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In

Software Engineering

Presented by

Riadh Laabidi

Notification Center: A cloud-based notification service for the Convergence project

Defended on September 29th, 2023 in front of the committee members:

Mrs. Aida Lahouij	President
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Academic Year : 2022 / 2023

Abstract

This report outlines the design and implementation of a notification center as a part of the ”Convergence” project, which aims to drive digital transformation within the insurance and finance sectors while improving client engagement and optimizing internal processes. The notification center provides a scalable solution for managing and delivering tailored notifications through various channels, facilitating timely and personalized interactions. This project was made during an end-of-studies internship in order to obtain the Master’s degree in Software Engineering at the Higher Institute of Computer Science and Mathematics of Monastir (ISIMM).

Keywords: Client Engagement, Notification Channels, User Segmentation, Spring Boot, Angular, PostgreSQL, Docker.

For everyone who has ever been a part of my life.

I dedicate this work.

Acknowledgment

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Acronyms

AOP Aspect-Oriented Programming.

API Application Programming Interface.

CI/CD Continuous Integration and Continuous Delivery.

CRUD Create, Retrieve, Update, and Delete.

CSV Comma-Separated Values.

CTR Click-through Rates.

DAO Data Access Object.

DTO Data Transfer Object.

HTTP Hypertext Transfer Protocol.

HTTPS Hypertext Transfer Protocol Secure.

JPA Java Persistence API.

JSON JavaScript Object Notation.

JWT JSON Web Token.

MVC Model-View-Controller.

MVVM	Model-View-ViewModel.
REST	Representational State Transfer.
SMTP	Simple Mail Transfer Protocol.
UML	Unified Modeling Language.

Introduction

In today's rapidly evolving digital landscape, the insurance, banking, and finance sectors are facing unprecedented challenges and opportunities. As customers increasingly expect seamless and personalized experiences, it has become imperative for companies in these industries to undergo a digital transformation. This shift not only enhances customer engagement and satisfaction but also boosts operational efficiency and employee productivity.

Recognizing this need, the "Convergence" project was initiated at Satoripop to provide innovative solutions that facilitate the digital transformation process, enabling organizations to stay competitive, deliver exceptional customer experiences, and achieve sustainable growth in the ever-changing marketplace.

Within the "Convergence" ecosystem, various tools and sub-projects are assembled, each playing a crucial role in this shared mission. Among these modules, we will be focusing on the Notification Center, as it plays a pivotal role in enhancing communication by providing a centralized system for timely and relevant notifications.

This report is structured in several chapters to provide a comprehensive overview of the project's progression. The first chapter introduces the project context, including a profile of the host organization and an overview of the project itself. The challenges and problems faced in the insurance and finance sectors are also assessed.

The second chapter discusses the initial sprint of the project, which revolves around gathering requirements, defining specifications and setting the groundwork to start the project execution.

Subsequent chapters delve into the specific releases of the project, outlining the specification, design and implementation steps. Each chapter provides a summary of the key findings and progress made during the respective phase.

Chapter I

Project Context

Introduction

This chapter presents the project context, including an overview of the host organization, the project objectives and the problem assessment. Afterwards, we will benchmark some existing solutions, and select a suitable work methodology for a successful project execution. By exploring the context surrounding the project, we aim to provide a deeper understanding of its relevance within the organization and the industry as a whole.

I.1 Host organization profile

Satoripop is a custom software development house that delivers a wide range of end-to-end, reliable software services and solutions for businesses across various industry verticals. Satoripop offers its services in many countries in Europe, Middle East and Africa.

Figure I.1: Satoripop Logo

Satoripop has structured its offering around four key service areas. As a solutions provider, and given that all interactions nowadays pass through IT systems, Satoripop is more than ever at the heart of customers' business.

Table I.1: Host Organization Details

Services	• **Custom development:** Web applications, Mobile applications, Application modernization • **Design UX/UI:** SEO, Netlinking, Optimization and assistance with content creation, Reporting • **Consulting & Framing:** Design thinking, Customer journey map, Wireframing, Prototypage • **Digital Marketing:** SEO, Netlinking, Optimization and assistance with content creation, Reporting
Phone number	Tunisia: +216 73 210 332
Address	Satoripop MEA, Blvd Hassouna Ayachi, Sousse 4000, Tunisia
Website	`https://www.satoripop.com`

I.2 Project overview

A notification is a message, email, icon, or another symbol that appears when an application wants a user to pay attention to something. These notifications can take various forms, including text-based messages which are plain text messages suitable for conveying essential information concisely, and image notifications which incorporate graphics, pictures, effective for providing visual instructions.

In modern communication strategies, different types of notifications serve specific purposes in reaching users efficiently. Common notification types are:

- **Email notifications**: These are messages sent electronically via email, ideal for asynchronous communication, and delivering detailed updates and information.

- **Push notifications**: These are short messages that appears as a pop-up on a desktop browser, or a mobile home screen. Push notifications display text and rich media, like images or buttons, which enable a user to take a specific action. Ideal for providing instant updates and information directly to users' screens.

- **SMS Notifications**: These are limited-length concise text messages sent to mobile phones, which are suitable for delivering direct and often time-sensitive messages.

- **Chat Notifications**: These are text and rich-media alerts within messaging apps or chat platforms. They enable interactive communication, allowing businesses to engage in quick and convenient exchanges with customers.

A notification center is a system that allows businesses to send and manage these types of notifications to their customers or employees. The value proposition of a notification center is that it can help businesses communicate with their stakeholders more efficiently and effectively, leading to increased engagement and productivity.

In the retail sector as an example, a company could use the notification center to send SMS, email, push or chat alerts about product recalls, special promotions, or other important information to customers. By using a notification center, businesses can improve communication with their customers and ensure that important information is quickly and effectively distributed.

I.3 Problem assessment and challenges

Implementing a notification center system in the retail sector poses certain challenges and requires a comprehensive assessment of the existing scenario. The following issues were identified during the evaluation:

- **Limited Communication Channels:** Many businesses in the retail sector rely heavily on traditional communication methods such as flyers, physical notices, or in-store announcements. These methods often lack efficiency, reach, and real-time delivery, resulting in delayed or ineffective communication.

- **Information Overload:** Businesses need to disseminate various types of notifications, like product recalls or special promotions. However, the challenge is to manage and prioritize notifications to prevent overwhelming customers with excessive information.

- **Personalization and Targeting:** Effective communication requires tailoring notifications to specific customer segments or individuals. The challenge lies in ensuring that customers receive relevant and personalized notifications based on their preferences, previous interactions, or location.

- **Multichannel Delivery:** Customers today expect to receive notifications through various channels such as SMS, email, push notifications, or social media. Managing multiple communication channels and ensuring consistent and synchronized delivery presents a significant challenge.

- **Privacy and Data Security:** With the increasing concerns about privacy and data protection, businesses must handle customer data securely while complying with privacy regulations. Safeguarding customer information and maintaining trust is crucial in implementing a notification center system.

I.4 Competitor benchmarking

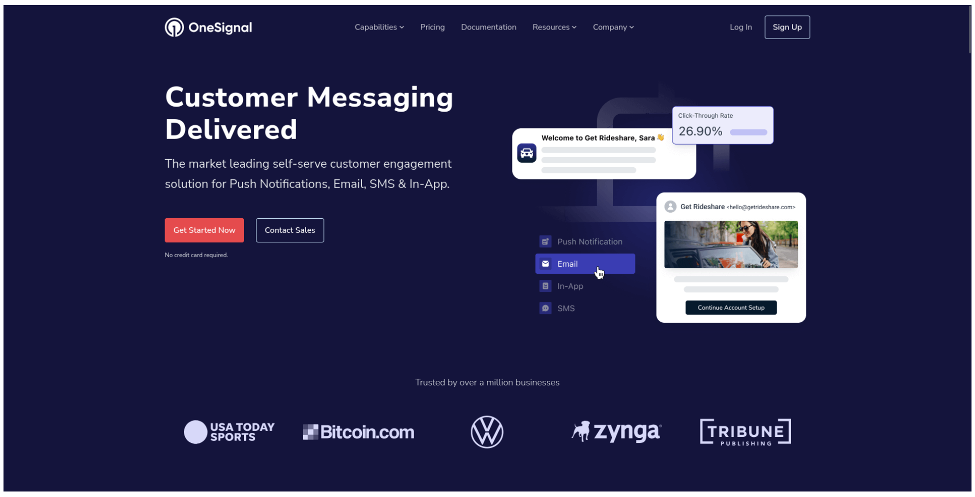
In this section, we will evaluate and compare existing notification delivery solutions. By examining the features, functionalities, and performance of these solutions, we aim to identify the strengths and weaknesses of each competitor in order to inform our own development process.

I.4.1 Competitors selection

During our search for similar existing functionalities, we have carefully evaluated numerous solutions and identified the three most closely aligned with our specific needs. We will present an overview of these chosen solutions, highlighting their key characteristics and capabilities.

I.4.1.1 OneSignal [1]

OneSignal is a popular notification service that supports multiple platforms including iOS, Android, and web. OneSignal offers a wide range of features, including segmenting users based on custom attributes, A/B testing, automation, and personalization. OneSignal also provides real-time analytics and delivery reports, allowing tracking and optimization of notification campaigns.



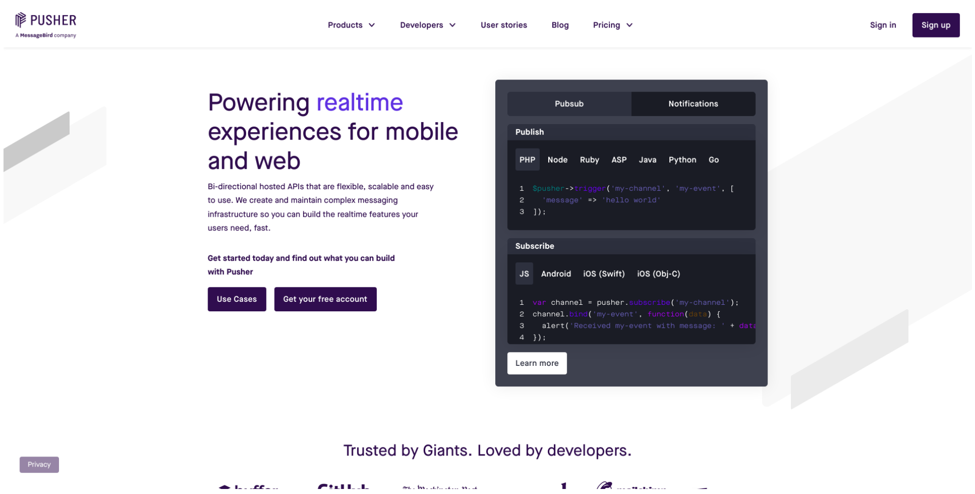
Customer Messaging Delivered

The market leading self-serve customer engagement solution for Push Notifications, Email, SMS & In-App.

Figure I.2: OneSignal homepage

I.4.1.2 Pusher [2]

Pusher is a cloud-based notification service that provides real-time messaging for mobile and web applications. It supports push notifications, in-app notifications, and allows integration with other services and platforms.



Powering realtime experiences for mobile and web

Bi-directional hosted APIs that are flexible, scalable and easy to use. We create and maintain complex messaging infrastructure so you can build the realtime features your users need, fast.

Get started today and find out what you can build with Pusher

```
$pusher->trigger('my-channel', 'my-event', [
  'message' => 'hello world'
]);
```

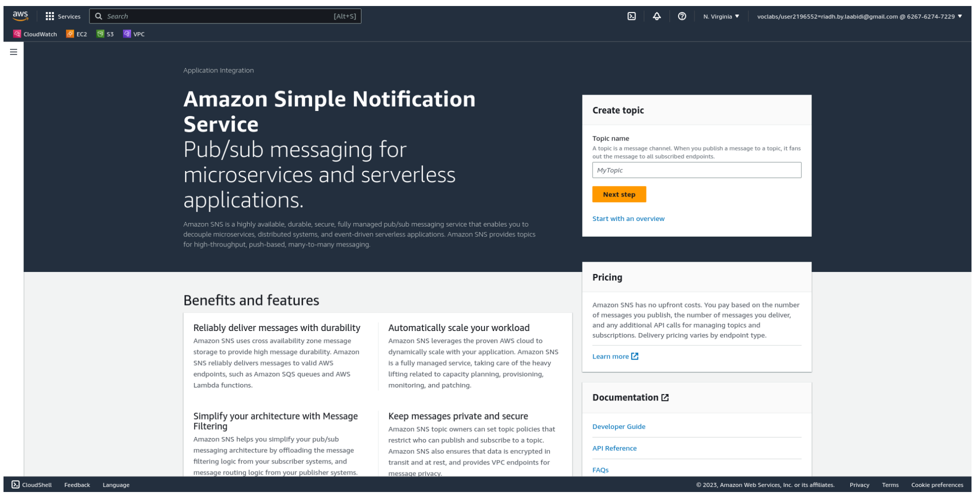
```
var channel = pusher.subscribe('my-channel');
channel.bind('my-event', function(data) {
  alert('Received my-event with message: ' + data
});
```

Trusted by Giants. Loved by developers.

Figure I.3: Pusher homepage

I.4.1.3 Amazon SNS [3]

Amazon SNS (Simple Notification Service) is a fully managed messaging service provided by Amazon Web Services (AWS) that enables you to send messages or notifications to a variety of distributed endpoints or clients.



Application Integration

Amazon Simple Notification Service

Pub/sub messaging for microservices and serverless applications.

Amazon SNS is a highly available, durable, secure, fully managed pub/sub messaging service that enables you to decouple microservices, distributed systems, and event-driven serverless applications. Amazon SNS provides topics for high-throughput, push-based, many-to-many messaging.

Create topic

Topic name

A topic is a message channel. When you publish a message to a topic, it fans out the message to all subscribed endpoints.

MyTopic

Benefits and features

Reliably deliver messages with durability

Amazon SNS uses cross availability zone message storage to provide high message durability. Amazon SNS reliably delivers messages to valid AWS endpoints, such as Amazon SQS queues and AWS Lambda functions.

Automatically scale your workload

Amazon SNS leverages the proven AWS cloud to dynamically scale with your application. Amazon SNS is a fully managed service, taking care of the heavy lifting related to capacity planning, provisioning, monitoring, and patching.

Simplify your architecture with Message Filtering

Amazon SNS helps you simplify your pub/sub messaging architecture by offloading the message filtering logic from your subscriber systems, and message routing logic from your publisher systems.

Keep messages private and secure

Amazon SNS topic owners can set topic policies that restrict who can publish and subscribe to a topic. Amazon SNS also ensures that data is encrypted in transit and at rest, and provides VPC endpoints for message privacy.

Pricing

Amazon SNS has no upfront costs. You pay based on the number of messages you publish, the number of messages you deliver, and any additional API calls for managing topics and subscriptions. Delivery pricing varies by endpoint type.

Documentation

© 2023, Amazon Web Services, Inc. or its affiliates.

Figure I.4: Amazon SNS service homepage

I.4.2 Comparison of existing solutions

We will conduct a comprehensive analysis of the selected existing solutions. By thoroughly examining their functionalities, strengths, and weaknesses, we aim to gain valuable insights into areas where improvements can be made to enhance user experience, streamline processes, and deliver a superior solution tailored to our specific requirements.

Our evaluation will be based on 6 criterias (Cx) that have been carefully selected as being the most relevant and aligned with the Convergence project requirements:

- **C1: Multi-channel delivery:** The ability to configure multiple channels (Email, SMS, Push, Chat) for notification delivery.

- **C2: Deliverability:** Ensuring that notifications and alerts are successfully delivered to users' devices.

- **C3: User Segmentation:** The ability to select and target specific groups of users based on criterias defined by the business requirements.

- **C4: Customization:** The ability to customize notifications content for targeted users accordingly.

- **C5: Analytics:** The ability to track different metrics during the delivery process in order to inform businesses about the effectiveness of notification campaings.

- **C6: Cost:** Charge per sent notifications for a larger user base and high notification volume.

- **C7: Ease of use:** The ability to easily setup and configure the different steps of the notification delivery process for non technical users.

The table I.2 describes our findings comparing the selected existing solutions.

I.5 Proposed solution

The benchmarking process allowed us to identify pain points and challenges commonly faced by businesses when implementing a notification center system. These challenges include the need for multi-channel notification delivery to ensure broad customer base reach, the demand for tailored and customized notifications to engage specific customer group effectively, the importance of gathering accurate analytics to measure the impact and inform businesses about the effectivenes of notifications campaings.

Based on these findings, we have concluded that developing a custom notification center tailored to our specific needs is the most suitable approach. By addressing the identified pain points and challenges, we can create a robust and user-friendly solution that empowers businesses to communicate more efficiently with their customers and employees.

The proposed notification center will incorporate multi-channel delivery options, advanced user segmentation, and personalized messaging capabilities. It will also prioritize customization and prioritization, enabling businesses to tailor notifications based on audience preferences and deliver essential information effectively.

The figure I.5 illustrates the main idea for our proposed solution.

Table I.2: Comparison table

	OneSignal	**Pusher**	**Amazon SNS**
C1 Multi-channel delivery	Provides most of channels (Push, Email, SMS), except for the Chat channel	Provides Push (Android, iOS, Web) notifications only	Provides the ability to send email, SMS, and push notifications
C2 Deliverability	Low Click-through Rates (CTR) that drops over time due to inactive receivers leading to misinformation for senders about the deliverability of notifications.	Relies on a retry mecanism for failed sending	Sets an internal delivery retry policy to 50 times over 6 hours, for Simple Mail Transfer Protocol (SMTP), SMS, and mobile push endpoints
C3 User Segmentation	Provides a user segmentation feature based on various criteria	Does not provide a user segmentation feature	Does not support targeting specific segments of users
C4 Customization	**Limited**: Users can't fully customize the layout of the notification	**Limited**: Only a subject and a body, no dynamic content	**Limited**: Emails are intended to provide internal system alerts, not marketing messages.
C5 Analytics	Provides insights dashboard	Provides simple metrics, relies on third party services for in-depth analytics	No detailed insights on sent notifications, relies on other AWS services for metrics
C6 Cost	**249$/month** (for 50,000 subscribers from push notifications only)	**99$/month** for 50,000 subscribers	Charge per usage (Pay as you go)
C7 Ease of use	Mostly easy to use for non technical users	Mostly Programmatic, does not provide a fully featured web interface	Complex and time-consuming particularly for non technical users

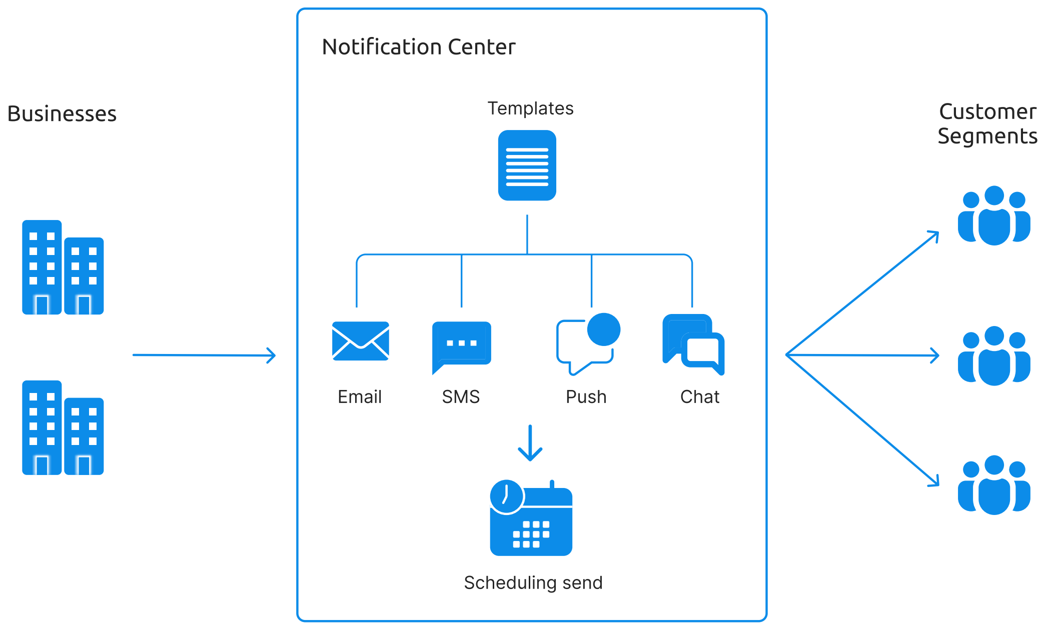


Figure I.5: Proposed solution illustration

I.6 Work methodology

With today's customers and businesses requiring rapid responses and changes, teams at Satoripop are embracing the Agile methodology, a project management approach that involves breaking the project into phases and emphasizes continuous collaboration and improvement, following a cycle of planning, executing, and evaluating.

