

Software Requirements Specification for Software Engineering: subtitle describing software

Team #2, Campus Connections

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Revision History

Date	Developer(s)	Change
Oct 2	Zihao Du	Add Section 6, 7, 8 Revision 0
Oct 2	Matthew Miller	Add Section 1, 5, 13, 16 Revision 0
Oct 2	Michael Kim	Add Section 15 Revision 0
Oct 2	Waseef Nayeem	Add Section 3, 19 Revision 0
Oct 4	All	Add Functional Requirements
Oct 6	All	Finish Revision 0
Oct 28	Zihao Du	Divide functional requirements to subcategories
Oct 29	Zihao Du	Add new non functional requirements from hazard analysis
Jan 10th	Zihao Du, Matthew Miller	Revision 1: Add new requirements form Hazard Analysis, remove out-of-date requirements

1 Purpose of the Project

1.1 User Business

The project being outlined in this document is an social media application with location-specific features for McMaster University to allow the university's students to connect with each other. The project will allow for interaction between users, in addition to allowing users to find information on different parts of the main campus of McMaster University, including on-campus events and room availability in buildings.

1.2 Goals of the Project

- 1.2.1 **Accurate Data Collection** The product must collect location and directional data to accurately ascertain the position of the user in the building and campus. This will allow the user to interact with the system and other users of the product to enhance social interactions. The error of data must be less than 5%.
- 1.2.2 **Ease of Use** The product must be user friendly and convenient to use, as many university applications are not used or underused due to the complexity and difficult operation. The end user must be able to easily download and learn the application without external guidance. At least 90% of users should feel comfortable about the product when conducting the user survey.
- 1.2.3 **Availability** The product must be able to support its users unless there is a planned maintenance or external failures. This is important as the product is using real-time data and significant delays or down-times will impact the accuracy and usability of the product.
- 1.2.4 **Reliable Data Communication** The product must have good and secure data communication to support the real-time nature of the product. This is important as the product is using real-time data and significant delays will impact the accuracy and usability of the product. The product must be able to provide the desired output within 5 seconds with good university WiFi connection.
- 1.2.5 **Protection of Personal Information** The product must keep all personal data provided by users secure in the database. Personal data

will be collected securely and only used for product functions. The application must support the removal of user data upon request. This is important because users will complete a consent form that acknowledges their privacy.

1.2.6 User Communication The product must be able to support user-to-user communication. It should provide a friend system for users to add new friends, send messages and emojis to friends and share current location and status (in lecture/event or free) with their friends. This is important because the main purpose of the project is to allow users to connect with peers effectively.

1.2.7 Interactable Campus Buildings The product must be able to provide interactions between users and campus buildings. It must show the availability of the lecture halls and information about ongoing events in a building since one of the purposes of the project is to help users utilize campus resources effectively.

1.2.8 Immersive User Experience The product should provide an immersive user experience to the users with some XR technologies. At least 90% of the users should find the product much more attractive and immersive than other university applications when conducting the user survey. An immersive user experience is one of the unique selling points of our product.

2 Stakeholders

2.1 Client

The client for this project is the university administration and the related departments who will be approving our project as well as the users.

2.2 Customer

The primary customers are the students and department staff members who will be directly using the mobile application to connect with others and discover events.

2.3 Other Stakeholders

- Legal experts – Could be consulted for legal advice regarding privacy laws
- Subject Matter Experts – Experts in the field of AR development we might consult for guidance
- Usability testers – UI/UX designers / testers we might get recommendations from the design

2.4 Hands-On Users of the Project

- **User Category: Students**
 - User Role: Regular users of the app, including students from various faculties.
 - Subject Matter Experience: Varied levels of experience with the app's features
 - Technological Experience: Varied levels of experience with mobile technology depending on technical background
 - Other User Characteristics: Diverse age groups, ethnicities, interests, and majors
- **User Category: Administrators**
 - User Role: Department members or Club representatives using the app for announcements, events, and communication.
 - Subject Matter Experience: Familiarity with campus events and announcements.
 - Technological Experience: Varied levels of experience with mobile technology depending on technical background
 - Other User Characteristics: Different departments, clubs, roles, responsibilities, older age demographic

2.5 Personas

N/A

2.6 Priorities Assigned to Users

- Key Users (Maximum priority): Students, club representatives and department members who are the most directly involved with the app and are critical to the continued success of the product.
- Secondary Users: Campus visitors and occasional users such as high school students on a university tour learning about the campus.
- Unimportant Users: Users with no association with McMaster university and no authorization looking to misuse the product

2.7 User Participation

Students, club representatives and contributing department members are expected to actively participate in providing feedback, usability testing, and suggesting new features during the development phase. Specifically:

Students can be expected to focus more on the immersion, navigation and the interaction improvements within the app by spending about 2-4 hours a week on the application and providing feedback.

Club/department representatives can be expected to focus more on feedback regarding event related features by spending about 1-3 hours a week on the application and providing feedback.

This method will ensure maximum efficiency in collecting useful feedback from the relevant user groups.

2.8 Maintenance Users and Service Technicians

The finalized version of the product will be regularly serviced and maintained by trained IT support staff and administrators on campus to ensure performance requirements such as reliability, robustness etc. are consistently met. This role will be assumed by the developers in the release build.

3 Mandated Constraints

3.1 Solution Constraints

There are no mandated constraints regarding how the problem must be solved.

3.2 Implementation Environment of the Current System

There are no mandated constraints regarding the implementation environment.

3.3 Partner or Collaborative Applications

There are no mandated constraints regarding interoperation with other applications.

3.4 Off-the-Shelf Software

There are no mandated constraints regarding external software that must be used.

3.5 Anticipated Workplace Environment

There are no mandated constraints regarding anticipated workplace environment.

3.6 Schedule Constraints

- The proof-of-concept shall be ready to demonstrate by Nov. 13-24, 2023.
- Revision 0 shall be complete and demonstrated by Feb. 5-16, 2024.
- The final product shall be complete and demonstrated by Mar 18-29, 2024.

3.7 Budget Constraints

- The project budget must not exceed \$750 CAD. The sole source of any funding shall be the team itself.

3.8 Enterprise Constraints

There are no mandated enterprise constraints.

4 Naming Conventions and Terminology

4.1 Glossary of All Terms, Including Acronyms, Used by Stakeholders involved in the Project

Term	Definition
Amazon Web Services (AWS)	Amazon Web Services is a cloud computing provider
ASP.NET	A server-side web application framework
Augmented reality (AR)	Technology that adds computer-generated components and images to a user's view of the real-world, allowing for an experience that combines virtual and physical components.
API	Application Programming Interface is a way for two or more components to communicate with each other.
Campus Connections	Campus Connections is the name of the company the capstone project team runs and the name of the application
Charles Proxy	A cross-platform HTTP debugging proxy server application for networking monitoring
Extended reality (XR)	AR technology combines the physical world with a “digital twin world” able to interact with it
Global Positioning System (GPS)	An utility that provides users with positioning, navigation, and timing services
ID	identifier of a user, in this application it refers to user email.
OSCARplus	OSCARplus is an appointment, registration and job posting system for McMaster students and alumni
Personal Identification Information (PII)	Personal data that could potentially identify a specific individual
User experience (UX)	The way a user interacts with the system, and the quality of those interactions.
User interface (UI)	The section of the overall system where interactions between the user and the system take place.
Unified Model Language (UML) diagram	UML diagram is a graphical notation used to construct and visualize object oriented system
Unity	Unity is a cross-platform game engine developed by Unity Technologies

5 Relevant Facts And Assumptions

5.1 Relevant Facts

- Due to McMaster University regulations, we cannot collect information on course schedules [1].

5.2 Business Rules

- Software should follow industry standard security protocols

5.3 Assumptions

- Administrators are experienced users and they will not intend to hack into the application.
- The app is not expected to function outside the campus of McMaster University.
- The backend server host has high availability and stable performance.

