Cross-Context Transfer of Electronic Title Documents

Wai Lin Wong and Jingzhi Guo
Department of Computer and Information Science, University of Macau
Av. Padre Tomás, Pereira, S. J., Taipa, Macau
Email: {ma76501, jzguo}@umac.mo

Abstract—Legal transfer of electronic title document across heterogeneous contexts is a challenging research problem in e-commerce and implies a wider e-commerce transaction scope. This kind of title transfer requires semantic consistency, confidentiality, integrity and legality between transferor and transferee. During the title transfer, cross-context semantic consistency must first be maintained between electronic title documents for legal title transfer while other requirements are considered. To solve the problem, this paper proposes a Cross-Context E-Title (CCET) approach, which satisfies the requirements for title transfer. Based on CCET approach, a CCET prototype is further implemented, on which some experiments are made to test the correctness and performance of the proposed approach.

I. Introduction

In e-commerce, a document of *electronic title (e-title)* is a digitally-written instrument [11][22], which is a type of e-business document representing the right of ownership in regard to certain property. Such a document is considered a sufficient proof that the person who possesses it is entitled to receive, hold, and dispose of the instrument and the goods that it covers. Examples of e-title documents are bill of lading, warehouse receipt, insurance policy, deed of house, and land certificate. E-title document research is important because it helps digitalize paper-based title documents, making the content of title document divisible, reusable and efficient in processing and transfer. E-title document transfer across contexts must satisfy the following requirements: (1) *secure* – any e-title document shall be uniquely identifiable, confidential and of integrity; (2) *understandable* – any e-title document shall be semantically readable and processable by both human and computer; (3) *contextual* – any e-title document shall be freely transferred between heterogeneous business environments.

The research of e-title document transfer is an intersection of field researches of e-commerce [23], document engineering [15], digital right management [12][20] and law [11][22]. Existing approaches of e-title document transfer are centralized record change and distributed title transfer. *Centralized record change approac*h is the change of title records in a centralized title repository from transferor to transferee (e.g. ELT [14]). *Distributed title transfer approach* is the transfer of a self-described title document from transferor to transferee. The former relies on a central title repository managed by a trusted third party for title transfer. The latter adopts a set of standardized metadata to describe and prove itself during transferring any legal e-title document, for example, Bolero.net and method in [21]. The advantage of the latter is that title can be independently described in an e-title document and transferred from one location to another without needing a central repository. The weakness is: (1) the metadata and the instance data describing e-title document must be semantically consistent between transferor and transferee; (2) the identities of transferor and transferee must be verifiable; and (3) the content of e-title document must be verifiable for truthness and integrity.

This paper aims at overcoming the weakness of distributed title transfer approach. It maintains cross-context semantic consistency between e-title documents of transferor and transferee by proposing a novel approach, called *Cross-Context E-Title* (CCET) approach. By this approach, e-title documents across heterogeneous contexts are understandable, confidential, integrative and legally transferable.

The rest of the paper arranges as follows. Section 2 discusses related work. Section 3 proposes a novel CCET approach. In Section 4, CCET approach is implemented in a prototype. Section 5 evaluates CCET approach by experiments. The final section concludes the paper, lists the contribution and describes the future work.

II. Related Works

A. Digital Right Management

Digital right management (DRM) [12][20] is a technique of controlling access to digital content or the right of using digital content. In DRM, digital rights are represented by right expression languages such as eXtensible rights Markup Language (XrML) [1], Creative Common Rights Expression Language (ccREL) [2] and Open Digital Right Language (ODRL) [3]. The represented rights restrict the permission of accessing to the managed digital contents.

B. Electronic Title Representation

Rather different from DRM, electronic title [11] such as electronic bill of lading [13][22] is the right of owning a legal or equitable interest. An electronic title (e-title) document often focuses on representing itself to express a right of ownership with features of security and cross-context semantic consistency. E-title document can be expressed in XML-based languages. For example, FSML (Financial Service Markup Language) [4] represents electronic checks. Bolero Bill of Lading [5] represents bill of lading in BoleroXML. An e-title document that could independently exist is often a self-encryptable,

self-verifiable and self-manageable document.

