STRATEGIC AND POLICY PROSPECTS FOR SEMANTIC WEB SERVICES ADOPTION IN US ONLINE TRAVEL INDUSTRY

by

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Abstract

Semantic Web Services (SWS), the emerging convergence of Web Services with Semantic Web, is the next major generation of the Web (and of the Internet), in which e-services and business communication become more knowledge-based and agent-based. This thesis discusses how SWS technologies have a particularly high chance to revolutionize one particular industry -- travel, i.e., its on-line aspect -- within the short- to medium-term time horizon (2-10 years). We focus on the U.S. on-line travel industry in particular, for which more up-to-date industry data and analysis sources are available.

Our first *new contribution* is an analysis that identifies a likely area of early *industry-wide strategic* impact for SWS technologies: what in the travel industry lingo is called "Dynamic Packaging" (DP). DP means *dynamically* (i.e., in real-time) putting together -- and pricing -- a package of several major travel components, e.g., air flight legs, hotel nights, car rental days, etc., from heterogeneous suppliers and heterogeneous information sources or back-end reservation services, even as *those* provide frequently changing availability or prices. We discuss the current U.S. retail travel industry, focusing on its strategic aspects; these have policy implications including issues of privacy, other regulation, and potentially anti-trust. SWS, especially using automated rules cf. the RuleML emerging standard, offers the opportunity for significantly greater automation of exception handling, through exchange of rules that represent pricing, business policies, or regulations.

Our second *new contribution* is to analyze the *strategic* drivers (i.e., promoters) and inhibitors of SWS adoption in DP in the travel industry, that are *particular* to that industry. We conclude that "the stars are aligned right" for SWS to actually have a major impact on the travel industry, largely through Dynamic Packaging, within the near- to medium-term time horizon (2-10 years), although technology investment is retarded by post-9/11 revenue volatility.

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In memory of my grandfather, Abdelkader Kabbaj who taught me to count to one hundred and much more…

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I would like to dedicate my work to the memory of my grandfather, Abdelkader Kabbaj, who left us on March, 15th 2002 and whose support and love helped me more than anything else in persevering and working. I would like to thank my family, especially my mother and my father, for their encouragement and their constant prayers. They have supported me through hardship and never doubted my potential. I am indebted to them for everything I am or I will be.

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1 Introduction

A man calls his mutual fund advisor and says "I am looking to retire at 55 -- let me know what I need to do." The advisor replies: "Well, let's see. I've got a list of 35,000 mutual fund options. Of those, I can prepare 323 combinations that would work for you. I'll send you some choices and you can let me know which ones you're interested in."

While consumers of financial services would never accept this kind of treatment from an expert financial advisor, online consumers of complex products, such as vacations and cruises, regularly encounter such a lack of guidance when faced with making a purchase decision. "Selling experience-oriented, complex products online remains very challenging, especially without the right expertise and tools to guide potential purchasers through the myriad of available options." [Using knowledge personalization to sell complex products, VacationCoach,2002]

Jupiter, for example, maintains that while barriers to online purchase are beginning to erode, "the complexity and high price point of cruise and tour products will continue to drive customers to traditional channels to consult in-person expertise before making purchases." (Jupiter Media Metrix, 2001) This statement is illustrated by the fact that just 100,000 travelers booked cruises and tours online in 2000 accounting for less than one percent of the total cruise and tour bookings that year. Together with the fact that just over one percent ($200 million) of the $18.2 billion in online bookings in 2000 were for cruises or tours (Jupiter Media Metrix, 2001), it's clear that complex travel products are a lot more difficult to sell online than simpler commodities like airline tickets. [See Appendix 7-2 to 7-3]

Travel planning and booking is the most successful business model on the Web [PhoCusWright, 2001]. However, planning an individual trip on the Web is still a time consuming and a complicated endeavor. Most of the huge number of travel sites provides isolated information about flights, hotels, rental cars, weather or they relate that information in a very restricted manner letting the consumer/end user the heavy task of putting all the pieces together. There exists currently no integrated service for arranging personalized trips to any desired destination, relying on distributed information sources which have to be reasonably combined. Recent approaches build on mediators that turn Web sources into structured data sources. Those mediators are the critical component of the whole system because they have to be build individually and kept up to date.

"What is needed is an individual travel agent which is able to arrange journeys to virtually any place using first hand information from a huge set of different Web sources. [Berners-Lee, 2001]

The objective of this thesis is (a) to give a sense of how Web Services (WS) and Semantic Web Services (SWS) can contribute to help travel providers ensuring effective customer decision support online (b) How this simplification of the shopping process can drive sales of complex products in an economical and scalable way (c) How the potential adoption of SWS technologies can potentially change the current travel industry business models.

Why The Travel Industry? At a first glance, the travel and transportation industry appears to be an excellent prospect for the deployment of Web services. The industry is globalized, has a high degree of collaboration in air travel and cargo logistics subsectors, is well standardized in a number of data interfaces and needs to communicate with its clients in a cost-effective, real-time basis. But the industry is experiencing turmoil, which began before 9/11. Airlines' top-heavy cost structures and inefficient hub-spoke routes compounded economic recession. The recent United Airlines and U.S. Air bankruptcies highlight the industry's financial troubles. The need for improved security processes for both passengers and cargo will divert much of the IT investment.

The travel industry possesses key attributes that make Web services deployments attractive and inevitable.

Our approach in this thesis is to focus on the retail travel industry in the United States and examine its markets and business model. We investigate how the online Retail Travel online market currently look, predict how it may be affected by the emergence of Web Services (WS) in general and Semantic Web Services in particular in 5-10 years on a macro level and a micro level.

To do so, we will start through a practical concrete introduction, going through what can be an early winner adoption area and a potentially key driver: Dynamic Packaging. This very simple concept that is enabled by Semantic Web services has the potential of changing completely the landscape of the industry. Seemingly, we will try to provide in the next chapters the technology and strategy background needed to understand fully the tradeoffs induced by the potential uprising of these technologies.

From there will move in the next chapters to an in depth analysis of what may be some adoption and development scenarios, and we will try to list some of the accelerants and inhibitors factors of adoption in the sector.

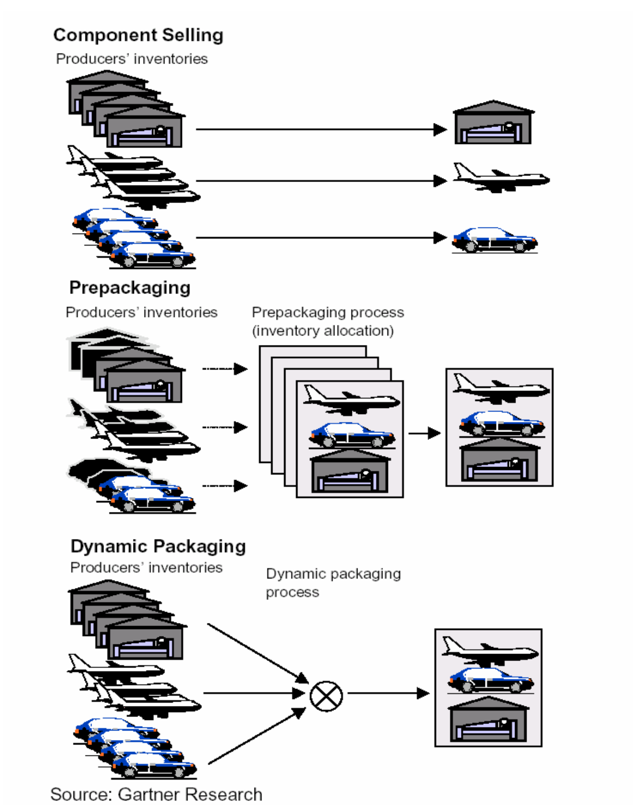
2 An early Winning Area for SWS : Dynamic Packaging

2.1 Definition: Dynamic Packaging

Definition: "*An industry buzzword for enabling the consumer (or booking agent) to build a customized itinerary by assembling multiple components of their choices and complete the transaction in* ***real time****.*" *(Stephanie Lofgren)*

DP is different from prepackaged travel- It is important to understand that DP and prepackaged travel are two concepts that are very different. Prepackaged travel relies on selling to the customer a complete package that includes usually flights, accommodations, car rental etc.. These packages are made sometime **months in advance** and published in brochures or sold online.

These packages allow the different actors of the travel industry from producers to resellers to offer "mass-market" products and to operate relatively simple business processes that allow them to have higher margins.



These "mass packages" offer:

- Fixed itineraries
- Inflexible dates
- Limited options

But as they are made months in advance, they also often **hinder the optimization of revenues** through yield-management techniques that are based on adjusting price and availability to demand in real-time.

In DP, the process is different even if the result could seem to be the same to the end customer: here, the components are "drawn from the inventories of the travel producers and combined to satisfy **a particular customer requirement which is collected during an interactive dialog"**

Figure 1-1: Difference between DP and component selling [Gartner,2001]

2.2 Benefits of DP- What is such a Big Deal?

From the Customer Perspective

For the typical leisure traveler, the "holy grail" is the ability to find and to book a holiday that suits him or her exactly in term of dates, times, places and provides choice for good value for money. The key concepts here are:

- Flexibility
- Customization
- Single point of contact

The ultimate DP model needs to provide the traveler with three features:

- Access to a wide choice of supplier commodity products to choose from and that can be compared automatically (which involve defining a relation of order in the mathematical sense)
- The ability to search for and to aggregate these components
- The ability of having the pricing of the package done by a trustworthy system/engine in real time by applying discount rules to the combined components.

From the Industry perspective

As Gartner Group [Gartner, May 2001] states: “The leisure travel business operates on high turnovers and low margins so any distribution process change that delivers even small improvements in yield will have a significant impact on profitability.” Here are some of the Key Problems addressed by the DP:

- Allow discounting to be more opaque, protecting revenue management technique and improve the rates achieved for the late sell-off of perishable inventories - *In the travel business, aircraft load factors, hotel occupancy rates and automobile utilization rates are only partial indicators of commercial operational effectiveness. During the past 15 years, the component travel industry has come to depend on complex revenue management algorithms to optimize yields and deliver profitability. Such equations rely on being able to sell identical products to different consumers at different prices by discriminating on factors, such as date of booking and geographic point of sale. More fundamentally, revenue management methods rely on customer ignorance of these methods and the underlying algorithms. Customers remain relatively unaware that the price they are being offered is not the lowest.*

- *Provide a counterbalance to the threat of commoditization-* Many major travel producers rely on product and service differentiation and branding to extract good margins from high value customers. A hotel chain may try to sell a “leisure experience,” not just a room with a bed in it. An airline might try to sell “relaxing personal time in a flying bed,” not just a seat in an aluminum tube with wings. The trouble is that today the focus online is all about price. Product features are not adequately conveyed and explored on intermediaries Web sites. “Enterprises such as priceline.com have offered only a stark view of the future for the producers. The consumer names a price, not a brand, treating the travel components as commodities to be bid for in an anonymous reverse auction process. Producers participate in this model somewhat reluctantly, because if too much inventory starts to move through such channels, brand based price premiums are eroded and yields may be diluted in the longer term.” [Gartner, May 2001] Producers want to gain an acceptable price for remainder inventory but also ensure that their product remains branded and can be specifically selected by the customer. Dynamic packaging solutions offer this opportunity.

- *Help product consumer brand integrity-* The temptation of the online environment is that it makes offer based tactical marketing simpler and cheaper to execute. The Internet has enabled sites, such as priceline.com and lastminute.com, to set up new models and new customer expectations of late availability, cheap sell-off. Inventory is shifted, but at a potential long-term cost. Over repeated buying cycles the brand image is tarnished and the price differential is eroded. Some dynamic packaging solutions, if used carefully, have the potential to control the mix of component brand associations and hide unusually low prices being attached to individual components at particular times.

2.3 Adoption Roadmap: Why only a new technology based on a shared ontology can make it happens?

DP is consumer driven—According to Anite : " Much of the demand for dynamic packaging has been created by the success of **low cost airlines** and with the proliferation of accommodation providers."

One of the (many) interesting question is what it would take –given the current state of the technology in place- for a vacation provider to build its own DP system?

The answer is that –with even a lot of money and resource- it is almost impossible. And this even if it has a call center available 24/24, 7/7 ,a web-based facility updated in real time , complex algorithms and an in-house discount rules and inference system . It will have to offer this dynamic packaging across multiple:

- Brands/business units
- Market/countries/currencies
- Distribution channels
- Inventory contracts/external sources/databases
- Thousands of suppliers….

While being efficient enough to do so **profitably**!

This chart taken from an Atinera presentation summarizes the challenges that the tour operators are facing:

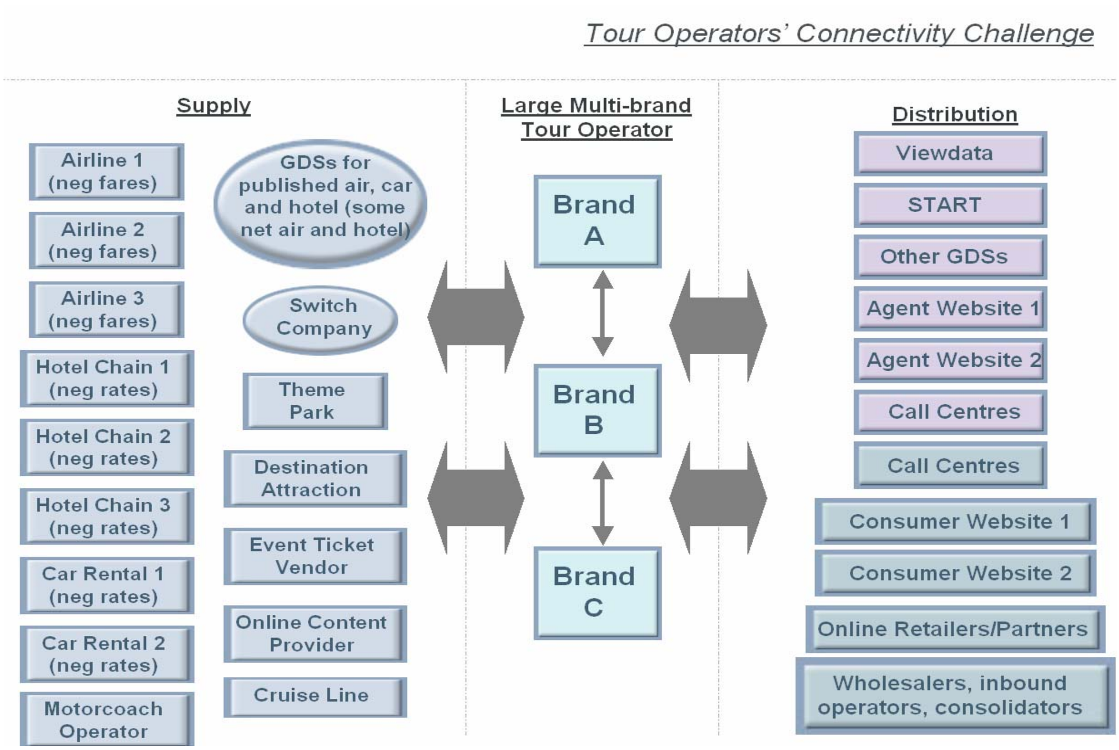


Figure 2-1: Tour Operators Connectivity Challenge

Current business models and the travel supply chain make this an **impossible trick** to put in place.: "The established tour operators with the standard commercial model of charter flight and accommodation commitments can't easily be flexible without compromising the basic economics of mass-market package holidays. Flexibility in these circumstances comes at a price that the consumer has to pay for." Actually it is interesting to notice that today only airlines, hotels and car hirers –e.g suppliers with a single commodity product- can today achieve real flexibility but only within their own offerings, however.

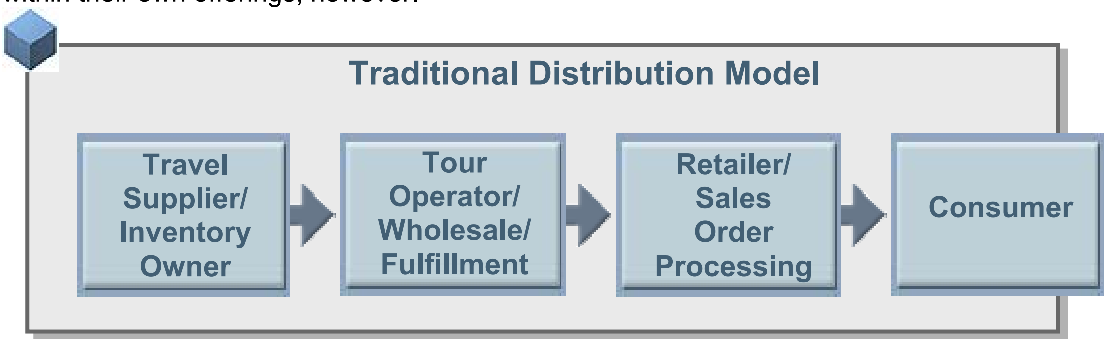


Figure 2-2: The existing linear distribution model

This chart illustrates the current distribution model. Some remarks arise:

- In a linear, sequential model like this, a given link in the chain can only access/interact with the next/precedent actor.
- These actors have different databases, standards, means… Some of them are very small and use SQL requests on "customized" Microsoft ® applications and others may use Teradata ® huge databases . In other term there is clearly an issue of "common language".

2.4 How the technology can enable Dynamic Packaging?

As we stated in the introduction, most of the huge number of travel sites provides isolated information about flights, hotels, rental cars, weather. They relate those information in a very restricted manner. There exists no integrated service for arranging personalized trips to any desired destination, relying on distributed information sources which have to be reasonably combined that is commercially widely deployed. Recent approaches built on mediators that turn Web sources into structured data sources. These mediators are the critical components of the whole system because they have to be built individually and kept up to date.

What technology should enable at the end of the day is something close to the model of figure 2-3.

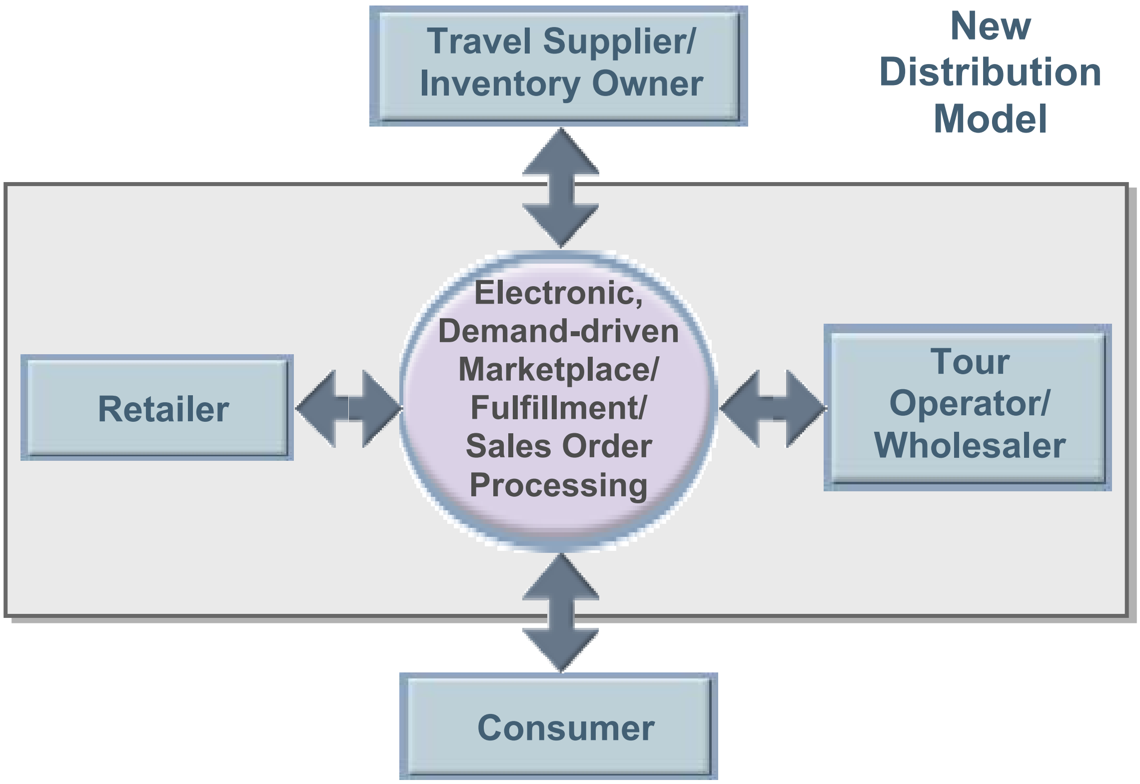


Figure 2-3: What could be a sustainable model for DP

The issue of a common language--
There is a different set of drivers and issues to consider when looking at the use of Web Services between trading partners within the travel industry. The first issue is the need for consensus on XML schema specifications to avoid the proverbial 'tower of Babel', in which every company talks a different lingo.

