A Trusted International Settlement Solution Based on Cross Check of CDRs

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Abstract. This paper proposes a trusted international settlement solution based on Cross Check of CDRs, improving the credibility and verification efficiency of international settlement, and preventing fraud and tampering. Based on the distributed settlement architecture of blockchain and cloud database, the solution confirm the CDRs of home operator, roaming operator, transit operator, third-party operator and user to form a trusted consensus. Based on smart contract reducing the duplication check of CDRs and bills, the solution improve the operational efficiency. Using cloud database and blockchain deposits technology, the solution solve the data storage capacity limitation and data tampering problem of blockchain. The solution effectively solves the problems of CDRs fraud, data tampering and disclosure, CDRs/bill duplication check in the existing international settlement service of operators. Experiment proves that the settlement efficiency of the single operator in the solution can be improved to hour level to realize the fully automation of settlement process.

Keywords: Settlement · Blockchain · CDRs

1 Background

With the continuous advancement of globalization, exchanges between countries and personnel exchanges has become more and more frequent, and operators' international settlement business has become more and more arduous. Taking an operator as an example, it has international roaming services with nearly 400 foreign operators and nearly billion CDRs service per day, which requires a lot of manpower and resources to carry out CDRs and account confirmation.

Blockchain technology is an integrated innovation of P2P (peer to peer) network, consensus algorithm, cryptographic algorithm, and smart contract. Telecom operators can use blockchain technology to establish mutual trust and cooperation between operators, communication industry. They also can try to apply blockchain technology to roaming settlement [1], security, IoT, electronic payment, copyright protection and many other fields [2].

2 Existing Technologies and Shortcomings

In the scenario (as shown in Fig. 1) of existing international settlement business (including user visiting/visited SMS, telephone service, traffic service, etc.): David of home operator (Operator A) visits country B and uses roaming operator(Operator B) service of country B. David calls Emma of third-party operator (Operator C) in country B. In this scenario, the settlement parties include home operator, roaming operator, third-party operator, transit broker 1 between home operator and roaming operator, and transit broker 2 between roaming operator and third-party operator.
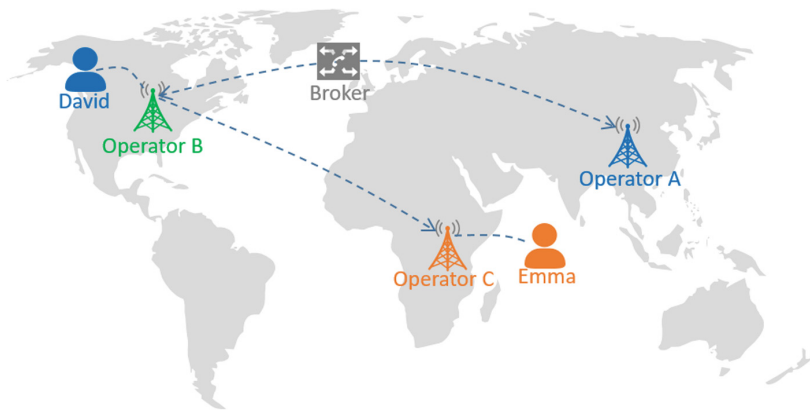

Fig. 1. Roaming call scenario

According to the contract, home operator shall pay roaming charges to roaming operator, third party operator, transit broker 1, and transit broker 2 within the contract period. The existing international roaming settlement process is as follows:

(1) Roaming operator and third-party operator create a roaming CDRs of home operator.
(2) Submit CDRs to home operator daily or monthly.
(3) Home operator performs the CDRs format check according to CDRs standard of GSMA (whether the format meets the standard, whether the logical correlation between the CDRs values is correct, etc.), returns confirmation if the verification succeed. If there is an objection, roaming operator and third-party operator performs step 1 again to generate the revised CDRs.
(4) According to the contract, roaming operator and third-party operator generate a bill based on the CDRs, then send the bill to home operator.
(5) Home operator validate the bill according to the previously confirmed CDRs and agreements. If there is any objection to the statement, roaming operator and third-party operator are sent a report, and step 4 is executed to generate the revised bill; if there is no objection, the confirmation would be sent.

(6) After receiving the confirmation, roaming operator and third-party operator shall generate the amount bill based on bill receivable and bill payable.

(7) Home operator performs payment with other operators and the transit brokers.

