# Thoughts on building meta-data representation

- based on several FDD attempts

BAS points representation

What information do we need?
- Location Information (location level)
  - Building. Floor. Zone

- Functional/Context Information (asset level)
  - Absolute Location ref of VAV/AHU (physical loc)
  - Context ref of asset (connection of ahu-vav, ahu-zone)

- Inner Information (point level)
  - Sensing points meta: type, asset ref, functionality (difference between outside/return/mix/ discharge[supply]/exhaust air)

Location Information

Building

Floor 1 — Floor 2 — Floor 3

1011 — Auditorium

320 — 321 — 305
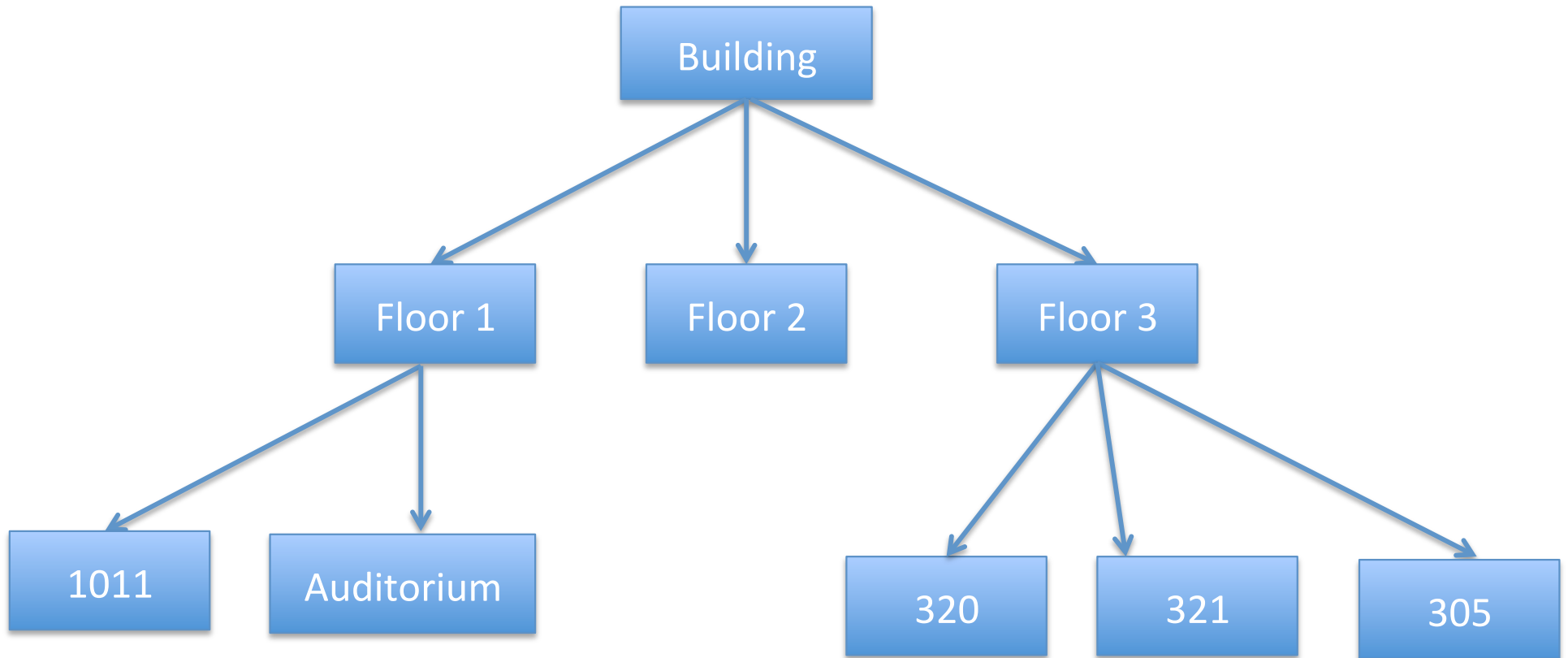
e.g., Building.Floor1.1011   Building.Floor3.320

