



Finding an Open Least Common Denominator for Live Integration of Non-space-system-standard Components within Constraint Budgets

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Outline



- **Context**
- **Run-time Integration**
- **Choices & Experiences**
- **Message-oriented Middleware**
- **Conclusion**

Context

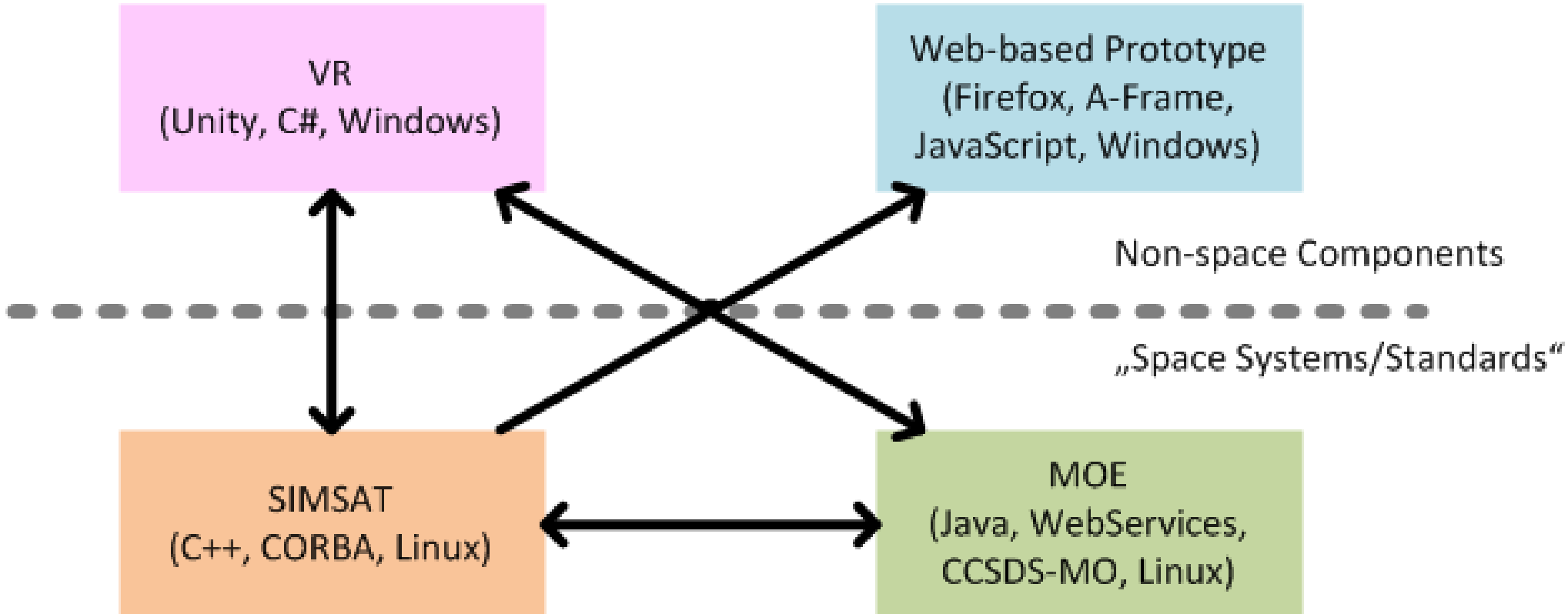


- **Two ESA Studies**
 - Improve ESA Operations & Ground Systems with
 - a) Virtual Reality
 - b) Augmented Reality
- **Ground Segment**
- **Software Systems**
 - ESA Software Systems
 - Mission Control System, Simulator
 - Third-party Systems
 - Virtual Reality, Augmented Reality
- **Constraint Budgets**

