The role of Linked Data and the Semantic Web in Building Operation

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Overview

1. Interoperability problems in AEC industry
2. Enterprise Data
3. Performance Framework
4. Performance Framework Tool

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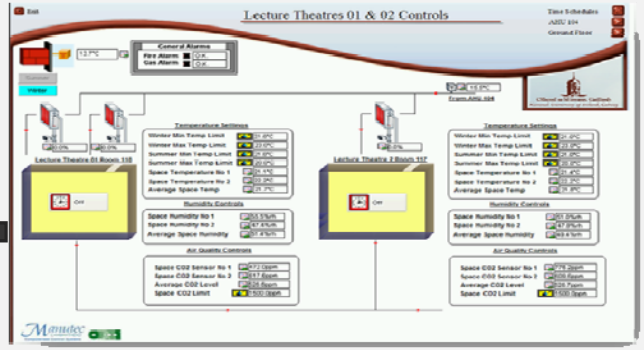
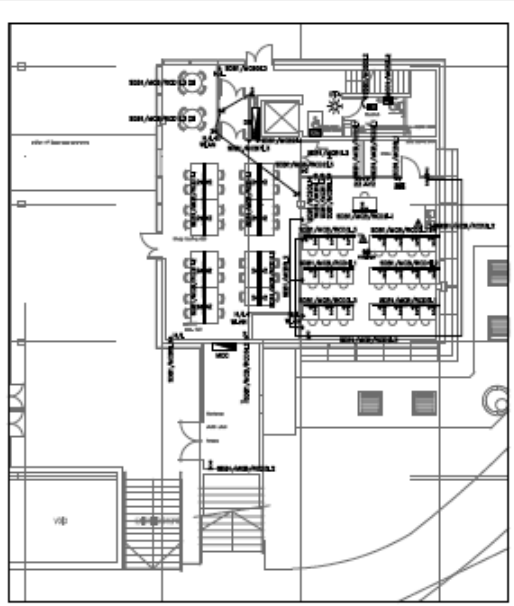
1 Background

Interoperability problems in AEC industry

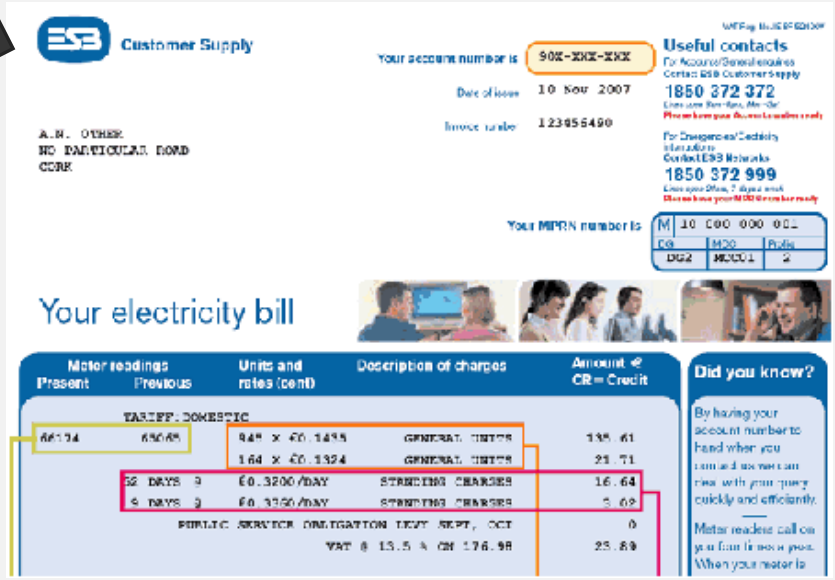
Organisations incur substantial costs due to lack of interoperability

- Poor Interoperability
  - Cost Overruns
  - Schema mismatch
  - Data mismatch
  - Data Access issues

