Delta Intelligent Building Technologies

The Practical and Theoretical:

What's Happening with AI at Delta IBT

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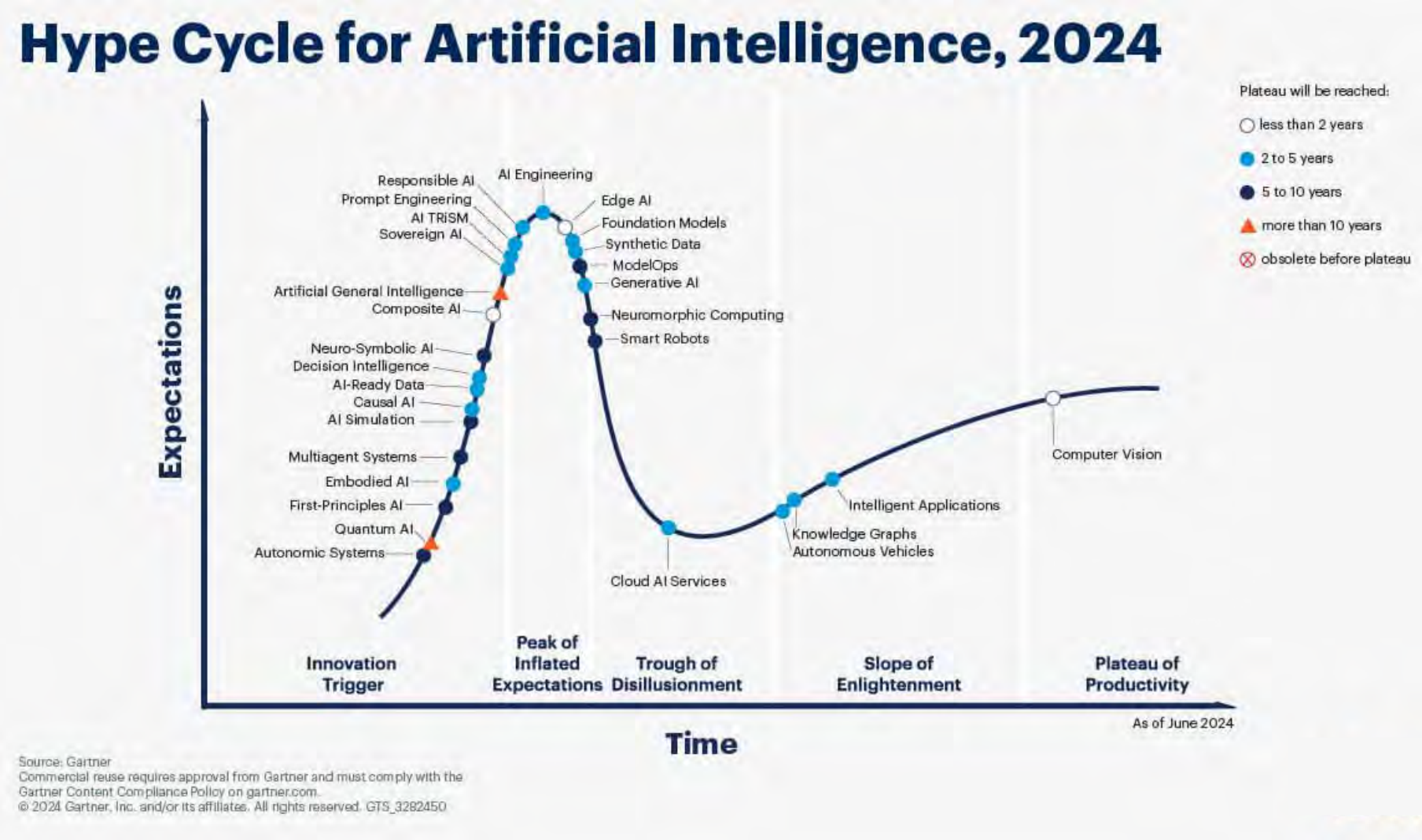
Agenda

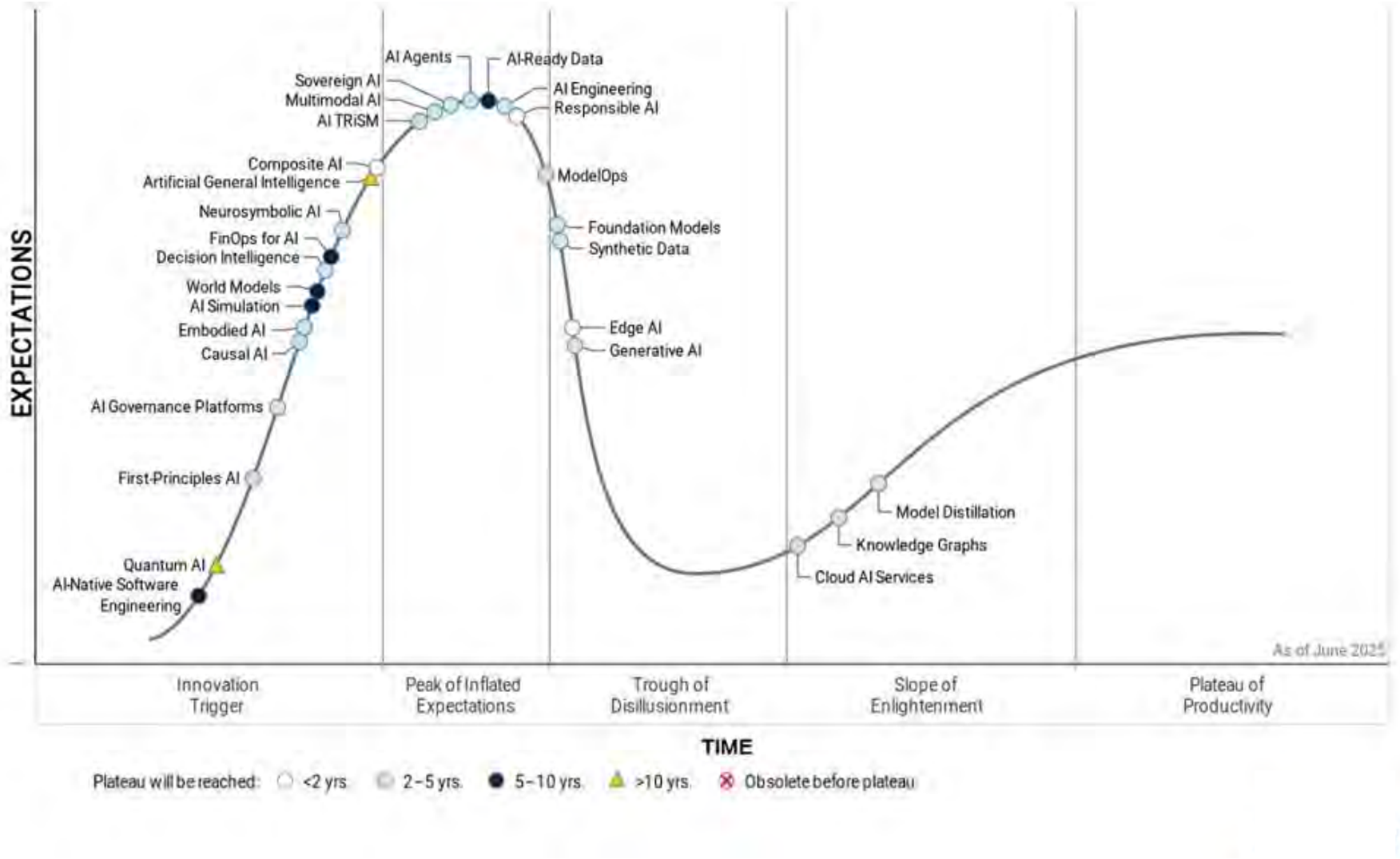
- The latest AI trends shaping the HVAC and building automation industry.
- Emerging technologies and what they could mean for the future of intelligent buildings.
- Real-world examples of AI improving building operations and performance.
- An introduction to emerging ASHRAE standards, and their role in enabling smarter building data and interoperability.
- How Building Canvas is applying AI to improve engineering workflows and project delivery.