One of the frameworks that helps practice building the mentioned agile priciples into work and that we will be focusing on is Scrum. we will provide an overview of this framework, highlighting its approach and key principles.

I.6.1 The scrum framework

Scrum is a lightweight framework that helps people, teams and organizations generate value through adaptive solutions for complex problems. It employs an iterative, incremental approach to optimize predictability and to control risk, while engages groups of people who collectively have all the skills and expertise to do the work and share or acquire such skills as needed.

I.6.2 Members of a scrum team

The fundamental unit of Scrum is a small team of people. The Scrum Team consists of one Scrum Master, one Product Owner, and Developers. Within a Scrum Team, there are no sub-teams or hierarchies. It is a cohesive unit of professionals focused on one objective at a time, the Product Goal [4].

- **Developers:** People in the Scrum Team that are committed to creating any aspect of a usable Increment each Sprint.

- **Product Owner:** One person that may represent the needs of many stakeholders in the Product Backlog. The Product Owner is accountable for effective Product Backlog management and maximizing the value of the product resulting from the work of the Scrum Team.

- **Scrum Master:** Deeply understands the work being done by the team and can help the team optimize their transparency and delivery flow. As the facilitator-in-chief, he/she schedules the needed resources (both human and logistical) for activities like sprint planning, stand-up meetings, sprint reviews, and sprint retrospectives.

I.6.3 Scrum events

The Sprint is a container for all other events. Each event in Scrum is a formal opportunity to inspect and adapt Scrum artifacts. These events are specifically designed to enable the transparency required.

- **The Sprint:** Sprints are the heartbeat of Scrum, where ideas are turned into value. They are fixed length events of one month or less to create consistency. A new Sprint starts immediately after the conclusion of the previous Sprint.

- **Sprint Planning** The work to be performed during the current sprint is planned during this meeting by the entire development team. Specific user stories are then added to the sprint from the product backlog. These stories always align with the goal and are also agreed upon by the scrum team to be feasible to implement.

- **Daily Scrum:** A 15-minute event for the Developers of the Scrum Team held every working day of the Sprint to inspect progress toward the Sprint Goal and adapt the Sprint Backlog as necessary.

- **Sprint Review:** The purpose of the Sprint Review is to inspect the outcome of the Sprint and determine future adaptations. The Scrum Team presents the results of their work to key stakeholders and progress toward the Product Goal is discussed.

- **Sprint Retrospective:** The purpose of the Sprint Retrospective is to plan ways to increase quality and effectiveness. The Scrum Team identifies the most helpful changes to improve its effectiveness and these changes are addressed as soon as possible.

I.6.4 Scrum artifacts

Scrum's artifacts represent work or value. They are designed to maximize transparency of key information. Thus, everyone inspecting them has the same basis for adaptation.

- **Product Backlog:** The primary list of work that needs to get done. It's a dynamic list of features, enhancements, and fixes that acts as the input for the sprint backlog. This list is constantly revisited, re-prioritized and maintained by the Product Owner in case items may no longer be relevant or problems may get solved in other ways.

- **Sprint Backlog:** The list of items, user stories, or bug fixes, selected by the development team for implementation in the current sprint cycle. A sprint backlog may be flexible and can evolve during a sprint without compromising the fundamental sprint goal.

- **Increment:** A concrete stepping stone toward the Product Goal. Each Increment is additive to all prior Increments and thoroughly verified, ensuring that all Increments work together. In order to provide value, the Increment must be usable.

Conclusion

To summarize our findings in this chapter, we introduced the host organization, then outlined the problem assessment and identified its related challenges. Next we analyzed competitors to get a grasp of the major pain points that we are going to tackle, and finally we presented the adopted agile approach in our team to foster flexibility and collaboration.

The next chapter will introduce the Sprint 0, where we kickstart the project, establish goals, and set the roadmap for upcoming sprints.

Chapter II

Sprint 0: Requirements gathering and Specification

Introduction

In this chapter, we place significant focus on gathering requirements and transforming them into well-defined and documented specifications. This includes creating use cases and user stories, which provide valuable insights into system interactions and user workflows. Furthermore, we establish a prioritized product backlog, ensuring efficient resource allocation and timely delivery of the most critical and valuable features. Finally, we emphasize defining the software architecture and making informed technologies and framework selection.

II.1 Requirements gathering

By conducting a comprehensive analysis of the requirements, we aim to bridge the gap between the stakeholders' vision and the actual implementation of the product or system. This analysis helps us define clear and concise specifications that serve as the foundation for the design, development, and testing phases of the project.

II.1.1 Identifying end-users

Identifying end-users is a crucial step in requirements analysis as it helps determine the needs, expectations, and constraints of the target audience. In our application, we were able to identify three types of actors:

- **Administrator**: Is responsible for overseeing user accounts, configuring and maintaining the resources needed by agents or employees to ensure the smooth operation of the system inside the organization.

- **Agent**: Is an employee inside the organization in charge of executing actions on the notification center: creating and scheduling notification campaigns including the creation of notification content, client base segmentation.

- **Client**: Is a customer who is going to be targeted by notifications from the business or organization they belong to. A customer should be able to receive notifications and set their preferences for receiving notifications from that business.

II.1.2 Functional requirements

Functional requirements define the specific actions, tasks, and behaviors that the product must be able to perform in order to meet the needs of its end-users. These requirements form the foundation of the system's functionality.

The functional requirements we captured for each actor are outlined below.

Authentication and Profile settings

- **Sign in:** A registered user should be able to access the system by providing valid credentials.

- **Edit profile settings:** A logged in user should be able to edit his profile settings.

- **View statistics:** A logged in user should be able to view notification activity metrics on his dashboard.

Administrator requirements

- **Manage agents:** An administrator should be able to add new agents, update, delete, desactivate accounts and reset passwords for existing agents.

- **Manage channels:** An administrator should be able to create new notification channels, update, delete, configure service providers for existing channels.

- **Manage topics:** An administrator should be able to create new notification topics, update, delete and configure topic's priority for existing ones.

Agent requirements

- **Manage templates:** An agent should be able to create new notification templates, update and delete existing ones.

- **Manage triggers:** An agent should be able to create new notification triggers, configure the target audience the scheduling, update, change status and delete existing triggers.

- **Manage audiences:** An agent should be able create new segments of users based on a criteria, update and delete existing ones.

- **View logs:** An agent should be able to view logs of sent notifications and their statuses.

Client requirements

- **Manage notification preference:** A client should be able to edit his notification preferences, channels and frequency of receiving notifications.

- **View notification history:** A client should be able to checkout a history of his received notifications (for in-app notifications).

II.2 Scrum implementation overview

This section provides an overview of the Scrum implementation in our project It includes a global use case diagram, showcasing the system's high-level functionalities, followed by the presentation of the product backlog and the planning of the sprints.

II.2.1 Global use case diagram

Using UML use case diagrams to model the requirements allows for a visual representation of the interactions between actors and the system, providing a clear and concise way to specify the functionalities and behaviors expected from the product.

Clients, acting as the base, can customize notification preferences and access their notification history. Agents, inheriting from clients, extend functionalities to include managing templates, triggers, audiences, and logs. Administrators, inheriting from agents, further enhance their capabilities to manage agents, channels, and topics. Agents and Administrators can sign in, edit profiles, and view statistics.

The figure II.1 illustrates the global use case diagram we modeled for our notification system.

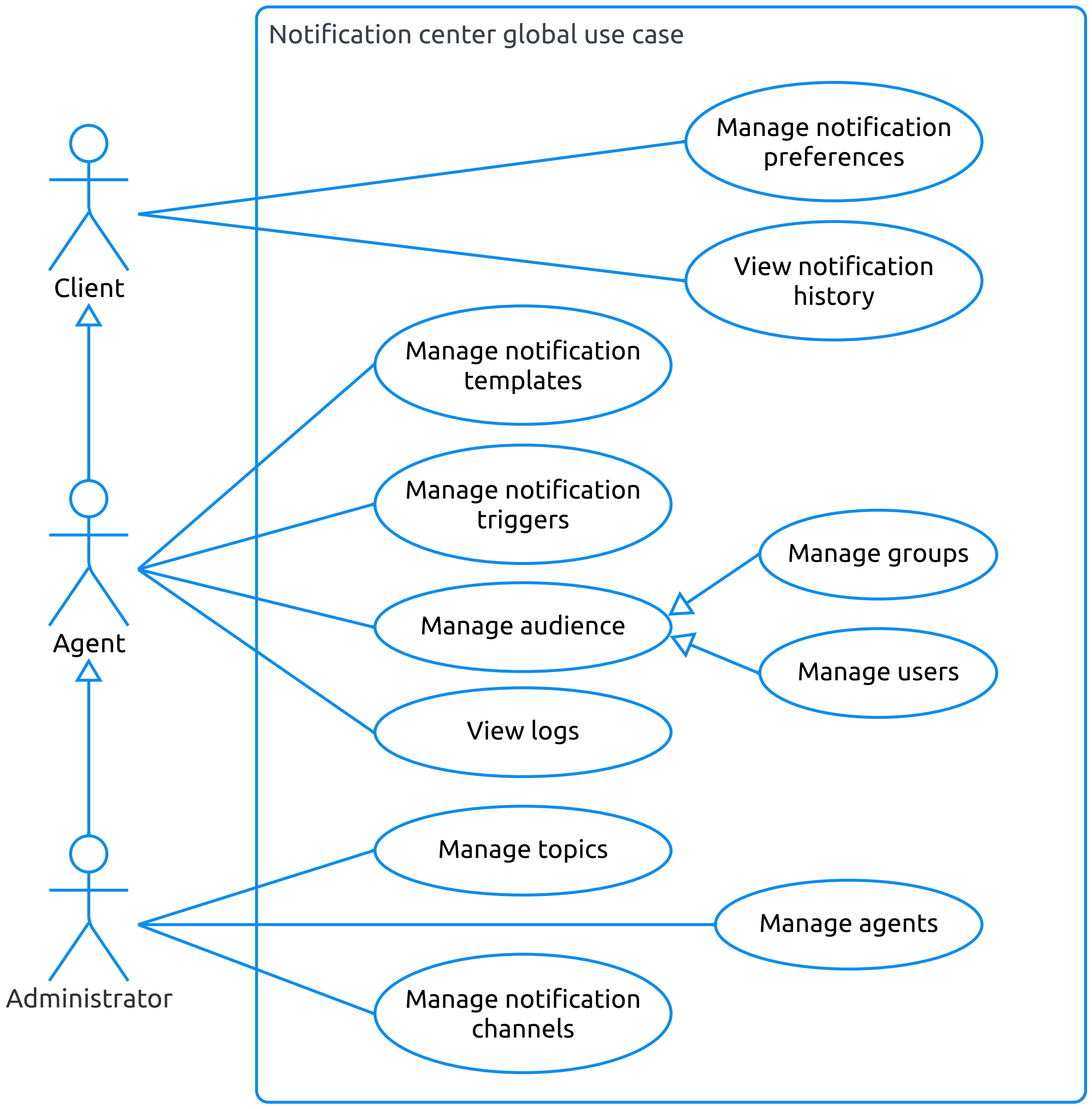

Notification center global use case
Client
Agent
Administrator
Manage notification preferences
View notification history
Manage notification templates
Manage notification triggers
Manage groups
Manage audience
Manage users
View logs
Manage topics
Manage agents
Manage notification channels

Figure II.1: Notification Center global use case diagram

II.2.2 Product backlog

The Product Backlog serves as a dynamic and living artifact that captures and organizes the ever-evolving list of features, functionalities, and enhancements desired for a software product.

- **Epic:** Is a large body of work that can be broken down into a number of smaller stories.

- **User story:** Is an informal, general explanation of a software feature written from the perspective of the end user or customer, in the form of:
  "As a [persona], I [want to], [so that]."

The table II.1 represents our product backlog.

Table II.1: Product backlog

Epic	**User story**
Authentication	**Authenticate**: As a registered user, I want to be able to log into my account securely using my email and password.
Agents management	**Create an agent**: As an administrator, I want to be able to create agents so that I can add them to the notification center.
	List agents: As an administrator, I want to be able to list agents so that I can view all registered agents.
	Edit an agent: As an administrator, I want to be able to edit agents so that I can modify their information.
	Delete an agent: As an administrator, I want to be able to delete agents so that I can get rid of no longer needed agents.
Users management	**Create a notification user**: As an administrator/agent, I want to be able to create users so that I can send them notifications.
	List notification users: As an administrator/agent, I want to be able to list users so that I can view all created users.
	Edit a notification user: As an administrator/agent, I want to be able to edit users so that I can modify their information.
	Delete a notification user: As an administrator/agent, I want to be able to delete users so that I can get rid of no longer needed users.
Audience management	**Create an audience**: As an administrator/agent, I want to be able to create an audience so that I can target specific individuals based on a criteria.
	List audiences: As an administrator/agent, I want to be able to list audiences so that I can view all created user segments.
	Edit an audience: As an administrator/agent, I want to be able to edit an audience so that I can change selection criteria and segment configurations.
	Delete an audience: As an administrator/agent, I want to be able to delete a group of users so that I can get rid of no longer needed groups..
Notification channels management	**Create a channel**: As an administrator/agent, I want to be able to create notification channels so that I can send notifications through these channels.
	List channels: As an administrator/agent, I want to be able to list notification channels so that I can view all created channels.
	Edit a channel: As an administrator, I want to be able to edit notification channels so that I can update their configurations.

Epic	User story
	Delete a channel: As an administrator/agent, I want to be able to delete notification channels so that I can get rid of no longer used channels.
Notification templates management	**Create a template**: As an agent, I want to be able to add notification templates so that I can send notifications based on that template.
	List templates: As an agent, I want to be able to list notification templates so that I can view all created templates.
	Edit a template: As an agent, I want to be able to edit notification templates so that I can keep them up to date.
	Delete a template: As an agent, I want to be able to delete templates so that I can get rid of no longer used templates.
Notification preferences management	**Set notification preferences**: As a user, I want to be able to set my notification preferences, so that I can receive notifications from the channels I want.
Notification triggers management	**Create a trigger**: As an agent, I want to be able to create triggers for notifications so that I can schedule notifications to be sent automatically.
	List triggers: As an agent, I want to be able to list triggers for notifications so that I can view all created triggers.
	Edit a trigger: As an agent, I want to be able to edit notifications triggers so that I can modify or update its configurations.
	Delete a trigger: As an agent, I want to be able to delete notification triggers so that I can get rid of outdated and no longer used triggers.
Notification history	**Get notification history**: As a user, I want to be able to list notification history so that I can review my received notifications whenever I want.
	List sending logs: As an administrator/agent, I want to be able to list sent notification logs so that I can review all sent notifications.
Dashboard	**View metrics**: As an administrator/agent, I want to be able to view metrics on my dashboard so that I can get an overview on important statistics related to notification activities.

II.2.3 Releases and sprints planning

A release refers to the deployment of a specific version or update of a software product. It involves meticulous planning and coordination to ensure successful delivery.

In the table II.2, we present the detailed planning of the releases, outlining the sprints included in each release, and the epics included in each sprint.

Table II.2: Releases and sprints planning

Release	Sprints	Epics
Release 1 User, segmentation & channels	Sprint 1	Authentication
		Agents management
		Users management
	Sprint 2	Audiences management
		Notification channels management
Release 2 Sending notifications & dashboards	Sprint 3	Notification templates management
		Notification preferences management
	Sprint 4	Notification triggers management
		Notification history
		Dashboard

II.3 Development infrastructure

In this section, we will discuss the development infrastructure established for the successful execution of the project. Our primary focus will be on defining the non-functional factors that are crucial for our product, then based on these factors, we'll proceed to discuss the software architecture, the database choice, and the curated set of tools and frameworks that were employed to support and streamline the development workflow.

II.3.1 Non-Functional requirements

When designing a notification system, various technical requirements need to be considered to ensure the solution's effectiveness, reliability, and scalability. Here are the key factors that we should focus on while architecturing our system:

- **Security:** The system shall enforce secure communication protocols, such as HTTPS, to protect sensitive data during transmissionn, also data and preferences stored in the system shall be securely encrypted to prevent unauthorized access or data breaches.

- **Real-time:** The system shall deliver notifications in real-time or near real-time to ensure timely communication, messages and notifications should be delivered with minimal delay for high priority topics.

- **Scalability:** The system should be designed to handle a high volume of concurrent users and notifications without compromising performance and the system architecture should be scalable, allowing for horizontal scaling by adding more servers or utilizing cloud-based infrastructure as the user base grows.

- **Customizability:** The system should provide flexibility and customizability to meet the specific branding and user experience requirements of different organizations. Also the system should allow customization of user preferences to provide a personalized experience.

II.3.2 Software architecture

To implement our notification center, we will base our work on a client-server architecture. In this approach, the client, representing the user interface, interacts with the server, which houses the application's core logic and data. This separation of concerns allows for centralized management of data and business logic while catering to various clients.

One of the extensions to the mentioned architecture, and the one we will adopt is the **three-tier monolithic architecture**, where all the application modules and components are tightly integrated into a single codebase. This decision was based on several factors such as the project's scope, timeline, and the team's familiarity with monolithic architectures. Furthermore, for the envisioned requirements, a monolithic design offered simplicity and ease of development and deployment to quickly get the application started.

The figure II.2 illustrates the separation of the three tiers in the monolithic architecture :

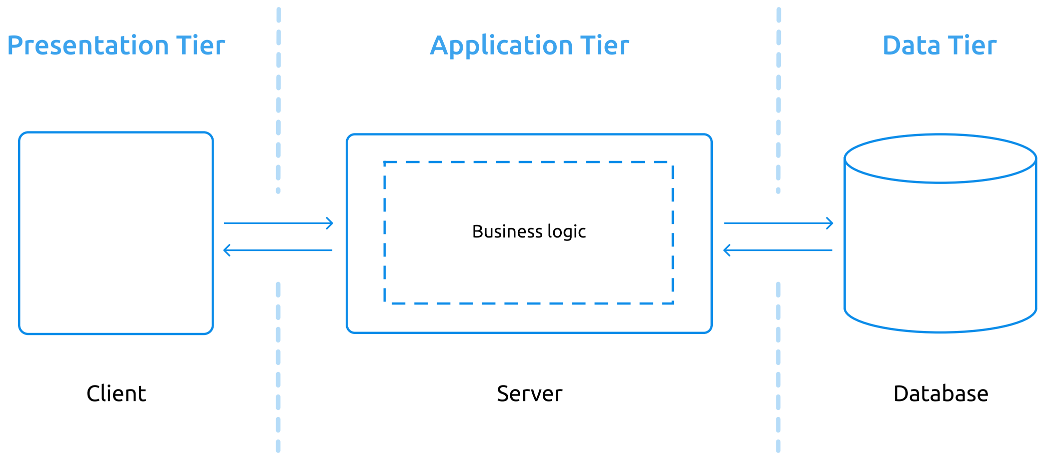


Figure II.2: Monolithic three-tier architecture

Presentation tier: The presentation tier is the user interface and communication layer of the application. Its main purpose is to display information to users and gather information from them. This top-level tier can run on a web browser, as desktop application, or a graphical user interface.

Application tier: In this tier, the data collected in the presentation tier is processed, sometimes against other information in the data tier, using business logic, a specific set of business rules. The application tier can also add, delete or modify data in the data tier.

Data tier: The data tier, sometimes called database tier, data access tier or back-end, is where the information processed by the application is stored and managed. This can be a relational database management system or a NoSQL Database server.

The user interface, business logic, and the database all reside on different machines and, thus, have different tiers. They are physically separated.