Context



- **Virtual Reality (VR) Study**



Run-time Integration



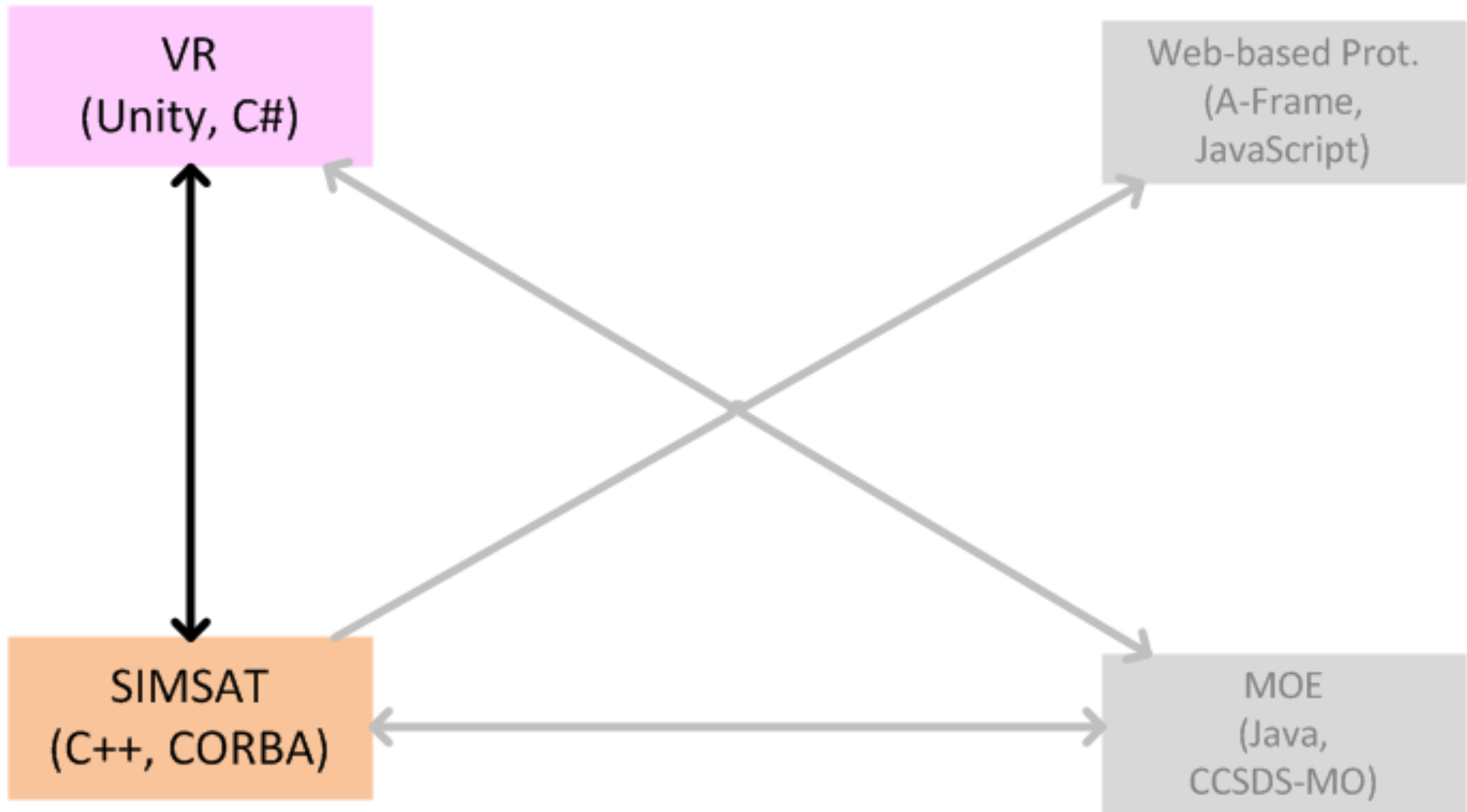
- **Communication Infrastructure/Middleware**
 - E.g., Sockets, CORBA, RMI, Message-oriented Middleware, ...
- **Serialization/Data Representation**
 - E.g., Protocol Buffers, XML, JSON, CORBA, ...

