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CBDC Taxonomy and Design Choices

Central Bank Digital Currency Research Center

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Introduction

As discussions around central bank digital currencies (CBDCs) and other forms of digital currency have matured over the past few years, significant progress has been made defining and describing the characteristics and technical distinctions of the various existing and emergent instruments that function as money. Notably, we have benefited significantly from the International Monetary Fund's Money Tree and the Bank for International Settlements' Money Flower, which respectively show how the properties of a claim or object (IMF 2019), along with the parameters governing issuance and access (BIS 2017), yield an array of different money-like instruments.[1]

The **R3 CBDC Working Group** has set out to publish a new taxonomy and augmented set of definitions for digital currency and potential design options, as the intent of this initiative is to provide actionable guidance for issuers of a CBDC. In this section we aim to provide a common language for understanding the considerations and decisions relevant to building a CBDC and highlight areas where certain features may complement or cause friction with one another.[2]

Document scope

This document is comprised of two sections:

1. **CBDC Definition and Taxonomy**: specifying the inalienable characteristics of a CBDC versus those that are variable or open to interpretation, then reviewing these characteristics in the context of other instruments commonly used as money
2. **Design Choices**: classifying four categories of design choices for CBDC and identifying potential tradeoffs

1 Most literature describes CBDC as a payment instrument. However, we propose that the role of a CBDC may be somewhat broader as it could function as a store of value.
2 This is meant to be generally applicable to all kinds of platforms, although it was written from the perspective of employees of R3, who have experience building DLT-based CBDC.

Definition and Taxonomy

Definition of a CBDC

A CBDC is a digital payment instrument and store of value issued by and as a liability of a jurisdiction's central bank or other monetary authority, and denominated in that jurisdiction's national unit of account.

Each element of the above definition is an essential characteristic of a CBDC. We explore each characteristic in further detail below. In addition, the term CBDC is generally used to refer to new forms of digital central bank money that are different from balances in traditional central bank reserve or settlement accounts, even though balances in these accounts would technically meet the definition set out above. We reconcile this discrepancy by proposing that what distinguishes CBDC from other forms of digital central bank money is that it either uses new technologies to facilitate transactions or extends access to new groups of users.[3]

A "digital payment instrument"

CBDCs are "digital-native", meaning that they are not, nor do they represent, physical real-world assets. Additionally, CBDC is intended to be used, and should be functionally capable of being used, as a means of payment.

Issued by and as a liability of a jurisdiction's central bank or other monetary authority

It is an essential feature that the CBDC is issued by the central bank or other monetary authority of the relevant jurisdiction. This means that the central bank or monetary authority is the issuer of the currency, acts as a "gatekeeper" and is responsible for the governance of the CBDC.

Further, any claim that a CBDC affords a holder is a direct liability of the issuer (e.g. the central bank or other monetary authority). The nature—and even the existence—of such a claim or liability has been debated by academics and policy makers, particularly as in most modern economies, holders of central bank money only have a repayment right in central bank money (e.g. the only right that the claim gives the holder of central bank money is a claim to central bank money). Nevertheless, we consider it helpful to include this as a characteristic of a CBDC to distinguish it from other instruments which may represent a claim on or liability of a person other than a central bank or monetary authority. Such instruments would not qualify as CBDCs under the definition set out above.

3 Prior R3 research (see "Central Bank Digital Currency: an Innovation in Payments" by Calle and Eidan 2020) has proposed a token-based digital currency with potential account access via API access. However, limiting the definition of CBDC to only token-based architectures would disqualify many interesting CBDC projects from consideration. The intent of the paper is to provide guidance applicable to any CBDC design.

Therefore, so-called "synthetic CBDCs" that are issued by commercial banks, intermediaries or other third parties are not truly CBDCs, as they are neither issued by nor do they represent a direct claim on or liability of a central bank. Synthetic CBDCs are instead a type of private money that are to CBDCs what traditional commercial bank deposits are to central bank reserve account deposits.[4] Synthetic CBDCs should however be distinguished from "hybrid" or "intermediated" CBDCs[5], where commercial payment service providers facilitate CBDC payments but holders still have a direct claim against the central bank or monetary authority (and so these are true CBDCs according to the definition set out in this paper).

Denominated in that jurisdiction's national unit of account

CBDCs must be denominated in the fiat currency of the central bank's country or currency zone. Tokens or liabilities issued in another denomination (including foreign currencies where the central bank does not have monetary authority) are not CBDCs of that jurisdiction.

