

RFID Usage for Monitoring Drug Dispensing in Hospitals

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List of Abbreviations and Acronyms

ABC: Activity-based computing

ADHB: Auckland District Health Board

BCMA: Bar Code Medication Administration

CAIR: Centre for Artificial Intelligence Research

CPOE: Computerized Physician Order Entry

EPC: Electronic Product Code

HF: High Frequency

HQSC: Health Quality & Safety Commission

HTA: Hierarchical Task Analysis

IOM: Institute of Medicine

IOT: Internet of Things

LF: Low Frequency

RF: Radio Frequency

RFID: Radio Frequency Identification

SDK: System Development Kit

SHERPA: Systematic Human Error Reduction and Predication Approach

UHF: Ultra High Frequency

UWB: Ultra-Wide Band

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Attestation of Authorship

I hereby declare that this submission is my own work that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Sincerely

A handwritten signature in black ink, appearing to read 'Zachary Zhou', is written over a light gray rectangular background.

Zachary Zhou

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Abstract

Medication errors during drug dispensing are common problems in healthcare and can cause serious problems both for patients and staff. Many information systems have been developed to prevent that the occurrence of such errors. However, poorly designed and developed computer systems may prove to be useless or difficult to use.

In this design science research, we have built a simple drug dispensing and administrating model to analyse possible errors. Based on that model, we designed and developed a prototype software application that utilise UHF RFID technology and can be used to monitor drug dispensing and administrating in a simulated hospital environment.

We have also designed and carried out experiments based on the drug dispensing model. Relevant data was collected during the experiments and processed by the purposely developed software application system. The generated detection graphs allowed the identification and analysis of errors that occurred during the simulations. This proved that the RFID technology can help to detect and understand medication errors. However, the low detection performance for shorter small time periods such as 10sec and some hardware related problems pose certain challenges to the design and development of RFID-based systems.

Chapter 1 Introduction

Medication errors are a common problem in the hospital environment. In their landmark study report, *To Error is Human: Building a Safer Health System* (Institute of Medicine, 2000), the United States of America Institute of Medicine (IOM) identified that drug errors are one of the leading causes of patients' injury and death in the US and increased the health care cost enormously. Moreover, in their later report (Institute of Medicine, 2006), the IOM showed that around 1.5 million patients are affected each year by medication errors. In New Zealand, we face the same serious situations. According to New Zealand Serious and Sentinel Events Report (HQSC, 2012), events such as wrong medication given or incorrect dosage are the second largest category of serious and sentinel events in New Zealand hospitals in 2010-2011 and has been increasing year by year.

Hence, preventing medication errors is necessary in hospital daily life. In recent years, "Five Rights" for drug administration have been established in this field: Right Patient, Right Dose, Right Drug, Right Route and Right Time (Grissinger, 2010). These "Five Rights" have been designed and developed for preventing medications errors. However, people may still break some of the rules described by the "Five Rights" during the actual route of the medication supply chain (Houliston & Parry, 2011).

1.1 Current Model

In order to reduce medication errors by applying the "Five Rights", the following standard protocol (Houliston & Parry, 2011) needs to be observed in current practice:

- 1) Drugs manufacturers label drugs in the standard way;
- 2) Doctors order drugs by computer through the hospital system;
- 3) Pharmacists use automated drug picking and unit dose packing system in pharmacy;
- 4) Nurses check drug administration list and bar-coded medication administration information for patients.

These steps of standard protocol do help to reduce some medication errors in daily drug dispensing routines. However, medication errors still keep occurring, and there are some worrying examples:

- 1) A patient died with wrong drug supplement due to the hospital identification sticker of hospital being put on another patient's medication chart accidentally (Johnston, 2007);
- 2) A patient needed to be resuscitated and to stay in intensive care unit for a couple of days as wrong oral medication was given to them from the medication supply chain (Program, 2008);
- 3) A patient in intensive care unit was in dangerous situation because systolic blood pressure exceeded 200mmHg due to misreading of the drug concentration with on the drug vial by a nurse (Smetzer & Cohen, 2007).

In recent years, computer-based drug dispensing and administrating information systems have been used in hospitals. However, the above breaches of safety rules can still happen because of poorly designed and developed systems. Even with suitable systems and devices in hospital, the staff tend to introduce a lot of problems as they must log in and log out of devices and computer systems, starting and stopping sets of applications, and browsing each to present the proper view for alternating activities (Bardram & Christensen, 2007). Hence, new technology with ubiquitous, context-aware and invisible features is becoming more interesting for researchers. Radio Frequency Identification (RFID) may be one of the most promising techniques that can be introduced in this kind of technology.

1.2 Research Motivation, Objective and Prior Research

Since RFID was introduced in hospitals, researchers have been keen to use this modern technology for reducing medication errors. It has been found that the introduction of RFID technology is likely to lead to fewer errors and limit the inappropriate use of prescription drugs when it based on the activity theory applied to pharmacists' and nurses' work (O'Leary, 2010). Other similar studies are also focused on human activities detections for actions based on RFID technology in hospitals (Bardarm, 2009) and (Smith et al., 2005). The above studies have proven that, the RFID technology can be used for actions detection and records tracking in real hospital environment. Therefore, it is worth investigating whether the use of RFID technology can help to reduce medication errors, which is the aim of this research.

The objective of this research to investigate the use of high resolution Passive Ultra High Frequency (UHF) RFID technology along with a prototype software application designed and developed to record RFID tags. We can then record the actual actions taken by staff by scanning the tags and compare with the obtained data to the expected or required actions. By analysing these data, we can understand possible errors and find out how to prevent erroneous actions during drug dispensing with the help of UHF RFID technology later on.

This work is an extension from the work done by Parry and Houliston (Houliston & Parry, 2011) of ARUA Lab at AUT. This work has summarized the RFID usage in drug dispensing from hardware requirements to software specifications and has pointed out the potential problems. This work was the results of collaboration with Dr Rob Ticehurst, a system pharmacist Auckland District Health Board (ADHB). The research for this thesis has taken their study a few steps further.

1.3 Research Question, Hypothesis and Thesis Structure

To achieve the research objective stated in Section 1.2, there are two research questions that will need to be answered in the course of this research. The first question as follows:

1. Can RFID-based drug dispensing systems assist in detecting and understanding errors in simulated ward-based dispensing?

The answer to the first question will essentially indicate whether the RFID technology can be used in the area of drug dispensing or not. If the answer is positive, we can then consider the second question:

2. What issues are involved in the development of a prototype RFID-based drug dispensing systems that can assist in detecting and preventing errors in ward-based dispensing?

The second question is used to uncover the problems and issues during the prototype development of RFID-based drug dispensing system. These findings could enhance future studies in this area.

This will lead us to make the following hypothesis during the entire research period: The RFID based prototype software system can continuously detect both normal and erroneous drug dispensing activities during the simulated drug dispensing period.

Chapter 2 provides a literature overview of some previous studies of ward-based drug dispensing and the types of errors that occur in that process. It also includes a brief overview of the RFID technology and some studies of computer-based information systems used in this area.

Chapter 3 discusses the research questions in detail and justifies the methodology that is used in this research. It also explains the selections of the research paradigm. In addition, the chapter describes the research design, the prototype system development and data collection and analysis process.

Chapter 4 discusses the drug dispensing model along with system design and development in Chapter Four. It also describes the methods adopted on the development of prototype system.

Chapter 5 describes the experiments and evaluations that used the developed prototype system based on RFID technology. It also explains how the data were collected and analysed by the software application developed as part of this research.

Chapter 6 summarises the entire project and discusses the findings. It also points out the limitations and problems that have occurred in both research design and software development.

The last chapter outlines the plans for future work. It includes both some short term plans and long term ideas that are related to the prevention of medication dispensing errors in future.

Chapter 2 Literature Review

Section 2.1 in this chapter provides a review of relevant literature that reports research findings related to ward-based drug dispensing and administration. It also reviews the types and causes of errors that occur in drug dispensing. Section 2.2 describes how computer-based information systems and RFID technology can help to prevent such errors. Section 2.3 provides an overview of the RFID technology and Section 2.4 discusses the use of the RFID technology in the area of drug dispensing. Finally, Section 2.5 outlines the data analysis method could be adopted for the analysis of data obtained from the simulation experiments.

2.1 Drug Administration Errors

Lane, Stanton & Harrison (Lane, Stanton, & Harrison, 2006) introduced a model ward-based drug dispensing and administrating process using Hierarchical Task Analysis (HTA). The HTA model use hierarchical levels to process drug dispensing and administrating. It starts with four tasks in the top level:

Medication details checking
Medication acquiring
Drug administering to patient and
Dosage Recording

Then, the HTA model specifies 86 activities at the lower level. Most of these actives are similar although they may be used for different forms of medications such as tablets, infusions, injections and liquids.

Lane et al. (2006) then applied the Systematic Human Error Reduction and Predication Approach (SHERPA) to the HTA. They identified that there are around 79 potential errors could occur for the whole processing. These errors are grouped in the following four types of errors:

- Action Errors: failed to perform something manually;
- Checking Errors: failed to confirm something;

- Retrieval Errors: failed to collect information;
- Selection Errors: failed to select something;

The above types of errors can be separated into procedural and clinical errors based on their key attributes. Similar studies by Cina et al.(Cina et al., 2006) and Silva et al. (Silva et al., 2008) described the specified drug dispensing process. They also indicated that the errors that could occur during the process are clinical errors, human errors and technology shortage. The possible reasons for medications errors that occur in the drug dispensing system include but are not limited to the following:

- Poor quality of handwriting
- Transcribing in the prescription with errors
- Non-standard abbreviations usage
- Verbal medical order
- Confusing or incomplete prescriptions
- Knowledge shortage of drugs
- Similar drug names
- Inadequate storage and incompatible associations by nurse
- Communication failure
- Difficulties in identifying generic names and trade names of drugs

These studies did not provide the actual data containing the errors that occurred during the drug dispensing. However, we can find some useful information from the studies carried out by McDowell et al.(McDowell, Mt-Isa, Ashby, & Ferner, 2010) and Westbrook et al.(Westbrook, Woods, Rob, Dunsmuir, & Day, 2010). They provide the following results from their works:

- At least one procedural error in around 73% of drug administrations;
- At least one clinical error in around 25% of drug administrations;
- Around 64% of the clinical errors are due to the drugs being delivered at the wrong time;
- Around 20% of the clinical errors are due to the wrong dose of drugs;

- Around 8% of the errors are due to the wrong volume of the diluents;
- Almost 59% administrations errors are due to failure to confirm patients' identity.

These high error rates for procedural and clinical errors in drug dispensing and administering tasks are very likely to cause either patients' death or long term harmful consequences. Davies et al.(Davis et al., 2003) stated that half of the preventable adverse events are due to a failure to follow procedures and protocols. Therefore, finding a way to reduce medication errors is very important. Recent studies have found that computer-based technologies may facilitate the reduction of such medication errors in hospitals by at least 20% (Sakowski et al., 2005).

2.2 Information System Solutions

There are quite a few information systems that have been developed or are currently under investigation and whose aim is to assist in reducing medication errors in drug dispensing and administrating. Table 2.1 shows a group of systems that used to assist the four high level tasks of HTA model.

Table 2.1

Information Systems for Drug Dispensing

Tasks	Information Systems
Medication Checking	CPOE (Computerized physician order entry)
Acquire medication	Smart drug cabinets Pharmacy automation robotic system
Drug administration	BCMA (Bar Code Medication Administration) ABC (Activity-based computing) Schedulers
Dosage record	BCMA

The CPOE systems use a database where the clinicians save their electronic drug order forms rather than use paper forms for writing orders. During the order process, all necessary information needs to be entered and the system provides a checking procedure for dose, drug expire date, etc. When compared to handwritten order forms, electronic forms are easily retrievable and more reliable. However, recent studies show that there are some issues with the effectiveness of CPOE systems such as staff adoption problems (Berger & Kichak, 2004).

BCMA systems are used by nurses to check patients' information before administering medications. Medication orders are store in a database by patients' information, usually in the CPOE systems. Nurses need to scan the barcode wristband on patients' arms. The drugs also have barcode label, which nurses will also need to scan it before administrating drugs. If the response from the database indicates that the drugs are not ordered for this patient or are not to be taken at this time, the nurse will be notified. BCMA systems have been proven to reduce medication errors during the drug dispensing and administrating in hospitals (Poon et al., 2010). However, this kind of

systems may also cause problems with patients' safety if they are by poorly designed and implemented (Koppel, Wetterneck, Telles, & Karsh, 2008).

Pharmacy automation robotic systems are used to reduce errors in drug preparation and selection. These systems have been proved to have high working efficiency and very low error rates when used in pharmacies (News, 2009). Pharmacy automation robotic systems are very smart and can be useful in hospital environment too, but the financial cost is currently very high.

From the studies discussed above, we can infer that, the current information systems solutions in this area do have problems. Thus, researchers are keen to find a new technology that can be easily integrated with current computer systems and can help avoid the existing problems. The RFID technology is one of the best choices in this area.

2.3 Overview of the RFID Technology

The basic working principle for RFID technology is using a wireless non-contact system that utilises Radio Frequency (RF) electromagnetic fields to transfer data from a tag that is attached to an object (Wikipedia). The purpose of using the RFID technology is the automatic identification and tracking of the objects with RFID tags. A specially designed and built system can easily scan the information stored in the tags and retrieve it for future usage.

The RFID technology is commonly used in the supply chain area and as a key prerequisite for “Internet of Things” (IOT). The term IOT was first used by Kevin Ashton as a title of a presentation he gave at Procter & Gamble in 1999 (Ashton, 2009). The main purpose of IOT is tracking uniquely identified objects and their virtualized presentation in an internet-like structure. Thus, the objects identification procedure will be generated through the use of the RFID technology as a replacement of the barcode or the 2D code technologies.

In 2008 IBM announced an initiative called “Smarter Planet” which is an actual representation of IOT (IBM, 2008). The purpose of the Smarter Plant is interconnecting all the instrumented objects that have attached RFID tags to them and processing by the generated information by purposely developed intelligent system (Palmisano, 2008). As a result, the RFID technology must be adapted accordingly to this situation and has improved rapidly.

The usage of the RFID technology is very similar to the use of barcode technology. Rather than using barcode scanner and labels, the RFID technology uses an RFID reader and tags. The main difference between these two technologies is that the barcode technology information must be printed on the barcode label clearly, whereas the RFID tags store data electronically and transmit it by using radio waves.

Compared to the barcode technology, the RFID technology has the following advantages:

- Readers can detect multiple tags at any given time;

- The RFID Readers do not need to read tags using a line of sight. While the barcode scanner must scan the visible area of the label, the RFID reader just needs to be near the tag to detect it;
- The RFID Tag can contain more information than barcode labels;
- The information in RFID tags can be modified

There are three types of tags operating with RFID technology: passive, semi-passive (also called semi-active) and active. The key difference between actives (including the semi-passive tags) and passive tags is that active and semi-passive tags have a built in the power source while passive tags do not have a power source. The main difference between active tags and semi-passive tags is that active tags can initiate communication but semi-passive tags cannot do that. Table 2.2 presents a comparison between the different properties of these three types of tags.

Table 2.2

Tags Comparison Table (Weis, 2007)

Tag Types	Passive	Semi-Passive	Active
Tag Properties			
Power Source	Harvesting RF energy	Battery	Battery
Communication	Response only	Response only	Response and initiate
Max Range	10 Meters	> 100 Meters	>100 Meters
Cost	Lowest Cost	High Cost	Most Expensive
Application Examples	EPC	Toll Roads	Live Stock Tracking

There are five operating frequencies in the RFID technology: Low Frequency (LF), High Frequency (HF), Ultra High Frequency (UHF), Microwave and Ultra-Wide Band (UWB). Operating frequencies play an important role in RFID systems. Different frequencies require different size and shape of antennae. The operating distances of different frequencies vary as well. Table 2.3 shows the frequencies and the operating distances for passive tags.

Table 2.3

RFID Operating Frequencies (Weis, 2007)

Frequency Range	Frequencies	Passive Read Distance
Low Frequency (LF)	120-140 KHz	10-20 cm
High Frequency (HF)	13.56 MHz	10-20 cm
Ultra-High Frequency (UHF)	868-928 MHz	3 meters
Microwave	2.45 & 5.8 GHz	3 meters
Ultra-Wide Band (UWB)	3.1-10.6 GHz	10 meters

2.4 RFID Technology Approach

According to the US 2007 national public opinion survey, 1404 Americans revealed variations in sentiments concerning the desirability of several mobile healthcare technologies based on RFID (Katz & Rice, 2008). A 2006 market survey shows that the RFID marketplace in hospitals would reach \$8.8 billion US dollars in 2010 (Nagy *et al.*, 2006). There are quite a few applications based on the RFID technology that have been developed in the healthcare area. For example, one application is used to record nurses' activities related to drug-dispensing and administrating (Smith *et al.*, 2005), while another application is developed to record for the patients' activities (Favela *et al.*, 2007). However, there are also some minor limitations of the RFID technology as well: it may have some inaccurate readings or may miss some information and have unreliable readings (Derakhshan, Orłowska, & Li, 2007).

In the field of drug dispensing and administrating field in hospital environment, RFID based computer systems can help to ensure drugs are dispensed accurately (Sakowski *et al.*, 2005); such system can also helped to automate the monitoring and recording of drug administration events (Houliston, Parry, & Merry, 2008). With the implementation of RIFD based inventory supply chains, the hospitals can reduce the spending on hospital supply and increase patients' safety (Nagy *et al.*, 2006).

2.5 Data Analysis Method

The data analysis method adopted for this research is confusion matrix. The method of confusion matrix has been widely used in the artificial intelligence area, particularly in machine learning. Confusion matrix contains information that showing of predicted and actual classifications (Kohavi & Provost, 1998). It represents the comparison with instances of predicted classes and actual classes under the supervised learning. The main advantages for confusion matrix are that it can identify critical situations and can offer a new perspective on the performance of various kinds of classifiers (FAA). Equation 1 calculates the true positive rate of the confusion matrix.

$$\frac{\sum \text{Number of Detected Minutes}}{\sum \text{Number of Detection Minutes}} \times 100\%$$

Equation 1: Detection Rate Formula

Equation 2 calculates the false negative rate of the confusion matrix.

$$\frac{\sum \text{Number of Not Detected Minutes}}{\sum \text{Number of Detection Minutes}} \times 100\%$$

Equation 2: Non Detection Rate Formula

Let's use an example to explain how this works. We assume that an experiment takes 3 minutes to detect RFID tags. If a tag has been detected in the first minute and the third minute, but not in the second minute, we selected first minute windows for detection of the items on the drug tray i.e. if a tag detected at all during a one minute non-overlapping period, then first minute and the third minute are the detected minute and the second minute is the not detected minutes, hence, the detection rate for this example is calculated by Equation 1 as 66.67% in this instance. The false negative detection rate calculated by Equation 2 is 33.33%

With the use of a confusion matrix, we can analyse the collected RFID data and work out the sensitivity and specificity of the RFID technology usage in the field of drug dispensing. Sensitivity and specificity are generally used to measure how well of the medical test, sign, or symptom is in test period (Medpedia). The main purpose to use the sensitivity and specificity concept is to evaluate clinical tests. In clinical tests,

sensitivity is a measure of how good a test is in correctly identifying people who have the disease (Loong, 2003); specificity is a measure of the ability of the test to correctly identify those patients who do not have the disease (Lalkhen & McCluskey, 2008). In our research, the use of sensitivity and specificity is quite similar to their use for clinical tests. Instead of test of the disease, we measure the performance for detecting of items by UHF RFID reader and tags.

Chapter 3 Research Methodology

The aim of this research is to investigate if it is possible to detect errors during the drug delivery period through the development and experimentation with a software system that makes uses of the RFID technology and try to prevent such errors later on. Therefore, a suitable research methodology needs to be adopted for this research.

In an information technology research, in particular for a problem solving research, the research method may not unique during the research period. In our research, we follow a develop-and-test iterative model according to the design science research protocol. A literature review is carried out as part of the background study.

Figure 3.1 shows the research model for this research. Three main methods are included on this research: Literature Review, Design Science and Experimental Study. We conducted design-develop-test iterative model the development of a prototype software system under design science research methodology, and combined it with an experimental study as the main part of this research.

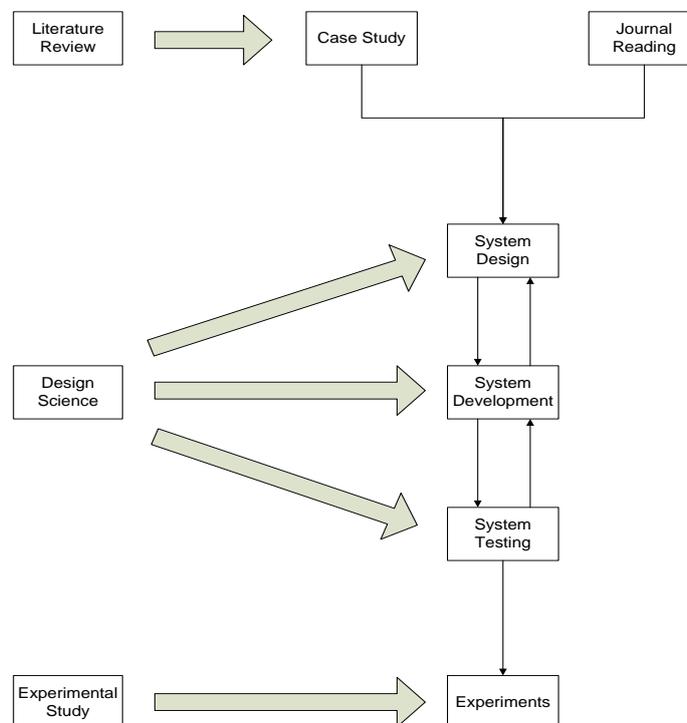


Figure 3.1 Research Model

3.1 Literature Review Method

A comparative literature review has been adopted as first part of this research. Chapter 2 presents a review of a wide range literature related disciplines. The literature topics range from ward-based drug dispensing problems to RFID technology utilised in drug administrating. The reviewed literature was collected from a large number of online libraries or databases such as Springer, IEEE, ACM, Science Direct etc. Some useful websites provided from vendors and organizations and related to the RFID and to medications have also been used.

3.2 Design Science Method

The second part of this research involves quantitative approach by using the investigating study accompanied with design science paradigm. Design Science is an outcome based information technology research methodology which offers specific guidelines for evaluation and iteration within research projects(March & Smith, 1995).

The design science research method plays a primary role in solving IT problems. IT research deals with artificial solutions instead of natural solutions. Design science research (also called design research) always seeks an innovative way to define ideas, analyse problems, and to design and implement solutions for problem solving effectively. There are six core steps during the design science research process(Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007): problem identification and motivation; definition of the objectives for a solution; design and development; demonstration; evaluation and communication.

In this research, according to above research process, literature review and prior research studying will become problem identification and motivation, definition and objects for a solution phase of design science. Prototype system design and development will be the design and development combined with demonstration phases of design science. Experiments and results through the software application could be evaluation and communication phase of the design science.

Design science research method is used to create an artefact to serve human needs. This method is technology driven and should be combined with field experiment. This can lead the researcher to retrieve and analyse data from the actual and specific environments to guarantee the reliability of the research tests. Compare to other research methods, design science has the following two main advantages:

- it seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artefacts (Hevner, March, Park, & Ram, 2004);

- the knowledge and understanding of a problem domain and its solution are achieved through the building and application of the designed artefact (Hevner *et al.*, 2004).

3.3 Experimental Testing

Experimental research takes a secondary role in this research. It is the collection of researches which use manipulation and controlled testing to analyse causal process. Experimental research is commonly used in scientific areas such as physics and chemistry. The aim of experimental research is to predict the simple phenomenon from the research. Experimental research often adapted on time priority or consistency in a causal relationship (Experiment-Resources.com, 2008). The key steps in experimental research are (Key, 1997):

- Manipulate the independent variable;
- Control: hold all other variables except the dependent variable constant;
- Observation: observe of the manipulating independent variable on the dependent variable.

The advantages of experimental research are (CSU): it can gain insight into methods for instruction and it can be combined with other research methods for rigor. The two main shortcomings of experimental research that could occur during the experiment are: the experiment settings in a laboratory are unable to completely reflect the actual environment (Collis & Hussey, 2009); human response can be difficult to measure (CSU).

In this study, we conduct simulations of real drug dispensing and administering environments that are similar to the hospital circumstances. We are also carefully control the movements of drugs refer to the real situations.

3.4 Methodology Justification

In this research, we propose to investigate if the RFID technology can help in drug dispensing and administrating in hospital environment through the use of a purposely developed prototype software system. This means this prototype application will be the artefact that we create for this research which is in line with the primary research methodology for this research, namely design science. There are six core steps of design science research identified by researchers (Peffer et al., 2007):

- Problem identifications and motivations;
- Objectives definition;
- Design and Development;
- Demonstration;
- Evaluation;
- Communication.

The above steps of the design science research are commonly followed by researchers during a design science research. These steps are very close to our research procedure, so we can identify that design science research method is suitable for our research.

Moreover, experimental research method will be adapted on evaluation period of design science research methodology. The evaluation is built on experiments to analyse the created artefact for research objective. Thus experimental research method is fitted for evaluation period of design science research method in our research.

The simulation method has been widely adopted in many RFID based studies, where some researchers combined simulations with experiments to analyse the RFID reading rates, the performance of detections and position locating algorithms for RFID experiments (Breahna & Johns, 2006). The researchers testify that real experiments allow them to collect accurate data and guarantee the reliability of correspond tests. Thus, we have adopted the simulation method to generate our research data during the experiments period in order to represent the simulated circumstances more accurately.

Chaper 4 Prototype Software Application Development

This chapter discusses the design and development of the RFID based prototype software application used to analyse nurses' drug dispensing and administrating actions. In Section 4.1 a drug dispensing model is established that reflects closely the real hospital environment. Section 4.2 describes the development of the prototype software application.

4.1 Drug Dispensing Model Design

We have established a simple model of drug dispensing and administrating whose design is based on the HTA model discussed in Section 2.1 and 2.2. Our model represents the real hospital drug dispensing and administrating supply chain. Visits to pharmacy and the patient department of the hospital have been very informative and helped to build the simulated drug dispensing and administrating model for this research.

Figure 4.1 shows the simulated model of drug dispensing and administrating that we have generated for our prototype system design and experiments. The development and all field experiments are based on the simulation model of drug dispensing and administrating that we have built.

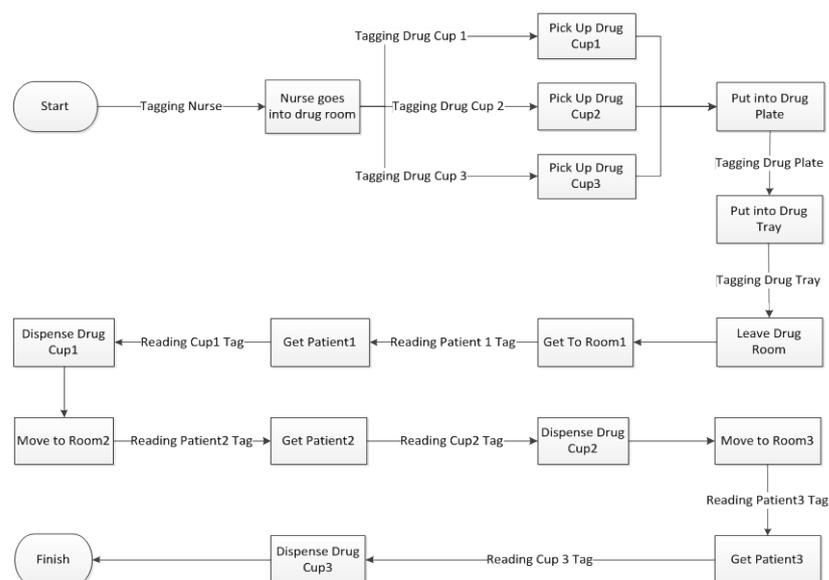


Figure 4.1 Simulated Drug Dispensing Model

The steps for this simulated drug dispensing can be described as following procedures:

- 1) Nurse will prepare to dispense medications in drug room;
- 2) Nurse will be tagged with an RFID tag during the preparing period;
- 3) Nurse will tag three drug cups with RFID tags at that moment;
- 4) Three drug cups will be put on a drug plate;
- 5) The drug plate will be tagged with 3 RFID tags;
- 6) Nurse will put the drug plate onto the smart drug tray;
- 7) The drug tray will also be tagged with an RFID tag;
- 8) Nurse will carry the smart drug tray with out of the Drug Room;
- 9) Nurse leaves Drug Room and goes to Room 1;
- 10) Room 1 tag will be detected once the nurse arrives;
- 11) Nurse goes to Patient 1 bed;
- 12) Nurse will read Patient 1 tag before dispensing Drug Cup 1;
- 13) Nurse will read Drug Cup1 tag and dispense drug cup to Patient 1;
- 14) Nurse leaves Room 1 and goes to Room 2;
- 15) Room 2 tag will be detected once nurse arrives;
- 16) Nurse goes to Patient 2 bed;
- 17) Nurse will read Patient 2 tag before dispensing Drug Cup 2;
- 18) Nurse will read Drug Cup2 tag and dispenses drug cup to Patient 2;
- 19) Nurse leaves Room 2 and goes to Room 3;
- 20) Room 3 tag will be detected once nurse arrives;
- 21) Nurse goes to Patient 3 bed;
- 22) Nurse will read Patient 3 tag before dispensing Drug Cup 3;
- 23) Nurse will read Drug Cup 3 tag and dispenses drug cup to Patient 3;
- 24) Nurse leaves Room 3 and goes back to Drug Room.

From the above description, we can see that a nurse will carry the drug tray and the drug plate with cups when approaching patients which is the same way as it happens in a real hospital. All drug plates and drug cups used for experiments are taken from the

Auckland City Hospital pharmacy to make the simulation as close to the hospital environment as possible.

4.2 Prototype System Application Development

The original software application has been built by AURA Lab using a VB.net version. For this research we have converted and extended that code to create more appropriate versions. This software application was developed and debugged in the C#.net programming language under the Microsoft Visual Studio 2010 IDE.

As this is a prototype system which is be used in experiments for evaluations, we have hard coded all tag IDs into the system. Table 4.1 shows the items used in the experiments and the corresponding ID tag for each of them.

Table 4.1

Items' tags IDs Table

Item	Tag ID
Drug Tray	3005FB63AC1F3841EC880467
Drug Plate Tag 1	AD97150415CE858D510000EF
Drug Plate Tag 2	E2003411B802011029356347
Drug Plate Tag 3	AD97150415CF518C4F000007
Drug Cup 1	6816341013010228113400E2
Drug Cup 2	0000AD000008052217243005
Drug Cup 3	E2003411B802011357286060
Room 1	3005FB63AC1F3841EC880411
Patient 1	E2003411B802011357286061
Room 2	3005FB63AC1F3841EC880422
Patient 2	E2003411B802011357286062
Room 3	3005FB63AC1F3841EC880433
Patient 3	E2003411B802011357286063
Drug Trolley	300833B2DDD9014035050000
Check Point 1	3005FB63AC1F3845EC880C01
Check Point 2	3005FB63AC1F3845EC880C02
Check Point 3	3005FB63AC1F3845EC880C03
Check Point 4	3005FB63AC1F3845EC880C04
Check Point 5	3005FB63AC1F3845EC880C05
Check Point 6	3005FB63AC1F3845EC880C06
Check Point 7	3005FB63AC1F3845EC880C07
Check Point 8	3005FB63AC1F3845EC880C08

4.2.1 Equipment Selection

Equipment selection is always the first step in an artefact design. The equipment for this research is used for the research experiments. Since this research investigates the use of the RFID technology, RFID reader and RFID tags are necessary for carrying out the experiments. We have used the UHF band frequency range for our research as we believe that this is the most suitable technology for our purpose. The selected equipment is discussed below.

4.2.1.1 RFID Reader

Due to the high cost and have experiencing of configuring an RFID system with multiple readers and tags, we decided to use a mobile handheld RFID reader instead. This kind of RFID reader has a lower cost and is easier to use. The reader we have chosen is Tracient Padl-R UF RFID Reader and is manufactured by a well-known New Zealand RFID solutions company called Tracient Technologies Ltd. Figure 4.2 shows the Tracient Padl-R UF RFID Reader that we have used in this research.



Figure 4.2 Tracient Padl-R UF RFID Reader(Tracient, 2007)

The Tracient Padl-R UF RFID Reader operates in the 855-960 MHz Radio Frequency range and can be connected in both USB port and Bluetooth. It provides the benefits of portability and longer access range benefits for our research. The main features for this reader are presented in Table 4.2.

Table 4.2

Tracient Padl-R UF RFID Reader Main Features Table (Tracient, 2007)

Feature	Specification
Size	210mm (h) x 70mm (w) x 15 mm (d) (approx.)
Weight	135 grams (approx.)
Operating temperature / storage temperature	-10 to +60° C
Ingress Protection	IEC 529 IP64
Approvals	CE, C-Tick, FCC
Drop specification	1m to plywood on all faces and corners.
User Interface	Single button for RFID reading, Multi-colour Leds, Audio beeper (multi tone). Configurable use case scenarios via USB or Bluetooth.
UHF Transponder	ISO 18000-6A, ISO 18000-6B, ISO 18000-6C, EPC Class 0, EPC Class 1 (GEN2). Frequency 862-955 MHz
Approximate read range	1.5m
Data rate	~40 kbps (EPC C1G2), ~80 kbps (ISO18000 - 6C)
Maximum O/P Power	0.5 W
Power control range / Power control resolution / Bluetooth Interface	3mW - 0.5W (+5dBm - +27dBm) 1dBClass 2 (typically 10m operation).
Antenna	Internal only
Additional Data communication Interface	USB – mini-B connector for wired applications
Power Supply	Via USB for high-capacity internal Li-Ion battery recharge
Firmware support	Field upgradeable via USB. Some configuration settings also available via Bluetooth interface.