JSON

```json
{
  "Building": {
    "building_meta": "on hold (building description, consruction year etc.)",
    "ref_id": "uuid",
    "structure": {
      "Floor1": {
        "floor_meta": "on hold (floor map, description, etc.)",
        "ref_id" : "uuid",
        "structure": [
          {
            "zone": "102",
            "zone_meta": "classroom",
            "ref_id": "uuid"
          },
          {
            "zone": "113",
            "zone-meta": "office",
            "ref_id": "uuid"
          }
        ]
      },
      "Floor2": {
        "floor_meta": "on hold (floor map, description, etc.)",
        "ref_id" : "uuid",
        "structure": [
          {
            "zone": "212",
            "zone_meta": "auditorium",
            "ref_id": "uuid"
          }
        ]
      }
    }
  }
}
```

```
▼ Building {3}
      building_meta : on hold (building description, consruction year etc.)
      ref_id : uuid
   ▼ structure {2}
      ▼ Floor1 {3}
            floor_meta : on hold (floor map, description, etc.)
            ref_id : uuid
         ▼ structure [2]
            ▼ 0   {3}
                  zone : 102
                  zone_meta : classroom
                  ref_id : uuid
            ▼ 1   {3}
                  zone : 113
                  zone-meta : office
                  ref_id : uuid
      ▼ Floor2 {3}
            floor_meta : on hold (floor map, description, etc.)
            ref_id : uuid
         ▼ structure [1]
            ▼ 0   {3}
                  zone : 212
                  zone_meta : auditorium
                  ref_id : uuid
```

Functional/Context Information

- Absolute Location ref of VAV/AHU (physical loc)
  e.g. AHU2: {loc_ref: floor_uuid}
     VAV1: {loc_ref: zone_uuid}

- Context ref of asset: The idea is to find out which VAVs/zones are drawing air from AHU, which AHU is supplying air for VAV/zone
  e.g. AHU2: {fun_ref: [vav_uuid1,…, zone_uuid]}
     VAV1: {fun_ref: ahu_uuid}
     FCU1: {fun_ref: zone_uuid}

- Point ref of asset: find all the points inside each asset
  e.g. AHU2: {point_ref:[uuid_1,uuid2]}

JSON

```json
{
  "AHU": {
    "AHU_meta": "on hold (ahu description, consruction year etc.)",
    "ref_id": "uuid",
    "loc_ref": "uuid",
    "fun_ref": [
      {
        "id": "uuid_1",
        "notes": "supplying air to the VAV"
      },
      {
        "id": "uuid_2",
        "notes": "supplying air to the zone"
      }
    ],
    "point_ref": ["uuid1","uuid2"]
  },
  "VAV": {
    "VAV_meta": "on hold",
    "ref_id": "uuid",
    "loc_ref": "uuid",
    "fun_ref": [
      {
        "id": "uuid_1",
        "notes": "draw air from this AHU unit"
      }
    ],
    "point_ref": ["uuid1","uuid2"]
  },
  "FCU": {
    "FCU_meta": "on hold",
    "ref_id": "uuid",
    "loc_ref": "uuid",
    "fun_ref": [
      {
        "id": "uuid_1",
        "notes": "supplying air to this zone"
      }
    ],
    "point_ref": ["uuid1","uuid2"]
  }
}
```

```
▼ AHU   {5}
    AHU_meta : on hold (ahu description, consruction year etc.)
    ref_id : uuid
    loc_ref : uuid
  ▼ fun_ref [2]
    ▶ 0   {2}
    ▶ 1   {2}
  ▼ point_ref [2]
        0  : uuid1
        1  : uuid2
▼ VAV   {5}
    VAV_meta : on hold
    ref_id : uuid
    loc_ref : uuid
  ▼ fun_ref [1]
    ▶ 0   {2}
  ▼ point_ref [2]
        0  : uuid1
        1  : uuid2
▼ FCU   {5}
    FCU_meta : on hold
    ref_id : uuid
    loc_ref : uuid
  ▼ fun_ref [1]
    ▼ 0   {2}
        id    : uuid_1
        notes : supplying air to this zone
  ▼ point_ref [2]
        0  : uuid1
        1  : uuid2
```

