Project Garuda: Navigating the Architecture
of Digital Rupiah

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PROJECT
GARUDA

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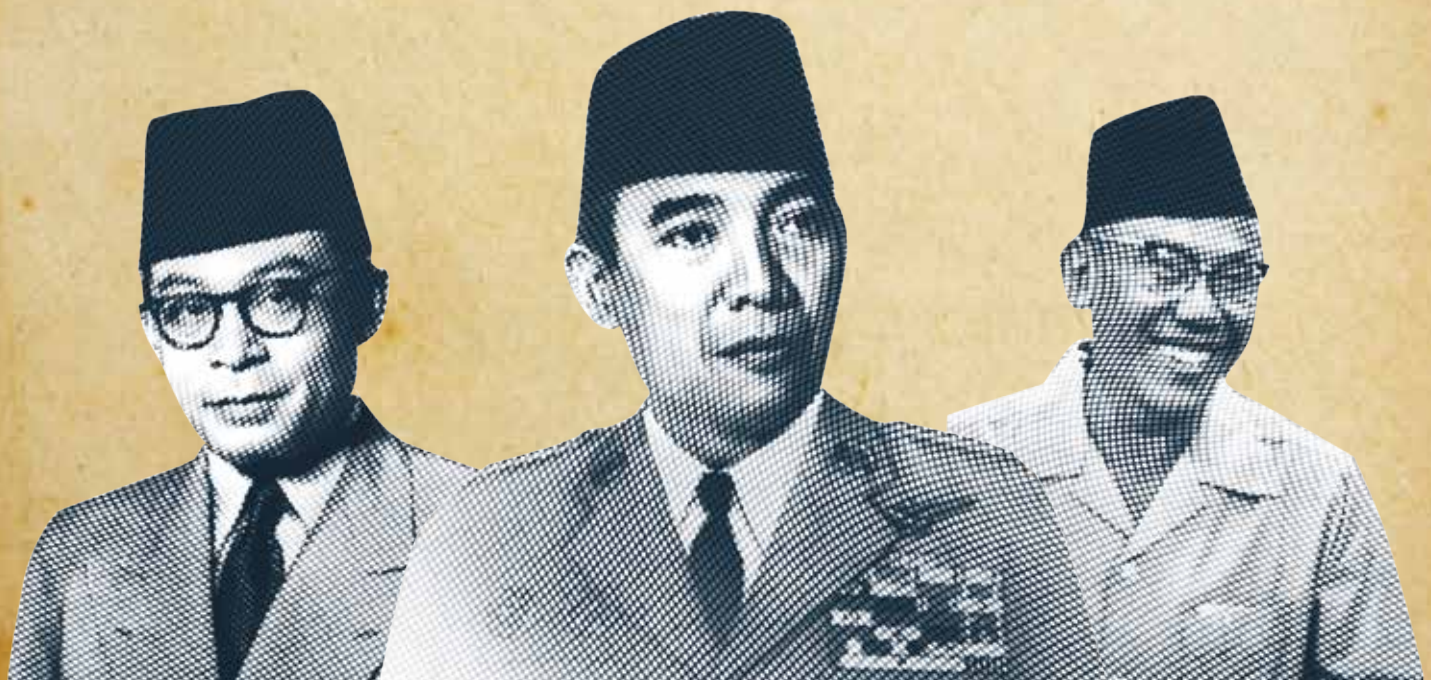
A Dream Of Having Our Own Currency

Upon their independence, Indonesians grew a strong will and determination to establish their own central bank and currency. In a meeting with Mohammad Hatta and Soekarno circa September to October 1945, Sjafruddin Prawiranegara (the first Governor of Bank Indonesia) advocated for the Republic to have its own currency. Initially hesitant, Bung Hatta agreed upon realizing that a currency does not merely function as a medium of exchange or legal tender, but also as a fundamental attribute of a free nation's sovereignty.



Tomorrow, 30 October 1946,
will be a historic day for our nation. Our people are about to embark on a new chapter in their lives. Tomorrow, we will have "Oeang Republik Indonesia" (Republic of Indonesia's currency) being circulated as the sole legal tender. Effective at 12 o'clock midnight tonight, the Japanese currency that has been circulating until now will no longer be legitimate to be used. Together with the Japanese currency, the usage Oeang De Javasche Bank will also be annulled. This signifies the end of an old chapter in the Republic of Indonesia financial history, a chapter full of that calamity and hardship for our people.

Mohammad Hatta

Proclaimer of Independence
First Vice President of the Republic of Indonesia

For the Sovereignty of the Republic of Indonesia

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ABBREVIATIONS

3i	Integration, Interoperability, and Interconnection
AML/CFT	Anti-Money Laundering and Combating the Financing of Terrorism
API	Application Programming Interface
BdF	Banque de France
BI-APS	Bank Indonesia Auction Platform System
BI-ETP	Bank Indonesia Electronic Trading Platform
BI-FAST	Bank Indonesia Fast Payment Systems
BI-RTGS	Bank Indonesia Real Time Gross Settlement
BI-SSSS	Bank Indonesia Scripless Securities Settlement System
BIS	Bank for International Settlements
BISIH	Bank for International Settlement Innovation Hub
BNM	Bank Negara Malaysia
BoT	Bank of Thailand
CBDC	Central Bank Digital Currency
CBUAE	Central Bank of the United Arab Emirates
CCP	Central Counterparty
Bappebti	Commodity Futures Trading Authority
CSD	Central Securities Depository
DeFi	Decentralized Finance
DLT	Distributed Ledger Technology
DNDF	Domestic Non-Deliverable Forward
DvP	Delivery versus Payment
e-money	Electronic Money
FGD	Focus Group Discussions
FMI	Financial Market Infrastructure
FSB	Financial Stability Board
G20	Group of Twenty
G2P	Government to Person
HKMA	Hong Kong Monetary Authority
IMF	International Monetary Fund
IPSB	Indonesia Payment Systems Blueprint
KDR	Digital Rupiah Depository
KYC	Know Your Customer
MAS	Monetary Authority of Singapore
MSMEs	Micro, Small and Medium Enterprises
P2G	Person to Government
PADG	Regulation of the Member of the Board of Governors
PBI	Bank Indonesia Regulations
PBoC DCI	Digital Currency Institute of the People's Bank of China
PFMI	Principles for Financial Market Infrastructures
PSP	Payment Service Providers
QR Code	Quick Response Code
QRIS	Quick Response Code Indonesian Standard
RBA	Reserve Bank of Australia
r-CBDC	Retail CBDC
r-Digital Rupiah	Retail Digital Rupiah
SARB	South African Reserve Bank
SDK	Software Development Kit
SNAP	National Open API Payment Standard
SNB	Swiss National Bank
SSS	Securities Settlement System
Suptech	Supervisory Technology
w-CBDC	Wholesale CBDC
w-Digital Rupiah	Wholesale Digital Rupiah

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PREFACE

Assalamu'alaikum Warahmatullahi Wabarakaatuh, May peace be upon us all, Shalom, Om swastiastu, Namo buddhaya, Greeting of virtue,

The future of the central bank is at a crossroads. Digital innovations may not only disrupt the banking system, but on a more pervasive scale, the possible disruptions on official currencies and central banking triggered by the advent of 'stablecoins and unbacked crypto assets'.

Technological innovations and shifts in economic agents' behavior are key drivers behind this dynamic. Advances in technology, especially Web 3.0 and Distributed Ledger Technology will further escalate massive development of unbacked crypto assets and stablecoins along with all the opportunities and risks they might bring. On one hand, this phenomenon has all the potential to increase financial inclusion and improve the efficiency of the financial system, including cross-border payments, and to lay foundations for decentralized finance that offers instant access to various financial products. On the other hand, this technological breakthrough, specifically stablecoins and unbacked crypto assets, might escalate the risk of money laundering and terrorism financing, and in many cases, macrofinancial risk in the form of shadow currency and shadow banking that undermine the effectiveness of central bank policy. Some experts even believe that globally operated stablecoins and unbacked crypto assets ecosystems may continue to grow and may eventually establish a Digital Currency Area that disregards central bank roles and subsequently exerts pressures on international monetary system on a more global scale.

Needless to say, central banking community will not just sit it out and do nothing. Nor will Bank Indonesia. In response to this unfolding event, the central banks will adjust their policies by deliberating over the issuance of central bank digital currency (CBDC) as a prospective future-proof solution. Coupled with this initiative, under the 2022 Indonesian Presidency of G20, the central banks of G20 together with international financial organizations acknowledge this crucial dynamic and endeavor to formulate regulations and supervision against unbacked crypto assets and stablecoins by emphasizing the principle of "same activity, same risk, same regulation".

However, the issuance of CBDC is by no means an easy task. Central banks need to prudently contemplate on CBDC design feature by balancing the benefits with its associated risk. There are three things that need to be considered by central bank in developing CBDC. Firstly, the design for CBDC needs to take into account public interest and central bank roles. This includes the choice between retail CBDC which will affect general public in their daily activities and wholesale CBDC for selected entities which will function as the basis for retail CBDC development as well. Secondly, CBDC's role in supporting financial inclusion, especially for Emerging Markets and Developing Economies (EMDE) through certain features such as offline functionality, low transaction cost, and capabilities in reaping the benefits from data granularity. This role will complement the initiatives for payment system digitalization that has been implemented recently, including QR standardization and open API for payment and the development of fast payment system. Thirdly, CBDC's ability to meet interconnectivity, interoperability, and integration (3i) aspects with existing payment systems (including in cross border contexts) and other financial market infrastructures.

In this regard, Bank Indonesia will develop CBDC as inspired by three key drivers. Firstly, Bank Indonesia will be the sole institution with legal privilege to issue Rupiah currency in Indonesia as mandated by the law. Secondly, the need to continuously promote digital transformation agenda which includes the conduct of Bank Indonesia's classic function in money circulation amidst the wave of decentralization in digital economy and finance. Thirdly, the need to arrange infrastructures for cross border payment to enable trade and international finance in digital era.

"The future is here." Through this white paper, Bank Indonesia is exploring the opportunity to issue Indonesian CBDC titled "Digital Rupiah" under the umbrella of "Project Garuda" as a means to ponder optimal CBDC design for the nation. It is a contribution brought by Bank Indonesia to the nation in a struggle to safeguard Rupiah sovereignty in the digital era. Confidently, endeavor may lead Indonesia to a brighter future.

Wassalamu 'alaikum Warahmatullahi Wabarakaatuh

Perry Warjiyo

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EXECUTIVE SUMMARY

- **The outbreak of the COVID-19 pandemic in the last couple of years has accelerated digital transformation that has been underway for decades.** Economic interactions are increasingly shifting towards online, driven by social distancing restrictions. Furthermore, the pandemic has advanced the adoption of crypto assets, including their derivatives such as DeFi and Metaverse, triggering a phenomenon of what so called "cryptoization". Digital disruption is no longer limited to shadow banking issues, it has also infiltrated to what so called "shadow currency" and "shadow central banking".
- **This situation forces central bank community, including Bank Indonesia, to recalibrate their approaches and policies.** Digital transformation originateding only from digitalization of payments systems, is no longer adequate. Within the perspective of public policy objectives, the solution would need to be expanded to cover the efforts to widen public access to the digital form of trusted money. Aside from meeting public demands for fast, easy, low cost, safe, and reliable means of payments, it is also needed by the central banks to meet their mandates in the digital era.
- **Central bank digital currency (CBDC) emerges as a future-proof solution.** It is seen to be a suitable tool to bridge the need to fulfill public demand with hundred years old central bank's role in sustaining a well-functioning financial system which set central banks at the center of it. CBDC fills the gap left by existing money by acting as the core instrument for central banks to maintain monetary and financial system stability within digital ecosystem.
- **However, the issuance of CBDC is by no means an easy task.** Deliberate plan and careful design is necessary to prevent CBDC from being counterproductive to the economy. At the very least, central banks need to take into account three principles in planning the issuance of CBDC, i.e.,

CBDC should not harm central bank policy mandate in monetary and macroprudential domains ("do no harm" principle), CBDC has to be able to coexist with other forms of money ("coexistence" principle), and CBDC should prompt more innovations and efficiencies.

- **This rationale paves the way for Bank Indonesia to launch "Project Garuda".** It harbors the initiatives to explore the plan and design of Indonesian CBDC which will be called Digital Rupiah. As an idea, this project reflects the needs of Bank Indonesia to; (i) address the rapid change in digital economy and finance with regards to its position as the sole authority for issuing legal tender in the Republic of Indonesia; (ii) strengthen its position in the global stage; and (iii) accelerate the integration of digital economy and finance. This project aims to result in the design for Digital Rupiah that is able to carry out its functions as; (i) the legal digital means of payment in the Republic of Indonesia; (ii) the core instrument for Bank Indonesia to conduct its legal mandate in digital era; and (iii) as a means to support financial inclusion and innovations as well as promote end-to-end efficiency.

- **Digital Rupiah is an integrated end-to-end configuration.** Digital Rupiah is a liability of Bank Indonesia to its user issued in digital format. It will be issued in two types, i.e., wholesale Digital Rupiah (w-Digital Rupiah) with a limited scope of access serving wholesale transactions and retail Digital Rupiah (r-Digital Rupiah) with an open scope of access serving retail transactions. It would possess an end-to-end business model which meets the 3i requirements (integration, interoperability, and interconnectivity) between w-Digital Rupiah and as r-Digital Rupiah platform, across traditional financial market infrastructures, and in terms of cross border interoperability.

- **Digital Rupiah will be built upon an agile design feature enabling new, innovative, and inclusive business models to grow on top of it**. Digital Rupiah will be equipped with features which ensure resiliency in the context of safety and availability, for instance offline functionality which will benefit wider access as well as financial inclusion in disadvantaged regions.[1] Digital Rupiah will also be supplemented with programmability features (e.g., smart contracts) which may further financial developments. Tokenization of tradable securities will also be implemented under the Digital Rupiah platform to create opportunities for market deepening.

- **The Digital Rupiah technology architecture will consist of three layers to realize this business model i.e., the technology platform, digital asset, and use case.** The technology platform layer includes various supporting features, such as smart contracts, identity services, regulatory services, cryptography, application programming interface (API), and sandboxing. The digital asset layer contains various digital assets managed by Bank Indonesia, primarily Digital Rupiah

1. Bank Indonesia might have an option to execute one-tier r-Digital Rupiah distribution scheme to regions that are not adequately served by the private sector.

and Digital Securities. Finally, the use case layer has functions and services that leverage the digital asset layer. This layer also includes use cases owned by Bank Indonesia as well as third parties.

- **To be effective, the implementation of Digital Rupiah will be enabled by appropriate regulations and policies**. Associated regulations and policies will be assessed iteratively from monetary, macroprudential, market deepening, and legal perspectives and simultaneously with the design planning. This includes aspects such as the use of Digital Rupiah as the settlement asset for monetary operations or for money market, intermediation issue, procyclicality issue, operational risk management, customer protection, privacy and data protection, and financial integrity i.e., AML/CFT compliance.

