WhatsApp on iOS: A Tool For Crime Intelligence Analysis

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Abstract

The analysis of telecommunications data has become ever-more integral to the work of Intelligence Analysts in investigating crimes. The technology, however, is developing beyond the familiar call data records that are obtainable from Call Service Providers and the amount of data produced is rapidly increasing. Instant messaging apps in particular are growing in popularity and potentially could be a preferable form of communication to text messaging. Analysts need to be able to keep up with this technology, and the need to work quickly, accurately and against a backdrop of financial and resource constraints suggests that they require new, affordable tools to help them handle this important information and avoid missing vital evidence.

This dissertation develops a tool that quickly provides an Analyst with statistics based upon the data held within the databases of WhatsApp, running on the iOS operating system. Currently there appear to be no other tools available to law enforcement that carry out this function. With Warwickshire Police Force in the UK as the main case study, the motivation behind this project is the fact that Analysts currently need to work for hours to obtain and organise data from messaging apps before it can be analysed, costing the investigation time and potential leads. Sometimes the value of the information held within these apps is overlooked and there is not a full appreciation of all the evidence they may provide. The author is a former Major Investigations Analyst from Warwickshire Police and current Cybercrime Analyst at Europol, who has worked extensively with telecommunications data.

A tool has been developed that takes the databases of the author's own WhatsApp and runs pre-devised queries against them, producing instant statistics in a report. It also allows the searching of key words against message content. The tool is created using Python and SQLite3 and aims to fulfil key aims and objectives (requirements), namely to be easy to use, accurate and fast and to provide investigative value that previously did not exist or was complicated to implement. The solution has been developed by making use of the '5WH' investigative principles to develop queries of value and has been evaluated by a Focus Group consisting of Analysts and a Senior Investigating Officer.

The final solution has been found to be effective at achieving the main aims and objectives. Possible future development and improvements have been suggested, however, to make the tool even more beneficial.

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1 Introduction

1.1 Background to the Problem

The impact of technological developments on criminal activity has become a common topic of discussion within the law enforcement community in the United Kingdom. Such developments have far-reaching consequences for investigative practices in catching criminals and detecting offences. Of particular note is the concern surrounding the ability of police personnel to deal with crimes with a cyber element, owing to an apparent lack of skills in dealing with the ever-growing array of devices and opportunities that they present to criminals[1]. Furthermore, the National Crime Agency's National Strategic Assessment of Serious and Organised Crime for 2016 tells us that cybercrime is a 'top 5' threat to the UK, indicating the scale of the impact of this developing crime area (NCA, 2016).

The role of Intelligence Analyst has become key to the investigative process in the last fifteen to twenty years. Analysts are the primary members of an investigation team who assess and interpret the whole range of data and information coming into the enquiry. The role of analysis is defined as below in the National Policing Improvement Agency's (NPIA) good practice guide, published in 2008:

> Analysis is the process of collecting, reviewing and interpreting a range of data and making inferences and recommendations. Analysis identifies patterns in information and draws inferences based on what is occurring to allow operational decision makers to decide on appropriate further activity (NPIA, 2008, pg. 10).

Thus, an Analyst's role is to access all available data with a view to drawing the most reliable and objective inferences that ultimately steer investigative direction. Analysis can, in fact, be the key element that identifies suspects and their activity and ultimately secures successful convictions. In late 2014, PA Consulting carried out a study in

[1] "Many police forces cannot show a clear understanding of the threat, harm and risk posed by cybercrime and many personnel are lacking training in this growing crime area, a series of reports have found" (Police Oracle, 2014).

partnership with the National Analyst Working Group (NAWG) in which 185 Analysts from 48 law enforcement organisations across the UK were surveyed; of these, only 30% said that they believed they have the tools and skills necessary to do their jobs effectively in the face of increasing volumes of cyber-related crimes, while 90% agreed that their work leads to operational action (PA Consulting, 2014). This indicates a notable skills deficit amongst Analysts that could have significant implications for the quality and impact of their analyses and the success of the cases they work on. Whilst it is clear that it is imperative for Analysts working in the cybercrime arena to have the necessary skills to deal with cybercrime-related data, it is also clear that those working on the more traditional crime areas will also encounter more and more digital evidence. As PA Consulting state, "the Internet and mobile communications have given rise to new crimes that exist purely in cyberspace, and old crimes whose scale and impact is transformed by the Internet and mobile communications" (PA Consulting, 2014).

In recent years, the data type that has particularly yielded evidential value to traditional crime investigations is communications data from mobile phones. Such data allows the connection of suspects to victims and can help build an evidential picture of conspiracy. It can help develop an understanding of a person's habits and movements as a result of plotting the mobile phone cell sites used by the phone. For example, Operation Cardston (a murder investigation carried out by Warwickshire Police's Major Investigations Unit in 2010) made use of phone evidence to plot a suspect's daily travel habits and placed him in the vicinity of a murder scene. Whilst at the location, he was found to be phoning the second suspect in the case. This produced good circumstantial evidence showing that his presence at the location was unusual and coincided with the offence time, proving crucial to the resulting conviction. Phone data is obtained from the Call Service Provider (CSP) via legal request (compliant with the Regulation of Investigatory Powers Act (RIPA)) where a phone number of interest has been identified and police access to data can be justified. Where the Police have access to a handset and/or SIM card, the Hi-Tech Crime Unit downloads the content and supplies the data to the Analyst. Analysts have regularly utilised this range of data to assist all manner of crime investigations. However, with the growth in the use of smartphones, they are now increasingly being presented with data from communications apps in addition to traditional telecommunications data. As has been highlighted by other researchers, "applications like WhatsApp offer users a free or very low cost alternative to SMS for text

messaging purposes…it is therefore unsurprising that such instant messaging applications have become extremely popular, as a result of which, it is reasonable to expect that more and more cases will involve messages originally sent via such applications" (Walnycky, D. et al, 2015). In a world where messaging apps could predominate over SMS usage (and even call usage owing to their phone call facility), data from CSPs reduces notably in value, as it cannot provide evidence of such calls and texts; obtaining the handset for forensic analysis becomes even more important.

A further key requirement of Intelligence Analysts deployed to operations is to work quickly and accurately. When an investigation begins, the speedy preservation of evidence is often key to its success. The Major Incident Analysis Manual, a good practice guide produced by the National Policing Improvement Agency (NPIA) and the Major Incident Analysis Working Group (MIAWG), specifies that "time pressures can be intrinsic to operational policing and decision making within major investigations. Therefore, it is vital that the Analyst can provide products in a timely fashion, meeting the Senior Investigating Officer's (SIO) requirements" (NPIA, 2006, pg. 10). It therefore follows that the quicker an Analyst can work with the material provided to them, the quicker key information may be found that an investigation team can act upon. It can take a significant amount of time for an Analyst to receive the data they need (due to administration or volume of work), and so where digital evidence is concerned, this can inevitably delay the discovery of key suspects and lines of enquiry. The quicker an Analyst can obtain data and the quicker they can 'cleanse' and formulate that data into a format they can reliably analyse, the better the results of the wider investigation. Furthermore, there is some dependence on the skill of the Analyst to ensure that the most important facts are established first, e.g. who the suspect called immediately before the offence may be more significant than who the suspect generally calls the most often.

The rise in the appreciation of the impact of analysis on successful convictions, along with the continuing development of technology that offers both useful and challenging data to law enforcement, undoubtedly applies more pressure on the skills of Intelligence Analysts in British police Forces. There is an ever-growing need for them to develop the skills to keep up with what is required of them, as highlighted earlier. The College of Policing (which has replaced the NPIA as provider of training to UK law enforcement) has offered two courses for Analysts in recent years that deal with

telecommunications and Internet evidence; these are the 'Core Skills in Communications Data' course and the 'Communications Data Analyst' course. Currently it is offering the 'Communications Data Investigation' course and the 'The Evolving World of Communications Data – Challenges for Investigative Teams' course, all of which appear suitable for Analysts (College of Policing, 2017). However, all Forces nationwide have suffered significant financial cuts since 2010, which has inevitably impacted training budgets at a time when, in fact, it could be argued that training for Analysts is most valuable and needed. Such courses are not compulsory for Analysts and come at a cost to Forces, so there is no guarantee that every Analyst will be able to attend such training.

An Intelligence Analyst is, therefore, a significant and key member of an investigation team with a need to work quickly and accurately, understanding all available data and information, in order to drive and direct decision-making processes and lines of enquiry. The growth of instant messaging apps as a major communication method means that handset data is becoming more and more important to investigations and may very soon supersede traditional phone data in terms of its value. For this reason, Analysts need to access and extract key findings and evidence from these datasets in an efficient manner.

1.2 Case Study: Warwickshire Police, UK

Warwickshire Police (now involved in a Strategic Alliance with the neighbouring Force, West Mercia Police, as a result of economic constraints[2]) is a small Force in the centre of England. Intelligence Analysts within the Force support a range of criminal investigations and typically come from Social Science and Criminology backgrounds (as well as other disciplines with an analytical element). As such, they are not traditionally required to have computer skills beyond the use of standard software applications and analytical tools (such as data mining and Geographical Information systems). Emphasis during recruitment is placed on analytical ability and training with the correct software tools is implemented once employed. This skillset is typical amongst Analysts across

[2] The Strategic Alliance involves the two Forces collaborating and sharing resources. Some functions have been amalgamated to save money and be more efficient. In effect, the two Forces work now as one Force, whilst outwardly maintaining their individual identities (Warwickshire Police, 2017).

other Forces in the country as well.

As a result of financial cutbacks, the number of Analysts in Warwickshire are considerably fewer than pre-2010, reduced by more than half. Analysts particularly report that the analysis of telecommunications data is in increasingly high demand, despite the fewer resources to properly work with this data. Investigators not only find themselves having to deal with such data more often, but positive analytical contributions result in Investigators being more keen for the support of an Analyst for their cases. With respect to phone handset and SIM card downloads, the normal procedure was that the Hi-Tech Crime Unit would download the data using UFED equipment and send an Excel spreadsheet to the Analyst containing the recovered data. It is now the case that the Hi-Tech Crime Unit are so busy and overworked with the number of devices they receive that they now send a CD to the Analyst containing all recovered data and the Analyst is required to use UFED software themselves to download the data into an Excel spreadsheet, which can take hours depending on the amount of data. Excel is the only format that the Analysts can use to analyse this data and they are unable to make use of the data in the original format they receive it in (due to skills and available software). Furthermore, the data now arrives on Blu-Ray discs instead of standard CDs as a result of the sheer volume of data that is now being recovered from modern smartphones (including the vast amount from instant messaging apps). In the absence of an Analyst due to resource limitations, investigators are forced to rely upon the reading of printed versions of handset downloads, greatly missing out on the value an Analyst can bring to their investigation.

The Excel files available to the Analyst contain the list of contact numbers (name, number and index reference) and message text with date and time. In other words, the data they are currently receiving is very limited.

Warwickshire Police now has use of a system that cleanses CSP phone data, saving the Analyst the time that would usually be spent doing this before most analysis can begin. This system also can produce a ‘top contacts’ chart, a statistic that is said to have proven useful both to Analysts and also to Investigators who are interested in a quick answer to this question. However, this system does not deal with data from handsets or instant messaging apps.

As explained in section 1.1, Analysts often have to work at a fast pace; therefore, there is some pressure on Analysts to draw quick inferences from this ever-increasing amount of data that they receive. Nowhere is this more relevant than in the Major Investigations Unit, where all murders and other serious offences in the Force are investigated. An Analyst in this environment not only needs to attend frequent briefings to share their findings (at a time in the investigation where lines of enquiry can develop and change by the hour) but also needs to prioritise and cleanse data quickly to seek answers to the most pressing questions. Sometimes there are no shortcuts and key findings simply cannot emerge for several days, until the necessary work has been done. Cutting corners could even lead to 'false positives' that can send investigations in a wrong direction. Therefore, there must always be a balance between speed and accuracy.

Of further interest is the case of Operation Lakenheath in 2009. This was a complex investigation that involved the possible use of a hitman to intimidate and cause serious injury (albeit not death) to a victim who was found to be involved in criminal activities and had several identified enemies. An inexperienced Analyst was initially deployed to this case and was found to have failed to search for key evidence in telephone data. That is, the Analyst failed to check phone activity that occurred around the time of the offence itself, instead only identifying top contacts and requesting subscriber checks to be carried out on those numbers. This basic error could have cost the investigation dearly, but is something that can happen when an Analyst is unfamiliar with the type of criminality and environment they are working in. Combined with poor guidance and leadership, or even lack of confidence to take the lead on the analysis, it is clear that such 'human error' can limit the effectiveness of investigations. Such an example is by no means limited to this one law enforcement agency and it therefore indicates how a system that assists an Analyst could potentially reduce room for such errors by ensuring that some basic data queries are done as a matter of course.

1.3 Outline of Research Topic

Given the nature of an Analyst's work and the increasing dependence on data from instant messaging apps, it is considered that Analysts working on crime investigations require more efficient ways of working with such vast amounts of data. The old ways of working with Excel may have once been appropriate for basic call, text and cell site data

obtained from CSPs, but they simply may not be effective or timely enough to provide all the answers held within complex app databases. Analysts also inherently do not have the technical computer skills to necessarily develop their own better ways of working with such data.

It is suggested that Analysts could benefit from a solution to improve the speed and accuracy with which they can access the evidence held within instant messaging app databases, and also provide them with evidential facts that they may not be able to access from those apps using current methods. In the face of an increasing amount of data to work with but a reduced workforce, it is suggested that Analysts will be ever more in need of such solutions. Also, given the reduced budgets in UK policing today, it cannot be expected that Analysts will receive extensive training to improve their technical skills. Even if recruitment requirements change to encompass technical skillsets, there remains a large pool of Analysts without technical computer skills who still will need practical ways to understand technical data as its impact on crime continues to grow.

This research project intends to develop a tool that takes the databases of apps (extracted during the handset download process), runs a series of defined queries against them and produces an output for Analysts to quickly assess and use in their work. Such an output could be used to inform inferences in conjunction with a wide range of other data and could also be reported quickly, such as during urgent briefings to investigation teams. The output could also assist Senior Investigators in cases where an Analyst is not readily available to provide in-depth or dedicated assistance. Such a tool would need to be very easy to use and fast (requiring limited technical computer knowledge) and be evidentially sound (should results need to be presented in evidence in court proceedings).

2 Review of the Literature

A review of the literature has revealed that there have been studies into instant messaging forensics and also the development of systems to assist instant messaging forensics. Additionally, there have been studies centred upon the needs and requirements of systems to make the work of Intelligence Analysts easier and more efficient. Some work has also been done to create systems that assist Analysts in working with telecommunications data.

Several research studies have examined the forensic artefacts that can be obtained from instant messaging apps, with a particular interest in WhatsApp running on Android devices (Anglano, 2014, Walnycky *et al*., 2015, Anglano *et al*., 2016, Thakur, 2013 and Sahu, 2014). Anglano (2014) and Walnycky *et al*. (2015) both delve into the kinds of information of forensic value that can be found within instant messaging databases that could be of relevance to criminal investigations. Anglano (2014) focuses on WhatsApp data on Android while Walnycky *et al*. (2015) explore several instant messaging apps and explain the data that they discover. These studies offer a useful oversight into how these databases store data and the value that the information contained within could potentially have for intelligence analysis. They do not, however, explore the development of ways to make this data more accessible to the investigator.

There have also been several projects in which there have been attempts to develop systems to assist the forensic process where messaging apps are concerned. Karpisek *et al.* (2015) looks at WhatsApp network forensics, focusing on understanding WhatsApp call signalling messages. This looks at a different aspect of WhatsApp forensics than intended by this project, but develops a command-line tool written in Python that converts a Wireshark file into a report to assist the law enforcement community in visualising the results of the analysis. The project that is subject of this dissertation intends to develop a similar tool, but one that utilises the WhatsApp databases on the handset as opposed to network data. Alzaabi *et al.* (2015) consider human limitations in the forensic analysis process and note that the comprehension of increasingly complex data can be dependent on the experience of the Investigator. As such, they determine that automated techniques can be used to help the Investigator analyse data quicker and more efficiently. Their project developed “Forensic-Driven Ontologies for Smartphones (F-DOS)”, a system which models the environment of a

smartphone through a set of concepts and their relationships, e.g. the relationship between a contact and the messages that relate to it (Alzaabi *et al.*, 2015, p. 106). This research was focused on smartphone content as a whole and a way to visualise that. It was, however, also motivated by the idea of improving efficiency and countering the issue of Investigator inexperience, a major motivator in the project of this dissertation. Miller (2008) specifically discusses a system designed to automate the analysis of crime data, which has been in use by some Police Departments in the US. The system, known as 'COPLINK CompStat Analyser', allows the mapping of data so that police can see, for example, where resources need to be focused. Traditionally, this is a function carried out by an Intelligence Analyst (such as by mapping crime data to see where hotspots in offending exist). This system consequently makes such analysis more readily available, reduces staff numbers and decreases the time required to produce such analyses. Such a system does not deal with forensic data, but again highlights the significance of greater efficiency to law enforcement activity.

There have also been several studies looking specifically at the needs of Intelligence Analysts and the issues they face in analysing data. An article in Law Enforcement Technology journal (author unnamed) states that Investigators and Analysts are in need of faster and more accurate ways of working, owing to the huge and varied amounts and sources of data they now need to handle. As it highlights, "missing data can mean the difference between catching the bad guy or not" (Law Enforcement Journal Technology, 2013). It stipulates that data management systems that assist the Analyst are very much needed. Undoubtedly, the more data involved, the greater the risk that an Analyst may miss something of relevance. Improved systems help to minimise this. Additionally, Chaflawee (2015) discusses the increasing importance of analytics in law enforcement and states that "when time is of the essence, analytics applications can have a profoundly positive effect on the outcome of an incident" (Chaflawee, 2015, p. 1). The US Department of Justice's Global Justice Information Sharing Initiative produced a report that defines the tools that an Intelligence Analyst needs in order to "effectively and efficiently perform their duties and produce meaningful and useful intelligence products" (Global Justice Information Sharing Initiative Working Group, 2007). Amongst these tools, they state that statistical analysis software is important:

> This software enables the user to create descriptive statistics, which in turn allows for the summarisation and analysis of qualitative and quantitative data, using calculations such as frequency, percent change, mean, median, mode, and measures of variance (SD and SE) (Global Justice Information Sharing Initiative Working Group, 2007, pg. 7).

Furthermore, they specify that Communications/Telephone Record software is needed that aids with understanding times, dates, sequences and patterns in relation to call data. They further state that "with advancements in communications technologies – such as e-mail [and] instant messaging (IM)…software packages should be capable of dealing with non-traditional communications data elements…" (Global Justice Information Sharing Initiative Working Group, 2007, pg. 8). This highlights again that systems that perform certain standard functions can assist the Analyst in their work, improving efficiency (and particularly in relation to communications data). It supports the aims of this project to produce a system that offers the Analyst a 'statistical' view of the data of instant messaging apps, so assisting the speed and efficiency of their analyses.

A study entitled 'Top Ten Needs for Intelligence Analysis Tool Development' also came up with a list of the type of systems Analysts could benefit from, based upon work with a focus group of Intelligence Analysts in the US (Badalamente and Greitzer, 2005). They explain that at the time of the study, "ongoing research efforts seek technology-based solutions to reduce the Analyst's workload and improve the throughput and quality of IA [Intelligence Analysis] products" (Badalamente and Greitzer, 2005, pg. 1). One of their ten identified system types was that of 'dynamic data processing and visualisation' – a tool that visualises data for the Analyst. Whilst this is a generalisation, it is again in line with the concept that systems that speed up and assist the Analyst in the understanding of data are very much desired amongst the analysis community.

A search online has revealed a company in the UK (called Forensic Analytics) that produces software for Analysts that cleanses and organises telecoms data from CSPs for the Analyst (Forensic Analytics, 2017). It can also generate a list of the top numbers called and runs some standard queries to generate results to common questions instantaneously. The software is called Cell Site Analysis Suite. Therefore, it is clear that software that helps with the analysis of data from service providers is commercially available, but the software does not deal with data from messaging apps

or indeed any other data from mobile phone handsets. There still appears to be a lack of widely available solutions for this. The described software notably runs queries in the same way as would be intended with this dissertation project, in order to assist Analysts in their work.

Whilst there has been research into messaging app forensics and also research into the requirements of Analyst systems, there does not appear to have been any research or systems developed to assist the Analyst with understanding messaging app data in a more efficient way. What is clear is that there is a consensus that tools that make both the work of an Analyst easier (and therefore results more reliable and effective) are indeed greatly needed in an environment of increasing volume and complexity of data.

3 Research Question

3.1 Aims and Objectives

This dissertation intends to develop a system that is easy for an Intelligence Analyst (as the end user) to use to access and understand instant messaging application data quickly and efficiently. The system will take the SQLite databases of WhatsApp, run a series of set queries against them and produce some output for the Analyst to interpret, assisting their analyses. It should achieve the following:

- It should require minimal technical expertise and minimal input from the user to assist their work effectively;
- It should produce accurate and fast results, so ensuring that time required to make analyses is kept to a minimum, allowing the Analyst to efficiently prepare for briefings and to be able to update Senior Investigators promptly, particularly in situations where life may be at risk;
- It will not substitute thorough analysis of data to understand complex and unique problems, but it will aim to execute standard queries that answer key questions quickly, assisting an Analyst to understand meanings within the data without the need to cleanse and normalise it first. Thus, it will contribute towards the analysis of complex and unique problems. It may also prompt further analytical thought processes and hypotheses;
- It will ensure that, via the standard queries, these specific searches are always carried out and therefore not missed by the Analyst, so improving efficiency;
- It should also be suitable for an Investigator to use in situations where an understanding of the contents needs to be obtained quickly to assist immediate operational decisions.

