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Data4Help and AutomatedSOS

Requirement Analysis and Specification Document

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1 Introduction

1.1 Purpose

TrackMe is a data management vendor whose business is mostly focused on healthcare. It wants to create a software system, called **Data4Help** to facilitate data acquisition by third parties of either a specific user or collective of users. Nowadays, in healthcare there would be tons of reasons in providing personal information: research centers may be interested in user data for carrying out large-scale studies or private clinics could monitorize remotely their patients, likewise public institutions could manage such data for the public health assistance. Unfortunately, not all of them can afford software-based systems and related infrastructures to provide a service at this level: TrackMe and then Data4Help wants to cover an intermediary role in this situation.
The trend in this field is also heading to the developement of smarter systems able to ensure readness in emergency situations in which users need to be immediately assisted, rather than only be passively monitored. The support and availability of several public and private hospitals in providing resources required to implement the service has pushed TrackMe to build on top of Data4Help, another important service: **AutomatedSOS**.

This RASD (Requirement Analysis and Specification Document) aims to describe and analyze deeply the two problems, trying to define goals and requirements under the external environment conditions. It is followed, moreover, by a formal definition and consistency testing of critical aspects of both the services through Alloy modeling. It is intended as a guide for further phases of the design as well as a valid reference for possible legal agreements.

1.1.1 Goals

Data4Help

- **[G1]:** A user can register personal health monitoring devices in the system
- **[G2]:** TrackMe acquires periodically health parameters specifically related to a user
- **[G3]:** Third parties can access health data of specific users, if expressively authorized by the them
- **[G4]:** Third-parties can request anonymous information about groups of people.

AutomatedSOS

- **[G5]:** The user has the possibility to specify the diseases he/she has, so the system can evaluate which health parameters monitorize
- **[G6]:** An ambulance may be sent within 5 seconds, if an emergency or anomaly condition is detected
- **[G7]:** A user designated as Supervisor of another one, is notified of both emergency and anomaly events occuring to the supervised user

1.2 Scope

1.2.1 Problem Analysis

Data4Help is a software system intended to facilitate the access to user-provided health data to third parties. The system covers an intermediary role between who wants to make personal information accessible to specific entities or specific purposes and who has an interest to access such information. Registered users can be monitored using personal sensor devices registered in the service and send information related to her/his health status to the system. Third parties, on the other side, can formulate requests to access the user data related to:

- a specific person
- a group of anonymous individuals

In the first case, the user must be notified by the system that someone is interested to acquire his/her personal data. The service must prevent third parties from accessing to the required information before the request has been accepted by the target user. The organization can attach a motivation, the purpose of the reason of the access request.
After a careful analysis, it has been established that, in order to not allow third parties to trace back to specific user information through anonymous requests, the involved individuals must be at least 1000. This means that, once received an anonymous request, the system must be able to evaluate how many anonymous users can be reached according to the research criteria specified by the third party, then accept or reject the request on the basis of the privacy policy enforced by the service.

1.2.2 World Phenomena

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

User: both Data4Help and AutomatedSOS users.
Third Party: more frequentely are companies that looks for health information for their market research, but they could also be facilities like hospitals or other activities interested in the health field.
Anomaly condition: alteration of health monitored parameters that causes an alert to the user.
Emergency condition: alteration of the health monitored parameters that directly triggers the sent of an ambulance.
False Positive: an erroneous detection of the system.
Supervisor user: every user that has access to another user information and location.
Sensor Device: all the health sensor devices that can be registered in the Data4Help system.
Supervised User: an AutomatedSOS user who is monitored by the application and has one or more Supervisors.
ASOS Monitor Mode: flag that tells the system if the user must be monitored or not, it can be changed from client-side application.
Emergency Resource Manager: is a system already implemented in all the hospitals subscribed to the AutomatedSOS service, it handles emergency calls and AutomatedSOS notifications. For each case manages the resources required by the emergency.
RescueSquad: general term used to refer a registered group of rescuers provided with the equipment required for the specific type of emergency.
Clinical condition: a risk condition associated to one or more health indicators that must be monitored in order to prevent fatal effects.
Minimum required sensors: the minimum set of sensors in AutomatedSOS that allows the system to monitor at least one clinical condition.

1.3.2 Acronyms

ASOS: AutomatedSOS
D4H: Data4Help

API: Application Programming Interface
RASD: Requirement Analysis Specification Document
GPS: Global Positioning System
HR: Heart Rate
ECG: Electrocardiograph
BLE: Bluetooth Low Energy
TLS: Transport Layer Security
HTTPS: HTTP over TLS
ERM: Emergency Resource Manager

1.3.3 Abbreviations

[Gn]: n-th Goal
[Rn]: n-th Requirement
[Dn]: n-th Domain Assumptions
24/7: 24 hours per day, for 7 days per week

1.4 Revision history

Up to now, there are no revision of this document as this is the first release.

1.5 Reference Documents

- Slides package: Requirement Engineerig part II
- Mandatory Project Assignement AY 2018-2019
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1.6 Document Structure

1.6.1 Chapter 1

In the first chapter is given a general presentation of the aim of this document, with the goals that the software has to satisfy. Morover are given other basic information in order to read easily the entire work, like the dictionary for example.

1.6.2 Chapter 2

Here is given a more detailed presentation of the software to be. In fact, in this chapter are presented the characteristics of the final users of the application, which will be the major functions of the system and the general interaction between the system and the user. Moreover are elencated all the constraints and the assumptions adopted in order to make the software work well.

1.6.3 Chapter 3

The third chapter is the most technical one. Here the requirements of the application are presented and is made clear the relation with them and the goals and the assuption of the previous chapters. Also various scenarios of a possible typical situation that needs the utilization of the software are listed. From them the use cases are created and so is possible to have, with the help of the UML diagrams, a more precise presentation of the interaction between the users and the system.

1.6.4 Chapter 4

This chapter is entirely dedicated to the analysis of the system, performed with Alloy. In the first subchapter the entire code is presented and, in the second one, there are the reuslts obtained .

1.6.5 Chapter 5

Chapter 5 presents the general amount of work required to complete this document and a list of references to the material we used to get the missing information.

2 Overall Description

Here you can see how to include an image in your document.

Here is the command to refer to another element (section, figure, table, ...) in the document: *As discussed in Section and as shown in Figure* **??**, ... Here is how to introduce a bibliographic citation [1]. Bibliographic references should be included in a `.bib` file.

Table generation is a bit complicated in Latex. You will soon become proficient, but to start you can rely on tools or external services. See for instance this https://www.tablesgenerator.com.

2.1 Product Perspective

2.1.1 Data4Help

The main goal of Data4Help is to guarantee control on the health parameters of the users in order to give the possibility to third parties to obtain the data. Every user registered in d4h knows that his/her registered parameters could be used for market information, but also for helping researchers to discovers new treatments. This possibility is made by providing two types of registration: the user and the third party.

There will be the possibility for the users to accept or deny personal requests from third parties, in this way there will be no privacy violations. On the other hand, every request from the third party that comprehend at least 1000 of anonymous users will not require the consultation of every single user involved. In order to control the user's parameters is possible to connect to the service various types of sensor devices.

2.1.2 AutomatedSOS

AutomatedSOS wants the users to feel safe. Provided the necessary sensor devices, the system guarantee a constant control on the health parameters. Every alteration that could possibly lead to an emergency is immediately notified to the user that could confirm the emergency condition or deny. Alteration that are definitely sign of emergency lead immediately to an ambulance call.

Obviously, in order to guarantee that the number of false positives remains as low as possible, the user is required to give correct health information when he/she registers to the service.

Is given also the possibility to accept supervisor users that are able to access to the entire data of the user supervised. In this way, in case of emergency, there will be someone promptly informed.

2.2 User Characteristics

In both, Data 4 Help and Automted SOS the main actor is who we already called User. He/She is the one that provides health information to TrackMe while is monitored after the registration to the app. Without this presence, the application does not have any reason to exist.

Another actor is the Thrid Party. It looks for the information provided by the users for its own interests (from business to healthcare).

