Systems Engineering
Solar Decathalon Source Group
Midterm Presentation

David Daily, Iman Malakooti, Iain Kierzewski, Parastoo Delgoshaei

Inspiration - University of Maryland Solar Decathlon Entry: WaterShed

Contents

System Objective

- The system object is to: develop a system to model the effect of different technologies on the temperature within a room
- This model will include the different constructions of window and wall material, the effects of an automated HVAC system, and the side effects from common heat generating appliances.
- Considerations will need to be given to the weather conditions.

Non-Functional Requirements

User must be able to set:

1. Desired Interior Ambient Temperature
2. Wall properties
3. Window properties
4. Appliance properties
5. Weather time frame
6. Simulation time frame

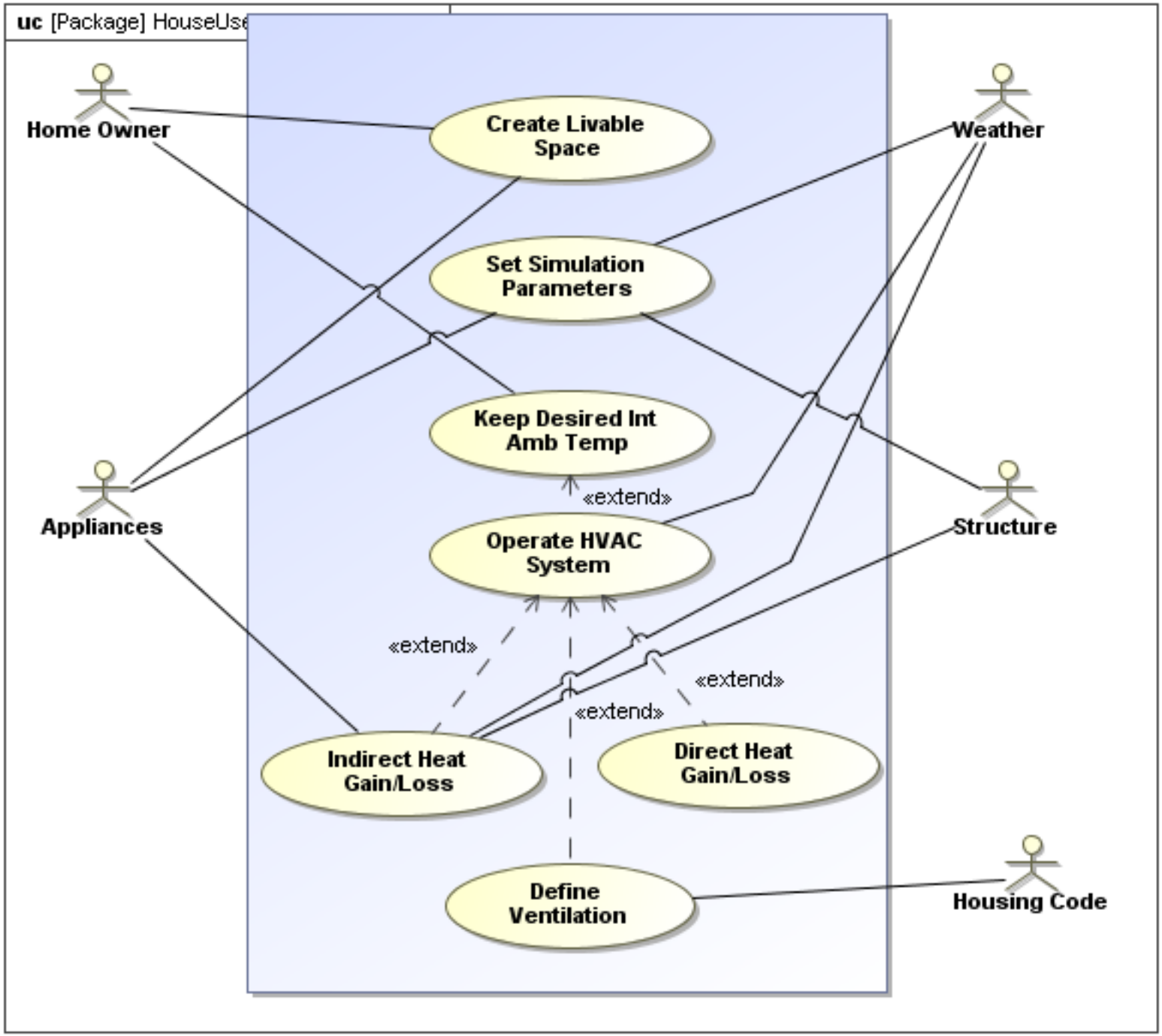
Functional Requirements

1. System should model and follow equations for heat flux and black-body radiation[1,2]
2. System should follow a set weather condition based on weather time frame parameter
3. HVAC is activated when a difference of 2 degrees from Desired Temperature is present
4. Minimum Ventilation standard is at 75 CFM[3]

