

# Leveraging Location-Based Services for Mobile Applications

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# Leveraging Location-Based Services for Mobile Applications

## EXECUTIVE OVERVIEW

The explosive growth of mobile devices including phones, personal digital assistants and pagers presents tremendous opportunities for companies to increase sales, improve productivity, and provide better service. But simply making existing applications available over mobile devices doesn't completely capitalize on the opportunities. Form factor, browsers, input/output limitations and even the type of transactions that are likely to be conducted all have to be considered. By leveraging location-based services in your mobile application, you can dramatically improve the adoption rate also take advantage of a whole new class of applications that aren't possible on desktop devices. Making your mobile applications location-aware can be complex and expensive, since you often need to aggregate technology and content from a variety of sources, which is often stored as large objects within a database. But Oracle9i Application Server Wireless (Oracle9iAS Wireless) is tightly integrated with Oracle Spatial, so creating and deploying location-aware mobile applications is easy and affordable.

## INTRODUCTION

The first generation of mobile devices were focused on placing phone calls and provided limited access to data in an offline environment. Mobile phones quickly gained access to wireless data applications, but small displays and difficult data input mechanisms reduced the likelihood of these devices being used for enterprise applications. PDAs such as Pocket PCs and Palm Pilots gained access to wireless networks, but the lack of bandwidth and poor coverage forced many of the applications to work in an offline as well as online environment. These applications were not able to identify their current location, but by enabling users to input their current location and or select from a list of frequently used locations, companies could overcome many of the device and network limitations.

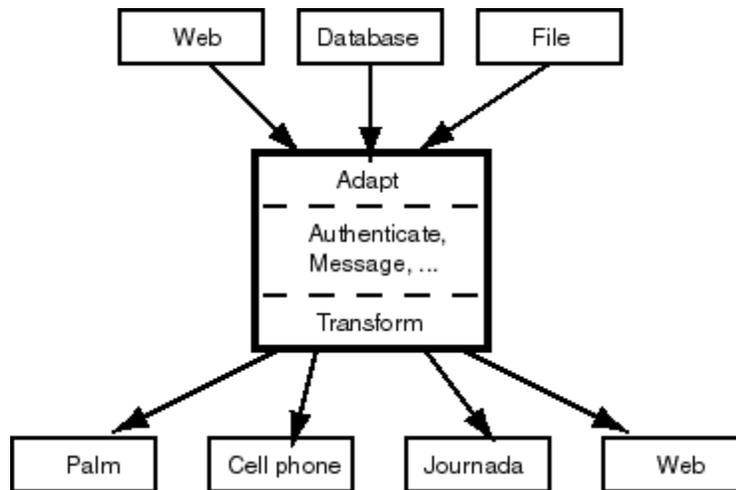
The confluence of several factors are significantly increasing the deployment of mobile applications, which will likely result in the rapid adoption of location-based services. These factors include the emergence of phone and PDA hybrids called smart phones, which have local storage, richer displays and better input mechanisms, faster and enhanced mobile data networks and low-cost positioning devices.

Without an appropriate location-aware mobile application development framework, many basic services will end up being re-implemented in each application, and cooperation between different location-aware applications will be difficult.

Most applications today do not automatically take into account the location information of the clients or the service providers. Two integrated products, Oracle9iAS Wireless and Oracle Spatial, provide an infrastructure for mapping services to areas of interest (or, regions) and clients to regions or addresses. Location information can be aggregated from a variety of remote sensing technologies and service providers, resulting in a single, seamless interface to the information. Applications built in this environment can then determine the locations of mobile business objects (services or clients) as well as the path taken by the mobile objects in a specified time window. Based on this type of information, developers can create innovative location-aware applications.

### LOCATION-BASED SERVICES WITH ORACLE9iAS WIRELESS

Oracle9iAS Wireless is a mobile middleware server that delivers any content to any device. Applications are independent of the target device, yet automatically can exploit specific features of the device and provide customized content depending on the availability of such features. It performs a variety of services: adaptation (aggregation) of content, general processing, and transparent transformation to each device.



**Figure 1: Location-Based Services with Oracle**

#### Any Content

Applications can use any content available on the Web, in the database, or a file system. Oracle9iAS Wireless can either accept data in MobileXML (Oracle's device-independent XML) or use one of its many adapters to convert content into

MobileXML. For the former, developers can output MobileXML instead of HTML from existing JSP, ASP, CGI or Perl code. Opportunities for reusing code and content are considerable, and the advantages for development time and cost are apparent.

### **Any Device**

Oracle9iAS Wireless Transformers then convert the MobileXML into the respective markup language required by each mobile device (WML, TinyHTML, c-HTML, VoiceXML, etc). Obviously, devices vary in their ability to display certain content in a reasonable manner, or even to store it in memory. For example, an application that presents high-resolution streaming video can be used only on a device with sophisticated capabilities. Voice recognition cannot be used on a Palm device without a microphone. However, MobileXML is flexible enough to enable different input and output options depending on a specific device's capability. For example, voice input can be used if the handheld device has a microphone. The application logic can be unaware of this feature, yet transparently benefit from it.

Oracle9iAS Wireless exploits the maximum hardware capability of the device to present information. If the application does not care about hardware capabilities, the device will do its best to present the information. Alternatively, an application can query device type and capabilities, and optimize the content accordingly. For example, a route-finding application could return text, map or voice XML results from each query. It might choose which form to display depending on the device characteristics. If the routing application chooses to ignore device characteristics and delivers the content as a default text and map format, a "smart" cell phone could automatically portray the content over several screens.