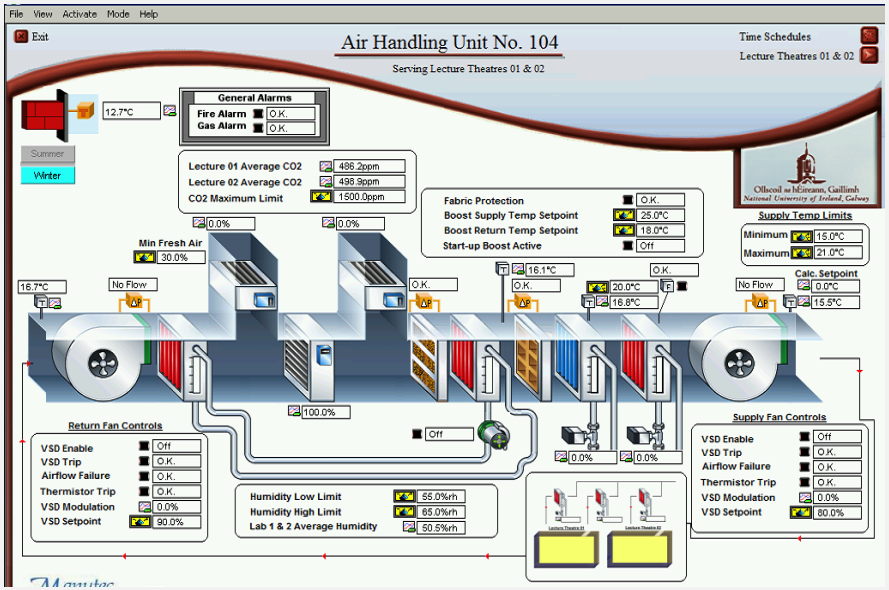




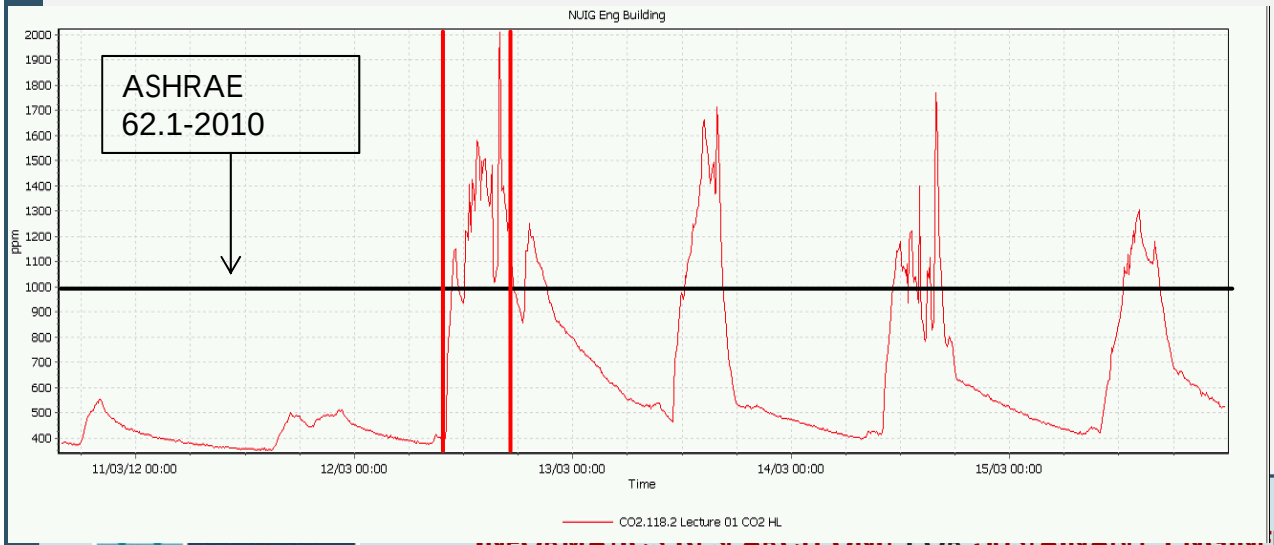
Building Manager



A concrete example

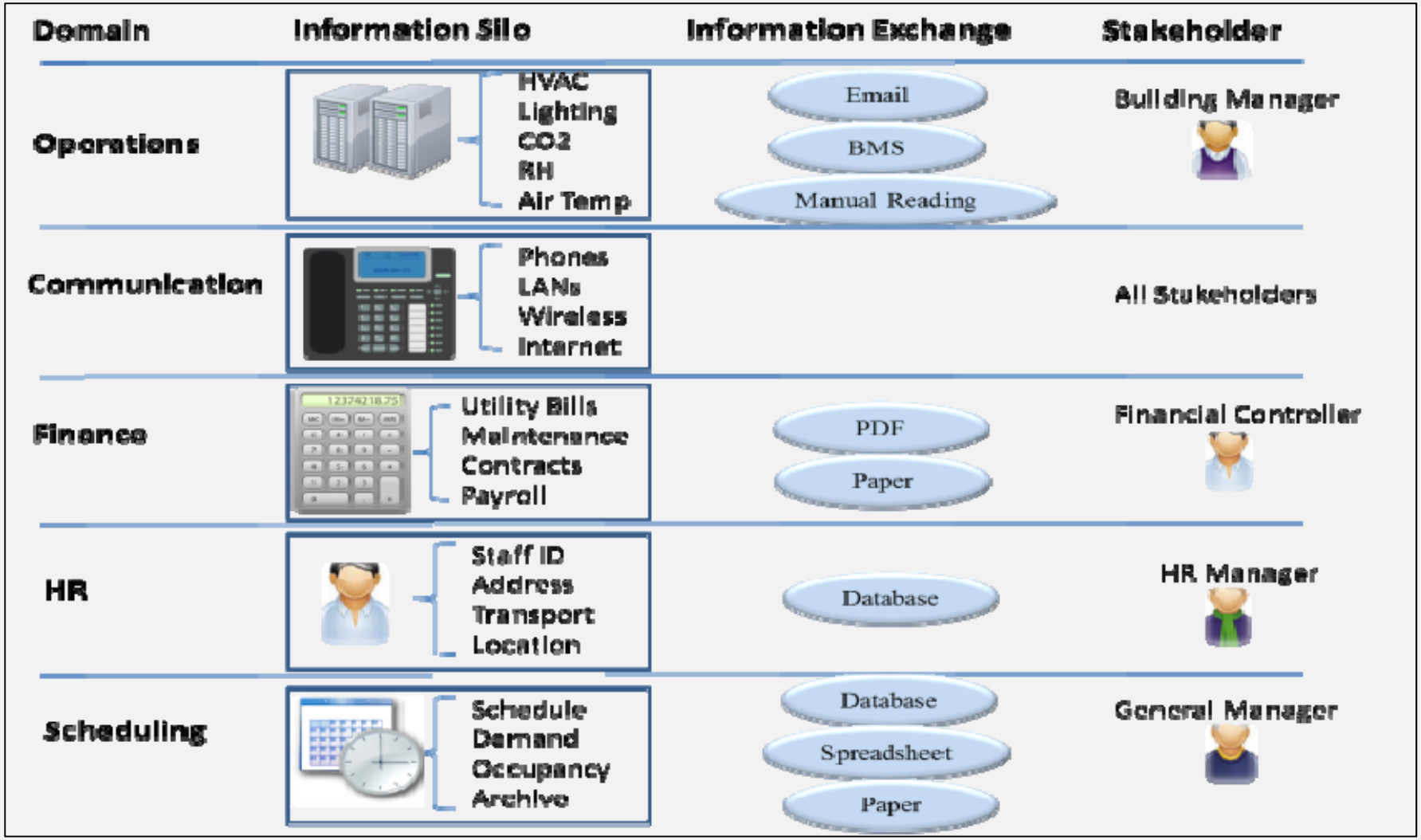


CO2 levels



Time	Monday	Tuesday	Wednesday	Thursday	Friday
08:00-09:00					
09:00-10:00	237		237	200	237
10:00-11:00		237	237	237	200
11:00-12:00	237	180	180	145	237
12:00-13:00	237	200	237	200	149
13:00-14:00			145		
14:00-15:00	221	237	145		140
15:00-16:00	221		120	160	140
16:00-17:00	149		250	160	
17:00-18:00	200			160	

