HYPERLEDGER FOUNDATION

Hyperledger in Action

Central Bank Digital Currencies

Contents

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Introduction

As central banks around the world have explored and researched the uses, viability, and needs for a central bank digital currency, Hyperledger's distributed ledger technologies (DLTs) have been at the forefront of these experimentations. Our DLTs, built in the open with vendor-neutral governance and currently deployed in several production networks in other sectors, provide proven technology with strong community support.

Central banks want to know that the technology they are using is sustainable, tested, and can withstand and adapt to the unique needs of this use case. We expect there will be many different DLTs used and explored for CBDCs and are proud to share these examples of how Hyperledger technology is leveraged and trusted for DLT-based CBDCs. We believe that for such an essential public good as digital cash, the technology that the future of money is built on should come from communities working together in the open, sharing ideas, knowledge, and lessons learned, to improve and test in a shared environment that everyone can benefit and learn from.

This ebook provides the reader an overview of the Hyperledger Foundation, why open source development is appropriate for all central bank projects and real-life examples of CBDC projects around the world.

> **"Open source motivates _higher-quality code._** _Everyone doing open source cares a lot more about the code they write, because they know anyone can see it."_

Makoto Takemiya,
CEO and co-founder at Soramitsu, the development company on Project Bakong - National Bank of Cambodia (NBC)

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Hyperledger Foundation

An Overview of the Foundation

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What is Hyperledger?

This section provides a high-level overview of the Hyperledger Foundation.

Hyperledger Foundation

The Hyperledger Foundation is the open, global ecosystem for enterprise blockchain technologies. As part of the Linux Foundation, it is a neutral home for developers to collaborate, contribute, and maintain open source software.

Hyperledger was founded in 2015 to bring the transparency and efficiency of DLT technologies to the enterprise market, leveraging the well-proven open source software model. The high level aim is to enable solutions that connect industries, organizations, and even individuals more directly, recreating how information is shared and business is conducted.

The Hyperledger Foundation hosts a number of open source software projects that serve as the building blocks for enterprise blockchain deployments.

Read Full Overview:
Hyperledger Foundation Paper

These projects are conceived and built by the Hyperledger developer community as freely available, enterprise-grade software that vendors, end user organizations, service providers, start-ups, academics, and others can use to build and deploy blockchain networks and even commercial solutions.

Because our projects are developed and governed as open source technologies, Hyperledger projects are all community led.

Open Source Development

Open source software development is a transparent process, which is particularly fitting for blockchain technologies. It brings together organizations and individuals with different requirements and drives them to work together to develop common solutions that can be the foundation for mutual success—another good parallel with blockchain.

Hyperledger Foundation Goals

Provide a neutral, open community around enterprise blockchain supported by technical and business Governance

Foster the development and adoption of cross-industry platforms powered by distributed ledgers

Educate the public about the market opportunity for business blockchain technology

CBDCs and Open Source

According to the Federal Reserve, the central bank of the United States, central bank money traditionally takes two forms: cash and reserves held by eligible financial institutions at the central bank. Central bank digital currency (CBDC) is a generic term for a third version of currency that could use an electronic record or digital token to represent the digital form of a nation's currency. A CBDC is issued and managed directly by the central bank and could be used for a variety of purposes by individuals, businesses, and financial institutions.

Central bank digital currency projects are moving quickly from prototypes to pilots and beyond with some well known projects already in production.

As CBDCs and other cross border payment use cases mature, central banks continue to partner with the private sector from small to big companies to accelerate and innovate, and Hyperledger technologies, built by our open source community, are at the forefront of most public CBDC projects.

In addition to developing products and services which many of deliver to their central bank customers, the Hyperledger community is also working to build the future of digital money with open source principles and goals.

Technology innovation happens when companies, developers, academics, and regulators come together to meet common goals, and Hyperledger Foundation is proud to host the development of code that will enable payment innovations around the world. CBDCs will be a game-changing public good that we believe should be built in an open and collaborative manner.

Hyperledger Projects

A distributed ledger is a multiparty database with no central trusted authority. When transactions are processed in blocks according to the ordering of a blockchain, the result is a distributed ledger. Hyperledger Foundation hosts a variety of platforms that serve as the foundation for blockchain networks across a range of industries and use cases.

Hyperledger Besu is an Ethereum client designed to be enterprise-friendly for both public and private permissioned network use cases. It can also be run on test networks such as Rinkeby, Ropsten, and Görli. Hyperledger Besu includes several consensus algorithms including PoW, and PoA (IBFT, IBFT 2.0, Etherhash, and Clique). Its comprehensive permissioning schemes are designed specifically for use in a consortium environment. **Learn More.**

Hyperledger Fabric is intended as a foundation for developing applications or solutions with a modular architecture. Hyperledger Fabric allows components, such as consensus and membership services, to be plug-and-play. Its modular and versatile design satisfies a broad range of industry use cases. It offers a unique approach to consensus that enables performance at scale while preserving privacy. **Learn More.**

Hyperledger Iroha is an easy to use, modular distributed blockchain platform with its own unique consensus and ordering service algorithms, rich role-based permission model and multi-signature support. **Learn More.**

Community Work with CBDCs

As you will see throughout this ebook, the Hyperledger community is actively advocating, developing and deploying digital currencies including those issued by central banks.

