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Design and Development of Mobile Payment Platform Software Supported by Analytical Capabilities for Payment Systems

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Abstract: The Paycell Mobile Payment application serves as a platform where users can benefit from various payment and shopping services. Each user explores services within the application based on their own interests and needs, and this process generates a significant amount of data. The data created has become an important resource for improving user experience and enhancing the services offered. The primary goal of our project is to enrich the user experience and offer personalized recommendations based on real transactions to meet financial needs more effectively. This approach represents a significant step in the mobile payment systems industry in terms of data analytics and personalization. Simultaneously, this approach aims to position the Paycell application as a 'super app' where users can personalize their financial transactions. Our project captures user-initiated transactions with the aim of providing personalized recommendations tailored to users' interests and needs. These data are analyzed using data processing methods to obtain meaningful results. The results are then used to offer personalized recommendations to users. This approach contributes to users having more tailored experiences and meeting their financial needs more effectively.

Keywords: Super app, Data processing, Mobile payment

Introduction

Mobile payment systems represent a rapidly growing and evolving field in the financial technology world. These systems enable users to perform their financial transactions quickly and securely in their daily lives and are increasingly adopted by more people every day. Gaining a competitive advantage in this dynamic sector and enhancing the user experience are the cornerstones of a successful mobile payment application. The main objective of the project is to improve the Paycell application, increase customer satisfaction, and employ innovative approaches and technologies for new Paycell customers. By analyzing the transactions users perform in the application using complex data processing methods, it is possible to enhance the ease of use and effectiveness of the application. This enables users to use the application more actively with an innovative approach and highlights the gains obtained, with the aim of achieving more gains. Paycell Mobile Payment aims to provide personalized services to every user by focusing on their unique interests and needs. This application is a platform that uses data based on real transactions to enrich the user experience and meet financial requirements more effectively.

In conclusion, the Paycell Mobile Payment application aims to transform financial needs into a personalized experience, providing users with more benefits on a reliable and user-friendly platform. This project represents a significant step in the mobile payment sector and elevates user expectations to a new level.

Throughout this paper, the project's main objectives, features, and advantages will be discussed in more detail. Additionally, the paper will emphasize the project's significance in the industry and how it can impact future financial transactions.

Recommended Project Architecture

The proposed software architecture we recommend processes data using the Apache Flink library, handling complex data by considering a series of events the user performs, and extracting personalized recommendations (García-Gil et al., 2017). Our project is designed to work on the existing Paycell microservices architecture. The Paycell Mobile Payment Platform is composed of a series of microservices. Requests are routed through the gateway. Figure 1 illustrates the communication between the client, gateway, and Flink.

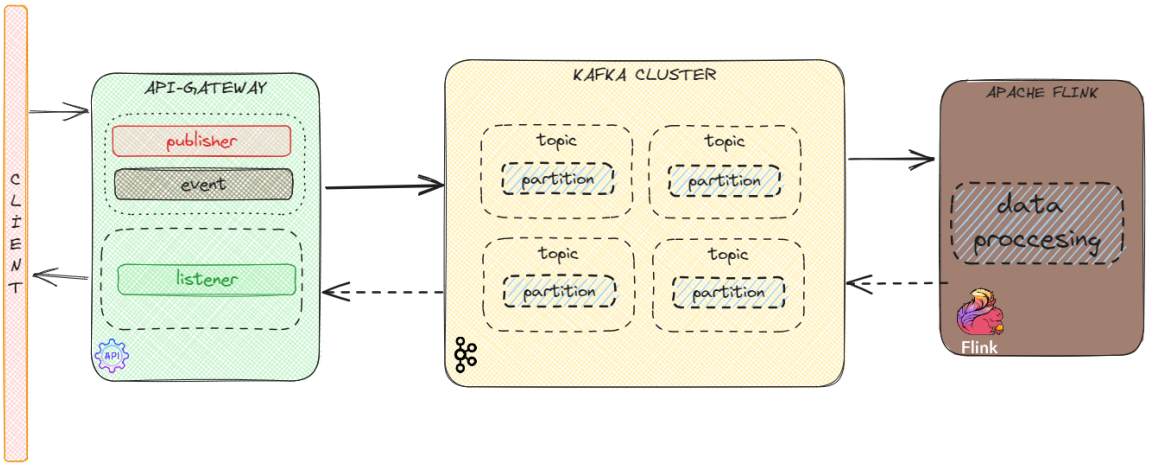

Figure 1. Communication between the client, gateway, and flink

On the API Gateway side, events are generated as a result of user interactions. The Kafka Cluster, which is an important component, comes into play. User events are sent to the Kafka Cluster and stored there (Sharvari T et al., 2019). Subsequently, Apache Flink processes this data in a complex manner. Apache Flink uses this data to generate personalized recommendations based on the user's actions.

