An Information Fusion-Enabled Third Party E-Commerce Platform Based on SOA

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***Abstract*—The rapid development of E-Commerce not only generate huge amount of business opportunities but also raises a new question to the supporting platform of E-Commerce. Nowadays, E-commerce platform design is one of the hot spot of E-commerce research. The traditional 3-layered E-commerce platform can't meet the requirement of today's E-commerce application which is more complicated than before[1]. The most significant disadvantage of today's platform is that it can not let clients share the commercial data in terms of their need and the platform is not in a form of a whole assembled software or webpage package reflecting various kinds of need of the customer or providing solutions for each specific customer request. This paper firstly use the use case diagram to analyze requirement of the third party E-commerce platform and then gives a SOA based solution called IFTPEC in which information integration ability is assembled. Then the paper analyzes its architecture and supporting environment and discusses its information fusion model. Finally it's working framework and key technologies are presented. The implementation of the system can resolve these two questions and provides effective support for integration and operation for the complicated and dynamic E-commerce mode.**

***Index Terms*—information fusion, SOA, third party, E-Commerce, Web Service**

I. Introduction

The internet makes the long distance E-Commerce possible without restraining from spatial or temporal distance. Because of this feasibility of the E-commerce over conventional business, the supporting software platform for the E-commerce is becoming a focus point for the researchers and developers. The platform can be established by seller, buyer or the third party. Generally, the intention of seller establishing its own E-commerce platform is to provide customers more options of selecting and purchasing its own products, while the intention of buyers establishing their platform is to make them having better service, finding what they need with lower price as soon as possible. But obviously no matter if the platform is established by the supplier or seller, its fairness and transparency is difficult to guarantee and thus its accessing rate is also low. Therefore, the third party E-commerce platform[2] is a better option for both buyer and seller.

The E-commerce platform developed by the third party is to provide business information and transactions services for multiple buyers and sellers. It is public and neutral business platform on purpose of client's need which is a potentially profitable E-commerce mode and provides conventional services in a creative mode. Both the sellers and buyers can benefit from its appreciation service. The characteristic of this platform includes: keeping neutrality to win customers' reliance and confidence; collecting both buyer's demand and sellers' offering; matching potential buyer's need and seller's offer thus advancing successful transaction; supporting transaction so that facilitating marketing operation.

However, designing a good and commercial successful third party E-commerce platform is not an easy task. One difficulty is it has to be able to dynamically integrate the E-commerce applications in order to coordinating enterprises which are E-commerce partners. The coordination among partners can be either of data exchanging or coordination in terms of client's need among various applications. The second difficulty is it has to be open to different kinds of commercial

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applications and businesses and allows mutual-operation among various platforms. Although current interactive E-commerce platform based on three layers architecture supports dynamic information publishing, interaction between system and client and connection between E-commerce system of enterprise and local information system inside the enterprise, the difficulties still can not be resolved by far.

This paper proposed a SOA based third-party E-commerce platform design (called IFTPEC) which can realize the information integration. Meanwhile, system architecture and supporting environment are analyzed. The paper focused on the information fusion model that can provide a good solution for the third-party E-commerce implementation. The creative point in this paper is it introduces the information fusion into the E-commerce platform design so that implementing commercial data[10] assembling in terms of customer's need. The structure of the paper is as follows: in the next section, we are going to use case diagram to analyze the function and demand of the third-party E-commerce platform; in the third section, we are going to discuss IFTPEC system architecture and its supporting environment and this is the basis of the third-party E-commerce platform; the forth section will analyze the information fusion model of the IFTPEC, including fusion structure design and fusion algorithm analysis; the fifth section will discuss the implementation of the IFTPEC and analyzing its operating process; final part is conclusion.

