BaaS Project: Covering the Building Design and Operational-Phase Interoperability Gap

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12th International Conference for Enhanced Building Operations

Manchester, 24th October 2012

Project funded by the European Community in the 7th Framework Programme

ICT for Sustainable Growth

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- BaaS solution
  - Premises
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  - Middleware platform approach:
  - Data Layer: extendedBIM (BIM + DWH)

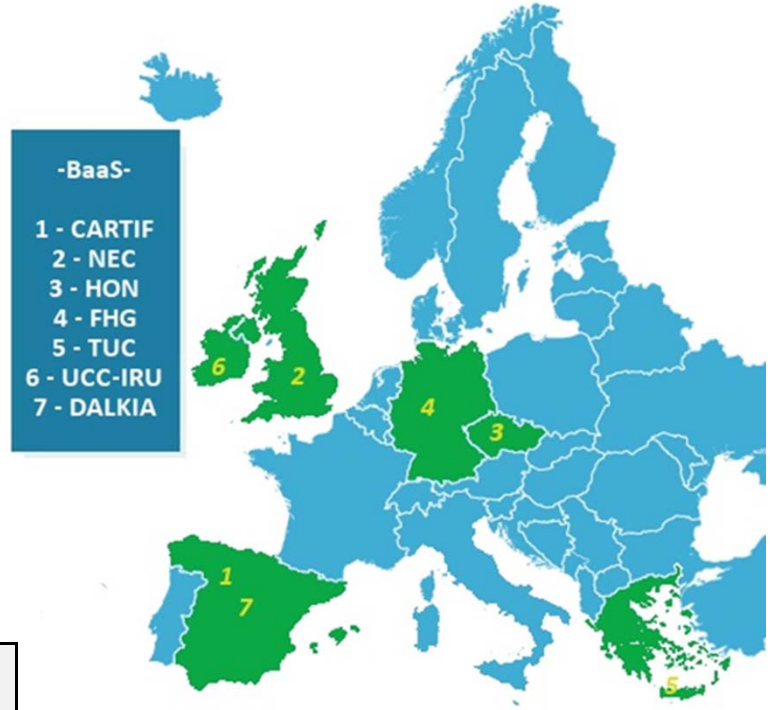
BaaS Overview

Acronym: BaaS

Tittle: Building as a Service (Ecosystem)
Proyect number: 288409

Call: FP7-ICT-2011-7
Topic: ICT 2011.6.2 ICT systems for Energy Efficiency (a)
Funding Scheme: STREP

Duration: 36 months
Maximum finantial EC contribution: 2176000€



No.	Participant organisation name	Short name	Country
1	Fundación CARTIF	CARTIF	Spain
2	NEC	NEC	U.K.
3	Honeywell	HON	Czech Republic
4	Fraunhofer Institute for Building Physics	IBP	Germany
5	Technical University of Crete	TUC	Greece
6	University College of Cork -IRUSE	UCC	Ireland
7	Dalkia	Dalkia	Spain

BaaS
Building as a Service

BaaS

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BaaS Overview

The BaaS system aims to optimize energy performance in the **application domain of "non-residential buildings, in operational stage**, when three main tasks have to be continuously performed:

- collect information and assess the buildings current state;
- predict the effect that various decisions will have to Key Performance Indicators (KPIs);
- optimize performance.

A **generic ICT-enabled system** will be developed to provide integrated **assess, predict, optimize (APO)** services that guarantee harmonious and parsimonious use of resources:

- A data management component
- A service middleware platform
- Energy models
- APO (assessment, prediction and optimization) services

Measurement and verification Plan

End-user acceptance analysing the **replication potential** and a **sensibility study**

BaaS Objectives

SO1: Building modelling and simulation for energy performance estimation and control design.

SO2: Integrated Automation and Control Services.

TO1: Data Management: Working on existing initiatives and ongoing projects results, integrating State of the Art of extended BIM, EEB Ontologies and Standards.

TO2: System Integration, Interoperability and Standards.

VERIFICATION AND VALIDATION OF THE BAAS SYSTEM.

1. Proofs of concept in test beds.
2. Demonstration in real Buildings.
3. Measurement methodology for energy-savings verification. (IPMVP)
4. End User Acceptance: sensibility analysis and replication potential.

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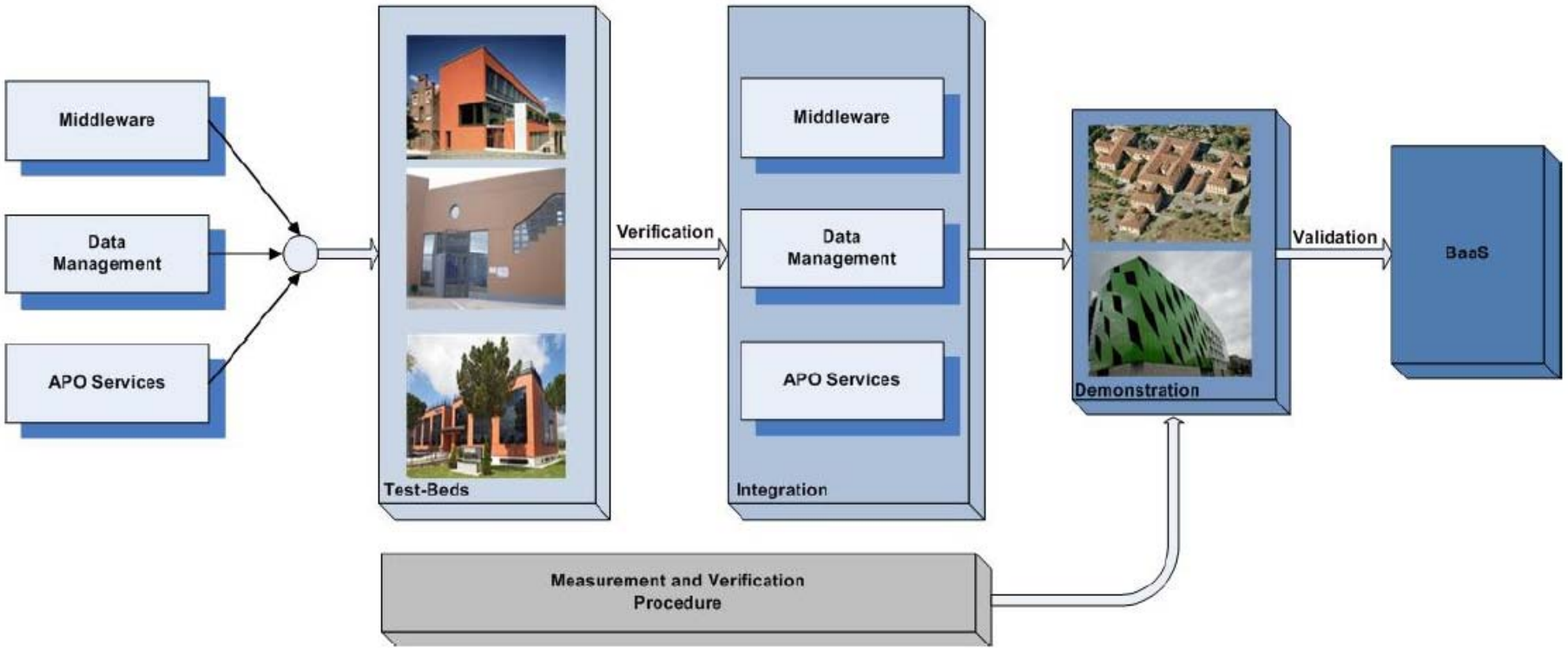
BaaS: Validation & Demonstration



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BaaS: Validation & Demonstration

Test Beds

Test-bed I: 	The centre for sustainability building is a 1348m² office building located in Kassel (Germany). 23 people deploy their activity in its four floors, and 821m² are conditioned. It has a BEMS, model Sauter Lon that allows management of building generation components and final energy uses. This BEMS is suitable to implement the proof of concept of the strategies developed in the project framework, because some special facilities as district heating, geothermal and PV plant and HVAC systems as well as final energy uses, radiant and air systems are sufficient in order to verify the improvement of energy performance using new concepts of management.
Test-bed II: 	The technical services building in the TUC campus is two-floor building with a total floor area of 450m². It is an office building with 12 occupants and is fully conditioned. A PLC-based Saia-Burgess BEMS is installed to control the heating and cooling systems. A PV array is to be installed in the roof. An extensive monitoring and sensing infrastructure has been deployed. This BEMS is fully accessible and programmable by the members of the TUC research group and can be used to test the control components (natural ventilation, HVAC control etc.) to be developed in WP5.
Test-bed III: 	The CARTIF building is a 7500m² office building. Approximately 150 people deploy their activity in its 3 floors. The building is fully conditioned, and a BEMS system is implemented that integrates several renewable energy (solar thermal and PV, geothermal) and conventional facilities. The building is completely monitored, as well as a comfort control system deployed in a distributed Lonworks network, which allows easy implementation of new strategies and management modes. CARTIF has available a middleware technology, SOA based, that allows the implementation of added value e-services, such as demand response and load balancing.

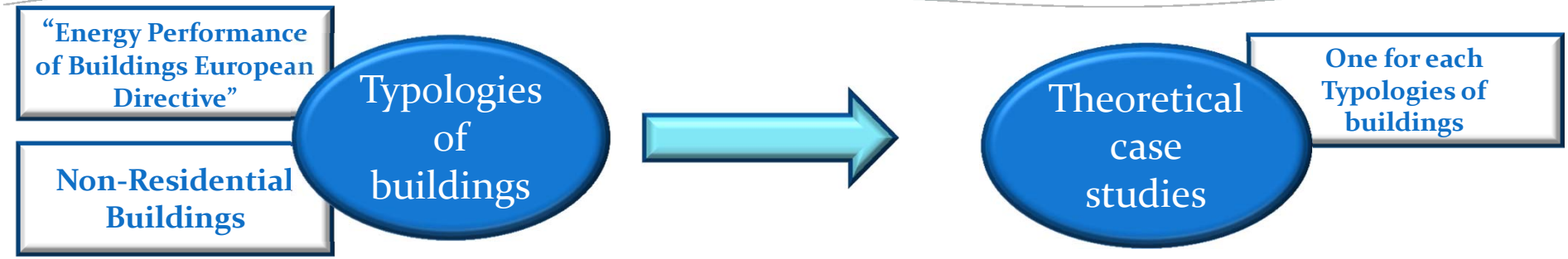
Scope of the project

"Energy Performance of Buildings European Directive"
http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm
Directive 2010/31/EU
Directive 2002/91/EC (and revision)

Typologies of Buildings:

- (a) single-family houses of different types;
- (b) apartment blocks;
- (c) offices;
- (d) educational buildings;
- (e) hospitals;
- (f) hotels and restaurants;
- (g) sports facilities;
- (h) wholesale and retail trade services buildings;
- (i) other types of energy-consuming buildings.

