CSCE 498/4980 | Senior Project I
American University in Cairo

Software Requirements Specification

Curis Catena

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Revision History

Date	Reason For Changes	Version
6/12/2017	Initial Document Draft	1.0
11/12/2017	Updates to UML diagrams	1.1

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1. Introduction

Curis Catena is an EPRs management and exchange system that allows the secure and efficient sharing and modification of patient medical data, using a blockchain-based infrastructure, while abiding by HIPAA healthcare IT system standards.

1.1 Purpose

The purpose of this document is to give a detailed description of the requirements intended for the *Curis Catena* system, through illustrating the system's scope, subcomponents, expected interfaces and interactions internally between its subcomponents and externally with external applications, on both functional and nonfunctional requirements levels.

1.2 Document Conventions

Format	Meaning
Italic text	Keywords
Bold Text	Headings
Indentation	Sub-component
Bulleted Lists	Lists of elements
Numbered Lists	Lists ordering elements based on their importance

1.3 Intended Audience and Reading Suggestions

The document is not intended for end-users of the *Curis Catena* system, as it may not be of use to them. It is, however, intended for the system's clients, developers, and testers, where:

- Clients should browse the document to verify that their functional and nonfunctional requirements have been met, and to possibly suggest modifications to its content.
- Developers of the system should maintain the document carefully and use it as a reference for the implementation of the system in a manner that suits the usecase scenarios.
- Testers of the system should use the document as a reference to validate all the high-level features of the system are working as intended, using the conditions stated for each usecase scenario.

1.4 Product Scope

The goal of the system is to provide a middleware for interactions between patients and healthcare facilities and their providers. Patients will be able to access their EPRs at all times remotely, while ensuring that only authorized healthcare providers will have access to them. Similarly, healthcare providers can access their needed patient EPR data also at all times remotely. And with all patients' EPRs accumulated, healthcare facilities can gain a base where research information can be mined for. The system's core functionalities will be built over an underlying blockchain-based system, which will allow it to achieve maximum security.

1.5 Literature Review and References

The following references were used for the creation of this document:

1) Ekblaw, Ariel, et al. "A Case Study for Blockchain in Healthcare:"MedRec" prototype for electronic health records and medical research data." Proceedings of IEEE Open & Big Data Conference. 2016. https://www.healthit.gov/sites/default/files/5-56-onc_blockchainchallenge_mitwhitepaper.pdf
2) Ethereum. *Ethereum Whitepaper*. Ethereum/Wiki, GitHub, 18 Sept. 2017, github.com/ethereum/wiki/wiki/White-Paper.
3) Peck, Morgen E. "Blockchains: How They Work and Why They'LI Change the World." IEEE Spectrum: Technology, Engineering, and Science News, IEEE Spectrum, 28 Sept. 2017, spectrum.ieee.org/computing/networks/blockchains-how-they-work-and-why-theyll-change-the-world.
4) McConaghy, Trent, et al. "BigchainDB: A Scalable Blockchain Database." 8 June 2016, www.bigchaindb.com/whitepaper/bigchaindb-whitepaper.pdf.
5) McFarlane, Chrissa, et al. "Patientory: A Healthcare Peer-to-Peer EMR Storage Network v1. 0." 2017. https://patientory.com/patientory_whitepaper.pdf
6) Wang, Jason. "How Do I Become HIPAA Compliant?", TrueVault, 30 Oct. 2013, www.truevault.com/blog/how-do-i-become-hipaa-compliant.html.

2. Overall Description

2.1 Product Perspective

The *Curis Catena* system, as shown below in figure 1, provides a blockchain-based database system where data navigates from patients to healthcare providers and vice versa in a completely secure manner. The patient has access to their EPR, choose which healthcare facility they wish to share their EPR with, while at the same time, healthcare providers can get the data that they need by accessing the patient's EPR when authorized to.

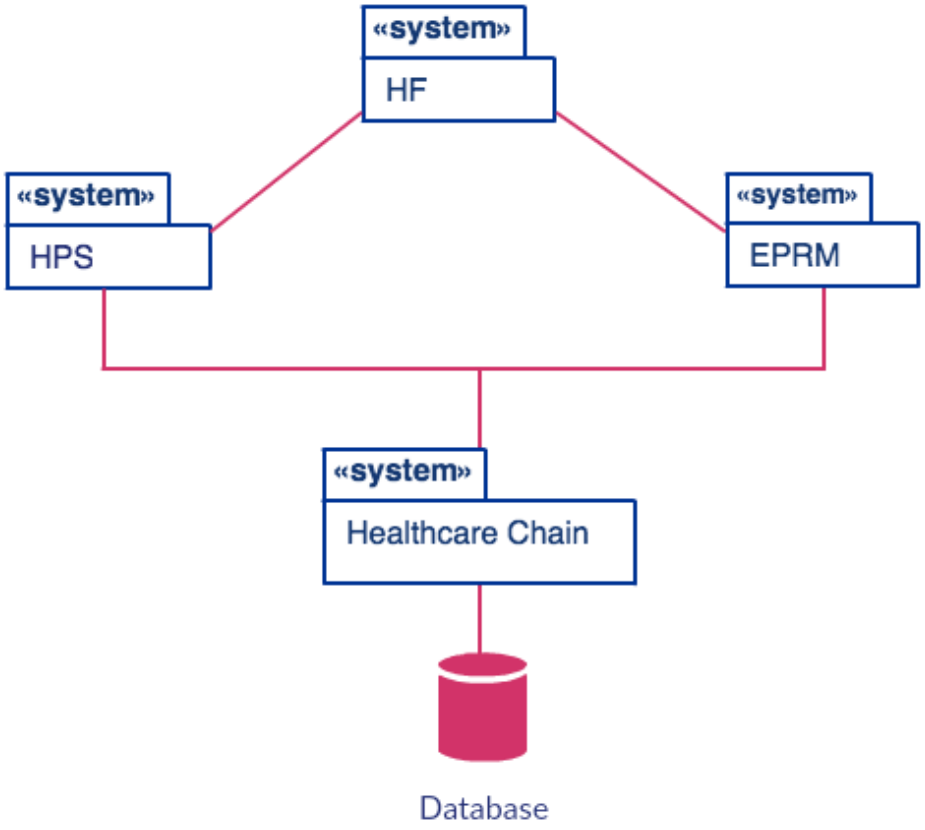

***Figure 1** | Curis Catena Sub-Systems*

2.2 Product Functions

The system provides the following functionalities, grouped by their respective end-users:

- Certificate authorities can:
  - Authenticate patients
  - Authenticate healthcare providers
  - Authorize EPR accesses

- Healthcare providers can:
  - Manage their account
  - View patients' EPRs
  - Modify patients' EPRs

- Patients can:
  - Manage their account
  - Modify their own EPR
  - View their own EPR
  - Pay for healthcare services
  - Grant a healthcare facility EPR access
  - Revoke a healthcare facility's EPR access

- Healthcare facilities (i.e. super administrators) can:
  - Register system administrator accounts
  - Revoke system administrator accounts

- System administrators:
  - Charge patients for healthcare service
  - Add a healthcare provider
  - Remove a healthcare provider

- Miners can:
  - Validate transactions over the system
  - Add transactions to the system's blockchain

- Databases can:
  - Handle incoming queries to fetch or add data

2.3 User Classes and Characteristics

The end-users are sub-classified as follows:

- **Certificate authorities:**
  Users who authenticate patients and healthcare providers and manage EPR access lists.

- **Healthcare facility (Super administrators):**
  Users in the healthcare facility who have higher privileges than system administrators. They can revoke system administrator accounts and register them.

- **System administrators:**
  Users in the healthcare facility who can add and remove healthcare providers from the system, and charge patients for healthcare services.

