TECHNISCHE UNIVERSITÄT DRESDEN

HESMOS
Virtual Energy Lab

HESMOS

ICT Platform for Holistic Energy Efficiency Simulation and Lifecycle Management Of Public Use Facilities

Prof. Grunewald, TU Dresden

ICT for sustainable homes, Nice 19.11.2010
Workshop on data models for ICT4EE

Project Overview

✓ **Three years project** **01/09/2010 – 31/08/2013**

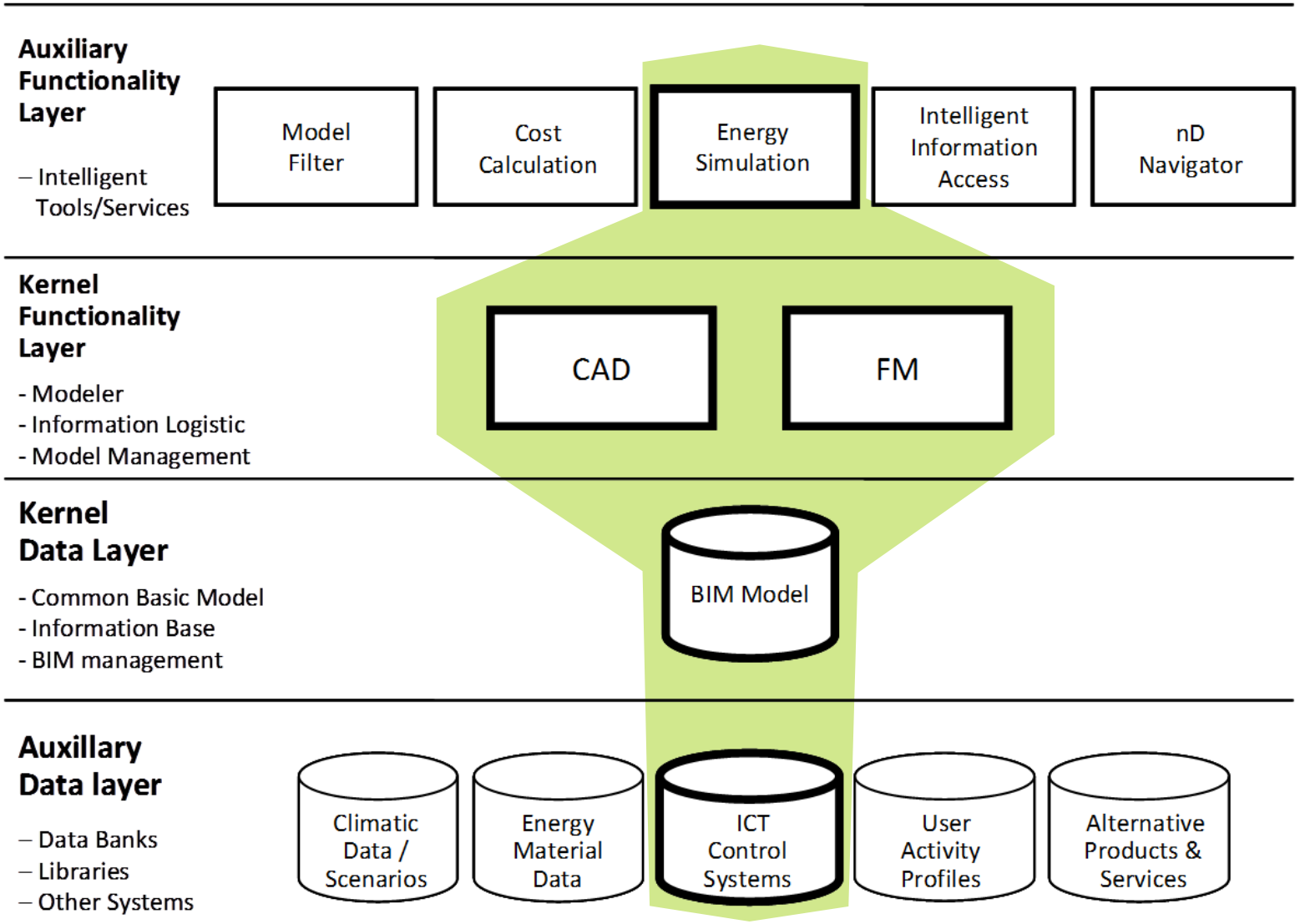
✓ **6 Partners**

Dresden University of Technology	Germany	
Institute of Construction Informatics (CIB, Prof. Scherer - Coordinator)		
Institute of Building Climatology (IBK, Prof. Grunewald)		
Institute of Applied Computer Science (TIS, Prof. Kabitzsch)		
Nemetschek Slovensko, S.R.O.	Slovakia	1064 Employees
Insinööritoimisto Olof Granlund Oy	Finland	360
Royal BAM Group NV	Netherlands	8954
BAM Utiliteitsbouw	NL	
BAM Deutschland AG	DE	
BAM Construct	UK	
Obermeyer Planen+Beraten	Germany	1200
AEC3	UK	3

✓ **Resources**

- **PersonMonths** - **420** **(11,7 Persons x 3 years)**
- **Funding** - **2,7 Mio. €**

Principal HESMOS Architecture



Interoperability in AEC/FM

Rules and regulations
Bldg, H&S, Planning

BIM software
Arch, Struct, Eng Services
Civ Eng

VRML
Visualisation
3D models

Knowledge databases
Company
External

Simulation
Comfort
Air, heating
Lifecycle costs
Light and sound
Insulation
Use
Fire
Environmental impact
Life expectancy

Functional description
Functions
Calculations
Requirements
Constraints

ID

BIM

ID

Reuse
Refurbishment
Demolition
Reconstruction

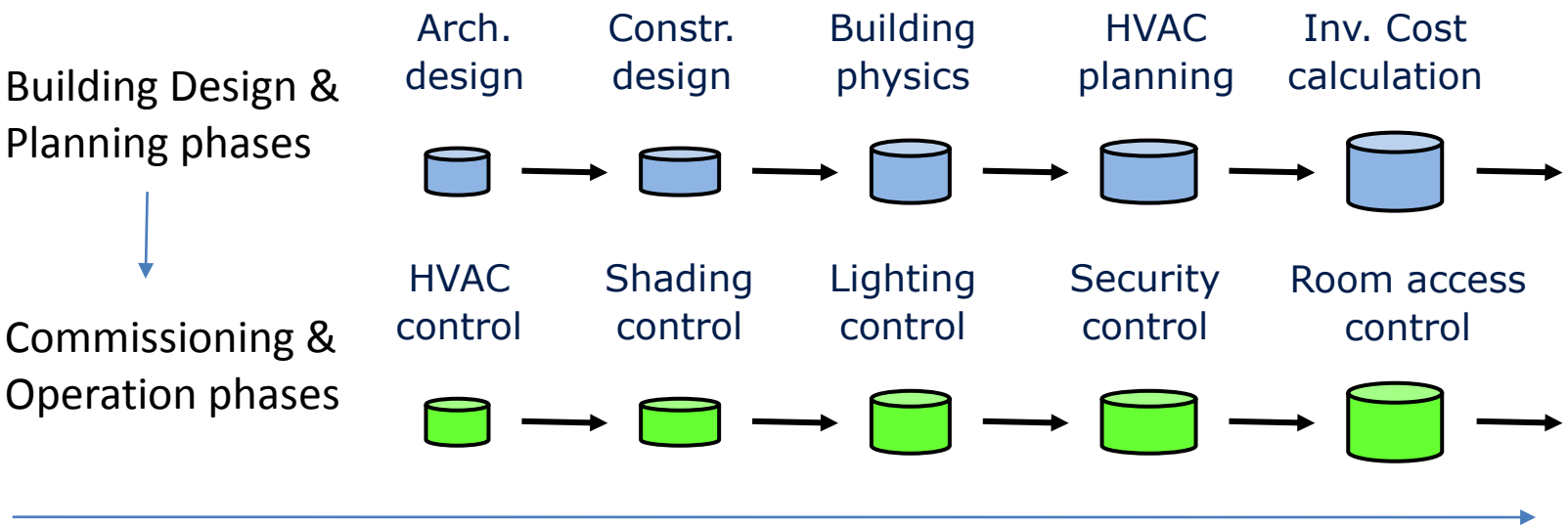
FM
Renting, sale and use
Maintenance
Warranty

Description
Inc cost estimates

4D
Schedules
Logistics

Sourcing
Product databases
Price databases

Interoperability in AEC/FM



Building Information Modeling (BIM)

- Interoperability of different tools
- Common open data model
- Growing databases

Greatest energy saving potential at the beginning and end of the value chain.

