Unified Electronic Currency and its Software Design based on the Fourth Party Platform Integrated Payment Service

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***Abstract*—This paper presents a solution of unified e-currency and its software design based on the fourth party platform integrated payment service. The purpose is to solve the problems of distribution and resource-wasting caused by the lack of unified e-currency, and to solve regulatory difficulties due to regulation size caused by a wide variety of e-currency. Methods: This article first analyzes the problems in the development of e-money, and then proposes the concept of a unified electronic currency based on the fourth party platform integrated payment service. Besides, it proposes a unified mechanism and transaction procedures for unified e-currency, and carries on the software design, the structural design and the attribute design.**

***Index Terms*—The fourth party platform integrated payment service, Unified electronic currency, Unified billing, Software Design**

I. INTRODUCTION

Electronic currency has a strong vitality. Compared with the traditional currency, it has unique advantages, such as improving the operational efficiency of capital, reducing the transaction costs of clearing, beyond the constraints of time space and so on. However, we cannot ignore the problems which appeared in the development of e-currency. For example, the problems of unity, security issues and regulatory issues, etc. To solve the above problems of electronic money, we need to propose a complete solution from the entire payment chain perspective. Therefore, this paper will develop unified e-currency based on the fourth party platform integrated payment service.

II. INTRODUCTION OF THE FOURTH PARTY PLATFORM INTEGRATED PAYMENT SERVICE

The fourth party platform integrated payment service is a comprehensive payment service platform for the payment chain which is based on the theory of The Fourth Party Payment. The Fourth Party Payment is an integrated service provider of electronic payment and value-added service, it can provide a set of solution to customers by integrating and managing various resources as well as the capabilities of complementary providers, standardizing the E-commerce process and providing the supervision interfaces through its own payment and value-added service. The service provided by the fourth party payment enterprises are not solely from a perspective angle of payment, but for uniting various protocols, providing a third-party cross-authorization and electronic payment supervision modes, and more value-added services. [1]

III. UNIFIED ELECTRONIC CURRENCY BASED ON THE FOURTH PARTY PLATFORM INTEGRATED PAYMENT SERVICE

A. Issuing unified electronic currency platform environment analysis

Construction of the entire platform is on the basis of the integration of payment industrial chain, and covers all aspects of industrial electronic payment; this provides a good environment for the issuance of unified e-currency.

First of all, the fourth party platform integrated payment service provides bank payment platform interfaces and tax control interface, and reaches an agreement with the Bank, which provides a good financial environment for distribution of the issuance of unified electronic currency.

Second, scale effect of the fourth party platform integrated payment service will attract many businesses, third-party payment and value-added services, which can

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greatly increase the scope of a unified electronic currency in circulation.

Third, the fourth party platform integrated payment service provides unified payment protocol and uniform cross authentication protocol, which can promote the circulation of unified e-currency.

Fourth, unified clearing and settlement services of the fourth party platform integrated payment service will help clarify and simplify the complex process of clearing and settlement.

Fifth, the fourth party platform integrated payment service provides unified tax and unified regulatory interface, which is very beneficial for the development of unified electronic currency.

B. The concept of unified electronic currency

Unified e-currency is a kind of electronic cash in pure electronic form. It is issued by the fourth party platform integrated payment service under the supervision of the relevant regulatory authorities and can be generic used in the whole network (Internet and mobile networks) as well as common industry. The fourth party platform integrated payment service reaches agreement with various electronic currency issued subject, which can make the unified e-currency realize the direct exchange and indirectly achieve these mutual exchange between the electronic cash. Besides itself has very broad range of flow. Unified e-currency itself has strong versatility and convenience. It has the features of wide coverage and the bank independence.

C. Unified electronic currency mechanisms and transaction process

Unified e-currency includes two functions: one is using the traditional currency recharge for consumption; the other is the use of other electronic cash recharge.

- Obtaining process of unified electronic currency

The users store a certain amount of cash after they apply to the fourth party platform integrated payment service for account. And then they will receive the appropriate client software, and that is the electronic wallet. After that they can use electronic cash to make purchases. As shown in figure1:

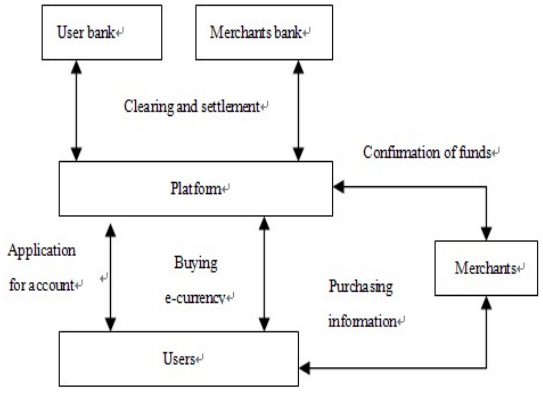

Figure 1. Obtain process of unified electronic currency

First, users apply to the fourth party integrated payment service for account.

