

Software Requirements Document for Smart Home Notification and Calendering System

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1 Introduction

1.1 Purpose

This document details both the functional and nonfunctional requirements for the Smart Home Notification and Calendering System (NCS).

This document serves as a contract between the team members of the Smart Home project (SHP) at Iowa State University to ensure fulfillment of project requirements and to describe the inner workings of the NCS and its interactions with the SHP.

1.2 Scope

This document covers the functional and non-functional requirements of the NCS including the physical description of the system as well as the behavioral and other factors necessary to provide a complete and comprehensive description of the NCS.

1.3 Definitions, acronyms, abbreviations

Term	Description
Smart Home (SH)	
Notification System	
Calendering System	
NCS	Notification and calendering System
ADLs	Active Daily Lives
SRS	Software Requirement Specification Document
RFID	Radio Frequency Identification Device

1.4 References

ADD ME LATER

1.5 Overview

The user demographic of the Smart Home is primarily elderly and disabled people. This particular demographic is often scared by a myriad of different software applications for CNS systems. These pre-existing software solutions are often far too complex and not specifically suited to the unique needs of this user demographic. At the same time our users are faced with potential decline in cognitive function and an ever increasing set of medical appointments and other senior activities as well as new dietary needs (such as low cholesterol diets, diabetic concerns, etc.). These increasing needs coupled with a desire to continue to be independent underlay the requirements and design of the entire Smart Home as well as the CNS specifically.

2 Overall description

This section seeks to clarify and describe the requirements of Smart Home NCS. Basically, the system provides schedule management, notification and planning. Since the target system is Smart Home and the target user is elderly or disabled people, it has design constraints and specific features different than general NCS. For example, a user interface should not be difficult. It should be simple and easy to understand. Moreover, features need to be related to safety and health of users and provide useful information for the target user.

The NCS of the Smart Home has a number of crucial functionalities. Calendaring functions give specific scheduling plan for elderly people such as appointments for a doctor, nurse, community event, and medicine and meal plan. Notification functions provides information about safety, emergency situation, health status, and security.

- Calendaring - Functional features
 - Scheduling transportation to community events
 - Scheduling a visit to doctor
 - Consulting with a nurse (virtual consultation)
 - Dispensing medications and taking pills
 - Recording exercise activities
 - Refilling prescriptions
 - Nutrition and Meal Planning
- Notification - Functional features
 - Monitoring health status (glucometer, blood pressure, spirometer, pulse oximeter, weight scales, and etc.)
 - Calling for help after a fall
 - Turning off the range automatically when it gets too hot or stays on too long
 - Looking to see who is at the front door (without opening the door)
 - Providing long-distance monitoring for safety
 - Requesting house cleaning or home maintenance services
 - Checking security system
 - Schedule for house work (When did I clean, when should I change a purifier filter, air filter, and so on)
 - Making shopping list automatically
 - Checking bank statements
 - Paying bills via Internet
- Non-functional features
 - Universal Design for elderly people
 - Safety constraints
 - Reconfigurable System

2.1 Product Perspective

This section is borrowed from the vision document by Chad Kilgore, Matt Peitz, Kendra Schmid.

Assisted Living Facilities: Assisted living facilities are for persons that need assistance with ADLs but wish to live as independently as possible. Most assisted living facilities create a detailed service plan for individual residents upon admission, which is updated regularly to assure that the resident receives the appropriate care as his or her condition changes. These services include help preparing meals, bathing, dressing, performing household chores, and aid for persons confused or experience memory problems. Other common terms for assisted living are residential care, personal care, adult congregate living care and supported care.