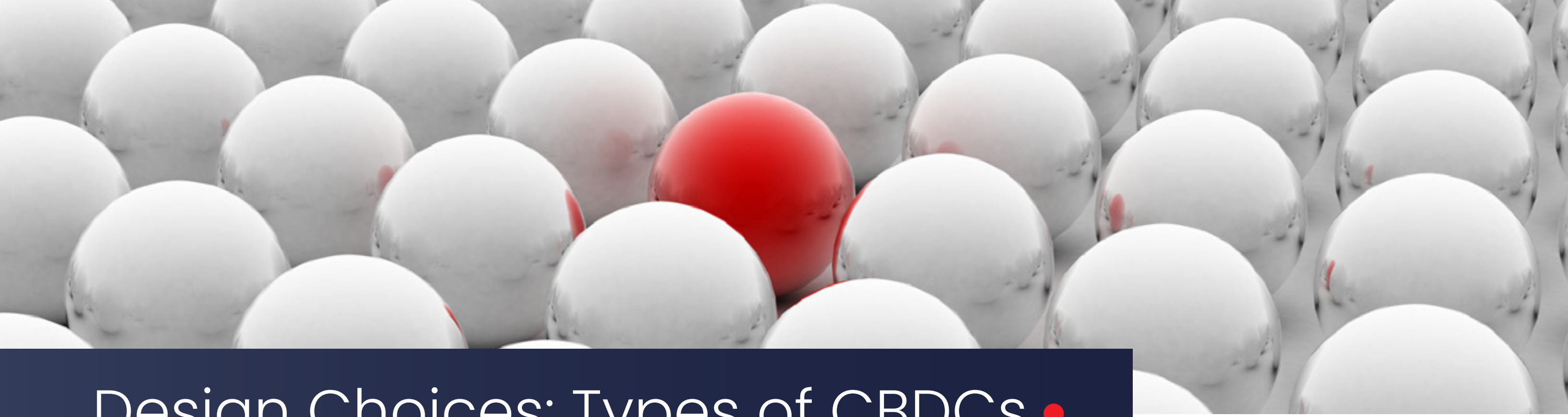
Additionally, in order to maintain the singleness of a currency, it seems necessary that CBDCs should exchange at par with other forms of central bank money (reserves and cash). However, it has been suggested that there may be reasons to break this 1:1 convertibility with forms of private money (commercial bank deposits) in limited circumstances.[6]

Taxonomy of Money-Like Instruments

Table 1: Characteristics of different types of money and money-like instruments

	Cash (bank notes and coins)	**Central Bank Money**	**Commercial Bank Money** (deposits)	**Government Debt**	**Cryptocurrency**	**Stablecoin**	**E-money**	**CBDC**
Digital v Physical	Physical	Digital	Digital	Digital (if dematerialized) Physical (if bearer)	Digital	Digital	Digital	Digital
Issuer	Yes (central bank / monetary authority)	Yes (central bank / monetary authority)	Yes (commercial bank)	Yes (government)	Typically no	Not necessarily (depends on structurer)	Yes (e-money issuer)	Yes (central bank / monetary authority)
Nature of holder's rights against issuer claim, right or interest	"Claim" on central bank / government for repayment (but typically limited to repayment in central bank money)	"Claim" on central bank / government for repayment (but typically limited to repayment in central bank money)	Claim on commercial bank for repayment in central bank money	Claim on government for repayment in central bank money	N/A	Depends on structure	Claim on issuer for repayment in fiat currency (commercial or central bank money)	"Claim" on central bank / government for repayment (but typically limited to repayment in central bank money)
Denomination (fiat v other)	Fiat	Fiat	Fiat	Fiat	Other	Either	Either	Fiat
Asset linkage	None	None	None	None	None	Depends on structure (fiat, commodity, or none)	Yes (fiat)	None
Interest bearing	No	Yes	Yes	Depends	No (but could be in theory)	No (but could be in theory)	No (but could be in theory)	Choice

4 Nevertheless, a wholesale-only CBDC coupled with commercial payment service providers issuing "synthetic CBDCs" could provide similar overall functionalities as a general use CBDC.
5 R Auer, G Cornelli and J Frost, "Rise of the central bank digital currencies: drivers, approaches and technologies", BIS Working Paper, no 880, August 2020
6 For example see the **CPMI paper (2018)** which provides a summary of this issue at footnote 12.



Design Choices: Types of CBDCs

This section outlines and defines a set of non-essential attributes that a CBDC may have, which are commonly described as CBDC design choices. Design choices are intrinsically linked to policy goals (such as 'promoting financial inclusion')[7] and use cases (such as 'improving the efficiency of cross-border payments')[8]. There are trade-offs to each and there is no one-size-fits-all solution.

This paper does not recommend how to build a CBDC. Rather, it identifies various functional features that a CBDC could have, describes at a high level the key trade-offs that arise when optimizing for one or more of these features and indicates how this choice impacts technical implementation decisions and non-functional properties of the CBDC. We identify 16 attributes in total, which are broadly grouped as follows:

Core considerations and capabilities: The first nine attributes are functional options based on policy preferences and generally reflect explicit goals cited in central bank-authored reports.

1. Accessibility & Adoption
2. Availability
3. Privacy & Anonymity
4. Transparency
5. Functional Interoperability
6. Network Sovereignty and Governance
7. Private Sector Role
8. Asset Programmability

Technical implementation options: The following four attributes are technical implementation options that will be dependent on the set of desired policy preferences above.