AI Hype Cycle – 2024



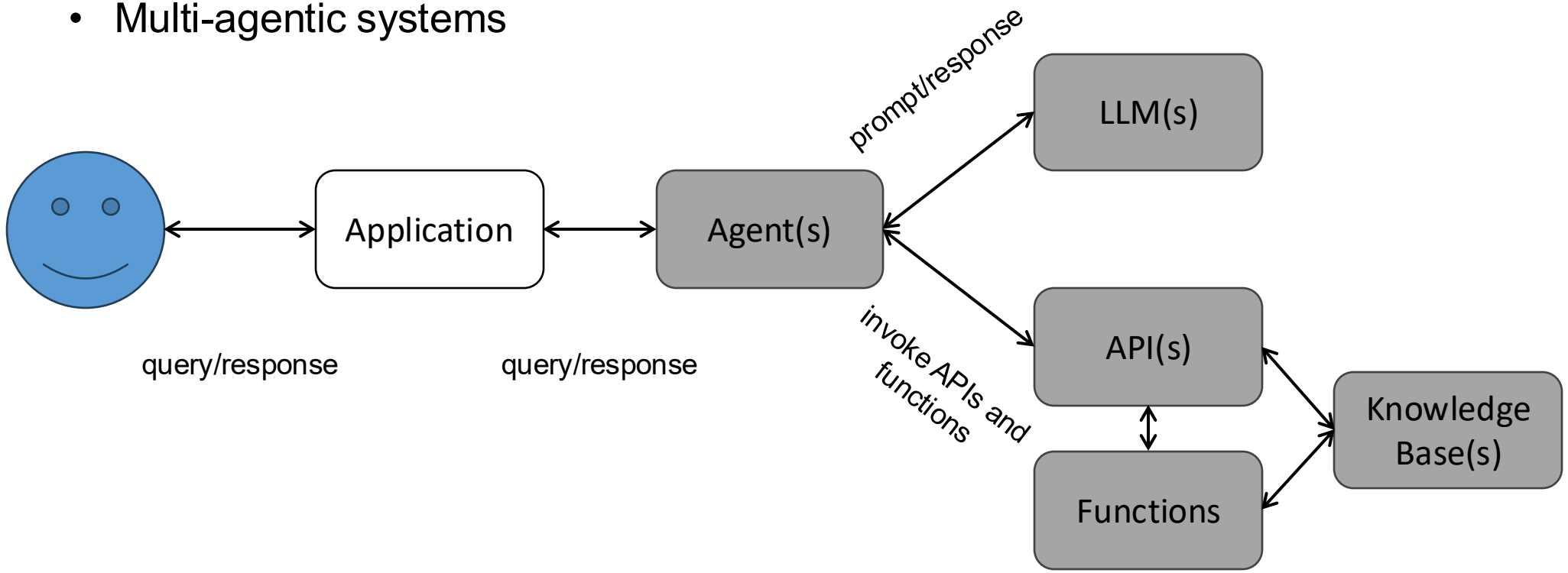
Source: Gartner

AI Hype Cycle – 2025

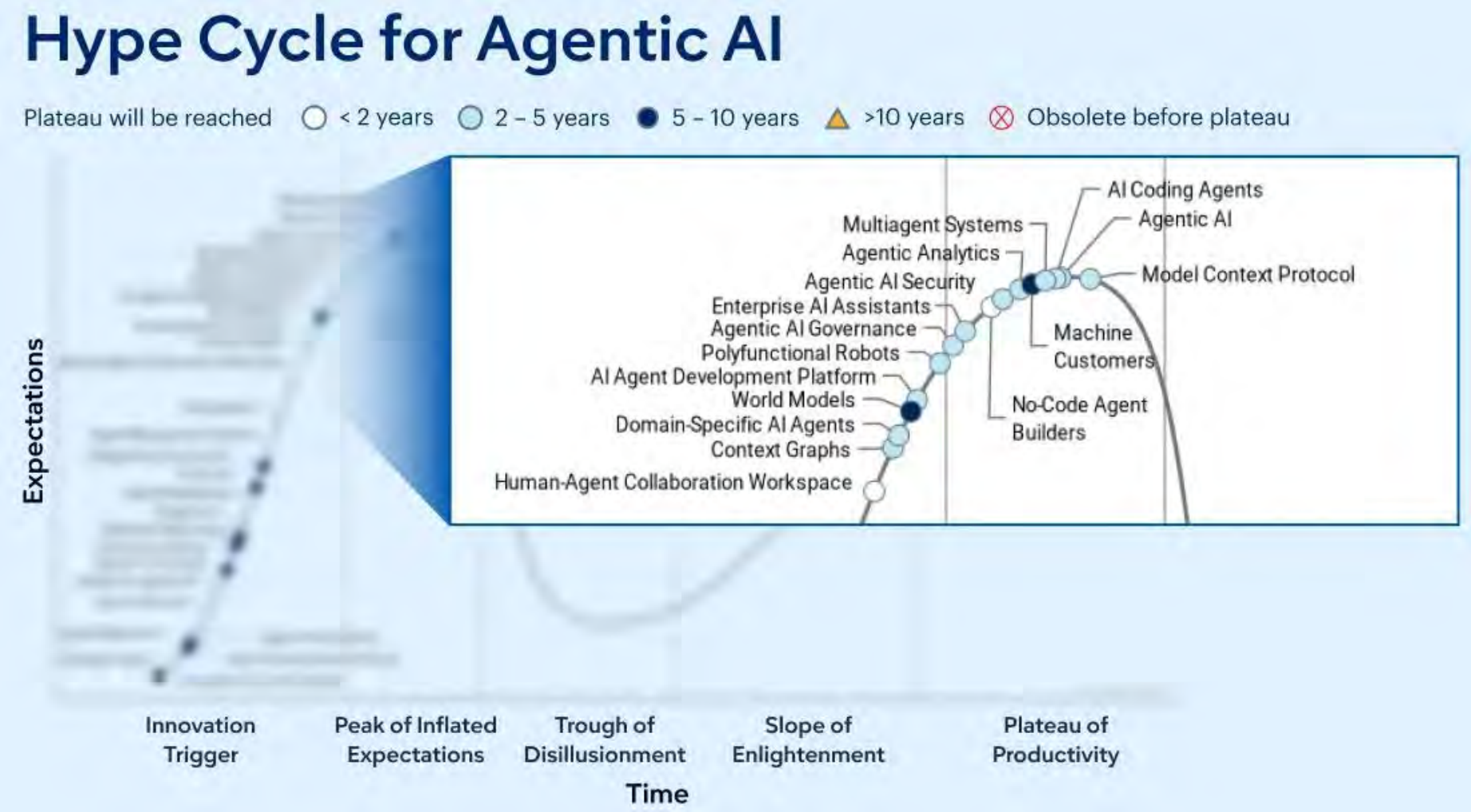


Agentic AI with Retrieval Augmented Generation and Tools

- Important Agentic AI considerations:
  - Function calling (i.e., tools)
  - Knowledge bases via API (e.g., databases, documents)
  - Model context protocol
  - Multi-agentic systems



Agentic AI Hype Cycle – 2026



Emerging Technology Highlights

- No-code applications
  - Agentic Apps with Operating System and Browser Access
- Skills
- Model Context Protocol (MCP)
- More efficient LLMs
- On-prem transformers
- Solidification of semantic data ontologies

AI and AI-Enabling Features

- Kalman filter operative temperature estimation from ceiling edge devices
- Camera-free occupancy estimation on ceiling edge devices
- Python in BACnet programs on edge devices
- Agentic BMS programming with Canvas AI

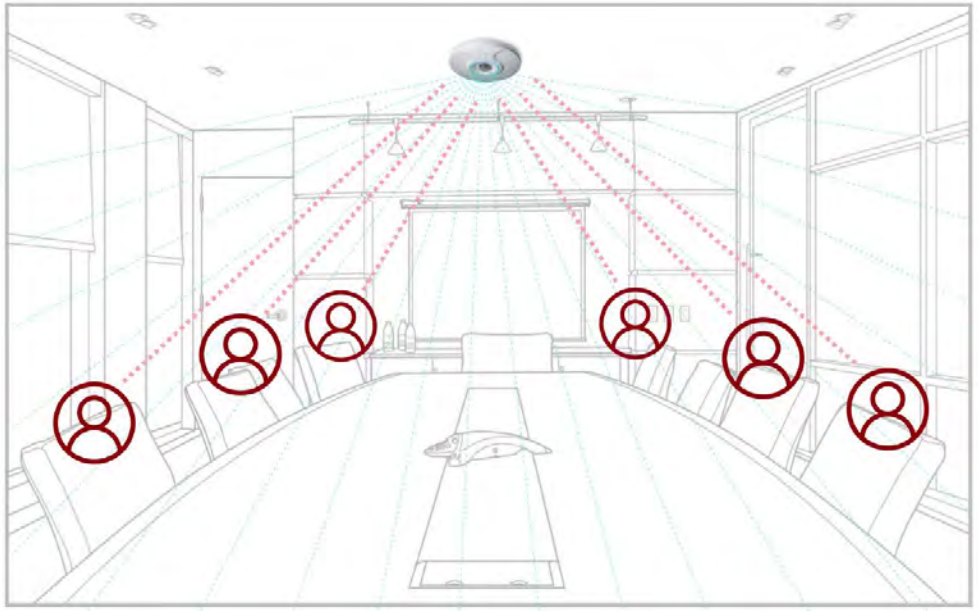
BUILDING CANVAS

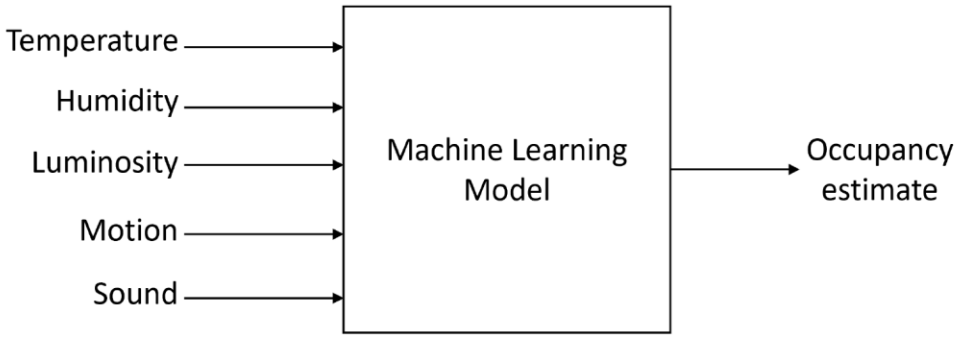
python™

AI Applications – Occupancy Sensor Fusion

- How can occupancy be estimated without a camera?

Sensor	Description
Composite Temperature	The estimated occupant temperature based on air temperature and IR temperature.
Relative Humidity	The occupant height adjusted relative humidity computed from an onboard RH sensor and the composite temperature.
Luminosity	Light intensity measured from an onboard light and color sensor.
PIR Sensor	Standard PIR sensor
Microphones	Two digital MEMs microphones





$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - x_i|$$

$$PW2 = \frac{n_{error<2}}{n_{total}}$$

AI Applications – Occupancy Sensor Fusion

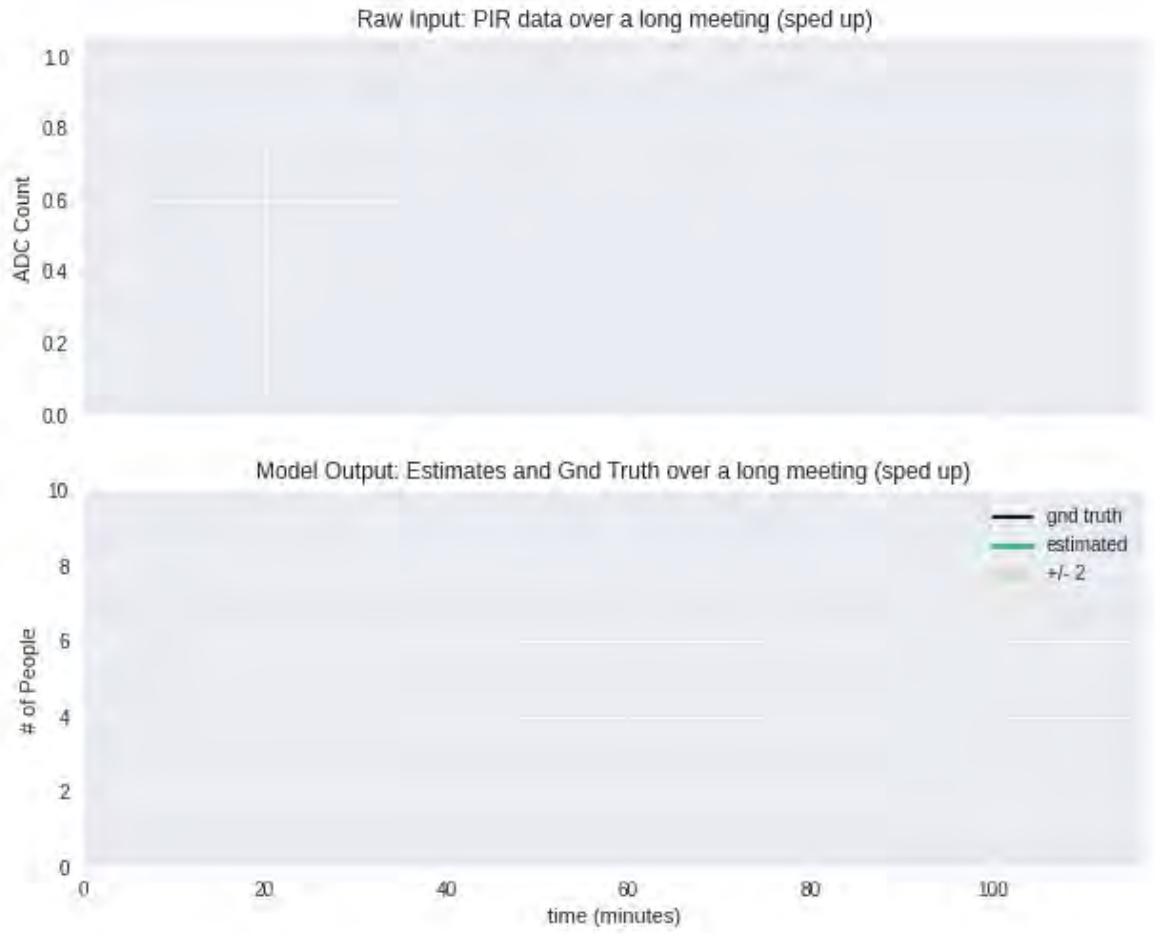
Estimated Occupancy (4143813.AV40)

3

Control Signal	3	at Priority 13
Control Source	O3-SENSE-00 4143813	
COV Minimum Increment	1	
Auto Value	0	
Reliability	No Fault Detected	

