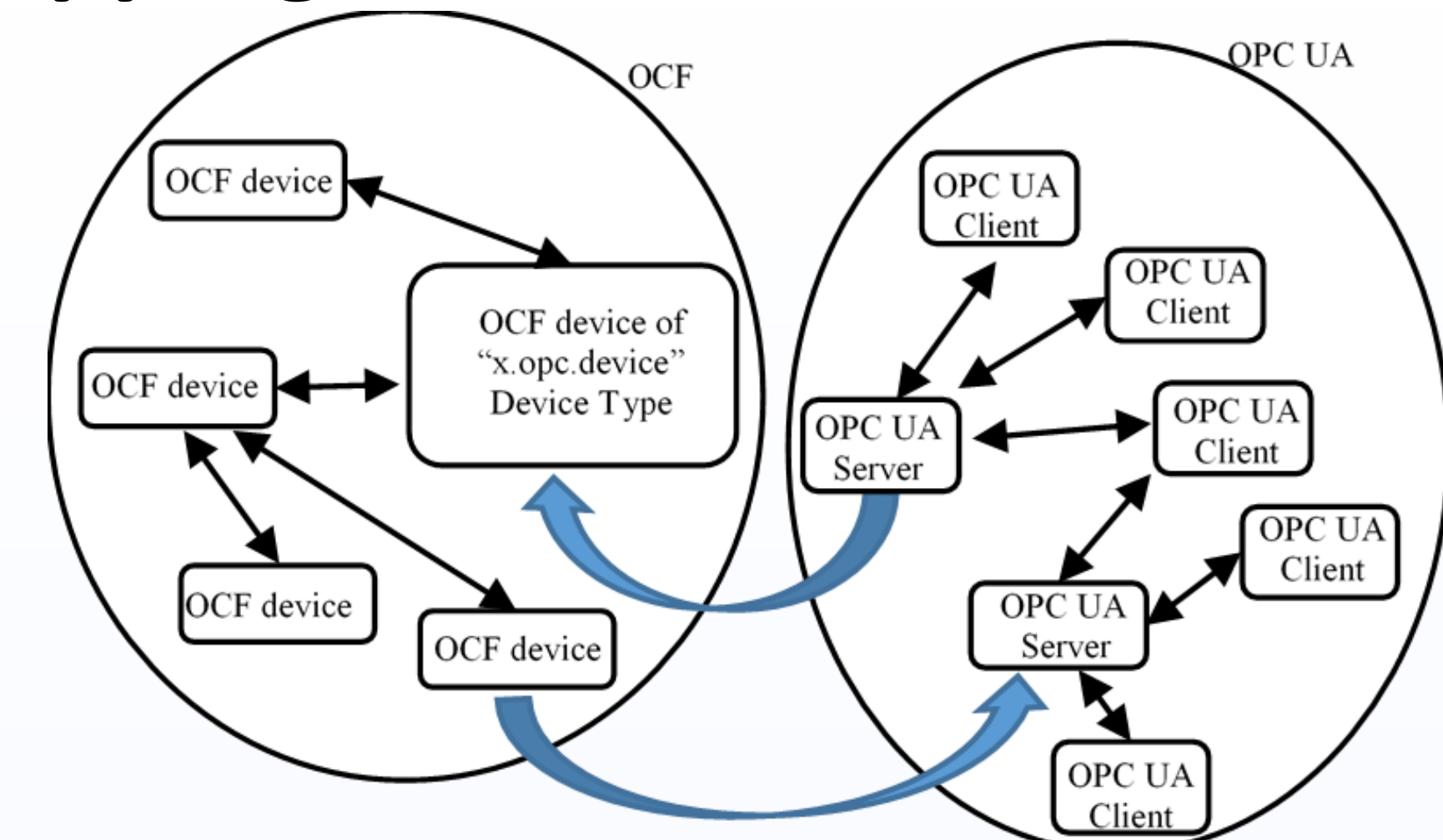
Cavalieri S, Di Stefano D, Salafia M G, Scroppo M S (2017). *Integration of OPC UA into a Web-based Platform to enhance interoperability*. Proceedings of ISIE 2017, 26th IEEE International Symposium on Industrial Electronics, 19-21 June 2017, Edinburgh (Scotland, UK)*

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, Scroppo M S (2017). *Integrating OPC UA with Web Technologies to Enhance Interoperability*. "Computer Standards and Interface" Journal

