SSN2018 workshop

Demo: Integrating Building Information Modeling and Sensor Observations using Semantic Web

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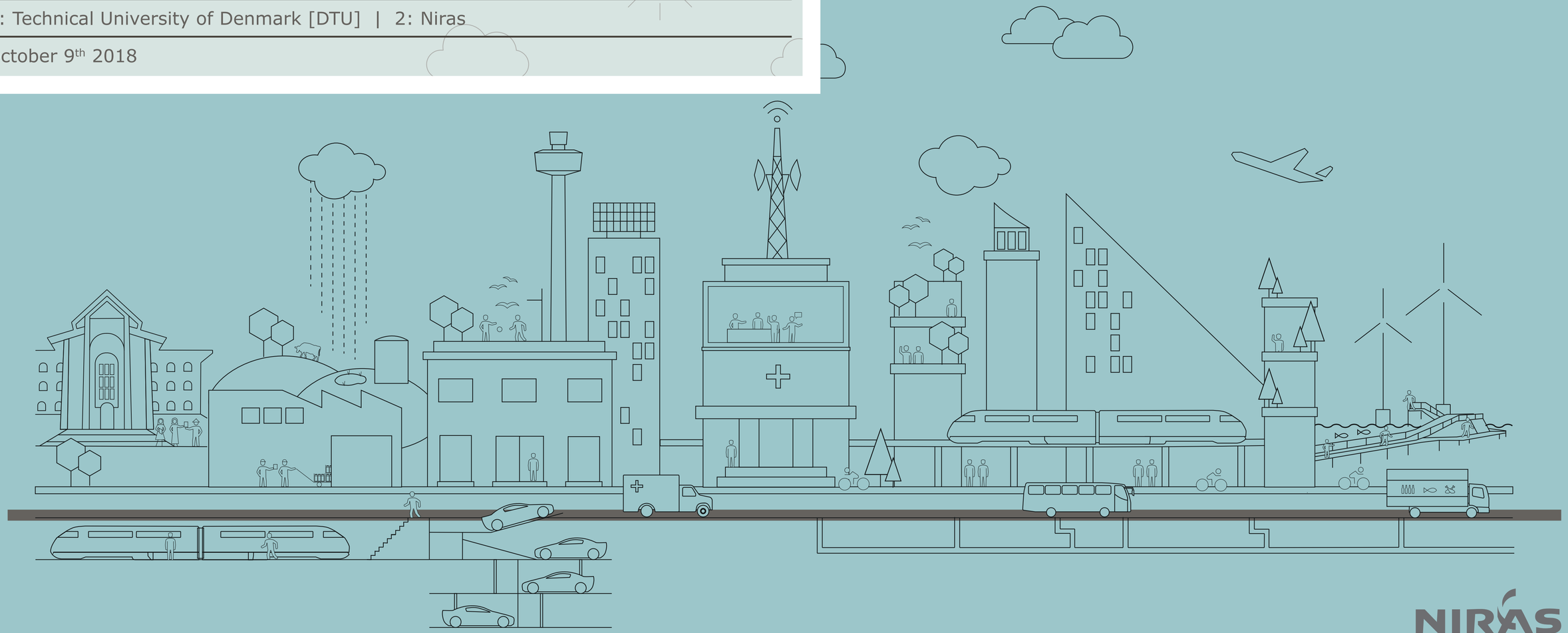
1: Technical University of Denmark [DTU] | 2: Niras

October 9th 2018



DTU

NIRAS

About me

2011	B.Sc. Architectural engineering, DTU
2013	M.Sc. Architectural Engineering, DTU
2013 2016	HVAC-engineer, NIRAS (former ALECTIA) 2,100 employees - offices in 27 countries
2016	Industrial PhD ”Digital Infrastructure and Building Information Modeling in the design and planning of building services”

