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IFIX: A New Era of Financial Information Exchange

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Abstract

Financial information exchange is a significant process for every financial industry. According to the growth of the world financial market, this information is essential for every business investor. So Financial Information eXchange (FIX) software was implemented and become standard in the trading organizations. There are 3 main problems under the use of FIX: security, reliability, and diversity of files from sub-brokers. This paper proposed the Interface Financial Information eXchange (IFIX) that runs as a background process to perform the trading transfer process between brokers, sub-brokers, custodian, and Stock Exchange of Thailand (SET) using IPSec. The evaluation result of the IFIX from experts and end users in the trading organization was acceptable and all of them were satisfied more than using FIX..

Keywords: Business Participants, Finance Information Exchange, Information Exchange, Information Security, Network Reliability

I. Introduction

Financial information exchange is a significant process for every financial industry. There are various types of exchange information, such as equities (can be called as securities), fixed income, derivatives, and Foreign Exchange (FX).

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According to the growth of the world financial market, this information is essential for every investor. Currently, Financial Information eXchange (FIX) software is implemented to serve all these needs. Unfortunately, there are limits to use this application especially security of the transmission information among business organizations.

Currently, the use of FIX becomes standard in the trading organizations. However, the manual process is the main task of any information technology operators in the organizations. Consequently, the problem is not only the security issue, but also the reliability of the transmission process. In addition, most of the financial organizations have business participants; those are foreign brokers, sub-brokers, and custodian.

These participants also perform the similar tasks as their brokers, except that their trading orders must be sent through their brokers instead of sending to SET. According to this process, there are various file types and file formats received from participants. So the brokers have responsibility to alter these received files to the standard format of FIX before sending to SET. By conclusion, there are two processes to be executed before an order at the participant can be sent to SET: sending an order file to its broker, and transforming the order file to the common FIX format at the broker site. Therefore, the orders at the participants may be delayed and the customers of the participants might have lost their investment opportunities. So this paper proposed a new framework, called as Interface Financial Information eXchange (IFIX), that can eliminate all these problems.

The rest of the paper is described as follow. Some related works are drawn in Section 2 while Section 3 is the explanation of the traditional business process of FIX. Then, the problem domain is defined in Section 4. Section 5 and Section 6 are the proposed solution and installed framework for this defined problem. Finally, discussion and conclusion are described in Section 7 and Section 8, respectively.

Related Work

Information Exchange

It is the fact that information is a sensitive issue that can cause positive or negative impacts to the organization's stability. Therefore, high speed of the information exchange process between organizations is significantly desirable. Thus, using the Internet for supporting this process is an essential method to perform in every organization. Information exchange can occur in every type of organizations, such as financial, healthcare, logistics, educations, etc.

In 1990, Tunstall started using the Open System Interconnection Model, called as OSI model, for information exchange between banks (Tunstall, 1990). Unfortunately, there was some errors occurred at the management level. Therefore, the business opportunity was interrupted according to these errors. Since the information exchange mechanism is very vital to the sensitive information such as financial information, Hay had reviewed and considered the issues of economic information exchange among different offshore centers (Hay, 2002). These offshore centers were such as financial organizations, stock market, and governments.

Since there were various types of offshore centers, there were various types of data formatted to be transferred. Thus, the underlying of exchanged data format was proposed by considering the overlapping of required data among offshore centers and onshore offices. Moreover, the author proposed that the responsibility to perform such job is the stakeholders in the offshore centers. A similar case study had performed for Ghana Stock Exchange in the year 2013 by Fiador to identify the mechanisms of cooperate governance in the financial information exchange over the Ghana Stock Exchange environment.

The study indicated that the board size and CEO's roles can affect to the success or failure of the Ghanaian market (Ogeh Fiador, 2013).Another example of information exchange is the use of information exchange between the Hospital Information System (HIS) and the Picture Archiving and Communication Systems (PACS). The HIS system deals with patient information and the PACS system manages image information. This solution of Lin, el al. leads the traditional hospital became the digitalized hospital. Currently, HIS uses the standard of HL7 and the PACS uses the standard of DICOM 3.0. Consequently, Lin and el al. (Liu, Li, Liu, Yuan, & Yin, 2008) proposed a method of establishing HL7/DICOM gateway so that information ex-change between HIS and PACS can be performed.

Trading System

One business type that causes a high impact to the world economy is the financial business. Like other business organizations, information exchange, especially trading information, is significantly sensitive by times.