Second, users login account and buy unified e-currency and download electronic purse through the net. And then unified e-currency will be stored in electronic purse.

Third, users choose commodities, then transfer product information and unified electronic currency to the businessman.

Fourth, businessmen confirm legitimacy of unified electronic currency to the fourth party integrated payment service.

Fifth, confirm the legality of unified electronic currency, businessmen delivery. Sixth, the fourth party integrated payment service makes unified settlement of funds according to financial information.

- Exchanging with other e-currency

Exchanging with other e-currency is a transitional method to promote the unified e-currency, which can also reduce the loss of the e-currency owners. At the same time, it is more favorable toward promoting unified e-currency.

Dead e-currency exchange: At present, there is Dead e-currency. The user makes an e-currency exchange, which can only buy the goods or services provided by the e-currency issuer, and cannot counter against the traditional currency. When the user no longer uses goods and services provided, the user account balance will be idle, resulting in waste.

In order to reduce this waste, the fourth party platform integrated payment service will reach agreement with all e-currency issuers, so that unified electronic currency can be as a bridge to realize the exchange between different dead e-currency. Unified e-currency exchanged from the dead e-currency can only be stored in the Internet account for the purchase of other e-currency, but it cannot be stored in the electronic wallet to purchase other commodities. The process shown in Figure 2:

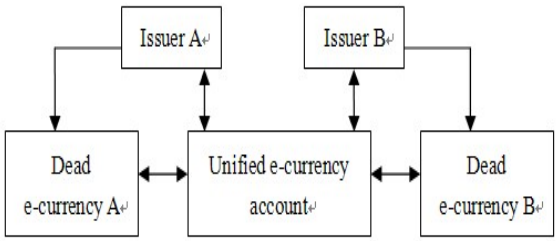

Figure 2. Dead e-currency exchange process

First, user logins the account of unified e-currency and makes dead e-currency exchange function available then selects dead e-currency A for exchange.

Second, user recharges unified e-currency with dead e-currency A; Then the fourth party platform integrated payment service adds the funds in the internet unified e-currency account according to e-currency exchange rate, and send encrypted recharge messages to dead e-currency issuer A; Dead e-currency issuer A deducts the funds in dead e-currency A account according to the encrypted recharge messages.

Third, user recharges the account B with the unified e-currency; then the dead e-currency issuer B adds funds in

the dead e-currency B account depending on the encryption information.

Fourth, the fourth party platform integrated payment service makes unified settlement and do hedge liquidation according to the recharge message.

Undead e-currency exchange: Undead e-currency is a kind of e-currency which can exchange with traditional currency. When the user no longer uses this kind of e-currency, e-currency account balance can be converted into bank account balances, and will not cause waste.

However, exchanging e-currency into bank accounts is a complicated, time-consuming and poor convenience procedure. When the account balance is very small, many users give up this part of the balance, resulting in a waste. And when users want to use other electronic currency, they can only use bank accounts to recharge. The e-currency cannot flow between different accounts, which are huge obstacle for the impact of a wide range of electronic money market.

Unified e-currency issuer reaches agreement with different e-currency issuers, through which other undead e-currency can be directly used to recharge and funds in the user electronic wallet will add. The funds can be used for shopping. The process shown in Figure 3:

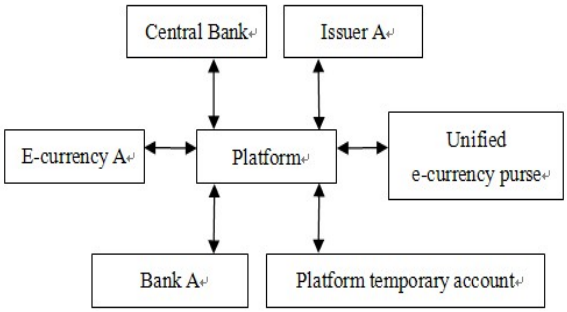

Figure 3. Undead e-currency exchange processes

In the process of exchange，unified e-currency purse must link to the Internet. Exchange funds are directly deposited into the electronic wallet, which can help separate unified e-currency and funds in Internet account out.