Disposition

01 Problem in scope

02 Linked Building Data

03 The case

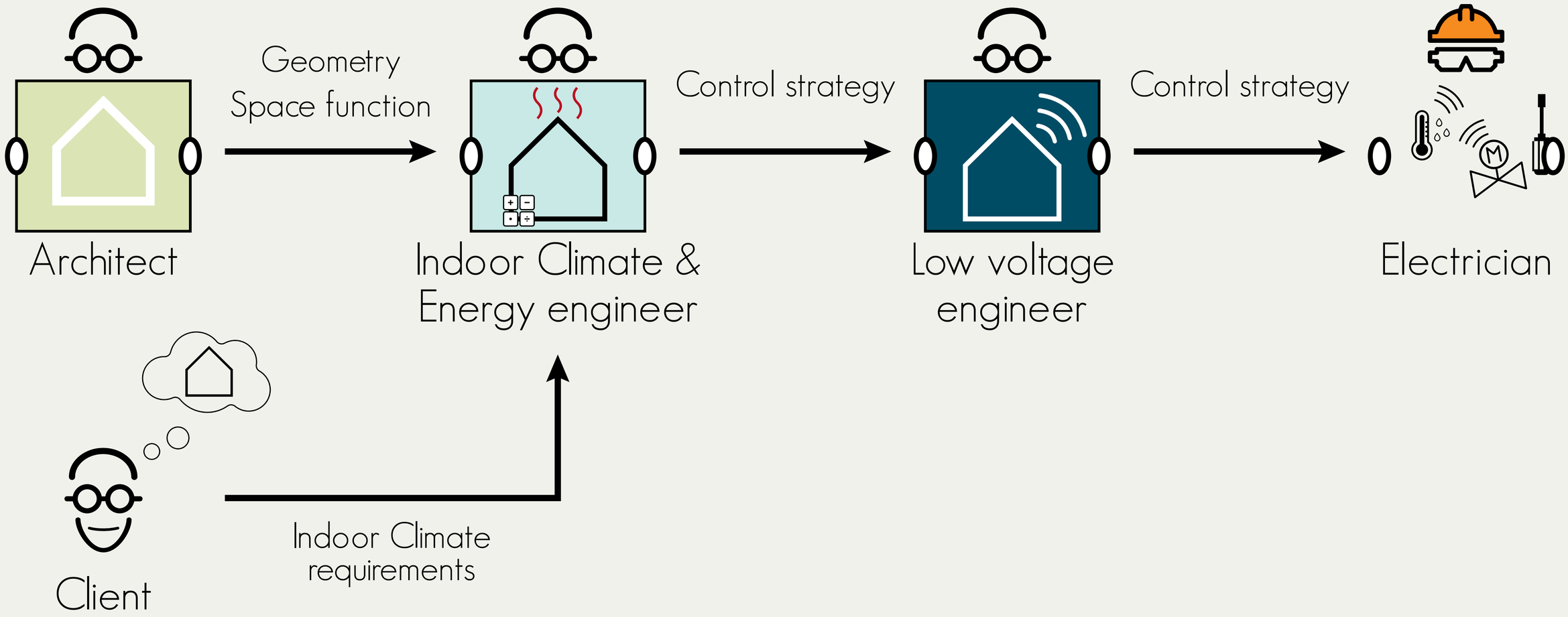
04 Implementation

05 Final Words

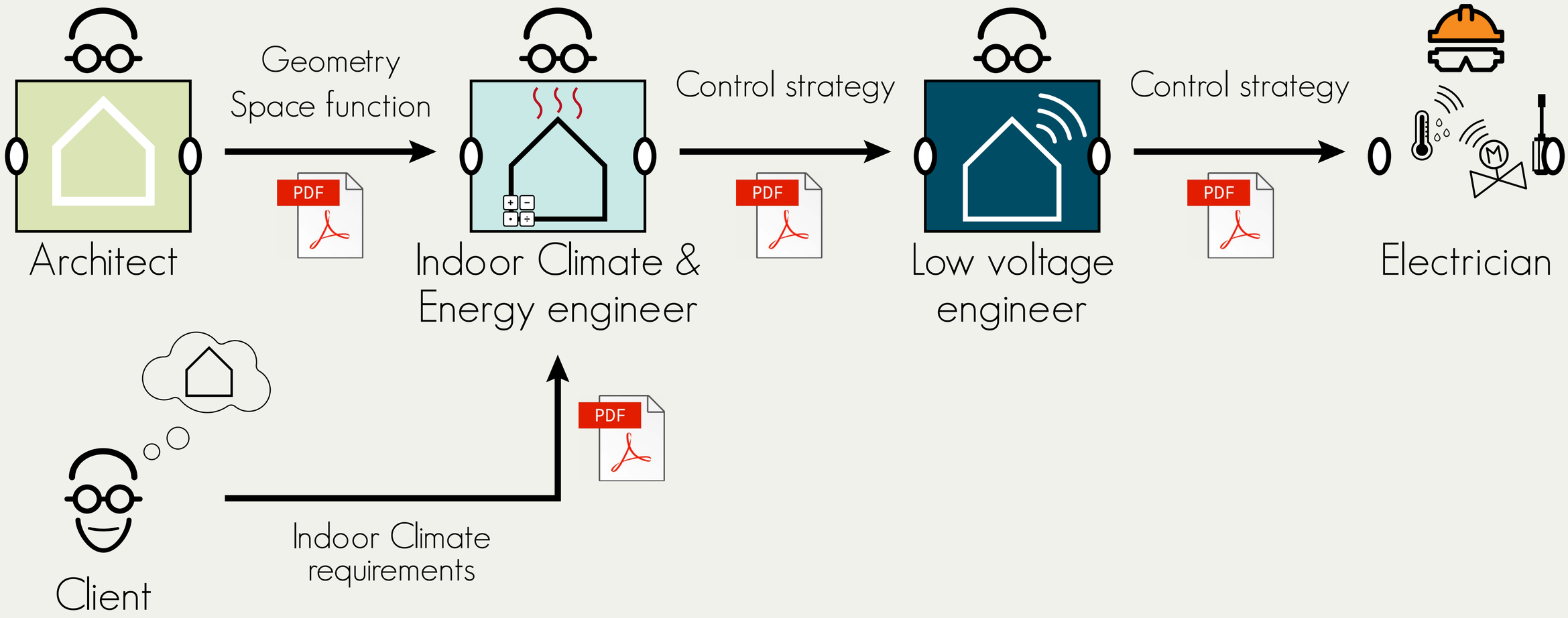
01

Problem in Scope

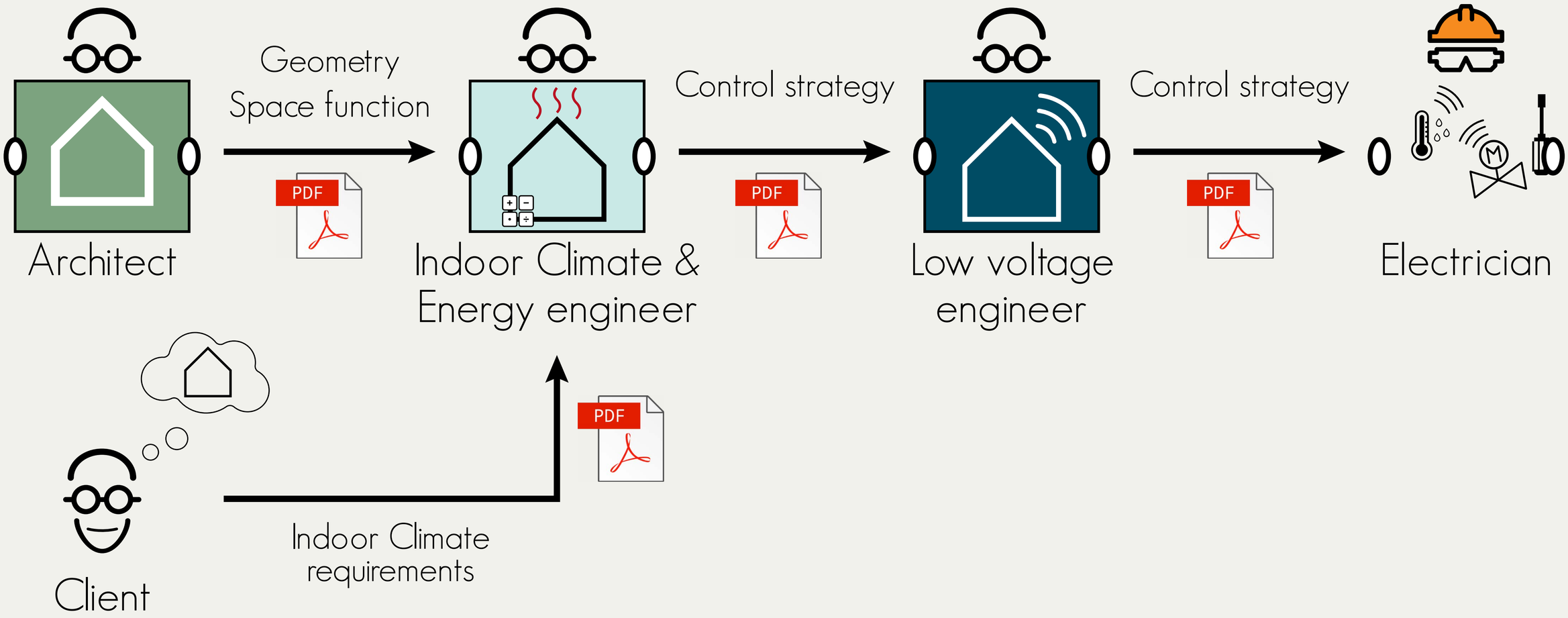
Overall information flow



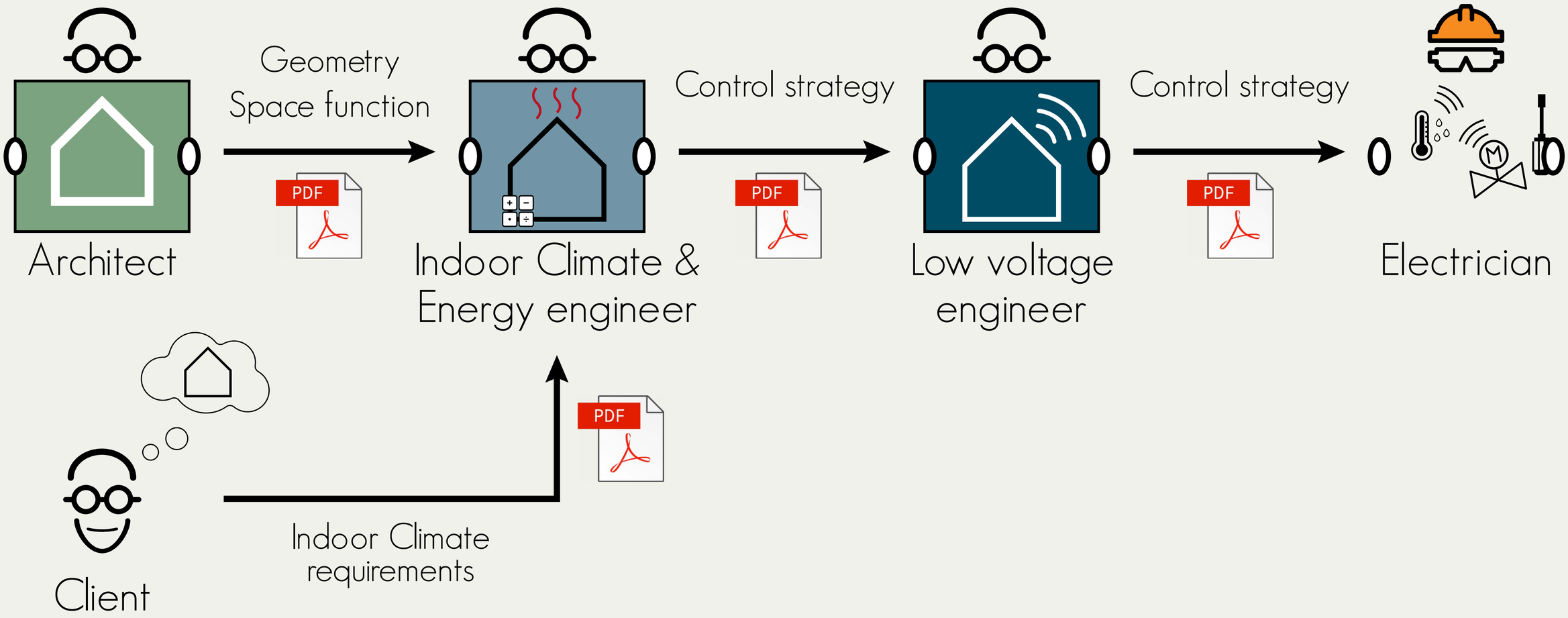
Data exchange of today



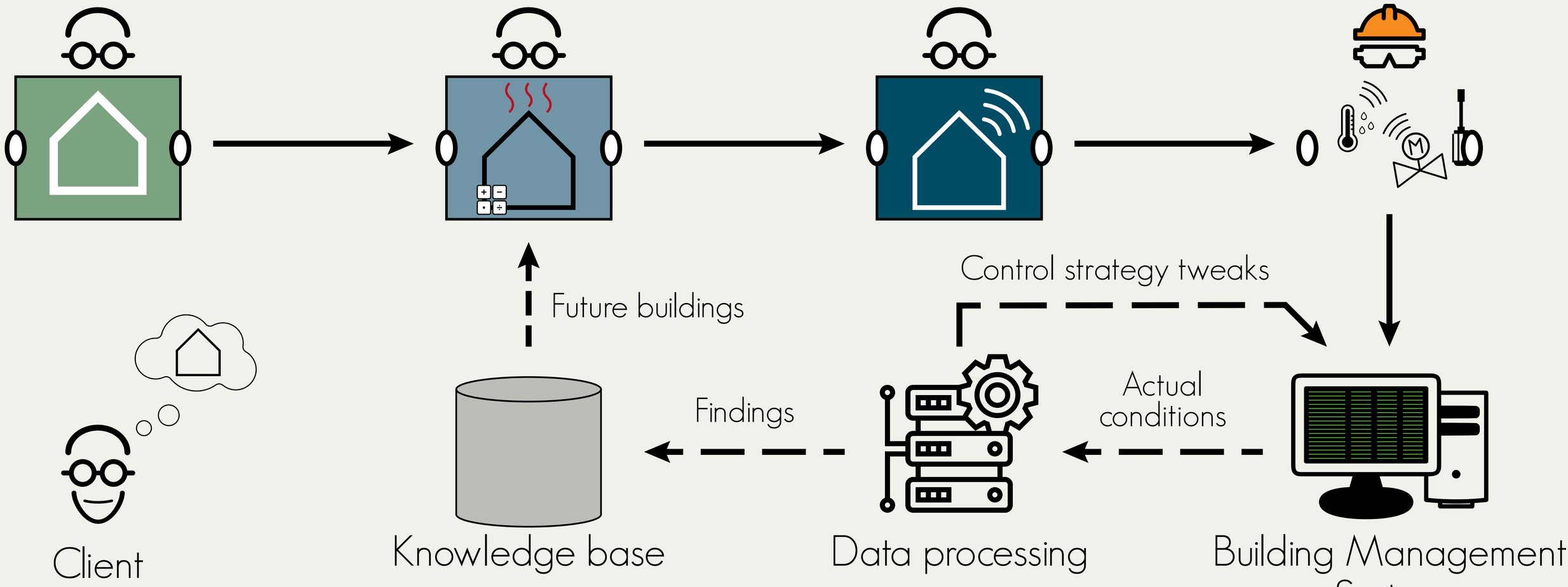
Change management



Change management



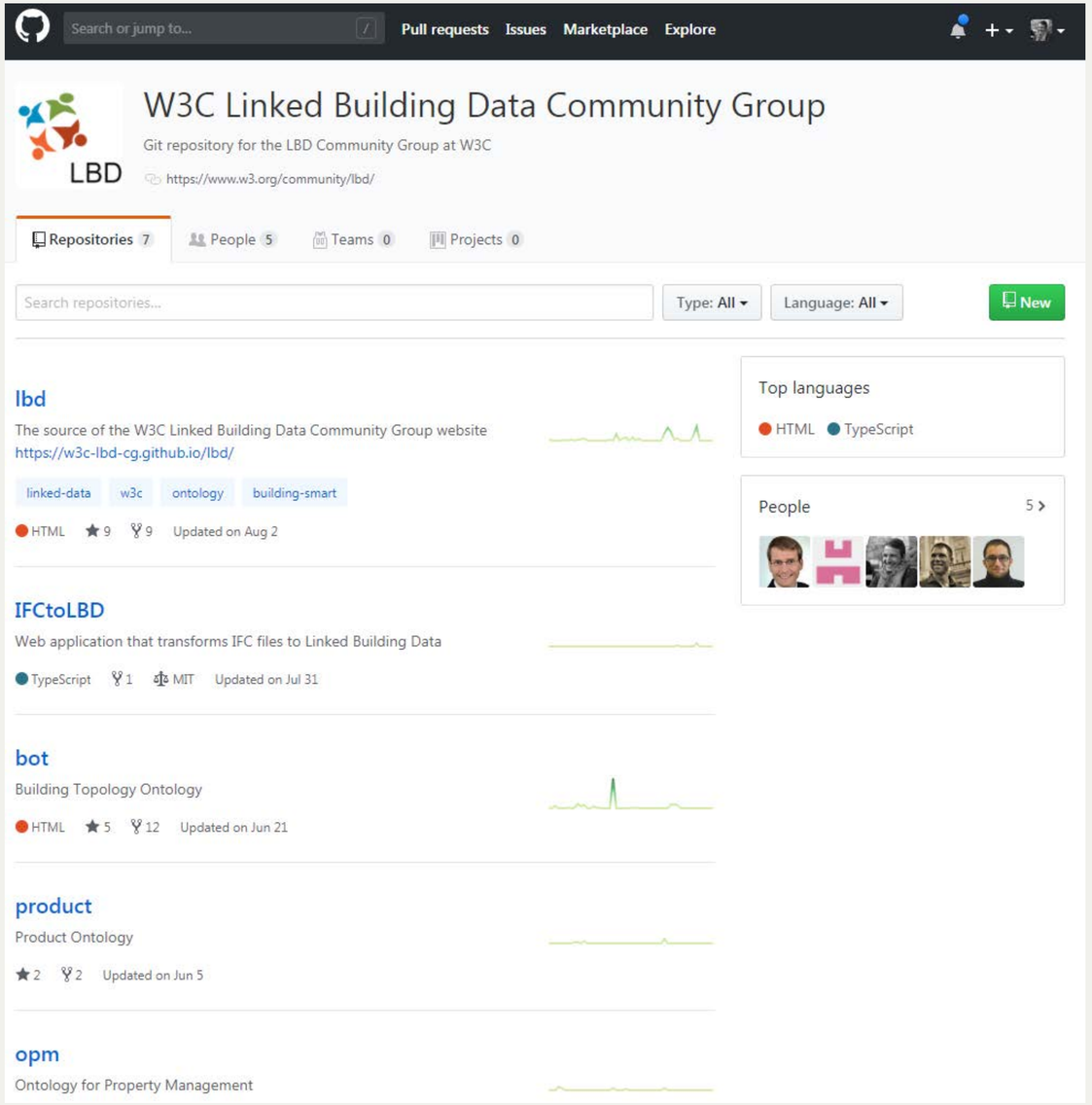
Future scenario



