
Software Design Documentation

for

URL Shorten System (USS)

Version 1.0 approved.

Prepared by

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PART A

1. Introduction

1.1 Problem Statement and Need

- a) Problem: Long and complex URLs can be difficult to share, remember, and manage. They may not fit within character limits imposed by certain platforms (e.g., social media posts) and can appear visually unappealing.
- b) Need: The need for a URL shortening system arises from the desire to create shorter, more manageable URLs. Shortened URLs provide a concise representation of the original long URL, making them easier to share, remember, display and trace in various contexts.

1.2 List of Capabilities

- Generate short URLs from long URLs.
- Customize short URLs.
- Store the mapping between short URLs and their corresponding long URLs.
- Redirect users from short URLs to the original long URLs.
- Track and analyze click data and user engagement.

1.3 List of Benefits

- **Convenience:** Easier to share verbally, in print, or on social media platforms with limited character counts.
- **Simplicity:** Adapt to scenarios with limited length, such as tweets, SMS.
- **Aesthetics:** Shortened URLs can be visually appealing.
- **Trackability:** USS can provide analytics and insights into user behavior, and the effectiveness of marketing campaigns.
- **Security:** Shortened URLs can mask the original long URLs, preserving privacy or hiding readable URLs.
- **Improved User Experience:** Shortened URLs reduce the cognitive load on users by presenting concise and simplified links.

1.4 List of Stakeholders and Their Roles

- **Developers:** The technical team responsible for designing, building, and testing the URL Shortening Service. They will use this SRS as a guideline for development.
- **Project Managers:** Responsible for overseeing the entire project. They ensure that resources are managed effectively and that the project stays on schedule. They will use the SRS to understand the requirements and constraints of the project.

- Marketing Staff:** Responsible for promoting the URL Shortening Service and identifying market opportunities. They will use the SRS to understand the intended functionality and benefits of the service.
- Users:** The end-users of the URL Shortening Service. They can be individuals or organizations who need to shorten long URLs for several reasons, such as sharing links more easily or tracking click analytics.
- Testers:** Quality assurance personnel who will test the URL Shortening Service for bugs, performance issues, and usability problems. They will use the SRS as a basis for their test plans.
- Documentation Writers:** They create user manuals, help files, and other documentation. They will use the SRS to understand the service and its features, which they will then communicate to users.
- Investors:** Stakeholders who finance the project. They use the SRS to understand the scope of the project and its potential return on investment.
- System Administrators:** Responsible for maintaining and monitoring the system. They ensure the system is up and running, perform routine maintenance tasks, and resolve any issues that may arise. They use the SRS to understand the system's requirements and guide their maintenance plans.
- Data Analysts:** Stakeholders who analyze the user and URL data collected by the system. They use the SRS to understand the data requirements and structure for their analysis.

STAKEHOLDER NAME	POSITION	EXTERNAL /INTERNAL	CONTACT	OPERATIONAL /EXECUTIVE	INTEREST
KAROL SERRERO	End User	Internal	Karolserrero3@gmail.com	Operational	High
MARIA UPSON	Analytics Manager	External	Mariaupson@com.ca	Operational	Medium
JOSEPH ANDERSON	Investor	External	Joseph15@gmail.com	Executive	High
KAYLEY PEARSON	Project Manager	Internal	Kayley1728@com.ca	Executive	High
RAYAN SMITH	Developer	Internal	Rayansmith79@gmail.com	Operational	High
DONALD TRUMP	Tester	Internal	DTrumpTest@gmail.com	Operational	High
MITCHELL OBAMA	Documentation Writer	Internal	MOBamaDocs@gmail.com	Operational	High
ALINA FATIMA	Marketing Officer	Internal	Alina.Fatima@gmail.com	Executive	High
MOHAMMED SAAD	Back-end Developer	Internal	Badruddinsaad14@gmail.com	Operational	Medium
NOORULHUDA KHAMEES	Data Analyst	Internal	noorulhuda@gmail.com	Operational	Medium
KONAIN ZAHRA	IT Security Officer	Internal	konain@gmail.com	Executive	Medium
DONGLI	Database Administrator	Internal	Dongli@gmail.com	Executive	High

1.5 Application Subsystems

The URL Shortening Service consists of several subsystems working together to provide a seamless experience for the users. These subsystems include:

- **URL Shortening Subsystem:** This subsystem is responsible for taking a long URL as input and generating a shortened version of it. It ensures that the shortened URL is unique and maps it to the original URL for redirection purposes.
- **Analytics Subsystem:** This subsystem collects, processes, and presents analytical data related to the shortened URLs. This may include the number of clicks, geographical location of the users, time of access, and more. The data can be used for monitoring, reporting, and optimizing the service.
- **User Management Subsystem:** This subsystem handles all aspects of user management. It takes care of user registration, login, password management, and the management of saved URLs for each user. It also ensures user data privacy and security.
- **Redirection Subsystem:** This subsystem manages the redirection of the shortened URLs to their original long URLs. When a user clicks on a shortened URL, this system ensures they are redirected to the correct original URL.
- **Database Management Subsystem:** This subsystem is responsible for the storage, retrieval, and management of data related to users and URLs. It ensures data integrity, security, and efficient access.
- **Caching Mechanism Subsystem:** This subsystem implements a caching mechanism to improve the performance of URL redirection and retrieval. It stores frequently accessed URLs and their mappings in a cache, allowing for faster access and reducing the load on the database.
- **System Administration Subsystem:** This subsystem provides APIs for system administrators to perform administrative tasks, such as managing users, URLs, and analytics data.

Each of these subsystems are interconnected, and they collaborate to ensure the functionality and performance of the URL Shortening Service.

1.6 Intended Audience

This SRS document is intended for:

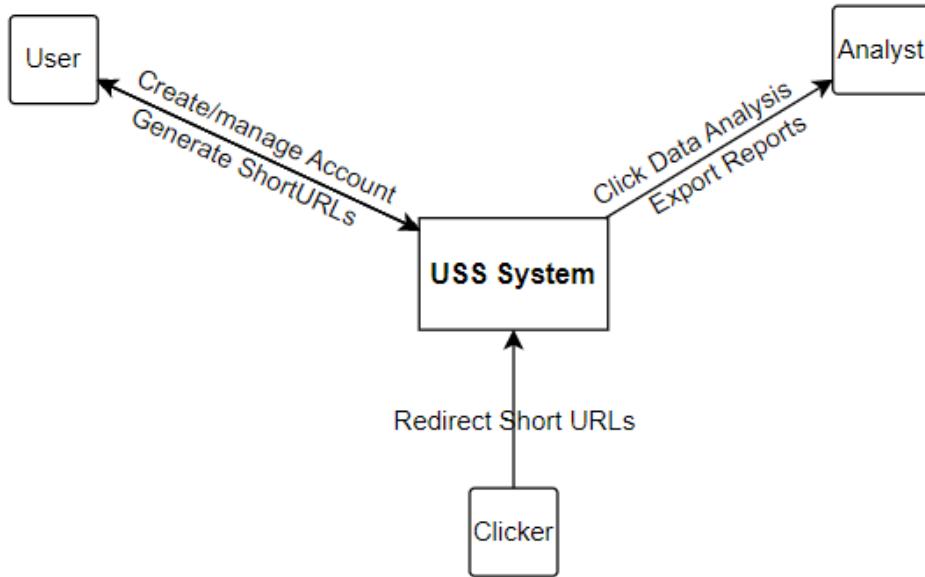
- **Developers:** To understand the functional requirements of the URL Shortening Service and translate them into software components. This includes front-end, back-end, and full-stack developers.
- **Project Managers:** To coordinate resources, manage project timeline and risks, and ensure all stakeholders are aligned with the project objectives.
- **Marketing Staff:** To understand the capabilities of the service to create effective marketing strategies and promotional campaigns.
- **Users:** To have a clear understanding of the functionalities and capabilities of the URL Shortening Service. This includes both registered users who create and manage short URLs and unregistered users who click on the short links.
- **Testers:** To understand the required functionality of the system, which will aid in creating test cases and scenarios, and performing thorough testing.
- **Documentation Writers:** To get a comprehensive understanding of the system, which will help in creating accurate and helpful user manuals, help files, and other documentation.
- **System Administrators:** To understand the deployment and maintenance requirements of the application.

- **Security Analysts:** To understand the security requirements and provisions of the system.
- **Investors and Stakeholders:** To understand the project's scope, functionality, and potential market value.

1.7 References

- [1] IEEE Std 830-1998, *IEEE Recommended Practice for Software Requirements Specifications*, IEEE Computer Society, 1998.
- [2] "TinyURL.com - shorten that long URL into a tiny URL." TinyURL, www.tinyurl.com.
- [3] "Bitly | URL Shortener, Custom Branded URLs, API & Link Management." Bitly, www.bitly.com.
- [4] "ow.ly - Shorten urls, share files and track visits." Owly, www.ow.ly.
- [5] "Short.io (formerly short.cm)." Short.io, www.short.io.
- [6] "IEEE Recommended Practice for Software Requirements Specifications - IEEE Std 830-1998". IEEE, 1998. This document provides the standard followed for creating this SRS document.
- [7] "User Interface Design Guidelines for Great Experience Design". Smashing Magazine, www.smashingmagazine.com. These guidelines were followed in designing the user interface of the URL Shortening Service.
- [8] "ISO/IEC 27001:2013 Information technology — Security techniques — Information security management systems — Requirements". International Organization for Standardization, 2013. This standard was followed to ensure the security of the system.
- [9] "Software Testing Standards - IEEE 29119". IEEE, 2020. The testing of the application followed the procedures outlined in this standard.
- [10] "The OWASP Top 10 - 2023 Edition". Open Web Application Security Project (OWASP), www.owasp.org. The system was developed with the considerations outlined in the OWASP Top 10 to ensure system security.
- [11] "URL Shortener Market Size, Share & Trends Analysis Report by Product, By Application, By Region, And Segment Forecasts, 2023 - 2030". Grand View Research, www.grandviewresearch.com. This report provides market research on URL shortening services.
- [12] "Web Accessibility Guidelines (WCAG) 2.1". W3C, www.w3.org. These guidelines were followed to ensure the accessibility of the web application.
- [13] Verma, S. (2022, January 6). System Design: Scalable URL shortener service like TinyURL. *Medium*. <https://medium.com/@sandeep4.verma/system-design-scalable-url-shortener-service-like-tinyurl-106f30f23a82>

2. Context Flow Structured Modeling



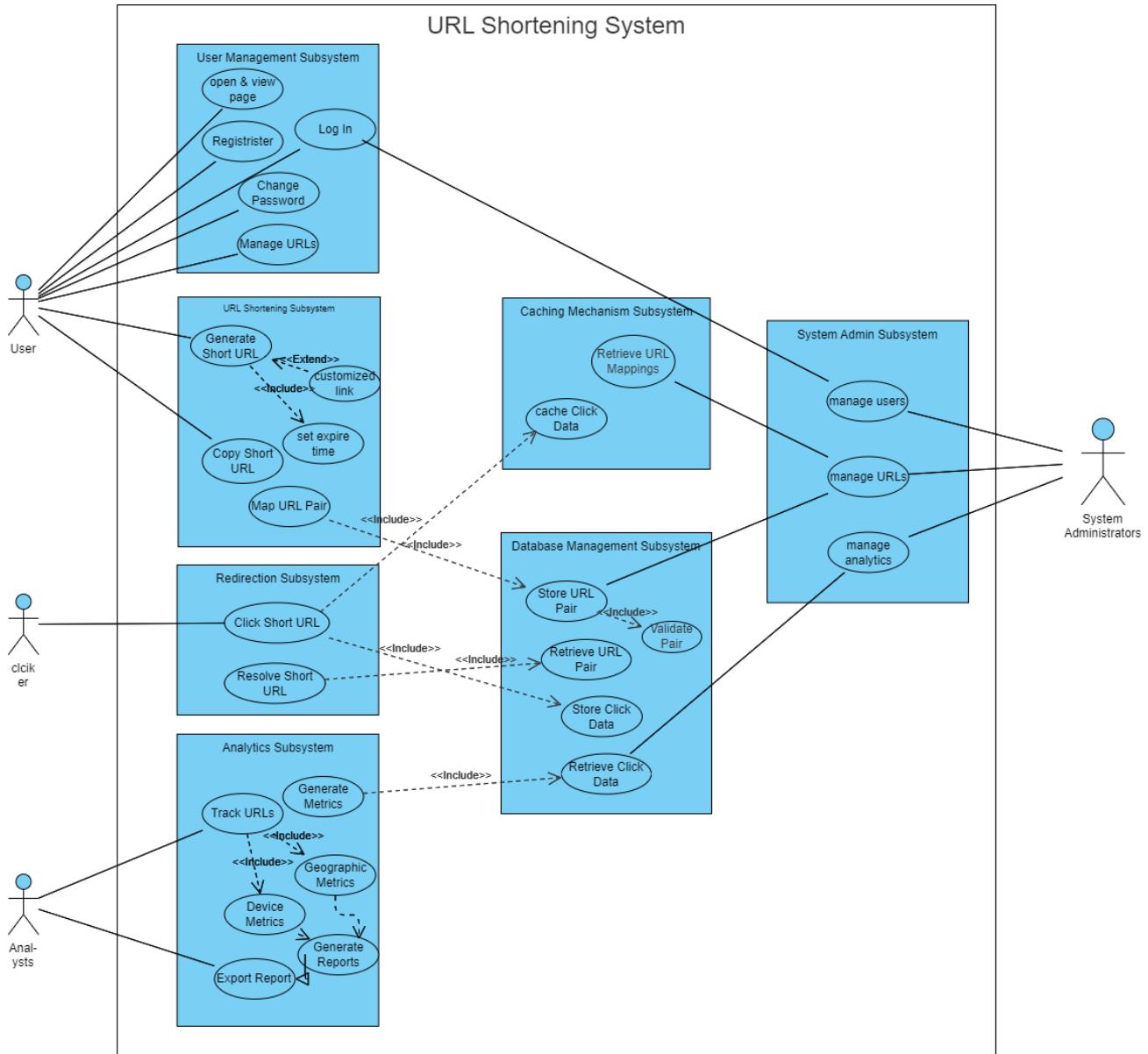
3. Functional Requirements

3.1 Goal Use Cases

<i>FR #</i>	<i>Goal Use Case</i>	<i>Role Player</i>	<i>Description</i>
<i>FR01</i>	Generate short URL	User	The system should generate a unique and shortened alias (short link) for a given long URL.
<i>FR02</i>	Redirect short URL	User	When users access a shortened link, the system should redirect them to the original long URL.
<i>FR03</i>	Customized link	User	Users should have the option to customize the short link for their URL.
<i>FR04</i>	Set expire time	User	The system should support setting an expiration time for shortened links.
<i>FR05</i>	Track URL	Analytics Manager	The system should provide analytics and tracking capabilities, including click number and distribution.
<i>FR06</i>	Manage URL	User	Users should be able to manage their shortened links, including editing, deleting, and tracking.
<i>FR07</i>	REST API Support	System Administrators	The system should provide REST APIs to allow other services to access and interact with the system.

FR08	Database Management	Database Administrator	The system should include database management to store and retrieve URL mappings and related data.
FR09	Caching Mechanism	System Administrators	The system should implement caching to improve URL redirection and retrieval performance.

3.2 Use Case Diagrams



3.3 User Stories

FR #	Goal	Role Player	User Story	Acceptance Criteria
FR01	URL Shortening	User	As a User, I want to shorten a long URL so that I can easily share it with others.	<ul style="list-style-type: none"> - Given a long URL, when I provide it to the system, it should generate a unique shortened alias (short link). - The generated short link should be easily copied and shared. - The short link should be mapped to the original long URL for redirection.
FR02	URL Redirection	Clicker	As a Clicker, I want to be redirected to the original long URL when I access a shortened link.	<ul style="list-style-type: none"> - Given a shortened link, when I click on it, the system should redirect me to the original long URL associated with the link. - Given a long URL, I should have the option to customize the short link by providing a preferred alias.
FR03	Custom Short Links	User	As a User, I want to customize the short link for my URL so that it is more meaningful or branded.	<ul style="list-style-type: none"> - The system should check the availability of the customized short link and assign it to the long URL if it is unique. - Given a shortened link, I should have the option to specify an expiration time for it.
FR04	Expiration Time	User	As a User, I want to set an expiration time for my shortened link so that it becomes invalid after a certain period.	<ul style="list-style-type: none"> - The system should invalidate the shortened link after the specified expiration time, preventing further redirection. - The system should collect click data for each shortened link, including the number of clicks, timestamp, and user information if available. - The system should provide analytics reports with relevant statistics.
FR05	Analytics and Tracking	Analytics Manager	As an Analytics Manager, I want to track and analyze click number and distribution for shortened links.	<ul style="list-style-type: none"> - The system should provide a user interface where I can view, edit, and delete my shortened links. - I should be able to track the performance of my shortened links, such as the number. - The system should provide well-documented REST APIs for system administrators to perform administrative tasks, such as managing users, URLs, and analytics data.
FR06	Link Management	User	As a User, I want to manage my shortened links by editing, deleting, and tracking their performance.	<ul style="list-style-type: none"> - The system should provide a user interface where I can view, edit, and delete my shortened links. - I should be able to track the performance of my shortened links, such as the number. - The system should provide well-documented REST APIs for system administrators to perform administrative tasks, such as managing users, URLs, and analytics data.
FR07	REST API Support	System Administrators	As a System Administrator, I want to access and interact with the URL shortening system through REST APIs.	<ul style="list-style-type: none"> - The system should provide well-documented REST APIs for system administrators to perform administrative tasks, such as managing users, URLs, and analytics data.

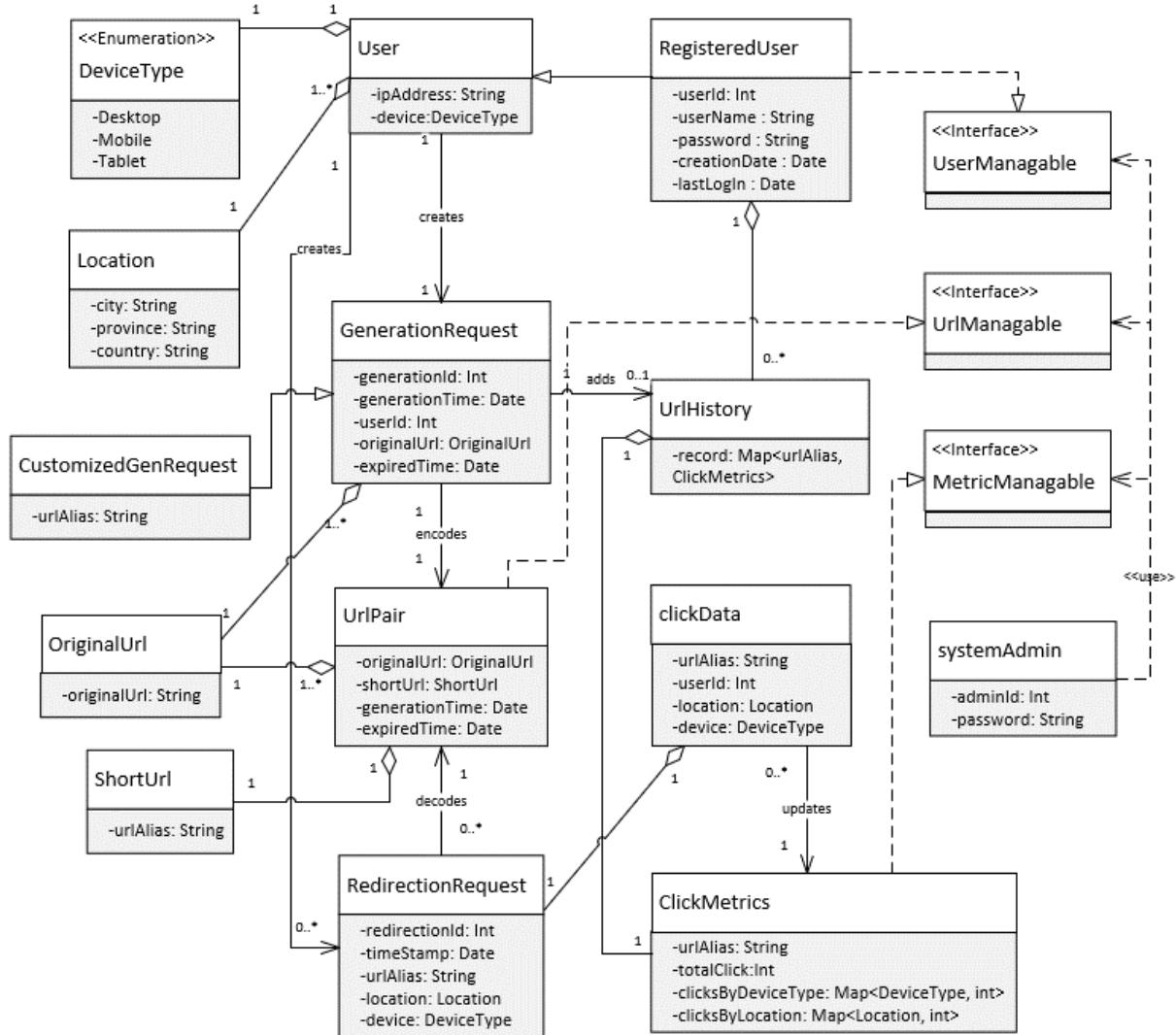
	FR08	Database Management	Database Administrator	<p>As a Database Administrator, I want the system to include efficient database management for storing and retrieving URL mappings.</p>	<ul style="list-style-type: none"> - The system should use a reliable and scalable database management system for storing and retrieving URL mappings. - The database should be optimized for performance and ensure data integrity.
		Caching Mechanism	System Administrators	<p>As a System Administrator, I want the system to implement caching to improve URL redirection and retrieval performance.</p>	<ul style="list-style-type: none"> - The system should implement a caching mechanism to cache frequently accessed URLs and click data. - The caching mechanism should improve URL redirection and retrieval performance by reducing database queries.

