SEM5640 Group Project

Group Report

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# Overview

In this project, our task was to design the Siarad system specified Appendix A. The system as a whole was a messaging system to enable students and lecturers to discuss topics on modules in a modern interactive way, similar to Blackboard (Bb) [1].

The system needed to allow for a multitude of users which were able to access specific material relating to the modules they were registered on; to notify these users when there was activity in their respective modules, and to facilitate specific searching for messages amongst other things.

The key outputs from this project were: The technical work (the Siarad system), this Group project report, Test Plan, Project Plan, Solr Technical Report [2], and the UML diagrams.

The technical work is broken down in to microservices and the design/implementation of this is described in the respective sections.

The group project report is broken down into the following sections:

* Requirements – In this section we discuss about the final set of requirements that were agreed upon and justify any requirements that may had been removed or added.
* Development Methodology – In this section we discuss about the methodology we followed throughout the project, the advantages and disadvantages this methodology yielded, the difficulties it entailed, and the rationale for selecting the methodology.
* Design – In this section we discuss the design for the system, presenting the initial designs that were created, we also talk about the appropriateness of these designs for the specific solution we pursued.
* Implementation – In this section we discuss how we developed the system, as well as the problems we encountered and how we overcame them. This section also talks about technical changes made to the design as a result of certain implementations.
* Testing – In this section we discuss the test plan that was made in the design stage of the project, as well as how it was enforced throughout the project, and the different styles of testing that were pursued as well as their appropriateness to each section of the project.
* Status – In this section we discuss where the functional state of the project at the end of development as well as any bugs that currently persist in the system.
* Critical Evaluation – In this section we evaluate the effectiveness and suitability of our development methodology and the outputs we produced. We also explore what we would had done differently if we started again, and what we would want to do given more time.

The test plan, project plan, Solr Technical report [2], and UML diagrams are included within the report as appendices and are referenced and evaluated at the relevant sections.

# Requirements

**IF WORD COUNT BECOMES AN ISSUE, MOVE REQUIREMENTS TO APPENDICES AND REFERENCE.**

During the project, there was a list of requirements that the final system should employ, in this section we will review these requirements explaining how they were implemented, or if they have not been, why, along with the justification for it.

**2.1. Messages**

**M-FR1 – Message Content**Messages are text-based content items within the system. Each message has the following information:

* User – the user id who wrote the message.
* Message body – the content of the message, written in Markdown [3] format

Previous, this requirement had another condition to do with emoticons, however, it was discussed with the client that the functionality involving emoticons was no longer required.

This functionality has yet to be implemented.

**M-FR2 – Referring to other users**A message can refer to other users by using @userid within the body of the message. That can generate a notification to alert the other user that they have been mentioned in a message.

This functionality has yet to be implemented.

**M-FR3 – Messages Groups**Messages are grouped by groups, within modules. A module has at least one group, which is the main group. Messages in a group are ordered by the time that the message was created.

This functionality has yet to be implemented.

**M-FR4 – Creating Groups**Any user can create new groups. When the group is created, an announcement is made in the main group. The group will be displayed in a list of groups for the module. A group is available to all users within the module.

This functionality has yet to be implemented.

**M-FR5 – One-to-one Messages**A user can send messages directly to another user.

We assume that another user can be a staff member.

This functionality has yet to be implemented.

**M-FR6 – Replying to messages**A user can reply to any message in the group. Replies are shown in the order in which they are created.

This functionality has yet to be implemented.

**M-FR7 – Editing Messages**A user can edit a message that they wrote. When a message is edited, there is an indication to everyone that it has been edited.

This functionality has yet to be implemented.

**M-FR8 – Deleting Messages**Any message can be deleted by members of the module staff or by administrators.

Students can delete their own messages if there are no replies to the messages.

When a message is deleted, it will be removed from the group of messages shown to users.  
A deleted message will not be removed from the Message Store; instead it will be marked as deleted so it is not shown in the group of messages.

