Integrating E-services with a Telecommunication E-commerce using Service-Oriented Architecture

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***Abstract*—In the past, electronic commerce only focused on customer-to-business web interaction and on business-to-business web interaction. With the emergence of business process management and of service-oriented architecture, the focus has shifted to the development of e-services that integrate business processes and that diversify functionalities available to customers. The potential of electronic commerce and its information technology also has attracted some telecommunication corporations—for example, Chunghwa Telecom, Singtel Telecom, and AT&T. They have built their electronic commerce environment on the Internet, too. Most of these worldwide telecom corporations have many kinds of operations support systems in their backend environment. In the past, enterprises had to integrate their telecom services manually, so that they could work together. However, this integration required considerable time and cost, and it worked only for the specific services that were manually linked. Adding additional services required even more effort. And then, enterprise application integration (EAI) solved these kinds of problems by working via point-to-point interfaces. In this paper, we present a research framework to describe the method. Then, we use two illustrations to explain the generality of our method, and we focus on how international telecom corporations have become concerned with the agility, the leanness, and the integration underlying electronic services (e-services) integration with enterprise application interface technology.**

***Index Terms*—electronic services, telecommunication, enterprise application integration**

I. Introduction

Many enterprises in order to increase the satisfaction of their customer, to manage electronic commerce (e-Commerce, e-commerce, EC) transactions and to rapidly and reliably deliver services to businesses and their customers, have started to consider how to develop business process management that, in enterprise operations, is more agile. In recent years, e-commerce has increasingly supported business services between enterprises and consumers. The biggest challenges that businesses face today is their need to get their diverse services, often built on different platforms, to work together when necessary. Hence, telecom corporations have adjusted their backend systems (including legacy and heterogeneous systems) so that common interfaces have integrated processes and so that the customer can access more telecom services. Hence, these corporations have questioned the feasibility underlying the e-services integration of these business process operations. By the definition proposed in [3], e-services provide value-added services whose delivery rests on the composition of existing functions. Figure 1 depicts the cooperation between e-services and backend systems when a chaotic situation arises.

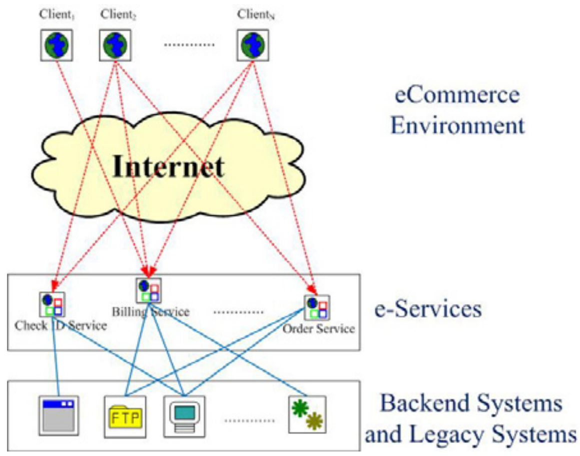

Figure 1. The chaotic situation between e-services and backend systems

In the past, if enterprises wanted to develop an e-service, they had to develop it section by section. Over time, an enterprise would accumulate more and more e-services that rested on heterogeneous platforms, a phenomenon that was especially pronounced in the telecommunication industry. The objective of this research is to help integrate heterogeneous platforms and e-services. For a general solution herein, the research applies both integration methodology and service-oriented architecture to the development of a enterprise application integration.

Hence, there will have many complexity problems in the e-services environment and these e-services are provided by the backed system and legacy system to user. Therefore, we need to propose a framework to manage a chaos e-services environment and let backend system and legacy system to be worked more efficiency. This research framework will use several information communication technologies to solve these problems.

More specifically, in section 2 of this research, we discuss the related works of Next Generation Operations Systems and Software (NGOSS) and Service-oriented Architecture (SOA). In section 3, we will describe e-services integration design with EAI technology. Next in section 4, we will start to illustrate the data flow of implementation and section 5 illustrates case studies by using telecommunication industry. Then we conclude with some comments and some suggestions for future research directions.