4. UML Domain Class Diagram

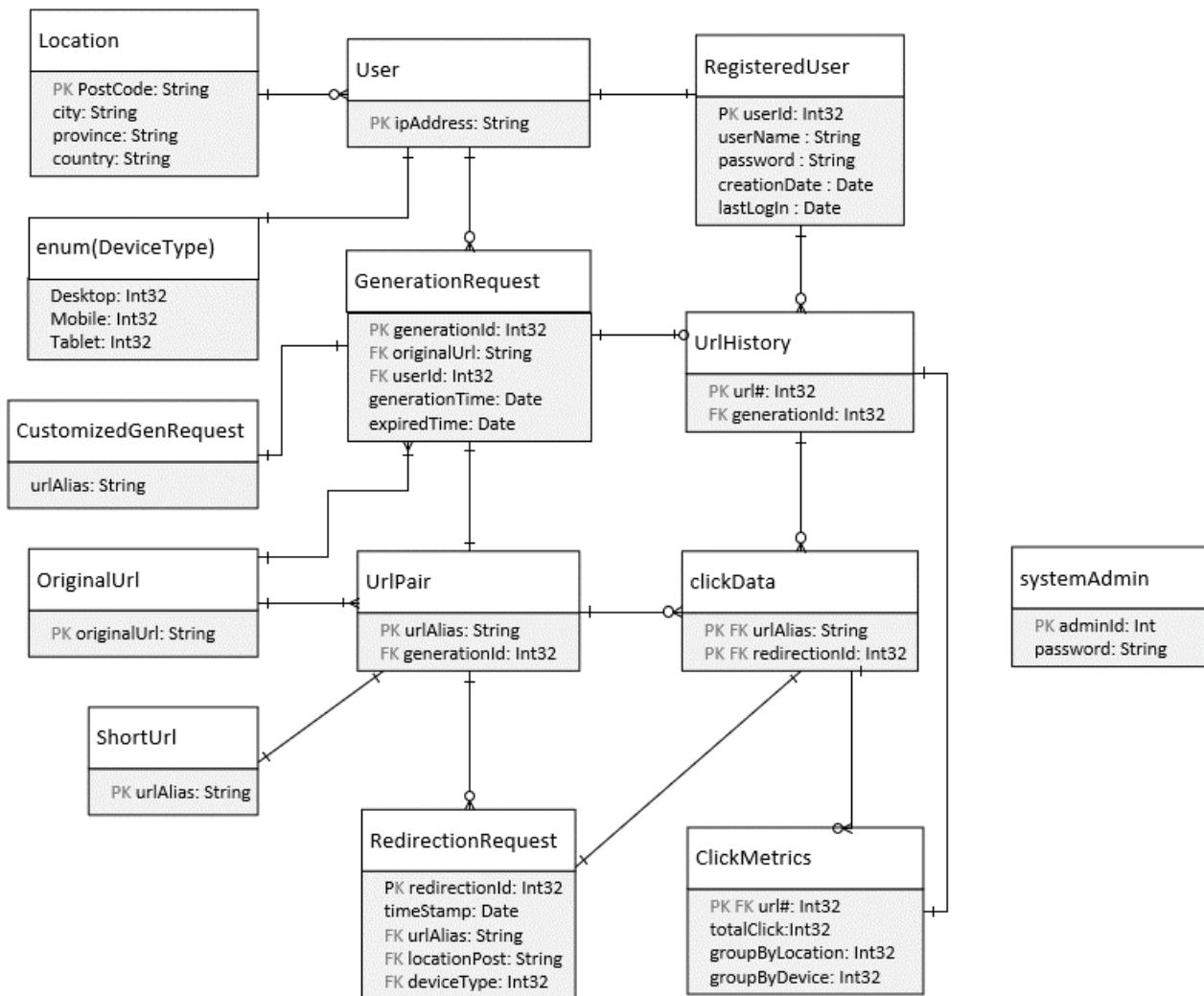
4.1 List of Classes

User	URL History
Registered User	Generation Request
System Admin API	Customized Generation Request
System Admin	Redirection Request
Original URL	Click Data
Short URL	Click Metrics
URL Pair	

4.2 UML Domain Class Diagram

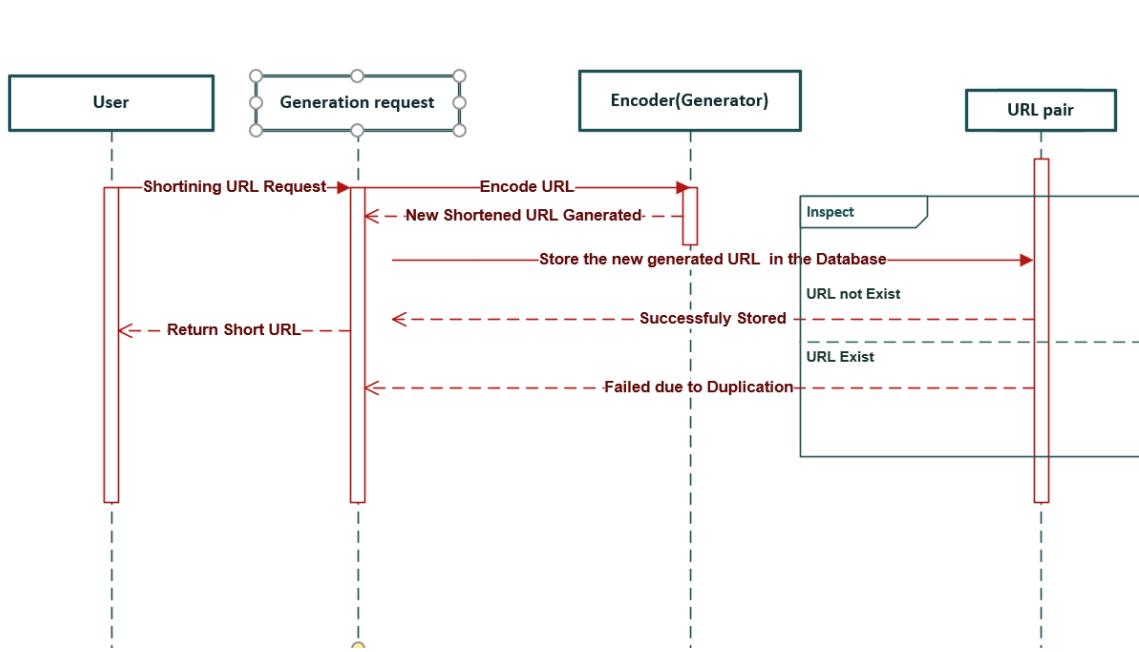


5. ERD Database (Non-UML)

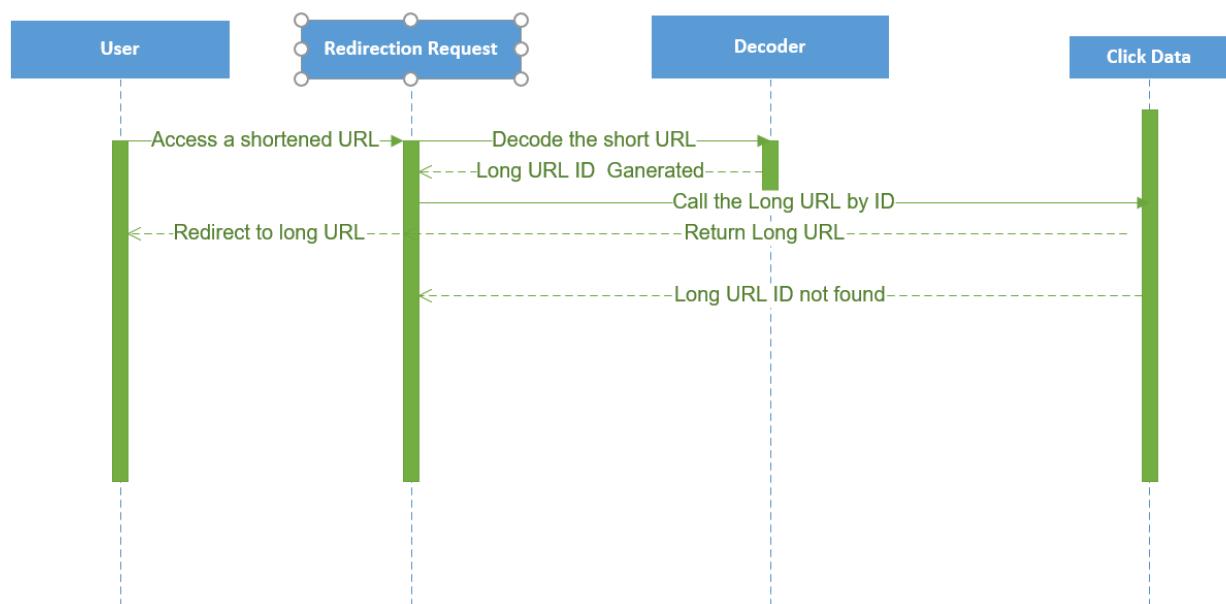


6. UML Systems Sequence Diagrams

6.1 URL shorten Use Case Sequence Diagram

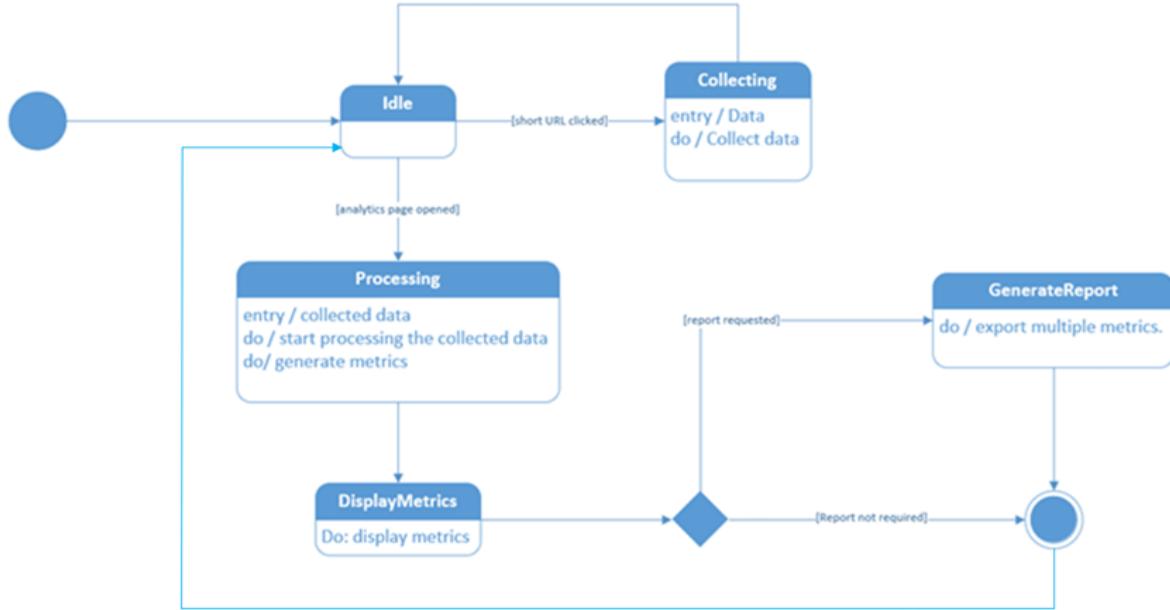


6.2 URL Redirection Use Case Sequence Diagram

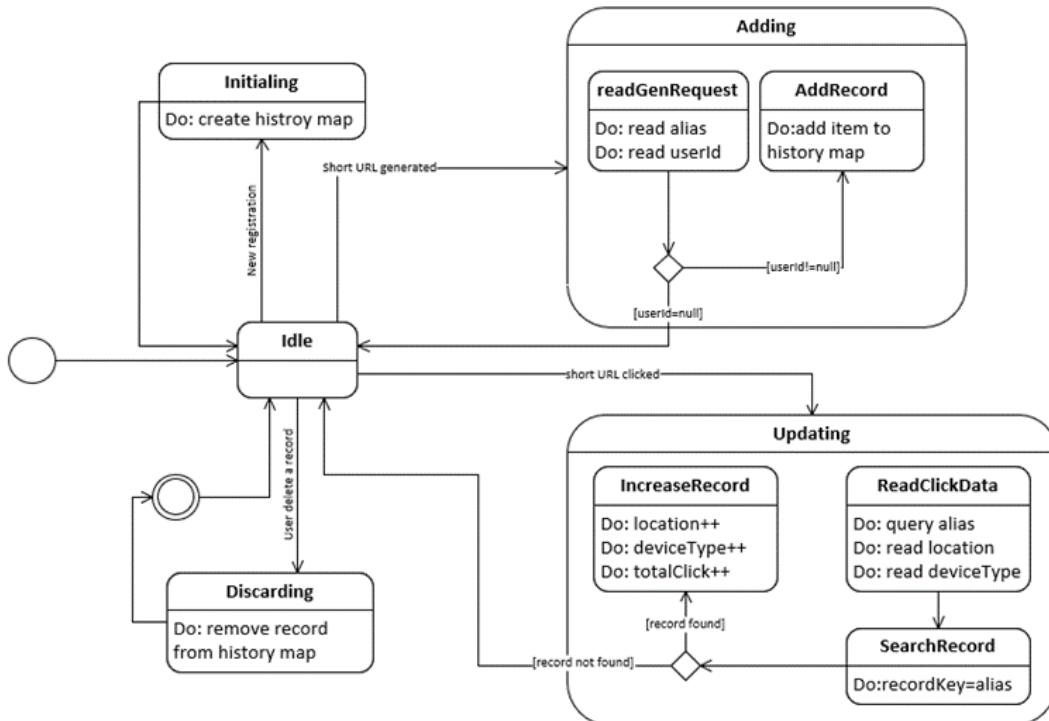


7. UML State Diagrams

7.1 Analytics State Diagram



7.2 URL History State Diagram



8. Technologies

For the URL shorten system, considering both a) Mobile and b) Web Application, but they will be presented in the browser as a website, so they will share most of the technologies. the typical tools for each type of application can be listed as follows:

a) Mobile Application (Web-compatible webpage):

Client side (Front-end - GUI):

- HTML: HyperText Markup Language is the standard markup language for creating webpages. It provides the structure and content of the webpage.
- CSS: Cascading Style Sheets is used for styling the webpage, including layout, colors, and fonts.
- JavaScript: JavaScript is a programming language that adds interactivity and dynamic behavior to webpages. It can handle user interactions and perform client-side tasks.

Business Logic (Middle layer - Class methods, etc):

- Node.js: Node.js is a JavaScript runtime environment that allows running JavaScript on the server-side. It can handle business logic and server-side operations.

Data side (Database):

- MongoDB: MongoDB is a NoSQL database that provides flexibility and scalability for storing and retrieving data in a JSON-like format. It can be suitable for storing URL mappings and related data.

b) Web Application:

Client side (Front-end – GUI):

- HTML: HyperText Markup Language is the standard markup language for creating webpages. It provides the structure and content of the webpage.
- CSS: Cascading Style Sheets is used for styling the webpage, including layout, colors, and fonts.
- JavaScript: JavaScript is a programming language that adds interactivity and dynamic behavior to webpages. It can handle user interactions and perform client-side tasks.

Business Logic (Middle layer - Class methods, etc):

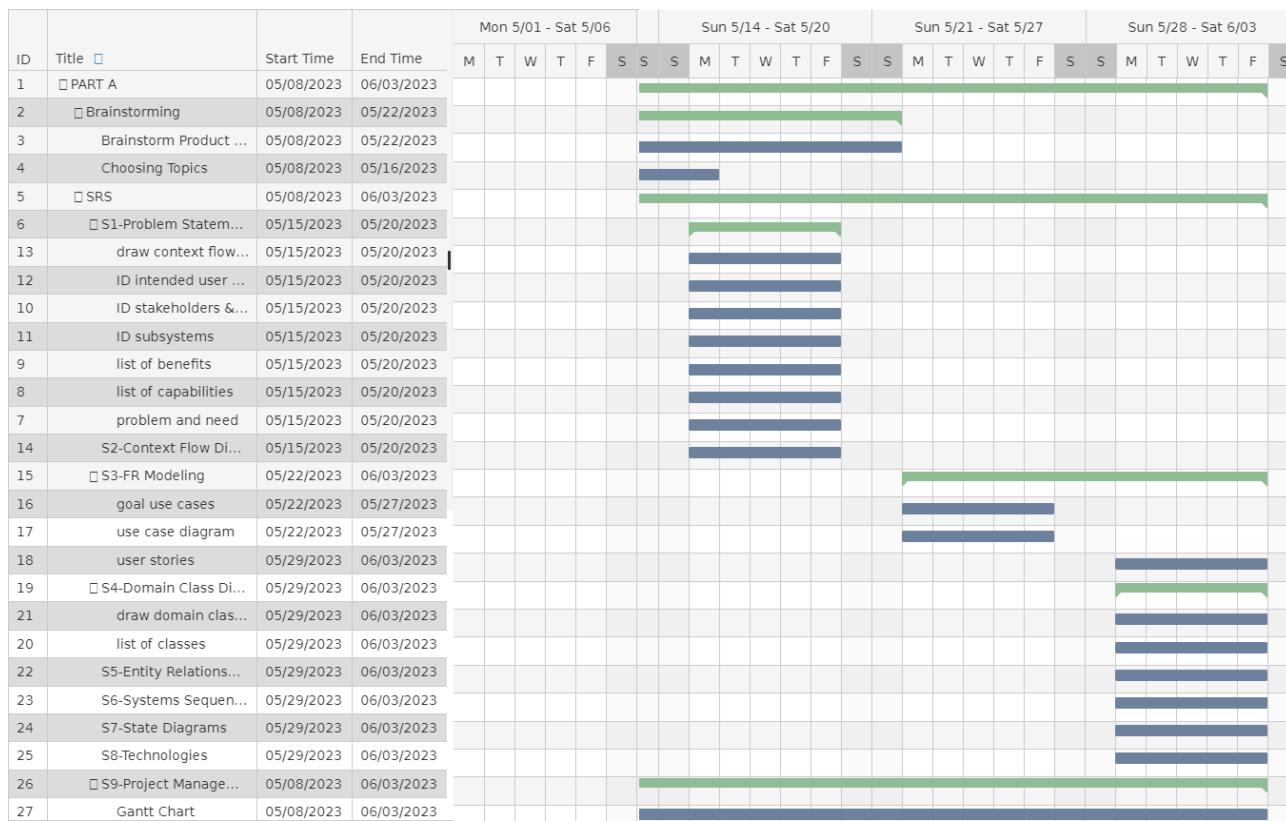
- Node.js: Node.js is a JavaScript runtime environment that allows running JavaScript on the server-side. It can handle business logic and server-side operations.

Data side (Database):

- MongoDB: MongoDB is a NoSQL database that provides flexibility and scalability for storing and retrieving data in a JSON-like format. It can be suitable for storing URL mappings and related data.

These technologies and tools can be considered for the development of the URL shorten system. The mobile application can be implemented as a web-compatible webpage using HTML, CSS, and JavaScript. For both the mobile and web applications, the business logic can be implemented using Node.js, and the data can be stored in MongoDB.

9. Gantt Chart



PART B

1. Requirement Edit to Part A

- List of Capabilities (Section 1.2)
 - Added customize short URL option.
- Application Subsystems (Section 1.5)
 - Added System Administration Subsystem.
 - Deleted User Interface Subsystem.
- Use Case Diagrams (Section 3.2)
 - Added System Administration Subsystem.
 - Added open & view page, set expire time use cases.
 - Reorganized the connections.
 - Revised caching subsystem.
- Domain Class Diagram (Section 4.2)
 - Added userId attributes to GenerationRequest Class.
 - Deleted hash attribute from UrlPair.
 - Deleted connection between RegisterUser and ClickMetrics.
 - Deleted connection between ClickData and UrlHistory.
 - Deleted connection between UrlPair and UrlHistory
 - Added multiplication to connection between GenerationRequest and UrlHistory.
 - Deleted location and device attributes from ClickData.
 - Modified multiplication between ClickData and UrlHistory.
 - Replaced multiple association connections to directed associations.
 - Rearranged the start of “adds UrlHistory” from GenerationRequest to UrlPair.
 - Created a new connection between User and RedirectionRequest.

- Reconnected <>DeviceType and Location from RedirectionRequest to User.
- Split SystemAdminAPI into 3 interfaces.
- Broke the connection between UrlPair and ClickData.
- Added userId to UrlPair.
- Changed the relationship between RedirectionRequest and ClickData to directed association.
- ERD Database (Non-UML) (Section 5)
 - Connected RegisterUser with UrlHistory.
 - Deleted hash column from UrlPair.
 - Reconnected <>DeviceType and Location from RedirectionRequest to User.
 - Modified multiplication of GenerationRequest and UrlHistory to 1 to 0 or 1.
- URL shorten Use Case Sequence Diagram (Section 6)
 - Renamed the objects of the 2 sequence diagrams.

2. Overview Model

2.1 Intended Users of SDD:

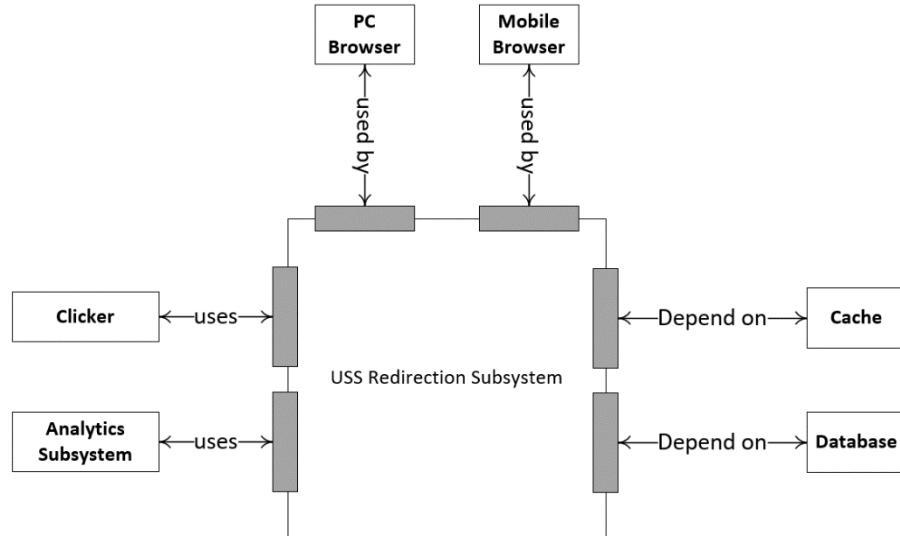
1. **Development Team:** The software design documentation is primarily targeted at the development team, including architects, designers, and programmers. It provides them with a detailed understanding of the system's architecture, design patterns, data structures, algorithms, and implementation guidelines. This enables them to effectively develop the different components of the URL Shortening application.
2. **Project Managers:** Project managers can refer to the software design documentation to ensure that the development team is following the planned architecture and design

principles. It helps them monitor the progress of the project and assess if it aligns with the defined design specifications.

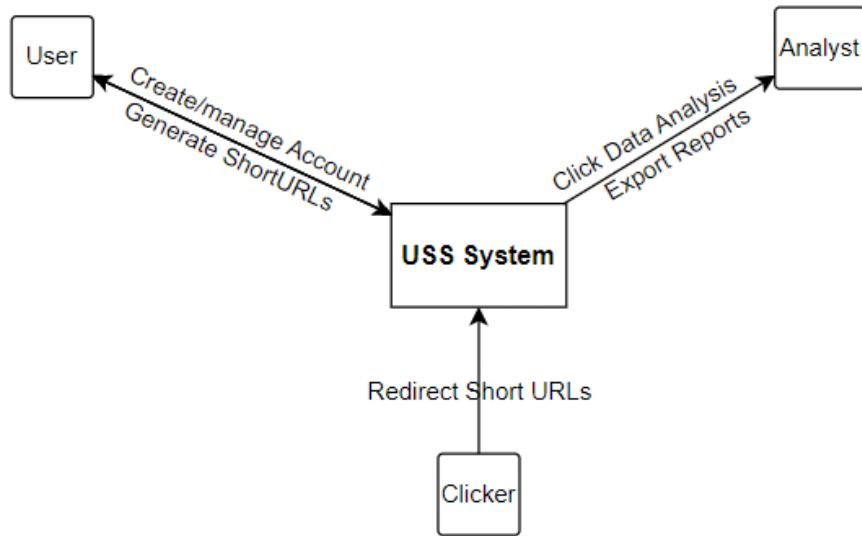
3. **Quality Assurance Team:** The software design documentation is valuable for the quality assurance team to understand the expected behavior of the URL Shortening application. It aids them in planning and executing comprehensive testing strategies, as they can refer to the documented design elements and expected system behavior.
4. **System Administrators:** System administrators can benefit from the software design documentation as it provides insights into the infrastructure requirements, deployment procedures, and configuration settings. It helps them understand how to set up and manage the URL Shortening application in production environments.
5. **Maintenance and Support Team:** The software design documentation is crucial for the maintenance and support team as it provides a comprehensive overview of the system's design and architecture. It aids them in troubleshooting issues, identifying areas for optimization, and maintaining the system effectively.
6. **Documentation Writers:** Documentation writers can utilize the software design documentation to create accurate and detailed user manuals, technical documentation, and other resources for end-users. It provides them with a deep understanding of the application's design and functionality, enabling them to produce helpful documentation.