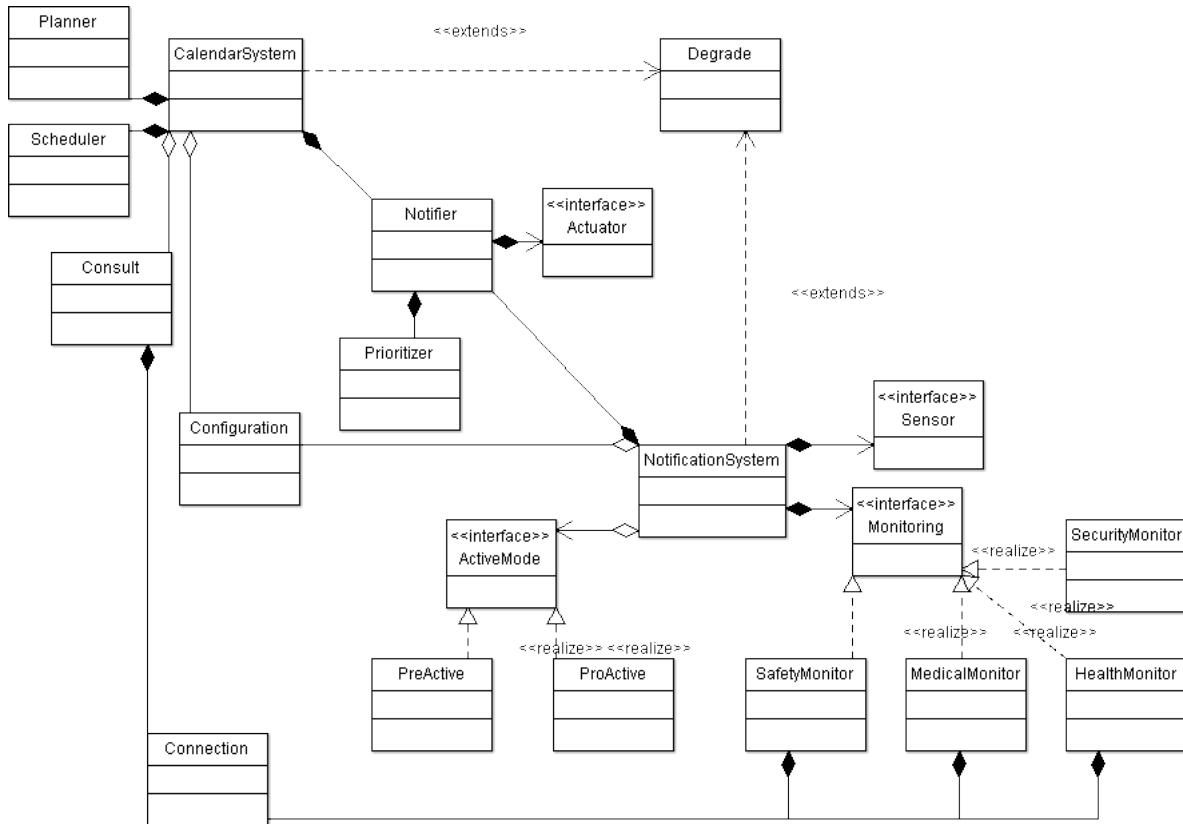
Nursing Homes: Nursing homes provide skilled nursing care and rehabilitation services to people with illnesses, injuries or functional disabilities. Even though most facilities serve the elderly, some facilities provide services to younger individuals with special needs, such as the developmentally disabled, mentally ill, and those needing drug and alcohol rehabilitation. Nursing homes are generally stand-alone facilities, focusing their attention on rehabilitation, so that their residents can return to their own homes as soon as possible. Some of the services provided by nursing homes include therapies, pharmacy services, and specialty care, such as Alzheimer's treatment, neuromuscular diseases, stroke recovery.

University of Florida: "The RERC-Tech-Aging is testing currently available home monitoring products relative to their effectiveness in relation to independence, quality of life and health related costs. The RERC-Tech-Aging is also identifying needs and barriers to home monitoring and communication technology, and addressing needs of special populations including rural-living elders, and people aging with disability. The results of this research will be relevant to health policy makers, device developers, and other investigators. The RERC-Tech-Aging works with companies on pre-product testing, including Honeywell's very promising Independent LifeStyle Assistant (ILSA). We are advancing very new consumer products such as Motorola's Smart Phone, to provide applications useful for older people with disabilities. We are also studying the requirements for, and development of a device / system for elders with cognitive impairment. We are applying the concept of pervasive computing to the needs of older persons through our work with smart phones and smart homes."

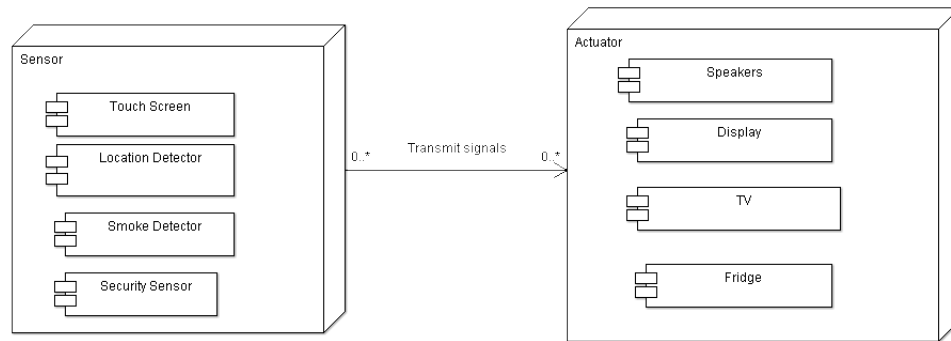
Niagara Framework: The Niagara Framework, developed by Tridium Software, is a Java-based framework that allows development of smart homes using different components from different manufactures. Niagara was developed using Java Beans that allows every component to be treated as an object. Niagara uses an adapter development pattern so that every object, regardless of manufacture, communication standard, or software can run from a standard web browser. The framework can then dictate to each device what needs to be done its own protocol, thus saving time that would be used to program all devices. The framework operates on a wide variety of hardware platforms and operating systems due to Java development. The Niagara Framework differs from the project vision since the framework is designed primarily for an electronic house, not necessarily a smart home.

2.1.1 Concept of Operations

The system will not only help users in daily tasks such as scheduling, shopping, it also protect an user inside the house with health care and neutrino system and security of the house. The system has an easy-to-use interface and is configurable. The system is fault tolerant i.e in the worst case the system does not do any harm to users. With an interactive interface, the system can visualize concepts and communicate with users in friendly and understandable ways.



The class diagram shows basic concepts of our system in a class perspective view. There are two main classes, Notification System and Calendar System. These classes manage notification and calendaring function respectively. Both classes extend Degrade class that detects system hazards and change a mode of the system to degraded mode. Notifier class manages notifications and alarms to send out and uses Prioritizer class to give priority to notifications and alarms. Configuration class provides an interface and functions to configure the system. Both Calendaring System and Notification System uses Notifier and Configuration classes. Calendaring System class uses classes such as Planner for planning schedule such as heal plan, food plan, exercise plan, etc, Scheduler for scheduling, and Consult for getting medical consultation services. Notification System class uses classes such as Pre/Proactive, Monitoring, and Sensor. Notification System detects safety, medical, health, security issues and notifies it to users and service providers such as a hospital, police, or fire station.



