

The many paths to mobile money interoperability: Selecting the right technical model for your market

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Twitter: **@gsmamobilemoney**
Email: **mobilemoney@gsma.com**



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Authors:

GSMA: Anant Nautiyal, Senior Manager, Inclusive Tech Lab; Bart-Jan Pors, Director, Inclusive Fintech Mobile Money
Sofrecom: Antoine Navarro, Manager; Sylvain Morlière, Principal; Ronan Paillon, Senior Consultant; Latifa Nanadoum, Consultant

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01 Introduction

There isn't just one way to build a bridge. Depending on the gap, traffic and strength of materials required, the right option might be a rope bridge, suspension bridge or a number of other choices. The same is true with interoperability. Just as a simple rope bridge would not be used to span San Francisco Bay, or a complex suspension bridge to connect two ends of a monastery in Tibet, some technical models are better suited to some contexts than others. There isn't just one way to join up financial service providers in a market, and one size does not fit all.

Mobile money interoperability has been implemented differently in different markets and contexts, as captured in the *GSMA Interoperability Landscaping Study*. The technical solutions deployed have been diverse, reflecting differences in scope and ambition, as well as evolving standards and regulations. While mobile money interoperability is not new, most solutions are still in their infancy.

Technical models for interoperability can range from local bilateral connections (e.g. between mobile money providers in a market) to regional interoperability deployments involving many more players (e.g. mobile money providers, banks and other financial service providers). However, all technical models for interoperability have five core building blocks in common: connection, settlement, governance, pricing and business model, and dispute resolution mechanisms.

This report presents four technical models for interoperability in mobile money markets: the bilateral model, aggregator model, mobile money hub model and the global payments hub model. The current spread of interoperability deployments across the globe can be mapped against these four broad headings.

Each of these models has its own unique technical architecture, including routing, clearing, messaging, APIs and other protocols. They also have distinct commercial and business implications for participants. While some may be cheaper to set up in the near term and offer participants greater control, others may be better suited to long-term growth but are inhibited by high set-up costs. Chapters 3, 4, 5 and 6 are dedicated to this analysis.



The precise impact of a particular technical approach is difficult to gauge given that mobile money providers have few strictly comparable experiences. However, Chapter 7 offers a framework for logically assessing different technical models for interoperability and selecting the right one—a vital decision that has far-reaching consequences for financial services in any market. The framework is based on five criteria—cost, revenue, scalability, robustness and governance—each of which has detailed sub-criteria showing the strengths and weaknesses of each model. Mobile money providers (MMPs) can use this criteria as a checklist to assess the business case for different interoperability solutions.

If you are building an interoperable bridge between financial services in your market, we hope this report is a useful resource for you.

02

Many paths to interoperability



2.1 Account-to-account (A2A) interoperability

In the context of mobile money, interoperability can mean many things, but the simplest use case is for mobile money providers (MMPs) to give customers the ability to transfer money between two accounts in different mobile money schemes, or between accounts at a mobile money scheme and a bank. This functionality is known as account-to-account (A2A) interoperability and is the focus of this report.

2.2 Core components of interoperability

To understand how interoperability can be achieved using different technical models, it is important to first identify the technical building blocks of interoperability. We have grouped the interoperability solutions in this report into five core components (Figure 1).

Figure 1

Five core components of an interoperability solution

Connection	The interconnection allows DFSPs (institutions holding the client accounts) to **exchange information, initiate and receive** transactions, accept or reject them and debit or credit end user accounts.
Settlement	The settlement mechanism is what allows the **flow of 'real' money** between participant organisations. In the world of e-money, this step need not coincide with the debiting and crediting of end user accounts.
Governance	Governance refers to the way participants of an interoperability solution make decisions.
Pricing and Business Model	Pricing and business model encompasses the key determinants of an interoperability solution's profitability and sustainability. These generally revolve around **processing or transaction fees, interchange** and **client surcharge**.
Dispute Resolution Mechanisms	Interoperability requires specific dispute resolution mechanisms, as enabling clients to perform cross-net transactions requires the ability to reach consensus with other DFSPs.

1. **Connection** refers to the mechanism allowing different digital financial service providers (DFSPs)—the institutions holding client accounts, including MMPs—to interconnect and exchange information, initiate and receive transactions, accept or reject transactions and debit or credit end user accounts. There are two main connection models:[1]

   - **Bilateral** – each corridor between DFSPs has a dedicated connection.
   - **Hub** – connects DFSPs, provides value-added services and manages mutual responsibilities.

2. **Settlement** is what allows the flow of "real" money between participants and can be completed in two ways:

   - **Pre-funding based**[2] (ex-ante) models – DFSPs allow incoming transactions if the sending DFSP has already deposited sufficient liquidity with them.
   - **Clearing-based** (ex-post) models – DFSPs allow incoming transactions before receiving the funds (which may be secured with a reliable third party, such as a hub, bank or central bank).

With e-money,[3] settlement does not need to be synchronised with the debiting and crediting of end user accounts.

3. **Governance** refers to how participants in an interoperability solution make decisions. There is a wide range of possible governance arrangements (see the GSMA Interoperability Landscape study for more details), but this report limits the scope to two options:

   - DFSPs having **full control** over the technical solution and business model; and
   - DFSPs having **less control** over the technical solution and business model, sharing it with entities like other commercial providers or central banks.

4. **Pricing and business model** are the key factors determining whether an interoperability solution becomes profitable and sustainable and generally include:

   - **Processing fees** – every transaction triggers a fee that is paid to a central entity processing the interoperable transactions (the "processor");
   - **Interchange** – the fee paid by one participant to the other (sender/receiver pays as agreed); and
   - **Client surcharge** – used when cross-net transactions trigger a higher fee for end customers than on-net transactions.

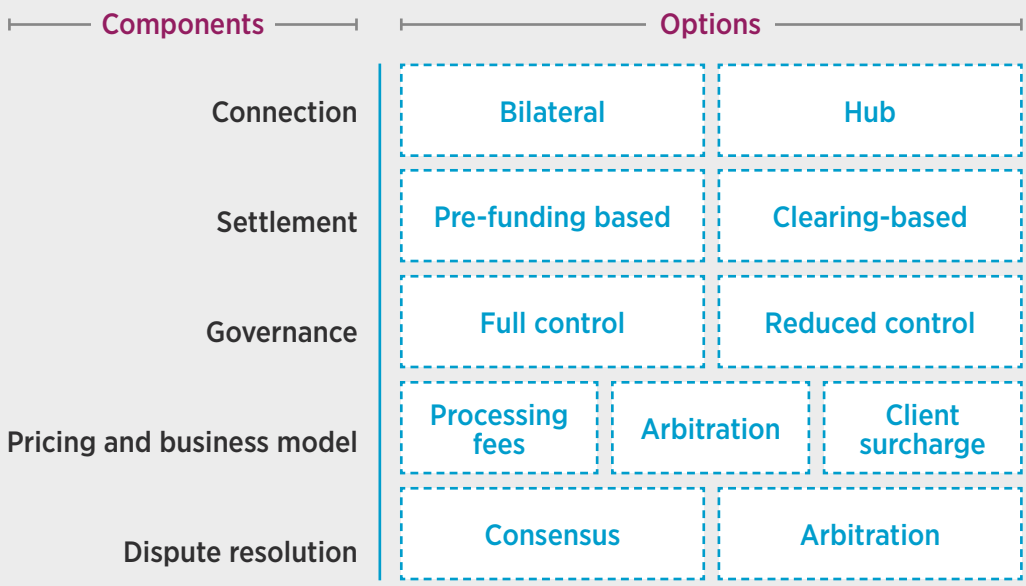
5. **Dispute resolution mechanisms** are a key component of interoperability as they enable DFSPs to reach consensus on a transaction's status and financial liabilities in the case of a dispute. This, in turn, allows customers to perform cross-net transactions with confidence and peace of mind. There are two main types of dispute resolution mechanisms:

   - The **consensus** option – parties must agree on a transaction's status; and
   - The **arbitration** option – one party has authority over a transaction's status.

1. There is another hub model that is not included in these options: a "black box" hub that enables a shared connectivity solution among several participants, but has no routing functions (each participant directs flows to a preselected participant) nor a view on transactions. This prohibits mutual clearing and other value-added functionalities, making it an antiquated model.
2. Prefunding is the act of maintaining an account in a counterpart's system that has been seeded with e-money or funds in advance for later use. Funds can be used (e.g. for cross-net transfers) up to the amount available in the account.
3. E-money, short for "electronic money," is stored value held in the accounts of users, agents and the provider of a mobile money (or other digital financial) service. In the case of mobile money services, typically the total value of e-money is mirrored in a bank account(s), such that even if the provider of the mobile money service were to fail, users could recover 100 per cent of the value stored in their accounts. That said, bank deposits can earn interest while e-money cannot. For more details, see: GSMA (2010). Mobile money definitions.

Figure 2

Interoperability core components options matrix



While all five components of interoperability are crucial and should be considered carefully, some are heavily influenced by the choices a DFSP makes about the other components. For example, pricing and dispute resolution are determined largely independently of technology choices. For this reason, we have prioritised the first three components—connection, settlement and governance—as the primary determinants of an interoperability model and have used them to characterise the four technical models featured in this report. While the four models are applicable to all DFSPs, this report focuses specifically on mobile money providers.

2.3 Four viable technical models for interoperability

The three core components of interoperability each offer two options for technical models. Of the eight scenarios listed in Table 1, four are viable.

Table 1

Four viable technical models for interoperability

	Model	Connection	Settlement	Governance	Viability
1.	Bilateral agreement	Bilateral	Pre-funding based	Full	✓
2.	N/A	Bilateral	Pre-funding based	Reduced	✗
3.	N/A	Bilateral	Clearing based	Full	✗
4.	N/A	Bilateral	Clearing based	Reduced	✗
5.	N/A	Hub	Pre-funding based	Full	✗
6.	Aggregator	Hub	Pre-funding based	Reduced	✓
7.	Mobile money hub	Hub	Clearing* based	Full	✓
8.	Global payments hub	Hub	Clearing* based	Reduced	✓

** Even though hub models have been shown to operate on the basis of a clearing-based settlement model, some hubs may also have prefunding requirements equivalent to or higher than those required under bilateral arrangements.*

- In a bilateral agreement model, interoperable participants connect to each other via one-to-one connections.
- In an aggregator model, a third party that is already integrated with multiple ecosystem players in a market helps to establish payments interoperability between participants.
- In a mobile money hub model, mobile operators set up a central entity that acts as a hub to connect them (as well as other DFSPs) interoperably.
- In a global payments hub model, an entity that is not a mobile operator sets up a central hub that enables DFSPs to be interoperable.