Ⅱ System Requirement Analysis

By examining a simple transaction on the Internet that conforms to IFTPEC business process, we can identify a customer looking for a product and a provider offering that product. After locating the provider the customer sends a request and waits for provider's response. This simple business transaction was used since the early days of Web. However, the activity "find a provider" has significantly changed due to tremendous internet growth. To deal with the overwhelming increase in the number and variety of providers, a number of services appeared that help the customer in finding providers. Search engines and portals are examples of such services. To take into account the role of such sites in the interactions between customers and providers, we introduce IFTPEC. The IFTPEC, in this case, adopts the activity formerly performed by the customer and enables simple discovery of potential providers. Finding a provider is only one of the services an intermediary may perform.

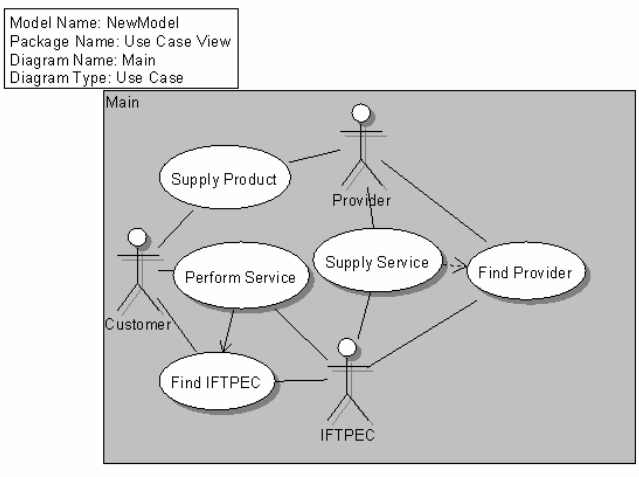

Figure 1. Use case diagram relating the actors of IFTPEC

The use case[3] driven modeling approach employs UML use case diagrams for describing the context of IFTPEC. The use case diagram associates IFTPEC actors and a number of use cases. Use cases are usually described by UML activity diagrams or sequence diagrams that model organizational business processes. They list the interacting actors, their activities, and artifacts produced during the business process, providing the input for the construction of the class diagram which communicates the domain model in a programmer-like style.

Figure 1 depicts the use case diagram that describes IFTPEC context. The diagram relates a customer, a provider, and an IFTPEC performing a generic service. In our model, IFTPEC performs services for both customer and provider, and acts as a connection between them. A customer uses the services of IFTPEC to simplify interactions with providers. We model this interaction by the use case Perform service. For example, IFTPEC can help a customer to find a dependable provider by advertising products on behalf of a provider.

After locating the provider, the customer can choose to conduct business directly with the provider. This situation is modeled by the use case Supply product that connects customer and provider. In this case, IFTPEC delivers products and handles payment on behalf of the provider. IFTPEC interacts with the customer and performs a service, but also interacts with the provider. We model the interaction with the Supply product use case. The two remaining use cases Find provider and Find IFTPEC model the initial process of locating providers and intermediaries.

The most interesting and complex use case is Perform service. In this initial modeling step we think of it as a generic service. IFTPEC can potentially offer an unlimited number of services. However, a typical business process consists of a combination of the following phases: advertising, negotiation, ordering, payment, and delivery. IFTPEC can provide a service that enables one, or a combination of the listed business phases. For example, IFTPEC can perform advertising on behalf of a provider. To be able to do advertising, IFTPEC needs a description of provider products, i.e. a product catalog from the provider. A provider may, in another scenario, entrust both advertising and negotiation to IFTPEC and supply the intermediary with the pricing and discount model that will guide the negotiation process. In another case, IFTPEC may offer a number of payment methods, e.g. different micro payment protocols, as a service, or enable delivery via push systems. It can also combine products coming from several providers and autonomously offer combined products to end customers. These are just some of the examples of

possible intermediary services that can become part of IFTPEC business processes.

To support the business process execution, IFTPEC needs to facilitate inter-operability. The exchange of standard messages that are understood by all business actors is a prerequisite for automatic communication. In IFTPEC, the actors should be able to exchange requests, orders, and offers to negotiate business terms related to delivery and payment. They should also be capable of delivering products to their customers, and collecting revenue for their services.

