# First responder help facilitated by the mobile cloud

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*Abstract* — **This paper presents a novel system that allows mobile users to have access to healthcare services in the case of emergencies. The cloud hosts a directory service containing a list of pre-registered professionals, such as doctors and nurses. Once a registered user sends a help message to the first responder cloud service, a look-up operation is started to search for the most suitable medical professional, taking into account the location of both users. Then, the cloud service will establish/monitor a communication link between the person requesting aid and the selected professional whereby these two users can start a chat session to exchange messages. For the purpose of enhancing system availability and dealing with connection issues, SMS is provided as an alternative communication method. The paper includes screenshots of the application and experimental data regarding setting up the connection between someone in an emergency situation and the first responder. The experimental results show that the amount of time needed to set up communication between users and medical professionals is around five seconds, which means no extra time will be added to the total medical response time. This will increase the chance of a better outcome.**

***Keywords: component; mobile; cloud; healthcare; medical emergency; help; doctors, SMS.***

## I. Introduction

Recent years have seen a significant increase in activity surrounding the adoption of IT solutions in the healthcare sector. These solutions are aimed at improving care services as well as reducing the total cost of seeking/providing them. This integration has produced a new term in the healthcare field: 'm-health' [1]. M-health stands for mobile health, which means providing health services to the public on the move.

Providing healthcare services to the public on an off-hospital basis reduces the pressure on health centres, whilst enabling people to continue managing their health. The new mobile technologies have made a significant difference in emergency or special medical cases, such as heart-related incidents. If healthcare services can be made accessible through mobile devices, they can offer benefits such as health service provision anytime, anywhere. Furthermore, smart phones can offer additional features unique to mobile devices, such as a location service, wireless ability (Wi-Fi and Bluetooth) and mobility.

However, mobile devices have limited resources, most importantly, limited battery life [2]. Mobile cloud computing (MCC) has recently been proposed as a solution to provide services to mobile devices [3]. The idea is to deploy the required services to the cloud, resulting in the shifting of high and complex tasks to the cloud instead of executing them on the mobile devices themselves. This new computing model adds strong features to any system, such as high performance and reliability [4].

In some cases, such as emergency situations that can happen to people on the move, the provision of healthcare services in the shortest possible period of time can be life-saving. A system that can support such a service requires unique features, such as availability, robustness, access to web/cloud information through different networking technologies, and the efficient management of mobile users.

As connectivity between users and the health service system is a key feature, in our previous paper [5], we introduced a mobile ad-hoc network (MANET) manager service hosted by the cloud that allows all mobile users to be reached, including those without cellular connectivity but who do have access to Wi-Fi.

In the current paper, we introduce a novel system that provides healthcare services to people who are in an emergency situation and out of reach of home or office, for example in a crowded area. These services are hosted in the cloud and can be accessed via mobile devices. The system consists of directories of medical practitioners: doctors, nurses, and medical organizations, such as emergency departments and medical centres, all of whom volunteer to provide a first responder service. This service is based on availability and location, and aims at helping people in need as quickly as possible. This service is part of a larger system that has the goal of achieving an effective point-of-care system to people on the move.

The rest of the paper is organized as follows: section II discusses research projects similar to this work; section III presents some real-world scenarios; section IV introduces the paper's objective; section V discusses the proposed system design; section VI describes the implementation of the system; section VII presents the experimental design; and section VIII presents the possible scenarios explored in the experiment. Finally, section IX presents our conclusions and future possibilities for research.

## II. Related Work

### A. Benefits of MCC integration in m-health

Chang et al. identify high-level requirements for providing healthcare services using cloud-computing technologies [6]. The paper reviews and analyses some of

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the existing IT-enabled healthcare ecosystems. In addition, the authors give their views on the imperatives for cloud computing research in supporting future IT needs for healthcare.