II.3.3 Technology stack and framework selection

In this part, we will delve into the technology stack and frameworks adopted for our project. This includes considerations for the back end, front end, and database components. By specifying these choices, we gain a clear understanding of the tools driving the development of our project.

II.3.3.1 JHipster Platform

In our quest of identifying efficient tools to expedite the development of an enterprise-level solution, we conducted research with a key focus on meeting the technical factors we envisioned. Our goal was to pinpoint a solution that not only accelerates project initiation but also empowers our team to concentrate on the core application logic while satisfying these crucial requirements.

We have reached a decision to adopt **JHipster** as the foundation for our project development. JHipster is a development platform to quickly generate, develop, and deploy modern web applications and microservice architectures [5].

The value proposition that JHipster provides is reflected in:

- The creation of fully configured applications for both the front and the back ends. In addition to the generation of code according to best practices and coding standards, ensuring a high level of code quality and consistency throughout the project.

- JHipster's integrated DevOps and CI/CD capabilities provide a seamless pathway to automate testing, deployment, and delivery processes.

JHipster provides flexibility and options, for the back end, it primarily supports Spring Boot, a popular Java-based framework which we discuss in detail in the following section II.3.3.2. On the front end side, JHipster offers a variety of choices including Angular, React and Vue, we elaborate on our choice for the front end technology in section II.3.3.3.

In conjunction with JHipster, we employed various complementary software tools to enhance the development process (see Appendix A).

II.3.3.2 Server-side technology

This section delves into the technology considerations for the backend part of our solution and the employed internal architectural pattern.

II.3.3.2.1 Spring Boot framework

Spring Boot emerged as the backend technology for our project. Spring Boot is built upon the robust Spring framework, makes developing production-grade Spring based web application and microservices faster and easier through three core capabilities:

- **Auto Configuration:** Spring Boot comes with built-in autoconfiguration capabilities, it automatically configures both the underlying Spring Framework and third-party packages based on the provided settings.

- **Opinionated approach:** Spring Boot chooses which packages to install and which default values to use, rather than requiring the developer to make all those decisions on their own and set up everything manually.

- **Standalone applications:** Spring Boot helps developers create standalone that run on their own, without relying on an external web server, by embedding a web server such as Tomcat into the application during the initialization process.

II.3.3.2.2 Spring boot flow architecture

Spring Boot uses a hierarchical architecture in which each layer communicates with the layer immediately below or above it as shown in the figure II.3.

1. **Presentation Layer**: The top layer of the spring boot architecture. It consists of views. It handles the HTTP requests and performs authentication. It is responsible for converting the JavaScript Object Notation (JSON) field's parameter to java objects and vice-versa. Then passes the request to the next layer.

2. **Business Layer**: Contains all the business logic. It consists of multiple service classes and is responsible for validation and authorization.

3. **Persistence Layer**: Implements all the database storage logic and it is responsible for converting business objects to the database records and vice-versa.

4. **Database Layer**: This layer provides integration with multiple databases. It is responsible for performing the CRUD operations.

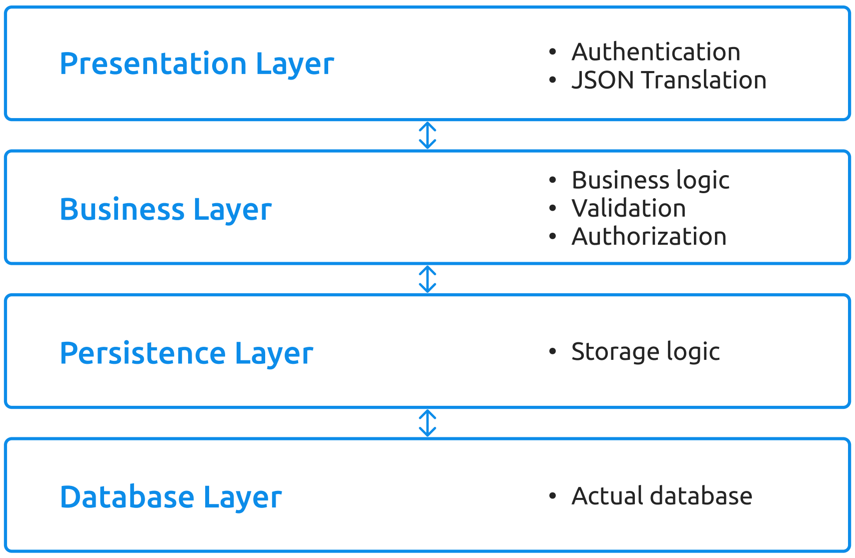


Figure II.3: Spring Boot application layers

Spring Boot integrates almost all of the features and modules of the Spring framework: like Spring MVC, Spring Core, Spring Data & JPA, etc. It follows nearly the same architectural pattern as Spring MVC, except for one thing: there is no need for Data Access Object (DAO) and DAO Implementation classes in Spring boot because its architecture has a data access layer and performs CRUD operations.

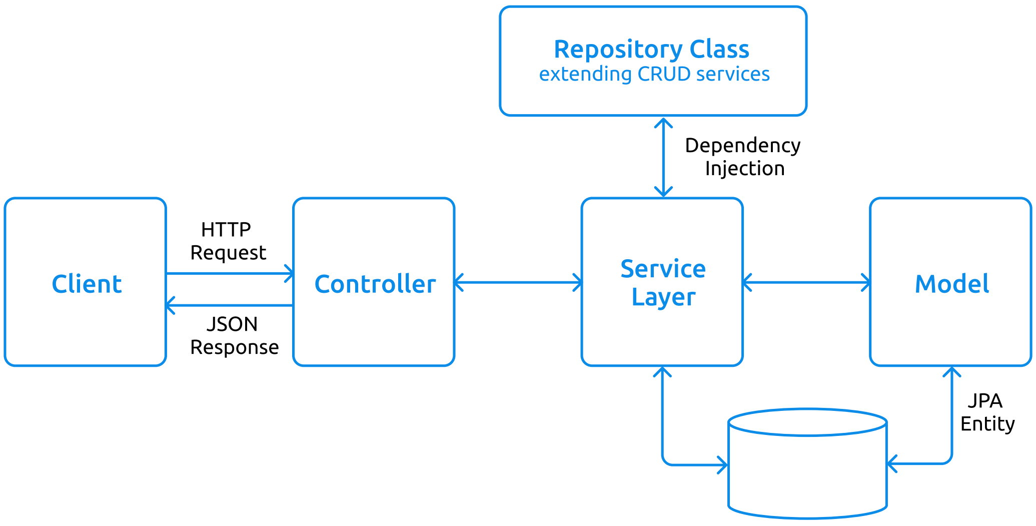


Figure II.4: Spring Boot flow architecture

Controllers are the major components in Spring's MVC framework. Their primary job is to handle HTTP requests and either hand off a request to a view to render HTML or like in our case write data directly to the body of the response as JSON [6].

In order to perform business logic on data, controllers call service classes from the service layer, which in turn inject repository classes to manipulate data in the database, and all entities are mapped to model classes through the Java Persistence API (JPA)

II.3.3.3 Client-side technology

This section illustrates the chosen technology for the client side of our solution and the adopted internal architectural pattern.

II.3.3.3.1 Angular framework

For the user facing part of our solution, we will select the **Angular** frontend framework. Angular, developed and maintained by Google, is a development platform, built on TypeScript and includes:

- A component-based framework for building scalable web applications.
- A collection of well-integrated libraries that cover a wide variety of features, including routing, forms management, client-server communication, etc.
- A suite of developer tools to help develop, build, test, and update code [7].

II.3.3.3.2 Angular architectural pattern

The architecture of an Angular application relies on certain fundamental concepts. The basic building blocks of the Angular framework are Angular components that are organized into `NgModules`. `NgModules` collect related code into functional sets which define an Angular application. An application always has at least a root module that enables bootstrapping, and typically has many more feature modules.

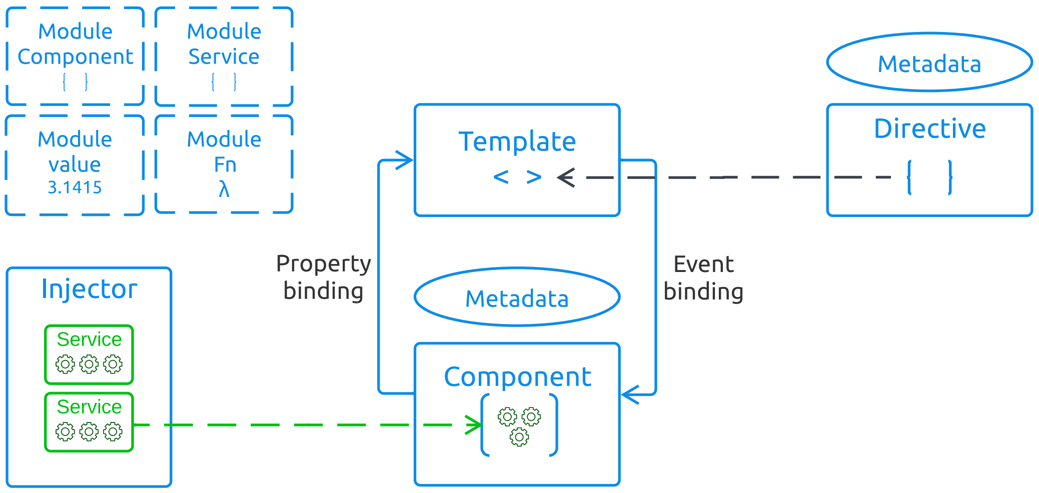


Figure II.5: Angular component-based architectural pattern

- Components define views, which are sets of screen elements that Angular can choose among and modify according to the program logic and data. Using event binding which lets the application respond to user input in the target environment by updating application data, and property binding which allows to interpolate values that are computed from the application data into the HTML.

- Components use services, which provide specific functionality not directly related to views. Service providers can be injected into components as dependencies, making our code modular, reusable, and efficient.

Modules, components and services are classes that use decorators. These decorators mark their type and provide metadata that tells Angular how to use them.

- The metadata for a component class associates it with a template that defines a view. A template combines ordinary HTML with Angular directives and binding markup that allow Angular to modify the HTML before rendering it for display.

- The metadata for a service class provides the information Angular needs to make it available to components through dependency injection.

An application's components typically define many views, arranged hierarchically. Angular provides the `Router` service to help you define navigation paths among views. The router provides sophisticated in-browser navigational capabilities.

II.3.3.4 Database

Selecting the appropriate database is a pivotal decision in our system design. After careful consideration, we've chosen to employ a relational database, specifically **PostgreSQL**. This choice is driven by the following criteria:

- **Structured Data:** We need to store notification channels and templates, user segments, and scheduling details in structured tables, these entities share relationships that interconnect them.

- **ACID Compliance:** We need to ensure data integrity and consistency, as it's critical for reliable notification delivery and management.

- **Query Flexibility:** We need to leverage SQL queries to effectively retrieve and manipulate Data, enabling comprehensive reporting and analysis.

PostgreSQL is an open source object-relational database system that has a strong reputation for its reliability, flexibility, and support of open technical standards. PostgreSQL comes with many features aimed to help developers build applications and help managing higher data loads.

Conclusion

In this chapter we laid the groundwork for the project by comprehensively gathering and analyzing the requirements. By identifying end-users, defining functional and non-functional requirements, and creating a clear specification through use case diagrams, elaborating the product backlog, planning sprints, specifying the application's architecture and the requisite development infrastructure, we have set the stage for the subsequent phases of development.

The insights gained from this chapter will prove invaluable in ensuring the successful implementation of the project and the satisfaction of the end-users. In the following chapter, we will start executing our project providing the practical realization of the initial release.

Chapter III

Release 1: Users, segmentation & channels

Introduction

In this chapter, we focus on the first release of our product, this release aims to create and enhance the user experience, implement userbase segmentation strategies, and manage notification channels. We will delve into the sprints backlog, design considerations, and the implementation process undertaken to bring these features to fruition.

III.1 Sprints backlog

During the Sprint Planning event, we estimated the effort required for each item in the first and second sprints backlog based on the number of working hours.

The priority of backlog items is reflected by their relative order in the table. Items positioned higher in the table indicate a higher priority.

Table III.1: Backlog of Sprint 1 & 2

Sprint	**Epic**	**User story**	**Estimation (hours)**
1	Authentication	Authenticate	16
	Agents management	Create an agent	16
		List agents	16
		Edit an agent	8
		Delete an agent	8

Sprint	**Epic**	**User story**	**Estimation (hours)**
	Users management	Create a notification user	16
		List notification users	16
		Edit a notification user	8
		Delete a notification user	8
2	Audience management	Create an audience	24
		List audiences	16
		Edit an audience	8
		Delete an audience	8
	Notification channels management	Create a channel	32
		List channels	16
		Edit a channel	8
		Delete a channel	8

III.2 Specification

In this section we are going to provide a detailed breakdown of some user stories. Each user story will be presented in a structured table format, ensuring ease of reference for the development team and that each user story is comprehensively documented. This table will include four key components:

- **Precondition:** Highlights any necessary conditions or prerequisites that must be in place before the user story can be initiated.

- **Business rules:** Business rules are critical as they define the constraints, policies, and conditions that govern how the software should behave in response to user interactions.

- **Technical specification:** This part specifies the technical aspects of the user story. It outlines the specific technical requirements, technologies, and architecture considerations that will be essential for the development team to realize the user story.

- **Acceptance criteria:** This section will provide a clear list of conditions that must be met for the user story to be considered complete and ready for release.

Table III.2: User stories specification

Epic	**User story**
Authentication	**Authenticate** As a registered user, I want to be able to log into my account securely using my email and password. **Precondition** • User is already registered and has a valid account. **Business rules** • Users must provide an email and password to authenticate. • Users should not be able to authenticate if credentials are incorrect. • Users must be redirected to the page they were trying to access before being prompted to log in. • Users must be able to reset their passwords if they forget them. **Technical specification** • The email field should accept a valid email address. • The login form should include a ”Forgot Password” link that allows the user to reset their password. **Acceptance criteria** • User email and password are both required for log in. • Users should be able to log in using their registered email and password. • Invalid login attempts should result in an error message.

Epic	**User story**
Notification users management	**Create a notification user** As an administrator/agent, I want to be able to create users so that I can send them notifications. **Precondition** • Administrator/Agent authenticated and has a valid account. • Users do not exist already **Business rules** • Creation form should include a first and last name, email, a phone number, a birthdate, a language key and a country. • Administrators/Agents should be able to download a file containing the data format to respect when importing users from a file. • Administrators/Agents shouldn't be able to add a user with an already existing email or phone number. • Administrators/Agents should be able to import a list of users from a file. **Technical specification** • The email field should accept a valid email address. • The phone number field should accept a valid phone number. • File import should accept only CSV files. **Acceptance criteria** • All required fields are provided: first and last name, email or phone number, and the country. • Created or imported users are saved to the database. • A message indicating the success or failure of the operation is displayed.

Epic	**User story**
Notification channels management	**Create a notification channel** As an administrator, I want to be able to create notification channels so that agents can use them to send notifications. **Precondition** • Administrator is authenticated and has a valid account. **Business rules** • Each notification channel must have a unique name. • The administrator should choose the type of notification channel, such as email, SMS, or push notifications. • The administrator should be able to configure the desired provider for the chosen channel type. **Technical specification** • A form should be provided for the administrator to enter the channel's name, type, the provider and its configuration. • The system should be able to handle multiple types of service providers, each with their own configurations. • The service provider credentials should be stored securely in the database. • The system should be able to integrate with external service providers using APIs. **Acceptance criteria** • The administrator can successfully create a new notification channel. • The administrator can conveniently configure the settings for each selected provider, such as API keys and credentials. • The system is able to deliver the notifications through the created channel according to its configurations. • A message indicating the success or failure of the operation is displayed.

Epic	**User story**
Audience management	**Create an audience** As an administrator/agent, I want to be able to create a segment of user subscriptions based on some criteria, so that I can target these subscriptions with notifications. **Precondition** • Administrator/Agent is authenticated and has a valid account. • Existing notification users and subscriptions. **Business rules** • Administrators/Agents should be able to create a segment based on one or more criteria including subscription channel, language, country, age, or other user or subscription attributes. • Administrators/Agents should be able to create as many audiences as they need. • Administrators/Agents should be able to store and retrieve audience data from the database. • Administrators/Agents should be able to get an estimation of the audience size while creation. **Technical specification** • A user subscription can be part of multiple audiences at the same time. • An audience shouldn't be empty, and should contain at least one notification subscription. • Administrators/Agents can create multiple audiences with different criteria. **Acceptance criteria** • The audience name should be unique. • Administrators/Agents can create an audience based on at least one criteria. • The group should only contain users satisfying the specified selection criteria. • A message indicating the success or failure of the operation is displayed.

III.3 Design

The design phase of software development is a critical step in the software development life cycle. It is the process of transforming the customer requirements into a detailed plan for how the software will be implemented. In this section we are going to focus on the design aspects related to the database and the software.

III.3.1 Database design

In this section, We will discuss the structure and organization of our database, defining tables and relationships between entities for efficient data management within our solution.

III.3.1.1 Data dictionary

First, we will define a data dictionary that describes the fields associated with each data element, indicating their types and constraints as shown in the table III.3.

Table III.3: Data dictionary of the first release

Entity	**Field**	**Description**	**Type**	**Constraints**
User	`id`	User's unique identifier	bigint	Primary key Not null
	`first_name`	User's first name	varchar(50)	
	`last_name`	User's last name	varchar(50)	
	`email`	User's email address	varchar(256)	Unique, Not null
	`password_hash`	User's encrypted password string	varchar(60)	Not null
	`image`	User's profile image url	varchar(256)	
	`lang_key`	User's prefered language key	varchar(10)	
	`avtivated`	User's account activation status	boolean	Not null
Authority	`name`	User authority (role)	varchar(50)	Primary key
NotificationUser	`id`	Notification user unique identifier	bigint	Primary key Not null
	`first_name`	Notification user's first name	varchar(50)	Not null
	`last_name`	Notification user's last name	varchar(50)	Not null
	`email`	Notification user's email address	varchar(256)	Not null
	`phone_number`	Notification user's phone number	varchar(50)	
	`lang_key`	Notification user's prefered language key	varchar(10)	Not null
	`country`	Notification user's country location	varchar(256)	Not null
	`birth_date`	Notification user's birth date	date	

Entity	Field	Description	Type	Constraints
Channel	`id`	Notification channel's unique identifier	bigint	Primary key Not null
	`name`	Notification channel's name	varchar(100)	Unique, Not null
	`channel_type`	Notification channel's type (EMAIL, SMS, PUSH, or CHAT)	varchar(10)	Not null
	`creation_date`	Notification channel's creation date	datetime	
	`service_provider_id`	Notification channel's specific service provider identifier	bigint	Unique, Not null
	`creator_id`	Identifier of the channel creator	bigint	Unique, Not null
ServiceProvider	`id`	Notification sending service provider's unique identifier	bigint	Primary key Not null
	`provider_id`	Service provider name identifier	varchar(50)	Not null
	`host`	Host address for the SMTP mail server	varchar(256)	
	`port`	Server port for the SMTP mail server	integer	
	`encryption`	Encryption type for the SMTP mail server	varchar(10)	
	`username`	Username for authenticating to the SMTP mail server	varchar(256)	
	`password`	Password for authenticating to the SMTP mail server	varchar(60)	
	`from`	The sender credential for the SMTP mail server or Twilio SMS provider	varchar(256)	
	`identifier`	Generic identifier for the service provider	varchar(256)	

Entity	Field	Description	Type	Constraints
	`token`	Access token for the service provider	varchar(60)	
	`messaging_service`	Whether or not to use a messaging service for Twilio provider	boolean	
	`channel_secret`	Secret code for the Line chat provider channel	varchar(60)	
	`service_account`	The whole configuration file content of the Firebase service account	text	
Notification Subsciption	`id`	Notification user subscription unique identifier	bigint	Primary key Not null
	`enabled`	Whether the subscription is enabled or disabled	boolean	Not null
	`device_token`	The user token used to send notifications through, could be an email address, phone number, social media identifier	varchar(256)	Not null
	`notification_user_id`	Subscription's user identifier	bigint	Not null
	`channel_id`	Subscription's notification channel identifier	bigint	Not null
Audience	`id`	Audience's unique identifier	bigint	Primary key Not null
	`name`	Audience name	varchar(100)	Unique, Not null
	`creation_date`	Audience's creation date	datetime	Not null
	`size_estimate`	Audience's size estimation	bigint	Not null
	`creator_id`	Audience's creator identifier	bigint	Not null
Criteria	`id`	Criteria's unique identifier	bigint	Primary key Not null

Entity	**Field**	**Description**	**Type**	**Constraints**
	`filter`	The attribute used to filter out notification subscriptions	boolean	Not null
	`operator`	The operator used to create the comparison for the filter	varchar(20)	Not null
	`value`	The value to filter subscriptions by	varchar(50)	Not null
	`audience_id`	The unique identifier of the audience to which this criteria belongs	bigint	Not null

III.3.1.2 Logical data model

A logical data model is a model that is not specific to a database that describes things about which an organization wants to collect data, and the relationships among these things [8]. It contains representations of entities and attributes, relationships, unique identifiers, and constraints between relationships. The goal of creating a logical data model is to develop a highly technical map of underlying rules and data structures.

