OliverWyman | J.P.Morgan

UNLOCKING $120 BILLION VALUE IN CROSS-BORDER PAYMENTS

How banks can leverage central bank digital currencies for corporates

CONTENTS

EXECUTIVE SUMMARY

Global corporates move nearly $23.5 trillion across countries annually, equivalent to about 25% of global GDP. To do this, they have to rely on wholesale cross-border payment processes which remain sub-optimal from a cost, speed, and transparency standpoint. As well as resulting in significant transaction costs of $120 billion per annum, these processes also result in additional costs from FX conversion, trapped liquidity and delayed settlements.

"While working on some strategic transactions, our team was on high-alert with inconsistent messages coming from numerous banks along the chain. While the current systems have been optimized to handle day-to-day transactions, the non-regular, high-value and time-pressured transactions are an area to improve."

— Senior Treasury Manager, Global Packaging MNC

While numerous private sector players, from the CLS Group to SWIFT, and central banks (such as the Hong Kong Monetary Authority and Bank of Thailand) have initiated various projects to resolve the existing pain points, we are yet to see a scalable and seamless solution that can work across countries, currencies, and payment systems.

We believe that a multi-currency central bank digital currency (mCBDC) network could provide an effective blueprint to tackle many of these problems simultaneously, thereby making 24/7 and real-time, cross-border, cross-currency payments a real possibility.

"I'm convinced that CBDCs could bring transactional cash management to the next level from the standpoint of Accessibility, Convertibility, Reachability, and Traceability."

— Head of Cash Management, Global Technology MNC

This paper builds on all the previous literature on CBDCs and aims to outline the implementation considerations for central banks to partner with commercial banks to develop, operate, and govern an mCBDC network.

Specifically, this paper outlines four critical elements required for implementation: (i) target design principles; (ii) key building blocks (minting and redeeming CBDCs, liquidity provisioning, market making, and foreign exchange payment-versus-payment settlements) (iii) roles and responsibilities of central banks, commercial banks, and other service providers (e.g. technology companies); and (iv) governance framework for managing network access and resolving disputes. It also details an alternative and complementary model of multi-currency digital corridor network.

While the implementation considerations could apply to participants globally, we have used the ASEAN region as an example, given it contributes approximately 7% of global cross-border trade and is home to thousands of European, Asian, and North American MNCs.

The end result: A full-scale mCBDC network which facilitates 24/7 real-time, cross-border payments and FX PvP settlements could save global corporates nearly $100 billion annually. Naturally, an mCBDC solution would trigger a rethink on how commercial banks and other foreign exchange providers may deliver their current offerings, however, we are encouraged by the potential for new business and operating models, which could yield long-term benefits for all participants.

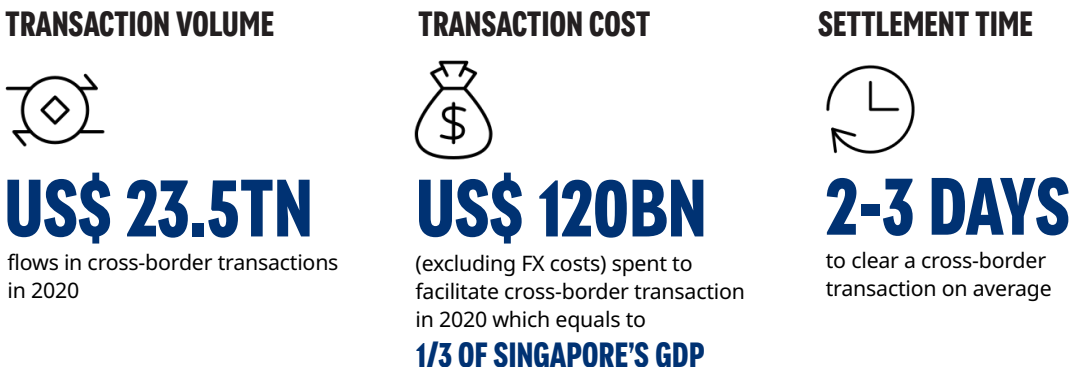
SECTION 1

THE BUSINESS CASE FOR MCBDC[1]

Global corporates move nearly $23.5 trillion[2] across borders annually. They predominantly rely on the wholesale cross-border payment processes of correspondent banking networks that cost approximately $120 billion[3] in transaction charges annually, or roughly a third of Singapore's GDP.[4]

Almost all the multinational corporations (MNCs) interviewed, especially those with frequent cross-border trades, have expressed issues with the current cross-border payment system. Namely, high transaction costs ($27 average cross border fee per transaction, excluding FX)[5], long settlement times (not uncommon for payments to take 2-3 days to reach end beneficiary[6]), and the lack of transparency (limited visibility of payment status).

Exhibit 1: Cross-border transactions: volume, cost and time



Sources: WTO, World Trade Statistical Review 2021, UNCTAD, World Investment Report 2021, Oliver Wyman and J.P. Morgan analysis

1 mCBDC is short for "multi-currency Central bank digital currency". In this paper, we illustrate a multilateral corridor that serves as a shared exchange place for participants in multiple jurisdictions to conduct cross-border payments via multiple currencies in the form of CBDC (mCBDC).

2 An aggregate of the world's total trade in goods and services (export value), and its total foreign direct investment (inward flow) in 2020 WTO, World Trade Statistical Review 2021, UNCTAD, World Investment Report 2021.

3 Oliver Wyman and J.P. Morgan analysis.

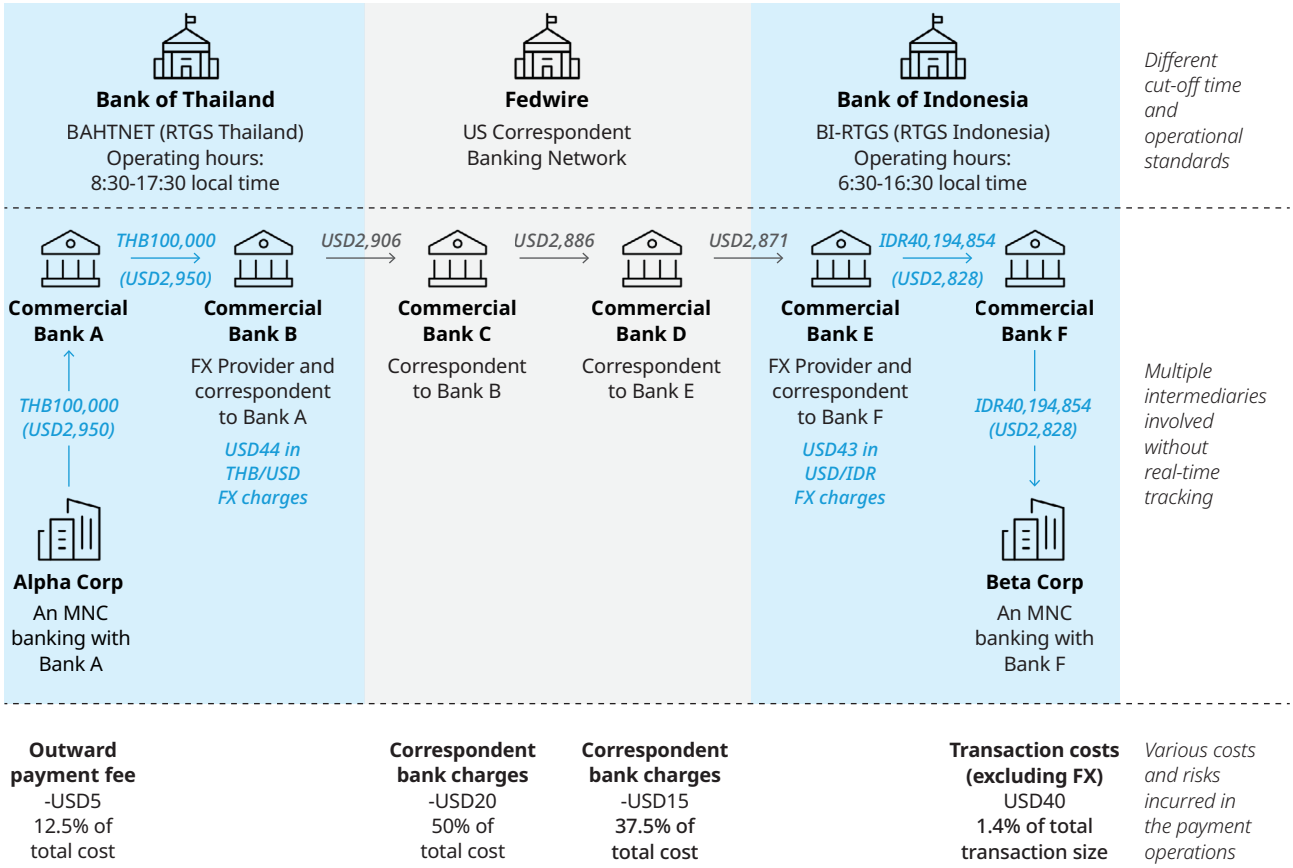
4 Singapore's 2021 GDP is estimated to total around $358 billion, according to the World Bank and IMF.

