

Loan Amortization Calculator

Revision: 2.0

Date: 10/09/2020

Revision History

Revision	Date	Name(s) of Editor	Description
1.0	09/15/20	Tasker	Original Document
2.0	10/09/20	Tasker	Updated Test Plan

Overview	4
Project Plan	4
Project Description.....	7
Loan Amortization Schedule	7
Definitions	8
Requirement Specifications	8
System Specification.....	9
Test Plan & Results	9
Testing Scenarios	9
Application Validation	9
Application Usability	9
Service Operation Validation	9
Client Test Cases	10
Service Test Cases	34
Testing Tools	39
Resource Requirements.....	39
System Design.....	40
Class Design	40
Client	41
Service	42
WSDL Specification	44
Sequence Diagram	46
Business Logic	46
Alternate Design	48
Development History	49
Conclusions	51
References	52

Overview

The project undertaken by Group Charlie consisted of creating a loan amortization calculator which given three of four variables calculates the forth and optionally emails an amortization schedule to the user's designated email address. This project offered a slight twist in that the calculation was performed by a WSDL-based SOAP service in the Heroku Cloud environment, and verified the user's email address using SendGrid's cloud-based email service. The technologies used to create the system included Java, Axis2, Tomcat, SendGrid, and the Heroku Cloud environment.

The project was challenging but enjoyable with everyone in Group Charlie participating in multiple facets of the endeavor. A user forum was created for general communication amongst group members as well as email usage, weekly conferences were held for status, collaboration, and general consensus on project details. An impromptu training session was also held to demonstrate Axis2 SOAP technology for the project. All project artifacts were stored in a GitHub repository. This group brought a variety of experiences to the table and offered a flexible, detailed, and pleasant atmosphere which created a productive environment to accomplish the goal of delivering a functional loan calculator.

Group Charlie Contributors:

Member	Contributions
James L.	design, development, documentation, testing
Aniebiet J.	design, development, documentation, testing
Mark Tasker	design, development, documentation, testing
Catherine W.	design, development, documentation, testing
Sam Y.	design, development, documentation, testing

Project Plan

The timeline and deliverables for this project which was to create a Loan Amortization Calculator, (see Project Description and figures 1a-c), was dictated by the course schedule so we adapted our project to it, see table 1. As detailed in table 1, there were four distinct phases and each had a specific set of tasks and deliverables for creating the calculator. The first phase included the creation and finalization of the WSDL file used to define the calculator's interface for the calling client, the client classes implemented using the MVC pattern, the calculator service that provided the four calculations, the creation of the Heroku based service environment, and the GitHub repository creation and check-in of the first iteration of the code base. The second phase included the connection of the client to the service, the creation of a Ping class for ensuring the availability

of the service, the creation of JUnit tests for the client classes, the creation of an IText PDF helper class to create an amortization schedule in PDF format which ended up not being used due to time limitations to fix formatting issues and was replaced using a plain HTML wrapper to generate an amortization schedule, the modification of the WSDL to add email verification functionality to the interface, JUnit tests for the service, SoapUI tests for the service, and updating documentation to reflect the current state of the project. Phase three involved adding the functionality to the client to allow the user to verify their email address using a 2-step verification process, the associated code additions to the service to support 2-step verification and amortization schedule creation as well as adding the SendGrid service interface to the Heroku environment which provided email capabilities to the service. Calculator functional testing, amortization schedule creation testing, email creation testing as well as end to end testing was performed throughout phase three. Phase four included end to end testing as well as final documentation.

Task	Date	Responsibility
Phase 1		
Finalize Loan Calculator WSDL	9/16-9/22	Group Charlie
Create Client Project	9/16-9/22	Group Charlie
Create Client Controller	9/16-9/22	Group Charlie
Create Client View Class	9/16-9/22	Group Charlie
Create Client Model Class	9/16-9/22	Group Charlie
Create Client Stub Classes	9/16-9/22	Group Charlie
Create Service Project	9/16-9/22	Group Charlie
Generate Service Classes from WSDL	9/16-9/22	Group Charlie
Generate Service Classes	9/16-9/22	Group Charlie
Create LoanCalcEngine Class	9/16-9/22	Group Charlie
Check-in code to Github	9/16-9/22	Group Charlie
Create Heroku Environment for Service	9/16-9/22	Group Charlie
Phase 2		
Connect Client to Service	9/23-9/29	Group Charlie
Review and enhance validation.	9/23-9/29	Group Charlie
Enhance JUnit tests for unit tests	9/23-9/29	Group Charlie
Test ping Timer class over a long duration (4 hours)	9/23-9/29	Group Charlie
Add field for email address & verification code to GUI if amortization table is selected. Include validation that sends email account a verification code to prove user controls account	9/23-9/29	Deferred to Phase 3
Review Service Calculation class	9/23-9/29	Group Charlie
Review and Enhance JUnit tests for unit tests	9/23-9/29	Group Charlie
Update WSDL with email address.	9/23-9/29	Deferred to Phase 3
Service Testing using SoapUI, JMeter	9/23-9/29	Group Charlie

Create Itext PDF helper class for creating pdf documents	9/23-9/29	Group Charlie
Updated Project Plan	9/23-9/29	Group Charlie
Update User Guide	9/23-9/29	Group Charlie
Update Testing Doc	9/23-9/29	Group Charlie
Update Technical Doc	9/23-9/29	Group Charlie
Create Phase 2 Report	9/23-9/29	Group Charlie
Phase 3		
Add 2-step email verification dialog to client	9/30-10/06	Group Charlie
Update amortization schedule displayed to include loan info with interest paid	9/30-10/06	Group Charlie
Client Security Review	9/30-10/06	Group Charlie
Defer final PDF generation modifications until Phase 4	9/30-10/06	Group Charlie
Update WSDL with email address and pin verification.	9/30-10/06	Group Charlie
Generate Web Service artifacts for client and service for 2-step verification for email address.	9/30-10/6	Group Charlie
Create email class for SendGrid – EmailManager – that allows emails with and without attachments.	9/30-10/6	Group Charlie
Service Testing of Email Functionality	9/30-10/6	Group Charlie
Add property file for SendGrid API access	9/30-10/6	Group Charlie
Add amortization schedule generation to service.	9/30-10/6	Group Charlie
Service Security Review	9/30-10/6	Group Charlie
End to End testing	9/30-10/6	Group Charlie
Assorted bug fixes	9/30-10/6	Group Charlie
Documentation updates	9/30-10/6	Group Charlie
Phase 4		
System Testing	10/7-10/13	Group Charlie
System Documentation Completion	10/7/10/13	Group Charlie

Table 1 – Project Timeline for the Loan Amortization Calculator

Project Description

The Loan Amortization Calculator provides a user the ability to determine any of the four variables used in the formula shown in figure 1 dependent on the other three variables being provided. The user will also has the option of emailing an amortization schedule showing the number of payments over the life of the loan and the breakdown of interest and principal for each.

$$A = P \frac{r(1+r)^n}{(1+r)^n - 1}$$

where

- A = loan payment per term
- P = loan principal
- r = interest rate per term
- n = total number of payments

Figure 1a – Amortization Equation

Loan Amortization Schedule

Loan Amount: 15000.00
Loan Payment: 1278.96
Interest Rate: 4.25
Loan Term: 12
Interest Paid: 347.55

Month	Payment	Principal	Interest	Balance
1	1278.96	1225.84	53.13	13774.16
2	1278.96	1230.18	48.78	12543.98
3	1278.96	1234.54	44.43	11309.45
4	1278.96	1238.91	40.05	10070.54
5	1278.96	1243.30	35.67	8827.24
6	1278.96	1247.70	31.26	7579.54
7	1278.96	1252.12	26.84	6327.43
8	1278.96	1256.55	22.41	5070.87
9	1278.96	1261.00	17.96	3809.87
10	1278.96	1265.47	13.49	2544.40
11	1278.96	1269.95	9.01	1274.45
12	1278.96	1274.45	4.51	0.00

Figure 1b – Amortization Schedule

Definitions

- Amortization is a process of reducing a debt by applying regular payments over some time period that typically includes both principle and interest.
- Loan Amount represents the magnitude of the loan.
- Loan Payment represents the amount of money to be paid on a regular basis that will reduce the balance of the loan and includes an interest payment.
- Loan Interest Rate is the amount charged as a percentage of the loan amount over each term.
- Loan Term represents the number of payment periods for the loan.
- Amortization Schedule is a report showing the characteristics of a loan (amount, payment, interest rate, and term) and a table that has the payment of each term of the loan consisting of payment, principal, interest, and the remaining loan balance.

Figure 1c – Definition of terms

Requirement Specifications

Functional Requirements	
Requirement #	Description
0	The System will provide a GUI interface.
1	The System will provide a cloud-based Loan Calculation Service
2	The System will provide a user with a form to enter 3 of the 4 required variables
3	The System will validate the data values at entry and calculation.
4	The System will provide the user with an error message if validation fails.
	The System will provide the user with an error message if connectivity fails
5	The System will calculate and display the missing variable.
6	The System will synchronously communicate with the cloud-based Loan Calculation Service via a SOAP API call over HTTPS
7	The System will optionally allow the user to create an amortization schedule.
8	The System will receive, calculate, and display the calculated variable and if selected an amortization schedule.
9	The GUI will timeout after n seconds of initiating a call to the Loan Amortization Service
10	The GUI will ping the service periodically to ensure that it is available and set the <Calculate> button according to availability (enabled/disabled)
11	The GUI will optionally email an amortization schedule after a 2-step email validation process.
Non-Functional Requirements	
Requirement #	Description
1	The System will not provide authentication or authorization.
2	The System will not be guaranteed to be available.
3	The System will not be guaranteed to be scalable.
4	The System will not permanently persist any user data.

Table 2 - Requirement Specifications

System Specification

Client Side

- The Amortization Calculator requires a computer with at least 4 GB memory, multicore CPU(s), and connectivity to the internet.
- The Java Runtime Environment (JRE) version 8 or greater must be installed.
- LoanCalcClient.jar must be installed.

Server Side

- Installation of the Loan Calculation Service into the Heroku Cloud environment that include the SendGrid service interface.

Test Plan & Results

The testing scope for the Loan Amortization Calculator included four test case scenarios with and without the email option selected, table 3, the expected application functionality, performance testing of the service, environmental dependencies (connectivity), JRE version compatibility, and minimum hardware configurations scenarios.

Testing Scenarios

Application Validation

- Test case for calculating loan amount with and without email option selection
- Test case for calculating loan payment with and without email option selection
- Test case for calculating loan interest rate with and without email option selection
- Test case for calculating loan term with and without email option selection
- GUI validates data as numeric and greater than 0

Application Usability

- GUI allows the user to select the variable to calculate and provides the required fields for entering the three required values to complete the calculation
- GUI gives the user the option of emailing an amortization schedule to email with the entered loan scenario after 2-step email verification is satisfied
- GUI reports connectivity issues
- GUI provides an enabled Calculate button for submitting the loan scenario to the Loan Calc Service
- GUI provides a Clear button for resetting all values displayed on the screen
- GUI provides the user with the ability to exit the application

Service Operation Validation

- SOAP request and response artifacts created in SoapUI for service operation testing Performance, Scalability, and Average Round Trip Testing

Client Test Cases

TC #	Variables To Be Calculated	Loan Amount	Loan Payment	Loan Rate	Loan Term
TC 1	Loan amount	223225.75	1250.00	5.375%	360 months
TC 2	Loan payment	45000	844.06	4.75%	60 months
TC 3	Loan Rate	60000	600	3.736%	120 months
TC 4	Loan Term	24950	699.50	7.25%	40 months

Table 3 – Test Cases used for both Loan Amortization Client and Service

Testing Scenarios – Application Validation

- Utilizing the first test case in Table 3 each loan amortization calculation scenario was performed to show the consistency of the resulting calculation (see figures 2a-d).

The screenshot shows the 'Loan Amortization Calculator' window. Under 'Select an Option to Calculate', the 'Loan Amount' radio button is selected. The input fields show: Loan Amount: 223225.75, Interest Rate: 5.375, Loan Term: 360, and Monthly Payment: 1250. The 'Email Amortization Schedule' checkbox is unchecked. The output area displays the loan details and a table for the first two months of the amortization schedule.

-----Loan Amortization Schedule-----				
Loan Amount	.....	223225.75		
Loan Payment	.....	1250.00		
Interest Rate	.....	5.375		
Loan Term	.....	360		
Interest Paid	.....	226774.25		
Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 2a – Loan Amount Calculation without Email Option

The screenshot shows the 'Loan Amortization Calculator' window. Under 'Select an Option to Calculate', the 'Monthly Payment' radio button is selected. The input fields show: Loan Amount: 223225.75, Interest Rate: 5.375, Loan Term: 360, and Monthly Payment: 1250. The 'Email Amortization Schedule' checkbox is unchecked. The output area displays the loan details and a table for the first two months of the amortization schedule.

-----Loan Amortization Schedule-----				
Loan Amount	.....	223225.75		
Loan Payment	.....	1250.00		
Interest Rate	.....	5.375		
Loan Term	.....	360		
Interest Paid	.....	226774.25		
Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 2b – Loan Payment Calculation without Email Option

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☒ Interest Rate
☐ Loan Term
☐ Monthly Payment

223225.75
 5.375
 360
 1250

☐ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount 223225.75
 Loan Payment 1250.00
 Interest Rate 5.375
 Loan Term 360
 Interest Paid 226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Calculate Clear

Figure 2c – Loan Interest Calculation without Email Option

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☐ Interest Rate
☒ Loan Term
☐ Monthly Payment

223225.75
 5.375
 360
 1250

☐ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount 223225.75
 Loan Payment 1250.00
 Interest Rate 5.375
 Loan Term 360
 Interest Paid 226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Calculate Clear

Figure 2d – Loan Term Calculation without Email Option

Testing Scenarios - Application Validation

- Utilizing the first test case in Table 3 each loan amortization calculation scenario was performed to show the consistency of the resulting calculation (see figures 3a-h) as well as the amortization schedule on screen and in email.

The screenshot shows a window titled "Loan Amortization Calculator". It has a section "Select an Option to Calculate" with four radio buttons: "Loan Amount" (selected), "Interest Rate", "Loan Term", and "Monthly Payment". To the right of these are input fields containing the values: 223225.75, 5.375, 360, and 1250. Below this is a checkbox "Email Amortization Schedule" which is checked, and an email address field containing "lislej@gmail.com". At the bottom are "Calculate" and "Clear" buttons.

-----Loan Amortization Schedule-----

Loan Amount	223225.75
Loan Payment	1250.00
Interest Rate	5.375
Loan Term	360
Interest Paid	226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 3a - Loan Amount Calculation with Email Option

The screenshot shows an email interface in Google Chrome. The email is from "info@loancalc.edu via sendgrid.me" to "lislej@gmail.com", received 12:36 PM (2 minutes ago). The email body contains the same loan amortization schedule data as Figure 3a.

