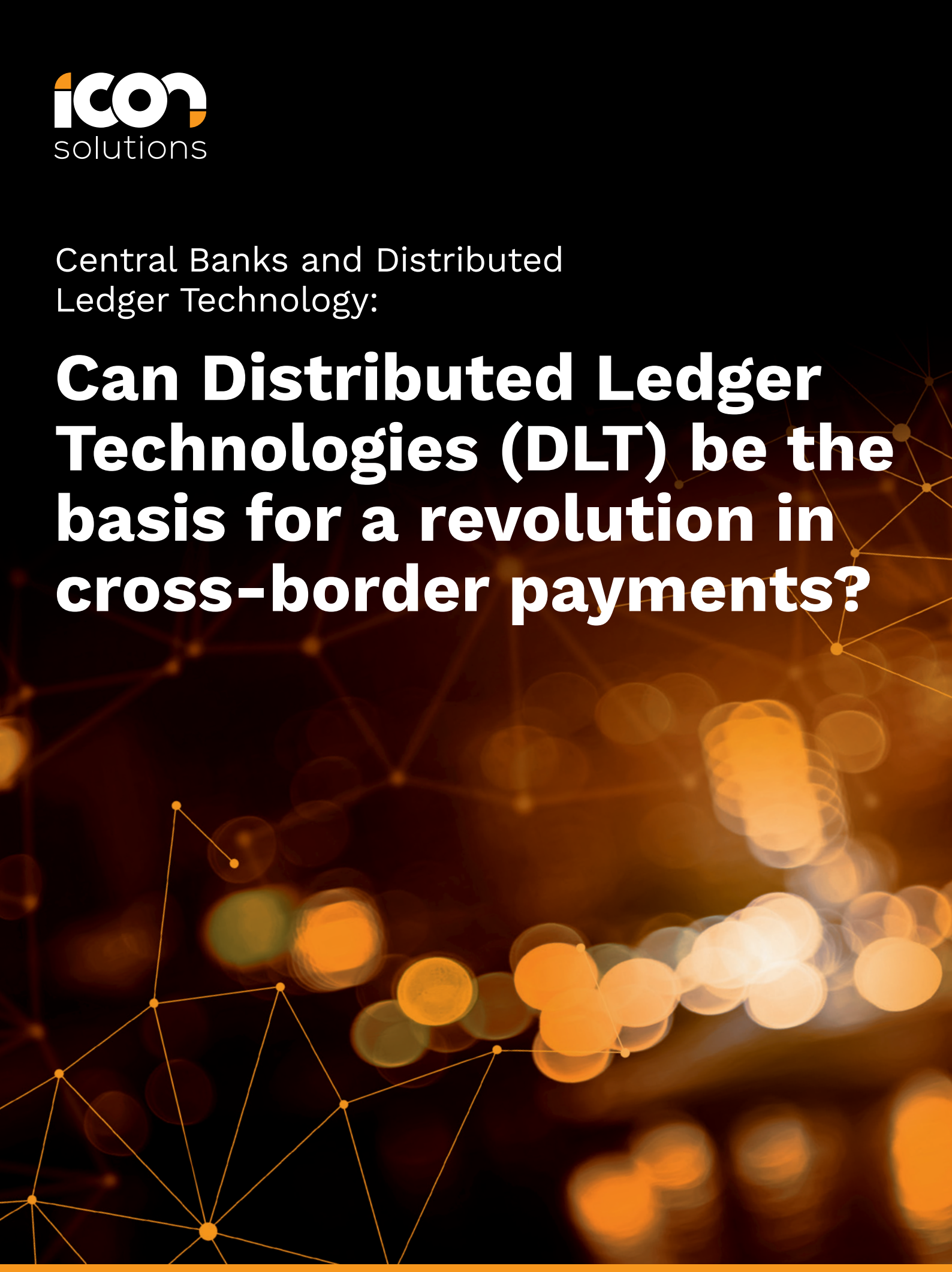
Central Banks and Distributed Ledger Technology:

Can Distributed Ledger Technologies (DLT) be the basis for a revolution in cross-border payments?



