Study on Blockchain Based Electronic Service of Legal Documents

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Abstract. Electronic service, as an innovated and supplementary type of judicial service, can solve the problem of "service difficulty", and has been applied extensively worldwide. However, its practice in China encounters four obstacles currently, namely address collection, identity verification, utility and convenience, and information security. Within the legislate framework in China, a blockchain based technical model was established in this paper, consisting of four key techniques, address sharing and information fusion, multi-layer anti-counterfeiting, identity verification and encryption, and evidence fixation, preservation and tracing. An electronic service system was then designed and developed. Compared with existing centralized systems, the blockchain based system has the advantages of high security, excellent reliability, complete traceability, and multi serving channels.

Keywords: Legal Service · Electronic Service · Blockchain

1 Introduction

Judicial service of legal documents is the basic link between judicial institutions and related parties for the information interaction, and plays an important role to ensure the normal progress of litigation activities while protecting the rights and interests of the litigants. Electronic service seeks to provide the advantages of low cost, non-contact and environmental protection. Since its first application by the Back Seat Chamber of the Royal Court of London, England in 1996, electronic service has become a prevalent method of judicial service in both the common law system and the civil law system worldwide.

Electronic service was first clearly stimulated by Chinese basic law in 2012, though China had conducted related judicial trials since 2003. According to the amended Civil Procedure Law, with the consent of the party served, the people's court can serve legal documents by fax, e-mail and other methods that can confirm the receipt. The people's courts at all levels, especially the internet courts, have accumulated abundant theoretical achievements and valuable experiences of multiple serving channels, with WeChat included. However, the application has not been promoted widely over the country. Low usage rate, limited preference, failed sending still exist in practical trails.

These restrictions can be explained by the current inconsistency between the instability of information technology and the stability of litigation system, which has caused an impact on the service subjects under the authoritarianism models in China. Several technical measures have been taken for improvement. Lei [3] suggested that digital signature can be used to ensure the integrity and authenticity of legal documents by preventing theft, tampering etc., and non-repudiation related technology can be applied to further prove whether the serving party sent the information or whether the served party received the information. Chen [2] proposed that electronic service should shift its mode from passive application to active application, and suggested the court can query and locate the litigants' information through big data technology in order to execute identity verification. Liu [5] contended that a combination of the establishment of mandatory pop-up system and the amendment of default permission regulations can justify the standard of "delivery on arrival" stipulated in the new Civil Procedure Law. Liang [4] applied QR to ensure the authenticity of legal documents and protect from malicious tampering.

Studies introduced above generally focus on certain technical points to enhance the practicality of electronic service while comprehensive solutions are urgently required. Besides, traditional centralized judicial system has risks of large-scale data leakage or data tampering, which may even cause the paralysis of the entire legal system. In this paper, blockchain based solutions within Chinese judicial framework were proposed to systematically solve the technical issues of electronic service. There are no published study or pragmatic cases of electronic service based on blockchain in China.

2 Technical Model of the Blockchain Based Electronic Service

To realize a more extensive application, both geographically and conceptually, the judicial electronic service needs to overcome the difficulties in address collection, identity verification, operating convenience, and most importantly information security [6]. Blockchain is an advanced distributed database technology. Compared with traditional centralized data management, blockchain has the features of decentralization, non-tampering, traceability and final consistency, and shows excellent strength in situations that require highly trusted environment [1]. Electronic service system based on the blockchain technique together with electronic authentication and data techniques can effectively empower the judicial practice through process reengineering, function
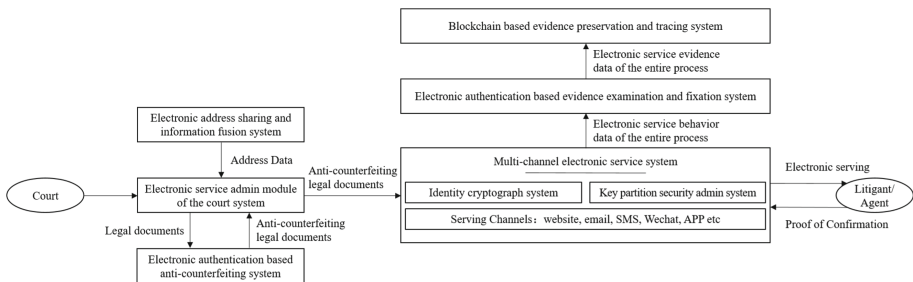
Fig. 1. Primary procedures and techniques of the blockchain based electronic service

collaboration and intelligence upgrade. The blockchain based process and technical framework are shown in Fig. 1.