Operational phase data retained in domain silos



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Technology and Data Interoperability

- Data scattered among different information systems
- Multiple incompatible technologies and schemas make it difficult to use
- Metadata, schema information and application logic all entwined
- Difficult to reuse data
- Data usually described to suit the application
- Instead, describe the data itself, separate from any application
- Use Open Data principles to publish this data
- Any application can then access this data

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Enterprise Data

Can the semantic web play a role?

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Enterprise Data

- Companies outside AEC industry have experienced similar problems with data
- Recognised value in being able to access data at an enterprise level
- Different approaches
  - Web oriented archtecture
  - APIs
  - Semantic Web

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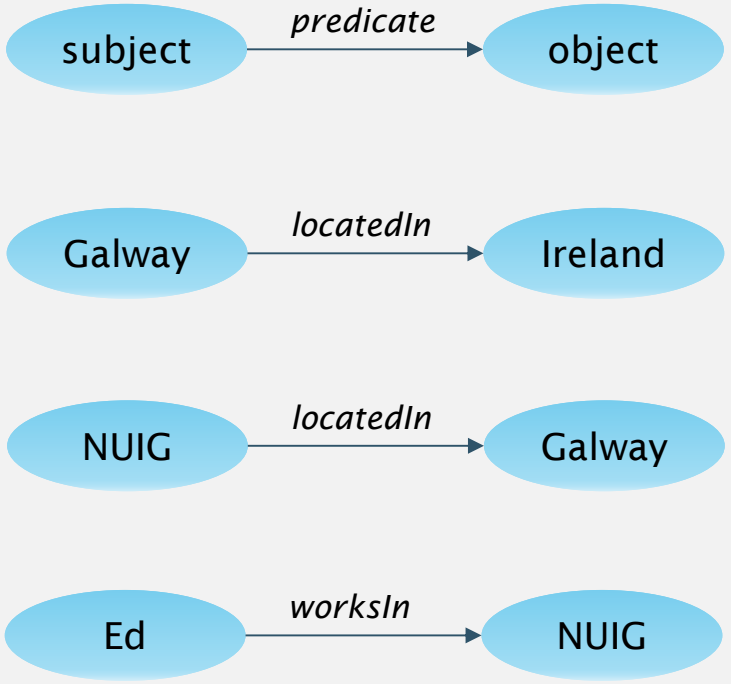
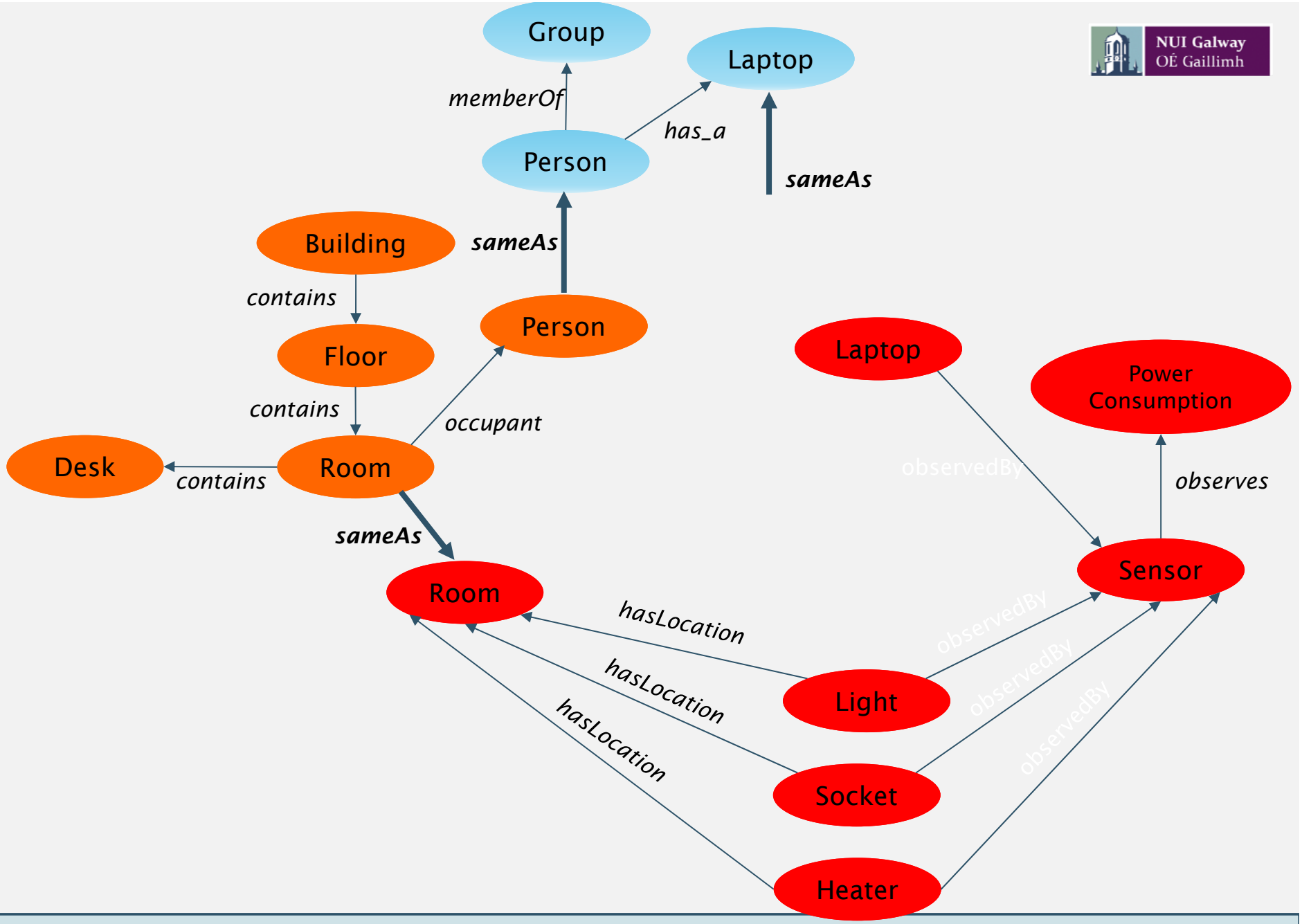
Semantic Web

