Multi-protocols and Data Manager for IoT Gateways: A smart-building use-case demo.

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***Abstract*—The dynamic semantic mapping gateway (DMway) is a middleware that facilitates the interconnection of heterogeneous data-sources with remote data management systems seamlessly.**

***Index Terms*—Heteregeneous data, multi-protocol Gateway, Data Semantic, Semantic web of things, Interoperability**

I. Introduction

In recent years, the Internet of Things has seen a huge increase in terms of deployment and usage. The multiplication of application domains such as smart home / smart building, industry 4.0, eHealth, etc. has come with increased complexity and interoperability issues. In addition, the high diversity of communication protocols implemented by the smart devices as well as the heterogeneity of data formats and software interfaces for their transmission and manipulation, add further hurdles in data integration and exploitation process. Supporting these many protocols generally involves significant overhead due to lots of specific and recurrent adaptations and thus reveals costly and time consuming in practice. On an other hand, the multiplication of back-end frameworks, platforms and applications (databases, data processing and analysis platforms, monitoring and management tools, etc.) which ingest, exploit and exchange data with IoT, the integration of an end-to-end, flexible and scalable approach for IoT data presents a real challenge [1] [2].

To address this challenge, a special focus is needed on the following issues: 1) How to manage heterogeneous data sources seamlessly 2) How to introduce data abstraction leveraging better data semantic support 3) How to bypass or at least avoid strong vendor lock-in 4) How to bring better compatibility with remote services (processing, analysis, storage, etc.) 5) How to support in an easier way the existing standards for data description that, while providing advanced mechanisms still suffer little success because of their complexity. 6) How to ease the process of interconnecting data and systems.

Several efforts have been made and are still ongoing to provide a uniform way to manage IoT devices, collect their data and perform actuation. Most notably we can cite OneM2M, LWM2M, OPC/UA, and more recently Web of Things. Still, there is no wide stream acceptance and usage of those technologies, except in niche markets or specific activities [3].

In this paper we will present a proposal to answer these issues in the form of lightweight IoT middleware having a modular software architecture and based on built-in data models support and conversion. Named DMWay (Dynamic Mapping Gateway), the proposed solution manages the formats heterogeneity of the collected data and the diversity of sensor communication interfaces. Additionally it handles data semantics based on generic data models setup, and interconnects devices with data management systems seamlessly.

II. Semantic dynamic mapping principle

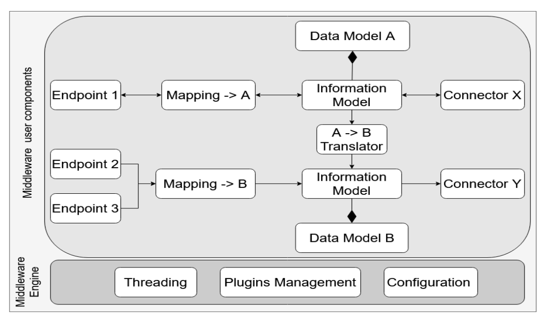

Fig. 1. DMWay global architecture.

DMWay goal consists in (a) facilitating heterogeneous devices integration and data sources, (b) managing their inner semantic or adding semantic layer when the underlying protocols came without it and (c)interconnecting to data management systems.

To perform those tasks, the key is the support and definition of a generic data semantic based on the use of a data ontology organization or information model. All ingested data is mapped to this ontology schema witch is associate with a data semantics (or data model).

Fig. 1 describes the current DMWay architecture. It consists of two main building blocks. The first one, ”User Component middleware”, is fully configurable by the user. Data ingested from different sources is first extracted via the ”Endpoint” modules and then mapped to the information model following

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pre-configured rules. These mapping modules are either linked to a particular technology or configurable by the user. In this step the specific semantic of the input data is either extracted or inferred. Then it gets mapped acccording to the reference information model used in DMWay. After that, the data can be seamlessly used by other DMWay modules.

The data stored in the model can be exported to remote systems via dedicated connectors, either directly or through translation to another data model that is compatible with the remote system. To switch from one data model to another, translators are available to translate the data and make it compatible with the target model. As with the mapping modules, the translators are configurable by the user.

The second part, “Middleware Engine”, allows to manage the service as such (management of plugins, implementation of components, configuration, error support, persistence, etc.).

III. Demo description

For this demo, we are showing how to integrate a variety of typical devices found in smart home and smart office deployments. Those devices are used to monitor the energy consumption of the building as a whole or specifically some typical office appliances and to measure common environment parameters like temperature, humidity, noise level, air quality, etc. We are using a several types of devices: custom made devices as well as off-the-shelf devices.

We have developed custom devices, based on the Zolertia ReMote platform, that support a wide variety of sensors. The sensors can be hot-plugged in or removed, depending on the parameters to measure. Those devices communicate either using raw CoAP or LWM2M communication protocols. The CoAP data are periodically pushed towards the 6LoWPAN Border Router where the payload is extracted from the received CoAP message and published on a remote MQTT Broker. The LWM2M data are directly sent from the devices to a remove LWM2M server based on Eclipse Leshan. The LWM2M data are then periodically polled using an HTTP module inside DMWay that collects the data from the northbound interface of the Leshan demo server.

RTL-433 devices are typical inexpensive sub-GHz devices found in hardware stores. They are used to measure simple parameters like the room temperature and atmospheric pressure. Their data are received with a Software Defined Radio device, and extracted and converted into a JSON payload, which is directly fed into DMWay. The Z-Wave devices are common off-the-shelf ones (Fibaro PowerPlug, Fibaro Motion Sensor, Neo Coolcam, ...) that are connected to several Z-Wave controllers distributed in the building. Those controllers are managed by several instances of ZWave2Mqtt. The devices are controlled and their data collected using MQTT. The LoRaWAN devices are off-the-shelf impulse counters (either optical or magnetic) used to measure water, gas and electricity consumption of the CETIC building. The LoRaWAN network is managed by a Gateway running Chirpstack Server. The data are forwarded to the MQTT broker.

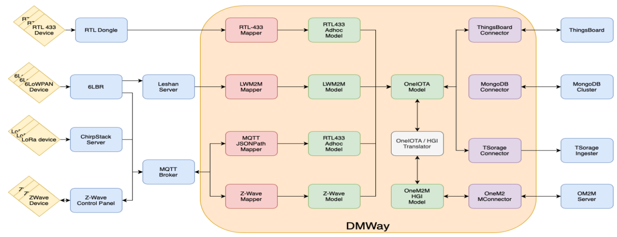

Fig. 2. Architecture overview of the DMWay demo.

To illustrate the possible use cases where DMWay could be used, the data are exported to four different endpoints, each representing a different typical usage scenario. We use Thingsboard to demonstrate the device management capabilities and instantaneous data visualisation. To test interactions with a historian application, we forward the data to a TSorage instance : a time series collection, long term data storage and processing solution developed by CETIC. The raw data are exported to a MongoDB instance to validate integration with other data management systems. Integration with a larger network management system is demonstrated with the export to OM2M.

Fig. 3. Visualisation of the demo data using TSorage and Grafana.

IV. Conclusion & perspectives

In this paper we presented an innovative IoT middleware addressing the complexity of managing heterogeneous data sources and interfaces with both end devices and back-ends.

The proposed abstraction through the management of data through a reference information model makes the solution easily adaptable and allows built-in conversion from one model to another. Hence it alleviates back-ends from caring about data sources low level specifics.

We illustrated the feasibility through deployment in our office building.As future work we plan to extend the solution with other external systems (devices and backends) and improved data-models support and conversion.

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