3   Key Technical Model of the Blockchain Based Electronic Service

3.1   Address Sharing Mechanism and Information Fusion Technique

Existed electronic service system has limited effectiveness in the determination and utility of addresses, for instance less info types, lack of reuse mechanism, insufficient information sharing within the court system, and difficulty of address confirmation. To improve correspondingly, three-level confidence addresses are integrated. The confidence levels are dynamically adjusted according to the feedbacks from actual serving circumstances and litigants' final court appearances.

For data sharing, alliance chain is constructed among court, procuratorate, notary office, certificate authority, and arbitration agency. Sharing technique is also suggested to optimize the features of shared computing power and storage efficiency. Considering the high requirements for data confidentiality and security from the judicial system, national secret standard is adopted to encrypt the shared address data. The specific procedures are shown in Fig. 2.

3.2   Multi-layer Anti-counterfeiting Technique

Legal documents have risks of being tampered by a third party during the serving process or by the served party after arrival. Anti-counterfeiting measures are essential to help judge the fidelity of documents received.

Digital signature can ensure the true identity of the signature, non-tampering of the signed document, and non-repudiation of the signing behavior. The technical flow of the multi-layer anti-counterfeiting technique based on digital signature is shown in Fig. 3. As shown, the model adopts an integrated solution to enhance the fidelity of legal documents by integrating digital signature, visual seal, and trusted timestamp techniques.
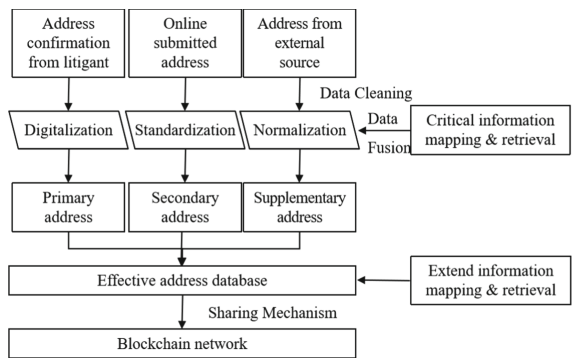

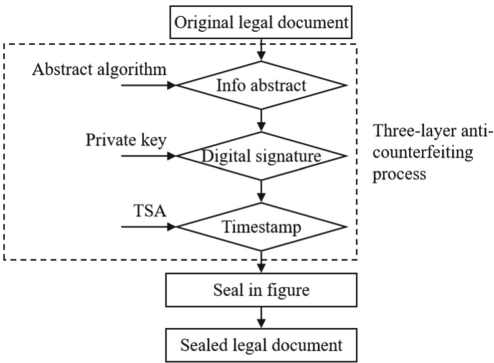**Fig. 2.** Logic diagram of address sharing and information fusion

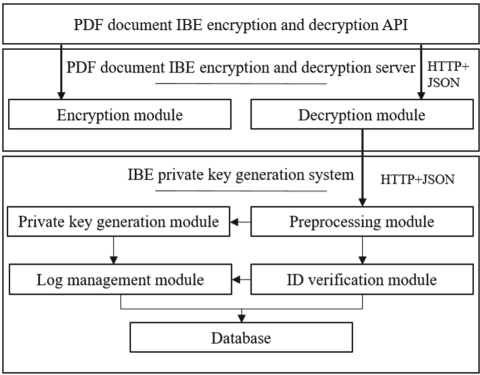**Fig. 3.** Diagram of anti-countering process

Fig. 4. Diagram of identity verification and encryption technique

3.3 Effective Serving Through Multi Channels

The difficulty of confirmation of knowledge has long troubled the courts, especially when email, SMS, or WeChat is used as service channel. For instance, the court cannot determine whether the litigant himself gets access to the legal documents when the URL links embedded in the email are opened, because the owner's email was generally registered on the external platform not the court's. The technical solution of effective serving is presented in Fig. 4.