- Web of Documents – html links to documents
- Web of Data – link actual pieces of data
- RDF – subject -> object -> predicate
- Use RDF to publish AEC related data
- Tool sets and rule engines can make connections from there
- Sits on top of existing architecture, does not replace it




Group
Laptop
memberOf
has_a
Person
sameAs
Building
sameAs
contains
Person
Floor
Laptop
Power Consumption
contains
occupant
Desk
contains
Room
observedBy
observes
sameAs
Sensor
Room
hasLocation
observedBy
hasLocation
Light
observedBy
hasLocation
Socket
observedBy
Heater

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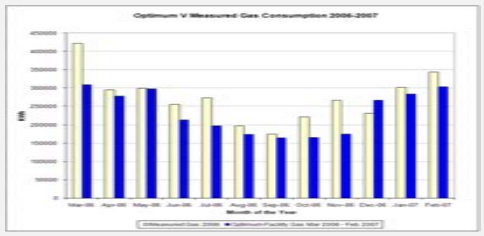
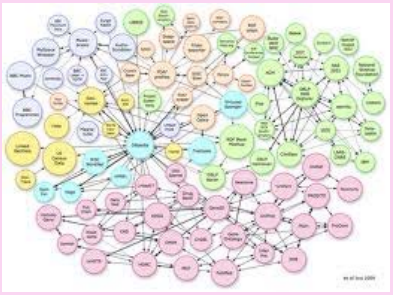
Performance Assessment Toolkit



Web Based
Web of Data
Standardised
Non domain Specific



Enterprise Data

Data published in RDF

BMS
BIM
Utilities
Weather
HR
BES
ERP
Finance

Raw Data

Several formats
Distributed
Difficult to access

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Performance Framework

A means to navigate through web of data

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Navigate through data

- Once enterprise data available in useable format, then what?
- Interested in building performance
  - Carbon Buzz – buildings consume 1.5 -2.5 times energy predicted at design time
  - Buildings not optimised
  - Poor fault detection
  - Impact of decisions not clear
- Provide a road-map through data
- Performance Assessment Framework