C. ConexNet Framwork

ConexNet [17][18][25] is a sign description framework theoretically developed from semiotics, in which every object in reality is described as a sign consisting of 4-tuple of (structure, concept, interpreter, context). All signs are collaboratively defined across heterogeneous contexts and thus all synonymous signs are semantically consistent no matter whether the sign forms are different. Signs are represented in three levels: vocabularies (sets of collaboratively mapped terms), document templates (designed by document designers using semantically-consistent vocabulary terms), and reified documents (instantiated and exchanged by document users). With this framework, any document template and its reification are semantically-consistent across heterogeneous contexts.

D. XML Product Map (XPM)

XPM [6] is a sign representation language, which organizes the signs (or terms) in a hierarchy. Each sign in a hierarchy is self-defined, atomic and independent. Any children signs connote their parent sign to describe the features of the parent sign. A document is thus naturally developed with any sub-hierarchy as an independent sub-document or a sign again. The benefit of XPM is that any document template can be arbitrarily designed and reified by atomic signs (i.e. terms in vocabularies) without losing semantic consistency when the reified document is exchanged between document sender and receiver across heterogeneous context

E. Existing Approaches of Designing E-Title Transfer Systems

In practice, e-title transfer systems could be divided into centralized record change approach and distributed title transfer approach. *Centralized record change approach* transfers e-title document from one party to another simply by changing the registered title records between the two parties in a centralized title database, often owned and run by a trusted third party like a government (e.g. www.flhsmv.gov/dmv/E-Title-FAQ.htm; www.dmv.org/title-transfers.php). *Distributed title transfer approach* transfers title from one party to another by a self-described and self-verifiable e-title document. For example, Bolero system [16][24] provides a core messaging platform and a title registry to perform e-title document transfer. In this approach, any e-title document itself represents a provable title such that anyone holding an endorsed e-title document has the right of the ownership. The features of self-description and self-verifiability are achieved by adopting standard metadata and standard digital signature. The former guarantees that e-title documents are interoperable in e-title document format and template. The latter ensures that the original e-title document has not been changed during transfer and the transferred title always pertains to the correctly identified party [19].

III. CCET Approach

Cross-Context Electronic Title (CCET) approach is a solution satisfying requirements of security, human-computer understandability and contextuality. Particularly, the approach maintains semantic consistency between e-title documents created and transferred across contexts down to the document instance level. It adopts ConexNet framework [17][18][25] and XPM [6] to describe e-title document templates and their reifications (i.e. instance documents) as signs. This approach has the following features in e-title document creation and transfer:

- XML- and XPM-compatible
- external XML standards compatible
- multilingual
- secure for document integrity and confidential
- right ownership isolated, such that an e-title is self-described and contained
- legally-transferable, such that title content will not be affected by the transfer process

These features are realized in CCET approach through several newly developed techniques, as discussed in the remaining section.

A. CCET Document Engineering

E-title document is engineered in CCET Document Engineering (CCET-DE) method, shown in Figure 1. This method separates e-title vocabularies from e-title documents. It designs the new e-title document systems over ConexNet Framework such that all semantic terms of e-title systems including metadata and instance data are retrieved through a term usage interface from the vocabularies of ConexNet Framework. This model guarantees that any e-title document created, transferred and stored is independent and context-adaptable between contextually different e-business systems.

