FiBEM model

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# Introduction

The FiBEM model defines entities that describe the components of buildings (or building energy systems respectively). These entities follow the FIWARE ngsi-v2 format, so that they can be instantiated in a FIWARE application. The model follows types and definitions from the Brick Schema ontology in order to provide the semantics for the model.

A complete documentation on how data models are defined in FIWARE can be found here: <https://fiware-tutorials.readthedocs.io/en/latest/entity-relationships.html> and here: <https://fiware-tutorials.readthedocs.io/en/latest/iot-agent.html#what-is-an-iot-agent>.

A short overview is given here:

* A FIWARE application uses an entity-relationship model that is a virtual representation of the considered real-life system. The Entities are held by the FIWARE Orion Context Broker.
* The objective of a FIWARE application is to monitor and control a real-life system, for example a smart house or a hardware-in-the-loop test bench. This means that the real-life system is equipped with a set of sensors and actuators that can measure and control the different components of the system. FIWARE needs to connect to these sensors and actuators.
* To connect to the sensors and actuators so called devices and an IoT agent are used. Devices are a special type of entity that describe a sensor or an actuator and usually reference an entity of which they logically are a part of. An IoT agent provides the necessary services to link in- and outgoing data over a communication protocol (for example MQTT) to the devices.

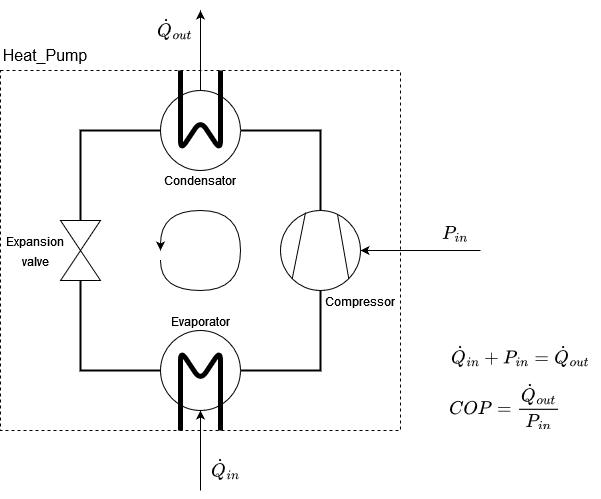
The structure of the FiBEM model is as follows:

* Dynamic device attributes: These are the definitions of the attributes that can be measured and controlled by devices, like temperature, pressure or volume flow. They are added to their corresponding devices under the “dynamic\_attrs” key.
* Relationships: The definitions of the different types of relationships that exist between entities. Entities do not have fixed relationships: Depending on the system, the user adds the relationships manually to the entities. However there exists a guide of common relationships and automatic methods to set these.
* Devices: Definitions of Entities that describe sensors/actuators and send/receive data over an IoT Agent. They reference their parent Entities.
* Entities: Virtual representation of real-life objects.

For every device, relationship and entity the type and definition are given by the Brick ontology. For some rare cases, where a suiting type could not be found within the Brick ontology, a custom type and definition have been added. This mainly is the case for the Heat\_Pump entity, which can neither be found in Brick nor in some of the other widely used ontologies such as Saref.

# Equipment

## Heat\_Pump



Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Heat\_Pump:<int> |
| type | Heat\_Pump |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick, extended by EBC | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | A device that transfers heat between spaces with the use of electrical energy, based on the refrigeration [vapor-compression] cycle. | |

Devices

Condenser – Thermal Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Heat\_Pump\_<int>\_Condenser\_Thermal\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Heat\_Pump:<int>:Condenser:Thermal\_Power\_Sensor |
| entity\_type | Thermal\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous power consumed |
| isPartOf | type: Relationship,  value: urn:ngsi-ld:<system\_name>:Heat\_Pump:<int> |
| dynamic\_attrs | heatFlow, temperature |

Evaporator – Thermal Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | HeatPump\_<heat\_pump\_number>\_Evaporator\_Thermal\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Heat\_Pump:<int>:Evaporator:Thermal\_Power\_Sensor |
| entity\_type | Thermal\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous power consumed |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Heat\_Pump:<int> |
| dynamic\_attrs | heatFlow, temperature |

Compressor – Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | HeatPump\_<heat\_pump\_number>\_Compressor\_Electrical\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Heat\_Pump:<id>:Compressor:Electrical\_Power\_Sensor |
| entity\_type | Electrical\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous power consumed |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Heat\_Pump:<int> |
| dynamic\_attrs | power |

Compressor – Power Command (Actuator)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | HeatPump\_<int>\_Compressor\_Command |
| entity\_name | urn:ngsi-ld:<system\_name>:Heat\_Pump:<int>:Compressor:Command |
| entity\_type | Command |
| definition | type: text, value: A Command is an output point that directly determines the behavior of equipment and/or affects relevant operational points. |
| isPartOf | type: Relationship,  urn:ngsi-ld:<system\_name>:Heat\_Pump:<int> |
| dynamic\_attrs | power |

