

Chapter 2: International experience including Japan

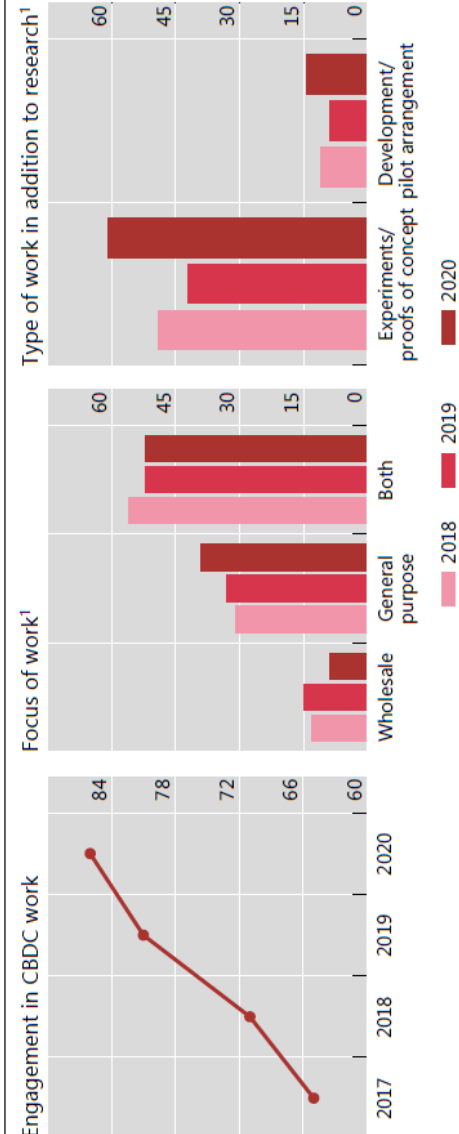
- **Modality of CBDC**
- **Global trend**
- **Impact of CBDC for stakeholders**
- **Technology**
- Key projects and discussions
- Summary (*including how to proceed with PoC*)

Modality of CBDC

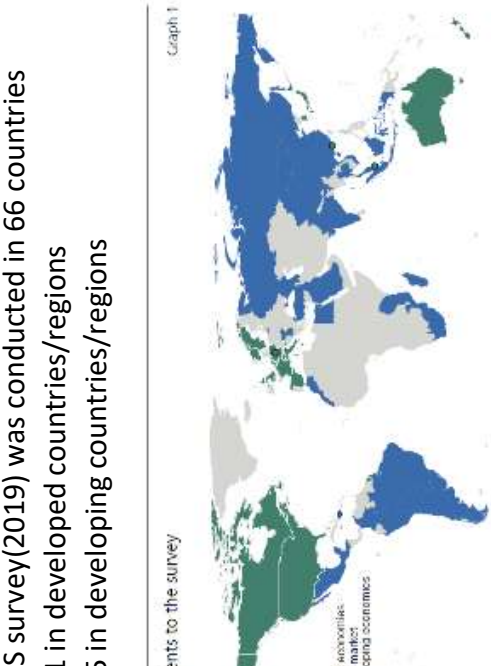
Motivation of CBDC

It is needed to confirm the discussion about central bank digital currency to tackle several issues such as enhancement of payment system and financial inclusion in Vietnam

- Most central banks are exploring CBDCs and continues their work and moving into advanced from study and/or conceptual study to practical experimentation
- According to the latest survey by BIS, emerging countries show stronger motivation for issuing CBDC than advancing countries in order to tackle the issues of financial inclusion, payments efficient
- From the central bank viewpoint, **CBDC will be one of the options to tackle the issues about financial inclusion and enhancement of payment systems including non-cash payments in Vietnam**



¹ Share of respondents conducting work on CBDC.



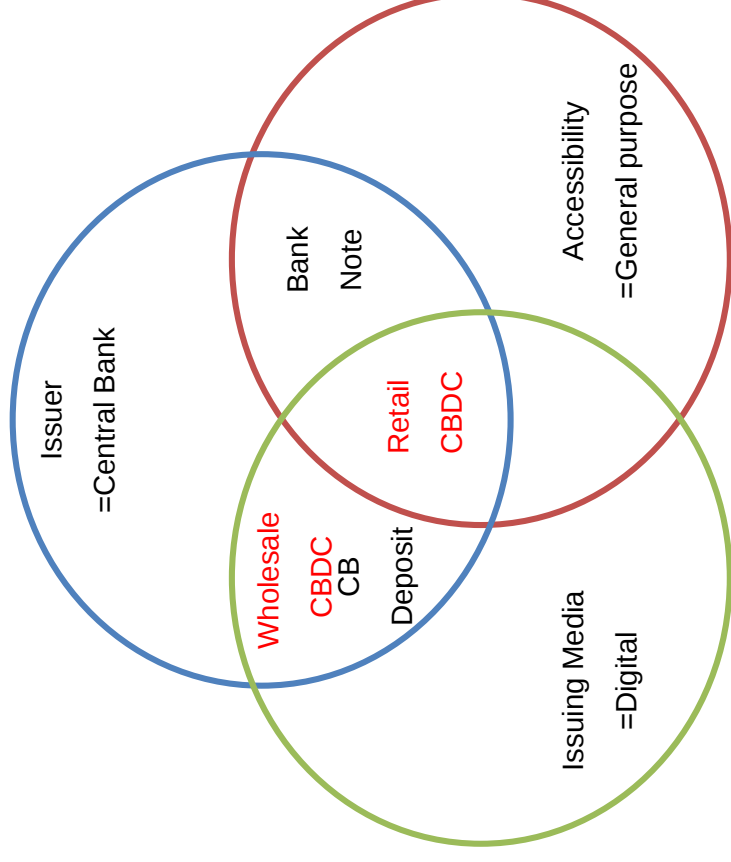
BIS survey(2019) was conducted in 66 countries
1 in developed countries/regions
5 in developing countries/regions

Modality of CBDC (2)

Definition of CBDC

Central Bank Digital Currency (CBDC) is not a well-defined term, but it would be a new form of digitalized central bank money

- Wholesale CBDC is intended for the settlement of interbank transfers and related wholesale transactions
- Retail CBDC is widely available to the general public (general purpose)



Modality of CBDC (3)

Issuance model: Direct/Indirect/Hybrid model

From the viewpoint of the central bank responsibility, there are 3 models are introduced in BIS paper. In realistic approach, direct model will not be realistic way to consider the modality of CBDC

- Regarding the retail CBDC architecture, legal structure of claims and the respective operational roles of the central bank and private institutions in payments should be designed

Model	Features			Description
	Claims	KYC	Role of payment system (Record of transaction)	
Direct model	CBDC is a claim on central bank	Intermediaries on central bank on board (KYC)	Central bank handles retail payment	It has a simplicity, and it eliminates dependence on intermediaries. But it is needed to compromise in terms of payment system's reliability, speed and efficient. The paper suggested that it would be developed and maintained by private companies due to the limitation of resources in central bank
Indirect model	indirect CBDC-like liability to the consumer is a claim on intermediary	Intermediaries on board (KYC)	Central bank handles wholesale payments	The indirect CBDC model is also considered as the two-tier CBDC because it would ensure the existing two-tier financial system. Similarity with the existing payment system and infrastructure is that there are regulatory and supervisory issues as well as deposit insurance etc.
Hybrid model	CBDC is a claim on central bank	Intermediaries on board (KYC)	Central bank periodically records retail balances	The hybrid model would have both advantages and disadvantages of direct and indirect model. One key element of the hybrid CBDC architecture is the legal framework that underpins claims, keeps them segregated from the balance sheets of the payments service providers (PSPs), and allows for portability. This model is more complex to operate than the indirect model because central bank has to manage the balance of retail transactions

Modality of CBDc (4)

Validation model: Account/token model

Looking to the viewpoint of validation methods of a claim, there are two type, Account type and Token type. Furtherly, there are another category from the issuer perspective. There are 4-quadrant in total

- Account type is that payment will be conducted based on the confirmation of account holder and payer. when payment is conducted
- Token-type is that authenticity of token is confirmed when payment is conducted

Type	Central bank directly issues for general public	FIs indirectly issues for general public
Account type (deposit-like) cash transfer required	Model 1 • Central bank holds accounts of general public (individual, corporates). • Central bank operations with heavy workloads, such as identity verification and account management operations	Model 3 • Central bank issues CBDcs for FIs, then intermediaries (FIs) transfer CBDc to individuals and corporates • Identity verification and account management operations are complicated by private banks' business systems
Token-type (currency-like) No cash transfers required	Model 2 • Central bank issues token(data incorporated financial values) and circulate it to general public • Central bank operations with heavy workloads, such as identity verification and account management operations • Needs legal system for token (Ownership and data attribution etc.)	Model 4 • Central bank issues CBDcs(token) for FIs, then intermediaries (FIs) transfer CBDc to individuals and corporates • Identity verification and account management operations are simplified by private banks' business systems (same form of distribution as cash • Needs legal system for token (Ownership and data attribution etc.)