Define information required by stakeholder and related data

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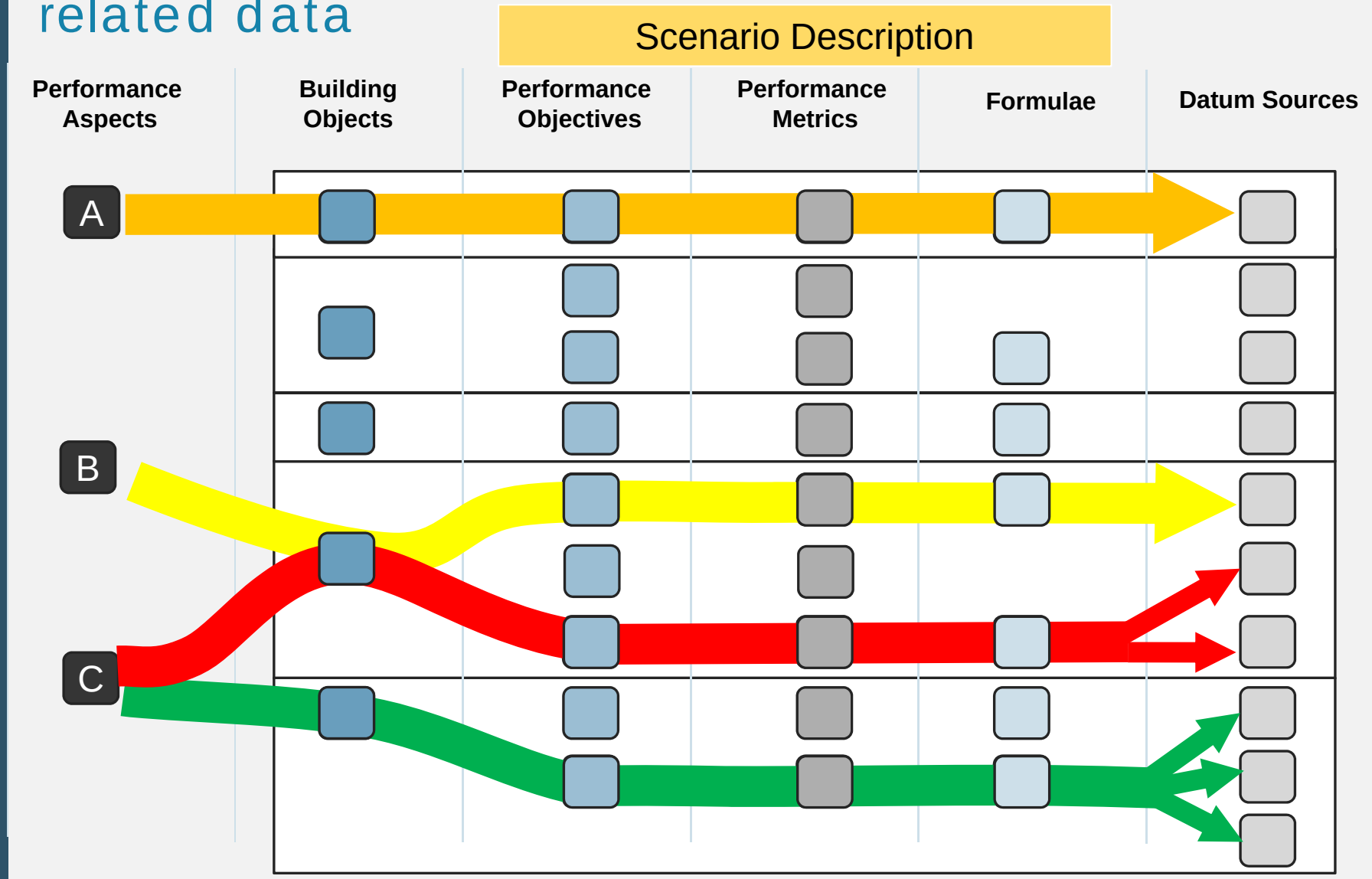
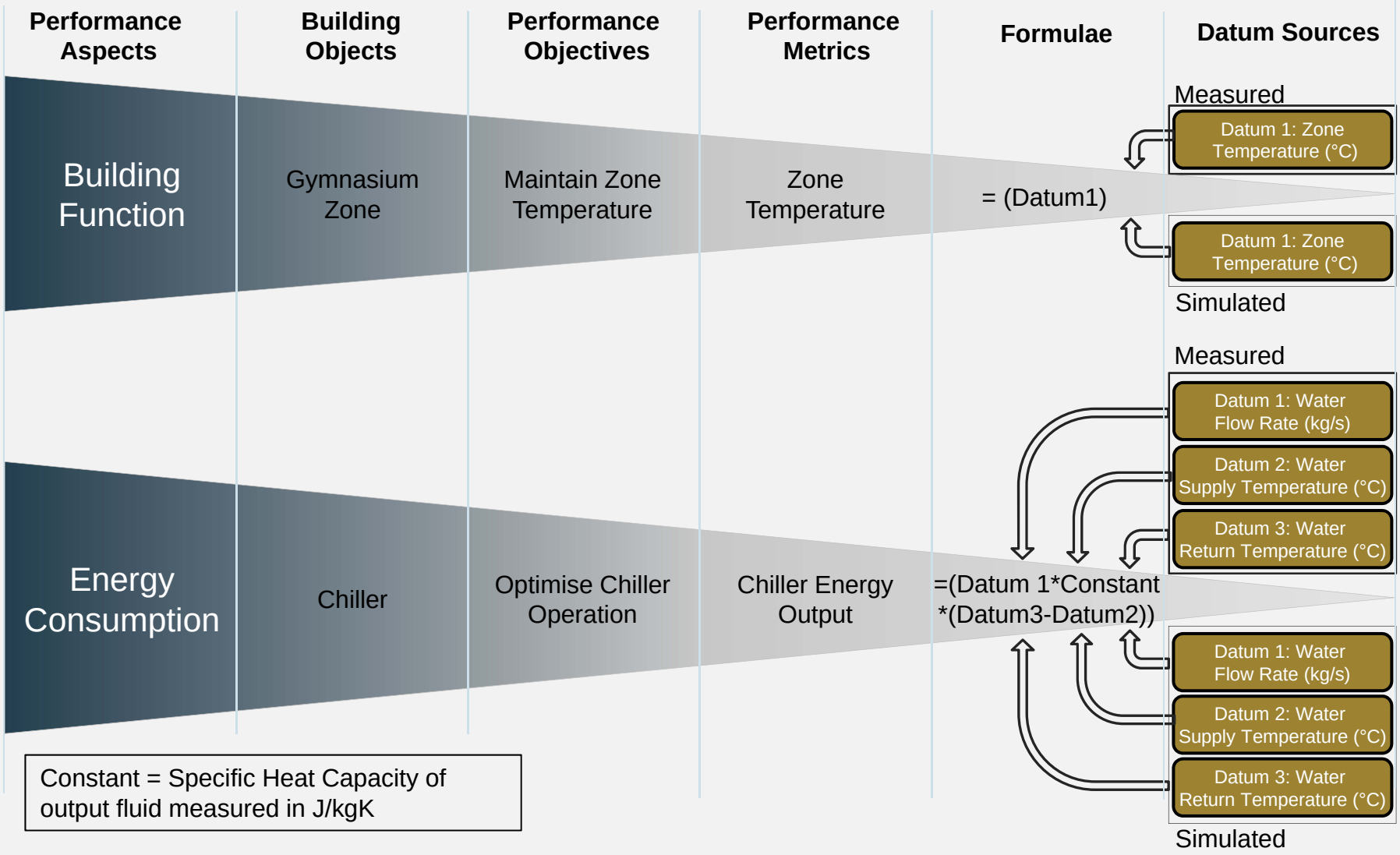