Case Studies



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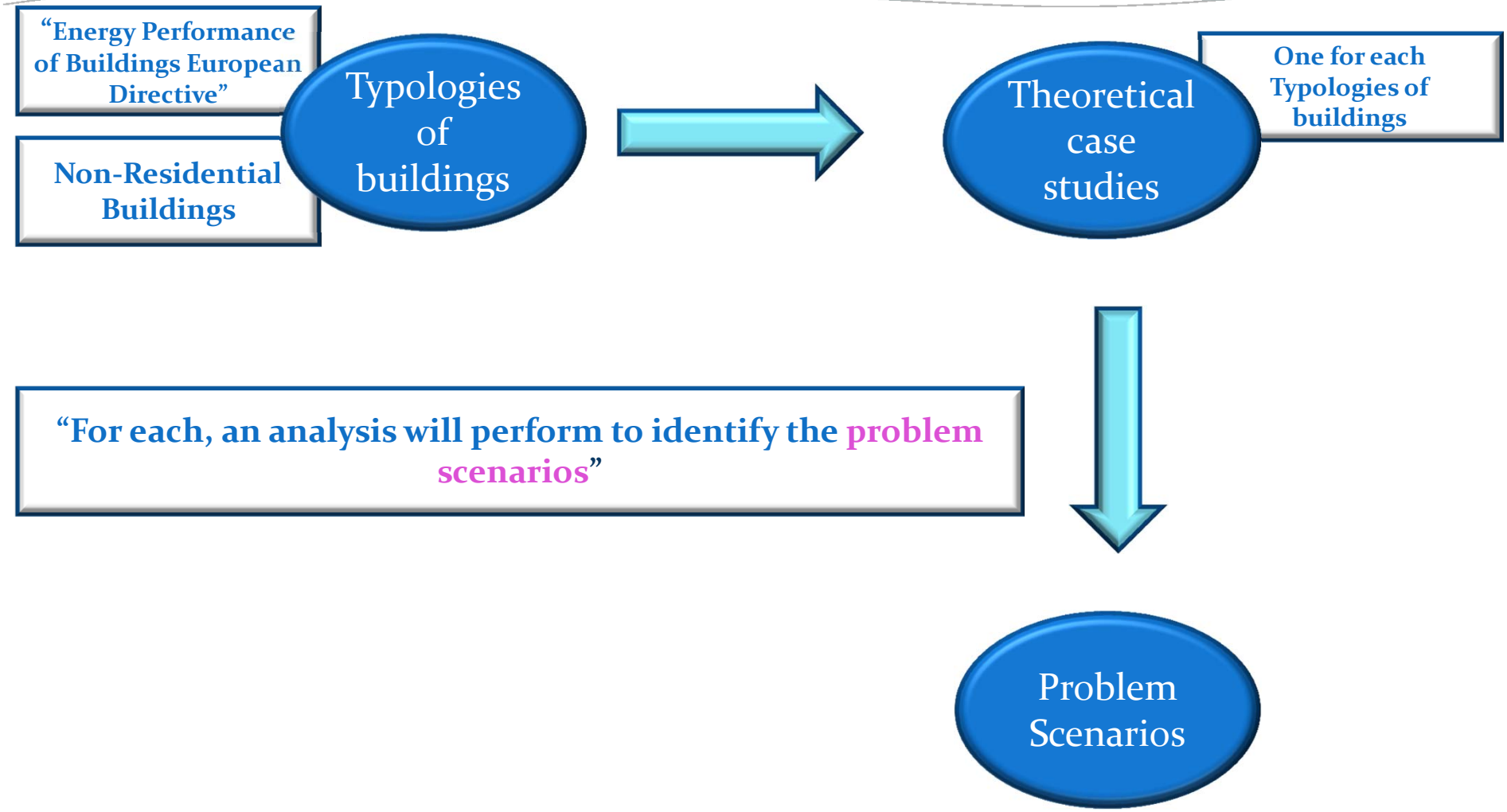
- (g) sports facilities;
- (h) wholesale and retail trade services buildings;
- (i) other types of energy-consuming buildings.

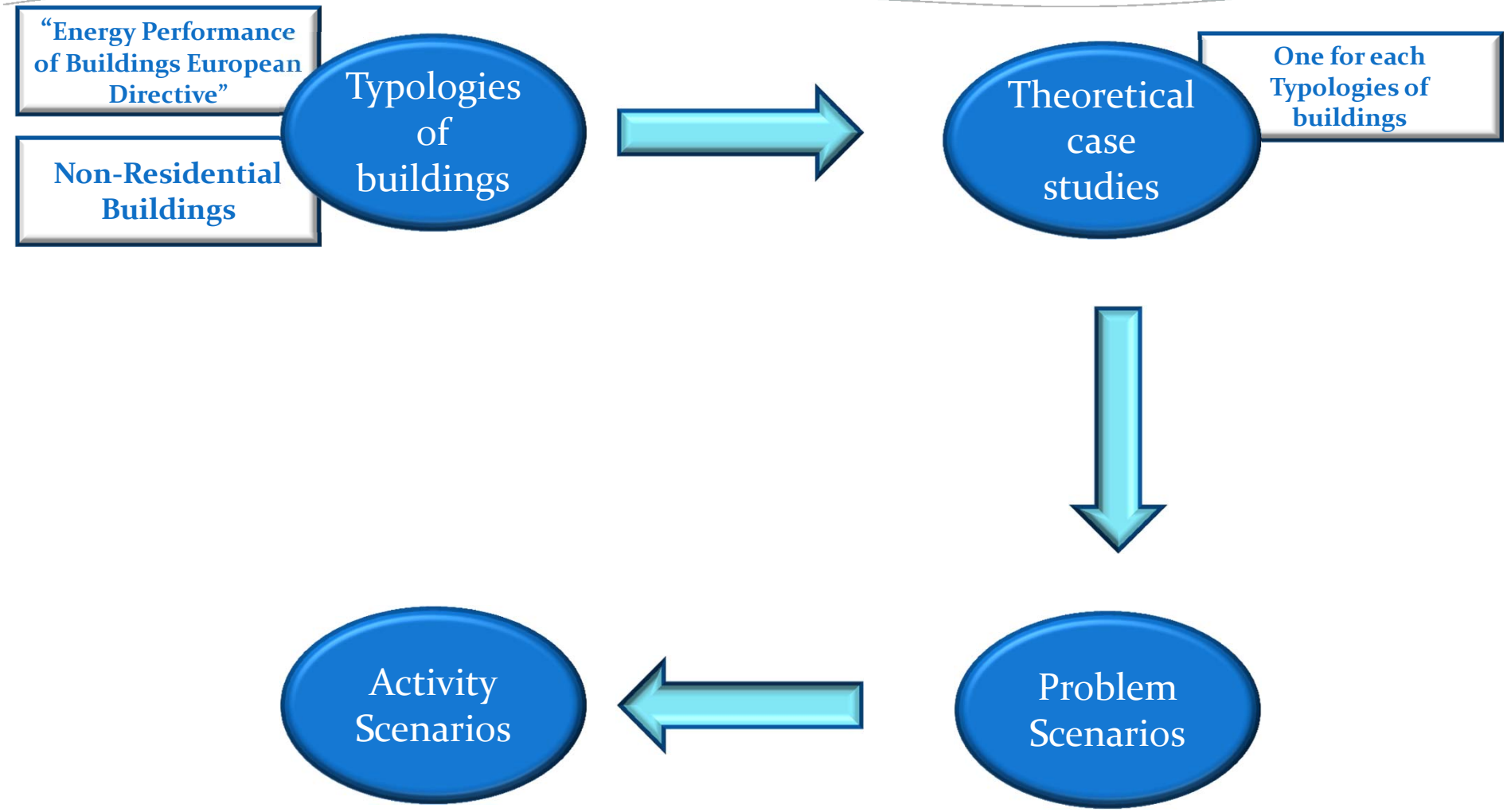
Theoretical Case Studies

- ---
- ---
- (TCS1) Offices Building;
- (TCS2) School;
- (TCS3) Hospital;
- (TCS4) Hotel;
- (TCS5) Swimming Pool;
- (TCS6) Shopping Mall;
- (TCS7) *Out of scope*