Other authors [7] review the significance and opportunities for implementing cloud computing in the healthcare field. The authors discuss the benefits of introducing the cloud paradigm to healthcare areas, such as on-demand self-service, ubiquitous network access, resource pooling, rapid elasticity, and a pay-per-use model. Furthermore, the paper presents several challenges that may occur, such as high cost, connectivity issues, and client assistance and disaster recovery mechanisms. The paper also provides several protection methods that can be utilized to deal with security and privacy issues.

### B. Similar projects and systems

Greer and Ngo [8] discuss the design and integration of social networking applications with cloud computing technology and mobile technology to provide a system that allows users to communicate during emergencies or disasters. A Facebook app is used in the paper to design a Personal Emergency Preparedness Plan (PEPP) that aims to allow users to collect geographical information, pictures and video, along with any other data that may be useful in these kinds of situations. As shown in this paper, non-medical professionals (such as friends or family members) are connected to the user to provide help in emergency cases.

Elsewhere, a web service called CliniCloud [9] presents a medical kit that allows people to track their state of health using smart phones and to store data in the cloud. Users then have the ability to contact a service afterwards called 'Doctor on Demand' [10]. This service allows users on the go to start a video call with a doctor. This service is only available in the US, and the system also requires extra medical diagnostic equipment, which results in higher costs.

An Android-based emergency alarm and healthcare management system is presented by Du et al. [11]. The system aims to provide two main functions to users: a trigger alarm to friends or hospitals, and a life reminder feature to remind the user to take medicine on time. The authors discuss the advantages of integrating health systems on mobile phones, these being portability, open operating systems, the use of a location service (GPS) and the ability to detect events using a gravity sensor. The proposed system was tested on Android mobile phones and lab-based servers. However, this system allows interactions with medical staff who are in the hospital, whereas our system benefits from medical staff who are not on a hospital site, such as on an airplane or in a shopping centre. The system is also part of the hospital, whereas our idea is to implement a standalone system that allows interactions with all the parties who are involved in an emergency.

A mobility management system for mobile cloud computing ($M^2C^2$) is proposed [12] that aims to create a local cloud(s) in emergency locations to help emergency providers reach cloud services. This is similar to the idea of cloudlets [13]. Operations such as executing mobile-based applications, collecting sensing data, and submitting wearable device readings happen locally, via Wi-Fi or 3G links, at what is called an Emergency Response Vehicle (ERV). This kind of vehicle offers functionality, such as low latency data processing, storage and access. This local cloud will then communicate with the public cloud on behalf of the users. According to the paper, more than one ERV can operate from the same emergency location and, therefore, a mechanism for selecting the most appropriate ERV in terms of networking and delay is discussed and tested in the paper. The authors claim that using their approach will benefit emergency services by reducing delays. Channeling activity through these emergency locations can be more than twice as fast as connecting directly to the public cloud. Comparing this approach with our paper, the system in the other paper is mostly provided to professionals such as ambulance crews or firefighters. Whereas, we aim to provide health services to normal users (i.e., the general public) as well as support to medical staff to allow them to deliver the right medical treatment to those people who are experiencing an emergency.

A cloud-based system that can be installed in an ambulance providing health support on the go has also been suggested [14]. The proposed system offers video conversations over a cellular network between a first aid crew at the scene and doctors who are located in hospitals. Doctors can update/view patients' medical records, retrieve the shortest path to the nearest hospital, and prepare the emergency department for what the patient needs based on information from the first aid crew. The authors claim that using this system will save lives by providing the right treatment at the right time and by taking into account mobility and road-traffic issues. However, using this system requires special equipment in ambulances. Furthermore, the selected specialists cannot provide any further help until the ambulance has arrived at the hospital if there are connection problems and a call cannot be made. Communication can also only be made with doctors who are present in the hospital, whereas our system makes use of doctors or any other medically qualified people who are within reach of an emergency location.

To sum up, to the best of our knowledge, most of the systems propose either to replace a current emergency help system with a full IT system, or to use a form of non-professional healthcare help that is provided by pre-defined and non-professional relatives and friends.