6 The Scope of the Work

6.1 The Current Situation

Currently, students do not have effective ways to connect with peers of same interest and resources available on campus. One of the most accessible tools for students to utilize campus resources is OSCARplus. However the website only allow user to see the event calendar and register, – it doesn't support interactions between users or advacned interactions between events and users – users cannot get a list of registered events or ask organizers more details of the event.

As for lecture room information, McMaster allows student to get a calendar of the course they enrolled, but not any other courses they are interested in. New students always get lost because of the poor description of lecture rooms. Students are expecting an advanced lecture management system and a more detailed campus map in their daily life.

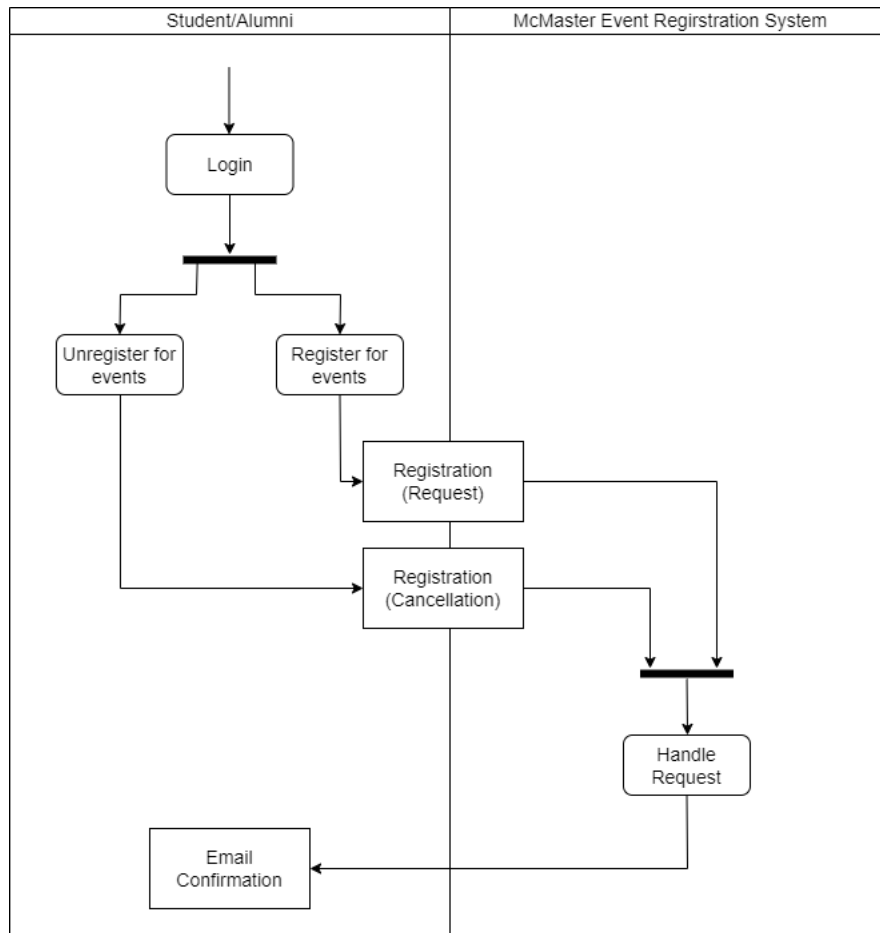


Figure 1: Context Diagram

6.2 The Context of the Work

The context diagram depicted below illustrates the interactions of the system with adjacent external systems and services.

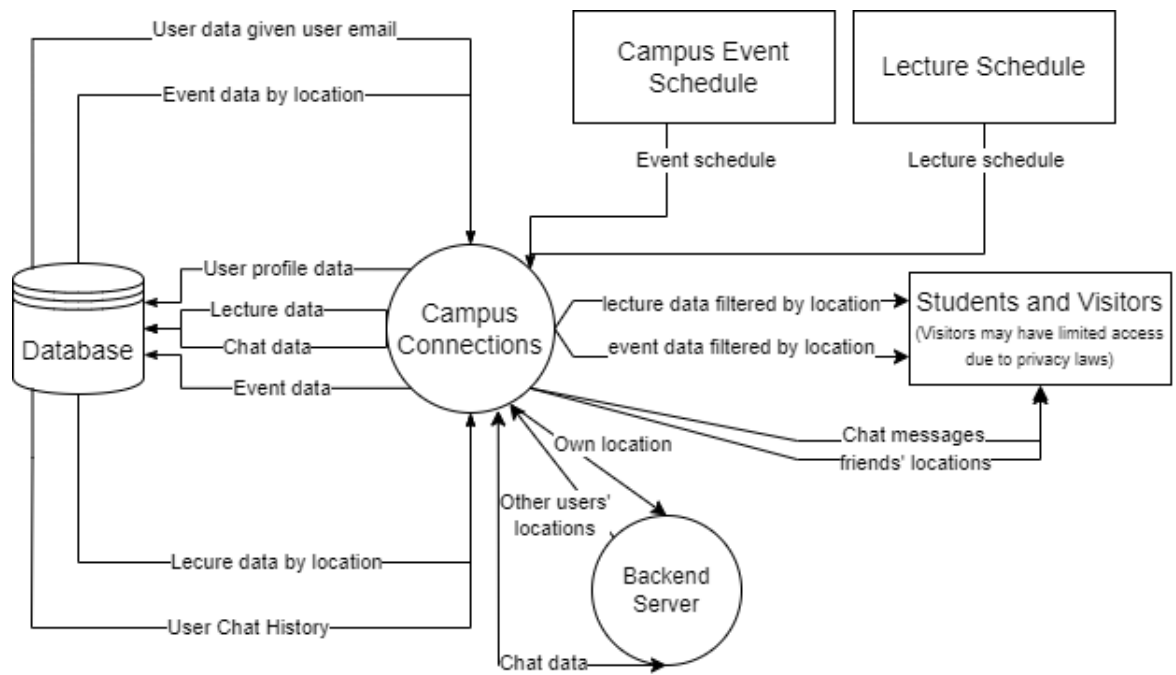


Figure 2: Current Situation

6.3 Work Partitioning

Event Name	Input/Output	Summary
Provide lectures list	IN: Lecture schedules	Give a list of lectures when there is an update and after every semester
Provide events list	IN: Event schedules	Give a list of campus events periodically and when there is an update
Record user data	OUT: User data	Record user related data, including user profile, user friends and interested lectures and events
Record lecture data	OUT: Event data	Record lecture data, including lecture name, time, duration and location
Record event data	OUT: Event data	Record event data, including event name, time, duration and location
Display events	IN: event data, OUT: event data filtered by location	Display events that are going to be held in in a given building
Display lectures	IN: lecture data, OUT: lecture data filtered by location	Display lectures that are going to be held in in a given building

Table 2: Business Event List

Event Name	Input/Output	Summary
Display user profile	OUT: User profile	Display user profile including user program and level, interested lectures and events
Display map view	OUT: Users' locations	Display the locations of the user and all friends on campus map
Display map view	OUT: Users' locations	Display the locations of the user and all friends on campus map
Display AR view	IN: Target building scene, OUT: AR objects	Display the information and activities of the target building in an AR way

Table 3: Business Event List Cont

6.4 Specifying a Business Use Case (BUC)

The following is an activity diagram for the Display event schedule process. The trigger of this business user case will be user interaction, and input will be campus event data from database. What will be displayed is a schedule of events held inside a specific building with detailed event information.