EXECUTIVE SUMMARY

Cross-border payments and the correspondent banking model have not kept pace with advances in domestic payments such as the move to real-time or instant payment processing. Many factors have contributed to this, including the lack of standardisation between jurisdictions in terms of regulatory requirements, data standards and operating hours, liquidity and FX costs.

This report is the first in a series exploring the use of Distributed Ledger Technology (DLT) to settle cross-border payments, starting with the approach by Central Banks. It sheds light on the complexities of cross-border payments, and the importance of ecosystem collaboration to come to a better solution.

In Q2 2017, Central Banks in Canada and Singapore successfully developed prototypes that explored the use of DLT to deliver domestic Real-time Gross Settlement functionality (RTGS). This report leverages the findings of these projects to propose two future state models that support cross-border payments, and provides:

- An overview of the current correspondent banking model, existing payment methods and their limitations.
- An assessment of the benefits of the SWIFT gpi initiative.
- An introduction to DLT and the principles of Wholesale Central Bank Digital Currency (W-CBDC).
- An assessment of two proposed future state W-CBDC models for cross-border payments.
- Considerations for using DLT going forward.

The observations and findings indicate that while Central Banks were able to address some of the current challenges, a considerable amount of legal and technology alignment is required before we can see a successful CBDC model for cross-border payments. This has opened the door for non-government organisations: such as Facebook's Libra, and JPMorgan's JPM Coin, which have delivered innovative DLT based solutions.

Introduction

Cross-border payments is a hot topic at the moment. Fuelled by increasing international commerce, migration and an ever-changing global economy, the landscape is trying to keep pace with market demands. We believe the key trends below will have significant impact on the future of the cross-border payments market:

- **Transaction growth:** studies indicate that the value of the cross-border payments "market is expected to rise by 5.6 per cent per year from $22 trillion in 2016, to $30 trillion in 2022 across both retail and corporate payments".
- **Relationship decline:** increased KYC, AML and financial crimes requirements have added financial burdens and liability on banks offering the service. To de-risk the process, banks have considered decreasing their network - the number of active correspondents fell by 15.5% between 2011-2017.
- **Cost and complexity:** Continued high cost and the complexity of the correspondent banking model has meant that it has failed to keep up with technology advances and innovation in the consumer to consumer (C2C) market.

Central Banks are now taking a more proactive role by looking at how they can address these issues, and if they can build upon initiatives they have undertaken in their domestic markets.

In the past two years Central Banks have investigated using Distributed Ledger Technologies (DLT) and Central Bank Digital Currency (CBDC) to improve the efficiency of Real-time Gross Settlement (RTGS) systems. Central Banks have conducted prototype projects assessing several DLT platforms such as IBM Hyperledger, R3 Corda and Quorum. The projects were aimed at addressing the following:

- **Digitisation of payments:** CBDC with RTGS settlement capabilities.
- **Decentralised processing:** distributed and resilient infrastructure that is available 24x7, eliminating single points of failure.
- **Queue handling and gridlock resolution:** uniform queuing system with prioritisation, holding and cancellation facilities.
- **Settlement finality:** final and irrevocable settlement of payment instructions with deterministic finality.
- **Privacy:** only the authorised parties have the right to access transaction details.
- **Liquidity Saving Mechanism (LSM):** implementing netting and gridlock resolution algorithms to maximise liquidity and efficiency.

The projects demonstrated the ability of the technologies to fulfil the objectives with a good degree of confidence. The next step is to extend CBDC capabilities to solve the cross-border interbank settlement challenge.

Evolution of cross-border settlement methods

Existing cross-border settlement methods rely on correspondent banking and Continuous Link Settlement (CLS). Here is a brief background to help set the scene.