2.3 Assumptions, Dependencies and Constraints

2.3.1 Domain Assumptions

Data4Help

- **[D1]:** The device to be registered, is supported by the system.
- **[D2]:** Data acquired by the connected sensors is intended to be accurate.
- **[D3]:** Health information manually provided by the user is intended to be

AutomatedSOS

- **[D4]:** The user is registered to AutomatedSOS.
- **[D5]:** The sensor devices monitoring the patient are providing reliable data.
- **[D6]:** The position of both the ambulance and the user are accurately
- **[D7]:** The Supervisor is a Data4Help registered user
- **[D8]:** The Supervisor is available when the notification is sent.

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 D4H: User Interfaces

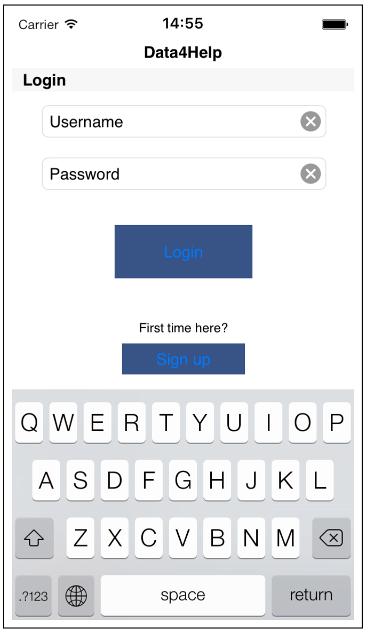
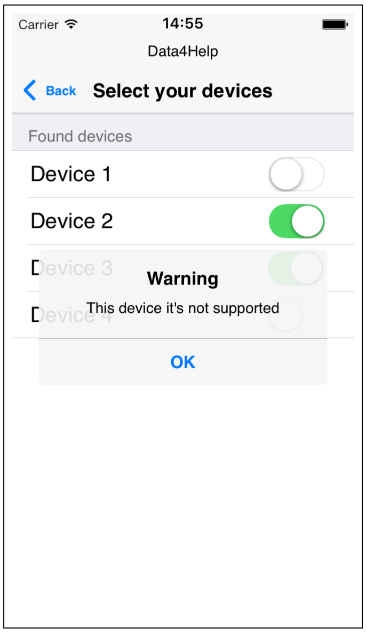


Figure 1: User Login



This device it's not supported

Figure 2: Device not supported

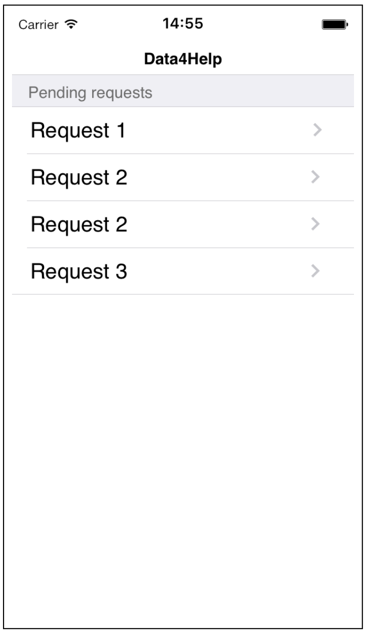
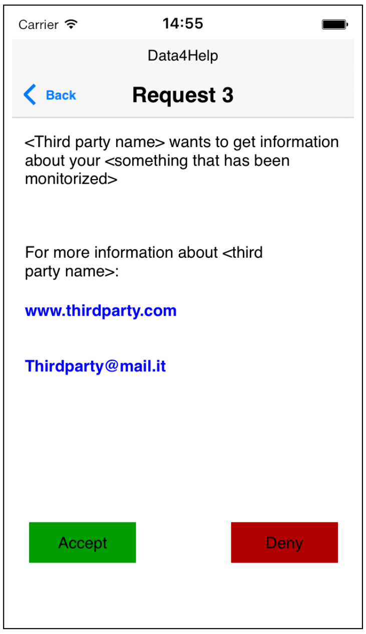


Figure 3: Pending TP requests



<Third party name> wants to get information about your <something that has been monitorized>

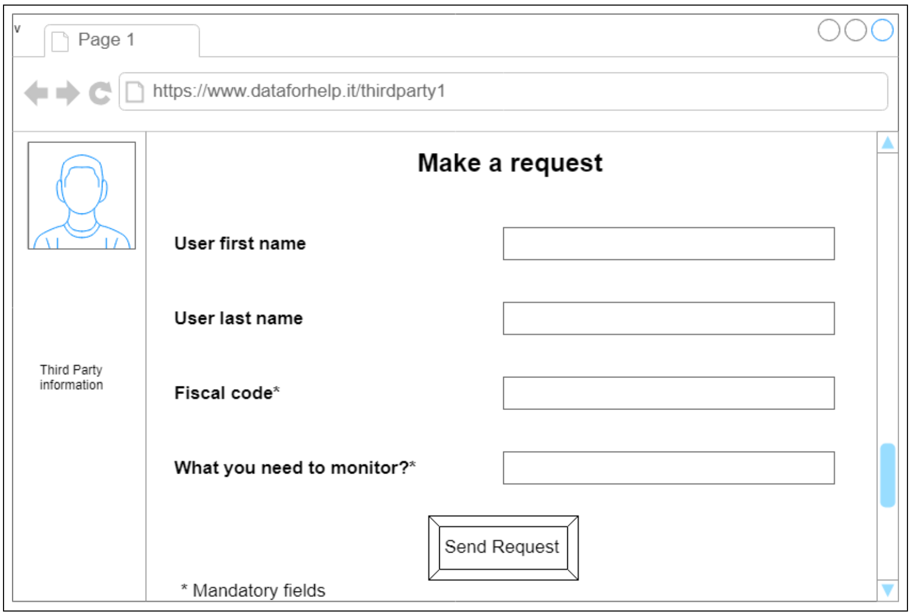
For more information about <third party name>:

www.thirdparty.com

Thirdparty@mail.it

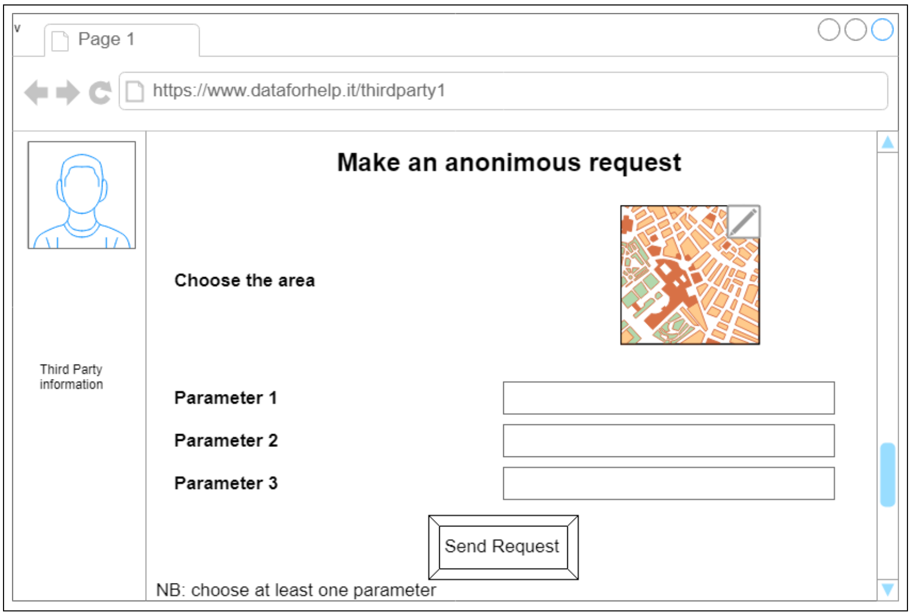
Figure 4: Evaluate Request

3.1.2 D4H: Third Party Interfaces



* Mandatory fields

Figure 5: TP make a request



NB: choose at least one parameter

Figure 6: TP make an anonymous request

3.1.3 ASOS: User Interfaces

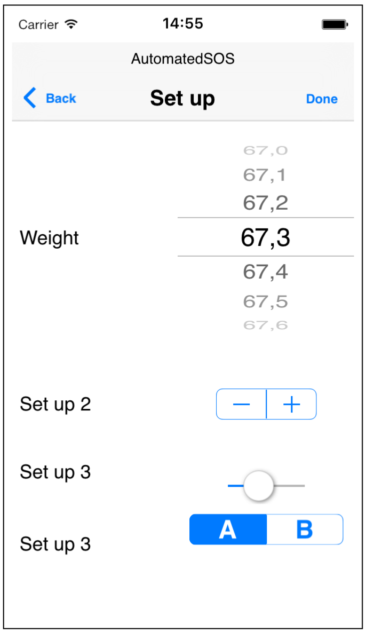


Figure 7: User Health Profile part 1

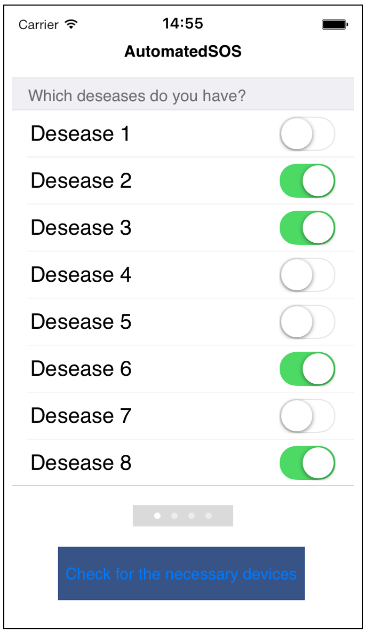


Figure 8: User Health Profile part 2

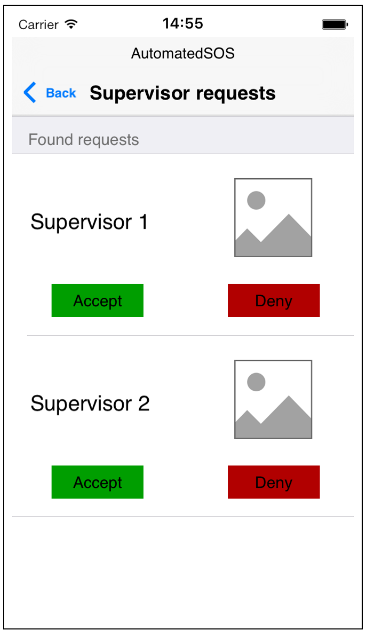


Figure 9: Supervisor Invitation

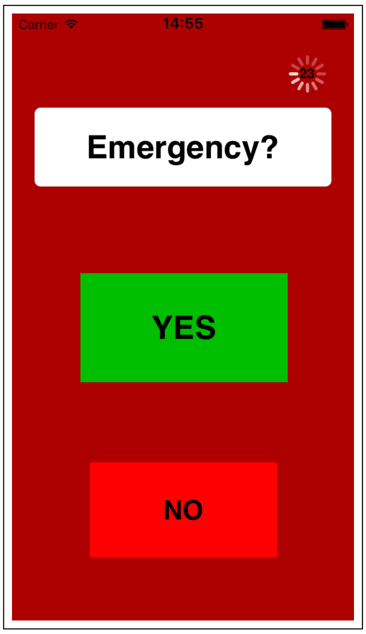


Figure 10: Anomaly Detection

3.1.4 Hardware Interfaces

In order to work well and give the possibility to take advantage of the services offered by the system, both Data4Help and AuomatedSOS are required to be installed in a smartphone that provides:

- GPS system
- Bluetooth (or BLE) interface

The first requirement is needed especially for ASOS users, as substitute of GPS bracelets or similar, in order to provide the position of the user each time the system asks for it.

The second requirement is important because most of the available sensor devices on the market can be connected to the smartphone using Bluetooth or BLE interfaces.

Sensor devices are not mandatory but strongly suggested to allow D4H to acquire health parameters (like blood pressure, HR, breath rate and so on), without them, the application does not provide consistent advantages to the users.

3.1.5 Software Interfaces

D4H and ASOS rely only on Google Maps API as external service. Both the computation and the storage part of the system are completely hosted and managed by TrackMe. Depending on more external services can affect negatively the reliability of the system.

3.1.6 Communication Interfaces

In order to ensure confidentiality, data integrity and server authenticity, HTTPS is likely to be used as network protocol to manage the encrypted communication between the client (user or third party) and TrackMe servers for security reasons. Since the protocol uses TCP at transport layer is probable to deal with problems related to delays in communication. A deep analysis of how much acceptable are such delays must be carried out.

3.2 Data4Help Scenarios

3.2.1 Scenario 1

Ross is a Dr. Herbert's patient, he discovers that he is registered to Data4Help, the new service provided by TrackMe and decides to subscribe to it in order to facilitate the doctor to access his own health indicators. Ross so, downloads the app on his smartphone, runs it and fullfils the form for the registration. The system asks Ross the permission to collect data from all the devices the user will register in the system. Once this procedure is completed, the service detects that a compatible smartwatch and a respiratory rate monitoring device are connected to the mobile phone through the bluetooth interface. Then, the application asks Ross which one he wants to register to the service. Ross selects them and allow the system to complete the operation. The app, once finished, signals to the user that it is ready to notify possible requests from third parties to access the monitored information. During the evening, Dr. Herbert receives the message from Ross who confirms his registration to Data4Help. The doctor logs in the service using the hospital credencials and inserts "Ross Gilbert" in the search form. Dr. Herbert then, once the system found the user's account, formulates the request including the motivation and sends it to Data4Help. Ross, the morning after, runs the application that notifies him of the awaiting request, so he checks for the requestor and accepts it.

3.2.2 Scenario 2

Angelo has bought two smart devices, an elastic strip equipped with a sensor able to measure blood pressure and an electronic bracelet for monitoring HR. He discovers that they can be interfaced with his smartphone through Bluetooth interface, so requests to the application to register the device, the service starts to check if the detected sensors are compatible or not. Unfortunately, only one of them is completely supported by the system: the sensor strip. So Angelo accepts to register only one device and the app, once performed the operation, update its status and return to collect data from all the connected devices.

3.2.3 Scenario 3

SoftGalaxy is a software company that is working on a new application to provide to registered users a modern service called Health Advisor. It can suggest changes in daily habits, in diet and more, according to user data provided to the system. Unfortunately, the company cannot afford a large-scale system to collect information in real-time. In order to save as much resources as possible, it decides to rely on Data4Help to achieve this task. Before releasing the application, SoftGalaxy connects to the system and registers itself as third party, fulfilling the proper form. In addition, Data4Help asks the company to provide its digital certification for security reasons. Once the procedure is completed, the organization confirms the registration through the company's email address.

3.2.4 Scenario 4

The company Virgin Active is considering opening a new gym near Saint Ambrogio church in Milan. In order to do so, it decides to ask to Track Me to receive the information about all the overweight people that live in the area of Saint Ambrogio. TrackMe replied with a negative answer because there are only 593 people that suits with the requirements. Virgin Active has to change the request and so asks the same information but for a larger area taking in also the area of Saint Agostino. This time there are enough people to let the request being forwarded and so Virgin Active can receive the information needed.

3.3 AutomatedSOS Scenarios

3.3.1 Scenario 1

Michelle has an elderly mother, Teresa, who suffers about a rare heart disease. She is constantly monitored by a portable ECG device due to the high risk of being hit by an heart attack. Unfortunately, Michelle works during the morning and in this period of the day no one takes care of Teresa. She suggests to the mother to rely on AutomatedSOS, a Data4Help-based service. Since the elderly woman has a smartphone, with Data4Help installed and a personal account, she decides to download the application and logs in with Data4Help credencials. The system notices that Teresa is using the service for the first time, so it asks some information about her health problems and through it the app creates an health profile and a list of required sensors. The ECG that is actually monitoring her, is already registered and used by Data4Help, but since she has specified that suffers about loss of consciousness the system warns her that a fall sensor should be registered to provide the proper assistance. Teresa has not the device yet, so ignores the warning and complete the profiling procedure. The app finally, is ready to monitor the woman's health status.

