Smart Home System

Software Engineering Project First Report

Group 12

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https://github.com/RUSEGroup12

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# EVERYONE CONTRIBUTED EQUALLY!

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1. Customer Statement of Requirements (CSR)

1.1 Problem Statement

Are you tired of having a fragmented home environment, fuddling through apps to control various things? Well, you have come to the right place; we are developing a new unified software environment that will make your daily routines a little less cumbersome. Our Smart Home System integrates your alarm, lights, utilities, and speakers into one neat and easy to use app.

You wake up early in the morning to commute to work or school but always seem to get stuck in traffic or delays and end up being late. Your time is too valuable to be spent sitting in traffic. Now we present you, with the option to beat unexpected delays with our Smart Schedule System. Before you wake up, the Smart Alarm will look up traffic and delay conditions on your commute and wake you up earlier to make sure you make it on time for that meeting with your bosses or the final exam you studied all week for. After you come from all long days work in the cold, you want your home to be *extra* warm. Instead, you are hit by a cold blast of air from your archaic heating system. If you had our Smart Energy System, your home would think for itself. Your home can be an igloo when you are not there but make it extra toasty just before you arrive at your kingdom. But wait it gets a better, we also provide an innovative way to listen to your music library. You are listening to your favorite tunes and want go to the kitchen to get the snack; you would have to pause the song, get the snack, and resume. With our intelligent tracking, the music follows you as you move from one room to another. These are some of the many ways our Smart Home System can make your life a little more easier.

Current home automation utilities are available from different vendors. This means that you have to pay a lot of money for each individual system and waste time configuring your specifications. After that, you have to use a set of apps on your smartphone to change any settings or trigger events that you would like to occur in the future. If you want your lights to be on at certain times, you need to buy special connected light bulbs, which cost hundreds of dollars each. This is only to have lighting in your home. Moving on to having your home at a comfortable temperature; you need to buy another system which connects to your HVAC system or thermostat to regulate the temperature of the home according to your habits and liking. Now that the home is lit and heated, you want to enjoy some music on your surround sound speaker system; however, you have to play it in a single room and is confined to that room. If you leave, you have to either pause it or miss a potion. To have a speaker system that is synchronized throughout your home, would require several speakers and all of them would have to be from the same manufacturer to make sure they can be interconnected. The price of automating your lights, HVAC, and sound system is now easily several thousand dollars. To earn this money, you have to wake up early and go to work. However, when your on your way to work, you may run into

unexpected traffic, which eventually causes you to be late to work. In your rush to get ready and get to work on time, you get preoccupied in other things and may forget some of the important tasks that you had to accomplish during the day. Now you'd definitely wish you had our system.

Our Smart Home System is a viable and cost effective way to automate your home at a fraction of the cost as the individual corporations currently in the market. We blend all of the features into a single environment, which can be accessed from your smartphone. The problems many people have with their disjointed smart ecosystems are the clunky interfaces that come along with each and every smart device. You have one app for your smart lights, another one for your climate control; the list is neverending. And worse, you may have to create a new user account for each and every device with a password. With our unified ecosystem those days are over. We will have a simple GUI app that will include a dashboard where you can control all your smart systems. It contains a section for the Smart Schedule System, Smart Audio System, and the Smart Energy System. Each section will have its own settings with an intuitive navigation control. Functionality and ease of use is our number one priority, not flashy cheap looking interface.

Our system will use a wide range of sensors and radios. The Smart Schedule System, Smart Audio System, and Smart Energy System will all connect to your Local Area Network(LAN) along with the Wide Area Network(WAN). The physical connections between the systems and your local switch(or wireless router) can occur with preferably a gigabit ethernet connection or at minimum 802.11n [1] access point. This allows for all of the components to be connected wirelessly and avoid the hassle of tangled wires.

The Smart Schedule System will connect to the Wide Area Network(Internet or Intranet) to get traffic updates. The Smart Audio System will connect to Amazon's Voice Assistant, Alexa, and other Amazon [2] services. And all three systems will communicate with the app on the user's smartphone to get updates or changes directly from the user.

Waste is not good for the environment, the economy, and one's bank account. At home we waste a lot for our convenience -- sometimes knowing or unknowingly. For example, leaving lights on in empty rooms and cooling/heating on when we are not home. The current lighting system in the average household is energy inefficient. We must walk over to turn on and off lights at a physical switch. When we are ready for bed we must turn the lights off and go unnaturally from a illuminated room to darkness creating risk of injury and inconvenience. Additionally, leaving heating and lights on wastes energy meaning it costs you more, and if the environment is one's concern, more coal/oil is wasted in generating that electricity to power heating/cooling/lighting. With the advent of sensors, algorithms, and the internet this waste can be eliminated. Why can't the system know when and where the resident needs lighting,

cooling/heating? This is because the current systems are all manual and the new smart systems do not share information with other hardware and services.

To make sure you don't miss a beat, the Smart Audio System will automate your music system throughout your home. When you play music, the system will use the position of your smartphone to locate where you are in the house and play your music in your vicinity. That means, if you're playing music in your room and suddenly walk to the kitchen, you don't have to pause the music. It will follow you and provide the surround sound experience wherever you are in the home.

It's easy to adjust any of the playback settings, such as volume or song, because of the Amazon's Voice Assistant, Alexa. With Alexa integrated in the system, you can speak to the system and it will adjust accordingly. This is efficient because, you don't have to preoccupied with managing the settings and can work on being more productive in their daily lives.

To make sure that your are the most productive, the Smart Audio System will read your schedule aloud to you when you wake up. This way, you know what needs to get done and can prepare for the day ahead in a more efficient manner.

The Smart Scheduling System will ensure that you are always punctual to your events. The system will initiate a wake-up notification before your first event in the morning. This notification is processed by the Smart Audio System so that you can be readily awoken and informed about your day. The wake-up notification is dynamically scheduled based on potential delays so that you always have plenty of time to prepare for your day and get to your destination on time. This system takes numerous factors into account, including travel distance, real-time traffic patterns, and weather forecasts.

The Smart Scheduling System allows you to add events to your daily calendar and will automatically handle timing conflicts for you. It will optimally prioritize the order of your events and will even inform you when you should prepare to leave for your next event. The scheduler is always keeping track of how long it will take to reach your next event so that you never have to worry about being late.

At the end of your day, this system will inform you when you should go to bed based on how much sleep you would like to get. This will prepare you optimally for waking up the next day. Now that you have seen what our smart system can do for you; we hope you consider it the next time you are stuck in traffic, listening to music, or wishing your utility bill was lower.

1.2 Glossary of Terms

HVAC — Heating, Ventilation, and Air Conditioning Unit.

GUI — Graphical User Interface

Smart Audio System (SAS) — A system which will allow the user to control music playback through a mobile application or voice assistant.

Smart Energy System (SES) — A system in which temperature and lighting are controlled based on user preferences and behaviors so that there is minimal to no energy waste.

Smart Home System (SHS) — The combination and intercommunication of the SAS, SES, and SSS.

Smart Schedule System (SSS) — An application that will inform the user when to go to bed and when to wake up.

User — The individual using the SHS who is living in the home.

Time-to-temperature — Time required to reach a specific home temperature based on current temperature

Time-to-home — Users estimate of how much time it will take them to arrive home

2. System Requirements

2.2 Enumerated Functional Requirements

Req-x	Priority Weight	Description
REQ-1	5	Scheduler should provide the user with a wake-up notification that allows the user enough time to travel to their destination.
REQ-2	4	Adjust wake-up notification time based on weather forecast and historic weather conditions.
REQ-3	4	Adjust wake-up notification time based on traffic delays along commute route.
REQ-4	1	**[FROZEN]** Adjust wake-up notification time based on the user's sleep phase
REQ-5	4	Set a bedtime notification for the user based on desired sleep duration
REQ-6	3	Create a schedule based on time ranges, durations, and event priorities
REQ-7	3	Notify the user of if an attempt is made to create an event that causes a timing conflict
REQ-8	4	Adjust heating, cooling, and lighting system when the user is at home and not at home for maximum cost efficiency
REQ-9	4	Heating and cooling system are adjusted for maximum comfort just before the user arrives
REQ-10	5	SAS should read aloud notifications from the SSS
REQ-11	4	Amazon Alexa integration into SAS to read todo list, play music, etc.
REQ-12	1	**[FROZEN]** Allow user to intercom from the phone to any room in the house.
REQ-13	2	Handle music conflicts on SAS by defaulting to master user when multiple users try to play music in the same room
REQ-14	5	Playing audio on multiple speakers in different locations at once

REQ-15	3	Follow the user around the home with audio playback
REQ-16	5	System predicts time required to reach a specific temperature
REQ-17	3	System shall detect when residents are only on one floor of a dual zone heating/cooling system and will adjust the zone which is not being used
REQ-18	3	User should be able to notify the system that they are moving to another zone so the system can adjust the temperature in time
REQ-19	3	The system shall predict when the user has awoken from sleep so the temperature can be adjusted
REQ-20	3	The system shall detect when the user has awoken from sleep so the lighting can be adjusted
REQ-21	4	The system shall detect which areas are not being occupied so the lighting can be adjusted
REQ-22	3	The system shall adjust temperature around sleeping hours for energy efficiency and comfort
REQ-23	5	System adjusts temperature before arrival to the home
REQ-24	5	System adjusts temperature and lighting after departure from the home
REQ-25	3	Systems displays energy savings
REQ-26	5	Admin User Access to System Shell

2.3 Enumerated Nonfunctional Requirements

Req-x	Priority Weight	Description
REQ-27	5	Installation Documentation
REQ-28	4	Simple GUI supported on wide range of platforms
REQ-29	5	Properly Grounded Circuit(for safety during power loss)
REQ-30	4	Loss of power and/or connection, results in manual control of utilities(lights & HVAC)
REQ-31	3	Gigabit Ethernet and 802.11n [1] (ac preferred)
REQ-32	3	Plug-and-play and retrofitted
REQ-33	3	Snooze feature for wake-up notification
REQ-34	2	Ability to turn on & off Alexa
REQ-35	1	Legal
REQ-36	1	Advertisment
REQ-37	2	The user is able to view the factors that lead the SSS to produce a given schedule: weather, traffic, and travel duration.

2.4 On-Screen Appearance Requirements

Req-x	Priority Weight	Description
OSR-1	5	Dashboard with tabbed section for each smart system
OSR-2	5	Settings menu inside of each section for each systems
OSR-3	4	Simple toggle switches to manage settings
OSR-4	3	Easy to use interface with reduced number of clicks
OSR-5	1	Splash screen to introduce the app upon open
OSR-6	2	Tutorial to help the user become oriented with the app

Project Management for Part 1

The first two meetings we had an agenda that we needed to decide the project cluster and then actual ideas. The other thing was that we set expectations of what each person in the group is responsible for in general. Next we had to narrow a project choice down. In the end we switched our initial idea traffic monitoring to home automation because we had a generally good idea with it and we all liked the idea. The last attribute that the group did was break into subgroups based on subproject.

