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| **An Android Application for the Ambulance Service**  **Gary Carr**  **August 2013**  **Computing Science MSc** |

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**Abstract**

This document discusses the current state of the NHS Ambulance Service, and past problems improving IT infrastructure. It is examined if an off the shelf smartphone could be introduced to the service to improve the support for paramedics. Based on the research a requirements document is produced and an Android application created and tested. Finally the document compares the finished application to the original aims and objectives.

**Declaration**

I declare this dissertation is all my own work except where otherwise stated.

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# 1.0 Overview

This chapter introduces the projects aims and objectives, and the background behind the problem that it seeks to solve.

## 1.1 Background to the NHS

At least two mistakes by ambulance crew in the past five years have led to the death of a patient. The first was due to morphine given to a patient who was allergic (BBC, 2010), and the second due to a paramedic not giving the correct treatment to a patient suffering a heart attack (Sky, 2011). There are eleven regional NHS ambulance trusts in England and prior to this project a survey found that the differences in operation are as fundamental as some services using computers for patient handover whilst another still give a vocal reports to a hospital receptionist (see appendix 3). Two of the three respondents did not provide patient medical details to the paramedics, which could have avoided the death of the patient given morphine. The project will attempt to understand if technology can provide further support to the paramedic.

Considerable barriers exist to IT development in the NHS; legacy systems hold data in incompatible formats, a lack of trust between departments, cost of training staff and possible reluctance by staff to adapt to new systems (Buchannan, B et Al . 2012). The NHS has become known for project failure, namely the National Project for IT (NPfIT); an ambitious plan to integrate all regional IT departments failed after 9 years of development and £11 billion spent (Martin, D, 2011). An attempt to develop a nationwide application must be realistic in that the NHS is unlikely to be able to change to accommodate third party software.

## 1.2 Summary of the project

An Android application will be developed to be used in the day to day activities of the ambulance service. Research will be undertaken to fully understand the requirements and barriers, and an attempt will be made to improve upon the current support available to the paramedics.

## 1.3 Overall Aims

* Replicate the current essential processes of the ambulance service.
* Provide extra information on the patient to the paramedics.
* Provide medical decision support to the paramedics.
* Create an application commended as highly usable.

The outcome of the final aim will be determined through user testing.

## 1.4 Objectives

**1.4.1 Research objectives**

* Identify the strengths and weaknesses of current processes used by the NHS.
* Discuss with NHS employees their own recommendations for improvements to existing systems and consider incorporating them into the design of the prototype.
* Identify strong usability concepts for human computer interaction on Android applications.

**1.4.2 Technical objectives**

* Implement security measures to protect highly sensitive medical data.
* Use common coding standards to enable easy adaptation to connect to servers in multiple regions operating different technological implementations.

**1.4.3 Personal objectives**

* Learn how to program an Android application.
* Gain experience in project management.

## 1.5 Project Risks

1. Because of the broad nature of the NHS, a failure to define the project scope could lead to a loss of focus on the primary aims.
2. A failure to make viable contacts in the NHS could slow design and complicate evaluation.
3. A lack of experience in Android development could result in the application not being built to a functional standard.

Point 1 will be considered throughout the research, which will result in a formal requirements document to define what the application must do to satisfy the projects aims. For point 2 before the project was formally chosen North East Ambulance Service was approached for information and to attempt to acquire contacts. Learning Android will be a continual process throughout the project.

## 1.6 Project Plan

The project will be completed over 10 weeks using a waterfall model approach, selected as it provides clear stop and start targets, beneficial in a short project. There will be an overlap between implementation and testing so that the application can be modified based on user testing. Documentation will be completed throughout the project. Figure 1 shows a Gantt chart summarising the process.

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| Figure 1:Gantt Chart |

# 2.0 Research

This section discusses primary and secondary research on the ambulance services, the use of technology, past IT projects in the NHS, usability on Android devices and reviews similar products for paramedic support.

## 2.1 Overview of current operations

Based on the following research a brief summary is documented below of a typical job at NEAS.

* A 999 call is received. The operator takes the address and incident details. The operator submits the job to a regional dispatcher.
* The regional dispatcher panels the job to the ambulance crew. This is communicated by a radio call and incident details are sent to an on-board computer.
* The ambulance crew arrive at the scene and input onto the on-board computer which hospital they are taking the patient to. The hospital does not receive any confirmation of an incoming vehicle. If the situation is severe the crew will radio the dispatcher to alert the hospital.
* On arrival at the hospital the paramedic must complete an Electronic Patient Report Form (EPRF), typed on a laptop in the ambulance. This is then sent to the hospital to be printed for the doctors.
* The paramedic must go to the hospitals reception to sign the patient in. After this they are available to collect the next patient.

## 2.2 Primary Background Research

**2.2.1 Interview with a paramedic**

For further information on the operations of the ambulance service an interview was conducted with a paramedic of three years from NEAS. A summary of the key points obtained are listed below and a full transcript of the conversation is included in appendix 2.

* Emergency jobs are stated as either R1 (cardiac arrest) or R2 (other emergency) and are targeted with an eight minute response time. The paramedic estimated ‘9 times out of 10’ they were not real emergencies and were due to patients wanting reassurance and operational problems at the 999 call centre.
* The dispatcher selects the emergency vehicle to send usually by the closest geographical location, however factors may make some ambulances unsuitable for selection such as if a vehicle needs to be returned to the depot for cleaning.
* The two people crew each carry a radio, and the paramedic is not aware of any situation where radio communication has failed. The incident details are sent to an on board computer called Terrafix.
* The ambulance service is fined when the eight minute target time is missed.
* If an ambulance crew unexpectedly misses the eight minute target time it is common to radio the dispatcher to inform them of the circumstances.
* Problems in communication between the dispatcher and paramedics are a cause of demotivation. Paramedics often feel they are misled, for instance when given a job a few minutes before the shift is due to end, even when they know other paramedics are available and closer.
* In general there is no decision support. If there is a cardiac arrest then they may call a clinical supervisor to ask for advice however this is used very rarely.

The paramedic said that they had recently submitted an ‘improvement request’ to change the process for the handover of a patient from the ambulance to the hospital. The EPRF they complete contain the incident details and physical condition of the patient. Afterwards they then have to queue to speak to a hospital receptionist to sign over the patient and complete a form by hand asking for identical information. The improvement request was to have the data from the ERPF, already received by the hospital, be sent to the receptionist and hence eliminate this manual task. The paramedic received lukewarm feedback and did not believe it would be implemented.

The request appears sensible, raising questions about why it would not be implemented. The paramedic stated that political problems between departments often outweigh the greater good for the NHS. Historically paramedics have always been responsible for booking the patient into the hospital and the paramedic believed that hospitals would be reluctant to take on an extra responsibility and have to provide staff training and changing their own IT process. This presents another problem to develop IT products for the NHS; a change in one department will likely affect another, and if a large efficiency saving on one side results in a small increment of work on the other then it will still be difficult to get mutual agreement. The paramedic was negative on the coordination of the NHS, stating ‘*The ambulance service gets fined for delayed handover times.  The ambulance service fine the hospitals for the delays, and now the hospitals are trying to fine the ambulances for the paramedics not clearing the jobs properly.  It is all about targets and money, not about patient care*.’

**2.2.2 Questionnaires for ambulance services**

A questionnaire was sent to 10 NHS ambulance regions to ask for information on their current operations and three responded; London Ambulance Service (LAS), West Midland Ambulance Service (WMAS) and East Midland Ambulance Service (EMAS).  The key findings from the respondents are listed below and the full responses are in appendix 3.

* Each region have a similar process to section 2.1, however they have their own implementation to achieve this.
* All send job details to a computer aided device and will only use radio’s if the paramedics fail to respond.
* EMAS and WMAS estimated that in over 67% of cases the patient name was known to the paramedics before collection. LAS did not see the importance of knowing names the name and did not keep records.
* No service provides patients medical details to the paramedic as standard. LAS have a voluntary scheme where vulnerable patients’ can request their medical information is shared.
* EMAS lets paramedics view previous ERPFs for patients who have been picked up in the past, but not access to their medical details. They are currently trying to implement this.
* Hospitals in EMAS and WMAS areas are able to see when an ambulance is delivering a patient to them. LAS do not notify hospitals they are transporting patients in non-emergency cases, but do radio to alert if the patient is critical.
* EMAS and LAS use EPRF’s to notify the hospital of the patients’ condition. WMAS paramedics verbally tell the hospital the condition.
* EMAS are trying to create a paramedic support application, to give advice on the course of action they should take.

The questionnaire highlighted the regional differences that exist for a service which in theory could be identical. In contrast it also exposes some of the differing goals and therefore the difficulty of producing a ‘one size fits all’ solution in the NHS. The failings of implementing past nationwide projects are discussed in section 2.3.1.

**2.2.3 Providing medical support**

The paramedic identified problems in the NEAS 999 call centre which relate to the use of a program called Pathway. Pathway has pre-set questions the operator asks, and the response leads them to another set of questions until an outcome is reached. The paramedic believed that as soon as the caller mentioned that the patient had a chest problem then the call centre had no choice but to assume cardiac arrest and define the job as category R2. A source working in the call centre confirmed that this was the reality, Pathway does not allow for informal conversation and if certain words are used an emergency ambulance will be sent regardless of the operators judgement. The NHS’s new non-emergency 111 number has had similar problems; in one instance it resulted in a paramedic being sent out to collect a person with hiccups (Telegraph, 2013).

The 999 processes are out of scope for this project, however it does provide an excellent example of the difficulties of trying to use software for medical decision making. During the design of an application it must be acknowledged that the tool is not to attempt to override the judgement of a paramedic, nor is it feasible to provide support for every scenario. At present a paramedic will ask a patient (or their family) to provide all current medication and knowledge of allergies so that they can make a judgement on their treatment. It is this type of information that the application should display to offer support, not direction.

## 2.3 Secondary Background Research

An interesting case study exists of an on-going attempt to create a nationwide Summary of Care register to list allergies, known allergies to drugs and drug prescriptions for every patient in the UK to be shared across the country.  Launched in 2006 to date only 50% of the population have such a report, data protection concerns and a lack of compliant computer systems are cited as reasons for the slow deployment (Health and Social Care Information Centre, 2013). The primary research has shown that even the ambulance services do not yet utilise these available records. This demonstrate that the software development is only part of the barriers for the NHS, scrutiny over data protection and co-operation with regional IT departments are also likely to cause lengthy delays.

Numerous reasons have been suggested for the failure of NPfIT; of particular note in 2007 the government listed ‘*failure to win the hearts and minds of the staff as a serious on-going risk*’ (House of Commons, Committee of Public Accounts, 2007).  Blobel comments that NPFIT was pushed through to make systems interoperable at the expense of usability, and that the use of a waterfall model resulted in gaps of between 12 and 18 months between establishing user requirements and the user testing the application resulting in high costs for redevelopment (Blobel, B Et Al , 2010).  A report by the Kings Fund discusses the conflicting arguments of staffs’ appreciation for new technology, in comparison to the reality that ‘*staff have a limited capacity to adapt to new modes of working … and the ability to train limits the rate of change*’ (Kings Fund, 2008).

A failure to involve the staff throughout development was mentioned by the interviewed paramedic as having caused front line issues. The call centre staff may input several lines of details but the Terrafix can only display 4 of those lines. This has led to instances where the paramedics think they are going to a cardiac arrest, to arrive and find out it was only a chest infection. It was also commented that the ERPF is not user friendly, giving the example that for each patient they have to complete mandatory multiple sections on the patients’ condition even when they are of no relevance. The task is time consuming and tedious, and as a consequence the paramedic stated that the general feeling was that paper patient report forms were a better option. It is clear there are long term benefits in involving front line staff in the design and implementation stages, and to iterate development to produce a high quality product. Jakob Nielsen shares these sentiments, stating “*even the most talented genius designer can’t design the perfect user interface in one attempt*” (Nielsen et al, 2013).

## 2.4 Usability Research

To obtain strong usability traits Nielsen and Raluca Buidi ‘*Mobile Usability’* was studied due to the relevance to the topic and because Nielsen is regarded as the ‘world’s leading expert on usability’ (Nielsen et al, 2013).  The key findings include

* It is almost twice as hard to understand complicated content when reading on the smaller screen
* For working on a small screen, reduce features and cut content to reduce the word count
* Have big targets for touch screens (fat finger problem)
* Design in expectation of a slow download speed, and notify users when the application is loading
* Highlight key words and use bullet points to enhance scan ability
* Support pre populating of forms and use defaults where possible.  Do not put strict constraints on the input
* The ideal tapping size for targets is 1cm by 1cm
* A usability study should simply measure the success rate of an individual to complete a given test.

In terms of human computer interaction, these findings are consistent with Nielsen’s original usability Heuristics, particularly minimalistic design, visibility of system status and consistency (Nielsen, 1994).  The book criticises applications where the reverse of the key findings have been implemented; small buttons, large amount of text, buttons that do different tasks on different screens etc.   The good practice techniques are repeated by Apple, who list similar human interaction guidelines when developing for IOS, such as giving people feedback during lengthy operations and elevating the content people care about (IOS Developers Guide, 2013).  Android recommends guidelines for designing applications for their phones, such as not using bottom tab bars or using designs to mimic an iPhone interface (Pure Android, 2013).

Alan Dix gave three principles for human computer interaction; learnability, flexibility and robustness (Dix et al, 2004).  Consistency and familiarisation techniques, such as mirroring how similar programs interactions work, help a user to adapt to a new application.  Dix supports customisation for users to define their own interfaces, or even better to have the system adapt to itself to the users habits.  In a mobile application this could be for the Android to learn if a user is swiping between screens rather than use tabs at the bottom, and hide the tabs automatically.  On robustness, an application needs to be recoverable from an error and not punish the user.  Dix, like Nielsen, states *‘evaluation should occur throughout the design process* ... *before any implementation has started’*.  Ben Shneiderman listed 8 golden rules of usability that also back the other findings, including striving for consistency, give informative feedback and offer error prevention (Shneiderman, B, 1998).

Throughout the literature review there is a common theme of keeping it simple.  By minimizing the user options chances for error are reduced, and when the error occurs allow the user to recover without losing data. Sticking to those guidelines ensures a higher level of usability, thus easing the transition to a new system for staff and hence increasing a devices chance of success.

## 2.5 Other Research

**2.5.1 Technology research**

Only Java can be used for coding an Android application. Android states there are 3 core areas for an Android project (Android Developers, 2013) -

* The manifest – States the permissions the application will have on the phone. All permissions are initially denied.
* Java class files – Determines the functionality. Files which extend the Activity class are used for on screen display.
* Resource folder – xml files which determine the layout of the activity screens. Android encourages using two degrees of separation and holding the strings used in the GUI in a separate file to where the layout is defined.

The application will need to make regular connections to the dispatcher and hospital servers. PHP will be used for this as it is the most popular server-side language, used by 80% of the web (World Wide Web Technology Surveys, 2013). The use of this standard language would make integration with multiple regional servers an easier task. For the same reason MySQL will be used for databases. To obtain information for a webserver the data will be passed in the form of a JavaScript Object Notation (JSON object) as it is faster and easier to parse than XML (w3Schools, 2013).

For security, salting and hashing will be used on all login details to reduce the possibility of a rainbow attack (PHP.net, 2013).

**2.5.2 On-going research**

Online tutorials are being undertaken to assist with learning Android. Websites and books will be used throughout the project as learning tools.

## 2.6 Similar systems

**2.6.1 Terrafix TVC3000 and the Terrafix PSPV**

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| --- | --- |
| Figure 2:Terrafix TVC3000 | Figure 3:Terrafix PSPV |

Terrafix have worked with regional ambulance services since 1991 to supply mobile computers to receive incident details from dispatchers. Currently nine services are using either the Terrafix TVC 1450 or the newer Terrafix TVC 3000 (see figure 2). The Terrafix PSPV, a version with identical features integrated onto a HTC mobile phone (see figure 3), is currently in trial in Staffordshire used alongside the TVC 3000 (Terrafix, 2013). The TVC 3000 will be reviewed as it is the most commonly used version of the Terrafix product line, and the PSPV will be reviewed as it is of similar ambition to this project. Both have touch screen interfaces, with GPS tracking and satellite navigation. For reliability the devices will automatically switch between GPRS and GSM to improve connectivity.

The following section outlines the user journey for the device. Terrafix were not willing to release all screenshots of the PSPV to show a direct side by side comparison of each interfaces. All screenshots for the TVC3000 and PSPV were obtained from promotional PDFs. Links to these are provided in section 10.

**Becoming available**

|  |  |
| --- | --- |
| C:\Users\Ali\Desktop\Dissertation\1TerraFix_login.bmp  Figure 4:TVC3000 Start page | Figure 5:PSPV Start page |

The device starts when the vehicle ignition is turned on. The layouts for each device are in figures 4 and 5. The user enters their login name and that they are mobile and the dispatcher will be able to panel jobs to them. During down time a map is displayed showing the current location.

On the TVC3000 there are 28 buttons the paramedic can press to toggle between displays and set an update on their status, arguably too many for a small screen. The buttons are closely spaced and their outline is not bold, against Nielsen’s principle of making a clear target area. The PSVP provides far less choices for the paramedic, giving focus to the option to go mobile and hiding the less common statuses displayed on the TVC3000 behind an ‘Other Status’ button. The use of colours makes the button areas more prominent. This is consistent with the usability research of limiting user choices and on screen display.

