EFFICIENT AUTONOMOUS AIRLINE MANAGEMENT SYSTEM (EA-AMS)

By

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CERTIFICATE

It is certified that the contents and form of thesis entitled “Efficient Autonomous Airline Management System (EA-AMS)” submitted by Ms. Rahila Nadir have been found satisfactory for the requirement of the degree.

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DEDICATION

I dedicate this project to My Parents, my siblings, my committee panel, especially my advisor, Sir Nauman Qureshi. It is due to his efforts and support that enabled me to complete my tasks.

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I am thankful to my friends who have supported me in every capacity they could.

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LIST OF ABBREVIATIONS

Abbreviation	Definition
AIDC	Automatic Identification and Data Capture
AUTO-ID	Automatic Identification
CAGE	Commercial and Government Entity
DoD	Department of Defense
EPC	Electronic Product Code
EPCIS	Electronic Product Code Information Service
RFID	Radio Frequency Identification
ROI	Rate of Interest
SGTIN	Serialized Global Trade Identification Number
UHF	Ultra High Frequency
WORM	Write Once Read Many

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ABSTRACT

The airline management system in Pakistan is vulnerable in the face of unexpected and erroneous situations. It has been seen that the biggest problem that airlines face today is the accurate tracking of passengers and luggage on the airports therefore a solution to this problem has become necessary considering the enhancements in the IT field.

The solution proposed provides a complete automation of the airline management system for the operational cycle of a passenger beginning from scheduling and booking a flight to reaching the correct destination with his luggage. This solution has integrated web services with the RFID technology for locating items and passengers on the airport.

RFID stands for Radio-Frequency Identification. It is the process of putting “tags” on objects so that they can be identified and tracked automatically through the RFID Equipment (antennas and readers) communicating and transferring data to the host computers. The data on the tag is a unique identification number which can be customized as per the requirements of the system. The tags are read by RFID readers when they enter their vicinity and the data is then transferred to the databases in the host computers for further processing [1].

The system designed consists of two modules. The first provides an airline management web-service allowing passengers to book flights, search for schedules, track their luggage location and purchase an e-ticket from the website. The second module caters to the security and reliability issues on the airport; tracking of luggage and passengers through RFIDs. Thus the solution will increase the efficiency of the airline management system in real time.

Chapter 1

INTRODUCTION

1.1 BACKGROUND

In recent years, the Auto-ID technology has made waves in fields like supply chain management, asset tracking, pharmaceutical industry and inventory management. Auto-ID techniques can track and capture information regarding anything tagged within its vicinity. [9]

Barcode labels were the initiators in the identification technologies. However with the increasing demand of efficiency and power; they have taken a backseat since they have a low storage capacity and are not reprogrammable.

The solution to these problems has been provided by the RFID technology. This technology provides us with the flexibility of a contactless transfer of data and power between the tags and the reader; thus we can classify it as a wireless automatic identification and data capture (AIDC) technology. Thus we can say that they are intelligent barcodes that can talk to a networked system to track any sort of product, person or thing.

The RFID standards are published and managed by several organizations. The foremost standard that is applied is the EPCglobal standard. This is the dominant standard for US and UK and this has created a single market place providing compatibility among readers, tags and encoded printers etc. This standard is further elaborated in chapter two. The US DoD has adopted this standard for the tracking and identification of military equipment being transferred and shipped from different suppliers. They made it a rule that the items sold to them are to be marked with a passive RFID Tag so that these items could be identified and tracked. They have also adopted the EPC Global standard for the coding of tags. However in

case the supplier is not a member of the EPCGlobal, the DoD RFID encoding scheme is based on CAGE (Commercial and Government Entity). This is based on the five byte alphanumeric string assigned by the government and uses only thirty bits for identification [1]. Thus EPC Global is the general standard adopted in manufacturing, warehousing, asset tracking, airlines etc.

1.2 PROBLEM TO BE SOLVED

The airline system of Pakistan has been working on the predefined traditional procedures for decades with very little improvement in the management system. The system gives very little importance to the tracking and security requirements of air travel and therefore is prone to mishaps such as losing of a bag or suitcase while traveling. To make this system more efficient, reliable and secure an RFID tag based system has been designed that provides us with a baggage and cargo tracking system and a secure boarding and check-in system so that no mishaps can occur and no person can escape the RFID readers thus assuring a safe and secure environment. The main aim of this project is to design an efficient autonomous airline management system that integrates RFID technology with the current airline management system for an optimal solution to all problems of air travel. For this purpose first an airline management system has been designed so as to provide the services of booking, reservation and scheduling; and an RFID system that tracks traveling passengers, cargo and luggage.

1.3 PROBLEM STATEMENT

“To design an ”Efficient Autonomous Airline Management System” using RFIDs for the reservation, scheduling and tracking of passengers as well as luggage”

The objective of this project is to provide a robust and scalable autonomous system for the management of Pakistan Airlines and this will be achieved through the RFID technology. The project caters to the requirements of an efficient ticketing, baggage and cargo system.

Chapter 2

LITERATURE REVIEW

In the early times when humans had to identify and distinguish objects based on what they observed about the characteristics of these individual objects, they often marked objects that seemed identical in order to distinguish them. This is where the concept of bar coding came from and hence they were globally used for identification purposes. However after a while it was realized that barcodes had many drawbacks and therefore had limited uses. [10]

RFID is the next generation wireless communication technology which can be applied to a number of fields such as distribution, transportation, tracking etc for the classification and organization of physical objects. It is a valuable business and technology tool and offers us unique identification technique for each and every individual item it is attached to. RFID has become this popular in the past few years because it offers strategic advantages for businesses such as tracking of inventory, tracking of humans, and monitoring of valuable assets for all sorts of companies and organizations.

2.1 BASIC COMPONENTS OF RFID SYSTEM

An RFID system is made up of the following components:[1]

2.1.1 Tag

It is a microchip transponder which holds a unique identification number that is contained in the tag's memory and this number is used for identification of objects which are to be attached to it. The coupling element used is the tag's antenna. There are basically two types of tags, active and passive which will be discussed later but the ones being used in this project are passive since they fulfill the requirements of the project. .

2.1.1.1 Tag Types:

2.1.1.1.1 Active Tags:

Active tags contain a microchip which has its own processing power and a battery which basically transmits signals to the reader antenna; this antenna transmits signals and receives the reader's replies, an onboard power supply so that it has its own power and does not depend on the reader and finally an onboard electronics power supply such as microprocessors, sensors etc which allow it to perform the specialized tasks.

These tags can either work by emitting a signal after specific intervals or they can transmit only when addressed by a reader, it depends on the battery power of the system. Active tags have a lot of processing power so they can have a number of properties. Therefore a few of the active tags uses could be for example in generating averages for temperature by detecting surrounding temperatures through the sensors attached to them.

Active tags are always the first ones to communicate when communicating with the reader. There are basically two types of active tags; a transmitter continuously transmits data with or without the presence of the reader whereas the second type of active tag known as the transponder goes into sleep mode when there is no reader around thus this way the battery power is saved.

2.1.1.1.2 Passive Tags

A passive tag has a microchip which does the processing and an antenna for receiving the signals from the readers.

A passive tag does not have a built-in power source so it cannot transmit on its own, it uses the power emitted from the reader in order to energize itself and after that it

communicates and transfers its data to its reader. It is a simple tag to build and has no battery power to limit its life so it has a long life.

The communication between the tag and the reader in this case is initiated by the reader. Thus for a passive tag the presence of a reader is necessary for it to transmit data.

2.1.1.1.3 Semi Passive:

Semi passive tags are made of a power source (low cost battery) as an on tag sensor; however it in no way enhances the range. It works by sending data back to the reader just in the way that a passive tag does, however it does have its own power source to run the chip circuitry. It has the traits of active and passive tags both; it needs a reader to start communication and it also has a battery to supply energy to the tag. A semi-passive tag is also known as a battery-assisted tag. The range of such a tag is about a 100 feet.

2.1.1.1.4 Read-Only Tags:

These tags contain a unique ID which cannot be changed and we cannot write on these tags.

2.1.1.1.5 WORM:

This stands for write once, read many; the users can encode the tags when they use it for the first time but once done, the code is locked and therefore cannot be changed thus named WORM.

2.1.1.1.6 Read-Write:

This tag allows the user to both read and write. The tag's information can be updated as often as possible; updates can be of the sort through which we can detect whether the item has passed the reader or not

Table 2.1 RFID Tag Attributes [11]

	Active RFID	**Passive RFID**
Tag Power Source	Internal to tag	Energy transferred using RF from reader
Tag Battery	Yes	No
Availability of power	Continuous	Only in field of reader
Required signal strength to Tag	Very Low	Very High
Range	Up to 100m	Upto 3-5m, usually less
Multi-tag reading	1000s of tags recognized up to 100mph	Few hundred within 3m of reader
Data Storage	Up to 128Kb or readwrite with sophisticated search and access	128 bytes of read/write

Table 2.2 RFID Tag Shapes[18]

Label	A flat, thin flexible tag
Ticket	A flat, thin flexible tag on paper
Card	A flat, thin tag embedded in tough plastic for a long life
Glass bead	A small tag in a cylindrical glass bead, used for animal tagging
Integrated	Integrated into the object, tagging rather than applied as separate label, molded into object
Wristband	Tag inserted into a plastic wrist strap
Button	Tag encapsulated in a rigid housing to protect from damage

2.1.2 Reader

A reader is basically a transceiver, it sends out a signal at a specific frequency. A reader will use its antennas to fuel tags, read their data and transmit it through a network to a host computer. The reader is also used to write data to the tags so readers are basically readers and writers both. The reader transmits a simple query and the tags transmit the results as its contents. The reader sends authentication information and the commands through radio waves

and the receiver detects the signal, authenticates the message and uses its antenna to send back its responses. Various important factors on which the performance of RFID Tags depends are identification range, identification rate, read range, read rate, write range and write rate.

The RFID Readers come in 3 configurations: stationary (fixed), handheld and mounted and the way they work is well explained by their names.

Readers operate in two modes namely autonomous and interactive mode. In autonomous mode the reader reads the tag which is in its zone and instantly transmits data to the host. In the interactive mode the reader stores the tag records until the host demands for it to be uploaded. The end user sends commands to the reader to for e.g. read the tag list and based on that the host system will update its internal mode of operation. The information contained in these tags usually includes stuff like:

- The tag identifier
- The date/time tag was first read
- The number of times the tag was read
- Which antenna was used to read the tag
- The name of the reader

The reader being used in this project is the Alien Reader.

Fig 2.1 RFID Reader[15]

2.1.3 Antenna

Antennas work by converting energy from electricity into radio waves. The readers and tags have antennas. A reader generates electricity which contains data and instructions and is fed to an external antenna. The antenna converts these signals to radio waves and broadcasts them. Now the tag's antenna converts these radio signals back to electricity to power the embedded IC chip in the tag and the data and instructions are decoded. Finally the tags generate a response through their own antenna

Fig 2.2 RFID Antenna[16]

2.1.4 Connectors

Connectors are used to connect cables to the readers and the antennas. They are to be handled with care as they are an important part of the design and any minute changes can cause a lot of imbalances.

2.1.5 Frequency Ranges

2.1.5.1 Low Frequency RFID Systems

Standard : The communication is governed by ISO 18000-2.

Frequency Range: The low frequency RFID range is between 125-134 kHz.

Range/Distance: Low frequency tags can be read to distances of about 20 inches.

Current Applications: They have slow tag-read rates but this does not become a problem as their current applications are in animal tagging, access control etc.

Storage Capacity: LF Tags store upto 60 characters

Opaque Materials: These waves can penetrate opaque materials and therefore are ideal in environments containing dirt, snow or mud.

2.1.5.2 High Frequency RFID Systems

Standard: ISO/IEC 18000 Part 3, ISO 15693

Frequency Range: The high frequency RFID range is between 13.5-15.57 MHz.

Range/Distance: High frequency tags can be read to distances of about 1 meter.

Current applications: They are widely used in smart cards, access control, libraries etc.

Opaque Materials: They are a little susceptible to opaque materials

2.1.5.3 Ultra High Frequency based RFID System

Standard: The communication is governed by ISO/IEC 18000-6.

Frequency Range: The RFID range is between 860-930 MHz.

Range/Distance: These tags can be read to distances of about 4-5-meters.

Current Applications: They are currently being used for supply chain management, asset management, electronic toll collections etc.

Opaque Materials: These waves are susceptible to opaque materials

2.1.5.4 Microwave RFID Systems

Standard: The communication is governed by ISO 18000-4.

Frequency Range: The RFID range is between 2.4-2.4835 GHz and 5.8 GHz.

Range/Distance: Microwave tags can be read to distances of about 10 meters.

Current applications: They are being used for security, access control and work tracking for factory automation

Storage Capacity: The storage capacity of these tags is up to 16000 characters

Opaque Materials: These waves are very susceptible to opaque materials

Table 2.3 RFID Tag Frequencies and Applications[12]

Frequency Range	**LF 125KHz**	**HF 13.56 MHz**	**UHF 868-915 MHz**	**Microwave 2.45 GHz & 5.8GHz**
Typical Max Read Range (Passive Tags)	<0.5m	~1m	~3m	~1m
General Characteristics	Relatively expensive, even at high volumes. Low frequency requires a longer, more expensive antenna. Least susceptible to performance degradations from metal and liquids, though read range is short.	Less expensive then inductive LF tags. Relatively short read range and slower data rates when compared to higher frequencies. Best suited for applications that do not require long range reading of multiple tags.	In large volumes, UHF Tags have the potential for being cheaper than LF and HF tags due to recent advances in IC design. Offers good balance between range and performance especially for reading multiple tags.	Similar characteristics to the UHF tag but with faster read rates. A drawback to this band is that microwave transmissions are most susceptible to performance degradations due to metal and liquids. Offers directional signal.
Tag Power Source	Generally passive tags only, using inductive coupling	Generally passive tags only, using inductive or capacitive coupling.	Active tags with integral battery or passive tags using capacitive, E-field coupling	Active tags with integral battery or passive tags using capacitive, E-field coupling
Typical Applications Today	Access control, animal tracking, vehicle immobilizers, POS, applications including SpeedPass	"Smart Cards", Item-level tracking including baggage handling (non-US), libraries	Pallet Tracking, electronic toll collection, baggage handling(US)	SCM, electronic toll collection
Notes	Largest install base due to the mature nature of low frequency, inductive transponders	Currently the most widely available high frequency worldwide, due mainly to the relatively wide adoption of smart cards	Japan does not allow transmissions in this band. Europe allows 868 MHz whereas the US permits operations 915 MHz, but at higher power levels	
Data Rate	Slower ⟷ Faster			
Ability to read near metal or wet surfaces	Better ⟷ Worse			
Passive Tag Size	Larger ⟷ Smaller			

2.2 The EPC Global Network [1]

The EPC Global Network is a platform which enables the identification, tracking and tracing of objects in a lot of industries.

The key components of the EPCglobal Network are :

- The Electronic Product Code(EPC)
- The ID system
- EPC Middleware
- EPC Information Services

2.2.1 Electronic Product Code (EPC)

The electronic product code is basically a standardized number which is used for identification of an object or thing. It is a number like for eg a license plate number or the national identity card number which uniquely identifies you or your things. The information stored in an EPC is accessible only to people who are using the readers to detect the identification number. The information stored in an EPC is usually the company name, product information, history, expiration date etc. The EPC is used to identify each individual object so that identical objects or boxes can be separated from one another.

