THE DESIGN AND IMPLEMENTATION OF HUMAN RESOURCE MANAGEMENT WEBSITE

By

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ABSTRACT

The consulting industry is one of the fastest growing business sectors worldwide with new opportunities emerging continually in hundreds of different fields. Software consulting and recruiting agencies match the requirements of the client firms with the skills of their employees and set up the interview between their employees and the client firm. Interviews are then conducted, and the candidates selected in the interview are recruited as consultants or contractors in the client's firm for the duration of the project (job).

This project examines the issues related to dynamic Human Resource Management and implements a web-based application for a fictitious consulting firm that participates in the placement of contractors in different organizations. The system is implemented using a 3-tier approach, with a backend database (MySQL database), a middle tier of Microsoft Internet Information Services (IIS) and ASP.NET, and a front end web browser (client). This report also discusses each of the underlying technologies used to create and implement the application

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1. INTRODUCTION

Software consulting and recruiting agencies match the requirements of the client firms with the skills of their employees and set up the interview between their employees and the client firm. Interviews are then conducted, and the candidates selected in the interview are recruited as consultants in the client's firm for the duration of the project.

The recent downsizing in businesses and other organizations has resulted in an increase in consulting business for two reasons. Many experienced and well-qualified professionals have found that offering their services on a consulting basis meets both their career and financial needs. Secondly, after downsizing, organizations find it economical and flexible to use consultants rather than full-time employees to fill their fluctuating technical, management and operation needs.

The above factors have led to the consulting industry becoming one of the fastest growing business sectors worldwide. Hence the consulting firms are attempting to automate as much routine activities as possible. An effective web-application can be a proper medium for bringing all the above parties together.

Web-based applications are web sites with user interactivity. The key advantage of the web-based application is its availability, as it can be accessed by anyone connected to the Internet and multiple users can access it at the same time. The web-application can be designed as a three-tier architecture, which includes a web client, network servers, and a back-end information system supported by a suite of databases [2]. The goal of this project is to develop a user-friendly web-based application that automates the routine activities for an IT consulting firm.

2. LITERATURE REVIEW

It is important to realize that many organizations are no longer staffed entirely by full time permanent employees. Activities previously done within firms are now accomplished externally by other businesses that specialize in those functions. The above factor has created rapid growth in many business sectors including computer and data processing services.

Large organizations frequently have a mixture of permanent employees and staffing based on Alternative Employment Structures (AES). The most significant categories of AES are outsourcing and consulting [1]. "Nearly four out of five employers use some form of nontraditional staffing arrangement" [5]. The non-traditional workforce, defined by U.S. Department of Labor, **Bureau of Labor Statistics** (BLS) includes multiple jobholders, contingent and part-time workers, people in alternate work arrangements, independent contractors/consultants and employees of contract companies. According to the Bureau of Labor Statistics (BLS) the non-traditional workforce is expected to grow by almost 50 percent from 2000 to 2010, compared to a 15 percent increase in permanent workers during the same time [3].

The computer industry and its related services are expected to experience rapid growth, adding 453,000 jobs between 2004 and 2014 [7]. As computers and software become more complex, support specialists will be needed to provide technical assistance to customers and other users. This in turn will increase the demand for consultants in the area of computers and software management.

As more companies seek to meet their technical needs by employing consultants, there is a growing demand for software tools, which will aid in dealing with the complexities of this new human resource management model. Over the past few years many vendors have created different software solutions for recruiting. Some of the available software solutions include, *cBizOne* [12], *Attract Recruiter* [13] and *PCRecruiter* [14].

Most of these solutions provide features such as,

- Employee database with the advanced search option
- Company database with the advanced search option
- Job search capability
- Interview scheduling
- contracts management
- performance reports

These solutions can also be customized wherein any of the above mentioned features can be selected to suit the recruiting company's business needs. A package that includes a minimum set of features could cost approximately $1000 per user. A small-size consulting firm has a minimum of 5 to 10 administrators who need to be registered users for the application products, in order to perform different tasks needed for their consulting firm. Additional features such as automated e-mail notification and calendar updates can be added for an additional price, which makes this an increasingly expensive product to purchase.

This project implements features such as employee database, company management, interview planning and scheduling, job vacancies and contract management and performance review reports, that are required to perform most of the operations in an IT consulting firm.

3. DESIGN OF THE PROJECT

A consulting firm has three kinds of users that access the system, the Employee Applicant, the Employer Contact and the Administrator. **Employee Applicants** are those who apply for the jobs through the consultancy. The Applicant can update the existing details in the Applicant's database including their personal information, skills and resume. Client is the company that seeks the services of the employees of a consulting firm. A client firm may have many employees, **Employer Contacts**, which require access to the system in order to add or update job or company information. The **Administrator** matches the skills of its employee with the skills required by the client company for a particular job and arranges an interview between the client contact and the Applicant. After a successful interview process, the Administrator will facilitate the consummation of the contract between the employee and employer.

To design the application, the relational database must be designed first. The **data model** and the **process model** are part of the design process. The data model focuses on how the database is structured while the process model deals with how the data is processed. In the context of the relational database, the data model is used to design the relational tables and the process model is used to design the queries that access and perform operations on those tables.

3.1. DATA MODEL

Data modeling is performed during the initial phases of the database development process. The data model focuses mainly on what information should be stored in the database. The information needed to build the data model is gathered during the requirement analysis. A comprehensive data model should take into account the current and future needs of an organization in order to support the business process within an organization.

To develop an effective web-based application for Human Resource Management, a consulting firm must maintain accurate and up to date information about companies and their prospective jobs as well as potential employees, including their skills and availability for employment.

In order to accommodate the above requirements a data model must be designed that captures the essential entities and relationship that are present in a Human Resource Management application. An Entity Relationship Diagram (ERD) gives a graphical representation of the tables (entities) in the database and the relation between them.

The entities are represented by a "rectangle", while a "diamond" represents the relation between them and a diamond within a rectangle represents an associate entity. The cardinality is the frequency of a relationship between two entities. The types of cardinality are

- **one to one** (1:1), every record in entity A matches exactly one record in entity B and every record in B matches exactly one record in A,
- **one to many** (1: M), every record in A matches zero or more records in B and every record in B matches exactly one record in A, and
- **many to many** (M: M), every record in A matches zero or more records in B and every record in B matches zero or more records in A.

If there is a many to many relationship between two entities, then the relationship between them is represented as Associative Entities. Figure 1 shows the data model for this application.

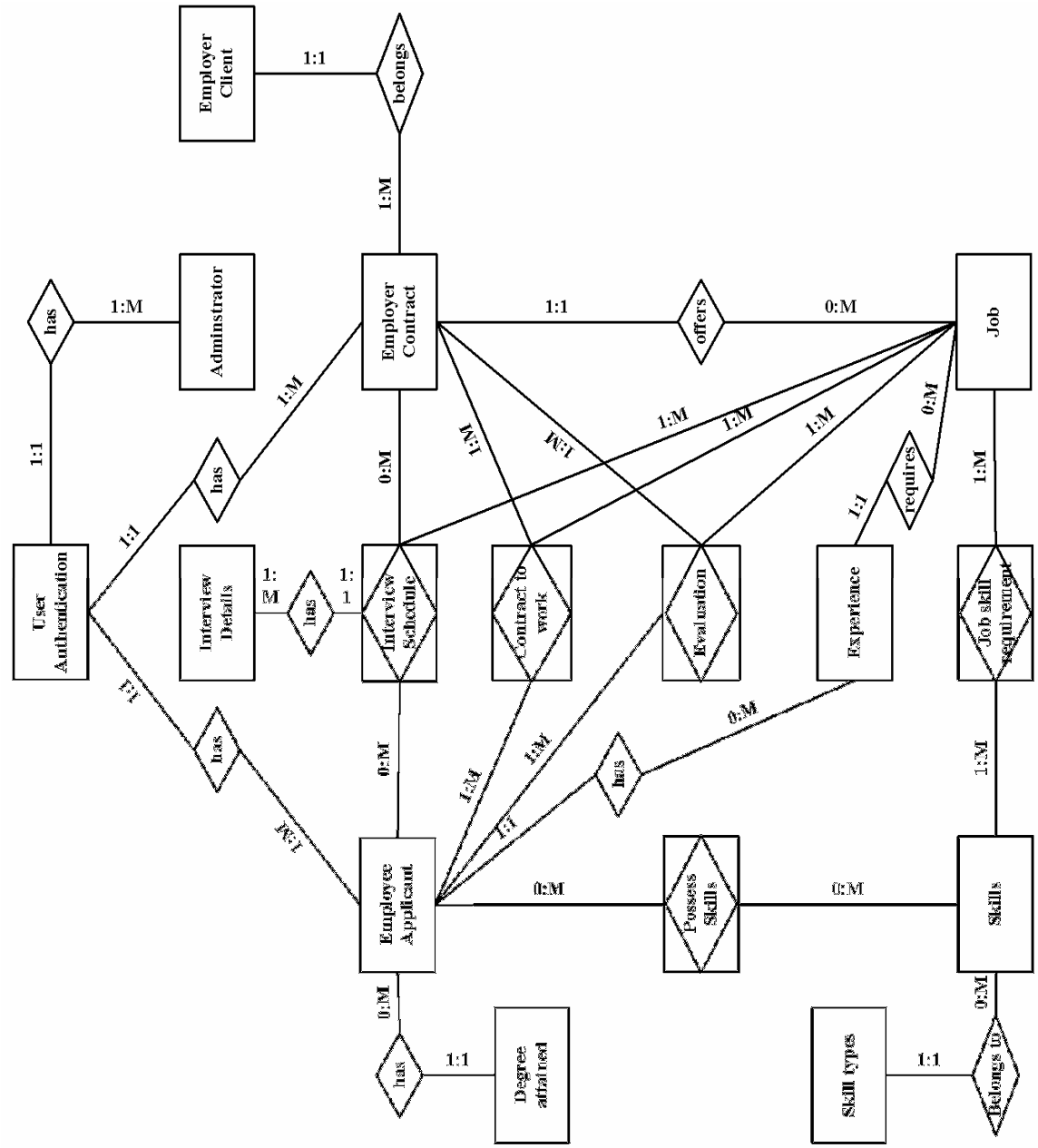


Figure 1 Entity-Relation Diagram

In order to protect access to the system, the users such as Employees, Administrator, and Employers must first be authenticated. An Employee Applicant updates his/her skill and personal information including the degree attained and experience. An Employer Contact adds a new job including details like the skill requirements for the job, the start and the end date, the experience required and the number of vacancies. An Administrator schedules an interview for an Applicant, who

possesses the skills required for the job. Upon a successful interview, the Applicant and the Contact enter into a contract for the job. After completion of the job, Employee Applicant is evaluated on his/her performance.

3.1.1 Database Design

In the Relational Database model, each of the entities including the Associate entities is transformed into a table. The attributes (fields) of each of the entities for the ERD shown in Figure 1 are as follows.

USER AUTHENTICATION

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	USERID	INT	10	PRIMARY KEY
2	USERNAME	CHAR	20	
3	PASSWORD	CHAR	20	
4	ROLE	CHAR	20	Applicant, client or administrator
5	ACTIVE	YES/NO		user has an active login

The "role" in the above table describes the relationship of the user with the firm, whether the user is an applicant or a client or the administrator in the firm.

EMPLOYEE APPLICANT

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	APPLICANT ID	INT	10	PRIMARY KEY (USERID FOREIGN KEY)
2	FIRST NAME	CHAR	25	
3	LAST NAME	CHAR	25	
4	MIDDLE NAME	CHAR	25	
5	ADDRESS	CHAR	50	
6	CITY	CHAR	50	
7	STATE	CHAR	10	
8	ZIP	INT	5	
9	DAY PHONE	INT	10	
10	EXTENSION	INT	6	
11	HOME PHONE	INT	10	
12	EMAIL	CHAR	40	
13	GENDER	CHAR	10	
14	DATE OF BIRTH	DATE		
15	MARITAL STATUS	CHAR	15	
16	DEGREE ATTAINED	CHAR	25	FOREIGN KEY
17	EXPERIENCE	INTEGER		FOREIGN KEY
18	RESUMESIZE	INTEGER		File size of the resume
19	RESUME	Doc file		

APPLICANT SKILLS

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	APPLICANT ID	INT	20	PRIMARY KEY / FOREIGN KEY
2	SKILLSID	INT	10	PRIMARY KEY/FOREIGN KEY

DEGREE ATTAINED

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	DEGREE	VARCHAR	100	PRIMARY KEY
2	SORT ORDER	INT	10	

WORK EXPERIENCE

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	EXPERINENCEID	INT	10	PRIMARY KEY
2	EXPERIENCE	VARCHAR	100	

SKILLS

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	SKILLID	INT	10	PRIMARY KEY
2	SKILLNAME	CHAR	25	
3	SKILLTYPEID	INT	10	FOREIGN KEY

SKILL TYPE

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	SKILLTYPEID	INT	10	PRIMARY KEY
2	SKILLTYPENAME	CHAR	20	Tech, communication, etc
3	INFORMATION	CHAR	30	

ADMINISTRATOR

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	ADMINISTRATOR ID	INT	10	PRIMARY KEY (USERID FOREI GN KEY)
2	FIRST NAME	CHAR	25	
3	LAST NAME	CHAR	25	
4	MIDDLE NAME	CHAR	25	
5	ADDRESS	CHAR	50	
6	CITY	CHAR	30	
7	STATE	CHAR	10	
8	ZIP	INT	5	
9	DAY PHONE	INT	10	
10	EXTENSION	INT	6	
11	HOME PHONE	INT	10	
12	EMAIL	CHAR	40	
13	GENDER	CHAR	10	
14	DATE OF BIRTH	DATE		
15	MARITAL STATUS	CHAR	15	

EMPLOYER CONTACT

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	CONTACT ID	INT	10	PRIMARY KEY (USERID FOREIGN KEY)
2	CLIENTID	INT	10	FOREIGN KEY
3	CONTACT NAME	CHAR	25	
4	DESIGNATION	CHAR	40	
5	TELEPHONE	INT	10	
6	EXTENSION	INT	8	
7	FAX	INT	10	
8	EMAIL	CHAR	40	

EMPLOYER CLIENT

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	CLIENT ID	INT	10	PRIMARY KEY
2	COMPANY NAME	CHAR	25	
3	ADDRESS	CHAR	40	
4	CITY	CHAR	25	
5	STATE	CHAR	25	
6	ZIP	INT	5	

JOB

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	JOB ID	INT	10	PRIMARY KEY
2	CONTACT ID	INT	10	FOREIGN KEY
3	START DATE	DATE		
4	END DATE	DATE		
5	OPEN	YES/NO		Info indicating if the position is still open
6	EXPERIENCE REQ	INTEGER	10	FOREIGN KEY
7	No OF VACANCIES	INT	10	
8	JOB DESCRIPTION	CHAR	40	

JOB-SKILL REQUIREMENT

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	JOBID	INT	10	PRIMARY KEY/FOREIGN KEY
2	SKILLID	INT	10	PRIMARY KEY/FOREIGN KEY

INTERVIEW SCHEDULE

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	INTERVIEW ID	INT	10	PRIMARY KEY
2	APPLICANT ID	INT	10	FOREIGN KEY
3	JOBID	INT	10	FOREIGN KEY
4	INTERVIEW TYPE	CHAR	25	
5	INTERVIEW DATE	DATE		
6	INTERVIEW TIME	TIME		

INTERVIEW DETAILS

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	INTERVIEWID	INT	10	PRIMARY KEY / FOREIGN KEY
2	INTERVIEW BY	CHAR	25	PRIMARY KEY
3	SELECTED	YES/NO		Info indicating if the applicant was selected in the interview or not
4	ACCEPTED	YES/NO		Info indicating if the applicant accepted the job or not

CONTRACT TO WORK

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	APPLICANTID	INT	10	PRIMARY KEY/FOREIGN KEY
2	JOB ID	INT	10	PRIMARY KEY/FOREIGN KEY
3	START DATE	DATE		
4	END DATE	DATE		
5	ACTIVE	YES/NO		Set to Yes
6	NEGOTIATED TERMS	TEXT		

EVALUATION

SNO	NAME	DATA TYPE	WIDTH	CONSTRAINTS
1	APPLICANT ID	INT	10	PRIMARY KEY/FOREIGN KEY
2	JOB ID	INT	10	PRIMARY KEY/FOREIGN KEY
3	DATE	DATE		
4	REMARKS BY	VARCHAR	50	PRIMARY KEY
5	REMARKS	TEXT		

3.2. PROCESS MODEL

The Process Model shows the overall functionality of the system. **Functional Decomposition Diagrams** and **Data Flow Diagrams** are two tools for process modeling. The Decomposition Diagram shows a hierarchical structure of the system while the Data Flow Diagram shows the sequence of events of a business operation.

3.2.1. Functional Decomposition Diagram

A Functional Decomposition Diagram shows the hierarchical structure of a system. Its objective is to break down a complex system step by step into small manageable chunks. The Functional Decomposition Diagram generally precedes the Data

Flow Diagram. The Functional Decomposition Diagram for the current application is shown in Figure 2.

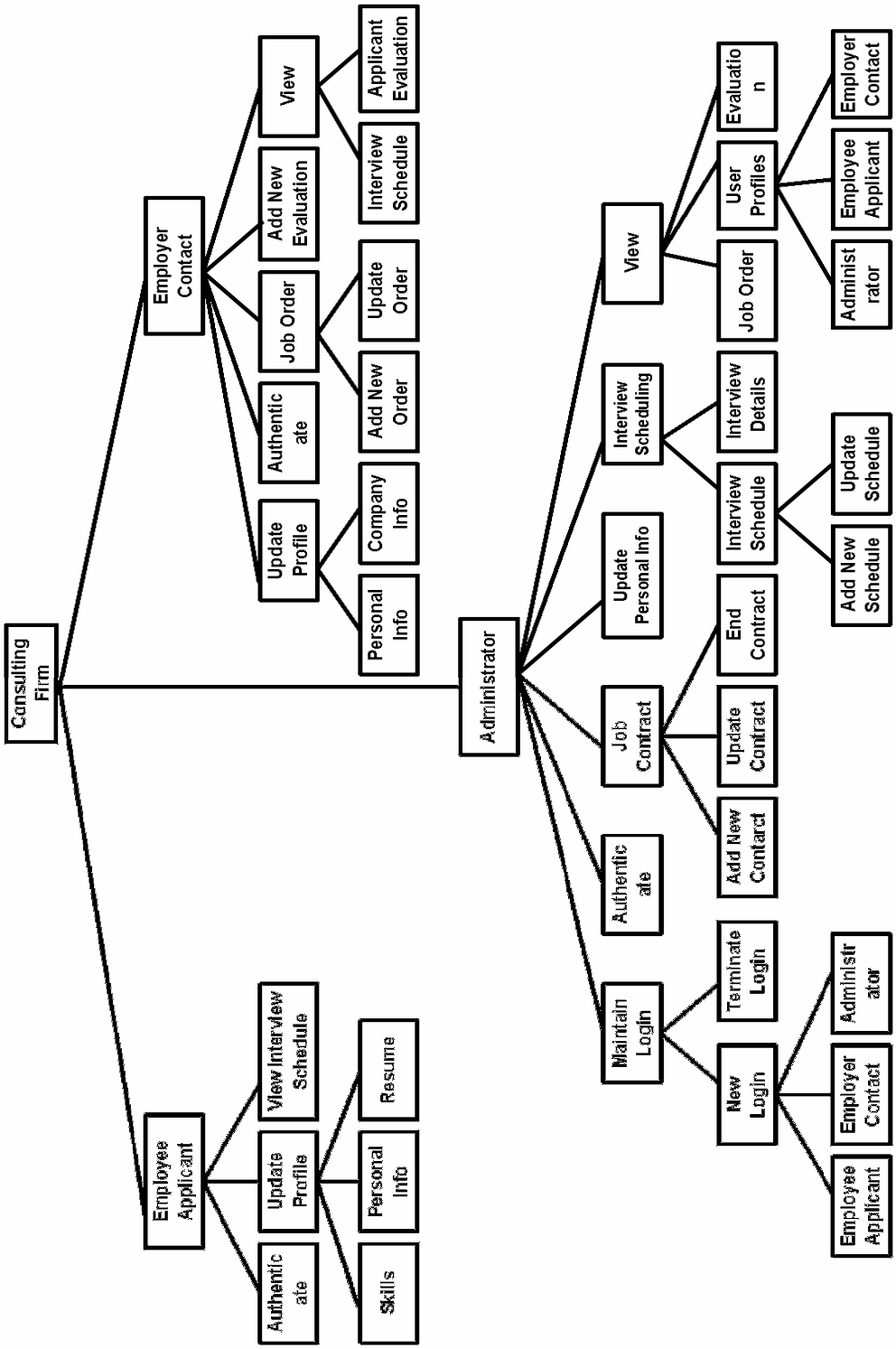


Figure 2 Functional Decomposition Diagram

The application can be divided into three sub systems, Employee Applicant, Administrator and Employer Contact. The **Employee Applicant** can authenticate, update his/her profile and view his/her interview schedule. The **Administrator** can authenticate, update personal information, maintain user's login and view user profile, job order or evaluation. Administrator can also add or update interview schedules, add interview details and add, update or end job contracts. The **Employer Contact** can authenticate, update personal or company information, add or update job orders and add evaluations. The Employer Contact can also view interview schedules and evaluation of an Applicant added by all the Contacts of the company.