II. RELATED WORKS

This section reviews the relevant research and practice literatures in the following areas. They are the Next Generation Operations Systems and Software (NGOSS) and the Service-oriented Architecture (SOA). The objective is to examine the current status of these research results and their relationship with this research study. We propose to extend NGOSS and integrate it with e-services technology. We also review SOA's research topics to identify their applicability and their feasibility in relation to enterprise's activities.

Next Generation Operations Systems and Software (NGOSS)

The TeleManagement Forum (TM Forum) was founded in 1988 and is a non-profit global organization that provides leadership, strategic guidance, and practical solutions for improving the management of and the operations of information and communications services.

In recent years, telecom corporations have encountered great difficulties in the integration of business-process frameworks with heterogeneous platforms. Because there are many business process workflows in telecoms such as ordering operations, billing operations, trouble management, resource management, and marketing, these corporations have invented several operations support systems to assist in the related work. Hence, TM Forum proposed Next Generation Operations Systems and Software that would support telecommunication business process.

The NGOSS 6.0 is not a system, it is a methodology that TM Forum developed in 2007 [13]. There are four core dimensions of NGOSS architecture, eTOM, SID, TNA, and TAM. Figure 2 depicts the core dimensions of NGOSS both separately and in relation to one another. The NGOSS has to provide a framework for building telecom operations support systems with following views:

First, the enhanced Telecom Operations Map (eTOM) describes all the enterprise processes required by a service provider and analyzes them according to different levels of detail that reflect the processes' significance and priority for the telecom business. For such enterprises, eTOM serves as the blueprint for process direction and provides a neutral reference point for internal processes, reengineering needs, partnerships, alliances, and general working agreements with other providers. For suppliers, eTOM not only outlines potential boundaries of software components so that these components better align with the customers' needs but also highlights the required functions, inputs, and outputs that must be supported by products [13]. This model also provides an overall concept and describes the business processes' relationship between internal and external entities in the enterprise. Hence, the TM Forum and the International Telecommunications Union Telecommunication Standardization Sector (ITU-T) have formally approved the eTOM framework.

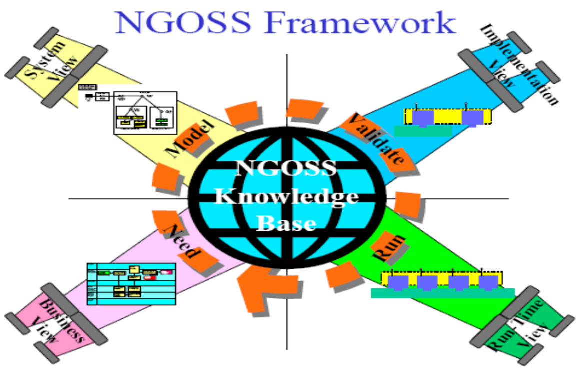

Figure 2. The NGOSS framework

Second, the Shared Information Data (SID) model defines the information entities so that developers can help map the eTOM model describing the business process. The SID model can be the common standard that connects diverse systems to one another; therefore, the SID model constitutes a common view in the telecommunication industry.

Third, the Technology Neutral Architecture (TNA) comprises key architectural guidelines that confirm high levels of flow-through amongst various systems. The TM Forum's definition of 'TNA' includes the following points:

- the core architecture is applicable to both legacy and next generation implementations
- the NGOSS Contract for distributed interfaces
- the NGOSS Metamodel defines the relationships of core elements
- the Distribution and Transparency Framework details capabilities that are necessary supports for a distributed NGOSS

Lastly, The Telecom Application Map (TAM) is a guide that can help telecommunication corporations and their suppliers use a common reference map and a common language to navigate a complex systems landscape that is typically found in mobile communication, fixed communication, data communication, and wire operators [13]. The TAM provides the bridge between the NGOSS framework's building blocks (eTOM and the SID model) and real, deployable, potentially procurable applications. TAM accomplishes this objective by grouping together process functions and information data into recognized OSS and BSS applications or services [13]. TAM also provides global telecom software with a reference that helps explain the relationships among many operational systems.

