Building Information Modeling

By

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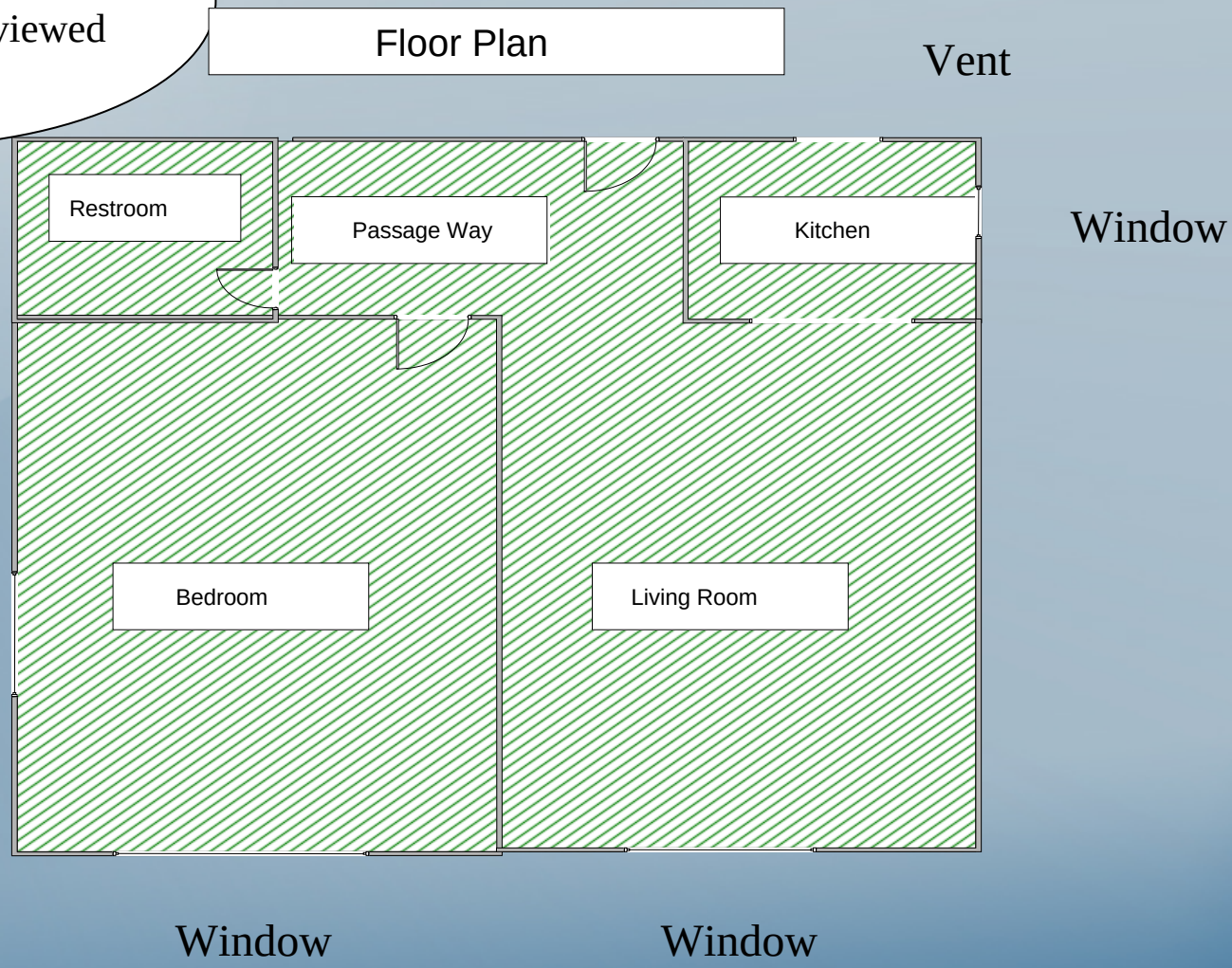
Agenda

- Project Description
- Opportunity for Improvements (O.F.I.) in Architectural Design
- Goals
- Benefits
- System Requirements
- System Structure
- Relation Diagram
- Challenging Aspects
- Conclusion and Future Work
- Software Used
- References

Floor Plan

Two Dimensional representation of a building layout as viewed from above.



Project Description

- Defining and categorizing the design requirements of a building from an architectural view point
- Preparing the system structure (Class Diagram) at a higher level of abstraction
- Defining Validation Parameters
  - To allow the architect to check potential building designs against the specification
    - Quickly
    - Easily
    - In early phases of the design

Building Modeling - View Points

- Architectural
- Structural
- Plumbing
- Electrical
- Security

• Concerned with the hierarchical decomposition of spaces within blocks
• During the early phases of the design, shapes are transformed into “architectural regions” (rooms)
• Preliminary evaluation, of properties (like size, shape, orientation, adjacency) coupled with the assignment of properties to regions

Opportunity for Improvements (O.F.I.) in Architectural design

- Three type of constraints in the floor planning process
  - Topological (i.e. orientation, traffic/pathway, and location/adjacency concerns)
  - Dimensional (i.e. size and space concerns)
  - Functional (i.e. aesthetic concerns)
  - Geometric (i.e. shape)
- Difficult to reconcile and tedious to verify
- Result in design process that often leave a poor record of why certain design decisions or implementation choices have been made

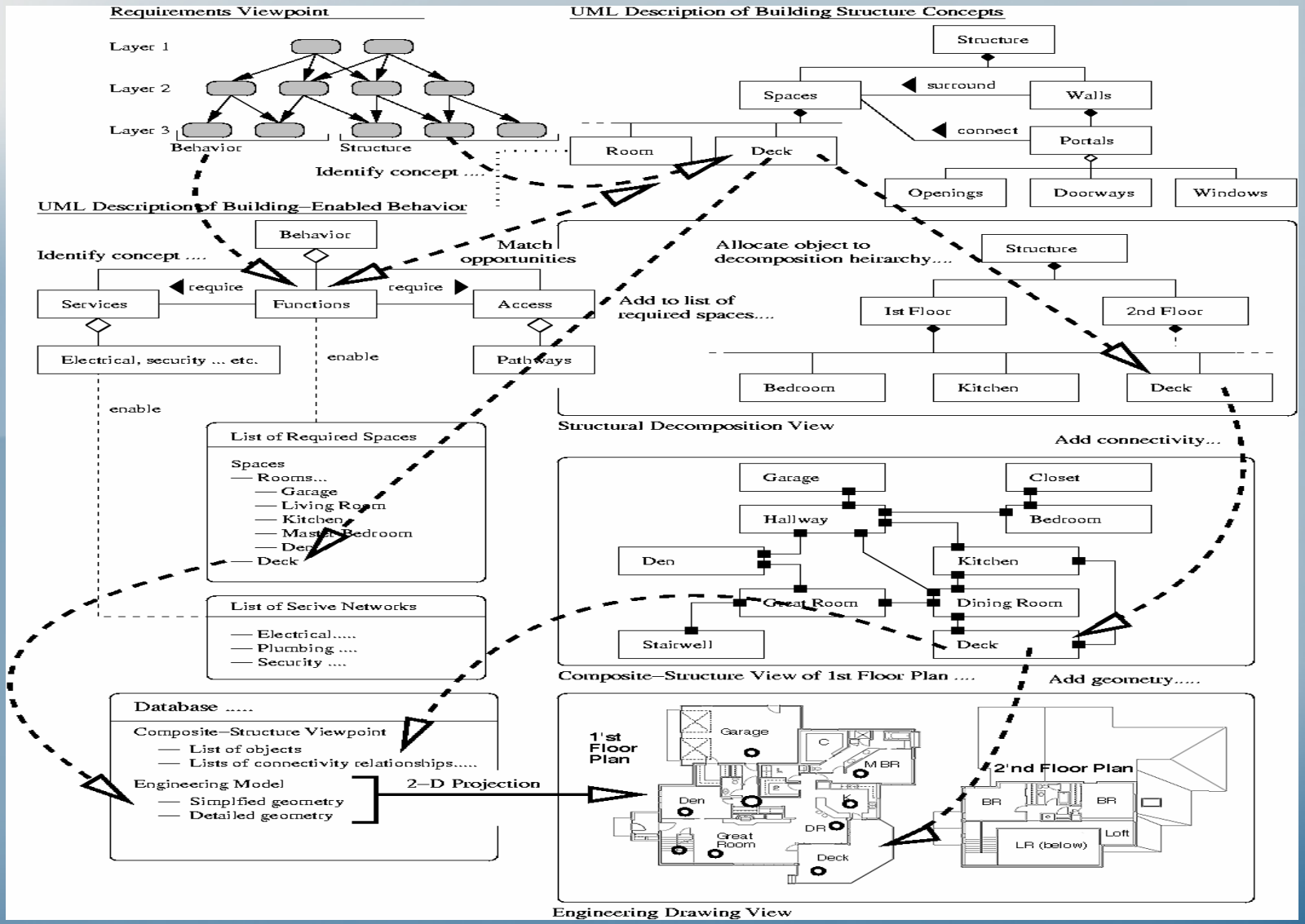
Goals

- Front end development of a Tool
  - for both architects and their clients
  - Simple and compact
  - Sufficiently powerful to capture the wishes of the client and the architectural design constraints
  - Enable the clients to formally specify design requirements for a building

Goals – Cont'd

- Allow the architects to check potential building designs against the specifications
  - quickly and easily
  - during the early phases of the design &
  - for consistency
- provide meaningful feedback about any discrepancies
- To help architects and clients to come up with a floor plan that achieves high optimality in the desired functionality.