2.2 Product functions



2.2.1 Scheduler

Title: Scheduler

Description: User needs to make or modify a schedule

Actor: user

Preconditions: The system is on and the user wants to make/modify a schedule

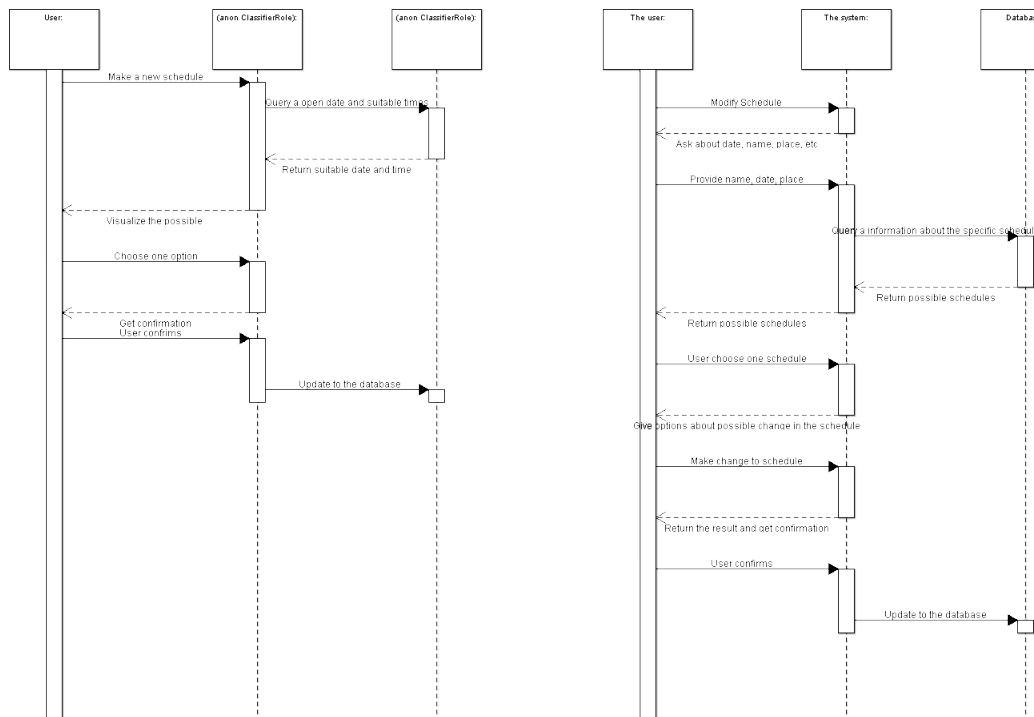
Post conditions: The user has made/modified a schedule and the system records changes in scheduling database.

Basic flow:

1. The user informs the system to make a schedule with given preference like date, time or place.
2. The system identifies which time and place is available and suitable (e.g weather conditions, traffic)for user's normal schedule
3. The system visualize available times and suitable places for the user to choose
4. The user decides which time is suitable
5. The system get confirmation from user and store in the database

Alternate flow:

1. The user wants to modify a schedule given name,date or time of meeting
2. The system searches through the database for possible matched schedules and visualize them for user
3. The user chooses the right one
4. The system displays options: correct the meeting time, cancel an appointment, change the meeting place.
5. The User chooses one option
6. The system follows the user's choice and continue until the user finishes modification
7. The system get confirmation about the modifications and store in the database



2.2.2 Medical Monitor

Title: Medical Monitor

Description: The system monitor the health status of the user

Actor: The system and user

Preconditions: The system is on and all sensors are in working condition

Post conditions: The information about health status of users is obtained.

Basic flow:

1. The system receives medical information from all sensors such as blood pressure, glucometer level, spirometer, pulse oximeter, weight scale, etc
2. The system checks the consistency with the information in previous period.
3. The system notifies the user immediately when the obtained information is abnormal.
4. If there is no response from user in specific amount of time, the system raises an alarm and calls the hospital for emergency case.

2.2.3 Security/Fire monitor

Titile: Security/Fire monitor

Description: The system provides security monitoring for users and the home

Actor: The system and the user

Preconditions: The system is on.

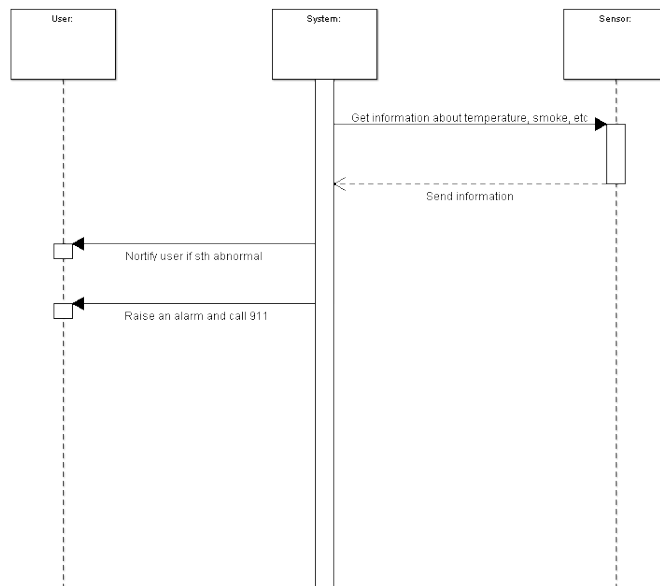
Post conditions:The house and the customer are safe.

