LGE

Secure Video Call Development

Phase1 Final Report

Security Specialist Team4 B1C2V3

2023-7-7

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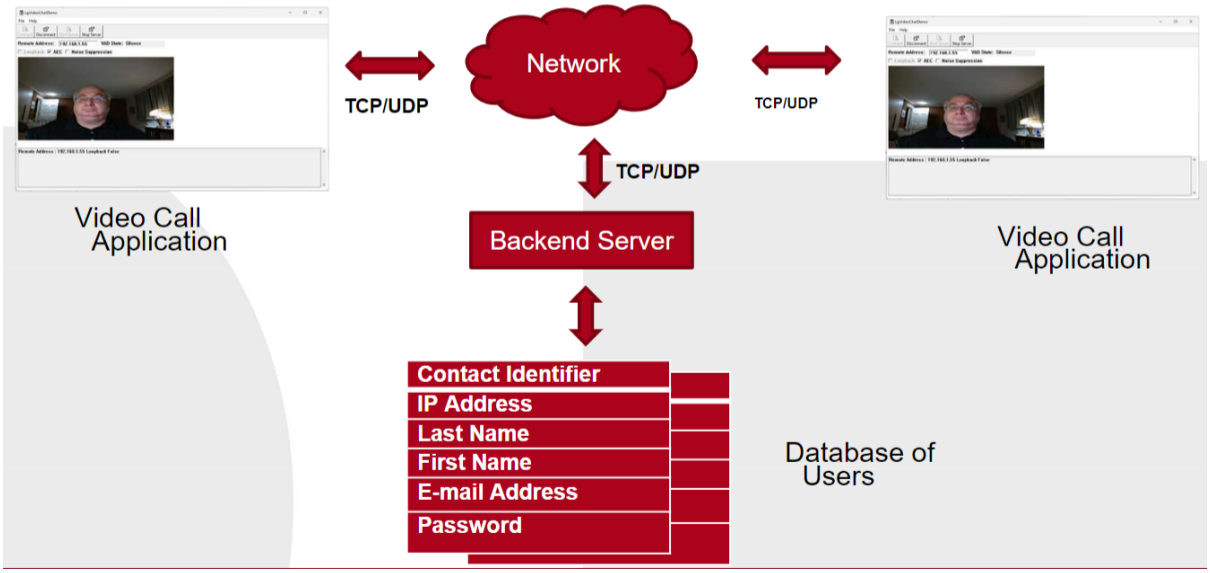
1. Introduction

1.1. Project Overview

System overview

- ✓ Video Call Application for both business and personal users
- ✓ Video Call Communication over the Network
- ✓ User registration and login function with two factor authentication
- ✓ **Current design needs to be improved in terms of security**



1.2. Project Team

Team Name : B1C2V3

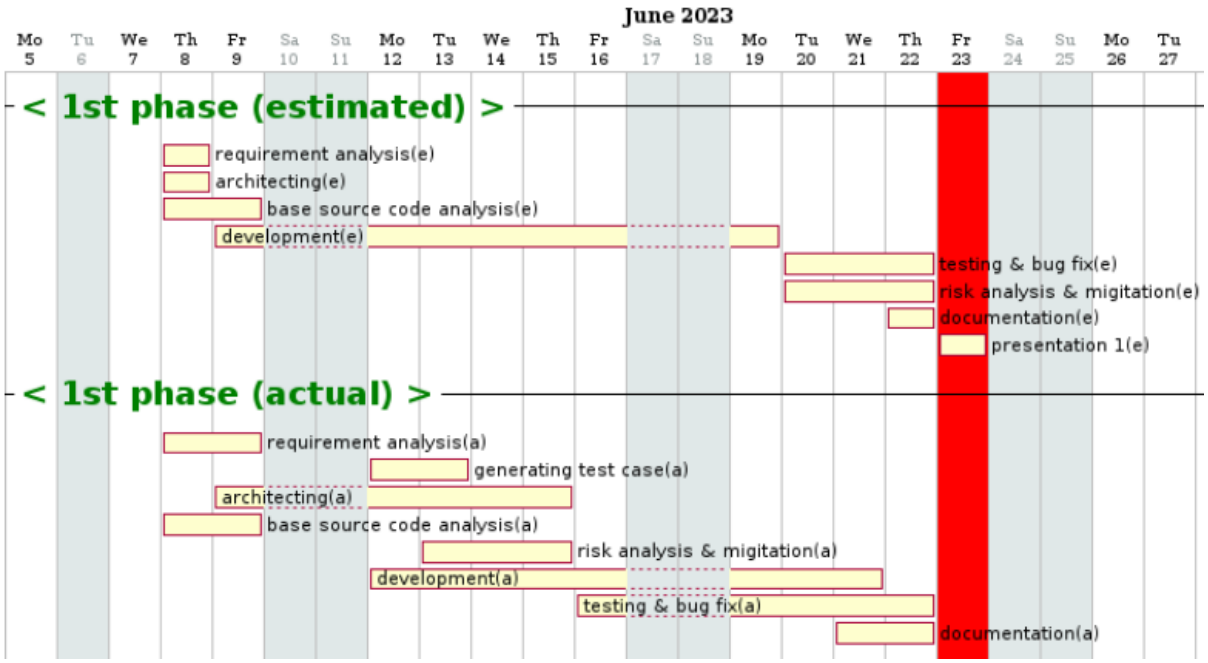
(1 member from BS company, 2 members from CTO, 3 members from VS company)

Team logo : B1C2V3

1.3. Roles and Responsibilities

Name	Responsibilities
Jongoh Ha	Team leader
Chanhun Seung	Threat Analyst & Architect
Youngjin Kim	Requirement manager & Test manager
Hongjae Lim	Application developer
Minji Tae	Application developer
Truong Quang Viet	Backend Server developer

2. Project Schedule



3. Requirement analysis

3.1. Requirement Analysis Result Overview

Functional Requirement	New user registration	11
	Login	8
	User email update	8
	Periodic password reset	10
	Lockout due to incorrect password	13
	Reset password	7
	Unique ID	1
	Contact list	2
	Call	4
	Connection	2
	Notice	2
	Disconnect	2

	Activation	1
	Communication method	1
Non Functional Requirement	Performance	1
	Authentication	2
	Communication privacy	1
	Non repudiation	1
	Reliability	1
Total		78

- ✓ Number of given requirements : 19
  (functional : 14, non functional : 5)
- ✓ Analyzed given requirements throughs **team workshop** and **mentor meeting**
- ✓ Requirement manager derived **78 system requirements** through additional analysis

3.2. Functional Requirements Details

Table 1. Functional Requirement Analysis Result

Req. ID	Req. Name	Sub Req. ID	Description	PR ID	Test ID	Implemented by
FR01	new user registration	FR01REG01	The system shall provide new user registration form that captures essential information such as first name, last name, email address, OTP and password.	PR01B	TC001	App
		FR01REG02	The system shall implement validation to ensure the uniqueness of email addresses to prevent multiple users from registering with the same credentials.	PR01	TC002, TC003	Backend
		FR01REG03	The system shall send a verification email to the user's provided email address upon registration	PR01F	TC002, TC003	Backend

			to confirm their ownership and prevent misuse.			
		FR01REG04	The system shall include an OTP in the email to be sent to verify their account.	PR01B	TC007	Backend
		FR01REG05	The system shall implement a mechanism to handle expired or revoked verification OTP		TC006	Backend
		FR01REG06	Passwords must be a minimum of 10 characters long and include one number and one special character.	PR01A	TC004	Backend
		FR01REG07	Passwords must be confirmed through re-type.		TC005	Backend + App
		FR01REG08	The system shall hash and salt the passwords before storing them in the database to enhance security.			Backend
		FR01REG09	The system shall provide meaningful error messages and validation feedback to users during the registration process to assist them in resolving any issues they encounter.		TC008	Backend
		FR01REG10	The system shall implement error logging and monitoring to track and investigate any registration-related errors or anomalies.		TC008	Backend
		FR01REG11	The system shall implement CAPTCHA or other anti-bot mechanisms to prevent automated registrations. (Optional)		TC009	
FR02	Login	FR02LOG01	The user shall provide the system their email	PR01A, PR01B	TC010	App

			address, password and OTP.			
		FR02LOG02	The email address should be in a standard format. (e.g., "example@example.com") .	PR01A	TC011	Backend + App
		FR02LOG03	The password information must be masked and show	PR01A		App
		FR02LOG04	The system should provide appropriate error messages or notifications to the user if there are any issues with the provided email address or password.		TC012	Backend + App
		FR02LOG05	If email and password are corrected, the user can request OTP	PR01B	TC013	Backend + App
		FR02LOG06	The OTP will be sent to the user's email.	PR01B	TC014,TC015	Backend
		FR02LOG07	The OTP must be 6 characters long and consist of numbers only.	PR01B	TC014,TC015	Backend
		FR02LOG08	The system should provide appropriate error messages or notifications to the user if there are any issues with the OTP.	PR01B	TC016	Backend + App
FR03	user email update	FR03UPD01	Only authorized users should be able to access the functionality to change their email address.	PR01E	TC017	Backend
		FR03UPD02	Before allowing users to change their email address, the system should authenticate their identity to ensure they are the legitimate account holders using password.	PR01E	TC018	Backend
		FR03UPD03	The system should validate the user-provided email address to ensure it	PR01E	TC019	Backend + App

			follows the correct format.			
		FR03UPD04	The system should send a verification OTP to the new email address provided by the user.	PR01E	TC020	Backend
		FR03UPD05	The system should require the user to confirm the change by entering the OTP within a specified timeframe	PR01E	TC020	Backend
		FR03UPD06	The system should implement proper error handling mechanisms to handle scenarios such as invalid email addresses, database failures, network errors, or other exceptional cases.	PR01E	TC021	Backend
		FR03UPD07	Ensure the audit trail is securely stored and accessible only to authorized personnel for monitoring, auditing, and investigating purposes.	PR01E	TC021	Backend
		FR03UPD08	The system should notify users via their existing email address when a change to their email address is requested or successfully completed.	PR01E	TC017	Backend
FR04	Periodic PW Reset	FR04PWRST01	The system shall store the date and time of the user's last password reset	PR01C		Backend
		FR04PWRST02	The system shall enforce a maximum password lifetime of one month (30 days)	PR01C	TC022	Backend
		FR04PWRST03	The system shall compare the current date with the user's last password reset date to determine if a password reset is required	PR01C	TC022	Backend
		FR04PWRST04	If the time since the last password reset exceeds	PR01C	TC023	Backend

			one month, the system shall prompt the user to reset their password			
		FR04PWRST05	The system shall display a notification to the user when their password is due for a reset	PR01C	TC023,TC024	App
		FR04PWRST06	The system shall validate and confirm the new password entered by the user to ensure accuracy	PR01C	TC025	Backend + App
		FR04PWRST07	The system shall log the date and time of the password reset for auditing and security purposes	PR01C	TC027	Backend
		FR04PWRST08	The system shall send a notification email to the user after a successful password reset, confirming the password change	PR01C	TC026	Backend
		FR04PWRST09	The system shall store the history of the user's previous passwords to prevent reuse of the same or similar passwords within a specified period (e.g., the last five passwords)	PR01C	TC028,TC029	Backend
		FR04PWRST10	The system shall provide an option for users to contact support if they encounter any issues during the password reset process or have concerns about their password security	PR01C	TC027	Backend + App
FR05	Lockout due to an incorrect password	FR05LOCK01	The system shall track the number of failed login attempts for each user.	PR01D	TC031	Backend
		FR05LOCK02	The system shall increment the failed login attempt count by one	PR01D	TC030	Backend

			each time a user enters an incorrect password.			
		FR05LOCK03	The system shall reset the failed login attempt count to zero if the user successfully logs in.	PR01D	TC031	Backend
		FR05LOCK04	The system shall lock a user's account if the failed login attempt count exceeds a predefined threshold (e.g., three).	PR01D	TC032	Backend
		FR05LOCK05	The system shall enforce a lockout duration of one hour for a locked account	PR01D	TC033	Backend
		FR05LOCK06	The system shall display an appropriate error message to the user when their account is locked due to excessive failed login attempts.	PR01D	TC035	Backend + App
		FR05LOCK07	The system shall prevent a locked account from being accessed during the lockout duration, regardless of the password entered	PR01D	TC033	Backend
		FR05LOCK08	The system shall display a countdown timer indicating the remaining lockout duration for the user	PR01D	TC033	App
		FR05LOCK09	The system shall automatically unlock the user's account after the lockout duration has elapsed	PR01D	TC034	Backend
		FR05LOCK10	The system shall notify the user via email when their account is locked due to excessive failed login attempts	PR01D	TC035	Backend
		FR05LOCK11	The system shall include a link in the email notification for the user to	PR01D	TC035	Backend

			contact support if they believe their account has been locked incorrectly or for any other account-related issues.			
		FR05LOCK12	The system shall log all account lockout events for auditing and security purposes	PR01D	TC032	Backend
		FR05LOCK13	The system shall provide an option for users to reset their password during the account lockout period using the password recovery functionality.	PR01D	TC036	Backend + App
~~FR06~~	~~Reset PW~~	~~FR06PWRST01~~	~~The system shall provide a form for users to initiate password recovery.~~	PR01F	TC037,TC039	App
		~~FR06PWRST02~~	~~The system shall show the user to enter their registered email address.~~	PR01F	TC037	App
		~~FR06PWRST03~~	~~The system shall validate the entered email address and verify its existence in the user database.~~	PR01F	TC037,TC038	Backend
		~~FR06PWRST04~~	~~If the email address is valid and registered, the system shall generate a temporary password and send it to the user's email address.~~	PR01F	TC037,TC038, TC040	Backend
		~~FR06PWRST05~~	~~The system shall provide a secure password reset form where the user can enter a new password after the user successfully login using the temporary password~~	PR01F	TC039	Backend + App
		~~FR06PWRST06~~	~~Upon successful password reset, the system shall notify the user via email that their password has been changed.~~	PR01F	TC039	Backend

		~~FR06PWRST07~~	~~The system shall log all password recovery and reset activities for auditing and security purposes.~~	PR01F	TC041~TC043	Backend
FR07	Unique ID	FR07UID01	After successful registration the system shall assign the user a unique contact identifier.	PR02	TC044	Backend
FR08	Contact list	FR08CTT01	The system shall provide a contact list that associates a person with their contact identifier (last name, first name, e-mail, contact identifier).	PR03	TC044	Backend
		FR08CTT02	When a contact is associated with a contact identifier the VoIP application shall display the contact's name instead of the contact identifier.	PR03	TC045	App
FR09	call	FR09CALL01	The system shall provide the ability to initiate a call using a contact identifier or the contacts list.	PR04	TC046	App
		FR09CALL02	The system shall maintain a log of call activities, including call start time, duration, participants, and call outcome (answered, busy, or rejected).	PR04	TC046	Backend
		FR09CALL03	Provide a call history feature that allows users to view and review past calls, including details like participants, timestamps, and call duration.	PR04	TC047	App
		FR09CALL04	During the call initiation, the user shall be presented with call status and outcome (answered, busy or rejected).	PR04	TC048	App
FR10	connection	FR10CON01	The system shall provide the ability to accept or	PR05	TC050,TC051	App

			reject calls while not in a call.			
		FR10CON02	Application shall show the caller's contact identifier or contact name during an incoming call.	PR05	TC050	App
FR11	notice	FR11NOTI01	The system shall notify the user of missed calls, in case of the call was not accepted.	PR06	TC051,TC0525	App
		FR11NOTI02	The system shall notify the user of missed calls, when the called entity was in another call.	PR06	TC053	App
FR12	disconnect	FR12DISC01	Provide the ability to terminate a call at any time while in a call.	PR04,PR07	TC049	App
		FR12DISC01	If a call is terminated by one user, the other caller shall be notified.	PR07	TC054	App
FR13	Activation	FR13ACT01	Application shall be brought to the foreground during an incoming call.	PR08	TC055	App
FR14	Communication methods	FR14CMM01	This application is a point-to-point communication system. That is, each end point of the call should function as both a server and a client.	PR09	TC056	App

3.3. Non Functional Requirements Details

Table 2. Non Functional Requirement Analysis Result

Req. ID	Req. Name	Func ID	Func Name	Description	PR ID	
NFR01	Performance	NFR01_PERF01	Real time communication	The system must deliver call video/audio as close to real time as possible.	PR10	
NFR02	Authentication	NFR02_AUTH01		The system must use two factor authentication for sign on and user credentials must be protected.	PR11	
		NFR02_AUTH02		Lost or compromised credentials must be handled in a reasonable way.	PR11	
NFR03	communication privacy	NFR03_PRI01	Privating communication	The system must ensure that calls remain private. No intermediary should be able to snoop or spy on an ongoing call.	PR12	
NFR04	nonrepudiation	NFR04_NREP01		Users should be confident that the entity they are on a call with is the one that they believe it is.	PR13	
NFR05	reliability	NFR05_REL01		The system must ensure that calls are reliable. The system should recover from networking errors and dropped calls as soon as possible. The goal is to maintain a secure, performant connection at all costs.	PR14	

3.4. Use Case Scenarios

FR01 New User Registration

Table 3. Use case scenarios

Req ID	FR01
Title	New User Registration
Primary Actor	User
Pre-conditions	● The user must have access to the registration form provided by the system. ● The system must be operational and able to handle registration requests. ● The user must have a valid email address to receive the verification email.

