# Intelligent Systems in Travel and Tourism

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## Abstract

Travel and tourism is the leading application field in the b2c e-commerce, it represents nearly 50% of the total b2c turnover. Already in the past travel applications were at the forefront of Information Technology, i.e., the airline Computerized Reservation Systems in the early 60s. The industry and its product have rather specific features which explain this circumstance: the product is a confidence good, consumer decisions are solely based on information beforehand; and the industry is highly networked, based on world-wide cooperation of very different types of stakeholders. Consequently, this industry depends on advanced IT applications. As such travel and tourism may serve as an example of what happens and will happen in the emerging e-markets, pointing at structural changes as well as challenging application scenarios. The paper provides an overview about the industry, describes ongoing structural changes, outlines domain-specific requirements and discusses achievements and challenges in the field, following an AI and e-commerce point of view. It finishes with considerations regarding a future IT scenario.[1]

## 1 Introduction

Despite unfulfilled business and stock market expectations, in some sectors such as the travel and tourism industry online transactions are rapidly increasing. This industry is the leading application in the b2c arena. The travel and tourism industry is witnessing an acceptance of e-commerce to the extent that the structure of the industry and the way business is conducted, is changing. The Internet is used not only for information gathering; there is an obvious acceptance of ordering services over the Internet. A new type of user is emerging; they become their own travel agents and build their travel packages themselves.

In the year 2002 European online bookings increased by 53 percent, accounting for about 3,5 % of all consumer spending in this domain, whereas in the US this number is about 11 % (according to the Danish Center for Regional and Tourism Research). 64 Mio. Americans researched their travel options online (Travel Industry Association of America); and 32 percent of US travelers have used the Internet to book travel arrangements (see www.nua.com/surveys/). Forecasts state that by 2007 30% of all transactions in the European tourism domain will be done via the Internet, at least in the German speaking countries [Schuster, 1998].

This importance of e-commerce can be explained by the features of the industry, but it highlights also another issue, not less important: e-commerce and especially the Web are not only transaction and business oriented, it is also a medium of curiosity, of creating communities or having just fun, all of which may or may not result into business. Especially the tourism product has to do with emotional experiences; it is not just business [Werthner, 2001].

The paper is organized as follows: the following two sections describe the industry and look at the changing business environment. Section 4 provides an overview on the emerging IT landscape, it discusses domain specific requirements and related application examples, pointing at open research issues.

## 2 The Industry

The travel and tourism industry is a global (and a globalization) industry, with very specific features:

- Travel and tourism represents approx. 11% of the world wide GDP (following the tourism satellite account method of the World Travel & Tourism Council).
- There will be one Billion international arrivals in the year 2010 (following the World Tourism Organization). And tourism grows faster than the other economic sectors.
- It represents a cross-sectoral industry, including many related economic sectors such as culture, sport or agriculture, where over 30 different industrial components have been identified that serve travelers.
- This explains the industry's heterogeneity, and due to its SME structure it has a huge importance for regional development. For example, in the EU there are around 1.3 Mio. hotels and restaurants (9 % of all enterprises). And 95 % of them are very small, i.e., 1-9 employees.

[1] This work is partially funded by the CARITRO foundation and the European FP5 projects Dietorecs and Harmonise.

