

# SEMANTIC ENCODING OF BUILDING REGULATIONS

CARDIFF  
UNIVERSITY

PRIFYSGOL  
CAERDYDD

# CONTENTS

- Overall Philosophy and Approach
- The Process of Automating Regulatory Compliance
- Mapping Between Regulations and BIM
- Execution of Regulations
- Future Work

# OVERALL PHILOSOPHY

Fully Automated – NLP etc...

- *Can regulation experts have confidence in this?*

- Automation vs Involvement of regulation experts?
- Role/Involvement of programmers?

Semi Automated Approaches

-*Adding metadata required to regulatory documents*

-*Using this added data to automatically convert to code*

Fully Manual – Manual Implementation by programmers...

- *Can regulation experts have confidence in this?*

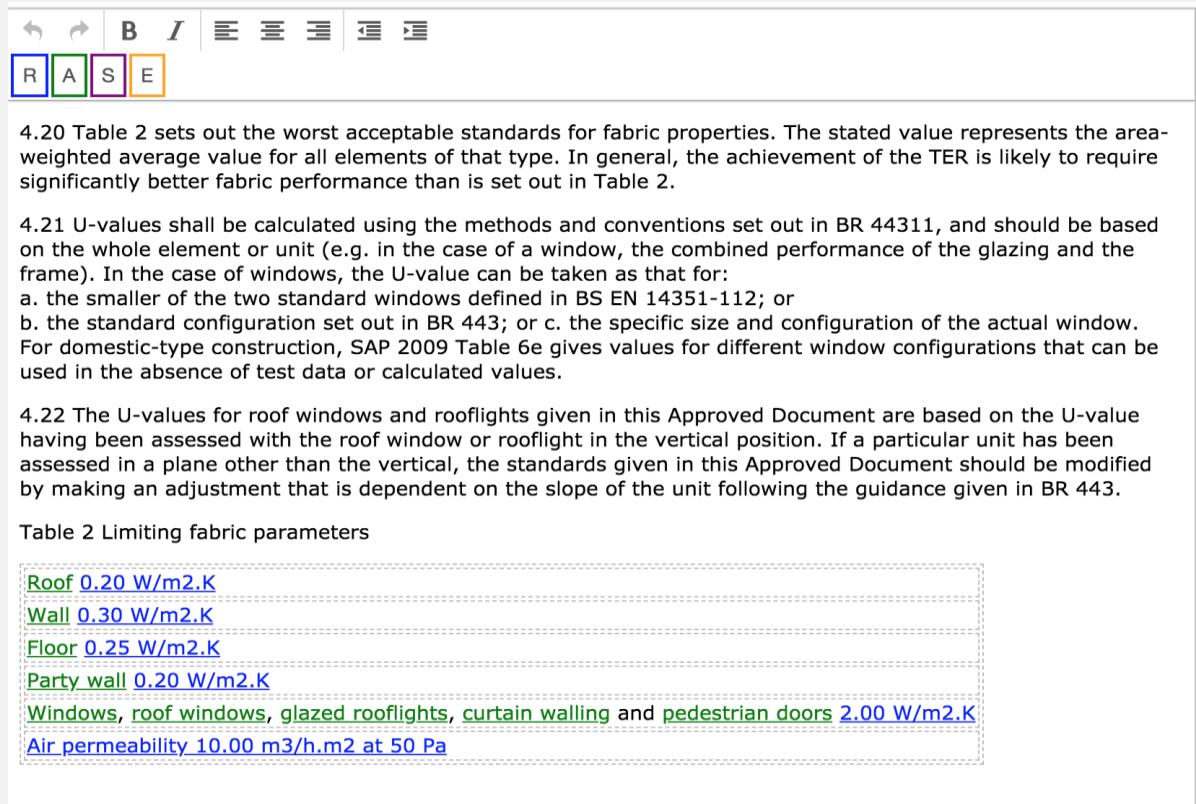
# MANAGEMENT OF AUTOMATED REGULATORY COMPLIANCE