**Incident received**

|  |  |
| --- | --- |
| C:\Users\Ali\Desktop\Dissertation\2TerraFix_start.bmp  Figure 6:TVC3000 - Job received | Figure 7:PSVP - Job received |

On the TVC3000 (see figure 6) when a patient needs to be collected the incident details are displayed to the ambulance driver such as name, address, category and incident details. At the bottom is a button asking for acknowledgement. On the mobile version (see figure 7) the address is prominent and the notes and details are held on a different screen. The most critical piece of information, the address, is obscured on the TVC3000 by the surrounding information. The PSVP displays the critical details in a more prominent way.

**Map display**

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| --- |
| C:\Users\Ali\Desktop\Dissertation\3TerraFix_status.bmp  Figure 8:TVC3000 Map display to patient |

A map displays the current location and the route to the patient, and then the patient to the hospital. The map options are at the right allowing the user to zoom and putting a shape around current location and destination. A negative feature of the interface is that it continues to allow the user to do multiple options that should not be executed in that order, for example in figure 8 it allows the user to both select arriving at the incident and arriving at the hospital. Clearly they will not be used in that order and those options bloat the interface and make a user far more likely than if those options were hidden.

No screenshots were available of the PVPS map or route to incident options.

**Choose hospital**

|  |
| --- |
| C:\Users\Ali\Desktop\Dissertation\5TerraFix_leaving.bmp  Figure 9:TVC3000 Hospital selection |

The paramedic will then confirm which hospital the patient will be taken to. Figure 9 shows they are presented with choices covering the whole of Lincolnshire, with options to scroll down for more hospitals. The text is very close together and not in a numerical order, and Skegness is repeated twice. This is a very poor interface; the possibility for an incorrect selection is high.

**2.6.2 Paratus Mobile System**

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| DSC_0883_300px.JPG  Figure 10:Paratus M-PC3 |

Paratus supply bespoke software to the London, Swedish and Danish ambulance services and is also used in the dispatch centres and hospitals to communicate data between all systems. In Sweden this handles over 500,000 calls a year (Saab Performit, 2012). A different company, Attobus, supply the hardware. The latest version, the M-PC3 which is touch screen with GPS tracking, wireless connectivity and can integrate with an on-board camera to help with reversing (Microbus, 2013). Both firms have adapted their product so it can be used on police cars and fire engines. At present they do not have a mobile phone application.

The M-PC3 has additional functionality implemented in the Swedish health system to provide decision support to paramedics. The device will connect to a health database where the paramedics can get information on drugs on allergies displayed on the screen. If the patient’s details are known then the paramedics can also access their current medical records to help determine treatment. The questionnaire conducted by London Ambulance Service showed that they did not use this functionality (see Appendix 1).

Paratus were not willing to release any screenshots for evaluation. Figure 10 shows the device which appears to have a more modern interface than the TVC3000, the buttons are clear and prominent against the background and use logos for recognition.

Other features are that the screen can be linked to a camera to aid reversing, and the device has a built in translator to determine the language of a non-native speaker. Two computers can be combined to enlarge the screen if necessary.

**2.6.3 Summary of similar systems**

There are strong similarities between Terrafix and Paratus. Both are touch screen and register user status, both provide real time communication between dispatcher and ambulance, both have GPS and satellite navigation and both provide GPRS and GSM for reliability. The concept is very simple, pass data between a server and mobile device, integrate a satellite navigation system, use data encryption and log statistics for later use by management. Providing medical information to the paramedics is a strong feature of the M-PC3 and research was unable to determine why it is not used by the LAS.

## 2.7 Summary of Research

The research has helped identified the high level requirements for the application, and the experiences of past projects has shown the importance of realistic targets and designing a highly usable products for a sector that may not have a desire to learn a new technology. To provide further medical information the project will assume that details can be obtained from the Summary of Care records to utilise the purpose it was designed for, though it is recognised from the research considerable difficulties would exist implementing this in the real world.

It would have been preferable to have interviewed another paramedic to provide a different viewpoint, and other stakeholders such as a dispatcher or a paramedic manager. It is unfortunate that a similar device could not be physically tested due to no public availability.

# 3.0 Requirements

Functional and non-functional requirements for the application were determined based on the research chapter. Each requirement is given a label and these labels are used for reference throughout this document. Requirements labelled as medium priority are deemed not critical for inclusion in the final application.

## 3.1 Functional Requirements

Table 1 lists the functional requirements for the application.

|  |  |  |
| --- | --- | --- |
| Label | Requirement | Priority |
| F1 | Allow secure login for authorized users, providing feedback when incorrect details are entered | High |
| F2 | The back button will be overridden to prevent the user accidently logging out of the application | High |
| F3 | The application will report the phones current GPS location so that the dispatcher can select a nearby ambulance to the incident | High |
| F4 | Incident details will be obtained from the 999 call centre and displayed to the paramedic | High |
| F5 | A map route will be displayed from current location to the patient | High |
| F6 | When summary of care details exist the paramedic will be able to view them | High |
| F7 | When summary of care details are found additional information on the allergies and medicines of the patient will be obtained. | High |
| F8 | When a patient is picked up a route will be displayed from the current location to the hospital. | High |
| F9 | The crew will be able to select the hospital they are taking the patient to. The application will create an entry in that hospitals records to notify them of an incoming patient | High |
| F10 | The ambulance crew can change the condition category of the patient after arriving at the incident from the 999 operators original assessment | High |
| F11 | The paramedic will be able to search for information on drugs and allergies | High |
| F12 | The application will report the phones current GPS location to the hospital so they can monitor the expected time of arrival (ETA) | High |
| F13 | After transferring the patient to the hospital the paramedic can select to wait for a new patient without having to exit the application | High |
| F14 | Unless involved in picking up a patient, the crew can log out the application | High |
| F15 | When travelling to a known destination directions will be spoken to the ambulance crew | Medium |
| F16 | The ambulance crew will be able to send messages to the hospital through the application | Medium |
| F17 | The length of time taken to reach the patient will be displayed on the phone | Medium |

Table 1:Functional Requirements

## 

## 3.2 Non-functional requirements

Table 2 lists the non-functional requirements for the application. All non-functional requirements are assessed as high priority.

|  |  |
| --- | --- |
| Label | Requirement |
| NF1 | The application should operate in real time |
| NF2 | The system will be safe from SQL injections |
| NF3 | For security login information will not be transmitted in clear text |
| NF4 | Repeated unauthorized attempts to will block access to the application |
| NF5 | The phone will wait for new jobs from the ambulance dispatcher without going into standby mode |
| NF6 | When the application is waiting for a job the screens display will constantly update to reassure the crew the phone has not crashed |
| NF7 | Jobs will only be panelled to a paramedic who is logged into the application |
| NF8 | The application will notify the user when they are out of 3G signal |
| NF9 | Guidance will be provided to the user in the form of on screen error messages. |

Table 2:Non-functional requirements

## 3.3 Assumptions

* The only purpose of the phone is to run the ambulance application. It will not receive phone calls or text messages.
* All users will have the cognitive ability and dexterity to operate a touch screen phone.
* The application only needs to be developed for the English language

## 3.4 Constraints and Dependencies

* Wide scale testing and feedback by real users will be difficult due to limited access to the ambulance service. Therefore volunteers without medical experience will test the application for feedback on usability.
* The server the databases and PHP scripts will be hosted on does not use HTTPs or TSL. In a live version this would be necessary to protect data.
* The coding will be compliant with the latest Android standard (API level 18). Older versions will not be supported

# 4.0 System Design

This chapter reviews the design stage where the interface, architecture and security are planned in an attempt to satisfy the requirements set out in chapter 3. Where a design feature satisfies a functional or non-functional requirement the requirement label will be bracketed in that sentence.

## 4.1 System structure

**4.1.1 Job becoming available**

When an operator creates a new job they will take the name, contact number, address and information on the condition of the patient. These details are referred to as the incident details. An available ambulance will be selected, and a JSON object populates a JSON file which the application can now obtain. After an attempt will then be made to locate the patient’s summary of care details, and if known then the patients known medication and allergies will be queried against a pharmaceutical database to obtain further information on each (F4, F6, F7).

Performing the summary of care search after the incident JSON has been created ensures responding to the job is not delayed by searching for the additional information (NF1).

**4.1.2 Communicating with the server**

To obtain the data the application will repeatedly execute a HTTP post request through the phone to connect to the dispatcher’s server. The server will host a database of the user login details for authentication, and contain PHP scripts to handle the HTTP post. If the user is valid the PHP will return the JSON object, to be parsed by the application. This structure will be used in all connections to the dispatcher or hospital servers, and to the Google Maps API to receive route directions (F5, F8). Figure 11 shows the architectural structure.

|  |
| --- |
| Figure 11:Applications connection to the server (Corkhill, H, 2013) |

**4.1.3 Database design**

Figure 12 shows the structure of the database the dispatcher’s server will hold. Ellipse 1 contains data queried when the user is logged in, and ellipse 2 holds the data queried to create a one off access code. Table 3 briefly describes each tables function.

|  |
| --- |
| Figure 12:Dispatchers database |

|  |  |
| --- | --- |
| Table | Function |
| login | Holds the paramedics username as a primary key and their password. The password will be time stamped and the number of failed attempts at login are held |
| one\_off\_access\_code | The one off access code has the username as the primary ID and will generate a code and store the phone id if the request has come from a valid user and valid device (authorized\_device). This is time stamped and only valid for one hour. |
| authorized\_device | A unique ID for each phone used by the ambulance service will be held to ensure only registered devices can login. |
| communication\_code | Upon successful login an authentication code is created and stored with the username to allow a device to communicate with the server. The disable\_device column is an integer and will be incremented if a device is stolen. A value will then be returned on the next PHP request disabling the application. |
| location | Stores the longitude and latitude for the paramedic’s current location. To be used for displaying location and Google map queries. |
| panelled\_job | When a job is created it is assigned to the specific paramedic, which will trigger the PHP request to get the details from the JSON file. |

Table 3:Database functions

The database for the hospital and pharmaceutical records will be of a similar structure with referential integrity to prevent duplication. PHP performing prepared statements MySQL requests will query the database (NF2).

## 4.2 Designing the GUI

Based on the functional requirements, the application has been broken down into 6 key sections, each contained within a separate GUI.

1. Secure login
2. Waiting for a job
3. Receiving a new job
4. Known patient information
5. Ability to select the hospital and to update the category of the patient
6. Menu to provide functions for optional decision support whilst taking the patient to hospital

The majority of the functional requirements will be achieved within those interfaces. In addition a separate application will be built to provide a one off access code for enhanced security. The usability principles from section 4.2 will be implemented throughout.

**4.2.1 Principles to be employed in each layout**.

* Buttons will be at least 70dp in width, with a margin of 30dp so they are easy to press (fat finger problem)
* Toast notifications will be used to catch errors and positioned in a visible place on the screen (NF9)
* Titles for headings will be in bold for prominence

Due to the likeliness that a paramedic would not touch the screen for long periods, the applications code will ensure the phone does not dim or go into sleep mode (NF5).

**4.2.2 Login screen**

The login page will be the first screen displayed to the user. Boxes for the username, password and the access code will be displayed and entered by the user for submission. If the login is successful then the user will be taken to the wait screen, if unsuccessful a pop up message will be displayed (NF9). A button will allow the user to reset their password (F1). Figure 13 shows a mock-up of the layout.

|  |  |
| --- | --- |
| Figure 13:Login page layout design | **Layout features**   * If the one off access code is stored in the phones clipboard memory, a pop up box will ask if the user wants it to be pasted into the edit text box. This supports Nielsen’s principle to support prepopulating where possible * Incorrectly entered boxes will highlight red to show they have not been filled correctly (NF9) |

The process for the login in task is shown in an activity diagram in figure 14.

|  |
| --- |
| Figure 14:Activity diagram for login screen |

**4.2.3 Wait screen**

The paramedic will now be logged in and able to accept jobs (NF2). Two threads will run continuously in the background, one reporting the ambulances current location (F3) and the other checking if any jobs are panelled to the paramedic (F4, NF1). Logging out will cease the background threads.

The user will be able to switch to a map view without interrupting the background threads. When a job is panelled a JSON object of the incident details will be returned and the user is taken to the job received screen.

Only at this stage the user is allowed to log out as they are not picking up a patient (F14). Figure 15 shows a mock-up of the layout.

|  |  |
| --- | --- |
| Figure 15:Wait Screen layout design | **Layout features**   * The progress text view will constantly update with messages from the dispatcher, to be informative and to show the application is still running (NF6). It will also notify when the device has no internet connection (NF8) * As ambulances will often park whilst not on a break and not be focused on the screen, the application will make a noise if out of signal for a lengthy period. (NF8) |

**4.2.4 Wait map screen**

Google maps will be built into the application and display the current location. If the background threads find a job the user is taken to the job received screen. Figure 16 shows a mock-up of the layout.

|  |  |
| --- | --- |
| Figure 16:Map layout design | **Layout features**   * A back button will be programmed to the top left corner so the user can toggle from the wait screen. * Google Map features such as zoom will be available |

**4.2.5 Job Received screen**

The JSON object of incident details will be parsed, and if successful the address, distance and category will be displayed on the screen (F4). A sound will alert the user that a job has been received. If the parsing fails a message will be displayed to prompt the paramedic to radio the dispatcher. Regardless of the parsing success, pressing confirm will take the user to screen 4.0. Figure 17 shows a mock-up of the layout, and figure 18 shows an activity diagram for the process.

When the user presses confirm a PHP script will be executed to notify the dispatcher the job has been received.

|  |  |
| --- | --- |
| Figure 17:Job Received layout design | **Layout features**   * This screens purpose is for the paramedic to respond and start driving to the patient, therefore any additional details inputted by the operator will not be displayed on this screen to minimize the information presented. * Although unlikely, an address and category could take up a full screen. A scroll view will therefore contain the job details to ensure all details are visible, |

|  |
| --- |
| Figure 18:Activity diagram of the Job Received screen |

**4.2.6 Patient Details – Tab 1**

On this screen the job incident variables will be displayed in full (F3). A time stamp is created to record and display the length of time from receiving a job to arriving at the patient (F17).

A thread will be launched to check if summary of care details have been found for the patient (F7 and F8). If details are found they will be stored as JSON object and then parsed into variables populating Screen 4.1.

The user can switch between tabs (Screen 4.1), switch to a map view (Screen 4.3), or signify they have arrived (Screen 5.0). The tabs have been placed at the top as it was identified in the research stage that Android recommends this. Figure 19 shows a mock-up of the layout and figure 20 shows an activity diagram for the thread trying to obtain summary of care details.

|  |  |
| --- | --- |
| Figure 19:Job Details Tab 1 layout design | **Layout features**   * If parsing of the incident details is unsuccessful the layout will change to show no further information, the tabs displayed in red, and obtaining the summary of care information will not be attempted (NF9) * A scroll view will be used in case there are more details then visible on the screen (also used in screen 4.1) * The tabs and bottom buttons will be within their own layout so they do not move whilst scrolling (also used in screen 4.1) |

|  |
| --- |
| Figure 20:Activity diagram for obtaining summary of care details |

**4.2.7 Patient Details – Tab 2**

If the summary of care details are obtained this screen will be populated, otherwise the tab will be changed to red to signal no information (F6).

Only the title of the known allergies and medication will be displayed, further information about these will be accessible by pressing a button and being taken to the medical information screen. The paramedics are already experts on the most allergies so to display the information by default would be against the principles of minimization.

Apart from the buttons to display extra details, the layout is identical to screen 4.1.

**4.2.8 Patient Details – Tab 2 – Medical Information screen**

Two identical screens will hold either the patients allergy or patients medication details. Only the names will be displayed and on pressing the name the extra details will become visible (F7). Figure 21 shows a mock-up of the layout. The users’ only option will be to close the screen.

|  |  |
| --- | --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Known Allergies.png  Figure 21:Job Details Allergy layout design | **Layout features**   * A scroll view will be used as it is very likely the allergy information will be longer than the length of the screen. The close button will be static at the bottom. |

**4.2.9 Job Received Map screen**

The map will draw the directions from the current position to the patients address (F5). Using data from a Google JSON object verbal directions of the route will be given to the driver (F15). The layout is identical to the wait screen map.

**4.2.10 Arrived screen**

The user will now be able to enter which hospital they are going and update the category condition of the patient. (F9) Updating the category is necessary as the research showed that frequently the category had been overestimated by the 999 centre. When the user presses submit all the known information on the patient will be sent to the chosen hospital, including the current GPS coordinates (F12).

|  |  |
| --- | --- |
| Figure 22:Arrived a job layout design | **Layout features**   * Pressing the hospital and category will pop up a pre-set list of options for the paramedic to select. If they do not select any options a pop up will notify them of the mistake (NF9). |

**4.2.11 Optional functions**

This screen will be a menu containing further screens where the user can either select to use the functions, or confirm they have completed the job and return to the wait screen (F13).

|  |  |
| --- | --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Menu Details.png  Figure 23:Arrived menu with further options | The optional screens are   * Reviewing the patient details (same screen as 4.2.6, 4.2.7 and 4.2.8) * Viewing a map route to the hospital (F8) * Sending a message to the hospital to give notes about the patient (F16) * Searching drugs and allergies (F11) |

**4.2.12 Separate Application – Access code Generator**

In practice this application would be in a separate piece of hardware similar to an RSA SecurID (RSA SecurID, 2013) to provide two factor authentication, however the resources are not available to do this so the function has been replicated as an Android application. The user will enter a valid username and a one-time access code will be displayed. This code will be valid for only one hour, combining with other security measures to satisfy F1. Figure 24 shows a mock-up of the display of the screen. The activity of the threads checking authentication is similar to the activity diagram in section 4.2.2.