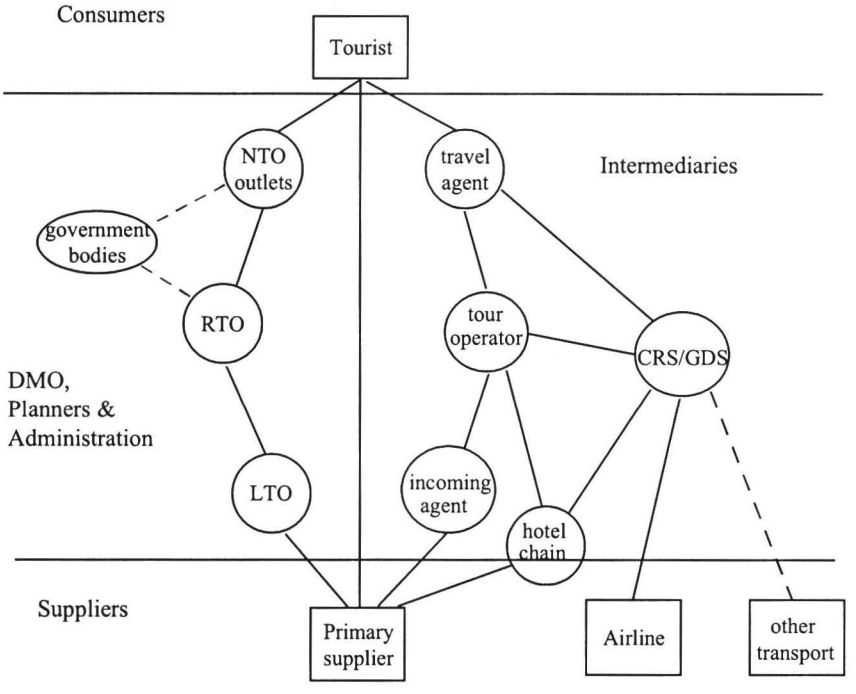


Figure 1: Structural view of the market [Werthner and Klein, 1999]

- The supply and the demand side form a worldwide network, where both production and distribution are based on cooperation.
- The product is perishable, complex and emotional: i) a hotel bed not sold for one night represents a lost income. Suppliers are in a risky situation, which can be reduced if access to information is available; ii) the tourism product is a bundle of basic products, aggregated by some intermediary. To support the rather complex bundling products must have well defined interfaces with respect to consumer needs, prices or also distribution channels; iii) vacations are emotional experience structures that involve cognitive and sensory stimulations as well as affective responses to certain events.

Tourism is an information based business, the product is a "confidence good"; an a priori comprehensive assessment of its qualities is impossible. Tourists have to leave their daily environment for consuming the product. At the moment of decision-making only a model of the product, its description, is available. This characteristic of tourism products entails high information search costs and causes informational market imperfections. Consequently, the industry has comparably long information and value chains.

Figure 1 differentiates between the supply and demand side and the respective intermediaries. Links mark the relationships as well as the flow of information, showing only the most relevant links. Nodes indicate the relevant types of players.

On the supply side we denote with "primary" suppliers enterprises like hotels, restaurants, etc., which are mostly SMEs. One should note that with respect to a functional differentiation these companies are at the same level as the "big" players like airlines. Tour operators can be seen as product aggregators, travel agents act as information brokers, providing final consumers with the relevant information and booking facilities. CRS/GDS (Central Reservation Systems / Global Distribution Systems), stemming from the airline reservation systems already developed in the 60s, include also other products such as packaged holidays, or other means of transport. Whereas the intermediaries on the right side can be seen as the "professional" connection between supply and demand (mainly based on the electronic infrastructure of the CRS/GDS), the left side is relevant for the management, planning and branding of a destination. Normally, these entities have to act on behalf of all suppliers within a destination and are not engaged in the booking process. The links to governmental – as dotted lines – indicate that Destination Marketing Organizations are often governmental organizations.

The upstream flow of Figure 1 consists of product information, whereas the downstream flow reports on market behavior, mostly represented in terms of statistical aggregates. Both information flows create a tourist information network tying together all market participators and, apparently, reflecting the economic relationships between them.

## 3 The New Business Landscape

The Web facilitates new ways to meet changing consumer behavior and to reach new market segments, leading to an "informatization" of the overall tourism value chain. This allows different strategies to generate value [Sweet, 2001]:

- Value extraction: increases efficiency and reduces costs, e.g., automation of processes or outsourcing to clients

such as self check-in of hotel guests or airline passengers.