3. Functional Requirements

3.1 Stakeholders

Investors: Selling smart home system bundled with homes and/or providing smart home services with a markup can generate a profit.

Super Commuters: People that have long commutes to work would want to utilize our system for its practicality of maximizing efficiency of sleep, dealing with delays, and keeping tracks of daily requirements.

Residents(General): People who like listening to music at home, having their home temperature and lighting save energy while maximizing comfort, and never missing in their scheduled day will greatly benefit from our SHS.

3.2 Actors and Goals

End-User - Initiating: The user will control various smart home functions and customize their settings. The user can customize the alarm to act appropriately to delays, adjust settings on his climate control system, add/remove items from his todo lists, control music being played, and more.

Communication Medium - Participating: Medium to relay information from one system to another(e.g. Wires, WiFi, Bluetooth, etc.)

Various Data Collection Sensor Controllers - Initiating: As the smart home systems learns user preferences it will adjust home settings by itself. As controllers for various smart subsystems detect changes of interest from its sensors; it will take action to start a defined procedure. Such examples include, the SAS detecting a change in user location and will change where music is being played, HVAC detects changes in time and appropriately changes temperature, and etc.

System Database - Participating: SHS keeps tracks of different logs from each subsystem, so the user can track down possible issues that may or may not occur.

System Shell - Participating: Monitoring what is happening in real-time on SHS and subsystems for troubleshooting purposes.

Amazon Alexa - Initiating/Participating: Voice commands to Alexa can be used to interact with various Amazon services. Alexa is also equipped with automated services which can remind you of tasks when the time is right, communicate with other devices, and play music.

3.3 Use Cases

3.3.1 Causal Description

Use Case - 1: Todo List [REQ-11]
At a specified time the SAS will play an automated todo list indicating the user's planned schedule throughout the day. It should play wherever the user is located.

Use Case - 2: Audio Room Selection [REQ-14]
User should be able to specify where his/her audio will be played.

Use Case - 3: Audio Selection Conflict Control [REQ-13]
Multiple user's should not conflict in audio room selection. When a user requests audio being played in one room where music is already playing, the system should default to the primary user's audio.

Use Case - 4: User Audio Tracking [REQ-15]
When a user is playing music in his/her room, the music should automatically detect and track users as they walk to other rooms(given no conflicts).

Use Case - 5: Amazon Alexa Integration [REQ-11]
The user can access all of Amazon Voice Assistant Services from the SAS. The functionality of Amazon's voice assistant is baked into the SAS.

Use Case - 6: Speakers for SSS [REQ-10]
The user can hear notifications from the SSS on the SAS.

Use Case - 7: Monitoring [REQ-26]
Administrative users has access to the SHS shell for troubleshooting purposes in the case something goes wrong with his/her system. Higher privileged users can look at backup logs of the whole system when they are troubleshooting.

Use Case - 8: Temperature Ready [REQ-16, 23]
User is returning home from work/errands and checks application for the time-to-temperature prediction and initiates heating/cooling when time-to-home is approximately the same.

Use Case - 9: Dual Zone Inactivity [REQ-17, 21]
No movement has been detected for a certain duration of time in one or both of the zones in a dual heating/cooling home and the temperature adjusts to minimize energy consumption and lights are shut off in the respective zone

Use Case - 10: Activate Dual Zone [REQ-18]
Users notifies system to adjust lighting and temperature in a zone they are moving to preferred settings

Use Case - 11: Sensor Activation [REQ-21]
User’s enter a room and lights are turned on if it is dark (low luminosity)

Use Case - 12: Wake Up Adjustments [REQ-19, 20]
Temperature adjusts to user's temperature preference slightly before the time they normally wake up. Lights turn on gradually when motion is detected.

Use Case - 13: Going to Bed Adjustments [REQ-22]
Temperature adjusts to energy efficient temperature around normal sleep hours. Lights turn off when user notifies the system through the application

Use Case - 14: Empty Home [REQ-24]
User notifies the system they are leaving their home. Lights are shut off and temperature adjusts to minimize energy consumption

Use Case - 15: Energy savings [REQ-25]
User checks their energy savings for a given time duration

Use Case - 16: [REQ-6, REQ-7]
The user has just downloaded the app and must enter his schedule, work location, and home location when the app is opened for the first time.

Use Case - 17: [REQ-37]
User can view weather condition, traffic on his route, time taken to his next destination when he opens the app.

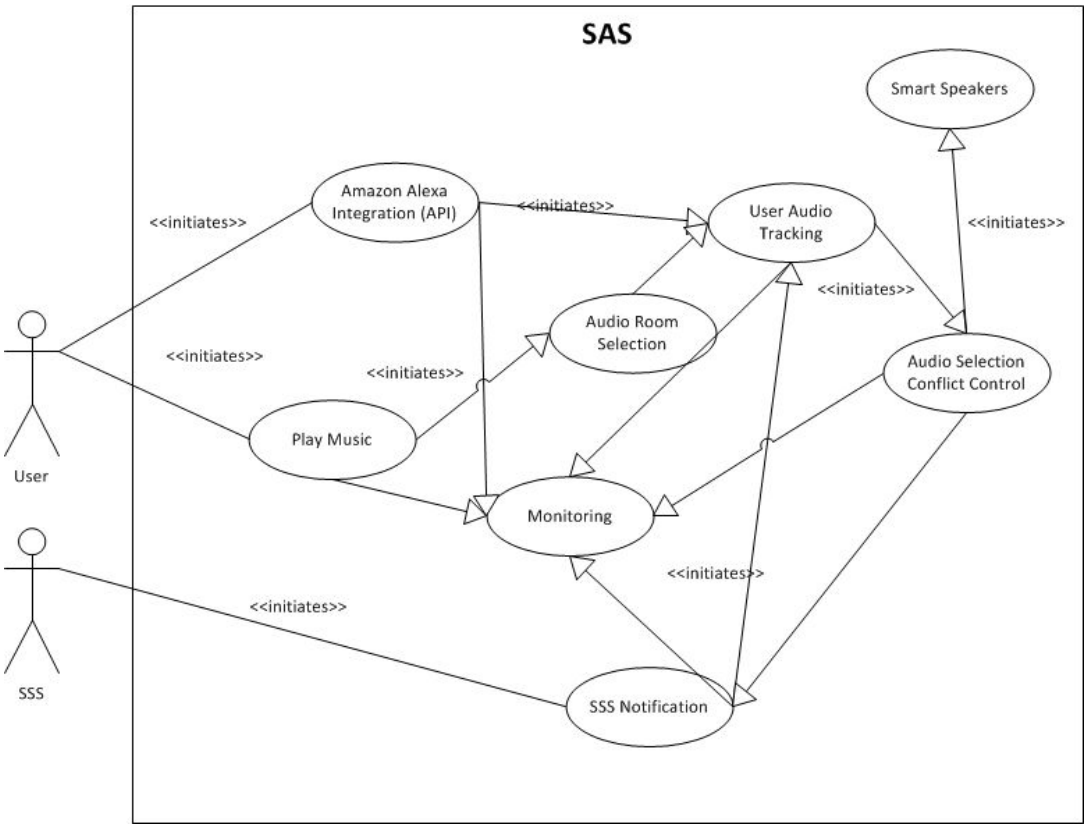
Use Case - 18: [REQ-11]
User can modify his schedule, destination, add holiday, change alarm sound.

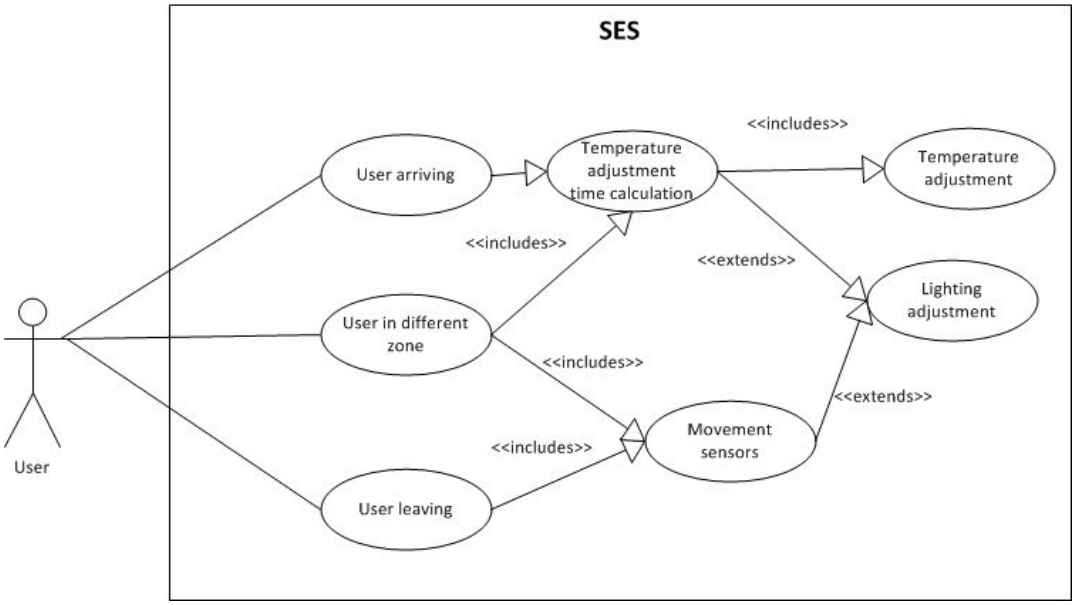
Use Case - 19: [REQ-1, 2, 3]
The user would like to go to bed without having to worry about being late for work. He knows that he must wake up when the alarm goes off and that if he does not, then he will be late. A wake-up notification will be set for the user, accounting for traffic conditions.

