A study of logistics infomediary in air cargo tracking

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Abstract
In e-commerce, the infomediary is rapidly becoming an important business model on the Web. A low cost Web-based infomediary for the air cargo industry can help integrate Air Cargo service providers and their customers, and thus improve the productivity of the logistics chain. Customers can access flight information of cargo carriers through the infomediary in a much more simplified way, thus management can better plan the subsequent operations. Proposes a three-tier paradigm for developing an air cargo logistics infomediary. This paradigm integrates emerging technologies of the next-generation Web-based systems to address the three issues for the development. A prototype system was developed to demonstrate its capability in accepting requests from general browsers, retrieving data from different platforms, and presenting data in a consistent and personalized format.

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Introduction

The advent of the Internet has given birth to electronic commerce (EC). In the short space of ten years, EC has shaped a new type of business world; it has greatly affected operations between business (B2B) and changed transaction channels between business and individuals (B2C). In general, effect of the Internet on commercial activity can be characterized by the three well-known facts. First, it is the shifting of power from sellers to buyers through the reduction of the cost of switching and the free distribution of a huge amount of price and product information. Second, it is the stimulation of economic activity through the reduction of transaction costs. Last, it is the creation of new commercial opportunities through low cost of distributing and capturing of information, which is carried out with a speed and wide range that has never been seen before. However, at the same time, buyers can feel overwhelmed by this new power in their hands, and they may want one-stop-shopping. This one-stop-shopping collects information, adds values to it, and distributes it to those who will find it useful. The need of this one-stop-shopping has helped in creating the infomediary, information intermediaries, which is sometimes called re-intermediation as opposing to the earlier understanding of dis-intermediation with traditional intermediaries (Grover and Teng, 2001).

Depending on relationships between providers (sellers) and customers (buyers), infomediary can be classified into four types (Grover and Teng, 2001):
1 specialized agents;
2 generic agents;
3 supplier agents; and
4 buyer agents.

The specialized agent serves a specialized market, thus is featured with a closed relationship with both providers and customers. The generic agent, on the contrary, maintains open relationships between providers and customers, and relies on open search capabilities for any customer to look for a provider. The supplier agent is featured with specific companies with a vested interest being the provider of the information, thus they do not necessarily provide unbiased options for customers. Finally, the buyer agent establishes relationships with a core set of buyers, and works on their behalf with any number of suppliers. The roles of infomediaries and business models associated with them have been discussed extensively in (*The Economist*, 1999; Hagel and Singer, 1999; Bailey and Bakos, 1997; Bakos, 1998; Malone and Yates, 1987; Rao, 1999; Sarkar *et al.*, 1996; Daniel and Klimis, 1999).

For the air cargo logistics industry, the reduction of delivery lead time of the supply chain system is paramount in the present EC environment. The delivery lead time could mean supplier's raw material or parts to the customers, or producer's product to the customer. A massive amount of data is processed and communicated in-between parties, which may include packing and unpacking, transportation and handling, customs clearing, carrier bookings, warehousing, and other related activities such as insurance. At present, most service providers do allow their customers to access their Internet cargo tracking systems to search for correct consignments and related flight information. However, the lack of coordination between agents is making it very difficult for a customer to track down the complete status of a shipment. The problems are, first of all, different systems may use different search keys in the

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querying process; thus, one has to access each system individually. Second, information presentation formats may be grossly different between service providers; users are left with no choice but dealing with them through their own pains-taking conversion process. Third, it is very difficult for agents to recover the information that has expired and is no longer available at a carrier's Web site. For example, the flight information may disappear shortly after the departure of a flight. Finally, one always likes to improve the personalization of information presentation (Vielmetti, 1999).

The purpose of this paper is to propose a Web-based framework for developing an infomediary of buyer agent type for cargo tracking purpose, which can seamlessly integrate partners of the supply chain by automatically retrieving cargo in-transit information from different computing platforms, and present it in a clear, concise, consistent, and desired format.

IT infrastructure

We believe the integration of Java and XML is the best strategy for overcoming the development issues, which consist of data acquisition from different computing platforms, data analysis and extraction from acquired data in HTML format, and unified message exchange for consistent presentation. In this section, we briefly review the technology that is used in the study and its application in addressing the three development issues.

