Central Bank Digital Currency Experiments
Progress on the Pilot Program (May 2025)

Payment and Settlement Systems Department, Bank of Japan

CONTENTS

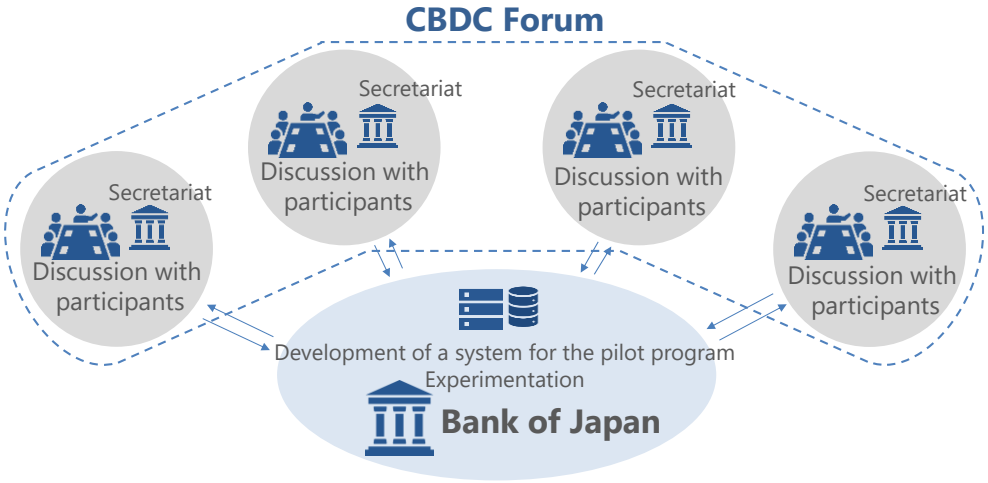
1. Introduction

Based on "The Bank of Japan's Approach to Central Bank Digital Currency," which was released in October 2020, the Bank of Japan conducted proofs of concept (PoCs) from April 2021 to March 2023, and it has examined whether the basic functions and features of a central bank digital currency (CBDC) are technically feasible.[1]

Since April 2023, the Bank has been proceeding with a pilot program with the aim of conducting technical evaluation not explored in the PoCs, while leveraging the skills and insights of private businesses. The pilot program revolves around two pillars: "development of a system for the pilot program and experimentation" and "the CBDC Forum" (Figure 1). In the former, performance tests are conducted on the system developed by the Bank, and various types of desktop experimentation are also carried out on functions that are not implemented in the system. In the latter, the Bank acts as the secretariat and conducts practical discussions on a wide range of themes with private businesses related to retail payments. The findings gained through the two pillars are fed into the work of each other as necessary.

This report, compiled by the Payment and Settlement Systems Department of the Bank, summarizes progress made on the pilot program as of the end of March 2025. In order to share more detailed insights and findings gained through the pilot program, "Progress of the Pilot Experiment on Central Bank Digital Currency: Supplement (May 2025, available in Japanese)" was compiled separately from this report.

Figure 1. Overview of the pilot program



[1] For the results of the PoCs, see the following references:

Payment and Settlement Systems Department, Bank of Japan, "Central Bank Digital Currency Experiments: Results and Findings from 'Proof of Concept Phase 1'" (May 2022)

Payment and Settlement Systems Department, Bank of Japan, "Central Bank Digital Currency Experiments: Results and Findings from 'Proof of Concept Phase 2'" (May 2023)

2. Development of a system for the pilot program and experimentation

The "development of a system for the pilot program and experimentation" involves the development of the system and the conduct of performance tests, as well as desktop experimentation on functions that are not implemented in the system. The following provides (1) an overview and the development status of the system and (2) an overview of and recent developments in the experimentation. We would like to clearly state in advance that the design of the system for the pilot program and desktop experimentation described here does not represent a finalized design for social implementation.

2.1 An overview and the development status of the system

The system for the pilot program covers a wide range of items to implement, from the central system to endpoint devices (apps for smartphones and tablets). Of these covered, the ledger for recording CBDC balances (CBDC ledger) is designed as an account-based data model managed separately between the central system and the intermediary systems.[2] In the system for the pilot program, additional functions, such as scheduled transfer and debit transfer, are implemented along with the basic functions, such as issuance/redemption, payout/acceptance, and credit transfers.[2]

As characteristics of the completed system for the pilot program, the following explains (i) consideration of privacy, (ii) process flow for credit transfers, (iii) consideration of performance (measures to enhance parallel processing), and (iv) consideration of functional scalability.

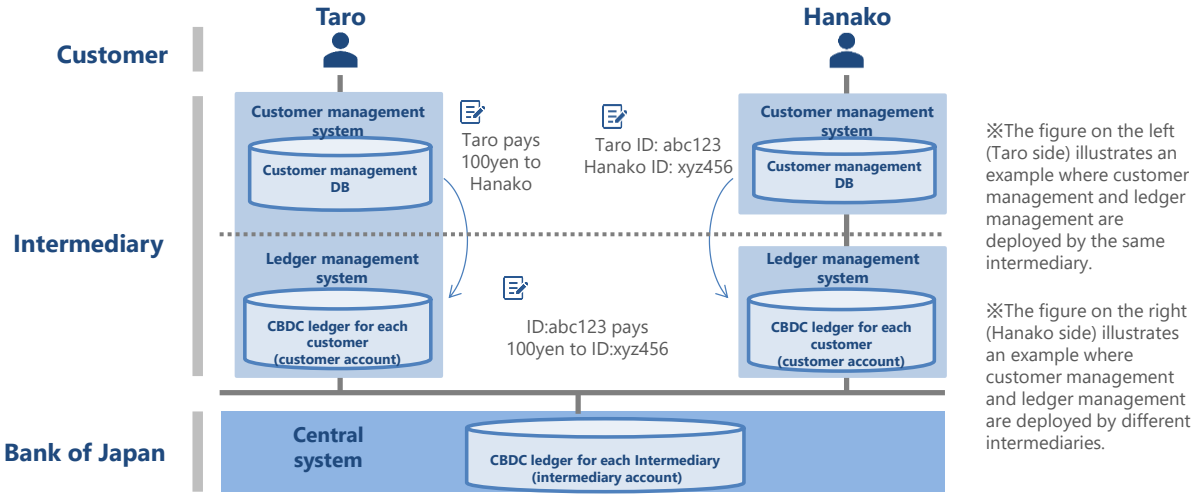
2.1.1 Consideration of privacy

It is assumed that between users and the Bank, there are intermediaries that act as a bridge for CBDC. This means that intermediaries increase and decrease users' holding amounts in the CBDC ledger while handling information on users and their transactions. When considering privacy, it is not desirable to handle user and transaction data on the CBDC ledger. Thus, in the system for the pilot program, operations of intermediaries are separated into the customer management component to handle user and transaction information, and the ledger management component to only deal with the information needed for settlements. Under this concept, the system for the pilot program has a mechanism in which the intermediary system is divided into a customer management

[2] For data models and a functional overview of the system for the pilot program, see Payment and Settlement Systems Department, Bank of Japan, "Central Bank Digital Currency Experiments: Progress on the Pilot Program (April 2024)."

system,[3] which handles user and transaction data, and a ledger management system,[4] which only deals with information needed for settlements (Figure 2).

Figure 2. Outline of the configuration of the system for the pilot program



For example, the customer management system handles information, such as "Taro pays 100 yen to Hanako," whereas the ledger management system deals with information in the form of "a user with ID: abc123 pays 100 yen to the user with ID: xyz456." The information that Taro's ID is abc123 (and Hanako's ID is xyz456) is linked in the customer management system of Taro (and Hanako) and is only retained by that customer management system. Other customer management systems and the ledger management system do not hold this information.

