

The Faster Payments Council (FPC) Cross-Border Payments Work Group is proud to present the first issue of the Work Group's Bulletin focused on Central Bank Digital Currencies (CBDCs) and their effect on cross-border faster payments. This series of Bulletins is designed to educate the payments industry on the developments of CBDCs in the cross-border faster payments area.

The Work Group recognizes there are both benefits and risks with any new method of payment. This and future editions of the bulletin will provide an ongoing source of information about CBDCs and their benefits, risks, and other considerations. Bulletin.01 starts the education process by providing a primer on CBDCs.

In this edition:

- Digital Currency Terms
- Drill Down on CBDCs
- Cross-Border Models

Background

The Cross-Border Payments Work Group was chartered by the FPC in 2020. Currently there are 30 Work Group members representing membership diversity.

In June of 2021, the Work Group published the Cross-Border Faster Payments white paper¹, which addressed Use Case and Experience Requirements for cross-border faster payments along the dimensions of Speed, Cost, Ubiquity, Transparency, and Risk. The paper was structured to identify interoperability approaches, along with associated settlement schemes that are necessary to create a world-class cross-border faster payment system.

Late last year the Work Group pivoted and revised its mission and charter to cover global industry initiatives affecting cross-border faster payments – focusing specifically on the impact U.S. Central Bank Digital Currency (CBDC) could have on the adoption of cross-border real-time payments.

This undertaking is timely as it comes on the heels of an Executive Order² announced in March 2022 outlining the U.S. Government's approach to addressing the risks and harnessing the potential benefits of digital assets and their underlying technology.

The Executive Order calls for U.S. leadership in international efforts involving CBDCs and digital assets, including a report on the various opportunities, implications, and threats.

The Executive Order commissioned a report to establish whether a U.S. CBDC is “deemed to be in the national interest.”

Definitions and Terms

Digital currency is the generic term for a form of currency that is available only in digital or electronic form. It is also called digital money, electronic money, electronic currency, or cybercash. All of these are included in the term “digital asset.” Here are some definitions of various types of digital currency that can help in understanding these new methods of payment.

- **Cryptocurrency** - A digital or virtual currency that is secured by cryptography³, which makes it impossible to counterfeit or double-spend. Cryptocurrency is not issued by any central authority, rendering them theoretically immune to government interference or manipulation.⁴
- **Stablecoin** - A class of cryptocurrencies that attempt to offer price stability and are backed by an asset. They may be pegged to a currency like the U.S. dollar or to a commodity's price such as gold.⁵
- **Central Bank Digital Currency** - A digital form of a country's fiat currency⁶, denominated similar to the local currency. A CBDC is issued and regulated by a nation's central bank and is the equivalent of cash.⁶ There are two types of CBDCs:

- **Wholesale CBDCs** are similar to holding reserves in a central bank. The central bank grants an institution an account to deposit funds or use to settle interbank transfers.
- **Retail CBDCs** are similar to a government-backed digital currency generally reserved for institutions, but in this case, the government extends it to consumers and businesses.

Drill Down on CBDCs

According to the International Monetary Fund (IMF), as of early February 2022⁸ there are approximately 100 countries exploring CBDCs. Some are in the research phase, others have moved on to testing, and a few have already started distributing CBDC to their residents.

U.S. Central Bank Digital Currency can be defined as a digital liability of the Federal Reserve that would be widely available to the public. Today, Federal Reserve notes (i.e., physical currency) are the only type of central bank money available to people. Like existing forms of commercial bank money⁹ and nonbank money, a CBDC would enable consumers to make digital payments. As a liability of the Federal Reserve, however, a CBDC would not require mechanisms like deposit insurance to maintain public confidence, nor would a CBDC depend on backing by an underlying asset pool to maintain its value.

A CBDC would be the safest digital asset, with no associated credit or liquidity risk.¹⁰

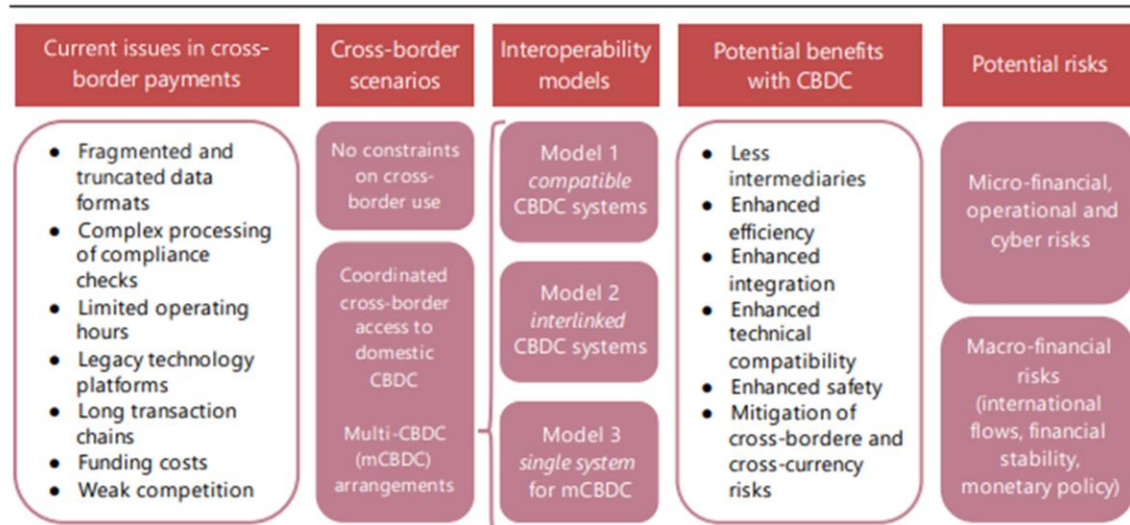
Central Banks are looking at CBDCs for a number of reasons: financial inclusion; to enhance/improve existing infrastructure; to drive innovation and new products; greater competition (inclusive of non-banks); and to retain sovereignty. The focus of this bulletin centers on issues related to cross-border payments.

The proliferation of these global CBDC initiatives will alter the traditional cross-border payment and correspondent banking paradigms. According to the Research and Analysis paper published by the Federal Reserve Bank in January of this year titled Money and Payments: The U.S. Dollar in the Age of Digital Transformation stated: “a CBDC could fundamentally change the structure of the U.S. financial system, altering the roles and responsibilities of the private sector and the central bank.”¹¹

CBDCs offer in a digital form the unique advantage of central bank money: settlement finality, liquidity, and integrity.¹² Further the issuance and use of a CBDC for cross-border payments could potentially help simplify intermediation chains, increase speed, and lower costs.¹³

Summary of the potential to enhance cross-border payments with CBDCs

Graph 1



Source: CPMI; BIS Innovation Hub; IMF; World Bank.

With any new innovation or service there are potential risks. This is as true for CBDCs as it is for any other financial innovation. A CBDC needs to be designed in a way that supports a central bank's primary objective of maintaining both monetary and financial stability. The design must be accompanied by appropriate, robust operational risk management and cybersecurity policies and procedures. Lastly, it needs to replicate the technical resilience, sound governance and integrity of the existing infrastructures to gain and keep the acceptance and confidence of the public. CBDCs will likely inherently focus on domestic issues in primary considerations as each central bank looks to improve on their country specific limitations. The likelihood is there will be a range of CBDCs implemented internationally, however with the nature of the globalized world, it is essential CBDCs are designed and implemented to interact within the global markets. Interoperability and standards will be the keys to the operational efficiency and acceptance of CBDCs cross-border.

The table below highlights how the different CBDC interoperability models and arrangements can facilitate cross-border payments.

The same dimensions noted above of Speed, Cost, Ubiquity, Transparency, and Risk from our original white paper can be applied as drivers for CBDCs.¹⁴

- CBDCs can address slow payment execution speed, transaction costs and poor traceability for cross-border transactions that have been ongoing industry and customer issues.
- Near-instant CBDC settlements will speed up cash cycles and improve intraday liquidity.
- CBDCs can increase transparency, settlement speed, and operational efficiency to power productivity in today's real-time digital economy.