Scenarios 2, 3, 4 and 5 were disregarded because they were either incompatible or unlikely:

- Models 2 and 4: DFSPs can only have full control over a bilateral interoperability solution.
- Model 3: Bilateral solutions are unlikely to implement a clearing-based settlement mechanism in the absence of a third party to perform clearing duties and guarantee the availability of funds.
- Model 5: DFSPs are unlikely to go through the effort of building a shared hub with full control if they still have to use a prefunding-based settlement mechanism.

Detailed technical architecture and flow diagrams of the four viable models are provided in Chapter 3. All these technical models have been implemented in different mobile money markets around the world (see the GSMA Interoperability Landscape study for more details).

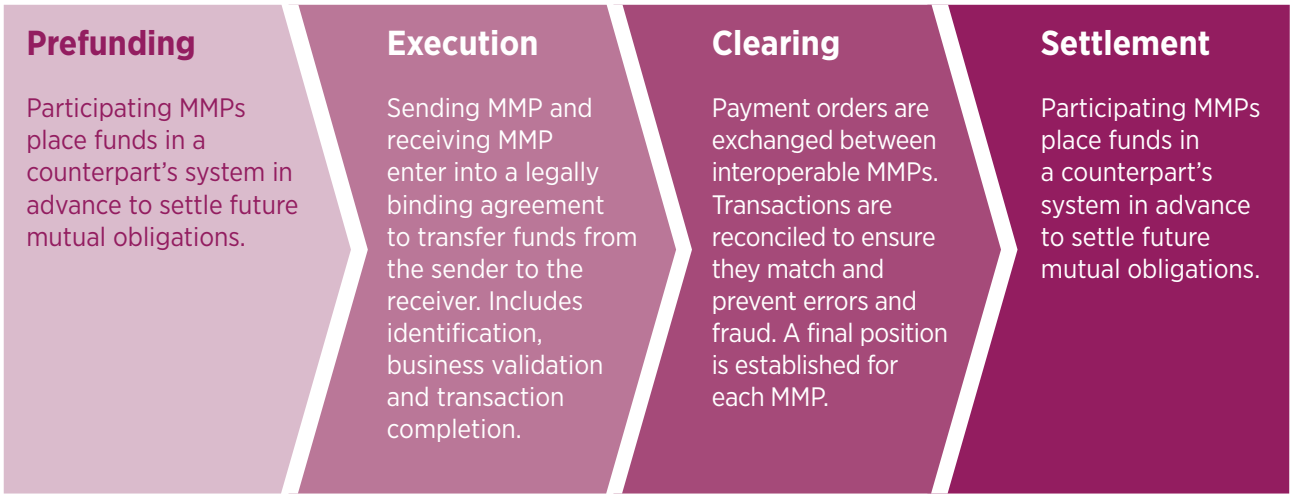
03 Stages of interoperable transactions

The four technical models for interoperability outlined in the previous chapter each have distinct technical architecture. However, before delving into these details, it is first important to identify the key steps involved in an interoperable payment transaction. Knowing these steps will help clarify how the choice of technical model influences each step in the process.

In a mobile money system, payment transactions between MMPs go through a four-stage process: prefunding, execution, clearing and settlement. This process is detailed in Figure 3.

Figure 3

Four stages of interoperable mobile money payment transactions



3.1 Prefunding

Prefunding is the act of maintaining an account in a counterpart's system by depositing e-money or funds in advance for later use. Funds can be used (e.g. for cross-net transfers) up to the amount available in the account.

3.2 Execution

A number of steps are involved in the execution of a payment transaction.

- The first step is **identification** of the sender and receiver. Know your customer (KYC) information may be exchanged depending on the transaction type and regulatory requirements for sending and receiving MMPs. This may require complex customisation of the messaging flow as the KYC information that MMPs make available and request can vary.

- The next step is **business validation**. Some elements of the validation process related to end users always take place at the MMP level. For example, the sender's ability to send money (based on availability of funds or authorisation to conduct a particular type of transaction), which happens before other parties become involved in the transaction, and the receiver's ability to receive the funds (e.g. checking that the transaction does not result in the account reaching a ceiling). Business validations related to MMPs may be handled by the MMPs themselves or by a central party that checks similar parameters at the MMP level.

- Depending on the transaction type and business rules, **pricing information** may be exchanged, (e.g. fees added or deducted from the transaction amount), especially if they are displayed to end users or accounted for separately by a central party and later factored into the settlement and reconciliation process.

- The final step is **transaction completion**, in which transactions are authorised and funds are transferred to the receiver/end user.

3.3 Clearing

While the execution stage involves interactions with mobile money users, the next steps of clearing and settlement only involve MMPs (and a central entity, if any) in charge of managing interoperable transactions. When players are interoperable, it becomes essential to record transactions and track the mutual obligations of participants.

Clearing involves the transmission of information, reconciliation and possibly netting. As a first step, payment orders are exchanged and transmitted between interoperable participants. This is usually a set of procedures whereby participants exchange data and/or documents related to interoperable payments. Then, transactions are reconciled by comparing data sets of transactions recorded by participants or by the central entity to ensure they match and prevent errors and fraud. Finally, clearing can involve the netting of payment instructions and the establishment of a final position for each participant (i.e. comparing the financial claims of each participant against the claims of others).

3.4 Settlement

Settlement is the act of discharging interoperable participants from their financial obligations to their counterparts through a transfer of funds.

Settlement performed after netting is also known as **net settlement**. When settlement happens without netting, it is referred to as **gross settlement**.

Box 1: Clearing or settlement?



Clearing and settlement are two important processes in account-to-account (A2A) transactions. The terms originated in banking when agents of banking clients would meet at the end of the day to exchange promissory notes and work out the net position of their clients (clearing). Once the net position was determined, they would move gold bars from the accounts of those who owed money to the accounts of those who were owed funds (settlement).

We have come a long way from moving gold bars between accounts, but the concepts of clearing and settlement remain central to the payments industry today.

04 Architecture of interoperability models

4.1 Functional blocks of interoperability

When deciding which interoperability model is best suited to their needs, MMPs should consider several key technical aspects of different models and understand the implications. Each of the four technical models for interoperability featured in this report have a distinct technical architecture that can have major commercial and business consequences for MMPs.

The high-level technical architecture diagrams of the four interoperability models featured in this chapter indicate where the functional blocks (Box 2) of interoperability are hosted and how they interact with each other. Understanding these diagrams will assist with the cost and efficiency analysis of different models presented later in this report.

Box 2: Functional blocks of interoperability

All cars have an engine, brakes and a chassis, but depending on the specifications of each component and how they fit together, the same parts can create very different models of cars. In a similar way, all interoperability models have many of the same moving parts, but their specific capacities and how they interact with each other will ultimately determine how the interoperability model looks and functions. What is meant by the functional blocks of interoperability?

Any interoperable model involving MMPs has the following components:

Box 2: Functional blocks of interoperability

Inbound-outbound channels	Interfaces and channels that serve as a touchpoint with customers of MMPs (e.g. USSD interface)
Core mobile money functions	Standard mobile money services, including on-net, off-net and cross-border transfers, merchant payments and utility payments.
Business validations	Checking that the transaction initiated by a user complies with a pre-defined set of rules. Rules can be at the scheme level and at the MMP level.
Security	Process of verifying and authenticating incoming requests based on certificate management and encapsulation of JWS signatures.
AML/ fraud	Process of performing anti-money laundering, counter terrorism and fraud verifications of incoming transactions based on consistent and systematic screening of transactions.
API	interface protocol between two parties.
API customisation	Customisation of local system to integrate with partner's API.
Gateway	Single point of entrance to the system, aggregating one or more protocols.
Routing	Act of looking up the payee MMP and end receiver information to subsequently route the transaction to the right entity.
Quoting	Process of information exchange between payer and payee on the cost of a transfer (conditions, fees, foreign exchange rates).
Transfer	Process of moving e-money between a payer and payee account with an MMP.
Settlement	Actual funds transfer from an MMP's bank account to another MMP's bank account.
Manual prefunding	In a prefunded model, this refers to manually (i.e. not automatically) transferring funds from an MMP's bank account to another MMP's bank account to allow future interoperable transactions.
Prefunding monitoring	In a prefunded model, this refers to surveillance and monitoring of the amount of funds made available for interoperable transactions.

4.2 High-level technical architecture of different interoperability models

4.2.1 The bilateral agreement model

The bilateral agreement model combines bilateral connections, a prefunded settlement mechanism and full MMP control over the interoperability solution.

As the flow diagram in Figure 4 shows, MMP A holds a wallet in its counterpart's system that is prefunded to allow cross-net transactions.