Modality of CBDC (5)

Validation model: Account/token model (Sample)

Image of ledger for both account type and token type . For token type, using cryptographic technology, it is general for user to have multiple public keys

Image of ledger for Account type

Account holder	ID (account number)	Balance (USD)
A	88-228-504	100,000
B	41-923-016	800,000
C	33-225-016	750,000
D	45-227-086	600,000
Total:		2,250,000

Image of ledger for Token type

Token	Public key	Holder (but does not recode in ledger)
50,000	25B48BA...	A
50,000	F14AB64..	A
450,000	HR330RT..	B
350,000	HH22408..	B
350,000	AH40021..	C
400,000	FHB01JAH	C
200,000	3HT0012H	D
400,000	15HAD35F	D

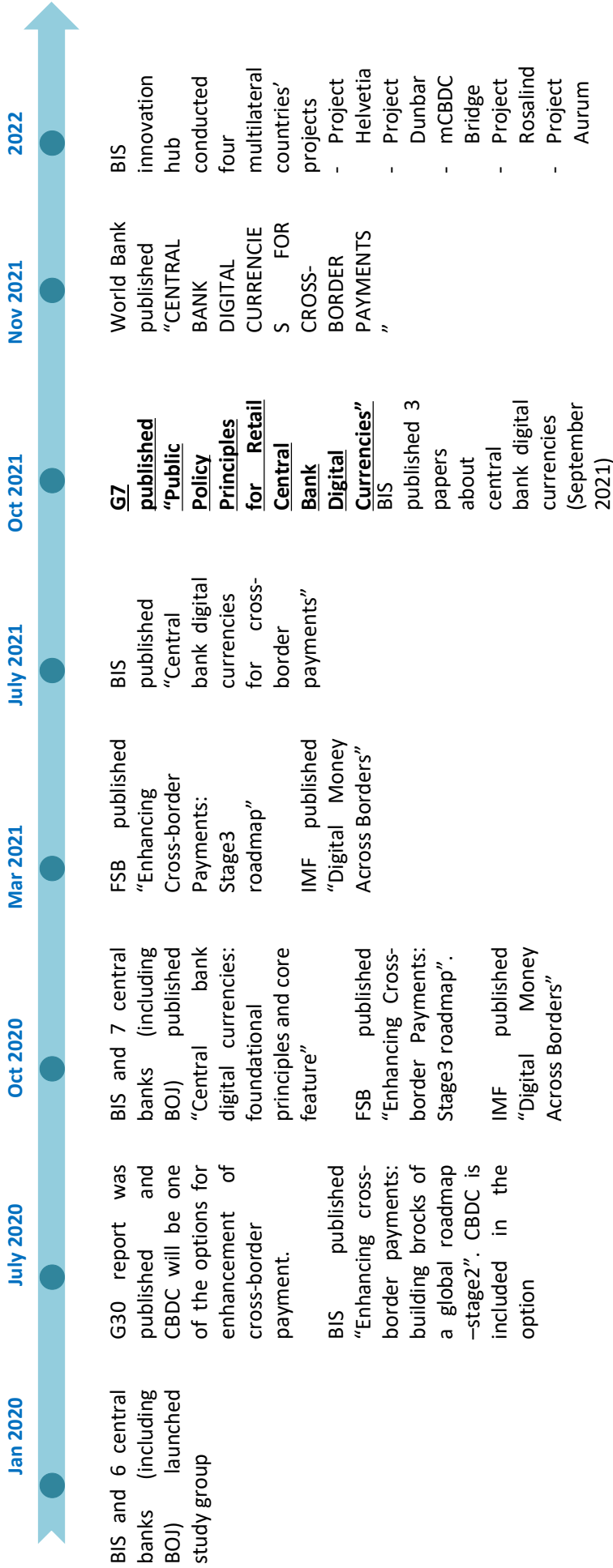
Total: 2,250,000

Global trend

History of the international discussion and activities about CBDC

Global discussions are shown in the following chart. From the viewpoint of cross-border payment, CBDC is discussed in as the global agenda

- One of the key initiatives for retail central bank digital currency, G7 published “Public Policy” for retail CBDC in October 2021 based on the previous paper published in October 2020



Global trend (2)

Multilateral countries' project and initiatives

Recently, BIS innovation hub has been actively initiated many projects for CBDCs. Some of the projects are multilateral projects to tackle the issue of cross-border payment

Cooperation type	Example of project			Description
	Authority/Project	Participants	Year	
BIS innovation hub: Multilateral countries' project	Project Helvetia	Bank for International Settlements (BIS), the Swiss National Bank (SNB) and SIX and commercial banks	2022	The objective is to test the feasibility of integrating CBDC's wholesale operations with the existing settlement systems and core banking system test systems to investigate interbank transactions, monetary policy, and cross-border trade settlements
	Project Dunbar	Reserve bank of Australia, Bank Negara Malaysia, Monetary Authority of Singapore and South African Reserve bank	2022	The objective is to develop two prototypes for a shared platform that could enable international settlements using digital currencies by multiple central banks
	Multiple CBDC (mCBDC) Bridge	People's Bank of China, Central bank of UAE, Hong Kong Monetary Authority, Bank of Thailand	2022	The purpose of this project is to develop a prototype of a CBDC based on distributed ledger technology (DLT) for multi-currency simultaneous settlement to enhance the convenience of foreign exchange transactions in international trade
	Project Rosalind	Bank of England	2022	The objective is to develop prototypes for an application programming interface based on two-tier distribution model of CBDC and also to explore some of the functionalities required to enable a diverse and innovative set of use cases to be developed by the private sector
BIS innovation hub: Single country project	Project Aurum	Hong Kong Monetary Authority	2022	The objective is to study the benefits and challenges of tiered architectures for the distribution of retail CBDC through commercial banks and payment service providers. This project will investigate two architectural models: hybrid CBDC and private CBDC-backed e-money
	G7	[Report] Public Policy Principles for Retail Central Bank Digital Currencies	2021	The Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements have collaborated on a report setting out common foundational principles and core features of a CBDC
Initiatives	BIS/several banks	[Report] Central bank digital currencies: foundation principles and core feature	2020	On January 21, 2020, "Group for Sharing Knowledge on Assessing the Potential Use for CBDC utilization" was established. The main research themes are as follows:(1) How to utilize CBDCs (2) Identifying technical issues (3) Sharing knowledge on CBDC design and advanced technologies

Global trend (3)

Foundational principles for retail CBDC

Foundational principles for general purpose CBDCs are common understanding for retail CBDC among advancing countries

- In October 2020, the “foundational principles” required for general purpose CBDCs(retail CBDC) were published
- Since then, The Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements have been working closely to continue in-depth policy analysis and practical policy analysis in line with the said principles

Foundational Principles	1. “Do not harm” to monetary and financial stability 2. Coexist with other types of money 3. Promote innovation and efficiency
Motivation and conditions	The fact that central bank money is at the core of the monetary system is a source of public trust in money , that will support public welfare The digitalization of the economy is progressing further, and user needs are changing rapidly. Innovation is reshaping financial services In many jurisdictions, cash use in payments is declining and new forms of digital money (e.g., stablecoins) issued by the non-banking private sector are emerging CBDCs can be an important tool for central banks to enhance financial stability, utilize new technologies, and continue to serve the public in the future International cooperation on CBDC could be an instrument to improve cross-border payments

Impacts of CBDC for stakeholders

Possible impacts and challenges

Although various benefits are expected for introduction of CBDC, many challenges exist in its implementation and realization

Items	Merits	Challenges
Lower overall economic costs	Reduction of costs for preparation, storage, transportation, security, etc. due to the decrease in payments and settlements in cash (banknotes and coins)	⇔ Even after issuing CBDCs, if the current currency supply and payment systems remain side by side, the cost is not expected to decrease
Contribution to the financial stability	CBDC could replace private banks' payments operations	⇔ If private bank deposits are substituted, the fund intermediary function may be reduced
Strengthening AML/CFT	Can monitor information recorded at the time of CBDC receipt and payment	⇔ It is necessary to decide how to share, manage, analyze, and utilize personal information protection and business use with private entities. (Balanced system design)
Promotion of financial inclusion	Spread of financial services as a means of payment for low-income groups, people living in rural areas, etc. who do not have accounts	⇔ Differentiation from other payment methods.(If only payment function, it is not much different from existing payment methods.)

Impacts of CBDC for stakeholders (2)

Cross-border payment

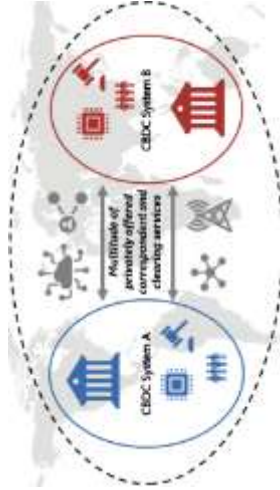
Under the G20 initiatives, Improvement of cross-border payment has been discussed

Allowing access from overseas

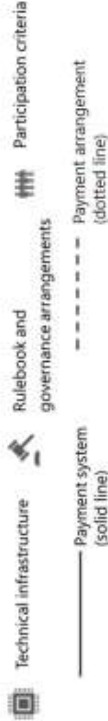
Each country designs its system in advance with interoperability and coordination in mind for use in cross border transactions

Model1: mCBDC arrangements based on compatible CBDC systems

Encourages compliance with international standards and technical standards for CBDCs under consideration



Legend



Model2: mCBDC arrangements based on linking multiple CBDC system

Connecting the infrastructures of each country by building technical interfaces, etc



Model3: Single mCBDC multi-currency system

Building a single infrastructure and allow multiple



Impacts of CBDC for stakeholders (3)

Cross-border payment (2)

CBDC has been the focus of attention in improving G20 cross-border remittances, but there are its effectiveness and challenges

Source: BIS(2021), “Central bank digital currencies for cross-border Report to the G20”		
Impacts	Effectiveness	Challenges
Potential increase in cross-border flows	Cheaper and more accessible remittances will benefit senders and recipients. This is to buffer economic shocks and stimulate growth	- Potential current account balances and balance of payment problems if the gross foreign asset positions are large - In addition, volatility of capital flow might be increased
Potential financial stability risks and currency substitution	If CBDC becomes available across borders the cost of obtaining, storing, and using foreign currency could be lowered	Especially in countries where inflation is high and the home currency is unstable countries, the incentive to obtain, store, and use foreign CBDC
Reserve currency configurations and backstops	Reserve currencies such as the dollar and the euro have been replaced by the emergence of CBDCs (digital dollars and digital euros) and their may become even more dominant	The relative position of the dollar and the euro will decline gradually if various and usable CBDCs are developed for global trade and finance

Technology

Overview

Ledger management, offline management, standardization and user adoption are key consideration points to select the appropriate technology for designing CBDC

- Many countries have been examined and studied distributed technology whether it will be applicable to CBDC
- Following tables shows the comparison table of distributed ledger technology

Ledger management	Management	Centralized or De-centralized: Resilience of centralized system is controlled by one authoritative entity, on the other hand, de-centralize system managed by different entities in a decentralized manner and update of ledger should be managed between the node of all entities
	Update	Account type or token type: Token-based CBDCs could use cryptography to anonymize users when linking them to each token
Offline management		
In an offline environment, the ledger administrator cannot check transactions. It is important to ensure the finality of payments safely, securely, and promptly using the user's terminal. The following three points are required to be considered when developing a system: (1) secure storage of monetary value, (2) information transmission between users, (3) authentication of holders and terminals, (4) settlement display and (5) securing power		
Standardization		
It is important to follow the standards of data format/data item (such as ISO20022), code structure and security for safety transmission of the data. It is necessary to select and combine international standards that are compatible with each elemental technology		
User adoption		
Some consumers may need to purchase new hardware because they do not have smartphones or do not have accounts. In this regard, it is important to link with the Merchant infrastructure. Integrating with existing Merchant accounting and point-of-sale (POS) systems will allow for early adoption and widespread use of CBDC		

Source: MRI analysis based on several sources such as BIS(2021), “Central Bank Digital Currencies: user needs and adoption”, BOJ(2021),” Standardization in Information Technology related to Digital Currencies “

Technology (2)

Decentralized ledger technology (DLT)

The selection of centralized or de-centralized ledgers is one of the consideration points for designing of CBDC. Especially, many countries are exploring the possibility to use de-centralized ledgers technology for CBDC through PoC or Pilot

Public type		Consortium type		Private type
Participation	Free	Permission		Permission
Features	No administrators	Muti organization		Single organization
Finality	No	Yes (to adopt consensus algorithm)		Yes (to adopt consensus algorithm)
Processing time for creation of block	Long	Short		
Examples	Crypto assets (Bitcoin, Ethereum etc.)	Hyperledger Fabric, Corda, Quorum etc.		