- **Healthcare providers:**
  Users in the healthcare facility, such as: doctors, nurses and pharmacists, who can be granted access to modify or view the patients' EPR.

- **Patients:**
  Users who do not require authentication to be registered on the system, view or modify their own EPR, and add or revoke a healthcare facility's access to it.

- **Miners:**
  Users in the healthcare facility who can validate the blockchain transactions in return for research data and add them to the blockchain.

- **Databases:**
  Systems in the healthcare facility responsible for the handling of system queries to fetch or add data.

2.4 Operating Environment

The system has two main environments of operation; mobile or web applications.The mobile application system should be able to operate on devices mainly running Android or iOS operating systems.The web application system should support the Chrome, Internet Explorer, Safari and Opera browsers, as well as varying screen display dimensions.

2.5 Design and Implementation Constraints

- Curis Catena will be implemented on a private or hybrid blockchain, but it is still not decided which platform it will be developed on.
- Curis Catena is to be integrated with various databases at healthcare facilities and some of these healthcare facilities operate on legacy systems.

3. System Features

The *Curis Catena* system is composed of four main subsystems, each formulating a set of common functionalities.

The subsystems are:

- Electronic Patient Record Management (EPRM) System
- Healthcare Facility System
- Healthcare provider Services (HPS) System
- Healthcare Chain System

3.1 EPRM System

3.1.1 Description

The EPRM system system includes features related to the patient's interactions with the system and certificate authorities. See figure 9 for the EPRM system usecase diagram.

The system's patient and certificate authority features are grouped under the following categories:

- Managing Account:
  - Registering Account
  - Editing Account
  - Deactivating Account
- Logging in to Account:
  - Forgetting Password
- Paying for Healthcare Services
- Adding Certifying Data
- Managing Healthcare Facility Access
  - Adding Healthcare Facility
  - Removing Healthcare Facility
- Viewing EPR
- Modifying EPR
- Logging Out from Account
- Authenticating Patient

3.1.2 Functional Requirements Usecase Tables

3.1.2.1 Managing Account | Registering Account

usecase ID	UC-1.1

usecase Name	Registering Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	Patient can create a new account through the EPRM system by registering for a new account.		
Pre-condition	None.		
Post-condition	Logging in to Account.		
Normal Flow	• User clicks on the sign-up button and a “Create Account Window” appears with the required and optional data fields. • Patient adds details: email (primary/secondary), name, birth date, gender, address and phone number. • User sets up account password by entering a password of valid difficulty, twice for confirmation. • User submits data and becomes registered on the system after the entered data is checked to be valid.		
Alternate Flow	If the user submits invalid data: • User is notified of invalid data field(s). • User is prompted to enter correct data in the invalid data field(s). • If valid information is entered, the user gets registered on the system. • If invalid information is entered, alternate flow is re-executed.		

3.1.2.2 Managing Account | Editing Account

usecase ID	UC-1.2		
usecase Name	Editing Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	Patient can change their password or credentials; which include their primary/secondary emails, age, phone number and address.		
Pre-condition	Patient must be logged into their account.		
Post-condition	Old user data is replaced by new user data.		
Normal Flow	• The user opens the user settings tab. • The user chooses the changes they need in their account data		

	(password, primary/secondary emails, phone number and address). ● If the user applies password changes, the user must confirm account password changes twice. ● If the user applies email changes, the system validates new email. ● The user confirms changes before they are applied.
Alternate Flow	None.

3.1.2.3 Managing Account | Deactivating Account

usecase ID	UC-1.3		
usecase Name	Deactivating Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	Patients can deactivate their account and the account becomes frozen. No access would be granted to the account until the patient logins in again, and authenticated healthcare facility would not be able to modify their EPR.		
Pre-condition	Patient must be logged into their account.		
Post-condition	● Patient's account is deactivated. ● Healthcare facility cannot modify the patient's EPR.		
Normal Flow	● The patient chooses to deactivate their accounts. ● A confirmation email is sent to the user's mail.		
Alternate Flow	None.		

3.1.2.4 Logging in to Account

usecase ID	UC-1.4		
usecase Name	Logging in to Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	Patient enters valid username and password to access their account and user data.		
Pre-condition	Patient must have a registered account		

Post-condition	Access account data and interact with the system.
Normal Flow	• Patient types username and password in their specified fields. • Patient accesses their account if username and password are authenticated.
Alternate Flow	If user enters invalid username or password: • Patient is notified of their access denial because their username and/or password are invalid. • Patient is allowed 3 trials to re-enter correct username and password, and the account is frozen beyond that and a notification about this will be sent to the patient's email and phone number. • Patient can choose to receive their forgotten username and password by entering their email and then resetting their account's password.
	If the patient is not registered yet, the system can redirect user to the "Create New Account Window" (refer to usecase table UC-1.1).

3.1.2.5 Logging in to Account | Forgetting Password

usecase ID	UC-1.5		
usecase Name	Forgetting Password		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient can request to create a new password		
Pre-condition	None.		
Post-condition	Password is changed.		
Normal Flow	• Patient clicks on "Forgot Password" button. • Patient types in primary email in the specified field. • Email gets sent to the patient where the user will write in a new password in the specified field.		
Alternate Flow	If user types a password that has been previously in use: • Patient will be notified that their password is denied for security reasons. • Patient writes password in the specified field, and is redirected to the normal flow.		

3.1.2.6 Paying for Healthcare services

usecase ID	UC-1.6		
usecase Name	Paying for Healthcare services		
Date Created	6/12/2017	Date Updated	6/12/2017
Primary Actors	Patient		
Description	The patient can pay for the service through the application, and if they have medical insurance it will be handled through the application.		
Pre-condition	The user must be logged in to their account.		
Post-condition	The healthcare services are paid.		
Normal Flow	• The patient chooses to pay for charges added by the healthcare facility through the application • Charges will be transferred to the healthcare facility		
Alternate Flow	If the patient does not have enough tokens to pay for the service, the application will ask the patient to buy tokens or pay in cash.		

3.1.2.7 Adding Certifying data

usecase ID	UC-1.7		
usecase Name	Adding certifying data		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient adds a certifying piece of data, such as their national security ID, to the system.		
Pre-condition	The user must be logged in to the account.		
Post-condition	Patient awaits authentication.		
Normal Flow	• Patient clicks on the “Certify Account” button. • Patient adds the certification data.		
Alternate Flow	If user does not add certification data to the system, they will not be allowed to use the system’s functionalities.		

3.1.2.8 Managing Healthcare facility Access | Adding Healthcare Facility

usecase ID	UC-1.8		
usecase Name	Adding Healthcare Facility		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient can add a healthcare facility to be granted access.		
Pre-condition	Patient must be logged into their account.		
Post-condition	Healthcare facility accesses the patient's data.		
Normal Flow	• Patient navigates to the healthcare facility page. • Patient clicks on the button "Add new". • Patient selects a hospital from a drop down list. • Hospital gets notified on the addition.		
Alternate Flow	If the patient does not find their desired hospital: • Patient clicks on the "Other" option in the list. • Patient types the name of desired hospital in the specified field. • Patient gets notified that our company will review the request.		

3.1.2.9 Managing Healthcare facility Access | Removing Healthcare Facility

usecase ID	UC-1.9		
usecase Name	Removing Healthcare facility		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient revokes a healthcare facility's access to their EPR.		
Pre-condition	Patient must be logged into their account.		
Post-condition	Healthcare facility cannot access the patient's EPR.		
Normal Flow	• Patient navigates to the "Healthcare Facility" page. • Patient clicks on the button "Remove" next to the healthcare facility they wish to remove. • Healthcare facility gets notified of the change.		

Alternate Flow	If the patient still has unpaid charges on their account for the healthcare facility, they will not have access to this functionality.