The presented use case diagram and its analysis have guided the definition of architectural principles for the IFTPEC. These principles and the architecture are addressed in the following section.

III System Architecture of IFTPEC

From the analysis of the case diagram in the second section, the third-party E-commerce platform is mainly an inter medium. Given the dynamic nature of the E-commerce, it is necessary for E-commerce architecture designer to consider how to adapt to this kind of varying multiple application modes. In another word, it should be able to configure or modify its function sets in terms of services it needs to provide thus to fulfill the informational or modernization need of enterprises. And the enterprise which is in charge of providing E-commerce platform needs to facilitate the information flowing between client enterprises and customers. The demanding information of buyers has to be given or collected instantly and accurately by E-commerce service provider and it might possible that E-commerce service provider participates in client enterprise information collecting process or system. This requires that E-commerce system has the ability to interfere or participate in clients' business activity and also can provide friendly data connection interface, service connection interface. But the conventional object oriented design (OOD) pay much more attention to object itself rather than service oriented, so for the connection between different enterprise systems OOD is not a good option and how to design a good one that can realize un-gap connection is still a bottleneck by far.

SOA[15] itself is a system architecture that is enterprise service oriented. That is to say, SOA is a new system architecture for system developing. In this structure, functions of specific application or program are obtained by combining loosely coupling components (service) which are with the unified connection port. Therefore, building SOA based architecture must start from a specific request of a enterprise. But the difference between SOA and the other kind of architecture is SOA can provide services feasibly. The feasibility of services makes the enterprise can response to service variance quickly and adjusting its services on time can improve its competitiveness significantly. Developing a feasible architecture means building an IT architecture that can potentially fulfill the needs of unknown services. SOA is an architectural style for building software applications using network-accessible services. In SOA, services are defined as loosely-coupled, implementation-independent, and well-defined software interfaces. Web services is a way of realizing SOA based on XML based open standards such as SOAP[11][12], UDDI, and WSDL which provide a common approach for defining, publishing, and utilizing Web services.

A Design Goals

The main design goals were component-orientation and inter-operability. Component-orientation was targeted in this ways: We wanted to make IFTPEC itself component-oriented to realize the dynamic application integration according to user requirements.

The second main goal for the design of the IFTPEC architecture was to have a flexible and extensible framework that could be easily tailored to the user. For example, if a site did not want to support payment or advertising, we do not require it to install unnecessary components. In contrast, we wanted to have a very minimal set of components to be required and allow a user to add further components as needed by his/her