(Continued next page)

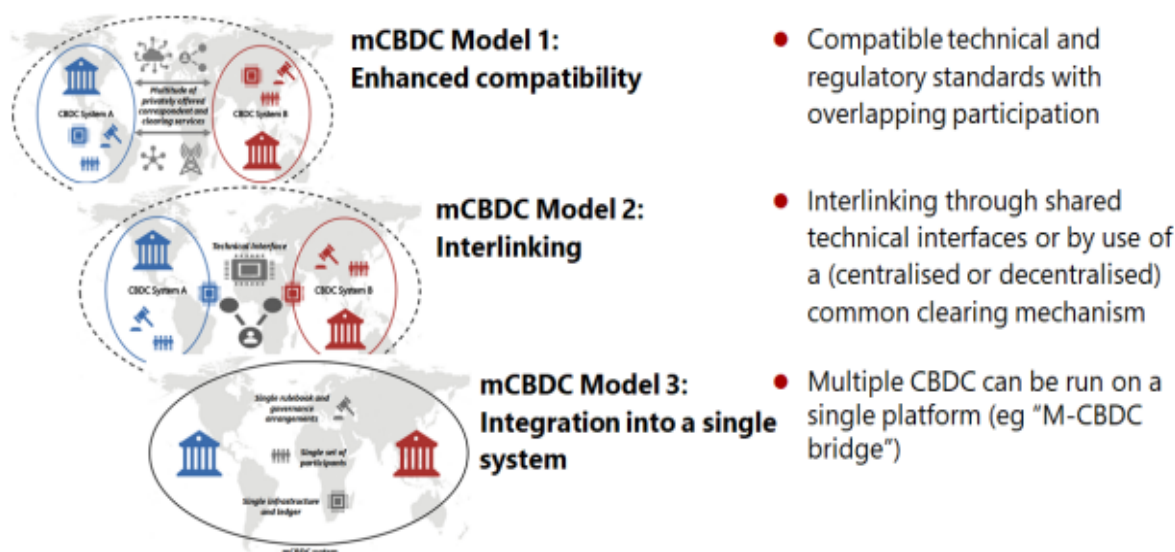


BANK FOR INTERNATIONAL SETTLEMENTS

As an example, in the intermediate interlinking model, a shared technical interface can bridge two separate payment systems. Thus participants in one system make payments to those in another directly through the technical interface, without go-betweens.

Multi-CBDC arrangements can facilitate cross-border payments

Graph 11



Source: R Auer, P Haene and H Holden, "Multi-CBDC arrangements and the future of cross-border payments", *BIS Papers*, no 115, 2021.

A CBDC is a central bank liability, and therefore would be free of credit and liquidity risks. It would not be a liability of a commercial bank and not be covered by deposit insurance.

- CBDCs enhance the potential for a central bank to offer a currency that mitigates risk.
- Central bank reserves provide a risk-free store of value and trust in the digital settlement asset.
- With a trusted instrument like a CBDC, the restrictive environment changes. It becomes more fluid and interoperable. Trust and ubiquity are the main factors that CBDCs can offer.¹⁵

The issuance of CBDCs adds dimensions that must be considered.

- **Trust** - An important aspect of any currency is trust, and a CBDC would not be successful without a secure platform that ensures user trust in the currency itself.¹⁶
- **Resiliency** - To maintain trust in the digital currency, a CBDC must guarantee the ongoing existence and usability of funds.¹⁷
- **Financial Inclusion** - The introduction of a CBDC could enable financial systems to reach people who are now excluded. Indeed, central banks consider financial inclusion as one of the most relevant arguments in support of the introduction of a CBDC.¹⁸
- **Reach** - Fiat money in the form of CBDC is a powerful tool for central banks to reach the broadest base of their populace because it is more efficient and reduces friction.¹⁹

Examples of Cross-Border Operating Models

There are a number of operating models for transaction messaging and moving money cross-border.

SWIFT

SWIFT is a world-wide cooperative of about 11,000 banks. It is a secure messaging system and does not itself move money, rather SWIFT's messages provide instructions to move funds located at participating banks.

Banks have correspondent banking relationships and maintain balances in their correspondents for the purpose of supporting customer payment requests. The SWIFT messages provide instructions to use these funds for customer and other payments. The funds must be replenished after the payments are made.

Under Basel III²⁰ these funds are included in the calculations of operating risks and require certain assets to be set aside. Also, these funds do not earn as much as they could if they were used for other purposes, e.g., loans.

Banks have a limited number of correspondent relationships and thus a limited number of deposit relationships with which to make payments. Therefore, many SWIFT messages and the parallel money movements need to go through several correspondent relationships to reach their final destination. Each correspondent or stop can add fees and foreign currency conversion expense, which can cause a lack of transparency in the cost of a transaction.

Also, in the original SWIFT system, there is no confirmation message saying the funds reached their final destination or how much was received by the recipient, i.e., how much the amount was reduced by intermediary fees and foreign exchange expenses. However SWIFT recently introduced a function called "Global Payments Innovation" (or gpi) which has solved some of these issues and is currently being adopted by SWIFT member banks.

FedGlobal

FedGlobal ACH Payments offer an efficient and low-cost means for sending cross-border credit payments to 33 countries around the world, plus debit payments to Canada only.²¹ The Federal Reserve gets foreign currency rates from multiple banks. FedGlobal is not real-time, transactions can take multiple days, and there is no authorization process. But it is typically less expensive than other forms of cross-border payments.

Other Solutions

More recently, blockchain based solutions coupled with digital currencies have driven innovation and change in cross-border payments allowing transactions to settle within seconds.

Ripple has developed a solution that allows financial institutions and payment providers from around the world to connect within a global network to send and receive payments instantly with finality and transparency. The solution leverages a blockchain ledger partnered with a digital asset which acts as a bridge between local fiat currencies, allowing institutions to eliminate pre-funding of destination accounts, reduce operational costs and unlock capital.

Other solutions include Circle and Lightning. Circle provides cross-border value exchange enabled by a stablecoin pegged to the US Dollar, which can be sent globally and allows users to transact digital dollars and convert back into local fiat at exchanges around the world. Lightning's solution connects e-wallets, crypto-wallets, QR code-based payments, bank accounts, and credit cards through their ecosystem making payments available under one roof to create a regional based settlement hub.

The Path Forward

A U.S. CBDC could be stored only in commercial bank accounts at the Fed or only in the accounts of the Federal Reserve banks or both. Presently, there is no agreement, consensus, or plan for if and when retail customers will have access to a U.S. CBDC. The U.S. CBDC could be solely used for interbank transactions, or it could be solely used for transactions between central banks or both. Furthermore, there is no agreement or plan for the Federal Reserve to have retail accounts and there is opposition to the idea from several important constituencies. There are no firm definitions or schematics showing how a U.S. CBDC or other CBDC would be used for cross-border transactions or how these transactions would be authorized, settled, and cleared, some initial studies are now underway.²²

Given the U.S. CBDC is a digital currency, the funds could include instructions stating how to credit the funds to the recipient. This would eliminate the need for maintaining costly funds in a correspondent bank and could eliminate the expensive Basel III operating risk issue. This would also eliminate the need for multiple hops.

None of these approaches eliminates the need for foreign currency conversion on the recipient's side,

but it may eliminate the need for a currency conversion on each hop and therefore reduce the cost of currency conversion.

At least three ideas for system approaches have been discussed:

- Creating one system for transmitting all CBDCs (e.g., U.S., U.K., Chinese, etc.).
- Creating multiple systems, each carrying one CBDC but compatible with the other systems.
- Creating a system carrying all the CBDCs intertwined with each other.

The definition of these three approaches needs further clarification, with emphasis on three important requirements, namely the need for finality, the need for liquidity, and the need for a trusted lender of last resort for certain types of transactions or certain situations. These topics will be addressed in future bulletins.

Summary

Development of CBDCs has moved beyond just conceptual thinking and they are now in the proof of concept and in some cases testing stages. It is however just the beginning of the journey. There is much to be learned as central banks continue to assess the impacts, implications, benefits, and risks of the issuance of CBDCs. CBDCs have the potential to change the payments landscape and ecosystem. It should be anticipated there will be many forks in the road ahead as the course of global CBDCs change and evolve.