The Hyperledger team, working with our Foundation members, have been following closely the activities and projects that are using Hyperledger technology. We know there are many public and not-yet-public examples exploring and using Hyperledger Besu, Hyperledger Fabric, and Hyperledger Iroha, as well as other DLTs. We hope this overview provides you with a good summary of those efforts.

How else can you get involved in this work happening at Hyperledger Foundation?

- Join as a Hyperledger Foundation member. Our member companies are leaders in financial services and technology working on these exciting projects. **Learn more about membership.**
- Download and learn more about our Projects: **https://www.hyperledger.org/use**
- Participate in our open communities, like our **Capital Markets SIG.**
- Deep dive into Hyperledger projects with **training and certifications.**
- Attend other **Hyperledger events and webinars.**
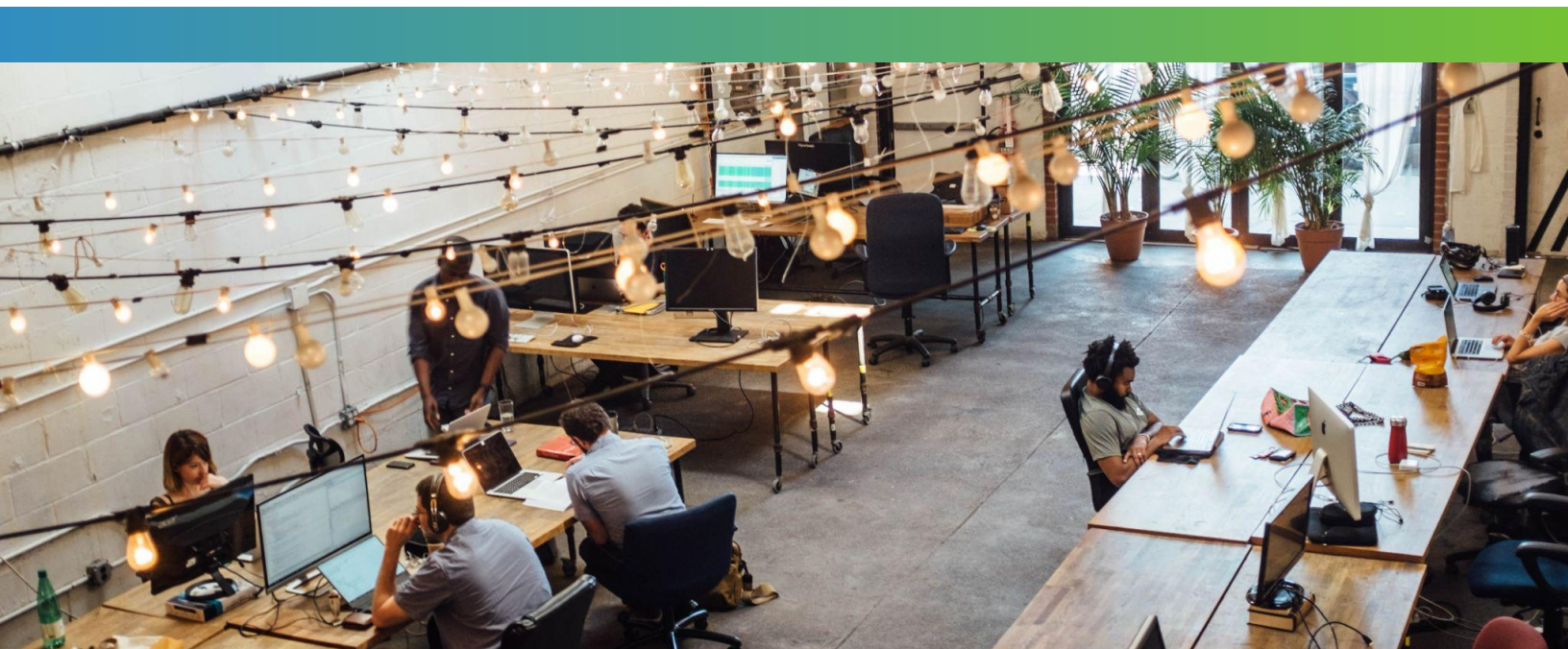
CBDCs around the Globe
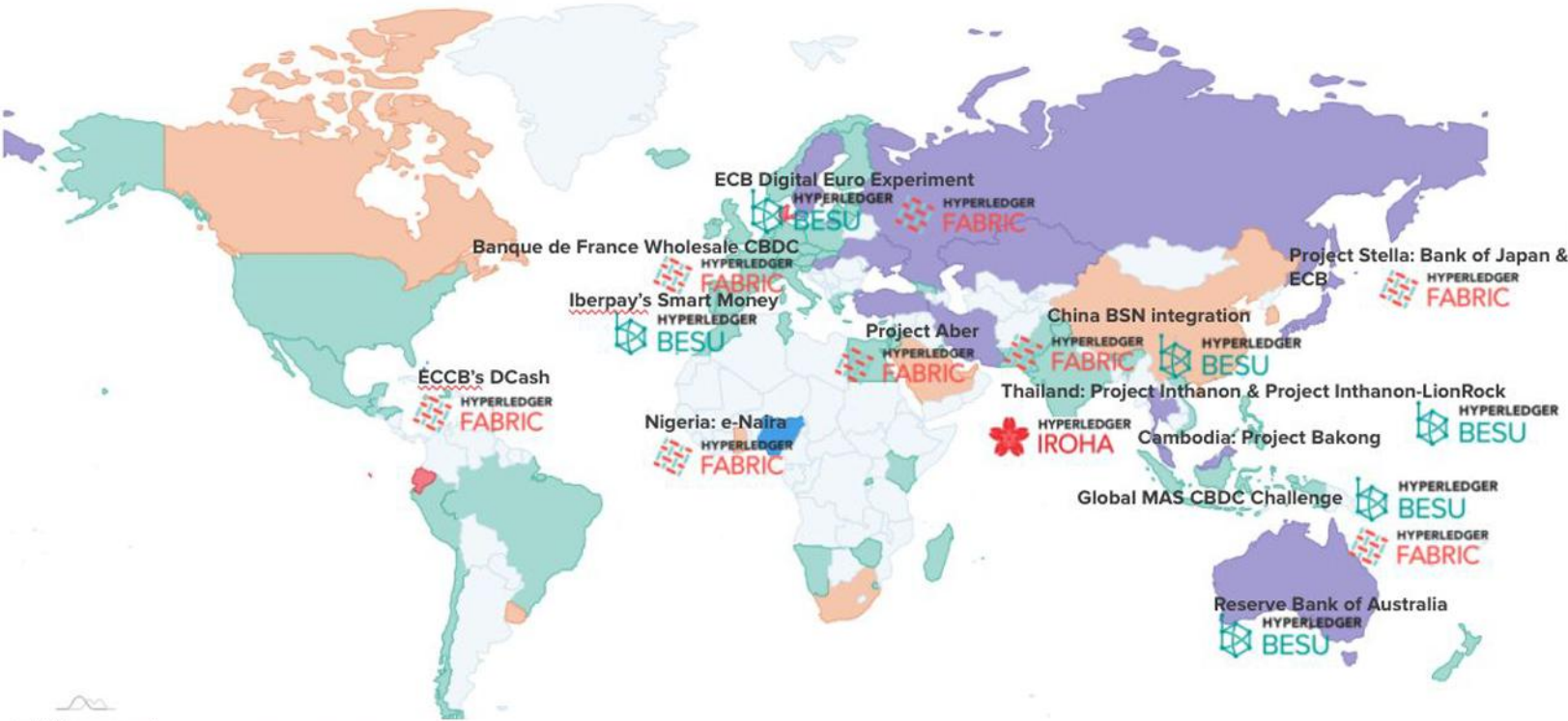
Hyperledger in Action by Region

