

Project Victoria

Settlement of Tokenised Assets with Hypothetical e-HKD



Participants



Supporting Partners



Foreword

In the hype-cycle of blockchain and DLT we often hear views on the “killer blockchain use case or app” and “Our blockchain solves this...” - the reality is that the true power of blockchain is interoperability and enhanced composability - multiple technologies working together, seamlessly, without risks that traditional technology integrations and business models always introduce, providing end-to-end integrity and transparency built implicitly into the transaction across these numerous data records, participants and systems. Project Victoria was established to bring together leading financial technology using tokenization and decentralised operating models to demonstrate value that can be added through a home lending use case, in particular using a hypothetical e-HKD.

The world is becoming infinitely more digital, more interconnected and countering the complexity this introduces will be important to continuing growth of prosperity for all stakeholders and ensuring an equitable distribution of benefits into the future. Tokenisation and decentralised operating models - which may be applied through a hypothetical e-HKD - can enable a new form of interoperability, one in which many systems and processes can be connected yet have the processing attributes of a single system (integrity, certainty, traceability, auditability) and importantly a similar risk profile rather than the escalating risks connecting systems and processes result in today. These new technologies and practices will be important in countering the complexity and maximising the privileges we all will have in this future world.

We believe the Fubon Bank HELOC Loan using these technologies and practices provides an example of this, and the implementable MVP we have created through Project Victoria provides an early yet important proof-point.

We would like to thank HKMA for selecting us as part of the e-HKD Pilot Programme as well as our supporting partners who have been critical in enabling the outcomes Project Victoria has achieved.

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Executive Summary

Central bank digital currencies (CBDCs) have emerged at the forefront of financial innovation with striking and transformative momentum in recent years, with many of the world's central banks launching initiatives to consider the technical and policy requirements for implementation. In Hong Kong, this has taken the form of the Hong Kong Monetary Authority's (HKMA) Project e-HKD Project, which seeks to explore the potential of a retail CBDC for the global financial centre.

Ripple, Fubon Bank and partners have contributed to this exploration of the hypothetical e-HKD through the development of a use case through the HKMA's e-HKD Pilot Programme, which seeks to elucidate the potential benefits of an e-HKD and the requirements for implementing the e-HKD as a CBDC.

A Home Equity Line of Credit (HELOC) credit facility using hypothetical e-HKD and asset tokenisation was presented to demonstrate how a blockchain-based CBDC could interact with other parts of an on-chain CBDC ecosystem. Several prominent technology companies' components were needed to deliver this HELOC loan solution. KodeLab designed the lending protocol and UI, TOKO created the asset tokenisation engine, Hex Trust offered regulated digital asset custody, and BCW Group supported DLT infrastructure.

The HELOC loan solution allows existing bank mortgage customers to open a revolving credit facility, releasing the equity in their home, with the funds paid out in hypothetical e-HKD. Consumers benefit through a simple process to quickly access hypothetical e-HKD, and banks benefit through business process re-engineering to allow the use of on-chain lending protocols.

As part of the pilot development efforts, the Project Victoria team noted several insights and learnings for developing CBDCs, from which the HKMA can draw when considering the implementation of the hypothetical e-HKD. Findings were considered in three areas: deploying a CBDC, tokenisation of assets and wider CBDC ecosystem factors.

CBDC deployment is complicated by policy, technical, and financial ecosystem interests. The Ripple CBDC Platform is flexible enough for commercial banks like Fubon Bank to issue a hypothetical e-HKD based on wholesale CBDC reserves, tokenised deposits, or other solutions or act as customer onboarding points onto the central bank's CBDC solution.

In a closed, limited ecosystem, tokenising the bank's lien on the property was an effective first step towards tokenising property, but in a future potential implementation land registry tokenisation would be more beneficial. This re-engineering of bank lending could enable more tailored loans at scale for unaddressable or unserviceable customer segments.

As part of the ecosystem transition, the HELOC loan solution brings benefits to customers first and foremost, but also brings benefits to other stakeholders including financial institutions. Consumer surveys performed concurrently with the pilot demonstrate that providing consumers

with an e-HKD can support CBDC use cases in payments, insurance, investments and public interest. Creating a new payment rail can also spur business process re-engineering to break down data silos and help realise the potential benefits of an e-HKD should it be issued.

The HELOC loan solution developed as part of the HKMA's e-HKD Pilot Programme is a reminder of CBDCs' potential and the constraints of creating them in global financial hubs like Hong Kong. Ripple, Fubon Bank, and partners are happy to offer this white paper's insights and learnings to support the HKMA's work on CBDC solutions that will benefit Hong Kongers' businesses and potentially unlock new economic drivers in the near future.

1. Introduction to Project Victoria

1.1 Background: HKMA e-HKD Pilot Programme

The Hong Kong Monetary Authority (HKMA) has initiated the e-HKD Pilot Programme as part of a multi-year exploration journey of central bank digital currencies (CBDCs), which started in 2017 and continues as part of the Fintech 2025 Strategy.

Thinking on the e-HKD has developed through multiple research projects in collaboration with leading institutions, first focusing on the wholesale application and benefits of CBDCs for interbank and cross-border payments with Project LionRock then Project mBridge, before turning to retail applications with Project e-HKD [\[1\]\[2\]](#).

Project e-HKD started in 2021 with two rounds of market consultations. Based on the responses, the HKMA set out their three-rail approach to prepare for the potential implementation of a retail CBDC, i.e. an e-HKD.

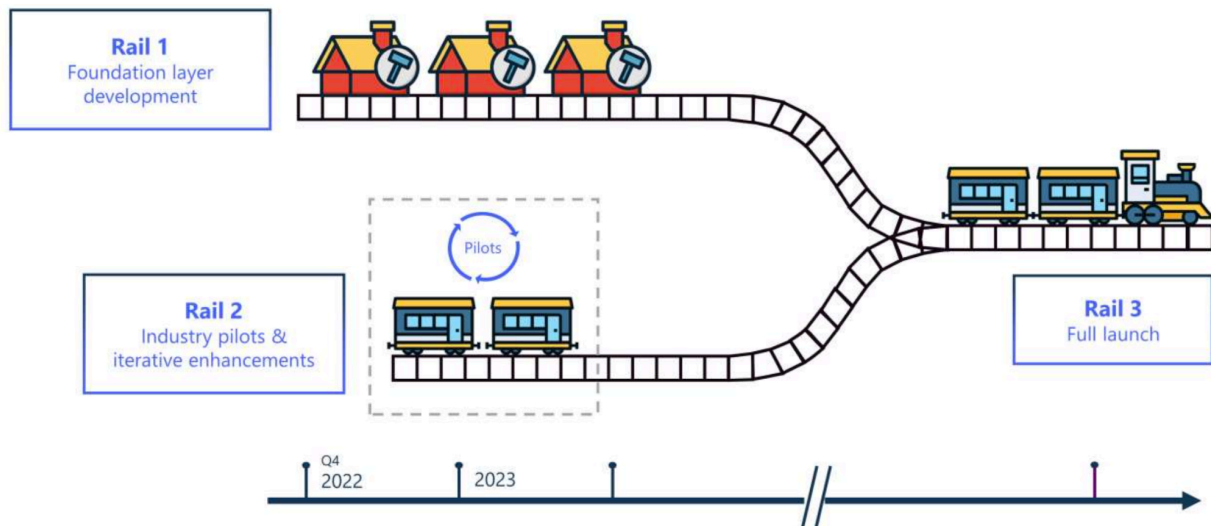


Figure 1. The HKMA's three rail approach for the potential implementation of an e-HKD. [\[3\]](#).

While Rail 1 means to analyse and define the technology and legal foundations for supporting the potential future implementation of an e-HKD, the e-HKD Pilot Programme under Rail 2 entails a deep dive into the application, implementation, and design issues relating to an e-HKD.

This pilot programme aims to enable the industry to examine the commercial viability of use cases for an e-HKD, with a view to gaining actual experience through novel, innovative use cases which should have a meaningful impact on citizens and financial landscape in Hong Kong. Ultimately, these use cases should highlight the benefits that a retail CBDC could bring in Hong Kong should it be implemented. A total of 14 pilots were conducted under Phase 1 of the programme.

Projects proposals for the e-HKD Pilot Programme were invited into the programme by the HKMA based on each applicant's ability to demonstrate that their e-HKD based use case is, Hong Kong centric, at the forefront of innovation, consumer centric, readily testable, and regulatory compliant^[4].

Companies selected to participate in Phase 1 included various banks and financial institutions as well as fintech, payment and technology companies. Fubon Bank and Ripple were selected to showcase their joint innovative solution combining CBDC (hypothetical e-HKD), tokenised real estate and CeFi/DeFi protocols using a combined Ripple CBDC Platform (built on XRP Ledger technology) and EVM Sidechain blockchain infrastructure and technology from a consortium of partners. The use case and solution developed have been delivered through Project Victoria.

1.2 Project Victoria Objectives

Ripple and Fubon Bank have combined to explore the possibilities of CBDCs and asset tokenisation as enabled by distributed ledger technology and a hypothetical e-HKD established for the purposes of the HKMA's Rail 2 e-HKD Pilot Programme.

As part of this program, the Project Victoria consortium led by Ripple and Fubon Bank, have designed and built a Proof of Concept (PoC) solution for a revolving home equity line of credit (HELOC) facility, utilising hypothetical e-HKD for settlement and asset tokenisation to represent the bank's interest in the mortgaged property. Combining these two concepts represents a new test for the implementation of CBDCs and is an exciting learning opportunity for the e-HKD Pilot Programme.

The proposed HELOC loan facility, fulfilled using hypothetical e-HKD, is intended to enable bank customers to unlock home equity more easily and with enhanced opportunities to integrate in many ways to a more digitised and interconnected economy. This use case was proposed as it represented a unique opportunity for the HKMA, banks and Hong Kong consumers to explore the combined benefits of CBDCs and asset tokenisation in a way that can bring tangible benefits to all stakeholders and the economy more broadly.

The Project Victoria use case can only be enabled through the integration of several decentralised technology capabilities. In forming this use case we established a partnership of best-in-class providers across each of these financial service and technology needs:

- **Ripple:** Decentralised Infrastructure and CBDC Platform
- **Fubon Bank Hong Kong:** Regulated Financial Services
- **KodeLab:** Decentralised lending protocol
- **Toko:** Real-world asset tokenisation (property / lien)
- **HexTrust:** Custody technology and services
- **BCW:** Program and technology management

Based on the exploration of the intended benefits of the HELOC loan facility for all stakeholders and the need to bring together multiple separate innovative technologies, Project Victoria has several specific objectives:

- Understand the existing awareness of direct participants (consumers and bank operations staff), identify and validate specific aspects of the HELOC loan facility and solution which will provide perceived benefits to those participants
- Demonstrate an end-to-end working solution for the HELOC loan facility bringing together hypothetical e-HKD, tokenised forms of real-estate property and a decentralised lending protocol
- Measure the working implementation against the validated direct benefits, and determine if they can be realised and any gaps which need further development
- Assess the broader implications of the use case beyond those to direct participants, including suitability to different financial architectures for the hypothetical e-HKD (retail)
- Provide guidance on the shortcomings of the initial implementation, improvements that can be included in the future and how future developments can enhance the ability to meet both direct participants and broader benefits

1.3 Project Methodology

Exploration of the Project Victoria use case involved the execution of three major workstreams, namely, solution design, PoC build, and public engagement.

