RETICULAR
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Using Intelligent Agents for Wireless E-Commerce Applications: The YellowStone Project

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The YellowStone Project

Introduction

The YellowStone Project is an internal Research and Development effort currently being conducted by Reticular Systems, Inc. The purpose of the project is to develop innovative applications using our intelligent agent technology. The project is focused on three primary (and overlapping) business areas – e-commerce, wireless communications and portable computing. The primary goal of the project is to identify and develop the technology required for implementing advanced information services that will be a part of next-generation e-commerce applications. These e-commerce applications will use wireless communications and portable computing devices.

Intelligent software agents are seen as the enabling technology supporting the fusion of these three business areas.

The goals of the project are:

- Identify products and services required for implementing a next-generation advanced information system
- Address identified technology shortfalls

- Demonstrate the use of agents and agent-based systems for implementing advanced information systems.
- Further develop markets for intelligent agents and our agent construction tools

Background

Limited E-Commerce

Existing e-commerce applications are focused heavily on business-to-business transactions. Consumers use e-commerce in only a few highly-publicized applications (buying books, music, software, etc.). Further, there is almost no local e-commerce activity (i.e., commerce involving local merchants). Almost all business-to-consumer e-commerce is national in scope and does not involve goods or services provided by businesses in the local community.

Limited Functionality using Portable Communications Devices
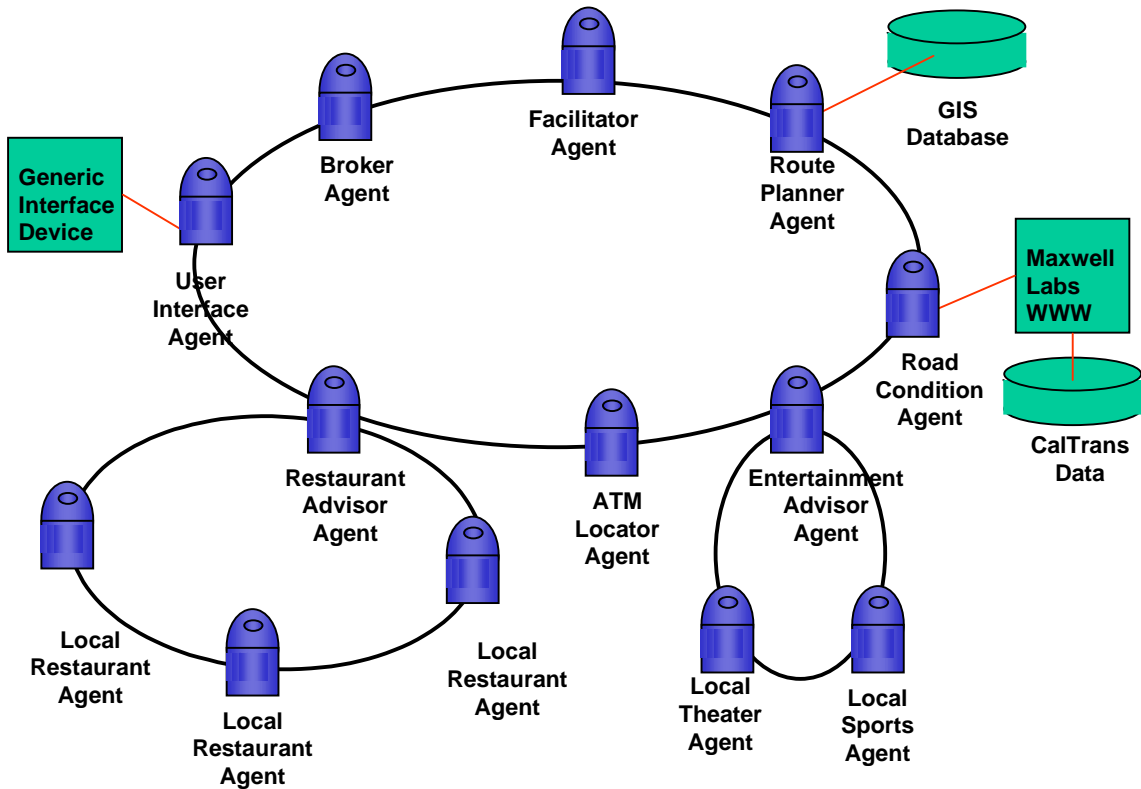
Cellular phone manufacturers and telecommunications service providers are seeking to provide additional services to their customers. They are integrating the functions of the Personal Digital Assistant (PDA) into the cell phone (or the phone into the PDA). These generally provide the same services as the original Apple Newton that was introduced in 1993. These services include calendaring, time management, phone and address book support, communications management, basic messaging and email services along with rudimentary Internet connectivity and browser support. These existing devices and services do little to encourage or facilitate e-commerce.