3.1.2.10 Viewing EPRs

usecase ID	UC-1.10		
usecase Name	Viewing EPR		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient views their EPR.		
Pre-condition	Patient must be logged into their account.		
Post-condition	None.		
Normal Flow	• Patient navigates to the “Health Information” page. • Patient is shown the data added to their record from every hospital. • Patient is shown the data required from their mobile or desktop application.		
Alternate Flow	None.		

3.1.2.11 Modifying EPRs

usecase ID	UC-1.11		
usecase Name	Modifying EPRs		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient can add their medical scans and personal health information, e.g. their weight updates and medication data.		
Pre-condition	Patient must be logged in.		
Post-condition	The new data will be added to the system.		

Normal Flow	• Patient navigates to the “Health Information” page. • Patient clicks on “Modify” next to the specified fields, such as weight. • Patient can add medical scans and lab reports by clicking on “Add New Document” button. • Patient submits the changes.
Alternate Flow	None.

3.1.2.12 Authenticating Patient

usecase ID	UC-1.12		
usecase Name	Authenticating patient		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Certificate Authority		
Description	The certificate authority approves that the newly registered account is owned by a valid patient with no other accounts on the system.		
Pre-condition	Patient has registered to the system.		
Post-condition	The patient will be able to interact with the system’s functionalities.		
Normal Flow	• Certificate authority gets notified when a new patient presents certification. • Certificate authority clicks on the notification. • Certificate authority views and verifies the patient’s certifying data. • Certificate authority approves/disapproves the patient.		
Alternate Flow	None.		

3.1.2.13 Logging Off Account

usecase ID	UC-1.13		
usecase Name	Logging Off Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient		
Description	The patient logs out off their account.		

Pre-condition	The patient must be logged in to the system.
Post-condition	The patient will be logged off.
Normal Flow	The user clicks on the “Log off” button.
Alternate Flow	None.

3.2 HF System

3.2.1 Description

The HFS system includes features related to the system administrators’ and the healthcare facility’s interactions with the system. See figure 8 for the HF system usecase diagram.

The system’s healthcare facility and system administrator features are grouped under the following categories:

- Logging in to account
- Adding healthcare provider
- Removing healthcare provider
- Registering Account
- Revoking Accounts
- Charging for healthcare services
- Logging out from Account

3.2.2 Functional Requirements Usecase Tables

3.2.2.1 Logging in to account

usecase ID	UC-2.1		
usecase Name	Logging in to account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	System Administrator		
Description	The System administrator enters their username and password to login to the account.		
Pre-condition	System administrator must be registered.		
Post-condition	Access the account and be able to add healthcare providers.		

Normal Flow	• System administrator types username and password in their specified fields. • System administrator accesses their account if their username and password are authenticated.
Alternate Flow	If user enters invalid username or password: • System administrator is notified of their access denial because their username and/or password are invalid. • System administrator is allowed 3 trials to re-enter correct username and password.
	If system administrator is not registered yet, user should contact their healthcare facility to create an account.

3.2.2.2 Adding Healthcare provider

usecase ID	UC-2.2		
usecase Name	Adding Healthcare provider		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	System Administrator		
Description	The system administrator assigns healthcare providers working in the healthcare facility to a patient case.		
Pre-condition	System administrator must be logged in.		
Post-condition	Healthcare providers will be authorized to access to patients' EPR.		
Normal Flow	• System administrator navigates to the "Healthcare providers" page. • System administrator assigns the healthcare provider to a patient.		
Alternate Flow	None.		

3.2.2.3 Removing Healthcare provider

usecase ID	UC-2.2		
usecase Name	Removing Healthcare provider		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	System Administrator		

Description	The system administrator removes healthcare providers working in the healthcare facility off a patient's case.
Pre-condition	System administrator must be logged in.
Post-condition	Healthcare providers will not have further access to patients' EPR.
Normal Flow	• System administrator navigates to the "Healthcare providers" page. • System administrator removes the healthcare provider from the patient case.
Alternate Flow	None.

3.2.2.4 Registering Account

usecase ID	UC-2.3		
usecase Name	Registering Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Healthcare facility super administrator		
Description	The healthcare facility is responsible for registering accounts for their system's administrators.		
Pre-condition	None.		
Post-condition	System administrator account gets registered.		
Normal Flow	• Super administrator navigates to the system administrators page. • Super administrator clicks on the "Add Administrator" button. • Super administrator types the administrator's credentials in the specified fields, such as: email, username, and position. • Super administrator sets up the account's password by entering a password of valid difficulty twice for confirmation. • Super administrator submits data and the system administrators become registered on the system after the entered data is checked to be valid. • Super administrator gets sent an email on the registration.		
Alternate Flow	If the healthcare facility's super administrator submits invalid data: • Super administrator is notified of invalid data fields. • Super administrator is prompted to enter correct data in the invalid data field(s). • If valid information is entered, the system administrator becomes		

	registered on the system. ● If invalid information is entered, alternate flow is executed again.

3.2.2.5 Revoking Accounts

usecase ID	UC-2.4		
usecase Name	Revoking Accounts		
Date Created	6/12/2017	Last updated	6/12/2017
Primary Actors	Healthcare facility super administrator		
Description	The healthcare facility revokes the account of a system administrator.		
Pre-condition	The system administrator is registered.		
Post-condition	The system administrator's account gets revoked.		
Normal Flow	● Super administrator navigates to the system administrator's page. ● Super administrator searches by name in the search bar for the system administrator, and clicks on 'revoke account' next to the name. ● Super administrator confirms the revocation action.		
Alternate Flow	None.		

3.2.2.6 Charging for Healthcare Service

usecase ID	UC-2.5		
usecase Name	Charging for Healthcare Service		
Date Created	6/12/2017	Last updated	6/12/2017
Primary Actors	System administrator		
Description	The system administrator adds the service charges to the patient's account.		
Pre-condition	None.		
Post-condition	Charges will be administered to the patient's account.		
Normal Flow	● System administrator navigates to the "Service Charges" page. ● System administrator searches for the patient's name in the search		

	bar, and selects “Charge Service” next to the name. • System administrator selects the kind of service from a drop down menu. • System administrator adds the required charges for the service in the specified field • System administrator clicks “Apply”’ and the patient will be notified on the charges on their account and email.
Alternate Flow	None.

3.2.2.7 Logging Off Account

usecase ID	UC-2.6		
usecase Name	Logging Off Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	System Administrator		
Description	The system administrator logs off their account.		
Pre-condition	The system administrator must be logged in to the system.		
Post-condition	The system administrator will be logged off.		
Normal Flow	The user clicks on the ‘Log off’ button.		
Alternate Flow	None.		

3.3 HPS System

3.3.1 Description

The HPS system includes features related to the healthcare provider’s interactions with the system, healthcare facilities and certificate authorities. See figure 7 for the HPS system usecase diagram.

The system’s healthcare provider, healthcare Facility and certificate authority features are grouped under the following categories:

- Managing Account
  - Registering Account
  - Editing Account
- Logging in to account:

    - Forgetting password
- Modifying EPR
- Viewing EPRs
- Authenticating Accounts
- Authorizing EPR Access
- Logging out from Account

3.3.2 Functional Requirements Usecase Tables

3.3.2.1 Managing Account | Registering Account

usecase ID	UC-3.1		
usecase Name	Registering Account		
Date Created	6/12/2017	Last Updated	6/12/2017
Primary Actors	Healthcare provider		
Description	Healthcare provider can create a new account through the HPS system by registering for a new account.		
Pre-condition	None.		
Post-condition	Logging into user account.		
Normal Flow	• Healthcare provider clicks on the sign-up button and create account window appears with required data fields. • Healthcare provider adds details (email, name, birth date, gender, facility name). • Healthcare provider sets up account password by entering a password of valid difficulty twice for confirmation. • Healthcare provider submits data and becomes registered on the system after the entered data is checked to be valid.		
Alternate Flow	If the healthcare provider submits invalid data: • Healthcare provider is notified of invalid data fields. • Healthcare provider is prompted to enter correct data in the invalid data field(s). • If valid information is entered, the healthcare provider becomes registered on the system. • If invalid information is entered, alternate flow is executed again.		