Technology (3)

Decentralized ledger technology (DLT) (2)

The selection of centralized or de-centralized ledgers is one of the consideration points for designing of CBDC. Especially, many countries are exploring the possibility to use de-centralized ledgers technology for CBDC through PoC or Pilot

- Following tables shows the comparison table of distributed ledger technology
- Compared with global digital payments such as VISA, the performance of throughput are limited and could be one of the issues for introduction of retail CBDC. Many countries have been examined and studied distributed technology whether it could be applicable to CBDC or not

Hyperledger Fabric		Corda	Quorum
			
Vendors	IBM	R3	ConsenSys
Developer	The Linux Foundation	R3 CEV	Enterprise Ethereum Alliance
Consensus algorithm	Endorsement Policy (Validation is conducted by endorser node and scalability was improved)	Validity consensus (proposed transaction and for every transaction in the backchain that generated inputs to the proposed transaction and notary node check uniqueness)	3 types of consensus algorithm: Clique POA*1 Raft-based Consensus*2 Istanbul BFT*3
Throughput	~2,700 tps	90-1,000 tps	~2300 tps

*1 Clique PoA (Proof of Authority) is that consensus is achieved through authorization of "Authority" node. Considering the normal consensus algorithm, the performance seems to be better

*2 Raft achieves Crash Fault Tolerant. Leader node is assumed to work properly but leader node will be selected from follower nodes so that network continues. If there is no transaction, "block" is not created. Therefore, it can save storage space

*3 Consensus of Istanbul BFT (IBFT) is achieved through a series of votes by validator.

Chapter 2: International experience including Japan

- Modality of CBDC
- Global trend
- Impact of CBDC for stakeholders
- Technology
- **Key projects and discussions**
- Summary (*including how to proceed with PoC*)

European Central Bank (ECB) published “Report on Digital Euro” in October 2020. ECB stated that they will proceed with design work in two years in July 2021

Background

- The change on the perception about retail payment based on digitalization and innovation
- It would be natural that ECB will be issuer of a digital EURO
- Relationship between cash and electronic payment methods
- Preference for electronic payment and expectations of safety and swiftness among younger consumer

Requirements

- Ensure the anonymity with security in some way
- Correspond to the cyber risks
- Promotion of new services

Core principles

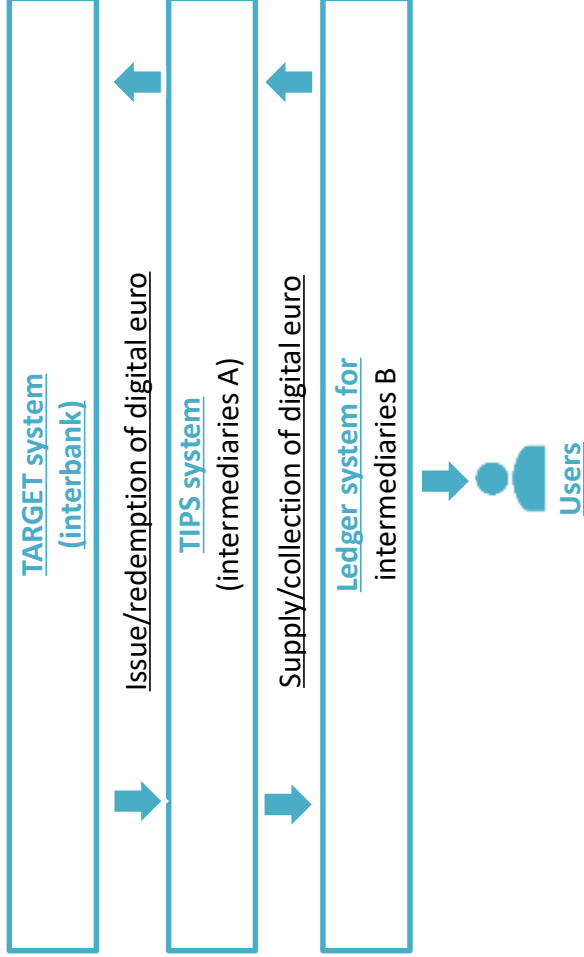
1. Compatibility: Not parallel currency
2. Liability of the Ecosystem: A digital euro is central bank money and its issuance is controlled by the Eurosystem
3. European solution: Widely accessible on equal terms in all euro area countries through service providers
4. Market neutrality: Not to crowd out private solutions
5. Trusted by end users: Trusted solution from the start and over time

From the several viewpoint, ECB stated the fundamental design of CBDC in “Report on Digital Euro”

Viewpoint	ECB stance
Access (to user)	• Preferable to limit the role of the central bank and access should be via intermediary institutions. In this sense, it is needed to supervise intermediaries
Anonymity	• Anonymity is not permitted to discourage AML/CFT and savings purposes. • Transactions and personal secrets (personal data) are protected by intermediaries
Prevention of usage for savings	• Option is individual threshold at any given time. • It would be feasible about tiered interest rate. (But this issue does not arise when risk-free nominal interest rates are clearly in positive territory)
Prevention of usage by non-residents	• Not good for internationalization of euro but for stability of financial system. • Necessary to cooperate with other central banks
Payment and instruments	• Intermediaries would record transactions and user authentication is conducted by device. For online-payments, various devices can be considered. It would be difficult to introduce the device which can offline payments with high usability and security • Regarding offline payments, it would be substitute for banknotes in case of contingent situations
Interest rates	• Necessary for both monetary policy and financial stability • Setting the spread from policy and tiering structure would be efficient
Legal tender	• Widespread, unlimited effects and standardization of definition
Collaboration (with private payment systems)	• Digital Euro would be beneficial for crisis measures • There are issues about cost efficiency and environmental footprint, duplicate investment for private firms

According to the joint report by ECB and 7 national central banks, two-tiered structure are considered. Tier1 is layer of intermediaries and issue and redeem digital Euro with the account in TIPS* and supply digital Euro to Tier2

- intermediaries A would be limited to financial institutions that participate directly in TARGET
- On the other hand, Tier 2 was intended to be operated by supervised institutions. In both cases, digital euros would be traded solely as dept of ECB and NCBs(National Central Banks)
- For increase of usability, common API will be prepared for all intermediaries B



*TIPS is an instant payment infrastructure and has been operated since 2018. TIPS is an expansion of TARGET2 that is interbank payment and settlement system
Source: MRI analysis

The Federal Reserve Bank of Boston (Boston Fed) and the Massachusetts Institute of Technology's Digital Currency Initiative (MIT DCI) are collaborating on exploratory research known as Project Hamilton

- Project Hamilton is a multiyear research project to explore the CBDC design space and gain a hands-on understanding of a CBDC's technical challenges and opportunities
- Boston Fed and MIT jointly created an open-source license for the software in Feb 2022, but there is no decision on moving to pilot or production phase

Phase1. Build a core engine to meet the key requirements of a nationwide US retail CBDC. (Feb 2022)

- Designs are benchmarked to assess:
 - Scalability(goal of 100,000 transaction per/sec), Speed (clearing and settlement in under 5 second), Resiliency (high resilient and robust recoverability) and Security (privacy)

Phase2. Code and test various design/policy choices to determine the impact on initial benchmarks and potential tradeoffs (e.g., privacy versus AML/CFT compliance) (Not decided yet)

- Selected topics under exploration: Privacy versus AML/CFT compliance, Programmability, Interoperability and Accessibility and offline

Federal Reserve Board (2)

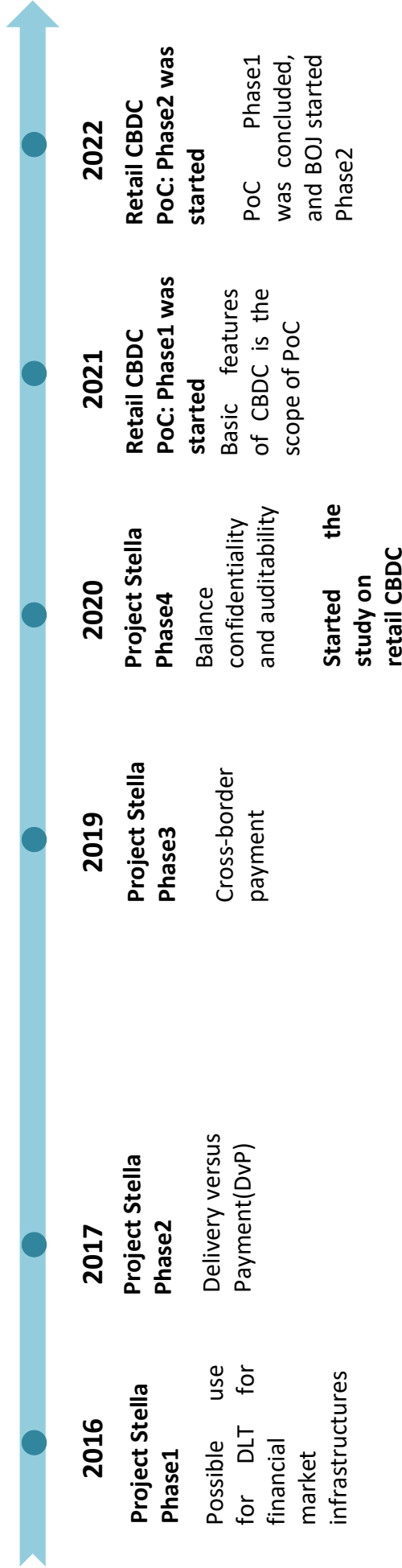
The discussion status in U.S. seems to be behind compared with other advancing countries such as Japan, England and Euro area