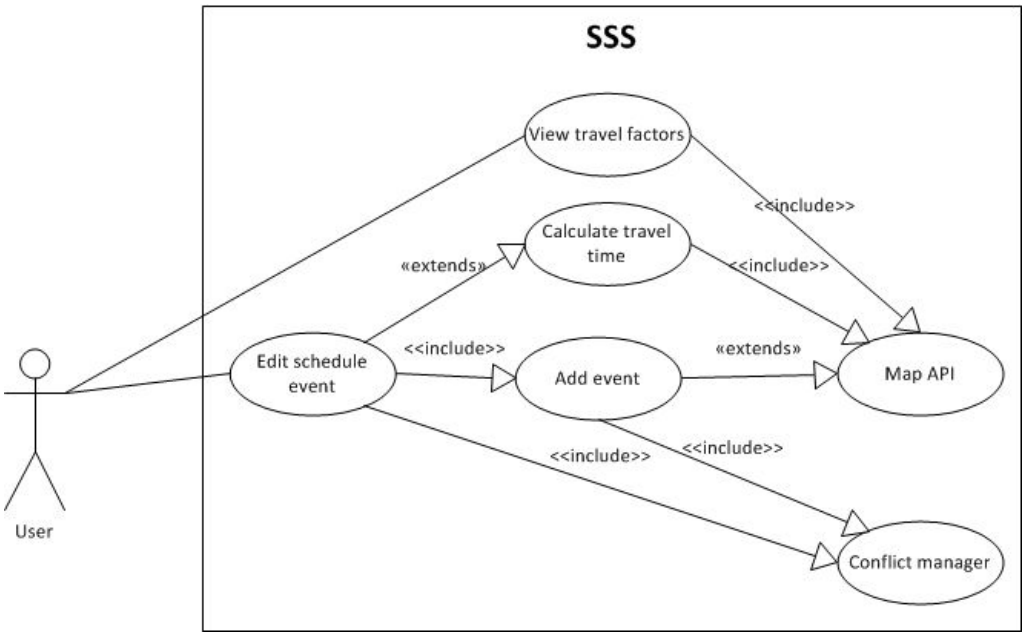
Use Case-20: [REQ-6, 7]
The user would like to put events in his schedule. If the event has a destination, then the SSS will tell the user the optimal time to leave for the event.

Use Case-21: [REQ-5]
The user has entered his daily activities, but would like to know when to go to bed in order to wake up the next morning after a specified duration, so the SSS will tell the user when he should go to sleep.

3.3.2 Use Case Diagrams






SSS
View travel factors
Calculate travel time
Edit schedule event
Add event
Map API
Conflict manager
User
«extends»
<<include>>
<<include>>
<<include>>
<<include>>
<<include>>
«extends»

3.3.3 Traceability Matrix

		User Cases																				
Req't	PW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
REQ1	5						x													x		
REQ2	4																			x		
REQ3	4																			x		
REQ4	1																		x			
REQ5	4																					x
REQ6	3																x				x	
REQ7	3																x				x	
REQ8	4																					
REQ9	4																					
REQ10	5	x					x															
REQ11	4	x				x													x			
REQ12	1																					
REQ13	2			x																		
REQ14	5		x																			
REQ15	3				x																	
REQ16	5								x													
REQ17	3									x												
REQ18	3										x											
REQ19	3												x									
REQ20	3												x									
REQ21	4									x												
REQ22	3											x		x								
REQ23	5								x													
REQ24	5														x							
REQ25	3															x						
REQ26	5							x														
REQ37	2																	x				
Max PW		5	5	2	3	4	5	5	5	4	3	3	3	3	5	3	3	2	4	5	4	4
Total PW		9	5	2	3	4	5	5	10	7	3	3	6	3	5	3	6	2	4	13	7	4

3.3.4 Fully Dressed Descriptions

The smart audio system's integration with Amazon Alexa is a core design function. It allows expandability of the audio system's function as new services and features are added to Alexa. The user will be able to use Alexa to handle various commands to control the SSS. When the user wakes up, it can play his/her todo list, play music wherever he/she is and more. Alexa API will be used to access the service and will be outputted to the speakers nearest to the user.

Use Case 5	Amazon Alexa Integration
Related Requirements	REQ 10 & REQ 11
Initiating Actor	SAS
Actor's Goal	To notify the user of the planned schedule for the day ahead.
Participating Actors	Amazon Assistant Alexa
Preconditions	Internet Access Amazon Alexa Integration to the SAS Network Access
Post Conditions	SAS gives up use of speakers

Flow of Events for Main Success Scenario
1. User Gives Alexa a Voice Command on App 2. Voice Command Uses API to Access Amazon Services 3. SAS returns Response from Amazon 4. SAS pulls location information of user 5. SAS plays response on nearest speakers 6. Alexa Proceeds to Commit Action(some commands)

Notifications sent from the SSS will be handled by the SAS. When the user sets an alert or an alarm on the scheduler all the information from the scheduler will have to be relayed to the SAS. All this information is transmitted across the local network so it will be important to have a good backbone. We recommend using 802.11n or AC but Gigabit Ethernet is preferred. Same as with the other functions as well, notifications will be played at the location of the user. So only specific user notification will delivered to the user.

Use Case 6	Speakers for SSS
Related Requirements	REQ 10 & REQ 1
Initiating Actor	SSS
Actor's Goal	To notify user with audio message relayed through the SAS
Participating Actors	SSS, SAS
Preconditions	SAS can communicate with SSS SSS can communicate with SAS
Post Conditions	SAS gives up use of speakers

Flow of Events for Main Success Scenario
1. A Reminder or Alarm Goes off on SSS 2. SSS signals SAS of the notification 3. SAS signals SSS that the notification was received 4. SAS pulls location information of user 5. SAS plays notification on nearest speakers

Use Case 8	Temperature Ready
Related Requirements	REQ 16,23
Initiating Actor	User of the application, resident of the house
Actor's Goal	To notify the system that they are arriving home so that the desired temperature could be met by the time they are home
Participating Actors	Thermostat, thermometer, server, application, timer
Preconditions	SES is live and working, no one is at home
Post Conditions	SES watches for movement

Flow of Events for Main Success Scenario
1. User will open the mobile or web application 2. User will input eta or give an eta based on Google Maps [3] 3. System will calculate the time to start adjusting the temperature 4. System will start a clock and make the change at the appropriate time

Use Case 9	Dual Zone Inactivity
Related Requirements	REQ 12, 21
Initiating Actor	Sensors
Actor's Goal	To sense the lack of movement in the a zone of the house
Participating Actors	Residents, pets, sensors, thermostat
Preconditions	A dual or tri zone hvac system, lack of movement
Post Conditions	Temperature adjustment

Flow of Events for Main Success Scenario
1. User moves from one zone to another 2. A certain amount of time, x has passed since movement has been seen in the other zone 3. System adjusts heating/cooling in that zone 4. User can reactivate zone by telling app

Use Case 10	Schedule Event Addition
Related Requirements	REQ-6, REQ-7
Initiating Actor	User
Actor's Goal	To add an event to his schedule
Participating Actors	SAS, Google Maps
Preconditions	App installed properly SSS able to send signals to the SAS
Post Conditions	Updated schedule. Updated wake-up notification time. Updated departure times.

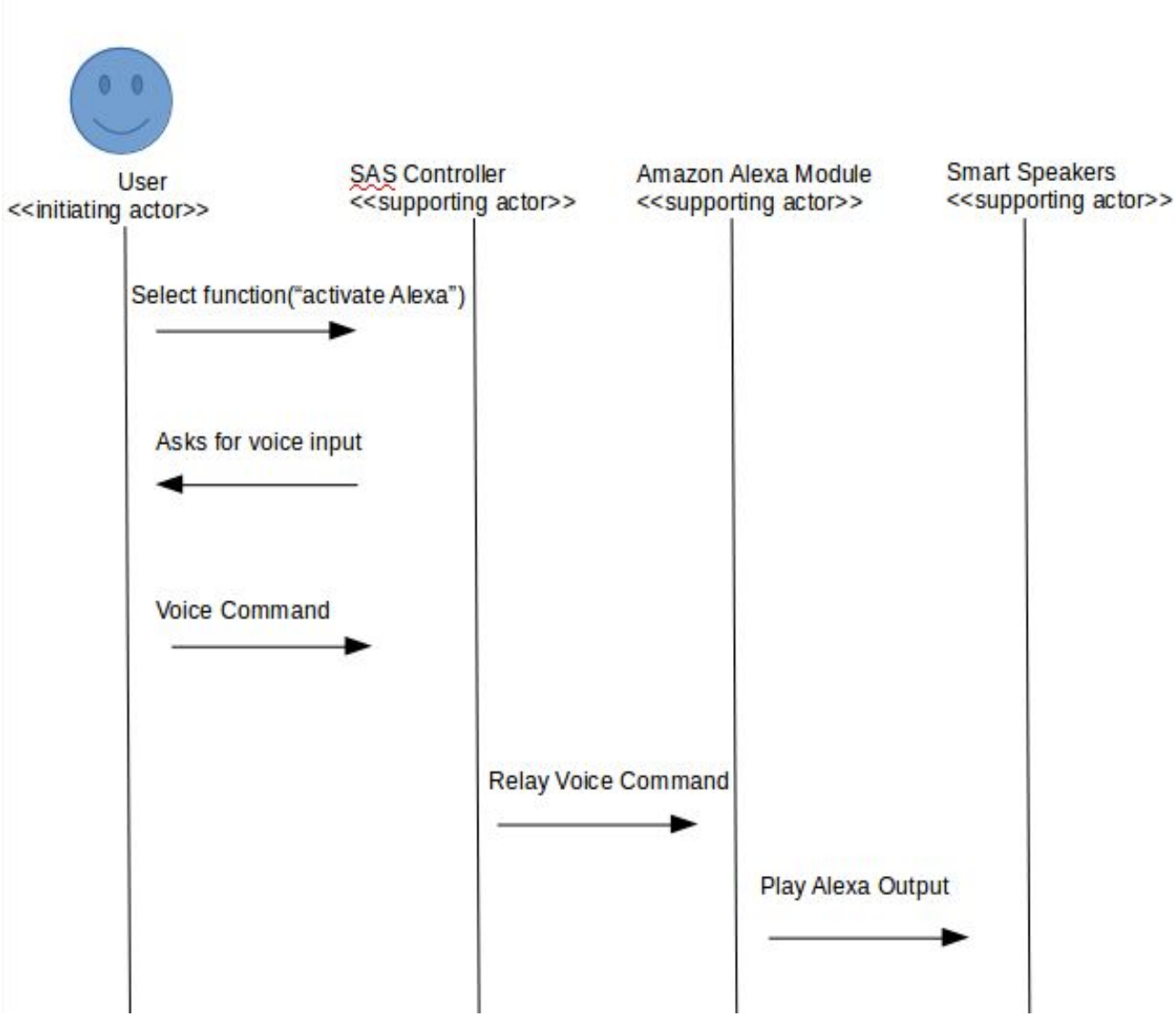
Flow of Events for Main Success Scenario
The user opens the SHS application. The user selects the SSS button from the sidebar The user inputs relevant event data: name, location, time, duration, deadline The SSS checks for a timing conflict with a preexisting event. The SSS requests travel route and duration to the event destination from Google Maps. The SSS checks for a timing conflict with a pre existing event based on the travel duration. The SSS sends a notification to the user indicating success or failure of event creation.