3.2 Rationality for Focus

WhatsApp has been chosen due to discussions that suggest it is the most popular messaging app at the time of writing. According to research carried out by similarweb.com (which looked at the most popular apps on the Android platform), WhatsApp was the world leader; it was the most used app in 109 countries (55.6% of the

world) when the research was published in May 2016 (SimilarWeb, 2016). Figure 1 (below) shows the findings of this research:

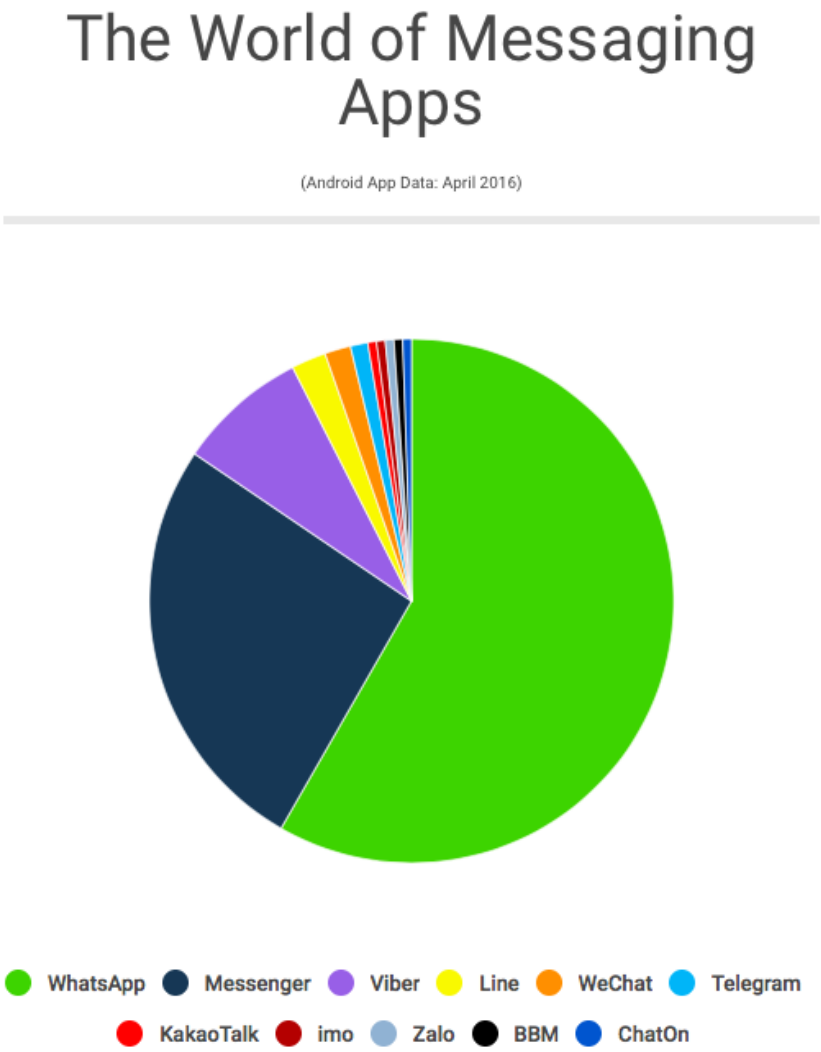

Figure 1: Top Messaging Apps Worldwide (April 2016) – Source: similarweb.com, 2016

Furthermore, several other researchers have chosen the app based on their own research into app popularity, concluding that WhatsApp is indeed one of the most commonly used (Anglano 2014, Karpisek *et al.* 2015, Thakur 2013). Android and iOS are also the two most common platforms in use today.

The research will focus on WhatsApp on the iOS platform. This is primarily due to the availability of databases. Given that such databases contain a lot of personal and private information, obtaining them for research purposes is difficult. The same can be said for those held by law enforcement that are related to investigations – these are operationally restricted and cannot be used in research such as this. Therefore, the writer's own WhatsApp databases will be used for the study, which are on the iOS platform. Whilst this is clearly a limitation, the advantage is that not only does it provide a set of 'real' data (as opposed to fake data), but the data is also known to the author. Therefore, this may make understanding the meaning of fields and content in the databases easier with less interpretation required.

4 Adopted Approach

4.1 Intended Approach

In order to meet the aims and objectives set out in the previous section, it is intended to produce a script using Python that runs SQL queries against the WhatsApp databases automatically and then produces the results as a text file. It is important that all queries can be run against the WhatsApp data of any iOS device. The user would simply run the Python script from the Command Line and would then see a message telling them that the analysis was successful and what the name of the outputted report is so that it can be located. The results in the text file will be comma delimited; it should be easy enough to read if printed out as it is or can be pasted by the Analyst into Excel and easily split into columns. The benefits of this are that the data can then be combined with other data, or charts can easily be produced.

It is also considered that a second Python script would be useful that allows the user to search the text message content for key words of interest to them. It should prompt the user to input a word and again, turn the results out into a text file and inform the user of such. Ordinarily, an Analyst would need to search using the 'find' function against all the messages in Excel format, for example, in order to carry out the same procedure. Any messages of interest would then have to be copied and pasted to take to a briefing. This, on the other hand, would quickly produce a simple, instant report that can be printed straight away. Another advantage of this is that an Investigator can ask an Analyst (even over the phone) to check for a key word and relay information back instantly, which is especially relevant in a fast-paced inquiry or a crime-in-action situation.

4.2 Obtaining Databases for Research

In order to develop the solution, it is necessary to extract the relevant databases from a mobile phone handset in order to have some test data. The databases required are:

- ChatStorage.sqlite
- Contacts.sqlite

These are the databases of interest in iOS devices. They are to be extracted from an iPhone 6 Model A1586 using Cellebrite Physical Analyzer running on a laptop. The extraction will be done by a qualified law enforcement forensic investigator. Only data relating to Instant Messaging will be downloaded directly onto a 32GB USB stick and then, using the software, the relevant databases will be extracted from the file system for analysis.

Cellebrite Physical Analyzer is a law enforcement tool and as such, it overcomes the issue of the encryption of the WhatsApp databases, a problem that would be encountered by using other independent methods. It also ensures the forensic integrity of the data, as you would expect in a real-life investigation. It is also logical to use this method, given that Analysts would typically obtain data from this method of extraction or very similar.

4.3 Method of Evaluation

In order to determine the success of the completed solution, it will be assessed against the aims and objectives set out in section 3. A Focus Group consisting of two Analysts from Warwickshire Police and one Analyst from Europol (who all work with, and have experience of working with telecommunications data) will also be asked to evaluate the system and results in terms of the key aims of this project. In addition, a Warwickshire Police Senior Investigator will also be asked to review the solution from their perspective, as someone who directs Analysts but also who could potentially use the tool themselves. They will be asked to assess it in terms of the following:

a. Ease of use;
b. Speed and accuracy;
c. The contribution the tool can make to their daily work and how it could improve what they already do;
d. Any limitations they can foresee.

4.4 Anticipated Limitations

The key and obvious limitation of the final solution is that it cannot currently be tested in a live investigative environment. This is due to the author currently not being directly involved in any ongoing operations utilising WhatsApp data and also because

data obtained for operational purposes is restricted. Whilst it would in theory be possible for Analysts within Warwickshire Police to run and test the system during their own active investigations, the background applications of Python and SQLite3 would need to be made available on corporate systems and authorisation would be required at a senior level. It is not anticipated, as a result of discussions with the necessary parties, that this could be achieved within the necessary timescales. Consequently, the Analysts will be asked to review the system in terms of the test database.

A further obvious limitation is that, with access to the data of only one handset, it is not possible to test against a variety of handsets. However, it is considered that carefully considered queries will work with any handset. For example, a query that shows contact numbers and names and the user's nickname as set by themselves should work well on any handset due to the fact that every database on iOS is structured the same. The main disadvantage of using only one database is the potential absence of any more unusual data, which consequently won't be detected.

Finally, the solution is only to be developed for iOS and not for Android. This is equally possible, but would require access to an Android database. As a result, at this time the tool would only help Analysts to analyse iOS data. If the solution is successful and considered valuable, this could be a future development.

5 Description of Results

5.1 Identifying Potential Evidence in WhatsApp

Having identified databases that can be used in the development of the solution, it is necessary to identify exactly what queries the system should perform in order to extract and show the most important information and statistics. The first step in this process is in understanding what evidence WhatsApp may hold for any given case.

When investigating a crime, there are five elements that need to be considered with regards to key evidence and developing hypotheses. These are known as the five WHs (5WH) in the United Kingdom. These are also taught to Analysts on the National Intelligence Analysis Training (NIAT) that is delivered in the UK to Police Analysts. 5WH are:

1. WHO?
2. WHY?
3. WHEN?
4. WHERE?
5. HOW?

In order to begin developing the queries, these keys areas have been considered in terms of the kind of evidence that data from WhatsApp could hold for any given case. This has been done using a technique known as ‘starbursting’, an idea generation technique suggested by Heuer and Pherson in their book ‘Structured Analytic Techniques for Intelligence Analysis’ (Heuer and Pherson, 2011). This has resulted in the diagram shown in figure 2. It is considered that the key points identified here in relation to each of the 5WH should be the basis of the queries. For example, ‘suspect/victim relationship’ has been identified as a key point; this means any information within the WhatsApp database that could provide evidence or leads in relation to this subject are important, and therefore queries should be developed to extract this information.

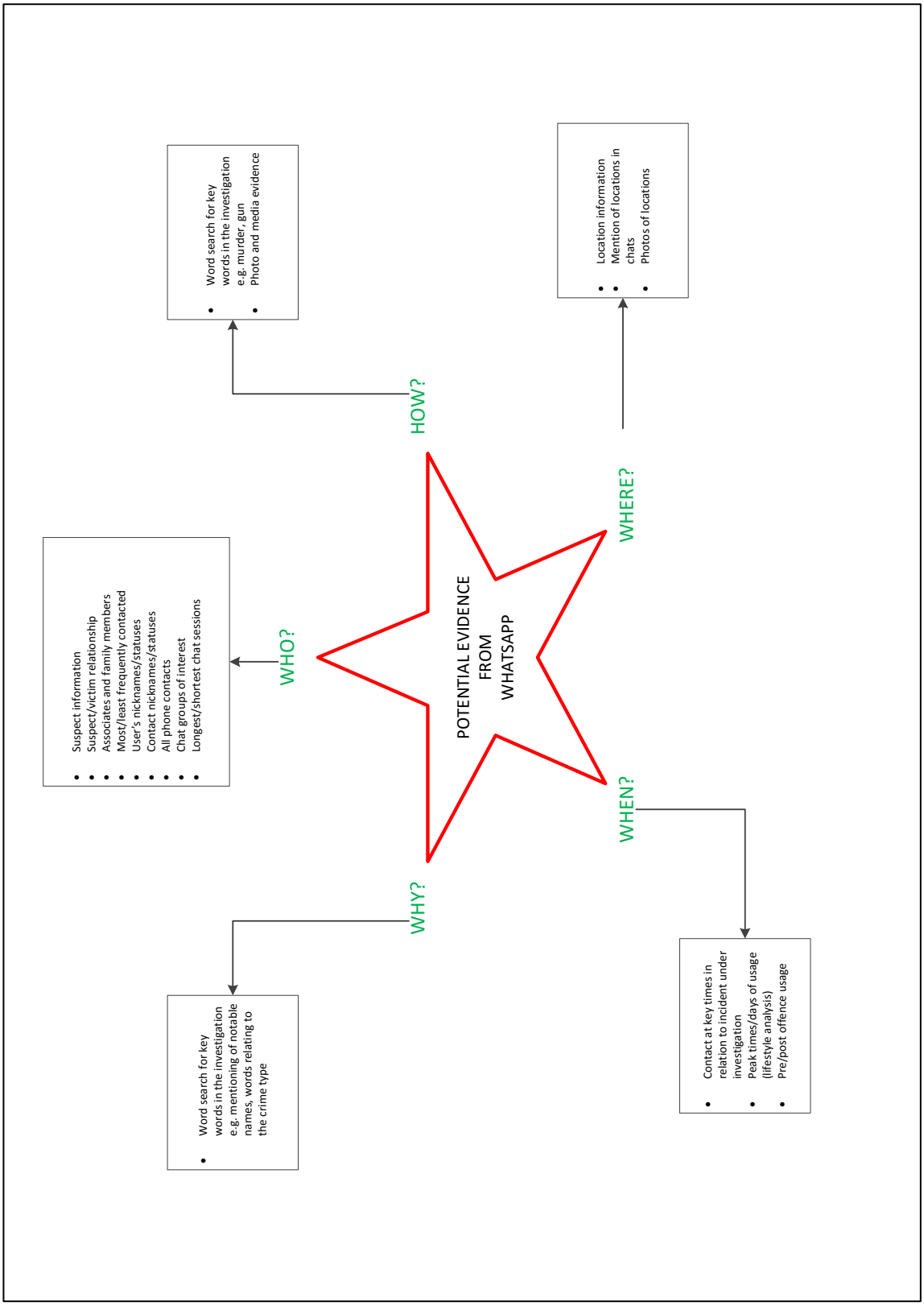

Figure 2: Potential Evidence from WhatsApp – Idea Generation

5.2 Developing Queries to Perform

Having obtained the databases for analysis, the program 'DB Browser for SQLite' has been used to view the structure of the databases, described in section 4.4.1 below. This allows an understanding of what information is contained in the databases and how tables are related to each other. Using this, the queries that the system will perform have been developed and tested to ensure that they all work correctly and yield the correct results. These are shown and described in sections 5.2.2, 5.2.3 and 5.2.4, along with how they relate to the findings from the 5WH idea generation carried out in the previous section (i.e. what investigative value they offer).

5.2.1 Database Structure

In order to develop the queries, the table schemas need to be understood alongside the identified 5WHs. Figure 3 below shows the tables in the Contacts.sqlite database that have been identified as containing data of interest and the fields they contain. The primary keys are highlighted, along with how these link to foreign keys in other tables (and thus link the tables together). Linked keys are shown in the same colours. Also shown is the data type for each field. Three tables were identified as holding data of interest:

ZWACONTACT	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZABUSERID	INTEGER
ZSORT	INTEGER
ZPARENT	INTEGER
ZSECTION	INTEGER
ZLASTMODIFIEDDATE	TIMESTAMP
ZFIRSTNAME	VARCHAR
ZFULLNAME	VARCHAR
ZHIGHLIGHTEDNAME	VARCHAR
ZIDENTIFIER	VARCHAR
ZINDEXNAME	VARCHAR
ZNICKNAME	VARCHAR
ZTOKENS	BLOB

ZWAPHONE	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZSPOTLIGHTSTATUS	INTEGER
ZCONTACT	INTEGER
ZFAVORITE	INTEGER
ZSTATUS	INTEGER
ZLABEL	VARCHAR
ZPHONE	VARCHAR
ZWHATSAPPID	VARCHAR

ZWASTATUS	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZCALLABILITY	INTEGER
ZENCRYPTIONCAPABLE	INTEGER
ZENCRYPTIONV2CAPABLE	INTEGER
ZPHONE	INTEGER
ZDATE	TIMESTAMP
ZPICTUREDATE	TIMESTAMP
ZPICTUREID	VARCHAR
ZPICTUREPATH	VARCHAR
ZTEXT	VARCHAR
ZWHATSAPPID	VARCHAR

Figure 3: Tables of Interest (Contacts.sqlite)

Likewise, figure 4 below shows all the tables of interest in relation to the ChatStorage.sqlite database. In total, nine tables appear to contain useful data:

ZWACHATSESSION	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZARCHIVED	INTEGER
ZCONTACTABID	INTEGER
ZFLAGS	INTEGER
ZHIDDEN	INTEGER
ZIDENTITYVERIFICATIONEPOCH	INTEGER
ZIDENTITYVERIFICATIONSTATE	INTEGER
ZMESSAGECOUNTER	INTEGER
ZREMOVED	INTEGER
ZSESSIONTYPE	INTEGER
ZSPOTLIGHTSTATUS	INTEGER
ZUNREADCOUNT	INTEGER
ZGROUPINFO	INTEGER
ZLASTMESSAGE	INTEGER
ZPROPERTIES	INTEGER
ZLASTMESSAGEDATE	TIMESTAMP
ZLOCATIONSHARINGENDDATE	TIMESTAMP
ZCONTACTIDENTIFIER	VARCHAR
ZCONTACTJID	VARCHAR
ZETAG	VARCHAR
ZLASTMESSAGETEXT	VARCHAR
ZPARTNERNAME	VARCHAR
ZSAVEDINPUT	VARCHAR

ZWAMESSAGE	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZCHILDMESSAGESDELIVEREDCOUNT	INTEGER
ZCHILDMESSAGESPLAYEDCOUNT	INTEGER
ZCHILDMESSAGESREADCOUNT	INTEGER
ZDATAITEMVERSION	INTEGER
ZDOCID	INTEGER
ZENCRETRYCOUNT	INTEGER
ZFILTEREDRECIPIENTCOUNT	INTEGER
ZFLAGS	INTEGER
ZGROUPEVENTTYPE	INTEGER
ZISFROMME	INTEGER
ZMESSAGEERRORSTATUS	INTEGER
ZMESSAGESTATUS	INTEGER
ZMESSAGETYPE	INTEGER
ZSORT	INTEGER
ZSPOTLIGHTSTATUS	INTEGER
ZSTARRED	INTEGER
ZCHATSESSION	INTEGER
ZGROUPMEMBER	INTEGER
ZLASTSESSION	INTEGER
ZMEDIAITEM	INTEGER
ZMESSAGEINFO	INTEGER
ZPARENTMESSAGE	INTEGER
ZMESSAGEDATE	TIMESTAMP
ZSENTDATE	TIMESTAMP
ZFROMJID	VARCHAR
ZMEDIASECTIONID	VARCHAR
ZPHASH	VARCHAR
ZPUSHNAME	VARCHAR
ZSTANZAID	VARCHAR
ZTEXT	VARCHAR
ZTOJID	VARCHAR

ZWAPROFILEPICTUREITEM	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZREQUESTDATE	TIMESTAMP
ZJID	VARCHAR
ZPATH	VARCHAR
ZPICTUREID	VARCHAR

ZWAGROUPINFO	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZSTATE	INTEGER
ZCHATSESSION	INTEGER
ZLASTMESSAGEOWNER	INTEGER
ZCREATIONDATE	TIMESTAMP
ZSUBJECTTIMESTAMP	TIMESTAMP
ZCREATORJID	VARCHAR
ZOWNERJID	VARCHAR
ZPICTUREID	VARCHAR
ZPICTUREPATH	VARCHAR
ZSOURCEJID	VARCHAR
ZSUBJECTOWNERJID	VARCHAR

ZWABLACKLISTITEM	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZJID	VARCHAR

ZWAMEDIAITEM	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZCLOUDSTATUS	INTEGER
ZFILESIZE	INTEGER
ZMEDIAORIGIN	INTEGER
ZMOVIEDURATION	INTEGER
ZMESSAGE	INTEGER
ZASPECTRATIO	FLOAT
ZHACCURACY	FLOAT
ZLATITUDE	FLOAT
ZLONGITUDE	FLOAT
ZMEDIAURLDATE	TIMESTAMP
ZAUTHORNAME	VARCHAR
ZCOLLECTIONNAME	VARCHAR
ZMEDIALOCALPATH	VARCHAR
ZMEDIAURL	VARCHAR
ZTHUMBNAILLOCALPATH	VARCHAR
ZTITLE	VARCHAR
ZVCARDNAME	VARCHAR
ZVCARDSTRING	VARCHAR
ZXMPPTHUMBPATH	VARCHAR
ZMEDIAKEY	BLOB
ZMETADATA	BLOB

ZWAPROFILEPUSHNAME	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZJID	VARCHAR
ZPUSHNAME	VARCHAR

ZWAGROUPMEMBER	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZCONTACTABID	INTEGER
ZISACTIVE	INTEGER
ZISADMIN	INTEGER
ZSENDERKEYSENT	INTEGER
ZCHATSESSION	INTEGER
ZRECENTGROUPCHAT	INTEGER
ZCONTACTIDENTIFIER	VARCHAR
ZCONTACTNAME	VARCHAR
ZFIRSTNAME	VARCHAR
ZMEMBERJID	VARCHAR

ZWAMESSAGEDATAITEM	
Z_PK *(PRIMARY KEY)*	INTEGER
Z_ENT	INTEGER
Z_OPT	INTEGER
ZINDEX	INTEGER
ZOWNSTHUMBNAIL	INTEGER
ZTYPE	INTEGER
ZMESSAGE	INTEGER
ZDATE	TIMESTAMP
ZCHATJID	VARCHAR
ZCONTENT1	VARCHAR
ZCONTENT2	VARCHAR
ZMATCHEDTEXT	VARCHAR
ZSECTIONID	VARCHAR
ZSENDERJID	VARCHAR
ZSUMMARY	VARCHAR
ZTHUMBNAILPATH	VARCHAR
ZTITLE	VARCHAR

Figure 4: Tables of Interest (ChatStorage.sqlite)

5.2.2 Queries Against the Contacts.sqlite Database

This database contains the contact phone numbers of the user's WhatsApp contacts, as well as all the contacts on the phone regardless of whether they use WhatsApp or not. It provides the opportunity to get a clear, quick picture of who the user's associates are, so answering several of the 'Who' areas in relation to the evidence. The below three queries will be run against this database:

Query 1: To list all contacts on the phone:

```
SELECT ZWACONTACT.ZFULLNAME, ZWAPHONE.ZPHONE, ZWAPHONE.ZLABEL

FROM ZWACONTACT, ZWAPHONE

WHERE ZWACONTACT.Z_PK = ZWAPHONE.ZCONTACT;
```

This query gives an immediate overview of all contacts, showing their full name as stored in the phone, their number and also the label given to it (i.e. home, work, mobile etc) in the subject handset. This immediately shows who the user is associated with and may give an indication of family members (e.g. numbers stored as 'mum'). It may be possible to get an instantaneous impression of whether the user is linked to a person of interest, or allows the identification of previously unknown persons of interest.