-----Loan Amortization Schedule-----

Loan Amount	223225.75
Loan Payment	1250.00
Interest Rate	5.375
Loan Term	360
Interest Paid	226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 3b – Associated Loan Amortization Schedule

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☐ Interest Rate
☐ Loan Term
☒ Monthly Payment

223225.75
 5.375
 360
 1250

☒ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount: 223225.75
 Loan Payment: 1250.00
 Interest Rate: 5.375
 Loan Term: 360
 Interest Paid: 226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Calculate Clear

Figure 3c - Loan Payment Calculation with Email Option

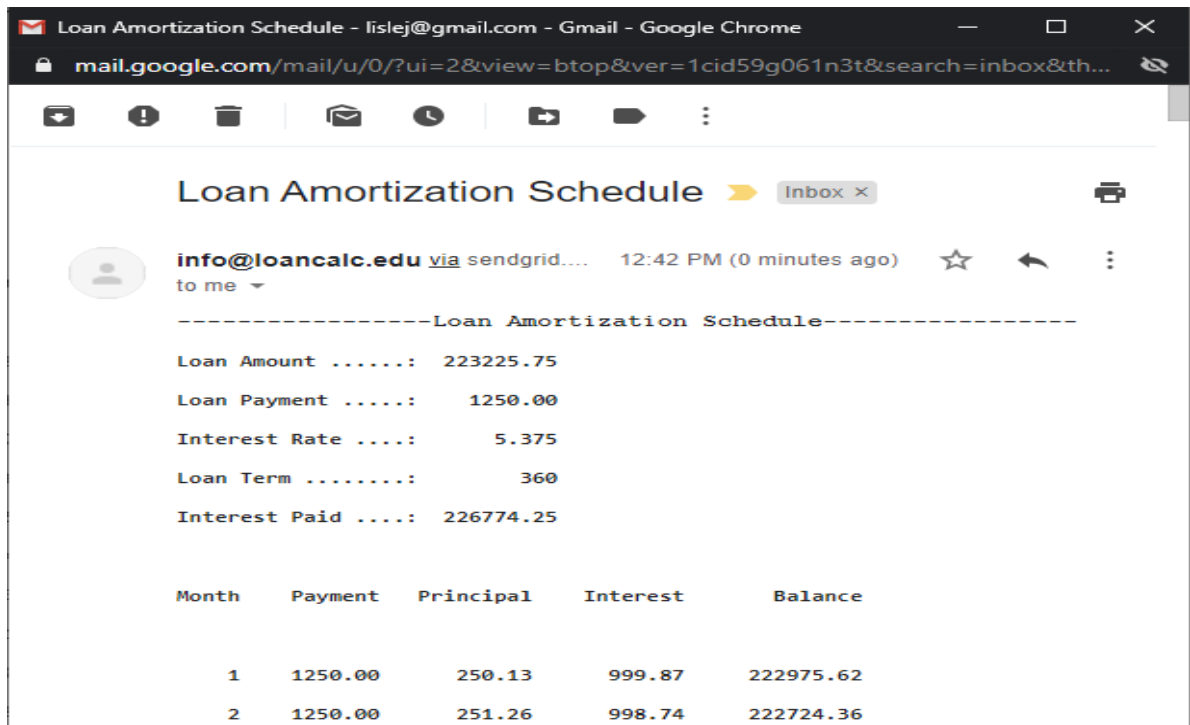


Figure 3d – Associated Loan Amortization Schedule

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☒ Interest Rate
☐ Loan Term
☐ Monthly Payment

223225.75
 5.375
 360
 1250

☒ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount: 223225.75
 Loan Payment: 1250.00
 Interest Rate: 5.375
 Loan Term: 360
 Interest Paid: 226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 3e - Loan Interest Rate Calculation with Email Option

Loan Amortization Schedule - lislej@gmail.com - Gmail - Google Chrome

mail.google.com/mail/u/0/?ui=2&view=bt&ver=1cid59g061n3t&search=inb...

info@loancalc.edu via sen... 12:44 PM (2 minutes ago) ☆ ↶ ⋮

to me ▾

...

-----Loan Amortization Schedule-----

--

Loan Amount: 223225.75
 Loan Payment: 1250.00
 Interest Rate: 5.375
 Loan Term: 360
 Interest Paid: 226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 3f - Associated Loan Amortization Schedule

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☐ Interest Rate
☒ Loan Term
☐ Monthly Payment

223225.75
 5.375
 360
 1250

☒ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount: 223225.75
 Loan Payment: 1250.00
 Interest Rate: 5.375
 Loan Term: 360
 Interest Paid: 226774.25

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

Figure 3g - Loan Term Calculation with Email Option

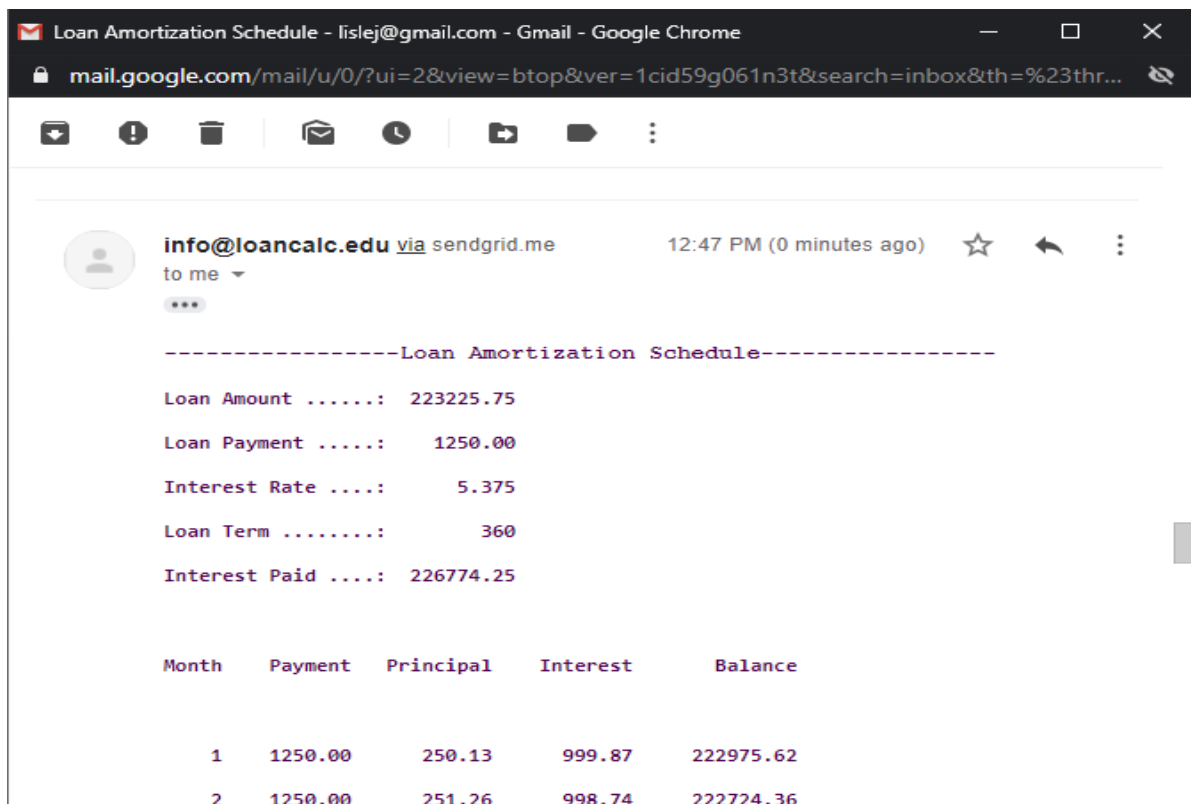


Figure 3h – Associated Loan Amortization Schedule

Testing Scenarios - Application Validation

- Utilizing the four test cases in Table 3 each loan amortization calculation scenario was performed with the email option selected to show the consistency of the resulting calculation (see figures 3a-h) as well as the amortization schedule on screen and in email.

The screenshot shows a web application titled "Loan Amortization Calculator". It has a section "Select an Option to Calculate" with four radio buttons: "Loan Amount" (selected), "Interest Rate", "Loan Term", and "Monthly Payment". To the right of these are input fields containing the values: 223225.75, 5.375, 360, and 1250. Below this is a checkbox labeled "Email Amortization Schedule" which is checked, with an email address "lislej@gmail.com" entered next to it. The main area displays a "Loan Amortization Schedule" with the following summary:

Loan Amount	223225.75
Loan Payment	1250.00
Interest Rate	5.375
Loan Term	360
Interest Paid	226774.25

Below the summary is a table with 5 columns: Month, Payment, Principal, Interest, and Balance. The first two rows are visible:

Month	Payment	Principal	Interest	Balance
1	1250.00	250.13	999.87	222975.62
2	1250.00	251.26	998.74	222724.36

At the bottom are "Calculate" and "Clear" buttons.

Figure 4a – Loan Amount Calculation with Email Option

The screenshot shows an email interface in Google Chrome. The email is from "info@loancalc.edu via sendgrid.me" to "me", received at 12:36 PM (2 minutes ago). The email body contains the same "Loan Amortization Schedule" as seen in Figure 4a, including the summary and the monthly payment table.

Figure 4b – Associated Loan Amortization Schedule

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☐ Interest Rate
☐ Loan Term
☒ Monthly Payment

45000
 4.75
 60
 844.06

☒ Email Amortization Schedule

```

-----Loan Amortization Schedule-----
Loan Amount .....: 45000.00
Loan Payment .....: 844.06
Interest Rate .....: 4.750
Loan Term .....: 60
Interest Paid .....: 5643.66

Month    Payment    Principal    Interest    Balance
1        844.06      665.94      178.13      44334.06
2        844.06      668.57      175.49      43665.49
  
```

Calculate Clear

Figure 4c – Loan Payment Calculation with Email Option

Loan Amortization Schedule - lislej@gmail.com - Gmail - Google Chrome

mail.google.com/mail/u/0/?ui=2&view=bt&ver=1cid59g061n3t&search=inbox&th=%2...

info@loancalc.edu via sendgrid.me 12:45 AM (0 minutes ago)

```

-----Loan Amortization Schedule-----
Loan Amount .....: 45000.00
Loan Payment .....: 844.06
Interest Rate .....: 4.750
Loan Term .....: 60
Interest Paid .....: 5643.66

Month    Payment    Principal    Interest    Balance
1        844.06      665.94      178.13      44334.06
2        844.06      668.57      175.49      43665.49
  
```

Figure 4d – Associated Loan Amortization Schedule

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☒ Interest Rate
☐ Loan Term
☐ Monthly Payment

60000
 3.737
 120
 600

☒ Email Amortization Schedule

```

-----Loan Amortization Schedule-----
Loan Amount .....: 60000.00
Loan Payment .....: 600.00
Interest Rate .....: 3.737
Loan Term .....: 120
Interest Paid .....: 11999.92

Month   Payment   Principal   Interest   Balance
1       600.00    413.15     186.85    59586.85
2       600.00    414.44     185.56    59172.41
  
```


Calculate Clear

Figure 4e – Loan Interest Calculation with Email Option

Loan Amortization Schedule - lislej@gmail.com - Gmail - Google Chrome

mail.google.com/mail/u/0/?ui=2&view=btot&ver=1cid59g061n3t&search=inbox&t...

Loan Amortization Schedule Inbox x

 **info@loancalc.edu** via sendgrid.... 12:50 AM (1 minute ago) ☆ ↶ ⋮
to me ▾

```

-----Loan Amortization Schedule-----
Loan Amount .....: 60000.00
Loan Payment .....: 600.00
Interest Rate .....: 3.737
Loan Term .....: 120
Interest Paid .....: 11999.92

Month   Payment   Principal   Interest   Balance
1       600.00    413.15     186.85    59586.85
2       600.00    414.44     185.56    59172.41
  
```

Figure 4f – Associated Loan Amortization Schedule

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount
☐ Interest Rate
☒ Loan Term
☐ Monthly Payment

24950
 7.25
 40
 699.50

☒ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount: 24950.00
 Loan Payment: 699.50
 Interest Rate: 7.250
 Loan Term: 40
 Interest Paid: 3234.09

Month	Payment	Principal	Interest	Balance
1	699.50	548.76	150.74	24401.24
2	699.50	552.08	147.42	23849.16

Calculate Clear

Figure 4g – Loan Term Calculation with Email Option

Loan Amortization Schedule - lislej@gmail.com - Gmail - Google Chrome

mail.google.com/mail/u/0/?ui=2&view=btot&ver=1cid59g061n3t&search=inbox&th=...

info@loancalc.edu via sendgrid.me 12:54 AM (1 minute ago)

-----Loan Amortization Schedule-----

Loan Amount: 24950.00
 Loan Payment: 699.50
 Interest Rate: 7.250
 Loan Term: 40
 Interest Paid: 3234.09

Month	Payment	Principal	Interest	Balance
1	699.50	548.76	150.74	24401.24
2	699.50	552.08	147.42	23849.16

