# Digital Turkish Lira Second Phase Progress Report

November 24, 2025


TÜRKİYE CUMHURİYET MERKEZ BANKASI

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# 1. Overview

Following the release of the Digital Turkish Lira First Phase Evaluation Report (the Evaluation Report) at the end of 2023, the Central Bank of the Republic of Türkiye (CBRT) initiated the second phase of the project. The work is being carried out in accordance with the principles of "privacy", "technological and architectural flexibility", "interoperability", "first, do no harm", and "intermediary-agnostic access", which were also cited in the Evaluation Report. The digital Turkish lira is intended to establish a base for innovative uses and a complementary payment channel, while ensuring uniformity in payments and enhancing financial inclusion. With the digitalization of the national money, the CBRT aims to preserve monetary sovereignty and the trust in the currency, as well as to increase efficiency in payments.

In the second phase of the Central Bank Digital Turkish Lira Research and Development Project (the Project), the CBRT —in coordination with its technology stakeholders[1]— is continuing its efforts on digital money.[2] Accordingly, work is underway to mature the prototype system developed in the first phase to a minimum viable product level and to incorporate financial intermediaries into the system. The second phase focuses primarily on programmable payments and offline payments. In addition, proof-of-concept studies on cross-border payments have been conducted within the CBRT.[3]

In addition to the work on the technological infrastructure, various analyses and preliminary work have been carried out on the legal and economic aspects of the project. In this scope, the CBRT runs simulations to assess the potential impacts of the digital Turkish lira on the financial system.[4] The results of these simulations will be published in the coming period.

Similar to the first phase, pilot tests will also be conducted in the second phase. Accordingly, system improvements, and new functionalities and scenarios will be tested. The pilots are planned to include scenarios that will increase real-time activity to measure the system's features and performance more comprehensively.

# 2. Fundamentals

**Digital money is the digital form of central bank money.** It can be used as a legal means of payment in both domestic and cross-border payments. **In Türkiye, the digital money is referred to as the digital Turkish lira.**

**The digital Turkish lira is not a different currency; it is the digital form of the Turkish lira.** Its value is the same as all forms of the Turkish lira (banknotes, bank money, etc.). It is

[1] As per the bilateral memorandums of understanding signed in 2021, TÜBİTAK, the Scientific and Technological Research Council of Türkiye, and technology companies ASELSAN and HAVELSAN, are the technology stakeholders of the project.
[2] As with the rest of the report, the term "digital money" is used as shorthand for "central bank digital currency".
[3] Programmable payments, offline payments and cross-border payments cited in this report also include money transfers.
[4] Current analyses have shown that in cases where the holding limits are set in a way that is consistent with existing user behavior, the circulation of the digital Turkish lira does not pose a systemic risk.

called digital only to indicate that it is a new form. It will not have a symbol or abbreviation different from the Turkish lira.

**Digitalization of money is a broad concept and should not be limited to the ability to make payments electronically.** Alongside money; financial assets, real-world assets, and workflows are also being digitalized. All these digitalization processes will help the financial innovation infrastructure in Türkiye to evolve. Consequently, the digital Turkish lira and the ecosystem that will be built around it will offer new services to users and reinforce user experience.

**Digital money is not a crypto asset.** There is a misconception that digital money is a crypto asset as it can also utilize distributed ledger technologies (DLTs), such as blockchain, which are used in crypto assets. Although digital money and crypto assets may share certain technological similarities, they differ entirely from an economic and legal perspective. Digital money will not be a commodity or capital market instrument; it will be a form of fiat money. Unlike crypto assets, digital money is a liability of a central bank.

**There are different opinions and studies around the world as to whether digital money should be remunerated or not.** Discussions are focused on the potential impact on demand: specifically, how remuneration would affect bank deposits, and how the absence of remuneration would affect digital money. As part of the Project, we are conducting impact analyses of these different scenarios. While a final decision is yet to be reached, the main scenario employs a non-interest-bearing model for the digital Turkish lira. This reflects the current focus on digital money being the digital form of banknotes.

**If the digital Turkish lira is put into circulation, banknotes and digital money will coexist.** The CBRT will meet the demand for both banknotes and digital money.

**The Digital Turkish Lira System consists of components that fulfill different functions related to the digital Turkish lira.** The core of this system is the Digital Money System, the component where transactions are finalized and recorded. Financial intermediaries operate the Service Layer component, which is under their control, to access the Digital Money System. The relevant parts of the wallet applications that serve end users are also considered components of the Digital Turkish Lira System.