This functionality has yet to be implemented.

**M-FR9 – New message Indicator**When new messages have been posted, the system will update the user interface to indicate that new messages are available within modules and groups.

This functionality has yet to be implemented.

**2.2. Module Registration**

**MR-FR1 – Module Information**The system will allow administrators to create modules, with the following information:

* Module Code, e.g. SEM5640
* Title, e.g. Developing Advanced Internet-Based Applications.
* Academic Year, e.g. 2020 will represent the year from September 2019 to August 2020.
* Staff members, which is a list of user ids for the staff working on the module.

For this requirement, we allow administrators to create a module, in addition to the initial requirements, we require that the Campus Code is also provided (e.g. AB0 – Aberystwyth), this is not controlled by a dropdown menu in case new Campus Codes are created in the future, the administrator would need to create the module with this in mind.

We do not allow for a list of staff members to be added, instead we have the main coordinator of the module listed, administrators can check the module and register staff members on it via the interface. This change is then persisted through the database, this was a change in functionality due to the authentication not working as intended, and thus modified so the system could still employ authentication, the details surrounding this are covered in section AA-FR1.

**MR-FR2 – Editing module information**The information about the modules can be edited by administrators.

This is implemented as expected, following the same data specified in MR-FR1. The data that is changed is persisted through to the database and the list displaying the modules is re-rendered with the appropriate changes.

**MR-FR3 – Student List**A module will have a list of students who are registered on the module. The University’s central student management system contains a list of students taking a module. A file can be exported from the system in a CSV format. This system will provide a facility for an administrator to upload that student list for each module.

This requirement has only been partially implemented. A list of students can be attained for a registered module, this is only accessible to administrators and can be viewed in the edit module section, this also allows an admin to remove and add students to a specific module.  
The system does not allow a list of students on a module to be exported.  
The system does allow for a CSV formatted student/module lists to be uploaded correlating to the example CSV files provided by the client.

The functionality to create the CSV file is within the code but has been commented out as it contained minor bugs and there wasn’t enough time to fix it.

This same functionality also applies to staff on a module, allowing the administrator to add or remove registered staff members, this is to fulfil the modified functionality of MR-FR1.

**MR-FR4 – Updating the student list**If a CSV list is uploaded to a module where there are existing students for the academic year, the module list is updated.

The system allows for a CSV file to be uploaded; if a general module list or staff list is uploaded, it will truncate data from all tables, this is essentially a “clear all” from the system. When they enter a student module list, it will not truncate the data as this would cause the previously uploaded module list to be erased.

One of the challenges we faced when designing this functionality was the system claiming that a duplicate key was being added when we tried to create the module – student link, this eventually was fixed with further validation checks on the data.

**MR-FR5 – Module Membership**The Module Registration part of the system will provide a resource to the rest of the system.  
It will enable other parts of the system to find out which modules a user is a member of for a given academic year.

The system provides this functionality as expected, the users’ specific information is displayed on their home page as they log in. The system by default will only pend the modules a student is on for the current year.

**2.3. Search**

**S-FR1 – Search**A user can search for messages that match text entered by the user. The search is limited to any modules that the user is associated with.

This functionality has yet to be implemented.

**S-FR2 – Search Filters**The search can be filtered in the following ways:

* Across all groups in a module.
* Within a specific group.
* Across all modules in a given academic year.
* In all modules that a user is associated with.

This functionality has yet to be implemented.

**S-FR3 – Search Results**The search results will display the messages that match the search text. Where the message is a reply to another message, it should be possible to expand the result to show all messages that follow the searched message, it is not required to show messages previous to the searched message.

This requirement was appended with the client due to difficulties with displaying the previous messages of the searched message.

This functionality has yet to be implemented.

**2.4. Notifications**

**N-FR1 – Register for Notifications**A user can register for notifications from the system. The system will present a set of notification types, as specified in N-FR2. A user can change the registration at any time.