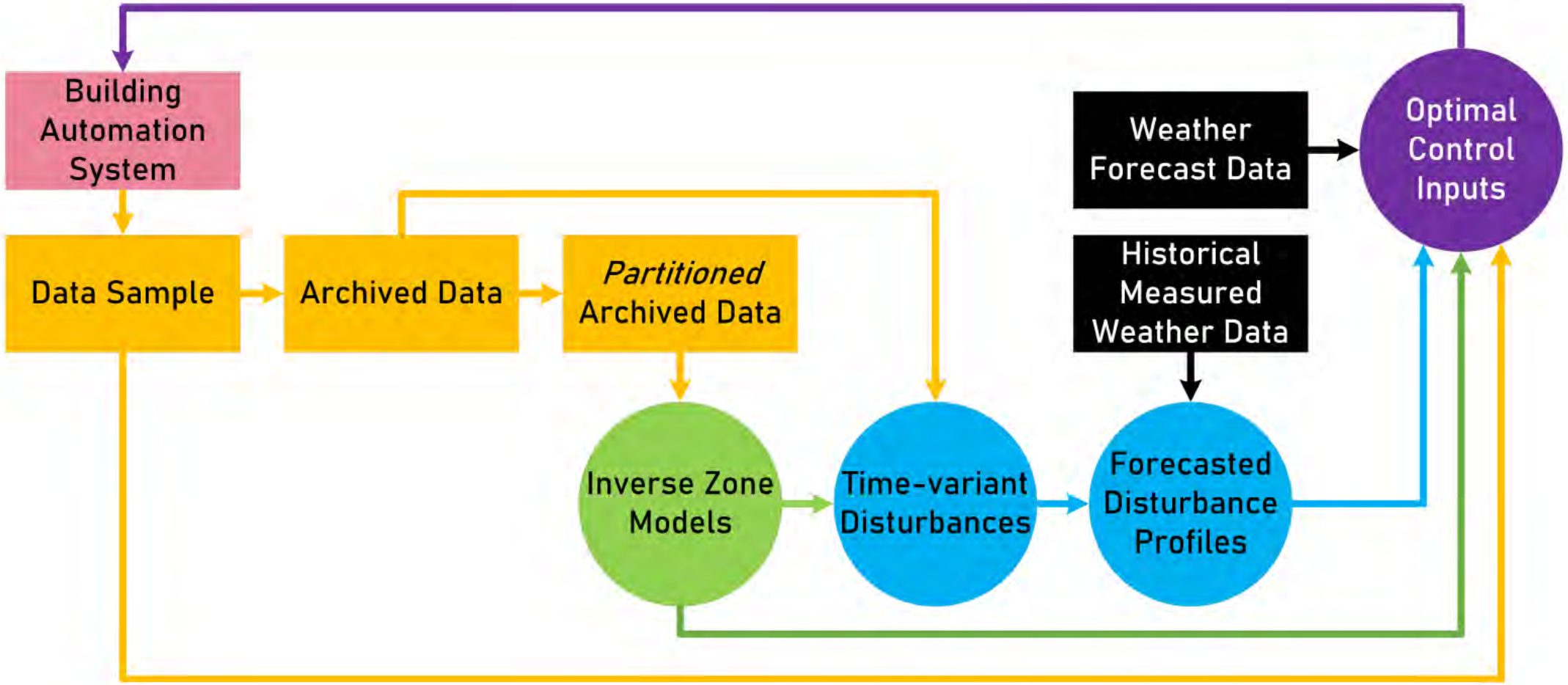
Configuration

Name	Estimated Occupancy
Units	(No Units)
Default Value	0
Reliability Evaluation Inhibit	☐
Commissioned	☐
Manual Override at	◉ Priority 5 ○ Priority 8
COV Minimum Increment	1
Fixed Point	☑
Decimal Places	0



- Privacy preserving, self-contained, approximate-people-counting solution
- Approximate but useful, close enough for most applications
- 86% of meetings contain 6 or less occupants

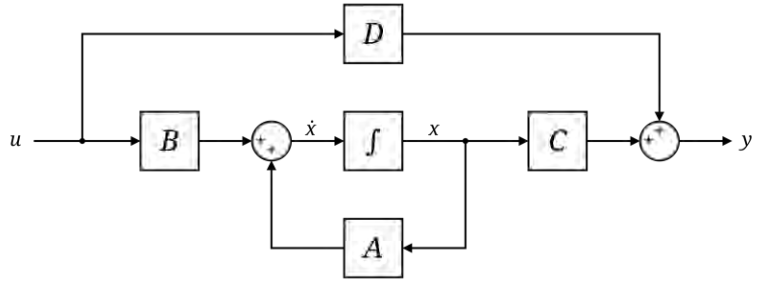
Cloud Supervisory Control Architecture

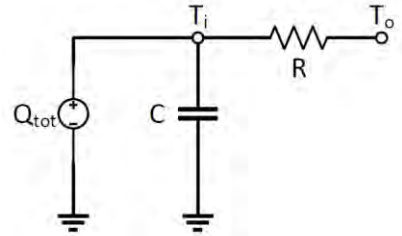


MPC Algorithm Considerations Explored

Optimization – Simultaneous for Energy and Thermal Comfort Using:

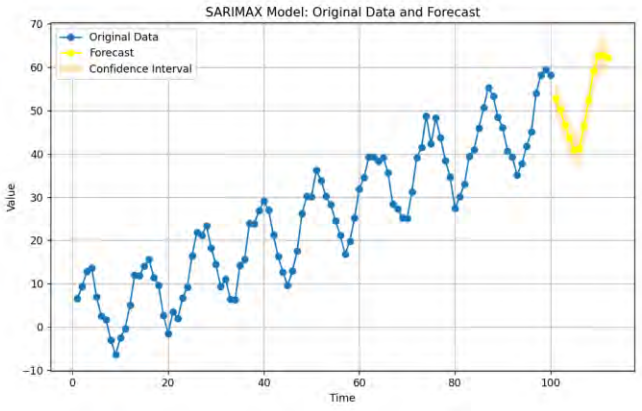
- Minimum Energy Trajectory Inputs
  - Zone Air Flow
  - Zone Discharge Air Temperature
  - Zone Air Temperature
- Thermal Comfort Inputs
  - Indoor Air Temperature
  - Indoor Air Temperature Setpoint



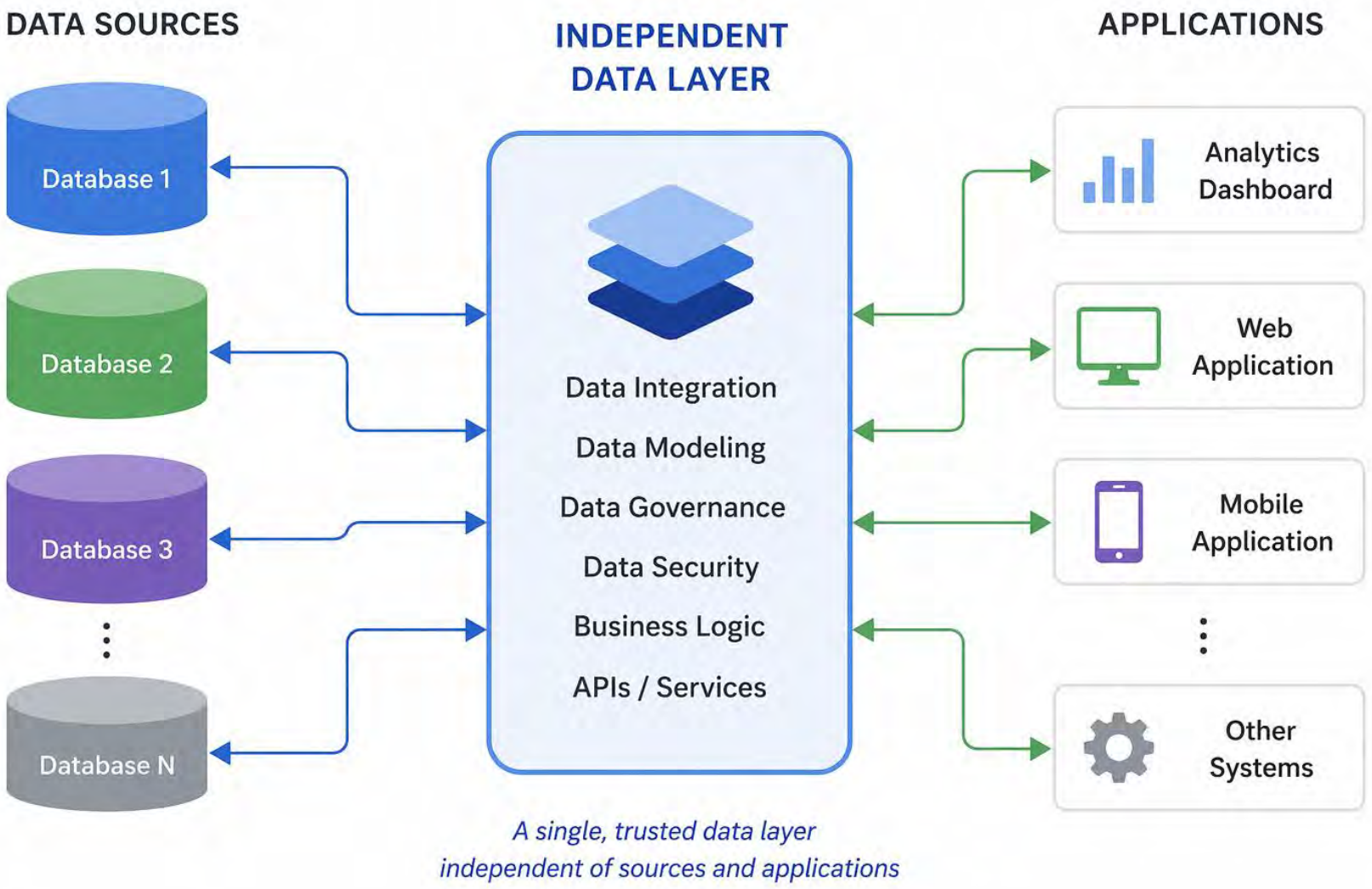


Models:

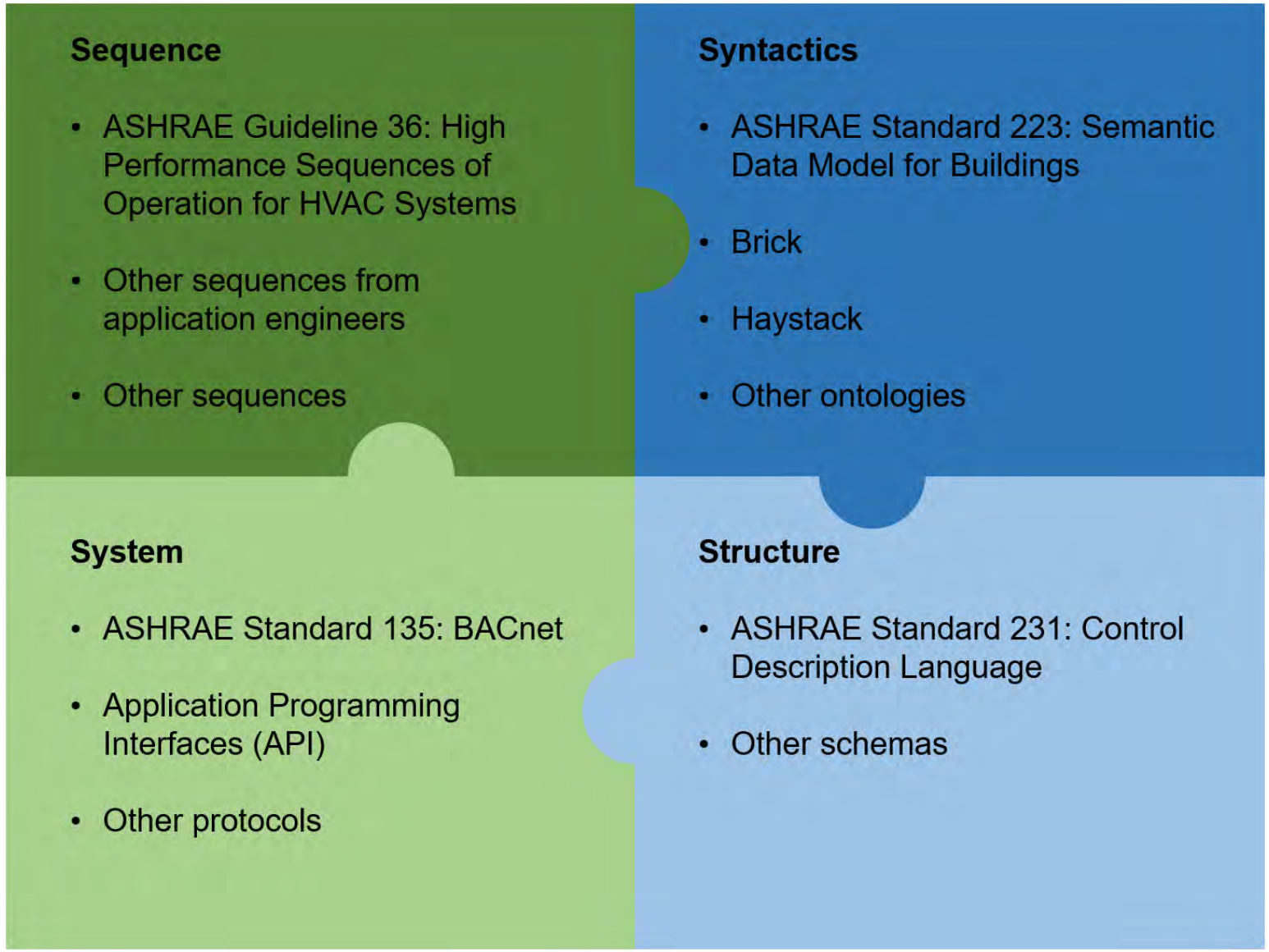
- State-space
- Lumped Capacitance
- Seasonal Autoregressive Integrated Moving Average with Exogenous Regressors (SARIMAX)