3.3.2.2 Managing Account | Editing Account

usecase ID	UC-3.2

usecase Name	Editing Account		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Healthcare provider		
Description	Healthcare provider can change their password or credentials; which include their primary emails, hospital of affiliation, work, phone number and address.		
Pre-condition	User must be logged into their account, and must await authentication from the system administrator before the change can take place.		
Post-condition	Old user data is replaced by new user data.		
Normal Flow	• The user opens the user settings tab. • The user chooses the changes they need in their account data (email, password, age, mobile number, home address). • If the user applies password changes, the user must confirm account password changes twice. • If the user applies email changes, the system validates new email. • If the user applies hospital of affiliation changes, user will await confirmation from the hospital before the change can take place. • The user confirms changes before they are applied.		
Alternate Flow	None.		

3.3.2.3 Logging in to account

usecase ID	UC-3.3		
usecase Name	Logging in to account		
Date created	6/12/2017	Last Updated	6/12/2017
Primary actor	Healthcare provider		
Description	The Healthcare provider enters his/her username and password to login to the account		
Pre-condition	User must have a registered account		
Post-condition	Healthcare provider will be able to access and modify their patients' EPRs.		
Normal Flow	• Healthcare provider enters the username and password. • Healthcare provider access their account if their username and/or password are authenticated.		

Alternate Flow	If user enters invalid username or password: • User is notified of their access denial because their username and/or password are not authenticated. • User is allowed 10 trials to re-enter correct username and password. • User can choose to receive their forgotten username and password by entering their email and then resetting their account's password.

3.3.2.4 Logging in to Account | Forgetting Password

usecase ID	UC-1.5		
usecase Name	Forgetting Password		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Healthcare provider		
Description	The healthcare provider can request to create a new password		
Pre-condition	None.		
Post-condition	Password is changed.		
Normal Flow	• Healthcare provider clicks on the "Forgot Password" button. • Healthcare provider types in primary email in the specified field. • Email gets sent to the patient where the healthcare provider will write in a new password in the specified field.		
Alternate Flow	If healthcare provider types a password that has been previously in use: • Healthcare provider will be notified that their password is denied for security reasons. • Healthcare provider writes password in the specified field, and is redirected to the normal flow.		

3.3.2.5 Modifying EPRs

usecase ID	UC-3.4		
usecase Name	Modifying EPRs		
Date created	6/12/2017	Last Updated	6/12/2017
Primary actor	Healthcare provider		
Description	The Healthcare provider can modify their patient's EPR.		

Pre-condition	The healthcare provider must be authorized access to the patient's EPR.
Post-condition	Modification saved to the database.
Normal Flow	• User navigates to the patients' assigned to them. • User searches for patient's' name in the search bar. • User clicks on "Modify EPR" next to the patient's name. • User can add scans or prescription notes or any medical material needed. • The patient gets notified with the changes to their EPR.
Alternate Flow	None.

3.3.2.6 Viewing EPRs

usecase ID	UC-3.5		
usecase Name	Viewing EPRs		
Date created	6/12/2017	Last Updated	6/12/2017
Primary actor	Healthcare provider		
Description	The Healthcare provider can view their patient's EPR.		
Pre-condition	The healthcare provider must be authorized access to the patient's EPR.		
Post-condition	None.		
Normal Flow	• Healthcare provider navigates to the patients' assigned to them. • User searches for patient's' name in the search bar. • User clicks on 'View EPR' next to the patient's name.		
Alternate Flow	None.		

3.3.2.7 Authenticating Accounts

usecase ID	UC-3.6		
usecase Name	Authenticating Accounts		
Date created	6/12/2017	Last update	6/12/2017
Primary actor	System Administrator		
Description	The system administrator authenticates the healthcare provider.		

Pre-condition	The healthcare provider must already be registered on the system.
Post-condition	Healthcare provider will be authenticated.
Normal Flow	• System administrator gets notified when a healthcare provider requests a change in their account information. • System administrator approve/disapprove the changes.
Alternate Flow	None.

3.3.2.8 Authorizing EPR Access

usecase ID	UC-3.7		
usecase Name	Authorizing EPR Access		
Date created	6/12/2017	Last update	6/12/2017
Primary actor	Certificate Authority		
Description	The certificate authority gives the healthcare provider the authorization to access their patients' EPRs.		
Pre-condition	The healthcare provider and patient must already be registered on the system, and the healthcare provider must request access to the patient's EPR.		
Post-condition	Healthcare provider is given access to view and modify the patient's EPR.		
Normal Flow	• Certificate authority navigates to the patient's page and clicks add healthcare provider. • Certificate authority chooses from a drop-down menu the healthcare provider. • The patient gets notified on the healthcare provider addition.		
Alternate Flow	None.		

3.3.2.9 Logging Off Account

usecase ID	UC-3.8		
usecase Name	Logging Off Account		
Date created	6/12/2017	Last update	6/12/2017

Primary actor	Healthcare provider
Description	The healthcare provider logs off their account.
Pre-condition	The healthcare provider must be logged in to the system.
Post-condition	The healthcare provider will be logged off.
Normal Flow	• The user clicks on the ‘Log off’ button.
Alternate Flow	None.

3.4 Healthcare Chain System

3.4.1 Description

The healthcare chain system includes features related to the healthcare chain system interactions with the system. See figure 10 for the healthcare chain system usecase diagram.

The system’s healthcare chain system and certificate authority features are grouped under the following categories:

- Requesting Read-only EPR
- Requesting Read and Write EPR
- Validating Transactions
- Adding transactions to blockchain
- Handling query

3.4.2 Functional Requirements Usecase Tables

3.4.2.1 Requesting Read-Only EPR

usecase ID	UC-4.1		
usecase Name	Requesting Read-Only EPR		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient, Healthcare provider		
Description	The patient or the healthcare provider requests viewing the patient’s EPR.		
Pre-condition	None.		

Post-condition	None.
Normal Flow	• An authorized patient or healthcare provider requests to view the patient's read-only EPR. • EPR is fetched from the database. • Patient or healthcare provider receives read-only EPR.

3.4.2.2 Requesting Read and Write EPR

usecase ID	UC-4.2		
usecase Name	Requesting Read and Write EPR		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Patient, Healthcare provider		
Description	The patient or the healthcare provider requests adding modifications to the patient's EPR.		
Pre-condition	None.		
Post-conditions	None.		
Normal Flow	• An authorized patient or healthcare provider requests to modify the patient's EPR. • Patient or healthcare provider receives read-only EPR. • The patient or healthcare provider adds modifications to fetched EPR and sends them back to the database. • EPR is added to the database.		

3.4.2.3 Validating Transactions

usecase ID	UC-4.3		
usecase Name	Validating Transactions		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Miner		
Description	Miners validate transactions on the healthcare chain system's peer to peer network. Transactions can be:		

	• Requesting Read-only EPR • Requesting Read and Write EPR
Pre-condition	Transaction was made on the system.
Post-condition	Transaction is added to the blockchain.
Normal Flow	• Miner views list of unvalidated transactions. • Miner selects transaction to validate. • Miner uses the system's computation validation algorithm to validate the transaction. • Miner receives incentive research data.