To that end, the Open Travel Alliance (OTA) was formed in 1998 and now has a global membership of over 150 travel companies from suppliers, such as airlines, hotels, car rental, rail, and tour companies, to intermediaries including Global Distribution Systems (GDSs) and travel agency groups, to technology providers, such as Datalex. The OTA's mission is to create an agreed set of schema specifications that can be shared throughout the travel industry.

Since the shared information is likely to go over the public Internet, a more secure and robust communication implementation is required. The OTA has chosen ebXML, which is a UN/CEFACT-backed, open standard that uses XML, schemas, and SOAP, but adds additional support for security, recovery and performance. The ebXML and Web Services standards efforts are to a large part closely aligned and complimentary. Where Web Services is focusing on solving interoperability issues, ebXML is focusing on delivering full support for an e-Commerce communications framework between companies using XML.

What can be done with Web Services (I use the term generically here to include ebXML) in the travel industry, given a common XML "dialect" from OTA? Quite frankly, "the mind boggles at the possibilities" [Datalex, 2002] ! What happens will not only be driven by the technology and its capabilities, but also by the shifting commercial realities that companies face.

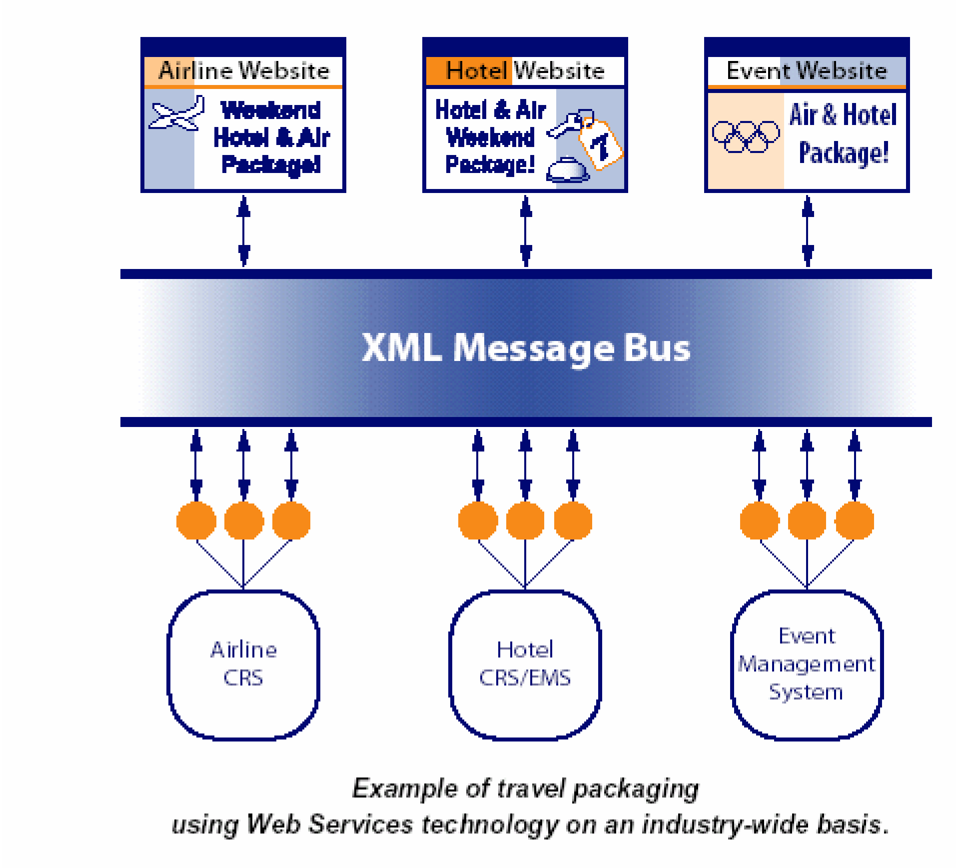


Figure 2-4: Web service technology could enable DP [Datalex,2002]

One might imagine a scenario in which every travel supplier in the world makes their product available via Web Services. These products can then be purchased, bundled, packaged, and redistributed by anyone that has a Web Services- enabled application attached to "the XML Message bus". For example within corporate travel, a purchaser has a self-booking tool that is Web Services enabled using OTA XML formats, and can look at suppliers' inventory and product directly, down to the level of each city, each hotel, each room, each car, each flight etc.

A more mundane but closer to home example might be two travel suppliers, say an airline and a hotel group, that want to cross-market each other's products and sell them in value-priced packages directly over their websites and call centers. This is called… dynamic packaging…

The DP application could sit over a broker that allows access to the product and inventory of each supplier, provides a combined view of the package reservation and manages the individual reservations within each supplier's own databases (see figure 2-5).

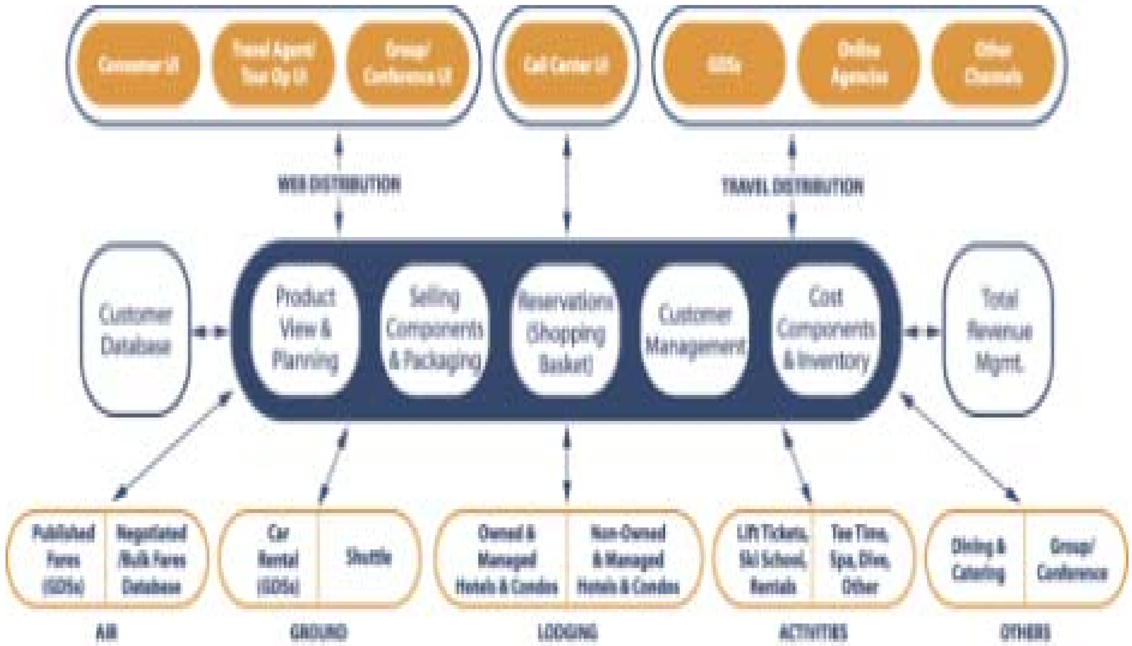


Figure 2-5: SWS and DP can enable the combination of products coming from different sources and manages individual reservation within the local databases [Adapted from Datalex, 2003

2.5 The Existing: The first wave of Dynamic Packaging enabling technology

In the field of Dynamic Packaging systems it is important to notice that the leaders are not the one that we could have expected and actually the whole strategic landscape is extremely dynamic and has changed tremendously in the past months.

In 2001, when Forester, Gartner, Jupiter and the others started to point at DP as a “next big thing” there were basically three main dynamic-packaging systems already operating:

1. **Neat Group** was a startup that has been developing its opaque distribution channel (ODC) “dynamic bundling” system since 1999 being funded first by a major airline. After a first phase of in testing and with some major brands signed up, it was launched in the second half of 2001. ODC is the most advanced Dynamic-packaging system we have seen so far and it is protected by a number of patents (one from the investing airline). Neat ODC allows **detailed rules** to be explicitly set by individual producers regarding how they will be appropriately packaged to protect brand integrity. For example, Hotel A could adopt a particularly deep price discount policy when sold in combination with Airline B, but also choose never to be sold in combination with car rental Brand C.

discount(50%)←Hotel(A)^Airline(B)
discount(not_offered)<-Hotel(A)^Rent(C)

Their main product is called Netsource and you can read on their web site (http://www.neatgroup.com/neatsource.htm):

NeatSource is the suppliers’ real-time “control room” to control and manage how their inventory moves through the supply chain. Using NeatSource, suppliers can define a set of ***“rules”*** *that* *establish the **terms and conditions for the sale of their products in the marketplace**. Supplier rules can apply to specific distributors or network-wide, and are set and operate in real-time.*

*The potential number and scope of rules is extensive. The set of rules defined may range from simple to extremely complex, according to supplier preferences. Suppliers are able to define rules for any aspect of distribution that allow them to control how, where, when and at what price any particular product may be offered. **The rules system is robust, flexible and reliab**le. Through NeatSource, suppliers can manage excess or high demand inventory by instantly adjusting the price and terms by which their products are offered. For components sold as part of a multi-component package priced in aggregate, the price of individual components is not revealed to consumers, distributors and competitors (i.e., "opaque pricing"). Suppliers are thus able to preserve the integrity of their brand, pricing and existing revenue management structure.*

2. **www.site59.com** maintains its own dynamic packaging Web site of primarily domestic travel to U.S. consumers and offers its system on an application service provider basis. This system has already attracted participation from several major U.S. travel brands and many smaller ones.

3. **www.classiccustomvacations.com** offers a Web site to U.S. consumers selling travel packages to European and Caribbean destinations. This system had already attracted participation from a small number of major European travel brands.

What happened since then?

- Classic Custom Vacations was bought by Expedia in 2002
- Travelocity.com (a Sabre company) acquired Site59.com and started dynamically packaging Disney, Universal.
- The NeatGroup was bought in April 2003 by Cedant, the holding company that own the CRS Galileo

Expedia for example, whose gross bookings jumped 82% in last year's dismal travel market to $5.3 billion, spent $36.5 million on product development in 2002, when its biggest initiative was installing the back-end technology necessary to support complex vacation package bookings. In May 2002, it rolled out the Build Your Own Trip tool that now sits front and center on its home page. In November, it added a multiple destination feature to the air search. In June 2003, Travelocity will introduce its "dynamic vacation" technology, which, the site claims, will be the first to allow users to book specific airline seats and hotel rooms themselves, in real time. Orbitz's package functionality is more incremental. Its One Click Rate feature brings you straight to a real-time final rate, bypassing the frustrating and usually misleading package teaser rates advertised on most site's front pages.

Not surprisingly, with this complexity and these prices, both Orbitz and Travelocity admit that at least 50% of their users complete their vacation package transaction on the phone. No surprise. Like online trading, using new technology to plan and book your travel can be empowering and gratifying. However, eventually clicking around for hours loses its charm, especially when you wind up paying more for your trip. For now, better to use the Web for travel research, and leave the details to the pros. (Forbes)

All the major online agencies are reporting a huge surge in vacation package sales. Expedia for example recently announced that vacation packages gross booking rose by 320% to $164 million.

Several interesting questions arise:

-What strategies online do or should travel suppliers have in place to keep this trend moving upwards?
-What strategies are in place to sell dynamic packages online?

-What investments will the online agencies have to make in new technology to allow customers to book packages online?

The rest of this thesis will try to find some answers.

2.6 The second wave: aggregation and content wrapping based travel agents

In the previous section, we tried to addressed the existing, deployed DP technologies, this section study some of the prototypes that are likely to be commercially deployed within 2-3 years: we called it the 2nd technology wave and as we will see this wave is mainly centered around aggregation technology. Later in this thesis, in part 6 to be more precise, we will study the third wave which is the one enabled by SWS and that we expect to be deployed in 5-8 years.

What is an aggregator?

An aggregator is an entity that collects and analyzes information from different data sources. Aggregation defines a new landscape in information retrieval for goods and services on the Internet.

Examples are presented in this section to illustrate the impact of those well-defined aggregators based technologies on the travel industry. New web-based extraction tools have made it possible for aggregators to easily and transparently gather information from multiple sources with or without the permission or knowledge of the underlying data sources. Mediation technologies allow for automatic comparison of information (e.g., book prices, bank accounts, shipping rates, intelligence information) and agent technologies allow for strategic use of aggregated information.

Examples of aggregators today include information management services that help users manage multiple relationships, consumer education services for making appropriate comparisons of different products, and shopbots for locating the vendor with the lowest price.

Aggregators pose significant threats to existing businesses through the consolidation and comparison of information posted on the World Wide Web. By reducing the consumer's search cost and enabling transparent comparisons across different offerings, aggregators eliminate **information asymmetry** in the marketplace [http://context2.mit.edu/aggregation/]. In addition, aggregators may also provide important post-aggregation services. By becoming a leading Internet-based intermediary, the emergence of aggregators may completely change the revenue models for many businesses on the Web.

Aggregation affects all the travel industry actors

Aggregation is one of the most significant technology and business innovations resulting from the introduction of easily accessible information on the web. **Every organization that provides information, product or services** will be effected by aggregation. Providing access to price, information and services over the Internet will immediately expose these organizations to the effects of aggregation causing **drastic rethinking of business models, partnerships, investment strategies, and web presence.**

Aggregation presents a new way of doing business. Aggregators provide access to comparisons of information and pricing that have not been possible in the past. In addition, after-aggregation information provides tremendous market intelligence whose value has yet to be realized.

COIN Mega Airfare Calculator:

Courtesy of Aykut Firat

The COIN mega airfare calculator is a program based on the COIN technology deployed by Prof Stuart Madnick research group at the MIT Sloan School of Management.

Overview of the Coin Technology

Advances in networking and telecommunications have increased physical connectivity (the ability to exchange bits and bytes) amongst disparate datasources and receivers. Unfortunately, these new technologies do not provide logical connectivity (the ability to exchange data meaningfully). This is because data can be imprecise becuase it is only meaningful if understood with reference to an underlying context which embodies a number of hidden assumptions.

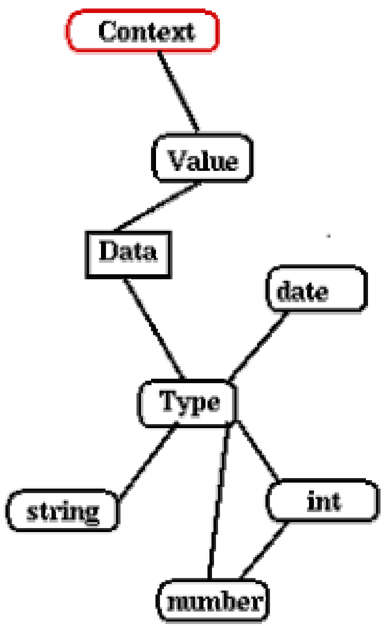


Figure 2-5b: Taking into account the context--

The COIN project seeks to address this problem by consolidating distributed datasources and providing a unified view to them. COIN technology presents all datasources as SQL databases by providing generic wrappers for them. The COIN model also defines a novel approach for integrating these disparate datasources by providing logical connectivity (the ability to exchange data meaningfully) among them. [http://context.mit.edu/~coin/description/meaning.html]

The Mega Airfare calculator is a direct application of the COIN technology and allows to get the information concerning the pricing of a given itinerary from more than 10 different sources on the web.

A powerful but limited technology:

The main advantage of this technology is that it allows to access information from different sources on the web independently from the format of the underlying web site. The mega airfare calculator (MAC) can easily be adapted to include the pricing of packages either by requesting quotes for packages from websites such as hotwire or priceline or by aggregating the subset of the information needed and by summing the prices. The main downside of this technology is the lack of flexibility induced by the inexistence of rules or pricing rules: in an aggregation based DP, you can only obtain a super shopbot for "prepackaged" components/travels.

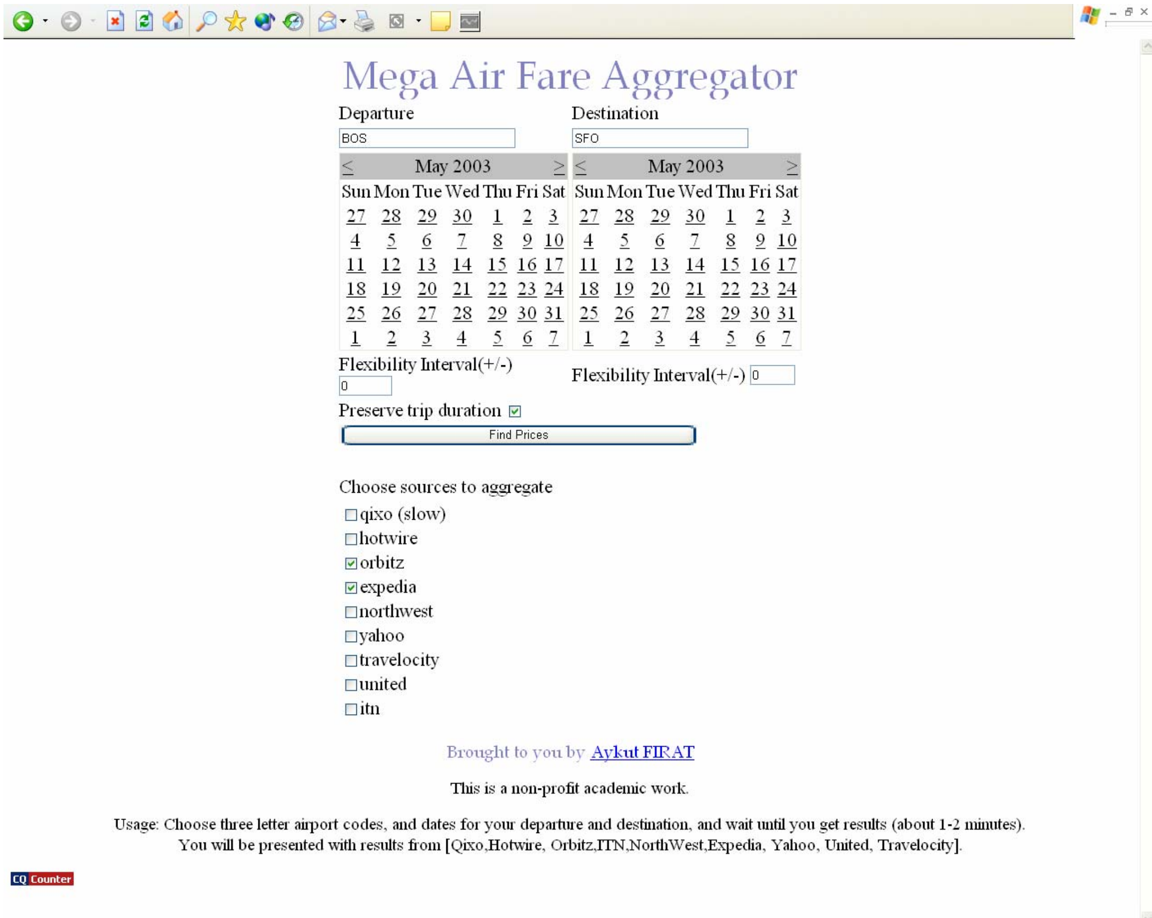


Figure 2-6: Screen capture of the Mega Airfare Aggregator interface [http://web.mit.edu/aykut/www/]

MAXMILES Relationship Aggregation: Managing Reward Programs via MaxMiles

Another application of the aggregation technology is the Maxmiles relationship aggregator: The following paragraphs are a paraphrased summary of M. Siegel paper on Maximiles and a summary of our understanding of Prof Madnick presentation at the 2002 MIT eBusiness conference:

"MaxMiles (www.maxmiles.com) runs a Web-based reward management program to help frequent travelers better manage the rewards earned from different airlines, hotels, and car rental companies. Users provide their account and personal identification numbers for all their reward programs to MaxMiles and authorize it to access and analyze their data. In return, MaxMiles provides its customers with a consolidated statement that shows, among other things, the number of points earned for each account and the number of points that will expire at each date.