- In the future, having a single source from which both human readable, and computer executable code can be generated is the best way to create and, maintain automated regulations checking in the construction sector

# AUTOMATING REGULATORY COMPLIANCE

- Step 1: Structure Regulation into a tree like form

- Section 1: Introduction
- Section 2: The Requirements
- Section 3: General guidance
- Section 4: Design standards
  - Regulations 24 and 25
  - CRITERION 1 – ACHIEVING THE TER
  - CRITERION 2 – LIMITS ON DESIGN FLEX
  - CRITERION 3 – LIMITING THE EFFECTS
- Section 5: Quality of construction and commissioning
- Section 6: Providing information
- Section 7: Model designs



The screenshot shows a document editor interface. At the top, there is a toolbar with icons for undo, redo, bold (B), italic (I), bulleted list, numbered list, decrease indent, and increase indent. Below the toolbar is a row of four colored boxes containing the letters 'R', 'A', 'S', and 'E'. The main content area contains three paragraphs of text, each starting with a number (4.20, 4.21, 4.22). Below the text is a caption 'Table 2 Limiting fabric parameters' followed by a table with a dashed border. The table lists various building elements and their corresponding U-values or air permeability values.

4.20 Table 2 sets out the worst acceptable standards for fabric properties. The stated value represents the area-weighted average value for all elements of that type. In general, the achievement of the TER is likely to require significantly better fabric performance than is set out in Table 2.

4.21 U-values shall be calculated using the methods and conventions set out in BR 44311, and should be based on the whole element or unit (e.g. in the case of a window, the combined performance of the glazing and the frame). In the case of windows, the U-value can be taken as that for:

- a. the smaller of the two standard windows defined in BS EN 14351-112; or
- b. the standard configuration set out in BR 443; or c. the specific size and configuration of the actual window.

For domestic-type construction, SAP 2009 Table 6e gives values for different window configurations that can be used in the absence of test data or calculated values.

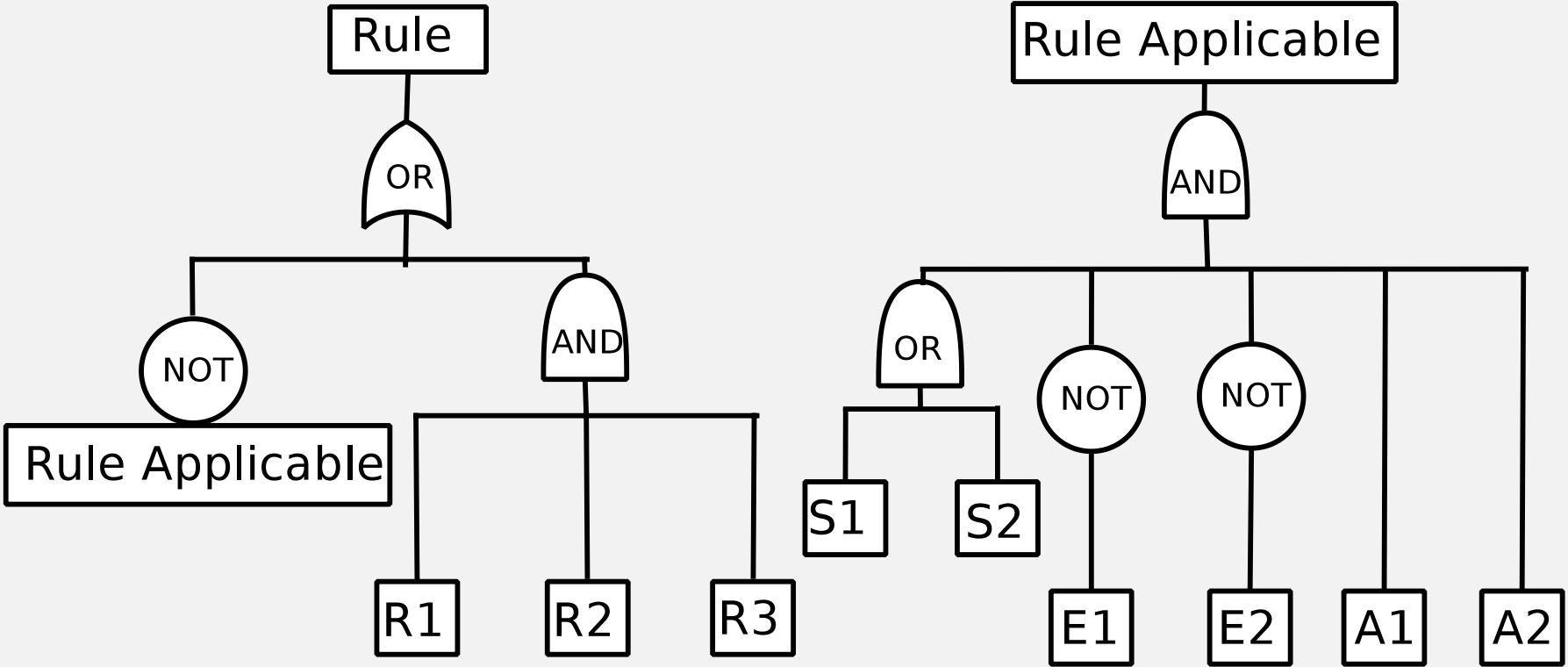
4.22 The U-values for roof windows and rooflights given in this Approved Document are based on the U-value having been assessed with the roof window or rooflight in the vertical position. If a particular unit has been assessed in a plane other than the vertical, the standards given in this Approved Document should be modified by making an adjustment that is dependent on the slope of the unit following the guidance given in BR 443.