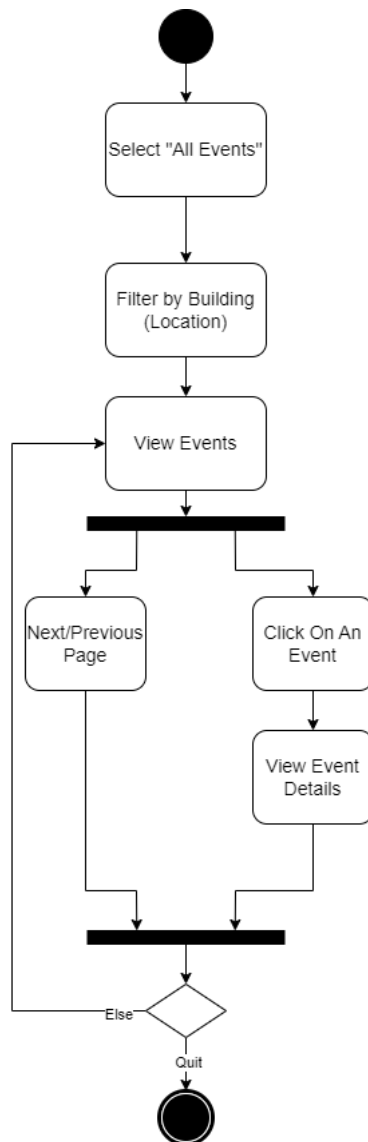


Figure 3: Activity diagram for Display Events List Process

7 Business Data Model and Data Dictionary

7.1 Business Data Model

The following UML class diagram shows all types of business data that will be used in this project.

All the classes represent corresponding business data, all these entries and their attributes will be defined and explained in the data dictionary. class are defined in the data dictionary.

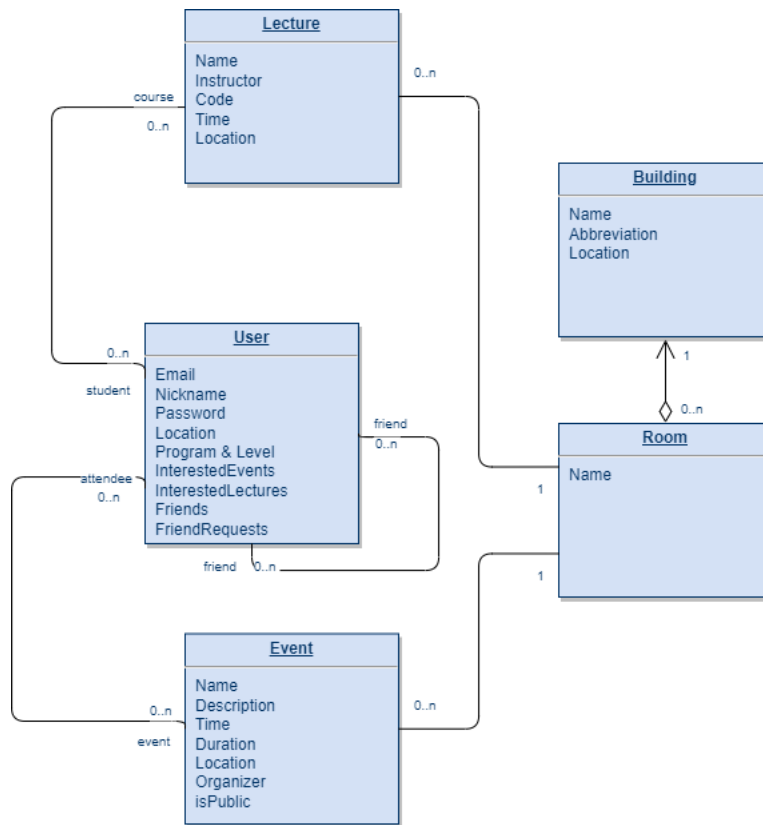


Figure 4: UML class model

7.2 Data Dictionary

This section will include definition of all classes in UML class model and their attributes. Some self-explanatory attributes like name will be ignored.

Name	Content	Type
Lecture	McMaster course data	Class
Lecture.Instructor	Course instructor	Attribute
Lecture.Time	Course schedule	Attribute
Lecture.Location	Course location	Room
Event	McMaster on-campus event data	Class
Event.Description	More information of this event	Attribute
Event.Time	Event time	*HH/MM/SS 24 hour clock*
Event.Location	Event location	Room
Event.Organizer	Held by which department	Attribute
Event.isPublic	Is this event open for non students?	True or False
User	User account data, friends data, location, event & lecture attendance	Class
User.Email	email of the user	Attribute
User.Nickname	name displayed in the application	Attribute
User.Password	password of the account	Attribute
User.Location	Geographic location	Attribute
User.InterestedEvents	List of event	Event, Attribute
User.InterestedLectures	List of lecture	Lecture, Attribute
User.Friends	List of friends	User , Attribute

Name	Content	Type
User.FriendRequests	List of users who want to be your friends	User , Attribute
Building	McMaster main campus building	Class
Building.Abbreviation	Abbreviation of building name	Attribute
Building.Location	Geographic location	Attribute
Room	Room inside a building	Class
Room.Name	Room number	Attribute

Table 4: Data Dictionary

8 The Scope of the Product

8.1 Product Boundary

The use case diagram depicted below identifies the boundaries between the users and the product.

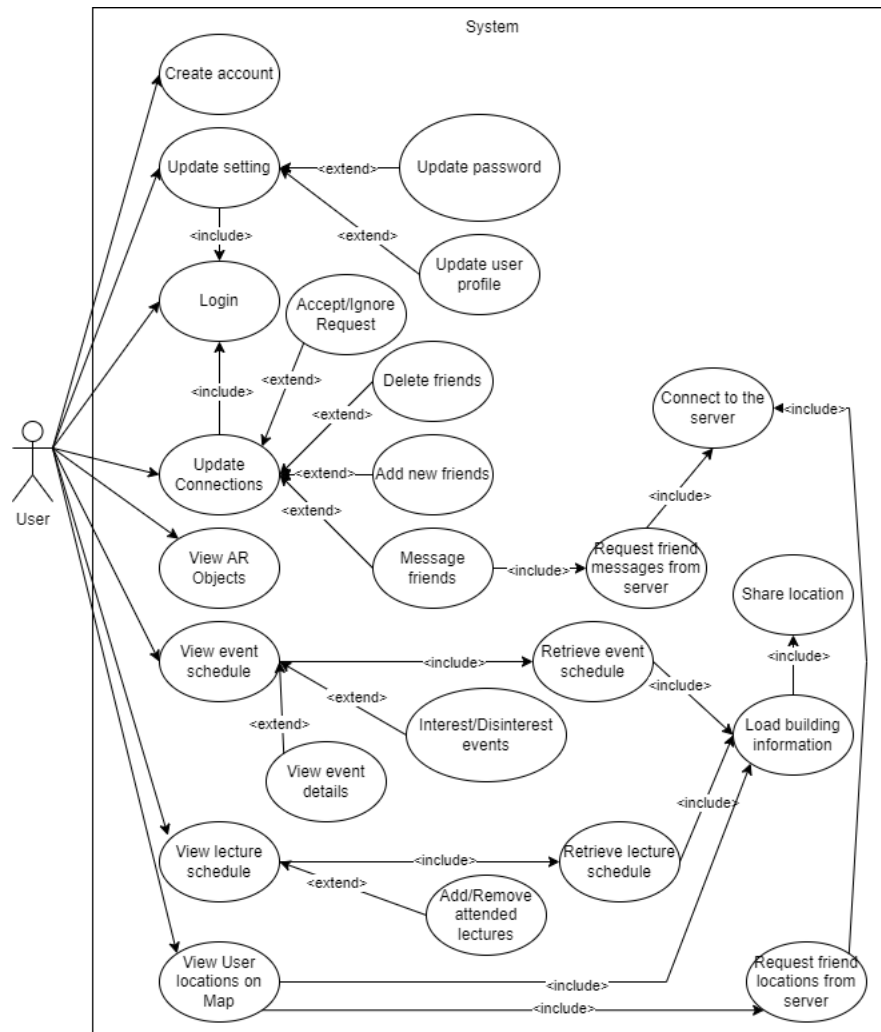


Figure 5: Use Case Diagram

8.2 Product Use Case Table

PUC No	PUC Name	Actor/s	Input & Output
1	Create Account	User	Email & Password (in)