BIM is not enough!

What are eeTools?

CAD

+ Geometry
+ Construction
+ Costs

eeGUI

+ Geometry
+ Materials
+ Construction
+ User Activity
+ Lighting
+ HVAC
+ Climate

BIM

DXF/DWG

gbXML

IDD/IDF

Construction
Commissioning

Facility
Management

Energy
Demand

Thermal
Comfort
I
Indoor Air
Quality
I
Hygrothermal
Bridges
I
Lighting
Control
I
Durability
Damage Analysis
I
Noise
Protection

eeTools

Investment
Cost

Operating
Cost

Energy
Cost

Life cycle
Cost

Provide advanced simulation capabilities (energy, costs) to decision makers in the whole life-cycle of buildings

How to integrate a Virtual Lab?

CAD

+ Geometry
+ Construction
+ Costs

BIM

DXF/DWG

gbXML

Virtual Lab

+ Materials
+ Construction
+ User Activity
+ Lighting
+ HVAC
+ Climate

Construction Commissioning

Facility Management

Energy Demand

Thermal Comfort
I
Indoor Air Quality
I
Hygrothermal Bridges
I
Lighting Control
I
Durability Damage Analysis
I
Noise Protection

eeTools

Investment Cost

Operating Cost

Energy Cost

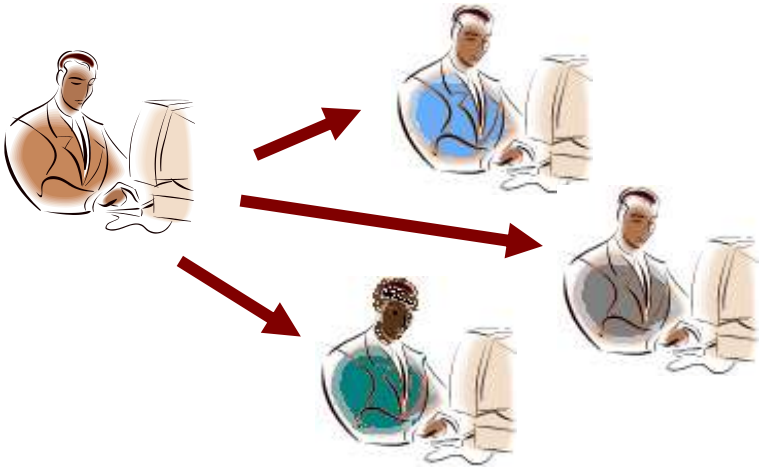
Life cycle Cost

Integrate a Virtual Laboratory to connect CAD and eeTools (enhance AEC actor's ee-competences)

What is eeBIM?

Architectural BIM
(Coordination View)

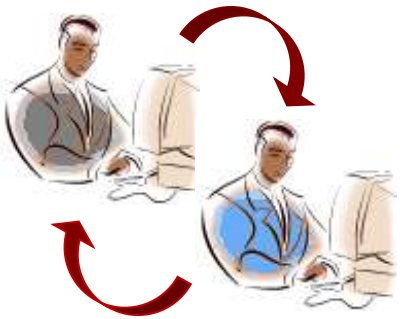
Design cooperation
Further needed data are mainly document based

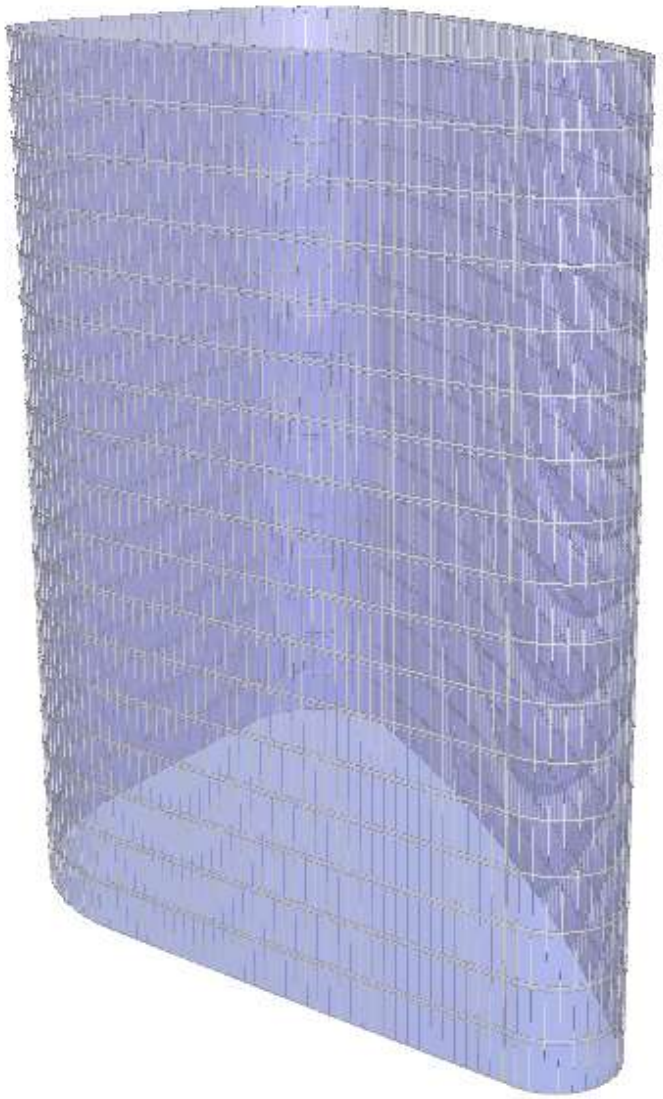


What is eeBIM?

Filtered Building Envelope (facades) View

Further needed data:
Environment, Climate,
Data from sensors and actuators
(Building Automation)





What is eeBIM?

- Individual design/construction domains require their own view of BIM
- Such views are typically subsets of the full BIM, but augmented with domain-specific model data
- People use BIM with different tools and in different ways
- In order to support their work, these tools need to be adapted to the specific user requirements and "speak“ the specific user language
- Unlike large CAD vendors, specialized AEC software developers often find it too difficult to work with the full IFC model

➔ Key: Multi-Model Views

What is eeBIM?