How to integrate the architectural model with the engineer's demands and the actual systems installed in the future building?

02

Linked Building Data



Linked Building Data Community Group

BOT The Building Topology Ontology

https://w3id.org/bot#

For describing any zone or
element in its context of the
building in which it belongs

PRODUCT Products' ontology

https://w3id.org/product#

For describing products
with relation to buildings

OPM Ontology for Property Management

https://w3id.org/opm#

For describing temporal
design properties that are
likely subject to changes

PROPS Properties' ontology

https://w3id.org/props#

For describing properties
with relation to buildings

BOT
Main Classes

bot:Zone

A spatial 3D division.
An instance of bot:Zone can contain other bot:Zone instances, making it possible to group or subdivide zones.

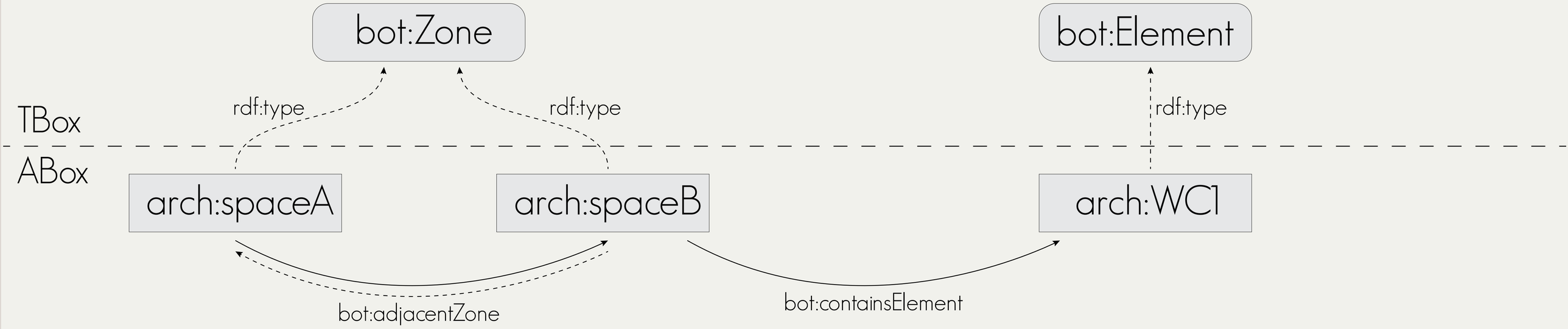
bot:Element

Constituent of a construction entity with a characteristic technical function, form or position