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Hyperledger Technologies in Action

CBDC projects and experimentations with Hyperledger around the world*

Today's Central Bank Digital Currencies Status
Database update: February 2022 • News update: Mar, 09 22

Legend: Cancelled | Research | Proof of concept | Pilot | Launched

ECB Digital Euro Experiment — HYPERLEDGER BESU, HYPERLEDGER FABRIC

Banque de France Wholesale CBDC — HYPERLEDGER FABRIC

Iberpay's Smart Money — HYPERLEDGER BESU

ECCB's DCash — HYPERLEDGER FABRIC

Nigeria: e-Naira — HYPERLEDGER FABRIC

Project Aber — HYPERLEDGER FABRIC

China BSN integration — HYPERLEDGER FABRIC, HYPERLEDGER BESU

Project Stella: Bank of Japan & ECB — HYPERLEDGER FABRIC

Thailand: Project Inthanon & Project Inthanon-LionRock — HYPERLEDGER BESU

Cambodia: Project Bakong — HYPERLEDGER IROHA

Global MAS CBDC Challenge — HYPERLEDGER BESU

Reserve Bank of Australia — HYPERLEDGER BESU, HYPERLEDGER FABRIC

*publicly announced
Source: https://cbdctracker.org/; https://www.bis.org/publ/bppdf/bispap114.pdf

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European Central Bank

ECB President Christine Lagarde has suggested that a digital euro can complement cash. Furthering the exploration of a digital euro, the European Central Bank released research on a tiered approach to test how centralized systems could operate with distributed ledger technology. Several European banks participated including the central banks of Spain, Italy, France, Lithuania, Luxembourg, Belgium, and Austria. The research found that Hyperledger Besu and Hyperledger Fabric, amongst others, were "**fully interoperable with existing fiat systems**." Read the full report **here**.

Image Copyright: Digital Euro experiment report

France

Banque de France completed a trial for a wholesale CBDC, partnering with HSBC, Hyperledger Foundation Premier Member IBM, and eight other organizations. This final stage of the experiment tested the interoperability between a CBDC blockchain network and a bond network **using Hyperledger Fabric and R3 Corda**, respectively, for the DLTs and **Hyperledger Labs' Weaver** as the interoperability tool.

"*By achieving the transfer of data and assets, as well as the exchange of assets across different blockchains in an atomic way, the Banque de France and HSBC have demonstrated the possibility of such interoperability, essential to ensure that the multiple environments, on which the efficient functioning of markets rely, can coexist.*" - Nathalie Aufauvre, Director General of Financial Stability and Operations at the Banque de France.