This functionality was implemented as expected, it is displayed as a settings tab on the navigation bar.

**N-FR2 – Notification Types**The system will provide the following types of notifications:

* Daily summary – request a daily summary of messages within a specified group or module. The summary can indicate how many messages were created during the day and provide a link to view the messages in the system.
* Mentions – request a notification when the user is mentioned in a message. The notification will include the text of the message and a link to see the message in the system.
* Replies to a message – request a notification when a specific message is replied to.

The user is able to opt in to all these settings, and then specific the frequency in which they should occur (depict as hours) as specified in section N-FR3, all these settings can be found in the settings tab described in section N-FR1.

**N-FR3 – Frequency of Notifications**The system will provide a mechanism to send notifications at set time intervals throughout the day. For example, once an hour, the system will check if any conditions have been met for the notifications. If they have, the notifications are sent to the relevant users.

This is implemented as expected, the notifications are sent to the user via email, mentions and replies are also notified to the user on the front-end server.

**2.5. Authentication and Authorisation**

**AA-FR1 – Authentication**The system should be configured to use an LDAP server within the Computer Science department to authenticate users. In addition to LDAP, the system should have an alternative authentication method for development and test purposes.

Although the LDAP was configured for the application, using the LDAP server to authenticate users did not work. Because of this the system was designed to incorporate the alternative method that was used for development and testing. Admin users were added to the system (stored within the Identity Server) and these admin users control the roles that all other users have (including other admin users). We also added an option for registration which would create a default user with the credentials specified, an admin would then have to authorise this user.

Unfortunately, this implementation means there is not a lot of automation for the admin user, this implementation is described in detail in Section 5.

**AA-FR2 – Authorisation**Users may be identified in the LDAP server as staff. This information can be used to distinguish between staff and student user categories.

The complications of this was specified in section AA-FR1, along with the alternative approach.

**2.6. External Interface Requirements**

**EIR-1 – Appearance**The system should be developed as a set of microservices. There should be a suitable User Interface that allows access to the different facilities; there might be one user interface that interacts with the different services. User access to the service is through a web interface that can be accessed through modern web browsers.

This is implemented as expected.

**EIR-2 – Internationalised Interface**The system should be internationalised so that the user interface can be available in different languages. English and Welsh should be supported in this version of the system.  
For delivery, only English language localisation need be provided.

Internationalisation is not been implemented, however, naturally English is supported. The reason it was not implemented is due to the complexity required for a minor feature, as well as the time consumption. Since we did not have a lot of available time, this was prioritised as a lower priority.

The system produced misses some of the functional requirements, it also misses some functionality that is not implicitly stated as a functional requirement, for example, it does not have SignalR implemented to allow for live notifications; these issues are covered in detail in section 7 of this report. The reasoning for this primarily relates to the scope and lack of resources of this project and is covered in detail in section 8.

# Development Methodology

We chose to use the Scrum Agile development methodology for our engineering process because it is a well-known and generally successful approach to engineering dynamic projects, although the requirements of this project were original set, we were informed by the client that these requirements may change at any time. The reason we wanted to pursue an Agile methodology is because there were a lot of unknowns within the project seeing as we did not have much experience in developing projects of this type and scope.

As well as Scrum, we adopted other software engineering practices, such as pair programming from the development methodology, Extreme Programming. ->

Scrum would usually have a scrum master assigning tasks that would be undertaken during a sprint; because we were a group of two, we omitted the scrum master component and relied on our active communication and understand to come to accords on what tasks to undertake.

In this methodology we developed our application in sprints; each sprint was planned to be one or two weeks depending on the size of the task that was committed to. At the end of the sprint we would have a review and retrospective of how the week went, this would outline the positive and negative qualities and strategize on how to improve on the next sprint. We originally want to accurately estimate the amount of time and effort required for each task and would then use that to better determine the order of the tasks that we should commit to, in addition to this we rated each task by priority which helped us further determine the order in which tasks should be undertaken.