Query 2: To list all WhatsApp contacts and their numbers:

```
SELECT ZWACONTACT.ZFULLNAME, ZWAPHONE.ZPHONE

FROM ZWACONTACT, ZWAPHONE

WHERE ZWACONTACT.Z_PK = ZWAPHONE.ZCONTACT AND
ZWAPHONE.ZFAVORITE IS NOT NULL;
```

This query shows only those contacts that are WhatsApp contacts. This is ensured by the criteria "is not null" for the ZFAVORITE field in the ZWAPHONE table (which contains no value if the contact is not a favourite). In WhatsApp, all WhatsApp contacts are listed as favourites. This is of further use in addition to the initial list as it shows which numbers we can expect to find contact with in the databases. It may also provide an indication of what other phones could contain valuable evidence. For example, if we

see a known drug dealer's number in the WhatsApp contacts, we get a clue that they are using a smart phone and may wish to prioritise the download of this handset above others should it come into our possession. It even gives a clue that we should be looking for a smart phone in any searches of that person or their property.

Query 3: To show each contact's status text in WhatsApp (as set by themselves), along with the file path to their profile photo and the time and date they set the photo:

```
SELECT ZWAPHONE.ZPHONE, ZWASTATUS.ZTEXT,
ZWASTATUS.ZPICTUREPATH, DATETIME(ZPICTUREID, 'unixepoch')

FROM ZWAPHONE, ZWASTATUS

WHERE ZWAPHONE.Z_PK = ZWASTATUS.ZPHONE;
```

The results of this query provide more identifying information in relation to the user's associates. Photos and status text could offer clues as to who these people are and assist with their identification. This information, in combination with the actual conversations, could prove to be powerful evidence when it comes to phone number attribution. Such information can be combined with call records obtained from service providers, particularly subscriber information. The query results show the picture path which, using the full download of the phone, can be located easily. The ZPICTUREID field gives us the date the picture was set - the query converts the date and time into UTC (human-readable) format. This date and time could have some evidential relevance at some point during the investigation.

5.2.3 Queries Against the ChatStorage.sqlite Database

This database contains a lot more information than the Contacts.sqlite database, detailing all the chats, groups and message text. Consequently, it is possible to do a greater number of useful queries against this database than the Contacts.sqlite database.

Query 1: To show the name of the contact or chat (as stored in the phone) and the number of messages exchanged with the phone under examination. Results are listed in order of most frequently contacted first:

```
SELECT ZPARTNERNAME, ZCONTACTJID, ZMESSAGECOUNTER
```

```
FROM ZWACHATSESSION

ORDER BY ZWACHATSESSION.ZMESSAGECOUNTER DESC;
```

The ZWACHATSESSION table, which this query uses, has a field that shows the total number of messages exchanged between the phone and the other participant in the conversation (or the total number of messages exchanged in a chat group). These results immediately show the Analyst the most active chats, which can be significant in the early stages of an investigation in identifying key associates and family members. The phone numbers can be seen within the WhatsApp ID. It would ordinarily take the Analyst some time to discover these findings, as they would need to cleanse and normalise the data and perform pivot table operations on it (usually in Excel) before this information can reliably be known. The query orders the results in descending order, with the most active chat first (as can be seen by the 'ORDER BY' operation in the query).

Query 2: To show the profile picture path of each contact and the date/time the picture was set:

```
SELECT ZWACHATSESSION.Z_PK, ZWACHATSESSION.ZPARTNERNAME,
ZWACHATSESSION.ZCONTACTJID, ZWAPROFILEPICTUREITEM.ZPATH,
DATETIME(ZWAPROFILEPICTUREITEM.ZPICTUREID, 'unixepoch')

FROM ZWACHATSESSION, ZWAPROFILEPICTUREITEM

WHERE ZWACHATSESSION.ZCONTACTJID = ZWAPROFILEPICTUREITEM.ZJID;
```

This query shows each contact again, this time showing the location of their profile photo. This could be good evidence of attribution and assist with identifying users. The time and date that the picture was set could also be of interest depending on the circumstances. The chat ID is shown to help the Analyst to associate this information with other query results where required. Again, the date and time are converted into a human-readable format.

Query 3: To show each contact who has a nickname set (as set by themselves in the app):

```
SELECT ZWACHATSESSION.Z_PK, ZWACHATSESSION.ZPARTNERNAME,
ZWACHATSESSION.ZCONTACTJID, ZWAPROFILEPUSHNAME.ZPUSHNAME

FROM ZWACHATSESSION, ZWAPROFILEPUSHNAME

WHERE ZWACHATSESSION.ZCONTACTJID = ZWAPROFILEPUSHNAME.ZJID;
```

This query allows the Analyst to see the nicknames of contacts, where they are available. This information could be useful for attribution purposes, or even for understanding the content of messages where a user is mentioned by name. Again, the chat ID helps the Analyst associate this information with the previous list. It is particularly interesting because we know that the user themselves set the nickname, rather than the user of the phone under examination.

Query 4: To show the date and time of the last message in each chat:

```
SELECT Z_PK, ZPARTNERNAME, ZCONTACTJID,
DATETIME(ZLASTMESSAGEDATE+978307200, 'unixepoch')

FROM ZWACHATSESSION;
```

This shows the last time a number was contacted. This can be of note if, for example, there was contact with a murder victim before the offence occurred and no subsequent contact afterwards. It could be an indicator that the phone user may have been involved in the offence if they normally contacted the victim frequently, but made no attempt afterwards. Such behaviour would be unusual and raise suspicion. While detailed analysis of the user's normal activity would need to be done separately to further interpret this, this query can give an early indication of an area of potential evidence that is owed more attention. The date and time are stored in this table in NS Date format and therefore need to be converted as shown in the query in order to be readable (calculated by adding the number of seconds since 2001 to the value and converting to Unix epoch time).

Query 5: To show the number of group chats:

```
SELECT COUNT(Z_PK) FROM ZWAGROUPINFO;
```

This query simply tells the Analyst how many of the chats are group chats, purely for statistical purposes – it is therefore possible to immediately see what proportion of the chats are with groups.

Query 6: To show the name of each group and the members within that group:

```
SELECT ZWACHATSESSION.Z_PK, ZWACHATSESSION.ZPARTNERNAME,
ZWAGROUPMEMBER.ZCONTACTNAME, ZWAGROUPMEMBER.ZMEMBERJID

FROM ZWACHATSESSION, ZWAGROUPMEMBER

WHERE ZWACHATSESSION.Z_PK = ZWAGROUPMEMBER.ZCHATSESSION;
```

Potentially, groups could be interesting in a number of circumstances, particularly in cases of organised criminality and terrorism. This query shows the details of members of each group by querying the ZWACHATSESSION and ZWAGROUPMEMBER tables. ZPARTNERNAME shows the name of the group while ZCONTACTNAME shows the name of the individual who is part of the group. The name of the group may offer some clues as to what the group is about. For example, there is a group in the test database called ‘hardcore walks team’, clearly indicating that the group contains people who are interested in walking together. Such information could potentially point to the type of criminal activity under investigation. Consider the example of a group called ‘Family’ – this could potentially offer investigators a list of people who are related to the user and therefore to each other. Of note is that the chat number is shown in the results, allowing the Analyst to cross-refer the results with the results of the previous query.

Query 7: To show groups that have profile pictures set, along with the date and time the picture was set:

```
SELECT ZCHATSESSION, ZPICTUREPATH, DATETIME(ZPICTUREID, 'unixepoch')

FROM ZWAGROUPINFO WHERE ZPICTUREPATH IS NOT NULL;
```

As with the earlier query that showed the profile picture locations for each contact (where set), this query does the same but shows all those for groups. Only groups with pictures are shown (i.e. where the picture path contains an entry and is therefore “not null”).

Query 8: To show members still active in each group chat:

```
SELECT ZWACHATSESSION.Z_PK, ZWACHATSESSION.ZPARTNERNAME,
ZWAGROUPMEMBER.ZCONTACTNAME, ZWAGROUPMEMBER.ZMEMBERJID

FROM ZWACHATSESSION, ZWAGROUPMEMBER

WHERE ZWACHATSESSION.Z_PK = ZWAGROUPMEMBER.ZCHATSESSION AND
ZWAGROUPMEMBER.ZISACTIVE=1;
```

This query shows which members are still in each group. It is the same query as Query 6 but this time returns only those where the field ZISACTIVE is set as 1, meaning that the member has not left the group. The results can be compared with those of Query 6 and it will be clear to see which members no longer appear and therefore have left their respective group. Depending on group subjects, such a query may offer intelligence of interest.

Query 9: To show the name of the contact who started each group chat:

```
SELECT ZWACHATSESSION.Z_PK, ZWACHATSESSION.ZPARTNERNAME,
ZWAGROUPINFO.ZCREATORJID

FROM ZWACHATSESSION, ZWAGROUPINFO

WHERE ZWACHATSESSION.Z_PK = ZWAGROUPINFO.ZCHATSESSION;
```

The results of this query show the name of each group and the WhatsApp ID of the group creator, using the ZWACHATSESSION and ZWAGROUPINFO tables. This could become useful if a group becomes of interest to the enquiry.

Query 10: To show the creation date of each group and the date and time the subject of the group was set:

```
SELECT ZCHATSESSION, DATETIME(ZCREATIONDATE, 'unixepoch'),
DATETIME(ZSUBJECTTIMESTAMP, 'unixepoch')

FROM ZWAGROUPINFO;
```

This query gives the chat ID of each group (which can be used to reference which group it represents by earlier query results) and the dates and times of creation and the setting of the group subject. The creation date and time of the setup of a group could be of evidential relevance if it is found that the group is of interest to an investigation. Likewise, the setting of the subject line could be key, for example if it has been changed immediately before or after a key time. Only the last change time and date is available (so it is not possible to know any previous changes).

Query 11: To show the last message sender in each group before the phone was downloaded:

```
SELECT ZWAGROUPINFO.ZCHATSESSION,
ZWAGROUPMEMBER.ZCONTACTNAME, ZWAGROUPMEMBER.ZMEMBERJID

FROM ZWAGROUPINFO, ZWAGROUPMEMBER

WHERE ZWAGROUPINFO.ZLASTMESSAGEOWNER = ZWAGROUPMEMBER.Z_PK;
```

It is not clear whether this query would be significant in terms of evidential value, however it has been included due to the fact that the information is available and could potentially offer something unforeseen to an enquiry, such as if the last sender was the victim in an investigation. The results of all the above queries that look at group chat data could prove powerful when combined together.

Query 12: To show all starred messages:

```
SELECT ZCHATSESSION, ZPUSHNAME, ZFROMJID, DATETIME(ZMESSAGEDATE,
'unixepoch'), ZTEXT

FROM ZWAMESSAGE WHERE ZSTARRED = 1;
```

Starred messages are those that a user has ‘bookmarked’ in order to be able to find them again quickly. Starred messages could be a good indication of the meaning of a message to the user (for example, it may have some emotional significance, which in turn may have relevance to an investigation where motive may be in question). A starred message may also contain information of importance, such as an address or anything that the user wanted to be able to locate again without the need to search through all messages. Such information could have some evidential value. The results of this query return an empty result in the ZFROMJID field where the message was outgoing. The message is starred where ZSTARRED has a value of ‘1’ for the record.

Query 13: To show blocked numbers:

```
SELECT ZJID FROM ZWABLACKLISTITEM;
```

This query shows all numbers that have been blocked by the user. This may be very good intelligence in cases where the phone under examination belonged to the victim of an offence (for example, where harassment or murder are being investigated). The ability to view this information quickly may allow for intelligence and subscriber checks against these numbers to be prioritised, potentially offering a new lead to Investigators quicker than it might otherwise have been discovered.

Query 14: Media items received by the phone:

```
SELECT ZWAMESSAGEDATAITEM.ZMATCHEDTEXT,
ZWAMESSAGEDATAITEM.ZTITLE, ZWAMESSAGEDATAITEM.ZSUMMARY,
ZWACHATSESSION.ZPARTNERNAME, ZWACHATSESSION.ZCONTACTJID

FROM ZWAMESSAGEDATAITEM, ZWACHATSESSION

WHERE ZWAMESSAGEDATAITEM.ZSENDERJID =
ZWACHATSESSION.ZCONTACTJID;
```

This query shows all media items received (not including photos); that is to say, these items are all web links. The query shows the link and the WhatsApp ID of the sender, as well as the time and date the message containing the media link was sent. These links can be further researched by the Analyst using Open Source Intelligence and Internet investigation techniques.

Query 15: Media items sent by the phone:

```
SELECT ZWAMESSAGEDATAITEM.ZMATCHEDTEXT,
ZWAMESSAGEDATAITEM.ZTITLE, ZWAMESSAGEDATAITEM.ZSUMMARY,
ZWAMESSAGE.ZTOJID, ZWAMESSAGE.ZTEXT

FROM ZWAMESSAGEDATAITEM, ZWAMESSAGE

WHERE ZWAMESSAGEDATAITEM.ZMESSAGE = ZWAMESSAGE.Z_PK AND
ZWAMESSAGEDATAITEM.ZSENDERJID IS NULL;
```

This query produces the same result as the previous, but this time shows outgoing messages containing media items (sent by the phone user).

Query 16: Pictures sent and received by the phone:

```
SELECT ZWAMESSAGE.Z_PK, ZWAMESSAGE.ZCHATSESSION,
ZWAMESSAGE.ZFROMJID,
DATETIME((ZWAMESSAGE.ZMESSAGEDATE+978307200), 'unixepoch'),
ZWAMEDIAITEM.ZMEDIALOCALPATH

FROM ZWAMESSAGE, ZWAMEDIAITEM

WHERE ZWAMESSAGE.Z_PK = ZWAMEDIAITEM.ZMESSAGE;
```

This query shows the paths of pictures that have been both sent and received by the phone. The date and time and the WhatsApp ID of the sender and receiver are shown and converted from NS Date format. These could be of particular relevance to an investigation. There may be pictures of weapons, crime scenes or vehicles of interest, for example, that may help to place events and people at key times prior to or post offence. An example of key photo evidence from a real case was that of a photo showing a rock that was used to carry out a murder. The photo was taken and sent the day before the offence, showing that at the time it was still in situ. Following the offence, the rock had been removed. The rock itself was not the primary subject of the photograph, but merely appeared in the background and demonstrates the potential power of this type of evidence. The results of this query can help focus attention on potential photos of relevance, where the dates and times are taken into consideration.

Query 17: To show messages that contain geographical co-ordinates:

```
SELECT ZWAMESSAGE.ZFROMJID, ZWAMESSAGE.ZTOJID,
ZWAMESSAGE.ZTEXT, DATETIME((ZWAMESSAGE.ZMESSAGEDATE+978307200),
'unixepoch'), ZWAMEDIAITEM.ZLATITUDE, ZWAMEDIAITEM.ZLONGITUDE

FROM ZWAMESSAGE, ZWAMEDIAITEM

WHERE ZWAMESSAGE.Z_PK = ZWAMEDIAITEM.ZMESSAGE AND ZLATITUDE <>
0.0;
```

This query shows co-ordinates sent (or received) with messages where available. The query requests all those where ZLATITUDE is not set to 0.0, as this appears to be a default entry where no co-ordinates are available. This can be good evidence, as it can place a suspect or victim at a key location when communication was taking place. This could be useful in support of any cell site evidence discovered from the call data provided by Call Service Providers. Whilst it only shows the location of the message sender and not the recipient, potentially any co-ordinates offer a more accurate idea of the user's location than cell site data, as cell site data can only provide the location of the cell being used rather than the location of the phone itself. Whilst location data cannot be taken as 100% accurate, it may suggest a more precise location than cell site data (e.g. cell site may place a phone on the same side of a town as an offence, whereas co-ordinates may place it in the same street as the offence).

5.2.4 Word Search Query

The query below has been developed to carry out the word search against the message text, which is located in the ZWAMESSAGE table of the ChatStorage.sqlite database:

```
SELECT ZFROMJID, ZTOJID, DATETIME((ZMESSAGEDATE+978307200),
'unixepoch'), ZTEXT FROM ZWAMESSAGE WHERE ZTEXT LIKE ?",
('%'+search_user_input+'%',)
```

The query takes the word input by the user (in the variable 'search_user_input') and shows only those messages where that word appears anywhere in the text. It then displays that text along with who the message was from/to, and also the date and time of

that message (which has been converted from NS Date format into a human-readable format).

5.3 The Python Scripts

Having developed all the required queries and being assured that they all work correctly, the next stage in developing the solution is to write the Python script that will carry out all the queries automatically. Two scripts have been written; one which carries out all the queries and one that allows the user to search messages for keywords. The full scripts, as well as the output text files, are shown in Appendices 1 and 2.

5.3.1 WhatsApp_Analysis_iOS.py

This script (shown and commented in Appendix 1a) carries out all the queries and produces the text reports showing the query results (results_contacts.txt and results_chats.txt). It begins by importing sqlite3, querying the Contacts.sqlite database and producing the report. It then queries the ChatsStorage.sqlite database and produces the report with those results. It then shows the user some messages confirming that the analysis has been done successfully and that the reports have been produced. It also warns the user that they should copy the reports to another folder to prevent them being overwritten the next time they run an analysis.

The program works by running the query and then storing it in a variable. Then, when the report file is written, a 'for' loop is used to write each row from the results to the file. The values in each column are separated by commas (','), not only to make the results easy to read but also because it is then easy to paste the results into Excel or other programs and separate them out into a table or spreadsheet. Column headings that clearly explain the contents are also written, along with explanations of what the results are showing. It was necessary in many cases to encode the results into UTF-8 format before writing to the text file so that they printed out correctly. Otherwise, some characters were not shown correctly. This was only necessary against those fields containing text characters and not necessary for fields such as those containing the Chat ID, for example. Appendices 1b and 1c show the text of the two output files, as seen by the user.

5.3.2 WhatsApp_Word_Search_iOS.py

This script asks the user to enter a word of interest to them in order to search for any messages that contain that word (the script is shown and commented in Appendix 2a). An example output file, showing the results for a search against the word 'theory', is shown in Appendix 2b.

The script begins by asking the user to enter the word they would like to search for and then press enter. The response in then stored in the variable 'search_user_input'. This variable is then used in the select query to bring back only those messages that contain the entered word. As in the analysis script discussed in the previous section, the results are then written to the report text file (word_search_results.txt), again separating each column by commas. The program will return any variation of the word; for example, searching the word 'theor' will return anything containing the words 'theory', 'theoretical', etc. Also, it is necessary to encode the text results of the message search in UTF-8 format. Again, the user will see a message on the screen informing them that the search was successful. This message will appear even if nothing is found and the report file will be blank. However, this is still seen as useful, as this blank file (which would still show the word that was searched for) could prove to be useful evidence in court proceedings to demonstrate that a search was made, but with no results (and therefore showing that the word does not appear in the messages). It may be the case that what is *not* found could be as key to an investigation as what is found. It is therefore not considered necessary to limit what the user can search for.

5.4 How the Tool Works in Practice

The following two sections (5.4.1 and 5.4.2) show how the user would run the two programs and what they would see.

5.4.1 WhatsApp_Analysis_iOS.py

Figure 5 below shows how a user would run the script. The first step is to ensure that the Python file and the database files are located in the same folder and that the Command Line points to that folder. The user would then type the 'python WhatsApp_Analysis_iOS.py' (as shown in the screenshot) and press enter. The script then runs and, if successful, the user sees messages to tell them so:

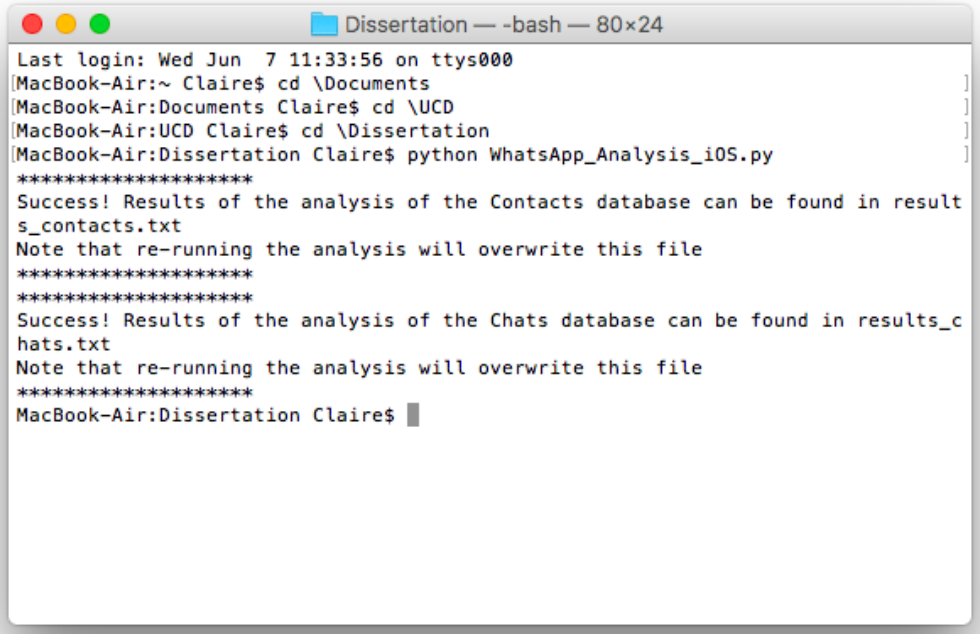

Figure 5: Running the script WhatsApp_Analysis_iOS.py

The script is therefore quick and easy to run and requires very little technical knowledge to do so.