Figure 4h – Associated Loan Amortization Schedule

Testing Scenarios - Application Validation

- GUI validates data as numeric and greater than 0

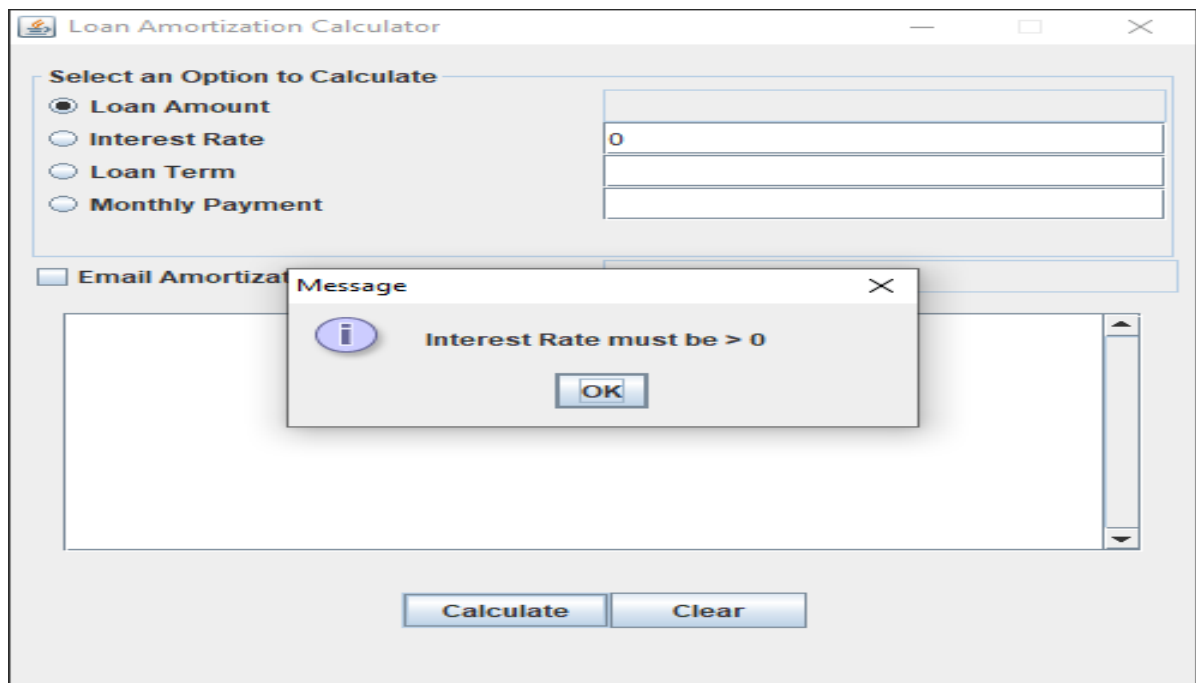


Figure 5a - Interest Rate validated as numeric and greater than 0

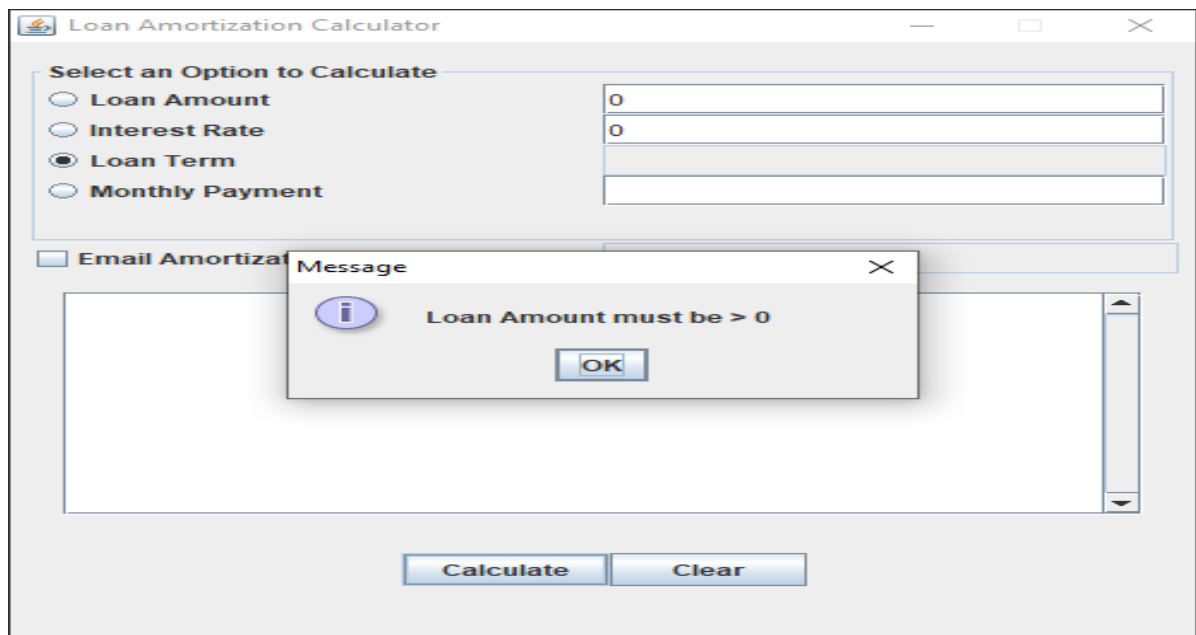


Figure 5b – Loan Amount validated as numeric and greater than 0

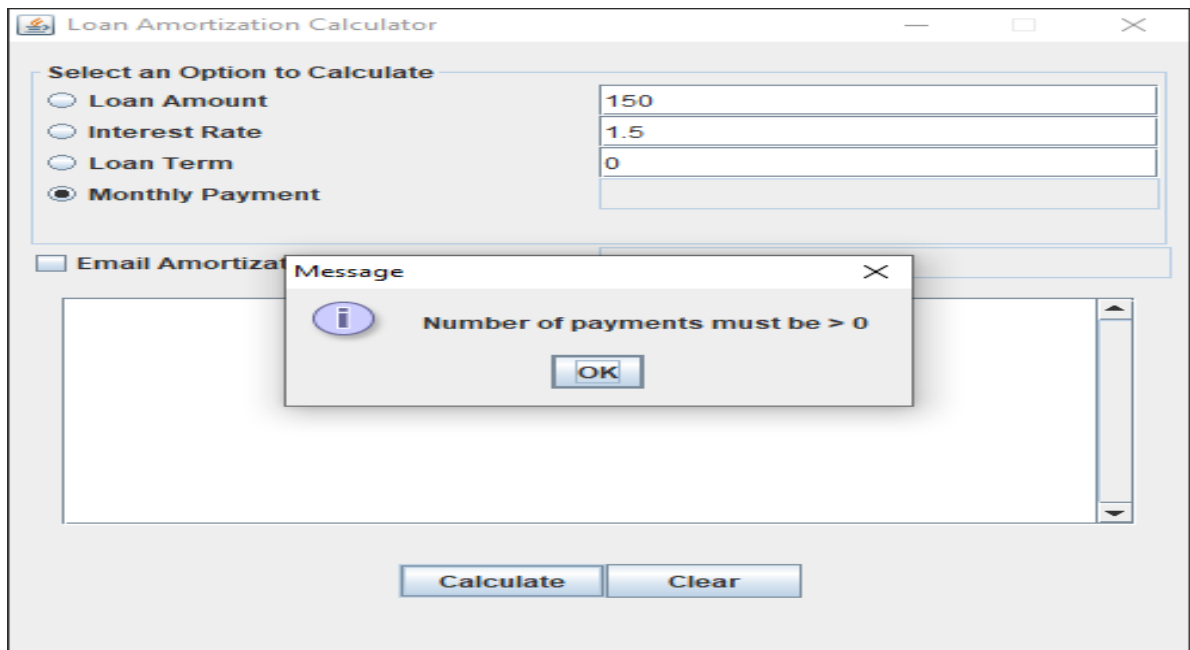


Figure 5c – Loan Term validated as numeric and greater than 0 present

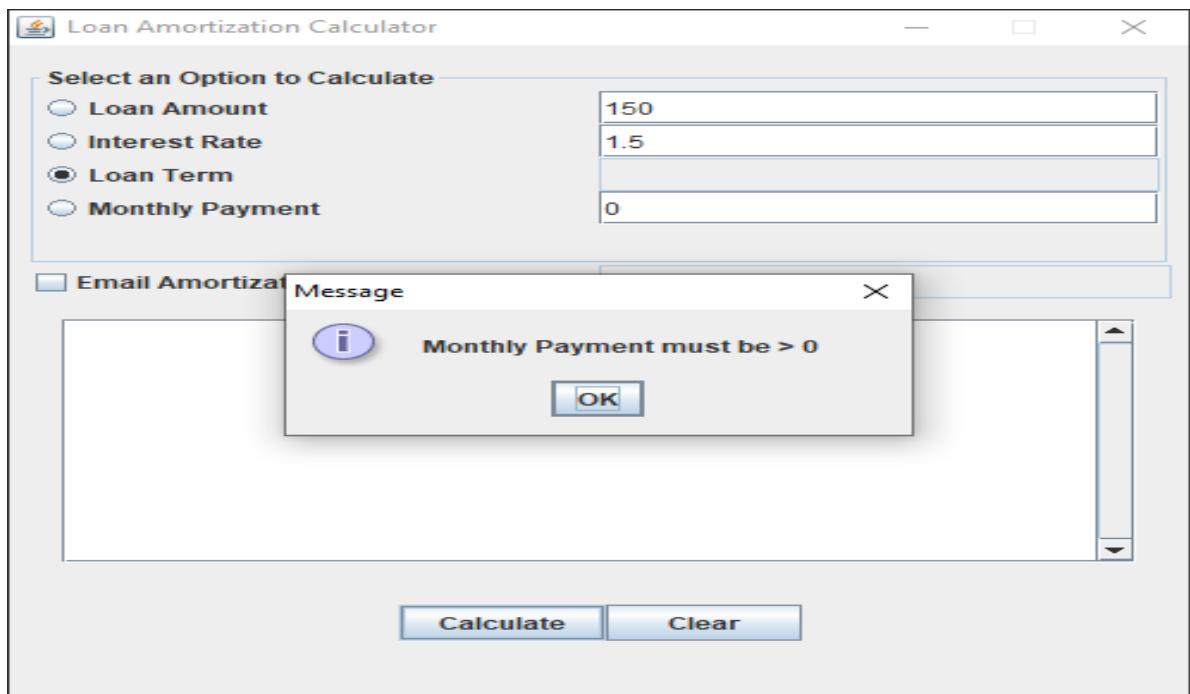
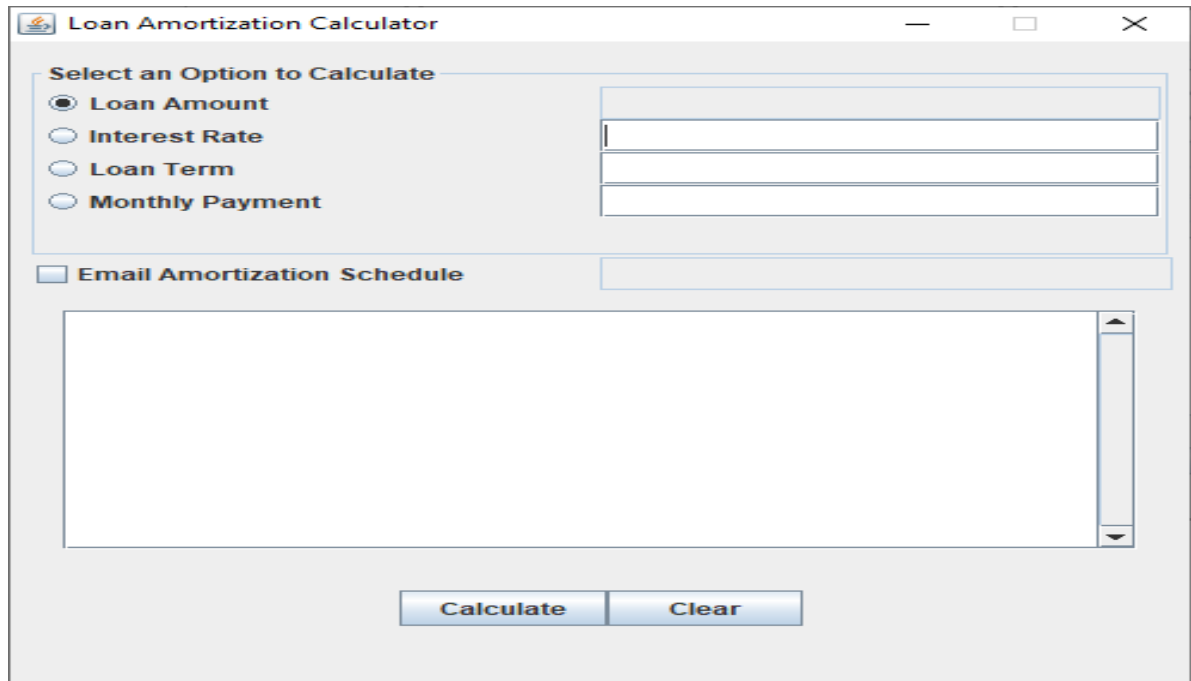


Figure 5d – Loan Payment validated as numeric and greater than 0

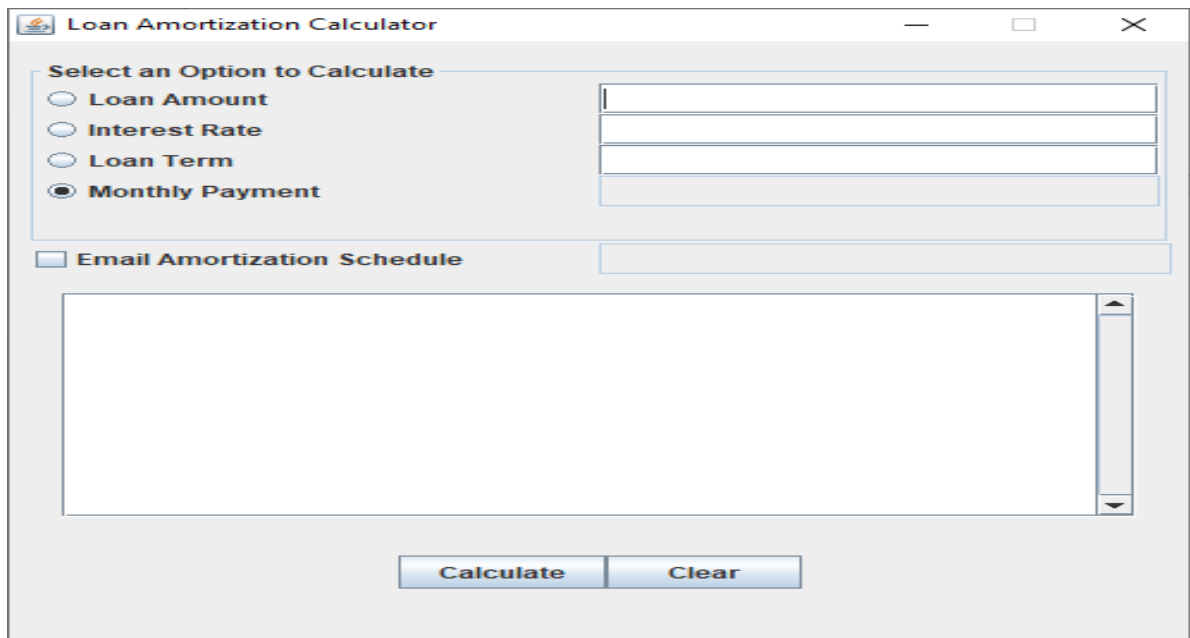
Testing Scenarios - Application Usability

- GUI allows the user to select the variable to calculate and provides the required fields for entering the three required values to complete the calculation



The screenshot shows a window titled "Loan Amortization Calculator". Inside, there is a section "Select an Option to Calculate" with four radio buttons: "Loan Amount" (selected), "Interest Rate", "Loan Term", and "Monthly Payment". To the right of these buttons are three empty text input fields. Below this section is a checkbox labeled "Email Amortization Schedule" and an empty text input field. At the bottom of the window are two buttons: "Calculate" and "Clear". A large empty text area with a vertical scrollbar is located below the "Email Amortization Schedule" checkbox.

Figure 6a - Calculating Loan Amount



The screenshot shows the same "Loan Amortization Calculator" window. In this state, the "Monthly Payment" radio button is selected. The three text input fields to the right are still empty. The "Email Amortization Schedule" checkbox and its associated text field remain empty. The "Calculate" and "Clear" buttons are still present at the bottom. The large empty text area with a vertical scrollbar is also visible.