For examples of elemental technologies for privacy protection, including technologies implemented in the system for the pilot program, see I. 1. of the supplement.

2.1.2 Process flow for credit transfers

It is assumed that customer management and ledger management operations conducted by intermediaries are performed not only by the same intermediary but also by different intermediaries. Therefore, the system for the pilot program has a new process flow, which was established on the assumption that multiple entities (the customer management system and ledger management system on both the payer side and the payee side) are involved in the credit transfer process. Figure 3 shows the process flow in which the payer side (Taro) transfers CBDC to the payee side (Hanako) (common process flow for transfer of CBDC). This flow consists of three main points, as follows.

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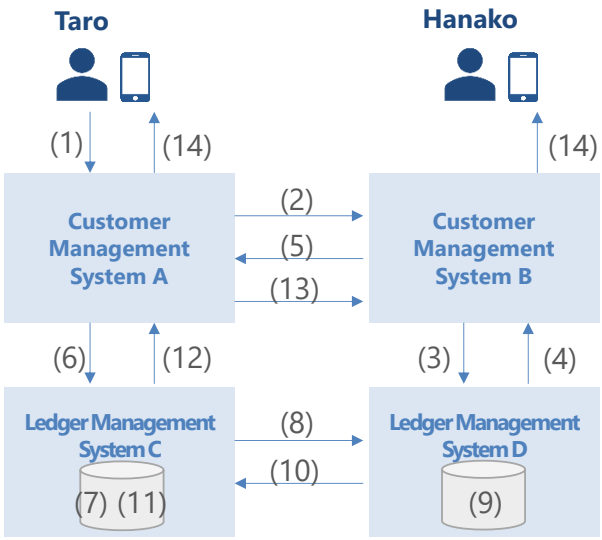
[3] A system for managing information about users' CBDC (user data group). Specifically, upon receiving a request from a customer, it sends messages, such as a payment instruction to the ledger management system. It can also handle the opening and closing of accounts as well as anti-money laundering/combating the financing of terrorism (AML/CFT).

[4] A system for recording CBDC balances.

Figure 3. Process flow for a credit transfer from Taro to Hanako (common process flow for a transfer of CBDC)



#	Actor	Process
(1)	Taro	Instruct credit transfer to Customer Management A
(2)	A	Identify payee (Hanako) and notify Customer Management B of incoming transfer
(3)	B	Request issuance of authorization token for ledger update to Ledger Management D
(4)	D	Issue and send token for incoming transfer to Customer Management B
(5)	B	Reply OK to Customer Management A
(6)	A	Instruct transfer to Ledger Management C
(7)	C	Reserve Taro's Balance for debiting
(8)	C	Instruct Ledger Management D to credit Hanako's balance
(9)	D	Verify received token (8) is identical to issued token (3) and credit Hanako's balance (settlement finality granted)
(10)	D	Notify completion of crediting to Ledger Management C
(11)	C	Confirm debiting of Taro's balance
(12)	C	Notify transfer completion to Customer Management A
(13)	A	Notify transfer completion to Customer Management B
(14)	A, B	Notify transfer completion to Taro and Hanako respectively

*Each communication is asynchronous with an aim to enhance resource and process efficiency.

First, the ledger management system and the customer management system are operated by different intermediaries. Assuming that the customer management system is connected to a specified ledger management system, the ledger management system should update a CBDC ledger based on the instructions from the corresponding customer management system.[5,6] As shown in Figure 3, when the balance of Taro's CBDC ledger is to be debited, Customer Management System A for Taro instructs Ledger Management System C for Taro to update the CBDC ledger in (6) in the figure. When the balance of Hanako's CBDC ledger is to be credited, Customer Management System B for Hanako requests permission from Ledger Management System D for Hanako to update the CBDC ledger (by issuing an update permission token in (3) and (4) in the figure). Finally, the balance of Hanako's CBDC ledger will be actually credited after the token is verified ((9) in the figure).

Second, the moment when the payment is completed (final)[7] is the point in time when crediting on Hanako's side is completed ((9) in the figure). Ideally the payment is

[5] For example, this refers to Customer Management System A in the case of Ledger Management System C in Figure 3.

[6] It is assumed that the customer management system determines whether or not the relevant transaction falls under any transaction restrictions, and it provides instructions to the ledger management system only if it has determined that the transaction can be conducted. In the system for the pilot program, restrictions are implemented on the transaction amount, the cumulative transaction amount, and the cumulative number of transactions.

[7] The point in time after which rollbacks will no longer be performed in the system.

completed by atomically[8] debiting Taro's balance and crediting Hanako's balance. However, since the system for the pilot program is based on the assumption that Taro's CBDC ledger and Hanako's CBDC ledger may be managed by different entities, we should be aware that the timing of debiting Taro's balance is different from that of crediting Hanako's balance. Because of this, if Taro's balance is successfully debited but Hanako's balance fails to be credited for some reason (e.g., crediting Hanako's balance causes a conflict with restrictions on the amount Hanako may hold), it is necessary to ensure that Taro's balance is fully restored. Hence, the debiting of Taro's balance is reserved in (7) in the figure. If Hanako's balance is successfully credited, the reservation is lifted ((11) in the figure). Conversely, if Hanako's balance fails to be credited, Taro's balance is restored to its state before the reservation.

Third, a consolidated account[9] in the central system does not intervene in each credit transfer. Previously conducted PoCs assumed that each user's CBDC holdings are managed on a real-time basis in both (1) the account of each user in the ledger management system and (2) the consolidated account in the central system. Accordingly, the systems were built on the assumption that in the case of a credit transfer across intermediaries, both (1) and (2) needed to be updated. However, this limited performance. Therefore, in the pilot program, that assumption was reviewed, and the systems were built on the assumption that each user's CBDC holdings are managed only in (1) and that even in the case of a credit transfer across intermediaries, the transaction is completed only by updating (1).[10]

The above common process flow for CBDC transfers will continue to be studied in terms of availability. For example, on the assumption that (in Figure 3) the Ledger Management System D causes a failure immediately after the payment becomes final, we will examine whether there is room for improvement in the flow on a more detailed level and how to detect failure and achieve recovery.

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[8] An atomic operation refers to a series of processes (in this case, "debiting of Taro's balance and crediting of Hanako’s balance") that are either fully executed as a whole or not executed at all.

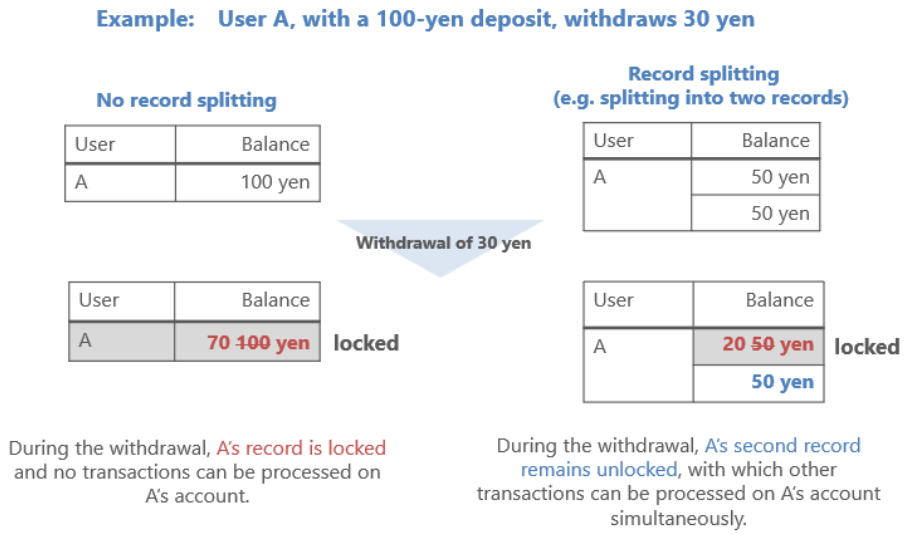
[9] It is an intermediary-level account that consolidates the balances of all users' accounts at the relevant intermediary. It was referred to as a "user account" in the previously conducted PoCs.