The structure of EPC makes its use very flexible. There are basically two fields, the header and the value field. The length, structure and the functions of the value fields are evaluated by the header value.

2.2.1.1 The Header

The header gives the overall length, the identity type and structure of the EPC tags encoding, explaining what encoding scheme has been followed by the header. Thus the header basically gives the overall structure information of the tag.

There are basically a few predefined encoding schemes used in the EPC Encoding schemes and an example is the 96-bit SGTIN encoding scheme. General structure of an EPC Tag encoded by the SGTIN Encoding scheme is as follows:

EPC example- 96-bit SGTIN tag

HEX representation from reader 30700048440663802E185523
Binary Representation
001100000111000000000000010010000100010000000110011001000000000000010111000011000010101010010
0011
URI representation after decoding

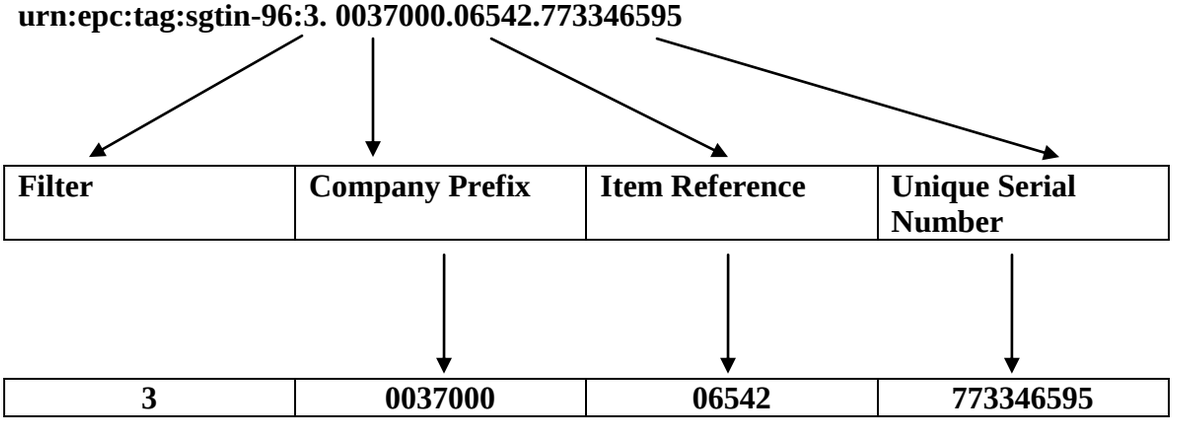


Fig2.3[17]

2.2.2 EPC Identification System

The ID system is used for classifying tags and readers and their mode of communication and the communication specification that is being used is the “air interface protocol”. The ID system provides the standardization of the tags and readers so that a tag from a vendor is compatible with a reader from another vendor but ofcourse from the same class. Thus this will open gates to a wide set of options for tags and readers and will provides greater flexibility.

2.2.3 EPC Middleware

The functions provided by the EPC Middleware help bridge the gap between the software applications and the software applications that use them. These functions are

- Resolving the EPC numbers by querying the ONS to track down the information about it.
- Obtaining all the raw data and converting it into useful information
- It converts/reformats the data in the form that your application needs

2.2.4 EPC Information Services

There are three main functionalities provided by the EPCIS

2.2.4.1 Object Naming Service (ONS)

The ONS contains an entry for every EPC that is registered, and through its pointers it can determine all the recognized sources of information about that EPC.

The ONS points to both static and dynamic information. Static information is basically the information on the object that wont be changed under any circumstances such as the weight of an object, manufacturer etc. Dynamic information is spread across a number of databases and the information is posted on and off by organizations using it.

2.2.4.2 EPC Information Service (EPCIS)

It stores information about items in a supply chain. Various companies are involved in the EPCIS storing and controlling of information and thus each pursues its own business model.

The language used for the storing of data is the PML (Physical Markup Language). This is a language used for describing physical objects in XML. It basically enables the organization and storage of the relevant information about a product such as the location information etc.

2.2.4.3 EPC Discovery Service (EPCDS)

Contains the directory of all EPCIS servers holding information regarding a particular item.

2.3 RFID AND BARCODES COMPARISON [1]

We are all familiar with bar codes, however there are quite a few reasons as to why RFIDs are replacing the bar code technology. Following are the benefits of RFIDs over Bar Codes:

- Bar Codes once printed cannot be modified whereas the RFID read/write tags can be modified after they have been written to.
- A bar code scanner needs a good line of sight to read a tag whereas there is no line of sight requirement in the case of RFIDs thus increasing the pace at which work is being done and also providing more security to the system
- Barcodes usually require to be within a few feet of the scanner, whereas RFID Tags and specializing among them, the UHF tags can be read at distanced of about 20 feet or so
- The storage capacity of the RFID Tags is much more then bar codes since they have IC in them
- Multiple tags can be read at one time whereas only one bar code can be scanned at one time
- RFID Tags survive better in severe weathers and conditions whereas a barcode would not be able to be read
- RFID Tags can be programmed to do a lot of important tasks such as performing calculations, recording sensor readings etc.

2.4 RFID APPLICATIONS

2.4.1 Case Study One

Mc Carran Airport is situated in Las Vegas and is considered to be one of the busiest airports in the Unites States. Before the use of RFID Technology, they were using barcodes for the tracking of luggage and they were facing the problem of misreading the codes to almost thirty percent [1]. The EPC global standard was used to integrate RFID systems integrator and software developer with the automated baggage handling system through a middleware. The tags were encoded with an EPC Global Serialized Bag Number and the encoding was done by including a one-digit prefix that classified the tag, a three digit airline code and a six digit serial number that identified the bags uniquely which was then translated into the EPC numbering scheme [4].

The deployment of this project elevated the accuracy of tag reading to over ninety nine percent thus increasing efficiency and lowering the operational costs boosting the overall ROI for McCarran [5].

2.4.2 Case Study Two

The Hong Kong International Airport is known to be one of the busiest airports in the world. Annually, the airport caters to about 38 million passengers and handles about 3 million tons of air cargo. It manages about 50 takeoffs and landings per hour at its peak and forty percent passengers have transit flights from this airport. The reader systems are installed to read and write to the RFID tags to provide baggage handling facilities. Different sorts of readers were installed to read and write the RFID tags applied to the passenger tags. The system installed ensured fast turn around times for flights with the delivery of the right bag to the right plane at the right time. [5] This system also implemented the EPC encoding scheme

and conducted tests which showed how efficient the system had become after the implementation of RFID technology [6].

A few other cases have been found in the reference document [6] and based on the tests conducted on various airports is became clear that the use of RFID Technology in airline management systems improved the efficiency by almost ninety nine percent.

Chapter 3

REQUIREMENT SPECIFICATIONS

This section is dedicated to explaining the requirements of the project and the aspects covered in the project.

3.1 PROJECT SCOPE

The project basically consists of two modules. The first module covers the web development part and it consists of a complete website providing a booking and reservations system through which a person books a seat on a particular flight; a scheduler that schedules a person's flight based on the source, destination and date information entered by the passenger handling international, national and transit flights; tracking of luggage and cargo through the website and finally the generation on an e-ticket to the passenger traveling through the airline. A database in Microsoft Access is used at the backend which allows us to save and retrieve information and allows correspondence with the software application and the RFID system.

The second module is the RFID module and consists of implementation of RFID reader application to read the RF Tags placed in the electromagnetic zone, storing this unique RFID Tag number against the particular reservation number for cargo and passengers in the database at the backend and maintaining checkpoints to update the location of passengers as well as cargo.

3.2 GOALS AND OBJECTIVES

The airline management system through RFIDs is designed to be used for the correct tracking of the luggage and cargo that is traveling through this airline and based on that airline traveling becomes more efficient and reliable. The software application enables fast and accurate baggage tracking and control system and this system allows baggage and travelers to

just go through the gates without having to wait in lines like the barcodes. This system is integrated with a strong database made in access to integrate the web service designed with the RFID system of readers and tags.

3.3 PRODUCT FEATURES

The key features of efficient autonomous airline management system (EA-AMS) are:

- A user friendly GUI that is easy to use and understand
- A reservation by a person by accessing the website online for a seat on a particular flight based on the schedule proposed by the passenger
- A search module to check the schedules of the flights
- After the reservation of the seat, the generation of an e-Ticket based on the information provided by the passenger
- A registration system through which special features such as extra miles provided to the user
- The RFID tag generation for the passenger and the luggage carried by the passenger
- RFID tag assignment to the cargo that is booked by a customer
- The tracking of the luggage and the cargo
- The association of the tag with the person who is carrying the luggage
- The placement of luggage in the correct aircraft through the verification of the readers at the carousals and the gates
- The check on whether the passenger in boarding the correct aircraft through the RFID tag associated with the passenger’s boarding pass
- The printing of e-tickets by the passengers by registration online
- The generation of alert in case luggage is boarded in the wrong aircraft

- The generation of alert in case a passenger boards the wrong aircraft
- Viewing of reports on luggage and passengers
- The interface for the administrator to manage the databases and modify them

3.4 PRODUCT LIMITATIONS

The limitations of the application are:

- Application is Windows based and uses 3 Tiered Client Server architecture.
- The application development environment can be Microsoft Development Studio series of tools but it can be used with as many languages as ALIEN's API allows.
- The application is scalable so that it can be used for deployment in an airline system
- The DLLS are used by the host PC in order to communicate with the ALIEN 9800 hardware equipment through LAN

3.5 PERFORMANCE REQUIREMENTS

3.5.1 Reliability

The system should be error prone, meaning it should never crash in face of a problem. Unless a task is completed, such as reservation, the system should not save the data as that data would be incomplete data.

3.5.2 Data Access

Since this is a desktop application, the data is to be accessed through the application that runs on a PC. The server will access the data through business objects. The business objects access the database using ADO technology.

3.5.3 Security

- The system is to determine the access rights of the users when they login based on their login and password

- The data in the databases should be allowed to be modified only by the administrator
- The administrator shall be able to edit the flight and airport info in the database

3.5.4 Portability

The software is to run on Windows platform. Considering long term deployment of this system is to be done in airlines, the current airline systems are also running on Windows platform so this is not going to create a problem.

3.6 PROJECT CONSTRAINTS

3.6.1 Regularity Issues

There are no regulations from the government of Pakistan for setting up radio frequency identification systems in tracking of airline luggage and passengers. This system has already been deployed in Chen One outlets.

3.6.2 Criticality of Application

This system is basically designed to assure complete reliability and security of luggage and passengers traveling. Looking at the current situation of Pakistan, lives of people are threatened and no one can be trusted, therefore the system is to maintain a tight security system and check on every passenger

3.6.3 Security Issues

Security has to be maintained for this application so that only allowed people can view and change the information

Chapter 4

TOOLS AND TECHNIQUES

4.1 OPERATING ENVIRONMENT

The efficient autonomous airline management system through RFID is hosted on a server that runs on Microsoft Windows 2000 Server. The Windows version that can be used is Windows 2000 or higher.

4.2 DEVELOPING ENVIRONMENT

4.2.1 Visual C#

The application's development environment is only Microsoft Development Studio version 2005 series of tools and can be used with Microsoft Visual C#. The ALIEN RFID readers and tags used for this project have supporting APIs for quite a few languages but the most suitable for this project was ASP.NET C#.

4.2.2 Microsoft Access

The application is window based using three tiered Client Server architecture. The server stores system and user data using Microsoft Access so that the data between the client and the server is secure. On the client side Microsoft Internet Explorer is required for logging on to the web service. In a three tier architecture, a middle tier was added, the business layer between the interface for the users and the database being maintained at the backend[3].

The Microsoft Access provides innovative capabilities to increase employee effectiveness. This server has the lowest implementation and maintenance costs in the industry. Thus we can conclude that it is a benchmark for scalability, speed and performance.

4.3 HARDWARE

The RFID equipment used in this project is provided by ALIEN Technology USA. The equipment included in the package are:

- One RFID Reader
- One RS-232 serial cable (for the connection to host computer)
- One power supply and cord
- The ALIEN RFID Fixed Reader Software Developer's Kit and User Documentation CDROM
- Alien RFID Gateway Application

4.3.1 RFID Reader

The specifications of the RFID Reader are given in the table below:

Table 4.1 RFID Reader [13]

Name	Alien Multi-Port General Purpose RFID Reader
Model Number	ALR 9800
Architecture	Point-to-multipoint reader network, multi-static
Operating Frequency	902.75 MHz – 927.25 MHz
Hopping Channels	50
Channel Spacing	500 KHz
Channel Dwell Time	< 0.4 Seconds
RF Transmitter	< 30 dBm at the end of 6 m LMR-195 cable.
Modulation Method	On Off Keying (OOK)
20 db Modulation Bandwidth	< 400 KHz
RF Receiver	2 Channels
Power Consumption	45 Watts (120 VAC at 600 mA)
Communications Interface	RS-232 (DB-9 F), TCPI/IP (RJ-45)
Inputs/Outputs	2 or 4 coax antenna, 4/8 optically isolated, com port, LAN, power
Dimensions	(L) 9.0" (22.9 cm) x (W) 11" (28 cm) x (D) 2.22" (5.6 cm)
Weight	Approximately 1.8 kg (4 lb)
Operating Temperature	0°C to +50°C (+32 °F to +122°F)
LED Indicators	Power, Link, Active, Ant0-3, CPU, Read, Sniff, Fault (red)
Software Support	APIs, sample code, executable demo app (Alien Gateway)
Compliance Certification	FCC Part 15 (Pending)

4.3.2 Alien RFID Antenna

The specifications of the antenna are:

Table 4.2 RFID Antenna [14]

Model	ALR-9610-BC
3 dB Beamwidth	E-plane: 65 degrees • H-plane: 65 degrees
Frequency	902-928 MHz
Gain (dBi)	5.73 dBi
Polarization	Circular
RF Connector	6 m LMR-195 with Reverse-Polarity TNC
VSWR	1.5:1
Dimensions	(cm) 22 x 27 x 4 • (in) 8.5 x 10.5 x 1.65
Weight	.57 kg • 1.25 lb

4.4 ALIEN RFID TAG

The tags used are UHF RFID Tags used for this project. It has 96 bits of EPC code which is a unique code assigned to each tag. These tags are passive tags so that once used these tags can be disposed off as the tags used for this project are basically assigned to luggage and boarding passes and once these passengers reach their destinations new tags are used. There are trillions of combinations of these EPC Tags that are generated and that is why we have a lot of options for combinations of the unique numbers generated.

Class 1 tags are to be used for this project. In this 96 bits tag, 64 bits are user-programmable and 32 bits are controlled by the reader to record state and the checksum information which is stored inside the tag.

4.5 BANDWIDTH AND DATA TRANSFER RATES REQUIRED

The RS-232 cable is connected to the serial port on the PC and the settings required for it are 115200 Bits per second, 8 data bits, 1 stop bit and no parity and no flow control. Generally speaking the higher the frequency, the higher the data transfer or throughput rates

that can be achieved. And wavelength (bandwidth) is inversely proportional to frequency and that is why the higher the frequency the lower the bandwidth.