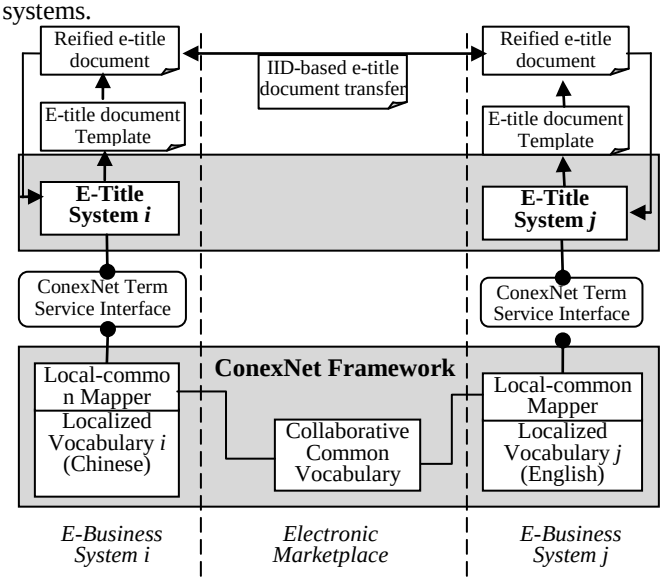

Figure 1: CCET-DE Method

In Figure 1, CCET-DE method separates the term creation from the term use and transfer. Terms for e-title document creation is collaboratively created and edited in ConexNet framework, in which ConexNet designers are responsible for maintaining semantic consistency of terms between heterogeneous e-business systems. E-title systems only use the

terms designed in ConexNet framework to construct e-title document templates and reification. The term creation in ConexNet framework and the term use and transfer in e-title systems are completely separated by the ConexNet term service interface. Since all e-title documents are made by ConexNet terms, e-title documents are semantically consistent across heterogeneous e-business systems.

B. CCET Document Representation

E-title document is represented in a CCET document representation (CCET-DR) method, shown in Figure 2. This method splits a document representation in three planes of structuration, abstraction and reification. By this separation, different roles of documents can work independently.

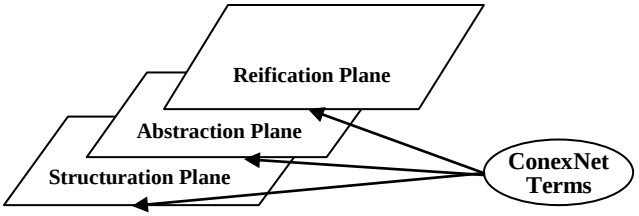

Figure 2: CCET-DR Method

In Figure2, *structuration plane* is a document syntax layer, in which *e-title document syntax* is represented based on XPM as a hierarchy of signs as follows:

$$sign =_{def} sign(sign_1, sign_2, \ldots, sign_n)$$

where each sign is a function of sign $=_{def}$ (structure, concept, interpreter, context) $\rightarrow$ reification, such that structure = (*term*) for expressing linguistic terms, concept = (*tid*) for unique identifier, interpreter = (*refs*, *logicComputing*(*qfier*, *bool*, *rule*), *children*(*maxOccurs*, *minOccurs*), *struct*(*dimn*, *leng*), *instruct*(*nthDimn*, *nthLeng*)) for expressing concept references (refs), logical computing of children elements, dimensional data structure (struct) and space position (instruct), context = (*myns*) for document ID, and reification = (*vstruct*(*op*, *dt*)) for reified document element content.

The advantage of this syntax is that document is sign-based in representation. Each document element (an atomic sign or a single term) is uniquely identified and hierarchically positioned in a document. This allows e-title document to be further designed and created in any personalized form but remains transferable between heterogeneous e-business systems. This advantage is achieved by its above independently-run abstraction plane.

Abstraction plane is a document template layer, in which various e-title document templates, such as blank bill of lading and blank warehouse receipt, are contextually designed using ConexNet terms and XPM e-title document syntax. Personalized e-title document templates are allowed in contextual e-business systems. This is because cross-context semantic consistency only relies on term semantics but not the underlying XPM e-title document syntax. Figure 3 illustrates how structure plane and abstraction plane are semantically separated.