Through the issuance of future bulletins, such as this, the FPC Cross-Border Work Group will not only provide the latest information about CBDCs but explore factors that need to be considered such as the technology frameworks and the regional and local legal and regulatory rules and mandates.

We welcome your input, assistance, and guidance to provide timely and topical information about the effects of CBDCs not only on cross-border payments but on the entire payment's infrastructure. The FPC Cross-Border Payments Work Group Bulletin.02 will explore the potential impact of CBDCs on cross-border payments.

About the Cross-Border Payments Work Group

The FPC Cross-Border Payments Work Group covers global industry initiatives, gathering information on various models and use cases for real-time payments across borders with the long-term goal of cross-border interoperability. The Work Group is currently focused on Central Bank Digital Currencies and their effect on cross-border real-time payments.

Cross-Border Payments Work Group Bulletin.01

Thank you to the members of the FPC Work Group

- Barry Tooker (Work Group Chair), TransactionBanker.com
- James Sellick (Work Group Vice Chair), Ripple Labs
- Maria Arminio (FPC WG Facilitator), Avenue B Consulting

Overall contributors:

- Steve Mott, BetterBuyDesign
- Varun Abrol, BMO Harris
- Tanmoy Banerjee, Citibank
- Karen Shunk, EMVCo
- Jonathan Holland, Mastercard International
- Kelvin Leung, Mastercard International
- Mark Corritori, Mastercard International
- Sameer Jain, Opus Consulting Solutions Inc.
- Peter Tapling, PTap Advisory, LLC
- Rodman K. Reef, Reef Karson Consulting, LLC
- Scott Green, SHAZAM
- Moa Agrell, Trustly, Inc.
- Srinivas Chintakrinda, Volante Technologies Inc.
- William DiSenso, Vments, Inc.
- Sarah Arnion, Walmart, Inc.
- Andrea Gildea, Wise Inc.

About the Faster Payments Council

The Faster Payments Council (FPC) is an industry-led membership organization whose vision is a world-class payment system where Americans can safely and securely pay anyone, anywhere, at any time and with near-immediate funds availability. By design, the FPC encourages a diverse range of perspectives and is open to all stakeholders in the U.S. payment system. Guided by principles of fairness, inclusiveness, flexibility, and transparency, the FPC uses collaborative, problem-solving approaches to resolve the issues that are inhibiting broad faster payments adoption in this country.

The contents of this bulletin are for educational purposes only and not intended to be an endorsement by the U.S. Faster Payments Council for Central Bank Digital Currency Solutions.

- [1] Faster Payments Council. (2021, June). Cross-Border Faster Payments. <https://fasterpaymentscouncil.org/blog/6369/Cross-Border-Faster-Payments>
- [2] The White House. (2022, March 9). Executive Order on Ensuring Responsible Development of Digital Assets. <https://www.whitehouse.gov/briefing-room/presidential-actions/2022/03/09/executive-order-on-ensuring-responsible-development-of-digital-assets/>
- [3] Kaspersky. (n.d.). Cryptography Definition. Retrieved May 3, 2022, from <https://www.kaspersky.com/resource-center/definitions/what-is-cryptography>
- [4] Investopedia. (n.d.). Cryptocurrency. Retrieved May 2, 2022, from <https://www.investopedia.com/terms/c/cryptocurrency.asp>
- [5] Investopedia. (n.d.). Stablecoin. Retrieved May 2, 2022, from <https://www.investopedia.com/terms/s/stablecoin.asp>
- [6] Investopedia. (n.d.). Fiat Money. Retrieved May 2, 2022, from <https://www.investopedia.com/terms/f/fiatmoney.asp>
- [7] Investopedia. (n.d.). Central Bank Digital Currency (CBDC). Retrieved May 2, 2022, from <https://www.investopedia.com/terms/c/central-bank-digital-currency-cbdc.asp>
- [8] Georgieva, K. (2022, February 9). The Future of Money: Gearing up for Central Bank Digital Currency. International Money Fund. <https://www.imf.org/en/News/Articles/2022/02/09/sp020922-the-future-of-money-gearing-up-for-central-bank-digital-currency>
- [9] Britannica. (n.d.). Bank Money. Retrieved May 2, 2022, from <https://www.britannica.com/topic/bank/Bank-money>
- [10] Board of Governors of The Federal Reserve System. (2022, January). Money and Payments: The U.S. Dollar in the Age of Digital Transformation. <https://www.federalreserve.gov/publications/files/money-and-payments-20220120.pdf>
- [11] Board of Governors of The Federal Reserve System. (2022, January). Money and Payments: The U.S. Dollar in the Age of Digital Transformation. <https://www.federalreserve.gov/publications/files/money-and-payments-20220120.pdf>
- [12] BIS. (2021, June 23). CBDCs: an opportunity for the monetary system. <https://www.bis.org/publ/arpdf/ar2021e3.htm>
- [13] Skingsley, C. (2021, July 9). Central bank digital currencies for cross-border payments. BIS. <https://www.bis.org/publ/othp38.htm>
- [14] Faster Payments Council. (2021, June). Cross-Border Faster Payments. <https://fasterpaymentscouncil.org/blog/6369/Cross-Border-Faster-Payments>
- [15] eCurrency. (2020, September 3). How CBDC should be designed to meet future payment needs? <https://www.ecurrency.net/post/how-cbdc-should-be-designed-to-meet-future-payment-needs>
- [16] Board of Governors of the Federal Reserve System. (2022, February 3). Security Considerations for a Central Bank Digital Currency. <https://www.federalreserve.gov/econres/notes/feds-notes/security-considerations-for-a-central-bank-digital-currency-20220203.htm>
- [17] Hansen, T. & Delak, K. (2022, February 3). The Federal Reserve Bank of Boston and Massachusetts Institute of Technology release technological research on a central bank digital currency. Federal Reserve Bank of Boston. <https://www.bostonfed.org/news-and-events/press-releases/2022/frbb-and-mit-open-cbdc-phase-one.aspx>
- [18] Barotini, C. & Holden, H. (2019, January). Proceeding with caution-a survey on central bank digital currency. BIS. <https://www.bis.org/publ/bppdf/bispap101.pdf>
- [19] eCurrency. (2020, September 3). How CBDC should be designed to meet future payment needs? <https://www.ecurrency.net/post/how-cbdc-should-be-designed-to-meet-future-payment-needs>
- [20] Investopedia. (n.d.). Basel III. Retrieved May 2, 2022, from <https://www.investopedia.com/terms/b/basell-iii.asp>
- [21] The Federal Reserve. (n.d.). FedGlobal® ACH Payments. Retrieved May 2, 2022, from <https://www.frbervices.org/financial-services/ach/fedglobal>
- [22] PYMNTS.com. (2022, March 31). ECB, Fed, BoE Work, on an Interoperable CBDC. <https://www.pymnts.com/cbdc/2022/ecb-fed-boe-work-on-an-interoperable-cbdc/>

The Faster Payments Council (FPC) Cross-Border Payments Work Group is proud to present the second issue of the Work Group's Bulletin focused on Central Bank Digital Currencies (CBDCs) and their effect on cross-border faster payments.

This series of Bulletins is designed to educate the payments industry on the developments of new payment methods supporting cross-border faster payments and provide an ongoing source of information on their benefits, risks, and other considerations.¹

Bulletin.02 presents a model cross-border transaction flow. This model will be referenced in future bulletins as a common framework.

In this edition:

- [Correspondent Banking Model](#)
- [Money Movement](#)
- [Questions to Consider](#)

Introduction

Will cross-border payments be faster, cheaper, easier, and more accessible if supported by a CBDC? Cross-border payments are complex for a variety of reasons. CBDCs hold the opportunity to address some of those reasons, but much depends on implementation choices made by various central banks and associated authorities, regarding whether and how digital versions of their fiat currencies are implemented.