Chapter 5

DESIGN

5.1 ARCHITECTURAL DIAGRAM

The architectural diagram given below explains how the components and users of the system interact with each other. There are three different users of the system. The administrator who is basically in charge of the overall system and its working and maintenance and management; then the user who interacts with the system in order to access the website and make reservations, see schedules etc and finally the check-In agent who is sitting on the check-In counter and is interacting with the hardware component of the system, RFID Reader and the tags. The Administrator and the user interact with the system through the GUI interface which has the web server working at the backend. The web server basically connects the central database with the GUI friendly interface provided to the users of the system. The RFID terminal is also connected to the web server and this web server basically translates the information read to the central database. The web server is the central unit through which all the parts of the system interact and communicate.

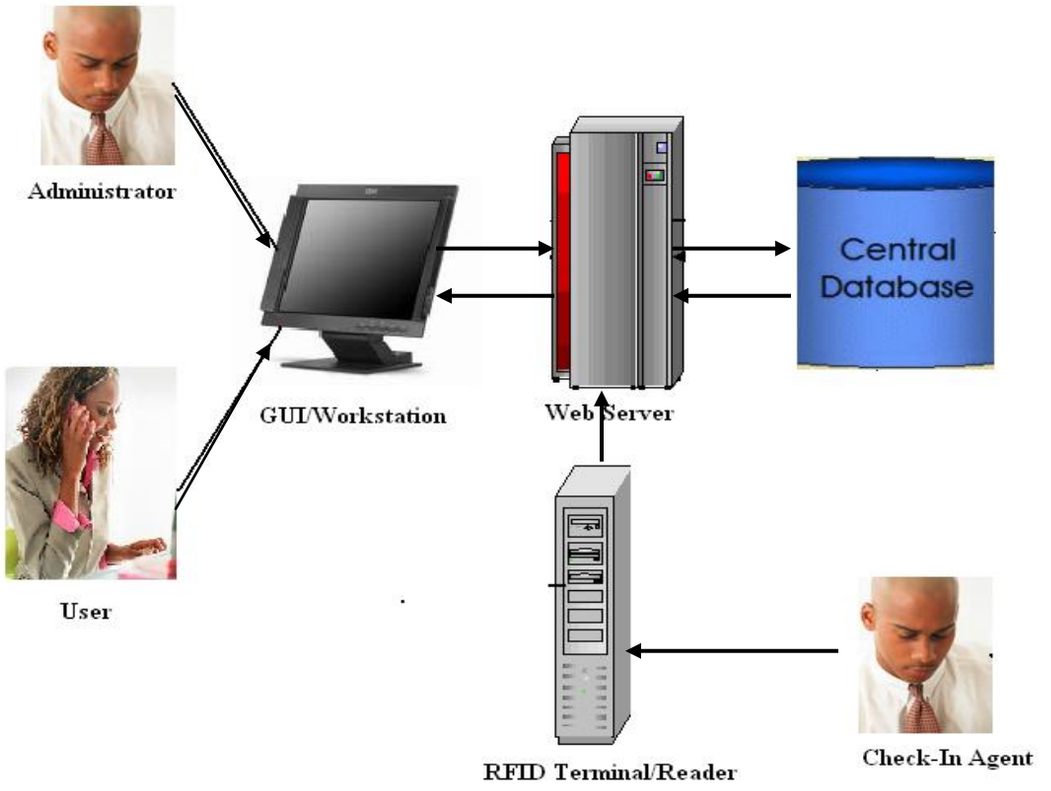


Fig 5.1 Architectural Diagram

5.2 LOGICAL ARCHITECTURE

The logical architecture of this system is based on the three tiered architecture. In this architecture a middle tier is added between user system interface client environment and the database management server environment. The middle tier is multi purpose; it can perform tasks from queuing to application execution to database staging [7]

ASP.Net uses the three tiered architecture. In this architecture the Web browser is the first layer. This layer is only concerned with the HTML returned from the Web Pages that it requests and it is not at all known to it as to how the business objects are functioning or how the database is returning or receiving values.

The second layer is the business object layer which compiles the components used in providing business logic to the ASP.NET Web Pages and this is done through the coding in C# or Java or which ever language is most suitable.

The third layer is the database layer[8].

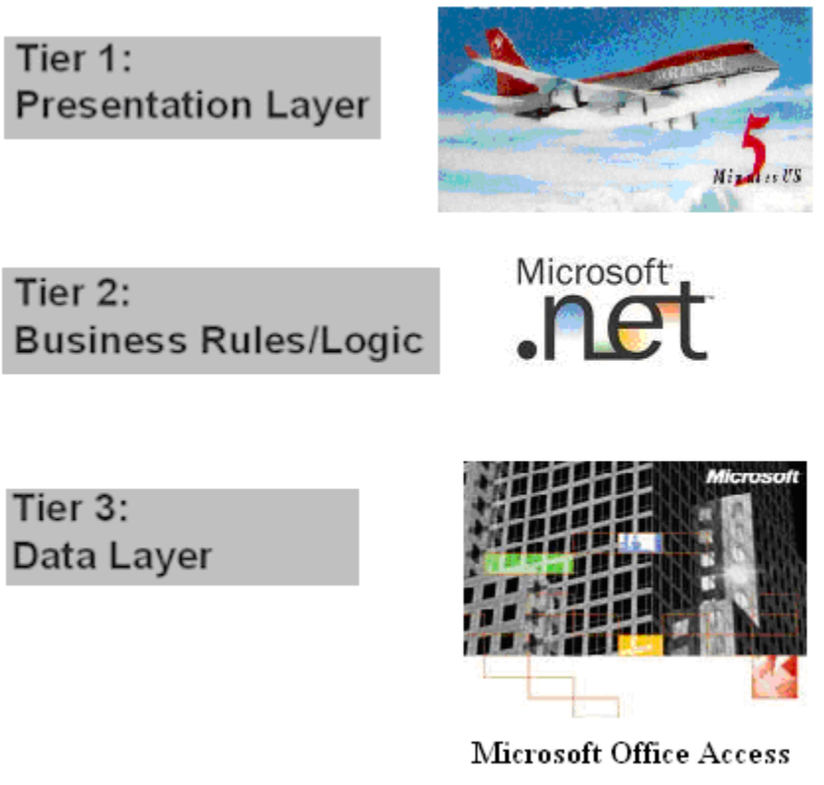


Fig 5.2 Logical Architectural Diagram[18]

5.3 WORKFLOW DIAGRAM

This diagram basically tells us the flow of the project, meaning how the work is being done, what is the procedure followed and what the sequence is. The diagram is self explanatory as the names of the processes explain exactly what they do.

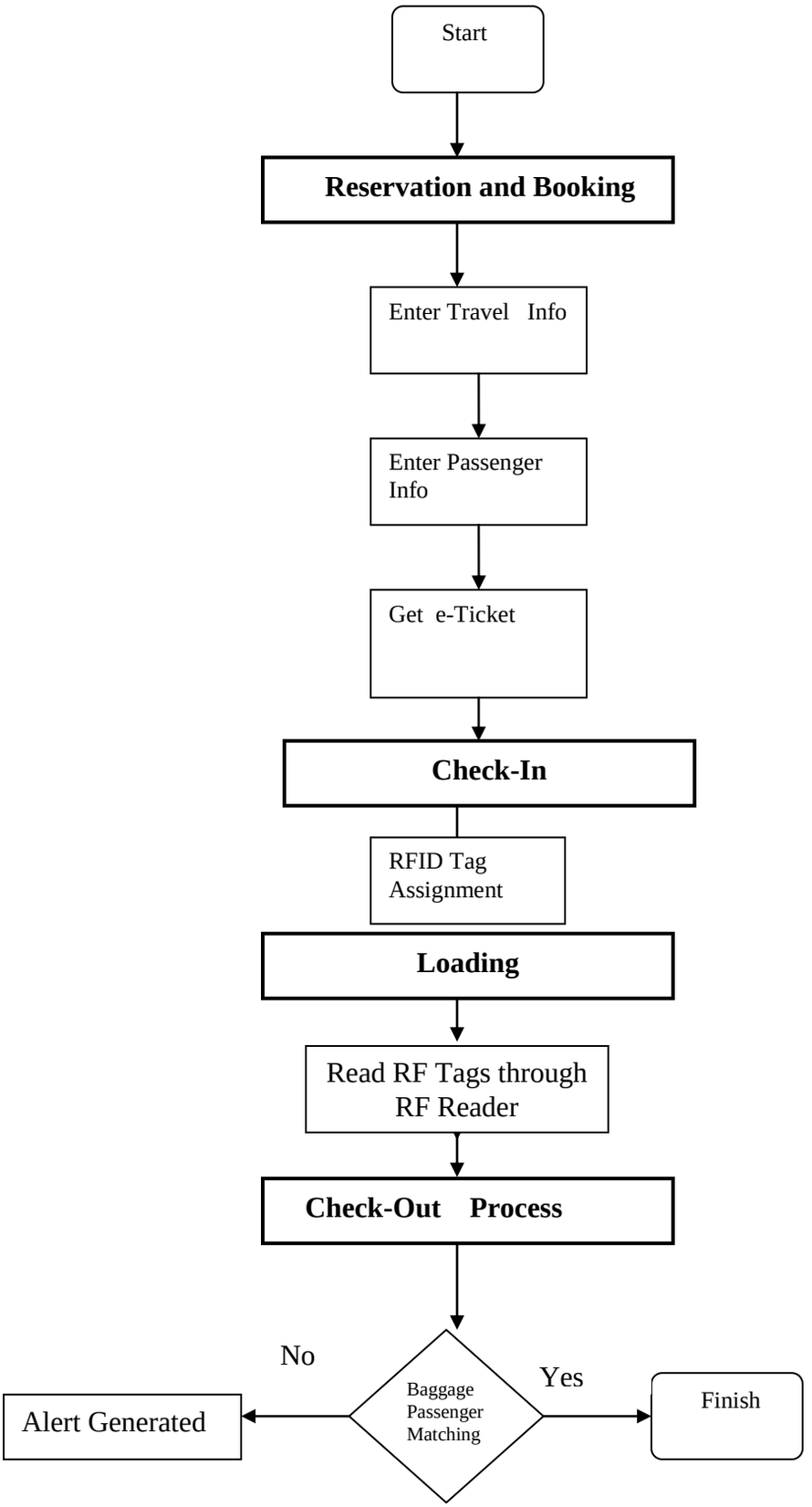


Fig 5.3 Workflow Diagram

ER DESIGN

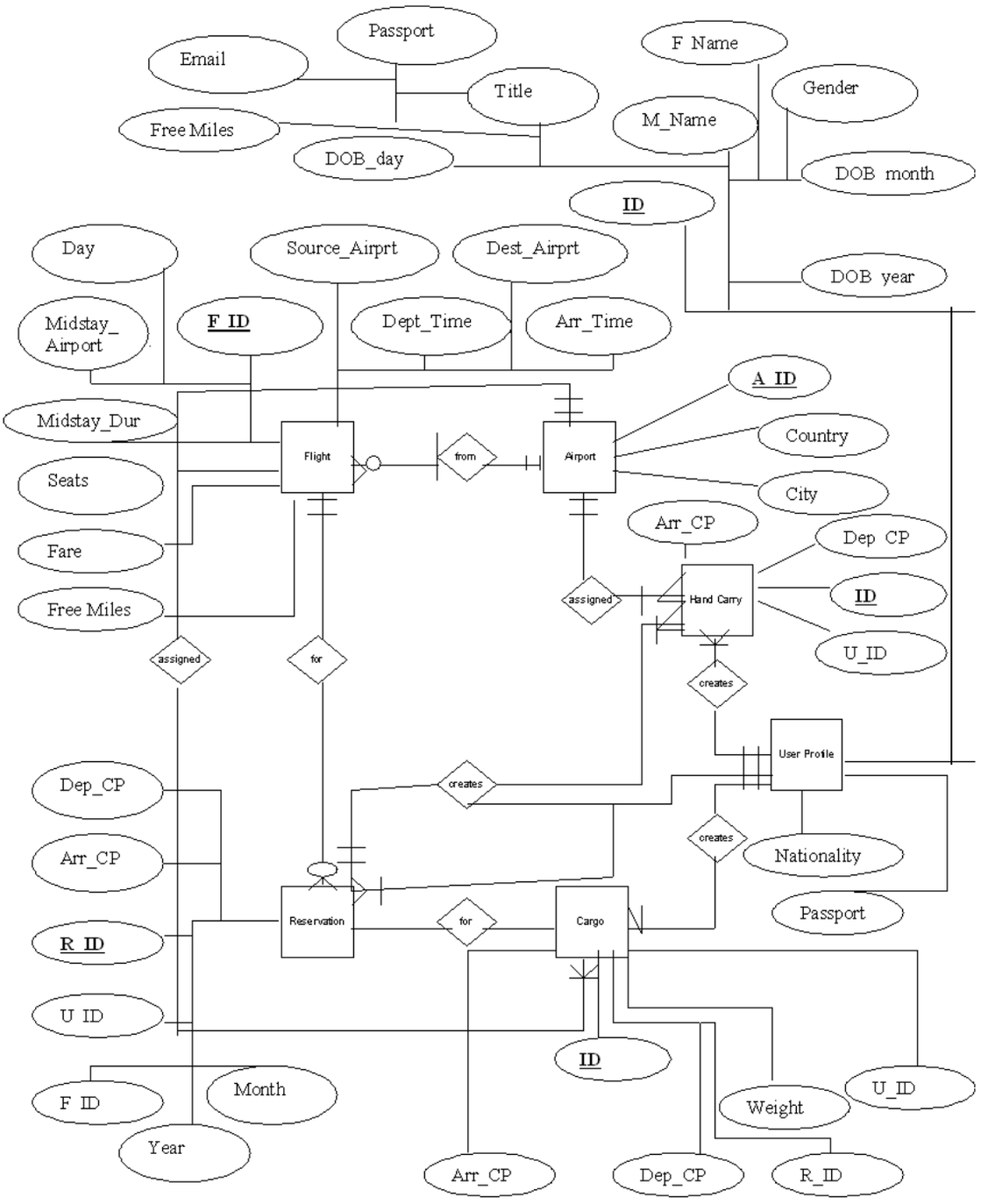


Fig 5.4 ER Diagram

As discussed earlier, the Microsoft Access server is used for this project. It creates, stores, retrieves and maintains database itself. The RDBMS is the relationships between different various attributes of the table and between attributes of different tables.

The ER Diagram shown in the figure gives an overview of project database design. There are basically six entities of the system and the way they are related to each other is given in the ER diagram. Following is the database design of the system.