PUC No	PUC Name	Actor/s	Input & Output
2	Update Password	User	Email & New Password (in)
3	Update User Profile	User	New Profile (in)
4	Login	User	Email & Password (in), Response Message (out)
5	Accept/Ignore Request	User	Friend Email (in), Accept or Ignore message (out)
6	Add New Friend	User	Friend Email (in), Friend Request (out)
7	Delete Friend	User	Friend Email (in), Confirmation Message (out)
8	Message Friend	User	Message Content (in), Message Sent Notification (out)
9	View AR Objects	User	User Interaction & target building (in), AR Objects (out)
10	View Event Details	User	User Interaction (in), Event Details (out)
11	View Lecture Details	User	User Interaction (in), Lecture Details (out)
12	Interest/Disinterest Event	User	User Interaction & Event Name (in)
13	Add/Remove Lecture	User	User Interaction & Lecture Name (in)
14	View User locations on Map	User	User Interaction & User Locations (out)

PUC No	PUC Name	Actor/s	Input & Output
15	Retrieve Event Schedule	System	New Schedule (out)
16	Retrieve Lecture Schedule	System	New Schedule (out)
17	Load Building Information	System	Location & Sensor Data (in), Building Name (out)
18	Request friend messages from server	System	Target Email (in), Messages (out)
19	Request friend locations from server	System	Target Email (in), Locations (out)
20	Connect to server	System	Email (in), Confirm Message (out)

Table 5: Product Use Case

8.3 Individual Product Use Cases (PUC's)

Use case #1: Create Account

Precondition: None

Trigger: The user clicks on create account button

Outcome

1. User provides the required information (email, nick name and password)
2. System verifies all required information has been provided
3. System securely registers user information
4. User is redirected back to the Home page

Postcondition: The user has successfully created an account and account information is stored and secured in a database.

Use case #2: Update Password

Precondition: The user has already created an account

Trigger: The user clicks on change password button

Outcome

1. User navigates to change password page
2. User provides old password
3. User provides new password
4. System verifies old password is correct and new password is valid
5. System updates password of current user in the database
6. User is redirected back to the Home page

Postcondition: The user has successfully changed the password.

Use case #3: Update User Profile

Precondition: The user has already created an account

Trigger: The user clicks on edit profile button

Outcome

1. User navigates to edit profile page
2. User updates the profile to a new one and saves the changes
3. System updates user information and redirects back to the Home page

Postcondition: The user profile has been changed successfully.

Use case #4: Login

Precondition: The user has already created an account

Trigger: The user clicks on login button on the home page

Outcome

1. User navigates to login page and enters email and password
2. System verifies all required information has been provided and matches the database record
3. User is redirected to the home page as a logged-in user

Postcondition: The user has successfully logged in to the created account with all settings and connections loaded from the database.

Use case #5: Accept/Ignore Request

Precondition: The user has already logged in

Trigger: The user directs to request management page

Outcome

1. User checked the requester email
2. Destined user accepts/rejects the request
3. User receives a notification

Postcondition: The user gets a new connection in their friends list.

Postcondition 2: The user is rejected and gets a notification about that.

Use case #6: Add New Friend

Precondition: The user has already logged in

Trigger: The user searches for another user and sends a friend request

Outcome

1. User searches for another user
2. User sends a friend request
3. System sends the request with requester email to the destined user
4. User receives a notification

Postcondition: A new request is added to the target user's request list.

Use case #7: Delete Friend

Precondition: The user has already logged in and has at least one friend

Trigger: The user clicks delete button on friend page

Outcome

1. User searches for a friend
2. User deletes the friend

3. System sends a confirmation prompt
4. User continues to delete
5. User receives a notification

Postcondition: The friend is deleted from user's friends list.

Use case #8: Message Friend

Precondition: The user has already logged in and has at least one friend

Trigger: The user texts a friend on friend page

Outcome

1. User clicks on a friend in the list
2. User starts to text the friend
3. System sends message to the destined friend

Postcondition: The friend receives a message from the user.

Use case #9: View AR Object

Precondition: The user has already logged in and gets into a target building

Trigger: The user turns on the AR camera

Outcome

1. User directs to AR Camera page and turns on the camera
2. User scans the surroundings with AR Camera

Postcondition: The user sees corresponding AR objects in target areas.

Use case #10: View Event Details

Precondition: The user has already logged in and there exist some events in the system

Trigger: The user clicks on an event from the list

Outcome

1. User directs to Event List Page

2. User finds a list of events
3. User clicks on one of the event
4. System displays more information about the event

Postcondition: The name, description, organizer, duration, time and location of the event are displayed.

Use case #11: View Lecture Details

Precondition: The user has already logged in and there exists some lectures in the system

Trigger: The user clicks on a lecture from the list

Outcome

1. User directs to Lecture List Page
2. User finds a list of lectures
3. User clicks on one of the lecture
4. System displays more information about the lecture

Postcondition: The name, code, instructor, time and location of the lecture are displayed.

Use case #12: Interest/Disinterest Event

Precondition: The user has already logged in and clicks on an event in the list

Trigger: The user clicks on pin/unpin button

Outcome

1. User browses the event list
2. User navigates to an event detail page with a specific name
3. User clicks on the corresponding button
4. System sends the request to the database

5. System displays the new state of the event

Postcondition: The event is added to/delete from the user correspondingly in the database and the UI changes as well.

Use case #13: Add/Remove lecture

Precondition: The user has already logged in and clicks on a lecture in the list

Trigger: The user clicks on pin/unpin button

Outcome

1. User browses the lecture list of the target
2. User navigates to a lecture detail page with a specific course code
3. User clicks on the corresponding button
4. System sends the request to the database
5. System displays the new state of the lecture

Postcondition: The lecture is added to/removed from the user correspondingly in the database is updated and the UI changes correspondingly.

Use case #14: View User Locations on Map

Precondition: The user has already logged and has at least a friend

Trigger: The user directs to campus map page

Outcome

1. User navigates to campus map page
2. System displays real time locations of the user and friends who are willing to share locations

Postcondition: The user sees real time locations of friends on campus

Use case #15: Retrieve Event Schedule

Precondition: None

Trigger: A request to update schedule is sent or trigger by the system timer

Outcome

1. System sends a request to the on-campus schedule interface
2. System gets the up-to-date schedule
3. System stores the new schedule to the database or the administrator adds the new schedule to the database

Postcondition: The new schedule is stored in the database and will be utilized later.

Use case #16: Retrieve Lecture Schedule

Precondition: None

Trigger: A request to update schedule is sent or trigger by the system timer

Outcome

1. System sends a request to lecture schedule interface
2. System gets the up-to-date schedule
3. System stores the new schedule to the database or the administrator adds the new schedule to the database

Postcondition: The new schedule is stored in the database and will be utilized later.

Use case #17: Load Building Information

Precondition: Location share is allowed and sensors are set properly

Trigger: A request for event/lecture schedule is sent by the user

Outcome

1. System gets geographic location and sensor data from the device
2. System finds the most likely building on campus
3. System displays building information

Postcondition: The system provides information of the building the user locates now.

Use case #18: Request friend messages from server

Precondition: User is connected to the server and has a friend

Trigger: The user opens a chat with friend

Outcome

1. System sends a request to the server to establish a session for message transfer between the user and the friend
2. System sends a message from the user to the friend
3. System request a message from the friend to the user

Postcondition: The user can send and receive to any friends.

Use case #19: Request friend locations from server

Precondition: User is connected to the server and has a friend

Trigger: The user directs to campus map page

Outcome

1. System sends a request to the server to establish a session for sending and receiving real time locations
2. System sends current location of the user
3. System request current locations of friends

Postcondition: The user can see everyone's real time locations on the map.

Use case #19: Connect to server

Precondition: User is logged in

Trigger: The user wants to send or receive any real time data

Outcome

1. System sends the user email as ID to the server
2. Server responds with a confirmation message

Postcondition: The user is connected to the server.

Postcondition 2: The user fails to connect due to some issues on the server side.

9 Functional Requirements

9.1 Pre-Login Settings

FR-1-1: The system shall ask all users to sign a consent form disclosure of personal information.

Rationale: It is a must to ask for users' permission before making use of their personal information.

Fit Criterion: Users must be able to sign or reject a consent form when they first log in.

9.2 User Profile

FR-2-1: The system shall allow users to create accounts with an email that does not exist in the database.

Rationale: Users must be associated with accounts to identify themselves and expand their social networking.

