PROJECT KHOKHA 2

Exploring the implications of tokenisation in financial markets

IFWG

INTERGOVERNMENTAL FINTECH WORKING GROUP

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FOREWORD

The South African Reserve Bank celebrated its 100-year anniversary during 2021 as the technical proof-of-concept (PoC) work for the second phase of Project Khokha (PK2) was being conducted. Experimentation surrounding wholesale central bank money has increased significantly since Project Khokha was launched in 2018. In addition, industry innovation surrounding the tokenisation of securities and privately issued 'money' – for instance, in decentralised finance and stablecoins – have become increasingly topical issues.

PK2 builds on the first iteration of the project which trialled the issuance of a wholesale central bank digital currency, exploring how such tokenised central bank money interacts within a tokenised market to highlight some of the policy and regulatory implications. Tokenisation holds the promise of bringing efficiencies and innovation to financial markets, in part through the ability of distributed ledger technology, to help restructure financial markets by reshaping the infrastructure upon which it is based. The implications must be carefully considered, not least surrounding how such innovation may impact on financial stability and resilience, the impact of new digital governance models and increased cybersecurity risk.

The project was launched in collaboration with the Intergovernmental Fintech Working Group, and a PoC with industry has helped to develop a deep appreciation of the practical considerations in experimenting with innovative projects of this nature. Teamwork remains key to the success of Project Khokha, and appreciation is extended to the industry participants, project partners and everyone who participated and added valuable contribution to the project.

Rashad Cassim
Deputy Governor

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EXECUTIVE SUMMARY

The first phase of *Project Khokha* was launched in 2018, published as *Project Khokha: Exploring the use of distributed ledger technology for interbank payments settlement in South Africa* – now referred to as PK1 (SARB, 2018). The project explored the implications of distributed ledger technology (DLT)-driven innovation in financial markets. More specifically, PK1 explored the use of DLT for interbank settlements by successfully replicating some functions of the South African real-time gross settlement (RTGS) system on DLT, focusing on performance, scalability and privacy. The results of PK1 set the foundation for further exploration of the implications of DLT in other use cases.

Digital financial innovation has, however, progressed since the finalisation of PK1, and developments related to tokenisation of money and securities by the public and private sector have underscored the need for further exploration.

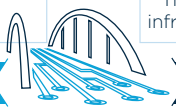
The second phase of Project Khokha (PK2) sought to unpack the use of DLT and tokenisation in the financial markets through a different use case, that is, the issuance of a South African Reserve Bank (SARB) debenture on DLT. Innovative technologies such as DLT allow securities to be issued in tokenised form (i.e. as a digital representation value recorded on a single shared ledger, reducing inefficiencies stemming from the current market design built around several centralised infrastructures). To create a token market, two DLT platforms were created – one on which tokenised assets such as the debenture token and commercial settlement token could be issued and traded, and the other focused on tokenised central bank money or settlement token (refer to Figure 1 for a conceptual design). Having both the security and settlement tokens available on an interoperable token market prompted further questions surrounding on-DLT settlement of both the securities and payments leg of a trade. The commercial bank settlement token option could also generally be referred to as a wholesale digital settlement token (wToken), while the central bank token is referred to as a wholesale central bank digital currency (wCBDC). The wCBDC was the chosen payment option in the primary market, while the wToken was selected for use in the secondary market.

PK2 took place as a proof-of-concept (PoC) to test the parameters of the technology and develop a clearer understanding of the policy, legal and regulatory arrangements that would need to be in place to support the PoC use case. As an experimental project, PK2 does not reflect any specific policy stance. Rather, PK2 explores what the future of trading, clearing and settlement may look like in a possible future tokenised world. Such explorations are crucial, given the growth of technological innovation in the financial ecosystem and the use of new forms of payment instruments facilitated by the rapid rate of technological expansion.

PK2 was a collaborative initiative with numerous stakeholders, including members of the Intergovernmental Fintech Working Group (IFWG) and the industry. The project was driven by the SARB's Fintech Unit and the other core team members included Accenture and Block Markets Africa as technical service providers, with Deloitte as the support partner. Active participants included Absa, FirstRand, Nedbank, Standard Bank and JSE Limited (JSE). The insights from the various role players contributed to technical and design components of PK2, and ultimately allowed for a deeper understanding of the potential implications of digitalisation in the financial markets.

PK2 demonstrated that building a platform for a tokenised security would impact the incumbents in the financial markets ecosystem, particularly that the number of intermediaries could be reduced and some of the functions performed by existing infrastructures could be collapsed onto a single platform, which could lead to reduced costs and reduced complexity. However, there are several legal, policy and regulatory implications which may arise from a possible financial market structure, which include a platform, built on DLT, that allows for tokenised securities to be issued on it. To the extent that a new infrastructure or platform performs similar roles and related functions to regulated entities, such new offering could be covered under existing legislative and regulatory frameworks. The challenge remains where current legislation does not cater for emerging innovation in its current market structure. The learnings from PK2 provide a solid foundation to explore the design of the relevant regulatory frameworks in order to be agile and adaptive on the one hand; and on the other hand, putting in place the necessary components of a framework that supports public policy objectives, enhances the safety and efficiency of the financial system and advances investor protection outcomes.

Figure 1: Conceptual design of the Project Khokha 2 proof-of-concept

	DLT network	wCBDC Zone	Khokha Hub			
Technology		R3 Corda	BitFair (A Cosmos implementation)			
Description		The overall network managing wholesale central bank money (wCBDC) on DLT, including the (i) Admin Console; (ii) Engine; and (iii) DLT network.	The Khokha Hub DLT network enabled the issuance of, and trade in, debenture tokens. The final design meant that it fulfilled the role of a trading platform, (de)centralised securities depository, securities settlement system and elements of a payment system. The Khokha Hub served as a token trading platform (TTP) enabling interoperability with other DLT platforms such as the wCBDC Zone through a software bridge.			
Ownership, Governance and Operator		SARB (central)	Envisioned to be a consortium* of market participants (decentralised) in the POC, with the Khokha Council serving as the governance structure. Any market participant may propose business logic (modules) which the Council votes on to determine whether it is implemented on the platform. * Theoretically, any of the market participants could establish such a DLT-based market infrastructure under a more centralised structure.			
		Software bridge				
Component		wCBDC DLT network	Debenture token module network	Khokha Token module	Debenture maturity engine (module)	Decentralised exchange module
Prototype brief		wCBDC	Debentures on DLT	Wholesale digital settlement token (wToken)	Debentures on DLT	Debentures on DLT
Tokens		wCBDC	Debenture token (a security token)	Khokha Token		Fractionalised Debt at Maturity (FDM) Token
Component/ module development and oversight		SARB	The SARB's Financial Markets Department (FMD)	Consortium of central banks	FMD	Secondary market participant (could be anyone)
Access		Settlement banks	Debenture buyers (commercial banks)	Debenture buyers (commercial banks)	Debenture buyers (commercial banks)	Debenture buyers (commercial banks)
Description		wCBDC tokens are used to purchase debenture tokens in the primary market	Debenture tokens are issued in the primary market	Khokha Tokens are used to purchase debentures in the secondary market. The Khokha Token is a commercial bank settlement asset/ token	Discharges debenture maturity obligations	Enabling trade in the secondary market


“Ultimately, the use of central bank money in securities transactions could enhance the safety and efficiency of the primary and secondary markets and extend the use of central bank money to new use cases in a tokenised world.”

BACKGROUND

Project Khokha 1 and subsequent developments

Overview

PK1 explored the use of DLT for wholesale interbank settlements. The project successfully proved that elements of South Africa's RTGS system – that is, the South African Multiple Option Settlement (SAMOS) system – could be duplicated at scale and speed using a standard messaging format, while maintaining privacy and confidentiality and providing the SARB sufficient visibility for oversight and operational management. The project considered three of the Principles for Financial Market Infrastructures (PFMI) published by the Bank for International Settlements (BIS) Committee on Payments and Market Infrastructures (CPMI) and International Organization of Securities Commissions (IOSCO), namely: settlement finality, money settlement and operational risk. The technical achievements of PK1 further helped establish a foundation of learning from which to explore the impact of DLT, particularly use cases such as the tokenisation of multiple assets for securities settlement and cross-border payments, in collaboration with relevant industry participants.

Subsequent developments: central banks and tokenisation

Exploration surrounding the issuance of both public and other forms of non-bank privately issued 'money'[1] has shifted greatly since the SARB published the PK1 report in 2018. For example, the results of a 2021 BIS central bank digital currency (CBDC) survey indicated that 86% of central banks were actively researching the potential of issuing a CBDC, while 60% were experimenting with CBDC (Boar and Wehrli, 2021). Deployment of actual CBDC pilot projects lagged slightly, with only 14% of responding central banks indicating that they were piloting CBDC. Respondent feedback indicated a 50% higher interest in retail CBDC (rCBDC) as compared to wCBDC, with the latter being more focused on areas such as cross-border payments and securities trading and settlement.

Box 1: Positioning wCBDC

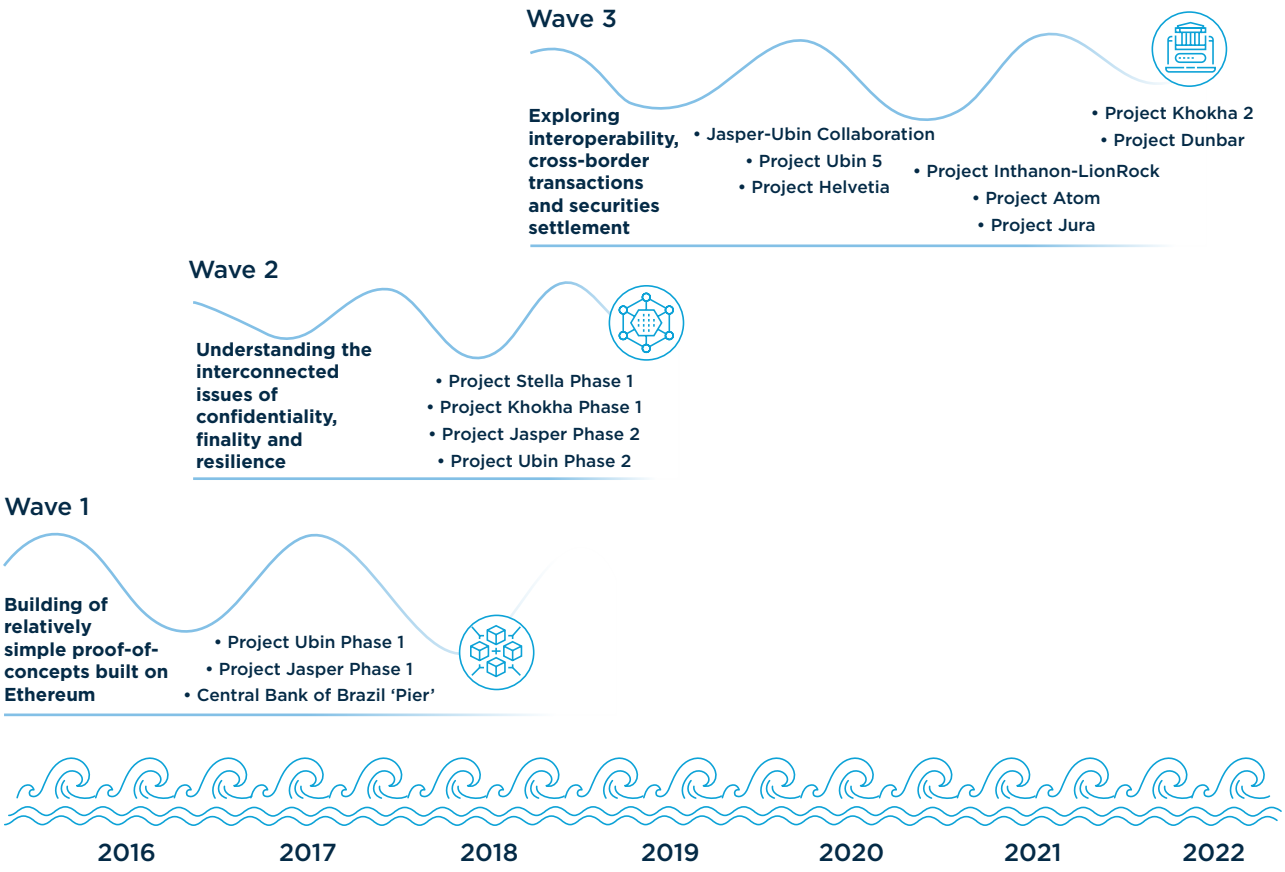
Wholesale central bank digital currency is digital money issued by the central bank (and is a liability of a central bank), which is restricted in use to specific financial institutions and can either be a token or account based (CPMI and MC, 2018). Account-based wCBDC currently exists in the form of reserve and settlement accounts with a central bank – exploration of wCBDC is therefore focused on whether there is a business case to issue token-based wCBDC into production. To this end, the term wCBDC in this report exclusively refers to token-based wCBDC.

Central bank money is also referred to as public money since it is typically issued on behalf of government as a public good. Central banks also issue money that is available to the general public (i.e. for retail use), which may take either physical form (i.e. notes and coin) or a digital form (i.e. rCBDC). rCBDC can be viewed as analogous to notes and coin used by the general populace, whereas wCBDC is used for settling wholesale transactions between settlement banks.

1 In the South African context, money is defined in the National Payment System Act 78 of 1998 as "a banknote or coin issued by the [South African] Reserve Bank in terms of section 10 (1)(a)(iii), read with section 14 of the South African Reserve Bank Act 90 of 1989, as amended". The reference here, particularly to private 'money', is therefore money in the broadest sense of the term and denotes non-central bank issued instruments that aim to function as payment instruments.