- Federal Reserve Board (FRB) published a report, “Money and Payments: The US Dollar in the Age of Digital Transformation” in January 2022
- FRB asked stakeholders about the benefits and risks of implementing CBDC and collecting a wide range of opinions

Viewpoint	Description
Conditions of CBDC	• Ensure that the benefits of CBDC to users, including households and businesses, and to the U.S. economy, outweigh its costs • Confirmation that CBDC are superior to the payment methods currently offered by the private sector • CBDC should complement, not replace, current forms of money and methods of financial service delivery • Users' privacy is protected • It protects against criminal activity • It has the support of a broad range of entities and institutions involved with CBDC
Benefits of CBDC	• Support innovation in the private sectors and reduce liquidity risk and credit risk • Improvement of Cross-border payment • Financial inclusion • Expansion of accessibility of central bank money
Potential risks Consideration point	• Change of the role between the central bank and private sectors • Safety and stability of financial system (sudden transfer from private sectors' money to • Efficiency of monetary policy framework (interests rate bearing)

Bank of Japan (BOJ) has been addressed a series of study about distributed ledger technology (Project Stella) with ECB and PoC for retail CBDC

- Project stella is one of the key projects for verifying the possibility of distributed ledger
- BOJ has been started a series of PoC for retail CBDC since 2020 and discussed relevant stakeholders



Project Stella was joint project between BOJ and ECB. It is not intended to replace or complement the existing payment and settlement systems of central banks. In addition, legal and regulatory aspects are out of scope of this project

Phase	Theme	Period	Overview
Phase1	Possible use for DLT for financial market infrastructures	2016	Develop liquidity saving features with DLT and confirm the efficiency and security. Through this PoC, it was confirmed that DLT based system can be same performance as RTGS. Platform was Hyperledger Fabric(ver0.61) and using smart contract
Phase2	Delivery versus Payment(DvP)	2017	Develop DvP with distributed ledger technology. From the viewpoint of connectivity between ledgers, HTLC* method was used
Phase3	Cross-border payment	2019	Develop cross-border payment infrastructure to verify synchronizing payments between different ledgers. 5 payment method defined (Trust line, On-ledger escrow, Third party escrow, simple payment channel and Conditional payment channel)
Phase4	Balancing confidentiality and auditability in DLT	2020	Research and address the issues to balance confidentiality and auditability in DLT.

*Hash Time Lock Contract is a technology for cross-chain atomic swap

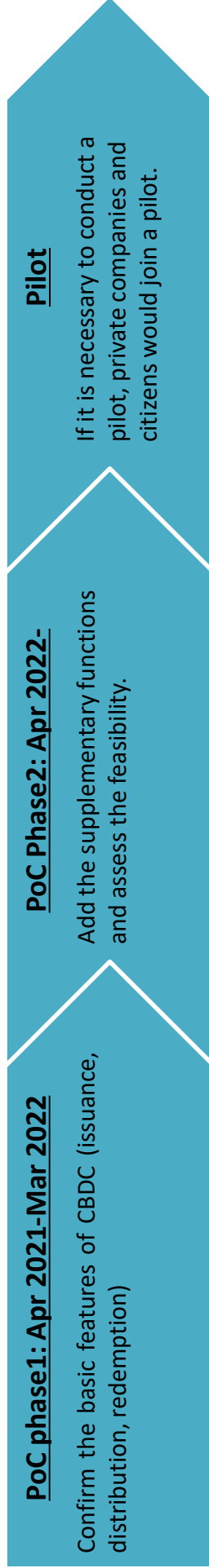
Source: Bank of Japan, Central Bank Digital Currency Initiatives by the Bank of Japan(Apr 2022)

The Bank of Japan(BOJ) does no have a plan to issue CBDC at this moment, but BOJ understood it is necessary to prepare from the viewpoint of stability and efficiency of the whole payment system through PoC and Pilot for retail CBDC

Basic Policy for a retail CBDC

- Given the rapid pace of technological innovation, it is possible that society's need for central bank digital currency (CBDCs) will increase rapidly in the future.
- In this regard, BOJ proceed with the PoC and discussion about regulatory framework.

Process for a PoC and a Pilot



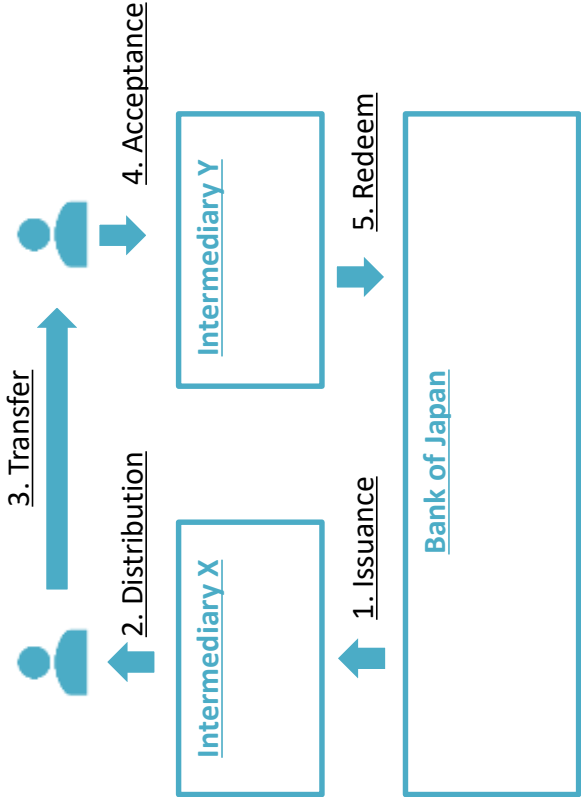
- In parallel with the PoC, the BOJ will proceed with consideration of regulatory design for CBDC:
 1. Cooperation and demarcation of role between the central bank and private firms
 2. Stability of financial system (Limitation of amount, interest rate)
 3. Ensure the privacy and handle the user information (Anonymity, AML/CFT, usage of data)
 4. Modality of standardization with related to digital currency (Standardization of data format)

In PoC phase1, basic features of CBDC were tested

Objectives

- Confirm the basic features of CBDC (issuance, distribution, redemption) from the technological viewpoint
- Blockchain and distributed ledger are not used in the PoC. The system environment was built on the public crowd platform.

Process for a PoC

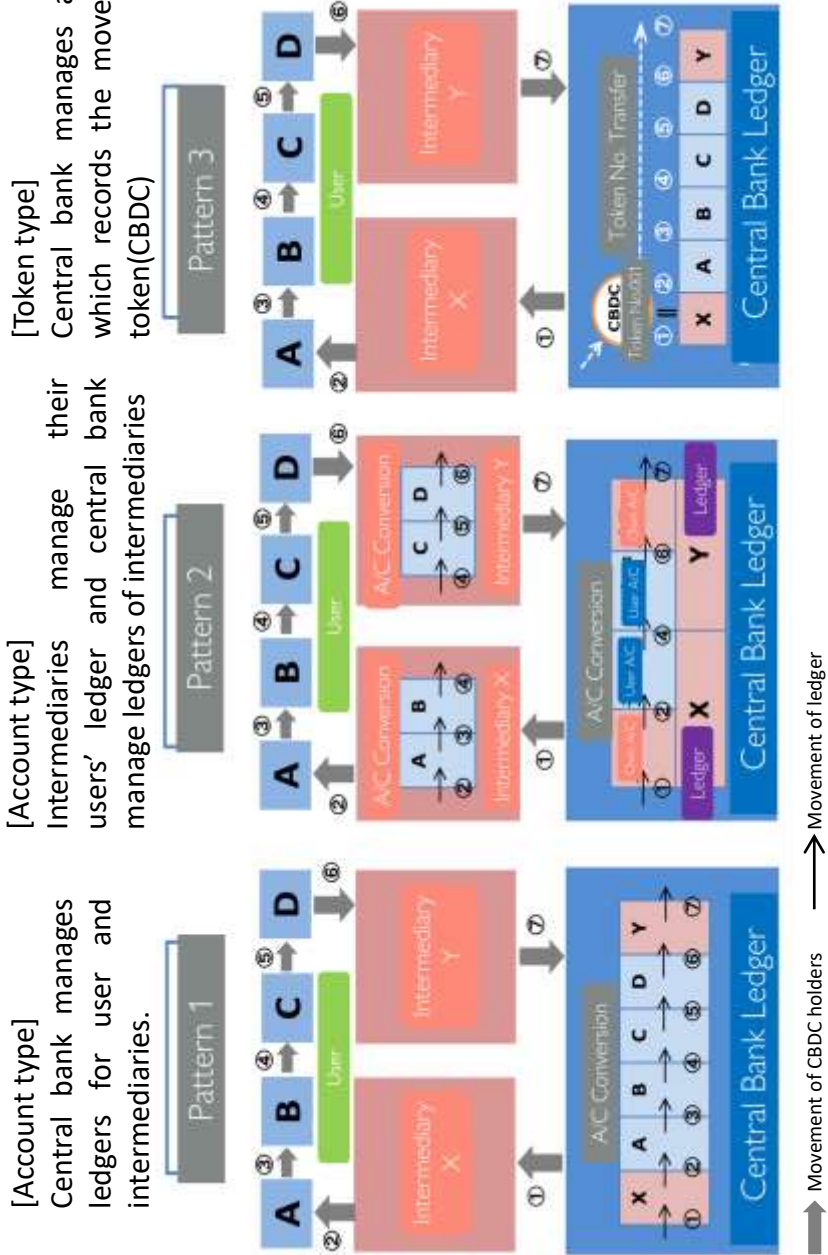


Basic transaction	
1. Issuance	Decrease current account of Intermediary X in BOJ-NET and issue CBDC
2. Distribution	Decrease deposit of User A and distribute CBDC to User A
3. Transfer	CBDC is transferred between User A and User B.
4. Acceptance	Intermediary Y accept CBDC from User B and increase deposit of User B
5. Redeem	CBDC is redeemed from Intermediary Y and increase current account of BOJ-NET

