Metadata Schema Generation for Data-driven Smart Buildings

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Presentation Outline

1. Background
2. What is a metadata schema of a smart building?
3. #GenerateMyMetadataSchema
4. Conclusion and outlook

Background

- One of the living labs in B4B project
- Tools with live data developed in B4B
  - Therefore, we need live data from the BMS

Fig.1 Living Lab Building

Background

- Usually, a “tag“ or “code” encapsulate data about Point.
- These complex tags are created to be understood by field engineers.
- Need lot of discussions with field engineer and customized translators, making it harder to use available data for any party interested in developing data-driven building controllers[2].
- How these BAS data points can be recognizable and unified across various vendors and buildings and how to make machine-readable?

What is a metadata schema of a smart building?

- **Metadata** (physical, logical and virtual assets in buildings and the relationships between them) represented in standard semantic descriptions.
- Created using ontologies (such as Brick, BOT).
- Use semantic web technologies.

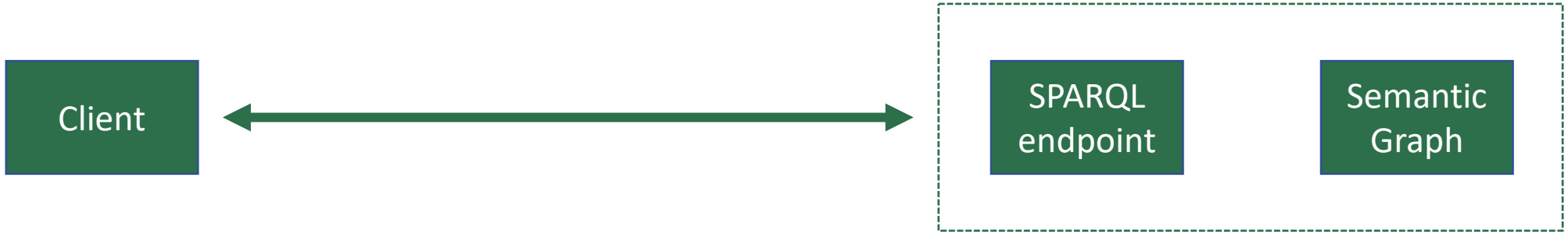


Fig.3 Using semantic web technologies (RDF data and SPARQL)

#GenerateMyMetadataSchema (5 Steps)

1. Identifying the objective
2. Sort the relevant metadata
3. Chose the ontology & identify the mappings to the ontology.
4. Generate the schema.
5. Integrate the schema with the applications.

Step1 : What we have and where we want to go

Table 1
Metadata extraction from BAS containing time-series reference (Item Reference) and descriptions

	Item Reference	Object ID	Object Type	Point Name	Description (NL)	Description (EN)
1	XXX.FEC005.CLG-O	CLG-O	AO Mapper	(33) 201.CV-02V--	Regelafsluiter koeler	Cooler control valve
2	XXX.FEC006.CLG-O	CLG-O	AO Mapper	(33) 202.CV-02V--	Regelafsluiter koeler	Cooler control valve
3	XXX.SHWP1-FAULT	SHWP1-FAULT	BI Mapper	(33) 001.TP-01A--	Transportpomp 1 storing	Transport pump 1 malfunction

Semantic Graph of BAS **to understand and query the timeseries data**

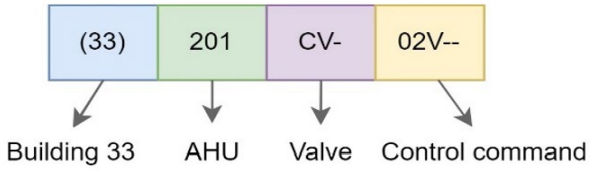


Fig. 4 BMS points naming convention

Systeem nr.	Omschrijving	Voorbeeld
001 t/m **009**	Ketels	001 = Ketel 1 002 = Ketel 2
011 t/m **019**	Transportsysteem Warmwa-ter	011 = Transportsysteem ketel 1 012 = Transportsysteem ketel 2
021 t/m **099**	Warmwater groepen	021 = Warm water groep 1