Several central banks have been exploring how a wCBDC can play a role as a safe settlement asset and potentially be used to optimise cross-border settlements between financial institutions as a key component of international transactions. Ultimately, the use of central bank money in securities transactions could enhance the safety and efficiency of the primary and secondary markets and extend the use of central bank money to new use cases in a tokenised world. Figure 2 below depicts some of these projects within the three waves of wCBDC exploration identified in PK1.

Figure 2: The waves of wCBDC exploration



Box 2: Notable related wCBDC projects

Some of the notable explorations from other central banks in the areas of wCBDC include the release of the 'Cross-border interbank payments and settlement' report by the Bank of Canada (BoC), Bank of England and Monetary Authority of Singapore (MAS) during November 2018 (KPMG, 2018), which examined existing challenges in cross-border payments within the context of existing initiatives at the time. This was followed by the BoC and MAS connecting the prototypes from Projects Jasper and Ubin – their respective wCBDC initiatives – to test atomic settlement of transactions utilising hashed time-locked contracts (BoC and MAS, 2019). The Bank of Thailand (BoT) and Hong Kong Monetary Authority (HKMA) also explored real-time payment-versus-payment (PvP) on DLT in Project Inthanon-Lionrock by considering how DLT could increase efficiency and address challenges through collapsing settlement layers by bundling together elements such as foreign exchange transactions using smart contracts (BoT and HKMA, 2020).

The MAS closed its Project Ubin initiative with the release of the fifth project report along with Temasek, which documents MAS's development of a DLT-based multi-currency payments network to conduct such payments on a single network (MAS and Temasek, 2020). This formed the basis for further work in Project Dunbar, launched by the BIS Innovation Hub's Singapore Centre to explore international settlement using multi-CBDC arrangements, initially on a single multi-currency DLT network (BISIH-SC, 2021).

From a securities settlement perspective, the BIS Innovation Hub (BISIH), SIX Digital Exchange and the Swiss National Bank (SNB) completed Phase 1 of Project Helvetia in 2020, to issue, clear and settle a security issued on the SDX DLT-based platform in two PoCs – one integrating with the SNB national payment system and the second with a SNB wCBDC. The project highlighted novel policy and governance questions in conducting the PoC (BISIH et al, 2020). SDX has since received approval from the Swiss Financial Market Supervisory Authority to operate a stock exchange and central securities depository issuing DLT-based tokens (FINMA, 2021). The Banque de France (BdF) has also launched an ambitious wCBDC programme, including an initiative where the BdF worked with the European Investment Bank (EIB) and Société Générale – FORGE to settle an EIB-issued digital bond with wCBDC (BdF, 2021a; 2021b). The list of experimental wCBDC projects is ever expanding, with Australia's Project Atom exploring the issuance of a Tokenised Syndicated Loan (TSL) on a DLT enabling payment with wCBDC through a CBDC utility created on the same DLT as the TSL Platform (RBA, 2021). One other BdF series of wCBDC initiatives was a collaborative project with the BIS' Innovation Hub and SNB called Project Jura, which explored DLT-based infrastructures which may support a tokenised financial system (BdF et al, 2021). The project efficiently and safely settled foreign exchange and tokenised asset trades using PvP and delivery-versus-payment (DvP). Phase 2 of Project Helvetia also explored settling tokenised assets with wCBDC on DLT-based infrastructures through integrating wCBDC into core banking systems and running transactions end-to-end (BISIH et al, 2022).

The launch of Project Khokha 2

Overview

PK2 was formally launched during February 2021 as an IFWG[2] Innovation Accelerator project driven by the SARB (IFWG, 2021). PK2 focused on the tokenisation of a security, that is, a SARB-issued debenture and the settlement of such tokenised asset in a safe and efficient way using DvP mechanisms.

The aim of PK2 is to highlight the policy and regulatory implications of tokenisation in financial markets based on DLT-driven innovation. Further, PK2 seeks to build on the foundations laid by PK1 by extending the application of a wCBDC and considering its interactions with other tokens in a DLT-based environment, namely with a SARB-debenture token and a wToken.

PK2 is an experimental research project and does not signal support, either explicit or implicit, for a particular technology nor does it seek to address a market inefficiency or signal any other policy positions.

Approach to PK2

As an experimental research project, an exploratory approach was followed in the design of the Project Khokha PoC. The current process for the issuance of debentures served as the basis upon which specific design options were discussed. It was important to explore how DLT may change existing processes to discover potential benefits and risks by designing for DLT and not merely duplicating existing processes on a new technology.

The future is inherently uncertain and there are multiple scenarios according to which financial markets may develop. One of the most prevalent trends relates to the emergence of different forms of privately issued money, including in the form of stablecoins and how stablecoins may potentially be used in securities transactions and interact with public money. The project issued both a wCBDC and wToken in order to observe both in action and to consider how they may interact in the same market. The wCBDC, as owned and operated by the central bank and used by a specific group of entities, had to be issued on a fit-for-purpose private permissioned DLT known as the wCBDC Zone.

The project also explored whether the SARB debenture token had to be issued on a SARB-specific DLT – like the wCBDC. However, in the current debentures environment, there are multiple players involved, for example, the debentures are issued on a central securities depository's (CSD) securities settlement system (SSS). Opting to issue the security on a central bank DLT may have prevented exploration surrounding how the different role players may continue to play a role in a DLT-based infrastructure. The decision was therefore to collectively re-imagine existing roles, potentially within a shared DLT infrastructure. This led to the development of a separate core DLT platform, namely the Khokha Hub, which served as a decentralised DLT-based TTP. The TTP effectively provided for the roles of a trading platform, CSD, SSS and elements of the payment settlement system.

One of the primary objectives of PK2 was for the overall design to explore interoperability between different DLT-based platforms, which was enabled by having both the wCBDC Zone and the Khokha Hub. Using DLT-based decentralised and modular design principles, the Khokha Hub was built as a decentralised platform, meaning that is possible to compose the DLT-based elements of financial markets in different ways by combining modular blocks of financial services business logic as one would combine Lego blocks to build new market

2 For more on the IFWG and its activities see: https://www.ifwg.co.za/Pages/default.aspx

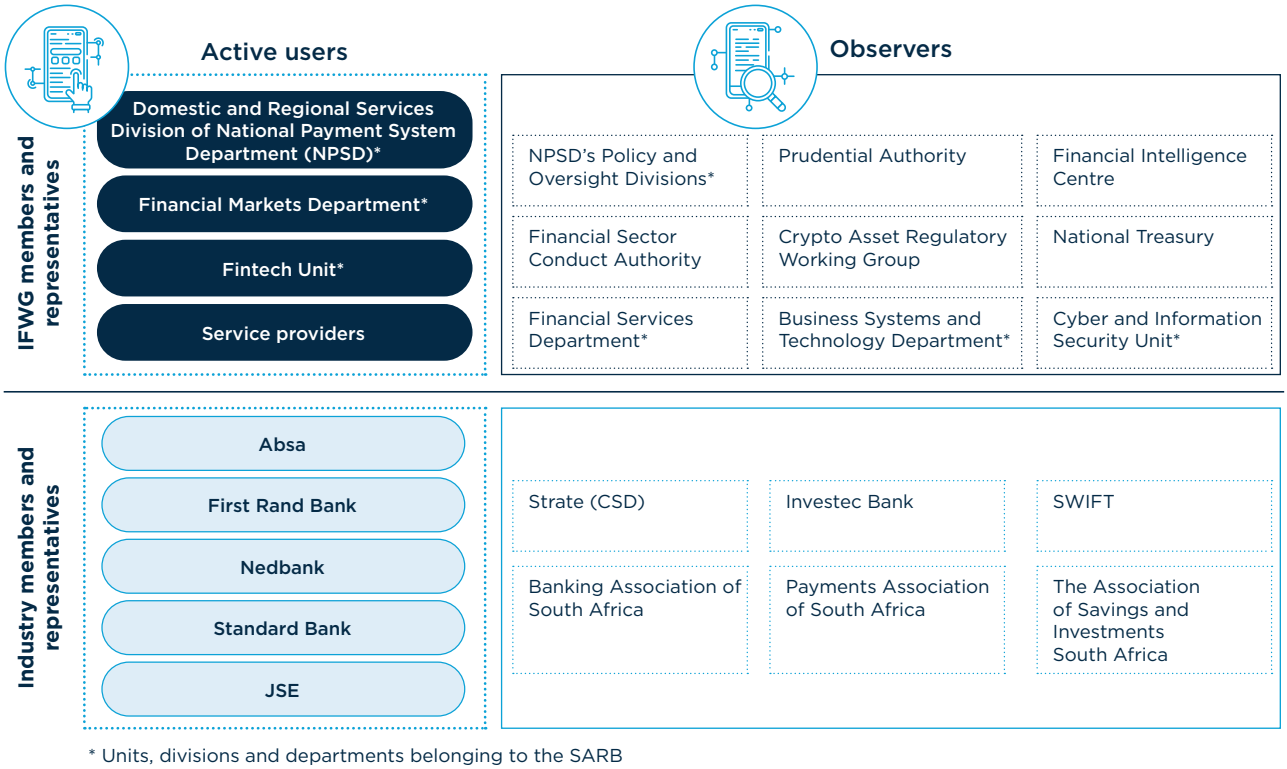
infrastructure. Interoperability was further explored by porting the wCBDC (i.e. moving its representative value) to the Khokha Hub and using it to buy debenture tokens in the primary market, while the wToken was used in the secondary market. The porting of wCBDC was enabled by a software bridge which introduced complexities requiring careful reflection. Such exploration is important because the interlinkages between different DLTs could increase the complexity of financial markets affecting their stability and resilience.

The design further served as the basis for engaging stakeholders, including the policy maker and regulators, on possible implications. The approach followed allowed for exploring a particular design and considering its relevant implications. However, there are multiple design options which must be considered along with their own unique trade-offs within a specific context.

Participants and roles

Continued involvement and willingness to promote responsible innovation by stakeholders on the Khokha journey has been key to the success of the project. The core team consisted of the SARB's Fintech Unit; Accenture and Block Markets Africa (BMA) as technical service providers; and Deloitte as support partner. Accenture designed and developed the wCBDC, while BMA designed and developed the SARB debenture token and the wToken prototypes. The broader project stakeholder group was divided into four groups as depicted in Figure 3 below. These were further classified based on whether a stakeholder was an 'active user' in the PoC – for instance, posting transactions on the prototypes – or whether they were 'observers' in the sense that they did not use the prototypes in the PoC but were involved in the discussions surrounding the potential impacts.

Figure 3: Overview of participants



* Units, divisions and departments belonging to the SARB

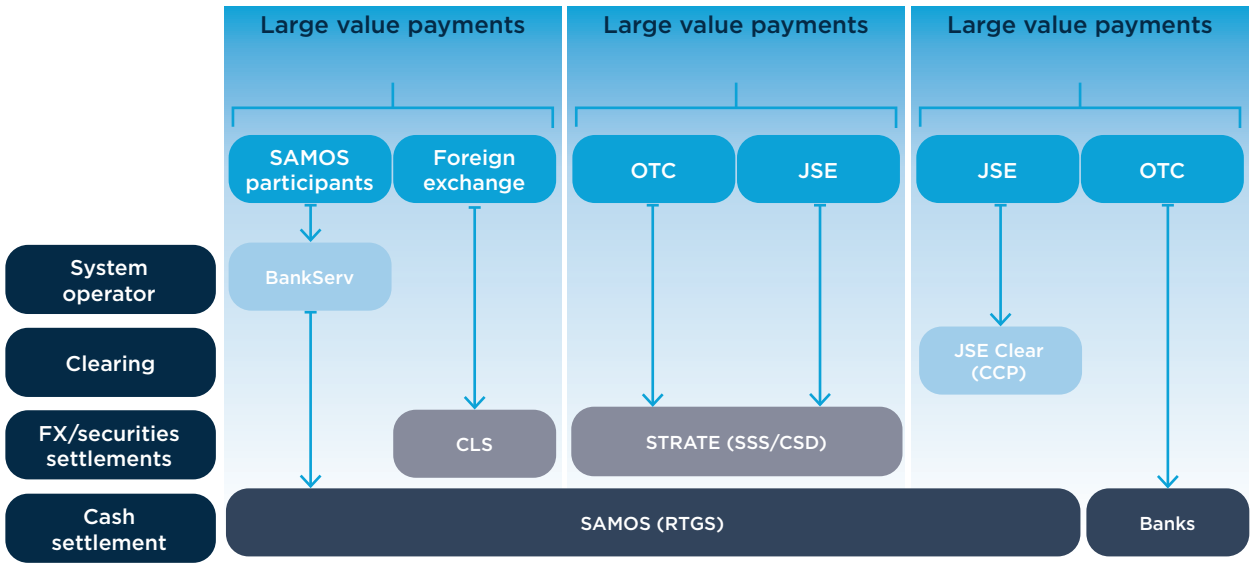
THE CURRENT DEBENTURES OPERATING ENVIRONMENT

Overview of the debentures market

The SARB debentures are a very specific type of debt security offered by the SARB. These are offered to market participants to drain excess liquidity from the domestic money markets. Debentures were selected as proxy for other securities since they are a short-term instrument directly under the control of the SARB – which made it easier to tokenise in a PoC, with the intent that insights could be applied in other environments.

In South Africa, debentures are issued and traded in the money market for immediate delivery. Issuance and trading happen over the counter (OTC) with securities settlement happening through a company called Strate – as the CSD and SSS. Money settlement happens through the SAMOS system as the RTGS system, which is owned and operated by the SARB.

Figure 4: South African financial market transaction flows



Source: NT et al, 2018

Incumbents and market infrastructures

Although the debentures market is an OTC market, the JSE still plays a role as the National Numbering Agency (NNA) in South Africa and issues the International Securities Identification Number (ISIN) which uniquely identifies each debenture. Debentures may also be used for liquidity at the JSE.