3.4.2.4 Adding Transactions to Blockchain

usecase ID	UC-4.4		
usecase Name	Adding Transactions to Blockchain		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Miner		
Description	Miners add validated transaction blocks to the healthcare chain system's blockchain.		
Pre-condition	Transaction was previously validated.		
Post-condition	None.		
Normal Flow	Miner adds transaction to the blockchain after its successful validation.		

3.4.2.5 Handling Query

usecase ID	UC-4.3		
usecase Name	Handling Query		
Date Created	6/12/2017	Last Update	6/12/2017
Primary Actors	Database		
Description	System's database handles EPR fetch or add queries.		

Pre-condition	Query was received.
Post-condition	None.
Normal Flow	Database automatically buffers all incoming queries and handles them in a First Come First Served order.

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4. External Interface Requirements

4.1 User Interfaces

4.1.1 Login Page

The user first views the login page to use the application (refer to figure 2).

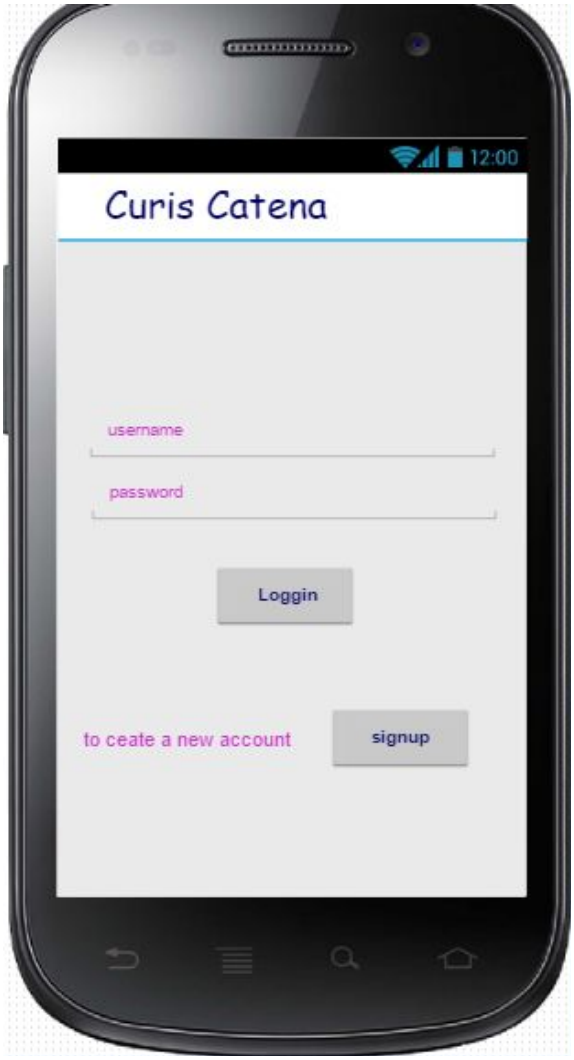

Figure 2 | Login Page User Interface

4.1.2 Homepage

After logging in the user is directed to their homepage where the patient can see the option of managing their EPR and healthcare facilities, and the healthcare provider can see a list of the patients and choose to view/modify their EPRs (refer to figure 3 & 4).

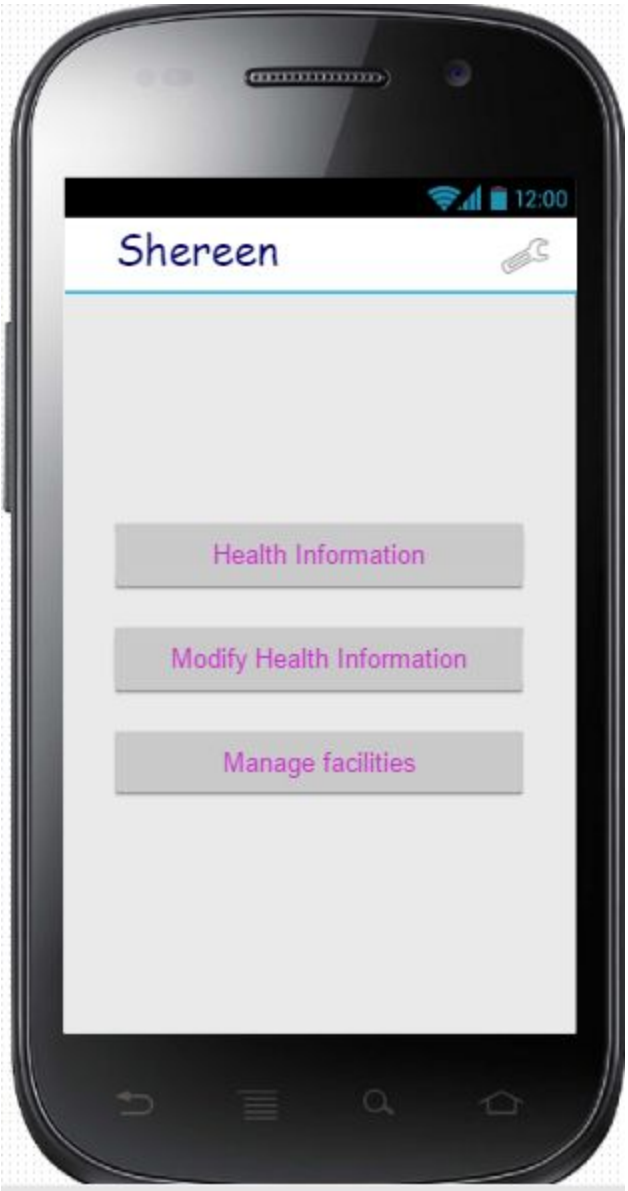

Figure 3 | Patient Homepage User Interface

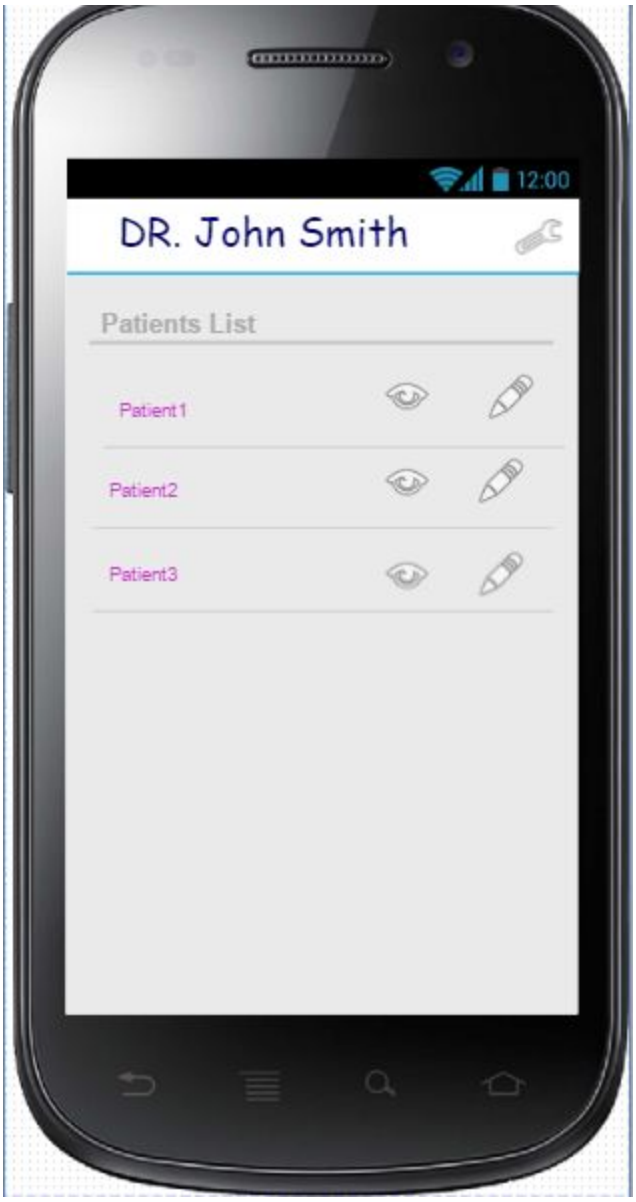

Figure 4 | Healthcare provider Homepage

4.1.3 Patient Modifying EPR

The user can modify and add information to their EPR through this page(refer to figure 5).