Fit Criterion: Users must be able to create an account with an email that does not exist in the database and a password.

FR-2-2: The system shall allow users to delete their accounts with all associated data.

Rationale: Users shall be able to quit whenever they want with all their data handled properly.

Fit Criterion: Users must be able to delete their account once they log into the application.

FR-2-3: The system shall allow users to log in with their email and the corresponding password.

Rationale: Users must be able to log into their account to expand social networking and enjoy all functionalities.

Fit Criterion: Users must be able to log in once they created an account successfully.

FR-2-4: The system shall allow users to change their password.

Rationale: This will allow users to improve the security of their account

and recover the account if they forget their password.

Fit Criterion: Users may request a password reset on the login page. The user shall receive an email to reset the password later.

FR-2-5: The system shall allow users to create and change a virtual avatar.

Rationale: A customizable avatar gives users a much stronger feeling of personalization.

Fit Criterion: Users shall be able to upload images as their avatar on the user profile page.

FR-2-6: The system shall allow users to verify their school email.

Rationale: Users shall be identified as McMaster students to have full access to all the resources. Therefore identifying McMaster email is necessary.

Fit Criterion: The user shall be able to add McMaster email to their profile and verify the email after receiving an email from the system.

FR-2-7: Users shall be able to edit their profile.

Rationale: Users shall always be able to update their displayed information for better socializing.

Fit Criterion: Users shall be able to edit their user profile (e.g. nickname program and level) on the user profile page.

9.3 Friend System

FR-3-1: The system shall allow users to send a friend request.

Rationale: One of the main purposes of this application is to make students connect with peers easily. For this to happen, they should be able to make new friends on this social media platform.

Fit Criterion: Users can search for other users through username and send a friend request, added friends can be removed from the friend list.

FR-3-2: The system shall allow users to delete friends.

Rationale: When users add users as friends by accident or they no longer connect, they should be able to remove them from the friend list.

Fit Criterion: Users can remove any friends from their friend list.

FR-3-3: The system shall allow users to send text messages to their friends.

Rationale: This will make the app more interactive and encourage and enhance socialization between users.

Fit Criterion: Users must be able to send messages and view received messages.

FR-3-4: The system shall allow users to share events conveniently with friends.

Rationale: This encourages onsite socialization and allows users to make better use of resources provided by the application.

Fit Criterion: Users shall be able to share a link that can be redirected to an event in the chat.

FR-3-5: The system shall allow users to share their location with friends.

Rationale: To expand social networking and meet friends in person, users shall be able to share their current location on campus with friends.

Fit Criterion: Users should be able to share their real-time location with friends as long as they agree on the corresponding terms.

FR-3-6: The system shall allow users to manage friend requests.

Rationale: Managing friend requests is a significant functionality to make new friends.

Fit Criterion: Users can either accept or ignore any friend requests.

9.4 Lectures and Events

FR-4-1: The system shall allow users to manage events they are interested in.

Rationale: It will be much easier for users to find events they are interested in and willing to join again. So that they do not have to browse the event list again and again. While their friends can see what events they are likely to join.

Fit Criterion: Users should be able to pin and unpin an event from the event list, this event will be displayed or removed on the user profile page.

FR-4-2: The system shall allow users to manage lectures they are attending.

Rationale: Sharing schedules with friends can strengthen friendship. Users can join lectures with friends and know their classmates better. So the system needs to have the functionality to display lectures a user is taking.

Fit Criterion: Users should be able to pin and unpin a lecture from the list as attended lecture, this lecture will be displayed or removed on the user profile page.

FR-4-3: The system shall allow users with an administrator account to add, edit, and remove events.

Rationale: The event information must be up-to-date and accurate. The administrator account will maintain all events so that there is a singular source of information. Additionally, this reduces the chances of errors being introduced to the system.

Fit Criterion: A new event can be created only by a user who is logged in as an administrator. The information for those events can be changed only by administrators. Events can be deleted only by administrators.

FR-4-4: The system shall allow users with an administrator account to add, edit, and remove lectures from the schedule.

Rationale: The lecture information must be up-to-date and accurate as well. Administrators are needed to manage the schedule.

Fit Criterion: A lecture on the schedule can be created, deleted, or updated by a user who logged in as an administrator.

FR-4-5: Each event shall be associated with an organizer (club/department), location, time and duration.

Rationale: For the application to schedule events for the users to see and interact with, all specific details about the event should be provided to the system

Fit Criterion: When a department/club requests for an event to be posted on the application, they have to provide details about the building and room number it will be held in, along with the date and time the event will take place at.

FR-4-6: Each lecture shall be associated with an instructor, location, course code and time.

Rationale: To find empty rooms and help users who want to attend specific lectures, all details about the lectures should be provided to the system.

Fit Criterion: When a lecture is added or modified, all the details mentioned above must be set as mandatory fields.

FR-4-7: User should be able to filter specific lectures out from the list by course code.

Rationale: It is necessary to allow users to filter out lectures they are interested in from a long list.

Fit Criterion: Users shall be able to input some keywords to filter the lecture list.

FR-4-8: User should be able to filter specific events out from the list by the organizer.

Rationale: It is necessary to allow users to filter out events they are interested in from a long list.

Fit Criterion: Users shall be able to input some keywords to filter the event list.

9.5 AR Camera

FR-5-1: The system shall recognize specific buildings on campus.

Rationale: AR camera will give users an immersive user experience interacting with campus buildings.

Fit Criterion: The system shall recognize proper camera input as buildings in the database.

FR-5-2: The system shall display corresponding event/lecture information as AR objects when a target is recognized.

Rationale: AR camera will give users an immersive user experience interacting with campus buildings.

Fit Criterion: User must see corresponding information about the target (e.g. events and lectures) in the format of AR objects once a target is recognized.

9.6 Map and Location

FR-6-1: The system shall allow users to see their own real-time locations on campus and the locations of friends who are willing to share.

Rationale: Sharing locations with connections can make it easier for friends to sync up in person on campus, which provides more opportunities for users to network

Fit Criterion: Users shall be able to see their avatar on the map showing their real-time positions, and also other users' avatars and locations on campus.

10 Look and Feel Requirements

10.1 Appearance Requirements

LF-A1: The product shall respond with visual (and auditory, if applicable) feedback once the user interacts with an interactive component.

Fit criterion: Each component must respond as designed in RESPONSE_TIME when they are triggered.

LF-A2: The product shall adapt to most of the common mobile screen sizes with screen components not being congested.

Fit criterion: Visual elements must not exceed the borders of the screen for all screens in SCREEN_VIEWPORTS list. If a user experience survey is taken among them, the application layout will get at least MIN_SCORE.

10.2 Style Requirements

LF-S1: The colors and themes shall be consistent across different pages.

Fit criterion: Consistency checks show the same color scheme being used on all pages.

LF-S2: The color scheme used shall be appealing and not cause eye strain.

Fit criterion: MOST_USERS agree with the statement that the screen does

not cause strain during a user experience survey.

11 Usability and Humanity Requirements

11.1 Ease of Use Requirements

UH-EOU1: The product shall have a user interface that is clear and easy to navigate.

Fit criterion: MOST_USERS in the testing stage shall be able to find their way to specific pages and access all different core features including messaging friend, lecture and event management and building scanning without needing to try again more than 3 times.

11.2 Personalization and Internationalization Requirements

N/A

11.3 Learning Requirements

UH-L1: The product shall include a user guide about its features available on GitHub repo.

Fit criterion: Users shall be able to access user guide in GitHub and MOST_USERS shall give positive feedback on that document.

11.4 Understandability and Politeness Requirements

UH-UP1: The product shall abstain from using technical and software-specific language.

Fit criterion: MOST_USERS shall hardly find technical and software-specific language among all text displayed by the application.

11.5 Accessibility Requirements

UH-A1: The colors used by the different components of the product shall contrast enough for items on the screen to be more easily visible.

Fit criterion: The color contrast is at least 4.5:1 per the Web Content Accessibility Guidelines' AA standards for accessibility[2].