3.2.2. Data Flow Diagram

The Data Flow Diagram (DFD) is the graphical representation of the processes and the flow of data among them. A data flow diagram illustrates the processes, data stores, external entities and the connecting data flows in a system. It is a common practice to draw a context-level Data Flow Diagram first which shows the interaction between the system and outside entities. This context-level DFD is then "exploded" into a detailed DFD. Figure 3 is an example of a typical DFD.

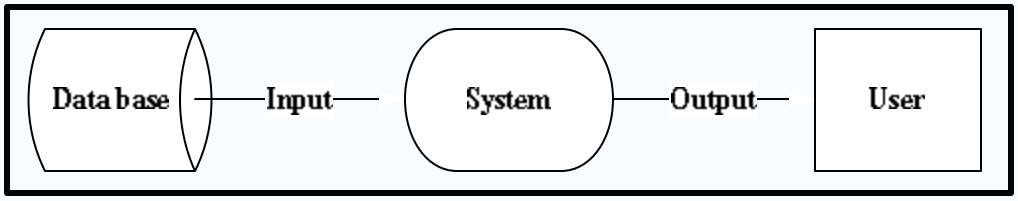


Figure 3 Example of a Data Flow Diagram

There are four components for a Data Flow Diagram. They are

- **External Entities/ Terminators** are outside of the system being modeled. They represent where information comes from and where it goes. These are represented by **rectangles**.
- **Processes**, usually represented by an **ellipse** (circle), which modify the input to generate the output.

- **Data Stores** represents a place in the process where data rests. This is represented by an **open-ended rectangles or a cylinder** symbol.
- **Data Flows**, represented by **arrows**, are how data moves between terminators, processes, and data stores

Figures 4 to 25 are the DFDs for the current system. To gain access to the system the user must first be authenticated. Depending on the role, the user is directed to the respective subsystem. The DFD for the user authentication process is shown in Figure 4.

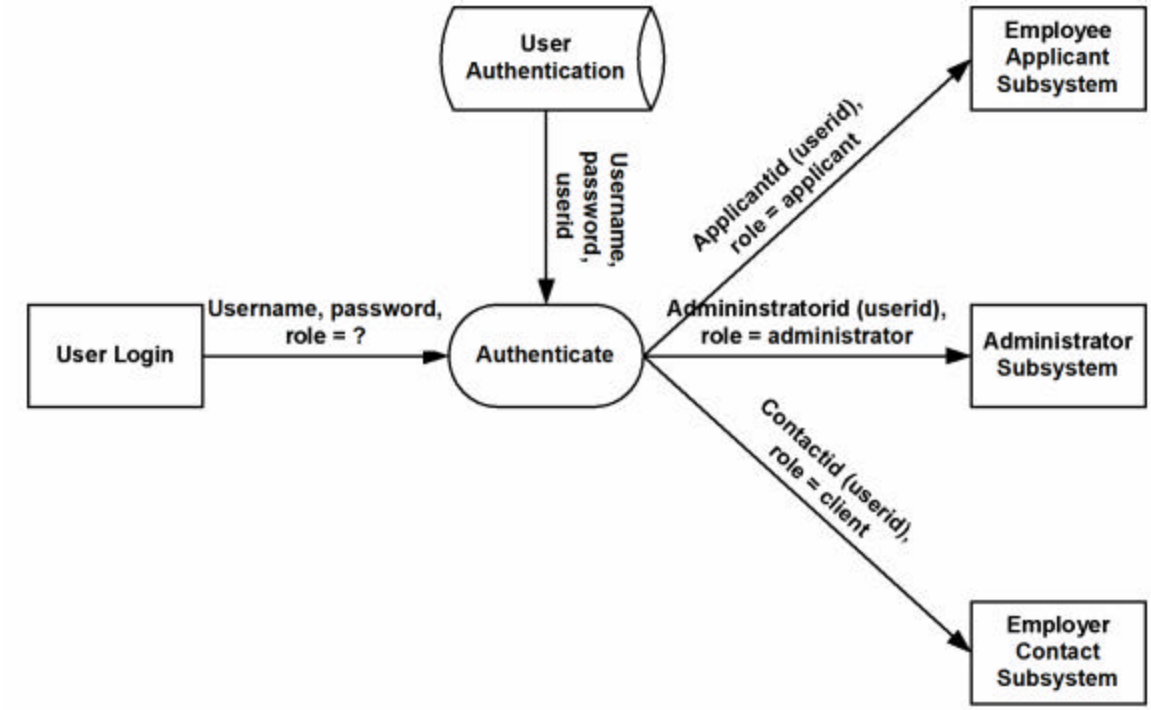


Figure 4 User Authentication DFD

Employee Applicant Subsystem

An authenticated Employee Applicant can update his/her profile or view the interview schedule. The Applicant can either update personal or skill information. The context level and the detailed DFDs for the Employee Applicant update profile process are shown in Figures 5 and 6 respectively.

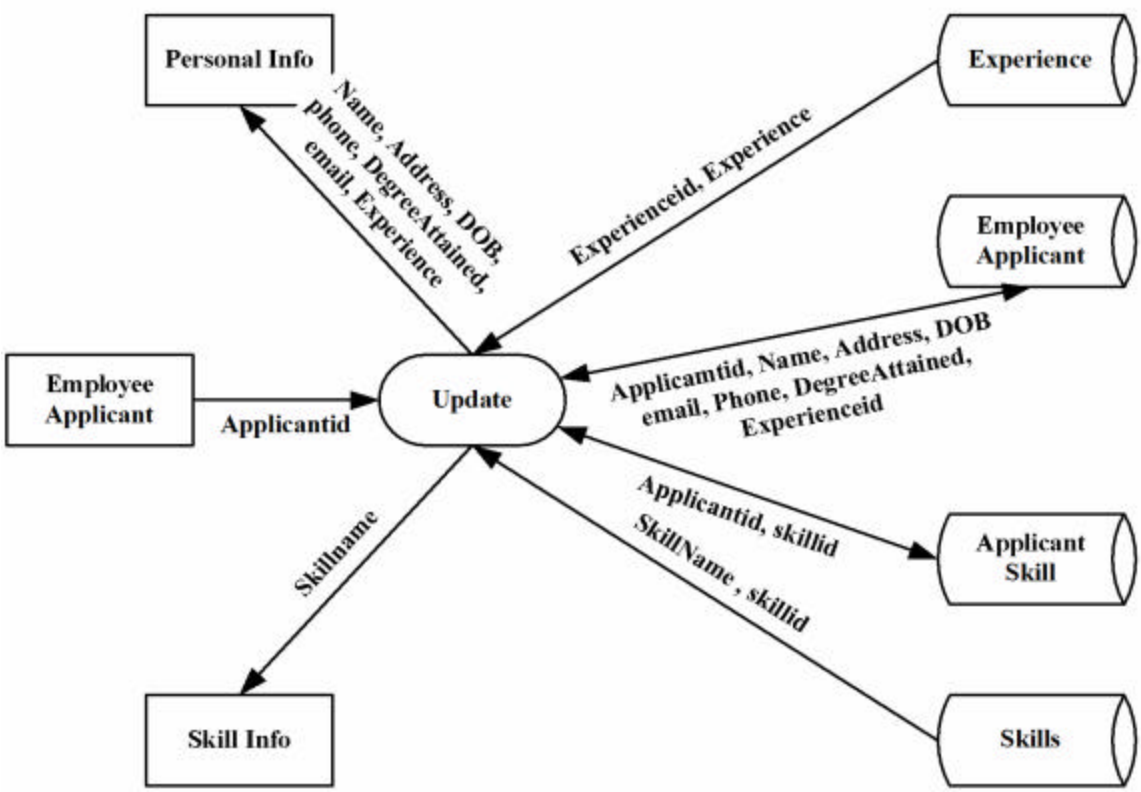


Figure 5 Employee Applicant - Update Profile Context DFD

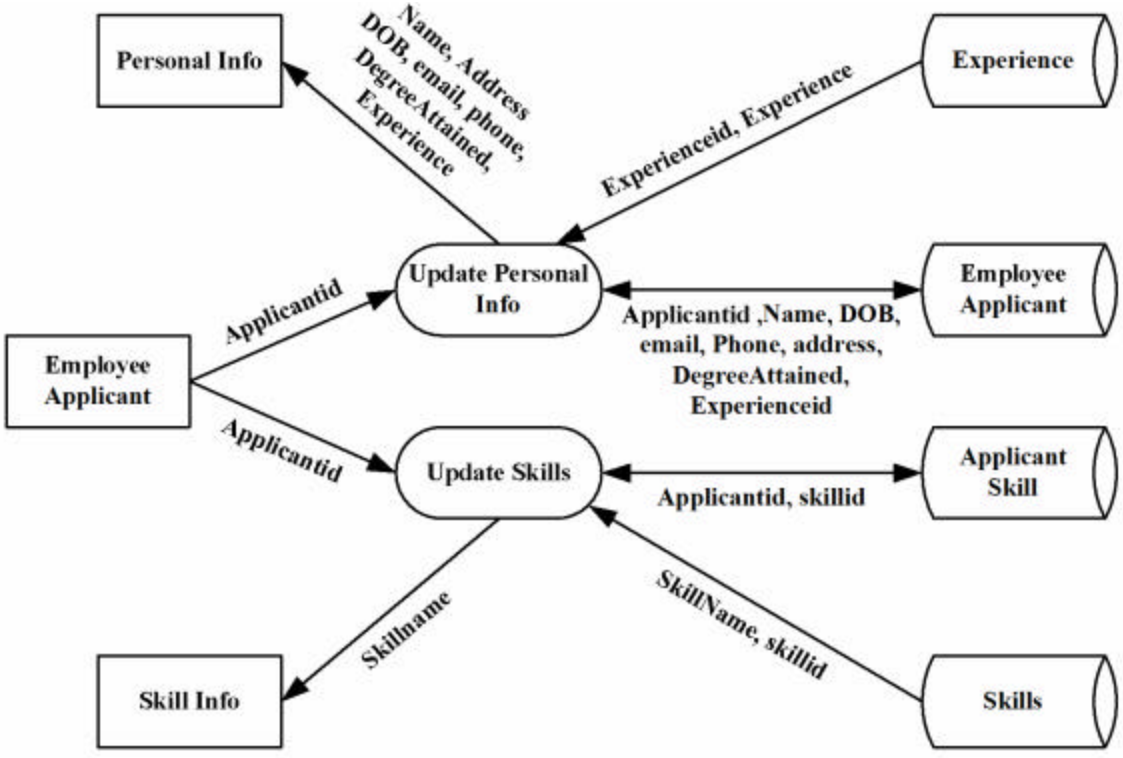


Figure 6 Employee Applicant - Update Profile Detailed DFD

An authenticated Applicant can view information about any scheduled interview, along with the relevant details of the corresponding job. The DFD for the interview schedule process is shown in Figure 7.

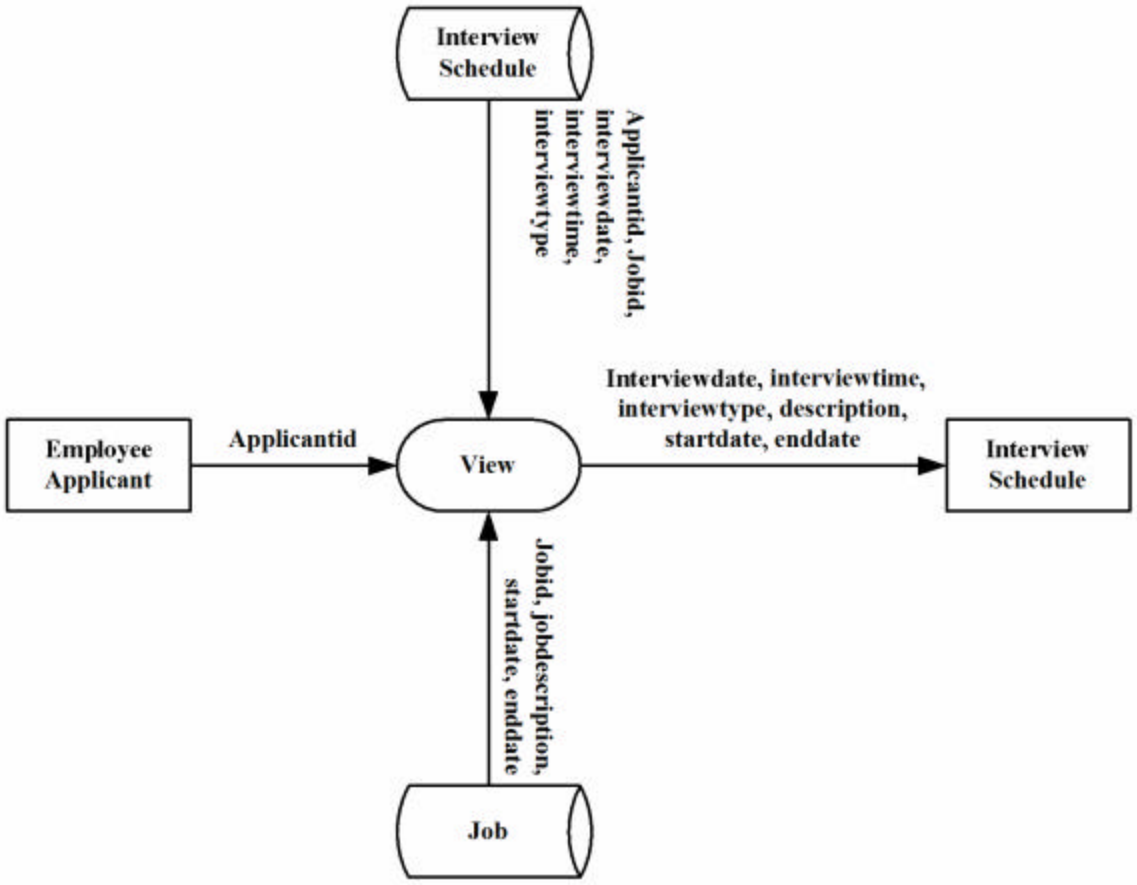


Figure 7 Employee Applicant - View Interview Schedule DFD

Administrator Subsystem

An authenticated Administrator can update personal information and maintain logins, interview scheduling and job contracts. The Administrator can also view user profiles, job orders and evaluations of Applicants. The DFD for the Administrators update personal information process is shown in Figures 8.

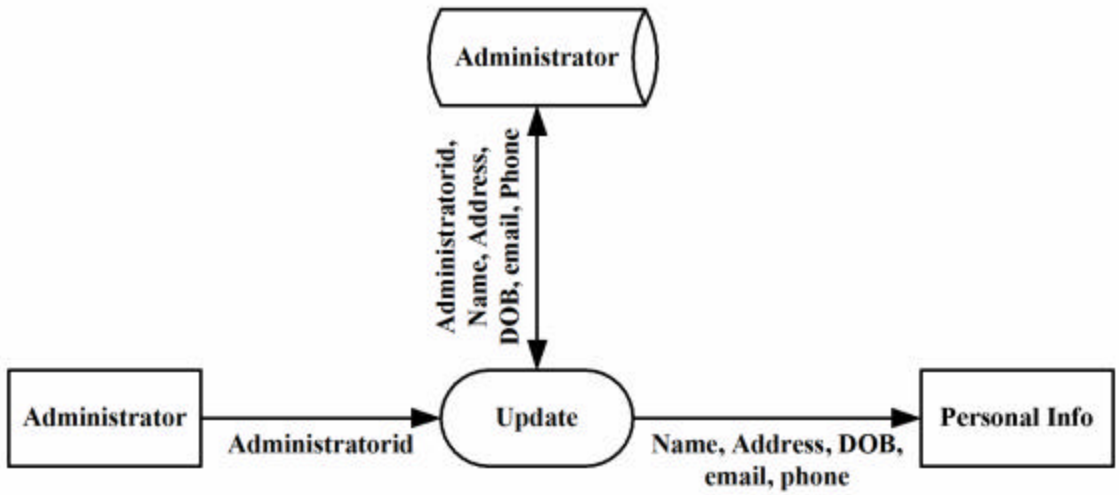


Figure 8 Administrator - Update DFD

An authenticated Administrator can create new user profiles and logins or terminate existing logins. The context level and the detailed DFDs for the creation of a new login is shown in Figures 9 and 10 respectively, while the DFD for terminating a user login is shown in Figure 11.