Table 2 Limiting fabric parameters

|  |   |
|--|---|
| Roof   | 0.20 W/m <sup>2</sup> .K                        |
| Wall   | 0.30 W/m <sup>2</sup> .K                        |
| Floor  | 0.25 W/m <sup>2</sup> .K                        |
| Party wall   | 0.20 W/m <sup>2</sup> .K                        |
| Windows, roof windows, glazed rooflights, curtain walling and pedestrian doors | 2.00 W/m <sup>2</sup> .K                        |
| Air permeability   | 10.00 m <sup>3</sup> /h.m <sup>2</sup> at 50 Pa |

- Step 2: Augment with Tags

# RASE TAGS



.....?

- Is a regulation true just because it is not false?
  - Is a regulation false because it is not true?
    - What about missing data?
- They may be things the design team don't know and thus not data in BIM.
  - But what about thinks that they don't know they don't know?

# METADATA

**Add Metadata** [X]

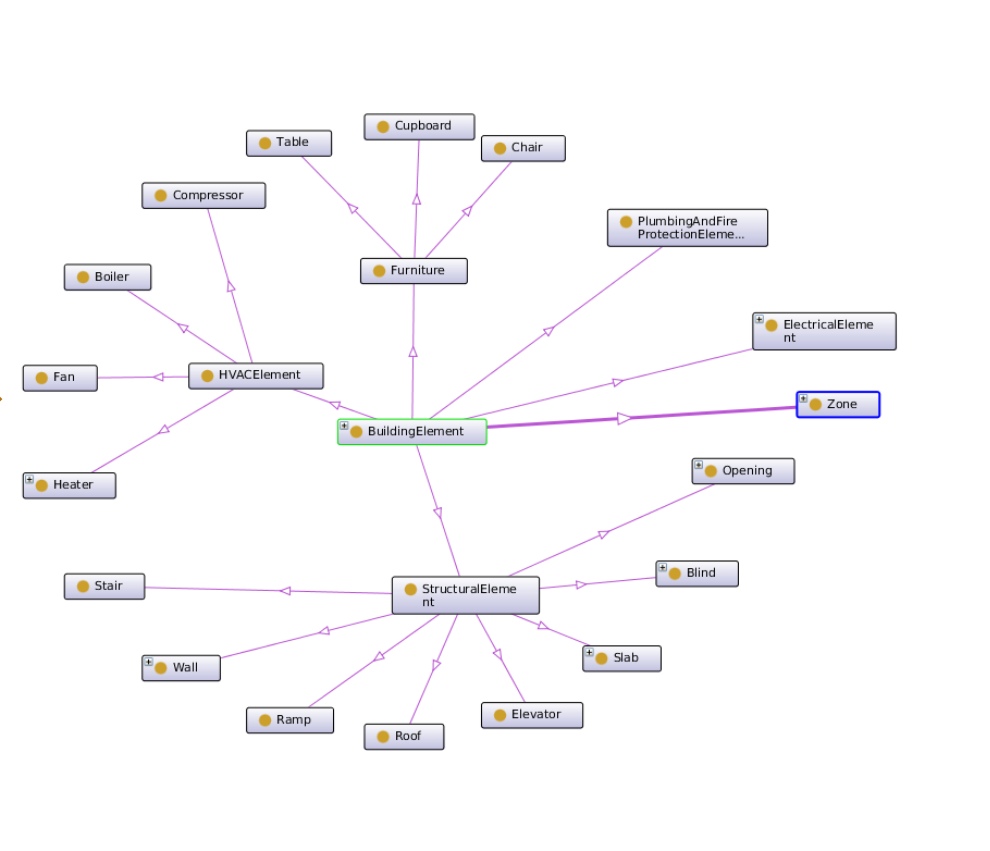
Object

Property

Comparison

Value

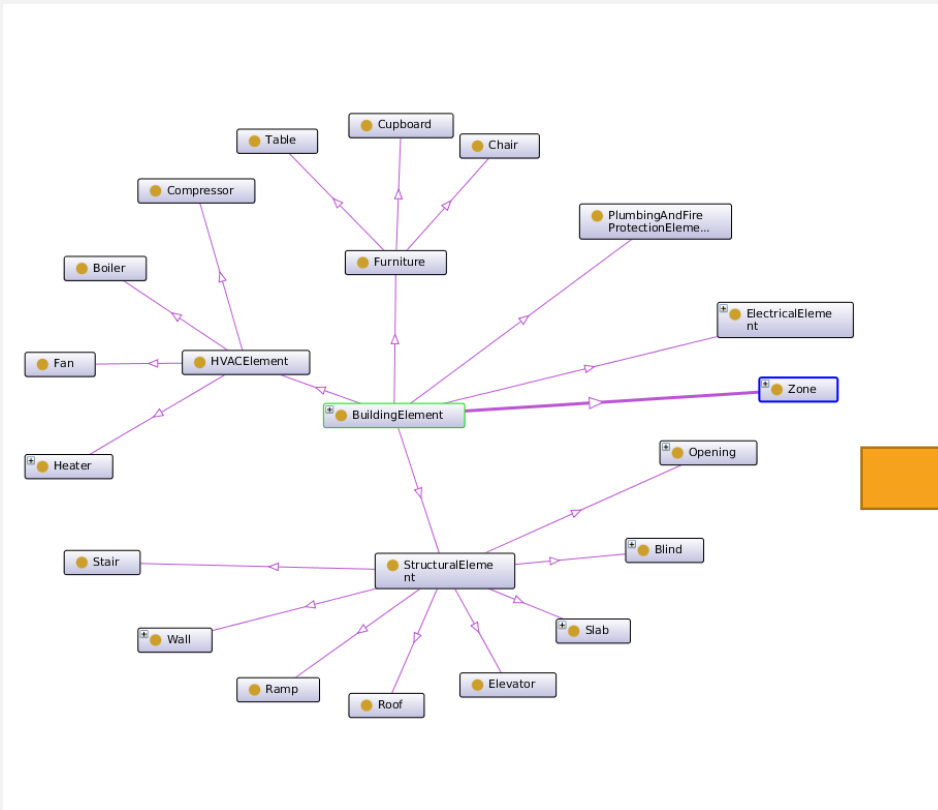
Unit





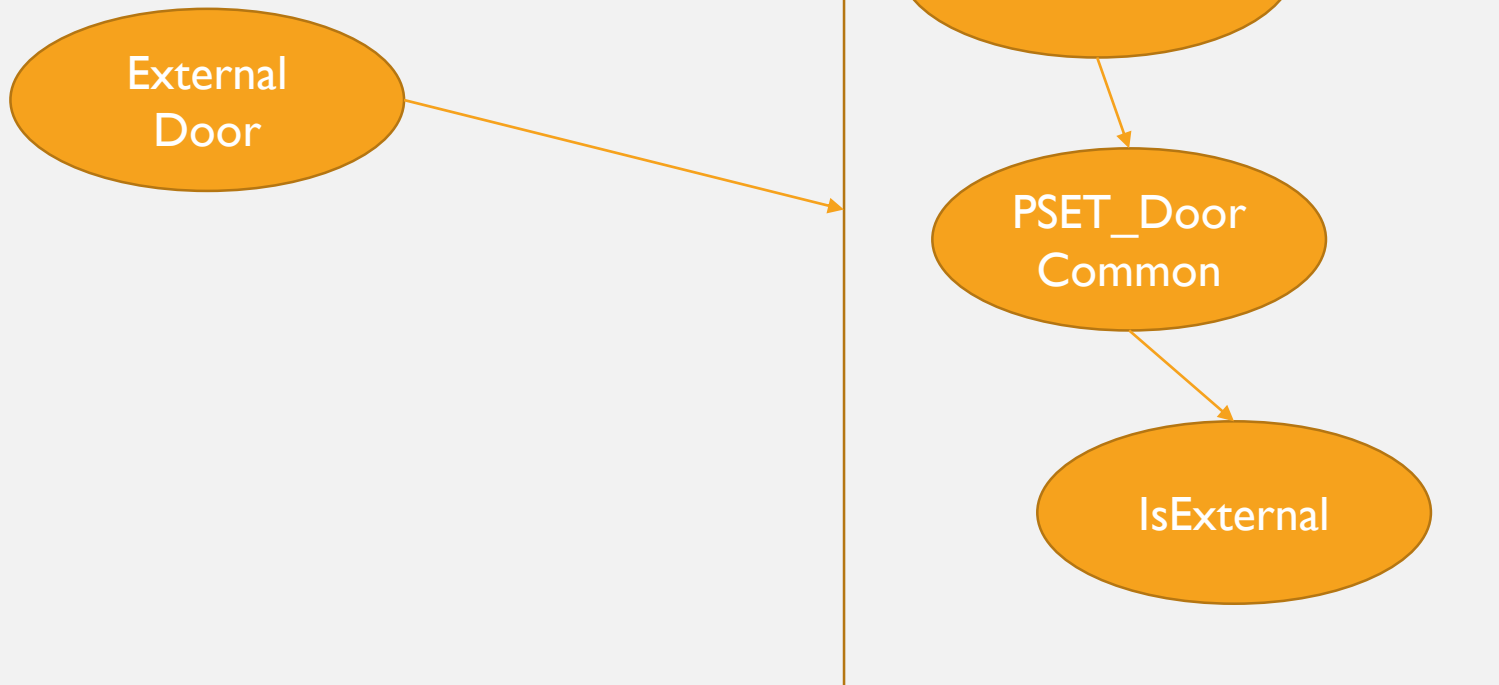
# MAPPING TO BIM

- Perhaps the most challenging element!