So Ming et al. (Fanbo, Minli, &Wuliang, 2010) proposed the use of web-based system for financial trading; this was a type of an electronic market that traders use to execute bundle orders. Then, in the year 2011, Sharma and Gupta compared Indian intraday trading software with foreign software (Sharma & Gupta, 2011).

Financial market prediction and trading describe a challenging task that attracts great interest from researchers and investors because success may result in substantial rewards. Huang and his team proposed an application of a hierarchical evolutionary fuzzy system called the HiCEFS (Huang, Pasquier, & Chai, 2008) for predicting financial time series. A novel financial trading system using the HiCEFS as a predictive model that employed a prudent trading strategy based on the price percentage oscillator (PPO) was proposed. In order to construct an accurate predictive model, a form of generic membership function named the Irregular Shaped Membership Function (ISMF) was employed; a hierarchical evolutionary genetic algorithm (HCGA) was adopted to automatically derive the ISMFs for each input feature in the HiCEFS.

Information Security

Since information exchange is performed over the Internet, there is a chance that information could be tabbed and stolen by unauthorized person from the communication channel. Therefore, the security of information is important to be concerned. Recently there are several methods to protect information from hackers, such as using cryptography, using security protocol, or using private communication channel, etc.

The cryptography is a technique to implement a mechanism or protocols that can protect information or message from intruders. However, implementing encryption method to the financial transfer mechanism might not be a practical solution because it is not a cost-effective solution (Chandra, Paira, Alam, & Sanyal, 2014).

The use of existing security protocol is another solution that can be implemented easily since all packets must be transferred using a transmission control protocol. One common transmission control protocol over the Internet is TCP/IP where many security protocols are developed over it, such as TLS/SSL, HTTPS, etc (Yoon, Chung, & Kim, 2009). These protocols were developed in the Application layer of the OSI-reference model that was closed to the running applications (Antonova, 2013).

In additional, there is a standard security protocol that has been commonly used for packet transferring over the Internet named as IPSec, Internet Protocol Security. This protocol is implemented in the network layer of the OSI-reference model that can cooperate with TCP/IP when a private packet is delivered. In the year 2007, an application-aware IPsec policy system on the existing IPsec/IKE infrastructure was proposed (Yin & Wang, 2007). This software monitored a socket' activities, wrote them into the IPsec Security Policy Database (SPD), and sent reports to a network administrator. The experimental results showed that the overhead of policy translation was insignificant, and the overall system performance of the enhanced IPsec was comparable with network setting and protection setting to those of security mechanisms at upper layers.

Business process management

Business process management (BPM) is a new kind of management theory that appeared and developed quickly in the recent years. It was established in the foundation of modern information technology, and focused to the managers' attention on the enterprises 'business process instead of business functions as appeared in the traditional model.

In the year 2010, Fanbo et al. had applied the concepts of object-oriented design and processes to the business process management system based workflow (BPMWF). The class diagrams generated from the object-oriented design were used to create the business process workflow (Fanbo et al., 2010). Therefore, the workflow of the business process management could be implemented easily.

Lately, a framework that could simulate the situation of business process management to predict the outcomes from the input scenario was proposed. As a result, the image of the business could be seen before the real implementation. Therefore, the business analyser can provide a complete prescient and prescriptive elements of recreation investigation to the business management committees in advance of their decision (Januszczak & Hook, 2011). Although the outcomes of the business process management might be predicted by the framework mentioned above, some risks of the processes might be ignored. Therefore, (Lhannaoui, Kabbaj, & Bakkoury, 2013) proposed the Risk-aware Business Process Management (R-BPM) to improve the business process model.

This research recommended that the business management could be modified in the right direction whenever the manager clearly understands all business processes inside the organization; then, the risk management could be performed.

Traditional Business Process of FIX

In the traditional trading process, there are two processes to be performed, as shown in Figure 1. The first process is the front desk process where a trading information is sent from a broker to SET until a deal occurs. Then, the second process or the back-office process performs the clearing with customers and a commercial bank, including deposit securities for customers. However, this research focuses only the efficiency of the back process.

In order to accomplish the back process, an IT operator is responsible for exporting flat files from the Securities Back Office (SBA) database. Then, this file will be uploading the file to SET through a web portal. Nevertheless, the validation process is executed by a module of the web portal before uploading the file to SET.