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| --- | --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Access code.png  Figure 24:Access code layout design | **Layout features**   * It is expected the user will wish to copy the access code to the phones memory, so to eliminate that task and reduce the possibility of error a pop up screen will offer to do this for them. |

**4.2.12 Additional screens**

Two displays will be implemented which are not part of the regular user journey.

* A reset password screen when the user has locked or forgotten their password (F1)
* A shut down screen triggered by an administrator remotely disabling the application

## 4.3 Security Considerations

* Only registered Android phones will be able to run the application, and only authorized users can execute the PHP scripts
* Each user will have a password for access. This will consist of a minimum of eight characters, including an upper case and non-alphabetic character.
* A user will be allowed three chances to enter the correct password and then the system will be locked and require an administrator to unlock it (NF4)
* Passwords will be stored in an SQL table after being combined with a salt and then hashed multiple times to make attacks more difficult and computationally expensive (NF3)
* After correctly inputting the username, password and access code an ‘authentication code’ will be generated to allow the application to communicate with the server for 13 hours without needing to retype.
* If the device is compromised an administrator will be able to disable the application

# 5.0 Implementation

This chapter explains the code used to create the application, and discusses how functional and non-functional requirements are met.

## 5.1 Overview

The code was created using Eclipse with the Android Development Tools plug in and tested on a Samsung Galaxy 2. Figure 25 shows the project. The layout screens are the GUI’s, and are also known as activities.

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| Figure 25:Android project on Eclipse |

Separate packages were created to store the activities, background threads and PHP connections. This separation of code aids future maintenance and assists with an issue identified in the research, namely that hospital servers could have multiple implementations and the PHP may need adjusting every time a new hospital is added to the network. Because of the separation in most cases a developer would only have to access the PHP package to make the change, reducing the possibility of introducing an error to the layout screens.

Care has been taken to ensure code is not duplicated in any class. For example on every screen the back button has been overridden to force the user to use the on screen log out buttons to exit the application properly (F2), and all the screens use a static method in the ‘CommonFunctions’ class to do this. The benefit is that if the developer wants to make a change the method now only needs to be amended once, and there is no possibility of forgetting to change a screen. Another example is that ten methods make HTTP post requests but all use the same method to make the connection. Figure 26 shows two methods performing completely different tasks, each using establishConnection() at lines 185 and 202 to communicate over the internet.

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| .  Figure 26:Using the same method to make a PHP connection |

## 5.2 Code used by multiple classes

**5.2.1 Concurrent Background threads**

After login two threads are launched to run throughout the duration of the session; RunChecker and GPSReporter

**RunChecker**

The RunChecker class is launched by a ScheduleExecutorService using the method scheduleWithFixedDelay(), which will execute a new thread every five seconds after the previous thread finishes. This type of execution is necessary to prevent queuing as the thread will wait when not able to perform any tasks. Figure 27 displays the threads run() method.

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| Figure 27:RunChecker |

RunChecker is responsible for searching for a job, deleting incident details or deleting summary of care details after successful parsing. Checking if there is an available job is attempted first (at line 76) as this is most important task (F4, NF1). If there are no tasks to complete the thread will wait until notified at line 59. A binary semaphore is used to manage this process. If there is a job required but no internet connection the method on line 67 will send a message to the screen stating no connection before waiting. The thread is woken by other classes when a task is available, or if internet connection is re-established GPSReporter will wake RunChecker.

In Android only the GUI activity thread can make changes to the GUI, so a static Handler is used between the WaitScreen and RunChecker to update the GUI. In the examples in figures 28 and 29 a response from the PHP connection is received at line 121 of figure 28. This is passed to the WaitScreen handler in figure 29 (the activity variable is the WaitScreen class). The PHP response will be “-5” to “0” if no job has been found (below zero indicates a type of connection error) and an appropriate message will appear on the screen (NF6, NF8, NF9). If a job is found jobFound() is called on line 237. Wait Screen will change the Boolean to say that the application is no longer waiting for a job, so on the next RunChecker execution there will be no active tasks and the thread will wait (at line 59 on figure 27).

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| Figure 28:RunChecker passing a message to WaitScreen Handler |

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| Figure 29:WaitScreen Handler receiving a message |

**GPSReporter**

GPSReporter creates a PHP request to report the GPS co-ordinates of the phone every 30 seconds using Androids LocationListener class (F3). The class is an IntentService, used in Android to perform asynchronous tasks without blocking the GUI thread. This was chosen because the device will only be handled whilst picking up a patient, at which point the delayed location report would not have an operational impact. Figure 30 shows the code for GPSReporter; on line 67 the current location is requested. If a result is obtained the latitude and longitude are stored as variables on lines 72 and 73. On line 76 it is tested if there is an internet connection (see section 5.2.3) and the coordinates sent to a PHP thread to be stored in the dispatcher’s database.

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| Figure 30:GPSReporter |

The GPSReporter also has the task of handling the application when the phone is out of signal. When connection drops line 88 is entered, the interval time for the thread to run is shortened to five seconds, and if the thread cannot connect four times in a row the else if statement on line 83 is entered, and a sound played to notify the user they are out of signal (NF8). The shorter execution intervals time ensures that RunChecker will be woken as quickly as possible on line 79 (NF1).

**AsyncTasks**

AsyncTasks, inner tasks of the GUI thread are used in Android to execute short threads separate from the GUI. In the PatientDetails screen an AsyncTask is launched on initialization to find summary of care details, so the user can still navigate the screen whilst they are being obtained (F6). AsyncTasks are useful for this process as they can directly return to the GUI. AsyncTasks are not suitable for RunChecker or GPSReporter as the Android documentation states AsyncTasks must only be used for short operations, as they will continue operating after the outer class terminates but hold an invisible reference to those fields, which then cannot be garbage collected.

**5.2.2 Web requests**

The Apache HTTP Client library has been added to the class path to execute HTTP post to PHP files. Figure 31 shows the establishConnection method used in figure 26. The parameters are inserted into the post at line 224 and the PHP response stored at line 229. The method will return the response which is then handled by the class which originally called the post.

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| Figure 31:PHP request |

**5.2.3 Code used on multiple screens**

**Screen never dims**

The code at lines 66 and 68 override standard Android implementation to ensure the screen never dims or goes into standby (NF5). This code is contained in every activity as it is not possible to use as a static method.

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| Figure 32:Code ensuring the Screen never dims |

**Checking internet connection**

The code testConnection() in the CommonFunctions class is used before any web connections are attempted. The method returns true if a connection can be established, otherwise returns false and triggers the GPSReporters process to notify the user of a lack of connection (NF8). Connection could still be lost whilst making the web requests and appropriate handling has been implemented for this. This code was obtained from Stackoverflow (Peceps, 2011).

**Progress Dialog**

To support Nielsen’s usability principle of showing when the system is loading, Androids progress bar is used to let the user to know when the device is waiting for an action to complete. In the example in figure 33 it is being used to display whilst an AsyncTask completes.

|  |  |
| --- | --- |
|  | Figure 33:Progress Dialog code and display |

**Toast messages**

Toast messages have been used in multiple classes to display system status and attempt to reduce user error, shown in figure 34 (NF9).

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| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-07-23-21-02.png  Figure 34:Toast message notification |

**Passing bundles between classes**

The incident and summary of care details are received as JSON objects then parsed and stored as parameters, which are then added to bundles used to pass between activities. This means the application does not have to keep connecting to the web to get this data. If the parsing is unsuccessful an error message is displayed on the screen. Figure 35 shows the process, with the JSON the parameter in line 181 and then the result of the parsing is added to the bundle.

|  |
| --- |
| Figure 35:Parsing the details and bundles |

**Maps**

Using Google Maps required registering the application with the Google Maps API and inserting a key into the manifest to allow connection. On launch the map is centralised on the longitude and latitude co-ordinates obtained by the GPSReporter.

When the job is panelled by the dispatcher a JSON object is obtained from Google obtaining the directions and distance between the ambulance and the destination. Code from PasteBin was used to accomplish this (insert\_jarak, 2013).

**Conventions**

For good practice, conventions recommended for Java and Android have been followed. This includes:

* Use of resource files to hold string variables for easier maintenance
* Each xml item has a unique android:id, prefixed with the initials of its class for easy identification.
* Full commenting of code

## 5.3 Individual Activities

**5.3.1 Separate Application – Access code Generator**

On this screen (see figure 38) the user enters their username and presses to generate an access code. This sends the username as a PHP post request and the validity is checked against an SQL database. If the username is valid a one off access code is produced (F1). Security is discussed in detail in section 5.4.

**Copy to clipboard**

For easier usability the application asks the user if they want to copy the access code into the phones memory, so it can be pasted into the login screen. This will also mean that users do not have to be familiar with how to copy text on Android. Figure 36 shows the prompt the user receives. The danger of keeping a code in the phones memory is negated by it only being valid for one hour. A string prefix, dash and the access code are copied to the clipboard so the code can be identified. In the example in figure 37 the copied text would be ‘ACCESSCODE-2146202’.

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| --- | --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-07-23-20-47.png  Figure 36:Access code screen | C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-07-23-21-21.png  Figure 37:Clipboard request |

**5.3.2 Login Page**

The login page is the screen which launches when opening the primary application. The user is required to enter their username, password and access code (F1). The layout of the screen is shown in figure 38. The edit text boxes and buttons have been positioned so that they are all visible whilst the Android keyboard is displayed.

When login is pressed if the user has not entered all the details into each box, the text view is changed to red and a toast message is used to notify the error (NF9). If all data has been inputted a PHP post will check the details and either login the user and take them to the wait screen or display a toast message to inform of an error.

**Paste from clipboard**

On opening the page, the contents of the phones clipboard are examined and if they contain a string with the prefix ‘ACCESSCODE-‘ a dialog box asks the user if they want to paste the remaining substring into the access code box.

**Resetting password**

Pressing to reset the password launches the Reset Password screen. This is discussed in section 5.4.4.

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| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-20-18-37-10.png  Figure 38:Login screen |

**5.3.3 WaitScreen**

The user is taken to the wait screen after they have logged in, shown in figure 39, and the GPSReporter and RunChecker are launched by an AsyncTask. The RunChecker informs the dispatcher’s database the paramedic can now accept jobs (NF7). Text will continuously update to show the screen has not stopped, in figure 39 this message is ‘Last year NEAS saved …’ This message is rotated every time the GPSReporter completes its execution, and also reports when connection is lost (see figure 40) (NF6, NF8, NF9) .

The user can toggle to the map view whilst waiting for a job. When the job is received the Job Received screen is launched. This is the only screen the paramedic can log out from, as it is the only part of the application where they are not involved with a patient (F14).

|  |  |
| --- | --- |
| Screenshot_2013-08-07-23-22-03  Figure 39:Wait Screen | Figure 40:Wait Screen - No connection |

**5.3.4 WaitScreen Map**

On launch the map will centralise on the current location (see figure 41). If RunChecker finds a job the activity is closed and the user taken to Job Received.

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| --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-07-23-22-41.png  Figure 41:Wait Screen Map |

**5.3.5 Job Received**

The job details are passed to the activity as a bundle and the address, category and distance to the patient are displayed to the user. This is shown in figure 42.

When the user presses confirm, the Patient Details – Tab 1 screen is opened. RunChecker is woken and notified that the incident details can now be deleted.

**Sound notification**

The application plays an MP3 to alert the paramedics’ attention whilst they are driving.

|  |
| --- |
| Figure 42:Confirmation Screen |

**5.3.6 Patient Details Tab 1**

The incident details are displayed on the screen, shown in figure 43 (F4). A scroll view allows all details to be visible to the paramedic; something research showed had not been implemented in previous versions of the Terrafix. The buttons at the bottom are static, contained in a relative layout and allow the user to go to the map or select they have arrived at the scene screen. If there has been a parsing error a notification will replace the name, and all other text views will be hidden. After parsing an AsyncTask will attempt to obtain summary of care.

**On arrival**

On pressing arrived, a toast displays the time taken to arrive, and the time is sent to the dispatcher to record in a database (F17). The user is then taken to the select hospital screen. The process is the same if the user presses ‘Arrived’ while viewing tab 2.

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| --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-07-23-23-00.png  Figure 43:Job Received Tab 1 |

**5.3.7 Patient Details Tab 2**

If summary of care details are obtained they will be displayed on this screen inside a scroll view, shown in figure 44 (F6). Bullet points have been used for lists to give emphasis to the data, identified in the research as a good usability feature, and also if the information goes over one line it will be clear to the paramedic where each field starts. As planned in the design, only the titles of the known medical details are displayed, and the user can press a button to find more information.

If the data is not found, the Summary of Care tab turns red to notify the crew that the information is not available, as seen in figure 45 (NF9).

|  |  |
| --- | --- |
| Figure 44:Job Received Tab 2 | C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-12-12-32-17.png  Figure 45:Details not found |

**5.3.8 Patient Details - Known Medical History**

By default the text views display the title and have an onClickListener implemented so when the user touches the title the view is toggled to show the full details. The details are in a scroll view bar so the paramedic can see the whole text, and the close button is in a relative layout at the bottom so to not be pushed off the screen when the whole text is visible. The known allergy and known medicine screens have identical layouts as shown in figures 46 and 47 (F7).

|  |  |
| --- | --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-23-22-43-45.png  Figure 46:Allergies screen showing titles | C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-23-22-43-50.png  Figure 47:Allergies screen showing full information |

**5.3.9 Patient Details – Map to patient**

Using the JSON file obtained from Google a route is plotted on the map from departure to destination. The code to do this was obtained from WpTrafficAnalyser (Mathew, G, 2013). The map is shown in figure 48 with a red line displaying the direction to drive (F5). The same process is used to show the route to the hospital (F8).

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| --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-23-22-50-25.png  Figure 48:Job Received Map |

The JSON object contains the directions that the driver must take, and Androids TextToSpeech class is used to announce this to the driver, shown in figure 49 (F15). The thread sleeps at line 330 so that the direction is not spoken before the map has loaded.

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| Figure 49:Speaking directions |

**5.3.10 Select Hospital and Category**

|  |  |
| --- | --- |
| Screenshot_2013-08-13-11-11-27  Figure 50:Select hospital and category | **Screenshot_2013-08-07-23-24-12**  Figure 51:Select category pop up |

Upon arrival at the patient, the application asks the user to input the hospital they are going to update the patients category (F10). When the user presses submit the RunChecker will create an entry in that hospitals database (F9). The displays are shown in figure 50 and 51. A toast is displayed if the user does not input both boxes (NF9). The hospitals GPS co-ordinates are stored in the code and added to the bundle to show a map to the hospital on a later screen (F8).

A spinner with a checkbox has been used to select the hospital. The choices are held as a string array in the resources folder and can be easily maintained or adapted for another city. The XML for the spinner is shown in figure 52 using entry ‘hospital\_options’, displayed in figure 53.

|  |  |  |
| --- | --- | --- |
| Figure 52:XML for Hospital spinner | |  | | --- | | Figure 53:Array of hospital names | |

**5.3.11 Arrival at hospital**

When the patient has been collected the paramedic is directed to a menu and now all further screens are optional. The menu bar is displayed in figure 54. When the task is complete they can press they have dropped off the patient and await a new job (F13).

‘Patient Details’ is the same display as section 5.3.6 and the Map displays the route from the current location to the selected hospital (F8).

|  |
| --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-23-23-13-19.png  Figure 54:Going to hospital menu |

**5.3.12 Search Drugs and Allergies**

This screen allows the paramedic to input a medical term and obtain information on that condition or drug, to support them if they are uncertain of what action to take with the patient. Figure 55 shows the layout of the screen (F11).

|  |
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| Figure 55:Searching for medical information |

**5.3.13 Message Hospital**

This screen allows the user to input a text message into the phone which is then transmitted to the hospital. This could be used to alert messages of importance, such as an incoming emergency or aggressive patient. A record of the conversation is kept and displayed on screen (F16). The layout is shown in figure 56.

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| Figure 56:Messaging the hospital |

## 5.4 Implementing Security

**5.4.1 Hashing and salting data to protect login details**

**Hashing**

The username and password are both encoded by using a secure hash algorithm (SHA-1) before they are sent in a PHP request. This is an irreversible process and means the system is far more secure, as if an unauthorized person saw the database they could not work out the original username.

As a further security measure the code is hashed 500 times. For a genuine user the time difference is under a second and makes no noticeable difference, but for an intruder attempting a rainbow attack this will be computationally very expensive as they would have to hash the millions of potential combinations 500 times each.