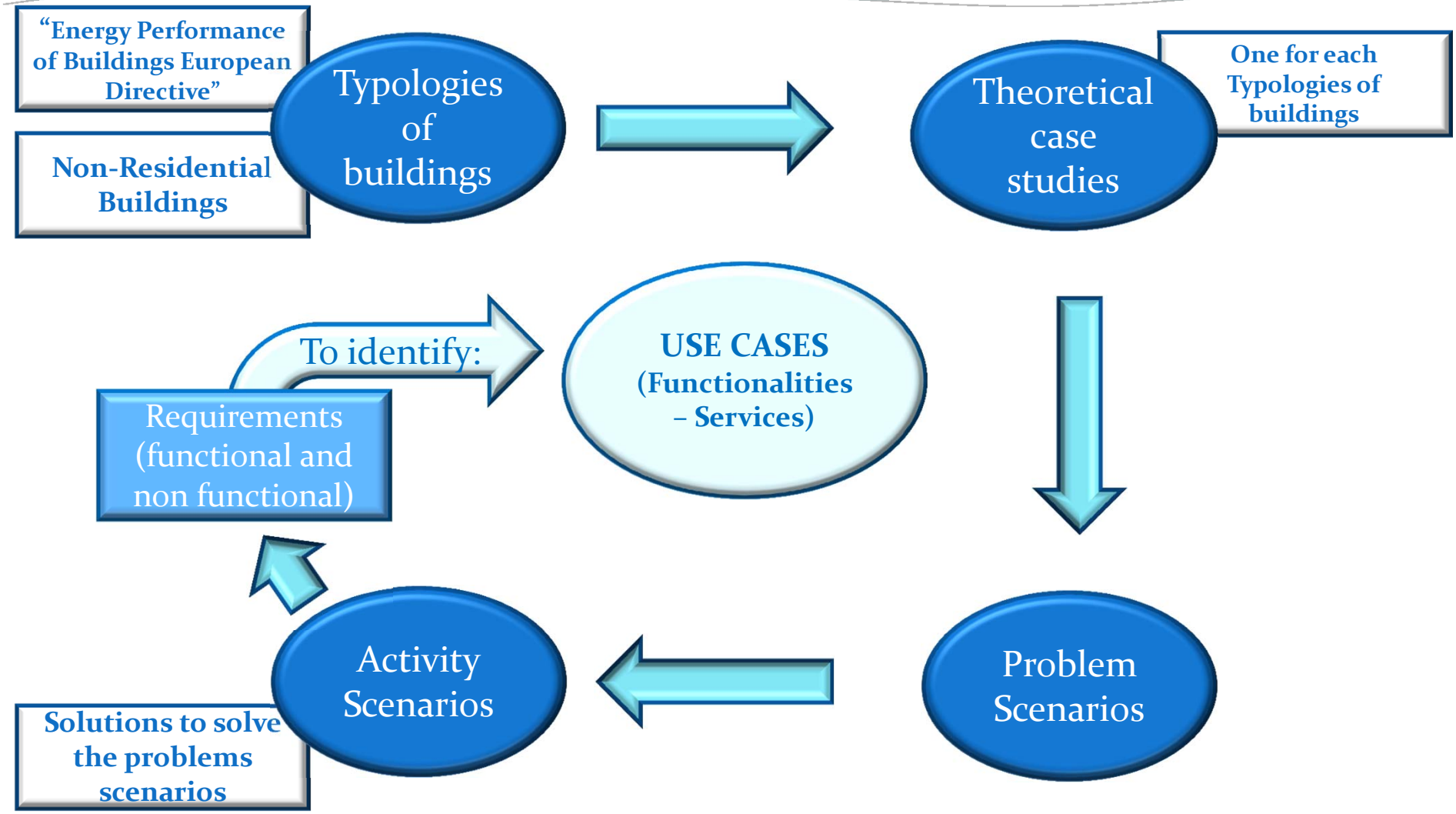
Case Studies



Case Studies



Case Studies



BaaS: Validation & Demonstration

					THEORETICAL CASE STUDIES					
Problem Scenarios		Activity Scenarios			Offices building	School	Hospital	Hotel	Swimming pool	Shopping mall
1	Lack of control strategies for thermal comfort and energy efficiency	1.1	Temperature control			X		X		
		1.2	Temperature & humidity control		X		X		X	
		1.3	Temperature, humidity & others, control							X
2	Lack of predictive control strategies	2.1	Advanced control system	Data gathering	X	X	X	X	X	X
				Weather Prediction Tool	X	X	X	X	X	X
				Demand Prediction Tool	X	X	X	X	X	X
				Control system	X	X	X	X	X	X
3	Unknown maximum energy performance of the facility to increase the profit margin of the end user (ESCO)	3.1	Rates to estimate consumes & other variables (Energy, Economy)		X	X	X	X	X	X
4	Different Building Management System in each building and across buildings	4.1	Management integration system and adjusted optimization logic		X	X	X	X	X	X
5	Lack of alarm management	5.1	Implementation of an alarm management system		X	X	X	X	X	X

BaaS: Validation & Demonstration

Demonstration buildings

- School: APOSTOLADO DEL SAGRADO CORAZÓN

  - Valladolid
  - Heat and HDW
  - Historical data from 2.004
  - 600 MWh_{HEAT} per year
  - Gas

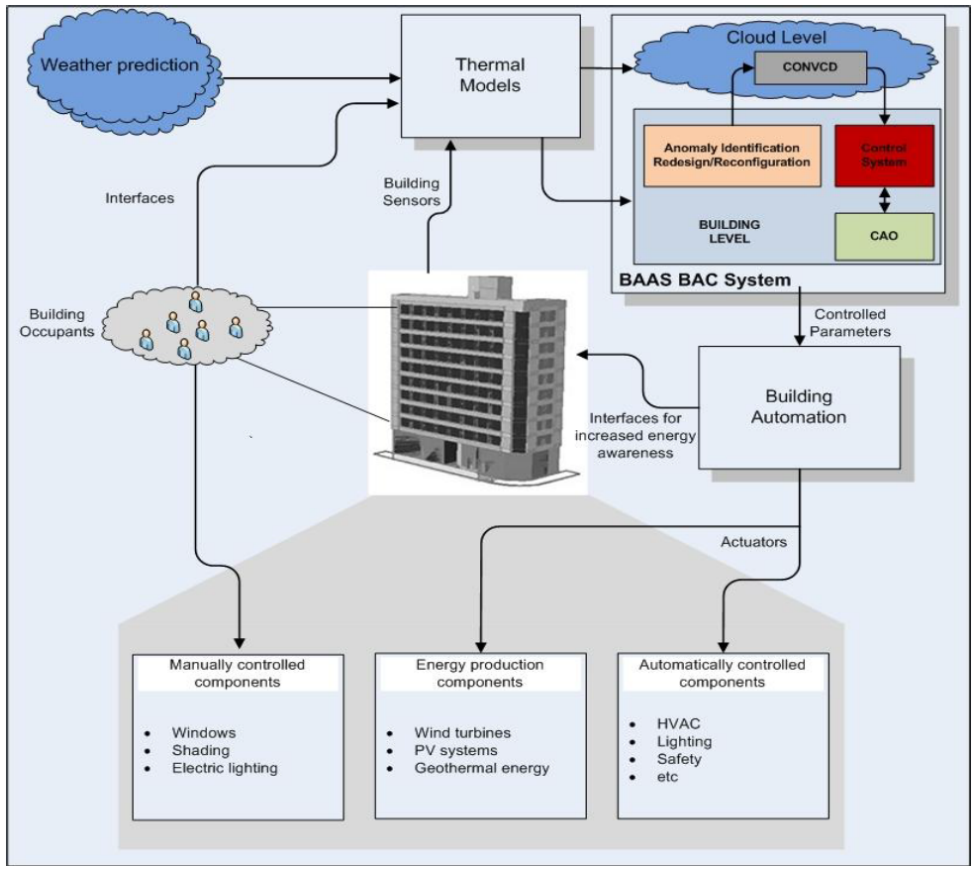
BaaS: Validation & Demonstration

Demonstration buildings

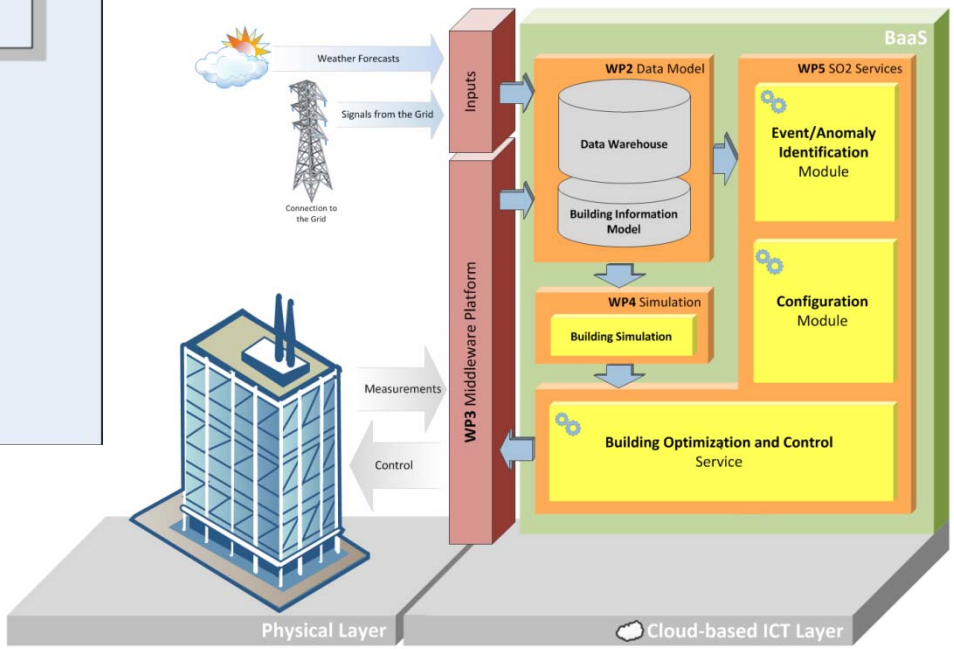
- Hotel: HUSA CHAMARTÍN

  - Madrid
  - Heat, Cool and DHW
  - Historical data from 2.001
  - 2.800 MWh_{HEAT} per year and 800MWh_{COOL} per year
  - Gas and Electricity

Baas Solution



Building Models used for control



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Premises

- High Level Services working on the buildings:
  - Assessments, Prediction and Optimization services
  - Visualization services
- Other tools working on the buildings:
  - Simulation tools…

- Data -> Interoperability:
  - Generic Infrastructure to support high level services
  - Considering near-real time data access for operational data from BAN-BMS
  - Access to data from DWH, BIM Server and external resources
  - Interoperability between information existing from design (retrofit) phase and operational flows of data.
- Data -> Standardization:
  - One unique vocabulary used by the whole system.