Figure 6b - Calculating Loan Payment

Loan Amortization Calculator

Select an Option to Calculate

- ☐ Loan Amount
- ☒ Interest Rate
- ☐ Loan Term
- ☐ Monthly Payment

☐ Email Amortization Schedule

Calculate Clear

Figure 6c - Calculating Interest Rate

Loan Amortization Calculator

Select an Option to Calculate

- ☐ Loan Amount
- ☐ Interest Rate
- ☒ Loan Term
- ☐ Monthly Payment

☐ Email Amortization Schedule

Calculate Clear

Figure 6d - Calculating Loan Term

Testing Scenarios - Application Usability

- GUI gives the user the option of emailing an amortization schedule with the entered loan scenario after 2-step email verification is satisfied

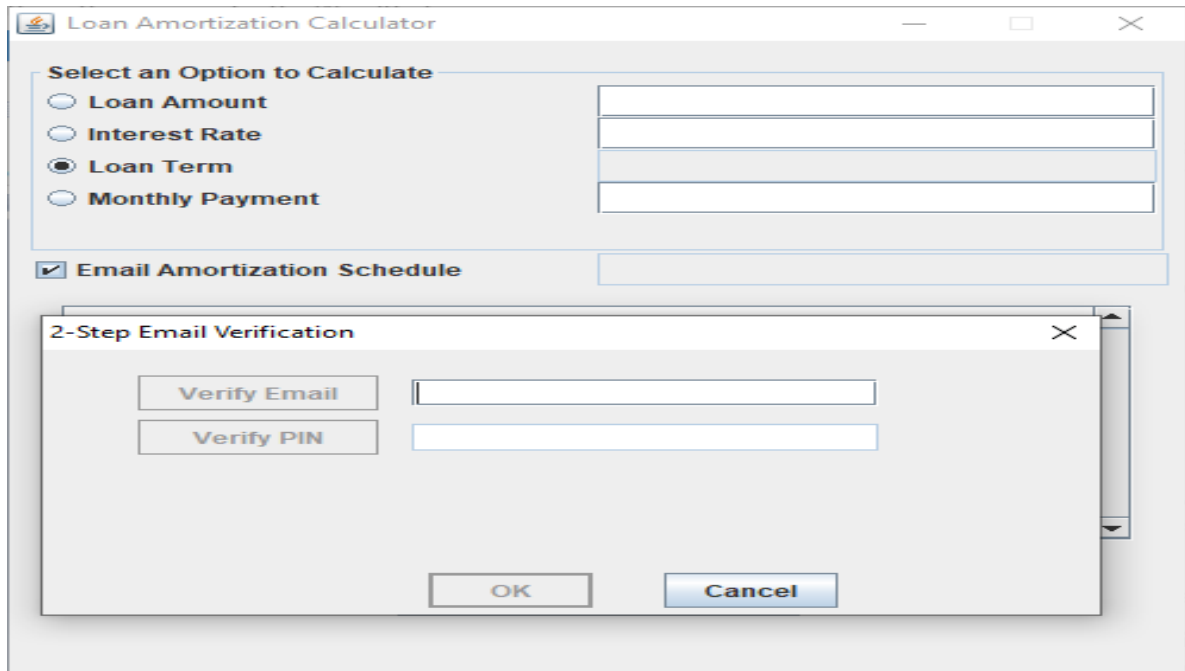


Figure 7a - 2-Step Email Verification

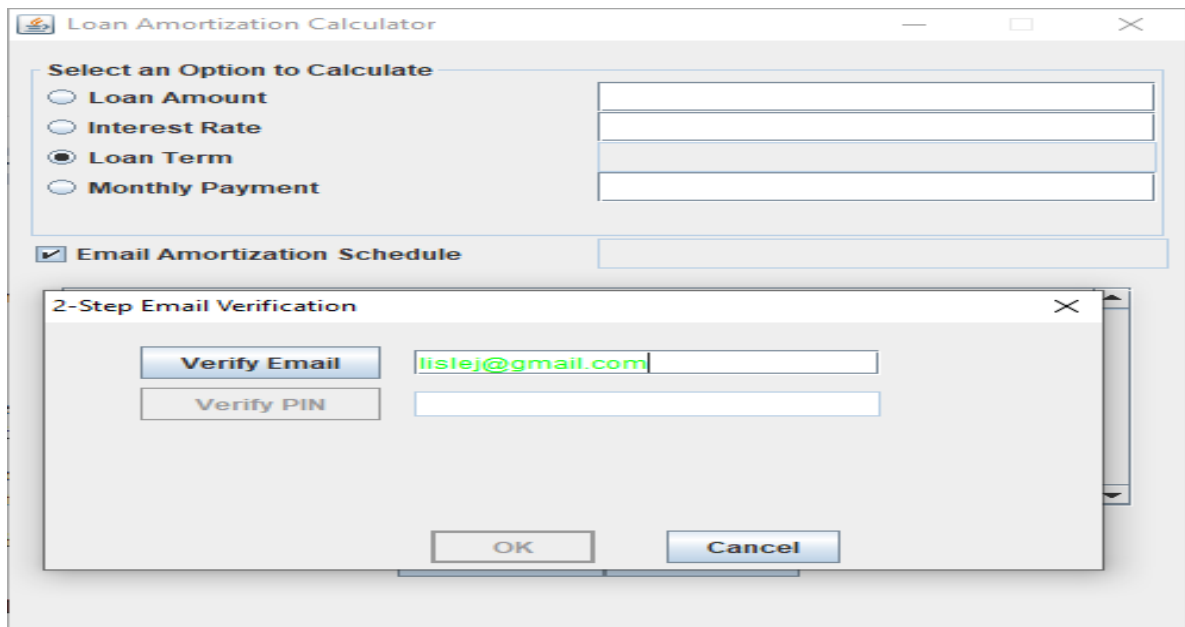


Figure 7b - 2-Step Email Verification with valid email address

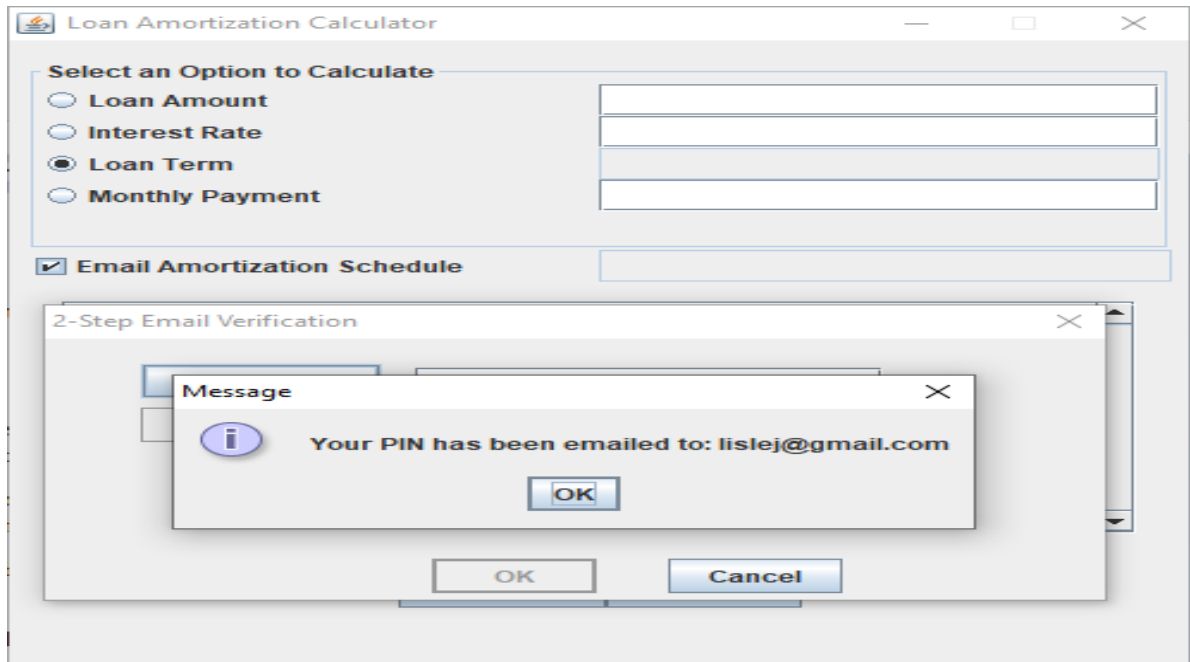


Figure 7c - 2-Step Email Verification with PIN sent to email address being verified

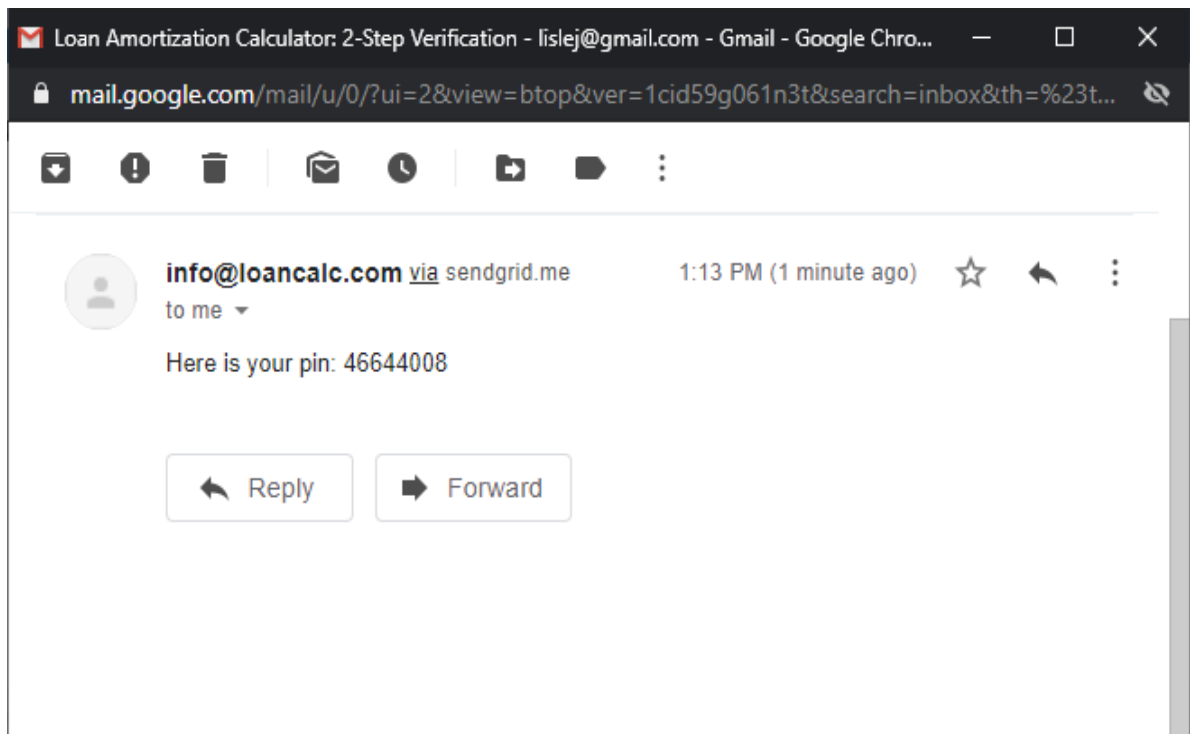


Figure 7d - 2-Step Email Verification with retrieving PIN from email

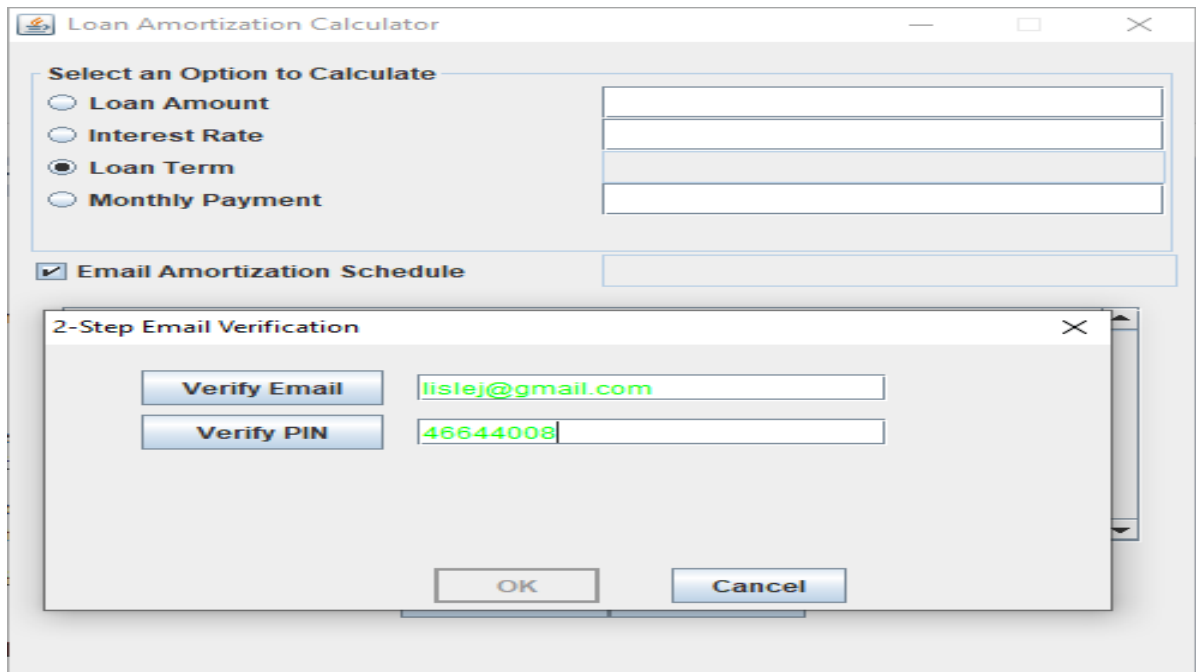


Figure 7e - 2-Step Email Verification with PIN being verified

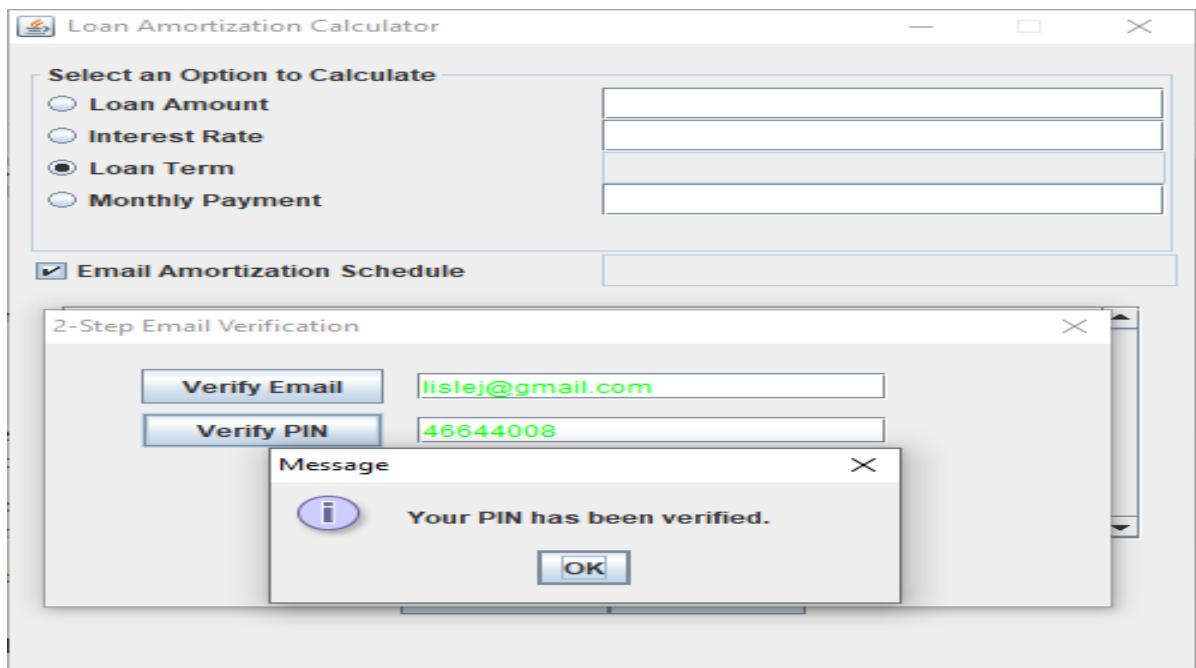


Figure 7f - 2-Step Email Verification with verified PIN

The screenshot shows the 'Loan Amortization Calculator' window. Under the heading 'Select an Option to Calculate', there are four radio buttons: 'Loan Amount', 'Interest Rate', 'Loan Term' (which is selected), and 'Monthly Payment'. To the right of these are four empty text input fields. Below this section, the checkbox 'Email Amortization Schedule' is checked, and the text 'lislej@gmail.com' is entered in the adjacent field. A large, empty rectangular area with a vertical scrollbar is positioned below the email field. At the bottom of the window are two buttons: 'Calculate' and 'Clear'.