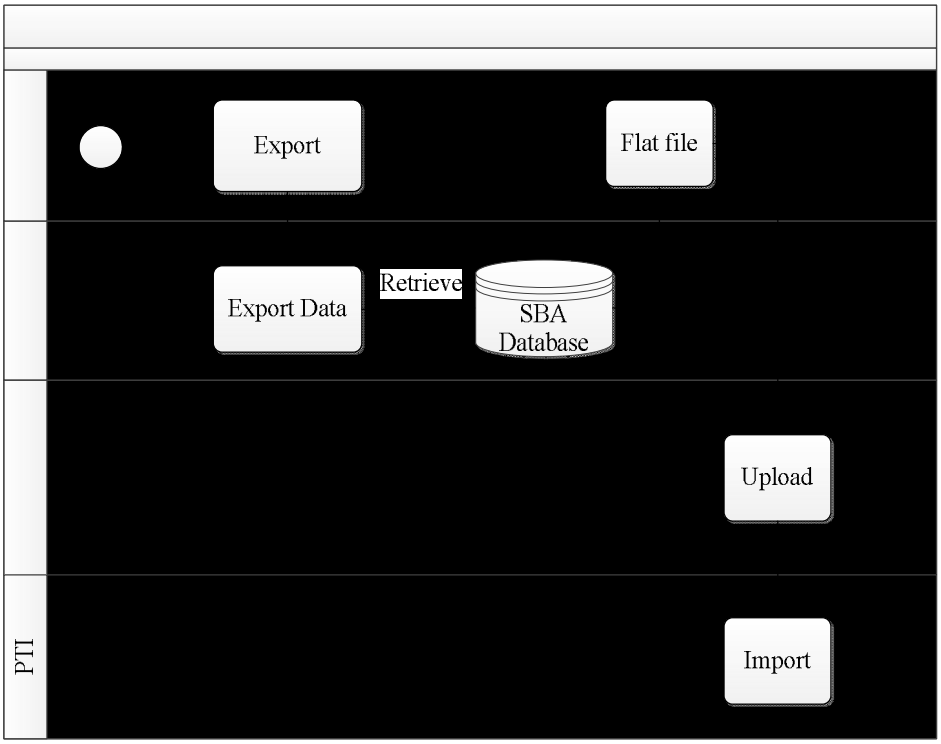

Figure 1: Traditional Business process

Presently, the FIX system is widely implemented in various financial organizations. Within the FIX system, there are two different roles that perform 2-side communication; these are initiator and acceptor. The FIX engine retrieves the data from the back-office management system and exchange this data with another acceptor using TCP/IP. However, there is no security protection over the transfer information along the communication channel. In addition, all sub-brokers cannot directly connect to SET. Therefore, the current FIX system is not up-to-date to compatible with the existing financial organizations. The architecture of the present FIX system is drawn in Figure 2.

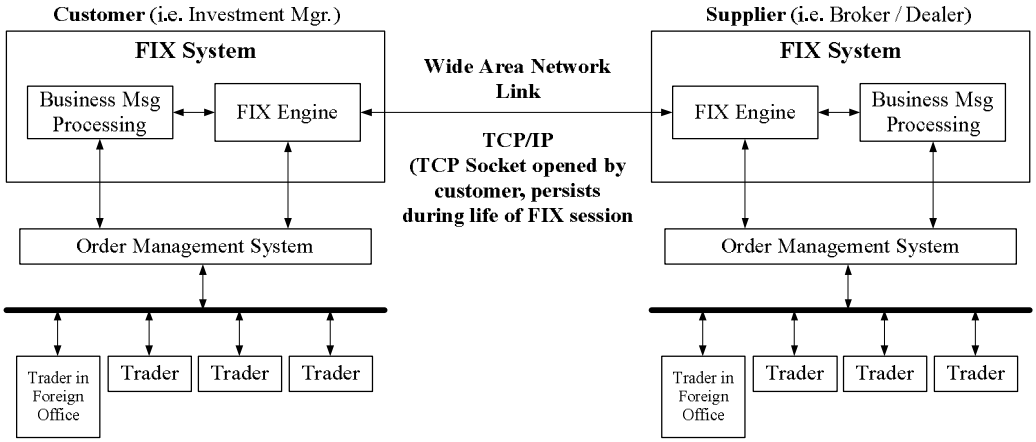

Figure 2: FIX System Connectivity (Tongkamonwat & Bhattarakosol, 2015)

Problem Domain

According to the traditional financial information exchange (FIX), there are several limited in transaction transfer process between brokers, including brokers and SET; this limitation occurs from the use of flat files in the transfer mechanism. The main problems of this traditional FIX can be classified in 4 categories: security, people, sub-broker, and reliability.