In the existing international settlement process, the main problems are as follows:

- The CDRs is provided by a roaming operator, and the CDRs is easy to be distorted. If the system of roaming operator has a clock inconsistency failure or the data flow process is artificially modified, the CDRs data will be distorted
- Duplication check of CDRs/bills consumes a lot of manpower. Home operator check the CDRs, bills which provided by roaming operator. Both CDRs and bills need to be checked separately by both parties, and it takes a lot of manpower.
- No user participation in the settlement process, complaints are easy to occur. Due to the long time period, it is easy to make doubts about the consumption and lead to complaints.
- Lack of credit evaluation system for operators and transit brokers. The lack of a fair and open credit evaluation query platform among operators increases the cost of new business development.

3   Proposed Blockchain Framework

This paper uses the characteristics of blockchain, which is decentralized trust, distributed accounting and consensus mechanisms, combined with smart contracts, introduce blockchain technology into existing international settlement processes, and provide an efficient and reliable blockchain platform solution for international settlement business [3, 4]. The overall architecture of the solution is shown below (Fig. 2).
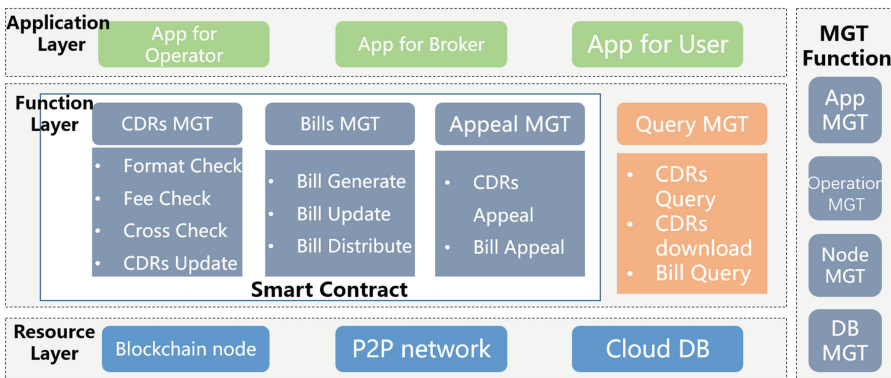

Fig. 2. Architecture

The solution is based on the consortium blockchain. Each participant (home operator, roaming operator, third-party operator, transit broker, user) participates in the blockchain platform to implement the CDRs Cross Check, Bill Output, Credit Evaluation and display through the blockchain platform.

The key processes of this solution are: (1) Smart Contract Maintenance, (2) CDRs Format Check, (3) simple CDRs Generation, (4) CDRs Upload, (5) CDRs Cross Check, (6) Unified Bill Output, (7) International Settlement, (8) Credit Rating Evaluation, (9) Credit Inquiry.

(1) Smart Contract Maintenance

Maintenance word of Credit Rating Evaluation smart contract, Billing smart contract, CDRs Cross Check smart contract in the process [5].

Billing smart contract is mainly used for the generation of unified bills. It is prepared by home operator according to the contract signed between operators and transit brokers, and is confirmed to be stored in the blockchain by the roaming operators and transit brokers. Home operator updates the smart contract synchronously when the billing contract is updated.

Credit Rating Evaluation smart contract calculates the credit rating according to the format check, the tariff rate check, the false CDRs, the timely settlement rate, and the user complaint rate of the international roaming participants.

(2) CDRs Format Check

Roaming operator, home operator, third-party operator need to perform format check by format standard of GSMA.

(3) Simple CDRs Generation

Roaming operator, home operator, third-party operator will generate the original CDRs to simple CDRs (including the necessary fields for generating bills, such as the calling number, called number, home operator code, duration, etc.) in accordance with format standard of GSMA, and fields of simple CDRs of all operators should be consistent.

Home operator, roaming operator, and third-party operator will perform the simple CDRs generation according to the following rules [6].

- Simple CDRs of roaming operator. The original CDRs are classified according to the operator ID of the calling number, and then classified again by operator ID of called number.
- Simple CDRs of home operator. The original CDRs are classified according to the operator network identification used by the calling number.
- Simple CDRs of third-party operator: The original CDRs are classified according to the operator ID and the operator network ID used by the calling number.

(4) CDRs Upload

Roaming operator, home operator, third-party operator upload the original CDRs and the simple CDRs into the cloud database every 30 min (the time period can be set, such as 30 min, 1 h).

Roaming operator, home operator, third-party operator upload access URLs, hash value of original CDRs and simple CDRs into the blockchain.

