POLITECNICO
MILANO 1863

TrackMe
Software Engineering 2 Project

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Contents

1 Introduction

1.1 Purpose

TrackMe is a company aiming to support interactions between users, who like keeping track of the health status and their activities, and third parties which can use data and enhance their value.

TrackMe app is composed of three main important service:

- Data4Help: basic support for health data;
- AutomatedSOS: add support for SOS services to elderly people;
- Track4Run: add support for running events.

Each of them will have as targets:

- Individuals users
- Third parties.

Since each service serves both the targets, the project consists of platform divided in a mobile application and a web-based interface to serve third-parties.

The system allows individual users to add and handle data on the app and to third parties to request and have access to these data.

In particular, a user of the application is able to keep track of his/her position during the activities but also during the normal day-life. The users' data are used to monitor the heartbeat and eventually to send an AutomatedSOS. Furthermore, TrackMe, is able to track all the athletes (that are using the application), during a run previously organised. Indeed TrackMe's app provide a section to setup a group run, specifying the path and other useful information.

1.2 Scope

1.2.1 Description of the problem

Nowadays a lot of persons track their activities with smartphone or smartwatch. For this reason TrackMe provide a new complete user experience allowing all the user to read briefly all the information about all activities' history. It's also provided a service to organise a group run, during which it's possible to monitor all the athletes information. Furthermore all the users are monitored and, in case of some trouble, an SOS will be launched.

1.2.2 World Phenomena

- *General user's health condition*: the machine doesn't know the information about possible user's disease.
- *First aid services status*: the machine doesn't know the actual first aid services status.
- *Overall third parties knowledge status*: the machine doesn't know which informations third parties already have about users.

1.2.3 Machine Phenomena

- *Third-parties registration*;
- *User's registration*;
- *Data anonymization.*

1.2.4 Shared Phenomena

- *Vital parameters*: the machine can read vital parameters of the user such as BPM.
- *User's location*: the machine knows or can read actual and past user's location.

1.2.5 Goals

[G1] Users can be recognised by their credentials.

[G2] Allow users to keep track of their health data.

[G3] Allow users to have access to an overview of their data, including health parameters and performed activities.

[G4] Allow users to manage their data access policy.

[G5] Allow users to monitor their performance during run workouts.

[G6] Each time vital signs go below a threshold value, first aid services have to be notified.

[G7] Allow users to organise running events.

- [G7.1] Allow users to create running events.
- [G7.2] Allow users to en-roll to events.
- [G7.3] Allow spectators to follow participants' live position during events.

[G8] Allow third parties to access data:

- [G8.1] Allow third parties to require access to specific user data.
- [G8.2] Allow third parties to retrieve anonymised aggregated data.
- [G8.3] Allow third parties to subscribe to da

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

- **Event:** An event organised by a user (*e.g scenario 3.6.3).*
- **Notification:** A warning that advise the user of a request by third parties.

1.3.2 Acronyms

- API: Application Programming Interface;
- ASOS: AutomatedSOS;
- BPM: Beats Per Minutes;
- D4H: Data4Help;
- RASD: Requirement Analysis and Specification Document;
- T4R: Track4Run.

1.3.3 Abbreviations

- $[Gn]$: n-th goal
- $[Dn]$: n-th domain assumption
- $[Rn]$: n-th functional requirement

1.4 Revision history

- 1.0.0 Initial version (10-11-2018)

1.5 Document Structure

2 Overall description

2.1 Product perspective

2.1.1 Class Diagram

The product perspective of TrackMe is now explained using the UML paradigms. The main classes of the UML are:

- **User** contains all the information about a user like username, password, fiscalCode, hometown, elderly, runners.
- **ThirdParties** contains all the information about the registered organisation.
- **Data** is an abstract class that has two concrete classes: **Health data** and **Location data**
- **Running Event**
- **Location** contains information like the start point and the end point of a running event.

A user creates an Event specifying the path ie the starting location, the ending location and some specific interesting point along the path. After the creation some user can join in. An organisation, as explained above, can subscribe to a feed of data or directly to a single user.