Towards the Independent Data Layer



ASHRAE Standards Enabling AI in Building Controls



Semantic Data Modeling with RDF & ASHRAE 223P

A Simple Building in Brick and RDF

NOTE: Brick is higher level and requires less entities and classes than 223P

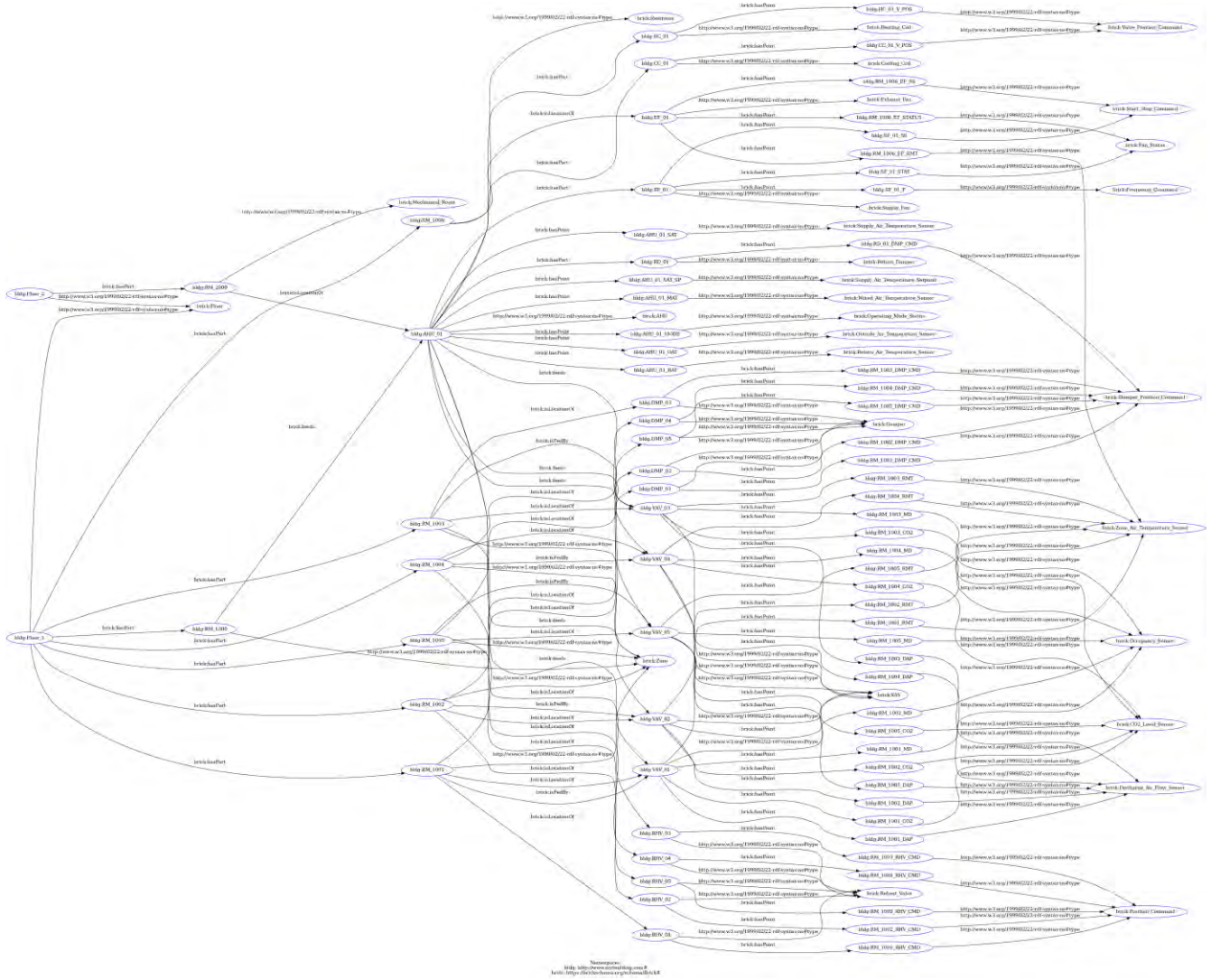
```
bldg:SF_01_SS a brick:Start_Stop_Command .

bldg:SF_01_STAT a brick:Fan_Status .

bldg:AHU_01 a brick:AHU ;
    brick:feeds bldg:VAV_01,
        bldg:VAV_02,
        bldg:VAV_03,
        bldg:VAV_04,
        bldg:VAV_05 ;
    brick:hasPart bldg:CC_01,
        bldg:HC_01,
        bldg:RD_01,
        bldg:SF_01 ;
    brick:hasPoint bldg:AHU_01_MAT,
        bldg:AHU_01_MODE,
        bldg:AHU_01_OAT,
        bldg:AHU_01_RAT,
        bldg:AHU_01_SAT,
        bldg:AHU_01_SAT_SP .

bldg:VAV_01 a brick:VAV ;
    brick:hasPoint bldg:RM_1001_CO2,
        bldg:RM_1001_DAP,
        bldg:RM_1001_MD,
        bldg:RM_1001_RMT .

bldg:VAV_02 a brick:VAV ;
    brick:hasPoint bldg:RM_1002_CO2,
        bldg:RM_1002_DAP,
        bldg:RM_1002_MD,
        bldg:RM_1002_RMT .
```



Semantic Data Modeling with RDF & ASHRAE 223P

A Simple Building in Brick and RDF

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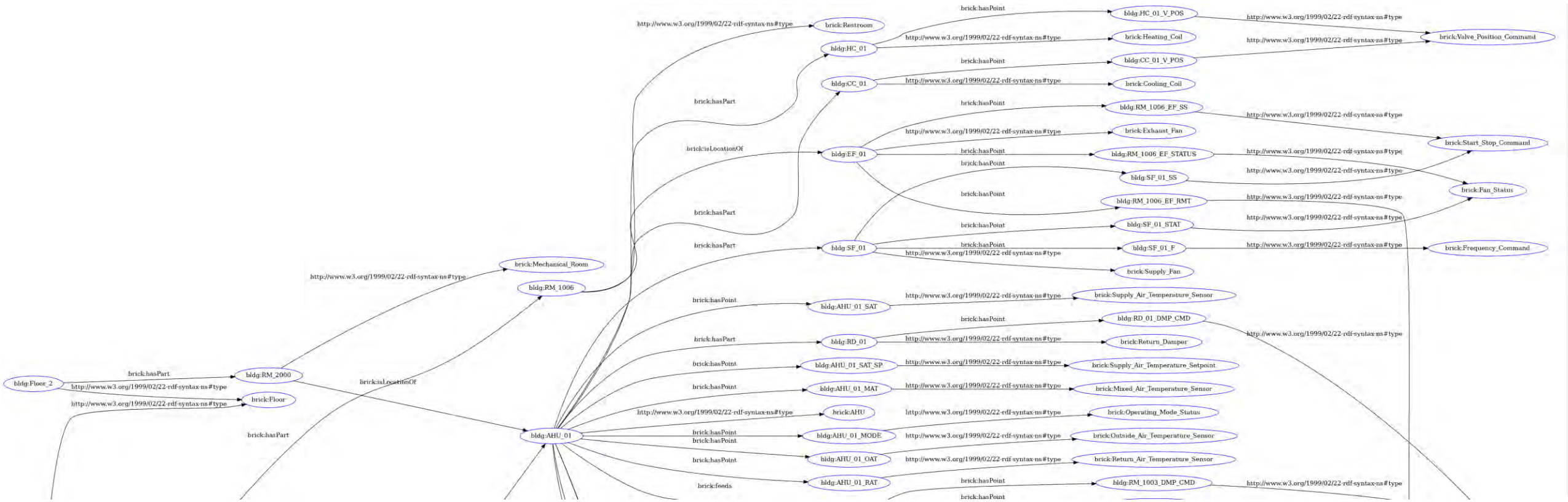

