Smart Home Automation System Testbed
Draft Statement of Work

The Smart Home Automation System (SHAS) is an intelligent monitoring and control system that monitors and controls various "smart" appliances and devices throughout an enabled house. The system supports the communication and integration of heterogeneous devices and services. While SHAS's role is to intelligently monitor and control a house, the controls and metrics are focused on *maximizing energy efficiency*. The SHAS Testbed is a simulation environment designed to test various SHAS devices and interfaces. It is intended to model both the devices and the environment.

Traditionally houses include various devices and appliances (e.g., washer and dryer, HVAC, etc.) that operate independently of one another. Under SHAS, these appliances and devices communicate and collaborate in an effort to increase energy efficiency and improve the homeowner's quality of living.

In order to manually set and control various conditions within the house, the homeowner interacts with SHAS through an Internet-enabled web browser or a mobile smartphone. SHAS communicates with the involved devices to set and control the various parameters set forth by the homeowner. SHAS will auto-regulate appliances and devices within the house in order to maintain an appropriate energy consumption level while providing the homeowner with a reasonable level of comfort.

The objectives of SHAS include, but are not limited to the following:

- Provide monitoring and controlling ability to various appliances and devices in the SHAS enabled house.
- Optimize appliances and devices energy consumption.
- Provide an environment to ensure that the home is constantly monitored and the homeowner remains safe.
- Suggest usage patterns in order to increase energy efficiency.
- Provide a unified point of access to allow the homeowner to monitor and interact with the various appliances, devices, and sensors throughout the house.

The Testbed simulates this environment to help the developers determine whether these objectives are likely to be satisfied in the field. The following features of SHAS must be captured in the Testbed, although devices will be simulated.

Key Features

SHAS should offer the following services:

Energy Conservation

- Turn air conditioning or heater on, off, or to some preset temperature when nobody is home or based on the outside temperature. This saves energy by alleviating strain on the air conditioning system.

- Adjust lighting whenever someone enters or exits a room, saving energy through minimal light usage.
- Monitor doors and windows to make sure that they are completely shut, so that no air escapes unknowingly.
- Monitor daily power and water usage in order to give reports to the homeowners while suggesting ways to better conserve their personal usages.
- Monitor recent precipitation levels to determine if lawn sprinklers should run or not. If it has rained recently, there is no reason to sprinkle the lawn.

Convenience

- Control of the house through a web interface or a smart phone. This allows the homeowners to easily have complete control of their home.
- Automatically contact police when a security alarm has been breached.
- Inform the fire department when smoke is detected.

Key Appliances and Devices

SHAS will interact with various appliances and devices throughout the house in order to accurately monitor and control the home. We assume that these appliances and devices are already in place and capable of interacting with SHAS. The appliances and devices being used can be classified based on the functionality performed and the domain of intended use. These appliances and devices are:

- **HVAC related**
  - Thermostat: the thermostat will be monitored and controlled in order to conserve energy. The thermostat can be set to a pre-determined temperature and adjusted according to pre-set times or motion sensor.
- **Safety related:** SHAS will monitor and alert the homeowners if a security device has been activated. In addition to alerting the homeowners (via phone call), SHAS shall also notify any current occupants of the situation and alert the appropriate authorities. The following detectors and security devices will be supported by SHAS:
  - Detectors (call fire dept)
    - Smoke
    - Carbon monoxide (CO)
    - Natural gas
  - Security (call police)
    - Home security system
- **Water related**
  - Lawn sprinklers: recent rain levels will be monitored in order to determine whether the lawn sprinklers should run. SHAS will determine, based on recent rain levels read by a rain gauge, when to run the lawn sprinklers.
  - Water meter: water meter will report current usage level of water and SHAS will calculate usage patterns based on affiliated devices in order to optimize for energy efficiency.

- **Electric related**
  - Electric meter: SHAS will monitor the electric meter in order to determine the overall power usage. This data is used to show the homeowners how much energy they are using and how they might save.
  - Lighting: lighting will be monitored and controlled by SHAS in order to both save energy and provide a convenient means of turning lights on or off. A sunlight sensor will be used to dim the lights to a comfortable level automatically.
  - Smart power outlets: monitored and controlled to save energy and turn devices on or off.
  - Windows/doors: will be monitored via sensors to see if they are open or not. If they are left open, SHAS will notify the home owner.

Relative Priorities for SHAS Testbed Functions

1. Web browser GUI with authentication to control SHAS
2. Sprinkler controls
3. Water usage reports
4. Electricity usage reports
5. Security (police)
6. HVAC (thermostat) for heating and cooling controls
7. Fire, CO, gas alarms (fire dept)
8. Window/door sensors
9. Smart phone GUI

Testbed Specific Requirements

The Testbed shall support simulations of all of the key appliances and devices described above.

The Testbed shall support simulation of the environment, e.g., outside temperature, when it starts raining, when it stops raining, how heavy the rainfall is.

The Testbed shall include both a simulator interface as well as the SHAS interface(s).