Basic flow:

1. The system receive information from medical monitor and sensors like temperature sensor, smoke sensor, etc around the house.
2. Anything abnormal happens, the system give warnings to user via communication devices like cell phone, email, etc.
3. After a specific of time without any confirmation from user, the system raises an alarm, and calls 911.

Alternate:

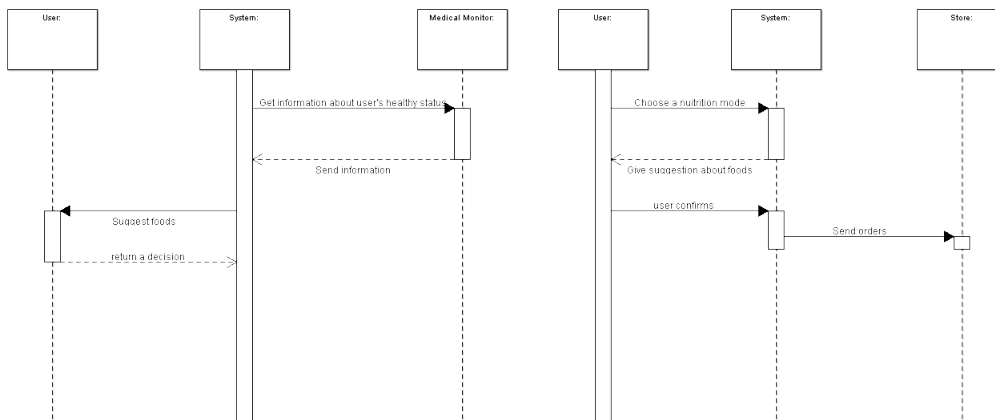
- 3(a). The user turns off the alarm.
4. The system verify the user's identity
5. The system turns off the alarm when the identity is clear

**2.2.4 Nutrition Monitor/Planner****Title:** Nutrition Monitor/Planner**Description:** Monitor food usage and help the user choose right food plan**Actor:** The system and the user**Preconditions:** The system is in working mode and the user's privilege is clear**Post conditions:** The nutrition level in user's meal is acceptable.**Basic flow:**

1. The system gets information from medical monitor to get health status of the user.
2. The system suggests the user which food is good for current status of user.
3. The user chooses specific food from suggestions.
4. The system send the food order to the market.

Alternate:

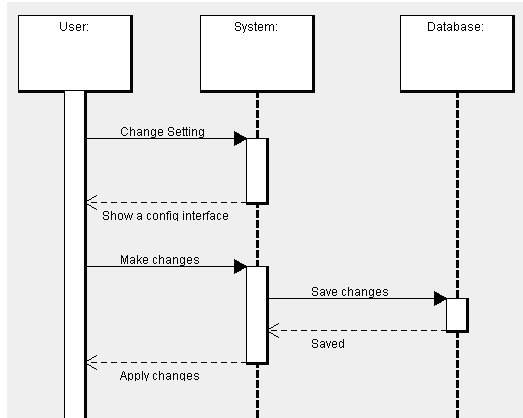
1. The user chooses a nutrition mode: normal or diet.
2. The system compares the health status of user and the mode.
3. If something conflicts, the system give a warning to the user.
4. If everything is fine, the system schedules and orders suitable food for user's nutrition mode.

**2.2.5 Configuration System****Title:** Configuration System**Description:** Configuration system provides an interface to configure system.**Actor:** User, system engineer, service provider**Pre conditions:** The system is on and configuration system is available for use.**Post conditions:** The system has been configured.**Basic flow:**

1. The customer instructs the system to be configured.
2. The system provides an interface to configure system.
3. The customer configures the system through the provided interface.
4. The system notifies the customer that the system has been configured.

Alternate flow:

- 1a) The system engineer instructs the system to be configured.
 1. The system provides a richer interface to configure system.



2.2.6 Medical consult

Title: Medical consult

Description: Consult with a doctor or a nurse about the customer's health condition.

Actor: Customer

Pre conditions: System is on and phone and/or network connections is available.

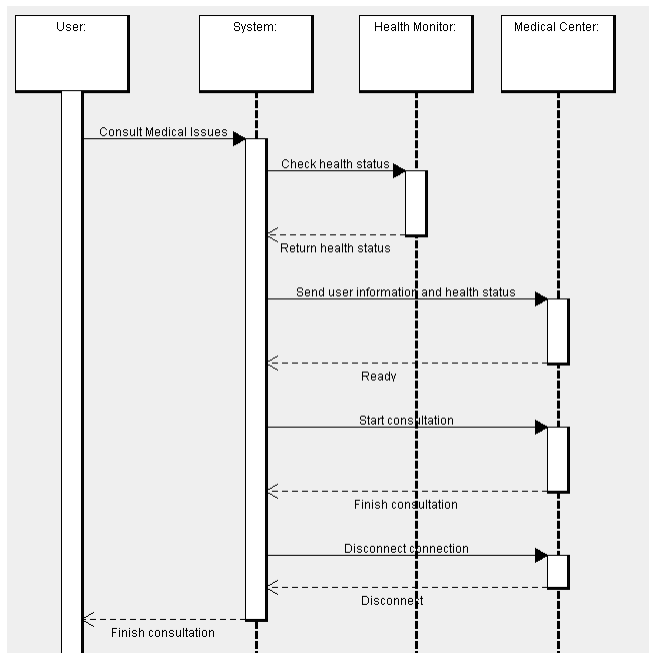
Post conditions: Medical issue has been resolved.