Semantic Data Modeling with RDF & ASHRAE 223P

A Simple Building in Brick and RDF

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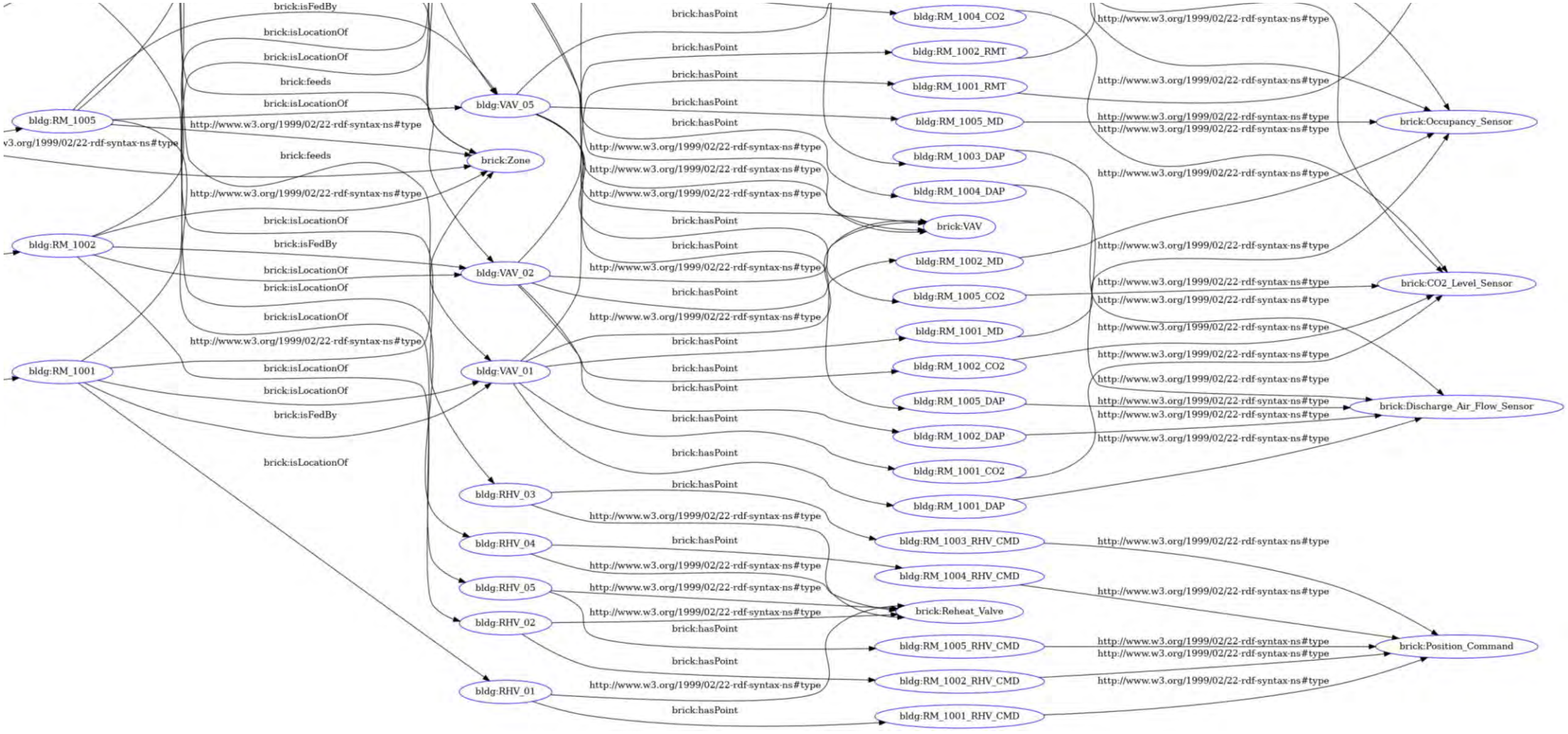
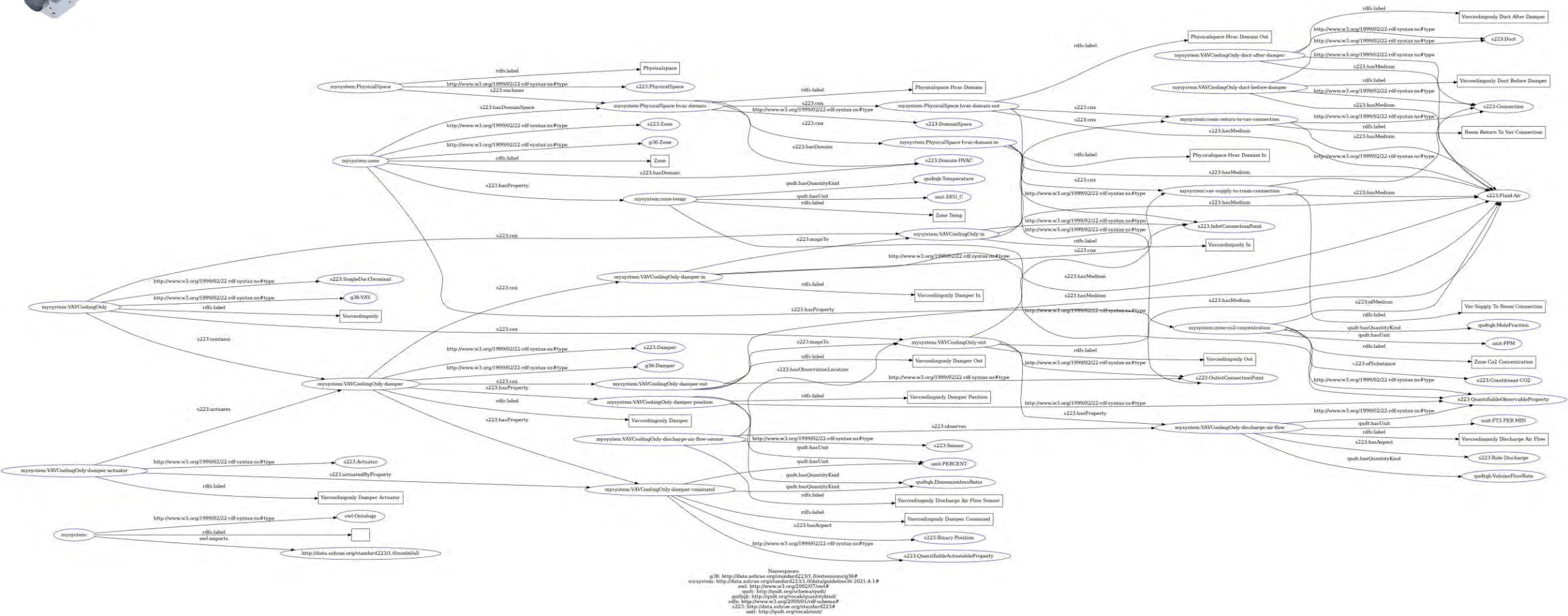


Semantic Data Modeling with RDF & ASHRAE 223P

A Cooling Only VAV in s223P and RDF



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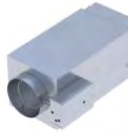

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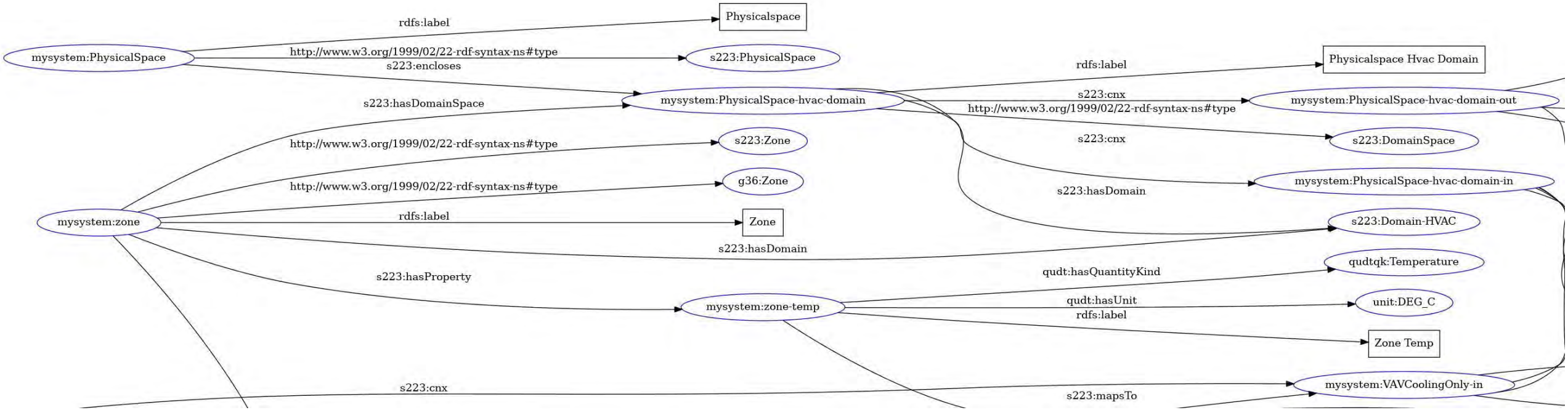

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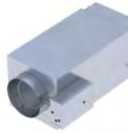

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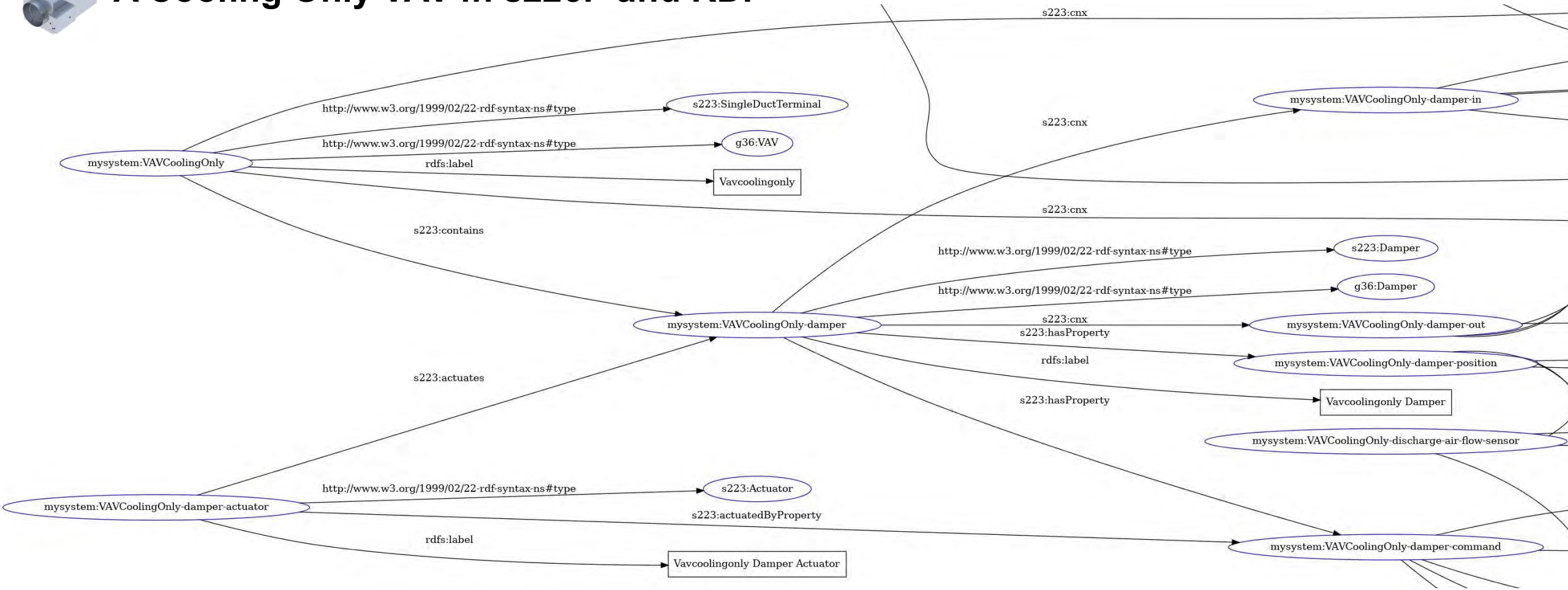
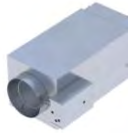


