Goldman Sachs | Project mBridge

1. Executive Summary

Digital securities which are issued, transacted and settled on a blockchain via the use of smart contracts enable streamlining of operational processes, shortened settlement times and greater visibility across participants. With the advent of Central Bank Digital Currencies (CBDCs), there is a need to investigate their role in the settlement process and take learnings to adequately adapt, or develop infrastructures to prepare for CBDC adoption.

The mBridge Platform (mBridge) explores the creation of an international settlement platform utilizing CBDCs, with a key foundation of the platform being its Payment vs. Payment (PvP) capability.

The use case outlined in this research paper evaluates the potential to leverage mBridge and a blockchain-based digital assets platform for an atomic cross-border tokenized security settlement, using a Delivery vs. Payment (DvP) settlement. It addresses the potential challenges[1], as well as anticipated benefits, including: enhanced product functionality such as fractionalization providing greater market access and increased liquidity; automation of asset servicing; risk reduction; and cost savings.

2. Introduction

Primary issuance and cross-border settlement of a digitally-issued tokenized corporate bond denominated in HKD, settled in THB, leveraging mBridge for Foreign Exchange (FX) and settlement.

Goldman Sachs proposes to leverage mBridge's integrated FX functionality to provide atomic cross-border settlement[2] for the primary issuance and settlement of a tokenized corporate bond. As mBridge currently only supports tokenized money, in this instance CBDCs, Goldman Sachs will develop a blockchain-based digital assets platform (hereafter referred to as "a blockchain-based digital assets platform") to natively issue a security and represent it on a decentralized securities ledger. While OTC secondary trading has not been included in the research, the proposed infrastructure and workflow could equally satisfy this portion of the asset lifecycle.

2.1 Traditional Primary Bond Issuance and Settlement Flow

Due to a lack of process automation and lengthy upstream processes, the typical settlement cycle of a primary-issued syndicated bond is up to T+4.

2.1.1 Transfer of funds, securities and settlement

Once investors are informed of their allocation, a ticket is booked and a trade confirmation sent. The new securities are created at the central securities depository (CSD) upon receipt of the instruction from the issuer that there is a commitment to pay. Next, a sequential chain of events follows which leads to a transfer of funds vs. securities on the settlement date. A transaction is considered settled once the CSD has credited the account of the buyer with the purchased securities (and debited the corresponding cash amount), while debiting the account of the seller with the securities (and crediting its account with the corresponding cash amount). This is a DvP settlement. Clearing systems effectively manage counterparty credit risk between trade execution and settlement, with CSDs involved at the final layer when ownership of the securities is transferred and recorded. Overall, the current process has scope for efficiency gains through redesign, streamlining and automation, in addition to eliminating some intermediaries and functions.