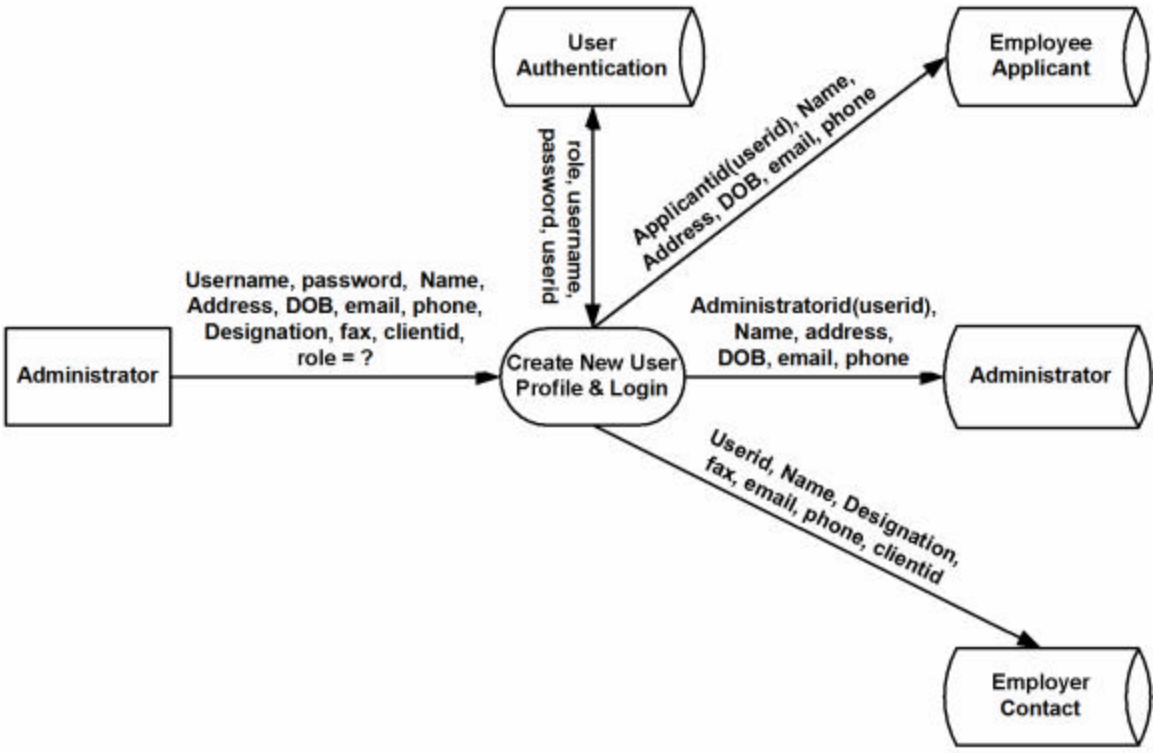


Figure 9 Administrator – Create New User Profile Context DFD

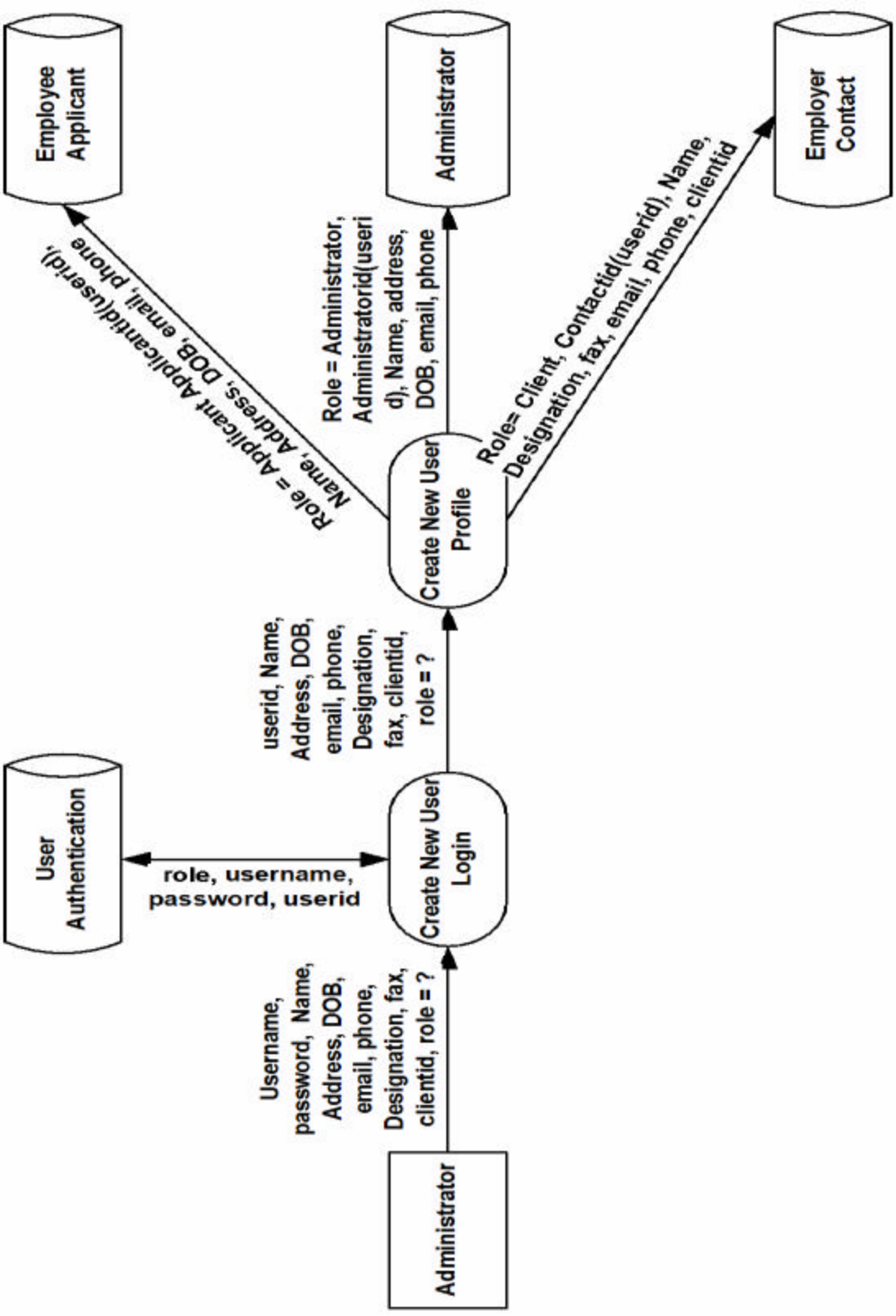


Figure 10 Administrator – Create New User Profile Detailed DFD

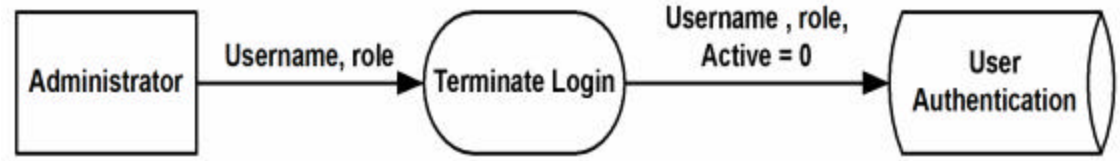


Figure 11 Administrator - Terminate User Login DFD

An authenticated Administrator can maintain details of an interview process. Administrator can add a new interview schedule or update an existing interview schedule. After the interview is conducted, the Administrator can then add the details of this interview. The context level and the detailed DFDs for the interview schedule process are shown in Figures 12 and 13 respectively, while the DFD for adding the interview details is shown in Figure 14.

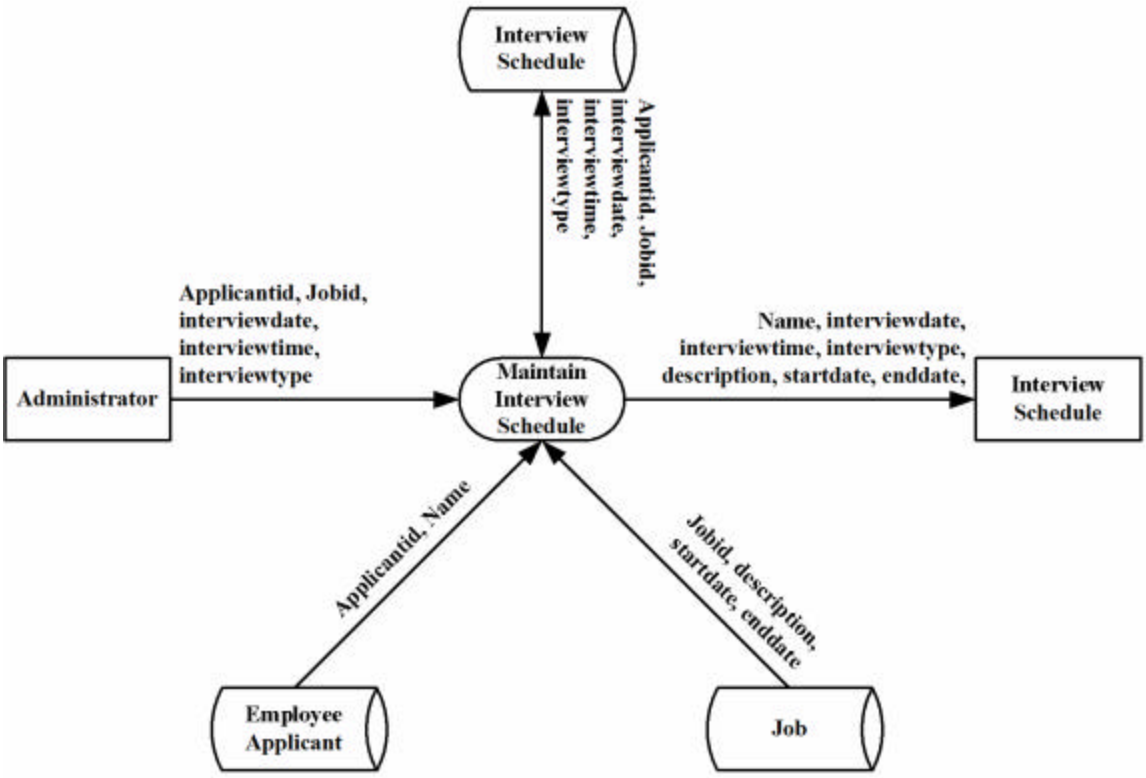


Figure 12 Administrator - Interview Schedule Context DFD

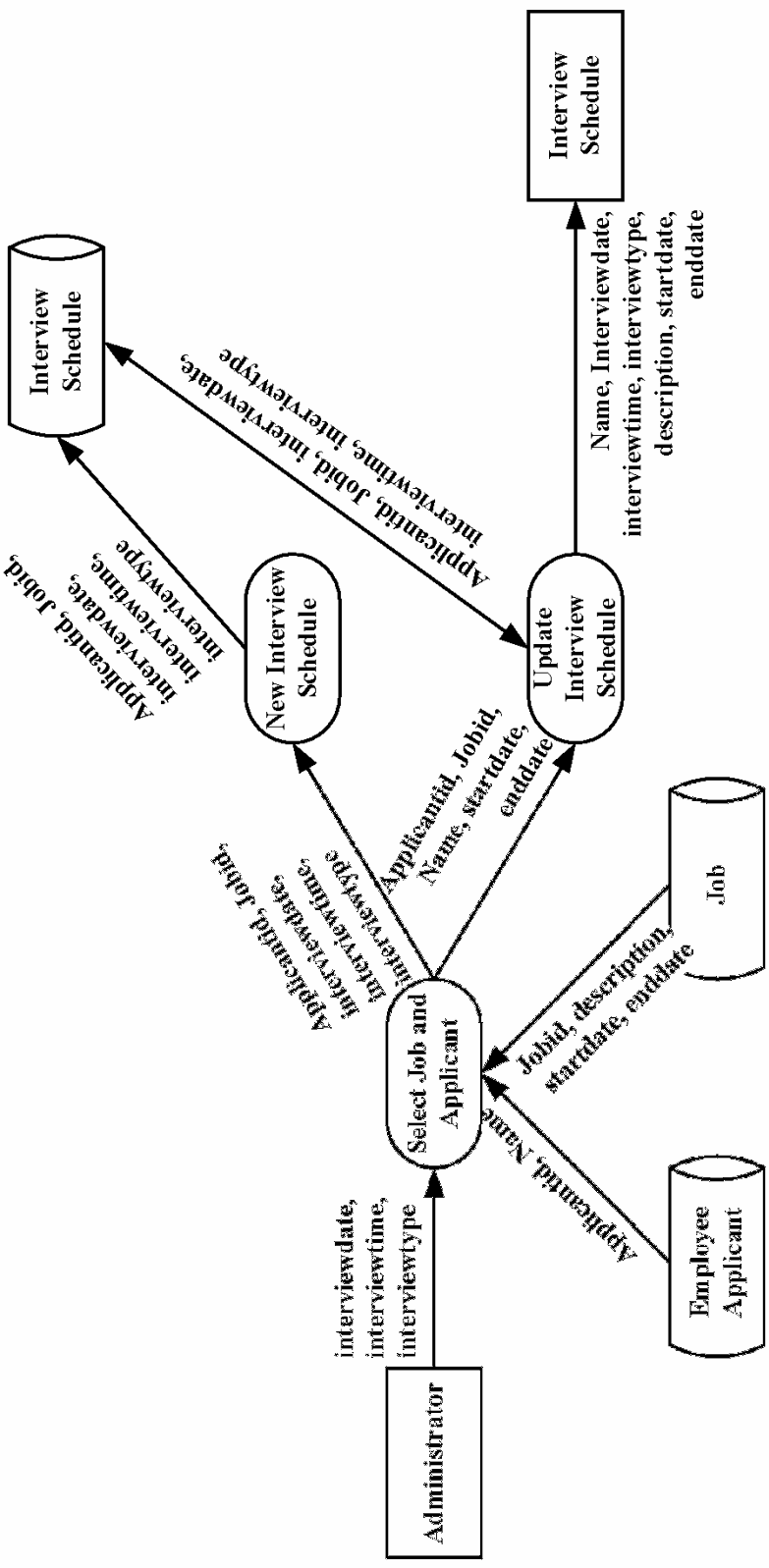


Figure 13 Administrator - Interview Schedule Detailed DFD

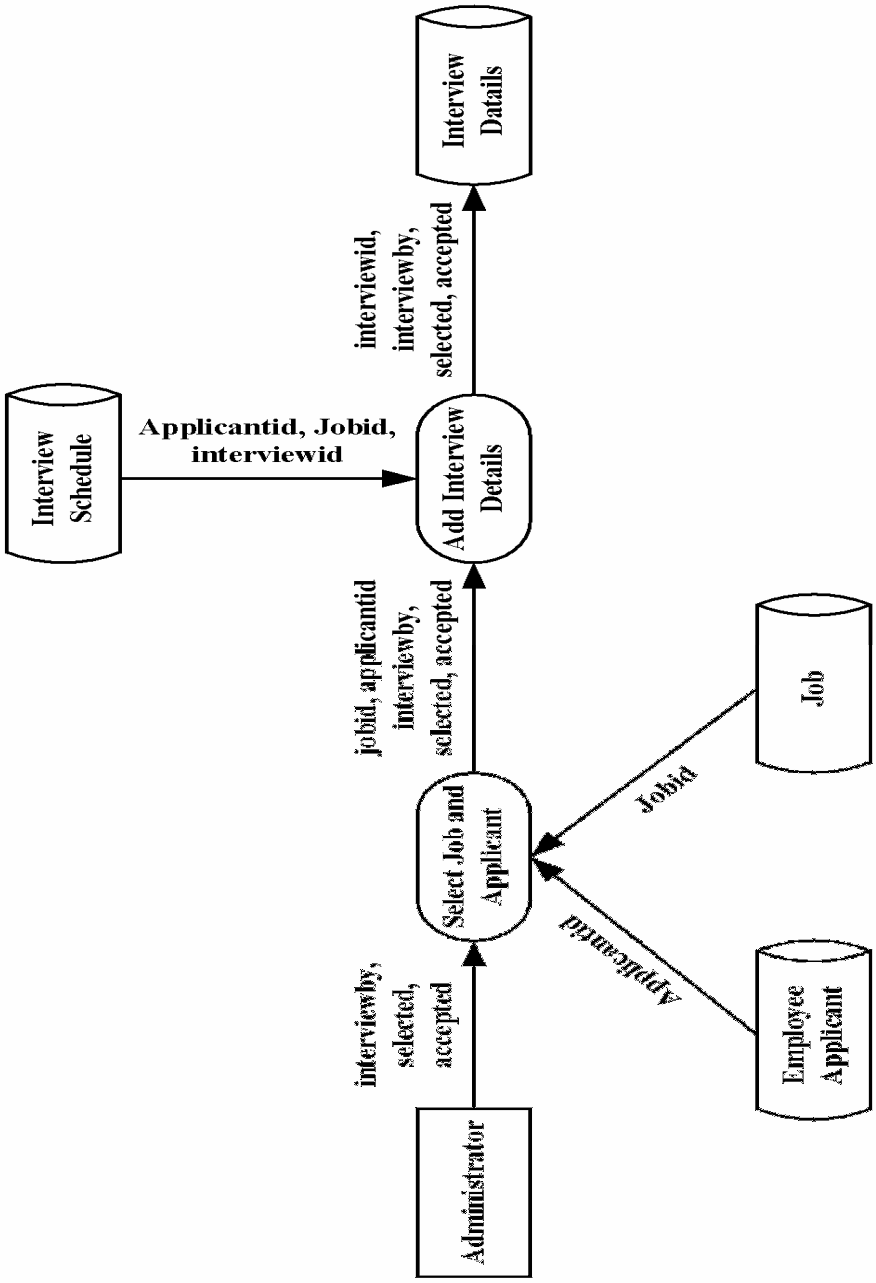


Figure 14 Administrator - Add Interview Detail DFD

An authenticated Administrator can add a new job contract and update or end an existing job contract. The context level and the detailed DFDs for the maintenance of the job contract process are shown in Figures 15 and 16 respectively.

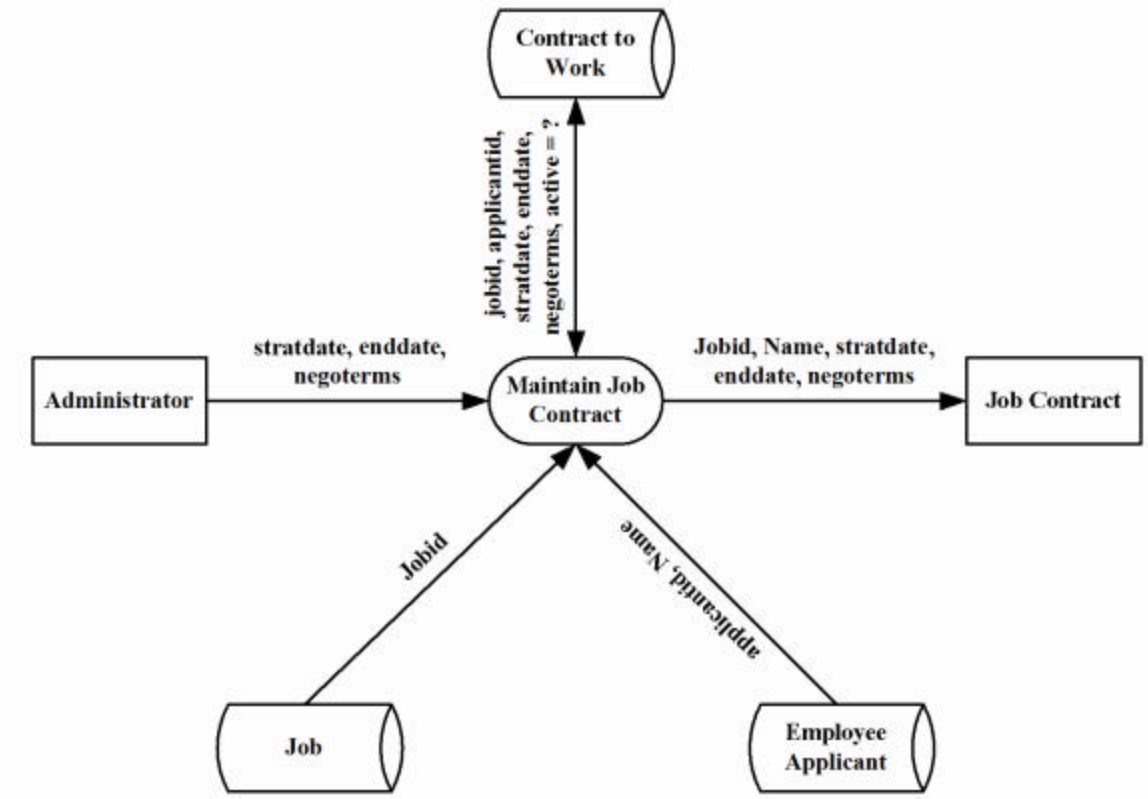


Figure 15 Administrator - Maintain Job Contract Context DFD

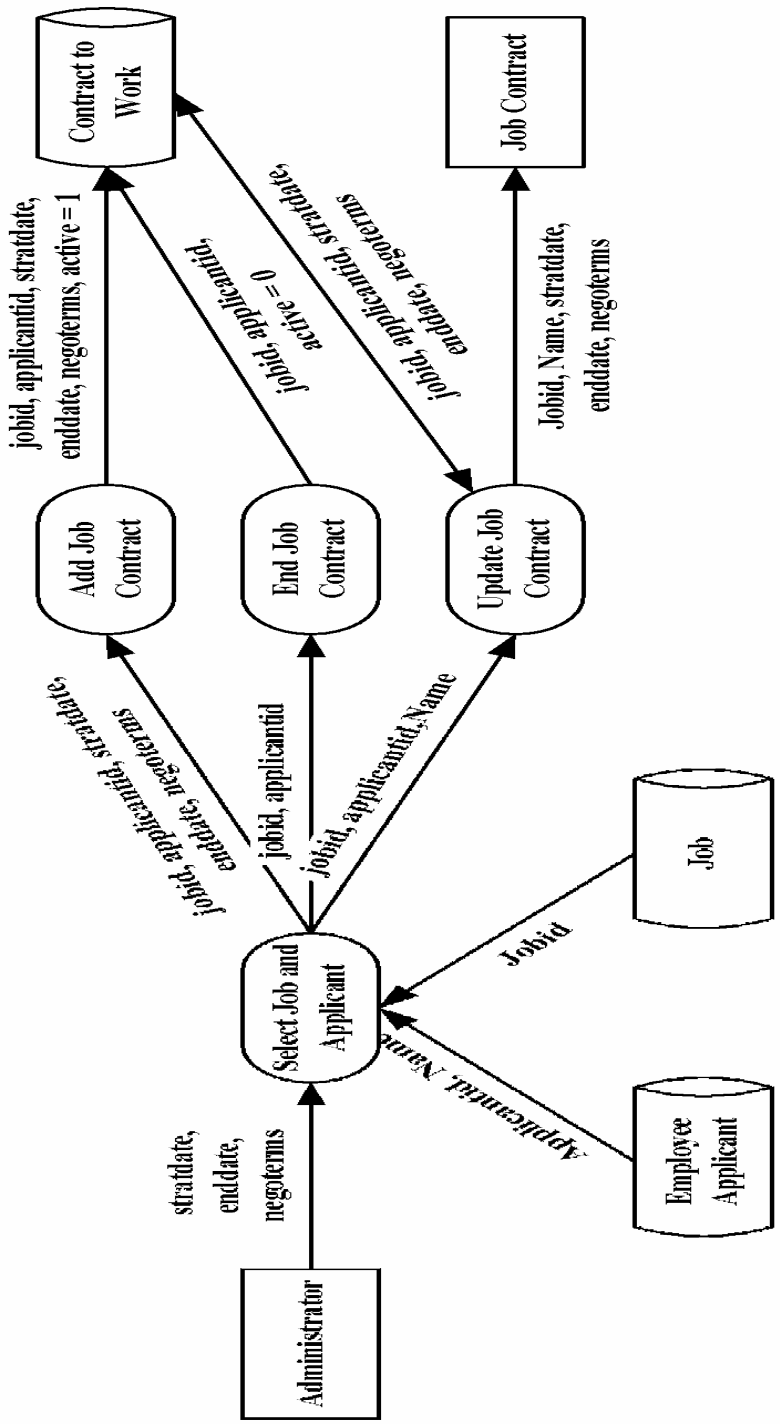


Figure 16 Administrator - Maintain Job Contract Detailed DFD

An authenticated Administrator can also view information about a job or the evaluations of an Employee Applicant completed by the Employer Contract. The process of viewing a job order and evaluation are shown in Figures 17 and 18 respectively.