# MAPPING TO BIM

- I. Class Level Mappings

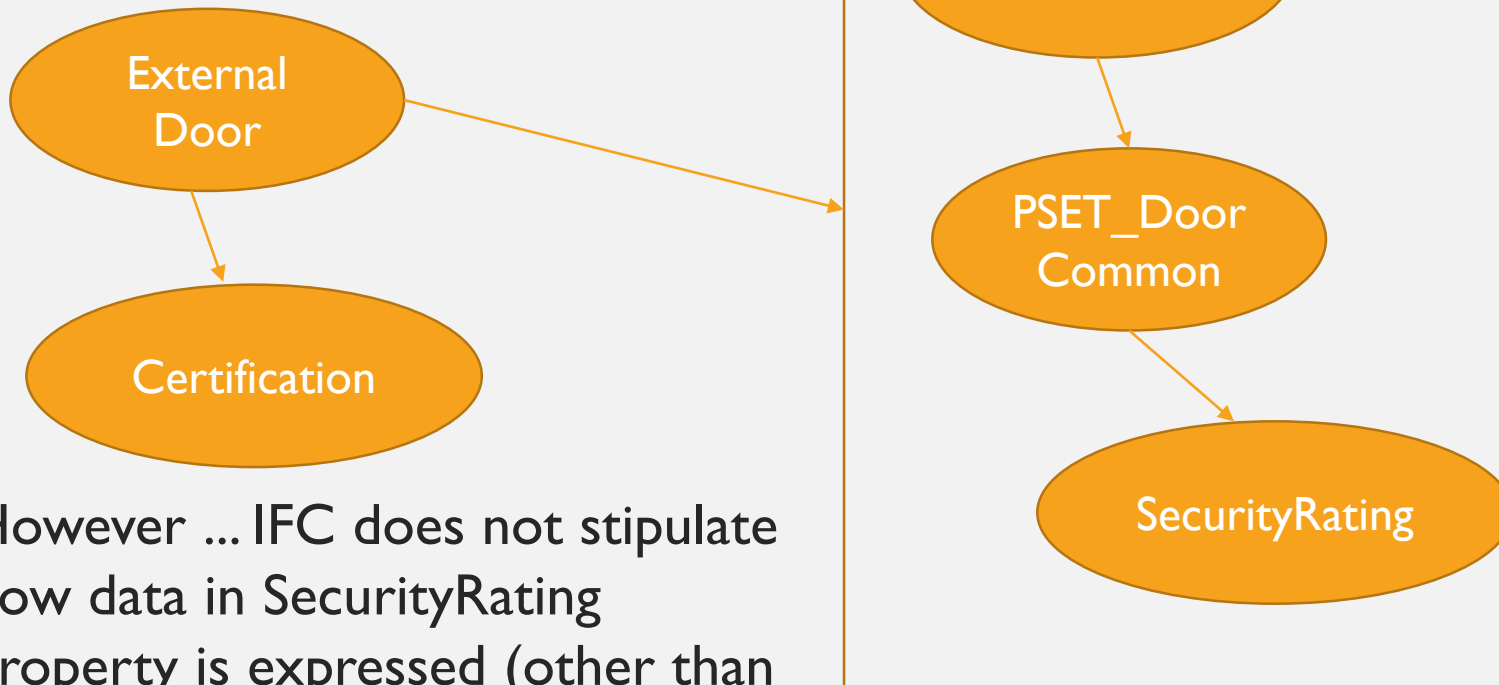


# WHY ADOPT SEMANTICS

- V1 – Non Semantic – DRL + Manual Mappings(85%)
- V2 – Semantic – Attempted to model mappings explicitly in semantics defined by me
- V3 – Using SparQL queries – more generic?
- Admittedly I wasn't aware of the LDC conversion work we heard about yesterday
- Also why bother with a regulation ontology? Because regulation experts tend to think in their own language
- Site vs Development Site
- Pool vs Tank(Open Topped?)