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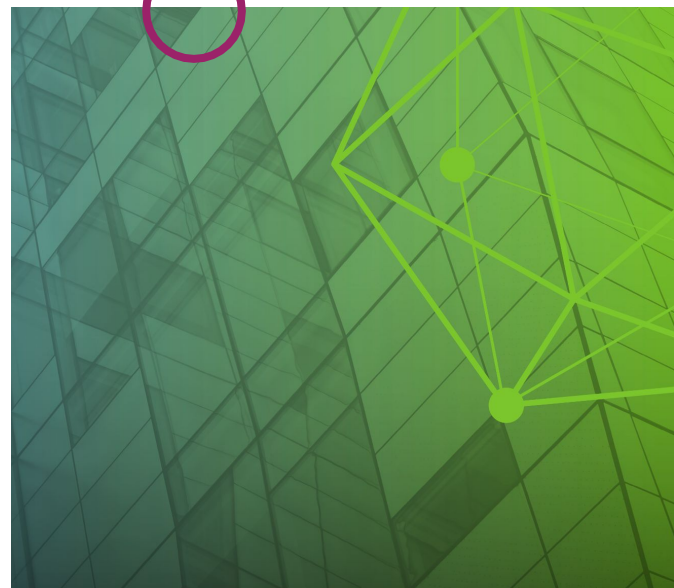
Please visit IBM for more information on blockchain-based CBDC architectures.

Thailand

Bank of Thailand's Project Inthanon was one of the first to demonstrate how blockchain can enhance efficiency and support innovations in payments and supply chain financing by leveraging CBDCs. Hyperledger Foundation Premier Member ConsenSys, alongside SCG and Digital Ventures, **used Hyperledger Besu** to meet both the functional and non-functional requirements of a retail CBDC. One of the business cases tested the use of a CBDC to simulate daily commerce, automate payments, and support procurement and financial management system called Procure-to-Pay (B2P) developed by Digital Ventures. Read the **full report.**

Please visit consensys.net for more information on blockchain-based CBDC architectures.

Project Inthanon-LionRock

Project Inthanon-LionRock, now the mCBDC Bridge Project, led by the Bank for International Settlements Innovation Hub, Hong Kong Monetary Authority, Bank of Thailand, People's Bank of China, and Central Bank of the United Arab Emirates has implemented Hyperledger Besu to demonstrate the completion of an international exchange of multiple CBDCs in seconds as opposed to several days. This could reduce costs to users by up to half and is part of the Phase 2 and 3 exploration of the now named **mCBDC Bridge project**. This project was developed in partnership with Hyperledger Foundation Premier Member ConsenSys and others.
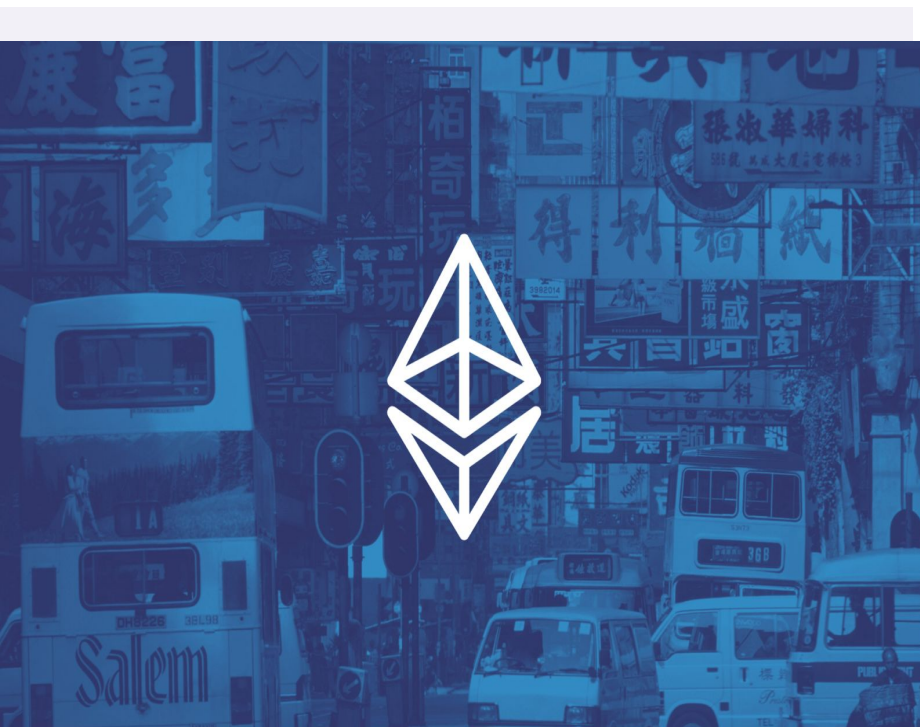

Image: Copyright ConsenSys
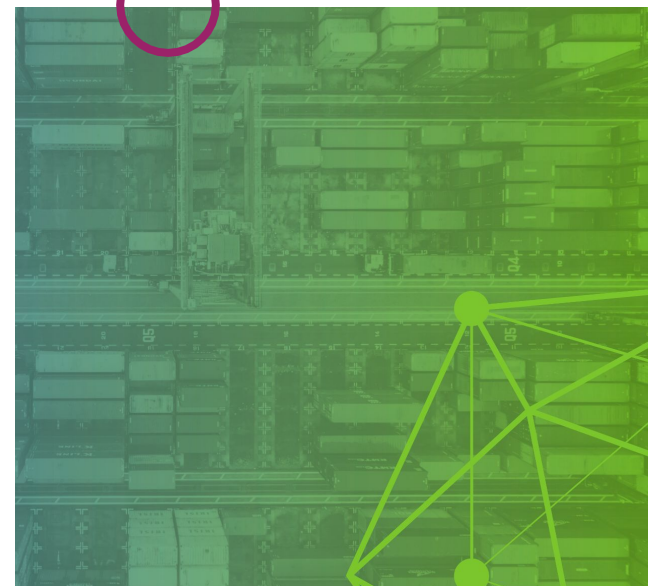
Please visit consensys.net for more information on blockchain-based CBDC architectures.