bot:Site bot:Building bot:Storey bot:Space

Zone Subclasses

BOT
Selected relationships

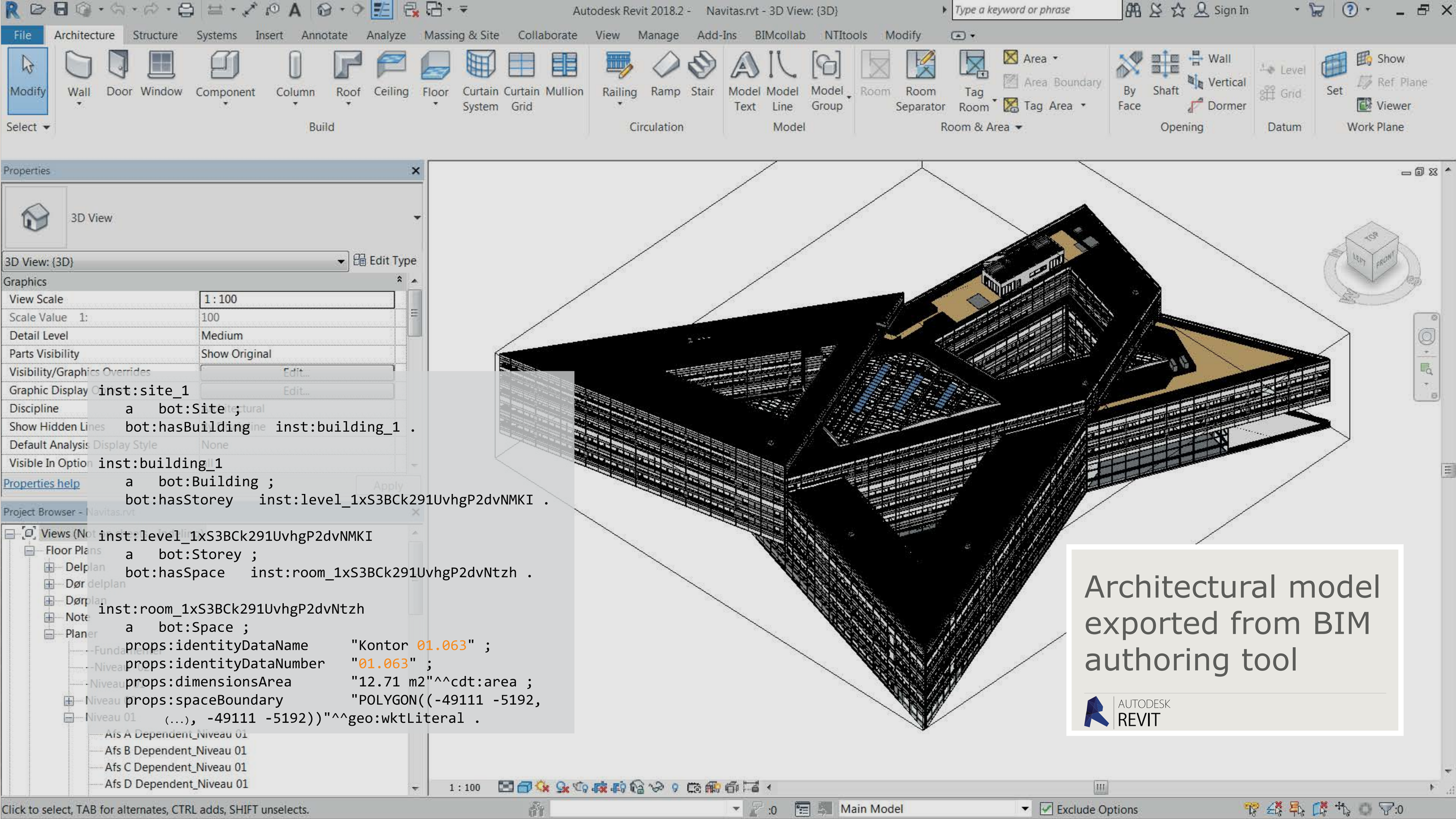


03

The case

Navitas

Aarhus University, Denmark


Autodesk Revit 2018.2 - Navitas.rvt - 3D View: {3D}
Type a keyword or phrase
Sign In
File
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
BIMcollab
NTItools
Modify
Modify
Select
Wall
Door
Window
Component
Column
Roof
Ceiling
Floor
Curtain System
Curtain Grid
Mullion
Build
Railing
Ramp
Stair
Circulation
Model Text
Model Line
Model Group
Model
Room
Room Separator
Tag Room
Area
Area Boundary
Tag Area
Room & Area
By Face
Shaft
Wall
Vertical
Dormer
Opening
Level
Grid
Datum
Set
Show
Ref Plane
Viewer
Work Plane
Properties
3D View
3D View: {3D}
Edit Type
Graphics
View Scale
1 : 100
Scale Value 1:
100
Detail Level
Medium
Parts Visibility
Show Original
Visibility/Graphics Overrides
Edit...
Graphic Display
Edit...
Discipline
Show Hidden Lines
Default Analysis Display Style
None
Visible In Option
Properties help
Apply
Project Browser - Navitas.rvt
Views (No
Floor Plans
Delplan
Dør delplan
Dørplan
Note
Planer
Fundament
Niveau
Niveau
Niveau
Niveau 01
Afs A Dependent_Niveau 01
Afs B Dependent_Niveau 01
Afs C Dependent_Niveau 01
Afs D Dependent_Niveau 01
inst:site_1
a bot:Site ;
bot:hasBuilding inst:building_1 .
inst:building_1
a bot:Building ;
bot:hasStorey inst:level_1xS3BCk291UvhgP2dvNMKI .
inst:level_1xS3BCk291UvhgP2dvNMKI
a bot:Storey ;
bot:hasSpace inst:room_1xS3BCk291UvhgP2dvNtzh .
inst:room_1xS3BCk291UvhgP2dvNtzh
a bot:Space ;
props:identityDataName "Kontor 01.063" ;
props:identityDataNumber "01.063" ;
props:dimensionsArea "12.71 m2"^^cdt:area ;
props:spaceBoundary "POLYGON((-49111 -5192,
(...), -49111 -5192))"^^geo:wktLiteral .
TOP
LEFT
FRONT
Architectural model exported from BIM authoring tool
AUTODESK
REVIT
1 : 100
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model
Exclude Options

Navitas.xlsm - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins eDocPrinter Acrobat Team ALECTIA

Cut Copy Format Painter Paste Clipboard

Calibri 11 Font

Wrap Text Merge & Center Alignment

General Number

Conditional Formatting Format as Table

Normal Bad Good Neutral Calculation Check Cell Styles

Insert Delete Format Cells

AutoSum Fill Clear Sort & Filter Find & Select Editing

S1

NAVITAS FACILITY
Building Integration SYSTEM

Hent data

Ønsket lokale: 01.063 – *Lokalenummer som der ønskes data på (niveau.lokalenummer)*
Fra Dato.: 2018-03-09 – *Data fra følgende dato (år-måned-dag)*
Til Dato.: 2018-03-15 – *Data til følgende dato (år-måned-dag)*