**Transactions involving the digital Turkish lira will be carried out through financial intermediaries.** In line with the adopted two-tier structure, central bank will be in charge of issuing the digital money, while financial intermediaries will ensure user access to the digital money. Users will be able to access their digital Turkish lira accounts through any financial intermediary. In this way, similar to banknotes, the digital Turkish lira will be usable in an intermediary-agnostic manner.

**The Digital Money System does not store users' identity data.** While transactions are recorded within the Digital Money System, users' identity data is held solely by the financial intermediaries of their choice. Under the adopted architecture, the central bank does not possess identity data of end users and therefore does not associate any transaction with a specific user. Thus, it will not be technically possible for the central bank to track consumption habits or usage patterns.

**A digital identity is the set of representations associated with persons, assets, or objects.** Claims regarding ownership and affiliation, including qualifications,

authorizations, and past transactions, can be verified electronically in a secure and efficient manner through digital identity models. Therefore, digital identity should not be considered as an identification number but rather as an umbrella term. Various digital identity models exist to address different needs. The project adopts the Self-Sovereign Identity (SSI) model, which enables users to retain control over their own credentials.

**User privacy is prioritized in digital Turkish lira design and implementation**. The SSI approach offers advantages in terms of user privacy, as it ensures that information sharing is kept to a minimum, and that users retain control over their documents, including those containing personal data. To enhance privacy, users can utilize virtual accounts linked to their digital Turkish lira accounts.

# 3. Programmable Payments

In the first phase, studies involved the use of digital money and digital identity in common transaction flows. In the second phase, the flows involve assets besides money and identity. The aim is to enable the use of programmable payment features, which will allow for both delivery versus payment scenarios as well as innovative payment scenarios such as credential-based[5], scheduled and recurring payments.

The Evaluation Report also mentions streaming payments, IoT (Internet of Things) payments, and invisible payments. Streaming payments are addressed within the scope of recurring and credential-based payments as part of the second phase studies. IoT payments and invisible payments, on the other hand, are anticipated to advance through private sector initiatives. Accordingly, innovative project proposals concerning IoT payments have been covered under the “machine-to-machine payments” category in the Call to Join the Digital Turkish Lira Project Ecosystem.

The programmability component developed under the second phase provides an innovative infrastructure that enables users to execute instant or recurring payments based on predefined conditions. This component operates in an integrated manner with digital identity, the Digital Money System, and tokenized asset systems by automating payment processes. “Payment templates” and “payment packages” form the basis for the programmability component.

## 3.1. Payment Templates and Payment Packages

Payment templates are a set of rules defined by authorities and institutions based on specific conditions, providing the fundamental framework for secure transactions. Payment packages are created using these payment templates. Packages are based on predetermined and immutable rules agreed upon between the parties. This structure ensures transparency and trust, thereby minimizing associated risks. Unlike payment templates, payment packages can also be created by individuals.

Payment packages consist of two main elements: conditions and actions. Conditions can be based on either time or criteria and define the requirements that must be met for the

[5] Credential-based payments do not aim to restrict spending. On the contrary, this facility is intended to make payment processes more flexible and efficient based on specific criteria.

associated transactions to occur. Relational operators (such as “greater than” or “less than”) and logical operators (such as “and” or “or”) allow for the flexible creation of diverse rule sets within payment packages. Actions include making a payment, requesting a payment, applying a discount, and buying and selling assets, among others. Payments can be triggered instantly as well as at a scheduled date[6], periodically, or conditionally. Programmable payments are intended to operate in alignment with digital identities and digital assets. The aim of such payments is to reduce the operational burden for both individuals and institutions through enhancing automation and efficiency in financial transactions.

The programmability component includes a Programmable Payments Sharing Environment that allows payment packages to be created and utilized by parties upon request. Additionally, peer-to-peer sharing is possible.

Users' eligibility for the criteria included in payment packages is cryptographically verified using the SSI model, while preserving user privacy.[7] With the SSI model, information from different documents can be used together and transmitted and verified independently of the document issuers, allowing users to easily prove that they meet the various criteria included in payment templates and, hence, in payment packages. This structure enables the creation of flexible, targeted and user-friendly packages. Consequently, both user satisfaction and transaction security can be increased, in addition to the speed and cost benefits that come with the reduction of intermediaries through digitalization. The concept of payment packages facilitates the scaling of innovative flows compared to fragmented capabilities found in traditional systems and services, enabling them to reach a much wider user base.