Cambodia

The National Bank of Cambodia's Project Bakong boosts financial inclusion with Hyperledger Iroha and was recognized by PwC in their **Global CBDC Index as #2 Retail CBDC globally and #1 in Asia.** Implemented by Hyperledger Foundation Member Soramitsu, Bakong is the first large-scale blockchain-based central bank-run interbank payment system in production. The blockchain-based retail interbank payment system, **reached 200,000 users in June 2021,** doubling from three months earlier, amassing 1.4M transactions at a value of $500M. Read more in the **Hyperledger Case Study.**
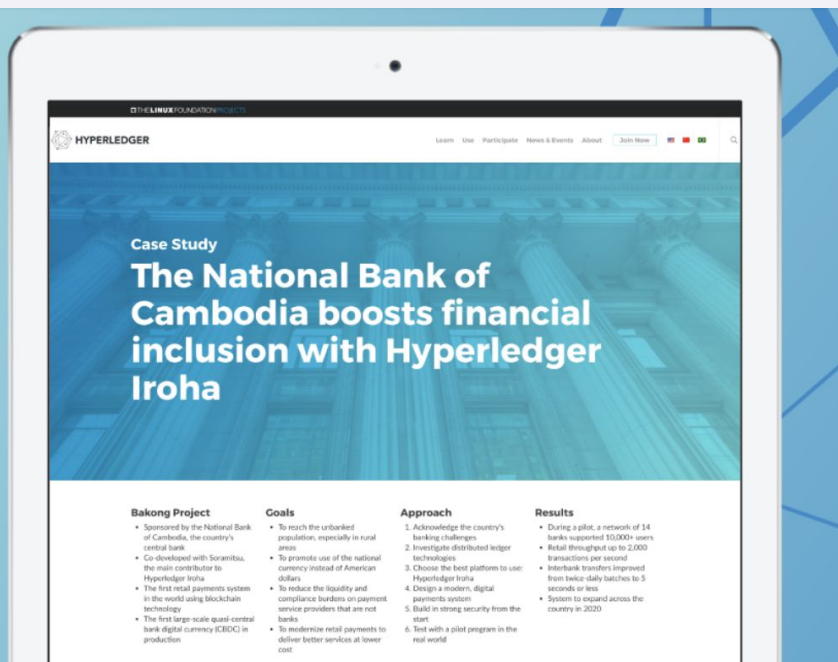
Please visit Soramitsu.co.jp for more information on blockchain-based CBDCs

Nigeria

The Central Bank of Nigeria launched a live CBDC in October 2021 on Hyperledger Fabric under the Project name "GIANT." Two applications were made available to citizens, the eNaira speed wallet and eNaira merchant wallet. By November 2021, there were already **600k app downloads** and **more than $1.2M USD minted** in late November 2021. The main objectives for launching a digital Naira were to improve the availability and access to central bank money, tax and revenue collection, support a resilient payments system, enable efficient welfare distribution, and facilitate remittances and cross border payments. **Read the white paper** for more information on the design and roadmap.
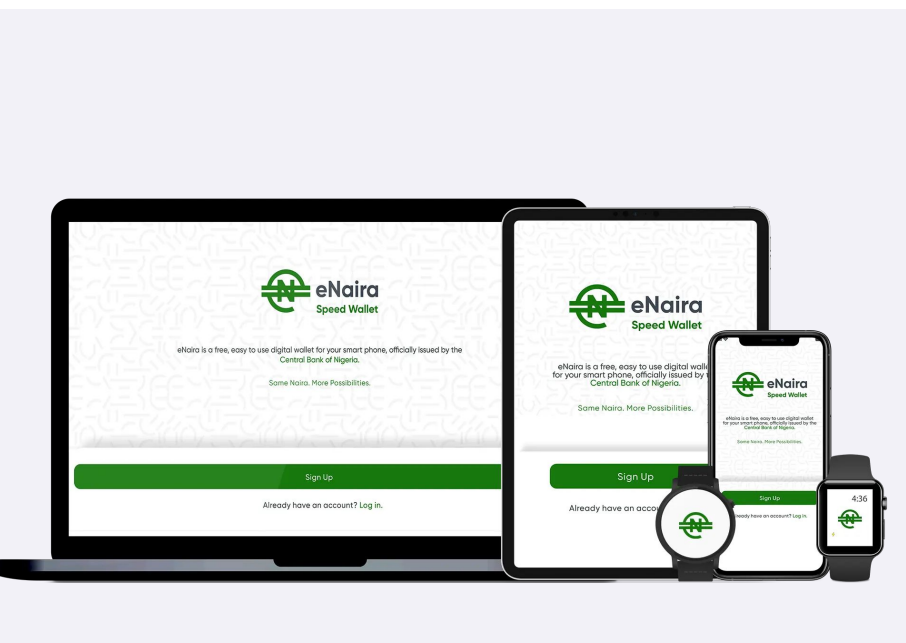
Image Copyright: eNaira