Data Modelling: In the project, the data obtained for processing is referred to as events. Event data obtained from the Paycell application can include various activities that occur, such as visit activities and purchase activities. In this context, an event can be defined as follows:

Event: It represents interactions that occur as a result of users of the Paycell Mobile Application using its features. Each event data includes the date and time of the event, user information who performed the event, object information related to the feature, and other relevant data.

Data Flow: Let's assume a digital product purchase request is generated by the client. In this case, the API Gateway point will create an ORDER_CREATED event in the Kafka Cluster to initiate the order. The Payment Service, listening to this event, will attempt to process the payment with the relevant user's information and update the payment status, creating an event like PAYMENT_SUCCESS or PAYMENT_FAILED. Simultaneously, the developed Flink application will listen to these created events, track the user's transactions, and prepare a recommendation tailored to the user, feeding the Kafka Cluster with an event like ADVICE_CREATED. This event can be listened to on the API Gateway, allowing the relevant client to access recommendations through notifications, messages, emails, and other channels.

Data Processing: Apache Flink is a powerful open-source data stream processing framework designed for real-time data processing and analysis, especially suitable for event processing scenarios. In our project, it processes the data obtained, generating meaningful insights based on the designed architecture. For example, it can perform data filtering, grouping, merging, or transformation steps. (Alaasam et al., 2019).

MongoDB Data Storage Environment: Within the scope of our developed module, event data collected is stored for reporting purposes after complex event processing analyses using Flink. MongoDB is used as the storage tool because it allows flexible data models, fast access, indexing, and querying capabilities. MongoDB

accommodates complex and hierarchical data structures, providing an environment for organizing and querying various analysis results (Patil et al., 2017).

Data Protection: One of the key features of the proposed software architecture is ensuring that created events are transmitted without loss or corruption. Data transfer from the data source to the data processing module is done through a topic-based data subscription communication method. With this method, it is possible to collect, store, and process data in real-time without any data loss. The Kafka Cluster structure enables this capability, ensuring data is processed without loss (Apache Kafka, 2023).

Implementation

In the implementation of the proposed project architecture, Java technologies have been utilized. Apache Kafka serves as the data subscription message delivery channel, and the Apache Flink library is used for complex data analysis. As depicted in Figure 2, the implemented system's architecture is based on the proposed project architecture illustrated in Figure 1.

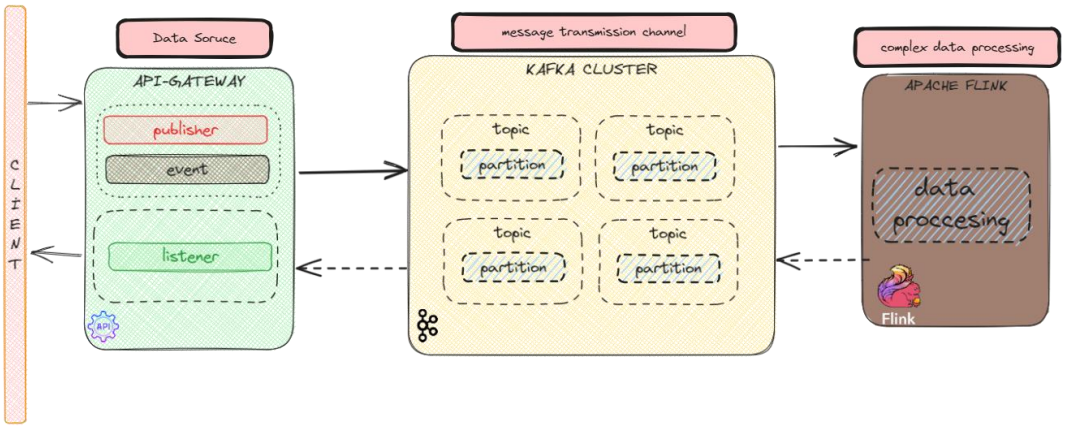

Figure 2. The implemented system's proposed architecture

Data Modeling in the Prototype: Complex event analysis will be performed on the collected event data, and events will be processed based on their adherence to predefined rules and the ranking of events. In this context, event data has been appropriately modeled to enable fast reading (runtime analysis), writing (for reporting), and querying (filtering events at runtime according to rules).