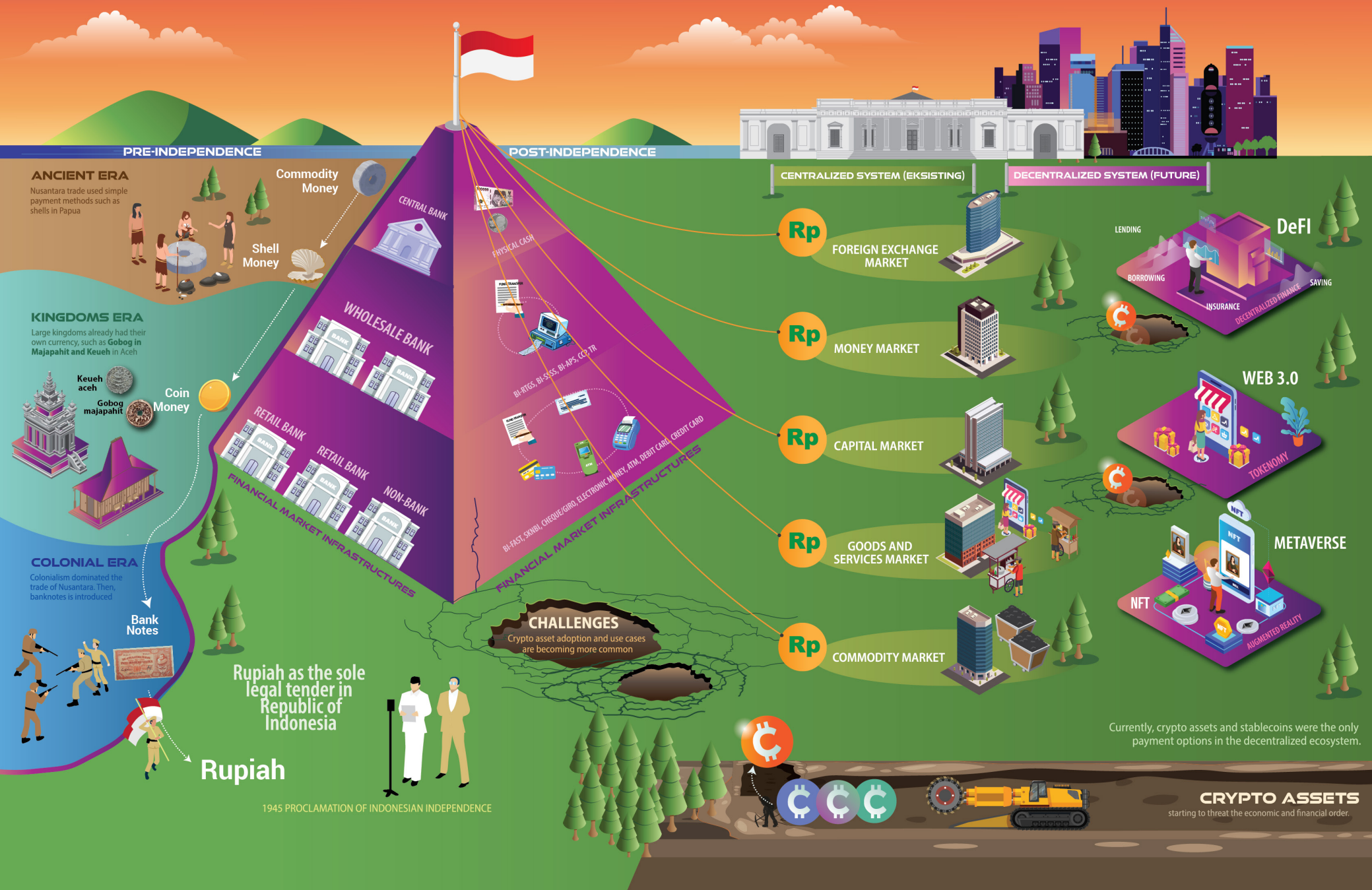
- **At the implementation stage, Digital Rupiah would be developed gradually in an iterative process**. There will be 3 (three) phases of development. At phase 1 (immediate phase), issuance, redemption, and transference use cases of w-Digital Rupiah experimentation will be commenced. At the next phase (intermediate phase), w-Digital Rupiah use cases will be expanded to include more diverse financial market transactions. Lastly, at the final phase (end state), the concept of integrated end-to-end w-CBDC and r-CBDC will be tested. This approach enables the investigation of various design options to ensure the achievement of optimal solution.

- **Considering its outreaching impacts, Project Garuda could be seen as a national scale initiative which should be conducted in synergy.** To that end, collaboration among various stakeholders, e.g., financial authority, ministry and government agencies, and industry is a key success factor for the project. At the same token, synergy with global central bank community and international organizations is also pivotal to ensure its alignment with various initiatives in promoting cross border payment interoperability.

- **This report elaborates the high-level design for Digital Rupiah under the hood of Project Garuda.** The project complements the preceding Bank Indonesia initiatives to spur national digital transformation agenda i.e., the Blueprint for Indonesian Payment System (IPSB) 2025 and Blueprint for Money Market Development 2025. Those initiatives will mutually support the objective to achieve an integrated end-to-end national digital economy and finance. Digital Rupiah is expected to become central bank money offering superior qualities i.e., stable, safe, and efficient and yet stay relevant to overcome various challenges in the digital era.

THE RUPIAH AS A SYMBOL OF NATIONAL SOVEREIGNTY

Rupiah currency preserves a long narrative of Nusantara's struggle since ancient times to the era of independence …



CHAPTER 1
RATIONALE

"A system grounded in central bank money offers a sounder basis for innovation, ensuring that services are stable and interoperable, domestically and across borders. Such a system can sustain a virtuous circle of trust and adaptability through network effects" (BIS, 2022)

Digitalization of economy and finance continues to persist during the pandemic. This creates challenges as well as opportunities. Digital disruptions will bring about quandaries that lead to shadow banking, shadow currency, and even shadow central banking. Evidently, the endeavor to promote economic and financial stability is becoming more challenging and this forces central banks, including Bank Indonesia, to recalibrate its approaches and policies. The implementation of Digital Rupiah is a constructive policy response from Bank Indonesia with its commitment to public interest and at the same time is an act to meet the mandate of central bank in digital era.

1.1 STRATEGIC ENVIRONMENT

Digitization of economy and finance shifts people's preferences towards faster, easier, cheaper, safer, and more reliable financial services. This phenomenon occurs globally, including in Indonesia, sustained by favorable a demographic structure. Indonesia has emerged as a potential digital market with a predominantly young population. By 2022, more than 70% of the population will be in the 15-64 years age group (BPS, 2022). Furthermore, basic infrastructure such as electricity, high-speed internet, and mobile phones are becoming more and more widely accessible. Indonesia occurs as the fourth-largest mobile cellular penetration in the world (Table 1).

During the COVID-19 pandemic, the shift in preferences has intensified. A study by Google, Temasek, and Bain (2021) found a significant increase in digital economic and financial activity in Indonesia. New digital consumers increased

Table 1. Digital Penetration in Indonesia 2022

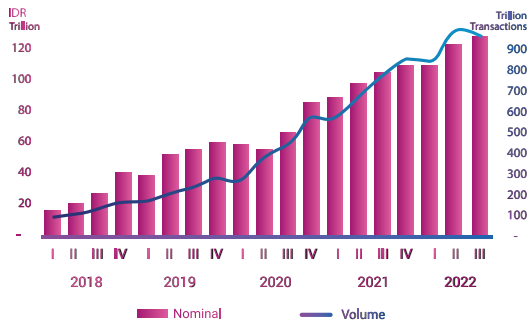
Populations (in million)	Mobile Customers 370.1 Million Penetration: 133%	Internet Users 204.7 Million Penetration: 74%	Active Social Media Users 191.4 Million Penetration: 69%
World 7,983	67%	63%	59%
Turkey 85.3	91%	82%	81%
Malaysia 32.98	128%	90%	92%
Thailand 70.01	137%	78%	81%
Philippines 111.8	140%	68%	82%
India 1,400	81%	47%	33%
Indonesia 277.7	133%	74%	69%

Source: WeAreSocial, DataReportal

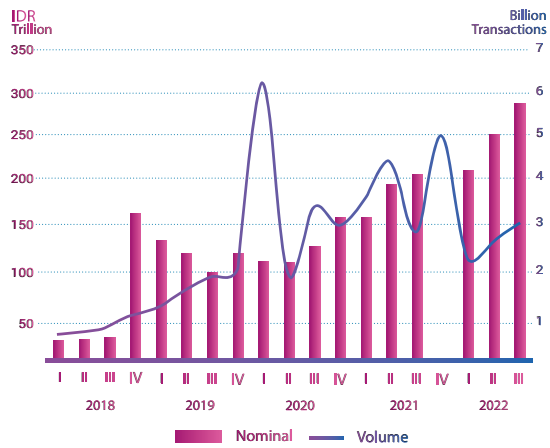
by 21 million with internet penetration rate reaching 74% of the population. This has heralded a new equilibrium for financial services in the digital era.

The demand profile is responded with agility on the supply side. In Indonesia, approximately 98% of merchants have used digital payments, 59% of which utilize digital financing (Google, Temasek, dan Bain, 2021). Fintech and e-commerce gain

Graph 1. The Growth of E-Commerce Transaction



Graph 2. The Growth of E-Money Transaction



their popularity through their innovative consumer centric solutions. They record positive growth (Graph 1 and Graph 2) which is predicted to sustain supported by both domestic and foreign funding.

However, digitalization also poses risks. These include shadow banking, cyber, fraud, money laundering and terrorism financing, unhealthy competition, and consumer data misuse. Moreover, their borderless characteristic would complicate law enforcement and efforts to safeguard national interests. Consequently, the aforementioned risks pose a threat to the implementation of central bank mandate in preserving monetary stability, financial system stability, and the smooth functioning of payment systems and thus economic sustainability (Bank Indonesia, 2019).

Responding to the dynamics, Bank Indonesia released Indonesia Payment Systems Blueprint 2025 (IPSB 2025) in November 2019. The blueprint is oriented toward navigating the digital economic and financial development in Indonesia. Five visions have been established which were then translated into five key initiatives as the end-state of the blueprint.

> ***...Digitalization of economy and finance also poses risks, such as shadow banking, cyber, fraud, money laundering and terrorism financing, unhealthy competition, and consumer data misuse..***

Entering the third year of IPSB 2025 implementation, payment systems digitization has been accelerated. As of October 2022, the Quick Response Code Indonesian Standard (QRIS) has successfully facilitated payments for 25.2 million users and 21.6 million merchants (Graph 3), more than 90% of which are Micro, Small and Medium Enterprises (MSMEs). Similarly, Bank Indonesia's Fast Payment system (BI-FAST) has also succeeded in driving fair competition and efficiency by cutting transfer fees by up to 60%, followed by wider accessibility which will benefit consumers. Furthermore, Bank Indonesia also took regulatory reforms along other milestones (see Box 1).

BOX 1
IPSB 2025 MILESTONES

Since its publication in 2019, IPSB 2025 has achieved several key milestones.

Regulatory Reform.
Bank Indonesia issued a number of Bank Indonesia Regulations (PBI)[2] alongside its detailed provision[3] to strengthen the whole Indonesian payment system ecosystem and to thrive fair business practices through collaboration with industry.

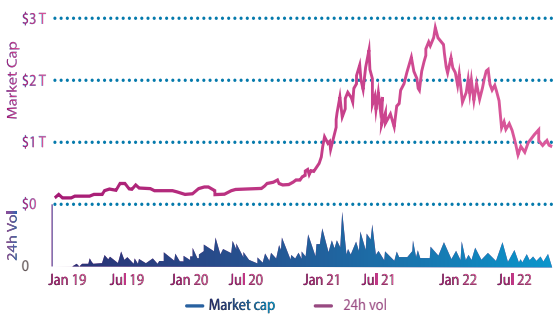
Payment System Infrastructure Development.
On this front, Bank Indonesia launched BI-FAST on December 21, 2021, as an instant retail payment system infrastructure which is efficient, secure and available 24/7. It is equipped with an affordable price scheme of Rp19 per transaction charged by Bank Indonesia to BI-FAST participants and a maximum of Rp2,500 per transaction charged by participants to users.

Standardization.
On August 17, 2019, Bank Indonesia launched a national standard for Quick Responses Code (QR Code) for Payments, or QRIS (implemented on January 1, 2020). The initiative was subsequently expanded through a cross-border QR Code collaboration with Thailand, Malaysia and Singapore. Cross border QR interoperability with Thailand has been implemented on 29 August 2022. Bank Indonesia also developed the National Standard Open Application Programming Interface (API) for Payments (SNAP) on July 1, 2022.

2. Bank Indonesia Regulation (PBI) No. 22/23/PBI/2020 concerning Payment Systems, PBI No. 23/6/PBI/2021 concerning Payment Service Providers and PBI No. 23/7/PBI/2021 concerning Payment Infrastructure Operators, and PBI No. 23/6/PBI/2021 concerning the National Standard for Payment System.
3. Member of the Board of Governor (PADG) No. 24/7/PADG/2022 concerning Payment System Operation by Payment Service Providers and Payment Infrastructure Operators, Internal PADG No. 24/7/PADG/2022 concerning Procedures for Determining the Classification of Payment Service Providers and Payment System Infrastructure Operators.

The adoption of crypto assets is increasing rapidly throughout the world leading to a phenomenon of so called cryptoization[5]. Based on data from Coinmarketcap, total market capitalization of crypto assets reached almost $3 trillion (Graph 4). The surge was particularly observed in the first two years of the pandemic whereby the market capitalization of crypto assets skyrocketed to 1,393.2% on November 10, 2021, compared to its position on December 31, 2019.

Graph 4. The Growth of Global Crypto Asset Market Capitalization

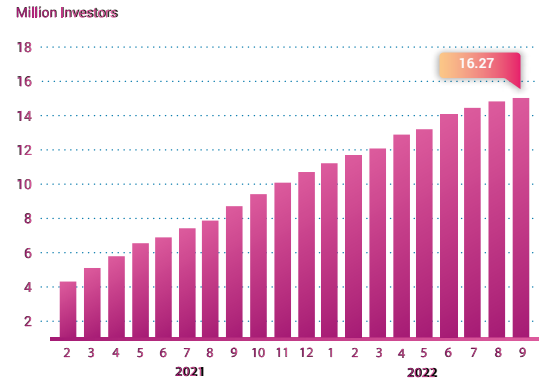


Source : Coinmarketcap (2022)

A similar development is also found in Indonesia. Based on Indonesian Commodity Futures Trading Authority (Bappebti) data, the number of crypto asset investors in Indonesia as of September 2022 reached 16.3 million, a significant growth of 81.6% (yoy) (Graph 5). The transaction value of the four largest crypto asset traders in Indonesia (Indodax, Tokocrypto, Luno and Zipmex) in March 2022 was recorded at Rp 38.3 trillion (Bank Indonesia, 2022).

Despite those benefits, various associated risks need to be considered. Those risks include risk to consumer protection,

Graph 5. The Growth of Crypto Asset Investors



Sumber : CoFTRA

disruption to the incumbents, as well as macro-financial risks that reduce the authority's control over monetary and financial system stability. The recent crypto winter[6] demonstrate how fragile crypto asset business model is. In fact, transaction fees went higher as the number of users grows.[7]

> ***...Adoption of crypto assets is increasing rapidly throughout the world (cryptoization), also in Indonesia. Despite those benefits, various associated risks need to be considered..***

1.2 DIGITAL RUPIAH RATIONALITY

1.2.1 CONSIDERATION

Money is the blood of the economy. Public confidence in money affects the entire economy and financial system. The elucidation of Article 23 of the 1945 Constitution of the Republic of Indonesia emphasizes the importance of money as a medium of exchange,

5. Cryptoization is a condition in which the use of crypto assets by residents are widespreading and the adoption is more rapid as compare to official local currency.
6. For example the fall of Terra (LUNA) and TerraUSD (UST) coin values on May 2022.
7. The variability of transaction fees in the crypto ecosystem is reflected in the mechanism for imposing a gas fee which is nothing but a transaction fee charged as compensation to validators (Aramonte et.al, 2021). The amount of the fee is positively correlated with transaction queues that are validated simultaneously.

store of value, and unit of account. Trusted money is generally accepted as a common unit of account, has a stable value, and is able to act as an efficient and safe means of payment. Within this context, trusted money fulfills the key element of public goods.