CAD

+ Geometry
+ Construction
+ Costs

BIM

DXF/DWG

gbXML

eeBIM

Virtual Lab

+ Materials
+ Construction
+ User Activity
+ Lighting
+ HVAC
+ Climate

Multi-Model Views

Integrate surrounding areas
extending current BIM
to **eeBIM**

Construction
Commissioning

Facility
Management

Energy
Demand

Thermal
Comfort
I
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eeTools

Investment
Cost

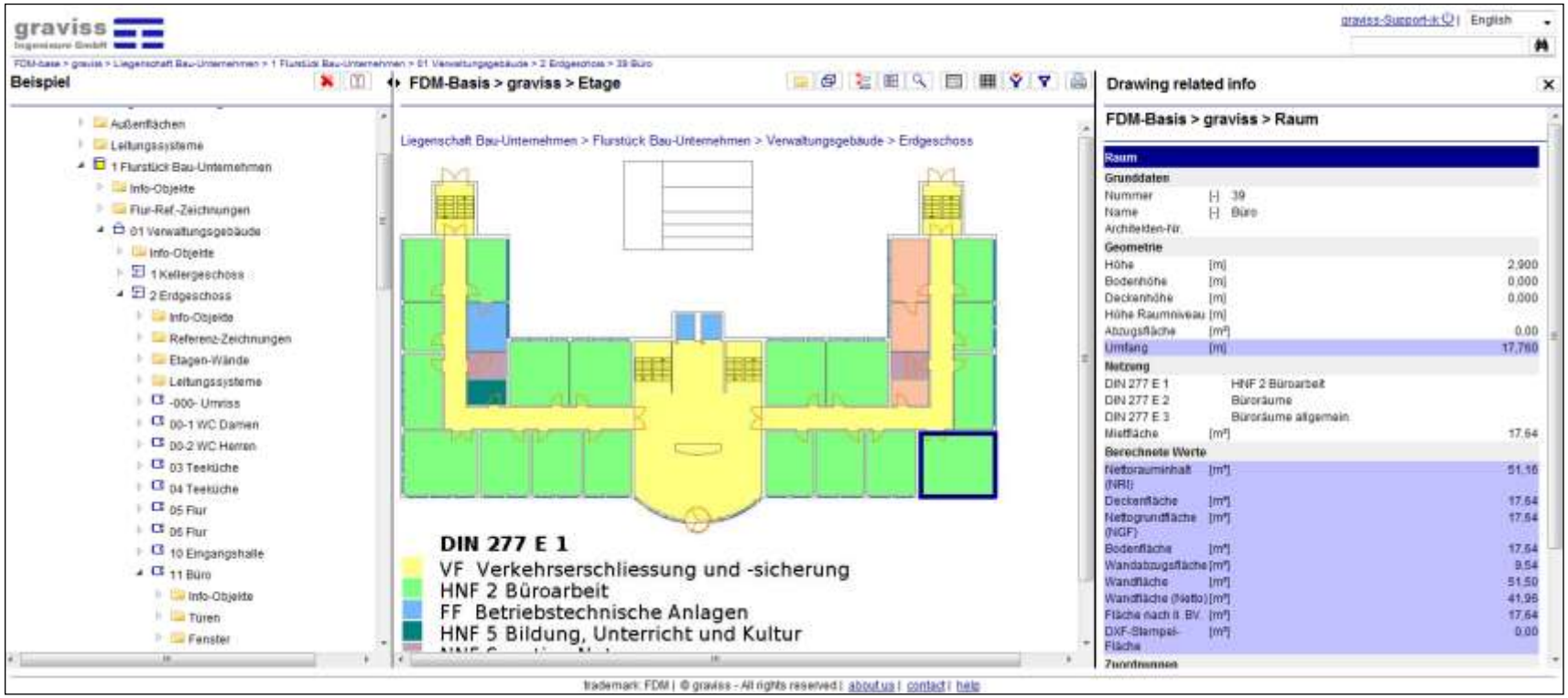
Operating
Cost

Energy
Cost

Life cycle
Cost

Web based framework

for facility data management and virtual energy lab



integration of facility management tasks	collaboration platform
preprocessing of energy simulations (soon)	information server function
visualization of the results of simulations (soon)	customizable front end

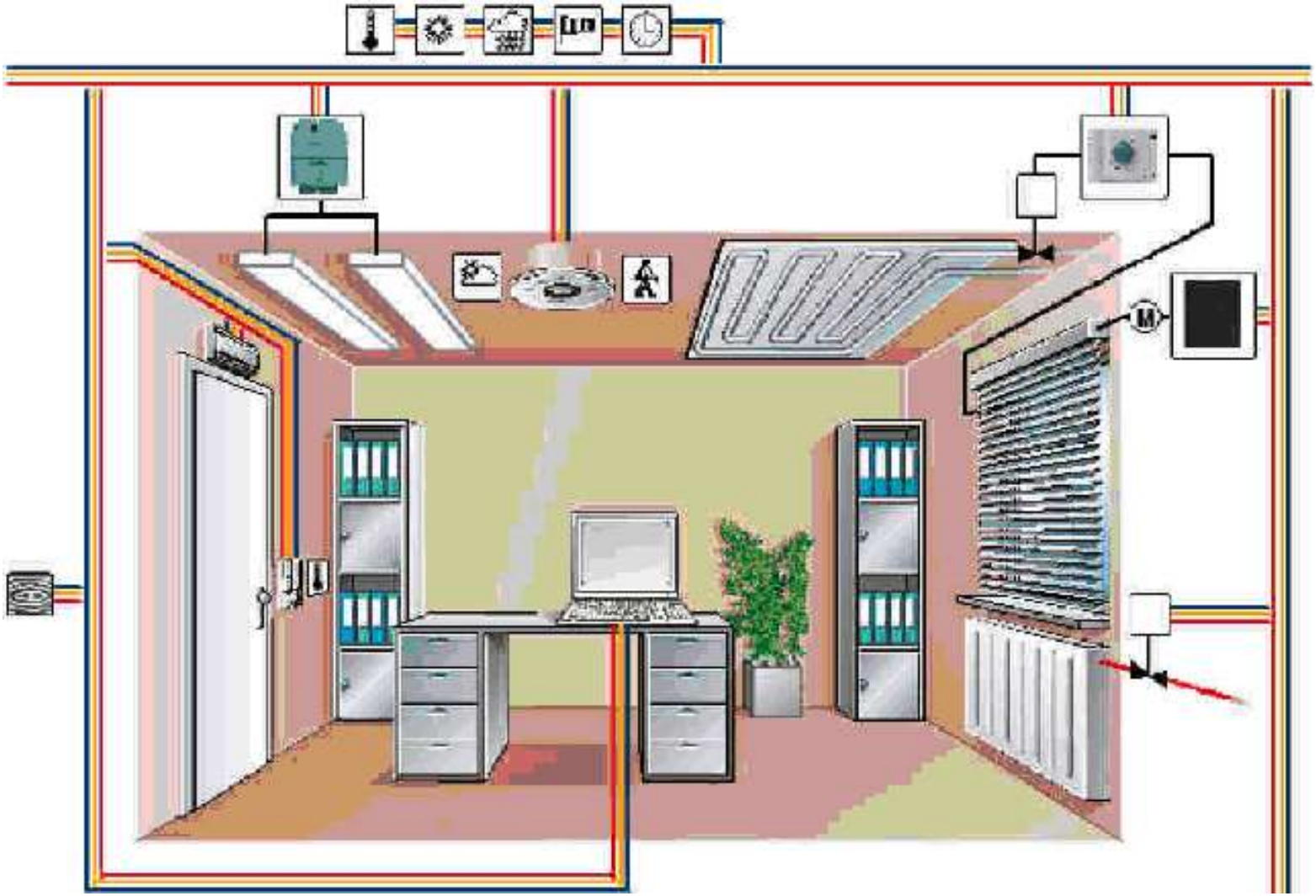
Objectives

1. **Provide advanced simulation capabilities** (energy, costs) to decision makers in the whole life-cycle of buildings
2. **Integrate a Virtual Laboratory** to connect CAD and eeTools (enhance AEC actor's ee-competences)
3. **Integrate surrounding areas** extending current BIM to **eeBIM**
4. **Close the gap between Building Information Modelling (BIM) and Building Automation Systems (BAS)** so that decisions can be made economically (energy & cost related) in all life-cycle phases