Solution design related to the conceptualisation and development of an ideal solution for the HELOC & hypothetical e-HKD use case, integrating the leading services from each of the consortium members. Major activities included workshoping of the solution, engagement with stakeholders on real estate tokenisation and technical delivery project management. Specifically workshops were conducted with the project team to assess the technical, regulatory and commercial feasibility of combining the leading offerings into a comprehensive end to end solution.

Creating a tangible implementation of this design involved the build of a PoC instance of the use case to demonstrate the feasibility of the solution and provide a live demonstration for the HKMA and the Hong Kong public through the consumer engagement activities. A common infrastructure was built and each consortium member integrated their solution to demonstrate an end to end flow from a bank customer perspective, giving an immersive experience of the use case. Integration of the technologies involved some cases of tactical compromises, each clearly identified and assessed for impact to user experience and how they could be feasibly remediated in a full strategic implementation.

Lastly, the project surveyed consumer and bank operations sentiment toward the solution and interest in the e-HKD as a viable consumer form of value and payment. Through the results of

these surveys and assessment with the solution design and PoC, the undertaking extended to provide comprehensive feedback on the whole project to the HKMA and the public through the form of this white paper and companion design paper. To assist in communicating the potential use case to a wider audience a promotional video was created, highlighting the potential of hypothetical e-HKD and HELOC loans.

2. Proposed Use Case & Solution

Fubon Bank and Ripple have proposed the implementation of a Home Equity Line of Credit (HELOC) facility which combines a hypothetical e-HKD, tokens representing the Hong Kong real estate legal title (i.e. legal or equitable mortgage or floating charge) and a financial lending protocol to enable Hong Kong citizens to more easily and quickly access funds based on the excess equity in their properties.

2.1 HELOC Loan Use Case

In Hong Kong, a large number of homeowners have significant equity in their homes. This equity has been built as a result of a number of factors, primarily due to the nature of the loans, whereby a customer makes principal repayments, thus creating equity, and also as a result of prudential measures which have required low Loan to Value (LTV) ratios, limiting the amount of borrowing.

Therefore, banks, such as Fubon Bank, have a considerable number of customers who could draw on the equity in their homes as a secured and efficient line of credit, potentially replacing other riskier unsecured personal loans while creating new lending opportunities.

It is expected that both consumers and banks would benefit from a HELOC solution combining hypothetical e-HKD and tokenised mortgages.

Consumers would benefit from increased availability and ease of access to loans secured by excess equity. This would lead to a great number of benefits, including

- A fully online, streamlined channel to access new funds based on existing equity (effectively making property more liquid)
- Lower borrowing costs: Consumers would have access to a secured loan facility for which a bank could offer a lower rate relative to current alternatives
- Faster approval of loans and drawdown facilitated 24x7 with real-time availability of funds
- More flexible and dynamic loan parameters and real-time metrics (including real-time interest accruals)

The use of hypothetical e-HKD and tokenised forms of real-estate will also improve traceability across the end-to-end loan lifecycle deriving benefits beyond the single use case, in particular providing irrefutable proof of important consumer aspects such as availability of funds, source of funds and serviceability capabilities.

Expected benefits to banks include reduced risks and operational efficiencies throughout the entire loan lifecycle. These primary benefits will provide greater flexibility and scalability in the lending markets, enabling the facilitation of more customised loans at a greater scale and increased access to lending markets for customers that are not currently accessible or serviceable.

2.2 Customer Journey

In considering the HELOC process from the customer perspective, the project team identified four key steps or functionalities required. These are loan application, drawing on the loan, repaying the loan and loan closure.

As a revolving credit facility, these steps occur in both a linear and cyclical fashion. Loan application and loan closure bound the process, while the draw and repayment steps can overlap and/or repeat, and the customer might keep the facility open even if they are not currently borrowing.

A step zero was also included in the scope to cover the issuance and inventory management of the hypothetical e-HKD, which captured the processes an issuer (such as Fubon Bank or the HKMA) would undertake to support funds for the HELOC user journey.

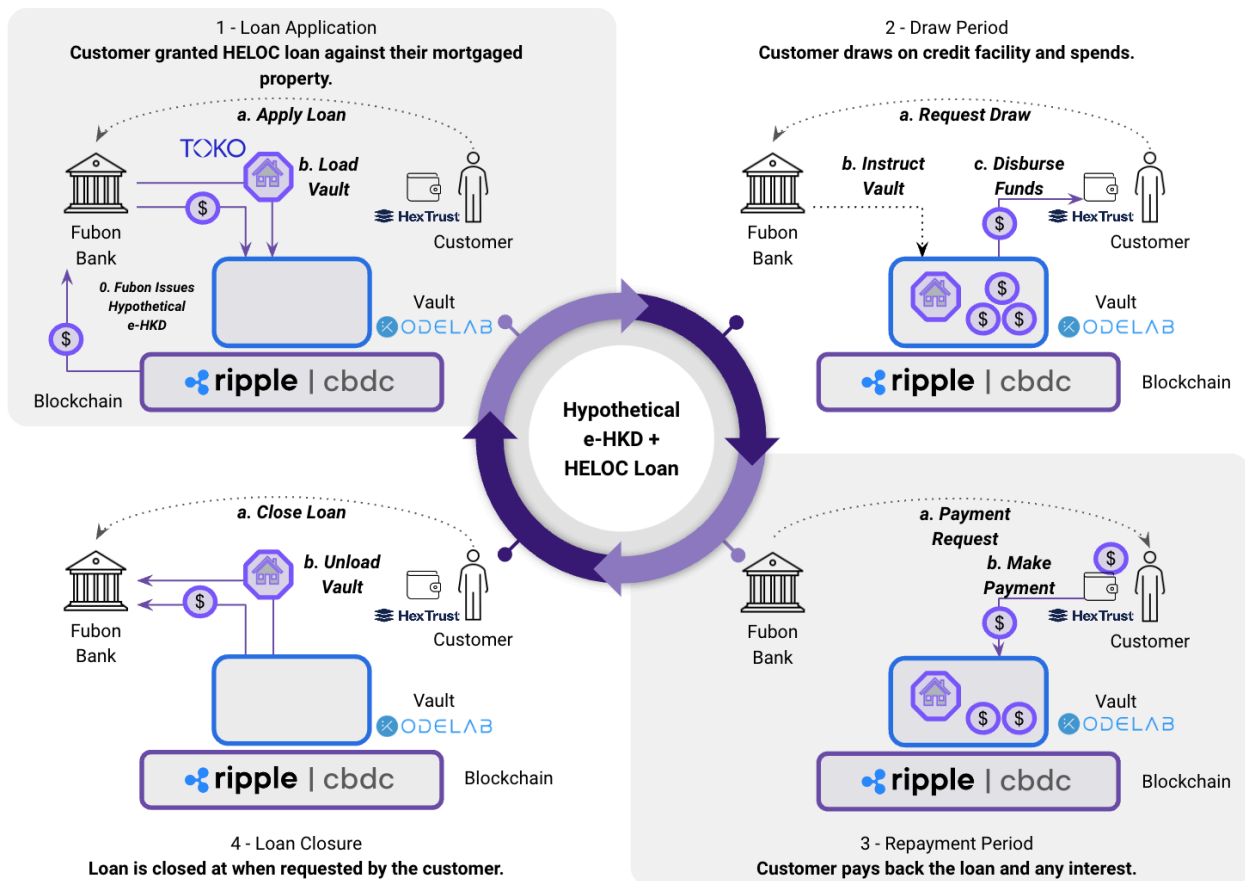


Figure 2. HELOC loan lifecycle and user journey steps.

The flows can be summarised as follows, with each of these steps further elaborated in the companion Project Victoria Design Specification paper:

(0) Minting of Hypothetical Retail e-HKD

Digital funds are pre-minted and distributed in preparation for disbursements by Fubon Bank through a secure process with multiple authorised operators and multi-sig functionality built into the underlying Ripple CBDC ledger:

- The funds that Fubon Bank shall draw upon to back e-HKD issuance is to be explored - see [Section 4](#) for further considerations across this.
- The functionality of the Real Estate tokenisation and HELOC loan use case extends to the possibility of HKMA directly issuing a retail e-HKD (in which case the HKMA could use the Ripple CBDC Platform to mint and distribute hypothetical e-HKD).

(1) Loan Application

Existing Fubon Bank Users access the HELOC function through the bank application, which is located within the Fubon Bank online banking, this provides a loan offer based on the existing property already held in mortgage with the bank. If accepted:

- A CBDC wallet will automatically be created for the user
- If not already created, a tokenised version of the lien on the underlying property will be created and allocated to the user
- The property lien token will be transferred to the loan protocol and used to setup a loan facility ready for disbursement

(2) Draw Period

The user will be able to drawdown hypothetical e-HKD funds at their discretion (24x7) with real-time availability of funds for use in their wallet. The vault established by the lending protocol will include a cryptographic record for each drawdown against the loan (and property lien) and manage the loan parameters set by Fubon Bank. Real-time details, including current LTV (Loan to Value Ratio), real-time accrual of interest, repayment schedule and others, will be made available and provided to the user through the Fubon Bank customer channel.

(3) Repayment Period

Repayment can be performed at the user's discretion or via an automated function, transferring available hypothetical e-HKD funds from the user's wallet back to the lending protocol. Interest is repaid as part of this process - initially calculated and accrued in real-time, and paid down as priority ahead of loan principal.

(4) Loan Closure

Once all funds are repaid, the user can choose to close the facility, which will verify the final full repayment and release the lien token back to a bank wallet, ready for reuse in another facility based on user instruction.

2.3 Design & Architecture

The key architectural components were broken down logically and aligned with the solutions provided by each of the Project Victoria consortium members as follows:

- Decentralised infrastructure and CBDC Platform - Ripple CBDC Platform and EVM Sidechain
- Lending protocol - Kodelab lending protocol
- Real-world asset tokenisation (property / lien) - TOKO tokenisation engine
- Custody technology and services - Hex Trust custody services

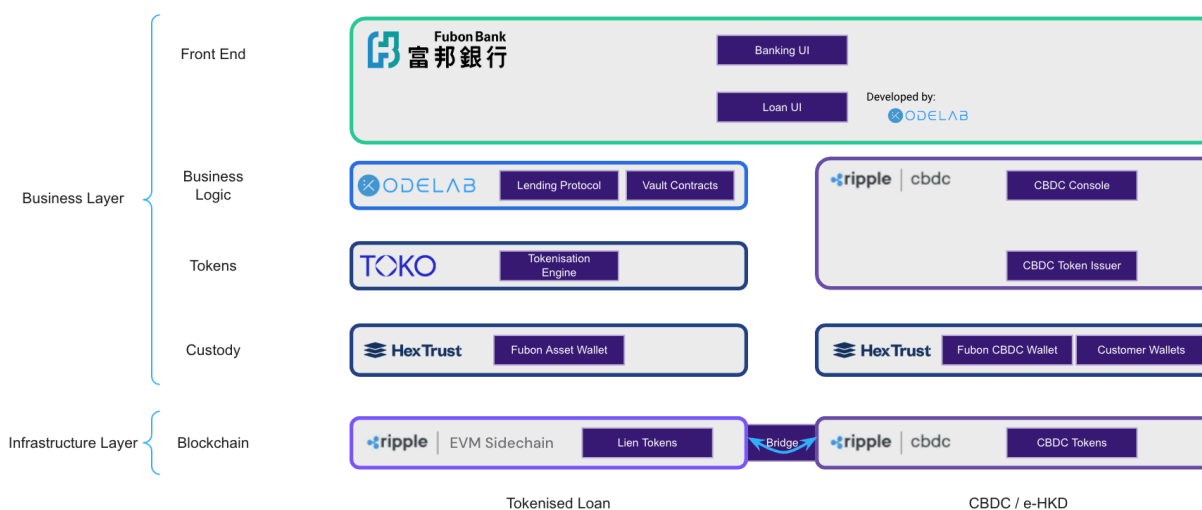


Figure 3. Solution architecture.

