I4.0-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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- Automation degree of component composition process
- Effort to implement point-to-point adapters
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<th>Automation degree of component composition process</th>
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<td>High</td>
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<tr>
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<tr>
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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.
Solution 3 involved the creation of semantic mappings between different information models.
Overall, the amount of time required to build an adapter from scratch is higher than expected.

<table>
<thead>
<tr>
<th>Adapter Solution</th>
<th>Usability in steps</th>
<th>Config.-Effort</th>
<th>Mapping Reusability</th>
<th>Level of Automation</th>
<th>Time in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sol. 1</td>
<td>6</td>
<td>Medium</td>
<td>None</td>
<td>Manual</td>
<td>90-100</td>
</tr>
<tr>
<td>Sol. 2</td>
<td>5</td>
<td>High</td>
<td>Multiple</td>
<td>Manual</td>
<td>5-10</td>
</tr>
<tr>
<td>Sol. 3</td>
<td>6</td>
<td>High</td>
<td>Multiple</td>
<td>Semi</td>
<td>15-20</td>
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Coming back to our dilemma from the beginning, we can conclude that the semantic device integration effort is highly dependent on the use case.

- Effort to create semantic interface specification
- Automation degree of component composition process
- Effort to implement point-to-point adapters
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!