The issuance and circulation of trusted money has become a classic function of central banks (BIS, 2022; BIS, 2020; Roberds and Velde, 2014) including Bank Indonesia.[8] The central bank is the sole authority to issue trusted money, which is then known as the central bank money[9]. Central bank money is the monetary obligation of the central bank. In addition to the central bank, commercial banks and the private non-bank sector[10] are also issuers of money (private money). Different from private money, central bank money has the lowest credit risk as it offers the highest certainty in the settlement for its users (CPSS-IOSCO, 2012).

Central bank money serves as a means of payment that forms the basis for the money supply process as well as an instrument for implementing monetary and macroprudential policies. Central bank money plays an instrumental role for the central bank to carry out its public policy objectives in providing the safest means of payment to the general public, businesses, and banks (BIS, 2022). Through this function, the central bank seeks to meet the transaction needs of the public, while at the same time controlling the behavior of economic agents, including the creation and circulation of money by parties outside the central bank, in order to maintain monetary stability and financial system stability (Blinder, 2010; Goodhart, 2010).

The central bank also provides infrastructure for commercial bank money and private non-bank money. This strategy is manifested through; first, services to commercial banks to complete interbank transactions using central bank money; second, the means for convertibility between private money and central bank money through the provision of paper money and coins as anchors; and third, providing contingent liquidity through the lender of the last resort function (BIS, 2020). Central bank money acts as an anchor for the monetary system that provides confidence for private money. Financial institutions would be able to convert private money into central bank money at the same amount through liquidation of liabilities, financial transactions with other financial institutions or through their accounts at the central bank (Warjiyo and Juhro, 2019).

Issues arise when general public do not yet have an option for digital form of trusted money. Currently, central bank issues physical cash (notes and coins) and reserves account. In contrast to access for physical cash, access for reserves account is limited to selected parties, such as banks. In contrary, existing electronic payment instruments e.g., e-money and card-based instrument are private money.

8. The legal basis for the existence of a central bank is laid down in the Fourth Amendment of Article 23D of the Constitution (UUD 1945). The legal basis is further clarified in Act No. 23 of 1999 as amended several times, most recently by Act No. 6 of 2009 concerning Bank Indonesia ("Bank Indonesia Law") which gives a mandate to Bank Indonesia as the central bank of the Republic of Indonesia, one of which is to regulate and maintain smooth payment system.
9. Money in CPSS-IOSCO (2012) is defined as settlement asset.
10. Money issued by commercial banks is known as commercial bank money and money issued by private non-banks is known as private non-bank money.

The diversity of crypto asset activities as mentioned earlier, triggers new type of risk of what so called "shadow currency" and "shadow central banking". Crypto asset creation, issuance, transference and management process take place outside the formal monetary system in which their global use could escalate to so called digital currency area as laid out by Brunnermeier et al (2019). A country's monetary sovereignty could be at risk should the risk be materialized.

Activities within Web 3.0 ecosystem, including crypto asset transactions, also add to the complexity of controlling financial systems, both in the context of mitigating micro-financial and macro-financial risks. In many cases, some of their activities may fall outside of traditional regulatory perimeter. This is mostly due to unclear legal status, especially associated with the legal clarity of the existence of legal entities which will be held responsible for those activities. Problems arise when the existing central bank money or commercial bank money are not a compatible means to be used in the ecosystem.

> ***... Central banks would need to find a future-proof solution to maintain public trust toward them in carrying out their mandate in the digital era..***

Central banks would need to find a future-proof solution to maintain public in them with regards to carrying out their mandate in the digital era. The solution in question has three main elements: first, fulfilling public's need for a risk-free medium of exchange accessible in digital form; second, maintaining monetary sovereignty; and third, ensuring the effectiveness of the implementation of the central bank's mandate in maintaining monetary stability, financial system stability, and payment system efficiency and security. Hence, it is important for central banks to consider issuing widely accessible trusted digital money.

Central Bank Digital Currency (CBDC) emerged as a prospective solution to address these challenges. CBDC is a new form of central bank money which is also a liability of the central bank and has the same denomination as the legal tender. Moreover, it can be used as a medium of exchange, unit of account, or store of value. Its adoption would be optimally achieved through the use of a currency that runs natively[11] within the ecosystem.

Central bank community and various international organizations are intensively exploring the solutions to respond the development of digital currencies. The Group of Twenty (G20) Saudi Arabia presidency (2020), Italy (2021),

11. *Digital native indicates that CBDC is only available in digital form and does not represent physical form.*

1.2.2 DIGITAL RUPIAH AND THE PROJECT GARUDA

The aforementioned issues prompted Bank Indonesia to recalibrate its policy approaches to digitalization. Shifts in public preferences has driven Bank Indonesia to examine the possibility of issuing widely accessible trusted digital money as a means of payment. The escalation of shadow banking, shadow currency, and shadow central banking risks require Bank Indonesia to find a solution which safeguards Rupiah's status as the sole currency of the Republic of Indonesia in the digital era. In addition, wider adoption of digital economy and finance activities require Bank Indonesia to develop a payment instrument capable of delivering Bank Indonesia's policy implementation in digital ecosystem.

Digital Rupiah is expected to emerge as a future proof solution. It is expected to emerge as a future proof solution for Bank Indonesia to fulfill its public policy objectives in digital era. With Digital Rupiah, public will have access to risk-free digital money denominated in Rupiah. At the same token, Bank Indonesia could maintain its service level to the public in the digital era while maintaining public confidence in Rupiah currency.

Digital Rupiah is expected to be more secure and efficient compared to cash and reserve accounts. With these qualities, Digital Rupiah will be able to emerge a more effective core instrument for Bank Indonesia in maintaining monetary and financial system stability in the digital era.[13]

> ***... Digital Rupiah is expected to emerge as a future proof solution. The "Garuda Project" covers various exploration for Digital Rupiah architectural design options..***

With Digital Rupiah, Bank Indonesia also aims at strengthening payment resiliency. Digital Rupiah would add to diversity of national payment instruments which guarantee public's ability to conduct transactions in every single situation. Digital Rupiah will complement the existing money being commonly used by the public, including physical cash. The task of Bank Indonesia in this regard is to respond to public demand and preferences. With the development of Digital Rupiah, Bank Indonesia aims at fulfilling public demand on fast, easy, cheap, safe and reliable Rupiah currency in the digital era.

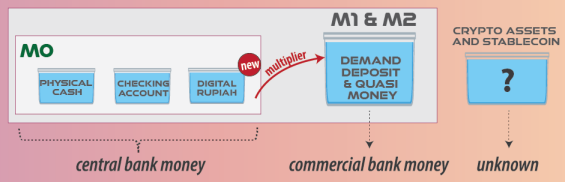
The "Garuda Project" covers various exploration for Digital Rupiah architectural design options. This project is Bank Indonesia strategic initiative to carry out a series of wholesale and retail Digital Rupiah experimentation projects. This report will provide a high-level design of Digital Rupiah configuration including its development plan.

13. This is in line with the explanation of the Group of Central Banks (2020) that the CBDC is one of the core instruments for the central bank to carry out its mandate in providing a safe form of money for the economy.

MONEY AS THE DRIVING FORCE OF THE ECONOMY

Digital Rupiah integrates the centralized national digital financial economy ecosystem with the decentralized ecosystem

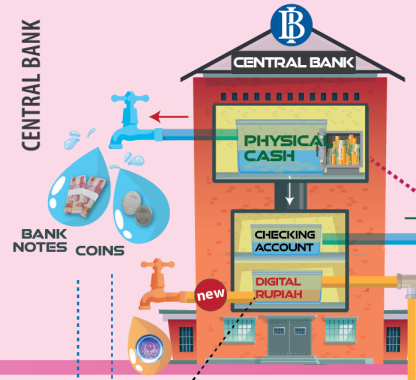
MONEY IN CIRCULATION



CENTRAL BANK

FINANCIAL SECTOR

REAL SECTOR



CENTRAL BANK PUBLIC SERVICE OBLIGATION

Money is **the blood of the economy.** The issuance and circulation of trusted money has become a **classic function of central banks**, including Bank Indonesia

1 PHYSICAL CASH

- Physical cash (banknotes and coins) is an **anchor** for payment instruments
- Physical cash is a **direct claim of its holder to central bank**

CENTRAL BANK INSTRUMENTS
control the velocity of money

new

Digital Rupiah will enter the decentralized ecosystem

3 DIGITAL RUPIAH

- Digital Rupiah will complement the physical cash
- Digital Rupiah will exist as an anchor for digital ecosystem

2 DEMAND DEPOSIT & QUASI MONEY

- Demand Deposit (cheque and giro) & Quasi Money (saving and deposits) are **a claim of its holder to commercial banks**

BANKING INSTITUTION

INTERMEDIARY

DEMAND DEPOSIT & QUASI MONEY

NON-BANKING INSTITUTION

lending, payment

new

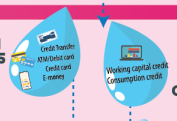
Digital rupiah will flow and return to the central bank via the PSP wallet

The effectiveness of money circulation process is critical to sustaining stable and sustainable economic growth

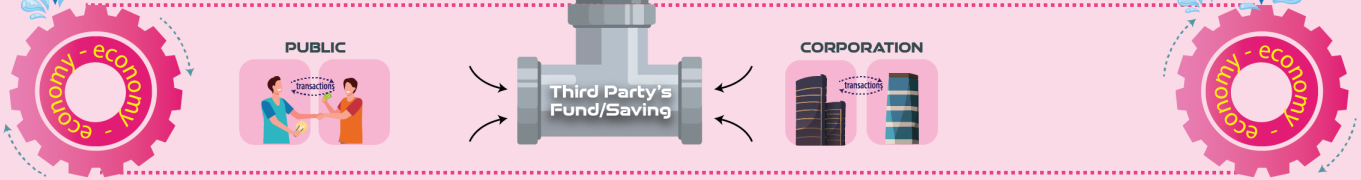
deposits

saving

NON-CASH PAYMENTS

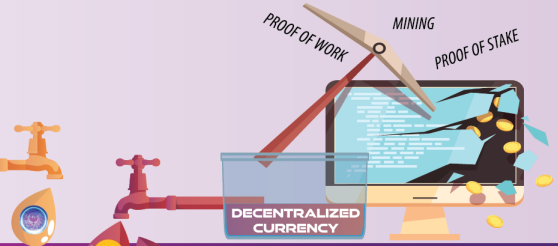


CREDIT



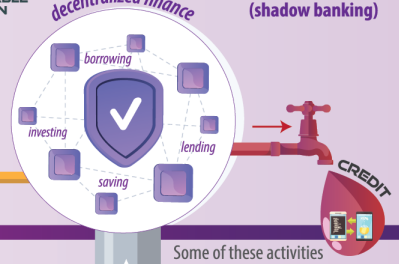
BLIND SPOT AREA

The use of crypto assets in a decentralized ecosystem creates a risk known as **shadow currency and shadow central banking**

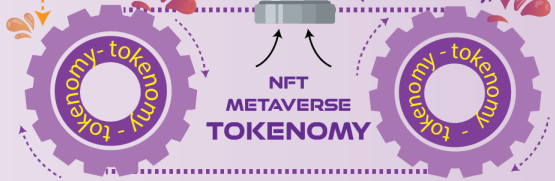


DEFI decentralized finance

DeFi's influence disrupts banking intermediaries **(shadow banking)**



Some of these activities may fall outside of traditional regulatory perimeter then impede the effectiveness of economic policies **(shadow economy)**



CENTRALIZED SYSTEM

DECENTRALIZED SYSTEM

CHAPTER 2
DIGITAL RUPIAH CONFIGURATION

"We cannot solve a problem by using the same kind of thinking we used when we created them."
(Albert Einstein)

Digital Rupiah exists as an anchor for payment instruments in digital era. The manifestation of that goal is reflected through holistic Digital Rupiah design which embodies integrated end-to-end configuration, from w-Digital Rupiah to r-Digital Rupiah. Digital Rupiah design will be directed to accommodate resilient features that enable development of new innovative, inclusive, and efficient business models. The comprehensive design will be supported by appropriate regulations and policies.

The design of CBDC plays an instrumental role in the success of its implementation. The selected configuration of CBDC design will determine CBDC potential added value for the economy, its ability to bridge central bank mandates, and its risks. The Group of Central Banks (2021) emphasizes three basic principles that must be observed by central banks in designing CBDC: (i) no harm to monetary and financial stability; (ii) coexistence and complementarity of public and private money; and (iii) promotion of innovation and efficiency.

In this context, the formulation of design of the Digital Rupiah faces three main issues.

First, the selection of CBDC architecture. Central banks will face an issue of choosing between wholesale CBDC (w-CBDC) or retail CBDC (r-CBDC). W-CBDC is generally more popular in developed countries where financial markets are deep and financial inclusion rates are high. In contrast, r-CBDC is generally popular in developing countries where financial markets are not yet advanced and financial inclusion rates are low[14]. Despite guaranteeing direct and universal access, r-CBDC generally requires more complex development than w-CBDC. In addition, issues also arise in selecting designs which support cross-border interoperability.

14. See Maryaningsih et al. (2022) for further elaboration.

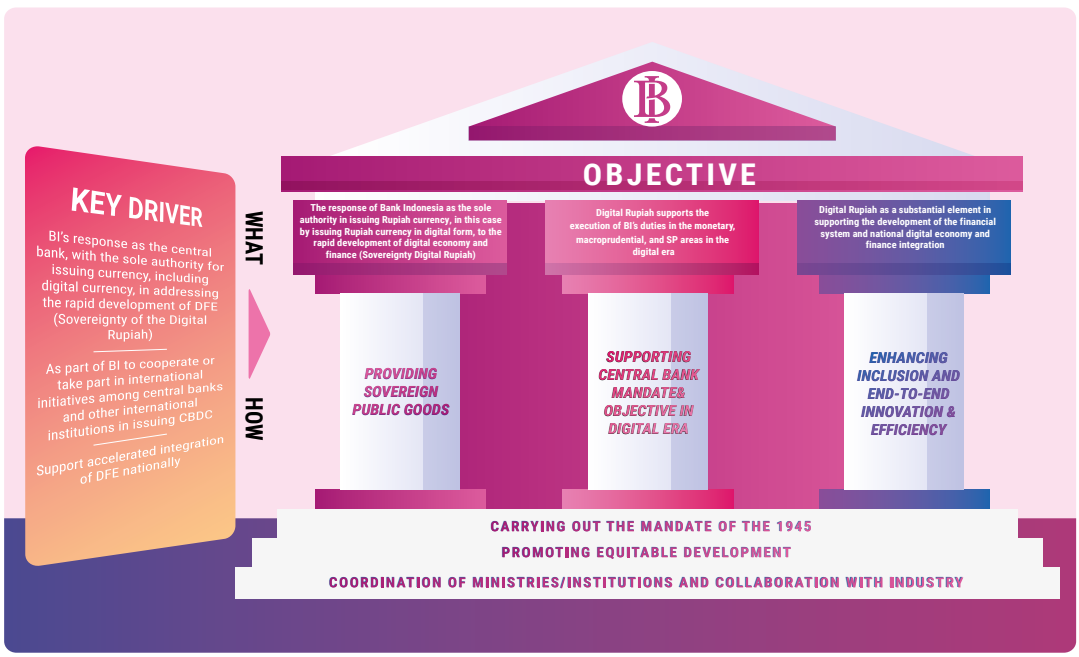
Second, the issue of CBDC contribution to financial inclusion. If designed properly, CBDC, especially r-CBDC, will be able to promote financial inclusion, for example through offline functionality features[15] and the utilization of granular data. However, financial inclusion in principle is a public policy objective that needs to be accelerated. Its achievement should not await or depend entirely on the issuance16 of CBDC. In Indonesian context, for example, efforts to promote financial inclusion have already been taking place through initiatives in IPSB 2025, such as QRIS, SNAP, and BI-FAST. CBDC, in this regard, will complement the efforts.