The South African Multiple Option Settlement system

The SARB implements RTGS through the SAMOS system to effect final settlement of interbank funds transfers on a continuous, transaction-by-transaction basis throughout the processing day. The SAMOS system facilitates the settlement of domestic individual high-value payment transactions, retail transaction batches as well as bond and equity market settlement obligations. At a wholesale settlement level, each settlement participant has an account with the SARB, from which interbank settlement obligations are settled.

Settlement accounts held at SAMOS are pre-funded to ensure that their transactions are settled. The pre-funded rule ensures that the participant is fully responsible for its liquidity positions. Transactions that are settled are final and irrevocable. Therefore, the point of settlement finality is the point at which both relevant accounts have been appropriately debited and credited. Payment for interbank securities settlement makes use of the real-time line (RTL) option to settle transactions in real time, on a gross basis. Collateral reserved in a separate loan account in the SAMOS system may be used for an automatic loan facility. However, all settlement happens from the settlement account and a settlement instruction is rejected if there are insufficient funds or liquidity.

The central securities depository

A CSD is the market's formal record or so-called 'source of truth' for the ownership of securities. This entity performs the role of creating, storing and recording the ownership of securities. CSD Participants (CSDPs) – normally the central bank and large commercial banks – have accounts with the CSD, which is responsible for ensuring that changes in ownership of securities are recorded accurately and timeously. In the South African market, this role is mainly performed by Strate, which is also the CSD in the debentures market. DvP is achieved by coordinating the payment leg of a transaction through the SAMOS system and the settlement (delivery) leg through the CSD's SSS. The settlement of debentures happens on a T+0 basis[3].

"A CSD is the market's formal record or so-called 'source of truth' for the ownership of securities. This entity performs the role of creating, storing and recording the ownership of securities."

3 The depiction indicates how many days after the transaction (T) settlement takes place, with T+0 representing same-day settlement.

The debentures life cycle

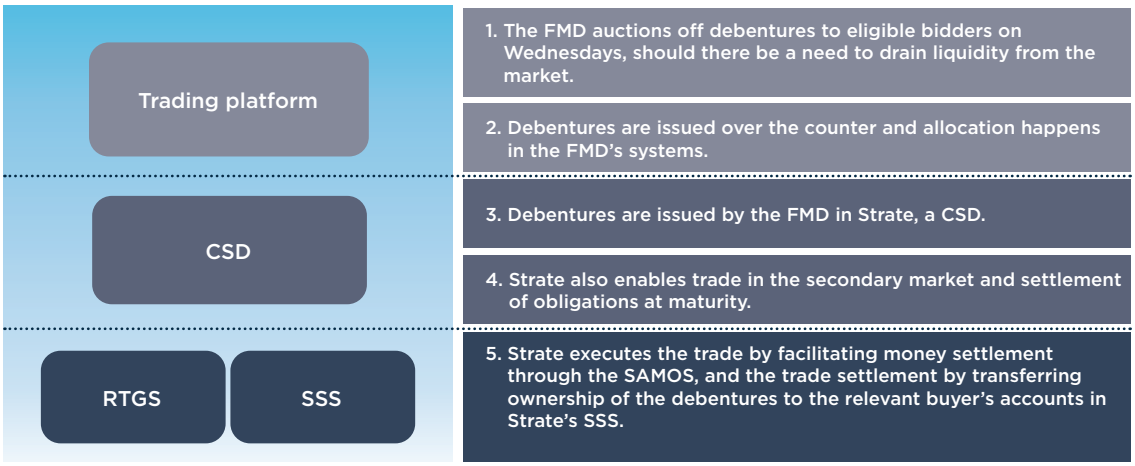
The SARB debentures are auctioned off by the SARB's FMD every Wednesday, should there be a need to drain liquidity from the market. The treasury functions of eligible commercial banks as well as asset managers who have signed global master repurchase agreements with the SARB place bids in terms of volume, maturity term and interest rate during a bidding period, after which FMD allocates the volume of debentures that they choose to sell into the market to the best bidders.

Once bids are allocated, debentures are issued by FMD within the CSD (i.e. Strate) and an ISIN is assigned to each debenture by the JSE as the NNA. Strate facilitates the purchase settlement leg of DvP via SAMOS and simultaneously transfers the debentures to the respective buyers' accounts in the CSD's SSS.

The SARB debentures are normally issued in units of ZAR1 million – while interest rates can vary, the maturity terms range from 7 to 56 days. During the life cycle of a debenture, it can be traded between commercial banks in the secondary market. However, such trade is limited since the SARB debenture is more often used as collateral for reserves in the SAMOS system and for liquidity at the JSE, making it more common for buyers to retain the instrument through to its maturity than to sell it in a secondary market. The number of debentures in issuance is relatively low, which also limits secondary market activity.

At maturity of debentures, the FMD ensures that sufficient funds are available to settle their obligations to commercial banks, and Strate facilitates the payout to the respective owners of SARB debentures of the combined principal and interest amount due, thus completing the life cycle of the debenture. Where an entity has given their SARB debenture up to be held as collateral for reserves at SAMOS or liquidity at the JSE, the settlement process completes a 'Maturity Financial Instrument Settlement Instruction' (MaFISI). This instruction diverts funds from the beneficiary through to the holder of the collateral, to ensure that the beneficiary's liabilities are managed.

Figure 5: Overview of debentures life cycle linked to relevant market infrastructures



THE PROOF-OF-CONCEPT

The scope of Project Khokha 2

In order to gain a deeper insight into how DLT-driven innovation is impacting financial markets, the technical teams designed, for DLT and reinterpreted the existing market infrastructures, roles and processes in the context of DLT-based market developments.

The brief to the technical teams included building three prototypes in the PK2 PoC, namely:

A wCBDC as a liability of the SARB to serve as an alternate form of central bank money, similar to money in reserve and settlement accounts with the central bank.

A DLT-based SARB debenture, which crucially had to be designed specifically for DLT and not merely move the existing process onto DLT.

A wToken as a commercial arrangement (i.e. not a liability of the SARB). The wToken had to be a settlement asset used in the settlement of wholesale transactions (CPMI, 2019), and could be considered as a stablecoin as it derives its value from the asset(s) backing it.

The co-design process followed

In order to consider the true impact that DLT might have on existing processes, the technical teams were given freedom and indeed the mandate to re-imagine the current South African debentures market through engagement with various stakeholders in a co-design process, which resulted in the design of the PK2 DLT-based 'debenture token market'. It was important to confirm upfront whether a DLT-based market could reliably execute securities trade and identify differences with the current market to highlight potential policy and regulatory implications. During the workshops, the project team gained an understanding of the purpose of various role players, their roles in the market, the role of debentures and financial instruments more broadly, as well as the existing processes.

The DLT-based design was informed by asking the following key questions:

- **How would one implement the issuance, trade and settlement of debentures differently using DLT?**
- **How could the various role players and financial market infrastructures (FMIs), like the CSD, function in a DLT-based debenture token market?**
- **Does a DLT-based design hold promise and meaningful new benefits for the debentures market and securities trade more broadly?**

Proof-of-concept technical objectives

While several potential benefits were considered during the design process, the following stood out as the primary opportunities to explore during the PoC:

- Lowering the barrier to entry for new market entrants by using DLT to reduce the minimum infrastructure requirements, systems costs and operational requirements for participation.
- Simplifying the reconciliation requirements in the settlement processes of all parties, including new capacity such as transparent visibility of market liabilities against a trading member or specific security held by a trading member, by consolidating several current market infrastructure components onto a single shared ledger.
- Enabling innovation opportunities through DLT-based securities trading and helping to prepare local markets for growing global adoption of wCBDC and other tokenised securities. This would lay the foundation for interoperability between DLT networks (private, permissioned and even public) and their applications – especially in expanding the utility of wCBDC on multiple networks.

The debenture token market proof-of-concept

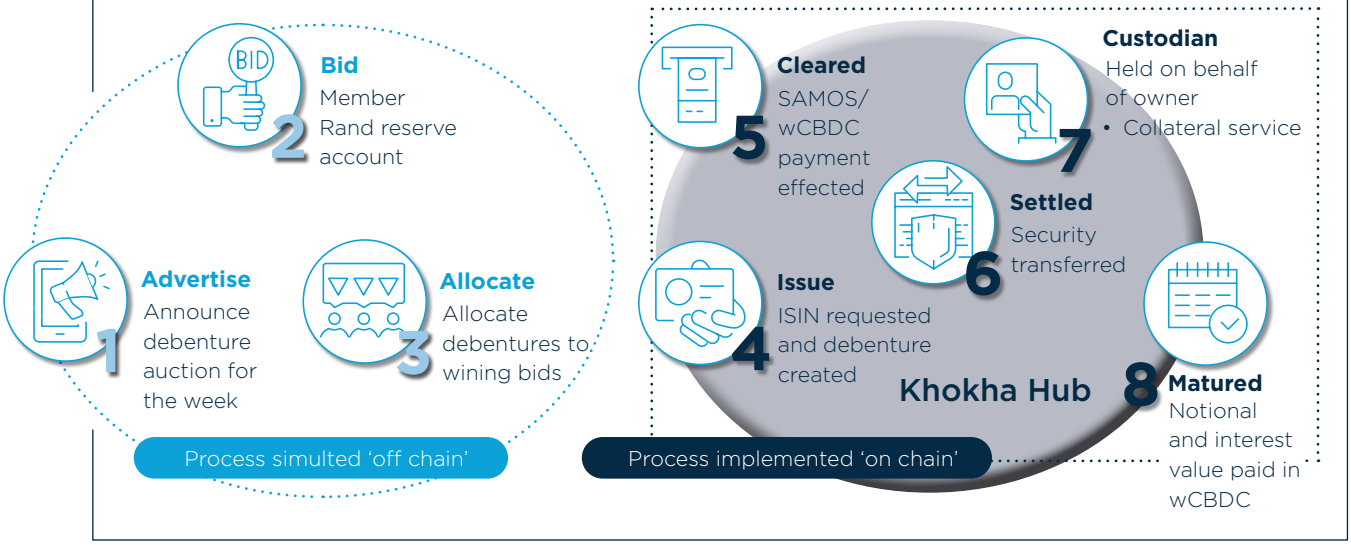
The co-design process resulted in the PK2 PoC multi-DLT debenture token market consisting of two core DLT networks – the wCBDC Zone, housing the wCBDC prototype; and the Khokha Hub, housing the debenture token and wToken prototypes. Debentures are bought in the primary market with wCBDC, while they are bought in the secondary market with the wToken (called Khokha Tokens in the PoC). In addition, FDM Tokens[4] were also created to facilitate secondary market trade of the debenture tokens using a fractionalised order book.

4 The FDM Tokens were created as a synthetic instrument to combine the principal value (debenture tokens locked in custodial wallets in the Khokha Hub) as well as the interest value of a debenture before maturity in order enable its trade in the secondary market. Interest for a particular debenture non-fungible token (NFT) is paid in wCBDC via the FDM contract, which executes maturity obligations similar to a MaFISI in the current market.

The debenture token life cycle

Figure 6 below provides an overview of the debenture token life cycle – mainly focusing on the primary market.

Figure 6: Debenture token lifecycle



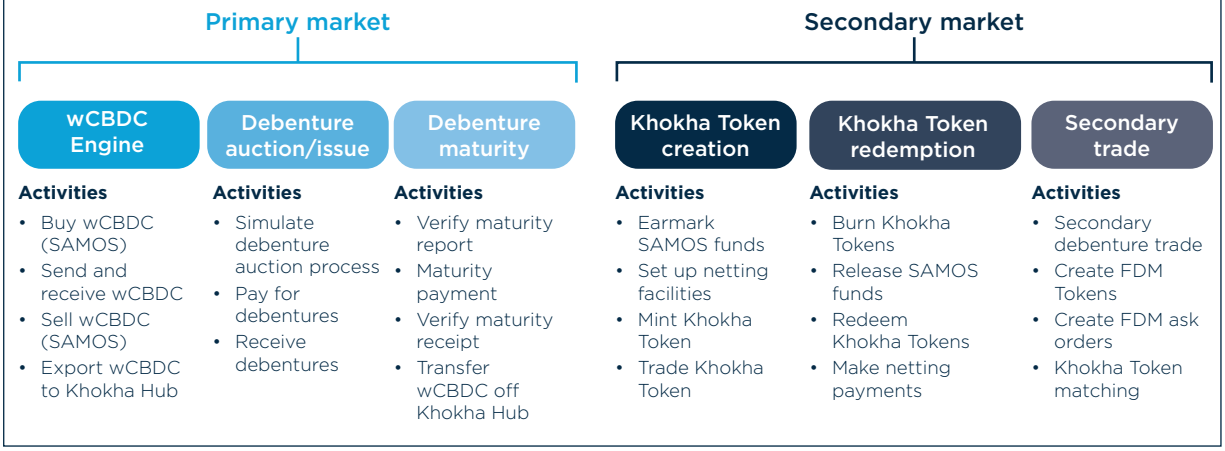
The steps in the debenture token life cycle are:

1. FMD may decide to hold a debenture auction and, if so, it is announced on a Wednesday.
2. Participants bid in the auction.
3. The FMD accepts bids and allocates debentures.
4. The FMD issues the debenture tokens on the Khokha Hub utilising a debenture token module. The ISIN is obtained from the ISIN simulator for registration along with other pertinent data such as the value of a contract, in the NFT[5] embodying the debenture token.
5. The terms of exchange are recorded on the Khokha Hub's DLT through the creation of a DvP smart contract address specific to the transaction to which the buyer must send wCBDC. The DvP smart contract, as part of the debenture token module, holds the debenture token in escrow.
6. The buyer sends wCBDC to the DvP smart contract, which verifies the token data against ISIN data, and if it matches and sufficient wCBDC was paid, the ownership of the debenture token passes to the buyer and the wCBDC is passed to the FMD. If any of the steps fail, funds are returned to the buyer and the debenture is returned to the FMD.
7. The buyer holds the debenture token in a custodial wallet provided by its CSDP, that is, commercial bank, on the TTP (i.e. the Khokha Hub). The debenture tokens are also locked in these wallets to enable the issuance of the FDM Tokens, as a synthetic instrument for trade in the secondary market against Khokha Tokens.
8. When a debenture token matures, the FMD makes payment on the principal and interest owed to a settlement contract per ISIN – it is also possible to aggregate liability across multiple debenture tokens. The DvP smart contract distributes wCBDC owed to relevant beneficiaries. A secondary smart contract is used to help settle third-party liabilities incurred against the debenture using FDM Tokens in the secondary market (like MaFISI in the current market).