AKM	Absorptiekoelmachine	MC-	Vochtregeling
BA-	Brandmelding	MT-	Vocht transmitter
BG-	Breekglaasje	NB-	No brak
BKA	Brandklep afvoer	ND-	Nooddrukker
BKT	Brandklep toevoer	O--	Optimalisering
BL-	Blusgasinstallatie	OK-	Overvalknop
BMC	Brandmeldcentrale	PA-	Systeemdruk alarm

Fig. 5 Identifiers in JC BMS Manual (pdf)

Step 2: Selecting the metadata from the Building

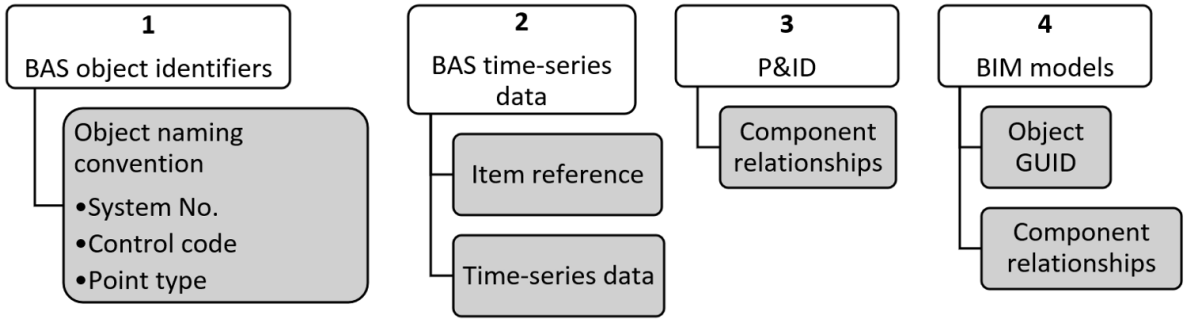


Fig.6 Metadata sources available in the building

Item Reference	Object ID	Object Type	Name	Description
TUDelft/FCB.Local Application.SYS-RESET	SYS-RESET	BI Mapper	(33) 801.RK-01SR2	Reset storing regelkast
TUDelft/FCB.Local Application.MISC3-A	MISC3-A	BI Mapper	(33) 801.RK-01AI-	Installatie automaten
TUDelft/FCB.Local Application.MISC2-A	MISC2-A	BI Mapper	(33) 801.RK-01OB-	Overspanningsbeveiliging
TUDelft/FCB.Local Application.MISC1-A	MISC1-A	BI Mapper	(33) 801.RK-01AN-	Netwachter
TUDelft/FCB.Local Application.Sprinkler-A1	Sprinkler-A1	BI Mapper	(33) 501.XA-01A1-	Sprinkeler storing
TUDelft/FCB.Local Application.Sprinkler-A3	Sprinkler-A3	BI Mapper	(33) 501.XA-01A3-	Sprinkeler reserve
TUDelft/FCB.Local Application.SHWP1-FAULT	SHWP1-FAULT	BI Mapper	(33) 001.TP-01A--	Transportpomp 1 storing
TUDelft/FCB.Local Application.Sprinkler-A2	Sprinkler-A2	BI Mapper	(33) 501.XA-01A2-	Sprinkeler reserve
TUDelft/FCB.Local Application.SHWP2-FAULT	SHWP2-FAULT	BI Mapper	(33) 001.TP-02A--	Transportpomp 2 storing
TUDelft/FCB.Local Application.FIRE-A	FIRE-A	BI Mapper	(33) 801.RK-01BA-	Brandmelding
TUDelft/FCB.Local Application.LA1-A	LA1-A	BI Mapper	(33) 901.LA-01A--	Wateroverlast technische ruimte
TUDelft/FCB.Local Application.LA2-A	LA2-A	BI Mapper	(33) 901.LA-02A--	Wateroverlast MER
TUDelft/FCB.Local Application.LA3-A	LA3-A	BI Mapper	(33) 901.LA-03A--	Wateroverlast DC ruimte
TUDelft/FCB.Local Application.MISC-A1	MISC-A1	BI Mapper	(33) 902.LV-01A--	Tracing vetvangleiding groep 1 storing