Third, CBDC design compliance to 3i (integration, interoperability, and interconnection) principles with existing domestic financial market infrastructures (FMIs) and in terms of cross-border payments. To achieve an efficient and integrated solution, CBDC platform must be able to develop interlinkage with the existing FMIs. In addition, these capabilities must also be present in the context of cross-border transactions through utilization of technology and simplification of distribution channels. This in turn will overcome high costs, low transaction speed, limited access, and opaque cross-border transactions.

2.1 FRAMEWORK

Digital Rupiah development is based on three key drivers (Figure 2).

Figure 2. Framework of the Digital Rupiah



15. Design features that allow CBDC to be transacted without adequate internet network to reach people in certain area or blank spot areas.

First, the necessity of Bank Indonesia as the sole authority in issuing Rupiah currency, to respond rapid development of digital economy and finance, in this case by issuing Rupiah currency in digital form. This step is required to preserve sovereignty of Rupiah in digital era.

Second, the effort of Bank Indonesia to strengthen its role on the international stage. Digital Rupiah will put Indonesia on the world map of CBDC development, alongside other countries. This includes Bank Indonesia's engagements in various cross-border CBDC interoperability initiatives.

Third, the need to accelerate integration of national digital economy and finance. This is necessary to ensure effective and integrated money supply process between digital economy and finance ecosystem and the existing economic structures.
Based on these key drivers, Digital Rupiah design will then be formulated to achieve three objectives.

First, Digital Rupiah, as a legitimate digital means of payment in the Republic of Indonesia will complement banknotes and coins. This objective will be achieved through issuance of Rupiah-denominated digital money which serves as sovereign public goods. Bank Indonesia will select suitable technology platform which can support Digital Rupiah's issuance and distribution

Second, Digital Rupiah as a key instrument in supporting the execution of Bank Indonesia's mandates in digital era. This objective will be achieved through development of Digital Rupiah design that in line with Bank Indonesia's tasks in monetary, macroprudential, and payment systems sectors.

Third, Digital Rupiah as a substantial element in supporting the development of financial system and national digital economy and finance integration. This objective will be achieved through the development of features that support end-to-end innovations, financial inclusion, and efficiency.

With this framework, Digital Rupiah would be able to fulfill its functions as a medium of exchange, store of value, and unit of account for other digital money in the Republic of Indonesia. Digital Rupiah will be developed in harmony with the 1945 Constitution, government's development policies, and in collaboration with all stakeholders.

This framework would be implemented based on fulfillment of three prerequisites. First, Digital Rupiah should have conceptual design which complies with "do no harm" principle to monetary and financial system stability. Second, Digital Rupiah should comply with 3i principles with existing and

> ***... With this framework, Digital Rupiah would be able to fulfill its functions as a medium of exchange, store of value, and unit of account for other digital money in Republic of Indonesia..***

future FMIs. Third, Digital Rupiah should be built upon technology platforms which support cross-border interoperability. Experimentation with various available options of technology platforms, both DLT and non-DLT, would be crucial.

2.2 CONFIGURATION

Determining appropriate design configuration is an essential part in Digital Rupiah issuance. Digital Rupiah design configuration consists of five main elements: (i) issuance; (ii) distribution and recording of transactions; (iii) access; (iv) use cases and interlinkage; and (v) infrastructure and technology (Figure 3).

2.2.1 Issuance

Digital Rupiah will be issued in two forms: wholesale Digital Rupiah (w-Digital Rupiah) and retail Digital Rupiah (r-Digital Rupiah) which will be developed using an integrated end-to-end approach from wholesale to retail. The development will commence with w-Digital Rupiah at the initial stage serving as the overall foundation of Digital Rupiah. Digital Rupiah is designed to be available in both wholesale and retail use cases, leading to greater potential adoption. The use of w-Digital Rupiah in the wholesale market is expected to support financial markets development and digital economy and finance integration.

Digital Rupiah would be a complementary to banknotes, coins, and third-party reserves at Bank Indonesia. They would play a role as risk-free settlement assets. Digital Rupiah is a direct claim of its holder to Bank Indonesia, with comparable issuance mechanism and scope of users as the existing central bank money.

> ***... Digital Rupiah design configuration consists of five main elements: (i) issuance; (ii) distribution and recording of transactions; (iii) access; (iv) use cases and interlinkage; and (v) infrastructure and technology***

W-Digital Rupiah would have limited accessibility to parties designated by Bank Indonesia. To obtain w-Digital Rupiah, these parties need to convert their reserves at Bank Indonesia. Hence, the issuance of w-Digital Rupiah would inherently only alter the composition of Bank Indonesia's monetary liabilities without changing the size of Bank Indonesia's balance sheet, or in other words, it would have a neutral monetary impact.

R-Digital Rupiah could be used by general public just as banknotes and coins. Public obtains r-Digital Rupiah by exchanging their banknotes and coins, bank deposits, or e-money balances for r-Digital Rupiah through intermediaries. These intermediaries then use their w-Digital Rupiah reserves to meet customer demand. This mechanism is comparable with current mechanism applied for banknotes and coins. The impact of r-Digital Rupiah

DESIGN CONFIGURATION OF THE DIGITAL RUPIAH

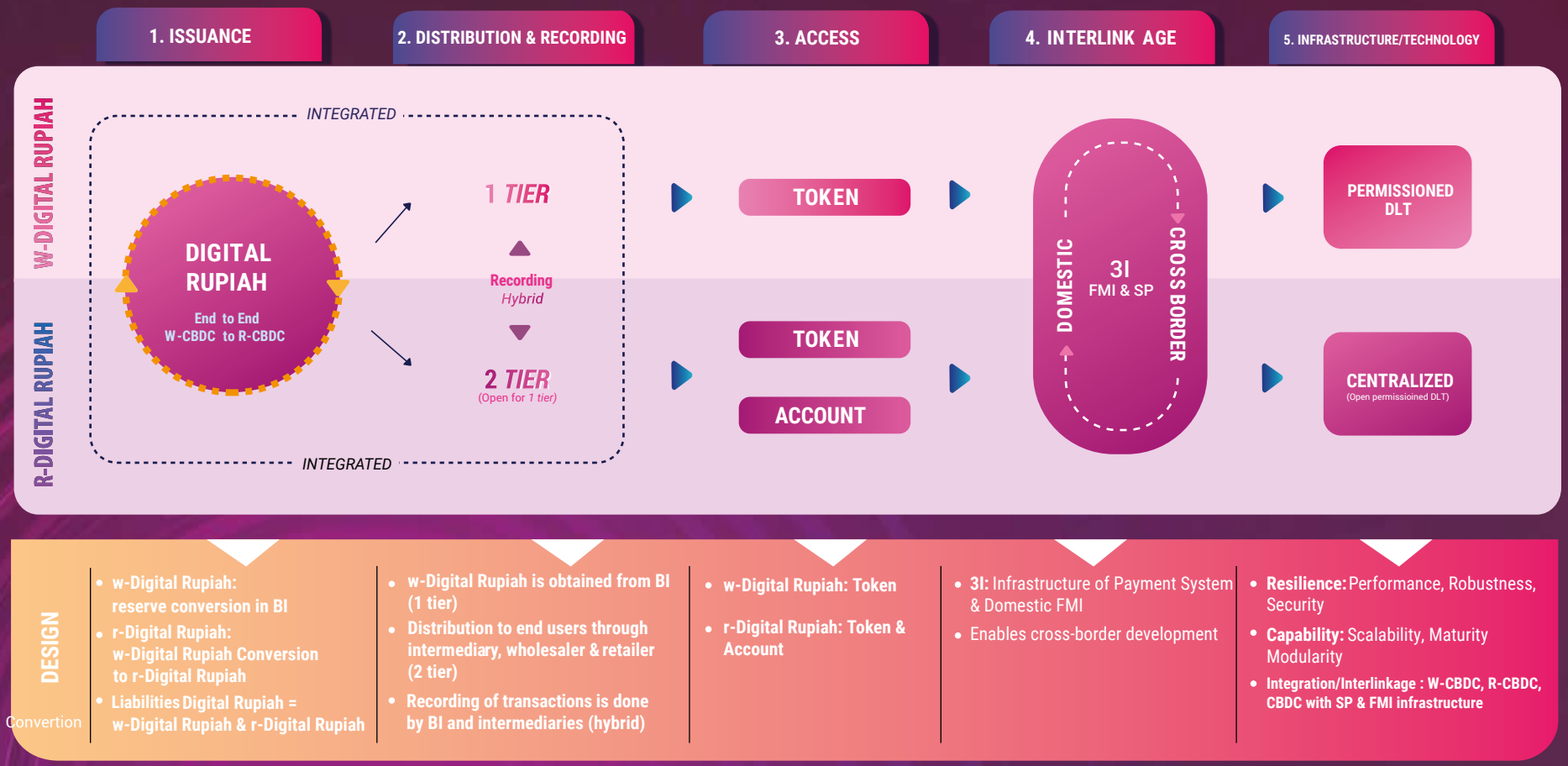


Figure 3. Design Configuration of the Digital Rupiah

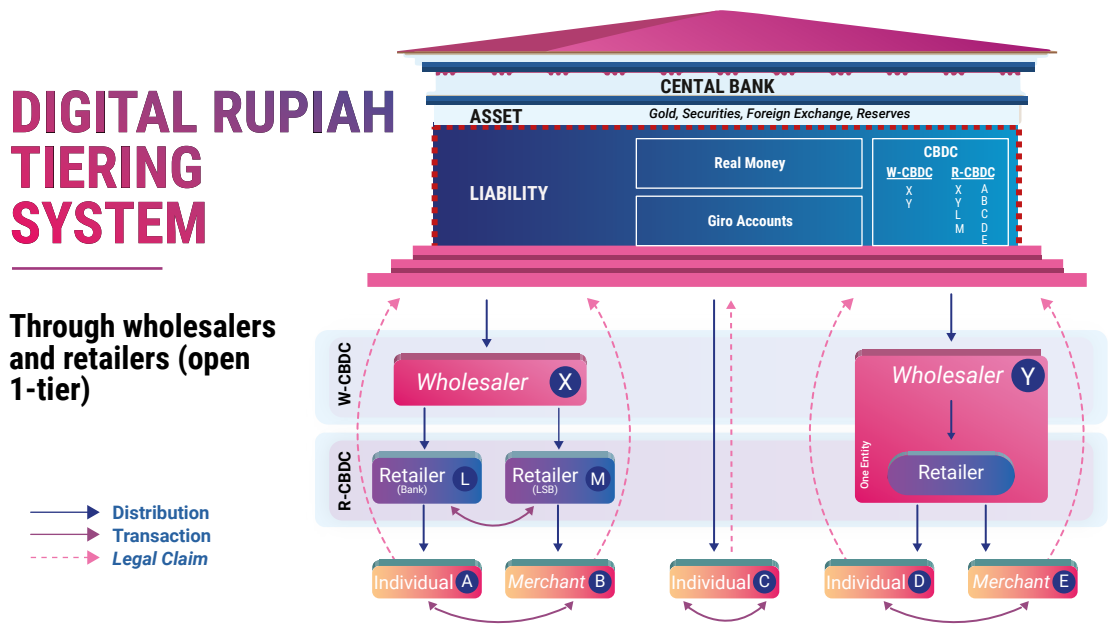
issuance on the balance sheets of Bank Indonesia, commercial banks, and non-bank e-money issuers would also be comparable with the current mechanism for converting bank deposits or e-money balances into banknotes and coins.[16]

2.2.2 Distribution and Recording

The aforementioned intermediaries above comprise of wholesalers and retailers. Wholesalers are parties who obtain the right to access Digital Rupiah directly from Bank Indonesia and distribute it to retailers and end users. Meanwhile, retailers are parties who obtain Digital Rupiah through wholesalers and distribute it to end users. Bank Indonesia designates the parties who would obtain the rights as wholesalers. In addition, retailers are parties that have obtained license to function as Payment Service Providers (PSP) from Bank Indonesia. In practice, a wholesaler could also act as a retailer.

The distribution scheme of Digital Rupiah is a combination of one-tier and two-tier architecture (Figure 4). W-Digital Rupiah distribution scheme would be one-tier whereby a wholesaler obtains W-Digital Rupiah directly from Bank Indonesia. While, r-Digital Rupiah distribution scheme would be two-tier through intermediaries. Bank Indonesia might have an option to execute one-tier r-Digital Rupiah distribution scheme if certain conditions are met, for example, lack of r-Digital Rupiah availability in frontmost, frontier, and disadvantaged regions. This option is also applied in the existing distribution scheme of banknotes and coins.

Figure 4. Digital Rupiah Distribution



16. In the event that the conversion to r-Digital Rupiah occurs through the exchange of banknotes and coins into r-Digital Rupiah, the impact on the balance sheets of commercial banks and institutions other than banks issuing electronic money will be neutral. Meanwhile, the central bank's balance sheet will only experience a change in composition from w-Digital Rupiah to r-Digital Rupiah without changing the size of the balance sheet.

Wholesalers distribute Digital Rupiah to end users through two channels. First, the direct distribution channel from wholesalers to end users; and second, the indirect distribution channel through retailers as intermediaries.

Under this scheme, Bank Indonesia can monitor intermediaries and end-users' Digital Rupiah balances and transactions at the granular level based on consent. This model, which is referred a hybrid recording model that enables Bank Indonesia to maintain control over the end-to-end management of Digital Rupiah in order to achieve monetary and financial system stability objectives. This model is also seen as more resilient, particularly if the system of one or more intermediaries experience failure.

2.2.3 Access

Digital Rupiah can be accessed through two methods: account and/or token.[17]

W-Digital Rupiah is accessible via token-based verification. Token-based is considered suitable for w-Digital Rupiah because of its assumed capabilities in facilitating complex transactions among participants in the financial market. Furthermore, it will complement the existing Bank Indonesia Real Time Gross Settlement (BI-RTGS) account-based arrangements.

R-Digital Rupiah is accessible via account- and token-based, arranged based on users' segmentation (tiering) and transactions value cap. Token based r-Digital Rupiah facilitates small-value transactions up to a certain threshold. Account based r-Digital Rupiah facilitates transactions higher than the respective threshold. Token-based r-Digital Rupiah mimics the flexibility of banknotes and coins. Bank Indonesia could obtain granular data from token-based r-Digital Rupiah transactions through information stored in wallet address. To fulfill AML/CFT compliance, account-based r-Digital Rupiah is considered best-fitted for higher-value transactions.