2.2 Architectural Context Diagram

2.2.1 Architectural Context Diagram - “How” Overview



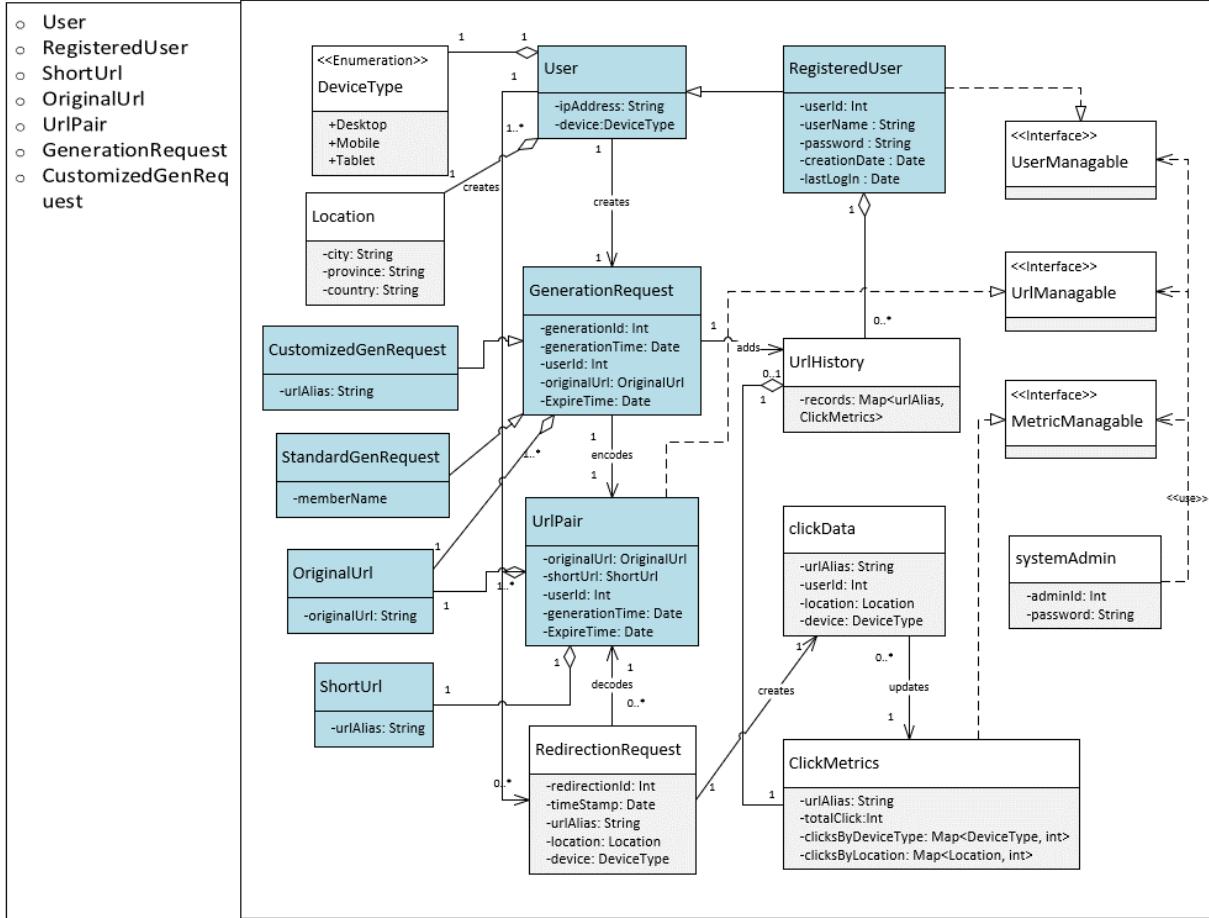
2.2.2 System Context Diagram (Part A) – “What” overview:



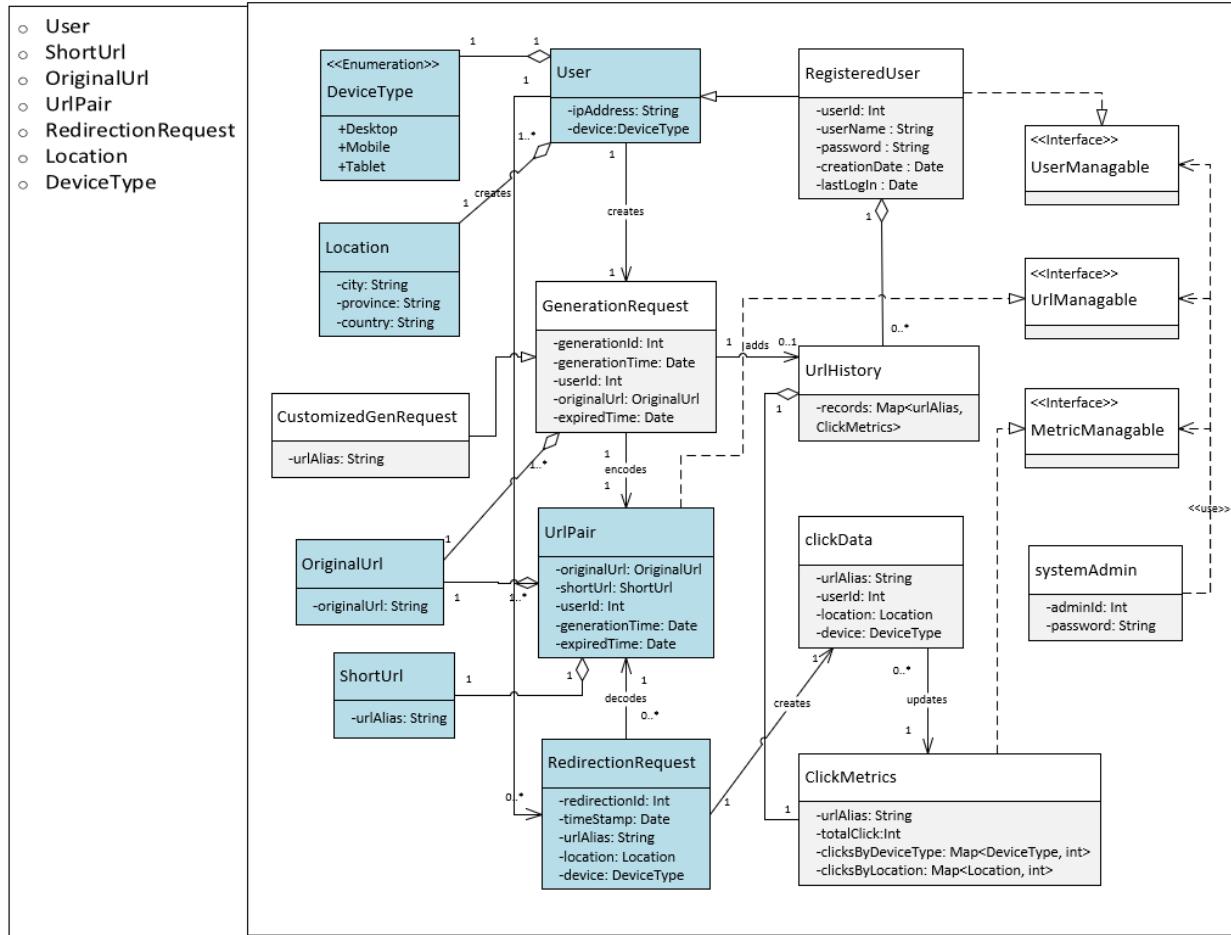
3. Modularization

3.1 Partition of the Analysis Model

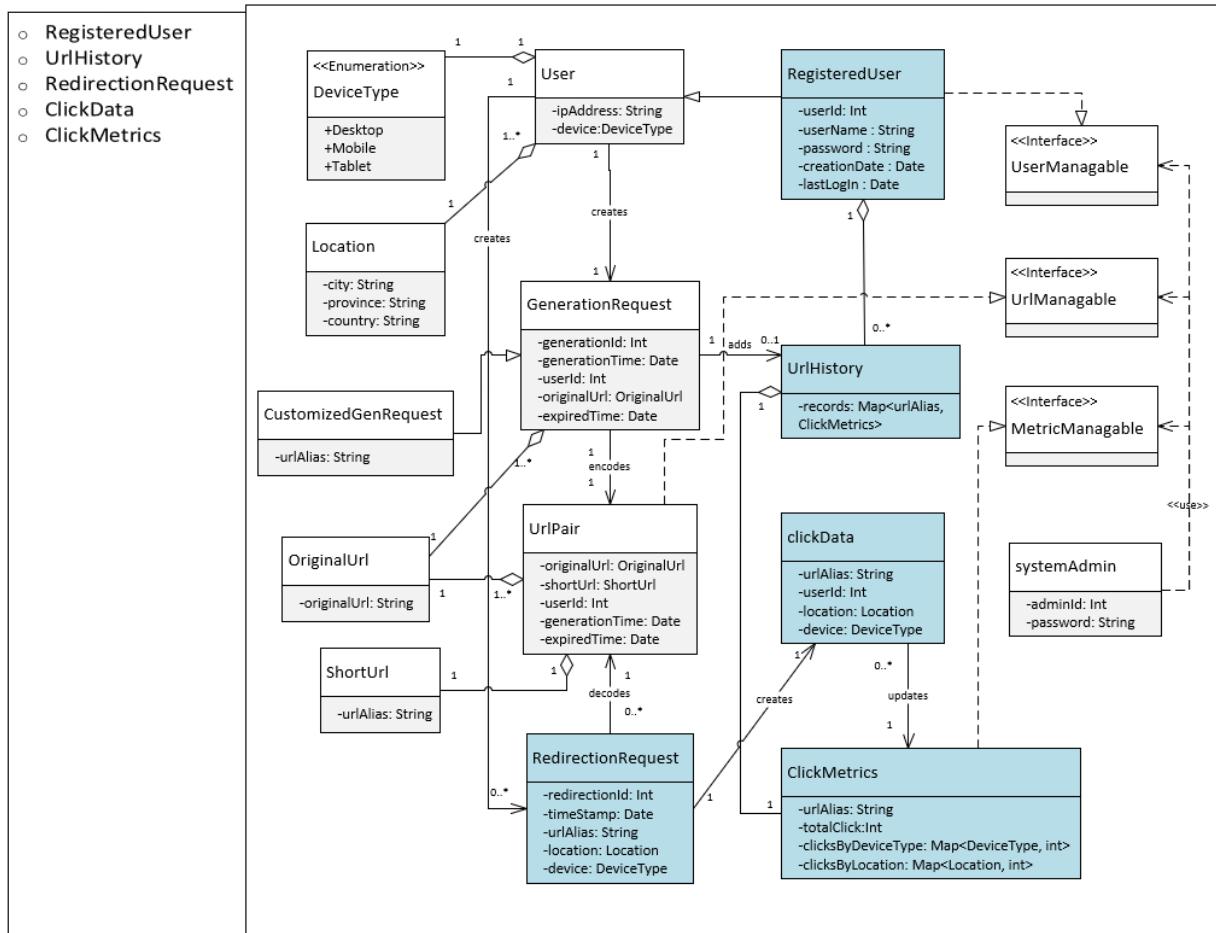
3.1.1 URL Shortening Subsystem



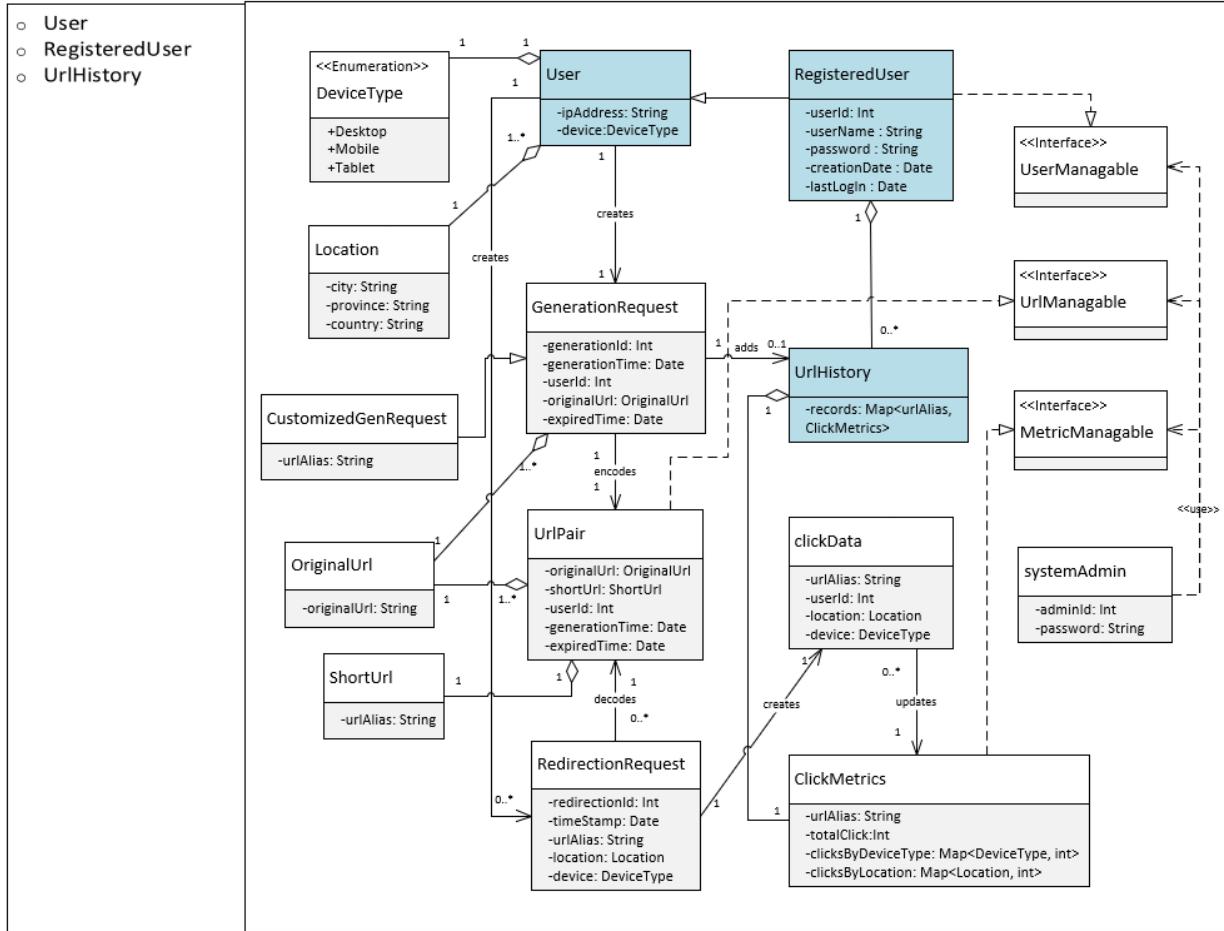
3.1.2 Redirection Subsystem



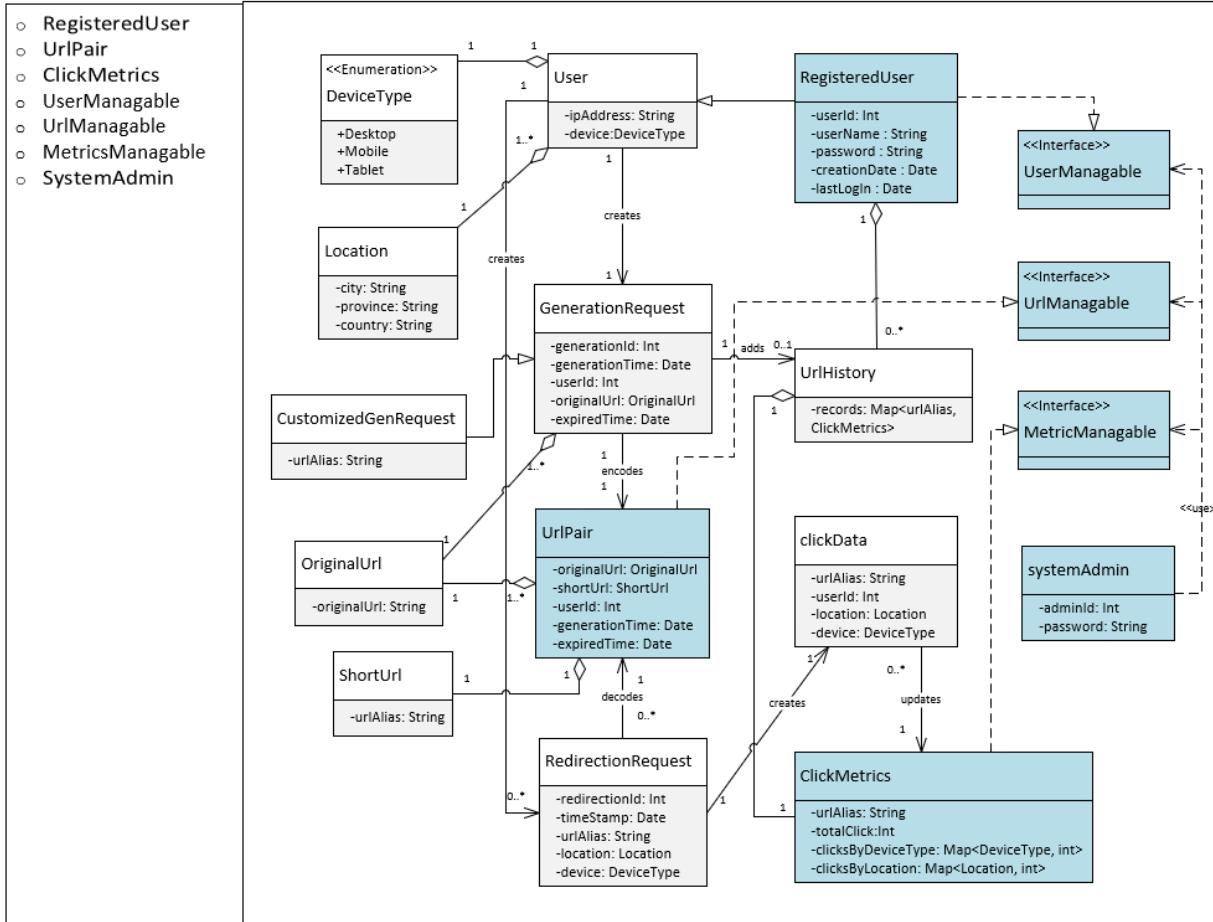
3.1.3 Analytics Subsystem



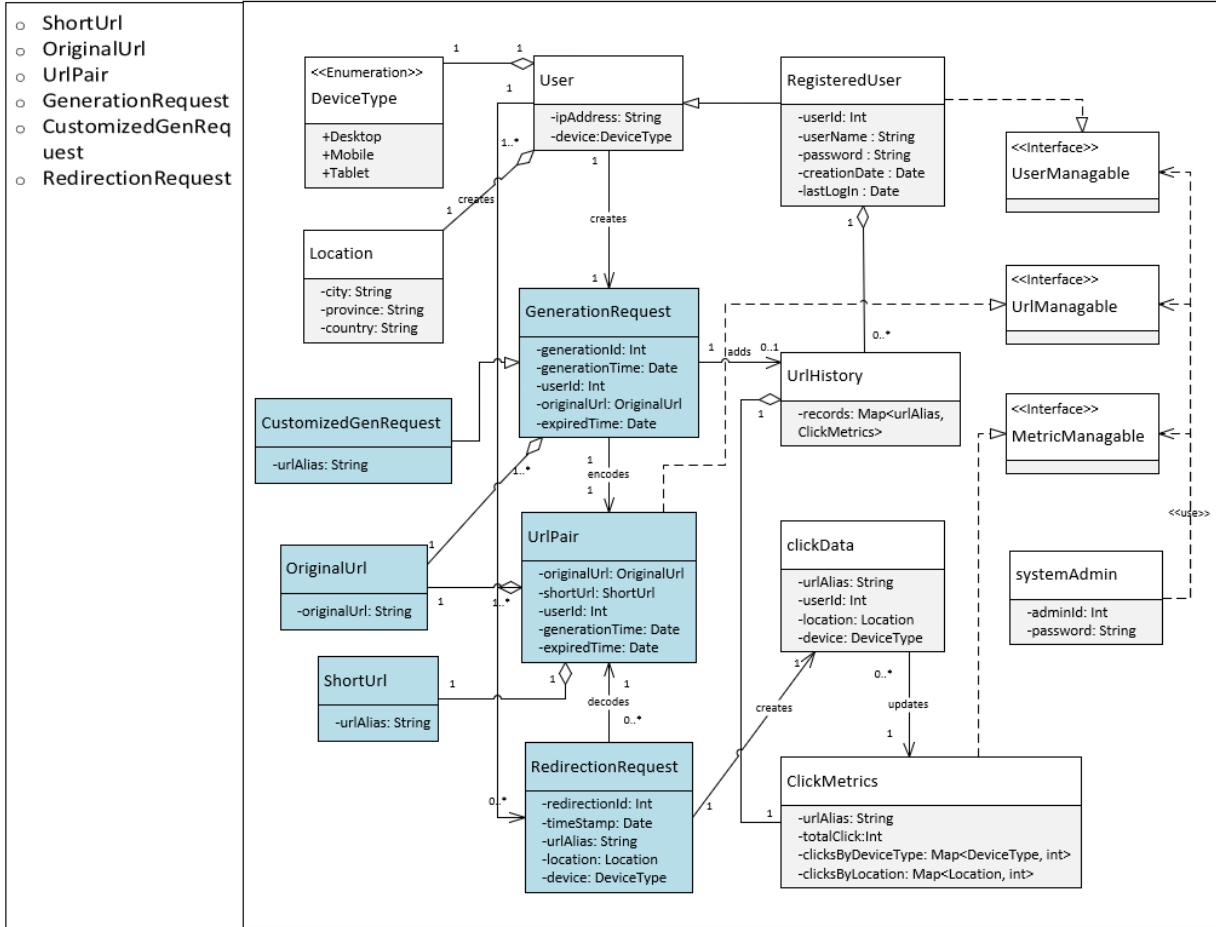
3.1.4 User Management Subsystem



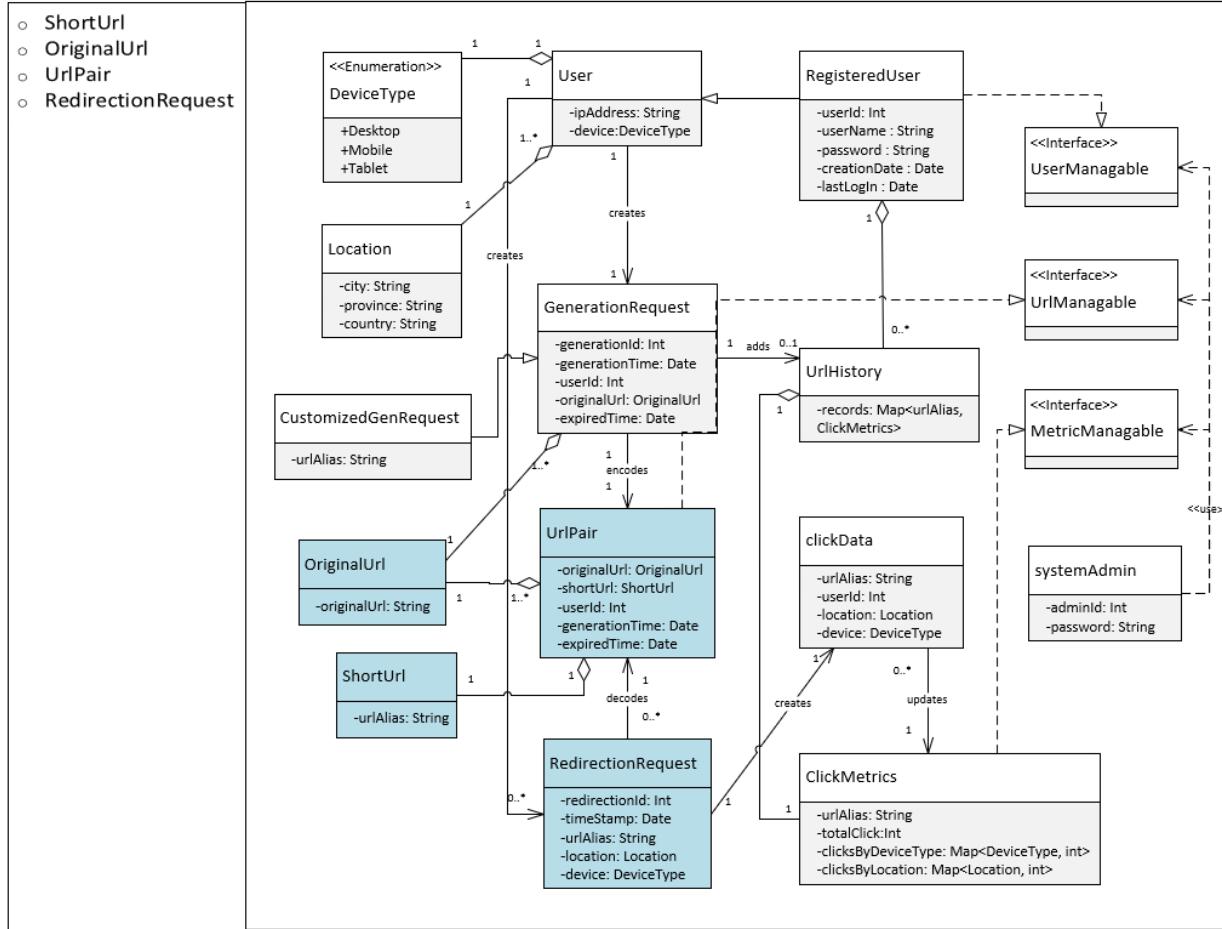
3.1.5 System Administration Subsystem



3.1.6 Database Management Subsystem



3.1.7 Caching Mechanism Subsystem



3.2 Class Responsibility Collaboration (CRC)

3.2.1 URL Shortening Subsystem

User												
Sub Classes: RegisteredUser												
Description: Represents a user in the system												
Attributes:												
<table border="1"> <thead> <tr> <th>Name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>ipAddress</td> <td></td> </tr> </tbody> </table>	Name	Description	ipAddress									
Name	Description											
ipAddress												
Responsibilities:												
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Name	Collaborator											
generateShortUrl	GenerationRequest											
redirectShortUrl	RedirectionRequest											
GenerationRequest												
Sub Classes: CustomizedGenRequest												
Description: Represents a generation request of short URL												
Attributes:												
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generationTime												
userId	null if user not log in											
originalUrl												
expiredTime	set by user, maximum limit											
Responsibilities:												
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Name	Collaborator											
setGenId												
encodeAlias	OriginalUrl, ShortUrl											
createUrlPair	UrlPair											
addUrlHistory	RegisterUser, UrlHistory											
UrlHistory												
Description: Represents a record of URL generated by a registered user												
Attributes:												
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Name	Description											
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Responsibilities:												
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Name	Collaborator											
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displayMetrics	RegisteredUser, DataMetrics											
deleteUrlHistory	RegisteredUser											

RegisteredUser																						
Super Classes: User																						
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Name	Description																					
userId	assigned when register																					
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Name	Collaborator																					
createUrl	<<Interface>>UserManagable																					
updateProfile	<<Interface>>UserManagable																					
deleteUser	<<Interface>>UserManagable																					
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viewMetrics	UrlHistory, ClickMetrics																					
exportReport	UrlHistory, ClickMetrics																					
UrlPair																						
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Name	Collaborator																					
createUrlPair	GenerationRequest, <<Interface>>UrlManagable																					
checkAvailability	CustomizedGenRequest																					
saveUrlPair																						
getOriginalUrl	RedirectionRequest																					
getUserid	RedirectionRequest																					
updateUrlPair	<<Interface>>UrlManagable																					
deleteUrlPair	<<Interface>>UrlManagable																					

CustomizedGenRequest						
Super Classes: GenerationRequest						
Description: Represents a customized generation request of short URL						
Responsibilities:						
<table border="1"> <thead> <tr> <th>Name</th> <th>Collaborator</th> </tr> </thead> <tbody> <tr> <td>setUrlAlias</td> <td>UrlPair</td> </tr> </tbody> </table>	Name	Collaborator	setUrlAlias	UrlPair		
Name	Collaborator					
setUrlAlias	UrlPair					
StandardGenRequest						
Super Classes: GenerationRequest						
Description: Represents a customized generation request of short URL						
Responsibilities:						
<table border="1"> <thead> <tr> <th>Name</th> <th>Collaborator</th> </tr> </thead> <tbody> <tr> <td>encodeUrlAlias</td> <td>UrlPair</td> </tr> </tbody> </table>	Name	Collaborator	encodeUrlAlias	UrlPair		
Name	Collaborator					
encodeUrlAlias	UrlPair					
OriginalUrl						
Description: Represents the original URL provided by user.						
Attributes:						
<table border="1"> <thead> <tr> <th>Name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>originalUrl</td> <td>long URL string</td> </tr> </tbody> </table>	Name	Description	originalUrl	long URL string		
Name	Description					
originalUrl	long URL string					
Responsibilities:						
<table border="1"> <thead> <tr> <th>Name</th> <th>Collaborator</th> </tr> </thead> <tbody> <tr> <td>setOriginalUrl</td> <td>GenerationRequest, User</td> </tr> <tr> <td>getOriginalUrl</td> <td>GenerationRequest, UrlPair</td> </tr> </tbody> </table>	Name	Collaborator	setOriginalUrl	GenerationRequest, User	getOriginalUrl	GenerationRequest, UrlPair
Name	Collaborator					
setOriginalUrl	GenerationRequest, User					
getOriginalUrl	GenerationRequest, UrlPair					
ShortUrl						
Description: Represents the original URL provided by user.						
Attributes:						
<table border="1"> <thead> <tr> <th>Name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>urlAlias</td> <td>string tail of short URL</td> </tr> </tbody> </table>	Name	Description	urlAlias	string tail of short URL		
Name	Description					
urlAlias	string tail of short URL					
Responsibilities:						
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Name	Collaborator					
setShortUrl	GenerationRequest, User					

3.2.2 Redirection Subsystem

User	
Sub Classes: RegisteredUser	
 Description: Represents a user in the system	
Attributes:	
Name	Description
ipAddress	
Responsibilities:	
Name	Collaborator
generateShortUrl	GenerationRequest
redirectShortUrl	RedirectionRequest
 <>Enumeration>>DeviceType	
Description: Represents a device type	
Attributes:	
Name	Description
Desktop	
Mobile	
Tablet	
 Location	
Description: Represents the location when click occurs	
Attributes:	
Name	Description
city	
province	
country	
Responsibilities:	
Name	Collaborator
resolvelpAddress	User

UrlPair	
Description: Represents the original URL and short URL map.	
Attributes:	
Name	Description
originalUrl	
shortUrl	
userId	
generationTime	
expiredTime	
Responsibilities:	
Name	Collaborator
createUrlPair	GenerationRequest, <>Interface>>UrlManagable
checkAvailability	CustomizedGenRequest
saveUrlPair	RedirectionRequest
getOriginalUrl	RedirectionRequest
getUserid	RedirectionRequest
updateUrlPair	<>Interface>>UrlManagable
deleteUrlPair	<>Interface>>UrlManagable
 RedirectionRequest	
Description: Represents a redirection request for the original URL	
Attributes:	
Name	Description
redirectionId	
timeStamp	
urlAlias	
location	
device	
Responsibilities:	
Name	Collaborator
getLocation	Location
getDevice	<>Enumerate>>DeviceType
decodeAlias	UrlPair
getOriginalUrl	UrlPair
getGenUserId	User, RegisteredUser
redirect	
createClickData	ClickData

OriginalUrl	
Description: Represents the original URL provided by user.	
Attributes:	
Name	Description
originalUrl	long URL string
Responsibilities:	
Name	Collaborator
setOriginalUrl	GenerationRequest, User
getOriginalUrl	GenerationRequest, UrlPair
 ShortUrl	
Description: Represents the original URL provided by user.	
Attributes:	
Name	Description
urlAlias	string tail of short URL
Responsibilities:	
Name	Collaborator
setShortUrl	GenerationRequest, User

3.2.3 Analytics Subsystem

RegisteredUser																							
Super Classes: User																							
Description: Represents a registered user in the system																							
Attributes:																							
<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>userId</td><td>assigned when register</td></tr> <tr> <td>userName</td><td>unique, set by user</td></tr> <tr> <td>password</td><td></td></tr> <tr> <td>creationDate</td><td>account created time</td></tr> <tr> <td>lastLogin</td><td>Date</td></tr> </tbody> </table>		Name	Description	userId	assigned when register	userName	unique, set by user	password		creationDate	account created time	lastLogin	Date										
Name	Description																						
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Responsibilities:																							
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Name	Collaborator																						
createUser	<<Interface>>UserManagable																						
updateProfile	<<Interface>>UserManagable																						
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generateShortUrl	GenerationRequest																						
login																							
signOut																							
resetPassword																							
deleteUrl	UrlHistory, UriPair																						
viewMetrics	UrlHistory, ClickMetrics																						
exportReport	UrlHistory, ClickMetrics																						

RedirectionRequest	
Description: Represents a redirection request for the original URL	
Attributes:	
Name	Description
redirectionId	
timeStamp	
urlAlias	
location	
device	
Responsibilities:	
Name	Collaborator
getLocation	Location
getDevice	<<Enumerate>>DeviceType
decodeAlias	UriPair
getOriginalUrl	UriPair
getGenUserId	User, RegisteredUser
redirect	ClickData
createClickData	ClickData

ClickMetrics	
Description: Represents the summary of click data for a short URL	
Attributes:	
Name	Description
urlAlias	
totalClick	
clicksByDeviceType	
clicksByLocation	
Responsibilities:	
Name	Collaborator
updateMetrics	ClickData, <<Interface>>MetricsManagable
visualizeMetrics	RegisteredUser, <<Interface>>MetricsManagable
generateReport	RegisteredUser, <<Interface>>MetricsManagable

ClickData	
Description: Represent the info of one click event	
Attributes:	
Name	Description
urlAlias	
location	
device	
Responsibilities:	
Name	Collaborator
UpdateClickMetrics	ClickMetrics

UrlHistory	
Description: Represents a record of URL generated by a registered user	
Attributes:	
Name	Description
records	map of alias and metrics
Responsibilities:	
Name	Collaborator
createMetrics	ClickMetrics
displayMetrics	RegisteredUser, ClickMetrics
deleteUrlHistory	RegisteredUser

3.2.4 User Management Subsystem

User	
Sub Classes:	
RegisteredUser	
Description:	
Represents a user in the system	
Attributes:	
Name	Description
ipAddress	
Responsibilities:	
Name	Collaborator
generateShortUrl	GenerationRequest
redirectShortUrl	RedirectionRequest
UrlHistory	
Description:	
Represents a record of URL generated by a registered user	
Attributes:	
Name	Description
records	map of alias and metrics
Responsibilities:	
Name	Collaborator
createMetrics	ClickMetrics
displayMetrics	RegisteredUser, ClickMetrics
deleteUrlHistory	RegisteredUser

RegisteredUser	
Super Classes:	
User	
Description:	
Represents a registered user in the system	
Attributes:	
Name	Description
userId	assigned when register
userName	unique, set by user
password	
creationDate	account created time
lastLogin	Date
Responsibilities:	
Name	Collaborator
createUser	<<Interface>>UserManagable
updateProfile	<<Interface>>UserManagable
deleteUser	<<Interface>>UserManagable
generateShortUrl	GenerationRequest
login	
signOut	
resetPassword	
deleteUrl	UrlHistory, UrlPair
viewMetrics	UrlHistory, ClickMetrics
exportReport	UrlHistory, ClickMetrics

3.2.5 System Administration Subsystem

RegisteredUser																							
Super Classes: User																							
Description: Represents a registered user in the system																							
Attributes:																							
<table border="1"> <thead> <tr><th>Name</th><th>Description</th></tr> </thead> <tbody> <tr><td>userId</td><td>assigned when register</td></tr> <tr><td>userName</td><td>unique, set by user</td></tr> <tr><td>password</td><td></td></tr> <tr><td>creationDate</td><td>account created time</td></tr> <tr><td>lastLogin</td><td>Date</td></tr> </tbody> </table>		Name	Description	userId	assigned when register	userName	unique, set by user	password		creationDate	account created time	lastLogin	Date										
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password																							
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Responsibilities:																							
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Name	Collaborator																						
createUser	<<Interface>>UserManagable																						
updateProfile	<<Interface>>UserManagable																						
deleteUser	<<Interface>>UserManagable																						
generateShortUrl	GenerationRequest																						
login																							
signOut																							
resetPassword																							
deleteUrl	UrlHistory, UrlPair																						
viewMetrics	UrlHistory, ClickMetrics																						
exportReport	UrlHistory, ClickMetrics																						
<<Interface>>UserManagable																							
Description: Interface providing user management functionality for system administrators																							
Responsibilities:																							
<table border="1"> <thead> <tr><th>Name</th><th>Collaborator</th></tr> </thead> <tbody> <tr><td>createUser</td><td>RegisteredUser</td></tr> <tr><td>updateUserInfo</td><td>RegisteredUser</td></tr> <tr><td>deleteUser</td><td>RegisteredUser</td></tr> </tbody> </table>		Name	Collaborator	createUser	RegisteredUser	updateUserInfo	RegisteredUser	deleteUser	RegisteredUser														
Name	Collaborator																						
createUser	RegisteredUser																						
updateUserInfo	RegisteredUser																						
deleteUser	RegisteredUser																						

UrlPair																	
Description: Represents the original URL and short URL map.																	
Attributes:																	
<table border="1"> <thead> <tr><th>Name</th><th>Description</th></tr> </thead> <tbody> <tr><td>originalUrl</td><td></td></tr> <tr><td>shortUrl</td><td></td></tr> <tr><td>userId</td><td></td></tr> <tr><td>generationTime</td><td></td></tr> <tr><td>expiredTime</td><td></td></tr> </tbody> </table>		Name	Description	originalUrl		shortUrl		userId		generationTime		expiredTime					
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Name	Collaborator																
createUrlPair	GenerationRequest, <<Interface>>UrlManagable																
checkAvailability	CustomizedGenRequest																
saveUrlPair	RedirectionRequest																
getOriginalUrl	RedirectionRequest																
getUserid																	
updateUrlPair	<<Interface>>UrlManagable																
deleteUrlPair	<<Interface>>UrlManagable																
<<Interface>>UrlManagable																	
Description: Interface providing URL pair management for system administrators																	
Responsibilities:																	
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Name	Collaborator																
createUrlPair	UrlPair																
updateUrlPair	UrlPair																
deleteUrlPair	UrlPair																

ClickMetrics											
Description: Represents the summary of click data for a short URL											
Attributes:											
<table border="1"> <thead> <tr><th>Name</th><th>Description</th></tr> </thead> <tbody> <tr><td>urlAlias</td><td></td></tr> <tr><td>totalClick</td><td></td></tr> <tr><td>clicksByDeviceType</td><td></td></tr> <tr><td>clicksByLocation</td><td></td></tr> </tbody> </table>		Name	Description	urlAlias		totalClick		clicksByDeviceType		clicksByLocation	
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urlAlias											
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Responsibilities:											
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Name	Collaborator										
updateMetrics	ClickData, <<Interface>>MetricsManagable										
visualizeMetrics	RegisteredUser, <<Interface>>MetricsManagable										
generateReport	RegisteredUser, <<Interface>>MetricsManagable										

<<Interface>>MetricsManagable									
Description: Interface providing metrics management for system administrators									
Responsibilities:									
<table border="1"> <thead> <tr><th>Name</th><th>Collaborator</th></tr> </thead> <tbody> <tr><td>updateMetrics</td><td>ClickMetrics</td></tr> <tr><td>visualizeMetrics</td><td>ClickMetrics</td></tr> <tr><td>generateReport</td><td>ClickMetrics</td></tr> </tbody> </table>		Name	Collaborator	updateMetrics	ClickMetrics	visualizeMetrics	ClickMetrics	generateReport	ClickMetrics
Name	Collaborator								
updateMetrics	ClickMetrics								
visualizeMetrics	ClickMetrics								
generateReport	ClickMetrics								

SystemAdmin							
Description: Represents a system administrator							
Attributes:							
<table border="1"> <thead> <tr><th>Name</th><th>Description</th></tr> </thead> <tbody> <tr><td>adminId</td><td></td></tr> <tr><td>password</td><td></td></tr> </tbody> </table>		Name	Description	adminId		password	
Name	Description						
adminId							
password							
Responsibilities:							
<table border="1"> <thead> <tr><th>Name</th><th>Collaborator</th></tr> </thead> <tbody> <tr><td>login</td><td></td></tr> <tr><td>signOut</td><td></td></tr> </tbody> </table>		Name	Collaborator	login		signOut	
Name	Collaborator						
login							
signOut							

3.2.6 Database Management Subsystem

OriginalUrl							
Description: Represents the original URL provided by user.							
Attributes:							
<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>originalUrl</td><td>long URL string</td></tr> </tbody> </table>		Name	Description	originalUrl	long URL string		
Name	Description						
originalUrl	long URL string						
Responsibilities:							
<table border="1"> <thead> <tr> <th>Name</th><th>Collaborator</th></tr> </thead> <tbody> <tr> <td>setOriginalUrl</td><td>GenerationRequest, User</td></tr> <tr> <td>getOriginalUrl</td><td>GenerationRequest, UriPair</td></tr> </tbody> </table>		Name	Collaborator	setOriginalUrl	GenerationRequest, User	getOriginalUrl	GenerationRequest, UriPair
Name	Collaborator						
setOriginalUrl	GenerationRequest, User						
getOriginalUrl	GenerationRequest, UriPair						
ShortUrl							
Description: Represents the original URL provided by user.							
Attributes:							
<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>urlAlias</td><td>string tail of short URL</td></tr> </tbody> </table>		Name	Description	urlAlias	string tail of short URL		
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Name	Collaborator						
setShortUrl	GenerationRequest, User						

UriPair																	
Description: Represents the original URL and short URL map.																	
Attributes:																	
<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>originalUrl</td><td></td></tr> <tr> <td>shortUrl</td><td></td></tr> <tr> <td>userId</td><td></td></tr> <tr> <td>generationTime</td><td></td></tr> <tr> <td>expiredTime</td><td></td></tr> </tbody> </table>		Name	Description	originalUrl		shortUrl		userId		generationTime		expiredTime					
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originalUrl																	
shortUrl																	
userId																	
generationTime																	
expiredTime																	
Responsibilities:																	
<table border="1"> <thead> <tr> <th>Name</th><th>Collaborator</th></tr> </thead> <tbody> <tr> <td>createUriPair</td><td>GenerationRequest, <>Interface>>UriManagable</td></tr> <tr> <td>checkAvailability</td><td>CustomizedGenRequest</td></tr> <tr> <td>saveUriPair</td><td></td></tr> <tr> <td>getOriginalUrl</td><td>RedirectionRequest</td></tr> <tr> <td>getUserid</td><td>RedirectionRequest</td></tr> <tr> <td>updateUriPair</td><td><>Interface>>UriManagable</td></tr> <tr> <td>deleteUriPair</td><td><>Interface>>UriManagable</td></tr> </tbody> </table>		Name	Collaborator	createUriPair	GenerationRequest, <>Interface>>UriManagable	checkAvailability	CustomizedGenRequest	saveUriPair		getOriginalUrl	RedirectionRequest	getUserid	RedirectionRequest	updateUriPair	<>Interface>>UriManagable	deleteUriPair	<>Interface>>UriManagable
Name	Collaborator																
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<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>redirectionId</td><td></td></tr> <tr> <td>timeStamp</td><td></td></tr> <tr> <td>urlAlias</td><td></td></tr> <tr> <td>location</td><td></td></tr> <tr> <td>device</td><td></td></tr> </tbody> </table>		Name	Description	redirectionId		timeStamp		urlAlias		location		device					
Name	Description																
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device																	
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getDevice	<>Enumerate>>DeviceType																
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getOriginalUrl	UriPair																
getGenUserId	User, RegisteredUser																
redirect																	
createClickData	ClickData																

GenerationRequest													
Sub Classes: CustomizedGenRequest													
Description: Represents a generation request of short URL.													
Attributes:													
<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>generationId</td><td>a incremental counter</td></tr> <tr> <td>generationTime</td><td></td></tr> <tr> <td>userId</td><td>null if user not log in</td></tr> <tr> <td>originalUrl</td><td></td></tr> <tr> <td>expiredTime</td><td>set by user, maximum limit</td></tr> </tbody> </table>		Name	Description	generationId	a incremental counter	generationTime		userId	null if user not log in	originalUrl		expiredTime	set by user, maximum limit
Name	Description												
generationId	a incremental counter												
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userId	null if user not log in												
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expiredTime	set by user, maximum limit												
Responsibilities:													
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Name	Collaborator												
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encodeAlias	OriginalUrl, ShortUrl												
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Attributes:													
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urlAlias	the string for short URL												
Responsibilities:													
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Name	Collaborator												
setUrlAlias	UriPair												