(5) CDRs Cross Check

The CDRs Cross Check smart contract validates the hash value of simple CDRs uploaded by home operator, roaming operator, third-party operator in 5 min after every 30 min CDRs uploaded. If the hash value is consistent, the user's CDRs are valid; if the hash value is inconsistent, the CDRs need to be reprocessed (Fig. 3).
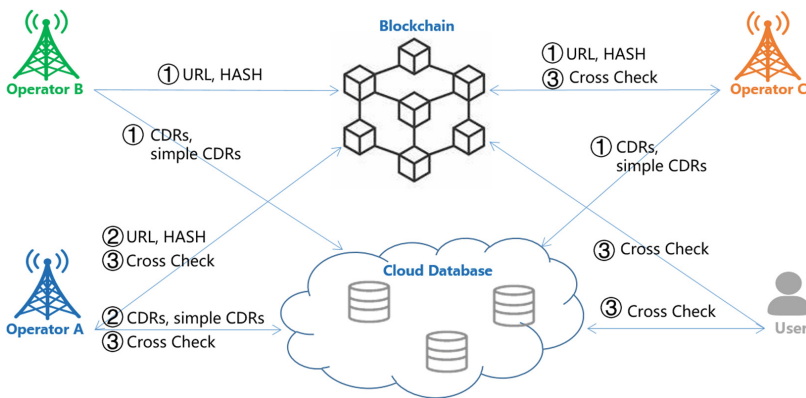

Fig. 3. CDRs cross check model

(6) Unified Bill Generate

After the agreed period (such as one month), Billing smart contract generates a unified bill for the previous month, and records the bill in the blockchain.

(7) International Settlement

The international roaming participants (home operator, roaming operator, third-party operator, transit broker 1, transit broker 2) perform offline settlement based on the generated unified bill. Operators and transit brokers shall submit the settlement vouchers to the system.

(8) Credit Rating Evaluation

According to the format check, tariff rate check, CDRs authenticity, settlement status (settlement certificate) and user complaint rate of the stakeholders during the settlement process, Credit Rating Evaluation smart contract carry out credit rating of international roaming participants [7, 8].
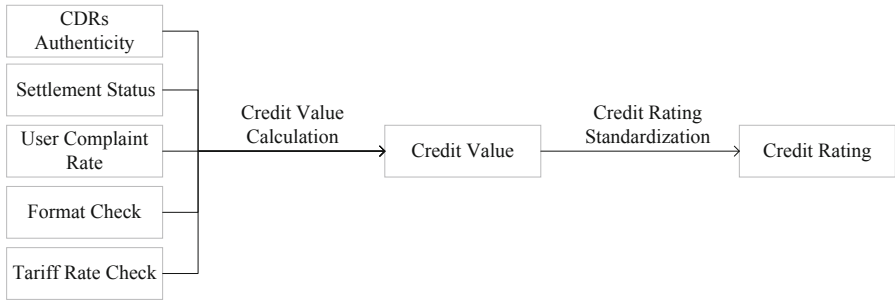
Fig. 4. Credit rating evaluation model

The credit scores in the model (as shown in Fig. 4) are calculated as follows:

$$Credit\ score\ =\ base\ score\ -\ a*CDRs\ authenticity\ -\ b*settlement\ status\ -\ c*user$$
$$complaint\ rate\ -\ d*format\ check\ -\ e*tariff\ rate\ check$$

$$(a > 0;\ b > 0;\ c > 0;\ d > 0;\ e > 0;\ a+b+c+d+e = 1)$$

The five parameters a, b, c, d, and e in the formula are configurable.

Credit score: Calculated by Credit Rating Evaluation smart contract on a daily basis, the value range of the credit score is (0, 100). When the lower or upper limit is reached, the score is no longer deducted or increased.

Base score: The base score of the participant is divided into 80 points. When the participant of the node has no deduction in one day, add 0.1 to the original base score. If there is a serious deduction (the deduction of 10 points (including more than 10 points)), the base score will remain at 80 points in the calculation period of the current month and the next month (Table 1).

Table 1. Deduction rules of credit rating evaluation

Items	Deduction rules
CDRs authenticity	• Found 1 false CDRs record, 10 points; • Each additional false CDRs record, 10 points
Settlement status	International roaming participants shall complete all fee settlements according to the bill within the agreed time; • Settlement exceeded time <5 days, 2 points • 5 days <= settlement exceeded time <10 days, 5 points • 10 days <= settlement exceeded time <30 days, 10 points • Settlement exceeded time >= 30 days, 20 points

(continued)

Table 1. (*continued*)

