

Future of digital currency in India

114 countries including India are exploring digital currency, and as is known, India has also launched its own retail CBDC on pilot. The RBI foresees e-Rupee issued and regulated by the central bank as the next-generation seamless, ubiquitous and anonymous payment mode that delivers value to customers. **Mihir Gandhi** and **Zubin Tafti** examine the pros and cons.

The need for changing payment modes

The Reserve Bank of India (RBI) has decided to withdraw INR 2,000 denomination banknotes from circulation. In a move reminiscent of demonetisation in 2016, people will now be required to exchange these notes by September 30 of this year.

This development may give the payment industry, which has witnessed a revolution through digital business models and innovative systems, a further boost. Banks are collaborating with third-party providers to boost innovation in the payment ecosystem. The government has provided platforms such as Unified Payments Interface (UPI) to encourage digital payment adoption. Consequently, the RBI has reported a two-fold increase in digital payments in India since 2018.

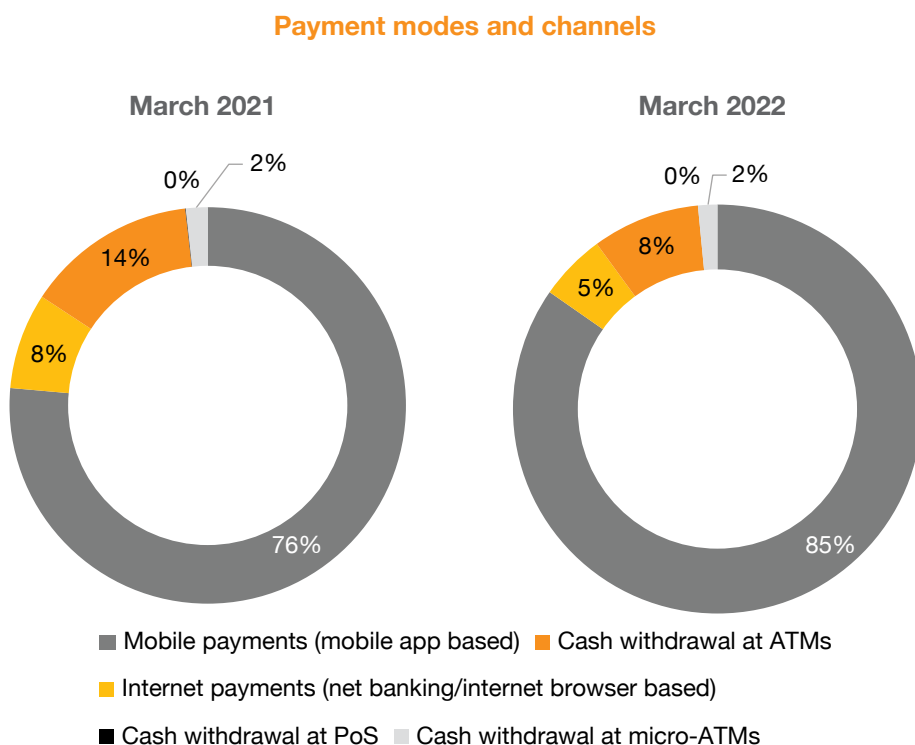
In 2022, India registered a record INR 149.5 trillion UPI and card transactions.⁸¹ As per the India Digital Payments Annual Report, UPI clocked over 74.05 billion transactions in volume and INR 126 trillion in terms of value.⁸²

81 <https://www.livemint.com/news/india/india-saw-record-of-rs-149-5-trillion-upi-card-transactions-in-2022-this-city-tops-the-list-11681789465771.html>

82 Ibid

The popularity of channels by transaction volumes is shown in Figure 1.

Figure 1: Payment system indicator – March 2021 vs March 2022



Technology is evidently evolving in parallel with the end user, and use cases are increasing with the emergence of new avenues of payments. Payments form the core of any financial institution and it's becoming imperative for central banks to provide avenues that offer new world functionalities for relevance. Central Bank Digital Currency (CBDC) is one such avenue that aims to help central banks facilitate financial services widely. The RBI foresees e-Rupee/Indian CBDC – that is, the digital form of the fiat currency issued and regulated by it – as the next-generation payment mode that is seamless, ubiquitous and anonymous, delivering customers value and a satisfying experience.

e-Rupee can act as a viable alternative to paper currency, the issuance and circulation of which entail a long process with the government incurring heavy costs. For example, for every INR 100 note, the cost estimate is around 15%–17% of the entire expense in a four-year lifecycle, including printing, distribution and returning due to soilage.⁸³ As cash circulation increases, it puts pressure on distribution and storage channels, along with the environment, owing to its carbon footprint. A larger amount of cash in circulation means pressure on regulators and governance in terms of printing, distribution and storage, thus posing several risks such as counterfeits, spoilage and security risks. Counterfeits are a huge risk with the RBI reporting an increase in fake

2,000 and 500 currency notes in fiscal year 2021–22.⁸⁴ A major risk with carrying cash is the risk of loss or theft. e-Rupee gives central banks better control over usage and distribution. This is one of the primary motivations for the RBI to launch CBDC.

Launching the e-Rupee in India would also mean taking a step towards a digital economy, given the rise in the adoption of mobile and internet-based payments, besides improving the cumbersome cross-border transaction process. One of the top priorities of the G20 has been to enhance cross-border payments and it has been implied that CBDC can be an appropriate tool. Cross-border transactions have always involved time-consuming processes laden with strict compliance checks owing to their dependency on the correspondent bank's availability and time zones. Financial institutions which have reserves in the RBI can transact in CBDC and make it easier to reduce counterparty risks. CBDC is also expected to accelerate the process by automating the method of transaction and settlement. Some other potential areas where CBDC can be leveraged to ease the process of transactions include government securities and international forex trade.

The design of CBDC depends on the functions it is expected to perform, as the RBI has underlined in its concept note.⁸⁵ The implications of CBDC for payment systems, monetary policy, and the structure and stability of the financial system will be determined by the design.

