



The MAS Financial Sector Technology and Innovation (FSTI)
Proof of Concept (POC) Scheme Whitepaper

Inclusive Cross-Border Remittances: Mojaloop and Inclusive Real-Time Payments

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Submitted by



In partnership with



Participants



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Foreword

Enabling Prosperity in Developing Economies by Advancing Financial Inclusion

Cross-border payments, especially remittances, are vital to people in developing economies. However, 1.4 billion people — the majority with a mobile phone — still lack affordable access to the digital financial services that make cross-border money transfers possible.

One of the major barriers to achieving financial inclusion for all is that it simply costs too much for the unbanked to send money across borders. A bank typically charges \$10-\$15 for every hundred dollars sent. Some instant payment services might charge \$4-\$5 per hundred dollars.

The United Nations (UN) has set a goal to reduce these fees to less than 3% of the transaction costs and eliminate remittance corridors with costs higher than 5% by 2030. According to the UN, there are approximately 281 million international migrants in the world today. Lowering the cost of remittances from this diaspora would mean that more money reaches the pockets of families, significantly boosting the GDP of the countries where they live. The Mojaloop Foundation believes that enabling transactions with fees of less than \$1 — or ideally no fees — is the only way to bring an entire population into the digital economy. Cheaper, faster, and transparent cross-border remittances can be delivered to low-income, rural areas by developing affordable, sub-national instant payment systems (IPS). There are several of these systems in existence, but each project is unique and highly complex because of a combination of regulatory and technical factors, including a constantly changing technical landscape.

To prove that a new remittance corridor between Singapore and the Philippines would work, ThitsaWorks, in partnership with INFITX and Visa, has conducted a Mojaloop-enabled proof of concept (POC). The Monetary Authority of Singapore's Financial Sector Technology and Innovation (FSTI) program provided the grant for the project.

This POC shows how national and international payment networks can be used to build core functionalities of the end-to-end remittance payment flow, and how they could be designed differently and more efficiently. Leveraging the digital public good Mojaloop, an open-source digital payment technology platform, the POC fosters best practices in an accelerated manner and enables the global sharing of software and the benefits of lessons learned. The Mojaloop Foundation believes this approach creates a mechanism for regulators, payment schemes and the developer ecosystem to co-innovate with a global audience and deliver a financial inclusion strategy that is market-ready.

The goal is to create a vibrant one-loop ecosystem with significant network benefits for all players, making money movement fast, easy and safe.

We are excited to see the possibilities that can be moved forward by this POC. There is a growing worldwide push to make cross-border payments and other financial services affordable, accessible and beneficial to all, and we are proud to be a part of it.

You can learn more about how to get involved in the Mojaloop community and make an impact at mojaloop.io.

Paula Hunter
Executive Director
Mojaloop Foundation

Executive Summary

ThitsaWorks, in partnership with INFITX (previously ModusBox) and Visa, was awarded a Proof of Concept (POC) grant on 29-June-2022 by the Monetary Authority of Singapore (MAS), Financial Sector Technology and Innovation (FSTI). The FSTI POC grant supports the experimentation, development, and dissemination of nascent innovative technologies in the financial services sector. The primary goal of the project is to demonstrate that cheaper, faster, and transparent cross-border remittance could be delivered to low-income, rural areas by developing and connecting affordable, sub-national instant payment systems (IPSS), leveraging an open-sourced Mojaloop payment technology platform, to national and/or international payment networks and investigating in detail on some core functionalities of the end-to-end remittance payment flow could be technically performed differently and more efficiently.

Overseas migrant workers who want to remit money to their home country enjoy a limited set of options. These options remain siloed, extremely costly, and generally slow. This challenge has been recognised globally. Indeed, enhancing cross-border payments has been set as a priority by the G20, Saudi presidency. With the objective of achieving this goal, the Financial Stability Board (FSB) has defined a roadmap, along with Key Performance Indicators (KPIs) to measure progress and create accountability. Re-affirming the sustainable development goals (SDG) published by the United Nations, reducing the cost of sending remittances, along with increasing payment processing speed, access and transparency¹ have been set as key priorities.

As a Proof of Concept, this project uses the Visa Direct network as an international payment network, located in one of the key financial hubs in Asia, Singapore. A corridor was selected, namely Singapore-Philippines, due to the presence of a sizable migrant worker population from the country in Singapore. For the mentioned corridor, this project leverages the i2i platform, which is a blockchain-based payment network, built and operated by UBX, the Philippines' Open Finance leader and the technology arm of Union Bank of the Philippines. To deeply understand the requirements of the migrants, Singapore-based neobank, Lucy, participated in this project. The transactions also originated through Lucy's wallet to i2i ecosystem participants which include rural and commercial banks, pawnshops, remittance networks, and agent communities in the Philippines. For cross-border settlement, Lucy in Singapore, and Union Bank in the Philippines acted as settlement counterparts, all members of the Visa Direct network.

While the project focuses on an Asian remittance corridor and currently uses VISA as the underlying network, the project team envisages that the solution developed in this project will serve as a technical and implementation blueprint for other developing countries as well. Accordingly, four key design principles were agreed upon at project initiation in June 2022 to deliver a more efficient and less costly remittance flow, ultimately increasing financial inclusion:

- focus on end users (both payers and payees) and limit cost to implementation fitting into existing user interface
- speed-to-market, and, as a consequence use of existing solutions as much as possible

¹ Details about the KPIs can be found here: <https://www.fsb.org/wp-content/uploads/P060722.pdf>

- scalability
- Replicability, having the ambition to tackle more remittance corridors over time

Similarly, the project followed eight technical objectives, such as inter-system payment, use of existing interface, cost transparency as well as low-cost operation for small financial institutions, among a few others, were identified to assess technical readiness. The technical objectives are described in more detail below. Suitable solutions were explored and tested in bilateral sandbox environments, and the results were measured against these technical objectives.

This white paper details the work conducted during the Proof of concept and the technical innovations delivered to achieve the delivery of a more effective remittance flow. In this white paper, we presented the proposed approaches as well as the outcome of these approaches, to achieve the objectives highlighted above. As we demonstrate in the following sections, each approach suggested demonstrated high feasibility. As the project team faced some challenges, this whitepaper also features the lessons learnt from the delivery of Proof of Concept, and potential next steps or considerations for the future, whether technical or functional.

Therefore, as logical next steps, we proposed end-to-end system testing to demonstrate the expected outcome - clearance of funds into the beneficiary's (or ultimate creditors in ISO 20022 terminology) accounts. The project team also highlighted several lessons learned and additional technical challenges uncovered during this project, which need to be investigated. Equally important, several technical gaps in the Mojaloop designs were identified and these will be incorporated into the subsequent releases of this open-source technology.

Introduction

Generic Challenges with Cross-border Remittance

While there exist broader definitions of cross-border remittances, they are widely defined as “cross-border, person-to-person payments of relatively low value that are typically recurrent,” as first used by the Committee on Payment and Settlement Systems (CPSS) and the World Bank (WB)². Although the cost of sending remittances is declining in many areas of the world, as new entrants enter the cross-border payments arena and force incumbents to review their pricing strategy, the cost still remains high, particularly in comparison with the total amount remitted and the average income levels of senders and receivers.

According to the World Bank’s index of Remittance Prices Worldwide³, the Global Average cost for sending remittances was 6.30 percent in the third quarter of 2022, which is more than double the 3 percent set by the FSB as a key performance indicator to achieve by 2030. There continue to be barriers to efficient cross-border remittance in many corridors. These explain the high costs currently faced by migrant workers who wish to remit funds to their families. Stringent regulations, liquidity challenges for banks where the remitted currency cannot be easily sold or exchanged without substantial fees for the bank, high risks of credit default, limited competition (particularly when it comes to sending money to underbanked recipients) inadequate payment infrastructure with sometimes non-existent domestic payment systems, are key challenges to solve in order to reduce the cost of remitting money, and, ultimately increase financial inclusion.

The beneficiaries may also face long and expensive journeys to reach facilities where they can receive the remittances, particularly when the money is remitted to friends or family who hold an account with small microfinance institutions or rural banks. The costs of travel for the beneficiaries, along with the inconveniences of making these journeys, are additional to the costs of the remittances themselves. These costs are usually not included in the statistical cost of remittances. While much progress has been made to build digital financial infrastructure, such as retail instant payment systems and open banking frameworks, these innovations remain domestic and have often not reached the rural regions, which are often hugely underserved by the new digital payments players as a consequence.

As a result of the cumbersome transfer process, many workers rely on informal channels in order to send money home. This can be expensive and unsafe.

Remittance as an Entry Point for Financial Inclusion

Strong use cases drive adoption. The ultimate goal of the project is to accelerate financial inclusion in low-income rural areas. Based on ThitsaWorks’ ongoing research in digital payment adoption⁴ In collaboration

² <https://www.bis.org/fsi/publ/insights43.pdf>

³ <https://remittanceprices.worldbank.org/>

⁴ “Market Analysis of Agricultural Value Chains and Payments” (2023) by ThitsaWorks

with a large international NGO organization, agricultural activities (domestic) and remittance (cross-border) are the two biggest cash inflow streams to rural communities. Lacking financial services, both agricultural income and cross-border remittance present enormous challenges for low-income rural populations. If we can solve for stronger, cheaper cross-border remittances, there is a high chance that we can accelerate financial inclusion as well as improve the overall level of economic activity in the areas which receive remittances.

Singapore -Philippines Corridor (SG-PH)

ASEAN is a region which is well placed to illustrate the inefficiency of the current cross-border (remittance) payments structures. The advanced economies in the region, such as Singapore and Hong Kong, make significant use of migrant labor from less developed economies in the region (e.g., Philippines, Indonesia, etc.).

According to Singapore's Ministry of Manpower, there was an overall total of 1.2m foreign workers in Singapore in December 2021⁵. This represents approximately one-third of the overall workforce at the same period⁶. Singapore has increasingly become an important destination for Filipino migrant workers. CEIC reports that there were 500,000 overseas workers from Philippines in Singapore (as of November, 2022⁷).

Figure 1. Cost of Remitting US\$200 Equivalent from Singapore to Key ASEAN Destinations (3Q 2022)

	Fee (in USD)	Margin (in %)
SG- Indonesia	4.70	0.92%
SG-Philippines	3.99	0.98%
SG-Thailand	4.77	2.39%
SG-Malaysia	8.47	1.60%

Source: Remittance Prices Worldwide (worldbank.org). <https://remittanceprices.worldbank.org/>

There are several other factors that have positioned Singapore as the ideal originating point for this pilot project, a well-established ecosystem, lower-average cost, and the presence of several different payment rails. First, as highlighted above with the number of workers, the country is a regional powerhouse with its geographical proximity to remittance recipient countries such as Indonesia, and the Philippines. This geographical proximity would ensure efficient coordination and communication during project implementation. Second, its well-established infrastructure, and presence of strategic market actors make

⁵ <https://www.mom.gov.sg/documents-and-publications/foreign-workforce-numbers>

⁶ <https://stats.mom.gov.sg/Pages/employment-Summary-Table.aspx>

⁷ <https://businessmirror.com.ph/2022/11/18/ubx-targets-ofws-in-sg-in-deal-with-thitsaworks/>

it a regional financial hub. The country hosts Visa's Asia Pacific regional office as well as its innovation center in Asia. Third, MAS is a renowned innovative regulator, with strong experience launching similar services such as Singapore to Thailand real-time cross-border remittance service, as well as constant efforts to create a Smart Financial Centre through FinTech and innovation. Lastly, Singapore has been enhancing its cross-border settlement infrastructure, which could be leveraged in the subsequent stages of this project as alternative ecosystem partners.

Strategic Goals and Hypothesis

Most recent innovations in payments are built upon existing infrastructure, mainly targeting customers who already hold a bank account: for instance, connecting Thailand's Real-time, Retail Payment Platform PromptPay, and PayNow in Singapore for cross-border transactions - primarily benefited existing bank customers. In addition, mobile wallet providers mainly focus on urban middle-class populations when developing digital use cases. According to the research by BCG, e-wallets in Southeast Asia are primarily used by customers who already have traditional banking services⁸. Without taking anything away from these innovations and the real benefits they bring, few would disagree that more can be done to extend the very same benefits of digital real-time payment solutions to low-income rural populations. Some US\$ 626 billion were remitted by migrant laborers from developed countries to their families in low-and-middle-income countries, according to the World Bank Migration and Development Brief 37⁹. For more than 70 countries, the remittance volume accounts for 4% of their respective GDP¹⁰.

Additionally, it is important to recognize that there are numerous small financial institutions such as pawn shops, rural banks, microfinance institutions, credit unions, and mobile money agents that are serving as the last-mile service providers, or as BIS CPMI and World Bank (2016) "readily available access points", to rural populations in almost all developing countries. As various researchers have demonstrated, the proximity of financial service providers to end users, especially those based in rural areas, is the key driver to the adoption of mobile money and digital payments¹¹. Therefore, these last-mile financial service providers, combined with recurring payment streams, like remittance in this case, can become a sustainable driver for Financial Inclusion.

However, to date, a host of challenges such as high capital requirements, complex technical infrastructures, certification, regulatory and compliance challenges prevent these organizations from participating in recent payment innovations and being involved in rapid, cost-effective remittance flows.

Against this backdrop, the hypothesis of this project is as follows:

If the host of challenges unique to small financial institutions can be overcome by a sub-national payment infrastructure that is affordable, purpose-built, and easy to integrate, and if such as

⁸ Southeast Asian Consumers Are Driving a Digital Payment Revolution, May, 2021.

<https://www.bcg.com/publications/2020/southeast-asian-consumers-digital-payment-revolutions>

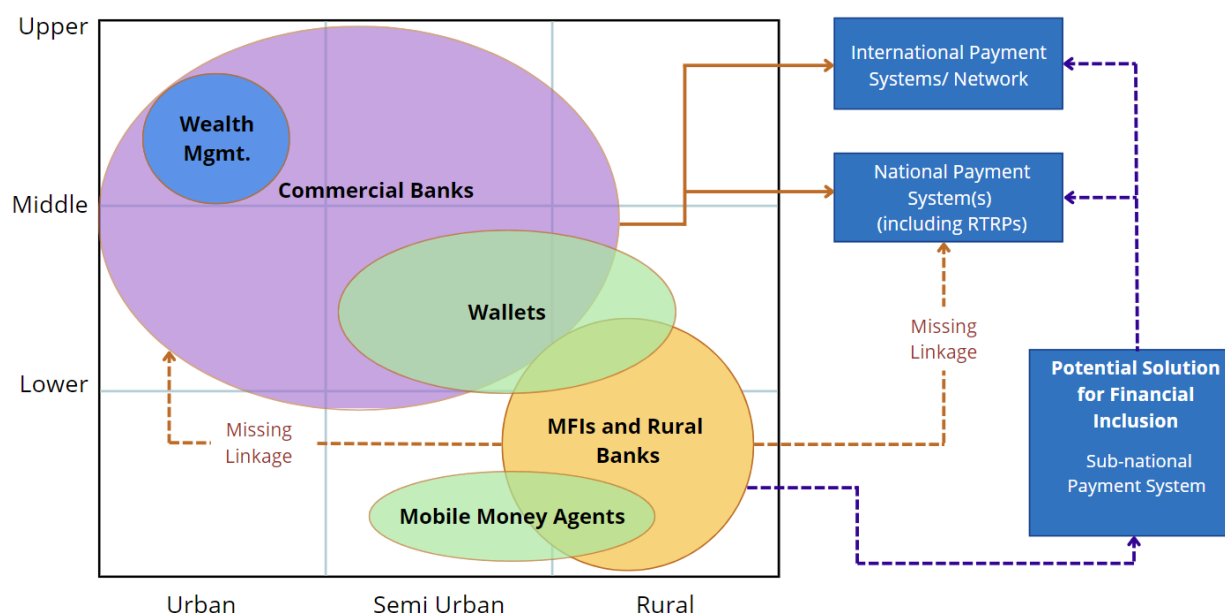
⁹ <https://www.knomad.org/publication/migration-and-development-brief-37>

¹⁰ <https://www.ifad.org/en/web/latest/-/12-reasons-why-remittances-are-important>

¹¹ Proximity Matters: Five Case Studies in Closing the CICO Gap, CGAP, May 2018

system can be connected to well-established payment systems, including national switch and international payment platforms, then low-income rural residences across developing countries can realize cheaper, faster and transparent remittance transactions.