3.2.7 Caching Mechanism Subsystem

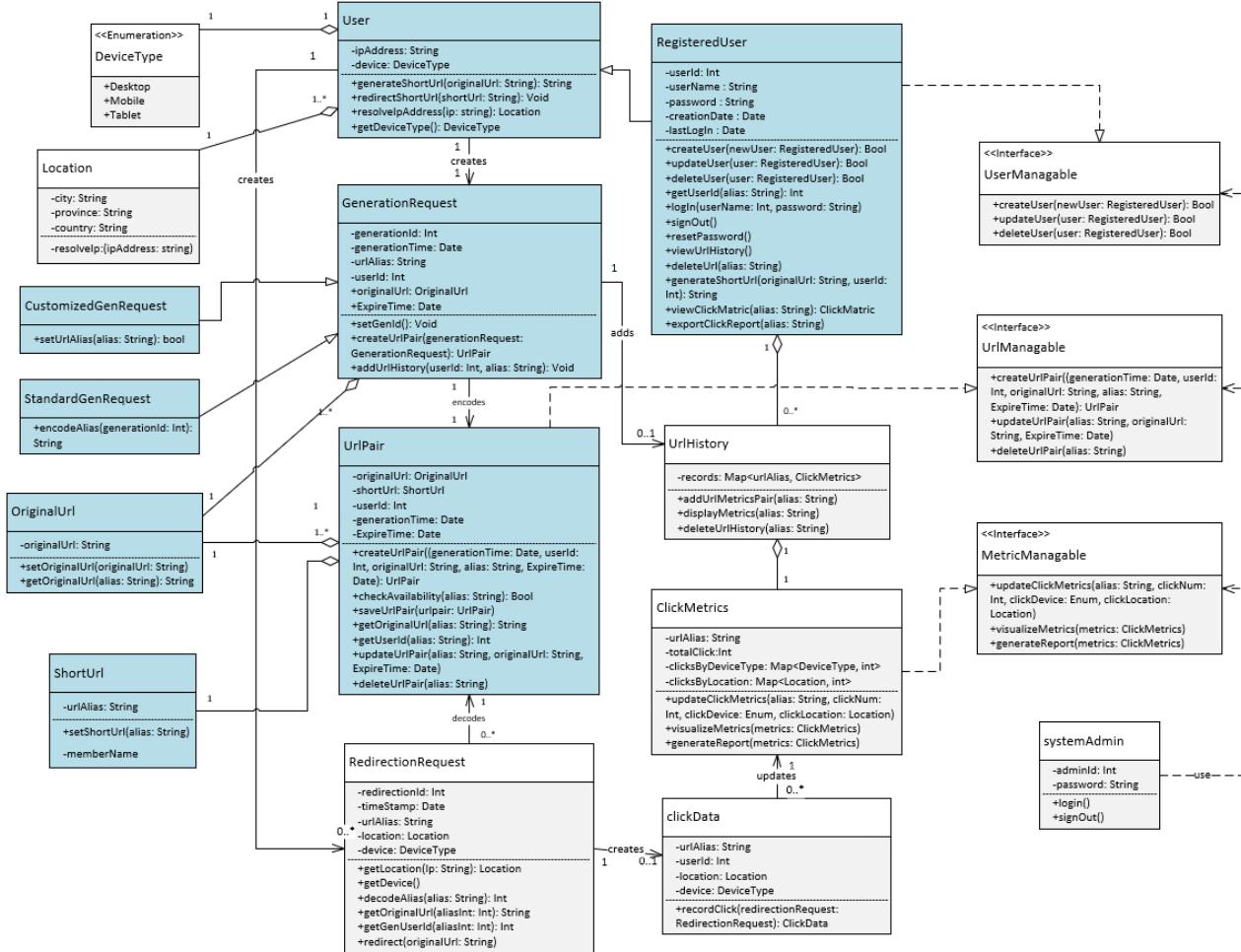
OriginalUrl							
Description: Represents the original URL provided by user.							
Attributes:							
<table border="1"> <thead> <tr> <th>Name</th><th>Description</th></tr> </thead> <tbody> <tr> <td>originalUrl</td><td>long URL string</td></tr> </tbody> </table>		Name	Description	originalUrl	long URL string		
Name	Description						
originalUrl	long URL string						
Responsibilities:							
<table border="1"> <thead> <tr> <th>Name</th><th>Collaborator</th></tr> </thead> <tbody> <tr> <td>setOriginalUrl</td><td>GenerationRequest, User</td></tr> <tr> <td>getOriginalUrl</td><td>GenerationRequest, UrlPair</td></tr> </tbody> </table>		Name	Collaborator	setOriginalUrl	GenerationRequest, User	getOriginalUrl	GenerationRequest, UrlPair
Name	Collaborator						
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ShortUrl							
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Attributes:							
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Name	Collaborator						
setShortUrl	GenerationRequest, User						

UrlPair	
Description: Represents the original URL and short URL map.	
Attributes:	
Name	Description
originalUrl	
shortUrl	
userId	
generationTime	
expiredTime	
Responsibilities:	
Name	Collaborator
createUrlPair	GenerationRequest, <<Interface>>UriManagable
checkAvailability	CustomizedGenRequest
saveUrlPair	
getOriginalUrl	RedirectionRequest
getUserId	RedirectionRequest
updateUrlPair	<<Interface>>UriManagable
deleteUrlPair	<<Interface>>UriManagable

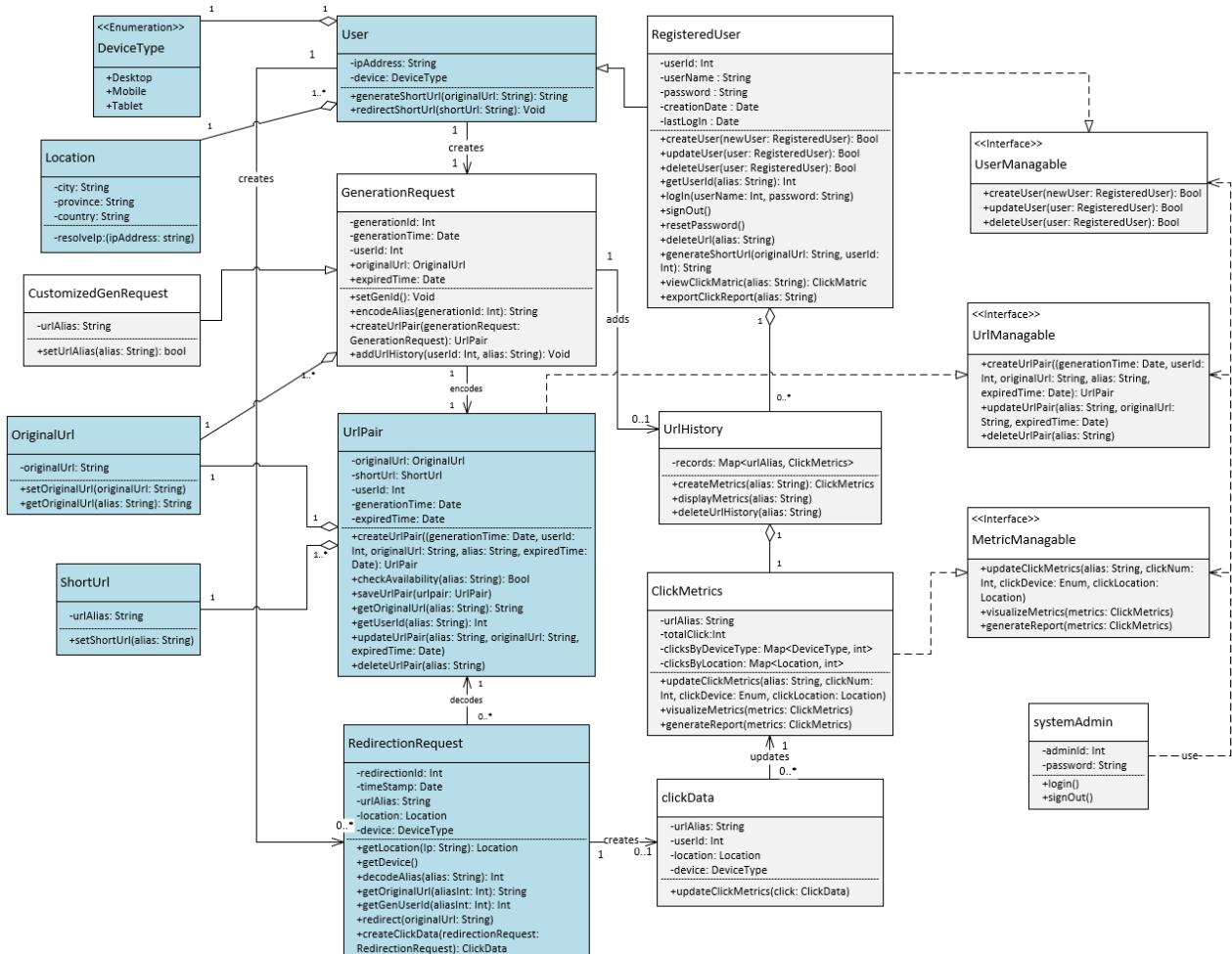
RedirectionRequest	
Description: Represents a redirection request for the original URL	
Attributes:	
Name	Description
redirectionId	
timeStamp	
urlAlias	
location	
device	
Responsibilities:	
Name	Collaborator
getLocation	Location
getDevice	<<Enumerate>>DeviceType
decodeAlias	UrlPair
getOriginalUrl	UrlPair
getGenUserId	User, RegisteredUser
redirect	
createClickData	ClickData