Digital certificate key, as the trusted ID of the litigant, is firstly partitioned, and then stored separately on the server end and the mobile end. Thus, neither the litigant nor the court can have an integrated private key. Furthermore, when the party served gets access to the legal documents and signs the proof of confirmation, the system can complete the confirmation of knowledge without troubles in asking for the integrated key.
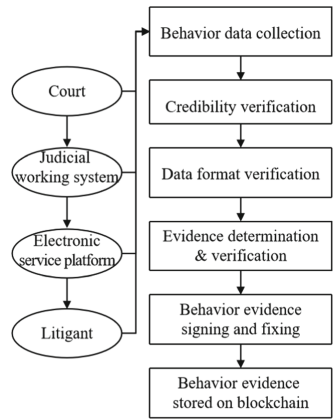
Fig. 5. Electronic service evidence fixation technique

3.4   Evidence Fixation of the Whole Judicial Procedure

Strong traceability and confirmability of judicial behaviors has always been the symbol of legislate authority. However, there is still a lacking in effective technical measures of non-repudiation for the conduction of critical behaviors. On one hand, the court usually finds it difficult to determine the responsibility based on the behavior traces provided by its own judicial platform. On the other hand, the court cannot conduct trial by default when the proof of confirmation is not verified technically. A technical solution of evidence fixation, preservation and tracing of the whole judicial process based on blockchain is proposed in Fig. 5.
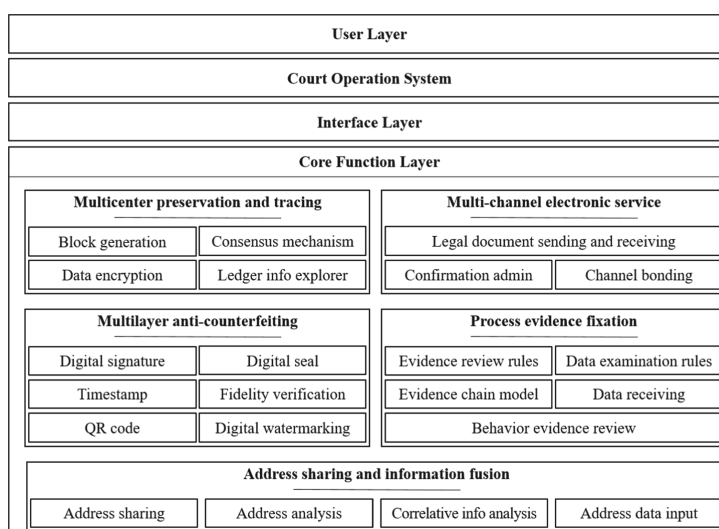
4   Development of Electronic Service System Based on Blockchain

4.1   Logical Architecture of Electronic Service System Based on Blockchain

The blockchain based electronic service system was designed with the characteristics of high security, excellent reliability, complete traceability and multi serving channels. As illustrated in Fig. 6, the innovated system functions as a platform with all services modularized. After docking with related systems, the platform can provide capabilities of supporting various business for both courts and litigants. The architecture is comprised by core function layer, interface layer, court operation layer and user layer. The user layer mainly functions for document anti-counterfeiting, document checking, document sending, serving status inquiry, serving process management etc.