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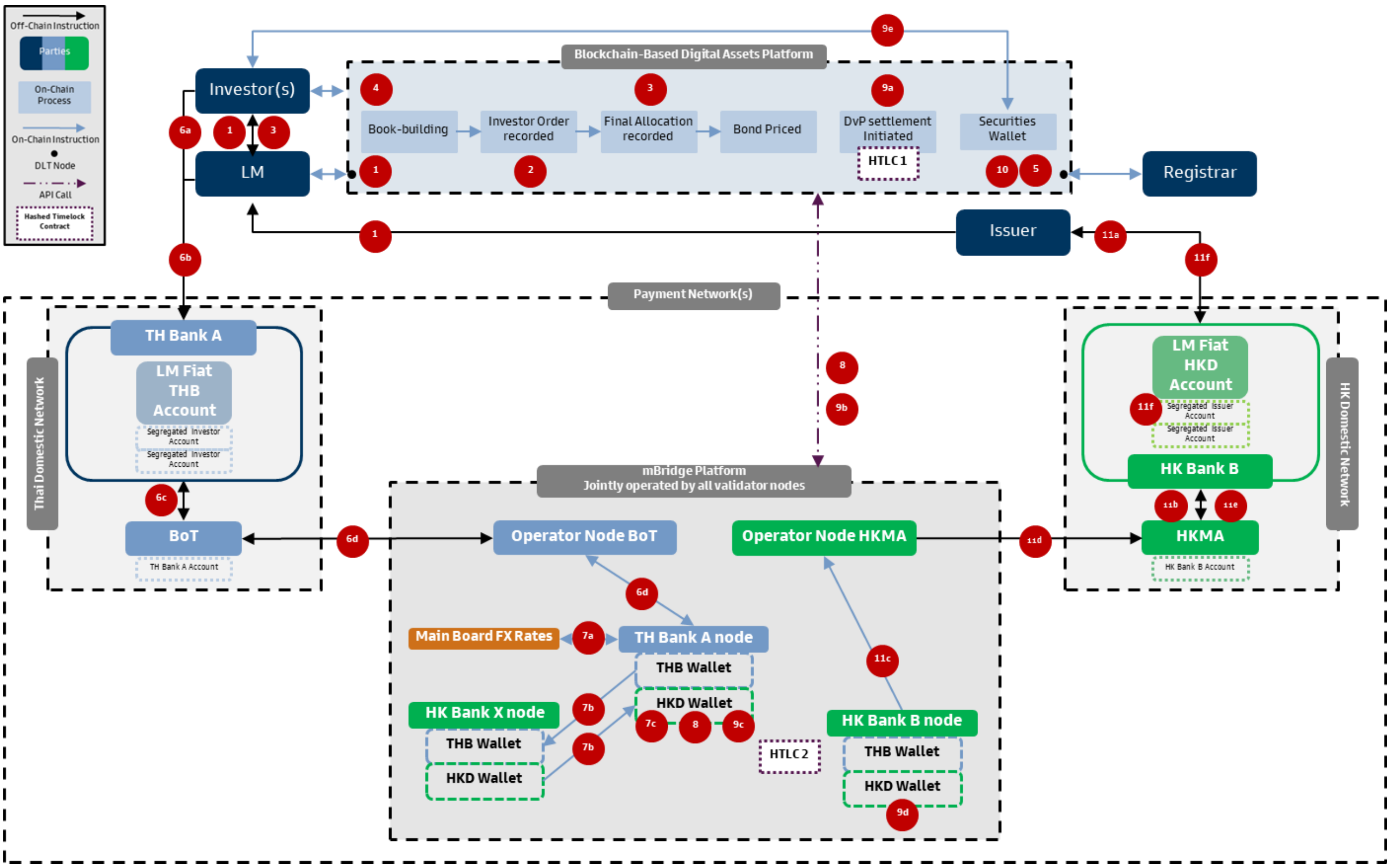
[1] *This research does not, at this point, detail legal, policy or external governance considerations required to execute this as a live transaction.*

[2] *Atomic Settlements means the simultaneous exchange of assets, and can be considered XvX as is asset & payment agnostic. Importantly, settlement cycles and settlement mechanisms should be dissociated from each other, atomic settlements are referring to a settlement mechanism, which does not automatically influence the settlement cycle. The contractual settlement date for an atomic settlement, can be determined to be any length, as guided by the conditionality of the atomic settlement. There is no standard settlement cycle for atomic settlements only settlement criteria, importantly, while atomic settlements can streamline a portion of the trading and settlement lifecycle they do not automatically result in a T+0 world.*

3. Proposed Cross-Border Primary Issuance and Settlement Flow[3]

The proposed atomic flow will leverage mBridge for cash tokenization and settlement, with a blockchain-based digital assets platform processing the security issuance, security token movement and ownership.