Figure 4

The bilateral agreement model

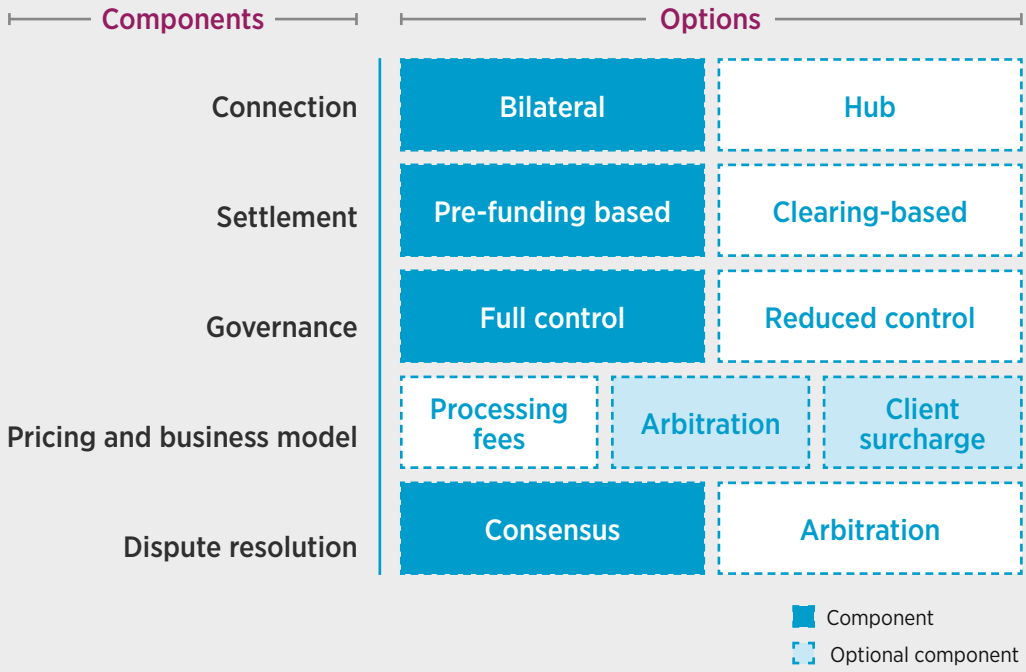
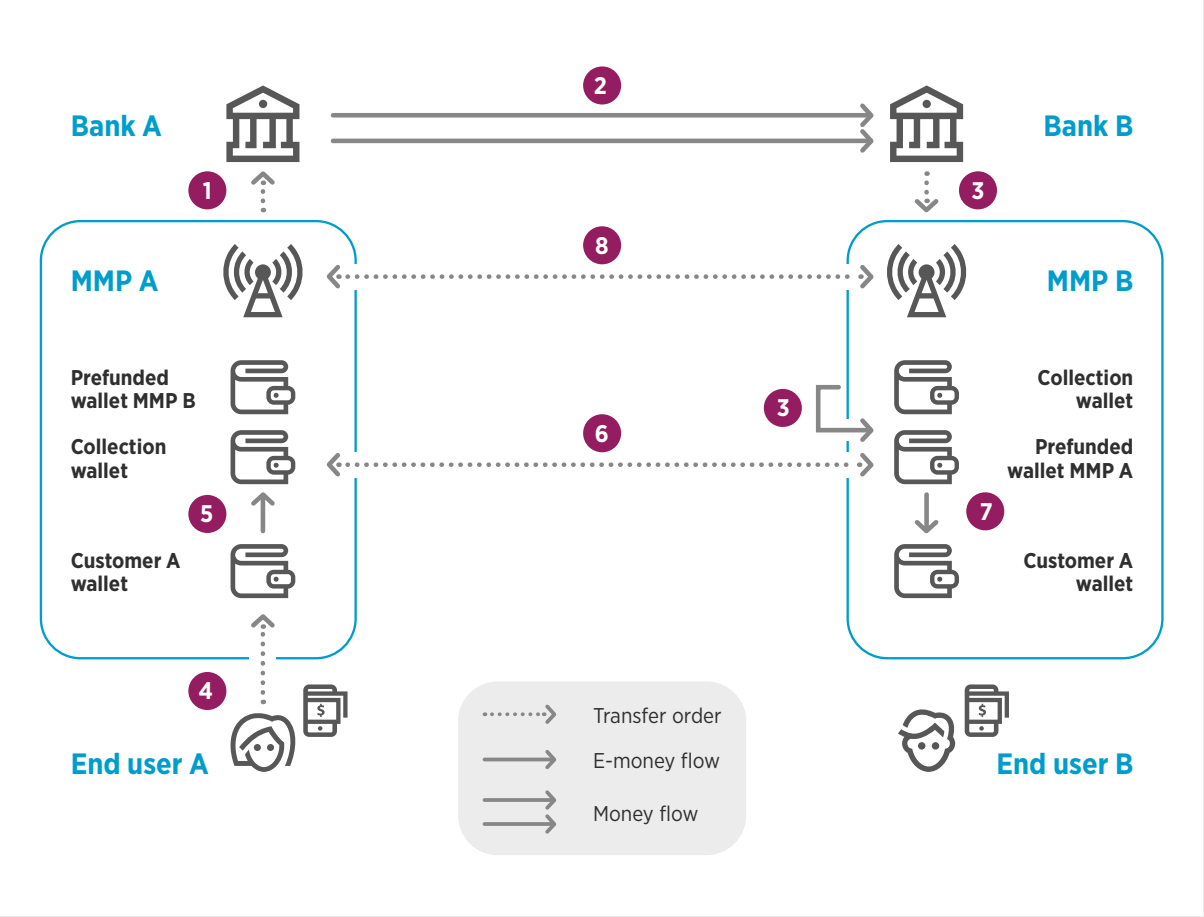


Figure 4

The bilateral agreement model



Prefunding phase

1. MMP A sends a transfer order to its bank to establish a prefunded position at MMP B.
2. Bank A transfers money from MMP A's trust account to Bank B holding the trust account of MMP B.
3. MMP B reflects the prefunded position in MMP A's wallet on its e-money platforms.

Execution phase

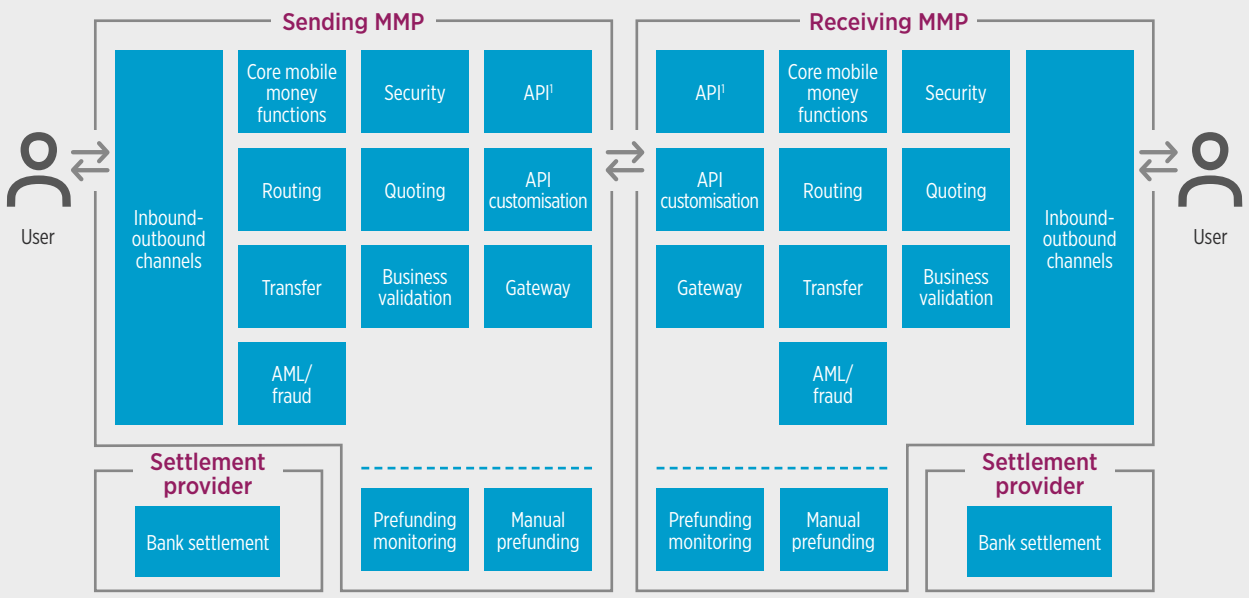
4. End user A initiates payment to end user B. Identification, business validations and authorisation are performed (not shown).
5. The payment amount is deducted from end user A's wallet.
6. Order is given by MMP A to MMP B to transfer funds from its prefunded wallet to end user B.
7. End user B's wallet is credited with the corresponding amount sent by end user A.

Clearing and Settlement phase

8. MMP A and MMP B reconcile their positions and adjust prefunding (step 1) if required, re-establishing opening day balances.

Figure 5

The technical architecture of a bilateral agreement interoperability model



(1): In a bilateral model with more than two MMPs involved, each MMP must have exposed and integrated its APIs with each API of its counterparts.


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4.2.2 The aggregator model

The aggregator model combines a hub connection with a prefunded settlement mechanism. Because the interoperability solution is provided by a third party, the MMP has less control over it.

As the flow diagram in Figure 6 shows, MMP A holds a wallet in its counterpart's system that is prefunded to allow cross-net transactions.

Figure 6

The aggregator model

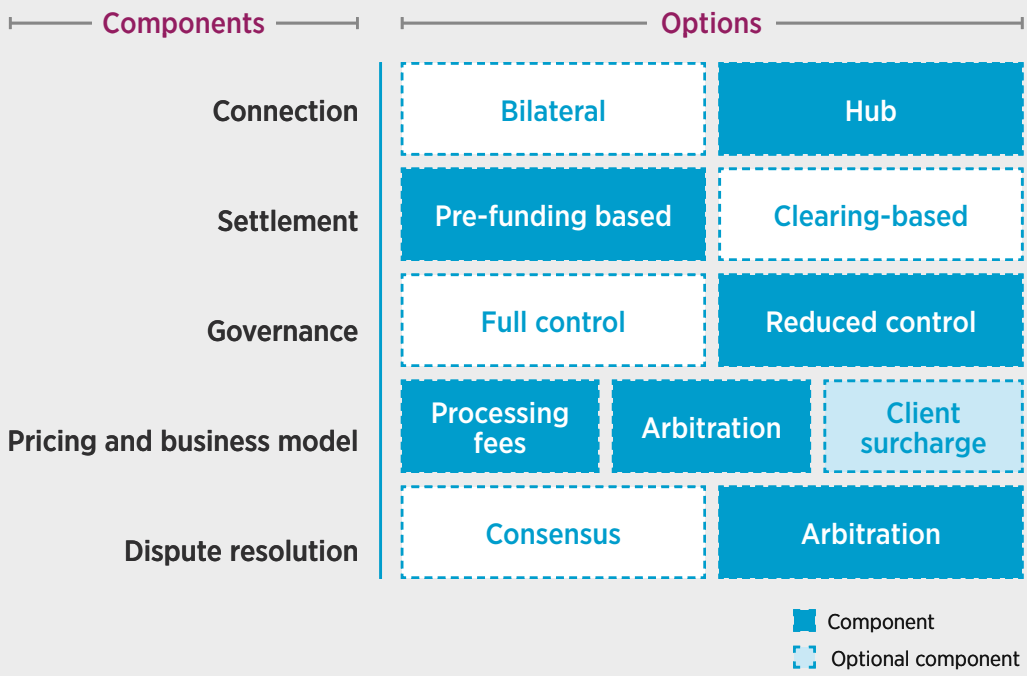
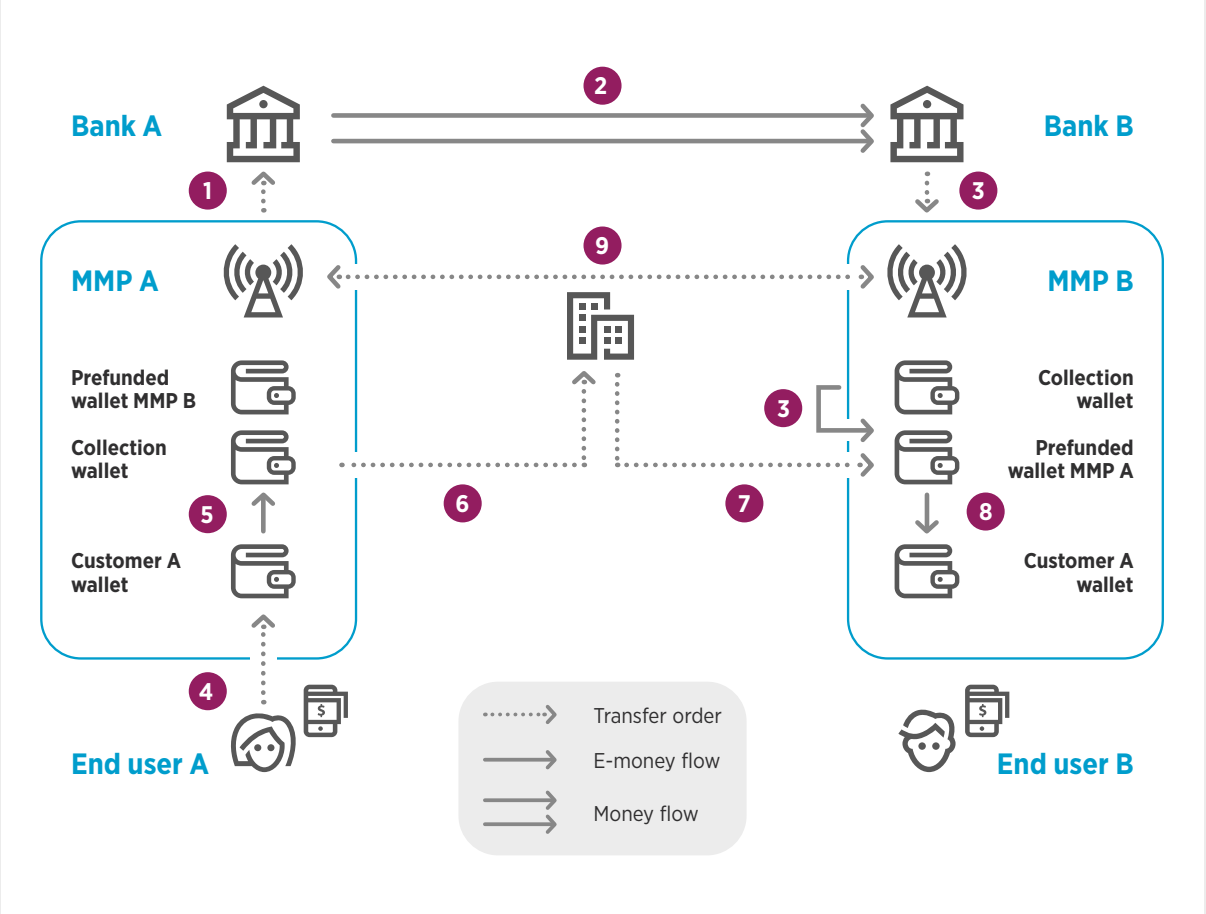