Run-time Integration, Trade-offs

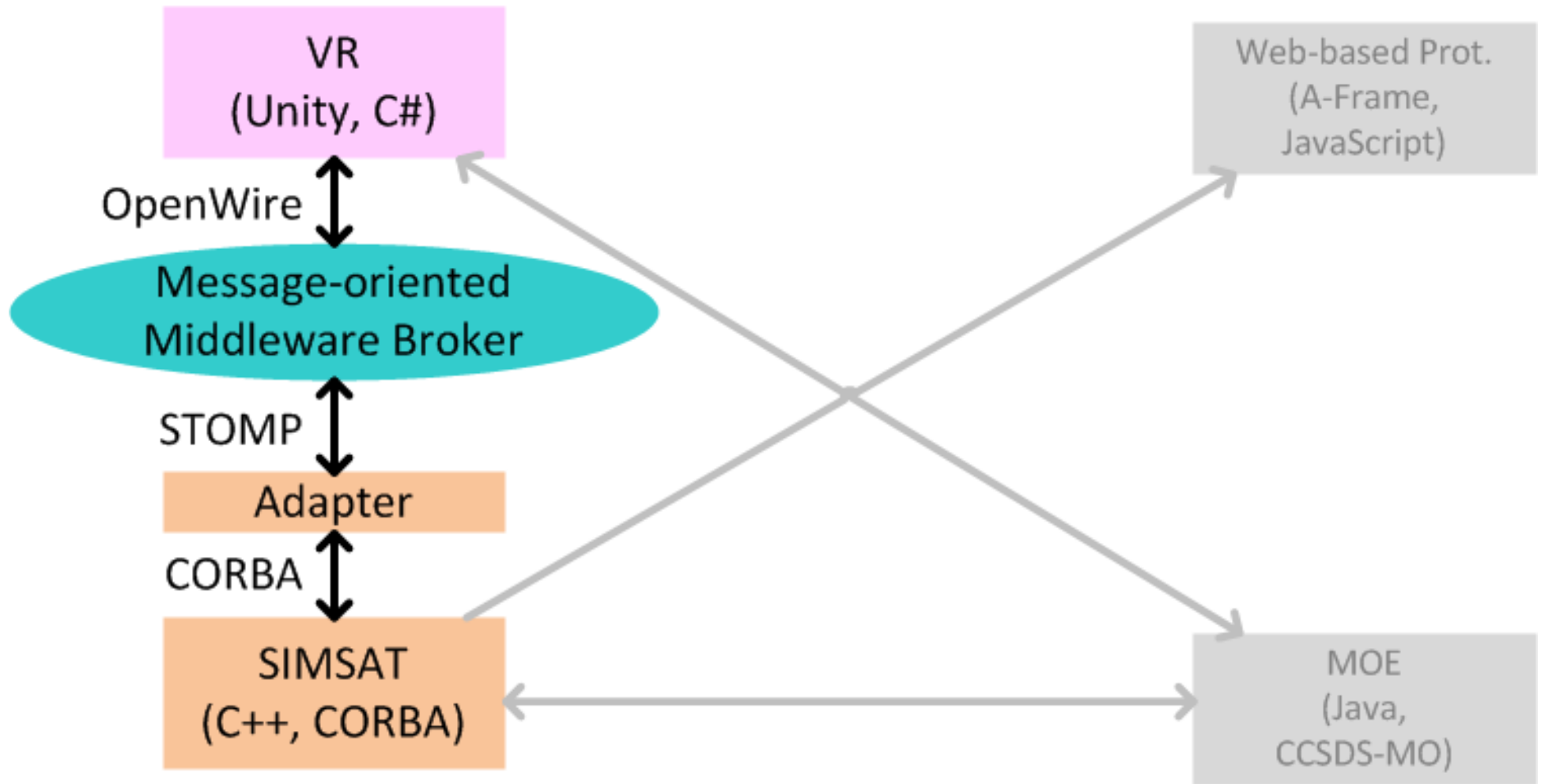


- **Ease of Use**
 - Available Libraries
 - Boiler Plate Code
 - E.g.: Connection Setup & Management, Data Transfer, ...
 - Code Generation
 - “Interface Definition Languages”
E.g.: CORBA, Protocol Buffers
- **Flexibility**
 - How easy are changes?
- **Performance**
- **Platforms**
 - E.g.: Desktop vs. HoloLens