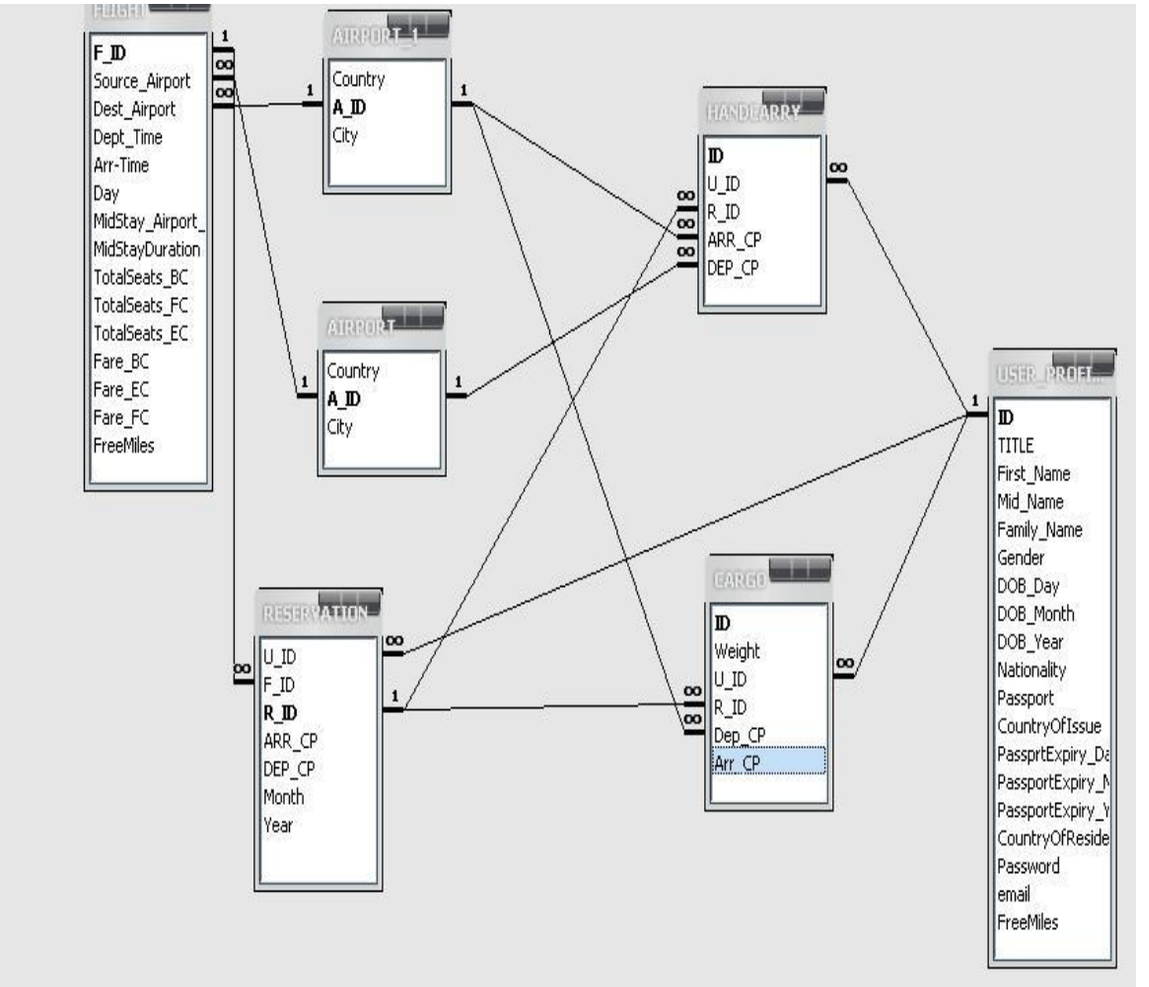


Fig 5.5 Database Design

5.3.1 Requirements Model

5.3.1.1 Primary Actors

- Customer/ Passenger
- Administrator
- Check-In Agent

5.3.1.2 Use Case Methods

USE CASE 1

Use Case Name	Register User
Participating Actor	Customer
Flow of Events	1. The passenger clicks on the registration button 2. The customer fills the customer profile form in detail 3. The customer clicks the button to confirm information and thus he gets
Entry Conditions	The passenger clicks on the register button on the website
Exit Conditions	The person gets registered to the website
Quality Requirements	In case the person does not complete his profile and get disconnected, information is not stored in the table unless the process is completed

USE CASE 2

Use Case Name	Search Flight Schedule
Participating Actor	Customer/Passenger

Flow of Events	1.The passenger selects the destination and/or the date on which he/she wishes to travel 2. A list is displayed and the passenger views all the schedules that fulfill his/her requirements 3. The passenger then views the routes that are available for traveling between the departure and destination and the stopovers 4. Finally the fares for each of the routes is available and the passenger can decide which fulfills his/her requirements
Entry Conditions	The passenger selects the view flight schedule button
Exit Conditions	The person views the required information and goes back to the main page
Quality Requirements	All the schedules are to be up-to-date and any changes in the schedules should be made asap so that passengers should remain informed all the time.

USE CASE 3

Use Case Name	Make Reservation
Participating Actor	Passenger
Flow of Events	1. The passenger selects the destination and/or the date on which he/she wishes to travel 2. A list is displayed and the passenger views all the schedules that fulfill his/her requirements

3. The passenger then views the routes that are available for traveling between the departure and destination and the stopovers
4. Finally the fares for each of the routes is available and the passenger can decide which fulfills his/her requirements
5. Then the passenger is asked for his/her profile and the credit card number that the passenger wishes to pay with
6. once the profile is completed and payment made the passenger can get the e-Ticket

Entry Conditions	The passenger selects the reservation button
Exit Conditions	The person gets the e-Ticket and prints it for himself
Quality Requirements	All the schedules are to be up-to-date and any changes in the schedules should be made asap so that passengers should remain informed all the time and in case the connection is broken, payment should not be deducted unless the e-ticket is obtained.

USE CASE 5

Use Case Name	Check Flight Status
Participating Actor	Passenger
Flow of Events	1. The passenger selects the destination and/or the date on which he/she wishes to travel 2. A list is displayed and the passenger views all the schedules that fulfill his/her requirements

	3. The passenger then views the routes that are available for traveling between the departure and destination and the stopovers 4. Finally the fares for each of the routes is available and the passenger can decide which fulfills his/her requirements
Entry Conditions	The system is working and the passenger is logged in
Exit Conditions	The passenger receives the ticket
Quality Requirements	In case of a connection to the server problem, the system should be quick in resolving the problem The system should be time and quality efficient.

USE CASE 6

Use Case Name	Passenger Booking Tracking
Participating Actor	Passenger
Flow of Events	1. The passenger enters the reference number 2. After the information is verified, the passenger views his/her booking information that was provided earlier for the reservation process and hence the flight he/she will travel on
Entry Conditions	The passenger selects the passenger booking option
Exit Conditions	The person views the required information and goes back to the main page

Quality Requirements	All the information should be provided as per the request and any changes previously made by the passenger should be updated.
USE CASE 7	
Use Case Name	Cargo Tracking
Participating Actor	Passenger
Flow of Events	1. The passenger enters the reference number 2. The Cargo is located and the location is displayed on the interface
Entry Conditions	The passenger selects the cargo tracking option
Exit Conditions	The person views the required information and goes back to the main page
Quality Requirements	The information should be up-to-date and verfied
Use Case Name	Add airport
Participating Actor	Administrator
Flow of Events	1. The admin log into the admin account 2. The list of all airports is shown and he can modify the list according to the requirements 3. Updates the database and exits
Entry Conditions	The admin logs in with the admin account ID and password
Exit Conditions	The admin verifies and modifies any data that was required to be modified
Quality Requirements	The information should be up-to-date and verfied

USE CASE 8

Use Case Name	Add flight
Participating Actor	Administrator
Flow of Events	1. The admin log into the admin account 2. The list of all flights is shown and he can modify the list according to the requirements 3. Updates the database and exits
Entry Conditions	The admin logs in with the admin account ID and password
Exit Conditions	The admin verifies and modifies any data that was required to be modified
Quality Requirements	The information should be up-to-date and verfied
Use Case Name	Manage Accounts
Participating Actor	Administrator
Flow of Events	1. The admin log into the admin account 2. The admin can modify the accounts of the users as per the changes made for updation of the database
Entry Conditions	The admin logs in with the admin account ID and password
Exit Conditions	The admin verifies and modifies any data that was required to be modified
Quality Requirements	The information should be up-to-date and verfied

USE CASE 9

Use Case name	Check-In
Participating Actor	Initiated by Check-In Agent

	Communicates with Passenger
Flow of Events	1. The Check-In Agent activates the Check-In process 2. The agent enters the RRN (reservation ID) and the UID of the passenger 3. The system verifies the ID numbers and adds information regarding handcarry and/or luggage carried by the passenger 4. Once the information is stored the system generates a boarding pass 5. The RFID # assigned on reservation is used. These tags are assigned separately to passenger and luggage.
Entry Condition	The Check-In Agent is logged on to the system and has access to all the resources required
Exit Condition	All information has been entered regarding the luggage The RFID tags are generated and properly associated.
Quality Requirements	The system should be fast and efficient so that passengers don't have to wait for the tag generation and assignment

USE CASE 10

Use Case Name	Maintain Check-In Points
Participating Actor	Check-In Agent
Flow of Events	1. The check in agent enters the departure point for validation

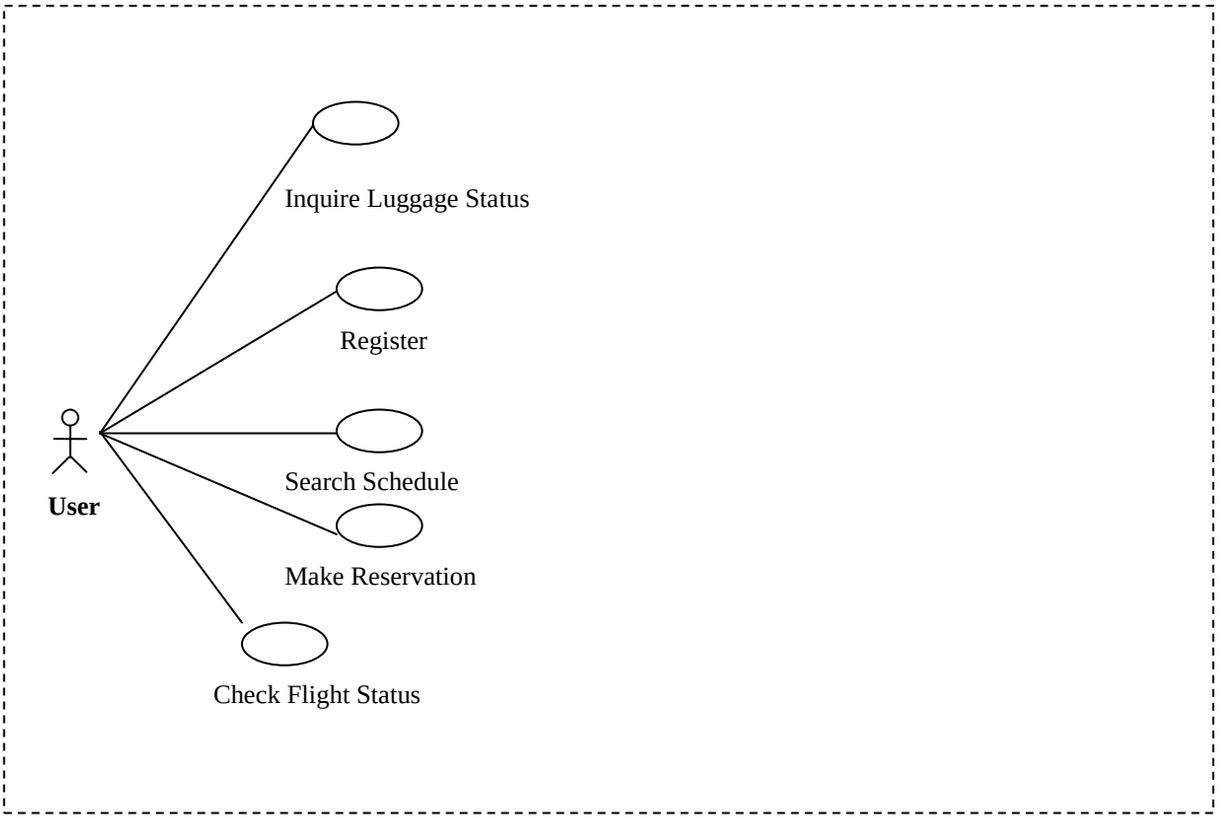
	2. The arrival checkpoint is updated for the person traveling once the departure check point is verified 4. Updates the database and exits
Entry Conditions	The check in agent is connected to the RFID Reader and Antenna
Exit Conditions	The admin verifies and modifies any data regarding the departure and arrival checkpoints
Quality Requirements	The information should be up-to-date and verfied

USE CASE 11

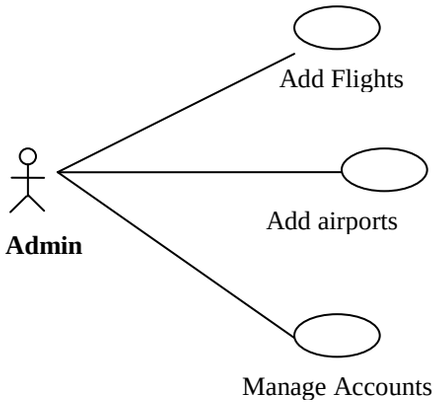
Use Case Name	Manage Accounts
Participating Actor	Administrator
Flow of Events	1. The admin log into the admin account 2. The admin can modify the accounts of the users as per the changes made for updation of the database
Entry Conditions	The admin logs in with the admin account ID and password
Exit Conditions	The admin verifies and modifies any data that was required to be modified
Quality Requirements	The information should be up-to-date and verfied