List of Assumptions

1. Exterior Ambient Temperature is an infinite source/sink
2. Interior Ambient Temperature experiences no diffusion (i.e. heat in is automatically evenly distributed throughout the space)
3. Interior Airflow is negligible
4. HVAC system operates at 100% efficiency
5. ERV is constantly working
6. 80% of heat used for Appliances is released back into interior space
7. No heat is absorbed in mediums (perfect conduction)
8. House is Wx2W sized plan with one window facing South
9. Threshold for HVAC system is +/- 2 degrees from Desired Int Amb Temp
10. R value is proportional to k/d in conduction equation
11. Each simulation starts with Int Amb Temp at Desired Amb Temp

Use Case Diagram



Goals and Scenarios

Goals 1. Allow homeowner to adjust conditioned space temperature

- Scenario 1.1: Summer, Day
- Scenario 1.2: Fall, Day
- Scenario 1.3: Winter, Day
- Scenario 1.4: Spring, Day
- Scenario 1.5: Summer, Night
- Scenario 1.6: Fall, Night
- Scenario 1.7: Winter, Night
- Scenario 1.8: Spring, Night

Goals 2. Show the effect of changing the wall material on the temperature of a room

- Scenario 2.1: Low R Value
- Scenario 2.2: Medium R Value
- Scenario 2.3: High R Value

Goals and Scenarios

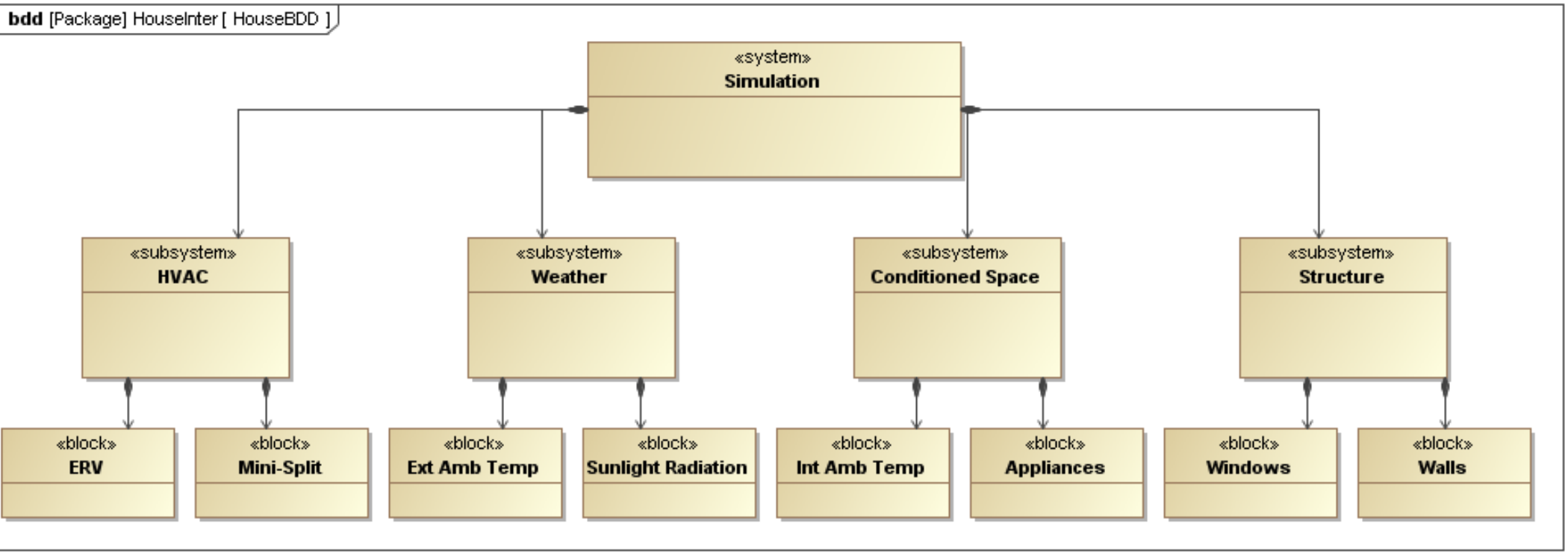
Goals 3. Show the effect of changing the window material on the temperature of a room