Debenture token market activities

The next section discusses some of the debenture token market activities for the different prototypes depicted in the overview provided in Figure 7 below.

Figure 7: Overview of debenture token market activities



Wholesale central bank digital currency functionality

The issuing of wCBDC

wCBDC was issued to commercial banks when they bought it with money from their settlement account in the SAMOS system. The wCBDC can be sold back to the SARB as and when required.

Using wCBDC to settle securities trades

wCBDC tokens were designed to carry a direct and fungible claim on the SARB and are recorded as an asset on the token holder's balance sheet. This means that when a wCBDC is transferred from one participant to another, the associated claim on the central bank is transferred with the token. In the PoC, this not only effected the function of payment, but also impacted legal and operational settlement. According to South African legislation, settlement in a designated settlement system is final and irrevocable. In the PoC, wCBDC is ported to the Khokha Hub to facilitate purchasing of debentures in the primary market where operational settlement occurred. The wCBDC Zone, for purposes of the PoC, is considered to be a designated settlement system as the platform on which central bank wholesale money is issued; however, Khokha Hub, as a more commercial construct, is not. This means that, if such a model is adopted in a future world, legal settlement would only occur once transactions are settled in the wCBDC Zone. The ability to port (export and import) wCBDC from its native network[6] – that is, the wCBDC Zone to a non-native network(i.e. the Khokha Hub) – requires that its use be restricted in line with its use on its native network, including restricting its use to only SAMOS settlement participants on the non-native network. Certain functionality, such as purchasing wCBDC from, or selling it back to, the SARB was only available on the wCBDC Zone.

6 Native network refers to the network upon which a token is issued on and is inherent to.

Debenture token functionality

Issuing debenture tokens

The SARB's FMD facilitated an auction process for participants in the PoC debenture token market, registering the debenture tokens with a simulation of the NNA for ISIN allocation, and issuing it directly onto a DLT. The debentures were issued as NFTs containing the relevant information for the security, such as debt instrument type, issuer, issuing and maturity dates, interest rates, beneficiary and other pertinent data.

Settling debenture tokens

In the primary market, the SARB debenture token purchases were settled with a specific DvP atomic swap[7] contract process, where three actions occur in the same transaction: (i) the DLT transfers the wCBDC token as settlement instrument from the buyer to the seller; (ii) updates the ownership (beneficiary) of the debenture NFT to the buyer; and (iii) validates the debenture NFT information against its ISIN record for verification. If any of these three actions failed, all three were rolled back, ensuring DvP.

Trading debenture tokens in the secondary market

At present, trade of debentures in the secondary market is not very active. To create more liquidity in the secondary market for debenture tokens, the challenges surrounding the high value of debentures (minimum value of ZAR1 million) and the fungibility of debentures with different maturity dates and interest rates were overcome through the creation of the FDM Tokens. This new (synthetic) tokenised liquidity could also be ported between DLTs, and ultimately exchanged for wCBDC on the debenture's native network at maturity of the debenture tokens.

Wholesale digital settlement token functionality

Creating an interbank settlement instrument

The wToken implemented on the project was called the Khokha Token and, as a privately issued settlement instrument, was created as a new fungible instrument against reserve assets provided by the respective participants. It was an important design requirement that the Khokha Token could be traded between commercial banks and issued by each participant, therefore making it a single 'collective issue' instrument, rather than a collection of 'single issuer' instruments which would lead to a complex process for determining the exchange rate as each participant priced the risk of another's balance sheet differently.

During the co-design process, the project stakeholders discussed different reserve asset options to back the value of the Khokha Token and the decision was taken to utilise funds in the individual SAMOS settlement accounts of settlement participants earmarked for that purpose. The Khokha Token had to be redeemable by all participants for a predictable, transparent and reliable value to function as an acceptable settlement instrument, hence the wCBDC was selected given its classification as a riskless asset. Utilising wCBDC in the redemption mechanism increased liquidity for the participants and enabled redemption on DLT.

Issuing and trading Khokha Tokens

The wToken is also transferrable to and from other DLTs where it can be traded between users. However, its minting (which entails the locking of reserve assets) and burning (which unlocks the reserve assets) as well as its redemption (for wCBDC) is only available on the wToken's native DLT.

7 An atomic swap is an automatic peer-to-peer exchange of tokens enabled by smart contracts. It may also be referred to as atomic cross-chain trading when two different distributed ledgers are involved.

Technical architecture

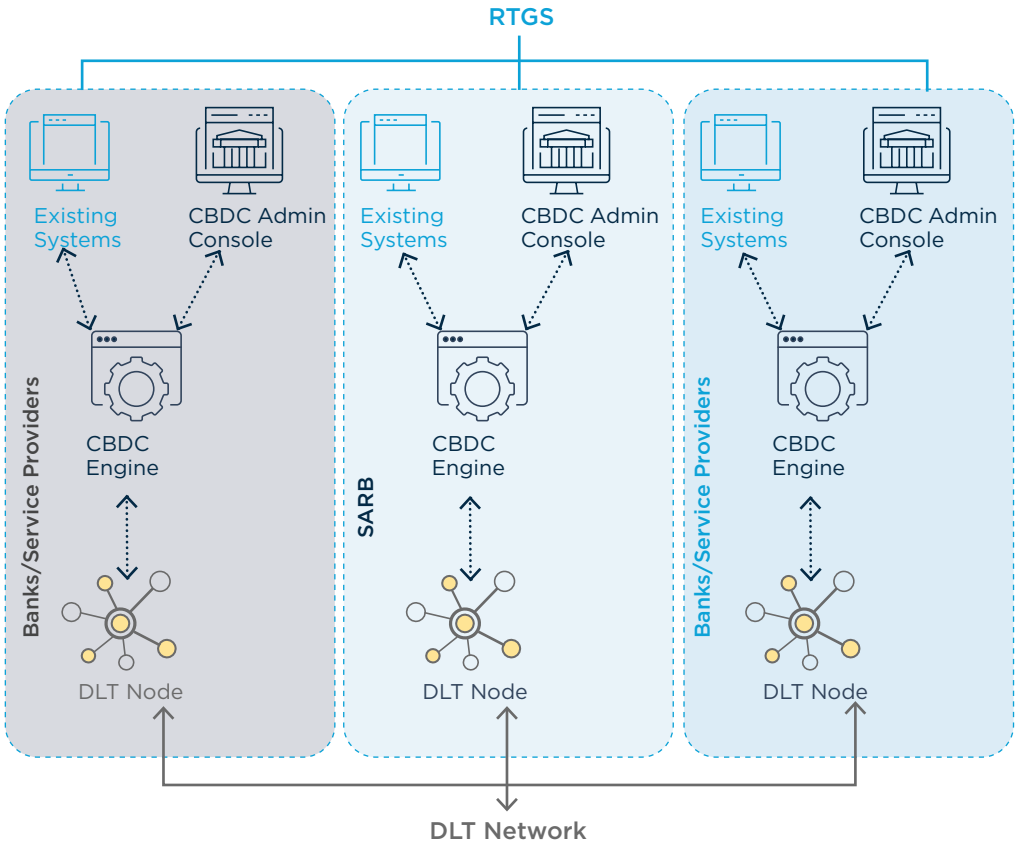
The next section describes the components of the debenture token market.

The wCBDC Zone

The wCBDC Zone was built on R3 Corda, an enterprise DLT which is designed specifically for highly regulated, mission-critical environments where resilience, scalability, security and integration are required. R3 Corda has been used in many high-profile central bank projects, including Project Inthanon-LionRock (BoT and HKMA, 2020), Phase 3 of Project Jasper (Payments Canada et al, 2019), and Project Jasper-Ubin (BoC and MAS, 2019).

The wCBDC token was minted on the wCBDC Zone by the SARB, making use of a SAMOS simulator (refer to Appendix 4 for a list of application engines used) rather than building a full integration to SAMOS for a PoC. Once a participating bank bought a wCBDC it was able to trade wCBDC with other participant banks, import or export wCBDC to the Khokha Hub and import back to the SARB. The wCBDC token fully maintained its value when exported to the Khokha Hub – a non-native network. Figure 8 below provides an overview of the architecture of the wCBDC Zone.

Figure 8: wCBDC Zone architecture diagram



Existing Systems
The wCBDC Zone interfaces with existing systems, such as the RTGS, fraud, risk, analytics, and payment systems via the CBDC Engine, which utilises Enterprise Integration.

CBDC Engine and Console
These orchestrate and maintain connections with existing systems.

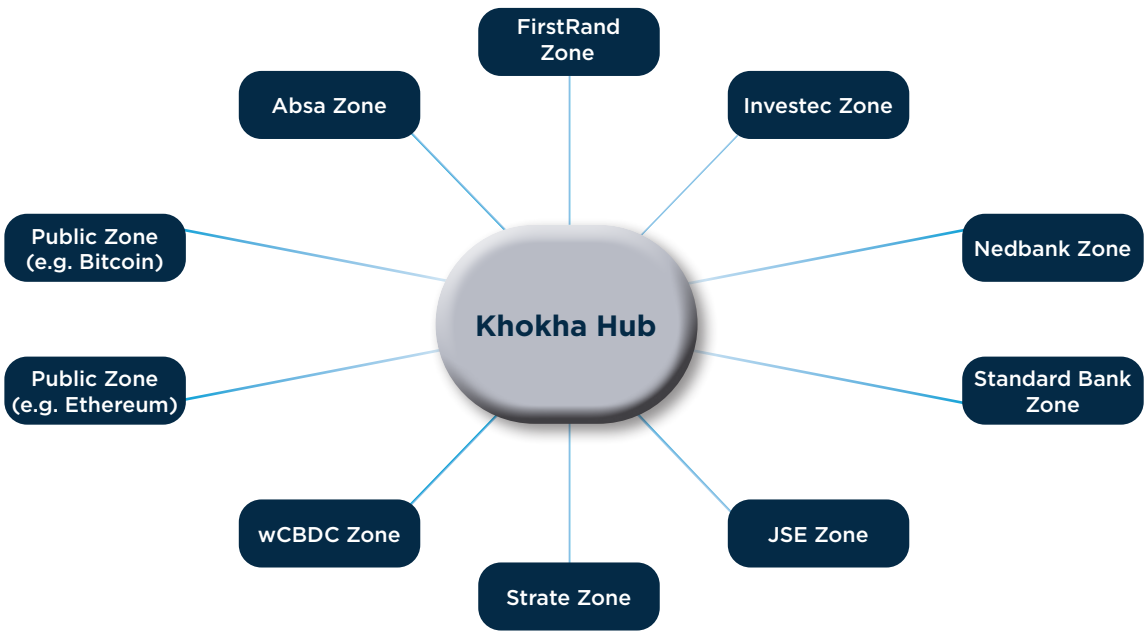
DLT Network
The DLT finalises and records all valid transactions and maintains the integrity of the wCBDC network.

The Khokha Hub

The Khokha Hub was developed on a custom implementation of the Cosmos blockchain called BitFair. The Khokha Hub's interoperability was enabled by Cosmos' modular architecture which consists of two types of DLT – hubs and zones. A hub being a central DLT platform designed to connect multiple zones (i.e. independent DLTs). The Cosmos architecture not only made it possible for the Khokha Hub to connect to the wCBDC Zone, but also to multiple bank zones, that is, private DLTs set up by the active participants in order to share value between the Khokha Hub and different bank zones. Business logic is implemented on Cosmos through modules which are comparable to a decentralised application (DApp) in decentralised finance (DeFi). The debenture token and wToken prototypes were deployed as modules on the Khokha Hub – refer to Appendix 4 for a listing of modules and centralised systems used to implement business logic in the PoC.

The star-based hub-and-spoke network design as depicted in Figure 9 depicts how the Khokha Hub, as a TTP, serves as the hub where tokens are traded between traders through their CSDPs. The spokes connect the Khokha Hub to various zones, including potential bank zones run by active participants. The CSD function in the decentralised TTP could theoretically be called a decentralised securities depository (DSD), which converts the CSDPs to DSDPs. The DSDPs run the validator nodes in the TTP. The Khokha Hub is operated jointly by all participants, including the central bank, through the Khokha Council, which serves as its governance structure. The Khokha Council votes on whether proposed changes to the Khokha Hub are implemented, including new modules which could result in integration with other more decentralised platforms.