A brief description of each component is given below, with greater detail covered in the companion Project Victoria Design Specification paper.

CBDC Platform

The Ripple CBDC Platform provides the tools required to issue and manage a digital currency for each of the participants involved. This full-stack platform considers the specific actions users take at each stage of the CBDC lifecycle. The foundation for this product set is the understanding that a CBDC issuance creates a new currency ecosystem and that users will have different needs for engagement channels and underlying infrastructure when participating in that ecosystem. The Ripple CBDC Platform consists of multiple products which support the CBDC lifecycle phases and associated actions highlighted below:



Figure 4. Ripple CBDC solution steps.

To implement the hypothetical e-HKD for Project Victoria, Ripple has deployed a custom, private version of its CBDC Platform consisting of the Digital Currency Issuer, a private CBDC ledger and an EVM Sidechain. The Ledger and Issuer components provide the efficient, secure basis for operating a digital currency, such as the hypothetical e-HKD. The EVM sidechain architecture includes a decentralised layer logically separate but cryptographically synchronised with the CBDC Ledger, on which the loan business logic is implemented as smart contracts interacting with the hypothetical e-HKD. This architecture enables the use of separate fit-for-purpose ledger implementations for value management and exchange (prioritising stability, predictability, connectiveness) as well as innovative business logic (prioritising flexibility, innovation and open functionality), whilst maintaining the primary characteristics (security, transparency, auditability, governance) of the decentralised platform as a whole.

Lending Protocol

The lending protocol for Project Victoria was developed as a bank grade implementation of DeFi lending protocol concepts and consisted of a smart contract structure which exists on the CBDC Solution at the ledger level, a middleware layer governing the smart contracts and orchestrating the activities of other components such as tokenisation and custody actions and finally a user interface which would be deployed within the Fubon Banking environment. Kodelab developed these components in an integrated manner to provide a seamless user journey familiar to users and deployable for a commercial bank

Tokenisation Engine

TOKO is responsible for the token issuance onto the selected network protocol. Using the data provided by the HELOC application, TOKO deploys the NFT ERC-721 smart contract to the EVM chain and mints the token representing the HELOC loan, ensuring that the token accurately reflects the loan's attributes and legal agreements.

Custody

To ensure safekeeping of both Bank and Customer assets, Hex Trust acts as a digital custodian of the e-HKD tokens using warm wallets which provides speed of transaction without compromising security as no private keys are held online on a server and are protected within an air gapped environment. Hex Trust holds a Trust or Company Service Provider (TCSP) license. The Hex Safe platform allows for seamless cross-chain integrations with other counterparties to receive deposit and withdrawal instructions within a chain agnostic ecosystem.

3. Consumer Research & Insights

The HELOC loan solution explored in Project Victoria is a proof-of-concept and therefore cannot yet be offered as a banking service to Fubon Bank’s customers. To gauge the market’s awareness of Project e-HKD and their receptiveness towards the proposed use case (based on hypothetical e-HKD), a market survey was conducted with a controlled group covering all staff at Fubon Bank Hong Kong. A licensed bank was selected as the source of survey respondents as the bank staff is both a potential customer and an operator of the solution.

3.1 Methodology

The data was collected through an online survey distributed to 850+ Fubon Bank staff, 680+ replies were received representing an encouraging 80% response rate. The survey consisted of eight questions and on average took seven minutes to complete.

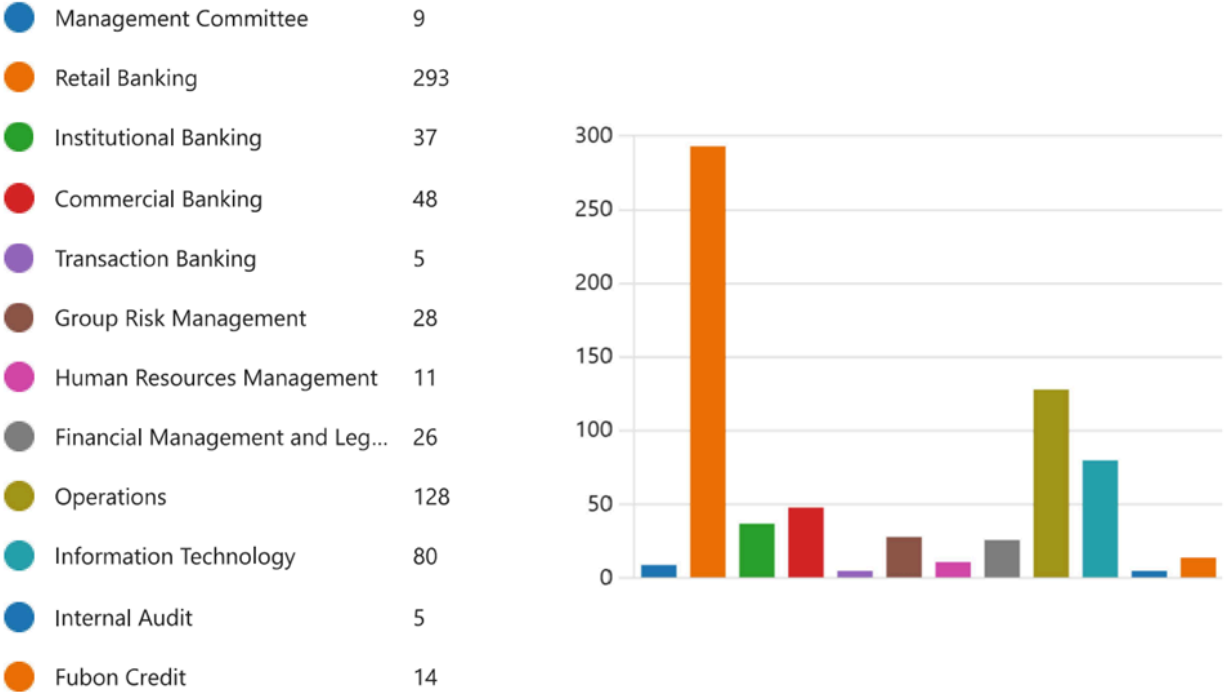


Figure 5. Survey responses by department group.

3.2 Survey Results

1. 70% of the participants are aware of the HKMA's Project e-HKD.



Figure 6. Number of participants aware of HKMA's CBDC initiative.

2. On a scale of 5, the participants have a 3.26 rating on their understanding of Project e-HKD (1 being "very well" and 5 "not at all").

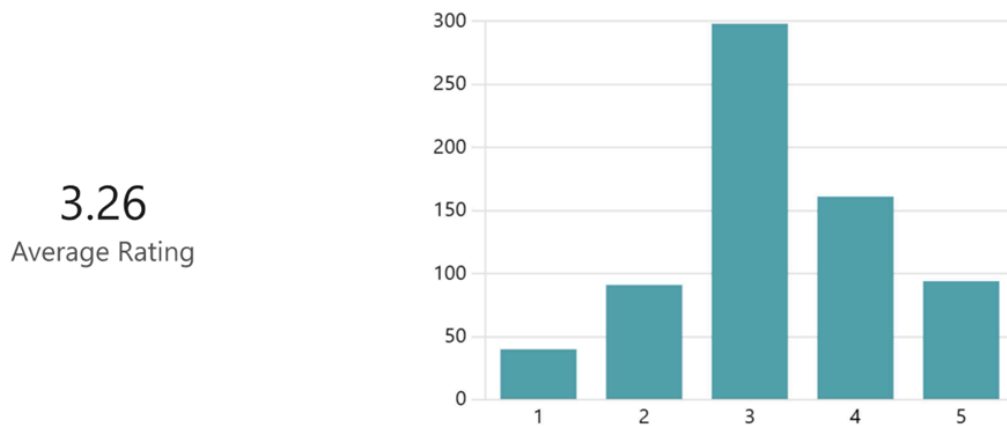


Figure 7. Participant self-reported understanding of Project e-HKD.

3. 74% of the participants are willing to use hypothetical e-HKD (when available) for their personal transactions (spending, investment, etc.)



Figure 8. Number of participants willing to use e-HKD.

4. The three most influential decision-making factors are: “Trust in the CBDC Issuer”, “Understanding of CBDC”, and “Privacy Concerns”.

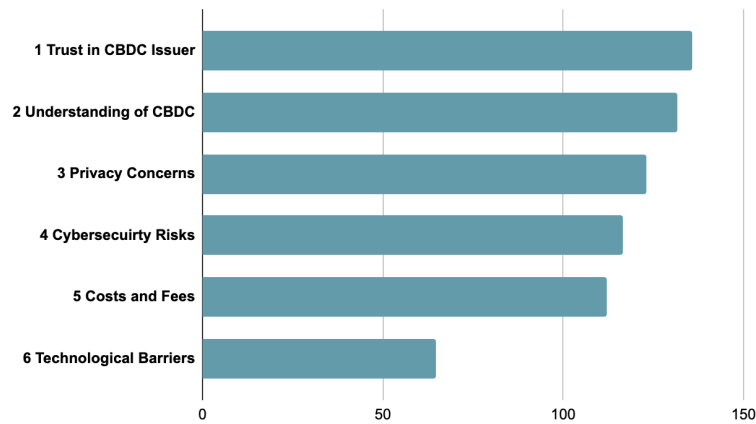


Figure 9. Number of responses for decision making factors.

5. 51% of the participants think that CBDC will replace traditional currency in the future.

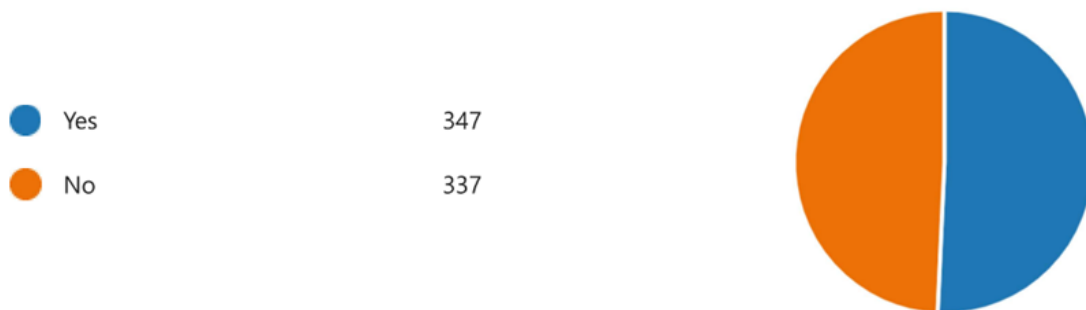


Figure 10. Number of participants who think CBDC will replace traditional currency.

6. On a scale of 5, the participants have a 3.26 rating on their understanding of asset tokenisation (1 being “very well” and 5 “not at all”).

