|  |
| --- |
| UAH Fit Vault Software Design Specification |
| CPE 656/658 Software Studio |
| Timothy R. Wilkins  Whit J. Sisulak  Glen L. Riden  James J. Duggan IV |

11/29/2015

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | Revision Date | Description of Change | Author |
| 0.1 | 10/12/15 | Initial Draft | J. Duggan  W. Sisulak |
| 0.2 | 10/25/15 | Updated scope and architecture. Changed title and file name. | J. Duggan  W. Sisulak |
| 0.3 | 11/07/15 | Added application framework section. Created detail design section. | W. Sisulak |
| 0.4 | 11/13/15 | Update scope and architecture overview. | J. Duggan |
| 0.5 | 11/14/15 | Added detailed design for SelectDataController and SelectActivityController. Added detailed design for Activity Model and ActivityType enumeration. | W. Sisulak |
| 0.6 | 11/15/15 | Added several new enumerations. Added detailed design for all the various system user objects. Added experiment object design. Created structure and relationship section with description of data ingestion feature. | J. Duggan |
| 0.7 | 11/22/15 | Added database schema and associated detailed designs of the various objects shown in the schema.  Added glossary. | J. Duggan  W. Sisulak |
| 0.8 | 11/22/15 | Added account controller | T. Wilkins |
| 0.9 | 11/22/15 | Added Administrator Tools features and corresponding detailed design of the classes involved. | W. Sisulak  J. Duggan |
| 0.10 | 11/29/15 | Added Physician detailed design and feature descriptions. Added feature description for account management. | G. Riden  T. Wilkins |
| 0.11 | 11/29/15 | Added patient delete notes to admin tools feature section 2.2.2. Added experiment detailed design and feature description. | J. Duggan |

Table of Contents

[Revision History i](#_Toc436615131)

[1 Introduction 1](#_Toc436615132)

[1.1 Purpose 1](#_Toc436615133)

[1.1 Scope 1](#_Toc436615134)

[1.2 Definitions, Acronyms, and Abbreviations 2](#_Toc436615135)

[1.3 References 3](#_Toc436615136)

[1.4 Overview 3](#_Toc436615137)

[1.5 Application Framework 3](#_Toc436615138)

[2 System Architecture Description 3](#_Toc436615139)

[2.1 Overview of Components 3](#_Toc436615140)

[2.2 Structure and Relationships 5](#_Toc436615141)

[2.2.1 Data Ingestion 5](#_Toc436615142)

[2.2.2 Administrator Tools 6](#_Toc436615143)

[2.2.3 Account Management 8](#_Toc436615144)

[2.2.4 Physician Actions 11](#_Toc436615145)

[2.2.5 Experiment Tools 13](#_Toc436615146)

[2.3 Database Schema 17](#_Toc436615148)

[3 Detailed Description of Components 17](#_Toc436615149)

[3.1 Presentation Layer Overview 18](#_Toc436615150)

[3.1.1 Controllers 18](#_Toc436615151)

[3.2 Business Logic Layer Overview 23](#_Toc436615152)

[3.2.1 Entities 23](#_Toc436615153)

[3.2.2 Enumerations 43](#_Toc436615154)

[3.3 Data Access Layer Overview 45](#_Toc436615155)

Software Design Specification

# Introduction

## Purpose

The purpose of this document is to provide a detailed design of the UAH Fit Vault software projects. This document should be used as a reference for the software system architecture and detailed design descriptions of the system components. The intended audience for this document includes system developers, testers, customers, and any other stakeholders.

## Scope

The UAH Fit Vault software package will be a web application that will accept medical data from users and display the data in a meaningful way. There are two major components to this software. The first is the data collection tool that is used by the users to upload their medical data that is recorded by one of the supported wearable medical devices. There are three different medical devices supported for this project that record various types of data. The data provided by these devices consists of different file formats, and the data is different from device to device. The software will have to determine the contents of each file and how to process them. The software needs to able to take in files that a user has downloaded from their medical devices, process those files, and store the data in a database. The software should have the ability to process multiple files at a time as well as individual files and allow for an activity to be assigned to them by date and time.

The other major component of the web application is the data analysis tools used to analyze the data that is captured from the data collection tool mentioned above. The software needs to perform data analysis over different intervals of time such as one week, one month, etc. There will need to be some way to manage user access to the various medical data that has been inserted into the database that this software will access. Below are some proposed data analysis ideas that can be incorporated into the project.

* Simple Moving Average
* Data correlation discovery between the multiple devices.
* Simply display data that was uploaded to the customer in a graphical format.
* Calculate the user’s activity.

The data analysis possibilities will likely not fully be realized until the project team understands the different types of data that are available. Also, there will need to be collaboration with the customer for additions or changes to the data measurements provided by this software. The web application will have to have different levels of user access which will be defined later in this document.

## Definitions, Acronyms, and Abbreviations

|  |  |
| --- | --- |
| *Account* | Roles and permissions assigned to a user and stored electronically |
| *Activity* | Action performed by patient (ex. running, walking, sleeping) |
| *ASP.NET* | Microsoft web based software architecture |
| *C#* | C “Sharp” Microsoft .NET programming language |
| *Controller* | Middle layer logic, interaction between the view and data model |
| *csv* | Comma-separated values |
| *Customer* | A person or group requesting the software to be built |
| *dat* | Data file |
| *Data* | Patient information |
| *Database* | Storage medium for patient data |
| *Database Service* | Database functionality accessible via the internet |
| *ECG* | Electro Cardio Gram |
| *Experiment* | Combining of data to generate a report based on input criteria |
| *Experiment Admin* | User of the system, able to run experiments on patient data |
| *GSR* | Galovanic Skin Resistance |
| *GUI* | Graphical User Interface |
| *HTTP(S)* | Hypertext Transfer Protocol (Secure) |
| *HRV* | Heart Rate Variability |
| *IEEE* | Institute of Electrical and Electronics Engineers |
| *Interface* | Medium in which a user interacts with the system |
| *Medical Device* | A device worn by a patient to collect medical data |
| *Model* | Data base representation |
| *MVC* | Model View Controller |
| *Patient* | User of the system, under the care of a physician |
| *Physician* | User of the system, treats patients |
| *Query* | Request for information based on parameters |
| *Query Builder* | Aids in building queries |
| *RSSI* | Bluetooth signal strength |
| *SDD* | Software Design Document/Software Design Specification |
| *SQL* | Structured Query Language |
| *Stakeholder* | Anyone who has a stake in the outcome of the project |
| *System Admin* | User of the system, able to manage other user accounts |
| *System Developer* | An individual involved in the design and construction of a system |
| *Tester* | An individual involved in the testing of a system |
| *UAH* | The University of Alabama in Huntsville |
| *User* | Operator of the system |
| *View* | User presentation GUI |
| *Web Application* | An application hosted on a server and accessible via the internet most commonly through a web browser |
| *Web Based* | Accessible via the internet utilizing HTTP/HTTPS |
| *Web Browser* | An interface to view web applications over the internet (example: Firefox, Internet Explorer) |
| *Web Service* | A software service accessible over the internet |

## References

IEEE Std 1016-1998, IEEE Standard for Software Design Specification

Definitions for New Race and Ethnicity Categories (https://nces.ed.gov/ipeds/reic/definitions.asp)

[UAH Fit Vault Sofware Requirements.docx](UAH%20Fit%20Vault%20Sofware%20Requirements.docx)

## Overview

The remainder of this design specification document addresses the software system architecture, detailed design information for the various system components, and the database schema design. Each major section will be broken into two pieces each detailing the design criteria for the two pieces of software the make the UAH Fit Vault.