	● The user must have a secure internet connection to access the registration form and receive the verification email. ● The database server must be accessible and able to store user data.
Scenario	1. User opens the registration form of the system. 2. System presents the registration form to the user, including fields for first name, last name, email address, OTP, and password. 3. User enters their registration information. 4. System validates the uniqueness of the email address. 5. If the email address is already registered, the system displays an error message to the user. 6. If the email address is unique, the system generates a unique identifier for the user. 7. System sends a verification email to the user's provided email address, including an OTP. 8. User checks their email and retrieves the OTP. 9. User enters the OTP into the registration form. 10. System validates the OTP and checks for expiration or revocation. 11. If the OTP is invalid, expired, or revoked, the system displays an error message to the user. 12. If the OTP is valid, the system enforces password requirements. 13. User enters and confirms their password, ensuring it meets the requirements. 14. System hashes and salts the password for secure storage. 15. System stores the user's registration data in the database. 16. System displays a success message to the user, confirming their registration. 17. User can now log in to the system using their registered email address and password.
Post-conditions	● Upon successful registration, the user's information is stored securely in the database. ● The user receives a verification email containing an OTP to verify their account. ● If the OTP is validated successfully, the user is considered registered and can proceed with logging into the system. ● The user can now access the system using their registered email address and password.
Alternate Flow	1. User opens the registration form of the system. 2. System presents the registration form to the user, including fields for first name, last name, email address, OTP, and password. 3. User enters their registration information. 4. System validates the uniqueness of the email address. 5. If the email address is already registered, the system displays an error message to the user. 6. If the email address is unique, the system encounters an error while generating a unique identifier. 7. System displays an error message to the user, indicating the problem with generating a unique identifier. 8. User can choose to retry the registration process or contact support for assistance. 9. If the user chooses to retry, the process continues from Step 1. 10. If the user chooses to contact support, the process is temporarily halted until the issue is resolved.

	11. Once the issue is resolved, the user can proceed with the registration process from the beginning.

FR02 Login

Req ID	FR02
Title	Login
Primary Actor	User
Pre-conditions	● The user must have a registered account with the system. ● The user must have a valid email address and password. ● The user must have access to their registered email account. ● The system must be operational and accessible.
Scenario	1. User opens the login page of the system. 2. System presents the login form to the user, including fields for email address, password, and OTP. 3. User enters their email address and password. 4. System validates the email address and password format. 5. If the email address or password is invalid, the system displays an error message to the user. 6. If the email address and password are valid, the user can request an OTP. 7. User clicks the "Request OTP" button. 8. System generates an OTP and sends it to the user's registered email address. 9. User checks their email and retrieves the OTP. 10. User enters the OTP into the login form. 11. System validates the OTP format and checks for expiration. 12. If the OTP is invalid or expired, the system displays an error message to the user. 13. If the OTP is valid, the system authenticates the user. 14. System logs the user into the system and grants access to the authorized features. 15. System displays a success message to the user, confirming their login. 16. User can now interact with the system and perform the desired actions.
Post-conditions	● The user is successfully logged into the system. ● The user has access to the authorized features and functionalities. ● The system tracks the user's session and activity. ● The user can perform actions within their authorized scope. ● If the user encounters any issues during the login process, appropriate error messages are displayed, and the user is guided to resolve the issues.
Alternate Flow	1. User opens the login page of the system. 2. System presents the login form to the user, including fields for email address, password, and OTP. 3. User enters their email address and password. 4. System validates the email address and password format. 5. If the email address or password is invalid, the system displays an error message to the user. 6. If the email address and password are valid, the user can request an OTP.

	7. User clicks the "Request OTP" button. 8. System encounters an issue sending the OTP to the user's email address. 9. System displays an error message to the user, indicating the problem with the email delivery. 10. User can choose to retry the OTP request or contact support for assistance. 11. If the user chooses to retry, the process continues from Step 7. 12. If the user chooses to contact support, the process is temporarily halted until the issue is resolved. 13. Once the issue is resolved, the user can proceed with the login process from the beginning.

FR03 User Email Update

Req ID	FR03
Title	User Email Update
Primary Actor	User
Pre-conditions	● The user must be an authorized user with access to the email update functionality. ● The user must have a valid account and be logged into the system. ● The user must have an existing email address associated with their account. ● The user must have a secure internet connection to access the email update functionality. ● The system must be operational and able to handle email update requests.
Scenario	1. User initiates the email update process. 2. System authenticates the user's identity by requesting their password. 3. User enters their password. 4. System validates the password and confirms the user's identity. 5. System presents the email update form to the user. 6. User enters the new email address they wish to update to. 7. System validates the new email address format. 8. If the new email address is invalid, the system displays an error message to the user. 9. If the new email address is valid, the system sends a verification OTP to the new email address. 10. System displays a success message indicating that the verification OTP has been sent. 11. User checks their new email address and retrieves the OTP. 12. User enters the OTP within the specified timeframe. 13. System verifies the OTP and confirms the email address change. 14. If the OTP is incorrect or expired, the system displays an error message to the user. 15. If the OTP is correct and within the specified timeframe, the system updates the user's email address. 16. System securely stores the audit trail of the email address change. 17. System sends a notification email to the user's existing email address, informing them of the email address change. 18. System displays a success message to the user, confirming the email address change.
Post-conditions	● The user's email address is successfully updated in the system. ● The user receives a notification email informing them of the email address change.

	● The user can now use the new email address for authentication and communication. ● If the user encounters any issues during the email update process, appropriate error messages are displayed, and the user is guided to resolve them.
Alternate Flow	1. User initiates the email update process. 2. System authenticates the user's identity by requesting their password. 3. User enters their password. 4. System validates the password and confirms the user's identity. 5. System presents the email update form to the user. 6. User enters the new email address they wish to update to. 7. System validates the new email address format. 8. If the new email address is invalid, the system displays an error message to the user. 9. If the new email address is valid, the system encounters an error while sending the verification OTP. 10. System displays an error message to the user, indicating the problem with sending the verification OTP. 11. User can choose to retry the email update process or contact support for assistance. 12. If the user chooses to retry, the process continues from Step 1. 13. If the user chooses to contact support, the process is temporarily halted until the issue is resolved. 14. Once the issue is resolved, the user can proceed with the email update process from the beginning.

FR04 Periodic Password Reset

Req ID	FR04
Title	Periodic Password Reset
Primary Actor	User
Pre-conditions	● User is logged in. ● User's password has expired.
Scenario	1. System prompts the user to enter a new password. 2. User enters a new password. 3. System validates the new password. 4. System updates the user's password in the system's database. 5. System logs the date and time of the password reset. 6. System sends a confirmation email to the user, confirming the password change.
Post-conditions	● User's password is successfully reset. ● User receives a confirmation email.
Alternate Flow	1. N/A

FR05 Incorrect Password Lock

Req ID	FR05
Title	Incorrect Password Lock
Primary Actor	User
Pre-conditions	● User has a registered account
Scenario	1. User enters their username and password.

	2. System verifies the entered credentials. 3. If the credentials are valid: A. System resets the failed login attempt count to zero. B. User is successfully logged in. 4. If the credentials are invalid: A. System increments the failed login attempt count by one for the user. B. If the failed login attempt count exceeds the predefined threshold: i. System locks the user's account. ii. System displays an error message to the user indicating that their account is locked due to excessive failed login attempts.
Post-conditions	● User is successfully logged in. ● User's account is locked if the failed login attempt threshold is exceeded. ● User receives an error message if their account is locked
Alternate Flow	4a. If the user's account is locked: 1. System displays an error message indicating that the account is locked. 2. System displays a countdown timer indicating the remaining lockout duration for the user. 3. User cannot access the account during the lockout duration, regardless of the password entered.

4. Test Case Design

Test cases are generated based on functional requirements in previous chapter.

Sign-Up

Test Case 1: Successful Registration

Test Case ID	TC001
Title	Successful Registration
Pre-conditions	The Sign-Up form is accessible and all required fields are provided.
Sequence	Enter a unique email address. Click "Duplicate Check" Button Enter a valid password. Confirm the password by re-typing it. Enter a valid first name. Enter a valid last name.
Input Values	Email Address: john.doe@example.com Password: Abcd1234!@#$ Confirm Password: Abcd1234!@#$ First Name: john Last Name: doe
Expected Result	User account is created successfully. Verification email is sent to the provided email address. Success message displayed.

Post-conditions	The user's account is registered and pending verification.

Test Case 2: Invalid Email Address

Test Case ID	TC002
Title	Invalid Email Address
Pre-conditions	The Sign-Up form is accessible.
Sequence	Enter an invalid email address format. Click "Duplicate Check"
Input Values	Email Address: john.doe@example.com
Expected Result	Error message displayed indicating invalid email address format.
Post-conditions	The system show to correct the email address format.

Test Case 3: Existing Email Address

Test Case ID	TC003
Title	Existing Email Address
Pre-conditions	The Sign-Up form is accessible.
Sequence	Enter an email address that is already registered in the system.
Input Values	Email Address: john.doe@example.com
Expected Result	Error message displayed indicating that the email address is already in use.
Post-conditions	The user is prompted to provide a different email address.

Test Case 4: Weak Password

Test Case ID	TC004
Title	Weak Password
Pre-conditions	The Sign-Up form is accessible.
Sequence	Enter a unique email address. Enter a weak password that does not meet the complexity requirements. Confirm the password by re-typing it. Enter a first name. Enter a last name.
Input Values	Email Address: john.doe@example.com Password: password123 Confirm Password: password123 First Name: John Last Name: Doe
Expected Result	Error message displayed indicating password complexity requirements not met.
Post-conditions	The user is prompted to provide a stronger password.

Test Case 5: Password Mismatch

Test Case ID	TC005
Title	Password Mismatch
Pre-conditions	The Sign-Up form is accessible.
Sequence	Enter a unique email address. Enter a valid password. Confirm the password by re-typing it with a different value. Enter a first name. Enter a last name.
Input Values	Email Address: john.doe@example.com Password: Abcd1234!@#$ Confirm Password: DifferentPassword123 First Name: John Last Name: Doe
Expected Result	Error message displayed indicating that the passwords do not match.
Post-conditions	The user is prompted to re-enter the password correctly.

Test Case 8: Error Logging

Test Case ID	TC008
Title	Successful Verification
Pre-conditions	The Sign-Up process encounters an internal error.
Sequence	Submit the Sign-Up form, triggering an internal error.
Input Values	N/A
Expected Result	Error is logged. Error notification is generated for further investigation.
Post-conditions	Error is flagged for investigation and resolution.

Sign-In

Test Case 10: Successful Sign-In

Test Case ID	TC010
Title	Successful Sign-In
Pre-conditions	The Sign-In form is accessible.
Sequence	Enter a valid email address. Enter a valid password. Click on the “Create OTP” button. Enter a OTP passed via email
Input Values	Email Address: john.doe@example.com Password: Abcd1234!@#$
Expected Result	User is successfully logged in

Post-conditions	The user is logged in and has access to their account.

Test Case 11: Invalid Email Address

Test Case ID	TC011
Title	Invalid Email Address
Pre-conditions	The Sign-In form is accessible.
Sequence	Enter an invalid email address format. Enter a valid password. Click on the "Create OTP" button.
Input Values	Email Address: invalidemail Password: Abcd1234!@#$
Expected Result	Error message displayed indicating an invalid email address format.
Post-conditions	The user is prompted to correct the email address format.

Test Case 12: Incorrect Password

Test Case ID	TC012
Title	Incorrect Password
Pre-conditions	The Sign-In form is accessible.
Sequence	Enter a valid email address. Enter an incorrect password. Click on the "Create OTP" button.
Input Values	Email Address: john.doe@example.com Password: IncorrectPassword123
Expected Result	Error message displayed indicating an incorrect password.
Post-conditions	The user is prompted to enter the correct password.

Test Case 13: Request OTP

Test Case ID	TC013
Title	Request OTP
Pre-conditions	The Sign-In form is accessible.
Sequence	Enter a valid email address. Enter a valid password. Click on the "Create OTP" button.
Input Values	Email Address: john.doe@example.com Password: Abcd1234!@#$
Expected Result	User is prompted to enter the OTP received via email. Start OTP time count down during a minute
Post-conditions	The user is prompted to enter the OTP for verification.

Test Case 14: Invalid OTP

Test Case ID	TC014
Title	Invalid OTP
Pre-conditions	The Sign-In form is accessible.
Sequence	Enter a valid email address. Enter a valid password. Enter an invalid OTP. Click on the "Verify OTP" button.
Input Values	Email Address: john.doe@example.com Password: Abcd1234!@#$ OTP: InvalidOTP
Expected Result	Error message displayed indicating an invalid OTP.
Post-conditions	The user is prompted to enter the correct OTP.

Test Case 15: Successful OTP Verification

Test Case ID	TC015
Title	Successful OTP Verification
Pre-conditions	The Sign-In form is accessible.
Sequence	Enter a valid email address. Enter a valid password. Enter the correct OTP received via email. Click on the "Confirm" button.
Input Values	Email Address: john.doe@example.com Password: Abcd1234!@#$ OTP: ValidOTP
Expected Result	User is successfully verified and logged in.
Post-conditions	The user is logged in and has access to their account.

Test Case 16: Error Logging

Test Case ID	TC016
Title	Error Logging
Pre-conditions	The Sign-In process encounters an internal error.
Sequence	Submit the Sign-In form, triggering an internal error.
Input Values	N/A
Expected Result	Error is logged. Error notification is generated for further investigation.
Post-conditions	Error is flagged for investigation and resolution.

