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Dynamic Travel Itinerary Management: The Ubiquitous Travel Agent

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Abstract

Independent travellers generally have only a rough idea of where they want to travel, how long they intend to spend in each destination and which attractions they intend to visit before they depart.

A dynamic itinerary management system that is able to dynamically modify the traveller's itinerary in response to events that occur during the trip such as the traveller changing location, availability of new last-minute specials, work opportunities and safety issues could provide added value while retaining flexibility.

This paper describes an architecture for such a system based on distributed co-operating software agents and mobile data technologies.

Keywords

Travel industry, software architecture, inter-organisational systems, communication systems, global IS, applications software, intelligent agents, mobile computing, ubiquitous computing

INTRODUCTION

Independent travellers generally have only a rough idea of where they want to travel, how long they intend to spend in each destination and which attractions and activities they intend to choose at each destination before they depart. A confirmed, inflexible itinerary therefore does not suit the way they like to travel. A system that allows maximum flexibility while still providing services that are perceived by the independent traveller to be of some value could allow Retail Travel Agents to penetrate this very difficult market. The level of demand for these services is uncertain at this stage due to the current immaturity of the technology.

A dynamic itinerary management system that is able to dynamically modify the traveller's itinerary in response to events that occur during the trip such as the traveller changing location, changes in exchange rates, availability of new last-minute specials, work opportunities and safety issues could provide the necessary added value while retaining maximum flexibility.

The focus of this research is the design of an architecture for such a system based on distributed co-operating software agents and mobile data technologies.

Of course, matching of product and destination characteristics to traveller preferences is still a key requirement (O'Brien, 1999b). Adding the ability to determine the current location of the traveller during the trip will allow dynamic changes to the itinerary and delivery of services that are personalised on the basis of recorded traveller preferences, location, context and events that are occurring.

Angehrn's (1997) proposed a model (ICDT) for analysing the impact of electronic commerce and information technology on an industry. The ICDT model has been applied to the travel industry to identify the potential new virtual services.

FOCUS OF THIS RESEARCH

The focus of this research is the development of a ubiquitous, dynamic, context aware virtual service delivery architecture for highly mobile people. Highly mobile people would include tourists, business travellers, sporting teams, travelling sales staff and emergency services. As a proof of concept a prototype ubiquitous travel itinerary manager is being built that will test the performance of the design in Angehrn's (1999) virtual Information, Communication, Distribution and Transaction spaces in the travel industry.

One key design requirement is that physical travel consultants will also be able to use the system to interact with their customers and assist them to make better choices during their trips, thereby adding value where they could not previously.

CURRENT TRENDS IN THE TRAVEL INDUSTRY

There is a worldwide trend towards independent travel and away from packages, particularly with European, Canadian & American travellers (Queensland Tourist & Travel Corporation, 1997; Poon, 1993). These “new tourists” seek maximum flexibility, minimal pre-arrangement, cultural experiences, independence, adventure and exotic destinations (Poon, 1993).

The industry is facing increased competition through globalisation and de-regulation, changing customer demands for more specialised trips, increasing customer expectations, particularly in relation to customisation and increasing knowledge and sophistication of customers. (Bloch & Segev, 1996; Sheldon, 1997).

O'Brien (1999b) recently found that

- Direct booking via the Internet is not very important except for simple point to point bookings
- For more complex trips travellers still tend to do research on the Internet, then book through a retail travel agent
- Travellers are becoming more sophisticated and knowledgeable and are looking for more exotic, specialised holidays
- Travellers are requiring increasing package personalisation and flexibility
- Fee for service is becoming acceptable provided the agent is able to find good deals. In Australia, WebJet (WebJet, 2001) is already offering bookings at cost plus a fee that varies from 2% to 10% depending on the level of service required
- Travellers want agents who work for them rather than agents for the principals/airlines/wholesalers/operators (O'Brien, 1998)

CURRENT INFORMATION TECHNOLOGY TRENDS

The trend for increasing processing power at the same or reducing cost is expected to continue for the foreseeable future. At the same time data communication costs, particularly mobile data communications costs, are expected to reduce, making high speed access to the Internet more affordable for more people, both at work, at home and more importantly, while travelling away from home and/or work. There have been dramatic advances recently in mobile data technologies that allow services to be delivered, on demand, to a mobile device such as a mobile phone or palm computer. WAP (Wap Forum, 2001) or I-Mode (NTTDocomo, 2001) based services are now available in Europe, the United States, Japan, Australia, most Asian countries, many South American countries and some African countries. These services have exploded onto the market over the last two years with varying success. Adoption in Europe, Japan and South-East Asia has been rapid with a very large number of subscribers to the NTT Docomo I-Mode service in Japan (Fitzpatrick, 2000). The potential of mobile data services has been demonstrated by the very successful I-mode service in Japan and WAP services in Northern Europe (Schaumann, 2000).