Figure 2. Visual Representation of Intended Customer and Solution Considered



Source: ThitsaWorks Research

Reasons to leverage a sub-national switch

Depending on a given country's situation, there are several options to connect (last-mile) small financial institutions to cross-border payment platforms. In fact, several initiatives came before this one to tackle the same challenges, such as G20 Roadmap for enhancing cross-border payments (FSB)¹².

For countries with well-established national payment platforms, small financial institutions may request direct participation in those platforms. However, in the Philippines, there are significant capital, technical, and certification requirements, making it very challenging for these small actors to join the network. In some cases, small financial institutions may be required to join the central bank-operated Real-time Gross Settlement (RTGS), making any involvement from these small institutions even more challenging, not the least because of system integration requirements. Lest we forget, many small financial institutions operate in legacy operation approaches.

In some countries, a major wallet provider, often with a near-monopoly status can partner with other major remittance actors in the originating country. This option, however, isn't likely to deliver an equitable and inclusive financial ecosystem.

¹² G20 Roadmap for enhancing cross-border payments: First consolidated progress report, October 2021. <https://www.fsb.org/2021/10/g20-roadmap-for-enhancing-cross-border-payments-first-consolidated-progress-report/>

National QR payment solutions may also resolve cross-border remittances to reach rural areas but it may need to take some time to be implemented. Naturally, all approaches have advantages and disadvantages.

The solutions developed in the proof of concept have taken stock of the disadvantages of each solution and aim to deliver a solution with increased speed to market and reach thanks to built-in interoperability features, and the use of subnational switches.

Strategic Goals (Design Principles)

In order to increase speed to market and guarantee significant reach of the network with the ultimate objective to increase financial inclusion, a few design principles were agreed upon at the beginning of the project, applicable beyond the proof of concept:

1. **A Catalyst for Financial Inclusion:** The solution is designed to extend modern payment solutions, cost-effectively, to low-income rural areas. According to recent research by BIS Committee on Payment and Market Infrastructure (CPMI), “digitalisation of remittances, i.e., sending remittances between transaction accounts, is an opportunity to increase access to and usage of these accounts more generally, thereby contributing to financial inclusion”¹³. Therefore, Remittance is chosen as an issue to tackle as it is one of the major income streams, along with agricultural-based income, for low-income rural areas. The project team should design the system in such a way that other rural-focused use cases (and their ecosystems) can be either incorporated or integrated.
2. **Design for Target End Users (rural, low-income residences):** Compelling use cases drive strong interest, but long-term adoption requires trust and control. Therefore, end users (both payers and payees) must have full transparency on fees, exchange rates, and the identity of their counterparties, and must be able to make informed decisions.
3. **Speed to Market as a Priority:** Adopting an ecosystem approach by leveraging appropriate characteristics and elements of existing infrastructure can accelerate solution development and create stronger value propositions. Meanwhile, change requests disrupt business-as-usual (BAU) for functioning payment systems and, therefore, delay acceptance and commercialization. The solution design, where possible, seeks to minimize changes required of existing systems to prioritize speed to market and limit cost of implementation.
4. **Replicable and Scalable Blueprint:** Although the POC focuses on Southeast Asia, the solution should be replicable anywhere with large unbanked/underbanked communities, and only features built-in interoperable functionalities. One-off solutions, even if expedient, should be avoided in favor of the broader application. Meanwhile, Mojaloop is a relatively new technology. To ensure scalability, major technical gaps should be identified during this project and resolved where possible.

Functionally, the project team set the following criteria in Figure 3 as the success factors of the project.

¹³ The Journey so far: Making cross-border remittance work for financial inclusion. BIS, World Bank, June 2022

Figure 3. Envisioning Success

	Existing Options	New Options if Implemented
Network	Close-loop, Same or Preferred Network	Interoperable
Last Mile Network	No	Yes
Channel	Hundi (Informal), Western Union or Bank Channels	Mobile Wallet, Mobile Agent Network, Microfinance, and Rural Banks
Convenience (End Users) (Remitter and Beneficiary)	Submit multiple forms and multiple processes	Minimal Data Entry without compromising Accuracy
Convenience (Small Financial Institution)	No Participation / Complicated Integration / Technical Challenges	Simplified, and Single Integration
Cost	Higher	Lower
Settlement	Nostro/Vostro (Bilateral)	Simultaneous and Centralized
Settlement Speed	T + 2 or T+3	At most 30 seconds

Source: ThitsaWorks Research; PayNow-PromptPay Linkage Whitepaper: A Playbook for ASEAN and the World

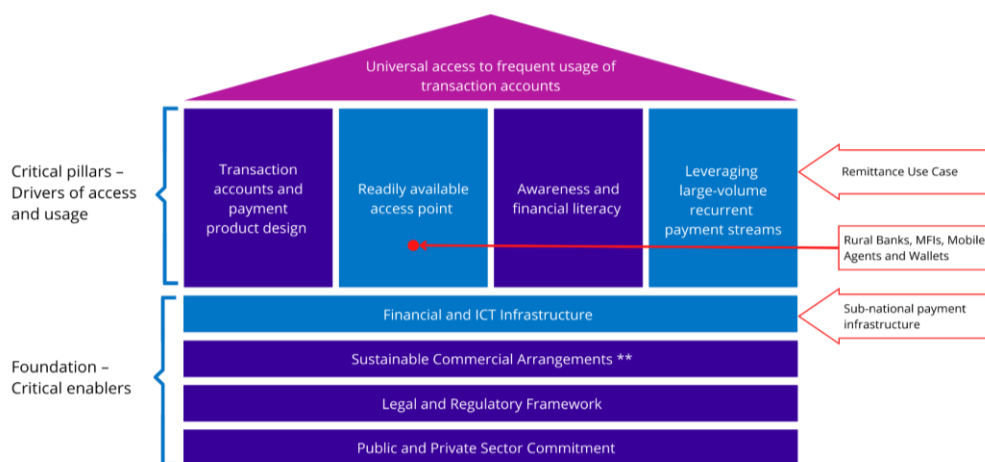
Project Scope and Participants

Project Scope

The proposed solution consists of a proof of concept focusing on the remittance flow, Singapore-Philippines, leveraging the sub-national platform, namely UBX's i2i Platform. Whilst focusing on a specific corridor due to time constraints, the solution is replicable to any receiving country with a Real-Time Payment network and open banking frameworks. It also fits into future cross-border multilateral schemes like BIS' Nexus Project or the Monetary Authority of Singapore's (MAS) and the Mojaloop Foundation's Central Bank Digital Currency Project (CBDC).

Successful operationalization of a cross-border remittance program requires alignment on several components, from use case drivers to enabling pillars. For a cross-border remittance program to become a key driver for financial inclusion requires even more complex coordination, as illustrated in Figure 4, by the joint research published by the Bank of International Settlement, Committee of Payment and Market Infrastructure (CPMI), and the World Bank.

Figure 4. Payment Aspects of Financial Inclusion: the Role of Remittance in Increasing Financial Inclusion



Source: BIS, CPMI, and WB (2016)

Note: Incorporate by the Project Team

As a reminder, the primary goal of this Proof of Concept is to demonstrate that smaller and affordable sub-national platforms can be connected to broader international payment networks, especially for the benefit of low-income rural populations. Therefore, technical aspects of system integration and innovation in this regard constitute the main focus of this project. For better visualization, the focus of this project is highlighted in light blue color in Figure 4 above. Other important aspects of successful cross-border remittance are discussed where appropriate but limited in scope.

Project Participants

To increase speed to market, one of the design principles followed by the project was to leverage existing market solutions. As a result, various participants bringing different sets of expertise, critical skills, and technology are involved in the project:

- **ThitsaWorks:** leads the project with a focus on scope management and grant reporting. ThitsaWorks have been a key project sponsor and a major contributor to the Mojaloop Community/Technology stack, providing technical and operational support, as Mojaloop hub Level 1 technical operation, and, influencing product development and open banking connectivity.
- **INFITX** (previously ModusBox) sits as a key Project Sponsor. Being a key contributor to the Mojaloop Community/Technology stack, and a developer, INFITX provides project management and technical delivery with a focus on the Mojaloop functionality and open banking connectivity.
- **Visa (Visa Direct):** is a key Project Sponsor and operates Visa Direct, Visa's global "money movement" platform that in the proof of concept enables the payment originators to use the Visa network in order to transfer funds in real-time. Visa also provides technical and product subject matter experts who provide substantial input into the solution design.
- **UBX (and UnionBank of the Philippines):** UBX is the hub operator of the "i2i" platform in the Philippines and along with UnionBank of the Philippines facilitates the settlement of transactions in

the Singapore-Philippines corridor, as a member of the Visa Direct network.

- **Lucy:** is a digital neo-bank based in Singapore and features an empowering community toolkit for entrepreneurial women. Lucy's app serving domestic migrant workers is the originating wallet of transactions for the POC.
- **Rapyd:** The Rapyd platform unifies fragmented payment systems worldwide by bringing together 900-plus payment methods in over 100 countries. Rapyd takes the role of the Bin Sponsor for Lucy to connect to Visa Direct clients for this project.
- **Mojaloop Foundation** provides a reference model for payment interoperability. Mojaloop Foundation maintains and constantly enhances its free, open-source software as public goods in service of financial inclusion. All Mojaloop codes developed by ThitsaWorks and INFITX under this POC have been contributed to open-source repositories managed by the Foundation.

System Design, Challenges, and Lessons Learned

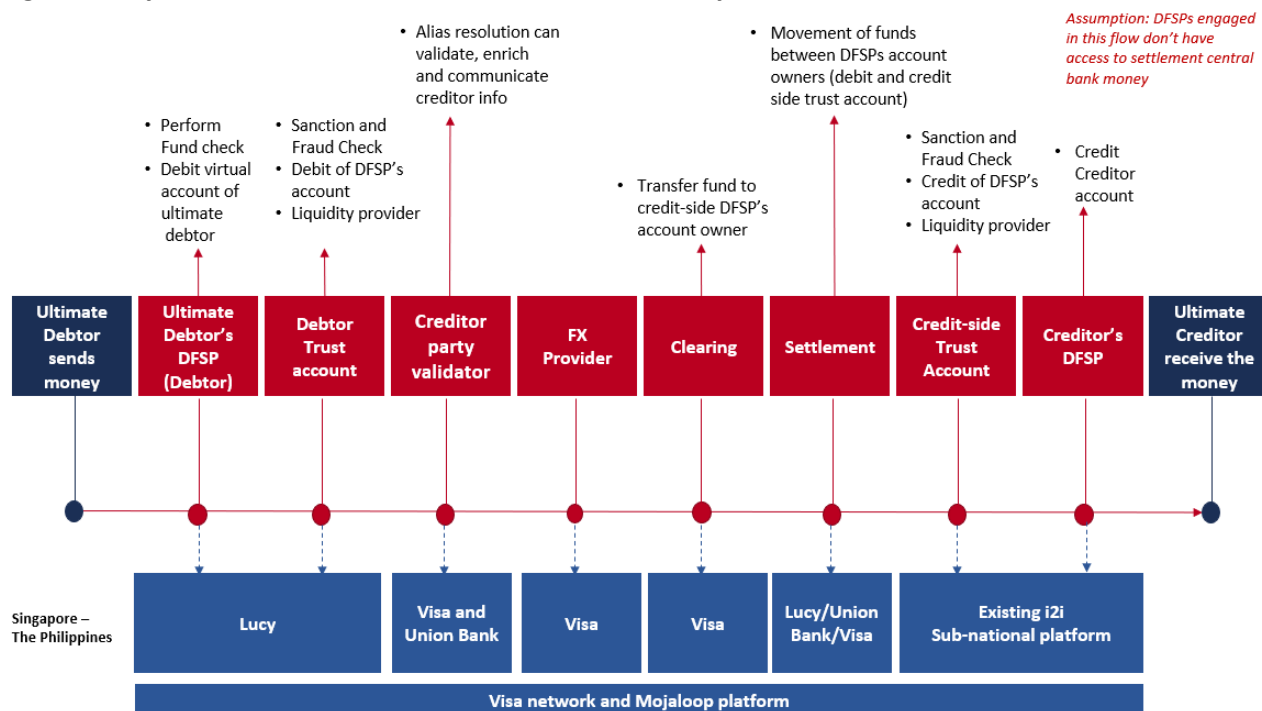
As a reminder, the project aims to connect small financial institutions to real-time payment networks to enable fast, convenient, and ubiquitous cross-border remittances, following the design principles detailed in an earlier section, and focusing on a specific corridor to start.

To accomplish this, the solution combines several market-ready innovations that have not been combined before, creating a real-time clearing payment network coupled with an alias resolution service so that the originator can send payments more conveniently.

As shown in figure 5, ThitsaWorks, INFITX, and Visa have created a first-of-its-kind, connected payment infrastructure supporting financial inclusion, leveraging and enhancing existing payments infrastructure, namely Mojaloop Platform, Visa Direct, and the sub-national payment platform called i2i platform.

- **i2i Platform (Philippines)** - i2i is a blockchain-based payment platform developed by UBX, a company providing an Open Finance platform in the Philippines. The i2i platform functions as an alternative clearing house and payment network and connects to the National Retail Payment System (NRPS), ecosystems of rural and commercial banks, pawnshops, remittance networks, and agent communities. In this project, the i2i platform will function as the payment platform to route incoming remittance from Singapore-based mobile wallets (Payer/Remitter) to its member financial institutions.

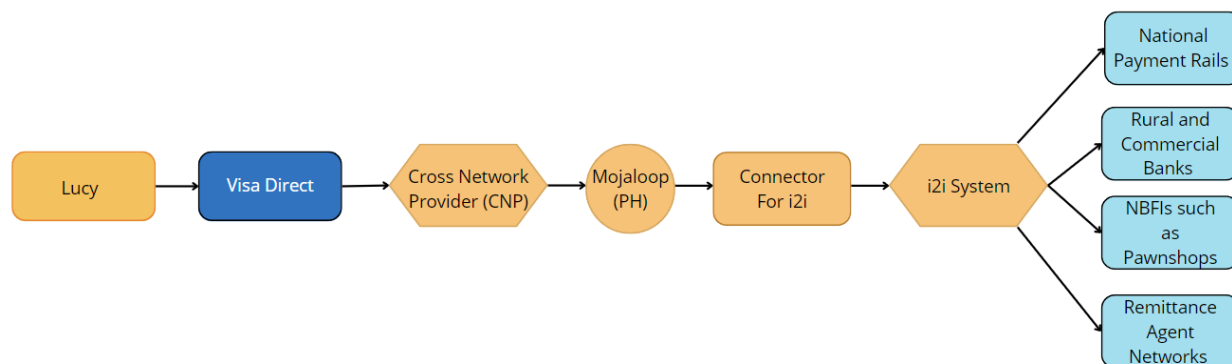
Figure 5. Key Roles within the Process of a Cross-border Payment



Detailed System Design

Figure 6. Architecture of the Proposed Solution

Singapore - Philippines Corridor



Step 1: Payment Initiation

Migrant worker (payer) initiates remittance payments through an authorized, 3rd party application (wallet) which can be connected to an originating financial institution, licensed within the relevant jurisdictions. Payment details include the amount to pay and the recipient's phone number, which is routed through the payer's wallet to Visa Direct System to the cross-network provider (CNP), a piece of Open-Source software which allows translation between the data structures and resources used by two different payment systems, such that requests initiated in one payment system can be executed in another.