Use Case 17	Checking relevant information about traffic
Related Requirements	REQ-37
Initiating Actor	User
Actor's Goal	To check time taken to next destination, weather condition, alternative routes
Participating Actors	Google Maps, Weather Provider
Preconditions	Internet Access, GPS
Post Conditions	Traffic and weather conditions updated successfully

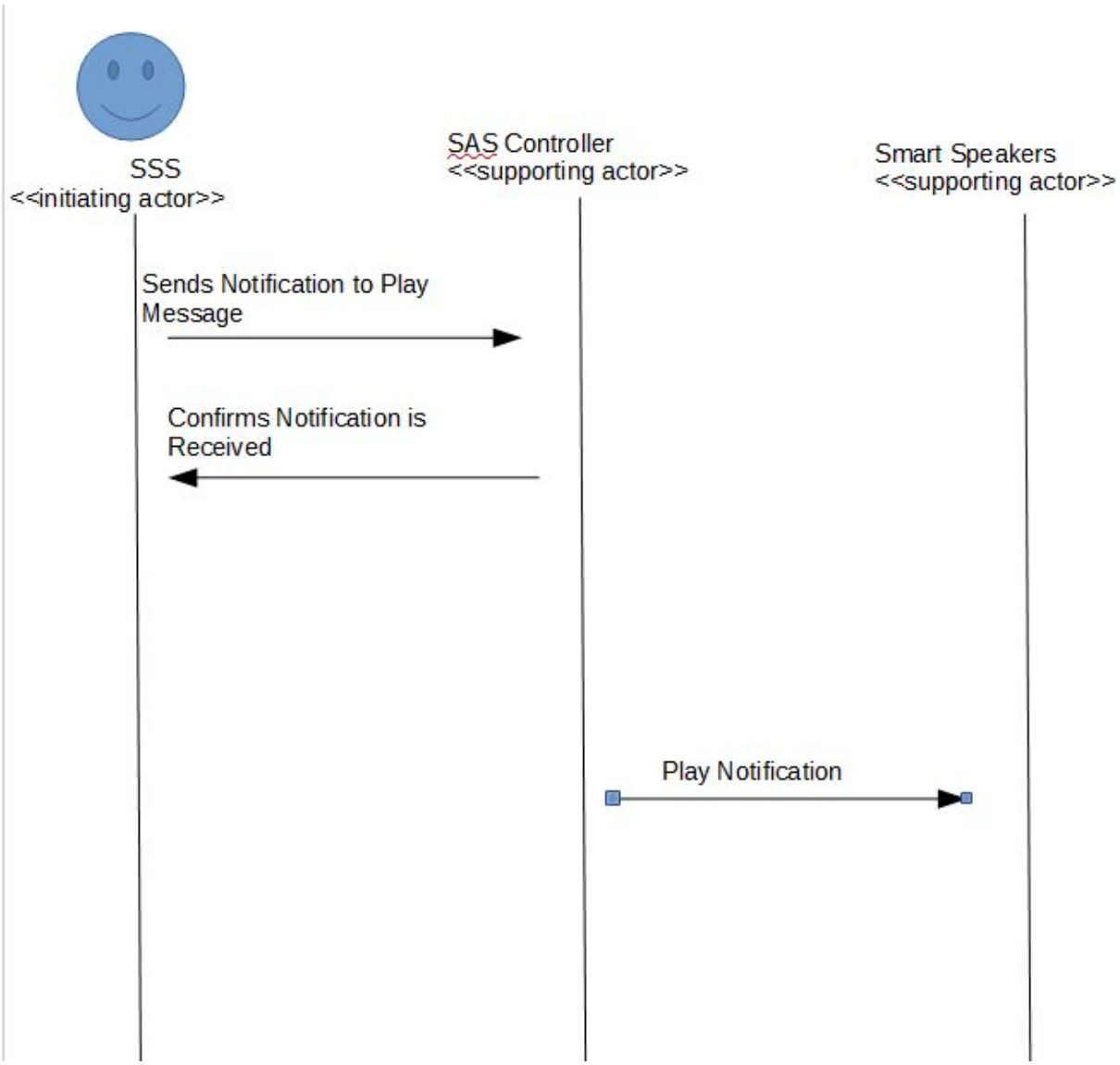
Flow of Events for Main Success Scenario
1. The user opens the SHS application. 2. The user selects the SSS button from the sidebar 3. The user chose the Next Destination Tab 4. The SSS display relevant information about traffic and weather to the next event