Users of the MaxMiles service immediately benefit from not having to manually keep track of all the passwords and are able to view all account activities through a single consolidated statement.

In addition to the standard account statement, MaxMiles provides additional after-aggregation services. For example, it is capable of identifying flight segments that possibly were not properly credited. It will deduce that some flight segments may not have been properly posted if, for example, the account data does not show an inbound segment for each outbound flight. In the not-to-distant future, MaxMiles expects to offer more personalized account statements that help users take advantage of special offers for which they are interested and eligible.

MaxMiles currently provides its service both to businesses and individual consumers. While the specific revenue from each business partner is not disclosed, individual consumers can sign up for the MaxMiles service for $2.95/month.

Interestingly, because MaxMiles does not have to partner with the reward programs in order to serve its clientele, a wide range of different relationships have developed. Some reward programs, such as the Hyatt Gold Passport Program, chose to pursue an active partnership with MaxMiles, outsourcing the task to reduce cost and leveraging the company's technology to better serve its customers.

On the other hand, US Airways initially took a more defensive and hostile attitude. US Airways explicitly prohibits in its click-wrap contract, the revelation of a user's password to a third party, with the intention of preventing MaxMiles from encroaching on to its business. MaxMiles countered this by requiring its users, as part of its registration process, to give it a **Limited Power-of-Attorney.**

It is very important to notice that , MaxMiles interposes itself **between the customer and the frequent flier programs**, the aggregatees. This is important to note as it can have significant effect on the aggregatees. As the aggregator replaces the direct relationship with the aggregatee, companies must change their business model. They may choose to cooperate and provide data and /or financing for preferential treatment (e.g., listing of special offers on MaxMiles.) They may cooperate for access to strategic data. It is important to note that MaxMiles is gathering knowledge of how everyone flies, rents cars and stays at hotels. This new set of information is extremely valuable to the aggregatees. These organizations may choose to outsource their frequent flier programs. Alternatively, they may choose to be more combative and try to limit access to the data. Regardless, the aggregator can have significant impact on the aggregatees' business and can change the relationship between the customer and these companies." [Siegel, 2001]

Today the aggregation based technologies and travel agencies are not extremely efficient mainly for two reasons:

- The information is available on the web in a human readable format (HTML) but not in a machine-understandable lingo [Cf part 4]. With the increasing adoption by airlines of XML based lingos, this should improve.
- Many companies, and in particular the airlines, are trying to not loose the control of some critical information about their customers. As the appendix 7.6 shows, the eBusiness models of the airlines is evolving and these companies, who used to have mainly customers type "A" and who used to control fully the information flows, see today this information "intercepted" by a whole bunch of new actors. We think that these companies can either outsource this whole process and accept the principle of having someone between them and their customers or limit the access to data to third parties (which can be voided by a limited power of attorney) while developing their own aggregation based technologies.

Source: www.ifao.net

“The building blocks for our vision for the future are very simple: The calendar on the desktop of your PC. The i:FAO business travel software. The selection of your destination using an interactive map. The database containing the rules and guidelines of the travel policy to ensure superior cost control and the personal preferences of the traveler.

The combination of these building blocks with i:FAO’s technology will make this vision a reality.

Imagine: Our traveler of the future has to travel to London on a business assignment. The trip includes an overnight stay and the departure is next week's Wednesday. The business traveler opens the calendar on the computer desktop and clicks on next Wednesday. The travel icon is automatically inserted, the appointment entered is automatically scanned for destination and date. An interactive map is automatically launched, at the same time the i:FAO software returns a list of available flights, matching company preferences. Another click secures a seat on the 8 a.m. service. A second click books easily the return flight and opens a new map for the city of London. In the map important points of interest for the corporation, like office or customer locations are pinpointed. More so the software also displays hotels on the city map which fit two criteria: They are approved by corporate travel policy and have rooms available. Upon contact with the cursor the hotel icons open a window which displays exhaustive information about the property. The selection is completed quickly and the hotel is booked with a single click.

The application returns a complete travel itinerary and at the same time performs a number of transactions according to the traveler's preferences. This secures the traveler's preferred seat and meal, takes care of payment procedures and includes data entry for frequent traveler programs. All is controlled by the detailed traveler profile, which in itself is governed by the corporate profile. All additional work happens in the background: Data for the travel expense report is already generated, payment for the airline ticket and review of corporate discounts happen automatically. The complete itinerary with additional information appears directly in the calendar and can be printed or sent by eMail.

Upon request a special agent software will pull together a "Smart Itinerary" for this trip. It will contain recent currency exchange rates, weather forecasts, a map of the hotels vicinity and up-to-date information on cultural and sports events and will be delivered by eMail in good time for this trip.”

2.7 A Comparative test of the existing Dynamic Packaging Systems

Forbes tested the bundling claims of the three main online agencies and found that it still pays to use a real live travel agent—in this case, Bryn Mawr/Amex Travel.

Expedia offered the most robust custom vacation technology of the three sites. Searches here were quickest, but promised savings of 30% never materialized—in part, because the cheapest flight options we were offered were not available and because our upscale hotel choices did not match available deals.

Travelocity is launching its dynamic packaging Tripmaker tool in June. In the meantime, planning a custom vacation here has some glitches. Nonetheless, it was the only online winner in our test. The site recently launched a preliminary flight-and-hotel bundling tool on its homepage.

Orbitz has yet to launch a full-featured custom vacation technology. Its Orbot search tool was extremely slow, and we received repeated error messages when trying to check hotel availability. However, it delivered pre-packaged offerings for two of our three trips.

With Bryn Mawr/Amex, the Forbes journalist discussed trip details by phone with an agent for 20 minutes. He was e-mailed bookable trip prices two business days later. When rooms are not available in one package, the agent was able to find rooms in another package and create the desired trip. Web sites could offer this service

Vacation Package	**Expedia**	**Travelocity**	**Orbitz**	**Travel Agent Bryn Mawr/Amex**
Beaches Turks & Caicos All-inclusive resort family of 4: kids aged 6 & 10, flying from Newark, N.J., March 22-29	no rooms available	no rooms available	$10,781	**$8,275.20**
DisneyWorld, Orlando Disney's Grand Floridian Resort & Spa, family of 4: kids aged 6 & 10, flying from St. Louis, M.O., April 19-26	$6,747.94	desired hotel not available	$6,608	**$5,880.90**
Three-City European Tour 3 nts. London: The Stafford Hotel 3 nts. Paris: Hotel de Vendome 3 nts. Amsterdam: Blake's June 28-July 9, 2003	$7,619.99	**$6,001.40**	desired hotels not available	$7,270.92

Figure 2-7: A comparaison of the efficiency of three existing DP technologies with the traditional “physical” booking agent [Adapted from a Forbes idea]

2.8 Conclusion: First projections

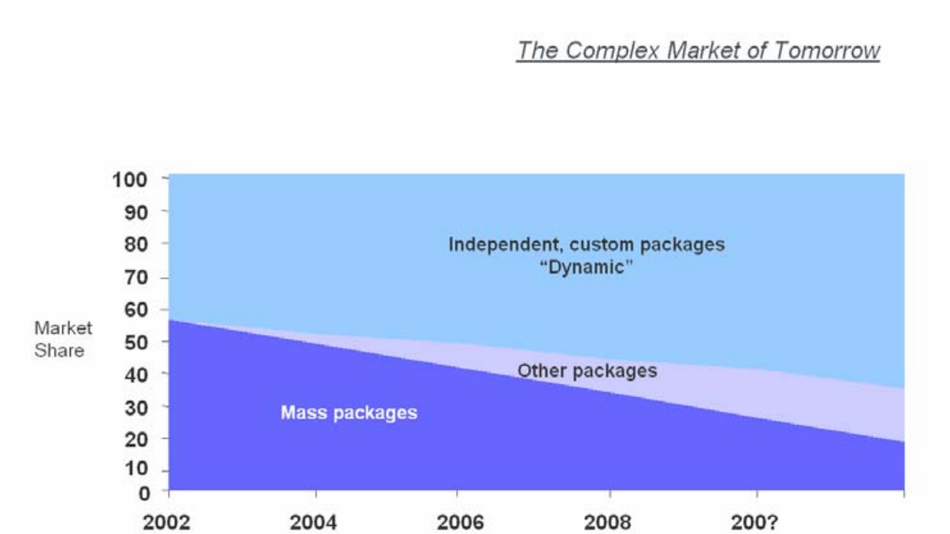


Figure 2-8: Some projections on the adoption of DP [Based on Anite figures, 2001]

We have discussed the trend toward the adoption of DP. We predict that they will be:

- Some of the consequences of DP Adoption:
- Shifting consumer preferences
- More demand for custom products
- Rapid changes in business requirements for suppliers
- Pressure on margin for intermediaries
- Better informed consumers (online price transparency)
- Emergence of multiple distribution channels…

By contrast, yesterday's "mass" packages were offering
- Fixed itineraries
- Inflexible dates
- Limited options

3 The current us retail travel industry: A strategy and policy overview

3.1 Airline Industry overview

3.1.1 Industry Characteristics

Airlines derive most of their revenues from the fares they charge passengers. They also earn ancillary revenues from transporting mail, shipping freight, selling in -flight services, and from serving alcoholic beverages.

The commercial airline industry concentrates its efforts on attracting the business traveler segment because its the primary money maker for airline companies. Business travelers generate higher margins because they typically book flights that are paid by the companies that send employees to different locations. Therefore, business travelers have a tendency to be price inelastic with regards to airfares. Airlines offer special deals to the business traveler. These special services can include priority check-in, expedited baggage handling, luxury lounges, in-flight amenities such as cellular phones, faxes, and outlets for laptop computer usage.

In contrast, the leisure traveler is **highly price conscious**. The leisure traveler usually goes out of the way to save money by using the Internet, discounted airfares, and other methods to save money.

Competitive Dynamics- Airlines face a tremendous amount of competition in various different product forms. For short trips, it is not practical to fly. Most travelers use automobiles and buses to travel. Automobiles encompass 79 percent of all travel while buses make up 3 percent of travel. Airlines also compete with railroads such as Amtrak. The average length for railroad travel is approximately 280 miles.

Airlines compete on price and service to attract the consumer/vacationer market. But business travelers require flight frequency and reliability when choosing an airline. Airlines can differentiate themselves from the competition through frequent flyer programs. These programs allow travelers to accumulate bonus miles to receive discounts on future travel. They are often redeemed for air tickets or service upgrades. These programs are designed to promote repeat business and solidify a customers' choice to use one airline carrier.

Airline Fares- Airline fares fluctuate by the month, week, day, hour, minute, an even second. Fare differentials can persuade leisure travelers. Business fares are rarely discounted because the demand for these seats is highly price inelastic. Passengers flying coach may get up to 12 different quoted fares. Walk-up fares (paid by passengers at depart time) are the highest because consumers have less of a chance to compare competitors' fares.

Airline seats are perishable inventory. This means that once a plane is in the air, its empty seats cannot be sold. Therefore, the airline loses the revenue from that seat. As a result, the airline industry has developed sophisticated models and software implementations to maximize its profits and efficiently manage its inventory. This has led to the flourishing of a practice known as yield management. Yield management is a powerful tool that alerts airlines of abnormal booking patterns, estimates the number of passengers, determines the number of seats that can be overbooked, and forecasts the number of customers who might cancel. Moreover, yield management forecasts demand by the hour, day, week, or month. It determines dynamically the prices of various fare classes and the number of seats reserved for each fare class. It also determines overbooking levels based on forecasts of cancellations and no-shows.

Airline Operating Costs- Labor represents 35 % of airlines costs. This includes costs for flights crews, flight attendants, ground service personnel, dispatchers, maintenance crews, and customer service (booking and boarding). Most airline personnel belong to a union. Most union negotiations last a year before a settlement is reached. Fuel costs are the second largest operating cost category representing approximately 10 percent of costs. Some airlines hedge fuel prices by buying and selling futures on the commodity market.
Weather can also affect airline costs and operations. Wind speed and air temperatures influence how much fuel an aircraft needs. Weather is the second largest cause of airline fatalities. The airline industry must obtain detailed weather forecasts that include cloud height, horizontal visibility, wind speed, and direction.

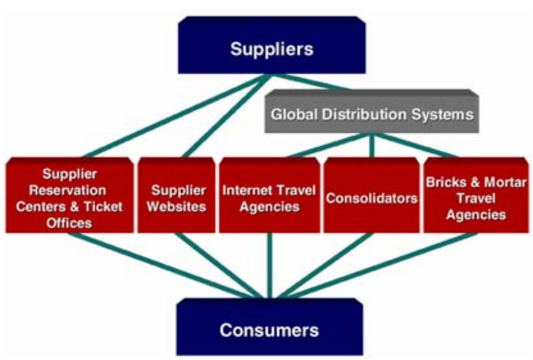
Airline equipment represents 9 percent of total costs. Airlines either buy or lease their fleet of aircraft. Most airlines perform routine maintenance but many outsource heavier repairs to firms that specialize.

3.1.2 Porter's Five Forces Analysis

Overall, low industry growth, low switching costs, high fixed costs and difficulties to fill completely the planes contribute to a very high rivalry in the airline industry. The only positive force is the low threat of new entrants as a result of the required initial investments and the government regulations.

3.2 The US travel Industry: The Current Value Chain

Supply Chain Analysis



The US Travel value chain consists of:
1. suppliers
2. buyers
3. Computer reservation systems (CRS)
4. Intermediaries

Figure 3-1: The existing online travel industry supply chain [Adapted from Global Aviation Associates, 2001]

The **CRSs** are companies that compile databases containing the travel information for the airlines, hotel, and rental car agencies that are part of their network. There are a few major CRSs in the US including Sabre, Galileo, Worldspan and Amadeus.

Travel agents and web-based intermediaries query these databases according to customer preferences. Historically, CRSs have come under fire for unfairly favoring certain airlines in the way they display information about available travel tickets that in turn has caused significant rivalry in the industry.

The figure above (courtesy from Global Aviation Associates, 2001) shows the structure of the US retail travel industry. If suppliers cannot get customers to use direct channels, purchases must go through the Global Distribution Systems or CRSs.

It is important to note that the Global distribution systems (or CRS's) are able to wield considerable power in this value chain. If suppliers can not sell direct to the customer either online or through their offline call centers and counter agents, the transaction must go through one of the few CRS's that hold all of the data for available travel.   Overall, due to the power of suppliers, the high Barriers to entry and low buyer power, the industry has intense rivalry between the major competitors).

3.3 The Existing Business Models

The existing: Three different eBusiness Models

When analyzing the eBusiness models for US retail travel we see three that dominate the field: direct to customer, shared infrastructure, and intermediaries (Each model attracts different customers depending on what features they offer; in addition, each model has a differing value proposition for the supplier.

Direct to Customer Model: Delta.com
Airlines websites like Delta.com are intended to reach customers and promote this loyalty by offering additional miles when you book online. Even if sales on Delta had increased 250% from 1999 to 2001, Delta.com is the preferred channel only for loyal Delta customers.

This model offers customers both a **direct link to their airline of choice and access to the least expensive flights of that airline**. This channel currently holds 12% of the market share for Delta and 50% of the online market share (2001: Global Aviation associates).
The atomic eBiz model of delta.com is the direct to customer model as shown in "Place to Space" [Weill&Vitale].

Full Service Provider Model: MYOBtravel.com, Expedia.com…

The MindYourOwn Business Travel website targets companies with five to fifty travelers. The idea is to provide a single point of contact for small and medium companies, acting as a full service provider and selling the products of other companies.

Expedia.com, and amex.com, are also example of Full Service Provider Model/ Intermediaries typical examples. Customers like these businesses because they can search for flights and hotels and easily compare prices and flight times, however, since the CRS stands between the suppliers and the end customer, this model is not as profitable for suppliers as it could be.

We will see later how a massive adoption of SWS may affect this model.

Shared Infrastructure: Priceline.com and Orbitz.com
The priceline Alliance sell tickets to customers for whom the price is the major determinant guiding their travel choices.

Delta and four partners have banned together to create Orbitz.com. This shared infrastructure model allows customers to search for the least expensive flights that each supplier offers (similar to the direct to customer model) but bypasses the CRSs and therefore allows suppliers to retain a majority of the revenue. It is unclear which suppliers will receive the in-depth information about customer purchases – which is a likely area of contention between the companies. But Priceline and Orbitz DO NOT own the customer relationship.

They are (mainly) for this reason an illustration of shared infrastructure model

Synthesis
See Appendix 7-6 for Integrated Business Model

Business	EBiz Model	Core Competencies	Critical Factor Success
Delta.com	Direct to Customer	➢ Use brand loyalty to encourage buying ➢ Targeted to the most loyal Delta customers ➢ Used as an information vector (investor center, corporate info, crisis management, emergency …) and as the "main door"	• Leverage hidden assets such as brand recognition and brand trust • Create customer awareness • Offer transparent, safe payment and delivery channels
MYOBtravel.com	Full Service Provider	➢ Create and follow relationships with SME ➢ Gather and analyze info about the targeted market-Manage the generated customer database ➢ Consolidate and aggregate the existing offers and comes with a strong value proposition ➢ Link and integrate firm wide IT infrastructures	• Own the customer relationship • Create a brand leadership in an important segment of the market • Build TRUST by accepting to provide third party product
Priceline.com Orbitz.com	Shared Infrastructure	➢ Bring multiple channels to customers ➢ Result of a coalition of competitors ➢ Target occasional Delta customers (Orbitz.com) or very price sensitive customers (Priceline.com)	• Reduce implementation costs by sharing them • Very competitive prices (too competitive?—Travelocity and Expedia are suing Orbitz) • Reach a critical volume and Build trust by offering

			different companies products

Figure 3-2: The existing ebusiness models in a nutshell

Revenue Streams

Each of these models allows a different percent of revenue to flow back to the suppliers. The presence of a CRS dramatically changes the amount profits that suppliers see. Over the past 15 years, CRSs have continued to wield their power by increasing the commissions they charge to suppliers to post available fares. Additionally, since this is an integral part of the offline travel agent based reservation system (which makes up 75% of the overall market), it is impossible for suppliers to abandon the CRSs altogether.

Because of the disparity in revenue streams, suppliers have tried to push customers to the more profitable channels (those that bypass the CRS). In doing so, suppliers have managed to push 50% of transactions to direct websites as opposed to intermediaries.