Figure 9: Khokha Hub's hub-and-spoke network model

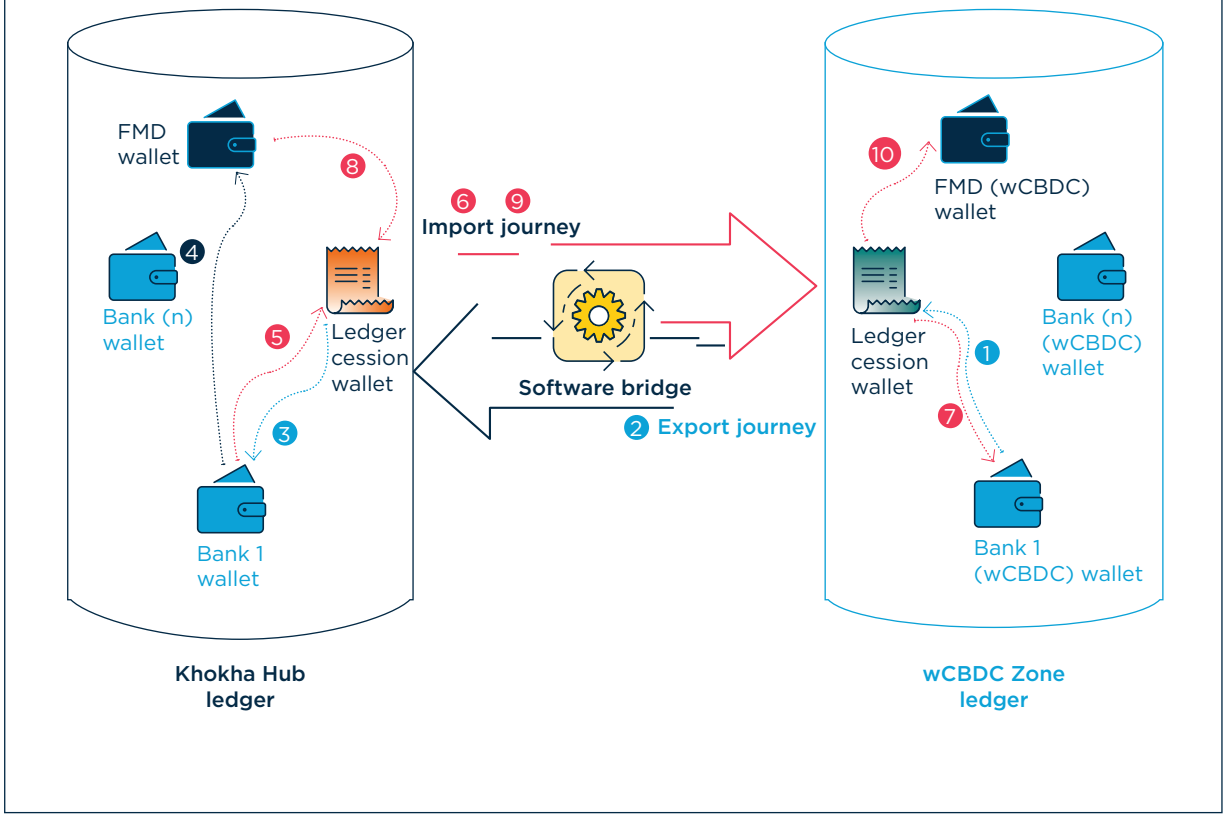


The modular architecture enabled the Khokha Hub to serve as a decentralised TTP and further illustrated how other market participants could innovate to add value in private, permissioned or public networks linked to the Khokha Hub. A token may be ported, that is, transferred between the hub and a zone, through a software bridge, which creates and maintains the relationship between the DLTs enabling the transfer of value.

The PK2 software bridge

The PK2 software bridge was designed for the purpose of transferring wCBDC between the wCBDC Zone and Khokha Hub. It was operated off-chain and it relied primarily on the use of application programming interfaces (APIs) to facilitate the exchange of value. The PK2 software bridge was operated centrally by the SARB to align the two networks (i.e. the wCBDC Zone and the Khokha Hub) and to ensure that all the wCBDC tokens transferred to the Khokha Hub, from the wCBDC Zone, were 'frozen' in the wCBDC Zone. This meant that wCBDC was moved to a cession wallet in the wCBDC Zone, preventing its use while an equivalent value of wCBDC was created on the Khokha Hub (exported) and moved to the wallet of the entity porting the wCBDC on the Khokha Hub for use. This guarantees a 1:1 mapping and value pegging between the wCBDC tokens in the Khokha Hub and the frozen tokens in the wCBDC Zone. The ownership of the tokens frozen in the wCBDC Zone was managed by the Khokha Hub. When tokens were imported back from the Khokha Hub to the wCBDC Zone, the process was reversed – the tokens were destroyed in the Khokha Hub and unfrozen in the wCBDC Zone. Thus, the ownership of the wCBDC tokens was again managed exclusively in the wCBDC Zone. In addition, the bridge allowed for a buffer or temporary holding area to be created, which could be utilised for managing pending transactions in the event of connectivity issues. Figure 10 below provides a simplified example.

Figure 10: Porting wCBDC to the Khokha Hub



Brief steps for porting wCBDC in a simplified example:

1. Bank 1 intends to buy debenture tokens and moves ZAR100 million in wCBDC to the ledger cession wallet in the wCBDC Zone where it is frozen and cannot be used any longer in the wCBDC Zone.
2. The software bridge creates ZAR100 million worth of (ported) wCBDC in the cession wallet on the Khokha Hub allocated to Bank 1.
3. The software bridge moves ZAR100 million in (ported) wCBDC to Bank 1's wallet on the Khokha Hub.
4. Bank 1 buys ZAR60 million worth of debenture tokens from the FMD. Transaction details are recorded on the Khokha Hub ledger as well as on the software bridge.
5. Bank 1 wants to import the remaining ZAR40 million of (ported) wCBDC back to the wCBDC Zone and initiates the process by moving the remaining balance back to the Khokha Hub ledger cession wallet.
6. The software bridge destroys ZAR40 million in (ported) wCBDC on the Khokha Hub cession wallet and unfreezes ZAR40 million in wCBDC on the wCBDC Zone ledger cession wallet.
7. The software bridge moves ZAR40 million of wCBDC from the wCBDC Zone cession wallet to Bank 1's wallet on the wCBDC Zone.
8. FMD wants to import the ZAR60 million of (ported) wCBDC from the sale of debenture tokens to Bank 1 to the wCBDC Zone and initiates the process by moving it to the Khokha Hub ledger cession wallet.
9. The software bridge destroys ZAR60 million in (ported) wCBDC on the Khokha Hub cession wallet and unfreezes ZAR60 million in the wCBDC on the wCBDC Zone ledger cession wallet.
10. The bridge moves ZAR60 million of wCBDC from the wCBDC Zone cession wallet to the FMD's wallet on the wCBDC Zone.

Decentralised design considerations

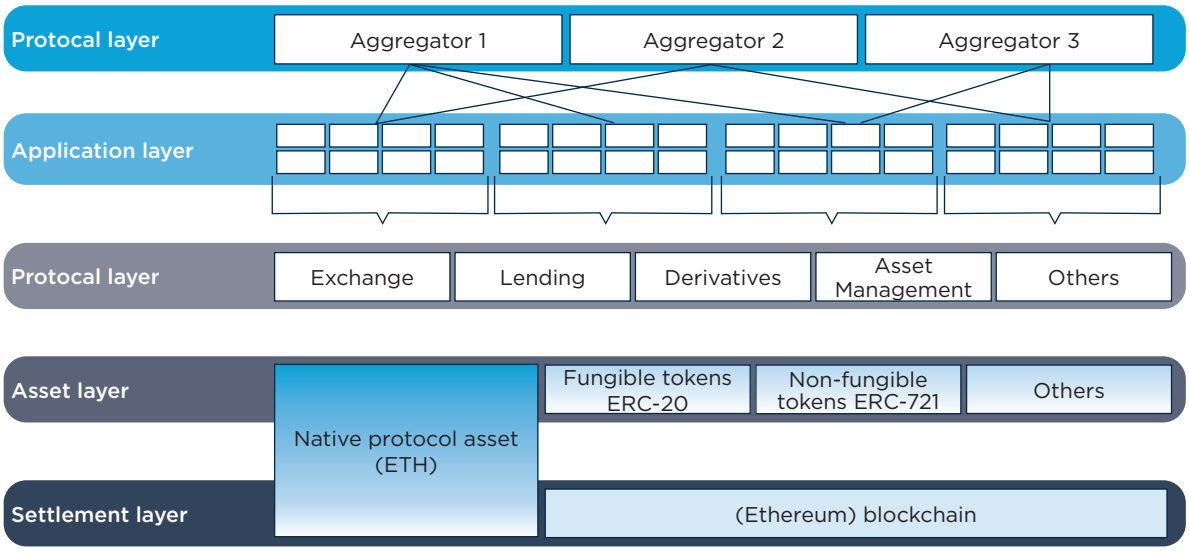
In considering a DLT-based market infrastructure, it is unavoidable to consider its ability to distribute and/or decentralise, particularly considering the growth of the DeFi market and the attention that it is starting to receive from regulators and central banks. **DeFi's decentralised infrastructure, protocols and DApps allow for the development of more 'open, interoperable and transparent' market infrastructure and functions, which is why it is referred to as the 'Money Legos' upon which financial services may be built.**

DLT enables a new paradigm to implement settlement and security instruments

Schär (2021) describes a multi-layered DeFi architecture (depicted in Figure 11) which illustrates the Money Lego nature of DeFi, which the technical teams used to reflect on in considering the design of the debenture token market based on the following five layers:

- The **settlement layer** is the foundation of the architecture and its native DLT protocol asset. For instance, Ether enables recording ownership information in line with its ruleset.
- The native protocol asset along with other assets (non- and fungible tokens) make up the **asset layer**.
- The **protocol layer** consists of the standards used to implement a set of smart contracts relevant to a particular use case, such as exchange or lending functionality, and is accessible by other users.
- User-oriented applications connecting users to specific protocols make up the **application layer**.
- The **aggregation layer** creates user-centric platforms connecting several applications and platforms.

Figure 11: Schär's DeFi architecture



The project team considered financial markets to broadly consist of the following three components.

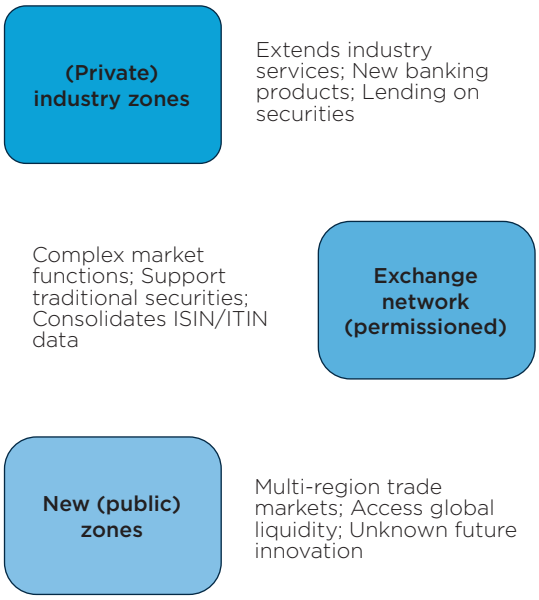
- **Role players**: These are the entities participating in the market and fulfilling roles such as issuing, buying, using and selling assets, and operators of market infrastructures. The role players fulfil specific functions in the market through the activities they conduct, which could include functions such as managing credit risk, providing custody services or providing the ledgers used to record payment transactions or recording the ownership of securities.
- **Assets**: Various assets are exchanged in a market, including settlement assets and securities.
- **Market infrastructure**: Market infrastructures enable the trading, clearing, settling and storing of assets. According to the PFMIs, there are five types of FMIs, namely central counterparties (CCPs), CSDs, payment systems (PSs), SSSs and trade repositories (TRs). The Financial Markets Act 19 of 2012 defines the following four licensed market infrastructures – CSDs, repositories, clearing houses and exchanges. Trading platforms enable trade between parties and may either be an exchange or OTC.

Within the debenture environment, the market infrastructure consists of the CSD, which includes the SSS; the PS – namely the RTGS system; and the trading platform, being OTC (refer to Figure 3). DLT provides a new way of organising this via a ledger that enables the storage of settlement instruments (recorded as single value balances) and their transactions as well as securities instruments (recorded as multi-value entries to describe additional data such as issuer, issuing date, monetary value and more) on the same ledger. The centralised debentures market has discrete functions which operate on independent systems, while DLT-based financial markets utilise an integrated layering of functions on a single ledger.