3.3.2 Scenario 2

Marianna turned 60 one month ago and recieved a notification from the app Data4Help that proupoosed her to join to asos. She decided that it could be a good idea in order to live better and safer. As soon as she acceptend to join it, Marianna is aked to fill a questionnaire about some basic information of herself. A few days after, she had dinner with friends and ordered a piece of cake without knowing that inside it there were almonds, a food that gaves her anaphylactic shock. Immediately she started to breath bad, her heartbeat increased and also her pressure. Her phone rung, asos was asking if everything was ok. As

Marianna needed an ambulance, she answered negatively. Her husband received a notification from asos that Marianna was sick and an ambulance arrived at the restaurant, saving Marianna.

3.3.3 Scenario 3

Carol is a young student, she is subjected to loss of consciousness episodes due to medicines she has to take for a congenital disease. Carol is an ASOS user as well as her mother, Jenny. This last one decides to watch over the health conditions of her daughter when she is outside home. So, Jenny in order to be notified of all the emergencies and provides support when near the daughter, opens AutomatedSOS and sends to Carol an invitation for becoming her Supervisor. Carol, during the school break receives the request and accepts it. Becoming a Supervisor, Jenny is allowed to be notified of the daughter health status when something goes wrong and to know the position of Carol.

3.4 Functional Requirements

3.4.1 Data4Help

[G1]: A user can register personal health monitoring devices in the system

- [R1]: The system must allow a registered user to associate a sensor device to the service.
- [D1]: The device to be registered, is supported by the system.

[G2]: TrackMe acquires periodically health parameters specifically related to a user

- [R2]: Each user is uniquely identified by the system.
- [R3]: The system can acquire health data by specific sensors connected to the user's main device.
  - [D2]: Data acquired by the connected sensors is intended to be accurate.
- [R4]: The system must provide the possibility to users to insert specific health information that cannot be acquired through other monitoring devices.
  - [D3]: Health information manually provided by the user is intended to be correct.

[G3]: Third parties can access health data of specific users, if expressively authorized by the them

- [R5]: The system must be able to identify and certificate the reliability of each organization that wants to request user data.
- [R6]: Each registered organization that wants to access health data of specific users must be able to formulate a request providing information related to the purpose of the request.
- [R7]: The system must notify each user of a third party request as soon as it is formulated, and allow him/her to accept or reject the request.
- [R8]: For each third party request the system should provide to the user information related to the requestor and the purpose of the request.
- [R9]: Once a third party request is accepted by the user, the third party must have full access to the entire collection of data of the user.

[G4]: Third-parties can request anonymous information about groups of users

- [R10]: Third parties must be able to request health data of groups of anonymous users, according to several criteria without being expressively authorized.
- [R11]: The system must prevent third parties to trace back to specific user information through anonymous requests.

3.4.2 AutomatedSOS

[G5]: The user has the possibility to specify the diseases he/she has, so the system can evaluate which health parameters monitorize

- [R12]: The system must give the possibility to the user to specify which diseases he/she has.
  - [D4]: The user is registered to AutomatedSOS.
- [R13]: The system must prevent the possibility to use the service, if the minimum required sensors are missing.

[G6]: An ambulance may be sent within 5 seconds, if an emergency or anomaly condition is detected

- [R14]: The system must be able to distinguish and detect emergency or anomaly conditions occurring to a specific user.
- [R15]: When an anomaly condition is detected, the system must send a notification to the user, asking if it is an emergency condition.
- [R16]: When an emergency condition is detected, the nearest ambulance must be alerted, providing all the information about the situation.
  - [D5]: The sensor devices monitoring the patient are providing reliable data.
  - [D6]: The position of both the ambulance and the user are accurately provided by the GPS system.

[G7]: A user designated as Supervisor of another one, is notified of both emergency and anomaly events occuring to the supervised user

- [R17]: A user must be allowed by the system to become Supervisor of another one.
  - [D7]: The Supervisor is a Data4Help registered user.
- [R18]: Each supervised user must be able to accept or reject the possibility to have a Supervisor.
- [R19]: The Supervisor must be notified by the system of all emergency and anomaly conditions occurring to the supervised user.
  - [D8]: The Supervisor is available when the notification is sent.

User Signs Up	
Actors:	User
Entry Conditions:	The user has already downloaded the application
Flow of Events:	1. The user clicks on "Signs up as User" 2. The user inserts all the required information 3. The user confirms the registration 4. The system asks the user if he/she wants to associate a sensor device to the service. 5. The user accepts to register the devices 6. The system redirect the user to the Device Registration space 7. The user registers the devices connected to the smartphone 8. The system redirect the user to his/her personal account
Conditions:	The user is successfully signed up
Exceptions:	• 3) The user is already registered to the service, a notification will be sent, preventing him/her to register again. • 4) The user skips the device registration and the system redirect the user to his/her account
Special Requirements:	None

3.5 UML Modeling

3.5.1 Data4Help Use Cases

User Login	
Actors:	User
Entry Conditions:	The user is already signed up
Flow of Events:	1. The user inserts the access credencials 2. The user taps on "Log in"
Exit Conditions:	The system redirect the user to his/her personal account
Exceptions:	• If the username or the password are incorrect the user is requested to rewrite them
Special Requirement:	None

Register Device	
Actors:	User
Entry Conditions:	The user is logged in Data4Help
Flow of Events:	1. The user taps on "Add Device" 2. The system provides the list of all the sensor devices connected to the smartphone 3. The user selects the devices he/she wants to associate to the service 4. The system registers the devices
Output Conditions:	A new monitoring device is added in the system
Exceptions:	• If the registered sensor corresponds to a new monitored parameter the information is associated to the current user in the system • If the device is not supported, the system sends a warning to the user and denies the device registration.
Special Requirement:	None

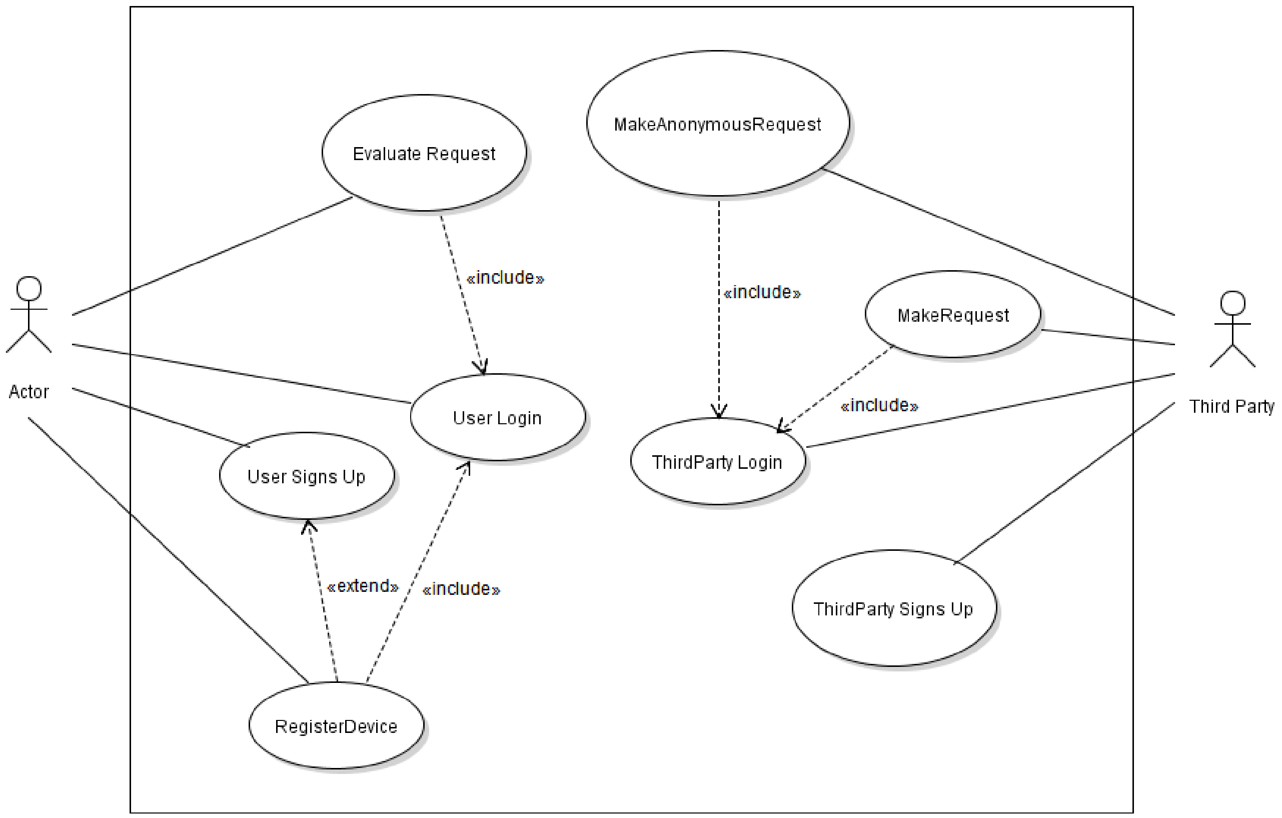
ThirdParty Sign Up	
Actors:	Third Party
Entry Conditions:	The third party has not registered to the service yet
Flow of Events:	1. The third party clicks on "Sign Up as Third Party" 2. The third party inserts the requested information 3. The third party provides a certification of its identity 4. The third party confirms the information provided 5. The system verifies the inserted data 6. The system confirms the registration and redirect the third party to its personal account.
Exit Conditions:	The third party is registered to Data4Help
Exceptions:	• If the information provided is incorrect or the third party is already registered, the system shows a warning and denies the registration
Special Requirements:	None