First, user logins unified e-currency wallet, select the recharge way: electronic cash recharge.

Second, user recharges unified e-currency purse with e-currency A.

Third, issuers of e-currency receive and sent recharge data through a special interface, then reduce the amount of e-currency A.

Fourth, the fourth party platform integrated payment service receives data through the special interface, send data to unified e-currency purse to increase the amount of e-purse.

Fifth, the fourth party platform integrated payment service makes unified settlement, then the funds of e-currency A in the bank A go to the temporary platform bank account.

- Characteristics of unified e-currency

Unified e-currency itself has strong versatility and convenience.

First, wide coverage. It includes the Internet and mobile networks. When they want to use e-currency to purchase the necessary items in the Internet or mobile networks, users just need to exchange unified e-currency. It is not necessary to exchanges two different e-currency respectively, which is very convenience for users.

Second, the currency exchange. It mainly refers that unified e-currency can be exchanged with varieties of e-currency, that is, unified e-currency is used as a bridge among varieties of e-currency, for example, exchanging foreign electronic money with unified e-currency, such as PayPal, liberty reserve and so on. It is a great market in China.

It has the problem of exchange rates when exchanging foreign electronic money. The fourth party platform integrated payment service will be on the basis of real-time exchange rates. Of course, it is not limited to conversion of foreign currency, which can stimulate the development of unified e-currency in the early time.

Third, the Bank independence. The fourth party platform integrated payment service reaches agreement with various banks and issues unified e-currency. The user can use these bank cards to get unified e-currency. Users can use the unified e-currency interbank business, without worrying about the various standards and protocols not compatible, and need not care about that their own bank card issuers do not issued e-currency or other business banks do not accept their e-currency. The fourth party platform integrated payment service issues unified e-currency, so the banks do not need to issue their own e-currency, which reduces issuance costs for banks and electronic money regulation size.

IV. UNIFIED E-CURRENCY SETTLEMENT MECHANISMS AND PROCESSES

The fourth party platform integrated payment service provides unified settlement function, and unified clearing and settlement of unified e-currency is completed in the fourth party platform integrated payment service. This platform itself includes the issuance money, regulation, clearing and settlement, tax and other aspects. Concentration of function is conducive to management and control of unified e-currency, the following is analysis of settlement of unified e-currency.

A. Unified e-currency shopping capital clearing and settlement

Currently, the main problem of domestic clearing is the cross-bank liquidation. Therefore, in the process of the cross-bank liquidation of unified e-currency, we introduce unified settlement of the fourth party platform integrated payment service.

User uses the bank account A to buy unified e-currency, the funds remains in the fourth party platform integrated payment service temporary clearing account. When using the unified e-currency shopping, the liquidation process is as follows:

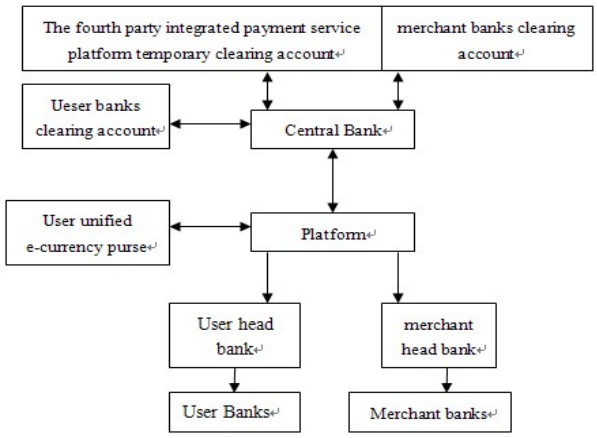

Figure 4. Unified e-currency shopping capital settlements

First, user buys unified e-currency and the purchase information is passed to the fourth party platform integrated payment service.

Second, the fourth party platform integrated payment service receives purchase information which includes user account information, funds information and so on.

Third, the fourth party platform integrated payment service sends finished information to the central bank, and then the central bank transfers the funds from User Banks to the fourth party platform integrated payment service temporary clearing account.