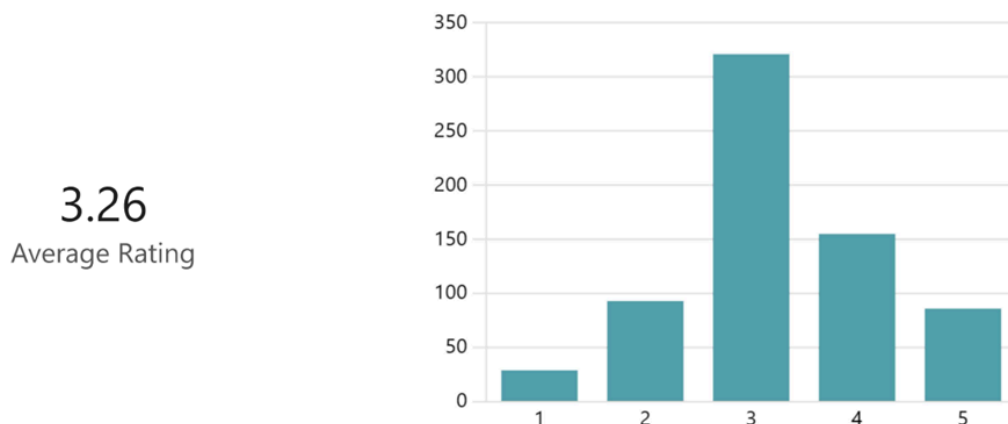


Figure 11. Participant's self reported understanding of asset tokenisation.

7. 69% of the participants think that tokenisation of the land title deed could be beneficial to retail residential mortgage business.

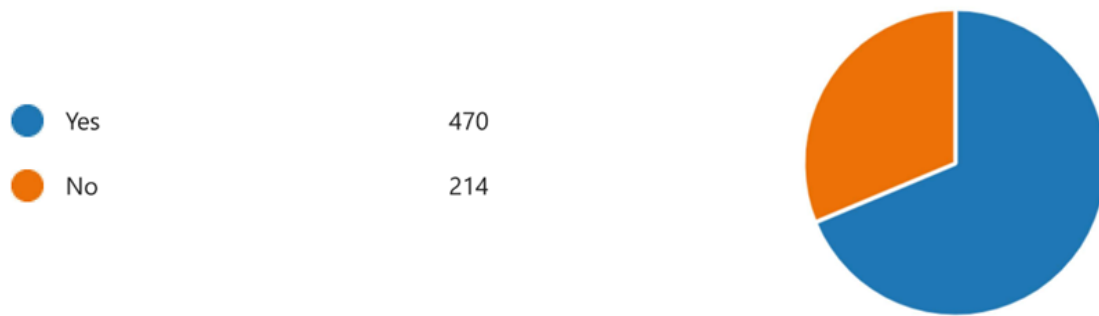


Figure 12. Number of participants who think tokenisation of land title deeds would be beneficial.

8. 56% of the participants think that more work will need to be done to boost readiness to adopt blockchain, DLT and tokenisation.



Figure 13. The number of participants who think Fubon Bank is not ready to adopt blockchain.

Participants could also leave comments with a total of 70 collected. They are summarised below:

1. **Communication & Education:** There was a strong emphasis on the need for clear communication and education about CBDCs to both the public and bank staff. This includes understanding the benefits and usage of CBDCs and real estate tokenisation.
2. **Cybersecurity & Technical Support:** The importance of robust cybersecurity measures was highlighted to protect customers. Technical support and IT infrastructure are also seen as crucial elements for the successful implementation of CBDCs.
3. **Pilot Programs & Practical Experience:** Several comments suggest starting with sandbox pilots to gain practical experience and assess the feasibility and potential challenges of these technologies.
4. **Potential Effects on Bank Deposits:** There was a concern about the potential impact of CBDCs on bank deposits.
5. **Transaction Costs:** Some comments express concern about transaction costs associated with CBDCs.

3.3 Analysis

In consideration of the limited scale and preliminary purposes of the survey, the majority of survey participants have good awareness and a decent understanding of the HKMA's Project e-HKD and good acceptance of the potential adoption and usage of hypothetical e-HKD and tokenisation. Trust in the issuer, understanding of CBDC, and privacy concerns are key decision-making factors. Participants were also split on the future of CBDC replacing fiat money.

On the basis of this analysis, more work may be needed on educating the general public and commercial participants on the potential characteristics of an e-HKD (especially on privacy and cybersecurity concerns), as part of evaluating the public's receptiveness towards the potential implementation of an e-HKD in greater depth. This work will also help enable these stakeholders to attain a more holistic understanding of the e-HKD.

3.4 Survey Findings

Recommendations

This is an initial survey and sets the foundation for further study and research:

1. **Educational Promotion:** Increase educational efforts to improve understanding of the e-HKD and asset tokenisation. This could include creating easy-to-understand resources, conducting workshops, and organising awareness sessions. It's important to target not just potential users but also bank employees and other stakeholders.
2. **Address Privacy Concerns:** Address privacy concerns by providing clear, transparent information about data handling and security measures. This could involve publishing detailed privacy policies and FAQs and ensuring these are easily accessible.
3. **Prepare for Blockchain Adoption:** Prepare banks for blockchain adoption through comprehensive training programs and infrastructure development. This includes investing in technology, recruiting professionals with blockchain knowledge, and fostering a culture of innovation.
4. **Pilot Programmes:** Continue with the e-HKD Pilot Programme and related sandboxes in exploring potential use cases for an e-HKD, as part of substantiating the case for an e-HKD and asset tokenisation. This will allow banks to gain practical experience, assess feasibility, and identify potential challenges.
5. **Partnerships:** Explore partnerships with technology providers and other banks for knowledge sharing and collaboration. This can accelerate the learning curve and drive innovation.
6. **Feedback Mechanism:** Establish a robust feedback mechanism to gather user opinions and concerns continuously. This will help in making necessary adjustments and improvements to the initiative.

Next steps:

This is the initial survey and set the foundation for further actions:

1. Expand the market survey to Fubon Bank's existing mortgage customers and other financial institutions (potentially including foreign banks and insurance companies).
2. Devise educational communications efforts to (i) improve understanding of hypothetical e-HKD and asset tokenisation, and (ii) address privacy concerns by providing clear information about data handling and security measures.
3. Form a focus group to walk through the proof-of-concept from hypothetical e-HKD minting to property lien tokenisation and HELOC user interface.
4. Prepare Fubon Bank for blockchain adoption through talent and infrastructure development.

Conclusion

Project Victoria has been met with a positive response, but there are areas which will require further research and testing. Addressing these concerns through education and clear communication will be key to a successful implementation and further pilot project studies.

4. Discussion: Developing and Deploying a CBDC

Developing a CBDC is a complex undertaking, given the interdependencies between policy and technology, as well as potential market impacts. If designed prudently, CBDCs can offer more resilience, enhanced security, increased access and lower costs compared to traditional forms of money.

We envisage that the successful deployment of a CBDC is anchored by three core pillars of design: technology, policy and usability. These three core pillars will now be considered in relation to the HELOC loan solution developed in Project Victoria.

4.1 CBDC Technology

The first pillar of a successful CBDC design, technology, provides the underlying capabilities of the CBDC, which will be carried through from experimentation to real-world implementation. It must be characterised by security and resiliency, but it must also be able to function at scale. Project Victoria provided practical insights into delivering these requirements, which will be shared below.

Secure, Resilient Technical Infrastructure

Any CBDC deployment requires a secure, resilient technical infrastructure. To implement the hypothetical e-HKD for Project Victoria, Ripple has deployed a custom version of its CBDC Platform consisting of the Digital Currency Manager (DCI), a private CBDC ledger and a private EVM Sidechain. Together, these components provide the efficient, secure basis for operating a digital currency, in this case, the hypothetical e-HKD, through the CBDC ledger and DCI while providing the functionality afforded by smart contracts through the linked EVM Sidechain.

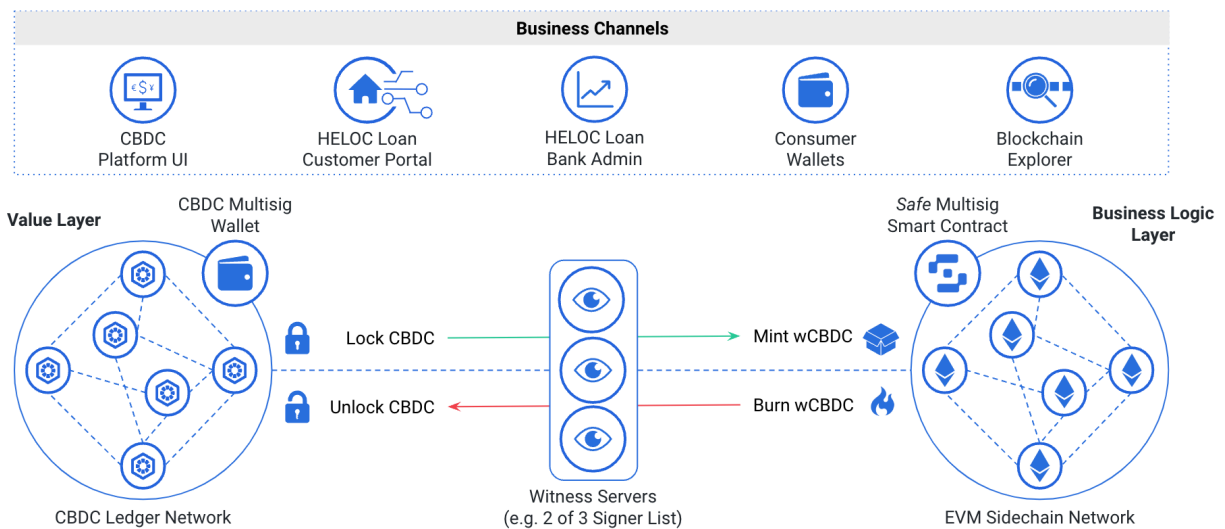


Figure 14. CBDC platform solution diagram for Project Victoria.

Regarding the functionality required from the CBDC infrastructure, the HELOC solution is typical of many decentralised applications and other potential uses of an economy-wide CBDC deployment. Aspects of the application technology stack will prioritise different characteristics, such as the highest level of security or the greatest flexibility.

Thus, the solution proposed in Project Victoria demonstrated interactions between multiple DLT technologies to meet the separate requirements of the application stack components. Further, the transfer of hypothetical e-HKD tokens was performed seamlessly and transparently without explicit inputs or additional steps required by bank customers or operational personnel.

Composability across DLT technologies is essential for a CBDC solution to provide the functionality required for complex use cases. However, it must not compromise double spending protections and auditability. The HELOC solution proposed by Project Victoria demonstrated an ability to securely transport value across chains and maintain an auditable trail of transactions.

Validation cross-chain and double spend avoidance are managed through the Cross Chain Bridge, developed by Ripple to support connections between XRPL-based ledgers (such as the private CBDC Ledger) and the EVM Sidechain. The bridge functions through a combination of programmability on the sending chain, or “locking chain”, and on the receiving, or “issuing chain”. A swarm of witness servers which operate independently from either chain, monitoring the locking and issuing of funds by functionality on either chain, reaching consensus on which funds should remain locked or be issued to prevent double-spending across the two ledgers.

During the HELOC use case, this functionality is used when hypothetical e-HKD is sent from Fubon Bank’s treasury wallet to fund the loan vault which resides on the EVM Sidechain.

1. The sequence of events is triggered by the lending protocol middleware requesting a transfer of funds by the wallet custodian,
2. the custodian then transfers the funds with instructions to the bridge door native function where the funds are locked,
3. the witness servers reach consensus on the locking of funds and
4. then instruct the bridge door contract on the issuing chain to mint and release the “Bridged hypothetical e-HKD” to the wallet destination on the EVM Sidechain.

All steps are recorded in a traceable manner across the CDBC ledger and the EVM Sidechain. Similar processes through the same infrastructure are used for the disbursement of funds to, as well as repayments from, the customer’s hypothetical e-HKD wallet.

This architecture maintains cryptographic record-keeping providing certainty in integrity, traceability and auditability of all movement of value, and further to the detailed relationship between value and the underlying property collateral record through the lien token and, potentially, in the future, a Land Registry tokenisation solution. All stakeholders can utilise this traceability to enhance audit trails internally, externally and potentially with regulators or other peripheral stakeholders.