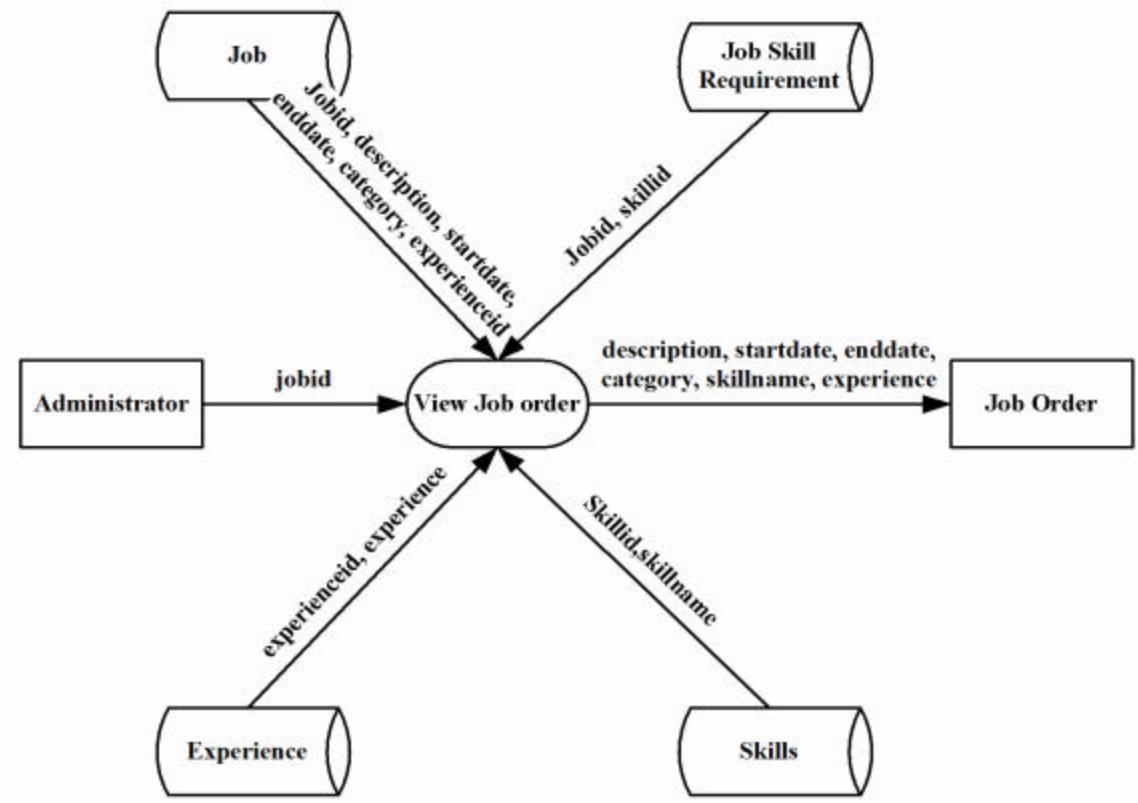


Figure 17 Administrator - View Job Order DFD

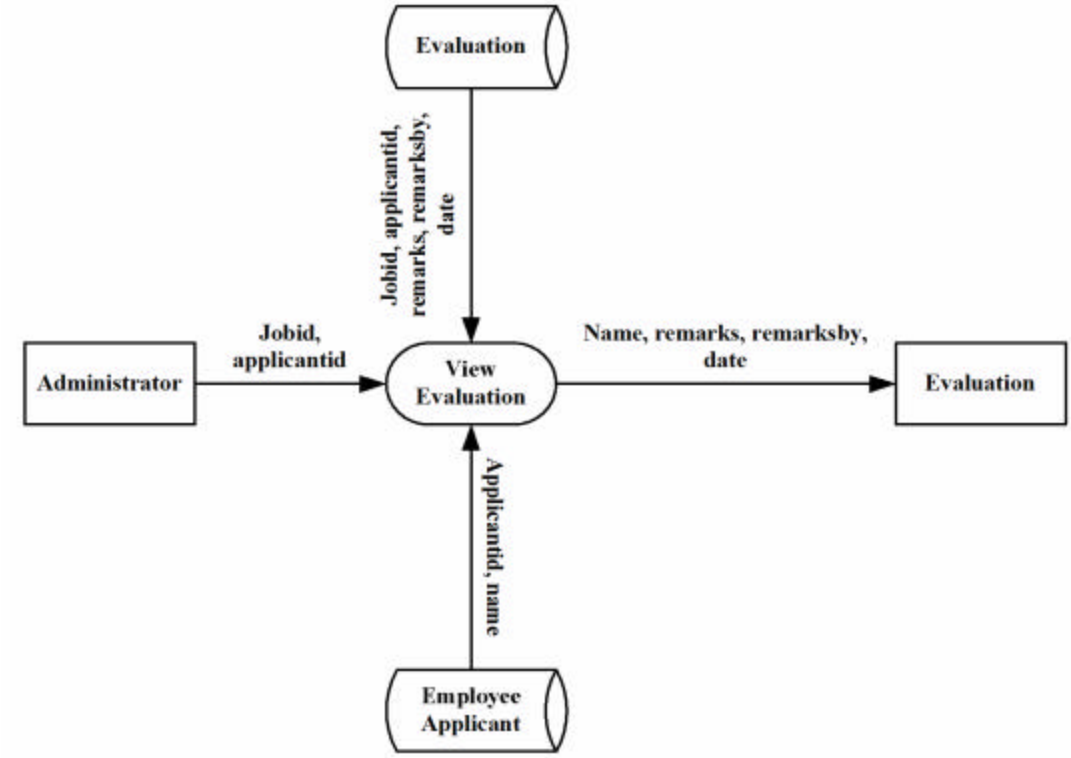


Figure 18 Administrator - View Evaluation DFD

Employer Contact Subsystem

An authenticated Employer Contact can update either his/her personal or company information, maintain job orders and add performance evaluations. The context level and the detailed DFDs for the Contact update profile are shown in Figures 19 and 20 respectively.

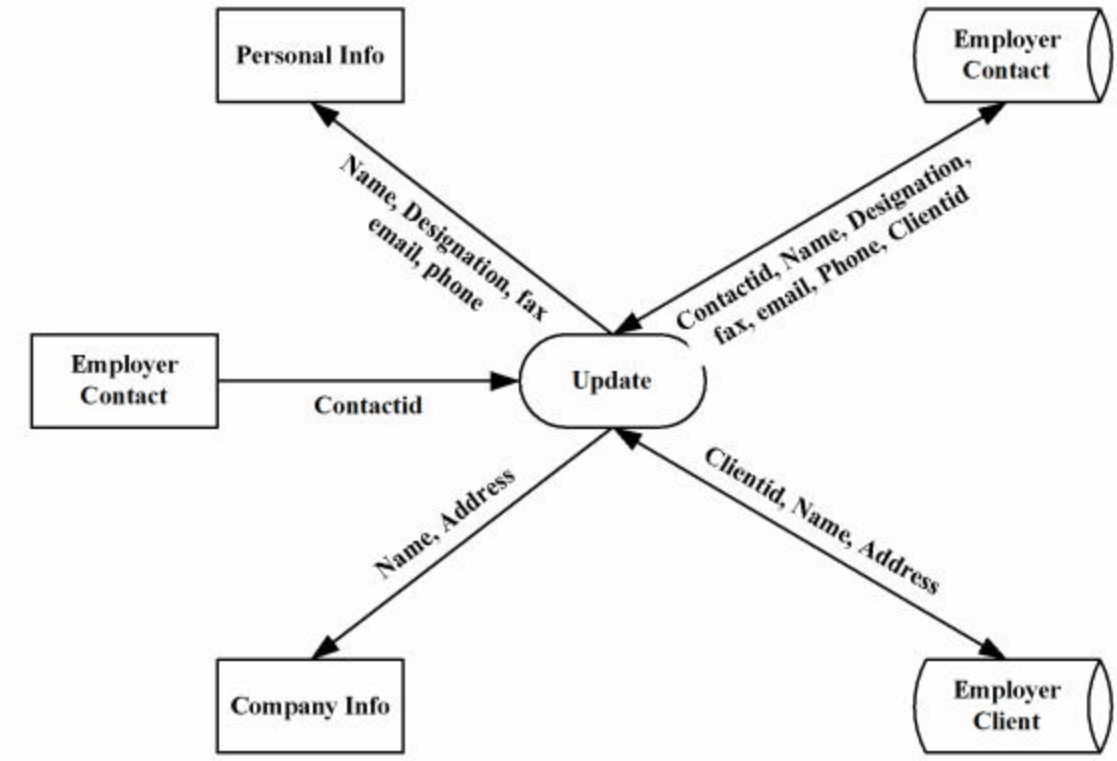


Figure 19 Employer Contact - Update Context DFD

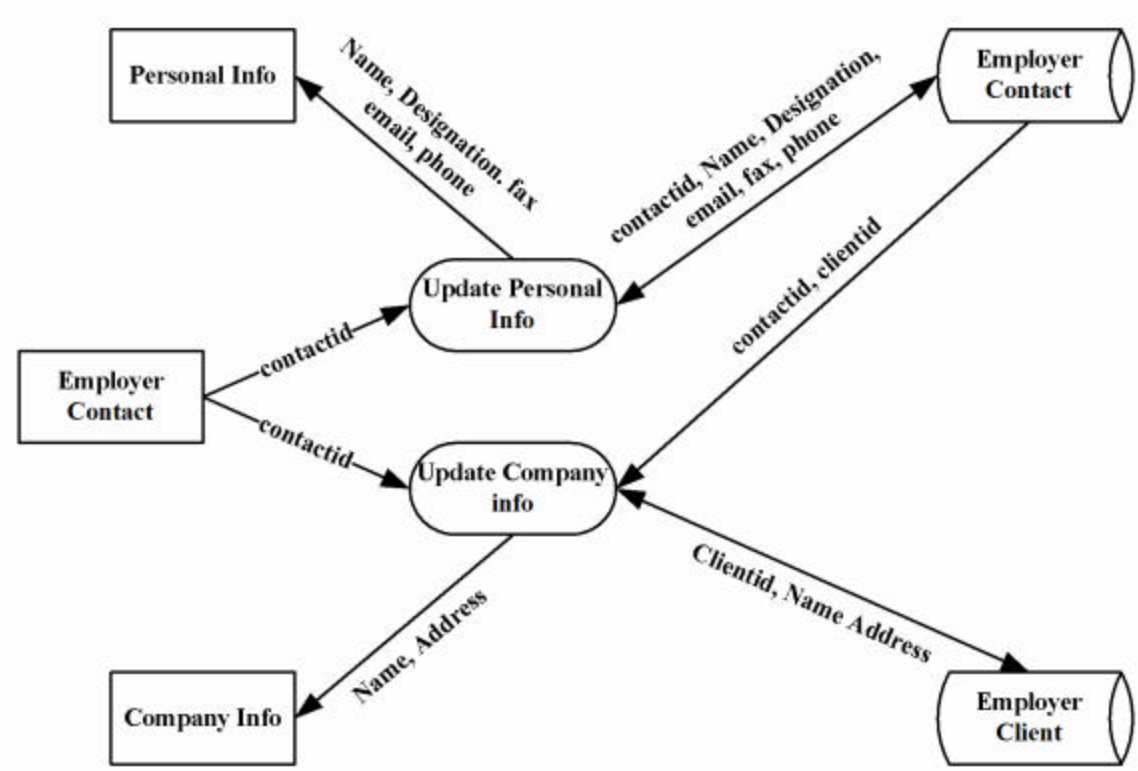


Figure 20 Employer Contact - Update Detailed DFD

An authenticated Contact can either add a new job order or update an existing job order. The context level and the detailed DFDs for the maintenance of the job order process are shown in Figures 21 and 22 respectively.

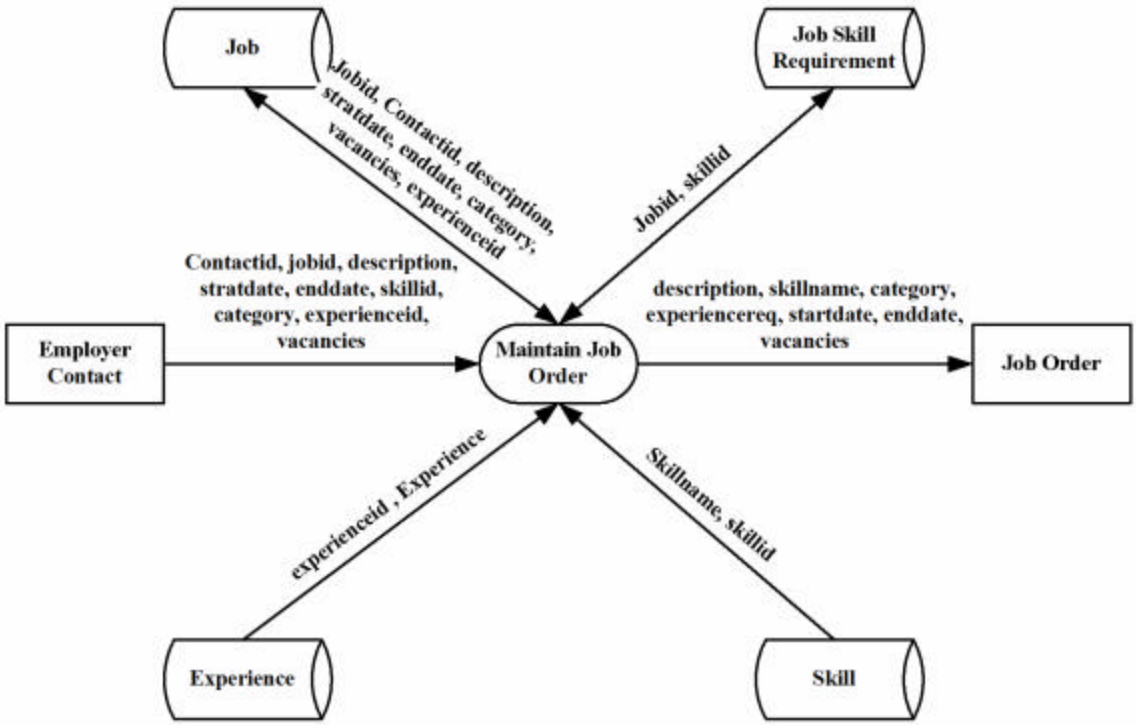


Figure 21 Employer Contact - Job Order Context DFD

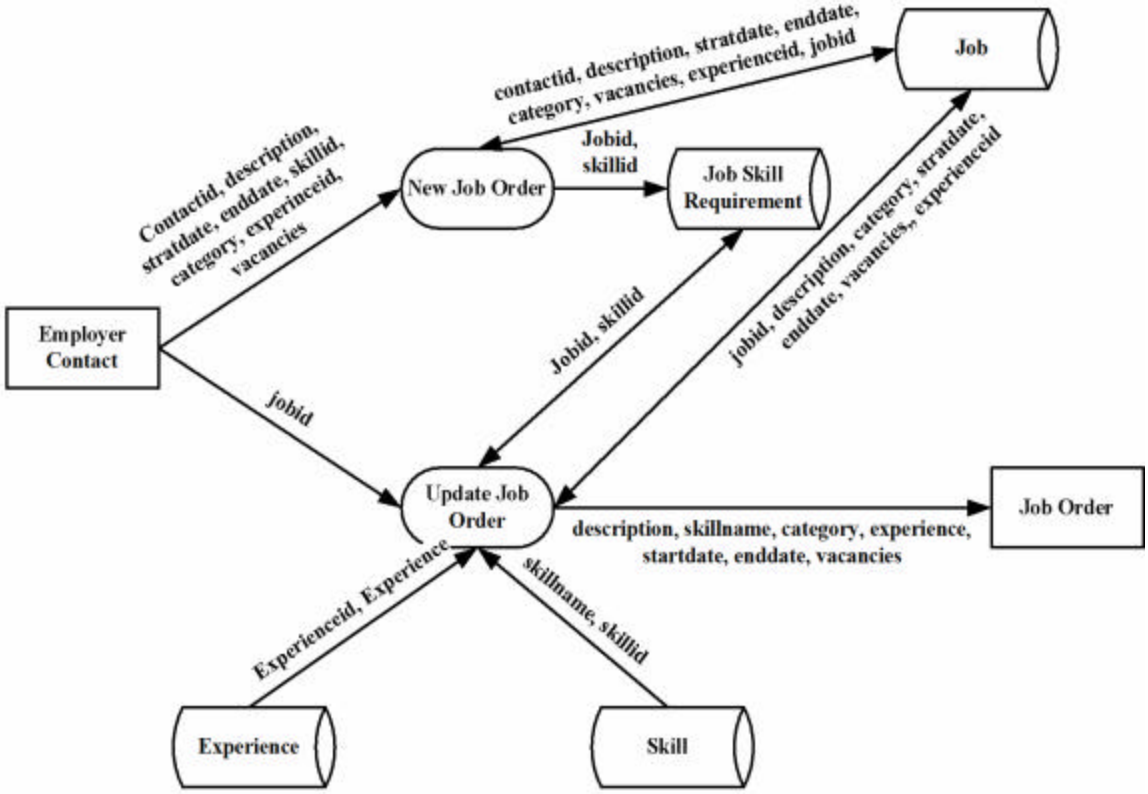


Figure 22 Employer Contact - Job Order Detailed DFD

Upon completion of the project (job), a Contact can evaluate the performance of the Applicant. The DFD for adding a new evaluation is shown in Figure 23.

Figure 23 Employer Contact - Add Evaluation DFD

An authenticated Contact can view the evaluations of an Applicant that were added for any job and by any Contact of the Company. They can also view information about any scheduled interviews. The processes of viewing evaluation for the Applicant and interview schedules are shown in Figures 24 and 25 respectively.