This success has been achieved despite the fact that these services are primarily delivered via mobile phones with very limited functionality, power and display capabilities. As the price of more sophisticated mobile communications devices and wearable computers reduces through initiatives such as Symbian (Tivoli Systems Inc, 2001) and Bluetooth (Bluetooth SIG, 2001), travellers will have access to cost-effective devices and communications services for mobile Internet access wherever they are located.

THE MOBILE VIRTUAL TRAVEL SPACE

Mobile technologies and the Internet have introduced new, virtual market spaces in addition to the traditional physical market spaces. Angehrn (1997) introduced a generic framework, the ICDT model to classify and illustrate significant business opportunities and threats generated by the Internet. Several opportunities and threats exist in each of the four virtual market spaces in the travel industry (See Table 1).

iJet Travel Intelligence (iJet, 2001) has recently developed a commercial system that provides many of these services via desktop systems, fax and email. They have also announced that they will be extending the system to mobile devices in the near future.

Information Space	Transaction Space
Alerts - currency, safety, specials Destinational information delivered in real time Accommodation information Transport information Attraction information Semantically encoded experience information from the Travel Agent & other travellers	Reservations for local accommodation, restaurants etc Ticket sales for local attractions Tickets for local transport On-line banking Currency exchange
Distribution Space	Communication Space
Maps and guides for the current location delivered on arrival or slightly before	Customer feedback to the travel agent Assistance from the travel agent during the trip Message service for relatives & friends

Table 1: Virtual Travel Services

ENHANCING RETAIL TRAVEL AGENT PERFORMANCE

O'Brien (1999b) recommended five key strategic responses that retail travel agents could take to enhance their performance in the age of ecommerce:

- reduce dependence on transactions for income;
- re-position as a consultant working for the customer;
- develop close relationships with customers to gain a clear understanding of their preferences and desired holiday experience;
- implement systems that provide fast, easy access to reliable product, destinational and personal experience information;
- implement systems that enable cost-effective production of personalised packages that are tailored to customer preferences.

The provision of these services via a dynamic itinerary management service delivered to travellers via a portable communications device will allow travel agents to add value to independent travellers in a way that was not previously possible.

Travel Information Broking

Although the Internet provides direct contact between suppliers and consumers, it is causing a growing problem of consumer information overload. To address this problem, new intermediaries are emerging to help the consumer integrate and analyse information (Bloch & Segev, 1996; Lamp & Keen, 1997). Travel agents are well placed to undertake this role by extending their existing real world role into the virtual market space using sophisticated intelligent software agents. Retail travel agents can provide value to the independent traveller by becoming proficient at working with these agents to continuously access, integrate, analyse and interpret information from distributed, heterogeneous sources and presenting it to the traveller with a recommendation of the best option. Des Paroz of Southern Cross Galileo supported this view, saying that, "the Internet is "an enormous repository of information" which could be used for background research and passed on to customers, adding value to travel agent's services (Paroz, 1997).

Mobile data technologies allow this to be done *continuously during* the trip rather than *once before* the trip. Depending on the mobile device the user is currently using and the communications infrastructure available, this may be text, graphics, voice, video or a combination.

Travel Consulting

As the transaction space is the space where information technology is having the most significant disintermediation effect (Angehrn, 1997), travel agents need to reduce their dependence on income from simple transactions prior to departure. Providing access to travel transaction services during the trip may enhance the viability of this role in the short term but in the long term their consulting role must move to provision of personalised consulting advice focussed on the needs of the customer (Sheldon, 1997), delivered to them anywhere in any format (Mobilocity, 2001).

Baker et al (1996) recognised that “there is clearly a need for an intelligent system that incorporates local knowledge, regularly updated, and interpretation of the customers’ needs, into the mapping process.... intelligent agents, either obeying rules when they exist, or observing and recording in order to learn or infer the correspondence, seemed ideally suited.”