# MAPPING TO BIM

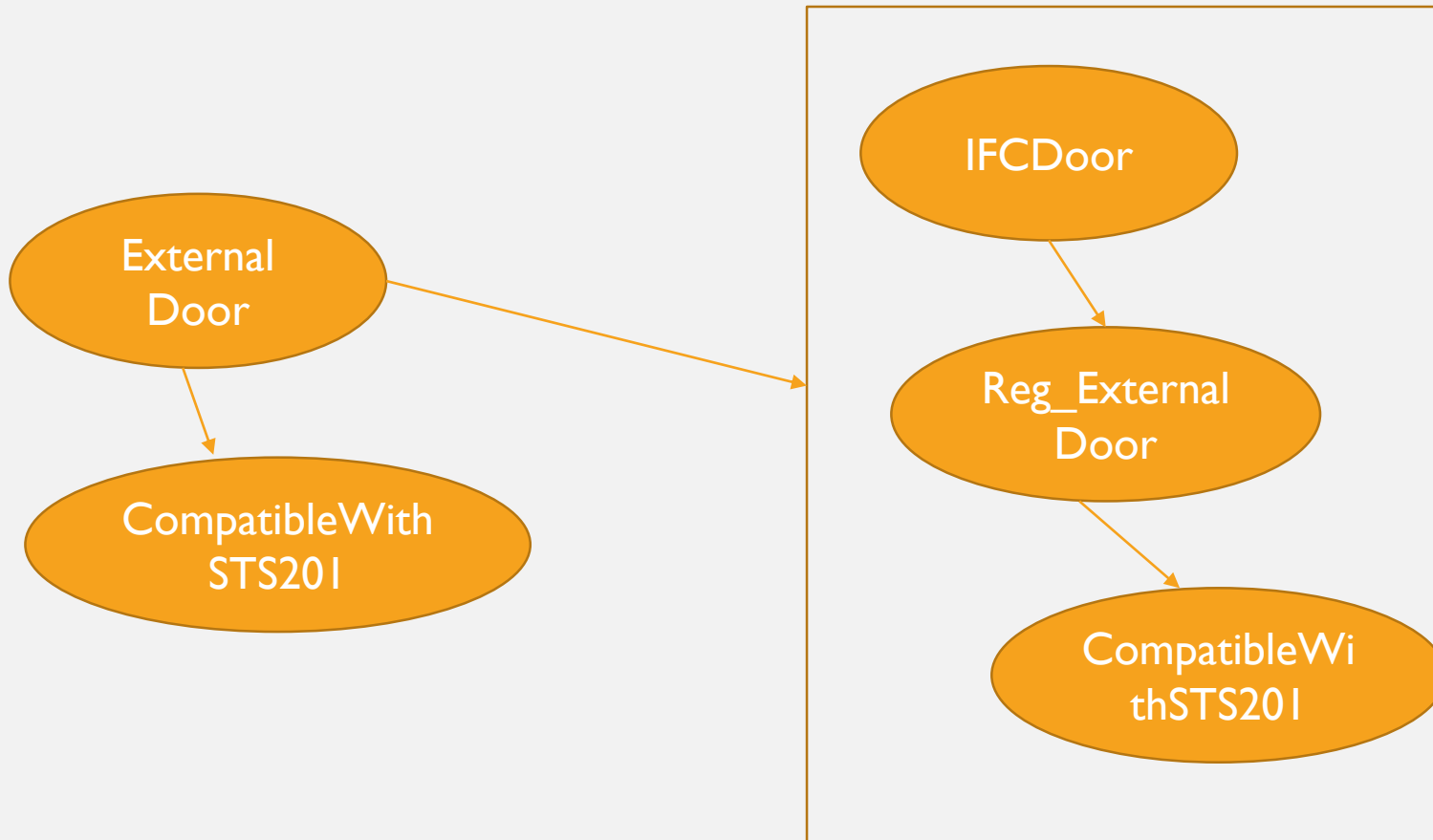
- 2. Property Level Mappings



- However ... IFC does not stipulate how data in SecurityRating property is expressed (other than being an index based system)... assumption made

# MAPPING TO BIM

- 2. Property Level Mappings (B)



# MAPPING TO BIM - PROBLEMS

- A large amount of data needed is often not in the BIM.
- This is because it is either:
  - (a) Calculated from data in the BIM
  - (b) The result of some complex work done by other applications i.e. energy simulations etc...
- We work around (a) by supporting the implementation of procedures specific in a programming language
- Working around (b) is more difficult – we need to marshal data from external applications - this leads to an entire eco-system for compliance checking.
- As a last resort prompts can be raised for user completion.