Inner Information

We assume all points are located within assets/zones, and we focus only on hardware points

- Uuid, asset_ref, (loc_ref)
- Point category: valve, temperature, fan
- functionality(extend Haystack): outside air temperature
- acronym: unique among each asset
- Value: define legitimate range of values
- Unit: F, cfm, kwh
- IOType: AI, AO, DI(BI),DO(BO)
- …. (extendable)

JSON

```json
[
  {
    "display_name": "OAT",
    "ref_id": "uuid",
    "asset_ref": "asset_uuid",
    "loc_ref": "loc_uuid",
    "category": "valve",
    "functionality": "outside air temperature",
    "acronym": "OAT",
    "value": "define legitimate range of values",
    "unit": "Fahrenheit",
    "IOType": "AI",
    "other": "..."
  }
]
```

▼ 0 {11}

display_name : OAT

ref_id : uuid

asset_ref : asset_uuid

loc_ref : loc_uuid

category : valve

functionality : outside air temperature

acronym : OAT

value : define legitimate range of values

unit : Fahrenheit

IOType : AI

other : ...

Dictionary

- Every time an uuid is created/updated, the path of that element will be stored into a dictionary.
  - E.g. {"uuid1": "location.Building.structure.floor1"}

- Easy access to elements in O(1) time

Application Example1

FDD rules applied to AHUs in different buildings.

"when supply air fan is on and both heating and cooling coil is on, raise an alarm" (Simultaneously heating and cooling)

We need **supply air fan, hot water valve, chilled water valve**

Sage	Johnson Control	AutomatedLogic	Siemens
PH.AHU.RMA17D.SAF. PRESENT_VALUE	PC-NAE-1/N2-1.EN1.SF-S.PRESENT_VALUE	AHU-4 I/O/SF s/s	DOH.AHU.001.SAF
PH.AHU.RMA17D.CCV. PRESENT_VALUE	PC-NAE-1_PC-NAE-1/N2-1.EN1.CLG-VLV.PRESENT_VALUE	AHU-4 I/O/chw vlv	DOH.AHU.001.CCO
PH.AHU.RMA17D.HCV. PRESENT_VALUE	PC-NAE-1_PC-NAE-1/N2-1.EN1.PH-VLV.PRESENT_VALUE	AHU-4 I/O/pht hw vlv	DOH.AHU.001.HCO

