

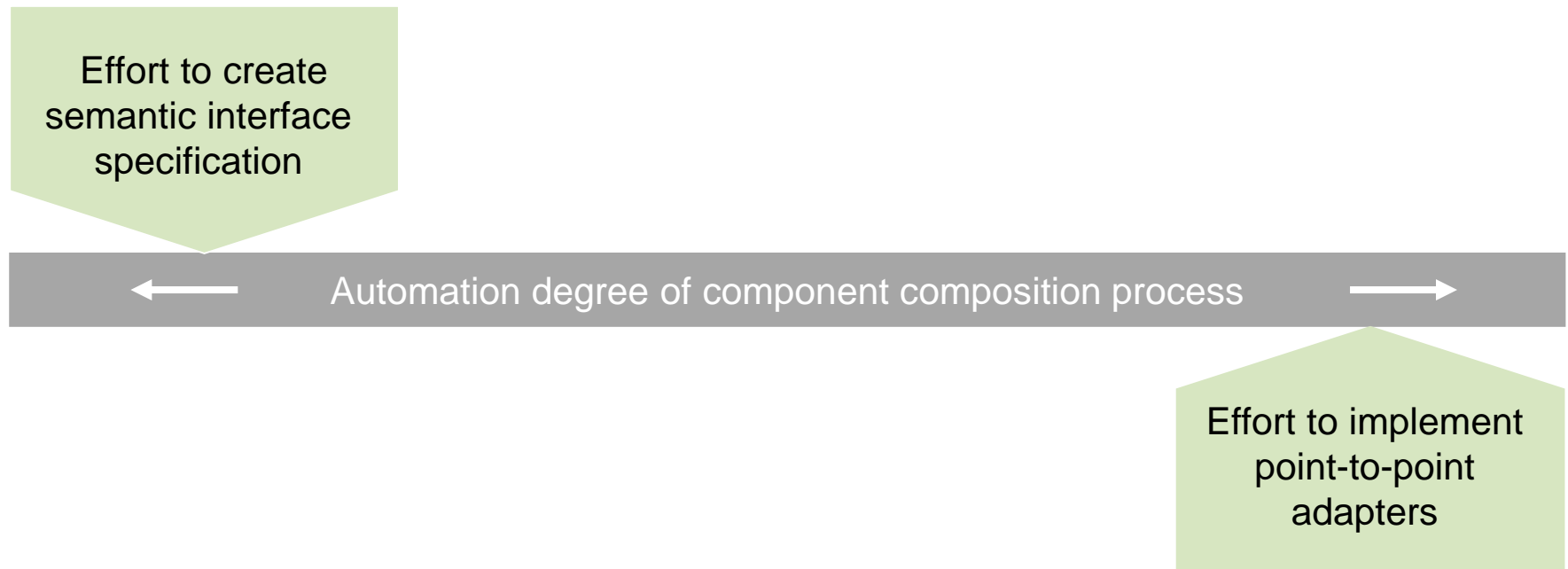


## **14.0-Device Integration: A Qualitative Analysis of Methods and Technologies Utilized by System Integrators**

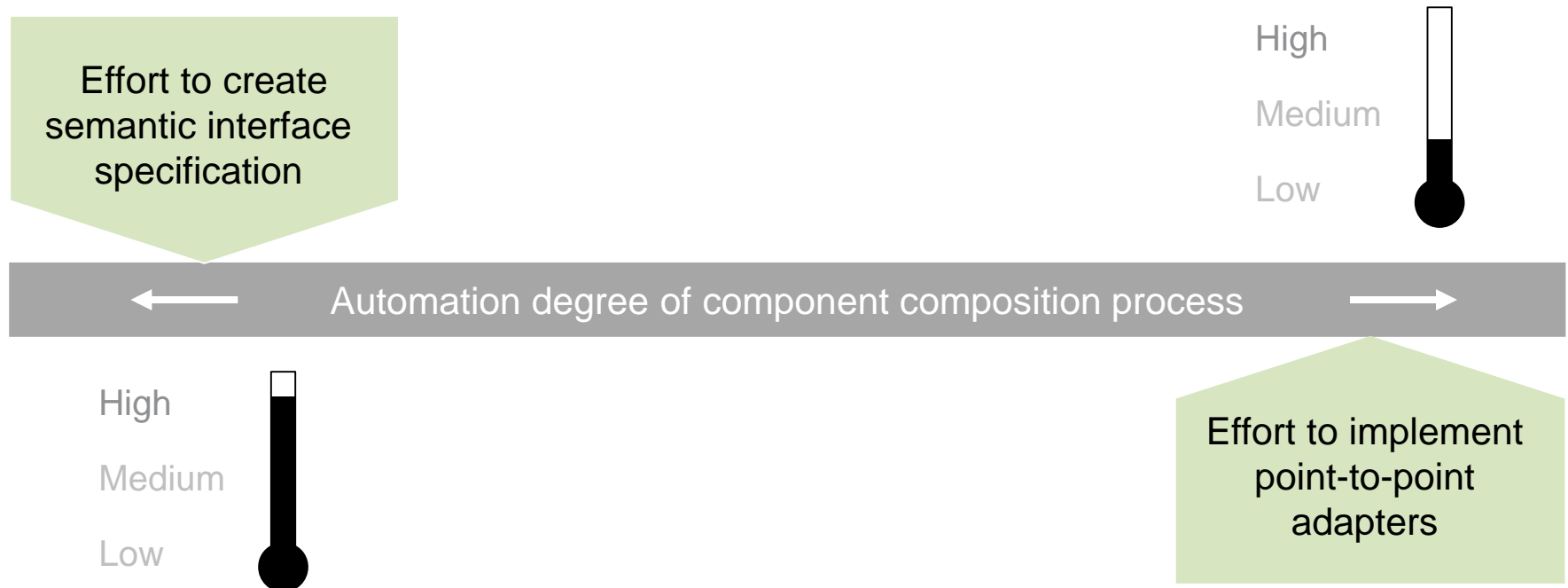
Implications for Engineering Future Industrial Internet of Things Systems