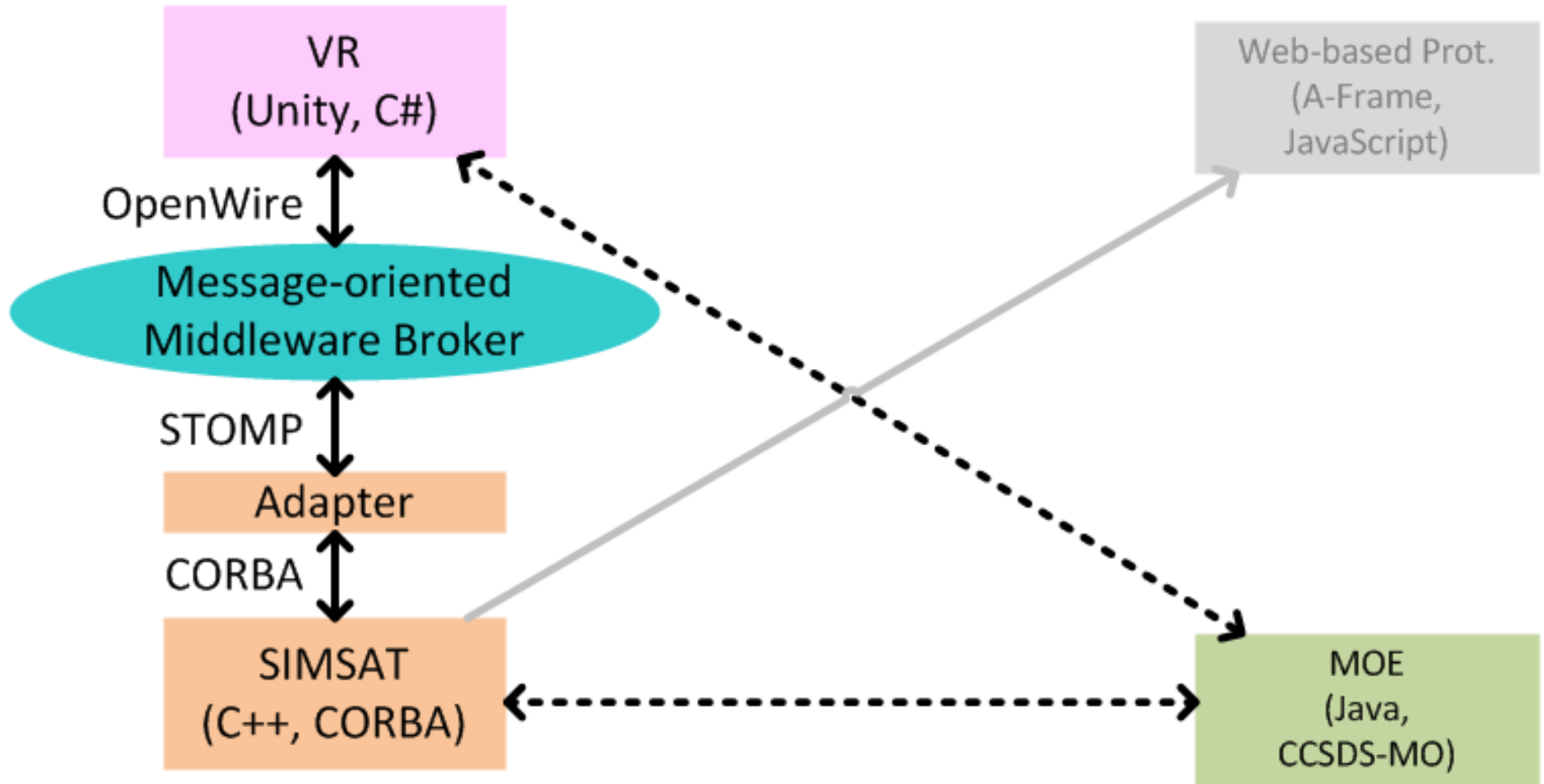
Choices & Experiences



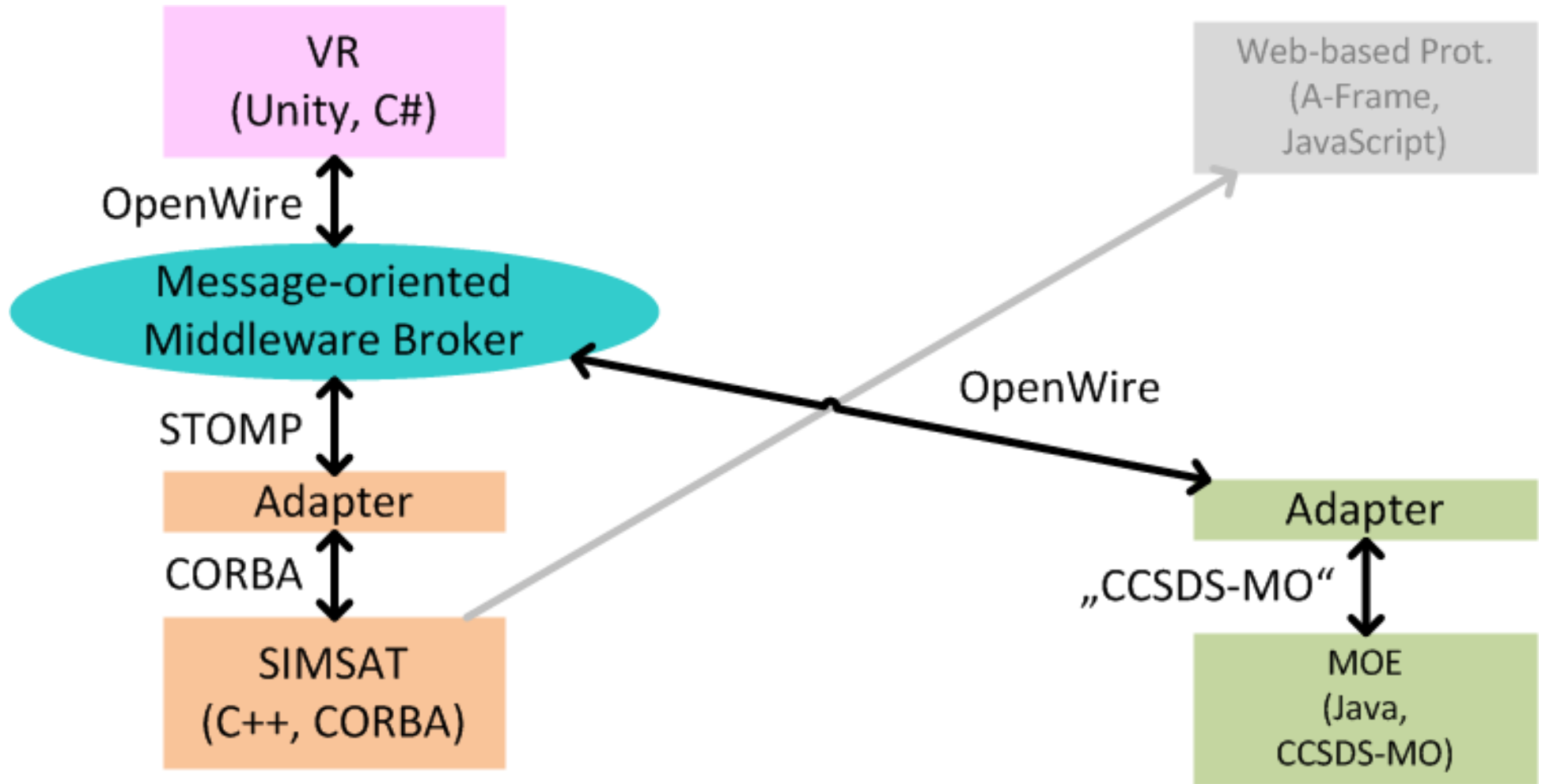
Choices & Experiences



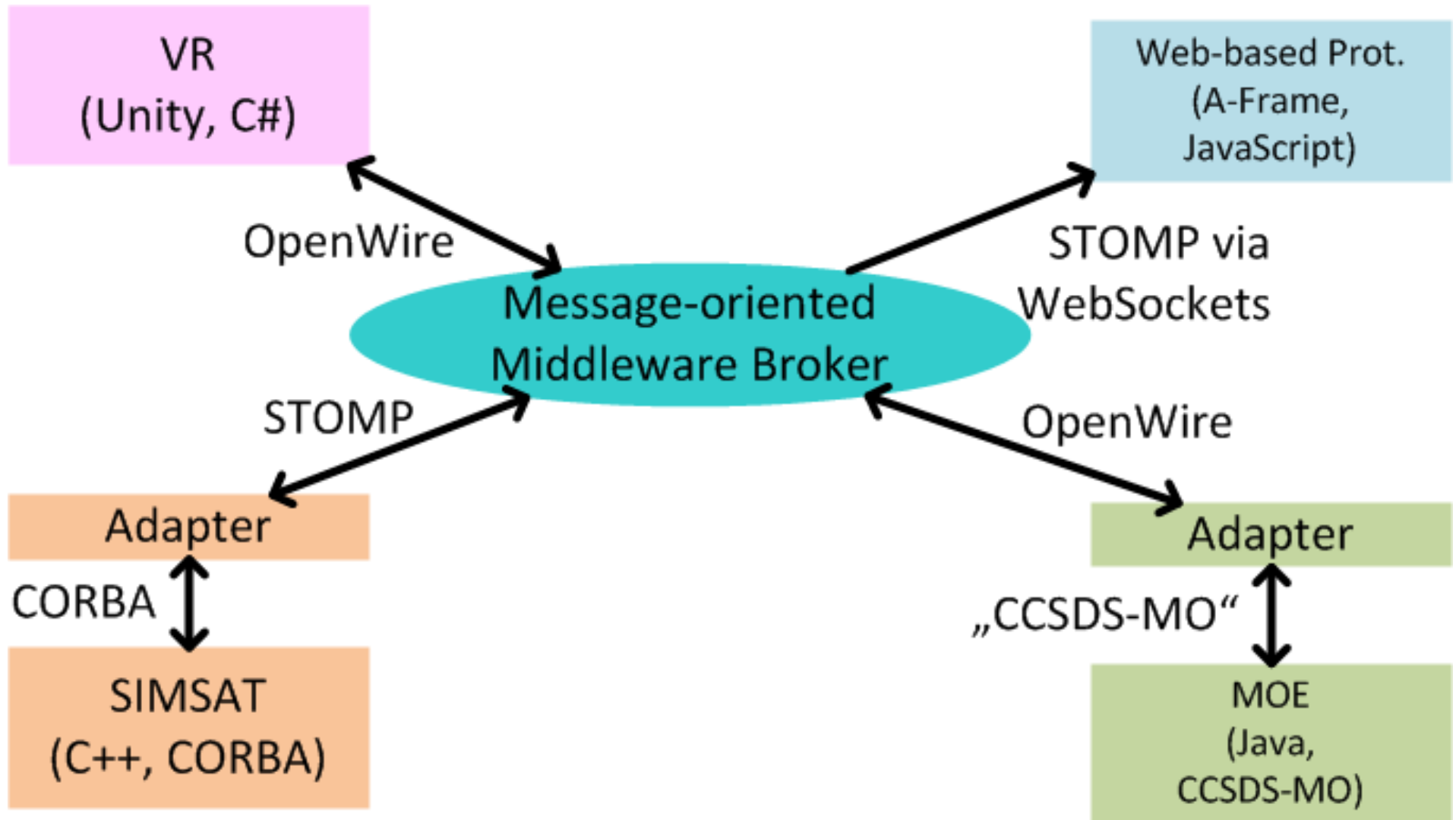
Choices & Experiences



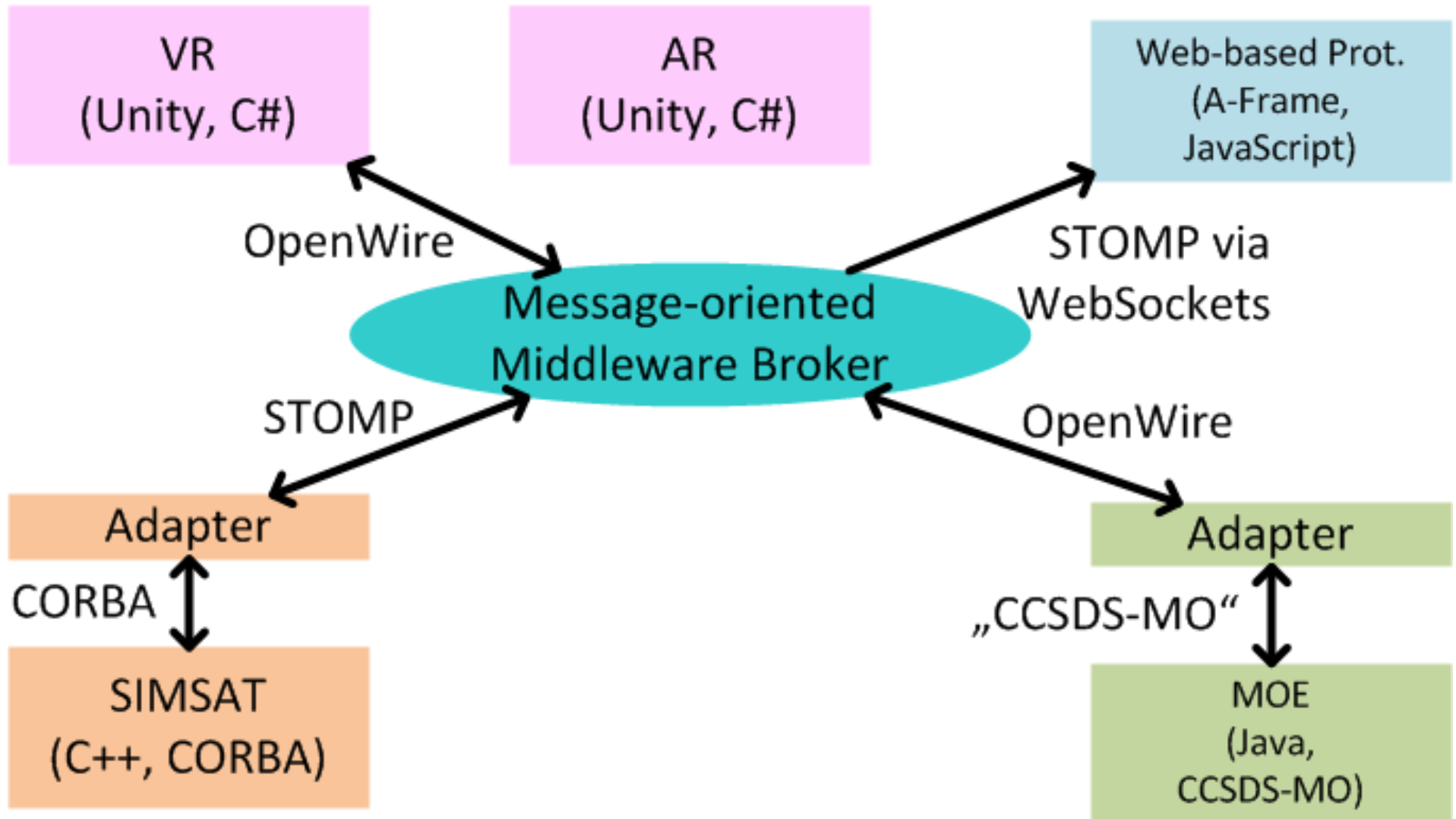
Choices & Experiences



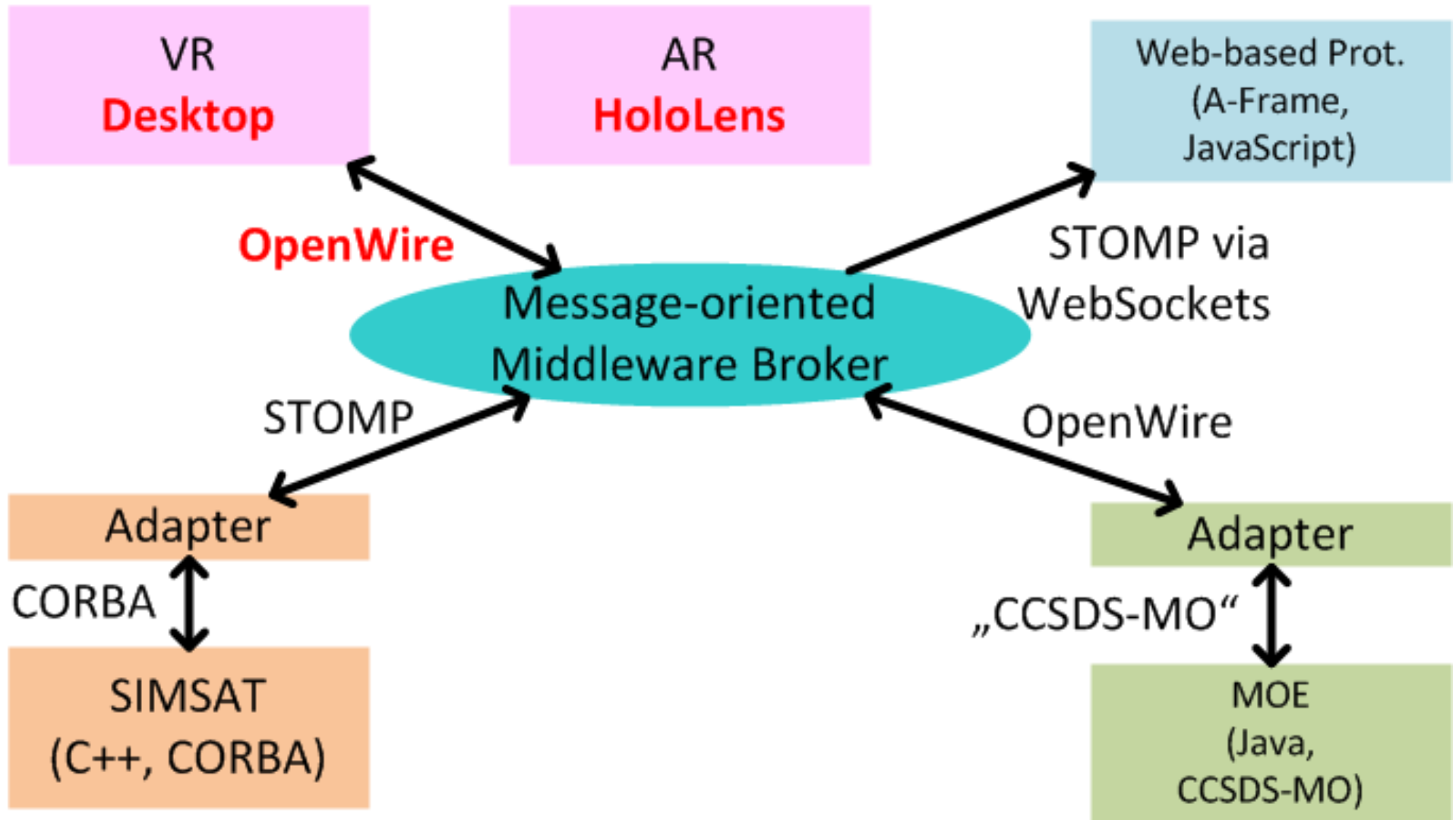
Choices & Experiences



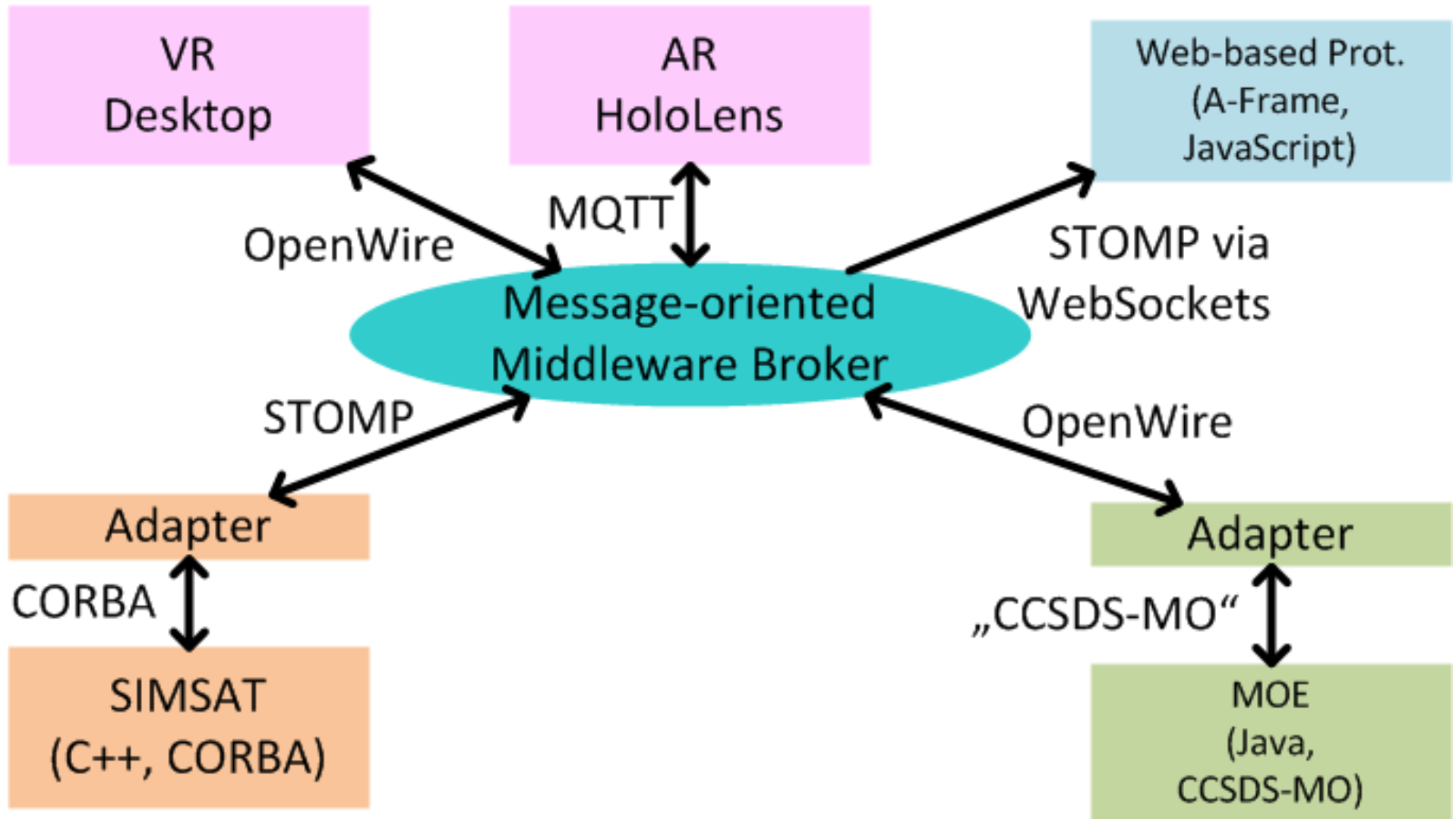
Choices & Experiences



Choices & Experiences



Choices & Experiences



