POLITECNICO
MILANO 1863

M.Sc. Computer Science and Engineering
Software Engineering 2 Project

Design Document

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GitHub Repository: https://github.com/federicohaag/GarganoGiannettiHaag

Version 1.0

Contents

1 Introduction **3**
1.1 Purpose . . . 3
1.2 Scope . . . 3
1.3 Definitions, Acronyms, Abbreviations . . . 4
1.3.1 Definitions . . . 4
1.3.2 Acronyms . . . 5
1.3.3 Abbreviations . . . 5
1.4 Revision History . . . 5
1.5 Reference Documents . . . 5
1.6 Document Structure . . . 5

2 Architectural Design **7**
2.1 Overview . . . 7
2.2 Component View . . . 10
2.3 Deployment View . . . 15
2.4 Runtime View . . . 17
2.5 Component Interfaces . . . 24
2.6 Selected Architectural Styles . . . 28
2.7 Other Design Decisions . . . 31
2.7.1 Class Diagrams . . . 31
2.7.2 Interfaces Use . . . 33

3 User Interface Design **35**
3.1 User Interface Mockups . . . 35
3.2 Mapping User Interfaces to Components . . . 39
3.3 User Application Interaction . . . 40

4 Requirements Traceability **42**

5 Implementation, Integration and Test Plan **48**
5.1 Components to be Implemented . . . 48
5.2 Component Dependencies . . . 50
5.3 Implementation Plan . . . 52
5.4 Integration Plan . . . 53

5.4.1 Integrations 53
5.4.2 Integration Plan Diagram 55
5.5 Testing Plan 56
5.5.1 Unit Testing 56
5.5.2 Integration Testing 57

6 Effort Spent **58**

7 References **61**

Chapter 1

Introduction

1.1 Purpose

TrackMe wants to offer a service named "Data4Help" on top of which two services, named "AutomatedSOS" and "Track4Run", will be built.
Data4Help will be a system collecting data of *Users* through a *Smart wearable* connected to their smartphone. This data may be sent to *Third parties* after *User* consent. AutomatedSOS will constantly monitor *User data* to allow for immediate assistance. Track4Run will allow individuals to organize running competitions, to enroll in or watch one.

More details of the purpose of this project may be found in section 1.1 of [3].

In this document, the design of the system to be will be explained and analyzed in detail. The analysis includes the identification of all the architectural components, the design decisions relative to the structure of the system to be and the patterns to be implemented. Moreover, implementation and testing will be discussed and planned.

1.2 Scope

TrackMe proposes to offer its system in a world in continuous technological evolution, where almost everyone owns a smartphone and is always connected to the Internet. By using Data4Help, *Users* will integrate their everyday activities with constant collection of their health data and position, through sensors of their *Smart wearable* and smartphone GPS. By adding *Third party Services* they may benefit of data monitoring and analysis with useful insights on their daily activities.

Users may enhance data collection by adding AutomatedSOS to their *Services*. This *Service*, by constantly monitoring their data, will allow for *Anomalous data* identification and immediate assistance for the *User in need*. This can be crucial for individuals with health issues and elders living alone.
People fond of running have the possibility of enrolling in a *Run* listed in Track4Run. Their data, including position and health data, will be shown to *Spectators*, who can watch the *Run*. The process of organizing running competitions will be carried out by *Organizers* through this *Service*.

More details on this section may be found in section 1.2 of [3], including a detailed analysis of shared phenomena.

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

User: registered individual of Data4Help who agreed top the acquisition and processing of their data (see *User data*).

User data: *User*'s health data and location acquired by Data4Help.

Third party: a company that is willing to access *User data* stored in Data4Help database. It may offer *Services* to *Users*.

Service: application available for Data4Help *Users*, generally offered by a *Third party*.

Group data: set of *User data* acquired by Data4Help. The set of *Users* is determined by specific characteristics and constraints defined by the *Third party* requesting the data. When sent to the *Third party*, this data is anonymized.

Smart wearable: smart devices that can be worn on the body as accessories. These devices are required to have specific sensors for data acquisition. They must be connected to an external device, such as a smartphone.

Anomalous data: health data that is outside certain intervals identifying a *User* normal health condition.

User in need: registered user of AutomatedSOS in need of assistance since their health data is *anomalous*.

Run: running competition registered on Track4Run.

Organizer: person organizing a *Run*.

Spectator: person participating as spectator of a *Run*.

Participant: *User* who added Track4Run to their services, participating in a *Run*.

1.3.2 Acronyms

GPS: Global Positioning Service

GUI: Graphical User Interface

RSA: Rivest–Shamir–Adleman

REST: Representational State Transfer

API: Application Programming Interface

1.3.3 Abbreviations

G_n: n^{th} goal

R_n: n^{th} requirement

1.4 Revision History

1. Version 1.0 - 10^{th} December 2018

1.5 Reference Documents

- Rumbaugh, Jacobson, Booch. 1999. *The Unified Modeling Language Reference Manual*. Addison-Wesley.
- *UML-Diagrams*. https://www.uml-diagrams.org/
- Rivest, Shamir, Adleman. 1977. *A Method for Obtaining Digital Signatures and Public-Key Cryptosystems*. https://people.csail.mit.edu/rivest/Rsapaper.pdf
- K. Beck. 2002. *Test-Driven Development: By Example*. The Addison-Wesley Signature Series.

1.6 Document Structure

This document is divided into seven chapters.

Chapter 1 This chapter provides a further introduction to the project, in terms of the purpose and the scope, as it has already been introduced in [3]. Moreover, the chapter contains the definitions, acronyms and abbreviations needed to properly understand the sections following. All the documents used during the development of this project are listed at the end of this chapter.

Chapter 2 This chapter contains a the proposed architecture of the implementation of the system to be described in [3]. The architecture takes into consideration all the goals and requirements listed in [3].
Deployment, sequence, class and other diagrams are provided to allow the reader to have a better understanding of the design of the system. Particular attention is dedicated to non functional requirements satisfaction, including but not limited to reliability and performance. The architecture is described following a top-down approach: the document starts from a general overview, gives a detailed description of component and their interactions and finally provides a detailed class diagram.

Chapter 3 All user interfaces of the system to be may be found in this chapter. These were already provided in section 3.1.1 of [3] and are further analyzed in this chapter. User interfaces are mapped to components of the system to be that are involved in the user-application interaction. Finally, for each user interface, all the possible actions and results are explained.

Chapter 4 This chapter is an analysis of which components, described in Chapter 2, allow the satisfaction of each requirement of section 3.2.5 of [3].

Chapter 5 Taking into consideration the architecture and the user interfaces shown in chapters 2 and 3, this chapter provides a list of activities needed to implement the system to be. The activities are analyzed in depth to identify the constraints that force certain activities to be executed before or after others. An implementation, an integration and a testing plan are provided.

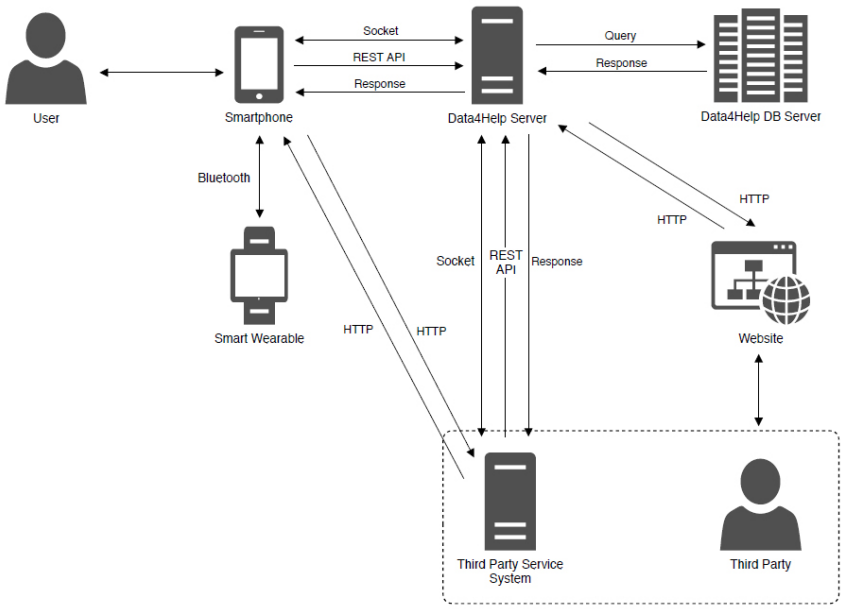
Chapter 6 Effort spent by all team members is shown as the list of all activities done during the realization of this document.

Chapter 7 References of documents that this project was developed upon.

Chapter 2

Architectural Design

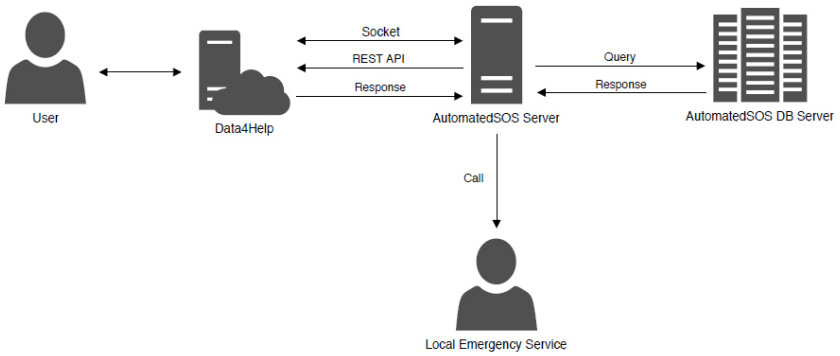
2.1 Overview



Data4Help Overview

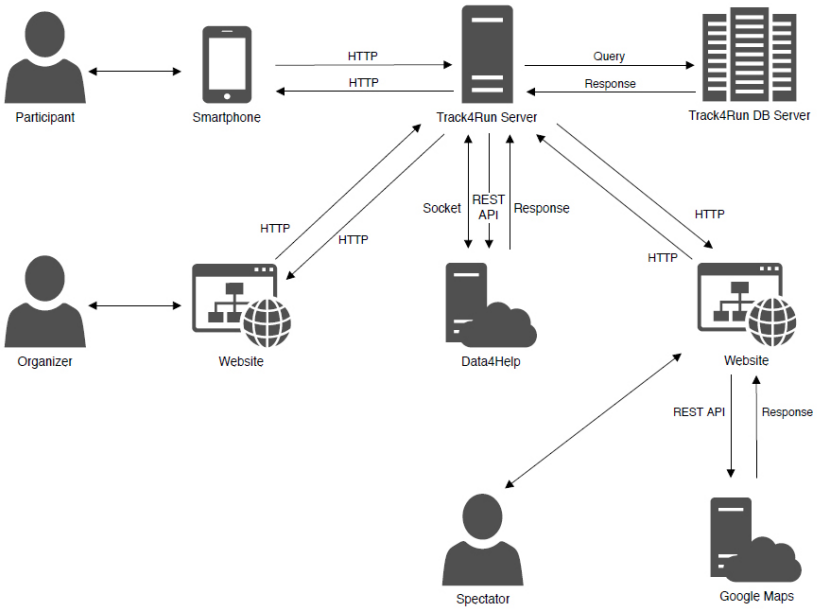
This diagram is a general overview of the system to be.
The *User* interacts with their smartphone performing several actions, including but not limited to managing their services, sending their consent to the sharing of their data with *Third parties*, and using a *Service*. The smartphone can

communicate with Data4Help Server calling the offered REST APIs. Data4Help Server also establishes a socket connection with the smartphone so as to collect *User data* at the maximum throughput frequency allowed by the *User Smart wearables*. The smartphone is also connected to the *User's Smart wearable*, allowing for continuous data collection.
Data4Help Server is the core of the system to be. It manages all *User* requests, collects their data and sends them to the database - Data4Help DB Server. It also sends through a socket connection newly collected *User data* only to those *Services Users* are subscribed to. It allows the forwarding of *Third Party User data* requests to *Users* and supports the interaction of *Third Parties* with the system through their dedicated website. Lastly, Third Party Service System communicates with the *User's* smartphone via HTTP since Data4Help offers the possibility of embedding *Third Party Service* websites into the Data4Help application.