Basic flow:

1. The customer instructs the system to connect a medical service center.
2. The system call a medical service center.
3. The customer consults with a doctor or a nurse about his/her condition.
4. The system disconnects the phone call.

Alternate flow:

- 2a) If the system has a camera and network connection, use a video conference.
- 3a) If the system has a network connection, the system sends user's health status.



2.2.7 Degraded function mode

Title: Degraded function mode

Description: Degraded mode keeps system working correctly through possible system hazard conditions. Possible hazards include blackout, network disconnection, sensor or device malfunctions and etc.

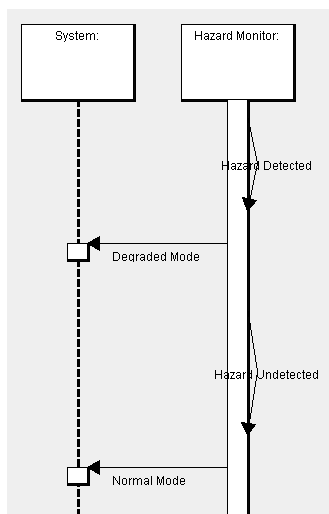
Actor: System

Pre conditions: The system detects a hazard.

Post conditions: The system keeps working.

Basic flow:

1. The system detects a hazard.
2. The system change its mode to degraded mode.
3. Depending on the type of hazard, the system performs the proper actions to keep working.



Alternate flow:

- 3a) If the system can not continue operation, the service center detects failure through a heart-beat technique.

2.2.8 Priortizer

Title: Priortizer

Description: The prioritize gives a function that prioritize notifications and alarms.

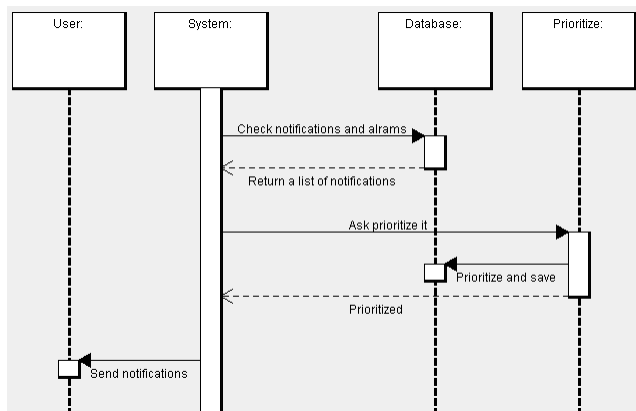
Actor: System

Pre conditions: System has notifications and alarms in queue to be processed.

Post conditions: Process the notifications and alarms based on priority.

Basic flow:

1. The system detects notifications and alarms to be sent.
2. The system checks the rules to prioritize notifications and alarms.
3. The system reorders the notifications and alarms based on priority.
4. The system sends the notifications and alarms based on priority.

**2.2.9 User Level Control**

Title User Level Control

Description The user desires to make a modification to a setting, or create a new event or modify some other setting.

Actor Customer

Pre condition The user is a properly authenticated user, and the system is on

Post condition The system is updated with the change to the user's preference

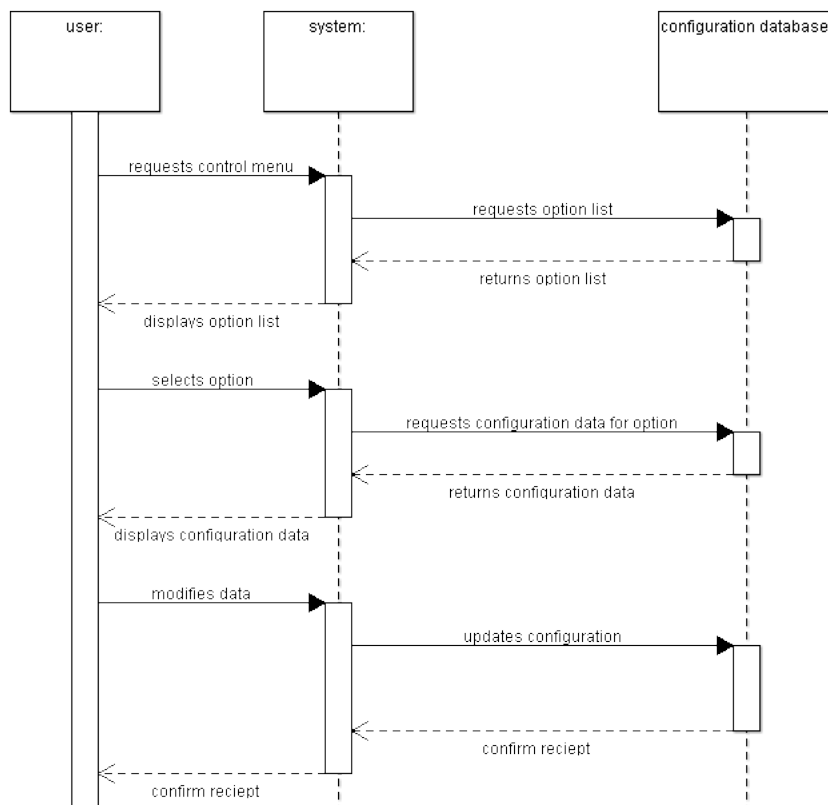
Basic Flow:

1. User selects the Control menu from listed options
2. System displays Control options for the User
3. User selects option to be changed

4. System displays data associated with option
5. User provides updated data
6. System saves configuration

Alternate Flow:

1. User leaves control before saving configuration
2. System disregards changes and returns to previous state



2.2.10 Caretaker Control

Title Caretaker Control

Description The caretaker desires to make a modification to a user

Actor Caretaker

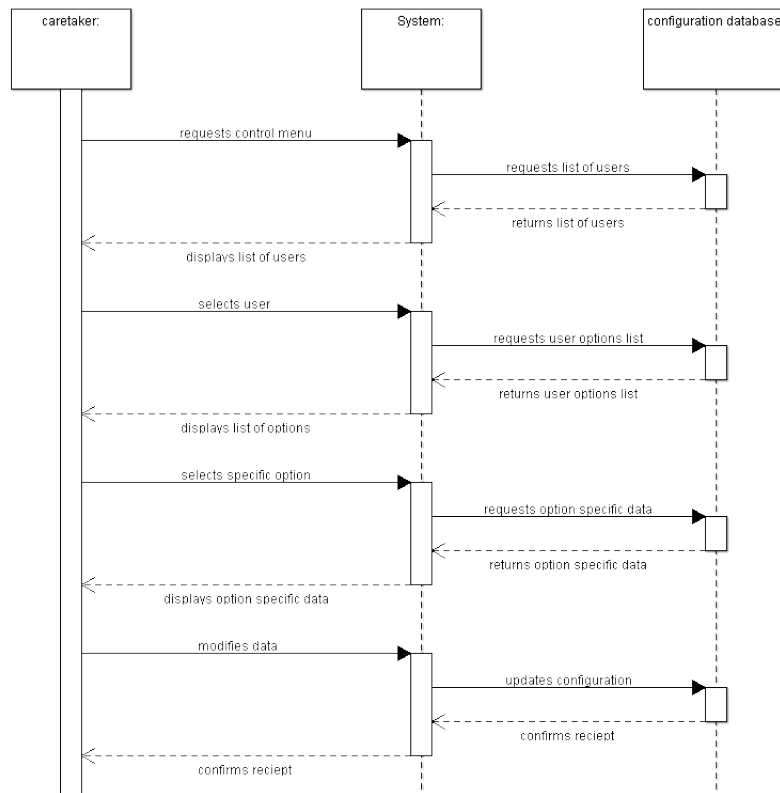
Pre condition The user is a properly authenticated caretaker and the system is in caretaker mode

Post condition The system is updated with the change to the user's preference

Basic Flow:

1. Caretaker selects the control menu from listed options
2. System displays list of users for the caretaker
3. Caretaker selects specific user to preform actions on

4. System displays a list of options associated with user
5. Caretaker selects specific option to modify
6. System displays data associated with option
7. Caretaker provides updated data
8. System saves configuration



Alternate Flow:

1. User leaves control before saving configuration
 - (a) System disregards changes and returns to previous state
2. a. Caretaker selects multiple users to modify at the same time

2.2.11 Proactive Alert/Notify System

Title Proactive Alert/Notify System

Description The CNS notifies/alerts user/caretaker of a pre-scheduled event. An example of this would be notification of the need to take medicine or of an appointment

Actor Customer, Caretaker

Pre condition A pre scheduled event is about to occur and the system is in a ready state

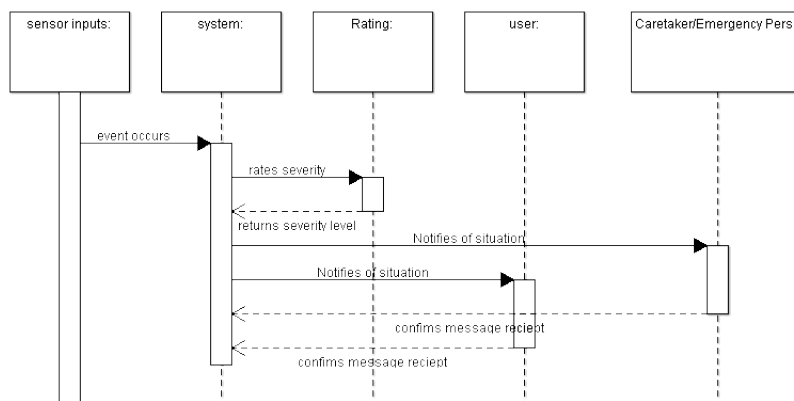
Post condition The user/caretaker has been notified and acknowledges the event or alert

Basic Flow:

1. An event has been previously scheduled with the CNS system and is about to occur (as defined in user preferences, i.e. user specified that they desire notification 20 minutes before scheduled Medical Consultations)
2. System determines location of user through proximity sensors and RFID tagging
3. System sends notification to device near user
4. User acknowledges alert

Alternate Flow:

1. System can not find user
 - (a) System sends notification via Cellphone Text Message (SMS) to user's phone
 - (b) User acknowledges via a text message
2. User does not respond to alert
 - (a) System re-sends alert to a wider display set near user (as determined by RFID and proximity sensors)
 - (b) User acknowledges request
3. User still does not respond
 - (a) Caretaker is notified of potential issue