For the security issue, the general FIX considers only the format of the transferring flat file without awareness of information stolen along the communication path. So, there is a high possibility that the files can be copied or altered by illegal partners. Therefore, this issue can be separated into 2 sub-problems: the use of transferring protocol and the use of transferred information (flat file) .The second problem is related to people who work in FIX because the transfer mechanism of FIX is based on a particular person. Thus, without the responsible man, the exchange of information cannot occur.

Additionally, after each trade succeeded, the trading information from the trading broker must be sent to SET to manage its real-time risk. However, this process causes interruption of other tasks because sending information is manually performed as mentioned earlier. As a result, every end of the day, all trading information at the brokers' sites must be submitted to SET to manage their risk.

As the fact that each sub-broker uses different software to manage its trading information, formats of flat files sending from sub-brokers are different. Thus, these file formats might not be able to be used by the FIX system. Consequently, the received files from sub-brokers must be transformed to the standard format of FIX at the broker site before sending to SET. So, the trading orders of customers of the sub-brokers are delayed.

Based on the manual transfer mechanism of FIX and unreliable network between brokers and SET, the responsible person must be aware that the submission process maybe fail and the resubmission must be performed, otherwise the trading information will be lost without a warning message. The failure situation, usually occurs at SET, is based on 2 situations. Firstly, the communication channel between brokers and SET is congest; long delay of packet transfer can terminate the transferring packets. Secondly, the server at SET is down without expectation and explanation, but this case is hardly occurred.

Figure 3 shows a cause and effect diagram which explains main problems and sub-problems of the traditional FIX that have mentioned above.

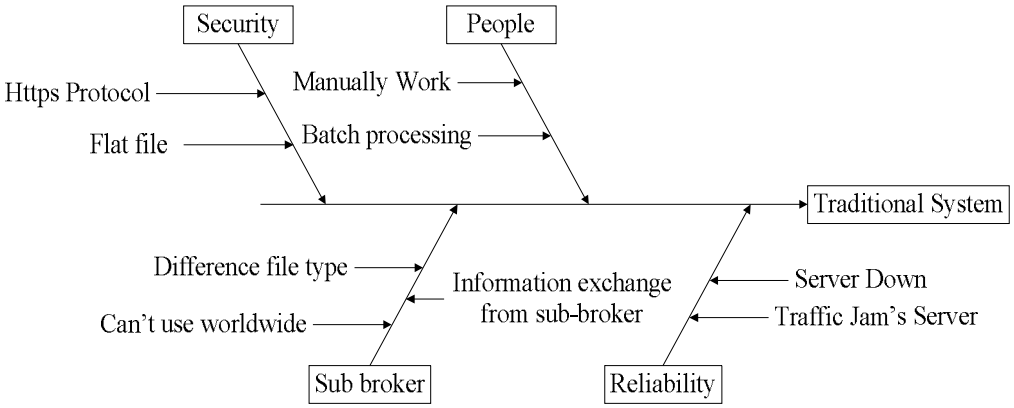

Figure 3: Cause and Effect Diagram of FIX

Proposed Solution

System development paradigm

In order to solve problems defined in Section 4, an Interface Financial Information Exchange (IFIX) was developed using a system development paradigm. This development paradigm consists of 6 processes: preliminary investigation, analysis, design, development, testing, and implementation. Each process is described below.

Preliminary Investigation

The preliminary investigation, or so called as feasibility study, is an important stage of software process since the real problems of the pre-installed system can be defined. Moreover, software re-quirement specification (SRS) is partially uncovered. In this research, a group meeting was conducted to capture requirements. So 6 persons in the same organization were involved in the group meeting; 3 persons are users with different tasks and 3 persons are software developers.

During the requirement capturing, the group meeting was performed every Friday for 4 weeks and each time spent 2 hours. After finishing the requirement elicitation process, a requirement list and minuets of meeting were sent to every person who joined the group meeting to verify the list and the minuet. The results of this study can be classified as functional requirements and non-functional requirements. Lists of all requirements are below.