User Email Update

Test Case 17: Successful Email Address Update

Test Case ID	TC017
Title	Successful Email Address Update
Pre-conditions	The user is logged in as "john.doe@example.com" and has access to the email address update functionality.
Sequence	Click on the "Update" button Enter the current password for authentication. Enter a valid new email address. Click on the "Duplicate Check" button. Click on the "Generate OTP" button. Retrieve the OTP sent to the new email address. Enter the OTP within the specified timeframe. Click on the "Confirm" button.
Input Values	Current Password: Abc123!@# New Email Address: newemail@example.com OTP: ValidOTP
Expected Result	User's email address is successfully updated to the new email address. User receives a notification to their existing email address confirming the email address change.
Post-conditions	The user's email address is updated in the system and they can now log in using the new email address.

Test Case 18: Incorrect Password

Test Case ID	TC018
Title	Incorrect Password
Pre-conditions	The user is logged in as "john.doe@example.com" and has access to the email address update functionality.
Sequence	Click on the "Update" option. Enter an incorrect password for authentication. Click on the "Submit" button.
Input Values	Current Password: IncorrectPassword123 New Email Address: newemail@example.com
Expected Result	Error message displayed indicating an incorrect password.
Post-conditions	The user is prompted to enter the correct password for authentication.

Test Case 19: Invalid Email Address Format

Test Case ID	TC019
Title	Invalid Email Address Format
Pre-conditions	The user is logged in as "john.doe@example.com" and has access to the email address update functionality.
Sequence	Click on the "Update" option. Enter the current password for authentication. Enter an invalid email address format. Click on the "Duplicate Check" button.

Input Values	Current Password: CurrentPassword123 New Email Address: invalidemail
Expected Result	Error message displayed indicating an invalid email address format.
Post-conditions	The user is prompted to enter a valid email address format.

Test Case 20: OTP Expiry

Test Case ID	TC020
Title	OTP Expiry
Pre-conditions	The user is logged in as "john.doe@example.com" and has access to the email address update functionality.
Sequence	Click on the "Update" button. Enter the current password for authentication. Enter a valid new email address. Click on the "Generate OTP" button. Retrieve the OTP sent to the new email address. Wait until the OTP has expired. Enter the expired OTP. Click on the "Verify OTP" button.
Input Values	Current Password: Abc123!@# New Email Address: newemail@example.com OTP: ExpiredOTP
Expected Result	Error message displayed indicating an expired OTP.
Post-conditions	The user is prompted to request a new OTP.

Test Case 21: Error Logging

Test Case ID	TC021
Title	Error Logging
Pre-conditions	The email address update process encounters an internal error.
Sequence	Click on the "Update" button. Enter the current password for authentication. Enter a valid new email address. Click on the "Generate OTP" button, triggering an internal error.
Input Values	Current Password: Abc123!@# New Email Address: newemail@example.com
Expected Result	Error is logged. Error notification is generated for further investigation.
Post-conditions	Error is flagged for investigation and resolution.

Periodic Password Reset

Test Case 22: Password Reset Prompt

Test Case ID	TC022
Title	Password Reset Prompt
Pre-conditions	The user is logged in and the password reset condition is met (exceeds 30 days since last password reset).
Sequence	User logs in. System compares the current date with the user's last password reset date. Password reset condition is met. System prompts the user to reset their password upon next Sign-In.
Input Values	N/A
Expected Result	User sees a notification or message indicating that their password needs to be reset. User is not allowed to access the system until they reset their password.
Post-conditions	User is prompted to reset their password before accessing the system.

Test Case 23: Password Reset Notification

Test Case ID	TC023
Title	Password Reset Notification
Pre-conditions	The user is logged in and the password reset condition is not met.
Sequence	User logs in. System compares the current date with the user's last password reset date. Password reset condition is not met. System displays a notification to the user indicating when their password is due for a reset.
Input Values	N/A
Expected Result	User sees a notification or message indicating when their password is due for a reset. User is allowed to continue using the system without any immediate password reset requirement.
Post-conditions	User is notified about when their password is due for a reset.

Test Case 24: Successful Password Reset

Test Case ID	TC024
Title	Successful Password Reset
Pre-conditions	The user has requested a password reset and successfully authenticated.
Sequence	User initiates the password reset process. User enters the new password and confirms it. User submits the new password. System validates and confirms the new password. System updates the user's password in the database. System logs the date and time of the password reset. System sends a notification email to the user confirming the password change.
Input Values	New Password: NewPassword123 Confirm Password: NewPassword123
Expected	User's password is successfully updated in the system's database.

Result	User receives a notification email confirming the password change.
Post-conditions	User can log in using the new password and has an updated password reset date.

Test Case 25: Password Reset Validation Failure

Test Case ID	TC025
Title	Password Reset Validation Failure
Pre-conditions	The user has requested a password reset and entered an invalid or non-matching password.
Sequence	User initiates the password reset process. User enters an invalid or non-matching new password and confirms it. User submits the new password.
Input Values	New Password: InvalidPassword123 Confirm Password: InvalidPassword456
Expected Result	System displays an error message indicating that the new password and confirm password do not match or do not meet the validation criteria. User is prompted to enter a valid and matching password.
Post-conditions	User is prompted to enter a valid and matching password for the password reset.

Test Case 26: Password Reset Email Confirmation

Test Case ID	TC026
Title	Password Reset Email Confirmation
Pre-conditions	The user has successfully completed the password reset process.
Sequence	User successfully resets their password. System sends a notification email to the user confirming the password change.
Input Values	N/A
Expected Result	User receives a notification email confirming the password change.
Post-conditions	User receives an email confirming the password change.

Test Case 27: Contact Support During Password Reset

Test Case ID	TC027
Title	Contact Support During Password Reset
Pre-conditions	The user encounters issues during the password reset process or has concerns about their password security.
Sequence	User encounters issues during the password reset process or has concerns about their password security. User selects the option to contact support for assistance.
Input Values	N/A
Expected Result	System provides a means for the user to contact support.
Post-conditions	User receives assistance or guidance from the support team regarding the password reset process or password security concerns.

Test Case 28: Password History Check

Test Case ID	TC028
Title	Password History Check
Pre-conditions	The user is attempting to change their password.
Sequence	User enters a new password that has been previously used within the specified period (e.g., the last five passwords). User submits the new password.
Input Values	New Password: PreviouslyUsed123
Expected Result	System detects that the new password has been used before and prevents its usage. User receives an error message indicating that the new password cannot be reused.
Post-conditions	User is prompted to enter a different password that has not been used within the specified period.

Test Case 29: Password History Check (Valid Password)

Test Case ID	TC029
Title	Password History Check (Valid Password)
Pre-conditions	The user is attempting to change their password.
Sequence	User enters a new password that has not been previously used within the specified period (e.g., the last five passwords). User submits the new password.
Input Values	New Password: NewPassword123
Expected Result	System validates the new password as it has not been used before within the specified period. User's password is successfully updated in the system's database.
Post-conditions	User's password is updated in the system's database and can be used for authentication.

Lockout due to an incorrect password

Test Case 30: Failed Sign-In Attempt Tracking

Test Case ID	TC030
Title	Failed Sign-In Attempt Tracking
Pre-conditions	User attempts to log in with an incorrect password.
Sequence	User enters an incorrect password. User submits the Sign-In form.
Input Values	Email address: john@example.com Password: IncorrectPassword123
Expected Result	System increments the failed Sign-In attempt count for the user by one.
Post-conditions	Failed Sign-In attempt count for the user is incremented by one.

Test Case 31: Successful Sign-In

Test Case ID	TC031
Title	Successful Sign-In
Pre-conditions	User attempts to log in with the correct password.
Sequence	User enters the correct password.

	User submits the Sign-In form.
Input Values	Email address: john.doe@example.com Password: Abc123!@#
Expected Result	System resets the failed Sign-In attempt count for the user to zero. User successfully logs in.
Post-conditions	Failed Sign-In attempt count for the user is reset to zero, and the user is logged in.

Test Case 32: Account Lockout

Test Case ID	TC032
Title	Account Lockout
Pre-conditions	User attempts to log in with an incorrect password exceeding the predefined threshold.
Sequence	User enters an incorrect password multiple times, exceeding the predefined threshold (three). User submits the Sign-In form.
Input Values	Email address: john.doe@example.com Password: IncorrectPassword123 (used three times)
Expected Result	System increments the failed Sign-In attempt count for the user by one for each attempt. System detects that the failed Sign-In attempt count exceeds the predefined threshold and locks the user's account. User receives an appropriate error message indicating that their account has been locked due to excessive failed Sign-In attempts. System logs the account lockout event for auditing and security purposes.
Post-conditions	User's account is locked, and the failed Sign-In attempt count is incremented.

Test Case 33: Account Lockout Duration

Test Case ID	TC033
Title	Account Lockout Duration
Pre-conditions	User attempts to access their locked account during the lockout duration.
Sequence	User enters the correct password to log in. User submits the Sign-In form.
Input Values	Email address: john@example.com Password: CorrectPassword123
Expected Result	System detects that the user's account is locked and prevents access, regardless of the password entered. User receives an appropriate error message indicating that their account is locked. System displays a countdown timer indicating the remaining lockout duration for the user.
Post-conditions	User is unable to log in due to account lockout.

Test Case 34: Account Automatic Unlock

Test Case ID	TC034
Title	Account Automatic Unlock
Pre-conditions	User's account is locked due to excessive failed Sign-In attempts.
Sequence	User waits for the lockout duration to elapse.

	User attempts to log in with the correct password.
Input Values	Email address: john@example.com Password: CorrectPassword123
Expected Result	System automatically unlocks the user's account after the lockout duration has elapsed. User is able to log in successfully.
Post-conditions	User's account is unlocked, and the user is logged in.

Test Case 35: Account Lockout Email Notification

Test Case ID	TC035
Title	Account Lockout Email Notification
Pre-conditions	User's account is locked due to excessive failed Sign-In attempts.
Sequence	User's account reaches the threshold for failed Sign-In attempts, and the account is locked. System sends an email notification to the user informing them of the account lockout.
Input Values	N/A
Expected Result	User receives an email notification stating that their account has been locked due to excessive failed Sign-In attempts. Email notification includes information about the lockout duration and a link to contact support for assistance.
Post-conditions	User receives an email notification about the account lockout.

Test Case 36: Password Reset during Account Lockout

Test Case ID	TC036
Title	Password Reset during Account Lockout
Pre-conditions	User's account is locked due to excessive failed Sign-In attempts.
Sequence	User clicks on the "Forgot Password" form User enters their registered email address in the password recovery form. User submits the password recovery form.
Input Values	Email Address: john@example.com
Expected Result	System verifies the user's email address and confirms that the account is currently locked. System sends a password recovery email to the user's registered email address, providing instructions to reset the password during the account lockout period. User receives the password recovery email with an OTP to reset their password.
Post-conditions	User receives a password recovery email with instructions to reset the password during the account lockout period.

Unique ID & Contact list

Test Case 44: Display unique contact identifier

Test Case ID	TC044
Title	Display unique contact identifier
Pre-conditions	N/A
Sequence	User has successfully logs in the system.
Input Values	N/A

Expected Result	Displayed contact lists (last name, first name, e-mail, contact identifier). No other user in the system has the same contact identifier.
Post-conditions	N/A

Test Case 45: Display contact name instead of contact identifier

Test Case ID	TC045
Title	Display contact name instead of contact identifier
Pre-conditions	The contact list contains a contact with associated contact identifier.
Sequence	User initiates a video call with a contact.
Input Values	N/A
Expected Result	The application displays the contact's name instead of the contact identifier during the video call.
Post-conditions	The video call is connected with the correct contact.

Call

Test Case 46: Initiate a call using a contact identifier

Test Case ID	TC046
Title	Initiate a call using a contact identifier
Pre-conditions	User is logged in and has access to the contact identifier.
Sequence	User enters a valid contact identifier to initiate a call.
Input Values	Contact identifier (valid)
Expected Result	The call is successfully initiated with the specified contact. The call log is updated with the call start time, duration, participants, and call outcome.
Post-conditions	The call log is updated with the call details.

Test Case 47: View call history

Test Case ID	TC047
Title	View call history
Pre-conditions	User has made previous calls and the call history is available.
Sequence	User navigates to the call history feature.
Input Values	N/A
Expected Result	The call history is displayed, showing past calls with details like participants, timestamps, and call duration.
Post-conditions	The call history is displayed to the user.

Test Case 48: Check call status and outcome during call initiation

Test Case ID	TC048
Title	Check call status and outcome during call initiation
Pre-conditions	User is initiating a call.
Sequence	User initiates a call.

Input Values	N/A
Expected Result	The user is presented with the call status (e.g., ringing) during call initiation. The call outcome is displayed once the call is answered, busy, or rejected.
Post-conditions	The user is informed about the call status and outcome.

Test Case 49: End the call during call initiation

Test Case ID	TC049
Title	End the call during call initiation
Pre-conditions	User is initiating a call.
Sequence	User initiates a call. User chooses to end the call.
Input Values	N/A
Expected Result	The call initiation process is interrupted, and the call is not connected.
Post-conditions	The call initiation process is terminated.

Connection, Notice and Disconnect

Test Case 50: Accept incoming call

Test Case ID	TC050
Title	Accept incoming call
Pre-conditions	User is logged in and is not currently in a call.
Sequence	User receives an incoming call notification. User selects the option to accept the call.
Input Values	Selected option = Accept
Expected Result	The system establishes the call connection. The user interface transitions to the active call screen, showing the contact name of the caller.
Post-conditions	The user is in an active call with the caller.

Test Case 51: Reject incoming call

Test Case ID	TC051
Title	Reject incoming call
Pre-conditions	User is logged in and is not currently in a call.
Sequence	User receives an incoming call notification. User selects the option to reject the call.
Input Values	Selected option = Reject
Expected Result	The incoming call is terminated. The user interface remains in the current state.
Post-conditions	The user is not in a call and returns to their previous state.

Test Case 52: Missed call notification (call not accepted)

Test Case ID	TC052
Title	Missed call notification (call not accepted)
Pre-conditions	User is logged in and has missed an incoming call.
Sequence	User receives a missed call notification. User opens the missed call notification.
Input Values	N/A
Expected Result	The system displays the missed call information, including the contact identifier or contact name of the caller.
Post-conditions	The user is informed about the missed call.

Test Case 53: Missed call notification (called entity in another call)

Test Case ID	TC053
Title	Missed call notification (called entity in another call)
Pre-conditions	User is logged in and has missed an incoming call due to the called entity being in another call.
Sequence	User receives a missed call notification. User opens the missed call notification.
Input Values	N/A
Expected Result	The system displays the missed call information, including the contact identifier or contact name of the caller.
Post-conditions	The user is informed about the missed call.

Test Case 54: Call termination notification

Test Case ID	TC054
Title	Call termination notification
Pre-conditions	User A and User B are engaged in an active call.
Sequence	User A terminates the call.
Input Values	Termination action by User A
Expected Result	User B receives a call termination notification.
Post-conditions	The call is ended for both User A and User B.

Test Case 55: Application brought to the foreground during incoming call

Test Case ID	TC055
Title	Application brought to the foreground during incoming call
Pre-conditions	User is logged in and the application is running in the background.
Sequence	User receives an incoming call.
Input Values	Incoming call notification
Expected Result	The application is brought to the foreground, becoming the active window. The user interface displays the incoming call screen with the contact name of the caller.

Post-conditions	The user is presented with the incoming call screen.