- Value capturing: client and sales data are used to support the marketing, e.g., data mining for forecast or yield management.
- Value adding: a linear combination of products / services to create richer product bundles, e.g., new service quality for consumers such as linking mobile services to existing Web services to advise tourists during their travel.
- Value creation: the focus is on network effects, e.g., tourists within a destination participate in service definition and planning.

Such strategies allow for the design of new products and services, enlarging the range of options to customize and to configure products. IT and, more importantly, improved organizational procedures lower the price of customization, enabling individualized offerings based on mass-customization. On the other side, configuration points at the bundling of different product or service components to integrated offerings. Core product can be combined with additional service elements in order to create integrated customer solutions.

Given the dynamics of the sector and the emerging already very competitive electronic market, nearly all stakeholders have implemented their Internet strategy. Travel and tourism has also become the playing field for new entrants, either start-ups or companies from the media and IT sector. Since tourism is an information-based business, it fits well with their respective background.

The overall trend points towards a further specialization and an ongoing deconstruction of the value chain paralleled by an integration of players and products. Companies will compete and cooperate at the same time, boundaries within the industry are blurring. All types of market players are affected:

- Tourists will be addressed by more players, and as they accept the Web as a booking channel, they will also play a more active role in specifying their services.
- Travel agents will see a diminishing power in the sales channel, as a consequence they will put more emphasis on consulting and complex products.
- Internet travel sites, as platforms with bundling of offerings will enhance by providing new market functionality and technology. This will lead to easier accessible price comparisons and market overviews, enabled by personalized intelligent tools for travelers.
- Destination management organizations will develop cooperation models within destinations and they will occupy a new role as consolidator and aggregator.
- Tour operator will blur the boundaries between individual and packaged tour, based on mass-customization and flexible configurations.
- CRS / GDS show an "INTEL inside" marketing strategy for major tourist Web sites to increase their transaction volume, and they also move into direct sales for the retail segment
- Suppliers will support electronic direct sales, increasing again price competition as well as price differentiation, and they will redefine customer processes (electronic ticketing, automated check-in, etc.).

This development leads to an evolution of the market best described as an ongoing interaction of concentration (e.g., as in the US with the major travel sites like Expedia, Orbitz or Travelocity) versus the simultaneous entering of new players. The related increased complexity, however, generates the need for new services such as providing transparent access or price comparisons. This enforces the design and deployment of more specialized services. Such a process will quite naturally create new business opportunities, accelerating competition and putting even more emphasis on technical innovation.

## 4 The IT Scenario

The described business scenario is based on flexible network configurations and the further integration of consumers into internal business processes. Adding the tourist life cycle – taking into consideration the mobility aspect of travelers – one can draw the following simplified figure of linking tourists' life cycles with companies' business processes.

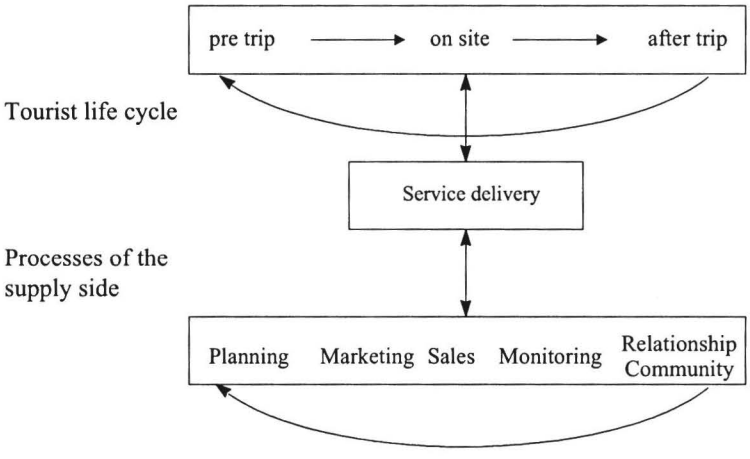


Figure 2: Tourist life cycle and companies' processes – both suppliers and intermediaries

Obviously, processes cross company borders, leading to distributed b2b2c applications, requiring cooperation between companies, and supporting also mobile communication with the consumer. Such a future business scenario is based on the assumption that technology – based on a common pervasive infrastructure – will become transparent, invisible for the consumer; information will be available at home, the work place and during travel. Given such a "holistic" approach interleaving business and technology perspectives, what are specific requirements when looking at the user – machine interaction? What is the intelligence needed to support collaboration among companies within a networked industry? These questions lead to interesting considerations regarding system architectures.