83 <https://economictimes.indiatimes.com/news/economy/finance/digital-rupee-to-save-costs-of-printing-distributing-and-storing-cash/articleshow/89413532.cm>




84 <https://www.thehindu.com/business/Economy/circulation-of-fake-currency-notes-continues-to-pose-challenge/article66330058.ece>

85 Concept note of CBDC




A primary consideration is that the design features of CBDC should be least disruptive. Accordingly, the key aspects include:

Types of CBDC or e-Rupee issued: Retail and wholesale⁸⁶

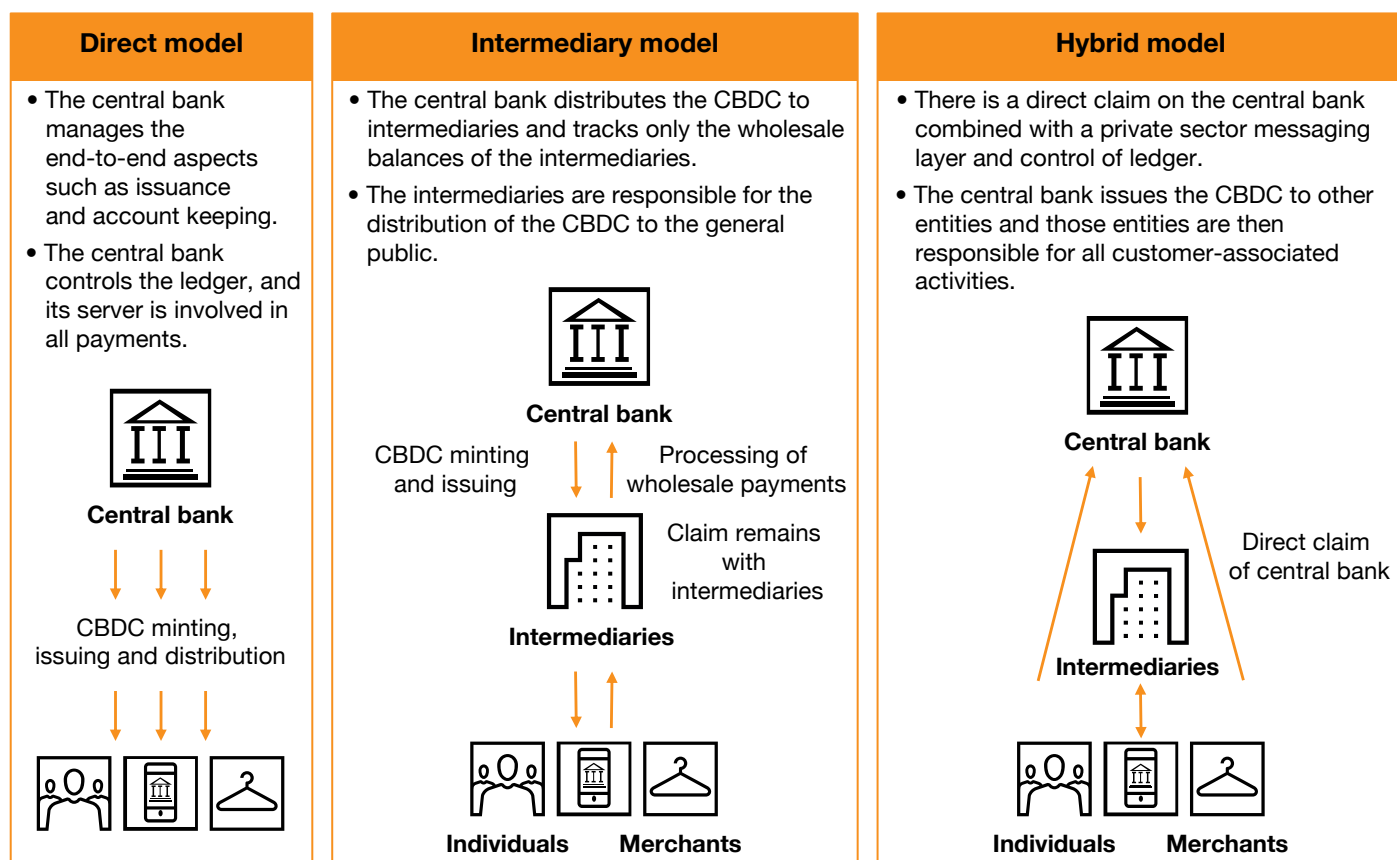
Retail CBDC

-  Intended for the private sector, non-financial consumers and businesses
-  Electronic version of cash primarily meant for retail transactions
-  Direct liability of central bank, and hence provides access to safe money with 24/7 availability, offering real-time to near real-time payment settlement

Wholesale CBDC

-  Intended for interbank transfers and related wholesale financial transactions like bond settlement and nostro transfers
-  Restricted to use for only select financial institutions
-  Could transform settlement systems, making them secure and efficient

Models for issuance: Direct, intermediary/indirect and hybrid⁸⁷



86 <https://rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=1218#CP4>

87 <https://rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=1218#CP4>

Form of design: Token based and account based⁸⁸

Account-based CBDC



- Account-based CBDC requires maintenance of record of balances and transactions of all holders of the CBDC and indicates the ownership of monetary balances. The intermediary will verify the identity of the account holder.
- It is a preferred mode for wholesale CBDC.

Token-based CBDC



- Token-based CBDC will function as a bearer-instrument like banknotes – whosoever holds the tokens at a given point in time would be presumed to own them.
- It is a preferred mode for retail CBDC, given its proximity to physical currency.

Around 114 countries are exploring CBDCs, and as many as 60 are at an advanced stage. Countries that have already launched a retail CBDC (R-CBDC) are the Bahamas, Cambodia, East Caribbean Union, Nigeria, China and Jamaica. Central banks which are exploring an exclusive wholesale CBDC (W-CBDC) include Singapore, Australia, Saudi Arabia and the European Union.

