Understanding Nine Central Bank Digital Currency Experiments Selected from the World

Edwin Ayisi Opare*, Kwangjo Kim**

*Global Information and Telecommunication Technology Program, KAIST

** School of Computing, KAIST

Abstract

Over the last decade, private-sector actors have issued several thousands of distributed ledger technology (DLT)-based digital currencies that neither possess intrinsic value nor are they backed by any tangible resources. The issuance of these private digital currencies such as Bitcoin, Ethereum and other altcoins threatens the stability of monetary policy and financial market infrastructures (FMIs). Facing the threat of disruption of monetary policy and financial market instability by such private sector issuances, many central banks have begun research and experimentation into the issuance of central bank-backed digital currencies (CBDCs) to guarantee financial market stability and monetary policy preservation. In this paper, we present a survey of nine CBDC experiments from the world with the goal of understanding the motivations and factors that influence the technical design considerations of the selected CBDC experiments.

Keywords: CBDC, digital currency, DLT, FMIs, monetary policy

I. Introduction

The invention of Bitcoin in 2009 by Satoshi Nakamoto[1] has given rise to the use of digital or crypto-currencies globally. In less than a decade since the introduction of Bitcoin, private sector actors have issued several thousands of digital currencies that lack intrinsic value and are not backed by any tangible resources[2].

Facing the threat of monetary policy and financial market instability by such private sector issuances, many central banks (CBs) have delved into research and experimentation on the issuance of central bank-backed digital currencies (CBDCs) to guarantee financial system stability and monetary policy preservation[3].

In a recent survey conducted by the Bank for International Settlements (BIS), of the 63 CB respondents of the survey, more than 70 per cent are currently investigating the possibility of issuing a CBDC[4].

In this paper, we present a survey of nine (9) completed CBDC experiments from the world to understand the motivations and factors that influence the technical design considerations of the selected experiments.

II. CBDC

A CBDC may be defined as monetary value similar to central bank-issued money that is stored electronically and represents a claim on asset on the CB[5]. It can be distributed in a decentralized manner and used to make payments.

CB-issued money from the perspective of accessibility are of two types: general-purpose (physical) money or cash, which is widely available and accessible to

the general-public; and wholesale electronic CB money (reserves or settlement balances) whose access is restricted to commercial banks (CMBs) and other high-value financial industry market participants[5].

Similar to the CB money types, there are two types of CBDCs: general-purpose CBDCs and wholesale CBDCs (W-CBDC). General purpose CBDCs can be broken down further into general-purpose account-based CBDC (GA-CBDC) and general-purpose value-based CBDC (GV-CBDC)[4].

The Bank for International Settlements (BIS) provides a further classification of money and CBDCs which are represented on Figure 1, the money flower. In Figure 1, the dark-gray shaded area represents the types of CBDCs issuable by a CB.

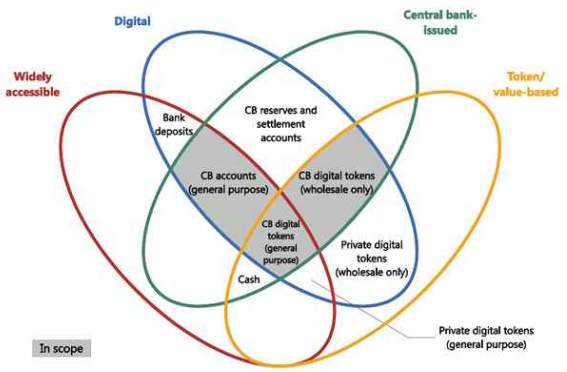

Figure 1: The money flower: a taxonomy of money (Source: BIS, 2019)

III. CBDC Experiment Selection

We search the World Wide Web for completed CBDC experiments and present our findings in this section. In particular, we crawl through resources of the World Economic Forum (WEF) which has been curating CBDC experiments of various types in one place at[6]. All CBDC experiments aggregated by the WEF as at August 10, 2019 are considered potential candidates for our survey subject to the fulfillment of our experiment selection criteria discussed in this section.

Additionally, we crawl the Whitepaper Database, a renowned data source in the cryptocurrency world where leading cryptocurrency projects such as Ethereum, Ripple, Tether, Stellar, and other altcoins were all published.

To qualify for inclusion in our survey, a CBDC experiment must meet the following criteria:

1. Must be published by the WEF, whitepaperdatabase.com or by the central bank/government implementing the CBDC experiment
2. Must have completed a proof-of-concept
3. Must have a detailed report about the experiment in English

Following our selection criteria, we present the selected CBDC experiments in Table 1 which summarize the candidate experiments surveyed in this paper.