Step 2: Alias Lookup/ Resolution

After the payer initiation, an '*Alias Resolution*' request API is sent to Visa Direct's alias directory, in order to retrieve information about the payee, namely the account number, using the phone number of the payee. Technically, the request is then forwarded to the CNP, Mojaloop's account Lookup service (ALS), and then the sub-national payments schemes.

If the payee's phone number is from the Philippines, the request is sent to the i2i platform's Cross network provider (CNP). The CNP then looks up which DFSP the payee's phone number is registered with. Indeed, performing an alias lookup, which queries multiple alias repository systems, the CNP, identifies which i2i - affiliated rural bank has that person on record.

If the payee is successfully identified, the payee details such as name and address, along with applicable fees and FX rates are returned to the payer for verification. If the payee is not identified, the payer will be notified with an error status returned from the '*Alias Resolution*' call and the process ends.

For this POC, to accommodate Visa's current design, the payee's details, such as identifying name and address, are returned along with Primary Account Number, or PAN, for Visa Direct to successfully route funds. This process is described in more detail in Appendix A.

Step 3: Payer Confirms and Transaction/remittance take effects

If the payer confirms the returned information (payee details, PAN (Primary Account Number), fees, and FX rates), those pieces of information are then sent in the payment execution request to make the payment. The information in the '*Push Funds Transaction*' API call is correctly transferred to the CNP endpoint by Visa Direct through the "*Receive OCT*" API request.

Step 4: Clearing / Settlement

A payment request is sent from the institution holding the trust account to the clearing and settlement institutions involved in the payment flow to reach the trust account on the payee (creditor) side.

Step 5: Transaction Confirmation

The beneficiary financial institution, namely Union Bank immediately notifies the payee of the transfer connected to all rural banks through the i2i network. This notification will come through the beneficiary financial institution' app, or network-level PISP, or Account Information Service Provider (AISP).

Confirmation of credit is also sent back to the payer through the originating channel to confirm the transaction is completed.

Technical Innovations Delivered

In order to create a complete, consistent end-to-end solution, the project team had to overcome a few technical challenges, and enhance or develop new components. Based on the solution design and design principles agreed on in the project, the following are key technical challenges the project team determined

as most critical and elected to resolve. To note, the following is not an exhaustive list. Other challenges that required solving in a project as complex as this one is listed and discussed further in Appendix A.

1. Connecting Different Payment Systems (Inter-System Transactions)

To be able to link the various schemes and have transactions flow smoothly through Visa Direct and the sub-national scheme, i2i, the technical team had to develop an adapter called **Cross Network Provider, or CNP**, which synchronizes different specifications across the two systems, especially the messaging format.

As described in detail in Appendix B, Mojaloop's Payment Manager, originally designed to connect Mojaloop Core with the Core Banking System (CBS) of Small Financial Institutions, was leveraged significantly to develop the CNP. The development of the CNP also benefited significantly from the previous collaboration between Visa, Mojaloop Foundation, and INFITX. *The solution is proven to work in the Visa Direct-Mojaloop Sandbox environment. It also satisfied the design requirement of "No-changes" to the existing Infrastructure, Visa Direct.*

Moreover, during implementation, the team discovered that i2i System utilizes an asynchronized API connector, which was not compatible with the original design of the CNP. For example, the callback API, which conveys the final status of a transaction as soon as it is delivered to the i2i system, was not working. As a temporary solution to overcome this challenge for the POC, the team implemented another Core Connector to call the 'Get InstaPay status' API to the i2i system until the final status message is received from the i2i system.

The temporary solution functioned well in sandbox testing. However, a long-term solution - incorporating Asynchronized Implementation in the Core Connector - is needed for commercial operationalization. This long-term solution was designed but not implemented due to time constraints. *The team is confident that the long-term solution will satisfy the design requirement of "No-changes" to the existing Infrastructure, in this case, "i2i".*

2. Using Existing User Interfaces

As a reminder, one design principle of the project was to demonstrate that it is possible for payers to remit overseas using existing UI/Channels (i.e., mobile wallets).

In order to fit in within Lucy's existing UI, the project connected Lucy to Visa Direct, using 3 APIs, namely 'Alias Resolution', 'Get Foreign Exchange', and 'Push Funds'. The system was successfully tested in Visa Direct Sandbox and Lucy Sandbox. In actual deployment for commercial purposes, Lucy would require a BIN Sponsor, which generally refers to a licensed, financial-institution member of the Visa network that serves as an acquiring bank for any merchant, to connect to the Visa Direct network. The project team has established, for commercial purposes, Lucy can connect to a BIN Sponsor the very same way it was integrated to Visa Direct. Moreover, the same integration method can be replicated across any Singapore-based mobile wallets. Therefore, the project team is confident that existing UI/Channels can be utilized by the payer/remitter.

Moreover, there was a discrepancy to tackle in terms of identifier format, as InstaPay in the Philippines

utilizes a 16-digit bank account number as the unique identifier. For this project, the project team mapped the bank account number with the mock phone number for testing purposes. For the next phase of the project, the team will work on an API which handles the mapping between MSISDN (Phone Number) and the bank account identifier of the recipient payee.

3. Transparency (Total Transaction Cost) before Remittance

To ensure full transparency and convey information like fees and currency conversion (FX Rates) and enable the payer/remitter to make informed decisions, the APIs provided by Visa Direct were used. Both Fees and FX rates were then appropriately displayed in the Lucy app as the design principles called for. Leveraging Visa Direct's API means that the project had to make some design compromise. Indeed, the current system can only support a single currency-pair conversion by the single settlement partner. For example, a Filipino migrant worker would initiate payment and the currency conversion only involves a single currency pair (SGD-PHP) and the proceeds are credited to PHP into the i2i trust account. Looking at the recently-announced QR payment linkage between 5 ASEAN nations, there is a preference within the region for bilateral currency trades¹⁴.

If, however, the remittance requires two currency-pairs conversions (e.g., first, from SGD-USD and then to USD-PHP), which is likely for currencies with thin liquidity in the secondary markets, the current system flow will not fulfill the full design requirement. In such a case, additional information needs to be captured at the Cross Network Provider level, and separate information flow would need to be considered to provide end-to-end transparency in rates and fees to the end user.

For the payer/remitter to see both legs of the transaction, Mojaloop must return the associated Fee and FX information with the Alias resolution and Visa Direct must be able to accept this additional information and then pass it to the payer's app. The Mojaloop system can accommodate the return of fees and FX information (extension parameters), but the project team is of the opinion that it will require certain changes within the Visa Direct system. Therefore, this scenario could contradict the "No-change" design principle. More investigation into this challenge will be required in the next phase of the project.

4. Resolving Addresses (Transaction Routing to Correct Account)

As mentioned in the strategic goal, with low-income, rural residences as the key user base, the solution (user experience) must be simple. In other words, the burden of technical complexities must be resolved by the system rather than the users. This means that, in the Mojaloop system, the payer (debtor) is only required to know the phone number of the payee (creditor).

During the initial planning stage, the project recognizes that a single phone number is being used to register (onboard onto) multiple wallets (DFSPs). To cater with this scenario, the Account Lookup Service (ALS) featured in Mojaloop had to be modified to **Multiple Alias Oracle**. The Multiple Alias Oracle enables the system to (1) resolve (and assign) which financial institutions (DFSP - wallet or MFIs) to route the payment

¹⁴<https://thepaypers.com/mobile-payments/five-southeast-asian-countries-to-welcome-linked-qr-code-payments--1257568#>

by first sending the address resolution to the respective repository; (2) receive a confirmation of which financial institution to intermediate the payment; and (3) allows the user (payee) to change the associated/preferred financial institution (DFSP) associated with the alias phone number (MSISDN¹⁵) to be changed. A detailed flow chart on this can be found in Appendix D.

When it comes to the preferred wallet provider, two options were considered: 1) an option called the **Default Preferred Setting Method via Wallet Provider**, where the payee can set the preferred DFSP (either wallet or rural bank) to receive the remittance or 2) an option called **Default Setting Method via Latest Registration**, the system automatically assigns the latest DFSP (wallet or MFI/Rural Bank) the recipient onboarded (opens an account with). Assessing the pros and cons of both options, the project team opted for option 2. The key disadvantage of the second option is that the recipient (payee) will need to register the preferred DFSP (wallet or MFI/Rural Bank). In addition, the payee (creditor/recipient) may not be aware that the preferred DFSP (*wallet) was changed due to the latest registration method if the necessary information was not acknowledged to the payee after the registration. However, to avoid dependencies on wallets and more particularly having to modify the UI wallet which would be against the design principle “no change to existing systems”, the second option was chosen, implemented, and tested successfully in the Sandbox environment. Moreover, the Alias Oracle was updated to allow the payee to change their preferred wallet with SMS verification.

During implementation, the project team discovered that the i2i system does not have the system capability to support the “fetch” function of the payee’s account information associated with the phone number (alias) (MSISDN). As a workaround solution, a mock repository was written into the program to support Mojaloop ALS. In the test environment, the mock repository successfully returns the needed information to effect payment. If the cross-border payment is to function according to the system’s original design principles, the “i2i” system will need to have an Account Look Up Service (ALS). This could be considered for the next step of the project.

5. Account Information Flow (Account Information)

As per transaction flow design, after the payer (debtor) initiated the remittance transaction, the payer (debtor) must be able to receive and review the actual name of the payee (creditor) associated with the given phone number. Only then the payer could continue to the confirmation stage to effect payment with confidence. To accomplish this, the account information of the recipient must travel from the recipient’s payment system to the payer’s payment system. This same function is equally important from the regulatory/compliance perspective, specifically AML/CFT screening by various parties.

To resolve this challenge, two solutions were considered. The key function of the **Multiple Alias Oracle** is to identify both the correct transaction route and enriched payee details using the phone number specified by the payer. Therefore, the payer’s payment system (Visa Direct, in this case) can leverage Multiple Alias Oracle’s functionalities through Mojaloop’s ‘*Get Party Alias*’ API and receive proper account / KYC

¹⁵ For reference, MSISDN is a number uniquely identifying a subscription in a Global System for Mobile communications. It is the mapping of the telephone number to the subscriber identity module in a mobile or cellular phone.

information. This approach, while expedient, will require a certain level of upgrades/updates on Visa Direct (the existing system).

Alternatively, a new system can be developed which would ensure that any new information (i.e., new accounts created or updates to existing account information) is simultaneously updated in Visa Direct's Alias Directory (through Visa Direct's *"Create Alias"* and *"Update Alias"* API functions). This approach - Federated Directory - can be highly applicable for connection with any other payment services. It would also satisfy our "No-changes" design principle.

However, having discovered this challenge late in the project, the project team was not able to implement and test the proposed solution, given the tight deadline. As a result, for this POC, this challenge was resolved by the project team directly duplicating the test alias samples within Visa Direct's own Alias Directory. Furthermore, it was agreed that the associated PAN (Primary Account Number¹⁶) will be returned for each transaction. For instance, if the payee (recipient) has changed the phone number and/or preferred wallet, the new information will not be updated in the Visa Direct system.

6. Funds can be Settled Across Payment Systems

As a reminder, the project team aimed to demonstrate that funds can be settled across systems and jurisdictions, without any need for the respective DFSPs of the payer (debtor) and payee (creditor) to arrange bilateral settlement arrangements. To accomplish this, the system, from the outset, was designed to leverage existing relationships between members of the Visa Direct network.

To successfully leverage Visa Direct as a centralized cross-border settlement institution, several options were explored. Initially, it was understood that every payee (creditor), regardless of where he/she resides, must have a Visa Direct' PAN for settlement between Lucy and Union Bank to take effect. However, accomplishing this would require additional mapping while unnecessarily inflating Visa Direct's Alias Directory. For practical reasons, during the POC, Lucy, and i2i were all assigned a mock PAN for settlement to take place. In other words, as the remittance from Lucy's client (the payer) takes effect, funds will be debited from Lucy and credited to Union Bank. At the point of this writing, there is no consensus on the effectiveness of this solution for long-term applicability and additional investigation is required.

The key challenge uncovered during the project is the need to ring-fence two separate classes of transactions in the hub - domestic transfers and cross-border remittances. Currently, the Mojaloop Core is only concerned with a single settlement transaction.

Recognizing the need to distinguish between internal transfers and remittance transfers and settle them according to separate settlement models, two solutions were considered;

- Use an identifier type which is specific to external transfers: This would enable participants to register their customers separately for the receipt of remittances which would enable the

¹⁶ For reference, PAN, also known as Primary Card Number, as they are generally found on payment cards such as debit card and credit cards, are generally used as the primary identifier by major payment companies such as Visa, MasterCards, and American Express. However, this solution is not a viable long-term solution.

participant to collect appropriate customer information but it would need modifications to the partyIdType.

- Use existing mechanisms to designate the transfer request as a transfer with a subclass of remittance. This translates to using the subScenario element of the TransactionType object in the Mojaloop request.

In both cases, the appropriate value would be set for inbound transfers by the CNP and there is no change needed to the behavior of creditor DFSPs and ultimate creditor. For a detailed discussion of the Settlement Model, please see Appendix A.

As a long-term solution, a function to distinguish between domestic transfer and cross-border remittance could be incorporated into the next version of the Mojaloop release.

Due to time constraints, the project team was not able to test the settlement model for the Singapore-Philippines Corridor at the time of this writing.

7. Rapid Funds Clearing Across Payment Systems

Clearing of individual transactions embedded in the Mojaloop technology is facilitated by the use of Interledger's cryptographic commitment and fulfillment elements and the JWS signing of participant messages. Accordingly, as soon as the payer confirms the transaction, the funds will be credited into the payee's account. The Mojaloop system ensures that clearing and settlement are executed in Singapore dollar (SGD) and their respective recipient currencies, in this case, the Philippine peso (₱).

Given Mojaloop's design, clearing of funds into the payee's (ultimate creditor) account is assumed to be automatic if the various participants in the transaction flow are confident that the preceding six technical objectives are successfully resolved. To validate this, end-to-end testing is required.

8. Lower Cost Operation

Several researches have indicated that lowering barriers to direct access to payment infrastructures and access points can lower costs and improve speed for cross-border remittances for financial services providers¹⁷. These studies uncovered the key driver for cost saving arises from DFSP/small financial institutions having direct access to payment infrastructures, which allows them to efficiently, and transparently, move funds across borders and settle them domestically. This cost-saving, in turn, can be passed forward to end users, both payers (ultimate debtors) and payees (ultimate creditors).

As mentioned earlier, the feasibility of a sub-national payment infrastructure is proven. Moreover, UBX's i2i sub-national platform is connected with a hub which was built with an open-source Mojaloop technology, which significantly reduced the upfront capital cost required to establish. In addition, Mojaloop's Payment Manager and Core Connect are leveraged to efficiently onboard small financial institutions. Last but not least, as the previous discussion illustrated, connecting Mojaloop-based sub-national payment platforms to

¹⁷ The Journey so far: making cross border remittance works for financial inclusion. BIS and World Bank, June 2022.

international payment networks is equally feasible and affordable. Therefore, the project team is confident that cross-border remittance settlement and clearing can be extended to rural-based small financial institutions cost-effectively.

Challenges and Lessons Learned: Non-Technical

Unforeseen technical challenges are common in almost all solution implementation projects. The previous section described in detail these challenges that were overcome by delivering new or enhanced functionality.

For this POC, the project team also faced a number of non-technical challenges. The following section outlines key challenges and mitigation actions implemented during the project.