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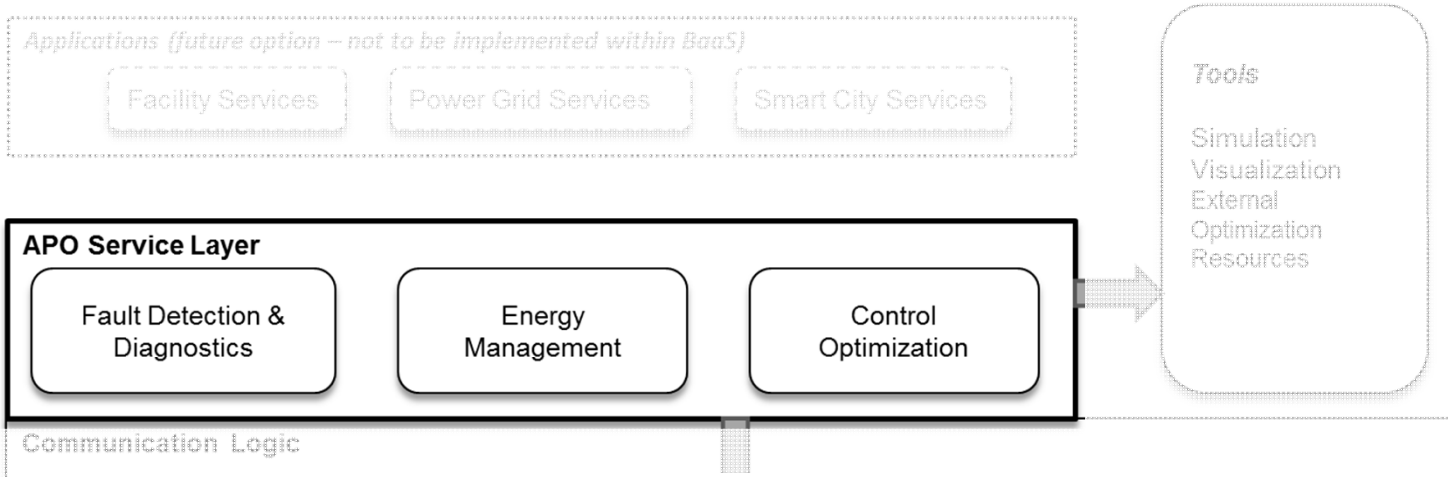
APO Services



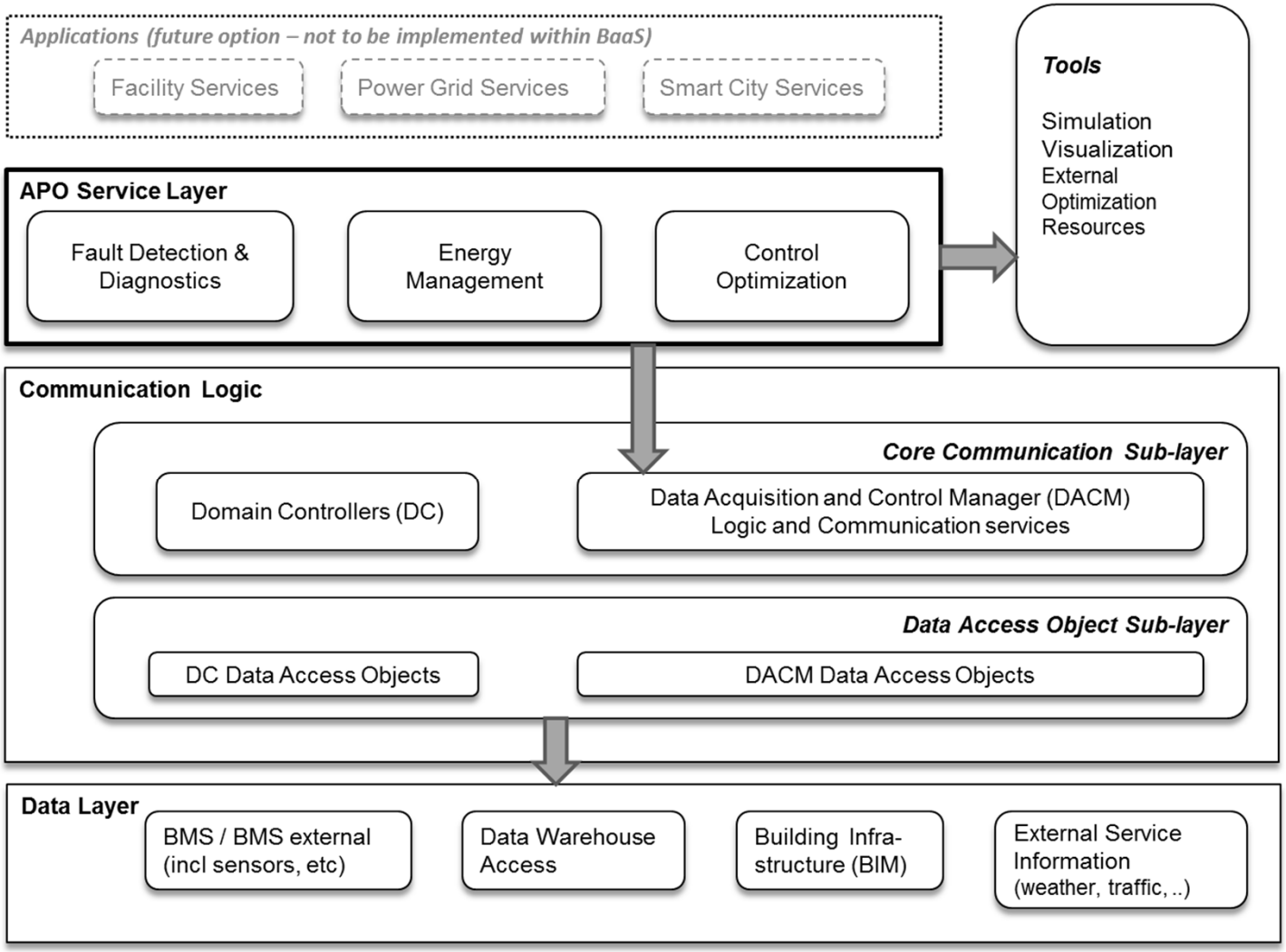
APO: core layer of the BaaS Platform

FD&D: analytics to detect and diagnose hard and soft faults (i.e. abrupt malfunctions vs. slow degradation

E-Mgmt: monitors equipment performance, identifies critical levels of efficiency, and triggers necessary maintenance

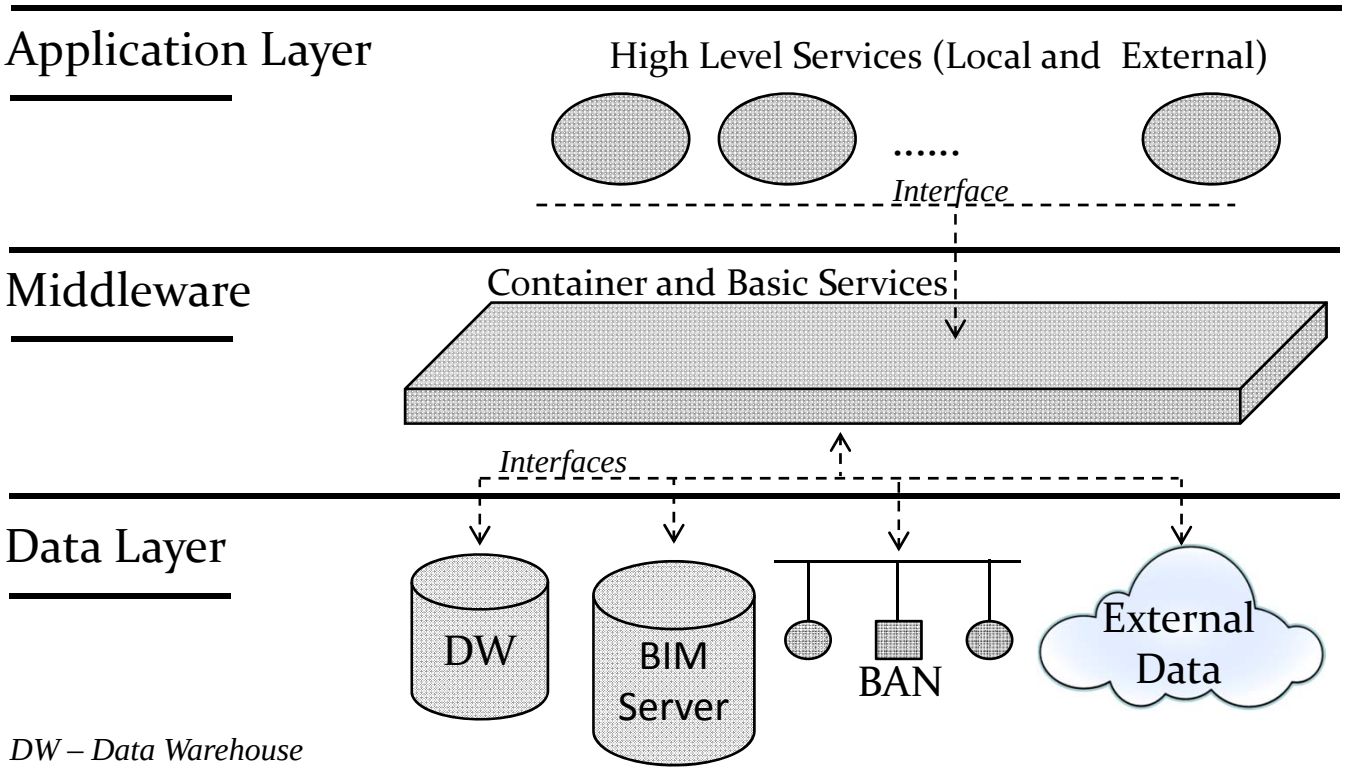
Ctrl Opt: monitors and optimises control strategies by identifying control faults and inefficiencies