Basic Event Data Structure
transaction_id
customer_id
customer_name
product_code
product_category
product_quantity
price
total_price

Complex Event Data Structure
event_rule
product_code
time
action

Customer Object
customer_id
customer_name
customer_surname
customer_email
customer_phone
customer_hobies

Data Structure objects
product_code
product_name
product_category
action

Figure 3. Event data structure

The data model used in the prototype is designed for conducting activities such as real-time campaigns and personal recommendations in the Paycell Mobile Application. The model is based on the user's example of purchasing digital game pins. The customer and product data structure is shown in Figure 3. In the proposed system, the customer's transactions in this area are considered events. The fundamental event data structure contains information related to the pins the customer purchases and their expenses within the Paycell Mobile Application. Data elements found in the event structure are depicted in Figure 3. As can be seen from the figure,

the event data structure includes data elements such as transaction_id, customer_id, customer_name, product_code, product_quantity, price, total_price, and more.

When a complex event chain adhering to the defined rules is established, a complex event chain is created. Complex event data contains the actions the system desires. When designing the complex event data structure, activities like campaigns and similar product recommendations that can be performed as transactions in the Paycell application were considered. The information related to the Customer Object and Product Data Structure objects is as shown in the figure.

Rule Design: The rules triggering complex event formation have been implemented in Apache Flink. The design follows a specific sequence of events and generates recommendations as events that meet the appropriate conditions follow one another. The structure that satisfies consecutive rules is shown in the schema in Figure 4. In the inclusive example shown in Figure 4, when an event providing the starting parameter in the event chain is encountered, the chain of rules advances. When the desired event is satisfied, the next node is visited, and the result is achieved. Event sequences can be defined based on project requirements and decisions to be made (Carbone et al., 2015).

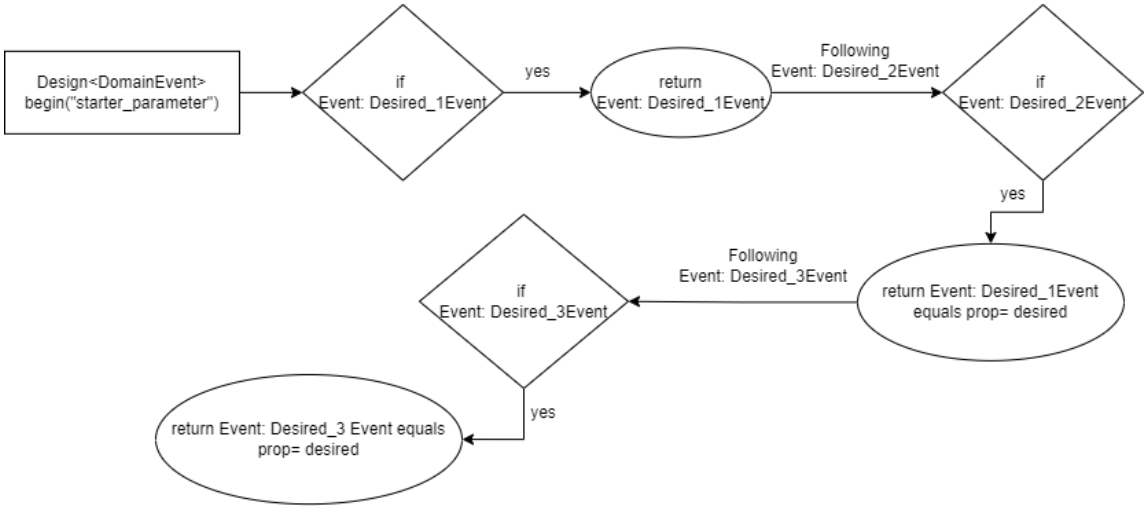

Figure 4. Sequence of rules

The occurrence of desired events leads to a conclusion as shown in Figure 5. In this scenario, a user who purchases in-game content in the Paycell mobile app satisfies the first rule, which is the "game content purchase" event. Subsequently, in the second step following this event, it is checked whether the content the user has purchased falls under the relevant category. If it falls under the "pubg_pin" category, the process advances to the final rule. When the subsequent event related to the vendor code has occurred and the code specified in the rule is satisfied, the user is provided with similar recommendations through in-app notifications, SMS, email, or other channels defined within the application.