Java-centric computing

We believe Java is, at present, the best choice for building the infrastructure for developing a Web-based infomediary. The Java programming language, initially designed for small consumer devices, became more prevalent when it was coupled with the WWW for developing distributed applications (Li, 1999; Ashok and Bansal, 1998). The wide popularity of Java is due to what it is able to achieve in building an enterprise-computing environment: object-oriented, client/server, and Internet based. Its feature of "write once, run everywhere" greatly simplifies the deployment process of application systems onto heterogeneous platforms; there will be no need of modifying or re-building the original systems. When working with a comprehensive set of application programming interfaces (APIs), Java offers a framework for efficiently developing a wide range of applications that include image processing, multimedia, database management, electronic commerce, information security, telephony, embedded systems, and more.

In developing Web computing facilities, it is very important to address the flexibility for a Web server to invoke external application programs from its browser, and redirect the responses from programs back to the Web browser. With the present HTTP protocol, the common gateway interface (CGI) does provide a simple and consistent way for building Web-based applications. The CGI program can be implemented in a number of programming languages, thus it provides a vehicle for legacy systems to be integrated with Web computing. It, however, does not provide the kind of flexibility and efficiency as Java Servlet, which is a salient feature of Java computing (Li, 1999). Servlets are small Java applications running on a Web server, and are based on the architecture-neutral request/response paradigm. Clients are allowed to make service requests from any platform, and have them processed by servlets on any other platform. More importantly, servlets can be used as middleware for developing distributed systems by seamlessly incorporating diverse Java APIs, such as universal database access via JDBC, and e-mail service via JavaMail. Servlet does overcome a number of pitfalls of CGI and makes it more attractive in developing Web-based systems. The most significant one is the fact that once a servlet is invoked, it becomes available to other requests, so that they will be loaded as lightweight threads and there will be no need of creating new processes as is the case in CGI. This could result in significant reduction of startup times and memory resources.

XML

XML (extensible markup language), developed in 1997 by W3C, is an enabling technology for facilitating vendor-neutral data exchange purposes (World Wide Web Consortium, 2000). It is a major improvement on HTML in defining markup languages. In addition to the well-known capability of HTML in describing the presentation layout of a document in a Web page, XML surpasses HTML in handling semantics and structure of documents in three key areas – extensibility, structure, and validation (World Wide Web Consortium, 2000). In extensibility, XML allows authors to define new tags and attributes for specifying the syntax and semantics of data. In structure, XML supports nested document structures similar to regular expressions. In validation, XML allows a document to be validated via document type declaration (DTD) specification, which identifies what elements are allowed in a document, the sequence of these elements, and element attributes, etc. Due to its vendor-neutrality, XML can be seamlessly integrated with the Web through its ability in facilitating data exchange between heterogeneous databases. It can also cooperate with major existing style sheets in document specifications, such as cascading style sheets (CSS) and extensible style language (XSL). As a result, XML makes it possible for businesses to electronically exchange the documents, forms and messages in an interoperable and transparent way (Glushko *et al.*, 1999; Meltzer and Glushko, 1998; Tornqvist *et al.*, 1999; World Wide Web Consortium, 2000), and allows a document to be rendered in different formats in supporting personalized presentation. In this research, we apply XML to provide the semantic basis for describing cargo status, which could support different presentation formats from general browsers.

System design and architecture

System requirements

In designing our system, we adopt the design principles suggested by Yen and Ng (2000), which include functionality, ability to upgrade and maintain, usability and operability, and availability and accessibility. The following guidelines were closely adhered to during the design process:

- *Functionality.* The system must be capable of automatically retrieving the query results from the original cargo carriers, and generating unified Web pages following the specified DTD. It must allow for the storage of semantic information of cargo delivery and management of such information.
- *Ability for upgrading and maintenance.* The system should be able to accommodate any new Web sites when new cargo carriers join the infomediary. The archived cargo semantic information should be systematically maintained in a consistent way, despite their heterogeneous nature in databases. New presentation styles can be added to the system any time for satisfying the needs of customers and the devices they use.
- *Usability and operability.* Friendly user interfaces must be provided, which include appropriate online guidance for navigating the infomediary system. The overload of installing and/or plugging-in software components for using the system must be avoided.
- *Availability and accessibility.* The system should allow customers to access the infomediary from anywhere at any time. Platform-neutrality must be applied at the user interfaces, so that a variety of access methods must be considered for accommodating the need of new devices from users.

System architecture

In developing the system architecture, we use the logistics needs of TradeVan (2000) as our guide. TradeVan is the first EDI-based value-added network established in Taiwan. Figure 1 shows the community environment of TradeVan. Government agents and industry partners can subscribe to TradeVan as members via a proprietary network or the Internet. International subscribers could access TradeVan through Société Internationale de Telecommunications Aéronautiques (SITA).