[10] However, it is possible that there may be a need to calculate the total amount of CBDC held by users at the end-of-day closing. Thus, we have implemented a mechanism to aggregate the total amount of balances of all users' accounts at each intermediary at the end-of-day closing.

2.1.3 Consideration of performance (measures to enhance parallel processing)

In the system for the pilot program, a mechanism of record splitting is implemented to enhance parallel processing and improve performance.[11] For example, as illustrated in Figure 4, if User A has 100 yen of CBDC and debits 30 yen, the traditional method (left of the figure) makes it necessary to lock the record during the debiting process (to prevent unintentional data rewriting due to any other process). While the record is locked, credits to and debits from User A cannot be made, and processing needs to be done sequentially. On the other hand, in the pilot program (in the right of the figure), when 100 yen held by User A is split into two records of 50 yen[12] and 30 yen being debited, the first record is locked,[13] but the second record is not locked. Therefore, if the transaction does not exceed 50 yen, concurrent and parallel processing can be done using the second record.

Figure 4. Mechanism for reducing the impact of record locking (a measure to enhance parallel processing)



With record splitting, there are points requiring attention in terms of implementation. For example, each record needs to be counted for calculating the CBDC balance of User

[11] In the previously conducted PoCs, it was pointed out that when debits from and credits to a certain account are concentrated, record locking (and waiting for the lock release) occur for the account, affecting the processing performance. A record lock is a necessary mechanism to ensure data integrity, so in the system for the pilot program, a measure has been implemented to reduce the impact of record locks by splitting records and enhancing parallel processing, rather than remove record locking.

[12] Here, for the purpose of explanation, the example of splitting a record of 100 yen into 50 yen x 2 records is used. In the system for the pilot program, however, the number of record splits can be set as a variable (but cannot be changed dynamically, depending on the transaction status).

[13] The system for the pilot program is designed to do the following: (i) debit a balance starting with the record with the largest balance and (ii) credit a balance starting with the record with the smallest balance.

A, and various judgment processes for insufficient balances, for example, cannot be performed with complete accuracy, which may cause a false alarm (a transaction that should not generate an error is judged as an error) in marginal cases.[14]

2.1.4 Consideration of functional scalability

In the system for the pilot program, functional scalability is enhanced by embedding measures that make it easier to add functions later. For example, during software development, loose coupling is used to minimize the impact of adding new functions. It enhances the independence of the internal logic of software elements (component level or service or system level integrating components), and it lowers the interdependence of the elements. In specific implementations in the system for the pilot program, each operation category is controlled by the customer management system to minimize impacts on the ledger management system when a new operation category is added so that the ledger management system does not need to be aware of differences in operation categories (such as credit transfers and payouts).

[14] For example, in the situation shown in the lower right of Figure 4 when User A tries to additionally debit 60 yen, the first record is not subject to processing, whereas there is only a balance of 50 yen in the second record. Therefore (although there is actually a balance of 50 yen - 30 yen + 50 yen = 70 yen), the balance is considered insufficient, so a debiting cannot be made. On the other hand, if a record is not split, debiting of 30 yen and 60 yen can be successfully processed in a sequential manner. (However, while the debiting of 30 yen is processed, the debiting of 60 yen is in a standby state.) As described above, though marginal, such false alarm occurs (depending on the number of record splits, the details of incoming transactions, and the timing). Still, even if such false alarm occurs, it can be handled more effectively, for example, by retrying immediately.

2.2 An overview of and recent developments in experimentation

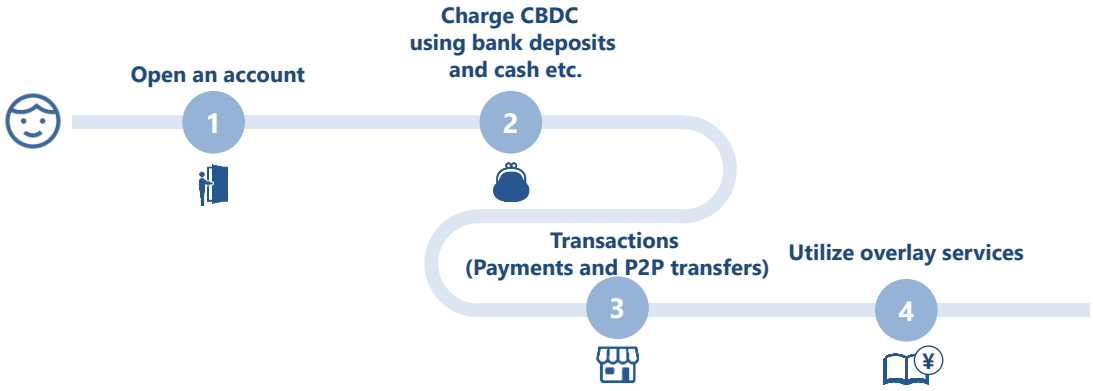
2.2.1 Experimentation using the system

After understanding the limitations inherent in the system for the pilot program, we explore technical issues and solutions to satisfy performance requirements in the event of its social implementation. For example, we will conduct testing to analyze the effects of enhancing parallel processing through record splitting described in "2.1.3 Consideration of performance (measures to enhance parallel processing)." We will also conduct testing by applying a load of 50,000 TPS[15] (read-and-write: 10,000 TPS + read-only: 40,000 TPS) to the system for the pilot program on the assumption of around one-tenth of the load at the time of its social implementation.[16] Then we will explore technical issues with scaling the system for the pilot program to a system required for social implementation using data obtained from these tests.

2.2.2 Desktop experimentation

Desktop experimentation is conducted mainly on functions that are not implemented in the system for the pilot program. While functions required in anticipation of social implementation are expected to be wide-ranging, the main examples of scenarios of CBDC usage by users will include the following: (1) Users need to request an intermediary to open a CBDC account, then (2) top up (pay out funds to) the CBDC account using other forms of money, such as bank deposits and cash, and (3) make payments at stores or conduct a P2P fund transfer in CBDC. Furthermore, in addition to basic payment methods such as those for credit transfers, it is also assumed that users will (4) receive additional services offered by overlay service providers (such as household account services).

Figure 5. Examples of scenarios of CBDC usage



[15] TPS is the abbreviation for Transaction Per Second, which refers to the number of transactions processed per second.

[16] In the previously conducted PoCs, we assumed a typical load of tens of thousands of transactions per second and a peak load of 100,000 or more transactions per second as the processing performance required for potential social implementation.

The following provides details of desktop experimentation related to (1) to (4) above under specific assumptions and conditions to clarify details of the experimentation and its scope, and it identifies challenges and considerations in achieving it. Note, however, that nothing has been determined as a framework design for CBDC and that the process flow and roles have not been finalized, with the process flow being merely an example.

We will perform desktop experimentation on non-functional aspects, such as availability and security, as well as functional aspects like interoperability.

(1) Opening CBDC accounts

A possible example of the operational flow for opening CBDC accounts is a form that is not much different from the existing operational flow for opening bank accounts. This means that intermediaries set up an account on the system after performing Know Your Customer (KYC) processes for the user.[17]

With regard to CBDC, the major differences from the existing operational flow for opening bank accounts will be the following: (i) There are differences in information that can be handled between the customer management system and the ledger management system,[18] and (ii) the user's bank account and CBDC account need to be linked for the user to pay out and accept CBDC using bank deposits and other forms of money.