Toward the start of the project, we were maintaining a high-level product backlog <APPENDIX> of major tasks. We also formally documented our weekly review/retrospectives.

Since the size of our development team was limited to 2, we did not uphold the Scrum practice of daily stand-ups; we instead chose to meet a few times a week for collaborative work and have an official weekly meeting. Our weekly meeting was intended to be combination of classical Scrum sprint planning, review and retrospective all rolled in to one; the reason for this was to prevent the process from becoming too cumbersome.

# design

The application is designed as four separate micro-services. The front end microservice that the user interacts with is a standard dynamic web application, the other three are microservices that expose REST APIs. The microservices communicate through REST calls to these APIs, the data format used for the REST calls is mostly JSON, although the Module Registration microservice does take in data in the format a CSV file for the purpose of updating module, staff and student lists. The microservices are listed below along with a description of their function and a component diagram to outline their interaction.

**Front End Application**

Responsible for handling requests, our applications UI and authentication. The front end communicates with the other three applications. It updates user notification preferences on the notifications microservices, queries the module registration to get information about the users registered on different modules and queries and stores user messages from and to the message store. The front end also keeps a database describing all the message groups on the system.

The instant messaging functionality of our application is provided through client-side code that is contained within this application. The client-side library used for this functionality it SignalR <REF> provided by Microsoft.

This microservice is written in ASP.NET core 2.2 <REF>. This technology was chosen because of the implementation for SignalR <REF> requiring this platform.

**Module Registration**

The module registration is the source of authority on what users are registered on what modules. It provides CRUD operations on modules and CSV file upload operations to be used by admins.

This microservice is written in ASP.NET core 2.2 <REF>. This technology was chosen because through the experience we had gained on the project up to this point, we were more comfortable using this technology.

**Message Store**

This microservice stores all messages in the system and is accessed by both the front end and the notifications. It provides CRUD operations on messages and exposes a search functionality to be used by the front end.

The search functionality of our site was not implemented by us. Instead we used a third-party application called Solr <REF>, this is an open source and comprehensive web application for searching that can accessed as a service from our own applications. More information is in the Solr technical report included in the appendices <CROSS REF>.

This microservice is written in Java EE <REF> and deployed on a Glassfish 5 <REF> server. This technology was chosen because of the design choice for the message store to communicate with Oracle’s Solr <REF> this being another service written in Java and with good java API support for interfacing to it.

**Notifications**

The notifications is a multi-threaded application that sends emails to users based off set preferences. The front end makes calls to its service to update user preferences stored in the application and then at certain points during the day the microservice queries the message store to gather the messages required for its email summaries to users.

This microservice is written in ASP.NET core 2.2 <REF>. This technology was chosen because of the easy use of Quartz Package <REF> for scheduling jobs to allow for the functionality of multi-threading.

**<COMPONENT DIAGRAM HERE>**

//separate section

We started the detailed design of the system by looking at the data each service would store and the operations each service would expose.  We modelled the systems data in a set of entity relationship UML diagrams and the microservices operations as a descriptive list of REST API URLs and associated response codes. These diagrams were updated throughout the project as we understood more about the project and refactored our implementation.

# Implementation

In this section, each sub-section is broken down in to two parts (unless state otherwise), these parts are the backend microservice implementation, and the front-end integration implementation.

All databases within this system use PostgreSQL. All databases use data models to create the tables, and data annotations or the model builder to control the data types and constraints of the data.

For a large portion of the frontend interface design as well as the functionality behind the Identity database, the webseries guide presented by “Kudvenkat”[5] of Pragimtech[6] was followed. This includes view models, cshtml razor pages, and the controller classes used in his guides, these have been modified to accommodate our specific needs for the project.