5.4.2 WhatsApp_Word_Search_iOS.py

As with the previous script, it is necessary for the Python script and the database files to be located in the same folder and for the Command Line to point to that folder. After typing 'python WhatsApp_Word_Search.py' and pressing enter, the following appears on the screen asking the user to enter the word they want to search for:

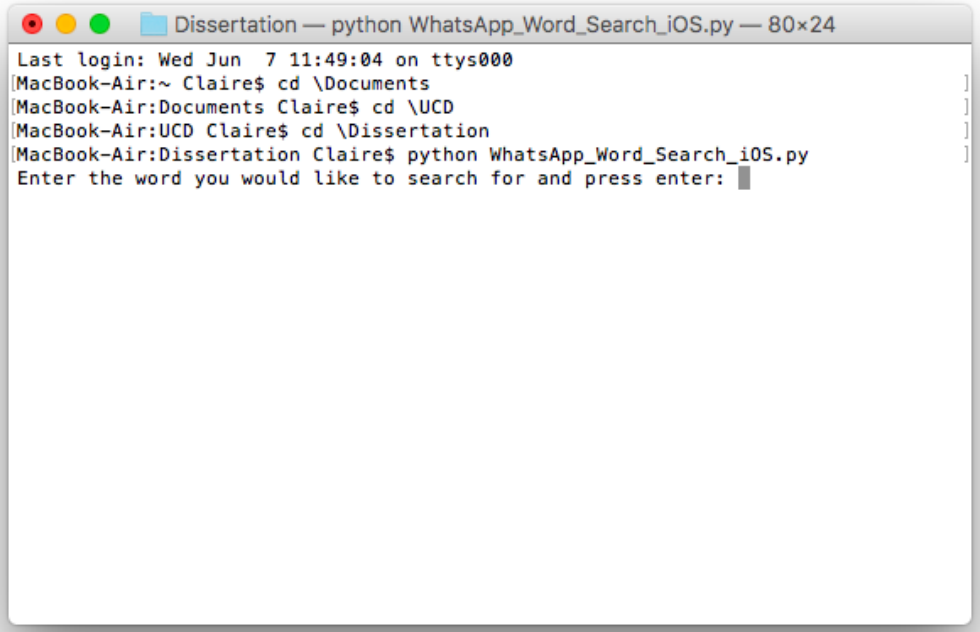

Figure 6: Running the script WhatsApp_Word_Search_iOS.py and entering a search word

After entering a word to search for and pressing enter, a message appears to tell the user that the search was completed. Results (if any) are shown in the report text file:

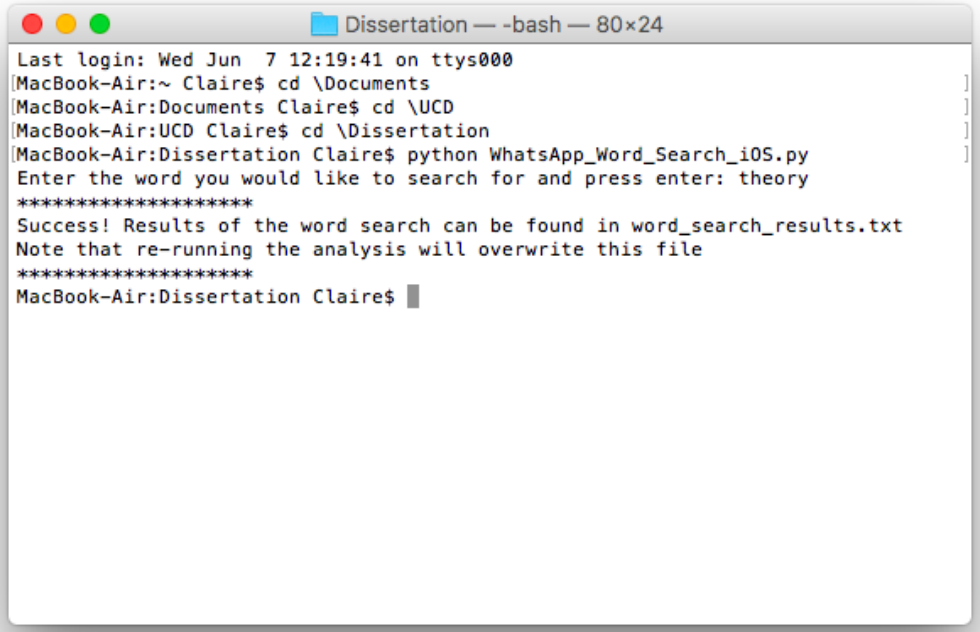

Figure 7: The result of entering a search word when running the script WhatsApp_Word_Search_iOS.py

Again, little technical computer knowledge is required to use the script. Albeit it does not make use of advanced search functions, it allows far quicker searching than Analysts can currently do (they would ordinarily need to have the messages in an Excel format before they could make any search).

6 Evaluation and Discussion of Results

6.1 Focus Group

As discussed in section 4.3, the Focus Group consisting of three Analysts and an Investigator were shown the system and how it works, as well as the output it produces. They were each asked to evaluate the system in relation to the following questions:

1. How easy is the system to use? Do you think it is easy enough for the average Analyst/Investigator to use? Is there any way this could be improved?
2. Although results are somewhat dependent on what can be usefully extracted from the databases, do the results give you the kind of information you need? Is there anything missing or anything else you would like to see?
3. Does it give you anything that you would not normally get from a phone download of WhatsApp data? If so, please describe what that is.
4. How would you use this in your current work? What do you think it would add?
5. What advantages do you see of a system like this? E.g. speed, accuracy, perhaps highlighting something you might not have thought to look for?
6. Do you see any disadvantages to this system? What could they be?
7. Any other comments welcomed...

The answers to these questions and discussions have been used to assist with the evaluation of the tool in the following section.

6.2 Review Against Aims and Objectives

Section 3.1 set out the aims and objectives of the project. In order to review the solution, these aims and objectives have been revisited and compared with the outcome.

Objective 1: The solution should require minimal technical expertise and minimal input from the user to assist their work effectively

It was established at the beginning of the project that Analysts have limited technical computer knowledge and that training opportunities in this area are limited. The final solution requires very little knowledge on the part of the user. They need to know how to ensure the Command Line is reading from the correct folder, but this can

easily and quickly be taught. The following comments were made by the Focus Group Analysts in relation to its ease of use:

"I think most Analysts are very computer literate and have some understanding of using a DOS prompt, so providing they were familiar with that I think they would find the system easy to use."

"The system is very simple to use. I believe any Analyst and most Police employees in general would have no problem using it."

Therefore, it is considered that the solution meets requirements for being easy to use. A couple of interesting disadvantages were discussed, however; it was suggested that, despite the offered warnings, it is very easy to overwrite the report files accidentally and this could be done if the Analyst was working with a lot of data under time pressure. Also, data such as phone numbers appear in different formats. For example, some queries show the phone number whilst others show the WhatsApp user ID. Whilst both show the same information (i.e. the user's number), the different formats would need to be normalised to make them all the same in some circumstances. Whilst it would not always be necessary to do this, and although it would not take long to do, it is still an aspect that could be further improved.

Initial set-up of the tool is potentially complicated. The local ICT department would need to ensure that the user's machine has access to Python and SQLite3. This would need to be approved and set-up would need to be completed before the tool could be used. In addition, there needs to be an understanding between the Analyst team and the Hi-Tech Crime Unit that the databases need to be extracted and given to the Analyst on appropriate media, such as on Blu-Ray discs. The Analyst should also have access to a complete download of the phone (i.e. the actual file structure) so that they can locate and view any relevant media. Educating the Hi-Tech Crime Unit to do this automatically may take some time, given that Analysts already often need to chase them to receive the information they already get. In the current climate, particularly across Warwickshire and West Mercia Police, resources are stretched where mobile forensics is concerned, as one unit now serves both Forces. That said, these are initial teething problems that over time could diminish. It is hoped that, once the benefits of the tool are

realised, support for it would increase. The below thoughts were offered by a Warwickshire Analyst regarding the set-up in their organisation:

"Perhaps IT could burn the SQLite files onto Blu-Ray discs. We have a problem with installing anything so that would pose a problem potentially. You have to be a Systems Administrator. Another option is to find a stand-alone machine, where it could be possible to install Python and SQLite tools. The preferred option would be for IT to install them on our personal thin client NUKs."

Objective 2: It should produce accurate and fast results, so ensuring that time required to make analyses is kept to a minimum, allowing the Analyst to efficiently prepare for briefings and to be able to update Senior Investigators promptly, particularly in situations where life may be at risk

The solution produces results instantaneously when implemented. In a situation where speed is essential and the provision of the data to the Analyst can be handled as priority, results can be delivered very quickly by the Analyst. In the case of the word search, any word can be searched immediately where a need arises. Once the Analyst has access to the data, they can immediately produce a report, assess its meaning and take those findings to a briefing. In that sense, the tool has met the objective of speed set out at the beginning of the project. The Focus Group commented that it is very effective as a tool for looking for specific information or patterns, rather than needing to trawl through all the data, therefore saving a lot of time. The word search functionality was considered particularly useful, especially in cases where a suspect is being held for a limited time-period for questioning. It was suggested that this could find a link to a crime very quickly and could potentially provide sharp focus to an investigation at an early stage, which is crucial. The word search was tested against a wide range of words and partial words, including words that were known to not be in the database.

Producing results like those in the outputted reports would not normally be possible for at least a few hours – for example, to discover top contacts, the Analyst would need to cleanse and normalise the data into a consistent format and produce an Excel pivot table. Then, outgoing and incoming contacts would need to be reviewed separately and combined. As things currently are, the Analyst does not have access to the information held in the ZMESSAGECOUNTER field of the ZWACHATSESSION

table, which provides this information without the need to do any background work. However, even before this stage in the analysis process, one Analyst from the Focus Group highlighted that they usually have to extract every type of information from the Blu-Ray disc separately (i.e. chats, contacts etc), so taking a considerable amount of time (in fact, hours). This tool therefore gives the Analyst information that would normally take a long time to obtain. Although it does not, in its current form, replace the need to extract all messages into Excel, it provides information immediately to support fast-paced investigations. The Focus Group particularly valued this speed, and highlighted that during live kidnap and extortion investigations, such speed is vital. This is an aspect of particular interest to Investigators.

As the queries process relatively standard information (such as top contacts, contact nicknames, members of groups etc.) it can be expected that results should be consistent for any iOS WhatsApp database, due to the fact that all databases will handle this information in the same way. Unfortunately, at this stage, this cannot be fully tested against other databases due to a lack of access to several different databases from different users. During the development, one notable issue that arose related to the format of text. While using UTF-8 encoding solved the problem of making the text readable in the report text files, it did not have the same effect for special characters. Some messages containing media items included Chinese characters which would not print to the text file and caused an error when the program was run (consequently causing the writing of the results to stop at that point). This error cannot currently be overcome. It was found, however, that the Chinese characters could be made to print to the screen. It is anticipated that in most cases, this error would not present a problem but would prevent the program running properly in the event of special characters being present. As a result, it would still be necessary at this stage to revert to manually reviewing WhatsApp download reports in such cases.

Objective 3: It will not substitute thorough analysis of data to understand complex and unique problems, but it will aim to execute standard queries that answer key questions quickly, assisting an Analyst to understand meanings within the data without the need to cleanse and normalise it first. Thus, it will contribute towards the analysis of complex and unique problems. It may also prompt further analytical thought processes and hypotheses

The queries developed for the tool carry out a number of standard functions, as has been previously stated, and produce statistics. These appear to have fulfilled the aim of providing the Analyst with something they can further work with. It was established early on through discussions with a Warwickshire Police Analyst that the information they receive to work with is currently very basic. This clearly suggests that the system offers them something they simply did not have access to previously. Therefore, whilst the initial aim set out to reduce the time spent cleansing and normalising data (which it does, as highlighted already), it has in fact been established that it provides new data to the Analyst. It can be said that as a result, it further helps the Analyst to understand complex problems by adding new information that they previously may not have even known existed. In that sense, the tool goes beyond what it was initially required to do.

Objective 4: It will ensure that, via the standard queries, these specific searches are always carried out and therefore not missed by the Analyst, so improving efficiency

As it has now been established that the tool provides the Analyst with information they did not previously have, it can be said that the tool is carrying out queries that would not previously have been possible. However, given that all the information does exist in the handset and that it is possible to extract it forensically, it highlights that little consideration has been given within the Warwickshire Force to the potential evidence within WhatsApp and other messaging apps. There is perhaps a general lack of understanding of the apps, or perhaps little attention has been paid to them because they are a new technology that has not yet impacted greatly on investigations. Warwickshire Serious and Organised Crime Analyst, Stuart Hall, stated that he does not regularly deal with WhatsApp data at the moment; this is primarily because criminals in the organised crime arena still have a preference for throw-away pay-as-you-go phones. However, this may change and certainly does not apply to other crime areas, such as domestic murder offences. Recent publicity surrounding the use of WhatsApp in the Westminster terrorist attack also highlights how messaging apps already are growing in significance where crime is concerned. An advantage that was suggested by an Analyst in the Focus Group was that the tool reduces the risk of missing something important, which was one of the goals of the tool. It could be argued that this is of great significance because an Analyst cannot analyse or search for something that they have not considered.

Objective 5: It should also be suitable for an Investigator to use in situations where an understanding of the contents needs to be obtained quickly to assist immediate operational decisions

As has been shown, the tool is very quick and easy for an Analyst to use once the necessary set-up has been done. A lot of Investigators have far less computer knowledge than Analysts, but nevertheless the system should not present too many challenges to them either, should they wish to use it. The outputted reports are also easy enough for an Investigator to interpret and use in the development of their hypotheses. Although not as effective as using the skills of an Analyst, an Investigator can use the system when just an overview of the data is required and there is no time for in-depth analysis.

6.3 Additional Conclusions

The general feeling amongst the members of the Focus Group was that the tool's strongest advantage is the speed at which statistics of interest are returned, eliminating the immediate need to download and manipulate data (a time-consuming process). It was felt that it is easy to use and would save a lot of time. The word search capability generated the greatest positive response, given how quickly this can highlight important lines of enquiry.

The value of some of the returned information was discussed. One Analyst believed that contacts and messages are the main types of data that an Analyst needs, and therefore would like to see the simple pulling-off of all messages in chronological order. This would eliminate their need to produce Excel files. Whilst the tool was originally only intended to assist the quick interpretation of the data, this suggestion seems possible and also could be a helpful feature. However, others in the group saw the value of the statistics it produces; for example, it was suggested that knowing members of group chats may assist in finding other offenders involved in a crime and that knowing the dates of the last messages in a group could help eliminate old contacts who are no longer relevant.

The group was in agreement that the code behind the tool could be produced in an evidential format for court (i.e. printed and exhibited, supported by a written statement

provided by the author, discussing how it was produced and how it works). The author could attend court as a professional witness if required.

The tool was well received and all Focus Group participants believed that it would add value to the work they do and that further development would make it increasingly valuable to them. It was highlighted that, in light of the recent publicity surrounding WhatsApp's end-to-end encryption (following its use during the Westminster terror attack), criminals may have increased their use of it as they may believe it to be a safer medium to use.

6.4 Limitations and Possible Further Developments

Whilst the solution successfully achieves many of its key objectives, it also has several limitations. These limitations are discussed below, and ways they could be counter-acted to make the tool more effective are suggested:

1. The handling of non-ASCII characters:

   The script stopped running and gave an error when it encountered Chinese characters. Using UTF-8 encoding when writing to the text report file did not solve the problem. It was found that the characters would print to the screen, but not to the file. Consequently, the solution cannot handle such characters in its present form and can only function correctly with ASCII characters. It was considered to have the results also print out to the screen, but as the results are very lengthy, it could be too difficult for the user to handle and interpret. However, this is an option for further development, as well as the exploration of how to correct this error.

2. Testing limitations

   The fact that only one handset could be used means that the solution could not be tested against other WhatsApp databases to check for the same behaviour. It could also not be run against operational data in a live environment. This was primarily due to the amount of behind-the-scenes arrangement that needed to be done to make this happen within the Warwickshire force, for which there simply was not enough time. It is, however, a next step in development to get the solution working in a live environment.

3. Understanding of the meaning of all data fields

   It was not always easy to understand what every data field was showing in the databases. Many meanings could be interpreted as a result of viewing the data on the phone or from personal knowledge of the data (for example, knowing which numbers had been blocked made it easy to understand the ZWABLACKLISTITEM table and knowing which messages were 'starred' made it possible to understand the meanings of the values 1 and 0 in that field). As such, there were some fields that could not be interpreted even after attempting to research their meaning. Whilst several researchers have described different aspects of the databases that relate to their own specific projects, there is a general lack of research into this area. In addition, most available research (as documented in the literature review) focuses on Android databases, which have a different structure to those on the iOS platform. A good separate piece of research could be carried out that focuses on understanding and documenting the meanings of all fields in the databases, particularly on iOS.

4. Complete replacement for current data working practices

   It is suggested that with further development, the tool could entirely replace the need of the Analyst to extract data into Excel using the UFED Analyser by additionally reproducing all the messages in chronological order. This would clearly save a lot of time that is currently spent on downloading them and would take the tool beyond merely producing key statistics. Also, further work could be done so that the program also cleanses and formats the data so that even less work needs to be done by the Analyst. It could become the primary way Analysts handle instant messaging data.

5. Limited app focus

   WhatsApp on iOS was the focus of this project, but the same solution could be developed for WhatsApp on Android, as well as other apps on both iOS and Android. In fact, this should be seen as the next step in creating a tool set that would allow Analysts and Investigators to easily analyse all the most popular apps. Given that separate scripts would need to be written for each app and each platform, it was beyond the scope of this project to focus on more than one.

6. Installation of required software on user systems

   It is suggested that a way of overcoming any difficulties in terms of installation on Analysts' machines is to use Docker, a software container platform. This is in effect a container that contains the required software and settings, which can be shipped to each user. The software always runs the same, regardless of where it is deployed (Docker, 2017). Using a system like this may make it easier for ITC departments to ensure the necessary dependencies are available on each Analyst's computer and can be updated easily as required.

7. Word Document reporting

   The tool produces the results in text file format, which is useful in terms of both printing and for import into other formats such as Excel. However, a possible future development would be to turn the results out into a Word document (which would be useful in cases where the results are required in an immediately presentable format). Code could be added to the Python scripts to do that. This could be done by importing the python-docx library to the script. The output would be tidier than the text files and make the tables easier to read. The website https://python-docx.readthedocs.io/en/latest/ offers an example of how this works and could be done.

8. Technical capabilities

   With greater technical capabilities of the author, there is the potential to develop a much more advanced tool. It was discovered during the literature review and in discussions with Warwickshire Police Analysts that a tool is available and in use to assist with the analysis of telecommunications data (phone call and text message data) but none to handle app data (hence this project). There is potential on a commercial scale to develop a single tool to handle data from several apps and with a Graphical User Interface, which would be even easier for the end user to manage. With more time and greater expertise, a better system could be developed. The tool could be developed to remove the need for Excel files altogether by providing the Analyst will all the data they need from the database (i.e. all messages in chronological order), rather than just key statistics. This is not complicated and very much achievable. Further work to remove the need for any data cleansing and

normalising could remove even more of the Analyst's workload, thus saving more time for the main task of analysing the information.

