

Transparent and Interoperable Mobile Money Transfer Protocols Across Distinct Mobile Network Operators

Dr. Bayomock Linwa André Claude¹, Mr. Bakayoko Moussa²

¹Head of department of Informatics,

International University of Grand Bassam (IUGB)

²Master Database and Software Engineering, FACULTY of Mathematics and Computer science,
University Félix Houphouët-Boigny (UFHB)

Abstract- This project proposes an innovative architecture that aims to ensure inter-mobile network financial transactions inside a specific country or between different countries. The architecture is a micro-service oriented. The architecture uses infrastructure as mobile server, gateways, that ensure interoperability, transparency and secure transactions between 2 separate mobile operators. Web technologies have been used to implement the solution. The architecture uses foundation principles of an open, efficient and inclusive financial ecosystem.

Keywords – Micro-service, Mobile Money, Transaction, interoperability, inter-networks.

I. INTRODUCTION

The rise of mobile financial services in Africa has profoundly transformed the business organization and payment methods inclusion. However, despite this rapid expansion of the mobile money payment, the financial transaction between clients using distinct mobile networks still remain fragmented, limiting the fluidity and efficiency of transfers between different mobile operators. In this context, the interoperability between "mobile money" platforms (money transfer between mobile clients by using the identifier of a mobile equipment or mobile phone number) is a major strategic challenge for the sender and receiver of mobile money.

The interoperability protocols define the rules, sequences, and exchange formats between systems of different operators. These protocols ensure the mutual understanding between distinct mobile gateways, the security of transactions, as well as the transaction compliance to technical standards and regulations. Thus, they ensure the consistency of the operations from the mobile money sender to the mobile money receiver.

In this document, first a transparent and interoperable protocols for mobile money transactions over inter-network 'mobile gateways is proposed. These gateways act as a smart intermediary server between the network transmitters and receivers, orchestrate the data exchange via mobile operator API and secure the transaction flow. The implementation of this architecture ensures not only the compatibility between heterogeneous network client systems, and the traceability, non-repudiation, and regulatory compliance of the transaction as well. Then the corresponding data model is described.

This project is part of a modernization and harmonization process of the mobile payment infrastructure in Africa, where the interoperable mobile money protocols over cross mobile networks is an essential factor to promote of financial inclusion and boost economic exchanges across countries.

II. MOTIVATION

The main motivation of this article is the need to promote effective interoperability of mobile payments across different networks in Africa. Despite the high adoption of mobile money on the Africa continent, money transfers inter-operator and inter-country remain complex, expensive and not transparent. This situation is one of the limit factors in regional economic integration success and also put aside rural people of getting banking account and financial networking with others.

As a researcher and professional in the area of information systems, we found that the lack of standardized protocols and technical architectures that are interoperable is one of the major obstacles to the financial transactions fluidity. Thus, the drafting of this article responds to that wish, and proposes a solution that is technical innovative, the proposed protocols are deployed on mobile gateways, then, enabling seamless communication between heterogeneous networks.

Our goal is to contribute to the debate of scientific and technical information on the models of mobile money interoperability in Africa, while highlighting the importance of traceability and transparency. This article describes the proposed protocols and mobile gateways interconnection, as well as the data model that ensures the traceability and transparency of the transactions.

III. STATUS OF RESEARCH

In several African countries, public and private initiatives have emerged to encourage the standardization of interfaces for communication and the sharing of the payment infrastructure.

In (Maune et al, 2022), the authors examine the effectiveness of moral persuasion exerted by the directorate of national payment systems in Zimbabwe. It also analyzes if the country needs an external entity to control the mobile payment interoperability services, or if a regulatory set of standards must be implemented.

The article Mobile Money Interoperability, and Financial Inclusion (Markus K. Brunnermeier et al, 2023), explores the trade-off between competition and financial inclusion induced by the vertical integration of the mobile network operators and mobile payment services. By combining the costs of mobile payment data of the "Wayback Machine", with the network coverage and financial data, authors examine the platforms interoperability disparities across the mobile network operators in Africa, then, promote a transaction and the competition policy between the mobile payment services' operators.

