Industrial Internet of Things: Security of Interoperability

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LIFO, INSA Centre-Val de Loire, 88 Bd Lahitolle 18000 Bourges, France

firstname.lastname@insa-cvl.fr

Abstract

Industry uses more and more *IoT* components to have a better control on production and logitistic processes. This growing openess induces some security risks. Moreover, the multiplicity of open and proprietary protocols used in *IoT* makes the interoperability management paramount, especially in the industrial world. We therefore propose to study data security in heterogeneous industrial *IoT* environments.

Industry and *IoT*

Machine to Machine (*M2M*) is more and more deployed in industry

- Allows real-time and direct control on processes
- Raises two main questions:

⇒ Proprietary systems → closed communication protocols

⇒ New communication and collaboration approach → attack surface enlarged

The next step: Internet of Things (*IoT*)

- Increasingly investigated for industry needs
- Rationalisation of deployments with cost-less and energy-efficient devices
- Usually with wireless protocols:

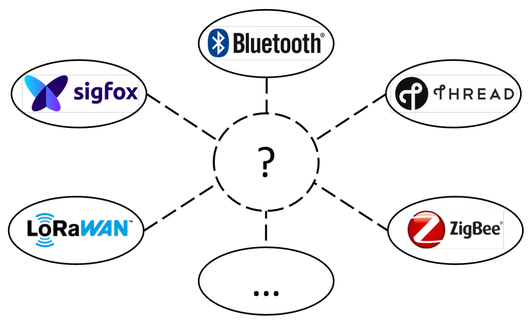
⇒ New security issues (no physical access needed...)

⇒ A multitude of used protocols → interoperability difficulties

Interoperability

Interoperability, a central point of industrial *IoT*

- Being locked into one manufacturer environement can be problematic
- Multiplicity of used protocols
- Required for control centralization



Standardization, the solution?

- Best way to solve interoperability in IT world
- Some intiatives exist (INTER-IoT, Intel IoT...)
- One stands out by its international support: **oneM2M**

oneM2M

The standard to rule them all:

- Based on smartM2M, an ETSI workgroup
- Supported by almost a dozen national and international standard institutes
- Facilitates management and interoperability in *M2M* and *IoT* networks

This standard is based on a modular approach where each entity has a specific role. The most relevant for us: Interworking Proxy Entity (*IPE*), the heart of interoperability [1]:

- An interface between *oneM2M* and a third party protocol
- Translates data and instructions

⇒ Important security role between oneM2M and third party protocols' security measures

Test Scenario

Objectives:

⇒ Experiment oneM2M with a third party protocol: *ZigBee*

⇒ Study the data security: interfaces, exchanges, translations...

The scenario:

⇒ A temperature sensor node and a display node (communicating with ZigBee)

⇒ We want to get those data in a oneM2M architecture

Implementation of oneM2M Architecture

Chosen oneM2M's implementation: *IoT OCEAN* [2]