TradeVan provides a number of services to support logistics management of its clients. Its subscribers may exchange messages using the EDI standard; for non-EDI members, TradeVan defines proprietary file transfer protocol to facilitate the communication. Its interactive EDI message exchange allows freight partners to order freight containers online and trace shipments with in-transient information. It also provides secure electronic payment facilitates between banks and members, and with the UN/EDIFACT standard, it allows different EDI messages to be defined upon members' requests. Currently, the customs cargo clearance system of TradeVan has 1,707 users, which include 1,422 customs brokers/freight forwarders, 134 shipping companies/agents, 55 warehouses/bonded warehouses, 48 importer/exporters, 34 airlines, and 13 government agencies. All of the cargo declarations are transmitted through the automated EDI system. Presently, more than 52,000 customs related EDI messages are processed by TradeVan daily. As shown in Figure 1, air carrier is a component of the current system, which is essential for other components of the logistics chain, including agent/broker, industrial park administration, cargo terminal operator, and customs. However, due to the high cost involved in joining the current EDI system, the current members represent only a small fraction of the total number of businesses that need the same service. If a low-cost Web-based infomediary can be developed, then more members of each component, who do not find the high cost of joining the EDI system justified, will be able to join the system.

The proposed system constitutes three tiers, they are client tier, infomediary tier and supplier tier as shown in Figure 2. The client tier is the component for customers to access the system via a general Web browser, which includes XML, HTML, and ProxiWeb or WAPman browsers. The latter is for access from handheld mobile devices such as