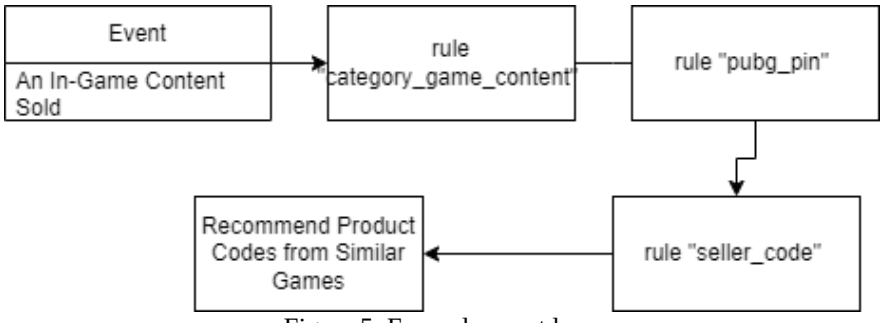

Figure 5. Example event loop

Working Scenario of the Prototype System: The primary objective of the prototype application we have developed is to track and analyze users' actions in real-time based on the transactions they perform and provide recommendations. These recommendations can be delivered through various communication channels (SMS, Bip, email, in-app notifications, etc.). The developed system is expected to be a high-performance management system. Figure 6 primarily illustrates the working scenario of the system.

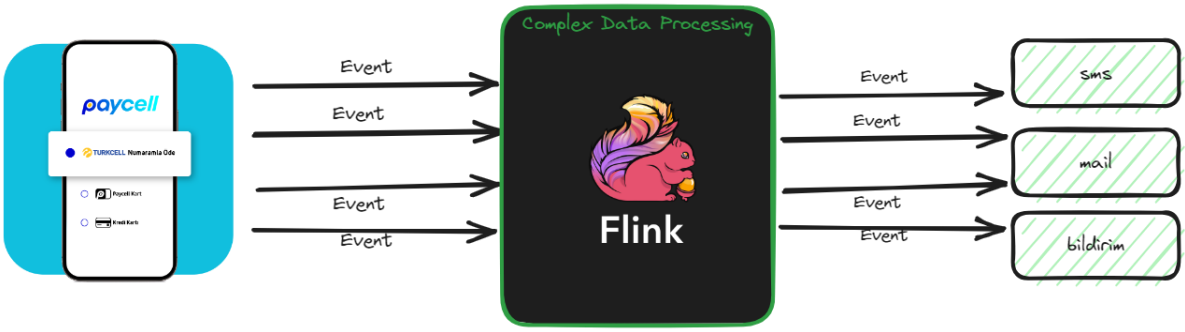

Figure 6. System work

The events generated as a result of these activities are sent to the Complex Event Processing Module. The Complex Event Processing Module generates complex events based on rule-based rules. Instant discounts, campaigns, bonuses, and other recommendations are made to the customers who cause these complex events. While implementing our system, we used the Apache Flink library. Flink is fed with data coming in real-time via a data subscription message delivery channel. For this purpose, Apache Kafka, which is the most suitable data subscription system for our system in terms of performance, has been chosen and used in the realization of the proposed system architecture. Apache Kafka is a high-throughput, fault-tolerant, distributed data streaming platform that records data like a log and can be used for transmission among different applications. It is designed to process large data streams reliably and fault-tolerantly. Additionally, it is scalable as your workload grows, and it can work in a distributed architecture.

For the simple and complex event data generated by customers through different sources, it is necessary to store and make it queryable in a big data infrastructure. After the events generated by customer actions in the Paycell mobile application are collected via Apache Kafka, these events are processed for complex data analysis using Flink. Flink is a powerful tool for big data processing and smart analytics. The collected event data is sent to Flink in real-time, and complex analyses are performed there.