Choices Summary



- **Communication Infrastructure/Middleware**
 - Message-oriented Middleware (MoM)
 - One Central Broker
 - Protocols
 - STOMP, OpenWire, STOMP via WebSockets, MQTT
- **Serialization/Data Representation**
 - JSON -> UTF-8 String -> Byte Array
 - No Complex Class Hierarchies
 - Generic Data Structures
 - Key-value (Map, Dict, ...)
 - Sequence (List, Vector, ...)
 - Primitive Types

Message-oriented Middleware



- **Wrapper/Abstraction**

- bowerick

- Based on:

- Apache ActiveMQ, Eclipse Paho, Spring Messaging, ...

- Eclipse Public License

- <https://github.com/ruedigergad/bowerick>

dojars [bowerick "2.6.2"] build passing BUILD STATUS PASSED coverage 91%



- **Focus**
 - Ease of Use
 - Flexibility
- **Performance**
 - VR Study: 75,000 parameters/second
 - Publication:
 - Ruediger Gad, Martin Kappes, and Inmaculada Medina-Bulo, “Monitoring Traffic in Computer Networks with Dynamic Distributed Remote Packet Capturing,” in 2015 IEEE International Conference on Communications (ICC), Jun. 2015
 - Up to ~750 Mbps

Conclusion



- **Two Studies**
- **Integration of Non-space-standard Components**
- **Least Common Denominator**
 - Communication Infrastructure/Middleware
 - Message-oriented Middleware
(OpenWire, STOMP, MQTT, STOMP via WebSockets)
 - Serialization Data Representation
 - JSON -> UTF-8 String -> Byte Arrays
- **Subjective Evaluation: 😊**
- **“Message-oriented Middleware in Space”:**
 - CNES ISIS (ZeroMQ), EGS-CC (Apache ServiceMix), GSOC (possibly MQTT?)

End



Thank you very much for your attention.

Questions?

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<https://github.com/ruedigergad/bowerick>

Meet us at

www.terma.com

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