Designing and Implementation of an Online System for Electronic Contract Negotiation Based on Electronic Signature

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***Abstract*—The contract is the bridge to transaction, as well as the core of business practice. Accompanying with the development of electronic commerce, contract negotiation under more complicated environment in advantage of internet is becoming increasingly urgent. This paper briefly introduces the status of electronic signature and electronic contract in China, then presents a reference architecture for an online system for electronic contract negotiation and signature in detail. This architecture is systematically designed on the basis of electronic signature technology to realize online contract signing, electronic contract storage on the trusted third party and online or offline verifications. All above ensures electronic contract's confidentiality, integrity and non-repudiation, makes a breakthrough for electronic signature in business field, and realizes the electronization in the whole process of business negotiation.**

***Index Terms*—e-commerce, e-contract, e-signature, online negotiation**

I. Introduction

With the rapid development of computer technology, the rapid expansion of web services and the fast integration of global logistics, e-commerce, as one of important strategic emerging industries, has become the vanguard of reform and opening up to play a significant role in the process of innovation and transformational development in China. In 2013, promoted by government, enterprises and consumers, e-commerce in China kept a smooth trend of rapid development. According to statistics, its trading volume topped more than 10 trillion yuan, a 27.8% increase compared with last year, which almost equaled to 18.6% of Chinese GDP in 2014[1]. Though more and more procedures of commercial activities being executed electronically, as an essential procedure of commercial activities, especially in B2B activities, contract negotiation and signature as an essential procedure developed relatively slowly on its way to electronization. The advanced stage of e-commerce is the realization of electronic processing in the whole business process. If the electronic contract negotiation could not be researched and used effectively, it would definitely restrict the high-speed development of e-commerce. Hence, this paper presents an online system for electronic contract negotiation based on electronic signature technology.

In recent years, a lot of papers focused on modeling of the online contract negotiation and signature. In 1997, Y. Lei et al detailed a comparison of various workflow metamodels [2]. But there was no work on conceptually modeling e-contracts or a methodology for transforming an e-contract into workflows. In 2004, talking Entity Relationship Diagram as a framework, P. R. Krishna et al described an implementation model of an e-contract which bridges between the XML contract document and web services, but only based on workflow [3]. In 2005, started from the angle of web services, T. Bui et al put up with the online negotiation platform structure model and negotiation process [4]. In 2006, taking SOLACE as a standard, O. Abass et al proposed a universal and multi-issues negotiation frame to satisfy the need of electronic negotiation system [5-6]. In 2007, T. Kwok et al designed a web-based and e-mail driven electronic contract management system supporting both internal and intra-enterprises workflows, and was used in several IBM pilot programs [7]. In 2008, S. Angelov et al presented a reference architecture of three levels for the development of e-contracting systems, which is aimed at facilitating the design of logical views of concrete e-contracting systems [8]. In the same year, combined with the technology of cloud computing, T. Kwok et al presented the first of a kind multi-tenancy Software as a Service (SaaS) e-contract management application, which may be more suitable for the small and medium businesses and in particular the very small businesses[9]. In 2009, X. Yu et al defined a lifecycle of e-contract and recounted the establishment process of e-contract. This system help to protect businessmen's right and interests, and facilitate governmental monitoring of the e-commerce market [10]. In 2010, from the perspective of reducing the manpower,

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material and financial resources, W. Xin et al put forward another platform of electronic contract based on electronic signature technology to meet the needs of ever-developing business model and the operations of supply chain [11]. In the same year, S. Liu et al also proposed solutions for electronic contact's supervision and notarization, which could be a breakthrough point for E-commerce supervision, related economic data analysis and related public service expansion, thus promoting the development of online trading in term of safety and normativity [12]. In 2012, J. Yang et al explained the status of current business negotiation in China, analyzed the difficulties in the popularizing of applying the electronic signature into commercial activities, and then raised the pioneer Network Platform for Electronic Contract Making as well as its applications [13]. In 2013, based on the automatic synthesis of fair non-repudiation protocols, K. Chatterjee et al showed how to specify the objectives of the participating agents, then explained clearly that assume-guarantee synthesis can be computed efficiently as the secure equilibrium solution of three-player graph games[14].