Architecture Approach



Components to be considered

- Interoperability between components in BaaS

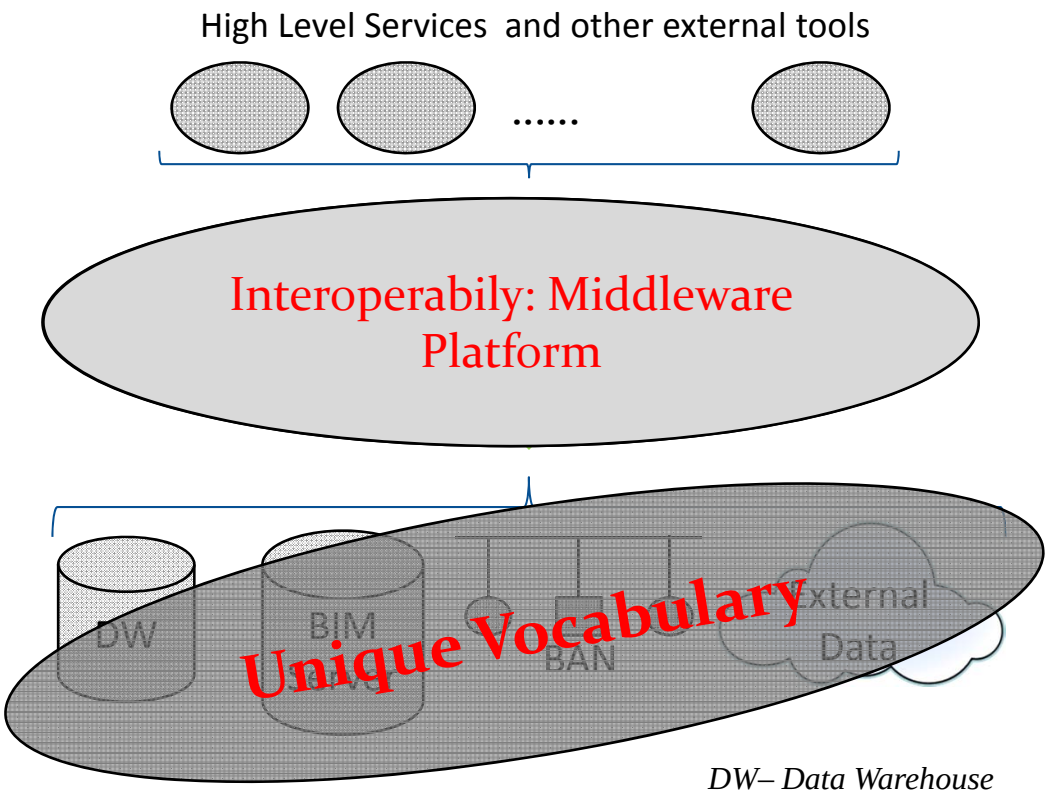


DW – Data Warehouse
BIM – Building Information Model
BAN – Building Automation Network
External Data: i.e.: Weather Forecast Service

- Using a common data model for all components

Data management premises

- Interoperability between component and data sources into the buildings
- Data Standarization



DW– Data Warehouse
BIM – Building Information Model
BAN – Building Automation Network
External Data: i.e.: Weather Forecast Service

- High Level Services need Data
  - Assessment services
  - Prediction services
  - Optimization services
- DW need to assure quality of data:
  - Data Pre-processing
  - Malfunction detection -> this malfunction should be communicated to the BIM.
- Changes in the model: retrofits or malfunctions.
  - Should be showed by means of the BIM to high-level services and to the DB.
- Runtime data access (BMS, BAN interfaces)
- External Data,
  - could be needed to be stored in the DB or directly used by Highlevel Services.

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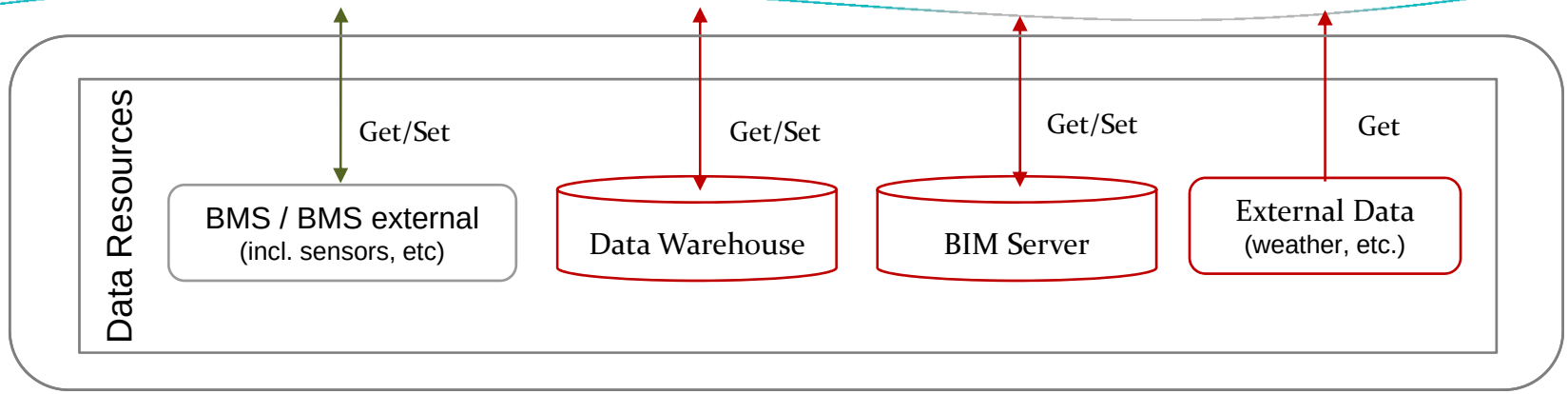
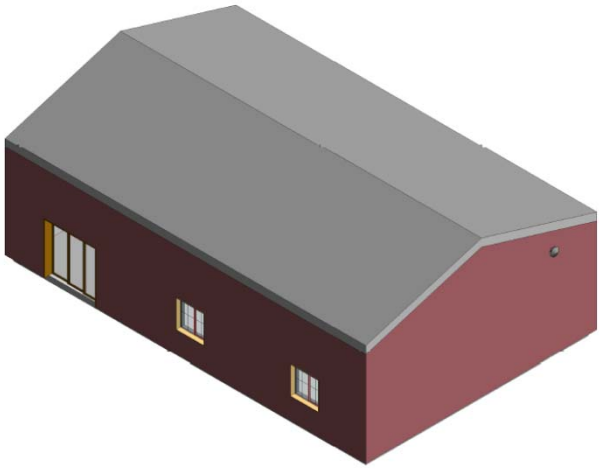
Data layer and interfaces definition

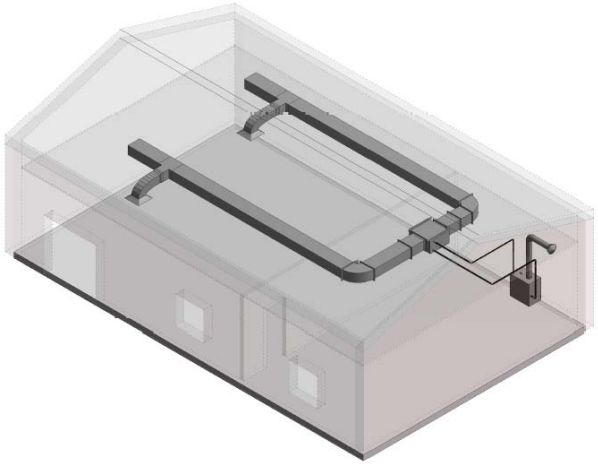


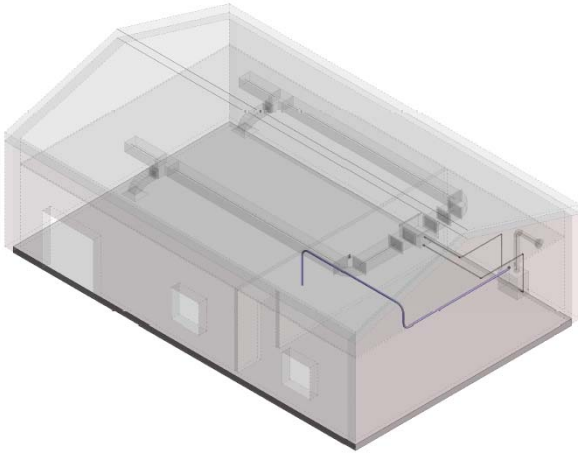
- Except for the data warehouse, DL has no data processing capabilities
- Four main components:
  - BMS: used for monitoring and controlling building automation systems & HVAC
  - BIM: holds static information on the "physical and functional characteristics" of an asset.
  - DW: Stores, pre-processes, and aggregates dynamic raw data from sensors, actuators, and meters & computes KPIs
  - External services: provide additional data which are needed for optimisation and control but are not available from the asset directly, e.g. weather data & forecasts

BIM (Design Phase)

- *In the Design phase is needed to include the whole building information involve in the building*