- Functional Requirements
  - Users can exchange information without difficulty
  - The system can authenticate and authorize users for system protection.
  - The system can directly interface with the database to retrieve data. The user can direct to the securities back-office database.
- Non-Functional Requirements
  - The path to exchange information is able to enhance security.
  - The reliability of the transferring system is maintained whenever the SET's server downs.
  - Users can use the system via a graphic user interface instead of using a command line as the current FIX system.

Analysis

There are 6 perspectives in the IFIX domain analysis: the context of the IFIX domain, customers and users, a running environment, tasks and procedures, competing software, and domain similarities. Figure 4 shows 6 perspectives of the IFIX domain analysis.

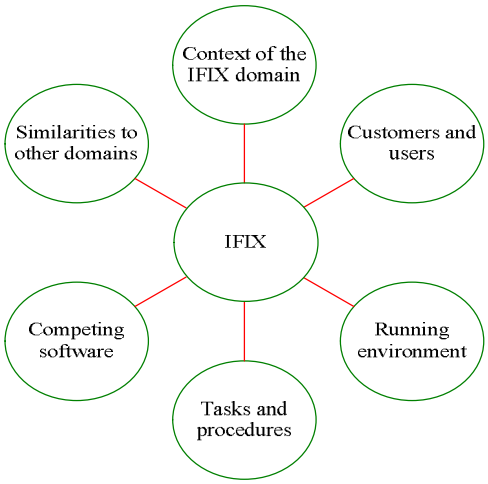

Figure 4: Six perspectives of the IFIX domain analysis

According to Figure 4, details of each node can be described as follows.

a) Context of the IFIX domain

This system, IFIX, focuses on a new mechanism of the financial business flow of orders from the forwarded orders. The information exchange must be updated in real-time over the electronic communication network. Therefore, the process of IFIX domain runs as a background process.

b) Customers and users

Broker, the representative of customers, receives orders from customers and sends to SET (TSD). Foreign Broker, Sub Broker and Custodian who have no license for trading equities and others are able to use the IFIX.

- c) Running environment

In order to fully support the process of trading mechanism of all financial organization, platforms of the IFIX will not limit to Computer or laptop e.g. Window XP, Window 7 or Window 8 with .NET 4.0.

d) Tasks and procedures

For depository system: users can select a command to perform a task or sending a message of FIX to TSD. For security: this system uses a firewall to protect hackers and malicious software.

e) Competing software

Many companies try to develop software similar to IFIX, such as DST and Freewill Solutions. However, most of them had withdrawn their software implementation except DST ("SET List of The ISV (Independent Software Vendor)," 2016). Nevertheless, the software of DST cannot fully support internal process requirements as much as the IFIX since IFIX is developed based on the requirement specifics than the DST's product.

f) Similarities to other domains

The similarity of this system with other do-mains, it's similar to XML (EXtensible Markup Language) or another data exchange system.

Design

All requirements from the previous section, the analysis process, are derived to the Unified Modelling Language (UML), as shown in Figure 5. The result of this use case leads to the screen design of the IFIX.