**<u>Efforts are spent to locate the required points!</u>**

Application Example 2

Trouble shooting: two AHUs in the same floor, one is 100% cooling, the other is 40% heating
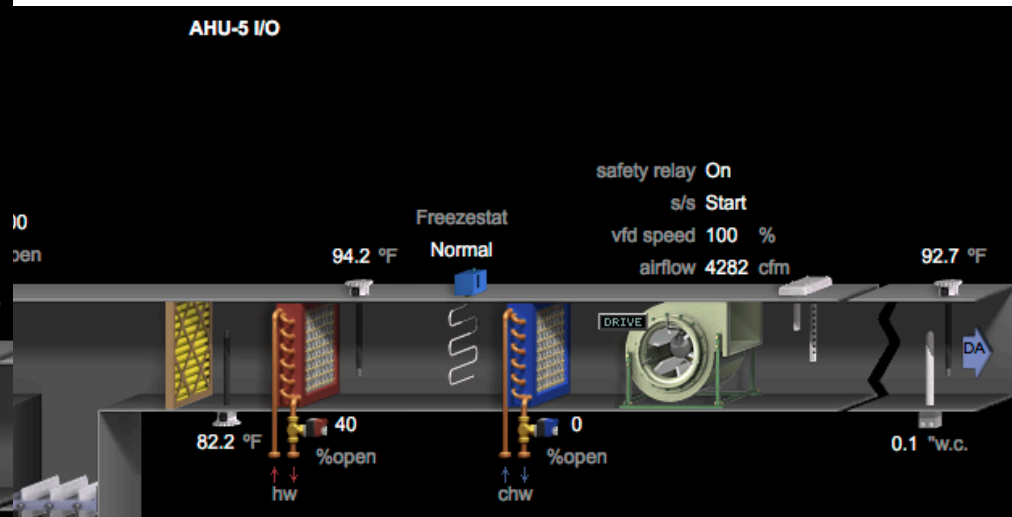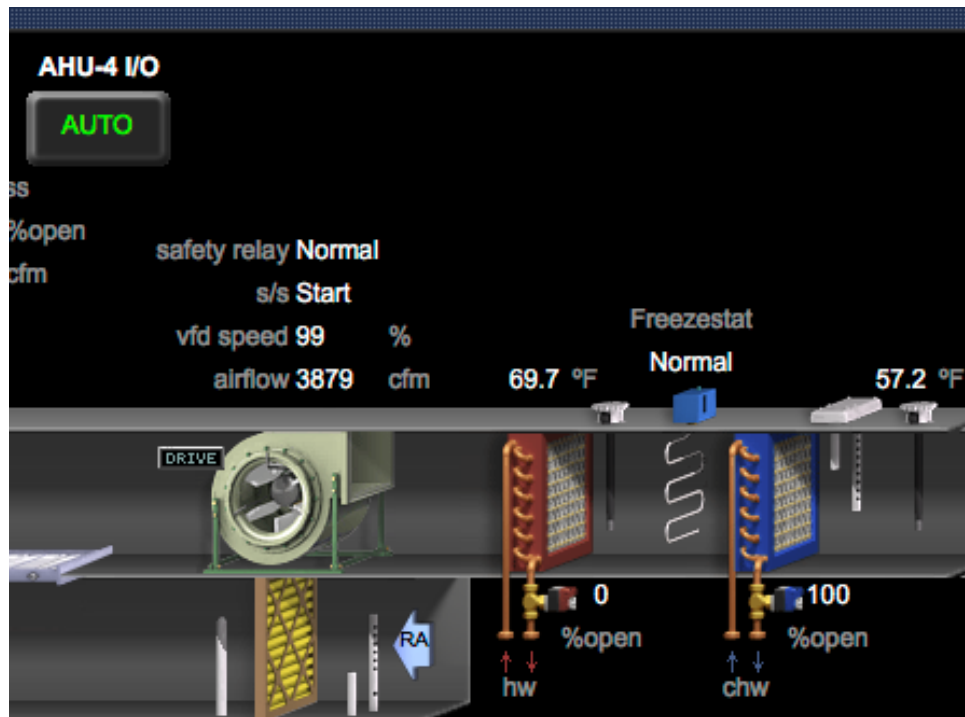
Application Example 2 (cont'd)

- Unable to find where the discharge air from AHU is supplied to. Go to design drawings.
- Well, not very informative...