Communication methods

Test Case 56: Point-to-point communication functionality

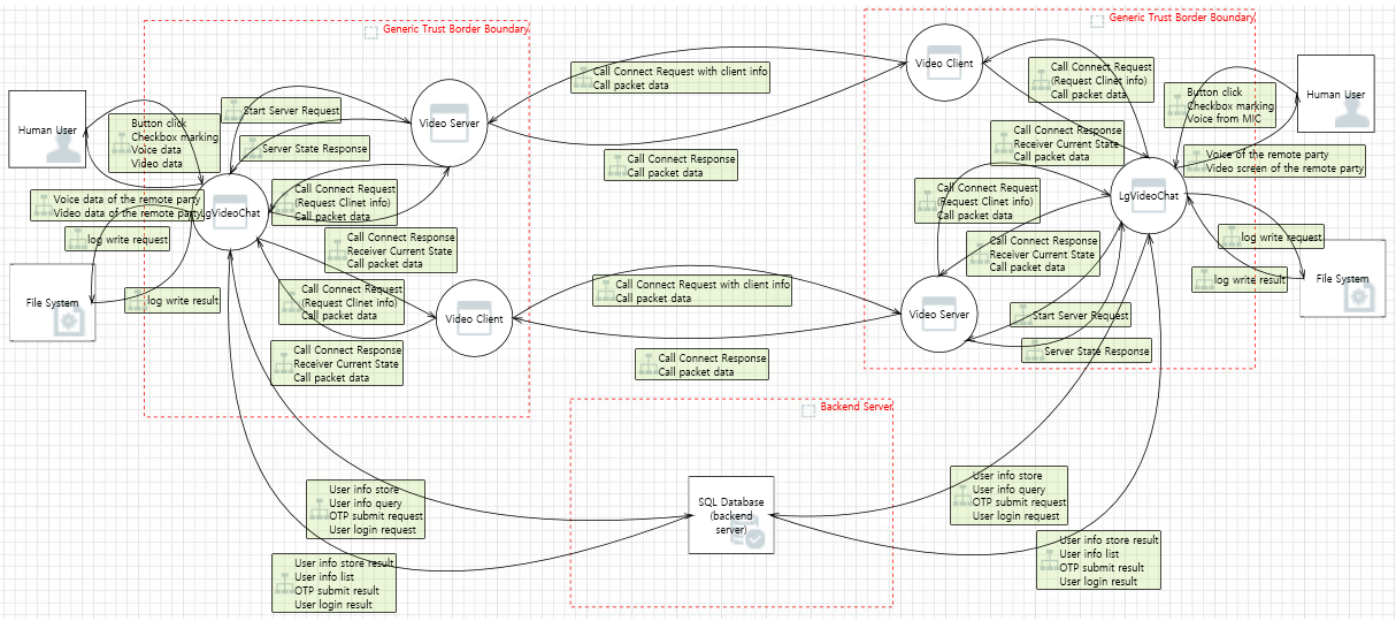
Test Case ID	TC056
Title	Point-to-point communication functionality
Pre-conditions	The application is installed and running on both endpoints of the call.
Sequence	User A initiates a call to User B.
Input Values	Call initiation by User A
Expected Result	User B functions as the server, waiting for a response from User A. User A functions as the client, receiving the call initiation request.
Post-conditions	User A and User B establish a point-to-point communication connection.

Test Case 57: Call initiation failure

Test Case ID	TC057
Title	Call initiation failure
Pre-conditions	The application is installed and running on both endpoints of the call.
Sequence	User A initiates a call to User B. User B's device is turned off or not connected to the network.
Input Values	Call initiation by User A
Expected Result	User A's application displays an error message indicating the call initiation failure. User B's application does not receive the call initiation request.
Post-conditions	The call is not established due to the unavailability of User B.

5. Threat analysis

✓ DFD and STRIDE methodology were used to perform Threat Analysis



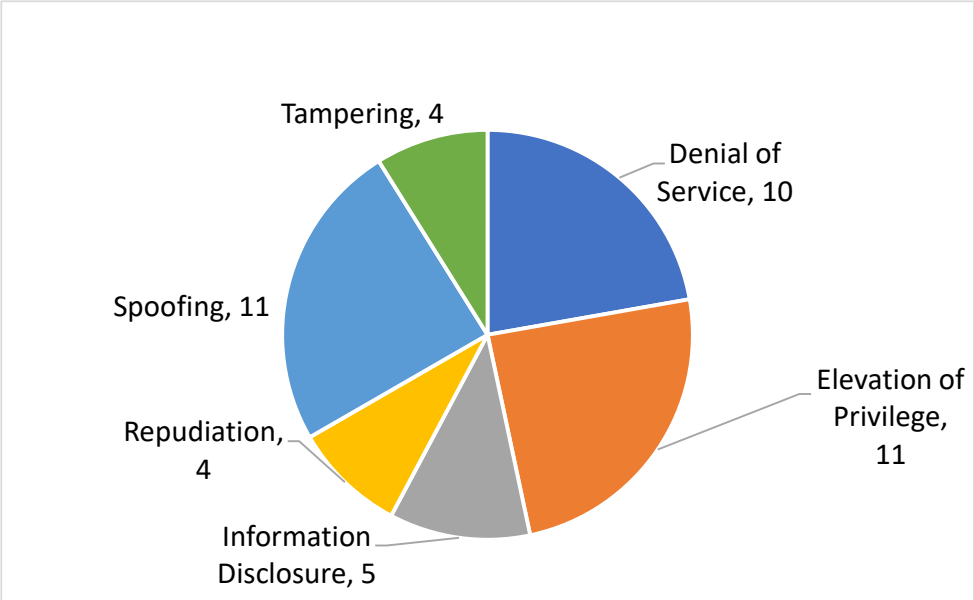


Figure 1. Number of Identified threats : 45

Table 4. Identified threat result

threat Id	Title	Category	Flow	Priority	Description	Identified threat, derived requirement and Mitigation	Deisgn or solution proposal
15	Spoofing the LgVideoChat Process	Spoofing	LgVideoChat->SQL Database	10	LgVideoChat may be spoofed by an attacker and this may lead to unauthorized access to SQL Database (backend server). Consider using a standard authentication mechanism to identify the source process.	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to the other party through the MITM attack. [Security requirement]	TLS will be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed design document.

						There must be a standard authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
16	Spoofing of Destination Data Store SQL Database (backend server)	Spoofing	LgVideoChat->SQL Database	10	SQL Database (backend server) may be spoofed by an attacker and this may lead to data being written to the attacker's target instead of SQL Database (backend server). Consider using a standard authentication mechanism to identify the destination data store.	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to the other party through the MITM attack. [Security requirement] There must be	TLS shall be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed design document.

						a standard authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
17	Potential SQL Injection Vulnerability for SQL Database (backend server)	Tampering	LgVideoChat->SQL Database	8	SQL injection is an attack in which malicious code is inserted into strings that are later passed to an instance of SQL Server for parsing and execution. Any procedure that constructs SQL statements should be reviewed for injection vulnerabilities because SQL Server will	[Identified threat] To execute unintended command in backend server, SQL injection attack can be performed by attacker. This will lead to disclosure of confidential information in backend server and make attacker to use shell command. [Security requirement] Input	Backend server shall perform input validation.

					execute all syntactically valid queries that it receives. Even parameterized data can be manipulated by a skilled and determined attacker.	validation should be performed for the data over external network. [Mitigation] SQL commands from external interface will be executed only when it passes internal validation fuction.	
18	The SQL Database (backend server) Data Store Could Be Corrupted	Tampering	LgVideoChat->SQL Database	10	Data flowing across User info store User info query OTP submit request User login request may be tampered with by an attacker. This may lead to corruption of SQL Database (backend server). Ensure the integrity of the data flow to the data store.	[Identified threat] Attacker can corrupt the data in the middle of the network. It will lead to store wrong information in backend server or send wrong request to backend server. [Security requirement] Integrity of data which is delivered over external network shall be checked.	TLS shall be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed design document.

						[Mitigation] Integrity check for all packet data.	
19	Data Store Denies SQL Database (backend server) Potentially Writing Data	Repudiation	LgVideoChat->SQL Database	6	SQL Database (backend server) claims that it did not write data received from an entity on the other side of the trust boundary. Consider using logging or auditing to record the source, time, and summary of the received data.	[Identified threat] Backend server claims that it didn't receive any request from the other party. This will make to use unnecessary resources. [Security requirement] Each service shall record the information which is sent or received over network. [Mitigation] Each service shall store log message.	Backend server shall store the log message as a file.
20	Data Flow Sniffing	Information Disclosure	LgVideoChat->SQL Database	10	Data flowing across User info store User info query OTP submit request User login request	[Identified threat] Data over external network can be sniffed by attacker.	TLS shall be applied to the communication between LgVideoChat and Backend server.

					may be sniffed by an attacker. Depending on what type of data an attacker can read, it may be used to attack other parts of the system or simply be a disclosure of information leading to compliance violations. Consider encrypting the data flow.	It will lead to disclosure of confidential information. [Security requirement] Data over external network shall be encrypted. [Mitigation] Encryption key shall be shared between the entities which will communicate with and the data shall be encrypted using the shared key.	For the detailed design, please refer to detailed design document.
21	Potential Excessive Resource Consumption for LgVideoChat or SQL Database (backend server)	Denial Of Service	LgVideoChat->SQL Database	8	Does LgVideoChat or SQL Database (backend server) take explicit steps to control resource consumption? Resource consumption attacks can be hard to deal with, and there are times that it	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity. [Security requirement]	TLS shall be applied to the communicatio n between LgVideoChat and Backend server. Only allowed APIs shall be processed in backend server.

					makes sense to let the OS do the job. Be careful that your resource requests don't deadlock, and that they do timeout.	Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication . Permission needs to be managed through access control.	
22	Data Flow User info store User info query OTP submit request User login request Is Potentially Interrupted	Denial Of Service	LgVideoChat->SQL Database	8	An external agent interrupts data flowing across a trust boundary in either direction.	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the time. [Mitigation]	TLS shall be applied to the communicatio n between LgVideoChat and Backend server. Only allowed APIs shall be processed in backend server.

						Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	
23	Data Store Inaccessible	Denial Of Service	LgVideoChat->SQL Database	10	An external agent prevents access to a data store on the other side of the trust boundary.	[Identified threat] Data over external network can be sniffed by attacker. It will lead to disclosure of confidential information. [Security requirement] Data over external network shall be encrypted. [Mitigation] Encryption key shall be shared between the entities which will communicate	TLS shall be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed design document.

						with and the data shall be encrypted using the shared key.	
52	Elevation by Changing the Execution Flow in LgVideoChat	Elevation Of Privilege	SQL Database->LgVideoChat	6	An attacker may pass data into LgVideoChat in order to change the flow of program execution within LgVideoChat to the attacker's choosing.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user, least privileage shall be applied. Input validation should be performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is delivered for video call.

51	LgVideoChat May be Subject to Elevation of Privilege Using Remote Code Execution	Elevation Of Privilege	SQL Database->LgVideoChat	6	SQL Database (backend server) may be able to remotely execute code for LgVideoChat.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user, least privileage shall be applied. Input validation should be performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is delivered for video call.
50	Data Store Inaccessible	Denial Of Service	SQL Database->LgVideoChat	8	An external agent prevents access to a data store on the other side	[Identified threat] Attacker can send excessive packet to the	TLS shall be applied to the communicatio n between LgVideoChat and Backend

					of the trust boundary.	application or backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	server. Only allowed APIs shall be processed in LgVideoChat.
49	Data Flow User info store result User info list OTP submit result User login result Is Potentially Interrupted	Denial Of Service	SQL Database->LgVideoChat	8	An external agent interrupts data flowing across a trust boundary in either direction.	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity.	TLS shall be applied to the communication between LgVideoChat and Backend server. Only allowed APIs shall be processed in LgVideoChat.

						[Security requirement] Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	
48	Potential Process Crash or Stop for LgVideoChat	Denial Of Service	SQL Database->LgVideoChat	6	LgVideoChat crashes, halts, stops or runs slowly; in all cases violating an availability metric.	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the	TLS shall be applied to the communication between LgVideoChat and Backend server. DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat.

						time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	
47	Weak Access Control for a Resource	Information Disclosure	SQL Database->LgVideoChat	6	Improper data protection of SQL Database (backend server) can allow an attacker to read information not intended for disclosure. Review authorization settings.	[Identified threat] Attacker can read information using weak access control. [Security requirement] All data shall be protected against unauthorized access. [Mitigation] Permission needs to be managed through access control.	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat.

46	Potential Data Repudiation by LgVideoChat	Repudiation	SQL Database->LgVideoChat	6	LgVideoChat claims that it did not receive data from a source outside the trust boundary. Consider using logging or auditing to record the source, time, and summary of the received data.	[Identified threat] LgVideoChat claims that it didn't receive any request from the other party. This will make to use unnecessary resources. [Security requirement] Each service shall record the information which is sent or received over network. [Mitigation] Each service shall store log message.	LgVideoChat shall store the log message as a file.
45	Spoofing of Source Data Store SQL Database (backend server)	Spoofing	SQL Database->LgVideoChat	10	SQL Database (backend server) may be spoofed by an attacker and this may lead to incorrect data delivered to LgVideoChat. Consider using a standard	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the	TLS shall be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed

					authentication mechanism to identify the source data store.	information transmitted to the other party through the MITM attack. [Security requirement] There must be a standard authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	design document.
44	Spoofing the LgVideoChat Process	Spoofing	SQL Database->LgVideoChat	10	LgVideoChat may be spoofed by an attacker and this may lead to information disclosure by SQL Database (backend server). Consider using a standard authentication mechanism	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to	TLS shall be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed design document.

					to identify the destination process.	the other party through the MITM attack. [Security requirement] There must be a standard authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
70	Spoofing the Video Server Process	Spoofing	Video Server->Video Client	10	Video Server may be spoofed by an attacker and this may lead to unauthorized access to Video Client. Consider using a standard authentication mechanism to identify the source process.	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to the other party	TLS shall be applied to the communication between LgVideoChat and Backend server. For the detailed design, please refer to detailed design document.

						through the MITM attack. [Security requirement] There must be a standard authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
71	Spoofing the Video Client Process	Spoofing	Video Server->Video Client	10	Video Client may be spoofed by an attacker and this may lead to information disclosure by Video Server. Consider using a standard authentication mechanism to identify the destination process.	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to the other party	TLS shall be applied to the communication between Video Server and Video Client. For the detailed design, please refer to detailed design document.

						through the MITM attack. [Security requirement] There must be a standard authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
72	Potential Lack of Input Validation for Video Client	Tampering	Video Server->Video Client	10	Data flowing across Call Connect Response Call packet data may be tampered with by an attacker. This may lead to a denial of service attack against Video Client or an elevation of privilege attack against Video Client	[Identified threat] Attacker can corrupt the data in the middle of the network. It will lead to store wrong information or send wrong request to the other party. [Security requirement]	TLS shall be applied to the communicatio n between Video Server and Video Client. For the detailed design, please refer to detailed design document.

					or an information disclosure by Video Client. Failure to verify that input is as expected is a root cause of a very large number of exploitable issues. Consider all paths and the way they handle data. Verify that all input is verified for correctness using an approved list input validation approach.	Integrity of data which is delivered over external network shall be checked. [Mitigation] Integrity check for all packet data.	
73	Potential Data Repudiation by Video Client	Repudiation	Video Server->Video Client	6	Video Client claims that it did not receive data from a source outside the trust boundary. Consider using logging or auditing to record the source, time, and summary of the received data.	[Identified threat] Application claims that it didn't receive any request from the other party. This will make to use unnecessary resources. [Security requirement]	LgVideoChat shall store the log message as a file.