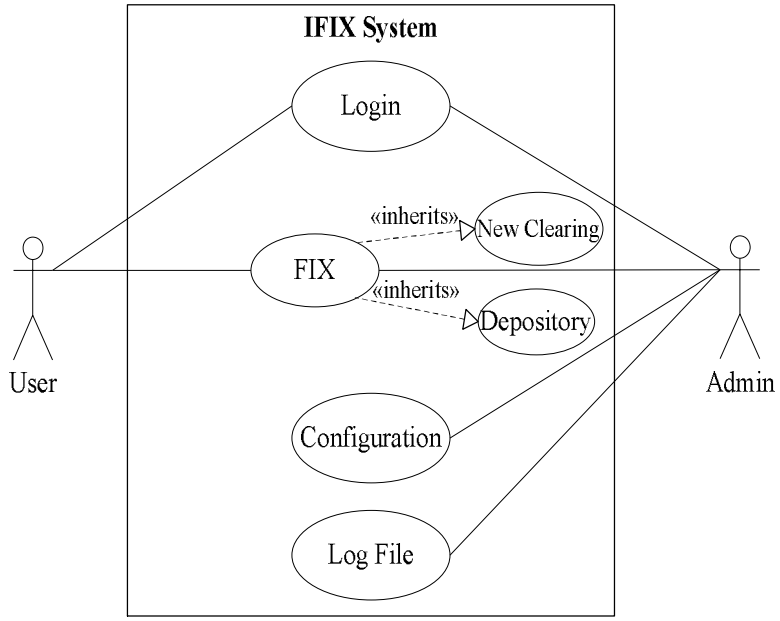

Figure 5: Use Case Diagram

The screen design of the IFIX can be separated to 3 types: Login, Command menu, and Response and request. The Login design, layout of login box, is placed on the centre of the screen due to easily access. Then, the screen of the Command menu is separated into two parts: a Heading part, and a Command menu part. In addition, when a user clicks menu at the left hand side of the Command menu, the form of the request-and-response message will be displayed to receive parameters.

Development

The development tools for the IFIX system were Microsoft Visual Studio by C#.NET and Microsoft SQL server. The Microsoft Visual Studio by C#.NET was used to design UI and the Microsoft SQL server was used for implementing the database.

Testing

In order to verify the IFIX system, the module testing and the system testing were performed. Details of each test are drawn as follow.

a) Module testing

Since the development approach is object-oriented, the module testing can be applied easily. Each module test was individually performed under a test plan and test data that was obtained from the User Accepted Test (UAT) server before delivering the software to the production server. The result of module testing indicated that there was no computing error or transmission error occurred.

b) System testing

After passing the module testing process, every module was integrated to form a system. The objective of the system testing was to confirm that every module could work together correctly and properly. Furthermore, it served users' expectations.

The system testing was performed using the testing data from the User Accepted Test (UAT) server as same as the module testing. The result showed that the entire system could work properly and correctly as expected.

Implementation

In order to implement the IFIX system, the parallel implementation was performed. The parallel implementation referred to the situation that the old system still lives while the new system is activated. Thus, if there is a problem occurred with the new system, the old system can cover the current process of the organization perfectly. However, whenever the new system, IFIX, could perform its task without error, the old system would be deactivated and terminated.

IFIX Mechanism

The IFIX mechanism is implemented to solve the problems of security, sub-brokers, and reliability of the FIX engine that are mentioned in Section 4. So the IFIX system is embedded with the FIX engine and has additional objects run as an above layer of the FIX system to manipulate these existing problems. The main responsibilities of the IFIX system are receiving and sending a FIX message which is generated by the FIX engine while connections between TSD and brokers still manages by the FIX engine. Details of objects that are implemented based on the IFIX mechanism are described below.

Security

a) IP security protocol - IPSec

Since the connection and transmission of all FIX messages usually relay on only one fundamental protocol, TCP/IP, there is no guarantee that these messages are completely save from hackers. Therefore, using a common security protocol as IP security protocol, or IPSec, while sending messages can provide a higher security protection for every IP package.

To access via Site-to-Site IPSec VPN over the Internet, every participant has to prepare its own Internet access environment. SET needs to provide the necessary information for each participant to configure IPSec on the participant's network equipment. After the IPSec connection has been established between participants and SET, all data are encrypted in standard and the most secure method. Figure 6 shows the IPSec site-to-site connection.

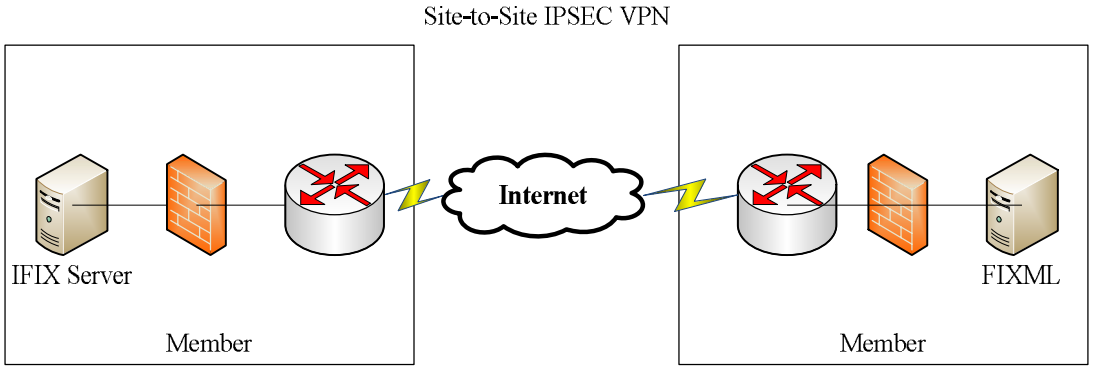

Figure 6: IPSec site-to-site connection

b) Reliability

Based on the standard FIX system, whenever there is no respond from SET, the brokers need to perform a manually check for connections until the respond returns. Thus, it is not convenience for brokers to deal with such problem. Therefore, the IFIX system can overcome this limitation by al-lowing an automatic checking and connecting be-tween SET and the broker, including resending the remaining FIX messages to SET.

