



# Monitoring Smart Building Performance Using Simulation and Visualisation

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# Introduction

- The building sector is responsible for 40% of total EU energy consumption
  - Energy reduction requires ambitious objectives
  - Performance based assessment of building operation
    - Requires building energy usage monitoring
- Building energy performance monitoring requires embedded technologies (Smart Buildings)
  - Measure aspects of the building environment relevant to energy consumption
    - E.g. effect of user behaviour
- Analysing Smart Buildings (SBs) at the design stage requires SB simulation.
  - Sophisticated building energy simulation programs have been developed
    - Energy profile tool, Green Star Rating, Revit
  - Provide users with key building performance indicators such
    - Energy use and demand, temperature, humidity, and costs.



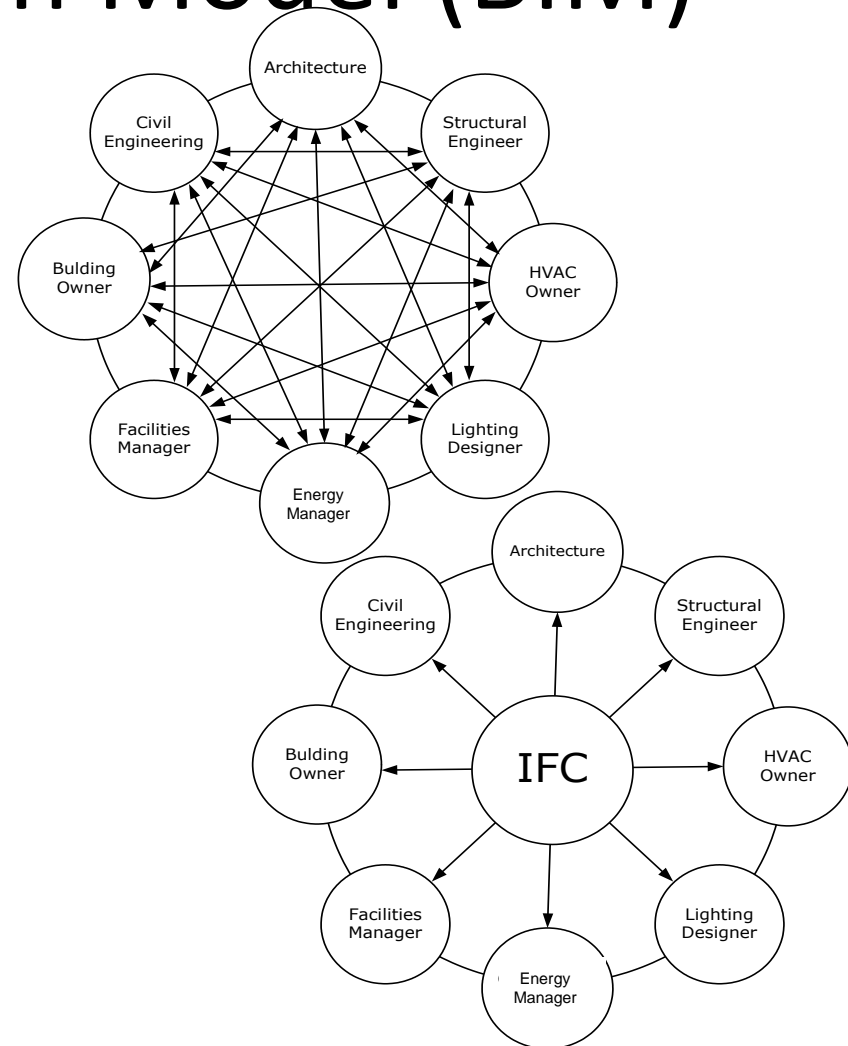
# Motivation

- Gaps remain in current knowledge and tools:
  - Monitoring energy usage into the operational phase of the Building Life Cycle (BLC)
    - Makes it difficult to determine if the building is meeting its original performance requirements.
  - Monitoring the impact of user behaviour on building energy consumption at design stage.
- To meet these identified gaps in the State of the Art we present work on integrating:
  - A Performance Framework Tool (PFT)
    - A civil engineering tool for defining building performance objectives.
  - VR based ubicomp simulation and visualisation platform (Pudecas)
    - Virtual Reality (VR) has been employed to conduct evaluations of applications which require contextual data from simulated sensors, e.g. location.
- Central to our approach is a shared Building Information Model (BIM) called the Industry Foundation Classes (IFC).