1.	Lead Manager (LM) initiates the book-building process and Investor(s) send orders to LM
2.	Book-Building process and capturing Investor orders occurs via a blockchain-based digital assets platform (with integrations to off-chain book-building platforms). As part of this process the LM must agree FX levels at which the Investor(s) is comfortable executing the transaction at *[assumed FX levels agreed by Investor for this scenario is HKD/THB = 4.13886 – 4.30428]*
3.	LM confirms final allocations back to the Investor (off-chain)
4.	Investors are also able to view the final allocation on-chain
5.	The Registrar (on-chain) records the deal details
6.	[Pre-Funding Process] Conversion of THB Fiat to equivalent HKD CBDC (pre-requisite for DvP Settlement to occur[4]) a. The Investor makes the fiat payment to LM's account (which is held at the local agent bank (TH Bank A)) using traditional payment rails. The amount is equivalent to that of the least favourable FX rate as agreed by the Investor. This may differ from the final FX rate obtained, if there is a delta, the delta will be released to the Investor post FX rate being selected and PvP initiated (7.b). The amount transferred in this scenario is THB 43m b. LM instructs the agent bank (TH Bank A) to pay HKD 10m (equivalent to THB 43m) to HK Bank B (conditional that an FX rate can be found within the FX levels agreed with the Investor and towards DvP settlement of securities) c. TH Bank A requests BoT to set aside THB 43m (equivalent to the least favourable FX rate as agreed by the Investor) in TH Bank A's Clearing Account with BoT d. BoT instructs Operator Node BoT to issue (mint) THB 43m worth of CBDC to TH Bank A node within the mBridge Network
7.	[Atomic FX PvP]

[3] *Assumptions: (i) single lead manager (LM) (ii) corporate bond issuance, denominated in HKD worth $10m HKD (iii) primary issuance only, asset servicing or secondary markets not considered as part of use case scope (iv) segregated client/investor accounts are able to be held as cash accounts & token wallets (v) The blockchain-based digital asset platform & mBridge Platforms are Private/Permissioned networks, Thai & Hong Kong domestic networks are traditional payment networks, therefore the workflow depicted illustrates an off & on-chain scenario.*
[4] *Once parties (investors) hold digital money (in this scenario CBDC) on a BAU basis there may not be a need for pre-funding conversion or FX PvP (therefore steps 6 & 7 may not be required for subsequent transactions).*

a. Best board rate is queried and accepted if within levels as agreed between LM and Investor, HK Bank X (one of the FX provider) is returned as having the best rate and hence selected as FX provider for this transaction.
b. PvP transaction is initiated between HK Bank X and TH Bank A nodes
c. At this point TH Bank A node receives HKD 10m CBDC in its HKD wallet and updates the investor's HKD CBDC position in its register (off/on chain)

8. [Fiat/CBDC Conversion Validation via API] *[API between TH Bank A node & a blockchain-based digital assets platform]* The blockchain-based digital assets platform issues a query to check the investor's HKD wallet balance held with TH Bank A node. If the result satisfies that the fiat conversion has occurred and the investor's HKD wallet with TH Bank A has sufficient HKD CBDC then the Hashed Timelock Contract (HTLC) DvP Settlement will be initiated (Step 9)

9. [HTLC DvP Settlement] Once the API has validated that there is sufficient CBDC within the Investor's HKD wallet the HTLCs will initiate, the Registrar initiates the HTLC based DVP settlement and in that process the security and cash tokens are atomically swapped.
a. The Registrar, via a blockchain-based digital asset platform locks (via HTLC 1) 10mil notional Bonds in the Issuer's security wallet using a secret known only to itself
b. The Registrar communicates the hash of the secret and the settlement details to a TH Bank A node using an API (offline channel)
c. TH Bank A node locks (via HTLC 2) HKD 10m CBDC using the communicated secret hash and sends and acknowledges back to the Registrar
d. The Registrar verifies the locked cash asset and unlocks the cash into HK Bank B node HKD wallet using the known secret and in the process auto publishes the secret
e. TH Bank A node uses the secret that is revealed by the Registrar to unlock security tokens into the Investor's security wallet on a blockchain-based digital asset platform

10. The DvP settlement is now complete – The Registrar records the deal closing. Post DvP settlement the Issuer has HKD 10m CBDC in it HK Bank B node HKD wallet and Investor has 10m notional Bonds in its Security wallet (held within a blockchain-based digital asset platform ledger)