Driving Forces for Change

Over the next five years we expect to see some changes in the US online retail travel industry. We expect to see changes in the revenue streams and subsequently the market shares of the different channels . These changes will be driven by Americans increasing desire to travel more, an increased comfort level with online purchases, a shift from price sensitivity to need for convenience, and the full implementation Orbitz.com.

These shifts will cause an ever-greater push from suppliers to have consumers use either the direct to customer, or shared infrastructure model for purchases. We predict that in 2005, roughly 70% of purchases will be made through these models and that the customers will choose the models based on their price sensitivity and need for specialization or customization. We predict that the online travel agent (amex.com) will continue to exist but only for VERY few players. We believe the presence of these models will be demand driven by customers who either have a relationship with the firm, or who need extra assistance. Since there is no way for the Expedia type intermediary to compete on either of these two dimensions, we expect they will start to get squeezed out of the market .

3.4 Driving and inhibiting Forces for IT Spending in the Travel Industry

A number of driving forces will boost IT spending in the transportation industry during the next four years. A major driver is the requirement for implementing business processes and IT solutions that provide much tighter passenger and cargo security. Another factor is the potential for biometric identification (ID) systems for transportation workers and passengers. Also, a new computer–aided passenger profiling system (CAPPS-2) with more powerful database inquiry tools may soon be approved by the Transportation Security Agency (TSA), in a cooperative design process with major U.S. air carriers.

Another strong IT spending driver is the tracking and status reporting of cargo containers, using radio frequency identification (RFID) devices, wireless local area networks (WLANs), and global positioning system (GPS) or cellular location reporting systems. The need for improved efficiency and visibility for supply chain management (SCM) in turbulent times, plus meeting government-mandated security processes, will fuel this spending.

A number of airlines and airports have been rolling out self-service kiosks for passenger check-in, seat selection, flight confirmation and changes, and frequent flyer status updates. The fact that airlines will spend money on kiosks in such a difficult economic climate indicates the importance they place on retaining the continued patronage and good will of a valuable asset, frequent flyers.

Key drivers for IT spending in transportation include the following (Source: Forrester)

- Asset and traveler safety and security
- Passenger services kiosks and portals
- Passenger profiling and identification
- Outsourcing cost reductions
- Business continuity
- Container tracking
- Container security
- WLAN and RFID
- Government security mandates
- Cargo portals
- Transportation management systems

Inhibiting Forces for IT Spending-- The 5 percent-to-7 percent growth rates projected for this period are a far cry from the frenetic double-digit CAGRs of the 1990s. Many factors have combined to put IT spending in decline during the past two years and will dampen the recovery in 2003-2006.

The list of problems is long: a go-slow attitude toward major IT investment on the part of CIOs, continued airline sector weakness and consolidation, the cost of affordable RFID sensors for cargo containers, government inability to help carriers fund a number of new regulations and a relatively unsophisticated IT user population outside the airline subsegment and the few IT early adapters in trucking, maritime and logistics services sectors. Key spending inhibitors include the following:

- CIOs' cautious investment mentality
- Airline financial problems
- Diversion of funds to security processes
- Lack of government funding or mandates
- An unsophisticated middle market
- No imperative for biometric solutions
- Lack of affordable RFID sensors

Source: Gartner,2001

4 Semantic Web Services: a survey from technological viewpoint

This section is a survey and an overview of the enabling technologies of what we think should become the underlying infrastructure of the third generation of travel agents and dynamic packaging systems. It is based almost exclusively on existing documents and is not an original thinking although we tried in section 4.4 to give some examples of rules and to code them in the different languages presented to give a more concrete example of what could enable a semantic web coupled with rules and web services.

4.1 Semantic web: Some key concepts

Definition: The ***Semantic Web*** is the representation of ***data*** on the World Wide Web. It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners. It is based on the Resource Description Framework (RDF), which integrates a variety of applications using XML for syntax and URIs for naming.

"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." -- Tim Berners-Lee, James Hendler, Ora Lassila, The Semantic Web, Scientific American, May 2001

This part is a **paraphrased summary** of many research papers from Forrester, Jupiter and Gartner groups.

Machines cannot easily make sense of most of the information on the Web. Web data is chiefly designed for human consumption. Almost all metadata (e.g., HTML) describing Web documents is about where and how to present a piece of information. Many attempts have been made to automate and improve the gathering and use of information (by means of “spiders” and “wrappers”) on the Web, but these technologies still only scratch the surface.

The Semantic Web seeks to improve the situation significantly. The idea of the Semantic Web is to refine the existing Web incrementally, inserting machine-readable “semantic” tags into Web documents or other data-streams. These tags are supposed to provide more information regarding the concepts within the data and their relationships to each other. The implications of such added semantic information could be far-reaching: Rather than being restricted to the Web, it would encompass virtually every aspect of life. “The two major business benefits are the promise for **tremendously improved search capabilities** and — in the long term — **improved systems interoperability**, potentially enabling machines to reach new levels of automation.” [Berners-Lee,2001] Such semantic tags will be increasingly used across many domains, but whether this will stretch across the whole Web in the near- to mid-term is still uncertain.

The Semantic Web will be based on the work of many XML initiatives also aimed at improving the description and structuring of information on the Internet and beyond. The Semantic Web, however, adds two new levels of complexity to “basic” XML standardization efforts: **ontologies** and **inference mechanisms**.

These concepts are not new. There are no substantial technological breakthroughs behind the Semantic Web. Nevertheless, the scope and scale of this initiative may induce a “breakout,” similar to the sudden breakout of the Web in the early 1990s, which wasn’t based on new concepts (i.e., hypertext and the Internet) either.

Ontologies are based on formal knowledge representation languages, which emerged from the field of artificial intelligence The term itself has been borrowed from philosophy and metaphysics. The objective of ontologies is to provide a formal specification of a part of the real world. There is a whole spectrum of ontology languages, ranging from very "light" to very "heavy." The simplest, "lightweight" ontologies relate to database schemas, which formally describe database record semantics.

Other lightweight ontologies are taxonomies or thesauri, which describe relationships like "is broader" vs. its inverse "is narrower" or, more specifically, "is a subclass of." More "heavyweight" ontologies allow even more specific kinds of relationships to be represented (e.g., "is part of," "is located in," "is owned by" or "is partnering with") and also allow the integration of further properties, rules and constraints. It is important to point out that this kind of modeling is closely related to object-oriented analysis, metadata dictionaries, and entity relationship modeling. Ontologies will consequently suffer from similar complexities (e.g., inconsistencies, maintenance, discord and lack of transparency).

Inference or Reasoning Mechanisms take all this coded information and can potentially deduce new information based on further requirements stated by a user. Consider this procurement example : Imagine that suppliers for certain travel components have coded their location, current capacities, product ranges and prices as part of a standard ontology, and thousands of distributors have done the same with their specialties, capabilities, capacities and prices. An inference engine could then take the requirements of an enterprise (e.g., regarding a current demand) and perform a matching/search process that
would incorporate all the provided data. The result would be a list of suppliers and distributors that would be able to satisfy the request most closely. In other words, inference is a process that takes coded information and deducts new information, based on formal rules. In its most basic form, this could just be pattern matching. If the provided information does not match directly, larger chains of reasoning may be required. It is not clear to the Semantic Web community how much of this inference is actually
required for solving real-world problems.

What the Semantic Web Means-In addition to the procurement example above, there exist many more scenarios that can illustrate the far-reaching potential of the ontologies and the Semantic Web. Many of these scenarios are long-range and we do not believe they will reach maturity in the near term.

Providing New Forms of Search and Discovery. Ontologies allow very sophisticated queries. For example, in the field of competitive intelligence, one could look for companies that are of a certain size, exist in a specific geographic region, produce certain types of goods, have rising profit margins and customers in weakening industries. This technology can then be used to develop new accounts or partnerships or to perform general competitive analysis. Ontologies can also facilitate parametric searching (see Gartner, "Different Approaches to Accessing Information") for fast specification of product requirements. Also, their navigational approach comprises sophisticated knowledge maps that allow for good luck as part of the search process, providing "Glue" Between Different Pieces of Information.

Ontologies formally relate different pieces of information (e.g.,information sources) to other pieces of information (e.g.,information occurrences). This "glue" can help avoid the inconsistencies that are prevalent in virtually all enterprises. For example, if an employee's phone number changes, each piece of data that included that number would need to be updated separately. An "employee ontology" could avoid these redundancies and potential sources of inconsistency. Other areas that might benefit include record tracking and analysis, workflow automation and customer relationship management.

Enhanced Systems and Data Interoperability. As ontologies potentially provide increasingly consistent semantic "layers," they will contribute to improved systems interoperability. Enterprises will be able to integrate information in product catalogs behind more-consistent data interfaces. These interfaces will probably not be completely consistent. Experience shows that this may be too expensive to accomplish. However, there are several ongoing standardization initiatives, such as the Universal Standard Products and Services Classification Code (UN/SPSC) and RosettaNet, that are creating upper-level ontologies that could be a basis for sellers' and buyers' ontologies. The potential cost reductions from matching seller and buyer ontologies are Enormous

.

"Facilitating the "Supranet." Semantically tagged data will also support the growing heterogeneity of devices. It will ease the tailoring of content to specific audiences, contexts and devices. The proliferation of devices will also facilitate the gathering of
information from all over the world" [Gartner, "Tagging the World: The Rise of a New Tagging Industry"].

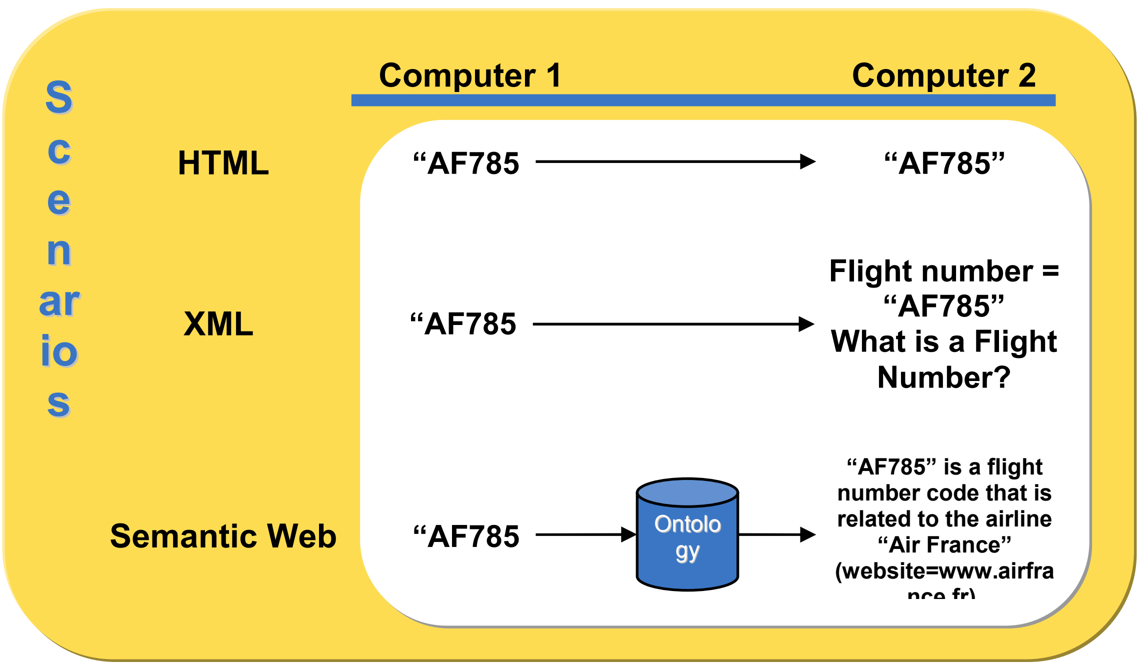


Figure 4-1: What "semantic" means in SWS?

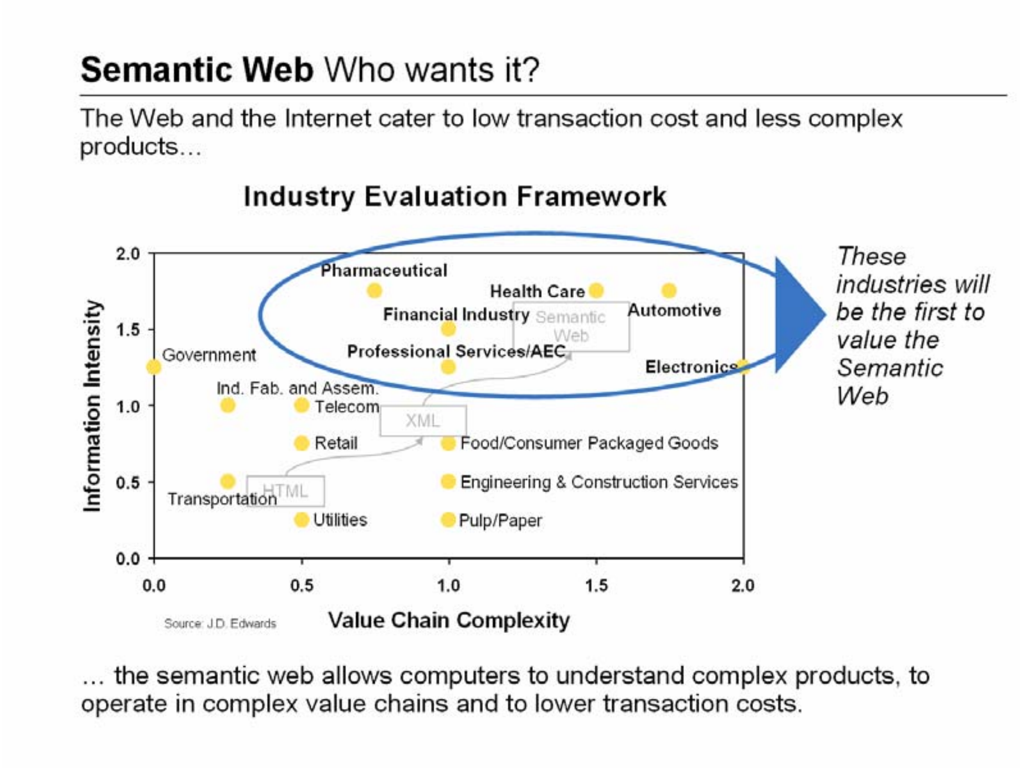


Figure 4-2: Semantic Web, who are the potential early adopters? [Adapted from a class 15.567 final presentation]

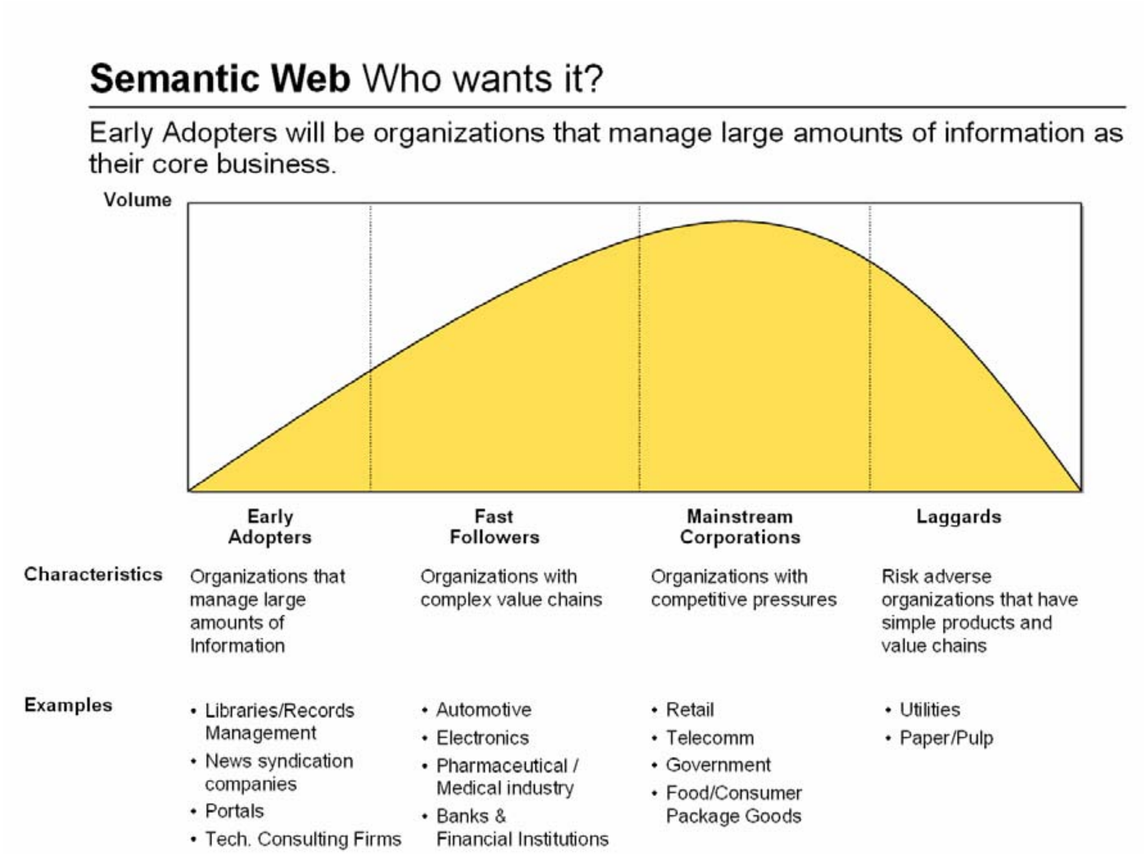


Figure 4-3: Adoption curve and adopters characteristics [Adapted from a class 15.567 final presentation]

4.2 Semantic Web Services Technology Overview

Web services are software components that interact with one another dynamically and use standard n Internet technologies, making it possible to build bridges between systems that otherwise would require extensive development efforts.

One of the tenets of Web services is that systems can advertise the presence of business processes, information or tasks that can be consumed by other systems. Web services can be delivered to any customer device — e.g., cell phone, personal digital assistant (PDA) and PC — and can be created or transformed from existing applications. More important, Web services use repositories of services that can be searched to locate the desired function to create a dynamic value chain. New specifications — such as the Universal Description, Discovery and Integration specification — allow the extension of business interaction by locating new processes or information, examining the description of what those processes do and binding to the new processes while the system runs.

Web services mean many things to many people. In essence, Web services should represent two things to an enterprise that embraces them: A means to transformation or a result of it. Some enterprises will use Web services to change the way they do business. Others will take the more radical step of actually assuming the model of being a Web service, utterly changing their future.

4.3 An example of what may become possible: Rating

" By 2008, at least $90 billion business-toconsumer (B2C) and $350 billion business-to-business (B2B) purchase decisions will be based on semantic "tags" containing information and opinions about items (0.6 probability)." [Gartner, Tagging the World: The Rise of a New Tagging Industry]

The flood of information, products and services available to today's consumers and businesses is spurring a focus on organizing and labeling choices in a way that supports a person's ability to find, prioritize and select items. Most recently, companies such as Yahoo have shown that systematic manual indexing can be performed on a massive scale to bring structure to chaotic collections of information. The huge potential audience on the Web is encouraging this type of knowledge industry to emerge, despite the difficulties many enterprises face in shaping the most appropriate business model.

The Web is playing host to opinion sites that facilitate the tagging of products, services and places by offering consumer opinions and ratings (e.g., www.bizrate.com, www.bbb.com, www.openratings.com, www.epinions.com, www.ciao.com and www.planetfeedback.com). Sites offering professional reviews also incorporate peer opinions (e.g., www.amazon.com) and try to increase the quality of reviews through feedback that rates how useful the review was (to discourage openly manipulative reviews.) Other vendors offer additional layers of information for improved transparency of the underlying information-bearing documents (e.g., yet2.com, Delphion for patents). Other sites tag questions to Web documents (e.g., Ask Jeeves; www.ask.com) to facilitate natural-language questions typed in as Web searches

This trend toward tagging will intensify through 2010. The capability to generate tags automatically will be a major driver of this phenomenon; in particular, the capability to create quality recommendations based on the implicit behavior and opinions of other people with similar tastes and preferences .