Heat\_Pump – Coefficient of performance

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | HeatPump\_<heat\_pump\_number>\_COP |
| entity\_name | urn:ngsi-ld:<system\_name>:Heat\_Pump:<int>:COP |
| entity\_type | COP |
| definition | type: text, value: Coefficient of performance |
| isPartOf | type: Relationship,  urn:ngsi-ld:<system\_name>:Heat\_Pump:<int> |
| dynamic\_attrs | COP |

## Electric\_Boiler

Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Electric\_Boiler:<int> |
| type | Electric\_Boiler |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | A closed, pressure vessel that uses electricity for heating water or other fluids to supply steam or hot water for heating, humidification, or other applications. | |

Devices

Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Electric\_Boiler\_<int>\_Electrical\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int>:Electrical\_Power\_Sensor |
| entity\_type | Electrical\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous power consumed |
| isPartOf | type: Relationship,  value: urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int> |
| dynamic\_attrs | power |

Power Command (Actuator)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Electric\_Boiler\_<int>\_Power\_Command |
| entity\_name | urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int>:Power\_In:Command |
| entity\_type | Command |
| definition | type: text, value: A Command is an output point that directly determines the behavior of equipment and/or affects relevant operational points. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int> |
| dynamic\_attrs | power |

Thermal Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Electric\_Boiler\_<int>\_Thermal\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int>:Thermal\_Power\_Sensor |
| entity\_type | Thermal\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous power consumed |
| isPartOf | type: Relationship,  value: urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int> |
| dynamic\_attrs | heatFlow, temperature |

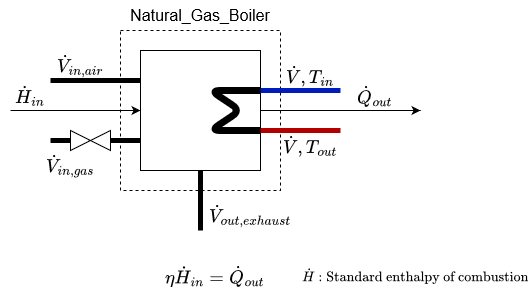
Water Flow Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Electric\_Boiler\_<int>\_Water\_Flow\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int>:Water\_Flow\_Sensor |
| entity\_type | Water\_Flow\_Sensor |
| definition | type: text, value: Measures the rate of flow of water |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int> |
| dynamic\_attrs | volumeFlow |

Conversion Efficiency

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Electric\_Boiler\_<int>\_conversionEfficiency |
| entity\_name | urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int>:conversionEfficiency |
| entity\_type | conversionEfficiency |
| definition | type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Electric\_Boiler:<int> |
| dynamic\_attrs | conversionEfficiency |

## Natural\_Gas\_Boiler



Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Natural\_Gas\_Boiler:<int> |
| type | Natural\_Gas\_Boiler |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | A closed, pressure vessel that uses natural gas for heating water or other fluids to supply steam or hot water for heating, humidification, or other applications. | |

Devices

Natural Gas Flow Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Natural\_Gas\_Boiler\_<int>\_Natural\_Gas\_Flow\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int>:Natural\_Gas\_Flow\_Sensor |
| entity\_type | Flow\_Sensor |
| definition | type: text, value: Measures the rate of flow of some substance |
| isPartOf | type: Relationship,  value: urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int> |
| dynamic\_attrs | volumeFlow |

Natural Gas Valve Command (Actuator)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Natural\_Gas\_Boiler\_<int>\_Natural\_Gas\_Valve\_Command |
| entity\_name | urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int>: Valve\_Command |
| entity\_type | Valve\_Command |
| definition | type: text, value: Controls or reports the openness of a valve (typically as a proportion of its full range of motion) |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int> |
| dynamic\_attrs | valvePosition |

Thermal Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Natural\_Gas\_Boiler\_<int>\_Thermal\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int>:Thermal\_Power\_Sensor |
| entity\_type | Thermal\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous power consumed |
| isPartOf | type: Relationship,  value: urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int> |
| dynamic\_attrs | heatFlow, temperature |

Water Flow Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Natural\_Gas\_Boiler\_<int>\_Water\_Flow\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int>:Water\_Flow\_Sensor |
| entity\_type | Water\_Flow\_Sensor |
| definition | type: text, value: Measures the rate of flow of water |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int> |
| dynamic\_attrs | volumeFlow |

Conversion Efficiency

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Natural\_Gas\_Boiler\_<int>\_conversionEfficiency |
| entity\_name | urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int>: conversionEfficiency |
| entity\_type | conversionEfficiency |
| definition | type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Natural\_Gas\_Boiler:<int> |
| dynamic\_attrs | conversionEfficiency |

## Cogeneration\_Plant