- Open-source
- One of the most actively developped

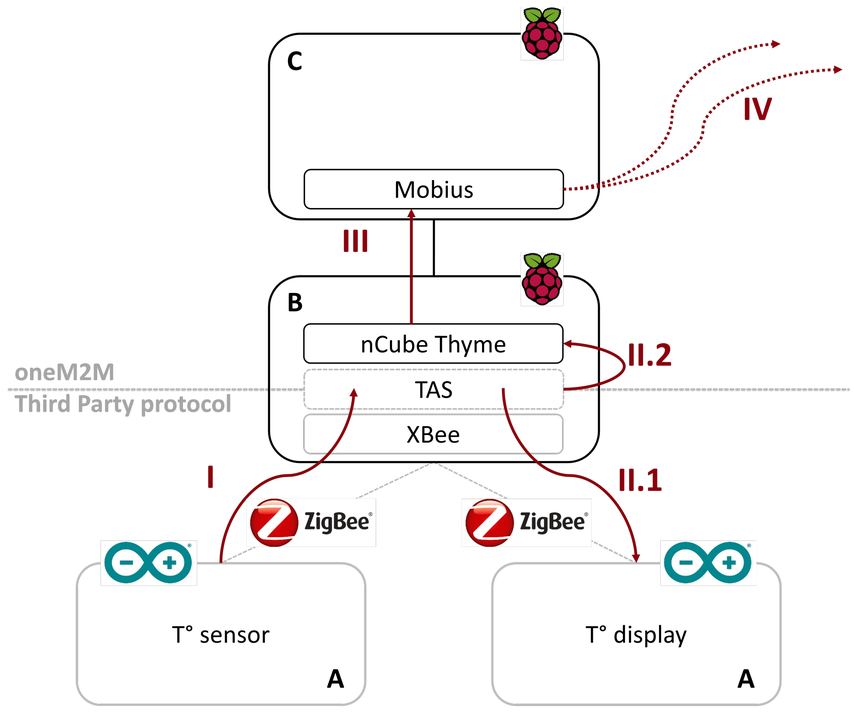


Figure 1: Implemented architecture

Implementation (cf. Figure 1):

A. 2 Arduino - Temperature sensor/display - *non-oneM2M Node* (*NoDN*)

B. Raspberry Pi - *Interworking Proxy Entity* (*IPE* ⇒ *TAS* in IoT OCEAN), *Application Dedicated Node* (*ADN-AE* ⇒ nCube in IoT OCEAN),

C. Raspberry Pi - *Infrastructure Node* (*IN-CSE* ⇒ Mobius in IoT OCEAN)

Thing Adaptation Software (TAS):

- IoT OCEAN's approach of the *IPE*
- Software component that communicates with third-party protocol and nCube
- Based on an implementation sample, homemade to work with a specific protocol
- Our *TAS* was done in Javascript and communicates with nCube through its REST API
- Integration of a new protocol → a new *TAS*

Data path in this system (cf. Figure 1):

I. The sensor node sends its data, in ZigBee, to the *TAS*

II. The *TAS* processes data, then re-sends them to the display node (**II.1**) in ZigBee, and to nCube in HTTP (**II.2**)

III. nCube immediatly shares the data it receives with Mobius

IV. If needed, Mobius can share these data with others actors

Security concerns

Inherent to *IoT* protocols:

- Security in most popular ones has already been largely studied
- On mature protocols, the majority of security issues are caused by improper implementation [3]

Inherent to interoperability:

- Unsolved open challenge: how to ensure end-to-end security in heterogeneous deployments?
- The study of security mechanisms in oneM2M can solely be theoretical as no open-source solution implements all of them (for now)
- The security of the interface (the *IPE*) is a critical yet midly studied point

Conclusion

- oneM2M is thus a promising standard to solve interoperability issues in the industrial world.
- There are some strong security functionalities in oneM2M (up to the *IPE*) and in the classical *IoT* protocols (up to the edge).
- Unfortunately, when using oneM2M as an interoperability tool, it is necessary to have a blind trust in the *IPE* and the third-party protocol edge.
- To ensure end-to-end data security, one must find solutions to mitigate this issue.

[1] J. Yun, R. C. Teja, N. Chen, N.-M. Sung, and J. Kim, "Interworking of oneM2M-based IoT systems and legacy systems for consumer products," in *2016 IEEE International Conference on Information and Communication Technology Convergence (ICTC)*, oct 2016.

[2] M. Ryu, J. Yun, T. Miao, I.-Y. Ahn, S.-C. Choi, and J. Kim, "Design and implementation of a connected farm for smart farming system," in *2015 IEEE SENSORS*, nov 2015.

[3] G. Tuna, D. G. Kogias, V. C. Gungor, C. Gezer, E. Taşkın, and E. Ayday, "A survey on information security threats and solutions for machine to machine (M2M) communications," *Journal of Parallel and Distributed Computing*, vol. 109, pp. 142–154, nov 2017.

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