## Application Framework

The application is designed to work with the Microsoft ASP.NET MVC web application framework. This framework uses the Microsoft .NET Framework and Common Language Runtime languages (specifically C#)

Using ASP.NET MVC helps guide the design process. The framework takes ideas from the traditional design patterns of Model-View-Controllers and bootstraps a web application allowing for simple design and allows us to leverage a lot of hard work done by people with far more expertise in web application framework development.

# System Architecture Description

## Overview of Components



**Figure 2.1**: Architectural Overview

The UAH Fit Vault application is a Web application that is comprised of and encompasses the presentation, business logic, and data access layers. The system interacts with the end user via a web interface and with an external SQL database hosted on a remote server. It is assumed that the user is authenticated to use the application.

* The presentation layer consists of a web interface for data processing and reporting. The various views and controllers used in this system will exist in the presentation layer. The views function as the user interface that gives the user a way to select the data files they wish to upload as well as a means for assigning activity information to the data. Other views will be used for account management and for displaying reports to the different users. The controllers process the data that is submitted to the system through the views from the user. The controllers are also responsible for determining the data that is used by the views to display the request information to the user.
* The business logic layer will consist of all the back end code comprised of classes to handle the parsing and processing of files as well as provide the logic to render metrics and reports. Business logic functions are those that are used to edit the data elements in the model classes in the system.
* The data access layer is structured using a singular repository object that provides a uniform means for persisting and retrieving data models from the database. This is intentionally done in order to abstract away other objects ability to communicate directly with the data source. The repository contains the necessary create, read, update, and delete functions necessary to change objects and processes requests from service objects. The data access layer will consist of all the back end code needed to interact with an external SQL database utilizing the data access library of choice. This system will use Entity Framework to manage the data access layer.

## Structure and Relationships

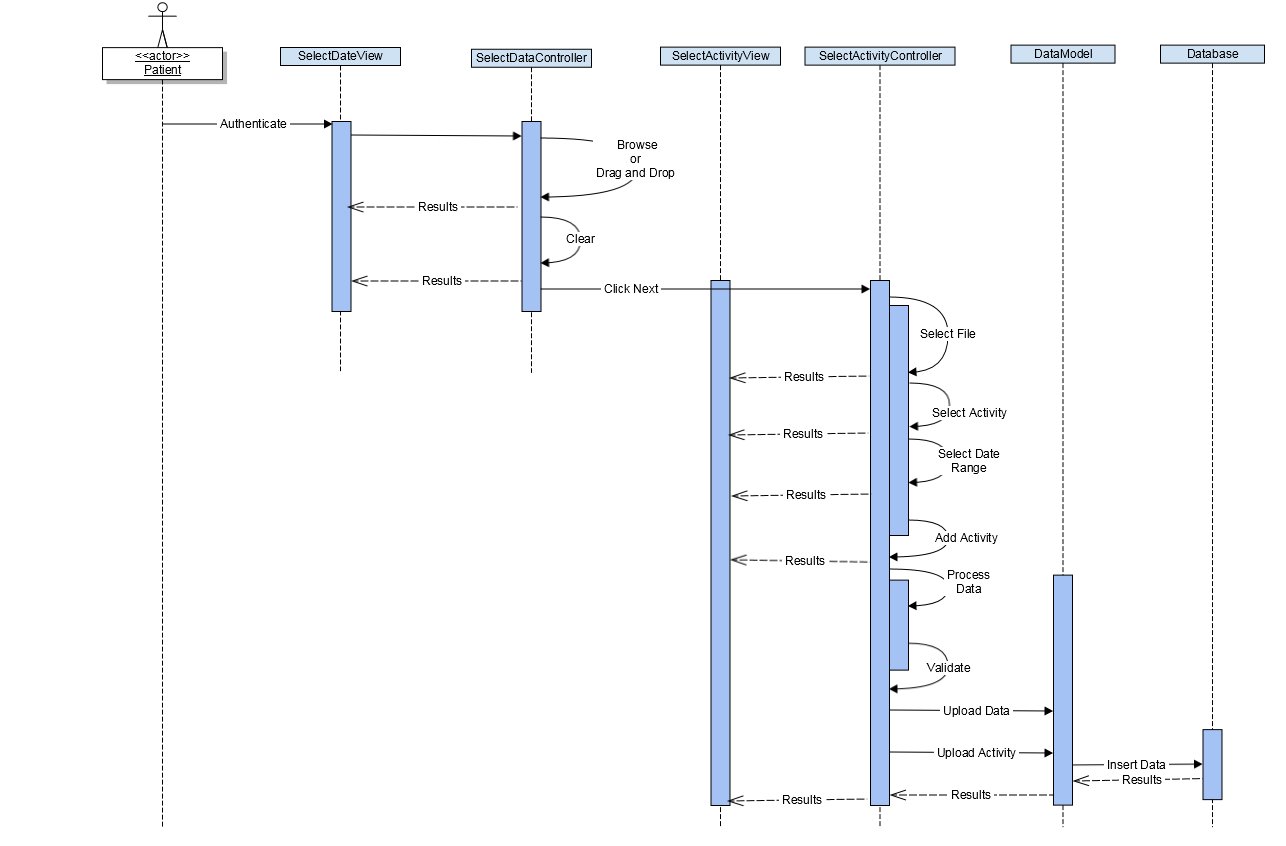
The following section is intended to describe the major features of the UAH Fit Vault system. Each feature shall contain a brief summary of the feature and information about how the feature will be implemented within the system. There will also be an accompanying sequence diagram to help visualize the relationship between the various system components needed to satisfy the feature’s functionality.

### Data Ingestion

Data ingestion is a feature that encapsulates the process of the patient selecting data files, assigning activities to the data, the system processing the data, and finally uploading the data and saving it to the system’s SQL database.

This process begins with a patient navigating to the **SelectDataView** and selecting the data that they would like to upload to the system. The data selection can occur in one of two ways. The system shall give the patient the ability to click a browse button on the view that will prompt the user with a modal that can traverse the file system structure of the machine the patient is using. The patient can use this tool to select a directory that contains the files that they wish to upload. The other option available for the patient is to drag and drop any files they wish to upload into the screen where the files would normally be listed. After either of these processes is performed the files will be listed in a list element on the view for review. The patient shall be given the opportunity to remove files from the list that they do not wish to upload. When the patient is satisfied the patient can click a “Next” button to proceed to assigning activities to the data.

After clicking the “Next” button the **SelectActivityView** will be loaded. This view allows the patient to enter any number of activities that occurred during the time of data capture. The patient will be provided with an interface to add, edit, and delete activities. Adding an activity will display date picker boxes to select the time period of the activity. There will also be a drop down select list containing preset activities that the user may choose from to label their data with an activity. Once the patient is satisfied with the activity list, the patient can click a “Upload” button to begin processing the data. After the system processes the data it will be uploaded and saved to the SQL database.



**Figure 2.2**: Sequence Diagram of Data Ingestion Feature

### Administrator Tools

The administrator shall have access to a number of tools used for user management. The first of these tools is the ability to approve or reject a user. When a new user registers as a Physician or an Experiment Administrator a System Administrator will have to approve their account in order for them to use the system. Upon creation of a new Physician or Experiment Administrator account, when a System Administrator views the **AdminHomeView**, they will see a list of user accounts that are pending approval. From this point the Admin will have the option of either clicking an approve button or a reject button. Based on that choice the user account will either update to an active or inactive status.