3.3 Design Class Diagrams

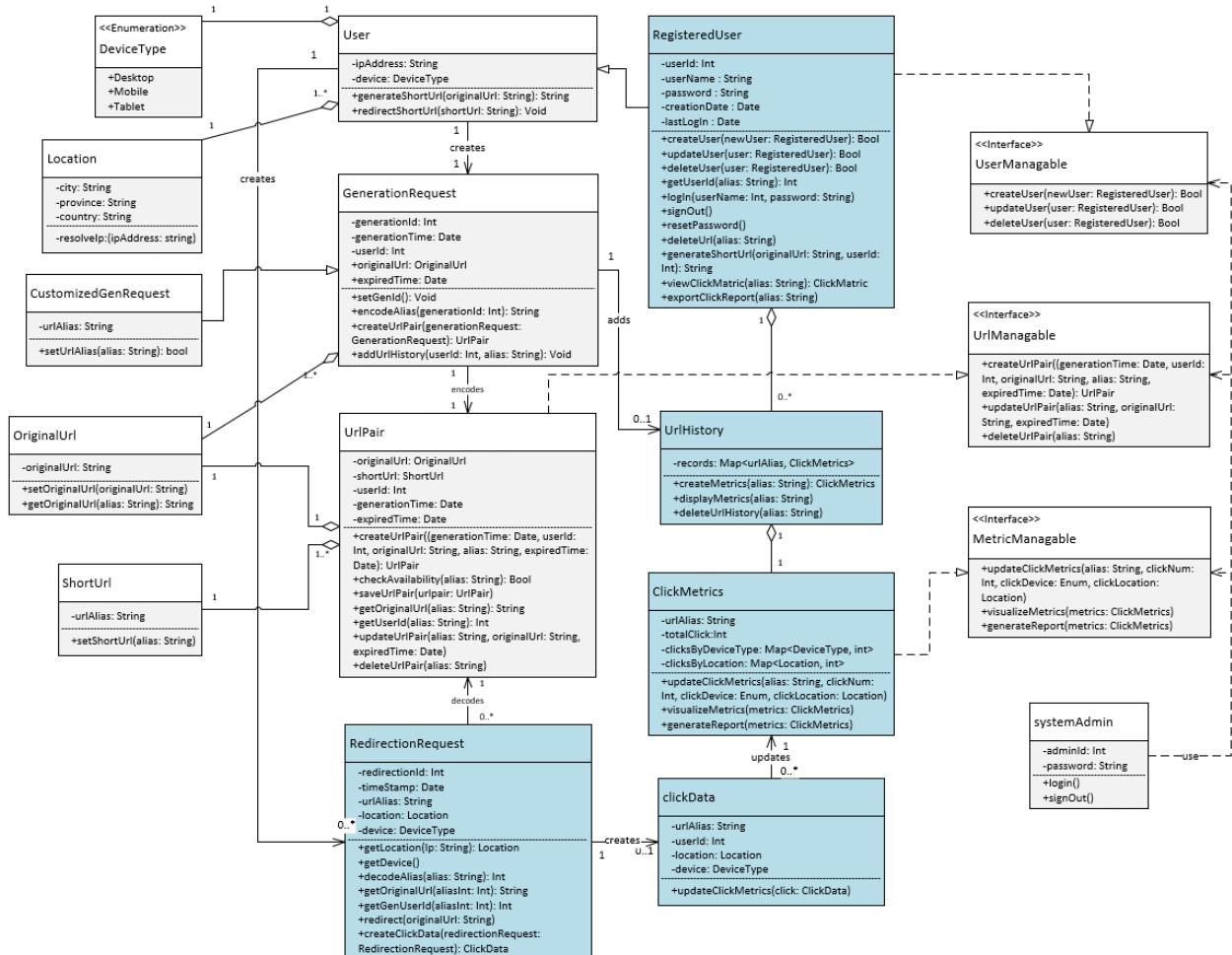
3.3.1 URL Shortening Subsystem



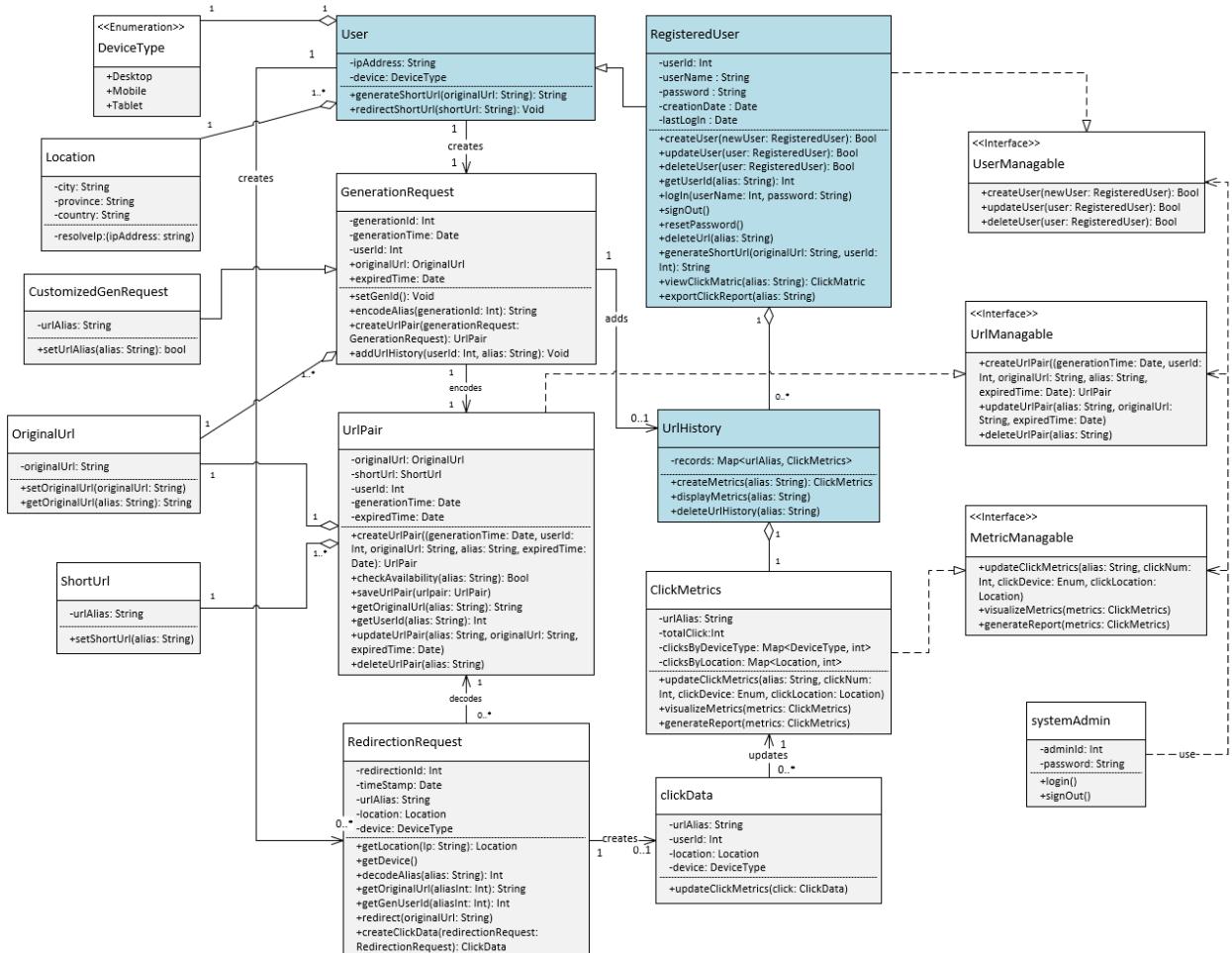
3.3.2 Redirection Subsystem



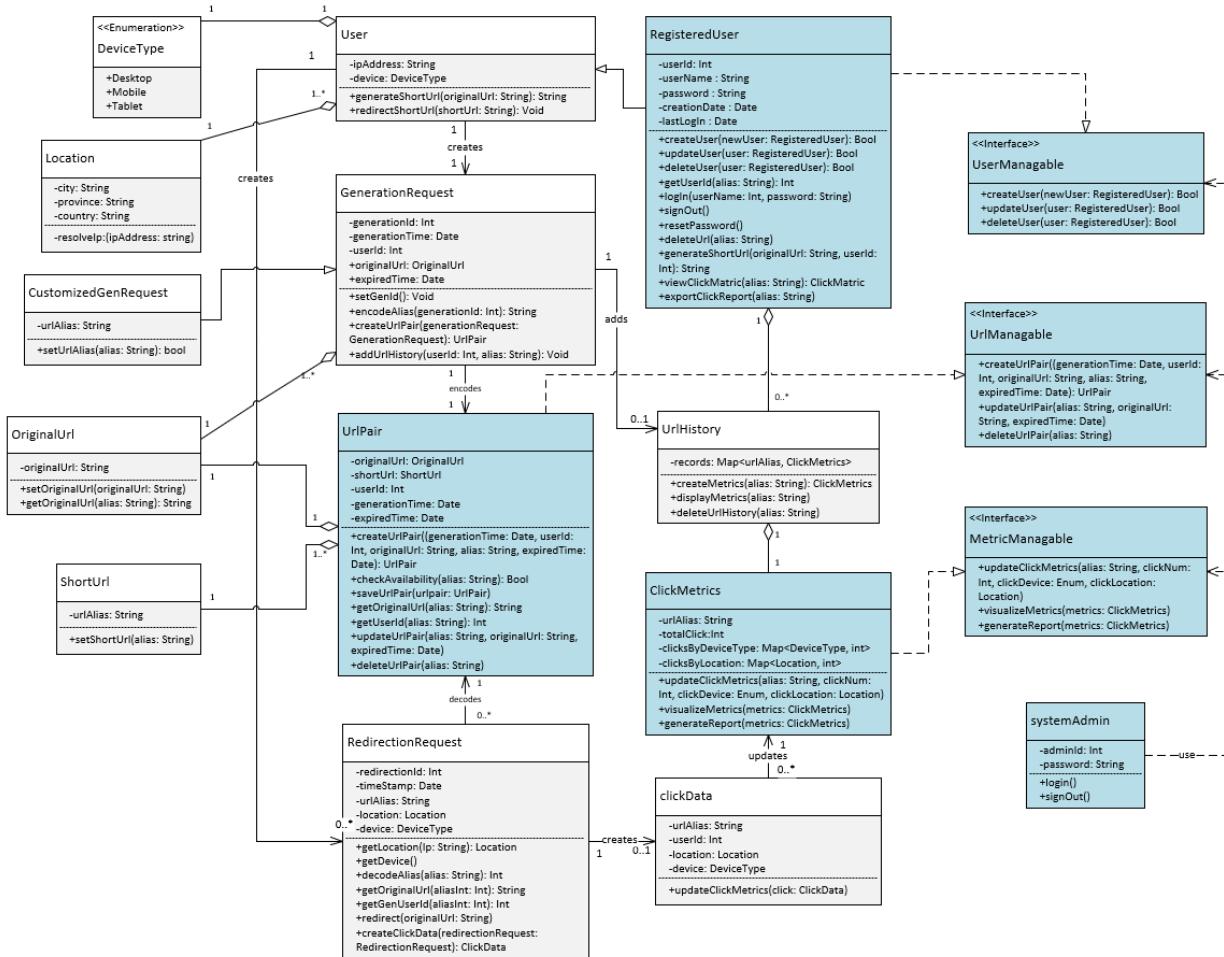
3.3.3 Analytics Subsystem



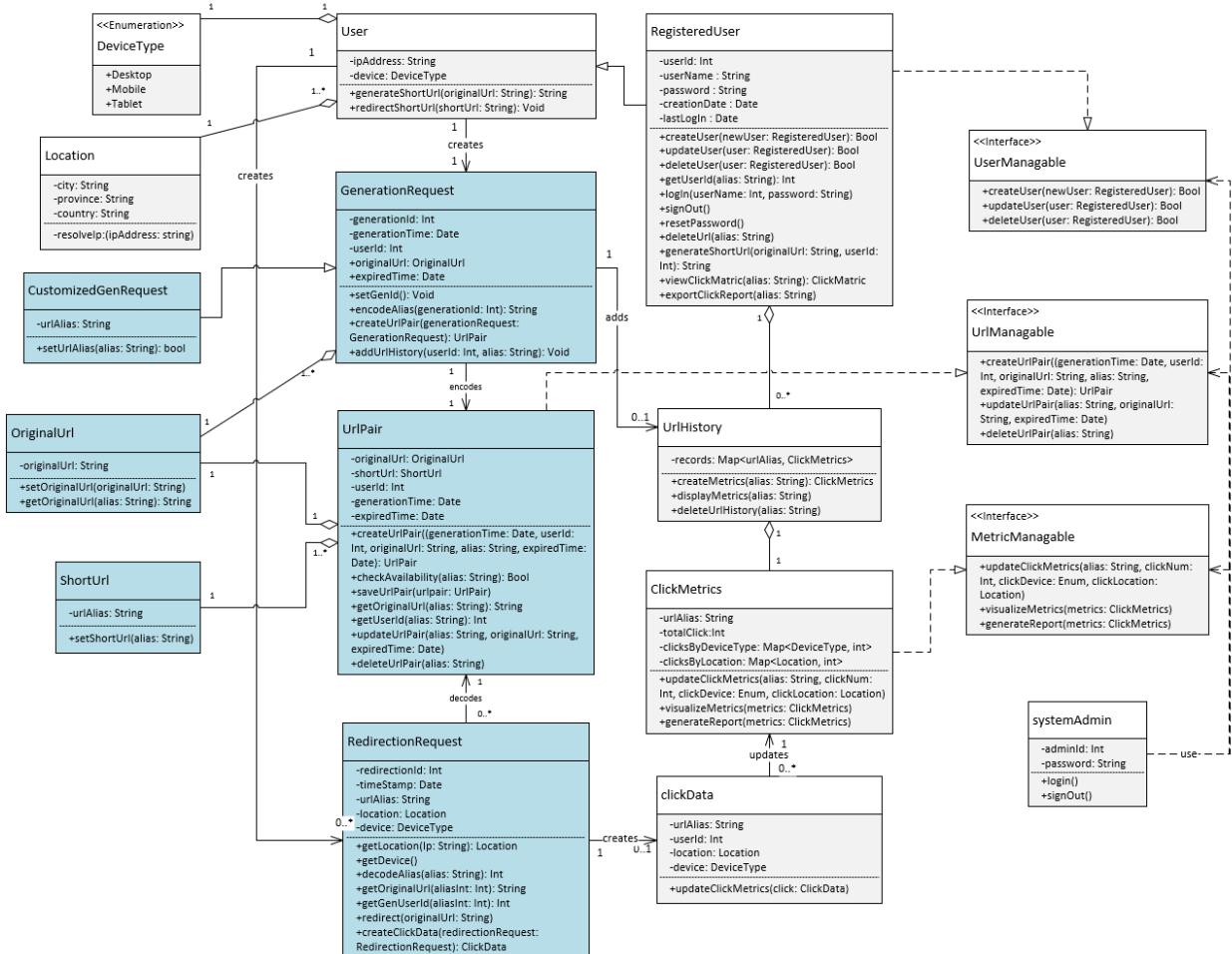
3.3.4 User Management Subsystem



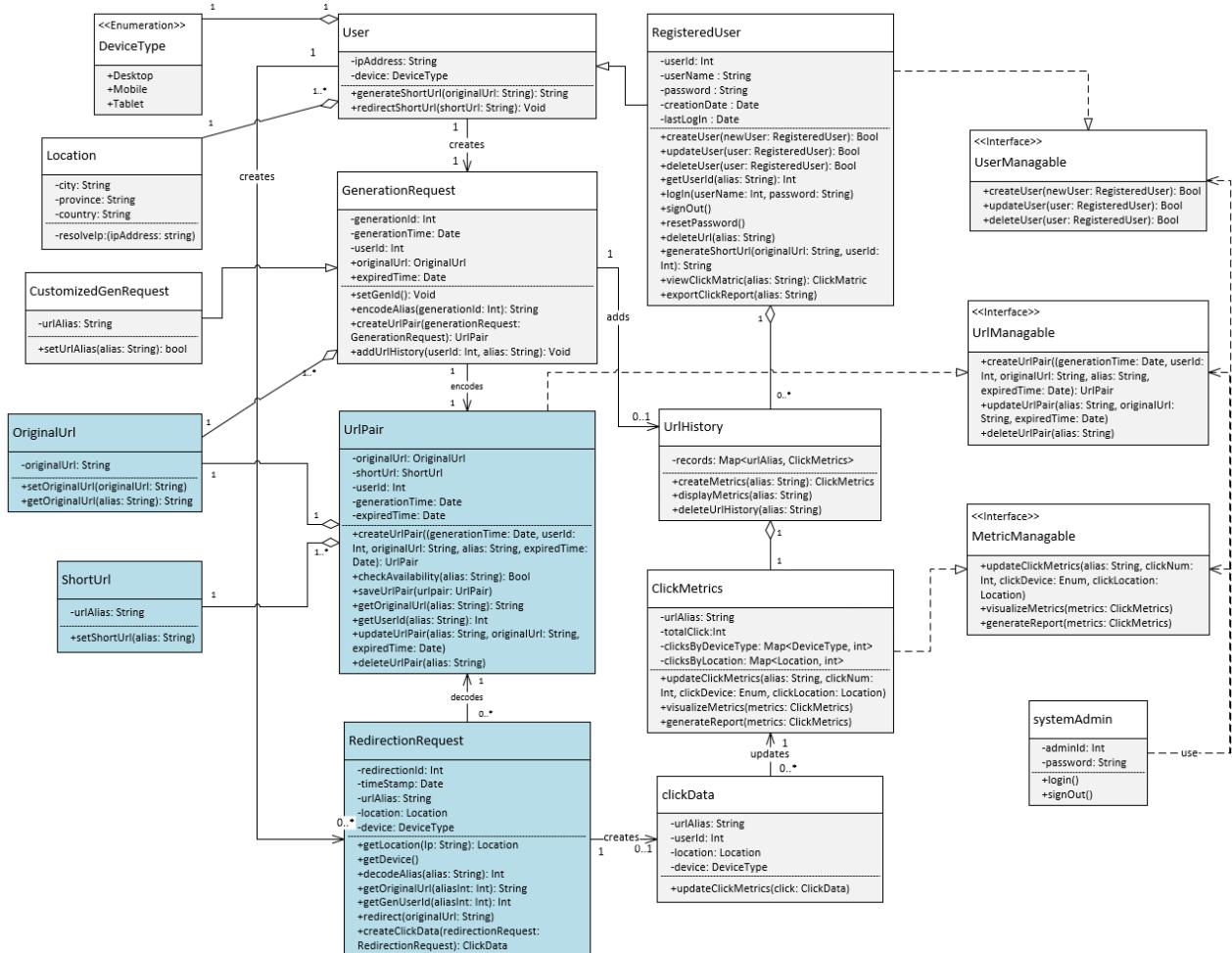
3.3.5 System Administration Subsystem



3.3.6 Database Management Subsystem



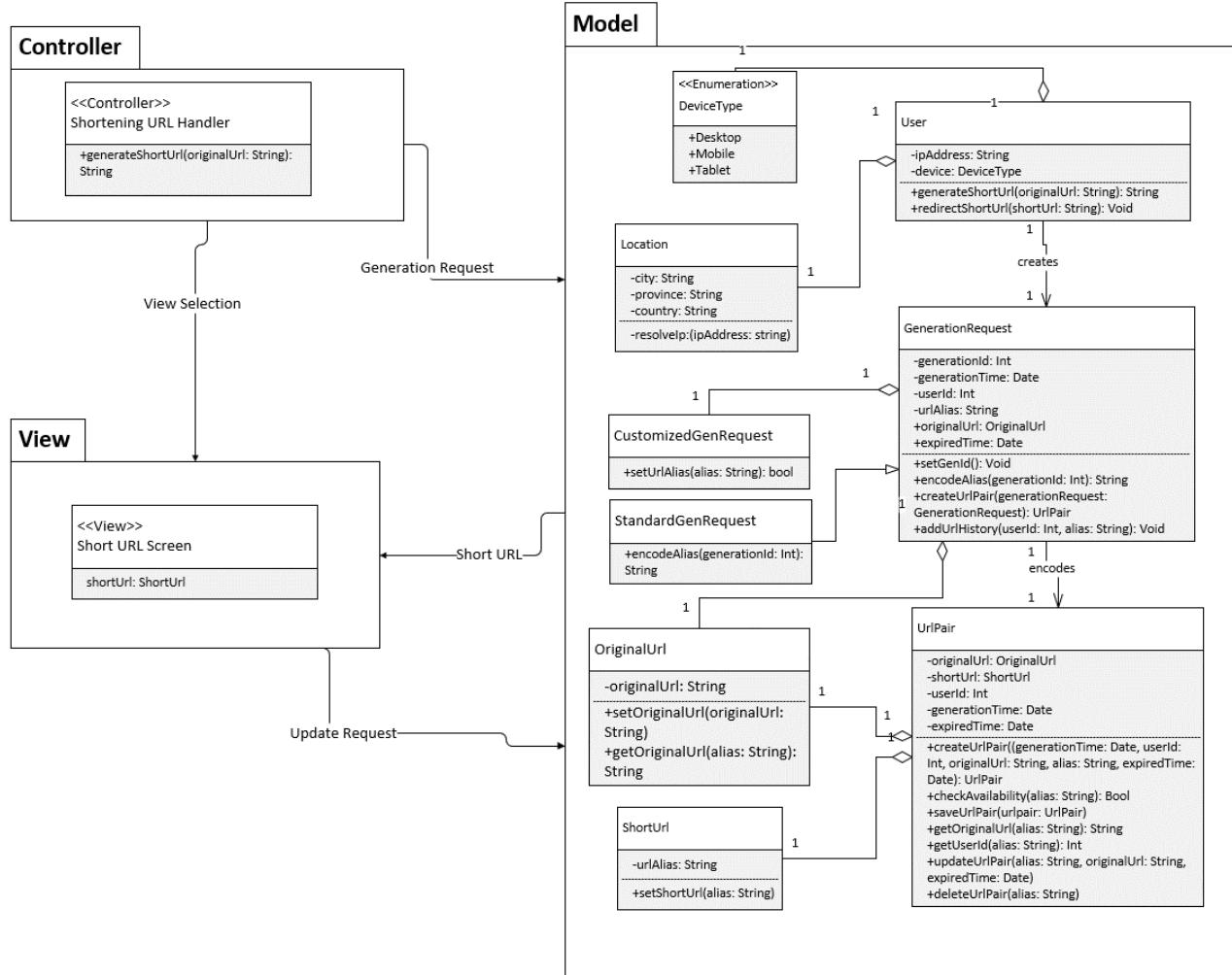
3.3.7 Caching Mechanism Subsystem



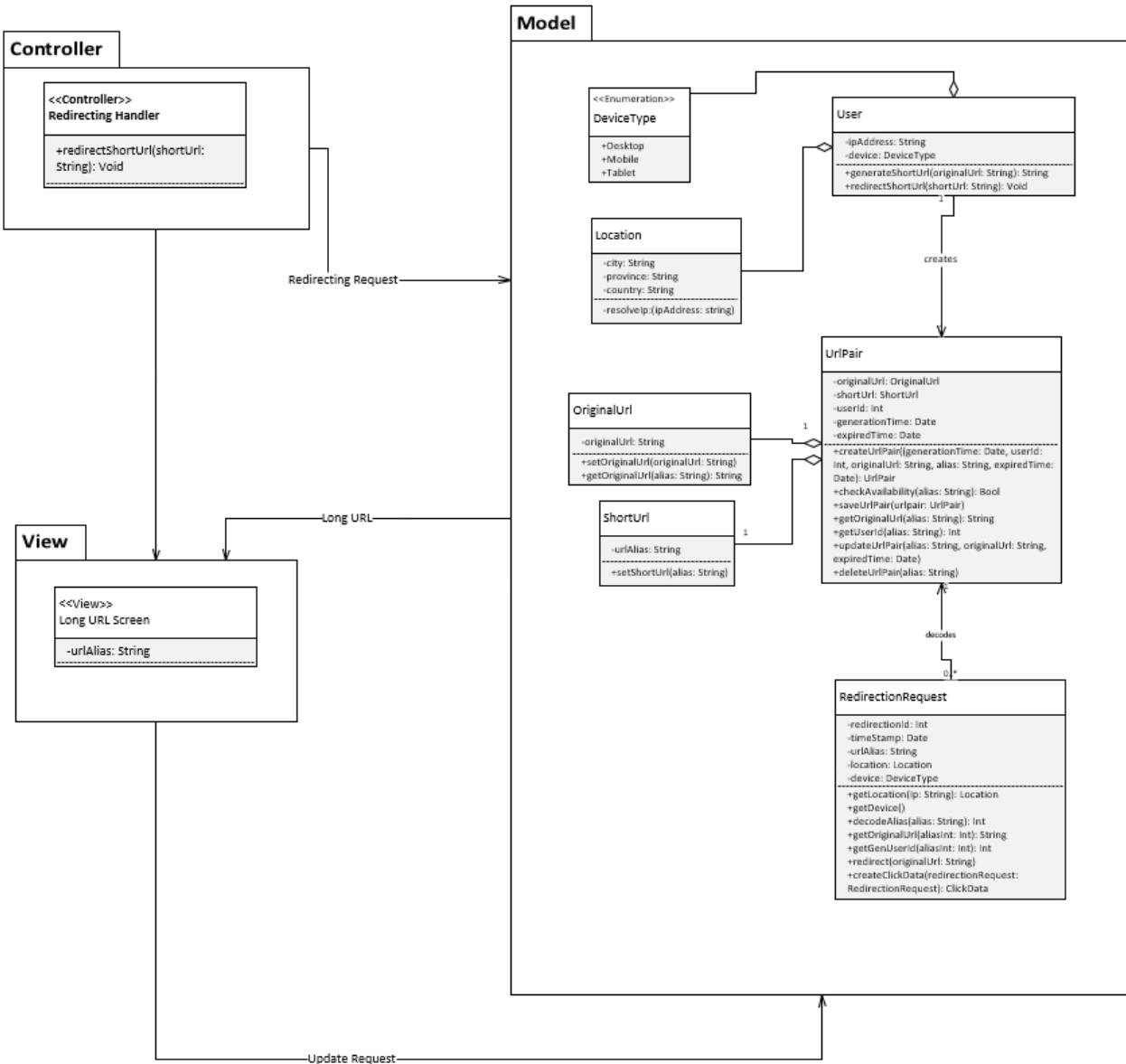
4. Framework M(odel) V(iew) C(ontroller)