This paper presents an architecture for an online system for electronic contract negotiation and signature. It also presents electronic contract's storage in the trusted third party (TTP) and two different verification ways, online and offline. This would realize the application and popularization of electronic signature in business contract field.

II. Status Of E-Contract, E-Signature And Online Negotiation

Nowadays, e-commerce in China showed that internet is largely popularized and online sales scale is increasing explosively. However, there are also several problems, for example, invasion of intellectual property right, counterfeit and shoddy products, malicious falsehood and other kinds of transgressions. Inadequate supervision may be one of the main reasons causing these situations, so the constraint for transactions is not enough. However, the goal of electronic contract, as the same as the traditional contract, is to constraint both parties in trading activities like production and business operation by the legal effectiveness in itself. Once an e-contract has been signed, the rights of both parties are under the protection of the law. Meanwhile, e-commerce trading environment will be greatly improved.

A. Electronic Contract

According to Chinese 'Electronic Signature Law', electronic contract can be defined as an agreement among both or multi litigants to establish, modify and terminate the civil rights and duties in property through electronic information net and by using electronic format.

According to statistics of year 2011 in China, there were around 11 million medium and small-sized enterprises, and 36 thousand large and medium-sized enterprises. Their average online selling rate was about 29.33%, and average online procurement rate was above 28.91% [15]. Supposing every medium and small-sized company had 10 contract negotiations per year, there would have 1.1 billion contract negotiations totally. If one fifth of them adopt online trading, there would be 22 million contract negotiations per year. Compared with traditional paper contract, electronic contract could decrease negotiation cost for enterprises, such as business travel expenses, express fee and time cost, etc. Meanwhile, the electronic form of e-contract is also easy to store and manage.

On the other hand, Chinese new 'Contract Law' expanded traditional contract to data message format. The No.11 item of new contract law says 'written form of contract is a form where contract papers, letters and data message (including telegram, telex, fax, electronic data exchange and email) can present its content in a visible way[16]. It means valid electronic contract will be empowered the same legal effectiveness as traditional paper contract. Once contract disputes appear, electronic contract and paper contract share the same reliable legal evidence [17-18].

B. Electronic Signature

In 5 July 2001, 'UNCITRAL Model Law on Electronic Signatures with Guide to Enactment', being drafted by United Nations Commission on International Trade Law (UNCITRAL) was adopted. Meanwhile, in 28 April 2004, 'Electronic Signature Law of the People's Republic of China was approved by the National People's Congress [13]. Electronic Signature means an attached electronic data in digital text used to verify the identity of signatory and show the approval of signatory. Electronic signature is a signature that using digital signature technology to sign in electronic document, but not a digital image of paper signature [19-20].

On the other hand, from the perspective of law, in many countries, including the United States, the European Union, India, China, Brazil and Australia, electronic signatures (when recognized under the law of each jurisdiction) have the same legal consequences as the more traditional forms of executing of documents.

In traditional commerce, contracting parties should sign or stamp in the paper. This kind of signature and stamp has several functions: first, showing the source of the document; second, demonstrating that signatories have confirmed the paper's content; third, constructing an evidence that signatories are responsible for the correctness and integration of the content of the paper [21]. And in No. 14 item of 'Electronic Signature Law' stipulates that 'reliable electronic signature has equivalent legal effectiveness as written signature and stamp'. Hence, electronic signature can realize the confirmation of traditional paper signatories and the verification of confidentiality, integrity and non-repudiation.

So far, most studies of electronic signature focused on the encryption technology. As a fundamental technology, data encryption is the corner stone of the security of all the communication. Scholars around the world offered symmetric and asymmetric encryption methods to ensure the security of data encryption. However, there was no breakthrough in the application of electronic signature. So far, the application of electronic signature in China is

only limited to certain parts of electronic e-governance, such as foreign trade declaration. In other fields, especially in production and business fields, it has still not found a right breakthrough point. Several reasons why electronic signature is still distant to our people could be concluded as follows:

First of all, lack of awareness. People even have no impression on the function of electronic signature; second, no breakthrough point is selected in its application; last but not least, technologies of electronic signature has not been well developed.