Analyse comfort and energy consumption

Scenario: Compare Comfort & Energy Consumption



Performance Framework

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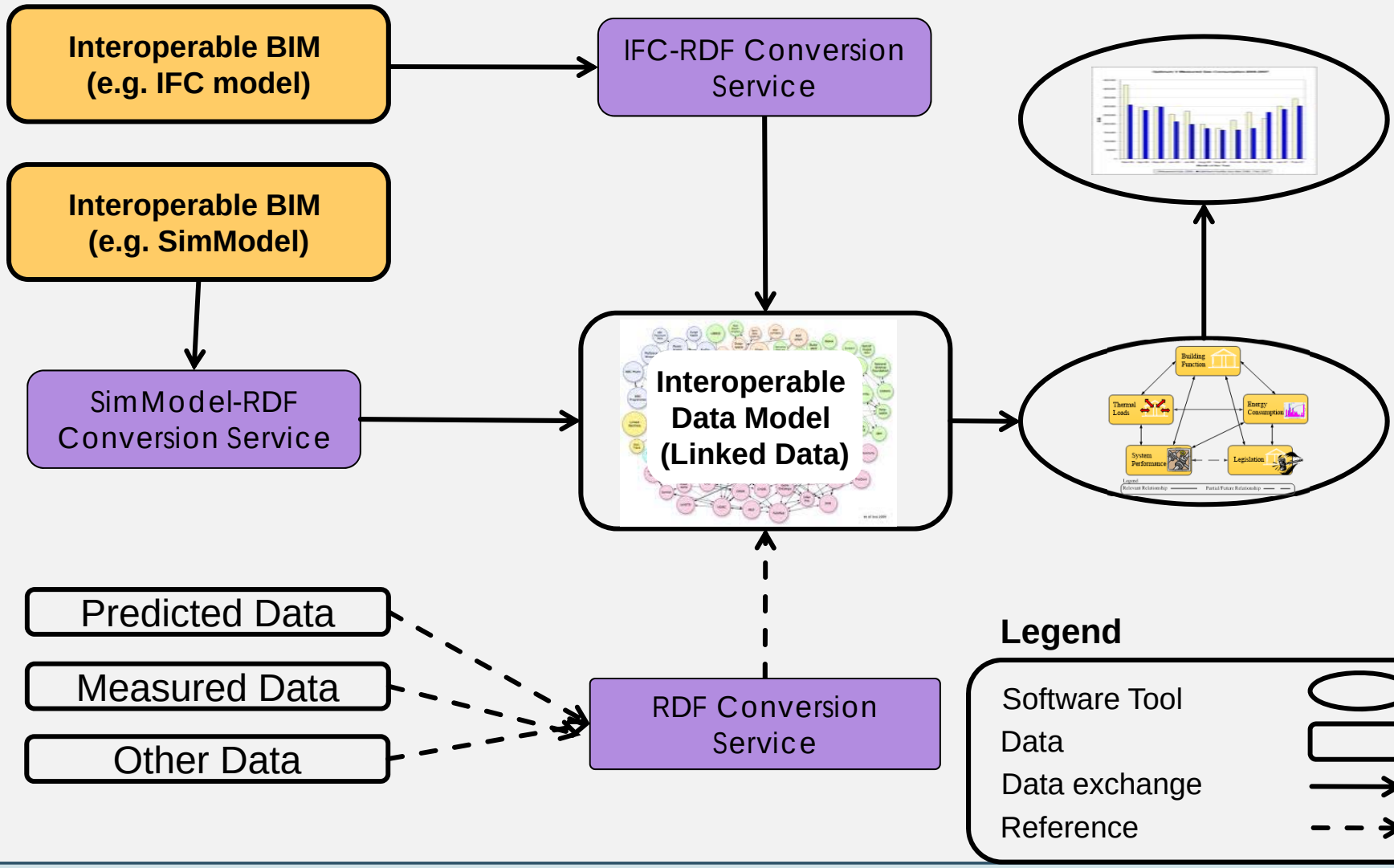