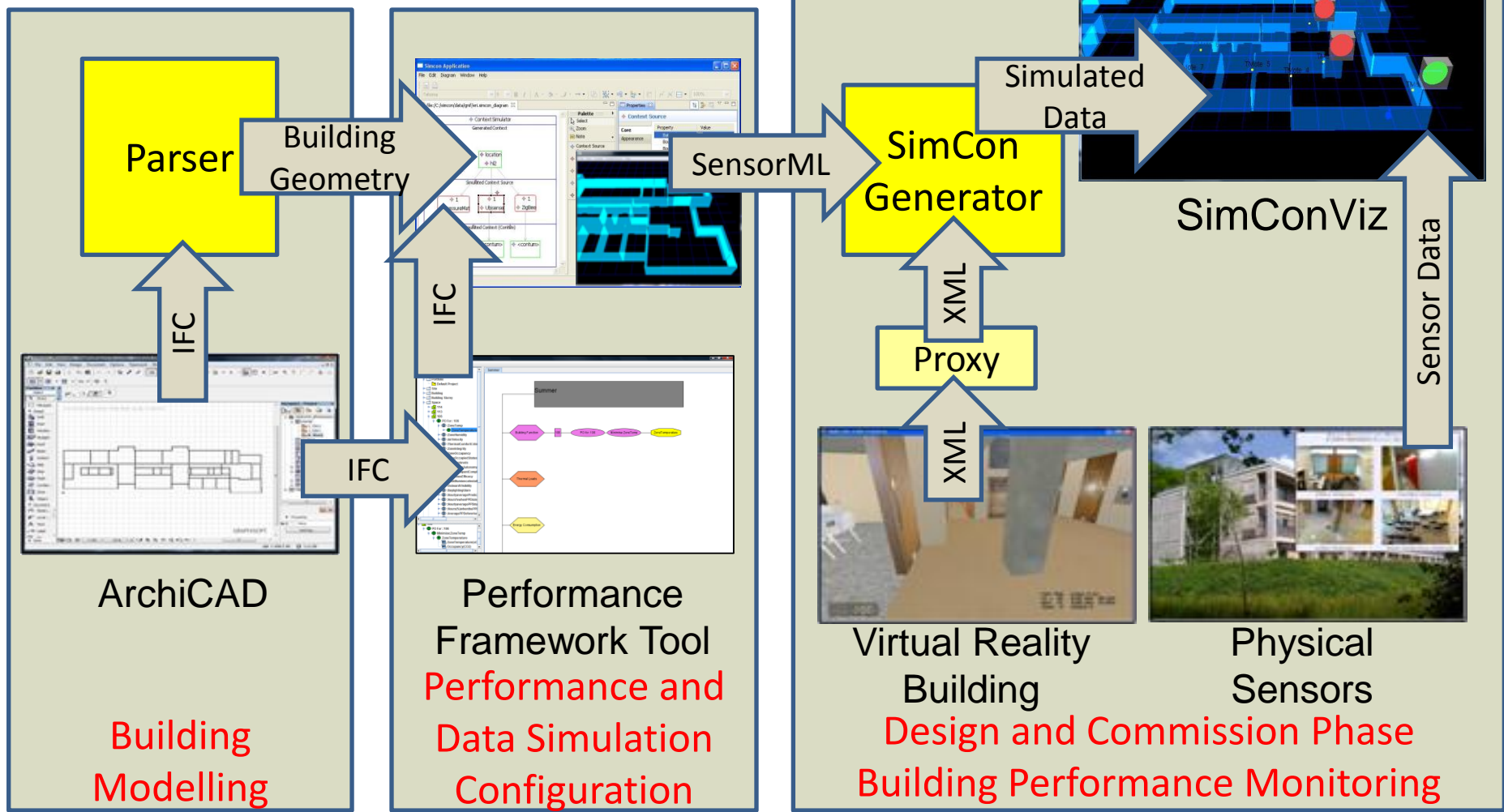
# Building Information Model (BIM)

- Describes a model for storing all the information relevant to the Building Life Cycle(BLC)
- BuildingSmart International is developing the Industry Foundation Classes (IFC) standard.
  - Enable service engineers to collaborate between heterogeneous disciplines, improving interoperability, reducing costs and overall design quality.
  - Currently, IFC is also the only BIM that is an accepted ISO standard.





# Monitoring Tool for Smart Building Assessment





# Building Information Model Support

- The IFC approach which supports this tool-set offers significant benefits in terms of interoperability and shared data support.
  - Enables interoperability with IFC compliant 3-D CAD tools.
- IFC is still limited in terms of sensor definitions and other devices of interest to the ubicomp domain.
  - Extensions are being developed within the NEMBES project
- The NEMBES project has brought together professionals from a diverse set of disciplines
  - Civil Engineering, Architecture, Ubiquitous Computing, Networking and Sensor Motes and Hardware.



# Next Steps

- Extend the analysis capabilities to include larger range of low level sensor concerns
  - Evaluate impact of imperfect context (sensor data inputs) on system behaviour.
  - Support and account for a fuller profile of analysis for SB systems
    - Address more of the building lifecycle.
- Make more extensive use of the Pudecas VR SB simulator
  - Investigate the impact of occupancy levels on building performance.
    - Draw on the occupancy and mobility simulation in Pudecas to drive multi-occupant test scenarios.



# Conclusion

- A tool-set and framework for monitoring SB performance using simulation and visualisation.
  - Initial integration of the PFT and Pudecas Simulation Platform
    - Provides a tool which can analyse the large data-sets gathered by building management systems.
  - Simulation enables designers of these buildings to perform assessments prior to the construction stage
    - view to delivering accurate predictions about the buildings efficiency.
- Our visualisation provides an intuitive view of the environment
  - Designer can use own mental model of building to more easily relate to the PFT output.



# Thank You.

## Questions?