The code for hashing can be seen in figure 57 and was obtained from Sha1-Online ([Sha1, 2013)/](http://www.sha1-online.com/sha1-java/). At line 126 SHA1 is chosen as the hash function, and then the input converted into bytes and on line 130 each byte hashed to create an irreversible code.

|  |
| --- |
| Figure 57:Hashing data |

**Salting**

It is not guaranteed that two hashed passwords will be unique, as two users with the same password will have the same hash. To avoid this, a unique string (salt) is added to the password during hashing. This further hinders rainbow attacks, as every attempt to enter a password will now need to contain a guess of the username as well. The coding for this is shown in figure 58 on line 245, where the hashed username is combined with the salt after the password has already been hashed 250 times. It is then hashed again 250 times (NF3).

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| Figure 58:Salt and hash code |

**5.4.2 Restricting access code requests for non-registered devices**

The code in figure 59 is used to obtain a unique ID for the phone. From line 177 onwards the device ID, SIM serial number, and a code randomly generated on the devices first boot are returned. The strings are hashed and sent as a PHP request. The code was obtained from Stackoverflow (Forloney, A, 2010).

|  |
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| Figure 59:Obtaining unique android ID |

The PHP code first checks that the phones hashed ID number exists in the dispatcher database to ensure communication is only established with registered devices. The PHP script is shown in figure 60. On line 10 the authentication code is searched for and if no rows are returned the method returns at line 24 and a toast would be displayed to the user (NF9). If the device is registered an access code is created. Note that only prepared statements being executed, guaranteed safe from SQL injections (NF2).

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| Figure 60:PHP checking the device ID |

**5.4.3 Generating a one-time access code**

If the username and phone ID are valid then the PHP will create and return a random ten digit number and a time stamp. The access code database can be seen in figure 61. If the user presses to generate another code, the first code is replaced and cannot be used.

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| Figure 61:Access Code |

On the login page the access code is checked against what is held in the database to validate entry. If the time has expired then a new access code will be required.

**5.4.4 Passwords**

The password is valid for only 30 days and if entered incorrectly three times the account will be locked (F1, NF4). The database where this information is held is shown in figure 62.

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| Figure 62:Database of username and passwords |

**Resetting a locked account**

The user is prompted by toast to reset the password and will press the reset button at the bottom of the login page to be taken to the ResetPassword screen (F1, NF9).

The user is instructed to contact an administrator to unblock the account, who will perform verbal validation (NF4). The administrator then creates a temporary code for the user to reset their password, which they enter into the edit text box and submit. Toasts are displayed if the wrong username or code is inputted (NF9).

If valid details are entered the screen ChangePassword is launched. The user must type their new password identically twice. For security it must be over eight characters in length, contain lower and upper case letters, a number, and must be different than the previous password (F1). A toast is displayed when the user enters an invalid password (NF9). The code for checking the validity of the password is shown in figure 63, where the method returns false if the conditions are not met. The check for a user entering the previous password is performed by the PHP. The user is notified when the password is changed and can then log in.

|  |
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| Figure 63:Checking validity of the password |

**Resetting an expired password**

If a password is more than 30 days old the user will be taken straight to the Change Password screen. The process to change the password is then identical to resetting a locked account. The reason users do not have to get an administrators code is that the account has not been comprised so no investigation is required.

**5.4.5 Communication after logging in and stolen devices**

After the user has successfully logged in, the application will communicate continuously with the dispatcher by PHP requests to obtain sensitive data. To ensure only the devices and users who have passed validation can have access; an authorization code is produced similar to the process in 5.4.2 but this time hashing the device ID with the username (NF3).

This alone could be weak. Illegitimate PHP requests cannot be easily blocked from the internet so an attacker could have many attempts to guess these strings. To resolve this, a millisecond time stamp is created and then subtracted with a random number and then included as a salt. Now an intruder with even the username, phone ID, and knowing the exact time of login would not be able to hash to the correct authentication code as they would not know the random number that was subtracted from the time stamp. The authentication code is therefore extremely difficult to recreate. The process is shown at line 43 of figure 64.

|  |
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| Figure 64:Creating an authentication Code |

The database storing the code is displayed in figure 65. The disable device column is 0 by default, and if a device is stolen an administrator can change it to 1 which will forbid any future operations on the phone (NF4).

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| Figure 65:Database of authentication codes |

Every PHP request checks first if the device is valid for authentication. If a correct username was provided but the wrong code entered, the FailedAttempt column would be incremented by one. Currently there are no restrictions on the amount of failed attempts allowed on a username as it would be very difficult for a brute force attack to succeed, and locking the account is likely to cause operational problems for the paramedic. The column has been included for administrators to be able to monitor unauthorized access attempts, so they can respond to the vulnerabilities on specific paramedic accounts.

If an administrator has disabled the device, the PHP code will return a shutdown command executed by the application. The user is taken to the screen in figure 66, background threads cease, and they cannot get back to the medical information.

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| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-14-11-14-01.png  Figure 66:Shut down screen |

## 5.5 Summary of Implementation

Due to time restrictions databases for the hospitals and pharmaceutical records could not be set up, so dummy data was used to show how the data would be displayed. Chapters 7 and 8 discuss this further.

# 6.0 Testing

This chapter discusses the testing carried out on the application during and after development to determine if the requirements had been met, the robustness of the software and feedback from user testing.

## 6.1 Requirements Testing

Each requirement set out in section 3 has been tested against the final application. The results, and if the requirements were met, are set out in the following tables.

**6.1.1 Testing Functional Requirements**

|  |  |  |  |
| --- | --- | --- | --- |
| Label | Expected outcome | Actual outcome | Met? |
| F1 | The user enters correct login details and is logged in, or use enters incorrect login details and is notified of the error | Login details are checked against a SQL database and if valid or invalid the expected action is taken. | Yes |
| F2 | If the user presses the back button they are notified they cannot log out this way | Pressing back opens a dialog box that informs the user they cannot exit the application this way. | Yes |
| F3 | The phones GPS co-ordinates are sent to a SQL database | A thread runs in the background of the application repeatedly transmitting the GPS co-ordinates to be stored in a database | Yes |
| F4 | Application displays the details entered by the 999 centre | A JSON object created by the 999 centre is parsed and displayed to the user | Yes |
| F5 | Application will show the route between current location and the patient | Google maps route shows the quickest route for the vehicle to take | Yes |
| F6 | Where available summary of care details are displayed | The application parses a JSON object and displays the summary of care details, or notifies when they cannot be found | Yes |
| F7 | Known details of patient allergies and medicines currently taken are displayed | No database was built to hold these records. The layout displays the information using dummy data. | Partial |
| F8 | A map will show the route from the ambulance location to the hospital | Google maps route shows the quickest route for the vehicle to take | Yes |
| F9 | The crew can select the hospital they are taking a patient to and that hospital is notified. | A spinner enforces the user to select a hospital, but no database was created for the hospital. | Partial |
| F10 | The crew can update the category of the patient | A spinner enforces the user to select a category. | Yes |
| F11 | The paramedic can search for medical information through the device | A layout for the paramedic to search that returns dummy data, but no database has been created. | Partial |
| F12 | After a hospital is chosen the ambulances GPS details are sent so the ETA can be monitored | As no hospital database existed the GPS details cannot be sent. The process is demonstrated by F3. | No |
| F13 | On arrival at hospital the paramedic can select to wait for a new job without exiting the device | A menu option allows the user to wait for a new job without exiting the application | Yes |
| F14 | The crew can log out of the application when they are not involved in collecting a patient | Log out buttons are displayed on the appropriate screens | Yes |
| F15 | Directions will be spoken to the driver when the destination is known | The first direction is spoken to the user, but the device will not recognize when the driver has moved | No |
| F16 | The crew will be able to send messages to the hospital | The interface has been created and messages are displayed like a text message, but there is no hospital database to send these to | Partial |
| F17 | The length of time to pick up a patient will be displayed to the paramedics | A toast of the journey time is displayed when the user arrives at the patient | Yes |

Table 4:Testing Functional Requirements

**6.1.2 Testing Non-Functional Requirements**

|  |  |  |  |
| --- | --- | --- | --- |
| Label | Expected outcome | Requirement | Met? |
| NF1 | System operates in real time | A PHP request to the dispatcher is made every five seconds to check for a job. | Yes |
| NF2 | System is safe from SQL injections | Prepared statements are used in SQL queries, guaranteed safe from SQL injections | Yes |
| NF3 | Data will not be transmitted in clear text | All data is hashed multiple times and salted before transmitting across the web | Yes |
| NF4 | Unauthorized attempts at access will lock the account | A user is locked out of their account if the wrong password is entered three times and passwords are only valid for one month. In addition, an administrator is able to manually disable an account and/or phone. | Yes |
| NF5 | The phone will not go into standby mode | Every screen contains code to ensure the application never goes into standby during operation | Yes |
| NF6 | The screen will change its display whilst waiting | A text view constantly updates with messages | Yes |
| NF7 | Only available paramedics can receive jobs | The database contains a cell which determines if a paramedic is available. | Yes |
| NF8 | The application notifies the user when out of signal | Toasts appear on screen when the user is out of signal. If out of signal for a long period the application will make a noise in case the paramedic has parked. | Yes |
| NF9 | The interface will inform the user of errors | Toast messages are used throughout to provide notification | Yes |

Table 5:Testing Non-Functional Requirements

## 

## 6.2 Software Testing

**6.2.1 White box testing**

To attempt total correctness JUnit, a unit testing framework for Java, has been used to test every classes method that returns a value and the establishConnection method that handles PHP connections. Testing every potential scenario was not feasible, so the strategy undertaken was to test for an expected result, an unexpected result, boundary inputs and check the response to empty strings. The benefits of extensive JUnit testing upon creation of a new function are numerous. If a change is made to the internal workings of a method but the outputted return value does not change then the user can have confidence that as long as a green result is displayed they have not introduced a problem, thus providing a strong framework to build on.

An example of the JUnit testing is shown in figure 67. The method being tested is the secure hashing algorithm which outputs a hashed version of the username. JUnit testing uses assert statements, with the expected returned result the first parameter, and the test the second parameter. On line 22 it is asserted an empty string input will not hash to the same output as *sha1 (“”).* On line 26 the expected outcome (a hash of ‘Password’) will be equal to the inputted string.

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| Figure 67:JUnit testing hashing |

When problems occurred during development the JUnit test was rerun. A green bar will display if the method is still correct, therefore it is known the bug is elsewhere.

**6.2.2 HTTP post testing**

Each web connection is to a PHP file, and the PHP returns a string. In figure 68 the PHP to delete the incident details is shown. At line 10 it is checked if an authorized code has been passed as a parameter, and that the administrator has not marked to disable the device. A buffered reader stores the output and the application acts dependent on the string received

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| Figure 68:DeleteJob PHP request |

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| Figure 69:Database for JUnit testing authorization code |

Test entries were included in the SQL databases, shown in figure 69. The JUnit test shown in figure 70, tests an empty string, an unknown code, a valid code, and a user with a valid entry code but the device has been disabled. These are the only scenarios that should occur; the JUnit testing of methods ensures that the PHP request cannot pass a null parameter.

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|  |
| Figure 70:JUnit testing PHP responses |

**6.2.3 Handling connection problems**

Before any attempt is made to connect to the web connectivity is checked, and the small length of the PHP operations make it unlikely that the connection will be interrupted. Despite this it is still a possibility that needs to be handled. In figure 71 when an IOException occurs at line 393 “-4” is returned. In this instance the WaitScreen will display “Trying to reconnect”. The thread will call wait and be woken when the connection is re-established.

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| Figure 71:No internet response |

In figure 71 it is shown that a MalformedURLException will result in a response of “-3”, and in figure 72 a message is displayed back to the user with a unique ID (“JF1”) so an administrator can immediately locate the part of the code having problems, aiding maintainability.

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| Figure 72:Error for MalformedURLException |

Some exceptions, like MalformedURL are less likely to occur and when it does it suggests serious system failure. It is difficult to recreate this event and as the user cannot do anything to recover, the scenario has not been JUnit tested. It is recognized the application does not have complete coverage testing, however a sensible attempt has been made to cover all likely scenarios.

**6.2.4 Static analysis**

FindBugs is a static analysis tool for finding potential problems in Java code. An Android plug in was added and the code was tested at the highest possible setting. The result is shown in figure 73.

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| --- |
| Figure 73:Results of FindBugs |

‘Class names with upper case letters’, ‘Fields should be package protected’ and ‘Field should be package protected’ are actually problems found in the standard Android library, and therefore have not been changed. ‘Unchecked/unconfirmed cast exceptions’ occur when assigning variables to an xml item. In theory each could be wrapped in a try and catch, however in practice if a cast exception existed the application would crash every single time the activity launched so this was not done.

The other issues relate to the GoingToPatientMap class, which connects to Google to get route directions. In testing the class consistently returned the correct result and never crashed the application, though if there had been more time available they would have been fixed.

**6.2.5 Google Map and direction testing**

To test the accuracy of the application mapping it was tested against Google Maps on an iPhone. As expected the results were identical as both come from the same provider. Figures 74 and 75 show an identical route was selected by both devices. As the same implementation (Google Maps API) was used this was expected.

|  |  |
| --- | --- |
| Screenshot_2013-08-20-21-39-48  Figure 74:Google Maps in the ambulance application | IMG_0407  Figure 75:Route and distance in Google application on iPhone |

The GPS co-ordinates were tested by entering the longitude and latitude generated by the application and stored in the database into [www.latlong.net](http://www.latlong.net). Figure 76 shows the co-ordinates outputted by the device, and figure 77shows the location, which is the correct location the phone was held.

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| --- |
| Figure 76:Results sent from phone to the database |

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| --- |
| Figure 77:LatLong.net showing the results of search |

## 6.3 Security testing

During JUnit testing, attempts to enter the application with incorrect usernames, access codes and authorization codes were undertaken and the outcome was as expected. The unique ID of the phone could not be tested as there was no access to another phone to test on, however Android documentation asserts the ID produced should be unique and it is assumed this is correct.

Within the dispatcher databases only four columns are stored in clear text -

* Date and time to check the access attempt is within the correct time period
* An integer counting the number of failed login attempts at log in
* An integer that is incremented if the device is reported stolen

All other data is hashed and salted by the Android, and hashed again by the PHP. This project does not comment on the administration of accounts but it should be noted that if a device was stolen an IT support team would be able to identify a username in a database by using the same algorithm.

## 6.4 Application testing

**6.4.1 Comments from the paramedic**

The paramedic interviewed during the research stage was shown the completed application and asked for feedback. The key points were –

* The interface was of a high standard and cleaner in layout than the current Terrafix device used by NEAS
* The information provided through integration with the Summary of Care database would be very useful
* Providing extra medical details was deemed helpful as it would provide reassurance, though it may only be used a couple of times per week
* The application replicated the essential functionality provided by Terrafix
* Additional functionality provided by the Terrafix is not present in the application, such as taking a break which is treated differently than logging out
* The small size of the map would not be appropriate for an ambulance. Further it was commented that an ambulance driver would never need directions back to a hospital

The paramedic was impressed overall with the application, but was not of the opinion that the NHS would implement a mobile device in the near future. The paramedic predicted older paramedics being unhappy if expected to use touch screen, and thought the size of the device may not appeal to drivers used to bigger screens. This is discussed further in the documents conclusion.

**6.4.2 Usability testing**

Near the end of implementation a one on one survey was undertaken with five participants who were asked to give feedback on the application. For each screen they were given a task and asked to rate the process and their feedback was then used to improve usability. This is the methodology recommended by Nielsen during the usability research. The key points of the tests are discussed in this section, and the full details of user testing are shown in appendix 4.

**Usability testing - Known Allergy screen**

The first three participants were confused about how to expand the allergy screen to get more information. The original screen is shown in figure 78. It was commented that the press area was not defined, and there was concern this would be even more difficult to do whilst in a moving vehicle. Although the original plan was not to do any development until all the testing was completed, it was felt that this had been proven to be a design flaw which could easily be remedied. Changes were therefore made to add padding and a border, shown in figure 79.

|  |  |  |
| --- | --- | --- |
| |  | | --- | | Screenshot_2013-08-07-23-23-11  Figure 78:Original Allergy Screen |  |  | | --- | | C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-20-17-45-30.png  Figure 79:Changed Known Allergy screen | |

This was an oversight of the design process, as the text displays were not originally conceived as buttons, so Nielsen’s recommendation to define a large space to solve the ‘fat finger problem’ was not implemented. The final two testers made no mention of any difficulties with the layout. A screenshot was sent to the first three testers, who agreed the new design resolved the issue.

**Usability testing - Layout issues**

Originally the login page displayed the ambulance service logo, and the three edit text boxes and login button on the page above the keyboard, shown in figure 80. The reset password button was hidden behind the keyboard, as an unlikely button to be pressed. Two testers commented that the page looked compact, and when the user was asked to reset the password there was hesitancy from three testers as they had forgotten the reset button was under the keyboard.

Making the text or boxes smaller could have resulted in other usability problems. As the logo was only included for aesthetic purposes, it was removed to resolve these issues, seen in figure 81.

|  |  |
| --- | --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-13-10-35-39.png  Figure 80:Original Login page | C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-20-18-37-10.png  Figure 81:Revised Login page |

**Usability testing - Spinner selection screens**

One tester, who does not own a smart phone, had difficulty when asked to select a hospital for the patient, as they responded by repeatedly pressing ‘Select Hospital’ rather than choosing an option from the list, causing frustration.

|  |
| --- |
| C:\Users\Gary\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Screenshot_2013-08-20-20-19-37.png  Figure 82:Failed attempt to change spinner selection |

Removing the entry was not possible as Android does not allow opening a spinner item with no pre-set selection. Various workarounds were considered, keeping the entry but removing the text left a blank space where it looked like information was missing. Changing the string to read ‘Select below hospital’ would mean having to make the selection button the width of the screen, the problem shown in figure 82.