> ***... Digital Rupiah can be accessed through two methods: account and/or token. W-Digital Rupiah is accessible via token-based verification also r-Digital Rupiah is accessible via account- and token-based..***

2.2.4 Use Cases And Interlinkage

Digital Rupiah is designed to be complemented by a variety of use cases both in the wholesale and retail ecosystem. The Digital Rupiah will be the settlement asset for various types of transactions in goods and services markets and financial markets. This applies for both traditional and digital ecosystems, such as Web 3.0 including DeFi and Metaverse.

17. The definition of CBDC access in this White Paper refers to CPMI-MC (2018) and CPMI (2019). In CPMI-MC (2018), the main difference between token-based and account-based access is the form of verification required when an exchange occurs (Kahn & Robards, 2009). Token-based payment systems rely on the ability of recipients to verify the validity of payment objects. In contrast, account-based payment systems rely on the ability to verify account identity.

Digital Rupiah will be equipped with various features that are expected to be able to provide added value to the economy. These superior features include programmability,[18] composability,[19] and tokenization[20] based on smart contracts. Furthermore, Digital Rupiah will also have the ability to capture granular data and information in real-time. Specifically, r-Digital Rupiah will be equipped with offline functionality. In addition, Digital Rupiah design would also anticipate cross-border interoperability alignment.

To meet these expectations, Digital Rupiah design must adhere to 3i aspects in terms of technical, business, and semantic. This applies to the context of interlinkage with both domestic and international FMIs. Digital Rupiah design is expected to coexist with existing and future infrastructures, including various infrastructures in the IPSB 2025 and Money Market Development Blueprint 2025.

> ***...Digital Rupiah will be equipped with various features that are expected to be able to provide added value to the economy. To meet these expectations, Digital Rupiah design must adhere to 3i aspects in terms of technical.. business, and semantic.***

2.2.5 Infrastructure and Technology

The infrastructure and technology platform of Digital Rupiah use a combination of DLT and centralized infrastructure. The choice of DLT for w-Digital Rupiah opens up the opportunity for Bank Indonesia and market players to achieve efficiency in financial transactions, among others through the various features offered by smart contracts. DLT is also considered more resilient than centralized systems as the former eliminates single point of failure issue. Permissioned DLT is chosen to ensure a better level of security since access to DLT platform is restricted to designated parties. In addition, it is also more scalable than permissionless DLT.

Nevertheless, permissioned DLT is regarded insufficient to facilitate high-volume retail transactions. Scalability constraints in DLT can affect settlement speed for retail transactions. As a result, r-Digital Rupiah is considered to use centralized infrastructure. However, DLT remains an open option for r-Digital Rupiah if its scalability issue could be resolved in the future. In practice, DLT solutions are not a prerequisite for CBDC platform as there are various options available (Box 2).

The fulfillment of the 3i aspects remain a principle that must be upheld in the choice of Digital Rupiah infrastructure and technology. The linkage between different technology solutions embedded in w-Digital Rupiah and r-Digital Rupiah would need to be materialized. This is to ensure end-to-end integration.

18. Programmability is the ability of a digital currency to integrate programs in payments.
19. Composability is the ability to combine several operations/transactions into a single operation/transaction.
20. Tokenization is an operation to produce a digital representation of money/assets.

BOX 2

CHOICE OF THE TECHNOLOGY PLATFORM FOR THE DIGITAL RUPIAH

As a solution, CBDC would need to be technology neutral. Although CBDC platform is frequently associated with DLT, it is not the only technological option available. The centralized technology scheme currently used in most payment systems can also be an option. In some countries, hybrid models which combines distributed and centralized platforms have also emerged as an option (Soderberg, et al., 2022). This model promotes CBDC innovations that are supported by DLT features, while retaining the advantages of a centralized platform.

DLT has several advantages. In general, there are four DLT main features, they are cryptographic techniques, data sharing, decentralized techniques, and programmability. Cryptographic techniques improve security by ensuring the validity and accuracy of each copy of the ledger, followed by a process of verifying network participants' access rights. DLT enables participants on a distributed network to record, share, and synchronize transactions and data (Krause, Natarajan, and Gradstein, 2017). Decentralization reduces the risk of a single point of failure due to the distribution of ledgers to many participants. The programmability feature enables the automation of various digital asset transactions.

Meanwhile, centralized systems outperforms decentralized systems in terms of control in scalability and security (Buterin, 2014). Operators in a centralized system can easily increase the number of transactions per second without jeopardizing security. Operational risks, including cyber risks, can be easily detected and mitigated in centralized systems. Furthermore, it can reduce double spending problem. However, it is prone to single point of failure risk because of the reliance on a single central entity.

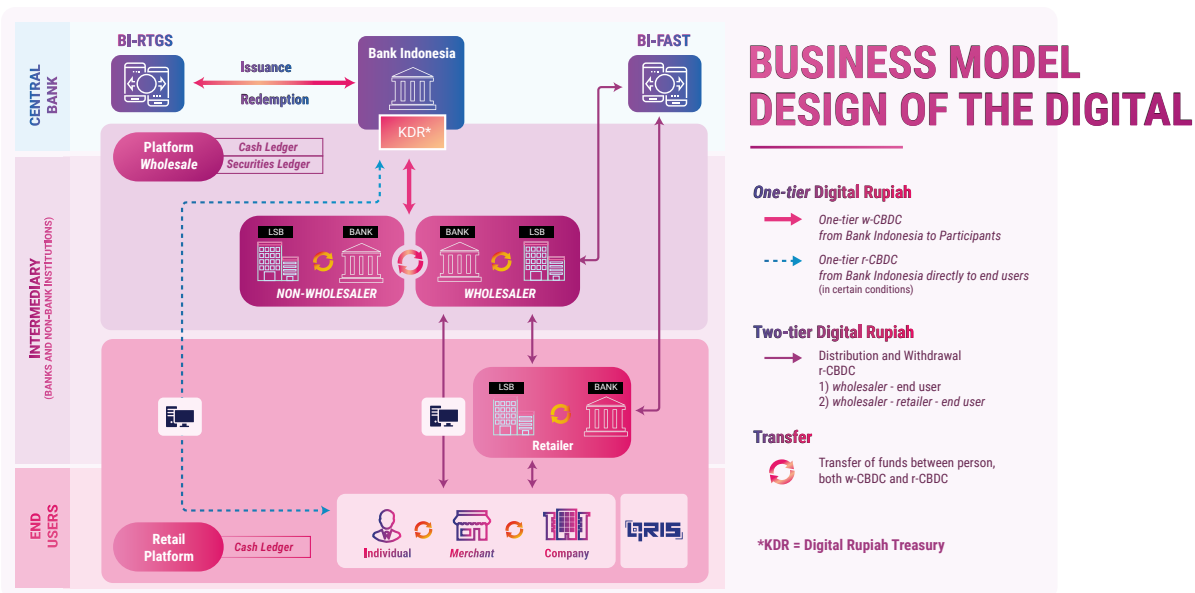
2.3 BUSINESS MODEL

Digital Rupiah business model encompasses an end-to-end process of issuing and distributing w-Digital Rupiah and r-Digital Rupiah. It is also an integrated process between Digital Rupiah platform and existing FMIs, including payment systems (Figure 5). The cycle of Digital Rupiah includes issuance, distribution, collection, and redemption. Bank Indonesia issues w-Digital Rupiah to wholesalers and non-wholesalers. Only wholesalers have the right to convert their w-Digital Rupiah into r-Digital Rupiah, as well as distributing them to retailers and/or end users. The process ends with the collection of r-Digital Rupiah into w-Digital Rupiah, followed by redemption of the latter.

Digital Rupiah Depository (KDR)[21] plays a central role in this cycle. KDR is a node in w-Digital Rupiah platform which is involved in the processes of issuance and redemption of w-Digital Rupiah tokens. The issuance process of w-Digital Rupiah tokens in KDR occurs on demand and immediately results in zero balance when the w-Digital Rupiah is circulated. Through this mechanism, KDR serves as the single point of contact to ensure the security, completeness, validity, and accuracy of Digital Rupiah supply.

Digital Rupiah cycle begins with the issuance of w-Digital Rupiah, which is accomplished by transferring funds from participants' reserves to Digital Rupiah technical account[22] in BI-RTGS.

Figure 5. Design of the Digital Rupiah Business Model



21. Equivalent to Continuous Depository Receipt in Project Ubin and Digital Depository Receipt in Project Jasper.
22. Technical accounts are Bank Indonesia accounts at BI-RTGS which contain sub-accounts belonging to each participant and are separate from the current reserve accounts and participant settlement account at BI-RTGS (omnibus account) which are specifically created for the purpose of issuing Digital Rupiah.

Simultaneously, these transactions will trigger instructions for issuance of tokens in KDR. Then, the tokens will be transferred to participants immediately afterward. The transference process among participants of w-Digital Rupiah in the wholesale market does not involve KDR.

R-Digital Rupiah is issued through conversion of w-Digital Rupiah by wholesalers. This event might be triggered by wholesalers need to meet users demand or just simply build r-Digital Rupiah reserves. Composition of w-Digital Rupiah and r-Digital Rupiah would be at wholesalers discretion based on customers' demands dynamic and their expected wholesale market transaction needs. Distribution of r-Digital Rupiah is done through three channels: (i) from wholesalers directly to end users[23]; (ii) from wholesalers to end users through other retailers by utilizing BI-FAST; and (iii) in certain circumstances, from Bank Indonesia directly to end users.

Digital Rupiah can be transacted by its users in both wholesale and retail markets. W-Digital Rupiah is directed to serve as the settlement asset for financial markets transactions, including monetary operation. R-Digital Rupiah is used to facilitate retail use cases related to personal/individual and business (corporate and merchant) transfer and payments.

Digital Rupiah cycle ends with redemption process. This process starts with the collection of r-Digital Rupiah. Wholesalers collect r-Digital Rupiah redeemed either directly by end-user or indirectly from users through retailers. In a case where a wholesaler wishes to reduce its stock of Digital Rupiah, the wholesaler will exchange r-Digital Rupiah for w-Digital Rupiah which is then converted into reserves balance in Bank Indonesia.[24]

Digital Rupiah platform is divided into wholesale and retail platforms. The purpose of this separation is to accommodate scalability and to minimize operational exposure, including cyber-attacks, against financial system stability. Despite this separation, interlinkage between both platforms is seamless, as previously described.

> ***...R-Digital Rupiah is issued throught conversion of w-Digital Rupiah by wholesalers. This event might be triggered by wholesalers need to meet users demand or just simply build r-Digital Rupiah reserves..***

The development of Digital Rupiah's technology platform will be done collaboratively. Bank Indonesia will develop DLT platform for w-Digital Rupiah. This platform consists of Bank Indonesia nodes, including KDR node, wholesaler nodes, and non-wholesaler nodes. Each participant will be responsible for node's hardware investment depending on their roles in w-Digital Rupiah ecosystem.[25] Bank Indonesia will also sequentially develop r-Digital Rupiah platform. The platform can

23. Conversion can also occur from w-Digital Rupiah to a reserve account without prior exchange of r-Digital Rupiah to w-Digital Rupiah in the event that Digital Rupiah is only used in the wholesale market.
24. For non-wholesalers, the no-node option is available. This option allows participants to own the ledger without investing in hardware. Non-wholesalers entrust their Digital Rupiah to the ledger operator Bank Indonesia.
25. Digital wallets are used to store and manage digital assets and cryptographic keys, especially private keys connected to public keys (HM Treasury, 2021)

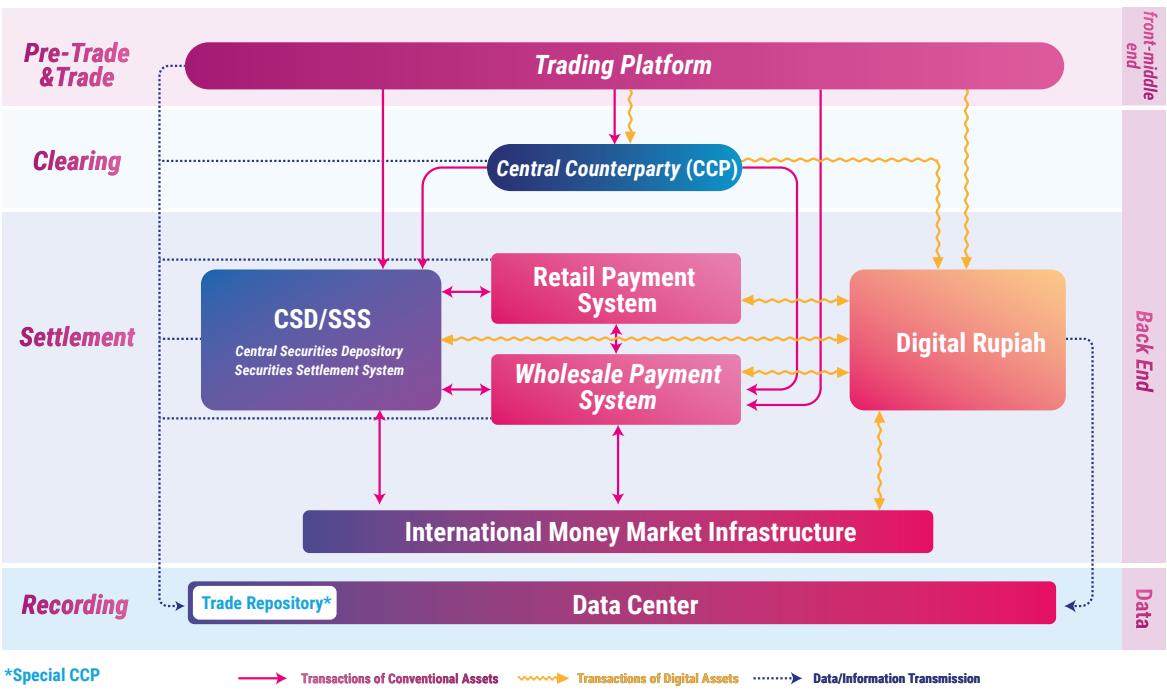
be accessed through web, applications, and digital wallets[26]. Investment in digital wallets will be done by the respective participants in accordance with their roles, including costs associated with the Know Your Customer (KYC) process.

2.4 3I ASPECTS

The coexistence between Digital Rupiah with the existing forms of money would be materialized through interlinkage between Digital Rupiah platform with existing FMIs. This interlinkage includes participation arrangements between different infrastructures. This arrangement ensures smooth and seamless convertibility as well as transfers of financial assets across different payment rails which will only be achieved if the 3i aspects are met.