3.4 System Sequence Diagrams

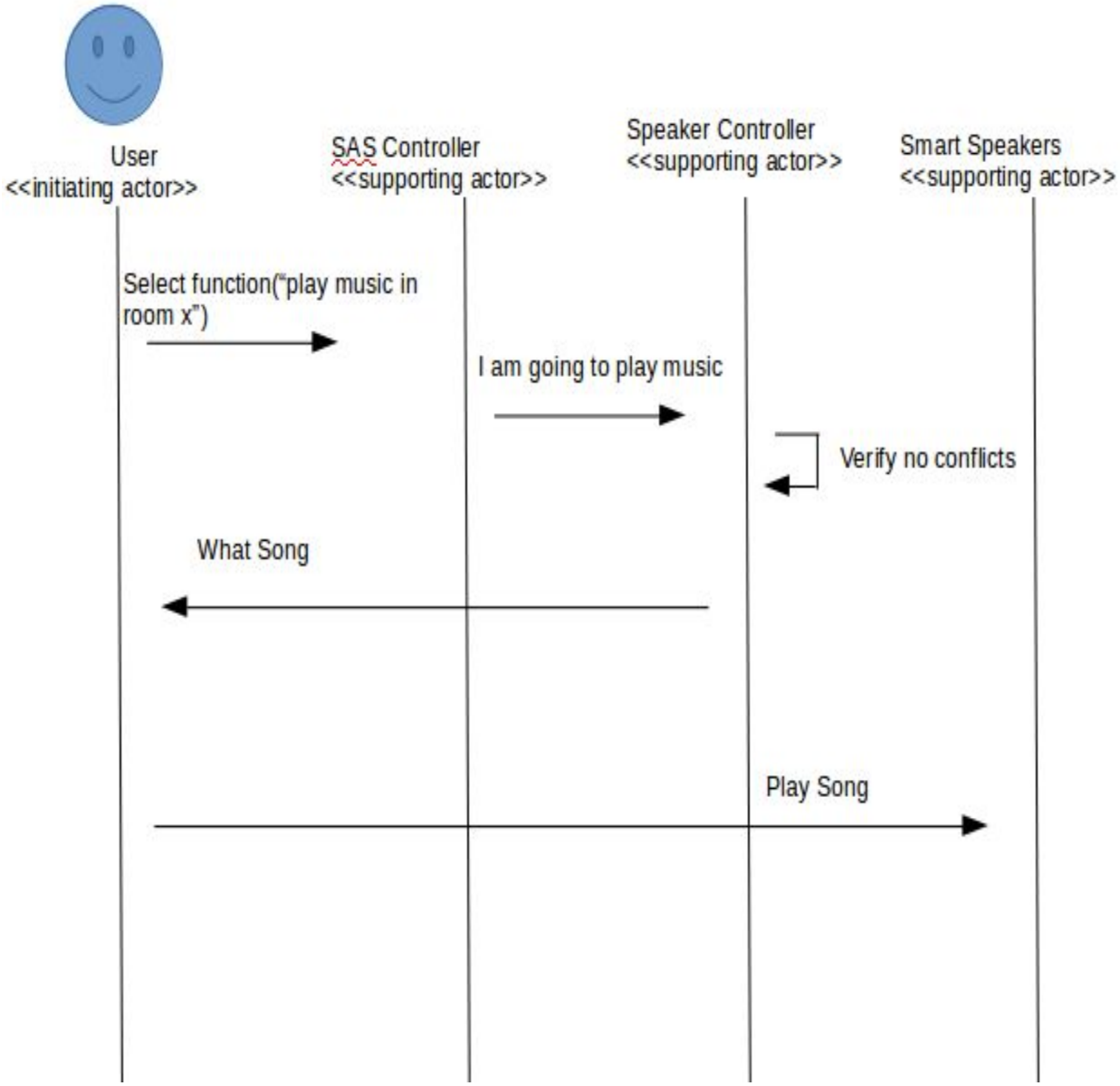
SAS Alexa Integration Sequence Diagram



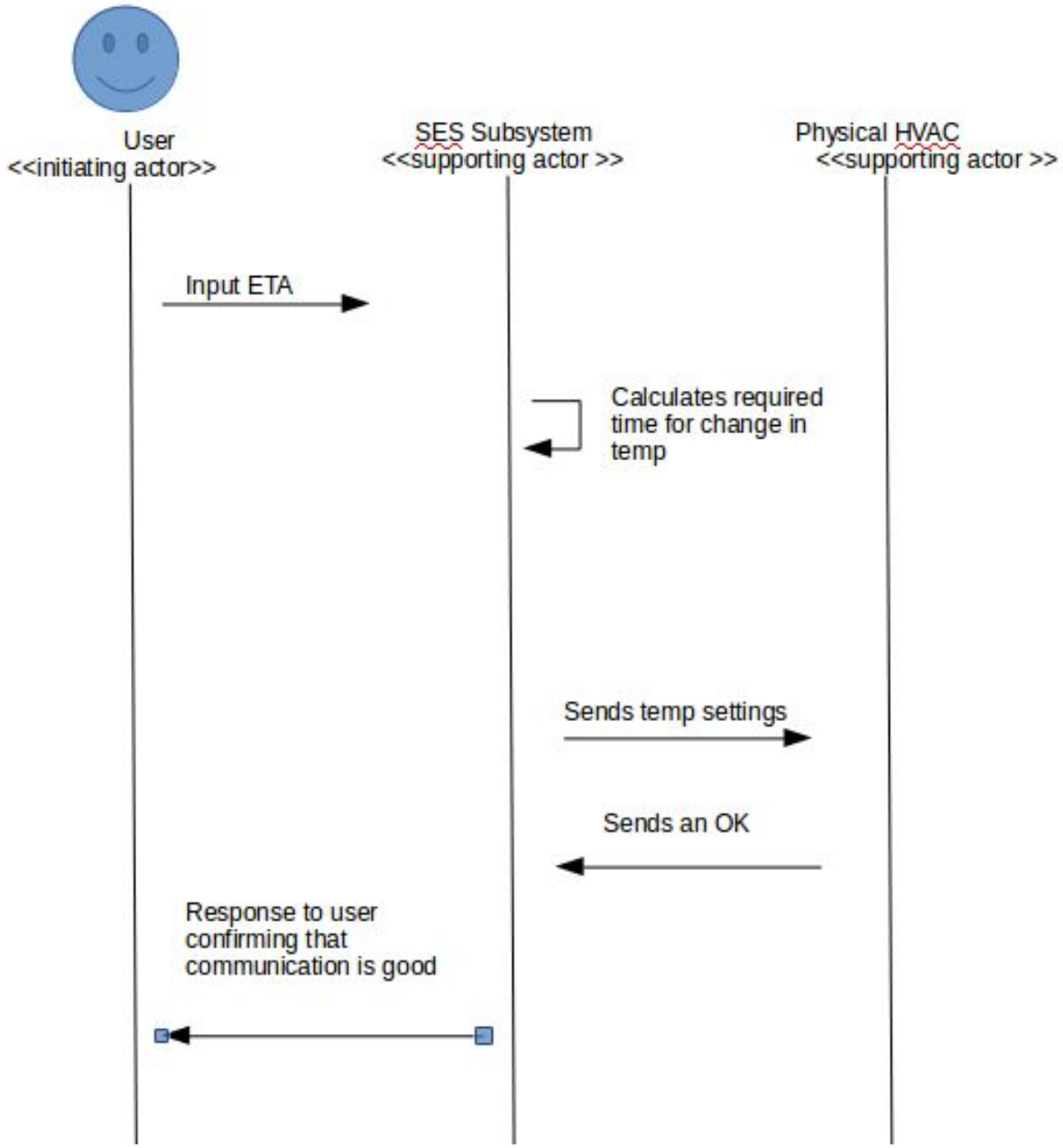
Notification Handling for SAS



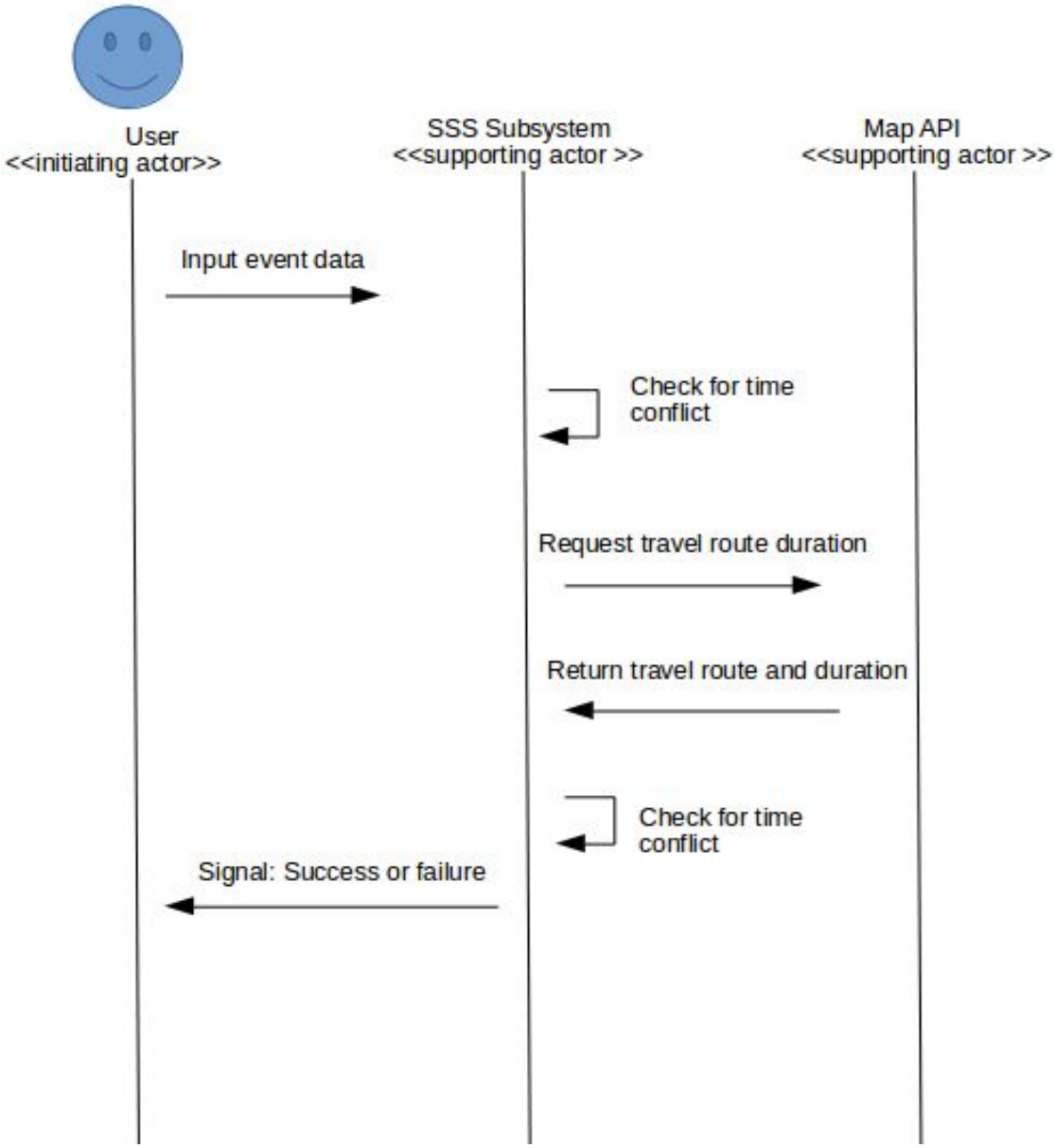
SAS Audio Conflict Handling Sequence Diagram