Figure 5 | Patient EPR modification

4.1.4 Patient Managing Healthcare Facilities

In the Patient Managing Healthcare Facility page the user can see a list of all the healthcare facilities that has been given a permission to access their information, and the patient can add or remove a facility (refer to figure 6).

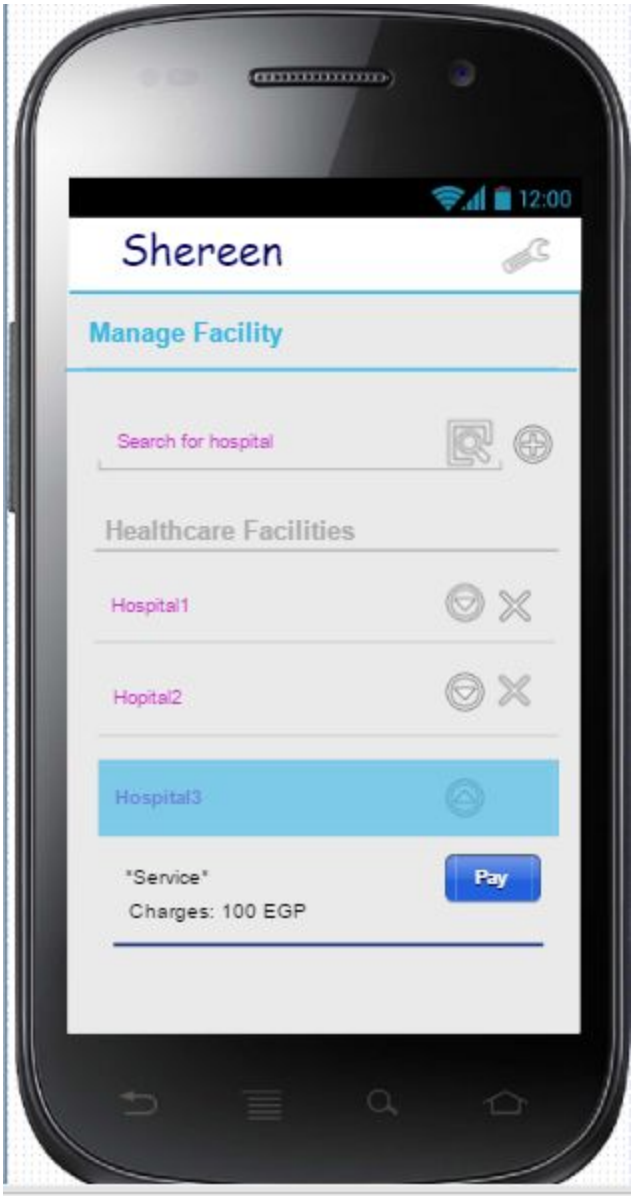

Figure 6 | Patient Healthcare Facility Management Interface

4.2 Hardware Interfaces

Since the service is to be offered through an application that uses remote server cloud storage for the blockchain data structure, and centralized databases hosted at the healthcare facilities, like MySql database, to handle its own patient and healthcare provider queries. Users will be able to access the application through their mobile devices or their personal computers.

4.3 Software Interfaces

The service will depend on multiple softwares to run efficiently. The server software will run on a server and various mobile phones operating systems, android and iOS. For the database system, it will run MySQL and it will be managed with phpMyAdmin. All payments will be handled using smart contracts.

4.4 Communications Interfaces

Since the concept of the service is to provide a safe and secure social system, all website services will be offered only over HTTPS and insecure HTTP will not be used at all to make sure no data can be intercepted and decrypted at all. An SSL certificate issued to the organization will be used to verify that all communication with the website.

5. Nonfunctional Requirements

5.1 Performance Requirements

- The system should be able to store all the patients records.
- All system queries should be handled as fast as possible, to accommodate to emergency situations and the magnitude of its users.

5.2 Safety Requirements

- To prevent data loss in case of failure, the administrators should make regular backups.
- In case of malfunction, the system should be able to notify the administrators, so they can take proper action.
- Multiple duplicates of the critical system components should be kept intact, so the system can recover easily from crashes or data loss. These components include the databases and the application servers.

5.3 Security Requirements

The security requirements are the required specification implementation of the HIPAA security rule:

- All users will have a unique username and strong password.
- Encrypting EPR before storing and decrypting when in use.
- Integrity control to make sure that EPRs are not modified illegally.
- Automatic logout after a certain time of inactivity.
- Audit control to record and examine activity in the system.

Other security requirements:

- After 3 failed login attempts, the user will be denied from login after that and the account will be frozen. User will be notified of the situation.
- All pages of the system are only obtainable after successful login and authorization.

5.4 Privacy Requirements

- The patients control who access their EPRs.
- The patients have the right to examine and modify their EPR.
- Patient accounts cannot be deleted, but they can be deactivated.

5.5 Software Quality Attributes

- Code used in the software should follow the convention of the language used and it should be well structured and documented.

- It should be portable, since the system should be accessed anywhere anytime, the interface of the services should be easy to use on mobiles and should have different sizes for different mobile sizes.
- Due to rapid changes in technology, the system should be change tolerant. Subsystems can be changed without affecting the functionality of the whole system.
- The system should easily adapt the increasing number of users.
- The system's code should be open sourced and available for peer reviewing.

5.6 Usability Requirements

In the case that users face any conflicts on the system:

- The user should be able to contact customer support with ease and support should be provided 24/7 with minimum delay in response (1 hour maximum).
- Patients can request unavailable healthcare facilities to be added to the system.

Appendix A: Glossary

Acronym	Meaning
EPR	Electronic Patient Record
HIPAA	Health Insurance Portability and Accountability Act of 1996
HF	Healthcare Facility
HPS	Healthcare provider Services
EPRM	Electronic Patient Records Management