Semantic Data Modeling with RDF & ASHRAE 223P



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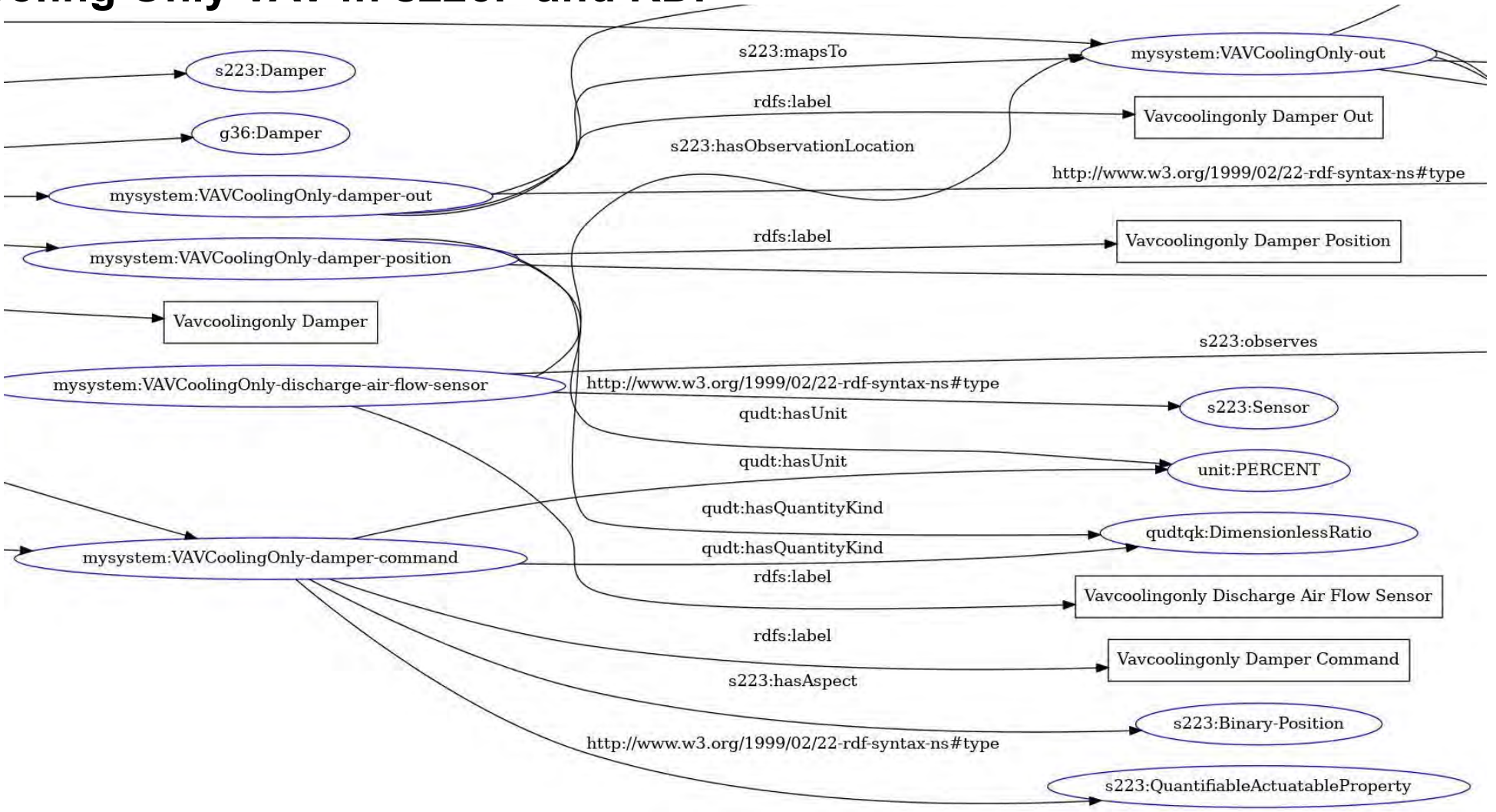

Semantic Data Modeling with RDF & ASHRAE 223P

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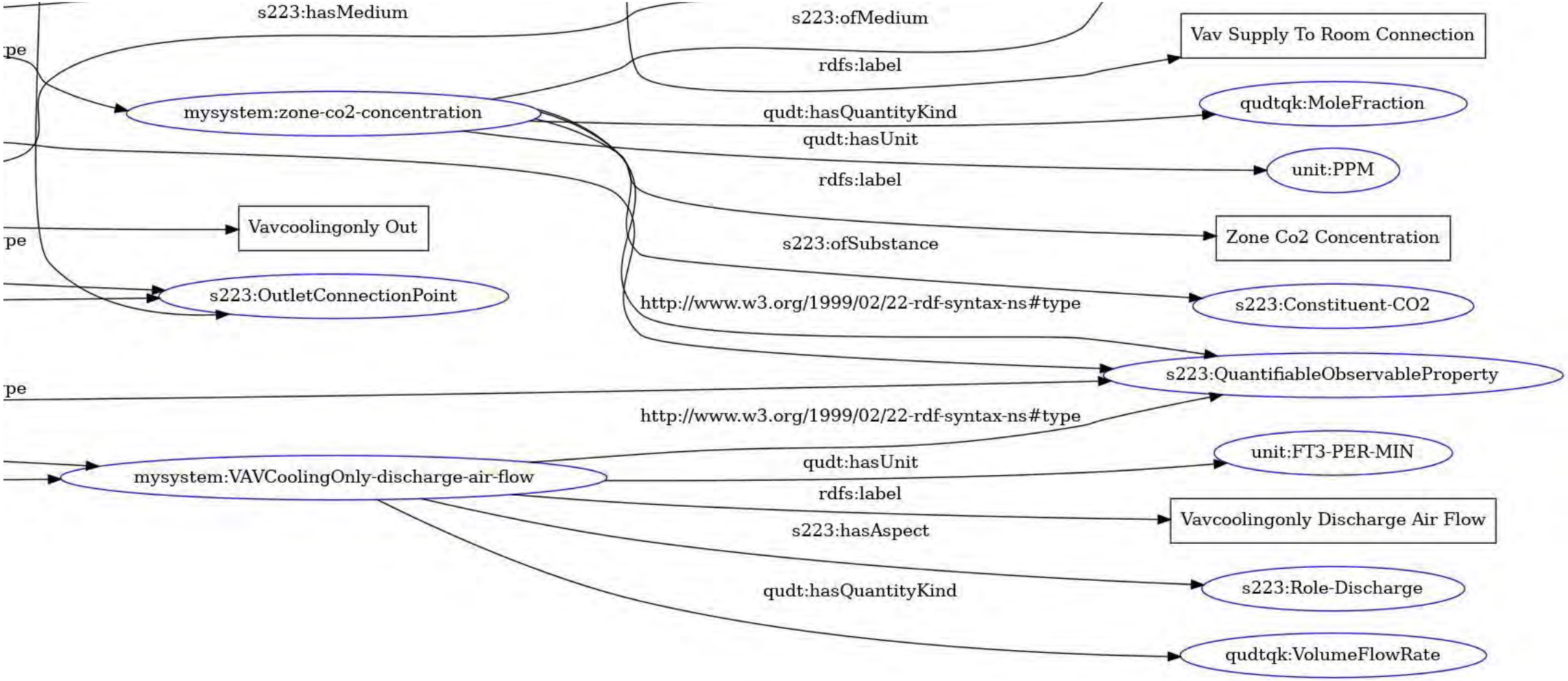

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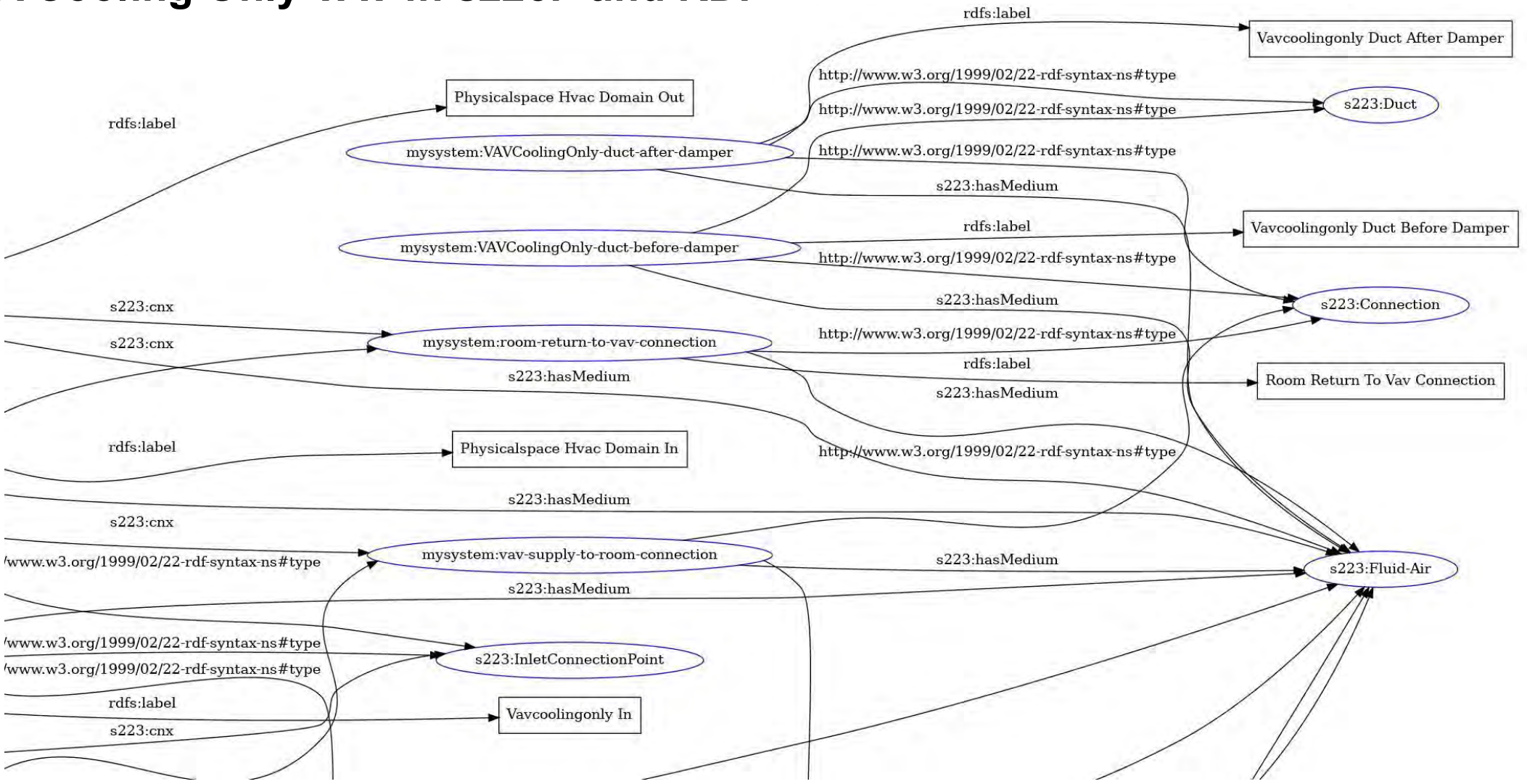


BACnet RDF

- Provides a path for combining BIM and BACnet (and everything between)
- Demonstrates the importance of linking metadata to dynamic assets

135-2024*ct*-1 BACnet Resource Description Framework

Rationale

While the SI-WG (ASHRAE 223p) is developing an RDF data model that can be used to build a graph of building equipment with interconnected components, these views are created for human interpretation and not necessarily machine readable.

This addendum describes the serialization of primitive data elements and constructed data using RDF.