Ultimately it was determined the issue was minor, easily explainable and unlikely to occur after very basic training on the application, so the original layout was retained.

**6.4.3 Summary of user testing**

Overall the responses were very positive. Each tester was asked how easy it would be to repeat each task and all rated it ‘very easy’, meeting a usability requirement set out by Dix on learnability. All users thought the clipboard feature was a very good idea. The only other high level comment made was that the allergies screen should have an 'expand all' button, but this was not implemented as the details are hidden for the specific reason that paramedics would not always require information on every type of allergy.

When the spinner selection was explained to the tester who had difficulties they were embarrassed, and stated that they should have been able to work it out. Whilst the problem may appear trivial, it is a very valid reminder that the users of this product may not have strong technical skills, or any experience with touch screen applications. The research identified that usability has been a major issue for NHS staff adapting to new IT projects, highlighting the importance of trying to eradicate even very minor difficulties.

The testing also provided the first use of the application by a user not involved in the development, and all functional requirements were demonstrated to be working as expected.

# 7.0 Evaluation

This chapter evaluates the strengths and weaknesses of the approach used to undertake the project.

## 7.1 Research Stage

A significant project risk was a lack of access to the NHS hindering the forming of a valid requirements document, necessitating the need for an assertive approach. Within the first week of the project all 11 UK ambulance services had been contacted to complete a questionnaire, three of whom responded. A telephone interview with an active paramedic was conducted providing an excellent source of information relating to barriers within the NHS and giving an understanding of the critical functional requirements. This was the most important part of the entire project as it provided the direction for every other stage. It would have been preferable to have spoken to more paramedics and other stakeholders in the service but connections could not be made.

Overall the data obtained from primary and secondary research exceeded expectations. The strong results of user testing showed the usability principles had been correctly applied. If there had been more time available a research section would have been completed on security.

## 7.2 Design

Much of the functionality and layouts had already been envisioned before the design stage took place, influenced by the consistency of the approach taken by Terrafix and Attobus, and findings from the research. The design was a short one week process, and it was satisfying that the end result so closely resembled the original diagrams. An initial design for the coding would have been very difficult to undertake due to the author having no knowledge at this point of Android development. This is discussed in the next section.

## 7.3 Implementation

Undertaking a solo project in an unfamiliar language created a heavy reliance on searching for information on the internet into the correct way to implement a piece of code. It is difficult therefore to know if a more efficient approach would have been possible. If the resource had been available, an expert would have been consulted for reference at several stages. The security section employs good practices but it is recognised that all software has flaws. There is confidence that the security would be sufficient against casual hackers, but for proper evaluation white hat programmers would need to be asked to test the application.

With hindsight more time should have been allocated to research Android. The reality of a deadline with no experience of estimating how long the learning would take resulted in starting to program at the earliest stage. In practice, when new code was learned it was often quickly inserted to perform a function in the application, resulting in code that became increasingly difficult to develop. An attempt was made in early August to try to adapt the code but the process was proving long, and the decision was made to write the majority of the code from scratch, in effect becoming a throw away prototype model.

This was a frustration and a setback, though it could be argued that the trial and error approach greatly accelerated understanding. From here a type of Agile model was followed, a function was planned, developed, and JUnit tested, sometimes within a matter of hours. Although it added pressure it was the correct decision to restart the code, and the results of testing appear to vindicate this.

Several areas planned at the design stage were not completed in the final version, particularly the databases to hold the summary of care details and pharmaceutical information. As time became a factor these were deemed to be of lower importance as it had already been successfully demonstrated in the application that MySQL queries through PHP was possible. The choice was made to learn other areas of Android code rather than repeat what was already understood. The map routing feature is also incomplete, as it does not respond when the users moves location.

## 7.4 Verification and validation

The use of JUnit testing during the implementation gave confidence that the application would provide the correct outcome, however until usability testing it was unknown if the user would be able to understand how complete the tasks. All users commented that it would be very easy to repeat a given task, suggesting high usability and a small learning curve, essential for a successful NHS software project. Feedback from five users is not enough to reach a conclusion, but close attention to the usability principles appears to have created a good platform to work from.

The feedback from the paramedic gave confidence that the functionality requirements had been met. Like the research stage it would have been preferable to have had additional stakeholders test the device. It had been planned to contact the sources from the regional ambulance services who had completed the original questionnaire, but the late completion of the coding, inability to get the application to them, and the difficulties of having users test the device based on screenshots alone meant this was not attempted. Clearly in future projects, access to people in the sector for the whole duration of the project would be preferable.

## 7.5 Maintenance

The author has no experience with the maintenance stage and it is impossible to predict a programs lifecycle, but theoretically the decisions taken during implementation would make future development easier. Only industry standard code is used, very few static analysis bugs exist (and would be quick to eradicate). HTTP posts have been separated from the screen layout classes, connections to all strings are defined in the same file for easy modification and prefixed with the name of the class they are used in for identification.

Crucially, each method is commented on and JUnit tested. This should limit the potential of introducing bugs to the core functionality of the application as new features are added.

# 8.0 Conclusion

This section summarises the project against the original aims, and suggests future work for the application.

## 8.1 Outcome of original aims

**8.1.1 Replicate the essential processes of the ambulance service**

The critical functionality provided by similar systems is demonstrated in the application. The application does not provide an exhaustive feature set covering all scenarios, as without daily access to the ambulance service this was not possible, however it could certainly be used in its current format to respond to an incident.

**8.1.2 Provide additional patient information to the paramedic**

The application is displaying Summary of Care details in a layout assessed as very easy to navigate. It is acknowledged that parsing real Summary of Care data would be more complex, nevertheless as the database is UK wide only one implementation would be needed for this.

**8.1.3 Provide decision support to the paramedics**

The application demonstrates proof of concept that through integration with the summary of care details, the medicine and allergy information of a patient can be retrieved. The paramedic who provided comments on the application stated this would be a very useful tool. The research showed that providing medical decision support is a complex operation, and medical experts would be required for design to work with the developers.

**8.1.4 Create an application commended as highly usable**

User testing showed that each task is rated as very easy to complete. With the expectation that all paramedics would have at least basic training on the application, the objective can be regarded as met. It is noted however, that testing would need to be conducted on a far wider scale.

## 8.2 Personal objectives

Each stage of the project closely resembled the timeline outlined in section 1.6. A few sections ran late due to delays with learning Android, however overall the project management was in line with expectations.

During coding a familiar pattern emerged of learning one way to implement a feature, then discovering a more efficient way leading to code having to be rewritten. When the code was restarted in August the author had far greater confidence writing in Android. In this sense the previous frustrations had been worthwhile and from a personal perspective the most satisfying outcome of the entire project was having learned a new language.

The use of another developer’s code for the Google Maps routing was a disappointment as it is the only major part where the author had to rely on another person’s full class. Using freely available code is not a problem for development, but due to time concerns the class was used before its methods were fully understood. This skipped the learning process and could have introduced a bug. The author has now had time to understand the class but in future this should be avoided.

## 8.3 Suggestions for Future Work

**8.3.1 ERPF and screen size**

During research it was considered if the ERPF could be integrated into the design of the application. This was not included as the amount of detail the paramedic is required to input would be unsuitable for a two inch keyboard.

Further research would be needed to determine an ideal size, but an 11 inch Galaxy tablet with attachable keyboard could be a solution to creating an all in one device. Identical Android code could be used, the map would be clearer and it would be cost effective as regions like NEAS would not have to supply a laptop to every ambulance in addition to the on-board terminal.

**8.3.2 Identifying languages**

A layout was considered for a tool to assist in identifying the language of non-English speaking patients. During the design it became clear that many scenarios could occur that hadn’t been considered, for example an illiterate patient may become distressed if a paramedic tried to encourage them to select an option they cannot understand. Ultimately the feature was dropped as unfeasible for this project, though with further research it would be a useful addition.

**8.3.3 Privacy**

Despite best efforts privacy is not completely protected. A thief can circumvent the attempt to disable the application remotely by turning off the 3G. Paramedics are also able to take screenshots of personal data. These scenarios need further research, as security breaches would bring the application and the ambulance service under public scrutiny.

**8.3.4 Integration with the dispatcher and hospitals**

In the early stages of the project a website was developed to allow 999 operators to create incident details to be received by the application. This was dropped for time constraints, and as research showed the unlikeliness of being able to change a process in another NHS department. The website is functional and if a hospital website was also built as well it could create a fully integrated system to be used by the NHS Ambulance Service, similar to what Paratus provide in Sweden. Screenshots of the website are shown in appendix 5.

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# Appendix 1 - Ethics Form

**FACULTY OF SCIENCE, AGRICULTURE AND ENGINEERING**

**Procedure for the Ethical Approval of Research**

**1. Introduction and Context**

[University Ethics Committee](http://www.ncl.ac.uk/business-directorate/ethics/ethics_committee.php) has delegated responsibility for the ethical approval of research to Faculties. It is a requirement of research councils and other funding bodies that HEIs demonstrate proper consideration of ethical approval.

All staff and students (UG, PGT and PGR) planning to undertake research must follow one of the processes as outlined below, whether or not the project is internal, external, funded or unfunded.

There are three types of research requiring ethical approval:

**Type 1**: Research involving:

* human subjects in a non-clinical setting, participants who are vulnerable or require the cooperation of a gatekeeper, using (but not limited to) questionnaire/survey, experiments, observational studies, covert observational studies, administration of drugs or other substances, collection of fluid or other samples.
* Use of sensitive economic, social or personal data
* Projects which pose a risk to the Environment or which involve work outside of the European Economic Area.

This requires internal Faculty approval, the process for which is outlined below in section 3.

**Type 2**: Research involving NHS patients/relatives/staff/access to data, organs or other bodily material of past and present NHS patients/use of NHS premises/facilities or vulnerable people in a clinical setting unable to make their own decisions.

This requires external ethical approval from the [National Research Ethics Service](http://www.nres.npsa.nhs.uk/) (NRES[)](http://www.nres.npsa.nhs.uk/).

**Type 3**: Research involving the use of live vertebrate animals or other organisms covered by the Animals (Scientific Procedures) Act.

This requires internal ethical approval from the [University Ethical Review Committee](mailto:lois.neal@ncl.ac.uk), plus Home Office licences where appropriate.

**2. Governance of the Ethical Approval of Research**

A Faculty Ethics Committee has been convened, chaired by the Dean of Research and supported by the Deputy Head of Administration who will assume the role of Faculty Ethics Coordinator. To ensure a broad spread of expertise and ownership for implementation at an academic unit level, in the first instance the other members are Directors of Research and, to cover the teaching remit, the Deans of Undergraduate and Postgraduate Studies. The membership will be reviewed annually.

Faculty Ethics Committee will operate mainly as a virtual committee in reviewing applications, but will meet at least once a year to review operations, consider a summary of preliminary ethical assessment forms/ethics approval applications and compile an annual report to University Ethics Committee. The submission of an annual report, through Faculty Steering Group, to the University Ethics Committee, will provide (a) a brief statement of the Faculty arrangements for consideration of the ethical issues in research; (b) a list of those activities where ethical consideration has been required; and (c) an indication of the problems which have been referred directly to the University Ethics Committee for their resolution. In addition, the University Ethics Committee may call for papers in individual cases as part of its auditing process. Training is arranged for all members, and such sessions are tailored to SAgE disciplines.

It is important to note that while responsibility for the ethical approval process lies with the Chair of the Faculty Ethics Committee, *the responsibility for ensuring the ethical conduct of research and for compliance with the established procedures lies with each individual investigator.*

**3. Procedure for the Approval of Type 1 Research**

**i) Preliminary stage before the proposed research is undertaken:**

* **Staff** planning to undertake research should complete the [Preliminary Ethical Assessment form](http://www.ncl.ac.uk/res/assets/documents/PreliminaryEthicsForm.docx) and submit it to the School Ethics Coordinator (your School Administrator/Manager) and copied to the Faculty Ethics Coordinator ([Kirsty](mailto:joanne.mayne@ncl.ac.uk) Anderson). For projects which are externally funded a copy should also be submitted to the University Grants and Contracts liaison person for your academic unit alongside the Blue Form at the point at which the application to the external funding body is lodged. *The preliminary ethical assessment form must be completed for every project.*
* **PGR students** should use the e-portfolio submission system as this already includes the Preliminary Ethical Assessment form. If full ethical approval is required, PGR students should then follow the procedure in section 3iii) below. Project Approval forms should be completed within 9 months of the commencement of the student’s research degree programme.
* **UG/PGT students** will be asked by the relevant module leader to complete the [Preliminary Ethical Assessment form](http://www.ncl.ac.uk/res/assets/documents/PreliminaryEthicsForm.docx) for all modules involving research projects. The module leader should then review the forms to ensure that ethical aspects of the research have been considered. If the planned research does not require full approval, the module leader should retain the batch of preliminary ethics assessment forms together with other formal module information. If full ethical approval is required, UG/PGT students should then follow the procedure in section 3iii) below.

**ii) When does research requiring full ethical approval have to be considered?** *(i.e. if the answer to any of the questions in the table within question 2 of the preliminary ethical assessment form/project approval form is ‘yes’)*

* For **staff** research requiring full ethical approval, this is normally if and when the project is awarded unless the Grants and Contracts team notify the PI at submission of the preliminary ethics assessment form that the funder’s terms and conditions require earlier ethical approval.
* For **PGR students**, this will be an immediate requirement as part of their project approval.
* For **UG/PGT students**, this will be an immediate requirement before they are able to begin their research.

**iii) Process for requesting full ethical approval:**

Where full ethical approval is required, the [Full Ethical Assessment Form](http://www.ncl.ac.uk/res/research/ethics_governance/ethics/procedures/stage2.htm) must be completed and submitted to the Faculty Ethics Coordinator ([Kirsty](mailto:joanne.mayne@ncl.ac.uk) Anderson) and copied to the University Insurance and Risk Manager who will address any issues regarding insurance/indemnity arising from the proposed research. Any proposed consent forms/participant information sheets should be submitted to the Faculty Ethics Coordinator together with the full ethics application. For funded applications, the form should also be copied to the Grants and Contract team.

Once received by the Faculty Ethics Coordinator, the form will be circulated for review to 2 members of the Faculty Ethics Committee (one more closely related to the discipline area; the other not related to the discipline) and returned with any comments/issues. Members are empowered to require amendments in the application or research protocol in order to address any particular areas of ethical concern. Their comments and concerns, if any, will be returned to the applicant for consideration and response. Provided that there are no remaining ethical issues, formal approval will be given by the Chair (or nominee) of the Faculty Ethics Committee and communicated to the applicant. The timescale for the process would normally be within 2 weeks of initial receipt. All applications will be tracked and monitored by the Faculty Office. The Faculty Ethics Committee may also refer particular cases to the University Ethics Committee if a decision cannot be reached and is obliged to consult with the University Ethics Committee where the research might create a precedent, or the research topic and methodology are particularly sensitive. The applicant may appeal to the University Ethics Committee against a decision by the Faculty Ethics Committee not to grant ethical approval for a project.

**4. Links to Further Information**

Information and forms relating to the ethical approval of research can be found at: <http://www.ncl.ac.uk/res/research/ethics_governance/ethics/index.htm>

# Appendix 2 – Interview with paramedic

2.56 - G - When you start a job, is it a depot that you go to?

P - Yes we all work from different stations. Paramedics are assigned to a station and the paramedics are given different rotas or on station relief. One station is your station, but sometimes sent to others for cover. 2 shift patterns, 2 A and E vehicles and 2 rapid response vehicles, both 12 hour shifts.

Paramedics come in 20 minutes before handover. Half the time the paramedics you are swapping with our late

4.16 – G Is that because they are held up by picking somebody up?

P – Yes. We don’t see the bigger picture. The people in control (contact centre) they know the big picture. This is where communication falls down between control and the people in the front line. They send us out on an emergency 5 minutes before we finish which will take us well over time, and often you wonder if there is another crew who could do this who have already swapped over. Anyway that’s rant over not sure if you need to know that.

5.05 G- It is what I need to know as I am seeing if we can improve communication between control centre and paramedics

P – In my eyes and a lot of other paramedics on the road it’s a failure between communication centre and us on the road. There are plenty of times we are sent on a job that will make us late and we will pass another crew on the way and wonder why they could not have been given that job. Maybe the control centre do not like the crew so they will send them to make sure they are late.

6.15 G – So they have a choice of which crew they send?

P – It comes up on screen which is the closest vehicle then they make a decision if the closest vehicle is the right one to send. A paramedic may not be able to do the job as they have downtime, or maybe they have to go back to the depot to clean the vehicle (due to patient vomiting etc.). So the closest people may not be available. Paramedics don’t know on the road what is going on in the call centre (and which vehicles are available). To be honest I would not like the call centres job, I’ve been in there and it is hectic. But they do tell us at times we are the closest crew and we know that were not and they are lying and it pees people off.