The research literature presents many suggestions for the development of business process operations that derive from eTOM[5][13]. From the technology viewpoint of Parkyn, eTOM can be implemented with many different technologies such as a .NET framework and J2EE solutions. Therefore, many researchers have started to survey the feasibility of NGOSS-based or eTOM-based solutions

Service-Oriented Architecture (SOA)

Before discussing the concept of SOA, we must first define 'e-services'. According to relevant literatures [3][11][12], e-services create value-added services and are self-describing, open components that support rapid, low-cost composition of distributed applications [9]. The Kim [8] defines 'e-services' as Internet-based services. The delivery of these services depends on a combination of existing backend systems, legacy systems, and e-services—a combination that tackles the problem of e-commerce business process integration [11][1][12]. In the telecommunication industry, e-services are vital to telecom corporations because the services enable the business processes to interact collaboratively with Internet users and with telecom internal operations systems in a new and digital way. Worth of note in this regard is that telecommunication business processes involve the management of many significant information services. These e-services also represent a business model in the corporation [12]. Hence, businesses that carry out e-services do so by invoking several other basic or composite processes. Casati [3] illustrated the integration of service composition into business process management. Stafford [12] listed the applications of e-services for product marketing, for the internal revenue service, and for e-commerce services. Song [11] proposed the use of e-services at FedEx, which has developed e-services and e-commerce. For example, FedEx has provided online shipping support for its customers. But most of these literatures are not describing how to implement these e-services; hence, for realizing our research goals, this research surveys feasible technology in order first to develop a common interface and second to integrate these e-services into one another. Web service is the optimal solution in integrating methodologies [5][6].

However, the development of service-oriented architecture derives from these e-services and treats software resources as services available on a network [2]. According to Huhns et al. [7][9], the SOA satisfies some key features:

- Loose coupling is the most important key to SOA. SOA should create an environment that is more agility, feasibility and user-friendly, whether the users are system developers or customers or anyone in between, they can reuse the e-services each other.
- Implementation neutrality means that no specific program language can underlie the development of the services. Only general implementation can underlie the development.
- Flexible configurability is necessary in SOA environment, because SOA is configured late and flexibly. Hence, the user can use the configuration to change dynamically as needed and without loss of correctness.
- Persistence is required for the service, although services do not need a long lifetime, but when the users deal with the transaction among heterogeneous platforms, they must always be able to handle exceptions. The service must exist long enough to handle this situation.
- Granularity means SOA's participants should be modeled and understood at a coarse granularity, and the developers should capture visible information with business contracts among participants.
- Teams include business partners and solve problems cooperatively or compete intelligently

In order to comprehend the current research on SOA, this research has surveyed relevant research literatures. Most of the research literatures that discuss the principle of SOA does not implement SOA [2][7][9]. Although Chen [4] helps companies to construct stronger relationships with their trading partners by integrating business logic with collaborative commerce, this research does not integrate heterogeneous web services into SOA. Shen [10] proposes an agent-based service-oriented integration architecture that features web services, but this research is applicable only to internal-enterprise manufacturing resource sharing. Hence, this research will propose a new framework that encompasses SOA, EAI, and e-services and that applies to the telecommunication industry.

III. E-SERVICES INTEGRATION DESIGN WITH EAI TECHNOLOGY

In this research, we propose a research framework that provides a context for analyzing several layers to better understand our goals, benefits, and limitations. In the past, many enterprises have implemented their e-commerce computing environment by the web technology. And they use web page to present their thinking of application for a specific function, once the customers have submitted their request to the enterprise. The webpage will process customers' request and notify the enterprise officers. To accumulate over a long period, the enterprise will have many web pages to present to customers and each web page has hid many business process and e-service without management. Hence, this research framework divides the web page into presentation layer and interaction layer. Due to different function has located in diverse backend systems and legacy systems, this research framework also proposes an exchange layer to integrate these heterogeneous platforms and use a processing layer to collect these diverse backend systems and legacy systems.

In this framework, a telecommunication corporation's complete computing environment can be divided into several layers: the presentation layer, the interaction layer, the exchange layer, the processing layer and the data layer.