4.1 MVC Pattern Diagram (Subsystem level)

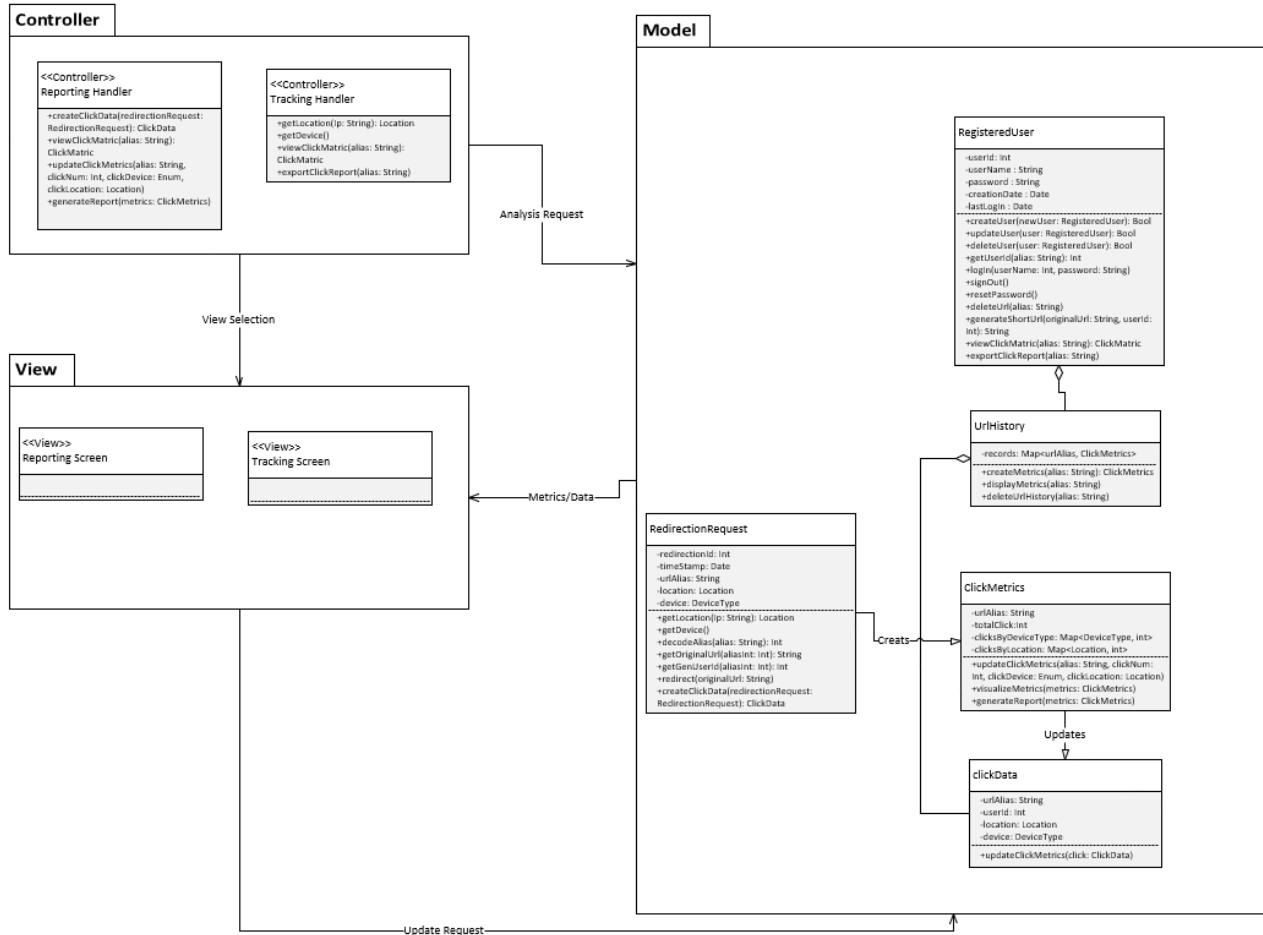
4.1.1 URL Shortening Subsystem



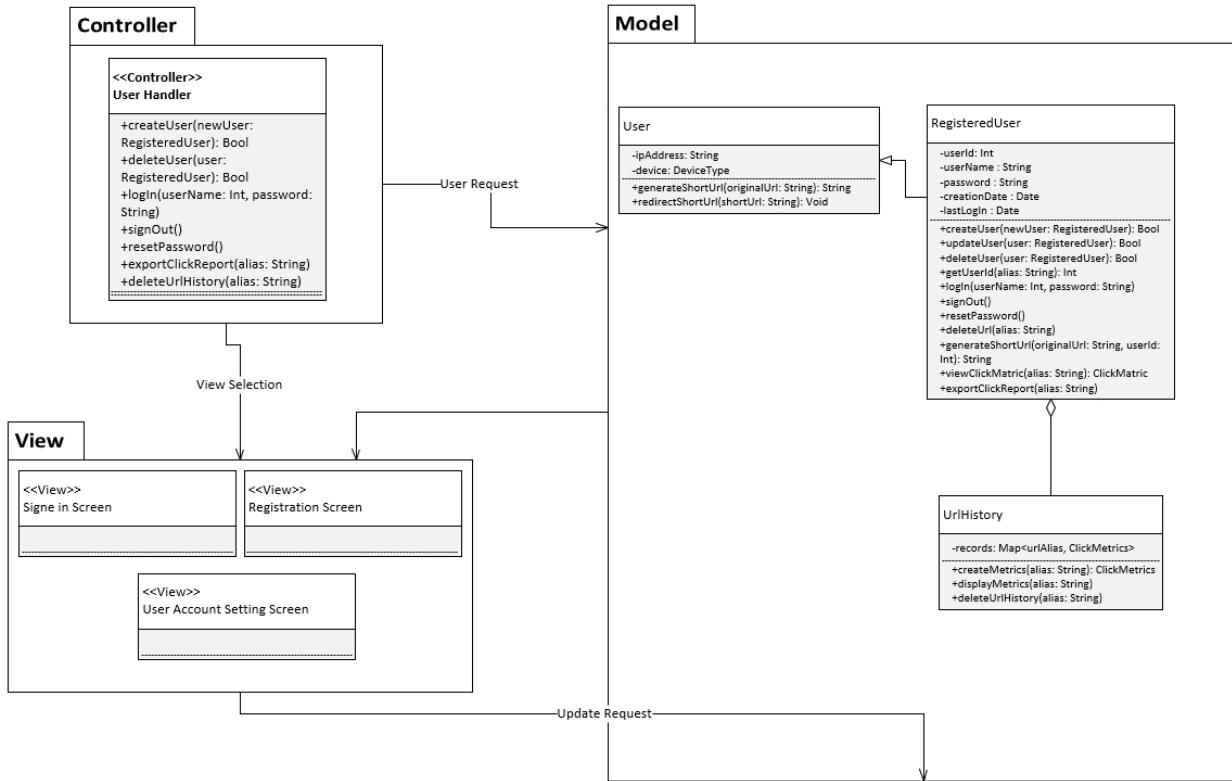
4.1.2 Redirection Subsystem



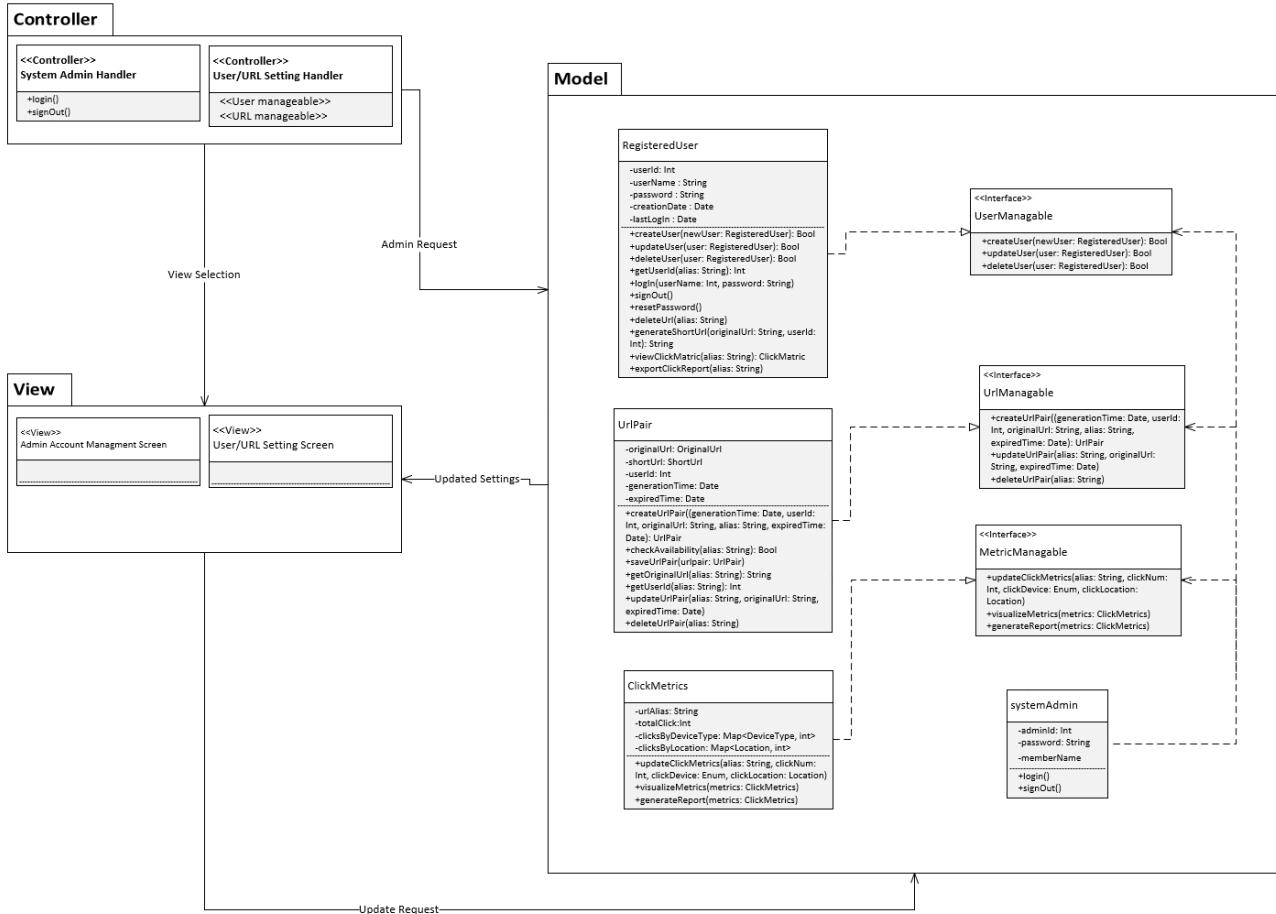
4.1.3 Analytics Subsystem



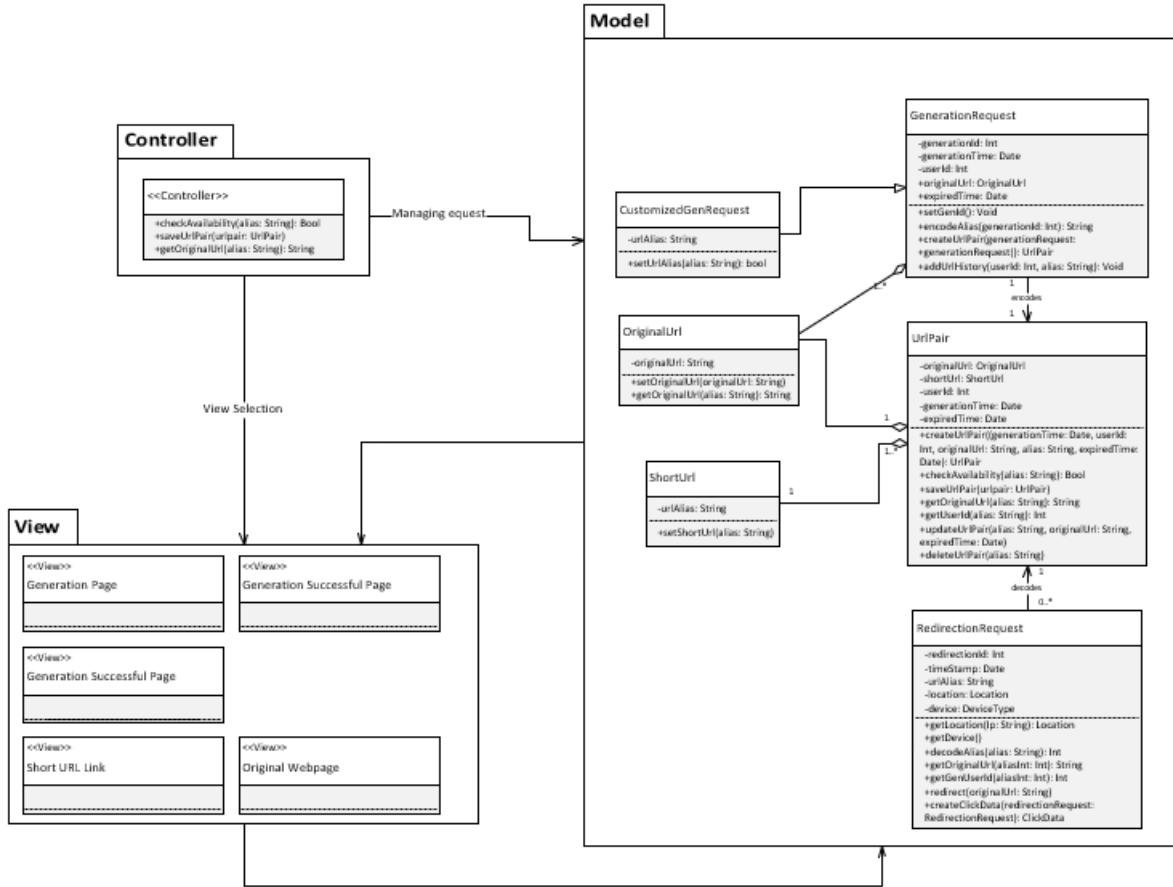
4.1.4 User Management Subsystem



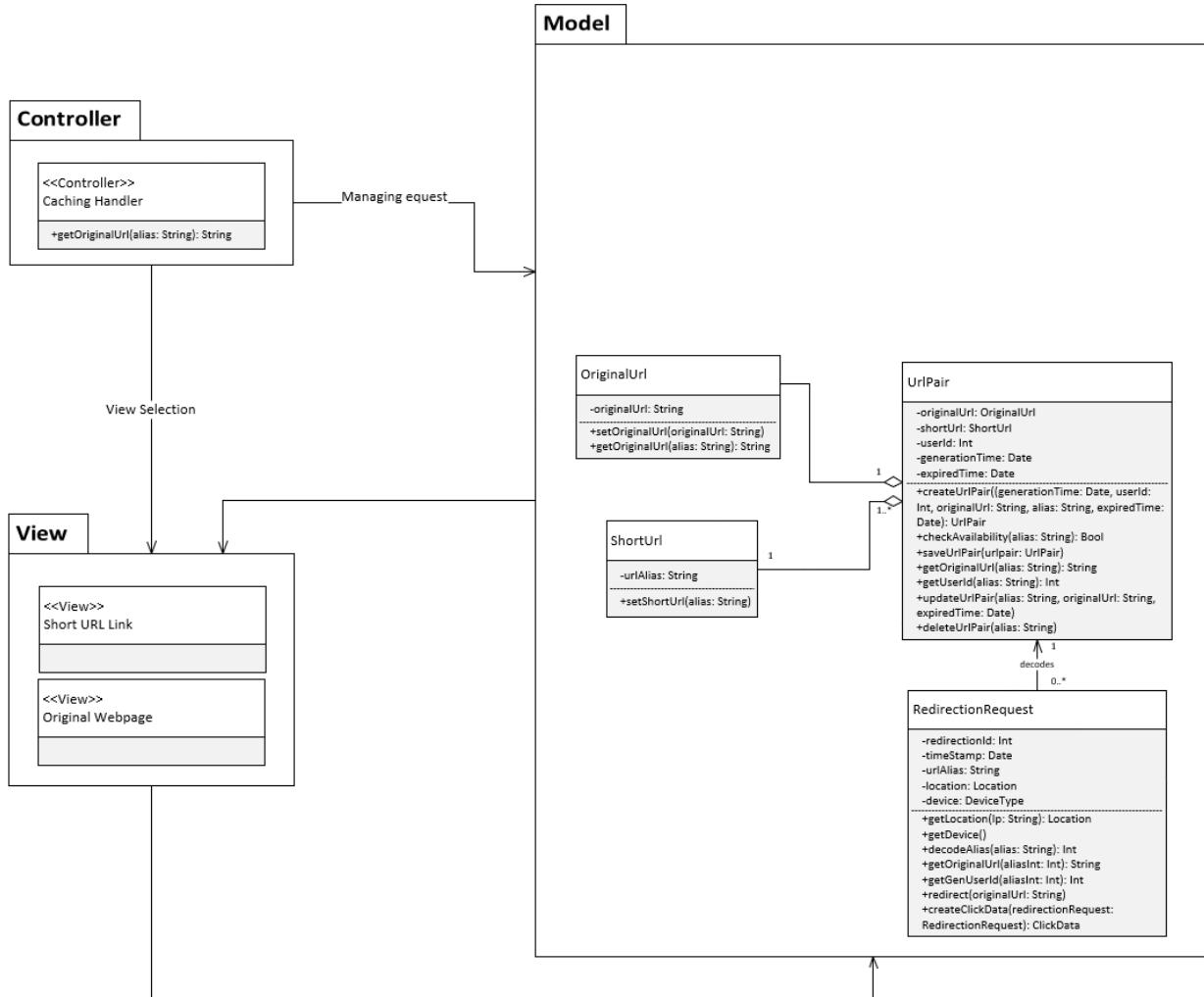
4.1.5 System Administration Subsystem



4.1.6 Database Management Subsystem

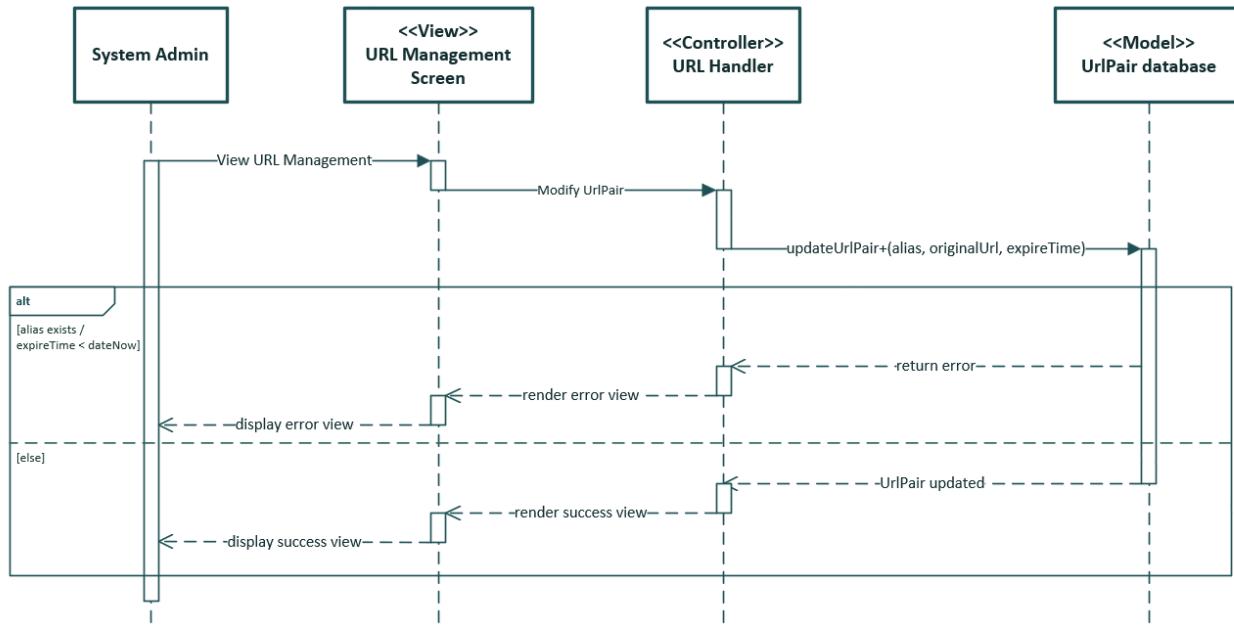


4.1.7 Caching Mechanism Subsystem

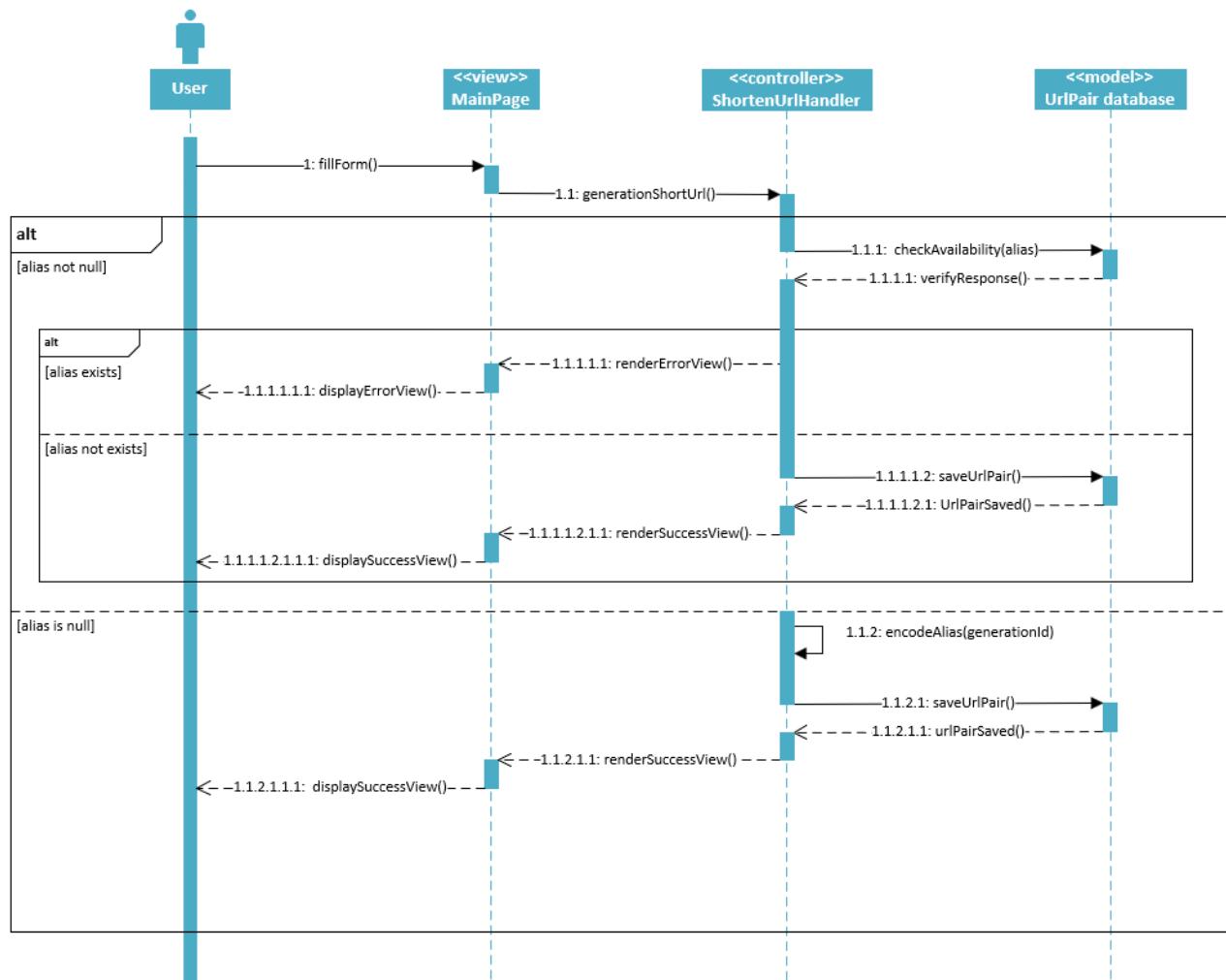


4.2 Two Full Sequence Diagrams (Updated with MVC)

4.2.1 Use Case #1: manage URLs

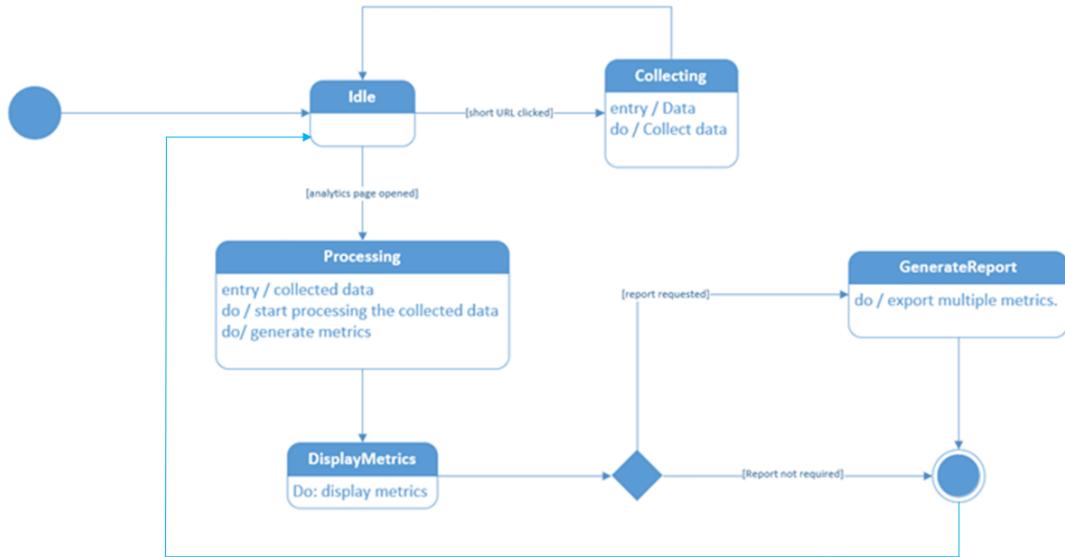


4.2.2 Use Case #2: Generate Short URL

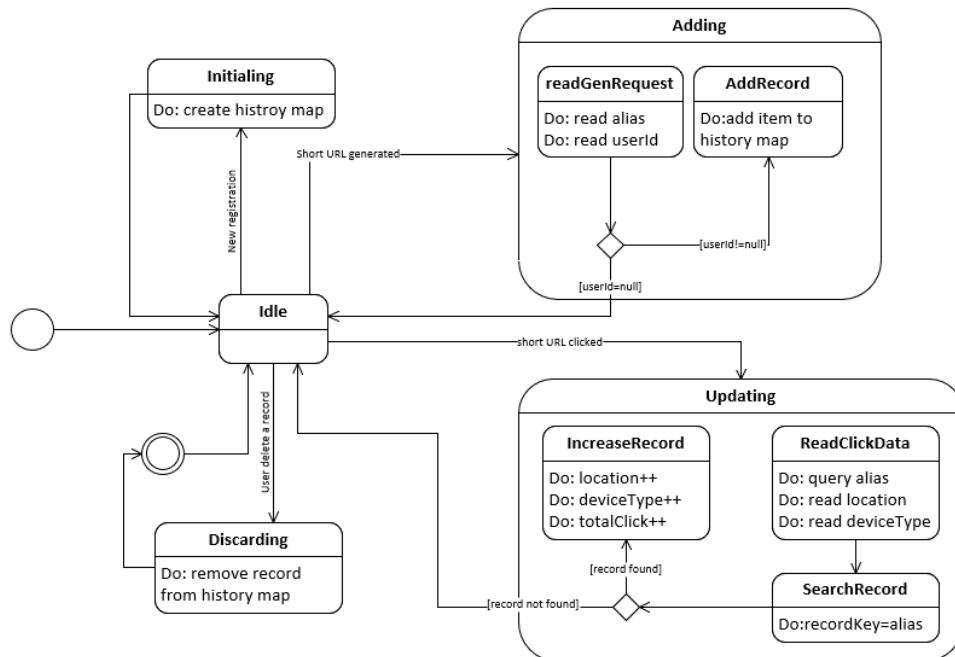


4.3 State Machine Diagrams

4.3.1 Object #1: Analytics

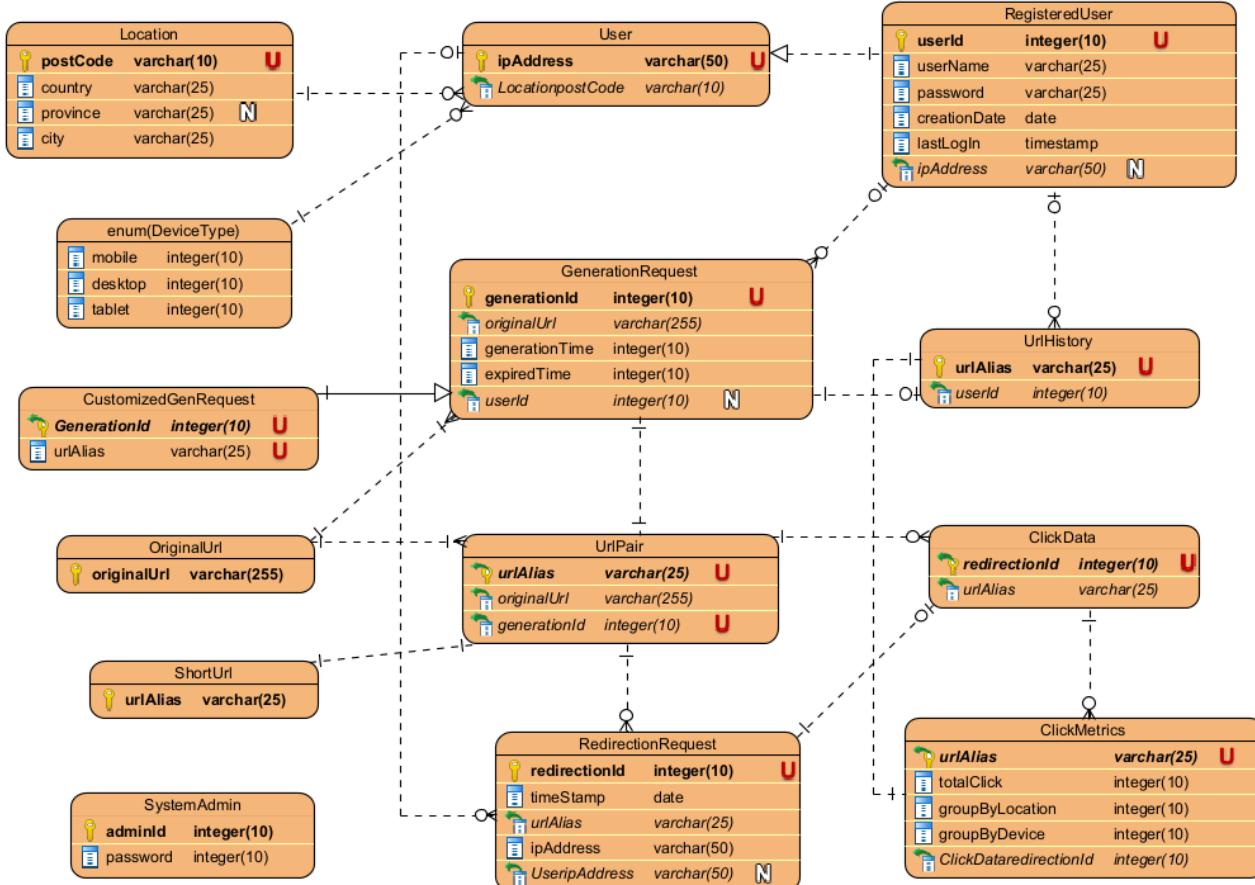


4.3.2 Object #2: UrlHistory



5. Data Layer

5.1 Database Schema



6. Gantt Chart

PART C

Requirement Edits of Part B

- 3.1.1, 3.2.1, 4.1.1:

Rearranged the hierarchy of GenerationRequest.

1. Software Design Patterns

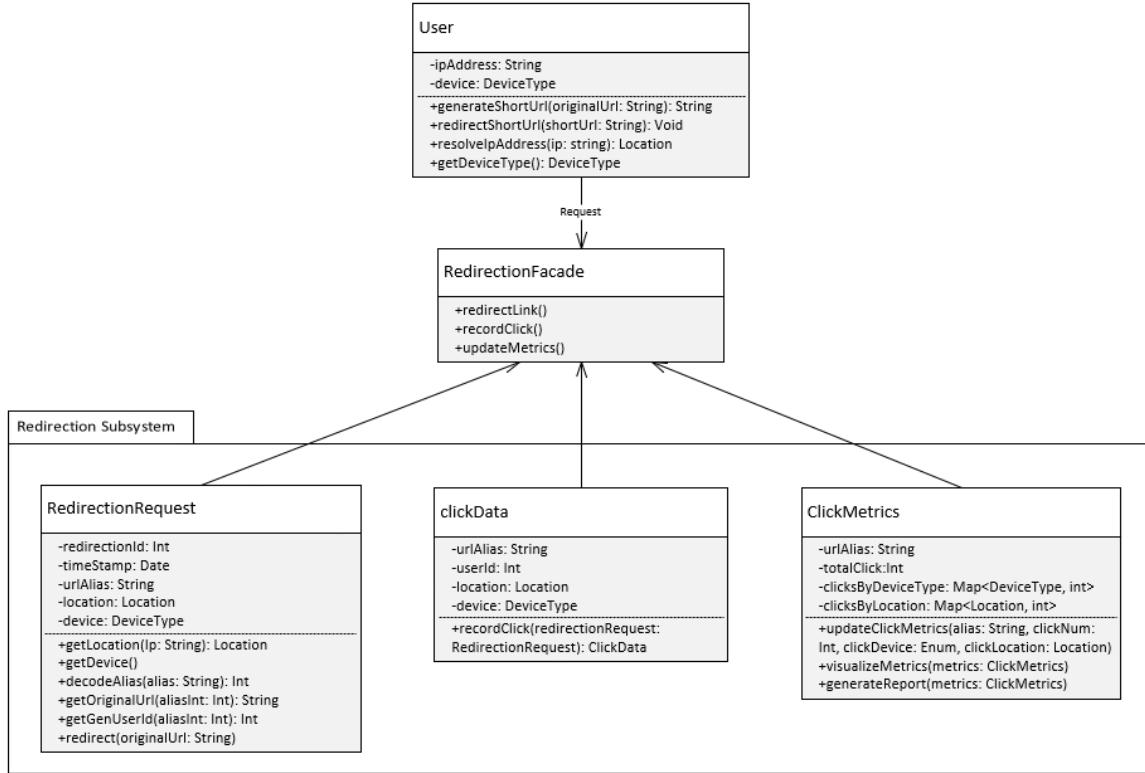
Name:	Façade Pattern in Redirection Subsystem
Problem:	On the user side, redirection subsystem is just simply clicking the link, but the backend should handle relatively complicated functions.
Solution:	Use Façade pattern to handle all the computation.
Example:	<pre> classDiagram class User class RedirectionFacade { +doRedirect() } class RedirectionSubsystem { class RedirectionRequest { +redirectLink() } class ClickData { +recordClick() } class ClickMetrics { +updateMetrics() } } User --> RedirectionFacade : RedirectionFacade --> RedirectionRequest : RedirectionFacade --> ClickData : RedirectionFacade --> ClickMetrics : </pre>
Benefits & Consequences:	It ensures simplicity on the user side and complexity on the server side.