[**Change** Clause 3.3, pg. 21]

…

RBAC	role-based access control
RDF	*resource description framework*
REQ	request primitive

…

BACnet RDF

ZZ.1 Example Object

The following example illustrates an Analog Input Object using the `bacnet:object-type` property to reference the ObjectType enumeration.

```
<ex:aio-1> bacnet:object-type bacnet:ObjectType.analog-input ;
      bacnet:object-identifier "analog-input,1" ;
      bacnet:object-name "OAT" ;
      bacnet:description "Outside air temperature" .
```

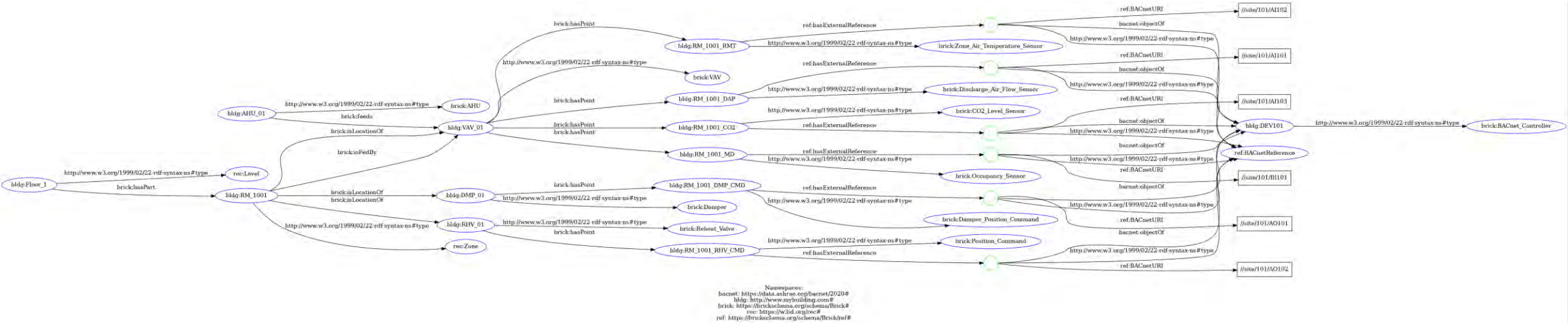
ZZ.2 Example Binary Value Object

The following example illustrates a Binary Value Object using `rdf:type` to describe the type of RDF node. The `bacnet:object-type` property value can be inferred.

```
<ex:bv-2> rdf:type bacnet:BinaryValueObject ;
      bacnet:object-identifier "binary-value,2" ;
      bacnet:object-name "OCCENAB" ;
      bacnet:description "Occupancy control enabled" ;
      bacnet:present-value bacnet:BinaryPV.active ;
      bacnet:out-of-service false ;
      bacnet:event-state bacnet:EventState.normal .
```

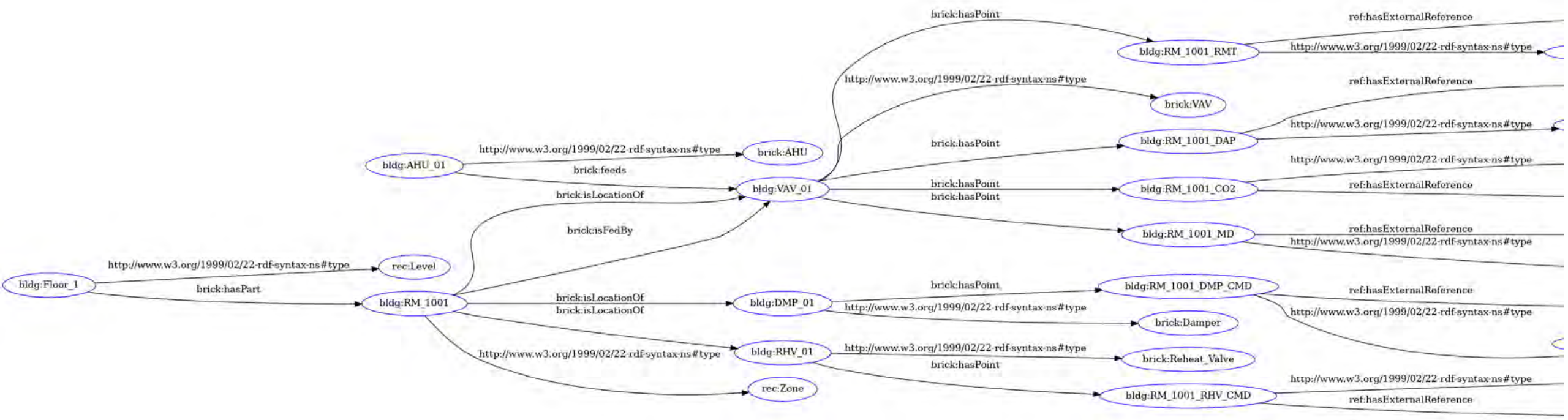
A Simple Application of BACnet RDF with Brick

Example:
VAV + Reheat



A Simple Application of BACnet RDF with Brick

VAV + Reheat



Building & External Relationships

Equipment & Components

Control Points & Classifications

A Simple Application of BACnet RDF with Brick

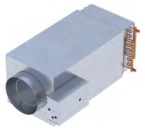
VAV + Reheat

bldg:AHU_01
bldg:VAV_01
bldg:RM_1001
rec:Level
brick:AHU
brick:VAV
bldg:RM_1001_RMT
bldg:RM_1001_DAP
bldg:RM_1001_CO2
bldg:RM_1001_MD
bldg:DMP_01
bldg:RHV_01
rec:Zone
bldg:RM_1001_DMP_CMD
bldg:RM_1001_RHV_CMD
brick:Damper
brick:Reheat_Valve
http://www.w3.org/1999/02/22-rdf-syntax-ns#type
brick:feeds
brick:isLocationOf
brick:isFedBy
brick:hasPoint
ref:hasExternalReference

Equipment & Components

Control Points & Classifications

A Simple Application of BACnet RDF with Brick



VAV + Reheat

Point Classifications

BACnet Objects

BACnet Controller

ASHRAE Guideline 36 with Standard 231

Guideline 36
Sequence of Operations

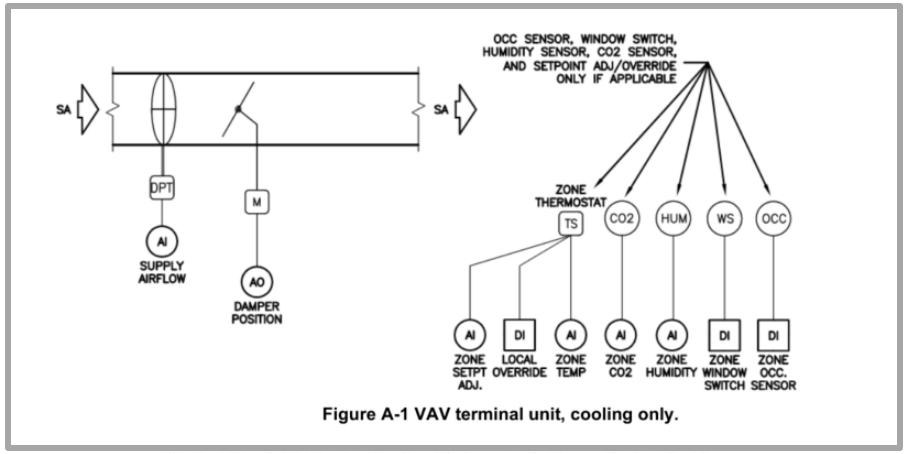


Figure A-1 VAV terminal unit, cooling only.

5.5.5.1. When the Zone State is cooling, the cooling-loop output shall be mapped to the active airflow setpoint from the minimum endpoint to the cooling maximum endpoint.

a. If supply air temperature from the air handler is greater than room temperature, the active airflow setpoint shall be no higher than the minimum endpoint.

5.5.5.2. When the Zone State is deadband, the active airflow setpoint shall be the minimum endpoint.

5.5.5.3. When the Zone State is heating, the Heating Loop output shall be mapped to the active airflow setpoint from the minimum endpoint to the heating maximum endpoint.

a. If supply air temperature from the air handler is less than 3°C (5°F) above the room temperature, the active airflow setpoint shall be no higher than the minimum endpoint.

5.5.5.4. The VAV damper shall be modulated by a control loop to maintain the measured airflow at the active setpoint.

5.5.6. Alarms

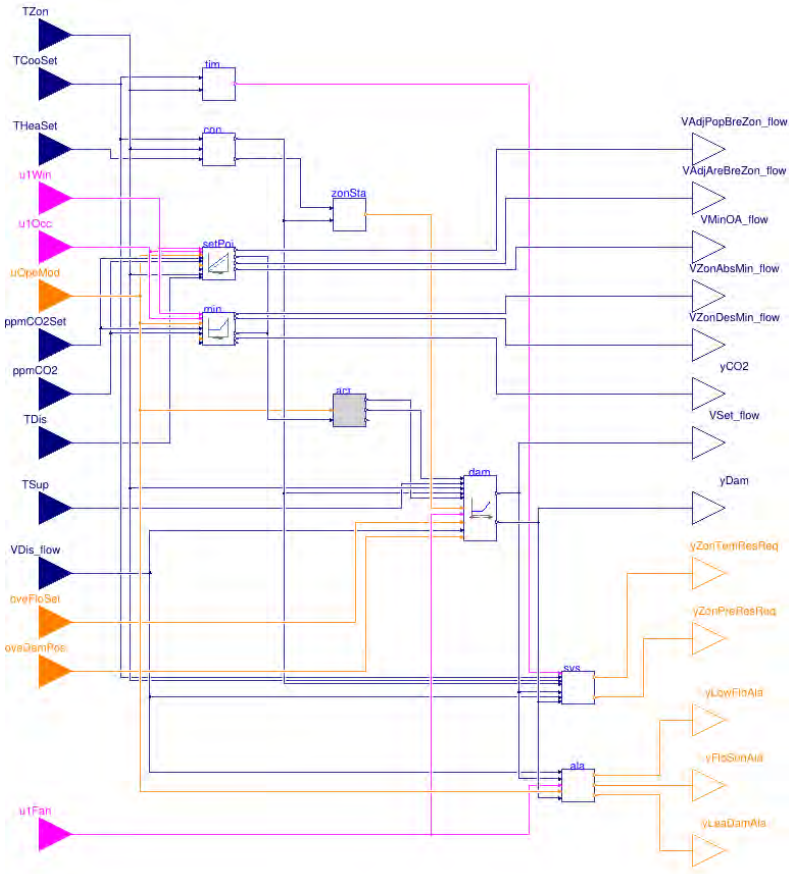
5.5.6.1. Low Airflow

a. If the measured airflow is less than 70% of setpoint for 10 minutes while setpoint is greater than zero, generate a Level 4 alarm.

b. If the measured airflow is less than 50% of setpoint for 10 minutes while setpoint is greater than zero, generate a Level 3 alarm.

c. If a zone has an Importance-Multiplier of 0 (see Section 5.1.16) for its static pressure reset T&R control loop, low airflow alarms shall be suppressed for that zone.

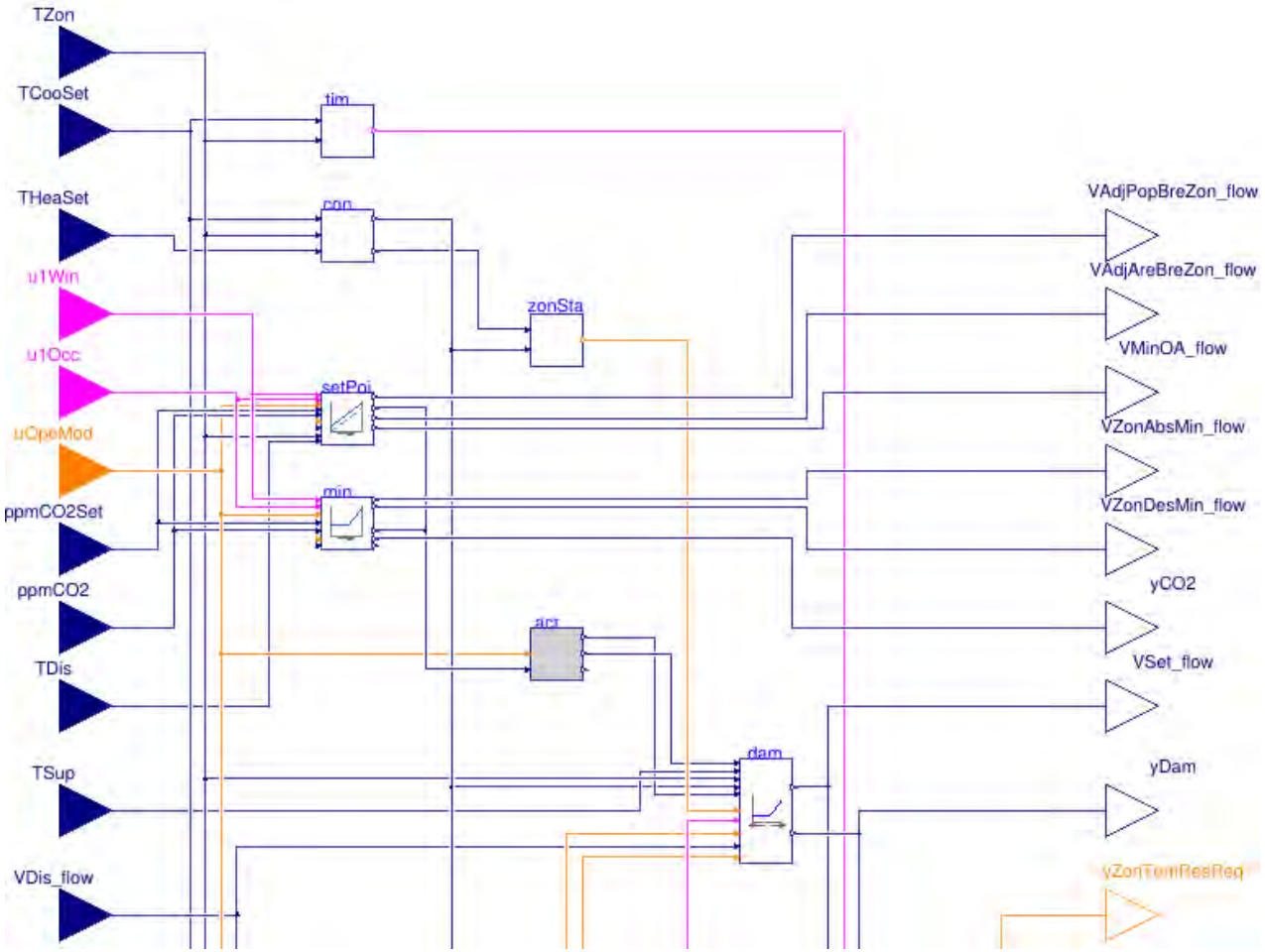
Standard 231
Control Description Language



https://simulationresearch.lbl.gov/modelica/releases/latest/help/Buildings_Controls_OBC_ASHRAE_G36_TerminalUnits_CoolingOnly.html#Buildings.Controls.OBC.ASHRAE.G36.TerminalUnits.CoolingOnly