Broader accessibility to the information through mobile technology will be another strong driver. The prevalence of tagging will apply not only to information-bearing objects (e.g., Web, documents and media), but also to places, events, companies and even people (e.g., an opinion about a particular taxicab driver). Tags and profiles will become a major and growing component of the economy and a significant force in the allocation of cash flows (e.g., through product selection and consumer attention).

Scenario: Tag, You're It (source: Gartner, Tagging the World: The Rise of a New Tagging Industry] *Imagine you are looking at the online version of Business Week. You don't have much time (say 20 minutes) so you want to read something that satisfies your current mood — i.e., the item shall be educating, entertaining, inspiring and about internationalpolitics. You would enter these criteria and the information retrieval system would match them against the collective reader feedback aggregated over the week. Such feedback comes fromreaders who evaluated the articles along predefined categories. The system automatically inferred your average 20-minute reading time from the reading software — available through ebooks and other electronic reading devices. After reading the article, you may ask yourself what other items were similarly enjoyed by the readers who liked this one. This type of tagging could be applied to recipes, restaurants, vacation places, books and electronic consumer goods.*

Consequences:
Broad availability of additional data will change the way that businesses and consumers buy, market and develop their products and services: Professional Infomediaries: Such entities will emerge in a growing number of subject areas, as small, independent enterprises and as part of

large, amalgamated enterprises evolved from today's specialists (e.g., online booksellers or travel sites). A major new billion-dollar industry will emerge, based on collecting, organizing and selling tags as a distinct commodity, separate from the items themselves.

Purchase Decision Support: "By 2008, more than 40 percent of U.S. households buying goods or services priced at more than $200 will partially base purchase decisions on semantic tags with Associated information and opinions at least once per month (0.6 probability)." [Gartner, idem]

Search: Additional data can be used to enhance indices and, consequently, directly improve search capabilities. Many business sales are lost today because potential customers can't find or remember products that they like. This applies beyond mass-market products and services — niche offerings will also have a body of associated information and reviews.

Innovation and Improvement: Added data will help enterprises streamline and enable continuous innovation, enhancement and improvement of their products and services. Personalization: All information about goods and services and other items will be used to synthesize buyer interest profiles.

Automation: Tagging information will also support the increasing interoperability of systems. This corresponds to what Tim Berners-Lee envisions as the "semantic Web

4.4 Semantic Web+ Web Services= Semantic Web Services

The purpose of this part is to study SWS enabling technologies and standards.

4.4.1 DAML+OIL (Web Ontology Language)

"Ontology "defines the terms used to describe and represent an area of knowledge" [www.daml.org]. Each ontology consists of classes that represent general concepts in the domains of interest, the relationships that can exist among these classes, and the properties that these classes may have.Ontologies are used extensively in knowledge management. They can represent the semantics of documents in a well-defined format that may be used by web applications and intelligent software agents.

DAML+OIL [W3C Web Ontology (WebOnt) Working Group. http://www.w3.org/2001/sw/WebOnt/] is a language for creating ontologies and marking up information in a machine readable and understandable format. It originated from two related efforts, DARPA Agent Markup Language (DAML) [DARPA Agent Markup Language. http://www.daml.org] and Ontology Inferencing Language (OIL) [DAML+OIL (March 2001) Reference Description. http://www.w3.org/TR/daml+oil-reference].

DAML+OIL is based on RDF, an XML language that represents metadata about Web resources .

In August 2001, the World Wide Web Consortium created a working group to define a standard Web ontology language. DAML+OIL is the main technical point of departure for this work.

4.4.2 OWL

The OWL Web Ontology Language [http://www.w3.org/TR/owl-features/#s1.2] is designed for use by applications that need to process the content of information instead of just presenting information to humans. OWL facilitates greater machine readability of Web content than that supported by XML, RDF, and RDF Schema by providing additional vocabulary along with a formal semantics. OWL has three increasingly-expressive sublanguages: OWL Lite, OWL DL, and OWL Full.

OWL Lite supports those users primarily needing a classification hierarchy and simple constraints. For example, while it supports cardinality constraints, it only permits cardinality values of 0 or 1. It should be simpler to provide tool support for OWL Lite than its more expressive relatives, and OWL Lite provides a quick migration path for thesauri and other taxonomies.

OWL DL supports those users who want the maximum expressiveness while retaining computational completeness (all conclusions are guaranteed to be computed) and decidability (all computations will finish in finite time). OWL DL includes all OWL language constructs, but they can be used only under certain restrictions (for example, while a class may be a subclass of many classes, a class cannot be an instance of another class). OWL DL is so named due to its correspondence with description logic, a field of research that has studied the logics that form the formal foundation of OWL.

OWL Full is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. For example, in OWL Full a class can be treated simultaneously as a collection of individuals and as an individual in its own right. OWL Full allows an ontology to augment the meaning of the pre-defined (RDF or OWL) vocabulary. It is unlikely that any reasoning software will be able to support complete reasoning for every feature of OWL Full.

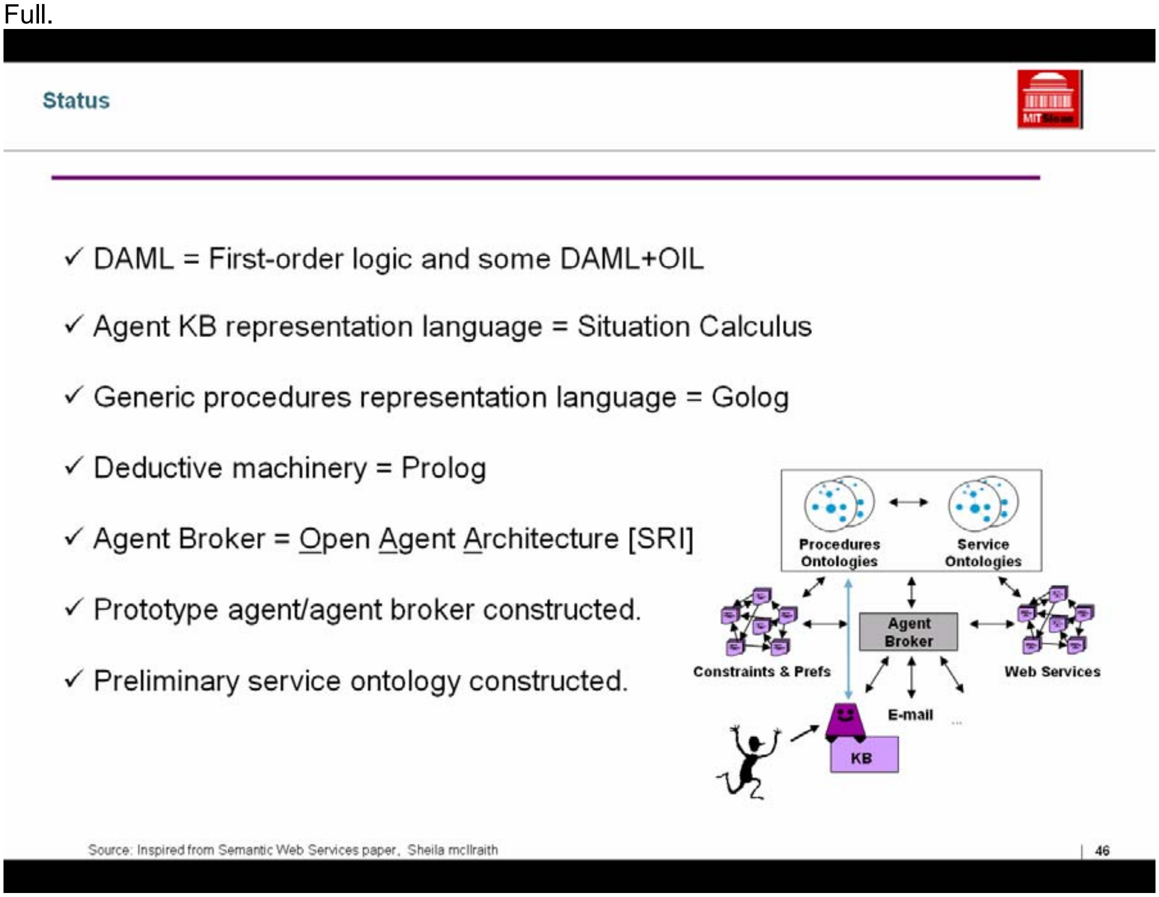


Figure 4-3b: A summary [Source: SWS paper, Sheila mcIlraith]

4.4.3 Business Rules and Situated Courteous Logic Programs

A *business rule* is an if-then rule used to describe some piece of business logic. Formally, it is an implication from an antecedent (IF clause) to a conclusion (THEN clause) in which the antecedent may contain multiple conjoined (AND'ed) conditions. A rule with only a conclusion but no antecedent is called a *fact*. Rules can be used to describe terms and conditions such as volume discounts, service provisions for refunds and other exceptional conditions, and requirements for surrounding business processes like the lead time to place an order. Consider the following example of volume discounting between an online travel agent- let say Site59- and the reservation center of a prestigious resort in Miami:

- (Rule A) If the web site purchases between 50 and 100 nights from the hotel and make this purchase 5 to 10 days in advance, then the price is $100 per night.
- (Rule B) If the buyer, the web site/the travel agent, purchases between 80 and 150 nights and accepts advance purchase 8 to 15 days in advance, then the price is $80 per night.
- (Rule C) If the buyer is a “premium” customer of the group to which the hotel belongs then the price is $70 per unit, regardless of the quantity or delivery date.
- (Priority Rule 1) If both A and B apply, then Rule B ‘wins’, i.e. the price is $80.
- (Priority Rule 2) If both A and C apply, then Rule C wins, so the price is $70.

In addition to their expressiveness to human readers, contracts specified with business rules can be automatically evaluated, modified, and executed by software agents. There is no need to have people struggling with linear systems or constraint based systems to calculate the right price.

One language for encoding business rules is called Courteous Logic Programs (CLP) . CLP is an extension of Ordinary Logic Programs, a well-established language in artificial intelligence for knowledge representation. CLP provides the additional mechanism of prioritized conflict handling, in which conflicting rules are resolved through pairwise mutual exclusion (mutex) statements and priorities between rules. This mechanism allows one rule to be overridden by another rule with higher priority. Rules may be given higher priority because they specify special cases, come from higher-authority sources, or have been updated more recently. In particular, contract terms can be modified during negotiation by adding higher-priority rules.
CLP rules may be encoded in several formats. The SCLPfile format is a straightforward text format for CLP. “<-“ stands for implication (i.e. “if”), “?” indicates a logical variable, and “;” ends a rule statement. “<...>” encloses a rule label, and “//” prefixes a comment line. The following is an SCLPfile encoding of the previous example:

```
<A> price(?Order,10) <-
  quantity(?Order,?Q) AND greaterThanOrEquals(?Q,50) AND lessThanOrEquals(?Q,100) AND
  advanceLeadtime(?Order,?D) AND greaterThanOrEquals(?D,5) AND lessThanOrEquals(?D,10)
;

<B> price(?Order,80) <-
  quantity(?Order,?Q) AND greaterThanOrEquals(?Q,80) AND lessThanOrEquals(?Q,150) AND
  advanceLeadtime(?Order,?D) AND greaterThanOrEquals(?D,8) AND lessThanOrEquals(?D,15)
;

<C> price(?Order,7) <- buyer(?Order,?Buyer) AND seller(?Order,?Seller) AND
  customerType(?Buyer,?Seller,preferred) ;

<priority1> overrides(B,A) ;
<priority2> overrides(C,A) ;

MUTEX price(?Order,?X) AND price(?Order,?Y)
  GIVEN notEquals(?X,?Y) ;
```

Figure 4-4: Example of Pricing rules applied to the room nights example

The MUTEX statement says that there can only be one price for every order. If rules A and B both apply during execution, then the priority rule overrides (B,A) is used to decide whether to set the price to 100 or 80. Since rule B overrides rule A, the price would be set to 80.

An important extension to CLP is the ability to express procedural attachments, resulting in situated courteous logic programs (SCLP) [Grosof, 2001]. This allows belief expressions in the rule system to be associated with procedure calls in a programming language like Java.

XML representation facilitates knowledge interchange on the Web. Previously, the Business Rules Markup Language (BRML) provided an XML encoding for SCLP rules. However, the emerging RuleML language, which is partly based on the design approach and criteria of BRML, is now the preferred XML embodiment for SCLP rules.

The IBM CommonRules rule engine [supports inferencing with SCLP rules. SCLP has been used in several major applications, including EECOMS, a three-year industry consortium effort led by IBM that focused on supply chain integration for manufacturing The project used SCLP to encode rules for supply chain processes, such as ordering lead time.

4.4.4 Exception Conditions

The terms of a contract establish a set of commitments between the parties involved for the execution of that contract. When a contract is executed, these commitments are sometimes violated. considers these violations to be coordination failures, or exceptions, and introduces the concept of exception handlers, which are processes that manage particular exceptions.

Consider the following example. Company A agrees to pay $149 per night for 2,000 nights of hotel B's product, and B agrees to hold 2000 nights in Premium Rooms with view on the beach (commitments). However, due to unforeseen circumstances, B only manages to hold 2000 nights in basement rooms with view on the parking (exception). B pays $100 to A as compensation for the "downgrade" (exception handler). The main problem in the existing websites is that the existing technology is not made/adapted fpr handling exceptions so in case of any problem there is a need to call the customer service of the web sites

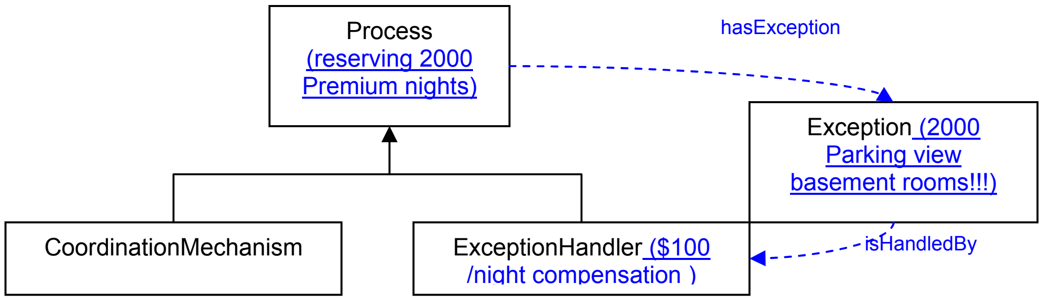


Figure 4-5: Exception handling [Adapted from Therry Poon, idem]

4.4.5 RuleML

RuleML (Rule Markup Language) is an early-phase initiative to create a standard language for exchanging rules in XML . RuleML is based on ordinary logic programs (i.e. Horn logic programs extended with negation)extended by the prioritized conflict handling and procedural attachment features of SCLP [B.N. Grosof, “Representing E-Business Rules for the Semantic Web: Situated Courteous Logic Programs in RuleML.” In *Proc. Workshop on Information Technologies and Systems (WITS '01)*, New Orleans, Louisiana, USA, 2001.] as well as other expressive features like equivalences, equations, and rewriting. Notably, RuleML allows URIs[1] to be used as names for local vocabulary and knowledge subsets, such as predicates, functions, and rules. This facilitates integration with emerging standards for ontologies on the Web, such as RDF/RDFS and DAML+OIL. As previously mentioned, we expect RuleML to become the preferred XML encoding for SCLP rules.<imp>

[1] Uniform Resource Identifiers , a standard for naming and addressing Web resources

```
  <head>
    <atom>
      <_opr><rel>price</rel></_opr>
      <var>Order</var>
      <ind>10</ind>
    </atom>
  </head>
  <body>
    <and>
      <atom>
        <_opr><rel>quantity</rel></_opr>
        <var>Order</var>
        <var>Q</var>
      </atom>
      <atom>
        <_opr><rel>greaterThanOrEquals</rel></_opr>
        <var>Q</var>
        <ind>50</ind>
      </atom>
      <atom>
        <_opr><rel>lessThanOrEquals</rel></_opr>
        <var>Q</var>
        <ind>100</ind>
      </atom>
      <atom>
        <_opr><rel>advanceLeadtimee</rel></_opr>
        <var>Order</var>
        <var>D</var>
      </atom>
      <atom>
        <_opr><rel>greaterThanOrEquals</rel></_opr>
        <var>D</var>
        <ind>5</ind>
      </atom>
      <atom>
        <_opr><rel>lessThanOrEquals</rel></_opr>
        <var>D</var>
        <ind>10</ind>
      </atom>
    </and>
  </body>
</imp>
```

Figure 4-6: RuleML encoding of former example

In the figure above, we encode the discounting rule example seen above using the Version 0.8 schema of RuleML. As shown, the RuleML format is quite verbose. This is the typical tradeoff made by XML, **favoring self-describing capability and interoperability over compactness.**

4.4.6 Typical Negotiation Process

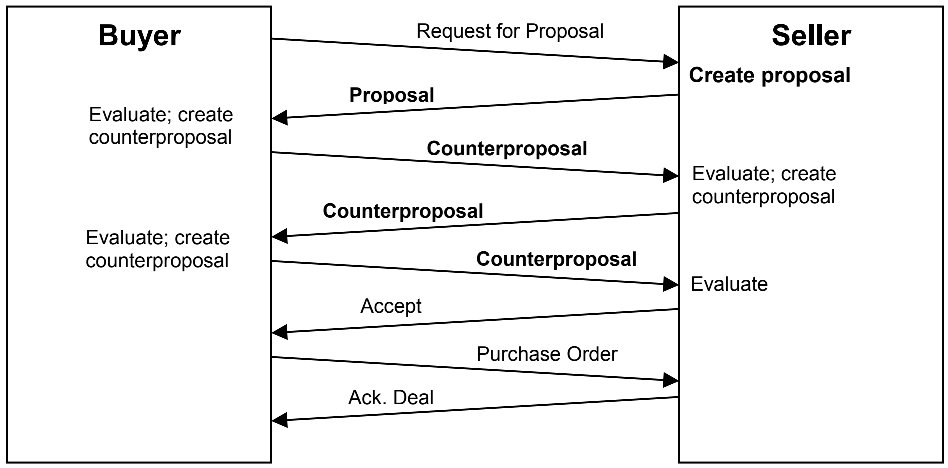


Figure 4-7: Typical negotiation process: *BuyUsingBilateralNegotiation [Grosof, 2001]*

We consider a typical negotiation between one buyer and one seller , as shown in The buyer initiates the process by sending a Request For Proposal (RFP) to the seller. The seller responds with an initial proposal. If the buyer is unsatisfied with the terms in the proposal, it may add some modifications and send back a counterproposal. The seller may respond to this with another counterproposal. In general, this sequence of counterproposals continues until one party responds with an “accept” or “reject” message. (Alternatively, the process may end if it exceeds the time constraints defined by the negotiation protocol.) If the proposal is accepted, it becomes a contract, and the buyer sends a Purchase Order. Finally, the seller responds with an acknowledgement of the deal, and the negotiation phase is complete. In the execution phase, the parties carry out the provisions specified in the contract. In particular, if any exceptions occur, the parties will react according to the exception handling provisions in the contract.

4.5 The third wave: Semantic Web Services based Travel agents

TAGA: Travel Agent Game in Agentcities

The best available technology to illustrate Travel Agent Game in Agentcities (TAGA) is an agent framework for simulating the global travel market on the Web. It extends and enhances the original TAC system [Wellman 99] to work in an Agentcities environment of FIPA compliant agents.