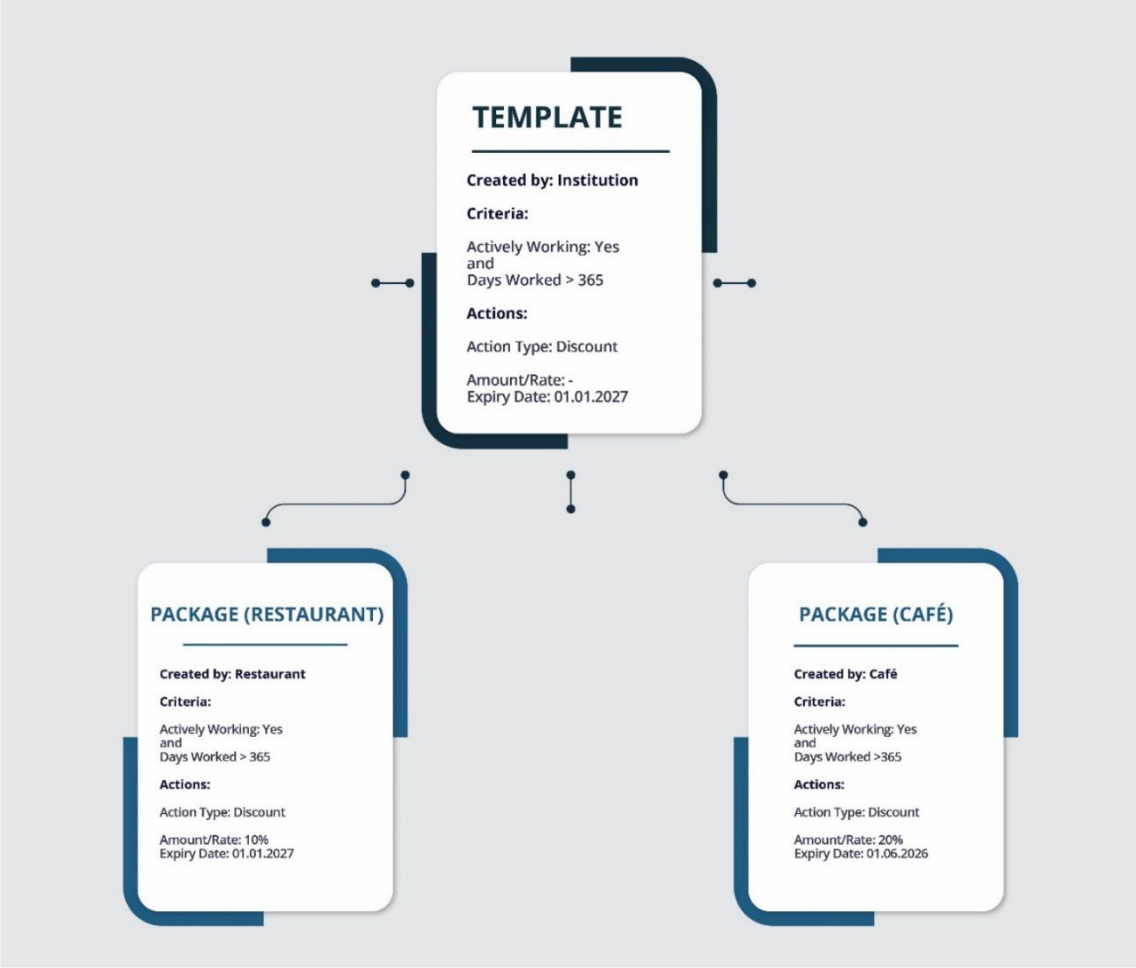
[6] In the Digital Turkish Lira System, payment messages are signed by the user with their own private key and transmitted to financial intermediaries. Financial intermediaries cannot initiate any payment transaction without users’ trigger. Therefore, for scheduled payments, the user’s signed payment order is recorded and the payment is made on the scheduled date using the stored order.

[7] The basic concepts of the SSI model are covered in section 3.1 of the Evaluation Report, while detailed information on how documents are issued and verified in the SSI model is provided in the “Appendix” of the report.