In the article (Okello candiya Bongomin et al, 2025), authors examine how the interoperability between the mobile money networks and digital payment systems can allow traders to gain finance remote access to facilitate the exchange specifically in Africa areas where the physical banks are absent.

In the report published by GSMA (Gianluca Storchi, October 2024), the author explores the fundamental components of the interoperability of mobile money: the dispute resolution mechanism, the financial regulation and the connection between suppliers. He also indicates that the digital streams 60% of the total value of transaction payment type used mobile money payment methodology in 2023, compared to 55% in 2019

The authors (Agbezouts, Urien and Dandjinou, February 2025), found that the mobile network operators manage their own mobile money transaction solution assuming sole responsibility for transactional databases and the interaction with their customers. This paper integrates the blockchain in the mobile money transaction and improves the mobile payment confidence. In his article (Aswinkumar Dhandapani, 2025), the author said the combination of microservices architecture, real-time processing capabilities, and cloud-native deployment creates a foundation for more agile, resilient, and customer-centric financial systems capable of adapting to rapidly changing market conditions. The author (Vinod Reddy Nomula, 2025) outlines key advantages of microservices, including improved scalability, enhanced fault isolation, faster time-to-market, and technology flexibility. It provides concrete examples and statistics demonstrating how major financial

institutions have benefited from implementing microservices across various operations, such as payment processing, account management, and fraud detection.

In his article (Ayoub Mswahili 2022), the author found that approximately 81.5% of the dependent variable, which is interoperability of mobile money services, was accounted for by the regression analysis and therefore can strongly be explained very well by independent variables, which are Perceived Ease of Use; price value; Network Availability; Security and Trust; Service quality; Task Characteristics. The article (Maune, Nyakwawa & Magara ,2022) examines whether the moral persuasion of the directorate of national payment systems works in Zimbabwe, and if the country is in need of an arbitration for the mobile money interoperability, or if regulatory intervention is required. In (Nyaaba, Kuusaana et al, 2018), authors argue that the use of ubiquitous mobile phones in Ghana has encouraged both the telecom operators that traditional banks to adopt innovative approaches that operate on mobile platforms.

In 2024, the authors (Facundo Rattel et al, 2024) have published a report on the interoperability of mobile money effect in Ghana, Kenya, Malawi, Rwanda and Tanzania. The report, published in the GSMA (Global System for Mobile Communications Association)) presents the adoption and use of mobile money evolution in the context of different interoperability models. In Kenya, the interoperability driven became effective in 2018. In the other four countries, the interoperability is now a regulatory requirement through the national switch. It should be noted that GSMA is an organization comprising of 750 mobile operators and more than 400 companies in the mobile devices and applications ecosystem.

Authors have highlighted also the central role of "Application Program Interface" API of Mobile Money in the trade facilitation inter-operators. These API today constitute the technical basis of several interoperability projects, by providing integration points normalized to the transactions, account management, agents, and compliance. Other research has focused on models of interoperability, regional, including through initiatives such as the Mobile Money Interoperability (MMI), implemented in Ghana, Tanzania, or Kenya, where the platforms are centralized allow transfers transparent between operators.

However, most of these approaches are based on architectures, centralized and owners, often limited to a national context. Little research focuses on the implementation of architectures interoperable decentralized or based on standardized protocols that can be expanded in many jurisdictions. In addition, the question of the security of the exchange inter-networks and the traceability of transactions remains a major challenge, especially in environments with high heterogeneity technology.

The actors involved in the transaction of national

Customer issuer: the person who initiates the transfer operation (the one who sends the money)

Transmitting Network: This is the mobile operator or service provider of the mobile customer issuer (Ivory Coast MTN Money, Orange Money, Moov Money).

Broker: The gateway interconnection, which manages the accounting and routing transactions between the various mobile operators, it plays the role of intermediary.

Receiving Network: The mobile operator of the receiving client, the mobile operator whose receive the transferred money.

Receiving client: the person who receives the transfer.

Transfer process

- Initialization of the transaction (Customer issuer – Transmitting Network)

The customer issuer loads the mobile money transfer form using the broker application URL.

The customer issuer enters the requested transfer information:

- Type (national/international): selects National
- Customer issuer' residence country
- Mobile money number of the customer issuer and the receiving client
- Amount of money to send,
- Automatic calculation of transfer charges
- Automatic calculation of money that will be received.