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8 Appendices

8.1 Appendix 1a: WhatsApp_Analysis_iOS.py

```
#!/usr/bin/env/ python

# -*- coding: utf-8 -*-

# Script:             WhatsApp_Analysis_iOS.py

# Author:             Claire Lawrence

# Purpose:            To generate a report showing key statistics
                      of WhatsApp databases used on an iPhone

# sqlite3 is imported to allow Python to interact with the
database:

import sqlite3

# The file that will become the results text file for the query
results of the Contacts.sqlite database is created:

outfile1 = open('results_contacts.txt', 'w')

outfile1.close()

# A connection is established to the Contacts.sqlite database so
that queries can be performed against it:

conn = sqlite3.connect("Contacts.sqlite")

curs = conn.cursor()

# Query to list all contacts on the phone (Name, number and phone
type as stored in phone):

contactsQ1 = curs.execute("SELECT ZWACONTACT.ZFULLNAME,
ZWAPHONE.ZPHONE, ZWAPHONE.ZLABEL FROM ZWACONTACT, ZWAPHONE WHERE
ZWACONTACT.Z_PK = ZWAPHONE.ZCONTACT;")

# The report text file created earlier is opened and the results
are written to it:

contacts_results = open('results_contacts.txt', 'w')

contacts_results.write("\nANALYSIS OF THE CONTACTS.SQLITE
WHATSAPP DATABASE\n")

contacts_results.write("\n" + "=" * 20)
```

```
contacts_results.write("\nAll contacts on the phone (not only
WhatsApp contacts): \n")

contacts_results.write("\nFULL NAME, PHONE, LABEL\n")

for rowQ1 in contactsQ1:

     contacts_results.write(str(rowQ1[0].encode("utf-8")) + ","
+ str(rowQ1[1].encode("utf-8")) + ","  +
str(rowQ1[2].encode("utf-8")) + "\n")

contacts_results.write("\n" + "=" * 20)

# Query to list all WhatsApp contacts and their number:

contactsQ2 = curs.execute("SELECT ZWACONTACT.ZFULLNAME,
ZWAPHONE.ZPHONE FROM ZWACONTACT, ZWAPHONE WHERE ZWACONTACT.Z_PK =
ZWAPHONE.ZCONTACT AND ZWAPHONE.ZFAVORITE IS NOT NULL;")

contacts_results.write("\nAll WhatsApp contacts and their
numbers: \n")

contacts_results.write("\nFULL NAME, PHONE\n")

for rowQ2 in contactsQ2:

     contacts_results.write(str(rowQ2[0].encode("utf-8")) + ","
+ str(rowQ2[1].encode("utf-8")) + "\n")

contacts_results.write("\n" + "=" * 20)

# Query to show number and status text of each contact (all in
phone), along with the path to their picture and the date/time
the picture was set:

contactsQ3 = curs.execute("SELECT ZWAPHONE.ZPHONE,
ZWASTATUS.ZTEXT, ZWASTATUS.ZPICTUREPATH, DATETIME(ZPICTUREID,
'unixepoch') FROM ZWAPHONE, ZWASTATUS WHERE ZWAPHONE.Z_PK =
ZWASTATUS.ZPHONE;")

contacts_results.write("\nAll phone contacts, including set
status of WhatsApp contacts, the path to their profile pictures
and the date/time the picture was set: \n")

contacts_results.write("\nPHONE, STATUS TEXT, PROFILE PICTURE
PATH, DATE/TIME SET (UTC)\n")

for rowQ3 in contactsQ3:

     contacts_results.write(str(rowQ3[0].encode("utf-8")) + ","
+ str(rowQ3[1].encode("utf-8")) + "," + str(rowQ3[2]) + "," +
str(rowQ3[3]) + "\n")
```

```
contacts_results.write("\n" + "=" * 20)

contacts_results.write("\nEND OF REPORT")

contacts_results.write("\n" + "=" * 20)

# The report text file is closed:

contacts_results.close()

# The connection to the database is closed:

conn.close()

# The file that will become the results text file for the query
results of the ChatStorage.sqlite database is created:

outfile2 = open('results_chats.txt', 'w')

outfile2.close()

# A connection is established to the ChatStorage.sqlite database
so that queries can be performed against it:

conn = sqlite3.connect("ChatStorage.sqlite")

curs = conn.cursor()

# Query to show name of contact and number of messages exchanged
in order of top contact first:

chatsQ1 = curs.execute("SELECT Z_PK, ZPARTNERNAME, ZCONTACTJID,
ZMESSAGECOUNTER FROM ZWACHATSESSION ORDER BY
ZWACHATSESSION.ZMESSAGECOUNTER DESC;")

chats_results = open('results_chats.txt', 'w')

chats_results.write("\nANALYSIS OF THE CHATSTORAGE.SQLITE
WHATSAPP DATABASE\n")

chats_results.write("\n" + "=" * 20)

chats_results.write("\nThe name of the contact, number of
messages exchanged and their nickname as set by them in order of
top contact first: \n")

chats_results.write("\nCHAT ID, USER'S NAME, WHATSAPP ID, NUMBER
OF MESSAGES EXCHANGED\n")

for rowchatsQ1 in chatsQ1:
```

```
     chats_results.write(str(rowchatsQ1[0]) + "," +
str(rowchatsQ1[1].encode("utf-8")) + "," + str(rowchatsQ1[2]) +
"," + str(rowchatsQ1[3]) + "," + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show the profile picture path of each contact:

chatsQ2 = curs.execute("SELECT ZWACHATSESSION.Z_PK,
ZWACHATSESSION.ZPARTNERNAME, ZWACHATSESSION.ZCONTACTJID,
ZWAPROFILEPICTUREITEM.ZPATH,
DATETIME(ZWAPROFILEPICTUREITEM.ZPICTUREID, 'unixepoch') FROM
ZWACHATSESSION, ZWAPROFILEPICTUREITEM WHERE
ZWACHATSESSION.ZCONTACTJID = ZWAPROFILEPICTUREITEM.ZJID;")

chats_results.write("\nEach contact and the path to their profile
picture, along with the time and date it was set: \n")

chats_results.write("\nCHAT ID, USER'S NAME, WHATSAPP ID, PICTURE
PATH, DATE/TIME PICTURE WAS SET (UTC)\n")

for rowchatsQ2 in chatsQ2:

          chats_results.write(str(rowchatsQ2[0]) + "," +
str(rowchatsQ2[1].encode("utf-8")) + "," + str(rowchatsQ2[2]) +
"," + str(rowchatsQ2[3]) + "," + str(rowchatsQ2[4]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show name of contact and their nickname as set by them
in order of top contact first:

chatsQ3 = curs.execute("SELECT ZWACHATSESSION.Z_PK,
ZWACHATSESSION.ZPARTNERNAME, ZWACHATSESSION.ZCONTACTJID,
ZWAPROFILEPUSHNAME.ZPUSHNAME FROM ZWACHATSESSION,
ZWAPROFILEPUSHNAME WHERE ZWACHATSESSION.ZCONTACTJID =
ZWAPROFILEPUSHNAME.ZJID;")

chats_results.write("\nThe name of each contact for whom there is
a nickname, as set by themselves on the app: \n")

chats_results.write("\nCHAT ID, USER'S NAME, WHATSAPP ID,
NICKNAME\n")

for rowchatsQ3 in chatsQ3:

     chats_results.write(str(rowchatsQ3[0]) + "," +
str(rowchatsQ3[1].encode("utf-8")) + "," + str(rowchatsQ3[2]) +
"," + str(rowchatsQ3[3].encode("utf-8")) + "," + "\n")

chats_results.write("\n" + "=" * 20)
```

```
# Query to show the date and time of the last message in each
chat:

chatsQ4 = curs.execute("SELECT Z_PK, ZPARTNERNAME, ZCONTACTJID,
DATETIME((ZLASTMESSAGEDATE+978307200), 'unixepoch') FROM
ZWACHATSESSION;")

chats_results.write("\nThe date and time of the last message in
each chat: \n")

chats_results.write("\nCHAT ID, USER'S NAME, WHATSAPP ID,
DATE/TIME OF LAST MESSAGE (UTC)\n")

for rowchatsQ4 in chatsQ4:

     chats_results.write(str(rowchatsQ4[0]) + "," +
str(rowchatsQ4[1].encode("utf-8")) + "," + str(rowchatsQ4[2]) +
"," + str(rowchatsQ4[3]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show the number of group chats:

chatsQ5 = curs.execute("SELECT COUNT(Z_PK) FROM ZWAGROUPINFO;")

chats_results.write("\nGROUP CHAT STATISTICS")

chats_results.write("\n" + "=" * 20 + "\n")

chats_results.write("\nThe total number of group chats: \n")

chats_results.write("\nNUMBER OF GROUP CHATS\n")

for rowchatsQ5 in chatsQ5:

     chats_results.write(str(rowchatsQ5[0]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show the name of each group and the members of that
group:

chatsQ6 = curs.execute("SELECT ZWACHATSESSION.Z_PK,
ZWACHATSESSION.ZPARTNERNAME, ZWAGROUPMEMBER.ZCONTACTNAME,
ZWAGROUPMEMBER.ZMEMBERJID FROM ZWACHATSESSION, ZWAGROUPMEMBER
WHERE ZWACHATSESSION.Z_PK = ZWAGROUPMEMBER.ZCHATSESSION;")
```

```
chats_results.write("\nThe name of each group and the members of
that group: \n")

chats_results.write("\nCHAT ID, GROUP NAME, MEMBER'S NAME,
WHATSAPP ID\n")

for rowchatsQ6 in chatsQ6:

     chats_results.write(str(rowchatsQ6[0]) + "," +
str(rowchatsQ6[1].encode("utf-8")) + "," +
str(rowchatsQ6[2].encode("utf-8")) + "," + str(rowchatsQ6[3]) +
"\n")

chats_results.write("\n" + "=" * 20)

# Query to show groups with pictures and the path to the group's
picture, along with the time and date the picture was set.  Note
the first part of the path shows the number of the person who set
the group picture:

chatsQ7 = curs.execute("SELECT ZCHATSESSION, ZPICTUREPATH,
DATETIME(ZPICTUREID, 'unixepoch') FROM ZWAGROUPINFO WHERE
ZPICTUREPATH IS NOT NULL;")

chats_results.write("\nGroups with profile pictures set and the
path to the group's picture, along with the time and date the
picture was set. \n")

chats_results.write("\nNote the first part of the filename shows
the number of the person who set the group picture: \n")

chats_results.write("\nCHAT ID, PICTURE PATH, DATE/TIME PICTURE
WAS SET (UTC)\n")

for rowchatsQ7 in chatsQ7:

     chats_results.write(str(rowchatsQ7[0]) + "," +
str(rowchatsQ7[1]) + "," + str(rowchatsQ7[2]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show members still active in each group:

chatsQ8 = curs.execute("SELECT ZWACHATSESSION.Z_PK,
ZWACHATSESSION.ZPARTNERNAME, ZWAGROUPMEMBER.ZCONTACTNAME,
ZWAGROUPMEMBER.ZMEMBERJID FROM ZWACHATSESSION, ZWAGROUPMEMBER
WHERE ZWACHATSESSION.Z_PK = ZWAGROUPMEMBER.ZCHATSESSION AND
ZWAGROUPMEMBER.ZISACTIVE=1;")

chats_results.write("\nMembers still active in each group: \n")
```

```
chats_results.write("\nCHAT ID, GROUP NAME, MEMBER'S NAME,
WHATSAPP ID\n")

for rowchatsQ8 in chatsQ8:

     chats_results.write(str(rowchatsQ8[0]) + "," +
str(rowchatsQ8[1].encode("utf-8")) + "," +
str(rowchatsQ8[2].encode("utf-8")) + "," + str(rowchatsQ8[3]) +
"\n")

chats_results.write("\n" + "=" * 20)

# Query to show the contact who started each group:

chatsQ9 = curs.execute("SELECT ZWACHATSESSION.Z_PK,
ZWACHATSESSION.ZPARTNERNAME, ZWAGROUPINFO.ZCREATORJID FROM
ZWACHATSESSION, ZWAGROUPINFO WHERE ZWACHATSESSION.Z_PK =
ZWAGROUPINFO.ZCHATSESSION;")

chats_results.write("\nThe contact who started each group: \n")

chats_results.write("\nCHAT ID, GROUP NAME, WHATSAPP ID OF GROUP
CREATOR\n")

for rowchatsQ9 in chatsQ9:

     chats_results.write(str(rowchatsQ9[0]) + "," +
str(rowchatsQ9[1].encode("utf-8")) + "," + str(rowchatsQ9[2]) +
"\n")

chats_results.write("\n" + "=" * 20)

# Query to show the creation date of each group and the date/time
the subject was set:

chatsQ10 = curs.execute("SELECT ZCHATSESSION,
DATETIME((ZCREATIONDATE+978307200), 'unixepoch'),
DATETIME((ZSUBJECTTIMESTAMP+978307200), 'unixepoch') FROM
ZWAGROUPINFO;")

chats_results.write("\nThe creation date of each group and the
date/time the subject was set: \n")

chats_results.write("\nCHAT ID, CREATION DATE/TIME (UTC),
DATE/TIME GROUP SUBJECT SET (UTC)\n")

for rowchatsQ10 in chatsQ10:

     chats_results.write(str(rowchatsQ10[0]) + "," +
str(rowchatsQ10[1]) + "," + str(rowchatsQ10[2]) + "\n")

chats_results.write("\n" + "=" * 20)
```

```
# Query to show the last message sender in each group:

chatsQ11 = curs.execute("SELECT ZWAGROUPINFO.ZCHATSESSION,
ZWAGROUPMEMBER.ZCONTACTNAME, ZWAGROUPMEMBER.ZMEMBERJID FROM
ZWAGROUPINFO, ZWAGROUPMEMBER WHERE ZWAGROUPINFO.ZLASTMESSAGEOWNER
= ZWAGROUPMEMBER.Z_PK;")

chats_results.write("\nThe last message sender in each group:
\n")

chats_results.write("\nCHAT ID, MEMBER'S NAME, WHATSAPP ID\n")

for rowchatsQ11 in chatsQ11:

     chats_results.write(str(rowchatsQ11[0]) + "," +
str(rowchatsQ11[1].encode("utf-8")) + "," + str(rowchatsQ11[2]) +
"\n")

chats_results.write("\n" + "=" * 20)

# Query to show all starred messages:

chatsQ12 = curs.execute("SELECT ZCHATSESSION, ZPUSHNAME,
ZFROMJID, DATETIME((ZMESSAGEDATE+978307200), 'unixepoch'), ZTEXT
FROM ZWAMESSAGE WHERE ZSTARRED = 1;")

chats_results.write("\nSTARRED MESSAGES AND BLOCKED NUMBERS")

chats_results.write("\n" + "=" * 20 + "\n")

chats_results.write("\nAll starred messages \n")

chats_results.write("\nNote that where user details appear as
'none', the message was outgoing: \n")

chats_results.write("\nCHAT ID, USER'S NICKNAME, WHATSAPP ID OF
SENDER, DATE/TIME OF MESSAGE (UTC), MESSAGE TEXT\n")

for rowchatsQ12 in chatsQ11:

     chats_results.write(str(rowchatsQ12[0]) + "," +
str(rowchatsQ12[1]) + "," + str(rowchatsQ12[2]) + "," +
str(rowchatsQ12[3]) + "," + str(rowchatsQ12[4].encode("utf-8")) +
"\n")

chats_results.write("\n" + "=" * 20 + "\n")

# Query to show blocked numbers:

chatsQ13 = curs.execute("SELECT ZJID FROM ZWABLACKLISTITEM;")
```

```
chats_results.write("\nBlocked Numbers: \n")

chats_results.write("\nWHATSAPP ID\n")

for rowchatsQ13 in chatsQ13:

     chats_results.write(str(rowchatsQ13[0]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show media items received by the phone:

chatsQ14 = curs.execute("SELECT ZWAMESSAGEDATAITEM.ZMESSAGE,
ZWAMESSAGEDATAITEM.ZMATCHEDTEXT, ZWACHATSESSION.ZPARTNERNAME,
ZWACHATSESSION.ZCONTACTJID,
DATETIME((ZWAMESSAGEDATAITEM.ZDATE+978307200), 'unixepoch') FROM
ZWAMESSAGEDATAITEM, ZWACHATSESSION WHERE
ZWAMESSAGEDATAITEM.ZSENDERJID = ZWACHATSESSION.ZCONTACTJID;")

chats_results.write("\nMEDIA ITEMS")

chats_results.write("\n" + "=" * 20 + "\n")

chats_results.write("\nMedia items received by the phone: \n")

chats_results.write("\nMESSAGE ID, MEDIA, SENDER'S NAME, WHATSAPP
ID OF SENDER, DATE/TIME RECEIVED\n")

for rowchatsQ14 in chatsQ14:

     chats_results.write(str(rowchatsQ14[0]) + "," +
str(rowchatsQ14[1]) + "," + str(rowchatsQ14[2]) +
str(rowchatsQ14[3]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show media items sent by the phone user:

chatsQ15 = curs.execute("SELECT ZWAMESSAGEDATAITEM.ZMESSAGE,
ZWAMESSAGEDATAITEM.ZMATCHEDTEXT, ZWAMESSAGE.ZTOJID,
ZWAMESSAGE.ZTEXT FROM ZWAMESSAGEDATAITEM, ZWAMESSAGE WHERE
ZWAMESSAGEDATAITEM.ZMESSAGE = ZWAMESSAGE.Z_PK AND
ZWAMESSAGEDATAITEM.ZSENDERJID IS NULL;")

chats_results.write("\nMedia items sent by the phone: \n")

chats_results.write("\nMESSAGE ID, MEDIA, SENT TO, MESSAGE
TEXT\n")

for rowchatsQ15 in chatsQ15:
```

```
     chats_results.write(str(rowchatsQ15[0]) + "," +
str(rowchatsQ15[1]) + "," + str(rowchatsQ15[2].encode("utf-8")) +
"\n")

chats_results.write("\n" + "=" * 20)

# Query to show photos sent/received by the phone and
corresponding message text (where there is any):

chatsQ16 = curs.execute("SELECT ZWAMESSAGE.Z_PK,
ZWAMESSAGE.ZCHATSESSION, ZWAMESSAGE.ZFROMJID,
DATETIME((ZWAMESSAGE.ZMESSAGEDATE+978307200), 'unixepoch'),
ZWAMEDIAITEM.ZMEDIALOCALPATH FROM ZWAMESSAGE, ZWAMEDIAITEM WHERE
ZWAMESSAGE.Z_PK = ZWAMEDIAITEM.ZMESSAGE;")

chats_results.write("\nPictures sent and received by the phone:
\n")

chats_results.write("\nNote that where 'Message From' appears as
'none', the message was outgoing: \n")

chats_results.write("\nMESSAGE ID, CHAT ID, MESSAGE FROM,
DATE/TIME (UTC), PICTURE PATH\n")

for rowchatsQ16 in chatsQ16:

     chats_results.write(str(rowchatsQ16[0]) + "," +
str(rowchatsQ16[1]) + "," + str(rowchatsQ16[2]) + "," +
str(rowchatsQ16[3]) + "," + str(rowchatsQ16[4]) + "\n")

chats_results.write("\n" + "=" * 20)

# Query to show messages that contain geographical co-ordinates:

chatsQ17 = curs.execute("SELECT ZWAMESSAGE.ZFROMJID,
ZWAMESSAGE.ZTOJID, ZWAMESSAGE.ZTEXT,
DATETIME((ZWAMESSAGE.ZMESSAGEDATE+978307200), 'unixepoch'),
ZWAMEDIAITEM.ZLATITUDE, ZWAMEDIAITEM.ZLONGITUDE FROM ZWAMESSAGE,
ZWAMEDIAITEM WHERE ZWAMESSAGE.Z_PK = ZWAMEDIAITEM.ZMESSAGE AND
ZLATITUDE <> 0.0;")

chats_results.write("\nLOCATION DATA")

chats_results.write("\n" + "=" * 20 + "\n")

chats_results.write("\nMessages containing geographical co-
ordinates \n")

chats_results.write("\nLatitude and Longitude of the message
sender.  Note that where 'from' or 'to' is 'none', 'none'
represents the phone user: \n")
```

```
chats_results.write("\nMESSAGE FROM, MESSAGE TO, MESSAGE TEXT,
DATE/TIME OF MESSAGE, LATITUDE, LONGITUDE\n")

for rowchatsQ17 in chatsQ17:

     chats_results.write(str(rowchatsQ17[0]) + "," +
str(rowchatsQ17[1]) + "," + str(rowchatsQ17[2])+ "," +
str(rowchatsQ17[3]) + "," + str(rowchatsQ17[4]) + "," +
str(rowchatsQ17[5]) + "\n")

chats_results.write("\n" + "=" * 20)

chats_results.write("\nEND OF REPORT")

chats_results.write("\n" + "=" * 20)

# The report text file is closed:

chats_results.close()

# Messages are displayed on the screen to the user to tell them
that the queries have been performed and where to find the
results:

print ("*" * 20)

print "Success! Results of the analysis of the Contacts database
can be found in results_contacts.txt"

print "Note that re-running the analysis will overwrite this
file"

print ("*" * 20)

print ("*" * 20)

print "Success! Results of the analysis of the Chats database can
be found in results_chats.txt"

print "Note that re-running the analysis will overwrite this
file"

print ("*" * 20)

# The connection to the database is closed:

conn.close()
```

8.2 Appendix 1b: results_contacts.txt

ANALYSIS OF THE CONTACTS.SQLITE WHATSAPP DATABASE

==========

All contacts on the phone (not only WhatsApp contacts):