## Example Scenario of Programmable Payments

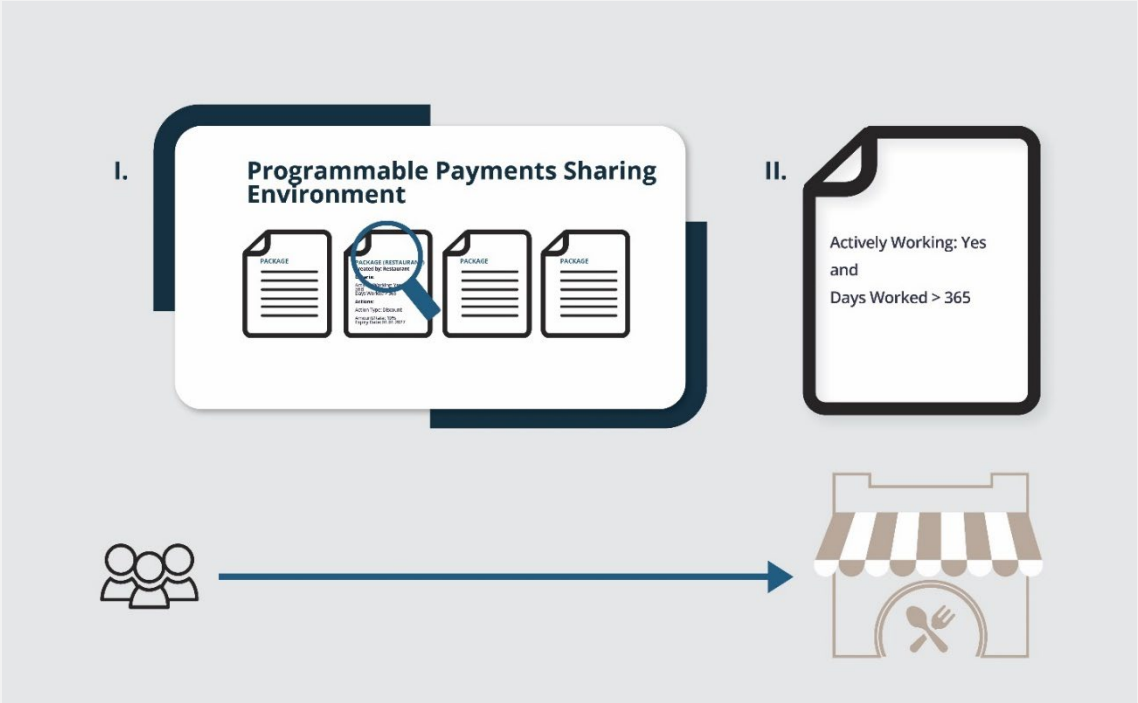
In the example scenario, restaurant and café businesses want to offer discounts to an institution's employees. The institution defines the payment template by setting the conditions for employees who are entitled to make use of the discount. The restaurant and café businesses then use the payment template to create their own payment packages. For the payment packages, the businesses determine the discount rate while maintaining the criteria in the payment template and they can set the expiry date to be earlier than that in the payment template. For instance, in this scenario, the restaurant business has set the discount rate at 10% and has not changed the expiry date in the template. The cafe business, on the other hand, has set the discount rate at 20% and changed the expiry date to an earlier date than the date in the template. An example payment template and example payment packages that can be used in this context are shown in Figure 1.

**Figure 1: Example Payment Template and Packages**




Employees of the institution who meet the conditions and want to benefit from these discounts, access the payment packages created by the businesses through the Programmable Payments Sharing Environment (Figure 2, Step 1). As shown in Figure 1, the relevant payment packages include criteria related to “Actively Working” and “Working Period.” For example, employees who wish to benefit from the discount at the restaurant can use the payment package by sending documents in digital form to the restaurant, proving that they meet these criteria (Figure 2, Step 2).

**Figure 2: Example Use of Payment Package**




The scenario described here shows an example of how payment packages can be used. Flows may vary depending on the scenario.

### 3.2. Digital Assets in Programmable Payment Flows

Payment flows may also include delivery versus payment scenarios. To test these scenarios, the Mock Asset System (MAS) was developed to represent tokenized assets. The MAS is a network that mimics an infrastructure holding representations of assets existing in a physical environment or assets issued directly in digital form. With the MAS, condition-based asset transactions and complex payment chains can be simulated without any impact or risk to a real system.

In the later stages of the second phase, it is anticipated that mock asset scenarios will be expanded to cover a variety of asset types (real-world assets, securities, etc.). Additional developments are planned to diversify conditions and combine payment packages to enable use with more advanced chained actions. The goal is to strengthen both the technical infrastructure and the user experience during this process.