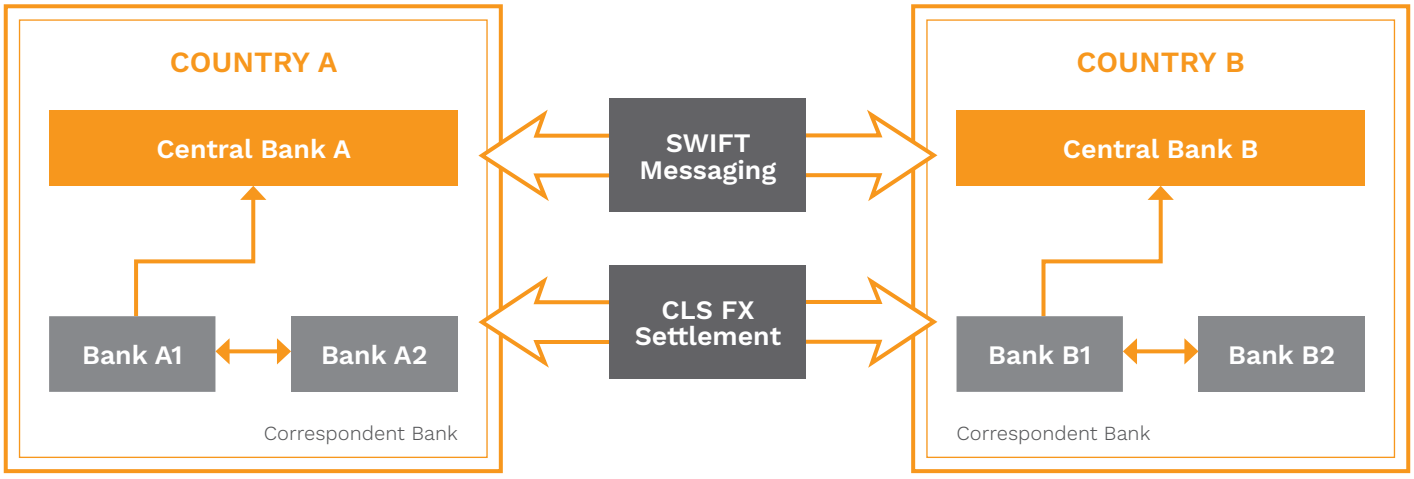
CORRESPONDENT BANKING

For centuries, the correspondent banking model has been complex and expensive. Banks must have an account in foreign countries in which they want to operate. This requires commercial banks to reach agreements on how to route payments, perform currency conversions, manage trapped liquidity in different jurisdictions and comply with different regulatory policies. This fragmentation of the financial industry made it difficult for an individual commercial bank to deal directly with all other banks globally. To enable payments to a country, the bank must establish a correspondent bank relationship via Nostro/Vostro accounts, with the necessary levels of liquidity. The bank can then service payment requests from clients.

CONTINUOUS LINK SETTLEMENT (CLS)

One challenge is the settlement risk where a counter party fails to meet its obligation after one leg of the foreign exchange transaction has been delivered. This is known as 'Herstatt risk' after the German bank that created the famous example in 1974. To reduce this risk, the CLS, a Payment versus Payment (PvP) system, was introduced. CLS calculates the net settlement of all currency pairs at scheduled windows in a liquidity efficient mechanism. To settle trades, each account is debited and credited on the books of CLS. Additionally, the operational time of CLS is limited to the operating times of the involved RTGS systems, meaning that difference in time zones will have a direct effect on the speed of settlement.

Whilst CLS was revolutionary at the time, in the current context, it can be seen as an evolution of the existing model. The below diagram provides an illustration of cross-border payments using the corresponding banking model.



Bank A1 in Country A is the originator bank sending a payment to the beneficiary Bank B2 in Country B, in currency B. Since both banks have no direct relationship, Bank A1 sends the payment to Bank A2 in currency B (FX conversion via CLS) which has a corresponding relationship with Bank B1 and is in the same jurisdiction as Bank B2. Bank B1 uses Country B's RTGS to make the payment to the beneficiary Bank B2. One or more correspondent banks can be involved in the settlement process if Bank A2 did not have a relationship with a bank in Country B, implying more intermediaries.

LIMITATIONS OF THE CURRENT MODEL

While the correspondent banking model presented provides a mechanism to move the money, there are a number of shortcomings that fail to meet customer expectations:

- **Lack of transparency:** the customer has no visibility of the status or the location of his payment during the transfer.
- **Long processing times:** due to being bound to the processing cycles of each bank and operating windows of the domestic RTGS systems.
- **High costs:** primarily due to the cost of trapped liquidity and number of parties involved to process the transaction.