Then the customer issuer hits a submit button to initiate the mobile money transfer from the customer issuer to the receiving client using the transmitting network.

Direct debit request (transmitting network server, customer issuer, broker)

The broker receives the transfer request from the customer issuer.

The broker retrieves and analyzes all transfer information values sent by the customer issuer.

The broker determines the mobile network operator of the customer issuer. Then, it generates a debit request by calling the debit API of the transmitting network server.

The transmitting network server retrieves the customer issuer (name, phone number), the amount of money to withdraw and the broker (name, phone number on the transmitting network).

The transmitting network server checks the balance of the customer issuer.

If the balance is less than the amount to withdraw, a message "insufficient funds" is sent to the broker. And the broker stops the transaction and forward the message to the customer issuer.

If the balance is greater or equal to the amount to withdraw, then a withdraw authorization is sent to the customer issuer. In case, the withdraw is authorized, the transmitting network

server credit the broker' mobile money number. And returns a successful execution back to the broker.

Verification and routing by the broker

The broker checks the received message.

In case its mobile money account in the transmitting network has been credited, then, the broker uses the receiving client (name, mobile money number), detects the receiving network server URL and generates a transfer request to the receiving client by calling the mobile money credit/debit API of the receiving network server.

Interaction with the receiving network and crediting the receiving client mobile money

The mobile money credit/debit API contains the broker mobile money number in the receiving network, the amount to transfer, the client receiver (name, mobile money number)

The receiving network server checks the balance of the broker mobile money number.

If the balance is less than the amount to withdraw, a message "Insufficient funds..." is sent to the broker. And the broker credits its mobile money account first and replay the withdraw request scenario.

If the balance is greater or equal to the amount to withdraw, then a withdraw authorization is sent to the broker.

In case, the withdraw is authorized, the receiving network server credit the receiving client' mobile money number. And returns a successful execution back to the broker.

Final Messages

The national transfer protocol ensures that the transfer transaction is completed by meeting the conformity requirements (integrity, expected amount vs received amount, and data registered in broker gateway server for transparency reasons). In case transfer completion meets the conformity, the broker sends a completion and successful request transfer to both client issuer and the receiving client.

The actors involved in the international transaction

- In an international transfer, involved actors are:
- The mobile operator issuer or transmitting network,
- The mobile operator receiver, or receiving network,
- The broker issuer,
- The broker receiver,
- The customer issuer,
- The receiving client.

Transmitting and receiving brokers communicate each other to ensure that the money transaction from the sender country to the receiver country.

Transfer protocol at the international level

At the international level, the transfer protocol process handles regulations diversity, currency conversion and more broker servers.

The international transfer protocol is shown in Figure 2.