4.2.1.2 RFID Tags

RFID tags are the other necessary equipment for this research. The three different kinds of RFID tags are described on Section 2.3. Since active tags have the longer detection range, they seem to best fit our research. However, there are two main reasons that active tags cannot adapt for our research. Firstly, active tags require an internal battery which would limit the time for using the tags. Passive tags are not equipped with internal battery and are much cheaper than active tags, which is an advantage for large scale deployment in an RFID system. Secondly, the aim of this research is to investigate the detection of pharmacy objects such as drug cups. Since these objects are used indoor, there is no need for a large range of detection. Hence, the shorter range tags are used the only tag's ID to represents objects and corresponded actions could be advantage for this research. For these two reasons, the passive tags are considered both affordable and suitable enough for this research.

The considerations for costs, detection range and power source have led to the choice of UHF band passive tags for this research. The UHF band tags have longer and wider detection range than the other passive RFID tags. Their operating frequency is 860 - 960 MHz and their size is around 40mm length and 40mm width size. The RFID reader chosen for this research has the same frequency range.

The UHF tags we have chosen are called UPM Raflatac UHF Passive RFID tag. Figure 4.3 shows the simple UPM Raflatac UHF Passive RFID tags. We have used a few different types of tags from this brand such as "BeltTM", "ShortDipoleTM", and "DogBoneTM". These kinds of tags have been successfully deployed in library control and warehouse inventory management around the world.

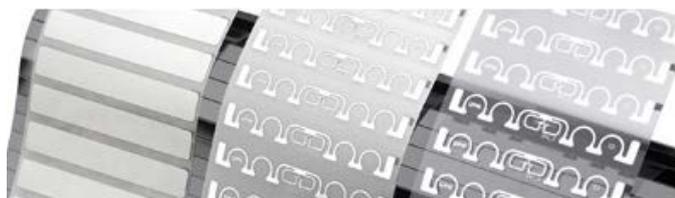


Figure 4.3 UPM Raflatac UHF Passive RFID tags(SMARTRAC)

4.2.2 Software Application Design and Development Process

During the research process, we have developed our software application in three versions. Each new version is an upgrade and is developed to suit some new functionality or requirements change.

4.2.2.1 Version 1

The first version of the software application was created as a modification of original VB.net code provided by ARUA Lab. The functionality of this software version is very simple it notifies the user that the items with attached RFID tags have been detected by the RFID reader. Figure 4.4 shows the interface of Version 1 of the software application.

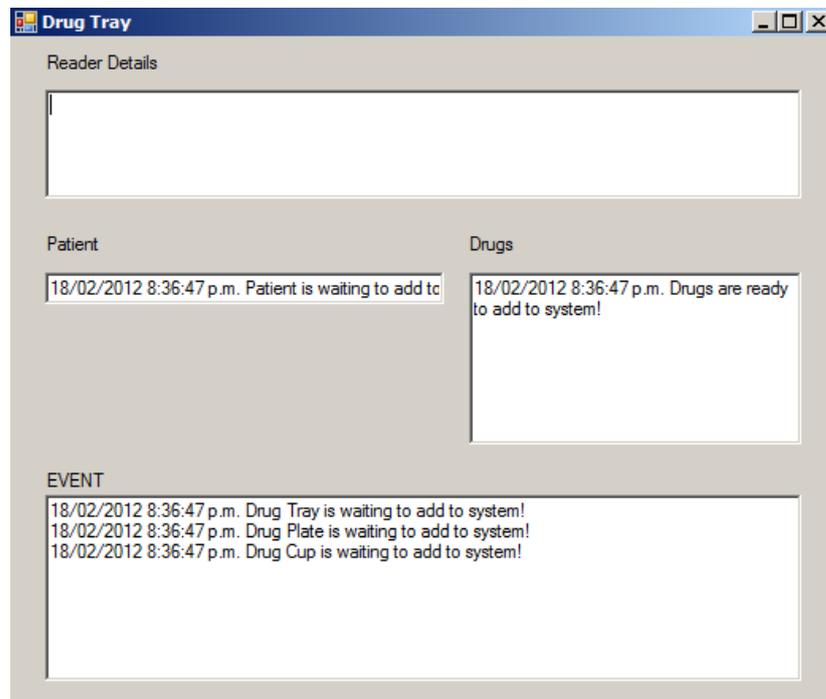


Figure 4.4 Application Version 1 Interface

The key idea in the development of Version 1 is that once the RFID reader detects tags that attached to items, the message box will pop up notifying the user item has been detected. All read tags will be displayed in Reader Details textbox. This instance read will be through Tracient TraceConnect RFIDWedge application which is provided by Tracient Technology. The setting for this application is discussed in Section 5.1. Once

the mouse leave event action has been activated, it will compare hard coded tags' IDs with detected tags' IDs. A message box pops out automatically to notify user that some relevant objects have been detected, e.g. "Drug Cup 1 Detected" or "Drug Tray Detected". If tags attached to a patient or to drug cups have been detected, the information will appear in the textbox blow. All detected events will be added to the EVENT textbox as log information which can be saved manually for future analysis. The pseudo code for Version 1 of the application is shown in Figure 4.5

```

Start
For each i in ReadTags
If i == patientTagId
Set Patient Read and Write Message
If i == drugTrayTagId
Set Drug Tray Read and Write Message
If i == drugCup1TagId
Set Drug Cup 1 Read and Write Message
If i == drugCup2TagId
Set Drug Cup 2 Read and Write Message
If i == drugCup3TagId
Set Drug Cup 3 Read and Write Message
If i==PlateTagID1 && PlateTagID2 && PlateTagID3
Set Drug Plate Read and Write Message
End For Loop
Finish

```

Figure 4.5 Pseudo Code for Application Version 1

4.2.2.2 Version 2

Version 2 of the application is designed and developed for the analysis of data collected during the experiment. The functionality of this version is different from that of Version 1 as it is mainly focused on the analysis of results from a text file instead of analysing instant detections. The text file is downloaded from the RFID reader through the Tracient RFIDSync application by Tracient.

This version has a different interface that provides the user with the necessary information. Figure 4.6 shows the application interface for Version 2. When the user clicks on the Read Data button, a dialog box will open that allows the user to select and

open text files as shown in Figure 4.7. The Analysis Data button is initially disabled until data is read successfully. If the application successfully loads data from a text file, a message box “File Load Successful” pops up and the Analysis Data button is enabled; otherwise, a message box “Fail to Load File” pops up and the Analysis Data button remains disabled.

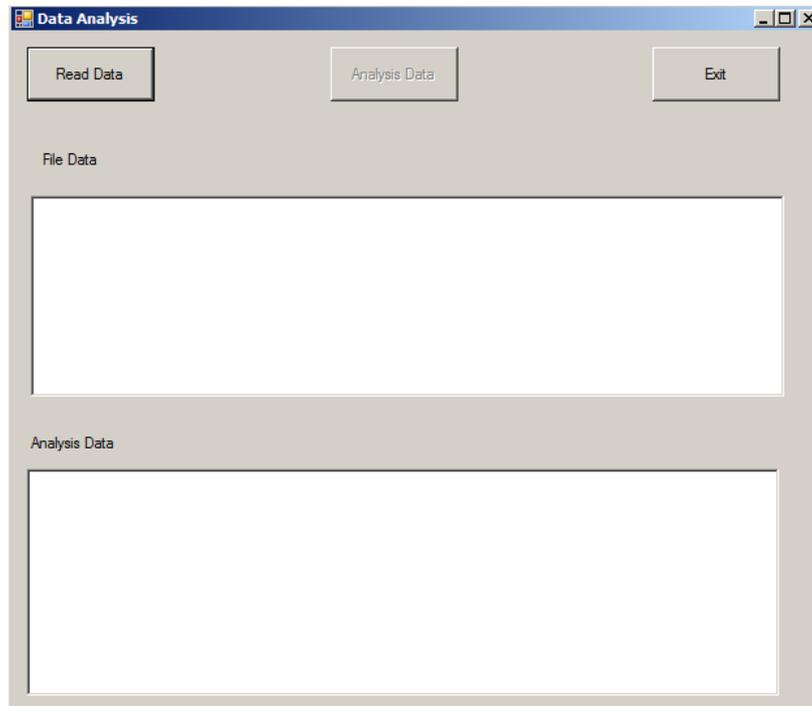


Figure 4.6 Application Version 2 Interface

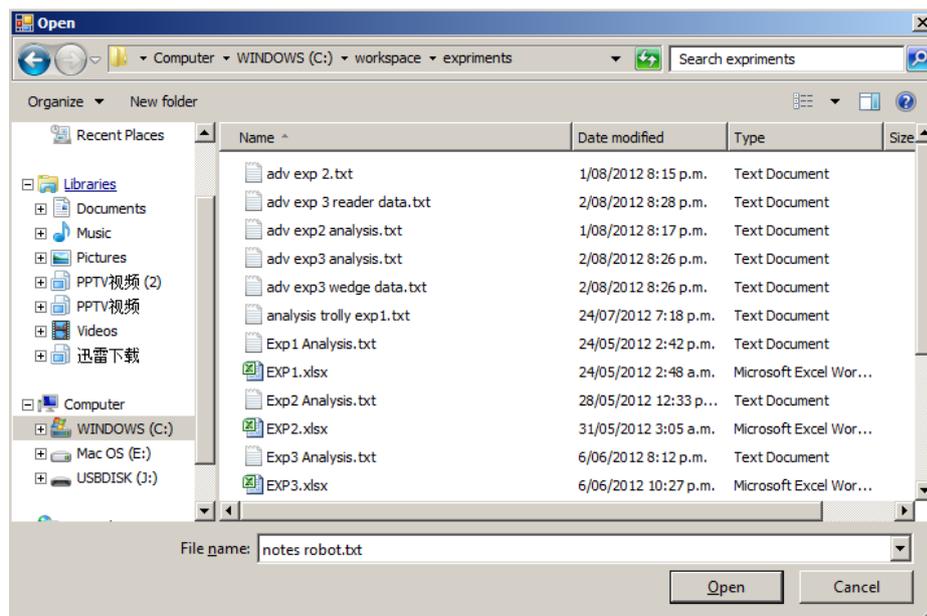


Figure 4.7 Application Version 2 Open File Dialog

Figure 4.8 shows the data loaded from a text file and its analysis by the software application version 2. The tags data with timestamps appears in the File Data textbox. When the user clicks on the Analysis Data button, the analysed data is displayed in Analysis Data textbox.

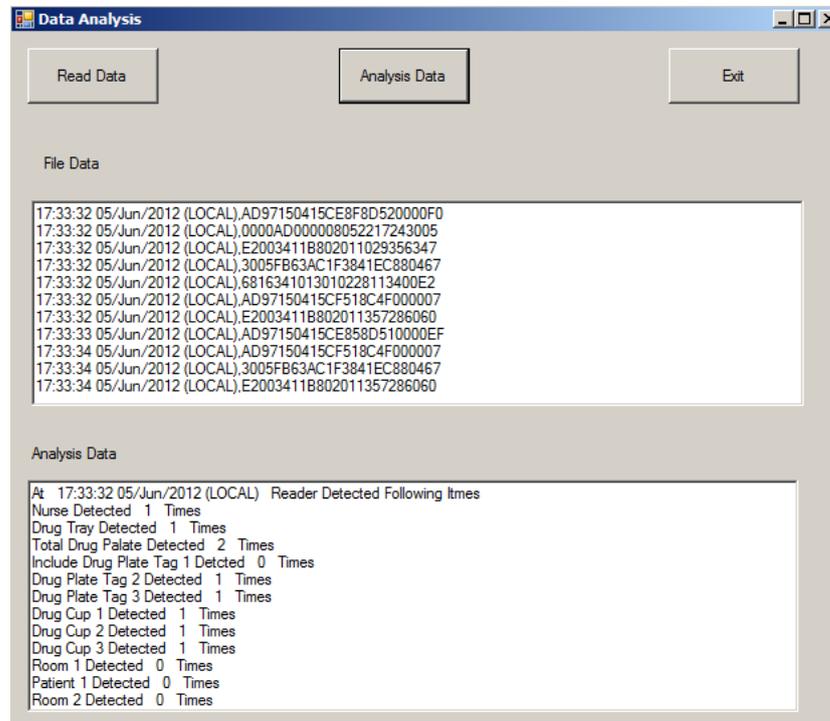


Figure 4.8 Application Version 2 Interface with Read Data

The format of analysed data displayed by Version 2 of the application is the following:

At timestamp Reader Detected Following Items:

- Nurse Detected N times*
- Drug Tray Detected N times*
- Total Drug Plate Detected N times*
- Include Drug Plate Tag 1 Detected N times*
- Drug Plate Tag 2 Detected N times*
- Drug Plate Tag 3 Detected N times*
- Drug Cup 1 Detected N times*
- Drug Cup 2 Detected N times*
- Drug Cup 3 Detected N times*
- Room 1 Detected N times*
- Patient 1 Detected N times*
- Room 2 Detected N times*
- Patient 2 Detected N times*
- Room 3 Detected N times*
- Patient 3 Detected N times*

The key idea for the development of this version is to use the tags information collected in a text file and group it by the time stamps. The data is sorted by using Dictionary data structure combined with Key-Value-Pairs collection method. Initially, the number of detection for each object is 0. If on this time stamp, the object has been detected, and then the number of this object detection number will increase with the number of detections for this object. All the information will be displayed in the Analysis Data textbox. The code for analysing timestamps is shown in Figure 4.9, and the pseudo code for analysing tags is shown in Figure 4.10.

```

string[] data = FileDataBox.Text.Split('\n');
Dictionary<String, List<String>> readEcoph=new Dictionary<String, List<String>>;
for(int i= 0; i<data.length -1;i++ )
{
string[] each = data[i].Split(", ".ToCharArray());
KeyValuePair<string, string>t = new KeyValuePair<string,string>(each[0],each[1]);
if (readEcoph.ContainsKey(t.Key)){
    readEcoph[t.Key].Add(t.Value);}
else {
    readEcoph.Add(t.Key, new List<string>(){t.Value});}
}

```

Figure 4.9 C#.net Code for the data analysis of group tags

```

Start
Set TempText
Start Foreach Loop 1
Set All Objects Detection Number Equals 0
Set List TempList
Get Each Key and Value from Dictionary
Write TempText to TextBox
Assign Each Value to TempList and Each Key to TempText
Start Foreach Loop 2
If each TagID in TempList Contains Related Object Tag ID
Related Object Detection Number + 1
End if
Do the same for all Objects
End Foreach Loop 2
End Foreach Loop 1
End

```

Figure 4.10 Pseudo Code for calculating the Number of Detections for each object

4.2.2.3 Version 3

Version 3 of the software application is more complex than the previous two versions. We have added checkpoints and drug trolley information. We also modified some of the information display to make it clear for the user. This version is an extension of version 2 and is used for advanced experiments in this research. Figure 4.11 shows the interface of Version 3 of the software application.

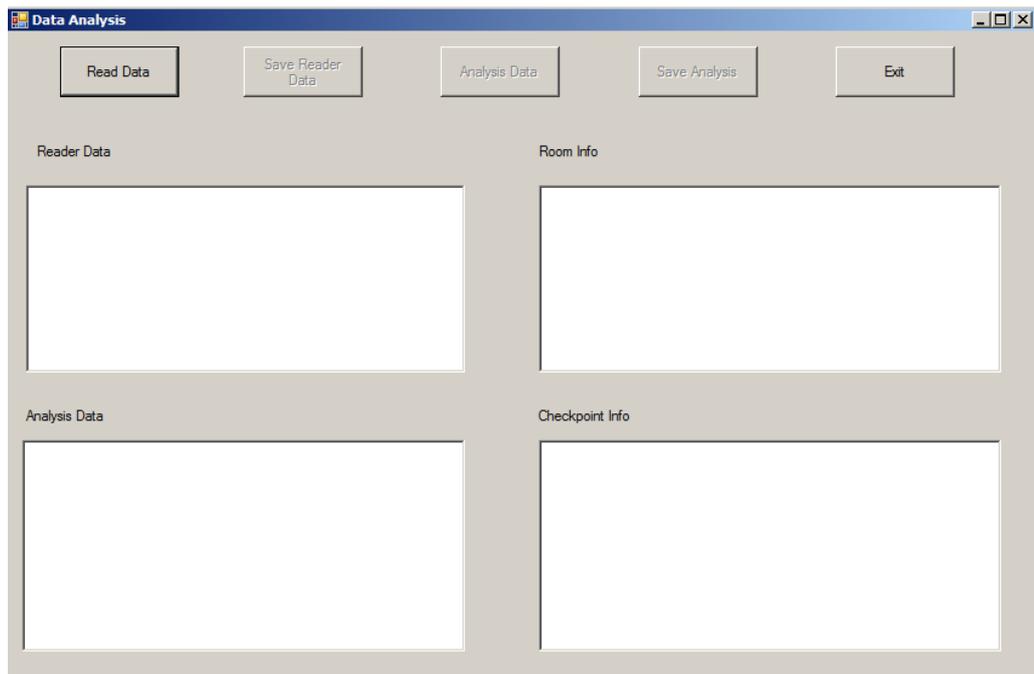


Figure 4.11 Application Version 3 Interface

Version 3 provides two ways of obtaining data for analysis: one way is to load a text file similarly to Version 2; the other way is to download data collected by Tracient TraceConnect RFIDWedge software application which is similar to Version 1. Once the RFID reader reads new entries, the information will automatically appear in the Read Data textbox through the functions provided by Tracient TraceConnect RFIDWedge. The button Save Reader Data is initially disabled until some entries appear in the Reader Data textbox that can be saved in a text file if the user clicks on that button. The purpose for this is that the saved text file can be compared with the text file downloaded from RFID reader for future access. The button Analysis Data is also enabled if there are entries in the Reader Data textbox. When the user clicks on the Analysis Data

Button, all Reader Data is analysed and displayed in the corresponding textbox; the Save Analysis button will become available for user to save the analysed data to a text file for future access. Figure 4.12 shows the interface of Version 3 displaying some analysed data.

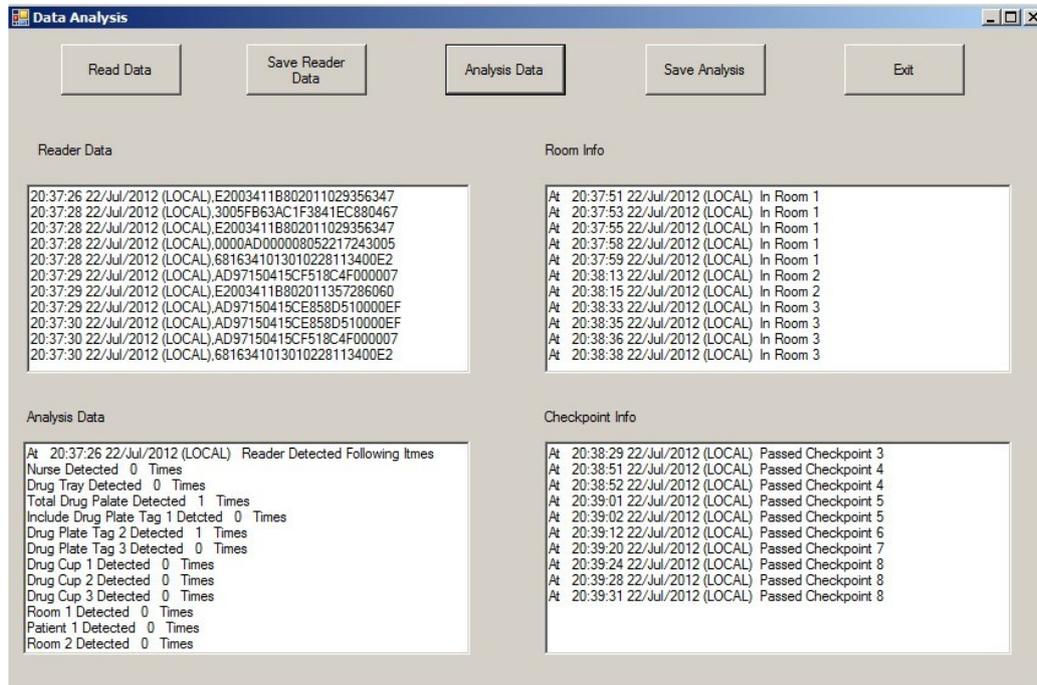


Figure 4.12 Application Version 3 Interface with Analysed Result

Once the development of each of the three versions of the prototype software application was completed, full tests were carried describe these. After that we could use the application for our experiments.

Chapter 5 Experiments and Evaluation

In this chapter, we first describe how to use the developed software application for the research experiments. Then we discuss the setup of the experiment. We also present the results from the experiments and evaluate the data we have collected. The data have been analysed and evaluated by the data analysis method that presented in Section 2.5.

We have carried out three different experiments for this research. The first experiment is related to the RFID Reader performance testing. This experiment is used to find out which position of the RFID Reader on the drug tray ensures the best reader performance, which is needed for the next experiment. We have described this experiment in Section 5.1.

The second experiment is measuring the detection rate. This experiment aims to identify the detection rate during the simulate drug dispensing and administering period. We have described this experiment in Section 5.2.

The third experiment is advanced detection rate measurement. This experiment is based on the second experiment with the addition of check points and a drug trolley for a more complex simulation. We have described this experiment in Section 5.3.

We also have used an indoor robot to assist our experiments. This robot assisted in the detection measurement rate experiments and advanced detection rate measurement. Moreover, the indoor robot also mapped the simulation indoor environment for a clear view. We describe this simulation on Section 5.4.

5.1 Simulated RFID Detecting Drug Tray Performance Test

5.1.1 Experiment Setup

This experiment is used to find out the best location for the RFID Reader. In our simulated hospital drug dispensing and administrating system, nurses use the drug trays to dispense drug cups to patients. We propose to use a smart drug tray, where the RFID reader integrated with the drug tray. Therefore, it is important to find the best location on the drug tray for the RFID reader. The drug tray is also tagged with an RFID tag during the experiment as the standard drug dispensing and administrating model is followed.

We have identified 16 possible locations for the RFID Reader on the drug tray and they are shown in Figure 5.1. Table 5.1 contains the exact position of each location.

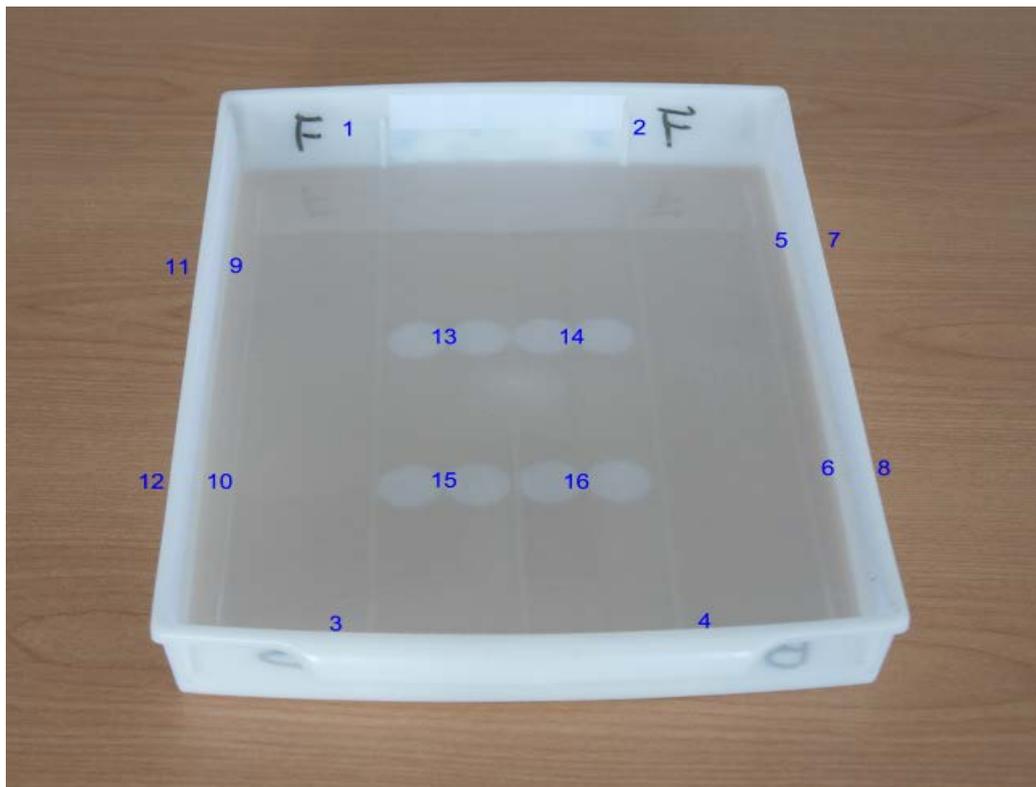


Figure 5.1 Possible locations for the RFID Reader on the drug tray

Table 5.1

Reader Locations Table

Number	Location	Number	Location
Position 1	Front Left	Position 9	Left Front Inside
Position 2	Front Right	Position 10	Left Back Inside
Position 3	Back Left	Position 11	Left Front Outside
Position 4	Back Right	Position 12	Left Back Outside
Position 5	Right Front Inside	Position 13	Under Left Front
Position 6	Right Back Inside	Position 14	Under Right Front
Position 7	Right Front Outside	Position 15	Under Left Back
Position 8	Right Back Outside	Position 16	Under Right Back

This experiment is run in the context of a simulated drug dispensing and administering system. Version 1 of our software application was designed and developed for this experiment. All the actions are recorded in the event message area so we can retrieve and analyse the experimental data in future. Figure 5.2 shows the experiment setup during the simulation. Since the first experiment is carried out to test the RFID Reader performance depending on its location on the drug tray, only one patient will be detected during the experiment.

*Figure 5.2* Reader Performance Experiment Simulation

As described in Section 4.2.2, Version 1 of the software application needs the Tracient TraceConnect RFIDWedge Reader Connection application to connect our software application and the RFID reader. Figure 5.3 shows the dialog box for connecting the RFID Reader.

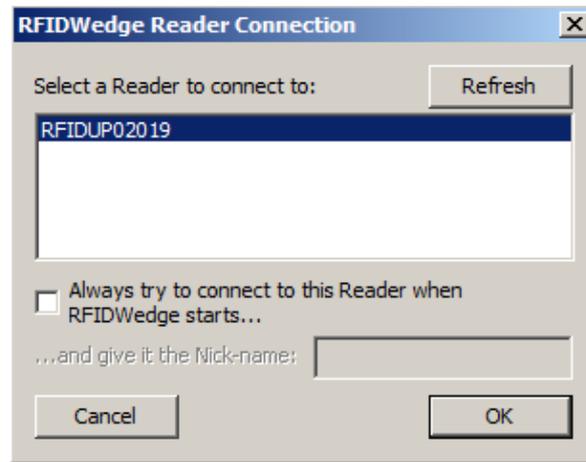


Figure 5.3 RFID Reader Connection by RFIDWedge

The serial number of the RFID Reader we used is 02019 and it can be seen in Figure 5.3 that, the RFIDWedge allows us to connect the Reader with RFIDUP2019 id while it is in the Bluetooth connection range. We also need to configure the settings of the RFID Reader which is done by using the Tracient TraceConnect RFID Control Panel application provided by Tracient Technology. Figure 5.4 shows the settings of the RFID Reader.

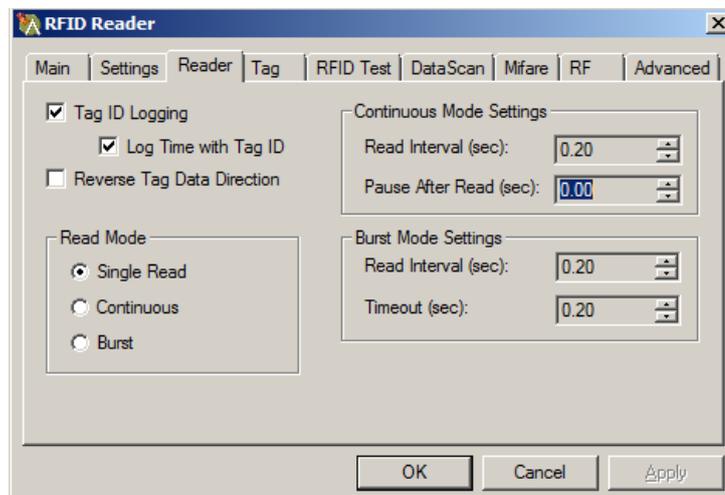


Figure 5.4 RFID Reader Control Panel for the Reader Performance Experiment

Since the aim of this experiment is to find out the best location of the RFID Reader on the drug tray, the Read Mode for this experiment is set for “Single Read”. Version 1 of the software application is also developed for this purpose. The application only works when once the mouse leaves the textbox Reader Details in Figure 5.4. If we use “Continuous Mode”, the application would not run the method for comparison between the read tags IDs and hard code tags IDs until the RFID Reader stops reading. “Burst Mode” has the functionality that is similar to that “Continuous Mode”, so we will not use this mode either. Thus, Continuous and Burst modes are not suitable for this experiment. The RFID Reader also records log data to its internal memory which we can analyse the collected data in future if we wish. Since Version 1 of our software application needs RFIDWedge application to connect to the RFID Reader, it is also necessary to set up the RFIDWedge connection application. Figure 5.5 shows RFIDWedge dialog box used to set up the connection to the RFID Reader.

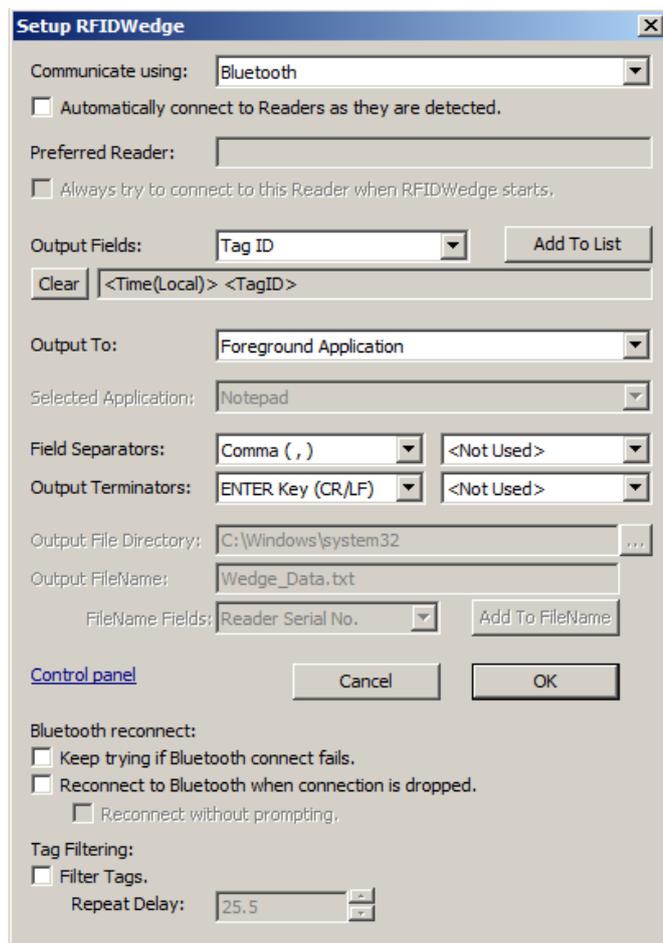


Figure 5.5 RFIDWedge Setup for Reader Performance Experiment

As it can be seen from Figure 5.5, we used Bluetooth connection during the experiment. Output Fields we use a combination of Time (Local) and Tag IDs, which determines the format of each entry as a combination of Time (Local) and Tag IDs, separated by a comma. This allows the user to see the timestamp and tag ID pairs clearly. The same format it used for saving the data log to the RFID Reader internal memory.

Output to Foreground Application method is used to put read details to specified location by RFID reader. Foreground Application means the closest application that running on computer by users. In this experiment, we run Version 1 of the software application and point the cursor to the Reader Details textbox which causes all the read tags to be transferred to the Reader Details textbox automatically.

After we have configured the RFID Reader settings and connected to our computer successfully, we start to collect data for this experiment. Table 5.2 shows the technical specifications for the computer that we have used to do the experiment. This computer has also been used for all other experiments for this research and for the development of all versions of the prototype software.

Table 5.2

Technical specifications for the computer used in this research

Desktop	Macbook Pro
Processor	Intel Core I5 M520 2.40GHz
Memory	4GB
Operating System	Windows 7 Professional 64-bit

Figure 5.6 shows a screen dump of the running software application during the RFID Reader performance experiment. Figure 5.7 shows a screen dump of the software application when it has completed the data collection.