TAGA is used to demonstrate Agentcities and Semantic Web technologies. TAGA is running on FIPA-compliant platform and Agentcities Environment. Interoperability of different agent development platforms, such as JADE and AAP, is tested in TAGA. WSDL is used to describe the services provided by FIPA compliant web service agent, and that will facilitate the .NET agent to access such services. FIPA Interaction Protocols are supported and tested, and we also suggest new protocols for Web Auctions. Agentcities facilities are used to add scalability and flexibility of TAGA game, e.g. the Web Service agents are found through Agentcities Service directory. RDF, a key Semantic Web component, is used as Message Content Language to enhance agent collaboration.

TAGA is used to simulate a **"real" web market**. By offering an agent-based framework, TAGA can better simulates the real web travel market for business research. The framework evolves from the client/server mode (TAC) to a distributed standalone agent community. This framework is a flexible and open system. Between the travel agents and the web service agents, more purchase methods are available: directly buy or auction. Between the customers and the travel agents, more contract model are available: pre-assigned model or contract model. Intelligent marketing strategies are needed by not only the travel agent, but also by the customer agent and the web service agent. Auction theory can be also tested and improved in this framework.

TAGA game simulates a global travel market in the Agentcities environment. A customer from City A want to have a recreational tour in resort R, so he/she needs a round-trip flight ticket and corresponding hotel accommodation when he/she is in resort R. Moreover, the customer will be happy if his/her preferences are satisfied, e.g. living in good hotel, enjoy a concert or go to a famous restaurant. In TAGA, all such service providers can sell their services on the Web and thus form a Web Travel market. Travel agents will help the customer to buy the travel package from the Web travel market. For a more detailed study of this system, please see appendix.

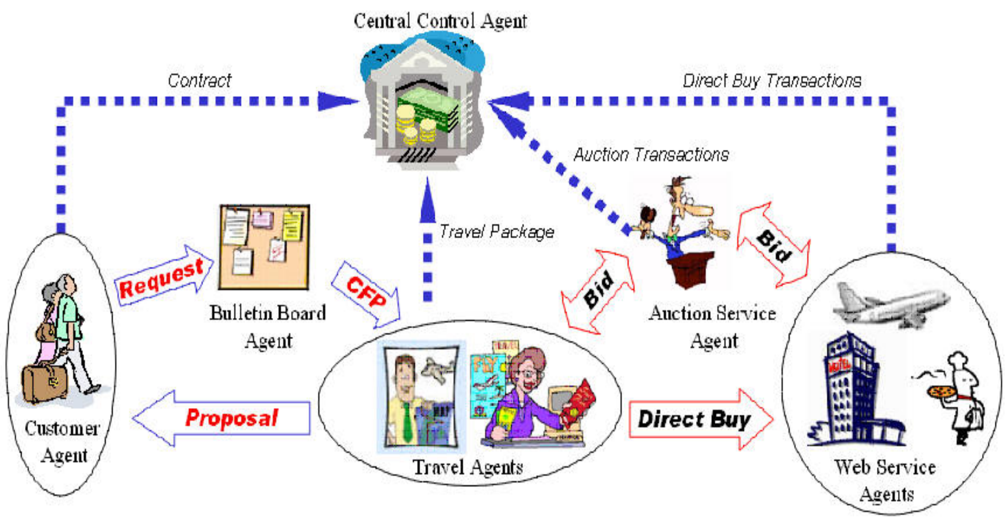


Figure 6-1: The TAGA vision [Adapted from TAGA website]

5 Semantic Web Services drivers and inhibitors in the travel industry

Web services adoption by the travel industry will be controlled by a number of factors, and these will have varying impact on the subsectors of the industry: air, rail, maritime, hotels, car rental and logistics. Since these subsectors have different business process dynamics,we expect that SWS adoption will vary. In this part we will discuss what we think are going to be the SWS drivers and inhibitors in the travel industry. This discussion id based on :
(a) interviews of professionals and consultants and (b) research reports on IT spending in the travel industry [Gartner,2002].

5.1 Semantic Web Services Drivers

The following points are the transportation industry's most powerful Web services drivers:

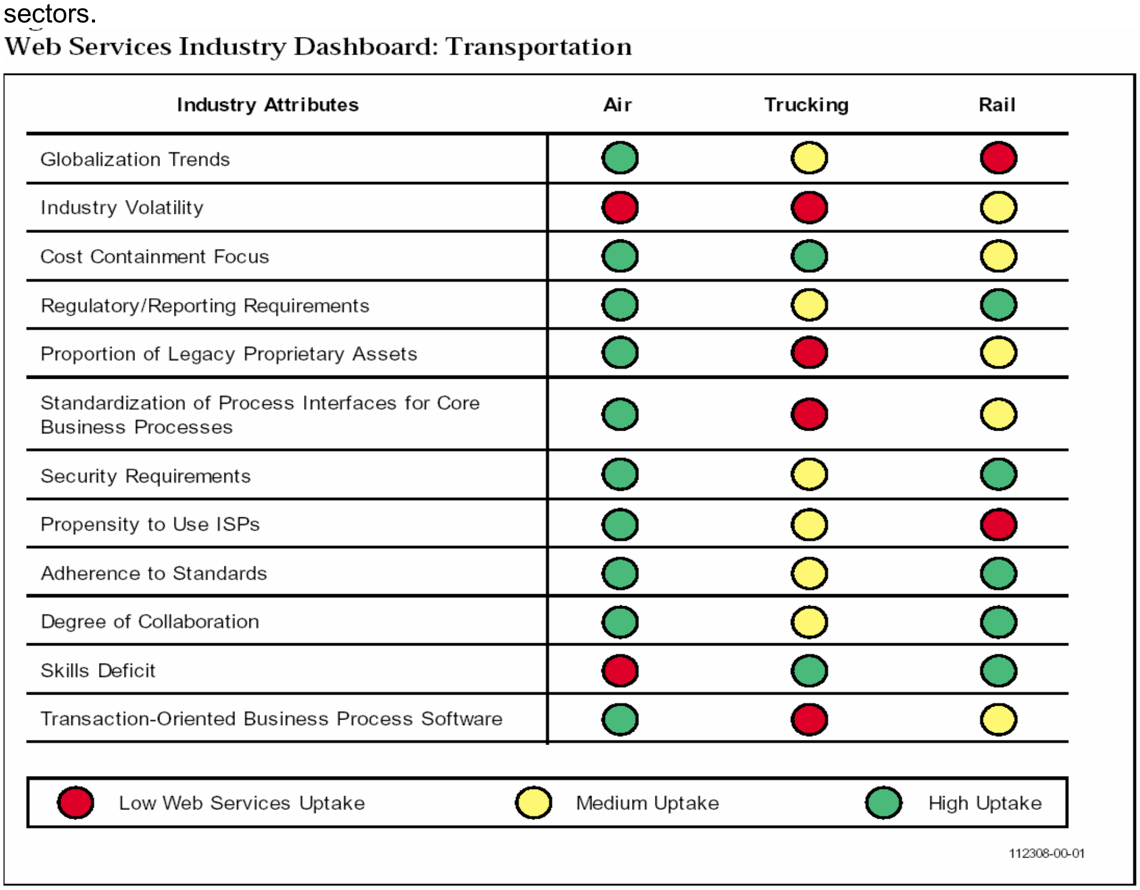
- The industry is highly **globalized** by its nature and the nature of its product and it requires a **high degree of collaboration**.
- The airline industry spends a **higher percentage of revenue** on IT services than other sectors and invest constantly in new technology with a demonstrated ROI on the short/medium term. For example, in 2002, and despite the current crisis companies like Delta and US Airways invested more than $80 millions in the installation of kiosks for easy check-in.
- Even though deregulation of the U.S. air travel have provided carriers with unprecedented freedom for market actions and pricing, government regulations for safety and operational reporting continue in place. Trade associations have also helped to keep operational and financial reporting relatively **uniform and standardized.** [Gartner,2002]
- The airline industry Global Distribution Services (GDS) providers, Sabre, Amadeus, Galileo and Worldspan, operate extremely complex core applications. These systems also require standardized data interfaces for exchange of information among many carriers.
- After the Sept. 11 terrorist attacks, asset, personal and information security became mission-critical business processes for the entire industry.
- All segments are closely focused on cost containment.
- Passenger travel, by definition, is transaction oriented and requires sophisticated transaction processing processes and software products for successful operation
- The airline sector has a high percentage of **"Type A"** (leading-edge adopters) IT users, who will adoptWeb services early in its life cycle.
- IT skill levels are not strong in the rail and maritime industries, making them good targets for integration services.
- All industry sectors have a propensity to use Internet service providers for their more complex systems design implementation and integration projects.

5.2 *Semantic Web Services Inhibitors*

The following points are the transportation industry's most powerful Web services inhibitors:

- **Financial considerations** will prevent many transportation firms from refreshing their technology, even though more capable, open systems are now available
- A relatively low percentage of Type A users are found in the trucking, rail and maritime subsectors: to be “useful”, SWS need to be implemented at all the level of the supply chain because you don’t want to have a message prompting while you are using a last generation SWS based travel agent asking you to call a number to get a part of the segment priceing.
- **Economic recession**, airline industry instability and post-Sept. 11 travel reductions and security concerns have made the entire industry highly volatile and after some huge IT investments mistakes in 1998-2000, some companies like Delta are more focusing on finding a way to leverage the existing than spending more money .
- **Legacy mainframes** are still in prominent use in GDS and airline/hotel/car rental reservation systems. Adapting them for efficient use with SWS may be costly and the GDS may be reluctant to bear the major part of the costs.

.
In general, the airline and logistics sectors are most likely to realize the benefits of Web services. A graphic "dashboard" comparison of Web services uptake attributes is shown in Figure 1 for the air, trucking and rail sectors.



ISP=Internet service provider

Figure 5-1: SWS travel industry dashboard [Adapted from Gartner,2002]

5.3 Strategic Trends and projections

Synthesis—Strategic Projections

This part is a parapharasing summary of the key findings of industry reports from HeeBs and Phocus Wright.

In the next 2-3 years expects the big online agencies/intermediaries to become even bigger through M&A. The merchant and opaque services will become even more popular at the expense of Internet less-savvy hoteliers. The disparity between Internet savvy hoteliers that push forward with comprehensive Direct Web Distribution Strategies and well-balanced Indirect Distribution Strategies, and the less savvy hoteliers (brands, franchisees, independents and hospitality management companies) that are becoming increasingly dependent on the online intermediaries, will increase even further.

Online travel is the largest e-commerce category and has attracted numerous big and small players. There are many possible classifications of the online travel services:

- By ownership:
  - o Owned by big offline travel suppliers (Trip.com owned by Cendant)
  - o Owned by big inventory distribution systems (Travelocity owned partly by Sabre)
  - o Joint ventures of major travel suppliers: Orbitz.com, Hotwire.com, TravelWeb.
  - o Public (e.g. Expedia) and privately owned (e.g. HDN.com)
- By business model:
  - o Agency Model (e.g. placestostay.com, TravelHero.com)
  - o Merchant Model (e.g. Hotels.com, Travelscape.com)
  - o Opaque Rate Model (e.g. Priceline, Hotwire, etc)
- By product range:
  - o One-stop multi-travel-product shops (e.g. Expedia)
  - o Lodging-focused sites (e.g. Hotels.com)

The online agencies/intermediaries are projected to maintain a steady online market share in the next 2 years. This share will depend to a great extent on how proactive the travel suppliers will become and how aggressive the direct-to-consumer sales efforts will be:

	1999	**2000**	**2001**	**2002**	**2003**
Online Agency Share:	48%	49%	47%	47%	47%
Supplier Branded Websites:	52%	51%	53%	53%	53%

(2001 PhoCusWright)

Jupiter Research provides a similar projection for the online market shares of travel suppliers vs. intermediaries in 2002, but its estimate for 2005 is much more favorable to the travel suppliers:

	2002	**2005**
Online Agency Share:	48%	45%
Supplier Branded Websites:	52%	55%

(2001, Jupiter Research)

The two leading online travel services, Expedia and Travelocity, will book more than $5 billion this year. Pegasus Solutions, originally established as a switch between major hotel brands and the GDSs, is already distributing hotel inventory through non-GDS channels on a mass scale, through websites and affiliates. WorldRes is in fact the first Web-based non-GDS hotel inventory distribution system.

Trends in the Intermediary Market

Here are several noticeable trends in the travel agency/intermediary market:

- The Agency Model is becoming a thing of the past

The leading US-based online agencies/intermediaries have embraced the "Merchant Model" and have switched from pure "Agency Model" to various forms of "Merchant Model" and "Opaque Rate Model". The Agency Model-type of hotel inventory is being used only as secondary and supplementary to the Merchant and Opaque Model inventory or as primary only in destinations where there are no Merchant hotels. For example in its "Hotels" section, Expedia features first its "Opaque Rate" and "Merchant Model" hotel offerings and only after that offers other hotels from its Worldspan inventory feed, the “Agency Model”.

- Travel players embrace the Merchant Model

Travelocity.com made a strategic acquisition earlier this year of Site59.com, whose dynamic packaging technology allows Travelocity to a) gradually start substituting and in the future replacing the Hotels.com Merchant listings with its own offerings, and b) respond to the growing popularity of Expedia's travel packages and dynamic bundling of travel components (air+hotel+car, etc). In the same manner Orbitz.com now uses TravelWeb for its Merchant Model hotel offers. Cendant recently acquired Lodging.com, a mid-size Merchant Model service provider.

- Proliferation of non-GDS distribution of hotel inventory

The increased direct sales via hotel-branded websites and focus of online intermediaries on the merchant and opaque models has created a major shift away from utilizing the GDS for hotel bookings. For example, Hotels.com sold 4.243 million hotel room nights in 2001 without using the GDS. In Q2 2002 Expedia reported 2.6 million total hotel room nights, including 2.1 million merchant room nights, which were booked without the use of the GDS. TravelClick reports that room nights booked via the GDS in the first half of 2002 have decreased by 6.9%.

- Consolidation is the name of the game

The consolidation of the travel agency/intermediary market in the U.S., which has been very intensive in the past 24 months, has created a hegemony of several large dominant players (Travelocity, Expedia, etc) and only a few remaining independent travel players worth mentioning (e.g. WorldRes). All major online agencies/intermediaries were either acquired by large offline public companies (Expedia and USA Interactive) or by global GDSs (Amadeus and OneTravel.com). A number of smaller online intermediaries were acquired by larger online agencies (Travelocity and Site 59, etc.). Similar trends could be seen in Europe and Asia.

- Emergence of several "Mega e-Travel Ecosystems"

Several dominant online travel ecosystems emerged as a result of the consolidation activity over the last 24 months:

o USA Interactive: Expedia--Hotels.com--CitySearch--ReserveAmerica--Interval International
o Cendant: Galileo--Cendant Hotels--Trip.com--CheapTickets.com--Highwire.com--Lodging.com
o Sabre--GetThere.com--Travelocity--DirectMeetings--VacationCoach--Site59, plus major users of Sabre (e.g. American Express) and GetThere (2000 corporations; 7 of the 10 top agency groups)

- Joint Ventures to the rescue

Joint ventures among several big travel industry players have become a successful approach by travel suppliers to deal with the increasing threat of online intermediaries. First Orbitz.com, then Hotwire, and most recently TravelWeb, are examples of how travel suppliers can overcome rivalries, pool resources and develop robust online services, which neither of the JV participants can afford on their own. We expect similar initiatives in the future, especially online services that combine the best of breed (e.g. major airline alliance + major car rental + major hotel brand) and JVs of destination-related travel suppliers.

- Making it big on the Internet is very difficult today

The launch of Orbitz, a $100 million joint venture, demonstrates the high cost of entry into the travel space. It is a costly undertaking that requires cooperation with existing industry players. Therefore, new entrants face enormous challenges. With the dot.com boom over and venture capital practically non-existent for B2C travel ventures, new and existing online agencies/intermediaries will not be able to raise sufficient capital to fuel their growth and compete with the mega-agencies like Expedia. We believe that in the next few years, only joint ventures of established travel players have the chance of becoming significant online players. Other successful ventures will be niche players that cater to special interest travel (e.g. spas, snowboarding, white water rafting) and destination-focused portals and players.

6 Conclusion

Semantic Web Services (SWS), the emerging convergence of Web Services with Semantic Web, is the next major generation of the Web (and of the Internet), in which e-services and business communication become more knowledge-based and agent-based. SWS technologies have the potential to dramatically affect the future design of the web and of a very broad range of software solutions, on a somewhat long-term time horizon, say 10-20 years. Along the way, they also have the potential of changing completely the whole business models of some industries. This thesis explores how SWS technologies may revolutionize on particular industry -- travel, i.e., its on-line aspect -- within the short- to medium-term time horizon. We focus on the U.S. on-line travel industry in particular, for which more up-to-date industry data and analysis sources are available.

Our first *new contribution* is an analysis that identifies a likely area of early *industry-wide strategic* impact for SWS technologies: what in the travel industry lingo is called "Dynamic Packaging" (DP). DP means *dynamically* (i.e., in real-time) putting together -- and pricing -- a package of several major travel components, e.g., air flight legs, hotel nights, car rental days, etc., from heterogeneous suppliers and heterogeneous information sources or back-end reservation services, even as *those* provide frequently changing availability or prices. SWS researchers (including in the closely related field of intelligent market agents) have been exploring dynamic packaging by travel agents for the last several years in their research concept prototypes. However, to our knowledge, we are the first to connect this to the current and forecasted trends of the travel industry itself (which is not very SWS-savvy!). We review and discuss the current U.S. retail travel industry, focusing on its strategic aspects. These strategic aspects bear on policy – one of our motivating arenas -- in several ways, most importantly in terms of implications for industry structure and for information-sharing, particularly issues of privacy, other regulation, and potentially anti-trust. A key shortcoming of current-generation business process automation in DP is handling exceptions to business processes. This frequently forces human intervention and thus creates anticipatorily incentives to resort to human interaction even when there are no exceptions. SWS, especially using automated rules cf. the RuleML emerging standard, offers the opportunity for significantly greater automation of exception handling, through exchange of rules that represent pricing, business policies, or regulations.

Our second *new contribution* is to analyze the *strategic* drivers (i.e., promoters) and inhibitors of SWS adoption in DP in the travel industry, that are *particular* to that industry. We find several existing conditions that are drivers, including: goods such as tickets or rentals that are frequently essentially cyber in nature ("digital rights"); a high degree of globalization; deep and broad supply chains with important market-share roles by infomediaries; and leading-edge general-IT adopters in the air sector of the industry. There have been relatively recently large IT investments made (especially in the air sector) with profitable payoffs that have, moreover, changed industry structure significantly -- witness the establishment of B2B Computer Reservations Systems such as Sabre and B2C customer reservation websites such as Orbitz, along with major reductions in smaller human-labor-intensive travel agencies. Existing inhibitors to SWS adoption include: dependence on legacy mainframes even in the airline/hotel/car sector; trailing-edge general-IT adopters in the rail, bus, and maritime sectors; and airline sector recession and instability in wake of Sept. 11.