Figure 7 shows the state diagram of the IFIX system in the reliability states. The reliability state diagram of the IFIX starts when a data was retrieved from the SBA database, the get Data event occurs. Then, the state changes to 'Wait To Send' state. If SET sends 'response' to the IFIX, the message is sent; this enters to the 'Sent state' and then terminate. Otherwise, the message is not sent; this enters to the 'Not Send' state. While the IFIX enters the 'Not Send' state, it immediately moves to 'Heart Beat' state and repeats requesting message until it receives the 'response' from SET. Finally, the message is sent and the IFIX stops working.

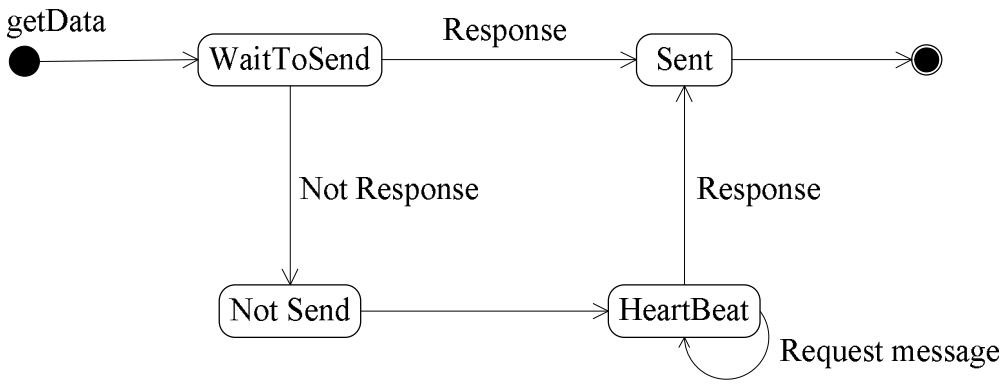

Figure 7: Reliability state diagram of the IFIX system

c) Sub-broker

The information exchange is not limited only between brokers and TSD, but also occurs among other business participants which are foreign brokers, sub-brokers, and custodian. So the IFIX must support the exchange process among those organizations as needed. Moreover, when the number of nodes of foreign brokers or sub-brokers or custodian increases, the broker becomes an initiator for SET and an acceptor to receive the deal orders from business participants. This is because the business participants have no trading license, they cannot exchange or trading directly. Figure 8 shows the IFIX architecture that manipulates all exchanged information around the financial system.