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Performance Framework Tool

Enhanced Decision Support

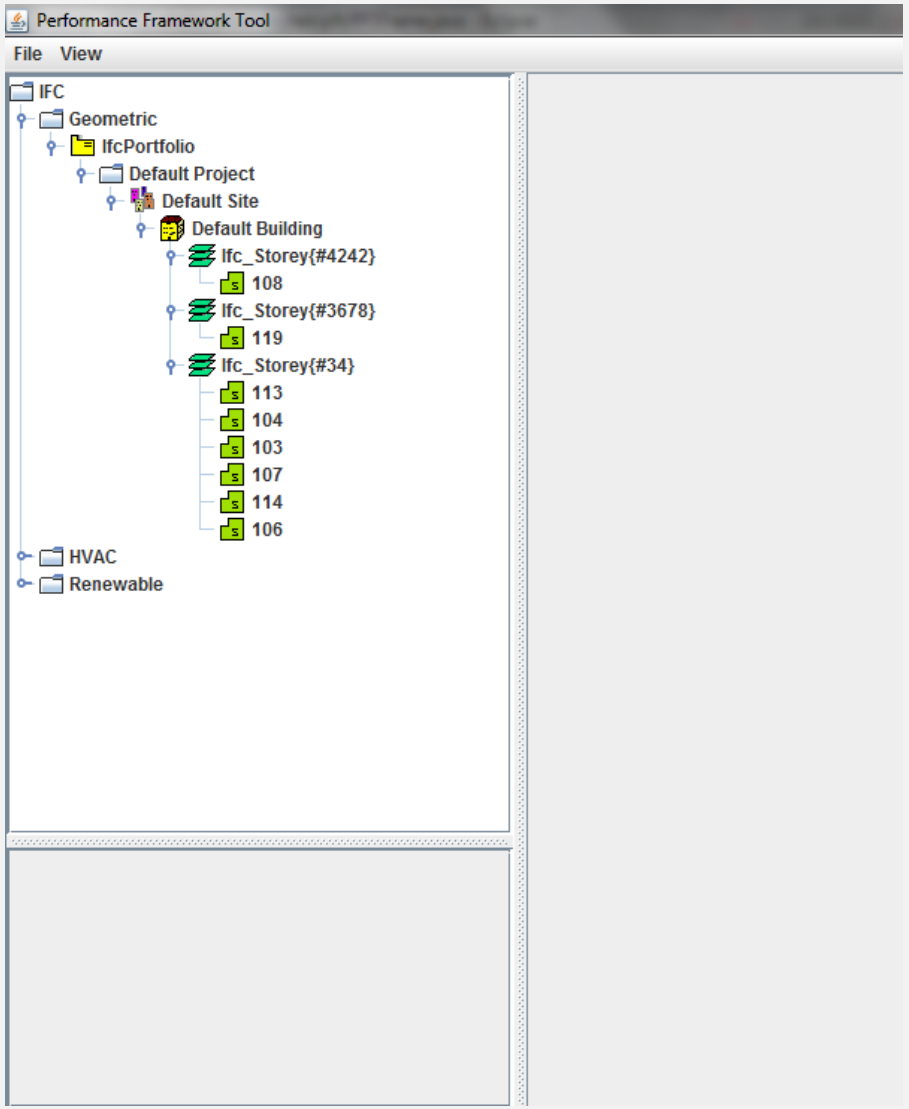
Ryan Institute

INFORMATICS RESEARCH UNIT FOR SUSTAINABLE ENGINEERING (IRUSE)

IRUSE

Performance Framework Tool

- IFCtoRDF converter used to publish BIM in RDF
- RDF imported into application
- Performance Assessment Scenarios associated with building objects



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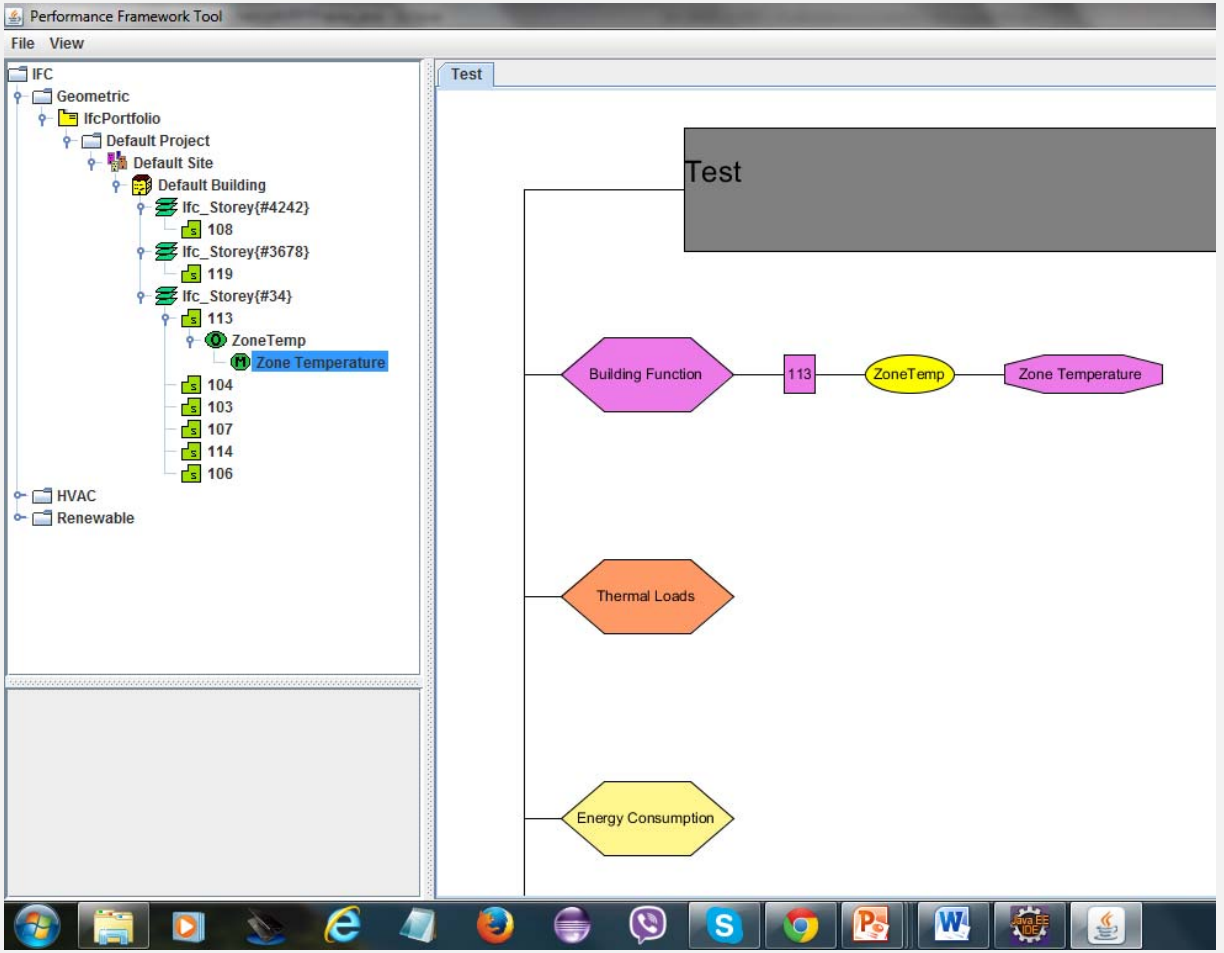
Performance Objective

- Performance Objective associated with building space
- Metric used to evaluate objective
- Performance Assessment ontology used to create instance of scenario graph in RDF



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What's under the hood?