AutomatedSOS Overview

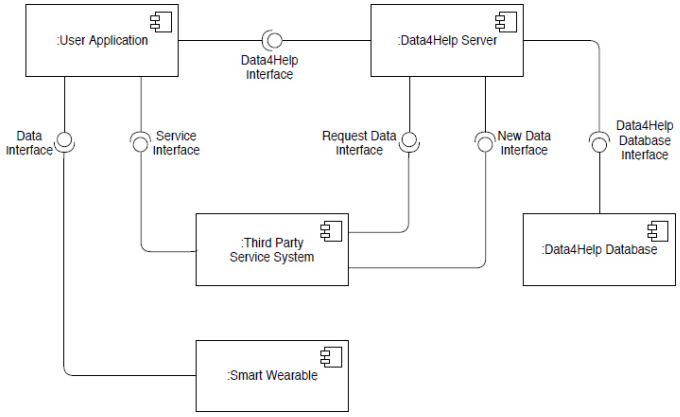
AutomatedSOS is based on a central server which receives *User data* as soon as it is produced and constantly analyzes it. The data is sent from Data4Help to AutomatedSOS via a socket connection, which is always active. When AutomatedSOS recognizes a *User* as a *User in need*, it calls Local Emergency Services and stores in the AutomatedSOS database all the relevant information, including which Local Emergency Services are in charge of assisting a specific *User in need*.



Track4Run Overview

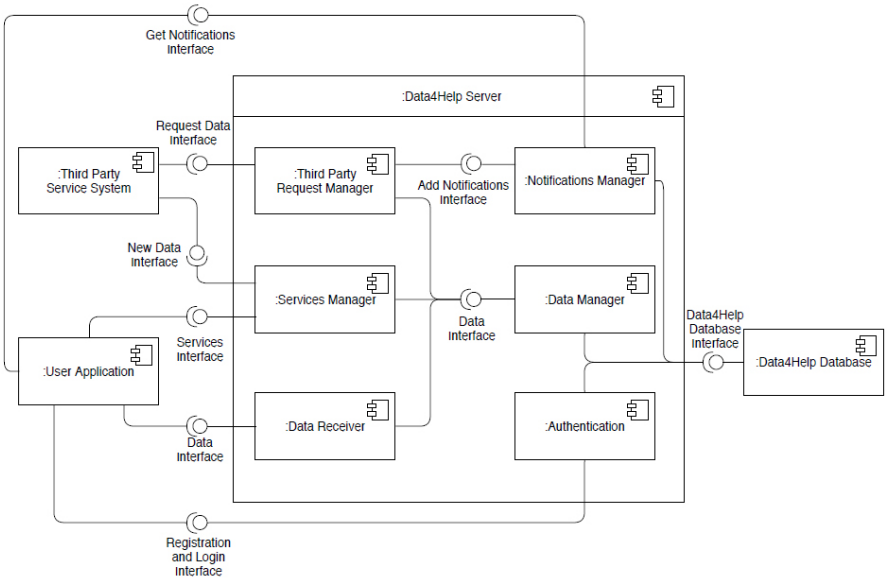
The overview of Track4Run gives a general idea of the several components that comprise this *Service*.
Track4Run Server manages all the actions that can be performed by the actors interacting with the *Service*. First of all, it allows *Organizers* to create a *Run* and manage it through a dedicated website. Moreover, it communicates with Data4Help to allow *Users* to enroll in a *Run* as *Participants* and acquire their real time data while running. This data will be displayed in the dedicated *Spectators* website, together with the real time position of *Participants*, retrieving the real world map of the *Run* through Google Maps. All data that needs to be stored, is passed to and retrieved from a database - Track4Run DB Server. This data is mainly made up of information about *Runs*.

2.2 Component View



Data4Help Component Diagram Overview

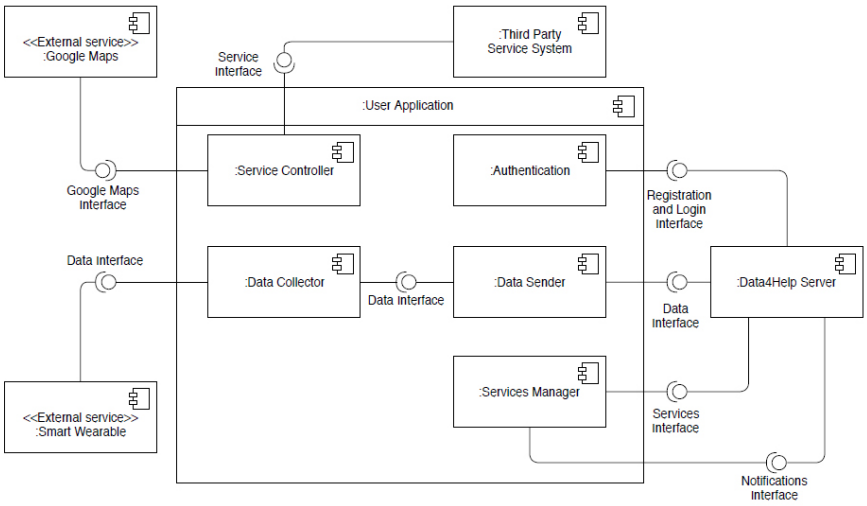
A general view of the main components of the system to be is given. The core components are the Data4Help User Application and the server side Application - Data4Help Server. They communicate through three different interfaces offered by Data4Help. These will be further explained in the following two diagrams. Here they are simplified under the Data4Help Interface. The Data4Help User Application receives data from the Smart Wearable through the Data Interface and pushes them to Data4Help. It uses the Service Interface to retrieve the *Service* website and interact with it.
The Data4Help Server provides an interface for the Third Party Service System to send data requests. It also sends newly collected data to the Third Party Service System through the New Data Interface. It finally communicates with the database through the offered Database Interface.



Data4Help Component Diagram

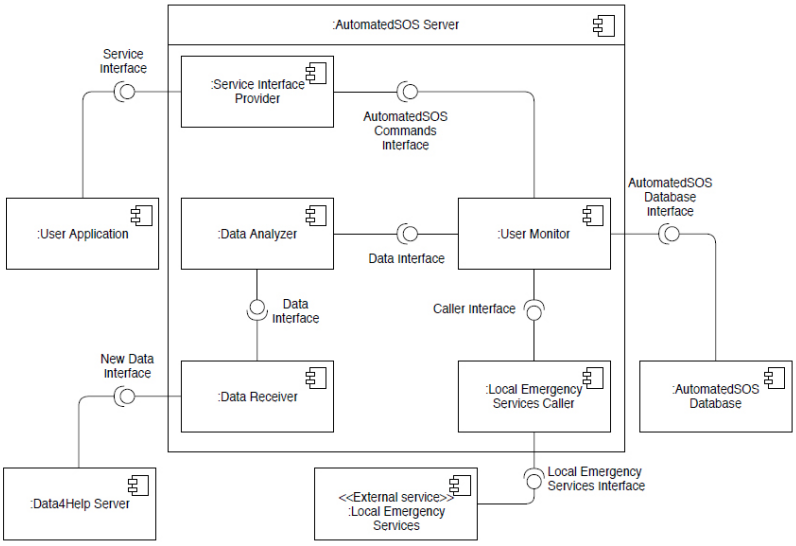
These are the internal components and interfaces of the Data4Help server side Application, together with the interfaces offered to external components.
The Authentication component is needed to authenticate the *User* through the User Application. It needs to access the database where all login information is stored through the Database Interface. The Data Receiver is needed to receive data from the User Application as soon as it is collected. It then sends it over to the Data Manager through the Data Interface, whose function is to manage all *User data* stored by Data4Help. In fact, it uses the Database Interface to query it.
The Data Manager has a crucial role when it comes to *Third party* requests. A *Third party* may send a request through the Request Data Interface. The request is processed by the Third Party Request Manager. It uses the Add Notifications Interface when a *User* has not yet given consent to a *Third party Service* and the *Third party* wants to acquire its data. It also uses the Data Interface of the Data Manager to retrieve *User data* and *Group data*. The interaction of this component with the others is further explained in section 2.4.
Furthermore, the Notifications Manager is needed to provide notifications to the User Application. In fact, the application constantly queries the Data4Help Server for new notifications through the Notifications Interface. The Notifications Manager interacts with the database to retrieve all notifications for a given *User*.
Finally, the Services Manager implements the Services Interface, which allows *Users* to add new *Services* or manage the ones they already have through the User Application. Moreover, it uses the New Data Interface offered by the Third

Party Service System when it needs to send new *User data* or *Group data* to *Third parties*.



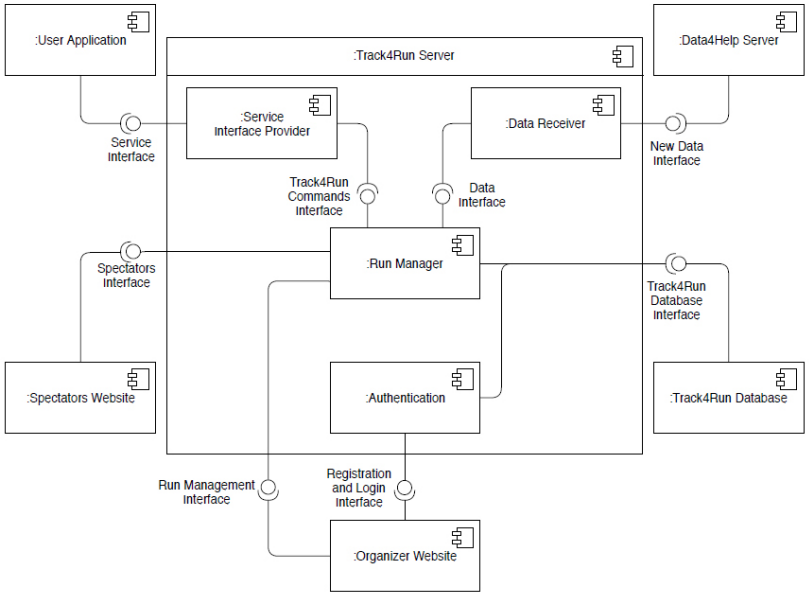
Data4Help User Application Component Diagram

The Data4Help User Application is used by *Users* to interact with the Data4Help Server and the *Services* they added. They can do this through several components and interfaces. They must be authenticated in order to use the Application: through the Authentication component, they can sign up and login into their Data4Help account. Moreover, the User Application will then use the Registration and Login Interface offered by the server side Application to authenticate into it. The User Application collects *User data* from both the smartphone and the *Smart wearable* through the Data Interface of the Data Collector. This forwards the data to Data4Help through the Data Interface offered by the Data Sender which sends them to Data4Help.
The Services Manager allows *Users* to add and manage their *Services*. This component exploits the Services Interface offered by Data4Help to accomplish its main functions. Moreover, it is in charge of constantly asking Data4Help for new notifications through the Notifications Interface.
Furthermore, the purpose of the Service Controller is to allow the interaction with a *Service* on the User Application through the Service Interface. In fact, the Third Party System will offer this interface for the User Application to connect and interact with. Finally, the Service Controller connects to Google Maps to obtain maps information for *Services* like Track4Run.



AutomatedSOS Component Diagram

The main component of AutomatedSOS Server is the User Monitor. It offers the AutomatedSOS Commands Interface for the Service Interface Provider to forward commands received from the interaction with the User Application through the Service Interface. In particular, it allows *Users* to reactivate their data monitoring. This component also uses the Database Interface to store which Local Emergency Services are in charge of assisting a specific *User in need*.
When new data is received from Data4Help, through the New Data Interface, it is passed to the Data Analyzer. The Data Analyzer compares the *User data* against certain thresholds, possibly identifying it as *Anomalous data*. When a *User* is identified as a *User in need*, the User Monitor sends a call request through the Caller Interface to the Local Emergency Services Caller, which calls the Local Emergency Services.