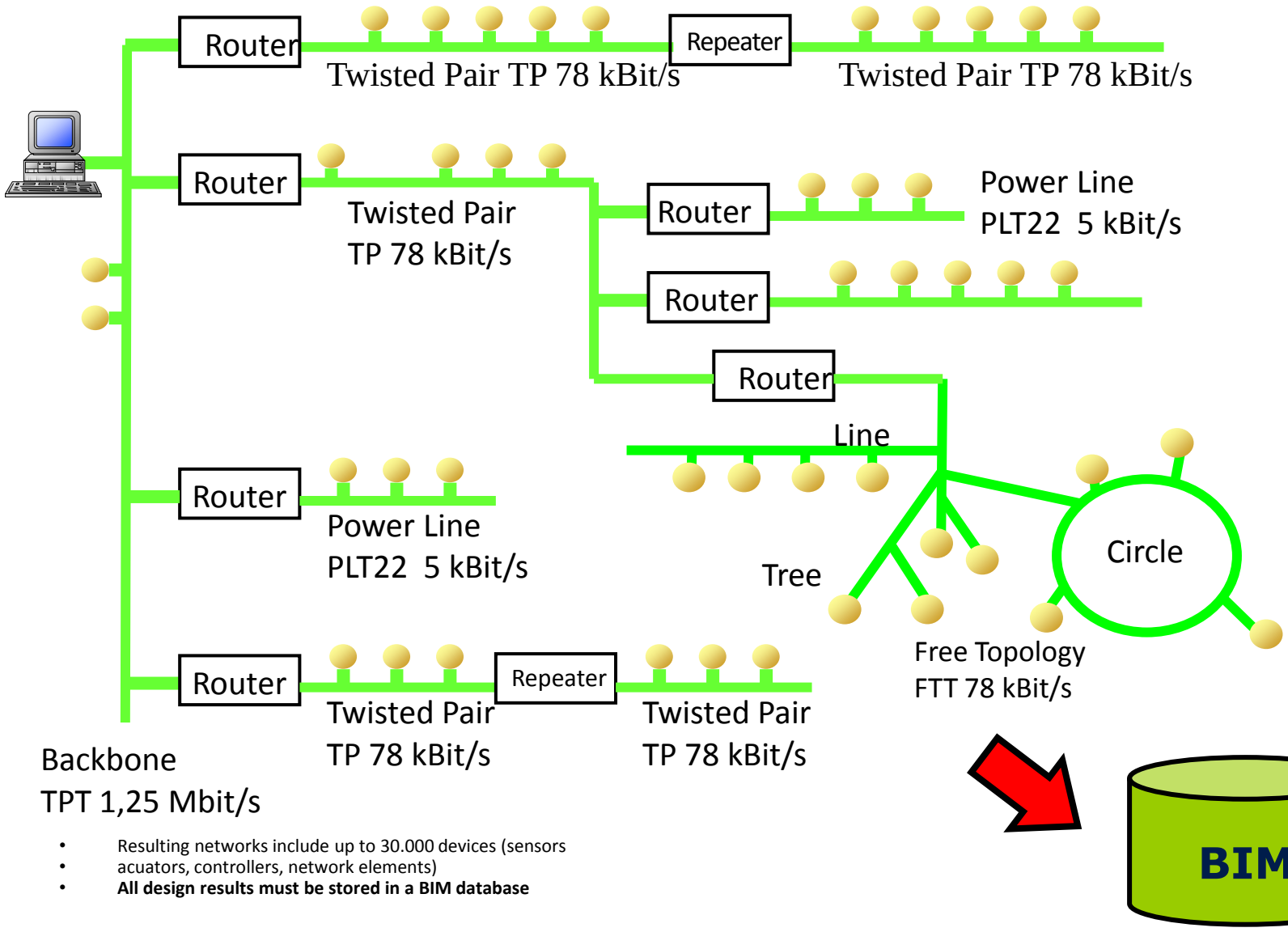
HESMOS Product:

Integrated Virtual Energy Laboratory (IVEL)

Connectivity & networked implementation

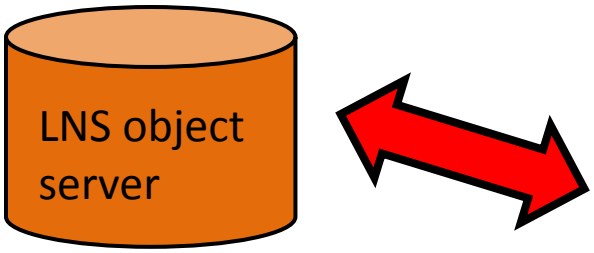


Connectivity & networked implementation

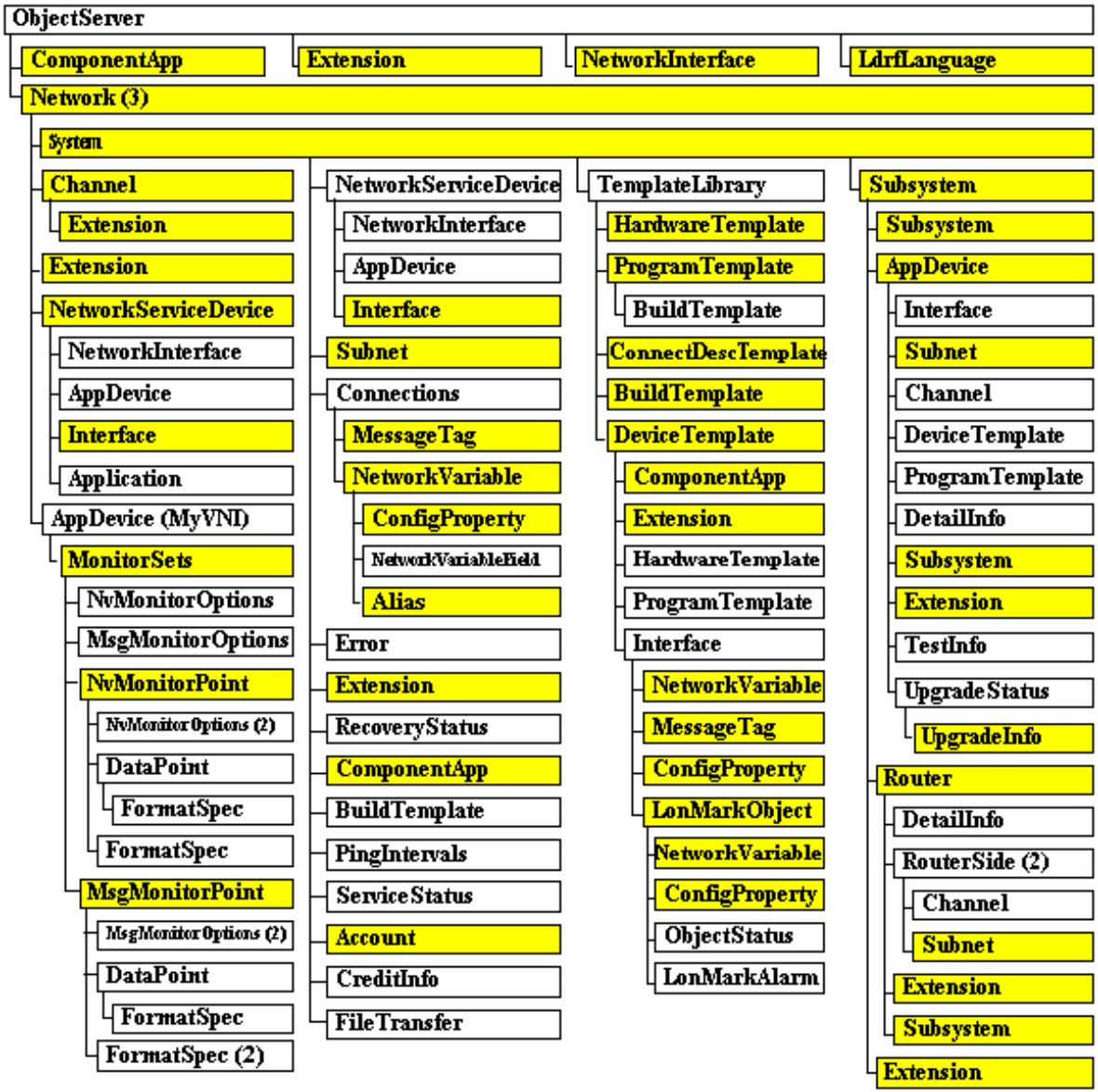


- Resulting networks include up to 30.000 devices (sensors
- acuators, controllers, network elements)
- **All design results must be stored in a BIM database**

Vendor Defined BIM <-> LNS



- LNS object server contains the design database, using an object-oriented programming model
- LNS data model defines a set of objects that represents the network, all devices and their embedded software
- The objects are hierarchically grouped



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HESMOS Product:

Integrated Virtual Energy Laboratory (IVEL)

Example eeTools

(IBK)

eeTools

1988 2000 2003 2006 2009 2010

Wall Assemblies

DIM 1, DIM 2, DIM 3

Heat-air-moisture analysis

DELPHIN 4

+ Salts, restructured code and libraries

COND 1 + Delphin 5

+ Multi-language and multi-platform support

COND 2 + Delphin 6 . . .