12 Performance Requirements

12.1 Speed and Latency Requirements

P-SL1: The product shall display the correct AR objects shortly after successful AR target recognition.

Fit criterion: The time from recognition to the appearance of the AR object is at most RECOGNITION_TIME.

P-SL2: The product shall periodically update the user's location on the real-time location map.

Fit criterion: A user's location must be updated on the map session within LOCATION_UPDATE_TIME.

12.2 Safety-Critical Requirements

P-SC1: The application will not collect or share any user's location or personal data without getting permission from the user.

Fit criterion: User's personal information does not appear in the database if the user did not grant permissions.

P-SC2: User data such as messages and location information will be securely encrypted to protect user's privacy.

Fit criterion: Contents of data packets being transmitted are nonsense when inspected with MONITORING_TOOL.

P-SC3: The product shall display a message upon map startup warning the user to be aware of their surroundings.

Rationale: The gameplay of real-time location map may lead to distracted

walking, therefore we need to warn the user for their safety.

Fit Criterion: A message telling the user to be aware of their surroundings is displayed upon map startup.

P-SC4: The product shall hide user's location if the user leaves campus.

Rationale: Users may stay connected and share their location even when they leave the campus. To prevent personal information leakage, we need to hide that information and disconnect the user.

Fit Criterion: A user's information shall not be shared once he or she leaves campus.

P-SC5: The product shall prevent the user from entering special characters in all text input fields.

Rationale: When creating accounts, users can perform SQL injection attacks by inputting some SQL statements.

Fit Criterion: Any text input with special characters will give the user an error.

P-SC6: The product shall validate the email format when creating an account.

Rationale: When creating accounts, users can perform SQL injection attacks by inputting some SQL statements.

Fit Criterion: An input in the email field that's not in the format of an email will give the user an error when creating a new account.

12.3 Precision or Accuracy Requirements

P-PA1: The product shall accurately identify buildings scanned by the user.

Fit criterion: The application shall identify a building on campus with a success rate of at least 80%.

12.4 Robustness or Fault-Tolerance Requirements

P-RF1: The product shall display an error message when there is no internet connection.

Rational: When there is no internet connection, the user should be made aware.

Fit criterion: An error message stating that there is no internet connection is displayed when the product fails to connect to the internet.

P-RF2: There must be a fail-safe for the product to function if the server or internet connection takes too long or fails.

Rational: This will allow the product to function to some degree even during high traffic or bad internet connection situations.

Fit Criterion: The product must be able to provide rudimentary functionalities without connecting to the internet or server.

P-RF3: The server shall attempt to restart when it crashes.

Rationale: This requirement enhances the robustness of the backend server and prevents it from going down for a long time because of some intermittent minor errors.

Fit Criterion: The server should try to restart after it crashes due to unknown errors.

P-RF4: AR Camera should have a notification available in the UI telling users possible reasons the target is not recognized.

Rational: The user should get a notification telling them that the AR camera may have a bad performance in some cases, and they should be able to report that to the developer if they want the problem to be solved.

Fit Criterion: The product should show the user a list of possible reasons that the camera does not work and the contact information of maintainers once they have trouble using the AR camera and click the help button.

12.5 Capacity Requirements

N/A

12.6 Scalability or Extensibility Requirements

P-SE1: This product server will be capable of processing about at most MAX_CAPACITY people concurrently in the release build with a plan of expanding it to support all students on campus (about 40,000 people) in the future.

P-SE2: This product database will be capable of storing the account and personal information of about MAX_USER_STORED users in the release build with a plan of expanding it to support all students on campus (about 40,000 people) in the future.

P-SE3: The application architecture will allow for the addition of new campus buildings and clubs without considerable drawbacks in performance.

12.7 Longevity Requirements

P-L1: This application will be expected to operate without major malfunctions in release build for a minimum of 1 year while undergoing further development.

P-L2: The finalized product will remain compatible with the promised operating systems and devices for a minimum of 3 years.

13 Operational and Environmental Requirements

13.1 Expected Physical Environment

OE-EPE1: The product will be installed on the user's smartphone (Android).

13.2 Wider Environment Requirements

N/A

13.3 Requirements for Interfacing with Adjacent Systems

N/A

13.4 Productization Requirements

OE-P1: The product shall be downloadable for Android devices.

Fit criterion: The product can be downloaded onto an Android device by downloading the APK file directly.

13.5 Release Requirements

N/A

14 Maintainability and Support Requirements

14.1 Maintenance Requirements

MS-M1: Major updates could be rolled out during periods of reduced usage such as Reading Week, after exams, or Spring semester.

14.2 Supportability Requirements

MS-S1: Feature requests or issues can be sent to the product GitHub.

MS-S2: A user manual will be compiled and stored in the GitHub, this manual will be updated with Frequently Asked Questions and other entries

as additional features are introduced.

14.3 Adaptability Requirements

MS-A1: The product shall be accessible on Android 11 and above for Android devices, as these operating systems are still supported and receive security updates.

15 Security Requirements

15.1 Access Requirements

S-A1: User with first level access is treated as a guest.

Rational: User persona: a grade 12 student on a university tour.

Fit Criterion: Guest must not have access to anything beyond the login, account creation, public events, map without other users' locations and account recovery pages.

S-A2: User with second level access is treated as an actual user.

Rational: User persona: a software engineer undergrad student.

Fit Criterion: User will have full access to all features except writing access to the database, which means a user cannot edit or create new lectures or events.

S-A3: User with third level access is treated as an administrator.

Rational: Full access of the system should be given to administrators who works as a maintainer.

Fit Criterion: Administrator will have all the access users have and the power to add, delete and edit official events, lectures and all users profiles.

15.2 Integrity Requirements

N/A

15.3 Privacy Requirements

S-P1: The application will comply with all relevant privacy laws and guidelines.

Rational: The application will respect the privacy of all the users.

Fit Criterion: The usage of a user's personal information by the product abides by the Privacy Act, The Personal Information Protection and Electronic Documents Act, and Canada and Ontario's data protection laws [3] [4].

S-P2: Accounts that are inactive for a certain period shall be deleted after notice to prevent unnecessary data from being held.

Rational: It prevents personal information from being stored in the database unintentionally for a long time.

Fit Criterion: Accounts that are not logged in for a semester will be cleaned from the authentication system and database.

15.4 Audit Requirements

N/A (This currently does not apply, once the product is ready to be used in multiple universities and regions, audit requirements will be reconsidered.)

15.5 Immunity Requirements

N/A (This currently does not apply, once the product is ready to be used in multiple universities and regions, audit requirements will be reconsidered.)

16 Cultural Requirements

16.1 Cultural Requirements

CUL-C1: The product shall not be offensive to any marginalized groups.

Fit Criterion: The product shall not use any language or symbols deemed offensive by any marginalized group.

17 Compliance Requirements

17.1 Legal Requirements

COM-L1: The data collected from users will be handled as per the same legal requirements for the university.

17.2 Standards Compliance Requirements

COM-SC1: The application will abide by the guidelines set by the university and club managers, adding options to accommodate their requests.

18 Traceability Matrix

FR	1-1	2-1	2-2	2-3	2-4	2-5	2-6	2-7	3-1	3-2	3-3	3-4	3-5	3-6	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8	5-1	5-2	6-1
LF-A1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
LF-A2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
LF-S1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
LF-S2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
UH-EOU1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
UH-L1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
UH-UP1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
UH-A1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
P-SL1																							X	X	
P-SL2													X												X
P-SC1	X																								
P-SC2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X
P-SC3																									X
P-SC4													X												X
P-SC5		X		X	X		X	X	X		X						X	X	X	X	X	X			
P-SC6		X		X			X																		
P-PA1																							X	X	
P-RF1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P-RF2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P-RF3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P-RF4																							X	X	
P-SE1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P-SE2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X		X
P-SE3																			X	X			X	X	X
P-L1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P-L2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OE-EPE1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OE-P1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MS-M1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MS-S1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MS-S2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MS-A1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
S-A1	X	X	X	X	X	X	X	X							X							X			X
S-A2	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X					X	X	X	X	X
S-A3	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
S-P1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X
S-P2	X		X																						
CUL-C1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
COM-L1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X
COM-SC1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 6: Traceability Matrix

19 Open Issues

- To target iOS devices, a device capable of building iOS apps is required.