Our model, however, provides a form of help that can be complementary to the existing emergency system (e.g., a two-way radio system or calling 999). Features such as looking for a medical professional who is an expert in a particular type of emergency are provided by taking into account their availability and the location of both parties.

## III. MOTIVATION SCENARIOS

In this section, we present three different scenarios that would benefit from a system that can provide a first responder to the scene more quickly than the emergency services. The goal is to have response times to emergency situations in the order of seconds and not minutes, whenever this is possible.

### A. Crowded places

When a large number of people are present in the same place to perform the same activity, such as watching a football match or attending a concert or religious event, there is a high chance that emergency medical cases will occur.

For example, in this paper, we consider *Al-Haj* (pilgrimage to Mecca) as such an event, where hundreds of thousands of people are present in the same area, for a short period of time, performing virtually the same actions. There has been a review [15] of the most common health issues that occur during the *Al-Haj* event. Some of these issues are related to the medical history of the pilgrims and others can occur because of the environment and the location of this event. Another paper [16] presents a mobile-based tracking service to help pilgrims in emergencies.

Imagine that a person who has a medical history, such as heart disease, requires healthcare urgently. Owing to the nature of the above crowd, reaching such a person with regular emergency services will be difficult or, in some cases, might even be impossible.

However, a doctor or a nurse might be located in the crowd, not too far away from that person and, therefore, can immediately be available to help. Alternatively, the person in need can use the mobile device to obtain directions to the nearest medical centre. Therefore, the kind of system able to link users who are looking for care with those who are able to provide that kind of care is potentially life-saving.

### B. Shopping centres

Another scenario related to people's daily activities is that of visiting leisure centres. In such places, emergency cases might occur, particularly related to children. For example, a child might lose his/her family or injure him/herself, prompting an urgent situation.

In this scenario, a system that allows parents to track their children's location in the case of losing them, as well as establishing a communication link between them, is required.

### C. Residential areas

Emergency situations can also occur in the home, from cases of people falling downstairs to serious fires that destroy the whole house. Assume now that such an emergency situation has been detected in the home using a modern home-monitoring device. Generally, this will trigger an alert to one of the emergency departments, such as the ambulance or firefighting services. However, it might be that a professional in close proximity is available and can, therefore, provide help before an ambulance or fire engine arrives.

Therefore, a multi-notification system is needed, one that automatically looks for doctors or nurses in the area of the emergency. It would also provide the shortest route to the location. This action would happen simultaneously to the triggering of an alert at an emergency centre.

## IV. PROBLEM AND HYPOTHESIS

Introducing cloud services to m-health will enhance the quality of healthcare services, as well as reducing the cost resulting from delivering such high-quality services. Many m-health systems have been shown to benefit from cloud computing features, such as high availability and a large scale [17]. The authors believe that the idea of deploying an m-healthcare application in the cloud is "far from mature" because of the critical challenges that have arisen when cloud services have been used in health sectors, involving issues such as offloading, data interoperability, security and privacy.

Our model discusses the kind of challenge that occurs when users have been in an emergency and are looking for appropriate and fast healthcare services. We introduce a cloud service that allows users to search for a professional who is available and, more importantly, located in close proximity to the person requesting help. We also develop different methods of reaching cloud services to enhance service availability, such as over the Internet (directly or via a neighbouring link) and by short message service (SMS). Furthermore, a directory service is hosted by the cloud and its entries are checked by the health authority to protect patients' privacy as well as to improve system trustworthiness.

Ultimately, the system presented in this paper will work side by side with current emergency systems (e.g., calling an emergency centre). Furthermore, it will offer a faster response by taking advantage of medical professionals who are located within reach of the scene of an emergency.

## V. SYSTEM DESIGN

The architecture of the system that will support the concept of the first responder on the scene is that of the mobile cloud. Mobile devices can connect either directly or indirectly to the cloud, using the cellular or Wi-Fi network.