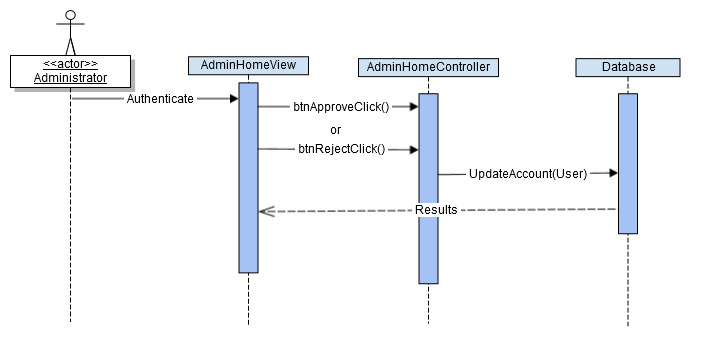
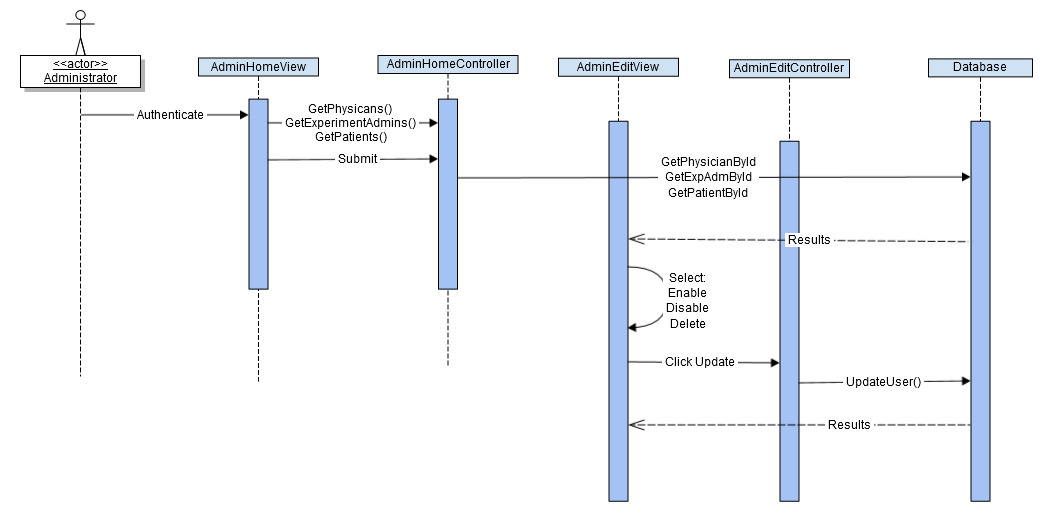


Figure 2.3: Approve Reject Account Sequence Diagram

The second set of Administrator tools involves editing the existing users in the database. These functions include enabling, disabling and deleting a user. When coming to the AdminHomeView the admin will see a list of Physicians and Experiment Administrators. When selecting a Physician, the Administrator will have the option to retrieve a list of the Physician’s patients from the database. Once a user has been selected the Administrator will press a submit button and will navigate to the AdminEditView. There will be three options available: enable, disable, and delete. After the action is selected the user record will be updated in the database.

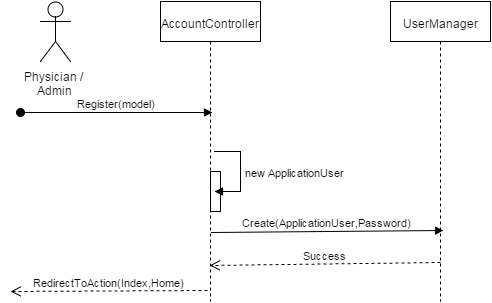
Regarding account deletion, when a system administrator deletes a user account that is a patient, all of the data associated with the patient will be deleted from the database. If in the future it is decided that this is not the desired functionality, it is suggested that the ability to delete a patient be removed from the system. A patient that would normally have been deleted shall be disabled instead. This will leave the patient record in the database allowing all the patient data to remain as well.

 Figure 2.4: Approve/Reject/Delete Account Sequence Diagram

### Account Management

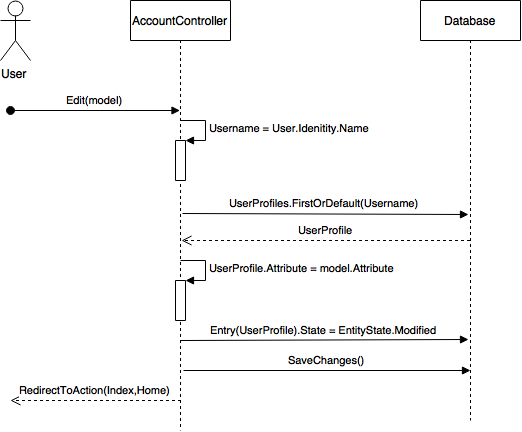
The account management feature encompasses the various tools available to the user for creating and managing their accounts. Patients will have access to the account management tools but will not be allowed to create their own accounts. Patient account creation will be described in the Physician Tools section 2.2.4.

The first tool shown below in figure 2.5 is account creation. The AccountController will provide a Register(model) procedure. The AccountController will create a new ApplicationUser when the Register() procedure is called. Then the AccountController will then call the Microsoft provided UserManager's Create(ApplicationUser,Password) procedure. This procedure will return a Success if the creation was successful. If a Success is returned, the AccountController will redirect the user back to the Home page.



**Figure 2.5**:Account Creation Sequence Diagram

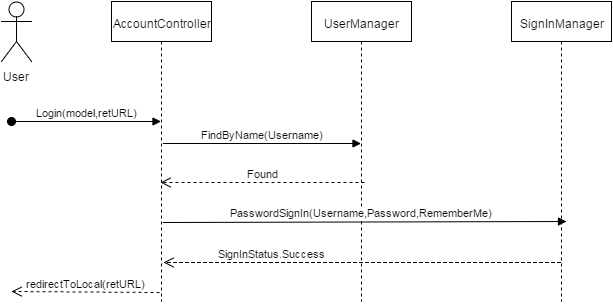
Next in figure 2.6 the edit account tool is detailed. The AccountController will offer a Edit(model) procedure. This procedure will interact with the Database object. When the Edit() procedure is called, the AccountController will get the username by using the Microsoft provided attribute User.Identity.Name. The AccountController will then call the Database's UserProfiles.FirstOrDefault(Username). This procedure will respond with the UserProfile corresponding to the Username. The AccountController will then set all the UserProfile attributes to the values provided in the model that was passed in with the Edit(model) call. Then the AccountController will set the Database's Entry(UserProfile).State to EntityState.Modified and call the Database's SaveChanges() procedure. The AccountController can then redirect the User to the Home page again.



**Figure 2.6**:Edit Account Sequence Diagram

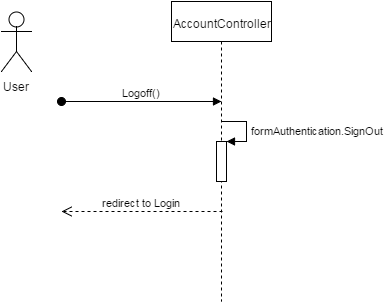
Two other key elements involved in user account management are the ability securely login to your account and to logout of your account. Figure 2.6 details the login in functionality, and figure 2.7 details the logout function.

The AccountController will offer a Login() procedure. It will interact with the Microsoft provided UserManager and SignInManager objects. When the Login is called it will call the UserManager's FindByName(Username) procedure to make sure the user exists in the database. Then the Login() procedure will call the SignInManager's PasswordSignIn(Username,Password,RememberMe) procedure. This will return a SignInStatus that tells the AccountController if the signin was successful. If the signin was successful, the AccountController will redirect the user to the retURL.