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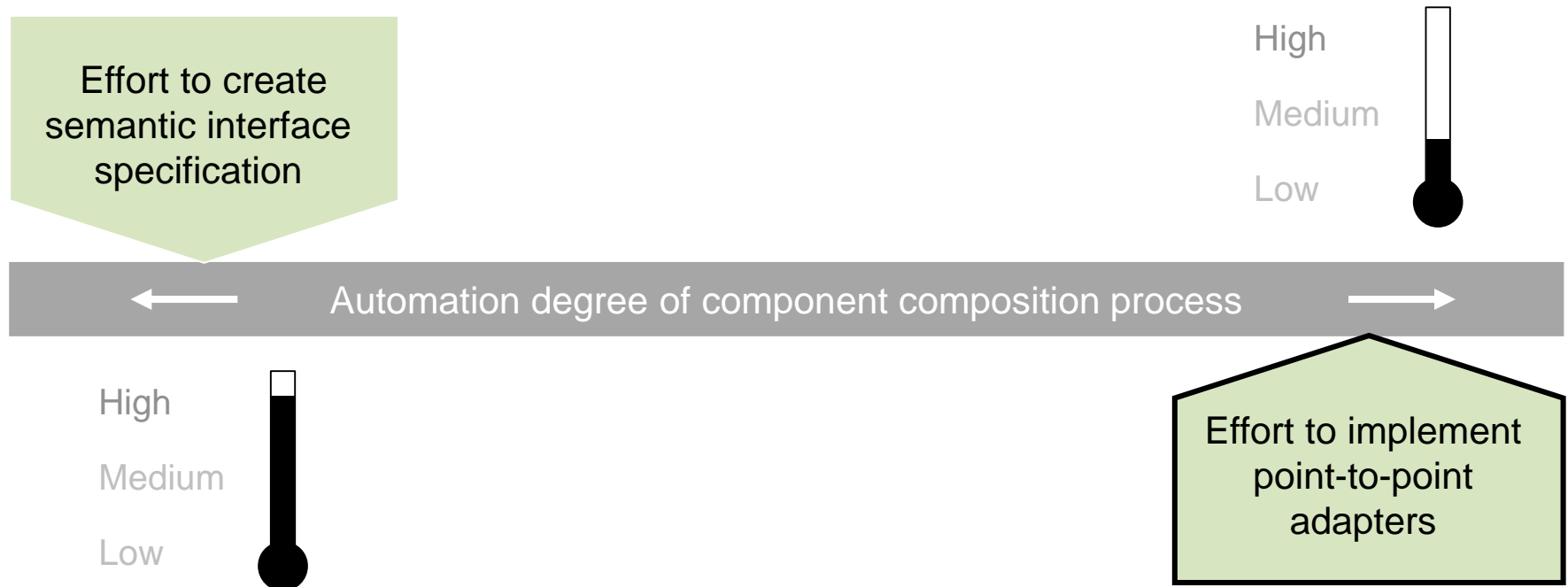
Currently, there is a dilemma between integrating devices using syntactic and semantic integration methods when no standard is available