5.3.2 Use Case Diagrams

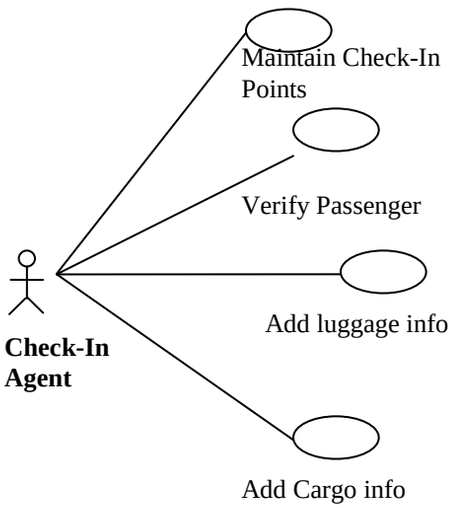
Customer/Client use case diagram



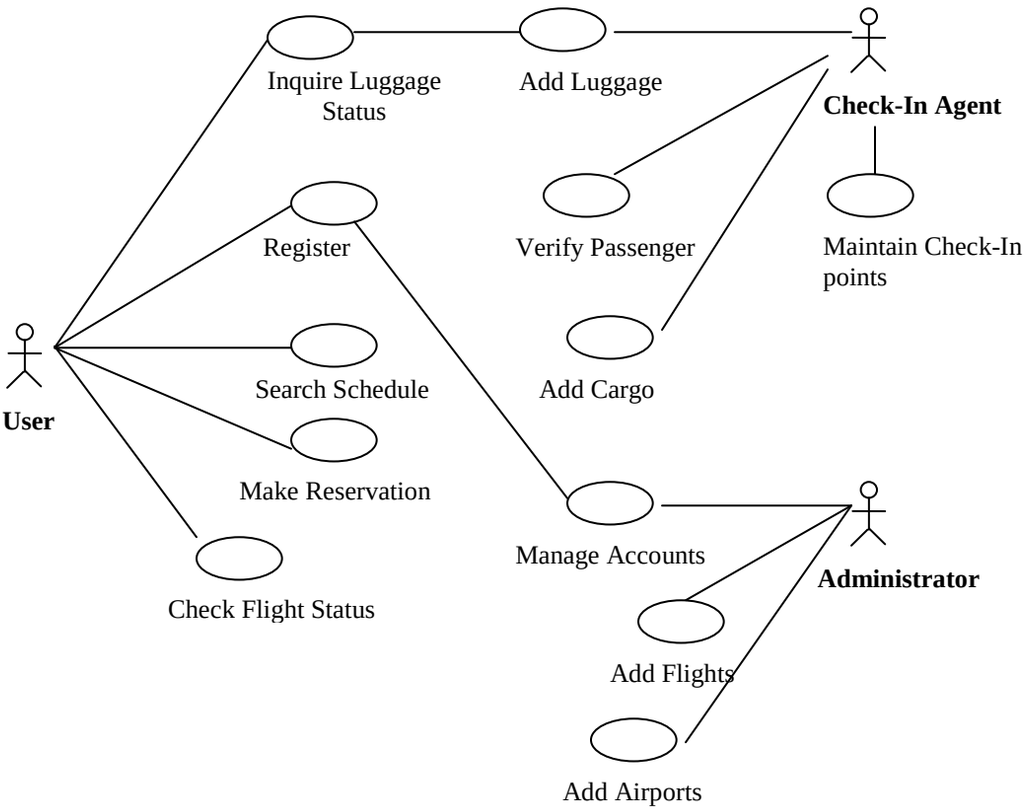
Administrator Use Case Diagram



Check-In Use Case Diagram

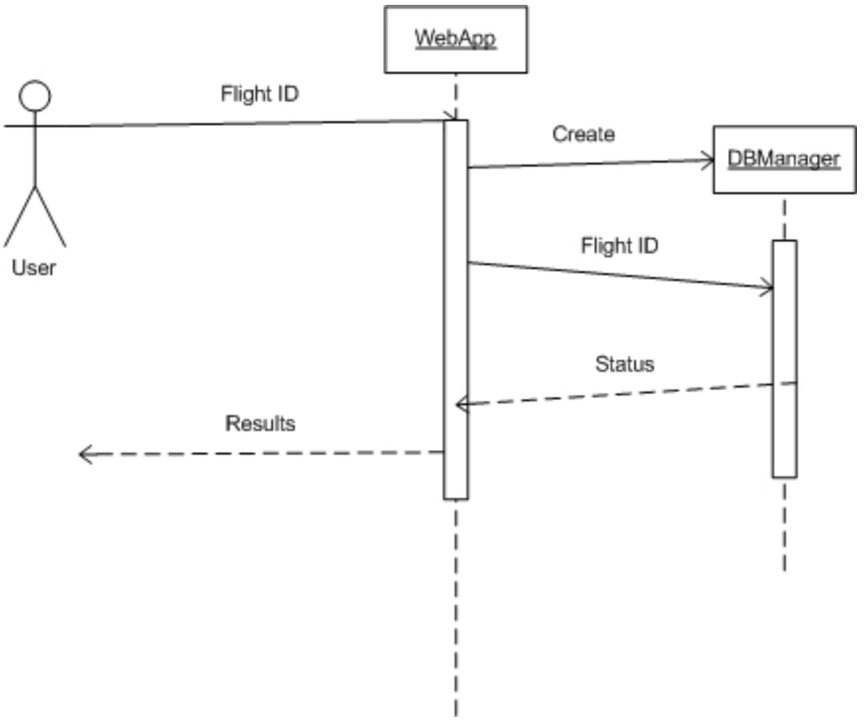


5.3.3 Use Case Model

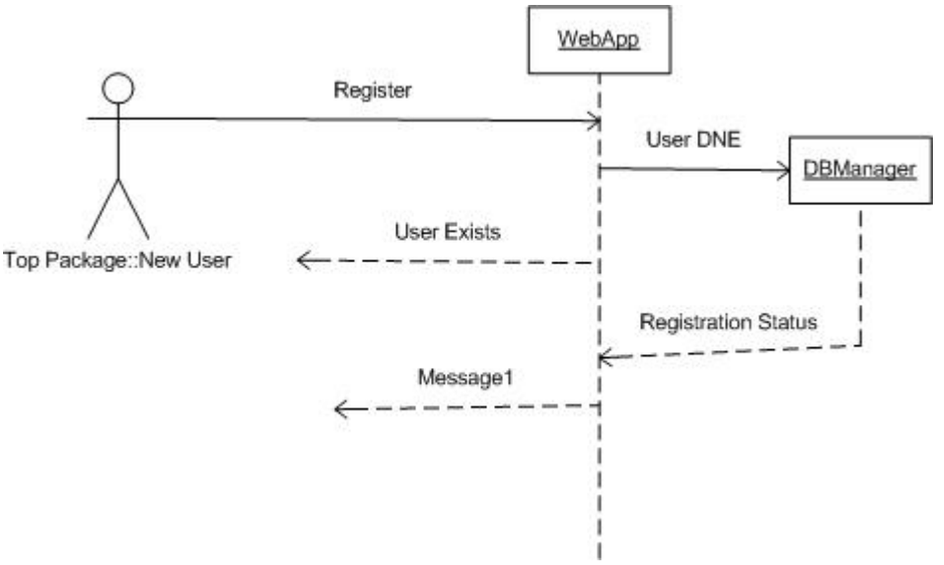


5.3.4 Sequence Diagrams

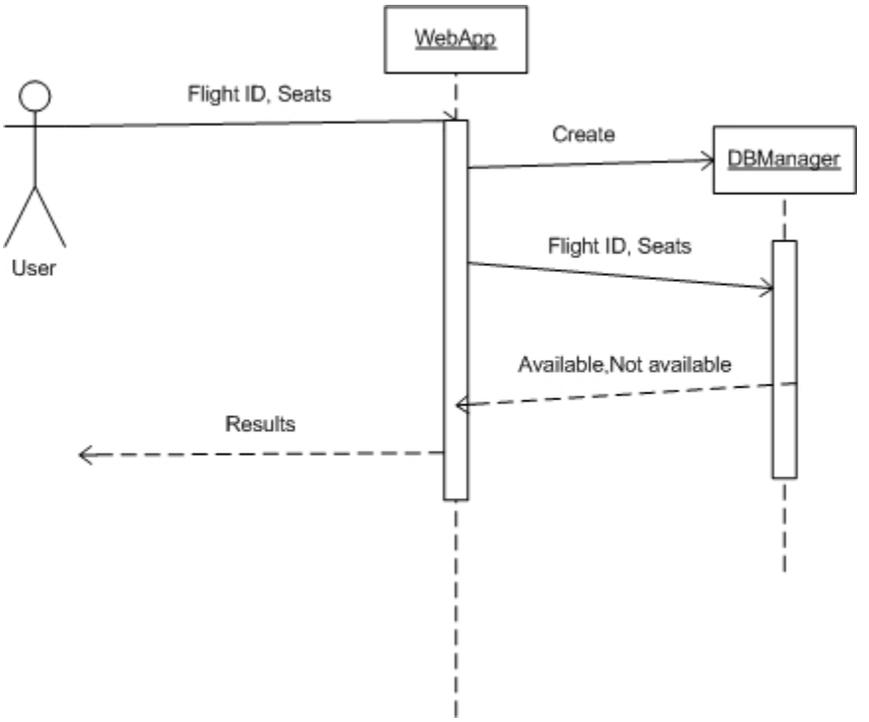
Check Flight Status



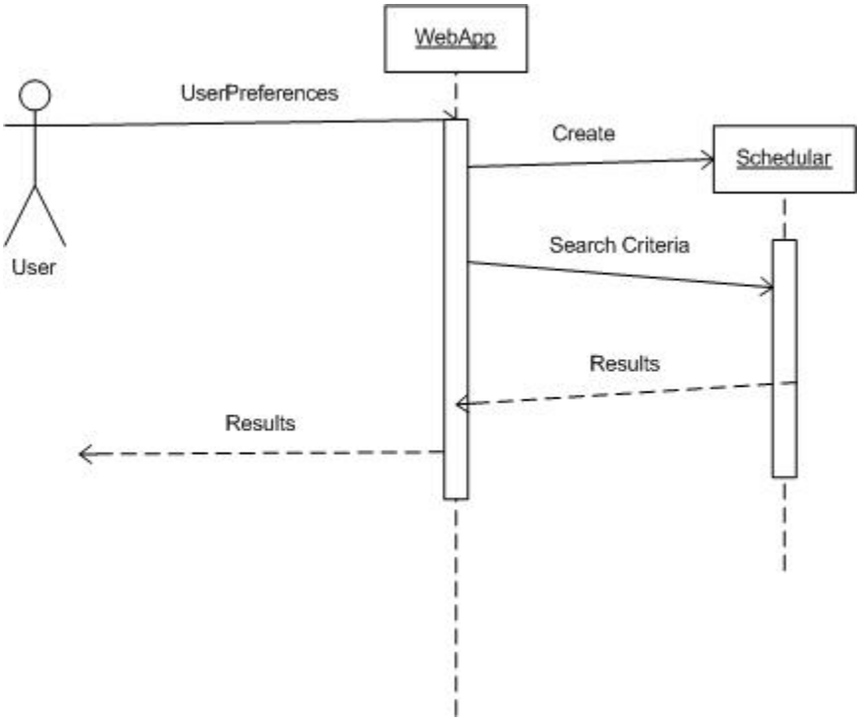
Register User



Flight Reservation

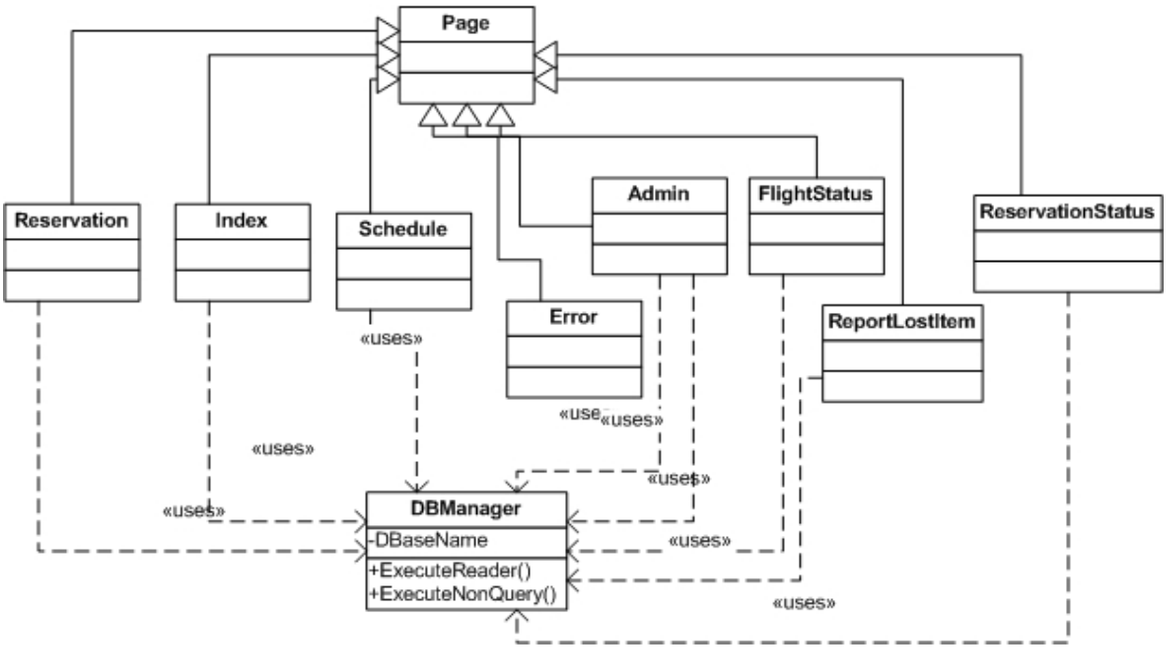


Search

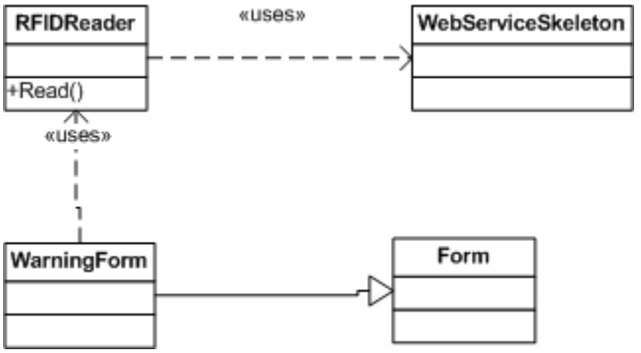

WebApp
UserPreferences
Create
Schedular
User
Search Criteria