Goals – Cont'd


Requirements Viewpoint
Layer 1
Layer 2
Layer 3
Behavior
Structure
Identify concept ....
UML Description of Building–Enabled Behavior
Behavior
Identify concept ....
Match opportunities
require
require
Services
Functions
Access
Electrical, security ... etc.
enable
Pathways
enable
List of Required Spaces
Spaces
— Rooms...
— Garage
— Living Room
— Kitchen
— Master Bedroom
— Den
— Deck
List of Serive Networks
— Electrical.....
— Plumbing ....
— Security ....
Database .....
Composite–Structure Viewpoint
— List of objects
— Lists of connectivity relationships.....
Engineering Model
— Simplfied geometry
— Detailed geometry
2–D Projection
UML Description of Building Structure Concepts
Structure
Spaces
surround
Walls
connect
Portals
Room
Deck
Openings
Doorways
Windows
Allocate object to decomposition heirarchy....
Add to list of required spaces....
Structure
1st Floor
2nd Floor
Bedroom
Kitchen
Deck
Structural Decomposition View
Add connectivity...
Garage
Closet
Hallway
Bedroom
Den
Kitchen
Great Room
Dining Room
Stairwell
Deck
Composite–Structure View of 1st Floor Plan ....
Add geometry.....
1'st Floor Plan
Garage
C
M BR
Den
K
DR
Great Room
Deck
2'nd Floor Plan
BR
BR
Loft
LR (below)
Engineering Drawing View

Benefits

- Result in
  - Building design with fewer errors
  - With better compliance among client's goals and building specifications
  - Assisting carrying out the unavoidable low level tasks such as consistency checking, drafting, area calculations, book-keeping

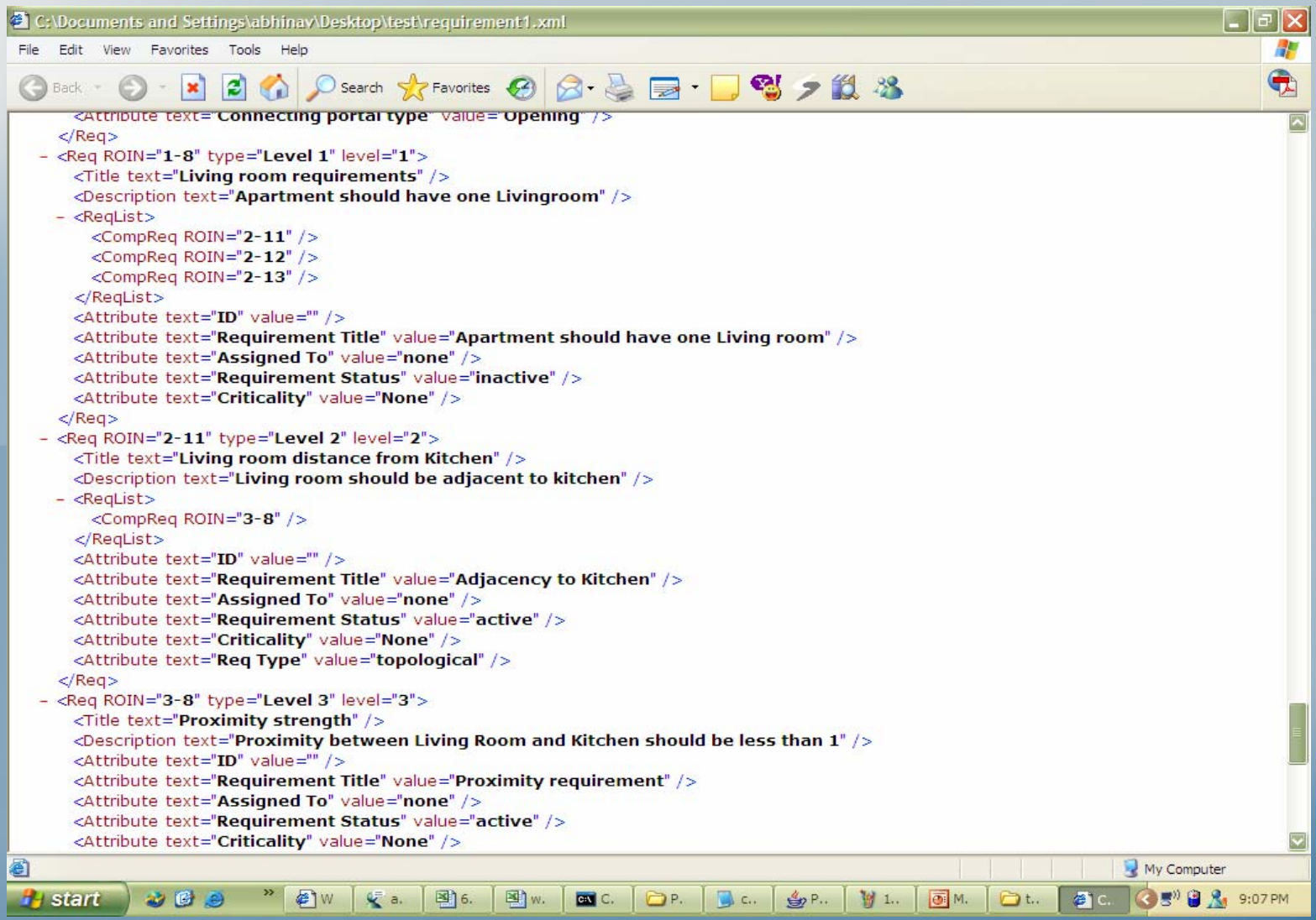
Benefits – Cont'd

- Result in
  - Allowing the user to quickly describe relatively complex relationships between rooms in a building
    - Like in an academic building
      - All classrooms should be relatively close together
      - But visually and acoustically separated
      - Every office should be close to one print/copy facility
      - Secretarial offices should be distributed among and visible from the faculty offices….and so on

Requirements

- Apartment Level
  - An apartment should have one bedroom, one living room, one restroom and one kitchen
  - An apartment entrance should not be through bedroom
  - An apartment should have easy pathway towards exit in case of emergency
- Room Level
  - Size of bed room should be X Sqft.
  - Rest room should be close to bedroom
  - Rest room should be far from kitchen