11. [Issuer HKD CBDC – HKD Fiat Redemption process] *[This stage of the process need not happen immediately after the DvP settlement; the Issuer can choose to redeem at their leisure]*
a. Issuer sends redemption request to HK Bank B (off-chain)
b. HK Bank B sends redemption request to HKMA
c. HK Bank B Node releases HKD 10m CBDC to Operator Node HKMA
d. HKMA Operator Node sends an instruction to HKMA to release HKD 10m Fiat to HK Bank B clearing account
e. HKMA releases HKD 10m to HK Bank B using traditional payment rails
f. HK Bank B updates the cash position to Issuer's account

4. Potential Challenges/Considerations

4.1 Foreign Exchange

mBridge offers three modes of FX execution[5] (i) Board Rate (ii) Request for Quote (RFQ) (iii) Off-Corridor Arrangements. In the primary issuance scenario detailed above there would be an expectation that FX levels can be conditions within the smart contract(s) and a transaction only executes if a Board Rate is obtained within the stated FX levels. The requirement to find a rate within the set levels is related to the freezing of the Investor's pre-funding payment within the Investor/Lead Manager's fiat account at an equivalent value to that of the least favourable FX rate as agreed by the Investor, this ensures that there are sufficient cash tokens available to execute the transaction when the Board Rate[6] is queried. Should there not be a rate within the specified levels the transaction will be rejected, the cash tokens will be unfrozen for the Investor's usage and the Lead Manager will be informed that the transaction has not been initiated (off-chain the Lead Manager will have the ability to renegotiate with the Investor as to their agreed FX levels). This FX rate requirement therefore reduces market risk for the Lead Manager.

Market makers publishing rates within the mBridge network will need to ensure they are triangulating the currency pairs with a standard pairing to reduce forex arbitrage risk. In addition, it is assumed that mBridge is a recipient of market maker rates versus being a publisher, hence rates will be published simultaneously on and off chain.

Due consideration should be given to the possible 24/7 market that blockchain permits and how to ensure price integrity across all transactions in such a state. Resultantly, there should be deliberation from both the platform operators and the banking participants on their ability to post FX rates and respond to RFQs 24/7 (vs traditional

[5] (i) Main Board Rate = Execute FX transactions by matching with the best rate available on the Board (ii) RFQ = Allow direct FX quotations through RFQ function and execution of FX transactions on agreed rate from quotes (iii) Off-Corridor arrangement = Settle FX transactions with are agreed bilaterally outside the corridor network. Source: https://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/Report_on_Project_Inthanon-LionRock.pdf
[6] Assumption: Main Board Rate aggregation and operations is hosted and managed by the Operator Nodes.

market hours), if it is not possible to secure alternate out of hours' liquidity provision then there should be attention to market cut-offs as there is in current practice, however this then restricts market access.

4.2 Liquidity

Whilst most primary bond issuances are pre-funded there is, in some markets, the ability to pre-fund with a combination of cash and margin, via mBridge there doesn't appear to be existing capabilities to pre-fund a portion of the allocation from margin. Resultantly, Investors may need to pre-fund with cash only which will have cost implications to participants. While pre-funding is standard practice, Investors currently have a period of time between allocation confirmation and settlement date to ensure they have related capital, hence the Lead Manager takes the settlement risk between these dates. In the proposed scenario it will either need to be made clear to Investors during the book-building process that capital is required at the time of order submission or a clear future trade date needs to be set for when the PvP & DvP settlements will happen, allowing Investors time to fund the deal (as with traditional markets) while still facilitating an atomic settlement, with atomic settlements providing precision on "freezing"[7] thus reducing the risks associated to long-dated pre-funding, therefore permitting the latter scenario in order to remain in line with current market practice while benefitting from streamlined settlement.

4.3 Interoperability

The assumption of this use case is that the interaction between the Lead Manager and Agent Bank is able to be conducted via either API or SWIFT message (assuming that the domestic networks are traditional payment rails). In the scenario researched, the payment and securities networks are operating on different networks, as such the depicted workflow doesn't assume implementation of any specific blockchain, thus the underlying blockchain infrastructure is assumed to be interchangeable without impact to the operational workflow.