1. Operational Role
2. Consensus Mechanism
3. Point of Finality
4. Platform Interoperability

Non-functional properties: The final four attributes are non-functional properties, which all operators will want to optimize for within the limits of technical feasibility.[9]

1. Scalability
2. Performance
3. Resilience
4. Security

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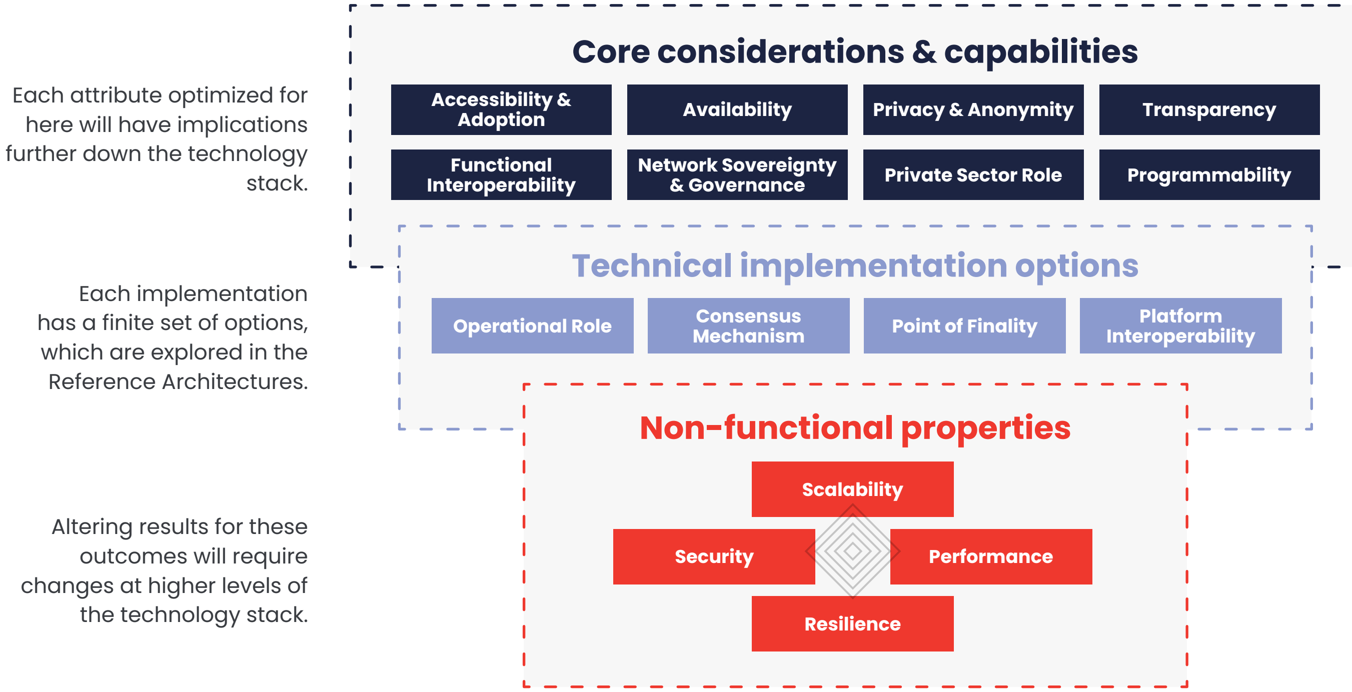
7 See the 'Conceptual Model' for a complete list of policy goals. Also, the BIS working paper, "Rise of the central bank digital currencies: drivers, approaches and technologies" provides a thorough summary.

8 The next three sections of this paper dive into both wholesale and general-purpose use cases for CBDC.

9 A thorough analysis of the non-functional properties requires situational context based on the outcomes of other decisions. While it is out of scope to discuss each without this context, a future report may analyze non-functional properties of a specific CBDC implementation.

Each attribute is deeply interlinked with others, as optimizing for one or choosing a specific implementation will impact potential outcomes for others regardless of where they sit on the diagram below.

Figure 1: Design Choices and Trade-offs for CBDC



Note: these categories are for organizing purposes only; they are not necessarily fixed categories that cannot be changed. For example, any design choice may belong to more than one category, and all have tradeoffs with ramifications across categories.

Core considerations and capabilities

Accessibility & Adoption

Though neither accessibility requirements nor the tools used to control adoption are considerations unique to CBDC (all forms of central bank money must address the questions of distribution and issuance overviewed here), it is included first because it relates directly to the issuer's motivation for issuing a CBDC and the use cases intended for the CBDC.

User profiles and use cases

'Who should be able to access CBDC and for what purpose?'