The figure III.1 illustrates the entity-relationship diagram for our first release.

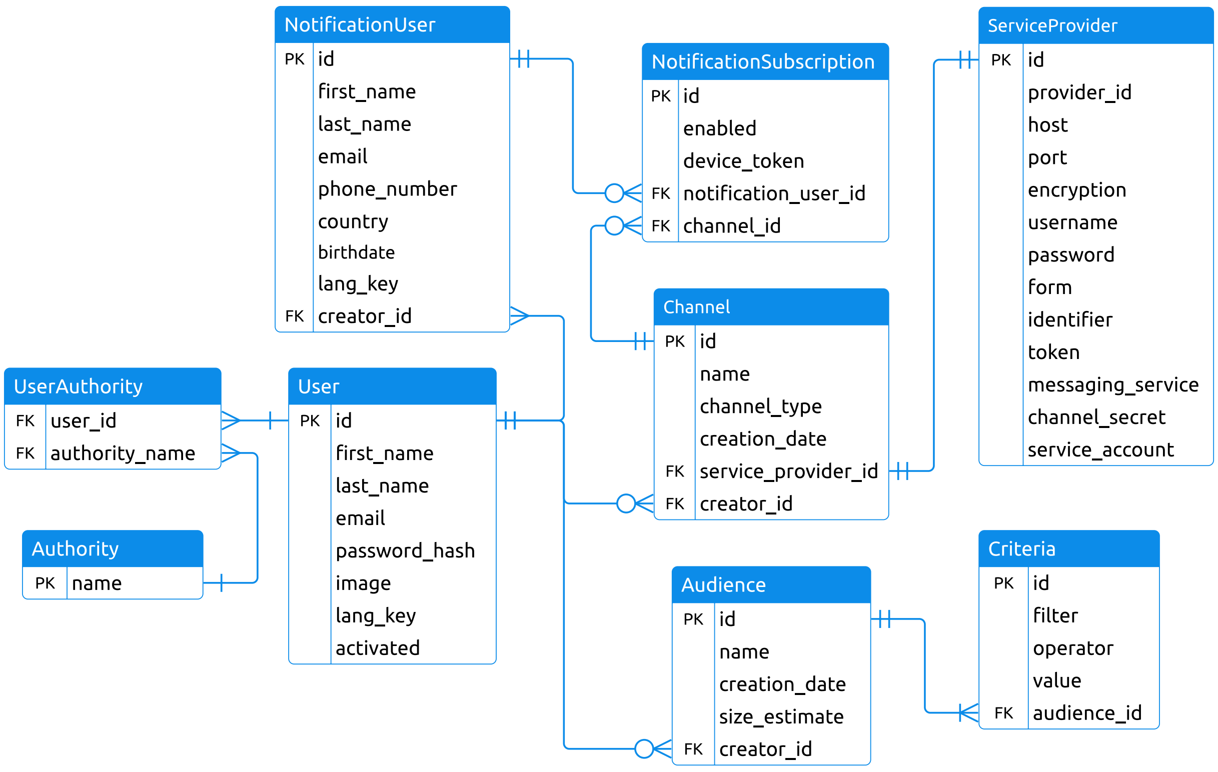


Figure III.1: The Entity-Relationship diagram of the first release

III.3.2 Software design

This phase is where we transition from defining the data structure to crafting the software's architecture and behavior. The software design section encompasses three crucial aspects: static modeling, dynamic modeling, and detailed design. Each of these facets plays a pivotal role in shaping a well-structured and efficient software solution. In this section, we will explore these components in-depth.

III.3.2.1 Static modeling

Static modeling serves as the blueprint that outlines how the various components of a software system interact, without considering their specific actions over time. One of the fundamental tools we rely upon to statically model our software systems is the class diagram. A class diagram provides a high-level overview of the system's static structure, attributes, methods, and associations between different classes.

The following table provides a description of each class being part of the first release design.

Table III.4: Classes description

Class name	**Description**
User	This class represents the user entity in our solution
Authority	This class represents roles which are going to be assigned to users
NotificationUser	This class represents the target customers for receiving notifications
Channel	This class represents the notification channels that are going to send notifications through to our target users
ServiceProvider	This class models the credentials of the third party service to integrate with the channel
NotificationSubscription	This class models a user notification subscription to a specific notification channel
Audience	This class models a segment of notification user subscriptions selected based on a criteria
Criteria	This class models a selection criteria for an audience, it represents a filter, an operator, and a value

In order to establish a clear understanding of the structural relationships within our software system, we defined the following key associations:

- A user can have many authorities, and an authority could be assigned to one or many users.
- A user can create zero or more channels, but a channel is created by exactly one user.
- A user can create zero or more audiences, but an audience is created by exactly one user.
- A notification user can have zero or many subscriptions, but a notification subscription belongs to exactly one notification user.

- A channel can have exactly one service provider.
- A channel can have zero or more subscriptions, but a subsciption is associated with exactly one channel.
- An audience can have one or more selection criteria, but a selection criteria is for exactly one audience.

The figure III.2 illustrates the class diagram for our first release.

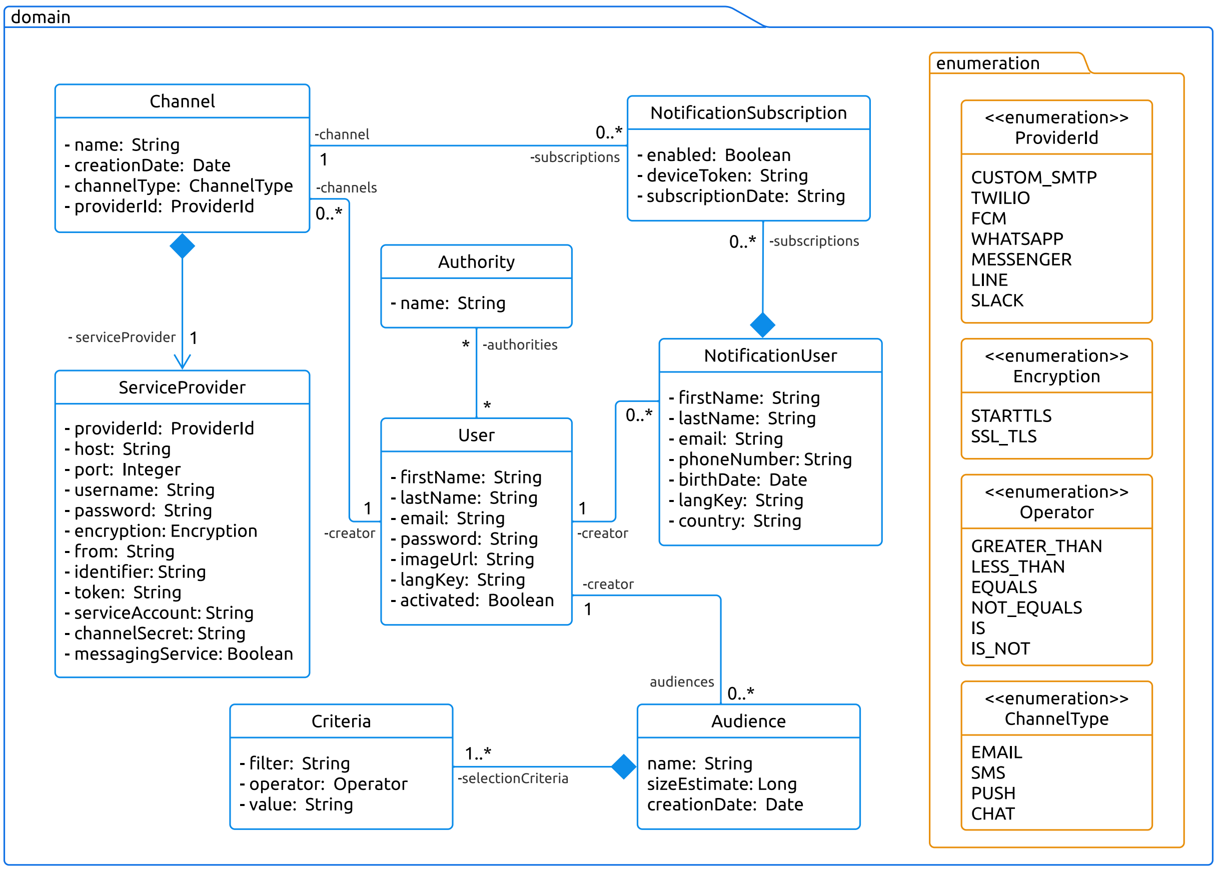


Figure III.2: The class diagram of the first release

We have taken an approach to separate the `User` class from the `NotificationUser` class. This separation is driven by two key considerations:

- First, the `User` class (generated by JHipster) is tightly integrated into our security and authentication system. Modifying this class directly is not recommended due to the potential security and compatibility issues. Therefore, we have chosen not to alter the existing `User` class using inheritance.
- Second, the `User` class is primarily responsible for handling user authentication and security-related aspects, ensuring the integrity of our application's security

model. In contrast, the `NotificationUser` class is designed exclusively for managing notification-related data, such as subscriptions and audiences. By keeping these classes independent, we ensure that `NotificationUser` entities remain independent from the authentication system and don't have any unintended access to our platform.

III.3.2.2 Dynamic modeling

In this section, we delve into the dynamic aspects of our software solution by employing UML sequence diagrams. These diagrams provide a visual representation of the interactions and communication patterns among various components and actors within our system. As we explore these sequences, we aim to shed light on the flow of information, the order of operations, and the coordination between different elements in our software architecture.

III.3.2.2.1 Sequence diagram for Creating a channel

First, we outline the process of creating notification channels, a critical functionality designed to integrate external notification delivery services within our solution.

As depicted in the user story, only administrators can create and manage channels. After filling the channel credentials the client validates the input data at the component level and hands the request to the server. In order to verify channel credentials, our server needs to communicate with external servers (Facebook, Twilio, Slack, Line). The reponse then tells if the channel is valid and could be saved in the database, or the credentials are invalid which cancels the request and asks the administrator to verify their input.

The following figure III.3 illustrates the sequence diagram for creating a channel.

III.3.2.2.2 Sequence diagram for creating an audience

For the user segmentation feature, both administrators and agents have the ability to create segments based on specific criteria. This essential functionality enables them to precisely target user subscriptions with relevant notifications.

In order to create an audience, users (administrators or agents) need to give their new audiences a name, then they can add one or more selection criteria while specifying for each criteria: a filter, a comparison operator, and a filtering value. The service layer of the client intercepts the changes while users are adding these criteria to make audience size estimation requests to the server, updating this information every short interval of time to keep users informed about the segments they are creating.

The following figure III.4 illustrates the sequence diagram for creating an audience.

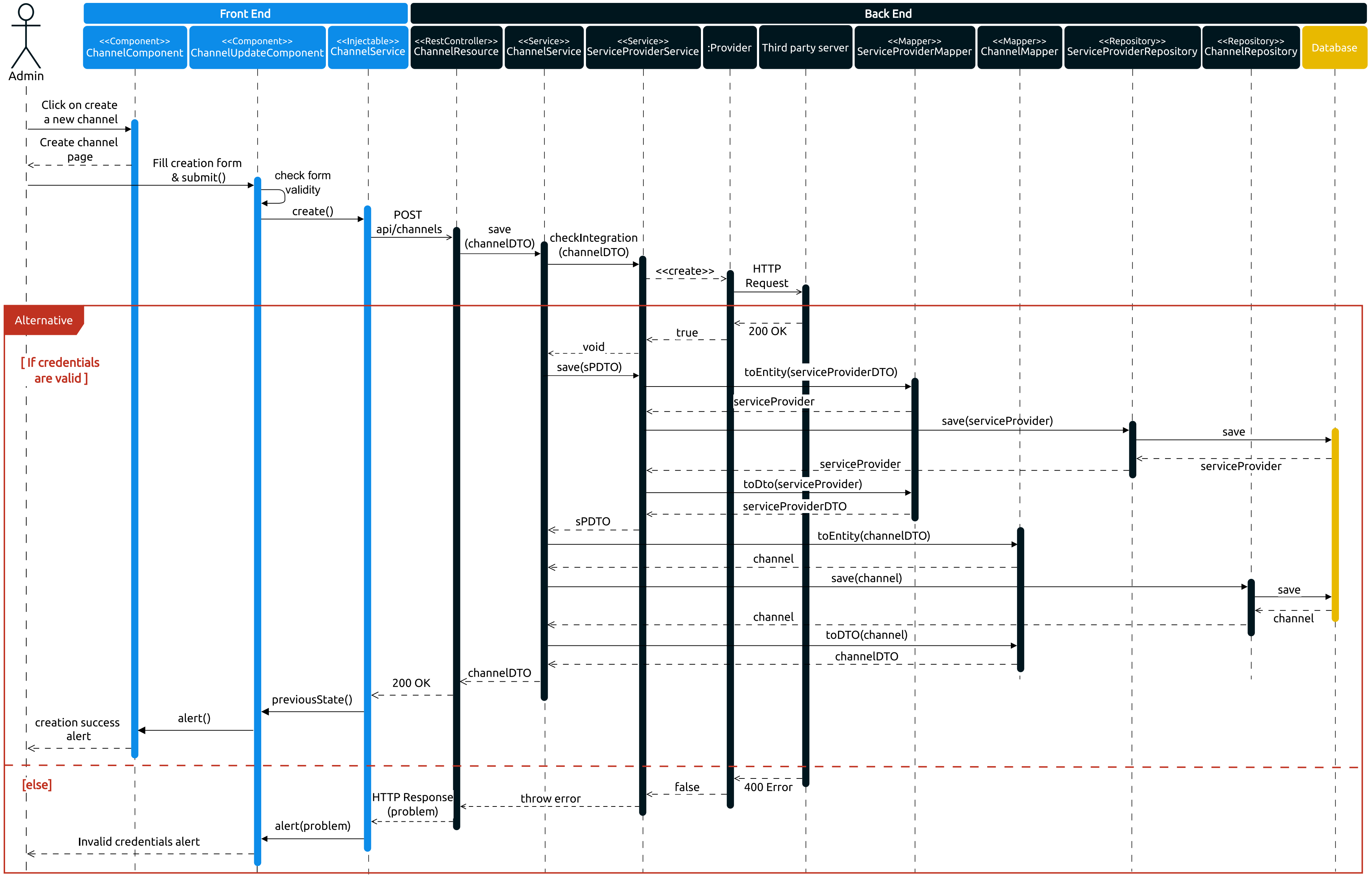


Figure III.3: Sequence diagram for creating a channel

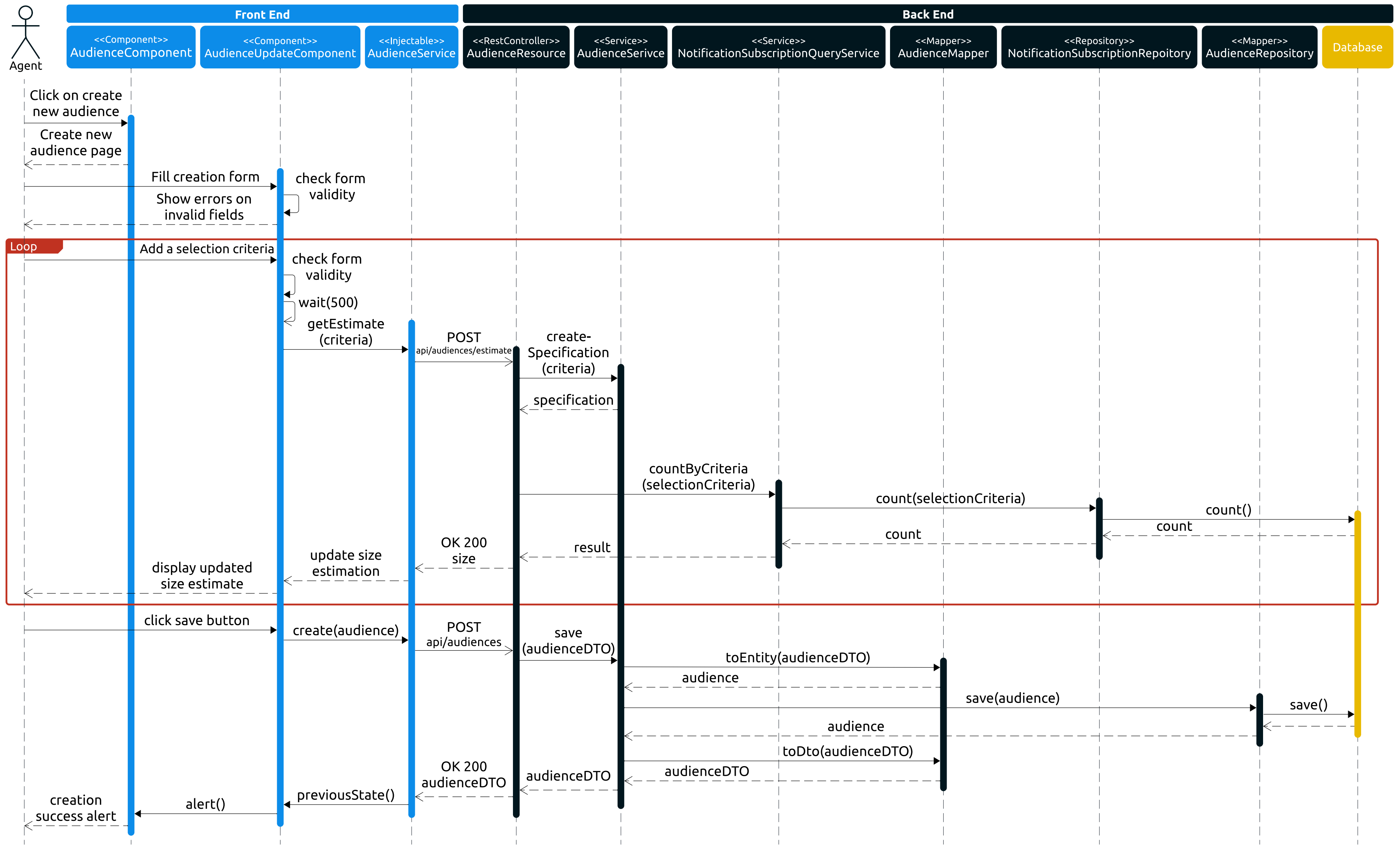


Figure III.4: Sequence diagram for creating an audience

III.3.2.3 Detailed Design

In this section we provide an in-depth look at various aspects of the detailed design process. This phase is a critical step that follows the high-level architecture and lays the foundation for the actual implementation of the system. It involves breaking down the system into smaller components, defining their interactions, and specifying how each component will function.

Our solution encapsulates 15 packages in total for the back end part, which are described as follows:

- **domain**: The `domain` package typically holds JPA entities. These are Java classes that represent the core data structures of the application. Each entity class corresponds to a database table.

- **domain.enumeration**: This package contains enumeration classes that define a set of constant values or options for specific attributes or properties of the domain entities.

- **repository**: This package contains JPA repositories. These are interfaces that provide methods for querying and manipulating data in the database. Repositories interact with domain objects for database operations.