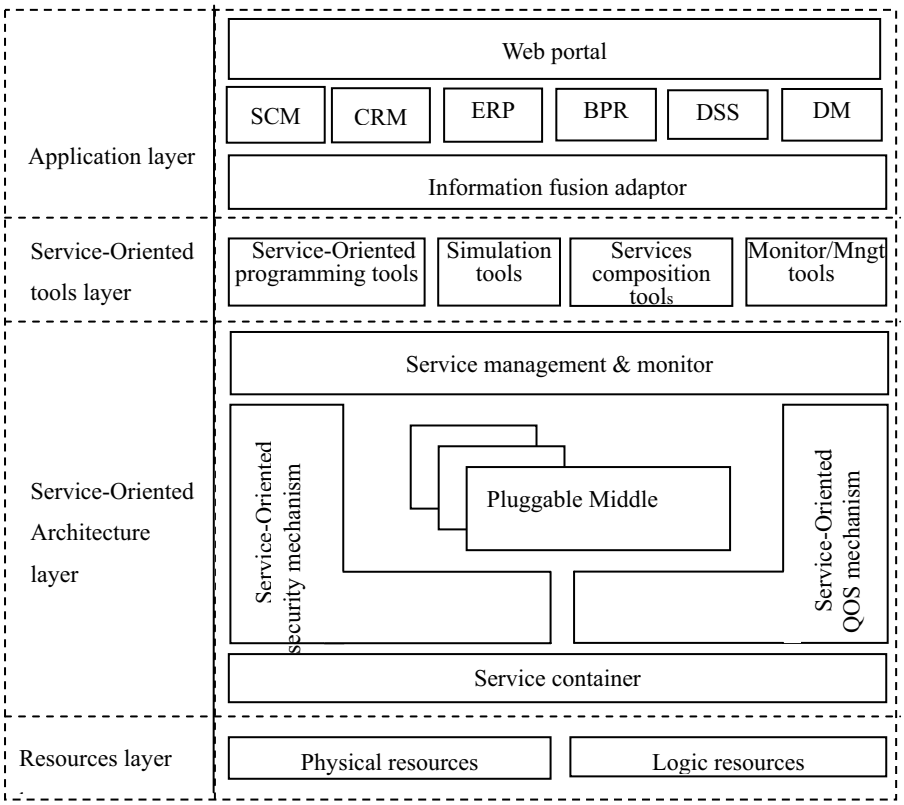

Figure 2. Four layers architecture of IFTPEC

business application or to delegate such functionalities to intermediaries.

B System Architecture

Recently many researchers proposed different architectures[4][5][6][13], but they are essentially homogeneous. On the basis of the above considerations, a SOA based IFTPEC architecture is proposed by the author (shown in Figure 2). From the top to the bottom, SOA based IFTPEC system architecture includes four layers: resources layer, service oriented architecture layer, service oriented tools layer and supported application layer. The main characteristics and functions of them are as follows:

Resources layer: This layer is the basis of all the E-commerce application. It consists of all sorts of abstract resources, including physically touchable resources like host computer, storage device, big equipment and abstract logic resources like wide band networks, software, application services. But because these resources belongs to different organization domain, they have independent accessing mechanisms therefore this resource layer structure exhibit that the third party E-commerce platform has heterogeneous, distributing and self-consistency feature.

Service oriented architecture layer: In order to support the developing, operating, configuration and testing of service oriented E-commerce application, service oriented architecture layer focuses on solving sharing and coordinating problems among various kinds of resources.

Service oriented tools layer: This layer is to provide programming model, debugging, simulating, monitoring, managing tool and service packing tool for various E-commerce application. Tools and API can simplify the developing, configuring, testing and managing of E-commerce.

Application layer: The typical example of this layer is embedded in Web service based E-commerce system. This system includes all top layers application such as supply chains management, payment, logistic and other E-commerce applications.

In Figure 2, source layer solves a problem how abstract source layer in function structure abstracts various heterogeneous resources. The service oriented architecture mainly solves the compatibility, open and distributing problems. Service oriented architecture provides independent, reliable running environment though extending safety mechanism and QOS mechanism in the server receptacles. The demanded functions for running a platform are concentrated in application layer and service oriented tools layer. The service oriented architecture layer is the core layer of the whole system. It provides a standard programming model for the services with various distributing mode. These standard software with service as platform can be discovered, distributed and called easily. The standard protocol of the Web service provides open, extensible standard protocol for the implementation of the services and interactive mechanism (we use WSDL based service picturing capability, UDDI based service discovery and dynamic bundling, SOAP and its extension based service calling, WS-security series service based secure inter-operation, BPE4WS based service grouping and service flow management, etc), thus can setting up an independent, reliable service management and inter-operation model.

The unifying principle of the whole IFTPEC architecture is component-orientation: Every component should be exchangeable if its interface specifications are obeyed. This component-based approach facilitates the distribution of components in a network and supports integration of third-party components. Additionally, it provides a simple way for configurations tailored to the users' needs and adjusts the size and functionality of a site's installation to the requirements and resources. IFTPEC components are independent of each other and can directly request services from the other components inside the same installation.