- Scenario 3.1: Single Pane, Low SHGC
- Scenario 3.2: Single Pane, High SHGC
- Scenario 3.3: Double Pane, Low SHGC
- Scenario 3.4: Double Pane, High SHGC
- Scenario 3.5: Triple Pane, Low SHGC
- Scenario 3.6: Triple Pane, High SHGC

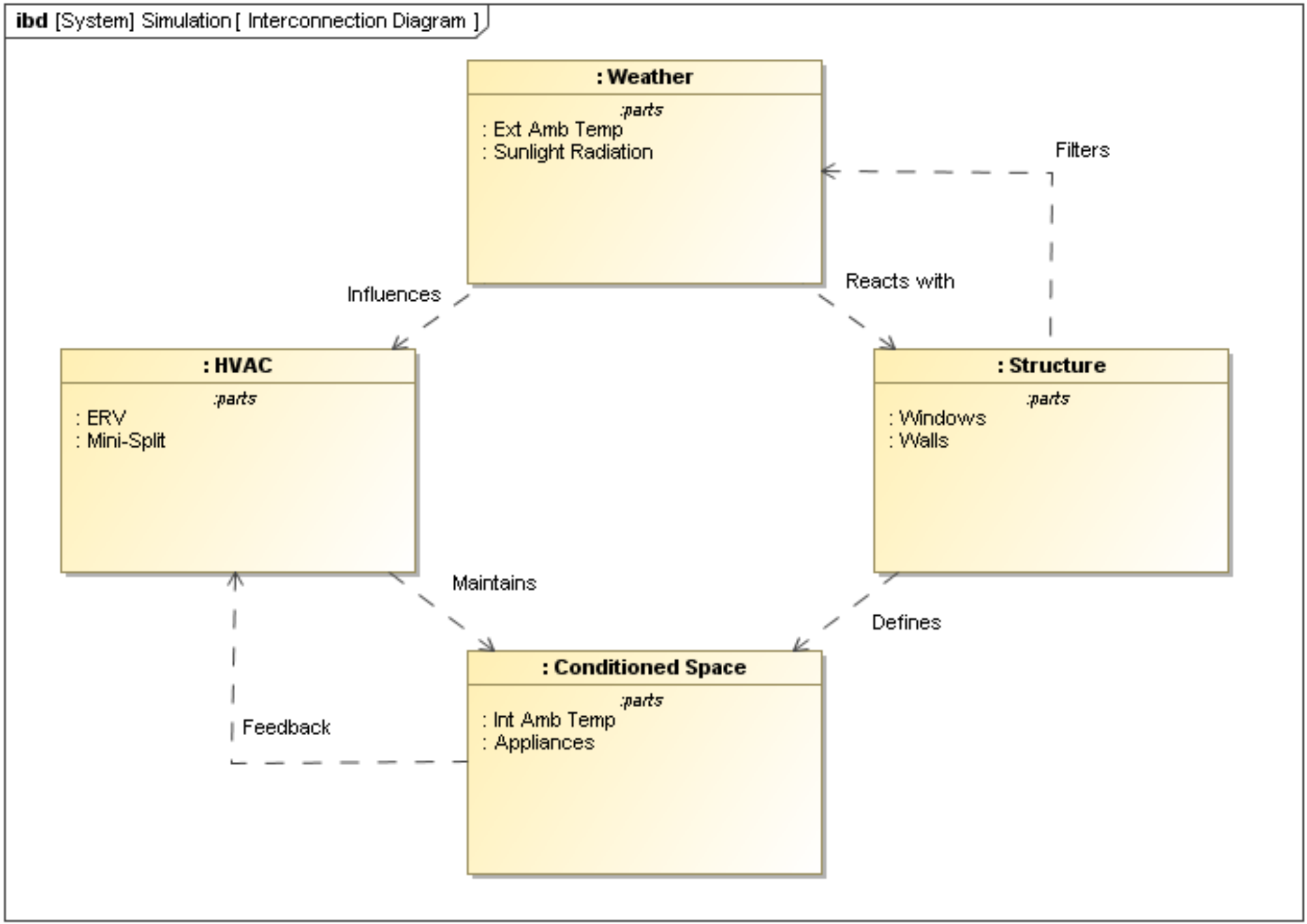
Goals 4. Show the effect of appliance type on the temperature of a room