Figure 2: Status of the status of CBDCs across 114 countries as of December 2022⁸⁹



Sweden's central bank has already tested two phases of its R-CBDC starting in 2020.

South Korea, Thailand and Russia have started testing their R-CBDCs in 2021 and 2022.

The European Central Bank has outlined plans to implement digital euro in 2023.

Contrary to their counterparts, the US and Canada are still researching the possibility of an R-CBDC.



88 <https://rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=1218#CP4>

89 <https://www.atlanticcouncil.org/cbdctracker/>

The following are a few notable collaborative development projects for wholesale initiatives:⁹⁰

Name	Participants	Motivations	Details
Project Dunbar	<ul style="list-style-type: none"> Bank Negara Malaysia South African Reserve Bank Reserve Bank of Australia Monetary Authority of Singapore 	<ul style="list-style-type: none"> Assess the function of a multi-CBDC platform in terms of key challenges, benefits, design and settlements 	<ul style="list-style-type: none"> Initiated in November 2021 Final report was published in May 2022
Project Helvetia	<ul style="list-style-type: none"> BIS Innovation Hub Swiss National Bank (SNB) Financial Infrastructure Operator SIX Included 5 commercial banks in Phase II 	<ul style="list-style-type: none"> Experiment with the integration of core banking system into W-CBDC in tokenised form based on distributed ledger technology (DLT) 	<ul style="list-style-type: none"> Phase I concluded in December 2020 Phase II concluded in January 2022 This test proved that it was possible to instantaneously execute payments ranging from 100,000 to 5 million Swiss francs while eliminating counterparty risks⁹¹
Project M-bridge	<ul style="list-style-type: none"> Bank of Thailand Hong Kong Monetary Authority People's Bank of China Central Bank of UAE 	<ul style="list-style-type: none"> Explore a specialised platform for the implementation of multi-currency CBDC for cross-border payments 	<ul style="list-style-type: none"> Initiative lasted for six weeks starting in August 2022 Over USD 12 million was issued on the platform, facilitating over 160 payment and FX PVP transactions totalling more than USD 22 million in value⁹²
Project Aber	<ul style="list-style-type: none"> Saudi Central Bank (SAMA) Central Bank of United Arab Emirates (CBUAE) 	<ul style="list-style-type: none"> Explore the feasibility of dual-issued digital currency for domestic and cross-border settlements 	<ul style="list-style-type: none"> Announced in January 2019 as a joint initiative between Saudi and the UAE

Benefits of CBDC in India

Several central banks in emerging markets and developing economies are implementing retail CBDCs. Globally, if we consider the reasons behind the implementations across China, Mexico, Nigeria, Bahamas, Jamaica and the Caribbean Union, one of them is enhancing the efficiency of payment systems. In the case of India, the concept note published by the RBI in October 2022 has listed the following additional motivations:

Widen financial inclusion

Lack of infrastructure, poor connectivity and socioeconomic barriers contribute to lower financial inclusion (as per RBI reports, India's FI-Index as of March 2022 is 56.4%⁹³). A digital mode of currency that does not require a fully functional bank account and can work offline will provide a major boost to inclusion.

Promote a cashless economy

Precautionary cash holding during

COVID-19 and the anonymous nature of cash transactions led to a rapid increase in cash usage during 2021–22. The introduction of CBDC with conditional anonymity will boost cashless transactions and thus be a step towards promoting a cashless economy.

Boost payment innovation

CBDC can serve as a platform for payment innovation and provide diverse options to consumers. It is also free from credit and liquidity risks and hence removes

90 <https://www.bis.org/>

91 Switzerland tests digital currency payments <https://timesofindia.indiatimes.com/business/international-business/switzerland-tests-digital-currency-payments-with-top-investment-banks/articleshow/88875811.cms>

92 Connecting economies through CBDC <https://www.bis.org/publ/othp59.pdf>

93 RBI's financial inclusion index rose to 56.4 in March 2022

barriers for firms to innovate new capabilities.

Curb money laundering

There is often a concern about privately issued digital assets and a sizable share of the population transacting, holding and trading in such assets. Unlike cryptocurrencies, CBDC is less vulnerable to volatility and instability, thus safeguarding individual rights.

Reduce operational costs and help achieve ESG goals

The cost of cash management in India has been immense. The expenditure incurred on printing between April 2021 to March 2022 was INR 4,984 crore – a figure that excludes the ESG impact.⁹⁴ Apart from the high printing costs, it should be noted that the Government of India subsidises the usage of UPI. The introduction of CBDC will ease the pressure on the government in terms of printing, distribution and storage of currency, and also contribute to India's ESG goals by helping reduce the carbon footprint.

Simplify securities settlement

Government securities can be settled using wholesale CBDC in India through a process known as delivery versus payment (DvP)

settlement. DvP settlement is a mechanism used to ensure that the delivery and settlement of securities occur simultaneously. In India, the RBI has launched a pilot wholesale CBDC called the 'Negotiated Dealing System-Order Matching (NDS-OM) CBDC' which allows banks to buy or sell government securities.

CBDC initiative in India

In December 2022, the RBI launched the pilot for retail e-Rupee. This pilot was launched with the aim of creating a digital version that is similar to paper currency and gauge usage for ensuring a seamless transition to CBDC. The RBI is rolling out the digital currency via an intermediary model, with initial participation from eight banks in the country. As of February 2023, this pilot project was being conducted in five cities within closed user groups comprising merchants and customers on an invitation-basis only. Under this project, the RBI issues CBDCs to intermediary banks that issue digital wallets to the end users. Transactions will be performed in the same way as those involving physical currency. While the e-Rupee will not earn any interest, it can be converted into deposits.

Some features that the RBI plans to incorporate into the e-Rupee include:

- offline functionality to support usage of CBDC in low/no network conditions
- programmability for restricting government benefits/grants usage for a defined purpose at identified merchants
- interoperability for enabling both newer and legacy payment systems to operate seamlessly and improve the likelihood of adoption
- anonymity to guarantee an individual's right to privacy as in the case of physical cash.