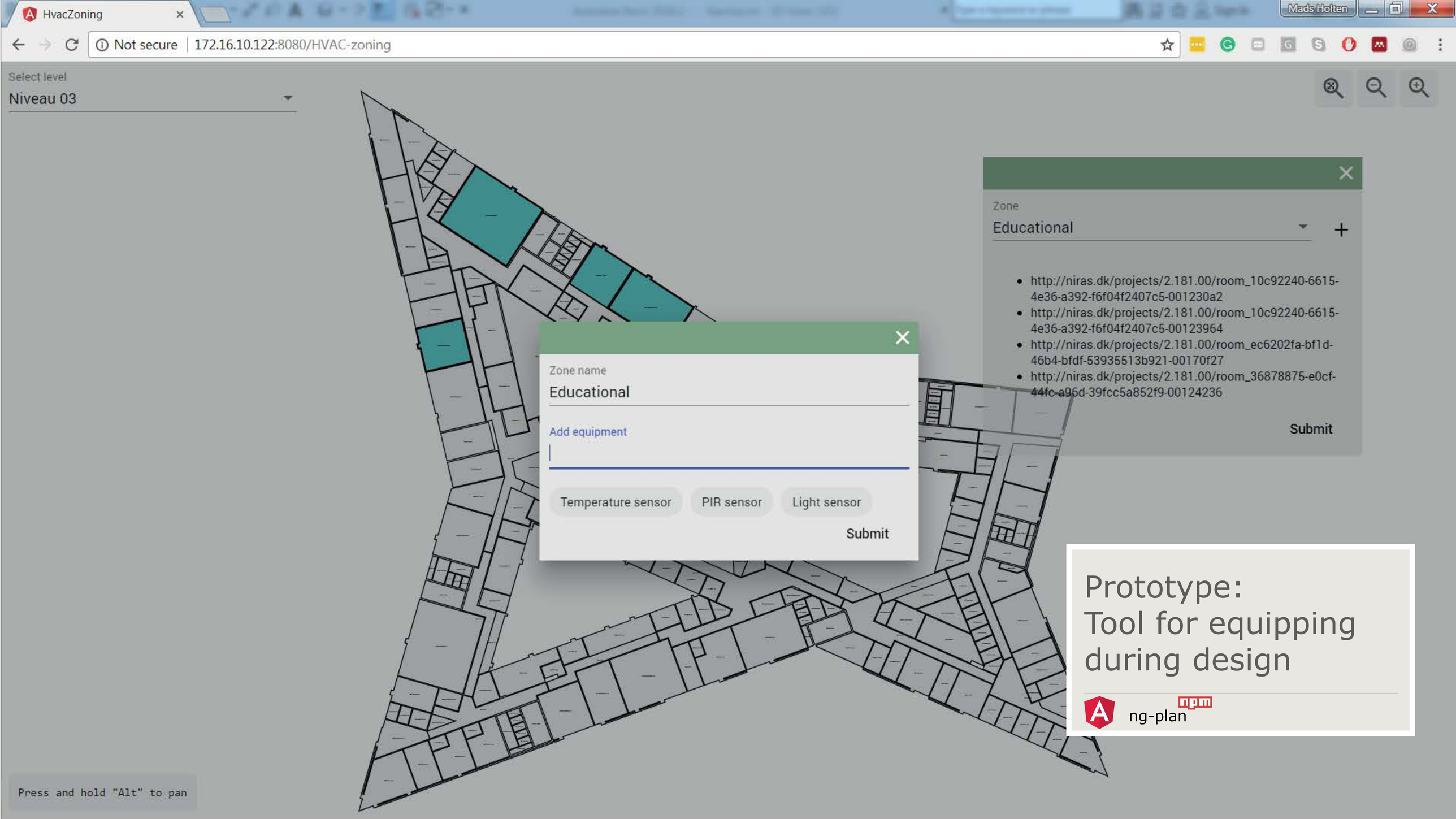
Datalognings tidspunkt Dato	Klokken	Regulerings Status	Holde tid (sec)	Luftkvalitet ppm	Aktuel Temp. (°C)	Setpunkt Temp. Calculeret (°C)	Setpunkt Temp. Komfort (°)	Setpunkt Temp. Standby (°C)	Hyst. Temp. Varme (°C)	Hyst. Temp. Vent. (°C)	Max. Temp. Bruger (°C)	Min. Temp. Bruger (°C)	Radiator Åbning (%)	Ventilation Indblæsning (%)	Ventilations Anlæg
09-03-18	00:18	OPVARMNING	1500	425	21.5	22.5	22.0	22.0	0.0	1.0	22.0	19.0	70	10	VE40
09-03-18	00:47	OPVARMNING	1500	425	21.4	22.5	22.0	22.0	0.0	1.0	22.0	19.0	100	10	VE40
09-03-18	01:18	OPVARMNING	1500	425	21.8	22.5	22.0	22.0	0.0	1.0	22.0	19.0	100	10	VE40
09-03-18	01:48	OPVARMNING	1500	425	22.1	22.5	22.0	22.0	0.0	1.0	22.0	19.0	90	10	VE40
09-03-18	02:18	OPVARMNING	1500	425	22.3	22.5	22.0	22.0	0.0	1.0	22.0	19.0	80	10	VE40
09-03-18	02:48	OPVARMNING	1500	425	22.4	22.5	22.0	22.0	0.0	1.0	22.0	19.0	50	10	VE40
09-03-18	03:18	OPVARMNING	1500	425	22.2	22.5	22.0	22.0	0.0	1.0	22.0	19.0	20	10	VE40
09-03-18	03:48	OPVARMNING	1500	425	21.7	22.5	22.0	22.0	0.0	1.0	22.0	19.0	40	10	VE40
09-03-18	04:18	OPVARMNING	1500	425	21.4	22.5	22.0	22.0	0.0	1.0	22.0	19.0	90	10	VE40
09-03-18	04:48	OPVARMNING	1500	425	21.7	22.5	22.0	22.0	0.0	1.0	22.0	19.0	100	10	VE40
09-03-18	05:17	OPVARMNING	1500	425	21.9	22.5	22.0	22.0	0.0	1.0	22.0	19.0	100	10	VE40
09-03-18	05:48	OPVARMNING	1500	425	22.2	22.5	22.0	22.0	0.0	1.0	22.0	19.0	90	10	VE40
09-03-18	06:18	OPVARMNING	1500	425	22.4	22.5	22.0	22.0	0.0	1.0	22.0	19.0	70	10	VE40
09-03-18	06:48	OPVARMNING	1500	425	22.3	22.5	22.0	22.0	0.0	1.0					
09-03-18	07:20	OPVARMNING	1500	425	22.0	22.5	23.0	23.0	0.0	1.0					
09-03-18	07:48	OPVARMNING	1500	425	21.9	23.5	23.0	23.0	0.0	1.0					
09-03-18	08:19	OPVARMNING	1500	425	22.0	23.5	23.0	23.0	0.0	1.0					
09-03-18	08:49	OPVARMNING	1500	425	22.4	24.0	23.0	23.0	0.0	1.0					
09-03-18	09:19	OPVARMNING	1500	425	22.5	24.0	23.0	23.0	0.0	1.0					
09-03-18	09:49	OPVARMNING	1500	425	22.9	24.0	23.0	23.0	0.0	1.0					
09-03-18	10:19	OPVARMNING	1500	425	23.2	24.0	23.0	23.0	0.0	1.0					
09-03-18	10:49	OPVARMNING	1500	425	23.2	24.0	23.0	23.0	0.0	1.0					
09-03-18	11:19	OPVARMNING	1500	425	23.2	24.0	23.0	23.0	0.0	1.0					
09-03-18	11:49	OPVARMNING	1500	425	23.4	24.0	23.0	23.0	0.0	1.0	22.0	19.0	70	10	VE40
09-03-18	12:20	OPVARMNING	1500	425	23.5	24.0	22.0	22.0	0.0	1.0	22.0	19.0	40	10	VE40

```
inst:room_01.063-Temp-Sensor-obs0
    a   sosa:Observation ;
    sosa:hasFeatureOfInterest   inst:room_1xS3BCk291UvhgP2dvNtzh ;
    sosa:hasResult              "20.7 Cel"^^cdt:temperature ;
    sosa:madeBySensor           inst:room_01.063-Temp-Sensor ;
    sosa:observedProperty       inst:room_01.063-Temp ;
    sosa:resultTime             "2017-04-18T05:11:32+01:00"^^xsd:dateTime .
```