Figure 1
Community environment of TradeVan

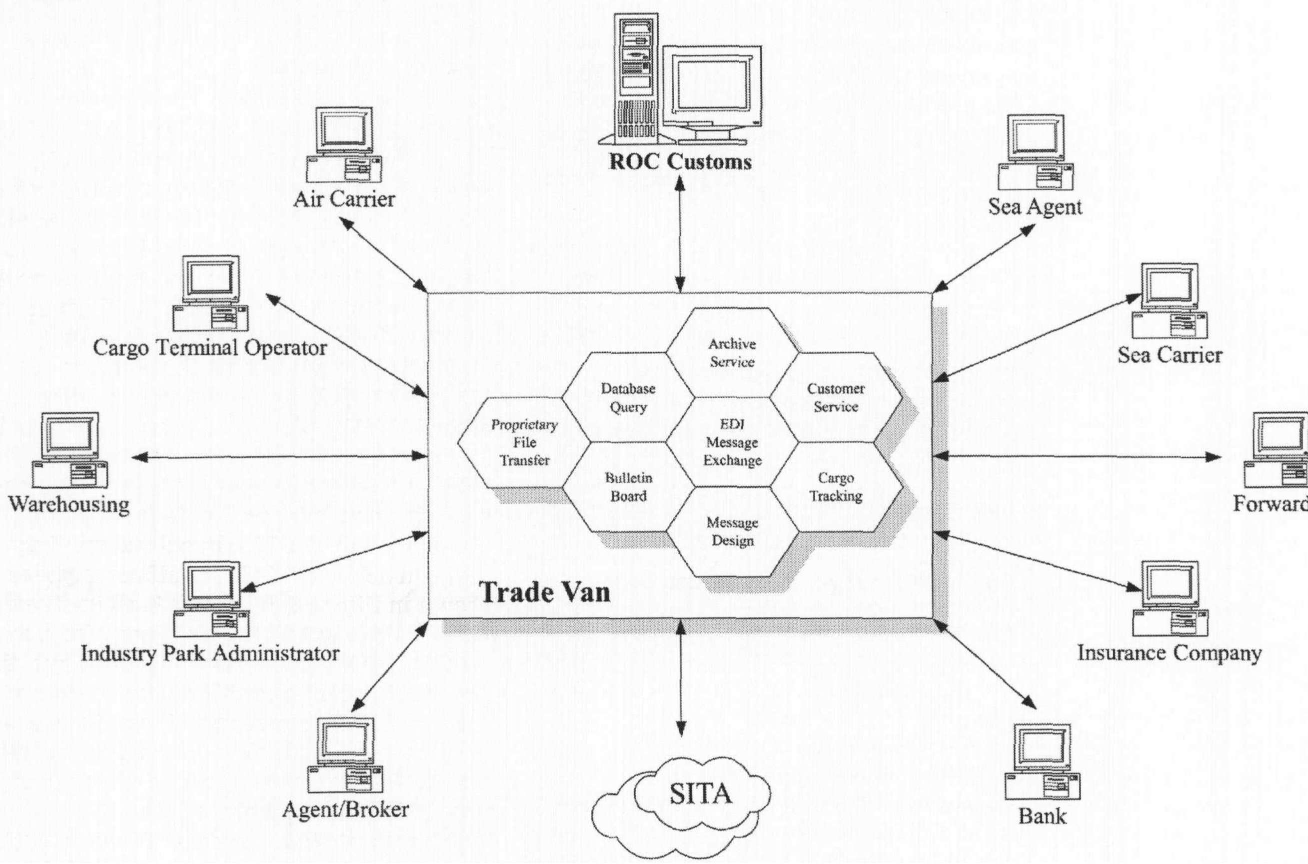
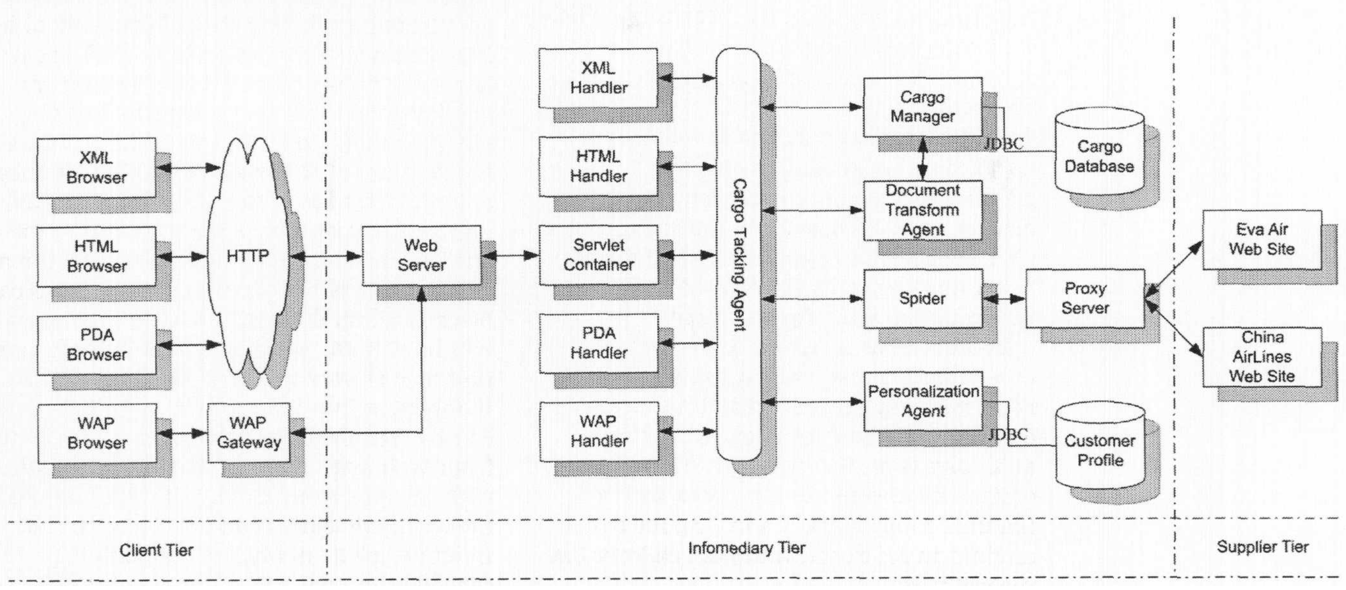


Figure 2
The system architecture of XML-based cargo tracking infomediary



PalmPilots's personal digital assistant (PDA) or WAP-compliant mobile phone (McGinity, 1999). The supplier tier, on the right hand side, is the Web sites of cargo carriers where information resides. The infomediary tier, as showed in the middle of Figure 2, has five major components:

1 cargo tracking agent (CTA);
2 Spider;
3 document transform agent (DTA);
4 cargo manager; and
5 personalization agent.

CTA acts as a gateway program for processing service requests from the client tier. The Spider is designed to crawl cargo carrier information from specified Web sites on requests from CTA. DTA, receiving original information from Spider, functions as a document translator for parsing and converting the retrieved HTML documents into XML formats, according to a pre-defined data type definition. The cargo manager stores historical cargo information in XML format to allow for future retrieval through XML Query Language. The personalization agent maintains the customer profile repository that will form the basis of presentation format for each individual user.