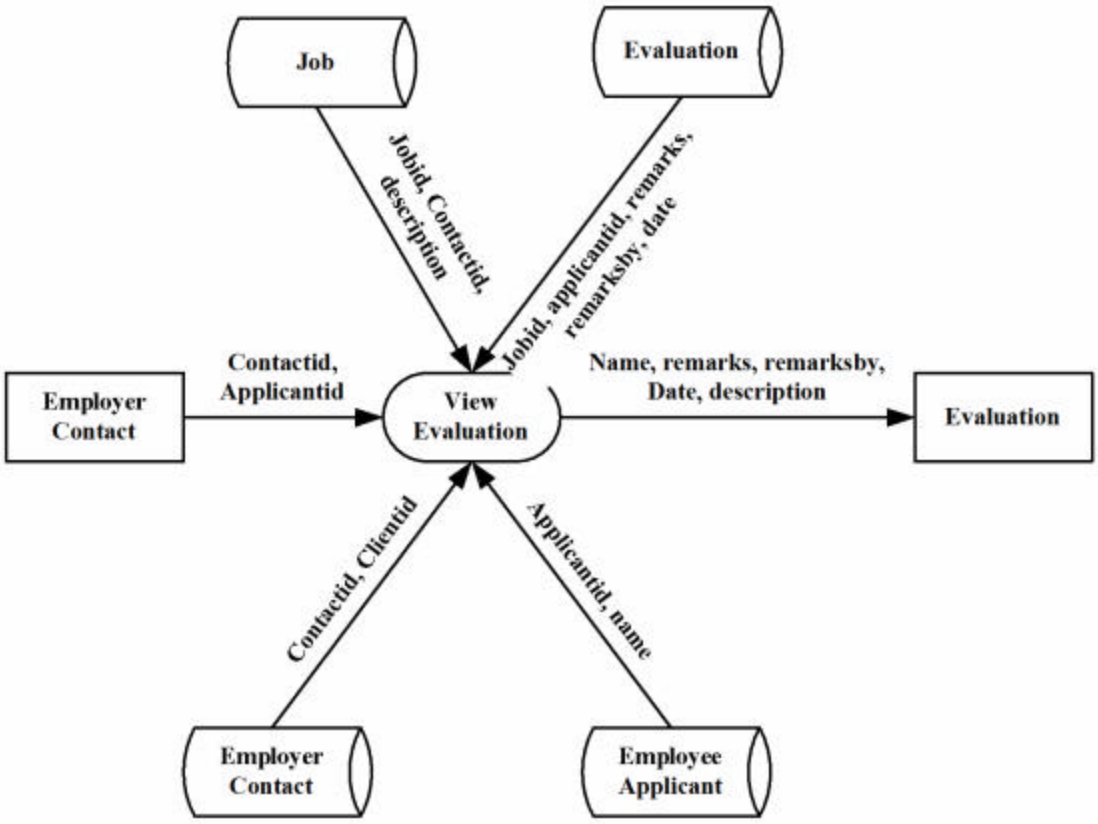


Figure 24 Employer Contact - Employee Applicants Evaluation

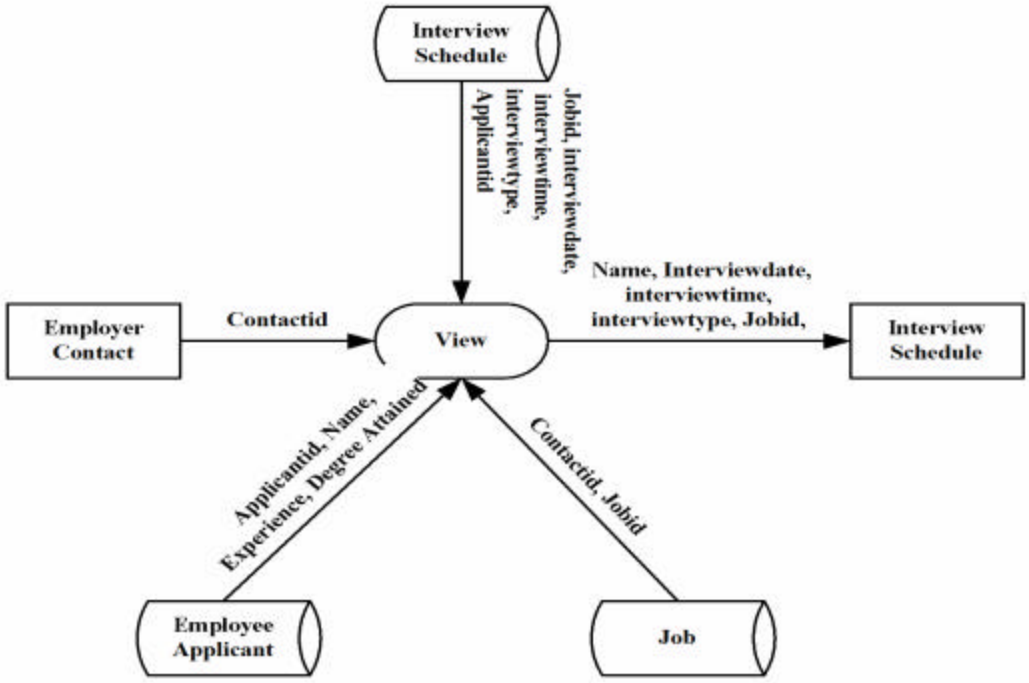


Figure 25 Employer Contact - View Interview Schedule

3.3. USER INTERFACE DESIGN

Before implementing the application, the layouts for few a pages were designed. Having these designs provided a guideline for developing the user interface of the application and helped in actual implementation. The initial layouts of the pages are shown in Figures 26 to 30.

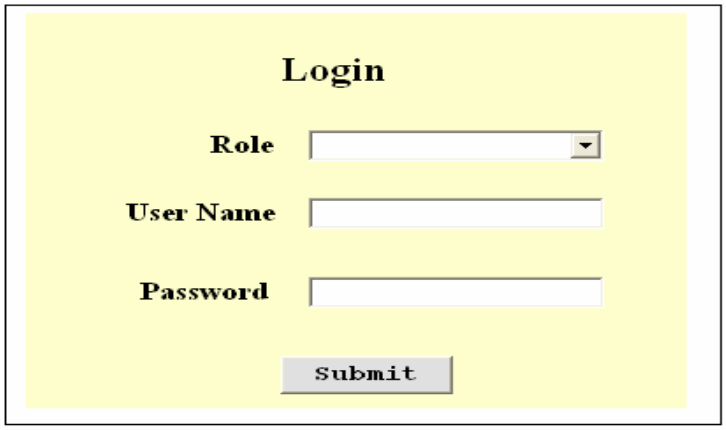


Figure 26 Login Form

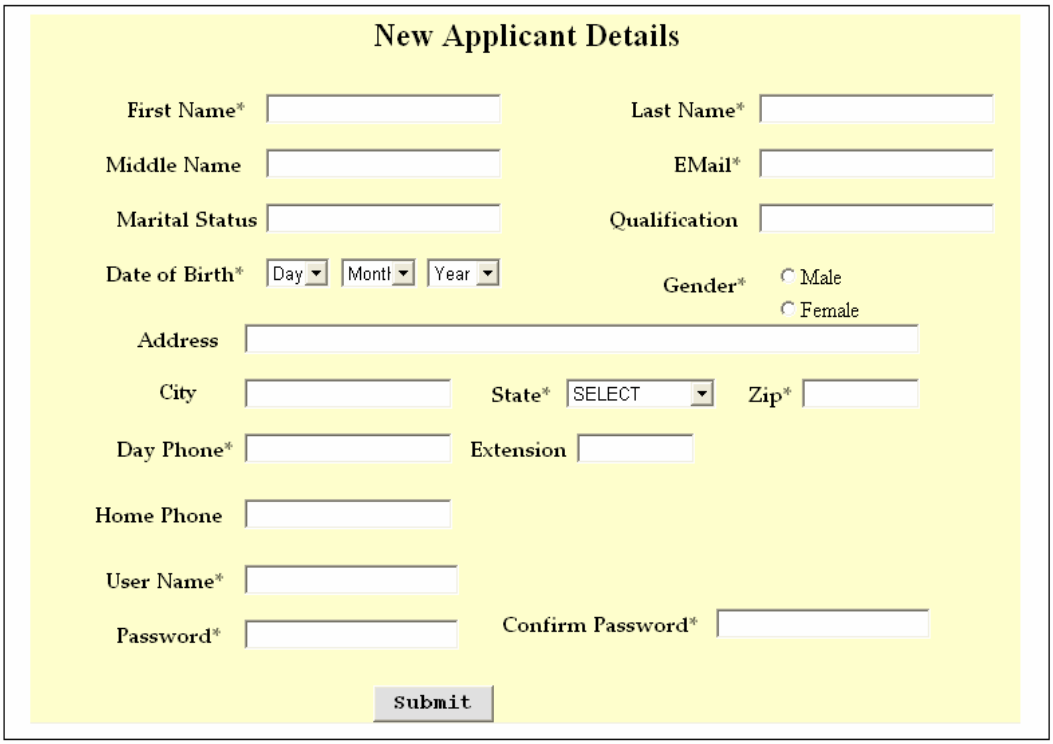


Figure 27 Employee Applicant Registration Form

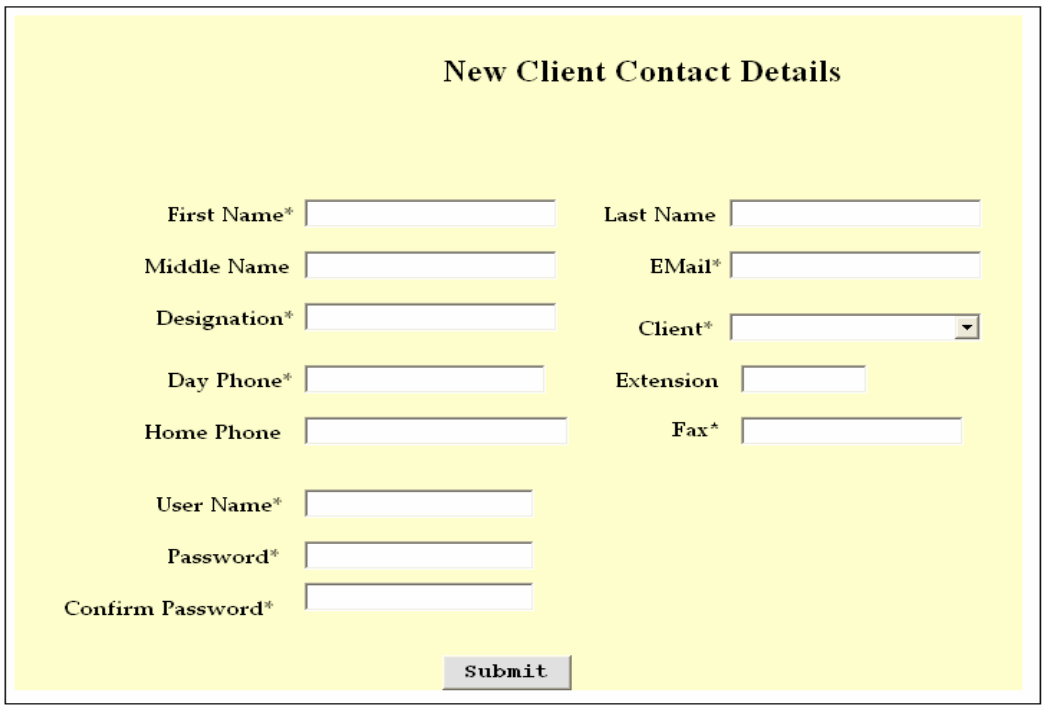


Figure 28 Employer Contact Registration Form

Figure 29 Job Order Entry Form

Figure 30 Job Contract Form

4. PROPOSED SYSTEM

To implement a web application client-server architecture is required. The most popular client-server architectures are the two-tier and the three-tier architecture. The choice of architecture affects the development time and the future flexibility and maintenance of the application. While selecting the architecture most suitable for an application, many factors including the complexity of the application, the number of users and their geographical dispersion are considered.

This system is designed based on a traditional three-tier architecture used by many web applications. **Three-tier** architecture includes a presentation layer, business rules/ logic layer, and the data layer. The three-tier architecture is shown in Figure 31.

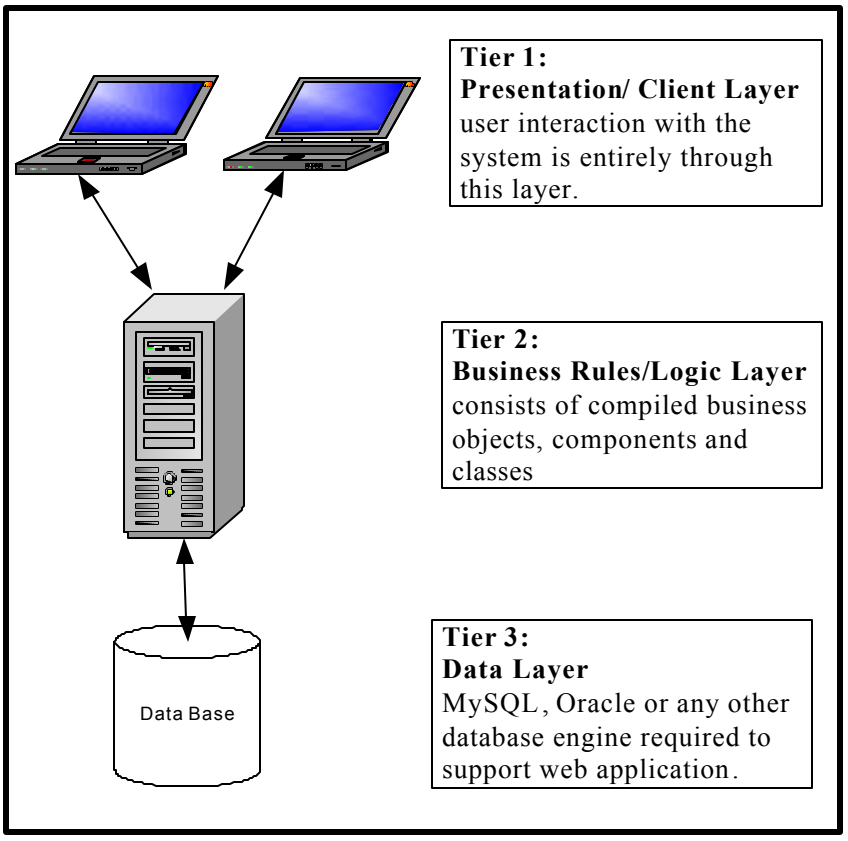


Figure 31 Three-tier architecture

The three-tier architecture is generally used when an effective distributed client/server design is needed that provides

- increased performance
- flexibility
- maintainability
- reusability and
- scalability

This model hides the complexity of distributed processing from the user. These features have made the three-tier architecture a popular choice over the two-tier architecture for Internet applications. The three layers are discussed below.

The Data layer is responsible for data storage. Primarily this tier (layer) consists of one or more relational databases and/or file systems.

The Business Rules/Logic layer is the middleman between the presentation layer and the data layer. This middle tier was introduced to overcome the deployment limitation (whenever the application logic changed the application had to be redistributed at each and every client) in the two-tier architecture. The middle tier provides process management where business logic and rules are executed and can accommodate hundreds of users.

The **Presentation Layer**, also called the Client tier, is responsible for the presentation of data, receiving user events, and controlling the user interface. The user interaction with the system is entirely through this layer.

5. IMPLEMENTATION TECHNOLOGIES

To implement any web-based application a web server is required. A web server is a piece of software that manages web pages and makes them available to the 'client' browser – via a local network or over the Internet. The web server can be accessed remotely or locally. There are many web servers available such as Apache, Internet Information Services IIS, Netscape Web Server and so on.

By typing a URL (Uniform Resource Locator) into the address box of the browser the communication between a browser and a web server is started. Each conversation consists of two pieces:

- a **request** for information from the browser software and
- a **response** from the server addressed by the URL.

The principle of communication between a client and a server is composed of successions of requests and responses. This communication is shown in Figure 32.

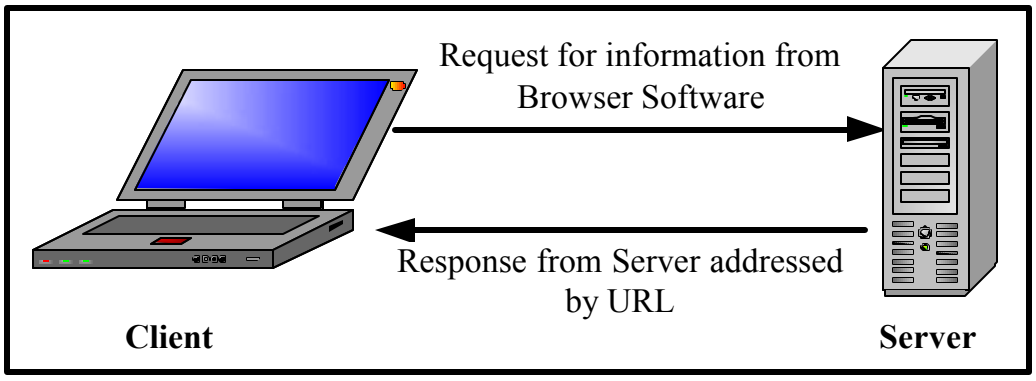


Figure 32 Communication between client and web-server

For the implementation of this application, IIS version 5.1 is used as web server.

5.1. IIS

IIS (Internet Information Services) is a group of Internet servers including a Web or Hypertext Transfer Protocol server and a File Transfer Protocol server. IIS is Microsoft's entry to compete in the Internet server market that is also addressed by Apache, Sun Microsystems (Sun Java System Web Server), O'Reilly and others. The current version of IIS is 7.0 for Windows Vista, 6.0 for Windows Server 2003 and IIS 5.1 for Windows XP Professional. IIS 5.1 for Windows XP is a restricted version of IIS that supports only 10 simultaneous connections and a single web site [15].

The web server itself cannot directly perform server side processing but can delegate the task to ISAPI (Internet Server Application Program Interface) applications on the server. Microsoft provides a number of these ISAPI applications including one for Active Server Page and one for ASP.NET.

A typical company that buys IIS can create pages for Web sites. There are two types of web pages, **static and dynamic web pages**. The static web pages are discussed in detailed in section 5.1.1 and the dynamic web pages are discussed in section 5.1.2.

5.1.1 Static Web pages

A Static web page consists of some HTML code typed directly into a text editor and saved as a .htm or .html file. The content and appearance of these web pages is always the same, regardless of who visits the page, or when they visit, or how they arrive at the page. The following five steps are involved for the building of a static web page:

1. An author writes a HTML page, and saves it within an .htm or .html file on the server
2. Sometime later, a client (user) requests a page by typing a URL into their browser, and the request is passed from the browser to the web server

3. The web server locates the .htm or .html page and converts it to an HTML stream
4. The web server sends the HTML stream back across the network to the browser
5. The browser processes the HTML and displays the page

Figure 33 shows the steps involved in creating a static web page

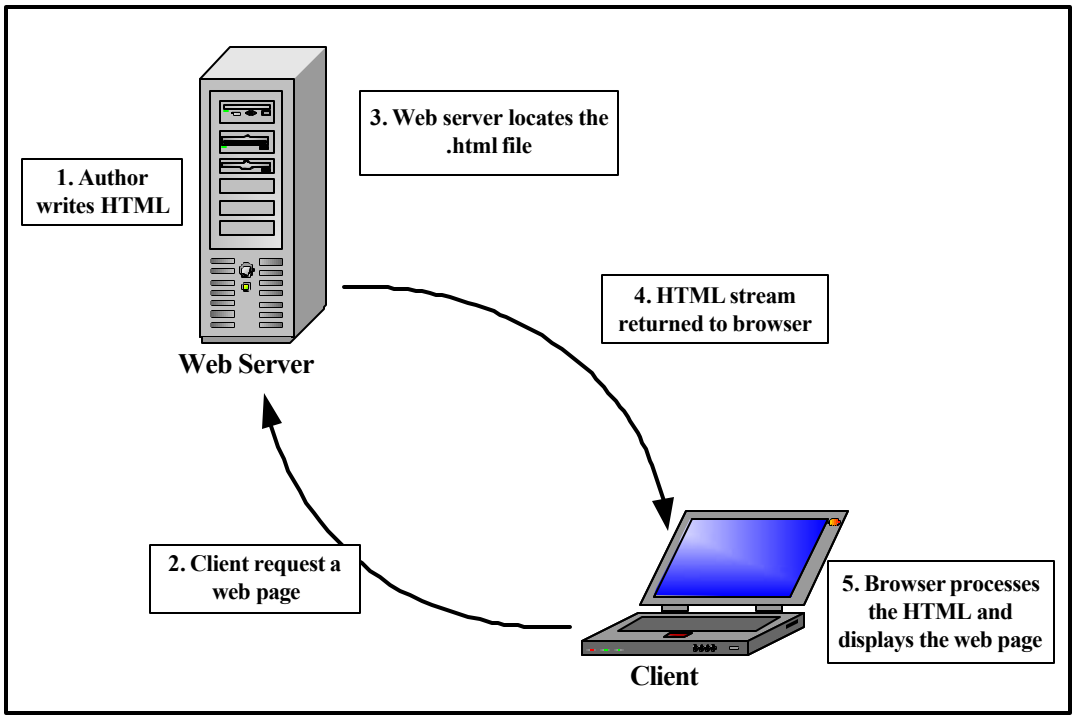


Figure 33 Steps for creating a Static Web Page [8]

There are several limitations for Static Web Pages. HTML offers no features for personalizing the web pages. Each web page that is served is the same for every user who request the page. The other limitation is that there is also no security with HTML as the code can be viewed by everybody. Though Static pages are very fast to download, as quickly as copying a small file over a network, they are quite limited without any dynamic features.