IFTPEC provides a set of services that fulfill functional and non-functional requirements of E-Commerce applications. Each component is devoted to accomplish a specific functionality and may rely upon or interact with other components of the architecture. The components have been identified on the basis of user requirements.

Compared to traditional three layers architecture, SOA based IFTPEC platform structure and its supporting environment gives the details of the structures and the mutual relations among different system components. It is more in details based on Web service technology over the traditional E-commerce functional structures. It provides the basis for Web service based the third-party E-commerce platform.

Ⅳ Information fusion model for IFTPEC

Information fusion[7][8][9] originated from the concept of data fusion proposed in the sonar signal processing project proposed by the Department of Defense of the United States. It hasn’t had the unified definition by far. The goal of information fusion is to synthesize various forms of information which comes from different sources, with different mode, through different media, coming in different time. Finally its panorama can be seen in more details from every perspective. With the fast development of the internet, data fusion technologies had been widely used in many areas like long distance diagnosis, remote sensing monitoring, and biology information. The meaning of information fusion itself had also experienced a great change from early synthetically multi-sensor data processing to lately Web based analysis and fusion for multiple data sources. The third-party E-commerce platform is a data fusion platform but the information with Web scale is all stored in various data sources. The management systems are also different regarding to different application service. In order to more effectively fuse these information, it is necessarily to build an infrastructure on the third-party E-commerce platform which are capable of fusing data from multiple distributed, heterogeneous and constituent data sources

while keeping the integrity and consistency of the data that comes from different systems. Furthermore, the platform ought to be able to overcome difference between personal information of two users and provide a unified and transparent entry point for the users. Based on the previous analysis, the project introduced data fusion function into the E-commerce platform design, setting up a general, platform independent, language independent information fusion component which is similar to a information sharing chain that can conduct connection and integration among many independent "information isolated island" on the IFTPEC service system structure layer. Each of the application systems in this chain can provide the dynamic information for the other system therefore they provide abundant information sources for building unified information system.

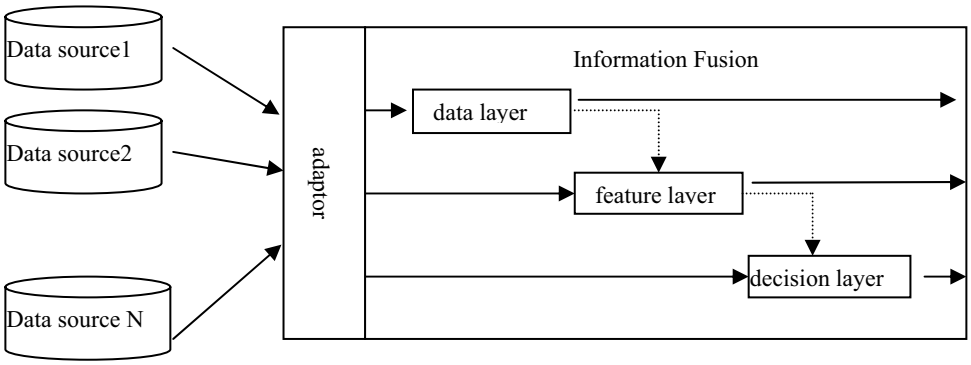

Figure 3. Information Fusion Architecture

A Information Fusion Architecture

Information fusion includes whole process of information source searching, associating, correlating, estimating, recognizing, categorizing, information evaluating. Its fusion structure uses layered system architectures which respectively are data layer fusion, feature layer fusion and decision layer fusion, as shown in Figure 3.

In the three layers fusion structure, the fusion of the first layer (data layer) includes pre-selection and analysis for the data from the database and networks. Through preliminary processing of the data information collected by multiple sources collecting system, the fused information obtains the accurate and conformal description of running status of the enterprises. In another words, this process is for conducting fusion on the very base of the raw data (or the later added raw data for increasing enterprises publicity (sensitivity)) from the enterprise management.