As the RBI moves ahead with its plan to implement a digital twin that can complement physical currency, boosted by state-of-the-art technology that offers a fast, efficient and seamless experience, our paper delves deeper to triage the best use cases and assess the challenges and potential risks with implementation and the way forward.



94 Digital currency to reduce RBI's cash management costs

How does Indian CBDC compare with global retail CBDC?

The table below shows some of the key differences and similarities.

Country	Instrument type	Live/pilot	Technology	Design	Regional motivation for CBDC
India (digital rupee)	<ul style="list-style-type: none"> • Token • Non-interest 	Pilot	<ul style="list-style-type: none"> • Central ledger works on hyperledger fabric and uses API-based interfaces • Non-native security protocol that represents token held on a wallet on the back of local digitally held balance • NPCI Switch enabling interbank transactions from existing payment rails 	<ul style="list-style-type: none"> • Two-tiered model wherein issuance and minting of CBDC token takes place on DLT and the user- based interface on API-based application • Commercial banks are providing customer interface which is separate from the minting layer • Partial anonymity: Even though transactions are recorded in the central ledger, the owners of the wallets are anonymous and won't be known to the government or intermediaries. Beyond a certain amount, the owner may be required to submit PAN. 	<ul style="list-style-type: none"> • Financial Inclusion and enablement of offline payments • Restriction on the use of privately held cryptocurrencies • Alternative resilient and interoperable digital payment rail
China (e-CNY)	<ul style="list-style-type: none"> • Account and token • Non-interest 	Live	<ul style="list-style-type: none"> • Hybrid ecosystem as there is a central ledger which is compatible with all DLT frameworks that intermediaries might choose to use • Software and hardware wallet depending on the carrier • Software wallet provides services through APIs, software development kits and hardware that uses security chip • Digital certificate, signature and encrypted storage to avoid any misuse 	<ul style="list-style-type: none"> • Two-tiered structure: Central bank for issuing and redemption, intermediaries help circulate • Anonymity for small-value transactions and traceable for high-value payment transactions • System collects minimum transaction information and restricts information flow to third parties or other government agencies • Internal firewall that implements privacy protocols to limit access to transaction data • Programmability deployed by smart contracts – self-executing with predefined limits and conditions 	<ul style="list-style-type: none"> • Support financial inclusion and need for digital cash • Reduction in friction among other payment platforms • Counter the popularity and risks posed by cryptocurrencies
Nigeria (e-Naira)	<ul style="list-style-type: none"> • Account • Non-interest 	Live	<ul style="list-style-type: none"> • Same DLT technology as some cryptocurrencies, to be stored in digital wallets • Hyperledger fabric variant of DLT for enterprise users with robust security architecture • Stringent access rights control by the central bank 	<ul style="list-style-type: none"> • Minting and issuance with the central bank • Intermediaries ensure distribution through a digital wallet platform • Intermediaries to provide transaction limits depending on risk • Transaction information, if required, may be shared with government authorities 	<ul style="list-style-type: none"> • Enabling households and businesses to accelerate payments through reliable, resilient and innovative means • Economic growth in terms of inclusivity and competitiveness

Key takeaways

- Central banks don't intend to use CBDCs for monetary policy operations as making CBDCs interest bearing carries several risks such as cannibalising other short-term investment vehicles. Such a move could lead to adverse effects on the economic structure, such as shifting of deposits from banks to CBDC tokens.
- Most countries follow a hybrid model so that user interactions are seamless, and the end-to-end framework can be easily scaled up on the back of an application programming interface (API), which can support a higher throughput compared to the pure DLT framework on the user interaction end.
- Global central banks have realised that offline payments on CBDCs can provide a real value proposition to the economy's objectives.

UPI versus CBDC

With the launch of e-Rupee, there is confusion around how UPI differs from CBDC. The table below explains the differences:

Parameters	UPI	CBDC
Form of payment	UPI is a real-time payment system that transfers money from one account to another instantly. It is not a digital rupee, but a facilitator of transactions.	CBDC or e-Rupee is akin to sovereign paper currency. A wallet is loaded with e-Rupee which can then be transferred to another wallet.
Dependency	UPI transactions happen between bank accounts, and hence they are dependent on banks, the National Payments Corporation of India (NPCI) and payment service providers (PSPs). When a payer makes a UPI payment to a payee, the transaction flow involves the NPCI, payer bank, payee bank, payer PSP and payee PSP.	A CBDC wallet is independent of the bank account and transactions can happen using the wallet balance. When a payer CBDC wallet scans or adds details of the payee CBDC wallet, the money is sent from one wallet to another like cash balances without any involvement of third parties.
Settlement	Settlement for end users happens instantly as the money gets immediately debited or credited. However, interbank settlement happens on a deferred net basis.	There is no settlement as the wallet balance gets transferred to another wallet.
Anonymity	UPI transactions are recorded by banks and reflected in the statement. When a payer makes a transaction through UPI, the money gets debited from the payer's bank account and credited to the payee. This gets reflected in both bank statements and the bank's ledger, making it non-anonymous.	Anonymity is a key feature of the CBDC. No data is captured on transactions from one wallet to another. During CBDC wallet transactions, there is no dependency or intermediation by the bank. This implies that the transaction will not be recorded in the statements, making it anonymous. This is true for all transactions lower than INR 50,000.
Liability	The liability lies with the users and bank accounts.	The liability lies with the central bank, i.e. the RBI.