Fourth, user uses unified e-currency purse to pay, and the secure payment information is passed to the fourth party platform integrated payment service

Fifth, the fourth party platform integrated payment service receives users' secure payment information. This information includes user payment amount information, the user bank information, and business information. The fourth party platform integrated payment service based on business information; determine the business bank account information, and business information.

Sixth, the fourth party platform integrated payment service clears up the financial information and bank account information received, analyzes the flow of funds between various banks, and makes the transmission of finished information to the central bank.

Seventh, according to information received, the central bank makes the capital settlement, and then sends the funds from the fourth party platform integrated payment service temporary clearing account to merchant banks clearing account.

Eighth, the central bank transfers liquidation Information to the fourth party platform integrated payment service, then the information is cleared up and sent to the merchants head bank by the platform.

Ninth, the head band sends the specific account information and financial information to the merchant bank branches, making the primary account and fund settlement.

B. Non-unified e-currency shopping capital clearing and settlement

When making purchases, the user can directly use the non-unified e-currency. Platform can judge issuer and currency exchange rates of RMB, according to the type of e-currency, and clears up the funds directly with the issuer bank account. It needn't to be converted into unified e-currency. The liquidation process is the same as the direct use of unified e-currency.

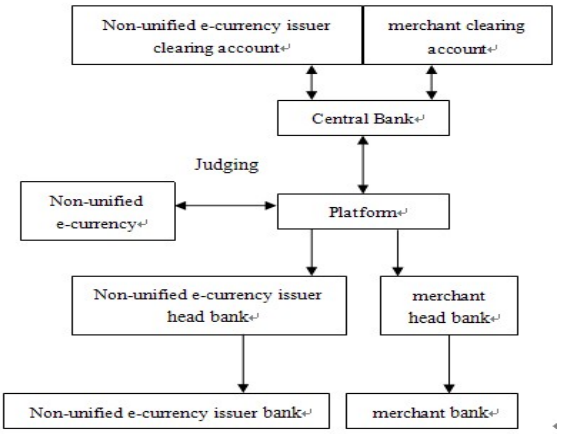

Figure 5. Non-unified e-currency shopping capital settlement

C. Dead e-currency and Undead e-currency clearing and settlement

Dead e-currency. The amount of Dead e-currency exchange is usually little, and the exchange involves interests of various businessmen. Therefore, dead e-currency uses the way of hedging accounts directly to clear up. The way of hedging accounts directly to clear up refers that it directly hedges user's account among dead e-currency issuers, is not to involve in the actual transfer of funds.

When the users exchange other kinds of dead e-currency, the fourth party platform integrated payment service passes exchange information collected to dead e-currency issuers in time. According to information received, issuers increase or decrease the amount of user e-currency accounts. In the conversion process, the fourth party platform integrated payment service control dead e-currency exchange rates, the funds still remain in the original publisher account.

Undead e-currency clearing and settlement. The users choose the function of undead e-currency exchange. The fourth party platform integrated payment service must reach agreement with undead e-currency issuers; provide the interface for them, clearing up thought the platform. Its liquidation mainly relates to inter-bank settlement; the process is the same as using Internet Bank to buy unified e-currency.

V. UNIFIED E-CURRENCY SAFETY AND REGULATORY

As we can see, unified e-currency has strong ability of circulation. To a certain extent, it has been very close to the traditional currency. Therefore, the safety and regulatory of circulation for unified e-currency is one of the most important factors.

A. Unified e-currency safety

The anti-money laundering: The strong ability of circulation that unified e-currency has is convenient for

money laundering activities. The fourth party platform integrated payment service can prevent from money laundering through these means which are mentioned below: First, the platform has strict censorship and control, and all e-currency issuers access into the platform are included in scope of financial regulation. Second, the platform closely contacts with the central bank to identify unusual and suspicious operations. Third, there is critical review of user identities, and creates detailed log. Fourth, the platform establishes the perfect certification system, and backup the private key to prepare for tracing purposes.

Data security： The data security is mainly the security of transmission and storage process. During transmission, the fourth party platform integrated payment service uses CA authentication, encryption and other technologies to ensure data security. In the storage process, the fourth party platform integrated payment service conducts detailed backup and strict management system to ensure data security.

The system security： There are two aspects of system security, including system stability and system flexibility. System stability is that the fourth party platform integrated payment service is not stopped. The computer network system must be running every day and not failure, which requires the platform device with a high degree of reliability. System flexibility is that the platform system must be able to reformed and expanded. A variety of emerging business will develop; the platform should be able to extend the system to run various applications. The fourth party platform integrated payment service uses cloud computing architecture system, which the advantages to fully meet the requirements of stability and flexibility.