Results
Results

5.3.5 Class Diagrams

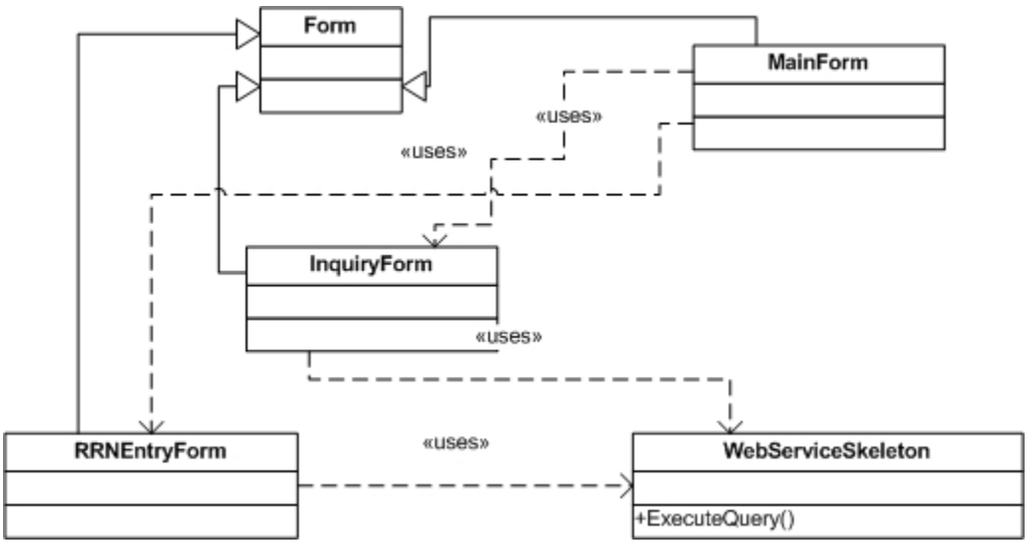
Class Diagram Web Application



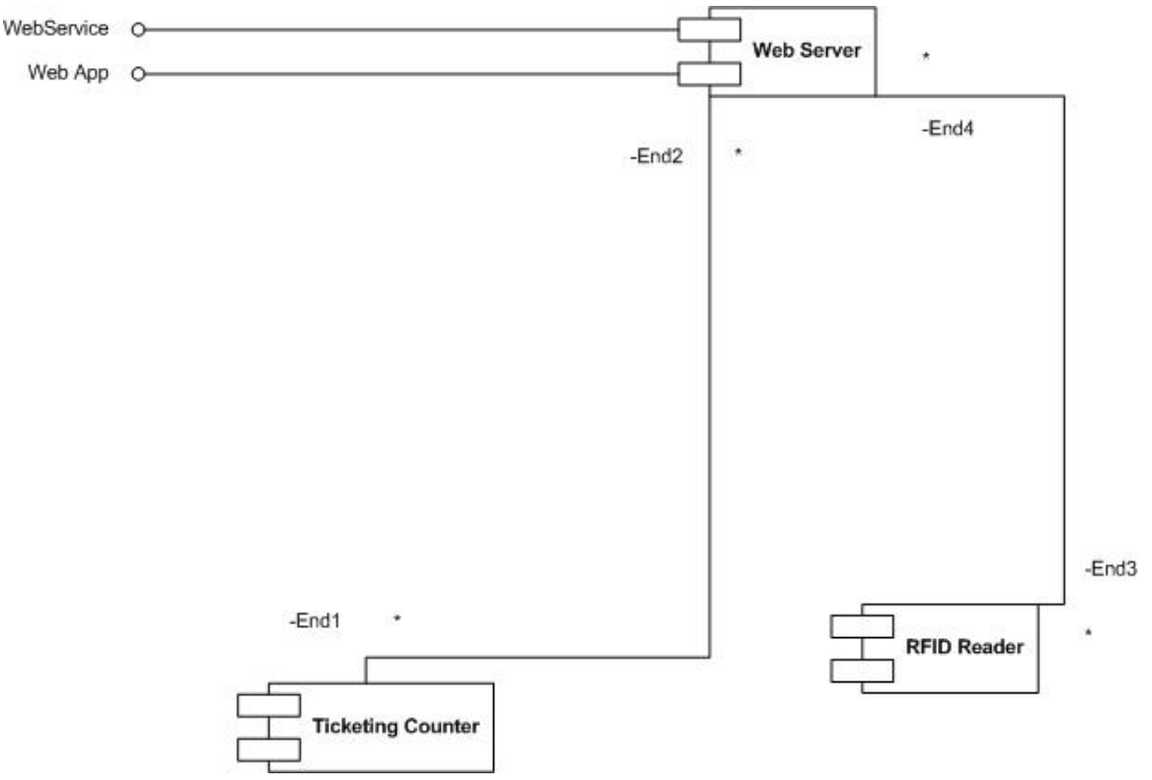
Class Diagram for Terminal



Class Diagram for Counter Application



5.3.6 Component System Diagram



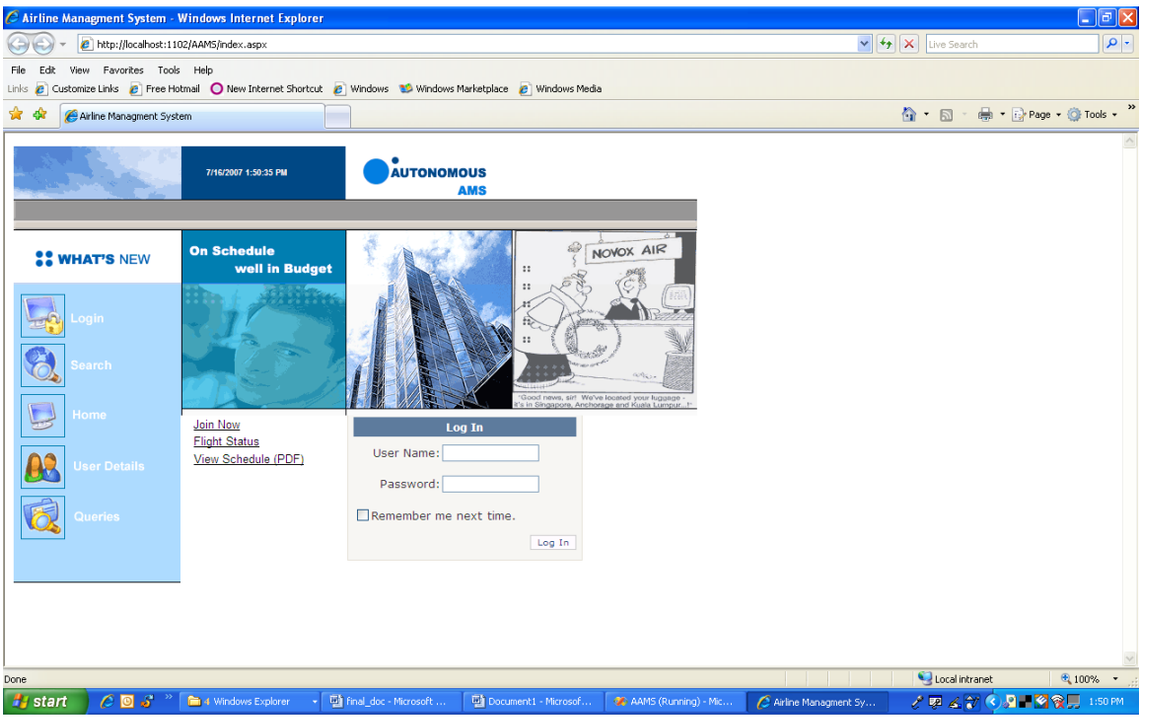
Chapter 6

IMPLEMENTATION AND SOFTWARE TESTING

6.1 Software Interfaces

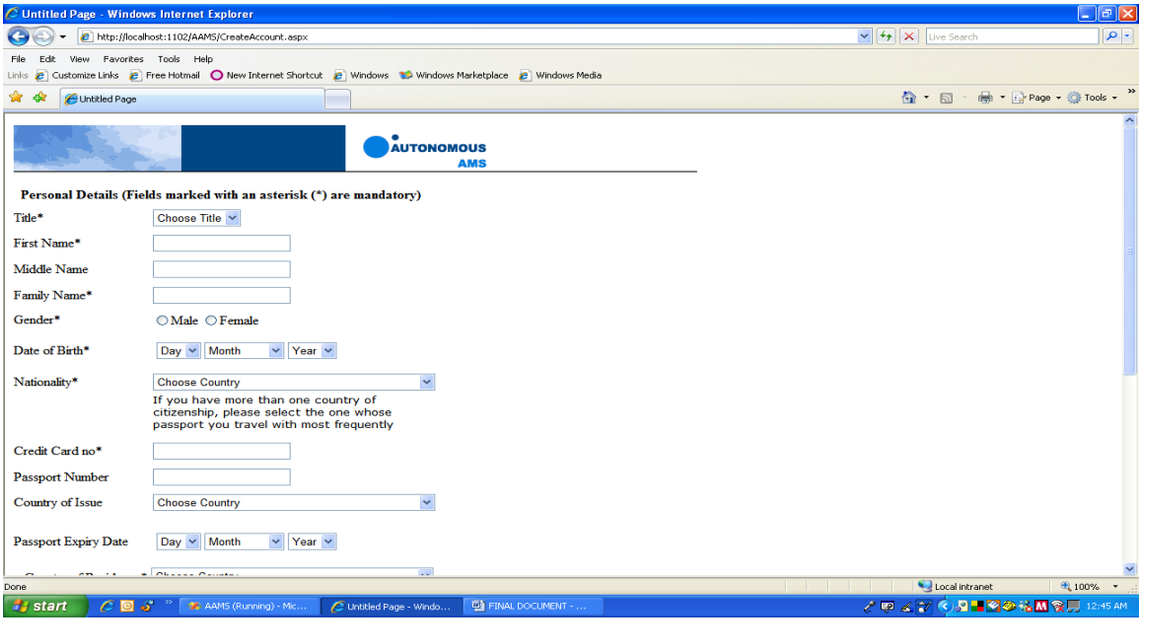
Main Page

The startup page for the website



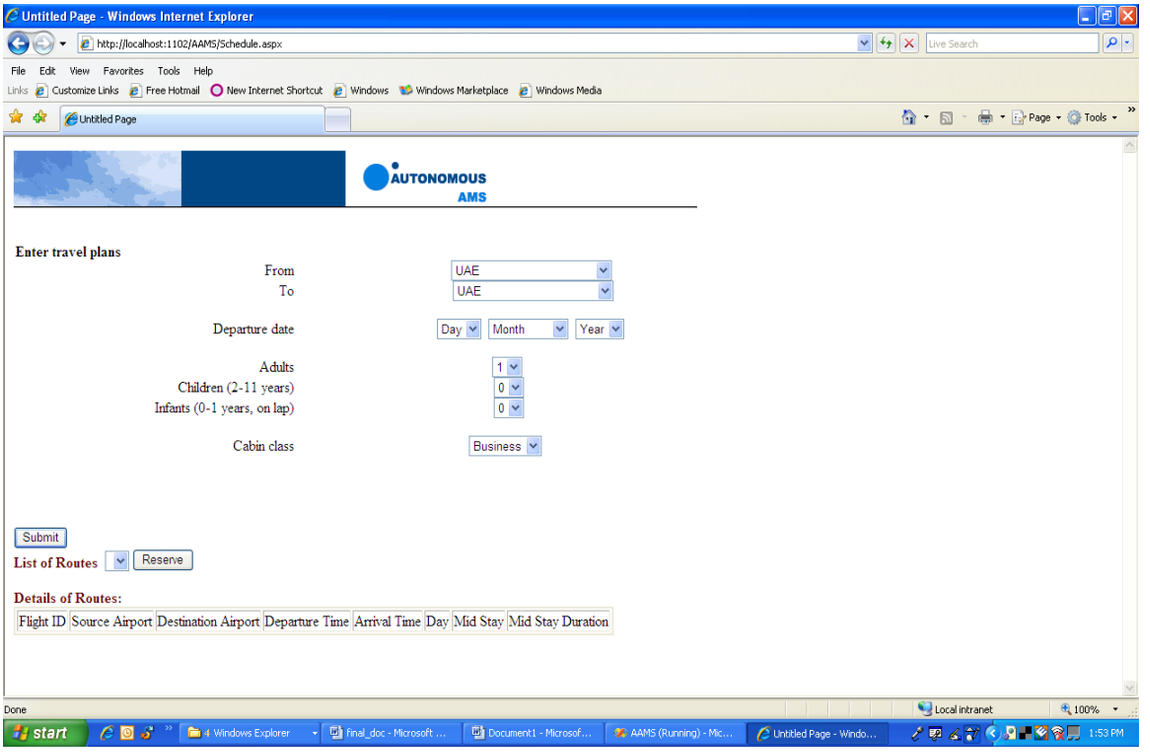
Registration

The registration page for the users



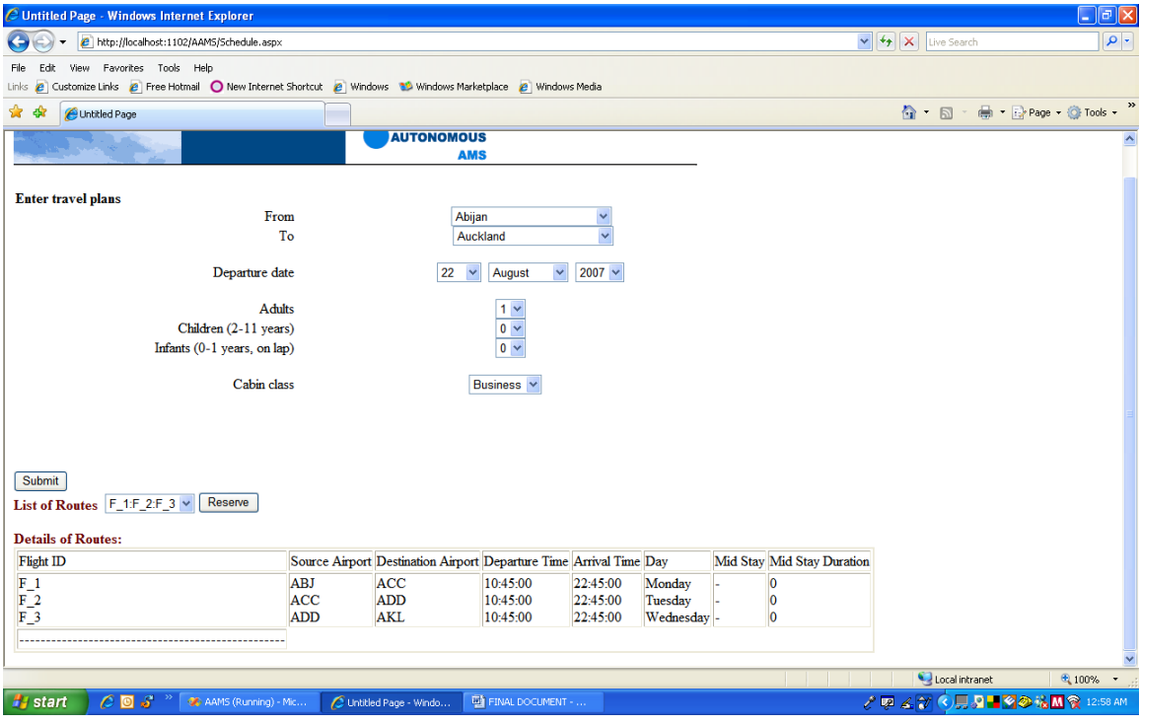
Search Flight Schedules