The most well-known distinction between CBDCs—wholesale v. general purpose—is rooted in who has access to the CBDC asset or system. Wholesale CBDC refers to a network restricted to financial institutions, many of which already have relationships with the central bank. A general purpose CBDC, however, encompasses a wider range of options and can cover usage by corporates, merchants or even the general public. We start with this consideration because it requires a full assessment of the goals of the digital currency project to determine the appropriate level of accessibility that the CBDC should have.

Wholesale

- Is access extended to additional entities, such as exchanges?
- Can the CBDC be held by a foreign FI or central bank?

General purpose

- Can it be held by foreign individuals, corporates, FIs?
- Can it be used as a means of payment for foreign individuals?
- Can it be used for remittance?

The remainder of this section of the paper will discuss features relevant to both general purpose and wholesale payments. Future sections will dive deeper into the unique requirements and considerations for either wholesale or general-purpose use cases.

Controlling adoption

'How do you optimize for usage among a desired user base and/or constrain usage?'

It will be necessary to consider the following questions to define optimum usage for a given general purpose CBDC implementation and then identify steps to achieve optimum usage. Different approaches may be needed to achieve successful adoption of a CBDC offering by different cohorts of potential users.

Table 2: Optimizing for Adoption

Question	Relevant consideration
What are the central bank's goals for number of users? Does the central bank have a target?	This could only be determined by the public sector on a jurisdictional basis.
What instruments would the CBDC compete with or complement?	Many projects cite the decline of cash as a primary reason for the need of digital sovereign money. This still leaves open questions around a potential CBDC's relationship with bank deposits or closed loop e-money networks.
How does the central bank promote the offering (achieve minimum usage)?	Other papers have suggesting that a CBDC could carry interest, which would incentivize users to hold CBDC over cash. This raises the question of whether to set the interest rate at the same or a different level from other forms of central bank money. In addition, the public sector would have to determine if fees are charged to CBDC holders to cover costs of running the infrastructure. Other papers discuss 'user-centric design'. User experience, along with promotional strategies are important, though they are out of scope for this paper.
What measures would the central bank take so that the CBDC offering does not compete with and undermine other offerings (control maximum usage)?	Limits and/or caps on holdings or transactions are a common technique for other forms of central bank money and have been proposed as a solution to achieve policy aims.[10] For example, there exists a disclosure obligation when taking more than $10,000 EUR abroad.

10 CPMI paper suggests limits/caps are easier to envision for account-based CBDCs than token-based CBDCs

Availability

Availability is a function of how accessibility and adoption requirements manifest within technology selection and implementation. While the questions asked here are not unique to CBDC, some of the solutions are new since many CBDC implementations leverage very different technology from existing monetary instruments. Specifically, here we ask the question:

How technically available should the system be and in which scenarios?

Depending on the user profile and use case, we can address various requirements and decisions relevant to users' ability to transact using CBDC with similar functionality to other payment systems and instruments. Three examples include functionality for offline payments, peer-to-peer payments, and operating hours of the payment system.

Functionality for offline payments

Being able to use CBDC in the event of a power outage or in a scenario without mobile network or WiFi is critical if a CBDC is to function in a way similar to cash. A few research papers have outlined potential solutions, each with various trade-offs.[11] [12]

Peer-to-peer payments

A common requirement for retail payment systems is for users to be able to transact with one another directly. Proposed CBDC implementations, however, differ greatly in network structure and the methodology by which transactions are verified.

Network availability hours (24/7?)

24/7 payment access is a feature of some retail networks (card payments) but not all. For example, bank transfers are not usually 24/7.[13] Even potential wholesale workflows—particularly security settlement and security settlement systems—often concentrate liquidity within pre-defined trading windows.

Privacy & Anonymity

Privacy and anonymity are among the most often discussed design choices for CBDCs. Here we will unpack the dimensions of this discussion, arriving at a more granular set of potential design choices beyond simply describing a system as 'private' or 'anonymous'. Specifically, any proposal or concerning privacy must be grounded in what facts they are keeping private and from which actors.

Privacy of what?

First, we focus on the objects or data in question. The two core things discussed in the context of privacy are identity and the transaction(s) one participates in. Both are complex topics and will require more granular solutions. For the purpose of this paper, we will generalize.

Identity Privacy—There is a range of identity data that may be considered here. On one end of the spectrum would be a pseudonymous key or metadata, which reveals little about a particular user's identity. On the other end of the spectrum would be personally identifiable information, such as a social security number.

11 Bank of Japan, 2020 (paper in Japanese. Here is summary: **https://www.ledgerinsights.com/bank-of-japan-offline-central-bank-digital-currency-payments/)**
12 Visa, 2020 **https://arxiv.org/pdf/2012.08003.pdf**
13 The Colombian RTGS, which moved to 24/7 in December 2020, show that interbank systems could run 24/7.

Transaction Privacy—Any transaction contains data, and it is likely that each may be governed differently even within the same regulatory regime. These include the fact that a transaction occurred, the amount of a transaction, the time of a transaction, the fact that two parties have transacted in the past at all, the fact that an account/address has made a transaction, the net inflows and actions of one account/address, among others.