(2) Conversion to and from other forms of money, such as bank deposits and cash (payout/acceptance)

In the case of payments at stores and P2P fund transfers using CBDC, users need to obtain CBDC in advance. One method to do this is for users to top up CBDC in exchange for other forms of money, such as bank deposits and cash (conversion to and from other forms of money, such as bank deposits and cash).[19] The following provides an overview of examples of the operational flow and issues.

A possible example of the operational flow for users converting various forms of money, such as bank deposits, and cash to CBDC is an intermediary reducing the user's bank deposits, for example, or obtaining cash from the user and then transferring CBDC from the intermediary's own account to the user's CBDC account.

Assuming a smooth conversion between CBDC and other forms of money such as bank deposits. the customer management systems for CBDC and the core banking systems of banks, for example, need to be connected. However, the following non-functional issues exist regarding connecting the two systems. With regard to the connection of the systems,

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[17] While KYC processes have two elements (identity proofing, that is, verification that the user is a real person, and authentication, that is, verification that the user is the person who was previously registered), the KYC process involved in opening an account will refer to identity proofing.

[18] See "2.1.1 Consideration of privacy."

[19] To intermediaries, this is equivalent to the act of paying out CBDC to users.

we have used the discussions of the CDBC Forum (described later) as a reference, where WG1 members discussed connection methods, points of consideration, and other matters (connecting the CBDC system and fundamental external systems).

(i) Differences in processing performance between systems

If users conduct a large volume of conversions between CBDC and other forms of money such as bank deposits in a short time, the traffic to core banking systems from the customer management system (that is expected to undertake the conversion) increases significantly. Therefore, it could be necessary to take measures to reduce the load on the core banking systems. For example, if the upper limits on the amount of CBDC held by a corporation were zero and large-scale retail stores frequently accepted CBDC and then immediately converted it to bank deposits, for example, a large load would be imposed on core banking systems of banks in particular. In order to avoid this situation, measures to reduce the frequency of conversions of accepted CBDC to bank deposits and other forms of money will be required.[20]

(ii) Differences in operating hours between systems

It is also anticipated that core banking systems will be temporarily stopped on occasion due to maintenance and other reasons and that they will be unable to connect with the customer management systems. In such cases, a possible measure is that payout, acceptance, and other processes are not conducted, and the customer management systems stop coordinating with the core banking systems.

(3) CBDC transfers and payments at stores

Basic CBDC usages include (i) transferring CBDC for the purpose of remittances to family and reimbursements for payments made by friends (P2P transfer) and (ii) paying for goods and other items at retail stores using CBDC (store payments). Regarding examples of operational flows, the following provides an overview of the operational flows on the assumption of common process flows for CBDC transfers as explained in "2.1.2 Process flow for credit transfers." In addition, for (ii), the similarities and differences of three major types of methods of store payments are examined, with mainly face-to-face store payments in mind.

(i) P2P transfers

A possible example of the operational flow for a P2P transfer involves the payer obtaining destination information, such as an ID (account ID), to uniquely identify the

[20] For example, even under the presumption of a zero upper limit on an amount held, based on the assumption that it is acceptable not to require the conversion of accepted CBDC to bank deposits and other forms of money in real time, it is possible to aggregate processing operations for a certain period of time on the customer management side and then collectively coordinate with core banking systems.

payee's CBDC account and then executing the common process flow for a CBDC transfer (see "2.1.2 Process flow for credit transfers").

(ii) Store payments

As for store payments, with the focus on devices owned by users, possible methods are: (a) reading a 2D code, for example, using digital tools including wallet apps installed on devices such as smartphones, and (b) using physical cards.[21] In addition, the method in (a) has (a-1) the Merchant-Presented Mode (MPM), in which the store presents a code, and (a-2) the Consumer-Presented Mode (CPM), in which the user presents a code, depending on the method of presenting a 2D code. Furthermore, the mode in (a-1) has static MPM, in which a 2D code is already printed and fixed and dynamic MPM, in which a 2D code dynamically changes with each payment.

(a-1) The operational flow of MPM

An example of the operational flow of static MPM is as follows. A user reads the store's account ID in the form of a 2D code with a wallet app, and enters the transaction amount themselves. The user then executes the common process flow for CBDC transfers (see "2.1.2 Process flow for credit transfers").

(a-2) The operational flow of CPM

An example of the operational flow of CPM is as follows. A user presents a reverse-lookup token generated by the customer management system to the store in the form of a 2D code. The store reads the 2D code. Next, the reverse-lookup token, together with the transaction amount entered at the store, arrives at the user's customer management system via the store's customer management system from a store terminal, after which the system verifies the token and executes the common process flow for CBDC transfers (see "2.1.2 Process flow for credit transfers").

(b) The operational flow using physical cards

An example of the operational flow for using physical cards, such as contact IC cards, is as follows. When a user inserts a physical card into a store terminal, a message authentication code is granted to the IC of the card. This information is then sent to the user's customer management system from the customer management system in the store's terminal, after which the system verifies the message authentication code and executes the common process flow for CBDC transfers (see "2.1.2 Process flow for credit transfers").

As described above, all store payments using CBDC consist of the following: (i) authentication (logging onto a wallet app or entering a PIN for a physical card); (ii)

[21] Other than these methods, the use of NFC embedded in devices, such as smartphones, and the use of biological information, are also possible. Both methods can roughly be considered applicable to one of the arrangements in (ii) from the broad operational flow perspective.

registration of the account ID of the payee (reading the 2D code or setting by the store) and registration of the transaction amount (entry by the user or the store); and (iii) an instruction on the credit transfer to the payer's customer management system (the instruction to transfer the transaction amount to the payee's account ID). From (iii) onward, the common process flow for CBDC transfers is invoked to execute transfers. However, (a-1) MPM and (a-2) CPM/(b) using a physical card are very different in terms of the route a message takes to get to the payer's customer management system in (iii), and they are also different in terms of the entities appearing on the route. Therefore, it is necessary to keep in mind that these routes and entities are different when implementing each method.

(4) Overlay services/API connection

Various private operators, including intermediary institutions, could provide a variety of overlay services to meet user needs on top of CBDC as a basic payment method, thus providing services that are different from current cash and compatible with digital society. While many overlay services assumed for CBDC are also provided for retail payments in markets, various services are anticipated, such as services that boost convenience in using and managing CBDC (e.g., household accounts services) and services that enhance payments with CBDC (e.g., programmable payment services).[22]

For desktop experimentation, we explored functionalities to be built into the customer management system, for example, and matters requiring attention to make it easy for intermediaries and overlay service providers[23] to provide overlay services.

As a result, we confirmed the possibility that many of the overlay services can be realized by equipping the customer management system with public read-only API (API for referencing CBDC balances and other information) and read-and-write API (API to update CBDC balances and other information). However, when envisioning a future where overlay services will be expanded in different directions, cases requiring functions other than read-only API and read-and-write API can also be expected. For example, like Webhook,[24] overlay services may be feasible if a function for notifications triggered by events arising in the customer management system (such as the execution of specific transactions) is provided.

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[22] See Bank of Japan, Liaison and Coordination Committee on Central Bank Digital Currency "Interim Report" (May 2022).

[23] Here, leaving aside institutional perspectives, such as what regulations are required, discussions were held focusing on technological issues.

[24] A mechanism in a web application that sends a push notification to other systems when a specific event arises.

The possibility that various overlay services can be built by combining a few fundamental APIs could help increase composability and further lead to the simplification of systems.