Personalised Package Development

The changing preference of customers for more individual, personalised holidays requires the travel agent to be able to integrate sub-products from different suppliers into a personalised package targeted to customers’ needs and preferences. Some work has been done on the development of prototype intelligent agents that assist in the selection of suitable holiday packages (IMTAS/CaBaTa) (Lenz, 1996) however little work has been done on the development of intelligent agents that assist in the selection and assembly of components into personalised holiday packages. This research focuses on the design requirements of a ubiquitous, *dynamic*, intelligent itinerary manager that can dynamically alter the traveller’s itinerary, re-configure his/her package and provide advice in response to internal and external events that occur during his/her trip.

MOBILE DATA APPLICATIONS IN TRAVEL

Mobile data technologies and the Internet are presenting significant opportunities for travel agents to improve their performance by re-positioning themselves to roles that increase the value they add.

Real opportunities exist for the virtual travel agent to become a network information broker (Lamp & Keen, 1997) by finding, assessing and quality controlling information obtained from the Internet and other electronic and physical sources and conveying it, together with appropriate advice, to the customer in a clearly understandable form.

Having direct contact with the customer during the trip also presents the travel agent with additional opportunities to broker services such as accommodation, restaurant and transport reservations during the trip for a fee or commission.

The literature and the exploratory interviews with recent independent travellers indicate that travel agents can increase the value they add by re-positioning themselves to become *consultants, information brokers and developers of personalised products*. Mobile data technologies allow these services to be extended by providing a ubiquitous, virtual travel agent that is aware of the traveller’s preferences, current location and other critical contextual information. Through this virtual persona, travel agents can deliver information that is dynamically filtered and can recommend itinerary changes dynamically as the traveller’s current location or context changes. When significant external events occur, such as unexpected conflicts and natural disasters the traveller can be immediately notified of recommended changes to her itinerary.

THE RESEARCH APPROACH

Exploratory interviews have been carried out with a small number of recent independent travellers to:

- determine the travel services they currently require and their level of importance
- rate the value and importance of a range of new virtual services that could be delivered through a handheld, location-aware device
- suggest any other virtual services that they believe would be valuable to them

Table 2 describes the services that the interviewees regarded as high value if delivered via a mobile service.

Traveller Service	Angehrn Quadrant	Value of Mobile Virtual Service	Description of Required New Mobile Service
Currency conversion	I,T,C	H	<ul style="list-style-type: none"> • Location aware currency conversion information and transaction services; • Alerts regarding expected major exchange rate fluctuations
City Map	D,C	H	<ul style="list-style-type: none"> • Location aware dynamic city map that highlights attractions and sites of interest to the traveller; • Alerts regarding proximity to dangerous areas
Weather, ski, surf info	I,C	H	<ul style="list-style-type: none"> • Location aware weather, snow, surf etc information;

			<ul style="list-style-type: none"> Alerts regarding weather, surf, snow etc; Alerts regarding special deals for relevant activities
Travel guide	D	H	Location aware travelogue
Language assistance	I	H	<ul style="list-style-type: none"> Language translation; Common phrases & pronunciation; Text to speech service for common phrases
Contact with similar travellers	C	H	<ul style="list-style-type: none"> Chat & email services with travellers going to & from your planned destinations; Alerts when travellers with similar interests are in the vicinity
Transport Timetables/Fares	I,C,T	H	<ul style="list-style-type: none"> Airline, bus, train & ferry timetables & fares Alerts regarding temporary changes, delays, specials Travel reservations & ticket purchasing
Event information	I,C,T	H	<ul style="list-style-type: none"> Future planned sporting, cultural, social events Alerts regarding new events, changes, specials
Travelogues (inside attractions)	D	H	<ul style="list-style-type: none"> Location aware voice, text & video descriptions of items of interest close to the traveller; Alerts regarding commencement of shows, presentations while visiting
Available jobs	I,C,D	H	<ul style="list-style-type: none"> Information regarding available temporary & casual work; Location aware alerts regarding immediately available short-term work
Safety alerts	I,C	H	<ul style="list-style-type: none"> Pre-departure information regarding political instability, crime, natural hazards; Alerts regarding changes in safety status of current location & planned destinations
Health information	I,C	H	<ul style="list-style-type: none"> Pre-departure information regarding health hazards; Alerts regarding changes in health hazards at current location & planned destinations

Table 2: High Value Mobile Services

One high value service type from each of Angehrn’s quadrants was then chosen for in-depth analysis. The services chosen were Health and Safety Alerts (Information Space), Transport Timetables/Fares/Reservations (Transactions Space), Traveller Contact System (Communication Space) and Available Jobs (Distribution Space). An appropriate architecture for delivery of these services to mobile devices carried by travellers was then designed. A prototype is being currently being developed as a proof of concept.