Figure 3 utilizes the XPM hierarchical structure of signs to make each sign (i.e. term) as an atomic concept. This atomic concept can be arbitrarily arranged in a tree without changing the atomic concept meaning such that $sign_x(position_1) = sign_x(position_2)$. The disambiguation of atomic concept meaning is by referencing document term IID to ConexNet term IID in vocabularies (e.g. IID = 00047), hence structuration plane and abstraction plane is separated.

```
<xpm:sign xpm:tid="1:0" xpm:term="document" xpm:refs="00047" xpm:lang="en"
xpm:myns="00000001">
  <xpm:sign xpm:tid="2:1" xpm:term="head" xpm:refs="10001" />
  <xpm:sign xpm:tid="3:1" xpm:term="body" xpm:refs="00053">
    <xpm:sign xpm:tid="5:3" xpm:term="Information" xpm:refs="00055">
      <xpm:sign xpm:tid="8:5" xpm:term="Recipient" xpm:refs="00051"/>
      <xpm:sign xpm:tid="9:5" xpm:term="Sender" xpm:refs="00052"/>
      <xpm:sign xpm:tid="10:5" xpm:term="Title" xpm:refs="00048"/>
      <xpm:sign xpm:tid="11:5" xpm:term="Version" xpm:refs="00058"/>
      <xpm:sign xpm:tid="12:5" xpm:term="Timestamp" xpm:refs="00057"/>
    </xpm:sign>
    <xpm:sign xpm:tid="6:3" xpm:term="Content" xpm:refs="00060">
      <!--E-Title Docuemnt Content -->
    </xpm:sign>
    <xpm:sign xpm:tid="7:3" xpm:term="Insert External Standard" xpm:refs="00061 00062
00063"
          xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
      <!-- Use W3C XML Signature Standard-->
    </xpm:sign>
  </xpm:sign>
  <xpm:sign xpm:tid="4:1" xpm:term="Insert External Standard" xpm:refs="00061 00062
00063"
        xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
      <!-- Use W3C XML Encryption Standard -->
  </xpm:sign>
</xpm:sign>
```

A Simplified ConexNet Vocabulary

00047:document ; **10001**:head ; **00053**:body ; **00055**:information ; **00051**:recipient ; **00052**:sender ; **00048**:title ; **00058**:version ; **00057**:timestamp ; **00060**:content ; **00061**:insert ; **00062**:external ; **00063**:standard

Figure 3: Separation of structure plane from abstraction plane

Reification plane is a document reification layer, in which any e-title document template is instantiated to reified documents. XPM e-title document template reification provides a novel semantic consistency feature than the existing document representation. In most existing instantiation of document templates, only document templates, designed using standard metadata, are semantically consistent between heterogeneous contexts. The contents filled in the document templates are not semantically consistent. This is because users who instantiate document templates use regular words of natural languages. Since each user might have different understanding of the same used words, semantic consistency cannot be guaranteed. CCET approach proposed in this paper uses ConexNet terms to fill in e-title document templates and thus maintains semantic consistency in the level of e-title document reification. Figure 4 illustrates this method through a *sign IID-based document content reification*.

```
……
<xpm:sign xpm:tid="16:15" xpm:refs="00037" xpm:term="Shipper">
  <xpm:sign xpm:tid="17:16" xpm:term="Name" xpm:refs="00071"
xpm:dt="xs:string">ProperNoun(Alex)</xpm:sign>
  <xpm:sign xpm:tid="18:16" xpm:term="Address" xpm:refs="00072"
xpm:dt="xs:string">80001</xpm:sign>
  <xpm:sign xpm:tid="19:16" xpm:term="Telephone Number" xpm:refs="00073 00074"
              xpm:dt="xs:int">INT(85501000)<xpm:sign>
</xpm:sign>
……
```

A Simplified ConexNet Vocabulary

00037:shipper **00072**:address **00071**:name **00074**:number **00073**:telephone **80001**:New York

Figure 4: Sign IID-based document reification

In Figure 4, the reified (or instantiated) content of e-title document template is not simply inputted from the keyboard by document users but from ConexNet vocabulary replacing readable terms by XPM IIDs (e.g. 80001 for New York). For

those types of data that cannot be uniquely identified by XPM IID, they are directly inputted in corresponding functions that interpret the data, for example, ProperNoun(Alex) for "Alex" and INT(85501000) for integer.