7.35 G – So if they were more open with what the other crews were doing then it would help morale?

P – Yes. Some of the control staff are quite good. Last night there were 2 crews at the RVI, both finishing in 5 minutes and finishing paperwork. The crew that was there before me and the other crew received a call saying ‘We’re really sorry, we know this is not what you want to hear there is an R1 (cardiac arrest) and you’re going to have to go to it’. When they are honest and say sorry and are nice it makes all the difference. Whereas some people just give the order and you get really annoyed.

8.55 G – Sorry to cut in, is R1 an emergency?

P – Yes. R1 is a cardiac arrest that you have to get to in 8 minutes. R2 is an 8 minute response where the patient is in a dire state of emergency. 9 times out of 10 they aren’t in a dire state. G2 which you have to get to in 30 minutes.

9.34 G –I was going to ask later on about how often the correct status of emergency is given for the patient’s condition. A few basic questions, is there always 2 people on a shift?

P –On an ambulance there is always a driver and an attendant, either 2 paramedics, a paramedic and a technician, paramedic and an ECSW (Emergency Care Support Worker), or a technician and an ECSW.

10.42 G- What is an ECSW?

P – They can drive the vehicle and do basic observation. If there is not anything serious with the patient they can sit in the back on the journey to hospital. But they cannot give out drugs nor do ECGs. Basically they are drivers and assist the paramedic.

11.01 G – Would the call centre when they are giving a job look at the crew of the ambulance and decide who is the most appropriate crew for the emergency?

P – No they don’t. They have A & E emergency vehicles which have to have a qualified person (paramedic or technician) but then you have urgent crews which are 2 ECSWs working together who are more transport. But the call centre will use them to meet the target times, so if there is an 8 minute emergency the urgent crew may be sent to hit the target time. So that crew is there and are just waiting for a paramedic, to make sure the call centre are not fined for missing the target time.

12.30 G – I had read about more than one vehicle arriving at a scene. Is that something that can be avoided or will it always be necessary to have someone arrive as soon as possible?

P – I don’t know that the protocol is in the call centre, but they will send any vehicle to hit the target times, which will be inappropriate at times. They will send an urgent crew to meet an 8 minute target when actually only a paramedic would be able to do anything.

13.45 G – A couple more questions about the start of the shift. Do you have a predefined route?

P – No basically, first thing in the morning you will get to the station. You have supposedly got 20 minutes to check the vehicle, check its clean, everything’s working, and check all the equipment and drugs are ready. You don’t normally get the full 20 minutes as before that you often get a job. When you get a job control radio you to tell you have a job. It then goes up on Terrafix, the computer inside the ambulance, which is also a satnav and GPS tracker. It gives you the directions and basic information of the job. Tells you the category, patient description and brief details. The paramedics do not get all of the information on the computer that the call centre have. The call centre could have an extra 4 or 5 lines that the paramedics do not know about. For example we will get a message about chest pain, as an emergency, but we will not know the rest of the information. Therefore we assume heart attack, and when we arrive find out it’s a chest infection (which the call centre had recorded but the information was not passed through). It is the Pathway system which is wrong, as soon as the patient says chest pain it comes up as an R2, as it could be a heart attack (even if the person on the phone has not said it is an emergency).

18.12 G – Do you know why you don’t get all the information?

P – The call centre have it but the Terrafix does not have enough space to display all the information, so it stops with a dot dot dot, so we know there is more information but cannot see it. I don’t know if it’s something that can be fixed or not.

19.23 G – Could you ever reject a job?

P – No. They’ve brought out a new policy to try to not send us to a job within 30 minutes of your finishing time to a G2 which will make you late finished, but will still send you to an emergency. Some of the dispatchers are good at that, some are not. You can call back the dispatcher and ask if it can be panelled elsewhere. It all depends if there are other vehicles available.

21.25 G – Do you get a radio or a phone call at the same time as the Terrafix to confirm the job?

P – Both crew members carry a radio and the first we will know of a job is a radio message from the dispatcher. That will tell us if we have an emergency job to do. If we are on station we have 45 seconds to get into the ambulance and be mobile. If you’re not on station they might put you on standby and ask you to sit somewhere until there is a job.

22.35 G – How often are you on standby? How often are you at the station?

Not very often at all. You are at the station for 2 half hour breaks. That is normally the only time you will be at station. 80% of the time there is another job waiting for you when you became available. Otherwise you will sit and wait in a car park where they think is the best place to wait.

24.30 G – When they are talking to you on the radio what are they saying to you?

P - It is very basic. Usually they say you’ve got an emergency, clarify the job. It depends on the dispatcher, sometimes that’s it and then you go and look at the job on the Terrafix. With the ECSW they give them a lot more information as they sometimes work by themselves, and it is hard to look at the Terrafix whilst driving.

25.53 G – Do you know what the fall back is if the paramedic doesn’t respond to the radio message?

P – I’ve not come across it. Both paramedics have a radio and phones. It’s never happened as far as I know.

26.35 G – What if you couldn’t find the patient?

P - The dispatcher will try to get in touch with the caller to get as much information as possible, landmarks, anything they can see etc.

27.33 G – Do you have to type information into the Terrafix?

P – No we can’t. It’s a touch screen computer. We tap in mobile (moving), at scene, at hospital, and when we finish tap in clear. We have the Electronic Patient Report Form (EPRF) which we have to fill in for the patient, and the job and what’s gone on.

28.15 – G – Is that EPRF done during the handover at the hospital?

P – It’s confusing what we’re supposed to be doing. We’ve been told we should not fill in the form in the ambulance but if we don’t it takes so long to do compared to paper that it takes 20 minutes to fill it in at the hospital and then we have to wait to hand over the patient and we are told off for the increasing hand over times, and the ambulance service are being fined. So in practice we do fill it in on the ambulance.

29.38 G – Why does it take so much longer (on EPRF) then on paper?

P - On paper its one form with different boxes to tick and fill in the job details that our relevant. The EPRF has lots of different pages which cover every possible scenario and each part needs to be filled in. There is too much information. We have had it for 18 months, so we are getting quicker at it, but there is a lot to go through. Some questions do not need to be asked. For example there is a symptoms page with different sections, general, cardiovascular, neuro, etc. and each section should be filled in regardless of the relevance to the patient. It’s about covering your own back and putting in enough relevant information.

33.28 G – Do you know if the hospitals have that ERPF when you submit?

P – The ERPF is not used to its full extent, and I have just done an improvement plan to give the information to the hospital. The ERPF has all the relevant information to the patient that the hospital requires and that is updated all the time, and as soon as you click the hospital which you are going to it goes onto their server and they can access it. The doctors and nurses much prefer paper as they have got it in front of them. If it’s electronic they have to go through 5 screens to print off the details, and have to find the page that they need. It’s not user friendly for them.

P - The ambulance service gets fined for delayed handover times. The ambulance fine the hospitals for the delays and now the hospitals are trying to fine the ambulances for the paramedics not clearing the jobs properly. It is all about targets and money, not about patient care. I still prefer paper handovers as part of the system, however for the improvement plan it is a historical fact that paramedics book in a patient. This is not fast tracked and we have to queue with everyone else to speak to the receptionist. That can take over 10 minutes. As soon as you’ve done the sign off with the receptionist then the job is cleared. The EPRF has the technology to send the required information to the receptionist without having to speak with them, so it should be a case of implementing to go the receptionists screen and training to cut out that unnecessary delay.

38.54 G – That sounds a lot better. Have you had any feedback or have they tried to implement that before?

P – I don’t think the people I spoke to really understand the problem, and could not imagine the difference it could make. I wasn’t encouraged to push it.

40.05 G – Between picking up the patient and taking to hospital are you communicating with the hospital?

P – No it’s all just us. We decide what treatment they need and which A&E to go to. If the patient is seriously ill or life threatening we will contact the dispatcher and ask them to put the hospital on pre alert for our arrival. We will give basic details and an ETA.

41.20 G – If you were unsure on the action to take on the patient do you have any support?

P - When we go to patients we always ask them to bring medication with them, if they are unconscious with no one with knowledge then we cannot get any more information. We have a clinical supervisor we can call and ask for advice, especially in a cardiac response. Depending on the rhythm they are in, we will ask for advice?

43.13 G – How often do you use that?

P – Very rarely.

43.37 G – Do stats and targets affect your job?

P – No. If we miss an 8 minute target we may be asked to explain why we didn’t hit the target. If there are bad traffic conditions I tend to update the dispatcher anyway so that they are aware.

46.40 G – With the patients who don’t really need an ambulance, in your opinion is it the 999 staff being too lenient or is it just that they can’t say no to an ambulance?

P – They can say no its just the Pathway system that they use when someone calls up will lead them in one direction, often the wrong direction and they will have no choice but to send an ambulance. As soon as the call is connected the timer starts and it takes a long time to ask the questions. In the past it would be ex paramedics working in the call centre who could make actual medical judgements, but now most are not medically trained and can only follow the systems they have in front of them. There is a lack of medical understanding.

49.52 G - Do you ever get to a patient and then not do anything more with them? If you think it’s been a wasted journey?

You’re open to a lot of problems if you leave them at home, but it does happen. Lots of times you will get there and they will just want advice and reassurance. In those cases we will just do basic observations and leave. Paramedics are being asked to do this more often.

51.17 G – Thank you for your advice and information. Is there anything else you want to add?

P - It’s all about communication. It would be appreciative if we were given more honest feedback from the dispatchers. Overall I love my job.

52.20 G – In the dissertation I can either put you as an anonymous or include your name. Do you mind your name being included?

P – I would prefer to be anonymous.

# Appendix 3 – Questionnaire to ambulance trusts

## East Midlands Ambulance Service

This questionnaire is to give a general overview of how the ambulance service operates on a normal day. The responses given can be from a high level perspective.

General details

|  |  |
| --- | --- |
| Please enter your name | Neil Spencer |
| Please enter the ambulance service you work for? (e.g. Yorkshire, North East, London) | East Midlands Ambulance |
| Is it okay to have your name included as a reference in the dissertation? | Yes |
| Is it okay to have your ambulance service included as a reference in the dissertation? | Yes |
| Date questionnaire completed? | 19/06/2013 |

\* If you do not wish to be listed as a reference then any comments will be treated as anonymous.

Going to a patient

|  |
| --- |
| How do ambulance crew members find out that a patient needs to be collected? (E.g. by telephone call, by computer message etc.)? |
| Our primary method of Dispatch is via the Mobile Data Terminal (MDT) in the ambulance or paramedic CAR. Incident details are sent from the Computer Aided Dispatch (CAD) system from our Emergency Operations Centres (EOCs) at either Lincoln or Nottingham. Dispatchers track all ambulance and cars and the CAD identifies the nearest available resource to an incident. The Dispatcher allocates the emergency to the resource via the MDT. If the crew are away from their vehicle the crew radio units automatically alert telling them to return to their vehicle.  As a fall back, all crews carry radios and mobile phones. |

|  |
| --- |
| When someone calls 999, are all the details given to the telephone operator passed on to the ambulance crew? If yes how is this information passed on (e.g. by telephone call, by computer message etc.)? |
| Incident details are passed to the responder via the MDT see above. |

|  |
| --- |
| As an estimated percentage, how often will the ambulance crew have the name of the patient before they arrive? |
| Considering emergencies can be reported by people who do not know the patient, such as people passing by, or CCTV monitoring staff etc., the percentage will be lower than people would perhaps expect. I looked at all calls for 3 days in June and found 67% of emergency calls had a patient name. 100% of non-emergency calls had a patient name (these are Dr’s urgent calls). |

|  |
| --- |
| When the crew do have the name of the patient, do they have access to any of the patient’s previous medical records? |
| EMAS has moved away from paper based Patient Report Forms (PRFs) and now uses electronic Patient Report Forms (ePRFs). This means responders can view previous records when the patient has been attended. This does not, however, include accesses to the patient’s previous medical records held by other parts of the NHS. This is a piece of work currently being investigated by EMAS. |

Returning to the hospital

|  |
| --- |
| How does the hospital know that the patient has been collected and is being delivered to that hospital (e.g. by phone call to the hospital, by phone call to a call centre, by a computer in the ambulance etc.)? |
| Almost all of our hospitals now have access to the computer based system that is fed by the ePRF so hospitals can see inbound patients. If a patient has a serious condition and we need to put resus on standby a pre-alert call is made to the hospital either directly from the responding crew or via the EOC. |

|  |
| --- |
| What information does the ambulance crew provide to the hospital about the condition of the patient? |
| Everything available on the PRF is now viewable, patient name, address, age, sex, and all obs taken, BP, BM, GCS, previous medical history recorded, nature of illness/injury etc. |

|  |
| --- |
| Does the ambulance crew provide recommendations to the hospital on what course of action should be taken upon arrival? |
| The ambulance crew will put in a pre-alert call to the hospital if they believe the hospital need to be on standby to receive the patient, for example sever trauma or patient requiring resus. |

Other information

|  |
| --- |
| The purpose of this questionnaire was to get a high level overview of the communication between the 999 centre, ambulance crew and the hospital. Is there anything you feel is important to discuss that has not been asked in this questionnaire? |
| New challenges are likely to happen in the future as services become fragmented, putting increased pressure on technical solutions. |

|  |
| --- |
| Please briefly mention any high level changes that you think would improve the quality of patient care provided (in relation to the communications and information exchange between the NHS services) |
| Our next phase of development is to implement a ‘Face to Face’ decision support algorithm onto the ePRF ‘Toughbooks’ that will link directly to the Directory of Services (DOS) to allow the responding crew to find the most appropriate pathway for treatment if the patient cannot be treated and left on scene by EMAS.  We already have access to the DOS via our Clinical Assessment Team who are based in our EOCs. |

Further research

At a later stage in the project further information may be required to assist with development of the system to be built. Is it okay to contact you personally with further questions?

|  |
| --- |
| \*Yes  \*Would prefer if you contacted general enquiries |

Thank you for completing the questionnaire. The answers submitted will be treated as confidential data and only used within the university.

## Questionnaire London Ambulance Service

This questionnaire is to give a general overview of how the ambulance service operates on a normal day. The responses given can be from a high level perspective.

General details

|  |  |
| --- | --- |
| Please enter your name | Gary Bassett |
| Please enter the ambulance service you work for? (e.g. Yorkshire, North East, London) | London Ambulance Service NHS Trust |
| Is it okay to have your name included as a reference in the dissertation? | Yes |
| Is it okay to have your ambulance service included as a reference in the dissertation? | Yes |
| Date questionnaire completed? | 20 June 2013 |

\* If you do not wish to be listed as a reference then any comments will be treated as anonymous.

Going to a patient

|  |
| --- |
| How do ambulance crew members find out that a patient needs to be collected? (E.g. by telephone call, by computer message etc.)? |
| If the crew are mobile then the information will be sent to them via the on-board Mobile Data Terminals (MDT’s). However if the crew are stationary then brief details will be given over the radio and this will then be followed up with any further information via Mobile Data Terminal. |

|  |
| --- |
| When someone calls 999, are all the details given to the telephone operator passed on to the ambulance crew? If yes how is this information passed on (e.g. by telephone call, by computer message etc.)? |
| The main chief complaint details are passed via MDT; any additional information, i.e. access details etc. are also sent in this way. |

|  |
| --- |
| As a  Percentage, how often will the ambulance crew have the name of the patient before they arrive? |
| . At the time of a 999 call this is not an important factor as the main focus is achieving a clear understanding of the patient’s symptoms. Patient names can be gained by crews when they arrive on scene. The exceptions to this are lower acuity calls where, following a further assessment by telephone an ambulance is sent, and for maternity cases, where contact may need to be made with the Maternity Unit where the woman is booked. |

|  |
| --- |
| When the crew do have the name of the patient, do they have access to any of the patient’s previous medical records? |
| Generally speaking, the only information crews have access to be that made available via the 999 call. We do however have a scheme whereby an emergency care component of a community care plan or palliative care arrangements can be agreed in advance and held on our system against the patient’s address. |

Returning to the hospital

|  |
| --- |
| How does the hospital know that the patient has been collected and is being delivered to that hospital (e.g. by phone call to the hospital, by phone call to a call centre, by a computer in the ambulance etc.)? |
| The only time a hospital is made aware that a patient is being brought there is where the patient is experiencing life-threatening symptoms, in this case the crew contact the control room via radio and the control room in turn contact the hospital via a dedicated telephone number. This also applies in some maternity cases. However the majority of patients are taken to hospital without any prior notice being given although there is always a handover of care including a copy of the assessment record being made available. Hospital staff then undertakes their own triage as would be the case if a patient had made their own way to Accident & Emergency by independent means. |

|  |
| --- |
| What information does the ambulance crew provide to the hospital about the condition of the patient? |
| Crew’s complete an electronic Patient Report Form, which is a record of the assessment and treatment provided. |

|  |
| --- |
| Does the ambulance crew provide recommendations to the hospital on what course of action should be taken upon arrival? |
| Once the handover of care has been completed the patient’s care is the responsibility of the receiving hospital staff. |

Other information

|  |
| --- |
| The purpose of this questionnaire was to get a high level overview of the communication between the 999 centre, ambulance crew and the hospital. Is there anything you feel is important to discuss that has not been asked in this questionnaire? |
|  |

|  |
| --- |
| Please briefly mention any high level changes that you think would improve the quality of patient care provided (in relation to the communications and information exchange between the NHS services) |
| Increased involvement of ambulance services in devising an emergency care component of a community care plan. |

Further research

At a later stage in the project further information may be required to assist with development of the system to be built. Is it okay to contact you personally with further questions?

|  |
| --- |
| \*Yes |

Thank you for completing the questionnaire. The answers submitted will be treated as confidential data and only used within the university.