- Salts, + Pollutants (VOC adsorption, diffusion)

CHAMPS-BES

DFG Deutsche Forschungsgemeinschaft

U.S. DEPARTMENT OF ENERGY EPA

Bundesministerium für Wirtschaft und Technologie (4 Projekte)

Room Models

Single-zone, single-node thermal model, 1D-wall discretization

Therakles

Single-zone, multi-node HAM model, 3D-wall discretization
Multi-language and multi-platform support

Glückmodel . . .

Whole Buildings

Multi-zone, single-node HAMP model, 1D-wall discretization

CHAMPS-Multizone PT

Multi-zone, single-node HAMP model, 1D-wall discretization
Multi-language and multi-platform support, IDF-Import

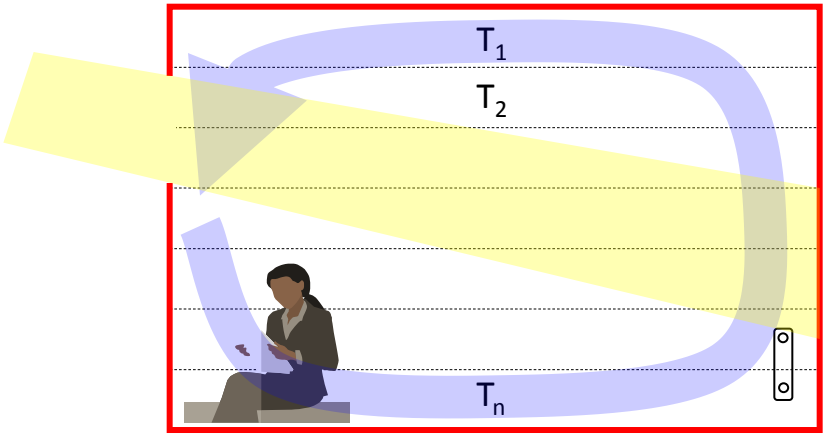
CHAMPS-Multizone V1 . . .

Basis

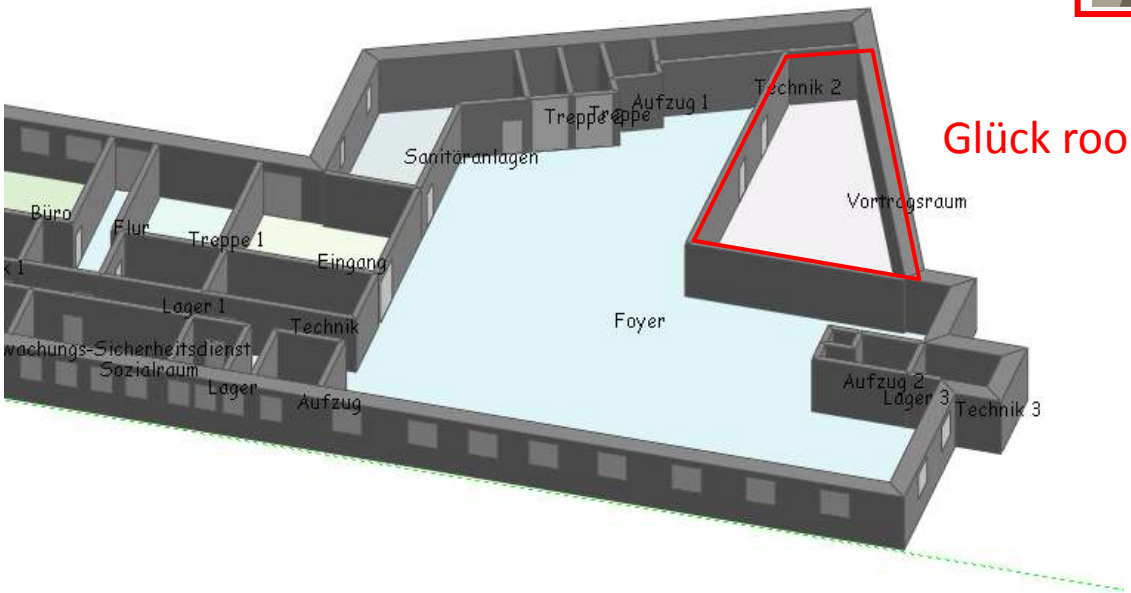
CVODE lib, CC lib → Sundials, IBK, Airflow, Pollutants, Solver libs → Platform . . .

CHAMPS-Multizone + Glück model

- Building geometry
- Wall, roof, floor constructions
- Zone activities
- Lighting concept
- HVAC systems



Vertical cross section



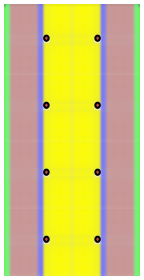
Glück room

- Radiant heaters
- Radiation balance
- Temperature stratification
- Air convection
- Comfort calculation

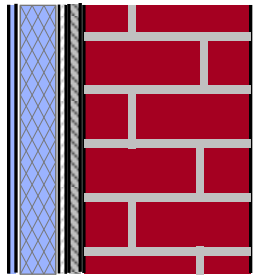
CHAMPS-Multizone + Delphin model

- Building geometry
- Wall, roof, floor constructions
- Zone activities
- Lighting concept
- HVAC systems

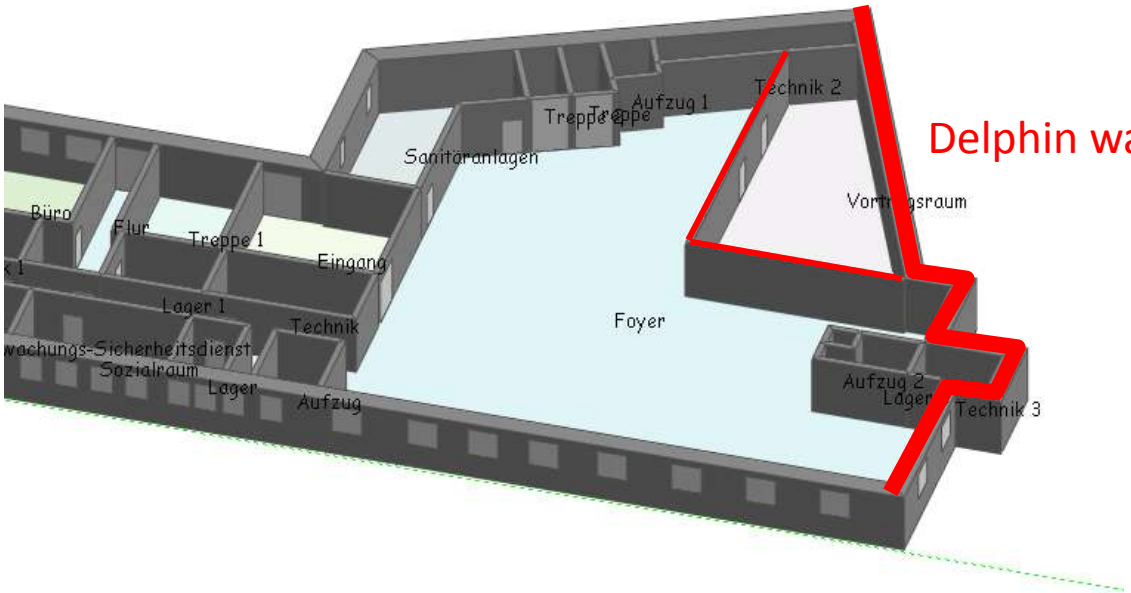
e.g.
thermo-aktive
construction



e.g.
capillary active
insulation



Vertical cross sections



Delphin walls (1D, 2D, 3D)