Implementation

A prototype version of the proposed infomediary has been developed for the cargo tracking service of TradeVan Information Services Co. In the following, we use actual information of two air cargo carriers, Eva Air and China Airlines, to demonstrate and explain the performance of the system. Figures 3 and 4 show original query results in HTML format from both carriers, which indicate gross inconsistency of presentation appearance. Both displays, in completely different formats, contain information of flight number, city of origin, scheduled departure time, actual departure time, flight status, scheduled arrival time, and actual arrival time. Figure 3 contains many more flights than Figure 4, because Eva Air uses flight number as the key to provide information, while China Airlines uses date.

In order to unify the information from both carriers, the system applies a pre-defined DTD, which describes an airline record containing airline number, scheduled departure time, actual departure time, city of origin, and destination. Figures 5 and 6 show the unified presentation in XSL for both airlines in Microsoft Internet Explorer 5.0, respectively.

Impacts

It is apparent from the system demonstrated above that such a low cost Web-based infomediary will have an impact on the cargo logistics chain. Within the chain, there are cargo service providers and customers of service providers. Customers of cargo service providers may include importers, exporters, brokers, forwarders, carriers, and operators who depend on the status identification of correct consignments and their arrival times to plan their subsequent operations or interfaces with other organizations, so that efficiency of delivery can be achieved in terms of time and cost. Previously, the lack of a low-cost means integrating customers with service providers of air cargo industry has led to a low level of productivity of the supply chain system (Leung *et al.*, 2000). Customers could, at best, access each carrier site individually and compile the contents information in a pains-taking way before other operations could be properly planned as shown in Figure 7.

The above system has shown that one can apply present information technology to develop a low cost Web-based infomediary that can achieve this integration purpose as shown in Figure 8. In Figure 8, all customers have to do is to talk to the infomediary, and achieve the same results as before. Thus, the complicity of relationships between cargo carriers and customers is being reduced from $n \times n$ to $n \times 1$, which can be easily translated into saving in time and cost as well as gain in productivity as a whole.

The benefits to customers of joining such an infomediary system are many fold. First, customers in essence have gained control in integrating with the service providers in a seamless way; despite the fact that service providers have been and will continue to be in a domineering position in providing cargo transient information. Second, customers can improve their operating efficiency significantly, because they can access information of all service providers at once and all information will be provided in a uniform format, thus communication cost can be substantially reduced, cargo wait may be minimized and subsequent operations can be carried out optimally. Third, customers will be able to access historical information that is currently impossible to do, because the infomediary is able to maintain a database of cargo records that are withdrawn from Web publication as part of the regular updating process. Lastly, but certainly not the least, customers can benefit from the infomediary by analyzing records of scheduled/actual arrival time/departure