## Questionnaire West Midlands Ambulance Service

This questionnaire is to give a general overview of how the ambulance service operates on a normal day. The responses given can be from a high level perspective.

General details

|  |  |
| --- | --- |
| Please enter your name | Liz Parker |
| Please enter the ambulance service you work for? (e.g. Yorkshire, North East, London) | West Midlands Ambulance NHS Trust |
| Is it okay to have your name included as a reference in the dissertation? | Yes |
| Is it okay to have your ambulance service included as a reference in the dissertation? | Yes |
| Date questionnaire completed? | 19.6.13 |

\* If you do not wish to be listed as a reference then any comments will be treated as anonymous.

Going to a patient

|  |
| --- |
| How do ambulance crew members find out that a patient needs to be collected? (E.g. by telephone call, by computer message etc.)? |
| By electronic CAD data transfer to MDT, followed by a verbal update if solo responder or if the DCA fails to mobilise |

|  |
| --- |
| When someone calls 999, are all the details given to the telephone operator passed on to the ambulance crew? If yes how is this information passed on (e.g. by telephone call, by computer message etc.)? |
| Relevant information is passed via transfer of specific areas of CAD data to MDT or passed verbally in the event of Airwave failure |

|  |
| --- |
| As an estimated percentage, how often will the ambulance crew have the name of the patient before they arrive? |
| 90% |

|  |
| --- |
| When the crew do have the name of the patient, do they have access to any of the patient’s previous medical records? |
| No |

Returning to the hospital

|  |
| --- |
| How does the hospital know that the patient has been collected and is being delivered to that hospital (e.g. by phone call to the hospital, by phone call to a call centre, by a computer in the ambulance etc.)? |
| Acute hospitals have access to an online version of WMAS live CAD. This enables them to view incoming patients and those booked into the hospital as a Doctors referral. |

|  |
| --- |
| What information does the ambulance crew provide to the hospital about the condition of the patient? |
| Verbal handover of clinical assessment |

|  |
| --- |
| Does the ambulance crew provide recommendations to the hospital on what course of action should be taken upon arrival? |
| No |

Other information

|  |
| --- |
| The purpose of this questionnaire was to get a high level overview of the communication between the 999 centre, ambulance crew and the hospital. Is there anything you feel is important to discuss that has not been asked in this questionnaire? |
| Control also has the facility to send SMS or page messages to crews via CAD. Hospitals are able to access limited read only information from the CAD on line facility. Hospitals have recently been given access to record via the CAD system the handover time via a pin number.  WMAS also have a Hospital Desk function which operates 16 hours daily and acts as a direct link into the regions acute hospitals which enables smoother management of hospital delays etc. daily communication between relevant parties is undertaken to ensure open lines of communication are maintained. This facility also gives hospitals a single point of access into control and bypasses the call taker which has in the past been problematic. |

|  |
| --- |
| Please briefly mention any high level changes that you think would improve the quality of patient care provided (in relation to the communications and information exchange between the NHS services) |
|  |

Further research

At a later stage in the project further information may be required to assist with development of the system to be built. Is it okay to contact you personally with further questions?

|  |
| --- |
| \*Yes |

Thank you for completing the questionnaire. The answers submitted will be treated as confidential data and only used within the university.

# Appendix 4 – User Testing

## User Testing – 1

|  |  |
| --- | --- |
| Please state your age | 25 |
| Do you own a smart phone? | Yes |
| Have you ever downloaded an application onto the smart phone? | Yes |
| Date | 18/8/13 |

On a scale of 1 – 5 please rate how easy you find learning new technology, with 5 being quick to learn and 1 finding it difficult.

|  |
| --- |
| 5 |

In this questionnaire where questions are asked on the difficulty of a task, 1 is very difficult, 5 is very easy. The interviewer will complete the questionnaire.

**Questionnaire**

In this questionnaire where questions are asked on the difficulty of a task, 1 is very difficult, 5 is very easy.

**Code Generator**

To access the device you will need to obtain a one off access code from the Code Generator application. Your username is ‘admin’. Attempt to get the code.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Did you think the dialog about the clipboard was useful? Please give comments | Yes as saves time and a task |
| Any other comments | No |

**Login**

Open the main application. To enter the device use the username ‘admin’, password ‘test’ and the access code you were provided with.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| Did any problems occur? Please give comments | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | None |

**WaitScreen**

|  |  |
| --- | --- |
| Is it clear what this screen is doing? | Yes as screen clearly displays it is waiting for a job |
| Do you have confidence that this screen is still operating? | Yes |

The demonstrator turned off the WIFI and 3G off of the device to force a no internet signal warning.

|  |  |
| --- | --- |
| Is the error message clear that the device has lost signal | Yes |
| Please provide any other comments on the wait screen | None |

**Map**

Try to flick to the map page

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | N/a |

**Job Received**

The demonstrator will create a new job with summary of care details

|  |  |
| --- | --- |
| Is it clear the application has received a new job | Yes |
| Is the address details suitably clear | Yes |
| Is it clear what the user has to do on this screen | Yes |
| Any other comments | No |

The interviewer will explain the difference between the incident details and summary of care

|  |  |
| --- | --- |
| Did you notice there were two tabs | Yes |
| Is the information presented in a way you find easy to read | Yes |
| Are you able to find more details on the allergies | Yes |
| Are you able to press on the allergy to view more details | The user saw the toast saying to touch the views but struggled to open each one |
| Try to view the map. Did a route show and is it clear? | Yes |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 3 |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 3 |
| Any other comments | User stated it would be even harder to view the allergy screens in the car |

**Arrived at patient**

|  |  |
| --- | --- |
| Is it clear what you have to do on this screen? | Yes |
| Were you able to select both categories successfully? | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Second patient test – Without summary of care**

|  |  |
| --- | --- |
| Do you notice the difference compared to the previous view | User noticed the different tab colours |
| Any other comments | No |

**Security**

**Wait Screen**

The interviewer will ask the tester to lock the account

|  |  |
| --- | --- |
| Is it clear your account has been locked | Yes |
| Are you able to reset the password | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Enter entry code**

The interviewer will give you an entry code ‘test’ to reset your password

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Reset password**

The interviewer will explain each password needs to be 8 characters, with an upper case and a number

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | Commented that this looked like a standard page he would see on any application |

Thank you for your feedback. We may make changes based on this. Can we contact you again to discuss these?

|  |
| --- |
| Yes |

## User Testing - 2

|  |  |
| --- | --- |
| Please state your age | 27 |
| Do you own a smart phone? | Yes |
| Have you ever downloaded an application onto the smart phone? | Yes |
| Date | 20/8/13 |

On a scale of 1 – 5 please rate how easy you find learning new technology, with 5 being quick to learn and 1 finding it difficult.

|  |
| --- |
| 4 |

In this questionnaire where questions are asked on the difficulty of a task, 1 is very difficult, 5 is very easy.

**Code Generator**

To access the device you will need to obtain a one off access code from the Code Generator application. Your username is ‘admin’. Attempt to get the code.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Did you think the dialog about the clipboard was useful? Please give comments | Yes – as a non-android user it was good that I didn’t have to learn that |
| Any other comments | Clear that the device hadn’t stopped by the progress bar. Clear |

**Login**

Open the main application. To enter the device use the username ‘admin’, password ‘test’ and the access code you were provided with.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| Did any problems occur? Please give comments | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | Buttons are very close together, making it hard to see |

**WaitScreen**

|  |  |
| --- | --- |
| Is it clear what this screen is doing? | Obvious what it is doing that it is waiting for a job. |
| Do you have confidence that this screen is still operating? | Yes because the notification is flickering |

The demonstrator turned off the WIFI and 3G off of the device to force a no internet signal warning.

|  |  |
| --- | --- |
| Is the error message clear that the device has lost signal | Clear that the internet is not connected |
| Please provide any other comments on the wait screen | None |

**Map**

Try to flick to the map page

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | None |

**Job Received**

The demonstrator will create a new job with summary of care details

|  |  |
| --- | --- |
| Is it clear the application has received a new job | Yes |
| Is the address details suitably clear | Yes |
| Is it clear what the user has to do on this screen | Yes as only one button |
| Any other comments | No |

The interviewer will explain the difference between the incident details and summary of care

|  |  |
| --- | --- |
| Did you notice there were two tabs | Yes |
| Is the information presented in a way you find easy to read | Yes |
| Are you able to find more details on the allergies | Yes |
| Are you able to press on the allergy to view more details | No. The user was not able to press the correct area of the text until the demonstrate showed how to do this. |
| Try to view the map. Did a route show and is it clear? | Yes very clear |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 3 |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 4 |
| Any other comments | None |

**Arrived at patient**

|  |  |
| --- | --- |
| Is it clear what you have to do on this screen? | Yes, the options look like drop down boxes |
| Were you able to select both categories successfully? | Yes |
| On a scale of 1 – 5 how easy was the process | 4 – As unsure what was needed before it was explained |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Second patient test – Without summary of care**

|  |  |
| --- | --- |
| Do you notice the difference compared to the previous view | Yes the red stands out |
| Any other comments | No |

**Security**

**Wait Screen**

The interviewer will ask the tester to lock the account

|  |  |
| --- | --- |
| Is it clear your account has been locked | Yes, pop up message was clear |
| Are you able to reset the password | Yes, button was clear |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Enter entry code**

The interviewer will give you an entry code ‘test’ to reset your password

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Ye |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Reset password**

The interviewer will explain each password needs to be 8 characters, with an upper case and a number

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes, the text box is clear |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | User deliberately entered the wrong password specifications. The system returned an error message, which he commented was good. |

Thank you for your feedback. We may make changes based on this. Can we contact you again to discuss these?

|  |
| --- |
| Yes |

## User Testing - 3

|  |  |
| --- | --- |
| Please state your age | 57 |
| Do you own a smart phone? | Yes |
| Have you ever downloaded an application onto the smart phone? | Yes |
| Date | 20/8/13 |

On a scale of 1 – 5 please rate how easy you find learning new technology, with 5 being quick to learn and 1 finding it difficult.

|  |
| --- |
| 2 |

In this questionnaire where questions are asked on the difficulty of a task, 1 is very difficult, 5 is very easy.

**Code Generator**

To access the device you will need to obtain a one off access code from the Code Generator application. Your username is ‘admin’. Attempt to get the code.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 4 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Did you think the dialog about the clipboard was useful? Please give comments | Yes as would otherwise have written on paper |
| Any other comments | No |

**Login**

Open the main application. To enter the device use the username ‘admin’, password ‘test’ and the access code you were provided with.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| Did any problems occur? Please give comments | No |
| On a scale of 1 – 5 how easy was the process | 4 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | User was surprised when the paste screen popped up but after explanation stated she liked the feature |

**WaitScreen**

|  |  |
| --- | --- |
| Is it clear what this screen is doing? | Yes |
| Do you have confidence that this screen is still operating? | Yes |

The demonstrator turned off the WIFI and 3G off of the device to force a no internet signal warning.

|  |  |
| --- | --- |
| Is the error message clear that the device has lost signal | Yes |
| Please provide any other comments on the wait screen | None |

**Map**

Try to flick to the map page

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | None |

**Job Received**

The demonstrator will create a new job with summary of care details

|  |  |
| --- | --- |
| Is it clear the application has received a new job | Yes, she said the sound was good in case the paramedic was driving |
| Is the address details suitably clear | Yes |
| Is it clear what the user has to do on this screen | Yes |
| Any other comments | No |

The interviewer will explain the difference between the incident details and summary of care.

|  |  |
| --- | --- |
| Did you notice there were two tabs | Yes |
| Is the information presented in a way you find easy to read | Yes |
| Are you able to find more details on the allergies | User was unsure if pressing the ‘More Details’ button would cause a problem to the device |
| Are you able to press on the allergy to view more details | The user commented it was difficult to open the allergy details |
| Try to view the map. Did a route show and is it clear? | Yes |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 3 |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 4 |
| Any other comments | No |

**Arrived at patient**

|  |  |
| --- | --- |
| Is it clear what you have to do on this screen? | The user was unsure and had to be told to press the drop down buttons. |
| Were you able to select both categories successfully? | No – the user tried to press ‘Select a hospital below’ and had to be informed of the correct process. |
| On a scale of 1 – 5 how easy was the process | 3 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | User said now she knew the process it would be very easy |

**Second patient test – Without summary of care**

|  |  |
| --- | --- |
| Do you notice the difference compared to the previous view | Yes |
| Any other comments | No |

**Security**

**Wait Screen**

The interviewer will ask the tester to lock the account

|  |  |
| --- | --- |
| Is it clear your account has been locked | Yes message was obvious |
| Are you able to reset the password | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Enter entry code**

The interviewer will give you an entry code ‘test’ to reset your password

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Reset password**

The interviewer will explain each password needs to be 8 characters, with an upper case and a number

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 3 - User initially made an error inputting the wrong password requirements |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

Thank you for your feedback. We may make changes based on this. Can we contact you again to discuss these?

|  |
| --- |
| Yes |

## User Testing - 4

|  |  |
| --- | --- |
| Please state your age | 26 |
| Do you own a smart phone? | Yes |
| Have you ever downloaded an application onto the smart phone? | Yes |
| Date | 21/8/13 |

On a scale of 1 – 5 please rate how easy you find learning new technology, with 5 being quick to learn and 1 finding it difficult.

|  |
| --- |
| 5 |

In this questionnaire where questions are asked on the difficulty of a task, 1 is very difficult, 5 is very easy.

**Code Generator**

To access the device you will need to obtain a one off access code from the Code Generator application. Your username is ‘admin’. Attempt to get the code.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Did you think the dialog about the clipboard was useful? Please give comments | Yes, user had never seen a feature like that before and thinks it should be more common |
| Any other comments | No |

**Login**

Open the main application. To enter the device use the username ‘admin’, password ‘test’ and the access code you were provided with.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| Did any problems occur? Please give comments | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**WaitScreen**

|  |  |
| --- | --- |
| Is it clear what this screen is doing? | Yes |
| Do you have confidence that this screen is still operating? | Yes |

The demonstrator turned off the WIFI and 3G off of the device to force a no internet signal warning.

|  |  |
| --- | --- |
| Is the error message clear that the device has lost signal | Yes |
| Please provide any other comments on the wait screen | N/a |

**Map**

Try to flick to the map page

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | N/a |

**Job Received**

The demonstrator will create a new job with summary of care details

|  |  |
| --- | --- |
| Is it clear the application has received a new job | Yes, voice is very clear to get attention |
| Is the address details suitably clear | Yes |
| Is it clear what the user has to do on this screen | Yes |
| Any other comments | No |

The interviewer will explain the difference between the incident details and summary of care

**Note** – At this point the known allergies page had been amended

|  |  |
| --- | --- |
| Did you notice there were two tabs | Yes |
| Is the information presented in a way you find easy to read | Yes |
| Are you able to find more details on the allergies | Yes |
| Are you able to press on the allergy to view more details | Yes |
| Try to view the map. Did a route show and is it clear? | Yes |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 4 |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 5 |
| Any other comments | No |

**Arrived at patient**

|  |  |
| --- | --- |
| Is it clear what you have to do on this screen? | Yes, drop down boxes are clear |
| Were you able to select both categories successfully? | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | None |

**Second patient test – Without summary of care**

|  |  |
| --- | --- |
| Do you notice the difference compared to the previous view | Yes |
| Any other comments | No |

**Security**

**Wait Screen**

The interviewer will ask the tester to lock the account

|  |  |
| --- | --- |
| Is it clear your account has been locked | Yes |
| Are you able to reset the password | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Enter entry code**

The interviewer will give you an entry code ‘test’ to reset your password

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Reset password**

The interviewer will explain each password needs to be 8 characters, with an upper case and a number

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

Thank you for your feedback. We may make changes based on this. Can we contact you again to discuss these?

|  |
| --- |
| No - unavailable |

## User Testing - 5

|  |  |
| --- | --- |
| Please state your age | 20 |
| Do you own a smart phone? | Yes |
| Have you ever downloaded an application onto the smart phone? | Yes |
| Date | 22/8/13 |

On a scale of 1 – 5 please rate how easy you find learning new technology, with 5 being quick to learn and 1 finding it difficult.

|  |
| --- |
| 5 |

In this questionnaire where questions are asked on the difficulty of a task, 1 is very difficult, 5 is very easy.

**Code Generator**

To access the device you will need to obtain a one off access code from the Code Generator application. Your username is ‘admin’. Attempt to get the code.

|  |  |
| --- | --- |
| Did you have to ask for help? | No, commented it was easy |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Did you think the dialog about the clipboard was useful? Please give comments | Yes, as user did not like androids copy and paste |
| Any other comments | No |

**Login**

Open the main application. To enter the device use the username ‘admin’, password ‘test’ and the access code you were provided with.