5 Assumes transaction fee of $5 per step, and assumes 40% of cross-border transactions incur fee deductions of $25 per correspondent bank for 2 banks.

6 Oliver Wyman and J.P. Morgan analysis.

As an example, we look at two MNCs operating in the ASEAN region using local small banks with no direct-dollar correspondent network. For a $2,950 payment (or THB100,000) from Alpha Corp in Thailand to Beta Corp in Indonesia, Alpha Corp incurs a transaction cost of $40 excluding FX costs by going through multiple intermediaries and facing high foreign exchange (FX) spreads, all while incurring liquidity costs along the payment chain. Additionally, different cut-off times, processing speeds, and compliance standards across the intermediary banks in the various jurisdictions can incur further delays in the settlement process. Alpha Corp and the banks upstream are also exposed to settlement risks if the banks downstream fail to execute their obligations. Alpha Corp does not have full control over the correspondent banking structure, the validation processes, nor complete visibility of the payment status once the transaction is initiated, incurring an additional layer of uncertainty.

Exhibit 2: An illustrative cross-border payment flow via correspondent banking



Assumptions:

Bank A (bank in Thailand) and Bank F (bank in Indonesia) do not have direct-dollar correspondence. They must route dollar payments through Banks B (bank in Thailand) and Bank E (bank in Indonesia).

Countries chosen are for illustration purposes only. There may be intra-ASEAN banking relationships between certain banks that do not require routing through the US correspondent banking network.

Rates assumed: THB100=USD2.950 and USD1=IDR14,213.5. All amounts are rounded to the nearest dollar.

Sources: Oliver Wyman and J.P. Morgan analysis

"While working on some a strategic acquisition transactions with multiple banks involved in the funds flow chain, our team was on high-alert with contradictory inconsistent messages coming from numerous the banks along the chain. While the current systems have been optimized to handle day-to-day transactions, the non-regular, high-value and time-pressured transactions are a real problem area an area to improve."

— Senior Treasury Manager, Global Packaging MNC

The current pain points corporates experience in cross-border transactions are primarily on account of the gaps in the existing correspondent infrastructure setup, and the lack of legal, regulatory, and operational consistency across multiple jurisdictions:

- **Correspondent banking system**: Given the lack of interoperability across the payment infrastructures of different countries, cross-border payments are settled using correspondent banking. The current setup involves sequential payment processing across multiple intermediaries, each with differing operating hours, messaging standards, and pre-funding requirements. This leads to uncertainty and a lack of transparency in payment processing, in addition to trapped balances in nostro/ vostro accounts Furthermore, additional settlement and credit risks are introduced in the system.
- **Legal, regulatory, and operational consistency**: Varied legal and regulatory requirements around Anti-money laundering / combatting the financing for terrorism (AML/CFT), and the differing operational windows of domestic payment infrastructures further add to transaction costs and time delays.

Numerous private sector players have taken initiatives to resolve such pain points (Exhibit 3). While these initiatives have achieved partial success, we are yet to realize a truly scalable, seamless interoperable solution. We believe an mCBDC infrastructure could be well positioned to achieve such a solution despite the effort needed by central banks to integrate and collaborate across jurisdictions.

Exhibit 3: Commercial efforts and central bank initiatives (illustrative examples)

	Project summary	Target stage			Challenges
		Low cost	Instant settlement	Trans-parency	
Commercial efforts					
CLS (Continuous Linked Settlement System)	• A multi-currency FX net settlement system • Intended to eliminate settlement risk ("Herstatt Risk") through FX Payment vs Payment (PVP)	◔	◔	◕	• 18 currencies supported. Difficult to scale owing to challenges in adding new currencies to existing set of 18 currencies • Delivery of currencies post settlement • Non-customizable netting windows
SWIFT (Global Payments Innovation)	• Track and trace capabilities with transaction processing SLAs • Intended to increase transparency to cross-border payments and improve processing time	◔	◔	●	• Reliant on current correspondent banking system with multiple intermediaries involved; trapped liquidity, credit and settlement risk continue to remain
FNALITY	• Quasi-CBDC networks Intended primarily to provide delivery-vs-payment capabilities	◔	●	●	• Pending regulatory approvals from 5 participating central banks and currencies
Ripple	• Cross-border payment infrastructure • Intended to use cryptocurrency XRP as the settlement instrument	◔	●	◕	• High volatility of XRP leading to limited willingness from banks in using it to facilitate payments • Relatively high costs owing to spreads between fiat and XRP
Central bank's initiatives					
Project Jasper-Ubin *Canada* *Singapore*	Exploring bilateral CBDC	●	●	●	• A highly integrated international collaboration with global scale requires a significant amount of coordination and negotiations
Project Inthanon-LionRock *Thailand* *Hongkong*	Exploring bilateral CBDC				
Project Dunbar *Singapore* *Malaysia* *Australia* *South Africa*	Exploring full-scale mCBDC Platform				
mCBDC Bridge *Thailand* *Hongkong* *China* *UAE*	Exploring full-scale mCBDC Platform				

Sources: Oliver Wyman and J.P. Morgan analysis

"I'm convinced that CBDCs could bring transactional cash management to the next level from the standpoint of Accessibility (being able to access liquidity in their accounts without cut-offs and cross-border delays), Convertibility (being able to convert to different currencies at will, enabling them to manage liquidity in smaller sets of currencies), Reachability (beyond just bank accounts) and Traceability (being able to have a clean trail of funds)."

— Head of Cash Management, Global Technology MNC

SECTION 2

POTENTIAL MODELS

As illustrated in Exhibit 4, the high-level, global efforts of central banks for cross-border constructs can be summarized within 3 models: RTGS upgrades (model 1), bilateral CBDC lite (model 2), and full-scale mCBDC (model 3).

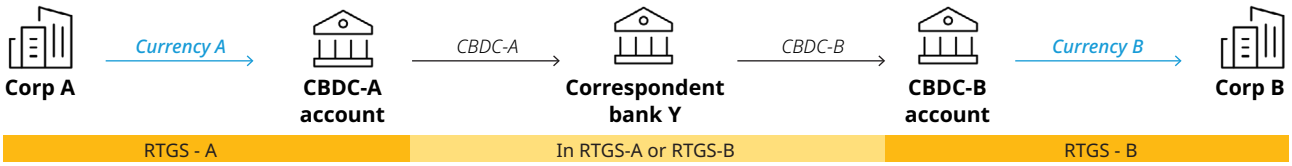
Model 1 still relies on the correspondent banking system, whereas Models 2 and 3 offer more comprehensive remediation to the current cross-border payment pain points. Model 3 is essentially a more comprehensive version of Model 2, as it further resolves the issue of scalability. However, whether upgrading the RTGS system or creating full-scale mCBDC solutions, an increasing level of coordination is required among the central banks to implement and govern any chosen model.

There is no optimal model among the three and, as such, we expect them to co-exist. However, given the comprehensive solution and promise of scalability offered by full scale mCBDC, Section 3 builds upon the previous CBDC initiatives and focuses on its implementation. We have taken the ASEAN region as an example, given it contributes 7% of global trade[7], and is home to thousands of European, Asian, and North American MNCs. The region has also demonstrated strong incentives for pushing cross-border payment innovation (e.g. Project Jasper-Ubin, Project Inthanon-LionRock, the mCBDC Bridge, and Project Dunbar) and furthering regional integration (e.g. the Regional Comprehensive Economic Partnership).