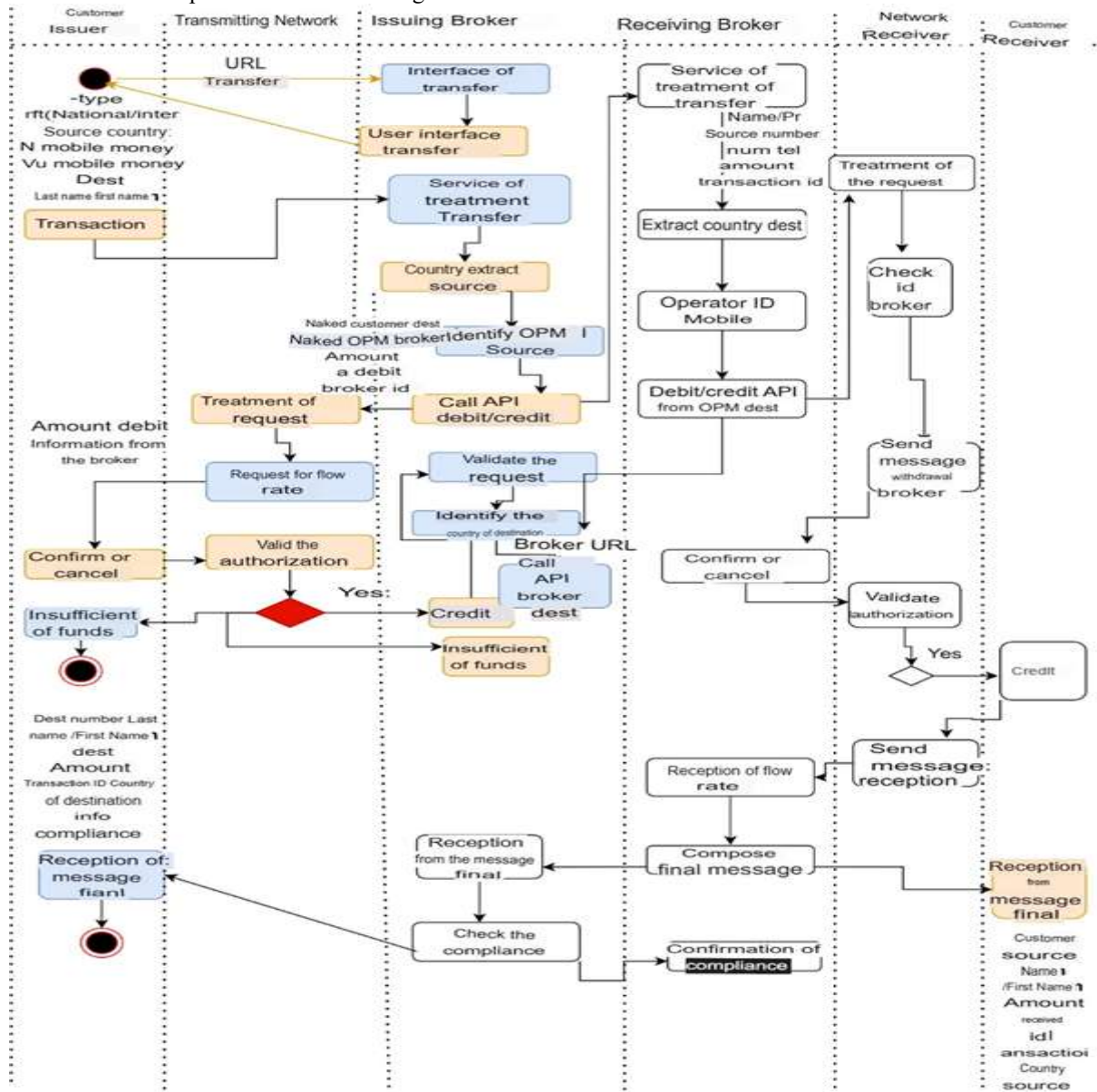


Figure 2: Transaction Protocol to the international level

Process international

- Initialization of the transaction (Customer issuer – Transmitting Network)

The customer issuer loads the mobile money transfer’ form using the broker issuer application URL.

The customer issuer enters the requested transfer information:

- Type (national/international): selects International,
- Customer issuer’ residence country,
- Receiving client’ country,

- Mobile money number of the customer issuer and the receiving client,
- Amount of money to send,
- Automatic calculation of transfer charges,
- Automatic calculation of money that will be received.

Then the customer issuer hits a submit button to initiate the mobile money transfer from the customer issuer to the receiving client using the transmitting network.

- Processing at the broker issuer

The broker receives the transfer request from the customer issuer.

The broker issuer retrieves and analyzes all transfer information values sent by the customer issuer.

The broker issuer determines the mobile network operator of the customer issuer. Then, it generates a debit request by calling the debit API of the transmitting network server.

The transmitting network server retrieves the customer issuer (name, phone number), the amount of money to withdraw and the broker issuer (name, phone number on the transmitting network).

The transmitting network server checks the balance of the customer issuer.

If the balance is less than the amount to withdraw, a message “insufficient funds” is sent to the broker issuer. And the broker issuer stops the transaction and forward the message to the customer issuer.

If the balance is greater or equal to the amount to withdraw, then a withdraw authorization is sent to the customer issuer. In case, the withdraw is authorized, the transmitting network server credit the broker issuer’ mobile money number. And returns a successful execution back to the broker issuer.

Processing broker issuer – broker receiver

The broker issuer retrieves the destination country and the corresponding broker receiver’ API debit/credit in the destination country.