FULL NAME, PHONE, LABEL

Hindlip HR,03003333000,_$!<Mobile>!$_

Wendy Cherry,+44 (0) 7909 902928,_$!<Home>!$_

Tracey Cooper,07968 399379,_$!<Mobile>!$_

Dad's International Phone,+44 (0) 7459 616086,_$!<Mobile>!$_

Dentist,024 7634 4222,_$!<Main>!$_

HMRC Abroad,01355 359022,_$!<Home>!$_

My Work,+31 70 353 18 48,Europol

The Hague,+31 6 50 53 90 99,_$!<Mobile>!$_

Neil Walsh,+31 70 353 10 74,_$!<Work>!$_

My Work,01788853960,_$!<Work>!$_

Tracey Price,+447536038885,_$!<Mobile>!$_

Twitter,86444,_$!<Main>!$_

Katherine Woakes,+44 (0) 7738 933846,_$!<Mobile>!$_

SOCA ENU,02072383657,_$!<Mobile>!$_

SOCA ENU,020 7238 3657,_$!<Main>!$_

Gordon Stovin,61 062,_$!<Work>!$_

No name,08000857857,_$!<Mobile>!$_

Hindlip HR,0300 333 3000,_$!<Main>!$_

Alan Grinstead,07766 785645,_$!<Home>!$_

No name,+4407459616086,_$!<Mobile>!$_

Sonia Cansado Jackson,+31 6 55 44 88 40,_$!<Mobile>!$_

Sonia Cansado Jackson,+31 6 15 88 74 84,_$!<Mobile>!$_

Apple Inc.,0800 039 1010,_$!<Main>!$_

Dentist,02476344222,_$!<Mobile>!$_

Katie Fiander,+31 (0) 6 17 99 48 12,_$!<Home>!$_

My Work,+31703531848,_$!<Other>!$_

Stella Paphitou,+31 6 17 85 50 86,_$!<Mobile>!$_

Lorraine Billenness,07929 246745,_$!<Home>!$_

Sonia Cansado Jackson,07525 795480,_$!<Mobile>!$_

Tracey Price,01788813229,_$!<Home>!$_

Twitter,86444,_$!<Mobile>!$_

UNISON,0800 085 7857,_$!<Main>!$_

Neil Walsh,+31 6 17 49 85 47,_$!<Mobile>!$_

Gordon Stovin,07980 236615,_$!<Mobile>!$_

Pete Hill,01788 853986,_$!<Work>!$_

Terry Conway,07835920522,_$!<Mobile>!$_

Jim Essex,07795223656,_$!<Work>!$_

Laura Hornby,+44 (0) 7976 252094,_$!<Mobile>!$_

Pat Conway,07986574808,_$!<Mobile>!$_

Persimmon Office,02476442059,_$!<Mobile>!$_

Julie Sidaway,07766732295,_$!<Mobile>!$_

Annette Cox,+34666061824,_$!<Mobile>!$_

Alan Townsend,07824 626589,_$!<Mobile>!$_

Linda Bridges,07990653832,_$!<Mobile>!$_

Yan Vin Ng,+852 6338 5332,_$!<Mobile>!$_

Jon Burford,+44 (0) 7961 992602,_$!<Mobile>!$_

Keira Huggins,+44 7833 460306,_$!<Mobile>!$_

Becki Brookes,0794682728,_$!<Mobile>!$_

Primrose Drive,02476645973,_$!<Home>!$_

Dad,+44 7837 278498,_$!<Mobile>!$_

Emma Wolfe,07772 392395,_$!<Mobile>!$_

Caroline McKenzie,07745535777,_$!<Mobile>!$_

Stuart Hall,07895637736,_$!<Mobile>!$_

British Embassy Spain,917146400,_$!<Mobile>!$_

NWHC;,024 7624 3000,

Pat Conway,02089535988,_$!<Home>!$_

Paul Hinton,07881500318,_$!<Mobile>!$_

Jay Chung,07780575848,_$!<Mobile>!$_

Irene McComiskey,+44 (0) 7425 133604,_$!<Mobile>!$_

Consular Assistance,+442070081500,_$!<Mobile>!$_

Andy Carrington,07771810401,_$!<Mobile>!$_

Derek Howlett,07903 545429,_$!<Mobile>!$_

Nanny,02089530887,_$!<Home>!$_

Pizza Hut Ricoh,02476669960,_$!<Mobile>!$_

Julie Kennedy,07816685746,_$!<Mobile>!$_

Roy Cox,+34666061823,_$!<Mobile>!$_

Peter Townsend,+44 (0) 7976 386749,_$!<Mobile>!$_

Jo Tait,+44 (0) 7722 529228,_$!<Mobile>!$_

Yan Vin Ng,+855 223387777,_$!<Home>!$_

Lindsey Taylor,07513 991433,_$!<Mobile>!$_

Jemma Bull,+44 (0) 7592 799578,_$!<Mobile>!$_

SEAT Listers,02476456700,_$!<Mobile>!$_

Chris Lyons,+44 (0) 7850 895472,_$!<Mobile>!$_

Dad Work,07976 409949,_$!<Mobile>!$_

British Embassy Spain,917146300,_$!<Mobile>!$_

Clare Hutchcox,+44 (0) 7827 317347,_$!<Mobile>!$_

Helen Parker,07730580055,_$!<Mobile>!$_

Rachael Chance,+44 (0) 7794 549550,_$!<Mobile>!$_

Johnny Chung,+44 (0) 7818 835422,_$!<Mobile>!$_

Jan Bilby,02476345380,_$!<Home>!$_

Irene McComiskey,02476596610,_$!<Home>!$_

Amy Ciclaire,07986058888,_$!<Mobile>!$_

Pete Hill,07824836747,_$!<Mobile>!$_

Mi Teléfono Español,+34654816817,_$!<Mobile>!$_

Caroline Winn,+44 (0) 7725 887797,_$!<Mobile>!$_

Louise Brook,+44 (0) 7977 219707,_$!<Mobile>!$_

Lesley Prentice,01276 471412,_$!<Mobile>!$_

Doctors,02476315432,_$!<Mobile>!$_

Ben Kirby,07818012659,_$!<Mobile>!$_

Pete Trahern,07920542262,_$!<Mobile>!$_

Julie Kennedy,01452 547783,_$!<Mobile>!$_

Linda Bridges,+44 7834 686353,_$!<Mobile>!$_

Carolina Nutt,+44 (0) 7796 344740,_$!<Mobile>!$_

Cadet Close,02476457311,_$!<Home>!$_

Gray Opticians,01788544948,_$!<Mobile>!$_

Hector Candelas Ortega,+44 (0) 7967 505855,_$!<Mobile>!$_

Julie Sidaway,+447427665905,Own mobile

Jon Burford,07798746010,_$!<Work>!$_

David McComiskey,+44 (0) 7773 782662,_$!<Mobile>!$_

Chris Lyons,07792 496302,_$!<Mobile>!$_

Sonia Cansado Jackson,+44 7525 795480,_$!<Mobile>!$_

Carolina Nutt,+44 7818 137200,_$!<Mobile>!$_

Nhien An Le Khac,+353 1 716 2929,_$!<Home>!$_

Louise Brook,07977 219707,_$!<Mobile>!$_

JATINDER lotay,+44 (0) 7740 895813,_$!<Mobile>!$_

Cristina Baroncelli,(06) 36 01 58 26,_$!<Home>!$_

Pablo Alonso,+34 667 97 55 41,_$!<Mobile>!$_

Trevor Clarke,07984 664908,_$!<Mobile>!$_

Sarah Mole,07958 744311,_$!<Mobile>!$_

Mum's International Phone,+44 (0) 7459 616625,_$!<Mobile>!$_

Francisco Luis,+31 6 26 93 17 96,_$!<Home>!$_

Ina Drewitz,07580 012039,_$!<Mobile>!$_

Laila,07984634532,_$!<Home>!$_

Sarah Mole,+44 (0) 7958 744311,_$!<Mobile>!$_

Jon Cooper,+44 (0) 7834 336088,_$!<Mobile>!$_

Alex Gutwin,+31 6 18965630,_$!<Mobile>!$_

Julia Watson,07814295022,_$!<Mobile>!$_

Steve Cox,+44 (0) 7528 833800,_$!<Mobile>!$_

Veerle Petit,+31 6 43044755,_$!<Mobile>!$_

Francisco Luis,+31 6 48519983,_$!<Mobile>!$_

Kama,+31 6 82907629,_$!<Mobile>!$_

Julie Timerick,07846 986194,_$!<Mobile>!$_

Aleks Buko,+31 6 28311190,_$!<Mobile>!$_

Keith Bristow,+44 7919 564510,_$!<Mobile>!$_

Manor Court Road Dentist,+44 24 7635 3450,_$!<CompanyMain>!$_

Sarah Mole,07890 055201,_$!<Work>!$_

Adrian Bobeica,+31 6 48519986,_$!<Mobile>!$_

Michael Mahl,00 31 6 28 66 76 65,_$!<Mobile>!$_

Cristina Baroncelli,(06) 36 01 58 27,_$!<Mobile>!$_

Alice Stokes,0627473487,_$!<Home>!$_

Shadi,+31 6 12689994,_$!<Mobile>!$_

Mum,+44 7837 278491,_$!<Mobile>!$_

Hans,+31 6 42121411,_$!<Mobile>!$_

Holywell House Hinckley,01455234758,_$!<CompanyMain>!$_

Julia Watson,01905747063,_$!<Work>!$_

Sandi Pirc,+31629054693,_$!<Home>!$_

International Health Centre,+31 70 306 5100,_$!<Home>!$_

Rob Van Der Veldt,+31 6 24 81 95 81,_$!<Mobile>!$_

Michelle Wright,07890 203514,_$!<Mobile>!$_

Tom Moore,07976 869162,_$!<Mobile>!$_

Massimo Badini Confalonieri,+44 (0) 7939 949587,_$!<Home>!$_

Nav Malik,+447810153870,_$!<Mobile>!$_

Nick Papanikolaou,+31 6 34 71 38 71,_$!<Mobile>!$_

Matthew Tullett,07957 379270,_$!<Mobile>!$_

Trevor Clarke,+44 (0) 7984 664908,_$!<Mobile>!$_

Mio Makauchi,44 7876124257,_$!<Mobile>!$_

Ina Drewitz,+44 (0) 7580 012039,_$!<Home>!$_

Landlord,+31 6 12 12 62 36,_$!<Mobile>!$_

Mio Makauchi,44 1908378771,_$!<Home>!$_

Limon,0703561465,_$!<CompanyMain>!$_

Xymena Skowron,+31 6 42 90 94 79,_$!<Mobile>!$_

Stefan Dulman,+31 6 45 38 23 52,_$!<Mobile>!$_

Julia Watson,(6) 10 63,_$!<CompanyMain>!$_

Roger,+47 943 21 560,_$!<HomeFAX>!$_

Steve Cox,07528 833800,_$!<Mobile>!$_

Jon Cooper,07834 336088,_$!<Mobile>!$_

Sarah Crowther,07847138546,_$!<Mobile>!$_

Aldona Trela,+31 6 33 09 20 03,_$!<Mobile>!$_

Enact Conveyancing,0844 244 3168,_$!<Work>!$_

Frank Tutty,+31 70 302 55 71,_$!<Work>!$_

Maher,(06) 85 11 30 96,_$!<HomeFAX>!$_

Frank Tutty,+44 7552 213195,_$!<Work>!$_

Frank Tutty,+31 6 38 39 54 11,_$!<Home>!$_

Frank Tutty,+44 7946 616031,_$!<Mobile>!$_

Aleksandrina,+31616739181,_$!<Home>!$_

Aldona Trela,+31 6 81 33 66 81,_$!<Work>!$_

Sander,+31617070090,_$!<Mobile>!$_

Kostas Dimkas,+31647704329,_$!<Home>!$_

==========

All WhatsApp contacts and their numbers:

FULL NAME, PHONE

Wendy Cherry,+44 (0) 7909 902928

The Hague,+31 6 50 53 90 99

Tracey Price,+447536038885

Katherine Woakes,+44 (0) 7738 933846

Sonia Cansado Jackson,+31 6 55 44 88 40

Sonia Cansado Jackson,+31 6 15 88 74 84

Neil Walsh,+31 6 17 49 85 47

Laura Hornby,+44 (0) 7976 252094

Yan Vin Ng,+852 6338 5332

Jon Burford,+44 (0) 7961 992602

Irene McComiskey,+44 (0) 7425 133604

Peter Townsend,+44 (0) 7976 386749

Jo Tait,+44 (0) 7722 529228

Chris Lyons,+44 (0) 7850 895472

Clare Hutchcox,+44 (0) 7827 317347

Rachael Chance,+44 (0) 7794 549550

Mi Teléfono Español,+34654816817

Caroline Winn,+44 (0) 7725 887797

Linda Bridges,+44 7834 686353

Carolina Nutt,+44 (0) 7796 344740

Hector Candelas Ortega,+44 (0) 7967 505855

Julie Sidaway,+447427665905

David McComiskey,+44 (0) 7773 782662

Sonia Cansado Jackson,+44 7525 795480

Carolina Nutt,+44 7818 137200

JATINDER lotay,+44 (0) 7740 895813

Cristina Baroncelli,(06) 36 01 58 26

Pablo Alonso,+34 667 97 55 41

Sarah Mole,+44 (0) 7958 744311

Jon Cooper,+44 (0) 7834 336088

Alex Gutwin,+31 6 18965630

Veerle Petit,+31 6 43044755

Francisco Luis,+31 6 48519983

Kama,+31 6 82907629

Aleks Buko,+31 6 28311190

Keith Bristow,+44 7919 564510

Adrian Bobeica,+31 6 48519986

Cristina Baroncelli,(06) 36 01 58 27

Alice Stokes,0627473487

Shadi,+31 6 12689994

Hans,+31 6 42121411

Sandi Pirc,+31629054693

Rob Van Der Veldt,+31 6 24 81 95 81

Massimo Badini Confalonieri,+44 (0) 7939 949587

Nick Papanikolaou,+31 6 34 71 38 71

Trevor Clarke,+44 (0) 7984 664908

Ina Drewitz,+44 (0) 7580 012039

Landlord,+31 6 12 12 62 36

Stefan Dulman,+31 6 45 38 23 52

Roger,+47 943 21 560

Aldona Trela,+31 6 33 09 20 03

Maher,(06) 85 11 30 96

Frank Tutty,+31 6 38 39 54 11

Aleksandrina,+31616739181

Sander,+31617070090

Kostas Dimkas,+31647704329

==========

All phone contacts, including set status of WhatsApp contacts, the path to their profile pictures and the date/time the picture was set:

PHONE, STATUS TEXT, PROFILE PICTURE PATH, DATE/TIME SET (UTC)

+44 (0) 7738 933846,Available,None,None

+31 6 55 44 88 40,Available,None,None

+31 6 50 53 90 99,Dutch Phone,Media/Profile/31650539099-1395820689,2014-03-26 07:58:09

+44 (0) 7909 902928,Waiting to see if I've won the lottery,Media/Profile/447909902928-1386188799,2013-12-04 20:26:39

+447536038885,Rugby World Cup 2015 - #Carrythemhome,Media/Profile/447536038885-1441639979,2015-09-07 15:32:59

+44 (0) 7961 992602,Hey there! I am using WhatsApp.,Media/Profile/447961992602-1393416189,2014-02-26 12:03:09

+44 (0) 7425 133604,Hey there! I am using WhatsApp.,Media/Profile/447425133604-1430152721,2015-04-27 16:38:41

+44 (0) 7827 317347,Sleeping,Media/Profile/447827317347-1423072878,2015-02-04 18:01:18

+44 (0) 7725 887797,Gin. It's the future ,Media/Profile/447725887797-1447702325,2015-11-16 19:32:05

+44 (0) 7976 386749,,Media/Profile/447976386749-1401476341,2014-05-30 18:59:01

+44 (0) 7850 895472,Hey there! I am using WhatsApp.,None,None

+447427665905,Walking the dog!,Media/Profile/447427665905-1377878848,2013-08-30 16:07:28

+44 (0) 7794 549550,Hey there! I am using WhatsApp.,Media/Profile/447794549550-1435128261,2015-06-24 06:44:21

+44 (0) 7722 529228,,Media/Profile/447722529228-1444822344,2015-10-14 11:32:24

+34654816817,Mi 3*rubia❤ mis 45* locas....Me pusieron límites en el cielo y me fui al infierno. ❤MYE❤ 24*loquiii,Media/Profile/34654816817-1446244925,2015-10-30 22:42:05

+44 (0) 7773 782662,Hey there! I am using WhatsApp.,Media/Profile/447773782662-1349789480,2012-10-09 13:31:20

+44 7834 686353,At work,Media/Profile/447834686353-1457019518,2016-03-03 15:38:38

+852 6338 5332,Dancing keeps me breathing~,Media/Profile/85263385332-1397921044,2014-04-19 15:24:04

+44 (0) 7967 505855,Hey there! I am using WhatsApp.,Media/Profile/447967505855-1420244378,2015-01-03 00:19:38

+31 6 17 49 85 47,,None,None

+44 (0) 7796 344740,,Media/Profile/447796344740-1457869142,2016-03-13 11:39:02

+44 (0) 7976 252094,Hey there! I am using WhatsApp.,None,None

+31 6 15 88 74 84,,None,None

+44 7525 795480,Es lo que hay,None,None

+44 7818 137200,Hey there! I am using WhatsApp.,None,None

+44 (0) 7740 895813,Pray and love...❤,None,None

+44 (0) 7580 012039,...status unknown...,None,None

+31 6 34 71 38 71,...status unknown...,None,None

+31 6 48519986,...status unknown...,None,None

+44 (0) 7958 744311,...status unknown...,None,None

+44 (0) 7984 664908,...status unknown...,None,None

+44 (0) 7834 336088,...status unknown...,None,None

+31 6 12689994,...status unknown...,None,None

+31 6 28311190,...status unknown...,None,None

+31629054693,Hey there! I am using WhatsApp.,None,None

+31 6 48519983,...status unknown...,None,None

+31 6 42121411,...status unknown...,None,None

+34 667 97 55 41,...status unknown...,None,None

+31 6 18965630,1+1=10,None,None

+31 6 12 12 62 36,...status unknown...,None,None

+44 7919 564510,...status unknown...,None,None

0627473487,...status unknown...,None,None

+47 943 21 560,...status unknown...,None,None

+44 (0) 7939 949587,...status unknown...,None,None

+31 6 82907629,,None,None

+31 6 24 81 95 81,...status unknown...,None,None

(06) 36 01 58 27,...status unknown...,None,None

+31 6 43044755,...status unknown...,None,None

+31 6 45 38 23 52,...status unknown...,None,None

(06) 36 01 58 26,...status unknown...,None,None

+31647704329,...status unknown...,None,None

+31616739181,...status unknown...,None,None

+31 6 33 09 20 03,...status unknown...,None,None

(06) 85 11 30 96,...status unknown...,None,None

+31 6 38 39 54 11,Hey there! I am using WhatsApp.,None,None

+31617070090,...status unknown...,None,None

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END OF REPORT

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8.3 Appendix 1c: results_chats.txt

ANALYSIS OF THE CHATSTORAGE.SQLITE WHATSAPP DATABASE

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The name of the contact, number of messages exchanged and their nickname as set by them in order of top contact first:

CHAT ID, USER'S NAME, WHATSAPP ID, NUMBER OF MESSAGES EXCHANGED

21,Aldona Trela,31633092003@s.whatsapp.net,5807,

17,Irene McComiskey,447425133604@s.whatsapp.net,817,

29,Yan Vin Ng,85263385332@s.whatsapp.net,459,

22,Julie Sidaway,447427665905@s.whatsapp.net,275,

42,City,31648519986-1454614809@g.us,197,

52,Roger,4794321560@s.whatsapp.net,194,

19,Hector Candelas Ortega,447967505855@s.whatsapp.net,175,

23,Jo Tait,447722529228@s.whatsapp.net,141,

38,Sonia Cansado Jackson,31655448840@s.whatsapp.net,139,

43,Francisco Luis,31648519983@s.whatsapp.net,108,

20,Drink tonight?,31633092003-1405170959@g.us,81,

50,Carolina Nutt,447818137200@s.whatsapp.net,71,

40,Frank Tutty,31638395411@s.whatsapp.net,60,

54,Aleksandrina,31616739181@s.whatsapp.net,34,

30,van Gogh,31633092003-1408727863@g.us,31,

31,People,31615887484-1409253193@g.us,29,

53,Veerle Petit,31643044755@s.whatsapp.net,29,

18,Francisco Luis,31626931796@s.whatsapp.net,25,

26,Sarah Mole,447958744311@s.whatsapp.net,24,

44,Hans,31642121411@s.whatsapp.net,24,

47,Shadi,31612689994@s.whatsapp.net,24,

60,+31 6 55485985,31655485985@s.whatsapp.net,23,

41,Cristina Baroncelli,31636015827@s.whatsapp.net,22,

27,Jon Burford,447961992602@s.whatsapp.net,21,

56,Kama,31682907629@s.whatsapp.net,20,

51,Pablo Alonso,34667975541@s.whatsapp.net,19,

58,Massimo Badini Confalonieri,447939949587@s.whatsapp.net,16,

49,Aleks Buko,31628311190@s.whatsapp.net,12,

57,Kostas Dimkas,31647704329@s.whatsapp.net,11,

37,Sonia Cansado Jackson,447525795480@s.whatsapp.net,10,

55,Alex Gutwin,31618965630@s.whatsapp.net,10,

25,Sonia Cansado Jackson,31615887484@s.whatsapp.net,8,

24,Tracey Price,447536038885@s.whatsapp.net,7,

48,Sander,31617070090@s.whatsapp.net,7,

59,WhatsApp,0@status,7,

32,Sushi and wine,31633092003-1434803776@g.us,6,

45,Carolina Nutt,447796344740@s.whatsapp.net,6,

33,Hardcore walks team,31633092003-1431192285@g.us,5,

28,+31 6 34340150,31634340150@s.whatsapp.net,4,

34,Nuestra cena,31650539099-1430852557@g.us,4,

35,New York,31633092003-1420974449@g.us,4,

36,Wednesday,31633092003-1427143565@g.us,4,

61,Carolina Nutt,447818137200@status,2,

==========

Each contact and the path to their profile picture, along with the time and date it was set:

CHAT ID, USER'S NAME, WHATSAPP ID, PICTURE PATH, DATE/TIME PICTURE WAS SET (UTC)

17,Irene McComiskey,447425133604@s.whatsapp.net,Media/Profile/447425133604-1430152721,2015-04-27 16:38:41

18,Francisco Luis,31626931796@s.whatsapp.net,None,None

19,Hector Candelas Ortega,447967505855@s.whatsapp.net,Media/Profile/447967505855-1420244378,2015-01-03 00:19:38

20,Drink tonight?,31633092003-1405170959@g.us,Media/Profile/31633092003-1405170959-1405178721,2014-07-12 15:25:21

21,Aldona Trela,31633092003@s.whatsapp.net,Media/Profile/31633092003-1395300120,2014-03-20 07:22:00

22,Julie Sidaway,447427665905@s.whatsapp.net,Media/Profile/447427665905-1377878848,2013-08-30 16:07:28

23,Jo Tait,447722529228@s.whatsapp.net,Media/Profile/447722529228-1484499985,2017-01-15 17:06:25

24,Tracey Price,447536038885@s.whatsapp.net,Media/Profile/447536038885-1441639979,2015-09-07 15:32:59

25,Sonia Cansado Jackson,31615887484@s.whatsapp.net,None,None

26,Sarah Mole,447958744311@s.whatsapp.net,Media/Profile/447958744311-1488412058,2017-03-01 23:47:38

27,Jon Burford,447961992602@s.whatsapp.net,Media/Profile/447961992602-1393416189,2014-02-26 12:03:09

28,+31 6 34340150,31634340150@s.whatsapp.net,Media/Profile/31634340150-1480883601,2016-12-04 20:33:21

29,Yan Vin Ng,85263385332@s.whatsapp.net,Media/Profile/85263385332-1397921044,2014-04-19 15:24:04

30,van Gogh,31633092003-1408727863@g.us,None,None

31,People,31615887484-1409253193@g.us,None,None

32,Sushi and wine,31633092003-1434803776@g.us,None,None

33,Hardcore walks team,31633092003-1431192285@g.us,None,None

34,Nuestra cena,31650539099-1430852557@g.us,None,None

35,New York,31633092003-1420974449@g.us,None,None

36,Wednesday,31633092003-1427143565@g.us,None,None

37,Sonia Cansado Jackson,447525795480@s.whatsapp.net,Media/Profile/447525795480-1427237937,2015-03-24 22:58:57