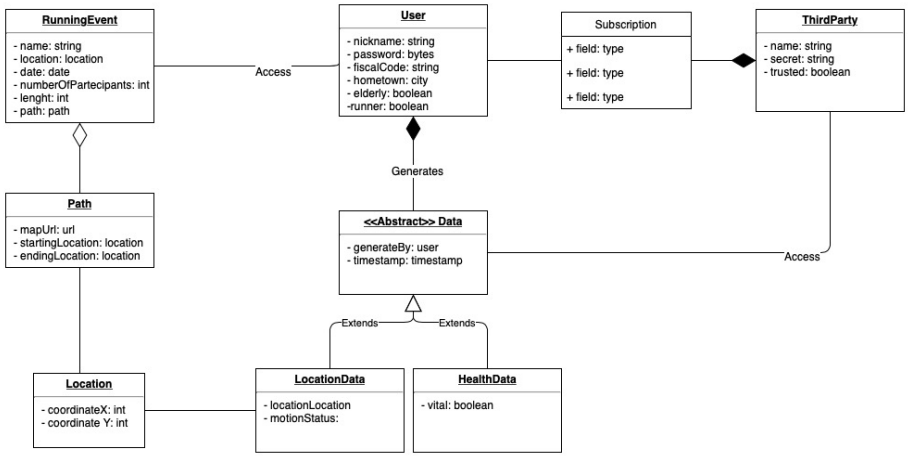


Figure 1: UML diagrams.

2.1.2 State Diagram

The whole system can be also seen as a set of different services relying on the main module Data4Help. Here we describe the main aspects of them with state diagrams.

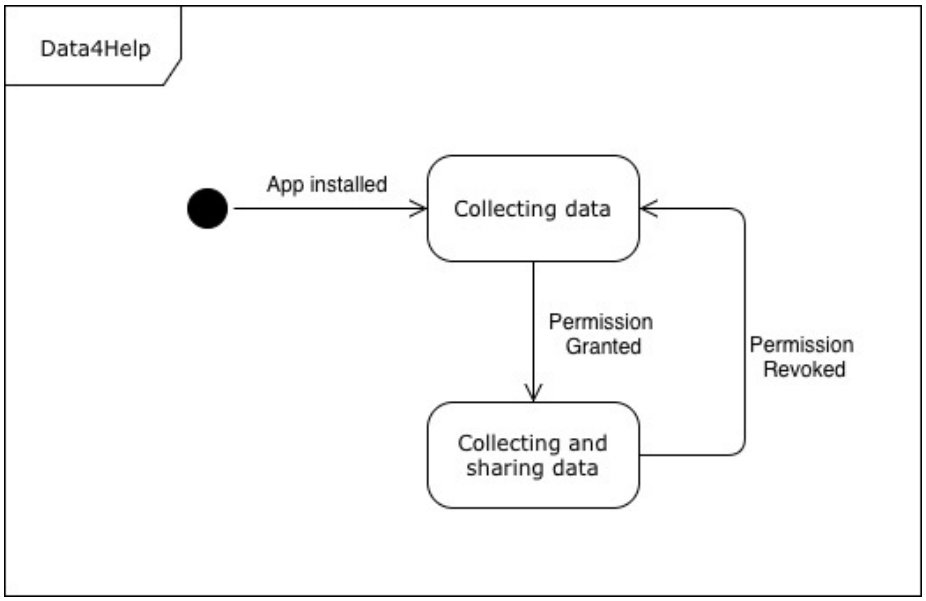


Figure 2: Basic Data4Help service state diagram.

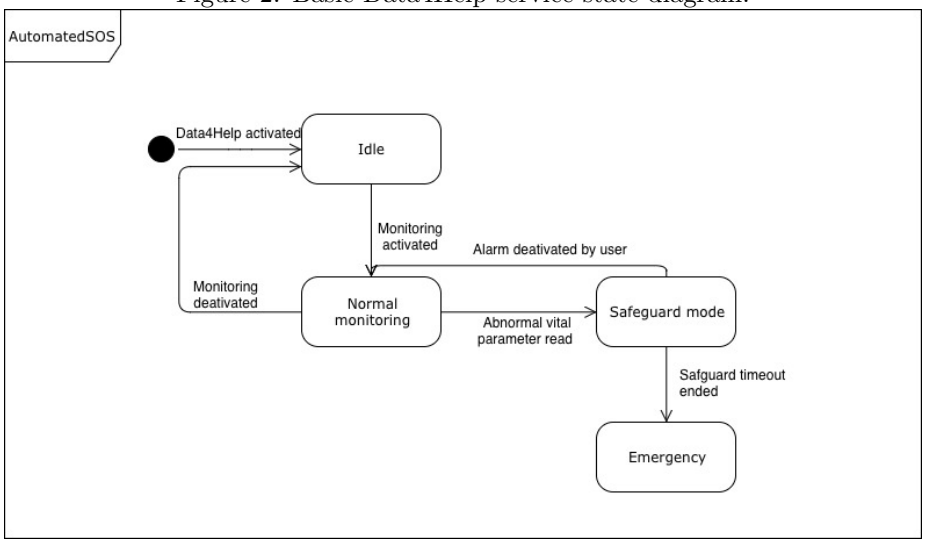


Figure 3: Automated SOS state diagram.