1. Shorter than Expected Project Timeline

At initiation, the project was expected to last 6 months. The actual implementation timeline was cut short - 4 months - due to the late approval from key stakeholders. In retrospect, the project scope should have been reviewed and adjusted. However, the project went ahead as originally planned.

2. Availability of Resources from Project Participants and Communication

Ensuring adequate time and resources were allocated to complete the POC successfully by all project participants was a challenge, particularly considering the number of parties involved in the POC. Indeed, to leverage upon several exciting solutions, as agreed in the design principles, the project sponsors invited numerous participants (please see Appendix E).

Their participation was extremely beneficial for the project as it allowed the team to understand each technical challenge holistically. However, this also created communication challenges and limited the efficient flow of information to key decision-makers. The roles and responsibilities of each participant, along with their availability should have been clarified and documented in detail at the project inception.

For the next phase of the projects, the following mitigation actions are considered:

Utilizing a project plan with critical path activities. The objective would be to more actively balance the priorities and workload of project team members and regularly monitor and track resource usage and risk to ensure that resources are being used effectively and that any issues or concerns can be identified and addressed promptly.

- Using RACI Framework (Responsible, Accountable, Consulted, Informed) or similar methodology to ensure efficient development and implementation.
- Aggressive testing of assumptions. As we have discovered, several technology modules perform the exact same functions, but the underlying logic and specifications can vary widely.

Other Potential Use cases

Whilst the POC is focused on a specific corridor, the project targets remittance in general and specifically, remittances by migrant workers to their families in remote/rural areas of the recipient country i.e. inbound remittance. However, the solution put in place is flexible and comprehensive enough to accommodate a number of different use cases, making it potentially more commercially profitable and more attractive.

1. Outbound Payments

Although the current project focuses on inbound transactions from Migrant Workers in Singapore to families in rural areas, the architecture could easily allow for the reverse transactions. For instance, family members and relatives in the Philippines, utilizing the cross-border mechanism derived from the Mojaloop payment platform, could easily send monthly living expenses to their children attending university in Singapore.

2. Cross-border Request to Pay

Referred to as RTP in the UK, Request 2 Pay (R2P) in Europe and “Collect” function in UPI Payments in India, this emerging function where the payee initiates a push payment from the payer, could bring substantial benefits to merchants (and potentially financial institutions). It is still secure because the payer is still in full control and makes the final decision as to whether the payment will take effect. More to the point, simple enhancements to the architecture of current POC can deliver this functionality for cross borders payments.

3. e-Commerce Transactions

The importance of e-Commerce platforms in the everyday lives of citizens in the Philippines is beyond dispute. Moreover, with significant improvements in cross-border logistics, more merchants and small businesses are deriving larger portions of their revenue by selling across various borders. With cross-border payment growing, small businesses in the Philippines could sell their goods to consumers in Singapore, without having to worry about payment challenges, driving C2B, B2C, and B2B including small-business-to-small-business payments.

4. Travel and Tourism

International travelers, utilizing Singapore-based and approved wallets, can pay for goods and services while traveling to the Philippines. By means of example, eco-tourist, or tourists traveling to rural areas could finally benefit from modern payments infrastructure. Today, generally, a tourist will have to exchange Singapore Dollars (SGD) or United States Dollars (USD) to local currency and carry local currency. However, with cross-border wallet-to-wallet payments, the situation could change. Tourists could easily bypass the need for cash notes, and make payments to local merchants through this platform.

5. Lending (Personal Loans)

Given that accelerating financial inclusion is a high priority for the project team, the proposed cross-border remittance solution, combined with Request-to-Pay, could indirectly improve financial inclusion and access to affordable lending in the recipient country. Many microfinance and rural banks in the Philippines offer

personal loans, tied to the income stream, mainly salary. However, to date, this type of product can only be linked to local income streams. If the cross-border wallet-to-wallet payment solution becomes a reality, many families will be able to secure affordable loans from reputable financial institutions based on the income stream of their primary earner, who is working as migrant workers in an international metropolis.

To effectively expand the scope of the POC to other potential further use cases, it is essential to identify potential customers and partners who would benefit from the solution. Additionally, conducting market research to understand the competitive landscape and identifying key differentiators for the solution is crucial in developing an effective Go-to-Market strategy. This strategy should clearly outline the target market, pricing, positioning, and sales and marketing tactics. To execute this plan, it is important to build a dedicated team or establish partnerships that have the necessary skills and resources to effectively bring the solution to market. This will help ensure the success of the solution in the given market and its ability to meet the needs of its target customers.

Conclusion and Next Steps

To deliver faster, cheaper and transparent cross-border remittance to low-income, rural areas in developing countries, the project team sought to validate the hypothesis that smaller financial institutions can be onboarded onto a sub-national payment platform which can then be connected to established national and international payment platforms, utilizing SG-PH corridor - as a case study. Four key design principles were identified as necessary to validate the aforementioned hypothesis:

- Designed for target end users
- Speed to market as a priority
- Replicable blueprint
- Scalable model

As this whitepaper have illustrated, required solutions to meet the POC objectives and following the design principles agreed were implemented in a bi-lateral sandboxes. Indeed, leveraging Mojaloop, INFITX, ThitsaWorks, Visa Direct, Union Bank, and Lucy's expertise and technology, the project delivered a solution that can enable migrant workers to remit money in rural areas of their home country, with more transparency, increased speed, and reduced operational costs. As migrant workers do not need to leverage informal solutions anymore, money can also be remitted more safely.

The success of this POC has also proven that a scalable and replicable solution to deliver faster, cheaper cross-border remittances, beyond this corridor in consideration for the POC can be implemented. Actually, different use cases like lending or eco-tourism, just to name a few, could also be tackled, assuming the technical future considerations described in this whitepaper have been investigated and brought to a conclusion.

To fully market this solution and convert this POC into a commercially sustainable solution, the next phase of the project would be to perform end-to-end testing with full clearance of remitted funds within the allotted time frame. Due to time constraints and some challenges encountered on the project like the disengagement of one partner, this activity remains to be performed.

Indeed, for this project, pre-existing settlement arrangements between Visa Direct member, in this case, Union Bank, was considered as a prerequisite. However, it should be noted that, in actual operation, the settlement windows of payment schemes may not coincide, potentially resulting in credit risk to the settlement banks. Each payment system has its own methods and timetable for settling funds between its participants, and its own rules for guaranteeing that participants have the funds available for settling the transfers they make. Commercial and other risk-mitigation arrangements such as interbank credit lines can be leveraged to resolve these types of issues. Best practices in this regard should be explored as a key next-step action item.

Therefore, the project team is fully confident that the proposed solution can become a scalable and replicable solution to deliver faster, cheaper cross-border remittance, at least from a technical perspective, and, even tackled different use cases, assuming that the technical future considerations will be investigated more and implemented.

Now that the project has developed an end-to-end solution, the next phase of the project could focus on converting this POC into a commercially sustainable solution, focusing more on the marketability of the solution.

Although the solution proposed is highly feasible, it is made possible by incorporating more market actors into the transaction flow. Therefore, the traditional revenue-sharing models focusing on markups for profitability may not work. A volume-driven probability model, striving for an economy of scale, seems probably more suited, especially if the value created through low-cost operation is to be efficiently transferred to end users (both payer/debtor and payee/creditor).

Perhaps to make the model more economically sustainable, more ecosystem partners could be on-boarded. Indeed, for this project, a single entity, namely Visa, provides both the settlement and the foreign currency conversion services. However, strong competition creates better pricing for end users, which drives adoption. Strong adoption and therefore transaction volume, in turn, creates a virtuous cycle and benefits service providers. Against this backdrop, it is highly advisable that, for the benefit of both end users and service providers alike, the platform is open for more FX service providers and clearing and settling partners. This can be easily implemented with API-driven solutions.

Last but not least, a stronger focus on regulatory and compliance requirements is recommended for the next phase in order to scale the platform. As illustrated, any necessary data/information can be captured for both payer/debtor and payee/creditor and this account information can be transmitted across different payment systems, allowing the involved party to meet financial integrity recommendations. However, the focus of this proof-of-concept project was more on the development of a technical solution. Therefore, for the next step, it would be recommended to analyze more in detail financial integrity requirements. Roles and responsibilities, along with agreed standards to abide by in this space would need to be discussed among the key stakeholders, particularly while consensus global on standards like account format or harmonized procedures remain work to be done.

Appendix

Appendix A - Technical Challenges to Investigate Further

One of the most valuable outcomes from the development and deployment of a Proof of Concept is that it brings to the surface issues which are not immediately obvious when the project is considered at a design level, but which actual implementation finds that it needs to define and solve. The Proof of Concept undertaken for this project was no exception to this, and this section describes the most significant challenges faced during the design and development phases, together with the immediate solutions adopted to make the Proof of Concept viable, and possible solutions to the longer-term problems when overcoming these challenges within the time constraints set by the POC was not achievable.

Directory Structures in an Interconnected System

One of the fundamental tasks for an interoperable payments system is the conversion of a tag into a route. A tag is anything which the sender of funds wants to use to identify their recipient: it might be an internationally recognised account identifier like an IBAN, or it might be something much less generally recognised, like a national ID number, which is unlikely to be recognisable outside the boundaries of the state that issued it. But in any case, the tag in itself is not of great use in executing a payment. For the tag to become usable, it has to be converted into two things. First, it has to be used to identify an account-holding institution which will commit to crediting the party identified by the tag with the funds being sent; and, second, there has to be a way of routing, and perhaps also converting, messages relating to the payment between the sending (debtor) institution and the receiving (creditor) institution.

Normally, payment systems solve this problem by holding a centrally available directory of information which can be used to identify an account-holding institution given a piece of information about the holder of the account in question. These directories are typically quite different in structure and function from each other, and no internationally recognised standard for them currently exists. In particular, there is a sharp distinction between centralized directories and distributed directories.

In a typical centralized directory, all the information relating to a beneficiary is stored as part of the directory. This will typically include, as well as a unique account identifier, information about the various tags which may be used to identify that account, and KYC information about the account holder. It is typically the responsibility of account-holding institutions to keep all of the information in a centralized directory up to date - so, for instance, if a customer moves house, the account-holding institution will update their address in the central directory.

Duplicate Identifiers

Typically, it is assumed that the identifiers used to locate the institution which administers a particular account are unique within a payment system. In some cases (for instance, an IBAN in the jurisdictions where they are used) this is a reliable assumption. In others (for instance, an MSISDN) it is not reliable. Users can belong to more than one mobile money service provider, or different family members might share a handset. Therefore, the MSISDN does not uniquely identify a mobile money system.

This scenario is multiplied when it is necessary to consider different payment systems. A migrant worker in Singapore may still use a phone from their home country, and they may register that phone as an alias for their bank account in the country where they are working. In their home country, their MSISDN may be used as an account identifier in a Mobile Money System. Now an address resolution query across both systems would return a result for the bank in the immigrant payment system, and a result for the mobile wallet in the home payment system, even though both entries are unique in their payment systems.

One highly possible scenario is that a customer has set up multiple mobile wallet accounts using the same phone number. This is a difficult problem which will not be solved immediately. It is generally recognised by international institutions such as UNCDF that solving it will take time, effort, and ingenuity. We have implemented a temporary solution for the POC, but over the long term, we would recommend joining these initiatives.

Settlement Models

Each payment system has its own methods and timetable for settling funds between its participants, and its own rules for guaranteeing that participants have the funds available for settling the transfers they make. Where transfers are made between payment systems, there will be a credit risk associated with any mismatch between the two forms of settlement: for instance, if the transfer in the target system must be settled before the funds are settled in the source system.

We made an initial innovation which enabled our target system to distinguish between transfers which were remittances and transfers which were internal to the payment system and to settle the remittance transfers on a different timetable. However, a longer-term solution to this problem will be required before the model can be fully generalized.

KYC Information

Eventually, there is a need for a mechanism to have an agreed set of KYC information which is capable of universal implementation, appropriate to the KYC structures of the poor, and to have a way for participants to request the KYC information specific to their jurisdictions. As illustrated in Technical Objective 5: **Account Information Flow**, necessary account-level (for payee / ultimate creditor) information for KYC and other compliance screening purposes can be stored at Mojaloop, either in a Federated Director or similar approach and made available to different actors in the remittance flow. In terms of agreed-upon format, the FATF regulations offer a potential way forward in this area, subject to general adoption of the most up-to-date recommendations, which do not require an account number to be included as part of the identification of the parties.

Fees

Many existing remittance corridors are operated on the basis of bilateral agreements between FIs, in which fees are typically settled out of band. Interoperability and agreement on fees are essential to replace bilateral relations with hub-and-spoke relations. The existing model will be unworkable at the kind of scale we want to think about.

From a functional and technical perspective, the solution is to extend the API's functionality to allow the definition of fees at a per-transfer level and the definition of fees at an IIPS level, where hub fees and interchange fees are charged. These can currently be charged and collected out of band, but this will not work with cross-network traffic. Thus, the Mojaloop API needs to be extended so as to support the definition of hub fees while retaining the non-repudiation check; and the Visa Direct API will need to be extended so as to allow a transfer phase in which the fees to be charge for a transfer are defined and passed back to the payment request initiator.

Connecting to Blockchain-based Payment Networks

During the project, the connection between UBX's blockchain-based payment solution and Mojaloop-based payment platform raised a number of technical questions that are out of the scope of this POC, but worth investigating further. The impact on Mojaloop Ledger's integrity (in current design) when connected to the blockchain network's ledger needs to be properly understood and, if needed, incorporated in future releases (versions) of the Mojaloop Core. The G20 Roadmap (FSB (2020b)) recognises the potential of global stablecoin (GSC) arrangements to improve cross-border payments, including international remittances¹⁸. The same is true with Central Bank Digital Currencies (CBDCs) as well. Therefore, a significant investigation into the compatibility of Mojaloop technology and the Blockchain-based payment platform is much needed.

¹⁸ The journey so far: making cross-border payments work for financial inclusion. BIS CPMI and WB, June 2022.

Appendix B - Technology and Innovation

The following are key technology components that were leveraged and/or developed for this project.

Mojaloop Open-Sourced Payment Technology

Mojaloop is a modern, real-time payment system governed by the Mojaloop Foundation¹⁹. As an open-source solution and digital public good, Mojaloop offers an alternative for countries and companies that want to control their payment software infrastructure. Mojaloop can handle a variety of transaction types: peer-to-peer, merchant payments, cross-border, etc., and comes equipped with extendable account lookup, ledger, third-party initiation, and settlement services. In the solution developed for the POC, Mojaloop acts as the foundation layer for the processing of the payments. New innovative functionalities have been built on top of the open-source code to increase the reliability, certainty, and reach of a payment.

The basic idea behind Mojaloop is that we need to connect multiple Digital Financial Services Providers (DFSPs) together into a competitive and interoperable network in order to maximize opportunities for poor people to get access to financial services with low or no fees. We don't want a single monopoly power in control of all payments in a country, or a system that shuts out new players. It also doesn't help if there are too many isolated subnetworks.

Mojaloop addresses these issues in several key ways:

- A set of central services provides a hub through which money can flow from one DFSP to another. This is similar to how money moves through a central bank or clearing house in developed countries. Besides a central ledger, central services can provide identity lookup, fraud management, and enforce scheme rules.
- A standard set of interfaces a DFSP can implement to connect to the system, and an example code that shows how to use the system. A DFSP that wants to connect up can adapt the example code or implement the standard interfaces into their own software. The goal is for it to be as straightforward as possible for a DFSP to connect to the interoperable network.
- Complete working open-source implementations of both sides of the interfaces - an example DFSP that can send and receive payments and the client that an existing DFSP could host to connect to the network.