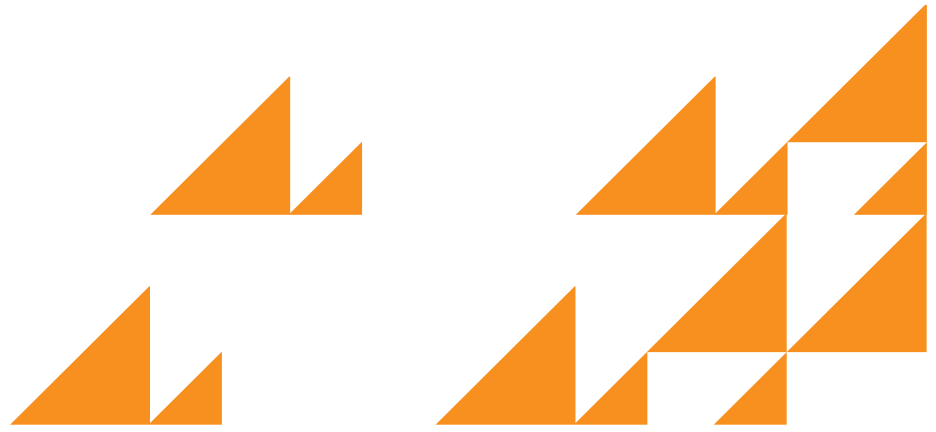
With rapid adoption and widespread usage, UPI has become a very popular mode of payment in India. UPI has been instrumental in accelerating the penetration of digital payments in India, making it a potential platform that can be merged with CBDC. This blend will serve as a better payment solution offering instantaneous fund transfers and accessibility.

Architecture of the retail CBDC (R-CBDC) ecosystem

India's CBDC architecture is based on the two-tiered model which supports a majority of CBDC implementations across the globe.

Under this model, banking intermediaries distribute CBDCs to the population based on the MO supply provided by the central bank. A hyperledger fabric powers the interaction between central banks and commercial banks. Commercial banks and other authorised intermediaries are present as nodes in the distribution tier through which minted R-CBDC tokens are transferred from the central bank.

The utilisation/end-user interaction layer takes place on an API-based framework supported by an NPCI switch for routing interbank transactions.

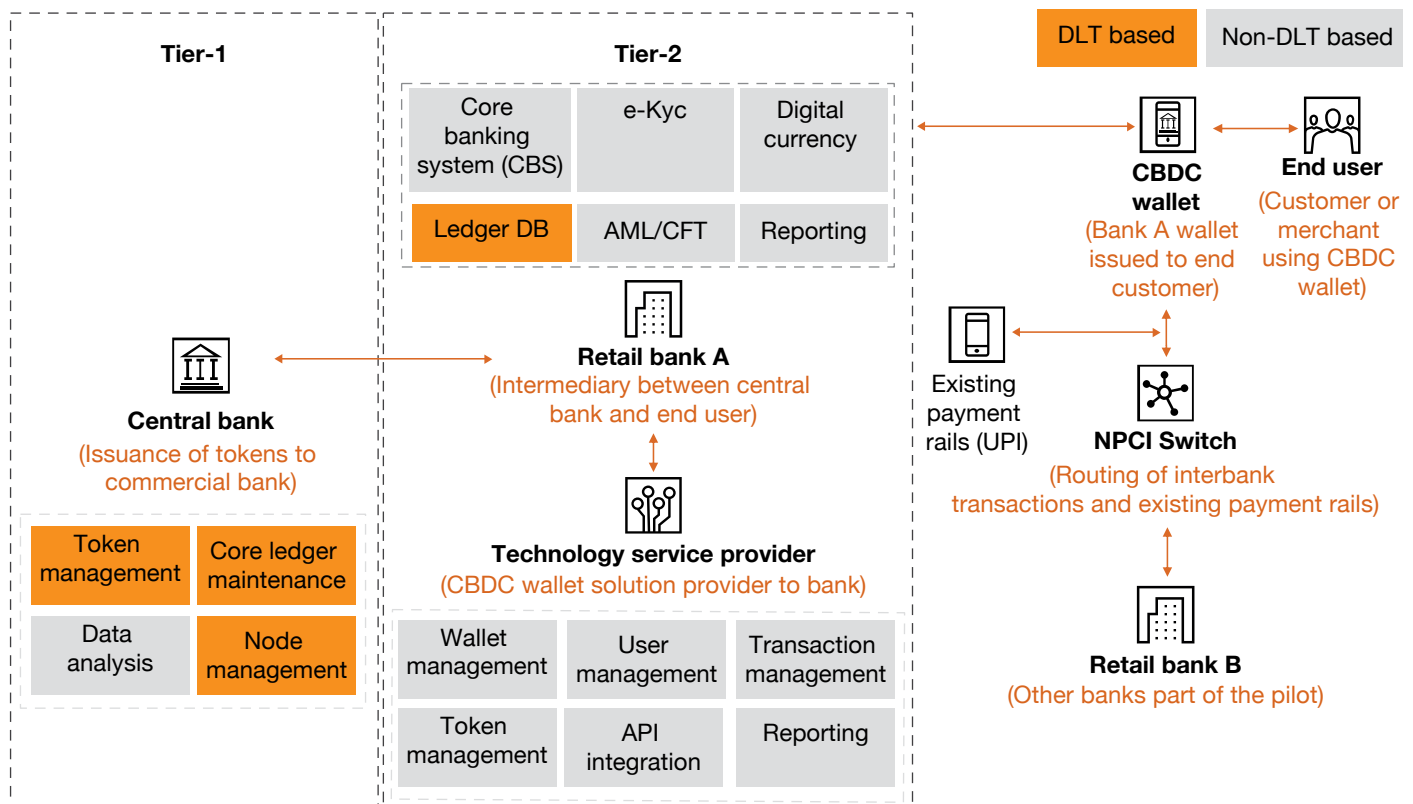


Why has India chosen a two-tiered model?

- Separation of the core payment rail and utilisation improves throughput and ability to handle many transactions as the system achieves critical mass in the future.
- It is not the central bank's domain to distribute money and provide payment services to end users.
- Through a bespoke model, the central bank wants to reduce disintermediation risk and is inclusive of PSPs that are already providing digital payment services through alternative payment rails like UPI.
- For the system to scale up, it is a prudent measure to reuse/ recreate an existing framework with enhanced functionalities to achieve the core objectives for the digital rupee.