B. Unified e-currency regulatory

The central bank regulation： The fourth party platform integrated payment service provides specialized interfaces to the central bank, for passing messages between the central bank and the platform, and achieving the central bank's regulatory purposes. The central bank achieves supervision of unified e-currency. First of all, the central bank develops a unified e-currency and RMB exchange rate, methods of exchange and monitoring, makes various businesses fulfill this requirement in order to address the issue of the impact of the RMB. Secondly, there is the analysis of unified e-currency flow in the network to provide unified e-money circulation; the central bank directly determines its circulation to solve the problem of inflation.

Tax regulation： The fourth party platform integrated payment service provides specialized tax interfaces for taxation of e-commerce transactions. The platform accesses a large number of merchants and issuers of e-currency. Through this interface, the tax authorities can track transactions to determine the tax object and subject, and make the taxation of e-currency in circulation as well as tax regulation.

VI. UNIFIED ELECTRONIC CURRENCY DETAILED SOFTWARE DESIGN

A. Model of unified electronic currency

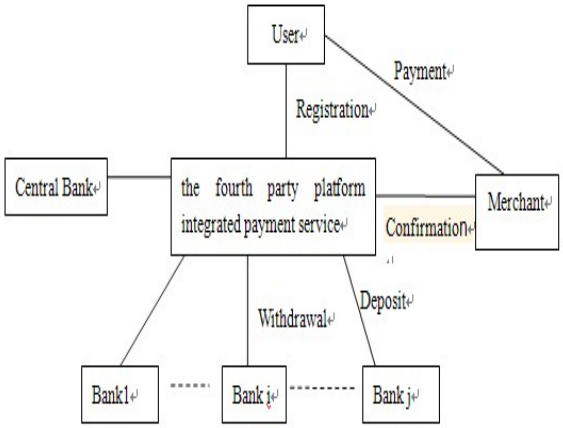

Figure 6. Model of unified electronic currency

It can be seen from the above, there are extracting, paying and storing three processes in the life cycle of e-cash uniform. Both users and vendors should register on the fourth party platform integrated payment service to communicate. Each bank reached an agreement with the platform, the platform to provide specialized communication interfaces.

*Registration: u*sers and venders finish registration and provide their bank details, download the e-wallet and get platform public key.

Withdrawal: users get uniformed e-cash from the fourth party payment service platform. Platform confirms whether the user's account have enough cash in the bank through a dedicated interface. If have, platform distribute e-cash to user's e-wallet and signed with the user interaction, while reducing the funds in bank account. In order to ensure that users with anonymous access to the premise of a unified electronic platform, the lawful currency of signatures, the user will interact with the platform for the implementation of the blind signature protocol, while a unified platform for electronic money must be satisfied on the user containing the necessary information.

Payment: users buy goods form the venders, and pay the uniformed e-cash to venders. Then, venders send payment information to the platform. The platform confirmed the validity of payment. If it is true, notify the merchants to accept transactions effectively, and funds go to the merchant account j at the bank, while completing unified electronic money recovered.

Tracking: In order to prevent extortion and money laundering and other illegal and criminal activities occurred within the scope permitted by law, consumer information platform for consumers and unified electronic currency tracking.

B. Unified E-currency Software Design

- Unified E-currency Design Structure

The fourth party platform integrated payment service must contain core software, which are platform server, the user e-wallet, merchant E-money processing software.

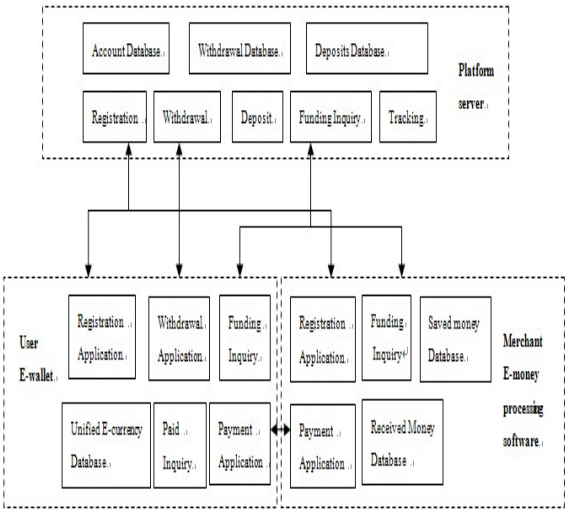

Figure 7. Unified E-currency Design Structure

- Unified E-currency Properties Design

The fourth party platform integrated payment service:

TABLE 1 ACCOUNT DATABASE

Field	Type	Remarks
ID	INT	Users sign up on the platform of random identity
Fund	INT	User account funds

TABLE 2 WITHDRAWAL DATABASE

Field	Type	Remarks
IDu	String	Withdrawal user random identity
Amount	INT	Withdrawal amount
TimeTFP	String	Timestamp issued Unified E-currency
W_Date	DATE	Term of validity for Unified E-currency
PK	String	If the Unified E-currency is already issued, platform records user public key in this filed
c#	INT	1024 bit random numbers

TABLE 3 DEPOSITS DATABASE

Field	Type	Remarks
IDs	String	Deposit merchant random identity
IDu	String	Withdrawal user random identity
Amount	INT	withdrawal amount
TimeTFP	String	stamp issued Unified E-currency
W_Date	DATE	Term of validity for Unified E-currency
PK	String	If the Unified E-currency is already issued, platform records user's public key in this field
c#	INT	1024 bit random numbers
used	String	If Unified E-currency is already used, in this field user's public key and transaction identification number are recorded

System establishment: With U, S, TFP, they represent users, businesses, and platform. p, q are two large prime numbers satisfying q |p-1, $p \geq 2^{512}$, $q \leq 2^{160}$. g is a generator of G_q subgroup and $g \in Z_p$. U, S, and TFP's private keys

User E-wallet:

TABLE 4 UNIFIED E-CURRENCY DATABASE

Field	Type	Remarks
IDu	String	Withdrawal user random identity
Amount	INT	withdrawal amount
$Time_{TFP}$	String	Time stamp issued Unified E-currency
W_Date	DATE	Term of validity for Unified E-currency
PK	String	If the Unified E-currency is already issued, platform records user's public key in this field
c#	INT	1024 bit random numbers
x_U	String	User key

TABLE 5 PAID DATABASE

Field	Type	Remarks
IDu	String	Withdrawal user random identity
Amount	INT	withdrawal amount
Tim_{eTFP}	String	stamp issued Unified E-currency
W_Date	DATE	Term of validity for Unified E-currency
PK	String	If the Unified E-currency is already issued, platform records user's public key in this field
c#	INT	1024 bit random numbers
amount	INT	Payment amount
IDs	String	Deposit merchant random identity
TID	INT	Unique data identification number used in recording each transaction
Timeu	String	Time stamp of the Unified E-currency Payment

Merchant E-money processing software:

TABLE 6 RECEIVED MONEY DATABASE

Field	Type	Remarks
IDs	String	Deposit merchant random identity
Amount	INT	withdrawal amount
TimeTFP	String	stamp issued Unified E-currency
W_Date	DATE	Term of validity for Unified E-currency
PK	String	If the Unified E-currency is already issued, platform records user's public key in this field
c#	INT	1024 bit random numbers
amount	INT	Payment amount
TID	INT	Unique data identification number used in recording each transaction
Timeu	String	Time stamp of the Unified E-currency Payment

TABLE 7 SAVED MONEY DATABASE

Field	Type	Remarks
amount	INT	Payment amount
TID	INT	Unique data identification number used in recording each transaction

are x_U、x_S、$x_{TFP} \in G_q$, the corresponding public key are $y_U = g^{xU} \bmod p$、$y_S = g^{xS} \bmod p$、$y_{TFP} = g^{xTFP} \bmod p$. Sign said

the message signed, VerSign is the signature verification. H Said one-way hash function, Time said timestamp.

Withdrawal: U establishes withdrawal application message M= (ID_u‖Amount‖W_Date‖$Time_U$). M′=Sign (M), encryption of (M, M ') is sent to the platform.

Platform verifies the formula VerSign (M′) =M. If the result is true, then the platform communicates with the bank through the bank interface, implementation of two interactive processes. First Platform verifies the adequacy of funds in user account, if not enough alerts the user. If there is adequate account from the U, the amount is deducted. At the same platform generates E= ($coin_1$, $coin_2$, …, $coin_n$), and Unified E-currency C_1= (ID_u-‖Amount‖c#‖W_Date‖E‖PK‖used‖$Time_{TFP}$).