Designing with the new DLT-based paradigm in mind

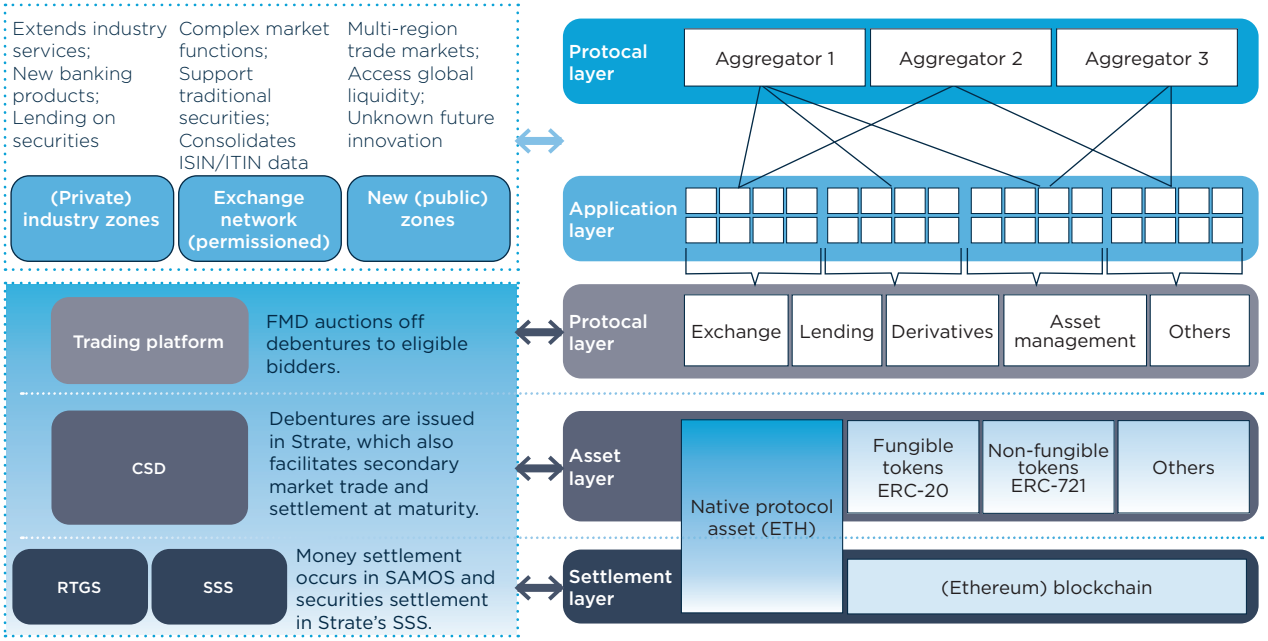
Utilising the insights gained from the public token markets, the technical team could see a clear parallel between the combined settlement and asset layers of the DLT-based TTP to both the CSD and RTGS in the current debentures market (see Figure 13 on page 32). The protocol layer compares to the trading platform in the current market, and like the protocol layer interfaces with the asset and settlement layer, the trading platform interfaces with the assets and payment system (RTGS) and SSS (CSD). The bottom three layers of Schär's DeFi architecture aligns with the implementation of the Khokha Hub as a decentralised TTP, and serves as the base for the multi-DLT debenture token market. The top two layers, that is, the application and aggregation layers enable interoperability with other DLTs, which essentially enables other market participants to innovate and add value in private, permissioned or public networks, and make TTPs accessible to existing centralised services (see Figure 12).

Figure 12: Example external networks (zones)



This insight informed the architectural design of the multi-DLT debenture token market, in particular, the Khokha Hub as a TTP. See Figure 13 below for a visual representation of how the current securities functionalities align with the bottom three layers of Schär's DeFi architecture, and how the top two layers of that architecture enables interaction with new networks and existing services.

Figure 13: Decentralised financial market infrastructure interoperability



The interoperability between DLTs enables the porting (importing and exporting) of tokens between their native DLT and non-native DLTs. A token's native DLT is the DLT that it is issued on – and using Ethereum as an example may include a native protocol asset (Ether) as well as other tokens issued on the DLT, which could be fungible (non-unique interchangeable) tokens issued under Ethereum's ERC-20 standard or non-fungible (unique) tokens issued under the ERC-721 standard. Having a verifiable link between the value of a token and the traditional financial system helps to create trust in token assets ported between decentralised systems. The PK2 project team set itself a stretch goal of exploring this interoperability in a sub-project called PK2.x to enable the active participants to develop their own tokens as well as DApps/ modules and implement functionality on top of the base layers developed during the main PoC.

Technical observations

When building the debenture token market, there were some technical observations about the process and the implications of using DLT relative to traditional methods. **These observations primarily relate to the way that the component parts of the new DLT-based model come together to create comparable capabilities to what exists in the current centralised paradigm.**

wCBDC served as a portable settlement asset

The wCBDC token was issued as an alternative form of central bank money in the PoC and it is equivalent in value to existing forms. Transferring it was therefore considered to be the same as transferring central bank liability between settlement participants in the SAMOS system. Besides hosting the wCBDC token, the wCBDC DLT platform further fulfils similar roles to the SAMOS system in that it provides an account with the central bank, in the form a wallet, and performs the settlement between participants. Porting the wCBDC token to the Khokha Hub created a technical challenge, since it created a break between the wCBDC ledger – which in the future could be designated as a settlement system, and the Khokha Hub thereby resulting in a split between when technical/operational settlement and legal settlement takes place. Should wCBDC be allowed to be ported, it would be imperative to determine how detailed transaction records are integrated back to the wCBDC ledger and how legal finality would be defined in that arrangement. Care should therefore be taken in porting wCBDC to networks not controlled by the issuing central bank.

wCBDC was fundamental to the debenture token market

The wCBDC prototype was key to both trade and bringing stability to the debenture token market. The wCBDC was used as a riskless settlement asset and the settlement system for the payments leg in the primary market. In addition, the Khokha Token was designed to be able to use different types of reserve assets which may have different levels of liquidity and credit risk. Making the Khokha Token redeemable for wCBDC meant that it reduced the risk for its users because they could easily move to a riskless asset on redemption thereby decreasing liquidity risk. Lastly, wCBDC was used to settle the interest and principal obligations of debenture tokens at maturity, including for the FDM Tokens. The FDM Tokens therefore represent a claim against wCBDC increasing its legitimacy. The wCBDC was consequently deemed to be fundamental in enabling trade in the debenture token market.

Delivery-versus-payment is more complex for non-fungible tokens

In the primary market, the purchase of a debenture in the auction process triggers a dedicated DvP contract to execute an atomic swap within the Khokha Hub debenture module as part of the issuance process. For the atomic swap to complete the transaction, it had to verify the NFT's data against ISIN data, including verifying the authenticity, value and any possible actions linked to the NFT. Alternatively, in the secondary market, the FDM Token was created as a synthetic instrument representing the debenture token's value at maturity to price the FDM Tokens and make them fungible, increasing liquidity in the market. Markets were set up for each maturity week, with trade setup being done utilising a decentralised exchange (DEX)[8] order book, with bids and orders being made on a peer-to peer (P2P) basis. The DvP contract for the fungible instrument was less complex since it did not have to complete all the same checks required by the DvP contract for the debenture tokens.

Factors affecting the complexity of porting a token

Porting a token may, depending on the nature of the token, require verifying three factors, namely the authenticity, value and potential actions linked to a token. With the wCBDC, particularly as a fungible token, its authenticity is linked to the SARB as its issuer, which attestation is then linked to the wCBDC Zone on which the wCBDC tokens are issued. With NFTs, it is not only the issuer that is important, but also verifying the authenticity of individual tokens, which is why the verification of the ISIN and other details become important. The verification of the value of the wCBDC is linked to the central bank as its issuer, whereas for the wToken, as a stablecoin, verification requires verification of the reserve assets to which its value is linked. In other words, for the wToken, it means verification that the value on the wToken arrangement is fully backed by central bank money earmarked in settlement accounts. Security tokens, such as the debenture token, may have actions linked to it, such as settlement of obligations like the payment of principal and interest at maturity. To increase the utility of a ported security token on a non-native network, it is important that the underlying actions linked to that security be linked to the ported-security and available to the non-native network.

8 An exchange enabling the direct trade of DLT-based tokens on a peer-to-peer basis without the need of an intermediary.

Concluding thoughts on the proof-of-concept

Reflecting on the primary opportunities, the team set out to explore in the PoC, DLT and the TTP enabled opportunities for innovation. For instance, the use of tokenisation enabled the team to create a fungible token which enabled trade in fractions of debentures thereby increasing liquidity in the secondary market. The exploration of interoperability between the Khokha Hub and other networks, such as the wCBDC Zone, in turn led to further exploration with the industry participants on the project, on how their DLT-based networks interact with the TTP and potentially even public networks. Exploring trading, clearing and settlement of debentures on DLT resulted in some benefits.

The use of a single shared ledger with different levels of access, depending on the role of the participant, enabled greater oversight of what was happening across the network, making reconciliations easier and providing FMD very useful real-time operational data. Having both the security and settlement tokens on DLT enabled DvP on a single network; however, the porting of the central bank's settlement token across two platforms also introduced some challenges, for instance, in the separation between operational and legal settlement introduced by porting the wCBDC token to the Khokha Hub. Although the use of DLT may result in reducing certain costs and reducing barriers to entry, for instance, through fractionalising debenture tokens in the secondary market, the overall cost-benefit analysis is complex as trading in tokens will most likely happen in parallel to existing markets and would require further work in the future. Some of the above points and questions asked in the PoC, such as the potential impact on FMIs, are discussed further in the next section of the report (i.e. section 5) on the implications identified from the PoC.

IMPLICATIONS

Section 4 of the report highlighted several technical observations and insights gained from the PK2 PoC. This section of the report explores, first the business and operational implications identified in the PoC, followed by a consideration of some potential policy and regulatory implications.

Business and operational implications

Transitioning to a tokenised market

Operating a DLT-based financial system will require new capabilities on the part of all role players in the market. The new DLT-based platforms will also need to be integrated with incumbents' legacy systems, including the components of market infrastructure such as the SAMOS system. As the transition is made to a financial services market that includes DLT-based tokens, standards will need to be developed, best practices established and a supporting ecosystem will need to be put in place.

A transition to a DLT-based system may be far less dramatic than what was needed in the last century to enable dematerialisation, yet it would not be a trivial undertaking and will require careful planning and execution. A DLT-based system will probably run in parallel to the existing system for a while, perhaps indefinitely. However, the challenges are not only technical and operational, and appropriate risk management must be implemented to ensure new systems are fully operational and secure. Further engagement and collaboration between policymakers, legislators, regulators and relevant industry players – particularly in regulated markets – would be required before any transition or incorporation of DLT-based systems can be realised.

New governance methods for new markets

While the underlying principles applied remain mostly unchanged, governance of DLT-based token markets is achieved in a different way from the governance arrangements in respect of incumbent systems, which could potentially be partially replaced. The application of good governance generally serves as an enabler for compliance, security, transparency and trust.

Tokens can, to some degree, have governance elements programmed into their design, in that they can be configured so that they are limited in their issuance and operation, and can be linked to the segregated roles set up within the governance model. The wCBDC and wToken implemented in the PK2 PoC, for example, could be limited in their usage to selected participants (e.g. only licensed banks) who had been placed on an approved participant list, that is white listed, by the SARB. The benefits of DLT's immutable record management presents a real advantage for governing entities needing to supervise the activities performed on the network. Compliance in DLT-based markets may be, at least partially, automated using smart contracts and real-time access to data on the DLT-network, enabling automatic monitoring as part of the regulatory framework which is referred to as 'embedded supervision' (Auer, 2019).

The consensus mechanism on a DLT creates trust that the data is credible and having a single source of truth reduces the effort in collecting, preparing and sharing the data – it also reduces the related costs. Although DLTs provide data transparency, they should also be designed to ensure privacy where appropriate. It is important for regulators and supervisors to evolve along with the advances in technology. The availability of data required to identify, manage or pre-empt certain risk types within the DLT-based token market benefits from the use of a permissioned DLT.

Within the PoC, the SARB retained the role of the governing entity and network operator of the wCBDC Zone, while the Khokha Hub followed a more decentralised governance model, with a Khokha Council and validators who voted on changes that were to be implemented on the network. In a production network, however, there are several existing roles and responsibilities which must be analysed further. In an interconnected DLT-based network, it is important to know who is accountable should things go wrong – for instance, if weaknesses in smart contracts are exploited.

DLT-based markets impact on existing role players

The PoC reflected how DLT-based platforms are able to disrupt the chain of market infrastructures, such as exchanges and clearing houses, as well as other FMIs involved in financial market trades. The Khokha Hub, as the DLT-based TTP implemented in the PoC, performed the functions of several market infrastructures, that is, the CCP, SSS, operational elements of the PS and trading platform. The PoC, however, did not explore full compliance with existing business and regulatory requirements and it is therefore possible that it may not be feasible to automate and/or collapse all roles on a single DLT platform. When considering the impact of DLT on financial markets, it is useful to separate the participating role players from their roles.

Role players in the debentures market can be split between market participants who issue, buy, use and sell assets and operators of the market infrastructure. Looking at market participants – for example, the issuers – their roles did not change; however, how they fulfilled those roles such as issuing their assets, including the debenture tokens and settlement assets did. The asset tokens were created on DLT where their attributes were set and all further operations happened. The fact that the assets and much of the capabilities of the different market infrastructures are all embedded on a single platform gives it its unique ability to change how processes are executed and how different role players interact with the system. In respect of the operators, their functions did not change, however, some of their functions were consolidated on a single TTP, which affected how the functions or responsibilities were executed. Similarly, supervision and regulation would have to adapt to a DLT-based paradigm.

Reducing incumbent operators and automating functions may lead to cost savings and lower barriers to entering a DLT-based market. In addition, a pre-funded market[9] may, for instance, simplify liquidity management and reduce the regulatory burden through automation. However, existing structures evolved over time to ensure the safety, efficiency and resilience of financial markets, and it would be advisable to fully understand the function and purpose of a specific structure before such a structure is discarded or replaced. Some of the existing frictions, such as those inherent in post-trade funding, may be there for business reasons. If there is an objective to enable easier access to payment and settlement systems, the regulatory barrier to entry is a crucial consideration. An enabling policy, legislative and regulatory framework is of primary importance in opening up access wider than the existing settlement participants.

9 The reference here is to a market where trading, clearing and settlement happen immediately and is not to be confused with pre-funding settlement accounts where the funds have to be in the account for a transaction to settle, but this may only happen x number of days of executing the trade.

Process implications of using DLT-based tokens

There are various representations of value in the current financial market, and various institutions who record the ownership of that value. This means that current processes and procedures were designed to record transactions and changes in ownership across multiple entities. It is important to recognise that a token, as a representation of value, and the DLT on which it is issued is a single system. Depending on the particular token platform, it is possible to have multiple assets, including money, on the same platform – as in the Khokha Hub. Having security and settlement tokens on the same smart platform opens up the possibility for re-imagining financial market interactions. For example, the participants recognised that the FDM Tokens, created to make the debentures fungible, could actually be used as a form of money without the need to sell them and convert them to wCBDC or Khokha Tokens. Thus, a security becomes a representation of value, and potentially a piece of 'Money Lego' around which further innovations could be constructed. This, however, also presented an interesting example of an unintended consequence, since the intent of issuing debentures is to drain excess liquidity from the market. However, the FDM Token, in turn increased liquidity by introducing a fungible, tradeable token – representing a claim against the central bank, into the market.