38,Sonia Cansado Jackson,31655448840@s.whatsapp.net,Media/Profile/31655448840-1469381902,2016-07-24 17:38:22

40,Frank Tutty,31638395411@s.whatsapp.net,Media/Profile/31638395411-1469642985,2016-07-27 18:09:45

41,Cristina Baroncelli,31636015827@s.whatsapp.net,Media/Profile/31636015827-1359585062,2013-01-30 22:31:02

42,City,31648519986-1454614809@g.us,Media/Profile/31648519986-1454614809-1454614918,2016-02-04 19:41:58

43,Francisco Luis,31648519983@s.whatsapp.net,Media/Profile/31648519983-1447489591,2015-11-14 08:26:31

44,Hans,31642121411@s.whatsapp.net,None,None

45,Carolina Nutt,447796344740@s.whatsapp.net,Media/Profile/447796344740-1488839423,2017-03-06 22:30:23

47,Shadi,31612689994@s.whatsapp.net,Media/Profile/31612689994-1471888753,2016-08-22 17:59:13

48,Sander,31617070090@s.whatsapp.net,Media/Profile/31617070090-1466183881,2016-06-17 17:18:01

49,Aleks Buko,31628311190@s.whatsapp.net,None,None

50,Carolina Nutt,447818137200@s.whatsapp.net,Media/Profile/447818137200-1489627092,2017-03-16 01:18:12

51,Pablo Alonso,34667975541@s.whatsapp.net,None,None

52,Roger,4794321560@s.whatsapp.net,Media/Profile/4794321560-1474478914,2016-09-21 17:28:34

53,Veerle Petit,31643044755@s.whatsapp.net,Media/Profile/31643044755-1489265575,2017-03-11 20:52:55

54,Aleksandrina,31616739181@s.whatsapp.net,Media/Profile/31616739181-1488244316,2017-02-28 01:11:56

55,Alex Gutwin,31618965630@s.whatsapp.net,None,None

56,Kama,31682907629@s.whatsapp.net,Media/Profile/31682907629-1490036587,2017-03-20 19:03:07

57,Kostas Dimkas,31647704329@s.whatsapp.net,Media/Profile/31647704329-1475513133,2016-10-03 16:45:33

58,Massimo Badini Confalonieri,447939949587@s.whatsapp.net,None,None

60,+31 6 55485985,31655485985@s.whatsapp.net,Media/Profile/31655485985-1462365259,2016-05-04 12:34:19

==========

The name of each contact for whom there is a nickname, as set by themselves on the app:

CHAT ID, USER'S NAME, WHATSAPP ID, NICKNAME

43,Francisco Luis,31648519983@s.whatsapp.net,Francisco Luís,

22,Julie Sidaway,447427665905@s.whatsapp.net,Julie Sidaway,

19,Hector Candelas Ortega,447967505855@s.whatsapp.net,Yo,

21,Aldona Trela,31633092003@s.whatsapp.net,ada,

29,Yan Vin Ng,85263385332@s.whatsapp.net,Angela Ng (6s),

17,Irene McComiskey,447425133604@s.whatsapp.net,reneemccomiskey23,

55,Alex Gutwin,31618965630@s.whatsapp.net,Alex,

49,Aleks Buko,31628311190@s.whatsapp.net,Alex B,

47,Shadi,31612689994@s.whatsapp.net,shadi ghandchi,

40,Frank Tutty,31638395411@s.whatsapp.net,Frank Tutty,

48,Sander,31617070090@s.whatsapp.net,Sander,

50,Carolina Nutt,447818137200@s.whatsapp.net,Carolina,

51,Pablo Alonso,34667975541@s.whatsapp.net,.,

52,Roger,4794321560@s.whatsapp.net,Roger,

53,Veerle Petit,31643044755@s.whatsapp.net,Veerle Petit,

23,Jo Tait,447722529228@s.whatsapp.net,Jo,

54,Aleksandrina,31616739181@s.whatsapp.net,Alex,

56,Kama,31682907629@s.whatsapp.net,Kama,

57,Kostas Dimkas,31647704329@s.whatsapp.net,Konstantinos Dimkas,

58,Massimo Badini Confalonieri,447939949587@s.whatsapp.net,Max,

60,+31 6 55485985,31655485985@s.whatsapp.net,Sandi PIRC (DUTY),

==========

The date and time of the last message in each chat:

CHAT ID, USER'S NAME, WHATSAPP ID, DATE/TIME OF LAST MESSAGE (UTC)

17,Irene McComiskey,447425133604@s.whatsapp.net,2017-02-22 15:53:45

18,Francisco Luis,31626931796@s.whatsapp.net,2014-07-10 14:32:14

19,Hector Candelas Ortega,447967505855@s.whatsapp.net,2016-12-08 15:05:04

20,Drink tonight?,31633092003-1405170959@g.us,2014-07-19 18:44:15

21,Aldona Trela,31633092003@s.whatsapp.net,2017-03-25 19:11:25

22,Julie Sidaway,447427665905@s.whatsapp.net,2017-03-13 20:43:45

23,Jo Tait,447722529228@s.whatsapp.net,2016-11-25 20:58:38

24,Tracey Price,447536038885@s.whatsapp.net,2014-07-29 19:21:09

25,Sonia Cansado Jackson,31615887484@s.whatsapp.net,2014-07-16 10:16:31

26,Sarah Mole,447958744311@s.whatsapp.net,2014-08-19 10:40:50

27,Jon Burford,447961992602@s.whatsapp.net,2014-08-01 20:22:37

28,+31 6 34340150,31634340150@s.whatsapp.net,2014-08-01 17:14:50

29,Yan Vin Ng,85263385332@s.whatsapp.net,2016-12-21 15:29:36

30,van Gogh,31633092003-1408727863@g.us,2014-08-22 20:37:45

31,People,31615887484-1409253193@g.us,2014-08-28 21:04:21

32,Sushi and wine,31633092003-1434803776@g.us,2015-06-20 12:36:16

33,Hardcore walks team,31633092003-1431192285@g.us,2015-05-09 17:24:45

34,Nuestra cena,31650539099-1430852557@g.us,None

35,New York,31633092003-1420974449@g.us,2015-01-11 11:07:29

36,Wednesday,31633092003-1427143565@g.us,2015-03-23 20:46:05

37,Sonia Cansado Jackson,447525795480@s.whatsapp.net,2015-10-20 19:49:13

38,Sonia Cansado Jackson,31655448840@s.whatsapp.net,2016-07-07 17:14:03

40,Frank Tutty,31638395411@s.whatsapp.net,2016-09-16 10:58:47

41,Cristina Baroncelli,31636015827@s.whatsapp.net,2016-03-28 18:43:54

42,City,31648519986-1454614809@g.us,2016-12-24 19:14:53

43,Francisco Luis,31648519983@s.whatsapp.net,2016-09-18 14:50:42

44,Hans,31642121411@s.whatsapp.net,2016-04-10 16:17:14

45,Carolina Nutt,447796344740@s.whatsapp.net,2016-04-23 17:18:37

47,Shadi,31612689994@s.whatsapp.net,2016-09-16 17:38:33

48,Sander,31617070090@s.whatsapp.net,2016-09-22 13:34:14

49,Aleks Buko,31628311190@s.whatsapp.net,2016-09-25 18:01:12

50,Carolina Nutt,447818137200@s.whatsapp.net,2017-02-17 17:38:15

51,Pablo Alonso,34667975541@s.whatsapp.net,2017-01-13 08:43:49

52,Roger,4794321560@s.whatsapp.net,2017-01-10 14:39:41

53,Veerle Petit,31643044755@s.whatsapp.net,2016-11-21 17:12:33

54,Aleksandrina,31616739181@s.whatsapp.net,2017-02-26 18:17:09

55,Alex Gutwin,31618965630@s.whatsapp.net,2016-11-25 19:22:44

56,Kama,31682907629@s.whatsapp.net,2016-12-11 16:18:28

57,Kostas Dimkas,31647704329@s.whatsapp.net,2017-01-12 17:33:46

58,Massimo Badini Confalonieri,447939949587@s.whatsapp.net,2017-02-15 08:49:41

59,WhatsApp,0@status,4001-01-01 00:00:00

60,+31 6 55485985,31655485985@s.whatsapp.net,2017-03-20 05:53:40

61,Carolina Nutt,447818137200@status,2017-03-16 13:57:37

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GROUP CHAT STATISTICS

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The total number of group chats:

NUMBER OF GROUP CHATS

9

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The name of each group and the members of that group:

CHAT ID, GROUP NAME, MEMBER'S NAME, WHATSAPP ID

20,Drink tonight?,Aldona Trela,31633092003@s.whatsapp.net

20,Drink tonight?,The Hague,31650539099@s.whatsapp.net

20,Drink tonight?,+31 6 33613330,31633613330@s.whatsapp.net

20,Drink tonight?,+31 6 81340989,31681340989@s.whatsapp.net

20,Drink tonight?,+31 6 34834148,31634834148@s.whatsapp.net

30,van Gogh,Aldona Trela,31633092003@s.whatsapp.net

30,van Gogh,The Hague,31650539099@s.whatsapp.net

30,van Gogh,+48 723 518 847,48723518847@s.whatsapp.net

30,van Gogh,+31 6 33613330,31633613330@s.whatsapp.net

30,van Gogh,+31 6 81340989,31681340989@s.whatsapp.net

30,van Gogh,+31 6 34834148,31634834148@s.whatsapp.net

31,People,Sonia Cansado Jackson,31615887484@s.whatsapp.net

31,People,The Hague,31650539099@s.whatsapp.net

31,People,+44 7875 702586,447875702586@s.whatsapp.net

31,People,+31 6 17966009,31617966009@s.whatsapp.net

31,People,+39 345 321 0073,393453210073@s.whatsapp.net

31,People,+357 99 652517,35799652517@s.whatsapp.net

31,People,+44 7846 273671,447846273671@s.whatsapp.net

31,People,+39 349 296 3199,393492963199@s.whatsapp.net

31,People,+39 392 066 8382,393920668382@s.whatsapp.net

31,People,+31 6 18885788,31618885788@s.whatsapp.net

32,Sushi and wine,The Hague,31650539099@s.whatsapp.net

32,Sushi and wine,Aldona Trela,31633092003@s.whatsapp.net

32,Sushi and wine,+31 6 33613330,31633613330@s.whatsapp.net

32,Sushi and wine,+31 6 81340989,31681340989@s.whatsapp.net

33,Hardcore walks team,Aldona Trela,31633092003@s.whatsapp.net

33,Hardcore walks team,The Hague,31650539099@s.whatsapp.net

33,Hardcore walks team,+31 6 28487952,31628487952@s.whatsapp.net

34,Nuestra cena,Carolina Nutt,447796344740@s.whatsapp.net

34,Nuestra cena,Hector Candelas Ortega,447967505855@s.whatsapp.net

34,Nuestra cena,The Hague,31650539099@s.whatsapp.net

35,New York,Aldona Trela,31633092003@s.whatsapp.net

35,New York,The Hague,31650539099@s.whatsapp.net

35,New York,+31 6 33613330,31633613330@s.whatsapp.net

36,Wednesday,The Hague,31650539099@s.whatsapp.net

36,Wednesday,Aldona Trela,31633092003@s.whatsapp.net

36,Wednesday,+31 6 34834148,31634834148@s.whatsapp.net

42,City,The Hague,31650539099@s.whatsapp.net

42,City,Adrian Bobeica,31648519986@s.whatsapp.net

42,City,Francisco Luis,31648519983@s.whatsapp.net

42,City,Alex Gutwin,31618965630@s.whatsapp.net

42,City,Aldona Trela,31633092003@s.whatsapp.net

42,City,Aleks Buko,31628311190@s.whatsapp.net

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Groups with profile pictures set and the path to the group's picture, along with the time and date the picture was set.

Note the first part of the filename shows the number of the person who set the group picture:

CHAT ID, PICTURE PATH, DATE/TIME PICTURE WAS SET (UTC)

20,Media/Profile/31633092003-1405170959-1405178721,2014-07-12 15:25:21

42,Media/Profile/31648519986-1454614809-1454614918,2016-02-04 19:41:58

==========

Members still active in each group:

CHAT ID, GROUP NAME, MEMBER'S NAME, WHATSAPP ID

20,Drink tonight?,The Hague,31650539099@s.whatsapp.net

20,Drink tonight?,+31 6 33613330,31633613330@s.whatsapp.net

20,Drink tonight?,+31 6 34834148,31634834148@s.whatsapp.net

30,van Gogh,The Hague,31650539099@s.whatsapp.net

30,van Gogh,+31 6 33613330,31633613330@s.whatsapp.net

31,People,The Hague,31650539099@s.whatsapp.net

31,People,+44 7875 702586,447875702586@s.whatsapp.net

31,People,+39 345 321 0073,393453210073@s.whatsapp.net

32,Sushi and wine,The Hague,31650539099@s.whatsapp.net

32,Sushi and wine,+31 6 33613330,31633613330@s.whatsapp.net

33,Hardcore walks team,The Hague,31650539099@s.whatsapp.net

33,Hardcore walks team,+31 6 28487952,31628487952@s.whatsapp.net

34,Nuestra cena,Hector Candelas Ortega,447967505855@s.whatsapp.net

34,Nuestra cena,The Hague,31650539099@s.whatsapp.net

35,New York,Aldona Trela,31633092003@s.whatsapp.net

35,New York,The Hague,31650539099@s.whatsapp.net

35,New York,+31 6 33613330,31633613330@s.whatsapp.net

36,Wednesday,The Hague,31650539099@s.whatsapp.net

36,Wednesday,Aldona Trela,31633092003@s.whatsapp.net

36,Wednesday,+31 6 34834148,31634834148@s.whatsapp.net

42,City,The Hague,31650539099@s.whatsapp.net

42,City,Adrian Bobeica,31648519986@s.whatsapp.net

42,City,Francisco Luis,31648519983@s.whatsapp.net

42,City,Alex Gutwin,31618965630@s.whatsapp.net

42,City,Aldona Trela,31633092003@s.whatsapp.net

42,City,Aleks Buko,31628311190@s.whatsapp.net

==========

The contact who started each group:

CHAT ID, GROUP NAME, WHATSAPP ID OF GROUP CREATOR

20,Drink tonight?,31633092003@s.whatsapp.net

30,van Gogh,31633092003@s.whatsapp.net

31,People,31615887484@s.whatsapp.net

32,Sushi and wine,31633092003@s.whatsapp.net

33,Hardcore walks team,31633092003@s.whatsapp.net

34,Nuestra cena,31650539099@s.whatsapp.net

35,New York,31633092003@s.whatsapp.net

36,Wednesday,31633092003@s.whatsapp.net

42,City,31648519986@s.whatsapp.net

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The creation date of each group and the date/time the subject was set:

CHAT ID, CREATION DATE/TIME (UTC), DATE/TIME GROUP SUBJECT SET (UTC)

20,2014-07-12 13:15:59,2014-07-12 13:15:59

30,2014-08-22 17:17:43,2014-08-22 17:17:43

31,2014-08-28 19:13:13,2014-08-28 19:13:13

32,2015-06-20 12:36:16,2015-06-20 12:36:16

33,2015-05-09 17:24:45,2015-05-10 14:43:17

34,2015-05-05 19:02:37,2015-05-05 19:02:37

35,2015-01-11 11:07:29,2015-01-11 11:07:29

36,2015-03-23 20:46:05,2015-03-23 20:46:05

42,2016-02-04 19:40:09,2016-02-04 19:40:09

==========

The last message sender in each group:

CHAT ID, MEMBER'S NAME, WHATSAPP ID

20,Aldona Trela,31633092003@s.whatsapp.net

31,+31 6 17966009,31617966009@s.whatsapp.net

32,Aldona Trela,31633092003@s.whatsapp.net

33,Aldona Trela,31633092003@s.whatsapp.net

42,Francisco Luis,31648519983@s.whatsapp.net

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STARRED MESSAGES AND BLOCKED NUMBERS

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All starred messages

Note that where user details appear as 'none', the message was outgoing:

CHAT ID, USER'S NICKNAME, WHATSAPP ID OF SENDER, DATE/TIME OF MESSAGE (UTC), MESSAGE TEXT

21,None,None,2015-11-05 21:35:24,￼ I thought you might do that, I guess I know you too well haha

21,ada,31633092003@s.whatsapp.net,2016-02-16 17:08:17,Please tell me if I again overload you with my issues, I don't want this to happen again...

21,ada,31633092003@s.whatsapp.net,2016-05-16 07:51:56,I know it is last moment but in case you have no other plans it would be nice if you joined me

21,None,None,2016-05-23 19:55:45,Hey by the way, I have the bike and I have been practicing a little bit...long way to go though, am not roadworthy yet. Wobbly and not great at steering at the moment

21,ada,31633092003@s.whatsapp.net,2016-05-23 20:55:57,Wow! Great news!

21,ada,31633092003@s.whatsapp.net,2016-05-23 20:56:06,I am proud of you!!!

21,ada,31633092003@s.whatsapp.net,2016-08-29 14:46:02,Please don't apologise, you were doing what you though was best and always with good intentions

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Blocked Numbers:

WHATSAPP ID

31614855420@s.whatsapp.net

31685113096@s.whatsapp.net

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MEDIA ITEMS

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Media items received by the phone:

MESSAGE ID, MEDIA, SENDER'S NAME, WHATSAPP ID OF SENDER, DATE/TIME RECEIVED

2979,http://www.policija.lt/index.php?id=35756,Sonia Cansado Jackson447525795480@s.whatsapp.net

2281,http://youtu.be/cIwTYL1fwJk,Irene McComiskey447425133604@s.whatsapp.net

2130,http://m.scmp.com/topics/occupy-central,Yan Vin Ng85263385332@s.whatsapp.net

6209,https://open.spotify.com/user/ganesh1975/playlist/0djX67wZ7DbMQq9UJ1TMMG,Sonia Cansado Jackson31655448840@s.whatsapp.net

6681,https://youtu.be/kgUpRwMeRr4,Irene McComiskey447425133604@s.whatsapp.net

6682,https://youtu.be/AhzkJaEOdpM,Irene McComiskey447425133604@s.whatsapp.net

7252,https://youtu.be/JQJnv0cxfxg,Irene McComiskey447425133604@s.whatsapp.net

7625,http://www.coventrytelegraph.net/news/local-news/man-charged-raping-girl-nearly-11868530#ICID=sharebar_whatsapp,Irene McComiskey447425133604@s.whatsapp.net

7741,https://youtu.be/v9589LOnhK0,Irene McComiskey447425133604@s.whatsapp.net

8648,https://www.facebook.com/yohomallhk/videos/1812167568996109/,Yan Vin Ng85263385332@s.whatsapp.net

9482,https://www.amazon.co.uk/gp/product/B01JPLQV84/ref=as_li_tl?ie=UTF8&camp=1634&creative=6738&creativeASIN=B01JPLQV84&linkCode=as2&tag=thboco-21,Pablo Alonso34667975541@s.whatsapp.net

9484,https://www.amazon.co.uk/gp/product/B01JPLQV84/ref=as_li_tl?ie=UTF8&camp=1634&creative=6738&creativeASIN=B01JPLQV84&linkCode=as2&tag=thboco-21,Pablo Alonso34667975541@s.whatsapp.net

10233,http://www.bbc.co.uk/news/world-europe-38957246,Massimo Badini Confalonieri447939949587@s.whatsapp.net

10354,http://www.coventrytelegraph.net/news/coventry-news/hillfields-pimp-trial-two-men-12639083#ICID=Android_CoventryTelegraphNewsApp_AppShare,Irene McComiskey447425133604@s.whatsapp.net

10636,https://youtu.be/yttbFbMPQeM,+31 6 55485985316554859 85@s.whatsapp.net

10643,https://goo.gl/maps/6YNCiLRF7y72,+31 6 55485985316554859 85@s.whatsapp.net

10645,https://m.facebook.com/public/Sandi-Pirc,+31 6 55485985316554859 85@s.whatsapp.net

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Media items sent by the phone:

MESSAGE ID, MEDIA, SENT TO, MESSAGE TEXT

2107,http://m.imdb.com/title/tt1825157/,447425133604@s.whatsapp.net

2972,http://youtu.be/JEATcvEOnDw,31633092003@s.whatsapp.net

3151,http://www.bbc.co.uk/news/uk-34643783,31633092003@s.whatsapp.net

3192,http://www.bbc.co.uk/news/health-34615621,31633092003@s.whatsapp.net

3996,http://youtu.be/ltjr8Bc1Q68,31633092003@s.whatsapp.net

5422,http://youtu.be/rLdRwySl170,31633092003@s.whatsapp.net

6149,http://www.funda.nl/koop/den-haag/appartement-49711755-van-aerssenstraat-132/,31633092003@s.whatsapp.net

6812,http://www.lifehack.org/402483/10-tips-to-manage-your-migraine?ref=mail&mtype=daily_newsletter&mid=20160608_customized&uid=984077&email=rickymartinuk%40hotmail.com&action=click,447425133604@s.whatsapp.net

7679,https://youtu.be/L9jF4_KItB0,31633092003@s.whatsapp.net

10288,http://news.sky.com/video/europol-chief-warns-brexit-makes-uk-more-vulnerable-10769943,31633092003@s.whatsapp.net

10563,http://global-journey.com/music.html,31633092003@s.whatsapp.net

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Pictures sent and received by the phone:

Note that where 'Message From' appears as 'none', the message was outgoing:

MESSAGE ID, CHAT ID, MESSAGE FROM, DATE/TIME (UTC), PICTURE PATH

1763,19,447967505855@s.whatsapp.net,2014-07-11 14:52:23,/Media/447967505855@s.whatsapp.net/d/0/d0691131e6f430ff97cf1533a4639b8d.m4a