Items	Deduction rules
User complaint rate	• The number of user complaints to the number of roaming visitors <10%, 1 point • 10% <= The number of user complaints to the number of roaming visitors is <40%, 3 points • 40% <= The number of user complaints to the number of roaming visitors is <60%, 5 points • 60% <= The number of user complaints to the number of roaming visitors is <90%, 10 points
Format check	• The number of CDRs with incorrect format check: 5–20, 1 point • The number of CDRs with incorrect format check: 21–50, 3 points • The number of CDRs with incorrect format check: 51–100, 5 points • The number of CDRs with incorrect format check: more than 100, 10 points
Tariff rate check	• The number of CDRs with incorrect tariff rate check: 5–20, 1 point • The number of CDRs with incorrect tariff rate check: 21–50, 3 points • The number of CDRs with incorrect tariff rate check: 51–100, 5 points • The number of CDRs with incorrect tariff rate check: more than 100, 10 points

(9) Credit Inquiry

Participants of the blockchain platform can query the credit status of each node in the system, as a reference for launching new services; users can also query the operator's credit status through the system as a reference for selecting operators.

4 Advantages Analysis and Experiment

In this paper, the trusted international settlement solution based on Cross Check of CDRs can reduce duplication check and the risk of user complaints, improve the settlement efficiency of roaming services, and provide a unified, open and transparent credit evaluation platform.

- Home operators, roaming operators, third-party operators and users are involved to contribute to CDRs, with cross check to enhance the trustiness. The validated CDRs are recorded in the blockchain to prevent tampering.
- The user provides CDRs data and participates in cross check to reduce user complaint behavior.
- Only hash value of the simple CDRs is stored in the blockchain platform, which can prevent the risk of the original CDRs leakage, protect the user's data privacy and solve the problem of data storage capacity limit in blockchain.
- Credit Rating Evaluation smart contract achieve a unified credit rating method in the blockchain system. Participants in blockchain can query the credit rating, which prevent the information leakage.

In the experiment, based on the Hyperledger Fabric platform, 4 operators were selected to carry out experiments. All 4 operators have international roaming services with each other and carry out roaming settlement at monthly. The offline contracts should be transferred to the smart contract, and the CDRs of all operators and users should be uploaded to the cloud database and blockchain for automatic processing. CDRs Cross Check, Billing smart contract check the CDRs and generate bills automatically.

Assuming that international settlement is carried out at monthly, it takes an average of 4.5 days to complete the clearing and settlement of a single operator with the current processing method. In the experiment, the clearing and settlement can be improved to the hourly level, which greatly reduces the manual checking workload and improves the clearing and settlement efficiency of roaming services (Fig. 5).
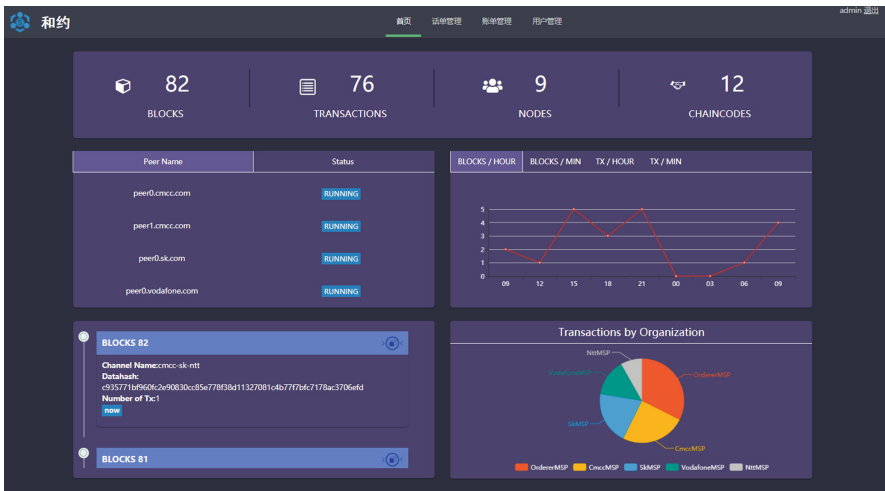

Fig. 5. Prototype of solution

5   Conclusion

This paper introduces the blockchain technology into international settlement business, and the characteristics of distributed network architecture, cryptographic algorithm, consensus mechanism, smart contract of the blockchain technology with cloud data-base. It provides an efficient and reliable blockchain platform solution for the inter-national settlement business between operators.

Based on the analysis and experimental results, it is shown that the clearing and settlement of international roaming service based on CDRs Cross Check can reduce the duplication check, improve the clearing and settlement efficiency of roaming service, reduce the risk of user complaints, and provide open and transparent credit evaluation platform for all operators.

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