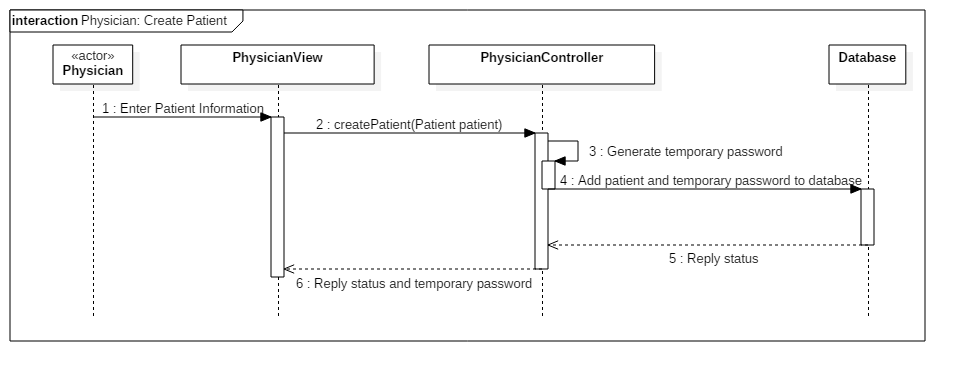
**Figure 2.7**:Login Sequence Diagram

The AccountController has a public procedure called Logoff(). This procedure when called by the user shall call the formAuthentication.SignOut() procedure provided by Microsoft in the MVC library. Once the SignOut() procedure has finished, the Logoff() procedure will redirect the user back to the Login screen.



**Figure 2.8**:Logoff Sequence Diagram

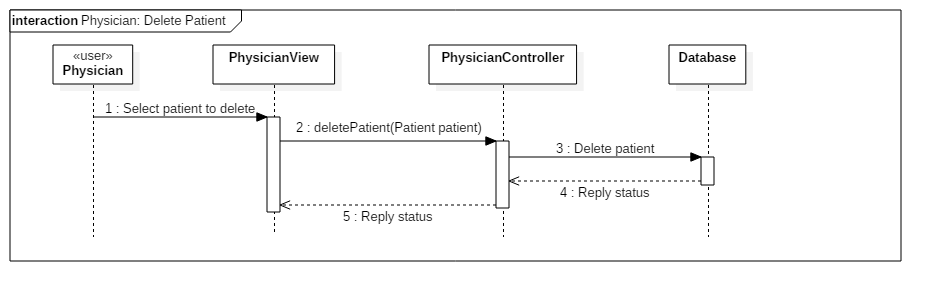
### Physician Actions



**Figure 2.9**:Create Patient Sequence Diagram

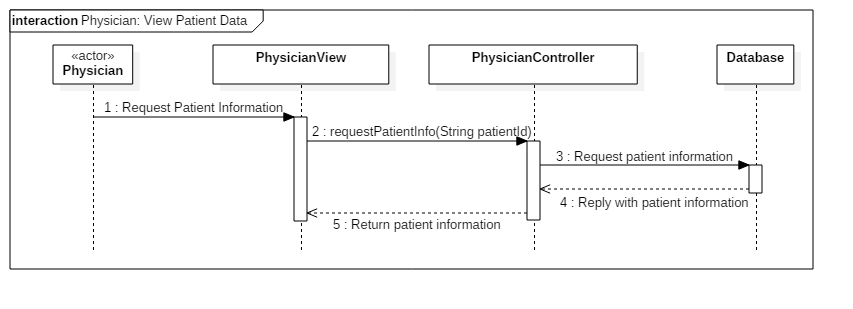
Physician: Create Patient

The “Physician: Create Patient” sequence diagram details the interactions when a physician adds a patient to the system. The physician will supply the details of the patient to the system, and the system will generate a password for the user and add the user to the database. If successful, the system will reply with a confirmation that the user was added to the database and the generated password. If unsuccessful, the system will display error information.

**Figure 2.10**:Delete Patient Sequence Diagram

Physician: Delete Patient

The “Physician: Delete Patient” sequence diagram details the interactions when a physician removes a patient from the system. The physician must select one of their patients to remove from the system. After the physician has selected a patient, the system will attempt to delete the patient. If successful, the system will reply that the patient was deleted or else display error information. As per section 2.2.2, deleting a patient will also remove all the patient data from the system.

 **Figure 2.11**:View Patient Data Sequence Diagram

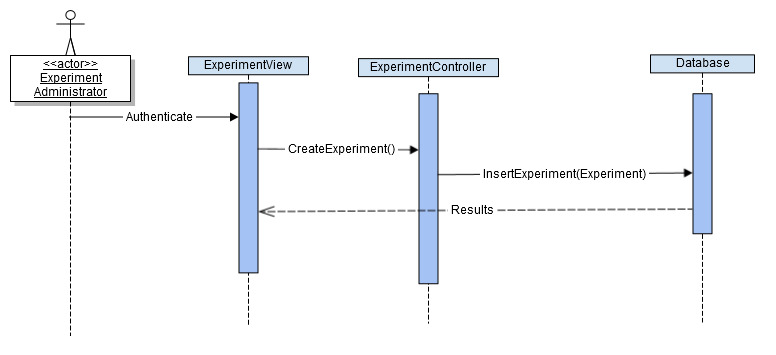
Physician: View Patient Data

The “Physician: View Patient Data” sequence diagram details the interactions when a physician wants to view the data for one of their patients. The physician selects a patient to view the data for. After the physician makes their selection, the PhysicianController will query the database for the patient information. The PhysicianView will display the patient information.

### Experiment Tools

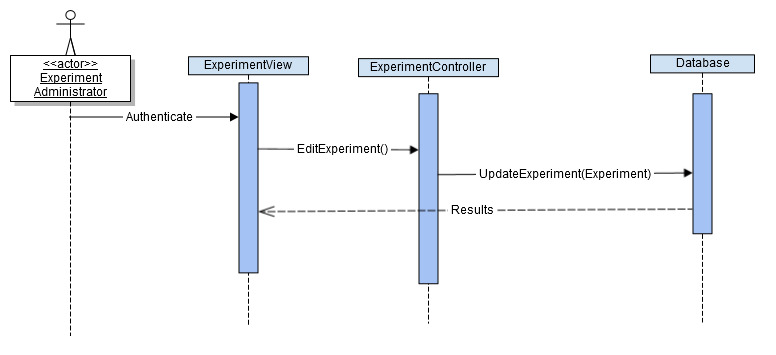
This section describes the various experiment tools made available to experiment administrators and physicians by the system. The experiment administrator will be the only user allowed to create, modify, and delete experiments. The physicians using this system will have access to view the experiments that have been created by the experiment administrators using the system. Experiments will be created based on various criteria such as age, height, weight, ethnicity, race, location, and gender.

The create experiment function in figure 2.12 functions as follows. As experiment administrator navigates to the experiment module in the web application. Pressing a create experiment button on the ExperimentView will display a modal form with criteria for creating the experiment. The form will include the criteria list above as well as drop down selection list containing various types of medical data that can be used in the experiments. Once the experiment administrator is satisfied with the experiment criteria, a create button on the modal can be pressed to call the CreateExperiment function in the ExperimentController. The controller will issue an InsertExperiment call passing the newly created Experiment object to the database to be added.