Privacy from whom?

Second, we need to consider who the piece(s) of data are private from. This will generalize into five types of entities:

- Issuer and/or network operator
- Counterparty to a transaction
- Other participants in the network
- Other actors not in the network
- Regulators

Table 3: Implications of Privacy on Network Characteristics

	Identity Privacy	Transaction Privacy
Issuer / Operator	Anonymity (as commonly defined)	Issuer / Operator can't see (elements of) the transaction
Counterparty	No restrictions on who anyone can transact with since counterparty doesn't know who they are	N/A *(they would have to be aware of the transaction since they are a party)*
Other network participants	No concept of an 'address book' where users could search for people by name or another ID factor	Transaction records could not be broadcasted to other users (ex: the Bitcoin network would not meet this criteria)
Actors without network access	Pseudonymous network, similar to Bitcoin	Transactions would need to be point-to-point, similar to above (ex: the Bitcoin network would not meet this criteria)
Regulator	Regulator cannot identify participating entities	Regulator is not aware of transactions

Transparency

Across which scenarios would increased transparency and visibility mitigate risk and potentially create benefits?

Often, transparency is the inverse of privacy or anonymity. As a result, we seek to address it directly after defining those terms and seek to apply a similar framework for understanding the motivations for making a CBDC transparent.

Table 4: Implications of Increased Transparency on Network Characteristics

	Identity Transparency	Transaction Transparency
Issuer / Operator	KYC/AML Financial Integrity Potential distribution of government benefits	Reduce financial crime Improved economic data
Counterparty	Risk mitigation	N/A (they would have to be aware of the transaction since they are a party)
Other network participants	Improved discovery	Improved value-add services if anonymized data is given to service providers
Regulator	KYC/AML Financial Integrity Sanctions Taxation	Reduce financial crime

Highly relevant to the conversation of CBDC transparency are the tools regulators have for supervising the payments network. Recent BIS research has proposed a model for embedding regulation into DLT-based financial networks.

Functional Interoperability

How do different systems and regimes share data, assets, contracts and applications?

Interoperability is the ability of systems to interact with each other and work together—ideally automatically and seamlessly. Potential barriers to interoperability can arise in different contexts and at different levels in a payments ecosystem.

Additionally, an issuer of CBDC would need to have a clear understanding of what degree of interoperability is even desirable. For example, interoperability can mean many things depending on whether it is attempted between applications within one network or between different networks.

Further, any entity or group of entities constructing a CBDC system must consider that if the system is not built with interoperability in mind, it can potentially become yet another collection of siloed assets requiring more integration work down the road.

Legal and regulatory interoperability

Policy-driven, legal or regulatory barriers to interoperability may arise through imposition of duplicative or incompatible requirements on different systems or actors in those systems. These issues can be particularly acute in a cross-border context, for example:

- if actors in different jurisdictions are required to carry out multiple manual KYC checks in relation to a cross-border payment (potentially meeting slightly different standards), or
- if incompatible technical specifications or legal requirements for a system are imposed by law or regulation in different jurisdictions.

Technical interoperability

If common technical standards and formats are adopted across different systems, technical interoperability should be an emergent characteristic of those systems. Indeed, local regulatory requirements often encourage or even require this level of interoperability.

Functional (vertical v. horizontal) interoperability

Vertical interoperability is a function of the number of integrations across different levels of the payment chain, with the potential benefits of providing end-to-end integration, automation and efficiency. Examples relevant to CBDC would be integration with user wallets, merchant terminals, payment rails, settlement systems or core banking systems.

Horizontal interoperability refers to the level of connectability between different systems and actors at the same level in the payment chain with the potential benefits of offering greater flexibility, choice and competition. Examples relevant to CBDC would be cross-blockchain protocol interoperability or cross-business network (or application) interoperability.

Network Sovereignty and Governance

Where does one's network infrastructure reside, and who has access control?

Network sovereignty is a critical consideration for the implementation of payment systems because while it creates friction with interoperability, it also enables high-level policy goals, such as monetary sovereignty. Suppose Country A wants to transact with Country B—the ways of facilitating that transaction vary depending on the interconnections and access points between parties in both networks. The central bank from Country A would need to decide if the central bank from Country B is able to transmit the digital currency freely within Country B or if access is restricted to various (types of) entities. Additionally, each network has its own infrastructure, and the benefits of interconnecting platforms should be viewed alongside the risks of sharing access to that infrastructure with other entities.

Relationship between network sovereignty and interoperability

- CBDC (or other assets) within two completely self-sovereign networks have no linkage, thus requiring a more robust interoperability framework in order to allow for transactions to take place between the networks.
- CBDC (or other assets) in different networks that share some level of network infrastructure require less formal interoperability, since the assets share some common denominator.