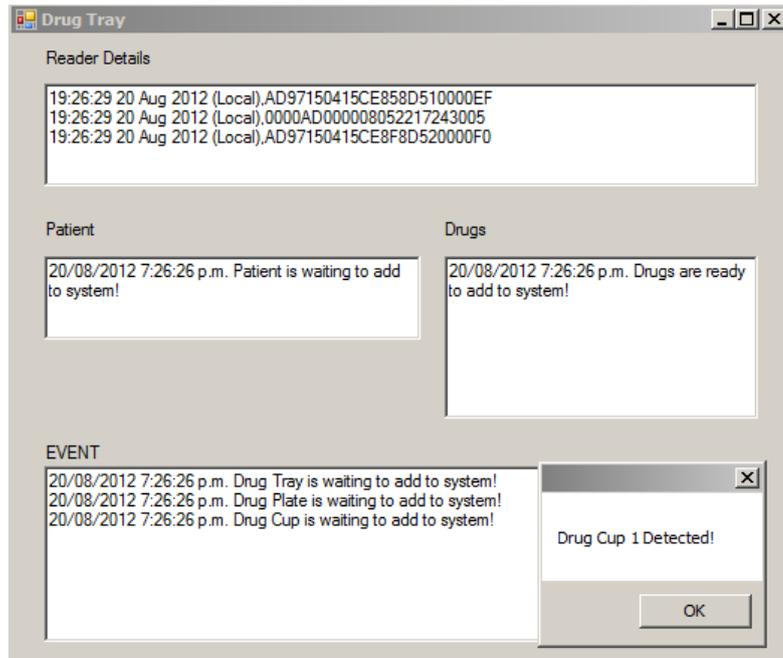


Figure 5.6 A screen dump of the running Version 1 of the prototype software

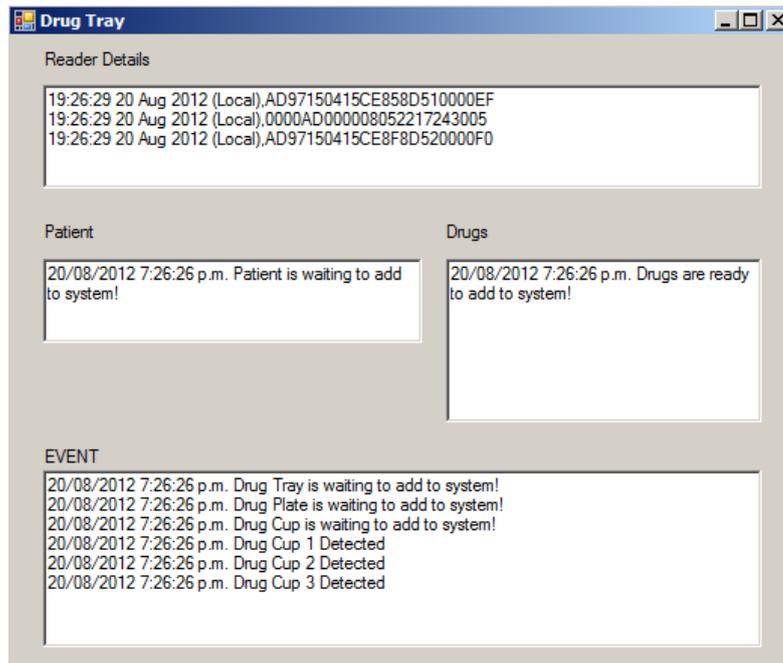


Figure 5.7 A screen dump of the Version 1 of the prototype software when it has completed the data collection

The results and evaluations for this experiment will be found in subsection 5.1.2.

5.1.2 Experimental Results

In this experiment, we ran 10 rounds of testing the RFID Reader's performance for each of its 16 possible locations on the drug tray. Each new round started after the previous round had finished. Table 5.3 shows the RFID Readers' performance results for each of its 16 possible locations on the drug tray. The results are represented as a percentage of its successful reading of the RFID tags attached to patients, drug cups, drug plates and drug trays at each time reading. The table also shows the average results for each tagged item (at the bottom) and the average results for each location (rightmost column)

Table 5.3

Results from the Read Reader's Performance Test

Tagged Items Reader Locations	Drug Tray	Drug Plate	Drug Cup1	Drug Cup2	Drug Cup3	Patient	Average
1	70.00%	60.00%	100%	90.00%	90.00%	90.00%	83.33%
2	100%	80.00%	90.00%	90.00%	80.00%	60.00%	83.33%
3	90.00%	0%	90.00%	100%	100%	100%	80.00%
4	40.00%	0%	90.00%	100%	70.00%	100%	66.67%
5	100%	90.00%	30.00%	100%	90.00%	80.00%	81.67%
6	60.00%	10.00%	100%	90.00%	80.00%	100%	73.33%
7	90.00%	40.00%	80.00%	70.00%	100%	90.00%	78.33%
8	80.00%	70.00%	90.00%	100%	100%	50.00%	81.67%
9	80.00%	100%	100%	90.00%	10.00%	80.00%	76.67%
10	50.00%	0%	90.00%	100%	90.00%	80.00%	68.33%
11	50.00%	60.00%	100%	100%	100%	60.00%	78.33%
12	100%	50.00%	60.00%	100%	100%	80.00%	81.67%
13	100%	60.00%	90.00%	90.00%	60.00%	50.00%	75.00%
14	70.00%	100%	80.00%	90.00%	100%	50.00%	81.67%
15	90.00%	20.00%	50.00%	100%	100%	30.0%	65.00%
16	60.00%	50.00%	100%	100%	80.00%	80.00%	78.33%
<i>Average</i>	<i>76.88%</i>	<i>49.38%</i>	<i>71.88%</i>	<i>94.38%</i>	<i>84.38%</i>	<i>73.75%</i>	<i>77.08%</i>

From the Table 5.3 we can see that the RFID Reader has the highest average rate of 83.33% in Locations 1 and 2, while its lowest average rate of 65.00% is when the Reader is in Location 15. The Reader has the highest average reading rate of 94.38% for Drug Cup 2, while its lowest average reading rate of 49.38% is for the Drug Plate. Therefore, the front part of the drug tray (Location 1 and 2) is the best place for the RFID reader to ensure its best performance. In the other two experiments, we mainly used Location 2 of the drug tray.

From the tags detection information that is displayed in the event message area of our prototype software, we can see that, for each testing round the software has recorded all information from the tags that the RFID Reader detected. If we refer to the Drug dispensing model discussed in Section 4.1, we can match these correspond tags with some of the simple related action presented in the model refer to drug dispensing model. We can understand erroneous actions from those actions in future by modifying software applications.

5.2 Detection Measurements

5.2.1 Experiment Setup

In the previous experiment we have found the best location for the UHF RFID Reader on the drug tray, we can now move on to the next experiment in this research. The purpose for this experiment is to find out how well the RFID technology actually works in a simulated drug dispensing and administering environment.

This experiment is based on the simulation drug dispensing and administering model that we have created and presented in Section 4.1. In this experiment we follow the model very closely.

The UHF RFID Reader is the key equipment in this experiment. All tag IDs that are collected during the experiment are stored in the RFID Reader's internal memory. The RFID Reader is attached to the drug tray in the best location established in the previous experiment; thus the drug tray and the Reader formed together a smart tray. The AUT Postgraduate Students' Thesis room WT406 was set up as the simulated hospital environment for this experiment and for the advanced detection measurement. Figure 5.8 shows the floor plan for the simulation. The plan was designed to reflect the drug dispensing and administering model we have created and presented in Section 4.1.

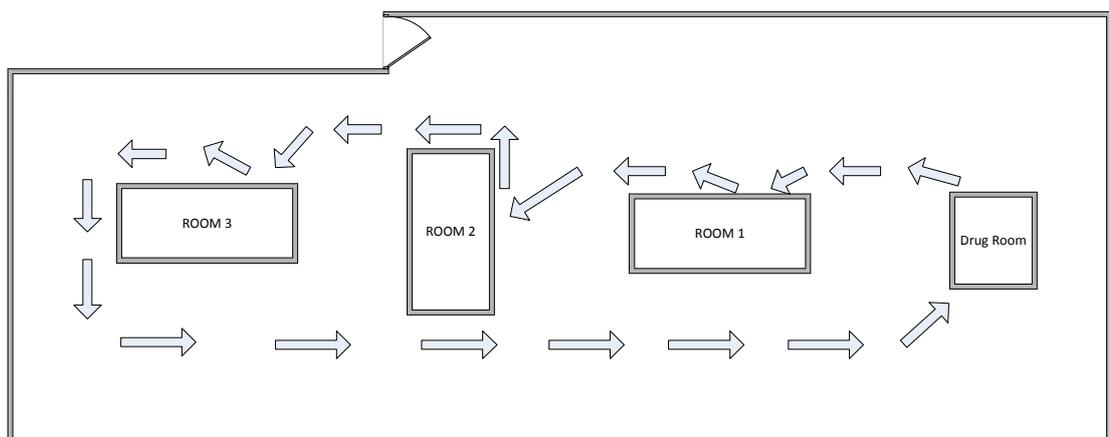


Figure 5.8 Floor plan for the simulated environment

The arrows in Figure 5.8 show the route that a nurse should take. The researcher acted as a nurse in the simulation and carried the smart drug tray to each room to dispense drug cups. Since the RFID Reader needs to keep reading tag IDs throughout the entire experiment, we needed to configure the RFID Reader differently to the previous experiment. Figure 5.9 shows the configuration screen for the RFID Reader.

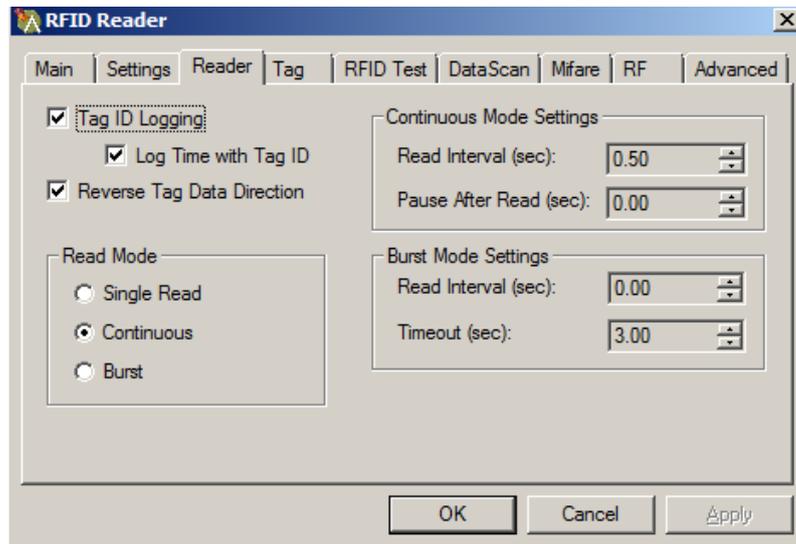


Figure 5.9 RFID Reader Control Panel for Detection Measurements

As can be seen in Figure 5.9, Read Mode is set to “Continuous”, Read Interval is set to 0.50 sec and Pause After Read is set to 0.00 sec which means the RFID Reader will conduct collections of tags in 2 interrogations in one second without any pause time. There are two main reasons for using these settings for the RFID reader. The first reason is that since we want to analyse the RFID Reader’s detection rate the data should be read continuously. In order to measure the sensitivity of the rate, there should be no pause after each reading therefore we set the pause time to 0.00 sec. Secondly, the lowest setting for Read Interval is 0.05 sec which would allow for 20 interrogations for each second of readings. We assume that the RFID Reader can detect 5 tags at each interrogation, which means 100 tag IDs (with duplicates) would be detected in one second. Since, the internal memory of the RFID Reader can only store 1000 tags IDs (with duplicates), theoretically, it could fill up only 10 seconds into the experiment. In reality the readings might be fewer and the memory might take longer to fill up, but

would still not be enough to make for the duration of the experiment. Thus, we have adjusted the reader settings to fit our experiment.

We repeated this experiment three times during the simulations. The first round took about one minute, the second round took about two minutes and the third round took around six minutes. In each round, we took the route and dispensed each drug cup to the respective patient in each room. The RFID Reader recoded tag IDs that it detected during experiment. After each round finished, we downloaded the log file from the RFID Reader for analysis by Tracient Traceconnet RFIDSyn. Figure 5.10 shows the log file downloading by RFIDSyn from RFID reader.

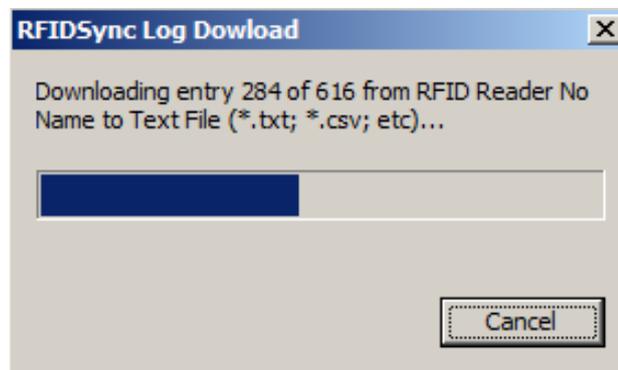


Figure 5.10 RFID Reader Log Downloading Sample

We adapted the downloaded text files to our Version 2 software application in order to analyse the collected data. The results and evaluations from this experiment can be found in Subsection 5.2.2.

5.2.2 Experimental Results and Evaluations

As we explained in the previous subsection, we repeated this experiment three times. Appendix A contains the spread sheets with the detection data. Each tag that attached to corresponded item will be analysed for detection rate and related actions. Ideally, based on the drug dispensing model we have created, nurse's tag, drug tray's tag and the tags from drug plate should be detected during the entire dispensing period. The reason we have used three tags for the drug plate is to increase the likelihood of detections by at least one of the tags with increasing number of tags.

Tags from drug cups are detected at the beginning of the simulated dispensing until they have been dispensed. In the drug dispensing model, three cups should be dispensed in sequential order. This means tag of drug cup 2 should have longer detection duration than tag of drug cup 1 and drug cup 3's tag should have longer detection time than drug cup 2's tag.

Each tag of room and patient should be detected as the nurse approaches them, and should disappear when the nurse moves away from them. Figure 5.11 shows the perfect detecting graph based on the drug dispensing model and the above description.

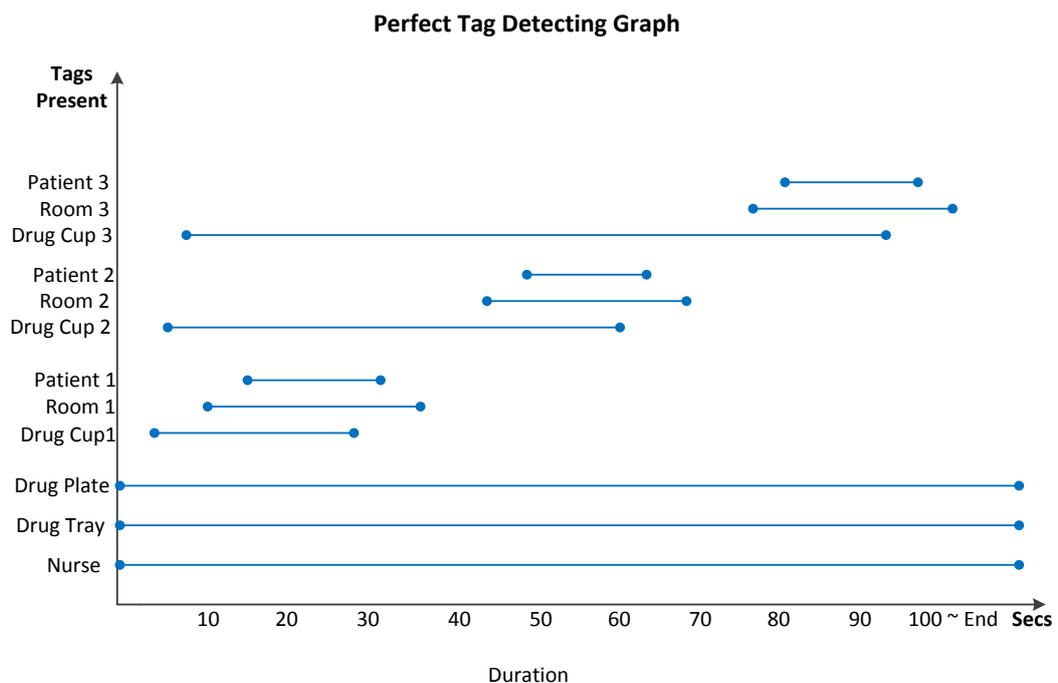


Figure 5.11 Theoretically Perfect Data Detection Graph

However, it is not possible to get perfect data during the actual experiment. We obtained the detection measurement graph from the data collected in each round and compared those to the graph presented in Figure 5.11 in order to analyse the difference between the actual collected data and theoretically perfect data. If some mistakes occurred during the experiment (such as wrong order of dispensing a drug cup) they would appear on the graph clearly.

5.2.2.1 Round 1

This first round took for about one and a half minutes. All together 150 tag ids were detected and collected by the RFID Reader. These data have been processed by the software application Version 2 for analysis. Figure 5.12 shows the experiment round 1 detection measurement chart for Round 1, which is based on the analysed results.

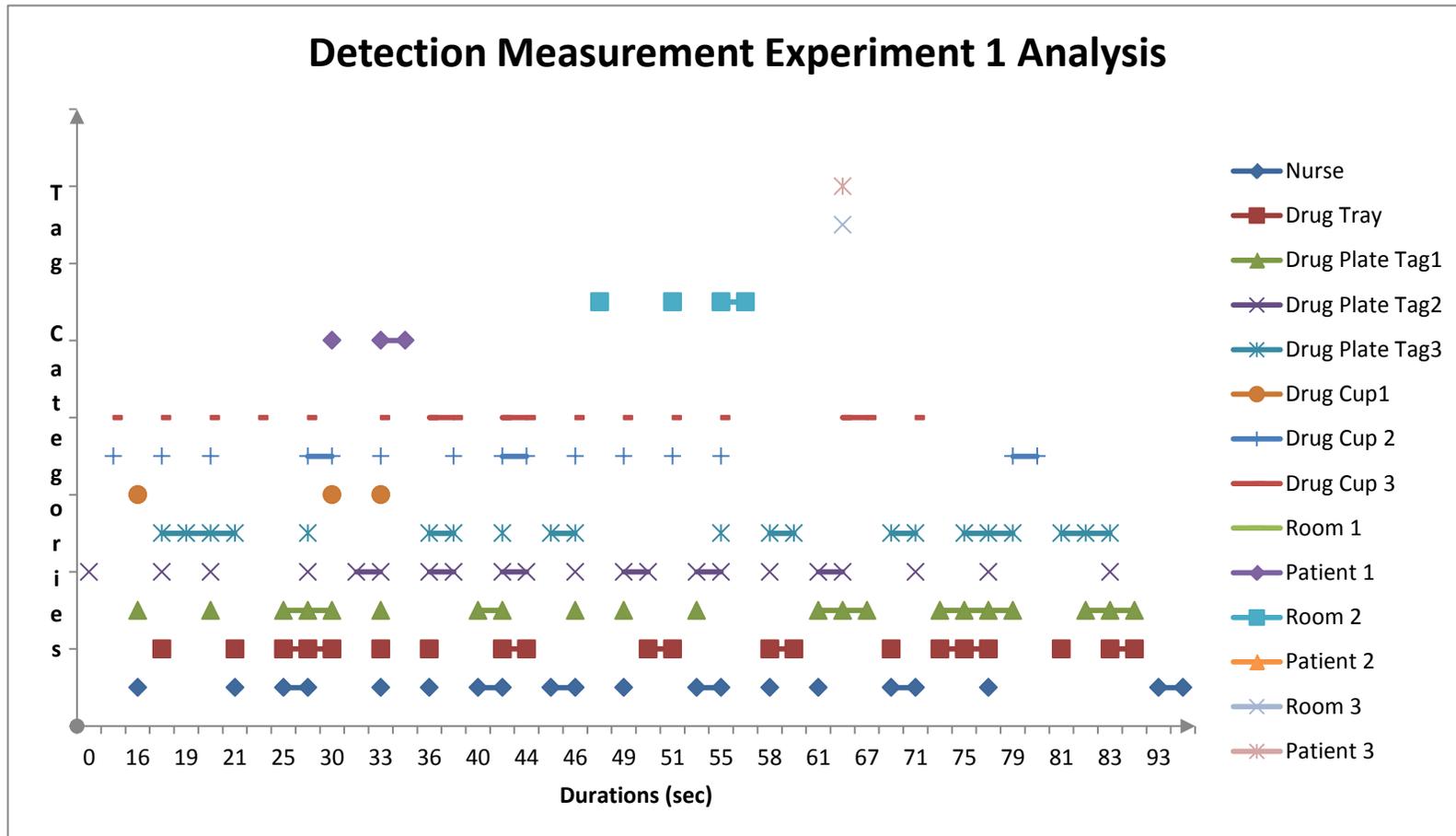


Figure 5.12 Detection Measurement Graph for Round 1 of the experiment

When compared to the graph in Figure 5.11 it can be seen that the actual detection in this experiment is very different from the perfect data detection. Tags of room 1 and patient 2 were not detected during this round. In this round of the simulation we have made a mistake here as we dispensed drug cup 3 before drug cup 2 which means we have dispensed drug cup for patient 2 to patient 3. The RFID Reader clearly recorded incorrect action and we can easily identify it by analysing the collected data.

We applied the method of confusion matrix to measure the detection rate of tags attached to the nurse, the drug tray and the drug plate for the entire duration of round 1 (about one and half minutes). In the other two rounds of this experiment and in the following experiments we calculated the detection rate for above times on average around 1 minute. For the detections that took place in last minute, if it more than 30 seconds, we calculated for 1 minute. Otherwise, we calculated them combined with previous minute. Theoretically, the tags attached to the nurse, drug tray and drug plate are should always be with no exception, so the true negative for these tags should be 0. Moreover, these tags should always be present during the entire dispensing period. Hence, the false positive for these tags should be 0 as well. If the related tag has been detected in the one minute period, that minute will be set as detected minute, and then the true positive detection rate is calculated by Equation 1. The false negative rate is when the tags are not detected and it is calculated by Equation 2. The cells in the confusion matrix table marked with "N/A" denote that is not necessary to measure. This is used for all possible combinations of the drug plate tags group. We have already measured detection rate for each individual tags on the drug plate. The possible combinations of these tags we just need to do know how the true positive detection rate could be. Other fields in confusion matrix do no need to be calculated at all. All the remaining confusion matrixes for the experiments are calculated as described above. Table 5.4 shows the detection rate of the confusion matrix for round 1 of the experiment.

Table 5.4

Confusion Matrix for Round 1 of the Detection Measurement Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

Table 5.4 shows the confusion matrix for this round of the experiment. As can be seen from the table, the detection rate is 100% for all tags. This means that all activities that have taken place during the 1 min duration of the experiment objects can be analysed.

We measured the detection rate for each drug cup until it was dispensed to related patient. We also measured the detection rate for each room and patient while the nurse was actually in that room. The calculation for the detection rate was made by applying the formula given in Equation 1. However, the calculation may not necessarily be correct as there might have been a few seconds difference between the RFID Reader detected the tags and our record of time when the nurse enter the room. Therefore, we estimated the nearest time for these data. We used the same way for measuring the detection rate for these objects in all rounds of these experiments. Table 5.5 shows the detection rate for these objects in round 1 of this experiment.

Table 5.5

Objects Detection Rate for Round 1 of the Detection Measurement Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	0%
Patient 1	100%
Room 2	100%
Patient 2	0%
Room 3	100%
Patient 3	100%

From Table 5.5, we see that the detection rate is also high for drug cups. However, the tags attached to room 1 and patient 2 were not detected in this round. One possible reason for the failure of the Reader to detect these tags could be that this is the first round of these experiment, the tag locations and the Reader configuration were not chosen well. This made us adjust some settings for the next round of this experiment.

5.2.2.2 Round 2

This round took around two minutes and all together 268 tag IDs were detected and collected by the RFID Reader during the simulation period. We analysed these data by using our software application Version 2 and have constructed a detection measurement graph show in Figure 5.13.

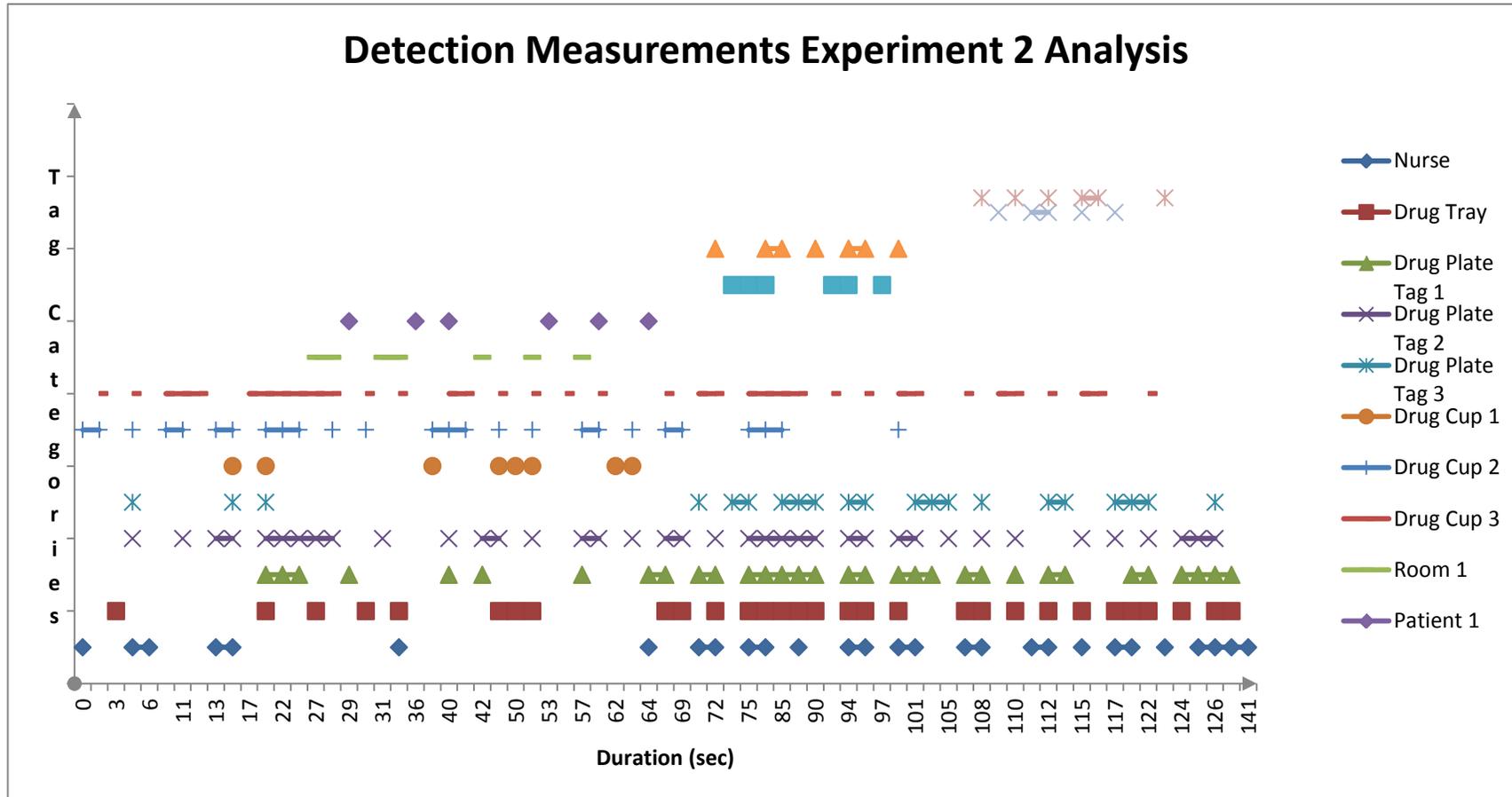


Figure 5.13 Detection Measurement Graph for Round 2 of the Experiment

Figure 5.13 shows that, all tags have been detected and no erroneous actions were undertaken for drug cup dispensing orders during the simulation period. Each drug cup's tag disappeared once the cup dispensed to the respective patient. Each patient's and room's tag IDs only appeared once the nurse arrived and then disappeared while the nurse left. Each room's and patient's tag IDs appeared together as expected. Tags attached to the nurse, drug tray and drug plate were detected from beginning to the end.

In order to analyse the RFID Reader's detection performance, we used detection rate for building a confusion matrix for Round 2 in the same way we did that for Round. Table 5.6 shows the confusion matrix for Round 2 of this Experiment.

Table 5.6

Confusion Matrix for Round 2 of the Detection Measurement

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

Table 5.6 shows that detection rate in average 1 minute is still very high in this round of experiment. All tags have the true positive detection rate 100% for average one minute in two minutes time period. This means that all key objects have were detected in this round of experiment in each minute and the false positive detection rates for all objects remain 0% as predicted.

Similarly to Round 1 of this experiment, we identified the detection rate for all tags attached to drug cups, rooms and patient and they are presented in Table 5.7.

Table 5.7

Objects Detection Rate for Round 2 of the Detection Measurement Experiment

Tagged Object	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

Table 5.7 shows that all tagged objects have 100% true positive detection rate for the relevant time period. Drug cups have 100% detection rates for the period before they were dispensed, while patients' tag and rooms' tags have 100% detection rate for the time the nurse approaching to them was present in the simulated drug room. This means all activities related on these objects can be recorded and analysed for the entire simulation duration of this experiment. This will allow for a better understanding of the activities and the possible errors associated with them.

Since this round of the experiment only took two minutes, it was easy enough to have the 100% average one minute detection rate for such a short period. We decide to increase the duration of the experiment and find out if this will affect the detection rates. This leads us to do the next round of the experiment.

5.2.2.3 Round 3

For this round of the experiment was set to last for about 7 minutes. The nurse had to spend about one and half minutes in each simulated room to dispense a drug cup to the respective simulated patient. This increased duration of experiment would allow for more data to be collected and analysed for this experiment. Altogether 799 tag IDs were detected and collected by the RFID Reader in this round. Version 2 of the prototype software application was used to analyse these data and assist to generate the detection graph for this round similarly to those for previous rounds. Figure 5.14 shows the detection graph for this round.

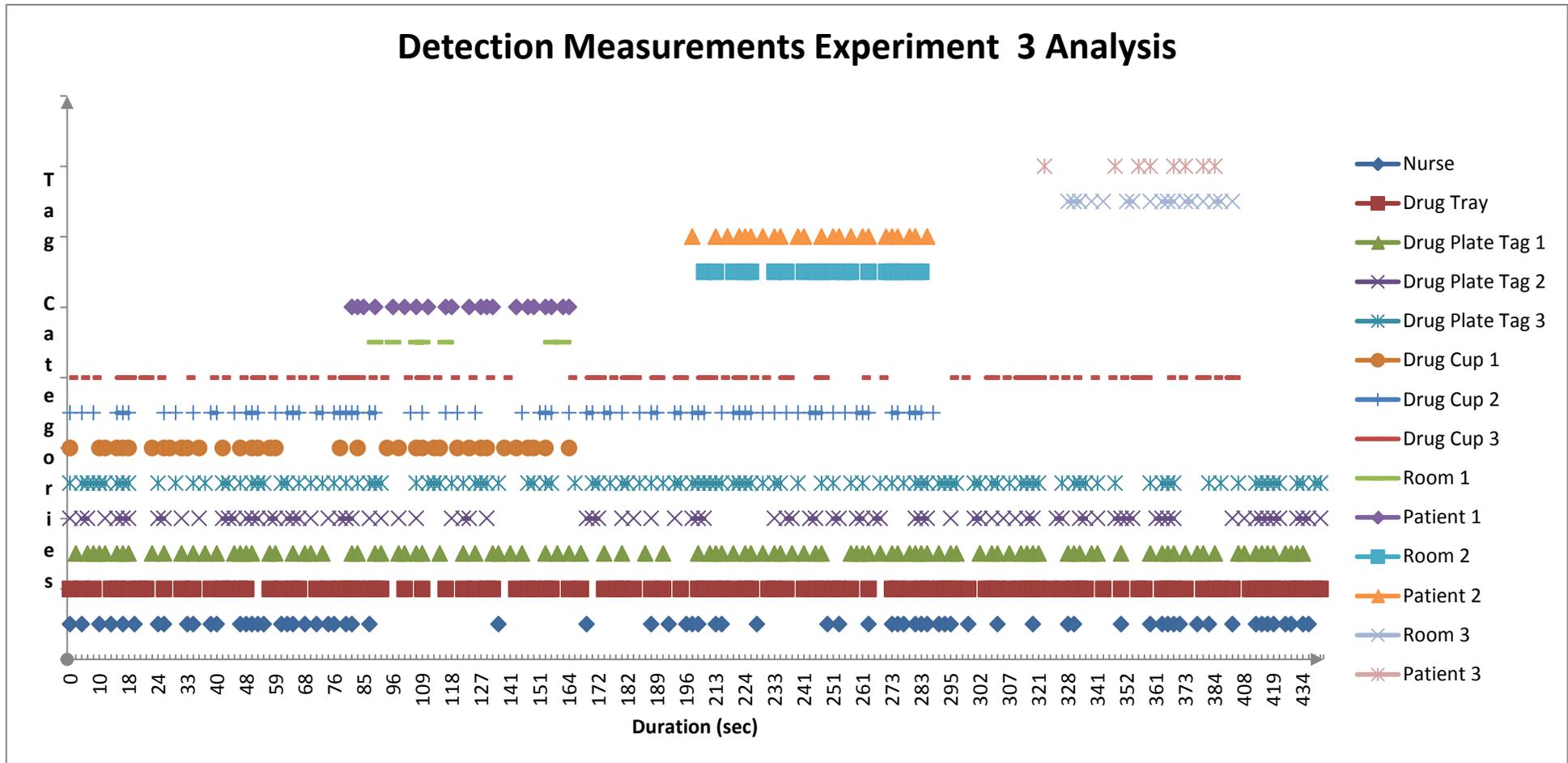


Figure 5.14 Detection Measurement Graph for Round 3 of the Experiment

The graph in Figure 5.14 indicates clearly the actions undertaken during the simulation period. No error has can be found in the action sequence. Figure 5.14 is quite similar to the prefect detection graph we presented in Figure 5.11. The drug cups', rooms' and patients' tag IDs appeared and disappeared just at the times they had to. All key objects were detected from the beginning to the end of the simulation period and all tags were detected during the simulation. However, from the graph we can also find that in some periods the nurse may not be detected which may affect the average detection rate for nurse's tag ID. Most of this happened in the period of dispensing a drug cup to a patient.

Table 5.8 shows the confusion matrix constructed for the detection rates in Round 3 of the experiment.

Table 5.8

Confusion Matrix for Round 3 of the Detection Measurement Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

Table 5.8 presents the confusion matrix for Round 3 of this experiment. All tagged objects have the detection rate in one minute period is 100% on average. This means that all the key objects were detected each minute in this round of the experiment. Although in the detection graph the nurse's tag appears not have been detected for a period of time, but based on the each one minute time period, the tag can be detected in that minute and increased detection performance of course. We identified the detection rate for all relevant objects as we did for the previous rounds. Table 5.9 shows the detection rates for these objects.