Requirements



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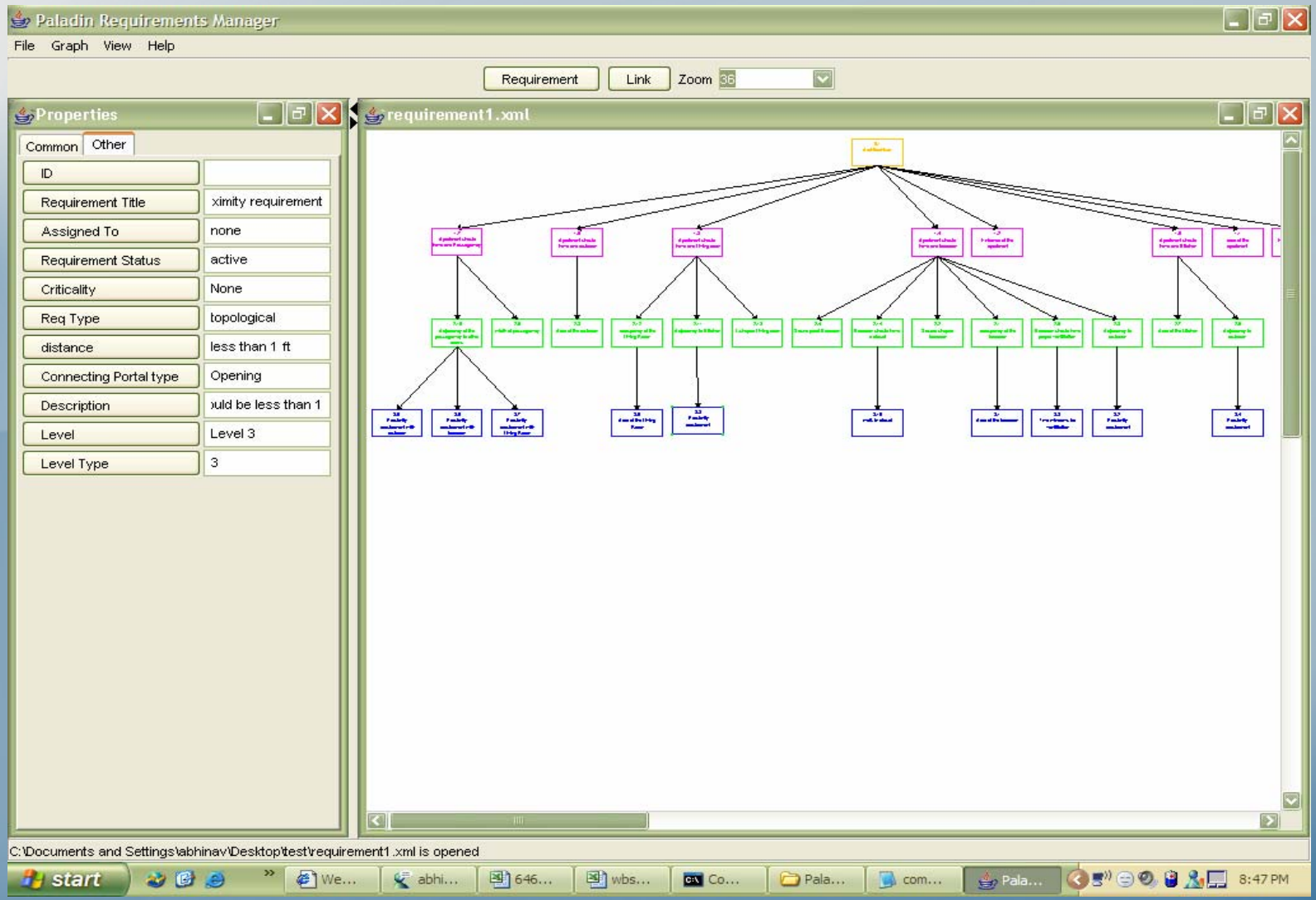

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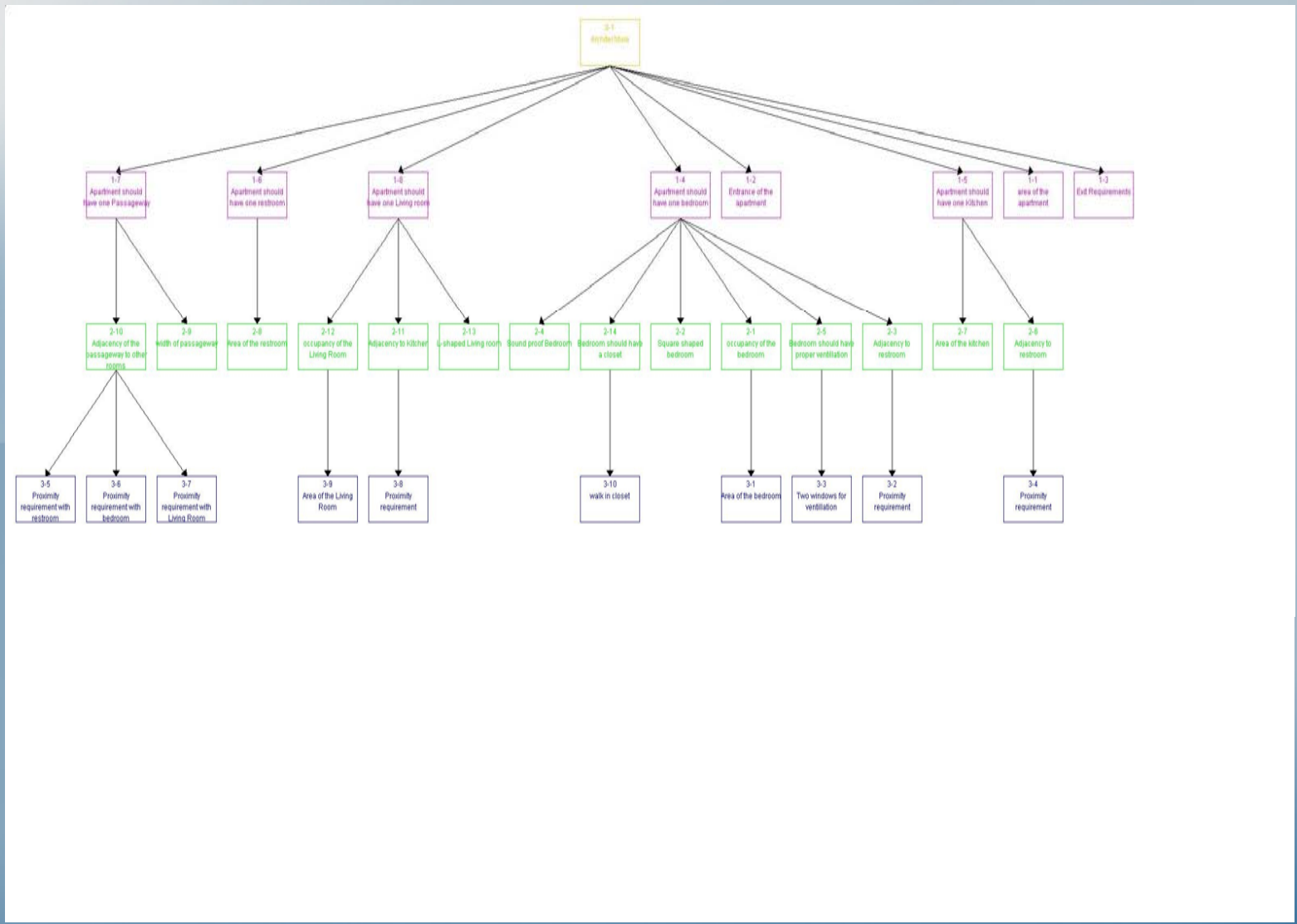
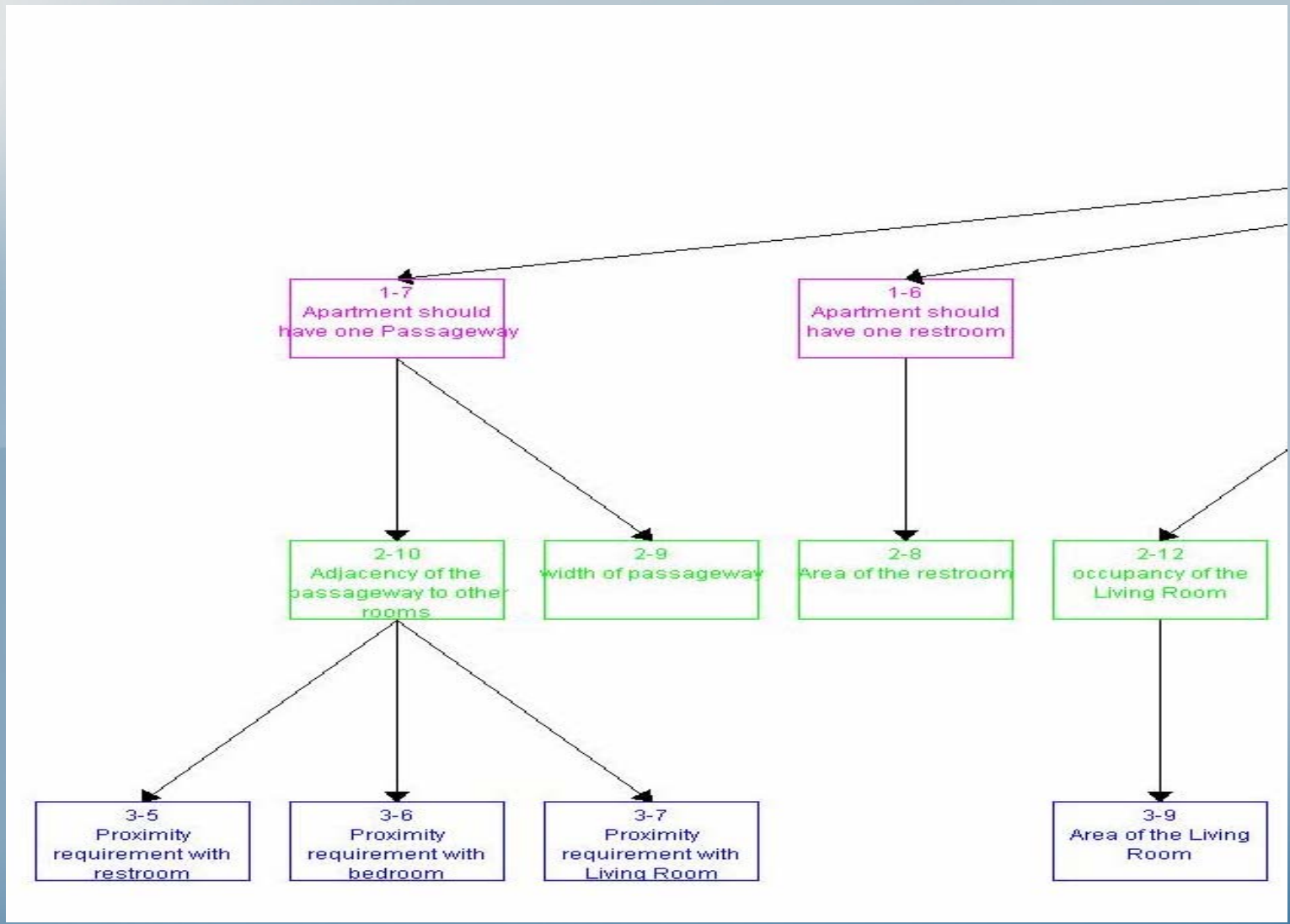