It is possible CBDCs will affect cross-border payments in part rather than in their entirety. And the flow of cross-border transactions can vary greatly. In this Bulletin, we propose a working model of an end-to-end cross-border payment that has been published by the Bank for International Settlements. This model will provide a consistent transaction structure for reviewing various scenarios in which CBDCs might influence cross-border transactions. We will use this structure as various scenarios are explored throughout this series of Bulletins.

A Global Frame: The Correspondent Banking Model

To examine the impact of CBDCs on cross-border payments, a simple cross-border correspondent banking payment flow is presented as a baseline. This flow is intended to be generic and serve as a guidepost for further exploration.

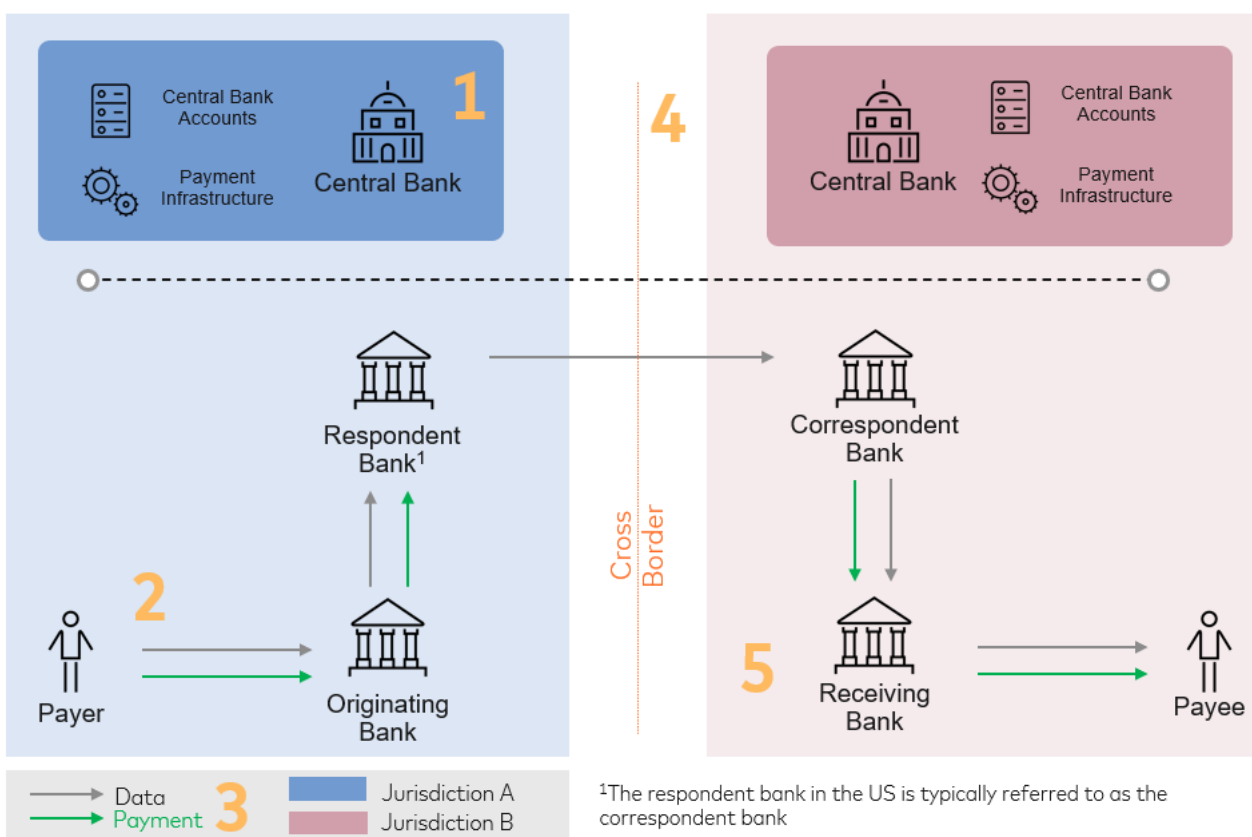
The proposed discussion model leverages a familiar correspondent banking model that can be found in the Bank of International Settlements (BIS) paper 115² titled, "Multi-CBDC arrangements and the future of cross-border payments" (graph #2 [Figure 1]). It is important to level-set this series by describing a typical 'happy path' for a correspondent banking flow while still leaving sufficient areas of exploration for future Bulletins. The introduction of a CBDC into the transaction will uncover many benefits, challenges, and impacts to the current infrastructure and it is important to anchor this analysis to a peer reviewed construct.

Introducing the Amended Correspondent Banking Model

The BIS model has been amended slightly to leave room for different payment types, constructs, technology, and distribution models. A few elements are added to the process to help simulate a variety of functions that might be impacted as a result of new technologies (e.g., Central Bank and payment infrastructures). Using this reorientation will allow for the exploration of what the effects of a CBDC could look like against the participants within the model.

A Drill-Down of the Proposed Model

Figure 1



1. Central Bank and Associated Infrastructure

The breakout of the Central Bank is important as we explore the monetary policy effects of new technologies. Money supply, distribution and rate setting functions of Central Banks could change with the introduction of a CBDC.

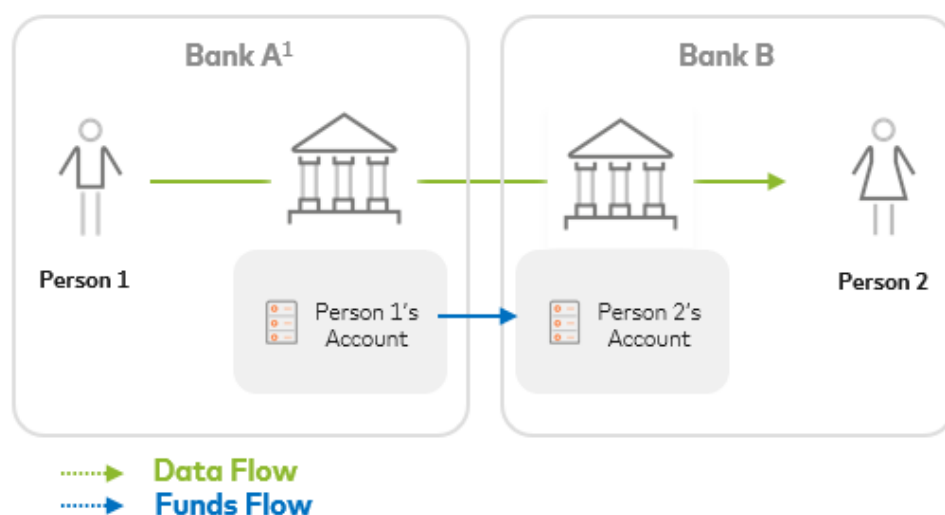
2. **Remitter or Sending Side** – The correspondent banking ecosystem relies on a network of banks to facilitate the movement of data and funding for payment activity. The sender (and by extension receiver) could need new technology, regulatory considerations, and Know Your Customer (KYC) mechanisms to participate in these new networks.

3. **Data vs. Funding Leg** – In a traditional correspondent banking model the data and remittance information travels from bank-to-bank with specialized instructions for the debit and credit of appropriate accounts. The funding leg will travel through correspondents and in many cases need to facilitate foreign exchange (FX) functions. With the introductions of new digital currencies, we will explore how this model could change in the future.
4. **Cross-Border Use-Case** – Jurisdictional considerations and a varying degree of regulatory gradients between markets will need to be recognized.
5. **Beneficiary and Currency Recipient** – Digital forms of money, Virtual Asset Service Providers (VASPs) and new custodial models will challenge the Correspondent Banking Model and need to be analyzed.

Money Movement

Keeping Figure 1 above in mind, here is a basic money movement flow that will provide context into how cross-border funds move. In a cross-border transaction, the flow of money movement can occur in a variety of different ways. The following example describes a typical funds flow assuming a 'happy path', where the transaction flows with minimal complexity and no errors.