**5.1. Module Registration**

When Module registration was first created, it supported a table for Student, Module and Staff. In its data model, it used composite primary keys to identify unique attributes, this caused a major issue when trying to create foreign key references that could never be resolved. Despite this we worked around a way to still get the correct data (although it was quite difficult to use and put stress on the front-end), however, we agreed that this was not usable in its current state due to the foreign key restriction creating the inability to validate creation and deletion.

The final version of the module registration backend is broken down into several tables; the three main tables are: Student, Module, and Staff. Following this there is also a Module\_Student and Module\_Staff table that holds the data of which student and staff are registered to what modules respectively, it does this using a foreign key reference to the respective tables.

In the data model, a key difference between the final database and the previous database is that the primary key is controlled by an auto-created surrogate primary key, this allowed for foreign keys to be created as there was no composite restraint. Although the data could be identified from unique attributes, using a surrogate was decided as the best route to take.

Student, Module and Staff have CRUD operations supporting them so that, from the front end, it is possible to populate and edit data within these tables. Module\_Student and Module\_Staff only support create, get and delete as there is never a need to update this data.

The module registration microservice exposes three POST endpoints for uploading CSV files containing module, student and staff data. On upload of module and staff CSVs the previous data on the server is truncated. For students the previous data is not removed as there are individual files for each module’s registered students. This may be a weakness of the implementation as student data will never be removed unless done explicitly by the CRUD operations available to an admin user.

One of the complications of this backend is the unnecessary duplication, this stems from the staff and student table being similar, in a retrospective we thought it would be better to merge these tables, but we knew that would cause a multitude of errors throughout connected systems and decided to keep the model as is. As an improvement to the system the staff and student tables/model would be merged into a single user table/model which would help reduce code duplication.

The frontend implementation of module registration is only available to users with the authentication level of “Admin”, this is because it performs operations that access the database. There is one exception to this, and that is retrieving the list of modules to display to the user or staff member.

When a user of authentication level “Student” or “Staff” logs in to their account, the frontend will call a list of modules that, that user is registered on, it does this by accessing the Module\_Student or Module\_Staff data table respectively, this is allow the functionality to view the groups for that module. A user of authentication level “Admin” will receive a list of every module, this creates quite a long list, but the admin requires the view to see every module to perform administrative actions.

An admin is given an additional navigation option on their navigation bar titled “Manage”, this opens a drop down menu with the options to manage “Users”, “Roles”, and “Modules”, upon clicking one of the navigation options they will be redirected to that specific page.

On the “Users” page, an admin can view a list of every user within the system, from this section they can edit the user information (forename, surname), or choose to delete the user. On the edit page for a user, they will see a list of authentication roles that, that user has applied to them, from here they can manage the roles and assign whichever role they wish.

From the “Users” page, an admin can also create a user, it is worth noting that when a user is created, they will have no authentication roles applied to them, the admin would then have to go in to that users roles and manage them.

For the scope of this project, there was no need to include the functionality for a users’ password to be changed.

On the “Roles” page, we see a similar interface as the “Users” page, there is the option to create a new role, or edit an existing role. Although the functionality allows for this to happen, it is not advised for any admin to change this unless they are editing the entire system as these roles directly correlate to authentication tags throughout the system.

On the “Modules” page, similar to the other pages, we have the functionality to edit and delete a module, when editing a module we have the options to edit the specific information for the module, manage the students registered to that module, and manage the staff registered to that module, the functionality behind this operates the same as the other pages.  
We also have the option to add a new module, or upload CSV files, the possible CSV files we can upload are the module file, staff file, or student module file. These inputs are modelled after the example CSV files, we received from the client. Some additional parameters are requested for Staff and Student Module file, both requiring the campus (i.e. Aberystwyth, Mauritius), and the Student Module file requiring the year it relates to. This allows the admin the mass-populate the database given the correct format of files.

**5.2. Authentication and Authorisation**

The backend support for authentication and authorisation is handled via Identity, a built in asp.net library. This created a database with auto-generated fields of type IdentityUser. We added some additional fields to IdentityUser so we could have greater control over what is happening within the system. The fields we added were; a Boolean variable for if the system display for the pages should be English, the default value of this is true, if the variable is set to false then we’d want to load up a Welsh version. We also hold a Forename and Surname cell, this is because we don’t want to constantly pull this data from the database, and instead use it locally.