4.4 Account & Wallet Segregation

This research is based on the assumption that there will be the ability for the Agent Banks (Participating Banks) to hold segregated client accounts or if omnibus accounts there need be a clear indication as to the client positions so the wallets can be queried via API.

4.5 Shared System & Operator Node Management

A single Bridge system could create operational governance challenges, including the maintenance of the "Operator Node(s)". Thought should be given to whether there will be an "Operator Node" per currency pairing, an "Operator Node" per participating central banks, or an overarching "Operator Node" co-managed by all participating central banks. The two former options pose potential challenges in the form of homogeny across the nodes governance and maintenance, with the latter posing potential consensus challenges. Irrespective of the Operator Node model, the instruction from the Lead Manager to the Agent Bank (in the scenario depicted above this role is played by TH Bank A) should include the Corresponding Agent Bank information (in the scenario depicted above this role is played by HK Bank B) so the appropriate Operator Node is selected.

4.6 New Risks

While not directly considered in this research paper, it should be noted that the emergence of new technology and processes introduces different risks, such as cyber risks, technology malfunctions (via human error or otherwise), security, fraud, data protection, network stability etc. The operational and technology implications of such risks must therefore be considered when reviewing the use case's commercial viability. Additionally, while not directly considered as part of this paper, legal implications resultant from regulatory regimes relating to: transfer of ownership; clearing and settlement; custody; books and records keeping, particularly in relation to cross-border transactions will need to be considered to assess jurisdictional legal requirements.

[7] https://www.bis.org/publ/qtrpdf/r_qt2003h.pdf

5. Potential Benefits[8]

Based on the aforementioned research use case the following benefits could be expected if the use case were to be realized:

5.1 Cost Savings & Operational Efficiencies

Aside from reduced settlement cycles, there is potentially greater efficiency via automation across the entire lifecycle of the product, including upstream processes such as book-building and allocation management. Creating an immutable, single source of truth provides the ability to certify, trace and view transactions in real-time, thereby reducing the need for intermediaries, which in turn may reduce risks and overheads.

It has been estimated that in a tokenized scenario issuance, servicing and ongoing custody costs will reduce by 35-65%[9] across the lifecycle vs a traditional issuance (highlighted in 2.1). Additionally, the blockchain and smart-contract elements of this use case allow for real-time audit and compliance monitoring of transactions, which potentially allows for a more robust governance structure and trading activity summary.

5.2 Liquidity & Market Access

The ability to tokenize securities facilitates increased structuring capabilities such as fractionalization[10]. With the capability to reduce the denomination of the asset comes increased market access and democratisation of markets. Increased market access will also result in increased market liquidity; particularly once secondary markets are connected.

5.3 Risk Reduction

The PvP system could bring a reduction of cross-currency settlement risk, however consideration should be given (as noted in 4.1) to the operational hours of the platform, with the potential scope increase of the platform to additional currencies the overlapping market hours will reduce. Therefore, in order to ensure this doesn't introduce limitations, operational hours and cut-offs should be adequately considered to ensure platform and FX integrity.

In addition to settlement risk, due to the ability to transact with finality, risks across the trade lifecycle are reduced, notably counterparty and operational risks. With the conditionality of smart contracts, counterparty risk could be minimised, in an atomic settlement scenario as there wouldn't be the case where one side fails leaving the other side at a disadvantage, additionally due to a reduction of failed transactions Broker/Dealers could reduce the typical buffers held from a capital and liquidity perspective associated with failed transactions.

6. Future Research/Considerations

6.1 Secondary Trading[11]

While not directly researched as part of this use case, secondary market access could be made available through a blockchain-based digital asset platform via connectivity to a Bulletin Board (which will operate as with existing OTC inter-dealer systems streaming prices and volumes). Broker/Dealers will have access to an on-chain Bulletin Board where indicative prices are published and available to trade, once a trade has been agreed between a buyer/seller, the matched trade instructions will be broadcast and the on-chain DvP settlement initiated in a similar manner to that of settlement of primary issuance/settlement. Should there be a cross-currency transaction mBridge could be used for the FX and cross-border settlement.