Looking for an appropriate flight schedule

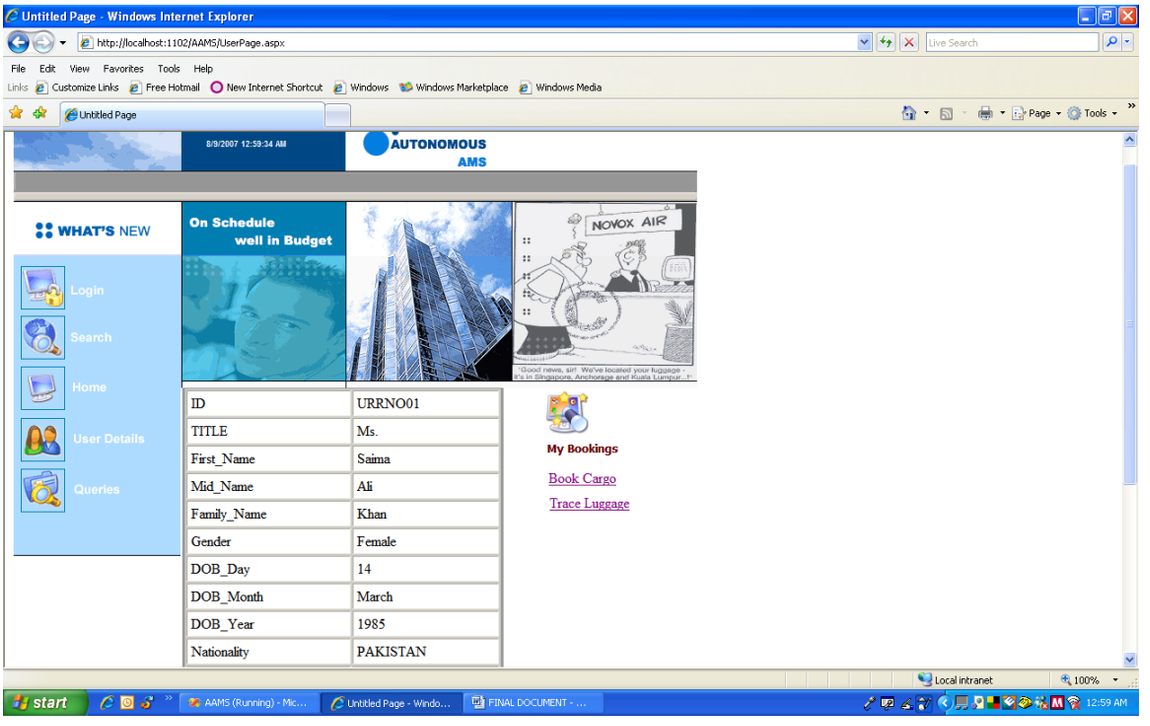


Show Schedules

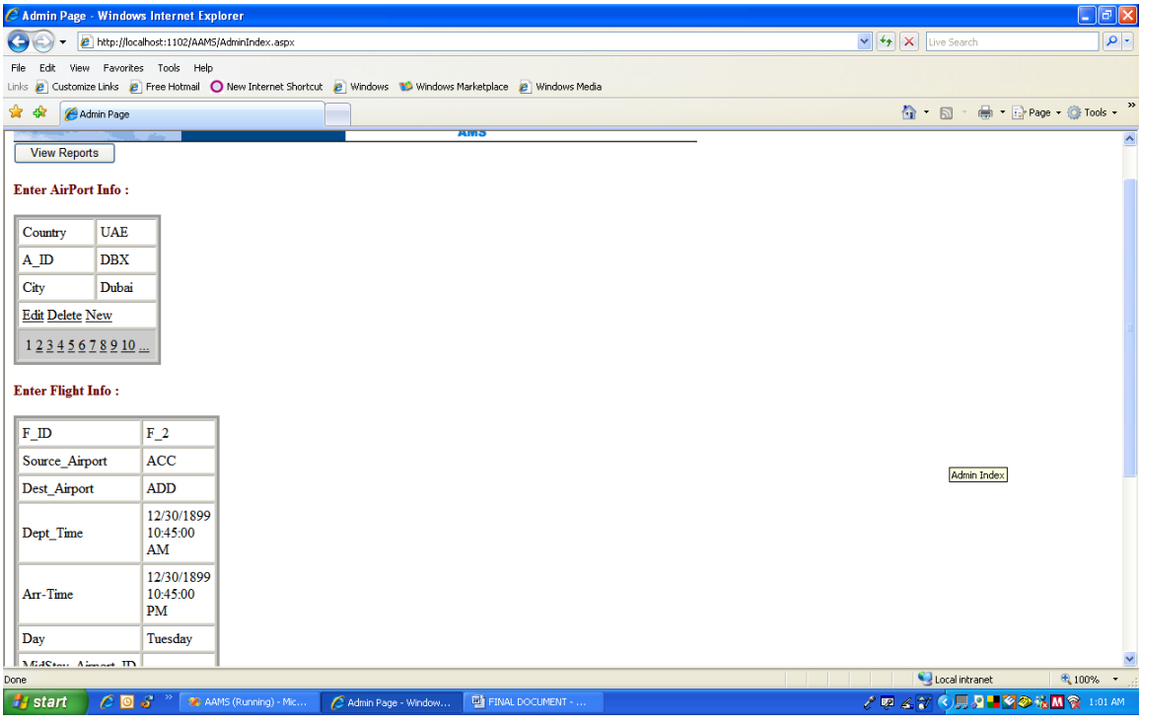
Providing details of routes for passengers



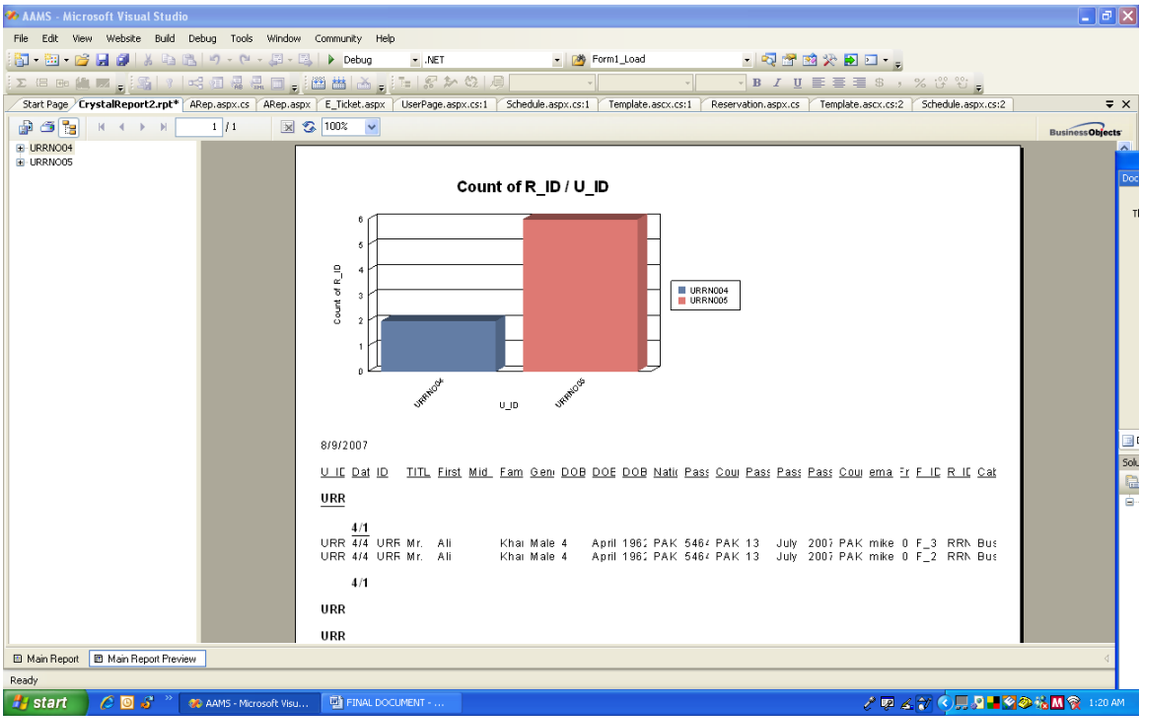
Check Bookings and Track Luggage



Admin Login Page

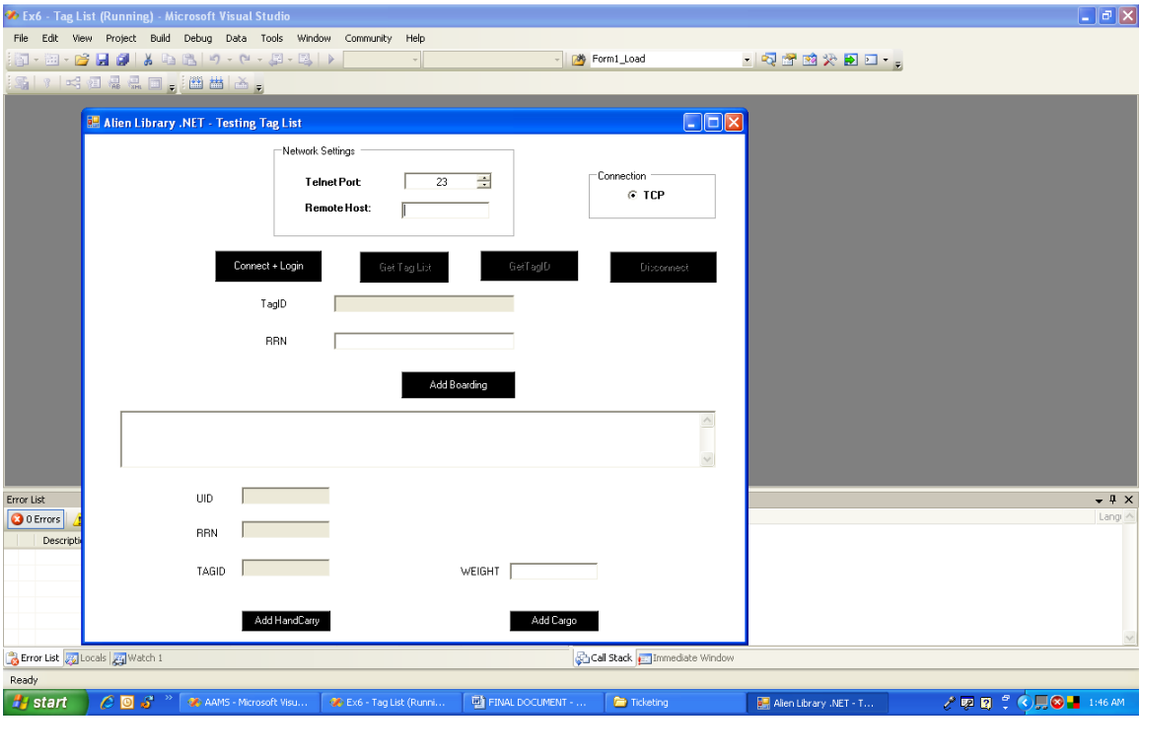


View Crystal Reports

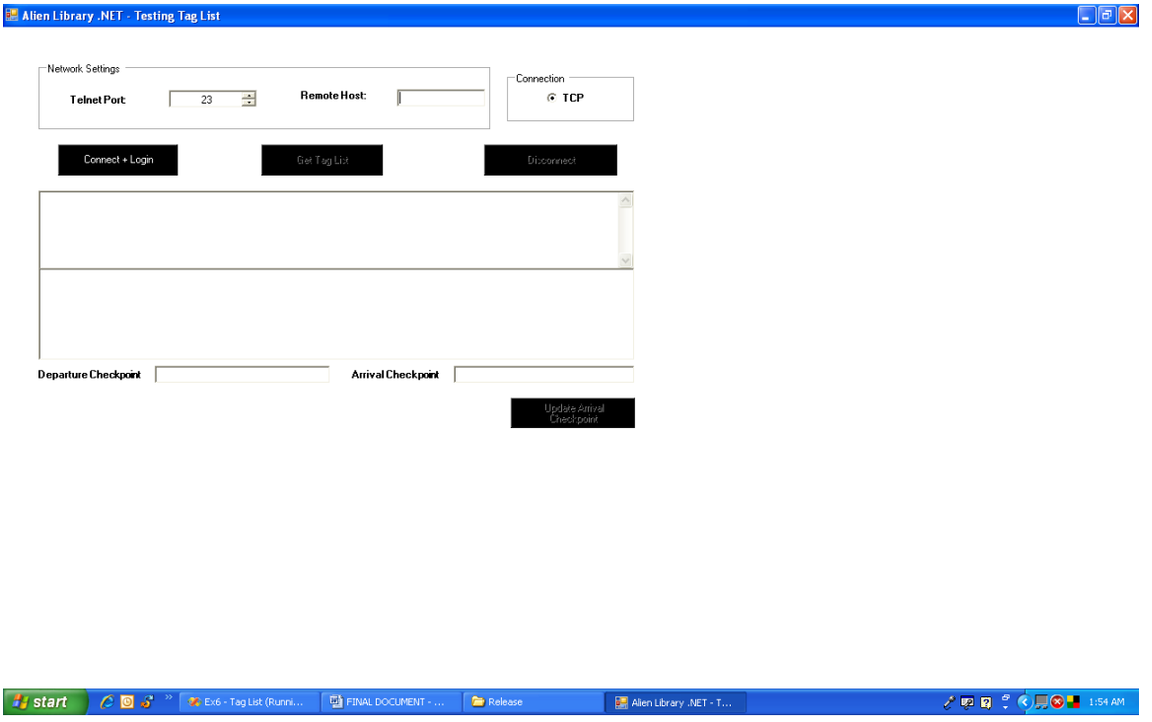


Show User Profile

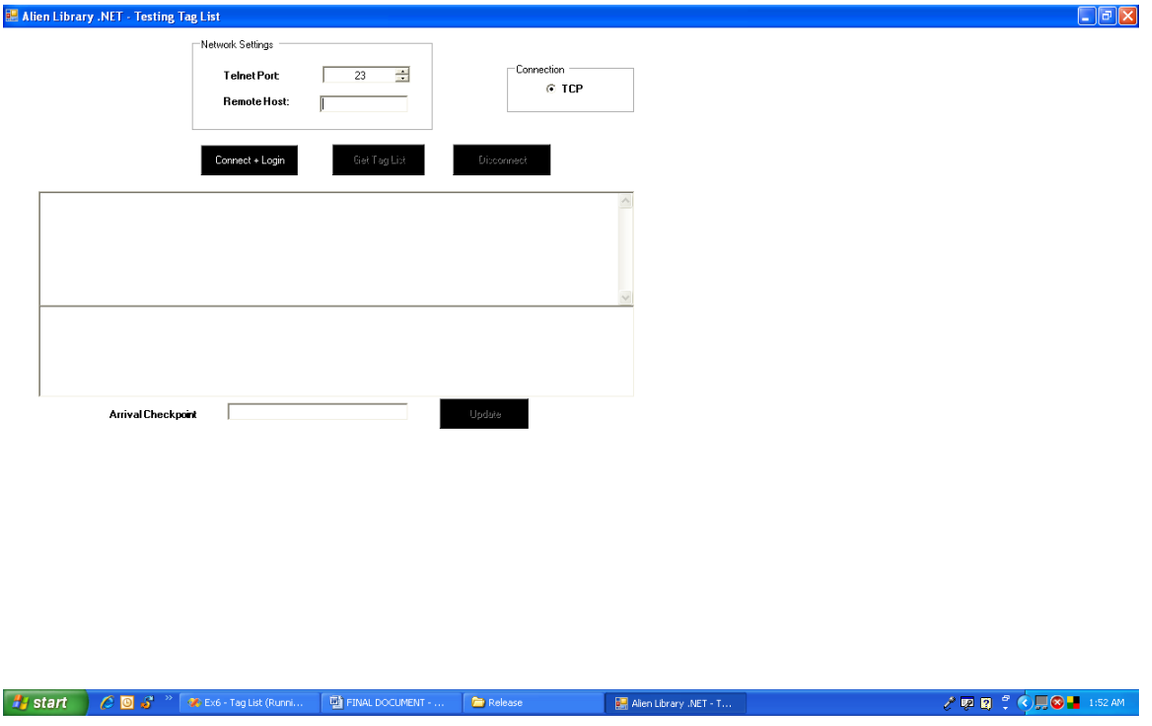
Ticketing Terminal



Departure Check-In Terminal



Arrival Check-In Terminal



6.2 Software Testing

6.2.1 Test Case 1

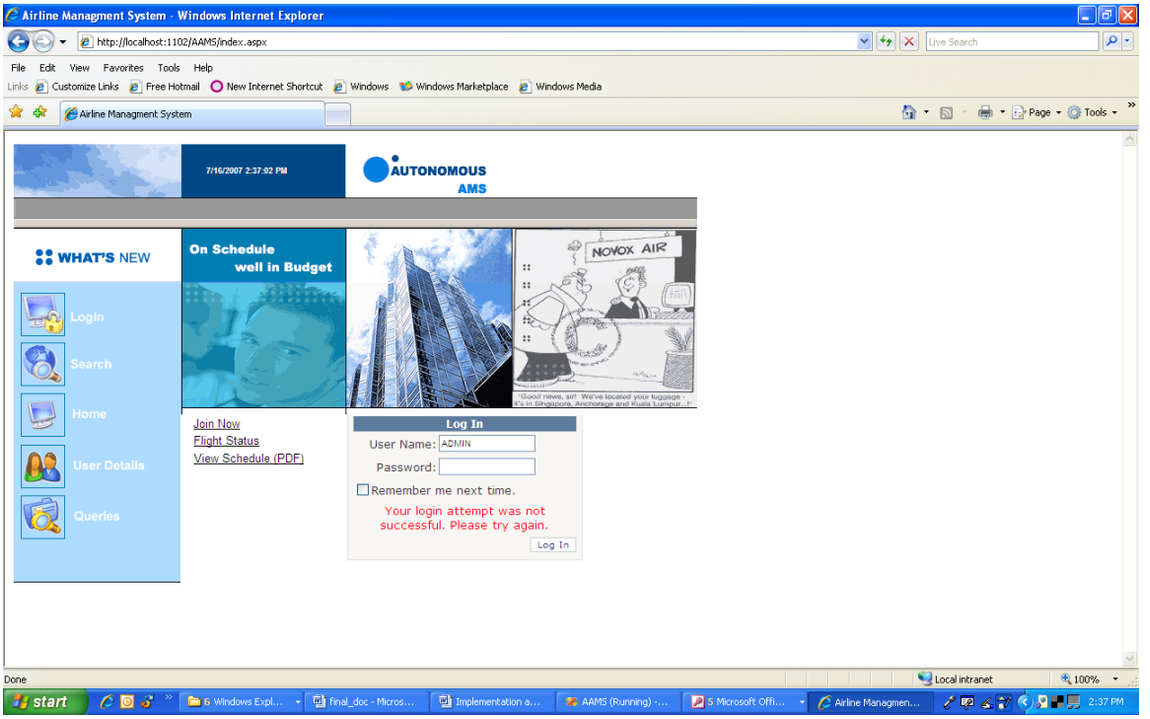
Name: “Client Login”