Figure 6

The aggregator model



Prefunding phase

1. MMP A sends a transfer order to its bank to establish a prefunded position at MMP B.
2. Bank A transfers money from MMP A's trust account to Bank B holding the trust account of MMP B.
3. MMP B reflects the prefunded position in MMP A's wallet on its e-money platforms.

Execution phase

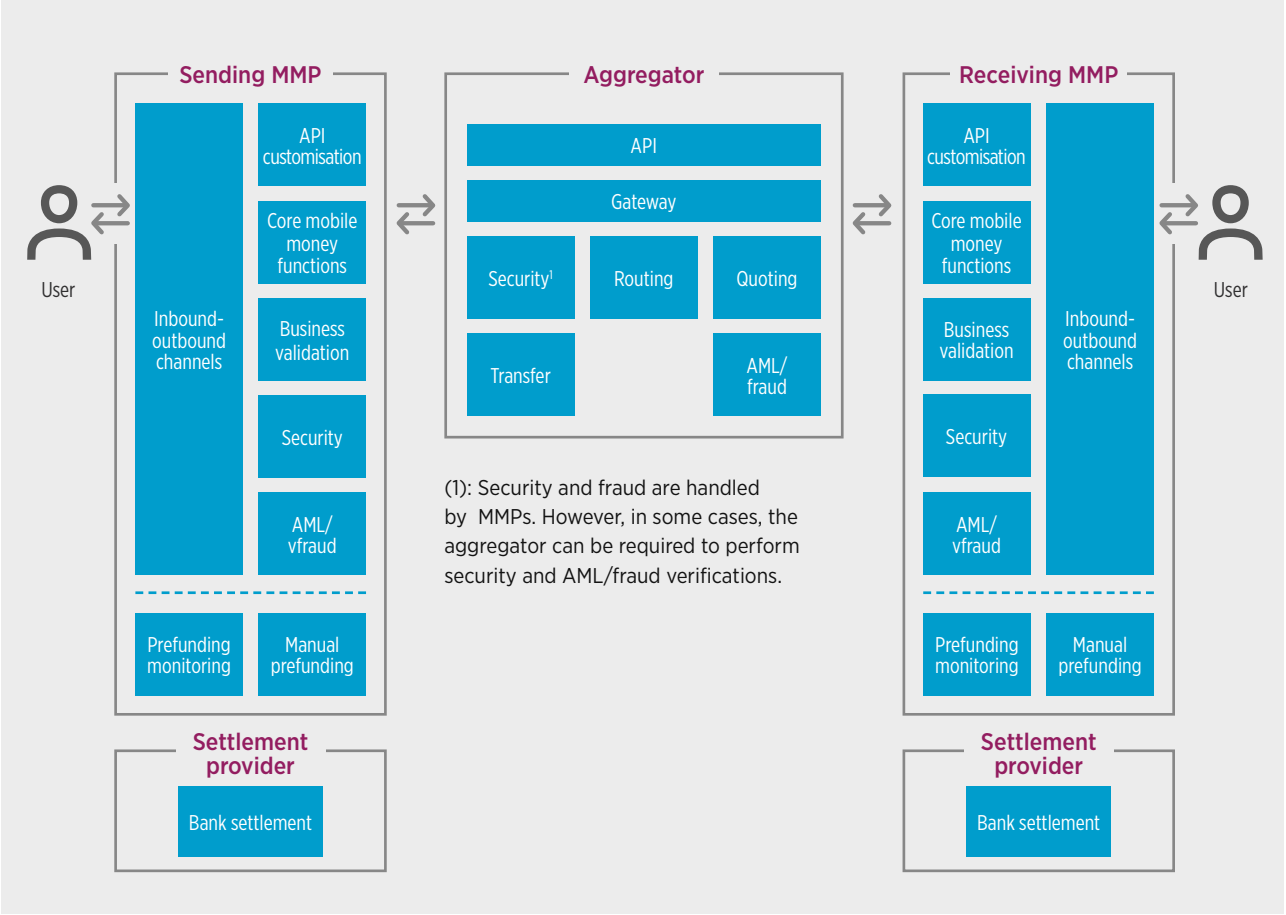
4. End user A initiates payment to end user B. Identification, business validations and authorisation are performed (not shown).
5. The payment amount is deducted from end user A's wallet.
6. Order is given by MMP A to the aggregator to route the transaction to MMP B.
7. Aggregator routes MMP A's order to MMP B to transfer funds from its prefunded wallet to end user B.
8. End user B's wallet is credited with the corresponding amount sent by end user A.

Clearing and Settlement phase

9. MMP A and MMP B reconcile their positions and adjust prefunding (step 1) if required, re-establishing opening day balances.

Figure 7

Technical architecture of an aggregator interoperability model





4.2.3 The mobile money hub model

The mobile money hub model combines a hub connection with a clearing-based settlement mechanism and full MMP control over the interoperabililty solution. In this model (Figure 8), participants are connected through a central platform that routes transactions as follows.

Figure 8

Mobile money hub model

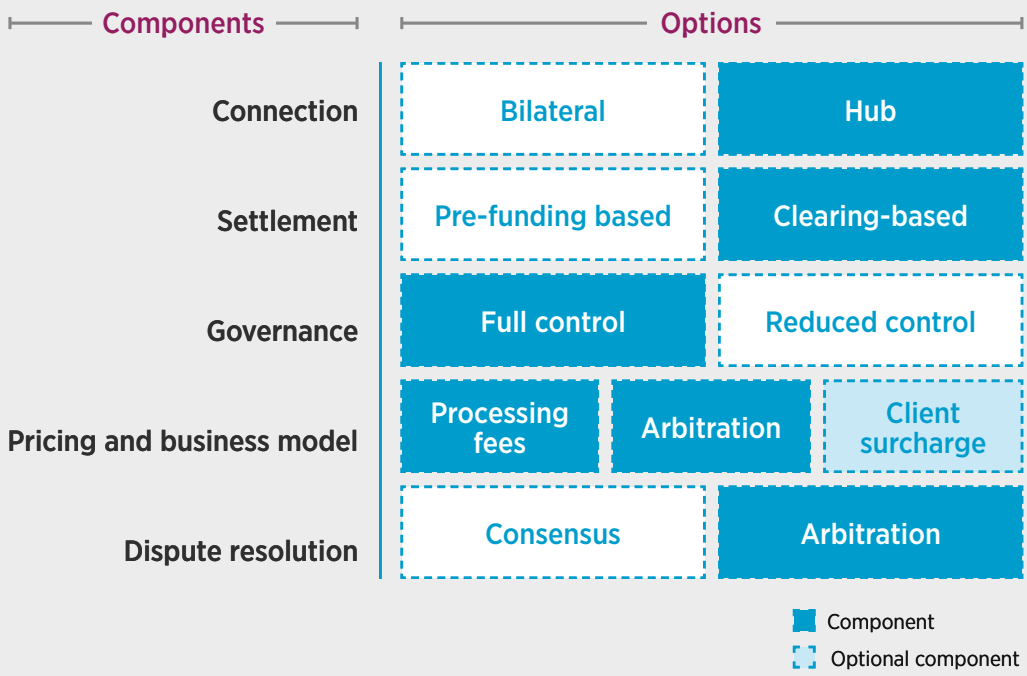
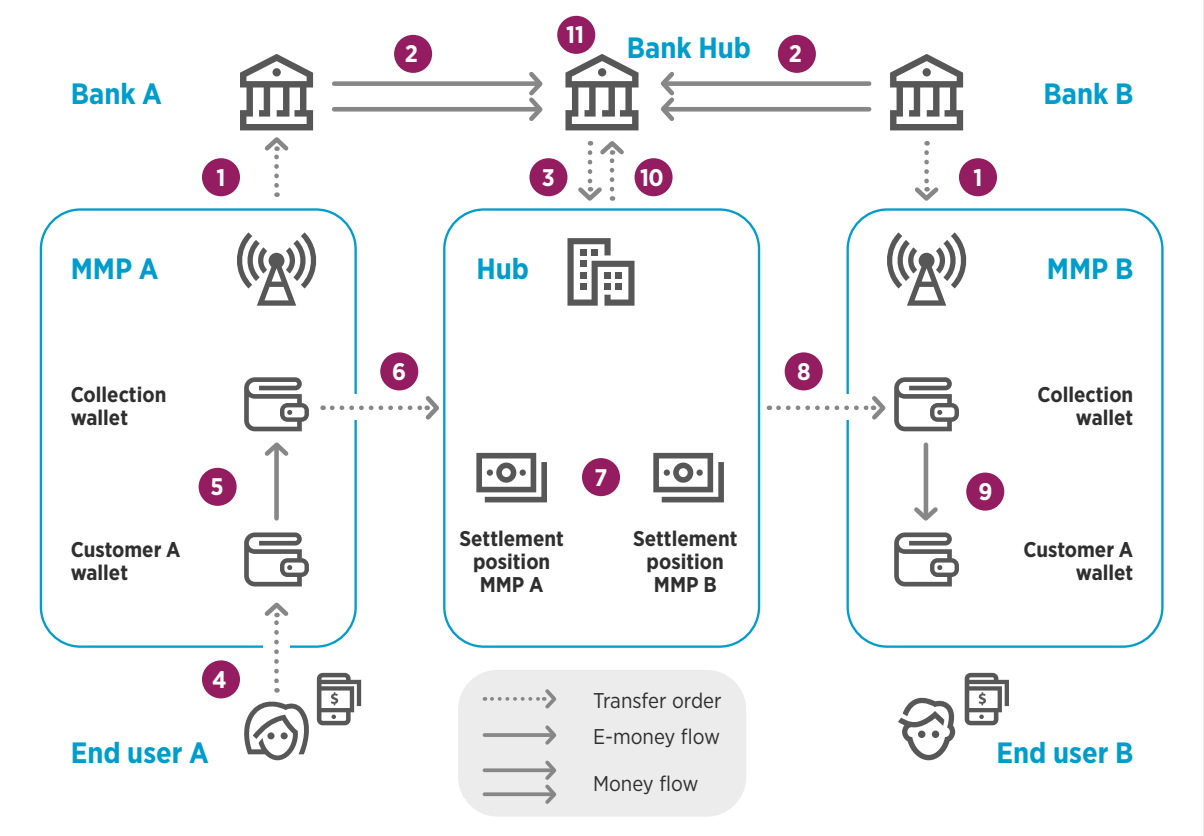