Requirements



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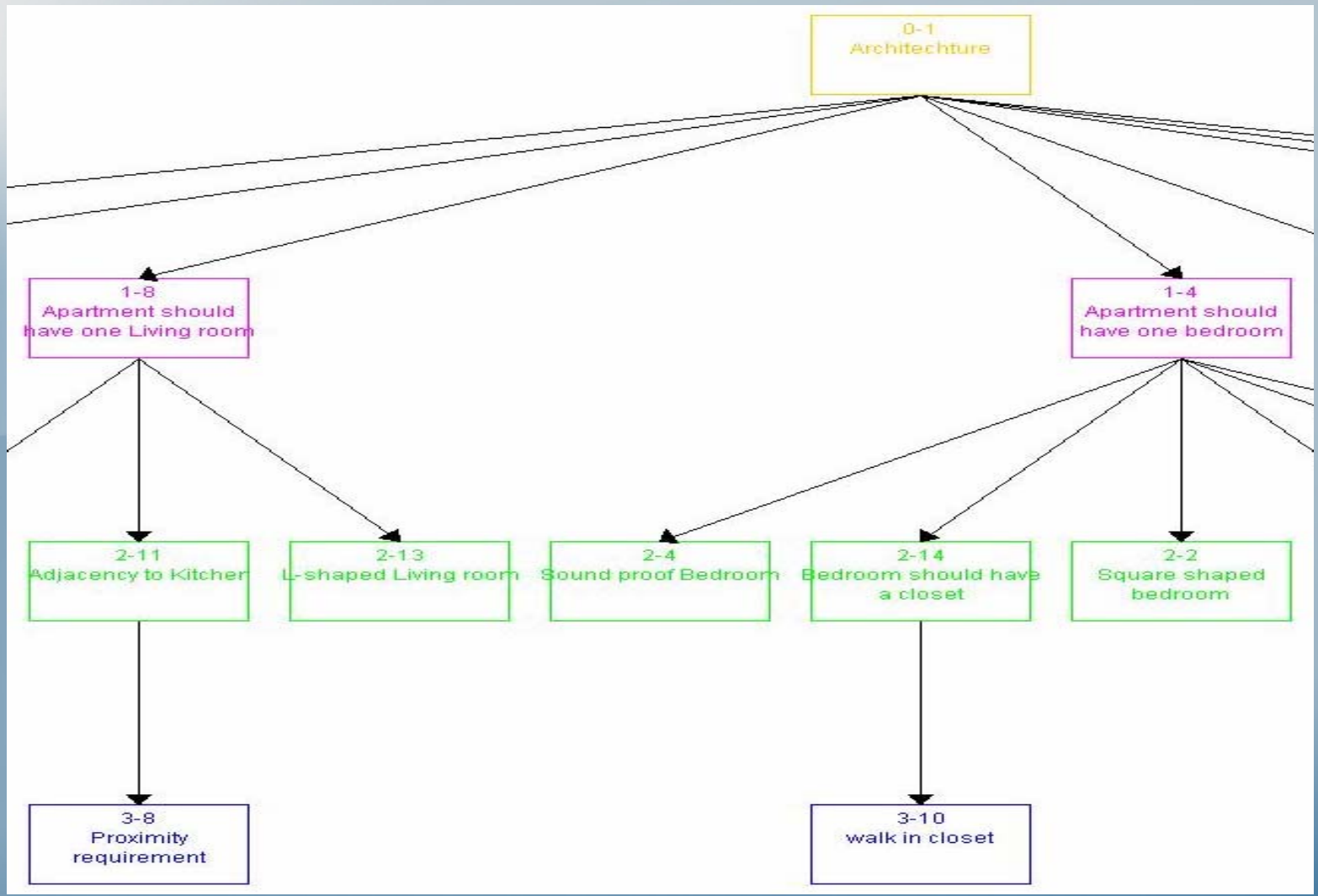