The table below summarises the issues with the existing process, elaborating on each limitation and providing an indication on the level of impact. The key challenges listed below form the criteria used to evaluate the effectiveness of the proposed future state models.

CHALLENGE/CAUSE	DESCRIPTION	IMPACT
Lack of Transparency Primarily due to the absence of standard messages and notifications	- End-users and banks have no visibility of the status of the transaction or associated fees - Limited control or visibility of the transaction route	**High**
Increased Processing time Limited operating hours and time zone difference of domestic RTGS systems	- Existing RTGS and commercial bank systems operate in batch mode due to the legacy infrastructure - Dependency on multiple parties limits the overlapping windows resulting increased complexity and time	**Medium**
High Cost Trapped liquidity along with associated risk and the need to comply with multiple regulatory policies across jurisdictions	- The need to maintain enough funds in nostro accounts with correspondent partners - Increased complexity and cost of setting up correspondent arrangements	**High**

IMPROVEMENTS VIA SWIFT gpi

SWIFT is the largest network for secure financial messaging; it is the infrastructure provider for today's inter-bank transfers. In response to the existing cross-border settlement limitations, SWIFT introduced the SWIFT gpi initiative that has been adopted by more than 3,500 banks, and accounts for 50% of all traffic. Members of SWIFT gpi have access to enhanced messaging which significantly reduces processing times, while having full visibility of fees and charges.

Model Evaluation – How SWIFT gpi tackles the challenges

CHALLENGE/CAUSE	MITIGATIONS
Lack of Transparency Primarily due to the absence of standard messages and notifications	→ SWIFT gpi improves the E2E payment visibility which is strongly dependent on the adoption by correspondent counter part involved in the payment process → Supports standard messaging format of ISO 20022 which also requires the underlying payment systems to be upgraded
Increased Processing time Due to limited operating hours and time zone difference of domestic RTGS systems	→ Optimised messaging reduces the processing times, however, there is still a dependency on the operating hours of the domestic RTGS systems and availability of the commercial banks' payment infrastructure
High Costs Trapped liquidity along with associated risk and the need to comply with multiple regulatory policies across jurisdictions	→ Despite slightly reducing the settlement risk by decreasing processing times, it does not eliminate the risk of a counter party failing to deliver its payment obligations → Relies on complex and costly correspondent banking agreements to be in place → Does not eliminate the cost of trapped liquidity

The introduction of Central Bank Digital Currency

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This can only happen if the risk of using the digital asset is low. Market risk associated with a digital asset is primarily due to the high volatility and strong fluctuations in value. This has been a challenge for crypto currencies like Bitcoin, Ethereum, Ripple and presents similar challenges for tokens issued and backed by a commercial bank. If holders and users of the token do not trust or believe in the commercial bank's ability to maintain a stable token value, then trust is lost, and the holding party is exposed to a high credit risk.

However, a Central Bank issued digital currency (CBDC) that is backed by a form of collateral would remove the credit risk and provide stability in the token's value. The concept of a wholesale CBDC is to replace the money currently used to settle interbank transactions (reserves held at the Central Bank) with a digital token acting as the medium of exchange. The token being an asset means transactions between accounts would transfer value from the sender to the receiver. The token is maintained and tracked using distributed ledger technology (DLT).

CBDCs can be categorised into two groups based on the accessing party:

→ Retail CBDC (R-CBDC) is a digital version of Central Bank fiat currency that is widely available and allows the public access to Central Bank assets, it replaces physical banknotes.

→ Wholesale CBDC (W-CBDC) is a form of money that is limited to commercial banks and settlement organisations that make up the interbank market.

W-CBDC is a type of permissioned DLT network where the Central Banks define the entry criteria and control the network. The built-in immutability, integrity and transparency features increases trust between collaborating parties while providing the regulators with enhanced oversight and the confidence that enough due diligence and compliance controls are in place. The increased trust and reduced liability will eventually counteract the declining correspondent relationships where transfers are restricted via certain corridors.

Politics and financial independence are not to be underestimated as drivers for setting up new banking networks. In April 2019 the Russian parliament, known as State Duma, had given the green light to use a SWIFT-like financial network as an alternative to avoid newly imposed western sanctions. The parliament has also announced it is having talks with Iran, Turkey, China and India about the joint use of the system.