For the HELOC user journey in Project Victoria, this entailed the demonstration of a secure, traceable audit trail of funds through the digital economy, through:

- Minting →
- Distribution of funding →
- Allocation to lending facility backed by property lien →
- Drawdown by the customer →
- Spending of funds →
- Repayment of loan →
- Loan closure

Onboarding of Users

Another key challenge for the development and deployment of CBDCs is ensuring that institutions, such as banks, can onboard, authenticate and support users at scale. Various channels and supporting applications can provide onboarding and support services at scale. However, the core CBDC infrastructure requires the assurance, authentication and processes which come with activities undertaken by regulated financial institutions.

Project Victoria demonstrated the ability of a bank to perform this role in a CBDC ecosystem through Fubon Bank partnering with Hex Trust to provide regulated digital asset custodian services on a white-label basis. The resulting division of responsibilities allowed Fubon Bank to manage the customer-facing KYC/AML requirements while Hex Trust provided a scalable, secure and resilient wallet solution.

4.2 CBDC Policy

The second pillar is policy, meaning the rules, guardrails and guidance established by the central banks and governments for the CBDC and the wider ecosystem. The HKMA's Project e-HKD has given significant consideration to the policy requirements and considerations for developing and deploying a CBDC in Hong Kong, with recommendations on this topic being a substantive outcome of the first rail as part of the HKMA's three-rail approach.

Project Victoria seeks to contribute findings from the practical design and development exercises undertaken to support the HKMA's explorations.

CBDC Structure

As a project under the HKMA's e-HKD Pilot Programme focused primarily on customer outcomes, Project Victoria has a certain degree of freedom in choosing a CBDC structure for the hypothetical e-HKD utilised in the pilot activities. Fubon Bank acted as the issuer of the hypothetical e-HKD during the pilot, determining the backing of the token to be considered out of scope for solution build but a key point of consideration for learning.

The HKMA has analysed structures for implementing CBDCs as part of its ongoing research, which includes varying roles for participating banks with a focus on four methods. From banks having no role (single tier, claim on Central Bank), hybrid/intermediated (two-tier, banks process transactions and Central Bank may record some or none of the retail transactions conducting only wholesale issuance), to bank-issued tokenised deposits (two-tier, claim against bank backed by CBDC holdings at the central bank).

Project Victoria, in the current study, requires Fubon Bank to perform the issuance of the hypothetical e-HKD tokens. Thus, from the perspective of the role of a participating bank, it is aligned with the third and fourth models explored by the HKMA in projects such as Project Aurum [5] as well as other authorities across the world such as Project Helvetia [6]. However, there is an open design choice concerning the backing of the hypothetical e-HKD utilised.

Fubon Bank and the Project Victoria team considered the possible backing for the issuance of the hypothetical e-HKD between a Wholesale CBDC provided by the HKMA and thus issuing a true retail CBDC or backing through a fiat deposits. Relating to the latter, an area attracting attention within the industry is “tokenised deposits” where money deposited with a bank is digitally represented on that institution’s own blockchain ledger.

The following provides a general comparison of features of of these options which may change in relation to future policy, regulation and market developments:

Note: "Tokenised deposits" are a developing area with no set industry standard - the characteristics described are the perspective of the authors and for indicative purposes only.

Reserve Type	Wholesale CBDC	Tokenised Deposits
Backing	Wholesale CBDC balances (in the wallet of the commercial bank), funded by transfer of funds through RTGS accounts or related wholesale funding method.	Total liabilities made to customers recorded on the balance sheet of the commercial bank and monitored through prudential, capital and liquidity regulated processes. These funds may optionally be held in a segregated account on an existing core system, a custodial arrangement such as a trust or even managed as a tokenised deposit from another financial institution.
Use of Reserves during lending	Wholesale CBDC balances held as a direct liability with the central bank during the period of issuance of the retail CBDC.	Tokenised Deposits are recorded as liabilities on the commercial bank balance sheet, and subject to prudential, capital and liquidity requirements applied to traditional on-demand deposits held with the bank. Such tokens (and deposited fiat

		currency balances) would remain outstanding until redemption of the bank-issued tokenised deposits.
Establishment and costs	<p>Pursuant to establishment of the Wholesale CBDC infrastructure.</p> <p>Costs at rates set by the central bank.</p>	<p><u>If establishing its own tokenised deposit structure</u> a commercial bank would need to ensure appropriate capital and assets are held to meet the multiple regulatory requirements already applied to traditional liabilities. Project Victoria did not consider the need to obtain any additional regulatory authorisations (e.g. VASP Licence) to issue the tokens.</p> <p>Capital and assets needing to be held by the bank would be considered a cost of the tokenised deposit.</p> <p><u>If acquiring tokens from another institution</u> the commercial bank would either need to pay full face value (and a margin) or borrow at interbank rates.</p>
Singleness of Money (SoM)	Retail CBDC meets SoM test so long as Retail CBDC and Wholesale CBDC ledgers are synchronised (and validated).	SoM for Tokenised Deposits would be dependent on both the soundness of the bank (and/or any regulatory backstop provided such as deposit insurance) as well as the convertibility functionality provided by the commercial bank and/or broader financial system.
Risk	Retail CBDCs backed by Wholesale CBDCs are considered risk-free.	Tokenised Deposit balances are not risk free and are subject to a range of risks including liquidity and solvency risk of the issuing institution (per the institutions credit rating).

Table 1. Comparison for wCBDC backed rCBDC or Tokenised Deposits.

The characteristics described above may change from time to time, and is not indicative of the final characteristics of an e-HKD and nor does it infer that an e-HKD will be issued.

Payments Infrastructure

Across the world, many factors are driving central banks to consider developing CBDCs. One factor of interest is the opportunity to provide new national payment infrastructure. While Hong Kong has a robust payment infrastructure through existing solutions such as FPS, there are reasons a market such as Hong Kong should still consider CBDCs to enhance payments. These include providing cost-effective micropayments, traceability for consumer spending to enhance

AML and source of funds rule enforcement and creating robust decentralised payment networks.

Project Victoria provided an initial insight into how a cost-effective micropayment infrastructure could impact a broad range of use cases. Key innovations in the HELOC product was the ability to support arbitrarily small payments combined with the granular record-keeping maintained as part of an end-to-end immutable record of the loan. In practice this meant drawdowns and repayments of any size, with any regularity and real-time tracking and pay down of interest accruals. For a bank, this has the double-benefit of providing greater flexibility to meet customers needs, whilst also improving the ability to assess customer's capacity to service loans and manage delinquent loans more proactively. These benefits are incremental in the impact to existing lending practices, but even more importantly will be key enablers as the market demands more flexibility, proliferation of lending needs and likely greater automation driving a significant magnitude of change in the scale needed.

Extending beyond the Project Victoria use case, there are potentials for micropayments to be included in a range of industries and uses if provided by a CBDC platform. Thus a micropayments capable CBDC could enable new use cases in new energy sharing or delivery systems, offering products which are traditionally directly owned as services with small billing increments and other finance related opportunities.

4.3 CBDC Usability

In addition to technical and policy factors, usability of the CBDC is critical to ensuring adoption by consumers. A user centric approach to the overall CBDC ecosystem and each use case is required to drive and maintain consumer engagement with the platform.

For Project Victoria this meant the creation of a simple HELOC user journey atop the multi-chain technical infrastructure, a bank-like experience for checking wallet balances, but also provided a source of hypothetical e-HKD funds which consumers could then spend, invest or exchange.

Simple User Journey

As identified in section 4.1, complete CBDC use cases are likely to require the use of multiple chains or technologies to provide the required functionality and interoperability. If not properly considered in the user journey this can create friction which could reduce consumer engagement with the CBDC.

By focusing first on the bank customer's perspective, Project Victoria determined that it was necessary to maintain a single customer view which presented information from both the CBDC Ledger and the EVM Sidechain together. Therefore, activities such as bridging of CBDC tokens to and from the lending protocol (located on the EVM Sidechain) were managed by the application middleware layers without direct instruction from the user.

Account & Wallet Experience

Wallets are a key user interface point for blockchain based systems, they typically give users a view of the funds or tokens they hold in their account and allow for transaction entry and authorisation among other functionality. Access to this wallet functionality also varies, with some wallets being stand alone applications (from phone apps to browser plug-ins) to elements integrated into a wider application.

Owing to the bank focused nature of Project Victoria's use case, the project decided that user access to their account should be controlled through the bank interface. This necessitated the use of a custodial wallet approach, whereby the user trusts a custodian with the keys to their on-chain account, which did not function as a separate application, but could be integrated into the bank interface.

A further consideration is how tokens from multiple banks will be managed. Under some versions of the two-tier model, it may be possible for multiple banks to offer hypothetical e-HKD tokens both with the same nominal value, but technically distinct. This distinction could be related to the ledger, that is they are minted on different chains, or they could be on the same blockchain networks but represent claims to the central bank with different risk profiles due to the fact they are issued by different banks.

If customer wallets are devised in the CBDC ecosystem which contain tokens from multiple issuers, wallet designers will need to consider how totals are summed across these tokens for consumer view and also any swapping mechanism necessary to complete transactions if customers hold fractions of various tokens.

Source of Hypothetical e-HKD

Another friction point for consumers in adopting and using CBDCs in day-to-day usage is if they are required to specifically source the CBDC at the time of usage. Therefore it is important to create natural entry points for consumers to acquire CBDCs which then can be used throughout the ecosystem. Common sources of funds for consumers include pay from employment, government payments, but also consumer lending from banks such as the HELOC loan proposed in Project Victoria.

As such, the HELOC use case in Project Victoria is an amplifier of any network effect driven hypothetical e-HKD benefits as consumers will acquire hypothetical e-HKD to use in the payments use cases considered by other participants in the e-HKD Pilot Programme.

5. Discussion: Asset Tokenisation

A unique aspect of Project Victoria is the combination of CBDCs with asset tokenisation. It will now be considered how tokenised assets support the adoption and utility of digital currencies, such as the hypothetical e-HKD and the vision for a seamless digital economy.

5.1 Global Tokenisation Vision & Use Cases

The global use case for asset tokenisation is growing rapidly as more organisations recognise the potential benefits it offers. Asset tokens have multiple use cases across multiple verticals, such as real estate, equity and debt, where asset holders and investors seek opportunities to increase asset liquidity and create flexible new products.

Key technical challenges for the tokenisation of assets remain the interoperability of different tokenisation, custody and DeFi technologies, along with providing a settlement solution which can operate under the same conditions as the tokenised assets. The potential is, therefore, for CBDCs in leading financial jurisdictions to provide the settlement currency for these online transactions, that is, digital dollars for digital assets.

Real Estate Tokenisation

Specifically in real estate, there are various opportunities currently being explored for tokenisation. These range from fractional ownership of large investment-grade properties to tokenisation and fractionalisation of individual homes, in the latter case potentially to enable new forms of home loan financing.

For traditional banks, the tokenisation of Home Equity Lines of Credit (HELOC) loans is particularly interesting as they allow existing mortgage holders greater financial flexibility, while allowing the bank to use tokenisation to drive business process reengineering. Also, for consumers, HELOC loans are becoming increasingly popular to monetise home equity without selling the house.

Lending Protocols

Tokenisation of assets has also been combined with traditional financing concepts to create new on-chain forms of enacting these activities, with various forms of lending protocols as particularly relevant for tokenised real estate.

