# 1 Description of the Use Case

## 1.1 Name of Use Case

|  |  |  |
| --- | --- | --- |
| Use case identification | | |
| ID | Area/ Domain(s)/ Zone(s) | Name of Use Case |
|  | User | Maintain room temperature near a user’s set point |

## 1.2 Version Management

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Version management | | | | |
| Version No. | Date | Name Author(s) | Changes | Approval Status |
| 0.7 | 2016-04-06 | Eugene/Cuong | Initial | Initial |
| 0.8 | 2017-08-31 | Eugene/Ed | Remove sensor gateway, change control message |  |
|  |  |  |  |  |

## 1.3 Scope and Objectives of Use Case

|  |  |
| --- | --- |
| Scope and objectives of use case | |
| Scope | A thermostat to remotely control the HVAC system through a local area network (LAN) in the home |
| Objective(s) | Provide the functional requirements for a thermostat to control the HVAC system based on user inputs or set points. |
| Related business case(s) |  |

## 1.4 Narrative of Use Case

|  |
| --- |
| Narrative of use case |
| Short description |
| This use case describes the operations of a thermostat to control an HVAC system. The thermostat has three operational modes – heating, cooling, and automatic control. |
| Complete description |
| This use case describes the operations of a thermostat to control an HVAC system. The thermostat has three operational modes – heating, cooling, and automatic control.    **User** can set the temperature set point for **thermostat** locally. **Thermostat controller** in thermostat can pull the room temperature from the temperature sensor, compare it to the set point and then remotely control **heating and cooling systems of an HVAC system** via an **HVAC controller** through a WLAN to maintain room temperature near the desired set point.  The thermostat communicates over the network and is globally reachable from the WLAN. This allows remote client applications to read the status of the thermostat and manipulate its set points. |

## 1.5 Key performance indicators (KPI)

|  |  |  |  |
| --- | --- | --- | --- |
| Key Performance Indicators | | | |
| ID | Name | Description | Reference to mentioned use case objectives |
|  |  |  |  |

## 1.6 Use case conditions

|  |
| --- |
| Use case conditions |
| Assumptions |
|  |
| Prerequisites |
|  |

## 1.7 Further information to the use case for classification / mapping

|  |
| --- |
| Classification Information |
| Relation to other use cases |
| None |
| Level of depth |
| Detailed |
| Prioritisation |
| High |
| Generic, regional or national relation |
| Generic |
| Nature of the use case |
| Technical |
| Further keywords  for classification |
| User, thermostat, thermostat controller, temperature sensor, HVAC controller, WLAN |

## 1.8 General Remarks

|  |
| --- |
| General remarks |
| This use case has the additional purpose to be an example for how to decompose a CPS and describe its conceptualization, realization, and assurance in its creation and usage. |

# 2 Diagrams of Use Case

|  |
| --- |
| Diagram of use case |
|  |

# 3 Technical Details

## 3.1 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

|  |  |  |  |
| --- | --- | --- | --- |
| Actors | | | |
| Grouping (Community) | | Group description | |
| Home Energy System | | The components of a home energy management system | |
| Actor name | Actor type | Actor description | Further information specific to this use case |
| Thermostat Controller | Controller | A controller in the thermostat to send and receive messages as well as control to the HVAC system |  |
| HVAC Controller | Controller | A controller in the HVAC to send and receive messages from the thermostat, as well as triggering the HVAC operations |  |
| Sensor | Sensor | Thermostat reads data from temperature sensor |  |

|  |  |  |  |
| --- | --- | --- | --- |
| ***Actors*** | | | |
| ***Grouping (Community)*** | | ***Group description*** | |
| Home Automation Users | | These are the users of the system | |
| ***Actor name*** | ***Actor type*** | ***Actor description*** | ***Further information specific to this use case*** |
| User | Person | The owner of the thermostat. A User would provide the inputs or set points for the operation of the thermostat |  |