6.2 Asset Servicing

Asset servicing is another segment of the lifecycle that benefits from automation and the on-chain nature of mBridge. To leverage CBDC as the cash leg the following would be a proposed model for asset servicing: (i) Coupon payments made wholly via a CBDC, (ii) in this scenario the smart contract on a blockchain-based digital asset platform would periodically send instructions to mint CBDC (via the relevant Agents Banks and Operator Nodes) and deposit it into the Agent Bank's Clearing Account on behalf of the Issuer (iii) with this then being transferred to the Investor/Bondholder's wallet (the Investor/Bondholder then has the option to redeem the cash token as fiat).

[8] *It should be noted that full realization of such benefits is subject to regulatory policy*
[9] *Cashlink & Finoa (2020) Cost Disruption in the Issuance Market https://cashlink.de/cost-disruption/*
[10] *Subject to relevant securities offering regulations*
[11] *A full assessment (including legal, regulatory, operational) of the validity of secondary trading would be required if commercialization is considered*

Additionally, consideration should be given to the FX rate for ongoing coupon payments, whether this is fixed at the initial product purchase price or based on the asset servicing date, if the former, additional products (forward(s)) would need to be purchased at trade date.

6.3 Market Infrastructure Interoperability

For full end-to-end lifecycle management and international connectivity, thought should be given to interoperability with existing market infrastructures such as CMU, iCSDs, Bond Connect, Local RTGS systems etc. as well as existing cross-currency settlement systems such as CLS and regionally focused infrastructures including GCC-RTGS.

6.4 Complex investment cases

Scenarios such as the instance where there are multiple investors all looking to purchase the product in their differing domestic currencies were not considered for this use case for simplicity purposes. However, these scenarios are possible via the same flow depicted in 3.1, the difference being that the Lead Manager would be sending separate instructions to each of the corresponding domestic agent banks for each Investor, all instructions would be conducted simultaneously to ensure overall transaction execution and settlement.

6.5 Regulation

The regulatory regime governing digital issuances is currently evolving, as such, new regulations and policies are likely to rapidly evolve, with new or updated laws and regulations or interpretations of existing laws and regulations potentially materially affecting the qualification and/or transfer and/or viability of issuances in the future. In relation to the use of DLT there are currently few jurisdictions that authorise the registration and transfer of unlisted securities using blockchain-based platforms and recognise it as a legally binding medium of settlement, thus if future research is pursued jurisdictional limitations should also be detailed. Legal implications of securities offerings regulations, cross-border/cross-currency settlements, anti-money laundering & counter-financing of terrorism management and considerations of legality of settlement finality were not considered for this research paper, however would be required should the use case be further developed.

7. Conclusion

This research paper has documented the potential for commercial banks, investment banks, investors (hedge fund, corporate, institutional and real-money client base) and issuers to leverage mBridge for cross-border cross-currency digitally-issued tokenized bond primary issuance and settlement.

- As mBridge is primarily intended for settling cross-border payments and handling tokenized money there is a requirement for the securities leg to be conducted and recorded on a separate platform as depicted in the use case via a blockchain-based digital asset platform and consortium blockchain networks, which have appropriate capabilities across this space.
- The paper highlights considerations relating to account and wallet set-up within the mBridge network, single system management, FX integrity, interoperability and 24/7 operations that should all be researched further prior to considering progression of the use case.
- Possible benefits to be derived are clearly noted and include the forecast of significant operational efficiencies, costs savings and overall risk reductions all aiding the development of sustainable and scalable cross-border market infrastructure.

Further research is required should this use case be commercialised, notably into the secondary markets and asset servicing portions of the trade lifecycle so to ensure there is full E2E automation and thus maximum efficiencies are realized.

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