Table 5.9

Objects Detection Rate for Round 2 of the Detection Measurement Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

Table 5.9 shows the detection rates are still very high for the respective time periods, similarly to the detection rates in the previous two rounds of experiment. All the drug cups' tag IDs have 100% detection rates until they were dispensed to patients. Rooms' and patients' tag IDs also have the 100% detection rate for the time period the nurse was in the each of rooms. This provides evidence that the nurse that arrived in the room and was close to patient during that period.

From the data collected in three rounds of this experiment, we can conclude that in this this experiment, RFID technology was able record all relevant activities undertaken by nurse during the simulation period. If there were some activities sequence errors, they could be also identified by analysing the sequence of activities. Since this is just a prototype software application developed to find out whether the RFID technology can help in understating errors, we do not need to provide a solution for prevent errors. In future development of the software for actual usage in practice, we would need to provide some additional functions that analyse the RFID tags and also ensure the user is warned that there are some sequence errors. However, in this experiment a problem that needs special attention is: dispensing route. We want to find a way to track the movements of the nurse along the dispensing route. This is made possible in next stage of our Advanced Detection Measurements.

Since in this experiment, we want to make the simulation closer to the real hospital drug dispensing situation, we have added a drug trolley that carries a drug tray from which drug cups are dispensed during the simulation. This is similar to what nurses do in the hospital during the actual drug dispensing and administrating period.

In this experiment, the drug trolley was tagged with RFID tags as usual. Initially we wanted to use the UPM Raflatac UHF Passive RFID “DogBone™” tag which we used for the other experiments in this research. However, during the preliminary testing before the simulation we found that this tag could not be detected at certain times due to the size of its read area or some obstructions between the RFID Reader and the tags. If a tag attached to the drug trolley cannot be detected during the experiment, we would not be able to analyse the detection rate, the sensitivity and specificity of that object of this research. Therefore, we replaced the tag for the drug trolley with a plastic tag called Intermec RFID UHF Tag provided by the Intermec Technologies Corporation. This tag has the same operating frequency as the previous tag, it has larger detection area. Figure 5.17 shows the drug trolley with attached RFID tags and carried smart drug tray with computer for this experiment. Figure 5.18 shows the drug trolley as it passes a simulated checkpoint.

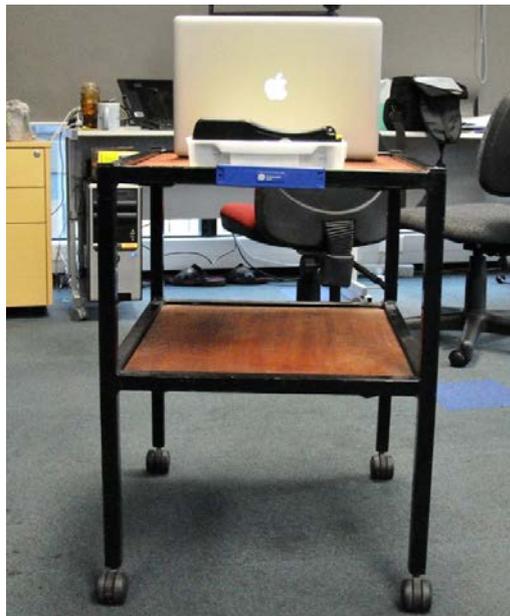


Figure 5.17 Drug Trolley Carries the Smart Drug Tray and a Computer



Figure 5.18 Drug Trolley Passing a Checkpoint

There are two ways to collect data either download it from the RFID Reader's internal memory or to get it direct from the Read Data textbox of the Version 3 software application which we have described in Subsection 4.2.2. During the experiment, we mainly used the Read Data textbox to collect data and the RFID Reader internal memory log file was considered a backup file.

We have undertaken three tests for this experiment. During each test the trolley is required to follow the route exactly. The drug trolley will pass each check point and stay there for a moment while the RFID Reader detects the checkpoint tag. Each test will take about 2 minutes. The results and evaluations for this experiment can be found can be found in Subsection 5.3.2.

5.3.2 Experimental Results and Evaluations

As pointed out in Subsection 5.3.1, this experiment is similar to the previous one. The only difference being that a tagged drug trolley is used for carrying the drug tray and also eight checkpoints are added in order to monitor the dispensing route. Appendix B contains the detection spread sheets with the recorded data for each round of this experiment.

Similarly to the previous experiment, ideally the key objects should be detected at appropriate times during the dispensing session. In this experiment, the drug trolley has to be always present at all times of the dispensing. Other objects have the same detection status as in the previous experiment. We also constructed a theoretical tag detection graph for this experiment shown in Figure 5.19.

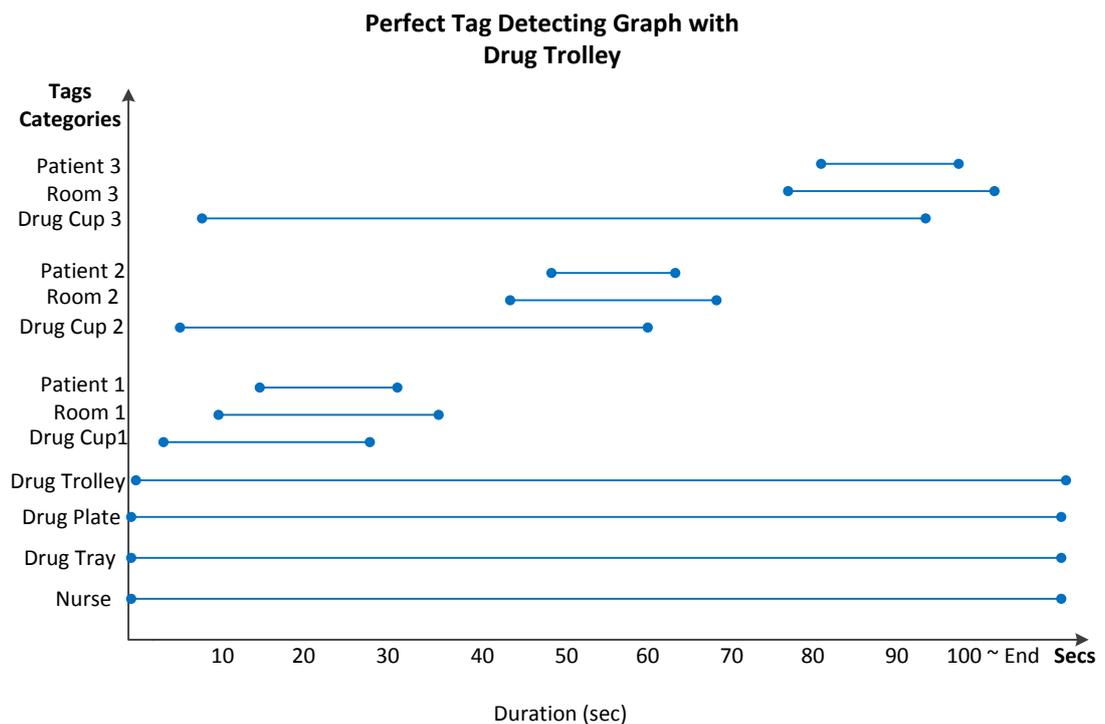


Figure 5.19 Theoretical Perfect Data Detection Graph that Includes the Drug Trolley

This graph is very similar to the one present in Figure 5.11 that was constructed for the experiment. As discussed in Subsection 5.2.2, this graph is only a theoretically perfect detecting graph, while the actual detection graph is expected to be different. In each session of this experiment, we generate a detection graph based on the collected data

and compare it with this graph in Figure 5.19. This is to analyse the RFID detections received for each session.

5.3.2.1 Session 1

This session took about 2 minutes to complete the experiment. Altogether 499 tag IDs were detected and recorded by the RFID Reader. These data was then processed by Version 3 of our software application. Figure 5.20 shows the detection graph constructed with the obtained results.

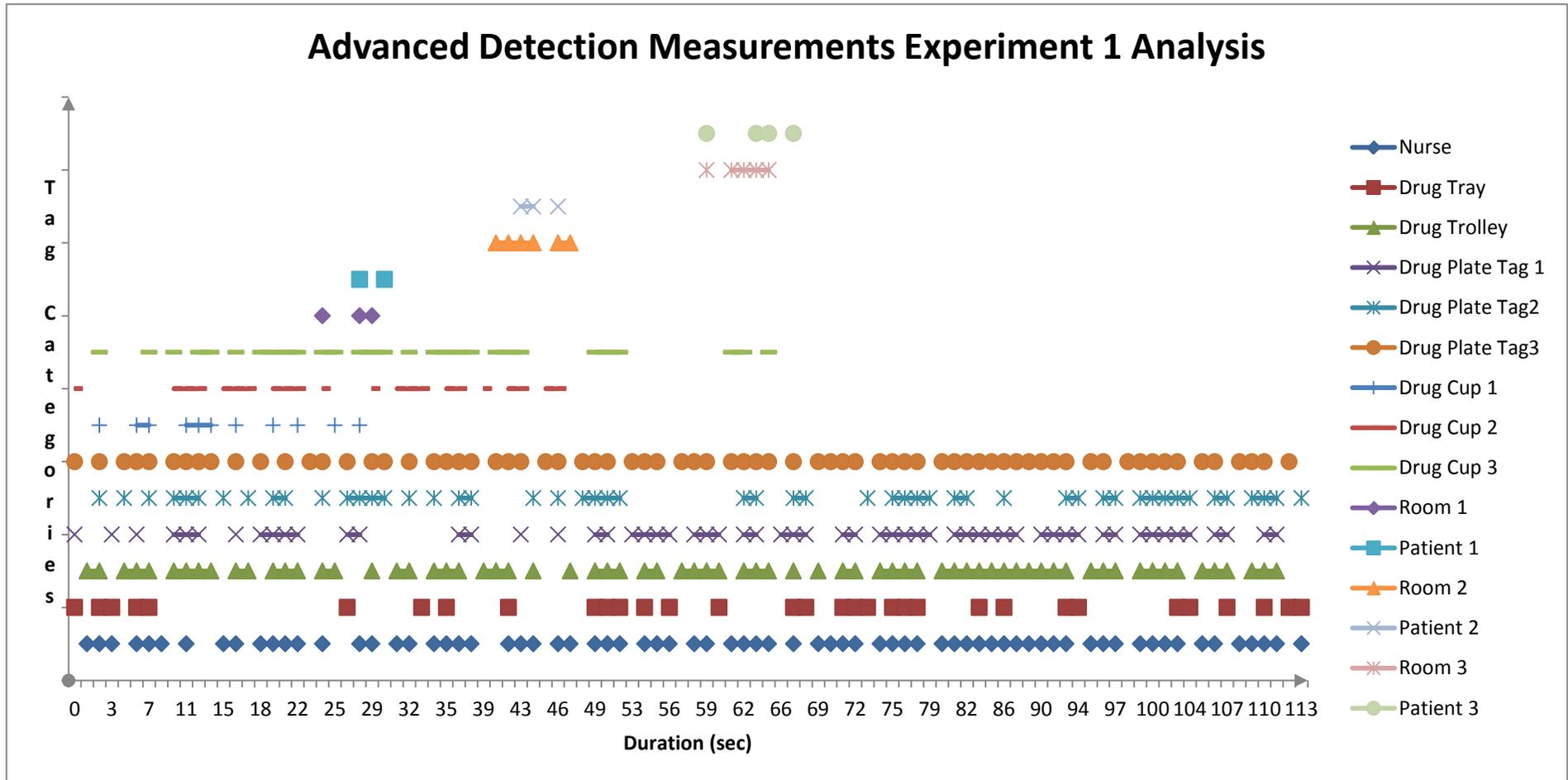


Figure 5.20 Advanced Detection Measurement Graph for Session 1 of the Experiment

Figure 5.20 shows clearly that all tagged objects have been detected in this session. Each drug cup's tag ID, the patient's tag ID disappeared from the graph when the trolley left the respected room. This means there are no errors in the sequence of activities in this session. The graph constructed with detections of tag IDs and presented in Figure 5.20 is quite similar to the design of model graph we generated (Figure 5.19). From the detections represented in this graph, we can see the detection rate is very good for almost all the tagged objects except for the drug tray. The confusion matrix for this session is shown in Table 5.10.

Table 5.10

Confusion Matrix for Session 1 of the Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Trolley	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

Table 5.10 shows that detection rate based on average one minute is also very good enough. All the objects have 100% true positive detection rate for each one minute period. This means all actions related on these objects can be recorded and analysed for each one minute period. The false negative detection rates were 0% as usual which we have expected. Table 5.11 shows that the detection rates for all tagged objects are 100%.

Table 5.11

Detection Rate for Relevant Objects in Session 1 of the Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

In Table 16, all the relevant objects in this session of experiment have 100% true positive detection rates in the corresponding time period. Each drug cup will be detected before being dispensed. Each room and patient tags have 100% true positive detection rate once the nurse approached to support this situation.

We also analysed the checkpoints detection data. Since the checkpoints are used to measure the route information we used during the experiment session, so we just simply analysed whether it each checkpoint is correctly detected or not. Table 5.12 shows the detection information of the checkpoints in this session of the experiment.

Table 5.12

Checkpoint detection status for Session 1 of the Experiment

Checkpoint Number	Detection Information	Manually Recorded Time
Check point 1	Not Detected	Not Applicable
Check point 2	Correctly Detected	Same
Check point 3	Correctly Detected	Same
Check point 4	Not Detected	Not Applicable
Check point 5	Correctly Detected	Same
Check point 6	Correctly Detected	Same
Check point 7	Correctly Detected	Same
Check point 8	Correctly Detected	Same

Table 5.12 shows that six of the eight checkpoints have been detected during this session and Checkpoint 1 and Checkpoint 6 were not detected during the simulation

session. As described in the experiment setup in Subsection 5.3.1 the drug trolley stops each checkpoint for a few seconds while the RFID Reader detect the checkpoints' tag. Compare each detected checkpoints RFID records with our manually recorded data, we can find that each detected checkpoints was the same time we were passing them.

In this session of the experiment we have added a tagged drug trolley and checkpoints to the experimental setup in order to make the experiment simulate reality more closely. The analysis of the results based on the collected RFID data and supported by the software application Version 3, show that all undertaken activities have been recorded by the RFID reader. The detection performance in this experiment is very good. The checkpoints identified the route information in this session.

5.3.2.2 Session 2

Similarly to Session 1, this session also took about 2 minutes to complete. Altogether 459 tag IDs were detected and collected by the RFID Reader. The collected data was processed by Version 3 of the software application for further analysis. Figure 5.21 shows the detection graph we constructed for this session of the experiment based on the collected data.

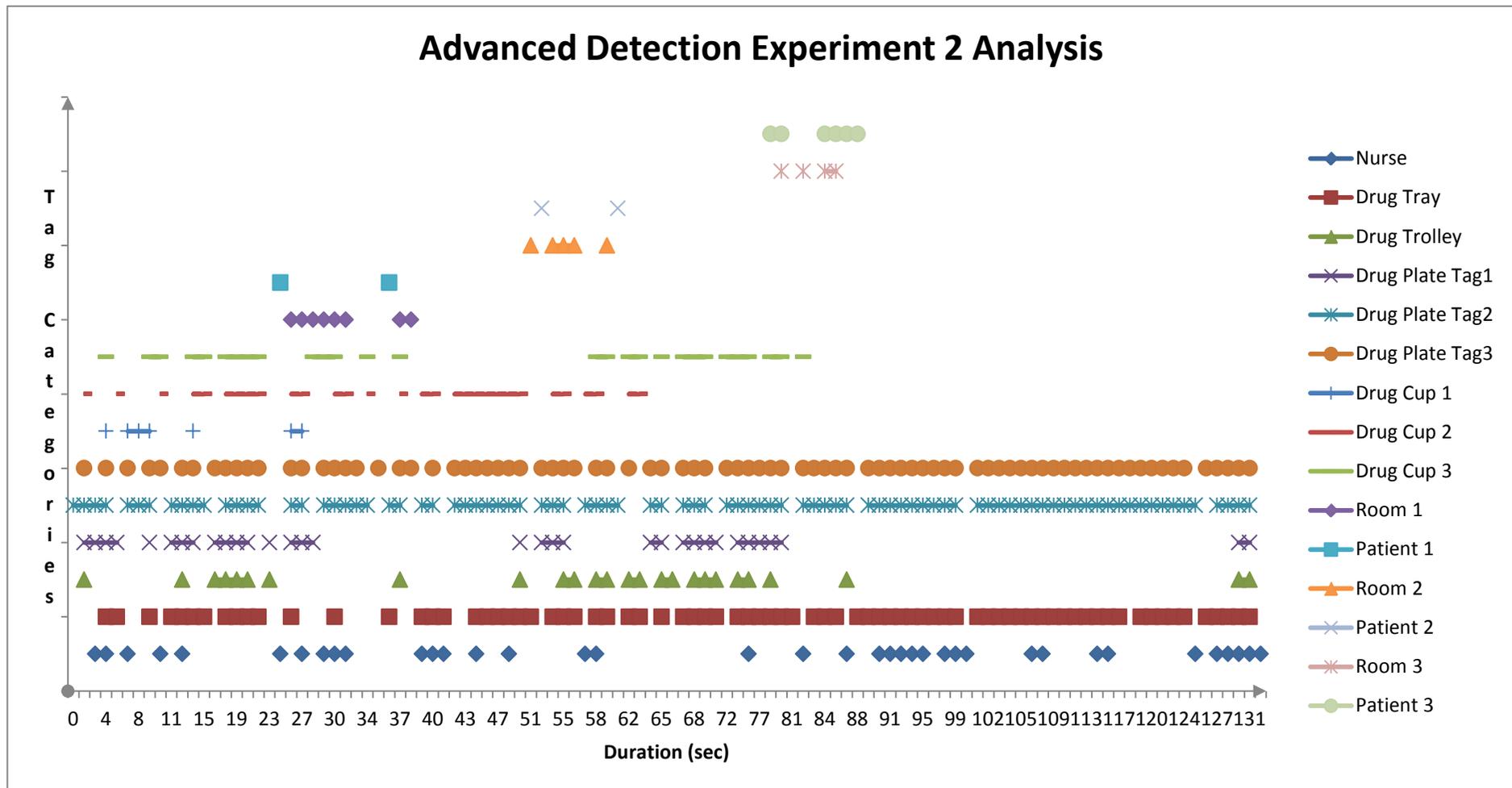


Figure 5.21 Advanced Detection Measurement Graph for Session 2 of the Experiment

Analysing the graph in Figure 5.21 shows that all objects have been detected in this session and that no errors were made in the sequence of activities. Each drug cup is no longer represented on the graph once the respective patient's tag ID has been recorded. All room and patient tag IDs appear and disappear on the graph as expected. We can see that on the detection graph some objects are not represented continuously. This may be due to the detection performance. Table 5.13 shows the confusion matrix constructed for this session.

Table 5.13

Confusion Matrix for Session 2 of the Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Trolley	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

Table 5.13 shows that the true positive detection rates for tags from all objects remain 100% in for the average one minute time period in this session. As discussed before, some objects may have low detection performance as seen in the detection graph of for some large gaps. However, as seen in the confusion matrix in Table 5.13, all the objects have been detected in each minute of the session. The detection rates for all relevant objects can be found in Table 5.14.

Table 5.14

Detection Rate for the Relevant Objects in Session 2 of the Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

Table 5.14 shows that, similarly to Session 1, all relevant objects have 100% detection rate. Each drug cup has been successfully detected before being dispensed to the respective patient. Each room and patient tags have the 100% detection rate once the nurse enters the patient's room which confirms that the nurse has actually been in this room.

We also analysed the route information based on the checkpoint detection information. Table 5.15 shows the checkpoint detection information for this session.

Table 5.15

Checkpoint detection status for Session 2 of the Experiment

Checkpoint Number	Detection Information	Manually Recorded Time
Check point 1	Not Detected	Not Applicable
Check point 2	Correctly Detected	Same
Check point 3	Correctly Detected	Same
Check point 4	Not Detected	Not Applicable
Check point 5	Not Detected	Not Applicable
Check point 6	Not Detected	Not Applicable
Check point 7	Not Detected	Not Applicable
Check point 8	Correctly Detected	Same

Table 5.15 shows that in this session only three of the eight checkpoints have been detected accurately, Checkpoint 2, Checkpoint 3 and Checkpoint 8. Each correctly detected checkpoint has the same timestamp recorded by the RFID Reader as our

manually records. Since the timestamps generated by passing the checkpoints of our records shows that the route was followed correctly, there must have been problems with detecting the checkpoints during the simulation for this session.

All dispensing actions in this session can be clearly represented on the detection graph in Figure 5.21. The analysis of checkpoints information combined with timestamp allows the dispensing route to be investigated. The true positive detection rate is excellent for all objects. With these such high average one minute detection rates, we can analysed the actions corresponded to these tags. However, some checkpoints were not detected during the simulation period which can cause wrong route identification. The analysis of this session results prompted the need for another session, where more data can be collected and analysed to address the identified issues.

5.3.2.3 Session 3

Similarly to the previous two sessions in this experiment, this session also took about 2 minutes to complete. Altogether 531 tag IDs were detected and recorded by the RFID Reader and then processed with Version 3 of the software application in order to analyse the actual events. Figure 5.22 shows the detection graph we generated based on the collected tag IDs.

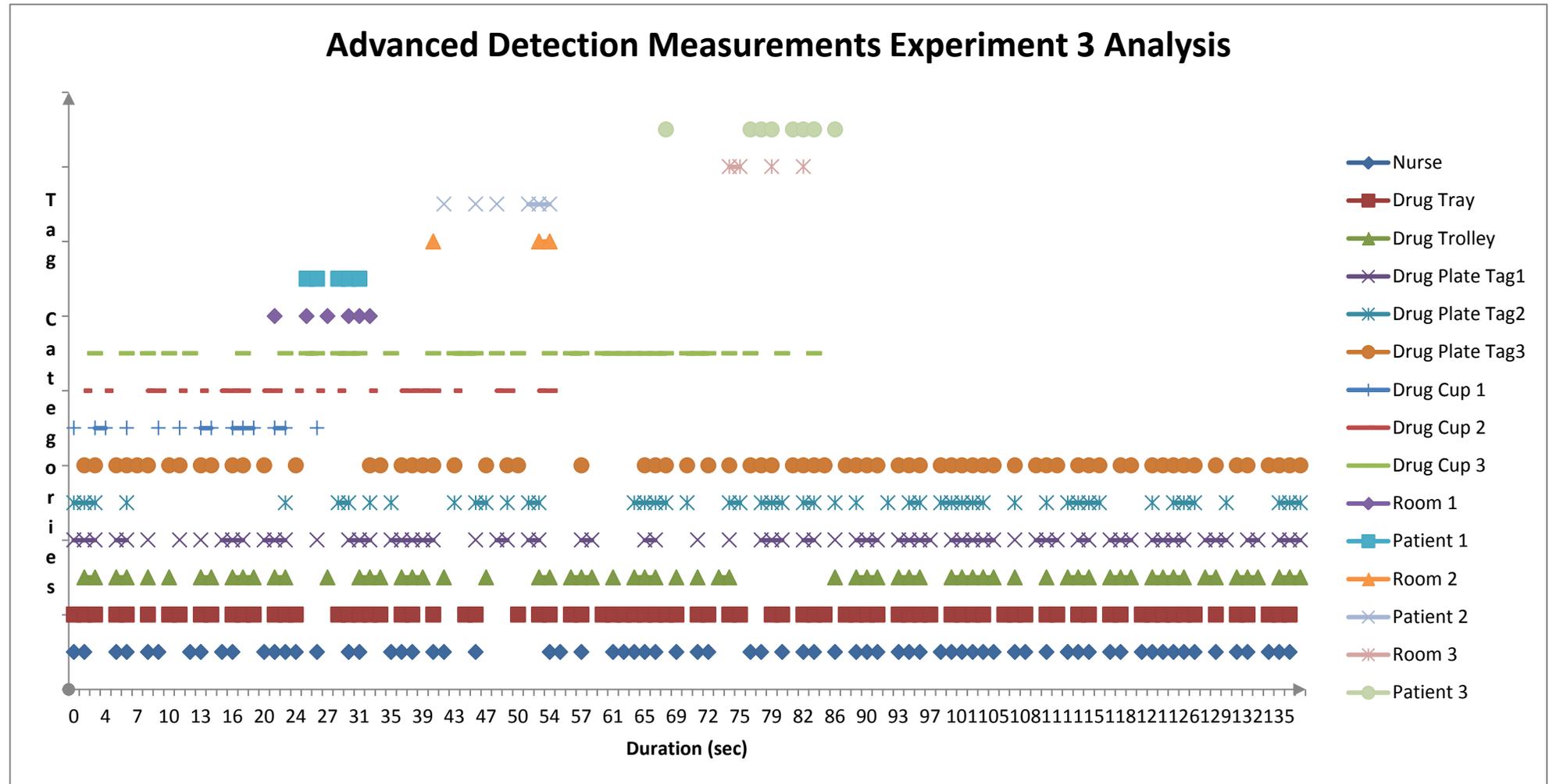


Figure 5.22 Advanced Detection Measurement Graph for Session 3 of the Experiment

Figure 5.22 shows that that all objects have been detected in this session and no errors were made in the sequence of dispensing. We can see that the graph in this figure is very close to the perfect data detection graph present in Figure 5.19. This means that this session was the closest to the ideal dispensing simulation in this experiment. The detection graph shows that the tags attached to the nurse, drug tray, drug plate and drug trolley have been always detected which indicates high detection performance of these objects. Tag IDs for Drug Cups, Rooms and Patients appeared and disappeared orderly and on time. Table 5.16 shows the confusion matrix generated for this session.

Table 5.16

Confusion Matrix for Session 3 of the Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Trolley	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

The true positive rates presented in Table 5.16 are similar to those in the previous two sessions. All key objects have 100% detection rates based for each minute of this session as predicted in the detection graph. This high detection rate means that all possible actions related to these objects can be easily recorded by the RFID Reader. Table 5.17 shows the detection rates for relevant tagged objects

Table 5.17

Detection Rate for the Relevant Objects in Session 3 of the Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

We can see that from Table 5.17, the true positive detection rates for all objects are very high as in the two previous sessions. All drug cups have 100% detection rate before they have been dispensed for on each minute of the session duration. All rooms' and patients' tag IDs have 100% detection rate once the nurse has arrived in the respective room which indicate that the nurse was actually in the room with patient.

Table 5.18 shows information about checkpoints detection obtained from processing the collected data by the software application.

Table 5.18

Checkpoint detection status for Session 3 of the Experiment

Checkpoint Number	Detection Information	Manually Recorded Time
Check point 1	Not Detected	Not Applicable
Check point 2	Correctly Detected	Same
Check point 3	Not Detected	Not Applicable
Check point 4	Not Detected	Not Applicable
Check point 5	Not Detected	Not Applicable
Check point 6	Not Detected	Not Applicable
Check point 7	Not Detected	Not Applicable
Check point 8	Correctly Detected	Same

Table 5.18 clearly shows that there are only two of the eight checkpoints were detected during the session, namely Checkpoint 2 and Checkpoint 8. This indicates that the

dispensing route may be wrong. However, based on the timestamps and compare the data collected for time of enter room information, we can infer that route is correct.

This session of the experiment is very close to a perfect detection and the detection graph is similar to the perfect detection graph. The high performance detection rates for these objects means the RFID Reader can record actions related to these objects easily and accurately. The detection rates are also excellent for all objects similarly to the results in the previous two sessions. However, the situation of that occurred in Session 2 also occurred in this session. Although the dispensing route was followed closely during the session, the checkpoints' tags were still not detected by the RFID reader. These will possible cause the analysis the route information not correctly in actual usage.

From the three sessions ran in this experiment, we can conclude that, the RFID Reader could record clearly all actions that involved the smart drug tray and trolley. The added checkpoints, made it possible to record the dispensing route as well. The specially designed and developed software application can help with the analysis of the dispensing actions and route information. The average read rate is high e for all objects within the one minute time period.

However, some readings of checkpoints tags IDS did not occur meaning the route information cannot be detected correctly. As described above, although the correct dispensing route was used in the experiment, the checkpoints could not be detected. This leads us to do the next experiment where a Robot is used rather than a person to play the nurse role. The robot can record information about the route it takes and this it be compared with the actual route information recorded by the RFID equipment.

5.4 Robot Simulation

This subsection, we describes the use of an indoor robot for mapping map the simulated drug dispensing environment when investigating the RFID Reader's detection rate.

5.4.1 Indoor Robot Mapping

The purpose of using indoor robot mapping is to investigate whether the robot is suitable for this research or not. We can also compare the maps create by robot to the initial map created for this experiment.

The robot we have used in this experiment is called Mobile Robotics Pioneer 3-DX indoor robot and was provided by Adept Technology Inc. This kind of robot has been widely used in academic research area for a range of applications such as mapping, localization, monitoring and autonomous navigation (Adept). Table 5.19 shows the specifications for the robot we have used.

Table 5.19

Mobile Robotics Pioneer 3-DX Specification (Adept)

Construction	Body: 1.6 mm aluminium (powder-coated) Tires: Foam-filled rubber
Operation	Robot Weight: 9 kg Operating Payload: 17 kg
Differential Drive Movement	Turn Radius: 0 cm Swing Radius: 26.7 cm Max. Forward/Backward Speed: 1.2 m/s Rotation Speed: 300° /s Max. Traversable Step: 2.5 cm Max. Traversable Gap: 5 cm Max. Traversable Grade: 25% Traversable Terrain: Indoor, wheelchair accessible
Power	Run Time: 8-10 hours w/3 batteries Charge Time: 12 hours (standard) or 2.4 hours (optional high-capacity charger)
Batteries	Supports up to 3 at a time Voltage: 12 V Capacity: 7.2 Ah (each) Chemistry: lead acid Hot-swappable Batteries: Yes
Microcontroller I/O	System Serial 32 digital inputs 8 digital outputs 7 analogue inputs 3 serial expansion ports
User Control Panel	MIDI programmable piezoelectric buzzer Main power indicator Battery charge indicator 2 AUX power switches System reset Motor enable pushbutton
Available Recharge Options	Direct plug-in Docking station Power Cube (3-battery charging bay)

The robot is equipped with a laser sensor called SICK which is used for mapping the indoor environment. The robot and the sensor are shown in Figure 5.23.

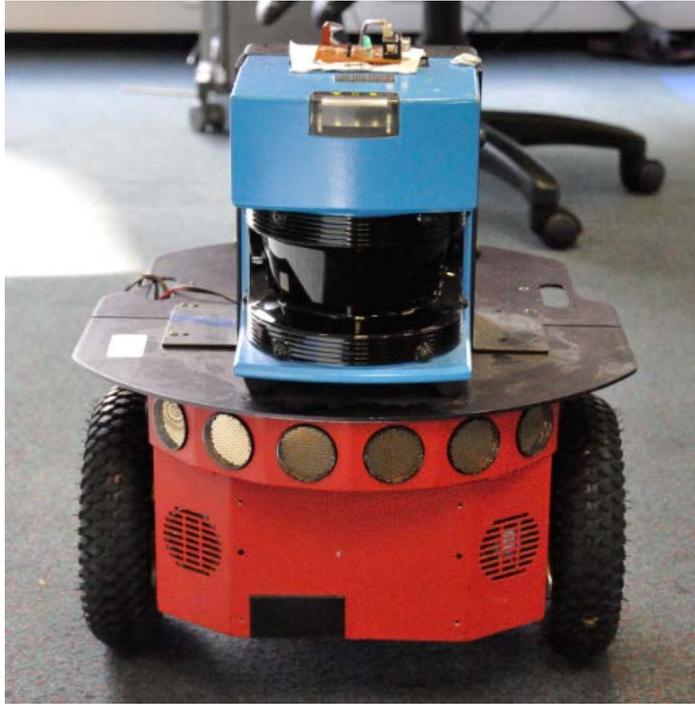


Figure 5.23 Mobile Robotics Pioneer 3-DX Robot Equipped with SICK Laser sensor

The original mapping algorithm and application for the robot have been developed at the Centre of Artificial Intelligence Research (CAIR) of AUT and were to test the theory of perceptual mapping (Yeap, Hossain, & Brunner, 2011). We have used the same algorithm and application with added timestamp for each step of the robot movement which was used later for analysing robot location.

```
View no. 1:

How much to turn? 0
How much to move? 0
At Wed Aug 29 20:34:37 2012

In this step: traveled distance = 0; angle = 0
Found 28 surfaces.
Plotting surfaces.png ...
Initialized MFIS.
Plotting MFIS to mfis.png.
Take another step? (y/n)
```

Figure 5.24 Robot Control Command in Linux

This application works on Ubuntu Linux. Figure 5.24 shows some control command for the robot. The command line “How much to turn?” is used to guide the robot turning

left or right by entering the degree for turning. If we want the robot to turn left by 45 degrees, we need to enter “45” after the command, while if we want it to turn right by 45 degrees, we need to enter “-45” after the command. Similarly, the command line “How much to move?” is used to indicate the distance we want the robot to travel with. If we want the robot to travel for 500 millimetres, we need to enter “500” at that line. By using these commend lines the robot was made to move around the simulated environment while mapping its route until it returned to the start point. Figure 5.25 shows the map generated by the robot using the application under and mapping algorithm developed in CAIR.