As a matter requiring attention, as-needed standardization of interface specifications is considered desirable for intermediaries and overlay service providers to easily utilize read-only API and read-and-write API. Another point to note is that attention should be paid to increases in the transaction volume (access loads) on the CBDC system from overlay services. For example, to check whether specific transactions are conducted, it is deemed preferable to explore measures to reduce loads by, for example, using the Webhook function instead of frequently executing read-only API from the outside.

3. CBDC Forum[25]

The CBDC Forum consists of members from a wide range of industries. They are financial firms and non-financial firms including start-ups that have insights in technologies and business practices of retail payments (64 participating firms). The Payment and Settlement Systems Department of the Bank acts as the secretariat, forming and organizing thematic working groups (WGs). This report mainly presents issues discussed from April 2024 to March 2025 in seven WGs (Figure 6).

Figure 6. Discussion themes for each WG

WG		Theme
[WG1] from Sept. 2023 to June 2024	Connection between CBDC system and fundamental external systems	- Connection with core banking systems
		- Connection with private payment and settlement infrastructure
		- Coordination with internet banking apps
[WG2] since Sept. 2023	Overlay services and CBDC ecosystem	- Business utilization of CBDC (overlay services)
		- External coordination of a CBDC system regarding overlay services
		- Design of CBDC ecosystem
[WG3] since Oct. 2023	KYC and user authentication/authorization	- Current practices of KYC and AML/CFT checks
		- Authentication/authorization
[WG4] since Jan. 2024	New technologies and CBDC	- Back-end layer (e.g. alternative data models)
		- Front-end layer (e.g. wallets)
		- Coexistence with other types of payment instruments and assets (stablecoins, asset tokenization, interoperability with DLT platforms, etc.)
[WG5] since Mar. 2024	User devices and UI/UX	- UI/UX and accessibility
		- Endpoint devices
		- Offline payments
[WG6] since June 2024	Horizontal coexistence of CBDC and other payment instruments	- Smooth conversion to and from electronic money and other forms of money
[WG7] since Sep. 2024	Operational flow of basic functions	- Operational flow of basic functions
		- Conversion between cash and CBDC

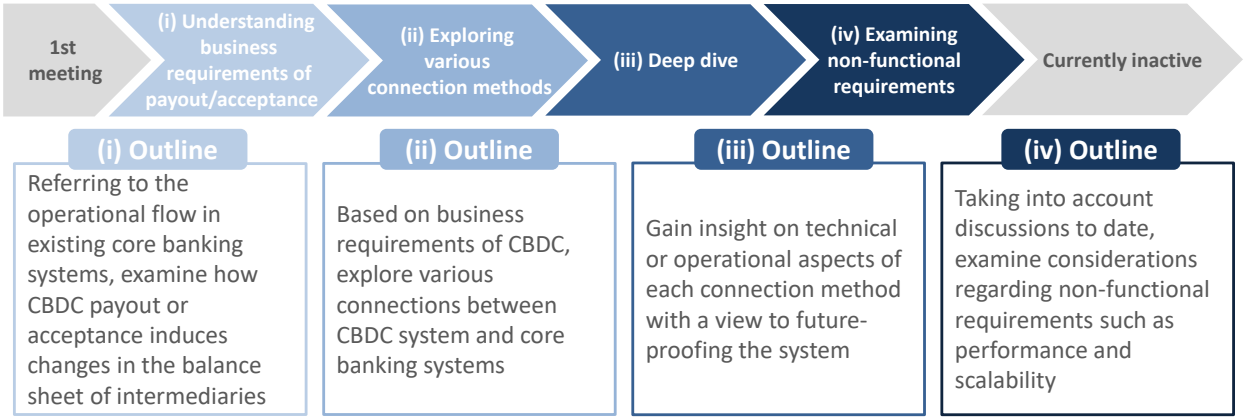
[25] Materials and minutes for each WG are available in Japanese (https://www.boj.or.jp/paym/digital/d_forum/index.htm).

3.1 [WG1] Connection between CBDC system and fundamental external systems

3.1.1 Overview

Since its first meeting in September 2023, WG1 has held 11 meetings to discuss connection methods for the CBDC system. In addition to topics initially planned to be covered ((i) to (iii) in Figure 7), we also held discussions on (iv) exploring non-functional requirements for various connection methods. Having achieved its objectives to a certain extent through its intended discussions, WG1 became inactive upon conclusion of the 11th meeting.

Figure 7. Overview of WG1



3.1.2 Major issues discussed to date

In a deep dive on the connection methods, members explored and discussed the feasibility of payout and acceptance where each customer management, ledger management, and core banking system is managed by the same intermediary as well as cases where each function is managed by different entities.

For non-functional requirements, members discussed the need to reduce the access load on core banking systems, considerations regarding forecasting transaction volumes, measures to shorten the processing time for settlements, and other matters.

3.1.3 Next steps

Having carried out all of its intended discussions, WG1 is currently inactive. Meanwhile, findings gained through the WG's efforts are being utilized for the development of a system for the pilot program and experimentation.

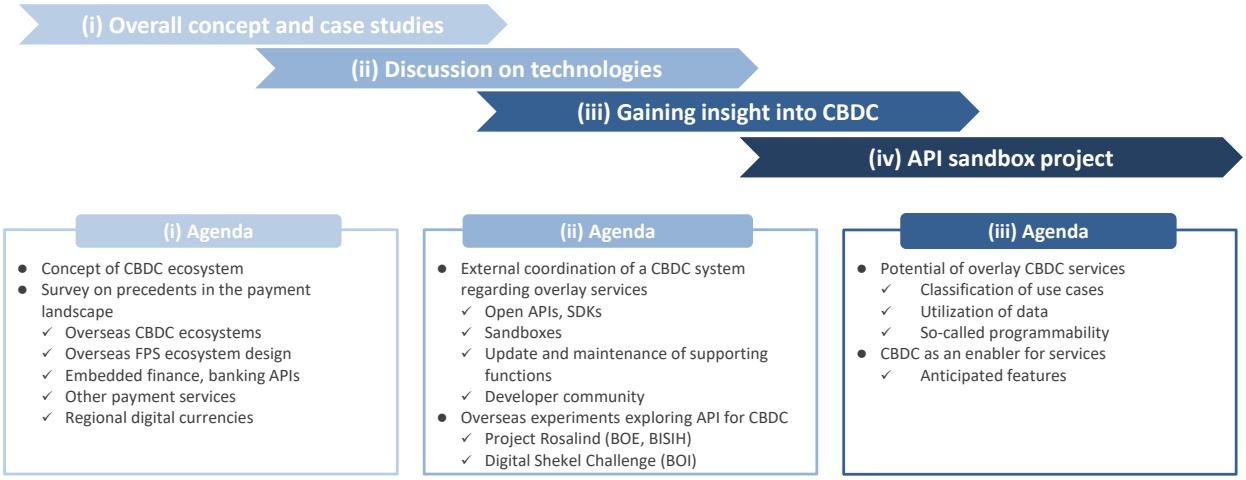
3.2 [WG2] Overlay services and CBDC ecosystem

3.2.1 Overview

Since its first meeting in September 2023, WG2 has held a total of 12 meetings to discuss case studies for an ecosystem in the payment landscape, the examination of use cases of overlay services, and the technological characteristics of CBDC as an enabler of services.

Specifically, members have presented precedents for a payment ecosystem in Japan and overseas and efforts of WG member firms, and have discussed the ideal CBDC ecosystem. In addition, the WG has established an API sandbox environment (see BOX), exploring how to provide overlay services for CBDC while leveraging the expertise of the member firms.