THE UBIQUITOUS TRAVEL AGENT

The ubiquitous travel agent must be able to deliver all of the traditional services as well as services that can dynamically react to events that occur during the traveller’s trip that change either the traveller’s state and/or context.

States

The state of a thing (or entity) can be defined as the set of current values of all the properties of the thing. When we represent a thing in an information system we choose the subset of properties of the thing that are relevant to the focus of the system and represent those properties using agreed attributes. The state of the representation of the thing would therefore be the current set of values of the relevant attributes of the thing. The allowed or lawful states of a thing are limited by its current context. For example, “sleeping” is an unlawful state of awakening for a person whose current activity is “driving a vehicle”. Things may also be related to other things within the domain of interest such that a change of state of a thing (or event) may cause a change of state of a related thing (Weber, 1997).

Events

An event (or state transformation) occurs when a thing changes its state. That is, at least one of its properties changes. A state transformation of one thing may also cause a state transformation in a related thing. The

related things may be within the same system (internal agents) or external to the system but coupled to a thing within the system (external agents). The external agents make up the context of the system (Weber, 1997). For example, an independent traveller changes her state when she travels from one location to another. This event may then trigger a safety alert from the virtual travel agent (internal agent). Similarly, a change in the availability of accommodation (external event) in a particular location may cause the traveller to move to another location, generating an internal event.

In a ubiquitous travel agency system the current state and current context of travellers must be monitored constantly so that significant events in either can be propagated to related internal and external agents. Commercial travel intelligence services such as WorldCue (iJet, 2000) provide comprehensive information and alerts about external events to travel agents, and in future directly to travellers. However, they do not propagate traveller events to external agents or travel agents. In this situation, when an unexpected change in the traveller's state occurs that affects his current itinerary, the onus is on the traveller to explicitly advise his travel agent or the external service provider. This assumes that the traveller is aware of the consequences of the state change and is capable of advising their external service provider and/or travel agent. Sickness, accident and lack of communication services may prevent this. It is therefore essential that the traveller's travel agent and/or external service providers be automatically advised of any relevant change in a traveller's state.

A traveller's state is determined by the current values of its properties or state variables. Traveller properties should include:

- Unique identifier such as URL
- Current location
- Current activity
- Preferences

A change in the value of any of these state variables will generate a *traveller event*.

Context

Decisions and assertions that are made regarding a traveller must consider the traveller's current state AND context. For example, information about current location and activity only allows decisions and assertions to be made about this location at this time. It does not allow decisions to be made about other times and locations.

WorldCue, a service that provides travel agents with travel intelligence and allows the agent to deliver alerts to travellers via email and fax is now available from iJet Intelligence Inc (iJet, 2001). The company has announced that it will soon be extending the service to allow delivery of alerts to mobile devices. The system does filter data and alerts according to the travellers' preferences but it does not take into account the traveller's current context. This limits the system's ability to eliminate irrelevant, unnecessary and inappropriate messages and alerts.

Lenat (1998) provides a detailed definition of the twelve dimensions of context:

1. Absolute Time: a particular time interval in which events occur
2. Type of Time: a non-absolute type of time period such as "just after eating"
3. Absolute place: a particular location where events occur, such as Paris
4. Type of place: a non-absolute type of place such as "in bed"
5. Culture: linguistic, religious, ethnic, age-group, wealth etc, of typical actors
6. Sophistication/Security: who already knows this, who could learn it etc
7. Topic/Usage: drilling down into aspects and applications – not sub-sets
8. Granularity: phenomena and details which are and are not ignored
9. Modality/Disposition/Epistemology: who wants/believes this content to be true?
10. Argument-Preference: local rules for how to resolve pro-con argument disputes
11. Justification: are things in this context generally proven, observed, on faith
12. Let's: local bindings of variables etc. that hold true in that context.