Temperature Ready

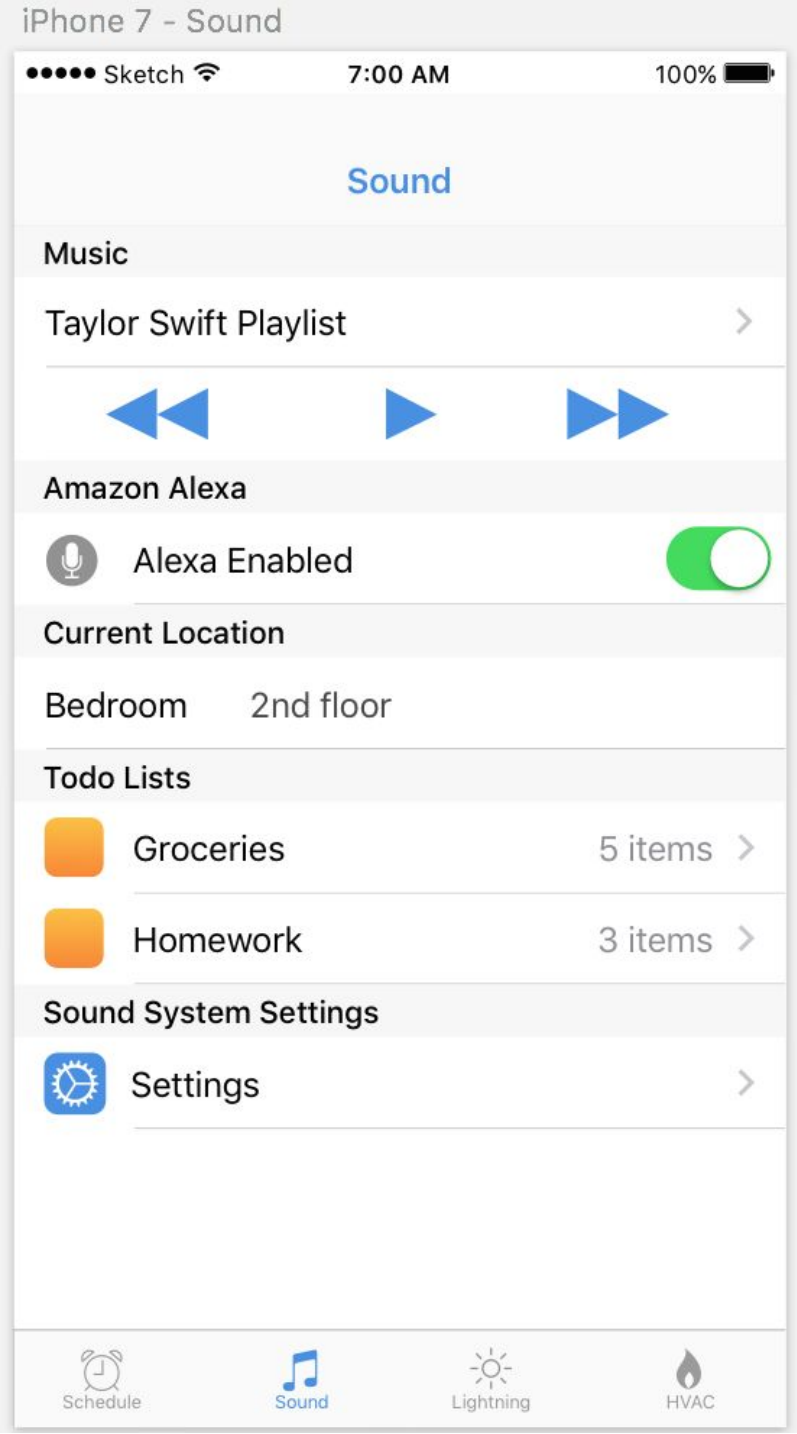


Traffic Time Schedule

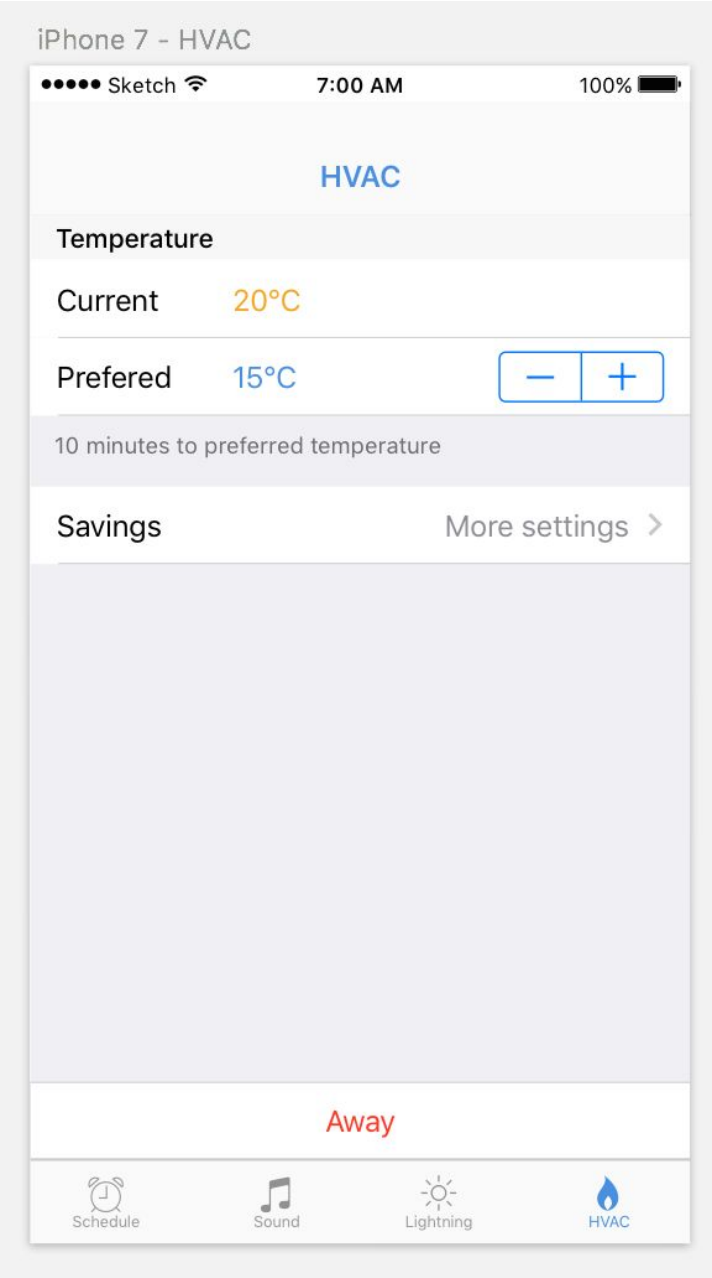

User
<<initiating actor>>
SSS Subsystem
<<supporting actor >>
Map API
<<supporting actor >>
Input event data
Check for time conflict
Request travel route duration
Return travel route and duration
Check for time conflict
Signal: Success or failure

4. User Interface Specification

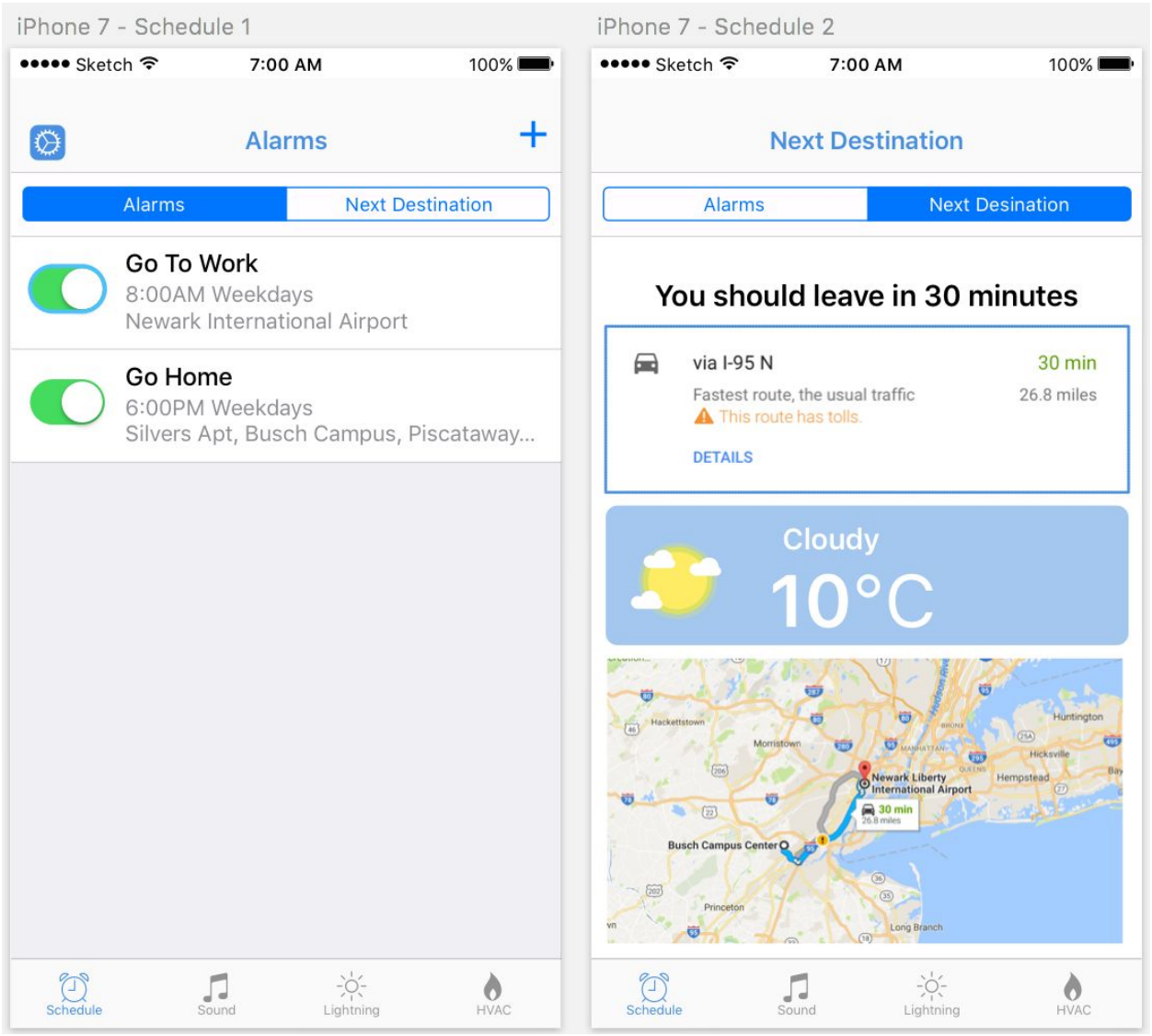
4.1 Preliminary Design



To access everything for Sound, click on Sound in sidebar. it. Once in it you'll have all the options to do what you want with the SAS. Click on settings and you can access and modify all its settings and preferences there. Hit the back button to get back to the dashboard. That's one click to get to all the functions and two clicks to all the settings. The Settings is filled with simple to use toggle switches and character input for specific settings management. It also provides basic troubleshooting detail whether you are connected to the rest of the network.



Based on use case 8 we can see what the GUI will look like. After opening the application the user would first click on the HVAC button. Once in HVAC the user will have options to edit their preferences. In this scenario the user would be heading home and want to have their house temperature be their preference on arrival. After clicking Time-to-temperature the user has the option to start the heating/cooling by pressing the start button or wait if their time-to-home is much larger than the time-to-temperature.



Navigaiton Sample Mockup : https://gfycat.com/ScientificRingedAstrangiacoral

4.2 User Effort Estimation

The navigation of our system is simple. Once you open the application you are given a dashboard with four navigation buttons: Alarm, Sound, Light and HVAC

SAS

Dashboard

- Select the SAS button in the sidebar.
- Click on Various Function you would like to Perform

Settings

- Select the SAS button in the sidebar.
- Click the Settings Gear Icon
- Toggle Switches of your Preferences
- Enter User Information in Text Boxes
- Hit Back Button to Get Back to Functions

Number of Clicks

- One Click to Function Dashboard
- Two Clicks to Access Amazon Alexa
- Two Clicks to Play Music
- Two Clicks to get to Settings

SES

Use case 8 requires 3 clicks [2 navigational, 1 data entry]

- Click HVAC
- Cick Time-to-temperature
- Click Start

Use case 15 requires 2 clicks [2 navigational]

- Click HVAC
- Click Energy Savings

In order to change heating/cooling preferences you need 5 clicks [4 navigational, 1 data entry]

- Click HVAC
- Click Heating/Cooling Settings
- Click Edit Temperature Preference
- Slide to Preferred Temperature
- Click Save

SSS

This case evaluates the effort required in order to add an event to the SSS assuming that the SHS application is already open.

Navigation:

Select the SSS button in the sidebar.

Select the “add entry” button in order to add an event to the schedule.

Data Entry

Select the “name” field and enter a name.

Select the “location” field and enter a location.

Select the “time field” and enter the time range of the event.

Alternatively, enter a duration and a deadline.

Select the “ok” button.

Project Management For Part 2

We have developed a variant of Agile. There are two phases of the project. The first is from the beginning of the semester till mid February in which we have mainly been communicating, writing up the reports, and discussing ideas. The second phase is when we have reports plus beginning of development so that we have minimum viable product by the first demo. The last phase will be similar to the second phase only it's the time between the first demo and last demo.

While in the first phase of the project, we have had weekly meeting. Initially, there was a few preset things to go over for the agenda like which project idea to pick and how to divide. Later we developed a variant of the standing meeting in which we had a round table on answering the following questions:

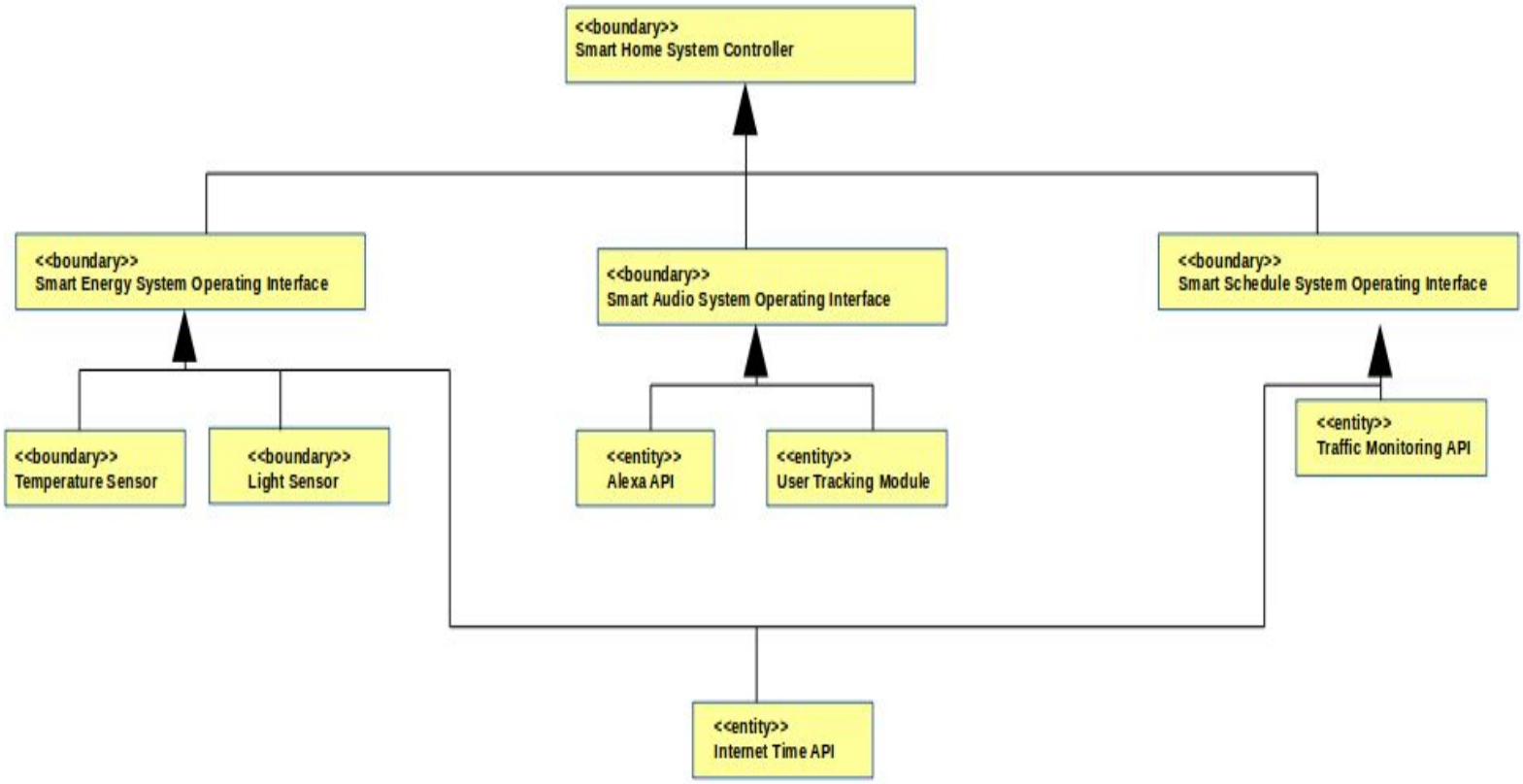
1. What did I do in this past week that helped the team with the goal?
2. What will I do this week to help the team reach the goal?
3. Do I see any impediments that prevent me or the development team from meeting its goal?