Lending protocols themselves are simply tools to enable secure, fast, immutable money creation and ultra-flexible lending against collateral using blockchain technology. Each loan created by a user of this lending protocol is distributed to a 'Vault', a unique and secure dashboard accessible only to this user's wallet. Initial vault-based lending protocols allowed users to post Ethereum as collateral, creating facilities they could draw down and pay back against, so long as they did not breach an agreed and computationally enforced LTV (Loan-To-Value); essentially consumer 'credit facilities', rather than loans with fixed terms and

fixed monthly repayments. Kodelab, in their HoCDAO solution, took the baseline vault technology and enhanced it by enabling users to place real estate (via an NFT legally representative of the right to title) as collateral, still an Ethereum-based asset, but with the full backing of bricks-and-mortar real-estate. The lending protocol is gifted with clearly defined 'seizure and sale' rights to the property underlying the NFT, should the user default on the terms of their credit facility (i.e. conditional rights). This provides the stability of real-world collateral with the efficiency of liquidation outlined in the pure Ethereum-collateral use case. Conditional 'seizure and sale' rights for a lending protocol regarding the underlying collateral are paramount for it to function properly. Under our solution in Project Victoria, this conditional 'seizure and sale' right is, efficiently, already in place with the lending protocol in the form of an existing fixed-rate mortgage, as the lending protocol *is* the bank.

5.2 HELOC Loan Tokenisation - Regulatory and Legal

When creating a tokenised asset, there are specific regulations or restrictions imposed by local jurisdictions that need to be taken into account. For instance, in Hong Kong, asset tokenisation requires compliance with the Securities and Futures Commission (SFC) regulations, diligent KYC and AML procedures for investor protection, adherence to data privacy norms, technology infrastructure evaluation, clarification of intermediary roles, liquidity and trading platform establishment, cross-border considerations, and precise legal documentation.

A brief discussion of these points follows, with a more detailed breakdown of these requirements in the breakout box "*Real Estate Tokenisation with DLA Piper HK*".

Tokenisation Strategy

For the HELOC use case, there were two key factors which determined the tokenisation strategy, namely providing a token with sufficient rights and information to the lending protocol to enable it to function and the existing legal and procedural requirements for registering property ownership and interests in Hong Kong.

In the context of Home Equity Line of Credit (HELOC) loan tokenisation, hashing the lien agreement and embedding it into the token offers a range of crucial benefits that enhance the security, authenticity, and legal validation of the tokenised asset. This practice leverages the core features of blockchain technology to ensure the integrity and trustworthiness of the token and its associated real-world assets. Hashing the lien for the HELOC loan agreement creates a unique digital fingerprint of the document. This hash is mathematically generated based on the agreement's content. Once hashed and stored within the token, any alteration to the original agreement would result in a different hash, ensuring the document's integrity.

The hashed lien serves as a legal source of truth for relationship, rights and obligations. By hashing and embedding the agreement into the token, ownership is unequivocally linked to the

digital token. This facilitates the establishment of ownership and simplifies any legal disputes or claims related to the tokenised asset.

Linking the legal rights through hashing the contract and embedding it on the token provides a robust mechanism for proving the authenticity, ownership, and integrity of tokenised real-world assets, such as HELOC loans, and strengthens the legal foundation of these digital representations.

Tokenisation of Title Deeds vs the Mortgage Lien

In Hong Kong the tokenisation of property is not currently possible under the existing legal framework. Therefore Project Victoria considered two options: engaging the Land Registry to pilot tokenisation of title deeds, and tokenising another aspect of the instrument.

Tokenisation of title deeds at the land registry level represents a transformational approach to the maintenance of these records. Today land registries around the world typically hold ownership records and registered interests in properties. For Hong Kong in particular, the Land Registry provides a public location for the registration of interests in property but does not provide conclusive evidence of ownership of the property - instead possession of the physical title deeds are essential. Tokenisation at the Land Registry level therefore could also entail a change in thinking of land registration in Hong Kong.

Land registry tokenisation has and continues to be an area of interest for Central Banks, government bodies, other regulators and broader stakeholders around the world. Ripple has also participated in pilots and studies on this capability and new processes it can enable. This includes working with a partner Peersyst and the Colombia Ministry of Information Technologies and Communications (Colombia MinTIC) to develop a register for land title deeds with the following goals:

- Prevent Counterfeiting
- Transparency
- Information Integrity
- Always accessible

Efforts across this area remain active, however there is significant legal complexity and the target state and ultimate benefits will be a long-term outcome.

Unfortunately given this complexity and due to the time constraints of the overall project it was not possible to engage in a pilot with the Hong Kong Land Registry to simulate a tokenised title deed. As such, an opportunity exists for future explorations of tokenised real estate and CBDCs to include this simulation in their scope.

For Project Victoria the team considered other options for tokenising the bank's security interest in the underlying property rather than simply a data object (i.e. the Land Registry record of the mortgage/lien). The rights comprising the bank's security interest relating to the HELOC loan could be tokenised, thus creating a transferable token which represents an interest in the underlying property.

Tokenisation of the record of mortgage/lien is an effective first step but has limits on usefulness outside of the context of Project Victoria. For instance the record of mortgage/lien does not encompass rights of title in comparison to a token which is linked to a fractionalised interest in a (tokenised) title deed, as it still relates to the fractional interest in the property which was the subject of the original mortgage of the issuing bank. This could have implications for future opportunities to constitute interests in mortgages on-chain and to facilitate a ledger-based secondary market trading facility for mortgage backed securities. In their discussions the team noted one of the key issues to address to achieve such tokenisation would be law reform and evolution of practice in respect of lending against and securing real property in Hong Kong and in the procedures of the Hong Kong Land Registry.

5.3 HELOC Loan Tokenisation and Hypothetical e-HKD

Tokenisation of assets in combination with CBDCs provide several key advantages which were demonstrated through the Project Victoria HELOC use case. These are the enhanced traceability and auditability which comes through asset transactions and value transactions occurring in a non-siloed manner and the opportunity for process reengineering which this new non-siloed space provides.

Traceability and Auditability

Accounting for the flow of funds and assets is a critical component in operating a financial system. This accounting is usually performed based on siloed information, only available to the company which collects the information and therefore limits the potential use of this data for market oversight, uses by individuals such as providing source of funds information for AML purposes and other transparency requirements.

In Project Victoria, transaction data, including the transfer of assets and funds were recorded against pseudonymous account numbers. Thus if it was required to audit this information, or use it in support of a customer's source of funds claim, the transaction history could be analysed if the user's account number is revealed.

This fundamental capability of blockchains is continuing to be shaped by efforts to enable traceability while also providing user privacy. Typically these projects utilise cryptography and information theories to obfuscate identities and reveal information or proofs of information only as required. One related example is the case of verified credentials in the field of digital identifiers. In this case, on chain logic would confirm that an ID holder meets a certain requirement, such as age, but perhaps source of funds rules, and reveals only that credential to those performing an information request.

Bank Process Reengineering

Project Victoria demonstrated that a lending protocol can be appropriately setup, managed and monitored by a commercial bank to meet their needs in the creation and servicing of collateralized loans. This adoption of blockchain based processes demonstrates that banks, payment companies and other institutions in the financial system may be able to benefit from process engineering in support of a hypothetical e-HKD adoption initiative. If so, there may be many second and third order benefits experienced throughout the financial system from the adoption of a CBDC.

Breakout: Real Estate Tokenisation with DLA Piper HK

Legal and regulatory considerations on real estate and mortgage loans tokenisation in Hong Kong

Rationale for the choice of HELOC Home Equity Loan tokenisation for the e-HKD Pilot Programme from a legal perspective

Given that tokenising the mortgage or ownership of the property would not be possible under the existing legal framework, the current viable approach from a land law perspective is to mint an NFT which represents the HELOC loan.

Since the loan agreement is hashed on to the blockchain, the token holder, i.e. Fubon would have the rights to repayment and interest just like it would under a traditional loan, and have a beneficial interest in the property.

By tokenising the HELOC loan instead of the underlying real estate or the mortgage, this dispenses with the need for Fubon to lodge for registration with the Hong Kong Land Registry. With the HELOC loan tokenisation solution as-is, there is no need to wait for any change in laws in regulating fractionalisation of property ownership or mortgage taking place.

Current legal regime and challenges for real estate tokenisation in Hong Kong

There have been discussions around whether a real estate property can be directly tokenised, so to create fractionalised real estate property, which can be mortgaged to secure tokenised loans (e.g. HELOC loans), or alternatively, the mortgage interest created under the mortgage documents over the Hong Kong real estate property can be tokenised to secure the HELOC lenders' interest. However, due to the property ownership system and land registration system in Hong Kong (with details to be elaborated below), either the route of tokenising a real estate property in Hong Kong or tokenising a mortgage interest over a whole plot of real estate

property in Hong Kong would appear to face legal difficulties under the current legal regime. Instead, similar to what is usually adopted in real-life real estate loans, security shall be created over the real estate property in Hong Kong (via mortgage which is to be registered with the Hong Kong Land Registry) to secure the tokenised HELOC loans. To further explore on the same route, if the HELOC loans are ever turned into syndicated loans (i.e. with more than one lender participating in lending the required commitment from the borrower), a security agent shall be appointed to hold the security created under the registered mortgage in trust and in favour of all of the lenders under the HELOC loans (which are tokenised).

Legal Hurdles from a Real Estate Perspective for Fragmenting Real Estate into Digital Tokens

In Hong Kong, virtually every piece of land is leasehold property and the owner of the real estate property will derive their ownership of real estate from the original Government grant (which can be of a form of Government Lease, Conditions of Grant, Conditions of Exchange, etc., in which the Hong Kong Government grant a leasehold interest to the first land owner signing a long lease with the Hong Kong Government) through a chain of title across all the historical owners of the real estate property passing through the legal rights over and interests in the land to the next purchaser. It is also specifically noted that Hong Kong does not have a title-proving land registration system similar to that in the England, and by having a person's name registered as an owner of a specific property with the Hong Kong Land Registry, it does not entail that such person has good legal and beneficial title to the property.

For a real estate owner (an "Owner") to prove that he or she has the legal and beneficial title to that specific real estate property, the Owner has to produce the original title deeds exclusively relating to the property, and all other documents relating to that property under sections 13 and 13A of the Conveyancing Property Ordinance (Cap. 219) ("CPO"). A purchaser or a potential mortgagee of the property (who are usually the persons have the motivations to request for the Owner to prove his legal and beneficial title to the property) would be entitled to raise requisitions to the title documents produced by the Owner and if it is found that any or all of the title deeds are missing or defective in nature (and complicated conveyancing transactional rules will apply in such scenarios), the Owner may be held to not be able to prove his or her own title to the property, and the title is therefore "encumbered" or "defective" and the value of the property will be severely impacted or even become non-transactable. Given the need to produce the original title deeds and documents exclusively relating to the property for an Owner to prove and give good title for a property, the current legal framework and longstanding practice of investigating title would not support tokens to be a digital representation of ownership in a piece of real estate. A digital representation of a real estate will not be able to achieve what is required to prove an Owner's title by producing the physical and original title deeds.

Land Registration System – Hurdles for Tokenising a Mortgage

As mentioned below, Hong Kong also operates a deed registration system such that instruments affecting land are registered with the Hong Kong Land Registry. While such deed registration system does not confirm or prove an Owner's title to the property, it is useful for any party who has an interest in the property (e.g. a mortgagee, a management company with its management fee owed, a judgement creditor etc.) to register its interest onto such public register to notify any third party of its interest. Priority of different interests in the property is therefore determined based on the land registration system (and details are set out in the Land Registration Ordinance (Cap. 128) ("LRO").