Intelligent Agents

Intelligent software agents provide an ideal mechanism for implementing complex systems. Software agents are well-suited to applications that are communications-centric. Agents are particularly well-suited for implementing distributed computational and information systems and for implementing systems that are dynamic in nature (i.e., the components that comprise the system change over time as new computational elements are added and old ones are removed). These dynamic systems require components that are autonomous and can readily adapt to changes.

YellowStone Concept

The project has developed a basic system concept that uses a network of communicating, cooperating intelligent software agents to provide advanced information services. The basic system concept is presented in Figure 1.

Generic Interface Device

User Interface Agent

Broker Agent

Facilitator Agent

Route Planner Agent

GIS Database

Maxwell Labs WWW

Road Condition Agent

CalTrans Data

Restaurant Advisor Agent

ATM Locator Agent

Entertainment Advisor Agent

Local Restaurant Agent

Local Restaurant Agent

Local Restaurant Agent

Local Theater Agent

Local Sports Agent

Figure 1. The YellowStone Concept

The basic system consists of a collection of software agents that communicate with each other. This community of agents is called an *agency*. This agency is unique to a particular geographic area and provides information services and e-commerce support for that area. Each agent in the agency can communicate with all other agents in the agency. Each mobile user (e.g., a cellular phone user) is equipped

with a device that includes a User Interface Agent (UIA). When a user enters the geographic area his unique UIA connects with the agency. Normally, many UIAs will be a part of any given agency (only a single UIA is shown in the figure). As mobile users move through the geographic area, UIAs will join and then leave the agency.

The Agents

User Inteface Agent - The UIA provides the primary interface between a mobile user and the information system (i.e., the agency). The UIA provides a number of unique services. These include

- Establishing connectivity with the agency
- Maintaining personal preference information about the user
- Maintaining the user's electronic wallet
- Forwarding information to the user's communications/display device
- Accepting commands from the user via the communications display device.

The UIA can be part of a cellular phone, PDA, laptop computer, AutoPC or desktop computer. For purposes of this research project, we define a *generic* interface device and make no claims as to the capabilities of the actual device. This is because our focus is on the underlying information services and not the detailed requirements/capabilities of the cellular phone, PDA, etc.

Route Planning Agent – The Route Planning agent communicates with a geographic information system and is used to develop optimum route plans for user agents. The Route Planning agent used in the demonstration system has extensive knowledge of roads, highways and freeways in the San Diego area.

Road Condition Advisory Agent (Traffic Advisor) – The Road Condition Advisory agent communicates with CALTRANS to obtain real-time information about current freeway speeds, freeway accident advisories and planned repair work. The Road Condition Advisory agent works with the Route Planning agent to develop real-time driving directions for the user that are based on current highway conditions.

Restaurant Advisor Agent – This agent has knowledge about restaurants in the geographical area. This agent communicates and cooperates with the User Interface

Agent to develop recommendations for a particular restaurant based on the user's personal preference, time of day, locations, etc.