Figure 2: Potential Cross-Ledger Interoperability Solutions

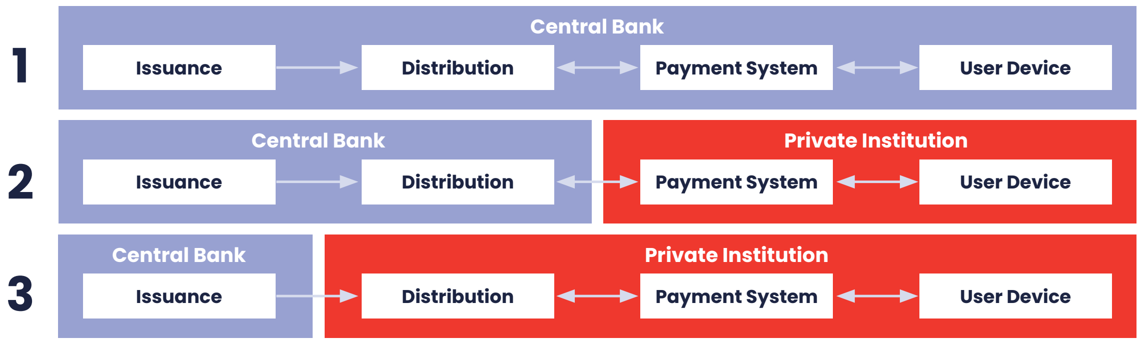
Network governance

There are two core groups relevant to the functionality of connected networks. First, the central bank or monetary authority is responsible for the governance of a CBDC and will need to develop an appropriate governance framework, covering issues such as the respective roles of different actors in the system, decision making processes (including how changes to the features / rules governing the CBDC can be made), dispute resolution, etc. Second, specifically within the CBDC space, there are opportunities for transnational bodies to provide governance and/or standards to facilitate more seamless global networks.

Private Sector Role

What role could the private sector play in the network, and which lines of business would be relevant to CBDC?

Figure 3: Range of Potential Roles in Network (Source: IMF)



Source: IMF, "A Survey of Research on Retail Central Bank Digital Currency"

There are multiple potential roles for private sector entities in a CBDC ecosystem. First, the public sector has limited experience creating consumer-facing interfaces, thus creating many opportunities for the private sector to provide user wallets, terminals or other physical interfaces for the transfer of a digital currency. Second, while the asset may remain a liability of the central bank, a CBDC could still traverse either new or existing payments rails provided by the private sector. Third, many models proposed by central banks involve a two tier network structure in which (most likely) banks would have the responsibility of distributing CBDC to depositors.

Irrespective of who is responsible for these mission critical roles, the private sector could also come in to a CBDC ecosystem to provide additional value-add services, such custodial services or other investment, trading or lending services.

Programmability

How can additional functionalities be built into the CBDC system that go beyond capabilities of other (non-DLT-based) payment systems?

The idea of 'programmable money' lies at the heart for why many central banks and policy makers are extremely excited about CBDC. Particularly, token-based CBDCs issued on distributed ledgers can be built with various functionalities or conditions already built into the asset itself. While this is a core capability that could enable many of the nuances discussed above, programmability also opens the door to various additional use cases for CBDC that do not exist in other forms of central bank money.

Potential functions include:

- Payment of tax at point of sale (PoS)
- Integration with physical devices or IoT
- Distribution of economic relief based on certain factors
- Functionality to check creditability of payment terminals or wallets before paying

Technical implementation options

Figure 4: Implementation Vectors

Operational Role

Network Structure
(what role does the central bank play)

Issuance	Y
Distribution	Y/N
Payment System	Y/N
User Device	Y/N

Consensus Mechanism

Security Parameters
(how are transactions verified)

By Identity (pseudonymous)	Y/N
By Identity (PII)	Y/N
By characteristics of object	Y/N

Point of Finality

Network Access
(who can facilitate transactions)

Central Bank	Y/N
Commercial Bank	Y/N
User (P2P)	Y/N
Other third party	Y/N

Interoperability

Network Portability
(where can this instrument be used)

Interchain	...
Intrachain	...
Integrate	...
Initiate	...
Interchange	...

Operational Role and Nature of the Claim

What roles do each party play in the core functions of the network?