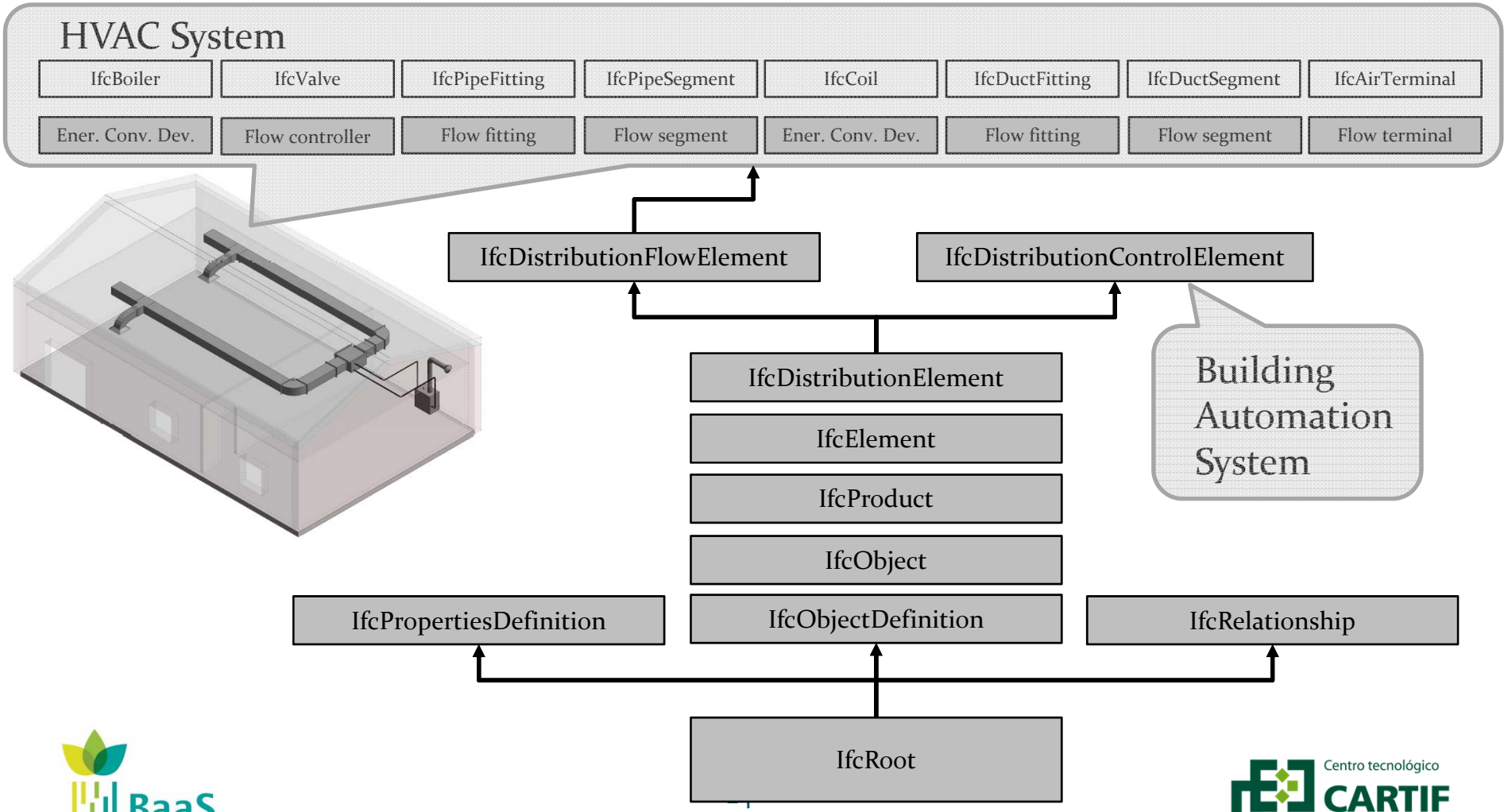
Architectural Domain

HVAC Domain

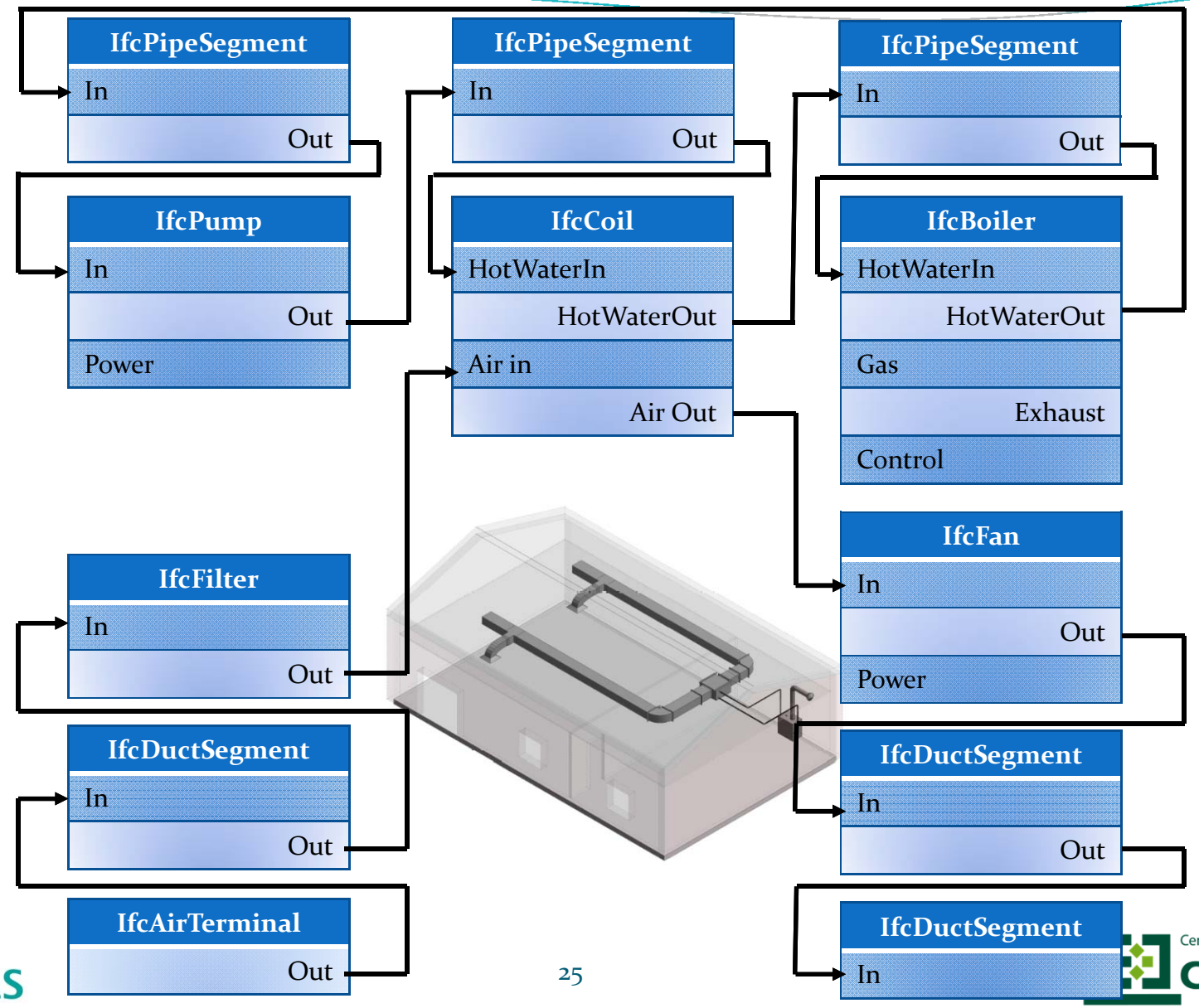
Automation Domain

The whole Building Information into the BIM Server.

Modelling HVAC systems using IFC



Modelling HVAC systems using IFC



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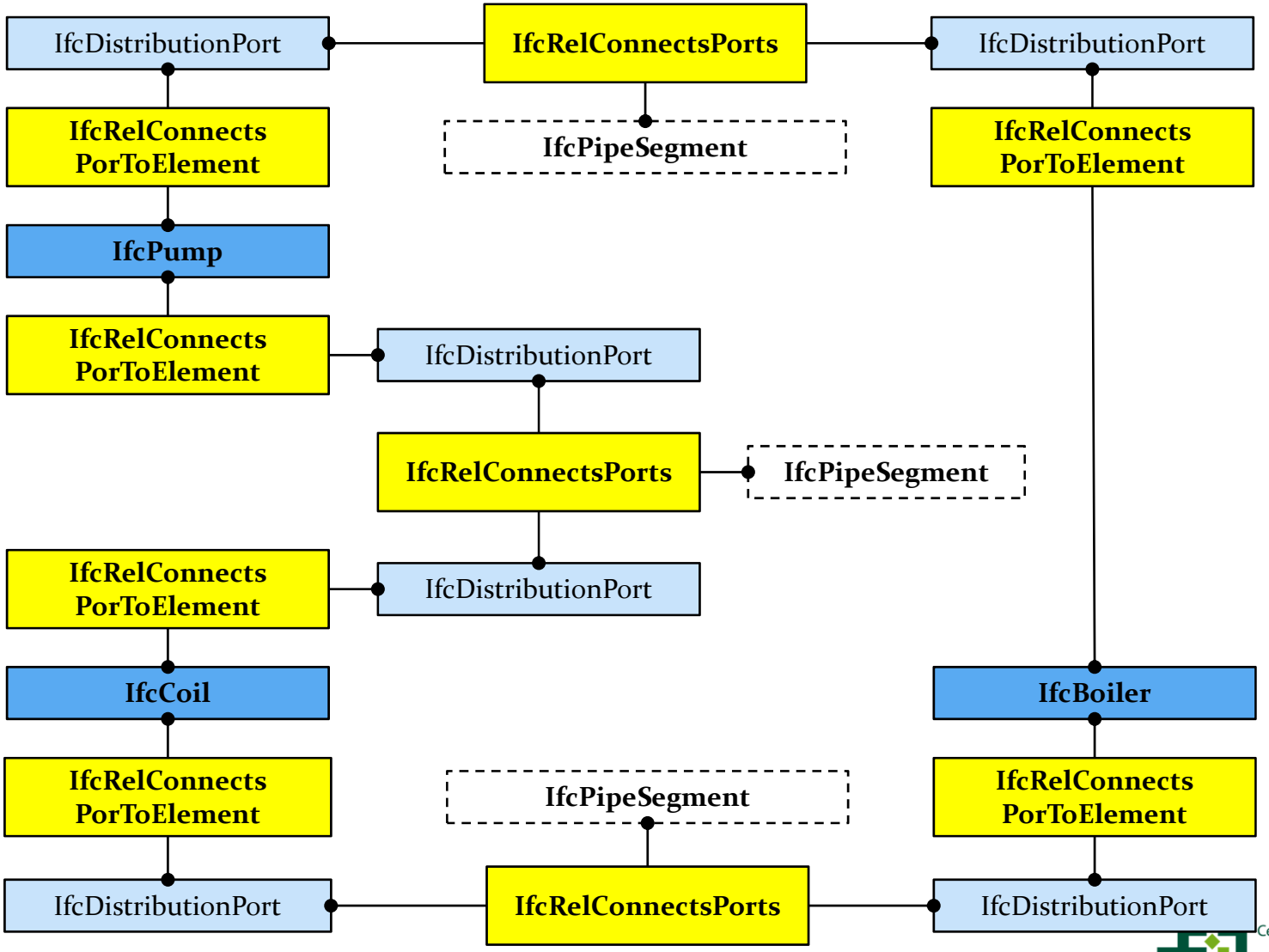
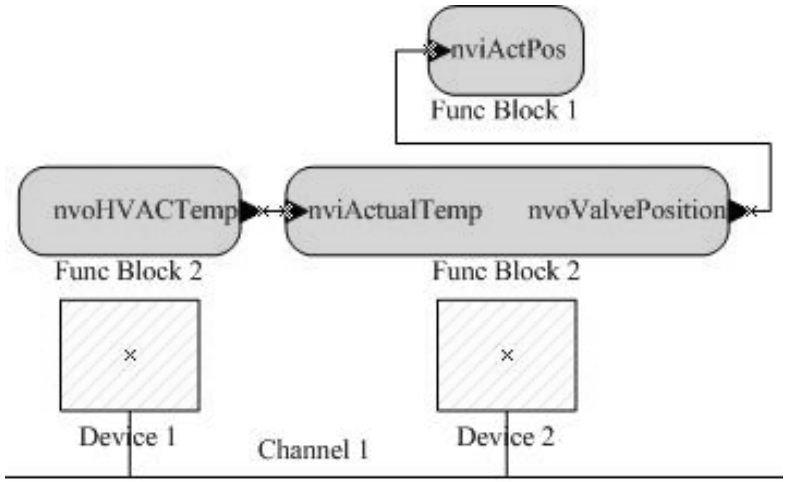
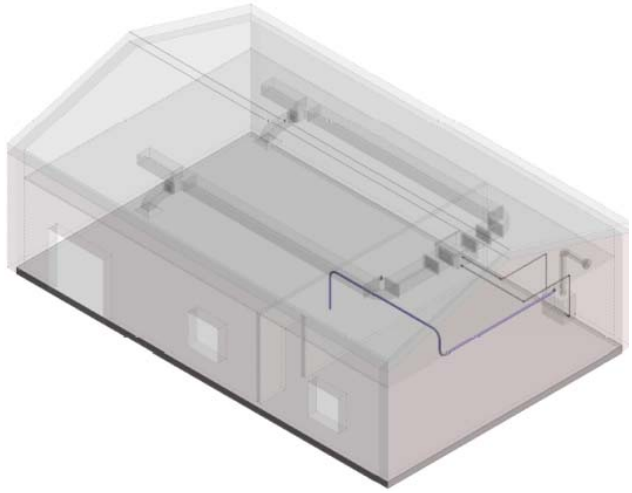
Modelling HVAC systems using IFC