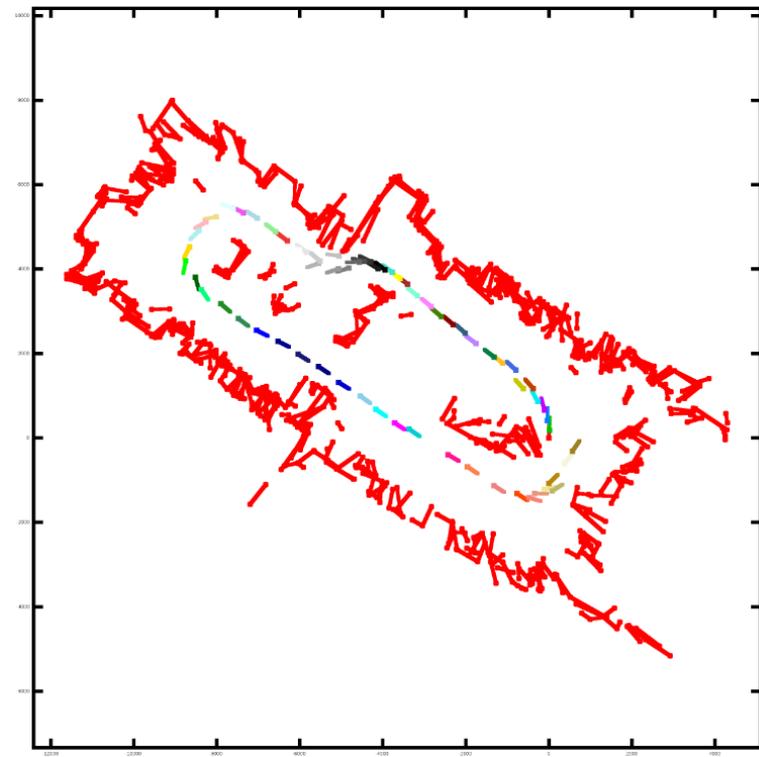


Figure 5.25 Generated Map by the Mapping Algorithm of the Research Robot

If we compare the map generated by the robot and presented in Figure 5.25 to the floor plan shown Figure 5.8, we can see that, the surface of boundary and contours of the path are very similar. Also, the route of the robot is clearly display on the map. We can compare the simulation dispensing route with this route to find out if the route is not correct in map. We can analyse the robot route by using the collected RFID data to find out if robot made any mistakes during the simulated drug dispensing period.

5.4.2 Simulated Robot Drug Dispensing

We have made the robot play the role of a nurse and dispense drug cups for patients in designated rooms. The robot carries the smart drug tray and a computer and we direct it to take same route used in previous experiments when dispensing drug cups to patients. Figure 5.26 shows the robot with the smart drug tray and the research computer during the simulation experiment.



Figure 5.26 Research Robot Carries Smart Drug Tray and Computer

Checkpoints on the dispensing route are also used in this experiment and are the same as the ones we used. To make the simulation as close to the real environment as possible, and ensure the best possible detection rate, we have adjusted the checkpoints height to suit the robot height. Figure 5.27 shows the research robot passing a checkpoint during the dispensing period.



Figure 5.27 Research Robot Passing a Checkpoint in Simulation

This experiment was carried out in a few rounds. Due to the application processing method and the robot's running speed, each round took about 10 minutes to complete. Since the RFID Reader can only store 1000 entries into its internal memory, it is not possible to store all tags detected for the 600 seconds (10 minutes) of a round's duration. Since we could not speed up the robot's dispensing period we failed to record the necessary data a few times. Although the robot would finish the dispensing successfully, we could still not get any data stored for analysis. This was due to the fact that once the RFID Reader's memory was full, all the data will be erased, and the RFID Reader would be reset to its factory settings. We decided to change the data collection methods. At beginning, we want to store data in the Reader Data Textbox instantly through Tracient TraceConnect RFIDWedge application just as in the advanced detection measurement. In Subsection 4.2.2 we said that it need set Tracient TraceConnect RFIDWedge application output the tag ids to foreground application. However, this is not possible in this situation due to the need for the robot to be controlled which makes it necessary to use Virtual Box for running Linux. If we use this setting, it will display tag IDs in the Linux command line area. Hence, we cannot control the robot under in that manner.

Finally, we decided to use text files to store all the tag information collected during the dispensing. The text files have format of a log file. Instead of sending the output to a foreground application, we set the RFIDWedge settings to output to data the text file. Once the robot has finished dispensing drug cups, we use the software application Version 3 to analyse collected tag IDs. The results and evaluations can be found in Subsection 5.4.3.

5.4.3 Robot Simulation Experiment Results and Evaluations

We ran 3 tests for this experiment. For each test, we generated the map with surfaces with route information to record the route information for our simulated dispensing environment. Checkpoints are also used. Similarly to previous experiment, eight checkpoints were set up, and the robot is guided to stay for a few seconds at each checkpoint to allow the RFID Reader to read the tag.

5.4.3.1 Test 1

This test took about 11 minutes to complete. Altogether 2,206 tags have been detected for the duration of the test. We guided the robot to follow the dispensing route we had created. The robot generated a map of its route for this test of the experiment and its map is presented in Figure 5.28.

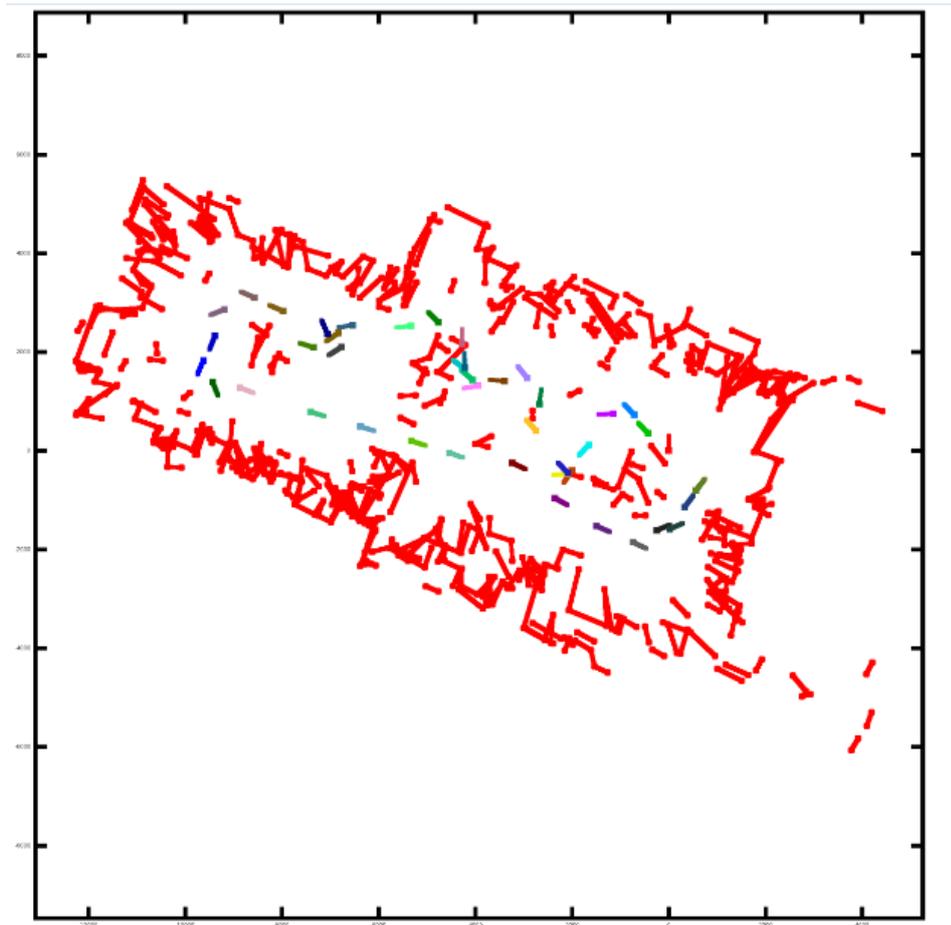


Figure 5.28 Robot Generated Map with Route Information for Robot Simulation Test 1

The map in Figure 5.28 clearly represents the route we have taken in this test. When comparing this map to the one in Figure 5.25, we can see that the robot has taken the correct route for dispensing. From the wall surfaces plotted by the robot in the map of Figure 5.25, we can see that it is similar to the dispensing environment we have created. We also generated a detection graph for this test to see how the tagged objects and the respective actions related to them were detected. Figure 5.29 shows the detection graph generated from the collected results that have also been processed by Version 3 of the software application.

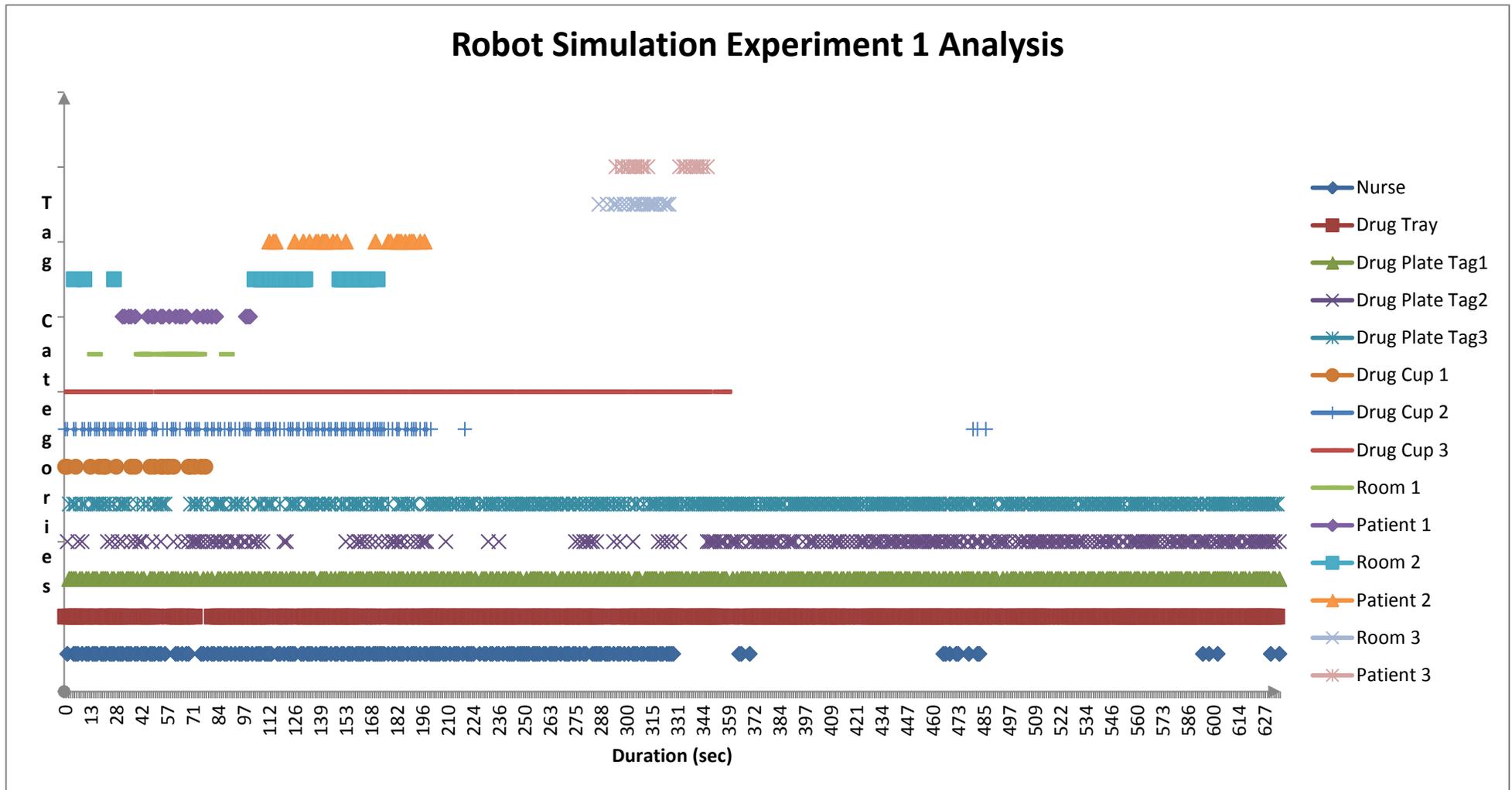


Figure 5.29 Detection Graph for Test 1 in the Robot Simulation

Figure 5.29 shows that there were some unexpected detections during the test. For example, room 2 is shown as detected at the beginning of the graph which implies that the tests started from room 2, while in reality it started from the pharmacy room as shown in the map generated by the robot and present in Figure 5.28. The distance between the pharmacy room and room 2 is at least 5 meters. The other unexpected detection represented on the graph is drug cup 2 which appear on the way back to the pharmacy room which should not have occurred. According to the route of the map displayed in Figure 5.28 and referring to the floor plan for this simulation, the dispensed drug cup should be in room 2 and at least 3 meters away from the route robot that back to pharmacy room. We make a note of this issue and will carry out another two tests in order to find out the possible reasons for that. Figure 5.29 shows that the nurse detection was not particularly good in the second half of the test. Table 5.20 shows the confusion matrix generated for this test.

Table 5.20

Confusion Matrix for Test 1 of the Robot Simulation Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	90.91%	0	0	9.091%
Drug Tray	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

The detection rates for key objects in this test are presented in Table 5.20 all good apart the detection rate of the Nurse's tag in average one minute time period. In Figure 5.29 we observe that the nurse's detection is very good until drug cup 3 was dispensed, but after that it is poor. The nurse's tag has the 90.91% detection rate, which means we did not detect tag from nurse at all in one minute period over 11 minutes durations during

the simulation test. As a result, the false negative detection rate for nurse is 9.091%. It may lose recording actions from nurse for that undetected minute in actual usage. The other objects have the great true positive detection rates as 100%. Similarly to the previous experiments, we measured the relevant objects detection rate in this test as well.

Table 5.21

Detection Rate for Relevant Objects in Test 1 of the Robot Simulation Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

Table 5.21 shows that, the smart drug tray had done very well for these objects and they all have 100% detection rate in related time period. Drug Cups has the 100% detection rate before they have been dispensed. Both rooms and patients have the 100% detection rate once the robot actually in the patient rooms. The checkpoint detection information is presented in Table 5.22.

Table 5.22

Checkpoints Detection Information for Robot Simulation Test 1

Checkpoint Number	Detection Information
Check point 1	Detected After Checkpoint 8
Check point 2	Not Detected
Check point 3	Correctly Detected
Check point 4	Detected After Checkpoint 5
Check point 5	Correctly Detected
Check point 6	Correctly Detected
Check point 7	Not Detected
Check point 8	Correctly Detected

Table 5.22 shows that six out of eight checkpoints were detected in this test. Checkpoint 2 and Checkpoint 6 were not detected during the simulation period for this experiment. If we refer to Figure 5.28 of the recorded route, and to the RFID detection information, it seems that the RFID detection information can be clearly present the route details with checkpoints detections. However, there were some problems during the detections. Table 5.22 shows that Checkpoint 1 was detected after Checkpoint 8 and Checkpoint 4 was detected after Checkpoint 5 according to the timestamp information. Therefore, these two checkpoints detection information may not be accepted. This is the first time we have encountered this situation, so we take note of this event and will carry out two more tests to find out the reasons.

This test proves that we can successfully use a robot to replace the nurse. It successfully dispensed drug cups and also recorded route information. Based on the map generated from the robot and recorded checkpoint information of the RFID Reader, we can analyse the route information easily. However, during the entire simulation test period there is one minute period of 11 minutes simulation time, which the nurse's tag was not detected. There are some problems with the detection of a few checkpoints detection either. We need to carry out another two tests to find out the possible reasons for that.

5.4.3.2 Test 2

This test took for about 10 minutes to complete. Altogether 2,053 tag IDs were detected and collected. Figure 5.30 shows the map generated by the research robot with route information.

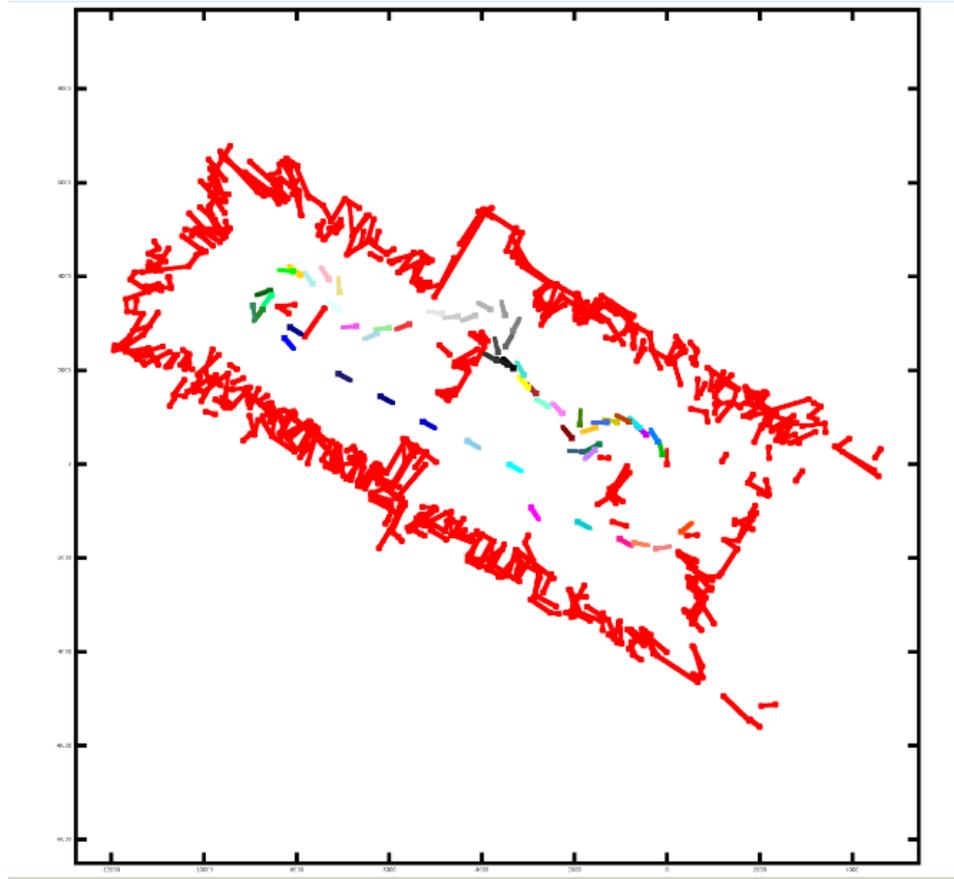


Figure 5.30 Robot Generated Map with Route Information for Robot Simulation Test 2

The dispensing route is clearly presented in Figure 5.30 and it is very similar to that in Figure 5.25 and close to the actual floor plan as well. From the generated graph, we can see that the correct route was taken for the experiment. Hence, this test can be accepted and compared with the other tests in this experiment. Figure 5.31 shows the detection graph constructed for this test based on the collect data which processed by Version 3 of the software application for analysis.

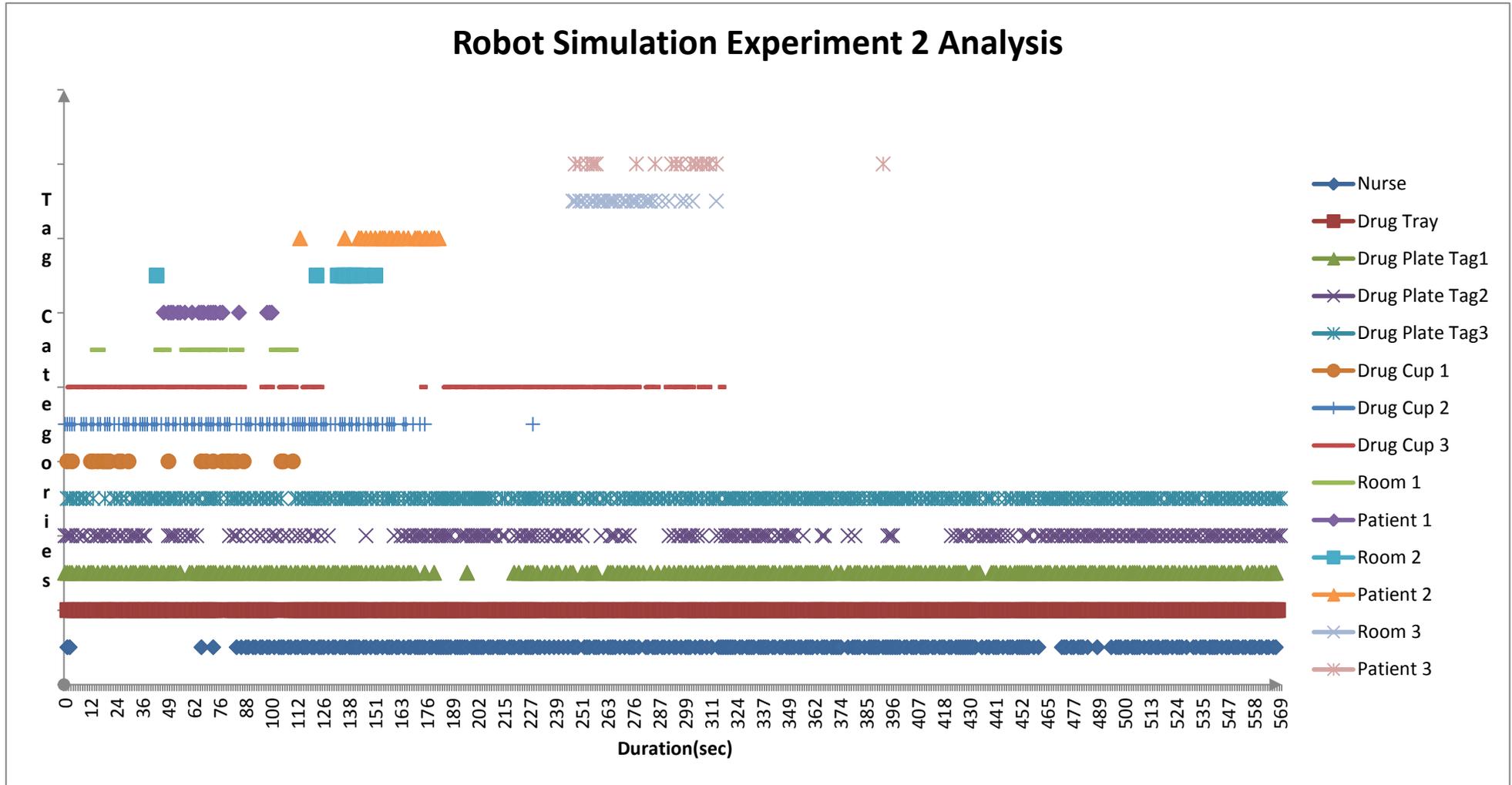


Figure 5.31 Detection Graph for Test 2 in the Robot Simulation Experiment

Figure 5.31 presents very well of the events for this test of experiment. Similarly to the previous test, there is some detection in the wrong order that is presented represent on the graph. The tag for room 1 was detected before the room was reached by the robot. The tag for room 2 was detected at around the time robot in room 1. The tag on drug cup 2 was detected after the robot left room 2 and patient 3's tag was detected when the robot half way back to the pharmacy room. However, these unusual detections only appeared very few times on the detection graph. If it wasn't for these unusual detections, the results for this test are good enough. When comparing to the ideal detection graph in Figure 5.11, we can see that the test results are close to the perfect detection.

Table 5.23

Confusion Matrix for Test 2 in the Robot Simulation Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	100%	0	0	0%
Drug Tray	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

The confusion matrix constructed for this test is presented in Table 5.23. We pointed out before that the detections for this test are very good as shown on the detection graph in Figure 5.31. The confusion matrix in Table 5.23 demonstrates this as well as all key objects have 100% detection for average one minute time period. The false negative detection rates for these objects are 0% as a result. This means all actions related to these objects can be recorded by RFID reader and analysed later on. We also measured the detection rates for the relevant objects and they are presented in Table 5.24

Table 5.24

Detection Rate for Relevant Objects in Test 2 of the Robot Simulation Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

Table 5.24 shows that the detection rates for related objects were excellent, similarly to previous test on the simulation time period. Drug Cups have 100% true positive detection rate before having been dispensed to patients. Rooms and patients all have 100% detection rate when the robot was actually in the room and the detection rate is a strong evidence to support this event. Table 5.25 shows the detection information for the eight checkpoints used for this test.

Table 5.25

Checkpoints Detection Informaion for Robot Simulation Test 2

Checkpoint Number	Detection Information
Check point 1	Correctly Detected
Check point 2	Correctly Detected
Check point 3	Not Detected
Check point 4	Detected After Checkpoint 5
Check point 5	Correctly Detected
Check point 6	Detected, some detections after Checkpoint 2
Check point 7	Detected After Checkpoint 1
Check point 8	Correctly Detected

The checkpoints detections were very good in this test. Table 5.25 shows that only checkpoint 3 was not detected during the simulations period. The other 7 checkpoints were successfully detected. Nevertheless, there are still issues with checkpoints in this test. As seen in Table 5.25, Checkpoint 4 was again detected after Checkpoint 5,

Checkpoint 6 was detected before Checkpoint 2 and Checkpoint 7 was detected after Checkpoint 1. All the distance between these checkpoints are more than 3 meters. It should be over the theoretical distance of passive UHF band frequency has. The possible reasons for these issues will be discussed after all tests are completed.

This is the second test of the robot simulation experiment. The robot successfully dispensed the drug cups to the patients. The detection rate is excellent for the key object in this test in average one minute time period. The detection graph and the map generated by the robot present clearly the movement information for this test. The detection rates for relevant objects are still high enough in this test. However, there are also very few noisy detections collected by the RFID Reader as well. The checkpoints detections have the same problems occurred in the previous test. A third and final test is carried out in search of the possible reasons for that.

5.4.3.3 Test 3

Similarly to previous two tests, this test also took about 10 minutes to complete. Altogether 2,308 tag IDs were read and collected. The robot also constructed a map of the drug dispensing route. Figure 5.32 presents the map generated by the research robot that contains route information.

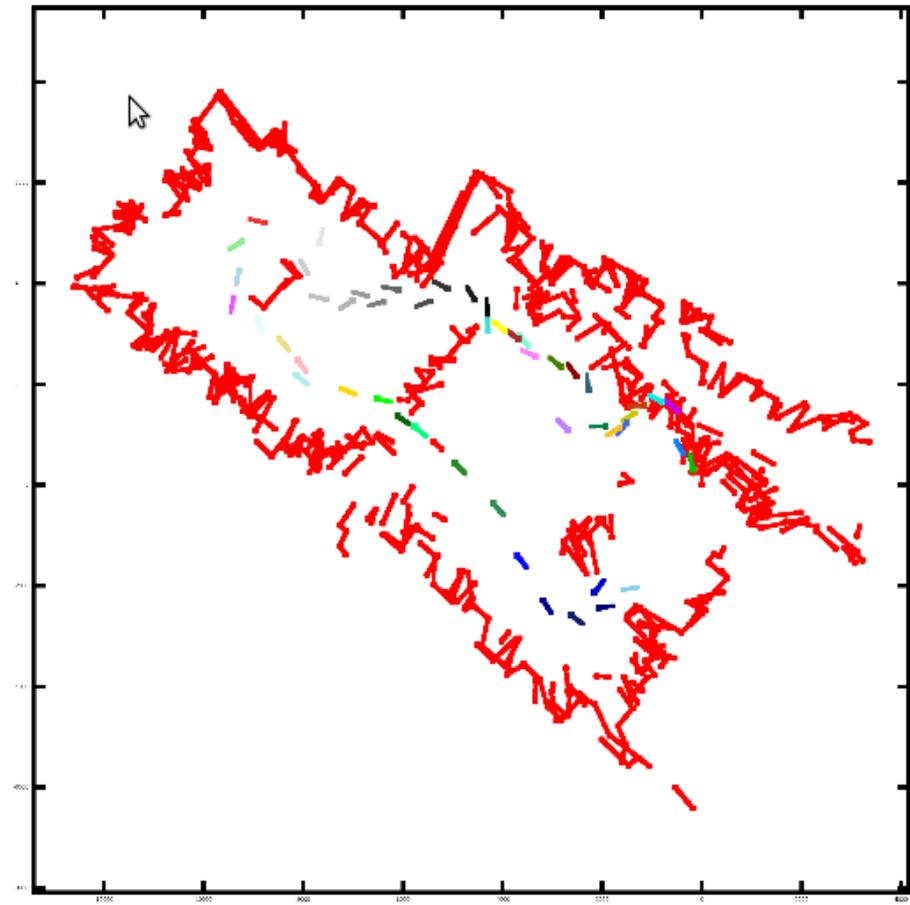


Figure 5.32 Robot Generated Map with Route Information for Robot Simulation Test 3

Figure 5.32 shows that the robot was running too close to the wall, so we adjusted the direction manually. This made the mapping surfaces were a bit messy, but this should not impact on the analysis of the route taken by the robot. When compared to the map in Figure 5.25, the route displayed in Figure 5.32 looks very close to the initially recorded route. Hence, the data collected in this test can be analysed for future use. The detection graph for this test is presented in Figure 5.33.

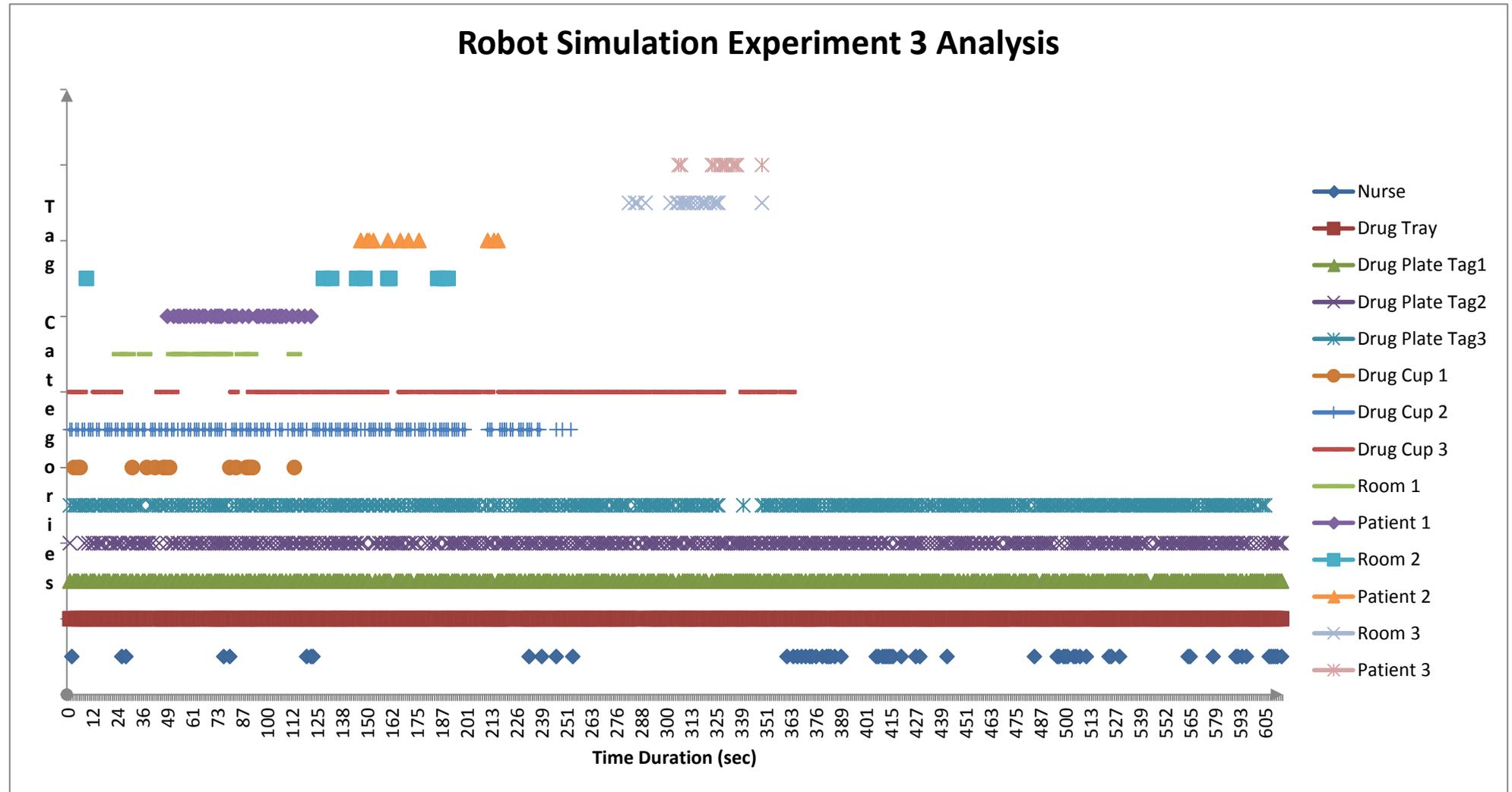


Figure 5.33 Detection Graph for Test 3 in the Robot Simulation Experiment

The detection graph presented in Figure 5.33 indicates that the same problem occurred in this test as in the previous tests. The tag for room 2 was detected at the early stage of the test which shouldn't have happened according to the generated map. However this unusual detection only happened once and no other unexpected detections can be identified in the detection graph. All other detections were excellent apart of the detection of the nurse's tag. Table 5.26 shows the confusion matrix constructed for this test.

Table 5.26

Confusion Matrix for Test 3 in the Robot Simulation Experiment

Tagged Objects	True Positive	True Negative	False Positive	False Negative
Nurse	90.00%	0	0	10.00%
Drug Tray	100%	0	0	0%
Drug Plate Tag 1	100%	0	0	0%
Drug Plate Tag 2	100%	0	0	0%
Drug Plate Tag 3	100%	0	0	0%
Drug Plate Tag 1 and Tag 2	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 2 and Tag 3	100%	N/A	N/A	N/A
Drug Plate Tag 1 and Tag 2 and Tag 3	100%	N/A	N/A	N/A
At least One Tag of Drug Plate Tags	100%	N/A	N/A	N/A

The confusion matrix shows that, except the nurse's tag, the other key objects have the 100% true positive detection rate on average in one minute time period. The nurse's tag was has 90% true positive detection rate in this test and its false negative detection rate was 10%. This means, that there was one minute time period of the entire 10 minutes test the nurse's tag could not be detected at all. This may mean that the actions of nurse that took place within that minute could not be detected by the RFID Reader. Other key objects have the excellent detection rate on average one minute time period as usual. Table 5.27 shows the detection rates for the relevant objects in this test.