7 WTO, World Trade Statistical Review 2021

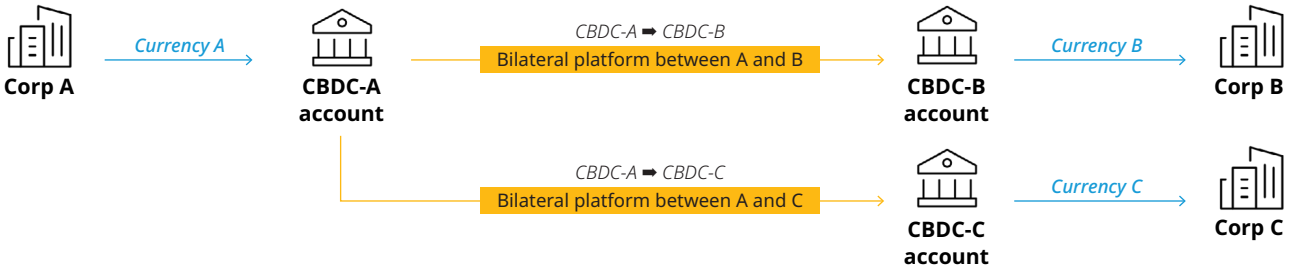
Exhibit 4: Illustrative process flow and model overview

Model 1: RTGS upgrades



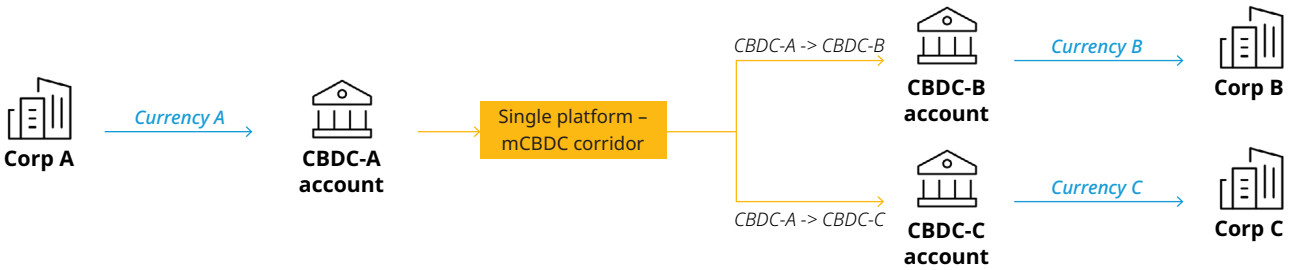
Model 1 (RTGS upgrades) depicts an RTGS-equivalent system for CBDCs in cross-border payments. While it still relies on the correspondent banking network, CBDCs are used for clearing, settlement, and FX conversion. This model offers the potential for 24/7 operations, thereby improving liquidity and reducing settlement risk concerns. However, it suffers from the same challenges of the correspondent banking network, with high transaction costs and longer transaction times.

Model 2: Bilateral CBDC lite



Model 2 (bilateral CBDC lite) entails a bilateral interlinked arrangement, where interoperability is built between two CBDC settlement systems under mutually agreed settlement rules and governance. This creates a platform allowing for potential regulatory standardization and harmonization. Given central banks directly hold accounts at each other's respective RTGS system, this reduces the dependency on correspondent banks. While bilateral collaboration is easier to implement, it sacrifices on scalability. For example, 2 countries require 1 connection, but 20 countries willing to work together would require 190 connections. Example initiatives are Project Jasper-Ubin by the Bank of Canada and Monetary Authority of Singapore (MAS), and Project Jura by the Banque de France and Swiss National Bank.

Model 3: Full scale mCBDC



Model 3 (full scale mCBDC) introduces a single platform for a multilateral corridor, which serves as a shared settlement platform for multiple jurisdictions. This helps resolve the scalability constraints evident in Model 2. However, it mandates coordination at the highest level on topics of governance and the setting of harmonized legal and regulatory standards. Example initiatives of this kind are mCBDC Bridge Project by the Bank of Thailand (BOT), Hong Kong Monetary Authority (HKMA), People's Bank of China (PBOC), and Central Bank of the United Arab Emirates (CBUAE) and BIS-led Project Dunbar, which includes the Reserve Bank of Australia, Bank Negara Malaysia, MAS, and South African Reserve Bank.

Sources: BIS paper: Multi-CBDC arrangements and the future of cross-border payments, Oliver Wyman and J.P. Morgan analysis

SECTION 3

MCBDC: DESIGN AND IMPLEMENTATION

The mCBDC corridor network model provides an alternative to the traditional correspondent banking model, whereby cross-border payments can be settled peer-to-peer using central bank digital currencies

In the absence of multiple intermediaries, central banks would need to partner with various commercial banks and technology players to replicate the critical steps required in moving money across borders, whilst solving for the pain points highlighted in section 1.

Four key considerations to establish a functioning mCBDC network are:

1. **Target design**: Design decisions on how payment rails would work, e.g. if mCBDCs should be interest bearing, level of privacy required, etc.

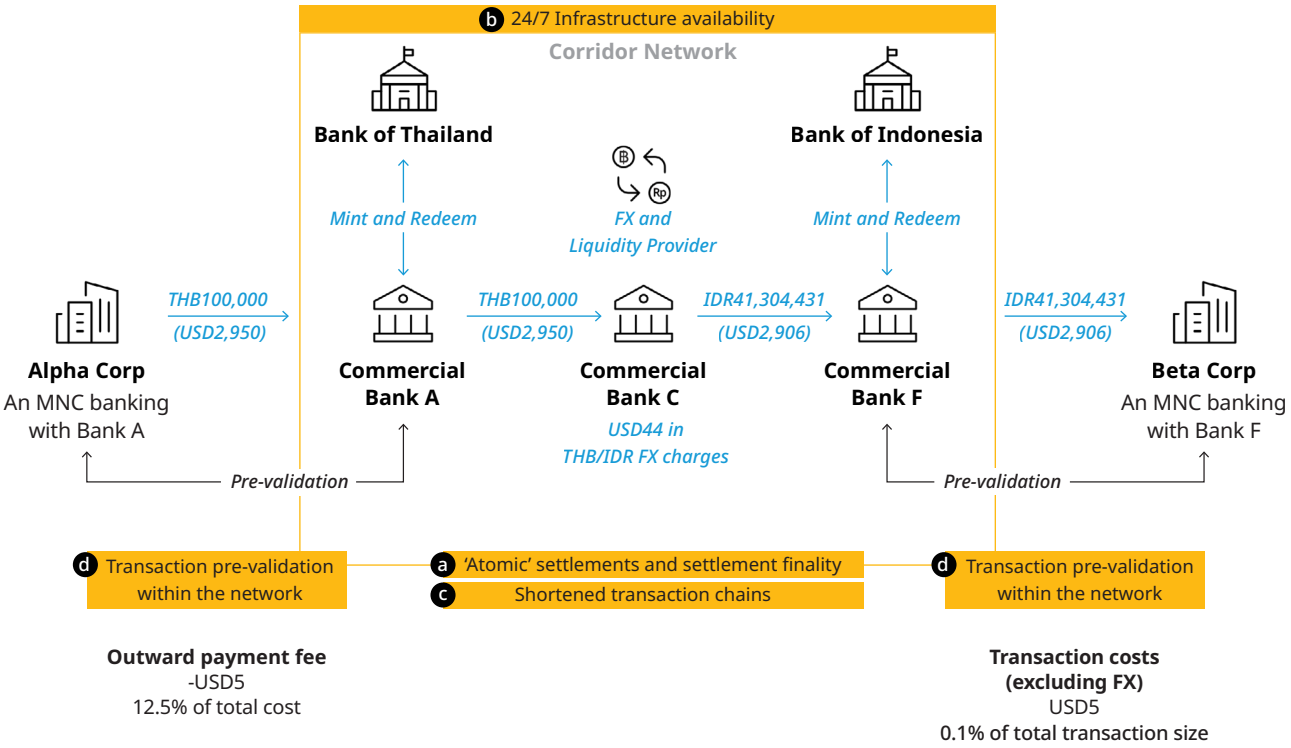
2. **Key building blocks**: From CBDC minting and redemption, to FX conversion and settlement

3. **Roles and responsibilities**: Central banks vs. commercial banks vs. technology vendors

4. **Governance model**: Legal and operational protocols required to govern the new network

Exhibit 5 elaborates on the proposed design for cross-border payments between Alpha Corp (in Thailand) and Beta Corp (in Indonesia) through an mCBDC corridor network. Essentially, the corridor network is designed to be an inter-bank, multi-currency settlement network based on a wholesale CBDC preserving the current two-tier structure of central bank money and commercial bank money. This structure is critical for the provision of end-to-end payment processing services, with minimal disruption to the current domestic banking architecture in all participating countries.

Exhibit 5: An illustrative cross-border payment flow via mCBDC corridor network



Assumptions:

Rates assumed: THB100=IDR42,026.9 and USD1=IDR14,213.5. All amounts are rounded to the nearest dollar.