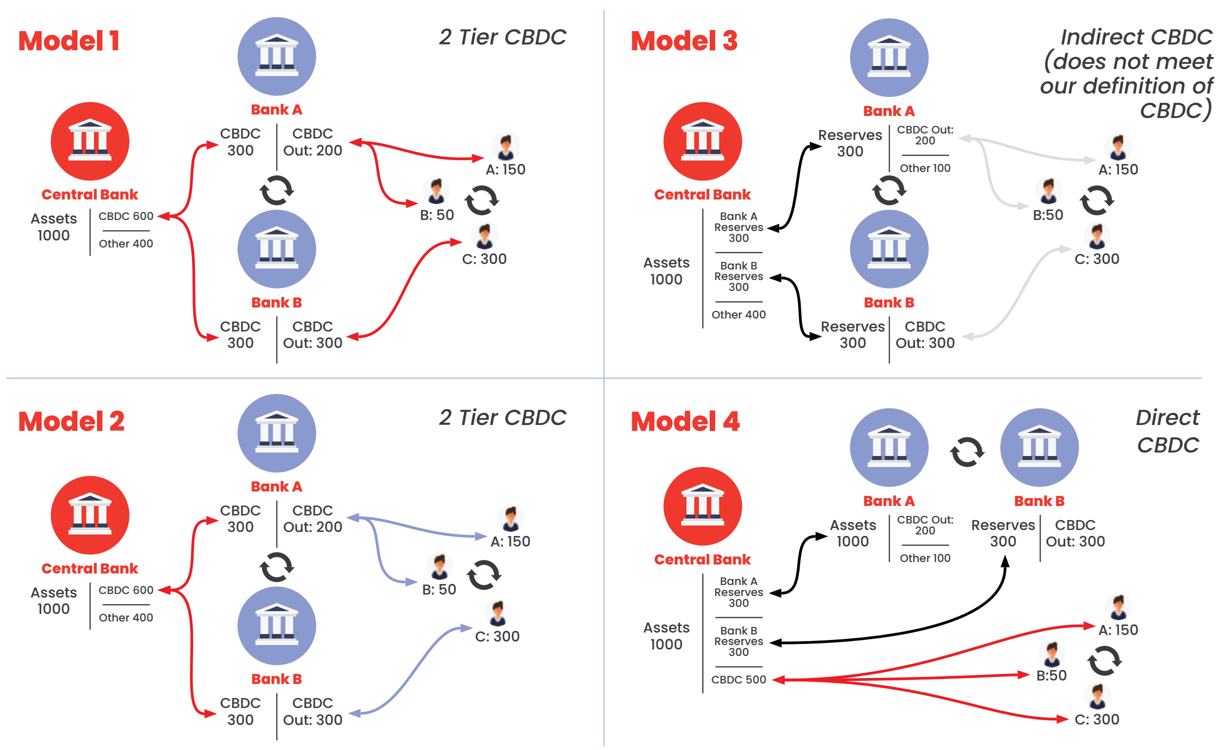
Existing CBDC papers propose a few interesting options for the architecture of a CBDC. For example, the BIS's seminal "The technology of retail central bank digital currency" proposes that a CBDC can either operate on a single tier (the "Direct Model"), two tiers where a commercial bank acts as an intermediary ("Indirect CBDC") or combine some properties of both solutions ("Hybrid CBDC" and later "Intermediated CBDC").

In the Hybrid CBDC model, the instrument is still a liability of the central bank, but commercial banks or other payment service providers (PSPs) would handle the facilitation of payments.[14] Additionally, in a hybrid model, the central bank would maintain a backup copy of the ledger. This differs slightly from the BIS's "Intermediated model", introduced a year later, in which the central bank only keeps a record of wholesale transactions.[15] Both of these are different from the "Indirect model" (which is similar to the IMF's "Synthetic CBDC"[16]), which is actually just a bank-issued stablecoin backed by an account held at a central bank.

At the most basic level, the resulting proposals present two vectors to consider:

- What is the operational role of the central bank?
- Which entity is the CBDC a legal claim on, and what are the properties of that claim?

Figure 5: The Relationship Between Operational Role and Liability in CBDC Architecture



14 This terminology was introduced by the BIS (2020), and further reinforced in policy papers such as BoE (2020). Also see section 1.3 for discussion of hybrid and intermediated CBDCs and the distinction between these and so-called "synthetic CBDCs"

15 R Auer, G Cornelli and J Frost, 2020

16 T Adrian and T Mancini-Griffoli, "The Rise of Digital Money" International Monetary Fund, July 2019

While some taxonomies include the question, 'Who is the CBDC a claim on?', we are assuming that it is a claim on the central bank (see section 1.3), which is why Model 3 does not meet our definition of a CBDC. While out of scope for this paper, it is worth noting that other types of digital currencies, such as private sector-issued stablecoins, are related to this discussion but raise whole new issues around areas such as fungibility.[17]

Consensus Mechanism

How are transactions verified?

There are two primary methods by which transactions can be verified in a distributed network: (i) verification via details guaranteeing object's validity and (ii) verification via details around the sender's claim to the funds.

Identity Validity—what pieces of information may be required?

- Personal Identifiable Information (PII) (e.g. bank account)
- Official identity documentation
- Pseudonymous key (e.g. cryptocurrencies)

Object Validity—what pieces of information may be required?

- Unspent transaction output (UTXO) (e.g. Bitcoin)
- Other type of cryptographic proof (e.g. other cryptocurrencies)
- Anti-counterfeiting technologies (e.g. physical cash)

A note on the relationship between the Consensus Mechanism and other attributes

Clearly, the method(s) used for achieving consensus have unique implications on many aspects in the prior section, such as privacy and accessibility. Additionally, the options are not mutually exclusive. For example, while cash may resemble 'object' and traditional bank accounts may resemble 'claim to funds', many blockchain systems include elements of both (private key proves your ability to move funds, the UTXO proves that the item is not double-spent).