Figure 3
The query result from China Airlines Web site

Figure 4
The query result from Eva Air Web site

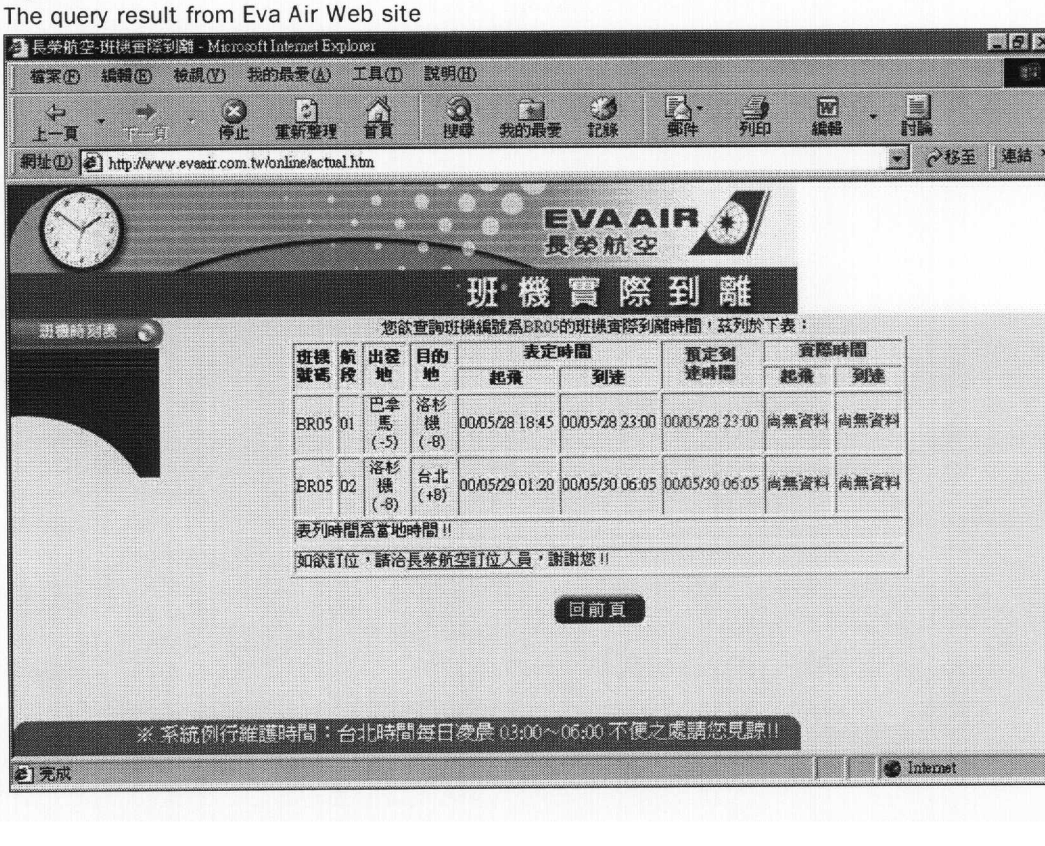


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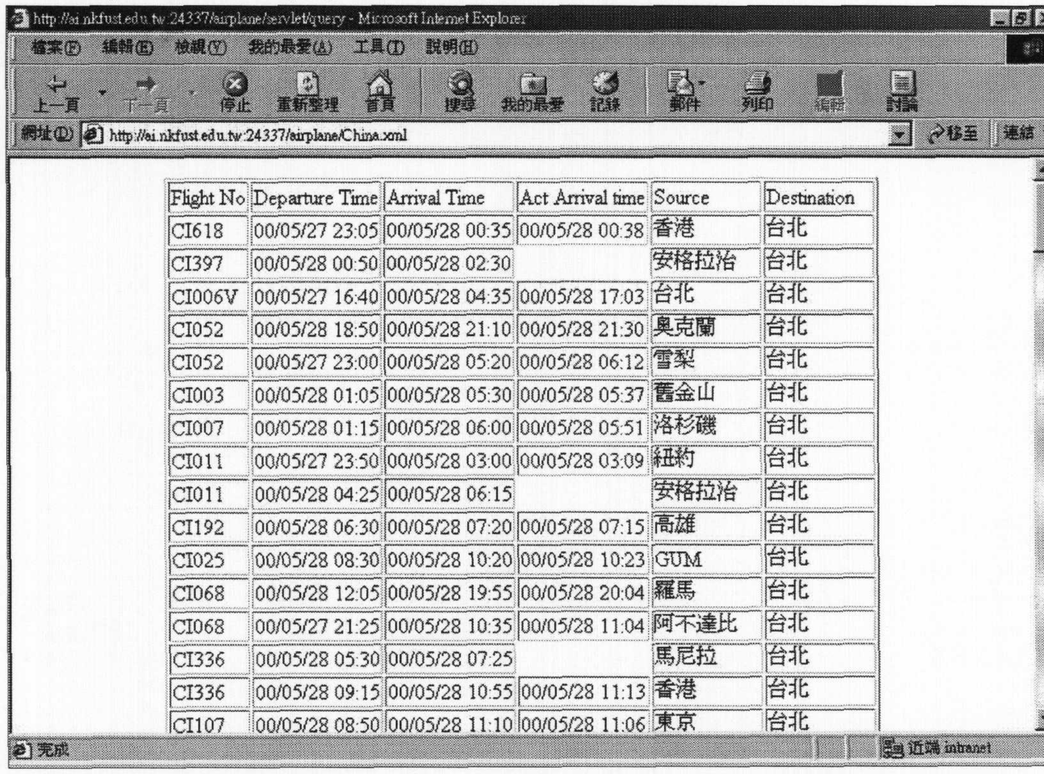
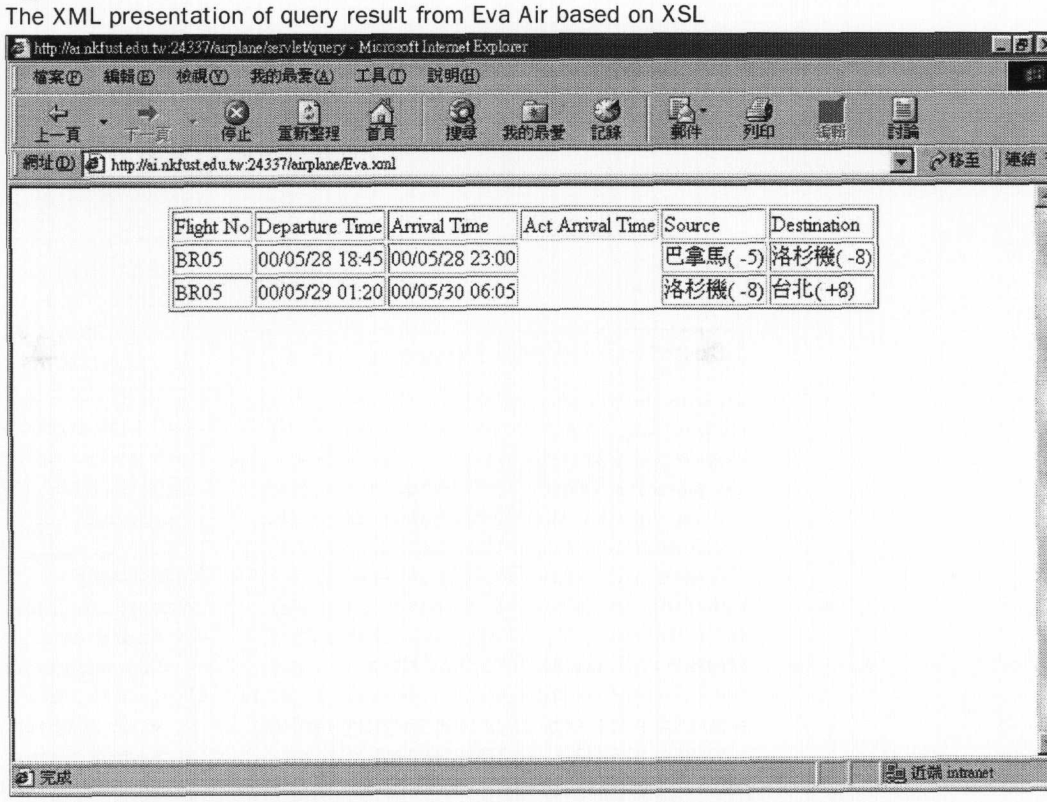
Figure 5
The XML presentation of query result from China Airlines based on XSL