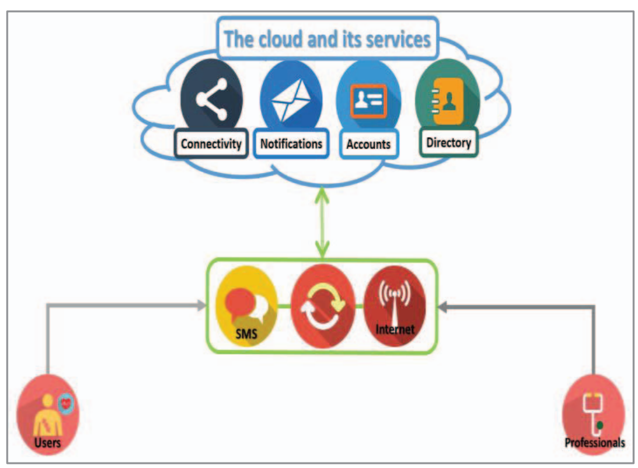


Figure 1. High-level overview of our model

According to the high-level overview of our model presented in Figure 1, the proposed system consists of three main components:

1. The cloud plays the most important role by hosting services that can be accessed by users.
2. The users/potential patients are people who might experience emergency situations and, once in that situation, will be seeking emergency medical services.
3. Professionals represent another group of people, such as doctors or nurses, who are both qualified and trusted to provide emergency services to public.

## VI. SYSTEM IMPLEMENTATION

The initial step is the registration of doctors, nurses and medical organizations with the cloud service. Only after that can users send requests to the cloud service when looking for a professional to deal with the medical emergency/concern that he/she has.

The cloud service is responsible for organizing all the professionals' details and tracking their availability in order to redirect medical cases that are coming from patients. In addition, the cloud service has to match the needs of the requesting patients with an available professional. When the request is directed to one of the professional the cloud service offers an active link to that professional in case other equipment is needed or a notification to another professional has to be arranged. Finally, a communication link has to be established between the requesting patient and the selected professional. The cloud tracks both users' activity as well as the status of the communication.

### *A. Registration of professionals*

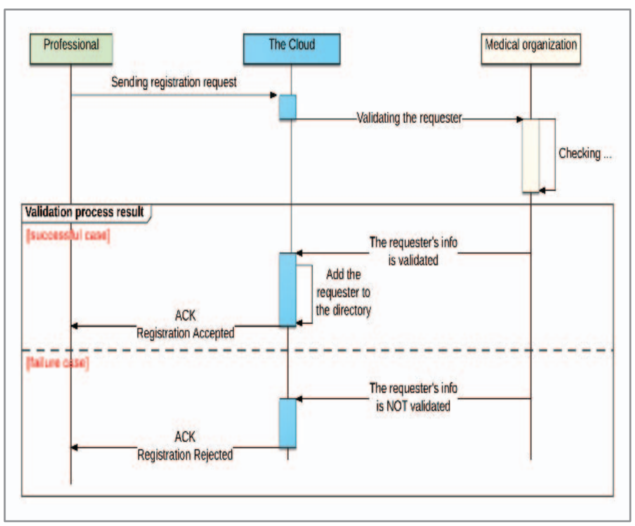


Figure 2. Professionals' registration operation

To create a directory that lists all the available volunteer medical professionals, those who are able to provide medical care have to register their details in the cloud through their medical organization before they begin providing a service. In addition, the details specifying the location and availability of each registered professional will need to be constantly updated.

These details will play a major role in the 'looking up' process. The cloud service will only redirect the request to the person who is able to provide proper care to the requesting patient and can respond very quickly.

To guarantee that the proposed system is trustworthy and that only qualified people are added to the directory, the cloud sends the details to the health authority to verify that the person in the process of registration is qualified to provide healthcare services to the public. If the user is validated, a new account will be created and a message containing the result of this operation will be sent to that user. In addition, the details will be added to the professional directory. Figure 2 presents these steps.