5.1.2. Dynamic Web Pages

In a dynamic web page content (text, images, fields, etc.) on the web page can change, in response to different contexts or conditions. There are two ways to create this kind of web pages:

1. Using client-side scripting to change interface behaviors within a specific web page
2. Using server-side scripting to change the sequence of the web pages or web content supplied to the browser. These are determined by conditions such as data in a posted HTML form, parameters in the URL, the type of browser being used and so on.

5.1.2.1. Client-Side Dynamic Web Page

In the client-side model, modules (or plug-ins) attached to the browser do all the work of creating dynamic pages. The HTML code is sent to the browser along with a separate file containing a set of instructions. These instructions are referenced from within the HTML page. It is also quite common to find these instructions intermingled with the HTML codes. The modules within the browser then use the instructions to generate pure HTML for the page, generating the page dynamically on request, which is sent back to the browser. This model hence involves six steps:

1. An author writes a set of instructions for creating HTML, and saves it within an .htm file. The instructions might be contained within the .htm file, or within a separate file.
2. Sometime later, a client (user) requests a page by typing it into their browser, and the request is passed from the browser to the web server.
3. The web server locates the .htm page, and any other file that contains the instructions.
4. The web server sends both the newly created HTML stream and instructions back across the network to the browser.
5. A module within the browser processes the instructions and returns it as HTML
6. The HTML is then processed by the browser which displays the page

Figure 34 shows the steps involved in creating a client side dynamic web page

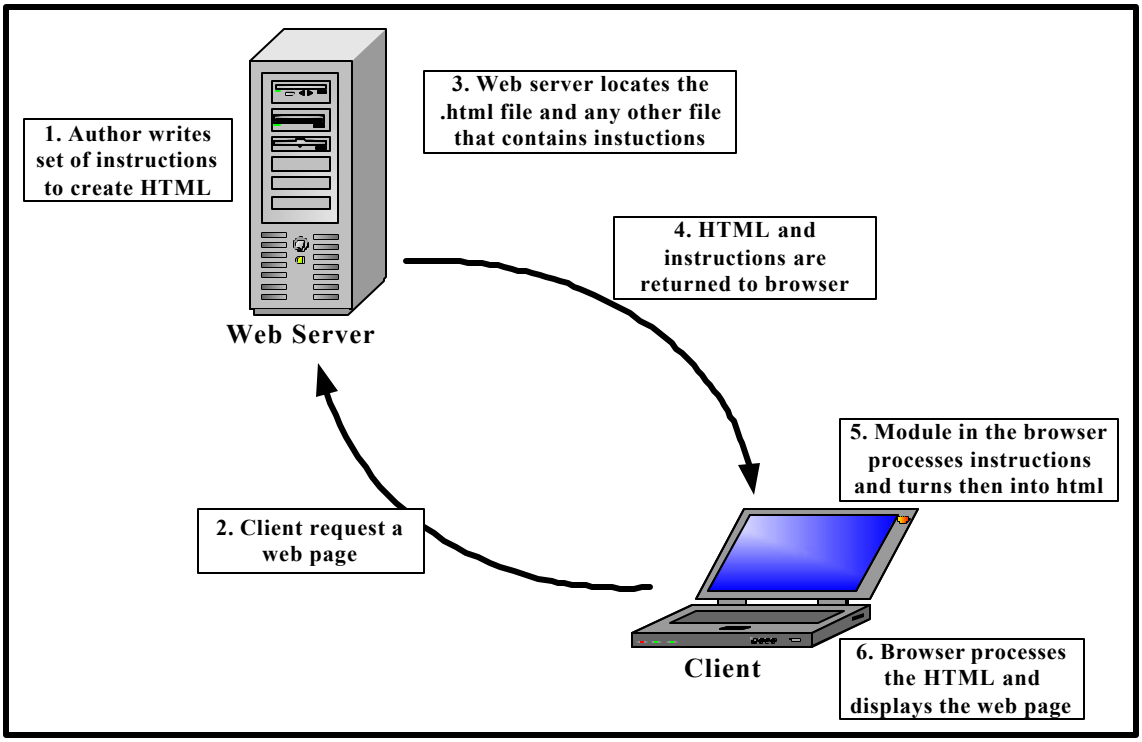


Figure 34 Steps for creating a client side Dynamic Web Page [8]

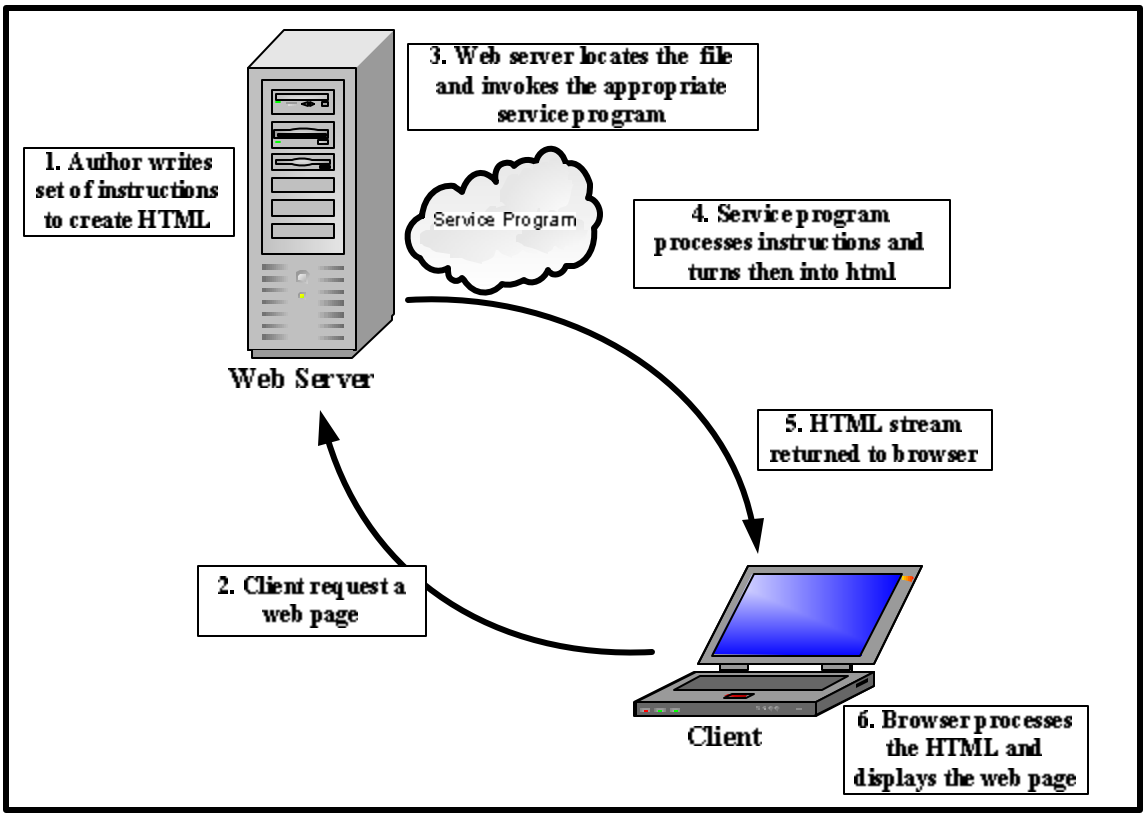
Client-side technologies have fallen out of favor in recent times. The main reason is that it takes a long time to download, especially when there is a separate second file for instructions. Another drawback is that each browser interprets these instructions in a different way and there is no guarantee that all the browsers will understand them. It is also difficult to write client-side code that uses server-side resources like database, as it is interpreted at the client-side. There are client-side technologies like Ajax (shorthand for Asynchronous Java and XML) for providing dynamic contents. The client side technologies are a mixture of scripting languages, controls and full fledged programming languages including JavaScript, VBScript and flash.

5.1.2.2. Server-Side Dynamic Web Page

In the server-side model, when a user types a page request such as an ASP, PHP or ASP.NET page, the web server locates the page and invokes the appropriate servicing program. The servicing program is not part of the Web server but it is an independent executable program running on the Web server. The servicing program, processes any user input, determines the action that must be taken, interacts with any external sources and finally produces an HTML document and terminates. The Web server then sends the HTML document back to the user's browser where it is displayed. The page is thus generated dynamically upon request. The six steps involved in developing a server side dynamic web page are

1. A web author writes a set of instructions for creating HTML, and saves these instructions within a file such as a .php or .asp or .aspx file
2. Sometime later, a user types a page request into their browser, and the request is passed from the browser to the web server
3. The web server locates the file of instructions and invokes the appropriate servicing program
4. The servicing program follows the instructions in order to create a stream of HTML
5. The web server sends the newly created HTML stream back across the network to the browser
6. The browser processes the HTML and displays the page

Figure 35 shows the steps involved in creating a server side dynamic web page


1. Author writes set of instructions to create HTML
3. Web server locates the file and invokes the appropriate service program
Service Program
4. Service program processes instructions and turns then into html
Web Server
5. HTML stream returned to browser
2. Client request a web page
Client
6. Browser processes the HTML and displays the web page

5.2. ASP.NET

ASP.NET is a server-side technology for creating dynamic web pages and interactive web applications. It uses any full-fledged programming languages supported by .NET such as C#, VB.NET and Java. VB.NET is the programming language used for the implementation of this application.

ASP.NET is a library of classes designed to handle HTTP requests. In addition to a class library, it also includes several IIS components for managing requests such as the ISAPI DLL named aspnet_isapi.dll and a worker process named aspnet_wp.exe. These components are explained below and shown in Figure 36.

An ASP.NET page is an HTML page that contains server-side scripts that are processed by a web server before being sent to the user's browser. It relies on a module attached to the web server. The ASP.NET module is aspnet_isapi.dll. ASP.NET installs new mappings in IIS, redirecting file requests for aspx, ascx and so on to aspnet_isapi.dll. From there, aspnet_isapi.dll directs the request to the aspnet_wp.exe [4].

ASP.NET runs as a process of its own, aspnet_wp.exe, unlike classic ASP which runs in the same memory space as the IIS. It simply uses IIS to receive requests and then to send out the responses. Therefore, the ASP.NET process can be created or destroyed without affecting IIS at all. This worker process manages the ASP.NET pipeline, the route through which requests flow within ASP.NET [11].

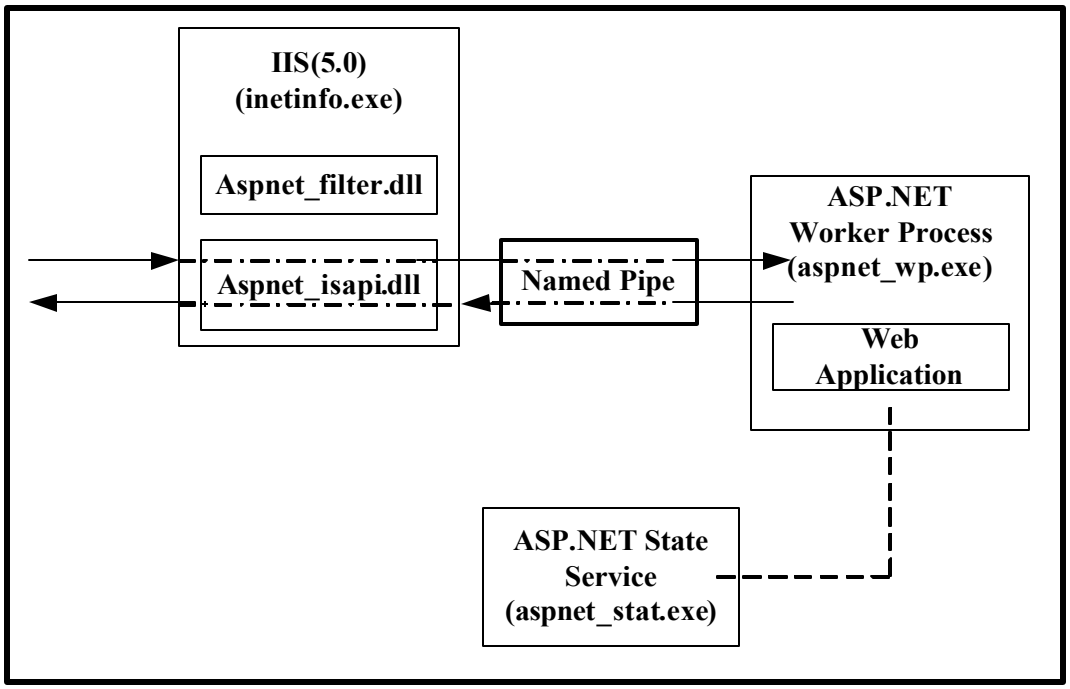


Figure 36 ASP.NET architecture with IIS 5.0 [10]

A Lightweight ISAPI filter, aspnet_filter.dll is used only to support cookie-less session state for ASP.NET applications. This runs inside Inetinfo.exe. The ASP.NET state service, aspnet_state.exe is an optional Windows service used to store session state for ASP.NET applications [10]. It can run on the web server or on a remote machine. The architecture of the ASP.NET with IIS 5.0 in shown in Figure 36

ASP.NET takes an object-oriented programming approach to Web page execution. Every element in an ASP.NET page is treated as an object and run on the server. An ASP.NET page gets compiled into an intermediate language by a .NET Common Language Runtime-compliant compiler. Then a Just In Time (JIT) compiler turns the intermediate code to the native machine code, and that machine code is eventually run on the processor. Because the code is run straight from the processor, pages are loaded much faster than classic ASP pages, where embedded VBScript or JScript have to be continuously interpreted and cached.

The database used to store the data for this application is MySQL database. The features and the advantages of this database are discussed in section 5.3.

5.3. MySQL

MySQL is a software package that enables the creation, maintenance and management of database. MySQL is a Structured Query Language (SQL) based, client/server relational database. Each of these terms describes a fundamental part of the architecture of MySQL Server.

Database: A database is a storage place for data. The user runs an application that accesses data from the database and presents it to the user in an understandable format.

Relational Database: There are different ways to organize data in a database but relational databases are one of the most effective. Relational database systems are an application of mathematical set theory to the problem of effectively organizing data. In a relational database, data is collected into tables (called relations in relational theory).

Structured Query Language (SQL): There are several different languages that can be used to manipulate relational databases. The most common of the languages is SQL. The American National Standards Institute (ANSI) and the International Standards Organization (ISO) have defined standards for SQL. Data within a database can be retrieved via SQL that is based on Relational Algebra.

Client/Server: In a client/server system, the server is a relatively large computer in a central location that manages a resource used by many people. When individuals need to use the resource, they connect over the network from their computers, clients, to the server.

MySQL's specific design goals were speed, robustness and ease of use. To improve the performance, MySQL was made as a multithreaded database engine. A multithreaded application performs many tasks at the same time as if multiple instances of that application were running simultaneously. Multithreaded applications have a lower overhead cost, when compared with multi processed databases.

In being multithreaded, MySQL has many advantages. A separate thread handles each incoming connection with an extra thread that is always running to manage the connections. Multiple clients can perform read operations simultaneously, but while writing, only the clients that need access to the data being updated are held. Even though the threads share the same process space, they execute individually. Because of this separation, multiprocessor machines can spread the thread across many CPUs as long as the host operating system supports multiple CPUs. Multithreading is the key feature to support MySQL's performance design goals and this is the core feature around which MySQL is built [9]. MySQL has other features but the most attracting features are cost and performance.

6. CONNECTING TO THE DATABASE

In this application ASP.NET uses ADO.NET to connect to the MySQL database. ADO.NET is discussed in detail in section 6.1

6.1. ADO.NET

ADO (ActiveX Data Object) is Microsoft's programming interface for data access. Though a good architecture, ADO has some disadvantages. It has a connection oriented data access, that is; the connection to the database remained open until the application was closed. The open connection raised concerns of database security and network traffic. The connections also use maximum system resources making system performance less effective. To cope with these disadvantages of ADO, ADO.NET was designed. ADO.NET is a connection-less approach to data access. In ADO.NET when an application interacts with a database, the connection is opened to serve a request and as soon as the request is served the connection is closed.

ADO.NET is a set of software components used to access and modify data. ADO.NET is part of the .NET framework. It is mainly used to access data stored in relational database, though it can also be used to access data in non-relational data sources including flat file database based on ISAM (Indexed Storage Access Method) or VSAM (Indexed Storage Access Method) and hierarchical databases. ASP.NET uses ADO.NET to connect to the database. The architecture of ADO.NET is shown in Figure 37.

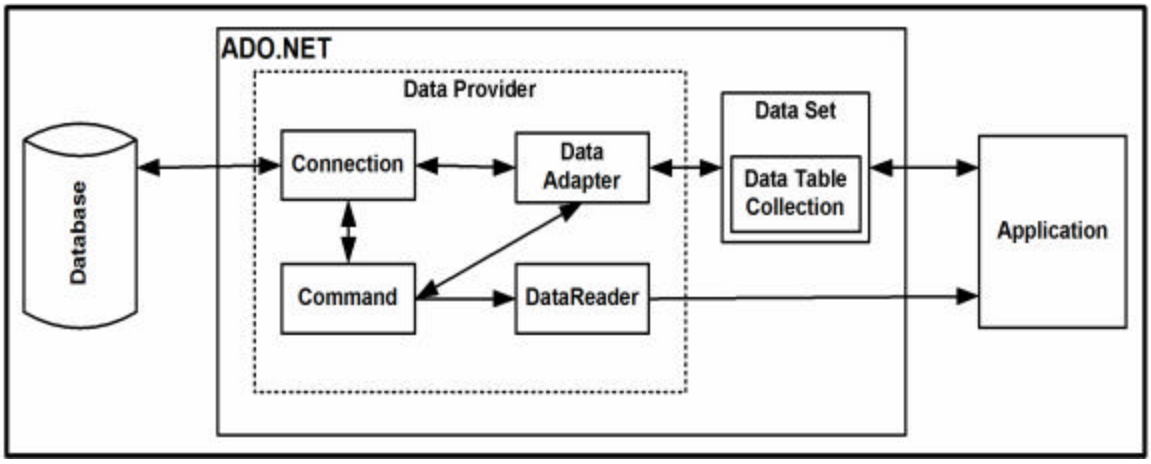


Figure 37 ADO.NET architecture

The two components of ADO.NET that are used for data access and manipulations are Data Provider and DataSet.

Data Provider is designed for data manipulation and fast access to data. It consists of the Connection object, Command object, DataReader, and DataAdapter.

- The **Connection** object provides connectivity to a data source.
- The **Command** object enables access to database commands to return and modify data.
- The **DataReader** provides a high-performance stream of data from the data source.
- The **DataAdapter** provides the bridge between the **DataSet** object and the data source.

MySQLDirect.NET is the Data Provider used in this application to access MySQL database server.

DataSet is designed for data access independent of any data source. The DataSet is a disconnected, in-memory representation of data. This is a local copy of the relevant portions of the database. The DataSet is persisted in memory and the data in it is manipulated and updated independent of the database. These changes are made to the database after the use for the DataSet is finished.

The DataSet contains a collection of one or more **DataTable** objects made up of rows and columns of data, as well as primary key, foreign key, constraint, and relation information about the data.

The application can connect to a database using either a DataReader or a combination of DataSet and a DataAdapter. While deciding whether the application should use a DataReader or a DataSet, the functionality of the application should be considered. According to Microsoft [16], DataSet is a preferred choice for an application that

- need to cache the data locally for manipulating
- interact with data dynamically, such as binding to a Windows Forms control
- perform extensive processing on data without requiring an open connection to the data source, which frees the connection to be used by other clients.

If the above functionalities are not required then using the **DataReader** can boost performance of the system. This is because the memory that would be consumed by the **DataSet** is saved and the processing required to create and fill the contents of the **DataSet** is not required. This application uses both DataSet and DataReader to read the data. Command object called ExecuteNonQuery is used to write the data into the database.