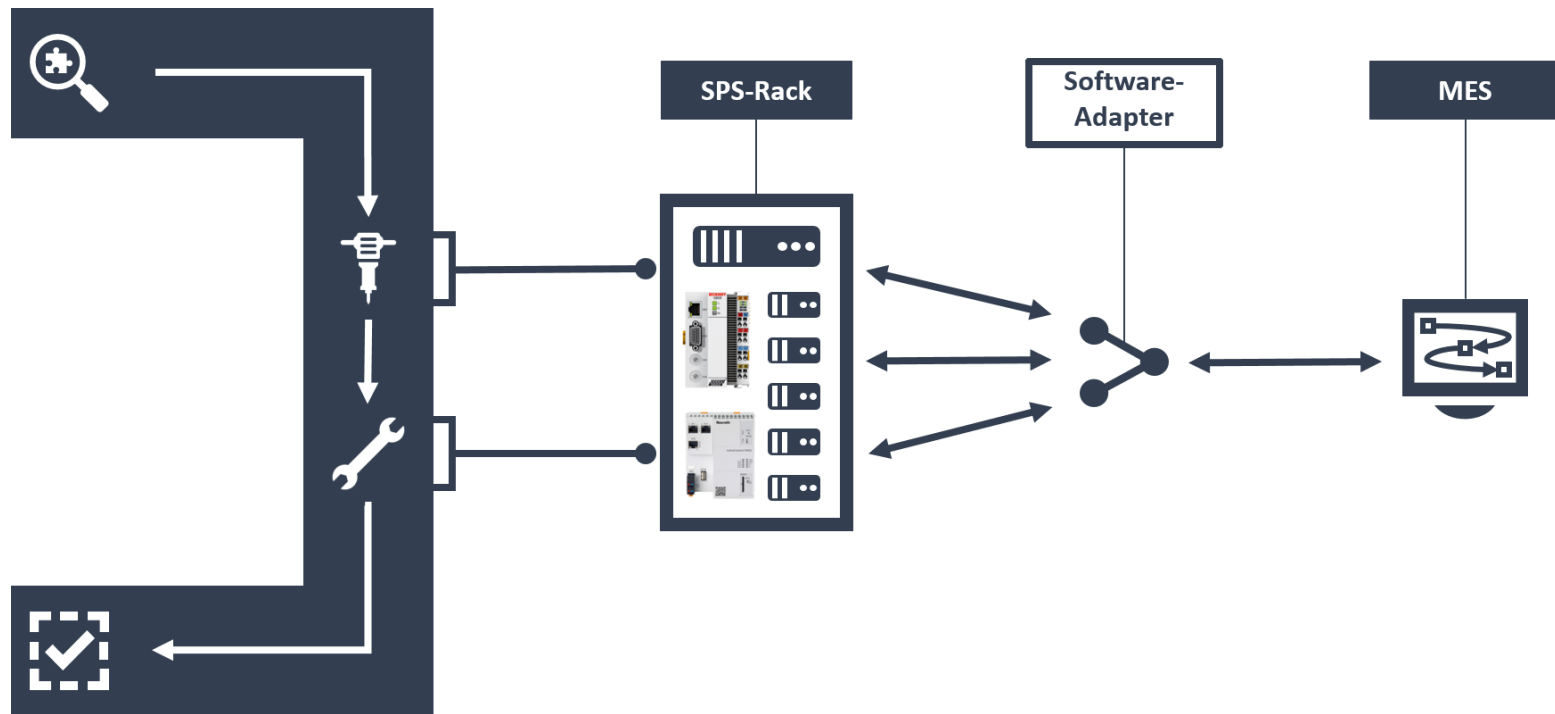
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In this work, we tried to get a qualitative impression for connecting two devices in an industrial automation setting