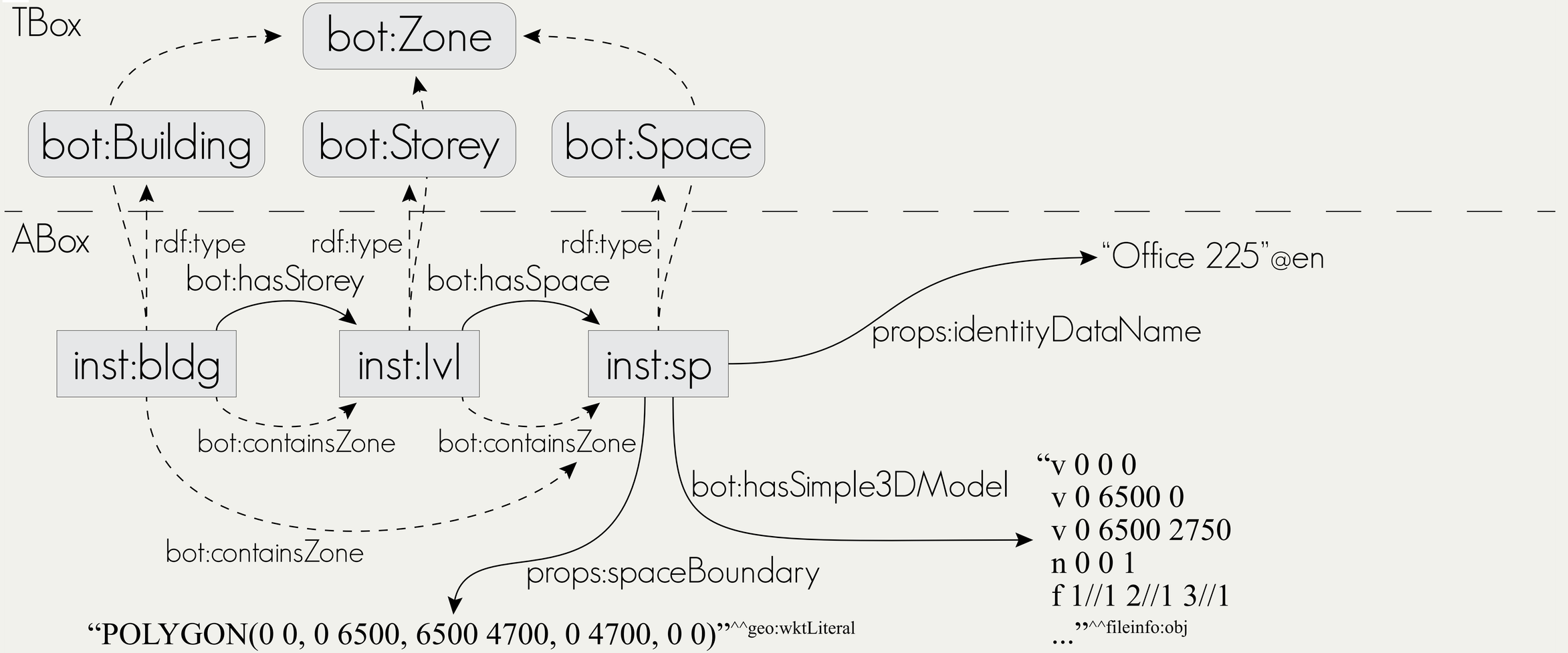
Sensor observations extracted from spreadsheets