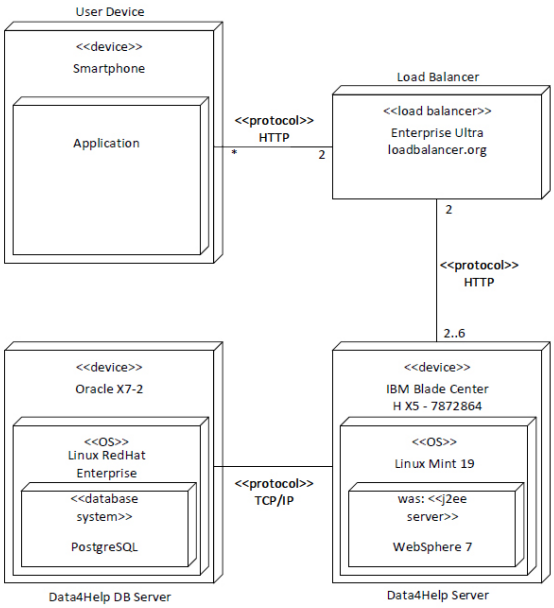
Track4Run Component Diagram

At the core of Track4Run lies the Run Manager. It is responsible for everything that concerns a *Run* and it offers several interfaces. First of all, it offers the Track4Run Commands Interface, for the Service Interface Provider to forward commands received from the interaction with the User Application through the Service Interface. In particular, it gives *Users* the possibility to enroll in a *Run* as *Participants* and to lookup available *Runs*. The Run Manager also gives *Organizers* the possibility to create and manage a *Run* through the Run Management Interface from the *Organizers* dedicated website. It uses the Database Interface to store relevant data in the Track4Run database. Moreover, it offers the Spectators Interface to *Spectators* to watch a *Run* through the *Spectators* dedicated website.
The Authentication allows *Organizers* to sign up and login in the dedicated website through the Registration and Login interface. Finally, the Data Receiver offers the New Data Interface, since all *Services* need to do so as to receive new data from Data4Help. It forwards the just received data to the Run Manager through the Data Interface, which is in charge of displaying it to *Spectators* and of storing it in the database.

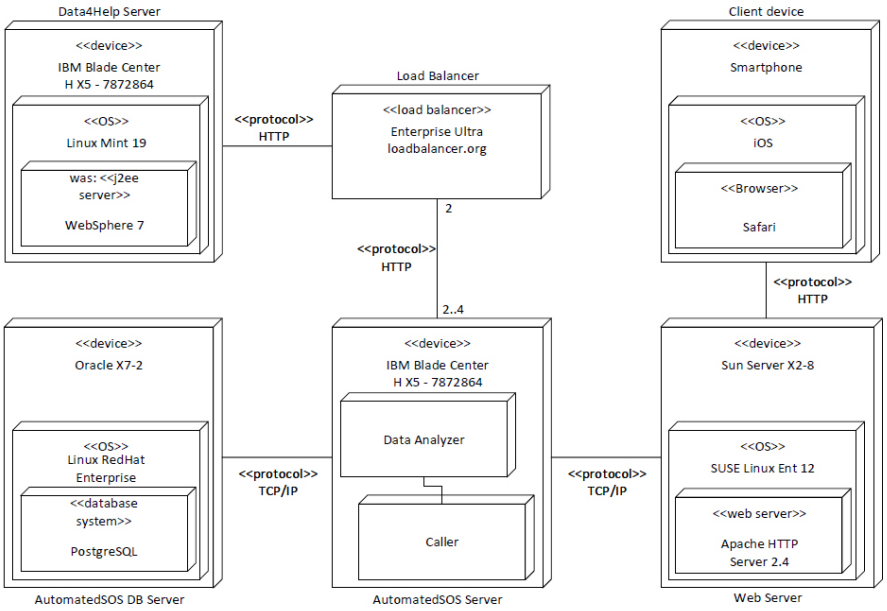
2.3 Deployment View

This section contains deployment diagrams, whose purpose is to show how the three systems will look like from a physical point of view, both hardware and software, when they will be implemented and delivered.
All three systems will have a central server architecture split in several servers to ensure reliability and availability. A load balancer is included in all three systems to balance the calls from the clients and send them to servers that are the least busy. There are two load balancers for availability. All servers communicate with the relative database through a TCP/IP protocol.

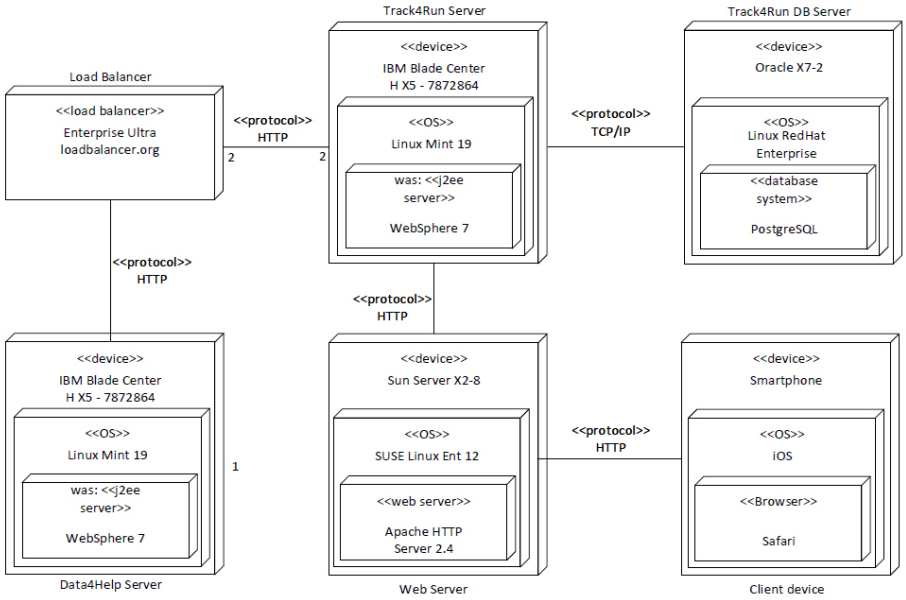
Services like AutomatedSOS and Track4Run have a Web Server since they need to offer websites to their users: *Users*, *Participants*, *Spectators* and *Organizers*.



Data4Help Deployment Diagram



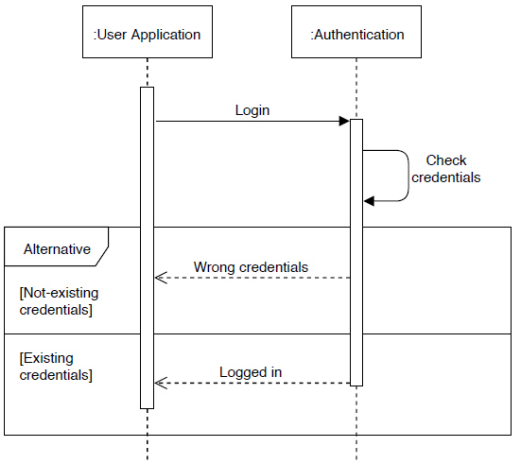
AutomatedSOS Deployment Diagram



Track4Run Deployment Diagram

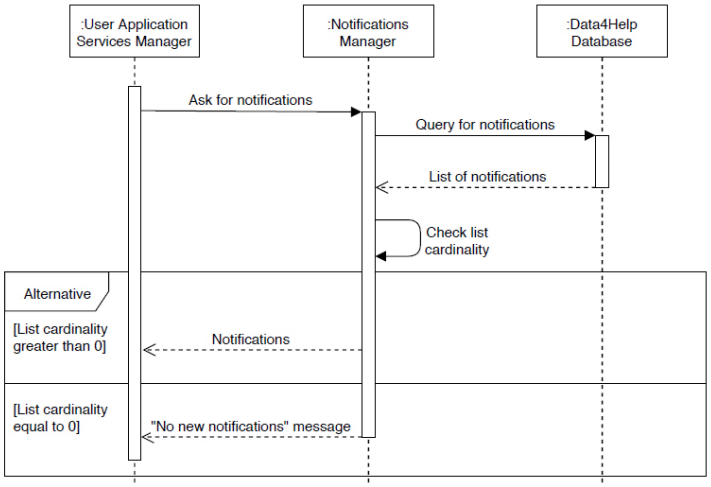
2.4 Runtime View

The following is a representation of the main functions and processes of the system to be through sequence diagrams. The actors of the diagrams are the components represented in section 2.2.



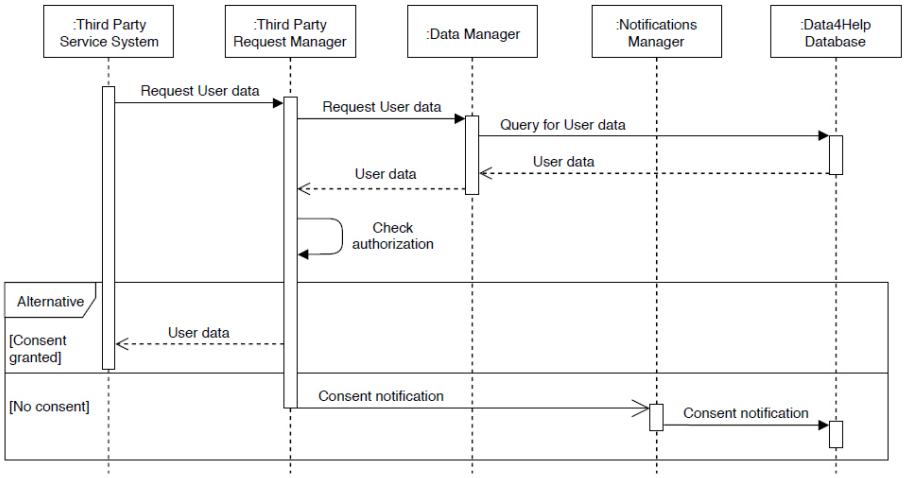
Login Sequence Diagram

In this sequence diagram the *User* login on the User Application is shown. The component involved in the process is the Authentication, which checks the credentials inserted by the *User*.



Notifications Sequence Diagram

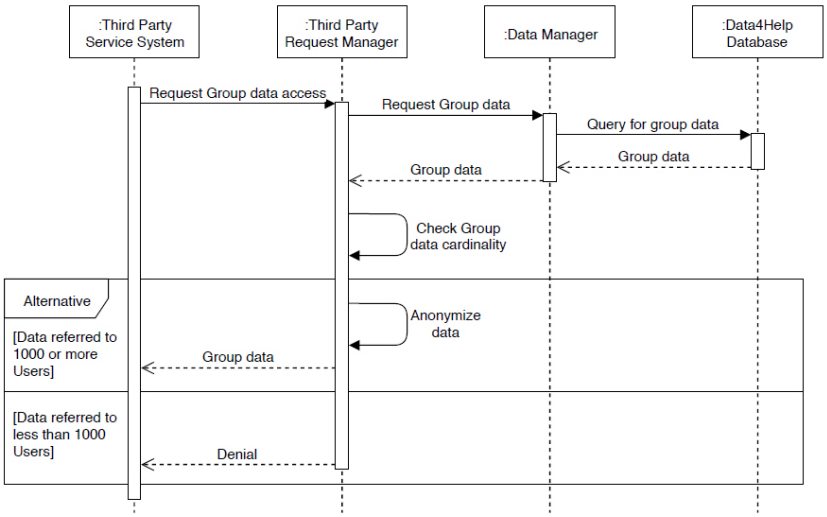
The User Application is able to receive notifications from Data4Help by querying the server side Application. The Services Manager of the User Application asks the Notifications Manager of the server for new notifications. If there are any new notifications for the *User*, then the Notification Manager returns them, otherwise it tells the Services Manager that there are no new notifications.