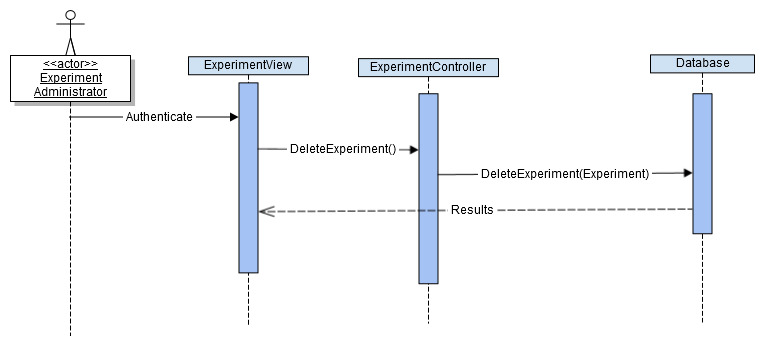
**Figure 2.12**:Create Experiment Sequence Diagram

The edit experiment function shown in figure 2.13 operates as follows. The experiment administrator shall have a list of their current experiments viewable when they access the ExperimentView. Selecting the edit option next to the experiment will display the same modal that was filled out when creating the experiment. This time the form will already be filled out with the current experiment criteria. The experiment administrator may now change any element of the experiment he or she wishes. Pressing an update button now on the modal will call the EditExperiment function in the ExperimentController. The controller will then tell the database to update the experiment record by calling the UpdateExperiment function passing the updated Experiment object as a parameter.



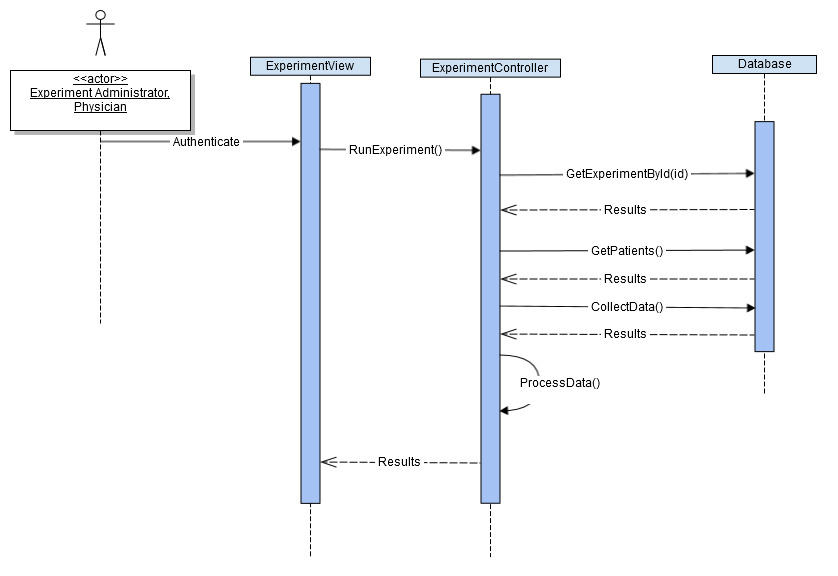
**Figure 2.13**:Edit Experiment Sequence Diagram

Deleting an experiment involves an experiment administrator navigating to the ExperimentView and pressing the delete button next to one of their experiments. A modal dialog asking if the experiment administrator is sure that they wish to delete the experiment will appear. Clicking the “OK” button will call the DeleteExperiment function in the ExperimentController. The controller will inform the database that the experiment needs to be deleted. This process is illustrated in figure 2.14 below.



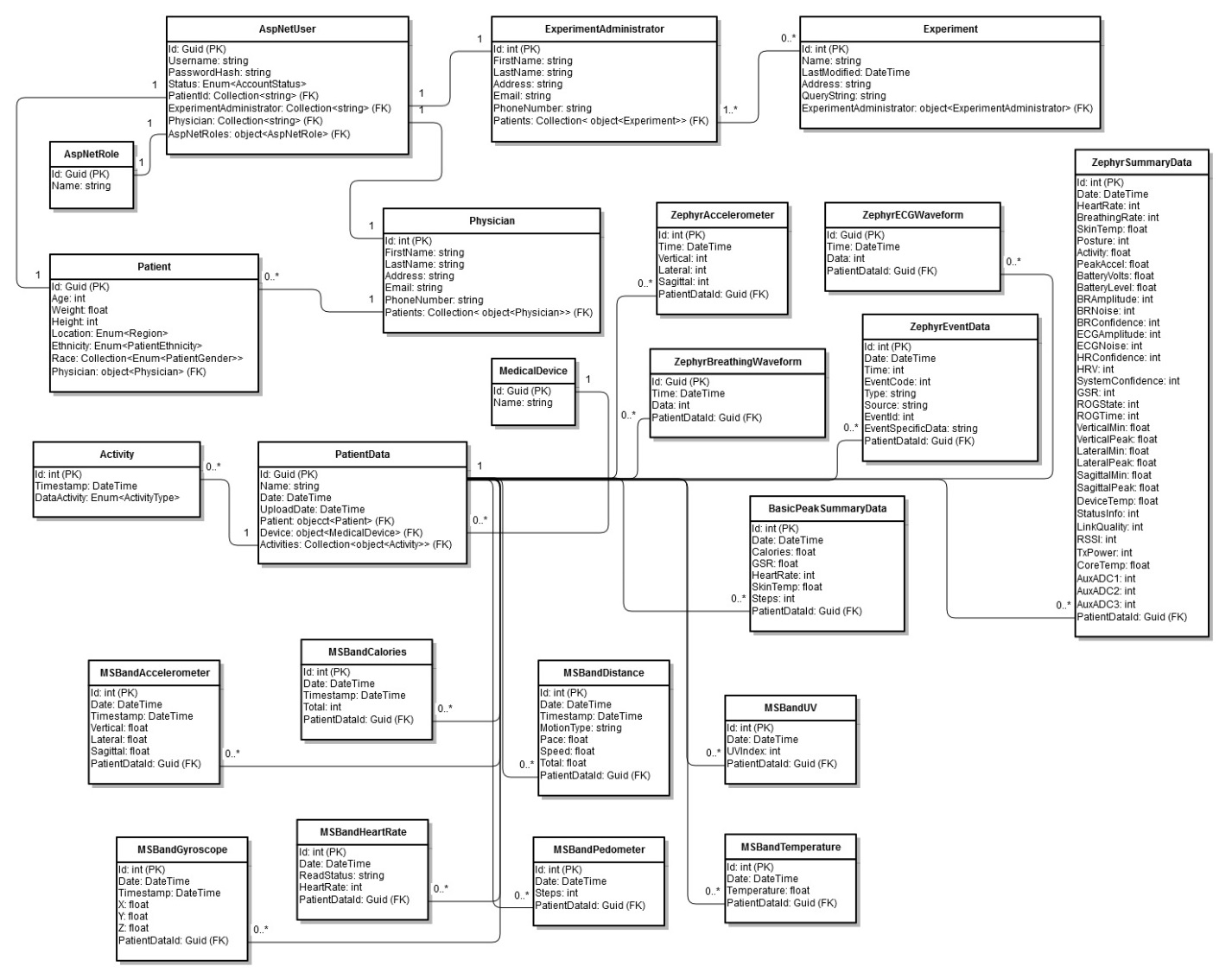
**Figure 2.14**:Delete Experiment Sequence Diagram

Both the physicians and experiment administrators will have access to viewing the experiments created in the system. Upon navigating to the ExperimentView, they physician will be able to view a list of all experiments in the system. The experiment administrator however will only have a list of the experiments they have created. Clicking a view button next to the experiment will call the RunExperiment function in the ExperimentController. This will get the experiment query information from the database and execute the query. The controller will collect all of the patients that meet the experiment criteria. The controller will then request the relevant medical data for each patient based on the experiment criteria. Figure 2.15 shows a function called CollectData(). This function is merely a placeholder for the various calls to the database that are required to collect all of the medical data. Once all the data is collect the controller will process the data in order to return in back to the ExperimentView where the results of the experiment are now displayed.

** Figure 2.15**:View Experiment Sequence Diagram

## Database Schema

Figure 2.9 below shows the SQL database schema that will be implemented with this system. The database that will be used is SQL Server 2014. The database will be developed using the Entity Framework 6.0 package through Visual Studio 2015. The diagram shows all the tables and columns in each table. Primary keys for each table are denoted with (PK), and foreign keys are denoted with (FK). The links show not only the association information but also point to the columns in each table the foreign key refers to. Each class is further described in the detailed design section 3.2.1.