The following is an illustrative representation of the end-to-end architecture for the pilot phase of the Indian CBDC:

End-to-end architecture for the digital rupee pilot



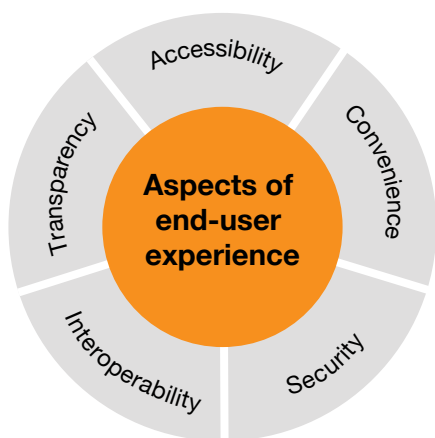


The RBI is in charge of issuing tokens and has direct liability. As mentioned earlier, the core ledgers are based on a DLT-based hyperledger fabric which has one or many nodes for the central bank and commercial banks to issue tokens as a primary objective. The core system oversees the governance of nodes and communication with the core infrastructure.

The retail layer of the solution is inspired by the API infrastructure of UPI and leverages and reuses many API libraries to create minimum disruption for the ecosystem players. The retail layer has not been placed on DLT intentionally, primarily because of scalability and throughput challenges faced related to this technology.

The tiers consist of intermediaries who play a vital role in onboarding customers, providing digital wallets and overseeing the distribution of tokens. Thus, the role of intermediaries includes account management, e-KYC, wallet management, transaction reporting and API integration with the RBI. The distribution layer is connected to the retail layer through APIs and directly issues tokens to the digital vault. The digital vault is the source of funds for wallets which connect to the issuer switch and CBDC switch for distribution, issuance and transactions. The wallet interface is connected to the bank's retail token service layer through API integration.

The end-user experience for an R-CBDC would depend on the specific design and implementation of the digital currency. However, in general, the following aspects can be expected:



Accessibility: An R-CBDC is typically designed to be easily accessible to the general public, allowing anyone with a compatible device to hold and use the currency. 24/7 access to the digital wallet will allow end users to make a transaction and manage their funds at any time.

Convenience: With an R-CBDC, users can transact and transfer funds digitally without needing a physical currency or intermediaries such as banks. This can make the process faster and more convenient.

Security: R-CBDCs are often built with advanced security features to protect users' funds and ensure the integrity of the currency. This can include encryption, multi-factor authentication, biometric authentication and secure storage solutions.

Interoperability: R-CBDCs are typically designed to work seamlessly with existing payment systems and infrastructure, making it easy for users to use the currency in their day-to-day transactions.

Transparency: CBDCs can offer a more transparent and accountable monetary system, allowing for better tracking and management of monetary policy by the central bank.

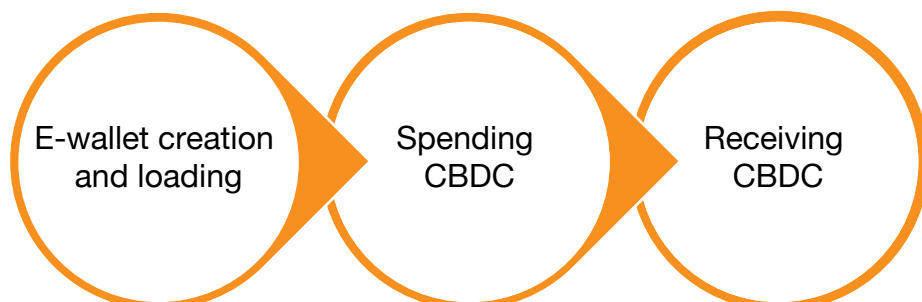
For the current R-CBDC pilot in India, the following end-user experience has been designed:

End-user experience

A. Creating a wallet

E-wallet: The e-wallet interface is a front-end solution with effortless onboarding. With its low cost and simplified features, an e-wallet can act as a catalyst for CBDC adoption.

Account creation: Account creation would typically involve providing personal information, verifying identity and setting up authentication methods for accessing e-wallets. Account management can be enabled



with a strong identity and access management feature with underlying fraud and cybersecurity monitoring.

There are three main categories of KYC (no KYC, minimum KYC and full KYC) and the user self-registration process has been defined accordingly. Aadhaar-based OTP is being used for one-time user authentication.

Loading and unloading: The user has to link any one of the onboarded banks to load and unload R-CBDC tokens from their bank account.

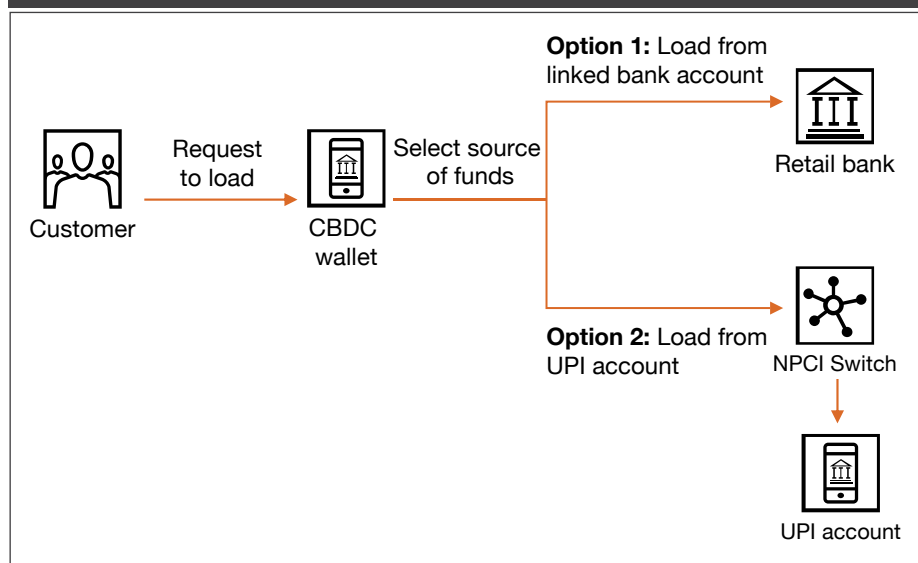
Wallet features: The wallet allows the user to check the current balance along with the denomination of the tokens available. A user can view his/her past transaction history as well as individual transaction receipts or acknowledgment copies.