RAPPORT Data

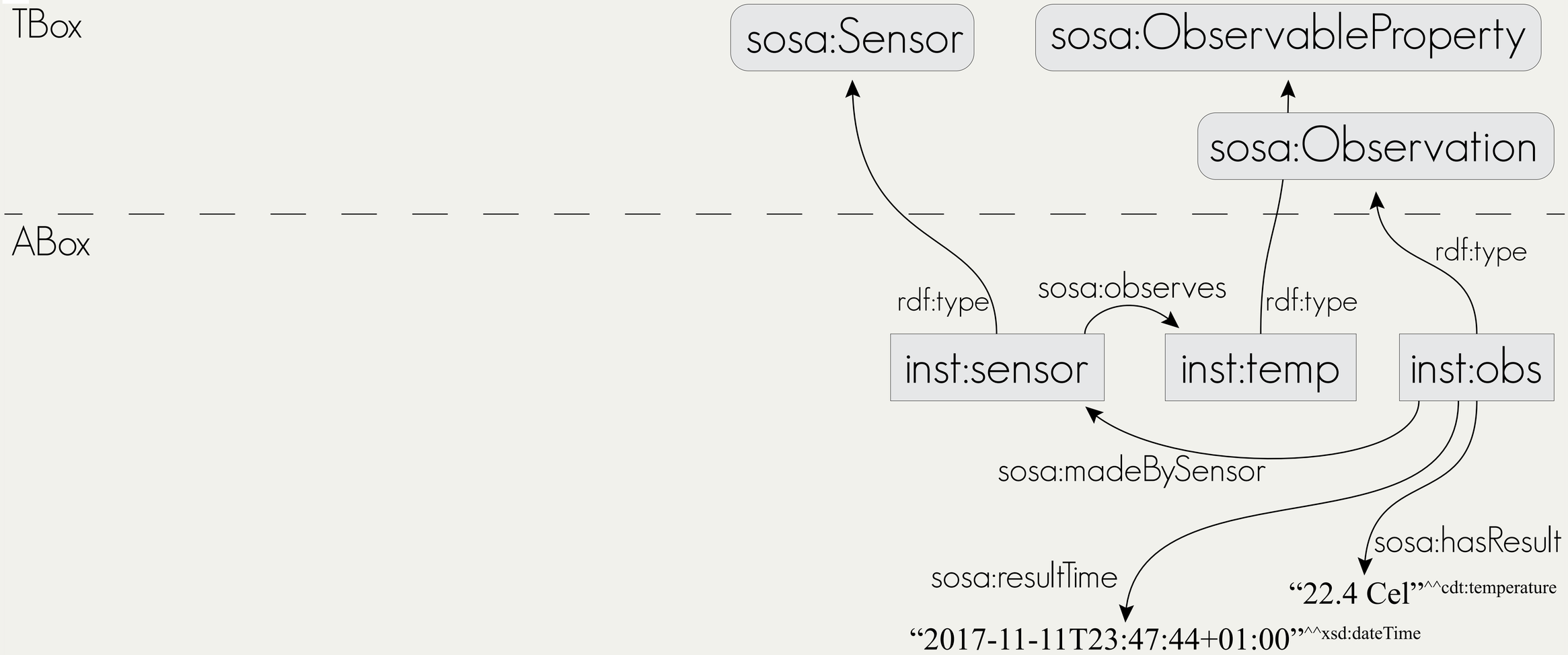
Ready 100%


HvacZoning
Mads Holten
Not secure
172.16.10.122:8080/HVAC-zoning
Select level
Niveau 03
Zone
Educational
http://niras.dk/projects/2.181.00/room_10c92240-6615-4e36-a392-f6f04f2407c5-001230a2
http://niras.dk/projects/2.181.00/room_10c92240-6615-4e36-a392-f6f04f2407c5-00123964
http://niras.dk/projects/2.181.00/room_ec6202fa-bf1d-46b4-bfdf-53935513b921-00170f27
http://niras.dk/projects/2.181.00/room_36878875-e0cf-44fc-a96d-39fcc5a852f9-00124236
Submit
Zone name
Educational
Add equipment
Temperature sensor
PIR sensor
Light sensor
Submit
Prototype:
Tool for equipping
during design
ng-plan
Press and hold "Alt" to pan

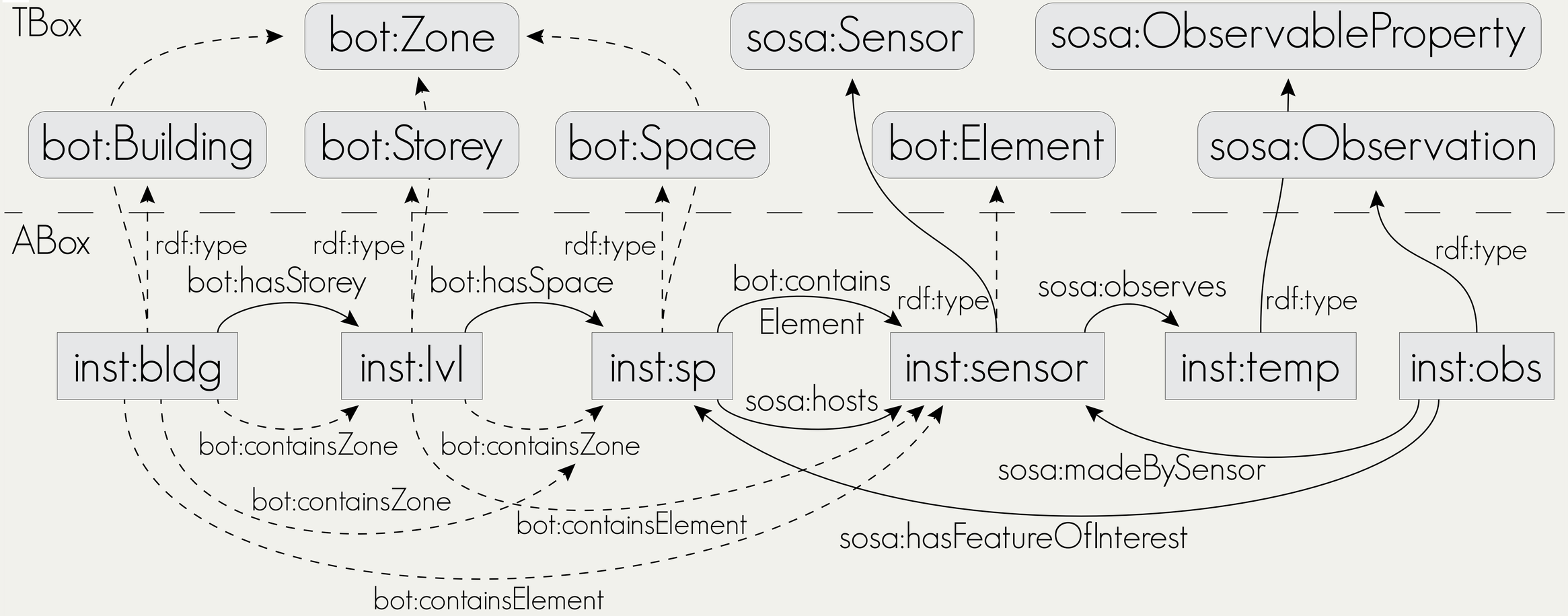
Data structure



Data structure



Data structure



04

Implementation

Iot

172.16.10.122:8080/iot

Select level

Niveau 04

Color by

Max temperature

2D | 3D

DEMO

https://youtu.be/P_38gIvrbmg

05

Final words

Conclusions

- Data model developed organically as project evolves
- Explicit information exchanges through all processes
- DEMO illustrates the ease of accessing the data

Future work

- Post-processing of observations
    - Use Linked Temperature Data Cube to pre-process the hourly, daily, weekly, monthly and annual min/max/avg temperatures explicitly
    - Optimize control of flow systems based on observations
- Re-do thermal simulations with actual occupant loads and weather data
- Use in real project to examine work flows and benefits
- Development of dedicated tools for describing control strategies etc.