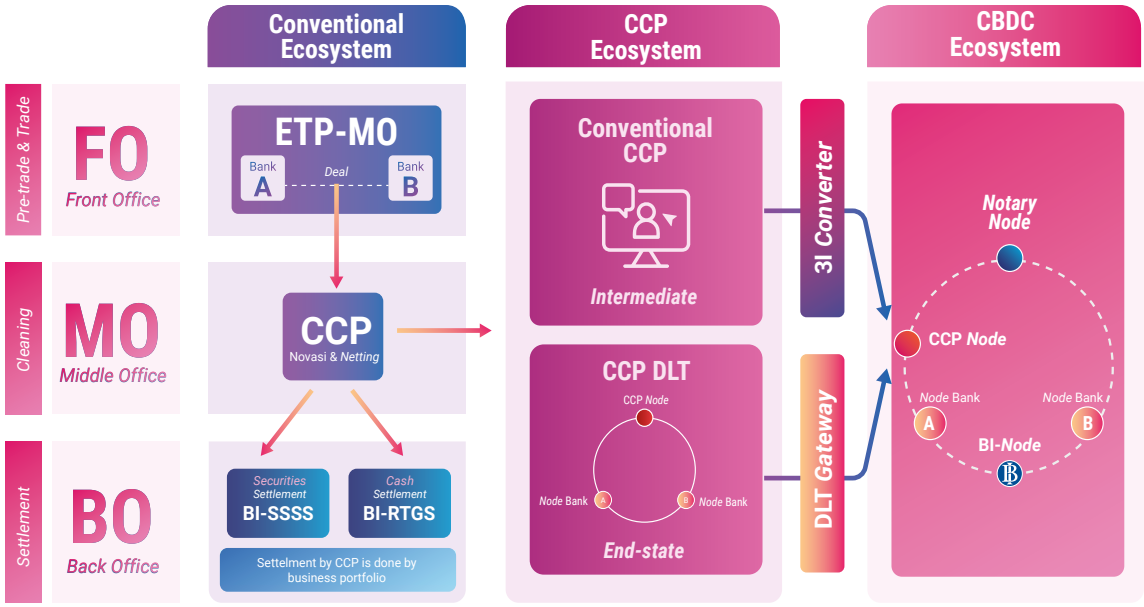
There are two prerequisites to meet the 3i aspects. First, the ability of Digital Rupiah platform to exchange information and perform transactions with existing and future traditional infrastructures (Figure 6), i.e., trading venues, central counterparty (CCP) for money market and foreign exchange market, securities settlement system (SSS), central securities depository (CSD), and wholesale and retail payment system. Second, the ability to meet technical, semantic, and business/legal standards in accordance with technological developments and policy needs.

Figure 6. High-Level Configuration of Indonesia Financial Market Infrastructures



26. Digital wallets are used to store and manage digital assets and cryptographic keys, especially private keys connected to public keys (HM Treasury, 2021)

Figure 7. Technology Platform Functionality Flow of Digital Rupiah



W-Digital Rupiah platform enables end-to-end straight through processing of transactions (Figure 7). At the front-end, it will connect with trading platforms to process near real-time transactions, smart contracts, and collateral management system. At the middle-end, it will connect with CCP for money market and foreign exchange market. At the back-end, it will include digital securities to allow for more efficient transaction processing time under Delivery-versus-Payment (DvP) model. These arrangements will shorten settlement and reporting process. Interconnection between different platforms would utilize application programming interface (API) and/or software development kit (SDK).

2.5 TECHNOLOGY

The design of Digital Rupiah technology will be built based on the following principles:

1. **Fast:** having capability for rapid processing of transactions within a transaction settlement timeframe acceptable by users.
2. **Secure:** having the ability to maintain the integrity of transactions and to mitigate operational risks, including cyber risks. Digital Rupiah technology platform needs to fulfill high security standards, including the ability to use technology that is resistant to quantum computer attacks (quantum resilient).
3. **Resilient:** having the ability to recover quickly from various operational disruptions.

4. **Interoperability:** having 3i capability with various other systems, both those that currently exist and those to be developed in the future.
5. **Extensible:** having the ability to accommodate the development of new functionalities and enables other parties to innovate through development of functionalities/services on the system.
6. **Flexible:** modular in nature, i.e., the characteristic of the system consists of various components so that it is easy to configure.

The primary goal of developing a CBDC system should be to achieve the optimal design. Nevertheless, the primary challenge for the central bank is whether the available technology solutions could meet the design requirements. This is a recurring issue faced by central banks throughout the world.

The Finance Track of the G20 Presidency of Indonesia 2022 had supported the efforts of finding prospective solutions to this issue with numerous initiatives. Among them was the G20 TechSprint 2022 (Box 3) which was a competition in the form of a hackathon, where participants were challenged to solve a specific problem statement around the development of CBDC. The results of the competition are expected to provide valuable insights into the development of CBDC systems.

BOX 3

G20 TECHSPRINT 2022

Under the auspices of the G20 Presidency of Indonesia 2022, Bank Indonesia together with the Bank for International Settlements Innovation Hub (BISIH) held the G20 TechSprint 2022 hackathon. The hackathon focused on solving technology challenges related to wholesale and retail CBDC. CBDC was also part of the focus area within the G20 Presidency of Indonesia 2022 under Finance Track priority agenda of "Payment System in Digital Era".

The hackathon that took place from April to October 2022 focused on solving three problem statements. Those problem statements were:

- Problem Statement A: implementing effective and robust issuance, distribution and transference.
- Problem Statement B: enabling financial inclusion.
- Problem Statement C: enabling connectivity and interoperability.

The selection of these topics was based on a survey to G20 member countries, several non-G20 countries with advanced CBDC experimentation, and international organizations.

The hackathon managed to attract almost 100 participants comprising of individuals, fintech firms, and multinational corporations from 18 countries. The selection process ended up with 21 of the best proposals offering innovative solutions.

In Problem Statement A, the finalists offered solutions of end-to-end CBDC platforms equipped with numerous operational business features, system security, and regulatory compliance e.g., transaction limits, KYC processes, and blacklisting. Several finalists proposed quantum resilient cryptographic to overcome quantum computer attacks. Finalists in this category generally proposed a two-tier CBDC model, with the possibility of extension for a one-tier model.

In Problem Statement B, the finalists demonstrated innovations that enable offline functionality, universal accessibility, and the utilization of granular data of CBDC transaction for financial inclusion. For offline functionality, the majority of finalists demonstrated innovative solutions to tackle double spending problem. For universal accessibility, several finalists developed applications which enable CBDC to be accessed through simple devices, such as feature phones and cards. For the utilization of granular data, some finalists offered innovative solutions that enable CBDC to be interconnected with a national digital identity system.

In Problem Statement C, the finalists offered innovations that enable CBDC interoperability, both in the context of cross-border transactions over multi-CBDC networks and interoperability with traditional infrastructures through CBDC payment gateways. Several technical solutions, namely API and DLT gateway, and business solutions, for example partnership with private parties and official authorities, were also offered as answers to formulation of this problem.

2.5.1 Technology Architecture Of The Digital Rupiah Platform

The technology architecture of Digital Rupiah is divided into three layers: the technology platform, digital asset, and use cases based on the business process design. (Figure 8)

The technology platform layer. This layer defines features that support Digital Rupiah as well as other types of existing and future Bank Indonesia's digital assets/liabilities. These features include, among others, smart contract, identity service, regulatory service, use of cryptography, API, and sandboxing schemes.[27] In this layer, the w-Digital Rupiah platform is separated from

> ***...The technology architecture of Digital Rupiah is divided into three layers: the technology platform, digital asset, and use cases based on the business process design..***

27. Cryptographic techniques in various functionalities aims at improving security. API features enable efficient communication and ease of interoperability. Sandboxing scheme allows for further exploration of technology options, service innovation, and regulatory compliance. Smart contract features enable programmability which drive innovation and efficiency in settlement. Identity services is instrumental for data privacy. Finally, regulatory service aims at maintaining compliance with applicable regulations and provisions.

r-Digital Rupiah, as aforementioned in the Business Model sub-chapter.

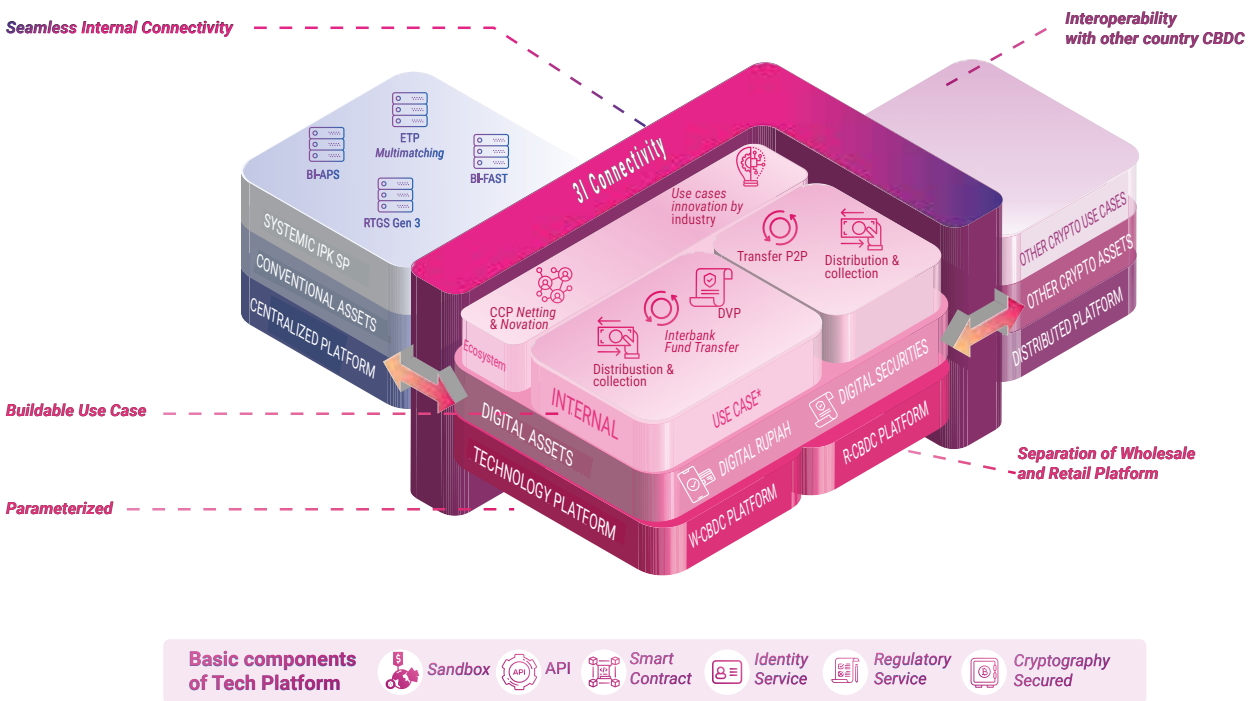
The digital asset layer. This layer contains digital assets managed by Bank Indonesia and is built on top of the technology platform layer depending on use cases. This layer comprises of two digital assets, Digital Rupiah and digital securities, built on a single platform to ensure technical efficiency. In DvP use case, for example, this enables atomic settlement, which is more efficient in terms of the process, time, and settlement cost.

The use case layer. It defines functions and services emerging from the use of digital asset layer. It contains use cases developed by Bank Indonesia and external parties. This layer is expected to serve as a solution to accelerate innovations in digital financial services.

In addition to these three layers, 3i connectivity bridge will be established to link Digital Rupiah platform with other FMIs. It enables various layers above to be connected with payment system platforms, financial platforms, and other digital asset platforms.

> ***...In addition to these three layers, 3i connectivity bridge will be established to link Digital Rupiah platform with other FMIs..***

Figure 8. The Technology Architecture of Digital Rupiah



2.5.2 Mitigating of Cyber Security Risk

One factor that determines the effectiveness of the adoption of Digital Rupiah is fulfillment of cyber security requirements. As cybersecurity is an essential element in the development of Digital Rupiah, it is important to manage this element from the beginning.

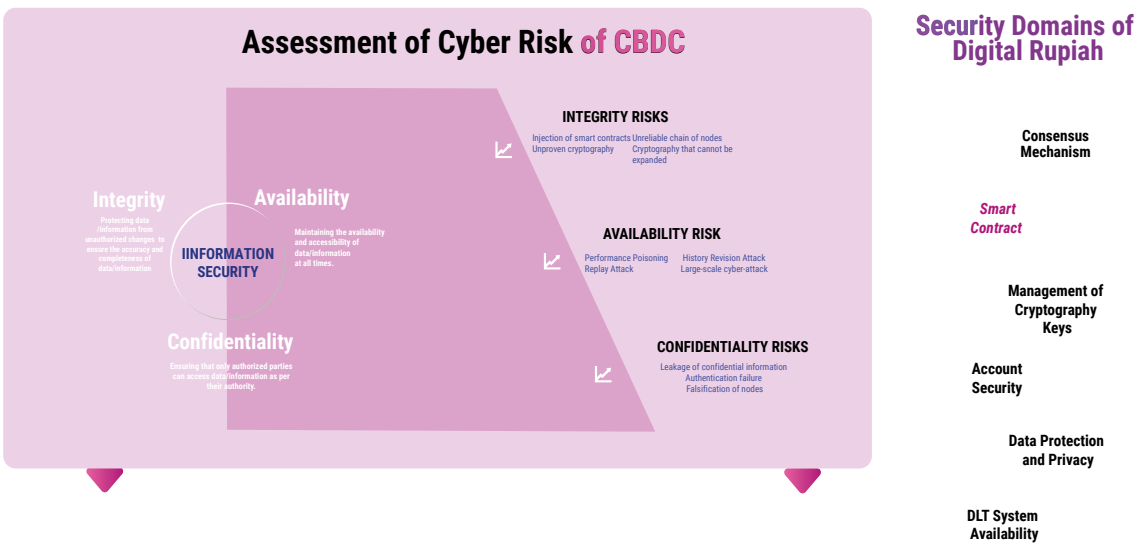
Generally, Digital Rupiah, as with any other IT systems, is also facing typical cybersecurity risks. Hence, similar security standards are also applied to Digital Rupiah. These standards consist of identity and access management (authentication and authorization), business sustainability management, security patching management, incident management, and development cycle management.

As a matter of fact, DLT, from a security perspective, offers some advantages over a centralized system. The decentralized cryptographic technology provides additional layers of security, making it more difficult for people with malicious intent to penetrate the system. Furthermore, the decentralized nature of its DLT's data/ transactions recording mechanism reduces single point of failure.

Nonetheless, cyber risk persists in Digital Rupiah due to its unique characteristics. The deployment of consensus mechanisms, smart contracts, cryptographic key management, account security, data protection and privacy, and other functions might inherently trigger the risk.

> ***...Digital Rupiah will be designed to have the quality in mitigating those unique risks, including cybersecurity. Assessment and identification of risks will be done accordingly to produce safe, reliable, and resilient Digital Rupiah technology design..***

Figure 9. Cybersecurity Risk Assessment of CBDC



Digital Rupiah will be designed to have the quality in mitigating those unique risks. Assessment and identification of risks arising from people, process, and technology will be done accordingly to produce safe, reliable, and resilient Digital Rupiah technology design. In addition, this process will also consider advancement in the overall cyber security risk mitigation techniques (Figure 9). Based on these notions, development of the system will refer to three basic principles of information system security, i.e., confidentiality, integrity, and availability.

2.6 IMPLICATION OF DIGITAL RUPIAH DESIGN ON REGULATION AND POLICIES

The development of Digital Rupiah is an iterative process among design, technology, regulatory and policy. This process can be viewed from two perspectives. First, regulatory and policy support the implementation of selected design and technology. Second, the degree to which regulatory and policy would provide feedback on the design and technology choices simultaneously. The scope of regulations and policies in this regard includes legal, monetary, financial market deepening, and macroprudential aspects.

From a regulatory perspective, the issuance of Digital Rupiah needs to be based on a solid legal framework. In this regard, Act number 23 of 1999 concerning Bank Indonesia as amended by the Act number 6 of 2009[28] is considered sufficient to be the legal basis for Bank Indonesia in issuing Digital Rupiah. Similarly, the law also acts as the basis of the issuance of reserves accounts in Bank Indonesia.