The Mojaloop hub is the primary container and references we use to describe the Mojaloop ecosystem which is split into the following domains:

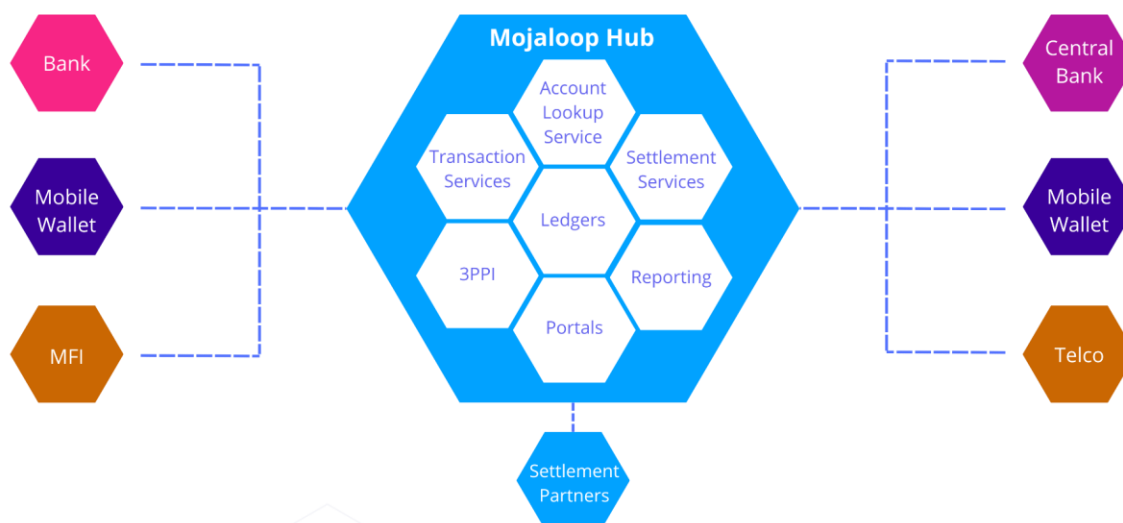
- Mojaloop Open-Source Services - Core Mojaloop Open-Source Software (OSS) that has been supported by the Bill & Melinda Gates Foundation in partnership with the Open-Source Community.
- Mojaloop hub - Overall Mojaloop reference (and customizable) implementation for Hub Operators is based on the above OSS solution.

¹⁹ <https://mojaloop.io/>

Figure 7. Mojaloop Design

Mojaloop Design Includes all Key Components for Interoperable RTP System

Interoperable, Real-Time, Push Payment Technology



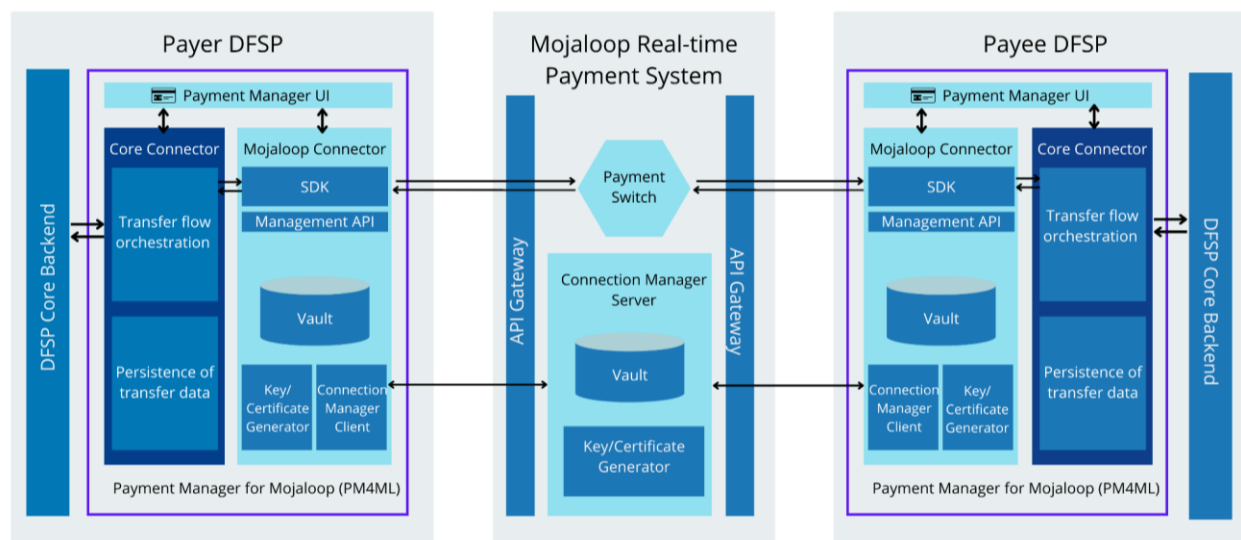
Source: Mojaloop Foundation

Payment Manager (Payment Portal)

In a Mojaloop Real-Time Payments (RTP) ecosystem, the Mojaloop Switch connects Digital Financial Service Providers (DFSPs) – such as banks or mobile wallet providers – in order to enable financial transactions between DFSPs' end users in an interoperable way. Designing, building, and validating a service that connects a DFSP's Core Backend through to a Real-Time Payments System, such as Mojaloop, requires a detailed understanding of the business, technical, security, and operational requirements of that system. To facilitate integration and onboarding, an adapter called Payment Manager has been developed by the Mojaloop Foundation.

The following diagram provides a high-level view of the integration between a Mojaloop Real-Time Payment System and a DFSP's Core Backend.

Figure 8. Payment Manager for Mojaloop – System Architecture



Source: Payment Manager for Mojaloop - DFSP Integration by INFITX (previously ModusBox)

This Payment Manager acts as the integration layer between Mojaloop and the DFSP, enabling a simple, seamless, and secure way of connecting to a Mojaloop Switch, and a toolkit that helps manage multiple connections as well as services and transaction monitoring. It appears to the DFSP as an external party which understands the DFSP's Core Banking System, and to the Mojaloop network as a Mojaloop participant. Payment Manager includes the following components:

- **Core Connector:** A key role of Core Connector is to "translate" the simplified synchronous Mojaloop API that Mojaloop Connector SDK speaks, for the DFSP Core Backend.
- **Mojaloop Connector:** Integrated SDK that provides a simplified synchronous version of the Mojaloop FSPIOP API and connection components to manage endpoints and certificate (TLS and JWS) security configuration, automating the exchange of this information with the hub. It also manages the Interledger Protocol (ILP) packet with signing and validation to simplify API interactions.
- **Payment Manager UI** - User interface that provides a set of tools that help with the monitoring of transactions and service status, as well as the debugging of errors and a connection wizard with a guided process to provide endpoints and certificates required to establish a secure connection.

The Payment Manager has the following technical characteristics:

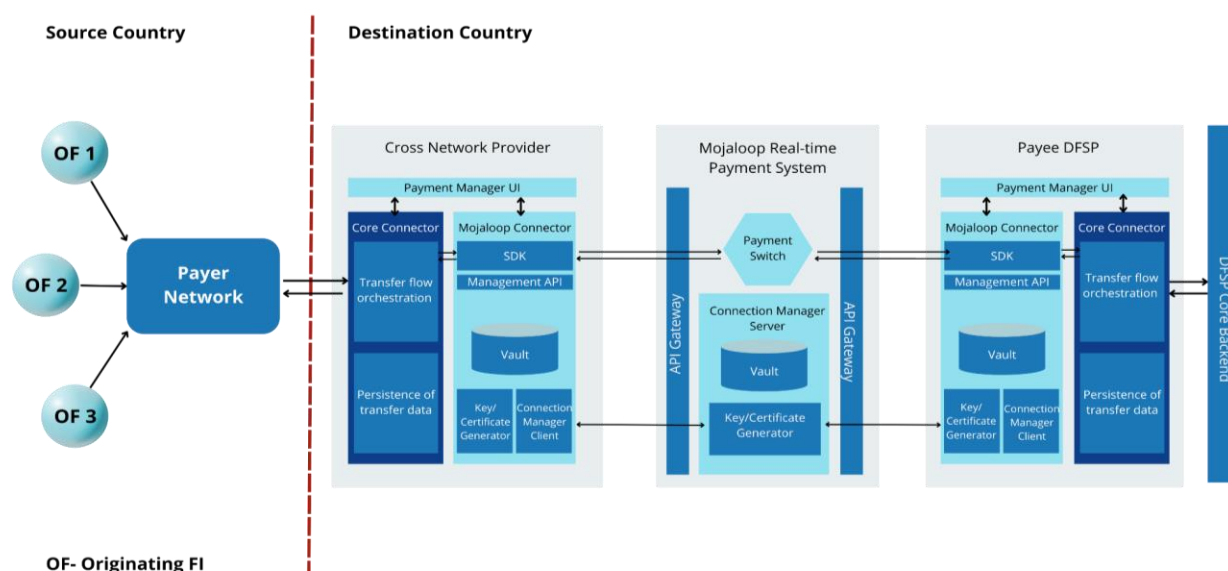
- It is provided as a set of Linux container images (Docker) and may be hosted on-premise using commodity server infrastructure or in an appropriate cloud infrastructure where available.
- It scales from a very small footprint to handling many hundreds of transactions per second (dependent on the performance of the DFSP's Core Backend).
- It comes with turn-key integration options.

- It is implemented using Apache Camel and Spring Boot, both of which are Open-Source technologies providing a simple and widely-understood method of coding transformations between data elements in two different data structures.
- The API at the back of the Mojaloop Connector SDK is a Mojaloop-centric API focused on resource types. The key resources of Mojaloop API are the party lookup, agreement of terms, and transfers services:
 - Party lookup service: Identifying the DFSP serving the Payee and the Payee itself (the recipient of funds in a transaction) based on a Payee identifier (typically a MSISDN, that is, a mobile number).
 - Agreement of terms service: Requesting a definition of the terms under which the transfer will be made and exchanging cryptographic proof to prepare and secure the transfer. The agreement of terms is a contract between a Payer DFSP and Payee DFSP for a particular financial transaction before the transaction is performed. It guarantees the agreement set by the Payer and Payee DFSPs about the Payer, the Payee, and the transfer amount, and is valid for a period specified by the Payee institution at the time the terms are set during the lifetime of a quote and transfer of a specified financial transaction.
 - Transfers service: Executing the transaction as per the agreed details and cryptographic proof.

Cross Network Provider (CNP) (Payment Manager)

A Cross Network Provider (CNP) is a specialized variant of a Payment Manager. Instead of connecting a DFSP's Core Banking System to the Mojaloop network, it connects another payment system to the Mojaloop network. It appears to the Mojaloop network as a normal Mojaloop participant, and to the external network (in this case, the Visa Direct network) as a normal participant in its network. Messages that are sent through the external network, but which are intended for participants in the Mojaloop network, have their format converted by the CNP before they are forwarded from the CNP to the recipient. The reverse happens with messages in the Mojaloop network which are intended for participants in the external network.

Figure 9. Cross-Network Provider – System Architecture



The Cross Network Provider (CNP) is an instance of the adapter pattern, used when an incompatible module needs to be integrated with an existing module without making any source code modifications. CNP is needed to route messages between schemes and to act as a proxy for one scheme in the other scheme for non-repudiation checking, liquidity cover, settlement, and directory look-up. There are two varieties of CNP; bridgehead and negotiator.

For the Bridgehead CNPs - They represent individual customers directly. This may be obscured because their customers don't necessarily have accounts with them in the traditional sense. For example, the customer simply transfers funds into what is effectively a temporary account at the bridgehead DFSP, which lasts for the life of the transfer. They need to provide liquidity cover for their transfers in the target scheme but there is no impact on them because they've already received the funds from their customers. The scheme in which they operate can treat them exactly like any other DFSP and no modifications to the scheme's operation are required. Non-repudiation guarantees are also made by that bridgehead DFSP. Examples of bridgehead DFSPs might include: for payment systems (TerraPay, Western Union, MoneyWise) and for blockchain systems (4Pay).

For Inter-scheme negotiators CNPs - They connect any DFSPs in two IRTP schemes with each other. They rely on a previously agreed relation of trust between the two IRTP schemes they connect. It's the relation of trust that does the heavy lifting in the connection between schemes. In particular, the relationship of trust should include an agreement to avoid double jeopardy on liquidity cover. This type of CNP allows an inter-scheme settlement to proceed without requiring the Inter-Scheme negotiator to participate. Also, non-repudiation guarantees should be made by the originating DFSP, not the inter-scheme negotiator. If there are any changes required to allow schemes to interconnect, it should happen as far as possible in the schemes, not in the connector.

For bridgehead cross-network provision, apply to the Payment Manager. Payment Manager allows a DFSP

of any kind to appear in a Mojaloop network as a participant in good standing which is what the third party wants.

Multiple Alias Oracle

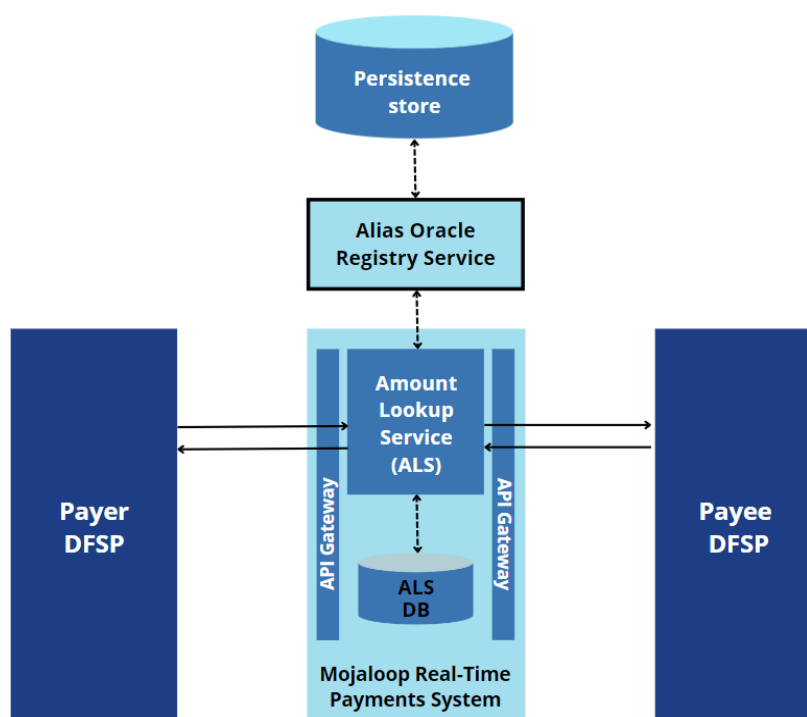
As mentioned in the previous section, Multiple Alias Oracle was developed by ThitsaWorks to facilitate Account Lookup Services across two different payment systems. In the Mojaloop ecosystem, payments are addressed using an alias (e.g. email address, a mobile phone number, or any other unique identifier). The i2i platform relies on users' (both payer and payee) phone numbers, which is in line with Mojaloop's design. However, the Visa Direct Network uses (XXXXXX) as a unique identifier while settlement banks rely on bank account information.

In order to route transactions in a Mojaloop-based real-time digital payments system, it is necessary for sending institutions (Digital Financial Service Providers (DFSPs)) to be able to clearly identify the receiving institution and payee party, given only a destination phone number without the need for of an account number or any specify complex routing details. Mojaloop-based systems facilitate this by exposing an account lookup service (ALS) to participating DFSPs.

As a Mojaloop-based payment hub, the hub provides and maintains an account lookup service and accompanying oracles, specifically an Alias oracle for Mobile Station International Subscriber Directory Numbers (that is, phone numbers or MSISDNs) to facilitate the identification of DFSPs in the case of initiating transfers by standard MSISDN.

For this POC, as described in the above section, in order to reliably return a single institution that will receive the funds, we have implemented the design of the oracle as automatically setting the latest registration institution as the default beneficiary for the duplicate phone numbers. Although many design solutions were considered, this solution is relatively simple to set up in a given timeline, and reasonably efficient while participant numbers are low and it doesn't require any changes from any of the participants.