Platform randomly chooses a number $k \in Z_p^*$, $k \neq 1$, and calculates $r=g^k \bmod p$. With the r, C_1 transmission to user U, platform records (r, ID_u, M, M ').

U randomly chooses number α、$\beta \in Z_p$, calculates $r'=rg^{-\alpha}y_{TFP}^{-\beta} \bmod p$, $e=h(r', C_1) \bmod q$, and $e'=e+\beta \bmod q$, then sends e′ to platform.

After the platform receives e ', it calculates s ' =k- e ' modq, and s ' is sent to U.

U calculates S_u= s ' – βmodq.

Then after platform blind signature, U obtain Unified E-currency C_2= (C_1 ‖S_u ‖e ').

Payment: After the user chooses the commodity, takes out the currency which value is amount from the currency which value is Amount. The division obtains E ' = ($coin_1$ ', $coin_2$ ',…, $coin_n$ '), and replaces ($coin_1$, $coin_2$,…, $coin_n$). At the same time, the e-wallet produces a random number to save as the transaction series number under TID, then it obtains C_2 ' = (ID_u ‖amount ‖c# ‖W_Date‖E ' ‖PK ‖used ‖$Time_u$ ‖TID). The business will send the Unified E-currency to the platform, confirm its validity by the platform as well as whether excess payment, if it is effective, then the platform notifies bank account transfer, simultaneously recycles the Unified E-currency.

Its interactive step is as follows:

U signs C_2 ' and obtains $Sign_U$ (C_2 '), and transmits (C_2 ', $Sign_U$ (C_2 ')) to the business.

If the result of the confirmation of VerSign ($Sign_U$ (C_2 ')) = C_2 ' is true, then with the inserting information it obtains C_3= (C_2 ' ‖ID_S ‖$Time_S$), and sends (C_3, $Sign_S$ (C_3) to the platform after the encryption.

The platform confirms VerSign ($Sign_S$ (C_3)) = C3, if for really, then confirms the blind signature. The platform calculates $r'' = g_s\, y_{TFP}^{e} \bmod p$, confirms $e=h(r'', C_2) \bmod q$. If it is true, then the platform confirms the new submission TID as well as the user public key, if in Deposits database, they are already saved, then it means that the business submits the Unified E-currency two times, the valid confirmation defeat, the platform does not give accepts with transfers accounts, simultaneously informs the business; if they are not stored up, the platform notifies bank to carry on the account transfer, after transferring accounts successfully, informs the business to trade successfully.

Tracking: In order to prevent and track online criminal activity, or to resolve disputes trading activities, the payment system should provide user anonymity revocation mechanism. Revoking the anonymity of the user relies mainly on the tracking of the user or money. In the system, U and S registration in the TFP, TFP records ID_u and ID_S which can be associated with the user and merchant identity number and account information, to track the users and resources.

VII. SUMMARY

Anonymity: Users buy uniformed electronic money is used blind signatures. Blind signature is a means to prevent the recipient in the message signed by the signer to obtain the specific content of the case taken by a special digital signature technology. Therefore, banks and businesses can not track the use of the uniformed e-cash by collusion. E-cash is not the unity of the purchasing behavior of users linked together to cover the user's purchase history of electronic cash;

Non-repeatability: Uniformed e-cash only can be used once. It is very easy to check out the repeat use of e-cash.

Unforgeability: No party can produce effective e-cash alone, so fake is not feasible.

Divisibility: The solution to divide uniformed e-cash is (N, K) payment mode. Platform signs several e-cash E once, while users can pay by E for any times. The payment is an integral number of small e-cash. E-cash every small cost cannot be repeated, therefore, between different electronic cash cannot be linked together with non-connectivity, thus protecting the user's identity privacy. After the separating of e-cash, the original serial number is used. This time, user’s e-purse transaction sequence number generated by TID, in fact, a second serial number, unlike venders also use this to mark a transaction, when the uniformed e-cash send to the platform, the platform will be transferred back to the user after the success of the existence of a public key and TID in a field named used, so that this electronic money has been spent, next time if there is a new currency to be compared used. Uniformed e-cash back once they are divided users to reduce the corresponding amount of e-purse, venders send payment information to platform to verify before accept a uniformed e-cash. The purpose of e-currency exchange is to replace the other e-currency smoothly in the early development. Security and supervision of unified e- currency must be able to keep up with development of unified e-currency, which requires the State and the community to pay adequate attention.

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