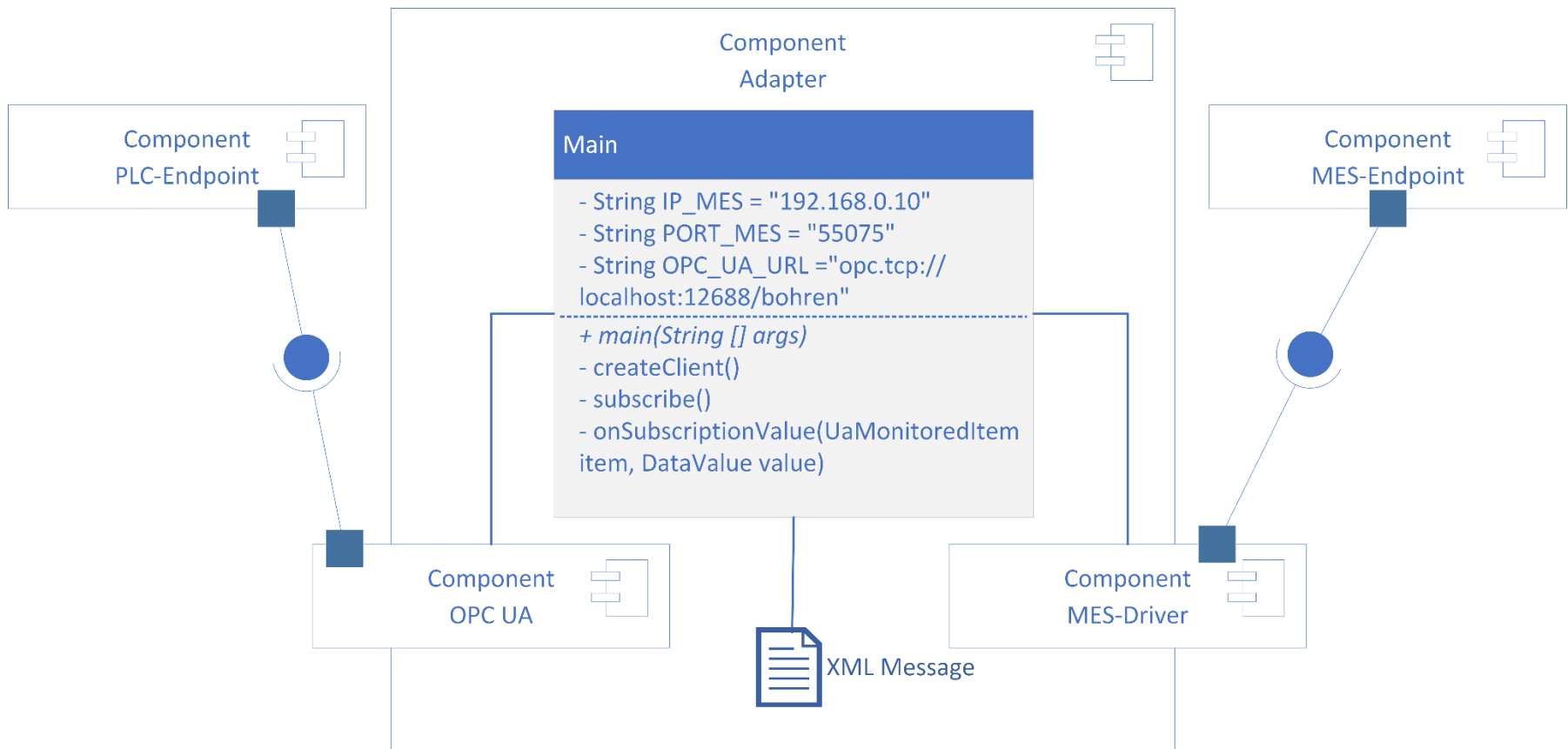
## Our explicit assumptions for integrating two devices are the following:

- Role: A system integrator, who is neither the device manufacturer nor the system operator integrates two devices by connecting their interface
- Device: Two devices exposes interface characteristics at different levels of abstractions and no standard is available
- Technology: Each device uses a different communication stack for interaction purposes
- Context constraints:
  - There exists a reliable network connection
  - No integration case is identical (i.e. there exists a semantic gap)
  - The system integrator is able to work with all concepts and technologies involved (i.e. there is no technical knowledge gap)

**Question 1: Which software adapter architectures are needed to support a minimalistic trigger-event communication style?**

**Question 2: What are positive and negative aspects experienced by the role system integrator?**

# Solution 1 involved implementing a software adapter with open source frameworks





## Solution 2 provided a user interface for creating mappings between component endpoints

Menu Service Save Import Export Triggers

Line  
 Station  
 SPS Settings  
 MES Settings  
 Events

partReceived  
 partProcessed  
 ...