The broker receiver API is called with the following data: the client issuer (name, mobile money number), the sent amount, expected amount to receive, the receiving client (name, mobile money number), the destination country.

The broker receiver determines the receiving mobile network. Then, it calls the debit/credit API of the receiving network server in order to initiate the credit. The parameters in the called API are the broker receiver mobile money number, the receiving client mobile number amount to withdraw.

The processing at the network receiver server

The receiving network server checks the broker receiver balance greater than the amount to debit.

If the balance is less than the amount to withdraw, a message “Insufficient funds...” is sent to the broker receiver. And the broker receiver credits its mobile money account first and replay the withdraw request scenario.

If the balance is greater or equal to the amount to withdraw, then a withdraw authorization is sent to the broker receiver.

In case, the withdraw is authorized, the receiving network server credit the receiving client’ mobile money number. And returns a successful execution back to the broker receiver.

Return information

The receiving network signals the broker receiver that the amount has been successfully credited to the client receiver. The broker receiver sends a confirmation message of the successful transfer completion to the broker issuer. Then, a final

message is built and sends to the customer issuer and the receiving client. The final message contains the customer issuer (name, mobile money number), the receiving client (name, mobile money number), the money amount sent, the money amount received, the transaction charges, the conformity conformation, received country, date time of the transaction completion.

The international transfer protocol ensures that the transfer transaction is completed by meeting the conformity requirements (integrity, expected amount vs received amount, and data registered in the issuer and receiver broker gateway servers for transparency reasons).

VI. DATA MODEL

The data model associated with the proposed protocol has been designed to ensure consistency, traceability and interoperability between the different actors of the system. They structure information about the users, operators, transactions, accounts and gateways, ensuring a smooth communication between the modules of the system.

This model is a relational model, where each entity (customer, mobile operator, transaction, account, service, compliance, payment gateway, etc) is related to another entity using primary and foreign keys. It establishes entity dependencies and associative entities.

The main objective is to provide a solid database for the storage, verification and synchronization of data management during the mobile money transfer process. This model guarantees the integrity and availability of information throughout the lifecycle of mobile money transactions.