Figure 8. Overview of WG2



3.2.2 Major issues discussed to date

With the CBDC ecosystem in mind, the WG discussed topics such as measures for promoting the adoption of CBDC, use cases, sustainability of ecosystems, quality of overlay services, differentiating overlay services from CBDC as a basic payment instrument, and enhancement of services as well as associated risks.

3.2.3 Next steps

WG2 will continue to deepen its understanding of the implications for CBDC by drawing on insights from its member firms regarding case studies on existing payment ecosystems and each firm's efforts and technologies underlying overlay services. In

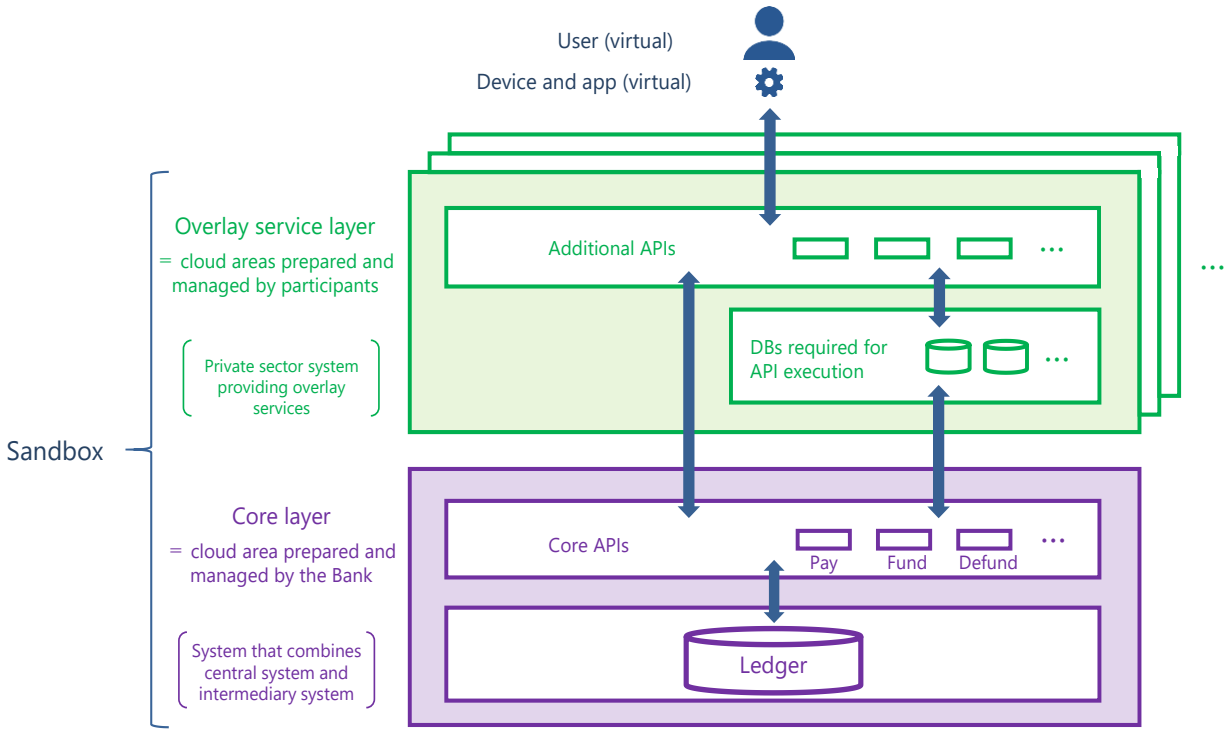
addition, the WG will continue discussions with members on how to provide overlay services for CBDC and on the desirable ecosystem design.

Furthermore, the WG will continue to explore overlay services for CBDC and specific use cases using an API sandbox while leveraging the technological expertise of member firms.

(BOX) API sandbox (experimental environment) project

Since April 2024, the Bank and volunteer members of WG2 have prepared an experimental environment in the cloud with overlay CBDC services in mind, and they have been developing various API functions. This is a separate initiative from that involving the system for the pilot program described in "2. Development of a system for the pilot program and experimentation." It focuses on external coordination of the CBDC system through APIs, discussions on the functional scalability of CBDC, and gaining hands-on experience (BOX Figure). Specific examples and use cases of overlay services are also discussed, taking into account the functionality of the built APIs.

(BOX Figure) Conceptual model of API sandbox



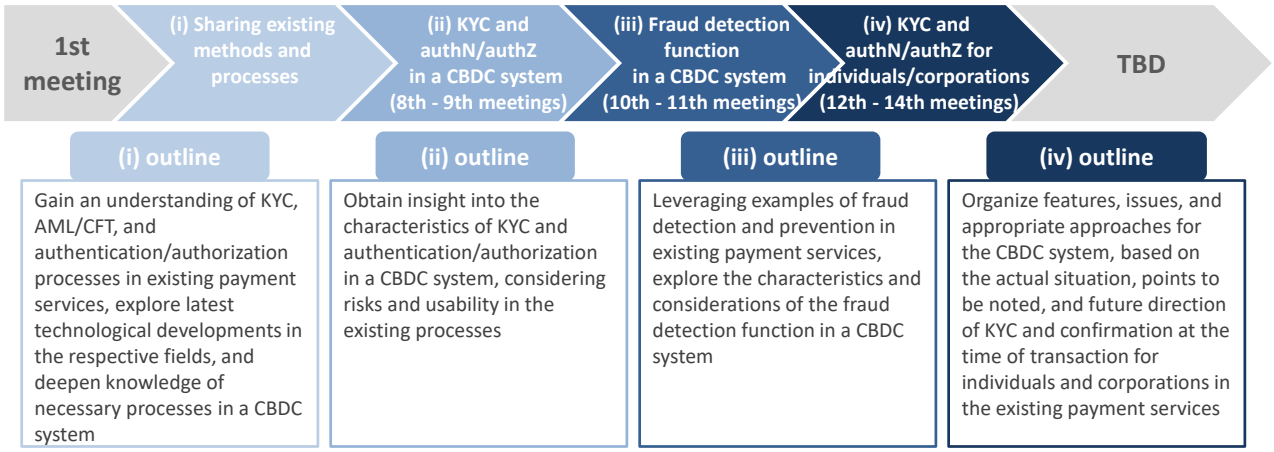
In the project, putting aside the institutional feasibility of the services, member firms are considering advanced services using APIs through a combination of (i) functions prepared in core areas (e.g., a locking function), (ii) functions developed in-house, and (iii) functions developed by other companies. Efforts have been advanced under multiple sub-themes, and the progress has been reported in WG meetings. For example, temporary reservation of deposits using a locking function (Hashed TimeLock Contract: HTLC), restricting usage based on users' consent, and a stablecoin backed by CBDC are virtually implemented by utilizing the sandbox to explore their application for specific services.

3.3 [WG3] KYC and user authentication/authorization

3.3.1 Overview

Since its first meeting in October 2023, WG3 has held a total of 13 meetings, focusing on Know Your Customer (KYC) and authentication/authorization, which are fundamental to the safe and secure use of payment services, to advance discussions on the usage of individual users (non-face-to-face and face-to-face).

Figure 9. Overview of WG3



3.3.2 Major issues discussed to date

Based on insights gained through business practices related to KYC and AML/CFT, members discussed considerations and challenges for conducting identity proofing, customer due diligence, prevention and detection of fraud, and system sharing.

Regarding authentication and authorization, the WG discussed the importance of authentication and the possibility of simplifying it, as well as the importance of appropriately developing and operating standards and guidelines.