						Each service shall record the information which is sent or received over network. [Mitigation] Each service shall store log message.	
74	Data Flow Sniffing	Information Disclosure	Video Server->Video Client	10	Data flowing across Call Connect Response Call packet data may be sniffed by an attacker. Depending on what type of data an attacker can read, it may be used to attack other parts of the system or simply be a disclosure of information leading to compliance violations. Consider encrypting the data flow.	[Identified threat] Data over external network can be sniffed by attacker. It will lead to disclosure of confidential information. [Security requirement] Data over external network shall be encrypted. [Mitigation] Encryption key shall be shared between the entities which will communicate with and the data shall be	TLS shall be applied to the communicatio n between Video Server and Video Client. For the detailed design, please refer to detailed design document.

						encrypted using the shared key.	
75	Potential Process Crash or Stop for Video Client	Denial Of Service	Video Server->Video Client	6	Video Client crashes, halts, stops or runs slowly; in all cases violating an availability metric.	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	TLS shall be applied to the communication between Video Server and Video Client. DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat.

76	Data Flow Call Connect Response Call packet data Is Potentially Interrupted	Denial Of Service	Video Server->Video Client	6	An external agent interrupts data flowing across a trust boundary in either direction.	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	TLS shall be applied to the communication between Video Server and Video Client. DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat.
77	Elevation Using Impersonation	Elevation Of Privilege	Video Server->Video Client	6	Video Client may be able to impersonate the context of Video Server in	[Identified threat] Attacker can send shell code and it will have excessive	DAC policy shall be applied properly for LgVideoChat. Admin or root permission

					order to gain additional privilege.	permission. [Security requirement] For each user, least privileage shall be applied. Input validation should be performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is delivered for video call.
78	Video Client May be Subject to Elevation of Privilege Using Remote Code Execution	Elevation Of Privilege	Video Server->Video Client	6	Video Server may be able to remotely execute code for Video Client.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user,	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data

						least privileage shall be applied. Input validation should be performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	which is delivered for video call.
79	Elevation by Changing the Execution Flow in Video Client	Elevation Of Privilege	Video Server->Video Client	6	An attacker may pass data into Video Client in order to change the flow of program execution within Video Client to the attacker's choosing.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user, least privileage shall be applied. Input validation	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is delivered for video call.

						should be performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	
102	Spoofing the Video Client Process	Spoofing	Video Client->Video Server	10	Video Client may be spoofed by an attacker and this may lead to unauthorized access to Video Server. Consider using a standard authenticatio n mechanism to identify the source process.	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to the other party through the MITM attack. [Security requirement] There must be a standard	TLS shall be applied to the communicatio n between Video Server and Video Client. For the detailed design, please refer to detailed design document.

						authentication mechanism for source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
103	Spoofing the Video Server Process	Spoofing	Video Client->Video Server	10	Video Server may be spoofed by an attacker and this may lead to information disclosure by Video Client. Consider using a standard authentication mechanism to identify the destination process.	[Identified threat] 1. The attacker disguises his identity by changing the Mac Address through an ARP spoofing attack. 2. The attacker intercepts and corrupts the information transmitted to the other party through the MITM attack. [Security requirement] There must be a standard authentication mechanism for	TLS shall be applied to the communication between Video Server and Video Client. For the detailed design, please refer to detailed design document.

						source process identification. [Mitigation] PKI-based server/client authentication must be applied CA certificate and server certificate for LgVideoChat must be issued	
104	Potential Lack of Input Validation for Video Server	Tampering	Video Client->Video Server	10	Data flowing across Call Connect Request with client info Call packet data may be tampered with by an attacker. This may lead to a denial of service attack against Video Server or an elevation of privilege attack against Video Server or an information disclosure by Video Server. Failure to verify that input is as expected is a root cause of a very large	[Identified threat] Attacker can corrupt the data in the middle of the network. It will lead to store wrong information or send wrong request to the other party. [Security requirement] Integrity of data which is delivered over external network shall be checked. [Mitigation] Integrity check	TLS shall be applied to the communicatio n between Video Server and Video Client. For the detailed design, please refer to detailed design document.

					number of exploitable issues. Consider all paths and the way they handle data. Verify that all input is verified for correctness using an approved list input validation approach.	for all packet data.	
105	Potential Data Repudiation by Video Server	Repudiation	Video Client->Video Server	6	Video Server claims that it did not receive data from a source outside the trust boundary. Consider using logging or auditing to record the source, time, and summary of the received data.	[Identified threat] Application claims that it didn't receive any request from the other party. This will make to use unnecessary resources. [Security requirement] Each service shall record the information which is sent or received over network. [Mitigation] Each service	LgVideoChat shall store the log message as a file.

						shall store log message.	
106	Data Flow Sniffing	Information Disclosure	Video Client->Video Server	10	Data flowing across Call Connect Request with client info Call packet data may be sniffed by an attacker. Depending on what type of data an attacker can read, it may be used to attack other parts of the system or simply be a disclosure of information leading to compliance violations. Consider encrypting the data flow.	[Identified threat] Data over external network can be sniffed by attacker. It will lead to disclosure of confidential information. [Security requirement] Data over external network shall be encrypted. [Mitigation] Encryption key shall be shared between the entities which will communicate with and the data shall be encrypted using the shared key.	TLS shall be applied to the communicatio n between Video Server and Video Client. For the detailed design, please refer to detailed design document.

107	Potential Process Crash or Stop for Video Server	Denial Of Service	Video Client->Video Server	8	Video Server crashes, halts, stops or runs slowly; in all cases violating an availability metric.	[Identified threat] Attacker can send excessive packet to the application or backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	TLS shall be applied to the communication between LgVideoChat and Backend server. Only allowed APIs shall be processed in LgVideoChat.
108	Data Flow Call Connect Request with client info Call packet data Is	Denial Of Service	Video Client->Video Server	6	An external agent interrupts data flowing across a trust boundary in	[Identified threat] Attacker can send excessive packet to the application or	TLS shall be applied to the communication between Video Server and Video Client.

	Potentially Interrupted				either direction.	backend server. This will lead to denial of service of each entity. [Security requirement] Each service shall be available all the time. [Mitigation] Mutual authentication shall be performed before starting communication. Permission needs to be managed through access control.	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat.
109	Elevation Using Impersonation	Elevation Of Privilege	Video Client->Video Server	6	Video Server may be able to impersonate the context of Video Client in order to gain additional privilege.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user, least privileage	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is

						shall be applied. Input validation should be performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	delivered for video call.
110	Video Server May be Subject to Elevation of Privilege Using Remote Code Execution	Elevation Of Privilege	Video Client->Video Server	6	Video Client may be able to remotely execute code for Video Server.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user, least privileage shall be applied. Input validation should be	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is delivered for video call.

						performed for the data over external network. [Mitigation] Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	
111	Elevation by Changing the Execution Flow in Video Server	Elevation Of Privilege	Video Client->Video Server	6	An attacker may pass data into Video Server in order to change the flow of program execution within Video Server to the attacker's choosing.	[Identified threat] Attacker can send shell code and it will have excessive permission. [Security requirement] For each user, least privileage shall be applied. Input validation should be performed for the data over external network. [Mitigation]	DAC policy shall be applied properly for LgVideoChat. Admin or root permission shall not be allowed for LgVideoChat. LgVideoChat shall validate input data which is delivered for video call.

						Each user shall have least privileage. All input data from external network will be checked by internal validation fuction.	
116	Spoofing of Destination Data Store File System	Spoofing	LgVideoChat->File System	4	File System may be spoofed by an attacker and this may lead to data being written to the attacker's target instead of File System. Consider using a standard authenticatio n mechanism to identify the destination data store.	[Identified threat] Attacker can replace the file system with the one of attacker's. It will lead to store the log information to attacker's storage. [Security requirement] File system shall have protection method against replacing it. [Mitigation] Hard disk drive shall be sealed with a sticker so that it can be detected	Sealing sticker shall be applied to the laptop which has LgVideoChat application

						when replacing is occurred.	
119	Weak Access Control for a Resource	Information Disclosure	LgVideoChat->File System	4	Improper data protection of File System can allow an attacker to read information not intended for disclosure. Review authorization settings.	[Identified threat] Attacker can read log message from file system and it can lead to disclosure of confidential information. [Security requirement] Log message shall be encrypted. [Mitigation] Log message shall be encrypted and stored to file system.	LgVideoChat shall encrypt log file.
201	Spoofing of the Human User External Destination Entity	Spoofing	LgVideoChat->Human User	10	Human User may be spoofed by an attacker and this may lead to data being sent to the attacker's target instead of Human User. Consider	[Identified threat] An attacker can issue malicious commands through identity disguise, causing unintended	Two factor authentication shall be applied to login to the LgVideoChat with following method. 1. password 2. OTP number using private email address

					using a standard authenticatio n mechanism to identify the external entity.	actions by the user. [Security requirement] Require enhanced authentication for user login [Mitigation] Two factor authentication based on password and otp should be applied.	For the detailed design, please refer to detailed design document.
199	Elevation by Changing the Execution Flow in LgVideoChat	Elevation Of Privilege	Human User->LgVideoChat	10	An attacker may pass data into LgVideoChat in order to change the flow of program execution within LgVideoChat to the attacker's choosing.	[Identified threat] An attacker can issue malicious commands through identity disguise, causing unintended actions by the user. [Security requirement] Require enhanced authentication for user login [Mitigation]	Two factor authentication shall be applied to login to the LgVideoChat with following method. 1. password 2. OTP number using private email address For the detailed design, please refer to detailed design document.

						Two factor authentication based on password and otp should be applied.	
198	LgVideoChat May be Subject to Elevation of Privilege Using Remote Code Execution	Elevation Of Privilege	Human User->LgVideoChat	10	Human User may be able to remotely execute code for LgVideoChat.	[Identified threat] An attacker can issue malicious commands through identity disguise, causing unintended actions by the user. [Security requirement] Require enhanced authentication for user login [Mitigation] Two factor authentication based on password and otp should be applied.	Two factor authentication shall be applied to login to the LgVideoChat with following method. 1. password 2. OTP number using private email address For the detailed design, please refer to detailed design document.
197	Elevation Using Impersonation	Elevation Of Privilege	Human User->LgVideoChat	10	LgVideoChat may be able to impersonate the context of Human User in order	[Identified threat] An attacker can issue malicious commands	Two factor authentication shall be applied to login to the LgVideoChat with following

					to gain additional privilege.	through identity disguise, causing unintended actions by the user. [Security requirement] Require enhanced authentication for user login [Mitigation] Two factor authentication based on password and otp should be applied.	method. 1. password 2. OTP number using private email address For the detailed design, please refer to detailed design document.
191	Spoofing the Human User External Entity	Spoofing	Human User->LgVideoChat	10	Human User may be spoofed by an attacker and this may lead to unauthorized access to LgVideoChat. Consider using a standard authentication mechanism to identify the external entity.	[Identified threat] An attacker can issue malicious commands through identity disguise, causing unintended actions by the user. [Security requirement] Require enhanced	Two factor authentication shall be applied to login to the LgVideoChat with following method. 1. password 2. OTP number using private email address For the detailed design, please refer to detailed design document.

						authentication for user login [Mitigation] Two factor authentication based on password and otp should be applied.	

6. Security requirements & Mitigation

- Prioritized each threat through team workshop
- Resulted in various score : 4, 6, 8, 10
- **Key Security Requirements & Mitigations** from high priority threats (Score 6, 8, 10) are as follows

Security requirements & Mitigations
PKI-based server authentication for App and Backend Server
Secure communication between Apps
Secure communication between App and Backend Server
Two factor authentication using password and OTP to email => Initial requirement has been specified in detail
Input validation check by Backend Server
Storing log file by App and Backend server

7. System design

7.1. Initial Design

Initial system architecture from given requirements was designed as follows

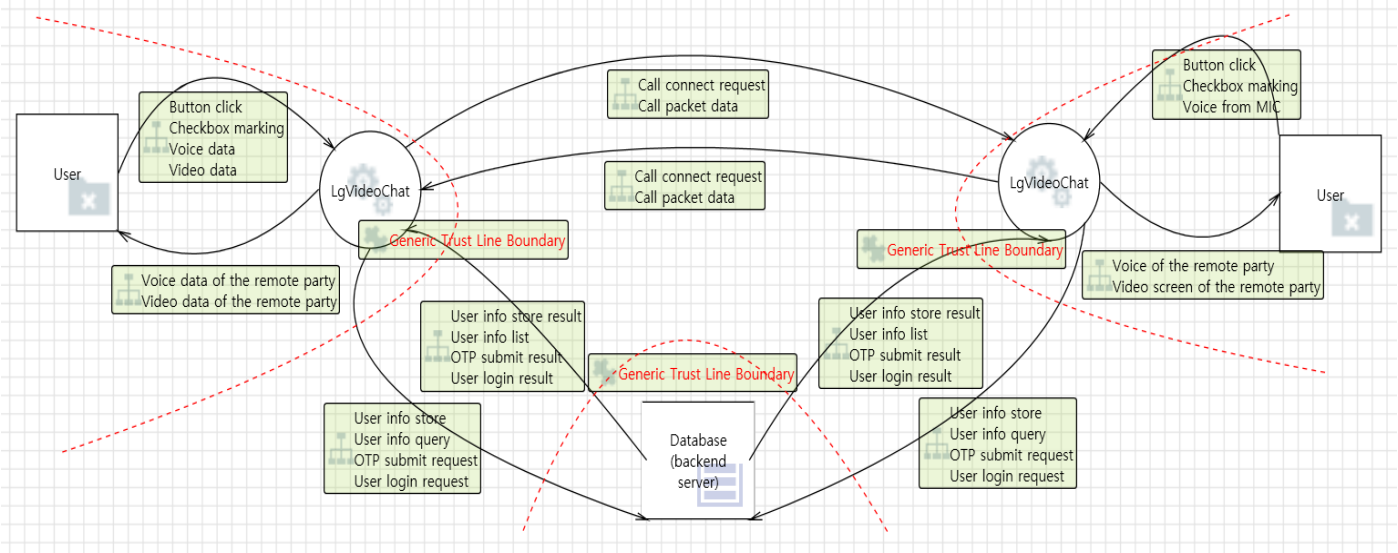


Figure 2. Initial Design reflecting all system entities and communication data

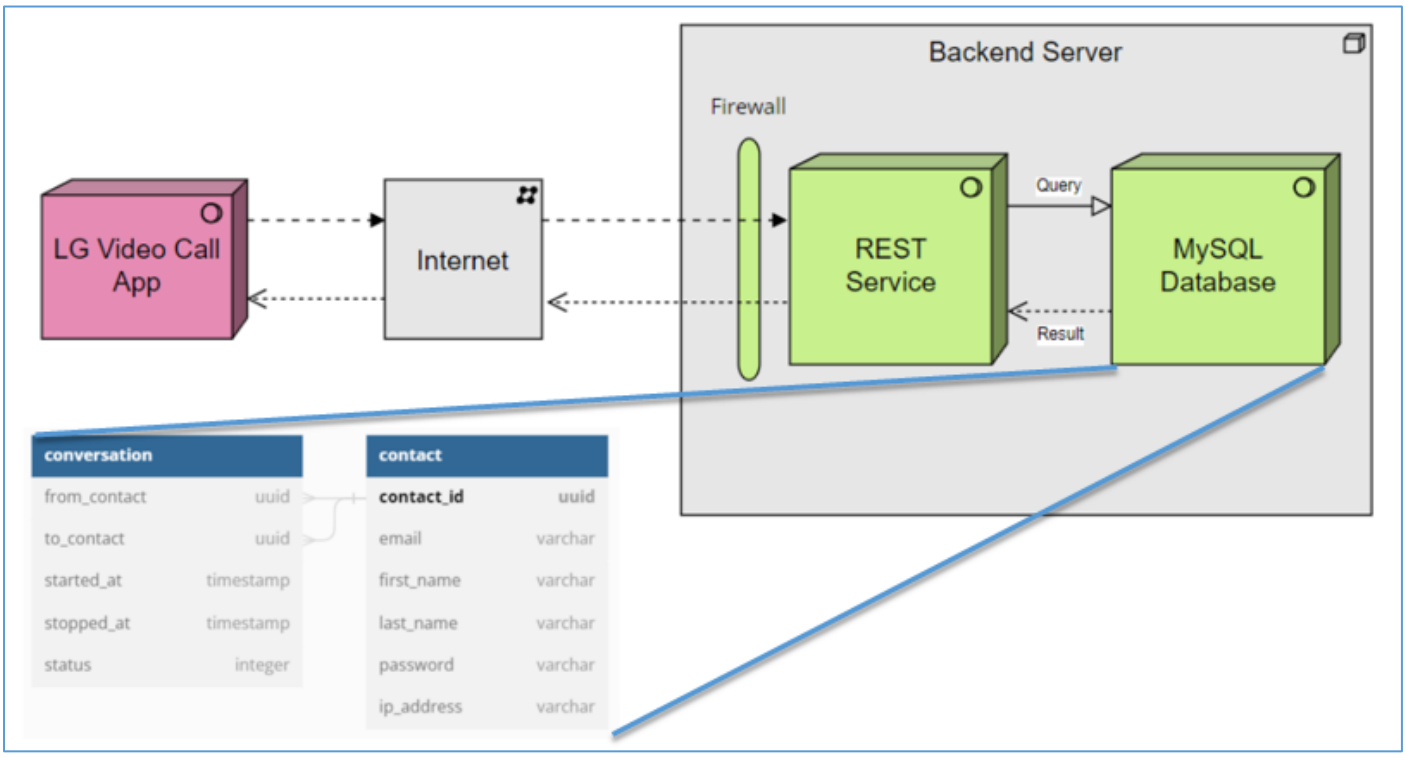


Figure 3. Initial Design for backend server

7.2. Design Improvement including Mitigation

After completing threat analysis, system design was improved by security requirements and mitigations