User Data Request Sequence Diagram

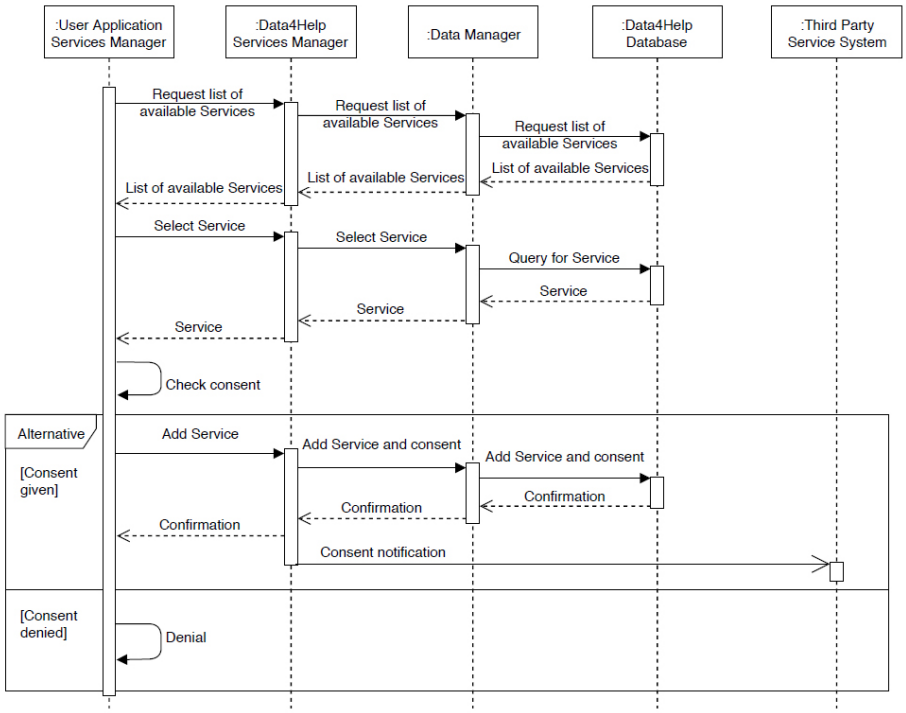
A *Third party* may request access to a specific *User data*. It sends a request to the Third Party Request Manager, which forwards it to the Data Manager. This

last component queries the database for *User data*. If the query returns non-empty *User data*, the Third Party Request Manager gets the data and checks if the *User* gave consent to the specific *Third party Service* that is requesting their data. If the consent was granted, then the *User data* is sent to the Third Party Service System. Otherwise, the Third Party Request Manager asks the Notifications Manager to add a new notification for that *User*, which is then stored in the database. The notification refers to the fact that the *Third party Service* wants to acquire their data.



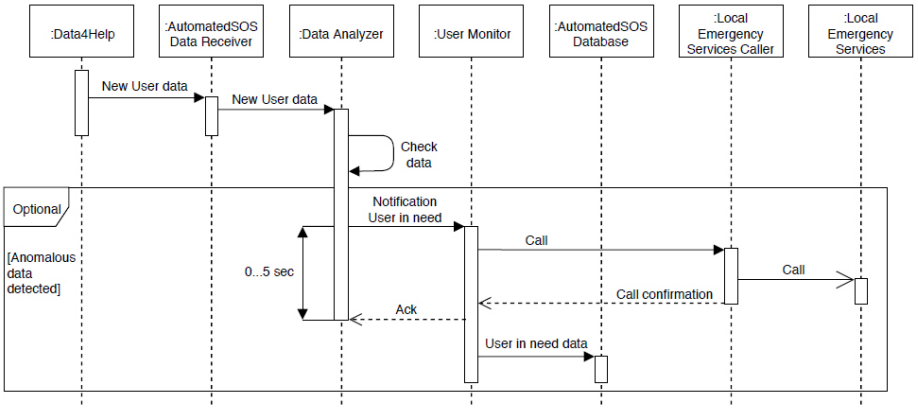
Group Data Request Sequence Diagram

When performing a *Group data* request, the *Third party* sends a request from the Third Party Service System to the Third Party Request Manager of Data4Help. This last component asks the Data Manager for group data, which queries the database. The *Group data* is sent back to the Third Party Request Manager, which checks its cardinality. If the data refers to 100 or more *Users*, the data is anonymized and sent to the Third Party Service System which made the request. Otherwise, a request denial is sent over.



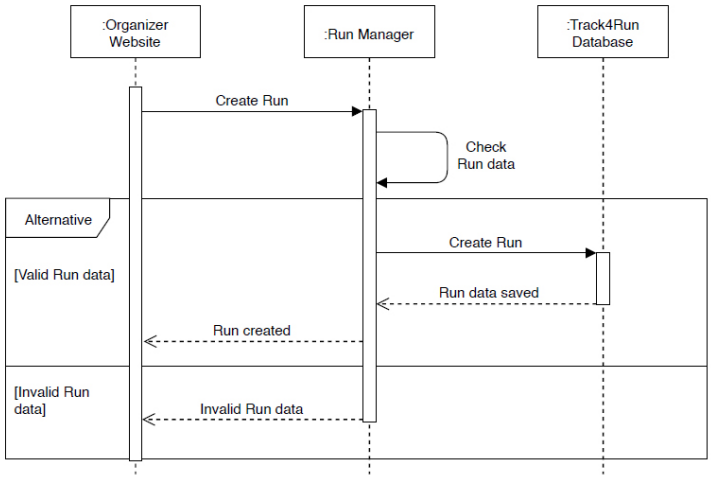
Add New Service Sequence Diagram

When a *User* wants to add a new *Service*, the User Application Services Manager sends a request for available *Services* to Data4Help. The request is received by the Services Manager that forwards it to the Data Manager, which queries the database. The list of *Services* is sent back to the User Application. Assuming there is always at least one *Service* available, the *User* selects one from the list and its details are returned to the User Application by Data4Help. If the *User* decides to give consent to their data acquisition by the *Third party*, then it checks the checkbox asking for consent and the User Application forwards to the Data4Help Server Services Manager the *User*'s decision. The Services Manager forwards the information to the Data Manager, which stores the consent in the database, together with adding the *Service* to the list of *Services* of the specific *User*. Moreover, the Services Manager sends a consent notification to the Third Party Service System. A confirmation message is sent back to the User Application.



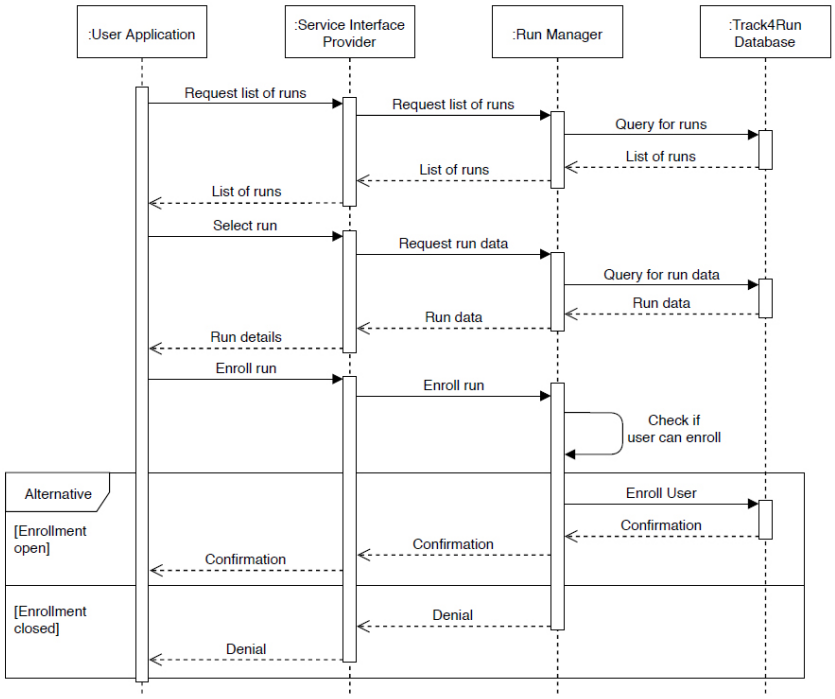
User In Need Assistance Sequence Diagram

When new *User data* is collected by Data4Help, if the *User* is subscribed to AutomatedSOS, the data will be sent to AutomatedSOS for analysis. In particular, the Data Receiver will receive the data and pass it over to the Data Analyzer which compares it against certain thresholds. If the data is identified as *Anomalous data*, then the Data Analyzer notifies the User Monitor that the *User* is in need of assistance. The User Monitor sends a call request to the Local Emergency Services Caller, which calls the Local Emergency Services, and sends the User Monitor a confirmation that the procedure of assisting the *User in need* has begun. The User Monitor finally sends an acknowledgement message back to the Data Analyzer and finally stores the *User in need* data in the database.



Run Organization Sequence Diagram

When they want to organize a *Run*, *Organizers* login into their dedicated website and send a *Run* creation request to the Run Manager of Track4Run. This last one checks the *Run* data is valid and if it is, it creates the *Run*.



Participant Enrollment Sequence Diagram

In this diagram the *Participant* enrollment process is shown in detail. A *User* who wants to enroll in a *Run* first needs to have all the available *Runs*. This is done by querying the Service Interface Provider through the Service Interface. The Service Interface Provider forwards the User Application requests to the Run Manager, which queries the database. It returns the list of available *Runs* to the User Application. Assuming that the list is not empty, the *User* will express their selection and the Data4Help components will return the *Run* details. The *User* may then select to enroll in the selected *Run*. The Run Manager is in charge of checking if the *User* can enroll or not - the latter may happen because the enrollment is closed. If the *User* can enroll in the *Run*, the Run Manager saves the *User* enrollment in the database and sends a confirmation to the User Application. Otherwise, an enrollment denial is sent back.

2.5 Component Interfaces

The following is a representation of the component interfaces that are offered by the system to be. The interfaces are both of external and of internal components so as to provide a clearer explanation of all the main methods available.

The naming convention adopted is of the form "Component_InterfaceName", where "Component" is the component the interface is offered by and "InterfaceName" is the name of the interface. The first interface - "dataInterface" - is used and offered by many components and it is needed to send and receive data. When the component name is "service", it means that the interface must be offered by all the *Third party Services*.

