Digital Twin in NGSI-LD

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Pauline FOLZ (Orange Innovation)

Thomas HASSAN (Orange Innovation)
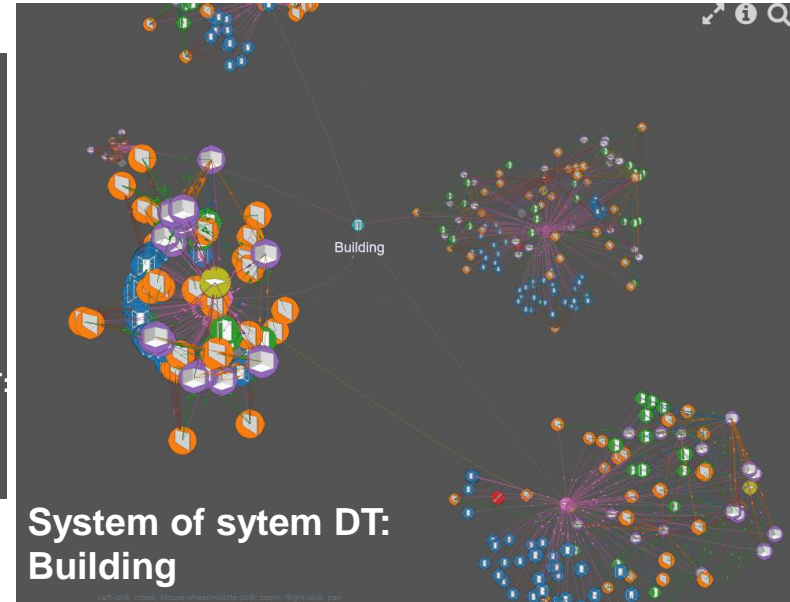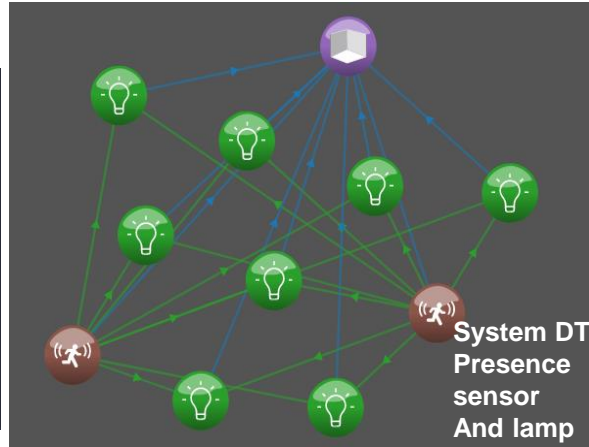
Definitions

In NGSI-LD a Digital Twin is an entity which can be **atomic** or be the **entry-point** of a **graph**.

Atomic NGSI-LD DT of a lamp/light bulb :

```
{
    "id": "urn:ngsi-ld:light1",
    "type":"Lamp",
    "colorRGB":{
        "type":"Property",
        "value":"0xABABAB"
    },
    "is-on":{
        "type":Property",
        "value": true
    }
}
```


System DT: Presence sensor And lamp

**System of sytem DT: Building**

Each Digital Twin:
- is universally **identified** with a **URI** (Universal Resource Identifier),
- belongs to a **well-known type** also universally **identified** by a **URI**,
- is characterized by several attributes which in turn are classified as:
  - **properties** holding data
  - **relationships**, each targeting another Digital Twin entity identified by a URI.

The digital twin is the digital counter part of a real-asset, which can be a **physical** asset or a **concept**.
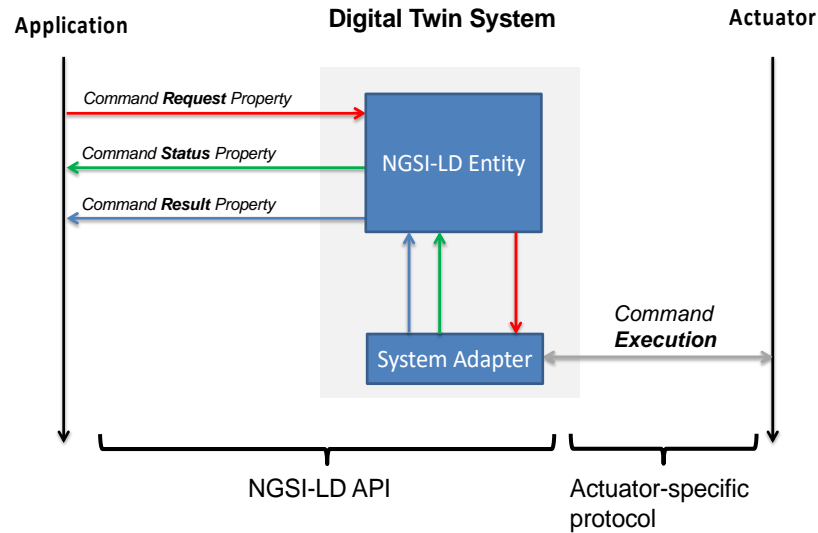
System Twin

Subgraphs of the overall graph that represent a "classical" self-contained system. Its constituent subsystems may either be captured as "atomic-twin" atomic vertices as described before, or decomposed further, recursively, into subsystems which may themselves be described by the same kind of rooted subgraphs.