Sources: Oliver Wyman and J.P. Morgan analysis

The salient features of the proposed corridor network include:

a. **'Atomic' Settlements and Settlement Finality**: Replacing today's sequential operational model with 'atomic settlement', i.e. simultaneous settlement, will be critical to address the pain points around trapped liquidity, settlement risk, transaction turnaround time and the lack of visibility

b. **24/7 Infrastructure Availability**: Designed as "always on" infrastructure that ensures the entire payment-lifecycle processes without cut-offs, and operates round-the-clock to support regional and global money flows

c. **Shortened Transaction Chains**: Reduction in the number of intermediaries involved in the end-to-end payment process through the usage of CBDC for settlement, leading to a reduction in transaction fees and liquidity requirements

d. **Transaction pre-validation within the network**: Incorporation of final beneficiary checks and/or sanctions pre-screening within the corridor network design to ensure payment certainty upon transacting

SECTION 3.1
TARGET DESIGN

To deliver on the salient features and encourage private sector adoption, a number of design issues would need to be addressed:

1. **Ability to support credit extensions**: Nearly 20%[8] of all cross-border transactions rely on intra-day credit, given the time differences between payments and collections. Until the problem is solved, the mCBDC network would need to allow credit provision on both an unsecured and secured basis. This could be done by creation of short term interbank lending marketplaces to facilitate intra-day FX swaps and intra-day repos.

2. **Agreement on "settlement finality"**: Agreement on when the settlement of funds becomes final and irrevocable would be a critical part of the network scheme's rules and needs to be considered when defining the scheme's ultimate controls.

3. **Agreement on interest-bearing scheme**: Interest-bearing CBDC accounts would need to be formulated within the mCBDC construct such that there would be no risk of deposit flight away from traditional nostro/vostro accounts, especially for countries with negative or near-zero interest rates. In this regard, value dates would be important to determine interest

4. **Alignment on privacy settings**: Given the participation of multiple central and commercial banks, data/access should be made available on a need-to-know basis. (E.g., no ability to view the balances of other commercial or central banks)

While the establishment of an mCBDC corridor network presents an opportunity to improve efficiency in cross border payments, it also presents participating countries with a platform to discuss and harmonize regulatory requirements pertaining to AML/CFT, KYC standards etc.

SECTION 3.2
KEY BUILDING BLOCKS

Transacting across different currencies and countries would require central banks to replicate critical steps in the current cross-border payment process. With this in mind, we have identified three key building blocks to facilitate the process within the mCBDC infrastructure:

- Mint and Redemption Functionality
- Liquidity Provisioning and Market Making
- FX Trade Settlement (PVP and Netting)

8 J.P. Morgan analysis based on data sampling.

MINT AND REDEMPTION FUNCTIONALITY

We have considered three different options that could be adopted for CBDC issuance to commercial banks and payment service providers against central bank money. Please note that one or more of these options, detailed in Exhibit 6 below, could co-exist based on the preferences of the participating central banks.

Exhibit 6: Mint and Redeem options

Option	Prerequisites	How the model works	Who mints/ redeems	Examples
Depository Receipts	Presence of a domestic CBDC network	• Central banks issue depository receipts against the equivalent amounts of domestic CBDCs held by the commercial banks with the central banks • Under this model, depository receipts get transacted amongst the respective participants	Central bank operator	Project Inthanon-LionRock *Thailand* *Hongkong*
On-Chain Nostros	Absence of domestic CBDCs in the respective countries	• Each central bank effectively offers a nostro account on the corridor network ('on-chain nostro') • CBDCs issued under this mechanism are fully fungible with the domestic nostro accounts held with the central banks	Central bank operator	Project Dunbar *Singapore* *Malaysia* *Australia* *South Africa* mCBDC Banque de France-MAS-JP Morgan ONYX *France* *Singapore*
Omnibus Accounts	Each central bank establishes an omnibus account (with multiple beneficiaries). Collectively, these are set up in the respective central banks' RTGS systems	• An independent third-party payment system operator (PSO) is appointed by the central bank to issue and redeem CBDCs	PSO	Bank of England

Sources: 'Depository Receipts': Project Inthanon-LionRock, 'Omnibus accounts': adapted from Bank of England Omnibus Accounts — Access Policy

For the three options (Exhibit 6), key considerations on mint and redemption functionality are:

- **Mass Conservation** — As the provisioning of CBDCs on the corridor network involves debiting the equivalent amount of central bank money either in domestic CBDC networks (Option 1) or within the existing fiat central bank nostro accounts (Options 2 and 3), mass conservation refers to the ability to carry out the process seamlessly, while ensuring that the debits and creation of new CBDCs in the corridor network are equivalent.
- **On-demand Issuance** — As the CBDC corridor network is designed to be a 24/7, "always on" network, the ability to add CBDCs to the network on demand would be critical for ensuring liquidity is always present on the network for round-the-clock payment processing.

LIQUIDITY PROVISIONING AND MARKET MAKING

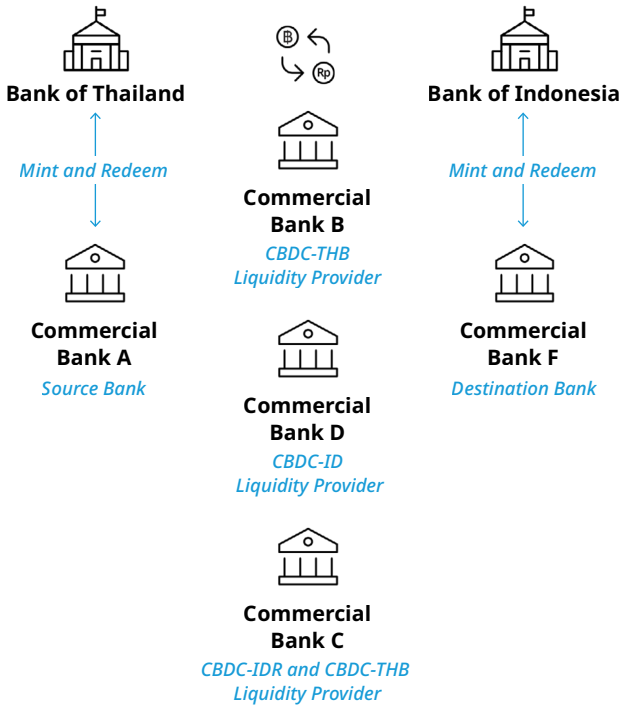
Liquidity provisioning in the source or destination currency would remain a key component for the facilitation of cross-currency transactions. Two options for the participants to consider: (i) reliance on conventional, centralized liquidity provisions using traditional commercial banks / FX providers, or (ii) exploration of newer liquidity provisioning models involving decentralized smart contract**s**.

While the former is applicable for the current business models of traditional banks / FX providers, the latter offers speed and transparency benefits, as the FX pricing to settlement procedures are all integrated within the smart contracts on the corridor network. As such, the corridor network should support both conventional liquidity provisioning and decentralized smart contract models until the full transition to decentralization occurs.

Option 1: Conventional liquidity provisioning mechanisms

This option requires a commercial bank to provide a bank account and hence liquidity in the relevant currency to the FX provider, and we expect the same process would need to exist within an mCBDC framework. Exhibit 7 highlights five conventional scenarios of liquidity provisioning that can be leveraged, with different roles available for source bank, destination bank and individual currency liquidity providers. In all instances, the process of sourcing rates could be based on Board Rates (with FX providers publishing fixed rates for currency pairs for fixed periods of time), Requests for Quotes (or RFQs, i.e. where FX providers provide on-demand quotes), or Off-chain FX (where FX rates are sourced off-chain).

Exhibit 7: Five conventional scenarios of liquidity provisioning and market making



Scenario	FX Provider	Liquidity Provider	Currency for liquidity provisioning
Scenario 1	Source Bank (Bank A)	Source Bank (Bank A)	IDR
Scenario 2	Destination Bank (Bank F)	Destination Bank (Bank F)	THB
Scenario 3	Source Bank (Bank A)	Commercial Bank (Bank D)	IDR
Scenario 4	Destination Bank (Bank F)	Commercial Bank (Bank E)	THB
Scenario 5	Independent Commercial Bank (Bank C)	Commercial Bank (Bank C)	IDR & THB