Name:	State Pattern in UrlPair Expiration
Problem:	To release the storage of database to maintain high performance, each UrlPair should have an expiration date. The URL managing function can also modify the state of the UrlPair.
Solution:	Create an abstract State class and two subclasses, which will focus on handling the state change.
Example:	<pre> classDiagram class UrlPair { -state: State +switchState() +request() } class State { <<abstract>> +handle(up: UrlPair) } class IsValid { +handle(up: UrlPair) } class IsExpired { +handle(up: UrlPair) } UrlPair "1" -- "1" State : UrlPair "1" -- "1" IsValid : UrlPair "1" -- "1" IsExpired : State --> IsValid : State --> IsExpired : </pre> <p>The diagram illustrates the State design pattern. It features an abstract class <code>State</code> with a protected operation <code>+handle(up: UrlPair)</code>. Two concrete subclasses, <code>IsValid</code> and <code>IsExpired</code>, inherit from <code>State</code> and implement their own <code>+handle(up: UrlPair)</code> methods. A <code>UrlPair</code> class maintains a reference to a <code>State</code> object and provides operations <code>+switchState()</code> and <code>+request()</code>. A note indicates that <code>request()</code> calls <code>state.handle(this)</code>.</p>
Benefits & Consequences:	By creating a complete process to handle the state change, the function is more stable and reusable than distribute operations to multiple classes.

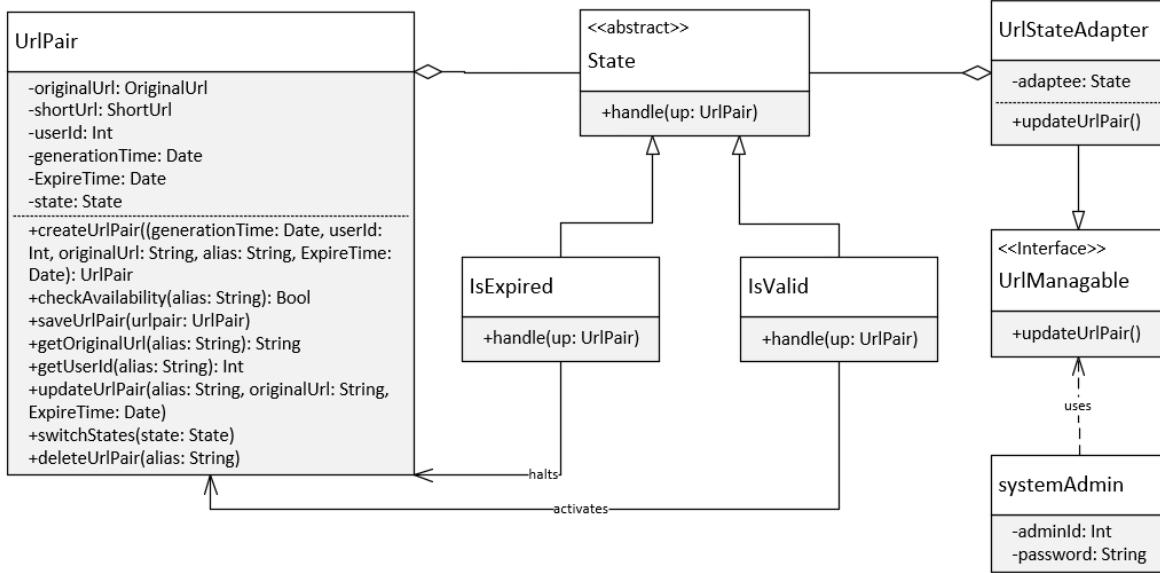
Name:	Factory Pattern in UrlPair Generation
Problem:	The alias can be customized or standard. Although the parameters are just slightly different, the algorithms are totally distinct and in need of encapsulation.
Solution:	Create an abstract factory class with two inherited concrete factories. These two factories will generate customized and standard UrlPair correspondingly.
Example:	<pre> classDiagram class User { --> GenerationFactory } class GenerationFactory { <<Interface>> -CreateGenRequest() } class CustomizedGenRequest { +createGenRequest() } class StandardGenRequest { +createGenRequest() } class CustomizedGenFactory { --> GenerationFactory creates UrlPair } class StandardGenFactory { --> GenerationFactory creates UrlPair } User --> GenerationFactory GenerationFactory --> CustomizedGenRequest GenerationFactory --> StandardGenRequest CustomizedGenRequest --> CustomizedGenFactory StandardGenRequest --> StandardGenFactory CustomizedGenFactory --> UrlPair StandardGenFactory --> UrlPair </pre> <p>The diagram illustrates the Factory design pattern. It starts with a <code>User</code> class that interacts with an <code>GenerationFactory</code> interface via a dashed arrow. The <code>GenerationFactory</code> interface defines a protected operation <code>-CreateGenRequest()</code>. Two concrete factories, <code>CustomizedGenFactory</code> and <code>StandardGenFactory</code>, inherit from <code>GenerationFactory</code> and implement their own <code>+createGenRequest()</code> methods. Both factories have a solid arrow labeled <code>creates</code> pointing to a <code>UrlPair</code> class.</p>
Benefits & Consequences:	The logics are encapsulated into the two factories.

2. Using Common Software Design Patterns

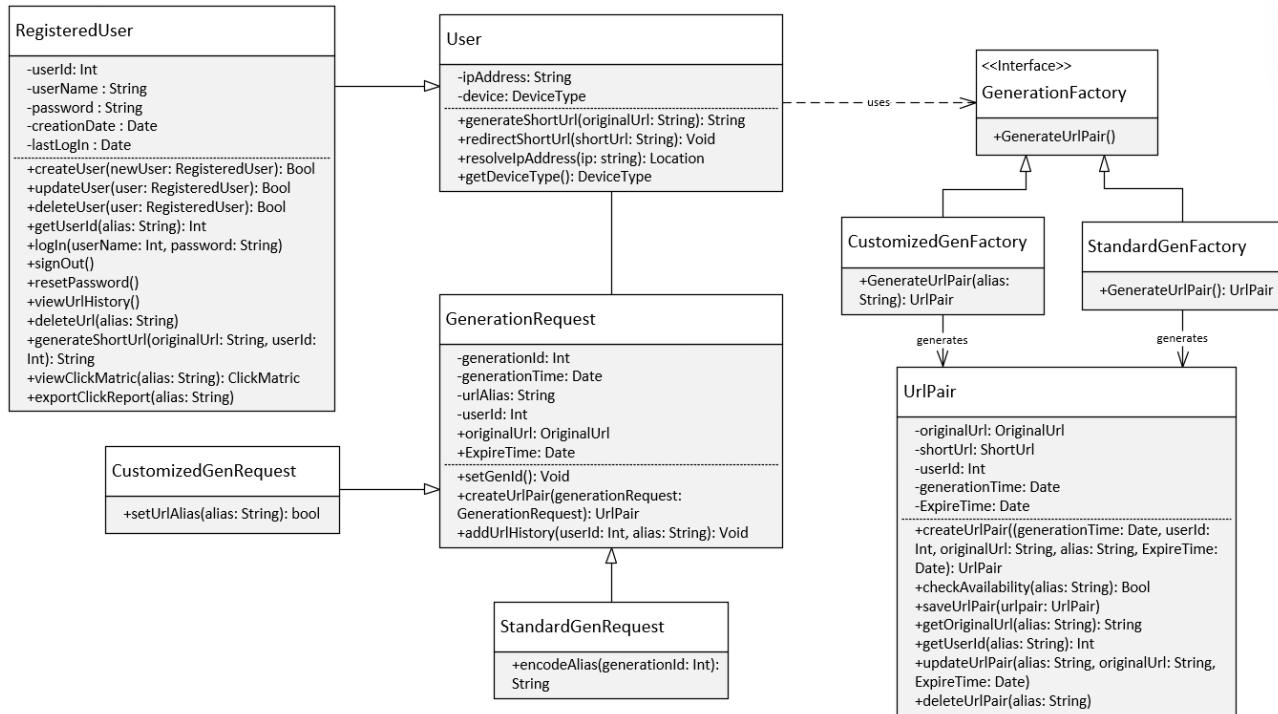
2.1 Façade Pattern – Short URL Redirection



2.2 State Pattern & Adapter Pattern–UrlPair Expiration

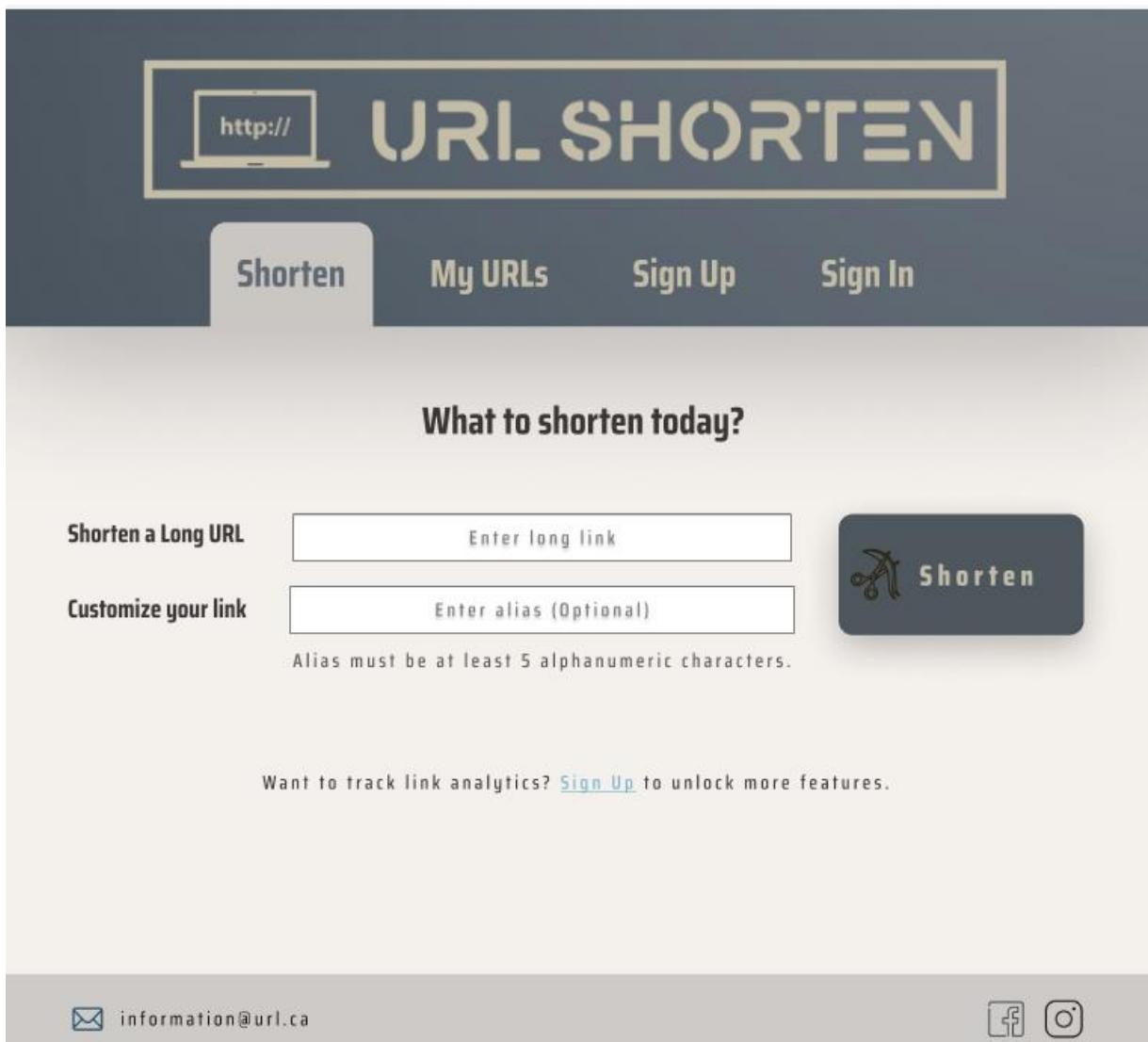


2.3 Factory Pattern – Short URL Generation



3. UI/UX Design

3.1 Shorten Page (Home page)



3.2 My URLs Page

The screenshot shows the 'My URLs' section of the URL Shorten application. At the top, there is a navigation bar with a laptop icon and the text 'http://'. To the right of the icon, the word 'URL SHORTEN' is displayed in large, bold, white letters. Below the navigation bar, there are four buttons: 'Shorten' (dark blue), 'My URLs' (light gray, currently selected), 'Sign Up' (white), and 'Sign In' (white). The main content area is titled 'Your Recent Shortened URLs' in bold black text. It displays three shortened URLs in separate boxes:

- uss.ca/5YKj2aB**
https://www.example.com/sdfd.....569
Copy Edit Delete Analyze
- uss.ca/ILoveCamping**
https://www.example.com/sdfd.....569
Copy Edit Delete Analyze
- uss.ca/aHb6yI0**
https://www.example.com/sdfd.....569
Copy Edit Delete Analyze

Below these boxes is a large, light-gray button with a white plus sign in the center.

At the bottom of the page, there is a footer bar containing an envelope icon followed by the email address information@url.ca on the left, and social media icons for Facebook and Instagram on the right.

3.3 Sign Up Page

The screenshot shows the sign-up page for a URL shortening service. At the top, there is a logo featuring a laptop icon with the URL "http:///" next to it, followed by the text "URL SHORTEN" in large, bold, white letters. Below the logo is a navigation bar with four items: "Shorten", "My URLs", "Sign Up" (which is highlighted with a light blue background), and "Sign In". The main content area has a light gray background and features the heading "Welcome to URL Shorten". Below this, there are three input fields labeled "User Name", "Email", and "Password", each with a corresponding placeholder text box. A note below the fields states: "By clicking on "Create Account", I agree to URL Shorten [Terms & Conditions](#) and [Privacy Policy](#)." A large, dark blue button with the text "Create Account" in white is centered below the note. At the bottom of the page, there is a footer bar with a mail icon and the email address "information@url.ca", and social media icons for Facebook and Instagram.

http:/// URL SHORTEN

Shorten My URLs Sign Up Sign In

Welcome to URL Shorten

User Name

Email

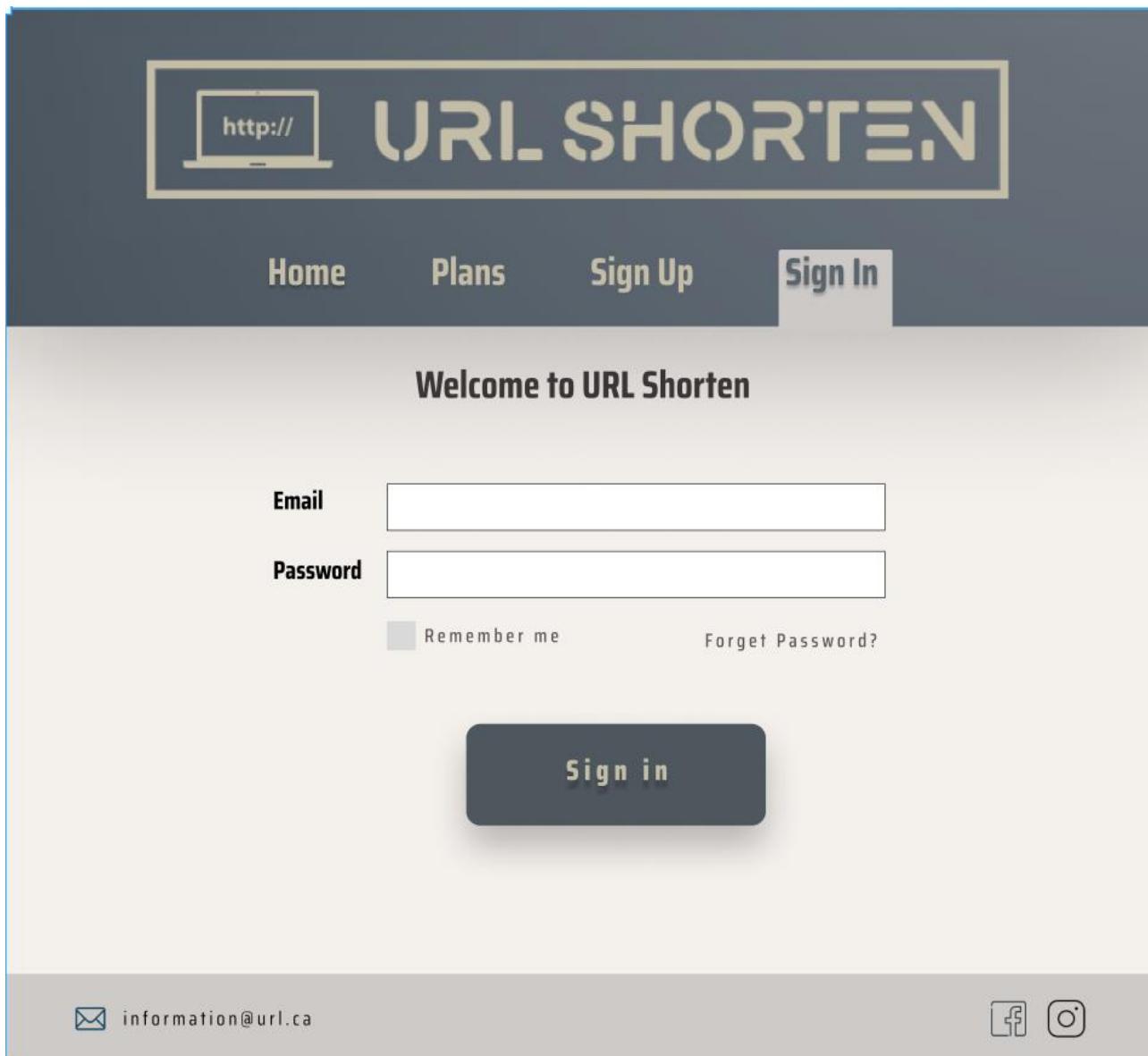
Password

By clicking on "Create Account", I agree to URL Shorten [Terms & Conditions](#) and [Privacy Policy](#).

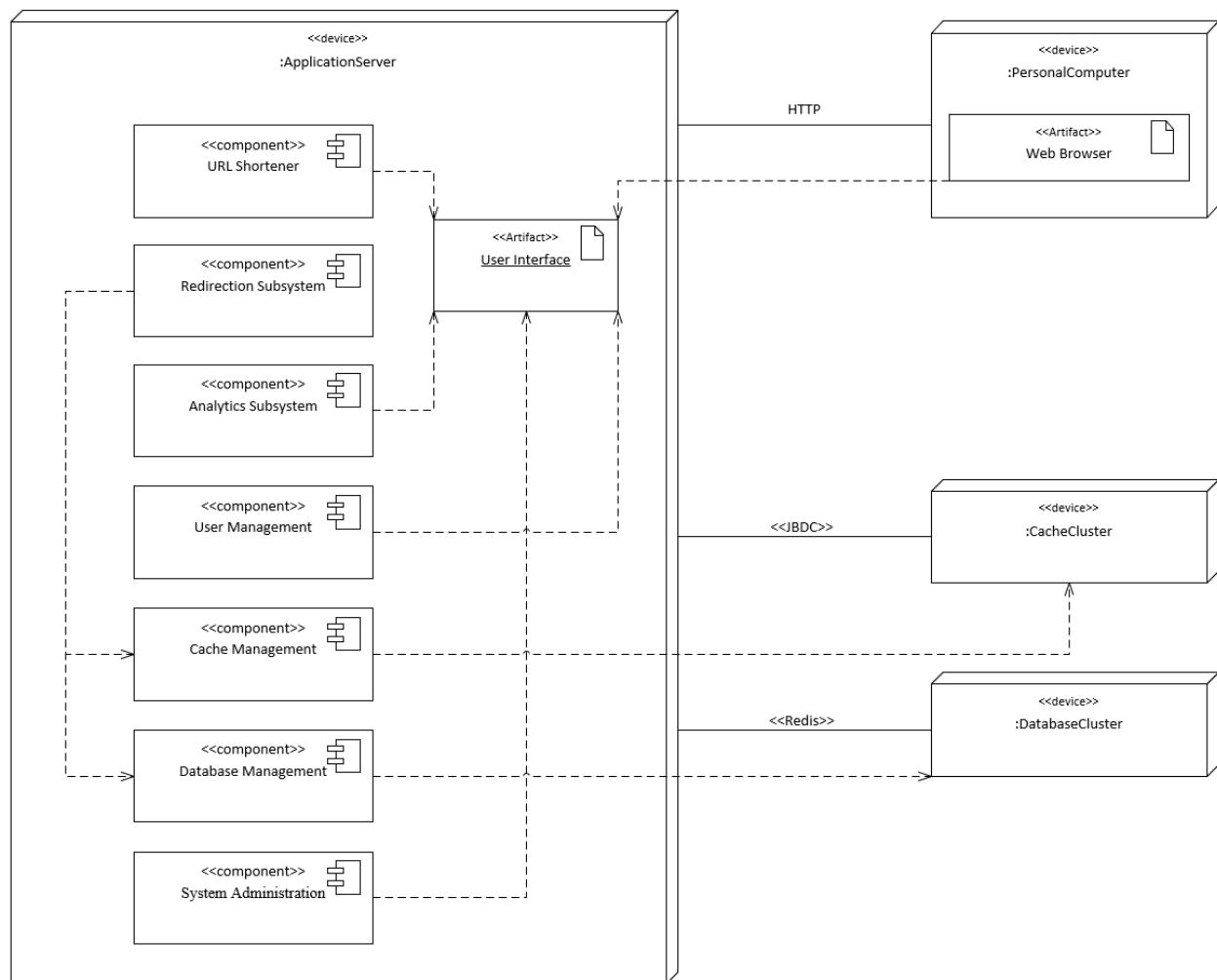
Create Account

✉ information@url.ca

3.4 Sign In Page



4. High Level Component/Deployment Diagram



5. Gantt Chart