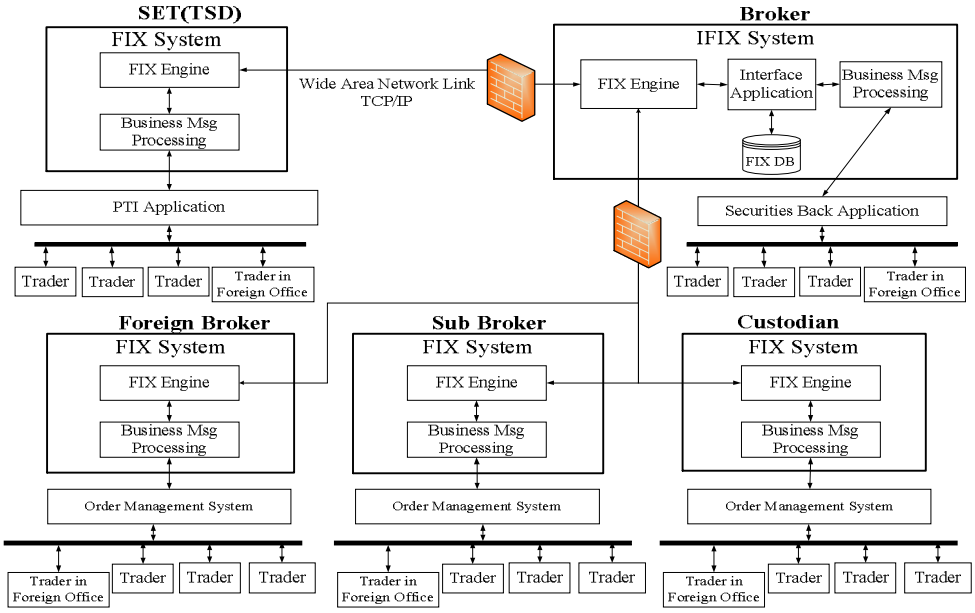

Figure 8: The IFIX architecture

The Installed Framework

The implementation of the IFIX, the hardware is able to run completely and support functions of the IFIX. The hardware used in this research are displayed in Table 1 below.

Table 1: Typical Hardware specification

Device	CPU	RAM	Hard Disk
Computer			
Developed	2.7GHz dual-core Intel Core i5	8GB	20 GB or upper
Client	Intel Core i3 2.4 GHz	4GB	5GB or upper
Database Server	Intel Xeon)R (3.07GHz	8GB	100 GB or upper
Application Server	Intel Xeon)R (3.07GHz	8 GB	20 GB or upper

User Satisfaction Evaluation

In order to evaluate the development of this proposed software, the IFIX, two individual groups are involved. The first group focuses at the people who are software developers with experience more than 3 years; this group contains only 3 persons. The sampling method for the first group is called as purposive sampling where the expertise in the area is selected for providing their opinion. The second group contains 4 persons in IT administrator, and 16 persons as end users. The second group is sample based on the accidental sampling method. The results from both groups are displayed in Table 2 and Table 3 which can conclude that both groups are satisfied with the proposed IFIX design and process.

Table 2 :Summary Results over all evaluation by experts

Summary Listed	Mean	Std .Dev.	Result
Design - Comparison existing system - Data and information Exchange - Security	4.28 4.47 3.80 3.80	0.45 0.28 0.38 0.27	Very Good Very Good Good Good
Average	**4.13**	**0.34**	**Very Good**

Table 3 :Summary Results over all evaluation by users

Summary Listed	**Mean**	**Std .Dev.**	**Result**
- Design - Comparison existing system - Data and information Exchange	4.32 4.44 4.48	0.38 0.63 0.64	Very Good Very Good Very Good
Average	**4.41**	**0.55**	**Very Good**

Discussion

Information exchange system is an important system for every organization since good information can support internal and external activities of the organizations smoothly and beneficially. Although information technology and the Internet have been implemented for years, the integration of both technologies that supports the efficiency of information exchange mechanism in financial organizations is hardly be seen. Even though FIX protocol was implemented and used as a standard for financial transfer packets, many limitations still exist.

One significant issue that FIX protocol does not cover is the security of the transferred securities between brokers and TSD. Moreover, every transmission process of FIX software mostly relies on manual process. Thus, whenever the network or server of SET is unreliable, the IT operator at the broker site must standby to resend the message again.

This is different from the proposed solution, the IFIX. The IFIX provides security to all delivering packets since it uses IPSec as a tool. Moreover, there is a mechanism to check the connections between brokers and SET, including reliability situation of servers at SET. Thus, the IFIX can resubmit the packet whenever the reliability of the connections or servers occurs.

One big difference between the IFIX and common FIX is that the opportunity of all business participants can use FIX to send their securities orders through their brokers. So the standard format of the sending transaction exists and the receiving transaction can be sent to SET faster than ever.

Conclusions

The information exchange is an important part of an information system. Although information system is widely used in organizations, the exchange of information among different organizations is still limited. Similar to other information exchange software, one standard information exchange in the financial organizations, FIX, also has lots of limitations and constraints. Thus, this paper proposed IFIX to overcome those problems by automatic processes.

The IFIX can solve the network security, reliability and sub-brokers' limits. Security is the first issue for information because the data is secret and valuable so IPSec is applied in the data transfer mechanism. Moreover, the IFIX performs self-checking and re-submission when a packet is sent to SET so it can reduce the human's workload whenever the network down, the server down, and other problems that cause information exchange interrupt. Therefore, reliability of the trading system can be maintained.

In addition, all securities orders from every sub-broker can be send using FIX and merged with other orders at the broker before sending to SET without worrying about different file formats or platforms. The evaluation result of the IFIX from experts and users indicates that they are appreciated to work with IFIX than working with the common FIX. It means the quality of the IFIX is good.

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