All in all, in terms of current situation, the breakthrough point of electronic signature application should be the procedures of online business negotiation and contract signing where electronic signature can be conducted frequently and exert its utility to maximum. The following research raises the online system for electronic contract negotiation based on electronic signature technology to a commercial environment.

C. Online Negotiation

Negotiation, such as commercial contract negotiation and international dispute negotiation, is a process where each party involved in negotiating tries to gain an advantage for themselves by the end of the process [22]. Compared with traditional negotiation that costs lots of social resources, productivities and opportunities for innovation, online negotiation, which can greatly improve negotiation efficiency, is more in line with the requirements of low-carbon life. On the other hand, in recent years, with the rapid development of e-business, globalization of e-commerce emerges inevitably. Additionally, modern companies have trended to be scalization, conglomeration as well as internationalization, which all contribute to an acute exploitation of a better negotiation manner with characteristics of economy, efficiency, effectiveness and security.

However, in terms of current situation, the research and popularize of online negotiation, as a key process of e-business transaction, still processes slowly. No mature electronic contract negotiation system is available nowadays. Although text, audio and video exchanging technologies have been sophisticated and applied in online chatting software, such as MSN, ICQ and Skype, nothing to do with negotiations for ceremonial electronic contracts.

III. System Architecture Of System

The trade standard 'The Process Specification of Online Setting Electronic Contracts (SB/T 11009-2013)', which is issued by the Ministry of Commerce of the PRC, entered into force in December 1, 2013[23]. The article in this standard stipulates that only through the system established by the third party, the fairness of negotiation process and the effectiveness of the signed electronic contract can be protected by law.

Hence, according to this trade standard, this paper presents such a system based on the independent third party platform of electronic contract negotiation and signature, separating the management and verification of electronic signature and the storage verification function of signed contract from platform. System architecture of the whole system is illustrated as Figure 1.

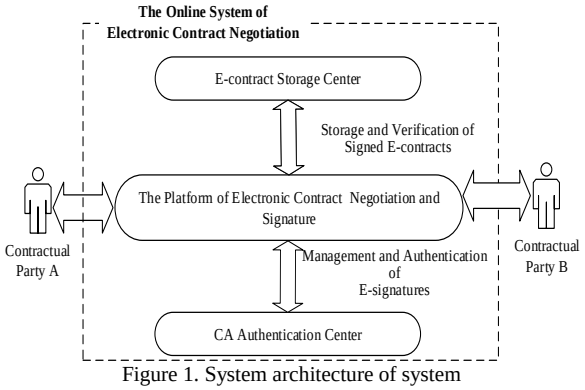

Figure 1. System architecture of system

This system architecture sets electronic signature server and electronic contract storage server in the Certificate Authority center and electronic contract storage center that are independent from the platform of electronic contract negotiation and signature, which has three advantages as follows:

(1) **Confidentiality:** Put electronic contract storage center in national authority organizations makes it less easy to steal and destroy.
(2) **Independency:** Once certain part of this system has problems, it can disconnect connection with other server immediately, thus minimize lost.
(3) **Conditionality:** Expand from the independent third party to realize balance among several third parties and ensure both parties' interests in the negotiation.

IV. Frame And Function Design

In the light of the basic functions that electronic contract negotiation system ought to possess, the trade standard SB/T11009-2013 puts forward seven requirements as follows[23]:

(1) Allow users to input contract templates, and automatically generate the contract text compliance with the requirements of law in user's format requirements.
(2) Allow for online negotiation and contract revision.
(3) Able to realize a variety ways of multimedia communication, such as text, video, audio, mobile.
(4) Able to realize real-time transmission and backup of the information of contract and negotiation in the process. Meanwhile, the backup data can be traced back and replicate.
(5) Apply electronic signature or other technologies to verify the confidentiality, integrity and availability (CIA triad) of the contract.
(6) Allow for storage online and third party at the same time.
(7) Be in line with the technology, equipment and management systems related to national security and confidentiality standards.

For meeting these above requirements, the main functions of the system frame are designed as six major parts: user management, contract management, contract negotiation, contract preview, online signature and online

contract storage, as shown in Figure 2.