The second layer (feature layer) fusion combines the fusion result from the first layer and corresponds to the running stats of the enterprise in terms of probability model. Based on the fusion retrieved from data association, the second layer also can set up a mapping from fused data to various emergencies of the enterprise and further give the solution or warning method to prevent the emergency happen. At the same time, the mapping between fused data and running state can also be obtained.

The third layer (decision layer) is corresponding to status evaluation in finally conducted process, including providing some reference information such as evaluation explanation, suggestions and analysis based on the evaluation. The third layer information fusion is conducted in the upper layer. The fusion result will be referred by the people who are in charge of enterprise scheduling, controlling, making decision. Therefore, the third layer fusion has to start from the specific decision needed to be made by enterprises, fully utilizing all sorts of grouping information form the second layer to implement by using best suitable fusion technology. The final result of the third layer fusion faces directly to the object of the decisions and the fusion result has direct impact over how the result of decision making is, good or not.

These three layers structure system can fulfill the various needs of enterprises in supervising, screening, evaluating their running status. The fusion structure of these three layers are from low to high, between each two specific layers, there is not clear boundary.

B Information fusion method

In general the benefit of fusion, presuming a proper fusion method, is that the influence of unreliable sources can be lowered compared to reliable ones. This is of a high practical relevance, because during system design it is often not clear how the different features and modalities will perform in real world environments. By applying information fusion, the dependency on the reliability of information sources can be minimized.

Based on the theory presented in the last section, in the practice of system design, the key point of information fusion is to associate data from multiple data source, then conducting seamless fusion in terms of data in each group with proper way. Using multiple sources to obtain the information of the object and environment information thus to retrieve general, integral information is embodied in fusion algorithms. So that the core issue of multiple information fusion is selecting good information fusion algorithm. Information fusion method can be categorized into several subgroups: directly operating on data source, for instance, weighted average, neural networks, etc.; operating in terms object statistical characteristics and probability model, for example, Kalman filtering, Bayesian estimation, multiple Bayesian estimation, statistical decision theory, etc.; deduction in terms of logic, such as, fuzzy logic, prove logic etc. In the data fusion algorithms, the major concerns are how to select good and effective method in terms of practical systems to maximize and optimize the fusion result. Different algorithms adapts to different fusion system. Selecting better algorithm based on the practical problem,

weighting the pro and con of real-time performance, accuracy and robustness of each algorithm are the basic principles of selecting the algorithm. In the practical application, all the fusion method faces uncertainty of incoming information. D-S method has its special advantage as an uncertain deduction algorithm. The fusion method of the D-S based methods is: after preprocessing to the data or information collected from each information source, then assigning the identity to the observing objects, these identities can be quantized by mass function. And then calculate the proof interval of the target identity (namely first stage fusion), utilizing Dempster law to synthesize these identity proof intervals. The union proof interval of each potential identity of the object can be obtained. Finally decision logic selects the best union proof interval to explain fused identities. In the developing process of the software based on D-S method, fusion technology of the feature layer and the decision layer is closely related to knowledge engineering and expert system. Especially the accuracy and integrity of the database has great impact over fusion result.

In IFTPEC, information fusion as an inner component of the platform is implemented by web service form. The major concern is to provide data and information support in terms of data sensitivity of the commercial application.