### *B. Directory service in the cloud*

This service, when hosted on the cloud, allows users to look up professionals who match their medical needs in the case of an emergency. Only registered professionals are listed in this directory. Entries are organized according to role (doctor, nurse, etc.). In addition to the details that are provided in the registration operation, this service will track each professional's activity, such as: connected, disconnected, busy, free, and location. The following is a list of data that will be collected by this service:

- **Current location**: the current location of the user, based on his/her latitude and longitude. When emergency cases are assigned to professionals, the system takes into account the value of this field, meaning that the nearest professional to the emergency location will be chosen.
- **Treated cases**: the total number of cases assigned to this user. For reasons of fairness, the cloud will ensure that all professionals are treated equally.
- **Status**: this contains the availability and the status of the professional, ensuring that only active and available users can receive cases. However, professionals can be contacted by phone or SMS if required.

This information will feature in the 'looking up' operation that is outlined in the following section.

### *C. Look-up operation*

This operation is executed when a user sends a HELP request to the cloud looking for a medical professional to provide help. The request is redirected to the directory service to select the professional who most closely matches the needs of the patient making the request. Four attributes are considered here: *status*, *availability*, *medical specialty* and *current location*. Thus, only a professional who is both actively receiving jobs from the cloud and available, meaning that he/she is not treating another patient and is able to deal with the received emergency case, will be considered. Finally, he/she will be selected according to his/her proximity to the location of the emergency case.

However, emergency services, such as the ambulance service, are also called when the look-up procedure starts.

### *D. One-to-one communication protocol*

Once a professional is selected to deal with the requesting case, a communication link is established between both users. The cloud is responsible for monitoring this link as well as providing any support to the professional, such as notifying other professionals. Figure 3 shows a sequence diagram for establishing a link between a requesting user and a professional.

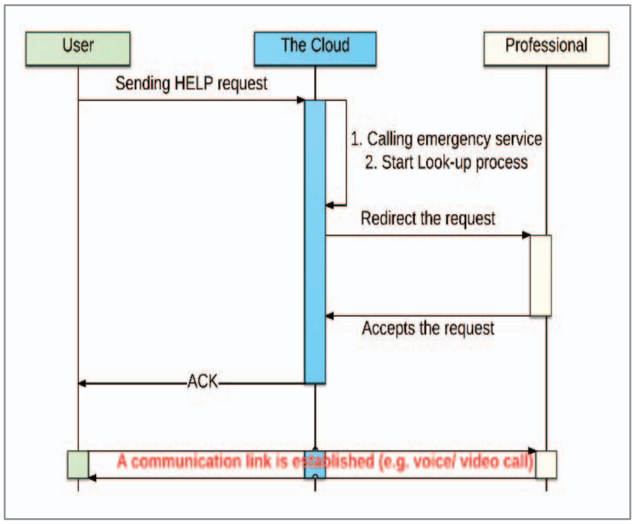


Figure 3. Sequence diagram for establishing a link between a requesting user and a selected professional

### E. *Notifying other people*

Depending on the medical situation of the requesting user, another professional might be required to attend the emergency location; for example, a doctor in another specialty. A request will then simply be sent to the cloud to notify this other professional. This kind of service is offered only to professionals who are on call. A communication link will be set up between the two professionals. In addition, directions to the emergency location will be provided if required.

### F. *HELP request prototype*

Any user who has an active account in the cloud can send a HELP request to look up a professional to discuss a medical case. This request has to provide information explaining the user's medical situation, current location, and connectivity status to help the cloud select the most suitable professional from the directory service.

The responses from the cloud to the HELP requests will be as follows, depending on the result of the look-up operation:

#### 1) *A suitable professional is found*

The cloud finds a professional who is active, available, matches the requested medical case and is located in reach of that user. The cloud then checks the connectivity of the requested user and the selected professional. The following scenarios will follow:

*a) Both users are or can be connected to the same MANET.*

Here, the cloud feeds each user with the details of the other user to allow them to communicate directly inside the MANET.