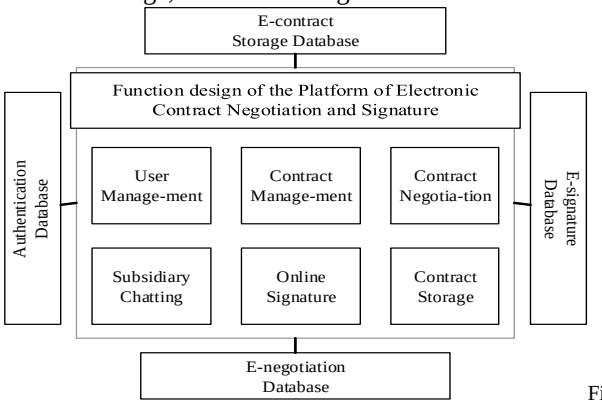

Figure 2. Topological graph for the function design of platform

(1) **User management:** mostly including system user's registration and its information storage and modification;

(2) **Contract management:** the classification and re-edition for user's contract template;

(3) **Contract negotiation:** a core function of the system. After the negotiation initiator inputs the contract draft, the negotiation part begins. Both parties modifies every item on the contract till they reach an agreement that they have no dissent for each item in the contract.

(4) **Subsidiary Chatting:** mostly including various real-time multimedia communication methods, such as text, video and audio. Its main purposes include:
   a) Promote final contract signing via both negotiation parties' conversation;
   b) Confirm each other's identity through audio and video chatting;
   c) Save the communication record as an effective evidence.

(5) **Online signature:** after several rounds of confirmation by both negotiation parties, they can sign this contract online by using the USBKEY that registered in local Certificate Authority center. Once signed successfully, this electronic contract will share the same legal effectiveness with paper contract.

(6) **Contract storage:** mainly including storage in local places, e-negotiation database and e-contract database.
   a) **Local storage:** mostly backing up locally for singed contract, unfinished contract and contract templates, which makes it convenient for enterprises or individuals to check and record.
   b) **Storage on e-negotiation database:** store contract templates and unfinished contracts mostly. Many enterprises have long-term relationship of supply and demand, so contents of contract are similar each time. Store contract templates in negotiation server can decrease negotiation time and increase negotiation efficiency. On the other hand, some contracts may be too complicated to reach a consensus in one or two days, so the unfinished versions must be saved till the end of negotiation.
   c) **Storage on e-contract database:** store signed contract only. It is also called contract third party storage, which is convenient for users to review, and regarded as a reliable legal statement when disputes appear between both negotiation parties.

V. Detailed Process Design

A. Application for Digital Signature

Traditional contract in paper is valid only if it is signed or stamped. It is the same with electronic contract. In network cryptography, a certificate authority (CA) is an entity that issues digital certificates, which certifies the ownership of a public key by the named subject of the certificate. This allows others (relying parties) to rely upon signatures or assertions made by the private key that corresponds to the public key that is certified. A Certificate Authority Center is an authoritative, reliable and equitable third party that is trusted by both the subject (owner) of the certificate and the party relying upon the certificate, and it is responsible for issuing digital certificates, authenticating digital certificates and managing issued digital certificates. In that sense, Figure 3 illustrates an implementation that one corporate representative applies for digital signature Certificates. After the corporate representative submitted corporate's related information, the CA center would verify the related information. Once confirmed, CA administrators will adopt PKI technologies to issue a digital signature certificate and save the encrypted certificate into USB card that used for digital signature, and then save the information of digital certificate to E-signature database.

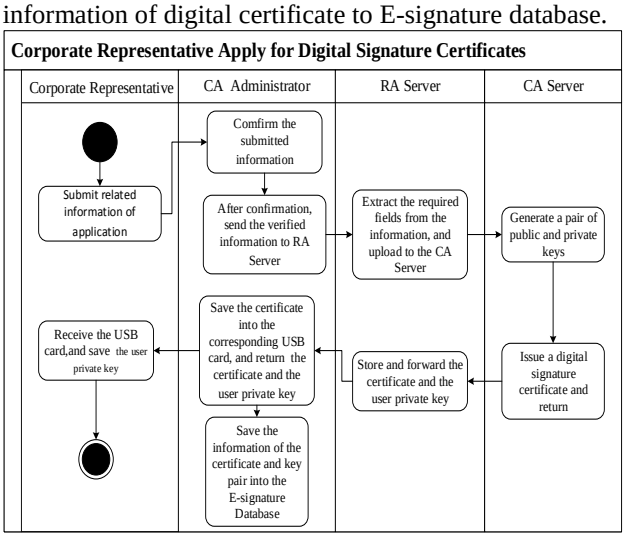

Figure 3. UML activity chart for corporate representative applying for digital signature in USB card stage