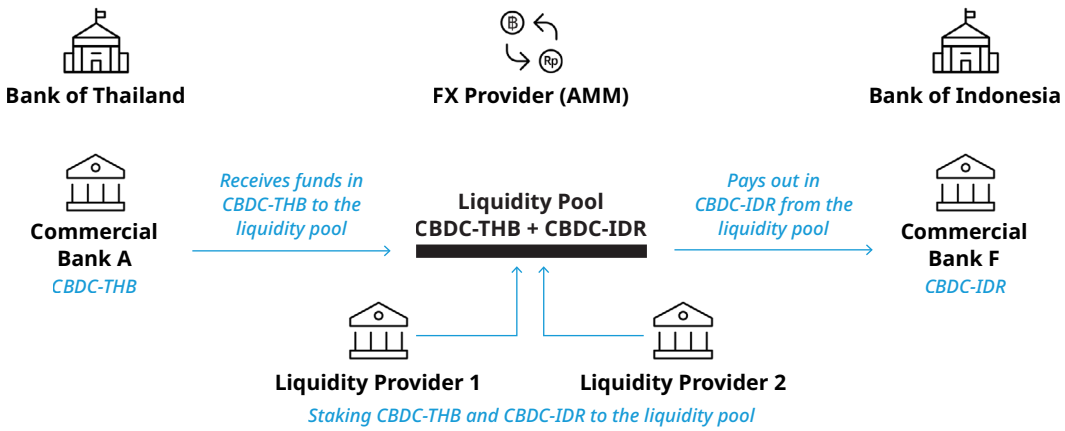
Sources: Oliver Wyman and J.P. Morgan analysis

Option 2: Alternative liquidity provisioning models involving smart contract-based liquidity pool managers

This option allows entities that hold CBDCs on the corridor network (e.g. commercial banks and payment service providers) to stake them into the liquidity pools (in currency pairs) in return for a fee. Staking in this context refers to locking CBDCs in pooling smart contracts for a period of time. Under this option, the FX provisioning is done algorithmically real time based on the available liquidity pool, number of transactions, and flow of transactions. For a more detailed description of Automated Market Making (AMM) and Liquidity Pool Managers, refer to the whitepaper titled "Liquidity Management in a Multi-Currency Corridor Network".[9]

The key considerations to keep in mind would be how to minimize slippage and impermanent losses (i.e. the potential losses resulting from different FX rates during staking and de-staking) for the liquidity providers.

Exhibit 8: Smart contract-based liquidity provisioning and market making



Sources: Oliver Wyman and J.P. Morgan analysis

9 For more information on Automated Market Making (AMM), please refer to the whitepaper titled "Liquidity Management in a Multi-Currency Corridor Network".

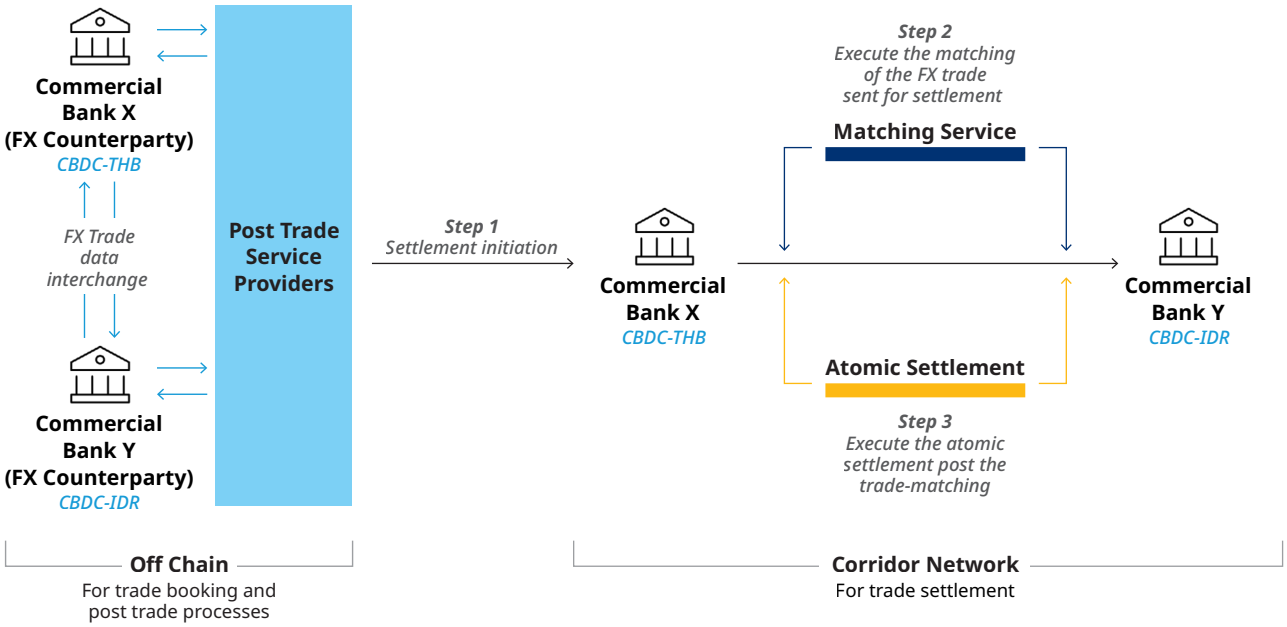
FX TRADE SETTLEMENT (PVP AND NETTING)

Supporting 24/7 FX PVP capabilities would be a key value proposition of the corridor network to mitigate cross-currency settlement risk (Herstatt risk). This would be especially important to broaden the network's scope from the 18 CLS-supported currencies[10], to also include all the ASEAN currencies. Currently, only the Singapore Dollar is a CLS-supported currency in the ASEAN region.

The key capabilities required to provide FX PVP-based services in the mCBDC network include:

- **FX Matching Service**, i.e. the ability to match FX settlement instructions based on attributes (i.e. common value date, common participating banks in the transaction, matching currency amounts, and common reference number)
- **Atomic Settlements**, i.e. the simultaneous settlement of currency pairs in the matched FX transaction

Exhibit 9: The process of executing FX PVP on the corridor network



Sources: Oliver Wyman and J.P. Morgan analysis

As illustrated in Exhibit 9, FX settlement initiation is undertaken subsequent to the FX trade booking and FX post-trade processes, with settlement initiation into the corridor network occurring as part of Step 1. Step 2 would execute the matching of the FX trades sent for settlement, and Step 3 would then execute the atomic settlement to complete the PVP process.

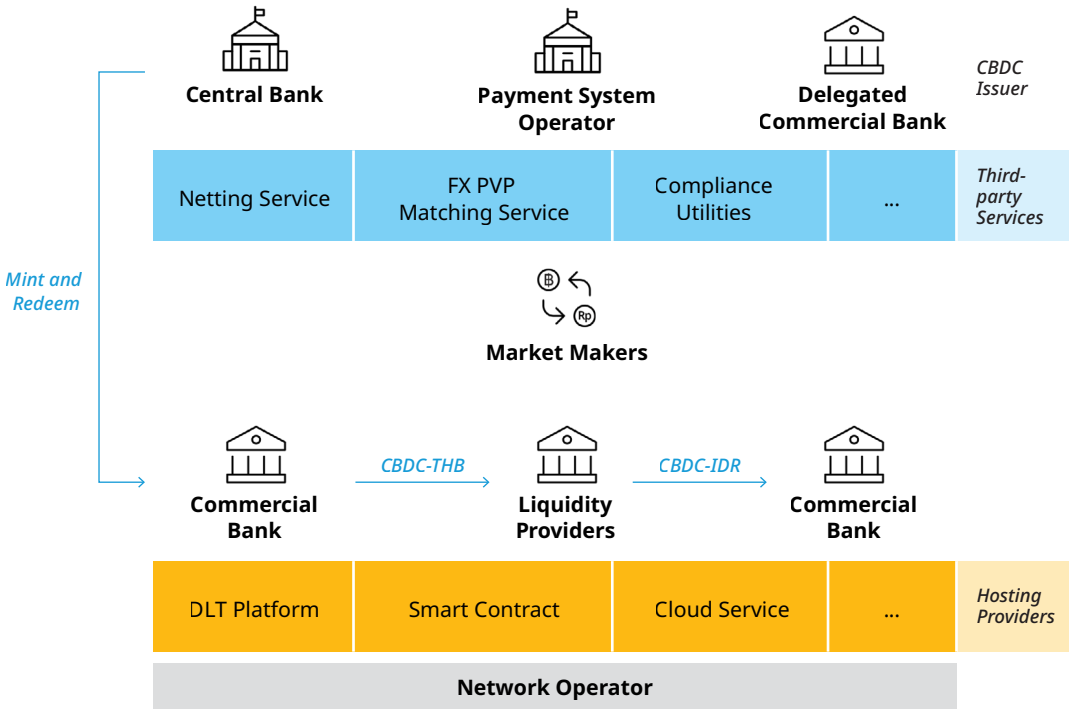
10 FX settlement risk remains significant. BIS Quarterly Review, 08 December 2019.

In addition to core gross settlements, netting capabilities would be critical to achieve liquidity savings as part of the settlement of FX trades. They would require the provision of transaction queues, customizable time windows for the execution of netting, and the ability to configure netting settings based on different transaction attributes.