Flight No	Departure Time	Arrival Time	Act Arrival time	Source	Destination
CI618	00/05/27 23:05	00/05/28 00:35	00/05/28 00:38	香港	台北
CI397	00/05/28 00:50	00/05/28 02:30		安格拉治	台北
CI006V	00/05/27 16:40	00/05/28 04:35	00/05/28 17:03	台北	台北
CI052	00/05/28 18:50	00/05/28 21:10	00/05/28 21:30	奧克蘭	台北
CI052	00/05/27 23:00	00/05/28 05:20	00/05/28 06:12	雪梨	台北
CI003	00/05/28 01:05	00/05/28 05:30	00/05/28 05:37	舊金山	台北
CI007	00/05/28 01:15	00/05/28 06:00	00/05/28 05:51	洛杉磯	台北
CI011	00/05/27 23:50	00/05/28 03:00	00/05/28 03:09	紐約	台北
CI011	00/05/28 04:25	00/05/28 06:15		安格拉治	台北
CI192	00/05/28 06:30	00/05/28 07:20	00/05/28 07:15	高雄	台北
CI025	00/05/28 08:30	00/05/28 10:20	00/05/28 10:23	GUM	台北
CI068	00/05/28 12:05	00/05/28 19:55	00/05/28 20:04	羅馬	台北
CI068	00/05/27 21:25	00/05/28 10:35	00/05/28 11:04	阿不達比	台北
CI336	00/05/28 05:30	00/05/28 07:25		馬尼拉	台北
CI336	00/05/28 09:15	00/05/28 10:55	00/05/28 11:13	香港	台北
CI107	00/05/28 08:50	00/05/28 11:10	00/05/28 11:06	東京	台北