Table 5.27

Detection Rate for Relevant Objects in Test 3 of the Robot Simulation Experiment

Tagged Objects	Detection Rate
Drug Cup 1	100%
Drug Cup 2	100%
Drug Cup 3	100%
Room 1	100%
Patient 1	100%
Room 2	100%
Patient 2	100%
Room 3	100%
Patient 3	100%

Table 5.27 shows results that what we have expected to get. Similarly to the previous two tests, the true positive detection rates are 100% for all objects. Drug cups have 100% true positive detection rate until they have dispensed. Each room and patient pair has the 100% detection rate which confirms that the robot was actually in the rooms to dispense drug cups.

Table 5.28

Checkpoints Detection Informaion for Robot Simulation Test 3

Checkpoint Number	Detection Information
Check point 1	Not Detected
Check point 2	Not Detected
Check point 3	Not Detected
Check point 4	Detected After Checkpoint 5
Check point 5	Detected Before Checkpoint 4
Check point 6	Detected, Some detections Before Checkpoint 4 and Checkpoint 5
Check point 7	Correctly Detected
Check point 8	Correctly Detected

The detection information for checkpoints in this test is presented in Table 5.28 and show that the checkpoints detections are not very good as only five out of eight checkpoints have been detected. Similar checkpoint detection problems also occurred in this test as previous two tests had. In this test, checkpoint 4 was detected after checkpoint 5 and checkpoint 6 was detected a few times before checkpoint 4 and

checkpoint 5. Initially these findings made us doubt the correct placement of the checkpoints on the route. However, reference to the records and the route map, confirmed that we made the checkpoints were placed in correct order for this test. The possible reasons for this issue are discussed further down.

Similarly to the previous two tests, this third test successfully completed and collected RFID data for analysis. The true positive detection rates are good enough for all key objects except the detection rate for the nurse on average one minute time period during the test period. The related objects detection rates are also excellent in the related time period. The map generated by robot graph presented route information for dispensing. However, errors in the checkpoints detections still persist in this test.

In the three tests undertaken for this experiment, the robot successfully plays the role of a nurse and dispenses drug cups to patients within simulation period. Equipped with a laser sensor and a mapping algorithm, the robot has been able to clearly record the route information and to generate a map for the simulation environment. However, some issues occurred in this experiment that did not occur in previous two experiments. All issues are related to the checkpoint and some unusual detections that out of order and therefore unexpected. The unexpected detections may be due to reflection or differences in tag performance. These issues can be addressed by using calibrated tags (Chawla, Robins, & Zhang, 2010).

Chaper 6 Conclusion

Section 6.1 in this chapter presents a brief summary of the research and provides answers to the research questions. Section 6.2 discussed the research findings and finally Section 6.3 present the limitations of this research study.

6.1 Summary

We started this study by researching RFID based drug dispensing systems that monitor drug dispensing from pharmacy to patient. Then we constructed a simulated drug dispensing model that was used for the design and development software application of this research. We designed three versions of a software application for processing data collected by the RFID technology; each version was used to fit the requirements of one of the three experiments that were undertaken for this research. We carried out the experiments and processed the collected data by using the respective versions of the software application followed by analysis and evaluation of the results.

Two research questions were formulated in Chapter 1. The first question is: “Can RFID-based drug dispensing systems assist in detecting and understanding errors in ward-based dispensing?” The results obtained from this research provide a positive answer for this question, namely that RFID-based drug dispensing systems can help to detect and understand errors in simulated ward-based dispensing. RFID tags that were detected by the RFID Reader were also recorded by RFID reader in various ways. By processing the recorded RFID data with the software application, we could easily analyse the actions and events that had taken place during the simulated drug dispensing. The added checkpoints allowed us to analyse the route information that had been recorded by the RFID Reader. Based on the timestamp indicating the detection time, we could determine the time the drug cups were delivered to patients. Errors that occurred during the drug dispensing could be easily identified by analysing the collected data. To prevent the occurrence of such errors in real life situation, some warning messages would have to be issued by the software application that could notify the nurse about some wrong drug dispensing actions. This modification to the software application is

likely to be carried out at the next stage of this research. The experiments for this research proved that, we can achieve “Four Rights” out of “Five Rights” which are: Right Patient, Right Drug, Right Route and Right Time. However, at this stage the RFID technique cannot be used to ensure the “Right Dose” which is the fifth one in the “Five Rights”, this could possibly be achieved by adding a camera to the research setup that would monitor the drug dose.

The second research question formulated in Chapter is: “What issues are involved in the development of a prototype RFID-based drug dispensing systems that can assist in detecting and preventing errors in ward-based dispensing?” We identified two main issues related to the development of the RFID-based prototype drug dispensing system. Firstly, the developed RFID-based drug dispensing prototype system development is very dependent on the hardware and need to be developed with consideration for the RFID Reader requirements, with some of the development being constrained by the requirements of the SDK of Tracient Padl-R RFID Reader. This put certain limitations on the functionality of the software application. Secondly, the RFID Reader detecting performance presented serious issues for the development of the prototype system. These issues are discussed in Section 6.3 and are related to three main factors: detection range, detection amount and detection rate. These issues let down the performance and the accuracy of the software application.

To sum up the entire research, we can say that, a carefully designed and developed information system based on the RFID technology could help to detect and prevent medication errors during the drug dispensing and administrating period. The software application can monitor all possible actions during the dispensing period and prevent medication errors that could potentially harm patient’s health. The next section outlines the main findings from this research.

6.2 Findings and Discussions

The literature review carried out in this research identified that medication errors are the common problems in the clinical area and may cause serious harm to patients. Hence, researchers built an HTA model for the analysis of possible errors that could occur during the dispensing period. Also, there are a few information systems that have been developed to prevent medication errors. However, these information technology solutions had certain problems during their actual usage. As a result, researchers have turned to the use of the RFID Technology for assisting drug dispensing and administering.

The experiments that were designed for this research and made use of the purposely developed software application have led us to certain insights and findings. Firstly, all possible events during simulated drug dispensing can be recorded if related tags have been detected by the RFID Reader. The software application allows us to analyse these events and to represent them on a detection graph clearly. All possible events and route information that from the simulation period have been recorded in Event Message box (in Version 1 of the software application) and in Analysed Data, Checkpoints Info and Room Info data boxes (Version 3 of the software application). Secondly, a group of tags attached to one object increased the detection rate substantially. In our experiments, we attached 3 tags to the drug plate. While a detection rate of 100% was achieved on average for the one minute period, the detection graph shows that each individual tag has lower performance for a few periods during the experiments. The detection for at least one tag of the drug plate presents more detection area than any other individual tag and possible combinations in the detection graph. Hence, using multiple tags on individual objects can be useful in future works. Finally, the software application performance and stability are dependent on RFID hardware, particularly on the RFID Reader. This could be a possible barrier for the use of RFID based software application.

6.3 Limitations

As with other studies, this research also has some limitations. Certain problems occurred during the research period. Four main issues were identified during this research mainly related to hardware issues: detection amount, detection range, detection rate and RFID Reader. These Four main limitations occasionally let down some of the experiments in this research.

6.3.1 Detection Amount

We proposed that all tags should be detected each time they are approached by the RFID Reader. However, during the research experiment for each reading interrogation of the RFID reader, at most seven tags could be detected including duplicate tags. Most of the time only five tags could be detected during each interrogation including duplicate tags. Sometimes only one tag could be detected. All this let down the average detection rate for the objects. When the detection rate is very low, it may not detect certain actions related to undetected tags.

6.3.2 Detection Range

Detection Range was the other main issues for this research. Theoretically, the detection range for UHF RFID band is up to 3 meters. However, during the entire research period, the detection range was only up to 30 centimetres. Although there were a few detections that were not necessary to be detected at that moment as discussed on Subsection 5.4.3, the detection range was still very limited. This means the RFID Reader needed to very close to the tagged object in order to to make the detection. All that limited the usability of the software application.

6.3.3 Detection Rate

Although the detection rates in all experiments carried out for this research were very high as expected for an average one minute period, the detection rate also needs attention. The detection rate was calculated based on a relatively large time window cap i.e. one minute time period. If we reduced the time window to 10 seconds, the detection rates would be much lower. Some detection graphs from the experiments show that

some objects did not get good detection in some periods. This means that for small time windows the detection rate cannot remain high. We suggested in the drug dispensing model (Section 4.1), that all tags attached to the nurse, drug tray, drug trolley and drug plate should be always detected during the dispensing period. Hence, there may have been some missed reading during the actual usage of the RFID Technology.

6.3.4 RFID Reader Barriers

The RFID Reader also slowed down the progress of this research. As pointed out before (Section 5.4), the Reader can only store 1000 entries of tag IDs into the memory. If its memory overflows, the Reader reset to factory settings and all stored data is erased from its memory. This situation is occurred a couple of times in the robot simulation experiment and we had to re-set our experiment procedures in order to collect data. The other issue that occurred at a certain stage with the RFID Reader was that it could not read at each second, although we had setup the read interval at 0.5 seconds. In reality, occasionally, the reader had to wait for two or more seconds before being able to resume reading data. This issue means that the RFID-based technology might fail to detect certain actions and events in real life situations.

Chaper 7 Future Work

Due to time constraints, this research has had certain limitations. In this final chapter, we describe our future work plans to extend this research. There are a few future work plans for extending this research. A few different future developments for this research have been planned and we grouped them into short term which discussed in Section 7.1 and long term which present in Section 7.2.

7.1 Short Term Plan

The short term plan is to extend the purposely developed software application. We propose to add a few more functions that could be used to analyse more actions that related to the corresponded tags once it have been detected at same time. This includes warning messages to alert the nurse that mistakes have been made if certain error actions have been detected during the dispensing period. As explained before, we only recorded and analysed the errors that occurred during the simulation. For real-life situations the software application would need to prevent the occurrence of errors that could potentially harm patients' health and lives.

Combining the smart drug tray with the existing hospital information system of is also planned in as short term development. In this research we design and developed a prototype system to analyse the use RFID technology for simulated drug dispensing. We purpose to use the software for testing RFID technology in real hospital environment and find out how well it can work with the current hospital system.

7.2 Long Term Plan

As a long term plan we propose to combine an image recognition system with the RFID smart drug tray system. This new system could be used to identify pills by image taken by a camera integrated in the setup. A system called “Pillbox” which developed by National Library of Medication has already been used (NLM, 2012). This system enables fast identification of unknown solid-dosage medications based on images. Another similar system called “Pill Identifier” is provided by Drug Information Online (Drugs.com, 2012).

We plan to design and develop functions similar to those described above that would suit our RFID technology based smart drug tray. The enhanced system would combine the smart drug tray with image recognition in order to measure the Right Dose in drug dispensing and administering period. That would allow the system to be used for monitoring all “Five Rights”.

We also propose the potential integration of the developed RFID-based system with smart phone and tablet applications. Tablets and smart phones have been widely used in hospitals. We plan to combine the smart drug tray system with this modern technology for that can be potentially used in hospitals.

Chaper 8 References

- Adept. *Pioneer P3-DX*. Retrieved June 5th, 2012, from www.mobilerobots.com/ResearchRobots/PioneerP3DX.aspx
- Ashton, K. (2009). That 'Internet of Things' Thing. *RFID Journal*.
- Bardarm, J. E. (2009). Activity-based computing for medical work in hospitals. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 16(2), 1-36.
- Bardram, J. E., & Christensen, H. B. (2007). Pervasive Computing Support for Hospitals: An overview of the Activity-Based Computing Project. *Pervasive Computing*, 6(1), 44-51
- Berger, R. G., & Kichak, J. P. (2004). Computerized Physician Order Entry: Helpful or Harmful? *Journal of American Medical Informatics Association*, 11(2), 100-103.
- Breahna, T., & Johns, D. (2006). Simulation spices RFID read rates. *Microwaves & RF*, 45(3), 66-76.
- Chawla, K., Robins, G., & Zhang, L. (2010, May 2010). *Object Localization Using RFID*. presented at the meeting of the 2010 5th International Symposium on Wireless Pervasive Computing (ISWPC), Modena, Italy.
- Cina, J. L., Gandhi, T. K., Churchill, W., Fanikos, J., McCrea, M., Mitton, P., ... Poon, E. G. (2006). How Many Hospital Pharmacy Medication Dispensing Errors Go Undetected? *Joint Commission Journal on Quality and Patient Safety*, 32(2), 73-80.
- Collis, J., & Hussey, R. (2009). *Business Research: A Practical Guide for Undergraduate and Postgraduate Students* (Third Edition ed.): Palgrave Macmillan.
- CSU. *Advantages and Disadvantages of Experimental Research: Discussion*. Retrieved Mar 4th, 2012, from <http://writing.colostate.edu/guides/research/experiment/pop5c.cfm>
- Davis, P., Lay-Yee, R., Briant, R., Ali, W., Scott, A., & Schug, S. (2003). Adverse events in New Zealand public hospitals II: preventability and clinical context. *The New Zealand Medical Journal*, 116(1183).
- Derakhshan, R., Orłowska, M. E., & Li, X. (2007). *RFID Data Management: Challenges and Opportunities*. presented at the meeting of the IEEE International Conference on RFID, Gaylord Texan Resort, Grapevine, TX, USA.
- Drugs.com. (2012). *Pill Identifier*. Retrieved Sep 1st, 2012, from <http://www.drugs.com/imprints.php>

Experiment-Resources.com. (2008). *Experimental Research*. Retrieved Mar 4th, 2012, from <http://www.experiment-resources.com/experimental-research.html>

FAA. *Confusion Matrix*. Retrieved June 10th, 2012, from <http://www.hf.faa.gov/workbenchtools/default.aspx?rPage=Tooldetails&subCatId=1&oolID=29>

Favela, J., Tentori, M., Castro, L. A., Gonzales, V. M., Moran, E. B., & Martinez-Garcia, A. I. (2007). Activity Recognition for Context-aware Hospital Applications: Issues and Opportunities for the Deployment of Pervasive Networks. *Mobile Networks and Application*, 12, 155-171.

Grissinger, M. (2010). The Five Rights: A Destination Without a Map. *Pharmacy and Therapeutics*, 35(10), 542.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Reserach. *MIS Quarterly*, 28(1), 75-105.

Houliston, B., & Parry, D. (2011). *Procedural Error Identification in Ward-based Drug Dispensing via RFID*. presented at the meeting of the HINZ 2011, Auckland.

Houliston, B., Parry, D., & Merry, A. (2008). *Sensors and Insensibility: Monitoring Anaesthetic Activity with RFID*. presented at the meeting of the Health Informatics New Zealand Forum, Rotorua.

HQSC. (2012). *Making Our Hospitals Safer: Serious and Sentinel Events reproted by District Health Boards in 2010/11*. Wellington: Health Quanlity & Safety Commission.

IBM. (2008). *Smarter Planet* Retrieved 1 Apr, 2012, from <http://www.ibm.com/smarterplanet/us/en/overview/ideas/index.html>

Johnston, M. (2007, August 25). Wired for saving lives. *Weekend Herald*, p. B4.

Katz, J. E., & Rice, R. E. (2008). Public views of mobile medical devices and services: A US national survey of consumer sentiments towards RFID healthcare technology. *International Journal of Medical Informatics*, 78(2), 104-114.

Key, J. P. (1997). *Research Design in Occupational Education*. Retrieved Mar 3rd, 2012, from <http://www.okstate.edu/ag/agedcm4h/academic/aged5980a/5980/newpage2.htm>

Kohavi, R., & Provost, F. (1998). Glossary of Terms:Special Issue on Applications of Machine Learning and the Knowledge Discovery Process. *Machine Learning*, 30, 271-274.

Koppel, R., Wetterneck, T., Telles, J. L., & Karsh, B.-T. (2008). Workarounds to Barcode Medication Administration Systems: Their Occurrences, Causes, and Threats to Patient Safety. *Journal of American Medical Informatics Association*, 15(4), 408-423.

Lalkhen, A. G., & McCluskey, A. (2008). Clinical tests: sensitivity and specificity. *Continuing Education in Anaesthesia, Critical Care and Pain*, 8(6), 221-223.

Lane, R., Stanton, N. A., & Harrison, D. (2006). Applying hierarchical task analysis to medication administration errors. *Applied Ergonomics*, 37(5), 669-679.

Loong, T.-W. (2003). Understanding sensitivity and specificity with the right side of the brain. *BMJ*, 327, 716-719.

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, 15, 251-266.

McDowell, S. E., Mt-Isa, S., Ashby, D., & Ferner, R. E. (2010). Where errors occur in the preparation and administration of intravenous medicines: a systematic review and Bayesian analysis. *Quality and Safety in Health Care*, 19(4), 341-345.

Medicine, I. o. (2000). *To Err Is Human: Building a Safer Health System*. Washington DC.

Medicine, I. o. (2006). *Preventing Medication Errors: Quality Chasm Series*. Washington DC

Medpedia. *Sensitivity and Specificity*. Retrieved June 10th, 2012, from http://wiki.medpedia.com/Sensitivity_and_Specificity

Nagy, P., George, I., Bernstein, W., Caban, J., Klein, R., Mezrich, R., & Park, A. (2006). Radio Frequency Identification Systems Technology in the Surgical Setting. *Surgical Innovation*, 13(1), 61-67.

News, F. N. (2009). *Robotic pill dispenser makes life easier for pharmacists* Retrieved 1 Feb, 2012, from <http://www.stuff.co.nz/taranaki-daily-news/business/2300503/Robotic-pill-dispenser-makes-life-easier-for-pharmacists>

NLM. (2012). *Pillbox Rapid Identification Reliable Information* Retrieved Sep 1st, 2012, from <http://pillbox.nlm.nih.gov/>

O'Leary, D. E. (2010). An Activity Theory Analysis of RFID in Hospitals. *International Journal of Applied Logistics (IJAL)*, 1(2), 64-81.

Wikipedia. *Radio-frequency identification*. Retrieved 1 March, 2012, from http://en.wikipedia.org/w/index.php?title=Radio-frequency_identification&oldid=485082556

Yeap, W., Hossain, M., & Brunner, T. (2011). On the Implementation of a Theory of Perceptual Mapping In D. Wang & M. Reynolds (Eds.), *AI 2011: Advances in Artificial Intelligence* (Vol. 7106, pp. 739-748): Springer Berlin / Heidelberg. Retrieved from http://dx.doi.org/10.1007/978-3-642-25832-9_75. doi:10.1007/978-3-642-25832-9_75

Chaper 9 Appendixes

9.1 Appendix A: Detection Measurement Data Sheets

9.1.1 Round 1 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
22/05/2012 15:01:34	0	0	0	1	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:01:49	0	0	0	0	0	0	1	1	0	0	0	0	0	0
22/05/2012 15:01:50	1	0	1	0	0	1	0	0	0	0	0	0	0	0
22/05/2012 15:01:51	0	1	0	1	1	0	1	1	0	0	0	0	0	0
22/05/2012 15:01:53	0	0	0	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:01:54	0	0	1	1	1	0	1	1	0	0	0	0	0	0
22/05/2012 15:01:55	1	1	0	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:01:58	0	0	0	0	0	0	0	1	0	0	0	0	0	0
22/05/2012 15:01:59	1	1	1	0	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:01	1	1	1	1	1	0	1	1	0	0	0	0	0	0
22/05/2012 15:02:04	0	1	1	0	0	1	1	0	0	1	0	0	0	0
22/05/2012 15:02:06	0	0	0	1	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:07	1	1	1	1	0	1	1	1	0	1	0	0	0	0
22/05/2012 15:02:09	0	0	0	0	0	0	0	0	0	1	0	0	0	0
22/05/2012 15:02:10	1	1	0	1	1	0	0	1	0	0	0	0	0	0
22/05/2012 15:02:13	0	0	0	1	1	0	1	1	0	0	0	0	0	0
22/05/2012 15:02:14	1	0	1	0	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:17	1	1	1	1	1	0	1	1	0	0	0	0	0	0
22/05/2012 15:02:18	0	1	0	1	0	0	1	1	0	0	0	0	0	0
22/05/2012 15:02:19	1	0	0	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:20	1	0	1	1	1	0	1	1	0	0	0	0	0	0
22/05/2012 15:02:22	0	0	0	0	0	0	0	0	0	0	1	0	0	0
22/05/2012 15:02:23	1	0	1	1	0	0	1	1	0	0	0	0	0	0
22/05/2012 15:02:24	0	1	0	1	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:25	0	1	0	0	0	0	1	1	0	0	1	0	0	0
22/05/2012 15:02:26	1	0	1	1	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:29	1	0	0	1	1	0	1	1	0	0	1	0	0	0
22/05/2012 15:02:30	0	0	0	0	0	0	0	0	0	0	1	0	0	0
22/05/2012 15:02:32	1	1	0	1	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:34	0	1	0	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:35	1	0	1	1	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:39	0	0	1	1	0	0	0	1	0	0	0	0	1	1
22/05/2012 15:02:41	0	0	1	0	0	0	0	1	0	0	0	0	0	0
22/05/2012 15:02:42	1	1	0	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:45	1	0	0	1	1	0	0	1	0	0	0	0	0	0
22/05/2012 15:02:47	0	1	1	0	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:49	0	1	1	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:50	1	1	1	1	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:53	0	0	1	0	1	0	1	0	0	0	0	0	0	0
22/05/2012 15:02:54	0	0	0	0	0	0	1	0	0	0	0	0	0	0
22/05/2012 15:02:55	0	1	0	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:56	0	0	1	0	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:57	0	1	1	1	1	0	0	0	0	0	0	0	0	0
22/05/2012 15:02:59	0	1	1	0	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:03:07	1	0	0	0	0	0	0	0	0	0	0	0	0	0
22/05/2012 15:03:08	1	0	0	0	0	0	0	0	0	0	0	0	0	0

9.1.2 Round 2 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Plate Tag 1	Drug Plate Tag 2	Drug Plate Tag 3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
26/05/2012 18:16:10	0	1	0	0	0	0	1	0	0	0	0	0	0	0
26/05/2012 18:18:41	1	0	0	0	0	0	1	0	0	0	0	0	0	0
26/05/2012 18:18:42	0	0	0	0	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:18:44	0	1	0	0	0	0	0	0	0	0	0	0	0	0
26/05/2012 18:18:45	1	0	0	1	1	0	1	1	0	0	0	0	0	0
26/05/2012 18:18:47	1	0	0	0	0	0	0	0	0	0	0	0	0	0
26/05/2012 18:18:50	0	0	0	0	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:18:52	0	0	0	1	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:18:53	0	0	0	0	0	0	0	1	0	0	0	0	0	0
26/05/2012 18:18:54	1	0	0	1	0	0	1	0	0	0	0	0	0	0
26/05/2012 18:18:56	1	0	0	1	1	1	1	0	0	0	0	0	0	0
26/05/2012 18:18:58	0	0	0	0	0	0	0	1	0	0	0	0	0	0
26/05/2012 18:18:59	0	1	1	1	1	1	1	1	0	0	0	0	0	0
26/05/2012 18:19:03	0	0	1	1	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:19:05	0	0	1	1	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:19:08	0	1	0	1	0	0	0	1	1	0	0	0	0	0
26/05/2012 18:19:09	0	0	0	1	0	0	1	1	1	0	0	0	0	0
26/05/2012 18:19:10	0	0	1	0	0	0	0	0	0	1	0	0	0	0
26/05/2012 18:19:11	0	1	0	0	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:19:12	0	0	0	1	0	0	0	0	1	0	0	0	0	0
26/05/2012 18:19:14	1	1	0	0	0	0	0	1	1	0	0	0	0	0
26/05/2012 18:19:17	0	0	0	0	0	0	0	0	0	1	0	0	0	0
26/05/2012 18:19:18	0	0	0	0	0	1	1	0	0	0	0	0	0	0
26/05/2012 18:19:21	0	0	1	1	0	0	1	1	0	1	0	0	0	0
26/05/2012 18:19:22	0	0	0	0	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:19:23	0	0	1	1	0	0	0	0	1	0	0	0	0	0
26/05/2012 18:19:24	0	1	0	1	0	1	1	1	0	0	0	0	0	0
26/05/2012 18:19:31	0	1	0	0	0	1	0	0	0	0	0	0	0	0
26/05/2012 18:19:33	0	1	0	1	0	1	1	1	1	0	0	0	0	0
26/05/2012 18:19:34	0	0	0	0	0	0	0	0	0	1	0	0	0	0
26/05/2012 18:19:37	0	0	0	0	0	0	0	1	0	0	0	0	0	0
26/05/2012 18:19:38	0	0	1	1	0	0	1	0	1	0	0	0	0	0
26/05/2012 18:19:41	0	0	0	1	0	0	1	1	0	1	0	0	0	0
26/05/2012 18:19:43	0	0	0	0	0	1	0	0	0	0	0	0	0	0
26/05/2012 18:19:44	0	0	0	1	0	1	1	0	0	0	0	0	0	0
26/05/2012 18:19:45	1	0	1	0	0	0	0	0	0	1	0	0	0	0
26/05/2012 18:19:48	0	1	1	1	0	0	1	1	0	0	0	0	0	0
26/05/2012 18:19:50	0	1	0	1	0	0	1	0	0	0	0	0	0	0
26/05/2012 18:19:51	1	0	1	0	1	0	0	1	0	0	0	0	0	0
26/05/2012 18:19:53	1	1	1	1	0	0	0	1	0	0	0	1	0	0
26/05/2012 18:19:55	0	0	0	0	1	0	0	0	0	0	1	0	0	0
26/05/2012 18:19:56	1	1	1	1	1	0	1	1	0	0	1	0	0	0
26/05/2012 18:20:03	1	1	1	1	0	0	1	1	0	0	1	1	0	0
26/05/2012 18:20:06	0	1	1	1	1	0	1	1	0	0	0	1	0	0
26/05/2012 18:20:09	1	1	1	1	1	0	0	1	0	0	0	0	0	0
26/05/2012 18:20:11	0	1	1	1	1	0	0	0	0	0	0	1	0	0
26/05/2012 18:20:12	0	0	0	0	0	0	0	1	0	0	1	0	0	0
26/05/2012 18:20:15	1	1	1	1	1	0	0	0	0	0	1	1	0	0
26/05/2012 18:20:17	1	1	1	1	1	0	0	1	0	0	0	1	0	0
26/05/2012 18:20:18	0	0	0	0	0	0	0	0	0	0	1	0	0	0
26/05/2012 18:20:20	1	1	1	1	0	0	1	1	0	0	0	1	0	0
26/05/2012 18:20:22	1	0	1	1	1	0	0	1	0	0	0	0	0	0
26/05/2012 18:20:25	0	0	1	0	1	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:26	0	0	0	1	1	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:27	1	1	1	0	0	0	0	1	0	0	0	0	0	0
26/05/2012 18:20:29	1	1	1	1	1	0	0	0	0	0	0	0	0	1
26/05/2012 18:20:30	0	0	0	0	0	0	0	1	0	0	0	0	1	0
26/05/2012 18:20:31	0	1	1	1	0	0	0	1	0	0	0	0	0	1
26/05/2012 18:20:32	1	0	0	0	0	0	0	0	0	0	0	0	1	0
26/05/2012 18:20:33	1	1	1	0	1	0	0	1	0	0	0	0	1	1
26/05/2012 18:20:35	0	0	1	0	1	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:36	1	1	0	1	0	0	0	1	0	0	0	0	1	1
26/05/2012 18:20:37	0	0	0	0	0	0	0	1	0	0	0	0	0	1
26/05/2012 18:20:38	1	1	0	1	1	0	0	0	0	0	0	0	1	0
26/05/2012 18:20:42	1	1	1	0	1	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:43	0	1	1	1	1	0	0	1	0	0	0	0	0	0
26/05/2012 18:20:44	1	0	0	0	0	0	0	0	0	0	0	0	0	1
26/05/2012 18:20:45	0	1	1	1	0	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:46	1	0	1	1	0	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:47	1	1	1	1	1	0	0	0	0	0	0	0	0	0
26/05/2012 18:20:49	1	1	1	0	0	0	0	0	0	0	0	0	0	0
26/05/2012 18:21:02	1	0	0	0	0	0	0	0	0	0	0	0	0	0

9.1.3 Round 3 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Plate Tag 1	Drug Plate Tag 2	Drug Plate Tag 3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
5/06/2012 17:33:32	1	1	0	1	1	1	1	1	1	0	0	0	0	0
5/06/2012 17:33:33	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:33:34	1	1	0	1	1	1	0	1	1	0	0	0	0	0
5/06/2012 17:33:38	0	0	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:33:41	0	1	1	0	1	0	1	1	1	0	0	0	0	0
5/06/2012 17:33:42	1	0	1	0	0	1	1	0	0	0	0	0	0	0
5/06/2012 17:33:43	0	0	1	1	1	1	0	0	0	0	0	0	0	0
5/06/2012 17:33:44	1	1	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:33:46	0	1	1	1	1	1	1	1	1	0	0	0	0	0
5/06/2012 17:33:48	1	0	1	1	1	1	1	1	1	0	0	0	0	0
5/06/2012 17:33:50	0	1	1	1	1	1	1	1	1	0	0	0	0	0
5/06/2012 17:33:51	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:33:52	0	1	0	0	0	0	0	0	1	0	0	0	0	0
5/06/2012 17:33:54	0	1	0	0	0	0	0	0	1	0	0	0	0	0
5/06/2012 17:33:55	0	0	1	0	0	1	0	0	0	0	0	0	0	0
5/06/2012 17:33:56	1	0	0	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:33:57	1	1	1	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:34:00	0	0	0	0	0	1	0	0	0	0	0	0	0	0
5/06/2012 17:34:03	0	0	0	0	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:04	0	1	1	1	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:05	1	0	0	0	0	1	0	1	0	0	0	0	0	0
5/06/2012 17:34:06	1	1	1	0	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:09	0	0	0	1	0	1	0	0	0	0	0	0	0	0
5/06/2012 17:34:10	0	0	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:34:11	1	1	0	0	0	0	1	1	0	0	0	0	0	0
5/06/2012 17:34:12	1	0	1	0	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:13	0	1	0	1	1	1	0	1	0	0	0	0	0	0
5/06/2012 17:34:14	0	1	0	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:34:17	0	0	1	1	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:18	1	1	1	0	1	1	0	1	0	0	0	0	0	0
5/06/2012 17:34:20	1	1	1	1	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:24	1	0	1	1	1	1	1	1	0	0	0	0	0	0
5/06/2012 17:34:26	1	0	0	1	1	1	1	1	0	0	0	0	0	0
5/06/2012 17:34:29	1	0	0	0	1	1	0	0	0	0	0	0	0	0
5/06/2012 17:34:30	0	1	1	1	0	1	0	1	0	0	0	0	0	0
5/06/2012 17:34:31	0	0	1	1	0	1	1	0	0	0	0	0	0	0
5/06/2012 17:34:32	1	1	0	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:34:34	1	0	0	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:34:36	1	1	1	1	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:39	0	1	0	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:34:40	1	0	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:34:41	0	0	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:34:42	1	1	0	0	0	1	0	0	0	0	0	0	0	0
5/06/2012 17:34:43	0	0	1	0	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:44	1	1	0	1	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:34:48	1	0	0	0	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:34:49	0	1	0	1	0	1	1	1	0	0	0	0	0	0
5/06/2012 17:34:51	1	1	0	1	1	1	0	1	1	0	0	0	0	0
5/06/2012 17:34:53	1	1	1	1	0	0	1	1	0	1	0	0	0	0
5/06/2012 17:34:56	0	1	1	0	1	1	1	1	0	1	0	0	0	0
5/06/2012 17:34:57	0	0	0	0	0	0	0	0	0	1	0	0	0	0
5/06/2012 17:34:58	1	1	0	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:35:00	0	1	1	0	1	0	1	0	1	1	0	0	0	0
5/06/2012 17:35:02	0	1	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:35:07	0	0	0	0	0	1	0	0	0	0	0	0	0	0
5/06/2012 17:35:08	0	0	0	0	0	0	0	0	1	1	0	0	0	0
5/06/2012 17:35:10	0	0	1	1	0	1	0	0	0	0	0	0	0	0
5/06/2012 17:35:13	0	1	1	0	0	0	0	1	0	1	0	0	0	0
5/06/2012 17:35:14	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:35:20	0	0	1	1	1	1	0	1	1	1	0	0	0	0
5/06/2012 17:35:21	0	1	1	0	0	1	1	1	1	0	0	0	0	0
5/06/2012 17:35:22	0	0	0	0	1	0	0	0	0	1	0	0	0	0
5/06/2012 17:35:23	0	0	0	0	1	1	0	1	0	0	0	0	0	0
5/06/2012 17:35:26	0	0	1	0	1	1	0	0	0	0	0	0	0	0
5/06/2012 17:35:27	0	1	0	0	0	1	0	1	0	1	0	0	0	0
5/06/2012 17:35:30	0	0	0	1	1	0	0	1	0	1	0	0	0	0
5/06/2012 17:35:33	0	0	0	0	0	1	1	0	0	0	0	0	0	0
5/06/2012 17:35:34	0	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:35:37	0	0	0	1	0	1	0	1	0	1	0	0	0	0
5/06/2012 17:35:38	0	1	1	0	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:35:39	0	0	0	0	1	1	0	0	0	1	0	0	0	0
5/06/2012 17:35:42	0	1	0	1	1	1	0	1	0	1	0	0	0	0
5/06/2012 17:35:43	0	1	1	0	0	0	0	0	0	1	0	0	0	0
5/06/2012 17:35:46	1	0	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:35:52	0	0	0	0	0	1	0	1	0	0	0	0	0	0
5/06/2012 17:35:53	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:35:56	0	1	0	0	0	1	0	0	0	1	0	0	0	0
5/06/2012 17:35:58	0	0	1	0	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:35:59	0	1	0	0	1	1	0	0	0	1	0	0	0	0