- **service**: The `service` package contains the business logic, those are service interfaces that define the contract or API for interacting with specific business entities. The methods in these interfaces declare the operations that can be performed on those entities. The service layer depends on the `repository` and `domain` packages to access and manage data, the `config` package for service configurations, and the `logging` package to write logs.

- **service.criteria**: This package contains classes related to criteria-based querying. These classes are used to build dynamic and complex queries to retrieve data from the database based on various criteria or search parameters.

- **service.dto**: This package contains Data Transfer Objects (DTOs). DTOs are used to transfer data between the front-end and back-end layers of the application. They allow us to control the data exposed to the client and can be customized to meet specific client requirements.

- **service.impl**: This package houses the concrete implementation of service interfaces defined in the service layer. These service classes contain the actual business logic and functionalities of the application. This package depends on the `dto` and `mapper` packages to convert data from the client to the database or vice versa.

- **service.mapper**: This package contains mappers, which are used to convert data between entities and DTOs when transferring it between layers of the application.

- **web.rest**: This package is responsible for handling HTTP requests and serving as the entry point for our application's RESTful API. It contains REST controllers, which are annotated Java classes that handle incoming HTTP requests, process data, and return HTTP responses in JSON format. This package depends on the `config` package for web configurations, the `service` package to handle business logic, the `security` package to ensure integrity, and the `logging` package to write logs.

- **web.rest.error**: This package is responsible for handling errors and exceptions in RESTful endpoints. It contains classes that handle various types of exceptions and return appropriate error responses to clients.

- **web.rest.vm**: This package houses view models for REST endpoints. View models are used to customize the data sent to clients, ensuring that sensitive information is not exposed.

- **security**: This package contains security-related classes. This includes Spring Security configurations, custom user detail services, authentication providers, and other components responsible for securing the application and handling user authentication and authorization. The security layer depends on the `service` package to handle authorization logic, and the `logging` package to write logs.

- **security.jwt**: This package is responsible for handling JSON Web Token (JWT) authentication and authorization in our application. JWT is a compact and self-contained token format that can be used to securely transmit information between parties for the purpose of user authentication.

- **config**: This package contains configuration classes. It includes various configuration files for database connections, security settings, and other application-specific settings. These configurations are essential for the proper functioning of our application.

- **aop.logging**: This package contains aspects and configurations related to logging using Aspect-Oriented Programming (AOP). AOP allows us to separate concerns like logging from the business logic, improving code modularity and maintainability. It also allows us to apply logging consistently across our application without scattering log statements throughout the codebase.

The figure III.5 illustrates the package diagram for our solution's back end.

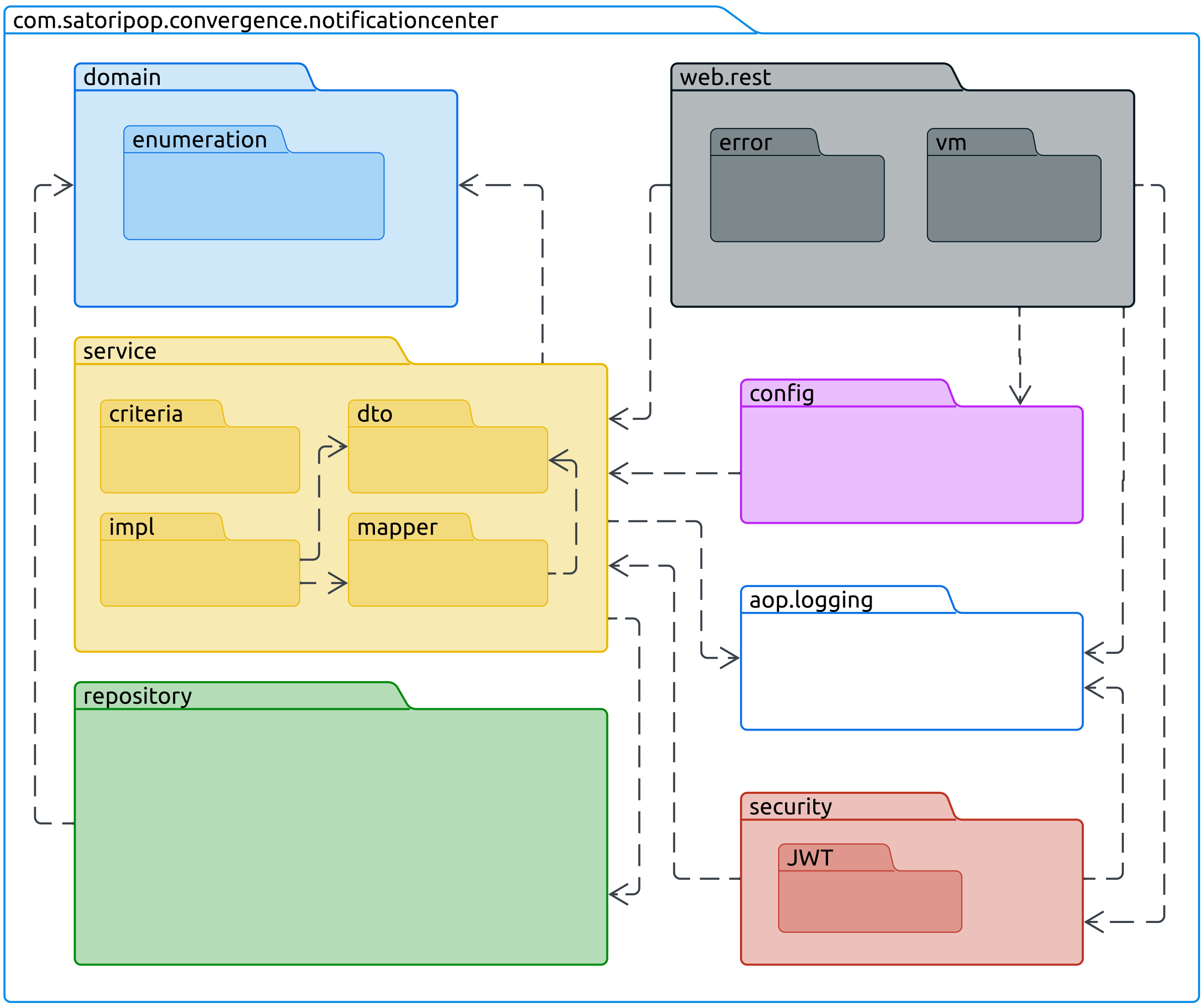


Figure III.5: Package diagram of the back end

To provide a comprehensive understanding of feature implementations, we will illustrate the classes that are directly tied to the channel creation functionality, encompassing all layers of our Spring Boot application. This focused diagram serves as an extension of the previously introduced package diagram, allowing us to zoom in on the precise classes and their interconnections that drive the implementation of this essential feature.

We have introduced an addition to our service layer: the `providers` package. This new package serves as a home for a collection of notification service providers, each catering to unique communication needs. Among the notable providers included are:

- **Twilio**: Twilio provides programmable communication tools for making and receiving phone calls, sending and receiving text messages, and performing other communication functions using its web service APIs.

- **Messenger**: Messenger, developed by Meta, is an instant messaging app that is used to send messages and exchange media.

- **WhatsApp**: WhatsApp is a freeware, cross-platform, centralized instant messaging service. It allows users to send text, voice video messages, and many other features.

- **Slack**: Slack is a cloud-based freemium cross-platform instant messaging service where users can communicate through text messaging, file and media sharing in private chats or within communities called “workspaces”.
- **Line**: Line is a freeware app for instant communications on electronic devices such as smartphones, tablet computers and personal computers.
- **Firebase cloud messaging**: Firebase cloud messaging is a cross-platform cloud service for messages and notifications for Android, iOS, and web applications.

To ensure a seamless and organized integration of these providers, we’ve implemented the Factory Method design pattern. This pattern is used to define an interface for creating an object, but let subclasses decide which class to instantiate [9]. In this pattern the participants are: the `Product` which defines the interface of objects the factory method creates, the `ConcreteProduct` which implements the `Product` interface, the `Creator` which calls the factory method to create a `Product` object, and the `ConcreteCreator` which overrides the factory method to return an instance of a `ConcreteProduct`.

A variation that we used on the pattern lets the factory method create multiple kinds of products. The factory method in the `ProviderFactory` class takes a parameter that identifies the kind of object to create (in our case it takes the `serviceProviderDTO`) and all of the aforementioned service provider objects the factory method creates will share the `Provider` interface which define methods to check integration validity and configure the external service provider. This strategic architecture empowers our application to dynamically select and utilize the most suitable notification service provider for a given parameter, enhancing the versatility and effectiveness of our communication capabilities.

Notice also the use of Jhipster provided filters in the `ChannelCriteria` class. These filter classes are crucial for creating dynamic queries in our application. Instead of writing static queries with fixed conditions, we can use these filters to construct queries at runtime based on user input or changing criteria. Jhipster provides a list of filter for all primitive types, among those we illustrated just the `StringFilter` for brevity. It also gives the possibility to extend those filters to create complex objects filtering.

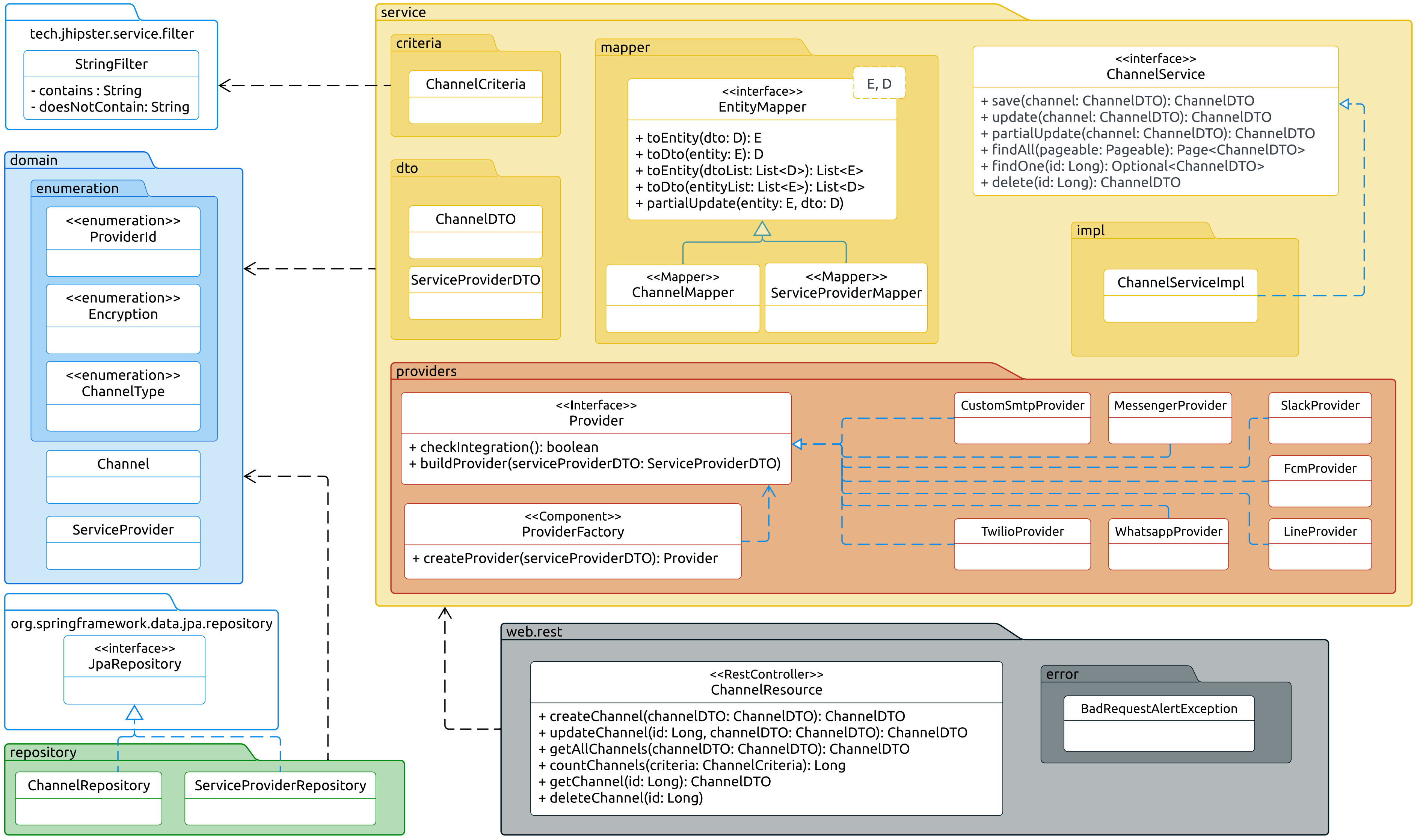

tech.jhipster.service.filter
StringFilter
- contains : String
- doesNotContain: String
domain
enumeration
<<enumeration>> ProviderId
<<enumeration>> Encryption
<<enumeration>> ChannelType
Channel
ServiceProvider
org.springframework.data.jpa.repository
<<interface>> JpaRepository
repository
ChannelRepository
ServiceProviderRepository
service
criteria
ChannelCriteria
dto
ChannelDTO
ServiceProviderDTO
mapper
E, D
<<interface>> EntityMapper
+ toEntity(dto: D): E
+ toDto(entity: E): D
+ toEntity(dtoList: List<D>): List<E>
+ toDto(entityList: List<E>): List<D>
+ partialUpdate(entity: E, dto: D)
<<Mapper>> ChannelMapper
<<Mapper>> ServiceProviderMapper
<<interface>> ChannelService
+ save(channel: ChannelDTO): ChannelDTO
+ update(channel: ChannelDTO): ChannelDTO
+ partialUpdate(channel: ChannelDTO): ChannelDTO
+ findAll(pageable: Pageable): Page<ChannelDTO>
+ findOne(id: Long): Optional<ChannelDTO>
+ delete(id: Long): ChannelDTO
impl
ChannelServiceImpl
providers
<<Interface>> Provider
+ checkIntegration(): boolean
+ buildProvider(serviceProviderDTO: ServiceProviderDTO)
<<Component>> ProviderFactory
+ createProvider(serviceProviderDTO): Provider
CustomSmtpProvider
MessengerProvider
SlackProvider
FcmProvider
TwilioProvider
WhatsappProvider
LineProvider
web.rest
<<RestController>> ChannelResource
+ createChannel(channelDTO: ChannelDTO): ChannelDTO
+ updateChannel(id: Long, channelDTO: ChannelDTO): ChannelDTO
+ getAllChannels(channelDTO: ChannelDTO): ChannelDTO
+ countChannels(criteria: ChannelCriteria): Long
+ getChannel(id: Long): ChannelDTO
+ deleteChannel(id: Long)
error
BadRequestAlertException

Figure III.6: Class diagram for the channel creation feature

III.4 Implementation

In the following section, we embark on a visual journey through a series of captured screenshots to provide an in-depth glimpse into the user interface and functionality of our application. the implementation of our application.

III.4.1 Authentication

The figure III.7 showcases the live implementation of the sign-in page, where users can provide their credentials (email address and password) in order to authenticate. The "Remember Me" checkbox allows users to stay signed in on future visits without the need to re-enter their credentials. The "Forget your password?" link provides a way for users to reset their password if they have forgotten it, and if there's an authentication error, a red banner with the error message is displayed above the input fields.

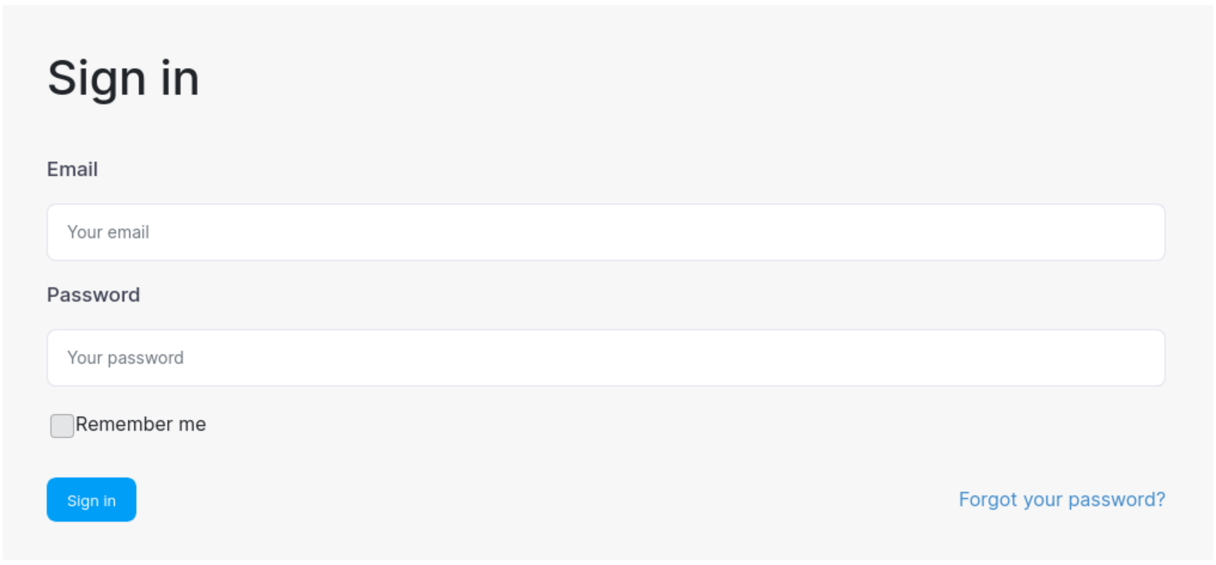


Figure III.7: Authentication page

The figure III.8 illustrates the implementation of the reset password page. A user is redirected to this interface when they click on the "Forgot your password?" link from the previous "Sign In" page, they should provide their email address and click on the reset button. A banner indicating that an email to recover their password is sent to their email address shows above the email input field.

III.4.2 Agents management

The figure III.9 illustrates the implementation of the agents management page. The table lists all the users (agents and administrators) for the logged in administrator, showing an overview of their information. For each user, an administrator can edit, reset a password, or delete an agent using the action buttons in the most right column, or else they can create a new agent or administrator using the "Create a new agent" button.

