A Performance and Cost Evaluation of Combining OPC-UA and Microsoft Azure IoT Hub into an Industrial Internet-of-Things System

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Overview

• Background
• Scenario
• Approach & Implementation
• Results
• Conclusion & Future Work
Background

• Post doc project
  • 50 billion devices, 10 times per second updates, 100ms response times
  • This work and scenario originates from one of our partner companies

• This paper aims to find and evaluate potential solutions for creating efficient and flexible Industrial IoT systems. In particular, evaluating the two prominent technologies OPC-UA and Microsoft Azure IoT

• This work seeks to answer the following two research questions:
  • 1) What is the expected response times and performance of an IIoT system that uses UPC-UA and Microsoft Azure IoT Hub?
  • 2) What is the estimated operational costs for the cloud system and will this be feasible for a typical IIoT scenario?
Scenario

- Based on a real world industrial turbine system
- With 1500 sensors attached to it
- 30% of the sensors are analog and 70% are digital
- Every second:
  - 500 new data points are created in the analog sensors
  - 100 new data points are created in the digital sensors
- Today, all these values are continually saved in a site local server
- To monitor the health and status of the machinery
- There is a need for a more flexible architecture
- And a more open access at different places in the value chain
- Hence, the idea is to make it available online via an IoT system
Approach

- Industrial sensors being connected to a site local server
- That is also connected to an IoT gateway
- That can send the data to the IoT cloud
- Which then makes it available to end user applications
Implementation

- **Measurements**
  - Latencies: S to G, G to E, and S to E
  - Monetary costs: for sending to cloud and to route inside the cloud
Results (Latency)

- Measurements
  - Fiber (SUNET)
  - LTE (Telia)

- Average ($\mu$)
- Standard deviation ($\sigma$)

- Maximum Response Time
  - Industry often discuss five-nines reliability, etc.
  - So we specified the MRT in our particular scenario to 99.999% of all values.

<table>
<thead>
<tr>
<th>Fiber</th>
<th>$\mu$</th>
<th>$\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>S to G</td>
<td>1.8 ms</td>
<td>1.6 ms</td>
</tr>
<tr>
<td>G to E</td>
<td>760 ms</td>
<td>330 ms</td>
</tr>
<tr>
<td>S to E</td>
<td>770 ms</td>
<td>330 ms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LTE</th>
<th>$\mu$</th>
<th>$\sigma$</th>
</tr>
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<tbody>
<tr>
<td>S to G</td>
<td>2.8 ms</td>
<td>1.5 ms</td>
</tr>
<tr>
<td>G to E</td>
<td>1100 ms</td>
<td>340 ms</td>
</tr>
<tr>
<td>S to E</td>
<td>1150 ms</td>
<td>340 ms</td>
</tr>
</tbody>
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Results (Cost)

- Our scenario produces 51 840 000 sensor values per day

- Sending to cloud
  - $5000 for our scenario

- Routing
  - Costs $0.05 per million operations
  - Resulting in $2.6 for our scenario

- Total: $5002.6 per month
Summary and Conclusions

• OPC-UA and Microsoft Azure IoT hub was used to create an industrial IoT system for a real life industrial scenario
  • A proof-of-concept system was implemented to evaluate its feasibility, performance, and expected monetary costs

• Latency
  • Average response time
    • Fiber: 770 ms, LTE: 1150 ms
  • Expected response time for 99.999% of all values
    • Fiber: 2.2 s, LTE: 2.6 s
  • The major part of the delay was consumed by Microsoft Azure’s internal system, not the network or OPC-UA

• Cost
  • The scenario will cost roughly $5000 per month
  • Which can be a significant cost for a small enterprise
Future Work

- We want to set up a testbed with more of the industrial system
  - Including connecting it with the process information management system as the end user application (Prevas AutArch)

- We aim for a “Secure Industrial Internet of Things” project
  - The value chain, device trust, and cloud trust

- Continue to evaluate cloud systems and fog computing
  - Especially when the scale and demands is pushed even higher
  - Billions of sensors, faster sensor updates, and short response times
Contact Information

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