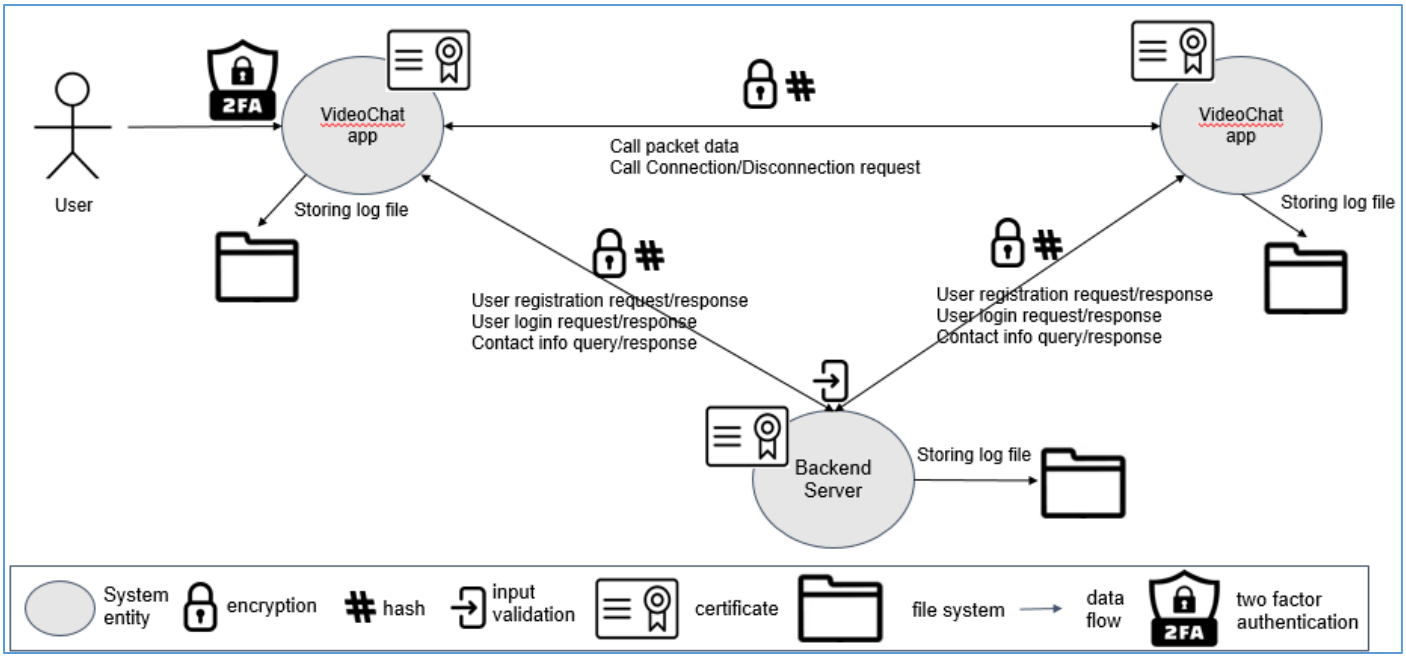


Figure 4. Overall system design

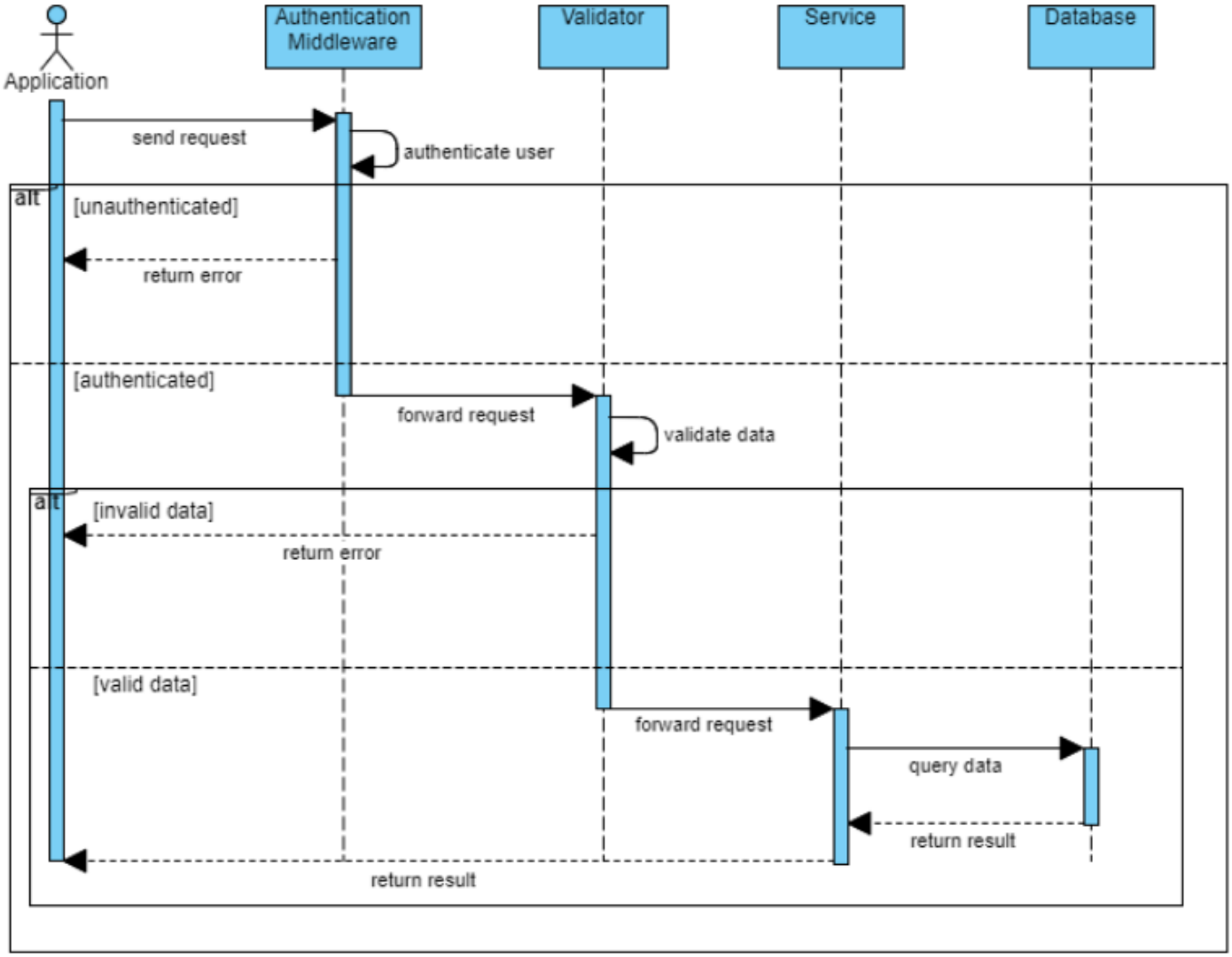


Figure 5. Input Validation Check by Backend Server

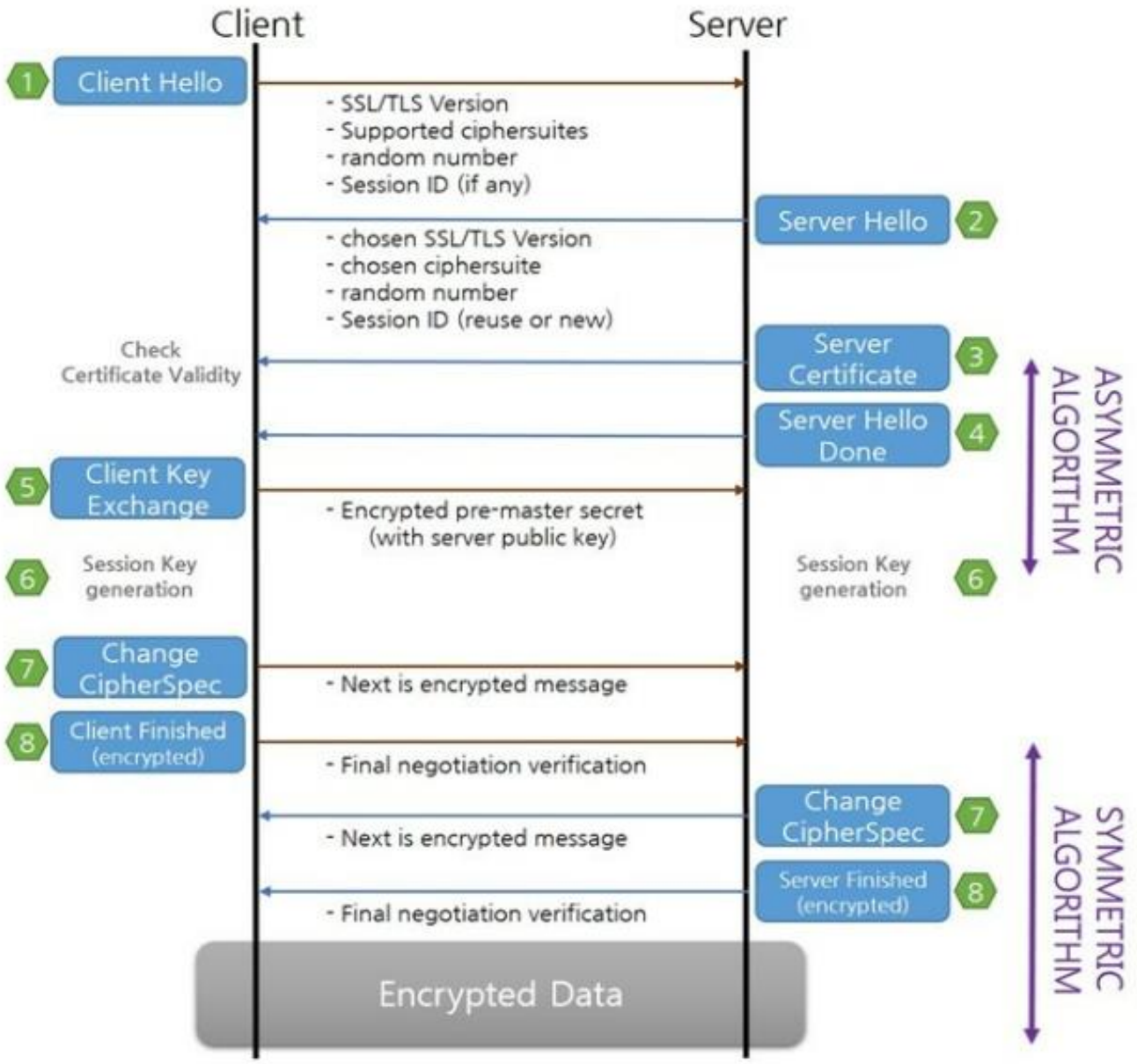


Figure 6. Secure Communication & authentication

- ✓ PKI-based server authentication for both Application and Backend Server
- ✓ Secure communication between Applications
- ✓ Secure communication between Application and Backend Server
- ✓ **Adopted Solution : TLS v1.3**

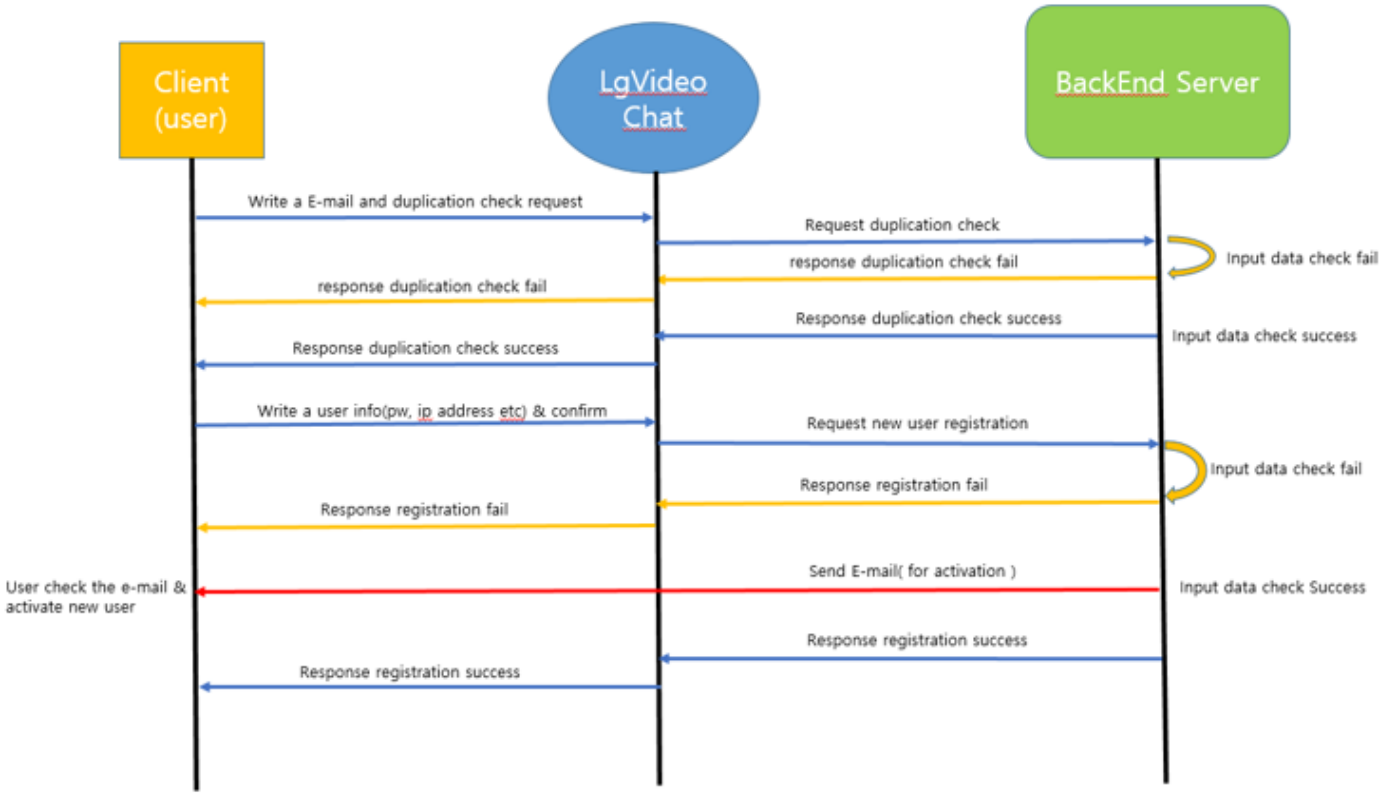


Figure 7. Two factor authentication (User registration)