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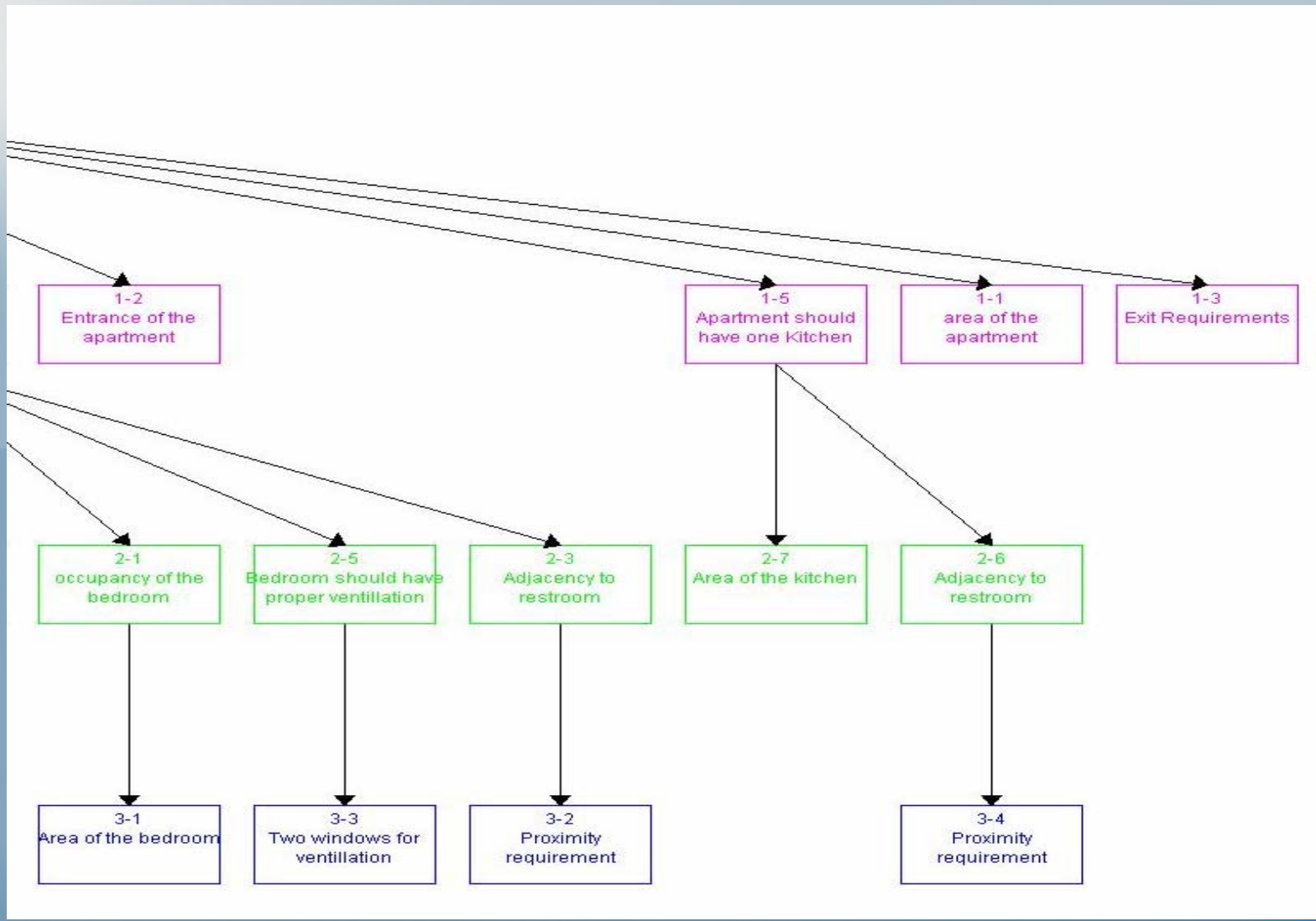
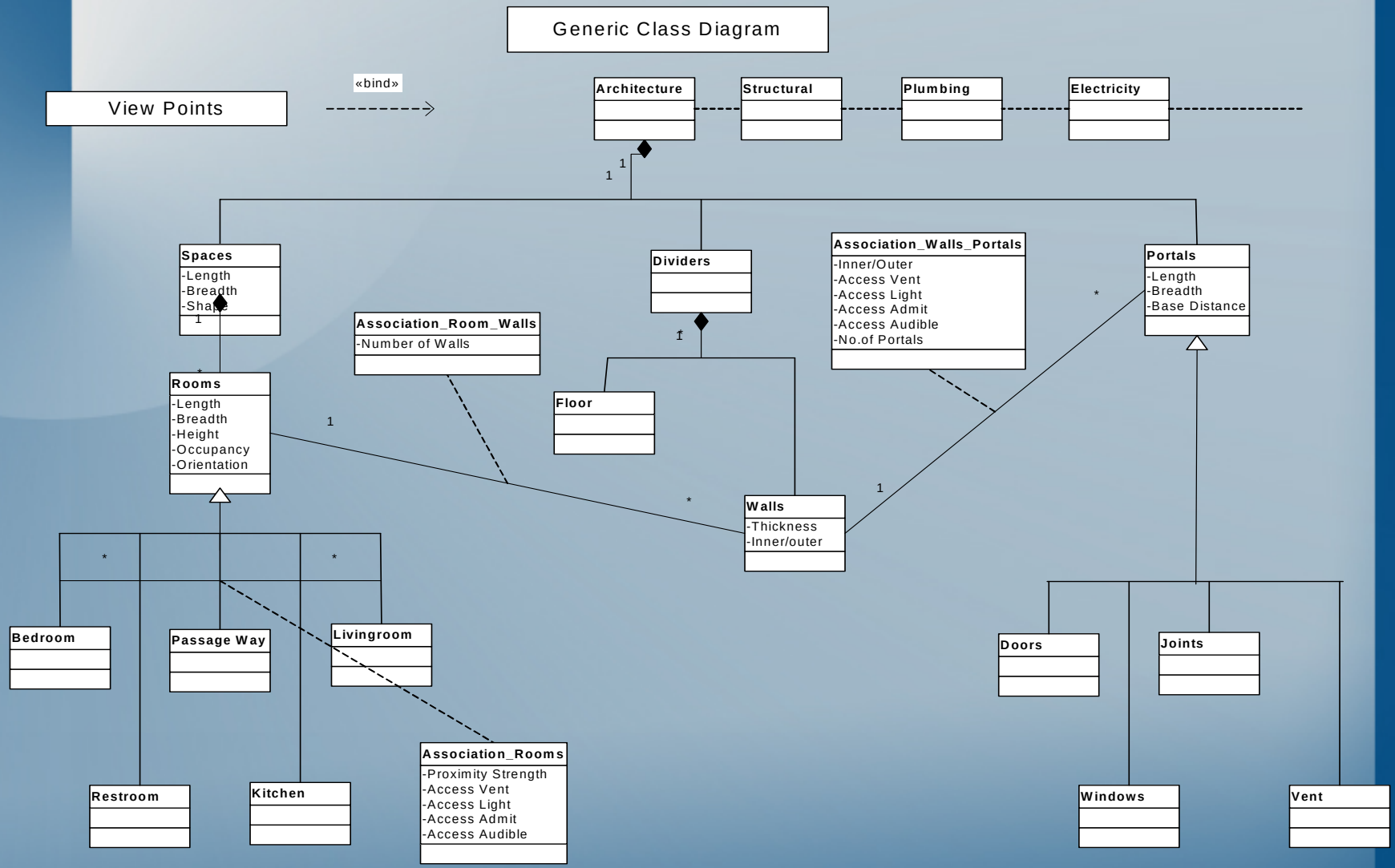
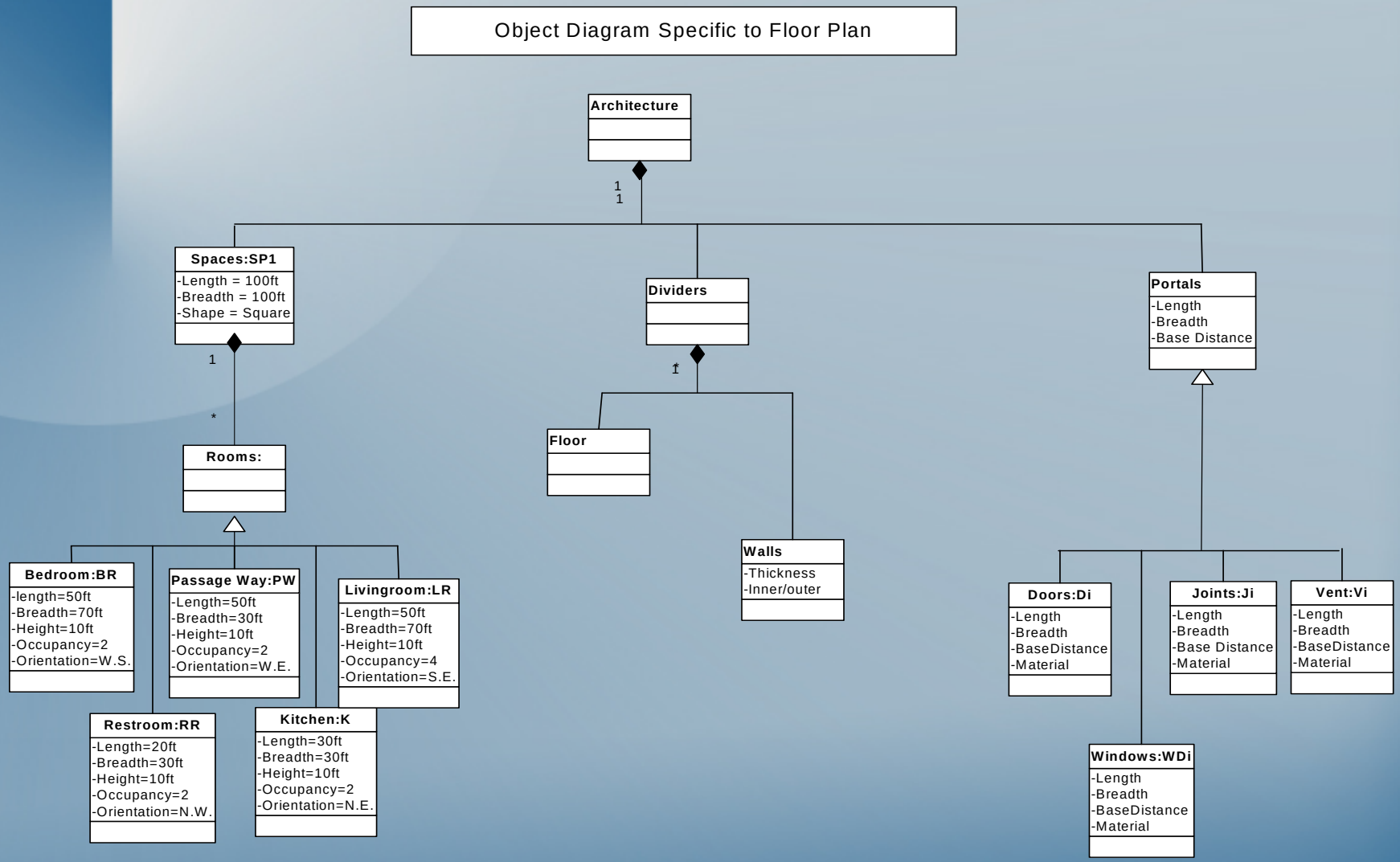