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| Did any problems occur? Please give comments | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**WaitScreen**

|  |  |
| --- | --- |
| Is it clear what this screen is doing? | Yes because of the text change |
| Do you have confidence that this screen is still operating? | Yes |

The demonstrator turned off the WIFI and 3G off of the device to force a no internet signal warning.

|  |  |
| --- | --- |
| Is the error message clear that the device has lost signal | Yes |
| Please provide any other comments on the wait screen | No |

**Map**

Try to flick to the map page

|  |  |
| --- | --- |
| Did you have to ask for help? | No |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | N/a |

**Job Received**

The demonstrator will create a new job with summary of care details

|  |  |
| --- | --- |
| Is it clear the application has received a new job | Yes although the tester would prefer a text message sound |
| Is the address details suitably clear | Yes |
| Is it clear what the user has to do on this screen | Yes |
| Any other comments | No |

The interviewer will explain the difference between the incident details and summary of care

**Note** – At this point the known allergies page had been amended

|  |  |
| --- | --- |
| Did you notice there were two tabs | Yes |
| Is the information presented in a way you find easy to read | Yes |
| Are you able to find more details on the allergies | Yes |
| Are you able to press on the allergy to view more details | Yes |
| Try to view the map. Did a route show and is it clear? | Yes |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 5 |
| Overall how was the process of navigating through patient details on a scale of 1-5 | 5 |
| Any other comments | No |

**Arrived at patient**

|  |  |
| --- | --- |
| Is it clear what you have to do on this screen? | Yes, |
| Were you able to select both categories successfully? | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | None |

**Second patient test – Without summary of care**

|  |  |
| --- | --- |
| Do you notice the difference compared to the previous view | Yes, tester commented red is a good choice of colour |
| Any other comments | No |

**Security**

**Wait Screen**

The interviewer will ask the tester to lock the account

|  |  |
| --- | --- |
| Is it clear your account has been locked | Yes |
| Are you able to reset the password | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Enter entry code**

The interviewer will give you an entry code ‘test’ to reset your password

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

**Reset password**

The interviewer will explain each password needs to be 8 characters, with an upper case and a number

|  |  |
| --- | --- |
| Is it clear what is required on this screen | Yes |
| On a scale of 1 – 5 how easy was the process | 5 |
| On a scale of 1 – 5 if you had to repeat the task how easy would this be | 5 |
| Any other comments | No |

Thank you for your feedback. We may make changes based on this. Can we contact you again to discuss these?

|  |
| --- |
| Yes |

# Appendix 5 – Website

During the early stages of the project a website was built to create the job for the application, to be used by 999 operators. The website is functional but the code is not fully developed. This section shows the screenshots for the site.

The website can be found at http://homepages.cs.ncl.ac.uk/g.carr/Website/CreateJob.html.

## Screenshot 1 - Create a new job

The 999 operator is presented with a HTML form to enter the incident address, incident details and category. After inputting the address the user presses the search button which takes them to stage 2.

****

Figure 83:Creating a new job

## Screenshot 2 – Locate ambulance drivers and summary of care records

After pressing the search button javascript is used to connect to Google Maps Api to get the distance of available ambulance drivers from the incident is displayed. An SQL statement searches a summary of care database and returns the names of any known people at the given address. The operator will select the appropriate checkboxes (see figure 84).

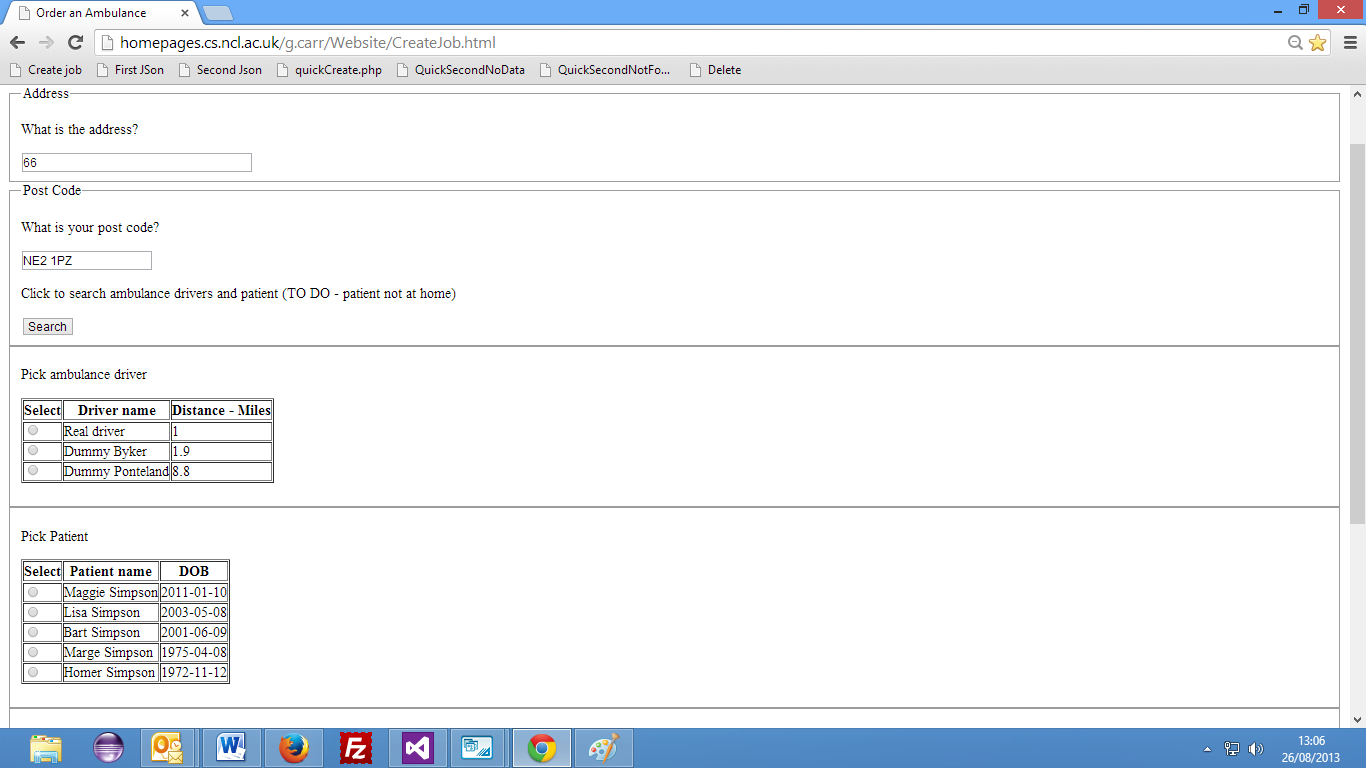


Figure 84: Locating information from Summary of Care database and Google Maps API

## Screenshot 3 – Entering incident details and submitting

The operator chooses a category of conditions and inputs the details of the incident. The operator then clicks submit. A SQL query will get the summary of care details for the patient selected and populate two JSON files, to be read by the application and turned into a job (see figure 85).

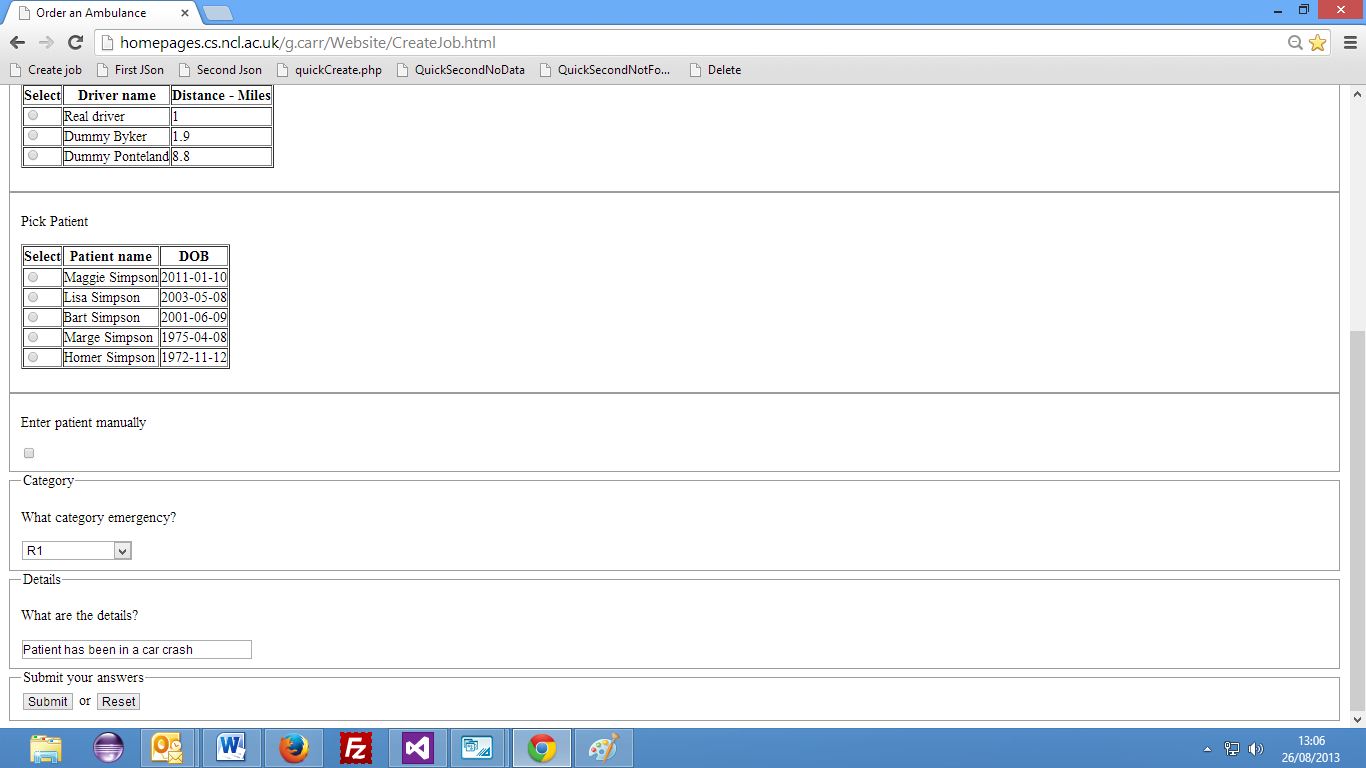


Figure 85: Inputting incident information and submitted job

## Screenshot 4 – Incident details - JSON Object

The details from the HTML are populated onto the JSON object. The latitude and longitude has been obtained from the Google maps API, along with the first route direction for the driver (see figure 86).

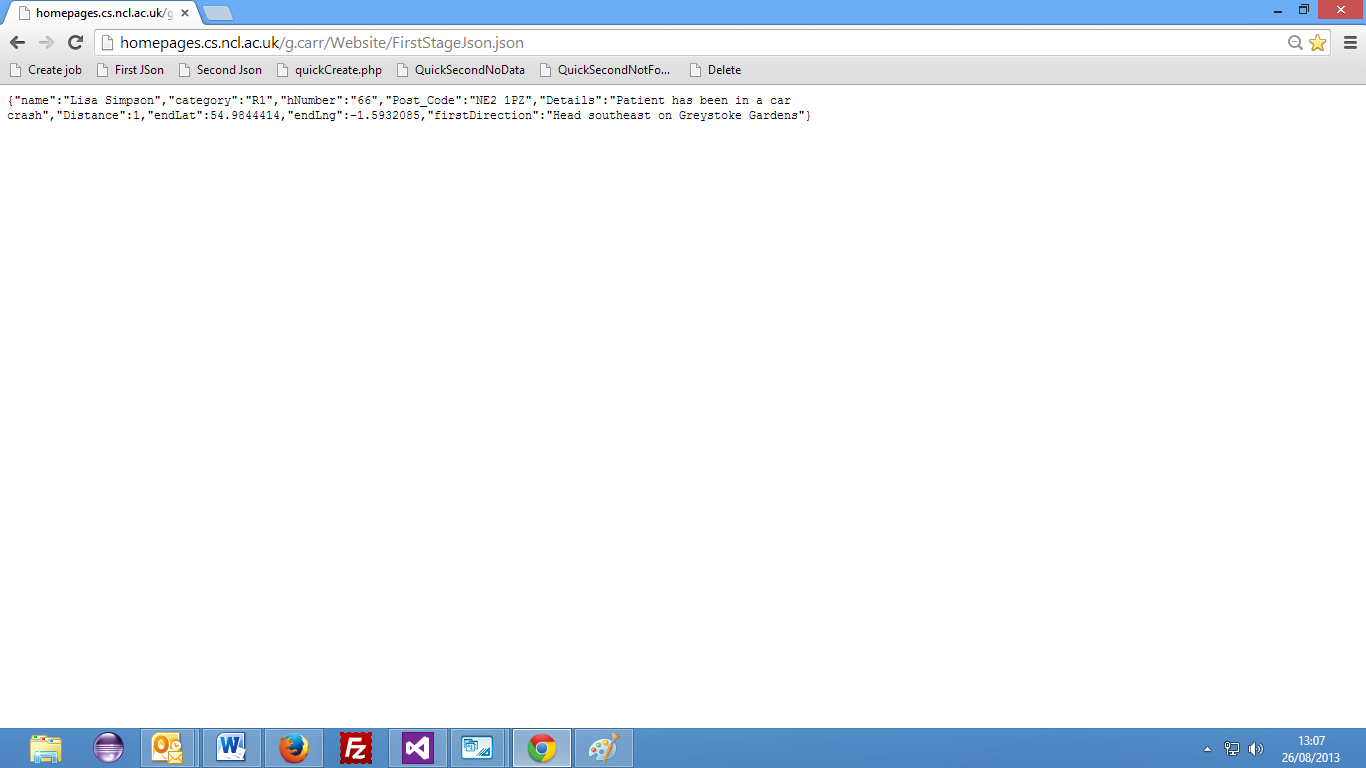


Figure 86: First stage JSON

## Screenshot 5 – Summary of care details - JSON Object

The summary of care details are obtained from the database and then put into a JSON file. Note that in the finished application the summary of care JSON has more information then in the object on figure 87.

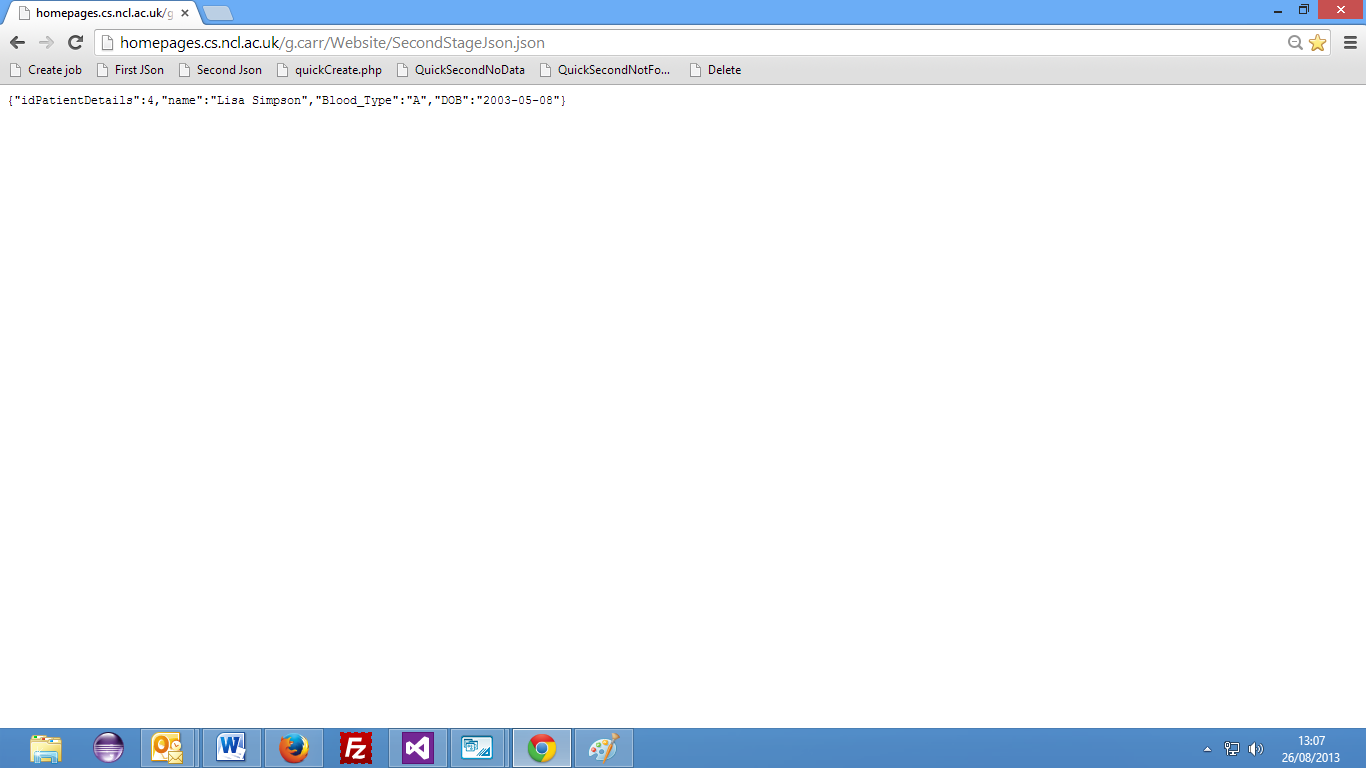


Figure 87:Second stage JSON