Figure 2

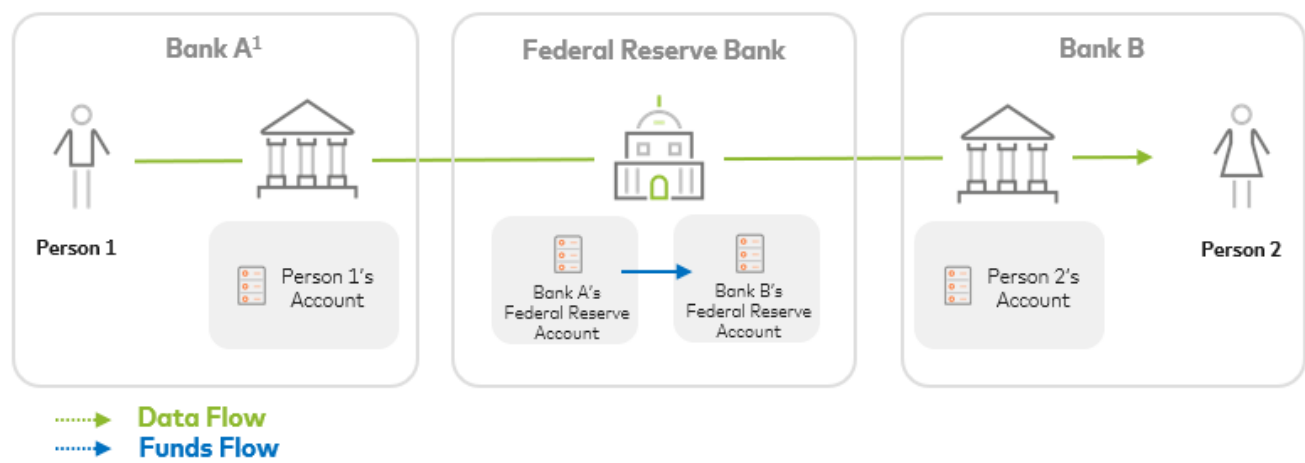


¹Bank A as a sender could be any form of depository financial institution in their respective jurisdictions; for instance, in the US, a bank or a credit union.

In the simplest transfer transaction (Figure 2), Person 1 at Bank A wants to move funds from his or her checking account to the checking account of Person 2 at Bank B. For the moment, assume both banks are in the U.S. Bank A could remove the cash from Person 1's account and manually deliver the cash using paper money and coins to Bank B for deposit to Person 2's account. The delivery could be by messenger, courier, armored car, etc. Over the years this process has been simplified

through the use of electronics and accounts at the Federal Reserve and similar U.S. institutions. Bank A can make the transfer by removing the funds from Person 1’s checking account and crediting its account at the Federal Reserve (Figure 3). It can then instruct the Federal Reserve to move the funds to Bank B’s account via Fed Wire. The Federal Reserve can then notify Bank B about the change in its account balance. Bank B can remove the funds from its Federal Reserve account and credit Person 2’s account.

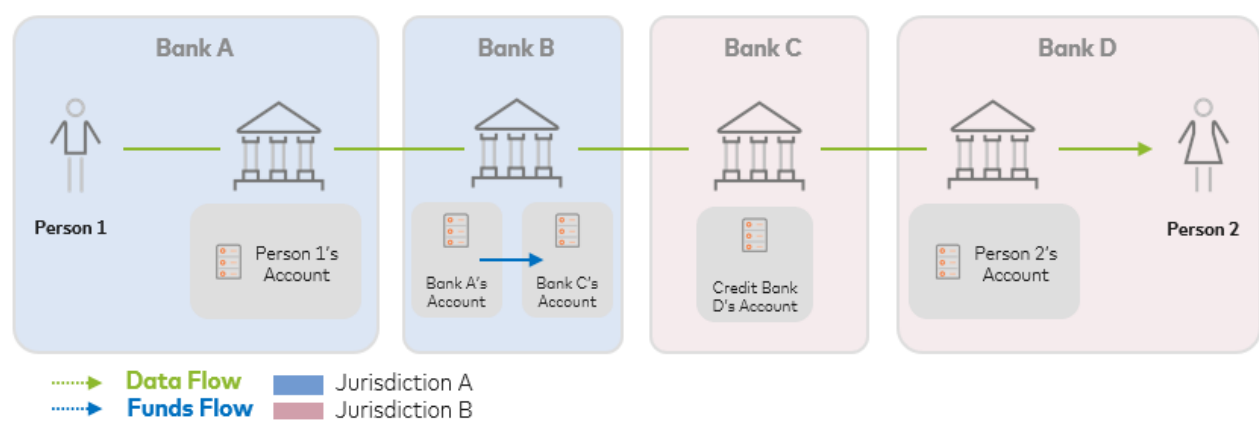
Figure 3



If the assumption about both banks being domiciled in the U.S. is removed, Bank A could still debit the funds from Person 1’s account. As in the days before the cross-border and cross ocean telegraph, Bank A could put paper money and coins, or gold bars, on horseback, on a stagecoach or on a ship destined for Bank B’s country. Once the physical money or gold was received, Bank B could convert it to the local currency and credit Person 2’s account. Obviously, this is a risky and cumbersome way to move money and one that takes a considerable amount of time. Therefore, to support trade and other activities, other methods were devised including correspondent banking.

In the simplest form of correspondent banking, Bank A has an account and money in Bank B. Therefore, Bank A can remove the funds from Person 1’s account and instruct Bank B to remove the funds from Bank A’s account and credit Person 2’s account. In the old days Bank A might have used regular mail or a telegram to notify Bank B about the transfer. In recent years it might use a system such as SWIFT³ to notify Bank B.

Figure 4



The process can get quite complicated when Person 2 does not have an account in a bank where Bank A has a relationship and an account. For example (Figure 4), if Person 2 has an account in Bank D and Bank A only has an account in Bank B, Bank A must find a path to Bank D. It might know Bank B has a relationship and funds in Bank C and Bank C has an account in Bank B. It might also know Bank C has a relationship with Bank D and Bank D has an account in Bank C. Therefore, Bank A would send a message to Bank B to remove funds from Bank A's account at Bank B and credit Bank C's account. It would also ask Bank C, using funds credited to its account at Bank B, to credit Bank D's account. And finally, it would ask Bank D to credit Person 2's account. The bank-to-bank notification can be done through systems such as SWIFT, SEPA⁴, and Target2⁵.

This process tends to have a significant number of errors (wrong account numbers, etc.) and tends to have significant delays in the recipient receiving the funds. The delays can be caused by time zone differences, working hour differences, errors, etc. Also, except when the most modern systems are used, the sender does not necessarily know the fees or the currency conversion rate each bank will use. Therefore, it can be hard to predict exactly the amount that needs to be sent for the recipient to receive a specific agreed amount.

The process of keeping funds in accounts in various overseas banks is expensive, time consuming and difficult to manage. The funds can have alternate and more profitable uses, e.g., to support loans at market interest rates which are typically higher than the rates banks pay for funds on deposit. Larger banks typically keep funds on deposit with other banks ("correspondents") to support the payment needs of its clients. Smaller banks, with fewer needs for cross-border transfers, are usually less inclined to maintain these expensive relationships and may use the services of a larger bank to make these payments.

Open Questions to Consider (not exhaustive)

Can CBDCs be designed to answer the following questions and reduce the friction in cross-border payments? There are a number of unanswered questions about money and information movement in the digital world, for example:

1. Would separate correspondent banking accounts be required?
2. Can the information about a transaction, e.g., account number, payment details, etc., move with the funds?
3. Is there an appropriately secure method to move funds with ease and ubiquity (similar to ease and ubiquity of email)?
4. Can an electronic form of money be used to move funds directly from Bank A to Bank D?
5. What could a cross-border payment look like in the future?
6. How can the time to receive and settle a cross-border payment be sped up?
7. How can costs (for both the correspondent bank and consumer) be reduced in the future?

8. What are the possible design elements for CBDCs in cross-border payments?
9. What is the impact to existing payment mechanisms?
10. What are the considerations of a CBDC within the context of cross-border payments?
11. How can fintechs and banks prepare for a more digital future including CBDCs?
12. How will regulation shape CBDCs and implications to all stakeholders?