There are 3 pattern for the ledger of CBDC and assess the performance, reliability, scalability. Basically, the modality of CBDC is considered two-tier model

Ledger pattern

- There are 3 pattern for the ledger of CBDC and assess the performance, reliability, scalability



Based on 3 ledger patterns, performance and functionality are confirmed in line with assessment scenario

Assessment scenario

- The required performance for actual CBDC Environment was tested
- Preconditions are number of end users: 100,000, number of intermediaries: 5, for Pattern3: the total number of issued tokens is 25 million
- There are 2 scenarios (normal scenario(500 TPS), high load scenario (3,000 TPS)
- Viewpoints of assessment are throughput, latency and resource usage(CPU usage)

Outcome

[Performance]

- Pattern 2 has lower processing performance than Pattern 1, but depending on the number of transactions, the same problem may occur pattern 1
- Pattern 3 needs more system resources than Pattern 1 and Pattern 2. but depending on the number of transactions, the same problem may occur pattern 1 and 2. In this sense, it is needed to consider increase of performance for servers (scale-up/scale-out) in the actual situation

[Functionality]

- There are not much differences for availability and resilience against security risks among 3 patterns
- There seems slight differences among each pattern from the viewpoint of scalability of functions but there is no significant differences at this moment
- It can be considered that resilience to failure of pattern 2 seems to be smaller than Pattern 1 and Pattern 2 but there might be a problem about data integrity after failure

During PoC phase1, following points were discussed. BOJ will continue discussion with relevant stakeholders about cost burden for CBDC and legal framework etc

No.	Items	Discussion
1	Basic payment method and additional services	CBDC can be divided into 2 layers from the viewpoint of payment services. (1) To provide basic payment method is a role of CBDC as an infrastructure and (2) intermediaries will provide additional services (programmable payment service, utilization of transaction data for business, accounting application based on the infrastructure)
2	Relationship between private payment infrastructure	Consider the relationship between CBDC and private payment infrastructure(such as Zengin-net: ACH)
3	Ensure the privacy and handle user information	From the viewpoint of privacy protection, user information will be a scope of law and regulation. On the other hand, it is necessary to comply with AML/CFT requirement
4	Cross-border payment	BOJ summarized the international trend about improvement of cross-border payment
5	Standardization of technology about CBDC	To ensure the interoperability and reliability for cross-border payment. In this regard, There are 3 areas for standardization (format, data item: ISO20022, code structure, technology for secure transfer). BOJ will discuss in ISO TC*/68

*Technical committee about standardization of financial services

Source: MRI analysis based on Bank of Japan, Central Bank Digital Currency Initiatives by the Bank of Japan(Apr 2022)

PoC phase2 is aim to add the supplementary functions to the CBDC built in phase1 and assess the feasibility

Objectives

- In parallel with PoC phase2, consideration on pilot phase, study and research individual technology (cyber security, identity verification, follow up practices in other countries and exchange views on a retail CBDC

Tentative schedule

- From April 2022 to March 2023

Scope of functions to be assessed

Increase of usability for payment

1. Booking of payment instruction by users
2. Bulk payment and reverse payment by users
3. Charge/discharge from/to Online CBDC and Offline CBDC

Economical design(Safety guard for financial stability)

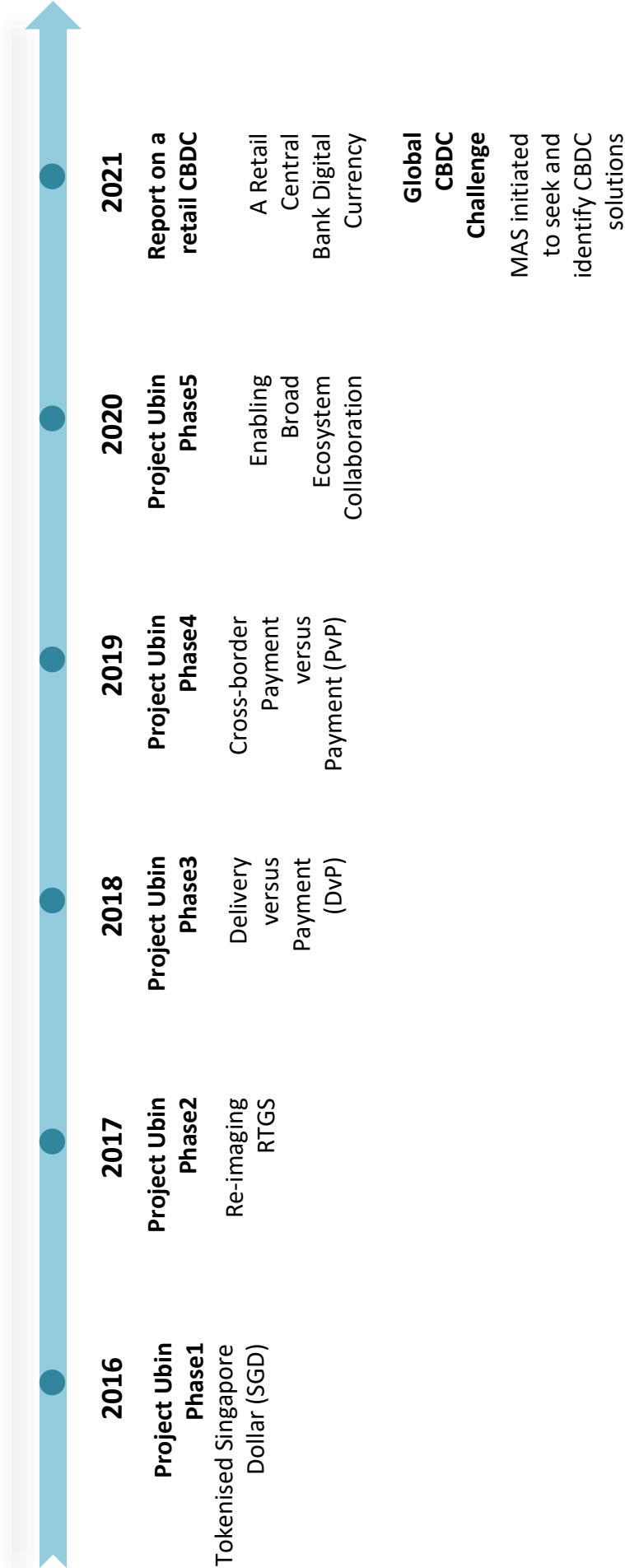
1. Limitation of amount for CBDC
2. Transaction limit of CBDC (per transaction/certain period)
3. Limitation of the number of transactions for CBDC (certain period)
4. Apply interest rate to amounts of CBDC etc.

Linkage with intermediary and external systems

1. Provision of multiple accounts for a user
2. Identify verification among multiple accounts
3. Linkage with private payment services
4. Function for exchanging between cash and CBDC

Monetary Authority of Singapore

Monetary Authority of Singapore (MAS) is leading FinTech situation in ASIA and has been conducted a series of POC for wholesale CBDC and cross-border cooperation on CBDC



Project Ubin is a collaborative project with the industry to explore the use of Blockchain and Distributed Ledger Technology (DLT) for clearing and settlement of payments and securities

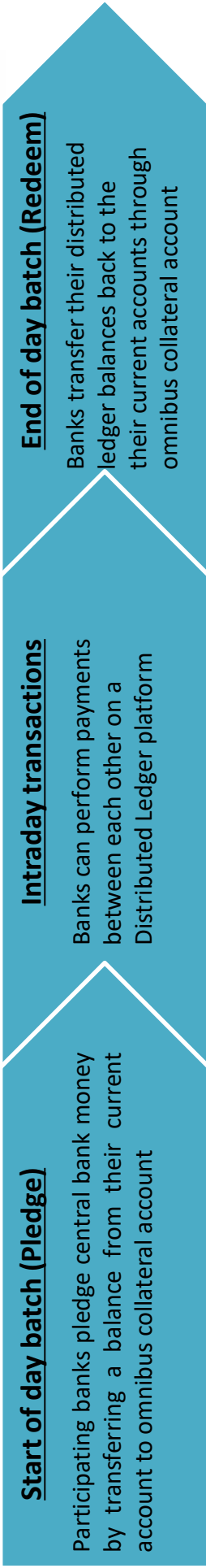
Phase	Theme	Period	Overview
Phase1	Tokenised SGD	2016 (6 weeks for PoC)	R3, a DLT company and 9 financial institutions conducted a proof-of-concept project to conduct inter-bank payments using Blockchain technology. Key point was how to collaborate with the existing payment system (RTGS: MEPS+*) through evaluating the implications of tokenized SGD on a distributed ledger
Phase2	Re-imaging RTGS	2017	5 technology partners (Accenture, R3: Corda DLT, IBM: Hyperledger Fabric DLT, CosensSys: Quorum DLT and Microsoft) - Developed a prototype of 3 different models for decentralized interbank payment and settlement system with liquidity saving mechanisms
Phase3	Delivery versus Payment (DvP)	2018	MAS and Singapore Exchange (SGX) collaborated to develop DvP capabilities for settlement of tokenized assets across different blockchain platforms. Key point was to realize DvP between tokenized assets and different DLTs/technologies.
Phase4	Cross-border Payment versus Payment (PvP)	2018-2019	The Bank of Canada, Bank of England and MAS jointly published a report and assessed alternative models that could enhance cross-border payments and settlements
Phase5	Enabling Broad Ecosystem Collaboration	2020	MAS and Temasek jointly released a report and provided technical insights into the blockchain-based-multi-currency payments network prototype