3.3.3 Next steps

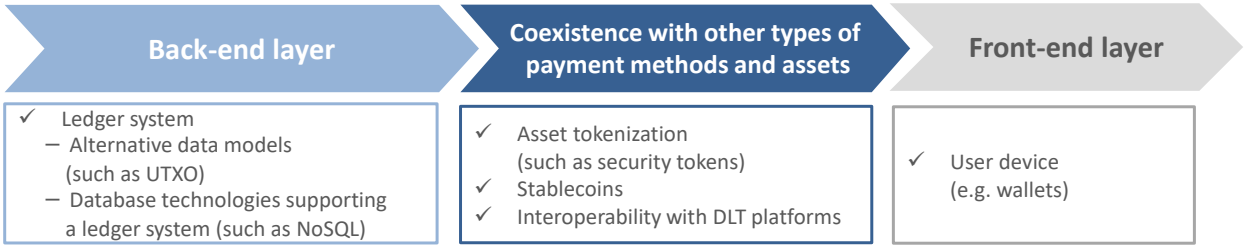
The WG will expand use cases to corporations (non-face-to-face and face-to-face), and it will delve into different cases involving individuals and additional points of consideration to gain insights into the methods and features of the anticipated KYC and authentication and authorization in case of CBDC.

3.4 [WG4] New technologies and CBDC

3.4.1 Overview

Since its first meeting in January 2024, WG4 has held a total of nine meetings. The scope of the discussions covers the CBDC system (back-end and front-end layers)[26] and the coexistence of CBDC with other types of payment instruments and assets. At the same time, the discussions have focused on technologies that could be utilized in the future without being constrained by existing technical assumptions and limitations.

Figure 10. Overview of WG4



3.4.2 Major issues discussed to date

In the back-end layer, the WG compared data models and discussed topics such as performance, security resilience, and considerations about the account-balance model and the UTXO model.[27] In addition, possible uses and considerations regarding distributed ledger technologies and new database technologies were discussed.

Regarding its coexistence with other types of payment instruments and assets, the WG discussed approaches to asset tokenization in Japan and overseas as well as interoperability technologies.

[26] For the purpose of discussions about the CBDC systems, the technological field such as ledger systems that have no direct contact with users is deemed to be the back-end layer, whereas the technological field such as wallets that have direct contact with users is deemed to be the front-end layer.

[27] UTXO is the abbreviation for Unspent Transaction Output. Although there is no definitive definition of this model, generally, it is considered to be a token-type data model that records the results of transactions. This is unlike the account-balance-based model, which keeps records by increasing or decreasing balances. When a transaction is conducted, the model generates a new output in the form of being linked to the consumed input, and it records the output as an unused transaction output that can be consumed as an input in a future transaction.

3.4.3 Next steps

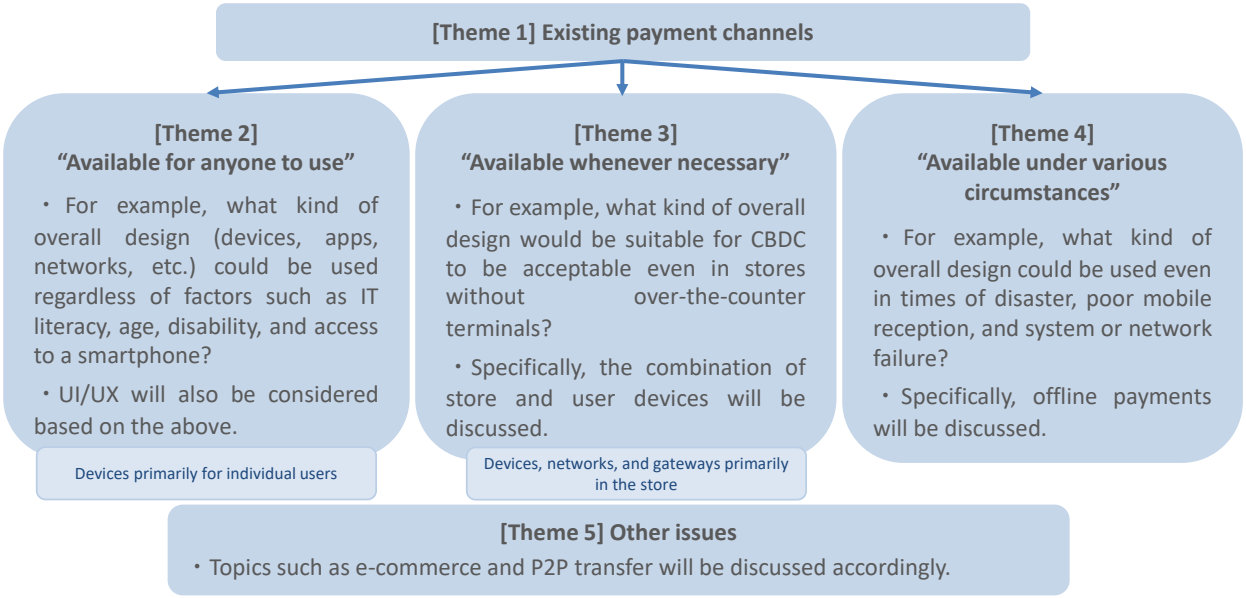
While continuing discussions about coexisting with other types of payment instruments and assets, the WG will also advance discussions on technologies associated with the front-end layer of the CBDC system.

3.5 [WG5] User devices and UI/UX

3.5.1 Overview

Since its first meeting in March 2024, WG5 has held a total of six meetings to discuss universal access and user interface (UI)/user experience (UX) and how to make CBDC available for anyone, anywhere, under a wide range of circumstances.

Figure 11. Overview of WG5



3.5.2 Major issues discussed to date

After exploring the overview and considerations of cashless payments, the WG covered the devices of individual users and in-store payment terminals from the perspective of making CBDC available for anyone to use and wherever necessary. It also discussed its use in offline environments and responses to system failures and problems from the perspective of making it available under various circumstances. In relation to these topics, promoting the use of CBDC and in-store operations were also discussed.

3.5.3 Next steps

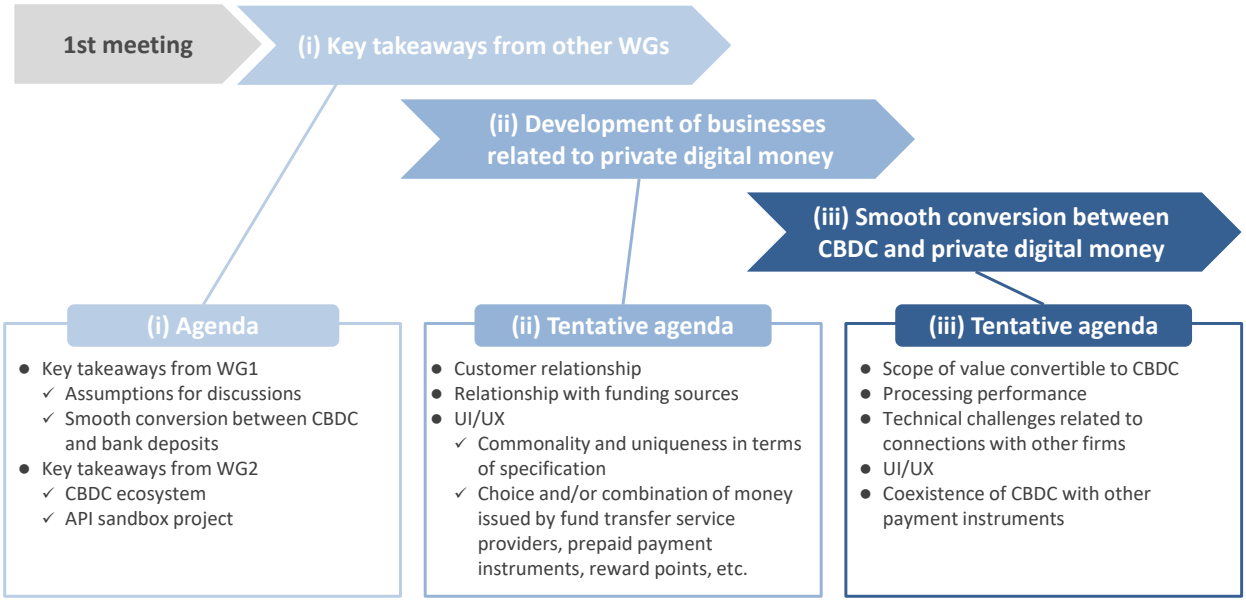
While being increasingly aware of the high convenience and scalability, the utilization of existing payment services and infrastructure, and the need to balance safety and instant payment capabilities, the WG will continue to discuss which approach is preferable when designing and enhancing UI/UX while incorporating the latest technologies and security measures.