The main function of the CA Administrator, RA Server and CA Server is clarified as follows:

- **CA Administrator:** assist corporate representatives in accomplishing the certificate application, and manage issued certificates.
- **Registered Authorization (RA) Server:** extract the required fields from the verified information of certificate application/update/invalidation, then submit to the CA server in a given format and, at

the same time, receive and record the returned results.

- **CA Server:** firstly, generate the public and private key pairs by means of software or hardware; secondly, receive the requirements of certificate application/update/invalidation from RA service; thirdly, regularly issue certificate revocation list (CRL).

B. Electronic Contract Negotiation and Signature

This section is divided into three parts: negotiation invitation, contract negotiation and online signature.

A) Negotiation invitation

Before this stage, the contract negotiation parties made a negotiation appointment firstly. By searching through the authentication database, the initiator confirms partner's information by each other and sends negotiation request. If the partner is online, they can confirm each other's identity and then prepare for negotiation; if the partner is offline, other methods, such as SMS and e-mail, could be used to notice the partner and wait to enter the negotiation stage together.

B) Contract negotiation

After the stage of negotiation invitation, both negotiation parties begin the contract negotiation stage. Firstly, one party of the contract edits an existed or new contract template, generates contract draft and enters negotiation page; at the same time, the other party waits for the contract draft's generation and then enters negotiation page automatically. After checking contract content, both party can edit contract items if necessary. To prevent the possibility that both parties are editing the same content at the same time and the inconvenience it brings, the system adopts simplex model which means only one party can edit content at one time, and only after one party finishes the edition, the other party can start editing. To better and safer reach an agreement, the subsidiary chatting function is added in this contract negotiation stage.

If one party has confirmed contract items, the contract content cannot be edited anymore. Once the contract has been confirmed by both parties, they have to preview the contract and confirm it one more time to browse the entire contract, and then both enter online signature stage. At this point, the system prompts that this contract will be saved as contract template for future usage. If the negotiation pauses or either party has disagreements towards the contract, it can be re-edited, and negotiation server will save details till the final confirmation of the contract.

C) Online signature

Once both parties have confirmed the contract, they have to finish online signature and empower the contract legal effectiveness. Both parties use the USB card that represents their enterprises identities to sign the contract online. After the digital certificates are verified through digital signature server, the online signature is done. This platform sends the signed contract to e-contract storage database, and will generate the contract in PDF format and unique QR code for both parties to download and store.

The whole process of electronic contract negotiation and signature is showed in Figure 4