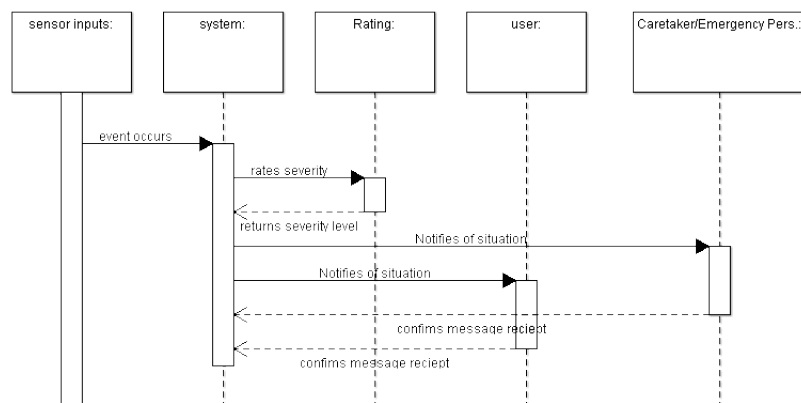
**2.2.12 Reactive Alert/Notify System****Title** Reactive Alert/Notify System**Description** The user desires to make a modification to a setting, create a new event or some other setting**Actor** User, Caretaker, Emergency Personnel**Pre condition** An event has occurred that requires intervention from the user, caretaker, or emergency personnel depending on level of severity**Post condition** Proper actors notified of issue and activated**Basic Flow:**

1. Some unplanned event occurs. Examples of events include:

- (a) Medical: stopped heart, low blood sugar, user fall, or other medical issue
 - (b) Safety: Break in, fire, or pipe burst detected
 - (c) User error: stove left on, refrigerator door left open
 - (d) Maintenance: sensor battery dead, not responding, equipment failure
2. The level of severity of the issue is rated by the system using predefined templates
 3. The system notifies the necessary actors based on severity level of the event.

Alternate Flow:

1. Actor does not respond to notification
2. System escalates notification to the next higher level of notification.



2.3 User characteristics

2.4 Constraints

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

The primary goals of the NCS user interfaces are accessibility, universality, and reachability. The user interface is comprised of input and output devices. The input devices shall have the following components:

- Touch screen
 - The touch screen interface must be unscrachable, finger controlable, and multi touchable.
- Mobile Device
 - The mobile device interface must be small, attachable, and compatible across different devices.
- Voice Recognition
 - The voice recognition system must accurately understand commands and, be able to handle noisy environments.
- Remote controls
 - The remote control must be simple, have big buttons, and have universal compatibility with devices in the smart home.
- Motion Detector
 - The motion detector must be able to accurately detect motion with out error. It also must be able to operate in low and no light conditions.

The NCS user interface shall also support the following output methods:

- TV
 - The television output device must be able to display information in a large and easy to read format.
- Mobile Device
 - The mobile device output must be able to display Wireless Markup Language (WML) pages as well as receive SMS text message notifications.
- Voice
 - The voice output system must be able to accurately announce messages. The system also must be configurable and have a selection of voices as many of the users of the system suffer from forms of hearing loss in some frequencies.

3.1.2 Hardware Interfaces

Basically NCS has sensors to get data and actuators to give a physical service. To handle getting data and make a service, NCS has a main computer so-called Home Server and also terminal so-called client computer to provides an user interface.

Sensors :

- RFID(location)
 - RFID and location sensors check user's position in Smart Home environment.
- Motion
 - Motion sensor catches user's motion by detects hand motion, eye direction, etc.
- Smoke, thermal, CO-detector
 - Smoke, thermal and CO-detector sensors detect fire.
- Body sensors(blood pressure, glucometer level, spirometer, pulse oximeter, weight scale)
 - Body sensors is essential to check the customer's health status.

Actuators:

- Auto door
 - Opening and closing a door is challenge for elderly and disability people. Auto door provides convenience for them.
- Light switch
 - Based on user's location and behavior, light system can be smart. The system turn on/off lights through the light switch.
- Sprinkler
 - When the system detects fire, an initial action is very important to prevent tragedy. Sprinkler system provides water to extinguish fire.
- Auto window
 - As auto door, auto window provides automatic open/close functions for a window.
- Alarm(audible, visible)
 - If the system detects safety, security or emergency situation, the system alert it through the audible and visible alarm actuators.

These sensors and actuators are connected to the home server computer through OSGi(Open Services Gateway Initiative) interface. OSGi supports component-based software. OSGi is an open industry framework and service-oriented architecture. OSGi also provides deployment of services in platforms. OSGi defines a framework to mange bundles (units of distribution) and the services they export Services can be obtained by querying the framework through a set of properties

3.1.3 Software Interfaces

As the NCS is a subsystem of the Smart Home System, the NCS shall follow the standards set forth for the SHS software interfaces. Furthermore, the NCS shall provide an a standardized API and protocol that will enable other subsystems of the smart home to communicate with it.