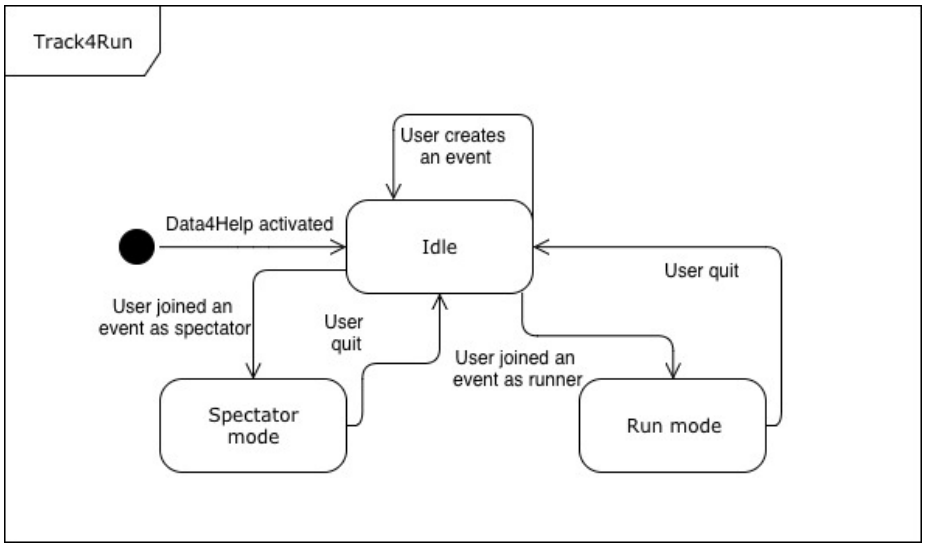


Figure 4: Track4Run state diagram

2.2 Product functions

The software developed by TrackMe included three different services: Data4Help supports user's data acquiring through smartwatches or similar devices, AutomatedSOS, a personalised and non-intrusive SOS service for elderly people and Track4Run, a service to track athletes participating to a run. Data4Help is also a service available for third-parties: in fact, organisations can request data to TrackMe and collect them for pursuing their objectives. Data acquisition can be performed in two different way: directly to a single user or to a groups of individuals. Concerning the single user case, companies, through a social security code, ask permission to access the corresponding information. In the other case, organisations can request, directly to TrackMe, data of group of individuals with particular proprieties (e.g. users between 20 and 30 years old or living in a certain district). In the latter, TrackMe provides data only if it can anonymised them correctly. AutomatedSOS it's great for those elderly people who want to monitor their health status and have the support of an ambulance in case their vital parameters are under certain thresholds. Track4Run it's a service dedicated to the runners: it offers the possibility to organise a run between other runners, define the path and the duration, allowing the invited ones to en-roll. In addition, Track4Run users who do not partecipate to the run can see live time on a map the position of all the runners. Finally, Track4Run supports the synchronisation of data with Data4Help.

All the goals presented in section 1.2.5 are going to be implemented. Here we describe deeply the requirements needed to implement application's functions.

[R1] Users can create an account with credentials.

[R2] Credentials can be retrievable also if forgotten/lost.

[R3] Users can log manually or automatically their data.

[R4] Users have to be able to accept/deny access to single data access request.

[R5] Users have to be able to see current data policies and to change them.

[R6] The machine has to be able to read health and position data.

[R7] The machine has to be able to recognise below threshold parameters.

[R8] The machine has to be able to communicate with third parties.

[R9] The machine has to be able to recognise data fragmentation level

[R10] The machine has to be able to store users' data.

2.3 Users characteristics

Users: any person that will use the service to keep track of health data, positioning or automated SOS during any kind of activities (walking or running during a lone run or an organised event).

Third parties: Organisation or other parties interested in the acquisition for their usage of the data provided by the user activities.

2.4 Assumptions, dependencies and constraints

2.4.1 Domain assumptions

[D1] Data manually logged by users well describes reality.

[D2] First aid services are ready to handle emergency notifications.

[D3] Data inserted by users are truthful

- [D3.1] Data are up to date.
- [D3.2] Data are correctly formatted.