6.1.1. Connecting the Application to MySQL using ADO.NET

The steps involved to connect the ASP.NET application to the MySQL database using ADO.NET are given below:

- **Import the required namespaces.**

```
Imports CoreLab.MySql
```

- **Create a Class that contains all the required ADO.NET objects**.

```
Public Class MysqlClass

    'connection object
    Public con As New MySqlConnection("UserId=root;
        Host=localhost; password=passwd; Database=project")

    'command object
    Public cmd As New MySqlCommand

    'datareader
    Public dataReader As MySqlDataReader

    'dataadapter
    Public dataAdapter As New MySqlDataAdapter

    'dataset
    Public dataSet As New DataSet

End Class
```

- **Create an object of the Mysql class**

```
Dim sqlObject As New MysqlClass
```

- **Create a SQL query**

```
Dim str1, str2, str3 As String

'sql string for datareader
strRead = "SELECT adminid FROM administrator WHERE userid = 4"

'sql string for dataset and dataadapter
strSet = "SELECT adminid, fname FROM administrator"

'sql string for executenonquery
strWrite = "INSERT INTO job_skill_requirement (jobid, skillid)
  VALUES( '4', 10 ")"
```

- **DataReader to read the result**

```
'command object
sqlObject.cmd.CommandText = strRead
sqlObject.cmd.Connection = sqlObject.con

'open connection
sqlObject.con.Open()

'Read the data
sqlObject.dataReader = sqlObject.cmd.ExecuteReader
If sqlObject.dataReader.Read = True Then
   Session.Item("adminid") = sqlObject.dr("adminid")
End If

'close connection
 sqlObject.con.Close()
```

- **DataSet and DataAdapter to bind the data to a control**

```
'command object
sqlObject.cmd.CommandText = strSet
sqlObject.cmd.Connection = sqlObject.con

'Filling the DataSet using Select Command of DataAdapter
sqlObject.dataAdapter.SelectCommand = sqlObject.cmd
sqlObject.dataAdapter.Fill(sqlObject.dataSet, "a")

'Bind the data to the Data Grid
DataGrid1.DataSource = sqlObject.dataSet
DataGrid1.DataBind()
```

- **To write the data to the database**

```
'command object
sqlObject.cmd.CommandText = strWrite
sqlObject.cmd.Connection = sqlObject.con

'open connection
sqlObject.con.Open()

'write the data
 sqlObject.cmd.ExecuteNonQuery()

'close connection
 sqlObject.con.Close()
```

7. APPLICATION

The objective of this project is to implement a web-based application that examines the issue related to dynamic Human Resource Management for a fictitious consulting firm. The application provides features such as the employee database, company database, interview scheduling, contracts management and performance report. Some screenshots taken while running the application are shown below. The functionalities are also explained accordingly.

To gain access to the system every user should be authenticated. When the user types the website's URL in the browser, the login page is displayed. The login page is shown in Figure 38.

Figure 38 Login Page

Depending on the role selected in the login page the user is directed to the respective subsystem, the Employee Applicant subsystem, the Administrator subsystem or the Employer Contact subsystem.

7.1. Employee Applicant

If the user logs into the system as an Employee Applicant, then the user is directed to the page with the Applicant menu. The menu is shown in Figure 39.

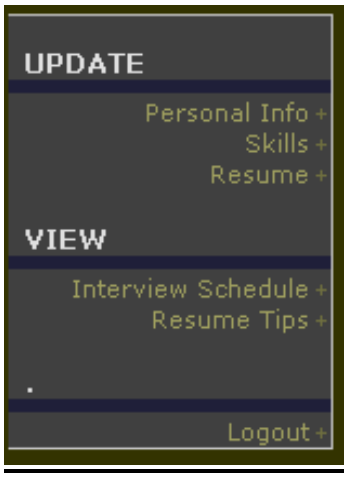


Figure 39 Applicant - Menu

The Applicant can update his/her profile such as personal information, skill information or resume. They can also view information about any interview scheduled for them. Figure 40 shows the page to update personal information while Figure 41 shows the page to update skill information. The pages are displayed with the current information of the user stored in the database. If the update button is selected, the new information is updated in the database and the page is displayed again with this updated information. If the cancel button is selected the page is redisplayed with the original information.

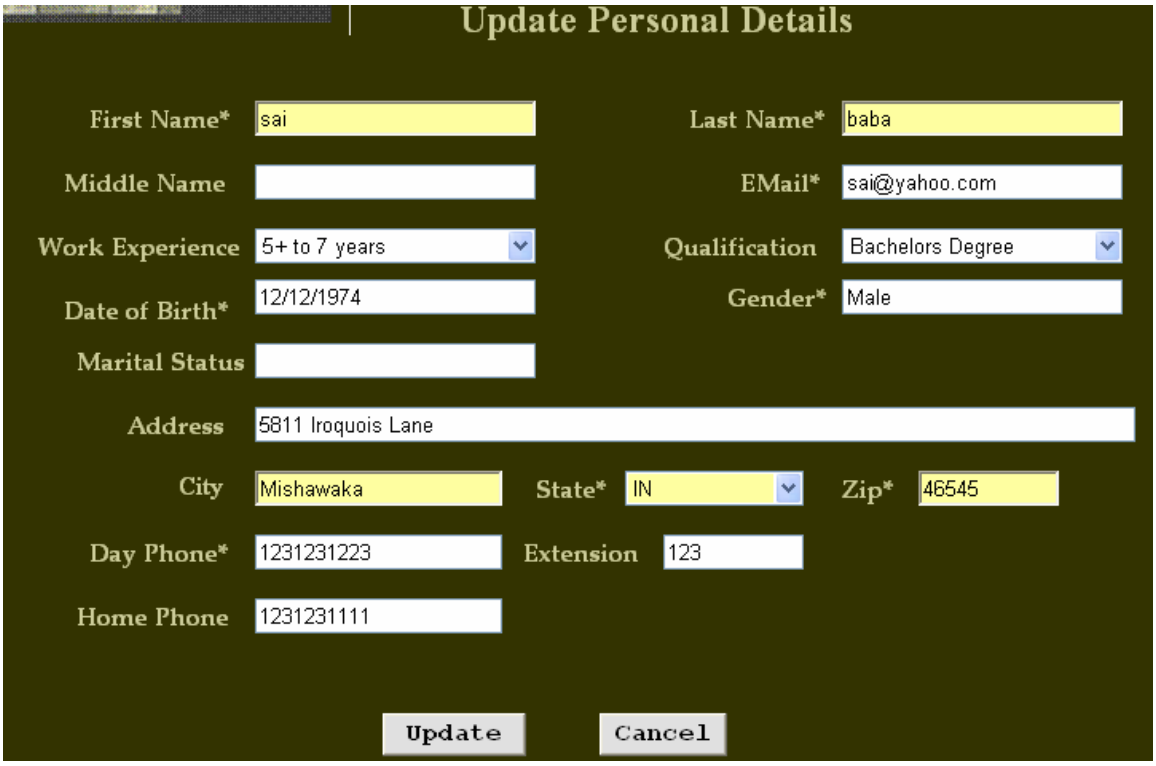


Figure 40 Applicant - Update Personal Information

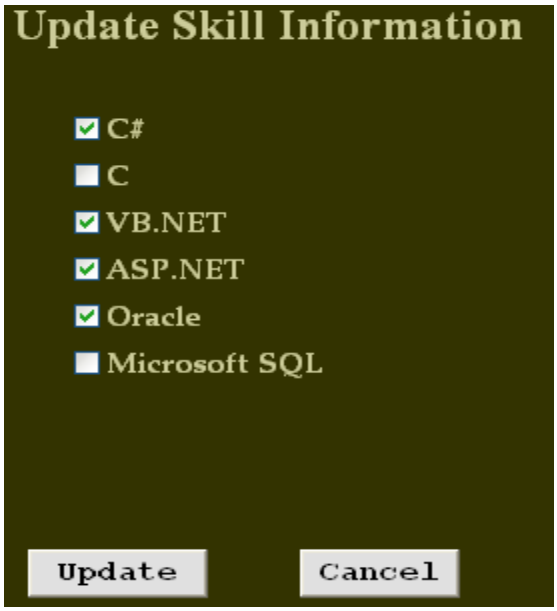


Figure 41 Applicant - Update Skill Information

Figure 42 shows the page to update the resume. By selecting the Hyperlink the Applicant can view the current resume stored in the database. If the resume needs to be updated the Applicant can browse to the location of the Microsoft Word File and can then select the update button.

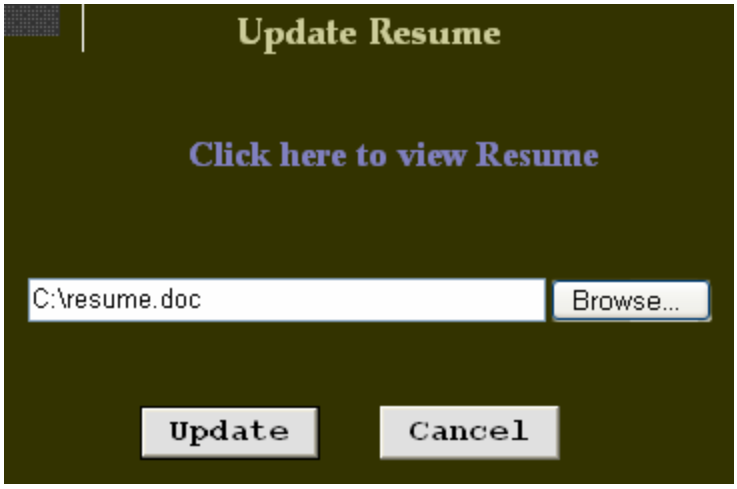


Figure 42 Applicant - Update Resume

Figure 43 shows the page that displays the interviews scheduled for the Applicant. It displays the date, time and type of the interview. It also displays the information about the corresponding job such as description, the start and end dates.

InterviewDate	InterviewType	InterviewTime	JobDescription	StartDate	EndDate
2007-5-27	oral	3:30 PM	The job requires a through knowledge of database. May need to work on call.	2007-5-22	2007-12-22
2007-5-29	technical	1:15 PM	The job requires a through knowledge of programming. Atleast 2 years experience in VB.NET	2007-6-4	2007-12-31

Figure 43 Applicant – View Interview Schedule

7.2. Employer Contact

If the user logs into the system as an Employer Contact, the user is directed to the page with the Contact menu. The Contact menu is shown in Figure 44.

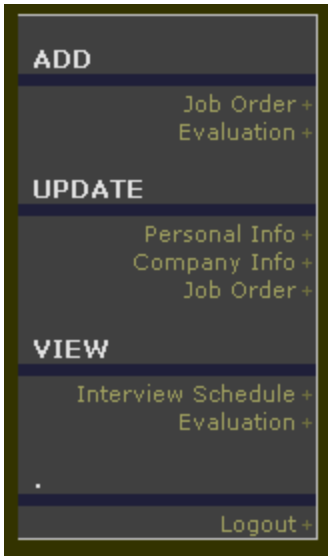


Figure 44 Contact - Menu

The Contact can update his/her personal or company information, add new job or update existing job and add evaluations. The Contact can also view the interview schedule and evaluation of the Applicants. Figure 45 shows the page to update personal information while Figure 46 shows the page to update company information. The pages are displayed with the current user information stored in the database. If the update button is selected, the new information is updated in the database and the page is displayed again with this updated information. If the cancel button is selected the page is redisplayed with the original information.

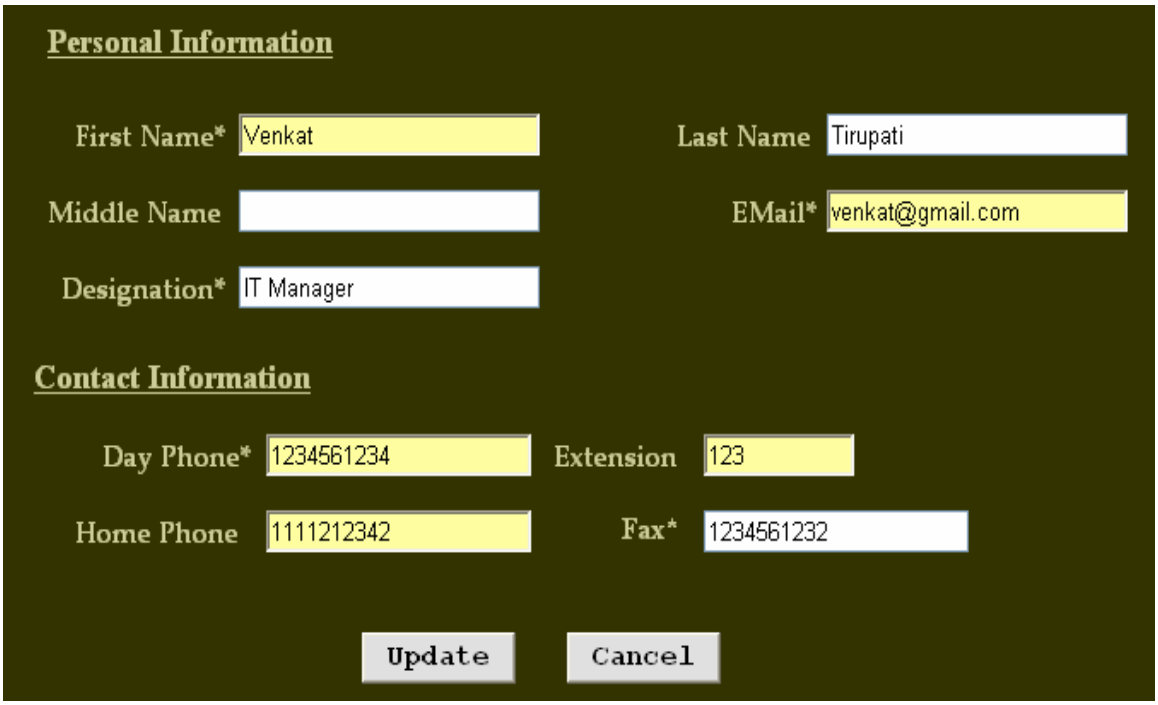


Figure 45 Contact - Update Personal Information

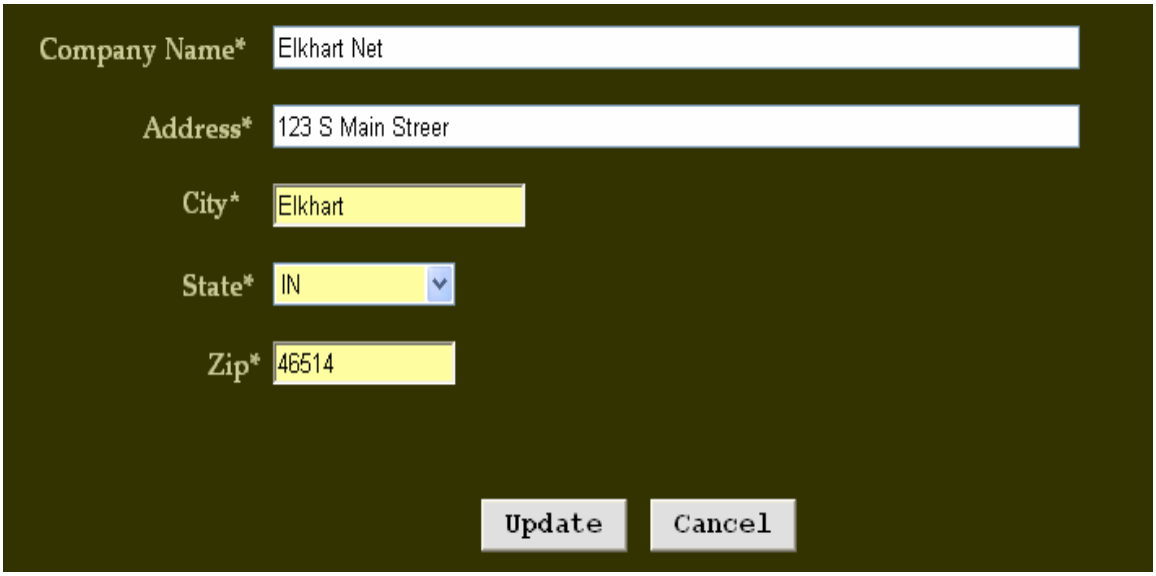


Figure 46 Contact - Update Company Information

Figure 47 shows the page to add a new job order. The Contact should enter a start and an end date, the job description, the experience required and the number of vacancies for the job. The Contact can also select a list of the skills required for the job.

Figure 47 Contact - Add New Job Order

Figure 48 shows the page to update the job order. The Contact selects the Job ID from the drop-down list, for the job order to be updated. The page is displayed with the current job details stored in the database. The open field indicates whether the job is still available. Updates can be done only for the open jobs.

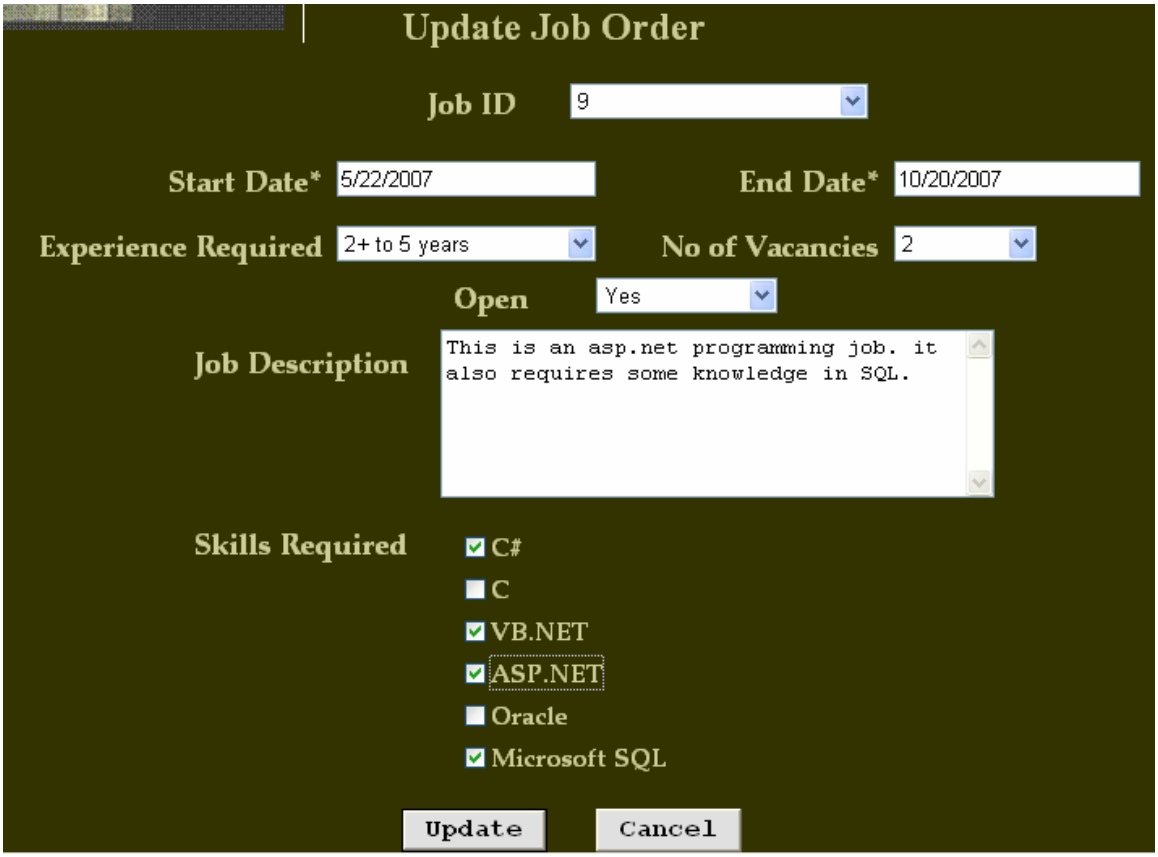


Figure 48 Contact - Update Job Order

A Contact can view the schedules of the interviews that are yet to be conducted. The Contact can also view the details of the corresponding Applicants like experience, degree attained and so on as shown in Figure 49.

Figure 49 Contact - View Interview Schedule

After completion of a job, the Contact can evaluate an Applicant on his/her performance. The page to add an evaluation is shown in Figure 50. The Contact can select the Applicant from the drop-down list and add a performance report for the Applicant. The drop-down list contains the name of all the Applicants that are presently contracted by the Contact Company.

Figure 50 Contact - Add New Evaluation

7.3. Administrator

If the user logs into the system as an Administrator, the user is directed to the page with the Administrator menu. The Administrator menu is shown in Figure 51.