SECTION 3.3
ROLES AND RESPONSIBILITIES

While the mCBDC-based corridor network challenges the traditional correspondent banking system, it also provides opportunities for the present participants (e.g. commercial banks, payment operators, market makers, and liquidity providers) to add new capabilities, and welcomes new participants such as technology and other third-party service providers. Exhibit 10 highlights some of the new roles that could come into effect, such as CBDC issuers, hosting providers, and network operators.

Exhibit 10: Key participants and roles within the corridor network



Sources: Oliver Wyman and J.P. Morgan analysis

While the mCBDC corridor network challenges the traditional correspondent banking system, it also provides opportunities for the banks and FX / Liquidity providers to add capabilities, and welcomes new third-party service providers.

Exhibit 11 summarizes the key responsibilities and prerequisites for all participants. These are directional and intended to function as guardrails. Where central banks deem fit, commercial banks or payment service providers could take on additional responsibilities, for example, those regarding minting and issuance.

Additionally, commercial banks with strong technical capabilities, such as JP Morgan with its Onyx blockchain technology, could become private CBDC issuers on behalf of central banks, or provide more value-added services (e.g. on-chain compliance utilities, FX matching services, and network operations). At the same time, the infrastructure build-out requirements could welcome new entrants to the cross-border payment process, from FinTechs to hosting providers and independent network operators, with risk / governance oversight.

Exhibit 11: Prerequisites and responsibilities for existing and new roles

Roles	Performed by	Key prerequisites	Responsibilities
Existing roles with new requirements and functions			
Payment Service Providers	• Commercial banks • Non-bank Payment Service Providers	• Connectivity to the mCBDC network • Able to support the payment orchestration requirements	• Hold mCBDC accounts on the network • Responsible for KYC of the corporates, AML, CFT, and sanctions screening
Liquidity Providers	• Commercial banks (for conventional liquidity or AMM) • Non-banks for AMM/liquidity smart-contract pooling	• Hold liquidity in the relevant currency pairs, which is key to the staking process for pooling smart contracts	• Provide liquidity to FX providers as part of conventional market making, or into liquidity pool smart contracts as part of AMM
Market Makers	• Commercial banks (for conventional liquidity or AMM) • Non-banks for AMM/liquidity smart contract pooling	• Access to the liquidity provider on the mCBDC network **For Automated Market Makers** • Require access to the liquidity pools • Algorithmic market-making ability on liquidity pools • Ability to meet the infrastructure requirements to support connectivity	• Provide Board Rate and RFQ services to the participants in the network
New roles with new functions			
CBDC Issuer	• Central banks • Commercial banks • Payment service operators (PSOs), with omnibus accounts setup by central banks	• Minting and redeeming capabilities • Regulatory authorization • Expertise in local compliance requirements	• Establish connectivity between the PSO account and mCBDC network, enabling minting and redemption to/from the mCBDC network • Provide account services to the participants in the network
Third-party Services	• Banks • Technology service providers • Law firms	• Access to transaction data • Knowledge in international regulatory frameworks • Expertise in smart contracts and FX execution	• A shared service on regulatory compliance-related processes (e.g. KYC, AML, and CFT) • FX PvP Matching • Payment-netting services • EOD FX position management
Hosting Providers	• Technology service providers, e.g. Consensys and Blockdaemon • Multiple hosting providers could co-exist	• Strong in privacy, scalability, resiliency, and finality • Established domestic adoption with regulatory approvals, given participating central banks are more willing to vote for the same DLT platform for domestic and international transactions	• Service the infrastructure needs (DLT platform, cloud service, etc.) of the participants (central banks / commercial banks)
Network Operator	• Profit / not-for-profit independent governing entity (details in Section 3.4)	• A trusted governing body by all network participants	• Onboard / offboard participating commercial and central banks • Push through smart contract upgrades • Provide technical support • Administer the network rule book • Arbitrate in dispute resolution

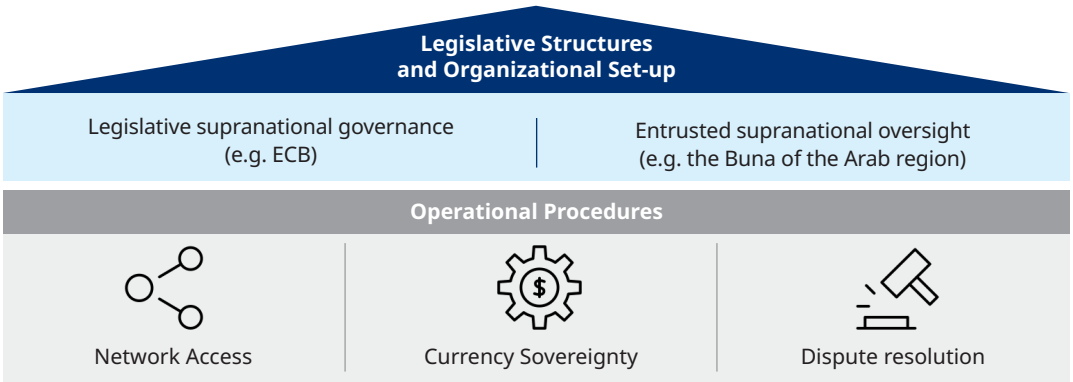
Sources: Oliver Wyman and J.P. Morgan analysis

SECTION 3.4

GOVERNANCE MODEL

A robust governance model is a prerequisite for multi-jurisdictional collaboration, as it can help ensure the effective functioning of the mCBDC network. The key considerations in setting up a governance model include establishing the appropriate legislative structure and operational procedures around network access and dispute resolutions, while preserving each individual country's currency sovereignty.

Exhibit 12: mCBDC governance model framework



Sources: Oliver Wyman and J.P. Morgan analysis

LEGISLATIVE AND ORGANIZATIONAL SET-UPS

Legislation serves as the foundation for effective governance. Though there are no perfect constructs, we can draw insights from existing structures in Europe or the Arab region that provide archetypes for consideration:

- **Legislative Supranational Structure (e.g. ECB)**: In Europe, the European Central Bank (ECB) serves as a regional supranational legislative entity empowered to establish policies and allocate responsibilities. This structure gives the ECB control to harmonize operations and negotiate regulatory complexities. Nonetheless, such a governance model presupposes an established level of regional integration, which could be difficult to replicate for all mCBDC platforms.
- **Entrusted Supranational Structure (e.g. Buna)**: Among the countries in the Arab region, a supranational body (the Buna Payments System) serves as a platform to facilitate discussion amongst all participating jurisdictions. In an mCBDC world, we envision this role could be performed by a network operator, or another entrusted supranational organization. Given the lack of legislative backing, this archetype sacrifices a degree of oversight power, however, this could be supplemented by oversight from the participating central banks. The advantage of this model is the ease of implementation, making it feasible to build multi-jurisdictional collaborations.

Whichever archetype meets the desired requirements of the participating central banks, due consideration should also be given to the creation of rules that make the supranational body the steward of the said mCBDC network. Its independence and impartiality would be critical to avoid any conflicts of interest that might arise as a result of political or economic allegiances. A failure to do so could jeopardize the intended functioning of the mCBDC corridor, to the detriment of all the participants involved.

Accordingly, all the various aspects of the organizational set-ups, such as the committee setups, election processes, voting rights, meeting cadences, etc., need to be cautiously implemented to ensure fairness in the decision-making process.

OPERATIONAL PROCEDURES

Based on the legislative structure and organizational set-up, the participating countries would need to agree on detailed operational procedures to allow for stable, efficient, and unbiased functions. We have identified three critical procedures that every mCBDC corridor should consider: network access (including onboarding / offboarding), currency sovereignty, and dispute resolution.

The operational governance of the network by the entrusted operator would be directed by a set of "rules" along these three dimensions. Moreover, the agreed-upon rules around the operational governance should be included in an mCBDC network rulebook and the supporting operational handbooks, which altogether would form the basis for administration.

Exhibit 13: Operational procedures

Sources: Oliver Wyman and J.P. Morgan analysis

(i) Network Access, including onboarding / offboarding

Access could be granted either at the mCBDC network level or on a currency-specific basis. For ease of implementation, the initial stages of a mCBDC roll-out could trial a dual access system, whereby, network access is provided at an mCBDC network level, followed by participant access for individual currencies facilitated by the respective central banks (and/or their designated corridor operators). Over time, as participant onboarding standards are harmonized, this model could evolve to allow participants to be directly onboarded across all mCBDC currency accounts in one go.