A mortgage over real estate is created by way of a legal charge, in writing and executed as a deed. Generally, the title deeds of the land would then be held by the mortgagee who has taken the "first charge" over the property. The security interest would need to be registered with the land registry within one month of its creation in order for the legal charge to take priority under the LRO.

Please also note that for a mortgagee to ensure its security interest has priority over any subsequent purchasers and/or mortgagees of the same property, registration with the Hong Kong Land Registry is required. A tokenised mortgage (if created) will have difficulty in being registered with the Hong Kong Land Registry. For registration purposes, one has to bring the physical instrument and the corresponding memorial to the lodgment counter at the Hong Kong Land Registry for the particulars to be entered into the Integrated Registration Information System. The Hong Kong Land Registry would then scrutinize and register the documents such that the land register can be updated. The current restrictive formality requirement of the Hong Kong Land Registry would not support mortgage tokenisation as original mortgage documents need to be produced for registration.

Similarly, pursuant to schedule 1 of the Electronic Transactions Ordinance (Cap 553) ("ETO"), all instruments related to land and any assignment, mortgage or legal charge or any contract relating to immovable property or an interest in immovable property must be executed in wet-ink. This will also add legal hurdle to tokenising a property or mortgage interest.

Practical Feasibility of Fractionalising Property or Mortgage interest by Tokenisation

Whether it is a tokenisation of real estate interest or mortgage interest will beg the follow up steps of fractionalising the tokenised interest, and creating liquidity of the fractionalised interest.

Under the current legal real estate legal regime, even if the property interest or the mortgage interest could be tokenised, each transfer of the fractionalised tokens would trigger either an assignment of a part of the property registered with the Hong Kong Land Registry or a transfer of mortgage interest (which is also registered with the Hong Kong Land Registry), and

therefore every token transfer will need to be registered with the Hong Kong Land Registry will be needed under CPO and LRO, and this would create a huge burden on each token holder.

And for such transfer of token is to be executed, the requirements in ETO will equally apply to require all transfer documents of either the property interest (in the form of a deed of assignment) or the mortgage interest (in the form of a mortgage transfer deed) to be executed in wet-ink but not digitally transacted.

Apart from the above, tokenising and fractionalising property interest or mortgage interest creates co-ownership issues and potential disputes. In normal cases of co-ownership of a property (e.g residential multi-storey buildings), ownership of a particular unit within the buildings is expressed in terms of undivided shares of the underlying plot of land where the building is located at; each of the flat owners are automatically become a party to a Deed of Mutual Covenant which governs the co-ownership rights and obligations of each unit-owner. This is a longstanding system to govern the relationships between all the unit owners of a building. Tokenising a property or mortgage interest will have similar co-ownership issues but there is no document in place to govern the relationship between the fractionalised token holders. This is an issue to be resolved if such route is to be further developed.

Mortgage tokenisation as the next frontier and which legal framework would allow this innovation in Hong Kong

Title Registration

If title registration is to be implemented in Hong Kong as opposed to the existing deeds registration system such that title register would be conclusive evidence of title to the property and the owner registered in the title register would be recognized as the legal owner, this may reduce the need for Owners to produce physical documents to prove his or her title to the property. This is however subject to further advancement on the precedent UK title register system (which limits the numbers of owners of a property to 4 persons) to cater for tokenisation and fractionalisation needs.

On top of that, blockchain technology may be able to help streamline the process by having contracts and ownership details preserved in a decentralised system, such that the records become indisputable, and a “title token” can be issued to the registered owner of the property to mirror the traditional title deed. However, it should be noted that title registration has been in discussion and consultation in Hong Kong for years and there has not been any prominent progress in recent years and there is currently no timeline for the Hong Kong property title system to be shifted into such direction.

Constraints regarding Digital Signature

Another barrier with digitalizing any property-related transactions is that under the ETO, electronic signatures are not allowed for instruments related to land, documents that are required to be stamped / endorsed under the Stamp Duty Ordinance (Cap. 117) and any assignment, mortgage or legal charge or any contract relating to immovable property or an interest in immovable property. Hence the ETO would need to be updated to support any digital conveyancing transactions or records.

Enforceability

Given that real estate tokenisation is still a largely unexplored territory, it is important to ensure that these ownership rights over real estate are recognized and enforceable. It is worthy to note that in the recent case of *Re Gatecoin* [2023] HKCFI 9, the Court of First Instance in Hong Kong has ruled that cryptocurrency is a “property” and is capable of being held on trust. This landmark decision is welcoming as it shows that Hong Kong is in line with other key common law jurisdictions and recognizes the legal rights of cryptocurrency holders and advances protection for digital assets.

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6. Discussion: The Power of CBDC Ecosystems

As the Project Victoria team initially considered the HELOC use case from an end-to-end user perspective it became clear that an isolated process, where a customer would need to swap in and out of hypothetical e-HKD as part of each disbursement and repayment would involve additional friction greater than the potential efficiency improvements from the use case. Providing consumers with hypothetical e-HKD which they could then spend or transfer through other pilot use cases only improved the potential benefit, with the interconnectedness and streamlined nature of a CBDC the apparent key to unlocking benefits with high multiplier effects.

More generally, a significant proportion of the value which can be accessed through the use of tokenisation and decentralised systems is dependent on connectivity and continuity between steps across a value chain as well as between separate but related value chains.

To explore this concept further, the Project Victoria team considered how the potential benefits of a CBDC would drive benefits in the verticals and industries adjacent to the HELOC use case.

6.1 Lending Value Chain & Adjacent Opportunities

Tokenisation of loans and payments in a CBDC, such as that implemented in Project Victoria, is one component of the lending value chain. The lending value chain involves a significant amount of disparate data being collected, exchanged and recorded through many separate processes each involving a set of participants and (likely) systems. Specifically the value chain involves critical steps beyond establishing the loan against the lien, sourcing of funds, disbursement, repayments and closure that Project Victoria has applied transformation through tokenisation and decentralised operating models.

As identified, the certainty, transparency and immutability of decisions and actions across these individual processes and records is the primary driver of benefits from these new practices. The degree of interconnectedness achievable within the ecosystem is going to drive the value of CBDCs, asset tokenisation, lending protocols and ways this transformation is realised.

A logical deduction based on this assessment is that the scope of the value chain that can be transformed using tokenisation and decentralised operating models will be a key determinant in the magnitude of value which can be added. This can be considered through two main axes along which to maximise interconnectedness, namely extending up or down the value chain through transformation of additional processes, as well as deepening the impact by increasing interconnectedness within an individual step between data records, participants and/or systems. These two axes are demonstrated visually in figure 15.

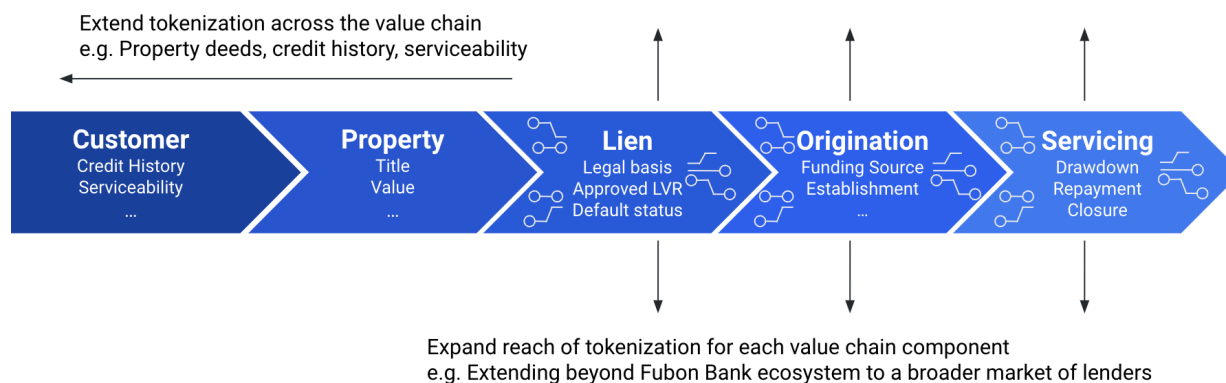


Figure 15. Lending related use case opportunities.

Extending up or down the value chain would entail the continued build out of the use of tokenisation and decentralised operating models (e.g. lending protocol) initiated in Project Victoria. Some examples which could potentially increase impact include:

- The natural consideration of not just tokenising the lien on the property, but the property land title itself enabling a digital, immutable, provable record of ownership and encumbrances for the industry as well as traceability throughout the entire lifecycle of each individual use as collateral and indeed the end-to-end lifecycle of the property.
- Customer credit history could be traceable through granular, auditable lending records including status, drawdown and repayment history and more.
- Provable serviceability records (assets, recurring cashflows, spending patterns, etc) can be used to reduce fraud, irresponsible lending practices and provide greater certainty with granularity of data to enhance the value of the loan formed.
- The use of digital identity and other personally identifiable information to reduce risk across KYC and AML, ultimately driving speed, cost reduction and the need for trust across relationships in the ecosystem.

Deepening the impact through individual processes would involve increasing the scope of data, participants and/or systems involved in the Project Victoria transformation. One example which would likely increase the value added would be to increase the scope from a pilot single bank ecosystem to a market in which multiple banks can participate.

From the Project Victoria scope, the greatest opportunity to realise this vision of interconnectedness is through the tokenisation of loans and property in a manner where origination and transferal of loans can occur across multiple banks. From a technical perspective, an open CBDC solution, such as that employed in the project, could provide the non-siloed platform to enable this type of solution.

6.2 Broader Ecosystem Considerations

We can extend the consideration of impact tokenisation and decentralised operating models can have beyond just the lending value chain, to the broader financial ecosystem and beyond. Ultimately lending is a value chain that has a relationship with other activities and services, for example money is generally lent for one or more purposes with the funds disbursed used in those products and services, making them interconnected. Today these services and products sit within data and value transfer silos that prevent true interconnectedness and value creation.

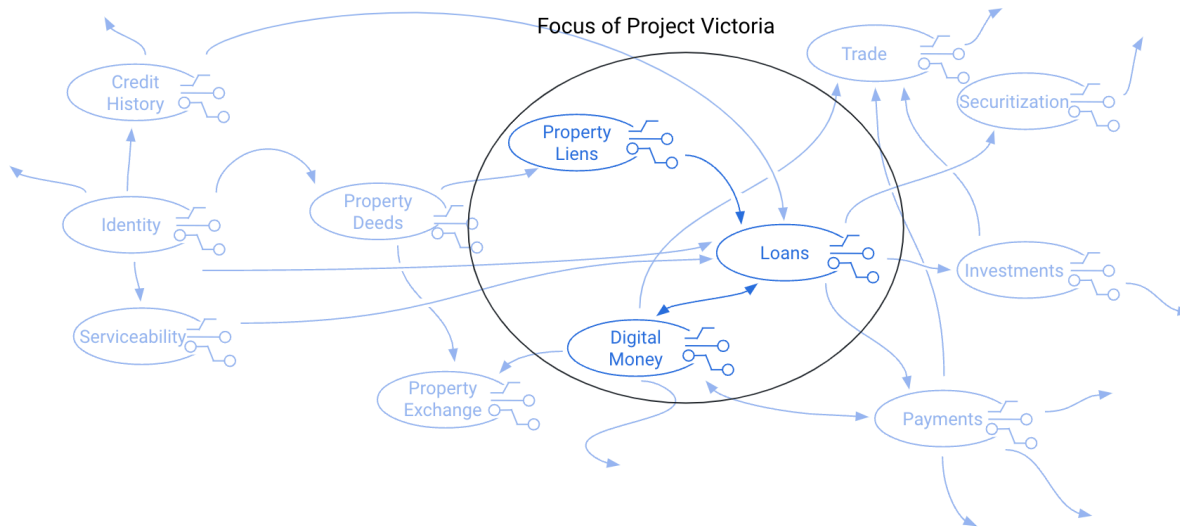


Figure 16. Ecosystem map.