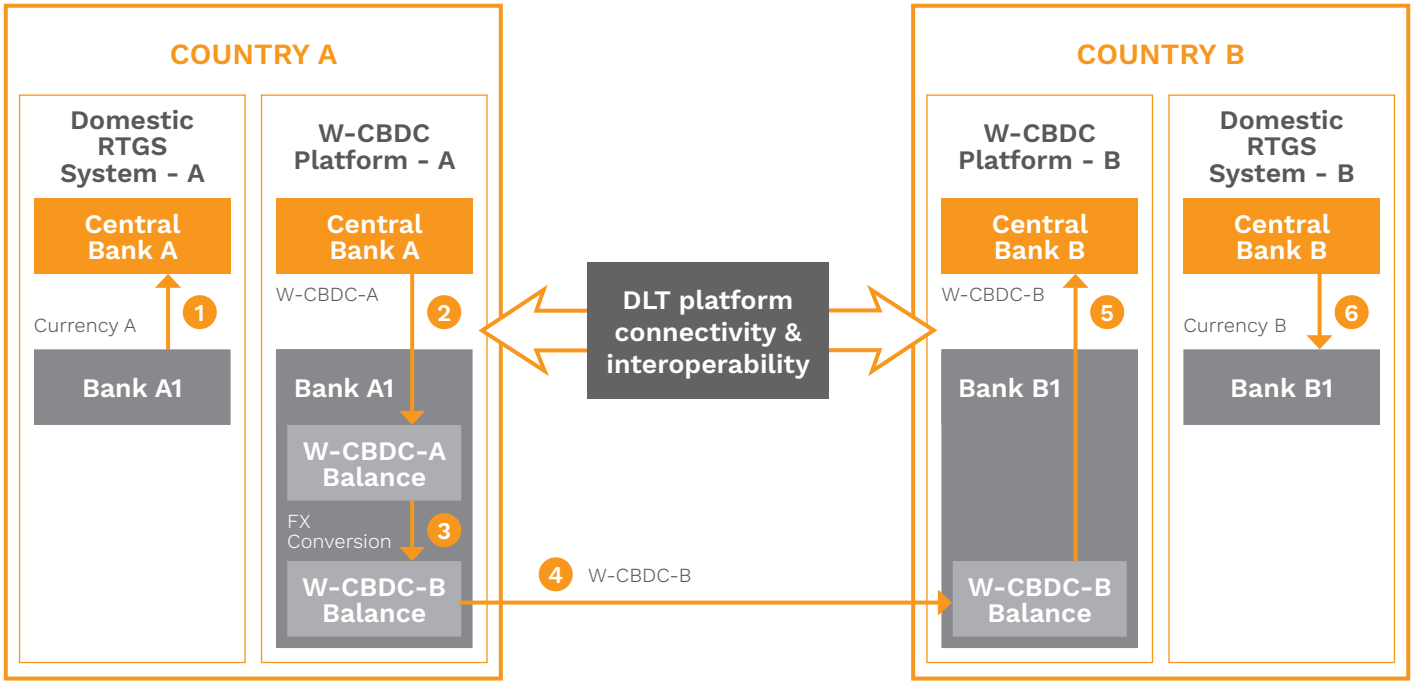
Cross-border settlement using Central Bank Digital Currency (CBDC)

There are several future models that leverage W-CBDCs for cross-border payments, for the sake of simplicity only two are discussed: Globally transferable CBDCs and Universal CBDCs. Both models for cross-border payments and settlements leverage central infrastructure to deliver improvements, this enables the evaluation of each model to outline the benefits and challenges against the evaluation criteria outlined earlier.

In the models Commercial Banks proposed, two jurisdictions A and B are considered; each jurisdiction has one Central Bank and several commercial banks. The scenario is Bank A1 (Sender) located in jurisdiction A and needs to make a cross-border payment to Bank B1 (Receiver) residing in jurisdiction B. Both banks have a settlement account with the Central Bank of their jurisdiction, each jurisdiction has a RTGS system for settling domestic payments.