## 4. Offline Payments

As stated in the Evaluation Report, the CBRT considers digital money not just a means of payment, but the digital version of banknotes. Digital money payments are expected to be capable of being executed without internet connection or mobile network access, as is the case with banknotes. To this end, work is underway on an offline payment function as part of the Digital Turkish Lira Project. Furthermore, with the offline payment function, digital money will create a complementary payment channel that is consistent with the principle of uninterrupted and continuous operation of payments, while also enhancing financial inclusion. The offline payment function will enable the use of the digital Turkish lira,

particularly in areas with limited network access, such as rural regions, or during service interruptions like natural disasters. Offline payments will not be limited to cases required out of necessity. They will be available for all transactions, including daily transactions. Method of payment will be based on the preference of the parties involved, covering both money transfers and payments to businesses. Proximity-based offline payments without network access offer a cash-like experience similar to physical payment transactions.

## 4.1. Technology

The main requirements defined in the design of offline payment technology are as follows:

- In a scenario where neither party has internet access, the recipient of the payment must be able to verify the transaction without being online.
- The recipient must be able to use the money received offline in another transaction later.
- A secure structure must be provided that safeguards the privacy of all relevant users in a series of offline payments resulting from successive transactions involving multiple users.

When developing offline payment capabilities, various design options arise that also influence the user experience. Two key elements stand out in this context: the hardware to store the balance and the tool to be used for exchanging payment information between parties.

The Evaluation Report lists smartphones, smart cards, and hardware wallets as options for storing offline balances. In the initial stage, developing a separate hardware wallet specifically for offline payments was deemed disadvantageous compared to alternatives, given its cost and the Project timeline. As for the smartphone solution, collaboration with device manufacturers and interaction with multiple firms to ensure device diversity are required.

As a result, smart cards stood out due to their low cost, established security standards, and already broad use. Although payment via smart cards requires an interface device, this need can now be comprehensively satisfied by smartphones, as many of them have the NFC feature. For these reasons, smart cards have been favored as the hardware choice in current studies. The cryptographic method employed to store the balance on the smart card and track transactions in the wallet has been developed with the flexibility to be compatible with future hardware options. This will allow various types of offline wallets to interoperate for offline payments.

While communication between the smart card and the smartphone is established via NFC, the options of Bluetooth and QR codes have been identified for sharing payment information between the parties. In current studies, the QR code option has been favored, prioritizing the user experience. As in the choice of hardware to store balance details, the solution for sharing payment information has been designed to be compatible with a range of future alternatives. Private sector is also expected to take on the provision of product-level offline payment solutions, in alignment with the CBRT's work.

### 4.2. Security

The offline payment design is based on cryptographic operations using public and private key pairs.

The Digital Turkish Lira Project employs tamper-resistant smart cards. This safeguards the private key from unauthorized access and ensures that balance details within the smart card application cannot be altered.

Along with cryptographic measures that guard against attacks like double spending, identification of potential cyberattacks is considered to be a part of security measures. Designs and developments have been made to detect attacks as soon as offline money is converted into online balance.

## 5. Interoperability and Integration

The Digital Turkish Lira System is being designed to interoperate with both current and prospective components of digital ecosystems, featuring a modular architecture. Here, interconnection with the existing financial infrastructure is an important requirement. This connection is expected to be established through the Service Layer and, by extension, financial intermediaries.

As a user-centric approach to digital identity, the Digital Turkish Lira System has adopted the SSI model starting from the first phase. The system has thus been connected to the SSI Türkiye Platform.

DLTs are seen to be widely used within the digital asset ecosystem. Consequently, the interoperability between digital assets and Digital Turkish Lira System is being tested through DLT-based MAS.

The use of digital money in cross-border payments is another interoperability issue. The CBRT continues its studies on this field. The model adopted in these studies assumes different currencies circulating on a common platform, and international money transfers being made directly using digital monies. If a common platform model is adopted globally, the Digital Turkish Lira System will need to be interoperable with potential emerging platforms.

### 5.1. Financial Intermediaries

As outlined in the Evaluation Report, financial intermediaries will be integrated into the Digital Turkish Lira System via the Service Layer. This layer will handle the know-your-customer process, user verification, and the triggering of digital Turkish lira transactions. Financial intermediaries are expected to be able to provide new financial services by integrating external systems into the Digital Turkish Lira System.

In the first phase of the project, a proof-of-concept study was conducted for the conversion between the digital Turkish lira and deposits. The second phase aims to evaluate conversion scenarios through pilot tests.