*MEPS+: MAS Electronic Payment System

Source: Monetary Authority of Singapore, <https://www.mas.gov.sg/schemes-and-initiatives/Project-Ubin>, 2022/8/15

Issuance model for tokenized SGD were defined three models. The Project Ubin chose “Continuous depository receipt model”. In the Project Ubin model, Bank deposit receipts account cannot be overdrawn

Monetary operation between MEPS+(RTGS) and distributed ledger



Monetary model	Overview
Cryptocurrency model	Balances tracked on the deposit receipts(DR) would be new token which is a direct liability of the central bank and an asset to the banks. In this case, MAS would be issuing new money in a new form so that this model was not selected in the PoC
The daily depository receipt model	This model represents the case when distributed ledger are created and destroyed on the DR on a daily basis, backed by money in a special omnibus collateral account. (This was Project Jasper model (the Bank of Canada))

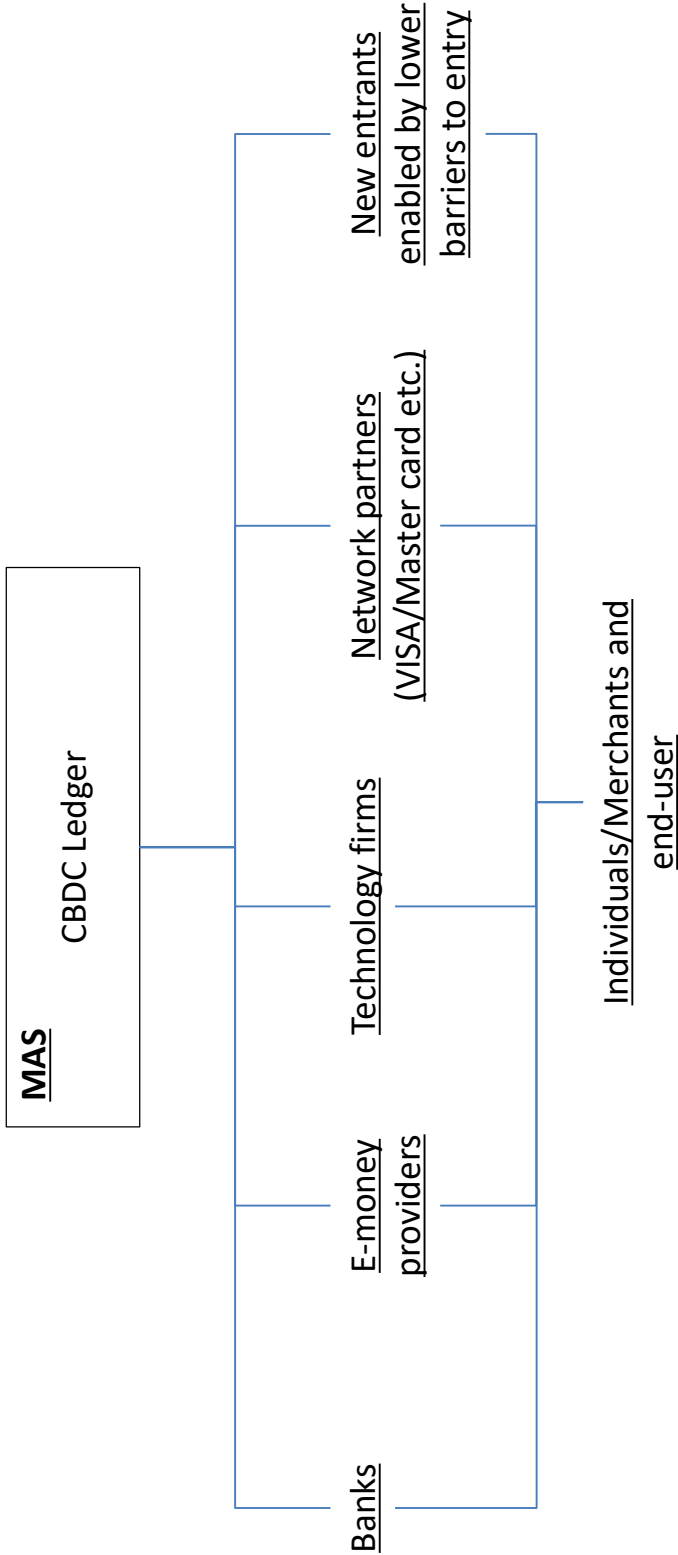


MAS tried “continuous depository receipt model” that is like the daily depository receipt model, but technical difference is that DR balances are created directly in bank DR accounts in one step, and not created in the central banks’ DR account and then transferred



MAS showed their preference on the two-tier model

- MAS showed their preference on the two-tier model where the central bank operates a foundational retail CBDC ledger to which intermediaries connect as they integrate the CBDC into digital payments
- To understand a set of technological options, MAS held the Global CBDC Challenge in June 2021



MAS has not decided to issue retail CBDC but decided to proceed with technological and policy explorations of a retail CBDC

- MAS does not show any positions for each viewpoint in the report but shows the possibility for “Synthetic CBDCs” that are digital money issued by private intermediaries who hold 100 % reserves at the central bank as backing for the digital money

Viewpoint	Description
Payment network	CBDC would play a dual role in the payment landscape: as a back-end infrastructure but also as a government-issued digital payment medium that ensures a minimum level of end-user welfare. The increase in the variety of payment networks would strengthen the resilience of payment system
Monetary and Financial stability	Limited coverage by deposit insurance and an absence of caps on CBDC holdings or the amount that can be transferred into CBDC wallets would further exacerbate run risks The presence of a CBDC could potentially lower the profitability of banks’ core credit intermediation business by raising their funding costs. However, the materiality of a CBDC’s impact on banks’ competitiveness and overall profitability is unclear at this juncture
Monetary policy	MAS assessed CBDC as a monetary policy instrument through the 3 criteria (1) measurability, (2) controllability, and (3) predictability
Macroeconomic impact	The shift from the use of cash and less technologically advanced payments such as cheques to the CBDC could have the effect of increasing the velocity of money (as less money is demanded in equilibrium). However, the impact of CBDC issuance on overall money supply growth is somewhat ambiguous

Bank of Thailand (BOT) is actively conducting a series of PoC for both wholesale CBDC and retail CBDC to confirm the new technology



The purpose and approach of PoC are similar to MAS. However, all PoC seems to be vendor-led approach with partnering R3. Based on phase3 outcome, BOT joined BIS innovation hub for seeking cross-border payments

Phase	Theme	Period	Overview
Phase1	Re-imaging RTGS	2019	The BoT and several participating banks conducted PoC for distributed ledger with partnering R3(Corda). The scope of PoC is tokenization of cash, decentralized bilateral transfers, queueing mechanisms, gridlock resolution, tokenization of bond, automated liquidity provisioning and non-functional capabilities (performance etc.)
Phase2	Delivery versus Payment (DvP)	2019	The BoT and several participating banks conducted PoC for distributed ledger with partnering R3(Corda) The scope of PoC is automation of bond life cycle events using smart contracts, implementation of a decentralized DvP for BOT bonds settlements in interbank market and repo transactions. In addition, the applicability of DLT for data reconciliation and non-resident regulatory compliance within the funds transfer process was examined
Phase3	Cross-border Payment	2020	The BOT and Hong kong Monetary Authority (HKMA) jointly conducted the PoC for cross-border payment versus payment. This project seeks a possibility of THB-HKD cross –border corridor network between the “Inthanon ”and the “LionRock” networks with partnering R3

BOT published “Retail Central Bank Digital Currency Implications on the Thai Financial Sector and Survey Results” in 2021. BOT conducted PoC in 2021 and will conduct Pilot for retail CBDC from late 2022 to 2023

- Following implications are summarized in the paper
- In the context of Thailand, BOT prioritized the opportunities of CBDCs are to provide a safe and reliable digital form of central bank money and enhance innovation and competition in financial services

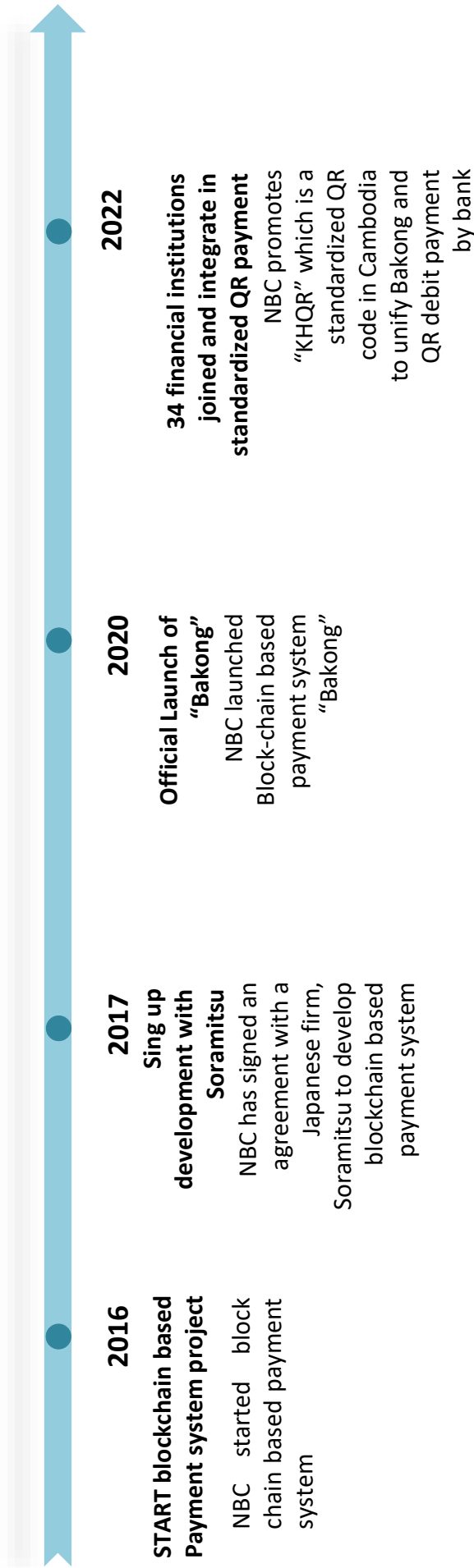
Opportunities
<u>Provide a safe and reliable digital form of central bank money</u>
<u>Enhance innovation and competition in financial services, and support the digital economy</u>
<u>Enhance efficiency in cross-border remittances</u>
<u>Reduce money laundering, illicit financing and tax evasion</u>
<u>Lower cost of cash distribution and management</u>
<u>Enhance financial inclusion</u>
Provide a more direct money policy tool
Provide continued access to central bank money for when access to cash is difficult/unavailable