One of the conclusions of this thesis is that we can tell that overall "the stars are aligned right" for SWS to actually have a major impact on the travel industry, largely through Dynamic

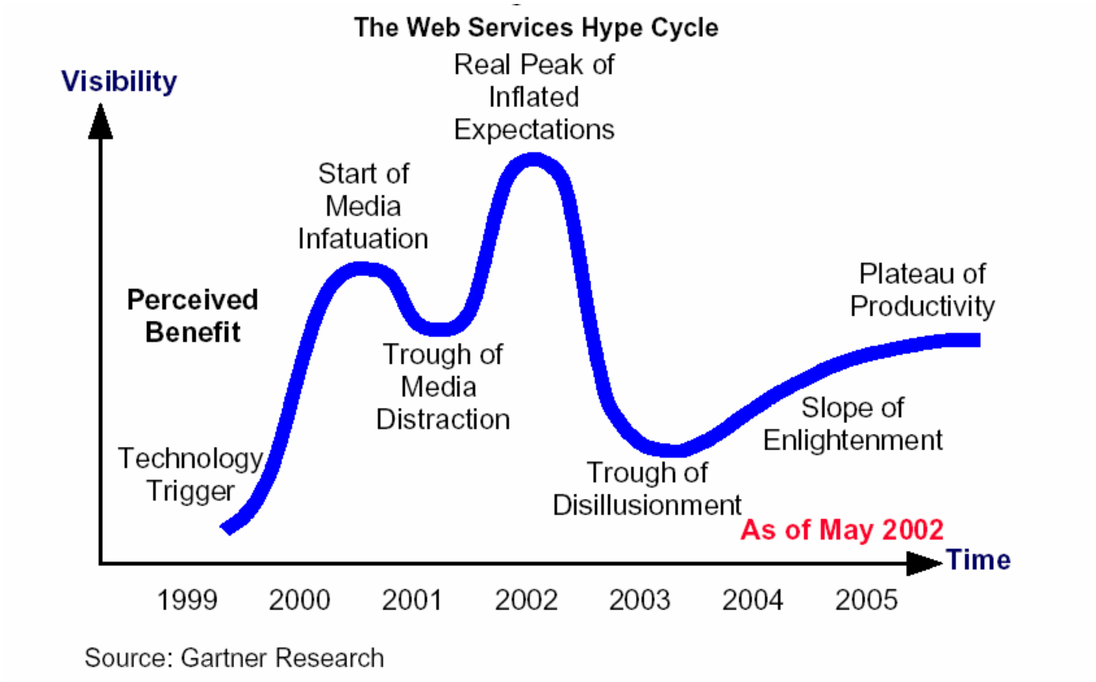
Packaging, within the near- to medium-term time horizon (2-10 years), although technology investment is retarded by post-9/11 revenue volatility.

How close is the Semantic Web?- Despite the catchiness of the term, the Semantic Web is a concept that needs to be interpreted cautiously. It can be misused, like other vague concepts, e.g., “intelligent machines.” There is no question that the Web will become increasingly semantic; this is happening already. But the “semanticization” of the Web will happen in different domains at different rates. For this reason, Forrester for example believes that although lightweight ontologies will proliferate on the Web as enterprises implement taxonomies on intranets and Internet portals, the future is riskier for heavyweight ontologies. Because of the huge effort necessary to create heavy weight ontologies or thesauri, there are very few available outside the life sciences arenas. It is not yet clear how creating such ontologies can be integrated into business models. The first workable heavyweight ontologies will likely be proprietary industry developments (e.g., in the pharmaceutical and aerospace industries) or joint efforts along particular supply chains, such as e-marketplaces and the publishing, healthcare, chemical, pharmaceuticals and Web services industries.

There are many obstacles that might slow down the Semantic Web. One of the biggest problems is that of an ontology proliferation. Even in very similar domains, people would come up with slightly different ontologies: The resulting mapping and matching problems will be almost intractable (the tower of Babel lingo…). Also, enterprises need to take into account that there are different levels of semantics, just as there are different notions of “intelligence.” Deciding on the *appropriate level of semantics* — i.e., how many relationships one is going to describe — is critical. Too little information will not help, while getting caught up into too deep levels of relationships, will just cause the Semantic Web to run up against the classic obstacles encountered in many earlier other artificial intelligence applications: complexity and intractability of maintenance…

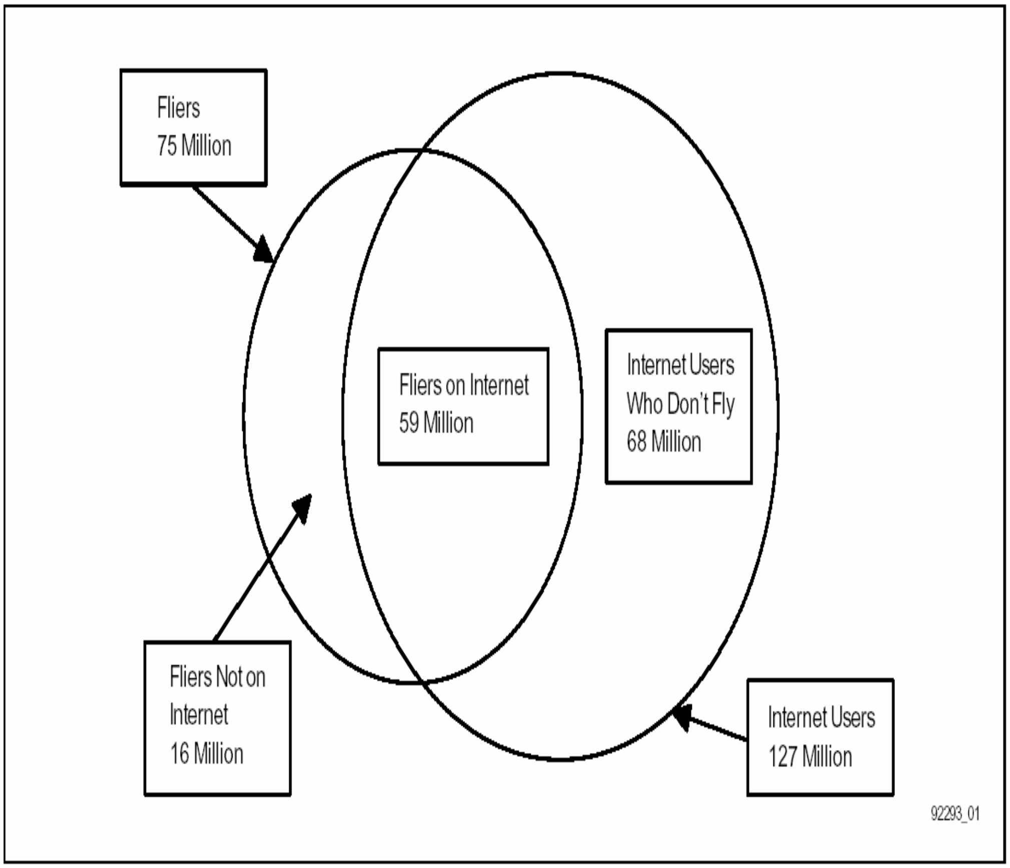
7 Appendix

7.1 The Gartner Web Services Hype Cycle



7.2 Converting Internet users to internet flyers

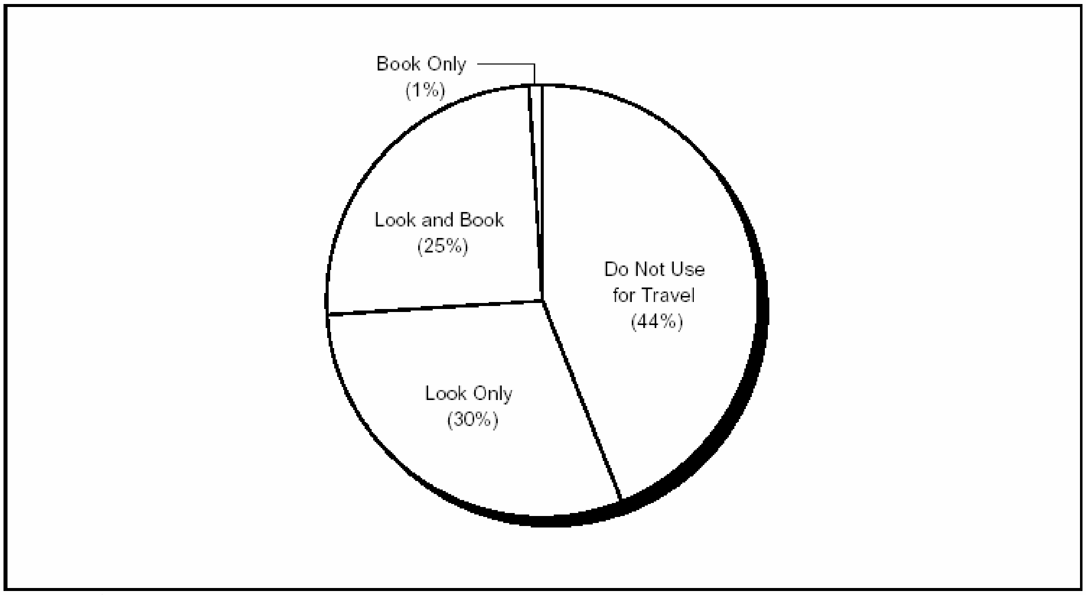
Comparison of Internet Users and Fliers



Base: All adults (198 million)
Source: Gartner (February 2000)

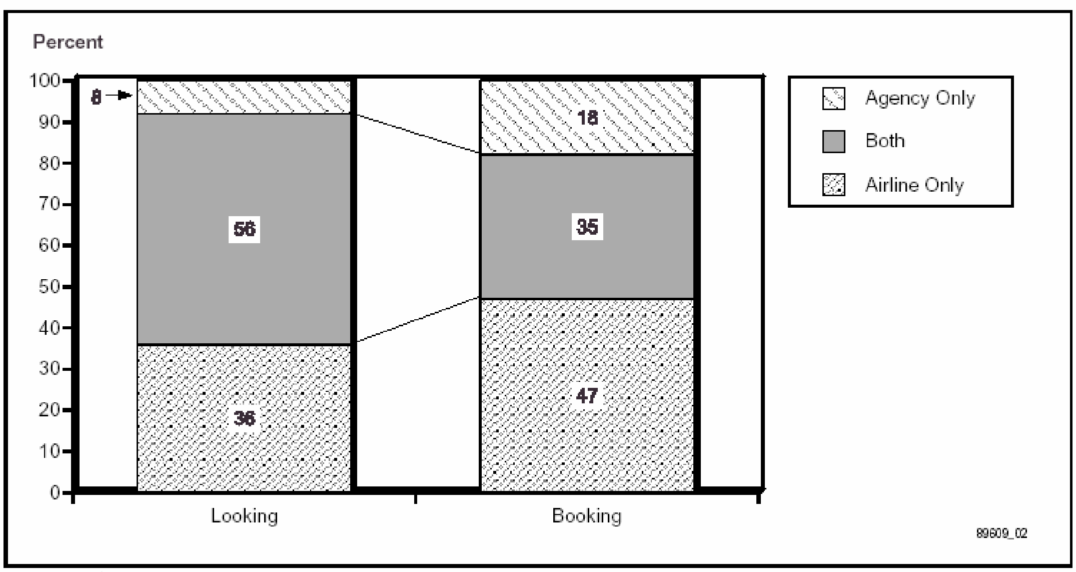
7.3 Online Consumer behavior

Distribution of Eligible Consumers



Source: Gartner (March 2000)
Base: Internet users who have flown in past year (59 million)

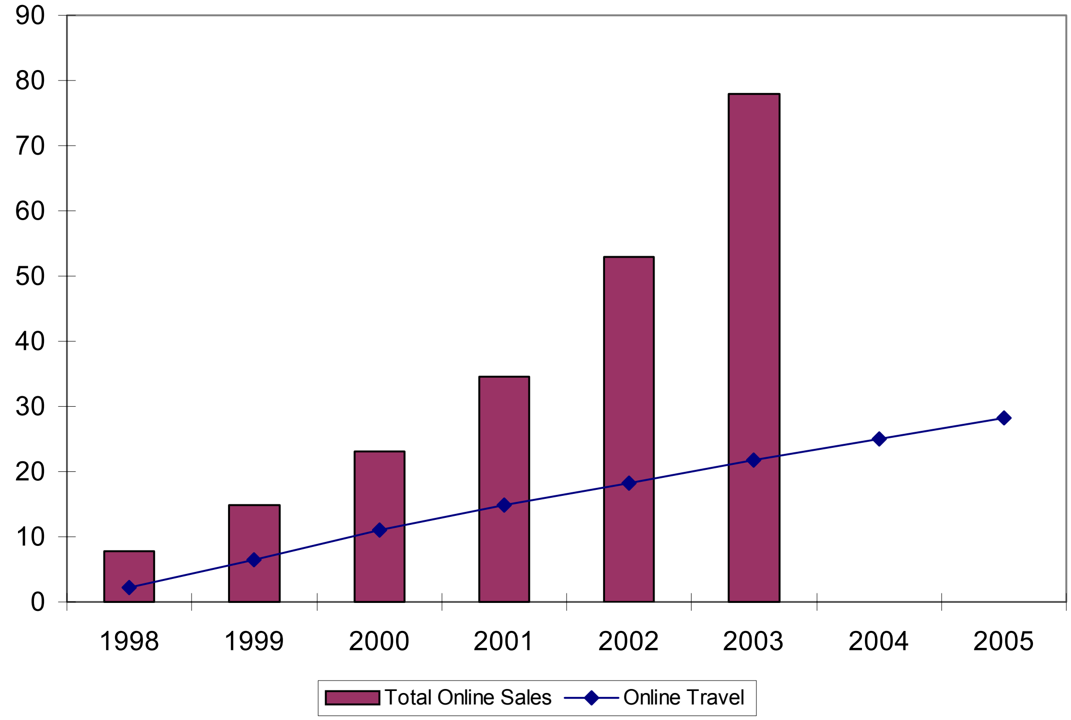
Site Choice Among All Lookers and Bookers



Source: Gartner (March 2000)
Base: Internet users who have flown in past year (59 million)

7.4 *Online travel spending*

This exhibit shows both the growth of online spending in the US and the percentage of total online spending that is attributed to the online travel industry. Travel constitutes roughly 25-30% of all online spending.



Jupiter Strategic Planning, 1999

Gartner research clearly shows that fliers act just like buyers of other products and services in their acclimation and use of the Internet for transactions. Internet users need to gain experience with the Web over time, before they are willing to buy goods and services. Analysis shows that fliers are very similar to other Internet users in terms of this acclimation process. The longer they have been online (based on the year of first Internet use), the more likely they are to buy other types of products or services over the Internet (see Appendix 2). In fact, fliers have slightly higher buying rates compared with all users who have been online an equivalent length of time. More importantly, this pattern of acclimation holds true among fliers for both research (looking) and even more strongly for transactions (booking) for airline travel (see Appendix 8-30.

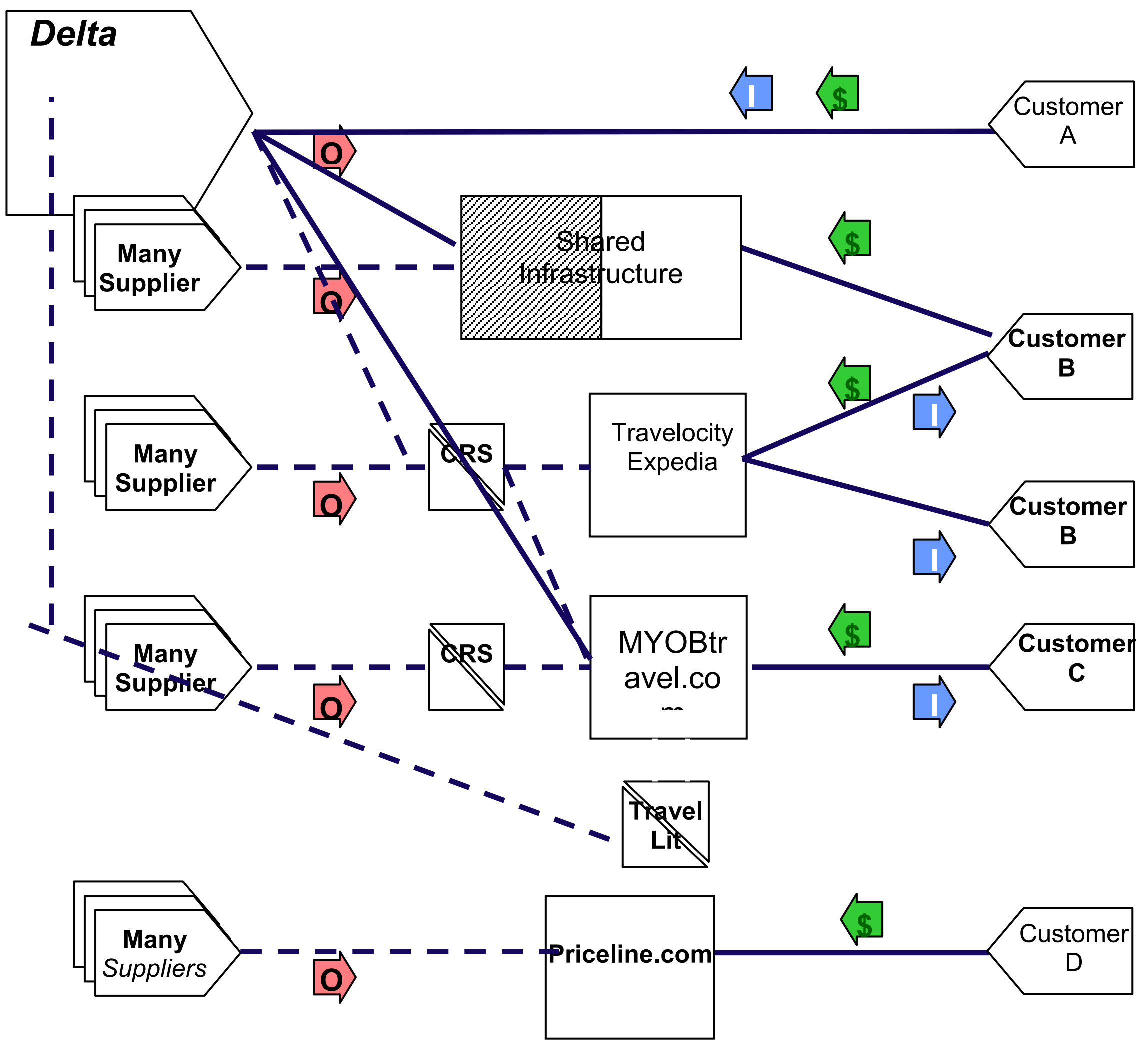
7.5 Customer segmentation

This exhibit shows the four main customer segments in the US Retail Travel industry. They vary in price sensitivity, need for convenience and the extent of their relationship with the firm in question.