As part of the project's second phase, the CBRT has issued a call to join the Digital Turkish Lira Project ecosystem. Through this call, institutions from the finance and technology

sectors are encouraged to identify sample use cases, create innovative projects based on these cases, and collaborate with one another. The goal is to diversify the use of the digital Turkish lira and establish it as a key component of Türkiye's financial technology ecosystem.

The conditions and processes for integrating financial intermediaries into the Digital Turkish Lira System will be finalized in the third phase of the project, upon a decision for circulation.

## 5.2. Digital Identity

The SSI approach, which was adopted in the first phase of the Digital Turkish Lira Project based on the principles outlined therein, was applied in the second phase as well. In this phase, however, the SSI Türkiye Platform, provided by TÜBİTAK (the Scientific and Technological Research Council of Türkiye) and used in various projects, is preferred over the prototype private network developed in the first phase. Within the scope of the use cases for digital money, this platform does not store any personal data.

In addition to its functions in the first phase, the SSI model is used to verify conditions related to programmable payments. Personal information related to these conditions is in the users' possession.

In the future, while it will be possible to implement the SSI model specifically to digital money use, the model's full benefits will materialize with the widespread adoption of business wallets and digital document issuance by institutions and organizations. The proliferation of user wallets is anticipated to serve as a solution that will enable interoperability between different networks.

## 5.3. Digital Assets

Initiatives on the tokenization of various assets are ongoing worldwide. Accordingly, efforts are underway to ensure the interoperability of the digital Turkish lira with tokenized assets. In the second phase, the programmability component is positioned as the interoperability layer.

The MAS, a system developed for tokenized asset scenarios, is used to demonstrate interoperability. With the integration of the MAS into the Digital Turkish Lira System, users can view and manage their tokenized assets via their mobile applications.

## 5.4. Cross-Border Payments

One of the CBRT's priorities in the field of interoperability is the improvement and diversification of cross-border payments. Currently, cross-border transactions are costly and slow, involving complex processes with non-transparent intermediate steps. The use of digital monies in cross-border payments aims to resolve these issues through utilizing flows conducted via central banks and implementing distributed architectures, in contrast to the correspondent banking model.

A proof-of-concept study on using digital monies for cross-border payments has been conducted, with a focus on making payments in local currencies. With a common platform, it is expected that transaction flows are simplified, transparency is enhanced, and

transaction times and costs are reduced. A distributed structure has been favored for the platform, where each member central bank acts as a node operator with equal authority.

The study tested the flows involving the use of digital monies in cross-border payments on a private distributed ledger, in which smart contracts and various external applications were developed. Foreign exchange transactions are executed by the services in the common platform. When foreign exchange orders are submitted to the platform, these services use the available orders to determine the least-cost and most efficient path from the source currency to the target currency.

There are various projects worldwide addressing cross-border payments for different needs and use cases. These projects are not expected to converge into a single structure in the future. Going forward, countries might be participants of different cross-border payment platforms. Accordingly, studies conducted at the CBRT focus on the interoperability of multiple cross-border platforms. As part of the studies, a DLT-based network has been developed to link various platforms together. This network offers a range of functions, including cross-platform fund transfers and currency exchange.

# 6. Conclusion

By the end of 2023, the first phase of the project was completed and the second phase began. As discussed in this report, progress has been made in the areas of programmable payments and offline payments while the Digital Turkish Lira System is being matured as part of the second phase. Additionally, efforts are underway to enhance interoperability, including financial intermediary integrations, the application of digital identity on digital money, the use of digital assets, and cross-border payments. Accordingly, the current status of the digital money studies is illustrated in Figure 3.

**Figure 3: Current Status of Digital Money Studies**


Once the second phase studies are completed, the Digital Money System is expected to reach the minimum viable product stage; programmable payments, offline payments, and financial intermediary integrations are expected to advance toward the minimum viable product stage; and cross-border payments are expected to reach the prototype stage.

The Digital Turkish Lira Second Phase Progress Report aims to provide information on the current status of the project. An evaluation report for the second phase will be published after this phase is completed. The CBRT also intends to publish additional documents detailing the sub-topics of the studies.

As noted in the Digital Turkish Lira First Phase Evaluation Report, requirements, principles and approaches regarding the digital Turkish lira have been set in the first phase. Under this framework, studies on the technological, legal, and economic aspects are in progress. The second phase is planned to be finalized upon the completion of the ongoing studies. If the circulation decision is made, the third phase of the project will commence, during which legal and other relevant processes will be performed.