In addition some weekly agenda was talked about based on what was due that week.

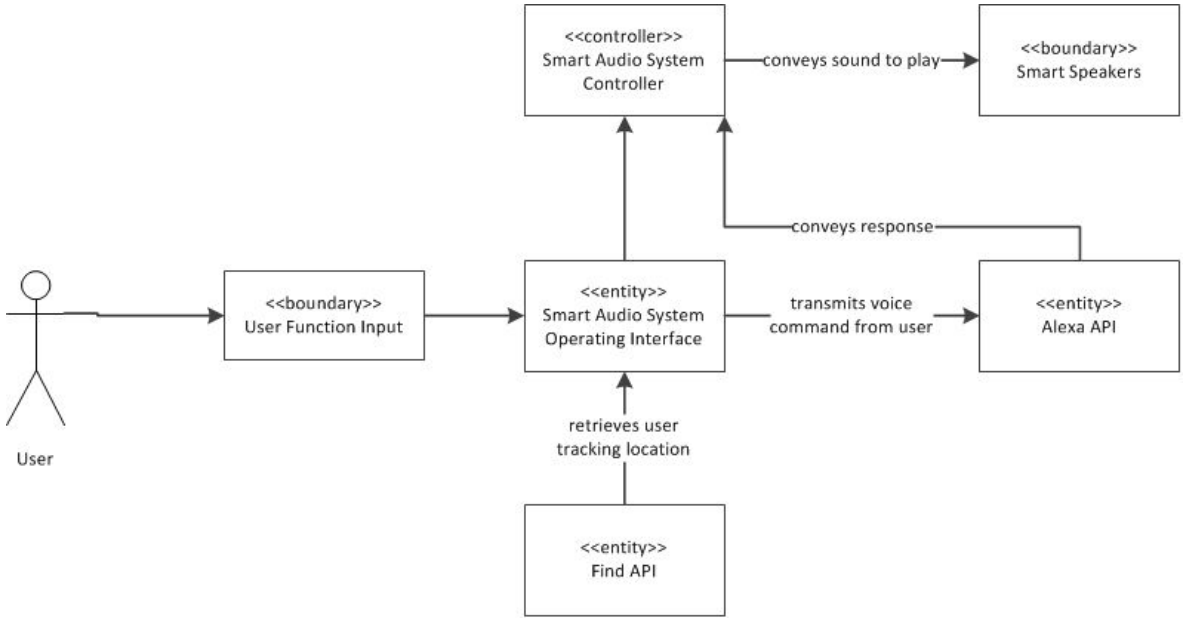
As we move into development phase our coordination will be more so on integrating the code and making sure the overall system works. For those weekly meeting it will probably just consist of the stand up meeting questions and then concerns for the group. The rest should be coordinated subgroup to subgroup, person to person.

5. Domain Analysis

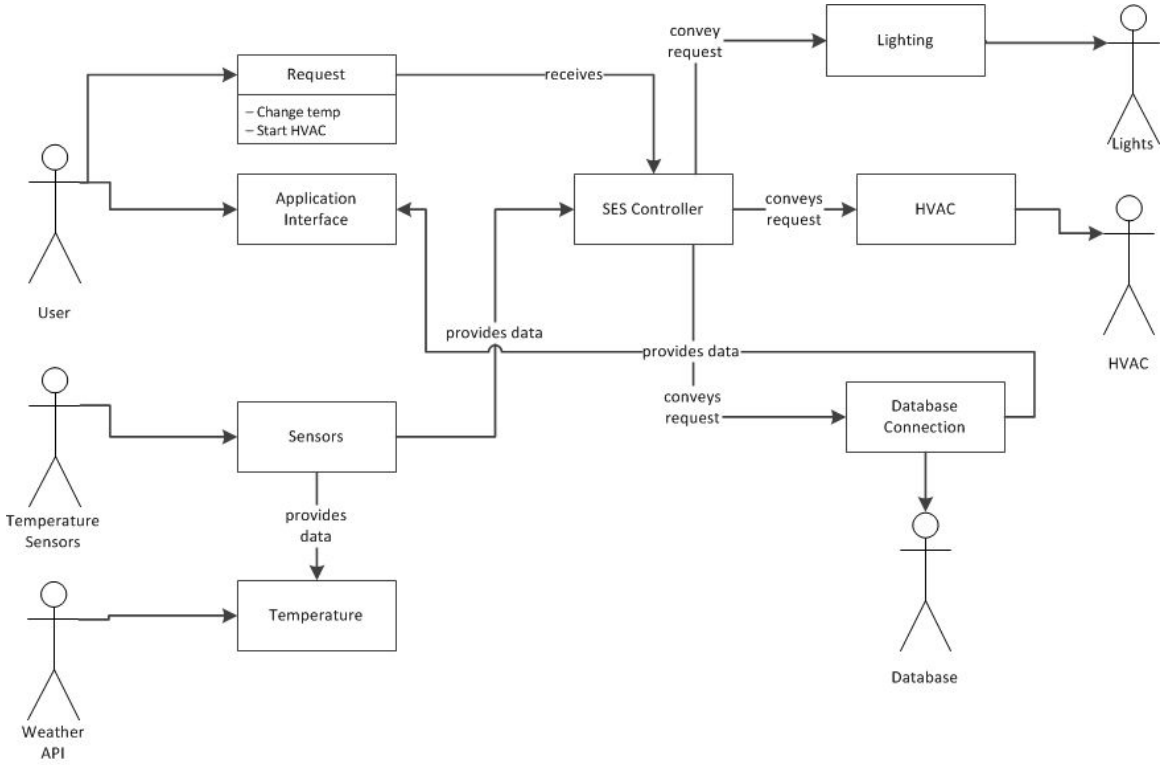
5.1 Domain Models



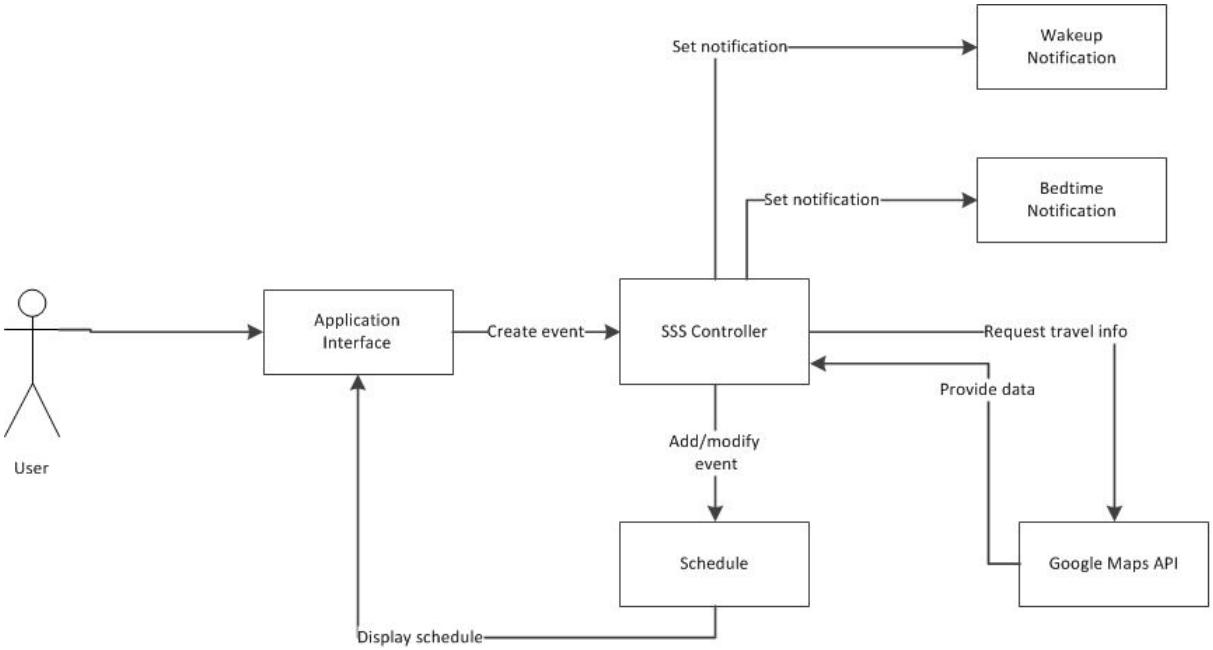
SAS Domain Diagram



SES Domain Diagram



SSS Domain Diagram



5.1.1 Concept Definitions

Description	Type	Name
A controller which controls the features of the Smart Home System	**D**	**Smart Home System Controller**
System that controls the interactions between the entities of the Smart Audio System	**D**	**Smart Audio System Operating Interface**
Speakers(Speaker System) which are connected to the internet, Amazon's Alexa, and the internet	**K**	**Smart Speakers**
Touch input from user app for requesting certain actions and features from the system	**D**	**User Function Input**
An open source API for indoor position of smartphones and laptops	**K**	**FIND API [4]**
An API created by Amazon for access and use of their voice assistant, Alexa	**D**	**Alexa API**
Connects the data stream from the application controllers to the database	**D**	**Database Connection**
App access to information from the internet	**K**	**Internet Connection**
Controls the HVAC	**D**	**HVAC**
Controls the physical lights	**D**	**Lighting**
Handles routing for the system	**D**	**SES Controller**
Is responsible for the taking data from the sensors and calling an API to provide data for the controller	**D**	**Temperature**
Temperature sensors that collect live data from the inside of the smart house	**K**	**Sensor**
Serves users pages and information via application so the user can get the current data about the	**K**	**Application Interface**
Takes the the input from the user	**D**	**Request**
A controller which controls the features of the Smart	**D**	**SSS Controller**