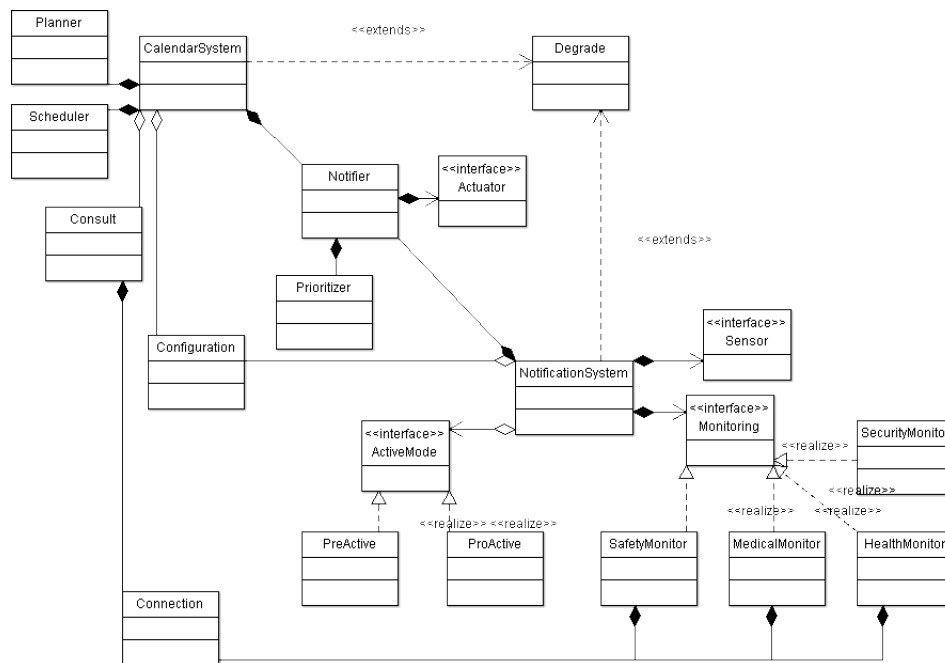
The Calendering System shall use the ical file format as defined in RFC 2445 as its data format for transferring information between itself and the rest of the smart home system as well as external systems as defined in section 3.1.4.

The Notification system also shall use an XML file format for communication with the rest of the home.

3.1.4 Communication Interfaces

- The system should be connected to the Internet or LAN.
- The system shall connect with the telephone lines.
- The system shall has a connection with an emergency protocol which is connected to a hospital, police, and fire station.

3.2 Classes



3.3 PERFORMANCE REQUIREMENTS

This sections specify performance requirements for calendering and notification sub systems:

- **UI Transition**: The information transfers between any devices (sensors/actuators) with main system should not more than 3s.
- **Data access time**: The system should access any data from database in reasonable time.
- **Start-up Time**: The time between system is reset and normally operated should be less than 10s.
- **Interoperability**: The system shall work smoothly with other smart home systems.

3.4 SOFTWARE SYSTEM ATTRIBUTES

3.4.1 Reliability/Dependability

The list below describes the requirement of reliability for the calendaring and notification sub-systems

- Mean-Time-Between-Failure: The failure rate of two sub-system must be below 1 times/month.
- Fault-Tolerance: Sub-system must have a backup copy to continue operation in case the primary system fails.
- Display data accuracy: The information displayed to users via user interface must be correct and prompt.
- User setting accuracy: The information about user's preferences of system must be consistent, reliable and up-to-date.
- Log accuracy: The log of everyday operation should be updated by the end of day and backed up on the weekend.
- Operation accuracy: Two subsystem must control hardware equipments like sensors and actuators precisely and safely.

3.4.2 Security

The list below describes the system requirement about security:

- Information confidentiality:
 - All information about users should be kept secret by strict information protection policy,
 - All information is classified according to clearance level and user's privilege.
 - Never store plain password, and auto-remember user password.
 - Restrict the number of reentering password simultaneously.
 - Using some password protect hardware device like dongle.
 - Implement User Access Control mechanism.
- Information Integrity:
 - The information can be only modified/deleted by users with specific clearance level.
 - The system is able to detect many unauthorized access, counter password-guessing technique, defend from outside attacks.
 - The system shall always synchronize data between prime-copy and back-up copy in every short period.
- Information Availability:
 - The system must provide information to right user with enough privilege in timely manner.
 - Always have a backup plan in every weak/month.

3.4.3 Availability

The list below describes availability requirement:

- The system shall provide requested service in 24/7
- The response time of the system when a request arrive should be prompt and precise.

3.4.4 Maintainability

The list below describes maintainability requirement:

- The system shall have a backup system to be upgraded parallel/online when a new device comes or some modification taken by technician.
 - The display device can be removed when an user still can issues command
 - A new sensor can be added to the system without any conflict in communication and transmission.
 - Every sensor and actuator can be configured and controller via GUI.
- With very low probability, the system will introduce bugs when updating changes.
 - The audit team can review source code and run code in simulation devices.
 - The system is able to update new code with any disruption.

3.4.5 Repairability:

The list below describes repairability requirement:

- The repair time shall be quick.
- The system is able to be diagnosed and replaced erroneous part when still running.

3.5 Design Constraints

The list below describes about design constrains in some aspects:

- Coding Constraint: Two sub systems shall be developed using Java language.
- Memory Constraint: The memory for all two subsystem shall not be larger than 1Gb.
- Line of code constraint: The total number of LOC should less than 100K.
- Functionality constraint: Two sub system shall provide ONLY functions required in the requirement
- Environment constraint: sub systems shall be developed under Windows NT OS.
- The interface between components shall be consistent and well described.

3.6 Other Requirements

NONE