- Scenario 4.1: High Efficiency Appliances
- Scenario 4.2: Standard Appliances

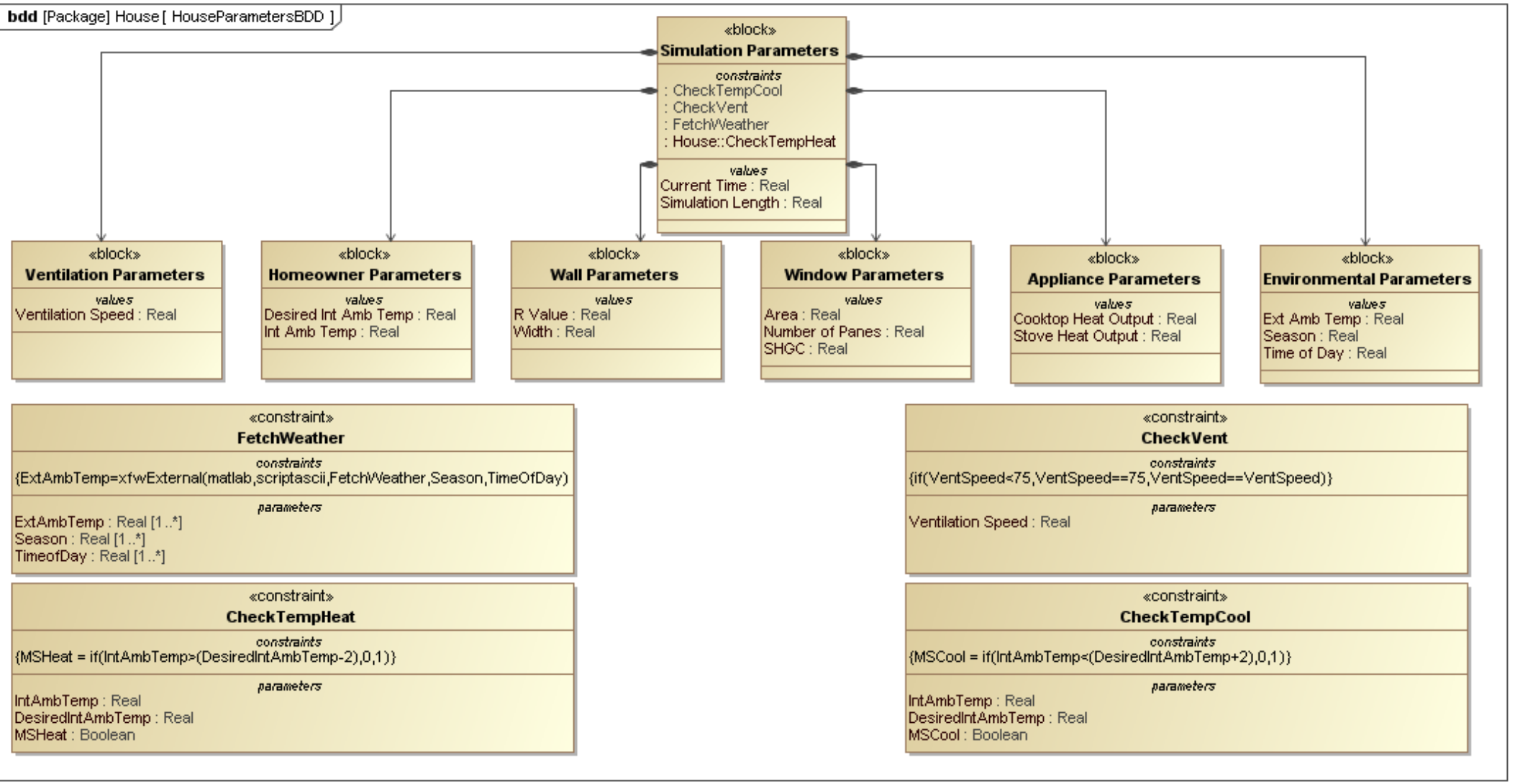
Structure Diagram



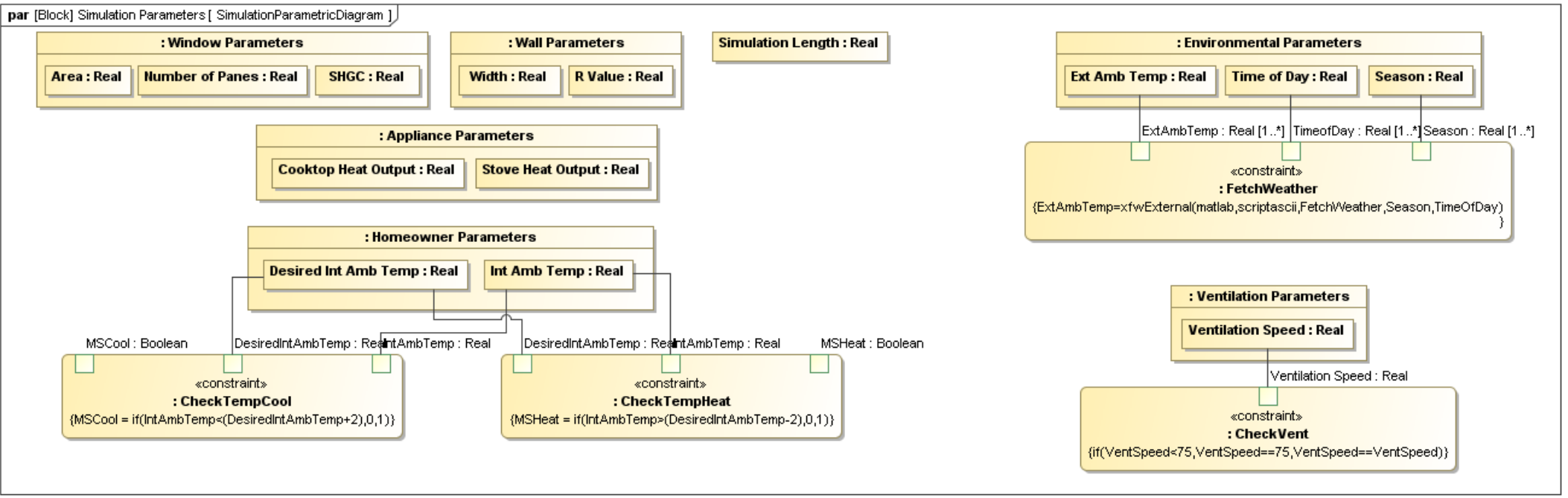
Relationship Diagram