Appendix B: Analysis Models

Usecase Diagrams

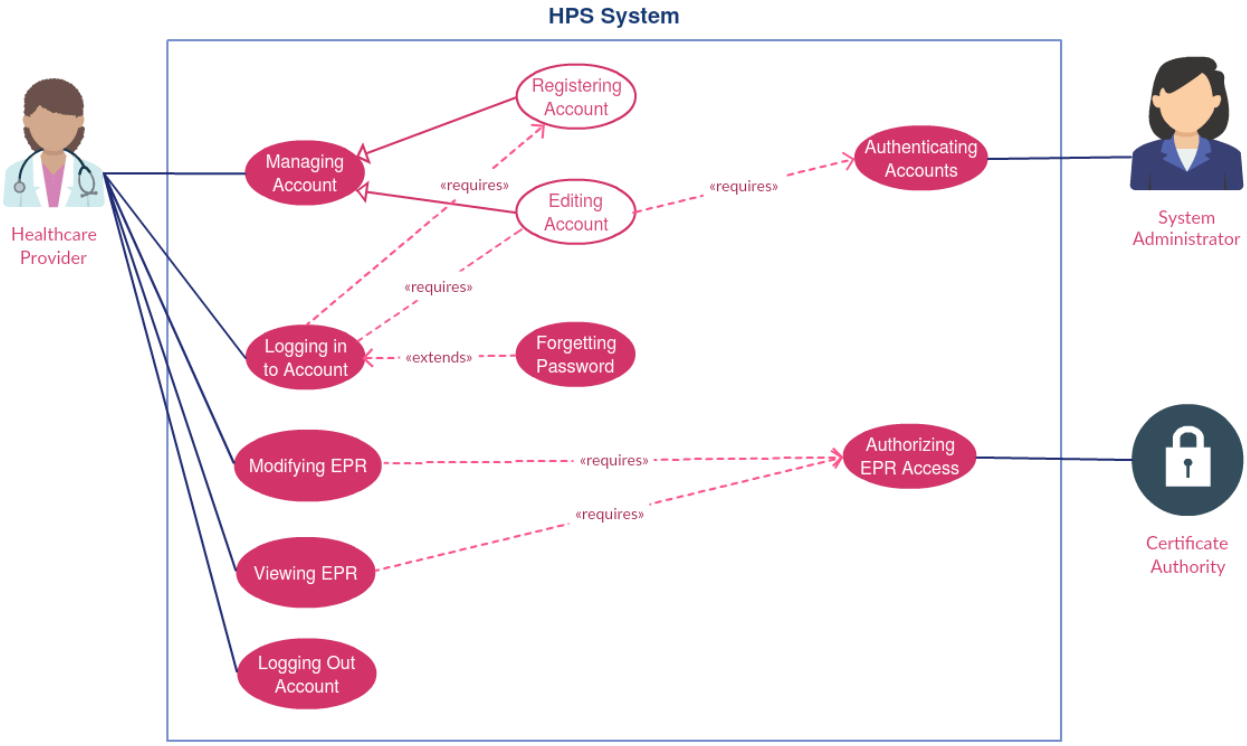

Figure 7 | HPS System Usecase Diagram

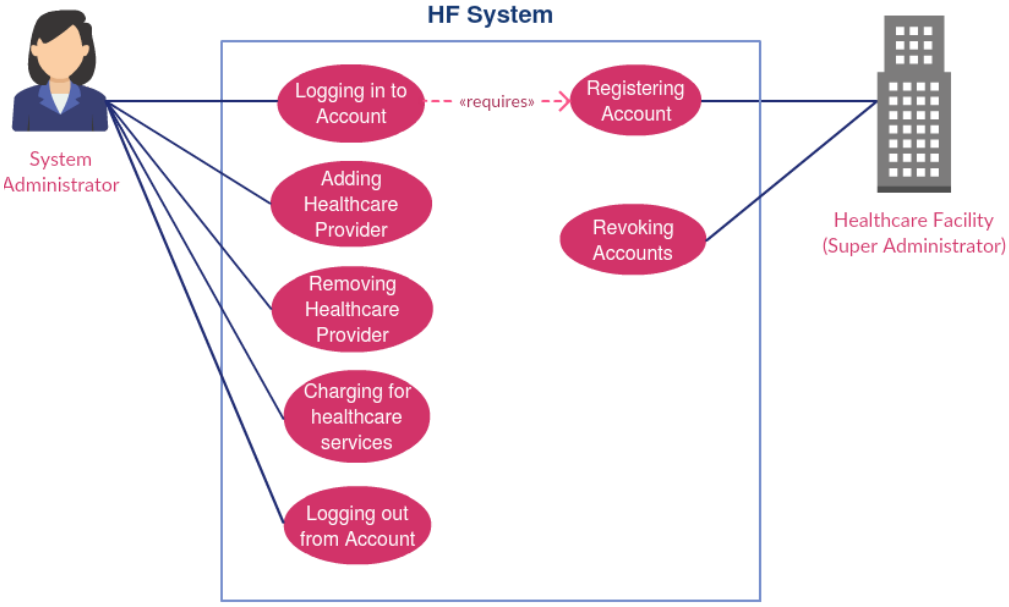

Figure 8 | HF System Usecase Diagram

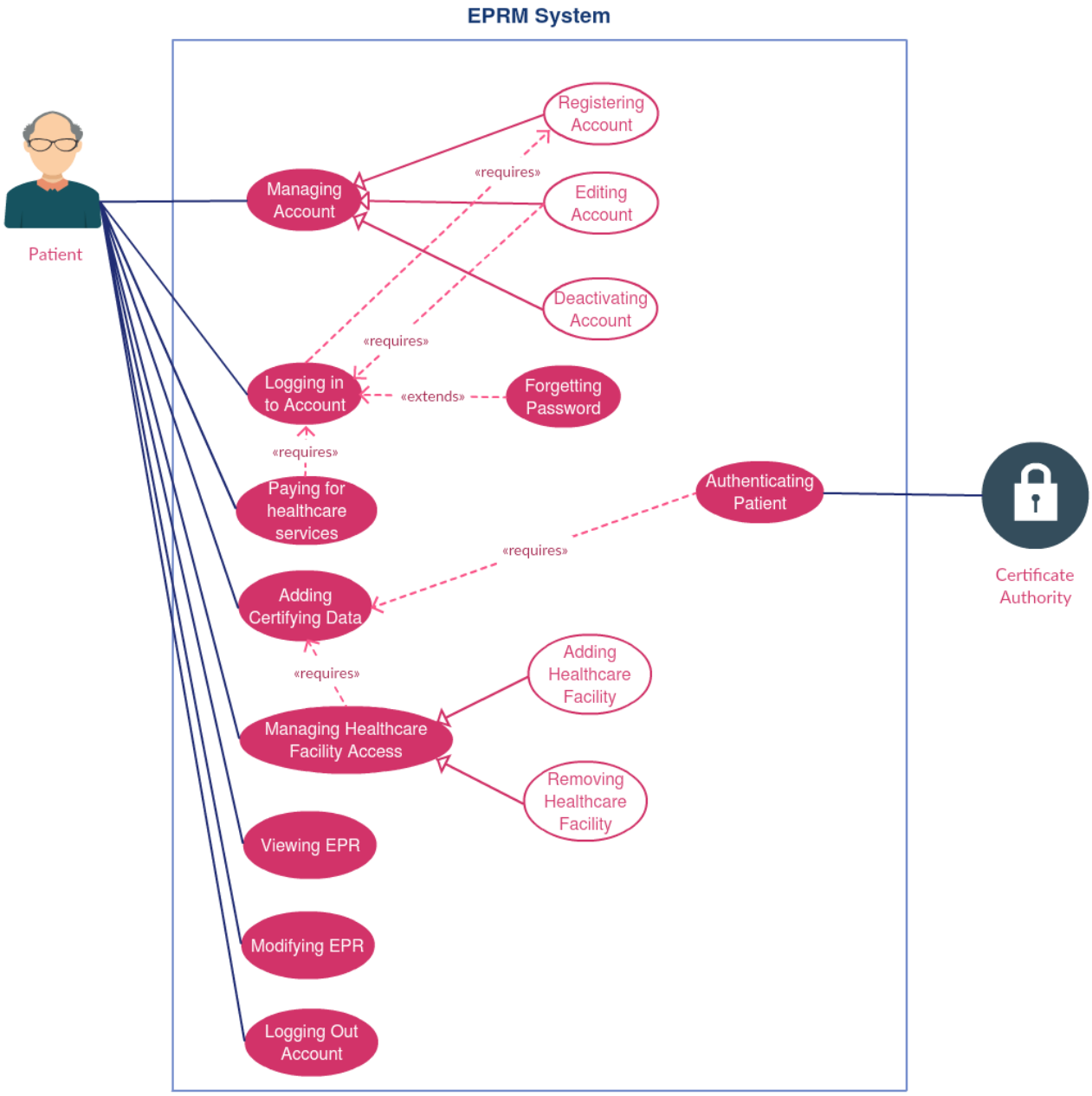