20 Off-the-Shelf Solutions

20.1 Ready-Made Products

- **Snapchat:** Snapchat is an existing social media platform that makes use of AR technology through its Lenses feature which provides various filters and effects that users can apply to their content.
- **Instagram:** Instagram is another platform that incorporates AR in the form of filters and effects.
- **TikTok:** TikTok similarly uses AR for visual effects and filters.
- **Facebook:** Many clubs at McMaster use Facebook Groups to coordinate events.
- **Meetup:** Meetup is another platform designed for organizing and finding events and other social gatherings.
- **CampusGroups:** CampusGroups is a platform that focuses specifically on university student groups. It allows universities to create private communities for various events and other student engagement activities.

20.2 Reusable Components

- Models and art assets can be obtained from the Unity Asset Store or similar sources.
- Existing database solutions such as MongoDB.
- Vuforia is another AR toolkit. It also provides an API for Unity.

20.3 Products That Can Be Copied

- Groups, events and a friend system similar to other popular social media apps. (Facebook, Instagram, ...)
- AR camera modes or filters similar to TikTok or Snapchat.
- Text and voice messaging as is common in other social media apps. (Facebook, Instagram, ...)

21 New Problems

21.1 Effects on the Current Environment

This application will not take place of any existing official tools. It intends to improve certain social networking processes students are following and provide a platform for users to connect with each other better. The following are some changes that will impact users.

Expand Networking

Students will be able to expand networking when attending events lectures on this social media platform. Users may lose connection with peers when there is a failure in the system.

Event Registration

Students and alumni will be able to login with their McMaster email and customize a list of activities and even post their program and level, which means there will be a risk of personal identification information (PII) leakage if the data is not stored securely.

Lectures and Events Management

This application can be utilized to get information about lecture and lecture time and location which should not be displayed publicly. Therefore insecure data storage may lead to data breaches.

21.2 Effects on the Installed Systems

The application will be completely stand alone and will not be interfacing with any existing systems. As described in the previous section, this application should not affect or replace any existing systems.

21.3 Potential User Problems

Any potential adverse reactions related to using the device in which application is being launched on (mobile device or tablet) would extend to the use of this application. Any adverse reactions of Virtual Reality and Augment Reality, like nausea, dizziness and disorientation would be introduced to the use of the application as well.

21.4 Limitations in the Anticipated Implementation Environment That May Inhibit the New Product

- The database free plan is not able to cope with our projected user growth pattern.
- Low quality internet connection will lead to latency between user inputs and in-app reactions or even failures of loading some assets.
- The accuracy of input data totally depends on device sensor. Low accuracy data may cause bad user experience.

21.5 Follow-Up Problems

Any failures or downtime on the server or the database may affect the availability of this application. In-app schedules may get out of date when the two external systems cannot provide new data or the administrator cannot update the schedule on time. There will also be a risk of violating privacy laws in the future since the application is collection personal information and there may be new laws prohibit this kind of information collection.

22 Tasks

22.1 Project Planning

The project schedule will follow the deadline for the deliverables outlined in the SFWRENG 4G06 course outline.

Phase	Task	Deadline
Revision 0	Hazard Analysis	Oct 20, 2023
	Verification and Validation Plan	Nov 3, 2023
	Proof of Concept Demo	Nov 13-24, 2023
	Design Document	Jan 17, 2024
	Demonstration	Feb 5-16, 2024
	Verification and Validation Report	Mar 6, 2024
Revision 1	Final Demonstration	Mar 18-29, 2024
	EXPO Demonstration	April 2024
	Final Documentation	Apr 4, 2024

Table 7: Project Plan

22.2 Planning of the Development Phases

The development of the project will be divided into two phases

- Revision 0, initial development
- Revision 1, refinement of the project and documents

Revision 0 starts now and ends with the Verification and Validation Report. In this phase, the team will work on some design-related documents and specify the scope of the project, what skills the team will be using, and how the interaction of different components be. Then the team will start implementation as proof of concept and demonstrate their product to stakeholders. After that, the team will write a V&V report based on the demonstration and stakeholder feedback. As for implementation, the following table show what should be done by end of the first round:

Task	Priority	Deadline
Database Set up	High	Nov 1, 2023
Server Set up	High	Nov 1 2023
Data structures	High	Nov 1, 2023
Migrate Mapbox to the project	High	Nov 15, 2023
Migrate Vuforia, the AR library to the project	High	Nov 15, 2023
Login system	Medium	Dec 1, 2023
List view of activities	Medium	Dec 15, 2023
Friend and request management	Medium	Dec 15, 2023
Baisc UI	Low	Jan 8, 2024
Chatting	Low	Jan 8, 2024
Filter and search activities	Low	Jan 8, 2024
CI & CD	Low	Jan 20, 2024
More consistent UI	Medium	Feb 12, 2024
AR camera with lectures and events details	High	Feb 12, 2024
User profile management	High	Feb 12, 2024

Table 8: Development Plan Rev 0

Revision 1 will focus on the refinement of the application and documents. In the previous phase, the team finished a bunch of drafted documents, and in this phase, the team should put all effort into incorporating feedback into these documents and the application itself. There will not be any major new features added in Revision 1. The following is the implementation plan for revision 1:

Task	Priority	Deadline
Access control	High	Feb 26, 2024
Usability survey	High	Feb 29, 2024
Unit testing	Medium	March 6, 2024
Notification	Medium	March 8, 2024
Multi-user map front end	High	March 15, 2024
Sending event or lecture in chat	Low	March 15, 2024
Error Handling	Medium	March 20, 2024
Resolve feedback	High	April 4, 2024
Code refinement	Medium	April 4, 2024

Table 9: Development Plan Rev 1

23 Migration to the New Product

23.1 Requirements for Migration to the New Product

There are no requirements to migrate to this product besides recruiting sufficient number of users. With the the starting users, there may not be enough engagement for this application to be widely used.

23.2 Data That Has to be Modified or Translated for the New System

Currently, all data we need are in OSCARplus and club management part of the university administration. These data will be requested via API or a new web based or internal input system will be made to move all the data over to our product.

As this product handles real time data, there is no need to migrate out-dated data to the product.

24 Costs

In the initial release build of our application, we will be keeping costs at an absolute minimum. We will be utilizing free technologies such as Vuforia for image recognition features and MongoDB as our database solution, our

development expenses will remain at \$0. Additionally, we plan on using GitHub's free hosting service for the deployment of our application, further eliminating any hosting-related expenses. We plan to scale our infrastructure with time where we may explore more premium options, such as AWS S3 bucket and MongoDB Atlas, to ensure the continued seamless operation and performance of our application while serving all McMaster students.

25 User Documentation and Training

25.1 User Documentation Requirements

- Digital User Manual:

The purpose of the document will be to outline the main functions the product serves such as navigation and event discovery and how the user can make use of them. This will also highlight some common possible errors / mistakes that can occur and how the user should interact with the system to avoid them in the first place or handle them in a sensible manner if they occur.

- Event Posting Guideline:

The purpose of this document will be to streamline and outline the process for clubs and departments to post events in the proper manner

- Privacy Policy:

This document will display the data handling and user privacy rights clearly.

- Terms of Service:

This document will outline terms of service and all user responsibilities.

Motivation:

User documentation will be created by the developers and will improve the on-app experience of the users.

25.2 Training Requirements

- Admin training:

Training provided to authorized club and department representatives on additional features associated with admin accounts such event posting / management and handling user issues.

Motivation:

To provide a better experience for administrators and avoid overwhelming them with the additional features presented to them. The training plan and the physical training will be carried out by different developers.

26 Waiting Room

- User generated content such as text or image posts.
- “Gamification” features (i.e. collectibles, achievements, stickers, ...) to increase or incentivize social engagement.