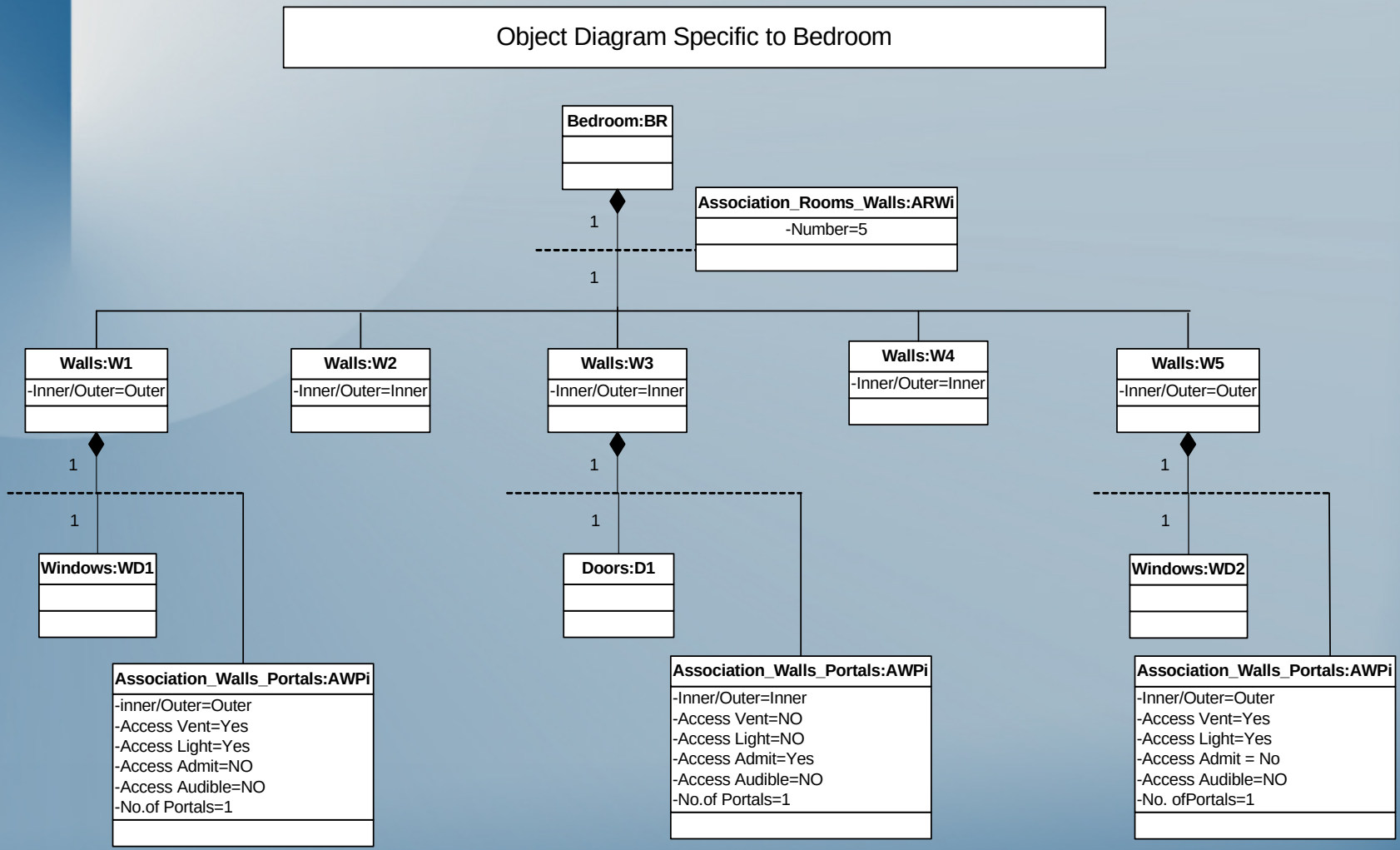
Generic Class Diagram



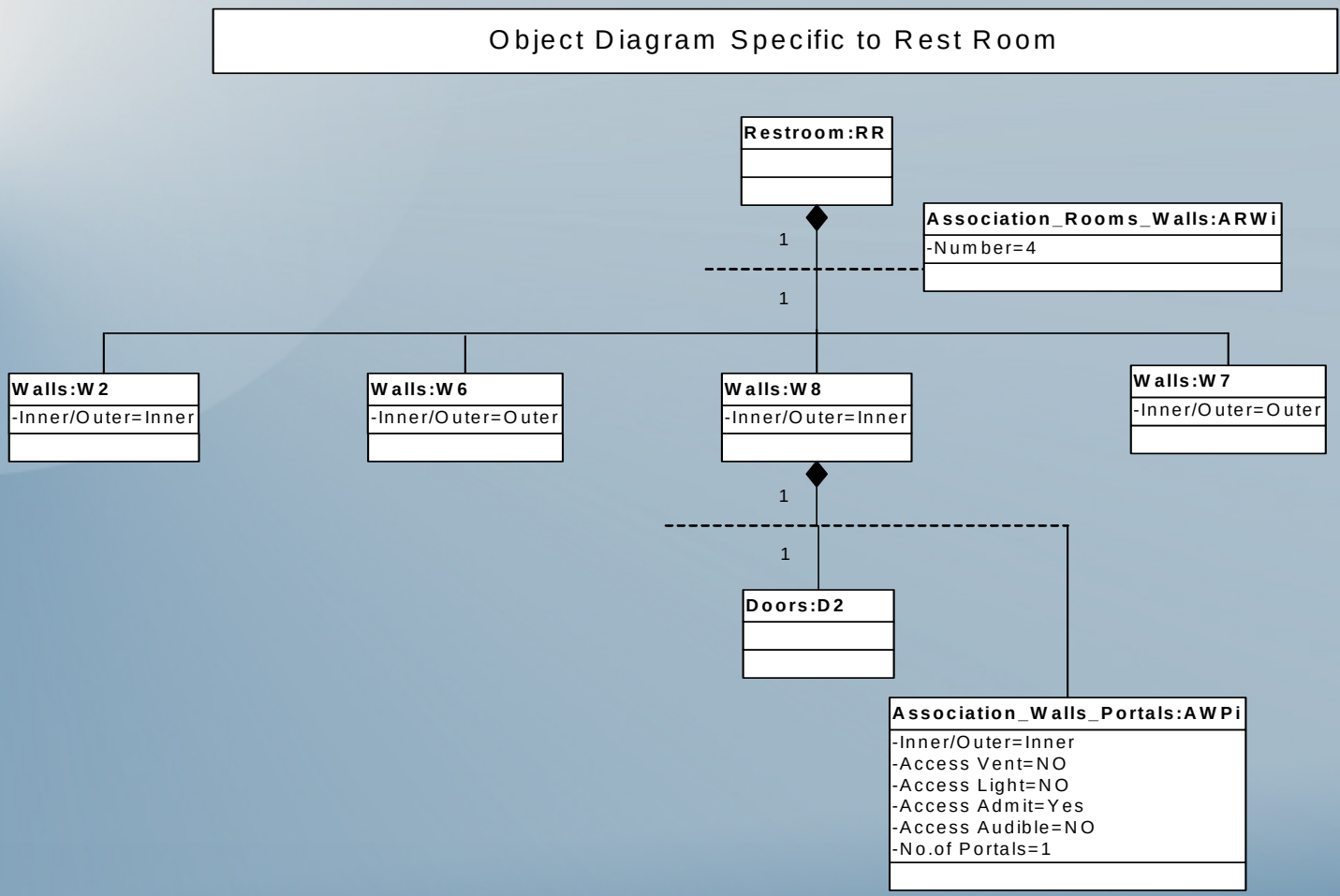
Class Diagram - Floor plan



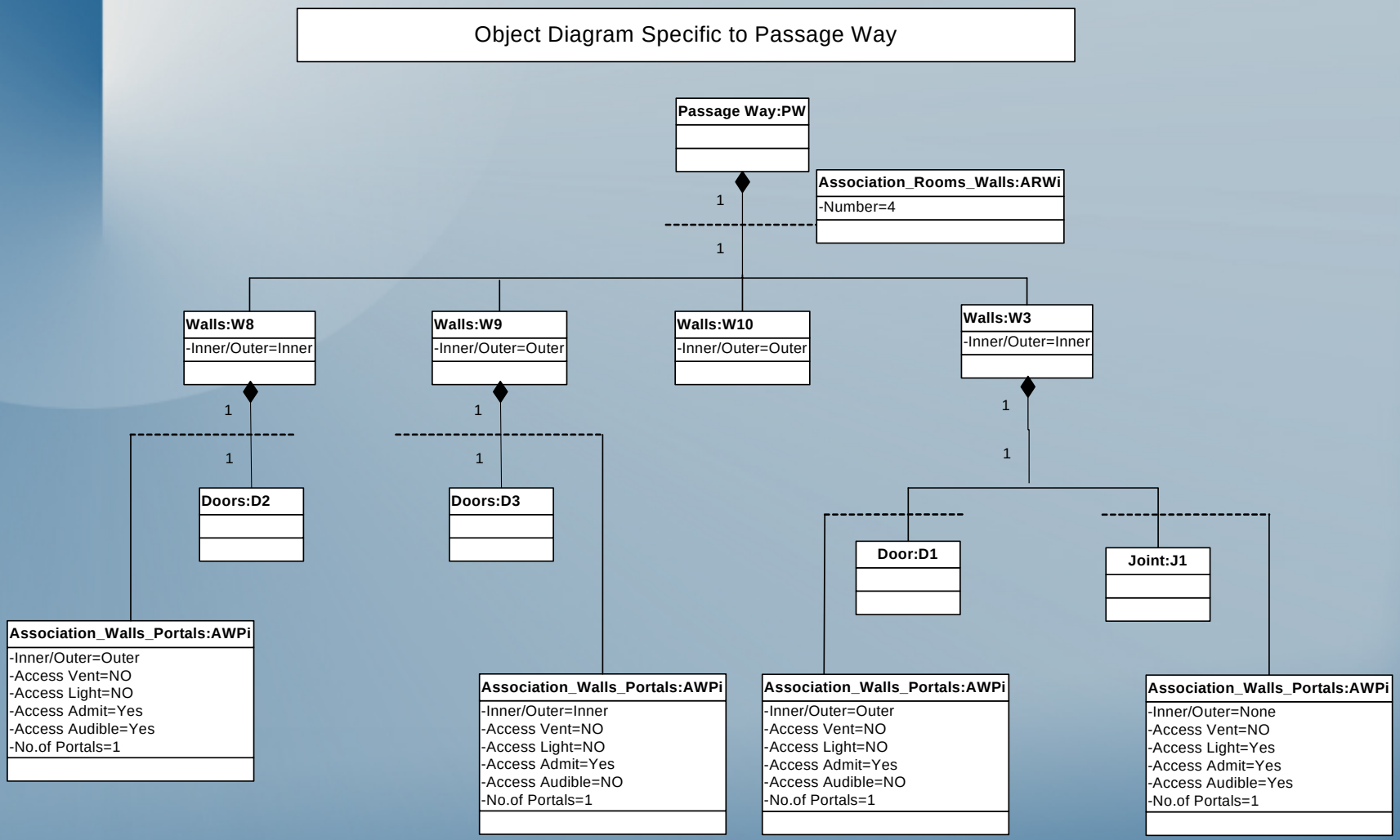
Object Diagram - Bedroom



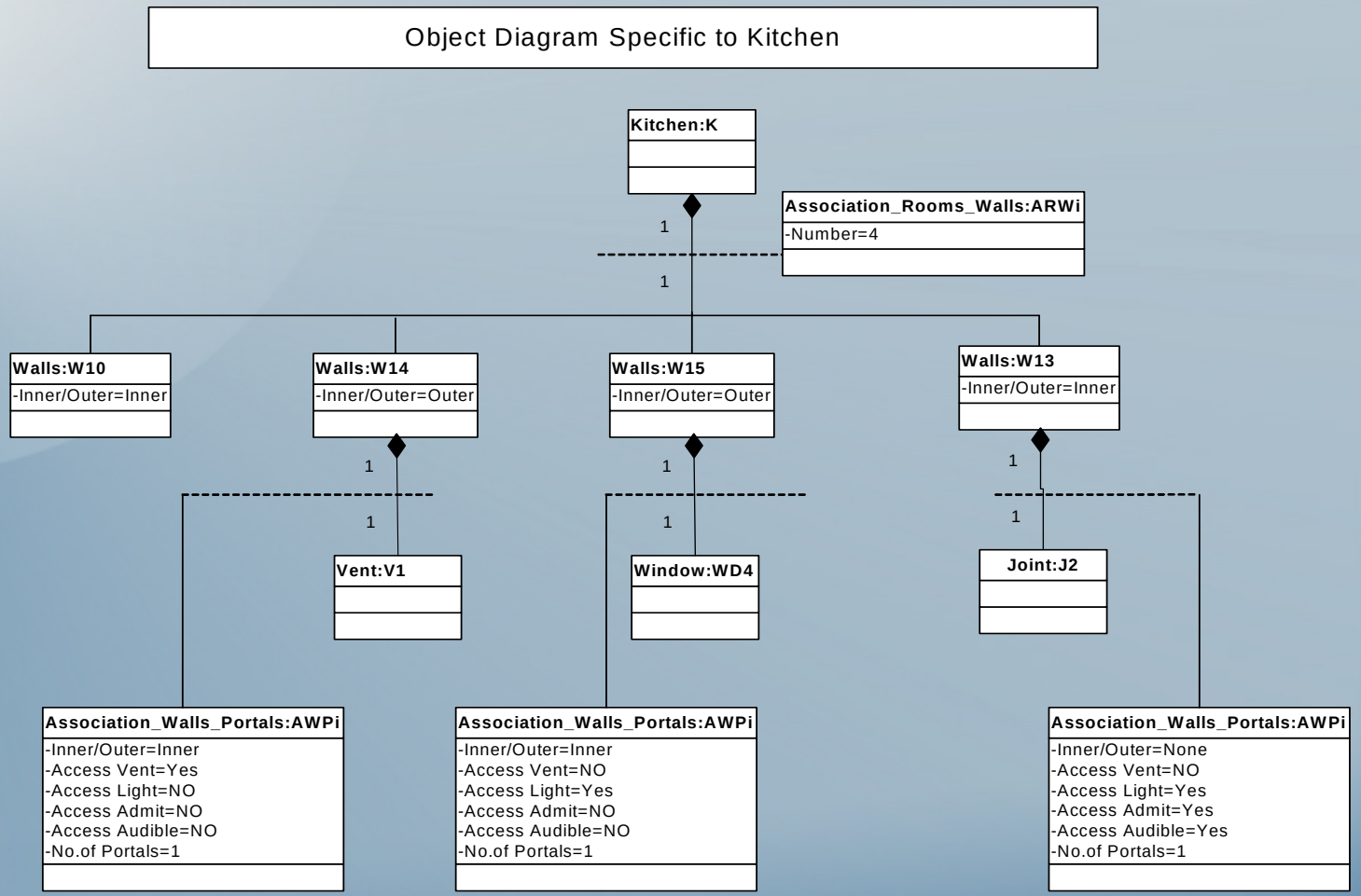
Object Diagram - Restroom



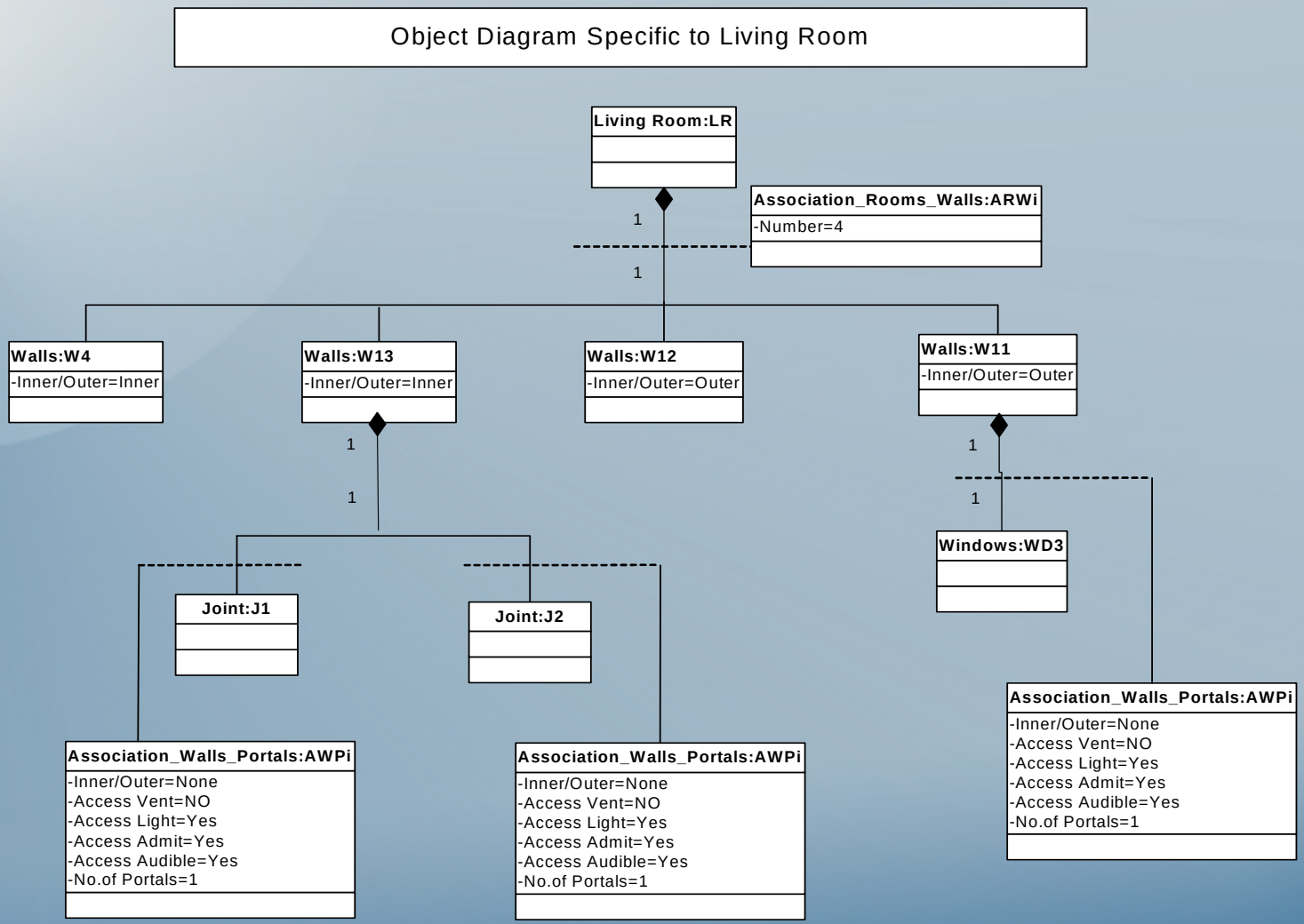
Object Diagram – Passage Way



Object Diagram - Kitchen

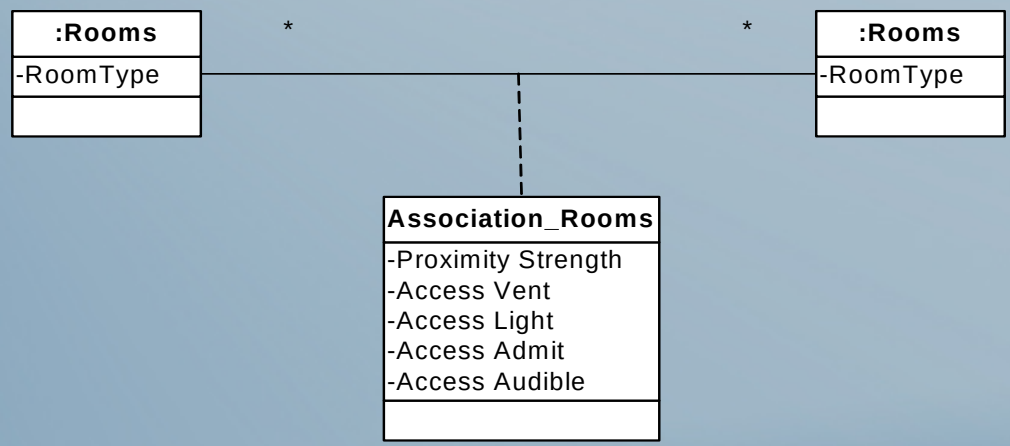


Object Diagram – Living Room

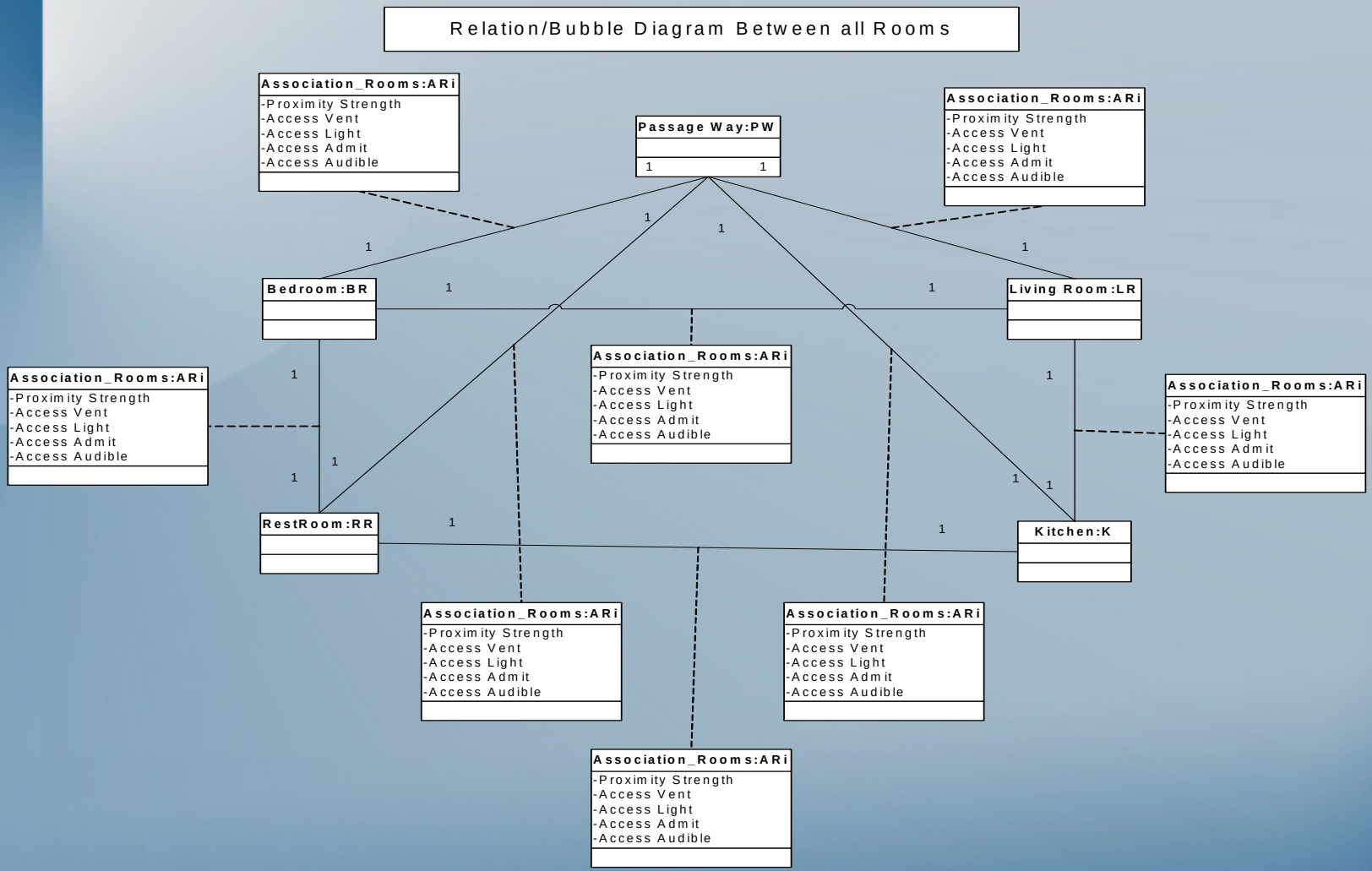


Generic Relation Diagram

Generic Relation/Bubble Diagram



Relation Diagram - All Rooms



Challenging Aspects

- Abstract Concept
- Absence of explicit system behavior
- Figuring out the approach
- Iterations
- Concession and Agreement
- Integration of different view points

Conclusion

- Defined methodology
- UML Diagrams as a basis for tool development for an architectural view point
- Known Validation Parameters

Future Work

- Defining methodology for other view points
- Integration of different view points
- Development of tools that allow
  - Formal basis for describing and reasoning about high level system architectural connection
  - Synthesis and checking of building architectures
  - Interact with other engineering disciplines
  - Vertical Integration of topological and geometric information
  - Promote single representation
- End to End development from requirements to UML representations and to engineering drawings

Software Packages Used

- PaladinRM
- MS Visio
- MS Office

References

- Papers
  - ENPM 642 Class Notes by Prof. Mark Austin
  - Interchange Format for Symbolic Building Design by Laura Downs, University of California, Berkeley
  - Graph-Based Visualization of System Requirements Organized for Team-Based Design by Mark Austin, Natalya Kositsyna, and Vimal Mayank
  - Representation and Visualization of Engineering Requirements attached to Multidisciplinary Engineering Models and Drawings by Mark Austin and Natasha Shmunis
  - IFC 2x Edition 2 Model Implementation Guide by Thomas Liebich, Version 1.7
  - Modeling multiple views of design objects in a collaborative CAD environment by M A Rosenman and J S Gero

Thank You!