- vertical **top-down** links (**e.g.** NGSI-LD:hasPart/hasDirectPart),
- vertical **bottom-up** links (**e.g.** *NGSI-LD:isContainedIn*)
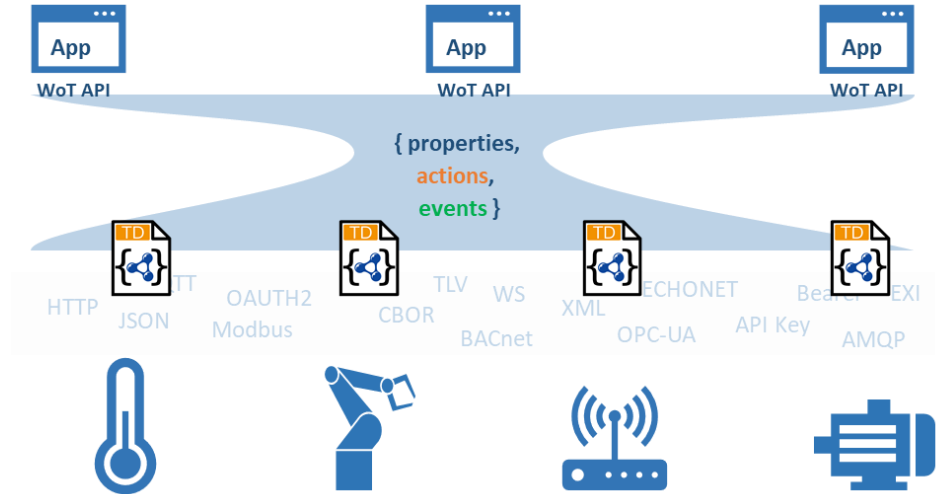- transversal links (**e.g.** *NGSI-LD:ConnectsTo,* sosa:isObservedBy...)
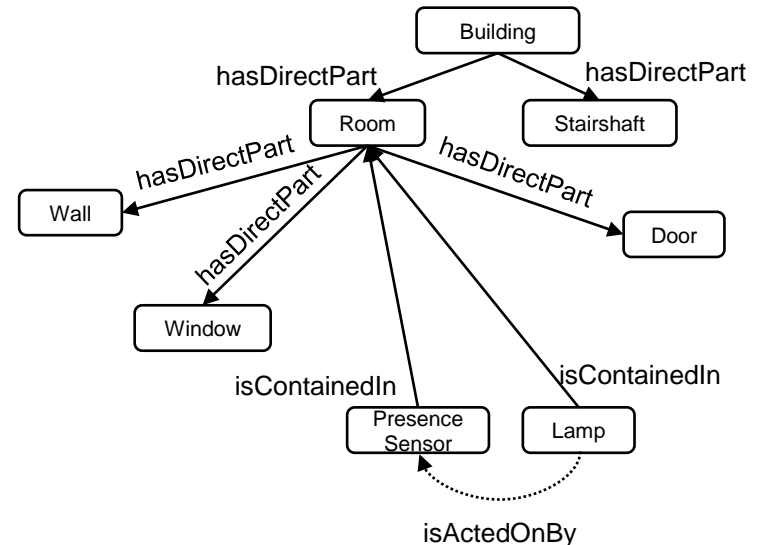
System Twin – Focus on DT's concept – Architecture for actuation

NGSI-LD

Web of Thing – W3C

System Twin – Focus on DT's concept – Data model fo a lamp

NGSI-LD

```
{
  "id": "urn:ngsi-ld:pHueActuator:light1",
  "type": "Lamp",

  "brightness": {"type": "Property", "value": 254},
  "saturation": {"type": "Property", "value": 254},
  "hue": {"type": "Property", "value": 4444},

  "is-on": {"type": "Property", "value":true},

  "commands": {
    "type": "Property",
    "value": ["turn-on", "set-saturation",
              "set-hue", "set-brightness"]
  }

  "turn-on": {"type": "Property",
              "value": {
                "cmd-value": false,
                "cmd-qos": "1",
                "cmd-id": "123456"
              }
}
  "turn-on-STATUS": {"type": "Property",
                     "value": {<cmd_status>}}
  "turn-on-RESULT": {"type": "Property",
                     "value": {<cmd_response>}}
  "set-hue": ...
  "set-hue-STATUS": ...
  "set-hue-RESULT": ...
  …
}
```

Thing Description W3C (JSON-LD)

```
{
  "@context": ["https://www.w3.org/2019/wot/td/v1"],
  "@type" : "ThingTemplate",
  "title": "Lamp Thing Description Template",
  "description" : "Lamp Thing Description Template",
  "securityDefinitions": {"basic_sc": {"scheme": "basic", "in":"header"}},
  "security": ["basic_sc"],
  "properties": {"status" : {"@type": "saref:OnOffState",[…],"forms": […]}},
    "actions": {
        "toggle" : {
          […]
          "@type":"saref:OnOffFunction",
          "forms": [{
            "op": "invokeaction",
            "href": "https://mylamp.example.com/toggle",
            "contentType": "application/json",
            "htv:methodName": "POST"
            }]
        },
        "saturation" : {
            "safe": false,
            "idempotent": false,
            "forms": [{
              "op": "invokeaction",
            "href": "https://mylamp.example.com/toggle",
              "contentType": "application/json",
            "htv:methodName": "POST"
          }]
        },
        "hue" : ...,
        "brightness": ...
    }
}
```

System of System Twin

- System of System Twin capture the relations between underlying System Twin thanks to hypernodes

    - Systems Twin are modelled as subgraphs, i.e. clusters of nodes

    - Hypernodes are nodes which can contain other graph (System graph) or basic nodes, they are represented by "NGSI-LD:graph"

- Relation between nodes and their parent hypernode are represented by "NGSI-LD:isNodeOfGraph"

- Hypernodes can be nodes of higher-level graph, as subgraphs of this graph and are link with the relation "NGSI-LD:isSubGraphOf "

Global view : Atomic, System, and System of System twins