Figure 7g - 2-Step Email Verification with verified email address

This screenshot shows the same 'Loan Amortization Calculator' window as Figure 7g, but with a '2-Step Email Verification' dialog box open in the foreground. The dialog box has a title bar with a close button. It contains two buttons on the left: 'Verify Email' and 'Verify PIN'. To the right of 'Verify Email' is a text input field containing 'lislej@gm' in red text, followed by an empty space. Below this is another empty text input field corresponding to the 'Verify PIN' button. At the bottom of the dialog box are 'OK' and 'Cancel' buttons. The background calculator window is partially visible behind the dialog.

Figure 7h - 2-Step Email Verification with incomplete email address

Loan Amortization Calculator

Select an Option to Calculate

- ☐ Loan Amount
- ☐ Interest Rate
- ☒ Loan Term
- ☐ Monthly Payment

☒ Email Amortization Schedule

2-Step Email Verification

Verify Email: lislej@gmail.com

Verify PIN: 466440

OK Cancel

Figure 7i - 2-Step Email Verification with incomplete PIN

Testing Scenarios - Application Usability

- GUI reports connectivity issues

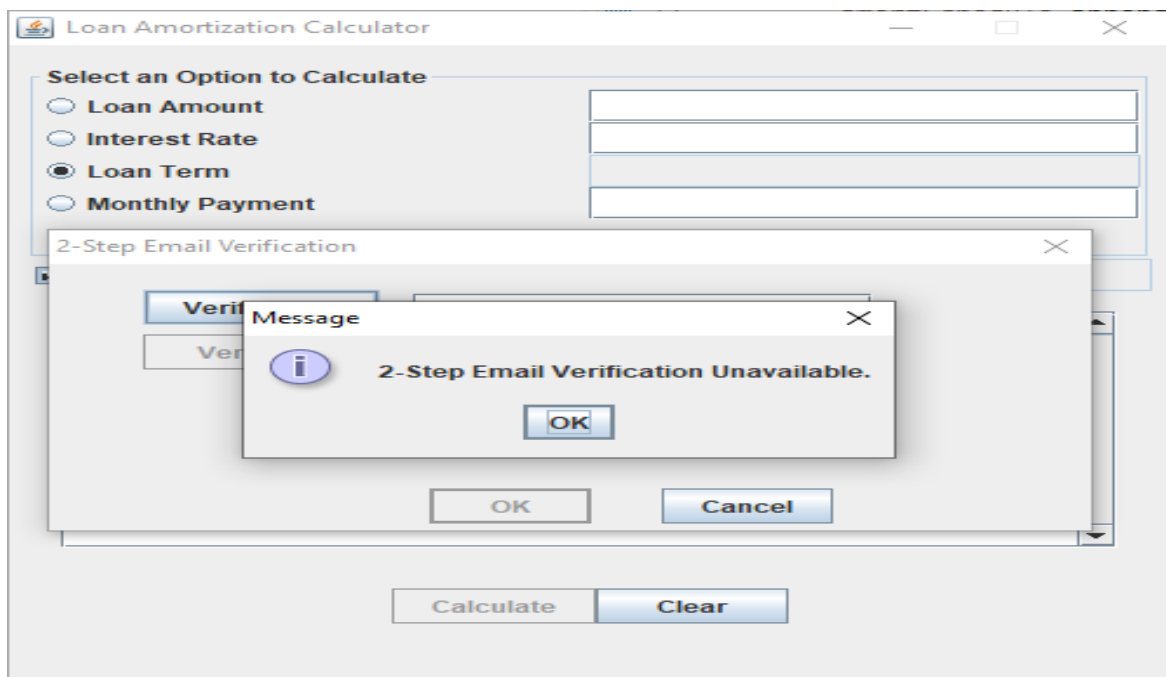


Figure 8a - 2-Step Email Verification Unavailable

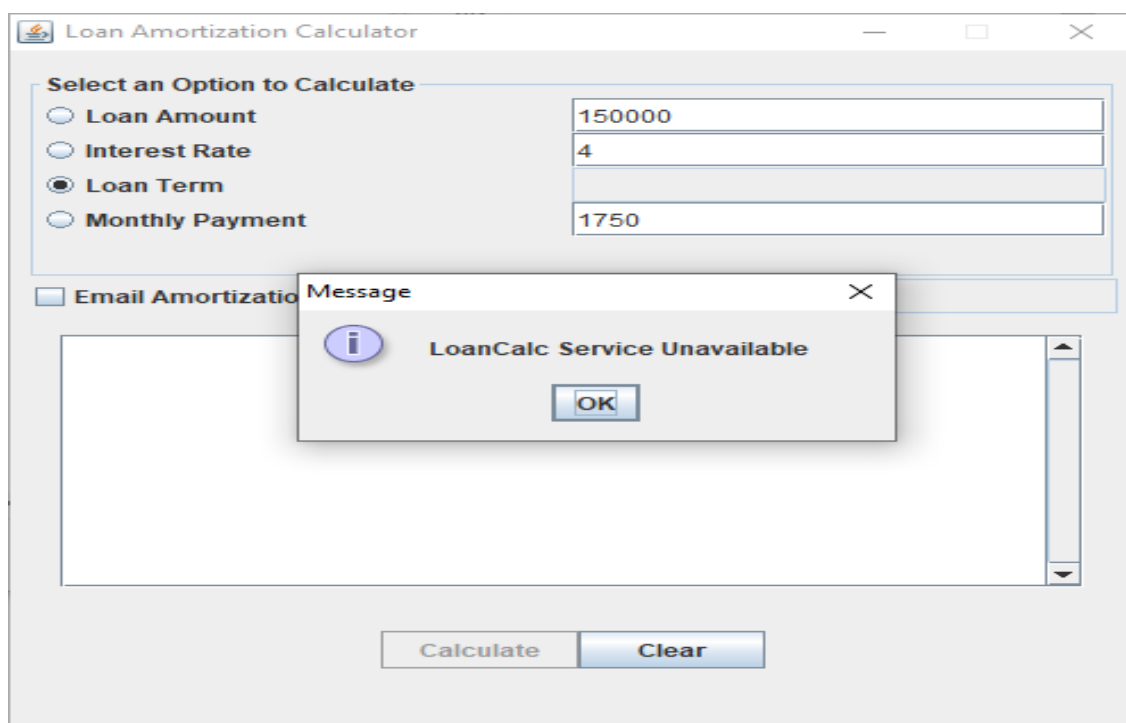


Figure 8b - LoanCalc Service Unavailable with grayed out Calculate Button

Testing Scenarios – Application Usability

- GUI provides an enabled Calculate button for submitting the loan scenario to the Loan Amortization Service

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount

☐ Interest Rate

☒ Loan Term

☐ Monthly Payment

☐ Email Amortization Schedule

Figure 9a – Calculator data staged for submission

Loan Amortization Calculator

Select an Option to Calculate

☐ Loan Amount

☐ Interest Rate

☒ Loan Term

☐ Monthly Payment

☐ Email Amortization Schedule

-----Loan Amortization Schedule-----

Loan Amount: 150.00

Loan Payment: 10.00

Interest Rate: 15.000

Loan Term: 17

Interest Paid: 17.16

Month	Payment	Principal	Interest	Balance
1	10.00	8.13	1.88	141.88
2	10.00	8.23	1.77	133.65

Figure 9b – Calculator results after submission

Testing Scenarios - Application Usability

- GUI provides a Clear button for resetting all values displayed on the screen

The screenshot shows the 'Loan Amortization Calculator' window. Under 'Select an Option to Calculate', 'Loan Term' is selected. The input fields contain: Loan Amount: 155000, Interest Rate: 2.75, Loan Term: 153, Monthly Payment: 1200. The 'Email Amortization Schedule' checkbox is checked, and the email field contains 'lislej@gmail.com'. A table displays the amortization schedule for 153 periods.

143	1200.00	1169.27	30.73	12240.44
144	1200.00	1171.95	28.05	11068.49
145	1200.00	1174.63	25.37	9893.85
146	1200.00	1177.33	22.67	8716.53
147	1200.00	1180.02	19.98	7536.50
148	1200.00	1182.73	17.27	6353.77
149	1200.00	1185.44	14.56	5168.33
150	1200.00	1188.16	11.84	3980.18
151	1200.00	1190.88	9.12	2789.30
152	1200.00	1193.61	6.39	1595.69
153	1200.00	1196.34	3.66	399.35

Buttons: Calculate, Clear

Figure 10a – Calculator view before Clear button press

The screenshot shows the 'Loan Amortization Calculator' window after the 'Clear' button was pressed. All input fields are now empty. The 'Email Amortization Schedule' checkbox is unchecked. The table area is empty.

Buttons: Calculate, Clear

Figure 10a – Calculator view after Clear button press

Testing Scenarios - Application Usability

- GUI provides the user with the ability to exit the application

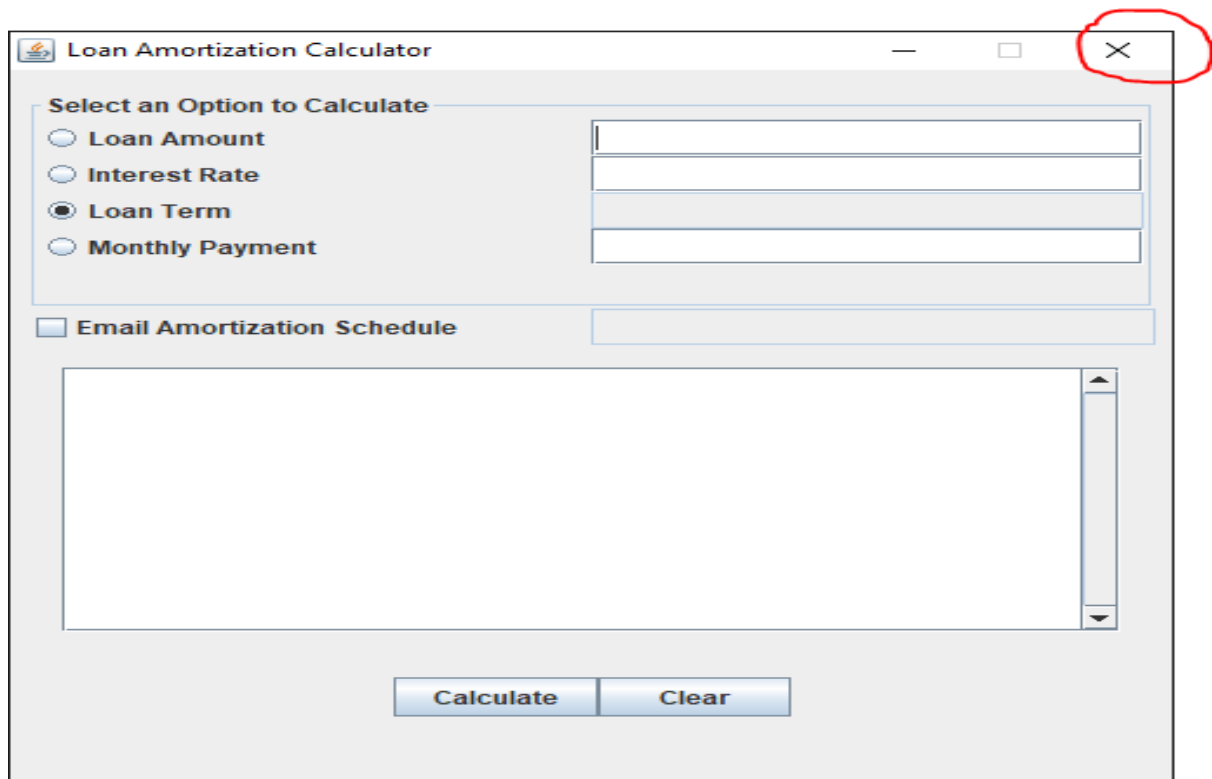


Figure 11 – Red Circled X shows the control to be pressed to Exit Application

Testing Scenario – Service Operations Validation

Service Test Cases













TC #	Loan Amount	Loan Payment	Loan Rate	Loan Term	Data Inputs	Expected Results	Actual Results
1	P 223225.75	1250.00	5.375%	360 months	 LAC-TC-01-CalcLoan Amt-Request.xml	 LAC-TC-01-CalcLoan Amt-Expected-Respc	 LAC-TC-01-CalcLoan Amt-Actual-Respon
2	45000	A	4.75%	60 months	 LAC-TC-02-CalcLoan Pmt-Request.xml	 LAC-TC-02-CalcLoan Amt-Expected-Respc	 LAC-TC-02-CalcLoan Amt-Actual-Respon
3	60000	600	R	120 months	 LAC-TC-03-CalcLoan Rate-Request.xml	 LAC-TC-03-CalcLoan Rate-Expected-Resp	 LAC-TC-03-CalcLoan Rate-Actual-Respon
4	24950	699.50	7.25%	n	 LAC-TC-04-CalcLoan Term-Request.xml	 LAC-TC-04-CalcLoan Term-Expected-Resp	 LAC-TC-04-CalcLoan Term-Actual-Respon

Table 3 – Service Operation Test Cases

Testing Scenarios - Service Operation Validation

- SOAP request and response artifacts created in SoapUI for service operation testing