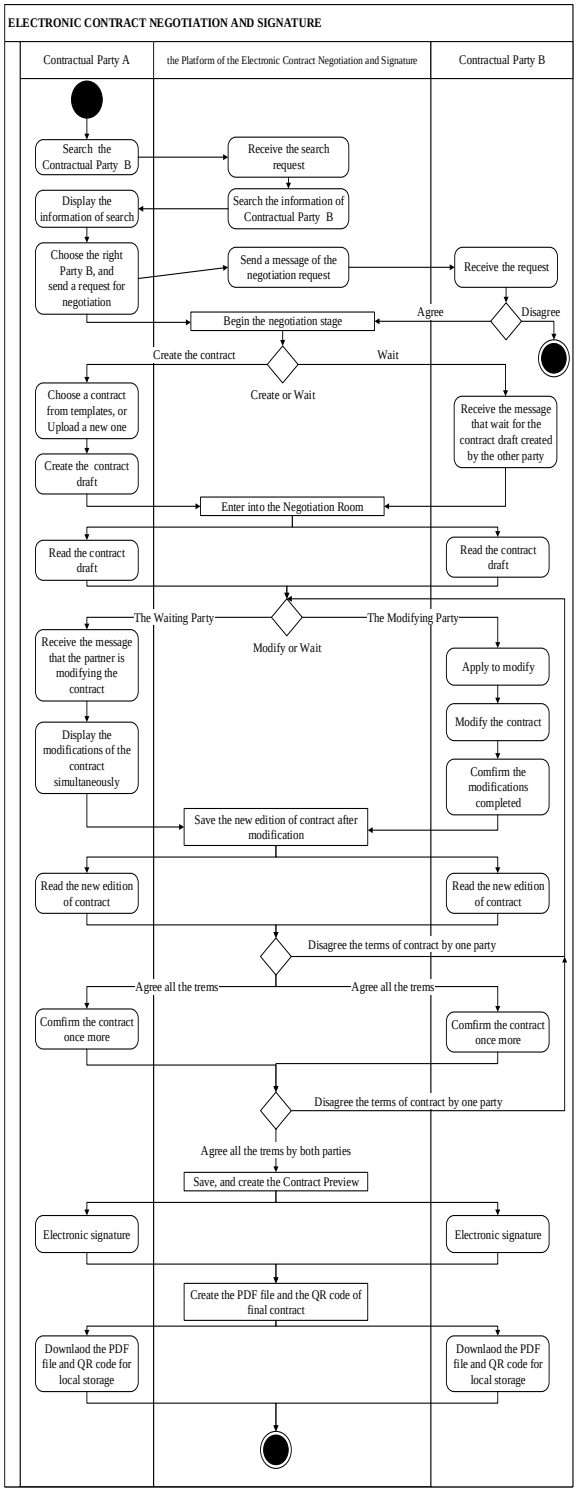

Figure 4. UML activity chart for negotiation and signature stage

C. Contract Online and Offline Verification

A) Contract offline verification

The PDF format of signed contracts contains digital signature and is encrypted. Adobe® Reader® and Acrobat® have provided comprehensive support for the authentication of digital data based on public key infrastructure (PKI) technologies [24]. When a PDF is

signed, the signer's certificate is embedded in the PDF file. Therefore verification of identity of both contract parties can be realized by verifying the digital signature in the PDF format contract offline.

B) Contract online verification

If users still have doubt on the authenticity, integrity and effectiveness of contract, users can verify contracts online, as shown in Figure 5. Once the application is made, users submit the contract document they need to verify and corresponding QR code to the system administrator and then verification can be done by comparing with contract backup copy in the e-contract storage database immediately. If they are well matched, this authentication is successful. If not matched, the contract may be modified after electronic signature.