Unlike the other databases, this database has no HTTP methods supported, this allows for a layer of security as the port is exposed to the system. The only way for a malicious user to edit this would be to attain the login credentials for an admin user or access the remote docker container with valid credentials.

As mentioned in section 5.1, when a user is created by either a new user or an admin user, they will initially have no authorisation to the system, this means they will only be able to view home page which will simply specify that they’re not registered on any modules (default view).

In an ideal solution we would use LDAP to handle this for us, but due to technical difficulties we couldn’t get LDAP to work (though it is still included in the project, commented out in the login section); more specifically, we could get an unauthorised connection to the LDAP server, but this did not contain the information required, we could not establish an authorised connection to get the specific details of the connecting user. Despite this we still needed authentication and authorisation within the system so although this requires more effort for an admin user, it creates the same level of result to validate the systems functionality.

Every page has a default level of authentication required (this is for the user to have an account of any role or no role), for certain views such as retrieving a student list, you would need to have the role of student else a default view would be returned. All admin pages have admin authentication required. The only pages that allow anonymous view is the register and login page, all unauthorised requests get redirected here.

**5.3. Message Store**

The Message Store microservice is built using JavaEE 7 <REF> running on a Glassfish 5 <REF> server. It uses the Jersey <REF> implementation of the JAX-RS <REF> java community standard for building RESTful web services in JavaEE. The message store makes use of the Java Persistence API (JPA) for interfacing with a PostgreSQL RDBMS via object relational mapped (ORM) model classes.

The messages are stored in a self-referential relation to capture the parent-child relationship of message replies. A message-user relation is used to describe the relationship between every user and every message. There were many issues with stack overflow during model serialisation and for this reason this association table is a single table not a link table, in the end this turned out suitable as the only piece of data for a user is the user id so there is not much data duplication despite the small lack of conventional database normalisation.

For serialising & de-serialising to or from JSON we made use of JAXB <REF> annotations. Originally a set of annotations for XML marshalling, EclipseLink moxy allows the easy use of these standardised annotations for JSON also. Custom message body writers and readers had to be used to achieve the desired result with JSON serialising. A long time was spent on getting serialisation to work for the project due to a bug in the version of glassfish (4.1) we were using at the time. During this period GSON <REF> was tried as an alternative for JSON serialisation.

The main code for the message store is in the controller that is responsible for the endpoints it exposes (MessageStoreREST.java). There are endpoints for CRUD on messages as used by the front end application and endpoints for retrieving message summaries for given users, made use of by the notifications microservice. There are also endpoints for creating associations between users and messages. This is to address a flaw with our design as not all users who should have associations with messages do until these endpoints are called by the front end.

**5.4. SolR**

The message store exposes a separate controller (MessageSearchREST.java) with a single POST action endpoint for search. This controller access Solr for the indexing and querying of messages through a java API called SolrJ <REF>. The search endpoint takes the following key-value pairs as criteria for the search: user id, filter type, filter & search text. Where the filter type is one of {GROUP, MODULE, YEAR, ANY}.

**5.5. Notifications**

The notification microservice is built using ASP.NET with two main functions in mind.

* To expose a CRUD REST service to the FrontEnd application for updating of user email preferences.
* To routinely pull messages from the message store and email them to users based of these preferences.

The CRUD service is the standard .net implementation of a REST API relying on a single entity framework core model for representing a user’s email settings. The notifications service connects to a PostgreSQL database using Npgsql <REF> package to achieve this. The settings for a user are three Boolean values describing if they want daily, reply & mention emails, along with a time interval describing when they are sent the reply & mention notification emails.