MODEL 1: GLOBALLY TRANSFERRABLE CBDC

This model is based on a currency specific W-CBDCs that can be transmitted and exchanged beyond jurisdictions of the issuing Central Bank. Commercial Banks can hold multiple W-CBDC tokens e.g., a bank based in UK could hold W-CBDCs in GBP issued by BoE as well as other W-CBDCs in EUR and US dollars issued by other Central Banks.



Central Banks A and B in both jurisdictions define a policy that permits members banks to hold and exchange the W-CBDCs issued by both Central Banks with each other. Each Central Bank can only issue and redeem W-CBDCs belonging to its jurisdiction meaning that Central Bank A can issue W-CBDC-A in exchange for reserves and vice-versa.

In the model above Bank A1 maintains balances in W-CBDC-A and W-CBDC-B on W-CBDC platform A, similarly, Bank B1 with Central Bank B. The conversion of W-CBDCs denominated in different currencies could take place through a FX market in a mechanism that is similar to what is happening today via CLS. W-CBDC platforms can be operational 24x7 and run in parallel with the existing RTGS platforms.

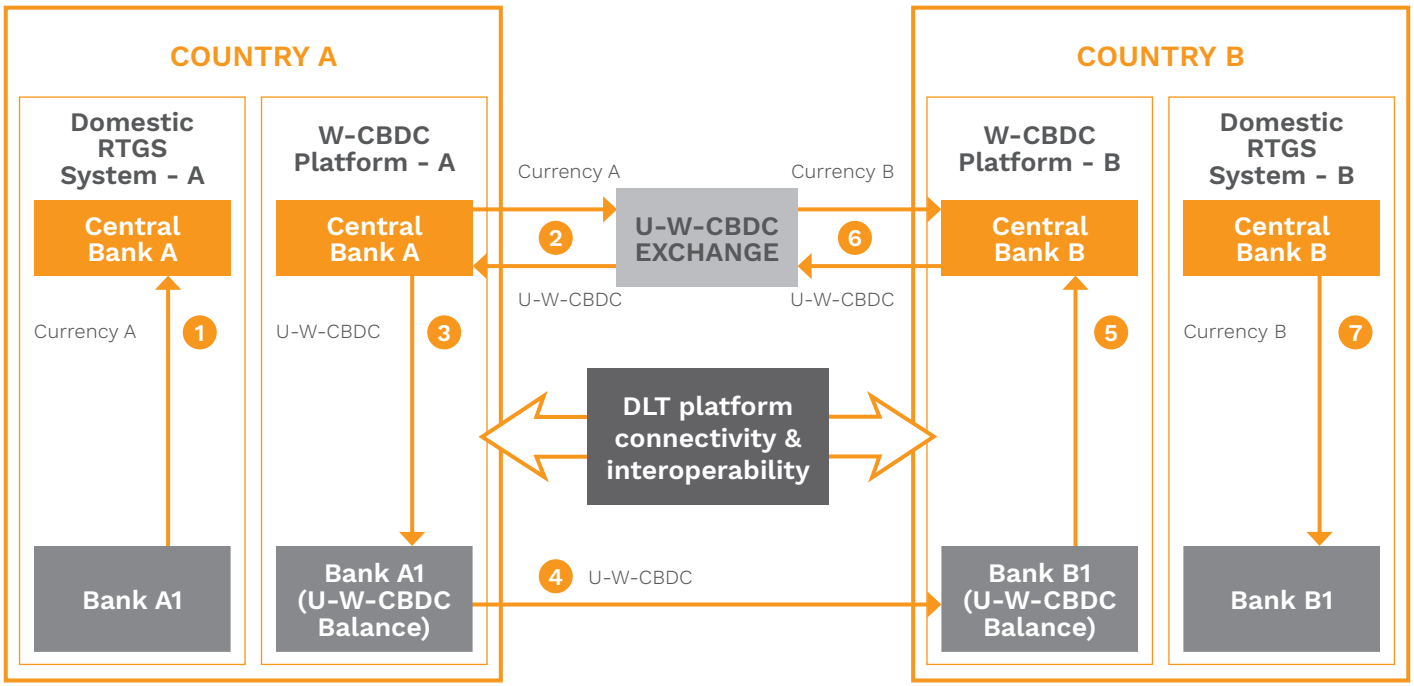
Model Evaluation

The key benefits include the elimination of correspondent banks and the associated complexity of liquidity management. This allows W-CBDCs to be instantly transferable across jurisdictions which reduces the number of relationships the sending bank needs to maintain. However, the limitations of this model are: Central Banks need to ensure interoperability of the CDBCs issued by the various Central Banks. The model also requires relationships to be managed by Central Banks across jurisdictions.