[D4] Running paths proposed by users are well formed (e.g: legit by law).

[D5] External services are reliable.

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

3.1.2 Hardware Interfaces

The system requires one or more dedicated servers for data management and for handling communication between users and third-parties.

3.1.3 Software Interfaces

- **Data4Help**
  User's health data can be inserted in Data4Help section of the application manually or automatically synchronised with data acquired by individual's wearable device thanks to HealthKit API provided by Apple.
  Third-parties can access to the different data through a web-based interface in which, in case the organisation is interested to the information of some specific individual, can select the single user by his/her fiscal code and send to him/her the request of data's visualisation; instead, in the case of interest in accessing data of groups of individuals, companies can select the parameters of interest and send to TrackMe the request on hold for a positive response.
  Data4Help also offers the integration with ResearchKit and CareKit APIs, also provided by Apple, to help third-parties to access more relevant data for their studies.

- **AutomatedSOS**
  Similarly as Data4Help, AutomatedSOS automatically synchronises data acquired from user's wearable device and monitors them to guarantee the safety of elderly people.
  In case of emergency, an ambulance will reach the location of the customer: AutomatedSOS uses Google Maps API to show live-time the position on the map of the arriving ambulance.

- **Track4Run**
  Since Track4Run aims to schedule and organise runs for the users of the service, it makes use of Google Calendar API to allow individuals to create and en-roll races. Also, for users not taking part of runs, Track4Run supports Google Maps API for live-tracking the position of the participating runners.

3.1.4 Communication Interfaces

3.2 Functional Requirements

3.2.1 Definitions of use cases

Name	Sign up
Actor	User
Entry conditions	The application has been correctly installed on user's iOS device
Events flow	1. Select the "Sign up" option 2. Fill in all the fields necessary for registering to the services 3. Tap on the sign up button to confirm the inputted data
Exit conditions	Data has been successfully saved and the customer can now use all the services offered by the application
Exceptions	1. User is already registered 2. User inputted email is already registered 3. User has chosen a username already taken 4. Not all fields were correctly filled 5. User has to recompile the sign up module correcting the invalid fields

Table 1: Sign up use case

Name	Log in
Actor	User
Entry conditions	The installed application and the registration to the platform are mandatory to correctly log in
Events flow	1. Select the "Log in" option 2. Fill in the "Username" and "Password" fields 3. Tap on the log in button to confirm the credentials
Exit conditions	User has been correctly identified by the system and redirected to the main page of the application
Exceptions	1. User inputted an invalid username 2. User inputted an invalid password 3. User is not register to the platform 4. User has to correct the invalid fields of the log in page

Table 2: Log in use case

Name	Manual data acquisition
Actor	User
Entry conditions	The application has to be correctly installed on an iOS device and the user has to be logged in
Events flow	1. Open the application and select the Data4Help section 2. Tap the "Insert" button to manually insert data into the application 3. Confirm the inserted data by tapping the "Confirm" button 4. Wait until the data inserted are correctly processed by the server
Exit conditions	Data are correctly updated and visible inside the application
Exceptions	1. Network error during the insertion phase 2. Inserted data are out-of-date 3. User is invited to update the inserted information or to try again later

Table 3: Manual data acquisition

Name	Automatic data acquisition
Actor	User
Entry conditions	The application has to be correctly installed on an iOS device and the user has to be logged in
Events flow	1. Open the application and select the Data4Help section 2. If not already updated, tap on the "synchronise" button 3. Wait until the synchronisation between the smartphone and the wearable device is completed 4. Wait until the data inserted are correctly processed by the server
Exit conditions	Data are correctly updated and visible inside the application
Exceptions	1. Network error during the insertion phase 2. Synchronisation problem between the smartphone and the wearable device 3. User is invited to check the connection between devices or to try again later

Table 4: Automatic data acquisition

Name	Specific-individual data request
Actor	Third-party
Entry conditions	The third-party has to be logged in on the TrackMe's web service page
Events flow	1. Select from the web page the interested individual by his/her fiscal code 2. Send a request for data sharing to the individual 3. Wait for the individual's response
Exit conditions	Customer has accepted the third-party request and the latter is now in possession of the individual's information
Exceptions	1. Network error during the request phase 2. Negative response by the customer 3. The third-party is invited to try with another individual or to try again later