The multi-threading required for the routinely pulling is messages is achieved through use of the Quartz package for .net core <REF>. There are two quartz jobs running on two different schedules. A daily job that is responsible for sending users daily message summaries that triggers every 24 hours. An hourly job that is responsible for sending users summaries of messages they have either been tagged in or messages that are replies to any of their own messages, this job triggers every hour and uses a value in user settings to determine if it is the hour for a user to receive an email. The message store keeps track of all notifications so no user will be spammed duplicate notifications.

The quartz jobs make use of two custom services one message client service class to get the messages for notification from the message store microservice and an email service class responsible for formatting and sending the messages over email via SMTP to registered users.

Standard quartz jobs are not able to use scoped services (such as DbContext). To get around this we used a class to wrap the quartz jobs to alter the scope of the service provider they use. The code for this class (QuartzJobRunner.cs) was taken from an online blog post by Andrew Lock <REF>, this is referenced in code as a comment.

On the frontend implementation, the only thing we want for the user to be able to do is opt in to receive notifications, the types of notifications they wish to receive, and the intervals they want to receive this. The default for any given user is that they will not receive notifications. When they click on the Settings tab on the notification, we create the default notification values for them (there is no point in doing this sooner), at this stage the user can then choose to edit those values to start receiving notifications. To opt out of notifications, they would simply need to adjust their settings to be that of default values (specifying to receive no notifications).

# testing

In this project we defined a very brief test plan that encompassed an overview of tests we’d apply to the entire system as we developed it, this was moderately brief as at the time it was created we had yet to start implementing the system and we did not have enough knowledge to accurate gauge what we’d need. Instead of updating this document as we progressed through the project, we instead internally decided the direction to pursue as with our limited resources we wanted to make sure that we were focusing on the most important and prioritised tasks.

The test plan can be found in appendix <INSERT>.

In the test plan we talk about the categories of testing we’d be performing, both manually and automatically; these were unit testing, integration testing, functional testing, and exploratory testing.  
We did not include acceptance testing or system testing as categories of testing, these tests were performed manually through exploratory and functional testing.

Within the project, unit tests were performed on the backend databases to validate some functionality, we decided that these tests were important to have here as it is the backbone of the frontend server, if we erroneous operations here, it is safe to say the frontend would not function as intended. It is also a measure to reduce debug time by finding these errors early on as cross-server debugging can prove quite challenging. In the test plan we talk about Moq tests for this section, but MSTests were employed.

Integration tests were primarily applied through Apache JMeter [4] using JMX tests, these tests allowed us to test the HTTP requests that are exposed from the database, this is because the frontend will retrieve data from the database via these RESTful connections, by validating that the functionality of these end points is as intended, we can assume that any errors that occur on the frontend would be down to the implementation of the frontend service, and not the database. This allows us to work on the frontend service disjointly from the database by giving us confidence in the backend.

For functional testing we exploratively tested the system whilst ensuring it met the functional requirements of the system, we did this to catch out unexpected bugs to fix them as the functional requirements enforce the core requirements of the system. This helped us identify many minor bugs to do with data manipulation within the databases from the frontend access.  
This replaced our system and acceptance tests to a manual system, if this functionality worked during testing then we could say that the functional requirement had been fulfilled, in combination with explorative testing we could ensure the robustness of this satisfaction.

As a whole, the system was exploratively tested with no real goal in mind other than to break the system, this allowed us to find bugs (especially related to erroneous user activity) which we could then fix, or document as bugs in the system.

# Status

When a user tries to manually type a URL in (for example, from the home page to a group of a module view), they will get an error as specific pages require certain models to be passed into them. This is considered erroneous user activity and we would not expect it to happen in general as it would require a user to know exact URLs.

# critical Evaluation

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DOCUMENT HISTORY

| *Version* | *CCF No.* | *Date* | *Changes made to document* | *Changed by* |
| --- | --- | --- | --- | --- |
| 0.1 | N/A | 09/01/2020 | N/A – Initial Creation | DOP2 |
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