Figure 8

Mobile money hub model



Prefunding phase

1. MMP A and MMP B send a transfer order to their banks to establish prefunded positions at the hub's bank, which serves as collateral.
2. Bank A and Bank B transfer money from MMP A's and MMP B's trust accounts to the Bank Hub, which holds the collateral.
3. The Hub reflects the prefunded positions of MMP A and MMP B.

Execution phase

4. End user A initiates payment to end user B. Identification, business validations and authorisation are performed (not shown).
5. The payment amount is deducted from end user A's wallet.
6. Order is given by MMP A to the Hub to route the transaction to MMP B.
7. MMP A's collateral settlement position is debited by the Hub and MMP B's collateral settlement position is credited.
8. The Hub routes MMP A's order to MMP B to transfer funds to end user B.
9. End user B's wallet is credited with the corresponding amount sent by end user A.

Clearing and Settlement phase

10. The Hub initiates the clearing of net positions and triggers intra-day settlement.
11. Bank Hub reconciles positions with MMP A and MMP B, which re-establish opening day balances.

4.2.4 The global payments hub model

The global payments hub model combines a hub connection with a clearing-based settlement mechanism, but with less MMP control over the solution. In this model, participants are connected through a central platform that routes transactions, as shown in Figure 9.

Figure 9

The global payments hub model

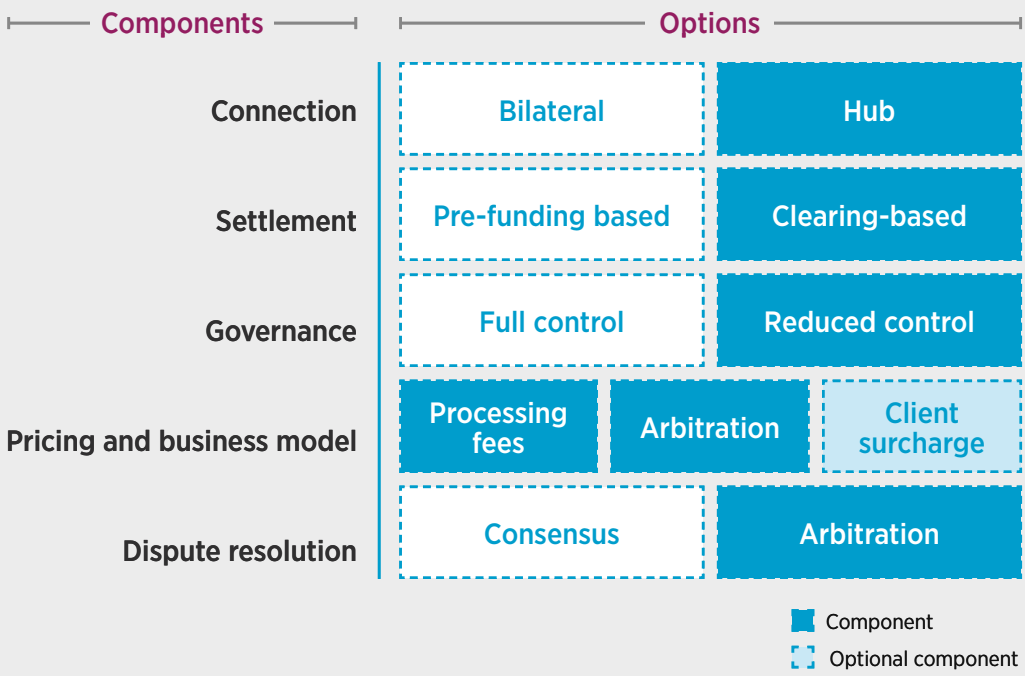
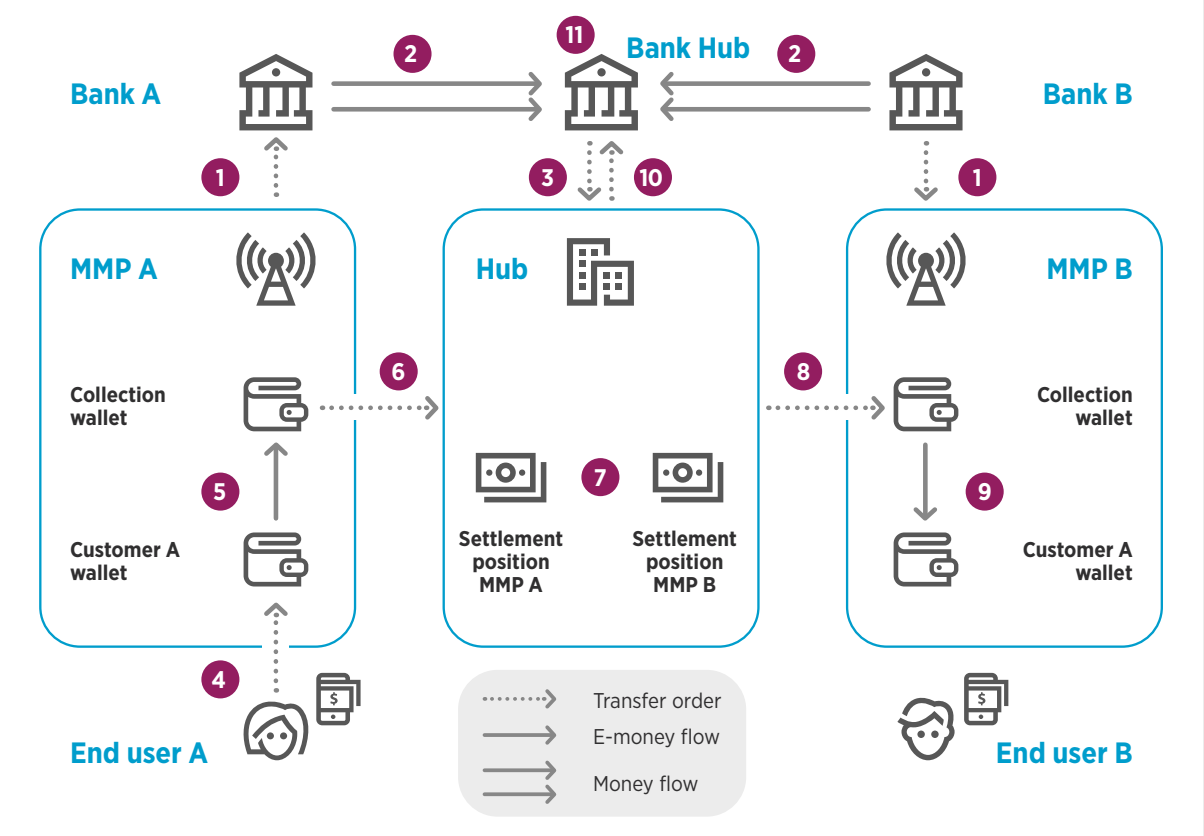


Figure 9

The global payments hub model



Prefunding phase

1. MMP A and MMP B send transfer orders to their banks to establish prefunded positions at the Bank Hub, which serves as collateral.
2. Bank A and Bank B transfer money from MMP A's and MMP B's trust accounts to the Bank Hub, which holds the collateral.
3. The Hub reflects the prefunded positions of MMP A and MMP B.

Execution phase

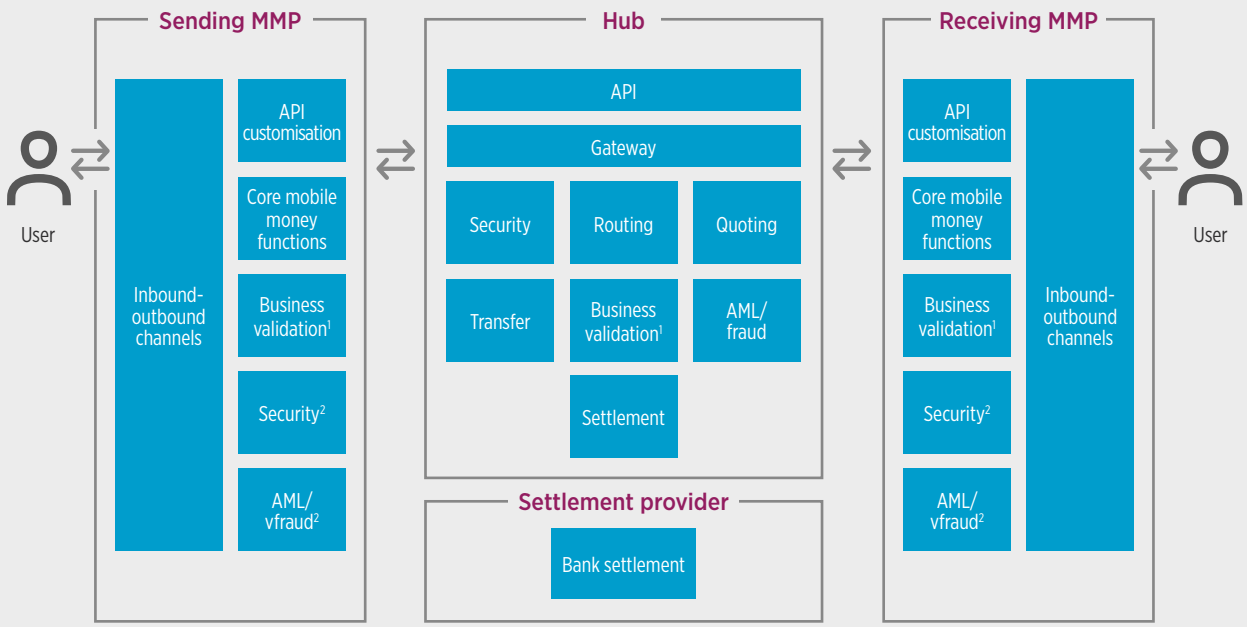
4. End user A initiates payment to end user B. Identification, business validations and authorisation are performed (not shown).
5. The payment amount is deducted from end user A's wallet.
6. Order is given by MMP A to the Hub to route the transaction to MMP B.
7. MMP A's collateral settlement position is debited by the Hub, and MMP B's collateral settlement position is credited.
8. The Hub routes MMP A's order to MMP B to transfer funds to end user B.
9. End user B's wallet is credited with the amount sent by end user A.