Security: Token management will entail robust anti-counterfeiting measures, auto-locking, freezing of breached accounts and continuous availability of systems. Additional measures must be taken to counter the potential vulnerabilities and safeguard the stored value of tokens.

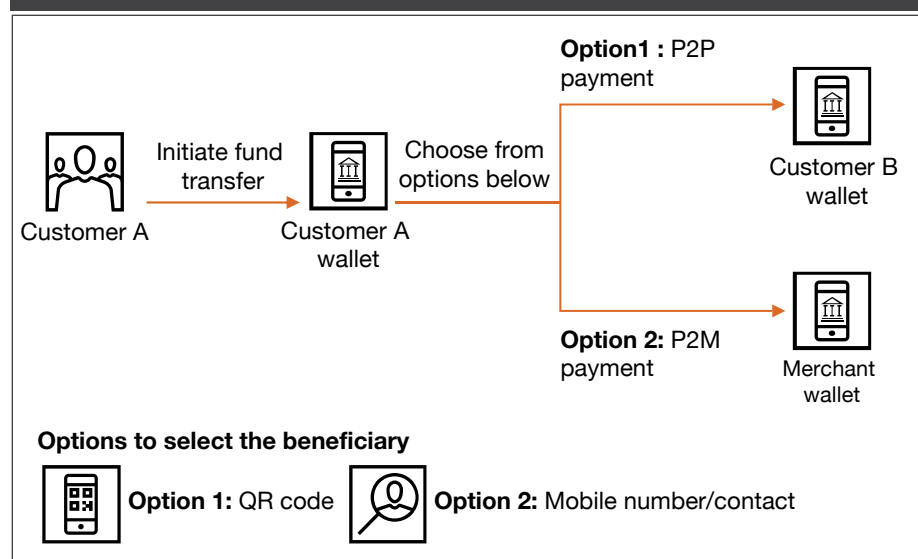
B. Spending CBDC

The end user can spend CBDC by making purchases at merchants, i.e. P2M payment, or by transferring it to another person, i.e. P2P. For this, the user has two options for searching for a beneficiary – scanning the QR code or by entering the mobile number that accepts CBDC. The end user would simply need to use their digital wallet to initiate the transaction and confirm the

Wallet loading and redemption



Fund transfer



details. There is an authentication password/PIN similar to UPI which the user needs to input to authenticate the payment.

Transactions should be enabled for continuous 24x7x365 functionality, offering operational resilience with minimal latency. This will enable real-time transaction settlement with minimal failure rates, leading to rapid adoption.

C. Receiving CBDC

The end user can receive CBDC in their digital wallet through various means such as direct deposit from an employer, peer-to-peer transactions or a central bank-operated platform.

The overall user experience of the R-CBDC e-wallet has intentionally been made to closely resemble the UPI user journey to minimise the user's learning curve and foster quick adoption.

Functions and role considerations of the end-to-end CBDC framework⁹⁵

Core system

1. **Core rulebook:** The RBI is the apex body for defining the principles of CBDC usage, outlining the legal basis, governance, risk management and access requirements for participants.
2. **Core infrastructure:** Issuing and redeeming CBDC is a core central bank function with certain technical aspects outsourced to third-party vendors.

Broader ecosystem

1. **Processing infrastructure:** The open infrastructure at the payment layer is facilitated by APIs between commercial bank participants to aid in message preparation, processing and reconciliation.
2. **Processing services:** Banks run the following functions which are inherent to guiding transactions from initiation to completion: (a) limit check and fund availability, (b) authorisation, verification and validation, and (c) screening.
3. **End-user interaction:** The following services are provided by banks through payment applications: (a) pre-transaction – channel access and onboarding of users, (b) execution – payment instruction and authentication, and (c) post-transaction – advice statements and confirmations.

4. **Use case arrangements:** Technical and business rules on how a use case should flow within an application are determined by the bank maintaining the CBDC application.

Potential challenges with implementation

The introduction of any new system in a vast market like India will entail some challenges. Some of the major challenges related to the implementation of CBDC are discussed below:

Ensuring consumer privacy and wallet security

- The governance policy should make up for the lack of personal data protection regulations and be flexible enough to adapt to the dynamic socio-economic system.
- Robust data security systems and stringent data access rules such as multi-level protection strategies and advanced intrusion detection systems must be examined before implementation to prevent any cyberattacks and breaches.
- Absolute anonymity may fuel money laundering and terrorist financing activities. Hence, defining the right regulatory framework with restrictions and gatekeeping conditions is a must.

System scalability

- DLT-based implementations are faced with potential scalability issues and performance concerns; proper research must be done on permissioned DLT to counter these concerns.

- Ensuring consistent transaction processing across all channels is paramount and hence correct execution of transactions is necessary even in the case of unforeseen events.
- Precise estimation of volumes of users and transactions is key to evaluating multi-server computing systems and data syncing needs for performance.

Data management and retention

- The KYC process should have stringent data processing and controls in place that make payment data accessible to end users and intermediaries only.
- Data management for anonymous low-value transactions and large-value transactions can be challenging, but the challenges can be mitigated by implementing identifiers or hash codes.
- Absolute anonymity within transactions will offer little insight into the movement of CBDCs and payment trends. Hence, striking a balance between data utilisation and consumer privacy is key to designing the right data model.

Accelerated adoption

- Policymakers should consider incentivising adoption of e-Rupee by not only end users but also intermediaries as the requisite technologies to implement the e-Rupee infrastructure may not be financially viable.