Local Restaurant Agents – Each of these agents represent a local restaurant and provides real-time information to the Restaurant Advisor Agent. These agents provide information such as restaurant locations, menu, daily specials, pricing, hours of operation, parking, etc. This information is used by the Restaurant Advisor Agent to make recommendations to the user.

ATM Locator Agent - This agent provides information about ATM machines in the geographical area. Information includes bank affiliation, location, etc.

Entertainment Advisor Agent – This agent communicates with local entertainment agents (Theater Agent and Sports Agent) and makes recommendations to the user about available entertainment. This includes real-time information about ticket availability, pricing, parking, etc.

Local Theater Agent – These agents provide information about the local theater including playbill, hours of operation, prices, special promotions, parking, ticket availability, etc.

Local Sports Agent – These agents provide information about the local sporting events including schedule starting times, prices, special promotions, parking, ticket availability, etc.

Facilitator Agent – The facilitator agent provides various services to the agency and to the various UIA agents. It's primary role is to provide agent name services to the various agents.

Broker Agent – The broker agent is used to match agent services to various consumers looking for those services. Agents joining the agency can advertise their capabilities to the broker and it can in turn provide matchmaking services to agents looking for those services. The Broker and Facilitator agent are often combined in the same physical agent.

Other Agents

Agents can be used in an unlimited number of areas. Possibilities include medical services, gasoline stations, shopping venues of all kinds including personal shopping agents, government services, etc.

The Demonstration System

Reticular Systems developed a demonstration system that includes a subset of the agency described above. This system was used to provide concept demonstrations at the Autonomous Agent's 99 Conference in Seattle in May 1999. Since the agency had to execute on two laptop computers, it consisted of only the following agents:

- User (Interface) Agent
- Restaurant Advisor Agent
- Route Planner Agent
- Road Condition Advisor Agent (Traffic Advisor)

Note that the purpose of the Demonstration System is to illustrate how multiple software agents can work together to solve complex problems and provide advanced information services. The user interface has been purposely kept simple. A production (non-generic) system will have much more elegant displays for presentation of information to the user.

The Demonstration Scenario

The demonstration scenario allows the user to plan a route throughout northern San Diego. The agents consider road and traffic conditions as well as the user's desired destination. The user's personal preferences are used in selecting a restaurant that is near the route of travel.

The system was implemented using our AgentBuilder agent construction toolkit. Figure 2 illustrates the use of the AgentBuilder Agency Viewer tool for viewing agency operation. Each icon represents one of the agents in the agency. As messages are communicated between agents, they are displayed on the panel at the bottom of the tool.

For purposes of the demonstration, we implemented a very simple generic user interface device. The primary purpose of this device is to control the agency operation and display results to the user. This generic device is not meant to be a prototypical user interface of any kind.
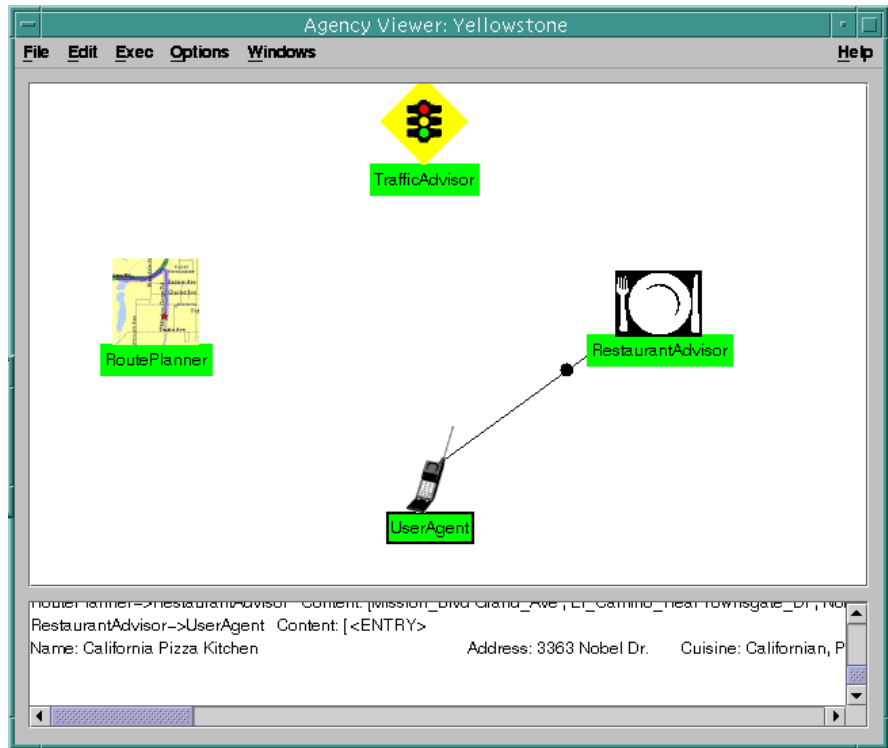
Figure 2. The Demonstration System in AgentBuilder Agency Viewer