Other potential implications include the possibility that actions affecting tokens could be automated, so conceivably things like corporate actions or interest rates could be applied to tokens by the relevant smart contracts. DLT-based markets could provide participants with improved data-transparency, which could improve the discovery mechanism when pricing assets and could provide participants with a more informed view of where collateral resides and how it moves through the system. A move to a DLT-based market – for instance, the debentures market explored in the report – effectively means a decision to move to a pre-funded market and participants will have to accommodate the operational and process implications of a T+0 settlement.

Settlement implications

The foundational question behind current wCBDC exploration is whether central banks should issue these tokens – at this time. Based on the PoC, it can be argued that it is wCBDC which unlocked the potential of the debenture token market. The use of central bank money provided participants with the certainty available only from a riskless settlement asset. With private 'money' arrangements, there is the risk that the issuer(s) may not be able to back the money, which then introduces the risk that if such a failure occurred, settlement would fail.

The wToken arrangement in the PoC was backed by central bank money earmarked in a settlement account in the SAMOS system, thereby reducing the risk in using it as a settlement instrument. Additionally, the wToken was redeemable for wCBDC, which increased participants' options and further reduced (liquidity) risk. Other reserve asset options, such as bank deposits or commercial bank stablecoins, would again increase risk as dependence on third parties and other factors increases. In a market where both a wToken, such as the Khokha Token, and a wCBDC are available, it is not likely that there will be a business case for the wToken. The wToken does, however, provide a less-risk settlement option (i.e. it is not riskless, but depending on the reserve asset, may entail less credit and liquidity risk than relying on a settlement asset issued and backed by a private entity) that is worth considering where wCBDC is not available and/or where a settlement option more prone to enabling innovation may be required.

Interoperability, porting and cross-border implications

In the PoC, wCBDC was exported to the Khokha Hub and imported back to wCBDC Zone utilising the bridge between the two DLT networks. In this way, the use of wCBDC was enabled on a non-native network. A similar operation already happened in decentralised finance (DeFi) where similar mechanisms are used to lock bitcoins and issue an Ethereum-based token against that value. Even though it is possible to port wCBDC between networks, there are several unanswered questions and risks, including technical risks related to the security and reliability of the bridge. The use of wCBDC on non-native networks should primarily be informed by a central bank's policy position, with adequate technical controls put in place to enforce that position.

Further consideration should be given to the concept of porting tokenised assets. For instance, the porting enables the emigration and use of other central bank issued value, as evidenced in the creation of the FDM Tokens, which could be used on other non-native networks. Aside from considering where issued assets may be migrated to, operators of TTPs should consider what they want to be imported onto their platforms. It is possible to import a wide array of tokens – for instance, ranging from foreign wCBDCs to crypto assets, enabling potentially a complex array of transactions and new innovations.

Policy and regulatory implications

The next section will explore the policy and regulatory implications identified as a result of the work conducted in the PoC. It will cover a general discussion followed by highlighting specific policy considerations.

General discussion

Aside from having to justify its adoption from a return-on-investment perspective, having certainty of how the component parts of DLT-based markets would be treated from a legislative or regulatory framework perspective could aid in the use or adoption of DLT-based token markets. A perpetual challenge for regulators is that advances in technology come quickly and regulators have to respond to their impact. However, this impact is often not immediately clear. There have been two broad approaches that regulators around the world have taken in responding to the development of DLT-based markets. The first approach has been to consider these innovations under the existing laws or regulatory dispensation; and the second has been to issue clarification or guidance where the existing laws do not clearly apply; or to develop new regulatory frameworks (OECD, 2021).

Even in following an activity-based approach to regulation, it is important to not be technology blind, particularly as the decentralised nature of DLT and its implications raise several questions which challenge existing policy and legislative or regulatory frameworks. The component parts in the debenture token market, that is, the wCBDC, wToken, debenture token and the Khokha Hub, all pose different policy, legal and regulatory challenges. In particular, how emerging risks, arising from disruptions to existing functions, business models or infrastructures ought to be accommodated into new or existing regulatory frameworks.

Policy considerations

The section below will highlight some of the policy considerations based on the experience in running the PoC, including raising questions, identifying gaps and suggesting responses.

Wholesale central bank digital currency considerations

The wCBDC in the PoC was set up to be an alternate form of wholesale central bank money, equivalent to money in a settlement account in the SAMOS system. The use of DLT means that the settlement asset, the account with the central bank as well as the settlement system are all embedded on a single platform.

The issuance of a wCBDC would require consideration of its impact on the mandate and legal framework of the central bank. A question for further exploration is whether it is legally permissible to use distributed ledgers for trading, clearing and settlement of securities. In addition, the legal status of the wCBDC token, the legal standing of wCBDC wallets as accounts with the central bank and the viability of designating the wCBDC's DLT as a settlement system merit further reflection and analysis. The expectation is not that central banks would replace their existing RTGS systems with fully DLT-based systems, but that consideration be given to how such systems co-exist with DLT-based systems.

PK2 showed that it is possible to port wCBDC between its native network and a non-native network. However, it also highlighted challenges which this may entail, including creating a split between legal and operational/technical settlement. This raises the question around the desirability of porting. Furthermore, the feasibility of porting assets and creating derivative instrument raises a broader question, which central banks need to reflect on – what is the central bank's role in new the innovative markets? It is therefore important for the central bank to experiment with new technologies to gain deeper insight into the potential changes that DLT may introduce in order to take informed decisions on the changing financial markets architecture and the role of the central bank in the future system.

Continued exploration, both on technical trials as well desktop research and analysis, is required to make informed and data-driven decisions on the potential implementation of wCBDC. Should a decision be taken to implement wCBDC, it would make more sense to designate the wCBDC arrangement as a settlement system to fully benefit from, atomic swaps for instance, and to use the wCBDC on its own platform for the full benefit of both technical/operational and legal settlement. Collaboration and continued engagement with industry remains imperative in considering any changes to be implemented to ensure a safe, stable and pertinent public good in the form of wCBDC.

Wholesale digital settlement token considerations

Like wCBDC, the policy imperative for allowing commercial bank entities to issue wTokens in production should be clear before permitting its use within regulated financial services. Considerations would include whether there is benefit to industry in its adoption (such as providing a safer settlement option in markets where wCBDC is not available) and what the costs may be (including the implications, should such a system fail). The wToken implemented in the PoC could be defined as a stablecoin used for wholesale settlement, and the policy response to wTokens would therefore have to align with broader regulatory approaches to stablecoins.

Should the central bank decide to allow wTokens into production, some of the practical considerations would be whether to designate such arrangements as an alternate settlement system and/or how such payment systems should interface with the RTGS system (for instance, through end-of-day settlement). Further considerations would include the potential systemic importance of the wToken and its governance and operating models. A key difference between stablecoins is in the various stabilisation mechanisms (at a high-level distinguishing between stablecoins whose value is linked to other assets and those that are not), and which reserve assets are used. The Khokha Token used central bank money as its reserve asset which, along with strong verification of its one-to-one backing, would carry less risk and may more likely receive regulatory preference than the one backed by lower quality assets.

Where an activity-based approach is followed, regulation of new forms of private 'money' should consider how existing forms of private 'money' are regulated, including prudential regulation as with commercial banks who issue private 'money' through credit extension. Since a DLT-based wToken could also be considered as a payment system in FMI parlance, further consideration would need to be given to the application of the PFMIs to such an arrangement, depending on its systemic importance. **A systemically important stablecoin arrangement, primarily used for making payments (transferring tokens between users), would be expected to adhere to all the relevant PFMIs, in line with the recommendations from relevant international standard setting bodies.** Some of the challenges stablecoin arrangements pose to PFMI compliance stem from its ability to use settlement assets and not central bank or commercial bank money; the interdependency between multiple stablecoin arrangements; the level of decentralisation of operations and governance; and its ability to scale (CPMI-IOSCO, 2021: 4). An example of some of the pertinent PFMIs, including a subset identified in the recent consultative report by the Committee on Payments and Market Infrastructures (CPMI) and Board of the International Organisation of Securities Commissions (IOSCO) (2021), include:

- PFMI 1 requires an enforceable legal basis for all material activities. At present, this may be problematic in South Africa, until it is determined how a wToken would be defined in law. This may include its treatment under the Financial Markets Act 19 of 2012 (FMA), the National Payment System Act 78 of 1998 and the future crypto regulatory framework, following on from the publication of the Crypto Asset Regulatory Working Group (CAR WG) policy position.

- PFMI 2 requires clear and transparent governance methods. Compliance with this principle would look quite different with more decentralised governance methods. The governance structure of the wToken would have to show how it complies with the requirements, whereas regulators would have to gain an understanding of alternate governance models. The ownership structure and operation should allow for direct and clear lines of responsibility and accountability, for instance, being owned and operated by legal entities controlled by natural persons (CPMI-IOSCO, 2021: 5).

- PFMI 3 requires comprehensive risk management, including regularly reviewing risks material to the functioning of the wToken (stablecoin) arrangement and developing appropriate risk management frameworks and tools (CPMI-IOSCO, 2021: 5).

- PFMI 8, on settlement finality, requires clear and final settlement, irrespective of the operational settlement method used – which may include clearly defining the point at which technical settlement is achieved and making it clear where technical settlement is not aligned with legal finality (CPMI-IOSCO, 2021: 5).

- PFMI 9 requires settlement in central bank money – where practical and available. Therefore, where central bank money is available it may be difficult to justify the issuance of a wToken. The principle, however, does not exclude the issuance of a wToken, but does, for instance, indicate that a key consideration, where central bank money is not used, is that the settlement asset should have little or no liquidity or credit risk. Considerations would include whether the arrangement provides its holders a direct legal claim on the issuer and/or any rights to the reserve asset for timely convertibility, at par, into liquid assets – including claims on a central bank (CPMI-IOSCO, 2021: 5).

From a national payment system perspective, allowing various alternative settlement system options may have an impact on liquidity in the SAMOS system, if money in settlement accounts is used to buy wCBDC and/or back wTokens. Similarly, introducing too many alternate options into the national payment system may fragment the system, unless a multi-settlement asset system can be created where different options 'plug-and-play' into the overall system.

Security token considerations

The debenture tokens issued in the PoC were issued by the central bank, which may in some instances affect its regulation. However, the discussion in this section will focus on security tokens in general (unless reference is specifically to the debenture token). The tokenisation of securities can take one of two forms: (i) security tokens, which as with the debenture tokens entail issuing the security directly on DLT where the token is the security; or (ii) tokenised securities, where an existing security is tokenised or encapsulated in a token wrapper. The implications between the two may differ in that, tokenised securities will have to provide verification of the legal right to the underlying asset and the fact that it is ring-fenced for purpose of tokenisation. Tokenisation enables different use cases such as fractionalisation as with the FDM Tokens. The use of smart contracts further enables the automation of actions linked to securities on DLT, such as the automatic settling of obligations at maturity. The tokenisation of securities is still at emerging stages, as can be seen from developments in DeFi.

There are several open questions surrounding tokenisation of securities, including how they may fit within public policy objectives and how that may impact on the regulatory treatment of the tokenisation of securities. Security tokens are not currently defined in the FMA, which makes their regulatory treatment uncertain. The FMA is currently under review and further discussion and consideration should be given to the regulatory treatment of security tokens and tokenised securities or at the very least updating the legislation in such a way that it enables an anticipatory agile and adaptive framework, which makes it easier to bring appropriate emerging asset classes and new forms of issuing existing asset classes into the regulatory perimeter. Updates to any piece of legislation should consider the overall legislative framework for financial services to avoid causing misalignment in regulatory responses. In addition, as consideration is currently being given to developing a crypto asset regulatory framework, following the publication of the IFWG crypto assets position paper (CAR WG, 2021), it would have to be clarified how such a future regulatory framework would interact with the securities regulatory framework, for instance, whether the issuer of a security token (also applicable to the issuer of a settlement token) would fall under the definition of a token issuer as contemplated in the crypto assets position paper.

Decentralised DLT-based token trading platform considerations

The establishment of the debenture token market, particularly the Khokha Hub, reflected the ability of DLT-based design to combine the components of financial markets in new and innovative ways. An initial policy response might be to allow such composition if the new market infrastructures meet the regulatory requirements for the different activities it performs, such as operating a platform which acts as an exchange, CSD, SSS and PS.

However, not all instances may be that straightforward. The composability of role players and market infrastructures may result in an environment like the Khokha Hub, where the SARB issued its debenture tokens, and a consortium of commercial banks issued its wToken. Such a structure would increase the complexity of determining who is accountable when things go wrong and ensuring the integrity and privacy of data, and the continued stability of the system. Such a model would also raise questions as to how the different modules or components of the TTP are governed. In the PoC, it was envisioned that the Khokha Hub would be owned by a consortium of industry participants with a more decentralised governance model, however, any of the individual participants, such as a stock exchange or CSD, could (theoretically) establish a token trading platform. The ownership and governance structure would affect the ability of the platform to comply with requirements such as those set out in the PFMIs. These structures would have to define clear rules of the game on the platform – like defining rules, obligations and accountability for token issuers on the platform, in line with any further requirements as may be specified in relevant legislative requirements or as specified by regulatory authorities.