Purpose: A registered customer has to log in before he can view his profile, because unless he has the password and ID to view his profile, he cannot access his account

6.2.2 Test Case 2

Name: Admin Login

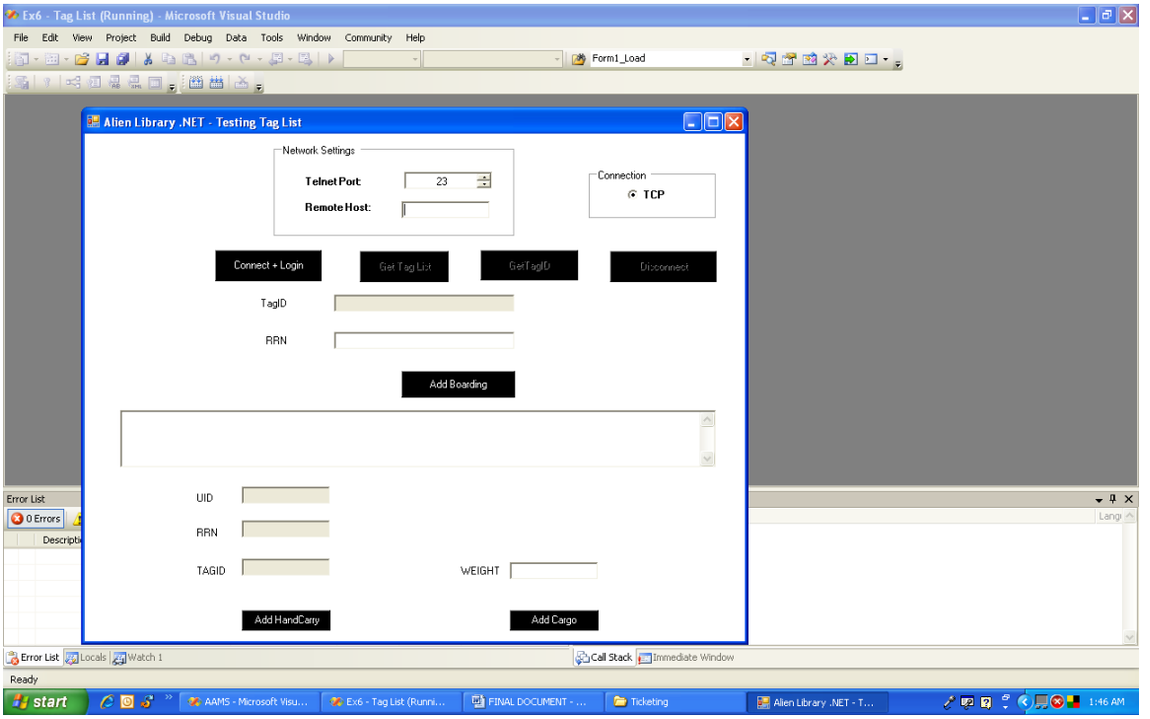
Purpose: To avoid any user accessing the database.



6.2.3 Test Case 3

Name: “Read Operation”

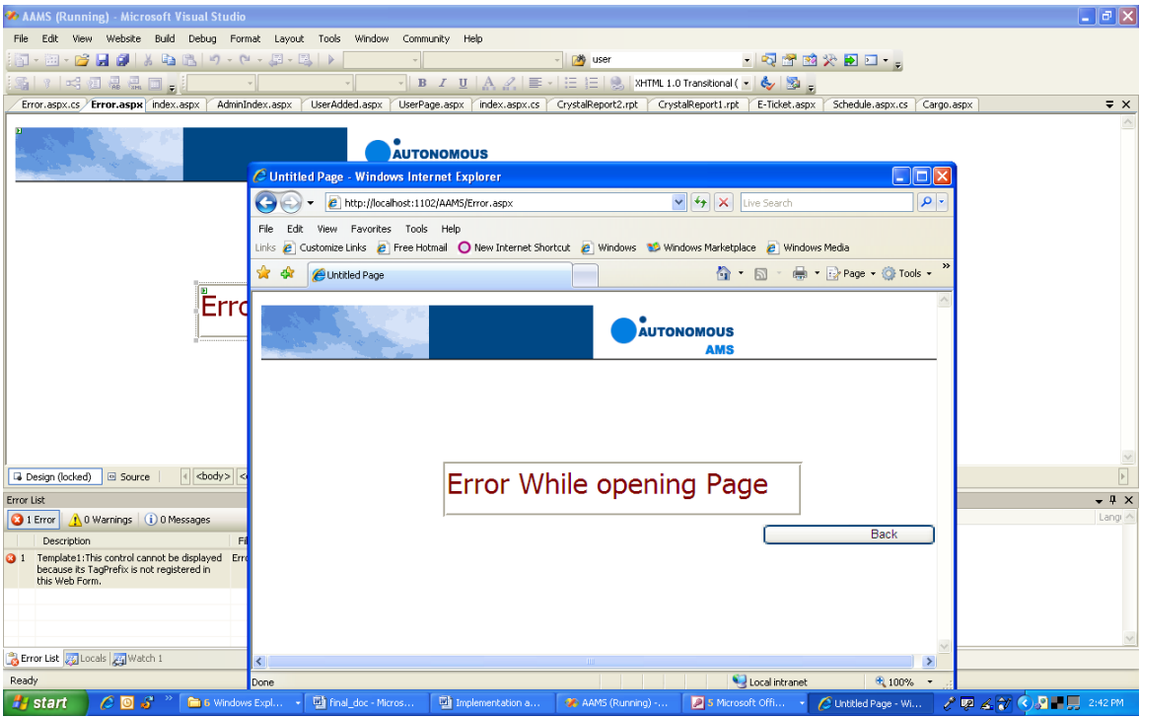
Purpose: Reading the Tag only functions when the connection is established with the reader and the tag is in the vicinity of the antenna



6.2.4 Test Case 4

Name: Session Handling

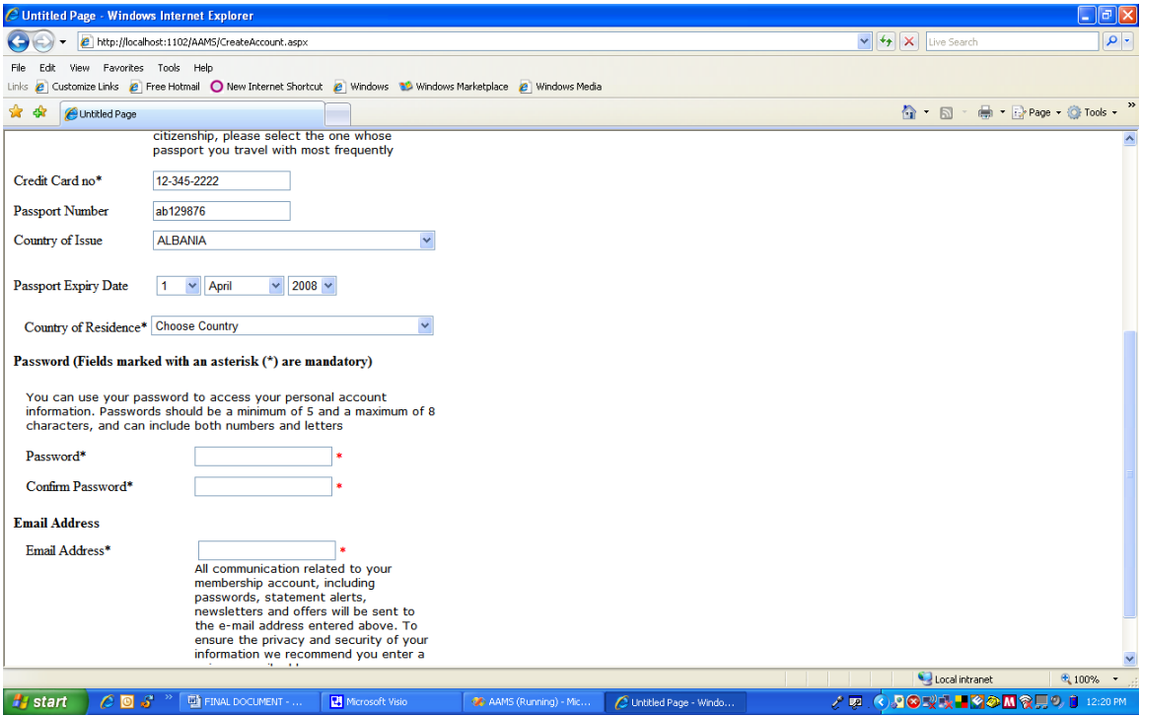
Purpose: To avoid access to secure data in database



6.2.5 Test case 5

Name: User Registration

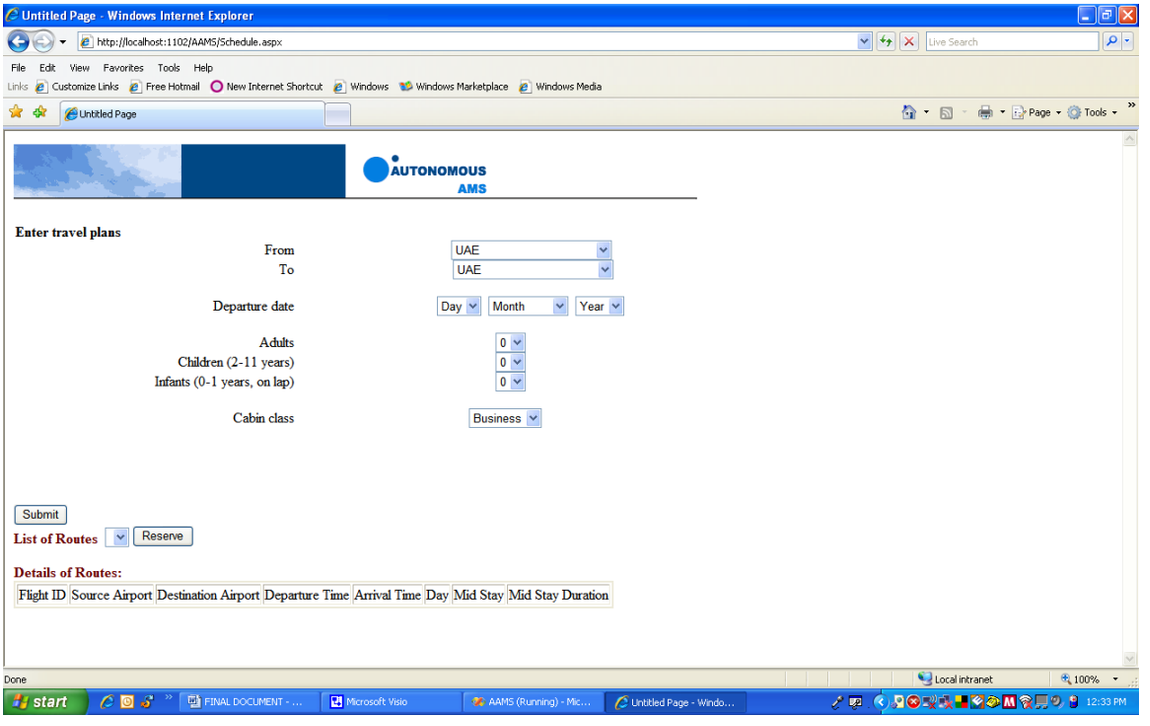
Purpose: The user is only registered when he submits the correct information in the correct format otherwise the account is not created; he has to submit the correct passport number format and has to fill all the required fields



6.2.6 Test Case 6

Name: “Reservation on Flight”

Purpose: If the number of seats booked on the flight is equal to the numbers of seats present on the flight, then no further booking is allowed



6.3 CONCLUSION

The solution proposed for the luggage handling and tracking and lose security of airline management systems is EA-AMS. This system basically integrates the airline management system with RFID based tracking and controlling of luggage. The project had two major parts:

- The complete reservation, scheduling and management system for an airline
- The use of RFIDs for luggage and passenger tracking

Since RFID is a new concept and hasn't been taught in our course, the learning and understanding of RFID systems was a major part of the project. After studying RFID systems thoroughly I realized the importance of RFIDs in today's world, both for technical purposes and general use. RFID is the best solution to the tracking of objects and living things.

The development of this project required of me to understand the airline system completely and based on that design an integrated system which fulfilled the requirements of both passengers and airlines. Thus for this purpose web development was done to assist the passengers and provide them with an option to register online and along with this RFID hardware is to be used at the terminals and check-in points to read the tags assigned to passengers and their luggage and cargo.

I have learnt a lot from this project as it helped me study a completely new and upcoming technology and it required my knowledge of the courses that I have studied in my university. It was a perfect blend of the two and thus I am pleased with the amount of learning this project made me do.

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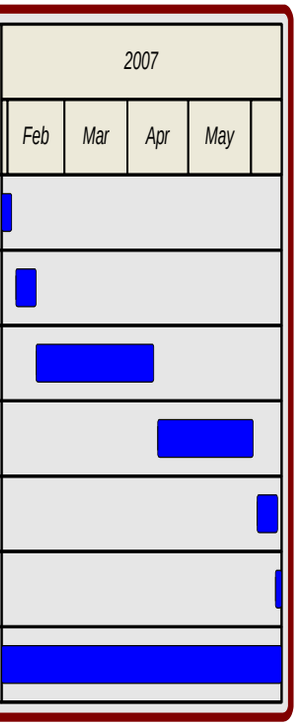
APPENDIX 1

ID	Task Name	Start	Finish	Duration
1	Requirement Elicitation	1/29/2007	2/2/2007	5d
2	Analysis	2/5/2007	2/14/2007	8d
3	Design	2/15/2007	4/13/2007	42d
4	Implementation	4/16/2007	6/1/2007	35d
5	Unit Testing/Debugging	6/4/2007	6/13/2007	8d
6	Integration	6/13/2007	6/29/2007	13d
7	Project Report	1/29/2007	6/29/2007	110d



APPENDIX 2

SCHEDULER ALGORITHM

Variables:

Dest= set of destinations on given date
D= our destination
S= our source

Algorithm:

If D€Dest
    SD=(Set of all flights where destination=D)
    If S€SD
        directly connected
    Else
        DS=(Set of all nodes where source=S)
        DS∩SD =CI
        If CI ≠{}
            CI represents interconnecting flights
        Else
            No interconnecting flights
            FI= All flights where source€DS && destination€SD
Else
    No destination

Our Path is:
    S + source of FI + Destination

First Case:
    Of FI + D

OR

Second Case:
    S +D

OR

Third Case:
    S +CI+ D