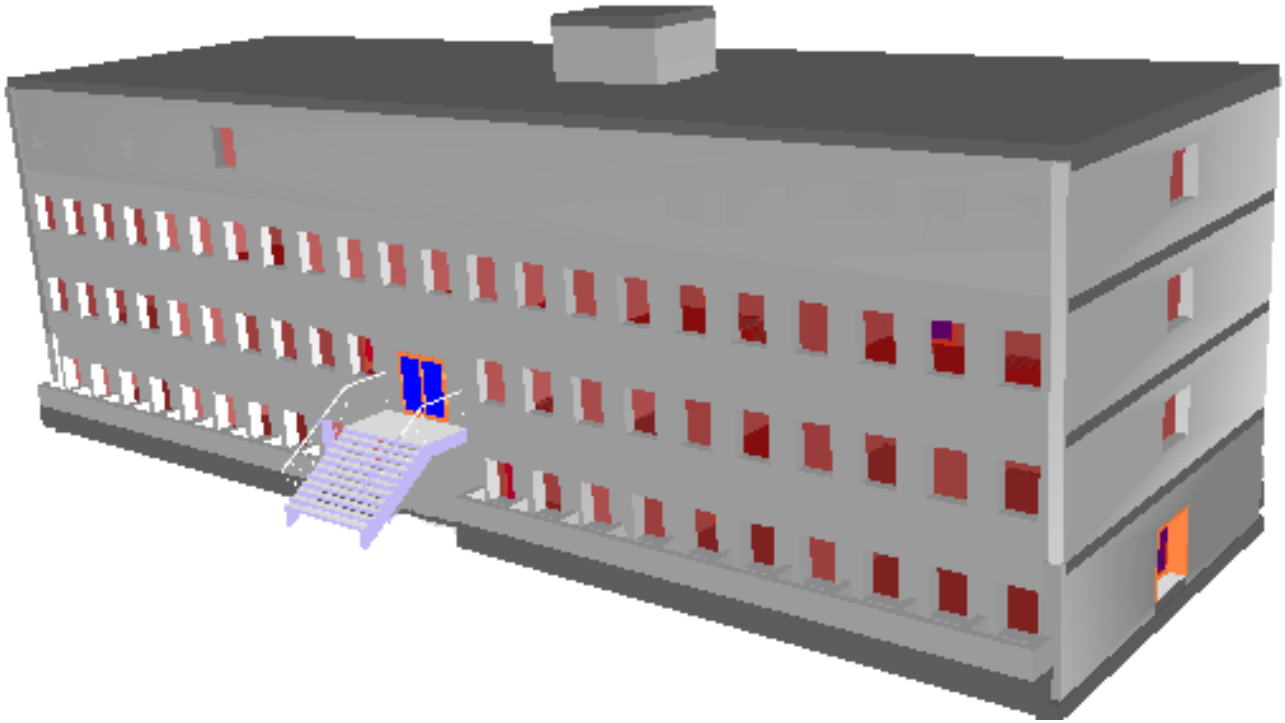
- Thermal storage effects
- Panel heating systems
- Hygrothermal processes
- Micro climate
- Durability
- Emissions

Example
Multi Model View Scenario

(CIB)

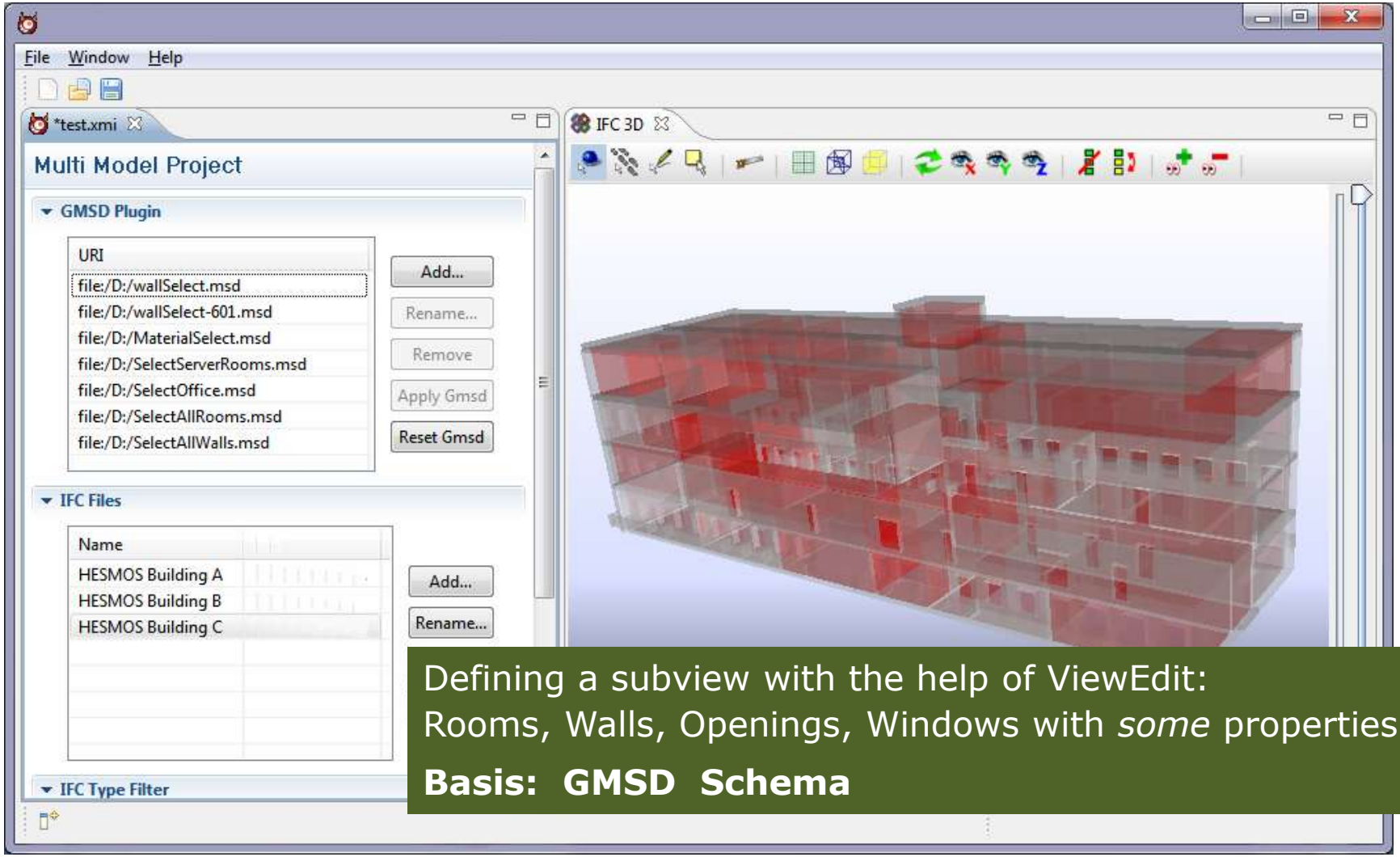
Multi-Model View Definition

Example Scenario: Integrating BIM with data from temperature and humidity sensors for room climate calculations