95_ https://www.bis.org/publ/othp42_system_design.pdf

- Intermediaries can capitalise on e-Rupee by ensuring that the underlying technology is interoperable with legacy payment rails and enabling smooth integration with third-party PSPs for innovations.
- Features such as programmability, offline modes, stability, language support, etc., must be incorporated to drive adoption among end users in both urban and rural areas.

Awareness and acceptability

- Establishing the right use case and motivations for the masses to move away from bank accounts to CBDC wallets can lead to increasing stickiness.
- Driving acceptability by conducting awareness initiatives in the right forums based on audience type, namely urban and rural.
- Initiatives like Jan Dhan Yojana should be implemented in the case of CBDC wallets to make it mainstream and increase financial inclusion among the rural population.

Future roadmap

India is one of the largest economies in the world with a large and diverse population, so there are varied expectations from the CBDC pilot with several use cases and business models expected to emerge as the ecosystem scales up. Future use cases and key considerations related to the CBDC ecosystem are outlined below:

Retail use cases

1. **Retail cross-border remittances:** A retail CBDC can help reduce the cost and increase the speed and reliability of remittances, especially for migrant workers who send money back to their families in India.
2. **Microfinance:** R-CBDCs can help support microfinance activities such as small loans and savings by providing a secure and accessible digital platform that embeds features like programmability and supports alternative underwriting models, digital onboarding, documentation, etc.
3. **Programmability:** The programmability of CBDCs can streamline direct disbursement, thereby widening financial inclusion.
4. **Offline payments:** Enabling payments in the offline mode is imperative for reaching the last layer. Given that CBDCs represent tokens, they are suited to offline transactions.

Wholesale use cases

1. **Interbank settlements:** One of the primary use cases of W-CBDC is facilitation of interbank settlements. Atomic swaps could improve the efficiency of settlements through automation based on predefined conditions. W-CBDC also helps in reducing counterparty and liquidity risk between banks, as well as settlement times and costs. DLT-based smart

contracts could enable round-the-clock settlement with a wider range of assets and a broader range of participants like non-financial corporations.

2. **Improvement in cross-border transactions:** India has the highest inward remittances in the world at USD 89,127 million in FY21–22⁹⁶ and the cost of sending these remittances assumes critical relevance. Cross-border payment transformation via CBDC will address challenges such as low speed, high costs, and lack of transparency in settlement. The CBDC will accelerate the settlement process and overcome time zone issues and exchange rate differences.
3. **Money market:** W-CBDC can also be used to facilitate trading in money markets, such as repo markets and interbank lending. This can lead to more efficient and transparent pricing of money market instruments. Additionally, it can reduce counterparty risks and increase transparency.

Impact of CBDC on global trade

- The impact of an Indian CBDC on global trade would depend on a variety of factors, including the adoption rate of the Indian CBDC, the functionality and features of the CBDC, and the overall state of India's economy and trade relations with the world.

96_India received highest ever foreign inward remittances in a single year <https://pib.gov.in/PressReleasePage.aspx?PRID=1897036#:~:text=During%202021-22%2C%20India%20received,question%20in%20Rajya%20Sabha%20today.>

- Given the current global geopolitical situation and the willingness of at least the BRICS countries to move away from US dollars as the primary instrument for global trade, there could be widespread adoption of an Indian CBDC. If that happens, it could have several benefits for India's global trade. For one, it could make cross-border transactions faster, cheaper and more secure, potentially increasing the efficiency of global trade with India. Additionally, an Indian CBDC could help reduce currency exchange risks and costs for international buyers and sellers, making Indian goods and services more attractive in the global market.
- However, the impact of an Indian CBDC on global trade could also be influenced by external factors, such as the stance of other countries on CBDCs and the overall global economic climate. For example, if other major trading partners of India do not adopt CBDCs, the benefits of an Indian CBDC may be limited. Additionally, if the global economy is experiencing a downturn, the impact of an Indian CBDC on trade may be mitigated.
- There could even be technological limitations with respect to the integration of the country's CBDC networks given that there is no single standard of implementation and various technologies are being adopted by other countries.
- Overall, it is difficult to predict the exact impact of an Indian CBDC on global trade till such time that there is more information available on the broader economic conditions at play.

Key considerations for increasing adoption/usage

1. Policy framework

- Anonymity:** There are expectations of a tiered anonymity framework with a threshold value for transactions. Beyond that, additional KYC requirements might be sought.
- Data privacy:** There is a need for stronger and bespoke data privacy frameworks based on the following principles:
 - Prioritise the best interests of citizens, especially vulnerable populations, when collecting data.
 - Limit the collection of personally identifiable information to what is necessary.
- Double down on resiliency:** Layer built-in risk controls like fraud protection and compliance.

2. Technology

- Scaling up central infrastructure:** Given that CBDC demands controllable decentralisation and supervision, emphasis should be laid on modular DLT architecture as transactions and throughputs increase within the framework.
- Operational efficiency:** Expand computing or operational capacity by setting rules for the distribution layer and let ecosystem players determine on-demand computing capacity as per adoption.

3. Business case

- Viable business case:** It will be important to define a viable business case that players can target which includes not only typical CBDC features but also new ones such as programmability and offline-based features.
- Technology enablers:** Open APIs are expected to play a key part in creating a level playing field that can help ecosystem players to innovate and create new use cases with supervised access to the backend.
- Services:** Banks and non-banks need to build core value propositions to build a CBDC portfolio with key areas including access-based services, user applications, e-wallets, processing support and technology vendors.

The rollout of CBDC or e-Rupee is a giant leap in India's digital transformation efforts. In view of the recent phasing out of the INR 2,000 denomination banknote, CBDC may just be the apt currency for financial transactions that the country needs to usher in more trust, resilience and efficiency in currency management. If the potential challenges in its implementation are addressed, CBDC could increase ease of doing business by overcoming geographical barriers. Cash usage has declined, paving the way for the emergence of alternative payment currencies and modes that are mostly decentralised. In this context, CBDC can ensure financial and environmental stability and financial inclusion, and catalyse innovation.

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