*b) Both users are connected to different MANETs*

However, if the users are connected to different MANETs, or are not even connected to one, the cloud will take on the role of building a connection to serve both users.

Once the connection is established, the cloud can carry out further actions:

- Changes the selected professional's status in the directory to 'on-mission'.
- Checks if this professional needs special equipment.
- Monitors the connection until the requesting case is completed.

#### 2) *No suitable professional is found*

In this case, no professional is found to help the requesting patient. The cloud service will trigger an alert to the nearest medical centre *(if it has not already done so)* to take on the role of providing appropriate assistance to that user.

## VII. Experimental Design and Evaluation

To determine the feasibility of the proposed system we implemented it on Android-based devices: one HTC and two Samsung S3 smart phones. The database and all the services were hosted on Amazon Instance [18]. We also deployed an SMS gateway to the cloud using the Twilio [19] web service API to allow the sending and receiving of SMS messages between users and the cloud.

### A. *User space*

As part of the same project on mobile cloud healthcare, the first-responder emergency service was included as an extension of the Android app presented previously [5]. Regarding the user interface, two types of screen were designed: the professional and the help interfaces.

#### 1) *Professional screen*

This is a screen containing a form for a user who wishes to register as a professional delivering healthcare to the public in emergency situations. The information to be given includes personal details (name, gender, etc.), employment details (ID, occupation, etc.) and contact details (email and telephone number). Current location and connectivity status will be collected in the background.

Once this form is completed, all the information will be sent to the cloud to be stored in the database. For the sake of simplicity, a more detailed description of the verification step will be given in a future paper of ours.

#### 2) *Help screen*

Any user who has an active account in the cloud can send a HELP request to the cloud service by clicking on the HELP request button on the app's dashboard. The user or someone giving help has to provide minimum information about the medical case, such as a keyword (e.g., "heart", "breathing" or "fainted"), through a HELP request screen. When the submit button is clicked, the request is sent to the cloud. Current location and connectivity status will also be supplied by the system and attached to the request. The cloud service generates a unique ID for this request after storing the attached information in the database. An acknowledgement is then sent to that user attaching the generated ID with the acknowledgement payload.

### B. Reaching the cloud

Users in emergencies can reach the cloud by sending a HELP request over the Internet via either a Wi-Fi (i.e., at home or work) or cellular network (i.e., GSM or LTE). However, it might be the case that users do not have an Internet connection but have the ability to use a cellular network to make calls and send SMSs. Therefore, to enhance the system availability, we allow users to send HELP requests to the cloud via SMS, as well as sending SMS notifications from the cloud to users.

Technically, sending and receiving SMSs in the Amazon cloud platform is provided only to US mobile numbers. Hence, deploying an SMS gateway in our cloud to allow users to send/receive SMSs freely from any country requires the integration of one of the SMS gateways. Twilio API was used in our system to allow the cloud to receive HELP requests via SMS, as well as to reach those (i.e., professionals or users) who do not have an Internet connection.

Put simply, a user sends a HELP request using the Android app after providing personal details (i.e., ID and name), a medical case description, and current location. Then, in the background, this information will be organized as an SMS payload and sent to a pre-saved mobile number that was allocated by the Twilio platform, which will then be responsible for redirecting the request to the cloud as an HTTP request, including the sender's details and the sent message payload. An acknowledgement will be sent to notify the user that the cloud has received the message successfully. Then, a look-up operation will be started to select the most suitable professional. When one is found, a request is sent to that professional that includes the sender's contact information for the purpose of starting an SMS conversation. The cloud also feeds the requested user with the selected professional's details.

### C. Cloud environment

To provide a first-responder emergency service, the following three services are deployed in the cloud.

#### 1) Directory service

This is the service that holds and tracks all the medical professionals' details, such as availability and location.