C. CCET Document Transfer

E-title document is transferred from transferor to transferee in a CCET Document Transfer (CCET-DT) method. This method is novel in two aspects:

- Representing any e-title document in transfer by common IID of terms (not local IID for terms) through transforming local terms of local vocabulary to common terms of common vocabulary and identifying common terms using common IID. This achieves: (1) natural-language neutral in e-title document transfer but allows contextual local natural language translation; (2) e-title document sense uniqueness and independence, preventing legal disputes from heterogeneous interpretation of a legal e-title document at local site by receiver.
- Signing and encrypting any e-title transfer document, allowing the e-title document legally transferred in a confidential and integrative way in a *title transfer chain*. For traditional title document, a legal transfer is established by the endorsement (a signature) of the received title document by transferee. CCET-DT simulates this process by allowing e-title document to be digitally signed by transferee (receiver) and thus obtains the right of the ownership of the title. This digitally signed title is again encrypted to prevent the exposure from Internet.

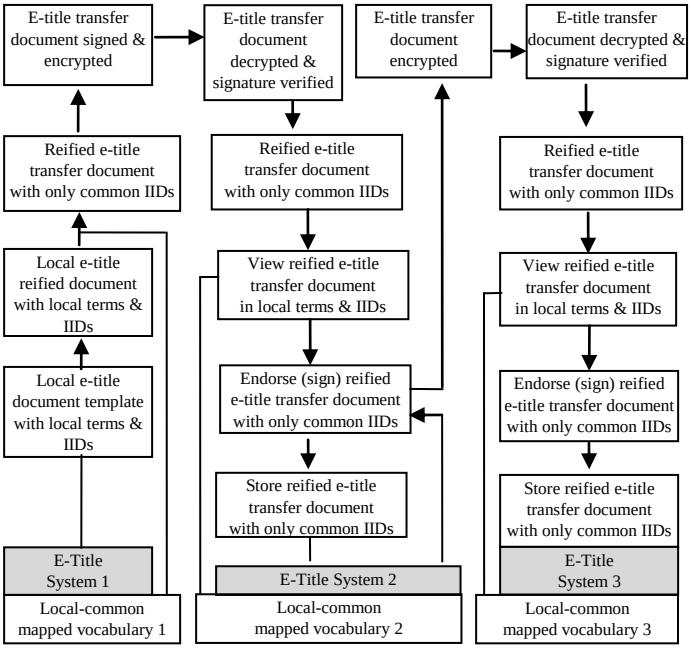

Figure 5: A title transfer chain using e-title document

The CCET-DT method is illustrated in Figure 5, in which a local reified e-title document is first expressed in common IID form, removing all local natural language terms with explicit and unambiguous meaning expressed in common IIDs. Then it is signed (endorsed) and encrypted. Any party who is the title document transferee (a receiver) must decrypt it and verify the transferor's signature and view its correctness in local language. If it is correct, it is immediately endorsed (digitally signed) to accept the title transfer. When the transferee wants to transfer the owned title again to another party, it must encrypt it and send to the next transferee again.

In the title transfer using e-title document, shown in Figure 5, the title (or right of ownership) in the transferred e-title document is self-contained, independent of transfer process and legally-atomic, that is, the legal content will not be affected during the step of the transfer.

D. CCET Standard Compatibility

E-title document is XML standard-compatible in CCET Standard Compatibility (CCET-SC) method. This method achieves XML standard compatibility through a simple yet novel technique. For example, using CCET-SC method, XPM is compatible with W3C XML Signature [7] and W3C XML Encryption [8].

First, CCET-SC method adds <xs:any namespace="##other" processContents= "strict" minOccurs="0" maxOccurs="unbounded"/> under the <sign> element of XPM sign schema to allow the XPM sign document to validate non-<sign> element.

Second, CCET-SC method introduces a special term "Insert External Standard" for a particular <sign> element to specify that only non-<sign> elements within this specified element is valid for introducing the external XML standard. This, on one hand, tells where an external XML standard is applied and, on the other hand, prevents the illegal non-<sign> elements appear in other <sign> elements.