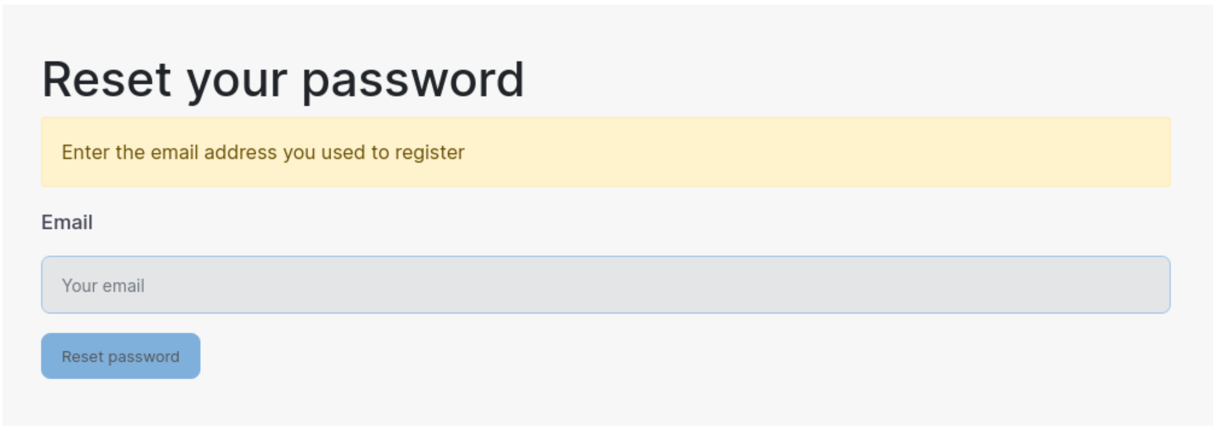
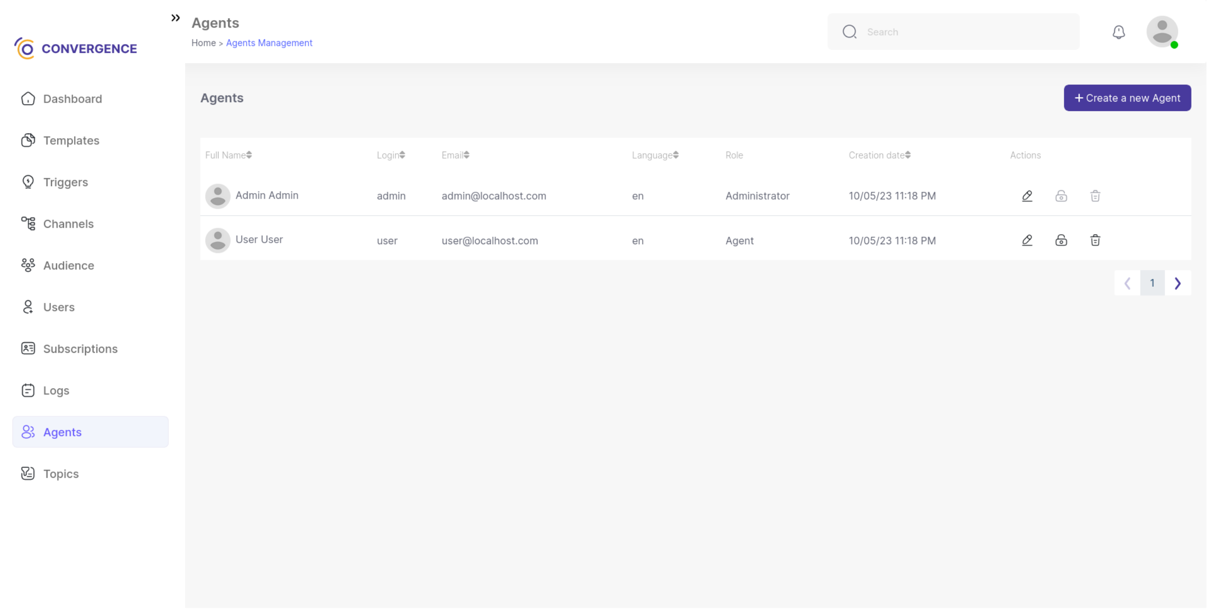


Figure III.8: Password reset page



Full Name	Login	Email	Language	Role	Creation date	Actions
Admin Admin	admin	admin@localhost.com	en	Administrator	10/05/23 11:18 PM	
User User	user	user@localhost.com	en	Agent	10/05/23 11:18 PM	

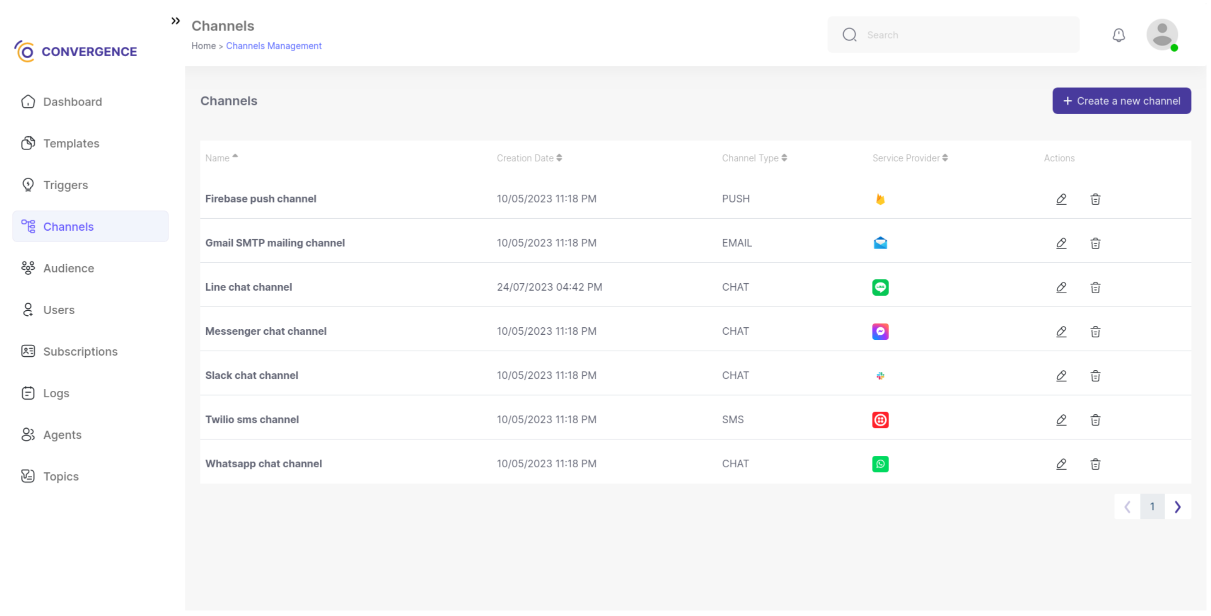
Figure III.9: Agents management page

III.4.3 Channels management

The figure III.10 illustrates the final result of the implementation of channels management. The table lists information about created channels for every service provider that can integrate with our solution. The administrator can edit or delete these channels using the action buttons.

III.4.4 Audience management

The figure III.11 illustrates the final result of the implementation of the audience creation page. We created some selection criteria: the subsciption channel should be of email type, users age should be greater than 18 years, and subscribers are located in Tunisia. The size estimation for such audience is displayed in the section above.

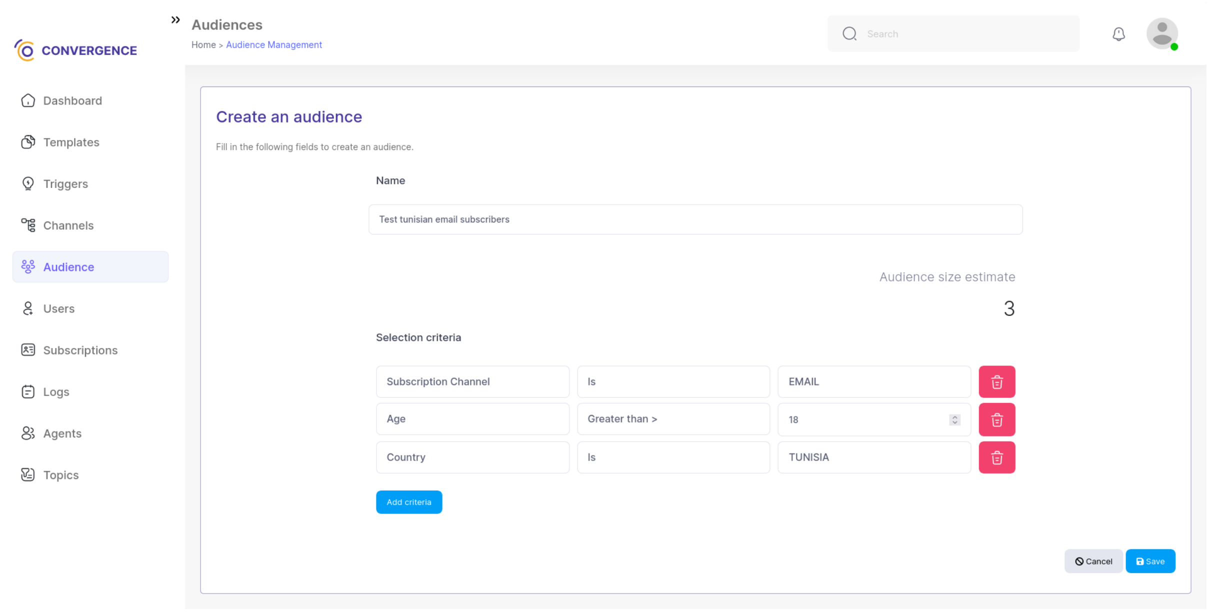


Channels
Home > Channels Management

Channels

Name	Creation Date	Channel Type	Service Provider	Actions
Firebase push channel	10/05/2023 11:18 PM	PUSH		
Gmail SMTP mailing channel	10/05/2023 11:18 PM	EMAIL		
Line chat channel	24/07/2023 04:42 PM	CHAT		
Messenger chat channel	10/05/2023 11:18 PM	CHAT		
Slack chat channel	10/05/2023 11:18 PM	CHAT		
Twilio sms channel	10/05/2023 11:18 PM	SMS		
Whatsapp chat channel	10/05/2023 11:18 PM	CHAT		

Figure III.10: Channels management page



Audiences
Home > Audience Management

Create an audience

Fill in the following fields to create an audience.

Name: Test tunisian email subscribers

Audience size estimate: 3

Selection criteria

Subscription Channel	Is	EMAIL
Age	Greater than >	18
Country	Is	TUNISIA

Figure III.11: Audience creation page

Conclusion

In this initial release, we defined user stories and related constraints in the specification phase. During the design phase we created a detailed plan that outlines how different components will interact to ensure that the software is well-organized, efficient, and capable of addressing the intended needs and goals. Finally, we showcased the result of implementing the essential components in our first release.

In the upcoming chapter, we will focus on the development of our second product release.

Chapter IV

Release 2: Sending notifications & dashboards

Introduction

Throughout this chapter, we will delve into the planning, design considerations, and implementation of our second product release. Building upon the foundation laid in our initial release, our focus now shifts towards fine-tuning the intricacies of notifications. This release encompasses a comprehensive overhaul of the notification system, spanning key areas such as notification templates, user preferences, delivery triggers, notification history, and the development of a powerful dashboard to provide insights into the delivery of notifications.

IV.1 Sprint backlog

During the second sprint planning event, we estimated the effort required for each item in the third and fourth sprints backlog based on the number of working hours. The priority of backlog items is reflected by their relative order in the table, same as the first release, items positioned higher in the table indicate a higher priority.

Table IV.1: Backlog of Sprint 3 & 4

Sprint	**Epic**	**User story**	**Estimation (hours)**
3	Notification templates management	Create a template	24
		List templates	16
		Edit a template	8
		Delete a template	8

Sprint	Epic	User story	Estimation (hours)
	Notification preferences management	Set notification preferences	16
4	Notification triggers management	Create a trigger	48
		List triggers	16
		Edit a trigger	8
		Delete a trigger	8
	Notification history	Get notification history	24
		List sending logs	16
	Dashboard	View metrics	32

IV.2 Specification

Similar to our approach in the first release, we will be detailing some selected user stories that we find most significant to drive the enhancements planned for this release.

Table IV.2: User stories specification for the second release

Epic	**User story**
Notification templates management	**Create a template** As an agent, I want to be able to add notification templates so that I can send notifications based on that template. **Precondition** • Agent is authenticated and has a valid account. • Existing notification topic. **Business rules** • Notification templates should include a name, a topic, a channel type, and the notification content. • Agents should be able to add placeholders for dynamic data in the template body. • Agents should be able to preview and test notification templates before saving. **Technical specification** • The system should persist notification templates in the database unpopulated with data. • Agents should be able to preview the notification template with test data without actually sending the notification to ensure that the message is rendered correctly. **Acceptance criteria** • Notification templates must have a name, a selected channel type, and non-empty body. • Agents can to add placeholders for dynamic data in the notification body. • Agents can preview the template with actual data and verify that the message is generated correctly. • A message indicating the success or failure of the saving operation is displayed.

Epic	**User story**
Notification triggers management	**Create a trigger** As an agent, I want to be able to create triggers for notifications so that I can schedule notifications to be sent automatically. **Precondition** • Agent authenticated and has a valid account. • Existing notification templates. • Existing audiences. **Business rules** • Agents should be able to choose a specific notification template. • Agents should be able to choose a specific audience to target. • Agents should be able to choose a delivery type for the trigger, either one time or recurring delivery. • Agents should be able to choose a frequency of sending notification in the recurring delivery type. • Agents should be able to specify a starting and ending date for the recurring delivery type. • Agents could create multiple triggers for the same notification template or audience. **Technical specification** • The system should provide a form where agents can select a notification template, an audience, set the trigger's schedule, and save the trigger. • The system should use a cron job or similar scheduling mechanism to send notifications according to the trigger's schedule. • The system should store the trigger and its associated scheduling data in the database. **Acceptance criteria** • Agents can sucessfully schedule the two types of notification delivery. • The notification system sends the notification according to the trigger's schedule. • The notification system stores the trigger and associated metadata in a database. • A message indicating the success or failure of the scheduling operation is displayed.

Epic	**User story**
Dashboard	**View metrics** As an agent I want to be able to view metrics on my dashboard so that I can get an overview on important statistics related to notification activities. **Precondition** • Agent is authenticated and has a valid account. **Business rules** • Administrators should be able to get a high-level metrics including: total number of sent notifications, subscriptions, delivery rates, open rates, and click-through rates. • The agent should be able to get an overview of notification activity specific to his account. • The administrator/agent should be able to get an overview on sent notifications by each of the channels to understand which ones are the most effective. • The administrator/agent should be able to get an overview on sent notifications metrics by each of the created segments of recipients. • The administrator/agent should be able to get an overview on sent notifications metrics by each of the created templates. **Technical specification** • Overviews should be displayed in the form of charts providing the metric for the current day and previous days. • Overviews by channel, audience or template should display the number of sent notifications per each category out of total. • Old metrics should be cached so that the system does not recalculate them with every request. . • Actual metrics should be calculated in real-time with a defined interval of update. **Acceptance criteria** • Overviews are displaying accurate metrics. • Update is happening after every defined interval of time. • Agents are getting metrics only for the notifications they sent. • Agents are getting metrics only for the templates and segments they created.

IV.3 Design

Building upon the insights gained from the initial design, this phase focuses on refining and expanding our software's architecture. In this section, we will explore the key considerations, decisions, and advancements made during this second release.

IV.3.1 Database design

In this section, We will elaborate on the structure and organization of our database from the first release, defining new tables and relationships for the implementation of this second release of our product.

IV.3.1.1 Data dictionary

In the table IV.3, we provide a comprehensive overview of the essential data elements that will define our entities and relationships for the second release.

IV.3.1.2 Logical data model

Building upon the foundation laid in our initial logical data model, we enter a phase of refinement and expansion. In this section, we present the second iteration of our logical data model, which encapsulates the newly added entities during this second release. This updated data model will offer deeper insights into the structure and relationships of our data entities for the whole solution.

The figure IV.1 illustrates the updated entity-relationship diagram for this second release.

Table IV.3: Data dictionary of the second release

Entity	**Field**	**Description**	**Type**	**Constraints**
Topic	`id`	Topic's unique identifier	bigint	Primary key Not null
	`name`	Topic's name	varchar(100)	Unique, Not null
	`description`	Topic's description	varchar(256)	
	`priority`	Topic's notification sending priority	varchar(10)	Not null
	`creator_id`	Topic's creator unique identifier	bigint	Not null
Template	`id`	Notification template's unique identifier	bigint	Primary key Not null
	`name`	Notification template's unique name	varchar(100)	Not null
	`channel_type`	Notification template's channel type	varchar(10)	Not null
	`title`	Notification title for push notification	varchar(256)	Not null
	`preheader`	The preheader for email notifications	varchar(256)	
	`subject`	The subject for email notifications	varchar(256)	Not null
	`body`	The notification body content	text	Not null
	`image`	An image path that can be added for push and chat notifications	varchar(256)	
	`topic_id`	The unique identifier for the topic of the notification template.	bigint	Not null
	`launch_url`	The url to redirect to when clicking on push notifications	varchar(256)	

Entity	Field	Description	Type	Constraints
	`creation_date`	The notification template's creation date	date	Not null
	`creator_id`	The notification template's creator unique identifier	bigint	Not null
Notification Trigger	`id`	Notification trigger's unique identifier	bigint	Primary key Not null
	`name`	Notification trigger's unique name	varchar(100)	Unique, Not null
	`status`	Notification trigger status	varchar(20)	Not null
	`audience_id`	The unique identifier of the audience to target with notifications	bigint	Not null
	`template_id`	The unique identifier of the notification template	bigint	Not null
	`delivery_type`	The delivery type to be used for the trigger	varchar(20)	Not null
	`frequency`	The frequency of sending for the recurring delivery option	varchar(10)	
	`start_time`	The sending start date and time	date	
	`end_time`	The sending end date and time	date	
	`creation_date`	The trigger's creation date	date	Not null
	`creator_id`	The trigger's creator unique identifier	bigint	Not null
Notification Preference	`id`	Notification preference's unique identifier	bigint	Primary key Not null
	`allow_email`	Whether or not to receive emails for the specified topic	boolean	Not null

Entity	**Field**	**Description**	**Type**	**Constraints**
	`allow_push`	Whether or not to receive push notifications for the specified topic	boolean	Not null
	`allow_chat`	Whether or not to receive chat notifications for the specified topic	boolean	Not null
	`allow_sms`	Whether or not to receive SMS notifications for the specified topic	boolean	Not null
	`topic_id`	The notification topic's unique identifier	bigint	Not null
	`notification_user_id`	The notification user's unique identifier	bigint	Not null
Notification	`id`	Notification's unique identifier	bigint	Primary key Not null
	`status`	The status of the notification	varchar(20)	Not null
	`sending_date`	The notification sending date	date	Not null
	`subscription_id`	The targeted user subscription's unique identifier	bigint	Not null
	`template_id`	The unique identifier of the template used to send the notification	bigint	Not null

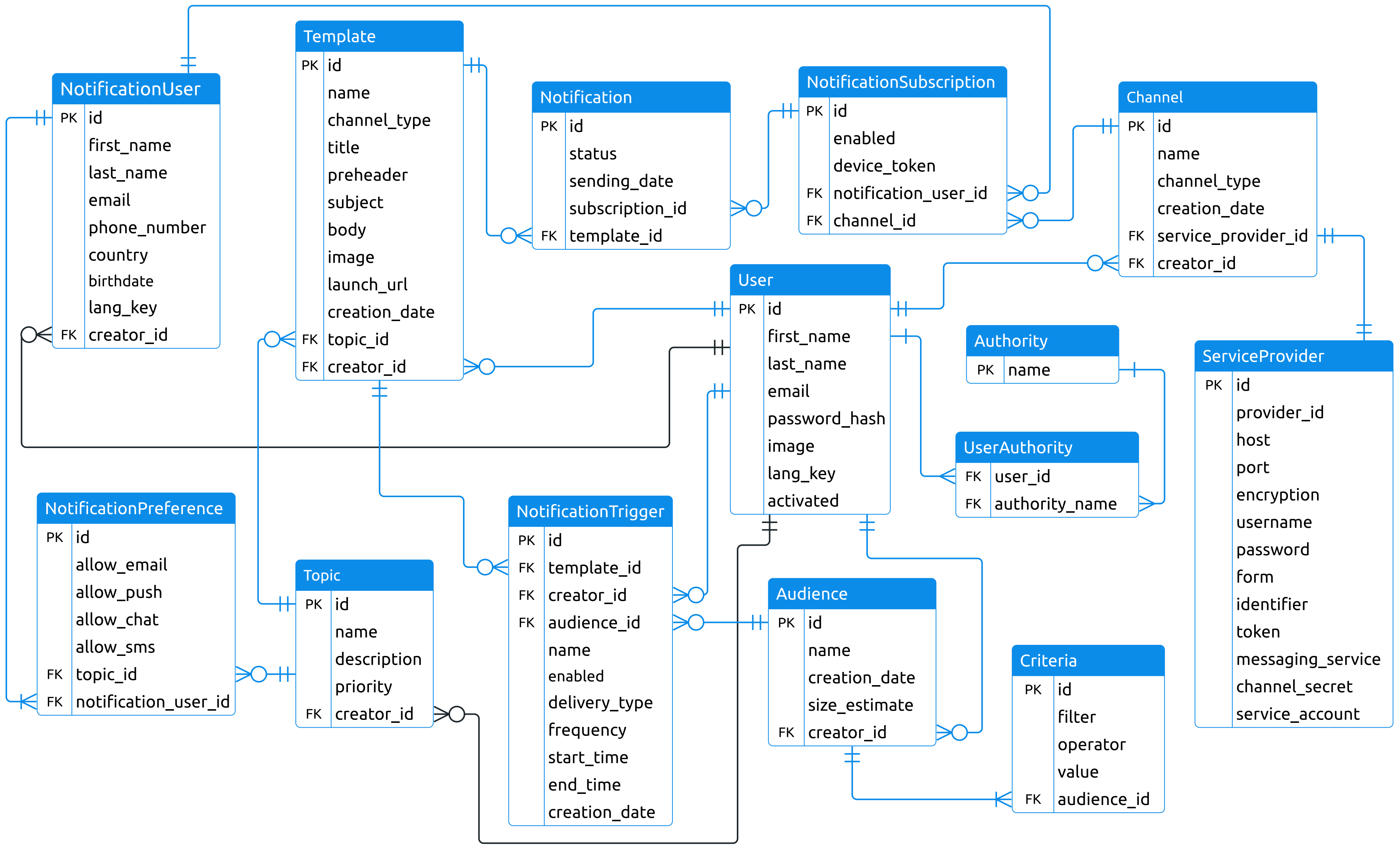


Figure IV.1: Entity-Relationship diagram of the second release

IV.3.2 Software design

Similar to our approach in the initial release, this software design section involves three key aspects: static modeling, dynamic modeling, and detailed design. All tailored to meet the unique requirements and enhancements of the second release.