ThirdParty Logs in	
Actors:	Third Party
Entry Conditions:	The third party is already registered in the service
Flow of Events:	1. The third party clicks on "Log in as Third Party" 2. The third party inserts the access credencials 3. The system verifies the provided information
Exit Conditions:	the system redirects the third party to its personal account
Exceptions:	• If the credencials inserted are not valid, the system sends a warning and denies the access
Special Requirements:	None

Make a Request	
Actors:	Third Party
Entry Conditions:	The third party has already signed up for Data4Help
Flow of Events:	1. The third party clicks on "Create Request" 2. The third party selects the user data types that wants to access and inserts the information required to find the user 3. The third party provides the motivation of the request. 4. The system checks if someone matches the search criteria and provide the result 5. The third party clicks on "Send Request" 6. The system notifies the third party that the request has been sent to the user
Exit Conditions:	The request is sent to the specific user
Exceptions:	• If the specified search criteria do not provide a valid result, the system shows a warning and the request is not created.
Special Requirements:	The third party knows exactly the minimum search information required to find the specific user

Evaluate Request	
Actors:	User
Entry Conditions:	• The user is logged in Data4Help • The user is notified by the system that a third party request has been received
Flow of Events:	1. The user enters the pending requests 2. The user selects the last request 3. The user taps on the request 4. The system shows to the user identity and motivation of the requestor 5. The user accepts the request 6. The system notifies the third party about the decision of the user
Exit Conditions:	The system allows the third party to access the requested user's dataset
Exceptions:	• If the user rejects the request, the system notifies the rejection to the third party • If the request has been aborted by the third party or is expired the system notifies the user that the request is no longer acceptable or rejectable
Special Requirements:	None

Make an Anonymous Request	
Actors:	Third party
Entry Conditions:	The third party is logged in Data4Help
Flow of Events:	1. The third party clicks on "Create Anonymous Request" 2. The third party specifies the search criteria required to find the group of anonymous users 3. The system checks if the number of involved anonymous users are at least 1000, according the search criteria 4. The system notifies the requestor that a valid dataset has been found
Exit Conditions:	The third party obtains the anonymous dataset
Exceptions:	• 3) If the anonymous users involved in the request are less than 1000 or no one matches the search criteria, the system notifies the event and rejects the request.
Special Requirements:	None



3.5.2 AutomatedSOS Use Cases

User Logs in ASOS	
Actors:	User
Entry Conditions:	The user is already registered in Data4Help
Flow of Events:	1. The user inserts the D4H access credencials 2. The user clicks on "Log in" 3. The system checks if the credencials are valid
Exit Conditions:	The system redirects the user to his/her personal AutomatedSOS account
Exceptions:	• If the user inserts wrong credencials the system sends a warning and denies the access • If the user has logged in for the first time, the system starts to profile the health conditions of the user (see:"Change User Health Profile")
Special Requirements:	None

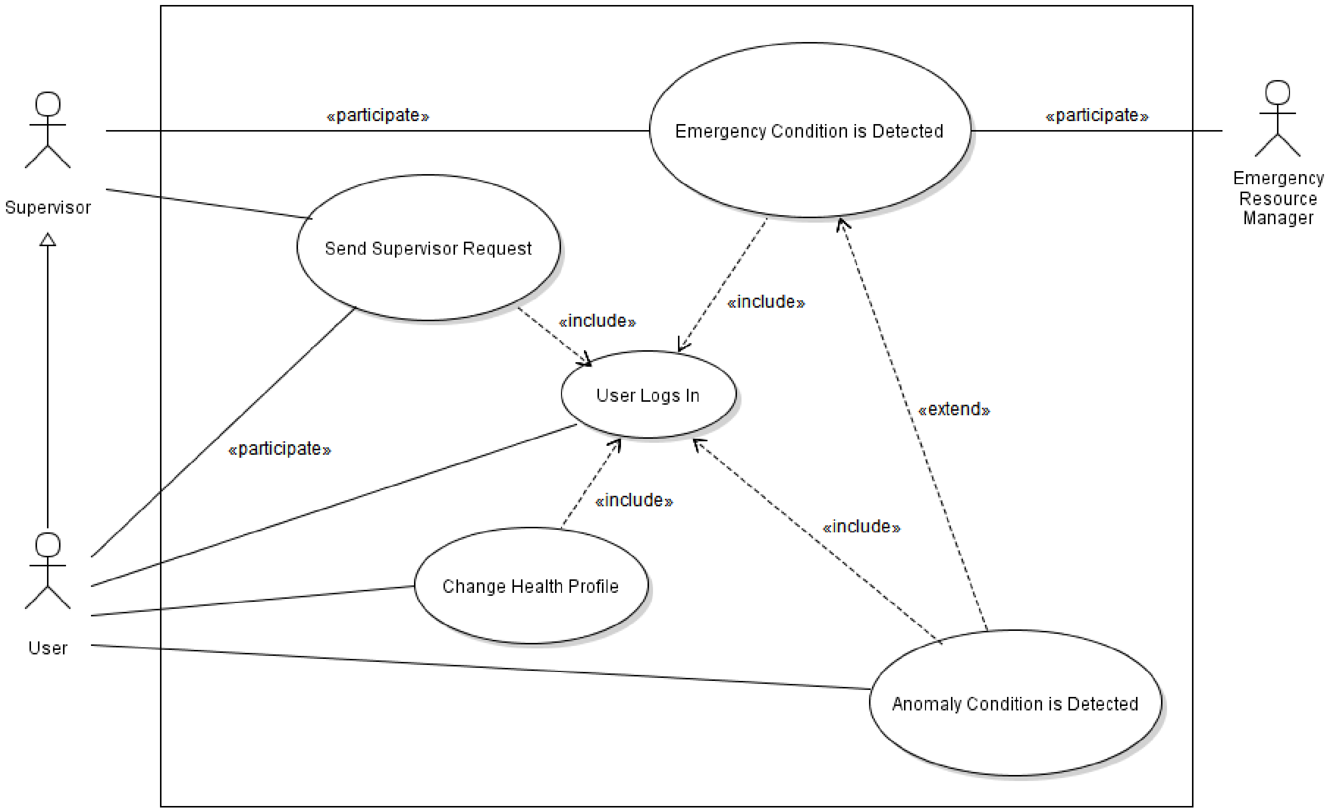
Change Health Profile	
Actors:	User
Entry Conditions:	The user is logged in for the first time
Flow of Events:	1. The user clicks on "Manage Health Profile" 2. The user inserts personal information regarding age, daily habits, addictions, diagnosed diseases 3. The system evaluates and provides a list of clinical conditions that can be monitored according to the inserted information 4. The system checks if the sensors required for monitoring the given clinical conditions are registered to D4H and connected to the smartphone 5. The user confirms the result
Exit Conditions:	The health profile is updated and the user is monitored according to the new clinical conditions
Exceptions:	• 3) If none of the minimum required sensors are registered or connected, the system warns the user and denies the service. • 3) If only a part of the required sensors (at least the minimum required ones) are registered in the service, the user selects which of the available clinical conditions he/she wants to be monitored and confirms.
Special Requirements:	None