X

Risks
<u>Provide a safe and reliable digital form of central bank money</u>
<u>Enhance innovation and competition in financial services, and support the digital economy</u>
<u>Enhance efficiency in cross-border remittances</u>
Reduce money laundering, illicit financing and tax evasion
Enhance financial inclusion
Provide a more direct money policy tool
Provide continued access to central bank money for when access to cash is difficult/unavailable

National Bank of Cambodia

Bakong is sometimes categorized as CBDC, but National Bank of Cambodia (NBC) highlighted the Bakong is a blockchain based payment system and infrastructure

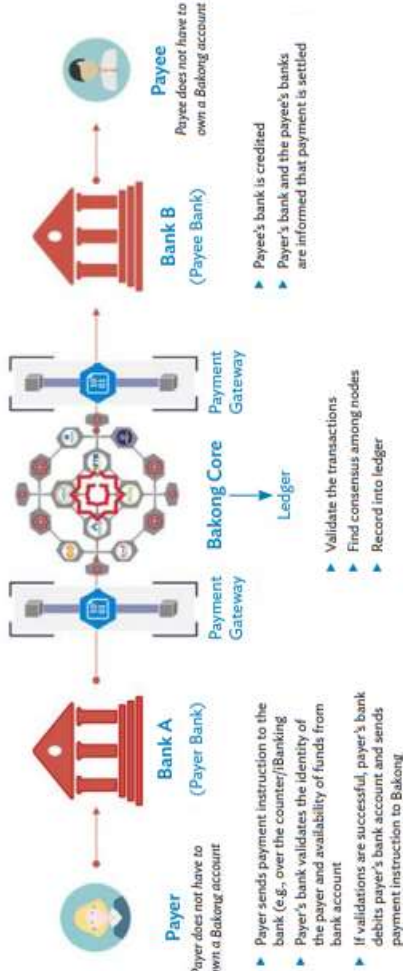


National Bank of Cambodia 🇰🇲 (2)

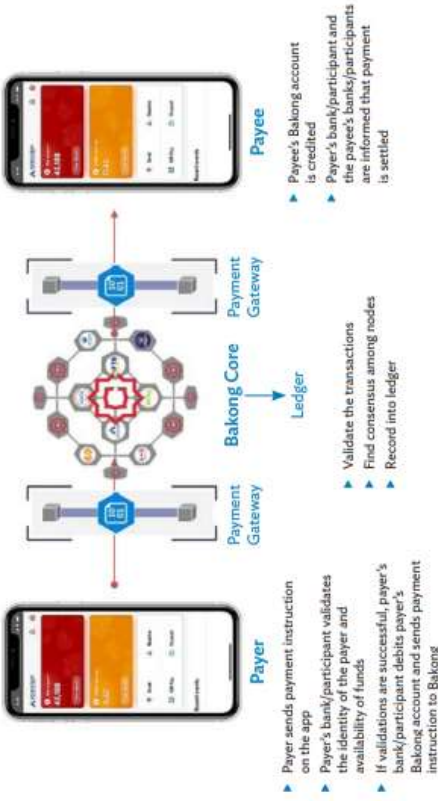
Bakong is sometimes categorized as CBDC, but National Bank of Cambodia (NBC) highlighted the Bakong is a blockchain based payment system and infrastructure

- Bakong is an instant peer-to-peer payment solution connecting all existing banks and multiple domestic payment service providers with blockchain technology, Hyperledger Iroha that SORAMITSU, one of the Japanese startup companies provided
- From the viewpoint of CBDC, Bakong is sometimes categorized as CBDC but National Bank of Cambodia (NBC) clearly highlighted the Bakong is a blockchain based payment system and infrastructure

Payment Workflow for Payment Switch



Payment Workflow for Peer to Peer Money Transfer



National Bank of Cambodia (3)

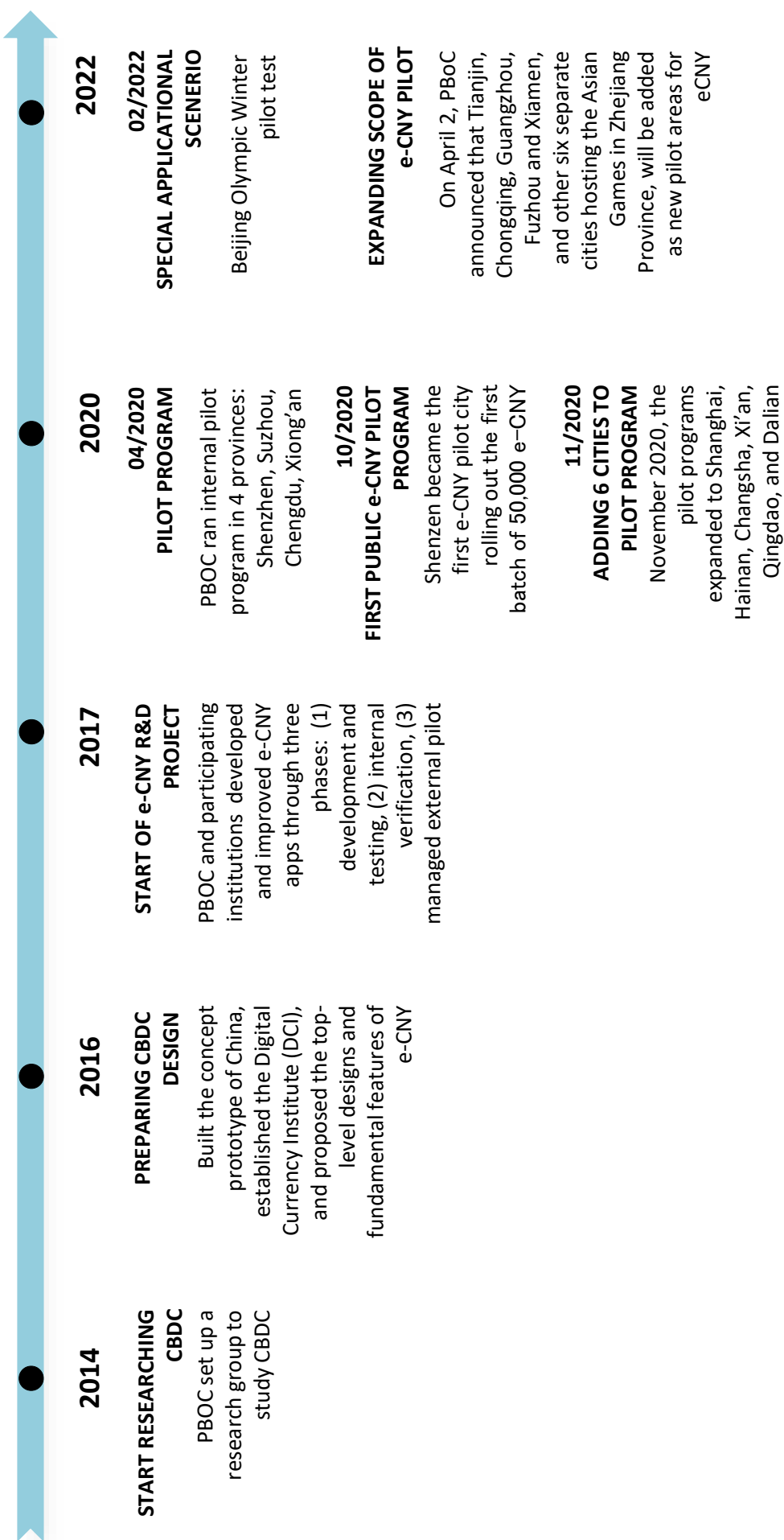
Bakong is payment system (not CBDC) according to NBC’s view, but there are some interesting features from the viewpoint of technology and use case

- Bakong is designed that there is no impact on the cash circulation and existing payment systems

Ledger management	Management	<u>De-centralized:</u> Decentralized architecture is adopted. Soramitsu developed Bakong based on Hyperledger IROHA
	Update	<u>Token type:</u>
Features	Interest rate	No interest rate
	Limit of issuance	Yes: (Asset backed the amount of the current account)
	Use case	Both wholesale and retail payment. Especially <u>the payment by standardized QR code (KHQR)</u> is conducted by Bakong
	Offline channel	No
Payment system linkage		FAST system (Interbank payment and settlement system) manage interbank transaction and core banking system in Bakong manages current account operation. Bakong is integrated into existing systems to transfer Bakong and current account/customer account simultaneously followed by ISO20022 message

People Bank of China (PBOC)

Start researching in 2014, after 6 years, e-CNY 's system and function ability has been tested by pilot program in many provinces



People Bank of China (PBOC) (2)

e-CNY is a digital version of fiat currency adopting two-tier operational system and can interoperate with physical Chinese Renminbi

Features	Description
Fiat currency	• Legal tender: – E-CNY has basic function of money: unit of account, medium of exchange and store of value • Digital version of China’s fiat currency: – The issuance and circulation of e-CNY is identical with physical RMB, while the value of the former is transferred in a digital form • Inter-exchangeable with physical RMB
Interoperability	• A retail Central Bank Digital Currency: – E-CNY is designed with purposes: (1) to meet the public’s daily payment needs; (2) further improve the efficiency of the retail payment system; (3) reduce the cost of retail payment • Allows to pay across authorized operators • Forms of holding e-CNY for user: Digital wallets (physical and online wallets)
Centralized management and a two-tier operational system	• PBOC Perspective: two-layer operational system – Higher tier (PBOC): controls and manages the supply of e-CNY and the flow of e-CNY between lower-tier banks – Lower tier (for commercial bank): facilitate the exchange, circulation of e-CNY with cash or bank deposits • Users’ Perspective: Multiple-layer operational system – Tier 1 (PBOC): issue E-CNY – Tier 2 (Operating institutions including 6 large state-owned banks + 2 internet banks which are WeBank and MYBank): open an e-CNY account/digital wallet, disseminate e-CNY, provide customer service and protect customer privacy, exercise KYC duties – Tier 2.5 (Other banks, payment service providers): provide payment and other services to e-CNY holders – End user (merchants, corporates, consumers): P2P/cooperate with “tier 2.5” institutions to set up digital infrastructure for receiving and paying e-CNY online and offline