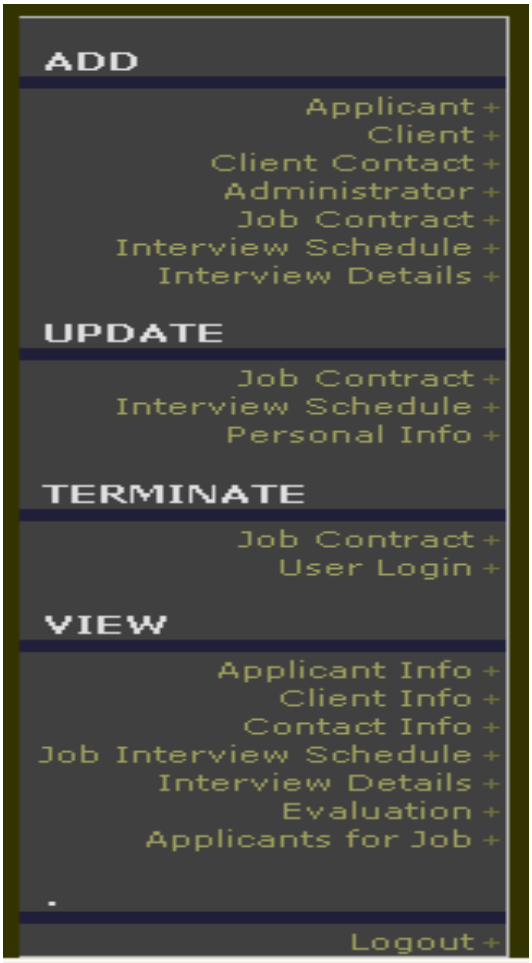


Figure 51 Administrator – Menu

An authenticated Administrator can update his/her personal information, add new user profiles, and terminate existing user logins. Administrator can also add new or update existing interview schedules. The Administrator can also view user profiles, job orders, and evaluation of Applicants. Figure 52 shows the page to update personal information. The page is displayed with the current user information stored in the database. If the update button is selected, the new information is updated in the database

and the page is displayed again with this updated information. If the cancel button is selected the page is redisplayed with the original information.

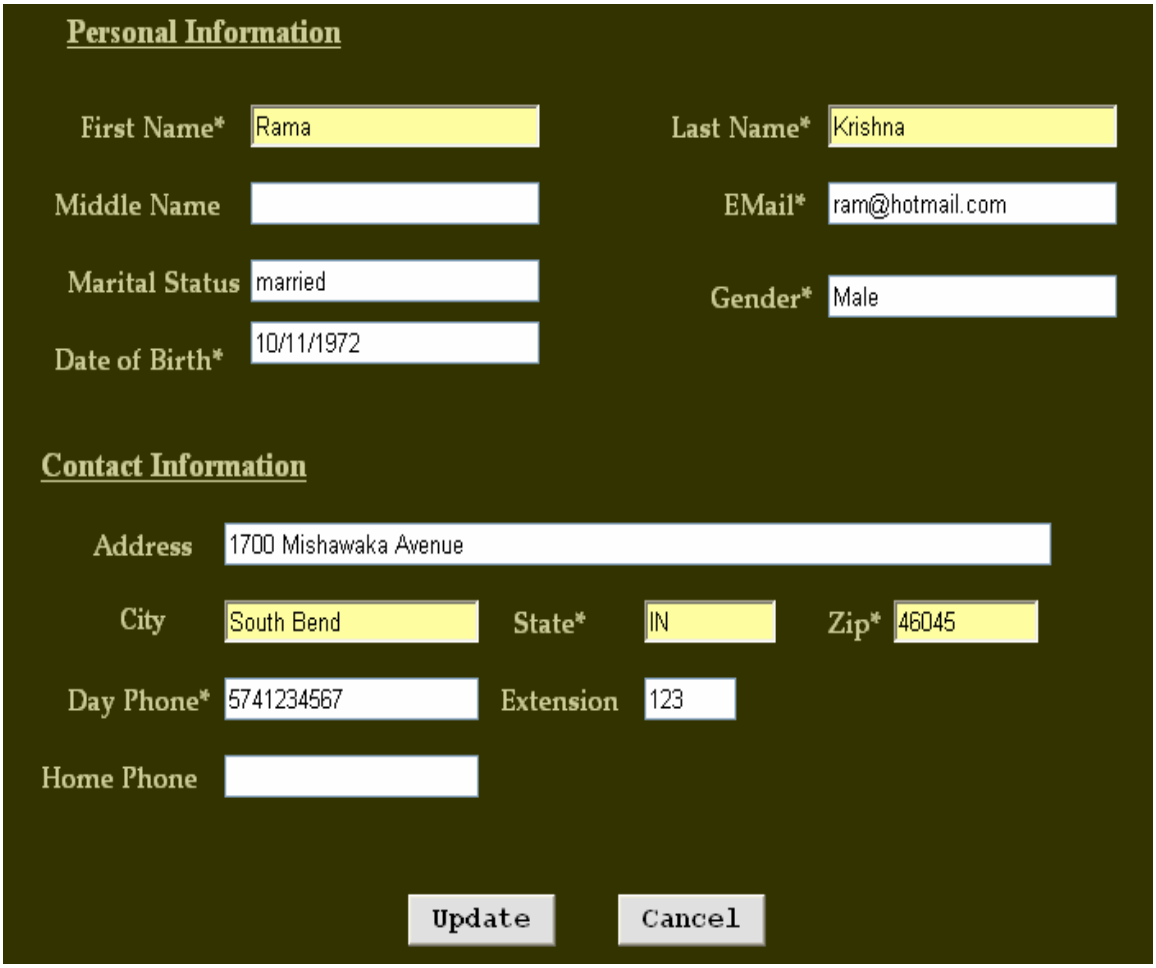


Figure 52 Administrator - Update Personal Information

The Administrator can create new user profiles and logins. Figure 53, Figure 54 and Figure 55 show pages to add a new Employee Applicant, a new Administrator, and a new Employer Contact respectively while Figure 56 is the page to add a new Employer Client.

Figure 53 Administrator - Add New Applicant

Figure 54 Administrator - Add New Administrator

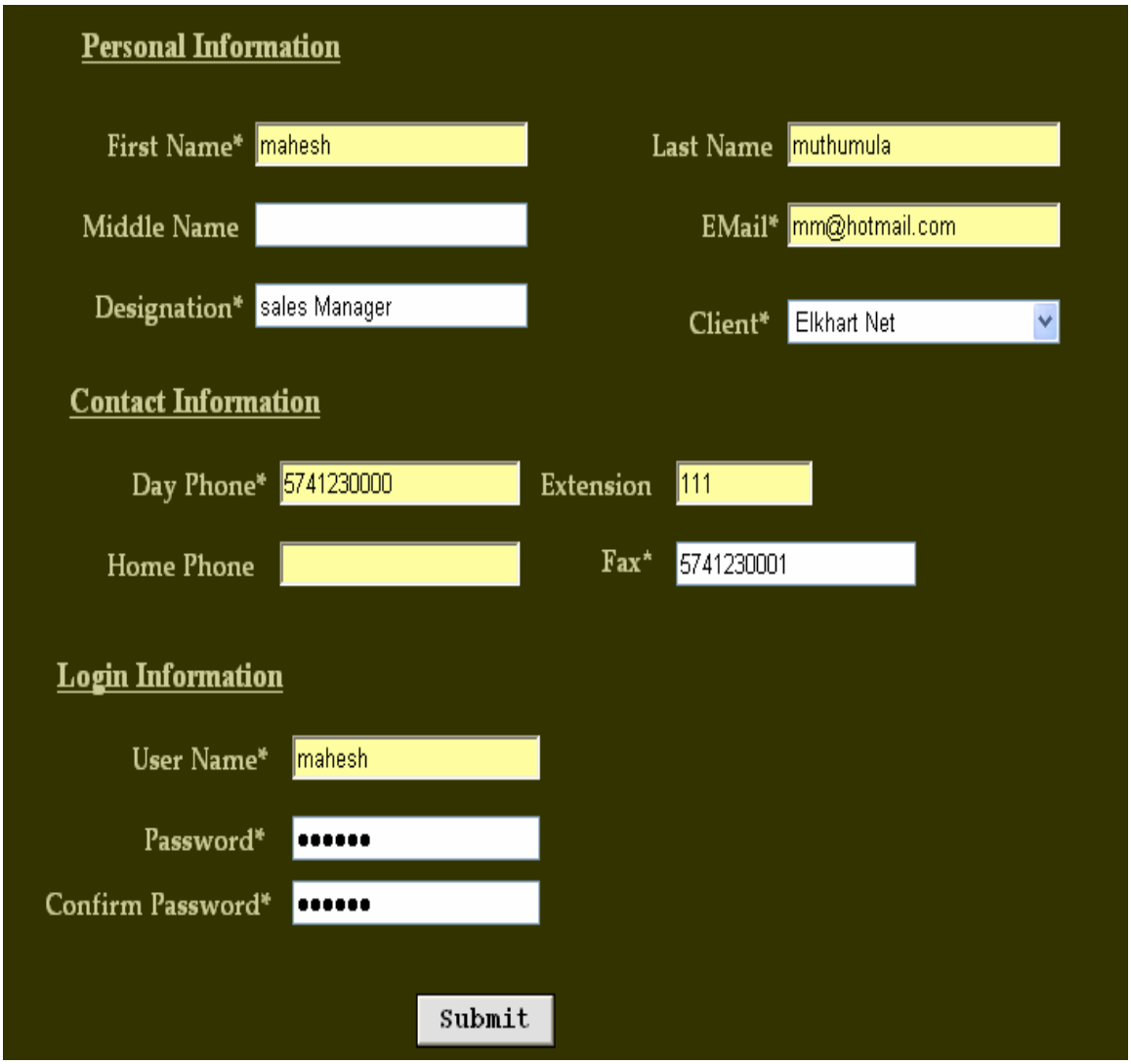


Figure 55 Administrator - Add New Contact

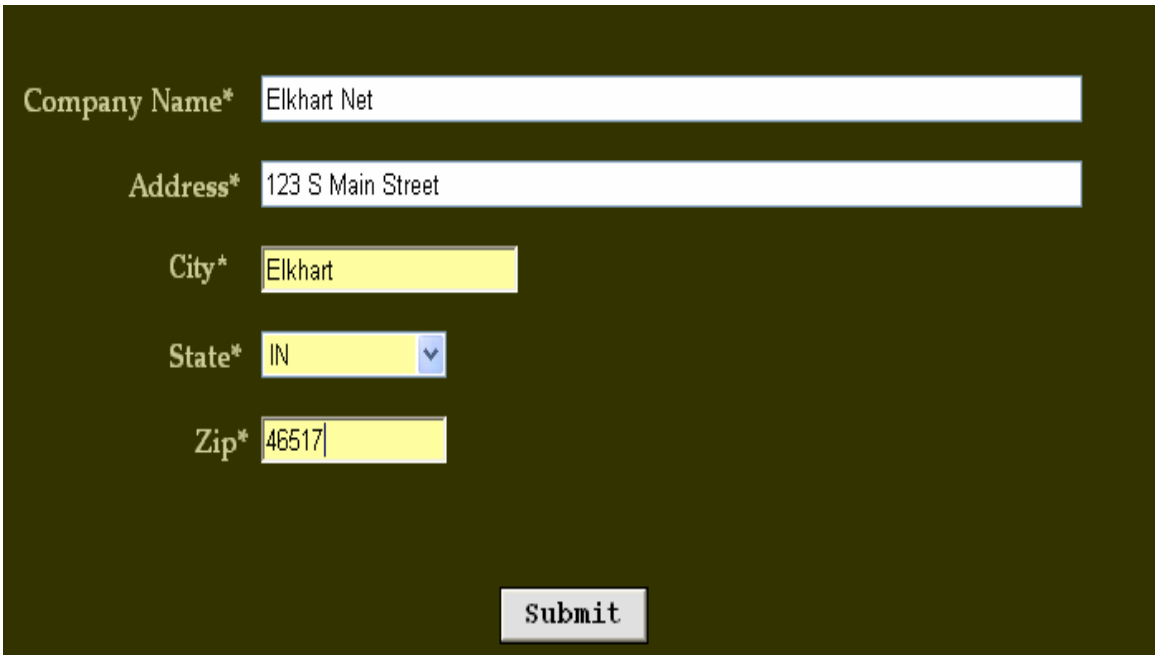


Figure 56 Administrator - Add New Client

An Administrator can also terminate a user's login account. The page to terminate a user's login account is shown in Figure 57. The Administrator first selects the role of the user and then the User Name drop-down list is populated with all the active users of the selected role.

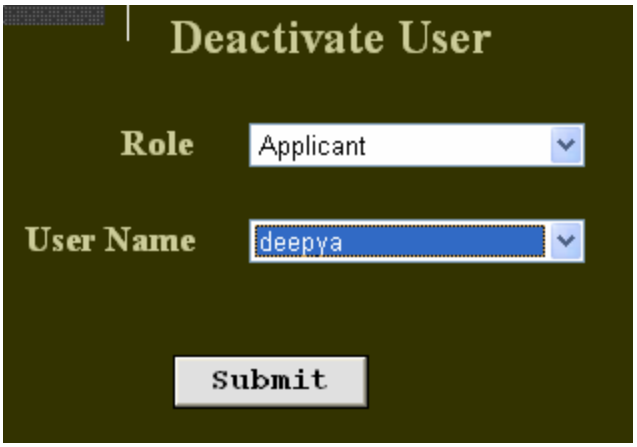


Figure 57 Administrator - Terminate User Login

Figure 58 shows the page to add a new interview schedule. The Administrator first selects a Job ID. Then based on the selected Job ID, the Applicants drop-down is populated with a list of the Applicants that match the job requirement. The Administrator should also enter the type, date and time for the interview.

Figure 58 Administrator - Add New Interview Schedule

Figure 59 shows the page to update an existing interview schedule. The Administrator first selects an Applicant. Then based on the selected Applicant, the Job ID drop-down is populated with a list of all the Job ID's that the Applicant has an interview scheduled for. Based on the selected Applicant and Job ID, details of the interview such as the interview date, time and type are obtained from the database. Updates can then be made to the schedule.

Figure 59 Administrator - Update Interview Schedule

After an interview is conducted the Administrator can add the details of the interview such as who conducted the interview, whether the Applicant was selected and if the Applicant accepted the job. Figure 60 shows the page to add the interview details.

Figure 60 Administrator - Add Interview Details

Upon a successful interview, the Applicant selected in the interview is recruited as consultant by the Contact firm for the duration of the project. The Administrator first selects the Applicant and based on the selected Applicant the Job ID drop-down list is populated. After selecting the Job ID the Administrator must enter the start date, the end date and the negotiated terms for the project. Figure 61 shows the page to add a new job contract.

Figure 61 Administrator - Add Job Contract

Figure 62 shows the page to update an existing job Contract. The Administrator first selects a Client. Then based on the selected Client the Applicant drop-down is populated with a list of all the Applicants that are presently contracted by the Client. Based on the selected Client and Applicant the job description, the start date, the end date and negotiated terms are obtained from the database. Updates can then be made to the start date, end date and the negotiated terms.

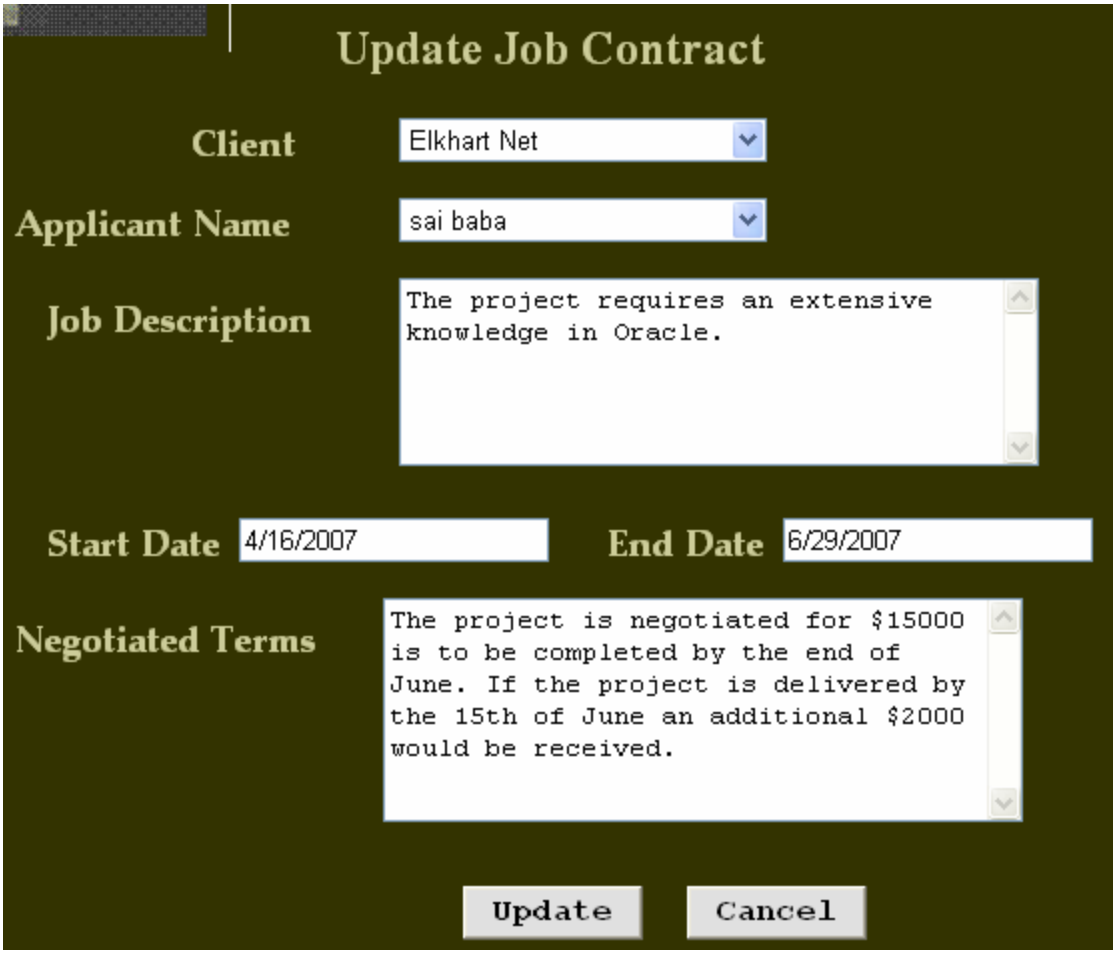


Figure 62 Administrator - Update Job Contract

Figure 63 shows the page to terminate an existing Contract. The Administrator first selects a Client. Then based on the selected Client the Applicant drop-down is populated with a list of all the Applicants that are presently contracted by the Client. Based on the selected Client and Applicant the job description and negotiated terms are obtained from the database. After the information is displayed the Administrator can select the End Contract button to terminate the contract.

Figure 63 Administrator - Terminate Job Contract

8. LIMITATIONS AND FUTURE DEVELOPMENT

There are some limitations for the current system to which solutions can be provided as a future development:

- The system is designed for a software consulting firm and skills provided by the firm are pre-defined. There is no user interface for adding new or editing existing skills. A user interface can be developed as a future enhancement.
- At present the Applicant can only upload a Microsoft Word File for the resume. This can be extended to include any other file types that are required.
- At present this product is run locally and cannot be accessed by everyone. It can be deployed on a web server so that anyone connected to the Internet can access it.

9. CONCLUSION

The consulting industry is one of the fastest growing business sectors worldwide with new opportunities emerging in different fields including computer related services. Software consulting and recruiting agencies match the requirements of the client firms with the skills of their employees and set up the interview between their employees and the client firm. Interviews are then conducted, and the candidates selected in the interview are recruited as consultants in the client's firm for the duration of the project.

Computer software engineers are projected to be one of the fastest-growing occupations from 2004 to 2014. [6]. Consulting opportunities for computer software engineers continue to grow as businesses seek help to manage, upgrade, and customize their increasingly complicated computer systems.

This project implements a web-based software tool for human resource management of a consulting firm that participates in the placement of consultants in different organizations. The system is implemented using 3-tier architecture. To

implement this application the web server used is Microsoft IIS and the server side technology used to create the web pages is ASP.NET. ASP.NET has several advantages such as enhanced performance, scalability, built-in security and simplicity. Many programming languages like VB.NET, C#, Java and J# are used to build ASP.NET web applications. The programming language used to build this application is VB.NET. ADO.NET is used to interact with the database. The database used to store the data is MySQL database.

In the course of the implementation of this application many lessons have been learned including designing an interface, database access technique and programming for the web. This application helped in understanding the different technologies used to create interactive web pages. It also helped in understanding the working of IIS and ASP.NET. The implementation of the project has given a precise knowledge of how ASP.NET is used to create web pages and how to connect to MySQL database using ADO.NET. Overall the implementation of this project was an excellent learning opportunity.

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