Figure 3 shows the Map interface provided as part of the generic interface. The user can use the map to see the route planned by the agents. In addition, this panel provides detailed driving directions.

Figure 4 shows the personal preference information used by the agents in planning user activities. Figure 5 shows the display for the electronic wallet maintained by the user interface agent. Figure 6 shows a control panel used for defining the user's itinerary.
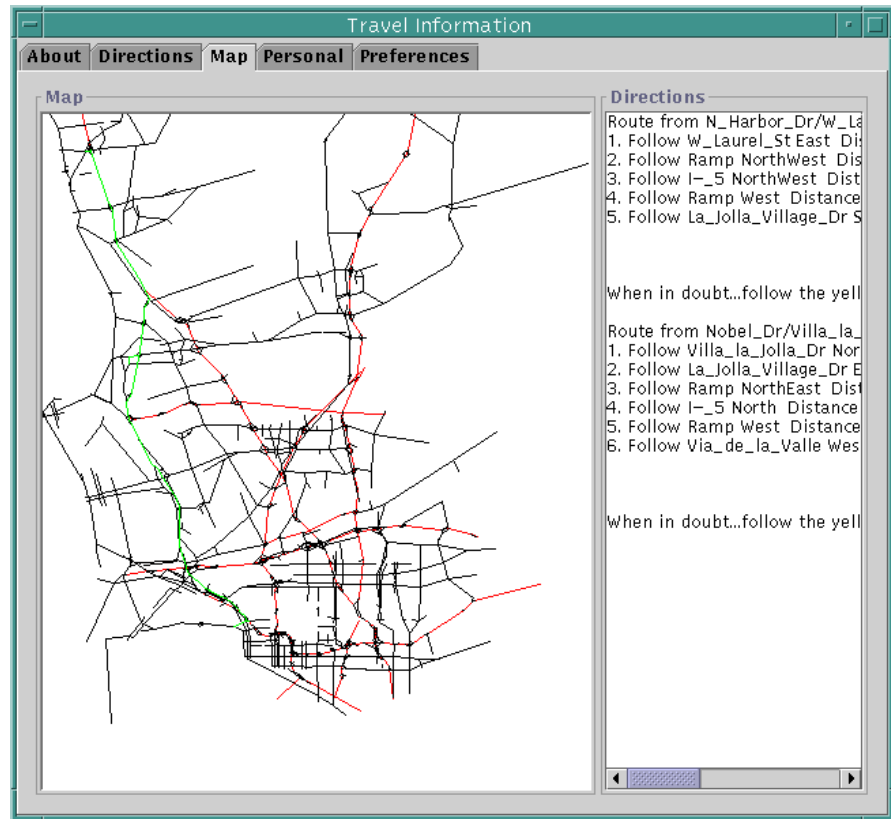
Figure 3. The Planned Route Displayed by the Interface Agent

Future Work

The demonstration system shows how multiple agents can communicate and cooperate with each other to provide valuable assistance to a mobile user. In the future, we will be adding more agents to the demonstration system. The current demonstration system is fully functional using the four agents described above. The agents communicate and cooperate with each other to solve a distributed planning problem that requires determining travel directions that meet the user's personal preferences and needs.