4.2   Utility Functions and Performance of Electronic Service System Based on Blockchain

The system has passed professional software acceptance test in accordance with Chinese national standard *GB/T 25000.51-2016 "Systems and software engineering-Systems and software Quality Requirements and Evaluation (SQuaRE)_Part 51:Requirements for*

User Layer
Court Operation System
Interface Layer
Core Function Layer

Multicenter preservation and tracing		Multi-channel electronic service	
Block generation	Consensus mechanism	Legal document sending and receiving	
Data encryption	Ledger info explorer	Confirmation admin	Channel bonding

Multilayer anti-counterfeiting		Process evidence fixation	
Digital signature	Digital seal	Evidence review rules	Data examination rules
Timestamp	Fidelity verification	Evidence chain model	Data receiving
QR code	Digital watermarking	Behavior evidence review	

Address sharing and information fusion			
Address sharing	Address analysis	Correlative info analysis	Address data input

Fig. 6. Function architecture of the blockchain based electronic service system

Table 1. Transaction request time efficiency

Program	Test (No.)	Con-currency	Average delay (ms)	Success rate
With digital signature and verification	1	1*10	4.10	100%
	2	1*10	4.20	100%
	3	1*10	4.10	100%

quality of Ready to Use Software Product (RUSP) and instructions for testing". For user end, the main functions consist of anti-counterfeiting and fidelity document generation, anti-counterfeiting and fidelity document sending, judicial evidence fixation result notification, judicial data fixation and preservation package, delivery details, on-chain data, etc.

The major performance of low level blockchain layer to be implemented is also tested according to *GB/T 29835.1–2013 "Efficiency of system and software-Part1: Indicator system"*. All indicators have passed the requirements, and the detailed testing results are as shown in Tables 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

(1) Time Efficiency Test
(2) Processing Efficiency Test
(3) User Capacity Test

Table 2. Historical information query time efficiency

Test (No.)	Concurrency	Average delay (ms)	Success rate
1	1*10	0.98	100%
2	1*10	0.90	100%
3	1*10	0.87	100%

Table 3. Block information query time efficiency

Test (No.)	Concurrency	Average delay (ms)	Success rate
1	1*10	0.73	100%
2	1*10	0.73	100%
3	1*10	0.65	100%

Table 4. Account information query time efficiency

Test (No.)	Concurrency	Average delay (ms)	Success rate
1	1*10	0.63	100%
2	1*10	0.58	100%
3	1*10	0.68	100%

Table 5. Block information query processing efficiency

Test (No.)	Transactions	Success rate	TPS
1	2,600,000	100%	47,272
2	2,600,000	100%	48,148
3	2,600,000	100%	46,428

Table 6. Account information query processing efficiency

Test (No.)	Transactions	Success rate	TPS
1	4,500,000	100%	88,235
2	4,500,000	100%	90,000
3	4,500,000	100%	90,000

Table 7. Transaction request user capacity

Program	Test (No.)	Concurrency	Result
With digital signature and verification	1	4,545	Pass
	2	8,333	Pass
	3	13,000	Pass

Table 8. Historical information query user capacity

Test (No.)	Concurrency	Result
1	3,469	Pass
2	18,627	Pass
3	27,272	Pass

Table 9. Block information query user capacity

Test (No.)	Concurrency	Result
1	4,861	Pass
2	25,424	Pass
3	40,000	Pass

Table 10. Account information query user capacity

Test (No.)	Concurrency	Result
1	8,196	Pass
2	62,500	Pass
3	90,000	Pass

5 Conclusions

As Chinese government implements the informatization of the judicial system, electronic service is a significant process in constructing the "intelligent court". Within the legislate framework in China, blockchain based solutions were proposed aimed at exiting primary obstacles in current practice. Sharing mechanism based on alliance chain is proposed to realize trusted sharing of digital addresses among multi parties related. For the confidentiality and security of these judicial data, the national cipher standard is adopted for disk encryption. Various serving channels are integrated in the comprehensive electronic service system. To ensure safety, a technical solution of identity ID and keys is proposed for the SMS and email channels, and key partition technique is applied for the APP channel. A series of digital signature, visual seal and time stamp, can further preserve the completeness and fidelity of legal documents served. A combination of electronic authentication technique for evidence fixation and blockchain technique for evidence storage are applied to avoid the repudiation of critical behaviors. The fixed evidence of the whole process can also enhance the overall effectiveness of the authenticity examination on the behavioral data processed with reliable digital signatures. As for prospects, system security, privacy preservation and soft compliance draw much attentions and require further theoretical support and technical advancement.

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