Scheduling System		
A 3rd party software for determining travel time,	**D**	**Google API**
Indicates when the user should wake up	**D**	**Wakeup Notification**
Indicates when the user should go to sleep	**D**	**Bedtime Notification**
Stores all of the events that the user plans to accomplish	**K**	**Schedule**

5.1.2 Association Definitions

Concept Pair	Association Description	Association Name
Sensor ↔ Temperature	Sensor receives data from sensors and sends data to temperature	Provides data
Temperature ↔ Controller	Temperature sents home temp. and outside temp. to controller	Provides data
Request ↔ Controller	Controller receives a request to process	Receives
Controller ↔ Light	Controller conveys users request to control the lights	Conveys request
Controller ↔ HVAC	Controller conveys user's request or request based on sensors to HVAC	Conveys request
Controller ↔ DatabaseConnection	Controller requests info and has database send info to the ApplicationInterface	Conveys request
DatabaseConnection ↔ ApplicationInterface	Provides information for the UI	Provides data
SAS Operating Interface ↔ FIND API	SAS Operating Interface retrieves data about indoor positioning from the FIND API	Provides data
SAS Operating System ↔ User Function Input	SAS Operating Interface gets user input from app through User Function Input	Provides data
Alexa API ↔ Smart Audio Operating System	Smart Audio System provides queries for information for the Alexa API. The Alexa API also provides response data from	Conveys request

	queries back to the SAS Operating Interface	
Smart Audio System Controller ↔ Smart Speakers	SAS Audio System Controller conveys what needs to play to the speakers	Conveys data
User Function Input ↔ SAS Operating Interface	SAS Operating System interprets the User Function Input from the user app.	Conveys data
SAS Controller ↔ Alexa API	SAS Controller recieves the information(data) from the Alexa API	Conveys data
SAS Controller ↔ SAS Operating Interface	SAS Operating Interface transfers data to the SAS controller to perform the desired actions.	Conveys data
Application Interface ↔ SSS Controller	Application Interface recieve the data from the user, then send it to to the controller	Create Event
SSS Controller ↔ Schedule	The controller send new data to the database	Add/Modify Event
Schedule ↔ Application Interface	Dispaly schedule data from the local database	Display schedule
SSS Controller ↔ Wake up notification	Set wake up notification base on data	Set notification
SSS Controller ↔ Bed time notification	Set go to bed notification base on data	Set notification
SSS Controller ↔ GG Map APIs	Set HTTP Get request to Google to get traffic data	Request Travel Info
SSS Controller ↔ GG Map APIs	Parsing JSON data from Google and adjust schedule	Provide Data

5.1.3 Attribute Definitions

Responsibility	Attribute	Concept
R1: Sends a post request to update the prefered temperature	**changePrefTemp**	**Request**
R2: Lets the system know that the user is away so that the temperature can be adjusted	**isAway**	**Request**
R3: Requests for the data related to the calculated saving to generate a graph/chart	**showSavings**	**Request**
R4: Sends payload to frontend with all the required data: current temperature, last preferred temp,	**serveData**	**Application Interface**
R5: Sends the page/UI that the user will interact with	**servePage**	**Application Interface**
R6: Calls all physical sensors and grabs their values	**senseData**	**Sensors**
R7: Sends payload of data to temperature object	**sendData**	**Sensors**
R8: Calls a weather API and returns the outdoor temperature at that particular zip	**getTempAtZip**	**Temperature**
R9: Gets the temperature data from the sensor and brings it to the temperature object	**getSensorData**	**Temperature**
R10: Sends the data to the controller	**sendPayload**	**Temperature**
Takes the temperatures update request and	**handleTempRequest**	**Controller**
location request, location response, location metric units	**getLocation(Find API)**	**Request**
Amazon Service Request, Response	**connectAmazon(Alexa API)**	**Application Interface**

play request handling of smart speakers	**relayToSpeaker(Smart Speakers)**	**Request**
Relays Audio to Smart Speakers	**shsAudioHandler**	**Handling**
Play Music Playlist	**playPlaylist**	**Requests**
Area Ownership for Conflicting Audio	**isAudioConflicting**	**Handling**
Status and troubleshooting between connection between SAS and SSS	**getSASSSSInternetworkStatus**	**Monitoring**
Status and troubleshooting between LAN and WAN	**getNetworkStatus**	**Monitoring**
Reset SAS to Default Settings	**factoryResetSAS**	**Troubleshooting**
Reset SES to Default Settings	**factoryResetSES**	**Troubleshooting**
Reset SSS to Default Settings	**factoryResetSSS**	**Troubleshooting**
Reset whole SHS to Default Settings	**factoryResetAll**	**Troubleshooting**

5.1.4 Traceability Matrix

SES

		Domain Concepts							
Use Case	PW	Request	Application Interface	Controller	Temperature	Database Connection	Lighting	HVAC	Sensors
UC8	10	X	X	X	X	X		X	
UC9	7			X	X		X	X	X
UC10	3	X	X	X	X	X		X	
UC11	3			X		X	X		X
UC12	6			X	X	X		X	
UC13	3			X	X	X	X	X	X
UC14	5	X	X	X		X	X	X	
UC15	3			X	X	X			

SAS

		Domain Concepts						
Use Case	**PW**	Smart Audio System Controller	Smart Audio System Operating Interface	Smart Speakers	User Function Input	FIND API	Alexa API	Database Connection
UC1	9			X			X	X
UC2	5	X	X	X		X		
UC3	2	X				X		
UC4	3	X				X		
UC5	4	X		X			X	X
UC6	5	X		X				

SSS

		Domain					
		Application Interface	SSS Controller	Schedule	Wakeup Notification	Bedtime Notification	Google API
Use Case	**PW**						
UC16		x	x	x	x	x	x
UC17		x	x	x			x
UC18		x	x	x	x	x	x
UC19				x	x		x
UC20		x	x	x	x		x
UC21		x	x	x		x	x

5.2 System Operation Contracts

[5]

Operation	**Schedule Event Addition**
Responsibilities:	Add new events
Use case:	UC-16
Exception:	Throw an error to user.
Preconditions:	App install successful. User give app access to device location, calendar. Device has internet access. Device has internet access. Device has GPS location.
Postconditions:	Updated schedule. Updated wake-up notification time. Updated departure times.

Operation	**Checking relevant information about traffic**
Responsibilities:	Fetch new data to update notification frequently
Use case:	UC-17
Exception:	None
Preconditions:	Device has internet access when fetching new data Device has GPS location when fetching new data
Postconditions:	Traffic and weather conditions updated successfully Alarms adjusted correspondingly to the new data.

Name:	**Temperature Ready**
Responsibilities:	Predict time needed for the home to adjust to a certain temperature and allow user to initiate heating/cooling when necessary
Use Case:	UC-8
Exceptions:	None
Preconditions:	User has defined set point temperature
Postconditions:	Time-to-temperature is displayed on the application along with a start button for heating/cooling

Name:	**Dual-Zone Inactivity**
Responsibilities:	When movement hasn't been detected for a fixed amount of time, heating/cooling systems and lights are adjusted
Use Case:	UC-9
Exceptions:	None
Preconditions:	No movement has been detected in x minutes
Postconditions:	Heating/cooling are adjusted to energy efficient settings; lights are shut off

Name:	**Amazon Alexa Integration**
Responsibilities:	When a request is sent to Amazon's Alexa through the app, the voice assistant will perform the desired task or retrieve the requested data.
Use Case:	UC-5
Exceptions:	If the voice is not interpreted properly, the app will ask for the same input once again from the user.
Preconditions:	User must have Alexa services enabled in the app settings and must have the activation word set up.
Postconditions:	Amazon's Alexa interprets the user's voice request and retrieve the desired data and/or perform the desired action.

Name:	Speakers for SSS
Responsibilities:	After the user is woken by the SSS, the SAS will read the user's schedule through Amazon's Alexa.
Use Case:	UC-6
Exceptions:	None
Preconditions:	The alarm goes off to wake the user, and the user wakes up and dismissed the alarm.
Postconditions:	The app will use Amazon's Alexa to notify the user of his/her schedule for the day ahead.

5.3 Mathematical Model

For SES, we decided to implement a model similar to Nest's thermal model [6], which is used to predict the time-to-temperature feature of our system. For our model, we plan on using the current state of the home and the HVAC state as the inputs. Sensors will collect data throughout the day and train the model so the system can make better predictions.We can also use Newton's Law of Cooling [7] for modeling the heating and cooling of a house. If we consider T(t) represent the temperature inside the house at time t. H(t) is the rate of increase in temperature is. U(t) is the increase or decrease of temperature. M(t) is the outside temperature of the building.

6. Plan of Work

Our goal after submitting Report 1 is to make headway in making an alpha version of our project come to fruition. We want to have some sort of testable object that can attempt to accomplish some of the use cases.

Task	2/26	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7
Report 2 Part 1											
Report 2 Part 2											
Report 2 Part 3											
Report 3											
Demo 1											
Demo 2											
Archive Documentation											
Server Backend Endpoints											
Database Connection to server via API											
General App UI											
SES frontend											
SAS Frontend											
Integration of Alexa API											
Integration of in home positioning API											
Prototype of an individual speaker with Alexa functionality											

7. References

[1] 802.11n https://www.en.wikipedia.org/wiki/IEEE_802.11

[2] Amazon Alexa API
https://developer.amazon.com/public/solutions/alexa/alexa-voice-service/content/avs-api-overview

[3] Google Maps APIs https://developers.google.com/maps/

[4] Internal Positioning(FIND) API https://www.internalpositioning.com/api/

[5] Operational Contract
https://www.comptechdoc.org/independent/uml/begin/umlopcontract.html

[6] Nest https://nest.com/downloads/press/documents/thermal-model-hvac-white-paper.pdf

[7] Newtons law of cooling http://www.math.tamu.edu/~mvorobet/Math308/Fall07/Lecture18.pdf