Modelling Building Automation Networks (BAN) using IFC



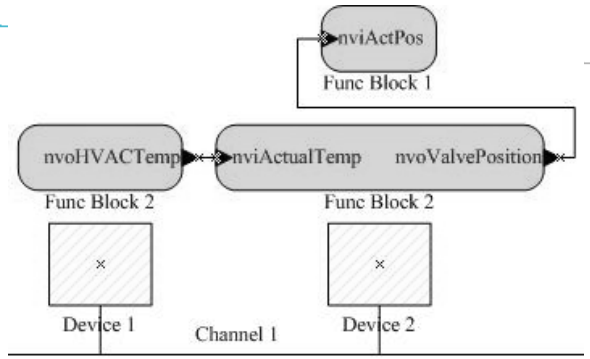
Design of a Building Automation Network
(LON technology)

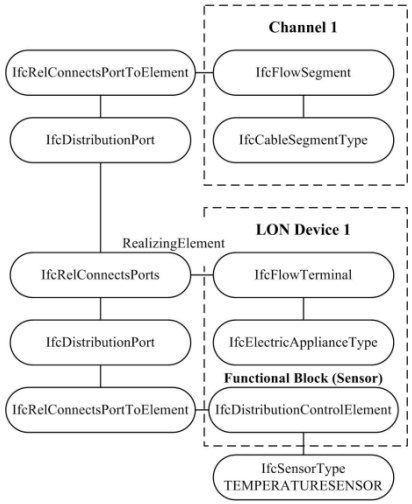


Modelling a Building Automation Network
(BIM)

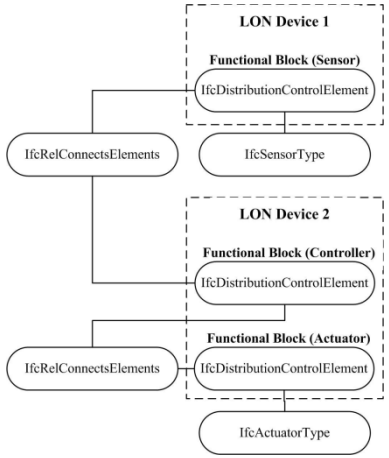
- Three levels:
  - Physical connections
  - Logical Connection -> Data Points (Dynamic Data)
  - Geometrical placement into the building