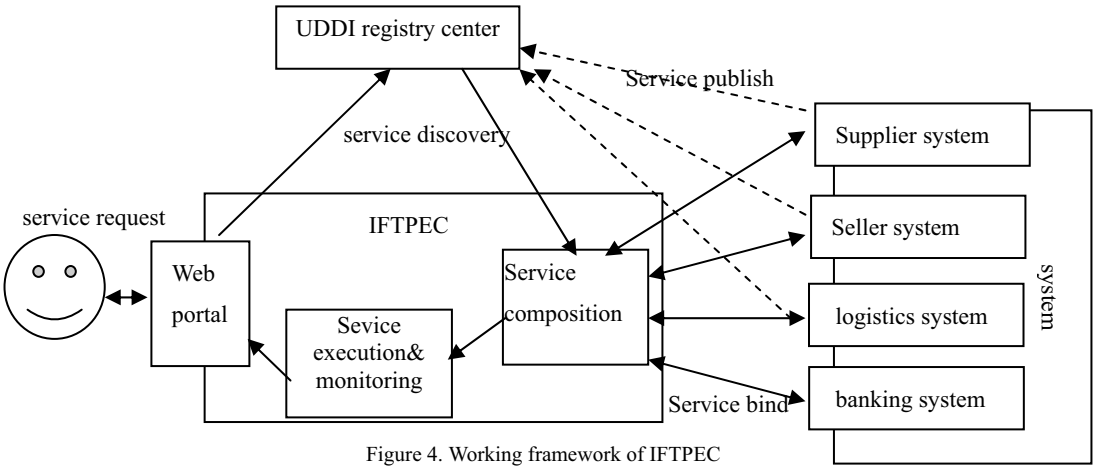

Figure 4. Working framework of IFTPEC

Ⅴ Implementation of the IFTPEC

A Working framework of IFTPEC

Web service technologies provide good supports for distributed IFTPEC. The Web service based IFTPEC system structure is shown as Figure 4. System includes four parts as web portal system, UDDI registry center, service composition component[14], service execution & monitoring.

Web portal system: providing unified user interface for all sorts of E-commerce business, ultimately selecting application services, parameters configurations, task submission through service entry point. Our XML based Web service flow description language can be used as task specification language, converting the task specification to task specification language then submitting the task to UDDI registry center, and showing to the user after the task is done.

UDDI registry center: providing catalogue searching service for the service components, one aspect is for the service component registration; and the other aspect is for dealing with the system searching request service in order to realize bundling between IFTPEC and specific service provider (either the various application service on IFTPEC or on the other application system from the other enterprises)

Service composition component: Analyzing XML based task specification language, determined what kind of service type and requirement that users need, searching UDDI registry center to collect necessary information and provide the service package to users based on specific strategy.

Service execution & monitoring component: according to service composition selection and packaging service selection, setting up a service task, executing tasks and supervising the execution in the process of running it. After the execution is done, return to the web portal system entry point.

Shown in Figure 4 is the schema adapted from IFTPEC. In this generic framework, three key roles are identified(a)service requestors, namely, customers (b)service providers, namely, specific online businesses (c)service brokers, who maintain registries (catalogs) of available services and their capabilities. Service providers publish the capabilities of their services and rules to access them via Web Service Description Language (WSDL) descriptions to these service registries which follow the Universal Description, Discovery and Integration (UDDI) standards. Interaction amongst these three roles is supported by the service platform which provides facilities for service composition and service execution for fulfilling service requests.

Customers request services from web service platforms. The web service platforms execute the task of locating appropriate services and acquiring the necessary WSDL descriptions. Services are located based on possibly registry-specific UDDI taxonomy and the actual description (the WSDL) is obtained via a predefined network access point. For example, services publish to the UDDI registry. Services may be composed in advance, registered by a service provider and used to service multiple requests. For example, service composed of other services may be predefined manually by an intermediary provider. However, under volatile conditions, such advanced composition may be unreliable during execution if component service

capabilities or predefined assumptions on the composite behavior required change. Further, component web services are opaque from the service platform's perspective, in terms of their internal behavior, side effects and failure modes. Without access to global execution state information (total or partial, local or global), developing strategies to react effectively to such volatility and fulfill a service request is essential for successful adoption of web services technology. Current manual approaches that have been demonstrated are programmatically intensive and commercial ventures (such as Amazon.com) control the execution environment vertically, i.e. manages each individual service and the platform. Mixing and matching of autonomous services to provide new types of functionality in a scalable manner requires new paradigms.