Figure 10. ALS and Oracles



Oracles are deployed as pods in a Kubernetes cluster. Oracles are stateless so multiple instances can be run at the same time for redundancy and capacity. To deploy an oracle in Kubernetes, a Helm chart is used. Helm acts as a package manager for Kubernetes, with the Helm chart containing all of the pre-configured resource definitions necessary to run an oracle inside a Kubernetes cluster. Helm charts are created as files organized into a particular directory tree. The directory name is the name of the chart (without versioning information), for example: alias-oracle.

A Helm chart is defined in templates, written in the “Go template language”. Each resource that is necessary to run an oracle has a template. Templates generate manifest files, that is, resource descriptions in (.yaml) format that Kubernetes can understand. All template files are stored in the chart’s templates/ folder. When Helm renders a chart, it will pass every file in that directory through the template engine.

As a next step, installing an oracle’s Helm chart will deploy the oracle. Oracle Helm charts get installed when running the infrastructure-as-Code (IaC) deployment process that builds the service components making up the hub infrastructure. Finally, Oracle is ready to be onboarded on hub by using Mojaloop's central ledger admin API.

This section provides context for the API calls used between the ALS service of the Mojaloop hub and the oracles. In a loan disbursement use case where payment is made by an MFI staff member to an MFI customer’s mobile wallet account, a MSISDN is used to identify the mobile wallet account. However, when the destination mobile wallet is not known upfront, it may not always be possible to unambiguously identify the wallet-provider DFSP based on an MSISDN only. The DFSP operating the mobile wallet may or may not be the mobile network operator (MNO) servicing the SIM with airtime. In addition, an end user may have

multiple mobile wallets with differing providers, hosted on the same mobile phone and associated with the same MSISDN.

In order to identify the destination mobile wallet account, the Switch must obtain a list of wallet provider DFSPs that can potentially service the MSISDN. The Switch retrieves the list of DFSPs from the Alias oracle, which contains the identifiers of all wallet-provider DFSPs who are onboarded to the Mojaloop hub. For each and every wallet-provider DFSP that connected to the Mojaloop hub, the Hub Operator (or Oracle Administrator) registered a unique identifier in the Alias oracle database (using *POST /participants*) as part of the onboarding process.

To retrieve the list of registered wallet-provider DFSPs, the Account Lookup Service (ALS) of the Switch sends a *GET/participants/{type}/{id}* request to the Alias oracle. Once the list of DFSPs has been returned by the Alias oracle, the Switch sends a wallet lookup "round robin" to all affected DFSPs to find out which DFSP holds the mobile wallet account identified by the MSISDN. As a result of those calls, the Switch will have another list, which now contains only those DFSPs that provide mobile wallet services to MSISDN. The Payer is requested to confirm which wallet they want to disburse the loan to.

After confirmation from the Payer, an alias is generated for the MSISDN-DFSP pair. The mapping is recorded in the Alias oracle. At one end of the mapping, there is the alias string. At the other end of the mapping, there are the two bits of information to identify the DFSP account: the MSISDN and the DFSP ID (=fspId, the unique identifier assigned to a DFSP when onboarding to the Mojaloop hub). To record the alias, the *POST/participants/ALIAS/{UUID-alias}* call is used. For more detailed information on this API request, we refer to the ALS-Oracle API Swagger specification (alias-oracle_als-server_API.yaml).

Settlement Design

The Mojaloop platform is only concerned with a single settlement structure.

In a cross-border remittance, funds will typically arrive from another scheme on a timetable which is not related to the remittee (payee) scheme's settlement timetable. This is likely to place significant liquidity pressure on the CNP as a settling participant in the remitter (payer) scheme.

As a result, there is a requirement to distinguish between internal transfers and remittance transfers, and settle them according to separate settlement models.

Solution suggested

There are two possibilities considered for this POC:

- 1) Use an identifier type which is specific to external transfers;

This would enable participants to register their customers separately for the receipt of remittances which would enable the participant to collect appropriate KYC but it would need modifications to the partyIdType.

- 2) Use the subScenario element of the TransactionType object.

In both cases, the appropriate value would be set for inbound transfers by the CNP and there is no change needed to the behavior of creditor DFSPs and ultimate creditor.

We can already define settlement models by ledger account type. We can apply a rule on transfer prepare which:

- Reads the content of the transfer
- Assigns ledger account types based on the content

By default, assigns the current account types. Now all our remittances can be settled separately.

The following assumptions were made to use the existing settlement functions to settle the remittance transactions separately from the ordinary transactions in the system:

1. Assuming that remittance transactions can be identified by setting the *subScenario* field in the *TransactionType* object to "REMITTANCE", this is expected to be done by the Cross Network Provider (Payment Manager) when it constructs the quote request for the agreement of the terms of the transfer.
2. Settling transfers which belong to different ledger account types in different ways which are already available; the existing settlement window workflow can be used.
3. Automatically assigning transfers to settlement models (which means, to ledger account types) based on their characteristics.
4. Mapping between the transaction content and the settlement model are designed.
5. The following settlement models are set up in the system and the necessary ledger accounts have been created for the POC:
 - A DEFAULT settlement model, which settles all transfers which are not remittances. The ledger account types for this model are:
 - "POSITION" for the position account and
 - "SETTLEMENT" for the settlement account.
 - A REMITTANCE settlement model, which settles all transfers which are remittances. The ledger account types for this model are:
 - "REMITTANCE_POSITION" for the position account, and
 - "REMITTANCE_SETTLEMENT" for the settlement account.

The desired outcome of this POC is transfers are assigned to the correct settlement model based on whether their *subScenario* is set to "REMITTANCE" or not, eliminating the need to change the current arrangements for settling.

Appendix C - Implementation and Testing

For the testing process, we approach two-phase testing, sandbox testing, and certificate environment testing. The purpose of this approach is as follows:

Phase 1: Sandbox Testing

The sandbox testing is to ensure that client applications can generate API requests in the correct format for consumption by the Visa Direct system, and that they can consume the results returned by the Visa Direct system correctly. In the first instance, we are only going to test the happy path: it's not necessary to demonstrate correct error processing. In this phase, we do not need, for instance, to use the PAN returned from an alias resolution call as the input to a payment execution call: it is sufficient to demonstrate that requests which are formatted correctly can be generated by the Lucy application and that the responses are correctly processed by the Lucy system. This will cover the following areas:

1. Lucy generates an alias resolution request using a MSISDN recognised by the sandbox. It receives the returned PAN and makes it available to the payment execution call.
 - Alias Resolution API
https://developer.visa.com/capabilities/visa_direct/reference#tag/Visa-Alias-Directory-API/operation/Resolve%20V2_v2%20-%20Latest
 - OCT – push transaction
https://developer.visa.com/capabilities/visa_direct/reference#tag/Funds-Transfer-API/operation/createPushFundsTransaction_v1%20-%20Latest
2. Lucy generates a payment execution request using a PAN recognised by the sandbox. This does not need to be the PAN returned from the alias resolution call. In this payment execution request, the BIN only needs to be a BIN recognised by the sandbox; it does not need to be an actual BIN.
3. Visa Direct generates a Receive OCT request to Mojaloop in which the data content must be formally correct and the MSISDN must be a MSISDN recognised by the Mojaloop system.
 - CNP / Mojaloop (Receive OCT - incoming)
https://developer.visa.com/capabilities/visa_direct/reference#tag/Issuer-Receive-API/operation/receiveOCT_v1%20-%20Latest
4. Visa Direct consumes a 200 response from Mojaloop to the Receive OCT request.

Phase 2: Certification Environment Testing

The full cycle of testing between all the participants is not available in the sandbox environment. So, all the phases were tested separately in the sandbox, and after readiness from all the participants – they were moved to the certification environment.

The certification environment testing is to ensure that end-to-end processing of requests can be managed correctly. This involves adding the following elements to the tests in the previous stage:

1. The information entered into the Lucy app is sent to the alias resolution call.

2. The PAN returned from the alias resolution call, together with the information entered into the Lucy app, are sent in the payment execution call.
3. The information in the payment execution call is correctly transferred to the Receive OCT call.
4. The information returned from the Receive OCT call by Mojaloop is correctly returned to Lucy.

Testing Result

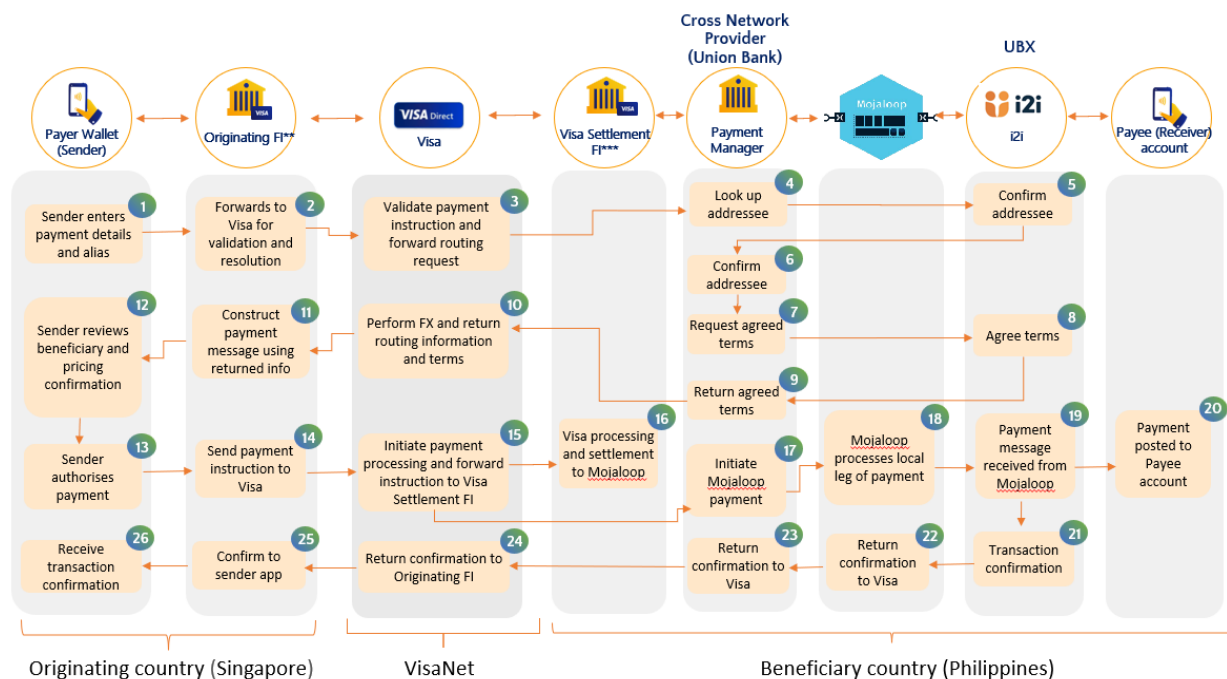
1) Happy Path		
Test Scenario	Expected Results	Status (Pass/ Fail)
Test with PH phone numbers	Should route the funds according to the country code, and recipient information must return correctly.	Pass

1) Error handling		
Test Scenario	Expected Results	Status (Pass/ Fail)
Phone number do not exist in recipient side (but number is valid)	Proper message must be returned.	Pass
Phone number do not exist in recipient side (but number is invalid)	Proper message must be returned.	Pass
Pass the phone number without country code	Proper message must be shown in the sending app GUI.	Pass
Insufficient Liquidity	Proper message must be shown in the sending app GUI.	Pass

Appendix D - Payment Flows and Sequence Diagrams

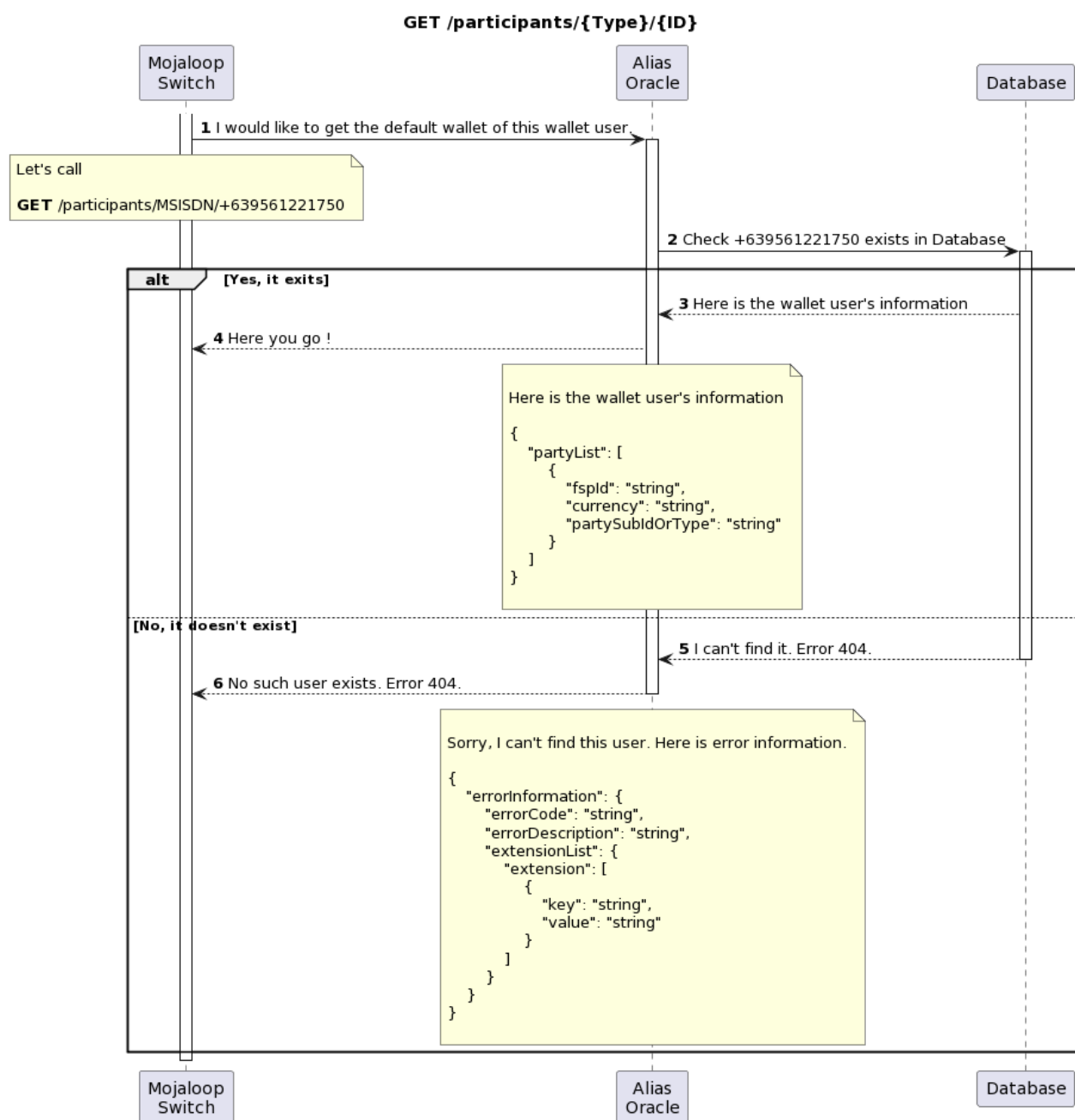
High-Level Information Flow

Figure 11. High-Level Information Flow (i2i-Union Bank – Philippines)