**Figure 2.9:** Database Schema

# Detailed Description of Components

## Presentation Layer Overview

### Controllers

#### SelectDataController

This class is responsible for selecting the data files for processing. This class provides the backend for the **SelectDataView**. See Figure 2.2 sequence diagram for this controller.

**<<Task>>**

**Attributes:**

* **Private Collection<int, String>** DataFiles
  + Dictionary containing the paths to the data files and a unique id.
* **Private String** DirectoryPath
  + Path to the directory containing the data files to be processed.

**Operations:**

* Sets and gets for all attributes.
* **Public ActionResult** btnFolderBrowseClick()
  + When the folder browser button is clicked a folder browser dialog object is created, a directory is selected by the user, and the DirectoryPath is set.
  + The results are returned to the **SelectDataView.**
* **Public ActionResult** DragAndDropFiles()
  + When the desired files are selected and dropped into the GUI window.
  + The results are returned to the **SelectDataView.**
* **Public ActionResult** btnClearClick()
  + When the clear button is clicked any stored data and file path(s) will be removed.
    - DirectoryPath variable reset
    - DataFiles collection emptied
    - The results are returned to the **SelectDataView.**
* **Private ActionResult** btnNextClick()
  + When the next button is clicked the file locations of the files in the DirectoryPath are added to the DataFiles collection.
  + The DataFiles collection is passed to the **SelectActivityController.**

#### SelectActivityController

This class is responsible for assigning an activity to a date and time portion of a data file. This class provides the backend for the **SelectActivityView**. See Figure 2.2 sequence diagram for this controller.

**<<Task>>**

**Attributes:**

* **Private Collection<Activity>** Activities
  + Activities is a collection used to hold all **Activity** objects.

**Operations:**

* Sets and gets for all attributes.
* **Public ActionResult** SelectFile()
  + A data file is selected (id).
  + The results are returned to the **SelectActivityView**
* **Public ActionResult** SelectActivity()
  + An activity is selected.
  + The results are returned to the **SelectActivityView**
* **Public ActionResult** AddDateRange()
  + A date and time range is selected.
  + The results are returned to the **SelectActivityView**
* **Public ActionResult** AddActivity()
  + An activity object is created and assigned the values from the selections
    - File id
    - Activity
    - Date time range
  + The results are returned to the **SelectActivityView**
* **Public ActionResult** ProcessData()
  + Iterates through the data files.
    - Calls the Validate method to validate each data file
      * If a file is invalid it is not process and any associated activates are dropped.
      * If a file is valid the UploadDataFile method is called and passed the data file object
        + Any activities associated with the data file is uploaded via the UploadDataActivity method.
  + When processing is complete the results will be returned to the **SelectActivityView**
* **Public ActionResult** Validate(**File file**)
  + Returns if the file is valid or invalid.
* **Public ActionResult** UploadDataFile(**File file**)
  + This method uploads the data file into the database.

* **Public ActionResult** UploadActivity(**Activity activity**)
  + This method uploads the activity into the database.

#### AccountController

This class is responsible for user accounts. This class provides the backend for the **AccountView**.

**<<Task>>**

**Operations:**

* **Public ActionResult** Login(LoginViewModel model, String returnURL)
  + Finds the user by name (username).
  + Calls the sign in manager to sign in by password.
  + Returns the returnURL.
* **Public ActionResult** Logoff()
  + Calls the form authentication’s sign out procedure.
* **Public Task<ActionResult>** Register(RegisterVIewModel model)
  + Calls user manager’s create
  + Returns success

#### AdminHomeController

This class is responsible for accepting or rejecting a user account request. This class provides the backend for the **AdminHomeView**. The AdminHomeView has a link to navigate to look-up a user in order to delete, enable, or disable their account. See Figure 2.3 and 2.4 sequence diagram for this controller.

**<<Task>>**

**Attributes:**

* **Private Collection<String>** UserNames
  + Collection of usernames of accounts to be approved or rejected.

**Operations:**

* **Public string** GetPhysicians()
  + Gets a list of all the physicians in the system.
* **Public string** GetExperimentAdministrators()
  + Gets a list of all the experiment administrators in the system.
* **Public string** GetPatients(int PhysicianId)
  + Gets a list of all the patients for the selected physician in the system.
* **Public ActionResult** btnApproveClick()
  + When the approve button is clicked the user account request is approved.
  + The results are returned to the **AdminHomeView.**
* **Public ActionResult** btnRejectClick()
  + When the reject button is clicked the user account request is denied.
  + The results are returned to the **AdminHomeView.**
* **Public ActionResult** btnSubmit()
  + A query by username is sent to the database and the user account information is returned.
  + The user account information is passed to the **AdminEditController.**

**Constructors:**

* **Public** AdminHomeController()
  + Default constructor

#### AdminEditController

This class is responsible for allowing the system administrator to enable, disable, or delete a user account. This class provides the backend for the **AdminEditView**. See Figure 2.4 sequence diagram for this controller.

**<<Task>>**

**Attributes:**

* **Private String** Username
  + The username of the account to modify.

**Operations:**

* **Public ActionResult** btnUpdate()
  + An update is sent to the database based on the selected option:
    - Enable
    - Disable
    - Delete
  + The results are returned to the **AdminEditView.**

**Constructors:**

* **Public** AdminEditController()
  + Default constructor

#### PhysicianController

This class is responsible for handling the various functions available to a physician. This class provides the backend for the **PhysicianView**. The actions available to the physician are detailed in the operations section below.

**<<Task>>**

**Attributes:**

* **Private Physician** physician
  + The physician associated with the class.

**Operations:**

* **Public ActionResult** CreatePatient(Patient patient)
  + The function to add a patient to the system.
* **Public ActionResult** DeletePatient(Patient patient)
  + The function to remove a patient from the system.
* **Public ActionResult** RequestPatientInformation(String patientId)
  + The function to request patient information from the system.

**Constructors:**

* **Public** PhysicianController()
  + Default constructor.

#### ExperimentController

This class is responsible for handling experiment functions called from the **ExperimentView**. The actions are available to the experiment administrators with physicians having access to the view experiment functionality.

**<<Task>>**

**Attributes:**

* **Private Collection<Experiment>** experiments
  + A collection of experiments available to the user.

**Operations:**

* **Public ActionResult** CreateExperiment(Experiment experiment)
  + The function used to add an experiment to the system.
* **Public ActionResult** DeleteExperiment(Experiment experiment)
  + The function used to remove an experiment from the system.
* **Public ActionResult** EditExperiment(Experiment experiment)
  + The function used to edit an experiment in the system.
* **Public ActionResult** RunExperiment(int experimentId)
  + The function used to run the selected experiment.
* **Private string** ProcessData(Collection<object>)
  + The function is here in the event that the data returned from the database will need to be processed in some way prior to be sending it to the view.

**Constructors:**

* **Public** ExperimentController()
  + Default constructor.

## Business Logic Layer Overview

### Entities

#### LoginViewModel

This class contains data associated with a user’s login information. The **LoginViewModel** class is used by the **AccountController**.

**<<Entity>>**

**Attributes:**

* **Public string** UserName
  + Username of the user that is used to authenticate their login.
* **Public string** Password
  + Password of the user that is used to authenticate their login.
* **Public bool** RememberMe
  + Used to inform the browser to remember the login and password information in a cookie for future logins by that user.

**Operations:**

* Sets and gets for all attributes.

#### RegisterViewModel

This class contains data associated registering a new user account. The **RegisterViewModel** class is used by the **AccountController**.