## 4.1 User Requirements

One could look at the human-computer interaction as a variant of the famous Turing test: as a competition between a human and an intelligent travel system.[2] Even if one thinks of it as an engineering task, and not as a cognitive science test, it poses hard questions: i) a simple problem like inquiring a flight from location A to B, with specific price and time constraints, complemented by a specific hotel, with similar constraints. In this case linking to a predefined database or to one of the CRS/GDS would be sufficient, if one ignores interoperability issues. This type of planning problem is already partially solved by existing online systems such as Expedia or Orbitz. But the need for more intelligent heuristics is obvious, when one thinks of the enormous number of scheduled flights and constraints such as different rates or different booking conditions within airline alliances, etc. ii) a complex problem which involves background knowledge of a specific traveler, e.g., the problem of traveling to Milan only when Milan plays. This needs the modeling of knowledge about the Italian city of Milan, the inference that in this case Milan refers to AC MILAN (a soccer club), the timing regarding soccer tournaments (normally at weekends). And other background knowledge might be needed such as specific weather conditions or cultural activities. In fact, the "leisure" domain might cover nearly all domains of daily life. And the information, stored in different bases with no common format and even unknown locations, needs to be extracted. Here wrapping techniques, learning accurate extraction rules and also adapting to structural changes in sites, are needed [Knoblock *et al.*, 2000; Kushmerick, 2000]. Other non-trivial tasks within this context are

- conversation with its semantic and pragmatic aspects,
- identification of problem domains,
- search and information retrieval with the related evaluation,
- negotiation including additional and even unsolicited offers, both having cooperative and opportunistic behavior.

However, these problem types assume that users are able to express their needs, which is normally not the case. Systems have to "become active" and to provide advice, adapting to different travel decision processes as well as navigation styles [Moutinho, 1987; Ankomah *et al.*, 1996]. For example, Grabler and Zins [2002] have identified, based on a study on 200 human – human and human – machine counseling sessions, 6 different traveler groups such as highly pre-defined, recommendation oriented or geography oriented ones. These groups differ in the order in which information is searched, the type of information needed, the level of support required and the level of personal flexibility and knowledge. Two groups of factors are identified: personal, i.e., socioeconomic and psychological/cognitive factors (experience, personality, involvement), and travel features, i.e., travel purpose, travel party size, the length of travel or the distance to the destination.

An application example of such an approach is Trip@dvice [Ricci and Werthner, 2002]. Based on Case Based Reasoning (CBR), it adapts its dialogue as it learns more about the user, supports product aggregation for a given travel, provides personalized recommendations based on previous system experience, and it applies query refinement methods helping to adjust queries according to the data available in a given product catalogues. Thus, it integrates topical information and "good" examples of product bundling contained in previous travels built by a community of users.