Point of Finality

Who can facilitate transactions?

With a centralized ledger or accounts, this function would live with the network operator. However, decentralized ledgers enable participants to 'write to the ledger'. Within a DLT environment, there are many different possibilities for who could facilitate transactions. For example, different participants could have different levels of access (e.g. not every participant needs to be a node).

The four main potential groups are:

- The Central Bank
- Commercial Banks
- Another third party, such as a PSP or other wallet provider
- Users (peer-to-peer) transactions

17 G Calle and D Zalles, "Will Businesses Ever Use Stablecoins", April 2019

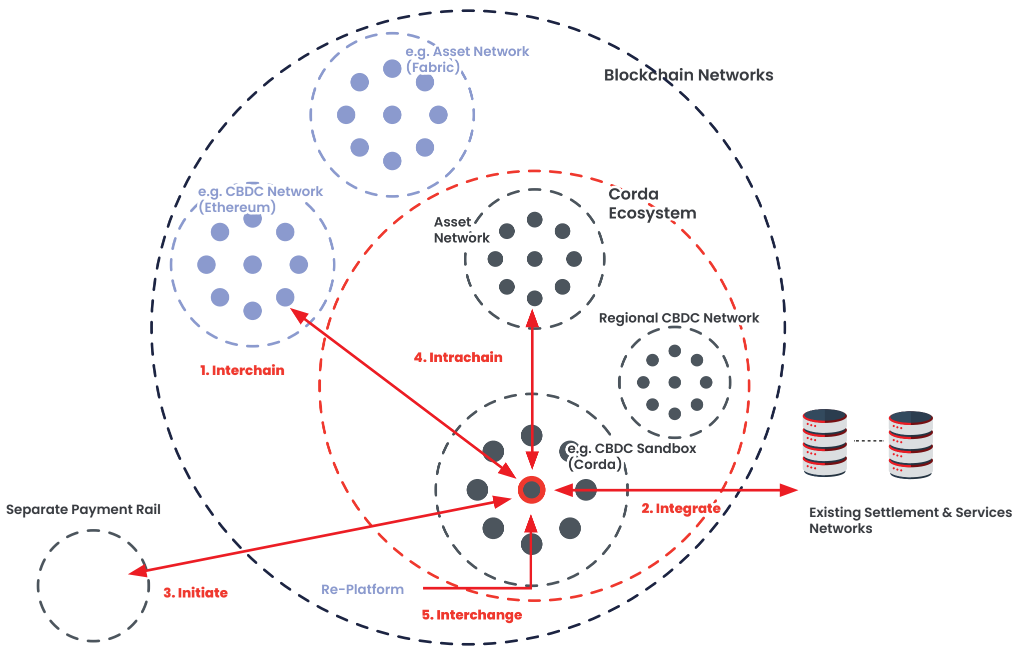
The discussion above considers operational finality of payments made via the system but that many legal frameworks also have a legal concept of settlement finality. Therefore, thought may need to be given to how these different concepts of settlement finality (operational and legal) interact and coincide.

Platform Interoperability

At a technical level, interoperability discussions raise five key questions:

- Can the system **integrate** with existing systems?
- Can the user **initiate** transactions that will be recorded and trigger a process on other networks and 'rails'?
- Can users transact **interchain** with solutions on other technologies on the same rail?
- Can users transact **intrachain** with solutions on different deployments of the same technology?
- Is the CBDC issuer or network operator able to **interchange** one underlying platform for another, thus reducing 'buyer's remorse'?

Figure 6: Five 'Ingredients of Interoperability' for Blockchain Platforms



Source: Inspired by Richard Gendal Brown, CTO of R3

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BIS	Central bank digital currencies: foundational principles and core features	2020	https://www.bis.org/publ/othp33.pdf
BIS	Rise of the central bank digital currencies: drivers, approaches and technologies	August 2020	https://www.bis.org/publ/work880.pdf
IMF	The Rise of Digital Money	2019	https://www.imf.org/~/media/Files/Publications/FTN063/2019/English/FTNEA2019001.ashx
IMF	Legal Aspects of CBDCs	Nov 2020	https://www.imf.org/en/Publications/WP/Issues/2020/11/20/Legal-Aspects-of-Central-Bank-Digital-Currency-Central-Bank-and-Monetary-Law-Considerations-49827
Bank of England	Broadening narrow money: monetary policy with a CBDCS	May 2018	https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2018/broadening-narrow-money-monetary-policy-with-a-central-bank-digital-currency.pdf
Institute and Faculty of Actuaries	Understanding Central Bank Digital Currencies	March 2019	https://www.actuaries.org.uk/system/files/field/document/Understanding%20CBDCs%20Final%20-%20disc.pdf
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