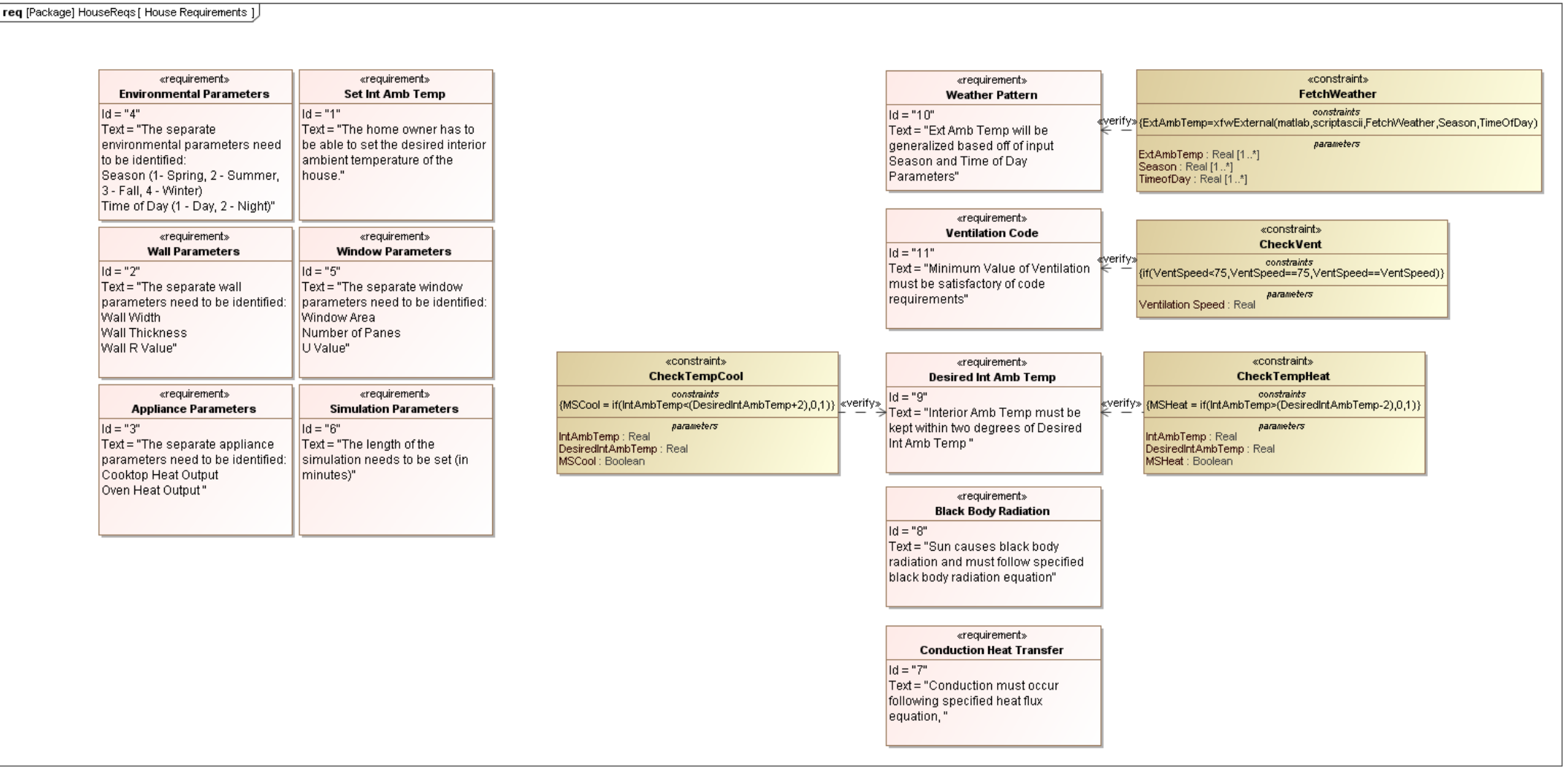
Parameters Structure Diagram



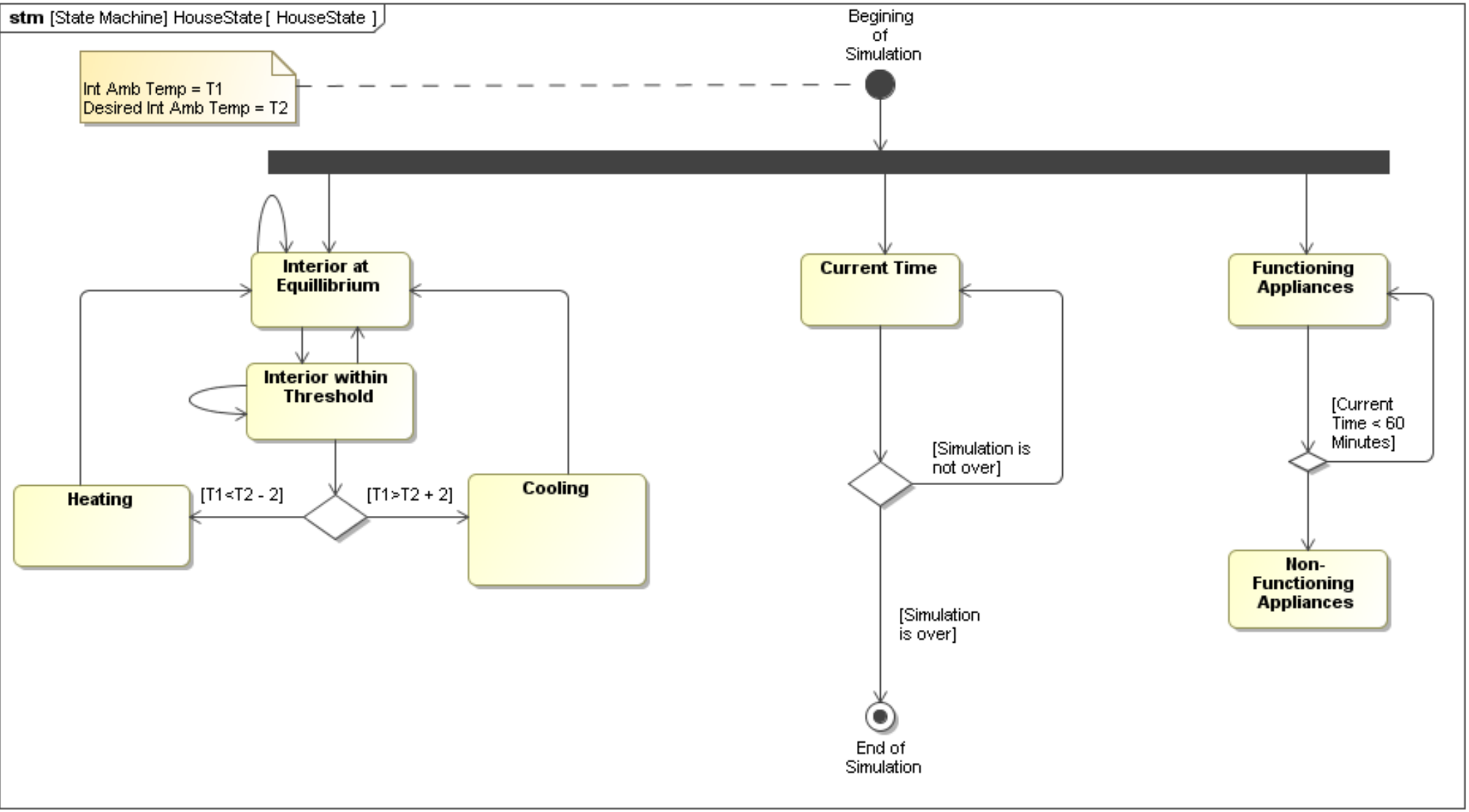
Parametric Diagram



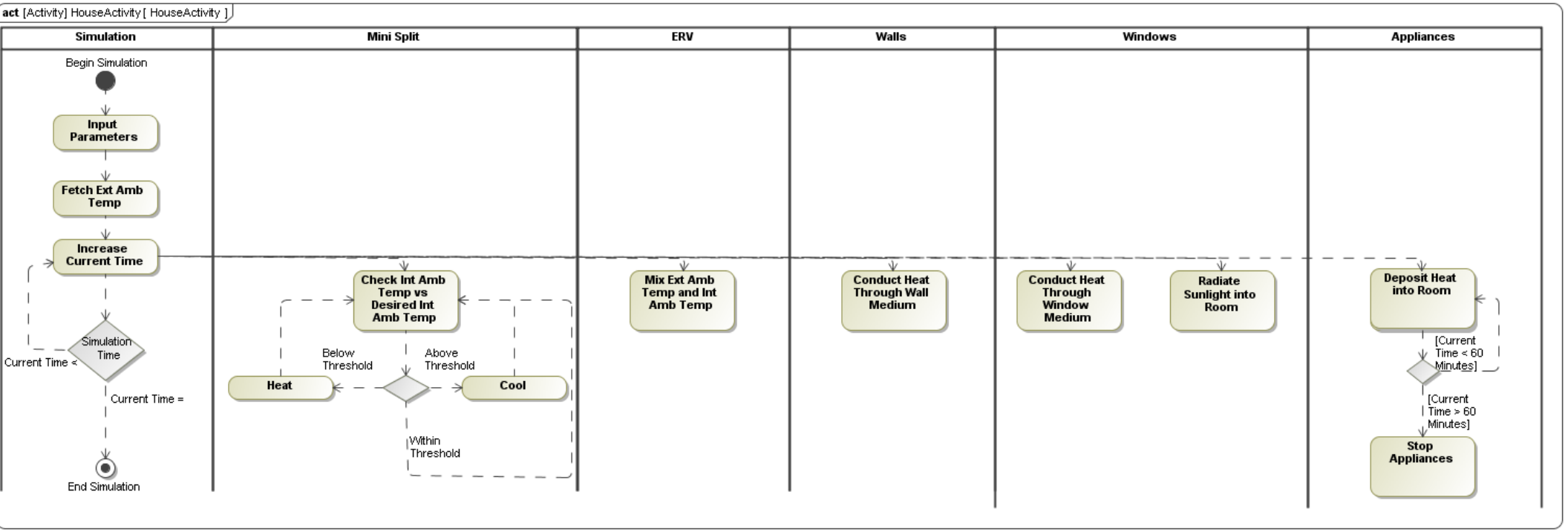
Requirements Diagram