Fig.7 BMS Metadata table

Step 3: Mapping to the Brick ontology

Brick's main focus is BMS, matured ontology

Can be linked with other ontologies (BOT, SAREF)

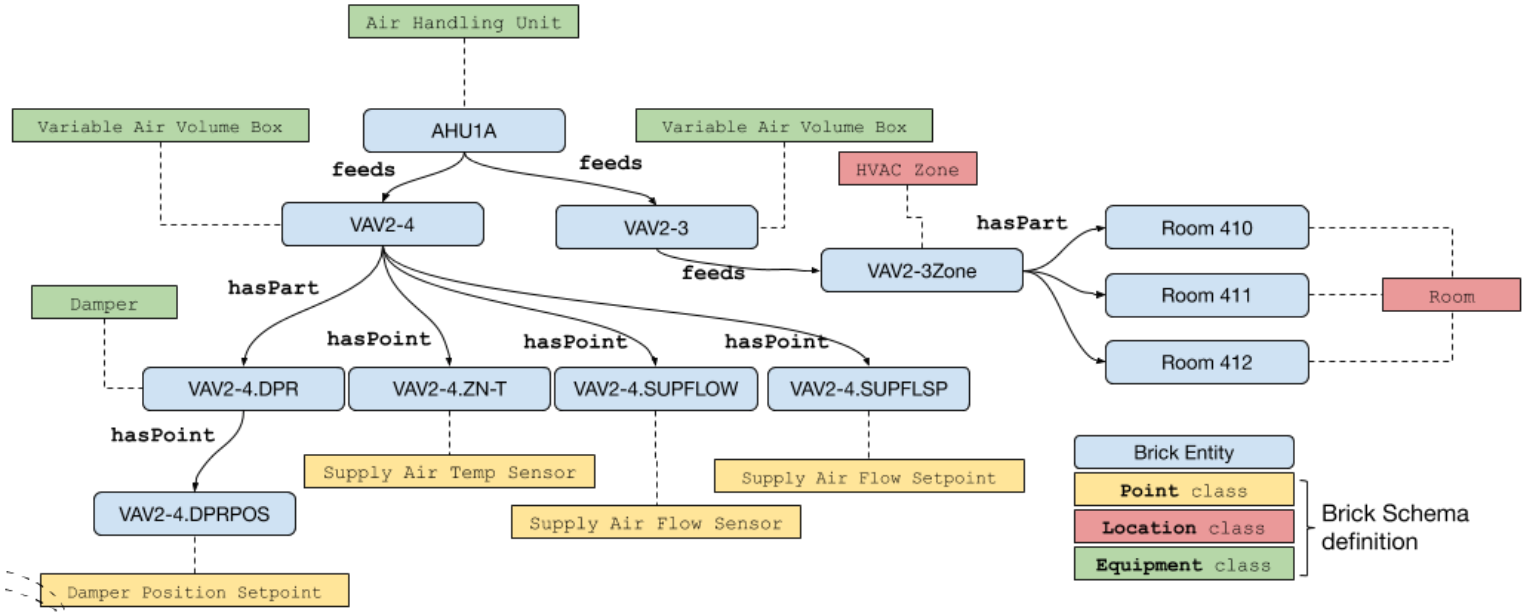


Fig.8 Representing AHU using the Brick ontology
https://brickschema.org/

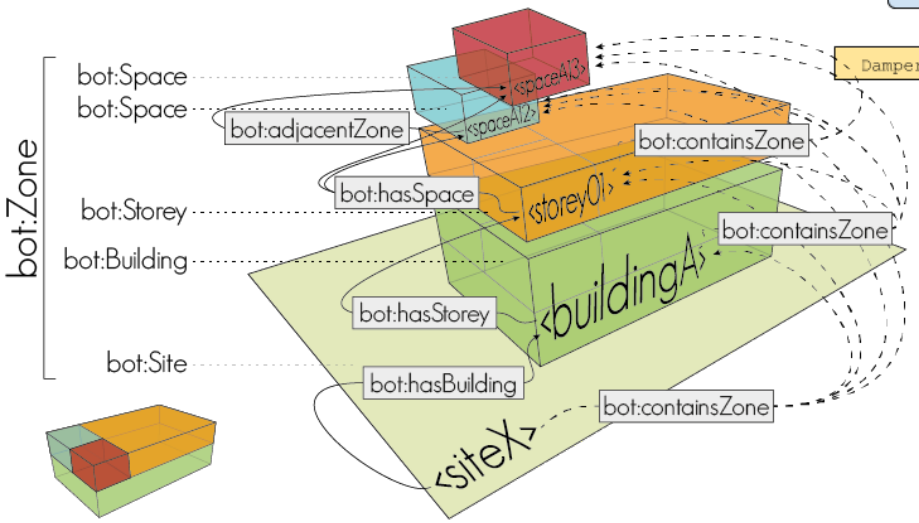


Fig.9 Representing the building topology using the BOT ontology
https://w3c-lbd-cg.github.io/bot/

Text search engine + Human Input

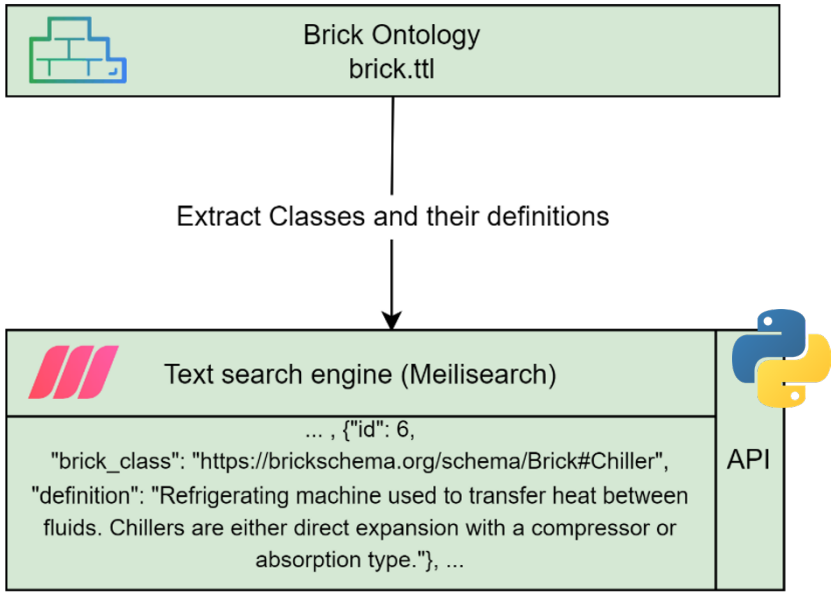


Fig.10 Extracting class names and definitions from the Brick ontology

System No.

Identifier	Description (NL)	Description (EN)	Brick Class
001	Ketel 1	Boiler 1	Boiler
001	Ketel 1	Boiler 1	Boiler
101	Koelmachine 1	Chiller 1	Chiller
201	LBK 1	AHU 1	AHU

brick:Equipment

Control Code

Identifier	Description (NL)	Description (EN)	Brick Class
CV	Regelafsluiter	Regulating valve	Valve
VA-	Afzuig ventilator	Exhaust fan	Exhaust_Fan
CR	Cardreader	Card reader	Access_Reader
HT	Enthalpie Transmitter	Enthalpy Transmitter	Enthalpy_Sensor

brick:Equipment

Point type

Identifier	Description (NL)	Description (EN)	Brick Class
A--	Alarm	Alarm	Alarm
B--	Bedrijfsmelding	Operation status	Status
V--	Sturing	Control	Valve_Command