Clearing and Settlement phase

10. The Hub initiates clearing of net positions and triggers intra-day settlement.
11. The Bank Hub reconciles positions with MMP A and MMP B, which re-establish opening day balances.

Figure 10

Technical architecture of a hub interoperability model



(1): Some degree of business validation is performed at the MMP level to initiate the transaction. However, validation of interoperability agreements is handled by the hub.

(2): Although security and fraud are handled by the hub, MMPs still perform standard verifications.

Note that the diagrams of the four interoperability models we have presented here are broad schematics; the specific steps and flows of deployments in different markets may vary slightly.

05 Technical implications of interoperability models

The choice of an interoperability model has a significant impact on the technical, commercial and business operations of mobile money providers. In this chapter, we focus on the technical implications of the four interoperability models.

5.1 API design and protocols

APIs and gateways are the structural components determining what information is exchanged between MMPs and a third party.

An application program interface (API) is a set of routines, protocols and tools for building software applications that specify how different software components should interact.[4] In the mobile money context, APIs are the interfaces determining which pieces of information are requested or shared by different services of a mobile money platform (KYC, transactional services, etc.). Gateways are the entry point for requests that dispatch a single request between the different services and their respective APIs.

The main challenge with APIs is not setting them up, but rather maintaining and upgrading them over the long term. Therefore, some time spent thinking about standards at the beginning of an interoperability project can save significant time and costs later. While the level of effort and cost of a one-time bilateral connection is fixed, it may grow exponentially with the number of connections, as each API evolution of one participant requires coordination with all counterparts so they can handle the changes simultaneously. This means that, even with decentralised interoperability solutions, a coordination forum may be necessary to agree on product lifecycle management, prioritise evolutions and ensure all participants allocate resources to handle evolutions in due time.

To facilitate maintenance and scalability, participants of an interoperability solution should seek to agree on standards. In a hub or aggregator context, these standards are usually mandated by the central entity with the provision for participants to weigh in (to a greater or lesser extent). At a time of growing demand for interoperability, either mandated by authorities or expected by customers seeking a seamless transactional experience across platforms, MMPs should seek to follow the trend of standardised APIs in the financial sector (see Box 3).

4. Beal, V. "API – Application Program Interface". Webopedia.

Box 3: The importance of APIs in expanding the mobile money ecosystem



As the reach and impact of mobile money increase, so do the demands on the technical platforms underpinning it. Substantial work is required to connect multiple partners in the ecosystem, and mobile money platform vendors are implementing bespoke API solutions to help. Unfortunately, significant time and money are spent on one-to-one vendor connection solutions, which in most cases cannot be reused. Bespoke APIs are causing fragmentation of vendor service APIs across platforms, services and regions. Two industry initiatives have been launched to address this problem.

The GSMA Mobile Money API[5] is a GSMA-led industry collaboration aimed at helping the mobile money industry speak the same technical language. Providing a modern and harmonised API for mobile money transactions and management that is both secure and easy to use, this common technical language—the API specification—enables easy integration between MMPs and organisations that want to interface with them. The API is based on RESTful principles, a common, easy-to-use set of principles used in modern APIs that provide an exceptional level of security. It supports the core set of mobile money use cases, such as cash-in/cash-out, bulk transactions, international transfers, account management, bill payment, merchant payment and interoperability with banks and between MMPs.

Similarly, the Mojaloop API,[6] supported by the Bill & Melinda Gates Foundation, links those in the payments ecosystem to open source software for creating digital payments platforms that connect all customers, merchants, banks and other financial service providers in a country's economy. Rather than a financial product or application in itself, Mojaloop establishes a blueprint for technology that bridges all financial products and applications in any given market.

Both the GSMA Mobile Money API and the Mojaloop API are hosted on the GSMA Inclusive Tech Lab's Interoperabiity Test Platform,[7] which provides an open source and secure environment enabling ecosystem participants to test their systems across different use cases.

5. GSMA Mobile Money API: https://www.gsma.com/mobilefordevelopment/mobile-money/mobile-money-api/
6. Mojaloop Overview: https://mojaloop.io/documentation/
7. Martins, B. (24 March 2020), *GSMA Inclusive Tech Lab launches new platform to test mobile money interoperability*. GSMA Mobile for Development Blog.

5.2 Account identification

A crucial step in the execution stage is account identification. Mobile money customers are identified through their phone number (MSISDN), and identifying which MSISDN belongs to which MMP is essential to routing transactions to the right mobile money account. This is a challenge, especially with the advent of the e-money issuer model in which mobile money operations are often not hosted by the same company as the parent telco.

Routing transactions to the right MMP is limited to three options:

1. **The sender has to know the recipient's provider:** The sender selects the provider prior to entering the MSISDN. The transaction is then routed to the selected MMP and, if the MSISDN is not recognised, the transaction fails. This is the least convenient method in terms of user experience (it adds the step of selecting the recipient's MMP) and understanding of the service (transactions may fail even if the MSISDN is correct).

2. **MMPs maintain internal directories:** In bilateral connections, MMPs can use internal directories to route transactions to the right recipient. For example, in countries where MSISDN portability is not allowed, MNOs (and related MMPs) are identified through specific prefixes. When third parties are involved (e.g. aggregators or hubs), they can maintain the directories and route transactions accordingly.

3. **MMPs use third-party directories:** In contexts where regulatory authorities allow customers to open several wallets with the same phone number, interoperability may become challenging to implement. For example, in Morocco, customers holding several wallets are required to "enrol" their preferred wallet for interoperable transactions, allowing the hub to route incoming transactions to the correct MMP. This regulatory requirement therefore creates technical constraints not only for the hub, but also for customer-facing MMPs, which must offer this enrolment functionality to customers. For scenarios such as these, as well as cross-border transactions, the GSMA supports the PathFinder project, which maps MSISDNs to MNOs and MMPs worldwide (see Box 4). This solution is used in the Mowali implementation, for example.

All the routing methods outlined here are possible to adopt in any of the four technical interoperability models. However, the more players involved, the more sense it makes to use a central directory (i.e. the third routing option). It is worth noting that even though MSISDN is a standard for end users, this does not exclude the use of other identifiers to link accounts, such as account or card numbers using the EMV standard.

5.3 Processing capacity and scalability

The capacity of an interoperable solution refers to the number of transactions it can process within a given time frame. It may seem intuitive that certain technical models of interoperability would have greater capacity to process transactions than others. However, a more nuanced discussion of the topic is merited.

The capacity of any interoperable solution depends largely on two elements: networks and servers. The network is the physical gateway through which information moves, while the server infrastructure ensures there is sufficient capacity to process the required volumes of transactions and related communication flows within the specified time frame.

Box 4: The GSMA PathFinder Service



PathFinder is a GSMA-branded solution operated by Neustar as a centrally hosted and managed service. Launched in 2009, PathFinder is a number resolution service used by communication service providers, including mobile operators, messaging aggregators, content providers, messaging hubs, financial service providers and social media networks.

GSMA PathFinder is operated by a team of industry experts that continuously update global telephone number data, including the number plans for 240 countries and territories with 8.6 billion telephone numbers. Service provider users are able to instantly identify the correct destination network for relevant traffic termination using the service. PathFinder acquires portability data using widely disparate protocols and assimilates the bespoke data formats from many different ported country data sources into a centralised PathFinder database accessible via a single API. To ensure the highest quality of information, PathFinder uses only authoritative data sources and draws on a network of over 100 points of contact to confirm updates.

GSMA PathFinder's interconnect feature enables customised data to be provided against telephone numbers, adding rich and dynamic information to the routing profile. Multiple fields can be added to the PathFinder database to support customised responses of customer-specific data. Accessible through a single interface, GSMA PathFinder is a carrier-grade solution that can be used for any service requiring telephone number information. Mobile apps that need to communicate with a user's service provider use GSMA PathFinder to identify the correct operator, allowing messages, API calls and mobile money payments to be routed correctly.

Find out more at gsma.com/pathfinder

The choice of network infrastructure is independent of any technical model for interoperability. In other words, which technical model of interoperability is adopted does not have an impact on the network infrastructure that supports it.

Server infrastructure options are also independent of the interoperability technical set-up, with the main choice to be made between in-house, physically hosted servers or virtual servers. Virtual servers are becoming the go-to solution for many industry players, especially since they ensure scalability (immediate purchase of server capacity rather than actual servers that must be purchased and installed), but also turn capital expenditures into variable cost (capacity is purchased on-the-go instead of maintaining a maximum capacity).

Network and servers—the two key determinants of the capacity of a payment system—are not affected by the choice of a particular technical model for interoperability. Instead, the capacity of an interoperability solution to process sufficient volumes at sufficient speed is made possible with adequately sized infrastructure and its architecture. The ability to have replicable infrastructures with multiple access points for different participants will also allow splitting of the transaction load and processing transactions without excessive queuing time.

5.4 USSD session timeout

When interoperability participants exchange information, they face the risk of timeouts. This is particularly important in mobile money systems where transactions often require the maximum duration of a USSD session. While on-net transactions can also face timeouts, the risk is greater in an interoperability context since MMPs and/or central parties like a hub must be able to enforce service-level agreements (SLAs), ensuring all the steps requiring an end user action can be finalised during the session. Excess timeouts and unsuccessful transactions can also foster distrust among users, particularly in underserved groups.