Table 5: Specific-individual data request

Name	Groups-of-individuals data request
Actor	Third-party
Entry conditions	The third-party has to be logged in on the TrackMe's web service page
Events flow	1. Select from the web page the interested parameters for which the third-party wants to receive the data 2. Wait for the data-anonymization control by TrackMe for the requested parameters
Exit conditions	TrackMe has ensured the anonymization of the data and has accepted the third-party request; the latter is now in possession of the individual's information
Exceptions	1. Network error during the request phase 2. Negative response by TrackMe (data-anonymization control failed) 3. The third-party is invited to try with less restrictive parameters or to try again later

Table 6: Groups-of-individuals data request

Name	Emergency situation
Actor	AutomatedSOS
Entry conditions	The application has to be correctly installed on an iOS device and the user has to be logged in
Events flow	1. The service automatically notice that one or more vital parameters are under the safe threshold 2. The service asks to the customer if there are any problems with a pop-up on-screen 3. If the service doesn't receive a response within 5 seconds, an ambulance is alerted to reach the customer's location
Exit conditions	The ambulance reach the customer's location to take of him/her
Exceptions	1. Network error while contacting the ambulance service 2. The system keeps trying to reach the ambulance service until it succeeds or the customer stops the process

Table 7: Emergency situation

Name	Definition of a path
Actor	User
Entry conditions	The application has to be correctly installed on an iOS device and the user has to be logged in
Events flow	1. Open the application and select the Track4Run section 2. Tap on the "Create new run" button 3. Select the starting and ending points on the map 4. Select the main spots of the path in order to define a complete route on the map 5. Wait until the data inserted are correctly processed by the server
Exit conditions	The path has been correctly defined by the customer and the run can be shared with the other users
Exceptions	1. Network error during the definition of the path 2. The starting/ending point or the main spots are not selectable 3. The path defined is not safe for the runners 4. The user is invited to redefine the path or to try again later

Table 8: Definition of a path

Name	Enrollment to a run
Actor	User
Entry conditions	The application has to be correctly installed on an iOS device and the user has to be logged in
Events flow	1. Open the application and select the Track4Run section 2. Tap on the "Available runs" button to show all the forthcoming runs 3. Select a run from those available and confirm the enrollment
Exit conditions	The user has correctly en-roll to the run
Exceptions	1. Network error during the enrollment 2. The run selected is no longer available/sold out 3. The user is invited to choose another available run or to try again later