The majority of the following interfaces must include a way to check that the calling component is both authenticated and authorized. For example, d4h_servicesInterface, which allows a *User* to retrieve the *Services* to which they are subscribed, must check that the calling component really is who it claims to be. Interfaces that have this need are marked in the following list with a comment "requires auth". From an implementation point of view, a possible solution to this could be always providing the result of a call to the interface encrypted with the RSA algorithm: the encryption is done with a key and the user, in order to read data, must use their private key generated on their smartphone during the sign up process. See *A Method for Obtaining Digital Signatures and Public-Key Cryptosystems* for further details (see section 1.5 for complete reference).

```
//Interfaces

public interface dataInterface{
   boolean receiveData(Data data); // requires auth
}

public interface service_newDataInterface{
   boolean receiveData(Data data); // requires auth
}

public interface service_serviceInterface{
   boolean executeCommand(String command); // requires auth
   //command varies from Service to Service (e.g. it may be an API call)
}
```

```
//Data4Help Interfaces

public interface d4h_getNotificationsInterface{
   List<String> getNotifications(String username); // requires auth
}

public interface d4h_addNotificationsInterface{
   boolean addNotifications (List<String> notifications, String username)
}

public interface d4h_registerAndLoginInterface{
   boolean isUsernameValid(String username);
   boolean isPasswordValid(String password);
   boolean login(String username, String password);
   boolean userExists(String username);
   boolean signUp(String fullname, DateTime dateOfBirth, boolean gender,
       String ssn, String email, String password);
      //gender: 1 for Male, 0 for Female
}

public interface d4h_servicesInterface{
   List<Service> lookupServices(String namelike);
   List<Service> getAllServices();
   List<Service> getUserServices(String username); // requires auth
   Service getServiceByID(int serviceID);
   boolean addServiceToUserServices(int serviceID, String username);
      // requires auth
   boolean deleteServiceFromUserServices(int serviceID, String
       username); // requires auth
}

public interface d4h_requestDataInterface{
   List<UserData> getUserData(UserDataRequest request); // requires auth
   List<AnonimousData> getGroupData(GroupDataRequest request);
      // requires auth
}


//AutomatedSOS Interfaces

public interface asos_automatedSOSCommandsInterface{
   boolean reactivateMonitoring(String username); // requires auth
   boolean subscribeUser(User user); // requires auth
   boolean removeUser(User user); // requires auth
}

public interface asos_callerInterface{
   boolean call(String username, Data userData);
}
```

```
//Track4Run Interfaces

public interface t4r_automatedSOSCommandsInterface{
   boolean enroll(User user, Run run); // requires auth
   boolean removeUser(User user, Run run); // requires auth
   List<Run> getAvailableRuns();
}

public interface t4r_spectatorsInterface{
   Run getRunByID(String ID);
   List<Run> getAllRuns();
}

public interface t4r_runManagementInterface{
   boolean createRun(String name, DateTime date, Position start, int
       maxNumberOfParticipants, DateTime enrollmentClosureDate);
      // requires auth
   boolean setPath(Run run, List<Position> path); // requires auth
}

public interface t4r_registerAndLoginInterface{
   boolean isUsernameValid(String username);
   boolean isPasswordValid(String password);
   boolean login(String username, String password);
   boolean organizerExists(String username);
   boolean signUp(String fullname, Date dateOfBirth, String email,
       String password);
}


//Database Interfaces

public interface d4h_databaseInterface{
   User getUserByUsername(String username);
   User getUserBySsn(String ssn);
   boolean insertUser(String fullname, Date dateOfBirth, boolean gender,
       String ssn, String email, String password);
   boolean deleteUser(String username);
   boolean insertData(UserData userData);
   UserData getUserData(String username);
   boolean deleteAllUserData(String username);
   boolean insertServiceForUserServices(String serviceID, String
       username);
   boolean deleteServiceFromUserServices(String serviceID, String
       username);
   List<Service> getAllUserServices(String username);
   List<Service> getAllServices();
   boolean insertNotification(String notification);
   List<Notification> getUserNotifications(String username);
}
```

```
public interface asos_databaseInterface{
   boolean insertUserInNeedData(Data data, String ssn);
   Data getUserInNeedData(String ssn);
   boolean insertCall(LocalEmergencyServices les, String ssn);
   LocalEmergencyServices getLocalEmergencyServicesForUser(String ssn);
   boolean reactivateMonitoring(String ssn);
}

public interface t4r_databaseInterface{
   List<Run> getAllRuns();
   boolean insertNewRun(Run run);
   boolean deleteRun(int runID);
   List<Participant> getAllParticipants(int runID);
   boolean insertParticipant(Participant participant);
   Run getRun(int runID);
   Map<Participant, List<Data>> getParticipantsData(int runID);
}
```

2.6 Selected Architectural Styles

Three Tier Architecture
For all the three systems to be developed, the chosen architecture is a three tier one. In fact, Data4Help, AutomatedSOS and Track4Run, all need three main components: one or more clients, a server and a database, in a remote presentation pattern.
In the remote presentation pattern the client is only responsible of providing a GUI to the user for them to interact with the server. Both Data4Help and *Third party Services*, in fact, need their users to interact with the application. For instance, a *User* may add a new *Service* or they may enroll in a *Run*. This architectural style was adopted for several reasons:

- **Performance** First of all, the decision of not having any logic on the client side allows to manage the processes only on the server side. This is crucial in order not to have a heavy impact on the user's smartphone performance.
- **Maintainability** This decision also has an effect on maintainability, since the application will not need any updates if a logic change is required in the future: only the server will be updated.
- **Platform independence** By doing this, if *Third party Services* already have a GUI in the form of a website, they do not need to implement a different GUI for the user to use: the *Service* website will be displayed on the client application. The GUI they offer is accessible from any operating system, since it is a website, with no need to have platform specific GUIs.

The server is the core of the system. For all three systems, it manages all the processes and the logic. It queries the database and it does not need any GUI. All users querying the server have a dedicated application, in the form of a website or of a smartphone application. For instance, the *Organizers* manage *Runs* from the *Organizers* website.
The database is where all information is stored. The decision of not having a local database for the client application is a consequence of the fact that there is no need of having it since all data can be retrieved through the network passing from the server.

Communication between Components
This paragraph makes references to elements shown in the diagrams of section 2.1.
Data4Help is based on constant data exchange from the client application to the server. In order to allow this continuous communication, a socket connection is established between client and server. This allows for a continuous data stream. Therefore, Data4Help can receive data as soon as it is collected by the client application. This kind of connection is present also between Data4Help and the Third Party Service Systems for them to receive new data as soon as it is produced as long as they are subscribed to it.

Data4Help Server offers REST APIs to both the client application and the Third Party Service Systems. The client application will use the REST APIs to interact with the server. *Third parties* will receive the documentation relative to the exposed APIs for them to communicate with Data4Help. By doing this, *Third parties* may develop their system, having in mind what operations they can do on the server. Moreover, there is no need of a particular communication protocol, as REST APIs are just basic HTTP calls exploiting the main operations: GET, POST, PUT, DELETE.
The communication between the client application and the Third Party System Service is done through HTTP, as already explained in the previous paragraph.

Track4Run Users
Track4Run has three kinds of users: *Spectators*, *Organizers* and *Participants*. These three all have different needs and interactions with the system, reason why they are kept separate. Each one has a different way to interact with the system:

- **Spectators** are the simplest kind of user. They only need a dedicated GUI where they can watch a *Run*.
- **Organizers** require a more complex GUI to interact with the system, allowing for registration and *Run* management.
- **Participants** are Data4Help *Users*, who, after adding Track4Run to their *Services*, may enroll in a *Run*.

For these reasons, *Spectators* and *Organizers* do not need to be Data4Help *Users*: in fact, their data collection is not needed. By doing this, the system is kept simple by not requiring *Organizers* to register to Data4Help and *Spectators* not to register at all.

Data Interface
When it comes to sending data from a component to another component, then it is the receiving component that offers the interface to receive data. This choice is due to the fact that as soon as data is produced, it must be sent over to the receiving component, assuming it is always ready for data receipt. If it were the opposite - where the interface would be offered by the sending component - then the receiving component would have to constantly query the sending component for new data. This solution would have as a consequence several useless queries. On the other hand, all the calls to the data interface are useful.

Notifications
The pattern used to implement the notifications system is the opposite of the one discussed in the previous paragraph. In fact, it is the client application that constantly queries the server for new notifications. As soon as they are

produced, the server will return them. This choice is driven by the fact that the client application is not always connected to the Internet, therefore, in an opposite scenario, all the calls from the server to the client application, when the latter is offline, would be useless as they will not have any answer. By implementing the chosen solution, all calls will be useful, even if many may still return an empty list of notifications.

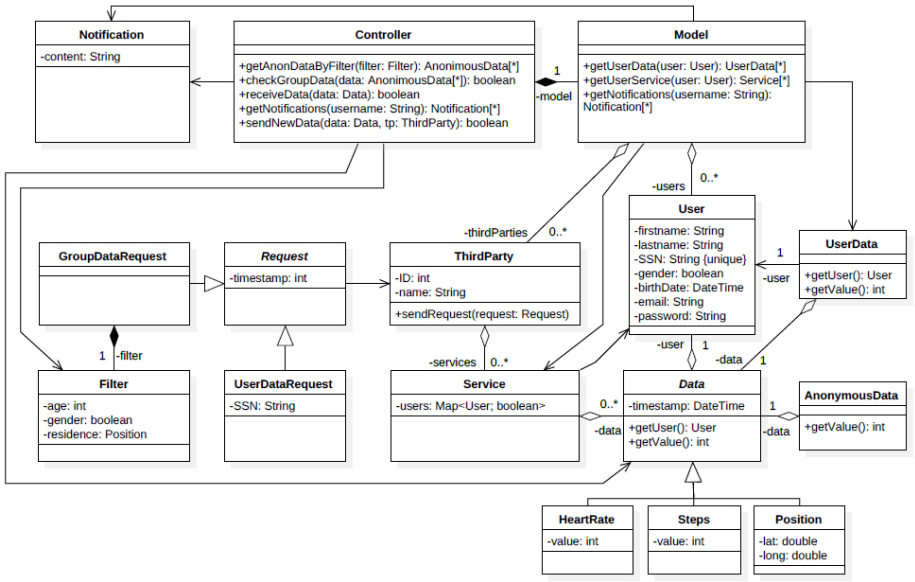
Third Party Services Interfaces
With the proposed design, there are only two different interfaces that *Third party Services* need to implement and offer. These are the Service Interface and the New Data Interface (see sections 2.2 and 2.5 for more details). The two interfaces are here analyzed in details:

- **Service Interface** must respect the documentation provided by TrackMe in order to allow the User Application to retrieve the GUI offered by the *Service*. In particular, the GUI must be a website for the *User* to interact with. The User Application will call methods of the interface, therefore this must be *Service*-independent. A solution to this lies in the executeCommand(String command) method, where the User Application will pass a string containing the command to be executed to the *Service* offering the Service Interface.
- **New Data Interface** must respect the documentation provided by TrackMe. This interface is crucial for *Third party Services* to receive new data. In fact, when new data is collected, it is sent to the subscribed *Third party Services* right away. In order to have a *Service*-independent way of sending new data, a common interface must be shared among *Services*.

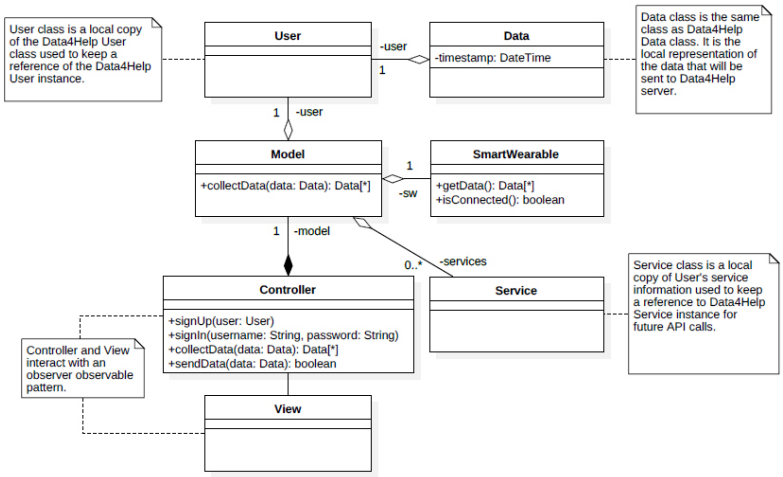
Database Interface Design
The databases of the system to be must not provide a way to execute any query on it. In fact, components have a precise purpose and specific actions they will perform. For each of them, there are methods that they will call to accomplish their functions. This defensive style is crucial to maintain separation between the two tiers - server and database. In fact, the server will not have complete control over the database not being able to execute any query.