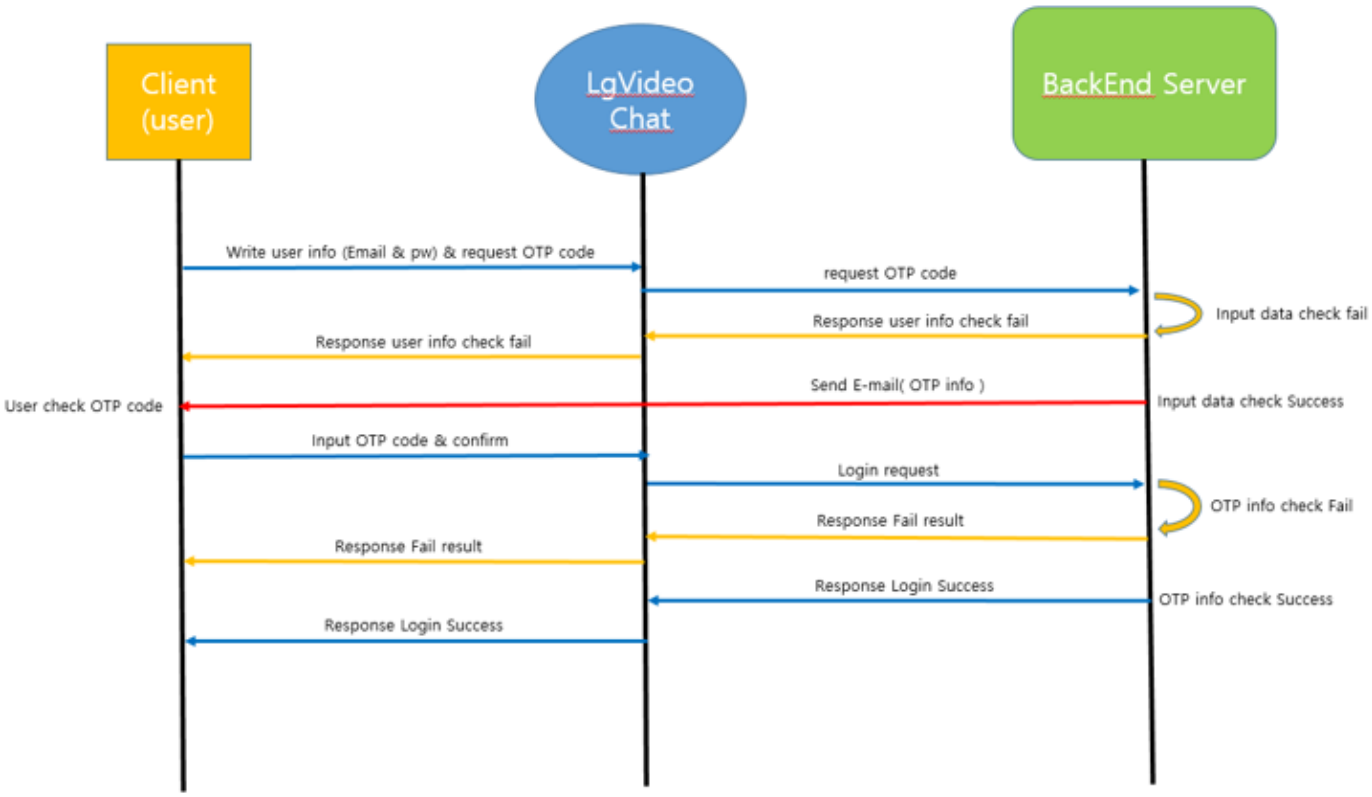


Figure 8. Two factor authentication (User login)

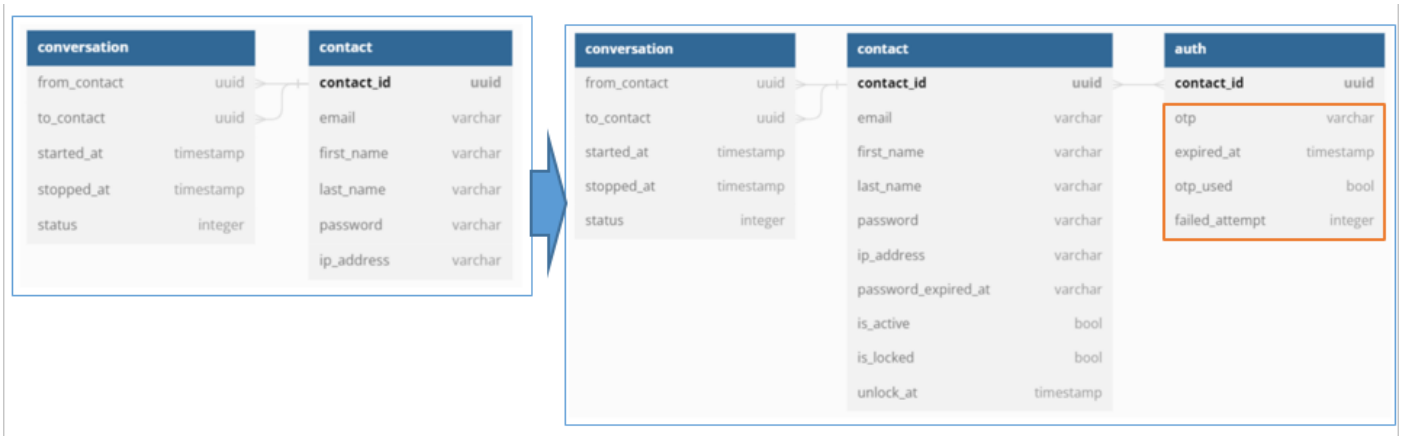


Figure 9. database table design for two factor authentication

7.3. Backend Server API design

To support security requirements, APIs provided by backend server are defined as follows.

Sign Up

```
# Signup example
$ curl -k https://20.119.70.194/api/user/signup -X POST -d
"email=viet.truong@lge.com&password=TestP4ss!@#&confirm_password=TestP4ss!@#&ip_address=192.168.11.1
1&first_name=Viet&last_name=Truong"
{"message":"User created successfully. Please check your email to activate your account!"}

# Open https://ethereal.email/mesages (login with chaim48@ethereal.email / eezpJY5ZAR8V9hRQbT), open
the email and click on the link to activate the account
```

Go to Ethereal email and click to the activation link to activate your account.

Login

```
$ curl -k https://20.119.70.194/api/user/generate-otp?email=viet.truong.tae@lge.com
{"message":"OTP has been sent to the email"}

# Send request to verify OTP
$ curl.exe -k https://20.119.70.194/api/auth/login -X POST -d
"email=viet.truong@lge.com&password=TestP4ss!@#&otp=123456"
{"message":"Successfully
login","access_token":"eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiMGU2MmIzYjUtMGFjZi0xMWVI
LTIkYmUtNjA0NWJkZGM5NGY3IiwiaWF0IjoxNjg2NzU5NjAzLCJleHAiOjE20DY4NDYwMDN9.u-rMAHspFsu6LUL6Bb-
2HXmma_foYowSNQs03BNkxso"}
```

Authorization Header

```
# Use access token to authenticate.
$ curl -k https://20.119.70.194/api/users -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiMGU2MmIzYjUtMGFjZi0xMWVILTIkYmUtNjA0NWJkZGM5NGY
3IiwiaWF0IjoxNjg2NzU5NjAzLCJleHAiOjE20DY4NDYwMDN9.u-rMAHspFsu6LUL6Bb-2HXmma_foYowSNQs03BNkxso"

# each page contains 10 users
$ curl -k https://20.119.70.194/api/users?page=2 -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiMGU2MmIzYjUtMGFjZi0xMWVILTIkYmUtNjA0NWJkZGM5NGY
3IiwiaWF0IjoxNjg2NzU5NjAzLCJleHAiOjE20DY4NDYwMDN9.u-rMAHspFsu6LUL6Bb-2HXmma_foYowSNQs03BNkxso"
{"data":[],"meta":{"page":2}}
```

Check Email

```
$ curl -k https://20.119.70.194/api/user/check-email -X POST -d "email=viet.truong@lge.com"
Status code: 403 Forbidden
{"message":"Email existed"}

$ curl -k https://20.119.70.194/api/user/check-email -X POST -d "email=viet2.truong@lge.com"
Status code: 200 OK
{"message":"Email does not exist"}
```

Query User Information From IP Address

```
$ curl -k https://localhost/api/user/get-info-from-ip -X POST -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2lkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MjQzODA1LCJleHAiOjE20DczMzAyMDV9.ooFqYc2whNSn62IvFXR3Xa80FkPlRceKHhPGWtFgJOg" -d
"ip_address=192.168.1.2"
Status code: 200 OK
{"contact_id":"69b72431-0e51-11ee-8925-
080027030fc4","email":"quangviet911@gmail.com","first_name":"Viet","last_name":"Quang","ip_address":
"192.168.1.2"}

$ curl -k https://localhost/api/user/get-info-from-ip -X POST -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2lkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MjQzODA1LCJleHAiOjE20DczMzAyMDV9.ooFqYc2whNSn62IvFXR3Xa80FkPlRceKHhPGWtFgJOg" -d
"ip_address=192.168.1.23"
Status code: 400 Bad Request
{"message":"Unable to find user with this IP address"}
```

Get User Information

```
$ curl -k https://localhost/api/user/me -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2lkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MTg0MDYxLCJleHAiOjE20DcyNzA0NjF9.ZrHFDX7Nc8C6p9gNMOobkFUKLOywB4CuMpSzveUtcXU"
{"contact_id":"69b72431-0e51-11ee-8925-
080027030fc4","email":"quangviet910@gmail.com","last_name":"Quang","first_name":"Viet","ip_address":
"192.168.1.2","password":"$2b$06$R6vakM65xf40h2y68yro0uJa.6JqlhdPK0JwlZ.H4Sac3shCSl4Ki"}
```

Get Information of All Registered Users

```
$ curl -k https://20.119.70.194/api/user/all -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2lkIjoiN2MxOWI2ZTMtMTA1MiOxMWVlLTlkYmUtNjA0NWJkZGM5NGY
3liwiaWF0IjoxNjg3NDEwNDkxLCJleHAiOjE20Dc00TY40TF9.y6Y5tiDiz43mEK3wTSCTD1cP6tK8feDzfp-vGeUvbGo"
{"data":[{"contact_id":"054b8da6-10b8-11ee-9dbe-
6045bddc94f7","email":"hongjae1.lim@lge.com","last_name":"Lim","first_name":"Hongjae","ip_address":"
192.168.0.126"},{"contact_id":"69474282-10ac-11ee-9dbe-
6045bddc94f7","email":"john.doe@example.com","last_name":"doe","first_name":"john","ip_address":"192
.168.0.212"},{"contact_id":"040fa4c4-108d-11ee-9dbe-
6045bddc94f7","email":"minji.tae@lge.com","last_name":"Tae","first_name":"Minji","ip_address":"127.0
.0.5"},{"contact_id":"5618a336-10b8-11ee-9dbe-
6045bddc94f7","email":"quangviet910@gmail.com","last_name":"Vo","first_name":"Hau","ip_address":"127
.0.0.2"},{"contact_id":"8a77e852-10ac-11ee-9dbe-
6045bddc94f7","email":"sch830414.test@gmail.com","last_name":"sung","first_name":"chanhun","ip_addre
ss":"10.177.249.171"},{"contact_id":"5a9291db-10b8-11ee-9dbe-
6045bddc94f7","email":"test1@example.com","last_name":"2","first_name":"1","ip_address":"192.168.1.2
12"},{"contact_id":"be596a89-10b9-11ee-9dbe-
6045bddc94f7","email":"test2@example.com","last_name":"2","first_name":"1","ip_address":"192.168.1.2
"},{"contact_id":"7c19b6e3-1052-11ee-9dbe-
6045bddc94f7","email":"viet.truong@lge.com","last_name":"Truong","first_name":"Viet","ip_address":"1
27.0.0.1"}],"meta":{"page":1}}
```

Generate OTP

```
$ curl -k https://localhost/api/user/generate-otp -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MTg0MDYxLCJleHAiOjE20DcyNzA0NjF9.ZrHFDX7Nc8C6p9gNM0obkFUKL0ywB4CuMpSzveUtcXU"
Status code: 200 OK
{"message":"OTP is sent to the new email"}
```

Update Email Only

```
$ curl -k https://localhost/api/user/update -X POST -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MjQz0DA1LCJleHAiOjE20DczMzAyMDV9.ooFqYc2whNSn62IvFXR3Xa80FkPlRceKHhPGWtFgJ0g" -d
'current_password=TestP4ss!@#&new_email=quangviet911@gmail.com&otp=630573'
Status code: 400 Bad Request
{"message":"Invalid OTP"}

$ curl -k https://localhost/api/user/update -X POST -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MjQz0DA1LCJleHAiOjE20DczMzAyMDV9.ooFqYc2whNSn62IvFXR3Xa80FkPlRceKHhPGWtFgJ0g" -d
'current_password=TestP4ss!@#&new_email=quangviet911@gmail.com&otp=612345'
Status code: 200 OK
{"message":"User data updated"}
```

Update Password Only

```
$ curl -k https://localhost/api/user/update -X POST -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MjQz0DA1LCJleHAiOjE20DczMzAyMDV9.ooFqYc2whNSn62IvFXR3Xa80FkPlRceKHhPGWtFgJ0g" -d
'current_password=Qviet1997!@#&new_password=Qviet1997!@#&confirm_new_password=Qviet1997!@#&otp=63057
3'
Status code: 200 OK
{"message":"Updated user data"}
```

Update Password & Email

```
$ curl -k https://localhost/api/user/update -X POST -H "Authorization: Bearer
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VyX2IkIjoiNjliNzI0MzEtMGU1MS0xMWVlLTg5MjUtMDgwMDI3MDMwZmM
OliwiaWF0IjoxNjg3MjQz0DA1LCJleHAiOjE20DczMzAyMDV9.ooFqYc2whNSn62IvFXR3Xa80FkPlRceKHhPGWtFgJ0g" -d
'current_password=Qviet1997!@#&new_password=Qviet1997!@#&confirm_new_password=Qviet1997!@#&new_email
=quangviet911@gmail.com&otp=630573'
Status code: 200 OK
{"message":"Updated user data"}

Status code: 422 -> invalid data (example: passwords do not match)
```