Of equal importance are the rules governing the offboarding of central banks and individual participants. Strict operational procedures should govern the offboarding of central banks from the mCBDC network in the event of central bank stresses (e.g. unilateral monetary policy changes, or major events such as civil war or government collapse). We envision this role to be performed by the supranational entity, with the mandate to limit any network contagion.

The offboarding process for individual currency participants could be performed by central banks and/or their designated corridor operators. Under such a scenario, the offboarded participants' CBDC accounts would be inactivated, their network access removed (i.e. revoked "signer" keys), and their infrastructure offboarded from the network. Some non-exhaustive scenarios that could lead to offboarding include the following:

- Breach / failure to comply with CBDC operational procedures and policies
- Participant insolvency
- Failure to comply with the applicable laws and regulations pertaining to the currency to which the participant was onboarded
- Voluntary withdrawal by the participant (after serving adequate notice). Naturally, the offboarding of a central bank would necessitate the eventual offboarding of all individual currency participants as well

(ii) Currency Sovereignty

The provision of absolute sovereignty to the respective central banks on the issuances and transactions of their respective currencies is a key operational consideration. To enforce this provision, the following procedures should be put in place:

- Exclusive Validator Status — Updates of mCBDC account balances must be the exclusive purview of the respective central banks for their currencies
- Differential interest rates across currencies — Each central bank should be free to set the interest rates offered on its currency accounts on the mCBDC network

(iii) Dispute Resolution

Dispute resolution, in the context of corridor networks, would stem primarily from failed transactions, the failure to meet the defined transaction service level agreements (SLAs), and the processing of incorrect transactions. Examples where disputes might arise include the following:

- Non-simultaneous FX PVP Settlement
- Failure to credit the beneficiary within the defined SLAs
- Incorrect transaction matching / netting

As a principle, we propose that multi-jurisdictional or platform level disputes be managed by the supranational entity, whereas single jurisdictional disputes be handled by the respective central banks.

Due consideration should be given to the creation of rules that make the supranational body the steward of the said mCBDC network. Its independence and impartiality would be critical to avoid any conflicts of interest.

SECTION 4

IMPLICATIONS TO EXISTING BUSINESS MODELS

The case for CBDCs to address the pain points in cross-border payments is very compelling. Central banks are uniquely positioned to drive this innovation by partnering with commercial banks and technology companies to unlock significant value for the real economy.

SECTION 4.1

CENTRAL BANK CONSIDERATIONS

While this paper is based on a simplified assumption that CBDCs are only adopted in cross-border payment applications, complexities may further arise in different model expansion variations. For example, adopting CBDCs in domestic payment applications may also introduce new policy and regulatory design considerations, around macroeconomic policies and currency / exchange rate. Additionally, central banks would also need to consider how these added complexities would impact existing players to ensure continued financial stability.

SECTION 4.2

COMMERCIAL BANKS: IMPACT ON THE BUSINESS MODELS

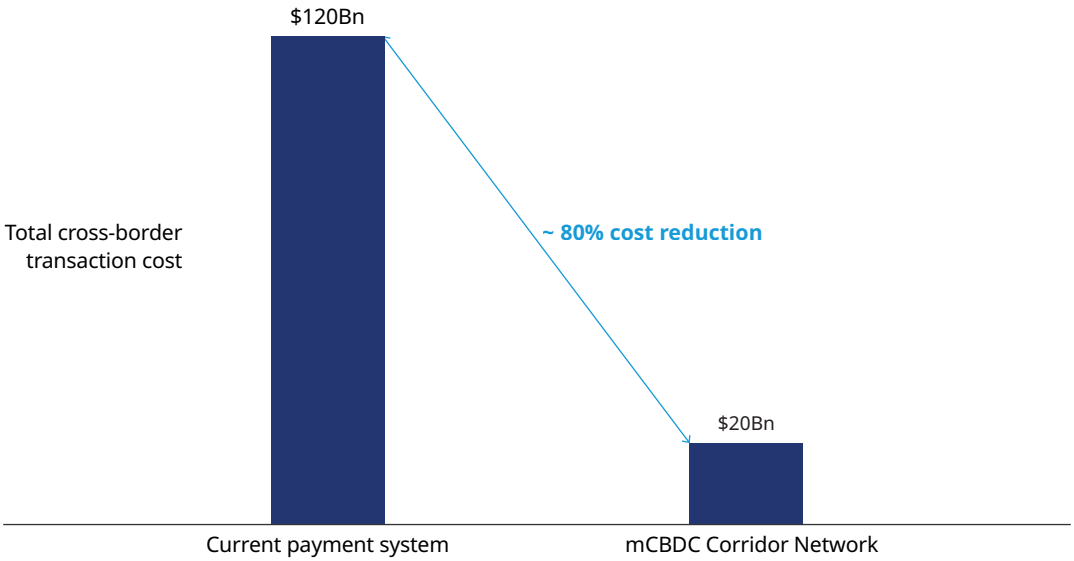
In the absence of multiple correspondent banks along the payment cycle, mCBDC solutions have the potential to reduce the cross-border transaction revenue by c80% annually from approximately $120Bn annually to $20Bn[11] (excluding FX revenues). This assumes at most 1 correspondent bank will continue to be utilized to facilitate cross-border payments. We expect actual savings to be larger in ASEAN given number of correspondent banks typically required, vs. 2-6 used across jurisdictions and currencies, as illustrated in our ASEAN example. Additionally, as corporates may not need to hold as much liquidity in their nostro accounts, commercial banks could see their overnight balances reduce significantly by about $10 billion[12], further impacting their traditional liquidity revenue streams from overdraft fees and interest. Lastly, in a world of both traditional cross-border payments and mCBDC solutions, commercial banks may need to consider the need to operate two cross-border payment systems in parallel.

11 The $100Bn reduction assumes 100% migration to the mCBDC corridor network. We estimate average transaction cost will come down from $27 involving 2 correspondent banks to $5 in a mCBDC world, implying 81% saving. Assuming constant annual transaction volume of 4.3Bn, this implies an annual reduction in transaction fees of c$100B.

12 Overnight balances are calculated via the assumption made on the ratio of average daily flows to average daily balances (~16%) and NII (~0.61%), according to Oliver Wyman and J.P. Morgan analysis.

At the same time, the mCBDC solutions in effect would present new opportunities for commercial banks, as they would be able to provide innovative on-chain products and services, such as subscription-based mCBDC corridor access, or smart contract-enabled cash management services. Commercial banks could also leverage their in-house technological capabilities to participate in the infrastructure build (as previously detailed in Section 3.3).

Exhibit 14: Impact to cross-border transaction cost



Sources: Oliver Wyman and J.P. Morgan analysis

SECTION 4.3

MARKET MAKERS AND LIQUIDITY PROVIDERS: IMPACT AND OPPORTUNITIES

While a traditional FX market operates on an OTC model, where market makers may provide different quotes upon request, and liquidity providers offer liquidity, these roles may change in an mCBDC world if alternative models are used. Specifically:

- Automated smart contracts could provide competition to the traditional market-making model
- The 24/7 nature of the mCBDC corridor could require market makers to continuously provide quotes for currency pairs (including liquid and illiquid pairs)
- Arbitrage opportunities would look very different, given the FX rates would be a function of the depth in the liquidity pools for the respective currency pairs and nature of transaction being executed
- There would be the potential for additional complexities from potential FX rate parity between two FX systems

SECTION 4.4
PAYMENT OPERATORS: IMPACT AND OPPORTUNITIES

mCBDC corridors would operate almost independently of legacy cross-border payment networks and the associated traditional clearing, settlement, and payment network solutions. However, players could leverage many of the existing efforts to capture new opportunities. E.g., Visa is exploring digital currency-related APIs (as well as conducting settlements via stablecoins), MasterCard is launching a CBDC-testing platform for central banks, and SWIFT is seeking to expand its role to a carrier of authenticated information about CBDC transactions. These are all solid foundations for players to unlock the full potential of mCBDC corridors.

SECTION 4.5
TECHNOLOGY UPGRADES IN A CBDC WORLD

Besides the business model impacts, mCBDC solutions would require technology enhancements for all players (Exhibit 15). While some legacy technology stacks could be leveraged in an mCBDC world (e.g. onboarding and compliance systems / capabilities), more systems would need to be built. These would offer more opportunities for players to compete in the arena of providing more innovative, efficient, and secure technology solutions.