**<<Entity>>**

**Attributes:**

* **Public string** UserName
  + Username of the user that is used to authenticate their login.
* **Public string** Password
  + Password of the user that is used to authenticate their login.
* **Public bool** ConfirmPassword
  + Password of the user that is used to authenticate their login. Must match the Password field in order to successfully register.

**Operations:**

* Sets and gets for all attributes.

#### Activity

This class contains data associated with an activity tied to a date and time portion of a data file. The **Activity** class is used by the **ActivitySelectionController**.

**<<Entity>>**

**Attributes:**

* **Public int** fileId
  + The id of the file to be assigned an activity.
* **Public DateTime** TimeStamp
  + The date and time of the activity.
* **Public ActivityType** DataActivity
  + The activity of the data.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** Activity()
  + Default constructor

#### AspNetUser

This class describes the attributes common to all users. This will act as a base class for **Patients**, **Physicians**, and **Experiment Administrators**.

**<<Entity>>**

**Attributes:**

* **Public Guid** Id
  + Unique id for each user.
* **Public string** UserName
  + The user name used by each user that will be used to log into the system.
* **Public string** PasswordHash
  + Hash string representing the user’s password used to log into the system.
* **Public AccountStatus** Status
  + Enumeration value that describes the current account status of the user.
* **Public Nullable<string>** PatientId
  + If the user is a patient this field will be used as a foreign key to the **Patient** table Id field.
* **Public Nullable<int>** Physician
  + If the user is a physician this field will be used as a foreign key to the **Physician** table Id field.
* **Public Nullable<int>** ExperimentManager
  + If the user is a experiment manager this field will be used as a foreign key to the **ExperimentManager** table Id field.
* **Public virtual AspNetRole** AspNetRoles
  + Link to the user role in the **AspNetRole** table

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** AspNetUser()
  + Default constructor

#### Patient

This class describes the attributes and construction of a **Patient** user object.

**<<Entity>>**

**Attributes:**

* **Public string** Id
  + Unique patient id created by the patient’s physician used to identify their patients.
* **Public int** Age
  + The age of the patient.
* **Public float** Weight
  + The weight of the patient.
* **Public int** Height
  + The height of the patient given in inches.
* **Public Region** Location
  + The state where the patient is located.
* **Public PatientEthnicity** Ethnicity
  + Enumeration value used to describe the patient’s ethnicity.
* **Public Collection<PatientRace>** Race
  + Collection of enumeration values used to describe the patient’s race.
* **Public PatientGender** Gender
  + Enumeration value used to describe the patient’s gender.
* **Public virtual Physician** Physician
  + Foreign key link to the patient’s physician.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** Patient()
  + Default constructor

#### Physician

This class describes the attributes and construction of a **Physician** user object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each physician.
* **Public string** FirstName
  + Physician’s first name.
* **Public string** LastName
  + Physician’s last name.
* **Public string** Address
  + Physician’s office address information.
* **Public string** Email
  + Email address for the physician
* **Public string** PhoneNumber
  + Phone number for the physician
* **Public virtual Collection<Parent>** Patients
  + Collection of all of the physician’s patients.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** Physician()
  + Default constructor

#### ExperimentAdministrator

This class describes the attributes and construction of an **Experiment Administrator** user object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each experiment administrator.
* **Public string** FirstName
  + Experiment administrator’s first name.
* **Public string** LastName
  + Experiment administrator’s last name.
* **Public string** Address
  + Experiment administrator’s address information.
* **Public string** Email
  + Email address for the experiment administrator
* **Public string** PhoneNumber
  + Phone number for the experiment administrator.
* **Public virtual Collection<Experiment>** Experiments
  + Collection of all of the experiment administrator experiments.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ExperimentAdministrator()
  + Default constructor

#### Experiment

This class describes the attributes and construction of an **Experiment** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each experiment.
* **Public string** Name
  + Experiment name.
* **Public DateTime** LastModified
  + Date information for when experiment was last modified.
* **Public string** QueryString
  + Query information used to collect the experiment data.
* **Public virtual ExperimentAdministrator** ExperimentAdministrator
  + Foreign key relationship to the experiment administrator that created the experiment.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ExperimentAdministrator()
  + Default constructor

#### Medical Device

This class describes the attributes and construction of an **MedicalDevice** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each medical device.
* **Public string** Name
  + Medical device name.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MedicalDevice()
  + Default constructor

#### PatientData

This class describes the attributes and construction of a **PatientData** object.

**<<Entity>>**

**Attributes:**

* **Public Guid** Id
  + Unique id generated by the system for each patient data record.
* **Public string** Name
  + Name of the patient data record
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public DateTime** UploadDate
  + Date when the patient uploaded the data record to the system.
* **Public virtual Patient** Patient
  + Foreign key relationship to the Patient that the data record belongs to.
* **Public virtual MedicalDevice** Device
  + Foreign key relationship to the MedicalDevice that the data record was collected from.
* **Public virtual Collection<Activities>** Activities
  + Foreign key relationship to a list of Activities that the patient used to describe the data record.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** PatientData()
  + Default constructor

#### MSBandAccelerometer

This class describes the attributes and construction of a **MSBandAccelerometer** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band Accelerometer data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public DateTime** Timestamp
  + Timestamp detailing the when in the record each data point was collected.
* **Public float** Vertical
  + Vertical axis of the accelerometer data.
* **Public float** Lateral
  + Lateral axis of the accelerometer data.
* **Public float** Sagittal
  + Sagittal axis of the accelerometer data.
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandAccelerometer()
  + Default constructor

#### MSBandCalories

This class describes the attributes and construction of a **MSBandCalories** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band Calorie data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public int** Total
  + Total calories burned at the moment of each data sample
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandCalories()
  + Default constructor

#### MSBandGyroscope

This class describes the attributes and construction of a **MSBandGyroscope** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band Gyproscope data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public DateTime** Timestamp
  + Timestamp detailing the when in the record each data point was collected.
* **Public float** X
  + X axis of the gyroscope data record.
* **Public float** Y
  + Y axis of the gyroscope data record.
* **Public float** Z
  + Z axis of the gyroscope data record.
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandGyroscope()
  + Default constructor

#### MSBandHeartRate

This class describes the attributes and construction of a **MSBandHeartRate** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band Heart Rate data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public string** ReadStatus
  + Read status of the heart rate monitor on the device.
* **Public int** HeartRate
  + Heart rate at the moment of each data sample
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandHeartRate()
  + Default constructor

#### MSBandDistance

This class describes the attributes and construction of a **MSBandDistance** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band Distance data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public string** MotionType
  + Describes the type of motion that is occurring at the time of each data sample
* **Public float** Pace
  + Describes the pace of the movement in min/km at the time of each data sample
* **Public float** Speed
  + Describes the speed of the user in km/hr at the time of each data sample
* **Public string** Total
  + Describes the total distance that has been travelled at the time of each data sample
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandDistance()
  + Default constructor

#### MSBandUV

This class describes the attributes and construction of a **MSBandUV** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band UV data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public int** UVIndex
  + UV index measured by the device at the moment of each data sample
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandUV()
  + Default constructor

#### MSBandTemperature

This class describes the attributes and construction of a **MSBandTemperature** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Microsoft Band Calorie data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public int** Temperature
  + Outside temperature (Celsius) measured by the device at the moment of each data sample
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandTemperature()
  + Default constructor

#### BasisPeakSummaryData

This class describes the attributes and construction of a **BasisPeakSummaryData** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each BasicPeak Summary data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public float** Calories
  + Total calories burned at the moment of each data sample
* **Public float** GSR
  + GSR data at the moment of each data sample.
* **Public int** HeartRate
  + Heart rate at the moment of each data sample.
* **Public float** SkinTemp
  + Patient skin temperature at the moment of each data sample.
* **Public int** Steps
  + Number of steps the patient has taken at the moment of each data sample.
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** MSBandCalories()
  + Default constructor