8. Implementation

- ✓ **Agile methodology was applied. The reason and how …**
  - Started implementation before completing all design due to lack of time
  - Need to reflect changed and added system design after threat analysis
  - Development and Verification was performed in parallel to find bugs earlier
  - Sync up meeting and sharing obstacles every day
    (http://collab.lge.com/main/display/SCSPECIALT/0.+Meeting+Minute)

- ✓ **Development environment and tools**
  - Visual Studio Community, Beyond compare
  - MySQL, Ethereal for Fake Email Service

- Self signed certificate for server authentication
- GitHub for sharing and integrating source code
- Additional library : Openssl, Boost, Nlohmann-json for application

9. Verification

9.1.Verification Overview

- Test case

  Generated based on Functional requirements

- Test purpose

  - To verify initial functional requirements
  - To verify additional security requirements

- Test constraints

  - Use Ethereal site for Fake email service
  - Laptops testing the application should be connected through router
  - Firewall configuration in Laptop should be disabled

- Final test result

  - Total test cases : 47
  - Pass : 34, Fail : 13 (not critical issues)
  - Pass rate : 72.3%

Test Case	Test Cycle1	Test Cycle2	Test Cycle3	Test Final
Sign-Up(9 → 6)	**PASS**(4) / **FAIL**(2)	**PASS**(4) / **FAIL**(2)	**PASS**(5) / **FAIL**(1)	**PASS**(6)
Sign-In(7)	**PASS**(2) / **FAIL**(5)	**PASS**(4) / **FAIL**(3)	**PASS**(4) / **FAIL**(3)	**PASS**(7)
Update(5)	**PASS**(2) / **FAIL**(2) / SKIP(1)	**PASS**(2) / **FAIL**(3)	**PASS**(2) / **FAIL**(3)	**PASS**(5)
Periodic P/W Reset(8)	N/A	N/A	**FAIL**(8)	**FAIL**(8)
Lockout due to an incorrect P/W(7)	N/A	N/A	**PASS**(3) / **FAIL**(4)	**PASS**(5) / **FAIL**(2)
~~**Reset P/W(7) : Optional Requirement**~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~
Unique ID & Contact List (2)	N/A	N/A	**FAIL**(2)	**PASS**(2)
Call(4)	N/A	N/A	**PASS**(3) / **FAIL**(1)	**PASS**(3) / **FAIL**(1)
Connection, Notice and Disconnect(6)	N/A	N/A	**PASS**(3) / **FAIL**(2) / SKIP(1)	**PASS**(4) / **FAIL**(2)
Communication methods(2)	N/A	N/A	**PASS**(2)	**PASS**(2)
Total(~~57~~ → 47)	**PASS**(8) / **FAIL**(9) / SKIP(30)	**PASS**(10) / **FAIL**(9) / SKIP(30)	**PASS**(22) / **FAIL**(24) / SKIP(1)	**PASS**(34) / **FAIL**(13)
Pass Rate	**17%**	**21.2%**	**46.8%**	**72.3%**

9.2. Verification Result Detail

- **Sign-Up**

PASS TC**001** Successful Registration

PASS T**C**002 Invalid Email Address

PASS **TC003 Existing** Email Address

PASS TC004 Weak Password

PASS **TC005 Password** Mismatch

PASS **TC008 error** Logging

- **Sign-In**

PASS TC010 Successful Sign-In

PASS TC011 Invalid Email Address

PASS TC012 Incorrect Password

PASS TC013 Request OTP

PASS TC014 Invalid OTP

PASS TC015 - Successful OTP Verification

PASS TC016 - Error Logging

- **User Email Update**

PASS TC017 Successful Email Address Update

PASS TC018 Incorrect Password

PASS TC019 Invalid Email Address Format

PASS TC020 OTP Expiry

PASS TC021 Error Logging

- **Periodic Password Reset**

  Not implemented yet. TC022~TC029

- **Lockout due to an incorrect password**

PASS TC030 Failed Sign-In Attempt Tracking

PASS TC031 Successful Sign-In

PASS TC032 Account Lockout

PASS TC033 Account Lockout Duration

PASS TC034 Account Automatic Unlock

PASS TC035 Account Lockout Email Notification

FAIL TC036 Password Reset during Account Lockout

If it is a lockout, you must provide a password reset function.

- **Unique ID & Contact list**

PASS TC044 Display unique contact identifier

PASS TC045 Display contact name instead of contact identifier

- **Call**

PASS TC046 - Initiate a call using a contact identifier

PASS TC047 - View call history

FAIL TC048 - Check call status and outcome during call initiation

An "Accept" or "Reject" button should appear.

PASS TC049 - End the call during call initiation

- **Connection, Notice and Disconnect**

PASS TC050 - Accept incoming call

FAIL TC051 - Reject incoming call

Call History will show both Accept and Reject as Called. (Displayed Missed Call if Reject)

FAIL TC052 - Missed call notification (call not accepted)

Even if it's a Reject, the duration is displayed as if the call was made

PASS TC053 - Missed call notification (called entity in another call)

PASS TC054 - Call termination notification

PASS TC055 - Application brought to the foreground during incoming call

- **Communication methods**

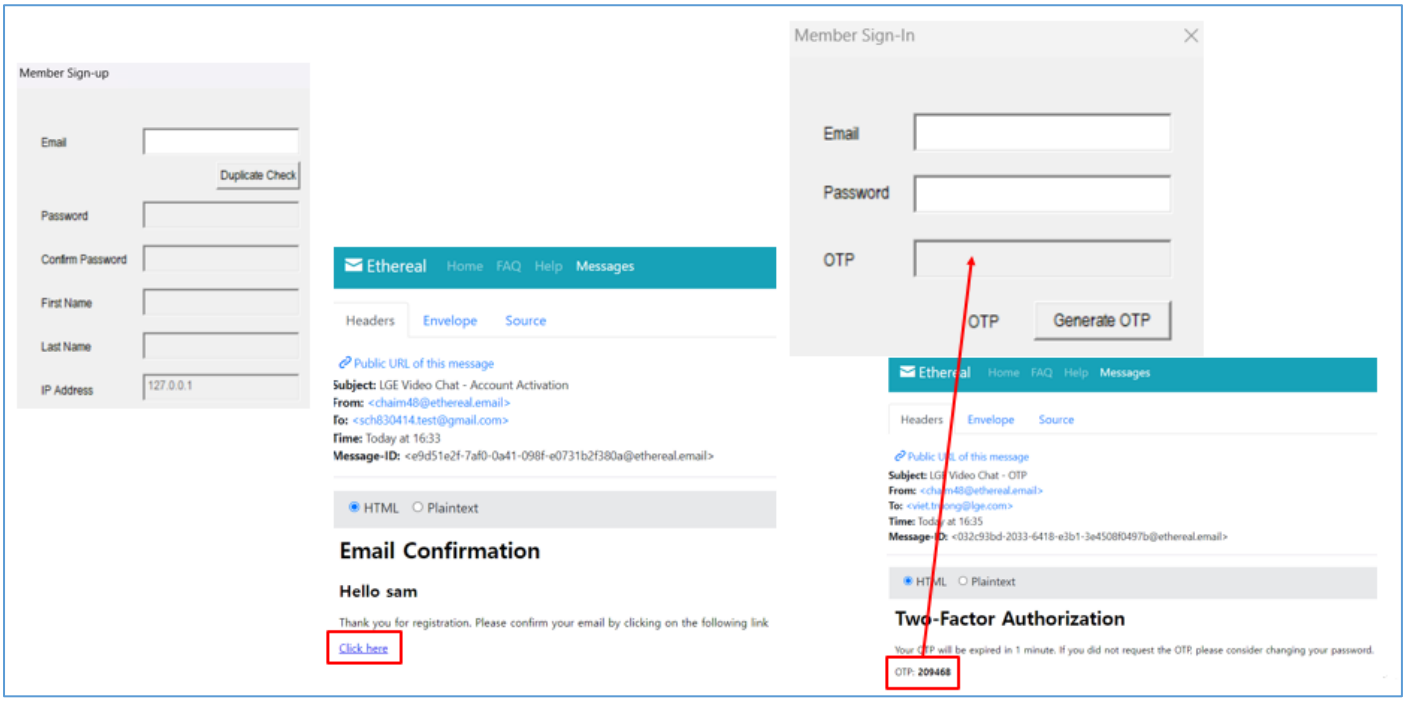
PASS TC056 - Point-to-point communication functionality

PASS TC057 - Call initiation failure

9.3. Verification Result on Security requirements

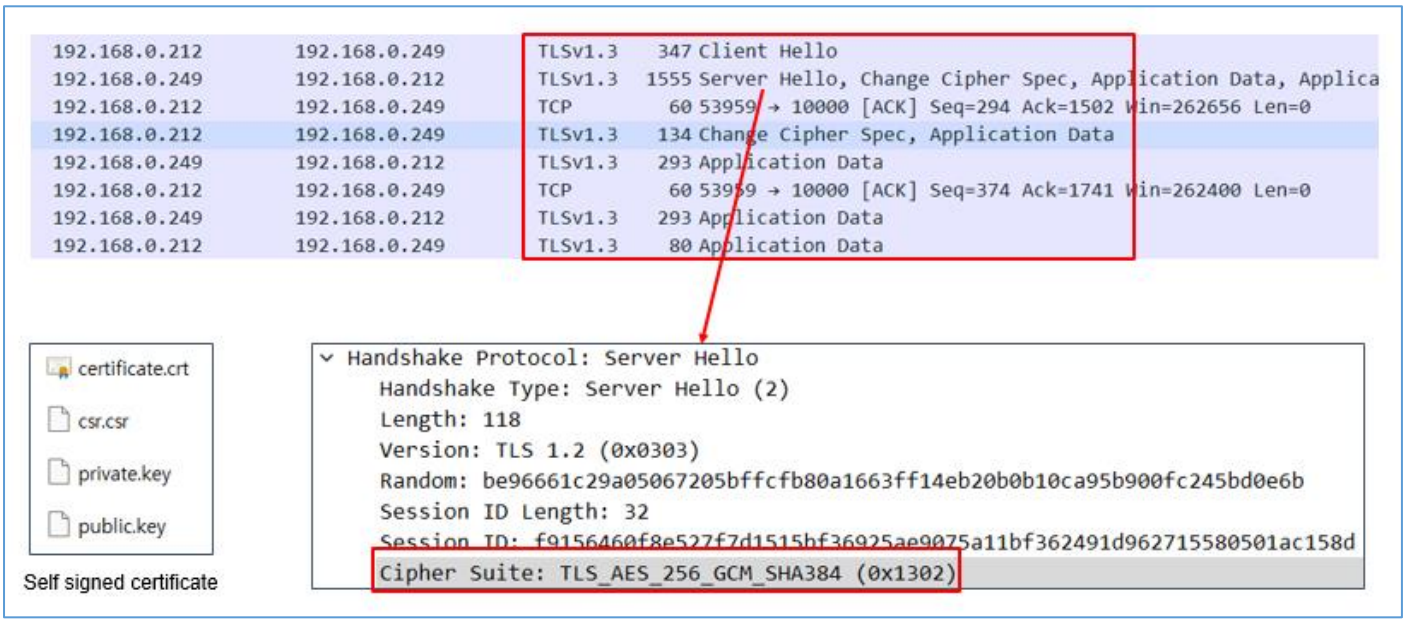
9.3.1. Two factor authentication

Passed



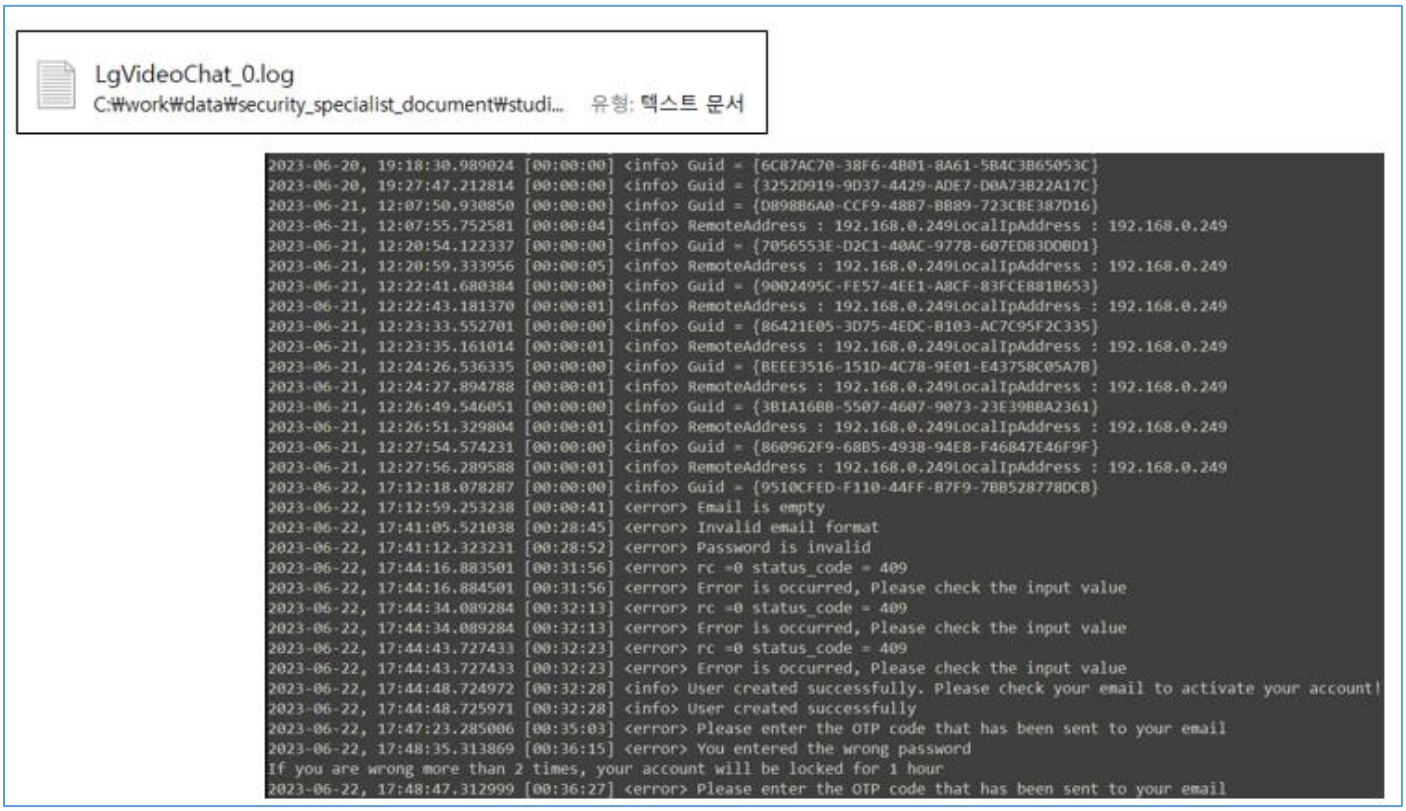
9.3.2. Server Authentication & Secure communication

Passed



9.3.3. Storing log file to the file system

Passed



10. Lessons Learned

✓ **Project Plan from Security Perspective**

- Our team could understand overall process for the project which has to consider security
- To catch up the unexpected needs, our team changed the initial schedule and order

- ✓ **Threat Analysis & Secure Design**

  - Our team was able to realize the importance of threat analysis for secure design
  - Applying only given requirement by customer can be very dangerous from security perspective
  - The more we learn and experience on security, the more we could find the threats and mitigations

- ✓ **Secure Implementation**

  - Using open source libraries were essential for our implementation
  - Not only secure coding but also managing vulnerabilities in the 3rd party libraries will be very important for secure implementation