In general, the presentation layer includes customer interface such as web pages and e-services links. We propose an interaction layer where integrating e-services both receives customers' requests and transfers these requests to several e-services. Sometimes these e-services should be aggregated or integrated with other e-services and placed in the e-services pool. The business process management will assemble relevant e-services to attend to customers' requests. But before integrating e-services accomplishes these requests, the business process management would get more information through the exchange layer. The enterprise application integration (EAI) is responsible particularly for integrating the backend systems and the legacy systems into the exchange layer. The backend systems and the legacy systems cover a variety of information systems such as the integrated customer content system, the data warehouse system, the management system, the provision service system, and the customer service system in the processing layer. Each backend system and each legacy system in the processing layer are controlled by EAI that are enabled by the integrating e-services. Figure 3 depicts the relationships among several layers in the telecommunication computing environment.

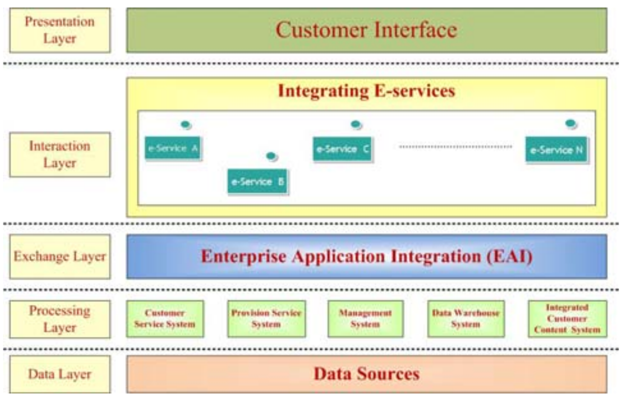

Figure 3. The context layers in the large ebusiness

Presentation Layer

This layer describes the client environment. The presentation layer is based on web technology, such as a java server page, an active server page, or a hypertext markup language. The resulting collection of client-themed information includes, for example, clients' requests, which web client then prepares. The web client transfers the requests to information collecting so that interaction layer can verify them.

Interaction Layer

Using eXtensible Markup Language (XML), presentation layer delivers all of the information to interaction layer. Several steps characterize this layer.

Step 1: After receiving clients' information, interaction layer will convert the customer information into an XML format. Before starting to execute the business process, the customer information conversion-and-verification will verify the XML format on the basis of XML Structure Definition (XSD).

Step 2: If step 1 has a successful pass, the system common component starts to process clients' information and sends it to functional components.

Step 3: The functional components will extract the information from the XML and will check the functional business process by using the database connection objects.

Step 4: When the e-services gateway receives functional components' requests, the e-services gateway will send the requests to the exchange layer and will wait for its response.

Step 5: Once the exchange layer has sent the request-related results to the e-services, the e-services will deliver the results—through the original request route—to presentation layer.

Exchange Layer

We borrow the advantages from the EAI to communicate with the processing layer and with the interaction layer. This layer also integrates several heterogeneous backend systems and legacy systems. The EAI facilitates the operation of information system communication. We also use XML standard to transmit user's request through the web service and wait for the response from the processing layer.

Processing Layer

The systems can be divided into two categories, backend systems and legacy systems. Each of them connects the exchange layer and the data layer to each other. In this layer, each system has different specific functionality such as a mobile billing, dedicated line provision and so on.

Data Layer

Finally, this layer collects the raw data and the historical data in the different databases and prepares to provide request-related information to processing layer.

In order to strengthen the efficient cooperation of these e-services with one another, this research will illustrate these concepts on the basis of the collaboration model. This research proposes a collaboration model that will help identify every stage in a relevant position.

In Figure 4, we depict the collaboration model that features e-services. The customers and the commercial agents send their requests into the square shape that represents information collection. After collecting the requests, the information collection uses the intranet to send them into e-services integration. The e-services integration represented by the square shape collects several e-services and coordinates relevant e-services. The oval-shaped is in an e-service aggregator, and the business processes are based on e-service. Then, the e-services seek matched systems so that e-services integration can provide e-services aggregator with e-services. To accomplish this objective, e-services integration uses an interface of enterprise application integration. These e-services include data, business logic, and object. The e-services assemble these characteristics according to different situations.