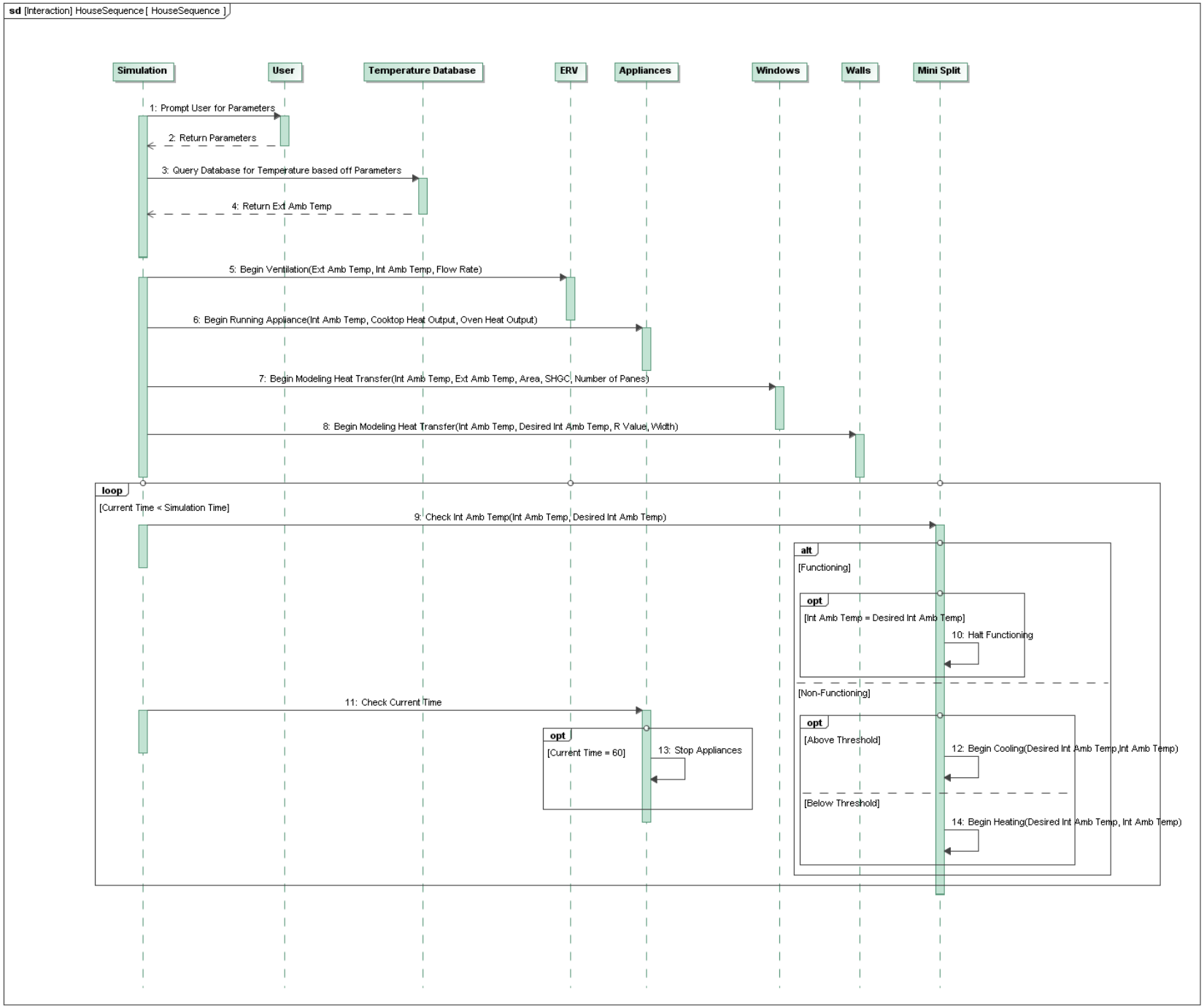
State Chart


stm [State Machine] HouseState [HouseState]
Int Amb Temp = T1
Desired Int Amb Temp = T2
Begining of Simulation
Interior at Equillibrium
Interior within Threshold
Heating
[T1<T2 - 2]
[T1>T2 + 2]
Cooling
Current Time
[Simulation is not over]
[Simulation is over]
End of Simulation
Functioning Appliances
[Current Time < 60 Minutes]
Non-Functioning Appliances

Activity Diagram



Sequence Diagram



Sources

1. http://hyperphysics.phy-astr.gsu.edu/hbase/mod6.html
2. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
3. International Residential Code 2009