Exhibit 15: Required technical upgrades and system interoperability for market participants

Service offering		Central banks	Commercial banks	FX liquidity provider	Payment operator
Issuance	Mint & redeem	■	■		
Distribution	CBDC Wallet		■		
	Client onboarding/ off-boarding		■		
On-chain payment infrastructure	DLT platform	■	■	■	■
	Smart contracts	■	■	■	■
	API	■	■	■	■
On-chain payment operations	Payment processing	■	■		
	Token conversion	■	■		
	FX PvP matching		■	■	
	Notary for settlement finality				■
FX execution	Market making		■	■	
	Liquidity provisioning		■	■	
	Netting management		■	■	
Compliance checks	KYC, AML, CFT	■	■	■	■
System interoperability		■	■	■	■

■ Technical upgrades and new build required

Sources: Oliver Wyman and J.P. Morgan analysis

SECTION 5

ALTERNATIVE AND COMPLEMENTARY MODELS TO MCBDC

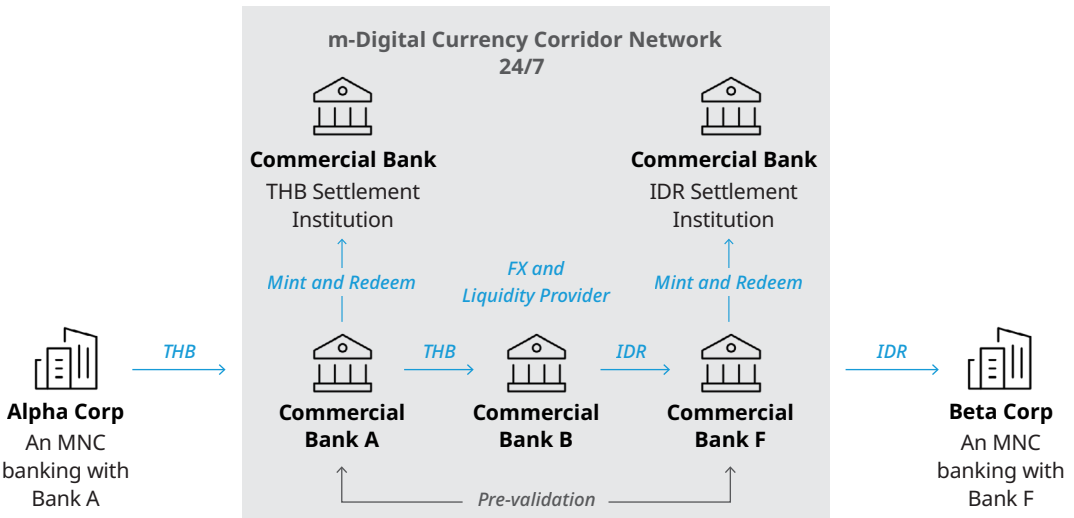
While mCBDC-based corridor networks challenge the existing paradigm of cross-border payments by offering 24/7, near-real time and atomic cross-border payment settlement using CBDCs, there are alternatives to the model that offer many of the purported benefits. One such variant could offer optionality for countries and currencies where CBDCs are unlikely to be offered in the short to medium term.

The multi-currency digital corridor network (or mDCN) is a corridor network based on commercial bank money (i.e. M1 in money supply parlance) rather than central bank money (i.e. M0). Conceptually, all the building blocks highlighted in section 3.2 remain the same between the mDCN and mCBDC networks. The major exception is that the role of a settlement institution is now played by a commercial bank instead of a central bank. This necessitates the said commercial bank to perform the mint and redeem functionality. All other roles and responsibilities outlined in Exhibit 11 would remain the same.

Partior — a Joint Venture by DBS, JP Morgan, and Temasek — is one such example of a commercial bank-based corridor network with USD settlement services provided by JP Morgan and SGD settlement services provided by DBS. Additional settlement banks could also be onboarded to provide settlement services for other currencies.

The below exhibit serves to illustrate commercial bank-based corridor networks.

Exhibit 16: Cross border payment flow in an mDCN construct



Sources: Oliver Wyman and J.P. Morgan analysis

The key differences between an mCBDC (central bank-based corridor network) and mDCN (commercial bank-based corridor network) are given below:

Exhibit 17: mCBDC versus mDCN

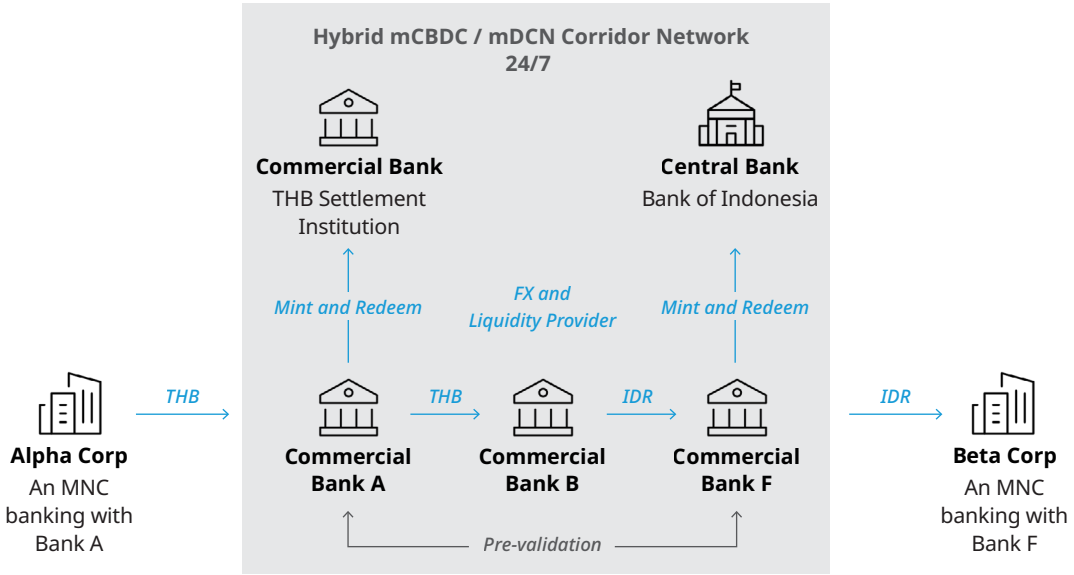
Attribute	mCBDC Networks	Commercial Bank Networks (mDCN)
Liquidity	• Central Bank Money (M0) or quasi M0 (in case of omnibus account model through PSOs) • Given that mCBDC networks are M0-based, liquidity would be limited given the lack of money multipliers	• Commercial Bank Money (M1) • M1-based liquidity, and given the money multiplier over M0, exponentially more money supply is possible
Credit Risks	• Equivalent to Sovereign Risk • All accounts on the mCBDC network are either provisioned by central banks or backed 1-1 by central bank money, so credit risk would be equivalent to sovereign risk	• Equivalent to credit quality of Settlement Institution • Credit risk would be determined by credit rating of the settlement institution
Credit Extension	• Potentially Limitless	• Limited by the settlement banks liquidity availability / appetite for a particular currency
Access	• Broad access to all licensed banks / financial institutions	• Other licensed financial institutions would require nostros with settlement banks

Sources: Oliver Wyman and J.P. Morgan analysis

Additionally, countries need not choose one model or another. In theory, hybrid models are possible, such as the illustrative example in Exhibit 18, where THB liquidity is provided by a commercial bank and IDR liquidity is provided by a central bank.

Despite the obvious merits of mCBDC networks as espoused in this paper, the administrative, coordination, and policy difficulties associated with the synchronous onboarding of multiple central banks could prove to be a hindrance for initiating mCBDC networks at scale. Consequently, commercial bank networks like Partior and/or hybrid networks with both central bank and commercial bank liquidity could provide more immediate and complementary pathways in a public-private partnership mode to help bootstrap these networks and prove benefits before large-scale adoption by the central banking community.

Exhibit 18: Hybrid mCBDC / mDCN Model



Sources: Oliver Wyman and J.P. Morgan analysis

APPENDIX: GLOSSARY OF TERMS

AML	Anti-Money Laundering
ASEAN	Association of Southeast Asian Nations
BIS	Bank for International Settlements
BOT	Bank of Thailand
CBDC	Central Bank Digital Currency
CBUAE	Central Bank of the United Arab Emirates
CFT	Combating the Financing of Terrorism
CLS	Continued Linked Settlement
CPMI	Committee on Payments and Market Infrastructures
DLT	Distributed Ledger Technology
ECB	European Central Bank
FX	Foreign Exchange
HKMA	Hong Kong Monetary Authority
KYC	Know Your Customer
MAS	Monetary Authority of Singapore
mCBDC	Multi-currency Central Bank Digital Currency
PBOC	People's Bank of China
PSO	Payment System Operator
PSP	Payment Service Provider
PvP	Payment-versus-payment
RTGS	Real Time Gross Settlement
SEPA	Single Euro Payments Area
SWIFT	Society for Worldwide Interbank Financial Telecommunication

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