Multi-Model View Definition

Level 1: BIM View Definition



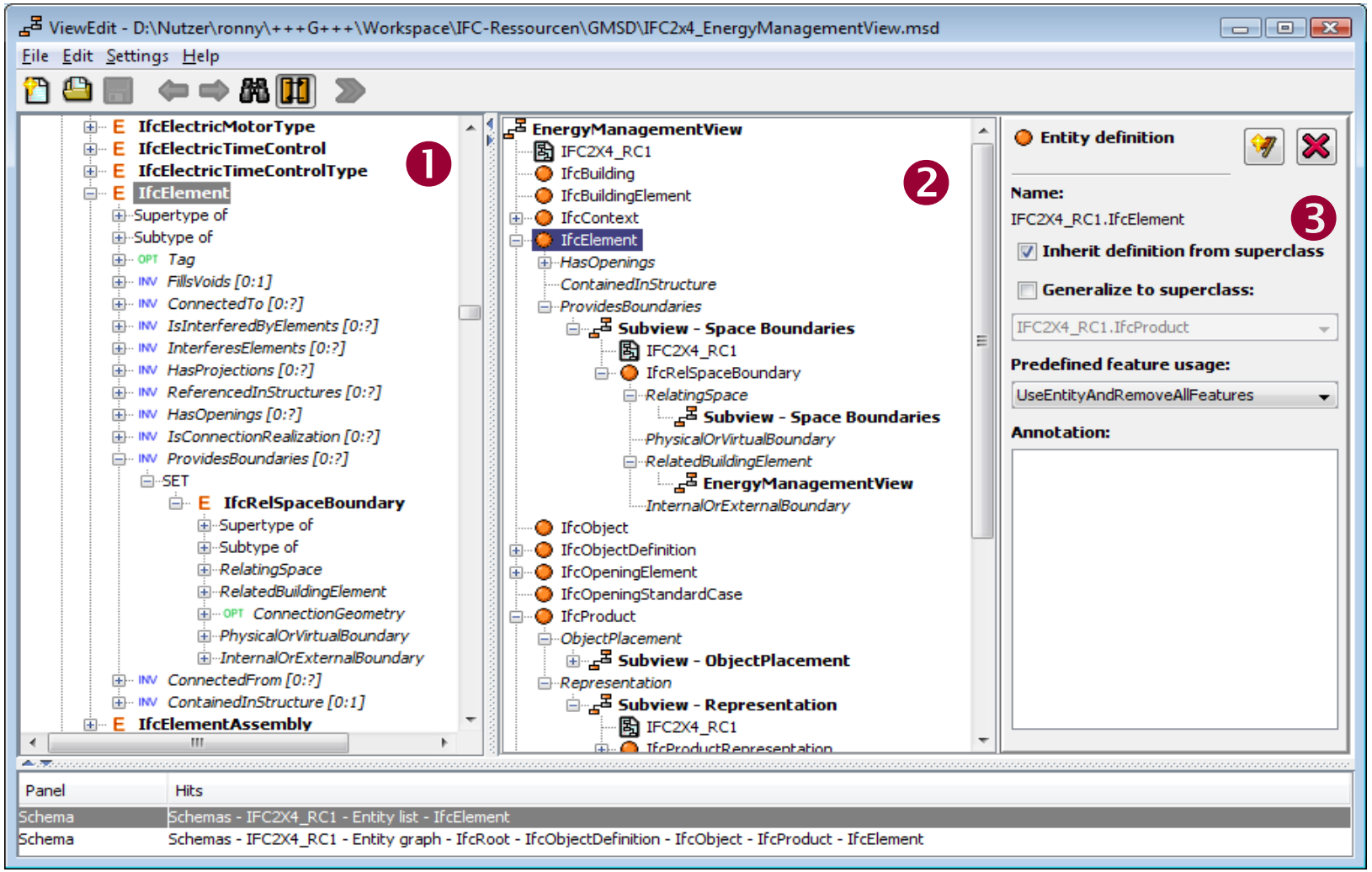
Defining a subview with the help of ViewEdit:
Rooms, Walls, Openings, Windows with *some* properties