5.5 Breakdown risk

Any technical infrastructure, no matter how robust, faces the risk of breakdown. In the case of bilateral interoperable connnections, the breakdown of a link between two participants will halt transactions between them, but other participants in the ecosystem will be relatively unaffected. Hub models, however, carry the risk of a single point of failure whereby a breakdown affects all entities connected to it.

The risk of a hub breaking down can be mitigated with the use of redundancies—if one server goes down, others are in place to back up transactions. This type of infrastructure is known as "active/active" and balances the load across geographically distributed servers so that one server failure goes unnoticed by users. This is unlike an active/passive infrastructure in which backup servers are only used if the primary ones crash. However, the extent to which such mitigation measures can be replicated in emerging market contexts is open to question.

This chapter has detailed the technical implications of selecting a particular interoperability model, focusing on a few select topics that are often top of mind for MMPs considering interoperability. However, the choice of an interoperability solution has a commercial and business impact on MMPs as well, and that is the focus of the next chapter.



06 Commercial and business implications of interoperability models

6.1 CAPEX

The choice of a technical model for interoperability influences the capital expenditure (CAPEX) an MMP incurs, which in turn influences the business models, fees and pricing structures that emerge.

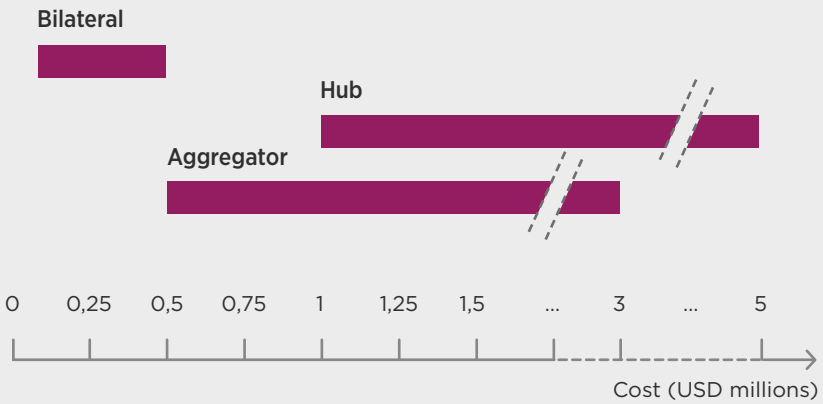
There are three main CAPEX costs associated with setting up any interoperability solution:

Conception and design	All costs incurred from defining and materialising the architecture, functional layers, technical assets and infrastructure of an interoperability solution.
Development and Integration	All programming costs incurred from developing the previous solution and integration with the existing ecosystem.
Infrastructure assets, network and security	All costs stemming from the procurement and installation of infrastructure assets, network connectivity set-up and implementation of security standards.

Specific details of the set-up costs of different interoperability models are valuable competitive information and hard to come by in the public domain. However, industry intelligence suggests that the set-up cost of a bilateral interoperability model can range from $100,000 to $500,000, whereas the cost of setting up a hub or aggregator model rises to the millions.

Figure 11

High-level cost of an interoperability solution built from scratch



However, the costs work differently in different interoperability models. In a bilateral agreement model, the set-up cost is repeated with the additional complexity of managing parallel interconnections, whereas in a hub model, the set-up cost is higher but offers network effects as one connection gives access to many. In both the aggregator and hub models, additional costs are supported by participating MMPs for integration work and the customisation or adaptation required to connect to a central platform. It is therefore essential to consider the costs supported by MMPs in different models, as well as those supported by a central platform operator.



6.2 OPEX

There are five main OPEX (operating expenditure) costs for MMPs in the early phase of an interoperability solution (Table 2).

Table 2

Primary OPEX costs for MMPs

1.	**Maintenance costs**	The internal or external resources required to maintain, update, upgrade and monitor the interoperability solution (including customer call centre costs).
2.	**Prefunding costs**	The cost of immobilising money in a bank account.
3.	**Membership fees and security**	In models involving a central platform, the central entity can charge a recurring fee to connected participants.
4.	**Processing fees**	In models involving a central platform, a fee can be applied by the central entity on every transaction it processes, either a flat fee or a percentage.
5.	**Interchange fees and security**	Fees paid between MMPs for the acceptance of payments. In a receiver pays model, the interchange fees are paid by the MMP receiving the funds. When incurred by the sending side, it is a sender pays model.

Membership and processing fees are both heavily influenced by the choice of interoperability technical model. In an aggregator or hub model, the central entity always bases its business model on a processing fee and an optional membership fee. In contrast, bilateral models work without a central player and therefore without a processing fee.

Maintenance and prefunding costs apply regardless of the model chosen, but vary from one model to another.

Finally, interchange fees can apply in any model, but the negotiation position of participants is influenced by the choice of model.

Table 3 shows how OPEX costs can be expected to fall on MMPs under different interoperability models.

Table 3

OPEX by interoperability model from an MMP perspective

	Bilateral agreement	Aggregator	Global payments hub	Mobile money hub
Maintenance cost				
Prefunding cost				
Membership fee	N/A	Optional	Optional	Optional
Processing fee	N/A			
Interchange fee	Optional	Optional	Optional	Optional

Relatively lower  Relatively higher

Colours indicate the relative cost supported by an MMP for a specific OPEX item compared with other models.

Hub models, which incur high expenses to set up an interoperability solution, must reflect these costs in their business model. This results in membership fees and processing fees that are eventually absorbed by MMPs. In contrast, such recurring fees are not applied in a bilateral agreement model. It is important to point out that in a mobile money hub model where the central platform is owned and controlled by MMPs, they may charge lower fees, but will not do away with fees completely as the platform will need to be sustainable.

Another major aspect to consider is maintenance costs. Such costs are likely to be much higher in a bilateral model where MMPs have to dedicate a specific team to monitor the modules they have built into their local system. In contrast, in a hub model, MMPs are responsible for some maintenance, but most is carried out by the central platform for all participants.

While the bilateral model can be slightly more CAPEX-intensive for MMPs than other models, especially when multiple bilateral connections are required, OPEX is more favourable primarily because there are no processing fees. In contrast, centralised models can be less CAPEX-intensive from an MMP perspective, but higher processing and membership fees can make interoperability less viable. In the middle is a mobile money hub owned by MMPs, which can mitigate fees while granting more governance control to MMPs.[8]

6.3 Time to market

In addition to CAPEX and OPEX, time to market is another important consideration when selecting an interoperability model as it also has significant commercial implications for MMPs.

When designing an interoperability solution, the implementation process differs slightly between models depending on the type of model a participant selects. In general, there are more steps involved in setting up a hub model than a bilateral model (Table 4).

8. At this point it is difficult to assess the economics of hubs for MMPs in the long term. Solutions have only been developed in recent years and often at a relatively high cost, as can be expected from prototypes in any industry. However, it should be possible to replicate these solutions at a fraction of the initial development cost going forward.

Table 4

Operational steps for setting up interoperability

Main steps in an implementation process	Time required	Step required	
		Hub model	Bilateral model
Create hosting company	Low	✓	
Hire staff	Low	✓	
Negotiate business rules	High	✓	✓
Procure technical solution	High	✓	
Develop technical solution	Medium	✓	✓
Expose APIs	Low	✓	✓
Negotiate bank agreements (for settlement)	Low	✓	
Interconnect/connect to technical solution	Medium	✓	✓
Test services	Medium	✓	✓
Upgrade UI (USSD menus)	Low	✓	✓
Obtain regulatory approval/no objection	High	✓	✓

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6.4 Prefunding and liquidity requirements

As explained in Chapter 2, clearing is a key step involving the transmission of information, reconciliation and possibly netting. Settlement refers to the act through which interoperable participants are discharged from their financial obligations to their counterparts via a funds transfer. Depending on the technical model for interoperability, settlement can be either prefunding based or clearing based. In a prefunded model, each MMP holds a wallet with its counterpart. The wallet is prefunded with a bank transfer, and debited/credited to reflect the end user's transactions. In contrast, when a clearing-based settlement mechanism is in place, the sender's and receiver's accounts are debited and credited instantly, while real money is transferred ex-post based on obligations identified during the clearing process. The prefunding requirement for any interoperability model is likely to be the outcome of not just technical, but also governance-related factors. It is possible that liquidity requirements for participants would increase in a shift from a bilateral to hub-based model, but this risk may be mitigated by introducing expense accounts for hub participants that can go into negative balance.

6.5 Dynamics with other stakeholders

Different interoperability models may affect relationships between MMPs and financial service providers differently. Hub models in particular have the potential to expose MMPs' key assets to other players, such as client interfaces and contractual relationships with partners, and this can have an impact on reputation and revenue. However, it is important to note that these impacts are not the consequence of the technical elements of an interoperability model, but rather what MMPs decide to implement (or are mandated to implement) as part of their technical model and under what conditions.

For instance, in MMPs' relationships with billers, the main revenue risk arises from the possibility that bill payment fees may become regulated and harmonised under some interoperability models, thereby removing the possibility of bilaterally negotiated agreements (from which MMPs could derive benefits in terms of revenue and differentiation). However, transaction fees would remain even though MMPs do not directly interface with billers and no longer hold corporate wallets.

Maintaining direct relationships with stakeholders is important because it helps MMPs protect competitive assets, preserve incentives to invest in the industry and continue serving the cause of financial inclusion.

6.6 Integration times

Integration between a service provider and an MMP is typically a time-consuming and costly exercise for both parties. In a market with bilateral interoperability, there must be a high number of bilateral connections between service providers and MMPs. In a hub model, the central infrastructure can potentially serve as a unique point of connection between all parties, drastically reducing the number of connections required and, in turn, requiring less investment and effort on all sides.

Different interoperability models can have a significant impact on the relationship between MMPs and their stakeholders (especially service providers) in the payments ecosystem. At the same time, while MMPs can lose some control over key aspects of their business, both MMPs and service providers can benefit from quicker integration times and lower integration costs. Depending on their context and position in the market, MMPs may prefer one model over another.

07

Selecting the right interoperability model

Interoperability models can be assessed using five performance criteria based on the goals of MMPs and regulatory authorities. These criteria also reflect the interests of customers or citizens using the country's payment system.

We realise that selecting an interoperability model may be a theoretical exercise in many contexts where the choice of model may be predetermined and driven by factors other than a business case. However, having a framework to systematically analyse different complex and multi-layered technical approaches to interoperability can be helpful.