Send Supervisor Request	
Actors:	User
Entry Conditions:	The user is logged in AutomatedSOS
Flow of Events:	1. The user clicks on "Become Supervisor" 2. The system asks the identification of who should be supevised 3. The user inserts the fiscal code of the supervised user 4. The system provides the result of the research 5. The user sends the request
Exit Conditions:	The receiver is notified of the supervisor request
Exceptions:	• 4) The research criteria do not match any existing AutomatedSOS user
Special Requirements:	None

Anomaly Condition is Detected	
Actors:	User
Entry Conditions:	• The user is logged in AutomateddSOS • The AutomadesSOS Monitor Mode is switched on • AutomatedSOS system has detected an Anomaly Condition
Flow of Events:	1. The user is notified by the system that asks to him/her if an ambulance is needed 2. The user confirms that is an emergency 3. The system turns the anomaly into an emergency condition
Exit Conditions:	The system raises an emergency condition (see:"An Emergency Condition is Detected")
Exceptions:	• The user is fine, he/she notifies the system that an ambulance is not required • If the user does not reply to the notification, the anomaly timeout expires and the system alerts the nearest hospital
Special Requirements:	The timeout must fixed to 30 seconds

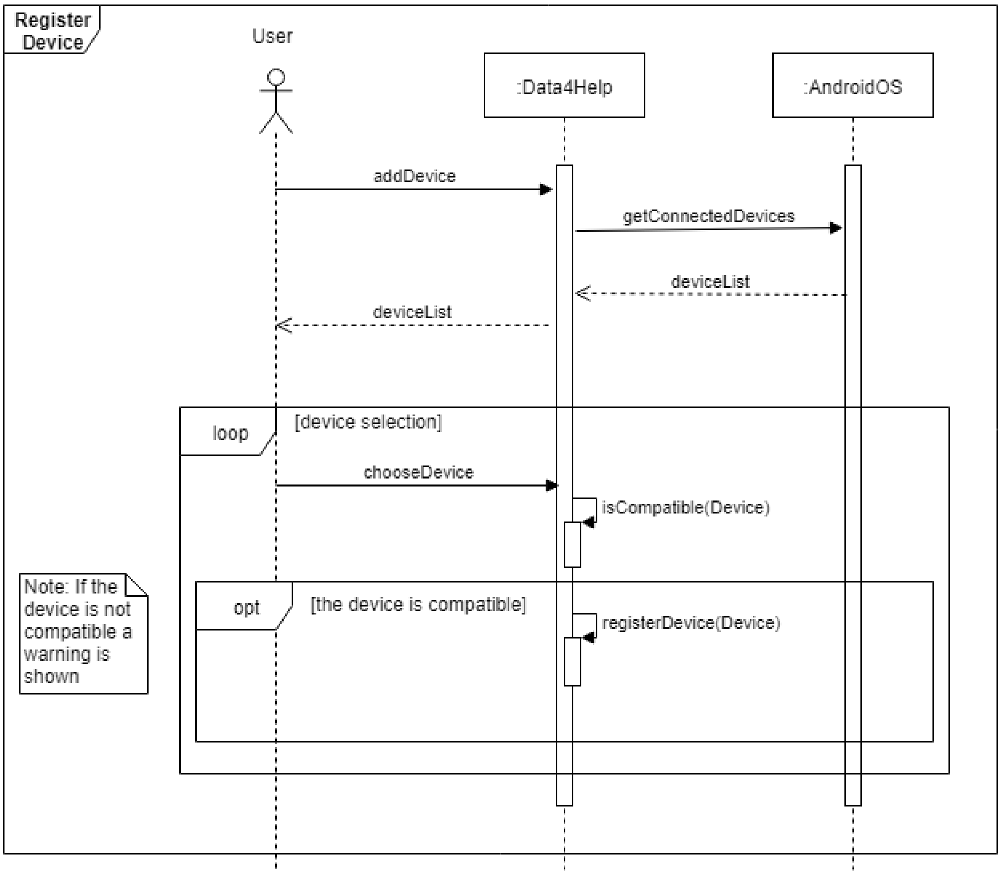
Evaluate Supervisor Request	
Actors:	User
Entry Conditions:	• The user is logged in AutomatedSOS • The user is notified that a Supervisor request has been received
Flow of Events:	1. The user enters the list of the pending supervisor requests 2. The user selects the request 3. The system provides the identity of the requestor 4. The user accepts the request
Exit Conditions:	The system notifies the new Supervisor and allow him/her to access the user's health status and position during emergencies
Exceptions:	• 4) If the user rejects the request the system notifies the requestor of the refuse.
Special Requirements:	None

An Emergeny Condition is Detected	
Actors:	EmergencyResourceManager
Entry Conditions:	• An emergency condition is detected. • An anomaly is turned into an emergency condition
Flow of Events:	1. The system sends an alert to the nearest hospital's ERM providing the identification and position of the user, the reason of the emergency, the time instant at which the event has been detected 2. The ERM alerts and dispatches that available RescueSquad which is the nearest to the user in danger
Exit Conditions:	The system is notified that a RescueSquad has been dispatched to the user
Exceptions:	• 2) If no RescueSquad for the alerted hospital is available, the system is informed about and sends the request to the ECM of the second nearest hospital, and so on if also the second attempt fails. If one of the alerted ECMs dispatches a RescueSquad for first, the system notifies the others of the dispatch. • 1) If the user is associated to one or more Supervisors, these ones are also alerted of the emergency and informed of the position of the user.
Special Requirements:	The time spent between the emergency detection and the RescueSquad dispatch must be at most 5 seconds