Conclusion

To appropriately analyze the effects of a CBDC on cross-border payments, this Bulletin.02 presents a baseline of information tied to industry standards so we can discuss the impact of new technologies. Future Bulletins will explore the Open Questions presented above, and more, in the context of the model presented here. Bulletin.03 will focus on the research and pilot projects using CBDCs for cross-border payments in countries around the world.

Cross-Border Payments Work Group Bulletin.02

Thank you to the members of the FPC Work Group who contributed to this edition.

CBPWG Leadership

Barry Tooker (Work Group Chair), TransactionBanker.com
James Sellick (Work Group Vice Chair), Ripple Labs
Maria Arminio (FPC WG Facilitator), Avenue B Consulting

Bulletin.02 Subgroup

Todd Koehn, Banker's Bank Madison
Steve Mott, BetterBuyDesign
Varun Abrol, BMO Harris
Mathew Farrell, BMO Harris
Jonathan Holland, Mastercard International
Peter Tapling, PTap Advisory, LLC
Rodman Reef, Reef Karson Consulting, LLC
Mark Dixon, The New England ACH Association
Srinivas Chintakrinda, Volante Technologies Inc.
William DiSenso, Vments, Inc.

Additional CBPWG Members

Mark Keeling, Catalyst Corporate Federal Credit Union
Tanmoy Banerjee, Citibank NA
Joshua Pynn, CMS Payments Intelligence
Karen Shunk, EMVCo
Jeremy Bambace, Form3 US Inc
Jason Brett, Key Bridge Advisors LLC
Kelvin Leung, Mastercard International
Mark Corritori, Mastercard International
Phil Ricci, MetaBank
Sameer Jain, Opus Consulting Solutions Inc. (C Corp)
Michael Cyr, Regions Bank
Jody Wigley, Regions Bank
Greg Melville, Regions Bank
Scott Green, SHAZAM
Sohaam Ghaaria
Bill Thomas, United Nations Federal Credit Union
Sarah Arnio, Walmart, Inc.

About the Cross-Border Payments Work Group

The FPC Cross-Border Payments Work Group covers global industry initiatives, gathering information on various models and use cases for real-time payments across borders with the long-term goal of cross-border interoperability. The Work Group is currently focused on Central Bank Digital Currencies and their effect on cross-border real-time payments.

About the Faster Payments Council

The Faster Payments Council (FPC) is an industry-led membership organization whose vision is a world-class payment system where Americans can safely and securely pay anyone, anywhere, at any time and with near-immediate funds availability. By design, the FPC encourages a diverse range of perspectives and is open to all stakeholders in the U.S. payment system. Guided by principles of fairness, inclusiveness, flexibility, and transparency, the FPC uses collaborative, problem-solving approaches to resolve the issues that are inhibiting broad faster payments adoption in this country.

The contents of this bulletin are for educational purposes only and not intended to be an endorsement by the U.S. Faster Payments Council for Central Bank Digital Currency Solutions.

[1] Note: The purpose of this bulletin is to discuss how a CBDC might be used to facilitate cross-border payments. There are many unanswered questions about CBDCs specifically in cross-border payments and their various attributes and potential advantages and disadvantages. This bulletin does not address such questions, and nothing in this bulletin should be read as a recommendation on the introduction of a CBDC in cross-border payments, the attributes of any CBDC in cross-border payments, interoperability of CBDCs in cross-border payments, or any other matter relating to regulatory policy.

[2] Auer, R., Haene, P. & Holden, H. (2021, March 19). Multi-CBDC arrangements and the future of cross-border payments. BIS. <https://www.bis.org/publ/bppdf/bispap115.htm>

[3] Swift. (n.d.). Retrieved December 14, 2022, from <https://www.swift.com/>

[4] European Central Bank. (n.d.). Single Euro Payments Area (SEPA). Retrieved December 14, 2022, from <https://www.ecb.europa.eu/paym/integration/retail/sepa/html/index.en.html>

[5] European Central Bank. (n.d.). What is TARGET2? Retrieved December 14, 2022, from <https://www.ecb.europa.eu/paym/target/target2/html/index.en.html>

The Faster Payments Council (FPC) Cross-Border Payments Work Group is proud to present the third issue of the Work Group's Bulletin focused on Central Bank Digital Currencies (CBDCs) and their effect on cross-border faster payments.

This series of Bulletins is designed to educate the payments industry on the developments of new payment methods supporting cross-border faster payments and provide an ongoing source of information on their benefits, risks, and other considerations.¹

Bulletin.03 focuses on the ongoing domestic and regional CBDC initiatives and the different implementation approaches being taken and frameworks being considered. The bulletin examines two possible design uses and choices, reviews the different stages and motivation of and for CBDC adoption.

In this edition:

- CBDC Market Landscape
- Wholesale versus Retail Distribution
- Liquidity Management

Central Bank Digital Currency (CBDC)

As described on the Federal Reserve's website, a Central Bank Digital Currency (CBDC) "is generally defined as a digital liability of a central bank that is widely available to the general public. Today in the United States, Federal Reserve notes (i.e., physical currency) are the only type of central bank money available to the general public. Like existing forms of money, a CBDC would enable the general public to make digital payments. As a liability of the Federal Reserve, however, a CBDC would be the safest digital asset available to the general public, with no associated credit or liquidity risk."² This is a broad definition of a CBDC. Some other definitions limit a CBDC to being used for transactions between central banks, between central banks and commercial banks, or between commercial banks.³

CBDCs can currently be implemented in at least three different ways:

- For transactions only between central banks, e.g., for transactions between the U.S. Federal Reserve and the Bank of England or the Bank of Canada. This might be one way to facilitate faster cross-border transactions.
- For transactions between commercial banks and between commercial banks and the central bank, e.g., the Federal Reserve. In the method of implementing CBDCs in this and the previous bullet, retail or consumer accounts would not have access to the CBDC.
- For transactions between all types of accounts, including retail accounts. In this case the CBDC could be used for any transaction which supports a digital currency.

No decision has been made in the U.S. about if, when or how a digital currency will be implemented. In addition, while there have been pilot or demonstration projects around the world showing the viability for using a CBDC for transactions between central banks, there have not yet been successful pilots or demonstration projects proving the viability of using CBDCs for transactions between commercial banks and for using CBDCs for digital transactions in the general economy.^{4 5}

This third edition of the bulletin will focus on some of the ongoing in-country, regional, and cross-border CBDC initiatives and the different implementation approaches being taken, and frameworks being considered. The bulletin examines two possible design uses and choices, reviews the different stages and motivation of and for CBDC adoption.

It is recognized that the exploration of CBDCs is continuing and ongoing. The shape and form of the exploration is far from determined and will likely vary between countries and regions. The research, pilot testing, and initial implementations will continuously unearth and expose different risks as well as the operational and procedural modifications needed for the adoption of this new form of currency.

Note: Recent comments from some policymakers indicate that any new CBDC should be accompanied by industry-level education and awareness of what a CBDC is and how it operates differently from existing payment systems.

Central Bank Digital Currency Market Landscape

Digital assets and more specifically Central Bank Digital Currencies are seeing an acceleration of exploration across many countries and central banks. It is important to distinguish some of the characteristics between privatized currencies (e.g., Bitcoin or Ethereum), distribution methods, public/private key management. Additionally, one of the key challenges of CBDC adoption is interoperability among new CBDC implementations as well as with legacy clearing and settlement systems (e.g., Fedwire and CHAPS). Recently, there has been an attempt by SWIFT to bridge the interoperability gap. In March of 2023 SWIFT announced the successful testing of their solution to enable CBDCs to move between Digital Ledger Technology (“DLT”) -based and fiat-based systems using existing financial infrastructure.⁶

It is interesting to understand the motivations of exploring and eventually deploying a CBDC in the market. It is important to keep in mind how regional differences and technological advancements help drive the design choices that support those differences. In traditional implementations of fiat currency, the central bank delivers value to facilitate commerce and the ability to pay taxes in country. *Fiat money* is a government-issued currency that is *not backed* by a physical commodity, such as gold or silver, but rather by the government that issued it.^{7 8}

Today methods of funds deployment include direct connection to participant banks domiciled within the country to be the custodians of this fiat currency. The central bank maintains a master set of centralized books and records distributing funds to downstream participants. Within a digital asset world and more specifically a CBDC world, given technological advancements (e.g., advanced computing power and telecommunications) funds distribution can take on many different forms (e.g., Central Bank to Central Bank, Central Bank to Commercial Bank, Commercial Bank to Commercial Bank, Central Bank to Consumer, etc.).