Figure 6
The XML presentation of query result from Eva Air based on XSL



Flight No	Departure Time	Arrival Time	Act Arrival Time	Source	Destination
BR05	00/05/28 18:45	00/05/28 23:00		巴拿馬(-5)	洛杉磯(-8)
BR05	00/05/29 01:20	00/05/30 06:05		洛杉磯(-8)	台北(+8)

Figure 7
Current cargo logistics chain

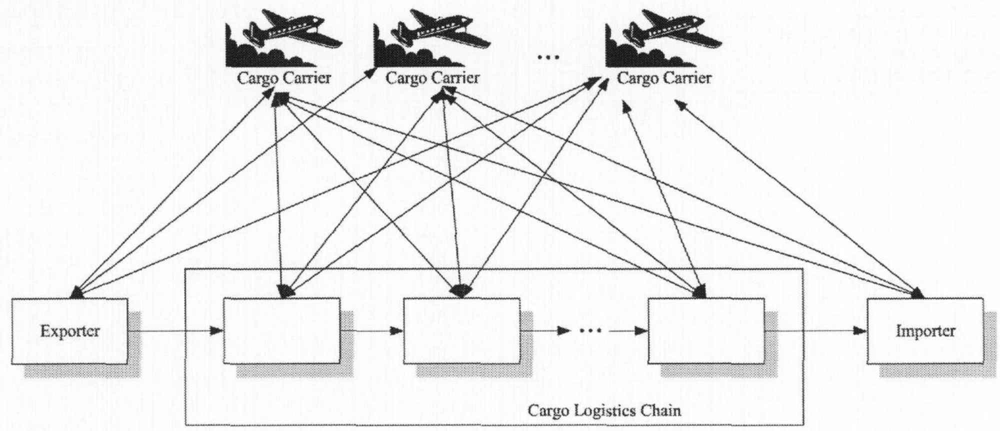
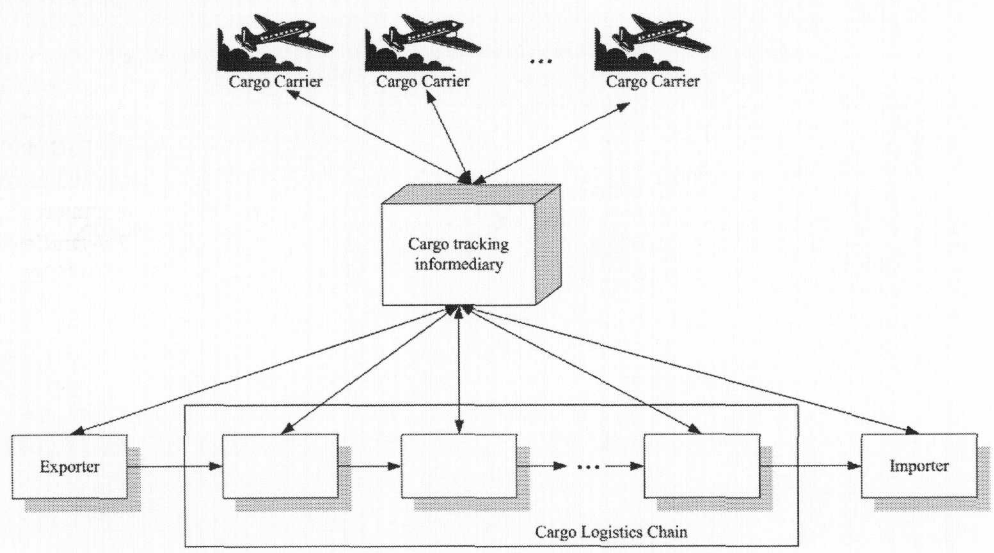


Figure 8
Cargo logistics chain with an infomediary



time of each carrier, and make comparison on service reliability of different service providers.

Conclusions and future work

In this paper, we proposed a framework for developing an air cargo infomediary, and developed a system to support cargo tracking services for TradeVan Information Services Co. in Taiwan. With Java-based computing infrastructure and XML-based document exchange, this infomediary is flexible in carrying out the tasks of data acquisition from different platforms, data extraction from HTML documents, and data transformation into desired formats. It offers a uniform GUI cargo status inquiry facility and returns with a consistent and personalized presentation. The overall benefit for the supply chain system of air cargo logistics can be quite significant. Management efficiency of customers could be improved as a result of the reduction of cycle time. Customs brokers can submit customs clearance forms earlier. Buyers, of SCM partners, could schedule production lines with better precision. The quality of door-to-door service of integrators, such as Federal Express, DHL, UPS, and TNT, could be guaranteed.

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