Spain

The Spanish financial sector completed the **Smart Money** experiment on the technical aspects of a digital euro's distribution, use, and design options. The initiative—led by Iberpay, 16 banks (CaixaBank, Santander, BBVA, ING, etc.), and with the Bank of Spain observing—aimed to test the technical features outlined in the European Central Bank's report for a digital euro. Using the **Red-i blockchain network, based on Hyperledger Besu**, Smart Money demonstrated the viability of a digital euro for the Spanish financial sector, including offline payments, and confirmed the two-tier infrastructure model as preferable over a centralized model. **Read the full report.**
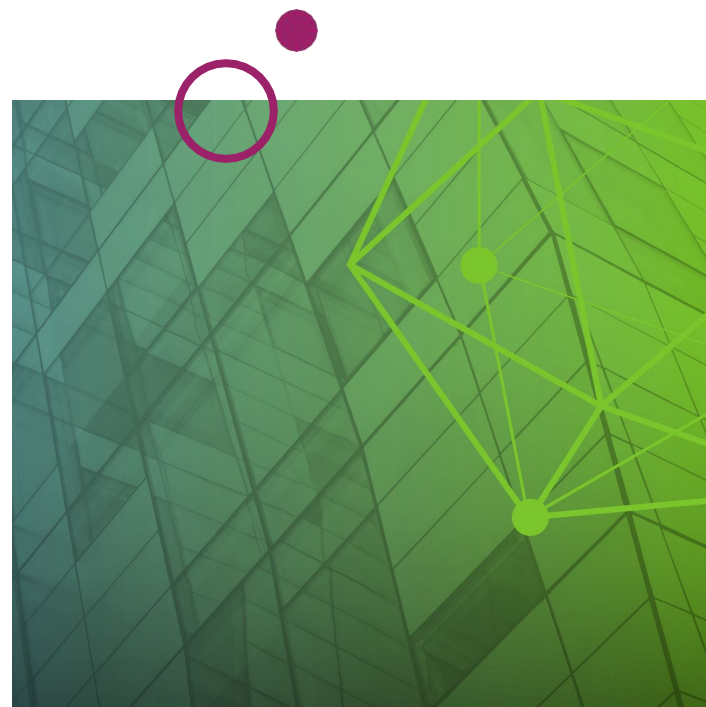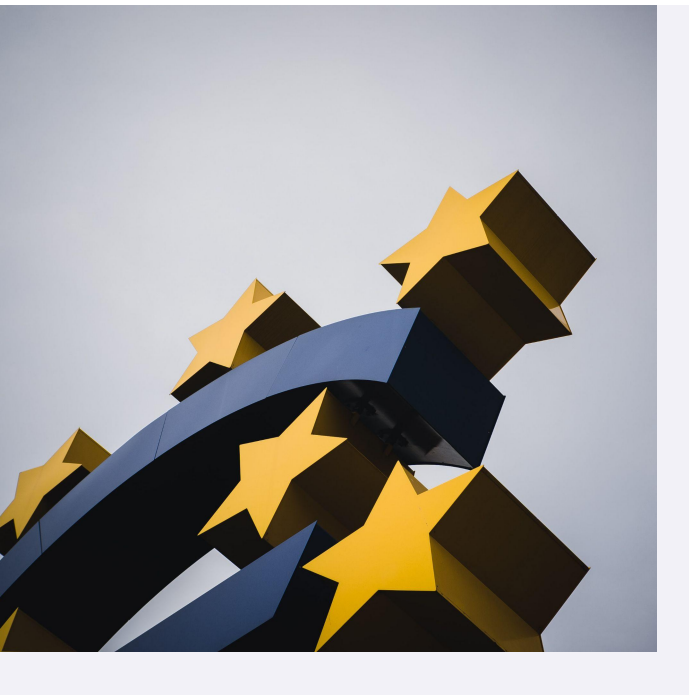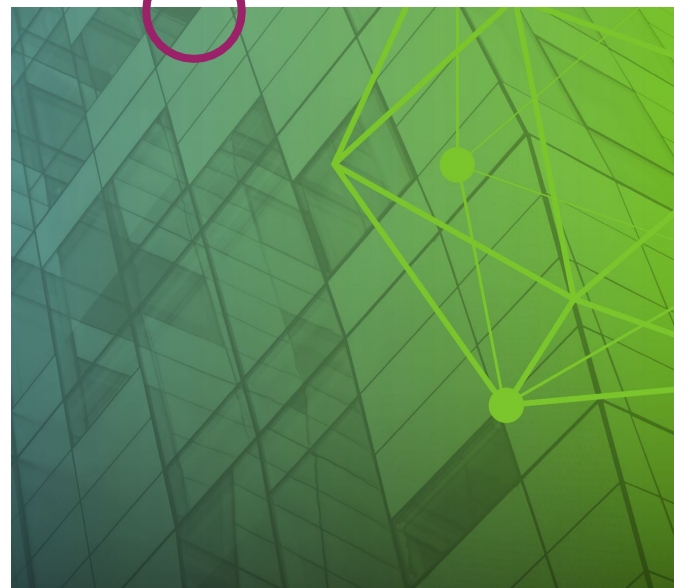
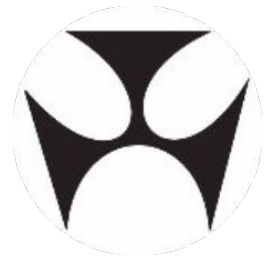**HYPERLEDGER BESU**