2.7 Other Design Decisions

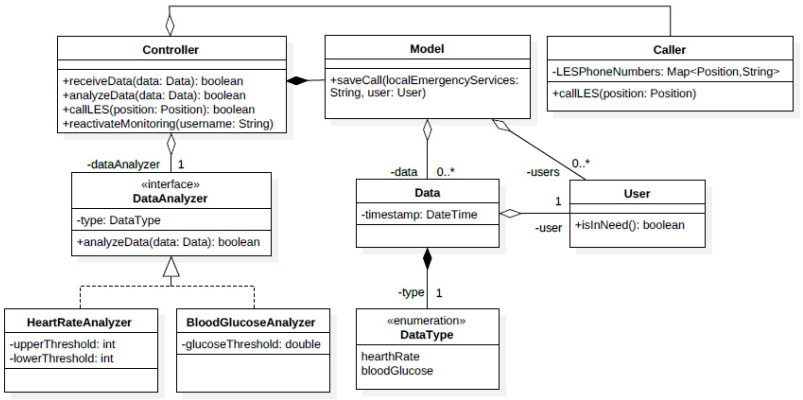
2.7.1 Class Diagrams



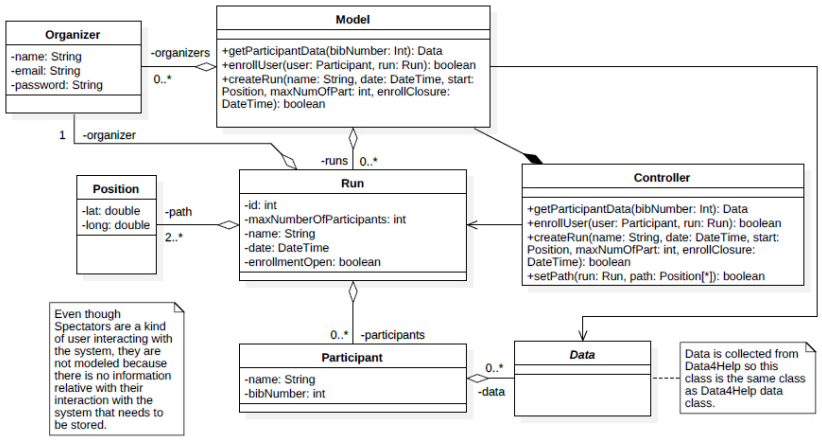
Data4Help Class Diagram



User Application Class Diagram



AutomatedSOS Class Diagram



Track4Run Class Diagram

2.7.2 Interfaces Use

The following list maps the classes defined in the class diagrams above (section 2.7.1 to the interfaces proposed in this document (section 2.5). By doing this, the purpose of each class is provided, since all the interfaces that are used by the class are listed.

Data4Help

- Data4Help Controller
  - Add Notifications Interface
  - Data Interface
  - New Data Interface
- Data4Help Model
  - Data4Help Database Interface
- ThirdParty
  - Request Data Interface

User Application

- User Application Controller
  - Data Interface
  - Get Notifications Interface
  - Registration and Login Interface
- User Application Service
  - Services Interface
  - Service Interface (AutomatedSOS)
  - Google Maps Interface
- SmartWearable
  - Data Interface

AutomatedSOS

- AutomatedSOS Controller
  - Caller Interface
  - Data Interface
  - AutomatedSOS Commands Interface

  - Local Emergency Services Interface
- AutomatedSOS Model
  - AutomatedSOS Database Interface
- DataAnalyzer
  - Data Interface

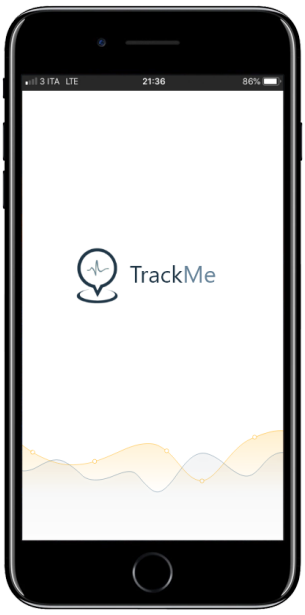
Track4Run

- Track4Run Controller
  - New Data Interface
  - Track4Run Commands Interface
  - Data Interface
- Track4Run Model
  - Track4Run Database Interface

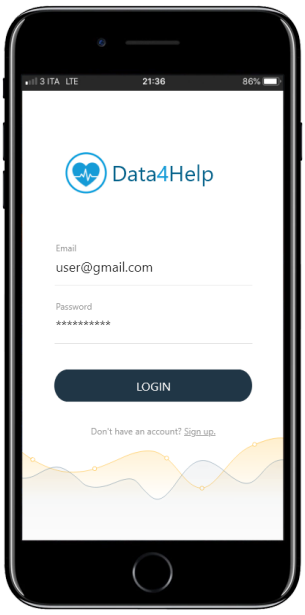
Chapter 3

User Interface Design

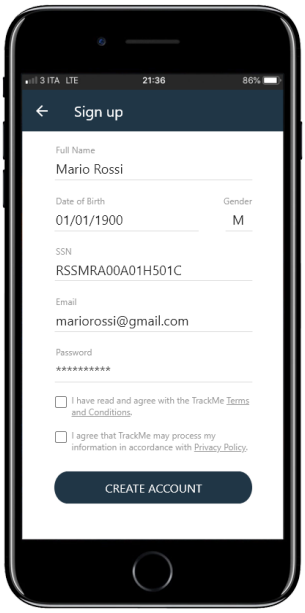
3.1 User Interface Mockups



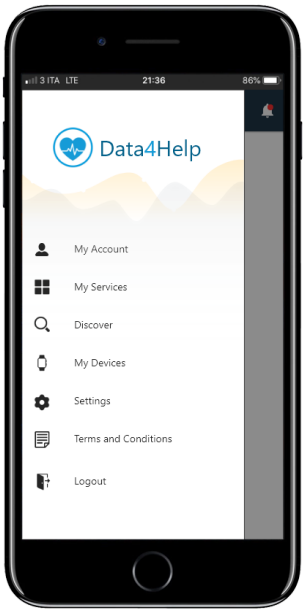
Data4Help Welcome Page



Data4Help Login Page

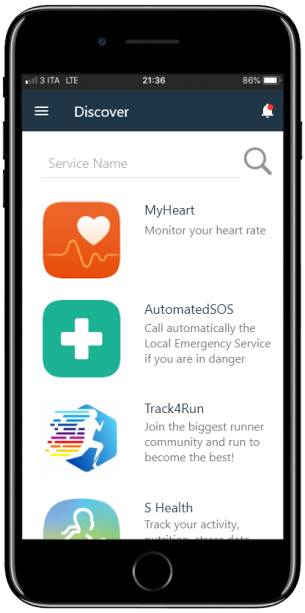


Data4Help Sign Up Page

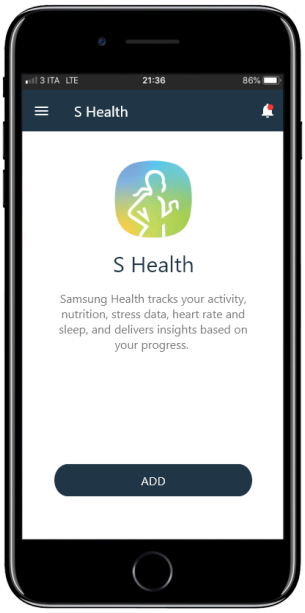


Data4Help Menu

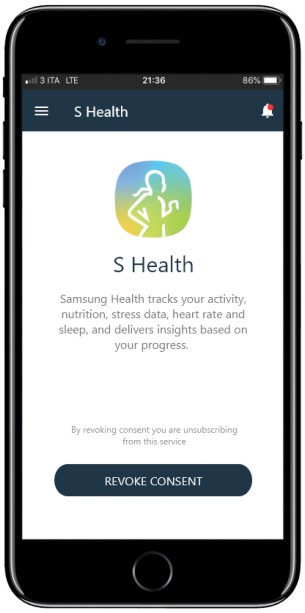
User Services Page



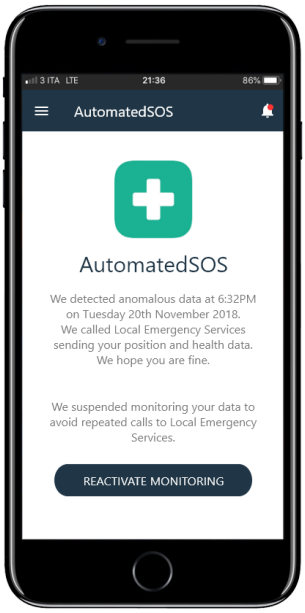
Services Discovery Page



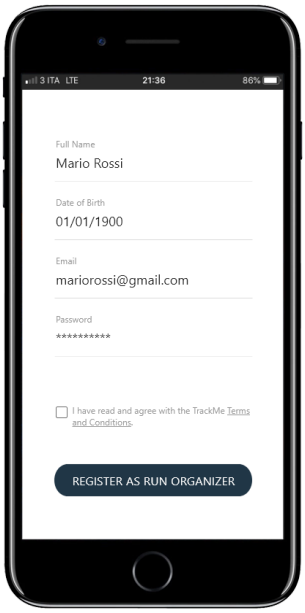
Add Service Page



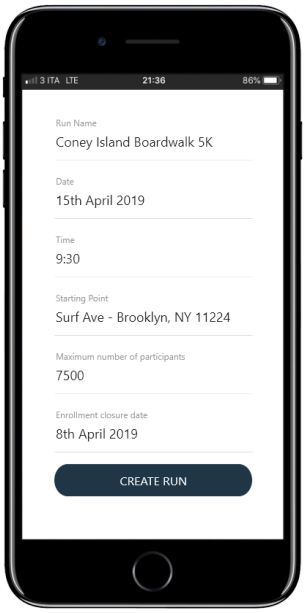
Subscribed User Service Page



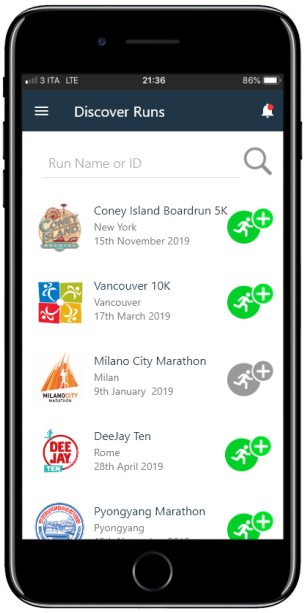
AutomatedSOS Page



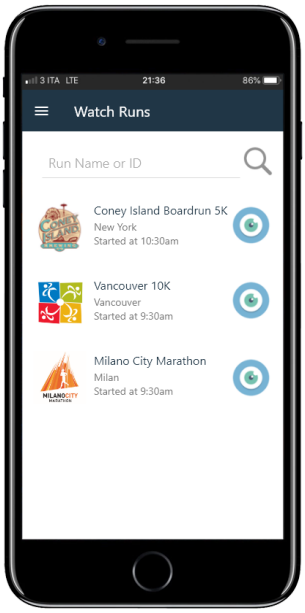
Organizer Registration Page



New Run Creation Page



Runs Discovery Page



Spectators Run Discovery Page

Watch Real Time Run Page

3.2 Mapping User Interfaces to Components

The following list maps each interface with the components that allow it to work properly and efficiently.

- Data4Help Welcome Page
  - No specific component: it is just a static content embedded in the application code source
- Data4Help Login Page
  - Data4Help App: Authentication
  - Data4Help Server: Authentication
- Data4Help Sign Up Page
  - Data4Help App: Authentication
  - Data4Help Server: Authentication
- Data4Help Menu
  - No specific component: it is just a static content embedded in the application code source
- User Services Page
  - Data4Help App: Services Manager
  - Data4Help Server: Services Manager
- Services Discovery Page
  - Data4Help App: Services Manager
  - Data4Help Server: Services Manager
- Add Service Page
  - Data4Help App: Services Manager
  - Data4Help Server: Services Manager
- User Subscribed Service Page
  - Data4Help App: Services Manager
  - Data4Help Server: Services Manager
- AutomatedSOS Page
  - Data4Help App: Service Controller
  - AutomatedSOS Server: Service Interface Provider
- Organizer Registration Page

  - Track4Run Server: Authentication
- New Run Creation Page
  - Track4Run Organizer Website
  - Track4Run Server: Run Manager
- Runs Discovery Page
  - Data4Help App: Service Controller
  - Track4Run Server: Service Interface Provider
- Spectators Run Discovery Page
  - Track4Run Spectators Website
  - Track4Run Server: Run Manager
- Watch Real Time Run Page
  - Track4Run Spectators Website
  - Track4Run Server: Run Manager

3.3 User Application Interaction

The following provides a description on how to move through interfaces when interacting with the User Application so as to give a clear idea of the navigation flows.