Wholesale versus Retail Distribution

An important distinction of CBDCs is their origination point is not only derived from the central bank, but it is also a direct liability. This means that the liability and therefore risk is directly with the central bank. There are of course trade-offs with this approach. While third-party risk is mitigated, know-your-customer (KYC), customer relationships and functions such as lending become more challenging. Related to this is the idea of single (retail) versus multi-tier (wholesale) distribution where differences from traditional fiat mechanisms become more apparent. In a retail model entities or individuals can either host their own “digital private keys” or custody with a third party such as a commercial bank. The former or single tier type distribution allows for greater flexibility by central banks in some use cases such as stimulus or tax payments but hinders others such as lending. In a multi-tier or third-party held key management model the third-party holds custody and potentially the liquidity for these assets, akin to traditional financial operations today.

Liquidity Management

There are several mechanisms that are observed across the CBDC spectrum. In a loose definition one would conceptualize settlement in the traditional fiat world where ledgers are reconciled based on debit/credit entries as a result of customer payment instructions (e.g., SWIFT). In a digital asset world, money movement is synonymous to the payment instruction associated with it. Therefore, in a CBDC world, this movement between participants needs an orchestration of liquidity especially in a multi-tier construct based on a standard set of rules.

There are several methods that are important to note.

- In one of the more straightforward methods in a cross-border use case (as an example) is the central bank hosted FX exchange. This is where the central bank would work in coordination of the host or recipient country to manage and maintain liquidity to handle FX conversion and distribution to end beneficiaries.
- A second model expounds upon the central bank construct but leverages a third-party intermediary to manage this liquidity on behalf of participants. Advantages could be objective key management and technological advancements that the central bank may not be able to maintain.
- The third and newer observed method is an Automated Market Maker or AMMs. These AMMs can operate on a set of rules established by a consortium and can operate across regions and time zones with greater efficiency.

The following table provides a description of some of the recent CBDC projects and their status as of March 2023. This is followed by a more detailed explanation of these individual projects.

Project	Description	Status
Project Sela	The BIS Innovation Hub Hong Kong Centre, the Hong Kong Monetary Authority and the Bank of Israel have joined forces in Project Sela to explore the cyber security and technical feasibility of a two-tier retail CBDC architecture that allows intermediaries to provide CBDC services without any related financial exposure. The goal is to complete the project and publish the findings by mid-2023.	Research
Project Jasper	In 2017, the Bank of Canada launched Project Jasper, which concluded after four phases, and included cross-border testing with the Bank of England and the Monetary Authority of Singapore. The experiment provided significant insights into the relative strengths and weaknesses of using DLT for financial market infrastructures.	Pilot
Project mBridge/ Multiple CBDC Bridge	Project mBridge is a collaboration between the BIS Innovation Hub Hong Kong Centre, the Hong Kong Monetary Authority, the Bank of Thailand, the Digital Currency Institute of the People's Bank of China, and the Central Bank of the United Arab Emirates. After experimenting with different technology architectures in earlier phases of the project, the project team developed a new blockchain – the mBridge Ledger – custom-built by central banks for central banks to serve as a specialized and flexible platform for implementation of multi-currency cross-border payments using CBDCs.	Pilot
Project Aurum	In March 2021, the BIS Innovation Hub in Hong Kong, in partnership with the Hong Kong Monetary Authority released a prototype CBDC which could issue both wholesale and retail tokens. Aurum is a full-stack (front-end and back-end) CBDC system comprising a wholesale interbank system and a retail e-wallet system. The aim was to bring to life two very different types of tokens: intermediated CBDC and stablecoins backed by CBDC in the interbank system.	Pilot
Project Mariana	In November 2022, Banque de France, Monetary Authority of Singapore, and the Swiss National Bank in partnership with the Eurosystem BIS Innovation Hub announced a cross-border automated market maker (AMM) project. This is aimed at exploring using AMMs to facilitate exchanges between Swiss Franc, Euro, and Singapore dollar on the wholesale level.	Pilot
Onyx/Multiple wCBDC	In July 2021, Banque de France announced the successful completion of a cross-border payment experiment with the Monetary Authority of Singapore that used JP Morgan's Onyx unit.	Pilot

Project Sela

Project Sela is an interesting concept based on a two-tier distribution method and looks to leverage third parties for liquidity management. One of the signature design elements of this concept is that liquidity does not sit on the intermediary's balance sheet. The main thesis of this project is that by mitigating the distribution of balance sheet risk and costs the central bank can distribute further through the value chain. The project is also seeking to explore how cyber risk can be mitigated by reducing balance sheet exposure but keeping data opaque eliminating attacks on individual entities on the infrastructure.⁹

Project Jasper

This longstanding project has undergone several phases of exploration. The most recent version of this project sought to explore wholesale distribution of a CBDC to commercial banks for cross-border use cases. This project utilized third parties to facilitate the movement of liquidity and smart contract technology to perform execution functions. The project used two different ledgers (one in each market) to demonstrate interoperability across markets.¹⁰

Project mBridge / Multiple CBDC

Similar to Project Jasper, Project mBridge seeks to test CBDC movement between two distinct markets. The biggest differentiator is mBridge looks to utilize a common ledger platform between two central banks. This design element is seeking to prove that one universal platform will increase efficiency while keeping costs down. This does assume one platform is robust enough to withstand security, throughput strains, uptime, and many other considerations.¹¹

Project Aurum

Project Aurum is a project between the Bank of International Settlements and the Hong Kong Monetary Authority (HKMA). This two-tiered system solves for use cases across the entire economy. The first, a wholesale CBDC, is a token that is distributed at the wholesale or bank level for inter-bank funding payments. The second, a retail CBDC, is a stablecoin that is backed by the wholesale CBDC-token. This system keeps the pure CBDC directly with the banks and uses an alternative currency for retail distribution. This keeps ledger systems separate and therefore enhances security. Legal, operational and policy considerations are also mitigated with such an approach as much of the debate lies with a direct linkage, retail to central bank relationship.¹²

Project Mariana

Liquidity is a constant theme when assessing different CBDC project constructs. Project Mariana seeks to solve the liquidity conundrum through the use of Automated Market Makers or AMMs. This becomes particularly important in a cross-border situation. In this model algorithms and pooled liquidity structures are combined to deliver an automated distribution and pricing (FX) mechanism to participants on the network. Specific objectives of this project were: (i) explore the design and application of AMMs for wholesale CBDCs; (ii) investigate if a supra-regional network could work as an efficient and trusted hub for cross-border settlement; and (iii) research wholesale CBDC governance models within that network.¹³

Project Onyx

Project Onyx combines the power of central bank liquidity with commercial bank like distribution through traditional FIAT mechanisms leveraging Real-Time Gross Settlement (“RTGS”) in a retail setting. The project conceptualized a multi-CBDC that leverages common liquidity pools to atomically swap currencies in a cross-border use case. This keeps both costs and liquidity usage down while keeping transparency and security in mind. The project relies on allocating (aka “staking”) idle balances to the general liquidity pool. Contributors to the general pool are compensated based on usage which generates yield for participants on the network.¹⁴

Conclusion

The global cross-border payments space has been under scrutiny for roughly ten years due to perceived high costs, lack of transparency, operational complexity, and generally slow transaction settlement.

This bulletin examined a few of the ongoing CBDC pilots. These and other ongoing projects are being looked at differently some are wholesale while others are retail, some are domestically focused while others are cross-border. These CBDC pilots can be central bank to central bank, among commercial banks and between the central bank and the commercial banks or available to all players including retail customers.