2020,26,447958744311@s.whatsapp.net,2014-07-23 07:47:04,/Media/447958744311@s.whatsapp.net/c/9/c9b0ccad4c2d41100d90ff1460d941a8.jpg

2021,26,447958744311@s.whatsapp.net,2014-07-23 07:47:05,/Media/447958744311@s.whatsapp.net/f/b/fb2adafbe454ff115fee26020b7b7a41.jpg

2022,26,447958744311@s.whatsapp.net,2014-07-23 07:47:05,/Media/447958744311@s.whatsapp.net/c/3/c331147cfe003bd07e510e43d6fb8f8b.jpg

2023,26,447958744311@s.whatsapp.net,2014-07-23 07:47:05,/Media/447958744311@s.whatsapp.net/b/b/bb562eaf9d3134775844e516cb96aaf1.jpg

2024,26,447958744311@s.whatsapp.net,2014-07-23 07:47:06,/Media/447958744311@s.whatsapp.net/0/4/04808f02715131a9c4c45d255c389a92.jpg

2025,26,447958744311@s.whatsapp.net,2014-07-23 07:47:07,/Media/447958744311@s.whatsapp.net/5/8/5830a689a5d7ad4eed1395a875ef86f5.jpg

2026,26,447958744311@s.whatsapp.net,2014-07-23 07:47:10,/Media/447958744311@s.whatsapp.net/6/5/653d3e4468514e50c6fa5c8e48d9d2c7.jpg

2033,26,None,2014-07-23
07:59:59,/Media/447958744311@s.whatsapp.net/7/2/7253cdc3541724a77cf9f3793f2ad42a.jpg

2034,26,None,2014-07-23
08:00:20,/Media/447958744311@s.whatsapp.net/4/5/45e7490a515ef009099201cf36fa240b.jpg

2035,26,None,2014-07-23
08:00:55,/Media/447958744311@s.whatsapp.net/5/9/59c19acdad0f36fb1c24f8051591c266.jpg

2332,29,85263385332@s.whatsapp.net,2014-08-31
14:55:18,/Media/85263385332@s.whatsapp.net/1/8/18a173046582456703415c50902ff3e7.jpg

2334,29,85263385332@s.whatsapp.net,2014-08-31
16:04:22,/Media/85263385332@s.whatsapp.net/8/8/889459b32c15ca368da61acb5ee32ffc.jpg

2352,21,31633092003@s.whatsapp.net,2015-10-10
13:43:40,Media/31633092003@s.whatsapp.net/e/2/e237ed708d18a2ee4eb435e098fddaa4.jpg

2383,21,None,2015-10-10
16:04:05,Media/31633092003@s.whatsapp.net/7/a/7a6efedcb65950b671a418c1ba805853.jpg

2859,21,None,2015-10-18
11:12:19,Media/31633092003@s.whatsapp.net/c/8/c83fe22a7b91cdabd6bdf4ff6b19706f.jpg

2864,21,31633092003@s.whatsapp.net,2015-10-18
11:13:39,Media/31633092003@s.whatsapp.net/6/e/6e5a6d361b50116ce1c1a248bf6a9a53.jpg

2877,21,31633092003@s.whatsapp.net,2015-10-18
11:17:06,Media/31633092003@s.whatsapp.net/6/2/62c6a3bae093c0d217bda0a167ed3179.jpg

2896,21,None,2015-10-18
15:12:38,Media/31633092003@s.whatsapp.net/3/a/3a3b046b50d326826563d697705ada58.jpg

2897,21,None,2015-10-18
15:12:43,Media/31633092003@s.whatsapp.net/d/b/db5142ad14f00fd5f715ad9c34b825a9.jpg

2933,21,31633092003@s.whatsapp.net,2015-10-18
17:56:18,Media/31633092003@s.whatsapp.net/9/b/9b4b01377f4069db76801de22c4d61f8.jpg

2954,21,31633092003@s.whatsapp.net,2015-10-18
18:25:23,Media/31633092003@s.whatsapp.net/a/4/a4905474cc4d2f1e2197f1b77b7d4299.jpg

2985,38,31655448840@s.whatsapp.net,2015-10-20
19:50:13,Media/31655448840@s.whatsapp.net/1/f/1f5bd5868619248408d05af4296bc45c.jpg

2986,38,31655448840@s.whatsapp.net,2015-10-20
19:50:13,Media/31655448840@s.whatsapp.net/3/3/3316c4e1617ace4bd2531287bb2d67d8.jpg

2994,21,31633092003@s.whatsapp.net,2015-10-21
18:44:26,Media/31633092003@s.whatsapp.net/2/0/201cb5ed4605ef2c177f83eeb36e0001.jpg

3158,21,None,2015-10-28
10:45:14,Media/31633092003@s.whatsapp.net/c/8/c865a8535ee164ecd68631c6801b5201.jpg

3226,17,None,2015-10-30
09:00:05,Media/447425133604@s.whatsapp.net/8/3/83ce8f54c33cbd82fec45e3d7e10a56e.jpg

3227,17,None,2015-10-30
09:00:22,Media/447425133604@s.whatsapp.net/e/1/e1b4e13d8a39a67e2766f2181e13d51f.jpg

3234,38,None,2015-10-30
09:30:57,Media/31655448840@s.whatsapp.net/2/b/2b444f8e36163b288a239d96d3856181.jpg

3235,38,None,2015-10-30
09:31:02,Media/31655448840@s.whatsapp.net/1/6/167cfa2dc3e845dcf02b6921cc7ca872.jpg

3251,38,31655448840@s.whatsapp.net,2015-10-30
09:56:12,Media/31655448840@s.whatsapp.net/4/0/40046b6dc75b3a143777996fee0f162b.jpg

3252,21,None,2015-10-30
10:07:05,Media/31633092003@s.whatsapp.net/4/8/483addeee4885706a4ad841804db3c98.jpg

3253,21,None,2015-10-30
10:07:04,Media/31633092003@s.whatsapp.net/a/4/a4b7355eaaf2d1966d25d3fcae9457a0.jpg

3255,21,None,2015-10-30
10:07:05,Media/31633092003@s.whatsapp.net/a/b/ab5e4233f33806a404d8f2aebbf7ce9e.jpg

3254,21,None,2015-10-30
10:07:06,Media/31633092003@s.whatsapp.net/6/1/61afb50255c97f65978f1423e8383ae9.jpg

3260,21,31633092003@s.whatsapp.net,2015-10-30
12:00:36,Media/31633092003@s.whatsapp.net/2/6/260e086c28608a04e37a5329f29fd8a8.jpg

3261,21,31633092003@s.whatsapp.net,2015-10-30
12:00:53,Media/31633092003@s.whatsapp.net/e/3/e3a740e6f94ae50ec56153268df6ebd6.jpg

3266,21,31633092003@s.whatsapp.net,2015-10-30
12:02:39,Media/31633092003@s.whatsapp.net/c/a/ca15730e12039470f10db33f02ca4974.jpg

3433,21,None,2015-11-11
06:03:08,Media/31633092003@s.whatsapp.net/4/0/40ceacebd1cfeef2dea8f4f92841702e.jpg

3665,21,None,2015-11-21
13:32:39,Media/31633092003@s.whatsapp.net/e/7/e7ae962ca2a7f634f6bf185474101b92.jpg

3880,17,447425133604@s.whatsapp.net,2015-11-27
22:44:31,Media/447425133604@s.whatsapp.net/2/c/2c3defbbe4b745859a360e1899c6e500.jpg

3893,38,31655448840@s.whatsapp.net,2015-11-28
20:17:15,Media/31655448840@s.whatsapp.net/c/3/c3024560b144e1ebbb3b41c0a4245ed5.jpg

3894,38,31655448840@s.whatsapp.net,2015-11-28
20:17:18,Media/31655448840@s.whatsapp.net/6/e/6ec7f36f0d28fad5055c36f88f086744.jpg

3895,38,31655448840@s.whatsapp.net,2015-11-28
20:17:18,Media/31655448840@s.whatsapp.net/5/3/53fd532729d5e8f383440fa505e7fa0d.jpg

3904,21,None,2015-11-29
12:27:43,Media/31633092003@s.whatsapp.net/7/3/7338c5c301936510b6025e7c702023cf.jpg

3987,38,31655448840@s.whatsapp.net,2015-12-01
22:02:24,Media/31655448840@s.whatsapp.net/0/c/0c9b0358a1ccc92a3dd042b7a43bd8d5.jpg

3996,21,None,2015-12-02 20:14:38,None

4068,21,None,2015-12-07
13:13:42,Media/31633092003@s.whatsapp.net/4/d/4d9da1e7b55ae4c8201477b752f0d4c1.jpg

4104,19,447967505855@s.whatsapp.net,2015-12-10
14:40:52,Media/447967505855@s.whatsapp.net/2/8/28cccbde8196f6dd6530fbc0fc6bc914.jpg

4117,19,447967505855@s.whatsapp.net,2015-12-10
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7610,29,85263385332@s.whatsapp.net,2016-09-10 08:21:13,Media/85263385332@s.whatsapp.net/3/e/3e62bfa483fc6a467468606a497deec0.jpg

7619,29,85263385332@s.whatsapp.net,2016-09-12 11:30:28,Media/85263385332@s.whatsapp.net/8/f/8fb5280f356b27b7568053b4fcf7e0a1.jpg

7625,17,447425133604@s.whatsapp.net,2016-09-14 14:52:57,None

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LOCATION DATA

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Messages containing geographical co-ordinates

Latitude and Longitude of the message sender. Note that where 'from' or 'to' is 'none', 'none' represents the phone user:

MESSAGE FROM, MESSAGE TO, MESSAGE TEXT, DATE/TIME OF MESSAGE, LATITUDE, LONGITUDE

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85263385332@s.whatsapp.net,None,None,2016-04-02 07:35:37,1334.0,750.0

85263385332@s.whatsapp.net,None,None,2016-04-02 07:36:58,750.0,1334.0

85263385332@s.whatsapp.net,None,None,2016-04-02 07:37:01,1334.0,750.0

None,31633092003@s.whatsapp.net,None,2016-04-02 18:06:56,1334.0,750.0

None,31633092003@s.whatsapp.net,None,2016-04-07 11:56:59,711.0,940.0

None,31633092003@s.whatsapp.net,None,2016-04-08 07:25:30,1600.0,1200.0

None,31633092003@s.whatsapp.net,None,2016-04-10 14:53:31,1280.0,960.0

None,31633092003@s.whatsapp.net,None,2016-04-16 09:23:03,468.0,480.0

None,31633092003@s.whatsapp.net,None,2016-04-16 16:32:22,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-04-18 19:55:04,300.0,300.0

85263385332@s.whatsapp.net,None,None,2016-04-19 13:36:34,1600.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-04-23 17:15:49,1600.0,1200.0

None,31633092003@s.whatsapp.net,None,2016-05-24 04:41:55,1600.0,1600.0

31648519986-1454614809@g.us,None,None,2016-06-08 11:09:54,1000.0,750.0

None,31633092003@s.whatsapp.net,None,2016-06-23 17:24:05,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-06-24 04:49:54,1334.0,750.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:38,1200.0,1600.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:38,1600.0,1200.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:38,1200.0,1600.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:39,1200.0,1600.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:41,1600.0,1200.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:43,1600.0,1200.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:44,1200.0,1600.0

31655448840@s.whatsapp.net,None,None,2016-06-26 11:12:54,1200.0,1600.0

85263385332@s.whatsapp.net,None,None,2016-06-27 04:17:35,1334.0,750.0

None,31633092003@s.whatsapp.net,None,2016-06-27 20:38:14,1199.0,619.0

None,31655448840@s.whatsapp.net,None,2016-07-06 14:59:21,1600.0,1200.0

31655448840@s.whatsapp.net,None,None,2016-07-07 16:46:40,960.0,1280.0

85263385332@s.whatsapp.net,None,None,2016-08-07 09:10:50,1600.0,1200.0

85263385332@s.whatsapp.net,None,None,2016-08-08 02:14:49,1600.0,1320.0

None,447967505855@s.whatsapp.net,None,2016-08-20 10:22:09,959.0,959.0

None,31633092003@s.whatsapp.net,None,2016-08-24 08:39:59,350.0,550.0

None,31633092003@s.whatsapp.net,None,2016-08-24 08:40:09,350.0,500.0

None,31633092003@s.whatsapp.net,None,2016-08-29 11:43:56,500.0,500.0

85263385332@s.whatsapp.net,None,None,2016-08-30 13:43:30,1600.0,901.0

85263385332@s.whatsapp.net,None,None,2016-08-31 13:54:33,1239.0,852.0

None,31633092003@s.whatsapp.net,None,2016-09-04 11:19:11,1200.0,1600.0

85263385332@s.whatsapp.net,None,None,2016-09-06 08:59:58,1200.0,1600.0

31648519986-1454614809@g.us,None,None,2016-09-08 10:39:07,1600.0,1200.0

85263385332@s.whatsapp.net,None,None,2016-09-09 12:34:48,1600.0,1600.0

85263385332@s.whatsapp.net,None,None,2016-09-10 08:21:13,1600.0,1200.0

85263385332@s.whatsapp.net,None,None,2016-09-12 11:30:28,960.0,720.0

None,31633092003@s.whatsapp.net,None,2016-09-15 18:29:06,1334.0,750.0

None,31633092003@s.whatsapp.net,None,2016-09-16 12:40:10,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-09-18 08:50:41,624.0,600.0

None,31633092003@s.whatsapp.net,None,2016-09-26 15:50:36,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-09-28 19:53:18,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-09-28 19:53:19,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-09-28 19:53:19,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-09-28 19:53:20,1600.0,1200.0

None,31633092003@s.whatsapp.net,None,2016-09-28 19:53:20,1600.0,1200.0

None,31633092003@s.whatsapp.net,None,2016-09-28 19:53:21,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-09-30 08:48:24,1600.0,1068.0

None,31633092003@s.whatsapp.net,None,2016-09-30 08:51:22,1600.0,1068.0

None,31633092003@s.whatsapp.net,None,2016-10-04 10:09:07,960.0,1280.0

None,31633092003@s.whatsapp.net,None,2016-10-04 10:09:07,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-10-04 20:40:19,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-10-04 20:40:43,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-10-05 13:25:03,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-10-06 16:52:17,544.0,960.0

None,31633092003@s.whatsapp.net,None,2016-10-07 18:04:02,960.0,1280.0

None,31633092003@s.whatsapp.net,None,2016-10-11 18:59:52,1600.0,1200.0

None,31633092003@s.whatsapp.net,None,2016-10-13 17:45:33,1200.0,1600.0

34667975541@s.whatsapp.net,None,None,2016-10-21 10:21:42,480.0,848.0

447967505855@s.whatsapp.net,None,None,2016-10-21 11:19:21,360.0,640.0

85263385332@s.whatsapp.net,None,None,2016-10-25 19:24:37,1600.0,1200.0

85263385332@s.whatsapp.net,None,None,2016-10-25 20:24:02,1200.0,1600.0

85263385332@s.whatsapp.net,None,None,2016-10-25 20:25:18,1200.0,1600.0

447967505855@s.whatsapp.net,None,None,2016-10-29 17:28:57,400.0,400.0

None,31633092003@s.whatsapp.net,None,2016-11-03 09:41:14,1004.0,796.0

None,31633092003@s.whatsapp.net,None,2016-11-05 21:11:16,960.0,1280.0

447967505855@s.whatsapp.net,None,None,2016-11-06 10:22:55,352.0,640.0

None,31633092003@s.whatsapp.net,None,2016-11-12 12:08:06,1600.0,1200.0

None,85263385332@s.whatsapp.net,None,2016-11-12 12:34:55,1600.0,1200.0

85263385332@s.whatsapp.net,None,None,2016-11-12 12:51:07,604.0,453.0

31643044755@s.whatsapp.net,None,None,2016-11-12 19:50:27,586.0,640.0

None,31633092003@s.whatsapp.net,None,2016-11-18 15:24:10,1200.0,1600.0

31643044755@s.whatsapp.net,None,None,2016-11-21 13:58:49,1136.0,640.0

31643044755@s.whatsapp.net,None,None,2016-11-21 13:58:51,640.0,1136.0

31618965630@s.whatsapp.net,None,None,2016-11-25 19:09:15,750.0,1334.0

85263385332@s.whatsapp.net,None,None,2016-11-26 12:14:41,1472.0,1600.0

None,31633092003@s.whatsapp.net,None,2016-12-05 19:13:56,1600.0,1280.0

None,31633092003@s.whatsapp.net,None,2016-12-05 19:15:24,224.0,368.0

None,31633092003@s.whatsapp.net,None,2016-12-05 20:05:55,368.0,480.0

None,31633092003@s.whatsapp.net,None,2016-12-06 18:02:12,1198.0,1600.0

447967505855@s.whatsapp.net,None,None,2016-12-08 15:03:40,848.0,480.0

None,4794321560@s.whatsapp.net,None,2016-12-19 14:03:10,1200.0,1600.0

34667975541@s.whatsapp.net,None,None,2016-12-31 14:40:33,480.0,640.0

None,31633092003@s.whatsapp.net,None,2017-01-05 20:15:21,1600.0,1200.0

None,34667975541@s.whatsapp.net,None,2017-01-13 08:27:48,576.0,480.0

None,31633092003@s.whatsapp.net,None,2017-01-26 14:14:58,1200.0,1600.0

None,31633092003@s.whatsapp.net,None,2017-02-06 12:09:36,236.0,236.0

None,31633092003@s.whatsapp.net,None,2017-02-06 12:10:20,220.0,320.0

None,31633092003@s.whatsapp.net,None,2017-02-08 09:28:58,672.0,668.0

None,31633092003@s.whatsapp.net,None,2017-02-16 08:44:33,768.0,1024.0

None,31633092003@s.whatsapp.net,None,2017-02-16 13:35:37,1600.0,1200.0

status@broadcast,None,None,2017-02-17 18:33:21,128.0,72.0

status@broadcast,None,None,2017-02-17 18:33:21,128.0,72.0

status@broadcast,None,None,2017-02-17 18:33:21,128.0,72.0

status@broadcast,None,None,2017-02-17 18:33:21,128.0,72.0

status@broadcast,None,None,2017-02-17 18:33:21,128.0,72.0

None,31633092003@s.whatsapp.net,None,2017-02-28 18:38:07,1600.0,1200.0

None,31633092003@s.whatsapp.net,None,2017-03-03 14:28:56,218.0,300.0

None,31633092003@s.whatsapp.net,None,2017-03-06 08:50:36,1600.0,1200.0

None,31655485985@s.whatsapp.net,None,2017-03-15 12:46:33,52.0923042297,4.27989006042

None,31655485985@s.whatsapp.net,None,2017-03-15 12:54:30,52.0923042297,4.27989006042

31655485985@s.whatsapp.net,None,None,2017-03-19 12:16:33,800.0,480.0

None,31633092003@s.whatsapp.net,None,2017-03-25 07:54:00,333.0,400.0

None,31633092003@s.whatsapp.net,None,2017-03-25 07:54:17,720.0,600.0

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END OF REPORT

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8.4 Appendix 2a: WhatsApp_Word_Search.py

```
#!/usr/bin/env/ python

# -*- coding: utf-8 -*-

# Script:                   WhatsApp_Word_Search_iOS.py

# Author:                   Claire Lawrence

# Purpose:                  To allow a user to search for key
                            words within WhatsApp databases used
                            on an iPhone

# sqlite3 is imported to allow Python to interact with the
database:

import sqlite3

# The file that will show the results of the word search against
the ChatStorage.sqlite database is created:

outfile1 = open('word_search_results.txt', 'w')

outfile1.close()

# A connection is established to the ChatStorage.sqlite database
so that the search query can be performed against it:

conn = sqlite3.connect("ChatStorage.sqlite")

curs = conn.cursor()

# The user is asked to input the word they would like to search
for:

search_user_input = raw_input("Enter the word you would like to
search for and press enter: ")

# The query is carried out, searching for the user's entered word
against all the text in the ZTEXT field:

search = curs.execute("SELECT ZFROMJID, ZTOJID,
DATETIME((ZMESSAGEDATE+978307200), 'unixepoch'), ZTEXT FROM
ZWAMESSAGE WHERE ZTEXT LIKE ?", ('%'+search_user_input+'%',))

# The results file is written:

search_results = open('word_search_results.txt', 'w')

search_results.write("\nSEARCH RESULTS FOR THE WORD " +
str(search_user_input) + ":" + "\n")
```

```
search_results.write("\n" + "=" * 20)

search_results.write("\nNote that the phone user is represented
in the 'from' and 'to' fields as 'None'\n")

search_results.write("\nFROM, TO, DATE/TIME (UTC), MESSAGE
TEXT\n")

for row in search:

     search_results.write(str(row[0]) + "," + str(row[1]) + ","
+ str(row[2]) + "," + str(row[3].encode("utf-8")) + "\n")

search_results.write("\n" + "=" * 20)

search_results.write("\nEND OF REPORT")

search_results.write("\n" + "=" * 20)

# The report text file is closed:

search_results.close()

# The user is made aware that the search was a success and
explains where to find the results:

print ("*" * 20)

print "Success! Results of the word search can be found in
word_search_results.txt"

print "Note that re-running the analysis will overwrite this
file"

print ("*" * 20)

# The connection to the database is closed:

conn.close()
```

8.5 Appendix 2b: word_search_results.txt

SEARCH RESULTS FOR THE WORD theory:

==========

Note that the phone user is represented in the 'from' and 'to' fields as 'None'

FROM, TO, DATE/TIME (UTC), MESSAGE TEXT

31633092003@s.whatsapp.net,None,2014-07-15 07:10:18,Trust me I know the theory

31633092003@s.whatsapp.net,None,2016-10-08 19:02:10,It is a lot of theory. I got pretty thick folder...

31633092003@s.whatsapp.net,None,2017-02-06 13:13:11,I know the theory Dear... It is the practice that I have issues with... ???

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END OF REPORT

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