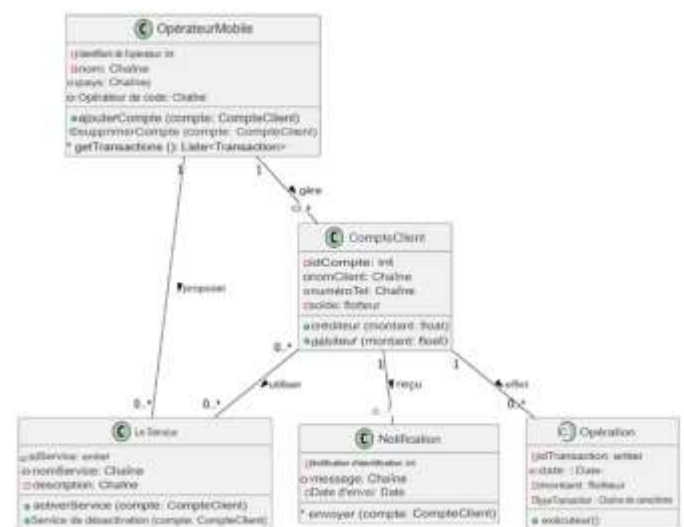


Figure 3: class Diagram mobile Operator

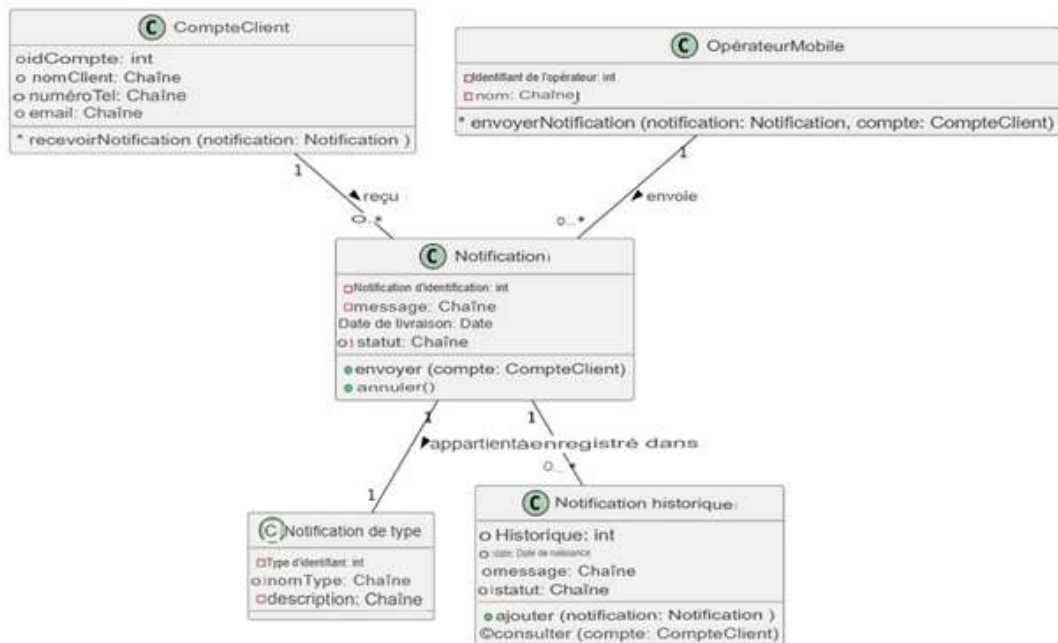


Figure 4: class Diagram Notification

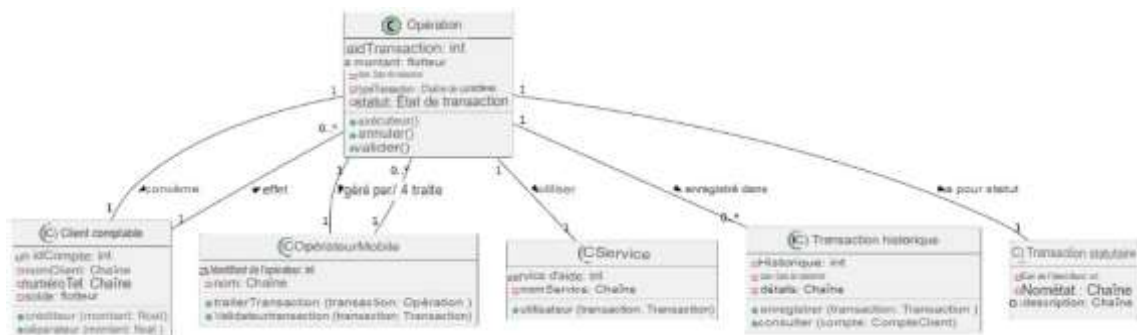


Figure 5: class Diagram transaction Management

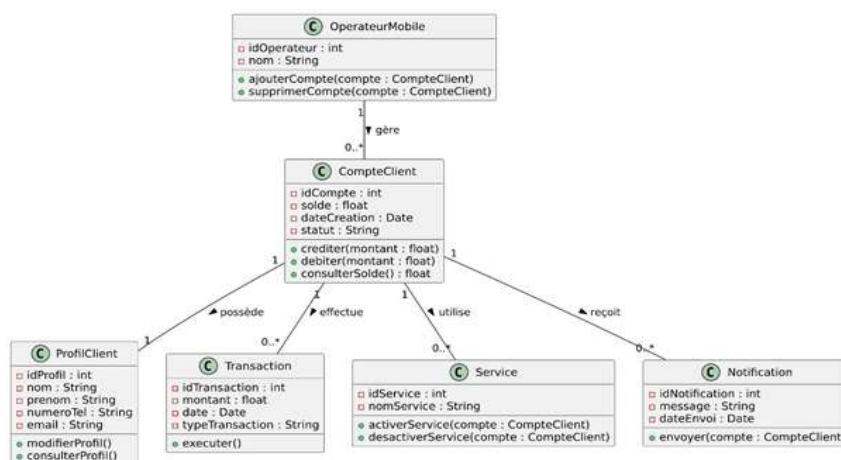


Figure 6 : class Diagram Management of client account

VII. CONCLUSION

In this research, interoperable mobile money transfers protocols (national and international) have been designed, defined and described. The essential principles of those protocols are: transparency, traceability, transaction compliance and middleware modularity of mobile money transfer across national or international mobile networks. By integrating standardized API, mechanisms of enhanced security and a clear structuring of the data exchange, the proposed data model helps to reduce existing technical barriers of mobile money transfers between distinct mobile network operators and to promote mobile money fluidity inclusion more widely.