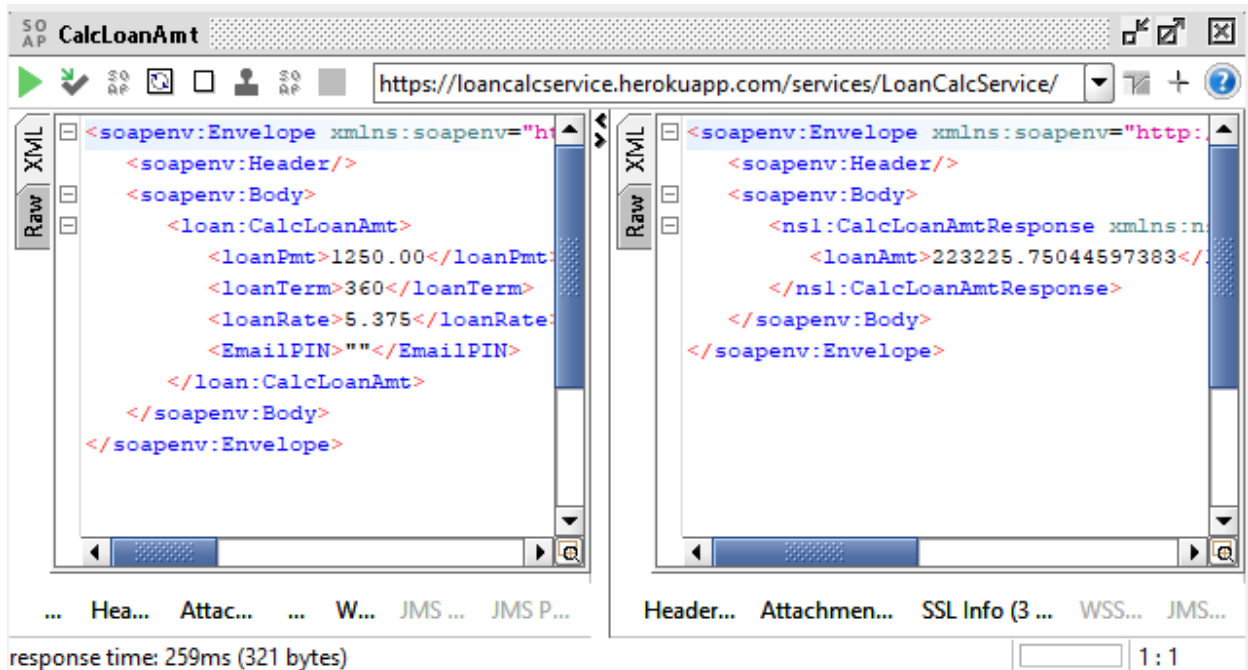


Figure 12 – CalcLoanAmt Request and Response in SoapUI

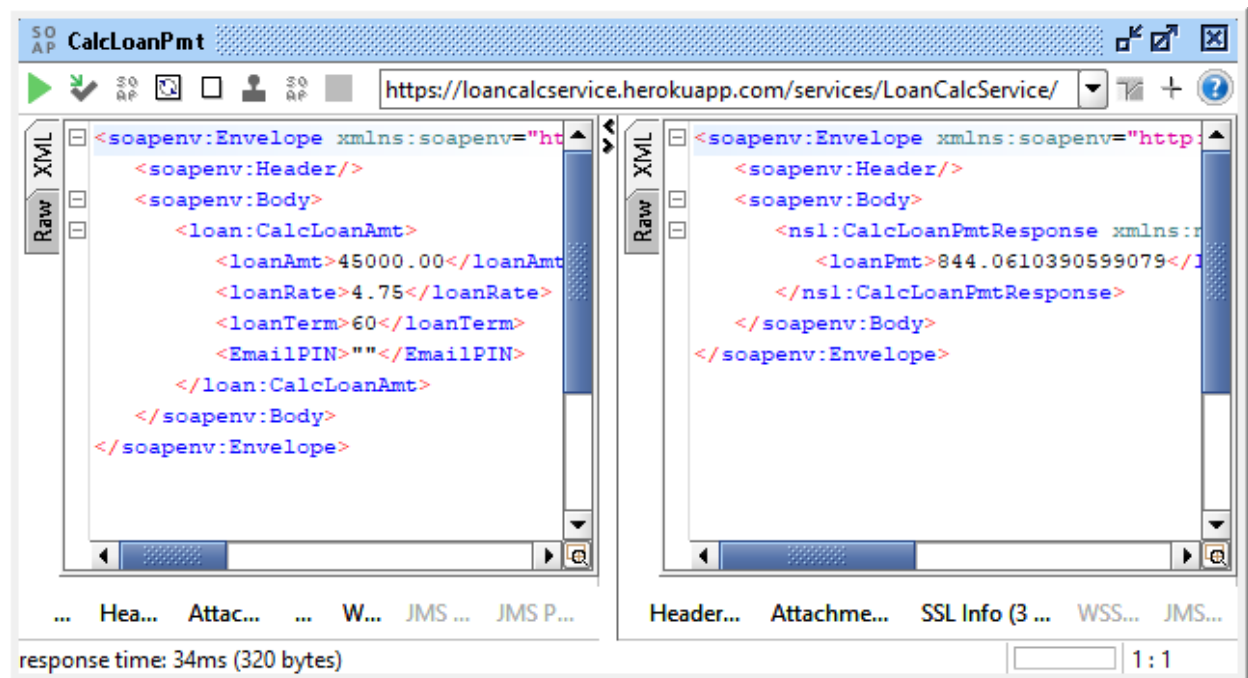


Figure 13 – CalcLoanPmt Request and Response in SoapUI

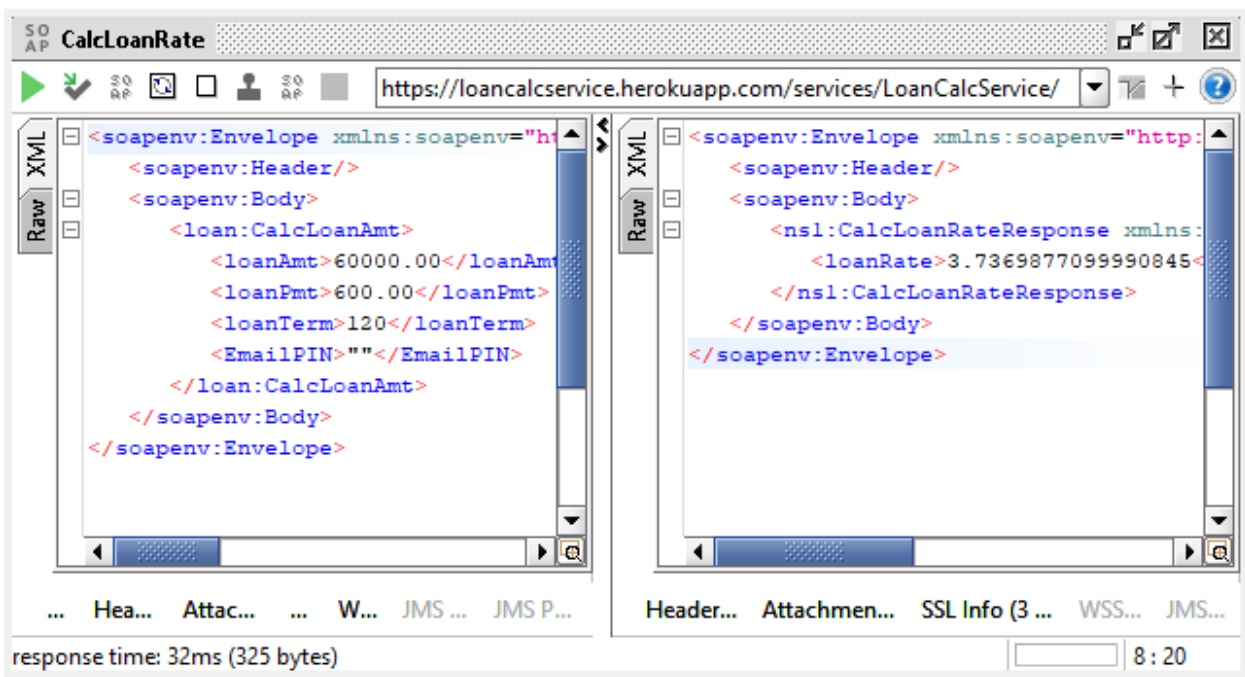


Figure 14 – CalcLoanAmt Request and Response in SoapUI

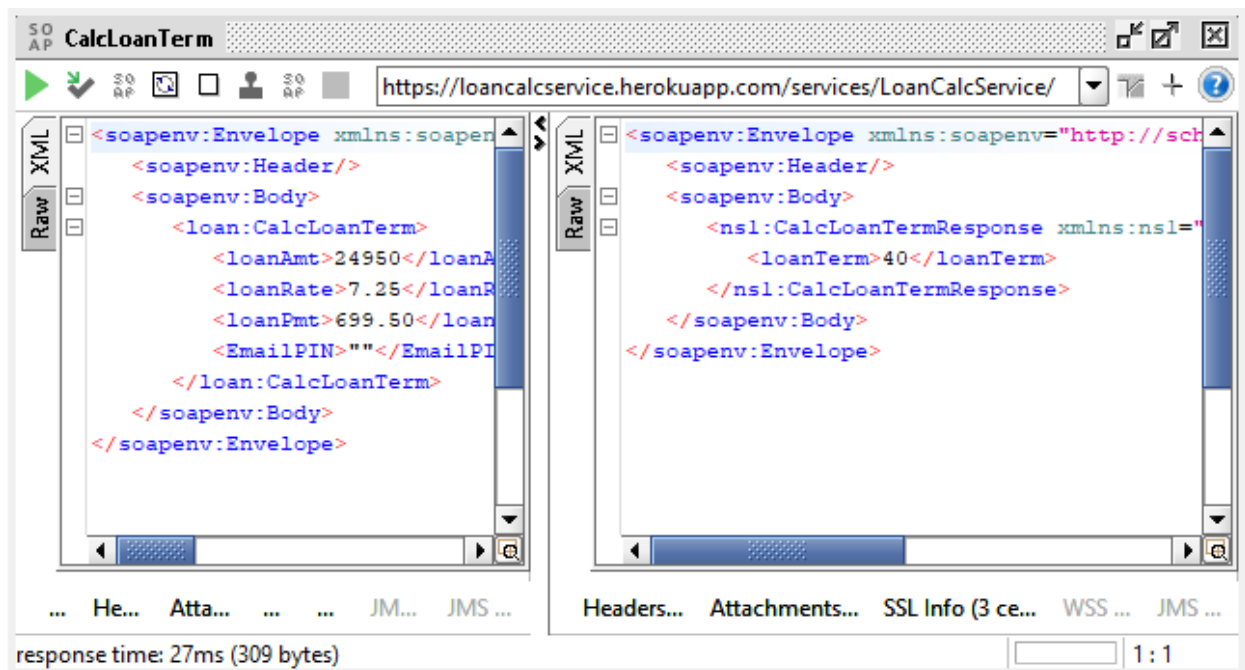


Figure 15 – CalcLoanTerm – Request and Response in SoapUI

Testing Scenarios - Service Operation Validation

- Rudimentary performance and scalability testing was performed across the four calculation operations and is shown in figures ... determined that given 5 concurrent connections submitting approximately 6 transaction per second yielded average round trip timings of 31.08ms to 65.55ms with throughputs ranging from 358 to 388 total transactions in 60s.