Flink supports various data analysis scenarios, including understanding customer behaviors, providing personalized recommendations, and more. This allows for a better understanding of customer actions and providing valuable insights into the Paycell mobile application.

Possible Scenarios: It designs a highly functional data analytics system based on the concept of real-time data analysis and recommendations. Additionally, this structure can effectively work in terms of performance and scalability using powerful tools like Apache Flink and Apache Kafka. However, various other scenarios and benefits of this system can be considered.

It is possible to offer personalized offers, recommendations, and customizations for user interactions on other functionalities in the Paycell mobile application. At the same time, with this structure, a different perspective can be used to quickly prevent potential security threats or fraud by examining the events created by the user along with Flink. The analysis of user interactions can be used as a tool to monitor and improve operational processes within the system. This aims to efficiently manage resources and increase operational excellence within the Paycell application.

Discussion on the Proposed Methodology

Paycell Mobile Application provides a platform for fast and secure financial transactions. The primary goal of this project has been to personalize the user experience and effectively meet financial needs. Within the project scope, user transactions have been recorded and analyzed using complex data analysis methods. These analyses have made it possible to provide personalized recommendations tailored to users' interests and needs. This approach has encouraged users to use the application more effectively and achieve their financial goals.

The personalized recommendations provided to users are based on real-time transactions, leading to increased app usage. This is a result of focusing on meeting the needs of users to enhance their experience. Additionally, by analyzing shopping habits and expenses, financial improvements have been made, and users have been provided with recommendations to make better decisions.

Paycell Mobile Application is moving towards becoming more than just a payment tool; it aims to become a "super app" and provide more benefits to users. Finally, real-time data processing capabilities have been enhanced using powerful tools. This plays a critical role in processing large data streams and providing quick responses. This successful project encourages opportunities to enhance the application's functionality in the future. For example, new use cases can be explored, such as monitoring security threats or optimizing operational processes.

In conclusion, Paycell Mobile Application not only meets financial needs but also provides a personalized experience. This success can inspire similar applications in the future to offer more personalization and user-friendly services.

Literature Review

This study focuses on big data processing techniques for real-time data. There exist a number of studies utilizing complex event processing for real-time event processing in different studies (Baeth et al., 2018; Sudan et al., 2020; Yildiz et al., 2020; Aktas et al., 2020; Uzun-Per et al., 2021; Dhaouadi et al., 2018; Uzun-Per et al., 2022; Can et al., 2022; Baeth et al., 2017; Pinar et al., 2021, Yildiz et al, 2020; Cansiz et al., 2020). We observe studies in different distributed system architecture research fields such as service-oriented architectures (Tufek et al., 2018; Aktas et al, 2005; AsTekin et al., 2021). However, this study is investigating methodologies for event-based distributed system architectures. There exist studies focusing on analyzing analyzing click-stream data to understand the user navigational behavior (Uygun et al., 2020; Olmezogullari et al., 2022; Olmezogullari et al., 2020). This study produced a prototype software. Different studies are seen in the literature to measure the quality of the prototype software implemented within the research studies (Sahinoglu et al., 2015; Kapdan et al., 2014). However, in this study, software quality is considered as out-of-scope.

Results and Future Work

Paycell Mobile Application is a platform developed with the goal of providing more than just speed and reliability in financial transactions. It aims to personalize the user experience and effectively address financial needs. In this academic paper, we share the design details and software development approaches we have identified for this application. By utilizing complex data analyses, it offers users personalized recommendations tailored to their interests and needs, encouraging users to use the application more effectively. Real-time personalized recommendations based on actual transactions have led to increased app usage, and by analyzing shopping habits and expenses, financial improvements have been achieved. Paycell Mobile Application goes beyond being a mere financial payment tool, striving to become a "super app" with strong data processing capabilities to handle large data streams and provide quick responses.

The system implemented in the Paycell Mobile application, when considered within a broader context, could serve as an inspiration for other payment system tools and e-commerce platforms in the market. With its advanced data analysis feature, it has the potential to contribute to the more efficient development of systems. This project also inspires opportunities to enhance the application's functionality in the future, such as monitoring security threats or optimizing operational processes. In conclusion, Paycell Mobile Application not only meets financial needs but also serves as a source of inspiration for similar applications in the future by offering a personalized experience.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

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