Nevertheless, existing laws and regulations have not yet provided the legal basis for Digital Rupiah to earn the status of legal tender[29]. This status is required by Digital Rupiah to become an anchor within Web 3.0 ecosystem, including DeFi and Metaverse, whereby the existing legal tender, i.e., banknotes and coins, is absent.

From a monetary standpoint, the impact of Digital Rupiah issuance is inherently neutral. As described in sub-chapter 2.2.1, the issuance only alters the composition of Bank Indonesia's monetary liabilities, without affecting the size of its balance sheet. Apart from that, Digital Rupiah does not provide remuneration (non-interest bearing) to its holders comparable to the existing central bank money[30].

Digital Rupiah, as a form of Bank Indonesia's liability, is recognized as a component of base money (M0). W-Digital Rupiah is comparable with reserves in central bank. With this quality, w-Digital Rupiah held by banks could be included in statutory reserve compliance.

> ***...Nevertheless, the existing laws and regulations have not yet provided the legal basis for Digital Rupiah to earn the status of legal tender..***

28. Act number 6 of 2009 concerning Stipulation of Government Regulation in lieu of Act number 2 of 2008 concerning the Second Amendment to Act number 23 of 1999 concerning Bank Indonesia to become Law.
29. The Currency Law Article 1 point 1 and 2, Article 21, and Article 23 further provide a strong legal basis for the existence of the Rupiah as currency and legal tender. As a legal tender, Rupiah must be received in every payment transaction and fulfillment of obligations.
30. This is aligned with the result of the survey by Zams et al. (2020) suggesting that the design of r-CBDC is appropriate for the characteristics of Indonesia is the cash-like CBDC, where one of its characteristics is having no remuneration.

The technological breakthroughs in the design of Digital Rupiah might strengthen monetary policy transmission. As mentioned in the earlier section, w-Digital Rupiah will be leveraged as settlement asset for monetary operation and financial market transactions complementing the existing reserves with Bank Indonesia. While possible, the inclusion of w-Digital Rupiah in these operations would require adjustment in regulations, e.g., eligible counterparty, eligible collateral, monetary instrument and strategy, money market and foreign exchange market in monetary operation area.

From the perspective of financial market deepening, the use of smart contracts will catalyze the emergence of new and more efficient business models. With smart contracts, the diversity of business models could be improved, and financial intermediary chain could be shortened. The integration of Digital Rupiah and digital securities in a single platform might streamline the DvP process, reducing settlement and liquidity risks as such increasing the efficiency of wholesale funding.

However, the emergence of new business models would require adequate regulatory and policy responses. The scope of regulations and policies on money market and foreign exchange market will be adjusted accordingly, covering (i) transacted products; (ii) transaction actors based on certain classifications; (iii) policy for price benchmarking; and (iv) supporting infrastructures referring to Principles for Financial Market Infrastructures (PFMI).

> ***...The development of Digital Rupiah will be directed at mitigating various risks including cybersecurity. Risk assessment and identification will be carried out in a measured manner..***

A more effective monetary policy transmission, aided by an optimal financial market deepening, will ultimately encourage productivity for sustainable economic growth. Greater efficiency in the formation of prices in the money and credit market has the potential to improve simultaneously both the multiplier effect and the speed of money circulation.

From a financial system stability perspective, the apprehension of the disintermediation consequences is usually found in r-Digital Rupiah. There is a concern that r-Digital Rupiah might reduce the amount of low-cost stable funding. If banks encounter lack of funding alternatives, that condition may tighten loanable funds which lead to the reduction of bank loan channeling. Consequently, this will have an impact on r-Digital Rupiah design.

Digital Rupiah as a risk-free asset could lead to procyclical effects, meaning that

there could be an amplification of bank run during a crisis period or financial stress (flight to quality). This risk could materialize if people move their bank deposits to r-Digital Rupiah at once and on a massive scale. From their perspective, r-Digital Rupiah would be a safe instrument to store value and could be accessed without frictions, e.g., easy, quick, effective, and cheap compared to bank deposits.

Digital Rupiah would need to be capable of mitigating the aforementioned risks. As a means of payment, it would not pay interest to its holder. Comparable to existing physical cash, people will have the option to convert their r-Digital Rupiah to bank deposit. While in managing procyclicality, Digital Rupiah would need to be complemented by certain parameters that have the ability to limit such exposure, e.g., capping and tiering.

Risks could also emerge from interconnectivity of Digital Rupiah platform. Interconnectivity across infrastructures in Digital Rupiah platform and between Digital Rupiah platform with other traditional infrastructures may escalate the risks. Moreover, wider scope of participation arrangements in Digital Rupiah which includes non-banks institutions, will further increase operational exposures, as well as systemic risk.

> ***...As a means of payment, Digital Rupiah would not pay interest to its holder. Public still have the option to convert their r-Digital Rupiah to bank deposit..***

These risks would be tackled through stronger capital provisioning. Measures ranging from minimum capital requirements, systemic capital surcharge, to the establishment of a more prudent liquidity cushion will be taken as an integral part of Digital Rupiah design.

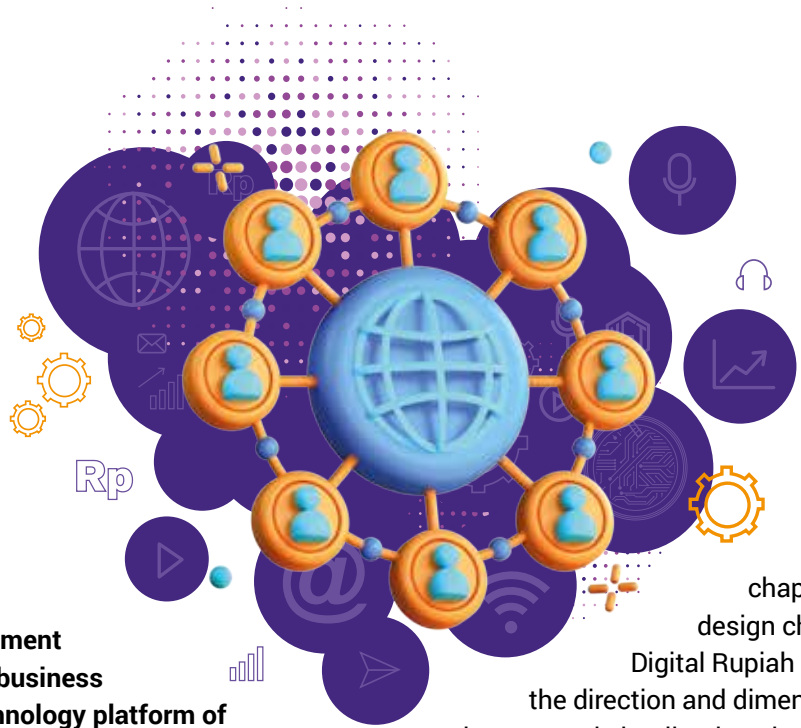
Bank Indonesia will also strengthen supervisory technology (suptech) to mitigate risks emerging from interconnection. Supported by real-time data, suptech is intended to improve surveillance capabilities and pre-emptive/ forward-looking analysis. All of these qualities might increase Bank Indonesia capabilities in promptly responding to vulnerabilities as well as financial shocks materialized, including systemic risk.

Digital Rupiah, especially r-Digital Rupiah will be equipped with features that can support financial inclusion. The existence of offline functionality can ensure equitable access of r-Digital Rupiah. The utilization of granular data which integrated with digital ID based on consent is expected to encourage financial inclusion as mentioned in preceding sections.

CHAPTER 3
ROADMAP AND SYNERGY

"The journey of thousand miles begins with one step"
(Lao Tzu)

The approach to the development of Digital Rupiah is conducted deliberately, iteratively, and gradually. Exploration is focused on the optimal value added for Digital Rupiah usage. With its massive implication, Digital Rupiah can be considered as a national scale initiative that requires synergy and collaboration among stakeholders.



The development of design, business model, and technology platform of Digital Rupiah is carried out iteratively and in stages. The considerations underlying the choice of this approach are as follows:

First, potential trade-offs in the planned design features. These trade-offs occur as, among others a conflict between performance and security, and programmability and privacy. This also includes scalability, security, and decentralization trilemma.[31]

Second, the potential implications of the chosen design. As explained in the preceding chapter, the design chosen for Digital Rupiah determines the direction and dimension of the economic implications it creates. In addition, implementation of the design of Digital Rupiah requires adequate regulatory and policy support to ensure the effective achievement of its objectives.

Third, the need to find a design that can simultaneously mitigate various risk factors. The design of Digital Rupiah needs to achieve a balance between mitigation of cyber risks, protection, and transparency of data to mitigate security risks, including to avoid the use of Digital Rupiah for practices of money laundering and financing of terrorism.

31. Several references that outline potential trade-offs in CBDC development include Fan et.al (2021), Rouhani and Deters (2019), Allen et.al (2019), and Al-Bassam et.al (2021). In addition, in the context of cross-border interoperability, Soderberg (2022) also highlights differences in CBDC technology designs between jurisdictions following differences in CBDC characteristics, functions, and objectives to be achieved by each country.

This approach enables Bank Indonesia to explore various design alternatives based on available technological solutions in order to ensure the most optimal added value for the economy. Discussion, research, and experimentation will focus on finding the answer of the aforementioned issues to come up with the best design features which meet criteria such as speed, resilience, efficiency, and scalability. This approach will also open up reasonably wide space of flexibility for stakeholders to make necessary preparation prior to Digital Rupiah commencement.

3.1 THE ROADMAP OF DIGITAL RUPIAH DEVELOPMENT

The development of Digital Rupiah will be divided into three stages, arranged based on the four criteria of feasibility: importance, urgency, readiness, and impact. This sequence will start with public consultations (consultative papers and focus group discussions), followed by technological experimentation (proof of concept, prototyping, and piloting/sandboxing), and conclude with policy stance review (Figure 10).

At the first (immediate) stage, the development of Digital Rupiah will start with w-Digital Rupiah for issuance, redemption, and transfer of funds use cases. These use cases are considered the most feasible choices for the initial stage of development of Digital Rupiah. These use cases are relatively more straightforward, as they involve a limited ecosystem, less transaction complexity, and minimum required system adjustment. This stage serves as the essential foundation for the development of subsequent use cases.

... The development of Digital Rupiah will be divided into three stages, arranged based on the four criteria of feasibility: importance, urgency, readiness, and impact.

Issuance and redemption use case constitute the process of conversion between reserve accounts and w-Digital Rupiah. To support this use case, w-Digital Rupiah platform will be integrated, interconnected, and interoperable (3i) with the existing BI-RTGS through a converter. Meanwhile, the processes of validation and settlement of fund transfers use case will be performed on w-Digital Rupiah platform. At this stage, participants can utilize sharing node prepared by Bank Indonesia or, in other words, does not need to prepare their own nodes.

At the next (intermediate) stage, w-Digital Rupiah use cases developed in the first phase will be expanded with additional use cases that support financial market transactions. These use cases include DvP for interbank money market and monetary operations, as well as Central Counterparties (CCP) fund settlements. At this phase, tokenization of securities will start to be developed on the w-Digital Rupiah platform. Parties that act as wholesalers will need to prepare their own nodes in accordance with their transactional needs.

DIGITAL RUPIAH ROAD MAP

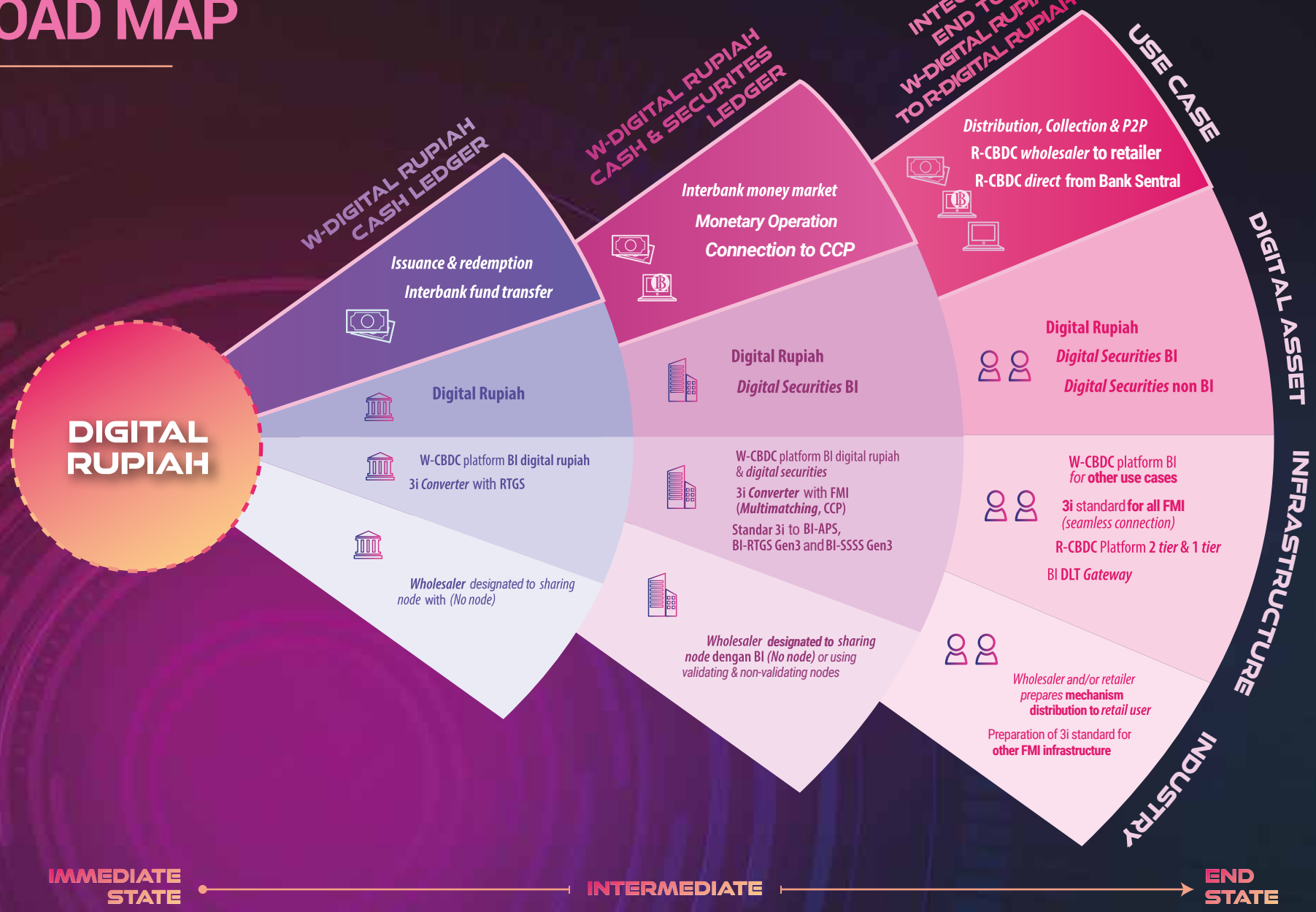


Figure 10. Digital Rupiah Road Map

DvP use case involves digital assets in the form of cash tokens (w-Digital Rupiah) and securities tokens. The process of issuing digital securities involves securities accounts held in BI-SSSS, as with w-Digital Rupiah issuance which involves reserve accounts in BI-RTGS.