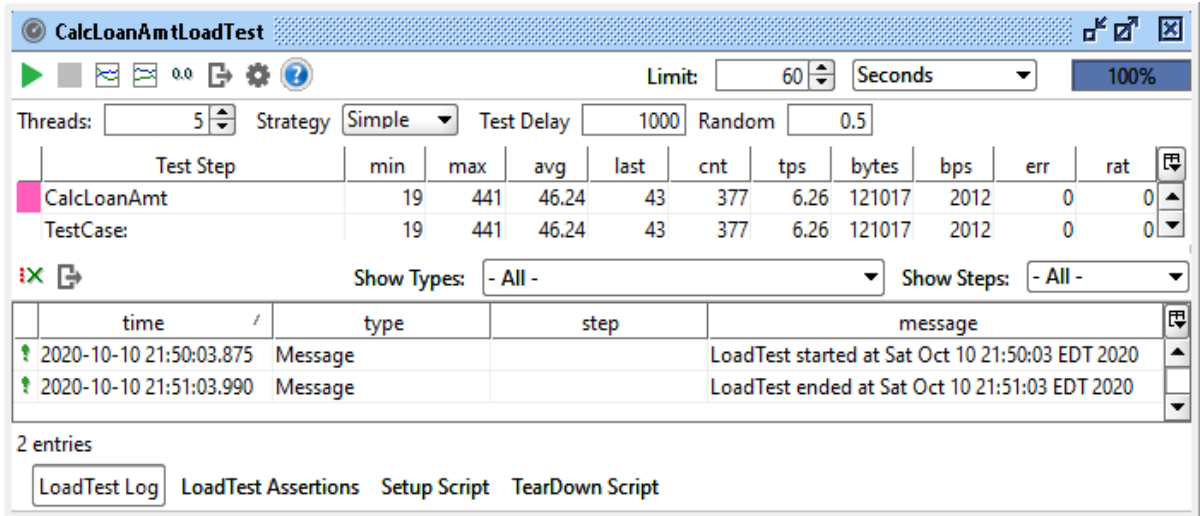


Figure 16a - Performance and scalability results for CalcLoanAmt

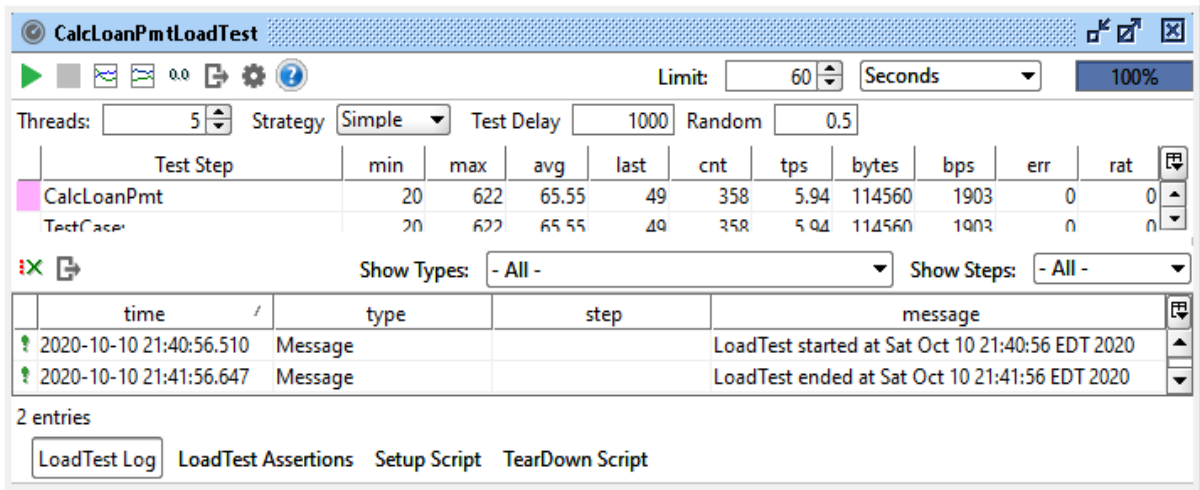


Figure 16b - Performance and scalability results for CalcLoanPmt

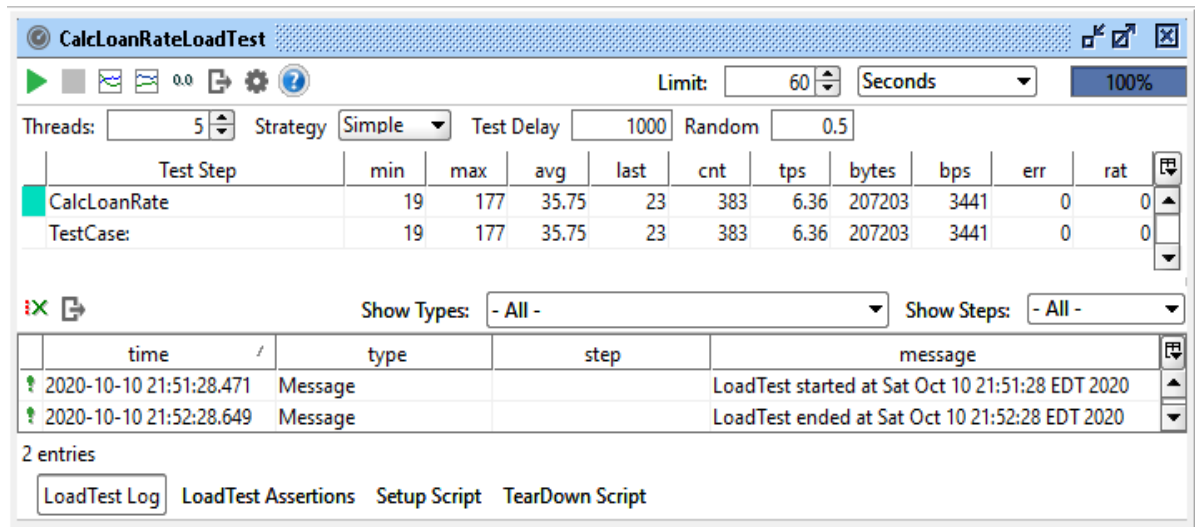


Figure 16c - Performance and scalability results for CalcLoanRate

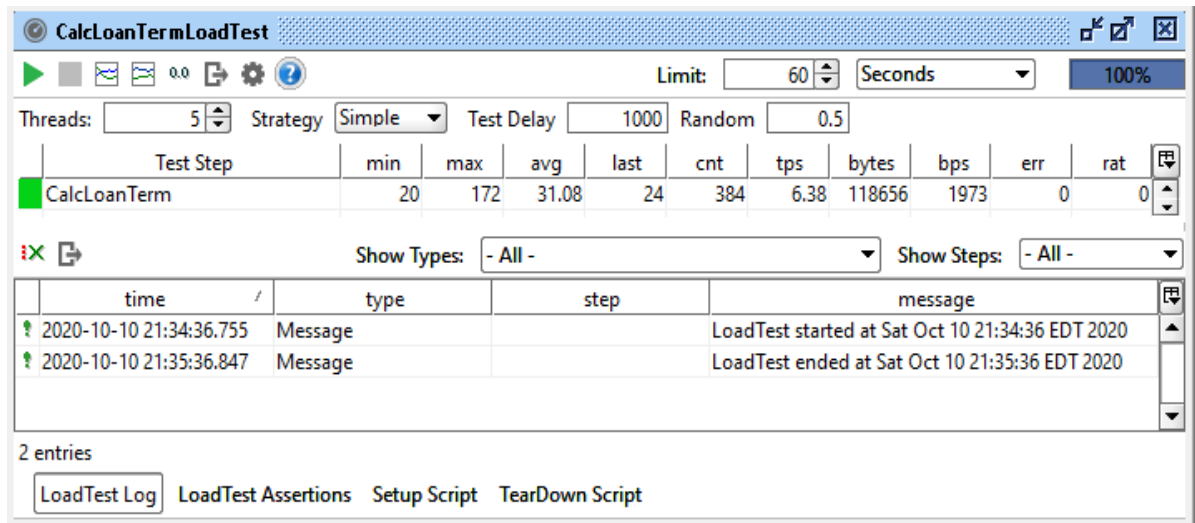


Figure 16d - Performance and scalability results for CalcLoanTerm

Testing Tools

Client

- Loan Amortization Calculator Client

Service

- Loan Amortization Calculator Client
- SoapUI Client – scenario testing
- SoapUI Client – performance testing
-

Resource Requirements

- Computer running with minimum hardware requirements of 4GB memory, 1GB free disc space, connectivity to the internet with one of the following OSs - Windows 10, MacOS 10.12+, any popular Linux distro
- Client application installed
- Java JRE 8+ installed
- Loan Calc Service installed on Heroku Cloud Environment

System Design

The proposed solution for the Loan Amortization Calculator includes a Java Swing Interface that can run on any modern operating system such as Windows, Mac OS X, or Linux with Java version 8 or above installed, and an internet connection to a cloud-based service that provides the loan amortization calculation engine, see figure 17.

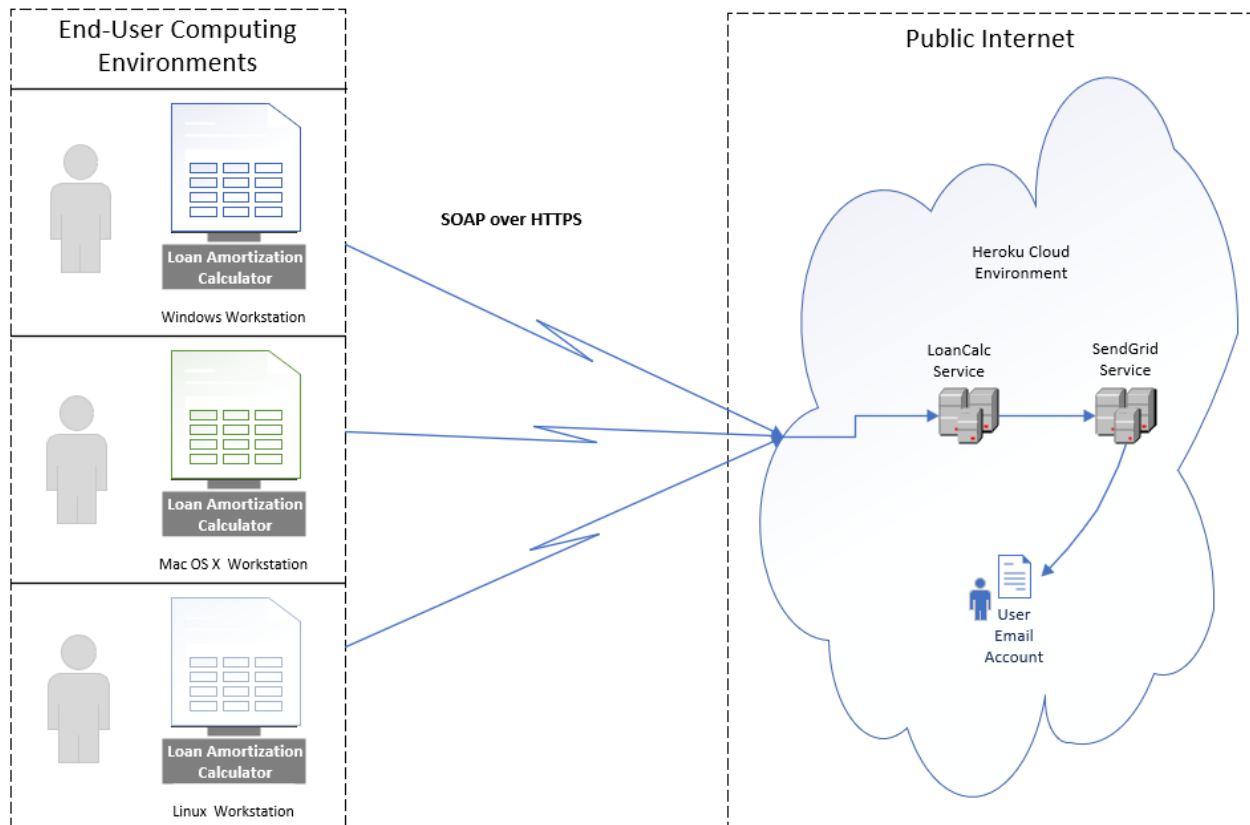


Figure 17 – System Architecture for the Loan Amortization Calculator

Class Design

The Loan Amortization Calculator design consists of a Java Swing GUI for selecting the type of amortization calculation desired and a remotely located service running on Tomcat 9.x in the Heroku Cloud to perform the actual calculation. The components communicate securely using the SOAP 1.2 protocol over HTTPS in a synchronous call.

Client

The client component implements an MVC design pattern using Java Swing. A high level view of the classes used to implement the GUI are shown in figure 18.

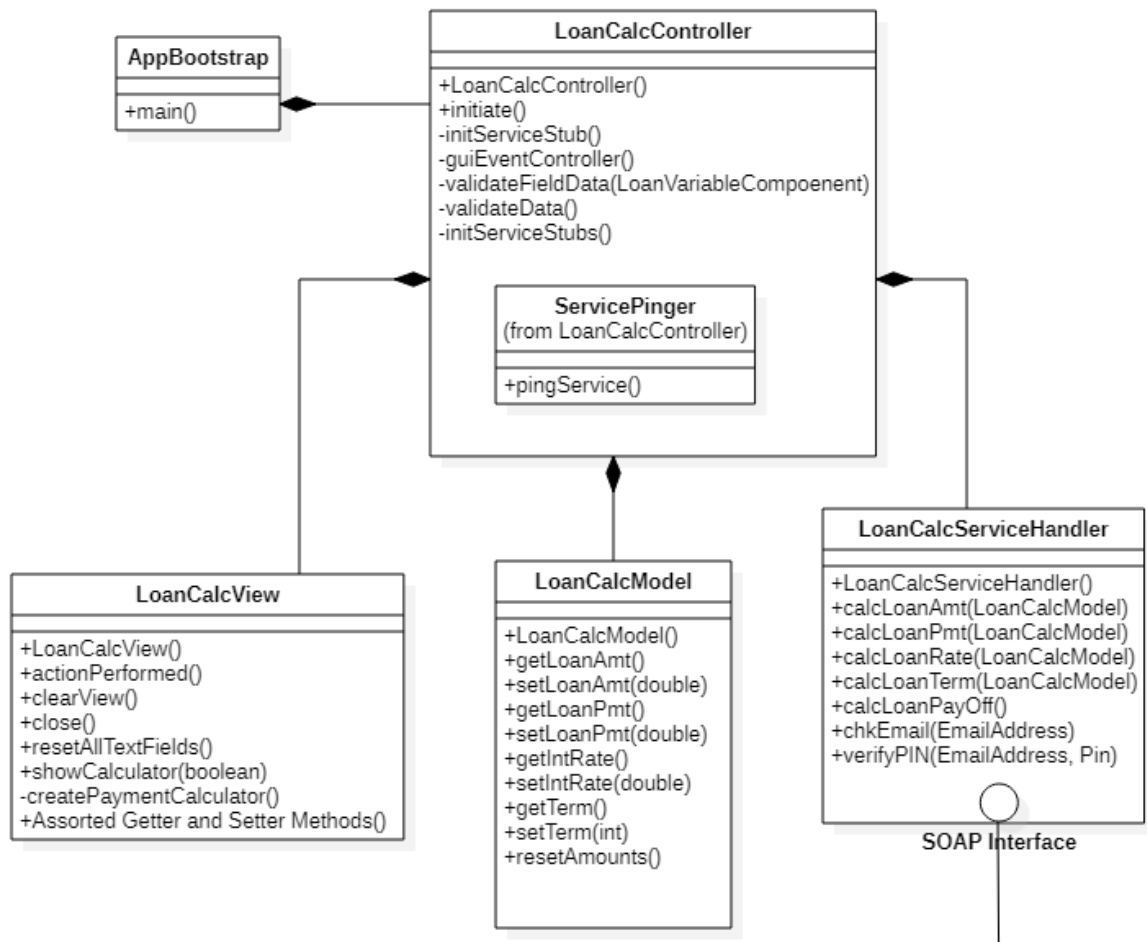


Figure 18 - Loan Amortization Calculator Client Classes

Service

The service component consists of a calculation class wrapped with a set of auto-generated classes by Axis2 to marshal/de-marshal the SOAP messages and route them to the corresponding operation. A high level view of the classes used to implement the Service are shown in figures 19, 20a, 20b, and 20c.