brick:Point

Fig.12 Three parts of the naming mapped to the Brick ontology

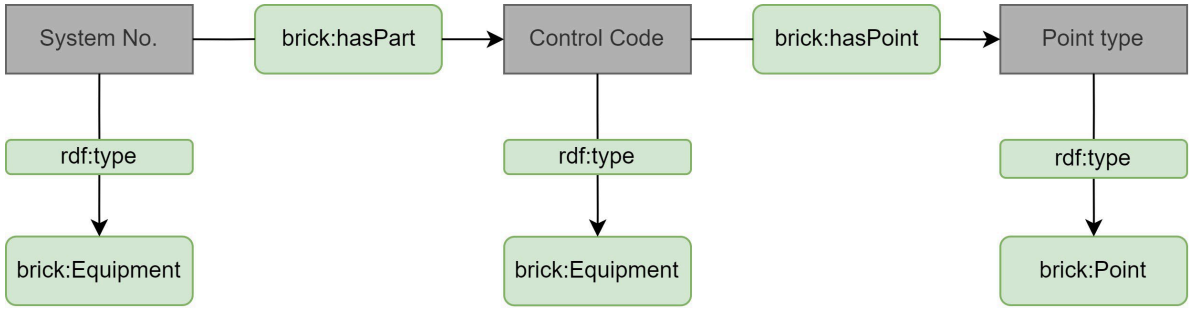


Fig.13 Relevant Brick Classes and Relationships

Step 4: Generating Metadata Schema

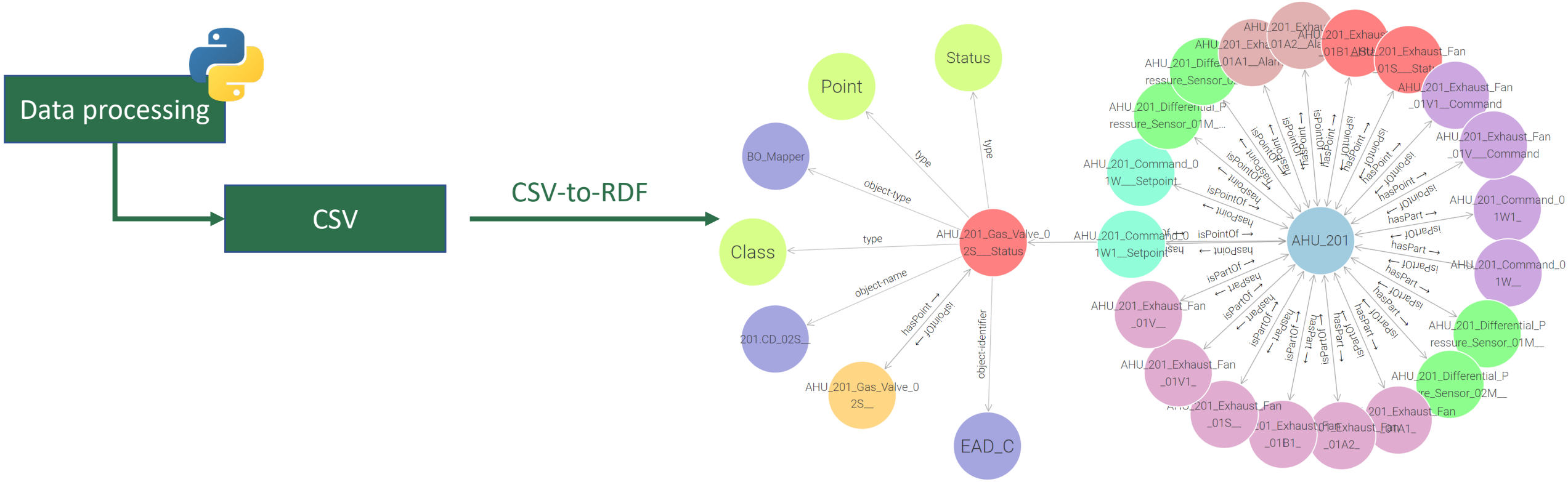


Fig.14 Part of the metadata (AHU 201)

CSV-to-RDF
https://docs.brickschema.org/lifecycle/creation.html#from-structured-tabular-sources