In addition, connection to CCP will also be tested at this stage. Fund settlements resulting from clearing of standardized interest rate and exchange rate derivative transactions (for example, Domestic Non-Deliverable Forward – DNDF) will be performed in w-Digital Rupiah platform. The role of CCP will be essential in the aforementioned process by becoming a participant on the w-Digital Rupiah platform. Through this use case, w-Digital Rupiah platform will be seamlessly connected based on 3i principles with BI-APS (previously BI-ETP), BI-RTGS, and BI-SSSS.

At the final stage (end state), the concept of integrated end-to-end w-Digital Rupiah to r-Digital Rupiah will be tested. Bank Indonesia will develop use cases for distribution and collection, as well as peer-to-peer transfers, including payments, in r-Digital Rupiah platform. One of the key use cases that will be explored is conversion between w-Digital Rupiah and r-Digital Rupiah reflecting interaction between wholesale and retail markets. Parties who assumed a wholesaler role would need to develop a distribution mechanism. In addition, w-Digital Rupiah use cases will be expanded to include the issuance of digital securities by parties outside central bank, including their inclusion as collateral in monetary operations and money market.

> ***... DvP use case involves digital assets in the form of cash tokens (w-Digital Rupiah) and securities tokens.***

Fulfillment of 3i aspects in Digital Rupiah architecture at this stage will involve three types of experimentation. First, interconnection between w-Digital Rupiah platform and r-Digital Rupiah platform. Second, interconnection of w-Digital Rupiah and r-Digital Rupiah platforms with other FMIs without using converters. Third, development of DLT Gateway for interoperability with DLT platforms outside Bank Indonesia.

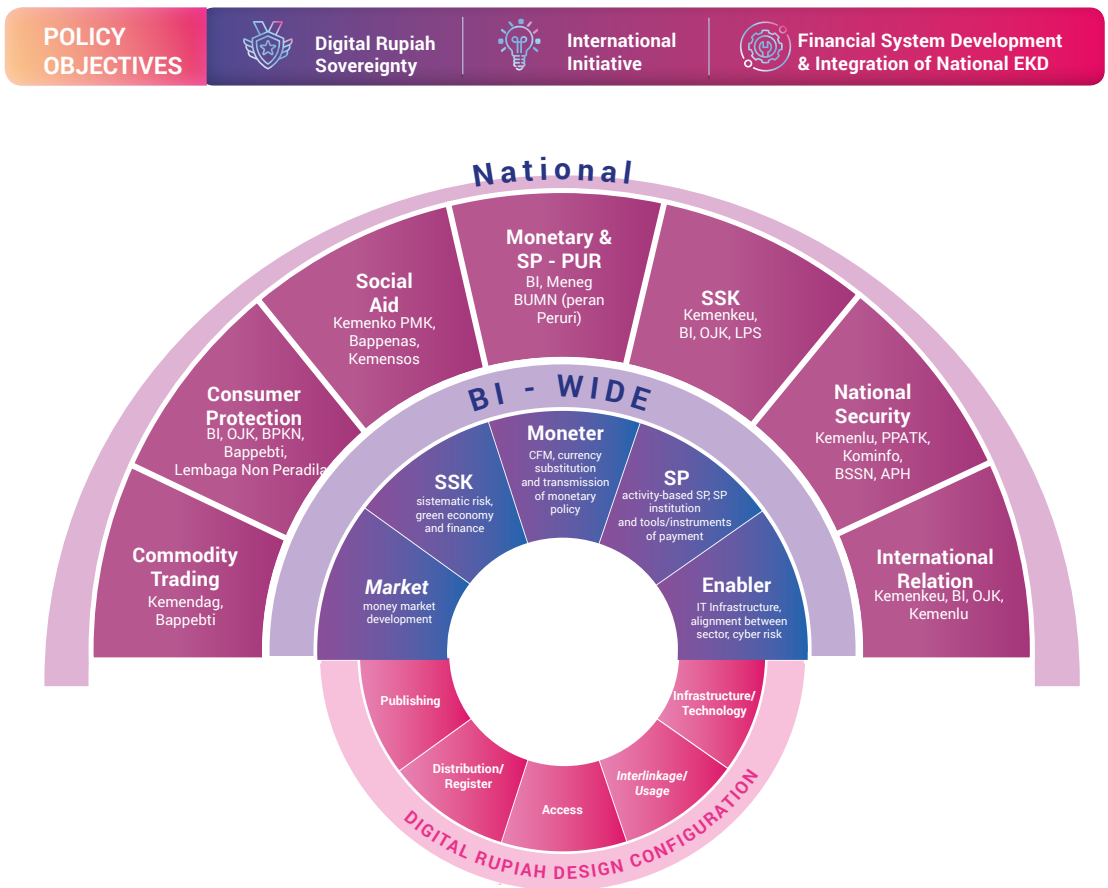
3.2 DOMESTIC SYNERGY AND COLLABORATION

Project Garuda is a national-scale initiative. Apart from having central bank dimension, Project Garuda also has embodied a rich national characteristic, given the position of Digital Rupiah as a national effort to preserve the sovereignty of Rupiah. The effectiveness

of its implementation will be determined by the creation of an end-to-end cross-sectoral ecosystem, which obviously involves all stakeholders from the supply side to the demand side. On this conceptual basis, support from all stakeholders is instrumental for the success of Project Garuda (Figure 11).

Synergy with stakeholders is an important part of the development of Digital Rupiah. Digital Rupiah development requires support beyond Bank Indonesia domain according to laws. Legal conformity, for example, requires support from government and parliament. Furthermore, public engagement in experimentation and piloting stages is a critical to ensure effective implementation of Digital Rupiah. Otherwise, the level of Digital Rupiah adoption would not be effective. Consequently, the achievement of the ultimate objective of Digital Rupiah development would be hindered.

Figure 11. Synergy & Collaboration with Stakeholders



Similar steps are also taken by central banks in several countries in developing their CBDC. The precedents and lessons learned from the development of CBDC in various countries will also be applied in the development of Digital Rupiah. Bank Indonesia will engage in active communication with all stakeholders regarding the plans for development of Digital Rupiah, through among others, publication of consultative papers, focus group discussions (FGD), and publication of technical reports from each stage of experimentation.

At the national level, synergy in Project Garuda will target seven non-exhaustive priority areas/issues:

- Monetary and payment system, which include issues and discussions on the impact of Digital Rupiah design options on monetary stability and the role of payment system industry in the Digital Rupiah business model;
- Financial system stability, which include issues and discussions on the impact of Digital Rupiah design options on financial system stability;
- Government transactions, which include the issues and discussions regarding the utilization of Digital Rupiah for the Government to Person (G2P) and Person to Government (P2G) use cases, including their use for social transfers and tax payments;
- National security, which includes issues and discussions on establishing cyber resilience;
- Consumer protection, which includes the issues and discussions regarding the design and mechanism of consumer protection;
- International relations, which includes the issues and discussions regarding the cross-border interoperability features in Digital Rupiah which allow it to be exchangeable with foreign CBDC; and
- Crypto asset trade, including the use of Digital Rupiah in the Web 3.0 ecosystem.

Solid cooperation and coordination among financial authorities, other relevant ministries and government agencies, and industry are necessary condition for Project Garuda. Those qualities can be optimized through inter-agencies discussion forum.

> ***... Project Garuda is a national-scale initiative that need synergy with stakeholders..***

3.3 INTERNATIONAL SYNERGY AND COLLABORATION

CBDC is seen as a prospective solution to carry out faster, easier, more transparent, and more inclusive cross-border payments. CBDC could overcome friction in cross-border payments such as funding cost, weak competition, fragmented and truncated data formats, complex processing of compliance checks, limited operating hours, legacy technology platforms, and long transaction chains.

CBDC, as a multi-currency platform, enables multiple parties to perform transactions and to pay each other directly using different currencies, without intermediaries such as correspondent banks. This is in line with the BIS survey in 2022, that efficiency in cross-border payments is the main motive for the development of wholesale CBDC, in both developed and developing countries. International initiatives in developing cross-border retail CBDC platform have been undertaken.

However, challenges remain. Despite the present of technical solution, designing interoperability across CBDCs from different jurisdictions would still requires a clear currency arrangement including issues related to capital flows management and liquidity provisioning.

These issues have become priority agendas at the international level. Cross-border interoperability of CBDCs occurs as one of the building blocks in FSB's Cross-Border Payment Coordination group. It is also underlined in G20 Presidency of Indonesia 2022.[32] As a concrete manifestation of Indonesia's efforts to promote this priority agenda, Bank Indonesia, in cooperation with the BISIH, conducted G20 TechSprint 2022 (Box 3). Similar initiatives have also arisen in multilateral studies, primarily driven by international organizations, such as Project Dunbar (RBA, SARB, BNM, MAS, and BISIH Singapore Centre), Project mBridge (HKMA, BoT, PBoC DCI, CBUAE, and BISIH Hong Kong Centre), and Project Jura (BdF, SNB, and BISIH Swiss Centre).

The issue in developing cross-border interoperability is also a concern of Bank Indonesia in the development of Digital Rupiah. Beside focusing on the development of domestic use cases, Bank Indonesia also anticipate the intention to align Digital Rupiah design with cross-border interoperability features. Project Garuda is a milestone for Bank Indonesia to engage with international discussion and initiative in this area.

Bank Indonesia will foster cooperation with global central bank communities and international organizations to achieve these objectives. In addition to cooperation with other central banks, Bank Indonesia will also collaborate with international organizations, among others include, the IMF, the BIS, and the World Bank in developing Digital Rupiah.

32. The 4th G20 Meeting of Ministers of Finance and Central Bank Governors in 2022 at Washington DC, expressed support for exploration of CBDCs as a payment solution between countries while maintaining the stability and integrity of the international monetary and financial system.

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GLOSSARY

Term	Meaning
Application Programming Interface	Mechanisms that enable two software components to communicate with each other using a set of definitions and protocols
Atomic Settlement	Atomic settlement is the instant exchange of two assets that are linked, such that the transfer of one occurs only upon transfer of the other one
Blockchain	Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network
Borderless	Without boundaries between countries
Capping	Limitation on balance or transaction value
Central bank money	Money that issued by central bank
Central counterparty	An entity that is the buyer to every seller and seller to every buyer of a specified set of contracts, e.g. those executed on a particular exchange or exchanges
Coexist	Exist side-by-side with other money
Collection	Process of collecting money
Composability	The ability to combine several operations/transactions into a single operation/transaction.
Cross-border	Between different countries, or involving people or businesses from different countries
Crypto asset	Digital assets that use public ledgers to prove ownership. They use cryptography, peer-to-peer networks and a distributed ledger technology (DLT) to create, verify and secure transactions
Crypto winter	A widespread collapse of crypto-asset valuations has cascaded through the crypto ecosystem and generated a number of high-profile firm failures
Cryptoization	A condition in which the use of crypto assets by residents are wide spreading and the adoption is more rapid as compared to official local currency
Decentralized Finance	A novel way of providing financial services that cuts out traditional centralised intermediaries and relies on automated protocols instead
Delivery versus Payment	A link between a securities transfer system and a funds transfer system that ensures that delivery occurs if, and only if, payment occurs
Digital Rupiah	Digital representation of Rupiah issued by Bank Indonesia
Digital securities	Digital representation of securities
Digital wallet	Interfacing toll for managing digital assets and cryptographic keys, especially private keys
Distributed Ledger Technology	A novel and fast-evolving approach to recording and sharing data across multiple data stores (or ledgers). This technology allows for transactions Bank and data to be recorded, shared, and synchronized across a distributed network of different network participants
Distribution	Process of distributing money
Do no harm	Avoiding any negative impact of an action / investment on the environment in which it takes place
Double spending problem	The expenditure of the same digital currency twice or more to avail the multiple services. It is a technical flaw that allows users to duplicate money
E-commerce	Venue or activity of electronically buying or selling of products on online services or over the Internet

Term	Meaning
Fintech	Technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated mate-rial effect on the provision of financial services
Fraud	Fraud is an act of deviation or omission that is intentionally to trick, cheat, or manipulate the Bank, customers, or other parties, which occurs within the Bank's environment and/or uses Bank facilities so that the Bank, customers, or other parties suffer losses and/or the perpetrator Fraud obtains financial benefits either directly or indirectly
Future proof solution	Solution that anticipates the future and developing methods of minimizing risks in the future.
Granular	The level of detail of your data within the data structure
Gross settlement system	A transfer system in which the settlement of payments, transfer instructions, or other obligations occurs individually on a transaction-by- transaction basis for full value
Integration, Interoperability, and Interconnection (3i)	Types of interlinkages among financial market infrastructures
Integration	The unification of post trade infrastructure in the same institution for the transaction service value chain
Interoperability	The ability for two or more systems to exchange information or transact without middleware
Interconnection	The ability between systems to exchange information or transact requires an intermediary, or in other words the interconnection between systems occurs indirectly
Issuance	Process of issuing money
Know Your Customer (KYC)	Principles applied to find out customer identities, monitor customer transaction activities, including reporting suspicious transactions
Ledger operator	Participant that can provide CBDC transaction & convertion services to no-node participant
Legal tender	Money that must be accepted if offered in payment of a debt
Lender of the last resort	A central bank that lends money to banks in difficult financial periods when they cannot borrow from anywhere else
Node	An integral piece of distributed ledger technology that store ledgers
Non-interest bearing	A financial instrument without any interest or remuneration
Outright	A transaction that is bought or sold individually and is not part of a multi-leg trade
Permissioned DLT	A closed-source distributed ledger technology variant where the participants are known, and authorization is required before usage or activity validation on the network
Permissionless DLT	An open-source distributed ledger technology variant where any party can participate in usage and activity validation on the network
Private money	A type of money which be issued by private entities
Programmability	A capability of Digital currency to integrate program in payments
Public goods	A commodity or service that is provided without profit to all members of a society, either by the government or a private individual or organization

Term	Meaning
Quantum Computer	A rapidly-emerging technology that harnesses the laws of quantum mechanics to solve problems too complex for classical computers
Quantum Resilient	An infrastructure that can withstand a quantum computing attack
QR code	A technological feature that allows payment transactions to be carried out only by scanning certain codes through a mobile application at the merchant
Redemption	Money burning process
Repo	A short-term secured loan where one party sells securities to another and agrees to repurchase those securities later
Retailer	A party who obtains Digital Rupiah through wholesalers and distributes it to end users
Sandboxing	The practice of isolating a piece of software so that it can access only certain resources, programs, and files within a computer system, to reduce the risk of errors or malware affecting the rest of the system
Settlement asset	An asset used for the discharge of obligations in financial market
Shadow banking	Credit intermediation involving entities and activities (fully or partially) outside the regular banking system
Shadow central banking	Central bank functions than can be replaced by other entities or mechanisms
Shadow currency	National currency functions that can be replaced by private money
Single point of failure	Any point in a system, whether a service, activity, or process, that, if it fails to work correctly, leads to the failure of the entire system
Smart contract	Programs stored on a blockchain that run when predetermined conditions are met
Software Development Kit	A set of software tools and programs provided by hardware and software vendors that developers can use to build applications for specific platforms
Stablecoin	Any cryptocurrency designed to have a relatively stable price, typically through being pegged to a commodity or currency or having its supply regulated by an algorithm
Tiering	Users' access to the services that arrange or organize in levels
Token	A bearer instrument which is a digital version of banknotes and coins
Tokenization	An operation to produce a digital representation of money/assets
Trading Venue	An infrastructure that functions to carry out financial market trades
Wholesaler	A party who obtains the right to access Digital Rupiah directly from Bank Indonesia and distributes it to retailers and end users