People Bank of China (PBOC) (2)

e-CNY system was built on “One coin, two databases, three center” approach with good privacy protection

Features	Description
One Coin, Two Databases, Three Centers	• One coin: e-CNY as the unit of currency. The e-CNY has the same valuation as the RMB • Two Databases: Central bank's ledger and Lower tier's ledger (commercial bank's ledger) • Three Center: Certification center, registration center, big data center which are controlled by PBOC – Certification center is authenticated and manage, issue certificates of user identities, Registration center: deals with issuance, transfer, and withdrawal of the e-CNY as well as the publication of registration information through distributed ledgers and “Big data center” is used by PBOC to monitor the payment flows for financial risks management such as Know Your Customer (KYC), anti-money laundering (AML) and detect illegal behaviours
Privacy	• Managed anonymity: anonymity for small value and traceable for high value transaction – Anonymity for small value transaction and Traceable for high value transaction: able to trace illegal activities, such as tele-fraud, Internet gambling, money laundering, and tax evasion • Strict information sharing policy – The e-CNY system does not provide information to third parties or other government agencies unless stipulated otherwise in laws and regulations • Strictly privacy and security protocols • Adoption of diversity technology – The e-CNY adopts technologies to protect security such as digital certificate system, digital signature, and encrypted storage • Design of ecosystem for not disclosing privacy information – As the design of e-CNY is a hierarchical design, the lowest level of digital wallet only requires a mobile phone number. The telecom operators in China are prohibited by law to share and disclose mobile phone customer information to third parties such as PBOC

People Bank of China (PBOC) (3)

PBOC has implemented many activities in pilot program to promote the e-CNY. Indeed, these activities have made e-CNY more widely known but there is still a backlog of unresolved problems

Subject	Overview of the pilot projects	
Area	• Current activities: – PBOC has launched pilot program to about 10 cities (such as Shenzhen, Suzhou, Chengdu, Xiong'an, Shanghai, Hainan, Changsha, Xi'an, Qingdao, and Dalian, etc.) • Future activities: – PBOC plans to expand further pilot program in major city such as Hongkong and other 11 cities including Tianjin, Chongqing, Guangzhou, Fuzhou, Xiamen, and six cities and Zhejiang province	
Project size	• Applied payment scenarios: – Number of applied scenarios: 1.3 million – Range of services: utility payment, catering service, transportation, shopping, and government services • Coverage: – Number of opened wallets: over 20.9 million personal wallets and over 3.5 million corporate wallets – Number of transaction: 70.8 million transactions – Total transactions value: approximately RMB34.5 billion	
Challenges	• Unactive Wallet: – Most of registered wallet is empty and most likely not in active with the average balance in individual wallets being RMB 3 (less then 0.5 USD) • Unattractiveness toward Chinese: – Chinese people do not show many interest in e-CNY because existed payment system has already quite modern. There's opinion that e-CNY will not be able to overtake private-sector alternatives at all without substantial government interference to the point of mandatory use • Low International Popularity: – Although e-CYN has been allowed to use through Beijing Olympic Winter but foreigners still prefer to use Visa card to buy tickets	

People Bank of China (PBOC) (4)

In 2020, The People Bank of China (PBOC) start implementing the first pilot program in 4 provinces. Since then, PBOC has expanded the range of pilot program to test application scenario and promote e-CNY consumption

Time	Scope/Activities	Results
April 2020	Pilot Testing in several cities (Shenzhen, Suzhou, Chengdu, Xiong'an) Activities: Xiong'an: authorities invited 19 companies, including McDonald's, Starbucks, and Subway to test the e-CNY	N/A
May 2020	PBOC discussed the possibility of cooperating with private companies to broaden the testing payment scenarios. Major private companies in China, such as Didi Chuxing , the ride-hailing company, and Meituan Dianping , a food delivery giant, were on the list of cooperation, as their wide-reaching capacity	Payment scenario: • Food: Ele.me, Hema, Meituan Dianping • Shopping: Tmall, JD.com, SF Express • Transportation: Didi Chuxing, Ctrip, Tuniu.com • Others: Bilibili (video sharing website), JD Finance (online investment and funding platform)
October 2020	First e-CNY pilot launched in Shenzhen PBOC distributed 10 million e-CNY for over 50,000 people. Application: consumable in 3,300 restaurants and retail stores	8.8 million e-CNY (US\$ 1.3 million) being used in over 62,000 transactions
December 2020	Second e-CNY pilot launched in Shenzhen PBOC distributed 20 million e-CNY for 100,000 people Application: consumable in over 10,000 supermarkets, retail stores, restaurants, transportation, daily services, and shopping malls	N/A
January, February, April 2021	Third e-CNY pilot launched in Shenzhen PBOC launched 3 batches of e-CNY with total value of 40 million RMB	N/A
February 2022	Beijing Winter Olympics Pilot deploying innovative scenario such as unmanned vending carts, automatic vending machines, unattended supermarkets, and wearable clothing/accessories with payment functions	

With the aim building an ecosystem that can meet the needs of all user groups under the requirement of KYC, PBOC has created a matrix system by different combinations of wallets

Criteria	Description	Features of the wallets
Personal information identification	Wallets are divided into 04, based on the strength of personal information identification	- The balance and payment limits are raised with each type of wallets in the direction of the higher level of wallet has the less restriction of limit and balance. For instance: Sign-up requirements are cumulatively stricter for the higher level of wallet - Type 1: sign-up at bank in person/Type 2: linking an existing bank account/Type 3: entering a Resident Identity Card number/Type 4: only mobile number needed - Users can open least-privileged anonymous wallets by default and upgrade them to higher-level real-name ones as needed
Type of wallet holders	Depending the type of holders, there are corresponding types of wallets.	Wallets is designed for the group of holders, of which the balance and limits are decided based on different conditions
Type of carrier	Types of wallet can be categorized by the applied technology, with different accessibility for each	- Software wallets (on digital platform):Accessibility: through mobile payment apps, software development kits (SDKs), and application programming interfaces (A/PIs) - Hardware wallet (physical devices): through IC cards, mobile phones, wearable objects, and Internet of Things devices
The authorization	To customerize the wallet's usability, users can set up a main wallet and create a number of sub-wallets under	- Increase information security by reducing the flow of data from multiple sources to big tech firms - The functionality of sub-wallets can be customized to meet the needs of each holders

Riksbank is one of the most active central banks to study CBDC in euro area. e-Krona project is a series of PoC and Pilot for CBDC



Policy paper1 (Economic Review)

Riksbank published policy paper about consequences from various point of views such as role of central bank, demand for e-krona etc

Sveriges Riksbank (Riksbank) (2)

One of the key analysis in e-krona project is the assessment on scenario and relationship between interest rate and e-krona from the viewpoint of demand for e-krona

Demand for e-Kronas and the effect on bank profits

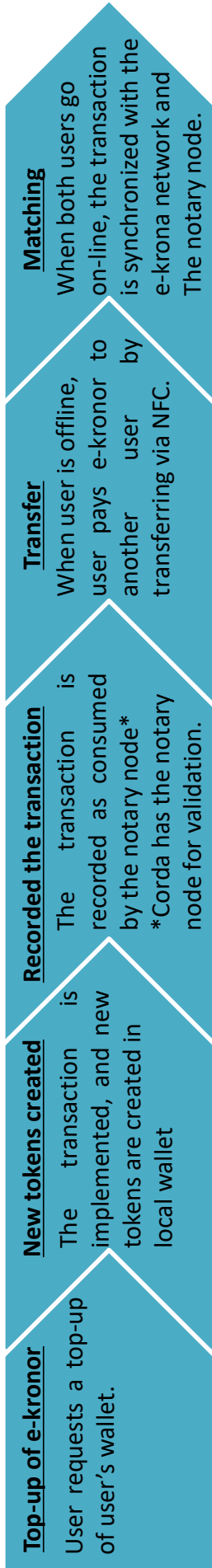
Criteria	Under the situation of positive repo rate	Under the situation of Negative repo rate	Situation of financial Unease/crisis and low confidence in the banking sector
No interest rate	Holding e-kronas is relatively unattractive	Holding e-kronas is attractive because the banks need to offer a deposit rate slightly above zero to retain their deposits	The search for safe assets means that it will be more attractive to hold e-kronas. Assets that are not covered by the deposit guarantee ill probably be exchanged for e-kronas. (But impacts on financial stability are unclear)
Interest rate that is tied to the repo rate (policy rate)	Holding e-kronas is attractive	Holding e-kronas is not attractive	The search for safe assets means that it will be more attractive to hold e-kronas. Assets that are not covered by the deposit guarantee ill probably be exchanged for e-kronas. (But impacts on financial stability are unclear)

Sveriges Riksbank (Riksbank) 🇸🇪 (3)

Pilot projects were conducted in a partnership with Accenture based on R3's corda network. Pilot phase2 includes the offline payment channel and test of integration with point of sales (POS) system

- Through a Pilot phase1 and phase2, Riksbank developed e-krona engine on R3 Corda's platform which is one of the distributed ledger technologies
- For phase1 and phase2, the scope of scenarios seem to be retail payment scenario but Riksbank highlighted that e-krona engine is not limited to retail payment. e-krona engine has a possibility to integrate with participants' internal system such as point of sales(POS)

Transaction flow for off-line payment



Consideratooin points

- How much money should one be allowed to store off-line?
- What size transactions should be accepted?
- Should there be different rules for different e-krona users?
- How many consecutive step-by-step off-line transactions can be allowed before an on-line synchronization is needed?
- How long should a user be allowed to remain off-line?
- How should risks be shared when making off-line payments?