Our future focus will be on enabling local e-commerce using the network of agents. We are investigating adding agents to local web sites and further developing our concept of *active yellow pages*. An active yellow page will operate much like a traditional yellow page except that it will provide real-time information to mobile users about the goods and services available from a local merchant.
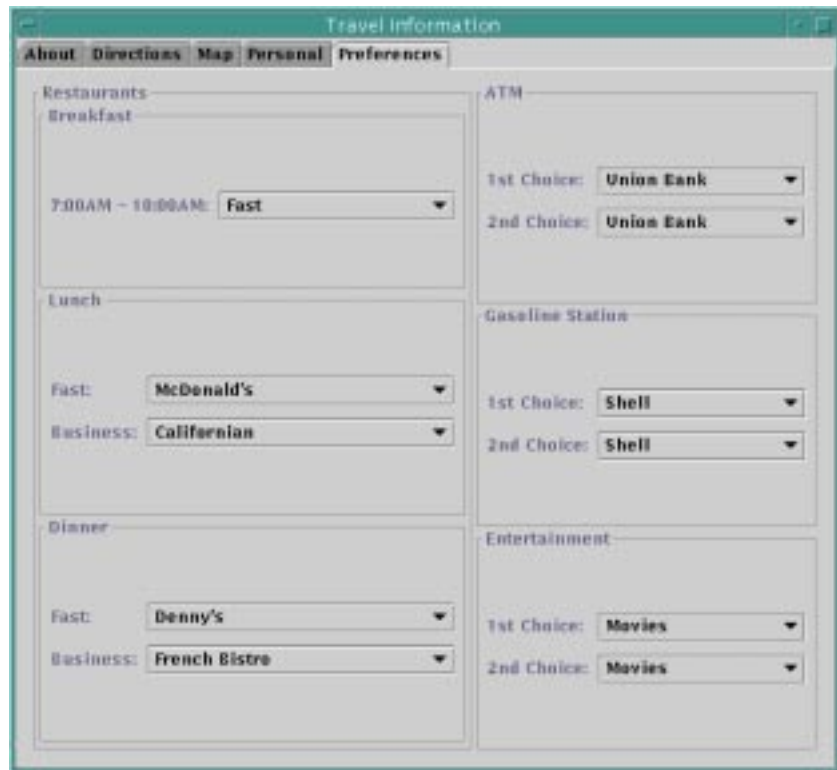