After receiving a help request, the cloud service starts a look-up process to search for a professional who is available and who matches the requester's medical needs. If the match returns more than one professional, the cloud here selects the one nearest to the requester's location. Then, the medical case is redirected to the selected professional. If the professional accepts the request, a map showing directions to the requester's location is shown on the app screen. The requester is also notified of the latest update to that request.

#### 2) Notification service

This service allows messages/alerts to be sent directly from the cloud to users or medical departments. Reaching users can be done using Google Cloud Messaging (GCM) for Android ID or by sending an SMS to their mobile phone numbers which are already stored in their account at the database.

#### 3) EMR service

This service allows users to create an electronic medical record (EMR) in the cloud. Each record will include a collection of electronic health information about an individual patient, such as medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, and personal statistics (e.g., age and weight).

When a user creates a new medical record, the cloud issues a unique identifier to each record. The cloud then allows professionals to view/edit these EMRs, if required. In other words, users should provide an EMR number with a HELP request and send it to the selected professional after the 'look-up' process that was previously presented. Nevertheless, requested users should ensure that they update their cloud account with an EMR number so that this can be sent if they have to ask for help.

### D. Chat application

The Android app offers a chat application feature with the help of the cloud service. This feature allows the requesting user and the selected professional to share text, photographs, and files after the look-up operation in the cloud has finished. Two scenarios are considered here depending on the status of the connection of both users.

Firstly, if the two users are connected to the same MANET and communicate directly, the chat application starts using their MANET IP addresses. Put simply, a chat screen is opened and messages delivered to their destination over the Transmission Control Protocol (TCP) to guarantee message delivery.

Secondly, if the users are not connected to the same MANET or are not connected to any MANET, the chat application will make use of a notification-based format with the help of the GCM platform. If the user sends a message to the selected professional, it will be sent from that user to the cloud and then to the GCM platform responsible for delivering the message to the professional. Similarly, the response will travel all the way back to reach the sender over the cloud and the GCM.

Therefore, after receiving a HELP request and a professional is selected at the end of the look-up operation, both users can start a chat session that is served by the cloud and GCM.

## VIII. Experimental Results

This section presents screenshots of the process of seeking medical help using the developed Android app, as well as results and discussion regarding the amount of time taken as a result of using our approach.

### A. Screenshots

#### 1) Professional registration

Figure 4 shows how a user can register as a professional in the cloud.

Figure 4. Professional registration screens in the app

*2) Seeking medical help using the Android app*

a) Normally over the Internet

Figure 5 show how users can send a HELP request to the cloud. This figure also shows the response from the cloud.

Figure 6 presents the process of selecting professional as well as the ability to start a chat screen with the requested user. Figure 7 shows how a notification is received on the requester's side, again with the ability to start chatting over the cloud with the selected professional.

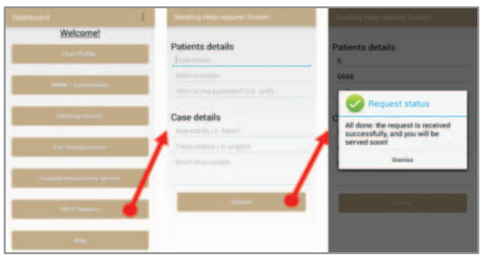

Figure 5. Sending a HELP request using the Android app

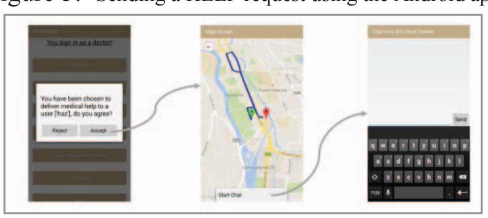

Figure 6. The process of selecting professionals using the Android app

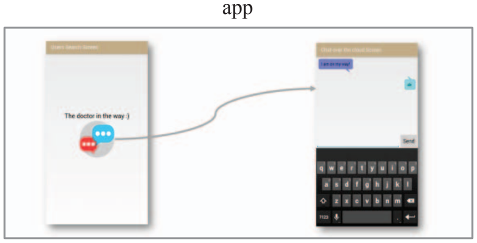

Figure 7. Notification is sent to the requester

b) Via SMS

As presented previously, users can seek help via SMS if they do not have an Internet connection. Figure 8 shows screenshots from the Android app for sending HELP requests to the cloud via SMS. Figure 9 shows a screenshot of assigning a new job from the cloud to serve an emergency case with the ability to send SMS messages to the requesting user. Figure 10 shows receiving an SMS-based notification from the cloud and professionals on the requester side using our Android app.