Photo by Mika Baumeister on Unsplash
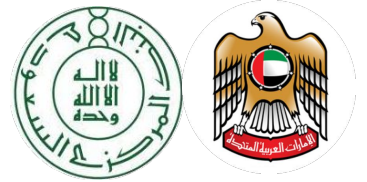
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Australia

Bank of Australia partnered with ConsenSys to develop a POC for the issuance of a tokenized form of CBDC that can be used by wholesale market participants for the funding, settlement, and repayment of a tokenized syndicated loan on a DLT platform. Built on Hyperledger Besu it showed that an "**enterprise-grade DLT platform with controls for access and security could address the requirements of a wholesale CBDC and tokenised assets platform**." Assistant Governor Michele Bullock said, 'Project Atom demonstrated the potential for a wholesale CBDC and asset tokenisation to improve efficiency, risk management and innovation in wholesale financial market transactions."

Photo by S O C I A L . C U T on Unsplash

Please visit consensys.net for more information on blockchain-based CBDC architectures.

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Saudi Arabia and U.A.E.

A **CBDC pilot using Hyperledger Fabric completed by** the central banks of Saudi Arabia and the United Arab Emirates (UAE) found that distributed ledger technology can improve cross-border transactions and meet the demands of financial privacy in a purely digital context. **In this report on Project Aber,** the two central banks outlined the lessons learned from a yearlong proof-of-concept meant to test the viability of a shared digital currency.


Image Copyright: Project Aber

Please visit IBM for more information on blockchain-based CBDC architectures.

Hyperledger Global Forum

Hyperledger Global Forum is the annual enterprise blockchain event for business and technology leaders.

In June 2021 at Hyperledger Global Forum (HGF), those on the front lines of CBDC deployments and the development of critical underlying platforms and technologies presented a mix of talks about requirements for and challenges of implementing current and future payment solutions.

Join us in Ireland Sept 12-13, 2022
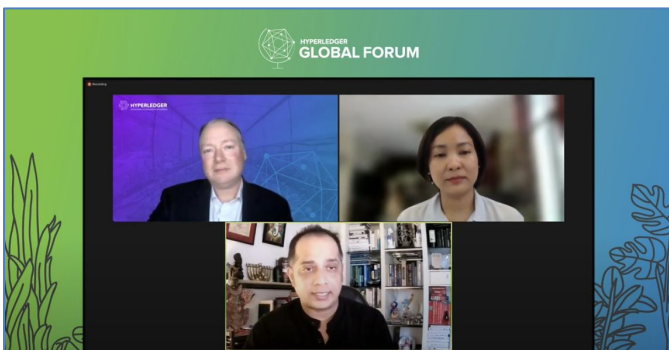
Keynote Panel: **Asia Pacific CBDC Innovation, Collaboration and the Drive to Interoperability** HE Serey Chea, National Bank of Cambodia (NBC); Sopnendu Mohanty, Monetary Authority of Singapore; Brian Behlendorf, Hyperledger.

Sessions on CBDCs:

- **Build CBDC Platform on Hyperledger Besu – Dive in Retail CBDC's Architecture –** Charles d'Haussy, ConsenSys
- **Lessons Learned Launching Bakong, a Hyperledger Iroha-based "synthetic CBDC"** - James Edwards, Soramitsu
- **Fireside Chat on Central Bank Digital Currencies –** Dave Treat & John Velissarios, Accenture; Jennifer Peve, DTCC
- **Panel: Hyperledger Contributions from IBM**
- **Digital Currency Interoperability With Messages –** Vipin Bharathan, dlt.nyc
- **Smart Contracts with Tokenized Fiat Currency on Sberbank's Platform** – Oleg Abdrashitov, Sberbank

Read more:
Hyperledger Global Forum Highlights: CBDCs, programmable money and interoperability – **Part I** and **Part II** recap blog post.

Additional Videos & Recordings

Hyperledger Capital Markets SIG Chair, Vipin Bharathan led a panel discussion on "**Addressing CBDC cross-border interoperability**" at the U.N. ITU DC^3 Conference - From Cryptocurrencies to CBDCs.

Hyperledger APAC Director Julian Gordon moderated the World Fintech Festival's "**How will CBDCs change the payments ecosystem?**" panel event.

Central Bank Digital Currencies: How Should Privacy Be Built In? Journalist Laura Shin moderated a panel for the 5th anniversary of Hyperledger featuring Rob Palatnick, managing director and global head of technology research and innovation at the DTCC and chairman of the Hyperledger Foundation board, Matthieu Saint Olive, Codefi payments product manager and CBDC advisor at ConsenSys, and Robert Bench, assistant vice president at the Federal Reserve Bank of Boston.

Jim Cunha, senior vice-president, secure payments and fintech of Hyperledger Foundation Member Federal Reserve of Boston, discusses the "**Boston Fed's CBDC Project**" as well as the wider impact of distributed ledger technology on the financial system.

Governance, standards and interoperability: Getting past the roadblocks to peer-to-peer financial transactions with IBM, ConsenSys and Soramitsu - discussing the use of Hyperledger technologies in wholesale and retail CBDC projects.