- Eventually, we have to call the technician, turns out AHU4(cooling one) is supplying air to VAVs and AHU5(heating one) is supplying air to a large grage space directly.
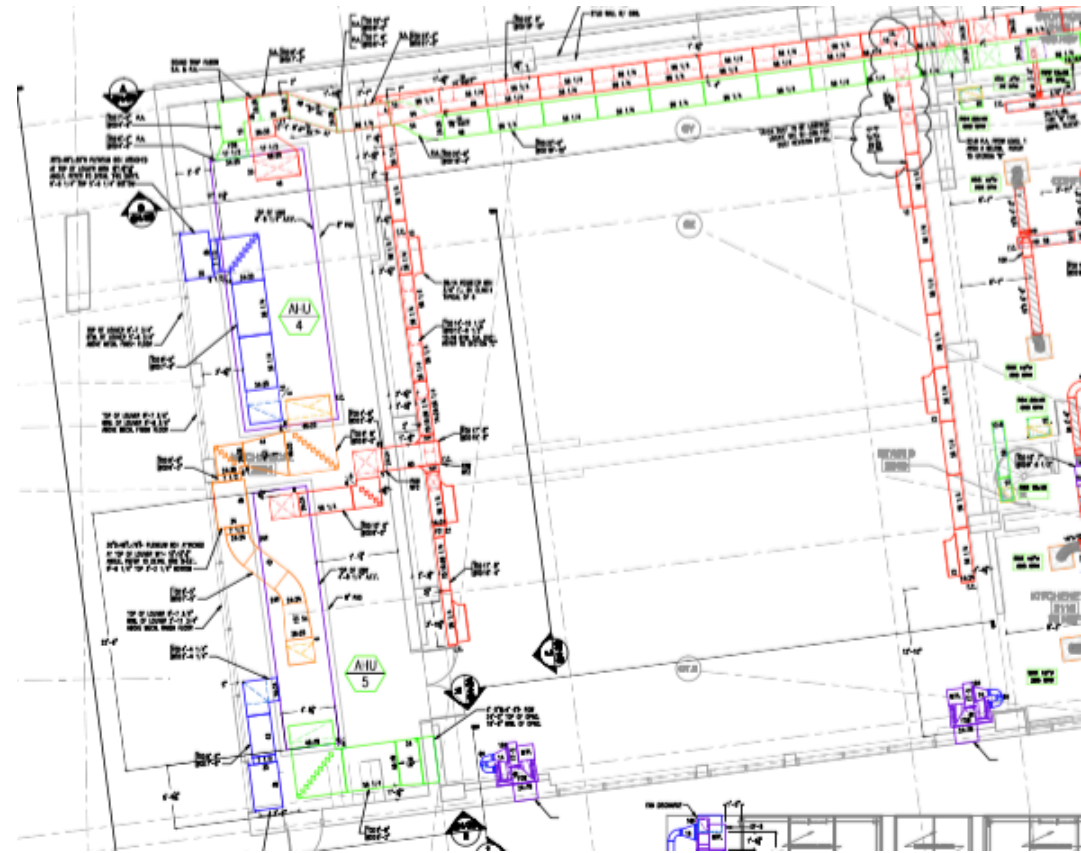
Application Example 3

- Abnormal duct pressure. (0.1 ''w.c., others are like 1.7 ''w.c) what does that mean?
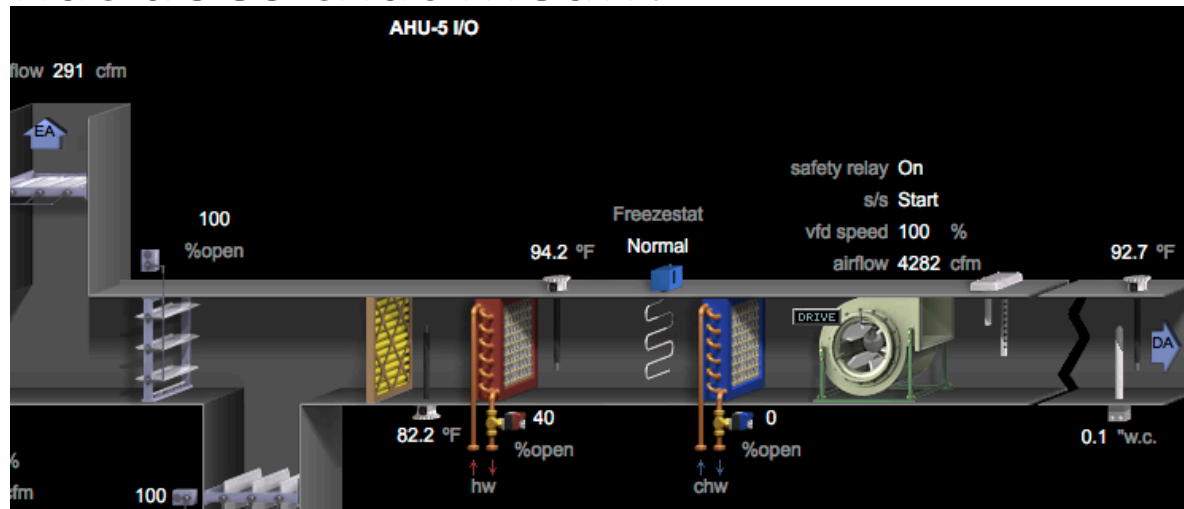
- People have to go to the design drawing, get the duct specs(size, shape, etc.), convert to flow rate, then check if the OAF+RAF ≈ EAF+DAF
- Turns out to be a broken sensor