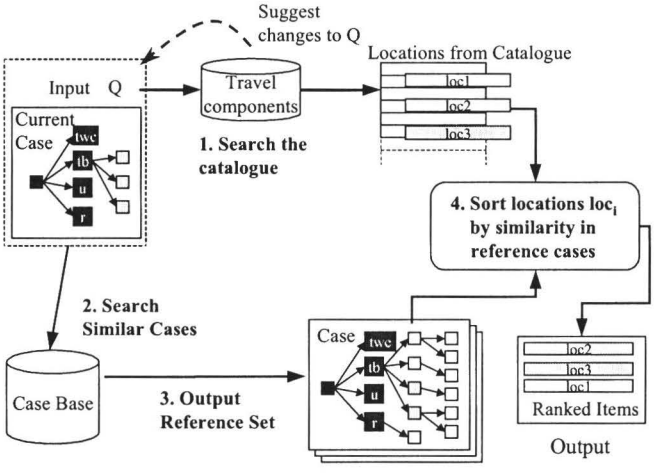


Figure 3: Sequence of interaction in Trip@dvice

Dietorecs, another example, extends this approach by integrating the iterative presentation and evaluation of alternative proposals [Fesenmaier *et al.*, 2003]. It assumes that by presenting specific images, which implicitly represent the most discriminating offers within a given product catalogue, the evaluation of the user provides indications about his/her references. At the beginning the systems performs a cluster analysis of the offers within a given catalogue. The user's choice is the starting point of an iterative process of refocused clustering and presentation. At

[2] These ideas are based on discussions with W. Grossmann, University of Vienna, O. Stock, ITC-irst, A. Tjoa, TU Vienna, and W. Wahlster, DFKI.

the end, either the user directly takes the chosen product, or the obtained criteria serve as input for a CBR process.

These examples show, that different decisions styles as well as the seamless switching between them have to be supported. But the choice on tourism products is not rational; these products are complex experience structures that involve cognitive and sensory stimulations. Due to the multi-sensory nature of tourism products, textual ways of describing vacations are very limited to convey a complete picture that can be used to formulate product expectations serving as a basis for decision.

A possible approach is to look at product trails – these are sources of information for the formation of brand beliefs since they involve an experience of the product through multiple senses – describing leisure experiences and to draw conclusions on how to present tourism information and how to guide a user in a non rational navigation process. Gretzel and Fesenmaier [2003] looked at 3000 randomly selected persons who were asked to imagine a trip and to report the colors dominating their mental image, the scents they would like to smell, and the sounds they expect to hear. They identified a number of such sensory categories, which were clustered to experiences representing coherent bundles such as Autumn or Scenic / Nature. These findings indicate that sensory domains and associations thereof exist and that these follow specific patterns. Such bundles can be used to describe coherent experiences sought after by certain groups of travelers. These results can provide substantial input for interface design and user guidance.

Finally, travelers need access to information whenever and wherever they want, making tourism a perfect application field for mobile computing. Latest generations of mobile devices and wireless networks offer new opportunities, but mobile devices still suffer from restrictions compared to web based systems. Moreover, the mobile context imposes a very different interaction style and decision model. But, on the other side, mobile applications could take advantage when linked to existing web sites and refer to already existing personal profiles and selected travel products. The mobile Intelligent Travel Recommender (mITR) supports travelers to complement their product while traveling [Ricci *et al.*, 2002]. The objective of mITR is to improve iteratively the "fitness" of recommended products. But instead of asking the user for explicit input, mITR exploits the knowledge contained in the pre-travel plan to guess an initial set of candidate products. The user can provide critics to some of these products, such as "I like this feature of this product" or "I want something less expensive", which is used for further interaction.

## 4.2 System Features – Intelligent Networking

System designed to support such applications should

- allow users to access information whenever and wherever they want,
- guide the user in the decision and traveling process, and
- allow the user to create product bundles.

Business services for the traveler may use Web services to be more easily integrated and bundled into new, ad-hoc products. Web services provide an open, flexible, modular, layered architecture that can integrate multiple communication models. But these services do only facilitate the "manual" combination of components across different platforms. The vision is that this should be available (semi-) automatically, for example, allowing a customer to plan a trip in the city of Vienna visiting restaurants with at least 15 gourmet points and some classical concerts. Another enabling technology might be Peer-to-Peer (P2P) services to directly exploit resources present at other nodes without intervention of any central server, where nodes may join and be integrated in an ad- hoc manner. Such services need to be described for the respective peer device and discovered in an ad-hoc manner in a decentralized scheme, without a centralized registry as this may be unavailable in a mobile environment; to be composed ad-hoc and to interact not only with servers, but also with other peers; and to be connectable to legacy systems.