RFID Usage for Monitoring Drug Dispensing

Zachary Zhou

5/06/2012 17:36:02	0	1	0	0	1	1	0	0	0	1	0	0	0	0
5/06/2012 17:36:03	0	0	0	0	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:36:04	0	1	1	0	1	1	1	0	0	1	0	0	0	0
5/06/2012 17:36:08	0	1	0	0	1	0	1	0	1	1	0	0	0	0
5/06/2012 17:36:12	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:15	0	0	0	0	0	0	0	0	1	1	0	0	0	0
5/06/2012 17:36:16	0	1	1	0	0	1	1	1	0	1	0	0	0	0
5/06/2012 17:36:19	0	0	0	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:20	0	1	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:21	1	0	0	1	0	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:22	0	0	0	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:24	0	0	0	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:36:25	0	1	1	0	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:36:28	0	0	0	0	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:29	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:30	0	1	1	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:34	0	0	0	0	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:36:35	0	1	0	1	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:36:36	0	0	0	0	1	0	1	0	0	0	0	0	0	0
5/06/2012 17:36:37	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:39	1	1	0	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:41	0	0	0	0	0	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:42	0	1	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:44	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:45	0	0	0	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:46	0	1	0	0	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:48	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:36:52	1	0	0	1	1	0	1	0	0	0	0	1	0	0
5/06/2012 17:36:54	1	1	1	1	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:36:56	0	1	0	1	1	0	1	1	0	0	1	0	0	0
5/06/2012 17:37:02	0	0	1	0	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:37:05	1	1	1	0	1	0	0	0	0	0	1	1	0	0
5/06/2012 17:37:08	1	1	1	0	1	0	1	1	0	0	0	0	0	0
5/06/2012 17:37:09	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5/06/2012 17:37:10	0	1	1	0	1	0	1	1	0	0	1	0	0	0
5/06/2012 17:37:14	0	0	0	0	1	0	1	1	0	0	0	1	0	0
5/06/2012 17:37:16	0	1	1	0	1	0	1	0	0	0	1	1	0	0
5/06/2012 17:37:19	0	1	1	0	1	0	1	1	0	0	1	1	0	0
5/06/2012 17:37:20	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:37:21	0	0	1	0	1	0	1	1	0	0	0	1	0	0
5/06/2012 17:37:24	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:37:25	0	1	1	1	1	0	1	0	0	0	1	1	0	0
5/06/2012 17:37:26	0	0	1	0	1	0	0	1	0	0	0	1	0	0
5/06/2012 17:37:27	0	1	0	1	0	0	1	1	0	0	1	0	0	0
5/06/2012 17:37:30	0	0	1	1	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:37:32	0	0	0	0	1	0	1	0	0	0	0	1	0	0
5/06/2012 17:37:33	0	1	1	0	0	0	0	0	0	0	1	1	0	0
5/06/2012 17:37:34	0	0	0	1	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:37:37	0	1	1	1	0	0	1	1	0	0	1	0	0	0
5/06/2012 17:37:40	0	1	1	0	1	0	1	1	0	0	1	1	0	0
5/06/2012 17:37:42	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:37:43	0	1	0	1	1	0	1	0	0	0	1	1	0	0
5/06/2012 17:37:46	1	1	0	1	0	0	0	0	0	0	0	1	0	0
5/06/2012 17:37:47	0	0	0	0	0	0	1	0	0	0	1	0	0	0
5/06/2012 17:37:50	0	1	1	0	1	0	0	0	0	0	1	1	0	0
5/06/2012 17:37:51	0	0	1	1	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:37:53	0	0	1	1	1	0	1	1	0	0	0	1	0	0
5/06/2012 17:37:57	1	1	1	0	0	0	1	0	0	0	1	1	0	0
5/06/2012 17:37:59	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:00	0	0	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:03	0	0	0	0	0	0	0	0	0	0	1	1	0	0
5/06/2012 17:38:05	1	1	1	0	1	0	1	0	0	0	1	1	0	0
5/06/2012 17:38:07	1	1	1	0	0	0	1	0	0	0	1	1	0	0
5/06/2012 17:38:08	1	0	0	0	1	0	0	0	0	0	1	0	0	0
5/06/2012 17:38:09	0	1	1	0	0	0	1	0	0	0	0	1	0	0
5/06/2012 17:38:13	1	0	1	1	1	0	1	0	0	0	1	1	0	0
5/06/2012 17:38:15	1	1	1	1	1	0	1	0	0	0	1	0	0	0
5/06/2012 17:38:17	1	1	1	1	1	0	0	0	0	0	0	1	0	0
5/06/2012 17:38:18	0	0	0	0	0	0	1	0	0	0	0	0	0	0
5/06/2012 17:38:23	1	1	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:26	1	1	0	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:27	1	1	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:28	0	1	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:31	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:32	1	1	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:33	0	0	0	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:34	0	0	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:35	0	1	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:36	0	1	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:37	1	1	1	0	1	0	0	0	0	0	0	0	0	0

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5/06/2012 17:38:38	0	0	0	1	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:39	0	1	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:40	0	0	0	1	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:46	0	1	1	0	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:47	0	1	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:49	1	1	1	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:53	0	1	1	0	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:54	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5/06/2012 17:38:57	0	1	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:38:58	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:38:59	0	1	0	1	1	0	0	1	0	0	0	0	0	0
5/06/2012 17:39:00	1	0	1	0	0	0	0	0	0	0	0	0	1	0
5/06/2012 17:39:05	1	1	1	0	1	0	0	1	0	0	0	0	1	0
5/06/2012 17:39:09	0	1	1	1	1	0	0	0	0	0	0	0	1	0
5/06/2012 17:39:11	0	1	0	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:39:12	0	0	1	0	0	0	0	1	0	0	0	0	1	0
5/06/2012 17:39:13	0	0	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:39:14	0	1	0	0	0	0	0	0	0	0	0	0	1	0
5/06/2012 17:39:21	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:39:22	0	0	0	1	1	0	0	0	0	0	0	0	0	1
5/06/2012 17:39:23	1	1	1	1	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:39:24	0	0	0	1	0	0	0	0	0	0	0	0	1	0
5/06/2012 17:39:26	0	0	0	1	0	0	0	1	0	0	0	0	1	0
5/06/2012 17:39:27	0	1	0	0	0	0	0	1	0	0	0	0	0	1
5/06/2012 17:39:31	0	1	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:39:32	1	0	1	0	1	0	0	0	0	0	0	0	1	1
5/06/2012 17:39:33	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:39:34	1	1	1	1	1	0	0	0	0	0	0	0	1	0
5/06/2012 17:39:38	1	1	1	1	1	0	0	1	0	0	0	0	1	0
5/06/2012 17:39:42	1	1	1	1	1	0	0	0	0	0	0	0	1	1
5/06/2012 17:39:44	1	0	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:39:45	0	1	1	0	0	0	0	0	0	0	0	0	1	1
5/06/2012 17:39:50	0	0	0	0	0	0	0	0	0	0	0	0	1	0
5/06/2012 17:39:53	1	0	1	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:39:54	0	1	1	0	0	0	0	1	0	0	0	0	1	1
5/06/2012 17:39:55	1	0	0	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:39:56	0	1	1	0	0	0	0	1	0	0	0	0	1	1
5/06/2012 17:40:04	0	1	0	0	1	0	0	0	0	0	0	0	1	0
5/06/2012 17:40:05	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5/06/2012 17:40:06	1	1	0	1	0	0	0	1	0	0	0	0	1	0
5/06/2012 17:40:07	0	0	1	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:20	0	0	1	1	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:21	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:22	1	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:26	1	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:28	1	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:31	1	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:33	0	1	0	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:34	1	0	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:41	1	1	1	0	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:42	0	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:46	1	1	1	1	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:48	1	0	0	1	0	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:49	0	1	0	0	1	0	0	0	0	0	0	0	0	0
5/06/2012 17:40:50	0	1	0	1	1	0	0	0	0	0	0	0	0	0

9.2 Appendix B: Advanced Detection Measurement Data Sheets

9.2.1 Session 1 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Trolley	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
02/08/2012 20:23:45	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
02/08/2012 20:23:46	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
02/08/2012 20:23:47	1	1	1	0	1	1	1	0	1	0	0	0	0	0	0
02/08/2012 20:23:48	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
02/08/2012 20:23:49	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:23:50	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:23:52	1	1	1	0	1	1	1	0	1	0	0	0	0	0	0
02/08/2012 20:23:54	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02/08/2012 20:23:55	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0
02/08/2012 20:23:56	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0
02/08/2012 20:23:58	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0
02/08/2012 20:23:59	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0
02/08/2012 20:24:00	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
02/08/2012 20:24:01	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0
02/08/2012 20:24:02	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
02/08/2012 20:24:03	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0
02/08/2012 20:24:04	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0
02/08/2012 20:24:06	1	0	1	1	1	1	0	1	1	0	0	0	0	0	0
02/08/2012 20:24:07	1	0	1	1	0	0	1	1	1	0	0	0	0	0	0
02/08/2012 20:24:08	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:09	1	0	1	0	1	1	0	1	1	1	0	0	0	0	0
02/08/2012 20:24:10	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0
02/08/2012 20:24:11	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:12	1	0	0	1	1	0	1	0	1	1	1	0	0	0	0
02/08/2012 20:24:14	1	0	1	0	1	1	0	1	1	1	0	0	0	0	0
02/08/2012 20:24:15	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0
02/08/2012 20:24:16	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0
02/08/2012 20:24:17	1	0	1	0	1	1	0	1	1	0	0	0	0	0	0
02/08/2012 20:24:18	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
02/08/2012 20:24:19	1	0	1	0	1	1	0	0	1	0	0	0	0	0	0
02/08/2012 20:24:20	1	1	1	0	0	1	0	1	1	0	0	0	0	0	0
02/08/2012 20:24:22	1	0	1	1	1	1	0	1	1	0	0	0	0	0	0
02/08/2012 20:24:23	1	0	0	1	1	1	0	0	1	0	0	0	0	0	0
02/08/2012 20:24:24	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
02/08/2012 20:24:25	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0
02/08/2012 20:24:26	1	1	1	0	0	1	0	1	1	0	0	1	0	0	0
02/08/2012 20:24:28	1	0	0	1	0	1	0	1	1	0	0	1	1	0	0
02/08/2012 20:24:29	1	0	1	0	1	0	0	0	0	0	0	1	1	0	0
02/08/2012 20:24:30	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
02/08/2012 20:24:31	1	0	0	1	1	1	0	1	0	0	0	1	1	0	0
02/08/2012 20:24:32	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0
02/08/2012 20:24:33	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:34	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
02/08/2012 20:24:36	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
02/08/2012 20:24:37	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0
02/08/2012 20:24:38	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:39	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:40	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:41	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:42	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:43	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:44	1	0	1	1	0	1	0	0	0	0	0	0	0	1	1
02/08/2012 20:24:45	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:46	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0
02/08/2012 20:24:47	1	0	1	1	1	1	0	0	1	0	0	0	0	1	0
02/08/2012 20:24:49	1	0	1	1	1	1	0	0	0	0	0	0	0	1	1
02/08/2012 20:24:50	1	0	1	0	0	1	0	0	1	0	0	0	0	1	1
02/08/2012 20:24:51	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:52	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1

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02/08/2012 20:24:53	0	1	0	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:54	1	0	1	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:24:55	1	0	0	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:24:56	1	1	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:24:57	1	1	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:24:58	0	1	0	0	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:24:59	1	0	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:00	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:02	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:03	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:04	0	0	0	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:25:05	1	0	1	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:06	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:07	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:09	1	1	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:10	1	0	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:11	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:13	1	0	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:14	1	0	1	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:15	1	0	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:17	1	0	1	1	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:18	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:19	0	1	0	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:25:20	1	0	1	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:21	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:22	1	0	1	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:25:23	0	0	0	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:24	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:25	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:27	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:28	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:29	0	1	0	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:25:30	1	0	1	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:31	1	0	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:32	0	1	1	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:25:33	1	0	0	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:34	1	0	1	0	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:35	1	1	1	1	1	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:36	1	0	1	1	1	0	0	0	0	0	0	0	0	0
02/08/2012 20:25:37	0	1	0	0	0	1	0	0	0	0	0	0	0	0
02/08/2012 20:25:38	1	1	0	0	1	0	0	0	0	0	0	0	0	0

=====
 ===== Checkpoint Info =====
 =====

- At 20:24:20 02 Aug 2012 (Local) Passed Checkpoint 2
- At 20:24:39 02 Aug 2012 (Local) Passed Checkpoint 3
- At 20:25:06 02 Aug 2012 (Local) Passed Checkpoint 5
- At 20:25:14 02 Aug 2012 (Local) Passed Checkpoint 6
- At 20:25:15 02 Aug 2012 (Local) Passed Checkpoint 6
- At 20:25:23 02 Aug 2012 (Local) Passed Checkpoint 7
- At 20:25:25 02 Aug 2012 (Local) Passed Checkpoint 7
- At 20:25:30 02 Aug 2012 (Local) Passed Checkpoint 8

9.2.2 Session 2 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Trolley	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
24/08/2012 19:57:03	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:04	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:05	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:07	1	1	0	1	1	1	1	0	1	0	0	0	0	0	0
24/08/2012 19:57:08	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:09	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0
24/08/2012 19:57:11	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
24/08/2012 19:57:12	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0
24/08/2012 19:57:13	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0
24/08/2012 19:57:14	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:15	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
24/08/2012 19:57:17	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0
24/08/2012 19:57:18	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0
24/08/2012 19:57:19	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:20	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0
24/08/2012 19:57:22	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0
24/08/2012 19:57:24	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0
24/08/2012 19:57:25	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0
24/08/2012 19:57:26	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:27	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
24/08/2012 19:57:28	0	1	0	1	1	1	1	1	0	1	0	0	0	0	0
24/08/2012 19:57:30	1	0	0	1	1	1	1	1	0	1	0	0	0	0	0
24/08/2012 19:57:31	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
24/08/2012 19:57:32	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0
24/08/2012 19:57:33	1	1	0	0	1	1	0	1	1	1	0	0	0	0	0
24/08/2012 19:57:35	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0
24/08/2012 19:57:36	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:37	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0
24/08/2012 19:57:38	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:39	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
24/08/2012 19:57:40	0	0	1	0	1	1	0	1	1	1	0	0	0	0	0
24/08/2012 19:57:41	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
24/08/2012 19:57:42	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:43	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:44	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:57:45	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:46	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:47	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:49	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:50	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:51	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:53	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0
24/08/2012 19:57:54	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
24/08/2012 19:57:55	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
24/08/2012 19:57:56	0	1	0	1	1	1	0	1	0	0	0	1	0	0	0
24/08/2012 19:57:58	0	1	1	1	1	1	0	1	0	0	0	1	0	0	0
24/08/2012 19:57:59	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0
24/08/2012 19:58:00	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
24/08/2012 19:58:01	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0
24/08/2012 19:58:03	0	1	1	0	1	1	0	0	1	0	0	1	0	0	0
24/08/2012 19:58:04	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
24/08/2012 19:58:05	0	1	1	0	0	1	0	1	1	0	0	0	0	0	0
24/08/2012 19:58:06	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0
24/08/2012 19:58:07	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
24/08/2012 19:58:08	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:09	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:58:10	0	1	0	1	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:11	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:13	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:14	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:58:15	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:16	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:18	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
24/08/2012 19:58:20	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0
24/08/2012 19:58:21	0	1	1	1	1	1	0	0	1	0	0	0	0	0	1
24/08/2012 19:58:23	0	1	0	1	1	1	0	0	1	0	0	0	0	1	1
24/08/2012 19:58:24	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
24/08/2012 19:58:25	1	0	0	0	1	1	0	0	1	0	0	0	0	1	0
24/08/2012 19:58:26	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0

9.2.3 Session 3 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Trolley	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
25/08/2012 20:12:46	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0
25/08/2012 20:12:47	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0
25/08/2012 20:12:49	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0
25/08/2012 20:12:50	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
25/08/2012 20:12:51	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
25/08/2012 20:12:52	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0
25/08/2012 20:12:53	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
25/08/2012 20:12:54	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0
25/08/2012 20:12:55	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0
25/08/2012 20:12:56	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0
25/08/2012 20:12:57	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0
25/08/2012 20:12:58	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:12:59	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0
25/08/2012 20:13:00	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0
25/08/2012 20:13:01	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:02	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0
25/08/2012 20:13:04	0	1	1	1	0	1	1	1	1	0	0	0	0	0	0
25/08/2012 20:13:05	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
25/08/2012 20:13:06	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:07	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0
25/08/2012 20:13:09	1	1	1	1	1	0	1	0	1	0	0	0	0	0	0
25/08/2012 20:13:10	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:11	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
25/08/2012 20:13:12	1	0	0	1	0	0	1	1	1	0	1	0	0	0	0
25/08/2012 20:13:13	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
25/08/2012 20:13:14	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0
25/08/2012 20:13:15	1	1	0	1	1	0	0	0	1	1	1	0	0	0	0
25/08/2012 20:13:17	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0
25/08/2012 20:13:19	0	1	1	1	1	1	0	1	0	1	0	0	0	0	0
25/08/2012 20:13:20	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
25/08/2012 20:13:21	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:22	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:24	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:25	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:27	1	1	0	1	0	1	0	1	1	0	0	1	0	0	0
25/08/2012 20:13:28	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
25/08/2012 20:13:29	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0
25/08/2012 20:13:31	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:32	1	1	0	1	1	0	0	0	1	0	0	0	1	0	0
25/08/2012 20:13:33	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
25/08/2012 20:13:34	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0
25/08/2012 20:13:35	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0
25/08/2012 20:13:36	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:37	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
25/08/2012 20:13:38	0	1	1	1	1	0	0	1	0	0	0	1	1	0	0
25/08/2012 20:13:40	1	1	1	0	0	0	0	1	1	0	0	1	1	0	0
25/08/2012 20:13:41	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/08/2012 20:13:42	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:43	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:44	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
25/08/2012 20:13:46	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:47	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:48	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:49	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:51	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:53	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
25/08/2012 20:13:54	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1
25/08/2012 20:13:55	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
25/08/2012 20:13:56	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0

9.3 Appendix C: Robot Simulation Data Sheets

9.3.1 Test 1 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
28/08/2012 20:09:07	0	1	0	0	0	1	1	1	0	0	0	0	0	0
28/08/2012 20:09:08	1	0	0	1	0	1	1	1	0	0	0	0	0	0
28/08/2012 20:09:09	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:09:10	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:09:11	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:09:13	1	1	1	0	1	1	1	1	0	0	0	0	0	0
28/08/2012 20:09:14	1	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:09:15	0	0	1	0	0	0	0	0	1	0	0	0	0	0
28/08/2012 20:09:16	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:09:17	0	0	0	0	1	0	1	0	0	0	1	0	0	0
28/08/2012 20:09:18	1	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:09:19	1	1	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:09:20	0	0	0	0	0	1	1	0	0	0	0	0	0	0
28/08/2012 20:09:21	1	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:09:22	1	1	1	0	1	0	1	1	1	0	0	0	0	0
28/08/2012 20:09:24	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:09:25	0	0	0	0	1	1	1	0	0	0	0	0	0	0
28/08/2012 20:09:26	1	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:09:27	1	1	1	0	1	1	1	1	0	0	0	0	0	0
28/08/2012 20:09:29	1	1	1	0	1	1	1	1	0	0	0	0	0	0
28/08/2012 20:09:30	0	1	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:09:31	1	0	0	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 20:09:32	1	1	1	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:09:34	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:09:35	0	1	0	0	0	1	0	0	0	0	0	0	0	0
28/08/2012 20:09:36	1	0	1	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:09:37	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:09:39	1	1	1	1	1	0	1	0	0	1	0	0	0	0
28/08/2012 20:09:40	0	0	0	0	1	0	0	1	0	1	0	0	0	0
28/08/2012 20:09:41	1	1	1	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:09:42	1	1	1	0	1	0	1	1	0	1	0	0	0	0
28/08/2012 20:09:44	1	0	1	1	0	1	1	1	0	1	0	0	0	0
28/08/2012 20:09:45	0	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:09:46	1	0	0	1	0	1	1	0	0	1	0	0	0	0
28/08/2012 20:09:47	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:09:48	0	0	0	1	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:09:49	1	1	1	1	0	0	1	1	1	0	0	0	0	0
28/08/2012 20:09:51	1	1	1	0	1	0	1	1	1	0	0	0	0	0
28/08/2012 20:09:52	1	0	0	0	0	0	1	1	1	0	0	0	0	0
28/08/2012 20:09:53	0	1	0	0	1	0	0	0	0	1	0	0	0	0
28/08/2012 20:09:54	1	0	1	0	0	1	0	0	0	0	0	0	0	0
28/08/2012 20:09:55	1	1	1	1	0	0	1	0	1	1	0	0	0	0
28/08/2012 20:09:57	1	0	1	0	1	1	1	1	0	1	0	0	0	0
28/08/2012 20:09:58	0	1	0	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 20:09:59	1	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:10:00	1	0	1	1	1	1	0	1	0	1	0	0	0	0
28/08/2012 20:10:02	0	0	1	0	1	1	1	1	1	1	0	0	0	0
28/08/2012 20:10:03	1	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:10:04	0	0	1	0	0	1	1	1	1	0	0	0	0	0
28/08/2012 20:10:05	0	1	0	0	0	1	0	1	1	1	0	0	0	0
28/08/2012 20:10:06	0	0	1	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:10:07	0	1	1	1	0	1	1	1	1	0	0	0	0	0
28/08/2012 20:10:09	1	1	1	0	0	0	1	1	1	1	0	0	0	0
28/08/2012 20:10:10	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:10:11	0	0	0	0	0	0	1	1	1	1	0	0	0	0
28/08/2012 20:10:12	1	1	1	1	0	0	0	0	0	1	0	0	0	0
28/08/2012 20:10:13	0	0	0	0	0	0	0	1	1	0	0	0	0	0
28/08/2012 20:10:14	1	1	1	0	0	0	1	1	1	1	0	0	0	0
28/08/2012 20:10:16	1	1	0	1	0	1	1	1	1	0	0	0	0	0
28/08/2012 20:10:17	0	0	1	0	1	1	1	0	1	0	0	0	0	0
28/08/2012 20:10:18	0	0	0	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:10:19	0	1	1	1	1	1	1	1	0	0	0	0	0	0
28/08/2012 20:10:21	0	0	1	1	1	0	1	1	1	1	0	0	0	0
28/08/2012 20:10:22	0	0	0	1	0	0	1	0	1	0	0	0	0	0
28/08/2012 20:10:23	1	0	0	0	1	1	0	1	0	0	0	0	0	0
28/08/2012 20:10:24	1	0	1	1	0	0	0	1	0	1	0	0	0	0
28/08/2012 20:10:25	0	0	0	0	0	1	1	0	0	0	0	0	0	0
28/08/2012 20:10:26	1	0	1	1	1	0	1	1	0	1	0	0	0	0
28/08/2012 20:10:27	0	0	0	0	0	0	0	1	0	0	0	0	0	0

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28/08/2012 20:10:28	1	1	1	1	0	0	1	0	0	1	0	0	0	0
28/08/2012 20:10:29	1	0	0	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:30	0	1	0	0	1	0	0	0	0	1	0	0	0	0
28/08/2012 20:10:31	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:33	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:34	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:10:35	1	1	1	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:36	1	1	0	1	0	0	0	0	1	0	0	0	0	0
28/08/2012 20:10:37	0	0	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:38	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:39	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:10:40	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:41	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:10:42	1	0	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:43	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:10:44	0	0	0	1	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:10:45	1	1	1	1	0	0	1	1	0	1	0	0	0	0
28/08/2012 20:10:47	1	1	1	0	1	0	1	1	0	1	0	0	0	0
28/08/2012 20:10:48	0	1	0	0	0	0	1	0	0	1	0	0	0	0
28/08/2012 20:10:49	1	0	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:10:50	0	1	1	1	0	0	0	1	0	0	1	0	0	0
28/08/2012 20:10:51	1	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:10:52	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:54	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:10:55	0	1	0	1	0	0	0	0	0	0	1	0	0	0
28/08/2012 20:10:56	1	0	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:57	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:10:59	1	0	1	0	1	0	1	1	0	0	1	1	0	0
28/08/2012 20:11:00	1	0	0	0	1	0	0	0	0	0	1	0	0	0
28/08/2012 20:11:01	0	0	1	0	0	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:02	0	1	1	0	0	0	1	0	0	0	1	1	0	0
28/08/2012 20:11:03	1	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:11:04	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:05	0	0	1	0	0	0	0	1	0	0	1	0	0	0
28/08/2012 20:11:06	1	1	0	1	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:11:08	0	1	1	1	0	0	0	1	0	0	1	0	0	0
28/08/2012 20:11:09	1	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:11:10	1	0	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:12	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:13	1	0	1	0	1	0	0	1	0	0	1	1	0	0
28/08/2012 20:11:14	0	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:11:15	0	1	1	0	1	0	1	0	0	0	1	0	0	0
28/08/2012 20:11:16	1	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:11:17	1	1	1	0	0	0	1	1	0	0	1	1	0	0
28/08/2012 20:11:18	0	1	1	0	0	0	0	0	0	0	1	0	0	0
28/08/2012 20:11:19	1	0	0	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:20	1	1	1	0	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:22	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:23	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:11:24	1	1	0	0	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:25	0	1	0	0	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:26	1	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:11:27	1	1	1	0	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:29	1	1	1	0	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:30	1	1	1	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 20:11:31	0	0	0	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:32	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:33	0	0	0	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 20:11:34	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:35	1	0	0	0	0	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:36	0	1	1	0	0	0	0	0	0	0	1	0	0	0
28/08/2012 20:11:37	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:39	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:40	0	0	1	1	0	0	1	0	0	0	0	1	0	0
28/08/2012 20:11:41	1	1	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:11:42	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:44	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:45	0	1	0	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:46	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:11:47	1	0	1	1	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:49	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:50	1	0	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:11:51	0	1	0	1	0	0	0	0	0	0	1	0	0	0
28/08/2012 20:11:52	1	0	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:54	1	1	1	1	0	0	1	1	0	0	1	0	0	0
28/08/2012 20:11:55	0	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:11:56	1	1	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:11:57	1	0	1	1	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:11:59	1	1	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 20:12:00	1	0	1	0	1	0	1	1	0	0	0	0	0	0

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28/08/2012 20:12:02	1	0	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:03	1	0	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:04	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:05	1	0	1	1	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:06	0	0	0	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 20:12:07	1	1	1	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:08	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:09	0	0	0	0	0	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:10	1	0	1	1	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:11	1	1	1	1	1	0	0	1	0	0	0	1	0	0
28/08/2012 20:12:12	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:13	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:14	0	1	0	0	0	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:15	1	1	1	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 20:12:16	0	0	0	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 20:12:17	1	1	1	0	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:18	1	0	1	1	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:19	1	0	1	1	1	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:20	1	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 20:12:21	0	1	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:22	1	1	1	0	0	0	1	0	0	0	0	1	0	0
28/08/2012 20:12:23	0	0	0	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:24	1	1	1	1	0	0	1	1	0	0	0	1	0	0
28/08/2012 20:12:25	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:26	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:27	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:28	1	1	1	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:29	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:30	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:31	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:32	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:33	1	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:34	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:35	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:36	1	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:37	0	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:38	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:39	0	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:40	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:41	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:42	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:43	0	1	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:44	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:45	0	0	0	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 20:12:46	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:47	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:48	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:49	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:50	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:51	1	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:52	0	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:53	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:54	1	1	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:55	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:56	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:57	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:12:58	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:12:59	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:00	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:01	0	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:02	1	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:03	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:04	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:05	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:06	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:07	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:08	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:09	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:10	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:11	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:12	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:13	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:14	1	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:15	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:16	1	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:17	1	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:18	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:19	1	1	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:20	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:21	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:22	1	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:23	1	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:24	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:25	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:26	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:27	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:28	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:29	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:30	1	0	0	0	0	0	0	0	0	0	0	0	0	0

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28/08/2012 20:13:31	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:32	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:33	1	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:34	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:35	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:36	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:37	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:38	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:39	1	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:40	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:41	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:42	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:43	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:44	1	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:45	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:46	1	1	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:47	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:48	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:49	0	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:50	1	0	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:51	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:52	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:54	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:13:55	1	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:56	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:13:57	1	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:13:58	1	0	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:13:59	1	1	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:00	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:01	1	1	1	1	1	0	0	0	0	0	0	0	1	0
28/08/2012 20:14:02	0	0	0	0	0	0	0	1	0	0	0	0	1	1
28/08/2012 20:14:03	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:04	1	0	0	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:05	0	0	1	0	0	0	0	0	0	0	0	0	0	1
28/08/2012 20:14:06	1	0	1	0	1	0	0	1	0	0	0	0	1	1
28/08/2012 20:14:07	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:08	1	1	1	0	1	0	0	0	0	0	0	0	1	1
28/08/2012 20:14:09	0	1	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:10	1	0	0	1	0	0	0	0	0	0	0	0	1	1
28/08/2012 20:14:11	1	1	1	0	1	0	0	1	0	0	0	0	1	1
28/08/2012 20:14:13	1	1	1	0	1	0	0	1	0	0	0	0	1	1
28/08/2012 20:14:14	0	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:15	1	1	0	0	0	0	0	0	0	0	0	0	1	1
28/08/2012 20:14:16	1	1	0	0	1	0	0	0	0	0	0	0	1	1
28/08/2012 20:14:17	0	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:18	1	1	1	0	0	0	0	1	0	0	0	0	1	1
28/08/2012 20:14:20	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:22	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:23	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:25	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:26	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:27	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:28	1	0	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:29	0	1	0	0	0	0	0	0	0	0	0	0	1	0
28/08/2012 20:14:30	1	1	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:32	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 20:14:34	1	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:35	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:37	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:38	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:39	0	1	1	1	0	0	0	0	0	0	0	0	0	1
28/08/2012 20:14:40	0	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:41	0	1	0	0	0	0	0	0	0	0	0	0	0	1
28/08/2012 20:14:42	0	0	1	0	1	0	0	1	0	0	0	0	0	1
28/08/2012 20:14:43	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:44	0	0	0	0	0	0	0	1	0	0	0	0	0	1
28/08/2012 20:14:45	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:46	0	1	1	0	1	0	0	1	0	0	0	0	0	1
28/08/2012 20:14:48	0	1	1	0	1	0	0	1	0	0	0	0	0	1
28/08/2012 20:14:49	0	1	0	0	1	0	0	0	0	0	0	0	0	1
28/08/2012 20:14:50	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:51	0	1	1	0	1	0	0	1	0	0	0	0	0	1
28/08/2012 20:14:52	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:14:54	0	1	1	1	1	0	0	0	0	0	0	0	0	1
28/08/2012 20:14:55	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:57	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:14:58	0	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:15:00	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:01	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:02	0	0	0	1	0	0	0	0	0	0	0	0	0	0

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28/08/2012 20:15:03	0	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:15:04	0	0	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 20:15:05	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:06	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:07	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:08	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:09	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:10	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:11	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:12	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:13	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:14	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:16	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:17	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:18	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:19	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:20	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:21	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:22	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:23	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:24	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:25	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:26	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:27	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:28	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:29	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:30	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:31	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:32	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:33	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:34	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:35	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:36	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:37	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:39	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:40	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:41	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:42	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:43	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:44	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:45	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:46	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:47	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:48	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:49	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:50	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:51	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:52	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:53	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:54	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:55	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:56	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:57	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:58	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:15:59	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:00	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:01	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:02	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:03	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:04	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:05	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:06	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:07	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:08	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:09	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:10	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:11	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:12	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:13	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:14	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:15	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:16	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:18	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:19	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:20	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:21	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:22	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:23	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:24	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:26	0	1	1	1	1	0	0	0	0	0	0	0	0	0

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28/08/2012 20:16:27	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:28	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:29	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:30	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:31	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:32	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:33	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:34	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:35	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:36	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:37	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:38	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:39	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:41	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:42	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:43	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:44	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:45	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:46	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:47	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:49	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:50	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:51	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:52	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:53	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:54	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:55	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:56	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:57	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:58	0	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:16:59	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:00	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:01	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:02	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:03	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:04	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:05	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:06	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:07	0	1	1	0	0	1	0	0	0	0	0	0	0	0
28/08/2012 20:17:08	0	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:09	1	1	1	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 20:17:10	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:11	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:12	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:13	0	1	1	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 20:17:14	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:15	0	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:16	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:17	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:18	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:19	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:20	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:21	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:22	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:23	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:24	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:25	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:26	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:27	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:28	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:29	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:30	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:31	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:32	0	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:33	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:34	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:35	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:36	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:37	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:39	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:40	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:41	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:42	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:43	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:44	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:45	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:46	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:47	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:48	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:17:49	0	1	1	0	1	0	0	0	0	0	0	0	0	0

RFID Usage for Monitoring Drug Dispensing

Zachary Zhou

28/08/2012 20:19:18	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:19	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:20	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:21	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:22	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:23	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:24	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:25	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:26	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:27	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:28	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:29	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:30	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:32	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:33	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:34	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:36	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:37	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:38	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:39	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:40	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:41	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 20:19:42	1	0	1	1	0	0	0	0	0	0	0	0	0	0
===== Checkpoint Info =====														
At 20:12:45 28 Aug 2012 (Local) Passed Checkpoint 3														
At 20:14:15 28 Aug 2012 (Local) Passed Checkpoint 5														
At 20:14:18 28 Aug 2012 (Local) Passed Checkpoint 5														
At 20:14:20 28 Aug 2012 (Local) Passed Checkpoint 5														
At 20:14:22 28 Aug 2012 (Local) Passed Checkpoint 5														
At 20:14:27 28 Aug 2012 (Local) Passed Checkpoint 5														
At 20:14:32 28 Aug 2012 (Local) Passed Checkpoint 5														
At 20:14:52 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:14:54 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:14:55 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:14:57 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:14:58 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:15:01 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:15:03 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:15:32 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:15:33 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:15:36 28 Aug 2012 (Local) Passed Checkpoint 4														
At 20:17:30 28 Aug 2012 (Local) Passed Checkpoint 6														
At 20:17:31 28 Aug 2012 (Local) Passed Checkpoint 6														
At 20:17:33 28 Aug 2012 (Local) Passed Checkpoint 6														
At 20:17:35 28 Aug 2012 (Local) Passed Checkpoint 6														
At 20:17:37 28 Aug 2012 (Local) Passed Checkpoint 6														
At 20:18:44 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:46 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:47 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:49 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:50 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:52 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:54 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:18:55 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:19:19 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:19:20 28 Aug 2012 (Local) Passed Checkpoint 8														
At 20:19:40 28 Aug 2012 (Local) Passed Checkpoint 1														
At 20:19:41 28 Aug 2012 (Local) Passed Checkpoint 1														
=====														