- *Data4Help Welcome Page* is shown when the User Application is opened.
- *Data4Help Welcome Page* redirects to Data4Help Login Page as soon as the User Application is loaded.
- *Data4Help Login Page* redirects to Data4Help Sign Up Page if the *User* taps on Sign Up, or redirects to Data4Help Menu if the *User* fills in the form and taps on Login.
- *Data4Help Sign Up Page* redirects to *Data4Help Login Page* once the *User* fills in the form and taps on Create Account (assuming inserted data is correct). If data is not correct, the interface does not change and an alert is shown.
- *Data4Help Menu* redirects to:
  - *User Services Page* if the *User* taps on My Services.
  - *Services Discovery Page* if the *User* taps on Discover.
  - *Data4Help Login Page* if the *User* taps on Logout.

My Account, My Devices, Settings, Terms and Conditions redirect to specific pages that are not listed in [3].

- *User Services Page* redirects to *User Subscribed Service Page* when the *User* taps on the icon of a *Service*.
  - If the *Service* is AutomatedSOS and the monitoring was deactivated due to a previous alarm since data was detected as *Anomalous*, the interface shown is *AutomatesSOSPage*.
- *Services Discovery Page* redirects to *Add Service Page* when the *User* taps on the icon of a *Service*.
- *Organizer Registration Page* is shown when an individual connects to the *Organizers* dedicated website and wants to register as an *Organizer*.
- *New Run Creation Page* is shown when an *Organizer* asks to create a new *Run*.
- *Runs Discovery Page* is shown when a *User* taps on Track4Run in their application.
- *Spectators Run Discovery Page* is shown when an individual connects to the *Spectators* dedicated website. It redirects to *Watch Real Time Run Page* when the *Spectator* taps on the icon of a *Run*.

Chapter 4

Requirements Traceability

The following is a way to ensure that all requirements defined in section 3.2.5 of [3] are satisfied by the components defined in section 2.2 of this document. Each component is needed in order to fulfill one or more requirements, therefore all components defined have a specific purpose. Moreover, where applicable, references to sequence diagrams are included so as to provide a graphical representation on how components fulfill each requirement.

Data4Help

R_1 Unregistered individuals and companies must not be able to use Data4Help.

- Authentication (User App and Data4Help)
- Login Sequence Diagram

R_2 At sign up, *User* must provide: first name, last name, SSN, gender, date of birth, email and password.

- Authentication (User App and Data4Help)

R_3 At sign up, *Third party* must provide a company name.

- Authentication (Data4Help)

R_4 At sign up, *User* must accept *Terms and conditions*, including the *Privacy statement*.

- Authentication (User App and Data4Help)

R_5 At sign up, *Third party* must accept *Terms and conditions*.

- Authentication (Data4Help)

R_6 Identify a *User* by their identifier.
- Authentication (User App and Data4Help)
- Login Sequence Diagram

R_7 Query Data4Help Database for a *User* by their identifier.
- Authentication (User App and Data4Help)

R_8 Receive *User Data*.
- Authentication (User App and Data4Help)
- Data Collector (User App)
- Data Sender (User App)
- Data Receiver

R_9 Validate *User Data*.
- Data Receiver

R_{10} Authenticate *User Data*.
- Data Receiver

R_{11} Store collected *User Data* in Data4Help Database.
- Data Receiver
- Data Manager

R_{12} Retrieve specific *User data* by querying Data4Help Database.
- Data Manager
- User Data Request Sequence Diagram

R_{13} Receive *Third party* data access request.
- Third Party Request Manager
- Group Data Request Sequence Diagram

R_{14} Validate *Third party* data access request.
- Third Party Request Manager

R_{15} Authenticate *Third party* data access request.
- Third Party Request Manager

R_{16} Forward *User data* access request to the specific *User*.
- Third Party Request Manager
- Notifications Manager
- Services Manager (User App)

- User Data Request Sequence Diagram

R_{17} Receive *User* consent approval or denial with respect to *Third party* data access requests.

- Services Manager (User App and Data4Help)
- Add New Service Sequence Diagram

R_{18} Check if a specific *User* gave consent to a specific *Service*.

- Third Party Request Manager
- Data Manager

R_{19} Send specific *User Data* to the requesting *Third party*.

- Third Party Request Manager
- Data Manager
- User Data Request Sequence Diagram

R_{20} Not send specific *User Data* to the requesting *Third party* if the specific *User* denied consent.

- Third Party Request Manager
- Data Manager
- User Data Request Sequence Diagram

R_{21} *Third party* must be able to set specific constraints to define a group of *Users*: age, gender, residence.

- Third Party Request Manager

R_{22} Check how many *Users* the requested *Group data* refers to.

- Third Party Request Manager
- Group Data Request Sequence Diagram

R_{23} Properly anonymize *Group Data*.

- Third Party Request Manager
- Group Data Request Sequence Diagram

R_{24} Send *Group Data* to the requesting *Third party*.

- Third Party Request Manager
- Group Data Request Sequence Diagram

R_{25} Not send *Group Data* if the group it refers to is made up of less than 1000 *Users*.

- Third Party Request Manager

  - Group Data Request Sequence Diagram

R_{26} Receive *Third party* subscription request.

  - Third Party Request Manager

R_{27} Validate *Third party* subscription request.

  - Third Party Request Manager

R_{28} Authenticate *Third party* subscription request.

  - Third Party Request Manager

R_{29} Automatically send new *User data* to subscribed authorized *Third parties* as soon as they are produced.

  - Data Receiver
  - Data Manager
  - Services Manager (Data4Help)
  - Third Party Request Manager

R_{30} Allow *Users* to add a *Service*.

  - Services Manager (Data4Help)
  - Data Manager
  - Add New Service Sequence Diagram

R_{31} Allow *Users* to unsubscribe from a *Service*.

  - Services Manager (Data4Help)
  - Data Manager

R_{32} Send to a specific *User* all their data stored by TrackMe.

  - Services Manager (Data4Help)
  - Data Manager

R_{33} Delete all data of a specific *User*.

  - Services Manager (Data4Help)
  - Data Manager

R_{34} Allow *Users* to request all their data stored by TrackMe at any time.

  - Services Manager (User App and Data4Help)

R_{35} Allow *Users* to request the deletion of all their data stored by TrackMe at any time.

  - Services Manager (User App and Data4Help)

AutomatedSOS

R_{36} Receive *User Data* from Data4Help.

- Data Receiver (AutomatedSOS)
- User In Need Assistance Sequence Diagram

R_{37} Compare *User Data* against certain thresholds.

- Data Analyzer
- User In Need Assistance Sequence Diagram

R_{38} Call local emergency services providing necessary *User Data* of *User in need*.

- User Monitor
- Local Emergency Services Caller
- User In Need Assistance Sequence Diagram

R_{39} *User* must be able to reactivate AutomatedSOS monitoring.

- Service Controller (User App)
- Service Interface Provider
- User Monitor

Track4Run

R_{40} Receive *User Data* from Data4Help.

- Data Receiver

R_{41} At sign up, *Organizers* must provide: first name, last name, email and password.

- Authentication

R_{42} At sign up, *Organizers* must accept *Terms and conditions*.

- Authentication

R_{43} Allow *Organizers* to create a *Run*, defining: name, path, date, maximum number of *Participants* and enrollment closure date.

- Run Manager
- Run Organization Sequence Diagram

R_{44} Allow *Users* to enroll in an existing *Run*.

- Run Manager
- Service Interface Provider

  - Service Controller (User App)
  - Participants Enrollment Sequence Diagram

R_{45} Prevent a *User* from enrolling in a *Run* if the maximum number of *Participants* was already reached.

  - Run Manager
  - Participants Enrollment Sequence Diagram

R_{46} Prevent a *User* from enrolling in a *Run* if it already started or finished.

  - Run Manager
  - Participants Enrollment Sequence Diagram

R_{47} Prevent a *User* from enrolling in a *Run* if enrollment is closed.

  - Run Manager
  - Participants Enrollment Sequence Diagram

R_{48} Show a *Run* by displaying the position of *Participants* on a map.

  - Run Manager

Chapter 5

Implementation, Integration and Test Plan

In this chapter, an implementation plan is introduced. This is followed by an integration strategy. Finally an analysis on how the system will be tested is provided.

5.1 Components to be Implemented

The following list includes all the components that must be implemented. The list takes into account the separation between the three systems to be developed: Data4Help, AutomatedSOS, Track4Run.

Data4Help

- Data4Help Server
  - Request Manager
  - Notifications Manager
  - Services Manager
  - Data Manager
  - Data Receiver
  - Authentication
- Data4Help User Application
  - Service Controller
  - Authentication

  - Data Sender
  - Data Collector
  - Services Manager
- Data4Help Database
- Data4Help Third Parties Website

AutomatedSOS

- AutomatedSOS Server
  - Service Interface Provider (website)
  - Data Analyzer
  - User Monitor
  - Data Receiver
  - Local Emergency Services Caller
- AutomatedSOS Database

Track4Run

- Track4Run Server
  - Run Manager
  - Service Interface Provider (website)
  - Data Receiver
  - Authentication
- Track4Run Organizers Website
- Track4Run Spectators Website
- Track4Run Database

5.2 Component Dependencies

The following list of components shows the logical and architectural dependencies between the components listed in the previous section.

Data4Help

- Data4Help Server: Request Manager
  - Data4Help Server: Notifications Manager
  - Data4Help Server: Data Manager
- Data4Help Server: Notifications Manager
  - Data4Help Server: Data4Help Database
- Data4Help Server: Services Manager
  - Data4Help Server: Data Manager
- Data4Help Server: Data Manager
  - Data4Help Database
- Data4Help Server: Data Receiver
  - Data4Help Server: Data Manager
- Data4Help Server: Authentication
  - Data4Help Database
- Data4Help User Application: Service Controller
  - No components dependencies
- Data4Help User Application: Authentication
  - Data4Help Server: Authentication
- Data4Help User Application: Data Sender
  - Data4Help Server: Data Receiver
- Data4Help User Application: Data Collector
  - No components dependencies
- Data4Help User Application: Services Manager
  - Data4Help Server: Notifications Manager
  - Data4Help Server: Services Manager
- Data4Help Database
  - No components dependencies

- Data4Help Third Parties Website
  - Data4Help Server: Authentication
  - Data4Help Server: Services Manager

AutomatedSOS
It depends entirely on Data4Help. The following dependencies are only between AutomatedSOS components.

- AutomatedSOS Server: Service Interface Provider(website)
  - AutomatedSOS Server: User monitor
- AutomatedSOS Server: Data Analyzer
  - AutomatedSOS Server: Data Receiver
- AutomatedSOS Server: User Monitor
  - AutomatedSOS Database
  - Local Emergency Services Caller
- AutomatedSOS Server: Data Receiver
  - AutomatedSOS Server: Data analyzer
- AutomatedSOS Server: Local Emergency Services Caller
  - No components dependencies
- AutomatedSOS Database
  - No components dependencies

Track4Run
It depends entirely on Data4Help. The following dependencies are only between Track4Run components.