3.6 [WG6] Horizontal coexistence of CBDC and other payment instruments

3.6.1 Overview

Since its first meeting in July 2024, WG6 has held a total of five meetings to discuss issues including the smooth conversion between CBDC and private digital money, coexistence of CBDC with other payment instruments, and motivation of introducing CBDC, while discussing the current state of business related to private digital money.

Figure 12. Overview of WG6



3.6.2 Major issues discussed to date

Based on the understanding of the current state of business related to private digital money, the WG discussed topics such as the smooth conversion between private digital money and CBDC, horizontal coexistence patterns, universal access, onboarding, instant payment capabilities, privacy and data utilization, and the possibility of CBDC driving the expansion of cashless payments.

3.6.3 Next steps

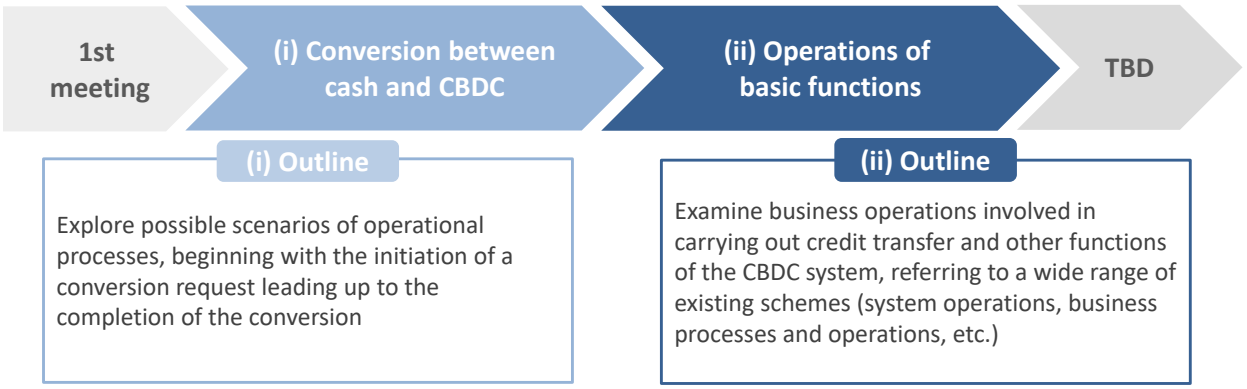
The WG will examine the smooth conversion between CBDC and private digital money and the coexistence of CBDC with other payment instruments in cooperation with other WGs while also delving into themes such as the current state of business related to private digital money.

3.7 [WG7] Operational flow of basic functions

3.7.1 Overview

Since its first meeting in September 2024, WG7 has held a total of four meetings. The WG has been discussing possible operational processes involved in the conversion between cash and CBDC as well as operations for the basic functions of the CBDC system. Discussions are held with feedback being provided by the Bank on its development of a system for the pilot program and experimentation.

Figure 13. Overview of WG7



3.7.2 Major issues discussed to date

With regard to conversion between cash and CBDC, the WG discussed a process flow for conversion procedures using ATMs, the necessity of conversion channels, the necessity of media to use CBDC such as cards in addition to smartphones, and a process flow taking into account the burden to modify existing systems.

In addition, the Bank explained the common process flow for CBDC transfers in the framework of the "development of a system for the pilot program and experimentation" (see "2.1.2 Process flow for credit transfers"), and the WG discussed topics such as consensus formation among customer management systems in this process flow, transaction controls in distributed databases, and considerations for ensuring data integrity.

3.7.3 Next steps

Under the theme of operational flows of basic functions, the Bank will continue to explain its findings in the development of a system for the pilot program and experimentation, which is the other pillar of the pilot program, and it will hold discussions with WG members.

4. Conclusion

In the pilot program the Bank has been continuing experiments and discussions from a broad perspective, based on the two pillars of "Developing a system for the pilot program and experimentation" and "the CBDC Forum."

The Bank will further advance experimentations, such as performance tests using the experimental system. It will also incorporate knowledge related to business practices gained through discussions in the CBDC Forum, which also discusses the findings of desktop experimentation, into the experimental process. The CBDC Forum plans to continue discussions in the six WGs that are currently active, as well as discussions centered on themes across the WGs.

Whether to issue a CBDC in Japan should be decided by discussions among the public. The Bank will steadfastly continue to explore CBDC with a view to providing a basis for such discussions.

(Appendix) CBDC Forum member list

AEON Bank, Ltd.
Infcurion, Inc.
Canal Payment Service, Ltd.
Coincheck, Inc.
Cotra Ltd.
JCB Co., Ltd.
THE SHIZUOKA BANK, LTD.
Joyo Bank, Ltd.
The Shinkin Banks Cooperative Center
The Shinkin Banks Information System Center Co.,Ltd.
SECOM Co., Ltd.
Seven Bank, Ltd.
Japanese Banks' Payment Clearing Network
Sony Corporation
SoftBank Corp.
SORAMITSU Co., Ltd.
Dai Nippon Printing Co., Ltd.
Daiwa Securities Co. Ltd.
Daiwa Institute of Research Ltd.
The ChibaBank, Ltd.
Tokio Marine & Nichido Fire Insurance Co., Ltd.
Toyota Financial Services Corporation
TradeWaltz Inc.
Nudge Inc.
NEC Corporation
IBM JAPAN, Ltd.
Japan Securities Clearing Corporation
Microsoft Japan Co., Ltd.
Nomura Securities Co., Ltd.
Nomura Research Institute, Ltd.
Panasonic Connect Co., Ltd.
East Japan Railway Company
Hitachi Solutions, Ltd.
Hitachi Channel Solutions, Corp.
FeliCa Networks, Inc.
Fukuoka Financial Group, Inc.
Money Forward, Inc.
Mizuho Bank, Ltd.
Mitsui Sumitomo Insurance Company, Limited
Sumitomo Mitsui Banking Corporation
Sumitomo Mitsui Trust Bank, Limited
MUFG Bank, Ltd.
Merpay, Inc.
JAPAN POST BANK Co., Ltd.
The Bank of Yokohama,Ltd.
Rakuten Payment, Inc.
Resona Holdings, Inc.
Lawson, Inc.
Lawson Bank, Inc.
au Payment Corporation
BIPROGY Inc.
BOOSTRY Co., Ltd.
Datachain, Inc.
JPX Market Innovation & Research, Inc.
NRI SecureTechnologies, Ltd.
NTT DATA Japan Corporation
NTT DATA FINANCIAL TECHNOLOGY CORPORATION.
NTT DOCOMO, INC.
PayPay Corporation
Ridgelinez Limited
SBI R3 Japan Co., Ltd
Startale Labs Japan Inc.
TIS Inc.
TOPPAN Edge Inc.

（as of March 2025）