There are five broad categories that market participants and regulatory authorities can use to assess different interoperability models:

- **Cost** is a primary concern for MMPs as interoperability has the potential to disrupt the relatively young mobile money business model.
- **Revenue** represents the opportunities an interoperability model offers participants to serve customers in a commercially sustainable manner.
- **Scalability** encompasses the shared concerns of MMPs and regulatory authorities, although MMPs approach this from a business perspective (scaling up operations and usage) while regulators view it more from a financial inclusion perspective.
- **Robustness** is of utmost importance to regulatory authorities, but is also key to MMPs since the stability of an interoperability solution has a major impact on reputation and business.
- **Governance** is key for MMPs to feel comfortable with an interoperable solution, as it can be a struggle to influence decision making and defend the best interests of their industry.

Table 5

Evaluation criteria and definitions

Category	Criteria	Relevance to stakeholders	
		MMP	Central bank
Cost	**CAPEX:** initial investment required to set up the solution	●	○
	Transaction cost: processing fees charged for each transaction to participating MMPs	●	○
	Maintenance cost: cost for each participant connected to the solution	●	○
	Settlement/prefunding cost: cost for each participant to circulate money with its counterparts	●	○
Revenue	**New opportunities:** extent to which participants are free to directly pursue new business opportunities with ecosystem players	●	○
	Appropriate pricing: ability of participants to independently set the price of services provided to ecosystem players	●	○
Scalability	**Time to market:** time needed to develop the solution and launch it commercially	●	●
	Scalability of volumes: capacity of the solution to handle more users and transaction volumes without technical failures	●	●
	Scalability of participants: capacity of the solution to incorporate new participants and use cases in a standardised and timely manner	●	●
Robustness	**Identification and monitoring of transactions:** extent to which the solution allows identification and monitoring of transactions, participants and end users	●	●
	Reliability and availability: ability for all users to access the solution at all times and trust the outcomes	●	●
	Security and resilience: solution's ability to protect financial data and resist external threats	●	●
Governance	**Decision-making power:** degree of influence of participants in the decision-making process	●	○

● Primary concern ○ Secondary concern

Based on these criteria, Table 6 provides an indicative assessment of the four technical models for interoperability. It is important to note that the colours assigned to the models in the table are subjective and viewed primarily through the lens of MMPs. A wide range of market conditions can affect the colours assigned to the parameters shown in the table. Even with these limitations, Table 6 provides a logical framework and, it is hoped, a useful checklist that MMPs can use to assess the various interoperability options available before selecting the one that best suits their needs.

Table 6

Assessment framework for interoperability models

Category		Bilateral agreement	Aggregator	Mobile money hub	Global payment hub
Cost	CAPEX				
	Transaction cost				
	Maintenance cost				
	Settlement/ prefunding cost				
Revenue	New opportunities				
	Appropriate pricing				
Scalability	Time to market				
	Scalability of volumes				
	Scalability of participants				
Robustness	Identify and monitor transactions				
	Reliability and availability				
	Security and resilience				
Governance	Decision-making power				

Extent to which the interoperability model supports objectives: Unfavourable — Favourable

What do the colours in this table broadly indicate for the four interoperability technical models? The following sections reflect on each model in turn.

7.1 Bilateral agreement model

In terms of cost, a bilateral integration requires limited capital expenditure. The level of effort may vary depending on whether or not it is a first interconnection, but the investment is generally measured in a few months and does not represent a significant cost for MMPs. Bilateral models are also the only ones without a processing fee as there is no intermediary to pay. Maintenance and settlement costs are not overwhelming, although having multiple bilateral connections may result in significant maintenance costs and complexity.

In terms of revenue opportunities, bilateral models allow MMPs to easily respond to new opportunities in their markets and charge an appropriate price for services that aligns with their cost structure and meets customers' needs.

Bilateral models undoubtedly have the fastest time to market. Although a delay in exposing APIs may hold back the entire process, this would not be caused by the technical design of the model. Volume scalability is unfavourable in this model as each additional participant requires integration with each existing player.

In terms of the robustness of a system, bilateral connections do not offer the possibility for a central party to assume fraud and risk management duties based on aggregated data. However, transactions can still be reported for supervisory purposes. Reliability and availability of services in bilateral arrangements can be hindered by the absence of a central party enforcing SLAs, and security and resilience may also be affected by the absence of uniform security standards. However, implementing best practices between players can go a long way towards mitigating this risk.

Finally, in the bilateral model, MMPs have full control over the interoperability solution, giving them room to customise it to the industry's specific needs.

7.2 Aggregator model

In an aggregator model, capital expenditures are low for MMPs, but they are borne by the aggregator that has to put infrastructure and processing capacity in place. This translates into MMPs paying the transaction cost. Other costs, such as transactions, maintenance and prefunding/settlement may be higher for MMPs than in a bilateral model.

The revenue opportunities offered by an aggregator model remain promising for MMPs, but they have less control than in a bilateral model.

Time to market is considered slightly less favourable in an aggregator model than in bilateral models because an external party is added (which may add time for procurement and require MMPs to align on the choice of service provider) and this can be affected by market conditions (availability of a service provider). The ability to scale is also affected by dependence on a third party. Although more favourable than in bilateral models, it still requires an activation effort per corridor by MMPs.

In terms of the robustness of the system, the aggregator model performs similarly to bilateral models because aggregators do not assume fraud and risk management duties. Aggregators have the ability to enforce some standards and SLAs, but tend to be more customised than hubs.

MMPs decision-making power in aggregator models is intermediate; they do not have full control, but usually have high bargaining power since they may constitute a large share of the aggregator's business.

7.3 Hub models

Hub models, both global payment hubs and mobile money hubs, have many things in common, but differences in ownership and membership will have a significant effect on an MMP's assessment.

The upfront set-up costs of a hub model are higher than for bilateral and aggregator models. Capital expenditures for MMPs are lower for a global payment hub, as they would be spread across a much higher number of players than in a mobile money hub, which have a few large MMPs.

However, transaction costs are expected to be lower for MMPs in a mobile money hub than a global payment hub, especially because this model is more likely to consider the specific needs of the mobile money business model, such as avoiding fixed fees or striking a balance between volume- and value-based pricing.

From an MMP's perspective, maintenance costs are kept low in a global payment hub model (a central entity is in charge of coordinating technical evolutions, monitoring connections and enforcing standards for all participants), but may be higher in a mobile money hub model where these costs can fall on MMPs.

In terms of revenue opportunities, the mobile money hub model offers MMPs much greater latitude than the global payment hub model, for obvious reasons.

Time to market is a potential drawback of a hub model, especially when it is built from scratch. Many prerequisites (e.g. cost factors) must be in place before launching interoperability through a hub, combining technical and institutional complexity. However, higher upfront set-up costs can yield longer term benefits in terms of scalability (both transactions and participants).

In terms of the robustness of the system, design hubs can help preserve the integrity of payments. Because they have a comprehensive view of transactions, they are well positioned to provide value-added services to participants, notably data-based fraud and risk detection. However, being linked to an MMP's platform means hubs cannot be protected from the risks affecting participants connected to them.

In terms of governance, global payment hubs can be the least favourable interoperability solution for MMPs, while mobile money hubs give them greater control over running the solution.

Box 5: Mowali – a mobile money hub at scale

In November 2018, Orange Group and MTN Group announced Mowali (Mobile Wallet Interoperability), a joint venture hosting interoperability services for domestic and international mobile money transactions. As one of the few solutions offering real-time transactions across MMPs, Mowali is being built on the open source Mojaloop platform.

Although launched by two large mobile money players, other participants can join Mowali if they comply with its business rules and meet its technical requirements. After the launch phase, a partner committee is expected to be set up to collect input from MMPs on products and services. To ensure implementation is sound, MMPs will be provided with clear business rules and information on the evolution of features in advance.

Mowali's founders have assigned the company a market utility role. Under this model, the purpose is not to seek profit, but to charge for services at cost and devote all remaining income to the development of new services. This approach assumes that value will be created for MMPs and the rest of the mobile money ecosystem not from interoperability services, but from increased mobile money use derived from a seamless customer experience (i.e. not having to cash-out for cross-net transactions or worry about a merchant's MMP prior to making a payment).

To implement interoperability, Mowali has an innovative vision: a single solution that spreads set-up costs across dozens of participants in different countries. In the meantime, Mowali has positioned itself as a gateway to connect MMPs to their national payment systems, taking on this effort on behalf of MMPs for what are usually complex, time-consuming projects involving the banking sector.

Whether this vision will be implemented is yet to be seen, as Mowali was not commercially live when this report was published. In addition, recent evolutions in the WAEMU (West African Economic and Monetary Union) region where Mowali is based indicate that MMPs will be required to connect directly to a central interoperability solution hosted by the GIM-UEMOA (Interbank Electronic Banking Group of the Economic and Monetary Union of West Africa).

08 Conclusion

This report has delved into an admittedly complex subject on which there is consensus in the mobile money industry. Rather than summarise the key points of the report, we would like to offer three observations:

1. Of the four ways in which MMPs can adopt interoperability, the mobile money hub model is likely the best option for the long-term growth and sustainability of the mobile money industry. However, it is not yet feasible for the industry to adopt at scale due to the long and complex set-up process. As such, **the bilateral model remains a valuable option** for MMPs.

2. Whichever interoperability model is selected, it must be commercially sustainable for participants, both in terms of OPEX and revenue opportunities. The liquidity requirements of different technical models are especially important for MMPs given the specificity of their business model. Regardless of the technical model, the prefunding requirement is likely to be the outcome of not just technical but also governance-related factors. However, it is widely felt in the mobile money industry that **liquidity requirements for participants would likely increase** if they moved from a bilateral to a hub-based model. Proponents of hub models should provide more clarity on this to allay industry fears. The provision of expense accounts for hub participants that can go into negative balance could also be a way to address this issue.

3. It is possible that the adoption of certain technical models for interoperability (e.g. the global payments hub model) could relegate MMPs to a second tier with limited potential to differentiate their service. In many emerging markets, dominant DFSPs (typically MMPs) already have access to the majority of customers, especially in rural and underserved areas. Against this backdrop, it is questionable how much hubs would contribute to financial inclusion if MMPs could not operate in an environment where they can enjoy the incentives to continually innovate, invest in and grow their services. Over time, this may have a **negative impact on financial inclusion**. Whichever technical model is chosen, innovation in interoperability should be left to the market.

Interoperability is a complicated topic that needs to be analysed carefully to assess the opportunities and potential pitfalls for the mobile money industry. It is undeniable that financial services operate in an increasingly interconnected world, and that MMPs must also strive to be part of this seamless landscape. However, the way in which interoperability functions in a market can have serious and far-reaching consequences for mobile money providers. It is hoped that this report has helped to shed some light on the many ways in which interoperability can be rolled out in a mobile money context, and how these models have the potential to help, or hinder, the overarching goal of financial inclusion.



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GSMA HEAD OFFICE
Floor 2
The Walbrook Building
25 Walbrook
London EC4N 8AF
United Kingdom
Tel: +44 (0)20 7356 0600
Fax: +44 (0)20 7356 0601