CHALLENGE/CAUSE	RESOLUTION
Lack of Transparency Primarily due to the absence of standard messages and notifications	→ A core feature of DLT is the traceability of transactions, authorised parties will be able to access data providing transaction certainty → Messaging can be designed to use ISO 20022 format to align with the future RTGS format → Interoperability between different tokens and DLT platforms introduces technical complexities
Increased Processing Time Due to limited operating hours and time zone difference of domestic RTGS systems	→ The DLT platform is going to be available 24x7 hence would not be limited to the operating windows of the RTGS systems → Requires banks to upgrade existing batch infrastructure to support 24x7 operations while holding enough W-CBDCs to allow payment processing outside of RTGS operating windows
High Cost Trapped liquidity along with associated risk and the need to comply with multiple regulatory policies across jurisdictions	→ This model eliminates the need for prefunded accounts and complex correspondent arrangements; however, it requires Central Banks to come to an agreement, requires alignment of policies across jurisdictions are not to be underestimated → Smart contracts can be used to ensure both legs of a transaction complete in FX operations → Layering of new DLT technology, on top existing systems introduces complexity, requiring investment to ensure the technology is adequate

MODEL 2: UNIVERSAL CBDCs

This model is based on a universal W-CBDC that is backed by a group of currencies which are accepted by all participating jurisdictions.



The participating jurisdictions, along with their Central Banks, collaborate to create a “Universal” Wholesale CBDC (U-W-CBDC). The U-W-CBDC will be backed by a group of currencies issued by the participating Central Banks. This U-W-CBDC would be issued through a universal exchange that is responsible for issuance and redemption of such U-WCBDCs. The exchange of a country’s currency into the U-W-CBDC would create a conversion rate between that currency and the U-W-CBDC. The mechanism for how this is managed would need to be collectively decided by the participating Central Banks. Banks can transfer these U-W-CBDCs to other banks to settle cross-border transactions. In the same manner as Model 1 the U-W-CBDC platforms are designed to be operational 24x7 and operate in parallel with the existing RTGS platforms to transact in U-W-CBDC between Banks and Central Banks within a specific jurisdiction.

Model Evaluation

Having a single global currency reduces the interoperability challenge and simplifies the management by eliminating the need to maintain multiple CDBC wallets for the different currencies. However, the questions arise as to who controls the exchange rates and how the money supply is managed. Central Banks will have to give away some of their control to align to policies across jurisdictions, which has high legal and process implications.

CHALLENGE/CAUSE	RESOLUTION
Lack of Transparency Primarily due to the absence of standard messages and notifications	→ A fundamental feature of DLT is the traceability of transactions, authorised parties will be able to access data, providing transaction certainty → Messaging can be designed to use ISO 20022 format to align with the future RTGS format → Having a single W-CBDC token that is accepted globally minimises interoperability challenge. Whether more than one DLT platform needs to be supported is an open question
Increased Processing time Due to limited operating hours and time zone difference of domestic RTGS systems	→ The DLT platform is going to be available 24x7 hence would not be limited to the operating windows of the RTGS systems → This requires the banks to upgrade existing batch infrastructure and support 24x7 operations while holding enough tokens to allow processing out of RTGS windows
High Cost Trapped liquidity along with associated risk and the need to comply with multiple regulatory policies across jurisdictions	→ This model eliminates the need for prefunded accounts and complex correspondent arrangements; however it requires Central Banks to come to an agreement and align on policies across jurisdictions which is not to be underestimated → Introduces new complexity of the universal exchange, the framework and policies around it raises key questions such as who controls it and how the money supply is being managed → Exchange rate risk emerges which now needs to be managed by the Central Bank → Universal currency (U-W-CBDC) may be used for purposes other than settlement and have the properties of financial assets, hence become subject to impacting the price and effectiveness of the token for a medium of exchange

Conclusion

Central Banks are pursuing a wholesale Central Bank digital currency to improve processing times, reduce cost and increase the transparency of cross-border payments. However, achieving real-time settlement for cross-border introduces complexity and dependencies on other layers of the financial system. From examining two future-state model, Globally Transferrable CBDCs and Universal CBDCs, it was clear that while both models introduced efficiencies to the process, they both also raised several questions that are yet to be answered.