9.3.2 Test 2 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
28/08/2012 21:06:41	0	0	1	1	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:06:42	1	1	1	1	1	1	1	1	1	0	0	0	0	0
28/08/2012 21:06:43	1	0	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:06:45	0	1	1	1	1	1	1	1	0	0	0	0	0	0
28/08/2012 21:06:46	0	1	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:06:47	0	0	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:06:48	0	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:06:49	0	0	0	1	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:06:50	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:06:51	0	0	0	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:06:52	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:06:53	0	1	1	1	0	1	1	1	0	0	0	0	0	0
28/08/2012 21:06:54	0	0	1	0	1	1	1	1	0	0	0	0	0	0
28/08/2012 21:06:55	0	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:06:56	0	0	1	1	0	1	1	1	1	0	0	0	0	0
28/08/2012 21:06:57	0	0	0	1	0	0	1	1	0	0	0	0	0	0
28/08/2012 21:06:58	0	1	1	0	0	1	0	0	0	0	0	0	0	0
28/08/2012 21:06:59	0	1	1	1	1	1	1	1	0	0	0	0	0	0
28/08/2012 21:07:01	0	1	1	1	0	1	1	0	0	0	0	0	0	0
28/08/2012 21:07:02	0	1	0	1	0	1	1	1	0	0	0	0	0	0
28/08/2012 21:07:03	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:07:04	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:05	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:07:06	0	0	1	1	0	1	1	1	0	0	0	0	0	0
28/08/2012 21:07:07	0	0	1	1	1	1	0	1	0	0	0	0	0	0
28/08/2012 21:07:08	0	1	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:07:09	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:10	0	1	0	0	0	1	1	0	0	0	0	0	0	0
28/08/2012 21:07:11	0	0	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:07:12	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:14	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:15	0	0	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:07:16	0	1	1	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:07:17	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:19	0	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:20	0	0	1	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:07:21	0	1	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:07:22	0	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:24	0	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:25	0	0	1	0	1	0	1	1	0	0	1	0	0	0
28/08/2012 21:07:26	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:07:27	0	1	1	0	1	0	1	1	1	0	0	0	0	0
28/08/2012 21:07:28	0	0	1	0	1	0	0	0	1	1	0	0	0	0
28/08/2012 21:07:29	0	1	0	0	0	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:30	0	0	1	1	1	1	1	1	0	1	0	0	0	0
28/08/2012 21:07:32	0	1	1	1	1	0	0	1	0	1	0	0	0	0
28/08/2012 21:07:34	0	1	1	1	1	1	0	1	0	1	0	0	0	0
28/08/2012 21:07:35	0	0	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:07:36	0	0	0	0	0	0	0	0	0	1	0	0	0	0
28/08/2012 21:07:37	0	1	1	1	1	0	1	1	0	1	0	0	0	0
28/08/2012 21:07:38	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:07:39	0	0	0	1	1	0	1	1	0	1	0	0	0	0
28/08/2012 21:07:40	0	1	0	0	1	0	1	1	1	0	0	0	0	0
28/08/2012 21:07:41	0	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:07:42	0	1	1	1	1	0	1	1	0	1	0	0	0	0
28/08/2012 21:07:43	0	0	0	0	0	0	1	0	1	0	0	0	0	0
28/08/2012 21:07:44	0	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:07:45	0	1	1	0	1	0	1	1	1	1	0	0	0	0
28/08/2012 21:07:47	1	0	1	0	0	1	1	1	1	1	0	0	0	0
28/08/2012 21:07:48	0	1	1	0	0	0	0	0	0	1	0	0	0	0
28/08/2012 21:07:49	0	0	0	0	1	1	1	1	0	0	0	0	0	0
28/08/2012 21:07:50	0	1	1	0	1	0	1	1	1	1	0	0	0	0
28/08/2012 21:07:52	0	1	1	0	1	0	1	1	1	1	0	0	0	0
28/08/2012 21:07:54	1	1	1	0	1	1	1	0	0	1	0	0	0	0
28/08/2012 21:07:55	0	1	1	0	1	0	0	1	0	1	0	0	0	0
28/08/2012 21:07:56	0	0	0	0	0	0	1	0	1	0	0	0	0	0
28/08/2012 21:07:57	0	0	1	0	1	0	1	1	1	1	0	0	0	0
28/08/2012 21:07:58	0	0	1	0	0	1	0	0	0	1	0	0	0	0
28/08/2012 21:07:59	0	0	0	0	0	0	1	0	0	0	0	0	0	0

RFID Usage for Monitoring Drug Dispensing

Zachary Zhou

28/08/2012 21:08:00	0	1	1	0	1	1	1	1	0	0	0	0	0	0
28/08/2012 21:08:01	0	0	1	1	0	1	1	1	0	0	0	0	0	0
28/08/2012 21:08:02	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:03	0	1	1	1	1	1	0	1	0	0	0	0	0	0
28/08/2012 21:08:05	1	0	1	1	1	1	1	0	1	0	0	0	0	0
28/08/2012 21:08:06	0	0	1	0	0	0	0	1	0	1	0	0	0	0
28/08/2012 21:08:07	1	1	0	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:08	0	1	1	1	1	1	0	0	0	0	0	0	0	0
28/08/2012 21:08:09	1	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:10	1	1	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:11	0	0	0	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:12	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:13	1	1	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:14	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:15	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:08:16	1	0	0	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:17	0	1	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:08:18	1	1	1	0	1	0	1	1	0	1	0	0	0	0
28/08/2012 21:08:20	1	1	1	1	1	0	1	0	0	1	0	0	0	0
28/08/2012 21:08:21	0	0	1	0	0	0	0	0	0	1	0	0	0	0
28/08/2012 21:08:22	1	1	0	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:23	0	0	1	1	1	0	1	0	1	0	0	0	0	0
28/08/2012 21:08:24	1	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:08:25	1	0	1	0	1	1	1	1	1	0	0	0	0	0
28/08/2012 21:08:27	1	0	1	1	0	1	1	1	1	0	0	0	0	0
28/08/2012 21:08:28	0	0	1	0	0	0	0	1	1	0	0	0	0	0
28/08/2012 21:08:29	1	1	0	1	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:30	1	1	1	0	0	0	0	1	1	0	0	0	0	0
28/08/2012 21:08:31	0	0	0	0	0	1	1	0	0	0	0	0	0	0
28/08/2012 21:08:32	1	1	1	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:33	1	0	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:34	0	1	0	1	0	0	1	0	0	0	0	1	0	0
28/08/2012 21:08:35	1	1	1	0	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:08:37	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:08:38	1	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:08:39	0	1	0	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:40	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:08:42	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:08:43	0	0	0	0	0	0	1	1	0	0	1	0	0	0
28/08/2012 21:08:44	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:45	1	1	1	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:47	1	1	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:48	0	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:49	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:50	0	1	0	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:51	1	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:52	1	1	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:53	0	1	1	0	0	0	0	0	0	0	1	0	0	0
28/08/2012 21:08:54	1	0	0	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:08:55	1	1	1	0	1	0	1	0	0	0	1	0	0	0
28/08/2012 21:08:57	1	1	1	0	1	0	1	0	0	0	1	1	0	0
28/08/2012 21:08:58	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:08:59	1	1	0	0	0	0	1	0	0	0	1	0	0	0
28/08/2012 21:09:00	1	1	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:09:02	1	1	1	0	1	0	0	0	0	0	1	0	0	0
28/08/2012 21:09:03	1	1	1	0	1	0	1	0	0	0	1	0	0	0
28/08/2012 21:09:05	1	1	1	0	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:06	0	1	1	0	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:07	1	0	0	0	0	0	1	0	0	0	1	0	0	0
28/08/2012 21:09:08	1	0	1	1	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:09	0	1	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:09:10	1	1	1	0	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:11	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:12	1	1	0	0	0	0	1	0	0	0	1	1	0	0
28/08/2012 21:09:13	1	0	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:09:14	0	1	0	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:15	1	1	1	0	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:16	0	0	0	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:17	1	1	1	0	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:09:18	1	1	1	0	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:20	1	1	1	0	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:21	0	0	0	1	1	0	1	0	0	0	0	0	0	0
28/08/2012 21:09:22	1	1	1	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:23	1	1	1	0	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:24	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:25	1	1	1	1	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:26	0	0	0	0	0	0	1	0	0	0	0	0	0	0
28/08/2012 21:09:27	1	1	1	1	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:28	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:29	0	0	0	0	0	0	1	0	0	0	0	0	0	0

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28/08/2012 21:09:30	1	1	1	1	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:32	1	1	0	1	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:33	1	1	0	1	1	0	1	1	0	0	0	1	0	0
28/08/2012 21:09:34	1	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:36	1	1	1	1	1	0	1	0	0	0	0	1	0	0
28/08/2012 21:09:37	0	1	0	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:38	1	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:39	1	1	0	1	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:40	0	1	1	0	0	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:41	1	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:42	1	1	0	1	1	0	0	0	0	0	0	1	0	0
28/08/2012 21:09:43	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:45	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:46	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:48	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:49	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:50	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:51	1	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:52	1	1	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:53	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:54	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:56	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:57	1	0	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:09:58	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:09:59	1	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:00	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:02	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:03	1	0	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:04	1	0	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:06	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:07	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:08	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:10	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:11	1	1	0	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:12	0	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:13	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:14	1	1	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:15	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:16	1	0	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:17	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:18	1	1	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:19	1	1	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:20	1	0	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:21	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:22	1	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:23	1	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:24	0	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:25	1	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:27	1	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:28	1	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:30	1	1	1	1	1	0	1	1	0	0	0	0	0	0
28/08/2012 21:10:31	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:32	1	0	1	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:33	1	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:34	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:35	1	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:36	0	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:37	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:38	0	1	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:39	1	0	0	1	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:40	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:41	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:42	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:43	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:44	0	0	1	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:45	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:46	0	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:47	1	1	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:10:49	1	1	0	1	1	0	0	1	0	0	0	0	1	1
28/08/2012 21:10:50	1	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:51	0	0	0	0	0	0	0	0	0	0	0	0	1	1
28/08/2012 21:10:52	0	1	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:10:53	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:10:54	1	1	1	0	1	0	0	0	0	0	0	0	1	1
28/08/2012 21:10:55	1	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:10:56	0	1	1	0	0	0	0	0	0	0	0	0	1	1
28/08/2012 21:10:57	1	1	1	0	1	0	0	1	0	0	0	0	1	1
28/08/2012 21:10:59	1	1	1	0	1	0	0	1	0	0	0	0	0	1
28/08/2012 21:11:00	1	0	0	0	0	0	0	0	0	0	0	0	1	0
28/08/2012 21:11:01	0	1	0	1	0	0	0	1	0	0	0	0	1	0

RFID Usage for Monitoring Drug Dispensing

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28/08/2012 21:11:02	1	0	0	0	1	0	0	0	0	0	0	0	1	0
28/08/2012 21:11:03	0	0	0	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:04	1	1	1	0	0	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:05	1	1	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:07	1	0	1	1	0	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:08	1	1	0	1	0	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:09	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:10	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:11	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:12	1	1	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:13	0	0	1	0	0	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:14	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:15	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:17	1	1	1	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:18	0	1	0	0	0	0	0	0	0	0	0	0	1	1
28/08/2012 21:11:19	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:20	0	1	0	0	1	0	0	0	0	0	0	0	1	0
28/08/2012 21:11:21	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:22	1	0	0	0	0	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:23	1	1	0	0	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:24	0	0	1	0	1	0	0	0	0	0	0	0	1	0
28/08/2012 21:11:25	1	1	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:26	1	1	0	0	1	0	0	0	0	0	0	0	1	1
28/08/2012 21:11:27	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:28	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:29	1	1	0	0	1	0	0	0	0	0	0	0	1	0
28/08/2012 21:11:31	1	0	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:32	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:33	1	0	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:34	0	1	0	0	0	0	0	0	0	0	0	0	0	1
28/08/2012 21:11:35	1	0	1	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:36	1	1	0	0	1	0	0	1	0	0	0	0	0	1
28/08/2012 21:11:37	0	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:38	1	0	1	1	1	0	0	0	0	0	0	0	1	1
28/08/2012 21:11:39	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:40	1	1	1	1	1	0	0	1	0	0	0	0	1	0
28/08/2012 21:11:41	1	1	0	1	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:43	1	1	1	1	1	0	0	0	0	0	0	0	0	1
28/08/2012 21:11:44	0	0	1	1	0	0	0	0	0	0	0	0	1	0
28/08/2012 21:11:45	1	1	0	0	1	0	0	0	0	0	0	0	0	1
28/08/2012 21:11:46	0	0	1	1	1	0	0	1	0	0	0	0	0	1
28/08/2012 21:11:47	1	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:48	1	1	1	1	1	0	0	0	0	0	0	0	0	1
28/08/2012 21:11:49	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:50	1	1	1	0	1	0	0	0	0	0	0	0	0	1
28/08/2012 21:11:51	0	0	1	0	1	0	0	0	0	0	0	0	0	1
28/08/2012 21:11:52	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:53	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:54	0	1	1	1	1	0	0	0	0	0	0	0	1	1
28/08/2012 21:11:55	1	1	1	0	1	0	0	1	0	0	0	0	0	0
28/08/2012 21:11:56	1	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:57	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:11:58	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:00	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:01	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:03	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:04	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:05	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:06	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:07	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:08	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:09	1	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:10	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:12	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:13	1	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:14	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:15	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:17	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:18	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:20	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:21	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:22	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:23	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:24	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:25	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:26	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:27	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:28	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:29	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:30	1	1	1	1	1	0	0	0	0	0	0	0	0	0

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28/08/2012 21:12:32	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:33	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:34	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:35	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:36	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:37	0	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:38	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:39	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:41	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:42	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:43	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:44	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:45	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:46	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:47	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:49	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:50	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:51	1	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:52	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:53	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:54	1	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:55	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:56	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:57	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:58	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:12:59	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:00	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:01	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:02	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:03	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:04	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:05	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:06	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:07	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:08	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:09	1	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:10	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:11	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:12	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:13	1	1	1	0	0	0	0	0	0	0	0	0	0	1
28/08/2012 21:13:14	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:15	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:16	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:17	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:18	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:19	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:20	1	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:21	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:22	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:23	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:24	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:25	1	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:26	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:27	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:28	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:29	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:30	1	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:31	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:32	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:33	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:34	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:35	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:36	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:37	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:38	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:39	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:40	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:41	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:42	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:43	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:44	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:45	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:46	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:48	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:49	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:50	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:51	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:52	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:53	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:54	0	0	1	1	0	0	0	0	0	0	0	0	0	0

RFID Usage for Monitoring Drug Dispensing

Zachary Zhou

28/08/2012 21:13:55	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:56	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:57	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:58	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:13:59	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:00	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:01	1	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:02	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:03	1	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:04	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:05	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:06	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:07	1	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:08	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:09	1	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:10	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:11	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:12	1	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:13	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:15	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:16	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:18	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:19	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:20	1	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:21	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:22	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:23	0	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:24	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:25	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:26	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:27	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:28	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:29	0	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:30	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:31	0	1	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:32	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:34	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:35	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:36	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:37	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:38	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:39	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:40	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:41	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:43	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:44	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:45	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:46	0	0	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:47	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:48	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:49	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:50	0	1	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:51	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:52	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:53	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:54	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:55	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:56	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:57	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:58	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:14:59	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:00	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:01	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:02	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:03	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:04	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:05	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:07	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:08	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:09	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:10	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:11	0	0	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:12	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:14	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:15	0	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:16	1	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:17	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:18	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:19	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:20	1	1	1	1	0	0	0	0	0	0	0	0	0	0

RFID Usage for Monitoring Drug Dispensing

Zachary Zhou

28/08/2012 21:15:21	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:22	0	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:23	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:24	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:25	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:26	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:27	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:28	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:29	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:30	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:31	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:32	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:33	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:34	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:35	1	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:36	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:37	1	0	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:38	0	1	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:39	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:40	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:42	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:43	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:44	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:45	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:46	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:47	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:48	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:49	0	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:50	1	0	0	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:51	1	1	1	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:52	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:53	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:54	1	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:55	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:56	0	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:57	1	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:58	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:15:59	1	0	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:00	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:01	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:02	1	1	1	0	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:03	0	0	0	1	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:04	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:05	1	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:06	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:07	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:08	1	1	1	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:09	0	1	0	1	1	0	0	0	0	0	0	0	0	0
28/08/2012 21:16:10	0	0	0	1	1	0	0	0	0	0	0	0	0	0

===== Checkpoint Info =====									
At	21:06:46	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:06:48	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:06:50	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:06:57	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:01	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:02	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:19	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:20	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:22	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:24	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:25	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:32	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:35	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:38	28 Aug 2012 (Local)	Passed	Checkpoint 1					
At	21:07:57	28 Aug 2012 (Local)	Passed	Checkpoint 7					
At	21:08:45	28 Aug 2012 (Local)	Passed	Checkpoint 2					
At	21:08:47	28 Aug 2012 (Local)	Passed	Checkpoint 2					
At	21:08:48	28 Aug 2012 (Local)	Passed	Checkpoint 2					
At	21:08:50	28 Aug 2012 (Local)	Passed	Checkpoint 2					
At	21:08:52	28 Aug 2012 (Local)	Passed	Checkpoint 2					
At	21:09:57	28 Aug 2012 (Local)	Passed	Checkpoint 6					
At	21:10:00	28 Aug 2012 (Local)	Passed	Checkpoint 6					
At	21:10:02	28 Aug 2012 (Local)	Passed	Checkpoint 6					
At	21:11:17	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:19	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:21	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:23	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:25	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:29	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:30	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:11:33	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:11:44	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:11:56	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:12	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:13	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:15	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:17	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:18	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:26	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:27	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:32	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:35	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:36	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:38	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:12:50	28 Aug 2012 (Local)	Passed	Checkpoint 4					
At	21:13:31	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:13:32	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:13:34	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:13:35	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:13:39	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:13:41	28 Aug 2012 (Local)	Passed	Checkpoint 5					
At	21:14:05	28 Aug 2012 (Local)	Passed	Checkpoint 6					
At	21:15:00	28 Aug 2012 (Local)	Passed	Checkpoint 8					
At	21:15:02	28 Aug 2012 (Local)	Passed	Checkpoint 8					
At	21:15:14	28 Aug 2012 (Local)	Passed	Checkpoint 8					
=====									

9.3.3 Test 3 Result Data Sheet

Time Stamp	Nurse	Drug Tray	Drug Plate Tag1	Drug Plate Tag2	Drug Plate Tag3	Drug Cup 1	Drug Cup 2	Drug Cup 3	Room 1	Patient 1	Room 2	Patient 2	Room 3	Patient 3
29/08/2012 20:09:57	0	0	0	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:09:58	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:09:59	1	0	0	0	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:00	0	0	1	0	1	1	0	0	0	0	0	0	0	0
29/08/2012 20:10:01	0	1	1	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:02	0	1	1	0	1	1	1	0	0	0	0	0	0	0
29/08/2012 20:10:03	0	0	0	0	1	1	0	1	0	0	0	0	0	0
29/08/2012 20:10:04	0	1	1	0	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:05	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:06	0	1	1	0	1	0	0	0	0	0	1	0	0	0
29/08/2012 20:10:07	0	1	0	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:08	0	0	1	0	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:09	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:10	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:10:11	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:12	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:13	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:14	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:10:15	0	0	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:16	0	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:17	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:18	0	0	0	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:19	0	1	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:10:20	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:21	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:22	0	0	0	1	0	0	0	0	1	0	0	0	0	0
29/08/2012 20:10:23	1	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:24	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:25	1	0	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:26	0	1	0	1	0	0	1	0	1	0	0	0	0	0
29/08/2012 20:10:27	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:28	0	0	1	1	0	1	1	0	0	0	0	0	0	0
29/08/2012 20:10:29	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:30	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:31	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:32	0	0	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:33	0	1	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:34	0	1	1	1	0	0	1	0	1	0	0	0	0	0
29/08/2012 20:10:35	0	0	0	1	0	1	0	0	0	0	0	0	0	0
29/08/2012 20:10:36	0	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:37	0	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:38	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:39	0	0	1	0	1	1	1	1	0	0	0	0	0	0
29/08/2012 20:10:40	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:41	0	0	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:42	0	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:44	0	1	0	0	0	1	0	0	0	0	0	0	0	0
29/08/2012 20:10:45	0	1	1	0	1	1	1	1	0	0	0	0	0	0
29/08/2012 20:10:46	0	1	0	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:10:47	0	0	1	0	0	1	0	0	0	0	0	0	0	0
29/08/2012 20:10:48	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:10:49	0	1	0	1	0	0	1	0	1	1	0	0	0	0
29/08/2012 20:10:50	0	0	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:10:51	0	1	1	1	1	0	1	0	1	1	0	0	0	0
29/08/2012 20:10:52	0	1	0	1	0	0	0	0	1	1	0	0	0	0
29/08/2012 20:10:53	0	0	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:54	0	1	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:10:55	0	0	1	0	1	0	0	0	0	1	0	0	0	0
29/08/2012 20:10:56	0	1	0	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:10:57	0	1	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:10:58	0	1	1	0	0	0	0	0	1	0	0	0	0	0
29/08/2012 20:10:59	0	0	0	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:00	0	1	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:11:01	0	0	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:02	0	1	0	0	0	0	0	0	1	0	0	0	0	0
29/08/2012 20:11:03	0	0	1	1	1	0	1	0	1	1	0	0	0	0
29/08/2012 20:11:04	0	1	0	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:05	0	0	1	0	0	0	0	0	1	0	0	0	0	0
29/08/2012 20:11:06	0	1	1	1	1	0	1	0	0	0	0	0	0	0

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29/08/2012 20:11:07	0	1	1	0	0	0	1	0	1	1	0	0	0	0
29/08/2012 20:11:08	0	0	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:09	0	1	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:10	0	1	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:12	0	1	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:13	0	1	1	1	1	0	1	0	1	1	0	0	0	0
29/08/2012 20:11:15	1	1	1	1	1	0	0	0	1	0	0	0	0	0
29/08/2012 20:11:16	0	1	0	1	1	0	1	0	1	0	0	0	0	0
29/08/2012 20:11:17	0	0	1	0	0	0	0	0	0	1	0	0	0	0
29/08/2012 20:11:18	1	1	0	1	0	1	0	1	0	1	0	0	0	0
29/08/2012 20:11:19	0	0	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:11:20	0	1	0	0	0	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:21	0	1	1	1	1	1	1	0	0	1	0	0	0	0
29/08/2012 20:11:22	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:23	0	1	0	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:11:24	0	0	1	1	1	0	1	0	1	1	0	0	0	0
29/08/2012 20:11:25	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:26	0	1	1	1	0	1	1	1	0	0	0	0	0	0
29/08/2012 20:11:27	0	1	1	1	1	1	1	0	0	1	0	0	0	0
29/08/2012 20:11:29	0	1	1	1	1	1	1	0	1	0	0	0	0	0
29/08/2012 20:11:30	0	1	0	1	0	1	0	0	0	0	0	0	0	0
29/08/2012 20:11:31	0	0	1	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:11:32	0	1	0	1	1	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:33	0	1	1	1	0	0	0	1	0	1	0	0	0	0
29/08/2012 20:11:34	0	0	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:11:35	0	1	1	1	0	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:36	0	0	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:37	0	1	0	1	1	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:38	0	1	1	1	1	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:39	0	0	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:40	0	1	1	1	0	0	0	0	0	1	0	0	0	0
29/08/2012 20:11:41	0	1	1	0	1	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:42	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:43	0	1	1	0	1	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:44	0	0	1	1	0	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:45	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:46	0	1	1	1	1	0	0	1	0	1	0	0	0	0
29/08/2012 20:11:47	0	1	0	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:11:48	0	0	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:11:49	0	1	0	1	1	0	1	1	0	1	0	0	0	0
29/08/2012 20:11:50	0	0	1	1	1	1	1	0	1	0	0	0	0	0
29/08/2012 20:11:51	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:11:52	0	1	1	1	1	0	1	0	0	1	0	0	0	0
29/08/2012 20:11:53	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:11:54	0	1	0	0	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:11:55	0	0	1	1	1	0	0	0	0	1	0	0	0	0
29/08/2012 20:11:56	1	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:11:57	0	1	0	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:11:58	1	0	1	0	1	0	0	0	0	1	0	0	0	0
29/08/2012 20:11:59	1	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:01	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:02	0	1	1	0	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:03	0	1	0	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:04	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:05	0	1	1	1	1	0	1	1	0	0	1	0	0	0
29/08/2012 20:12:06	0	0	0	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:07	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:08	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:09	0	1	0	1	0	0	1	1	0	0	1	0	0	0
29/08/2012 20:12:10	0	0	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:11	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:12	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:14	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:15	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:12:16	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:17	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:18	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:19	0	1	0	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:12:20	0	0	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:21	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:22	0	0	0	1	1	0	1	1	0	0	1	0	0	0
29/08/2012 20:12:23	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:24	0	1	1	1	1	0	1	1	0	0	0	1	0	0
29/08/2012 20:12:25	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:12:26	0	1	0	0	0	0	1	0	0	0	1	0	0	0
29/08/2012 20:12:27	0	1	1	0	1	0	0	1	0	0	0	1	0	0
29/08/2012 20:12:28	0	1	1	0	1	0	1	1	0	0	0	1	0	0
29/08/2012 20:12:29	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:30	0	1	0	1	1	0	1	1	0	0	0	1	0	0
29/08/2012 20:12:31	0	0	1	1	1	0	1	1	0	0	0	0	0	0

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29/08/2012 20:12:32	0	1	0	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:12:33	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:34	0	1	0	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:35	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:36	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:37	0	1	1	1	1	0	1	0	0	0	1	1	0	0
29/08/2012 20:12:38	0	0	1	0	0	0	1	0	0	0	1	0	0	0
29/08/2012 20:12:39	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:40	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:41	0	0	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:42	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:44	0	1	1	1	1	0	1	1	0	0	0	1	0	0
29/08/2012 20:12:45	0	1	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:46	0	0	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:47	0	1	1	0	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:48	0	1	1	1	1	0	1	0	0	0	0	1	0	0
29/08/2012 20:12:49	0	0	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:50	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:51	0	1	0	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:52	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:53	0	0	1	0	1	0	1	1	0	0	0	1	0	0
29/08/2012 20:12:54	0	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:55	0	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:56	0	0	0	1	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:12:57	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:12:58	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:12:59	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:00	0	0	0	1	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:01	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:02	0	0	0	1	0	0	0	0	0	0	1	0	0	0
29/08/2012 20:13:03	0	0	1	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:04	0	1	1	0	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:05	0	1	1	0	1	0	1	1	0	0	1	0	0	0
29/08/2012 20:13:07	0	1	1	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:08	0	1	1	1	1	0	1	1	0	0	1	0	0	0
29/08/2012 20:13:09	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:10	0	0	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:11	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:13	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:14	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:15	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:16	0	1	1	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:17	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:18	0	0	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:19	0	1	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:20	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:21	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:22	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:23	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:24	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:25	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:26	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:27	0	0	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:28	0	1	1	1	1	0	1	1	0	0	0	1	0	0
29/08/2012 20:13:29	0	1	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:30	0	1	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:31	0	0	0	0	1	0	0	0	0	0	0	1	0	0
29/08/2012 20:13:32	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:33	0	1	1	1	0	0	0	1	0	0	0	1	0	0
29/08/2012 20:13:34	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:36	0	1	1	1	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:37	0	1	0	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:38	0	1	1	0	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:39	0	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:40	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:41	0	0	1	1	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:42	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:43	0	0	0	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:44	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:45	0	1	1	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:46	0	1	0	1	1	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:47	0	0	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:48	0	1	0	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:49	1	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:51	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:52	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:53	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:13:54	0	0	1	0	0	0	1	0	0	0	0	0	0	0
29/08/2012 20:13:55	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:13:56	1	0	0	0	1	0	0	0	0	0	0	0	0	0

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29/08/2012 20:13:57	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:58	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:13:59	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:00	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:01	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:02	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:03	1	1	1	1	0	0	1	1	0	0	0	0	0	0
29/08/2012 20:14:04	0	0	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:05	0	1	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:06	0	1	1	1	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:14:07	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:08	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:09	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:10	0	1	0	0	1	0	1	1	0	0	0	0	0	0
29/08/2012 20:14:11	1	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:12	0	0	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:13	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:14	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:15	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:16	0	1	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:17	0	0	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:18	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:19	0	1	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:20	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:22	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:23	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:24	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:25	0	1	0	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:26	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:27	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:28	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:29	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:30	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:31	0	1	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:32	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:33	0	1	0	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:34	0	1	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:35	0	0	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:36	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:37	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:38	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:39	0	1	1	1	0	0	0	1	0	0	0	0	1	0
29/08/2012 20:14:40	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:41	0	0	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:42	0	1	1	0	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:14:43	0	0	1	1	0	0	0	0	0	0	0	0	1	0
29/08/2012 20:14:44	0	1	0	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:45	0	0	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:46	0	0	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:47	0	0	0	1	1	0	0	0	0	0	0	0	1	0
29/08/2012 20:14:48	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:49	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:50	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:51	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:52	0	1	0	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:53	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:54	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:55	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:56	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:57	0	1	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:14:58	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:14:59	0	0	1	1	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:00	0	1	1	0	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:01	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:02	0	1	0	1	0	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:03	0	1	1	1	1	0	0	1	0	0	0	0	1	1
29/08/2012 20:15:04	0	0	0	1	1	0	0	1	0	0	0	0	0	1
29/08/2012 20:15:05	0	1	1	0	0	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:06	0	1	1	0	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:07	0	1	1	1	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:09	0	1	1	1	1	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:10	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:11	0	0	1	1	1	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:12	0	1	0	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:13	0	1	1	1	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:14	0	1	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:15	0	0	0	1	1	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:16	0	1	1	1	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:17	0	0	1	0	1	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:18	0	1	0	1	0	0	0	1	0	0	0	0	0	0

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29/08/2012 20:15:19	0	1	0	0	1	0	0	0	0	0	0	0	1	0
29/08/2012 20:15:20	0	1	1	1	1	0	0	1	0	0	0	0	0	1
29/08/2012 20:15:21	0	0	0	1	0	0	0	0	0	0	0	0	1	1
29/08/2012 20:15:22	0	1	1	0	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:23	0	1	1	1	1	0	0	1	0	0	0	0	1	0
29/08/2012 20:15:25	0	1	1	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:26	0	1	1	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:27	0	1	1	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:28	0	1	1	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:29	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:30	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:31	0	0	0	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:32	0	1	1	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:33	0	1	1	1	0	0	0	0	0	0	0	0	0	1
29/08/2012 20:15:34	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:36	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:37	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:38	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:39	0	0	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:40	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:41	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:42	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:43	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:44	0	1	1	0	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:45	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:46	0	1	0	1	1	0	0	0	0	0	0	0	1	1
29/08/2012 20:15:47	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:48	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:49	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:50	0	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:51	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:52	0	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:53	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:54	0	1	1	1	0	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:55	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:56	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:57	0	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:15:58	1	1	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:15:59	0	0	1	1	1	0	0	1	0	0	0	0	0	0
29/08/2012 20:16:00	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:01	1	1	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:02	0	0	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:03	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:04	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:05	1	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:06	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:07	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:08	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:09	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:11	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:12	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:13	1	0	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:14	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:15	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:16	1	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:17	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:18	1	0	0	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:19	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:20	1	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:21	0	1	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:22	1	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:23	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:25	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:26	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:27	0	1	0	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:28	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:29	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:30	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:31	0	0	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:32	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:33	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:34	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:35	0	0	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:36	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:37	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:38	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:39	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:40	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:41	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:16:42	0	1	1	1	1	0	0	0	0	0	0	0	0	0

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29/08/2012 20:19:32	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:34	0	0	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:35	1	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:36	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:37	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:38	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:39	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:41	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:42	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:43	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:45	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:46	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:47	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:48	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:49	1	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:50	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:51	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:52	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:53	1	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:54	0	0	0	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:55	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:56	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:57	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:58	0	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:19:59	0	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:00	0	1	1	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:01	0	1	1	0	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:02	0	1	0	1	1	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:03	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:04	1	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:05	1	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:06	1	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:07	1	1	1	0	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:08	1	1	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:09	0	0	1	1	0	0	0	0	0	0	0	0	0	0
29/08/2012 20:20:10	1	1	1	1	0	0	0	0	0	0	0	0	0	0

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Checkpoint Info
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At 20:12:51 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:12:59 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:13:02 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:15:13 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:23 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:26 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:27 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:30 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:32 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:33 29 Aug 2012 (Local) Passed Checkpoint 5

At 20:15:48 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:15:49 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:15:51 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:15:51 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:15:54 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:16:13 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:16:15 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:16:19 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:16:21 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:16:23 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:16:44 29 Aug 2012 (Local) Passed Checkpoint 4

At 20:18:01 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:03 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:04 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:06 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:08 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:11 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:12 29 Aug 2012 (Local) Passed Checkpoint 6

At 20:18:55 29 Aug 2012 (Local) Passed Checkpoint 7

At 20:19:07 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:09 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:10 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:11 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:13 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:14 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:16 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:17 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:35 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:37 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:41 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:43 29 Aug 2012 (Local) Passed Checkpoint 8

At 20:19:46 29 Aug 2012 (Local) Passed Checkpoint 8

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Checkpoint Info
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