27 Ideas for Solution

Implementation ideas for solutions

- AR feature
 - Vuforia supports some AR functionalities and works as a library of Unity
 - gather.town might be a good design approach to follow after from the campus navigation and interaction perspective
- Server
 - AWS might be a purchasable and reliable option for the back-end
 - SignalR is a real-time communication library used by lots of other projects, it is based on C#, so it should work with ASP.NET as our back-end server
- Map

- The library Mapbox can be useful for outdoor positioning and it is compatible with Unity.

28 Appendix

28.1 Symbolic Parameters

The definition of the test cases will call for SYMBOLIC_CONSTANTS. Their values are defined in this section for easy maintenance.

Table 10: Symbolic Parameter Table

Symbolic Parameter	Description	Value
MOST_USER	Majority of the users	80% users
MIN_SCORE	The passing grade for a category in the survey	7/10
RESPONSE_TIME	Max time the system takes for visual response	1 second
SCREEN_VIEWPORTS	List of all popular mobile screen sizes	360X740, 390X844, 820X1180
USER_PROFILE	All information about the user	username, password, gender, age, email, area of study
RECOGNITION_TIME	Max time the system takes for image recognition	3 second
MESSAGE_TIME	Max time the system takes to send user message	2 second
LOCATION_UPDATE_TIME	Max time the system takes for location update	10 second
MONITORING_TOOL	Tool to use when monitoring network	Charles Proxy
GPS_ACCURACY	Accuracy of location sharing	25 meter
MAX_CAPACITY	max number of simultaneous users	200
MAX_USER_STORED	max number of user account stored	500

28.2 References

References

- [1] Freedom of Information and Protection of Privacy Act (FIPPA), McMaster University; University Secretariat, <https://secretariat.mcmaster.ca/privacy/notice-of-collection-use-and-disclosure/>
- [2] Web Content Accessibility Guidelines (WCAG) 2, Web Accessibility Initiative, www.w3.org/WAI/WCAG21/quickref/#contrast-minimum. Accessed 13 Oct. 2023.
- [3] Legislative Services. “Personal Information Protection and Electronic Documents Act.” Personal Information Protection and Electronic Documents Act, 28 Sept. 2023, laws-lois.justice.gc.ca/eng/acts/p-8.6/.
- [4] “Consolidated Federal Laws of Canada, Privacy Act.” Privacy Act, 28 Sept. 2023, laws-lois.justice.gc.ca/eng/ACTS/P-21/page-1.html#h-397177.

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

1. What knowledge and skills will the team collectively need to acquire to successfully complete this capstone project? Examples of possible knowledge to acquire include domain specific knowledge from the domain of your application, or software engineering knowledge, mechatronics knowledge or computer science knowledge. Skills may be related to technology, or writing, or presentation, or team management, etc. You should look to identify at least one item for each team member.

The team members will need to collectively acquire some technical and non-technical skills and knowledge in order to succeed in this capstone project. The following is a list of skills that are critical to the project and course deliverables.

- 1 Presentation skills for demonstrations and capstone EXPO
 - 2 Documentation skills
 - 3 Team management skills including time management and work distribution
 - 4 Skills of Unity game development
 - 5 Skills of Unity AR development
 - 6 Integrating external backend systems into a Unity project
 - 7 Skills of git
 - 8 Front-end development skills
 - 9 Back-end development skills including server deployment and database
 - 10 Organizational skills to lead meetings and discussions on unclear topics in the project
2. For each of the knowledge areas and skills identified in the previous question, what are at least two approaches to acquiring the knowledge or mastering the skill? Of the identified approaches, which will each team member pursue, and why did they make this choice?

For non-technical skills, team members can develop those skills by practicing and attending courses/workshops. Members can leverage LinkedIn Learning and McMaster workshops to develop management and organizational skills. For documentation and presentation skills, team members can also join related events hosted by the university or refer to past documents and presentations.

There are even more resources available for developing technical skills. Online learning platforms like Udemy will be used for the team to learn new technology-specific domain knowledge and skills. Other online resources like YouTube tutorials and official documentation can help the team master those technical skills as well.

Listed below under each team member's name is a list of skills that the team member will focus on and why they decide to work on them.

- **Zihao Du**

- Skills: 1, 2, 3, 4, 8

Soft skills are quite important for a team and an engineer. And that's why I'd like to focus on soft skills like presentation skills and documentation skills. It will be not only critical to succeed in this capstone project but also beneficial to software engineering careers. Communication plays a very important role in software engineer's daily work and I will take this opportunity to further improve my skills.

I'll also focus on Unity game development and front-end development because that attracts me the most and what I have the most experience in and I'd like to strengthen my skills and learn more about game development during this project.

- **Michael (Minsung) Kim**

- Skills: 3, 7, 9, 10

All documentation and work progress will be tracked on git and meetings. Additionally, the work done will always be added to git to keep track of all work records. This will improve my skills in git and allow me to resolve merge conflicts better and manage any issues from the CI/CD pipeline. As the liaison, I need to ensure that the team is on the right track and no misunderstandings are left. We will have meetings regarding work done to keep everyone

updated and let everyone know which tasks may be difficult or require further clarification. There will be discussions before the supervisor meeting so that we know what we need to ask and what subjects we could use their advice in.

I will focus on the back-end of the project so that data communication is secure and efficient. I am very interested in the database architecture and encryption that goes into on disk and in transit communication. I will learn more about different databases such as SQL and MongoDB, their benefits and security. As I have the advanced databases course, this will help me with the database skills. The information security course will help with the data encryption part of the back-end development as well. Further research and looking into open source libraries that support back-end will help significantly as well.

- **Firas Elayan**

- Skills: 4, 5, 6, 7, 9

Unity and other general platforms for developing products such as the one in our capstone project are a new field to me that I do not have a lot of experience in. I'd like to acquire a near-advanced level of technical skills in relation to those platforms so that I'm able to build an array of good products of a very useful type that function properly and meet all requirements.

Git is an extremely beneficial tool if used correctly. I'd like to improve my skills in git to ensure this project and future projects I participate in building have a smooth development life, especially with how expensive errors and issues can become the more complex the project gets.

- **Matthew Miller**

- Skills: 1, 2, 4, 8, 9

I want to work on my presentation skills and documentation skills so that I can focus on improving my oral and written communication skills. Since I have autism, communication has always been a challenge, so I would like to take the opportunity to work on those skills. I also chose to focus on Unity game development skills, front-end development skills, and back-end development skills so that I can gain experience with a variety of different coding skills.

- **Waseef Nayeem**

- Skills: 2, 4, 5, 6, 10

I have chosen to focus on a combination of skills that I am experienced in as well as ones that are more difficult or new to me. Game development is one of my passions and main hobbies and I always want to learn new techniques to improve my skills. This is why I want to focus on the Unity game and AR development tasks. Since most of my experience is with 2D games, 3D will pose some challenges that I am excited to tackle. I am also interested in learning how to integrate external systems and services into game engines such as Unity as I believe the experience will benefit my future projects. My work on prior projects has taught me the importance of proper documentation. I could improve my documentation skills by practicing technical writing or documentation prior projects. I could also learn new documentation tools and techniques such as using GitHub's wiki features or making a ReadTheDocs page. Lastly, I would like to improve my organization and participation in team settings. To accomplish this I could prepare a personal agenda of items ahead of time or log a to-do list of action items.

- **Abhiram Neelamraju**

- Skills: 3, 4, 5, 6

The skills I plan on acquiring and focusing on have been chosen based on where I feel like I want to improve the most and where I feel like I can contribute the most. I want to be a good team member and possess good team management skills so that I can do well in the future as well in team oriented- environments. I can do so by taking an active role in group discussions and doing my fair share of work on time. I'm also extremely interested in learning about the Unity engine as a whole (4,5,6). Starting from learning basic skills related to Unity game development and Unity AR development. These skills can be acquired through looking through the detailed and comprehensive documentation available online and well as free video tutorials on websites such as YouTube. The specific skills for Integrating external backend systems into a Unity project is more specific and will be learned

more through reading documentation, but there are still video tutorials that teach these skills which I will be following. I also plan on exploring paid options for digital courses on websites such as coursera and Udemy.