- RDF used to describe performance objective
- Clear link to building object
- Can be associated with data stream
  - Measured – Semantic Sensor Ontology
  - Simulated – SIM model to RDF conversion
- Scenario model retained in semantic web

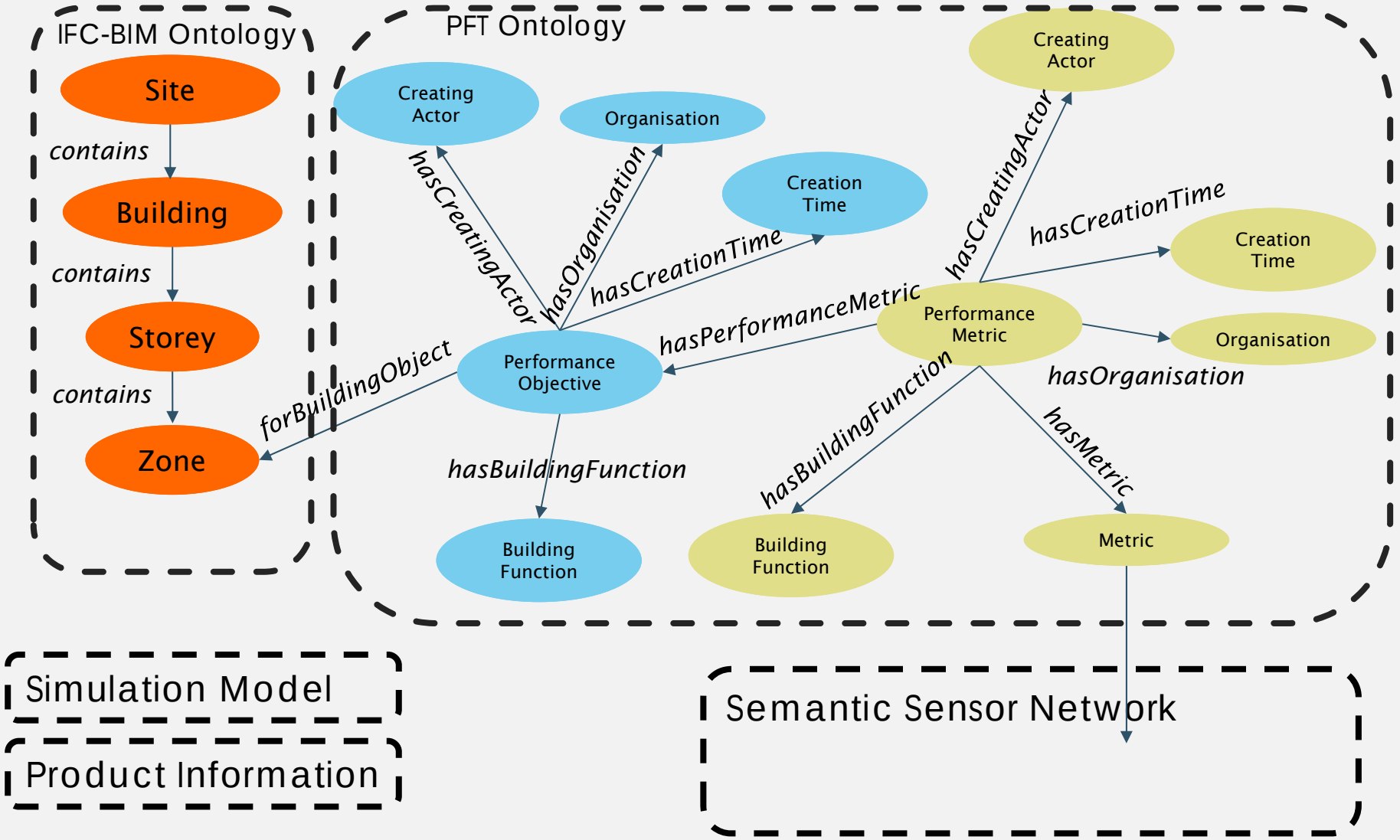
```
<http://performanceframework/instances#ZoneTemp>
    a
<http://performanceframework/ontology#PerformanceObjective> ;
    <http://performanceframework/ontology#forBuildingObject>
 "http://ifc.mmlab.be/IFC-
repo/Bank.ifc#GUID0ed1c5aea265842e28d2bc38a665a0" ;

<http://performanceframework/ontology#hasCreatingActor>
        <http://performanceframework/instances#organisation12345D> ;

<http://performanceframework/ontology#hasCreationTime>
        "2013-11-08T22:38:36.781Z"^
       ^<http://www.w3.org/2001/XMLSchema#dateTime> ;
 <http://performanceframework/ontology#hasPerformanceAspect>
        "http://performanceframework/ontology#BUILDINGFUNCTION" ;

<http://performanceframework/ontology#hasPerformanceMetric>
        <http://performanceframework/instances#Zone Temperature >
```

Vocabulary Used



Key Challenges

- Technology and Data Interoperability
  - Data scattered among different information systems
  - Multiple incompatible technologies make it difficult to use
  - Dynamic data, sensors, ERP, BMS, assets databases, …
- Semantic web builds context between systems
  - More holistic view of building
  - Built on top of existing systems – does not modify or replace existing architecture
  - Not restricted to particular schemas
- Performance Framework Tool
  - Creates a roadmap through data sources
  - Tailored to different stakeholders
  - Cross Domain data use

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Questions

- Thank you for you attention
- Any queries
  - www.iruse.ie
  - edwardcorry@nuigalway.ie