While we have seen high levels of excitement about DLT and positive collaboration between Central Banks, the extent of impacted legalities and infancy of the technology, highlights there is still some way to go before replacing existing systems.

The absence of a near term Central Bank solution has created an opportunity for organisations with Central Banks like traits. Capitalising on wide global reach and trust, non-Central Bank organisations have started playing an innovative role in cross-border payments by issuing low-volatility digital assets (known as stable coins, such as JPM Coin and Libra Coin).

JPMorgan's JPM Coin is a commercial bank proposition for a stable digital currency that is pegged to US dollar (with plans to include additional currencies). It is designed to allow members of the JPM network to make instant cross-border payments. JPM can play such a role due to its extensive network of 259 banks and strong balance sheet that brings the risk of settlement to a minimum. However, creating a financial network that is managed by a single authority significantly increases the risk of centralisation and dominance.

Facebook's Libra Coin is an example of a new entrant issuing a global digital currency targeted at the P2P market instead of Wholesale banking. It is designed to have a stable value as it is backed by a collection of low-volatility assets known as the Libra Reserve, the currency is managed by a decentralised independent body called the Libra Association which ensures both continuity and resilience. With 2.4 billion Facebook users, Libra could become one of the largest cross-border P2P networks.

It is evident there are many horses in the race for a cross-border solution. Should the issues with cross-border payments be solved by Central Banks, Commercial Banks, or new entrants? It is an interesting debate to be had. We firmly believe that new cross-border projects will certainly cannibalise the revenues of the existing correspondent banking participants. Success will belong to propositions that score the highest against the evaluation criteria along with an equally successful go-to-market strategy to onboard the ecosystem.

→ ABOUT THE AUTHOR

Hussam Kamel is a Payments Architect with extensive experience navigating Global Tier-1 financial organisations through digital transformation journeys. His management consultancy background enables him to provide detailed viewpoints on key market initiatives, as well as pragmatic advice and recommendations for successful payment transformation.

Use Cases

PROJECT NAME	OBJECTIVES	RESULTS
Bank of Canada Project: Jasper	**Phase 1** explored using DLT inter-bank settlement using Ethereum **Phase 2** evaluated further RTGS functionality and migrated to Corda platform introducing the concept of decentralisation via the 'Notary' feature	**Phase 1** provided the required functionality in non-production environment. However, concerns were raised regarding scalability **Phase 2** worked as intended, with the ability to process large transactions volumes within an acceptable window
Monetary Authority of Singapore Project: Ubin	**Phase 1** a proof-of-concept was based on Ethereum, testing the feasibility of using CBDC equivalent of Singapore dollar for inter-bank transfers **Phase 2** consisted of three prototypes developed on 3 DLT platforms: Corda, Hyperledger and Quorum with focus on specific RTGS functionalities focusing on Liquidity saving mechanisms (LSM)	**Phase 1** successfully code agreements into the network's smart contracts. **Phase 2** findings demonstrated that all three workstreams can perform fund transfers, queue reprioritisation and gridlock resolution in a decentralised manner, without compromising the privacy of the transactions. Tests for scalability, performance and resilience were successful
Bank of Japan-ECB Project: Stella	**Phase 1** investigated whether innovations in distributed ledger technology could ensure faster and cheaper payment processing and settlement **Phase 2** examined whether and how DLT can deliver securities against cash	**Phase 1** findings suggest it meets the performance needs for Japan and Euro area and strongly depends on network size and configuration **Phase 2** had success in exchanging securities against cash (DvP) but there must be more exploration into legal and security aspects

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