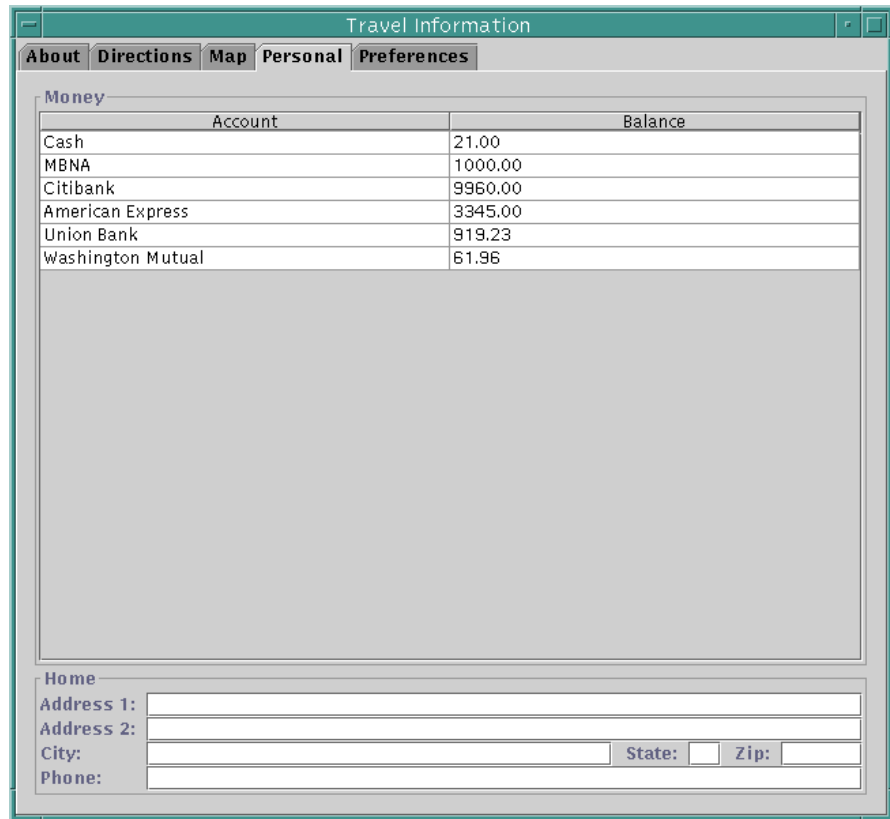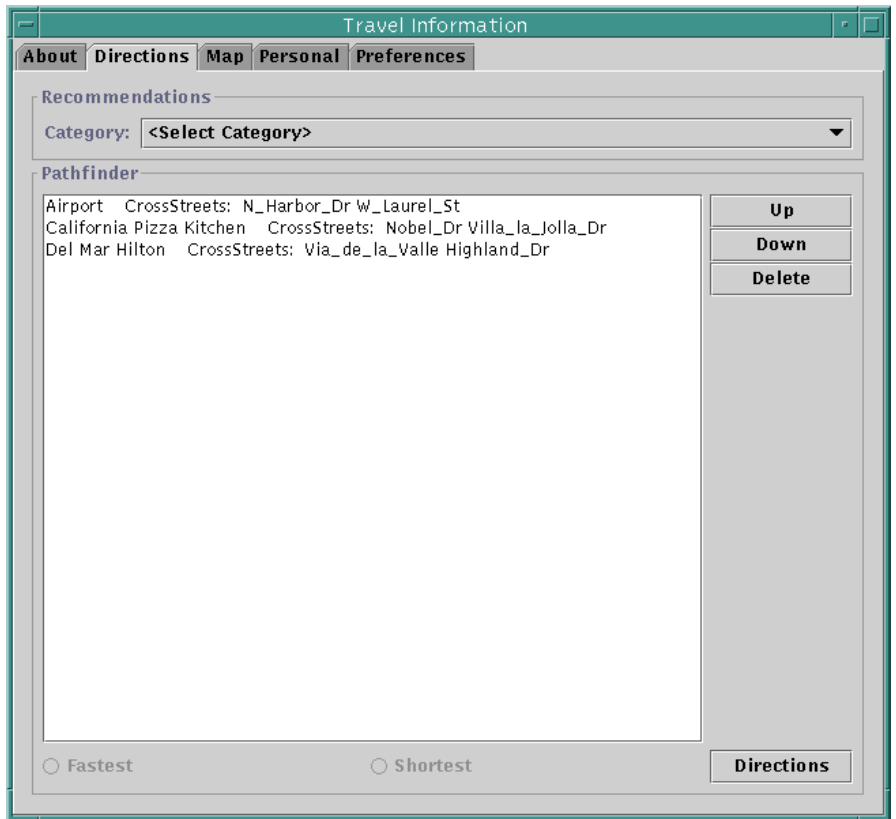**Figure 4. Personal Preference Information**

Figure 5. Electronic Wallet Interface

Figure 6. Travel Information