ASHRAE Guideline 36 with Standard 231

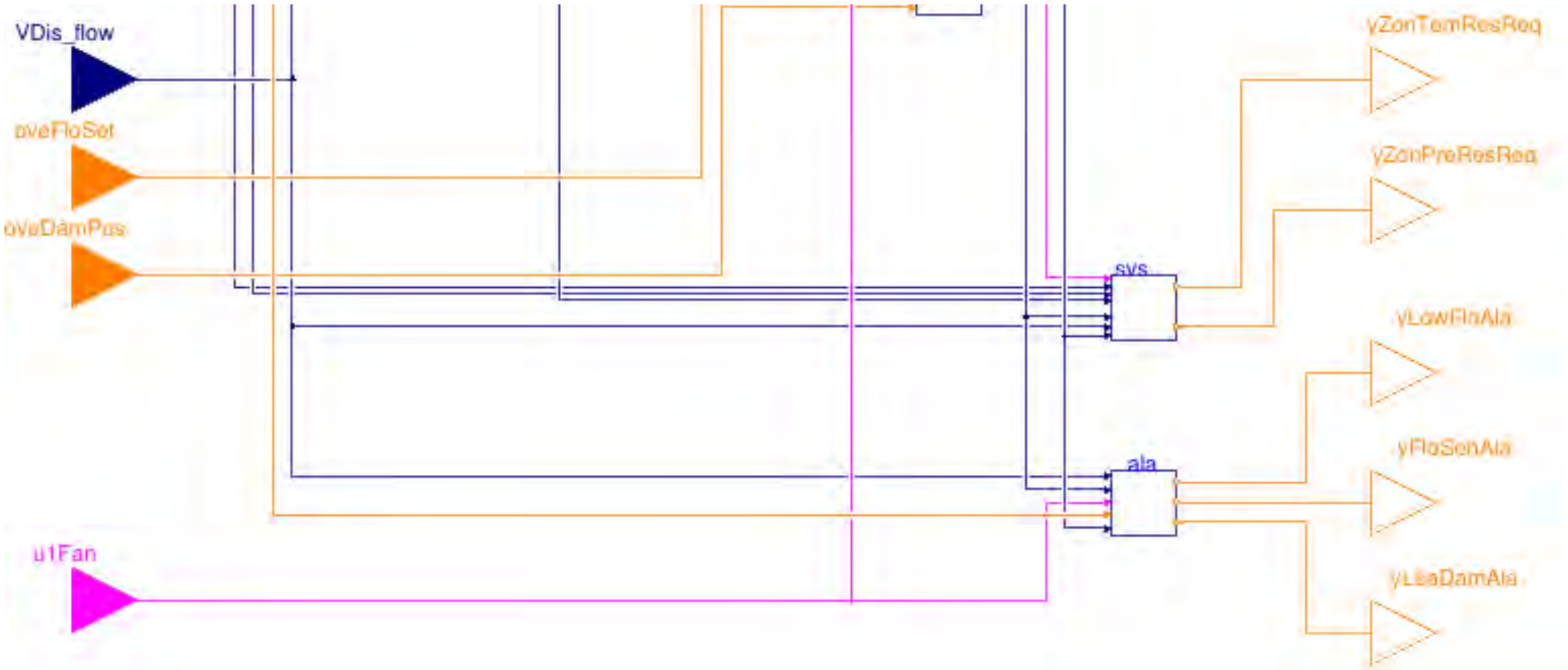
Cooling Only VAV in S231 (Control Description Language)



https://simulationresearch.lbl.gov/modelica/releases/latest/help/Buildings_Controls_OBC_ASHRAE_G36_TerminalUnits_CoolingOnly.html#Buildings.Controls.OBC.ASHRAE.G36.TerminalUnits.CoolingOnly

ASHRAE Guideline 36 with Standard 231

Cooling Only VAV in S231 (Control Description Language)



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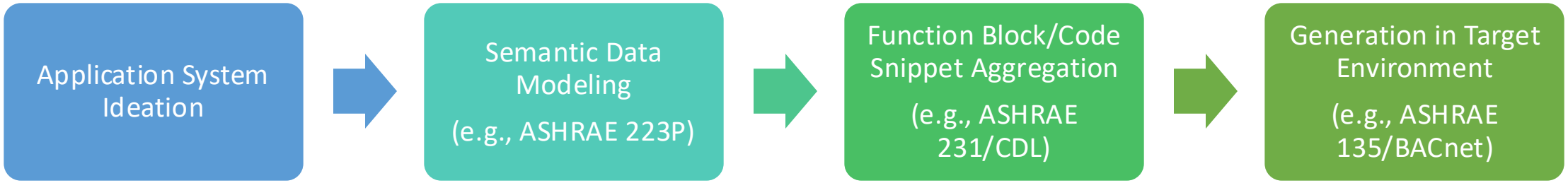
ASRHAE 223 and 231 Resources

- ASHRAE Standard 223P Examples: https://models.open223.info/
  - Can be rapidly viewed here if you paste the text: https://www.ldf.fi/service/rdf-grapher

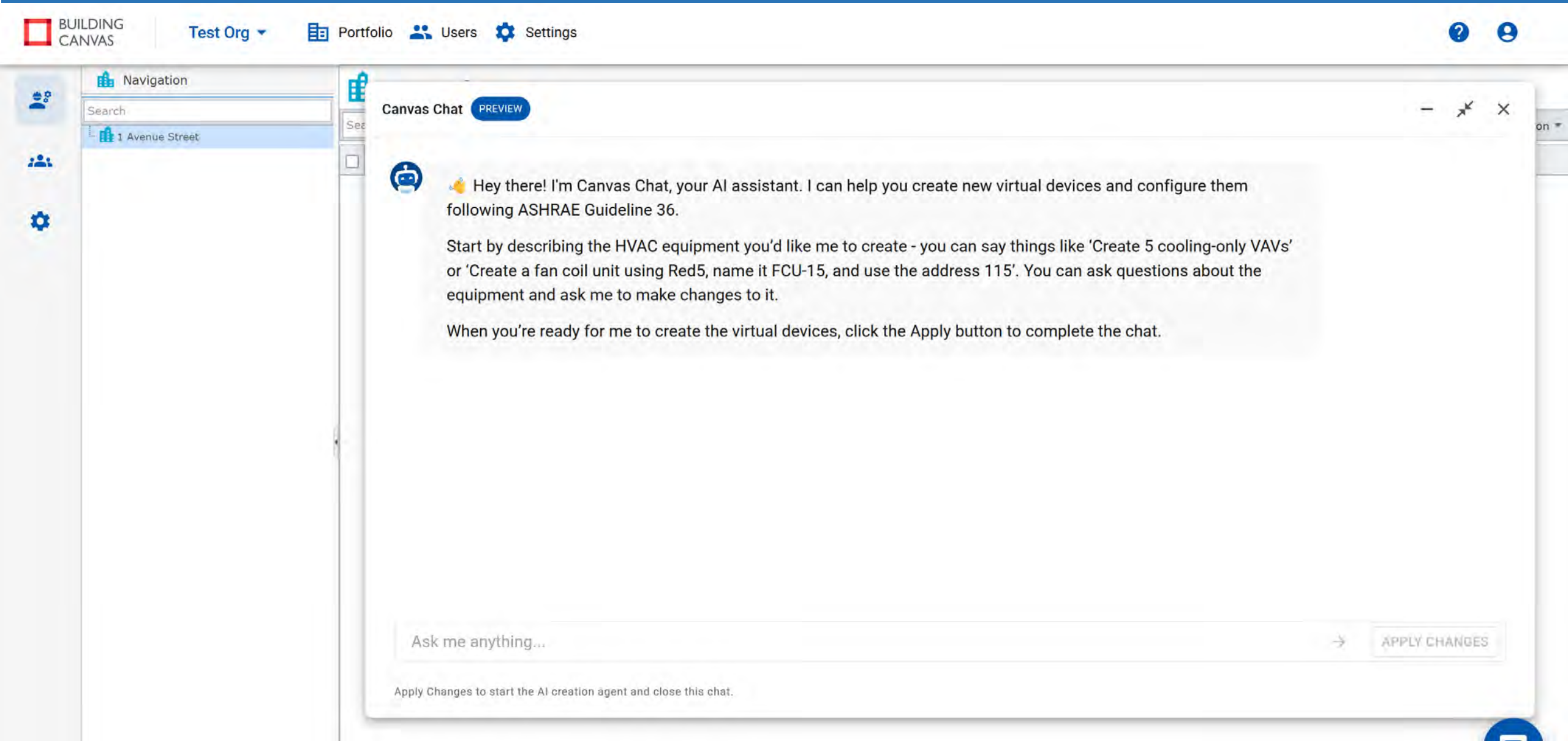
- ASHRAE Standard 231 Data: https://data.ashrae.org/standard231/

Semantic Data Model Based Workflows in Building Automation

- Rapidly configure control graphics and graphical user interfaces (GUI)
- Rapidly configure analytics from public (or semi-public) libraries
- Improve single-pane-of-glass data aggregation from multiple protocols and application programming interfaces (API)
- Provide normalized context with ontological definitions of the assets in a system to LLM-powered AI systems



Agentic BMS Programming



Moving *with* Emerging Technology

Independent Data Layer, Ontologies, and Multimodal Data

- Native Resource Description Framework (RDF) to support Brick and ASHRAE 223
- Model Context Protocol for direct AI agent usage of project data
- Brownfield Autotagging to ingest existing infrastructure into the Canvas environment
- Ingestion of drawings and natural language sequences for the purpose of generating controller programming

Closing Remarks

- The AI space continues to move quickly
  - But the focus has moved from foundation models to agentic applications
- Semantic Data Modeling ties digital and physical assets together in a format that AI applications can easily interact with
  - ASHRAE and Brick are leading the way on generative AI technology support
- Canvas AI will continue to improve as AI technology improves
  - Skills did not exist at scale when development began
- Unmanaged analytics as they are today in buildings will be commodified by leveraging agents, Model Context Protocol, and Semantic Data Modeling

Questions

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