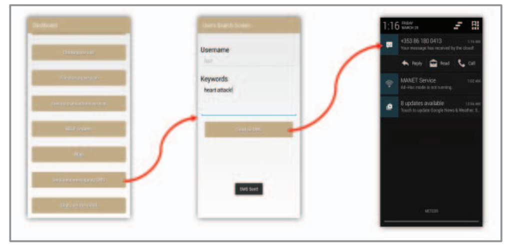

Figure 8. Sending a HELP request via SMS (user's side) using the Android app

Figure 9. A professional receiving a HELP request via SMS using the Android app


Figure 10. SMS notification is sent from the cloud to the requester side using the Android app

## *B. Communication set-up duration*

Experiments were carried out 10 times to determine the time consumed for setting-up the connection between the person in need and the first responder. The average time needed to set up a connection between a user and one of the professionals who is listed in the cloud's directory was around five seconds. This delay is acceptable and ensures the request is directed to a professional who matches the requested medical assistance as well as being located within reach of the requester's location.

The time needed to respond to medical emergency cases is an important factor in healthcare fields. The time has been standardized as follows: "Response times of four minutes for BLS [basic life support] first response and eight minutes for paramedics have become an international standard for urban EMS [emergency medical services] systems" [20]. However, exceeding this time would not result in lower patient survival rates in all cases, according to real-word experiments presented elsewhere, and it is suggested that realistic response time standards should be developed that take into account the needs of each case [21].

However, our system achieved a response from a medical professional in around five seconds, as well as the system delivering details of an emergency case to the emergency services. This means that the amount of extra time involved will not affect the overall response time for this type of emergency case. This amount of time can increase, however, if the selected professional does not respond as soon as the request is received. To avoid any delay that might result from the human factor, the cloud gives the selected professional 1-3 minutes to interact with the received request and, if there is no response, the request will be assigned to another professional. However, in some situations, this delay might not occur; for example, in the *Al-Haj* scenario, there are usually a number of medical volunteers who are readily available to serve pilgrims.

Moreover, there is another factor that might have an impact on the length of time involved, which is the quality of the communication links. As mentioned previously, we discussed the ability to use SMS messages as an alternative communication method. Here, the cloud or users can communicate via SMS messages to avoid low-quality Internet connections.

## IX. CONCLUSIONS AND FUTURE WORK

This paper presented a mobile cloud service that offers to people who are experiencing medical emergencies while on the move the possibility to 'look up' doctors or nurses who are located within their proximity and who can respond more quickly than the emergency services. Furthermore, it established details of a communication link that is managed by the cloud service, as well as starting a chat session to exchange text, photographs, and files. The SMS messaging ability is also provided as an alternative method for reaching the cloud services and seeking medical help in emergencies. The system benefits from using cloud features such as high performance and availability and extended connectivity through MANETs, previously developed within this project. We designed and deployed the aforementioned service on real mobile devices and real cloud instances as a validation test. The set-up time was around five seconds, which meets the initial time requirement of the system as well as ensuring no extra delay is added to the total medical response time. On the contrary, it will make the best use of a medical professional who may be present just a few steps away from the medical case.

Our future work will develop the communication side of the application to allow users to communicate via video with first responders, emergency services and medical centres. We will also extend the system to allow automated/smart alerts to be sent to the cloud after the detection of an emergency event, such as identifying emergencies from wearable medical devices.


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