Table 1. Selected CBDC Experiments

No.	Country	Experiment Name	Type of CBDC
1	Canada	Project Jasper	W-CBDC
2	Singapore	Project Ubin	W-CBDC
3	Hong Kong	None	W-CBDC
4	Brazil	None	W-CBDC
5	South Africa	Project Khokha	W-CBDC
6	Germany	BLOCKBASTER	W-CBDC
7	Thailand	Project Inthanon	W-CBDC
8	Bilateral 1 (Canada, Singapore)	Jasper-Ubin	W-CBDC
9	Bilateral 2 (EU, Japan)	Project Stella	W-CBDC

IV. CBDC Motivations and Technologies

In this section, we present the motivations and choice of technology (DLT or otherwise) for each selected CBDC experiment in Table 2.

Table 2. CBDC Experiment Motivations and Technologies

Country	Experiment Name	Motivation	DLT used
Canada	Project	Understand how	Ethereum

	Jasper	DLT could transform the future of payments in Canada	; Corda
Singapore	Project Ubin	Evaluate the implications of having a tokenized form of the Singaporean Dollar on DLT, and its potential benefits to Singapore's financial ecosystem.	Ethereum ; Corda; Hyperledger Fabric; Quorum
Hong Kong	N/A	Carry out an open-minded and in-depth examination of DLTs and identify possible applications of DLT in banking industry	Ethereum , Hyperledger Fabric
Brazil	Project SALT	Explore central bank use cases that could benefit from the potential of DLT	Ethereum ; Corda; Hyperledger Fabric; Quorum
South Africa	Project Khokha	Build a PoC wholesale payment system for interbank settlement using a tokenized South African rand on DLT	Quorum
Germany	BLOCKBASTER	Create a conceptual prototype for a Blockchain-based transfer and settlement of securities and cash	Hyperledger Fabric
Thailand	Project Inthanon	Access the potential of DLTs on Thailand's financial market infrastructure	Corda
Bilateral 1 (Canada, Singapore)	Jasper-Ubin	Enable cross-border high value transfer between different DLT platforms	Quorum, Corda
Bilateral 2 (EU, Japan)	Project Stella	Implement liquidity saving mechanism functionalities on DLT	Hyperledger Fabric, Elements, Corda

We note that all the CBDC experiments surveyed in this paper are W-CBDCs. Additionally, all the experiments were implemented on at least one of Ethereum, Corda, Quorum or Hyperledger Fabric DLT platforms.

V. Conclusion

In conclusion, we provide a summary of CBs motivation for undertaking CBDC experiments. We also highlight some of the pros and cons of existing DLT platforms.

1.1. Motivations for CBDC Experiments

CBs have indicated the following as their key goals for undertaking CBDC experiments:

- Availability: elimination of the single point of failure problem associated with the execution of transactions that rely on a central authority for payment, clearing, and settlement
- Performance: reduction in transaction processing time and cost as DLTs eliminate the need for third parties for transaction verification and validation, thereby removing transaction processing time and cost bottlenecks that otherwise exist with current financial market infrastructure (FMI) schemes
- Auditability: improved real-time payment, clearing and settlement monitoring and guarantees of transaction transparency by CBs and financial market participants
- Transparency: minimize the occurrence of fraudulent transactions through the use of a single shared ledger with capabilities for transaction traceability that allows for efficient transaction screening over relatively shorter times compared with screening for existing FMI implementations
- Cost reduction: operational simplification through the use of a shared ledger for improvements in back-office processing and reduction in reconciliation costs in securities clearing and settlement among transacting parties
- Trust: Elimination or reduction of counterparty risks through the use of

smart contracts for transaction automation to ensure that counterparties do not renege on their commitments in payment transactions

- Security: enhanced transaction data privacy due to the underlying public key cryptography systems underlying DLT implementations

1.1. Pros and Cons of DLTs

DLTs refers to a combination of technologies and capabilities that provides strong auditability and traceability guarantees to enable different actors to share in a trustless environment, access to the same data over multiple logical and geographic locations. Blockchain, a type of DLT popularized by Nakamoto's implementation and release of the Bitcoin core in 2009 [1].

While the bitcoin blockchain possesses a number of desirable attributes for the financial industry, a number of shortfalls with its original implementation undermine its suitability for FMIs.

Firstly, Bitcoin is a public, permissionless blockchain, meaning that anyone can join the Bitcoin network without a need for verification of their identity[7].

Secondly, the public nature of Bitcoin means that all Bitcoin transactions are publicly visible making it unsuitable for data privacy requirements required by FMIs and financial transactions[6].

Lastly, Bitcoin's consensus protocol, which is based on the Proof-of-Work (PoW) protocol, is resource intensive, requiring excessive amounts of energy and time to append new blocks to the transaction ledger of a blockchain system. In FMIs, payment transactions usually require a fraction of a second to be completed while Bitcoin only adds transactions to blocks and propagates such blocks to the blockchain ledger every 10 minutes[3].

To address the Bitcoin shortfalls, leading CMBs are collaborating with financial technology (Fintech) companies to develop permission-based DLT platforms as an alternative to the Bitcoin system.

Notable among the myriad of DLTs for the financial services industry includes the Quorum, Corda, and Hyperledger Fabric DLT platforms.

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