# USE OF SEMANTICALLY ENCODED REGULATIONS

- Generation of human readable documents (using latex).
- Execution (SWRL) Rules

- 1. Introduction ✓
- 2. The Development – Layout & Design (Planning Issues) ✓
- 3. Security of Dwelling ✓
  - 3.1. Introduction ✓
  - 3.2 Front Door ✓
  - 3.3. Side and back doorsets ✓
  - 3.4. Sliding patio/Bi-fold doorsets <sup>N/A</sup>
  - 3.5. Communal dwellings <sup>N/A</sup>
  - 3.6. Flat entrance doorsets served off a shared corridor or stairway <sup>N/A</sup>
  - 3.7. French window(s) & external glazed double doorsets <sup>N/A</sup>
  - 3.8. Garages (interconnecting doorsets) <sup>N/A</sup>
  - 3.9. Windows ✓
  - 3.10. Roof lights <sup>N/A</sup>
  - 3.11. Dwelling security lighting ✓
  - 3.12. Conservatories <sup>N/A</sup>
  - 3.13. Intruder alarms ✓
  - 3.14. Utilities ✓
  - 3.15. Party wall construction and sound Insulation ✓
  - 3.16. Loft hatches in communal areas <sup>N/A</sup>
- 4. Ancillary Security Requirements ✓

Doorsets shall be certificated to one of the following standards:

- PAS 24:2012 (Note 21.1.1 and 21.1.2), or:
- STS 201 Issue 4:2012 (Note 21.1.3), or:
- LPS 1175 Issue 7:2010 Security Rating 2 (Note 21.1.4), or:
- STS 202 Issue 3:2011 Burglary Rating 2 (Note 21.1.4), or:
- LPS 2081 Issue 1:2014 Security Rating B (Note 21.1.5)

Note: PAS 24: 2012 was published on 31st August 2012 and replaces PAS 24:2007+A2:2011.

Note: PAS 24:2012 embodies two routes to compliance:

- The previous PAS 24:2007+A2:2011 test methodology, albeit updated; or
- BS EN 1627:2011 Resistance Class 3 (which references BS EN 1628, 1629 & 1630), with additional test criteria to address known criminal methods of entry within the UK (which are insufficiently catered for within the European standard).

NB: If manufacturers wish to use the European standard as a route to compliance to PAS 24:2012, then all testing must be conducted in accordance with the latest published version of the 'UK Police Service Secured by Design (SBD) Interpretive Document for BS EN 1627:2011, BS EN 1628, BS EN 1629 and BS EN 1630'. This document can be found on the Secured by Design under SBD standards explained.

Note: STS 201 is the unique reference number for Warrington Certification's published standards replicating the requirements within PAS 24:2012.

# CURRENT CASE STUDIES

- Secured by Design
- Building Regulations
- Secured by Design more prescriptive – thus actually easier to implement
- Building Regulations contain more requirements that require simulation data or complex geometric processing etc....
- Previous work (on a more basic system) also looked at BREEAM.



# FUTURE THOUGHTS

- Performance of JENA/SWRL and Pellet reasoner at scale.
- Can complexity of all regulations be modelled by the tree like structure i.e. BREEAM – or should regulations be rationalised to fit with an explicitly modelled structure?
- Lack of data in BIM models what is solution:
  - Marshal external applications?
  - Perform calculations?
  - Require CAD tools to include data?

# D-COM

- I am leading a research network for the UK's centre for digital built Britain (CDBB).
- The topic of this network is on regulatory compliance.
- The D-COM Network will bring together academic and industrial participants to work on the area of automating regulatory compliance. This network will;
  - (a) assessing the current state of the art in the area,
  - (b) gathering requirements from stakeholders,
  - (c) defining, together with industrial and policy making stakeholders, the future pathways for development,
  - (d) defining the capabilities and research required to deliver the defined pathways
  - (e) build a community that can conduct this research and develop capabilities.

ANY QUESTIONS?