B Technologies used in IFTPEC

Communication technologies: the communication technologies that are used in IFTPEC are: the Java Event Distribution Infrastructure (JEDI) for intra-site notifications (asynchronous heterogeneous communication); Java RMI for service requests and communication between components of one IFTPEC installation (synchronous heterogeneous communication); XML via HTTP for homogeneous communication (between identical components in different IFTPEC installations); all messages are XML documents. Our decision was based on the following goals: communication should be as open as possible and rely on standards; the infrastructure must be light-weight to be usable on the client-side; communication must be efficient (large data sizes, asynchronous where possible, etc.); and the best communication paradigm for a certain communication requirement should be used.

The choice of XML-based messages was obvious since XML is one of the base technologies of IFTPEC. For notifications we wanted to rely on an existing event-based infrastructure and decided to use JEDI since it satisfies our requirements, is lightweight and available from a project partner which allows us to adopt it to our requirements easily. For homogeneous communication we decided to use XML via HTTP because these technologies are widely used and are open standards which facilitate communication between IFTPEC systems of different vendors if they adhere to the communication standards. Additionally, it puts minimal requirements on the availability of network support and security. For heterogeneous communication we considered RMI, SOAP and XML RPC. On the basis of an evaluation of SOAP and XML RPC we decided to use plain RMI. The main reason for this decision was that SOAP and XML RPC require considerable implementation efforts by the industrial project partners while this communication type is invisible to the outside world.

Security technologies[16][17]: One of the main concerns for most customers is security. Platform need to be security conscious to safeguard the confidentiality of customer interactions. The security mechanisms implemented in the third party e-commerce platform should have a high level of security to ensure the privacy and authenticity of the information being exchanged. Public key infrastructure (PKI) and secure socket layer (SSL), SET all needs to be evaluated properly to offer easy and secured solutions.

E-commerce opens up unprecedented access to sensitive information. There have been plenty of instances where hackers have been able to download malicious code and hack sensitive data despite the efforts of leading-enterprise firewalls, Checkpoint; and RSA Security's SecurID token-based authentication system. Firewalls are electronic moats that are built around the enterprise castle. Yet these moats will provide only a false sense of security if they aren't properly configured or maintained, or if they are one-way systems that don't include controls for outbound traffic. E-business is now inviting foreign packets, and thus company firewalls are becoming increasingly overwhelmed by the task of sorting out everything.

Security systems should have IPsec-standard VPN that can interoperate with the major corporate VPN gateways; content filtering software; antivirus software and digital certificates from VeriSign or any other agencies.

Ⅵ Conclusion

E-commerce is an important infrastructure for a nation or a country who wants to embrace the incoming of the information era. Currently the third-party E-commerce is in its growing and mature stage and it can provide a good platform entry for middle or small enterprise entering this area. Using Web Service based system synthetic integration technology not only can simplify the connection between two different systems but also can connect supply chains effectively by referring to UDDI broadcasting, discovering and assembling mechanism thus a highly effective B2C, B2B compatible third party E-commerce platform can be established.

In this paper, we present a third party e-commerce platform that supports distributed data sharing and application integration. The system addresses issues pertaining to the two main requirements of application integration and distributed data sharing on IFTPEC: 1) exploiting of geographically and organizationally distributed computing resources to solve application integration problem, 2) supporting seamless data/computing resource sharing. In order to address the first requirement, we design a layered system architecture based on SOA described in section 2, supports all of the characteristic properties of IFTPEC: distribution, autonomy and heterogeneity of sources, as well as some capabilities like user profiles, access rights to federated data for each profile and source transparency. For the second requirement, we develop information fusion service which supports distributed data sharing on demand.

In our future work, we will continue the development of the prototype for constructing applications with the proposed architecture. We will also perform case studies to evaluate the proposed architecture. The studies should

provide insights for further improving the proposed technology.

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