The ongoing pilots and research projects have already provided some lessons learned:

- There is no universal case for CBDCs because each country/economy is different. So central banks need to tailor plans to their specific circumstances.
- Security and privacy are paramount: Central banks must ensure their digital currency projects are secure and protect user privacy. This includes implementing strong encryption and authentication protocols, as well as ensuring that the system is resilient to cyber-attacks.
- Cooperation in areas like regulation, interoperability and standard setting and more knowledge sharing between banks will be critical for development and adoption.
- The lack of coordination on technology and messaging standards in the initial stages of development could imply that retrofitting CBDC for cross-border use will be costly and complex.

At the same time, these CBDC pilots and research efforts have reinforced traditional payment processing procedures:

- Clearing and settlement - Authorities are researching how central bank digital currencies (CBDCs) could make payment and settlement systems faster and more efficient.
- Contingency – Payments made using a CBDC necessitate the ability to process, clear, and settle continuously 24x7x365 and require back-up systems and stand in processes to keep funds moving in real time.

- Exceptions - The need for the creation of schemes with rules and standards to handle multiple conditions, such as exceptions and returns.
- Interoperability - CBDCs need to interface with not only other CBDCs but with other payment systems, private and public blockchains. The global CBDC ecosystem risks becoming fragmented with numerous central banks developing digital currencies based on different technologies, standards, and protocols. If left unaddressed, this fragmentation could lead to 'digital islands' springing up across the globe.¹⁵
- Liquidity - In a CBDC world, the movement of funds between participants needs an orchestration of liquidity especially in a multi-tier construct based on a standard set of rules.
- Local rules and regulations - Current legislation in some jurisdictions may prevent or restrict the issuance of CBDCs.

These and future pilots and projects may lead to more research and ultimately industry acceptance of some form of CBDCs. CBDCs *have the potential* to enhance the efficiency of cross-border payments¹⁶ and transform traditional correspondent banking practices.

Future editions of these bulletins will be focused on industry initiatives affecting and impacting cross-border payments such as ISO 20022, Immediate Cross-Border Payments (IXB), and Open Banking while continuing to monitor ongoing cross-border CBDC projects and initiatives.

Cross-Border Payments Work Group Bulletin.03

Thank you to the members of the FPC Work Group who contributed to this 3rd edition of the Bulletin series. To view previous editions:

[Cross-Border Payments Work Group Bulletin.01](#)

[Cross-Border Payments Work Group Bulletin.02](#)

CBPWG Leadership

Barry Tooker (Work Group Chair), TransactionBanker.com

James Sellick (Work Group Vice Chair), Ripple Labs

Maria Arminio (FPC WG Facilitator), Avenue B Consulting

Bulletin.03 Subgroup

Todd Koehn, Banker's Bank Madison

Jeremy Bambace, Form3 US Inc

Jonathan Holland, Mastercard International

Rodman Reef, Reef Karson Consulting, LLC

Mark Dixon, The New England ACH Association

Additional CBPWG Members

Steve Mott, BetterBuyDesign

Mark Keeling, Catalyst Corporate Federal Credit Union

Mark Corritori, Mastercard International

Peter Tapling, PTap Advisory, LLC

Greg Melville, Regions Bank

Janice Ong, United Nations Federal Credit Union

Bill Thomas, United Nations Federal Credit Union

About the Cross-Border Payments Work Group

The FPC Cross-Border Payments Work Group covers global industry initiatives, gathering information on various models and use cases for real-time payments across borders with the long-term goal of cross-border interoperability. The Work Group is currently focused on Central Bank Digital Currencies and their effect on cross-border real-time payments.

About the Faster Payments Council

The Faster Payments Council (FPC) is an industry-led membership organization whose vision is a world-class payment system where Americans can safely and securely pay anyone, anywhere, at any time and with near-immediate funds availability. By design, the FPC encourages a diverse range of perspectives and is open to all stakeholders in the U.S. payment system. Guided by principles of fairness, inclusiveness, flexibility, and transparency, the FPC uses collaborative, problem-solving approaches to resolve the issues that are inhibiting broad faster payments adoption in this country.

The contents of this bulletin are for educational purposes only and not intended to be an endorsement by the U.S. Faster Payments Council for Central Bank Digital Currency Solutions.

- [1] Note: The purpose of these bulletins is to discuss how a CBDC might be used to facilitate cross-border payments. There are many unanswered questions about CBDCs specifically in cross-border payments and their various attributes and potential advantages and disadvantages. This series of bulletins does not address such questions, and nothing in this bulletin should be read as a recommendation on the introduction of a CBDC in cross-border payments, the attributes of any CBDC in cross-border payments, interoperability of CBDCs in cross-border payments, or any other matter relating to regulatory policy.
- [2] Board of Governors of the Federal Reserve System. (n.d.). *Central Bank Digital Currency (CBDC)*. Retrieved May 26, 2023, from <https://www.federalreserve.gov/central-bank-digital-currency.htm>.
- [3] BIS. (n.d.). *Central bank digital currencies*. Retrieved May 26, 2023 from <https://www.bis.org/cpmi/publ/d174.htm>.
- [4] Srinivasan, K. (2022, July 7). Opening Remarks at Peer-Learning Series on Digital Money/Technology: Central Bank Digital Currency and the Case of China. *International Monetary Fund*. <https://www.imf.org/en/News/Articles/2022/07/07/sp070722-central-bank-digital-currency-and-the-case-of-china>.
- [5] Wang, S. (2022, April 24). The Beijing Olympics Was the Coming Out Party for China's Digital Yuan. What Comes Next? *Decrypt*. <https://decrypt.co/98315/the-beijing-olympics-was-the-coming-out-party-for-chinas-digital-yuan-what-comes-next>.
- [6] Swift. (2023, March 9). *Successful testing paves way for CBDC use cross-border*. <https://www.swift.com/news-events/news/successful-testing-paves-way-cbdc-use-cross-border>.
- [7] Note: This of course is different than representative money that is backed by a commodity, the currency itself has little value of its own thus backed by a universally recognized asset.
- [8] Chen, J. (2023, March 28). Fiat Money: What It Is, How It Works, Example, Pros & Cons. *Investopedia*. <https://www.investopedia.com/terms/f/fiatmoney.asp>.
- [9] BIS. (n.d.). *Project Sela to test a cyber-secure retail CBDC architecture that reduces the financial exposure of intermediaries*. Retrieved May 26, 2023, from <https://www.bis.org/about/bisih/topics/cbdc/sela.htm>.
- [10] Bank of Canada, Monetary Authority of Singapore, Accenture, and JPMorgan. (2019). *Enabling Cross-Border Payments High Value Transfer Using Distributed Ledger Technologies*. <https://www.mas.gov.sg/-/media/Jasper-Ubin-Design-Paper.pdf?la=en&hash=EF5857437C4857373A9287CD86F56D0E7C46E7FF>.
- [11] BIS. (n.d.). *Project mBridge: Connecting economies through CBDC*. Retrieved May 26, 2023, from https://www.bis.org/about/bisih/topics/cbdc/mcbdc_bridge.htm.
- [12] BIS. (2022, October). *Project Aurum: A Prototype for Two-tier Central Bank Digital Currency*. <https://www.bis.org/publ/othp57.pdf>.
- [13] BIS. (2023, April 11). *Project Mariana: CBDCs in automated market-makers*. <https://www.bis.org/about/bisih/topics/cbdc/mariana.htm>.
- [14] Banque de France, Monetary Authority of Singapore, and JPMorgan Chase & Co. (2021, November 12). *Liquidity Management in a Multi-Currency Corridor Network*. <https://www.mas.gov.sg/-/media/mas-media-library/development/fintech/onyx-bdfmas-liquidity-management-in-a-multicurrency-corridor-networkv.pdf>.
- [15] Swift. (2022, November 24). *CBDCs interoperability: 5 key takeaways from our ground-breaking experiments*. <https://www.swift.com/news-events/news/cbdc-interoperability-5-key-takeaways-our-ground-breaking-experiments>.
- [16] BIS. (2021, July). *Central bank digital currencies for cross-border payments*. <https://www.bis.org/publ/othp38.pdf>.