Source: Jupiter, Selling Complex Travel, 2000

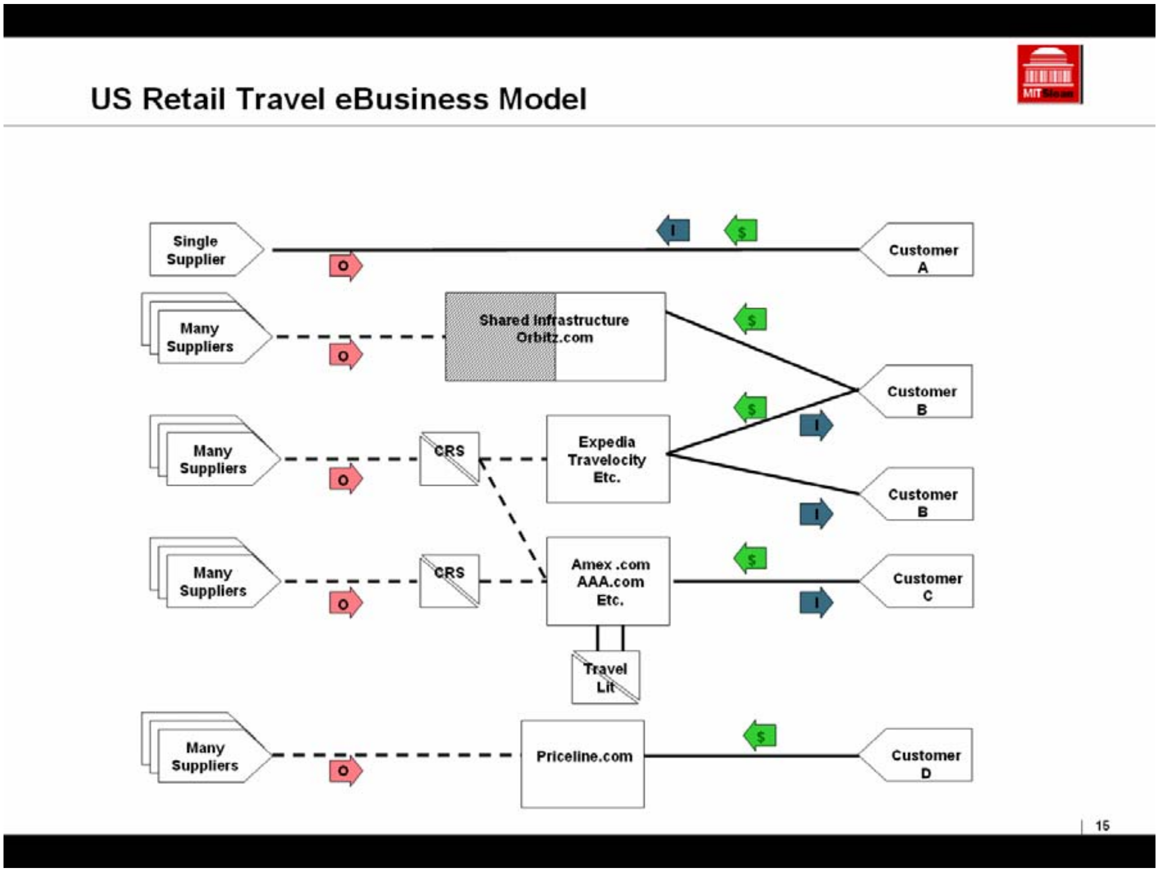
Customer A	Brand and perks “feels more secure” *or* Willing to “shop around” for best price
Customer B	Price sensitive Information access Experience buying online
Customer C	Full service Relationship with agent or firm More complex vacations Unfamiliar destination
Customer D	Extreme price sensitivity Willing to forgo convenience

7.6 Typical American Airlines business model: the example of Delta

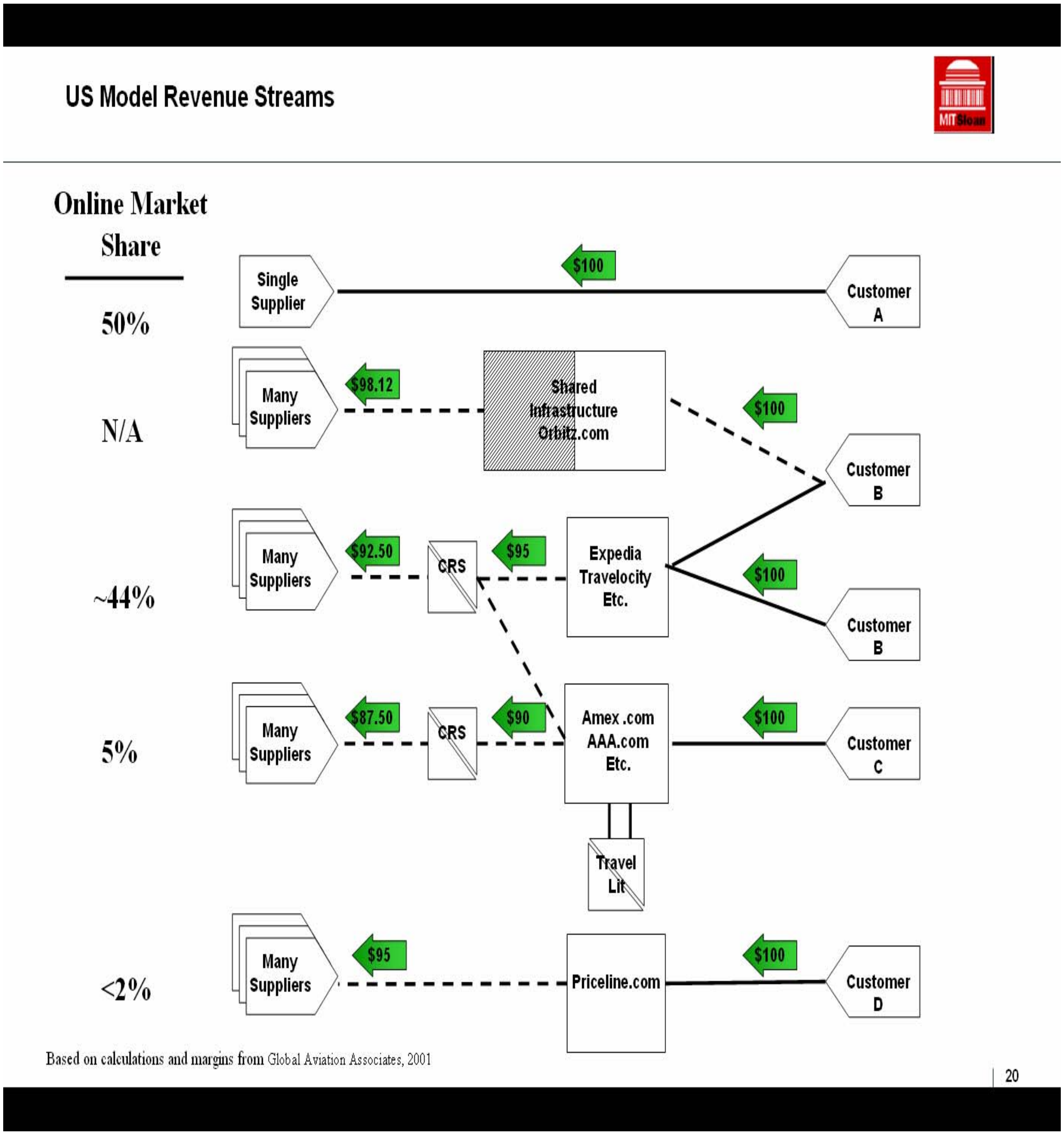


7.7 US Travel industry existing Business models

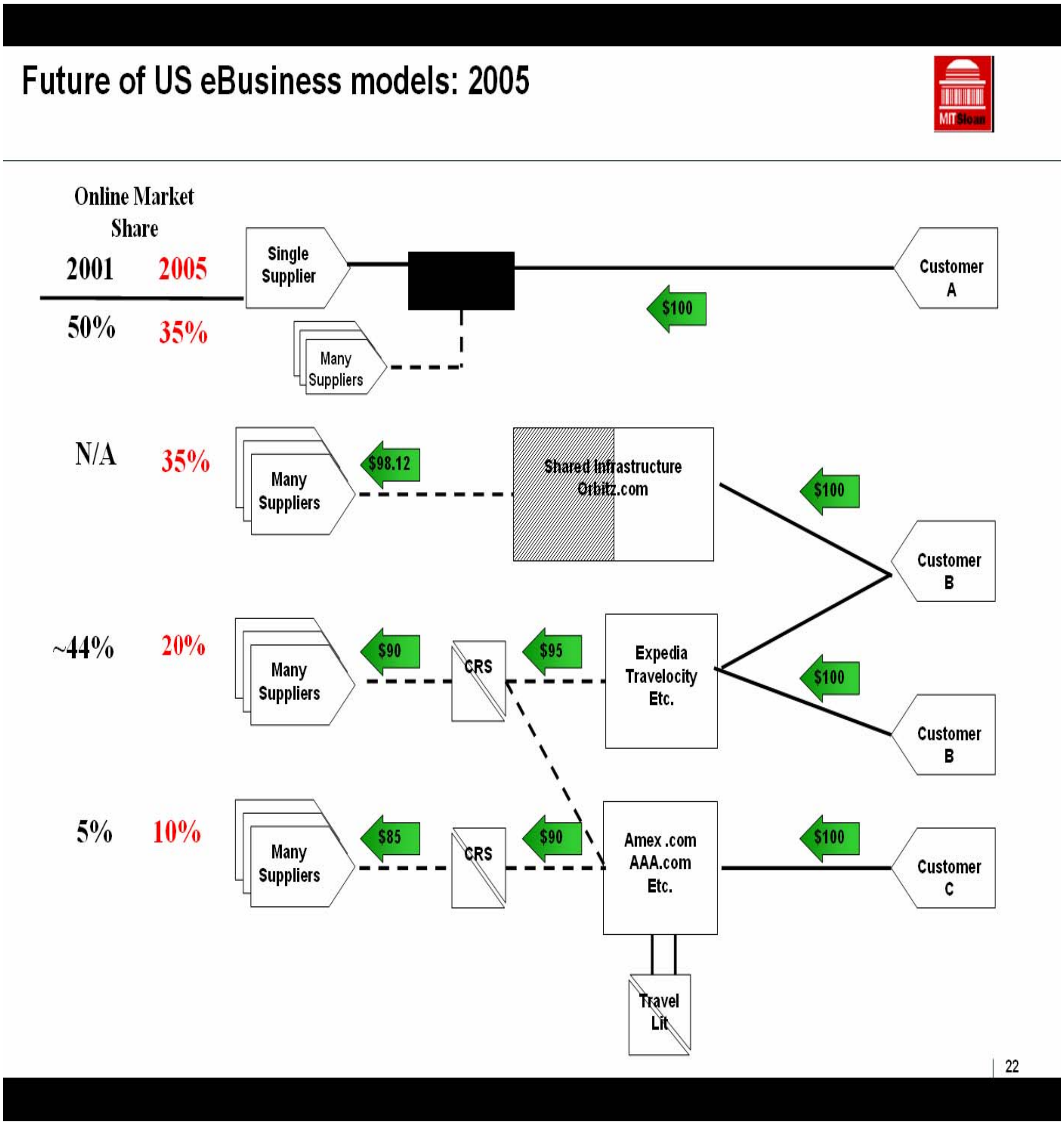
Methodology based on “eBusiness Models” class of Prof Weill



7.8 US Business Models Revenue streams (2001)



7.9 US Business Models Revenue streams in 2005



7.10 The travel agent games in agentcities

Source: http://taga.umbc.edu/taga2/

Travel Agent Game in Agentcities (TAGA) is an agent framework for simulating the global travel market on the Web. It extends and enhances the original TAC system [Wellman 99] to work in an Agentcities environment of FIPA compliant agents.

TAGA is used to demonstrate Agentcities and Semantic Web technologies. TAGA is running on FIPA-compliant platform and Agentcities Environment. Interoperability of different agent development platforms, such as JADE and AAP, is tested in TAGA. WSDL is used to describe the services provided by FIPA compliant web service agent, and that will facilitate the .NET agent to access such services. FIPA Interaction Protocols are supported and tested, and we also suggest new protocols for Web Auctions. Agentcities facilities are used to add scalability and flexibility of TAGA game, e.g. the Web Service agents are found through Agentcities Service directory. RDF, a key Semantic Web component, is used as Message Content Language to enhance agent collaboration.

TAGA is used to simulate a "real" web market. By offering an agent-based framework, TAGA can better simulates the real web travel market for business research. The framework evolves from the client/server mode (TAC) to a distributed standalone agent community. This framework is a flexible and open system. Between the travel agents and the web service agents, more purchase methods are available: directly buy or auction. Between the customers and the travel agents, more contract model are available: pre-assigned model or contract model. Intelligent marketing strategies are needed by not only the travel agent, but also by the customer agent and the web service agent. Auction theory can be also tested and improved in this framework.
Overview: TAGA game simulates a global travel market in the Agentcities environment. A customer from City A want to have a recreational tour in resort R, so he/she needs a round-trip flight ticket and corresponding hotel accommodation when he/she is in resort R. Moreover, the customer will be happy if his/her preferences are satisfied, e.g. living in good hotel, enjoy a concert or go to a famous restaurant. In TAGA, all such service providers can sell their services on the Web and thus form a Web Travel market. Travel agents will help the customer to buy the travel package from the Web travel market.

TAGA Agents
There are six types of agents in TAGA: Customer Agent, Travel Agent, Bulletin Board Agent, Web Service Agent, Auction Service Agent and Central Control Agent. These agents are autonomous and can collaborate in the distributed Agentcities environment.

2.1 Customer Agent (CA)
CA represents the human customers. A customer intends to buy a travel package. A CA can support either one customer or a group of customers. A CA can: (1) maintain user preference, which can be either synthesized or directly collected from the real customers; (2) select a proper TA to delegate the customer to buy preferred travel package in the travel market. Contract is signed to ensure the TA to buy and submit the travel package.

2.2 Bulletin Board Agent (BBA)
BBA is a robot, which facilitates the communication between CAs and TAs. A BBA can: (1) allow TAs to subscribe (normally TAs will subscribe BBA at the beginning of game); (2) accept CA's recruiting request, and then broadcast the attached travel package CFP all subscribed TAs.
2.3 Web Service Agent (WSA)
WSA represents the real world companies, who sells goods on the Web. The goods can be real life services, such as an airline ticket, a hotel room reservation, and an entertainment ticket, or

items, such as artifact, food, and etc. A WSA can: (1) allow other agents to query its own description (e.g. service type, service quality, location) or its inventory (the quantity or price of a certain type of goods); (2) allow the other agent to buy the goods it has; (3) bid intentionally in the auctions to sell its good, e.g. listing its goods in auction and wait for the proper buyer.

2.4 Auction Service Agent (ASA)

ASAs are robots, which provide auction services on the Web. An ASA can: (1) create an auction instance upon receiving CreateAuction request; (2) handle bids upon receiving SubmitBid proposal message and send feedback message back; (3) report auction result to affiliate agents when auction close. ASAs are categorized by the type of auction they supported. Current TAGA has following types of ASAs:

Priceline Auction Service Agent(PASA) -- Priceline auction is buyer initiated, and the buyer wants to minimize his expenditure. Such auction runs in a fixed time frame. In Priceline auction, the buyer will create an auction with his requirements and offer price. If there is a seller who is satisfied with the offer and willing to fulfill the request, then the seller submits a bid to the auction. The Priceline auction closes under either of two condition: closes unsuccessfully if time-out, or closes successfully once the auction received a bid,

Hotwire Auction Service Agent (HASA) -- Hotwire auction is seller initiated. The sellers will post their services with sell price on the HASA. The HASA will create auctions for goods in the same type, e.g. flight tickets from A to B on day D, and then compute an ask price for that auction. The buyer first queries its interested auctions and then place a bid to the auction with its offered price, which must be higher than the ask price.

2.5 Travel Agent (TA)

TA represent the human travel agent, who assembles travel packages for the customers. It can

(1) propose contract to CA according to the customer's travel package CFP; (2) buy goods from the travel market through all possible purchase mechanisms.

2.6 Central Control Agent (CCA):

CCA is a robot, which controls and audits the TAGA game. It can (1) start/stop a TAGA game instance; (2) record the reported market transactions in TAGA, (3) publish the other agents' performance, e.g. TAs total wealthiness ranking, TAs' reputation ranking.

Market Mechanisms

TAGA agents collaborate to achieve market mechanisms. There are two important types of market mechanisms in real world travel market: contract and purchase. A customer first make a contract with a travel agent and let the travel agent to buy him/her a travel package. Secondly, the travel agent, whether get the contract or not, will purchase goods in the travel market to assemble travel packages in the future. Running in the cyberspace, TAGA game does the same thing. Note that an authority, played by CCA, is used to monitor the market transaction, such as ownership change and payment, and a

3.1 Contract Mechamism

A customer will not directly buy his travel package from the web travel market, and he/she will let a TA to do so. A TAGA contract mechanism shows how the CA and TA interact from the CA issues the travel request to the CA receives the feasible travel package. Two options are available: static contract and dynamic contract.

Normally, a contract includes following elements: the identity of the customer and the travel agent, the customer's budget limit, the travel package inventory, how the travel agent get paid, the penalty for failure.

As for the payment of a contract, one possible solution is that the customer give fix-amount of money to travel agent, and the travel agent will take the difference between the payment and real cost as his/her profit. Another solution is that the customer select the agent with lowest proposed budget, and give x% of cost to travel agent for his/her service.

3.1.1 Static contract
This idea is already used in TAC, and the idea is simple: a customer directly send its travel request to its travel agent (i.e. the customer must go to the travel agent), and the travel agent will buy a travel packages for the customer and sent it back. Note that the travel agent knows the customer's utility function and the submitted travel package does not need to be exactly the same as the user's preference. This mechanism needs following sub-interaction protocols:
FIPA Request Interaction Protocol Specification -- customer requests travel agent to buy a travel package according to the customers' travel preferences.
3.1.2 Dynamic contract.
It allows the customer to select a propos travel agent. The customer's utility function is hided in CA side. The travel agents need to compete with each other to win a contract with the customer. The communication need the support from bulletin board. This mechanism is now running as Dynamic Contract Interaction Protocol Specification, and needs following sub-interaction protocols:
FIPA Recruiting Interaction Protocol Specification -- customer let the recruiter to send its message to the travel agents.
FIPA Propose Interaction Protocol Specification -- travel agent proposes its contract to the customer for making a contract
Note that FIPA Subscribe Interaction Protocol Specification is also used to allow travel agents to subscribe at bulletin board -- the recruiter.

3.2 Purchase Mechanism
A travel agent purchases goods from the Web travel market to assemble travel packages. A TAGA purchase mechanism shows how buyer and seller interact to make purchase. Three options are available:

3.2.1 Hotwire Auction
This purchase mechanism is initiated by the seller. The seller list its goods in auction house for sale, and the buyers can buy their wanted goods by send buy bid to the auction house. In such auction, the buyer only knows partial information about the goods, i.e. the type, quality level and date, before it submits the buy bid. And the rest information, such as the seller's identity and the final price, will be discovered when the auction closes. It is possible that no buyer will by the listed goods. This mechanism is now running as Hotwire Auction Interaction Protocol Specification, and needs following sub-interaction protocols:
FIPA Request Interaction Protocol Specification -- the seller requests auction house to list its goods in auction instance
FIPA Query Interaction Protocol Specification -- the buyer queries auction house for interested goods and auction instance
FIPA Propose Interaction Protocol Specification -- the buyer proposes a buy bid to the auction house to buy goods in an auction instance
3.2.2 Priceline Auction
This purchase mechanism is initiated by the buyer. The buyer post its wanted goods in the auction house, and the sellers will check the requirement and offer price and then decide whether or not sell goods to the buyer. A seller can sell its goods by sending a sell bid to the auction house. In such auction, the sell can only specify partial requirement on the goods, such as the final price, the quality level, the type and the date. And the rest information, such as the seller's identity, will be discovered when the auction closes. It is possible that no seller wants to sell goods to the buyer. This mechanism is now running as Priceline Auction Interaction Protocol Specification, and needs following sub-interaction protocols:
FIPA Request Interaction Protocol Specification -- the buyer requests auction house to create an auction instance on its requirement

FIPA Propose Interaction Protocol Specification -- the seller proposes a sell bid to the auction house to sell goods to the buyer
Note that FIPA Subscribe Interaction Protocol Specification is also used to allow sellers to subscribe at the auction house

3.2.3 Direct Buy
This purchase mechanism is initiated by the buyer. The buyer can directly buy goods from the seller. Direct Buy often cost more than auctions, however, the buyer can enjoy the benefit of receiving the goods immediately with a known price. This mechanism is now running as Direct Buy Interaction Protocol Specification, and needs following sub-interaction protocols:
FIPA Query Interaction Protocol Specification -- the buyer queries the seller for interested goods
FIPA Request Interaction Protocol Specification -- the buyer requests the seller to sell the specified goods to it for ask price

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