IV.3.2.1 Static modeling

We have expanded our design to include five pivotal classes. These classes play a fundamental role in implementing the user stories related to notification management. They encompass critical aspects such as notification topics, templates, triggers, subscribers' notification preferences, and the core functionality of notifications—both for sending and maintaining a historical record. This section delves into the structure and relationships of these classes.

Table IV.4: Classes description

Class name	**Description**
Topic	This class models a notification topic which is used to categorize and prioritize notification delivery
Template	This class models a notification template which is used to create dynamic notifications content and configurations
NotificationTrigger	This class models a delivery trigger for sending notifications at a specific date and time
NotificationPreference	This class models a notification user preference for receiving notifications from the center
Notification	This class models each single notification that is going to be sent out to target users

For these new classes, we have outlined the following associations:

- A template can have exactly one topic.
- A template is created by exactly one user, and one user can create zero or more templates.
- A trigger can have exactly one template.
- A trigger can have exactly one audience.

- A notification preference is related to exactly one notification user, but a notification user can have zero or more preferences.

- A notification preference sets preference for only one topic, and a topic can have exactly one notification preference.

- A notification user can set zero or more notification preferences, and a notification preference belongs to exactly one notification user.

- A notification is made from one template, and a template can be used to send zero or more notifications.

- A notification is sent to only one subscription, and a subscription can receive zero or many notifications.

In the figure IV.2 we illustrate the extention of our class diagram, we highlighted newly added classes among others for a better readability.

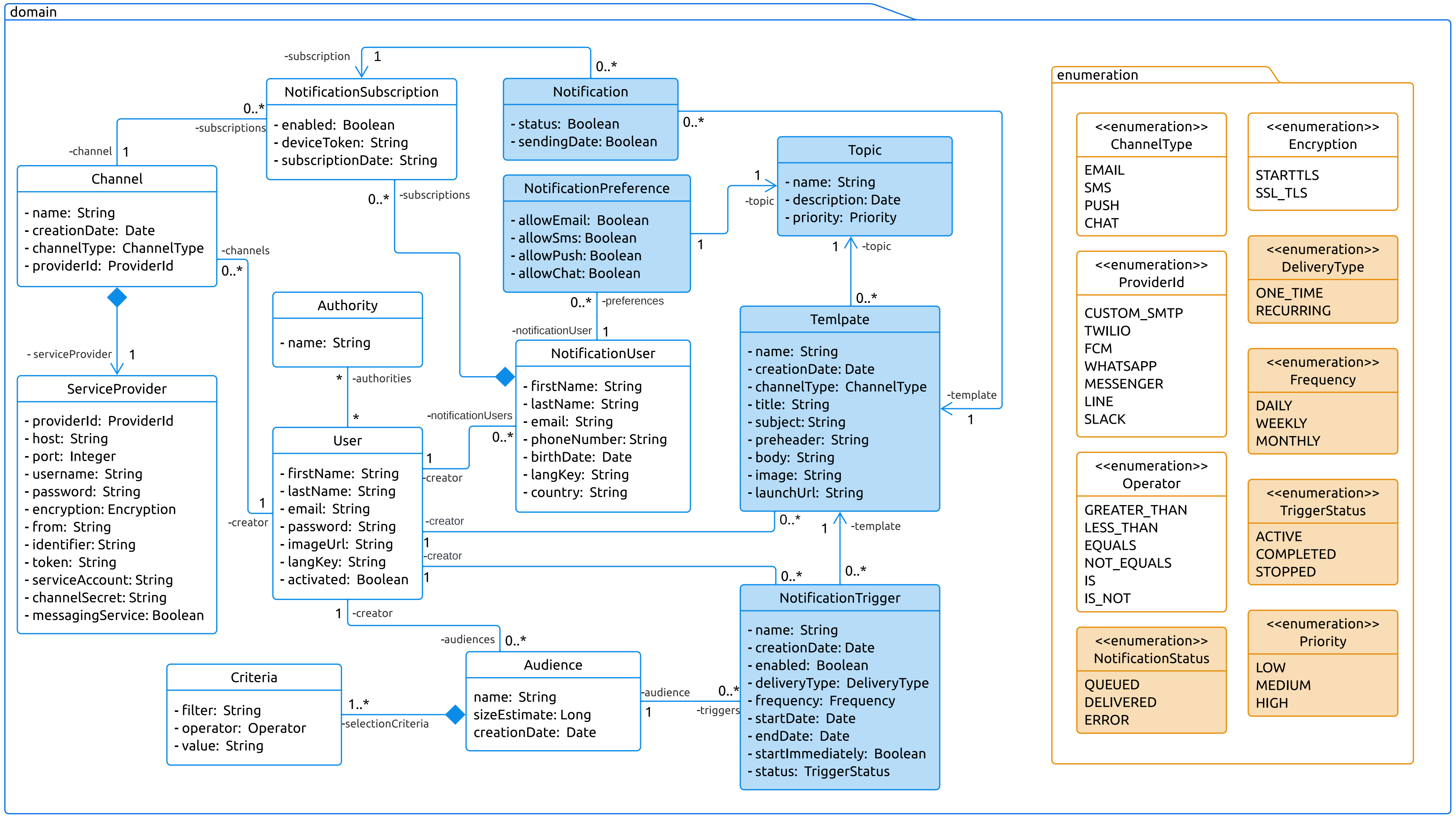


Figure IV.2: Class diagram of the second release

IV.3.2.2 Dynamic modeling

In the subsequent section, we revisit the dynamic facets of our software solution through further representation of the interactions and communication behaviors of components and actors within our system.

For this release we are going to focus on describing the process of creating notification templates and triggers, as we found those two functionalities to be the most important steps in order to be able to send notifications through our platform.

IV.3.2.2.1 Sequence diagram for creating a template

Agents can create templates by selecting the notification type and filling the required information. Agents can test templates before saving, in this case a REST request is made to the server which calls the service layer to configure and send the test notification.

When the agent proceeds to saving the template, a different REST request is sent to the server. The controller validates the request and calls the template service to map the data received to a template entity which is later saved by the repository in the database. The conroller finally sends a response back to the client indicating the success or failure of the operation.

The figure IV.3 illustrates the sequence diagram for creating a notification template.

IV.3.2.2.2 Sequence diagram for creating a trigger

In order to create a trigger, an administrator/agent selects a specific notification template, chooses a target audience, specifies a delivery type (one-time or recurring), sets the frequency, and defines a start and end date for recurring deliveries. Then the update component processes the user's input and formulates, through its service layer, a request to the backend for creating a notification trigger.

The controller receives the REST request and processes the incoming data. It validates the input and interacts with the service layer. The service layer ensures that the chosen notification template and audience exist, the dates and delivery type are valid, then it schedules an internal trigger based on those configurations. The reference for the internal trigger is then linked with the notification trigger we are creaating.

After applying this business logic, the service proceeds to save the notification trigger by calling the repository which in turn interacts with the database. Upon successful processing, the controller sends a response back to the cient indicating that the notification trigger has been created and scheduled successfully.

The figure IV.4 illustrates the sequence diagram for creating a notification trigger.

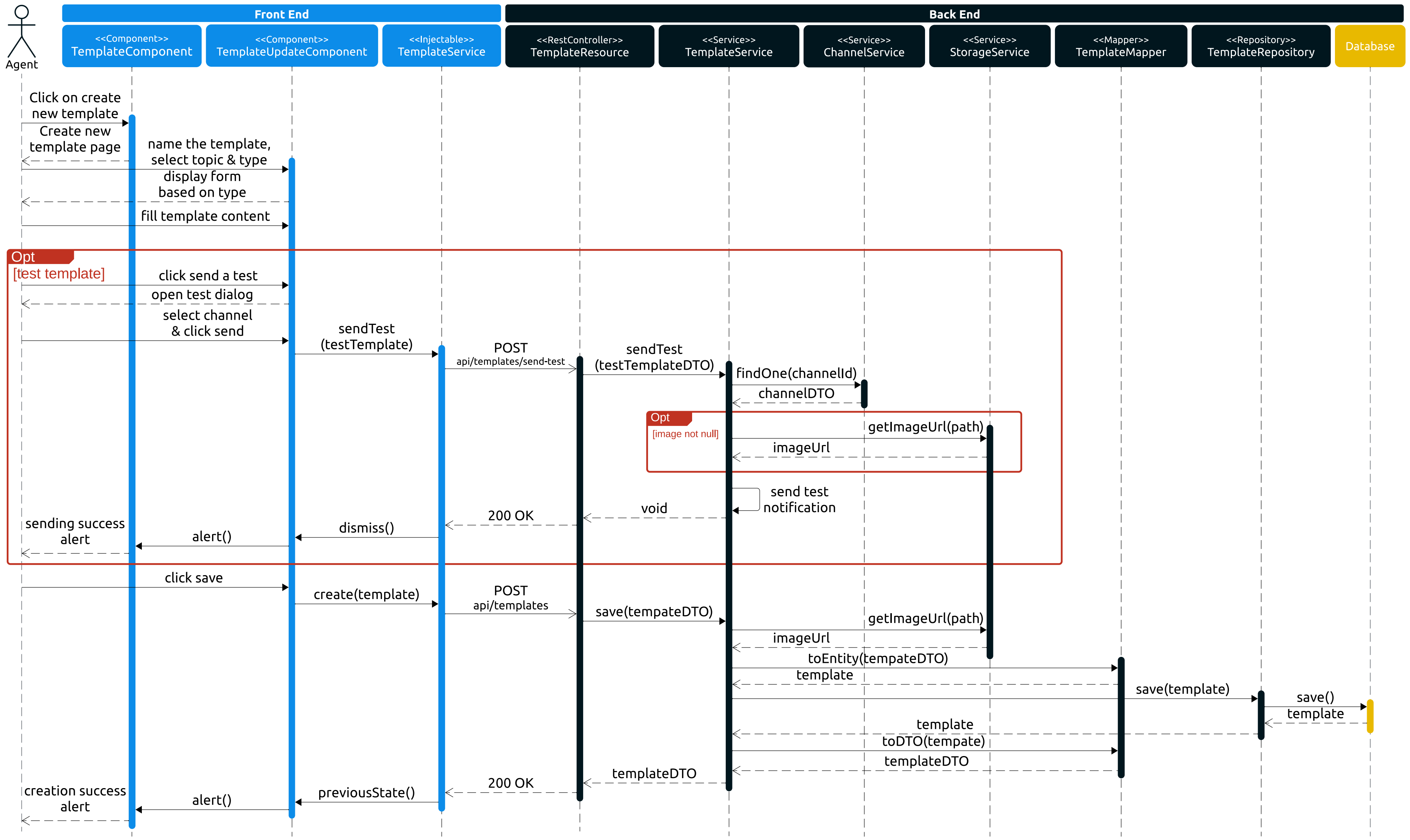


Figure IV.3: Sequence diagram for creating a notification template

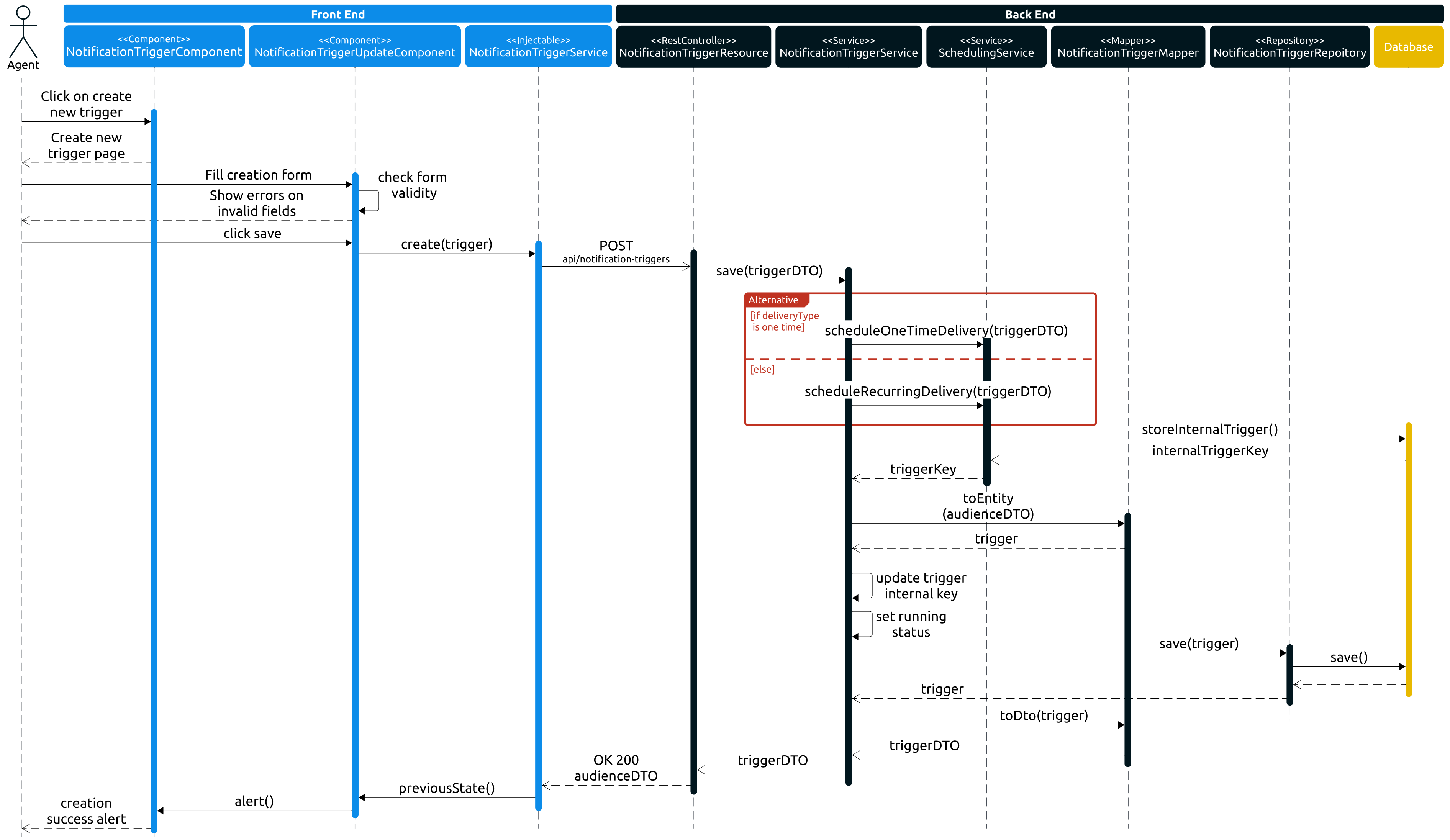

Agent
Front End
Back End
<<Component>> NotificationTriggerComponent
<<Component>> NotificationTriggerUpdateComponent
<<Injectable>> NotificationTriggerService
<<RestController>> NotificationTriggerResource
<<Service>> NotificationTriggerService
<<Service>> SchedulingService
<<Mapper>> NotificationTriggerMapper
<<Repository>> NotificationTriggerRepoitory
Database
Click on create new trigger
Create new trigger page
Fill creation form
check form validity
Show errors on invalid fields
click save
create(trigger)
POST api/notification-triggers
save(triggerDTO)
Alternative
[if deliveryType is one time]
scheduleOneTimeDelivery(triggerDTO)
[else]
scheduleRecurringDelivery(triggerDTO)
storeInternalTrigger()
internalTriggerKey
triggerKey
toEntity (audienceDTO)
trigger
update trigger internal key
set running status
save(trigger)
save()
trigger
toDto(trigger)
triggerDTO
triggerDTO
OK 200 audienceDTO
previousState()
alert()
creation success alert

Figure IV.4: Sequence diagram for creating a trigger

IV.3.2.3 Detailed design

In our solution, notification sending triggers are pivotal components that enable us to initiate communication with our users. In this section, we chose to further model the notification trigger management feature, as this is at the heart of this release and links all the parts we created so far.

Notification triggers represent various events or conditions that warrant sending notifications, such as updates, reminders, or alerts. To manage this process efficiently, we've chosen to leverage Quartz, a highly versatile job scheduling library in the world of software development. Its flexibility and reliability make it an excellent choice for automating tasks such as sending notifications at specific times or intervals. By integrating Quartz into our system, we can ensure precise and efficient scheduling of this kind of jobs.

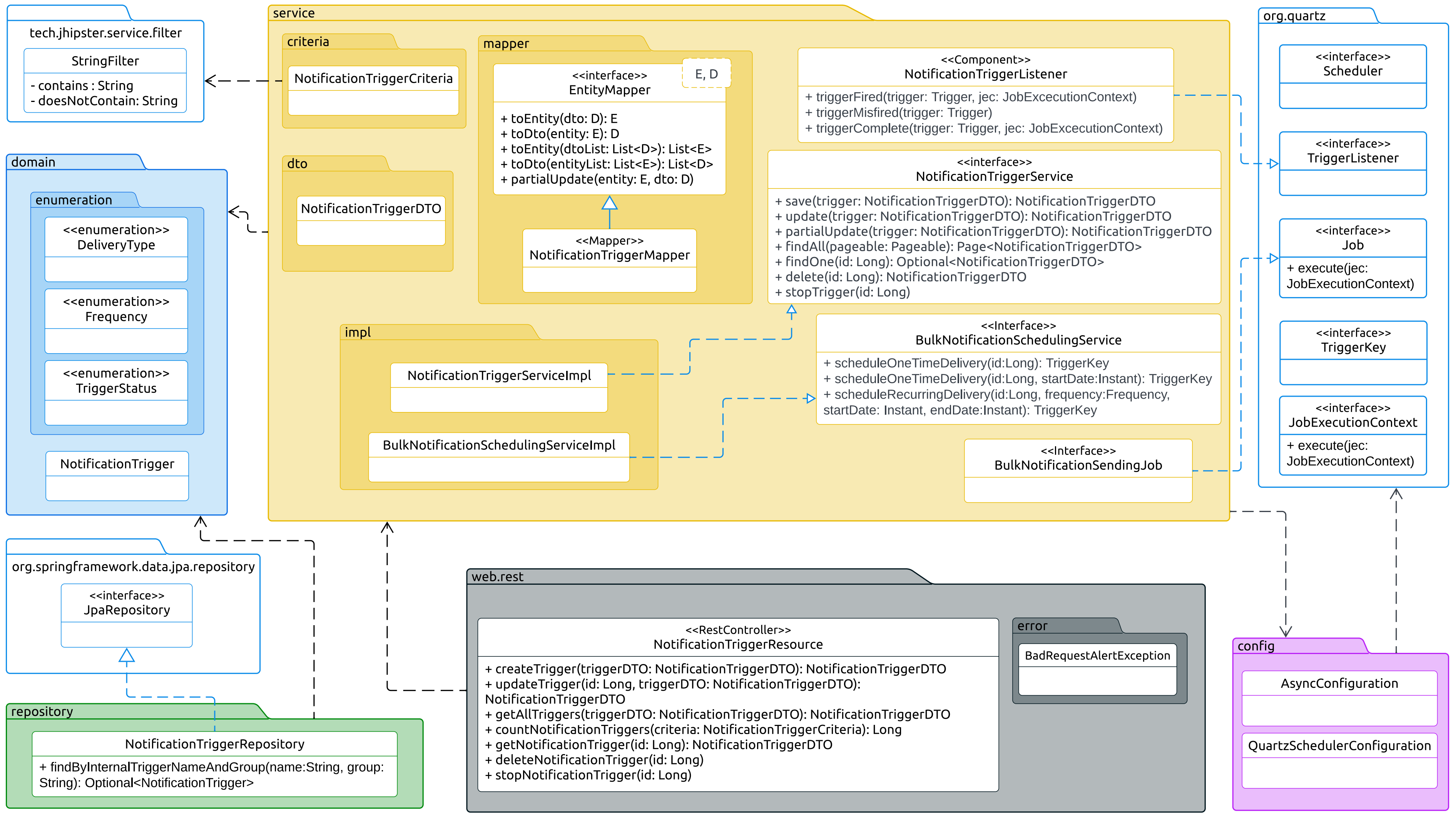
In order to make use of Quartz in our project, we have introduced two essential configuration classes: `AsyncConfiguration` and `QuartzSchedulerConfiguration`, these classes will enable us to tune both the asynchronous job running configurations, and the Quartz scheduling configurations in our application.