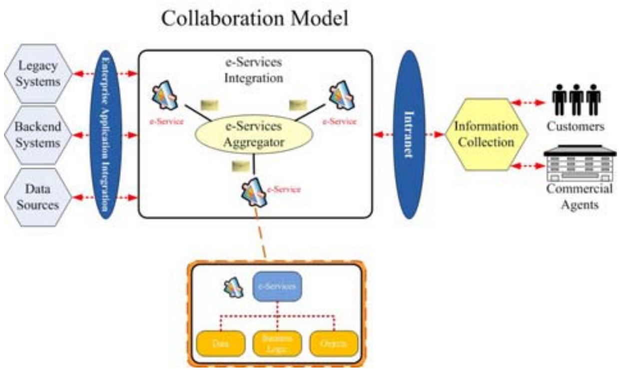

Figure 4. The NGOSS-centric collaboration model in the framework

IV. The Data Flow of Implementation

In order to illustrate the data flow of user request, we depict the steps that characterize a website's processing of user requests in Figure 5.

Step 1: The web application receives the user request and transfers it into an XML document.

Step 2: The web application sends the XML document through the firewall by using the web service.

Step 3: After receiving the XML information, the web server transforms this information into the specified data format by using the remote systems.

Step 4: The remote system processes the result of step 3 and sends the result to the web server.

Step 5: The web application sends the results to the web user.

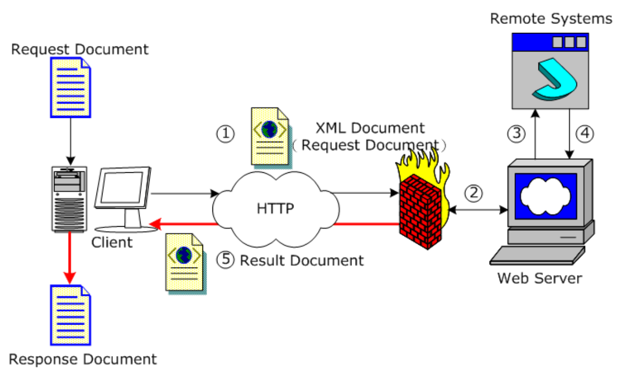

Figure 5. The process of a user request through the e-services portal

And in order to realize these research proposes and solve research issue, we will develop a prototype to accomplish these tasks. This prototype will enable several information technologies:

Web Technologies

Many information technologies make the web page to be ideal. Ajax, Javascript/Vbscript, Html, Active Server Page and Adobe Flash provide user with a rich and fun interactive experience without drawbacks of most old web applications. These information technologies aim to display and invoke web services just like software resource. These web technologies also can use XML format to deliver user request.

XML

XML is an abbreviation of extensible markup language and it was announced by W3C in 1998. XML can be defined by user and use a tag to describe the presentation of information. XML also has a descriptive language and a interchange format. In this research, we will use XML to be a communication message between each layer.

Web Service

Web service is a self-contained, self-described, published, located, and invoked over a network. Web service makes distributed processing difficulties invisible and treats invoked application to be a software resource. Web service also provides a means for wrapping existing applications so developers can access them trough standard languages and protocols. It is a way of realizing service oriented architecture, focusing on the integration and enabling machine-to-machine communication. In general, web service uses XML for data description; HTTP for message transfer; the Simple Object Access Protocol (SOAP) for message exchange; the web services description language (WSDL) for service description; and universal description, discovery, and integration (UDDI) protocol for discovering and publishing web services.

V. The Case Studies of Telecommunication Corporation

Once we have finished the work of system development. We use two case studies to evaluate the feasibility and validity in this research. In the feasibility, we use a real telecommunication environment to validate the functionalities of trouble management in the telecommunication corporation.

A Live Case Study

The company in question is the largest telecommunication corporation in Taiwan and is also the 423rd largest company in the world (according to Forbes' survey). The company's scope of services covers local phone services, long-distance phone services, international calls, mobile communication, data communication, Internet services, broadband networking, satellite communication, intelligent network, mobile data, and multimedia broadband. The company is the most experienced and largest integrated telecommunication provider in Taiwan, and providing these telecommunication services to more than 25 million customers. The Table I depicts the subscribers of the major service in telecommunication corporation.