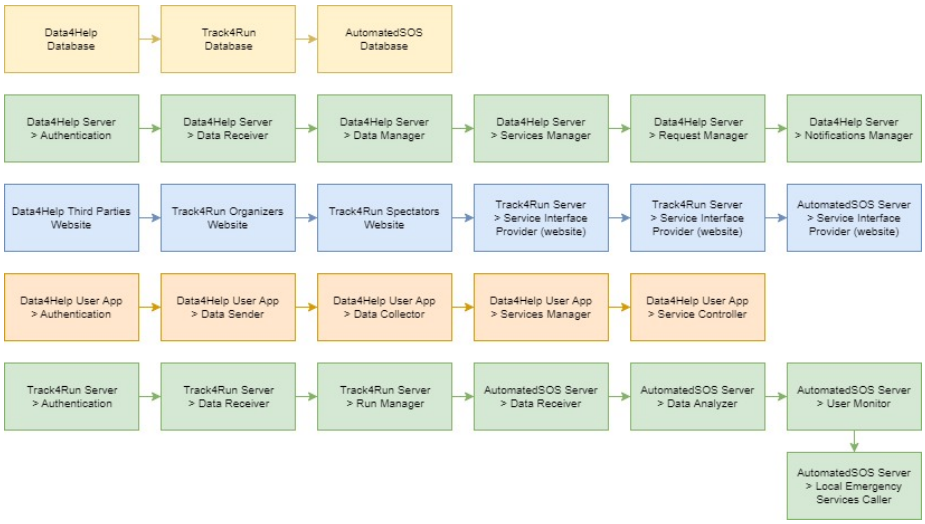
- Track4Run Server: Run Manager
  - Track4Run Database
- Track4Run Server: Service Interface Provider (website)
  - Track4Run Server: Run Manager
- Track4Run Server: Data Receiver
  - Track4Run Server: Run Manager
- Track4Run Server: Authentication
  - Track4Run Database
- Track4Run Organizers Website

  - Track4Run Server: Authentication
  - Track4Run Server: Run Manager
- Track4Run Spectators Website
  - Track4Run Server: Run Manager
- Track4Run Database
  - No components dependencies

5.3 Implementation Plan

The effort done in the design of the system to be, in particular in the identification of the core components, reflects as a significant simplification of the implementation phase. All components shown, in fact, have well defined interfaces: this gives to the developing team more flexibility in choosing the sequence of the components implementation. Potentially, all components could be implemented in parallel. This gives the integration phase the responsibility of enabling all the functionalities of the system to be by putting together all the components.

Considering a realistic scenario in which team size and costs constraints influence the planning of the activities, the following is a possible implementation plan based on development skills.



Development skills based Implementation Plan

The diagram shows the implementation of all the modules of Data4Help, AutomatedSOS and Track4Run using five parallel developing processes:

1. Database implementation - Database development skills
2. Data4Help Server implementation - Backend development skills
3. Websites needed by Data4Help, Track4Run, AutomatedSOS - Full stack web development skills
4. Data4Help User Application - Full stack application development skills
5. AutomatesSOS and Track4Run Servers - Backend development skills

As previously mentioned, the interfaces independence of all the components of the system to be allow modifications to this plan according to team size and budget constraints.

5.4 Integration Plan

The following section contains a list, divided by macro-component, showing which integrations must be performed. To declare a macro-component completed, all relative integrations must be performed. All *Services*, including AutomatedSOS and Track4Run, depend on Data4Help. Therefore, in addiction to complete all integrations as stated before, another fundamental condition is that Data4Help is completed and fully working (integrations of this type are marked with an asterisk "*").

This is just a proposed order of integration. Other orderings are possible within macro-components.

5.4.1 Integrations

Data4Help Server

- Data4Help Server: Request Manager **and** Data4Help Server: Data Manager
- Data4Help Server: Notifications Manager **and** Data4Help Server: Data4Help Database
- Data4Help Server: Services Manager **and** Data4Help Server: Data Manager
- Data4Help Server: Data Manager **and** Data4Help Database
- Data4Help Server: Data Receiver **and** Data4Help Server: Data Manager
- Data4Help Server: Authentication **and** Data4Help Database
- Data4Help Third Parties Website **and** Data4Help Server: Authentication
- Data4Help Third Parties Website **and** Data4Help Server: Services Manager

Data4Help User Application

- Data4Help User Application: Authentication **and** Data4Help Server: Authentication
- Data4Help User Application: Data Sender **and** Data4Help Server: Data Receiver
- Data4Help User Application: Services Manager **and** Data4Help Server: Notifications Manager
- Data4Help User Application: Services Manager **and** Data4Help Server: Services Manager

AutomatedSOS

- AutomatedSOS Server: Service Interface Provider (website) **and** AutomatedSOS Server: User Monitor
- AutomatedSOS Server: Data Analyzer **and** AutomatedSOS Server: Data Receiver
- AutomatedSOS Server: User Monitor **and** AutomatedSOS Database
- AutomatedSOS Server: User Monitor **and** Local Emergency Services Caller
- AutomatedSOS Server: Data Receiver **and** AutomatedSOS Server: Data Analyzer
- * AutomatedSOS Server: Data Receiver **and** Data4Help Server

Track4Run

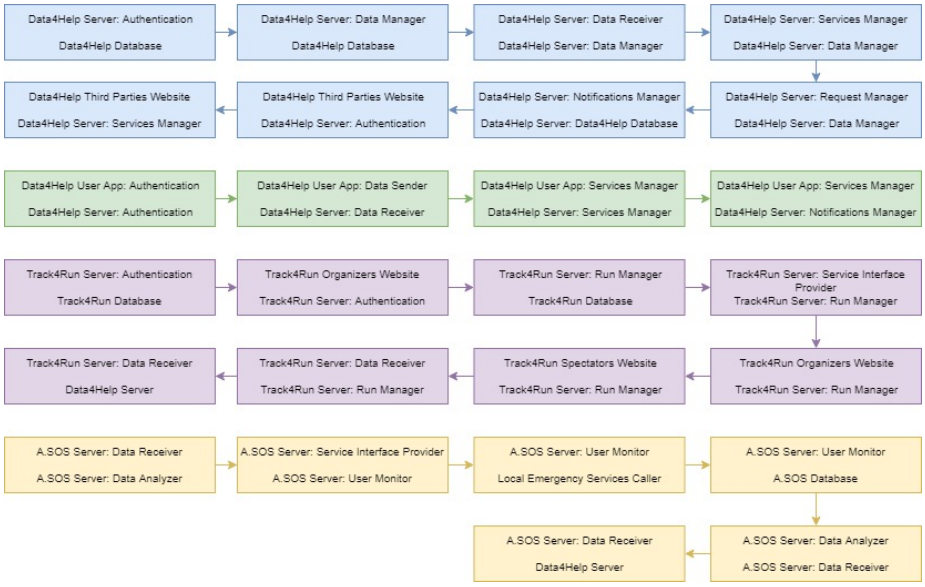
- Track4Run Organizers Website **and** Track4Run Server: Authentication
- Track4Run Organizers Website **and** Track4Run Server: Run Manager
- Track4Run Spectators Website **and** Track4Run Server: Run Manager
- Track4Run Server: Run Manager **and** Track4Run Database
- Track4Run Server: Service Interface Provider (website) **and** Track4Run Server: Run Manager
- Track4Run Server: Data Receiver **and** Track4Run Server: Run Manager
- Track4Run Server: Authentication **and** Track4Run Database
- * Track4Run Server: Data Receiver **and** Data4Help Server

5.4.2 Integration Plan Diagram

Two components can be integrated only if they are fully implemented, so the integration plan is implementation-dependent.

For example, AutomatedSOS Server: Data Receiver is integrated with Data4Help Server at the end of all integrations concerning AutomatedSOS. Implementing Data4Help completely takes a long time and because of this, the integration will not be performed until the the end of the implementation processes. For this reason it is inserted as the last one in each integration process. By doing so, all other integrations can be performed and none will be delayed.

The following diagram represents four parallel integration processes based on the implementation plan introduced in the previous section.

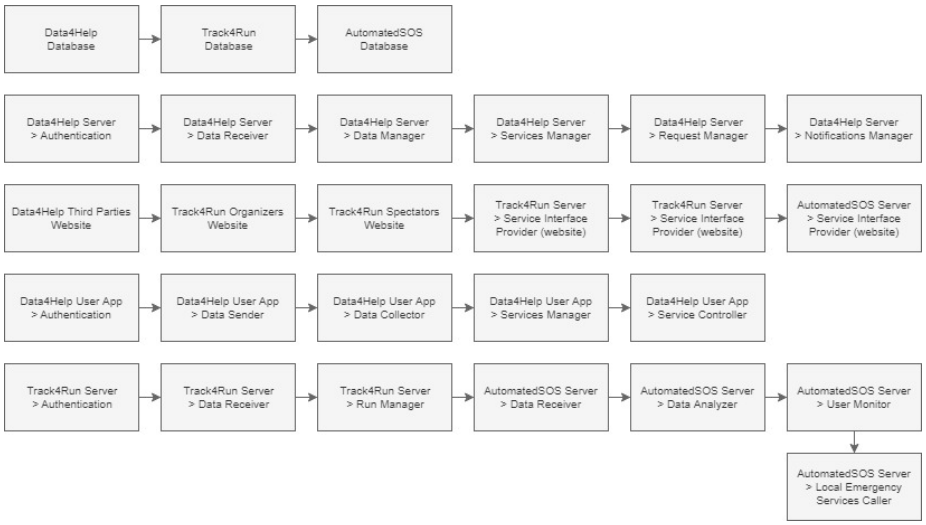


Integration Plan

5.5 Testing Plan

5.5.1 Unit Testing

Unit testing must be performed during the development of each component and finalized at component completion time. For this reason, the unit testing plan completely depends on and follows by the implementation plan.



Unit Testing Plan

Methodologies

- **Approach** A TDD - Test Driven Development - style will be followed when implementing the components of the system to be. Further details of this method may be found in *Test Driven Development: By Example* (see section 1.5 for reference details).
- **Coverage** The test coverage will be of 100% for methods and classes and of 90% for all the lines of code.
- **Tools** In order to monitor effectively the coverage, it tools like SonarQube and JUnit will be in use.

5.5.2 Integration Testing

Integration testing will be performed on each case listed in the integration plan section 5.4. Testing will be undertaken in parallel with the integration of components, as a way to test and confirm the correctness of the integration. A general and comprehensive test at the end of each integration will be also performed. Since integration testing must be executed in parallel with the integration of components, the integration testing plan completely depends on and follows by the integration plan.

Integration Testing Plan

Chapter 6

Effort Spent

Gargano Jacopo Pio Total hours of work: 40h

- 3h DD review homework
- 2h Purpose, Scope
- 3h Overview and Component diagrams
- 2h Deployment diagrams
- 2h Component diagram revision
- 2h Requirements traceability
- 2h Component interfaces
- 2h Class diagrams
- 2h Overview and Component diagrams explanation
- 2h Overview and Component revision
- 3h Sequence diagrams explanation
- 1h Requirements traceability revision
- 2h Component interfaces completion
- 1h UML revision
- 2h Architectural Styles and Patterns
- 1h Meeting with Professor
- 7h General Revision
- 1h Final Revision

Giannetti Cristian Total hours of work: 43h

- 3h DD review homework
- 1h Creating subfiles structure in Latex
- 3h Overview, Component Diagrams
- 2h Deployment diagrams
- 2h Component diagram revision
- 2h Requirements traceability
- 2h Component diagrams
- 5h Component and Overview diagrams
- 2h Diagrams review
- 2h Component and deployment diagrams
- 2h Diagrams review
- 4h Sequence diagrams
- 1h Requirements traceability revision
- 2h Component interfaces completion
- 1h UML revision
- 2h Interface use and Effort spent
- 1h Meeting with Professor
- 5h Diagrams review
- 1h General Revision

Haag Federico Total hours of work: 35h

- 3h DD review homework
- 3h Overview, Component diagrams
- 2h Deployment Diagram
- 2h Sketch sequence diagrams
- 1h Review of sketched Sequence diagrams
- 3h Component and Overview revision
- 4h UML Class diagram
- 2h User interface design
- 1h General revision

- 2h Implementation Plan
- 2h Integration and Testing Plan
- 1h UML revision
- 1h Meeting with Professor
- 1h Component interfaces and User interfaces
- 3h Implementation, Integration and Testing plans
- 3h General Revision
- 1h General Revision

Chapter 7

References

1 E. Di Nitto. *Lecture Slides*. Politecnico di Milano.

2 E. Di Nitto. *Mandatory Project Assignment AY 2018-2019*. Politecnico di Milano.

3 J. Gargano, C. Giannetti, F. Haag. *Requirements Analysis and Specification Document*. Politecnico di Milano.