Hyperledger Director of Ecosystem, Karen Ottoni, speaks with Dante Disparte (Circle) and Philipp Sandner (Frankfurt School Blockchain Center) on the "**Adoption of stablecoins and the digital euro**" at the European Blockchain Convention.

Hyperledger Foundation Member Government of Bermuda **on CoinDesk Money Reimagined**
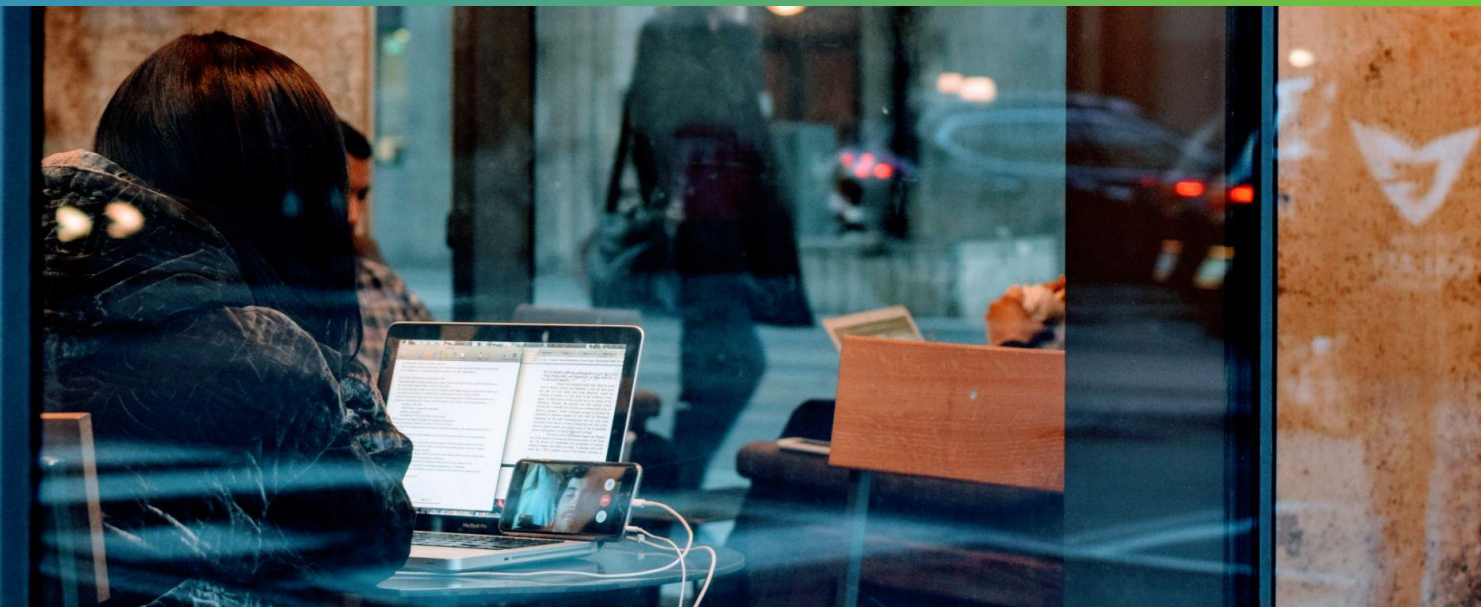
Additional Reading

- The Federal Reserve Bank of Boston and the Digital Currency Initiative at the Massachusetts Institute of Technology released the **findings of Project Hamilton**, which describes a theoretical high-performance and resilient transaction processor for a CBDC by developing open-source research software, **OpenCBDC**.
- Hyperledger team contributed to the **Digital Currency Governance Consortium White Paper Series**, which explores numerous critical topics related to CBDC and stablecoins, including an evaluation of their value proposition for the underserved, identification of key policy and regulatory actions, and discussion of salient technology considerations and trade-offs.
- **BIS report on Interoperability with m-CBDC Bridge**
- **BIS 2021 Survey on CBDCs**

- **The Digital Dollar Project Exploring a US CBDC** - May 2020 Accenture paper
- **Central banks and BIS publish first central bank digital currency (CBDC)** report laying out key requirements
- Trackers:
    - **Atlantic Council CBDC Tracker**
    - **Kiffmeister Wholesale CBDC Tracker**
    - **Kiffmeister Retail CBDC Tracker**
    - **BCG CBDC Tracker**
- **Design Choices of CBDCs from Atlantic GeoTech Center**
- Board of Governors of the Federal Reserve System release paper on pros and cons of a US CBDC "**Money and Payments: The U.S. Dollar in the Age of Digital Transformation**"
- **OMFIF Retail CBDCs: The next payments frontier**

Photo by Mark Boss on Unsplash

About the Authors

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Daniela Barbosa serves as General Manager Blockchain, Healthcare and Identity at the Linux Foundation with overall strategic and operational responsibility for staff, programs, expansion and execution of Hyperledger Foundation's mission.

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Karen Ottoni

Director of Ecosystem,
Hyperledger Foundation,
CBDC Initiative Lead

Karen Ottoni supports the diverse ecosystem of innovative companies implementing enterprise blockchain in various industries. She leads in promoting best practices and examples of how digital assets can improve financial systems.

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Thank You

Join us in our journey to build enterprise
blockchain ecosystems through global,
open source collaboration.

JOIN US

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