Concluding thoughts on implications

This section of the report considered some of the business and operational implications of tokenisation in financial markets, and the fact that it enables business innovation through the DLT-based decentralised financial market infrastructures. There is no expectation that there would be an immediate, nor full, transition to tokenised markets, particularly in the short term, but, more likely, that DLT-based markets would continue to develop alongside existing financial markets. Tokenisation and DLT-based decentralised infrastructure introduced a few complexities and uncertainties in relation to the current legislative and regulatory framework. Several central banks and international standard-setting bodies are exploring the various technological, legal, operational and potentially systemic implications of new technology on the existing functions and architecture of the financial markets, and these learnings underscore the need for a measured and informed response to any adaptations. From a South African perspective, the regulators are cautiously considering developments before implementing regulatory changes, fully appreciative that regulated entities are waiting for regulatory certainty before committing to enter DLT-based token markets. In the meantime, developments in unregulated markets continue to emerge.

In some respects, South Africa faces an opportune time to consider how to treat these DLT-based platforms and the use of tokenisation in the financial markets, as legislative reforms in the payments and financial markets are underway to update the legislative framework in response to market developments and technological innovation. When reviewing and developing new or updated legislative and regulatory frameworks, care should be taken to ensure that legislation is technology neutral and principle based, and should define the desired outcomes and allow for the detail to be further clarified by the relevant regulatory agencies in response to changing market conditions in a manner that is appropriate to the South African environment. Careful consideration is required when developing interconnected frameworks to avoid unintended consequences – and it is envisaged that the policies, mechanisms and legal frameworks will continue to be developed through collaboration between policy makers, regulators and the industry.

CONCLUSION

Project Khokha 2 journey

PK2 sets out to highlight implications of tokenisation in financial markets driven by DLT innovation. Consideration was given to both the tokenisation of existing assets on DLT as well as issuing new assets as DLT-based tokens. Tokenisation was explored through a PoC of the issuance, clearance and settlement SARB-debenture tokens on DLT using a wCBDC for payment in the primary market and a wToken for payment in the secondary market.

The project team was tasked to not just replicate existing processes on DLT, but to design for DLT and re-imagine existing processes in the light of decentralised and modular design principles. The PoC implemented two DLT platforms in a debenture token market, that is, the wCBDC Zone and Khokha Hub. This proved that it was possible to move away from the current centralised financial market architecture to a composable financial market where different financial role players, roles, infrastructures and assets can be built into TTPs in new and innovative ways.

Insights gained along the way

The wCBDC was implemented as central bank money, comparable and equivalent in value and quality to settlement accounts with the central bank. Issuing a token-based wCBDC on DLT created a riskless settlement asset on a platform which also serves as a payment settlement system as well as hosting settlement participants' account, as a wallet on the DLT, with the central bank. It has been established that it is feasible to port – export and import – the wCBDC to other (non-native) DLT-based platforms while maintaining a link back to its own (native) DLT. The wCBDC served as a corner stone to other components on the debenture token market, enabling trade on the market. The Khokha Hub was built as a TTP with its building blocks consisting of a TPP, CSD, SSS and, through porting the wCBDC, elements of the payment settlement system. The modular design of the Khokha Hub enabled the creation of further tokens such as the FDM Token as a synthetic instrument to enable trading of debentures in the secondary market. Both the porting of the wCBDC and the FDM Tokens proved that it was possible to port central bank value to other networks, which would require serious reflection on how to balance the benefits of interoperability between enabling innovation and managing access to central bank assets, in line with policy objectives. Participants have observed that the true benefit and challenge from DLT may not stem from the technology itself, but from the business process innovation it enables. Based on the PoC, although the number of operators could potentially be reduced, the roles and functions did not disappear and therefore existing regulatory frameworks would still apply. The design of the PoC did, however, result in the issuance of DLT-based tokens which are not defined in law and modular design of TTPs and would require further consideration to determine whether and how frameworks may need to be updated. Further work is required to gain deeper technical insights and contribute to the development of informed technology responses.

Possible way forward

The PK2 PoC was completed successfully and it led to some valuable insights on the technological capability – interoperability challenges and the initial legal and policy areas for further exploration.

PK2 also allowed for deeper collaboration between regulatory agencies and the industry, which led to further technical collaboration with industry on decentralised TTPs, pointing to four broad possible directions for further exploration, namely:

The creation of a DLT-innovation acceleration platform with industry for an extended period – which would allow the industry to explore DLT application with participation and oversight of regulators.

Collaboration with other jurisdictions – for instance, building on the SARB's participation in Project Dunbar, multi-wCBDC may be explored with the Southern African Development Community.

A new phase of Project Khokha may be initiated to build on the work done in PK2 – for instance, to perform live transactions in a sandbox environment in a different use case.

Desktop research exploring the implications of DLT-driven innovation on financial markets in more detail, considering possible policy and regulatory responses.

PK2 has continued to **provide a collaborative space** for experimentation with DLT within the industry, **contributing** to the continually **growing body of knowledge** in this area.

Appendices

Appendix 1: List of references

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Appendix 2: Glossary

Blockchain

Blockchain refers to a method of recording transactions in a shared distributed ledger that makes the information immutable using cryptography. The blockchain ensures the validity and integrity of each record in each block.

Central bank money

Central bank money is issued by a central bank and is a liability of the central bank. It may either be physical money (traditionally notes and coin) or digital (traditionally settlement accounts with the central bank). It is either made available to the public (retail use) – traditionally, in physical form or is restricted in use to financial institutions to enable settlement with each other – traditionally, via settlement accounts. Notes and coin can be deemed as a form of token, but with the advent DLT, it enables the creation of a token-based digital form of money (CPMI and MC, 2018). Also referred to as public money in this paper.

Central bank digital currency

A central bank digital currency (CBDC) is a digital form of central bank money which may be issued for either retail (rCBDC) or wholesale (wCBDC) use. CBDC may be either token/value-based or account based (CPMI and MC, 2018).

Central counterparty

An entity that interposes itself between counterparties to contracts traded in one or more financial markets, becoming the buyer to every seller and the seller to every buyer and thereby ensuring the performance of open contracts (CPMI-IOSCO, 2012).

Central securities depository

An entity that provides securities accounts, central safekeeping services and asset services, which may include the administration of corporate actions and redemptions, and plays an important role in helping to ensure the integrity of securities issues (i.e. ensures that securities are not accidentally or fraudulently created or destroyed or their details changed) (CPMI-IOSCO, 2012).

Collateral

An asset or third-party commitment that is used by a collateral provider to secure an obligation vis-à-vis a collateral taker (CPMI-IOSCO, 2012).

Cross-border payment

A payment in which the financial institutions of the payer and the payee are located in different jurisdictions (ECB, 2009).

Crypto asset

A crypto asset is a digital representation of value that is not issued by a central bank, but is capable of being traded, transferred or stored electronically by natural and legal persons for the purpose of payment, investment and other forms of utility; applies cryptographic techniques and uses DLT (CAR WG, 2021). Less formally, referred to as cryptocurrency.

Custodian

An entity that safekeeps and administers securities or other assets for its customers and that may provide various other services, including clearing and settlement, cash management, foreign exchange transactions, securities lending and collateral management (ECB, 2009; CPSS, 2003).

Decentralised finance

The term decentralised finance (DeFi) refers to an alternative financial infrastructure built on top of the Ethereum blockchain. DeFi uses smart contracts to create protocols that replicate existing financial services in a more open, interoperable and transparent way (Schär, 2021).

Delivery-versus-payment

A securities settlement mechanism that links a securities transfer and a funds transfer in such a way as to ensure that delivery occurs if and only if the corresponding payment occurs (CPMI-IOSCO, 2012).

Distributed ledger technology

Distributed ledgers use independent computers (referred to as nodes) to record, share and synchronise transactions in their respective electronic ledgers (instead of keeping data centralised as in a traditional ledger) (World Bank Group, 2018).

Final settlement

The irrevocable and unconditional transfer of an asset or financial instrument, or the discharge of an obligation by the financial market infrastructure or its participants in accordance with the terms of the underlying contract. Final settlement is a legally defined moment (CPMI-IOSCO, 2012).

Financial market infrastructure

A multilateral system among participating institutions, including the operator of the system, used for the purposes of clearing, settling or recording payments, securities, derivatives or other financial transactions (CPMI-IOSCO, 2012).

Gross settlement

The settlement of transfer instructions or other obligations individually on a transaction-by-transaction basis for full value (ECB, 2009).

Interoperability

The technical or legal compatibility that enables a system or mechanism to be used in conjunction with other systems or mechanisms. Interoperability allows participants in different systems to conduct clear and settle payments or financial transactions across systems without participating in multiple systems (ECB, 2009; CPSS, 2003).

International securities identification number

An ISIN is a 12-digit code that is used to uniquely identify a security's issue (e.g. shares and bonds). This is currently the main method of securities identification worldwide. The JSE is the recognised numbering authority for issuing ISINs for South Africa, as authorised by the Association of National Numbering Agencies (ANNA) (JSE, 2022).

International token identification number

The International Token Standardisation Association (ITSA) is developing and implementing an open market standard for the safe and secure identification of cryptographic tokens. An ITIN involves the assigning of a 9-digit alphanumeric identifier to all types of cryptographic tokens for an unambiguous identification, decreased operational risk and increased transparency (ITSA, 2021).

Native network

A native network is the network upon which a token is issued on and is inherent/native to. A non-native network is any other network or distributed ledger.

Netting

Netting is the offsetting of obligations between or among participants in the netting arrangement, thereby reducing the number and value of payments or deliveries needed to settle a set of transactions (CPMI-IOSCO: 2012).

Pledge

The delivery of assets to secure the performance of an obligation by one party (the debtor or pledgor) vis-à-vis another (the secured party or pledgee). For the secured party, a pledge creates a security interest in the assets delivered, while ownership of the assets remains with the debtor (however, in certain jurisdictions, irregular pledge arrangements include the transfer of ownership) (ECB, 2009; CPSS, 2003).

Real-time gross settlement

The real-time settlement of payments, transfer instructions or other obligations individually on a transaction-by-transaction basis (CPMI-IOSCO, 2012).

Appendix 3: Abbreviations

API	Application Programming Interface
BdF	Banque de France
BIS	Bank for International Settlements
BISIH-SC	Bank for International Settlements Innovation Hub – Singapore Centre
BMA	Block Markets Africa
BoC	Bank of Canada
BoT	Bank of Thailand
CAR WG	Crypto Asset Regulatory Working Group
CBDC	Central Bank Digital Currency
CCP	Central Counterparty
CPMI	Committee on Payments and Market Infrastructures
CPSS	Committee on Payment and Settlement Systems
CSD	Central Securities Depository
CSDP	Central Securities Depository Participant
DApps	Decentralised Applications
DeFi	Decentralised Finance
DEX	Decentralised Exchange
DLT	Distributed Ledger Technology
DSD	Decentralised Securities Depository
DSDP	Decentralised Securities Depository Participant
DTCC	Depository Trust and Clearing Corporation
DvP	Delivery-versus-Payment
EIB	European Investment Bank
FDM	Fractionalised Debt at Maturity
FIC	Financial Intelligence Centre
FINMA	Swiss Financial Market Supervisory Authority
FMA	Financial Markets Act
FMD	Financial Markets Department
FMI	Financial Market Infrastructure
FSCA	Financial Sector Conduct Authority

HKMA	Hong Kong Monetary Authority
IFWG	Intergovernmental Fintech Working Group
IOSCO	International Organization of Securities Commissions
ISIN	International Securities Identification Number
ISO	International Organization for Standardization
JSE	JSE Limited
MaFISI	Maturity Financial Instrument Settlement Instruction
MAS	Monetary Authority of Singapore
NNA	National Numbering Agency
NPS	National Payment System
NFT	Non-Fungible Token
NT	National Treasury
OECD	Organisation for Economic Co-operation and Development
OTC	Over the Counter
P2P	Peer-to-Peer
PFMI	Principles for Financial Market Infrastructure
PK1	Project Khokha phase 1
PK2	Project Khokha phase 2
PoC	Proof-of-Concept
PS	Payment System
PvP	Payment-versus-Payment
rCBDC	Retail Central Bank Digital Currency
RTGS	Real-Time Gross Settlement
RTL	Real-Time-Line
SAMOS	South African Multiple Option Settlement (system)
SARB	South African Reserve Bank
SDX	Six Digital Exchange
SNB	Swiss National Bank
SSS	Securities Settlement System
TR	Trade Repository
TTP	Token Trading Platform
wCBDC	Wholesale Central Bank Digital Currency
wToken	Wholesale Digital Settlement Token

Appendix 4: Application engines

The application engines used in the proof-of-concept, that is, the combination of DLT modules and centralised systems which performed the required business process logic and used for the various functions utilised in the debenture token market included:

- Centralised **SAMOS and ISIN** were used to abstract the complexity of integrating to these systems and provided a simulation of the real-world links to the RTGS system and the National Numbering Agency.

- The **wCBDC engine** interfaced with the SAMOS simulator and DLT modules on the wCBDC Zone to facilitate the creation of wCBDC.

- The centralised **wCBDC bridge** was implemented as DLT modules on both the wCBDC Zone and the Khokha Hub to safely transfer wCBDC with fail-forward redundancy.

- The centralised **debenture engine** simulated the auction process, interfacing with the **debenture token module** on the Khokha Hub to issue and settle debentures on DLT.

- The **Khokha Token engine** interfaced with the **SAMOS simulator** to earmark funds as collateral, and with the **Khokha Token module** on the Khokha Hub DLT to lock and unlock collateral for Khokha Tokens, and to manage the redemption, netting and liability of these tokens.

- The **maturity engine** was a Khokha Hub DLT module that executed maturity settlement, recorded pledges against maturity to create synthetic liquidity, and performed maturity actions – including claims on the created synthetic liquidity for wCBDC at maturity.

- The Khokha Hub **DEX** DLT module was used for P2P DEX traded debenture synthetics, exchanging one token for another at a rate of exchange determined by a **P2P order book**.

Appendix 5: Acknowledgements

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