Basis: GMSD Schema

Multi-Model View Definition

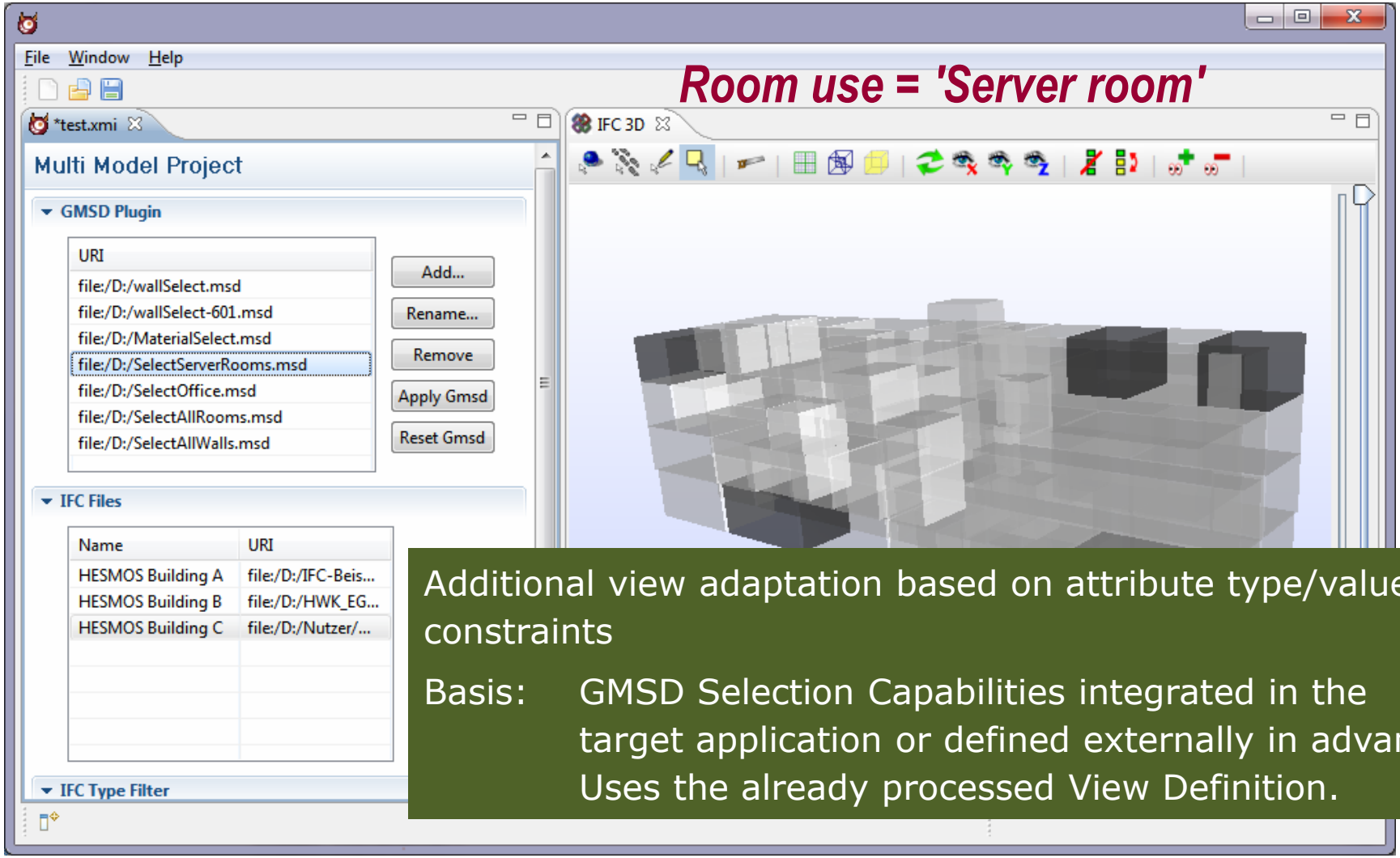
Level 1: BIM View Definition

GMSD Use: ViewEdit



Multi-Model View Definition

Level 2: Adding Class Level Constraints

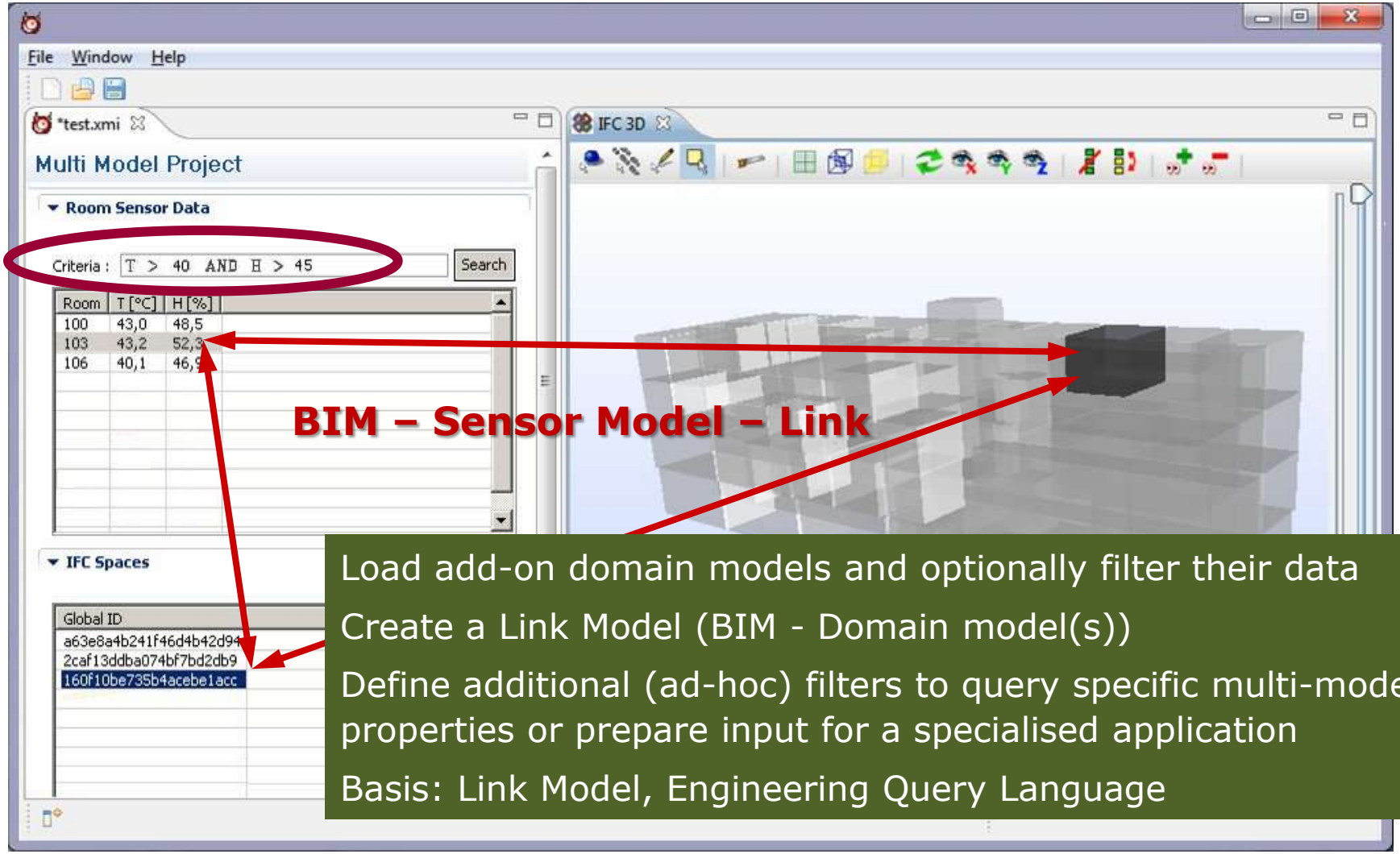


Additional view adaptation based on attribute type/value constraints

Basis: GMSD Selection Capabilities integrated in the target application or defined externally in advance
Uses the already processed View Definition.

Multi-Model View Definition

Level 3: Object Level Multi-Model Filtering



Load add-on domain models and optionally filter their data

Create a Link Model (BIM - Domain model(s))

Define additional (ad-hoc) filters to query specific multi-model properties or prepare input for a specialised application

Basis: Link Model, Engineering Query Language

Demonstration cases to be selected (BAM, Obermeier)

Demonstration cases

- **2 pilot projects, preferably in two different countries** (Germany, UK or NL)
- **Purpose:**
  - Establish, check and adjust key performance indicators for further use in a broader range of facilities using the pilot results as best practice examples
  - Validate and disseminate the project findings to a broad audience, providing actual practical proof-of-concept from ‘live’ facilities
  - Provide continuous bidirectional feedback throughout the project duration

Demonstration case candidates

West Dunbartonshire Schools

PFI contract involving BAM PPP (finance & investment), BAM Construction (D&C) and BAM FM (O&M)

Location: near Glasgow, UK

The project encompasses 3 secondary schools (completed Aug. 2009) as well as 1 primary school (due late 2010). The schools are built to latest UK building standards (fit to purpose Community Learning Centres). Heating and cooling are provided via ground source heat pumps.

Capacity: over 4500 pupils

Investor: BAM PPP (100%) – responsible for the day-to-day management of the facilities, with BAM FM providing operational and maintenance services such as janitorial services, security, energy and utilities management, waste management.

Concession period: 30 years

All influencing variables must be recorded and documented to inspect and evaluate the calculated values for the heating and cooling system.

BAM FM (UK) will be able to provide data and information on energy consumption, while BAM Construction (UK) will be able to provide information on design and specification, as well as building standards, regulations and other relevant data for HESMO analysis and simulation tools.

Demonstration case candidates

Solihull Schools

PFI contract involving BAM PPP (finance & investment), BAM Construction (D&C) and BAM FM (O&M)

Location: near Birmingham, UK

The project comprises 3 secondary schools and 1 special education needs facility. The three schools provide replacements for 1,400 pupils each, the special-needs facility is a new purpose-built building for 50 pupils, a 40 place PRU and a sports hall. Integrated services include places of worship and multi-purpose social spaces. All facilities are operational since 2009.

Investor: BAM PPP (100%)

FM contractor: BAM FM (100%)

Concession period: 25 years

The project includes a number of different facility types that can be very useful to test and validate HESMOS products.
These include, beside the mentioned school buildings a new theatre and chapel, a sports hall and a reconstructed swimming pool and sports complex.

As above, BAM FM and BAM Construction (UK) will be able to provide the needed data for HESMOS analysis and simulation tools.

Demonstration case candidates

New Construction of the Landtag Brandenburg

PPP project; Public contracting body: Ministry of Finance of the State of Brandenburg, Germany

Location: Potsdam, Germany

The new construction of the Landtag of Brandenburg is being developed in the historical centre of the regional capital Potsdam. Behind the historical 3 part façade, a total of 4 modern office floors are installed. The preservation of monuments requires strong cooperation and coordination with the customer and the authorities.

In particular, to be able to adhere to the guidelines of the ENEV (energy saving regulation), the installation is as follows: constructive damping on inner concrete walls and the historical facades in front.

Key figures:

Gross volume	150,632 m³
Gross floor area	34,525 m²
Building costs:	ca. € 120 mill.
FM contractor:	BAM (100%)
Concession period:	30 years

Similar to the presented UK projects the influencing variables must be recorded and documented to inspect and evaluate the calculated values for the heating / cooling system. This includes the recording of the energy consumption from the use of the IT systems to just the same extent as the heating up of the building through insulation. In addition options must be created that enable the inspection of energy storage and energy retrieval.

BAM will provide energy-related and other necessary data from FM and construction in their capacity of both contractor and operator of the facility.

Demonstration case candidates

Rudolf-Harbig Stadium Dresden

PPP project: Landeshauptstadt Dresden, Dresden Stadium Projektges. mbH, BAM AG

Location: Dresden, Germany

The new Dresden stadium has a capacity for ca. 32,000 spectators (incl. a VIP area for 1,343 persons). A particular focus provides the use of a large number of pre-fabricated elements.

Key figures:

Gross area	78,870 m^2
Field area	22,603 m^2
Building costs:	ca. € 47 mill.
FM contractor:	BAM (100%)
Concession period:	30 years

The operation of the stadium is characterised by a multiple use concept: (1) football arena, (2) staging of musical events for 100 up to 32,000 people, (3) exhibitions/meetings in the business area, and (4) entertainment events (PPP contract duties).

HESMOS should enable greater energy efficiency by (1) simulation of usage scenarios, (2) reducing peak electricity loads, (3) simulation of work performance to aid decision-making and (4) integrated reduction of emissions while taking the operating situation into account.

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Thank you!

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