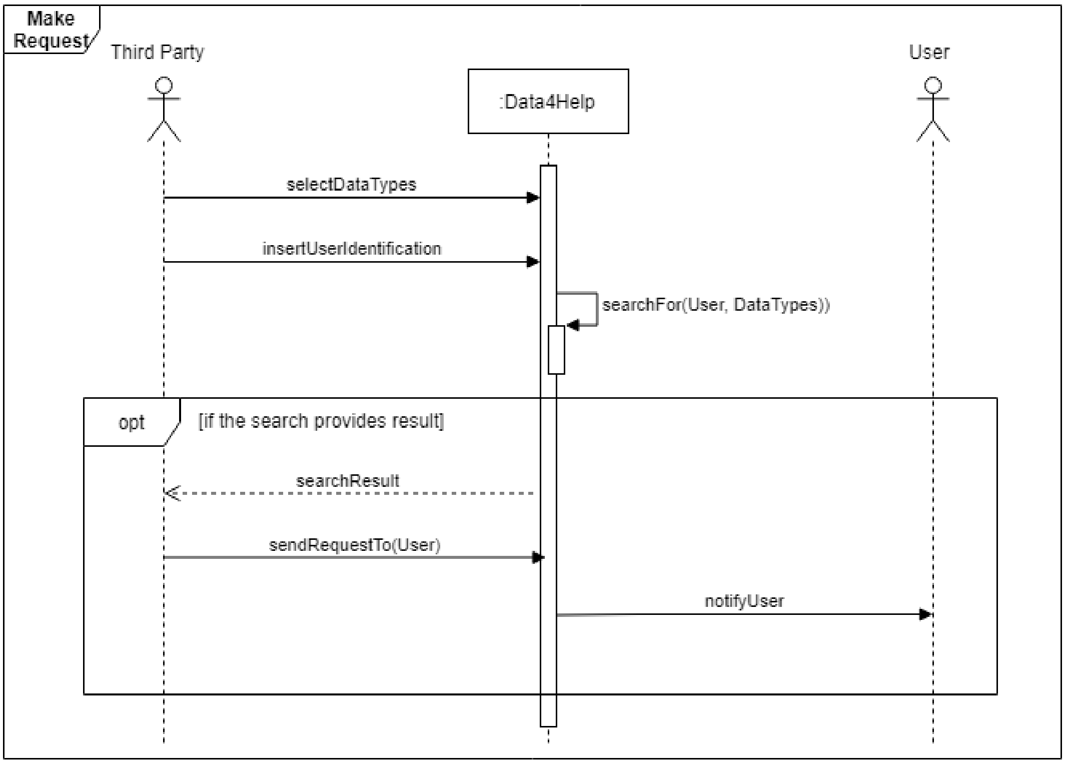


3.5.3 Data4Help Sequence Diagrams

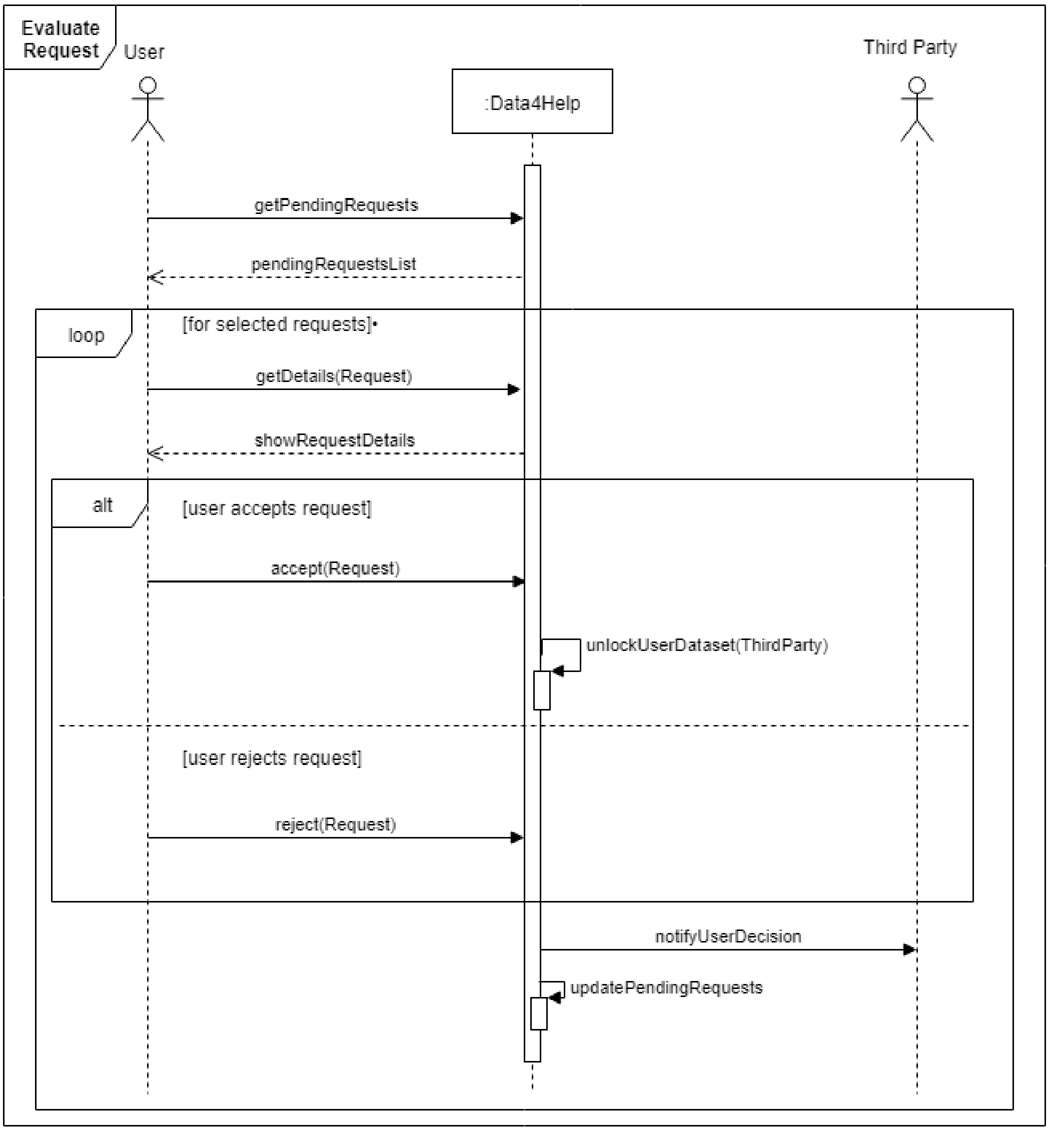
Register Device



Make Request

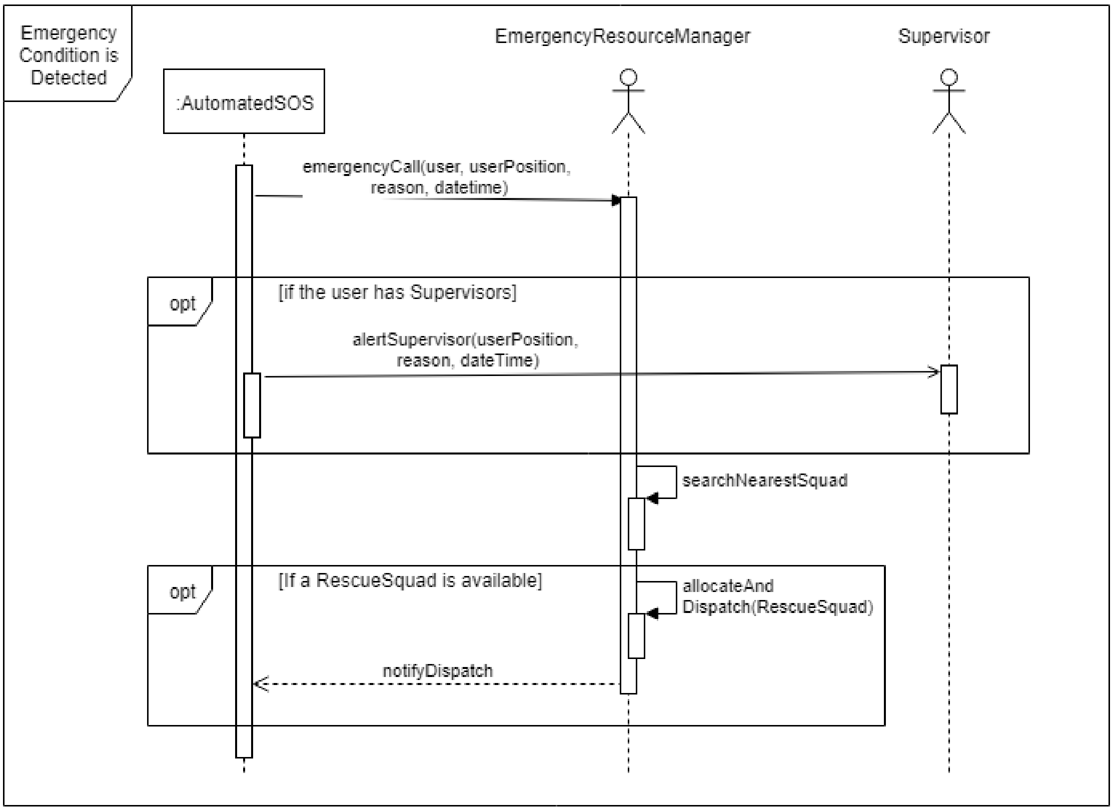


Evaluate Request



3.5.4 AutomatedSOS Sequence Diagrams

Emergency Condition is Detected


Emergency Condition is Detected
:AutomatedSOS
EmergencyResourceManager
Supervisor
emergencyCall(user, userPosition, reason, datetime)
opt
[if the user has Supervisors]
alertSupervisor(userPosition, reason, dateTime)
searchNearestSquad
opt
[If a RescueSquad is available]
allocateAnd Dispatch(RescueSquad)
notifyDispatch

3.6 Performance Requirements

Both Data4Help and AutomatedSOS aim to help the highest number of people. AutomatedSOS must guarantee that the user's information is sent in real time to the application so the emergency can be solved as soon as possible. A delay higher than 3 seconds can't be tolerated. Data4Help have to make avaiable the information of each user during an entire month.