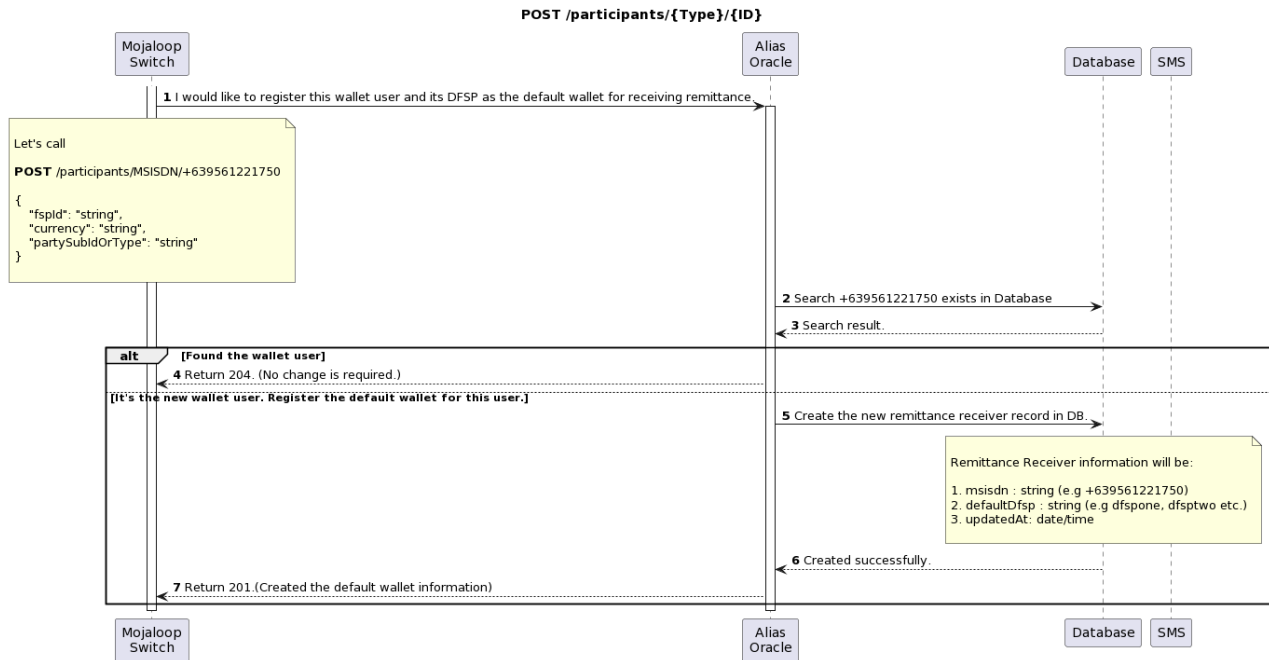


Design of Alias Oracle for Mojaloop

1) GET-participants-from-Oracle

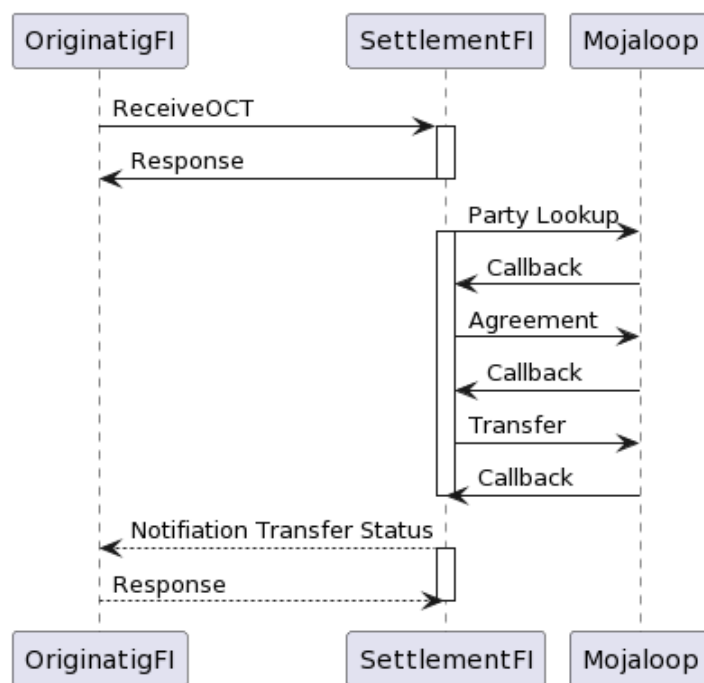


2) POST-participants-to-Oracle

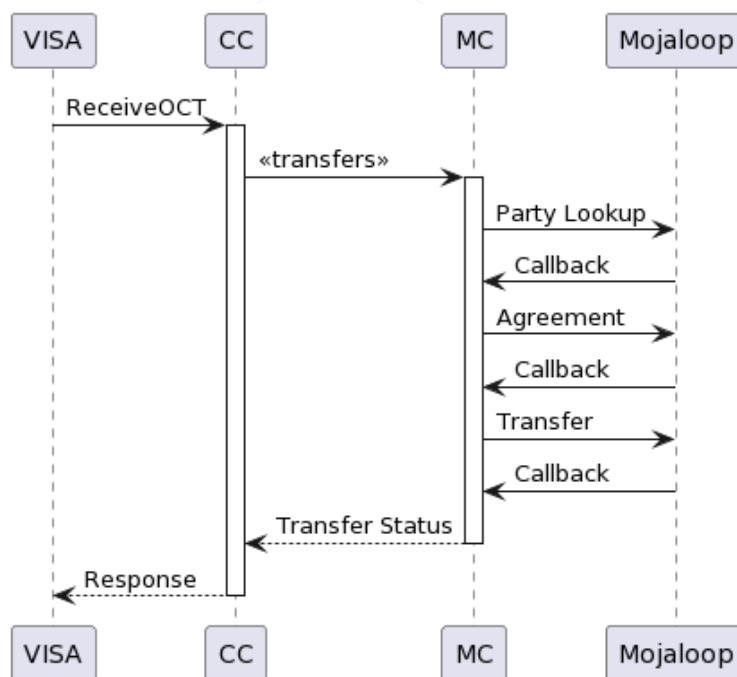


Cross Network Provider for Visa Direct

1) Asynchronous

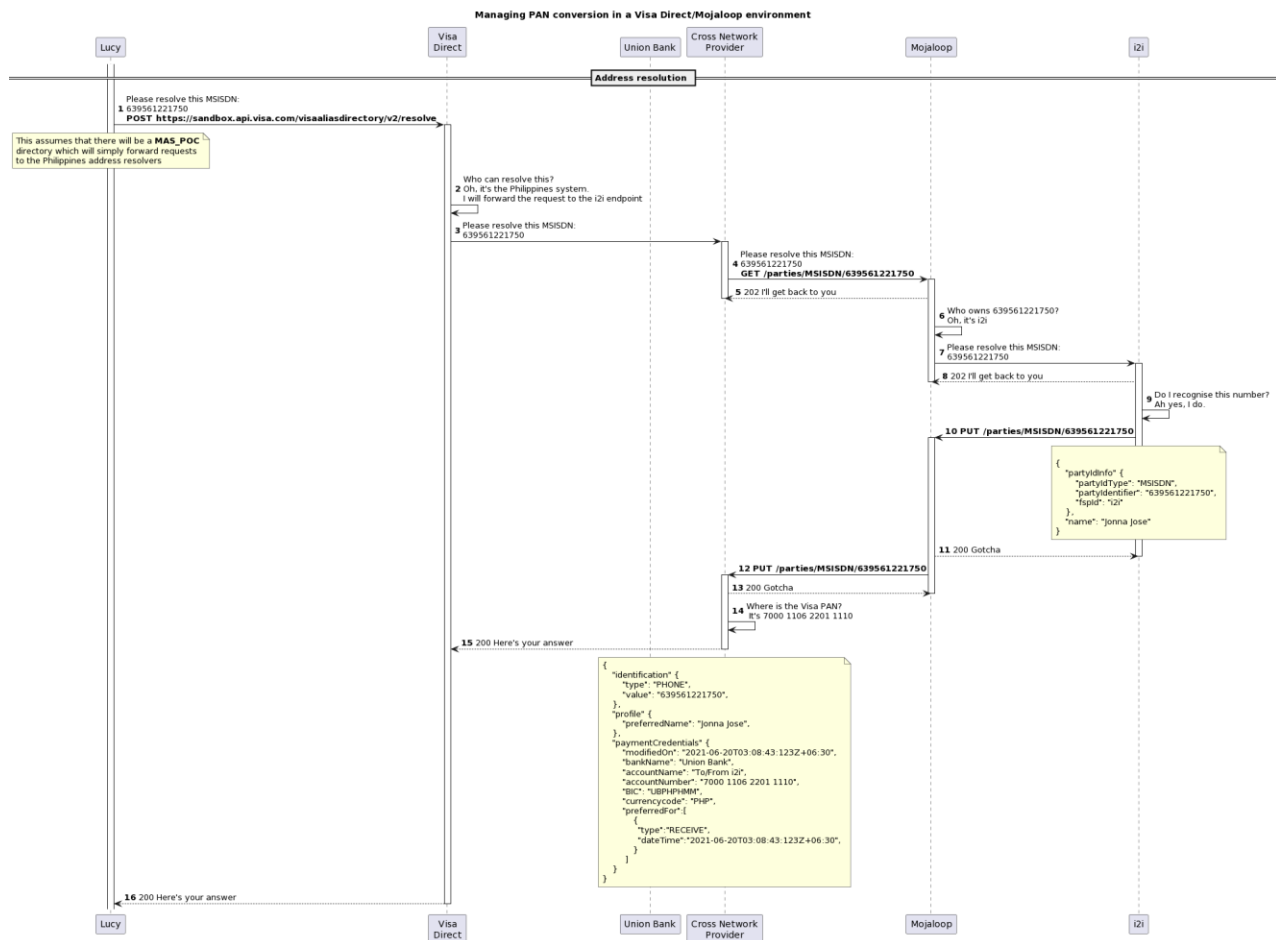


2) Synchronous

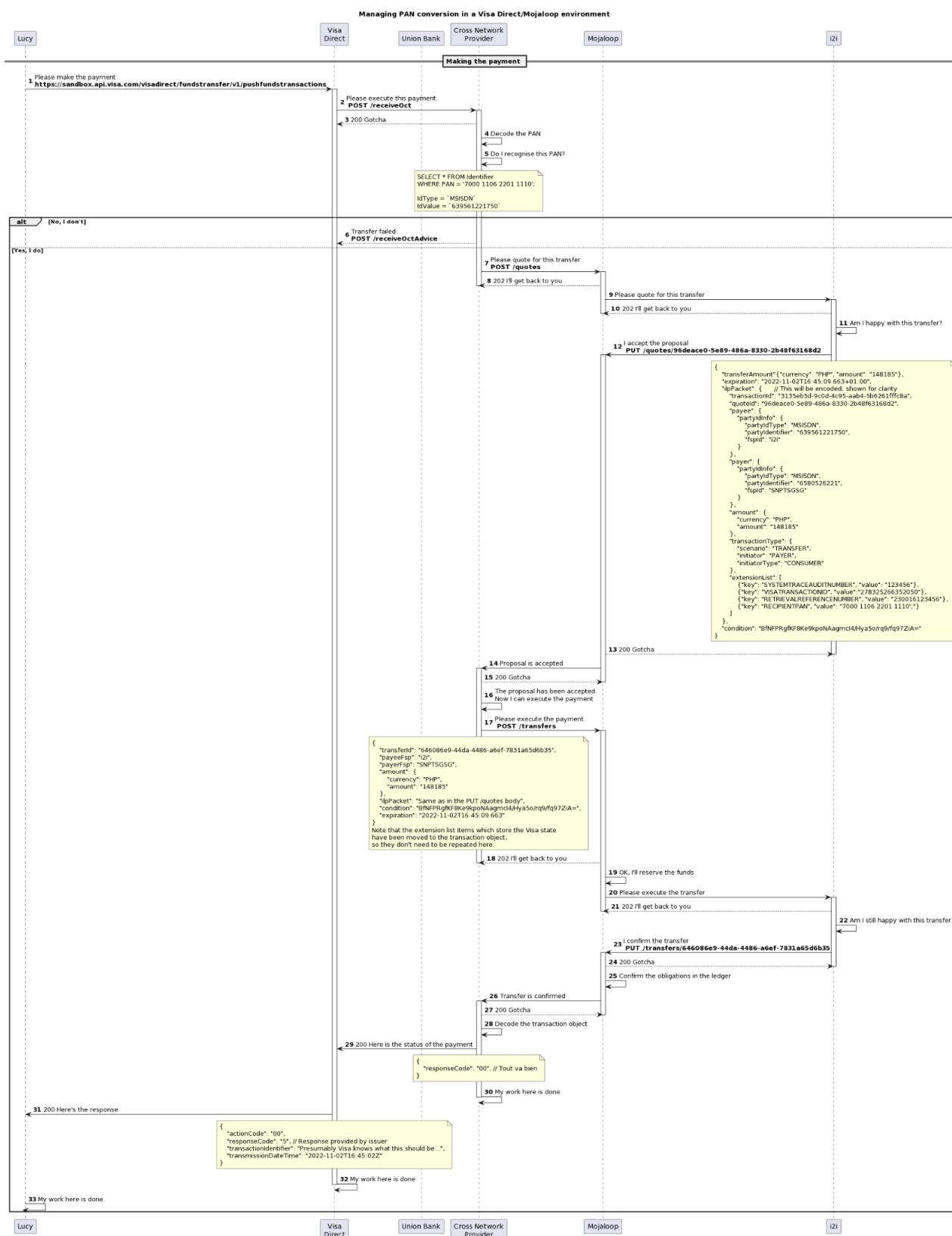


End-to-End Sequence Diagram (Ideal Version)