Table 9: Enrollment to a run

3.2.2 Use case diagram

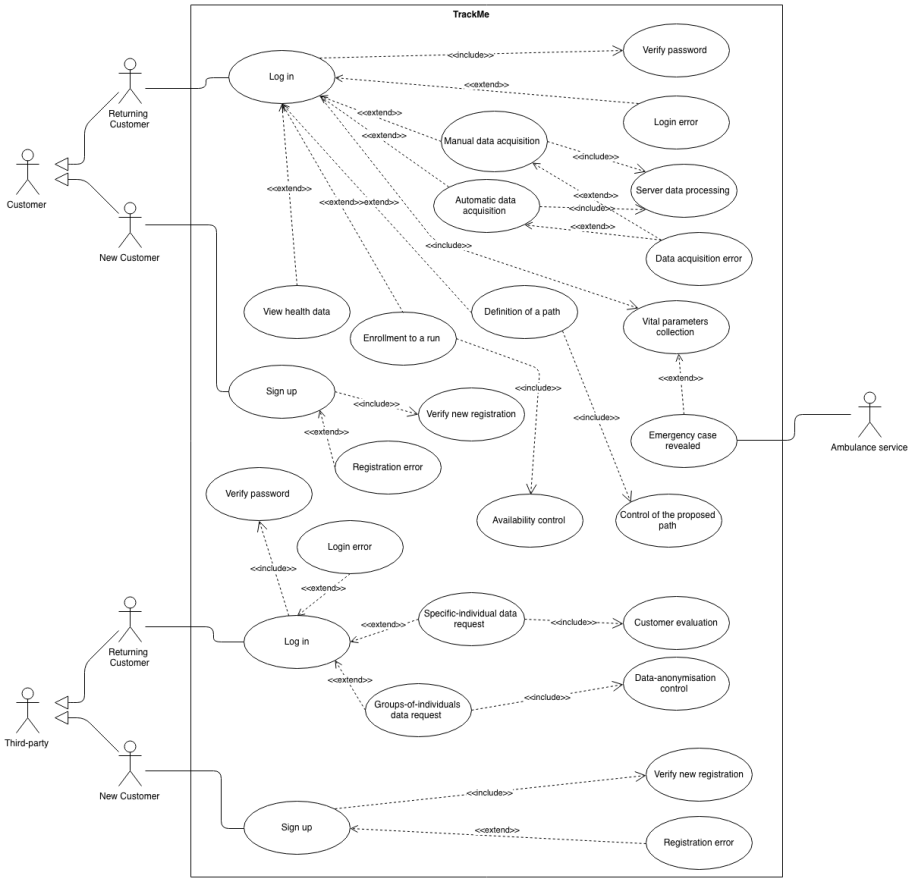


Figure 5: Use case diagram

3.3 Sequence diagrams

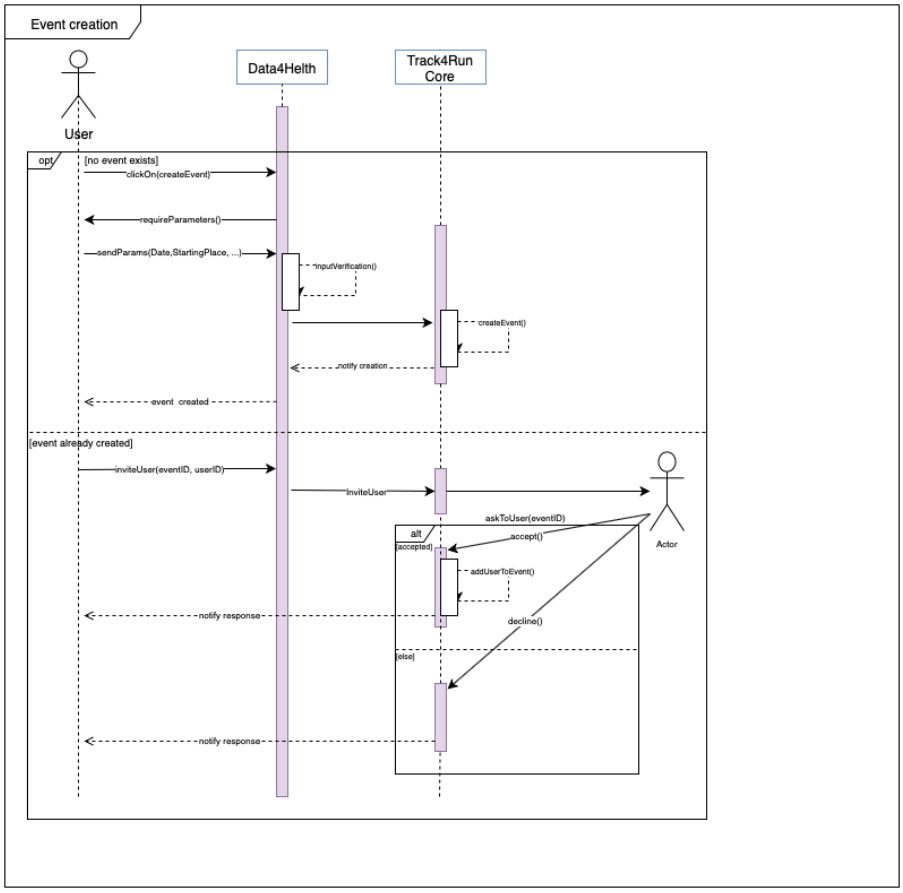


Figure 6: "Event creation and handling" sequence diagram

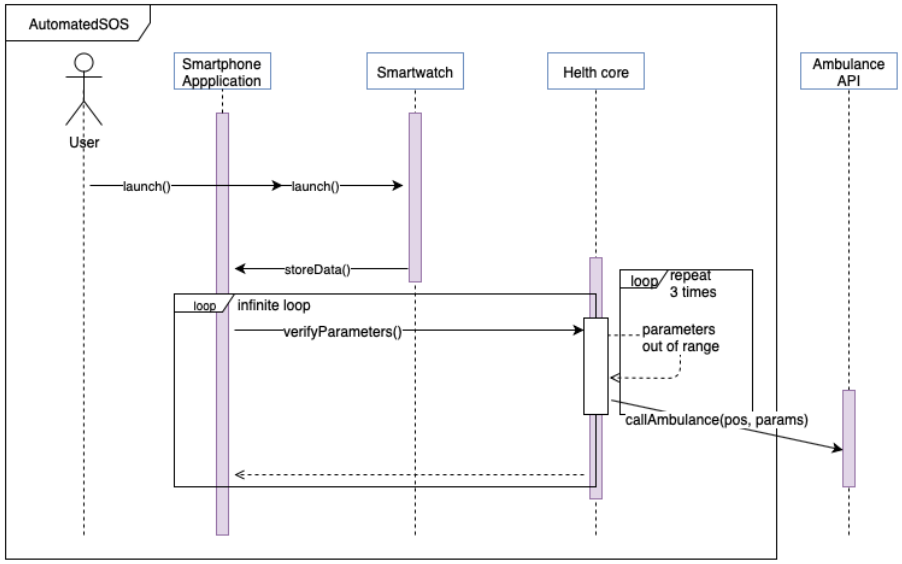


Figure 7: "AutomatedSOS" sequence diagram

3.4 Performance Requirements

3.5 Design Constraints

3.5.1 Standards compliance

The software application should handle a big amount of data, stored online on servers. It also should manage a great number of simultaneous requests when, in example, third-parties ask to access data or during the period of enrolment to a run.
The services offered by TrackMe should also work in background and not only when the application is open.

3.5.2 Hardware limitations

TrackMe is a software application available only on iOS devices. It requests an internet connection (WiFi, 2G, 3G, 4G/LTE) and GPS connectivity.
Some functionalities are available only for the owners of wearable devices.

3.5.3 Any other constraint

The application needs to access to the current location of the user. It also may need to access individual's contact list to easily find possible user's friends.

3.6 Software System Attributes

3.6.1 Reliability

The application and the external services offered by the application must be available 24/7.
Servers' maintenance, communicated to the user in advance and only during determined hours of the day, is the only exceptions accepted.

3.6.2 Availability

TrackMe services are available only in Italy for free.

3.6.3 Security

3.6.4 Maintainability

3.6.5 Portability

Portability to the Android operating system will be take into consideration after a first initial phase of development dedicated to the iOS market.
The application will also be constantly updated to guarantee compatibility to an increasing number of wearable devices.

3.7 Scenarios

3.7.1 Scenario 1