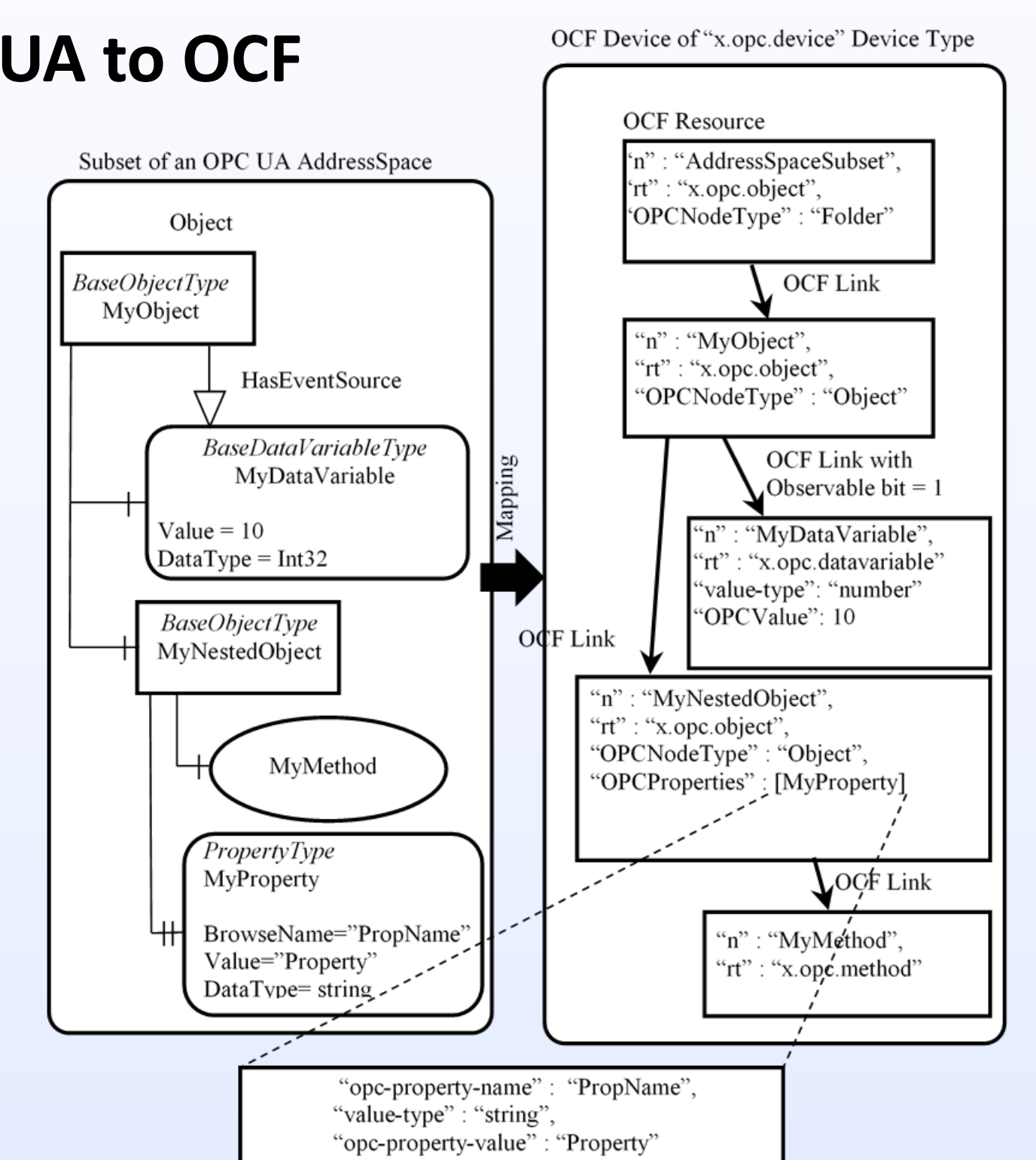
Mapping between OPC UA and OCF



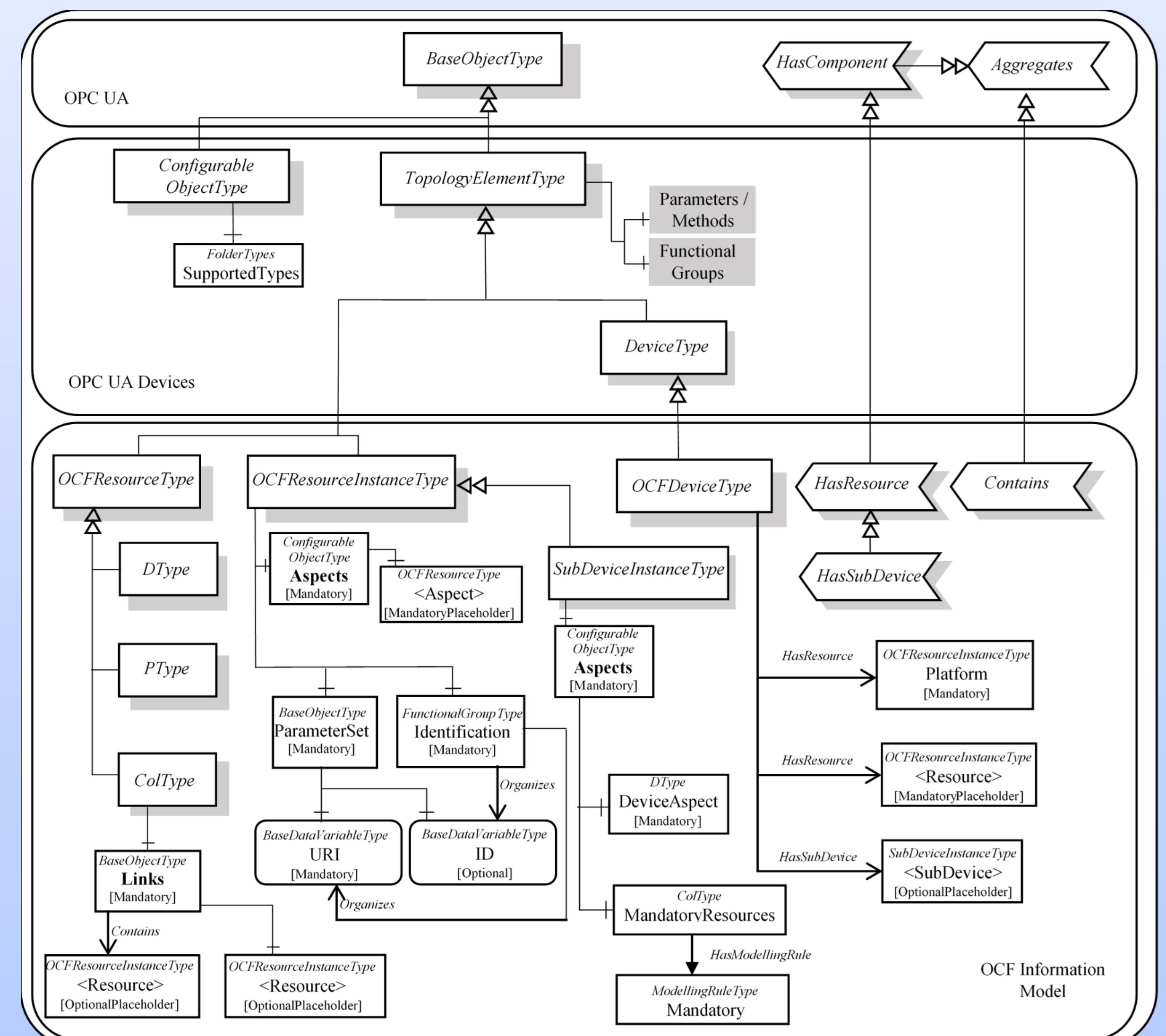
From OPC UA to OCF

Based on the definition of an ad-hoc OCF Device Type named "x.opc.device" Device Type. A Device of this type is made up by several OCF Resources representing OPC UA Nodes. Each Resource belongs to one of three ad-hoc defined Resource:

- **"x.opc.object"** mapping OPC UA Object Nodes.
- **"x.opc.datavariab"** mapping OPC UA DataVariable Nodes.
- **"x.opc.method"** mapping OPC UA Method Nodes.



From OCF to OPC UA



Mapping between OPC UA and OCF Publications

Cavalieri S, Salafia M G, Scroppo M S (2018). Realising Interoperability between OPC UA and OCF. "IEEE Access" Journal **

Cavalieri S, Salafia M G, Scroppo M S (2018). Towards interoperability between OPC UA and OCF. "Journal of Industrial Information Integration" Journal **

Cavalieri S, Salafia M G, Scroppo M S (2018). Interoperability between OPC UA and OCF. Submitted and under review in ICIT 2019, 20th International Conference on Industrial Technology, 13-15 February 2019, Melbourne (Australia). **

Cavalieri S, Scroppo M S (2018). A proposal to make OCF and OPC UA interoperable. Proceedings of ICIT 2018, 19th International Conference on Industrial Technology, 20-22 February 2018, Lyon (France).*

Cavalieri S, Salafia M G, Scroppo M S (2018). Mapping OPC UA AddressSpace to OCF resource model. Proceedings of ICPS 2018, 1st International Conference on Industrial Cyber-Physical System, 15-18 May 2018, Saint-Petersburg (Russia).*

* Attendance and presentation of the work at the conference

** Submitted and under review