1) Address Resolution

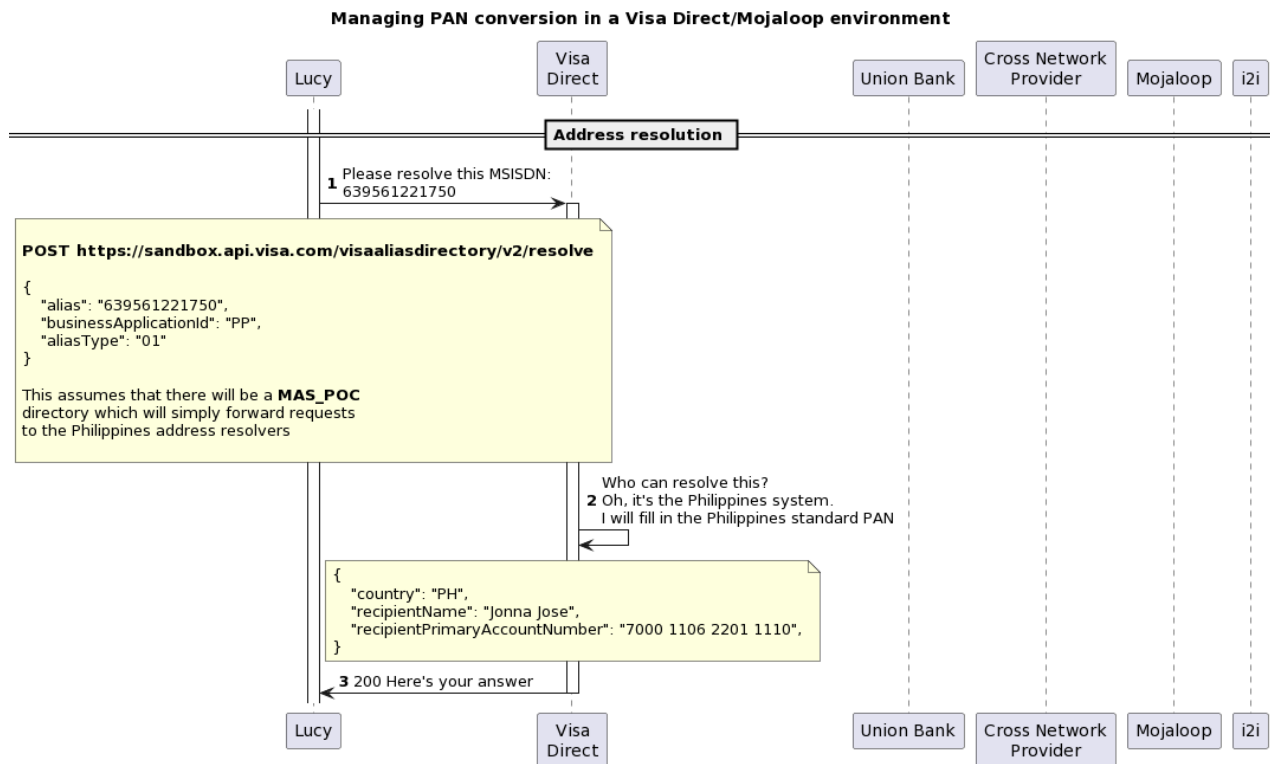


2) Making Payment

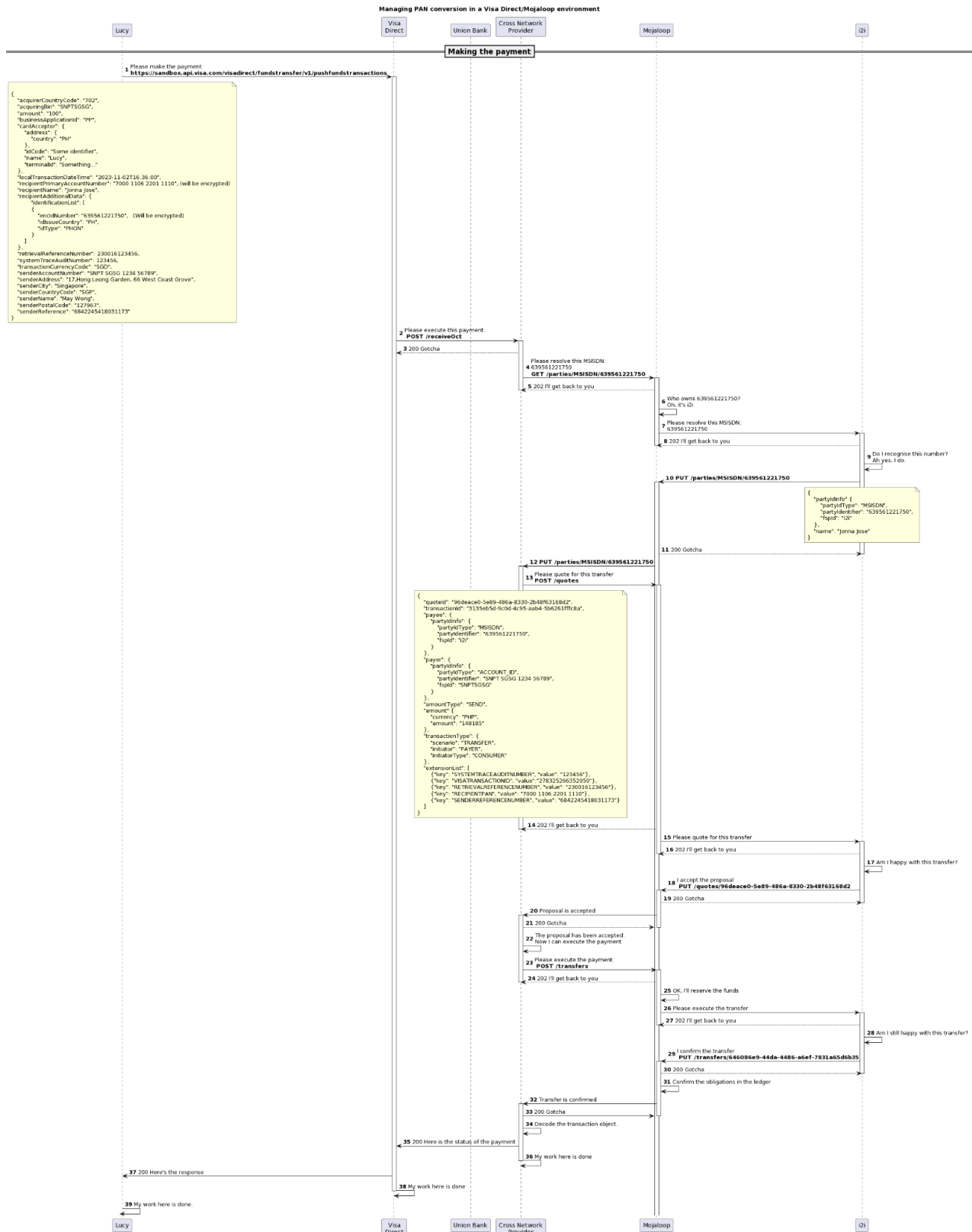


End-to-End Sequence Diagram (POC version)

1) Address Resolution



2) Making Payment



Appendix E - Project Management

Governance

The project is made possible and, more importantly, built upon previous collaborations between key project sponsors (Visa, ThitsaWorks, INFITX). As a background, Visa (Visa Direct) and INFITX (previously ModusBox) have successfully tested Visa Direct-Mojaloop connectivity in a Sandbox Environment in 2021.

For this project, ThitsaWorks was appointed as the Project Manager and the key liaison to grant provider, Monetary Authority of Singapore (MAS). Additionally, three work streams were established (please see below for more information). Strategic decisions were made by the Steering Committee while the working groups met weekly - virtually - to coordinate the development and implementation of various solutions, as well as multiple offline discussions to ensure effective communication. The frequency of working group meeting frequency increased as the project neared the deadline.

The Project Steering Committee composed of the following individuals was formed during the initial meeting on June 10th, 2022.

- Mr. Nyi Nyein Aye, ThitsaWorks
- Mr. Warren D. Carew, INFITX (previously ModusBox)
- Mr. Steve Haley, Mojaloop Foundation
- Mr. John Januszczak, UBX
- Mr. Nat Scheer, VISA
- Ms. Debbie Watkins, Lucy

The following individuals from the organizations participating in the POC contributed in delivering the project.

- Mr. Alvin Aruselman, Lucy
- Mr. Pye Phyo Aung, ThitsaWorks
- Ms. Su Mon Aung, ThitsaWorks
- Mr. Aung Thaw Aye, ThitsaWorks
- Mr. Paul Baker, INFITX (previously ModusBox)
- Mr. Christian Calabia, UBX
- Mr. Mario Domingo, UBX
- Mr. Mario Jordan Fetalino III, UBX
- Ms. Julie Guetta, RedCompass Labs
- Mr. Min Tha Gyaw, ThitsaWorks
- Mr. Myo Min Htet, ThitsaWorks
- Mr. Hyunuk Jung, Lucy
- Mr. Pyae Phyo Lwin, ThitsaWorks
- Mr. Sithu Kyaw, ThitsaWorks
- Ms. Nang Zin Nyein Mon, ThitsaWorks

- Ms. Maria Cindy Pascual, UBX
- Ms. Bhavana Ravindran, VISA
- Ms. Michael Richards, INFITX (previously ModusBox)
- Ms. Sneha Shanu, VISA
- Mr. Pavel Stepanov, VISA
- Ms. Jane Stroucken, INFITX (previously ModusBox)
- Ms. Thet Htar Swe, ThitsaWorks
- Ms. Zar Chi Tun, ThitsaWorks (Project Manager)

Workstreams

The project was structured into three distinct workstreams. Each workstream was responsible for different aspects of the project. By dividing the project into these three workstreams, it allowed for a clear division of responsibilities and better coordination among the team members, which in turn led to a more efficient and effective delivery of the project.

The three workstreams involved in the project were:

- **Business:** This workstream, led by ThitsaWorks, initially focused on recruiting key participants such as Lucy, and UBX. As the project gained traction, the Business workstream focused on research and documentation of user requirements (both end users and small financial institutions), settlement model, the feasibility of different business models, as well as internal and external communications (including press releases, signing ceremony).
- **Technology and Development:** This workstream, co-led by ThitsaWorks and INFITX, focused on research and identification of technical gaps, solution design, and development. The workstream was later expanded to include all of the senior technology executives from all the participants to ensure efficient solution implementation and testing in various environments/sandboxes. This workstream was also responsible for the establishment of testing environments, network infrastructure, and software implementation according to the solution design.
- **Hub Operations and Settlement:** This workstream provided support to the Technology/Development workstream, and provided critical input and testing support for the settlement model, clearing, messaging, and system information flow. A significant contribution was made by this workstream to ensure that the solution design meets the broader goals of the project.

Methodology

The project used the Scaled Agile Framework (SAFe) approach to deal with the uncertainties inherent in multi-stakeholder, multi-technology POCs. SAFe is a scalable approach that emphasizes flexibility, customer centricity, and rapid delivery of value with quality embedded at the heart of delivery. The principles of visible, consultative, and inclusive planning for all work ensure that the business and management team members are involved in all decision-making with the teams.

Planning and execution were divided by Program increments (PIs). Each PI contains five, two-week sprints, and work was broken down in detail and planned for each sprint. On the final day of the sprint, a review is held for all concerned parties to understand what was delivered. The chosen agile delivery approach, in conjunction with a high functionality and configurable technology solution, allowed for adequate ad hoc exploration of each user story and the ability to incorporate sprint feedback into future sprint planning. All work, including the cloud or infrastructure required, was delivered in accordance with Scaled Agile Framework (SAFe) methodology. The collaborative approach inherent in this way of working ensured that the delivery teams were composed of highly experienced people in a cross-functional team. This collaboration enabled the teams to assess scope adjustments, as needed, based on budget feasibility.

Appendix F - Glossary of Key Terms

Term	Definition
Account Lookup	An API that uses the entered identifier to find the associated account.
Account Lookup Services (ALS)	A service which uses aliases to identify individual payees at different DFSPs.
Account Lookup Oracle	Account Lookup Oracles are software plugins that perform the mapping between the Payer identifier and the DFSPs they belong to.
Agreement of terms	The agreement of terms is a phase in the definition of a transfer which allows both parties to be clear about the terms under which the transfer will be executed. Some factors that can be varied are Fees, FX rate, Commission, and Taxes. A set of agreed terms is usually guaranteed for a short time period, after which the Payee DFSP is no longer under an obligation to accept the transfer if it is proposed.
Alias	An alternative identifier used to identify accounts, such as a mobile phone number or the identity number of the account owner.
Alias-based payment services	Payment services that allow users to link a unique identifier other than their personal identity to their payment account (e.g., phone number or email).
API	Application Programming Interface (API): A software intermediary that allows two software applications to communicate with each other.
Bilateral connection	A system where each DFSP or operator is required to connect directly with every other DFSP or operator, leading to each DFSP/operator needing to manage many different connections.

Term	Definition
Clearing	The process of transmitting, reconciling, and, in some cases, confirming transactions prior to settlement, potentially including the netting of transactions and the establishment of final positions for settlement. Sometimes this term is also used (imprecisely) to cover the settlement. For the clearing of futures and options, this term also refers to the daily balancing of profits and losses and the daily calculation of collateral requirements.
CNP	Cross Network Provider. A Cross Network Provider is a piece of Open-Source software which instantiates the <u>Adapter pattern</u> . It allows for translation between the data structures and resources used by two different payment systems, such that requests initiated in one payment system can be executed in another.
Configurations	The different ways in which components of a programme, application, or service can be arranged.
DFSP	Digital Financial Services Provider. The entity that provides a digital financial service to an end user (either a consumer, a business, or a government.) In a closed-loop payment system, the Payment System Operator is also the provider. In an open-loop payment system, the providers are the banks or non-banks which participate in that system.
End user	The customer of a digital financial services provider. The customer may be a consumer, a merchant, a government, or another form of enterprise.
Fees	The payments assessed by a provider to their end user. This may be a fixed fee, a percent-of-value fee, or a mixture of the two. A Merchant Discount Fee is a fee charged by a Merchant Services Provider to a merchant for payment acceptance. Payment systems or schemes, as well as processors, also charge fees to their customers (typically the provider.)
Financial Inclusion	The sustainable provision of affordable digital financial services that bring the poor into the formal economy.

Term	Definition
Hub	The central operations where the Mojaloop hub is installed. It is the physical instance of a Mojaloop scheme and the non-functional supportive structures that support this scheme.
Hub-and-spoke model	The hub-and-spoke model refers to a distribution method in which a centralized hub exists; every transaction either originates in the hub or is sent to the hub for distribution to consumers.
Identifier	The code or data used to identify a particular account, such as an account number, mobile phone number, or ID number.
ILP	Interledger Protocol. A cryptographic protocol is used for sending messages across different ledgers and connecting blockchains. The ILP fulfillment is used in Mojaloop as proof of agreement and transaction.
JWS	JSON Web Signature — a security mechanism implemented to ensure end-to-end integrity and non-reputation at the application layer. It represents content (transaction message) secured with digital signatures using JSON-based data structures. Ensures payer DFSP and payee DFSP can trust messages shared between each other without potential modification by the hub.
KYC	Know Your Customer. The process of identifying a new customer at the time of account opening, in compliance with law and regulation. The identification requirements may be lower for low-value accounts ("Tiered KYC"). The term is also used in connection with regulatory requirements for a provider to understand, on an ongoing basis, who their customer is and how they are using their account.
Liquidity Cover	The availability of liquid assets to support an obligation. Banks and non-bank providers need liquidity cover to meet their obligations incurred in the execution of transfers. Agents need liquidity cover to meet cash-out transactions by consumers and small merchants.

Term	Definition
MFI	Microfinance Institution. MFIs are organisations that provide loans to clients who traditionally lack access to mainstream sources of finance from banking institutions.
Mojaloop Connector	Mojaloop Connector: An open-source tool to reduce complexity, avoid incompatibilities between providers, and ensure specification compliance. Allows the DFSP's own platform to communicate with the hub.
MSISDN	A number uniquely identifying a subscription in a Global System for Mobile communications or a Universal Mobile Telecommunications System mobile network.
MTLS	Mutual Transport Layer Security (mTLS): Secures the communication channel for bidirectional asynchronous connections.
OAuth2:	OAuth2: IA security protocol which is used to provide role-based access to hub endpoints
Open source	Open-Source Software is publicly available to anybody who will consent to the terms of the standard license which govern its use. The source code of Open-Source software is made publicly available for others to adapt or add to.
P2P	Person-to-person transactions, where the transaction occurs between two natural persons.
Payment Manager	A Mojaloop open-source product which includes Mojaloop SDK but provides additional functionality and provides functionality for integration/ onboarding, business operations, and technical operations.
PISP	Payment Initiation Service Providers (PISPs). A PISP is authorised by the consumer or payer to initiate a payment from their bank account. It is still a 'push' payment (which we'll get into more detail about later on) and the payer still has complete control without the receiver getting any information about the payer's account. Some of the larger PISPs in India are PayTM, PhonePe, GPay, and WhatsApp.

Term	Definition
Platform	Platform: The physical software and infrastructure technology that realizes the business needs of the scheme.
Regulator	A governmental organization given power through national law to set and enforce standards and practices. Central Banks, Finance and Treasury Departments, Telecommunications Regulators, and Consumer Protection Authorities are all regulators involved in digital financial services.
RTPN	Real-time payment network. A RTPN is a multi-actor, instant, 24/7 electronic fund transfer that can be initiated through a variety of channels.
Sandbox	A 'demo' environment where users can test different tools, applications, use cases, and ideas without impacting the production system
Scheme	An instance of a Mojaloop implementation with the rules, structures, and governance that is required to support it.
Settlement	The process of discharging the obligations that participants incur in relation to each other as a consequence of requesting and clearing transfers.
Settlement bank	The bank partner that is performing the reconciliation between financial providers connected to the Mojaloop hub.
Switch	A switch is the key engine component of a Mojaloop Scheme. A back-end payments technology that allows for off-net transfers between the user networks of multiple FSPs, by interacting between their digital ledgers, typically through APIs.

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