The proposed approach stands out by its ability to provide a fluid and secure communication between heterogeneous mobile network systems, while respecting the requirements of compliance, transparency and traceability. It lays on solid basis of sustainable interoperability mobile money transfers in a country or between countries, able to support the development of financial transfer ecosystems in Africa.

Future work will focus on:

- The implementation of the proposed protocols using web technologies and mobile platforms (as Android) to evaluate the performance and resilience;
- The integration of emerging technologies, such as block chain, to enhance the mobile money transfer traceability, transparency, security and compliance;
- The extension of the data model to include cross-border payments, and expanded digital financial services (Fintech, Banks, e-commerce), and, finally, the establishment of regional mobile money transfer standards for a wide-scale adoption by mobile network operators and financial institutions.

In sum, this work opens the way to new opportunities for innovation in the field for interoperable mobile money services, and provides a solid basis for Africa sustainable development.

REFERENCES

1. Alexander Maune, Gerald M. Nyakwawa & Tinashe Magara, "Financial Inclusion: A review of Mobile Money Interoperability in Zimbabwe", *Acta Universitatis Danubius. (Economica)*, Vol. 18, No. 6, 2022.
2. Ali Yakubu Nyaaba, Mariama Marciana Kuusaana & Daniel Owusu-Ansah, "The political economy of mobile money interoperability and transactions in Ghana", *Journal of African Political Economy & Development (JAPED)*, Vol. 3, December 2018
3. Aswinkumar Dhandapani, "micro-services Architecture in Financial Services: Enabling Real-Time Transaction Processing and Enhanced Scalability", *European Journal of Computer Science and Information Technology* (EJCSIT), Vol. 13 issue 32, pp 145-159, 2025, micro-services Architecture in Financial Services: Enabling Real-Time Transaction Processing and Enhanced Scalability - *European Journal of Computer Science and Information Technology* (EJCSIT)
4. Ayoub Mswahili, "Factors for Acceptance and Use of Mobile Money Interoperability Services", *The Journal of Informatics*, March 2022, *The Journal of Informatics*2(1):1-21, DOI:10.59645/tji.v2i1.45, Factors for Acceptance and Use of Mobile Money Interoperability Services
5. Edem Kodjo Agbezoutsi, Pascal Urien & Toundé Mesmin Dandjinou, "Advancing Mobile Money Payments Through Blockchain and Interoperability Protocols", in *AFRICOMM 2023: Towards new e-Infrastructure and e-Services for Developing Countries*, Springer, 2025.
6. Facundo Rattel, Kalvin Bahia, and Winnie Wambugu, "The Impact of Mobile Money Interoperability on Financial Inclusion", *GSMA Intelligence*, January 2024, The impact of mobile money interoperability on financial inclusion
7. Gianluca Storchi, "Understanding mobile money interoperability, its evolution, and path to a sustainable future", *GSMA Intelligence*, October 2024, Understanding mobile money interoperability, its evolution, and path to a sustainable future | *Mobile for Development*
8. GSMA, "Unlocking mobile money interoperability and merchant payments across Africa through Mowali", *GSMA Intelligence*, November 2020, Unlocking mobile money interoperability and merchant payments across Africa through Mowali | *Mobile for Development*
9. Okello Candiya Bongomin, G., Chrysostom, E., Atingi-Ego, M. & Yourougou, P., "Fueling Sustainable Digital Future for Intra-African Trade: Using Mobile Money Interoperability to Increase the Trade Prospects of the African Continental Free Trade Area", *AIB Insights*, 2025.
10. Vinod Reddy Nomula, "Optimizing Financial Systems with micro-services Architecture", *International Journal of Computer Engineering and Technology (IJCET)*, IAEME Publication, 2025, vol. 15 issue 5, pp 229-236, OPTIMIZING FINANCIAL SYSTEMS WITH micro-services ARCHITECTURE.