#### ZephyrAccelerometer

This class describes the attributes and construction of a **ZephyrAccelerometer** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Zephyr Accelerometer data record.
* **Public DateTime** Time
  + Date information for when the patient collected the data.
* **Public int** Vertical
  + Vertical axis data from the device accelerometer
* **Public int** Lateral
  + Lateral axis data from the device accelerometer
* **Public int** Sagittal
  + Sagittal axis data from the device accelerometer
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ZephyrAccelerometer()
  + Default constructor

#### ZephyrBreathingWaveform

This class describes the attributes and construction of a **ZephyrBreathingWaveform** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Zephyr Breathing Waveform data record.
* **Public DateTime** Time
  + Date information for when the patient collected the data.
* **Public int** Data
  + Waveform data point
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ZephyrBreathingWaveform ()
  + Default constructor

#### ZephyrECGWaveform

This class describes the attributes and construction of a **ZephyrECGWaveform** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Zephyr ECG Waveform data record.
* **Public DateTime** Time
  + Date information for when the patient collected the data.
* **Public int** Data
  + Waveform data point
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ZephyrECGWaveform ()
  + Default constructor

#### ZephyrEventData

This class describes the attributes and construction of a **ZephyrEventData** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Zephyr Event data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public int** Time
  + Time in ms at the moment of each data sample.
* **Public int** EventCode
  + Event code defined by the device when the event is triggered by the device.
* **Public string** Type
  + Type of event that was triggered by the device
* **Public string** Source
  + Source of the device that caused the event to occur.
* **Public int** EventId
  + Id given to the event.
* **Public string** EventSpecificData
  + Detail of what occurred that triggered the event.
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ZephyrEventData ()
  + Default constructor

#### ZephyrSummaryData

This class describes the attributes and construction of a **ZephyrSummaryData** object.

**<<Entity>>**

**Attributes:**

* **Public int** Id
  + Unique id generated by the system for each Zephyr Summary data record.
* **Public DateTime** Date
  + Date information for when the patient collected the data.
* **Public int** HeartRate
  + Patient heart rate measured by the device at the moment of each data sample.
* **Public int** BreathingRate
  + Patient breathing rate measured by the device at the moment of each data sample.
* **Public float** SkinTemp
  + Patient skin temperature measured by the device at the moment of each data sample.
* **Public int** Posture
  + Patient posture measured by the device at the moment of each data sample.
* **Public float** Activity
  + Patient activity measured by the device at the moment of each data sample.
* **Public float** PeakAccel
  + Patient peak acceleration measured by the device at the moment of each data sample.
* **Public float** BatteryVolts
  + Current voltage being supplied by the device battery.
* **Public float** BatterLevel
  + Current battery level of the device battery.
* **Public int** BRAmplitude
  + Patient breathing rate amplitude measured by the device at the moment of each data sample.
* **Public int** BRNoise
  + Patient breathing rate noise measured by the device at the moment of each data sample.
* **Public int** BRConfidence
  + Device confidence in the breathing rate measurement.
* **Public int** ECGAmplitude
  + Patient ECG amplitude measured by the device at the moment of each data sample.
* **Public int** ECGNoise
  + Patient ECG noise measured by the device at the moment of each data sample.
* **Public int** HRConfidence
  + Device confidence in the heart rate measurement.
* **Public int** HRV
  + HRV measured by the device at the moment of each data sample.
* **Public int** SystemConfidence
  + Measurement of overall system confidence in the measurements.
* **Public int** GSR
  + GSR measured by the device at the moment of each data sample.
* **Public int** ROGState
  + Some device state at the moment of each data sample
* **Public int** ROGTime
  + An incremental time value representing how many samples occurred inside the current ROGState.
* **Public float** VerticalMin
  + Minimum value of the vertical axis measured by the device accelerometer between summary sample points.
* **Public float** VerticalPeak
  + Maximum value of the vertical axis measured by the device accelerometer between summary sample points.
* **Public float** LateralMin
  + Minimum value of the lateral axis measured by the device accelerometer between summary sample points.
* **Public float** LateralPeak
  + Maximum value of the lateral axis measured by the device accelerometer between summary sample points.
* **Public float** SagittalMin
  + Minimum value of the sagittal axis measured by the device accelerometer between summary sample points.
* **Public float** SagittalPeak
  + Maximum value of the sagittal axis measured by the device accelerometer between summary sample points.
* **Public float** DeviceTemp
  + Device temperature at the moment of each data sample.
* **Public int** StatusInfo
  + A status code provided by the device.
* **Public int** LinkQuality
  + Measurement of the quality of the device link.
* **Public int** RSSI
  + RSSI value measured by the device at the time of each data sample.
* **Public int** TxPower
  + Transmit power measured by the device at the time of each data sample.
* **Public float** CoreTemp
  + Device core temperature at the moment of each data sample.
* **Public int** AuxADC1
  + Auxillary ADC value.
* **Public int** AuxADC2
  + Auxillary ADC value.
* **Public int** AuxADC3
  + Auxillary ADC value.
* **Public Guid** PatientDataId
  + Foreign key relationship to the id of the patient data record from the **PatientData** table that this data record corresponds to.

**Operations:**

* Sets and gets for all attributes.

**Constructors:**

* **Public** ZephyrSummaryData ()
  + Default constructor

### Enumerations

#### ActivityType

This is the enumeration that contains the various activities a user could be performing while wearing the medical device and capturing data.

**<<Enumeration>>**

**Attributes:**

* Running
* Walking
* Sleeping
* Sitting
* Standing

#### AccountStatus

This is the enumeration that contains the different account statuses.

**<<Enumeration>>**

**Attributes:**

* Pending
* Active
* Inactive

#### PatientEthnicity

This is the enumeration that contains the ethnicity categories defined in the National Center for Education Statistics that a patient may belong to.

**<<Enumeration>>**

**Attributes:**

* Hispanic or Latino
* Not Hispanic or Latino

#### PatientRace

This is the enumeration that contains the racial categories defined in the National Center for Education Statistics that a patient may belong to.

**<<Enumeration>>**

**Attributes:**

* American Indian or Alaska Native
* Asian
* Black or African American
* Native Hawaiian or Other Pacific Islander
* White
* Other

#### PatientGender

This is the enumeration that contains the different gender types.

**<<Enumeration>>**

**Attributes:**

* Female
* Male

#### Region

This is the enumeration that contains the names of the fifty states that make up the United States plus other major regions in the world.

**<<Enumeration>>**

**Attributes:**

* Alabama
* Alaska
* American Samoa
* Arizona
* Arkansas
* California
* Colorado
* Connecticut
* District of Columbia
* Delaware
* Florida
* Georgia
* Guam
* Hawaii
* Idaho
* Illinois
* Indiana
* Iowa
* Kansas
* Kentucky
* Louisiana
* Maine
* Maryland
* Massachusetts
* Michigan
* Minnesota
* Mississippi
* Missouri
* Montana
* Nebraska
* Nevada
* New Hampshire
* New Jersey
* New Mexico
* New York
* North Carolina
* North Marianas Islands
* North Dakota
* Ohio
* Oklahoma
* Oregon
* Pennsylvania
* Puerto Rico
* Rhode Island
* South Carolina
* South Dakota
* Tennessee
* Texas
* Utah
* Vermont
* Virginia
* Virgin Islands
* Washington
* West Virginia
* Wisconsin
* Wyoming
* European Union
* Eastern Europe
* Africa
* South America
* Central America
* Asia
* Oceania
* North America
* The Caribbean

## Data Access Layer Overview