Tim has to sustain an important medical exam aimed to discover if he suffers or not of tachycardia. He has available the latest model of smartwatch that supports the EGC monitor so his doctor suggests to use Data4Help to monitor for 24/48 hours his heart rate. Data4Help allows Tim to just use his smartwatch, instead of the classic Dynamic ECG machine, for registering his heart's data in the app so that his doctor, after committing a request to Tim through his fiscal code, can examine the results after few hours by the end of the test and give to Tim a response in a very short time.

3.7.2 Scenario 2

Fitness & More is a brand new sport center situated near a very big residential area with many educational institutions from elementary to high schools. The centre offers swimming and tennis lessons with expert instructors and also a well supplied gym with personal coaches.
Fitness & More asks to TrackMe the access to weight and height data of kids between 6 and 19 year old who live in the above mentioned area to make an analysis of the presence of overweighted individuals and so sponsor its sport center.

3.7.3 Scenario 3

The next PolimiRun will be held on the 11th of November in Lecco. Polisport, the sport organisation of the Politecnico di Milano, decided to arrange a few workouts for the runners who are attending the competition and so they suggest to use Track4Run to manage the path of the workouts around the city of Milan and also to let runners en-roll the training sessions.

4 Formal analysis using Alloy

In this section we give a description of the system trough and Alloy model. The following relations are described:

- Data access request system is described. Third parties can access a user's data only if a previous request has been made and approved.
- SOS events are raised in case of low vital parameters.
- Users can join to running events.

The following assumptions are taken in order to make the model cleaner:

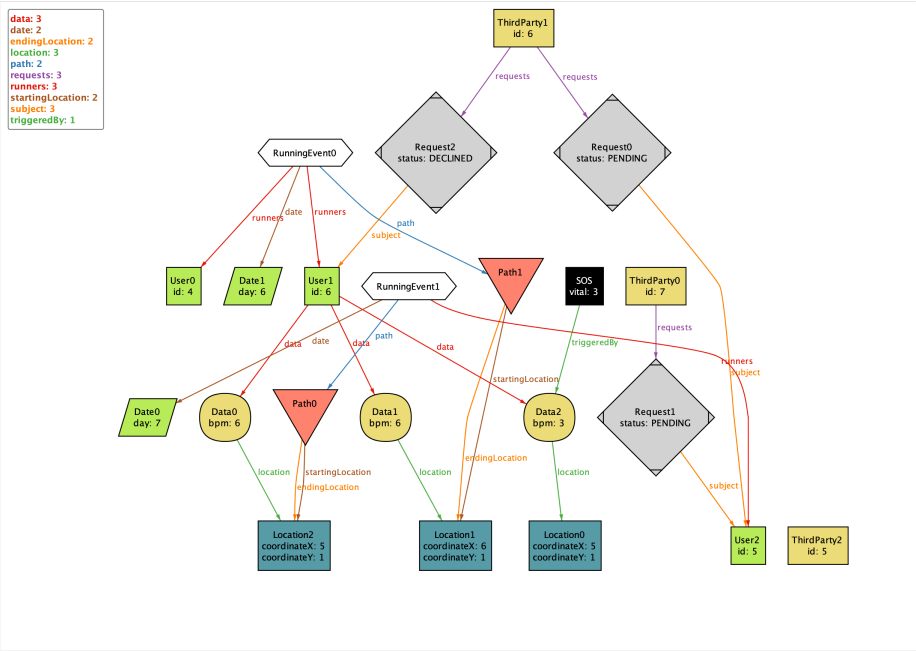
- All not necessary (to Alloy model) attributes of entities are omitted.
- All entities that have to be unique are identified by a single integer field: *ID*.
- Dates are represented trough a single integer field: *day*.