However, when taking the supply side's point of view, the requirements become even more complicated: For instance, a middleman might search for 100 individual web services hosted by several individual, privately-owned hotels and with golf courses nearby in the Tyrol within a diameter of 100kms in order to bundle them with flights into tourist packages. In this case functions are needed to

- enable middlemen to create sets of bundled products,
- ease the participation of SMEs to larger networks, and
- facilitate networking leading to virtual organizations.

In this context networked business operations could be defined as P2P enabled semantic Web services that integrate business networks allowing for an n:m organization and communication between participating enterprises. This transfers the level from composing individual instances of services to composing sets of services; and from ad-hoc integration between two participants to an arbitrary number of cooperating enterprises. The orchestration of a large set of web services requires possibilities for business planning with more refined means. Techniques of constraint reasoning, multi-value optimization and relaxation might be used to aggregate web services at the set level and to achieve specific business goals, e.g., profit optimization or the equal distribution of income within a destination.

However, such a scenario is based on a non-existing assumption: there exists no agreed electronic standard to describe tourism services. Those existing such as the OTA (Open Travel Alliance) specifications are just adopted by few players. Given that the number of available tourism relevant information sites is huge, e.g., out of the 1.3 Mio European enterprises in this sector nearly 40% have already their Web site, it can be foreseen that also future standardization initiatives will fail.

One approach to this problem is the European project Harmonise, creating an ontology based mediation and harmonization tool [Dell'Erba *et al.*, 2002]. The project puts emphasis on the combination of a social consensus process with the application of new technologies. The goal is to allow participating tourism organizations to keep their proprietary data format while cooperating with each other.

Specific tourism mediators are dedicated to the "translation" needs between these data sources. Such a mediator looks at information from a higher conceptual semantic level using this level of abstraction for the mapping purpose.

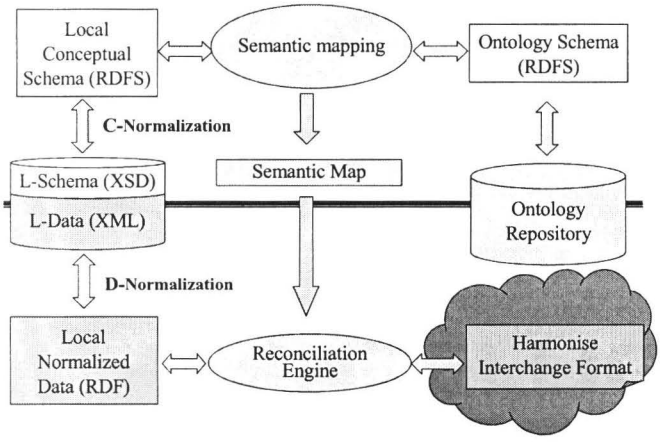


Figure 4: The Harmonise process

The data model of a source document, assuming XML, is first lifted to a local conceptual schema (C-Normalization) and then semantically mapped to the terminology specified by the shared ontology, which is built by domain experts. The output of the mapping process is a set of reconciliation rules, which are used in order to transform the local data and to code them according to the ontology content. Harmonise is based on RDF(S) as "language" for representing local conceptual schemata as well as the mediating ontology. But Harmonise has several limitations: i) it does not solve the problem of ontology versioning, which is severe in a domain with constantly new products; ii) and Harmonise, though mapping between different conceptual models, does not support ontology reasoning, or even more advanced concepts such as approximate reasoning, needed in a domain which is based not only on true axioms or facts.

## 5 Conclusions

The tourism business is changing. More specialized services, flexible network configurations and further consumer integration into internal business processes will lead to smart market places, integrating all stakeholders. The underlying IT scenario, enabling as well as enforcing this development, shows that tourism is an interesting field of application. But it also demonstrates that this industry poses hard challenges, which offer interesting research opportunities. This has also been acknowledged by the European Union, placing tourism as one of the preferred application fields of the European IT research.

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