Step 5 : Integrating the schema with a smart building API

- Stored in a **graph database** and integrated with the building API

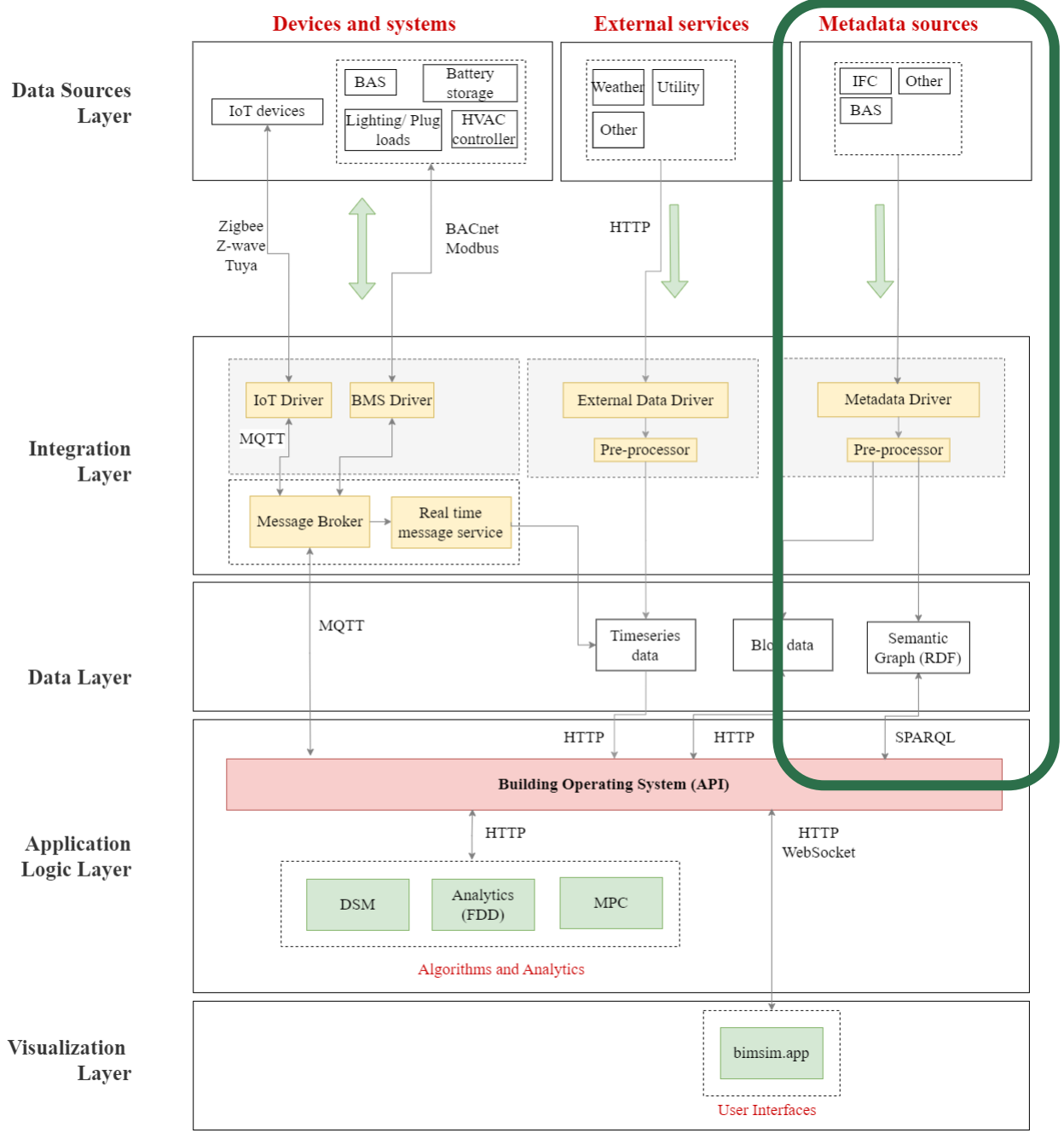
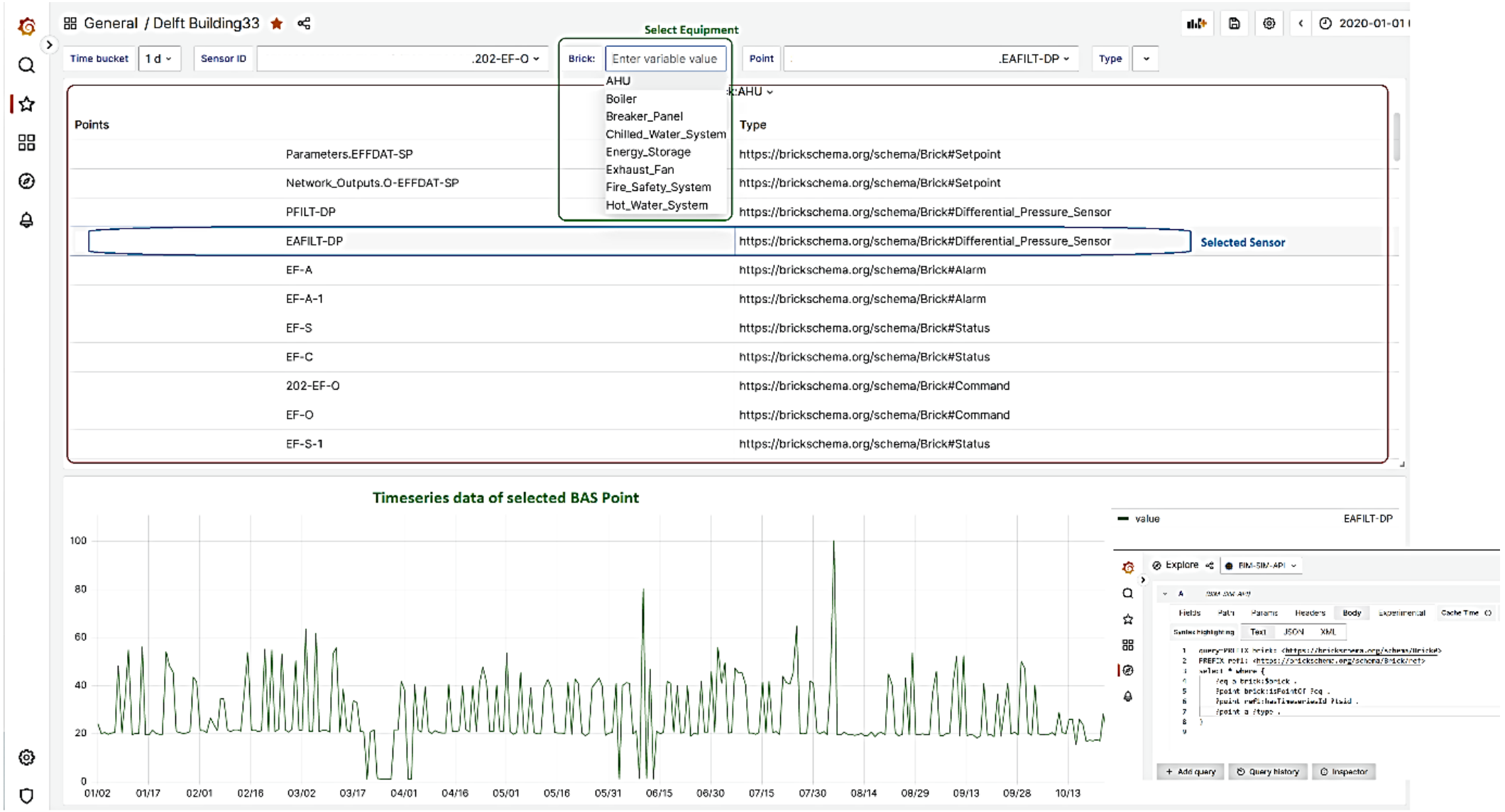


Fig.15 Smart building system architecture[12]

Demo: Grafana dashboard



Demo: Grafana dashboard

Summary and outlook

- Given a proper naming convention, mapping to Brick is achievable, but many buildings do not have a documented naming convention.
- Other improvements include,
    - use sensor readings in the classification (sensor type)

Thank you

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