TABLE I. SUBSCRIBE NUMBER IN THIS LIVE CASE

Subscriber Number of Telecom's Major Services	
Services	Subscriber number (Oct. 2007)
Local phone service	12,985,386
Mobile phone service	8,661,817
Payphone service	102,971
Internet access service	4,071,727

The goals of this research are to establish an NGOSS-centric telecommunication e-services enabling operations support systems in an e-commerce environment. Hence, in this section, we use two illustrations to describe the situation of trouble management and QoS-management, and we then depict the implementation plan. This research will illustrate these topics in the following sections:

Trouble management Illustration

This section uses trouble management to explain the benefits that NGOSS and e-services have for integration. In the past, trouble management provided only passive information to customers.

Since 2002, the TM Forum has proposed a third version of NGOSS architecture. There are three eTOM sections:

(1) strategy, infrastructure, and product (SIP);
(2) operations; and
(3) enterprise management.

The SIP section supports, at least in theory, customer operations. Enterprise management provides several services that, on behalf of telecommunication service providers, improve the efficiency of telecom business operations. Customer relations management is a key feature of eTOM. Hence, we will discuss CRM operations in eTOM. And this topic will focus the CRM process on problem management. The problem management processes help system receive trouble reports from customers, resolve problems, increase customer satisfaction, maximize Quality of Services (QoS), and repair circuits. According to [13], several processes underlie eTOM architecture's problem management:

- Isolate Problem and Initiate Resolution: In this initial stage, the system identifies a customer's problems and receives the customer's request that states the problem.
- Report Problem: After receiving the customer's request, the system should generate a trouble report from the previous process and match the report with relevant problems.
- Track and Manage Problem: When a telecommunication business has many problem reports, it needs a tracking mechanism to monitor the progress of the trouble reports. The purpose of this process will be to track a customer's trouble report actively.

Figure 6 depicts the business process of legacy trouble management operations. In this figure, two major procedures characterize the legacy operations: one is receiving customers' requests from the Internet, and the other is making the subsequent arrangement in the worker database. Although the legacy trouble management operations have had a simple business process for responses to customers' requests, the operations cannot provide customers with satisfactory service. Owing to the competitive telecommunication market, to changes in the environment, and to improved information technology, telecommunications corporations have started to provide more e-services functionality on the Internet.

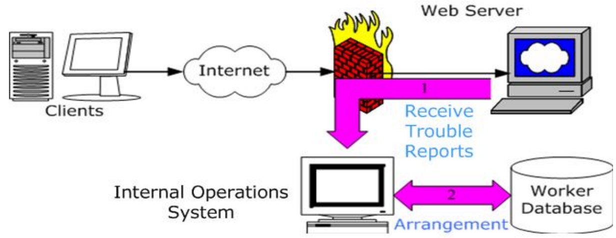

Figure 6. The business process of the legacy trouble management operations

Integration between e-services and backend systems Telecom corporations have many types of backend systems such as operations support systems, customer relations management systems, and billing management systems. These systems provide several telecommunication operations business services such as applications for a new home phone, transfer of a phone service, and reactivation of a home phone. But these backend systems might derive from heterogeneous platforms. Hence, we have started to consider a common technology such as EAI that might integrate these platforms.

Close Problem: If the telecommunication businesses have finished their trouble reports, the last stage will be to ensure that the problem has been resolved and to inquire into the customer's satisfaction.

QoS-management Illustration

In the past, developers tried to integrate data and resources into each other but found the task difficult. Hence, researchers started to use interfaces. But this method grows complex when a business tries to integrate m systems with n systems: The integration generates m*n interfaces so that these systems can interact each other. So the complexity constitutes an m*n problem. Therefore, the enterprise application integration (EAI) will emerge, and all the systems will have a common interface bus. Once the systems have connected to the EAI bus, all the messages will flow into the bus. Although the EAI has solved many integrated problems, the EAI can solve neither business process problems nor business transaction problems.

In order to provide customers with functions that have greater agility (quickness), greater flexibility (range of responsiveness), and greater efficiency (leanness), this research uses an SOA-centric collaboration design. There are several pertinent characteristics in the SOA. First is service. All services have a clear boundary that identifies the services' own purposes and portal. Each system can invoke service through the portal. Second is autonomy. No service depends on an outside system. An autonomous service manages itself, and none can intrude on the other service. Third, e-service uses common data schema and common data validation to illustrate a service's data format. Because most services differ from one another regarding their internal data format, they need a standard data representation to illustrate their data format—XML will be the appropriate solution. Finally, SOA uses policy to define connective-port rules, data rules, function rules, and security rules. SOA also uses service to coordinate the interaction of flows.