4.1 Alloy Model

```
abstract sig EventStatus  {}
one sig LIVE extends EventStatus {}
one sig SCHEDULED extends EventStatus{}
one sig FINISHED extends EventStatus{}
one sig CANCELLED extends EventStatus{}

sig RunningEvent {
	runners: set User,
	path: one Path,
	date: Date
}

abstract sig RequestStatus{}
one sig APPROVED extends RequestStatus{}
one sig DECLINED extends RequestStatus{}
one sig PENDING extends RequestStatus{}

sig Request {
	subject: User,
	status: RequestStatus
}

sig Data {
	location: Location,
	bpm: Int
} { bpm > 0}

sig SOS {
	triggeredBy: Data,
	vital: Int
} { vital > 0}

-- All user' not foundamental fields are omitted.
-- Identification pass trough a single integer field "Id"
sig User {
	id: Int,
	data: set Data
}{ id > 0 }

sig ThirdParty {
	id: Int,
	subscribedUsers: set User,
	requests: set Request
}{ id > 0}

-- In this Alloy model, date are simplified and represented with a single number.
sig Date {
	day: Int
}{ day > 0 }

sig Location {
	coordinateX: Int,
	coordinateY: Int
} { coordinateX > 0 and coordinateY >0 }


sig Path {
	startingLocation: one Location,
	endingLocation: one Location
}
```

```
/*** FACTS ***/
fact uniqueEntities {
	no disjoint u1, u2 : User | u1.id = u2.id
	no disjoint t1,t2: ThirdParty | t1.id = t2.id
	no disjoint d1,d2 : Date | d1.day = d2.day
	no disjoint r1,r2 : Request | some t: ThirdParty |
		r1 in t.requests and r2 in  t.requests and
		r1.subject = r2.subject
	no disjoint s1,s2 : SOS | s1.triggeredBy = s2.triggeredBy

}
-- Paths exist only if associated with one running event.
-- Date exist only if associated with one running event.
-- Since data are collected by the user, they cannot exist witouth him/her
fact onlyRunningPath {
	all p : Path | one r: RunningEvent | r.path = p and
	all d: Date | one r: RunningEvent | r.date = d and
	all d: Data | one u: User | d in u.data
}
-- Requests only exist if the associated Third Party exist
fact requestExistence {
	all r: Request | one t: ThirdParty | r in t.requests and
	all r: Request | one u: User | r.subject = u
}

fact subscriptions {
	--all t: ThirdParty, u: User | some r: Request |
	-- if there is a request from a third party to a user that is APPROVED, then that third party is
	-- subscribed to that user
	all r:  Request, t: ThirdParty |
		(r in t.requests and r.status = APPROVED)
			implies
		r.subject in t.subscribedUsers

	-- if there is a request from a third party to a user that is DECLINED or PENDING, that third party
	-- cannot be subscribed to that user
	all r:  Request, t: ThirdParty |
		(r in t.requests and (r.status = DECLINED or r.status = PENDING))
			implies
		r.subject not in t.subscribedUsers

	-- if there is a third party which is subscribed to a user, then there must be a request approved
	-- for that third party and for that user
	all t: ThirdParty, u: User |
		u in t.subscribedUsers
			implies
		some r: Request | r.status = APPROVED and r.subject = u and r in t.requests
}

fact SOS {
	all s: SOS | s.vital < 4
	all s: SOS | one d: Data | s.vital = d.bpm and s.triggeredBy = d
}

pred show {
}

run show
```

4.2 World Generated



5 Effort spent

6 References