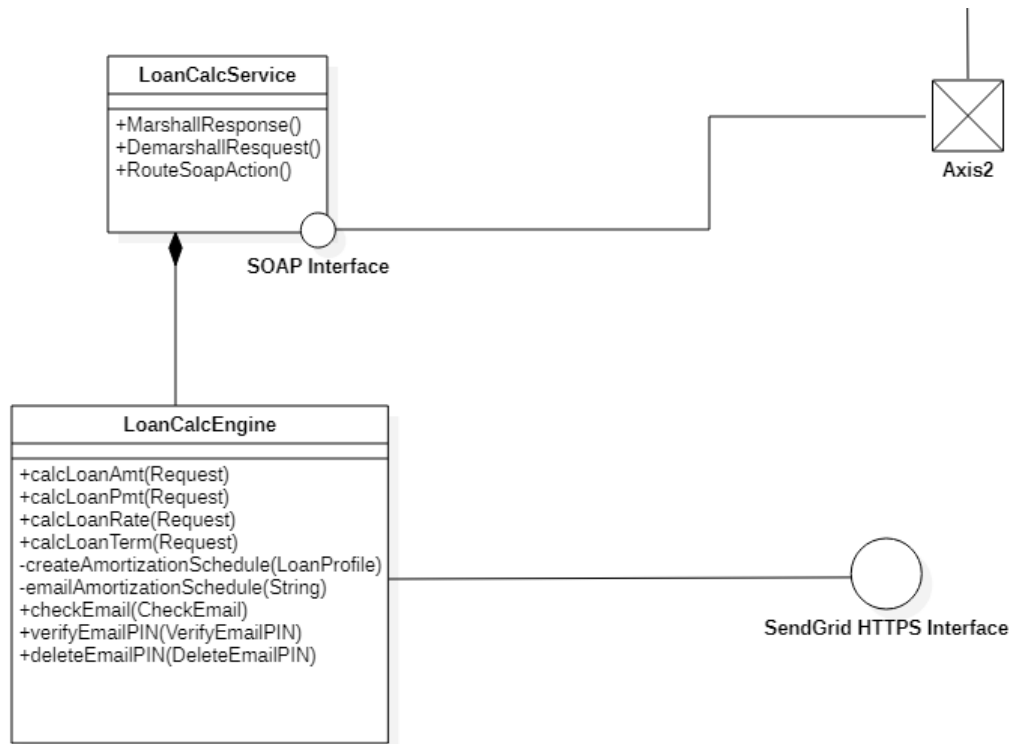


Figure 19 - Loan Amortization Calculator Service Classes

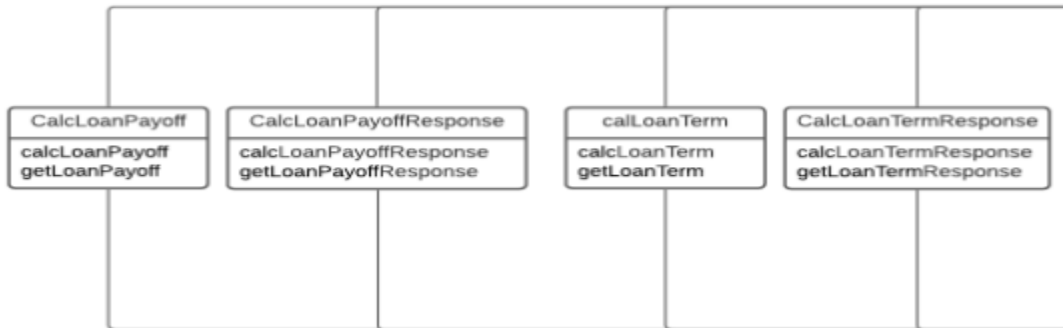


Figure 20a – Axis2 Request and Response Classes

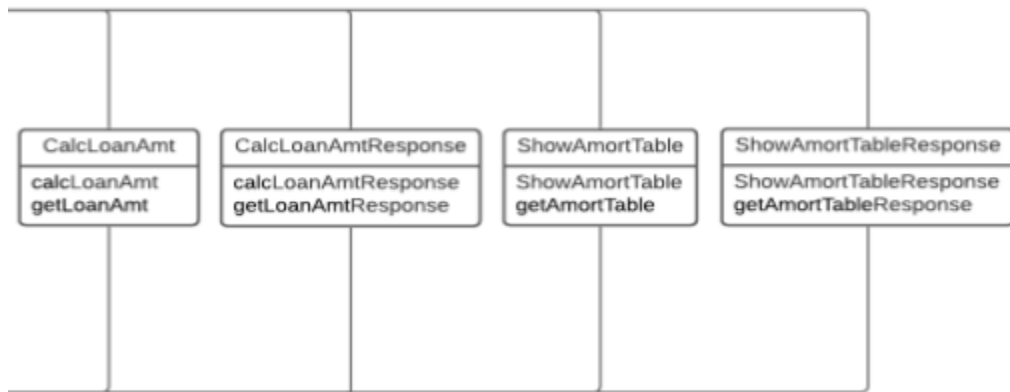


Figure 20b – Axis2 Request and Response Classes

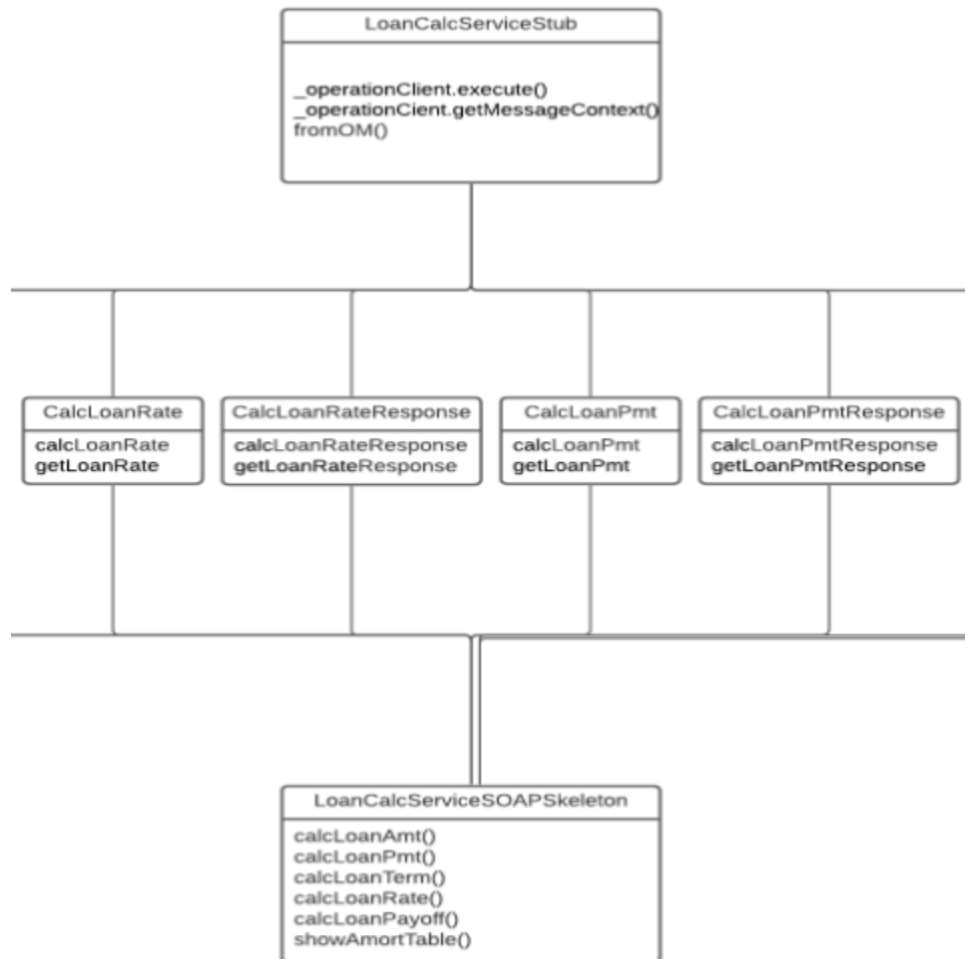


Figure 20c – Axis2 Request, Response, Stub, and Skeleton Classes

WSDL Specification

The service is defined by a WSDL specification shown in Figure 5. In brief, this file specifies the schema of the service, the associated messages, a port type that defines an operation and the associated request and response messages, a binding which defines the ‘style’ and transport of the message, which generally are either RPC or Document and HTTPS or SOAP, respectively, and the service.

LoanCalcService		
CalcLoanAmt		
input	parameters	CalcLoanAmt
output	parameters	CalcLoanAmtResponse
CalcLoanPmt		
input	parameters	CalcLoanPmt
output	parameters	CalcLoanPmtResponse
CalcLoanTerm		
input	parameters	CalcLoanTerm
output	parameters	CalcLoanTermResponse
CalcLoanRate		
input	parameters	CalcLoanRate
output	parameters	CalcLoanRateResponse
CheckEmail		
input	parameters	CheckEmail
output	parameters	CheckEmailResponse
VerifyEmailPIN		
input	parameters	VerifyEmailPIN
output	parameters	VerifyEmailPINResponse
DeleteEmailPIN		
input	parameters	DeleteEmailPIN
output	parameters	DeleteEmailPINResponse

Figure 21 - WSDL specification for the Loan Amortization Calculator

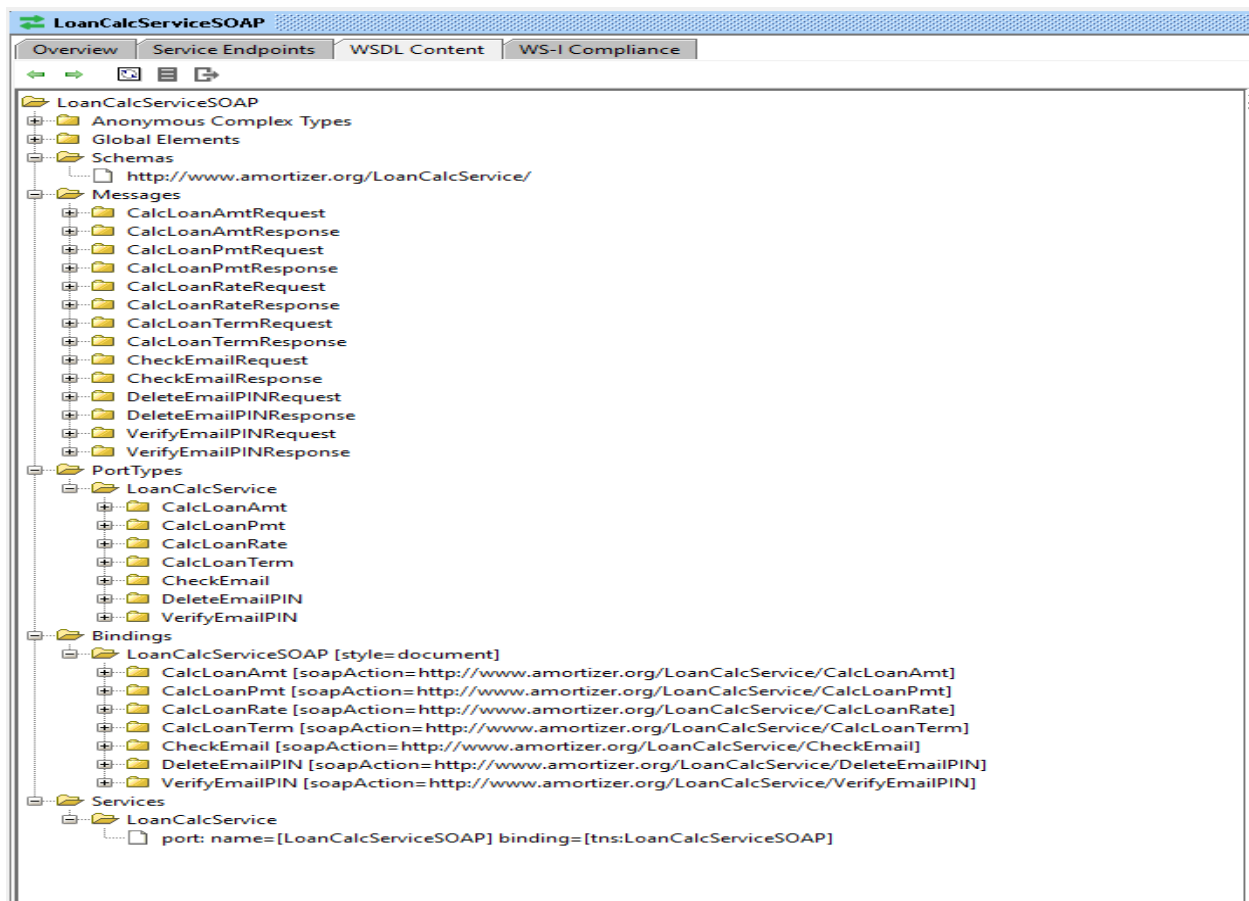


Figure 22 – LoanCalcService Components of SOAP Interface

Sequence Diagram

End to end call for passing a SOAP request from the Loan Amortization Client to the Service with a SOAP response returned with the calculated result.

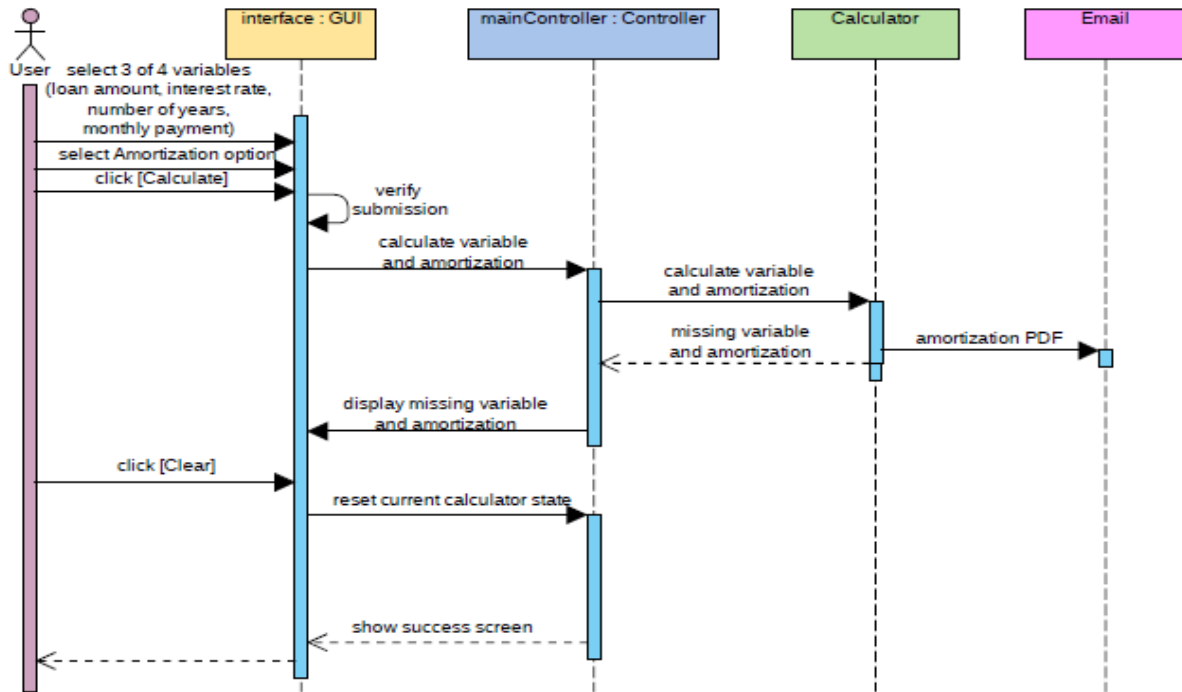


Figure 23 – Loan Amortization Calculation Sequence Diagram

Business Logic

Loan Payment Calculation:

$$A = P \frac{r(1 + r)^n}{(1 + r)^n - 1}$$

Loan Amount Calculation:

$$P = A \frac{(1 + r)^n - 1}{r(1 + r)^n}$$

Loan Term Calculation:

$$n = \frac{1 - (r * P)/A}{1 + r}$$

where

- A = loan payment per term
- P = loan principal
- r = interest rate per term
- n = total number of payments

Loan Rate Calculation:

```
double maxRate = 100;  
double minRate = 0;  
double midRate = 0;  
double guessLoanAmt = 0;  
double monthlyRate = 0;
```

```
While (minRate < maxRate - DELTA) {  
    midRate = (minRate + maxRate)/2  
    monthlyRate = midrate / (12*100)  
    loanAmtGuess = calcLoanAmt(...)  
    if ( loanAmtGuess > loanAmt)  
        maxRate = midRate;  
    else  
        minRate = midRate;  
}
```

```
this.rate = midRate
```

Data Model

There is no persistent data model used in this application.

Performance

The Loan Amortization Calculator has been shown to perform in sub-second throughput in performance testing.

Risk

The biggest risk to this application is that the service is unavailable due to connectivity issues or outage.

Assumptions

The end user will be able to set up the application with a valid JRE and a necessary internet connection.

Alternate Design

The only alternate design per say that was utilized in this project is an HTML wrapper to create the loan amortization schedule in place of creating a PDF file due to formatting complications.

Development History

The development history for this project is outline in the four phases of the project plan listed in

Task	Date
Phase I	
Finalize Loan Calculator WSDL	9/16-9/22
Create Client Project	9/16-9/22
Create Client Controller	9/16-9/22
Create Client View Class	9/16-9/22
Create Client Model Class	9/16-9/22
Create Client Stub Classes	9/16-9/22
Create Service Project	9/16-9/22
Generate Service Classes from WSDL	9/16-9/22
Generate Service Classes	9/16-9/22
Create LoanCalcEngine Class	9/16-9/22
Check-in code to Github	9/16-9/22
Create Heroku Environment for Service	9/16-9/22
Phase II	
Connect Client to Service	9/23-9/29
Review and enhance validation.	9/23-9/29
Enhance JUnit tests for unit tests	9/23-9/29
Test ping Timer class over a long duration (4 hours)	9/23-9/29
Add field for email address & verification code to GUI if amortization table is selected. Include validation that sends email account a verification code to prove user controls account	9/23-9/29
Review Service Calculation class	9/23-9/29
Review and Enhance JUnit tests for unit tests	9/23-9/29
Update WSDL with email address.	9/23-9/29
Service Testing using SoapUI, JMeter	9/23-9/29
Create Itext PDF helper class for creating pdf documents	9/23-9/29
Updated Project Plan	9/23-9/29
Update User Guide	9/23-9/29
Update Testing Doc	9/23-9/29
Update Technical Doc	9/23-9/29
Create Phase 2 Report	9/23-9/29
Phase III	
Add 2-step email verification dialog to client	9/30-10/06
Update amortization schedule displayed to include loan info with interest paid	9/30-10/06
Client Security Review	9/30-10/06

Defer final PDF generation modifications until Phase 4	9/30-10/06
Update WSDL with email address and pin verification.	9/30-10/06
Generate Web Service artifacts for client and service for 2-step verification for email address.	9/30-10/6
Create email class for SendGrid – EmailManager – that allows emails with and without attachments.	9/30-10/6
Service Testing of Email Functionality	9/30-10/6
Add property file for SendGrid API access	9/30-10/6
Add amortization schedule generation to service.	9/30-10/6
Service Security Review	9/30-10/6
End to End testing	9/30-10/6
Assorted bug fixes	9/30-10/6
Documentation updates	9/30-10/6
Phase IV	
System Testing	10/7-10/13
System Documentation Completion	10/7/10/13

Table 4 – Loan Amortization Calculator Project History

Conclusions

This project was an exercise in creativity, collaboration, time management, execution, and delivery. At the end of the day a reasonable product was created, tested, and delivered which fulfilled the goals described in the design document. The project was successfully delivered based on teamwork and common goals. While the Loan Amortization Calculator created by Group Charlie is functional many more elements could be added to give it greater usability such as prepayment options, loan payoff scenarios, what if scenarios, as well as graphics to show the principle and interest curves over the life of a loan and of course a PDF-based amortization schedule. All in all this project was a lot of fun and served the purpose of providing a work product that was achieved based on executing a set of choreographed steps that are essential to delivering a quality software application in a predictable period of time.

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