3.7 Design Constraints

3.8 Software System Attributes

3.8.1 Reliability

Data4Help presents a critical factor related to the data processing on server side. As already motivated, this huge amount of information related to each connected user should be processed in real-time especially when supporting AutomatedSOS users, any failure of both the services could potentially lead to the death of a person. A domino effect, in which a generic fail may cause the blackout of the entire service is unacceptable and must be avoided.

3.8.2 Availability

The software has to be online 24/7, in particular the AutomatedSOS part because its chore is to guarantee a constant control of the users. In this case the system should be kept down for the least time possible when performing maintenance. For minimizing the risk of having interruption of service for patients who need assistance, an availability of at least 99.999% has to be granted. It is an exigent but required value. Since AutomatedSOS relies on Data4Help for collecting data, both the services should have the same availability. Unfortunately this requirement is too expensive for all the users of D4H. It is sufficient to provide such level of availability only for all the users who rely on AutomatedSOS and a value of 99.99% for the remaining ones. This solution can reduce appreciably the costs of maintenance.

3.8.3 Security

Companies and organizations that want to rely on the service must certificate their identity. For the first version of the application, a third party has to provide to the service a valid digital certification, released by a well-known and reliable Certification Authority. This represent an essential security requirement that also provide a strong encrypted communication between the third party and TrackMe. Since TrackMe is also provided with a digital certification, user data sent to the server are encrypted using TLS (Transport Layer Security).
Passwords of both users and third parties, must be hashed and salted on server side.

3.8.4 Maintainability

Especially for Data4Help, the system will deal with an enormous amount of data coming from a wide variety of sensors. Maintainability challenges will concern mainly with the support of new sensor devices appearing in the market that must be supported by the system. The architecture should facilitate the introduction of new products to speed up updated versions of the system.

3.8.5 Portability

The application have to be developed in order to support all the Android devices with an API level higher or equal to 15 (Android 4.0, Ice Cream Sandwich).

4 Formal Analysis Using Alloy

```
-- MODEL SIGNATURES

module model_signatures

open util/integer
open util/boolean
open util/time


-- DATA4HELP


sig Location {
        --Latitude
        lat: one Int,
        --Longitude
        long: one Int
}{
        long ≥ -90 and long ≤ 90 and lat ≥ -180 and lat ≤ 180
}


sig Timer{
        seconds: one Int
}



sig User{
        dataset: lone UserDataset,
        pendingList: lone PendingRequests,
        devices: set Device
}



sig Device{
        user: lone User,
        healthParameters: set HealthIndicator,
        location: Location lone -> Time,
        supported: Bool one -> Time,
        registered: Bool one -> Time,
        connected: Bool one -> Time
}


sig FiscalCode{
        identify: lone User
}


sig HealthIndicator{

}


abstract sig Dataset{}

sig UserDataset extends Dataset{
        subject: one User,
        sensors: set Device,
        healthStatus: set HealthIndicator,
        userPosition: set Location
}


sig AnonymousDataset extends Dataset{
        involvedUsers: set User,
        healthStatus: set HealthIndicator
}


sig ThirdParty{
        requests: set Request,
        accessTo: set UserDataset
}


sig Request{
        accepted: Bool one -> Time,
        requestor: one ThirdParty,
        requestObject: one UserDataset,
        userDecision: Bool one -> Time
}


sig PendingRequests{
        requests: set Request
}


sig AnonymousRequest{
        accepted: Bool one -> Time,
        involvedUser: one Int,
        requestor: lone ThirdParty,
        requestObject: lone AnonymousDataset,
}


-- AUTOMATED SOS


sig ERM{
        position: one Location,
        userDistance: one Int,
        squads: some RescueSquad
}{
        userDistance > 0
}

sig RescueSquad{
        position: one Location,
        userDistance: one Int,
        available: one Bool,
        dispatched: one Bool
}{
        available = False implies dispatched = False
        userDistance > 0
}


sig TriggerEvent{
        indicators: some HealthIndicator,
        constraints: some Int,
        criticality: one Bool
}


abstract sig Condition{
        user: one User,
        emPosition: one Location,
        triggerEvents: some TriggerEvent,
        time: one Time
}


sig AnomalyCondition extends Condition{
}{
        -- Anomaly conditions are all those conditions in which the trigger event is NOT
```

```
            ↪ critical
        all te: TriggerEvent | (te in triggerEvents) and (te.criticality = True)
}


sig EmergencyCondition extends Condition{
}{
        -- Emergency conditions are all those Anomaly conditions in which the trigger event is
            ↪  critical
        all te: TriggerEvent | (te in triggerEvents) and (te.criticality = True)
}




-- CONSTRAINTS D4H

-- FACTS

-- Devices of the same user cannot provide data of the same health indicator
fact userDevicesNoSameIndicator{
        all disj d1, d2: Device | d1.user = d2.user implies d1.healthParameters ≠ d2.
            ↪ healthParameters
}


-- The device can be registered only if connected and supported by the system
fact registeredIfSupported{
        all d: Device | all t: Time | d.registered.t = True implies d.supported.t = True and d
            ↪ .connected.t = True
}


-- One UserDataset cannot be associated to two different users
fact oneUserToOneDataset{
        all disj ds1, ds2: UserDataset | ds1.subject ≠ ds2.subject
}


-- If the anonymous request does not involve at least 1000 users
fact mustInvolve1000AnonUsers{
        all ar: AnonymousRequest | all t: Time | ar.accepted.t = True iff #(ar.involvedUser) ≥
            ↪  1000
}


-- A specific-user request has a unique subject
fact oneRequesToOneUser{
        all r: Request | all disj u1, u2: User | r.requestObject.subject = u1 implies r.
            ↪ requestObject.subject ≠ u2
}


-- a third party accesses to a UserDataset only if authorized
fact onlyAuthorizedAccess{
        all tp: ThirdParty, ds: UserDataset, rq: Request, t: Time |
         (ds in tp.accessTo and ds.subject = rq.requestObject.subject) iff rq.accepted.t =
             ↪ True
}


-- AUTOMATED SOS CONSTRAINTS

-- FACTS


-- PREDICATES

-- the device is supported by the system
pred isDeviceSupported[d: Device, t: Time]{
        d.supported.t = True
}
```

```
-- the device is connected to the master device
pred isDeviceConnected[d: Device, t: Time]{
        d.connected.t = True
}

-- register a device in the system
pred registerDevice[us: one User, d: Device, h: HealthIndicator, t: Time]{
        isDeviceSupported[d,t]
        isDeviceConnected[d,t]
        d.user =  us
        d.healthParameters = h
        d.registered.t = True
}

-- create a third party request
pred makeRequest[u: User, tp: ThirdParty, r:Request, t: Time, pr, pr': PendingRequests]{
        r.requestor = tp
        r.requestObject.subject = u
        pr'.requests = pr.requests + r
}

-- user accept request and the request is removed from the pending list
pred acceptRequest[u, u': User, r: Request, ds: UserDataset, t: Time, tp, tp': ThirdParty]{
        r.requestObject.subject = u
        r.accepted.t = True
        r.requestObject = ds
        tp'.accessTo = tp.accessTo + ds
        u'.pendingList.requests = u.pendingList.requests - r
}

-- user rejects request and the request is removed from the pending list
pred rejectRequest[u, u': User, tp: ThirdParty, r: Request, ds: UserDataset, t: Time]{
        r.requestObject.subject = u
        r.accepted.t = False
        r.requestObject = ds
        u'.pendingList.requests = u.pendingList.requests - r
}




-- D4H Testing
run isDeviceSupported for 5 but 3 Device, 3 Time, 1 User, 5 HealthIndicator, 1 Location
run isDeviceConnected for 5 but 3 Device, 3 Time, 1 User, 5 HealthIndicator, 1 Location
run registerDevice for 5 but 3 Device, 3 Time, 1 User, 5 HealthIndicator, 1 Location
run makeRequest for 5 but 2 User, 2 ThirdParty, 2 Request
run acceptRequest for 2 but 2 User, 1 ThirdParty, 2 Request, 1 Time
```

5 Effort Spent

References

[1] S. Bernardi, J. Merseguer, and D. C. Petriu. A dependability profile within MARTE. *Software and Systems Modeling*, 10(3):313–336, 2011.