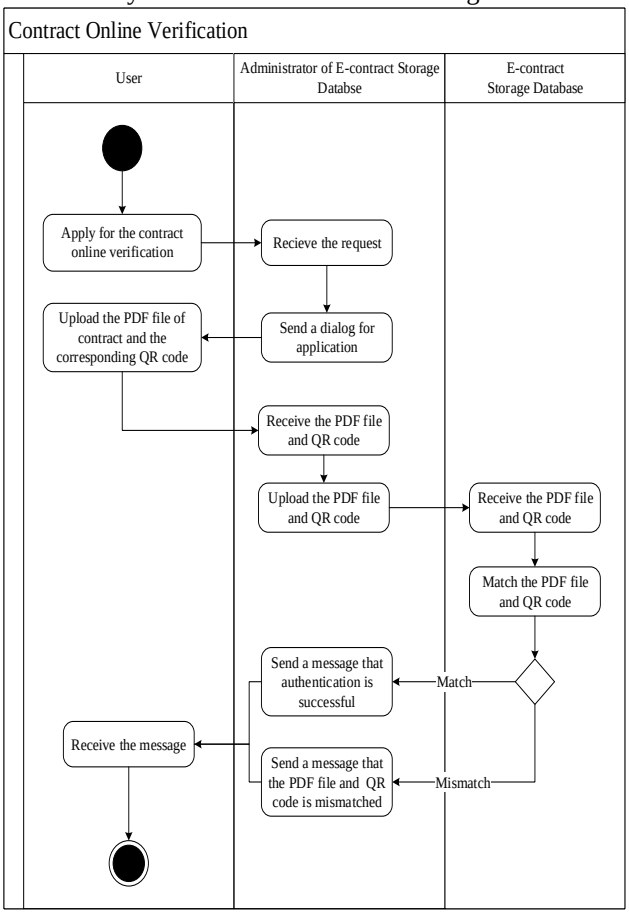

Figure 5. UML Activity Chart for Contract Online Verification

VI. INNOVATIONS OF SYSTEM

A. Satisfy Enterprises' Urgent Need of Remote Business Negotiation

According to the study of Borough et al, negotiation activities take 20% of manager's working time in organizations [25]. However, in those real negotiations, negotiators can hardy reach satisfactory results. The ineffectiveness decreases useful resources in society, productivity and opportunities of creativity, and increases social conflicts and self-destruction.

With the prosperous development of domestic and international E-commerce, enterprises has the tendency of scale expansion and collectivization, the frequency different kinds of remote business negotiation will increase, so enterprises' need for remote business negotiation becomes more urgent Online negotiation and contract signature system is not limited to geography restrictions and can meet enterprises' urgent for remote business negotiation. Besides, this system can effectively reduce negotiation cost, including business trip expenses, express fee and time cost, etc. [26-27].

B. Realize Electronization in the Whole Process of Online Business Negotiation

In this research, based on the 'Electronic Signature Law' and existing mature electronic signature technology, this system realizes the electronization of business negotiation and contract signature and the formation of the entire online business negotiation platform setting the functions of supplier/customer's connection, negotiation invitation, contract signature and signed contracts tracking management in one.

C. Realize the Expansion and Application of Electronic Signature in Business Field

The research provides users a whole new concept of business negotiation through the creative application of electronic signature on contract making, realizing the equal legal effect between paper contracts and electronic ones. Meanwhile, this research presents an electronic contract application mode to meet the legal requirements and designs the application process and framework with the electronic signature technology and independent third party electronic contract preservation to fill the blank in the expansion and application of electronic signature in domestic and foreign business fields.

D. Develop a Standard Structure of Electronic Contract Templates to Adapt the Form of Online Negotiation Independently

It seems that no standard structure of electronic contract templates is widely used in online business negotiations all over the world currently. In this research, XML electronic contract markup language and XML documents are used for automatically generating the contract templates through paste the text from Microsoft word or excel, where pictures are also acceptable, according to the requirements of users. Meanwhile, this research also benefits for the normalized construction in digital business market.

E. Achieve the Preservation of Electronic Evidence on an Independent Third Party

This system achieves online preservation of electronic evidence including electronic contracts and documents. Meanwhile, the use of a VPN dedicated channel makes sure of safe delivery of electronic contracts, and the comprehensive utilization of the technologies of time stamps, network attached storage (NAS), Storage Area Network (SAN) and third-party data security and disaster recovery to meet the data security requirements of the 'Electronic Signature Law'.

VII. CONCLUSIONS

In this paper, we focused on the development environment of electronic commerce and the current situation of e-contract, e-signature and online negotiation, especially in China. According to the Chinese latest trade standard 'The Process Specification of Online Setting Electronic Contracts', then we proposed that e-contract should involve electronic signature as its primary element and an independent third party should be introduced into the negotiation and signature of e-contracts. Based on these views, we broke the ice and raised a whole new system framework for the online system for electronic contract negotiation based on electronic signature technology, where we defined a lifecycle of e-contract negotiation and two different ways of verification, online and offline. Finally, we cited the innovations of this system in list.

Contracts are required in most business transactions in companies of all sizes as they constitute the binding relationships between a company and its suppliers, business partners, or customers. Likewise, e-contract is a sensitive point in e-commerce area, which involves many parties' rights and interests. Especially on the view of management, we need a mature and practical solution to regulate and accelerate the development of e-contract. This paper gives a good point of penetration to achieve above goals, but we still need more study on related area to improve our system, including its security, practicability and operability. On the other hand, there are still many blanks in the law of electronic commerce field, and people lack of enough trust on the application of electronic signature. Hence, it still has a long way to go to achieve massive substantive expansion and application of electronic signature in business field.

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