According to Chou et al. [5], they use the SOA-centric collaboration design of QoS management. It not only integrates several backend platforms, but also provides a convenient web client to the developer. The developer will monitor and manage the QoS network through the internet. Figure 7 depicts these SOA characteristics.

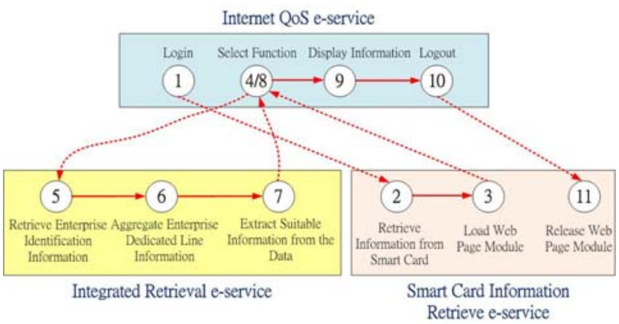

Figure 7. The SOA-centric collaboration design of QoS management

Figure 7 presents three main e-services: the Internet QoS e-service, the integrated retrieval e-service, and the smart card information retrieval e-service. Here is a description of each e-service:

Internet QoS e-service

This e-service provides four services to customers: the login service, the select function service, the display information service, and the logout service. Users trigger the login service after they insert a smart card into a card reader. Comparable to a service gateway, the select function service delivers and receives information between the integrated retrieval module and the smart card information retrieval module. The display information service presents information to the user unless the user triggers the logout service.

Integrated Retrieval e-service

The purpose of this model is to integrate several backend systems and to retrieve relevant information according to the conditions from the smart card information retrieval e-service. The integrated retrieval e-service provides three services to customers: the enterprise identification information retrieval service, the dedicated-line aggregating enterprise-information service, and the data-based information-extraction service. This e-service receives requests from the smart card and returns the results to the original source.

Smart Card Information Retrieval e-service

Located behind the front-end layer, this e-service processes user requests such as pin-code validations and displays a mapped web page to the user before the user triggers the logout service from the Internet QoS e-service. The smart card information retrieval e-service offers three services to customers: after it retrieves information from the smart card, the module will load the web page module. Once the web page module receives the logout service, the QoS-management will offer customers no more services.

VI. Conclusion and Future Research

This research provides several technologies that make possible an increase in telecommunication e-commerce performances and that promote user satisfaction. We also have invented an NGOSS and an SOA and have applied them to telecommunication e-commerce that, itself, operates on web-information systems. Furthermore, we have applied these operations to the largest Taiwan telecommunication corporation. And we will use e-services to compose the web-service technology and the backend system's communication through EAI and ESB. On the basis of our findings, we conclude that our framework and our method will provide many innovative kinds of telecom services, reduce corporate costs, and increase user satisfaction.

The Internet is an open and unsafe environment. In order to enhance the security and the reliability of Internet e-services, we propose a number of new certificate-authority policies. Certificate-authority policies are validated web-client identification. The authority policies provide several kinds of certificates such as Mobile Codes; Authentication, Authorization, and Accounting (AAA); GCA (Government Certificate Authority); MOICA (Ministry of Interior Certificate Authority); and Non-CA (verification only by customer DB).

In this research, we have described and discussed a theoretically sound approach to advance the development of business process management of e-services in the telecommunication industry. In the method, the collaboration layers are created to present an innovative approach to generate a flexible, agile and integrated network services.

Regarding this research, we will continue to use the research framework and collaboration model through which e-services will integrate an on-demand business process into dynamic e-commerce services. This effort will facilitate the study of possible interaction patterns between partners and will ensure proper collaboration.

In the near future, we will continue to extend and expand on the collaboration layers and we will also integrate ontology engineering to construct telecommunication e-service knowledge base. Then, we try to associate diverse e-services with semantic web service to realize autonomy e-service and we hope the future research could be to realize on-demand and agile enterprise e-services.

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