## 3.3 References / Issues

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| References | | | | | | |
| No. | References Type | Reference | Status | Impact on use case | Originator / Organisation | Link |
| 1 | Document | Framework for Cyber  -  Physical Systems | Draft |  | NIST | http://www.cpspwg.org/Portals/3/docs/CPS%20PWG%20Draft%20Framework%20for%20Cyber-Physical%20Systems%20Release%200.8%20September%202015.pdf |
| 2 | Open  source project | Project | In progress |  | NIST | https://github.com/usnistgov/cpsframework/ |

# 4 Step by Step Analysis of Use Case

## 4.1 Overview of scenarios

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Scenario Conditions | | | | | | |
| No. | Scenario name | Scenario description | Primary actor | Triggering event | Pre-condition | Post-condition |
| 4.1 | Heating Mode | This is the heat setting on the thermostat | Thermostat Controller | Temperature difference | Lower temperature than or equal to temperature set point | The HVAC is running until the temperature is lower than or equal to the set point |
| 4.2 | Cooling Mode | This is the cool setting on the thermostat | Thermostat Controller | Temperature difference | Higher temperature than or equal to temperature set point | The HVAC is running until the temperature is higher than or equal to the set point |
| 4.3 | Automatic Control | This is the automatic mode on the thermostat | Thermostat Controller | Temperature difference | Lower temperature than or equal to temperature set point  Higher temperature than or equal to temperature set point | The HVAC is running until the temperature is lower than or equal to the set point  The HVAC is running until the temperature is higher than or equal to the set point |

## 4.2.1 Steps – Scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scenario | | | | | | | | |
| Scenario Name : | | Heating Mode   (The commands and statuses reference to both heat pump and fan ) | | | | | | |
| Step No. | Event | Name of process/ activity | Description of process/ activity | Service | Information producer (actor) | Information receiver (actor) | Information exchanged (IDs) | Requirements  R-ID |
| 1 | Set  Temperature Set Point |  |  |  | User | Thermostat Controller | TemperatureSetPoint |  |
| 2 | Temperature Change | Temperature update | Temperature sensor reports the new temperature | REPORT | Temperature Sensor | Thermostat Controller | Temperature |  |
| 3 | HVAC Operation | HVAC switch on | If the temperature is lower than or equal to the set point, then the thermostat controller sends a command to turn on the heating system of HVAC system   |  |  |  | | --- | --- | --- | | 0 | 1 | 1 | | CHANGE | Thermostat Controller | HVAC Controller | Control |  |
| 4 | Status Update | HVAC Status On | The HVAC controller reports that the status of HVAC system | REPORT | HVAC Controller | Thermostat Controller | Status |  |
| 5 | Temperature Change | Temperature update | The HVAC controller reports the new temperature | REPORT | Temperature Sensor | Thermostat Controller | Temperature |  |
| 6 | HVAC Operation | HVAC switch Off | If the temperature is higher than or equal to the set point, then the thermostat controller sends a command to turn off the heating system of HVAC system   |  |  |  | | --- | --- | --- | | 0 | 0 | 0 | | CHANGE | Thermostat Controller | HVAC Controller | Control |  |
| 7 | Status Update | HVAC Status Off | The HVAC controller reports that the HVAC system is on | REPORT | HVAC Controller | Thermostat Controller | Status |  |