For the notification sending task that the trigger relies on, we have introduced the `BulkNotificationSendingJob` class that implements the Quartz `Job` interface, which is used to define the task executed when a Quartz trigger fires. This interface allows us to encapsulate the logic for sending batches of notifications to an audience and integrate it seamlessly into the Quartz scheduler's workflow.

We have also introduced the `BulkNotificationSchedulingService` interface to handle the scheduling aspect of our feature. This interface exposes methods that enable the scheduling of triggers based on the chosen delivery type, whether it's a one-time occurrence or a recurring event. This design provides a clear and flexible way to manage the scheduling of notification triggers.

To keep track of our triggers, we have used the `NotificationTriggerListener` class, which implements the `TriggerListener` interface from Quartz. This implementation is designed to facilitate the tracking of trigger status, enabling us to effectively manage trigger completion and respond in case of failures. The `TriggerListener` interface is a key component of Quartz, and it allows us to handle various trigger-related events, ensuring that our notification triggers are monitored, managed, and responded to appropriately throughout their lifecycle.

The figure IV.5 represents the detailed class diagram for implementing notification trigger management.



tech.jhipster.service.filter
StringFilter
- contains : String
- doesNotContain: String
domain
enumeration
<<enumeration>> DeliveryType
<<enumeration>> Frequency
<<enumeration>> TriggerStatus
NotificationTrigger
service
criteria
NotificationTriggerCriteria
dto
NotificationTriggerDTO
mapper
<<interface>> EntityMapper
E, D
+ toEntity(dto: D): E
+ toDto(entity: E): D
+ toEntity(dtoList: List<D>): List<E>
+ toDto(entityList: List<E>): List<D>
+ partialUpdate(entity: E, dto: D)
<<Mapper>> NotificationTriggerMapper
<<Component>> NotificationTriggerListener
+ triggerFired(trigger: Trigger, jec: JobExcecutionContext)
+ triggerMisfired(trigger: Trigger)
+ triggerComplete(trigger: Trigger, jec: JobExcecutionContext)
<<interface>> NotificationTriggerService
+ save(trigger: NotificationTriggerDTO): NotificationTriggerDTO
+ update(trigger: NotificationTriggerDTO): NotificationTriggerDTO
+ partialUpdate(trigger: NotificationTriggerDTO): NotificationTriggerDTO
+ findAll(pageable: Pageable): Page<NotificationTriggerDTO>
+ findOne(id: Long): Optional<NotificationTriggerDTO>
+ delete(id: Long): NotificationTriggerDTO
+ stopTrigger(id: Long)
impl
NotificationTriggerServiceImpl
BulkNotificationSchedulingServiceImpl
<<Interface>> BulkNotificationSchedulingService
+ scheduleOneTimeDelivery(id:Long): TriggerKey
+ scheduleOneTimeDelivery(id:Long, startDate:Instant): TriggerKey
+ scheduleRecurringDelivery(id:Long, frequency:Frequency, startDate: Instant, endDate:Instant): TriggerKey
<<Interface>> BulkNotificationSendingJob
org.quartz
<<interface>> Scheduler
<<interface>> TriggerListener
<<interface>> Job
+ execute(jec: JobExecutionContext)
<<interface>> TriggerKey
<<interface>> JobExecutionContext
+ execute(jec: JobExecutionContext)
org.springframework.data.jpa.repository
<<interface>> JpaRepository
repository
NotificationTriggerRepository
+ findByInternalTriggerNameAndGroup(name:String, group: String): Optional<NotificationTrigger>
web.rest
<<RestController>> NotificationTriggerResource
+ createTrigger(triggerDTO: NotificationTriggerDTO): NotificationTriggerDTO
+ updateTrigger(id: Long, triggerDTO: NotificationTriggerDTO): NotificationTriggerDTO
+ getAllTriggers(triggerDTO: NotificationTriggerDTO): NotificationTriggerDTO
+ countNotificationTriggers(criteria: NotificationTriggerCriteria): Long
+ getNotificationTrigger(id: Long): NotificationTriggerDTO
+ deleteNotificationTrigger(id: Long)
+ stopNotificationTrigger(id: Long)
error
BadRequestAlertException
config
AsyncConfiguration
QuartzSchedulerConfiguration

Figure IV.5: Detailed class diagram

IV.4 Implementation

Building upon the foundation laid in our first release, we showcase the evolution and refinement of our solution, highlighting the advancements made to meet our user requirements for this second release.

IV.4.1 Templates management

To be able to send notifications, first agents have to create a template by providing a name, selecting a specific topic for the template and choosing the template type (whether it's an email, sms, push or chat notification). Agents then should fill the template content, adding placeholders for dynamic data in the template body content, selecting and uploading an image if it is the case for the chosen type (as for the chat template), and if they want to test the template before saving they can do so by clicking the "Send test" button, else they can proceed to saving by clicking on "Save".

IV.4.2 Triggers management

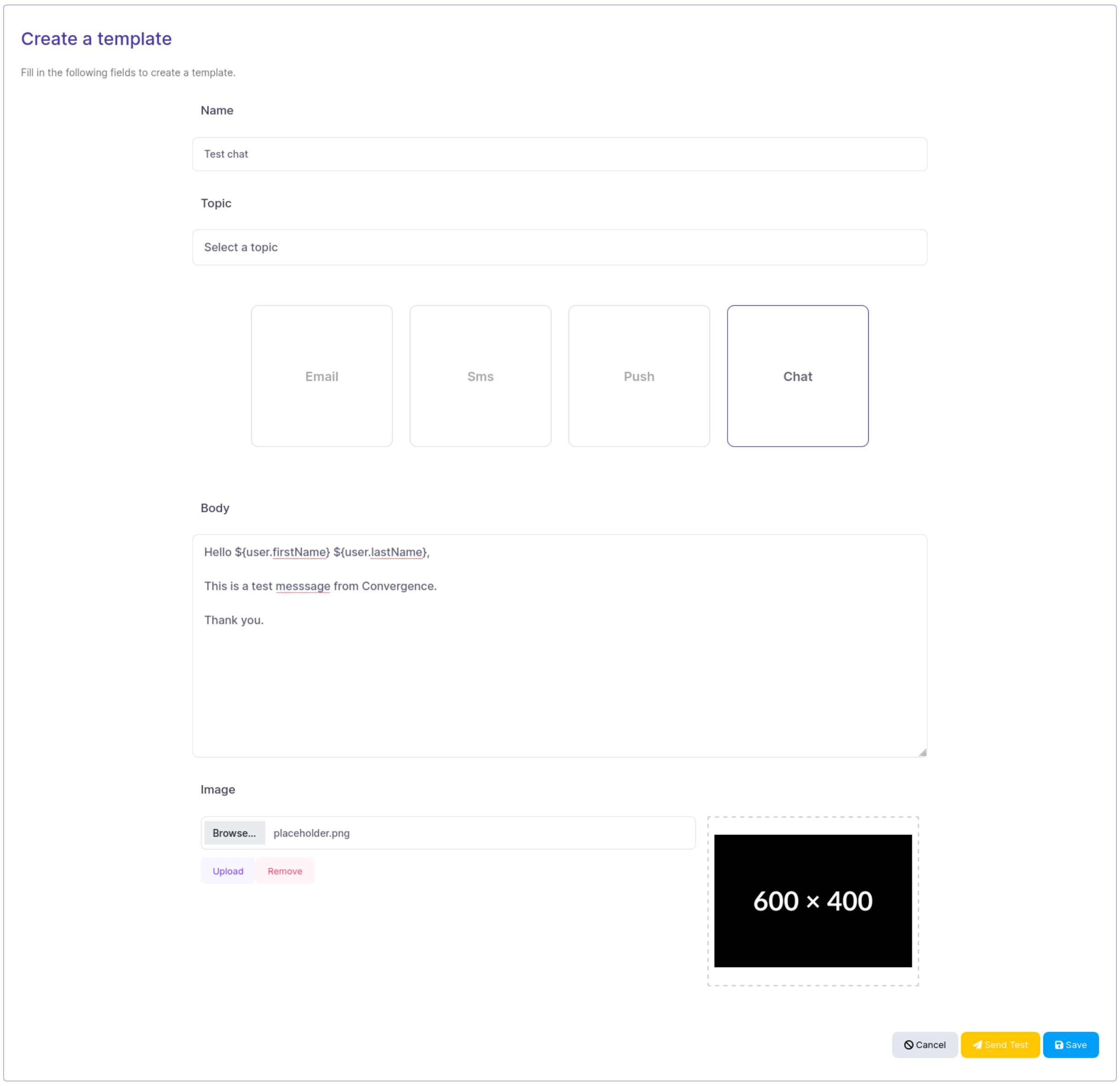
Creating a notification trigger involves selecting a notification template and a target audience, choosing a delivery type (one-time or recurring), and setting the associated parameters, including frequency, start date, and end date.

The figure IV.7 shows the actual creation form where we selected an SMS test template, all SMS subscribers audience, the one time delivery type, and chose the option to send immediately. This option eliminates the need to specify a start date.

On saving success, the client navigates back to the notification triggers listing page, where we can see our created at the top of the list, showing its important details. Notice the status of the trigger is now set to "Running" while it is sending notifications. Upon acheiving, the status will change to "Complete" as shown for the older triggers in the figure IV.8.

Conclusion

In this chapter, we focused on the second release of our project, which centers around improving the notification sending processs. We started by specifying requirements related to this release, and delve into crucial design aspects to transform those requirements into actual implementations. Finally, we highlight our progress by showcasing visual representations of features covering templates and triggers management to enhance our notification system.


Create a template

Fill in the following fields to create a template.

Name

Test chat

Topic

Select a topic

Body

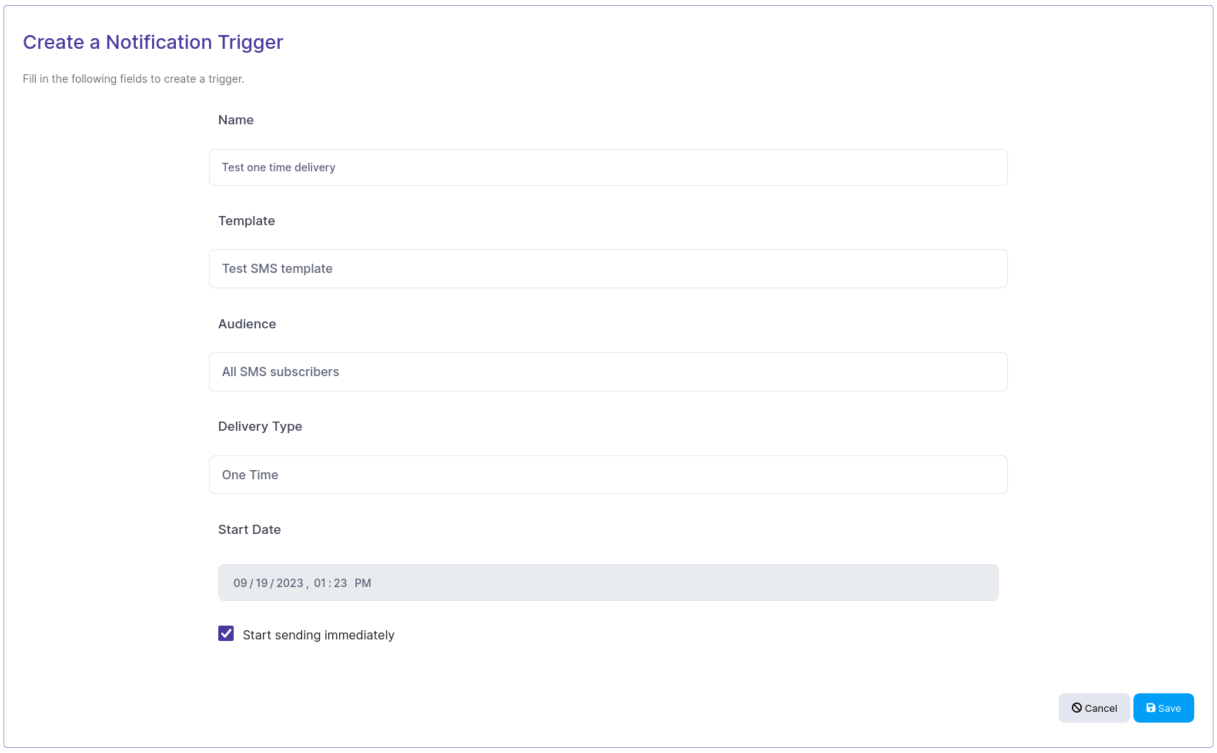
Hello ${user.firstName} ${user.lastName},

This is a test messsage from Convergence.

Thank you.

Image

Figure IV.6: Template creation page



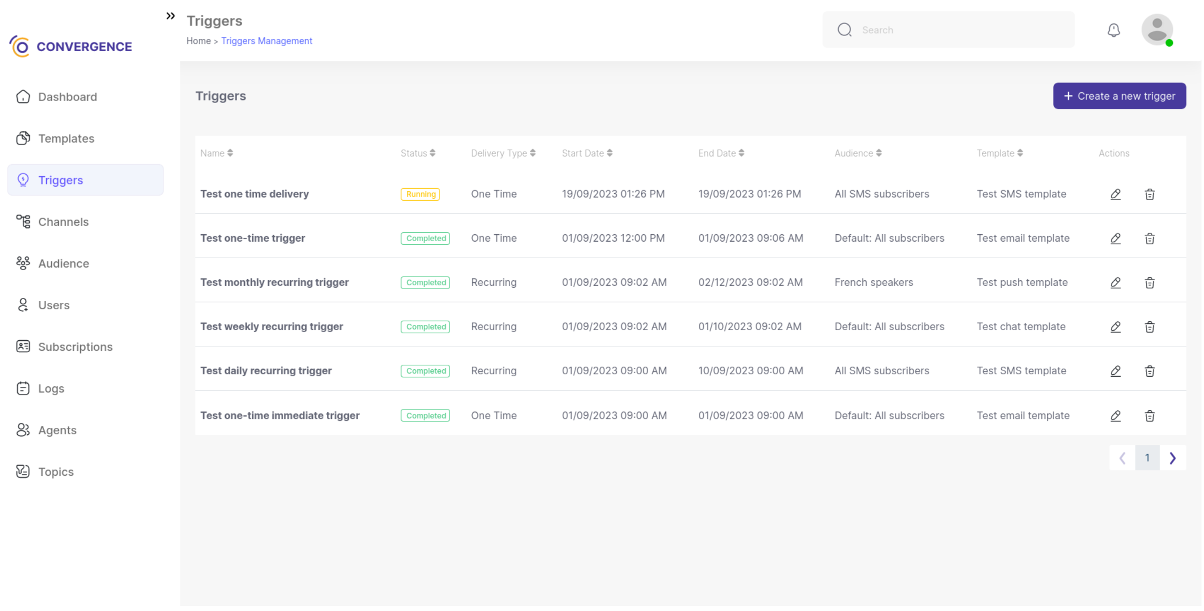
Create a Notification Trigger

Fill in the following fields to create a trigger.

Name	Test one time delivery
Template	Test SMS template
Audience	All SMS subscribers
Delivery Type	One Time
Start Date	09 / 19 / 2023 , 01 : 23 PM

☑ Start sending immediately

Figure IV.7: Trigger creation page



Name	Status	Delivery Type	Start Date	End Date	Audience	Template	Actions
Test one time delivery	Running	One Time	19/09/2023 01:26 PM	19/09/2023 01:26 PM	All SMS subscribers	Test SMS template	
Test one-time trigger	Completed	One Time	01/09/2023 12:00 PM	01/09/2023 09:06 AM	Default: All subscribers	Test email template	
Test monthly recurring trigger	Completed	Recurring	01/09/2023 09:02 AM	02/12/2023 09:02 AM	French speakers	Test push template	
Test weekly recurring trigger	Completed	Recurring	01/09/2023 09:02 AM	01/10/2023 09:02 AM	Default: All subscribers	Test chat template	
Test daily recurring trigger	Completed	Recurring	01/09/2023 09:00 AM	10/09/2023 09:00 AM	All SMS subscribers	Test SMS template	
Test one-time immediate trigger	Completed	One Time	01/09/2023 09:00 AM	01/09/2023 09:00 AM	Default: All subscribers	Test email template	

Figure IV.8: Triggers management page

Conclusion

In the fast-evolving digital landscape of today's world, the insurance, banking, and finance sectors face both unprecedented challenges and exciting opportunities. The need for seamless, personalized experiences has driven companies in these industries to embark on a journey of digital transformation. This transformation enhances customer engagement and elevates operational efficiency.

Our journey through the "Convergence" project at **Satoripop MEA** has been nothing short of transformative. Our mission was clear: to provide innovative solutions that facilitate the digital transformation process for organizations, enabling them to remain competitive, deliver exceptional customer experiences, and achieve sustainable growth in an ever-changing marketplace.

Within the "Convergence" ecosystem, we navigated various tools and sub-projects, each playing a vital role in our shared mission. Among these modules, we focused on the Notification Center, recognizing its pivotal role in enhancing communication by providing a centralized system for timely and relevant notifications. This project has allowed us to gain practical experience in designing and implementing complex systems, and most importantly developing proficiency in crucial technologies and frameworks.

As we bring this report to a close, we reflect on the significant milestones achieved during this internship project. We've took part in delivering a notification center that empowers organizations to communicate efficiently, engage customers effectively, and ensure the timely delivery of critical information.

However, our journey does not end here. The digital landscape will continue to evolve, and new challenges will emerge. Looking ahead, we must remain vigilant in adapting our notification center to meet the ever-changing needs of our clients and end-users. We envision future enhancements, such as campaing journeys, advanced analytics, AI-driven personalization, and even more secure data handling, to further solidify our position at the forefront of digital transformation.

In conclusion, the "Convergence" project has been a testament to our dedication to innovation and our commitment to solving real-world problems. We look forward to the next phase of this exciting journey.

Appendix A

Tools

This section presents the set of software tools we used to collaborate and support the development process.

docker	Docker is a set of platform as a service products that use OS-level virtualization to deliver software in packages called containers. We used docker to create containers for the database and other components we needed for development and also to fully dockerize the application and all the services that it depends on.
ATLASSIAN Bitbucket	Bitbucket is a Git based source code repository hosting and collaboration tool owned by Atlassian. We used this service to host the source code for our project.
	Postman is an API platform for building and using APIs. Postman simplifies each step of the API lifecycle and streamlines collaboration to create APIs faster. We used postman to test and maintain our notification center API.
IJ	IntelliJ IDEA is an integrated development environment for developing computer software written in Java, Kotlin, Groovy, and other JVM-based languages.
	Figma is a collaborative web application for user interface and user experience design, with an emphasis on real-time collaboration, utilising a variety of vector graphics editor and prototyping tools. We used Figma to create wireframes, UI designs and illustrtations for our solution.
	draw.io is a cross-platform graph drawing software that can be used to create diagrams such as flowcharts, wireframes, UML diagrams, etc. We used draw.io to create the uml diagrams during the software desgin process.

ATLASSIAN Trello	Trello is a web-based visual work and tasks management tool. We used trello to keep track of and to collaborate on the development tasks during the execution of the project.

Table A.1: Software tools

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