Device-specific Station configuration

XML Message

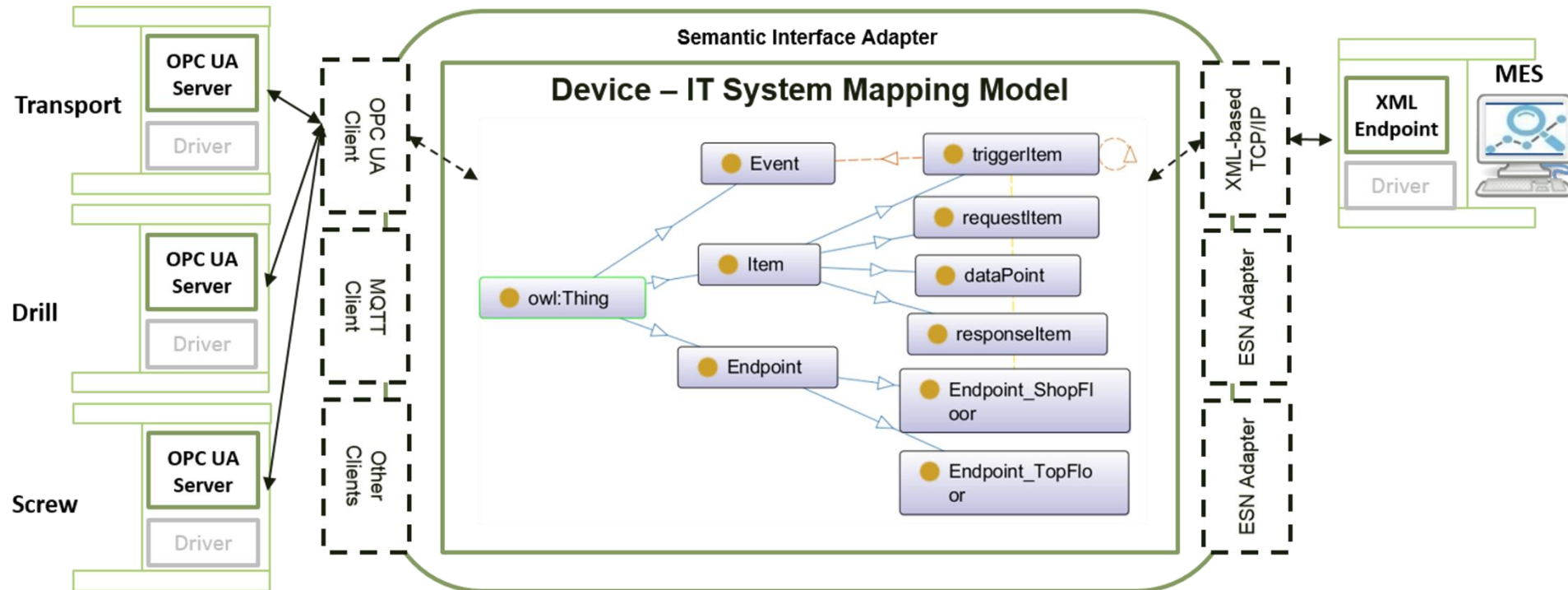
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1 <?xml version="1.0" encoding="utf-8" standalone="yes"?>
2 <root>
3 <header eventId="{@eventId}" eventName="partReceived" version="1.0" eventSwitch="-1"
4 <location lineNo="10" statNo="3" statIdx="1" fuNo="1" workPos="1" toolPos="1" applic
5 </header>
6 <event>
7 <result returnCode="0">
8 </result>
9 <trace />
10 </event>
11 <body>
12 <items>
13 <item name="typeNo" value="" dataType="8" />
14 <item name="typeVar" value="" dataType="8" />
15 <item name="partForStation" value="0" dataType="2" />
16 </items>
17 </structs />
18 </body>
19 </root>

```

PLC Variables	
Name	Type
Var1	Int
Var2	Bool
...	...

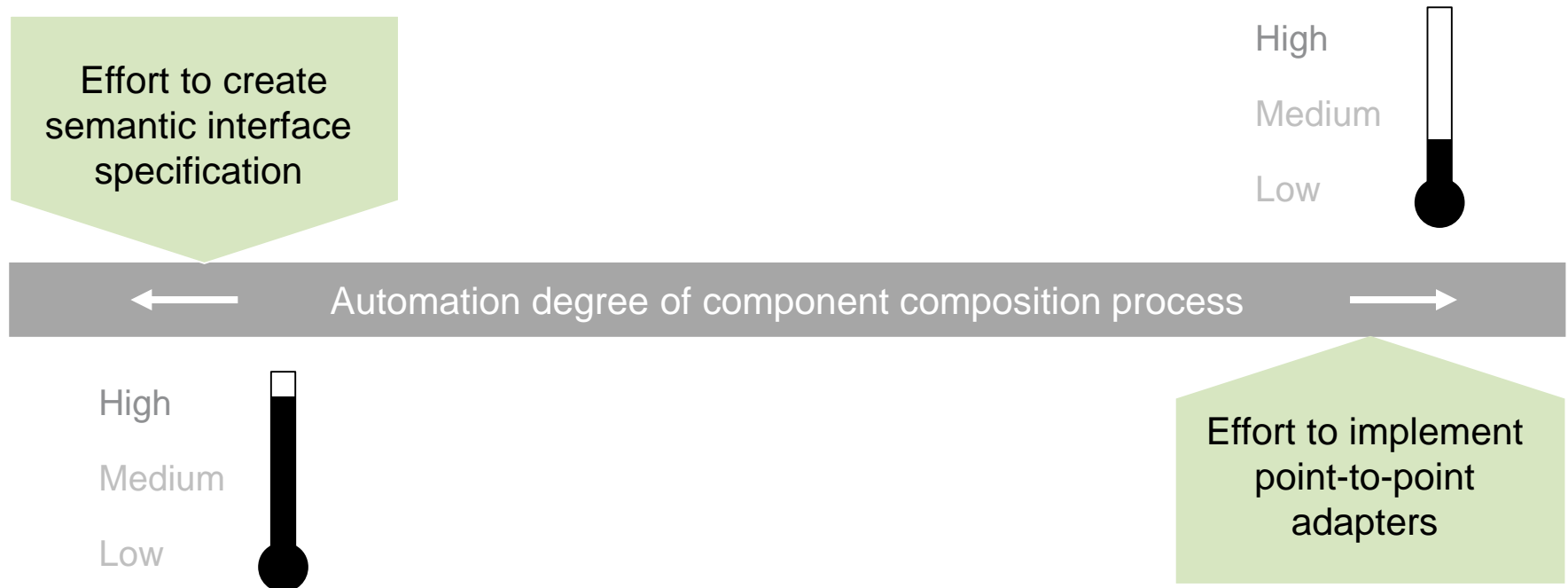
## Solution 3 involved the creation of semantic mappings between different information models



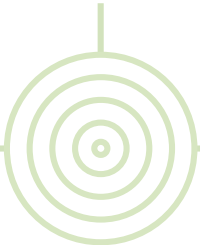
Overall, the amount of time required to built an adapter from scratch is higher than expected

<i>Adapter Solution</i>	<i>Usability in steps</i>	<i>Config.- Effort</i>	<i>Mapping Reusability</i>	<i>Level of Automati on</i>	<i>Time in minutes</i>
Sol. 1	6	Medium	None	Manual	90-100
Sol. 2	5	High	Multiple	Manual	5-10
Sol. 3	6	High	Multiple	Semi	15-20

Coming back to our dilemma from the beginning, we can conclude that the semantic device integration effort is highly dependent on the use case



## Which implications could we derive from our experience?



### Technology Standards

If there is no standard supported by I4.0-Devices, implementing software adapter will become a time consuming task depending on their application field

### System Integrator

System Integrator should be equipped with new skills, tools and methods in order to tame the complexity of Industrial Internet of Things Systems

### Role uncertainty (for discussion)

The triad of system operator (e.g. user/requirements engineer), solution developer and system integrator (system architect/platform vendor) is not clearly staffed for all IoT-Systems



**Thank you for your attention!**