Assertions about a thing are generally only applicable in specific contexts. Therefore, an answer to a question about a thing must be a pair <context, answer>. That is, "the answer is in this context". For example, two possible answers to the question "Who is the Prime Minister" would be <1972-75, Gough Whitlam> and <1996 – 2001, John Howard> (Lenat, 1998)

Lenat's (1998) experience with contexts or micro-theories has shown that it results in simpler assertions and extensive re-use of assertions but also imposes the additional burden of choosing the most appropriate context from a large number of small contexts. Consequently, a trade-off needs to be made between coding time within

the contexts and time to select the best context. Mobile data technologies allow data to be captured that simplifies the selection of the most appropriate context and hence, simplifies the automated decision-making process.

Integration Of Heterogeneous Travel Data

The format of information required by travellers includes:

- structured data such as reservation information and transport timetables;
- unstructured data such as textual descriptions of destinations and attractions;
- graphics such as maps;
- images such as photographs of destinations and attractions;
- audio and possibly video.

This information is likely to be sourced from many different organisations, generally in non-standard data structures. To enable automated exchange of data these non-standard data structures must be mapped to a standard structure or an agreed structure. The Open Travel Alliance has published a draft standard for reservations data (OTA, 2001) that is based on ebXML (ebXML, 2001). Since the United Nations and the Australian Federal Government have adopted ebXML as a business document interchange standard, it is most likely to be adopted generally within Australia and Europe.

Unfortunately, automated conversion of HTML encoded data into XML has been shown to be a non-trivial process. Until XML coding of Internet content becomes the norm, generic algorithms for conversion of all Internet content will not be feasible. Consequently, ad-hoc translation algorithms will need to be developed to translate critical content until that content is converted to XML.

Co-operating Multi-Agent Architecture

The dynamic itinerary manager (Figure 1) includes a software agent for each of the services that provide relevant data. The role of these agents is to continuously monitor events that are occurring in the physical and virtual travel spaces associated with those services, to take the required action for any events that affect that service and to advise any the virtual service manager agents to which that service has been registered.

This requires:

- A software agent for each service, such as Qantas reservations service
- A service management agent for each type of service, such as reservation service
- A software agent to provide a persistent on-line presence (persona) for each registered traveller
- A software agent to provide a persistent on-line presence (persona) for each registered travel agent
- A registration process for traveller agents, travellers and service agents
- A rendering process in the traveller agent to convert information to the required format for delivery to the traveller
- The ability to determine the physical location and current activity of the traveller
- Awareness of the traveller's current context including location and type of location
- Ability to detect user events, service events and external physical events
- An agreed ontology
- Agreed message formats

Service Provider Agent	Service Management Agent
<ul style="list-style-type: none"> • Monitors a <i>particular</i> on-line or external service such as wcities (wcities corp., 2001) for significant changes • Converts information regarding changes in a <i>particular</i> service into the agreed XML and OTA interchange format • Sends the required information to the Service Management Agent for that <i>type</i> of service • Runs on a server 	<ul style="list-style-type: none"> • Requests/obtains/parses/monitors a particular <i>type</i> of information from service provider agents using XML and OTA agreed message formats • Can request information from traveller agents, virtual travel agents and service provider agents • Filters information and alerts coming from service provider agents, traveller agents and virtual travel agents and generates any consequential alerts • Runs on a server

Traveller Agent	Virtual Travel Agent
<ul style="list-style-type: none">• collects traveller data from the traveller's communication device and sends alerts generated by traveller events to service manager agents and virtual travel agents• collects filtered data & alerts generated by service managers and virtual travel agents and sends it to the traveller's communication device• Runs on a server	<ul style="list-style-type: none">• can request information from traveller agents, service provider agents and other virtual travel agents• Filters information and alerts coming from service provider agents, traveller agents and other virtual travel agents• Generates alerts and messages and sends them to relevant traveller agents• Interfaces to physical travel agent's network workstation• Runs on a server

LIMITATIONS

The mobile communications infrastructure in most locations is very limited with the exception of major cities in Europe, the United States, Japan, Singapore, Hong Kong and Korea. Similarly, the large size and weight, small screen size, limited processing power and high cost of current mobile devices limits their attractiveness to budget and weight conscious independent travellers. This will limit the effective deployment of the system in the short term but will not prevent the development and testing of a prototype.

It is expected that advances in voice recognition and speech synthesis technology will soon make its deployment to mobile devices more practical. This will significantly enhance their usability.

The nature of the tourism industry, with tight margins and many intermediaries may limit the commercial uptake of the system.

OPPORTUNITIES FOR FURTHER RESEARCH

Although the prototype only includes four service types, the system architecture will allow it to be extended to include other travel service types as well as other industries.

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