Linking these various services and products together into a digital ecosystem that ensures certainty in integrity, streamlined end-to-end processes and traceability drives value. Some examples of interconnectiveness through these new capabilities include:

- The connection from drawdown and funds disbursed to use of these funds, this can provide greater certainty and proveability for instant proof of source of funds, or ensure correct use of purpose-bound funds, or providing an instant vehicle for an atomic process to connect serviceability details, encumbrance on collateral and consumption of funds for spending, investment, trade or other needs.
- A financial institution can tokenize the asset a cashflow created as the loan and use a tokenized securitization process to instantly onsell this to remove the liability from their balance sheet. The end state would provide granular traceability through to tokenized identity, serviceability and collateralized property details for an aggregated book of assets that itself can be fractionalised to maximise value and liquidity.

In the future all participants will be thinking about information and value moving together, with certainty, through and between these different services, instantly across the world. This will be the future of tokenisation.

7. Conclusions and Recommendations

The HELOC loan use case developed and explored by Ripple, Fubon Bank and partners has been a reminder of the potential of CBDCs and asset tokenisation, specifically highlighting the benefits around immediacy and traceability which would have immediate impact for consumers, but also the wider ecosystem and process reengineering benefits stemming from associated transformations.

From a technical perspective it was found that a combination of solution packages could work together to maximise benefits. This was evident even within the selection of ledgers for the CBDC, where both the Ripple CBDC Ledger and EVM Sidechain were selected, along with appropriate bridging technology, to provide value and business logic layers. It was also found that the use of specialist custodians was an important step to providing banks with the technical capability to onboard users at scale into a CBDC ecosystem.

Project Victoria also provided insight into the policies required to implement a hypothetical e-HKD. The HKMA has previously reviewed two-tier models for implementing a CBDC, with various forms of backing for the tokens issued. The technology employed in the project is compatible with a broad range of these models, making the use case able to support a range of policy positions that the HKMA might consider.

With regards to asset tokenisation it was found that the combination of CBDC and tokenised assets created a compelling use case which supported the value propositions of a hypothetical e-HKD. While the tokenisation of real estate as required in these use cases is best performed at the land registry level, tokenisation of the lien was found to be an effective step towards broader tokenisation of property deeds, particularly when used in a closed, limited ecosystem (such as a single commercial bank).

Combining these technologies also supported the use of lending protocols by banks. It was found that they can be appropriately set up, managed and monitored by a commercial bank to meet their needs in the creation and servicing of collateralized loans. This, in combination with tokenisation in general and CBDCs provides an opportunity for the Hong Kong economy to experience a broader process reengineering benefit as legacy systems are updated around an e-HKD, should it be issued.

Lastly the project found that the ability to link these services and products together into an ecosystem that ensures high integrity, streamlined end-to-end processes will ultimately provide the highest value to Hong Kong. As the e-HKD could spark a new financial ecosystem, information and value will begin moving together, with certainty, across financial and other services, and eventually instantly across the world.

Appendix - Further Legal Commentary and Policy Suggestions from DLA Piper

The following was provided by DLA Piper in response to a request from HKMA FFO for supplementary analysis across the legal commentary provided in the breakout section earlier in this document.

Potential Policy Suggestions in relation to the Legal Hurdles for Real Estate Tokenisation

The Securities and Future Commission of Hong Kong has recently published two circulars on tokenisation of SFC-authorized investment products and intermediaries engaging in tokenised securities-related activities, but real estate tokenisation is still being explored in the world and is paved with significant challenges and regulatory hurdles in Hong Kong as the regulatory environment in this area is still premature. The above echoes with the various legal hurdles as listed in the Breakout: Real Estate Tokenisation with DLA Piper HK section in the Project Victoria – White Paper. In furtherance of the discussion, we set out below the policy considerations and potential changes which are required to reshape the existing legal framework to create a more friendly legal framework for real estate tokenization in Hong Kong. Please note that for the below policy consideration, we are focusing the discussion in terms of tokenization of the real estate property, as we tokenization of the loan interest has been discussed in the Project Victoria White Paper as an alternative solution under current legal framework.

Reconciliation with Property Ownership and Land Registration System

Title registration system

Hong Kong adopts a registration of instruments and title deeds affecting land, not of registration of title to land. The deeds register only indicates the priority of such instruments but not the validity of it. As such, to prove legal and beneficial title to a specific real estate property, the owner has to produce the original title deeds which exclusively relates to the property pursuant to the Conveyancing and Property Ordinance (Cap. 219). This is contrasted with the title registration system adopted elsewhere in the world (e.g, the UK) where the relevant government authorities (e.g. in the UK, the HM Land Registry) would guarantee title to registered estates and interests in land.

To facilitate real estate tokenisation, as one of the first steps, Hong Kong shall consider adopting a digitalized title-proving land registration system such that a person's name registered as an owner of a specific property would be conclusive evidence of title to dispense with the need for

purchasers to investigate the chain of title. Like the UK, the original title deeds should only be needed when land or property is registered for the first time at the Land Registry.

We understand that the implementation of title registration system i.e. the Land Titles Ordinance (Cap. 585) (the “LTO”) has been passed by the Legislative Council in July 2004, and the Land Registry has confirmed that they would be proceeding to prepare legislative amendments to the LTO and the target is to introduce the amendment bill to the Legislative Council in early 2024. This reform would provide greater assurance and certainty of title and simplify the existing conveyancing procedure which is required for proving title, for mortgagees, subsequent purchasers and/or any interested parties dealing with the property.

Electronic system

Hong Kong recognizes the validity of electronic signatures for most contracts and documents, but under the Electronic Transactions Ordinance (Cap. 553) (“ETO”), all instruments related to land and any assignment, mortgage or legal charge or any contract relating to immovable property or interest in immovable property must be executed in traditional wet signature in order to be valid.

In the UK, the HM Land Registry has accepted electronic signatures for the transfer of ownership of property, leases mortgages and other property dealings in 2020 and have recently started to pilot the use of Qualified Electronic Signature (QES) without requiring a witness as they include an independent identity check as part of the process. It is proposed that Hong Kong should follow suit and dispense with the need of having wet-ink signatures on immovable property related instruments to support electronic lodgment as only if we have a digitalized registry system would we be able to incorporate blockchain into the registry system.

Tokenisation of title deeds and decentralizing the domain

Policy change would also be required in the regulatory landscape to recognize that property ownership can be represented by digital tokens on a blockchain. The concept of real estate tokenisation entails that purchasers of land can request to be issued with a title token, mirroring his/her title and property rights. The title token would function like a title certificate with advanced security features, and when the owner sells his/her property, the title certificate would be returned to the registry for cancellation. The title token would contain ownership and estate information, copies of all recorded documents which affects title to the property. Every transaction in relation to the property would be recorded on the blockchain, be it an assignment of a part of the property or transfer of mortgage interest if security tokens are further issued.

Another point to note is that the traditional real estate system relies on centralized registries, but when the land title and property rights are tokenised, there would not be any need to keep this kind of record in a traditional registry as the blockchain would serve as the registry itself, and no registration would be required as the blockchain would serve as a secure repository where records or transactions related to the property cannot be revoked or tampered with. We

note that this concept of dispensing with centralized registries would be even a step further and advanced to the title registration system we mentioned earlier, and would require a higher level of commitment to move the land title system towards the decentralized technologies with minimal government or regulatory intervention and administration actions.

Decentralized technology also heavily relies on smart contracts to automate and enforce the real estate transaction, which reduces the need for intermediaries. Blockchain technology would provide an infrastructure for peer-to-peer land trading between landlord and interested party with minimal involvement from third parties such as public servants given that it would be algorithms, not people, who manage the property records. In this regard, a vast amount of work would need to be done in education and capacity building for professionals such as lawyers, surveyors and building managers to understand how to interpret smart contracts and compliance with relevant regulatory standards.

However, as raised in the Project Victoria White Paper about real estate tokenization, the co-ownership and co-use issue will still need to be further considered even if the above policy changes. If tokens representing fractionalized ownership for real estate properties which are not physically stratified are available, there should be restrictions (which can be encrypted in the tokens) on further change of ownership or creation of encumbrance over the token (which represents ownership interest). Potentially, any unit or building which is overly stratified without proper co-use agreement and building management unity may face potential issues regarding property devaluation, as shown in various examples where commercial buildings in Hong Kong having been stratified on individual unit / floor basis without unity in building management which leads to low liquidity of individual titles in the building. While tokenization of such real estate promotes lower investment hurdles potentially from smaller institutional or retail investors, it will need to be balanced with the above consideration of adding in change of ownership / encumbrance restrictions into the real estate tokens.

Market Transparency and Investor Protection

Part of the aim of real estate tokenization is the increased liquidity it offers and the enhanced market accessibility. Given that the security tokens can be traded on a secondary market, the Securities and Futures Commission (SFC) would need to create new regulations to define the legal status of real estate tokens, rights and obligations of each token holders and have regulatory oversight of tokenized offerings. One would also expect there to be less intermediaries compared to REITS and trading in the secondary market will be made on automatic exchanges rather than stock exchanges. The exchange platform would need to be highly regulated with reporting requirements for issuers and mechanisms to prevent any market manipulation.

Opening the platform to retail investors

A key benefit of real estate tokenisation is the democratization of real estate investment opportunities which was previously out of reach for private retail investors. Investor protection is a critical step, and it is essential that interested investors should first go through a verification process such as identity verification and accreditation checks. The marketing and distribution of the security tokens would also need to comply with the disclosure requirements and regulatory approval from the SFC such that investors would have access to accurate and transparent information about the underlying asset, project risk and potential returns. It is hoped that eventually with such opening of the retail investment platform, retail investors would be able to invest in fractionalized real estate or security tokens with sufficient protection – this shall be further examined and considered by the SFC and relevant legal professionals focusing on securities offering.

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Definitions

Abbreviations & Acronyms

AML	Anti-Money Laundering
BIS	Bank for International Settlements
BISIH	Bank for International Settlements Innovation Hub
CBDC	Central Bank Digital Currency
CDS	Cross Domain Solution
DLT	Distributed Ledger Technology
EVM	Ethereum Virtual Machine
HELOC	Home Equity Line of Credit
HKMA	Hong Kong Monetary Authority
HSM	Hardware Security Module
KYC	Know Your Customer
LTV	Loan To Value Ratio
MVP	Minimum Viable Product
PoC	Proof of Concept
SLA	Service Level Agreement

Terms & Definitions

Note: these definitions are provided solely for the purpose of this paper.

Blockchain	A type of distributed ledger technology which chunks transactions into “blocks” for processing, resulting in a traceable and immutable ledger of transactions.
Central Bank Digital Currency	A natively digital fiat currency, typically operating on a DLT solution.
Distributed Ledger Technology	A record of transactions operated by a network of nodes, which are decentralised to some degree. This can include blockchain solutions.
Home Equity Line of Credit	A revolving credit facility issued by a bank to a customer currently holding a mortgage with the bank to unlock the equity in their home.
Hypothetical e-HKD	The implementation of the e-HKD for exploration purposes in Project Victoria.
Retail CBDC or rCBDC	CBDC issued by a monetary authority / central bank or participating bank to retail customers.
Wholesale CBDC or wCBDC	CBDC issued by a central bank to a participating bank.

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