Third, CCET-SC method finds the namespace of external XML standard defined in the specified <sign> element to determine which API of external XML standard should be used. By a lookup table of (XML standard namespace, API), the part of XML codes in external XML standard is parsed and executed by the corresponding API (*see* the example in Figure 3).

CCET approach provides a contextual, secure, multilingual, legally-transferable, standard-compatible yet 100% semantic consistent model for e-title document creation and transfer.

IV. CCET Prototype

CCET approach is implemented in a CCET prototype, which follows a system framework, shown in Figure 6. This framework consists of the following components:

- *Transfer Manager* is a user interface for managing e-title document creation and transfer. In this paper, e-title creation mechanism is not implemented as it is another big project out of the research scope of this paper.
- *Signer* is responsible for signing and verifying a common IID-based reified e-title document.
- *Encrypter* is responsible for encrypting and decrypting a common IID-based reified e-title document.
- *Local-Common Translator* is responsible for translating between local termed e-title document and common IID-based reified e-title documents.
- *ConexNet Local-Common Mapped Vocabulary* provides the mapped ConexNet vocabulary between local

vocabulary of e-business system and common vocabulary of ConexNet e-marketplace.

- *E-Title Document Viewer* is responsible for displaying various e-title documents.
- *Instance Function Library* provides helper functions such as INT(), ProperNoun() and Decimal() for displaying non-IIDed terms for reified document content.
- *XPM Parser* is used for parsing and validating XPM e-title document.

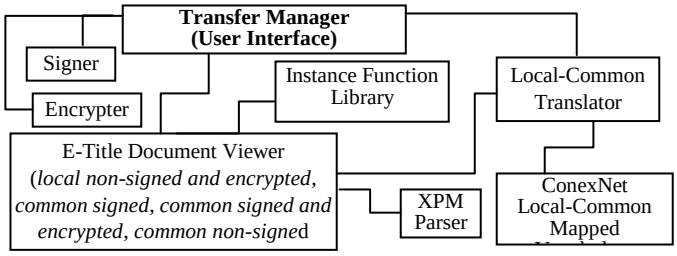

Figure 6: System framework of CCET Prototype

In this paper, the components of the prototype are implemented in C# programming language including using MySQL database for local-common mapped vocabulary. Transfer Manager demonstrates a user view of the CCET prototype, in which reified XPM e-title documents are sent, received and validated. Figure 7 visualizes how reified XPM e-title documents are received.

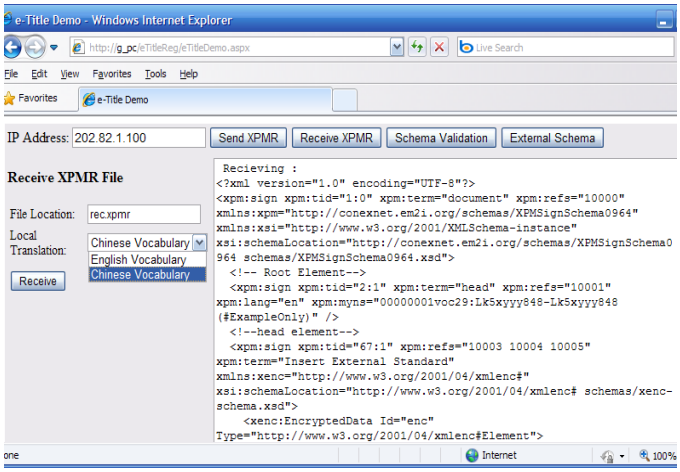

Figure 7: E-Title Transfer Manager (Demo of receiving a document)

Particularly, in prototype implementation, to achieve the legal transferability (i.e. legal content is unambiguous and without change between the title transferor (sender) and transferee (receiver)), a new E-Title Document Transfer (ETDT) algorithm is designed and implemented as follows:

ETDA Algorithm *(E-Title Document Transfer Algorithm)*
- Precondition: ET_o - Common IID-ed reified e-title document of transferor
- Postcondition: ET_e - Common IID-ed reified e-title document of transferee
- Computing process
  (1) Read(ET_o);
  (2) ET_oEnc = Encrypt(ET_o);
  (3) Send(ET_oEnc, transferor's certificate, transferee);
  (4) Receive(ET_oEnc, transferor's certificate);
  (5) ET_oDec = Decrypt(ET_oEnc);
  (6) SemanticConsistencyCheck(ET_oDec); // Meaning correctness of title
  (7) ET_oDigest = Hash(ET_oDec);
  (8) ET_e = ET_oDec+Sign(ET_oDigest) // Endorse the received e-title document

By this algorithm, a received e-title document must strictly experience the steps of encryption, decryption, identity verification, e-title content (semantics) verification, and endorsement. Particular, the final step of endorsement is extremely important. If missing the endorsement, the legal right of ownership for the transferred title still belongs to the transferor but not the transferee.

V. Experiments on CCET Prototype

A. Design of Experiment

We evaluated system performance by CCET approach and compared the average transaction time spent of CCET with the existing approaches of trade documentation. The experiments were set in the virtual environment using VMWare in a computer with Intel® Core™2 CPU T7200 @ 2.00 GHz, 2.00 GB RAM, 110GB hard disk and Windows XP SP3.

We performed two experiment scenarios. First, it randomly reified 25 e-title documents from the vocabulary data set to collect the function correctness and average transaction time spent. This experiment model was designed to record the modules of signer (signature and verification), encrypter (encryption and decryption), and local-common translator. Second, we used SIMUL8 [9] to simulate the virtual document transfer and measure the simulation time under the condition of transferring through several companies.

B. Results

The first experiment scenario verified the correctness of CCET approach through human users' visual monitoring. The results show that all modules are correct without any deviation. It reflects that (1) cross-context semantic consistency is maintained during e-title document transfer; (2) transfer security is guaranteed including confidentiality and integrity; (3) transfer document is understandable by both computers and human. The average time spent was 0.043 seconds (excluding time of document transfer through Internet that depends on Internet traffic). In comparing with existing approach of the simplest International Trade Transaction [10] of 18 seconds, the prototype saves a lot.

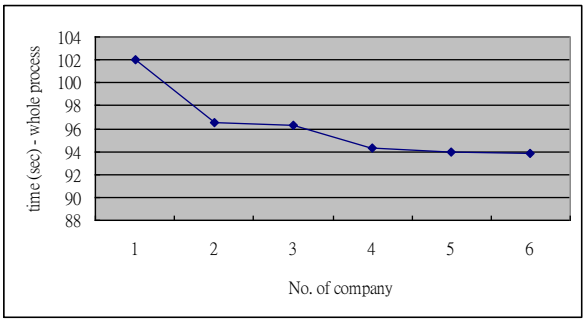

Figure 8: Average Execution Time

The second experiment scenario evaluated the whole processes (including document reification and estimated average time of document transfer through Internet), average execution time with number of companies from 1 to 6 by adopting the theory of semantic inference on heterogeneous e-marketplace activities [26]. The experiment illustrated that the

total time spent decreases when the number of companies increases.

VI. Conclusion

This paper has described a novel approach of how to transfer a legal e-title document across contexts satisfying the requirements of security, understandability and multi-contexts through a novel CCET approach. This approach is designed based on the existing technologies of ConexNet and XML Product Map (XPM) by proposing several new techniques of CCET document engineering (CCET-DE), CCET document representation (CCET-DR), CCET document transfer (CCET-DT), and CCET standard compatibility (CCET-SC). It is implemented in a CCET prototype with a new system framework and a novel E-Title Document Transfer (ETDT) algorithm.

CCET approach is important. It has been solved a challenging problem of cross-context semantic consistency maintenance for a legal title document transfer. It has made several contributions: cross-context semantic consistency between multilingual environments, XML standard compatibility for e-title document creation and transfer, three-plane e-title document representation for e-title document independence and context-adaptability, and e-title document transfer chain for legal transferability.

The collaborative vocabulary is the foundation of designing and implementing CCET approach. A future work of this paper is to gather and collaboratively add title-related terms to the existing ConexNet vocabulary.

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