Figure 9 | EPRM System Usecase Diagram

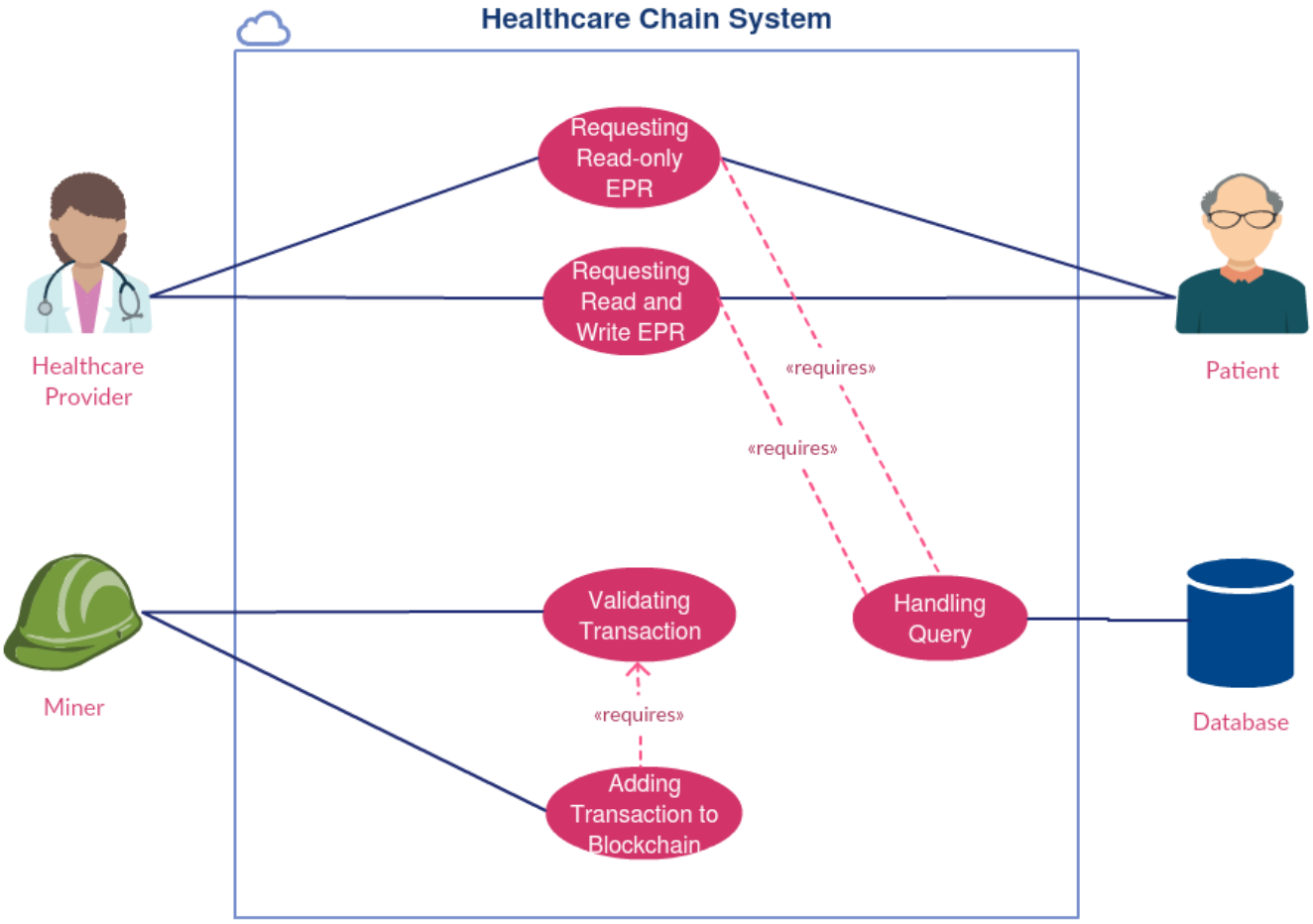

Figure 10 | Healthcare Chain System Usecase Diagram

Activity Diagrams

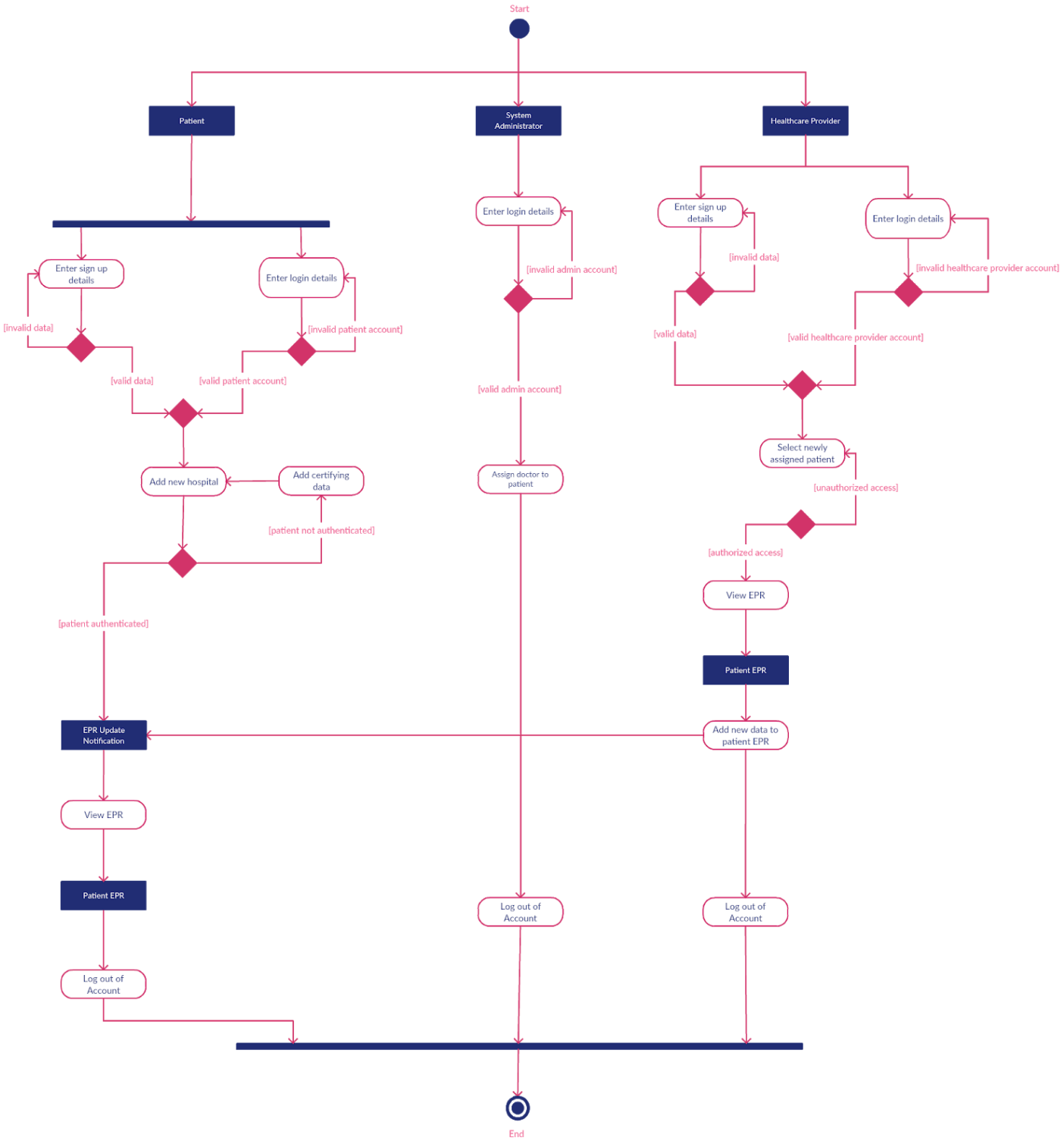

Figure 11 | Patient Assigned to Healthcare Provider Activity Diagram