## 4.2.2 Steps – Scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scenario | | | | | | | | |
| Scenario Name : | | Cooling Mode     (The commands and statuses reference to both cool pump and fan ) | | | | | | |
| Step No. | Event | Name of process/ activity | Description of process/ activity | Service | Information producer (actor) | Information receiver (actor) | Information exchanged (IDs) | Requirements  R-ID |
| 1 | Set  Temperature Set Point |  |  |  | User | Thermostat Controller | TemperatureSetPoint |  |
| 2 | Temperature Change | Temperature update | The HVAC controller reports the new temperature | REPORT | Temperature Sensor | Thermostat Controller | Temperature |  |
| 3 | HVAC Operation | HVAC switch on | If the temperature is higher than or equal to the set point, then the thermostat controller sends a command to turn on the cooling system of the HVAC system   |  |  |  | | --- | --- | --- | | 1 | 1 | 0 | | CHANGE | Thermostat Controller | HVAC Controller | Control |  |
| 4 | Status Update | HVAC Status On | The HVAC controller reports that the HVAC system is on | REPORT | HVAC Controller | Thermostat Controller | Status |  |
| 5 | Temperature Change | Temperature update | The HVAC controller reports the new temperature | REPORT | Sensor gateway | Thermostat Controller | Temperature |  |
| 6 | HVAC Operation | HVAC switch Off | If the temperature is lower than or equal to the set point, then the thermostat controller sends a command to turn off the cooling system of HVAC system   |  |  |  | | --- | --- | --- | | 0 | 0 | 0 | | CHANGE | Thermostat Controller | HVAC Controller | Control |  |
| 7 | Status Update | HVAC Status Off | The HVAC controller reports that the HVAC system is on | REPORT | HVAC Controller | Thermostat Controller | Status |  |

## 4.2.3 Steps – Scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scenario | | | | | | | | |
| Scenario Name : | | Automatic Control Mode     (The commands and statuses reference to heat pump and fan) | | | | | | |
| Step No. | Event | Name of process/ activity | Description of process/ activity | Service | Information producer (actor) | Information receiver (actor) | Information exchanged (IDs) | Requirements  R-ID |
| 1 | Set  Temperature Set Point |  |  |  | User | Thermostat Controller | Temperature set point |  |
| 2 | Temperature Change | Temperature update | The HVAC controller reports the new temperature | REPORT | Sensor gateway | Thermostat Controller | Temperature |  |
| 3 | HVAC Operation | HVAC switch on | If the temperature is higher than or equal to the set point, then the thermostat controller sends a command to turn on the cooling system off the HVAC system   |  |  |  | | --- | --- | --- | | 1 | 1 | 0 | | CHANGE | Thermostat Controller | HVAC Controller | Control |  |
| 4 | Status Update | HVAC Status On | The HVAC controller reports that the HVAC system is on | REPORT | HVAC Controller | Thermostat Controller | Status |  |
| 5 | Temperature Change | Temperature update | The HVAC controller reports the new temperature | REPORT | Temperature  Sensor | Thermostat Controller | Temperature |  |
| 6 | HVAC Operation | HVAC switch Off | If the temperature is lower than or equal to the set point, then the thermostat controller sends a command to turn on the heating system of HVAC system   |  |  |  | | --- | --- | --- | | 0 | 1 | 1 | | CHANGE | Thermostat Controller | HVAC Controller | Control |  |
| 7 | Status Update | HVAC Status Off | The HVAC controller reports that the HVAC system is on | REPORT | HVAC Controller | Thermostat Controller | Status |  |

# 5 Information Exchanged

|  |  |  |  |
| --- | --- | --- | --- |
| Information Exchanged | | | |
| Information exchanged ID | Name of information | Description of information exchanged | Requirements IDs |
| Temperature | Temperature | Float temperature value |  |
| TemperatureSetPoint | Temperature | Float temperature value |  |
| Control | Control | Control  1 = On, 0 = Off  Example:   |  |  |  | | --- | --- | --- | | Cool | Fan | Heat | | 0 | 0 | 0 | |  |
| Status | Status of HVAC | Contains the current status of the HVAC  0 = Off, 1 = On |  |

# 6 Requirements (optional)

|  |  |  |
| --- | --- | --- |
| Requirements (optional) | | |
| Categories ID | Category name for requirements | Category description |
|  |  |  |
| Requirement ID | Requirement name | Requirement description |
|  |  |  |
|  |  |  |

# 7 Common Terms and Definitions

|  |  |
| --- | --- |
| Common terms and definitions | |
| Term | Definition |
|  |  |

# 8 Custom information (optional)

|  |  |  |
| --- | --- | --- |
| Custom information (optional) | | |
| Key | Value | Refers to section |
|  |  |  |