Modelling Building Automation Networks (BAN) using IFC

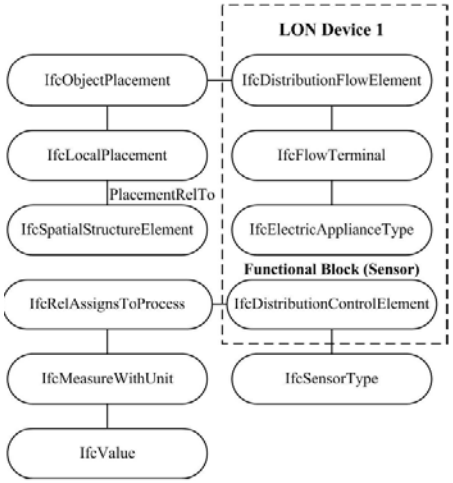




Physical connections



Logical Connection

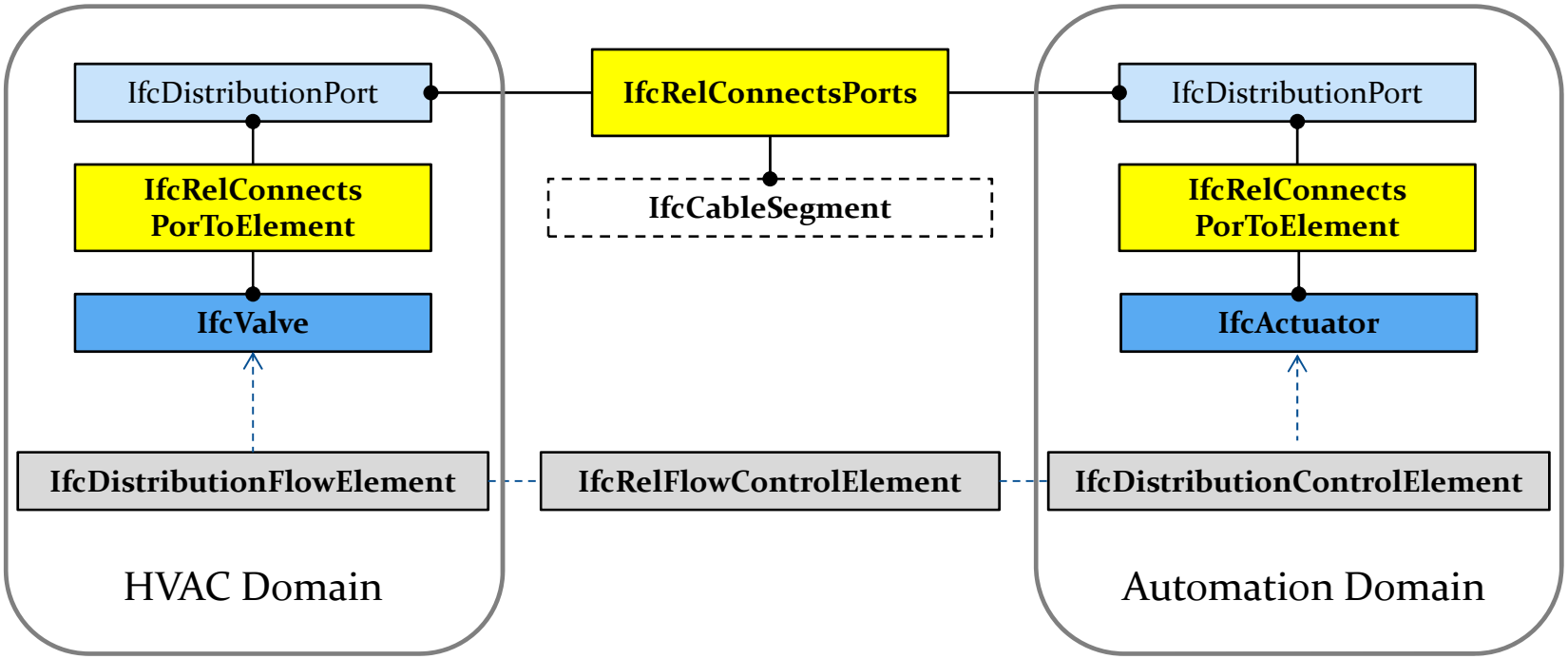


Geometrical placement into the building

**** *Integration of Building Automation Network Design and 3D Construction Tools by IFC Standard by Alexander Karavan*

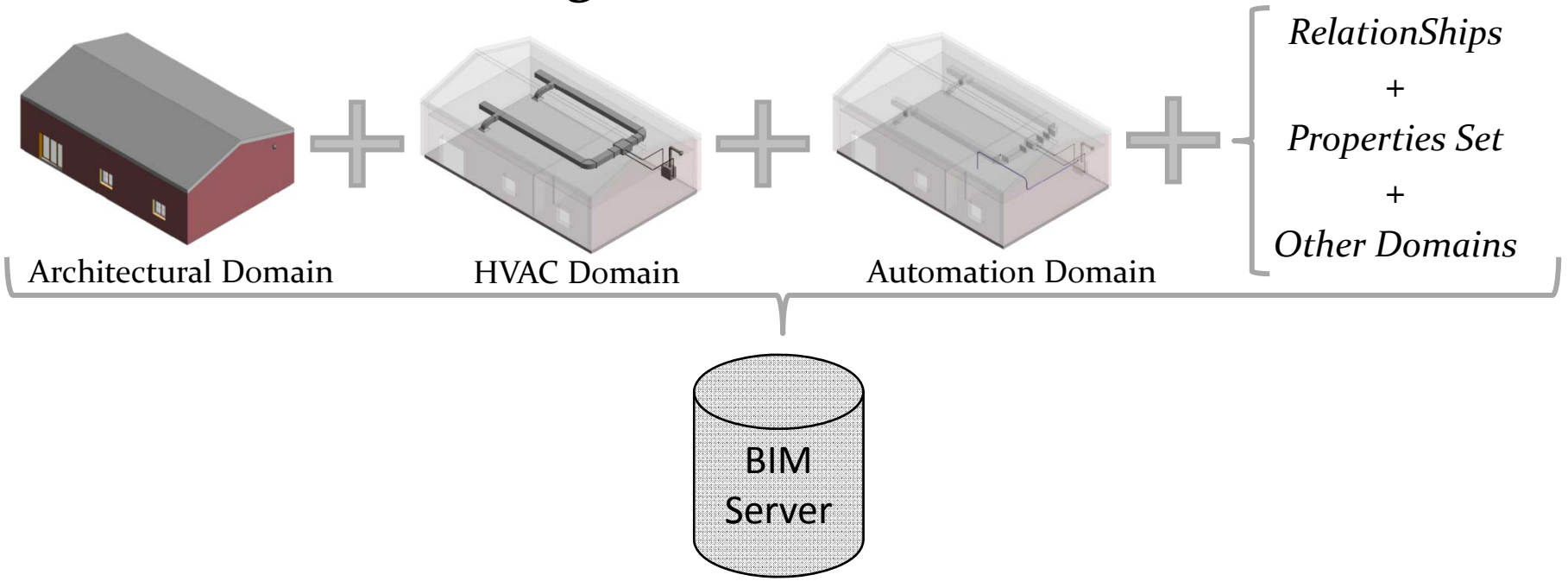
Modelling the relationship between HVAC and BAN domains using IFC

- Relationship between:
  - BAN (sensor, actuators, controller)
  - HVAC (terminal equipment, distribution pipes….)



BIM Server

- The whole Building Information into the BIM Server.



- In the Design phase is needed to include the whole building information involve in the building and …
- their relationships…!!
- and their properties (including controller's parameters)

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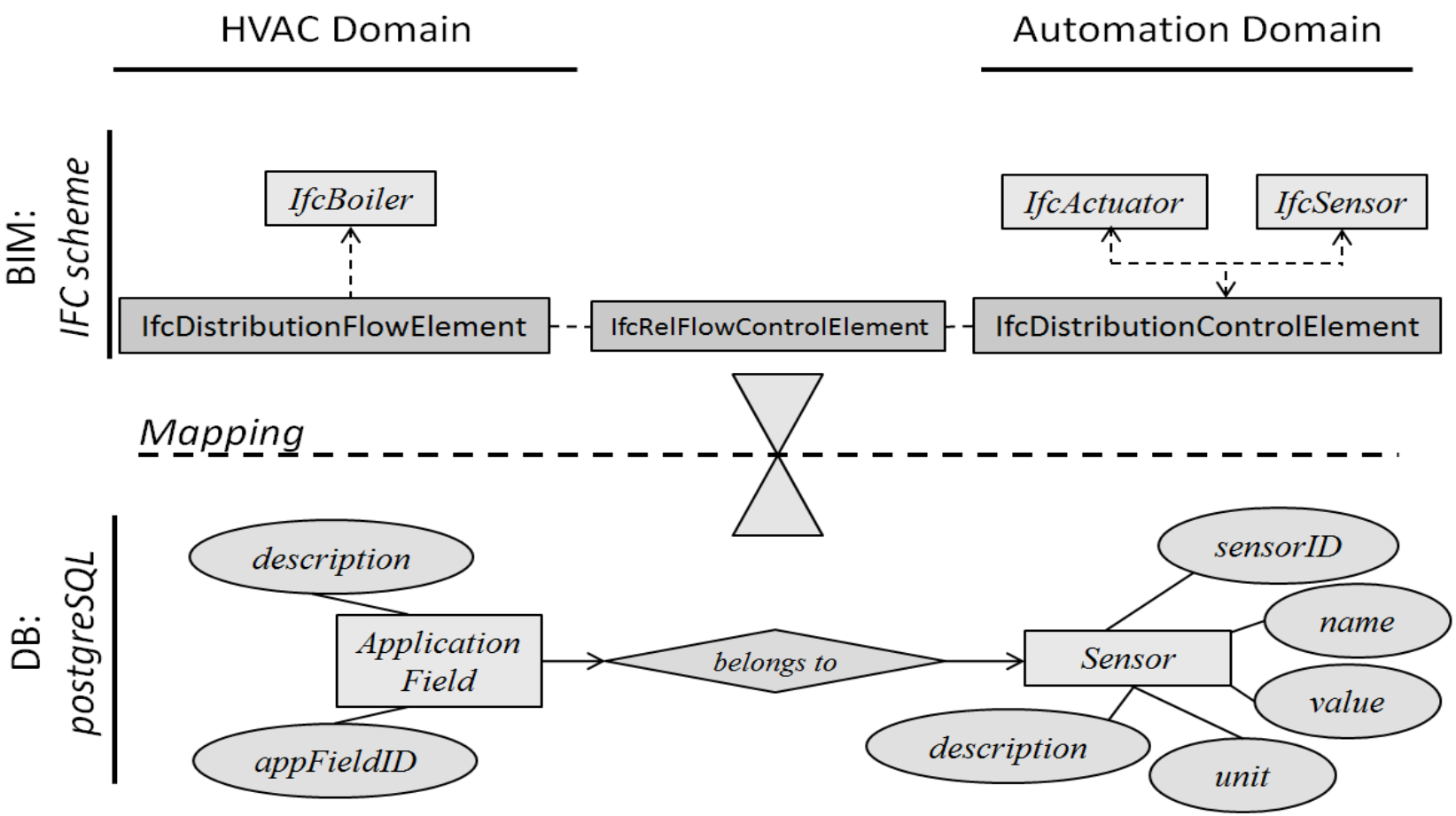
Data Storage (Operational Phase)



Mapping the existing IFC schemes in the Data Warehouse schemes

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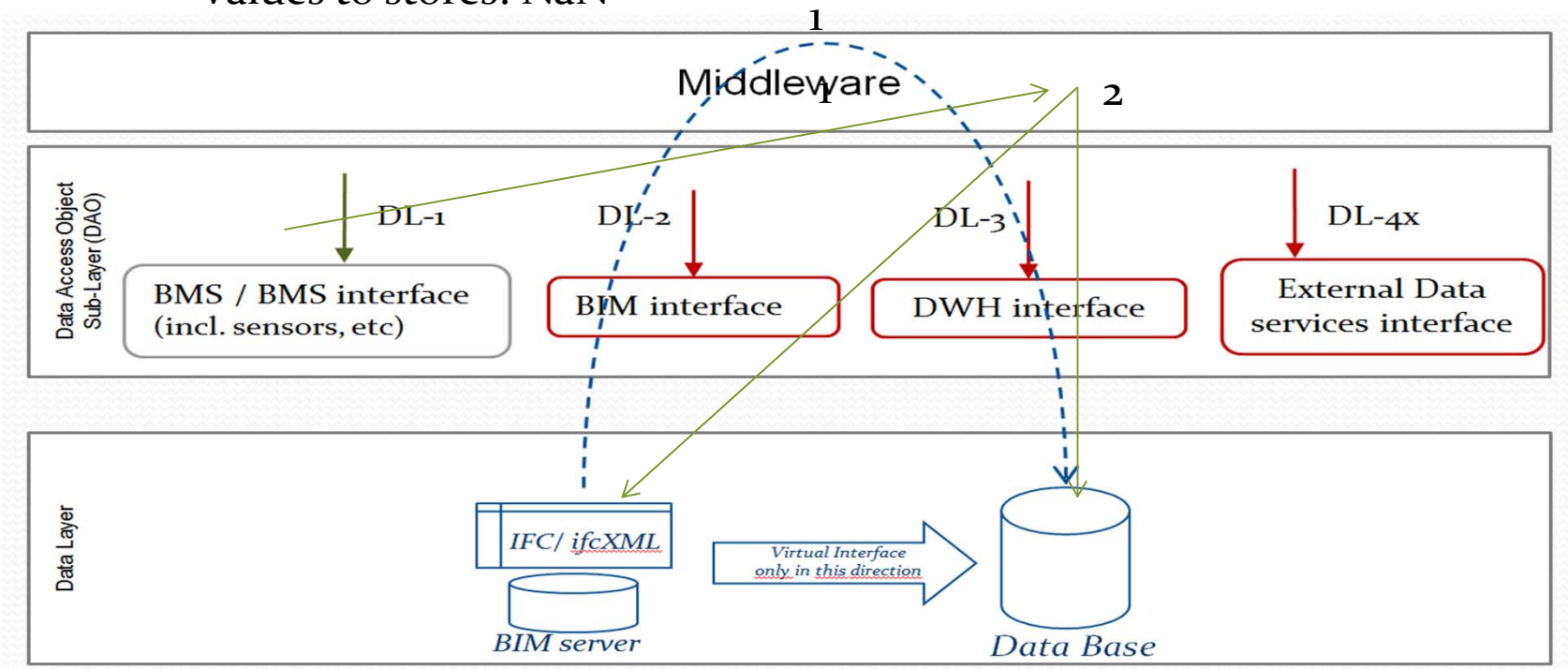
Operational example

- 1) Changes on BIM -> uptate DWH scheme
- 2) Malfuctions Detection: BAN (sensor, actuator, controllers)
  - (Action) update DHW and BIM:
    - status: from ready to malfunction
    - Values to stores: NaN



- In both cases, the HighLevel services know the new status for following tasks

Acknowledges

BaaS
Building as a Service

This papers deals with the FP7 EU project “Building as a Service” (BAAS) < www.baas-project.eu > funded into the call FP7-ICT-2011-7 (ICT-2011-6.2 – ICT systems for Energy Efficiency) under the umbrella of the “ICT for sustainable growth” team at the European Commission.

SEVENTH FRAMEWORK PROGRAMME

Project funded by the European Community in the 7th Framework Programme

ICT for Sustainable Growth

European Commission Information Society and Media

Thanks for your attention!

BaaS
Building as a Service

Any questions and comments are welcome!

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