Most importantly, applications that work on today's devices will continue to work without limitation with tomorrow's more advanced devices and markup languages.

### **Anywhere**

Oracle9iAS Wireless provides a foundation for deploying location-aware mobile applications. Mobile devices naturally benefit from location awareness, especially when supported by mobile positioning technology. With Oracle9iAS Wireless, the method by which the network determines "location" is irrelevant. A user can choose whether to base location on automatic positioning or manual positioning. Automatic positioning uses the mobile network information, GPS in the mobile phone, or some other hybrid technology to detect the user's physical location. Manual positioning uses a location specified by or defaulted for the application user. Oracle9iAS Wireless allows each user to define certain locations (such as home, office, and local airport), and to designate any of them as the default. It also lets users enter an arbitrary location, such as a distant city. Manual positioning can be used when the automatic positioning is not available or not relevant. It is useful for "what-if" scenarios or performing a query for a location other than the

user's current location (such as "Which hotels will be available within five miles of the San Francisco airport?").

### **Any Provider**

Location-awareness for mobile applications is incomplete without specialized services, such as geocoding, reverse geocoding, driving directions (routing), yellow pages (proximity search), maps, weather forecasts, traffic reports, and demographic information. The technology for all these services is available and mature. By deploying on a common open LBS platform, location service providers can maintain the flexibility of choosing from multiple tools and online service providers.

Oracle9iAS Wireless provides independence from any specific location technologies, tools, data or service providers. An application can use location data from both internal and external providers. Generally, a provider of a location-based service does not possess the resources, technology, or data to provide all services in-house. A combination of an internal location-based platform (for proximity queries) and external services (such as real-time traffic information) is becoming a common deployment architecture. Oracle9iAS Wireless serves as a framework to integrate both internally deployed solutions with externally hosted content services. It lets application providers easily prioritize and automatically switch between external providers, thereby making the decision to rely on external providers easier and more palatable. The result is mutually beneficial to both parties: a "buyer's market" aiding application developers, and the resulting market growth aiding data and service providers.

### **STORING GEOGRAPHIC AND LOCATION DATA WITH ORACLE SPATIAL**

Oracle Spatial serves as a foundation for deploying enterprise-wide spatial information systems. It provides data management for location information such as road networks, wireless service boundaries, and geocoded customer addresses. Many of the leading external providers of geocoding, mapping and routing services store their data in Oracle Spatial. In most cases, large enterprises, wireless carriers, and portals will want to store location data in-house. Since Oracle Spatial is part of Oracle9i, developers will get the highest performance possible. Geographic and location data are manipulated using the same semantics applied to the CHAR, DATE and INTEGER types that are familiar to all users of SQL. Specific features of Oracle Spatial include:

- Open, standard SQL access to all functions and operations
- Spatial object type storage accommodating geometry type and linear referencing
- Spatial operations and functions including layer constraints and aggregates (for example, unions and user-defined aggregates)

- Fast R-tree and quadtree indexing
- Comprehensive storage, management and use of geodetic data
- Partitioning support for spatial indexes
- Powerful linear referencing system
- Advanced replication for deploying distributed systems
- Tools supporting seamless integration of heterogeneous data (fusion), including projection management and coordinate transformation

## **UNDERSTANDING LOCATION-BASED SERVICES**

Oracle9iAS Wireless supports access to a number of spatial services, such as geocoding, driving directions, yellow pages, and mapping. It does not necessarily perform the services itself, but instead relies on external location services providers.

The multiplexing approach provides several technical and business-related advantages:

- **Integration of internal and external services:** Any existing in-house proximity solution (such as a yellow pages database) can be easily integrated with suitable external services. For example, Oracle9iAS Wireless can be configured to only access an external yellow pages provider if the internal yellow pages database is unavailable or overloaded.
- **Business flexibility and risk abatement:** Relying solely on one external provider for a service amounts to a commitment that can become expensive and risky for companies and government agencies.
- **Global deployment:** Large wireless carriers and portal sites will need to aggregate multiple LBS tools and content providers from different geographies in delivering a seamless global service for roaming customers.
- **Code simplicity:** Without the multiplexing provided by Oracle9iAS Wireless, more code (and more complexity) would be required to handle directly a portfolio of several external providers.
- **Cross-application communication:** Information exchange between services, such as between yellow pages and driving directions, is simplified.

The following sections describe some of the services in more detail, including issues associated with each.

### **Accessing Internal And External Service Providers**

Any provider, whether internal or external is accessed with a proxy that provides the necessary translation. In the case of external providers, some authorization must be added for the Oracle9iAS Wireless server to prove to the external

provider its identity. External location services can be accessed from the Oracle9iAS Wireless server. Using an access password, an external provider can provide online syndicated LBS services. If an internal service provider is used, no password or dependency on external providers is needed.

### **Geocoding**

Geocoding determines the longitude and latitude coordinates of an address. Geocoding is the most fundamental of location services, because it is used directly or indirectly by the other services. The technical requirements of a geocoding service can range from trivial to demanding. A trivial approach is to disregard any address fields except the postal code and return the coordinates of the center point (centroid) of the postal code area.

Most geocoders provide more than the simple postal code centroid. Where the data is available, geocoders can locate the approximate location of the address along a street network. In addition, consideration regarding which side of the street the address is located must be taken into account. For example, providers of driving directions sometimes use the side of the street to determine whether the user should turn left or right out of the driveway. If the geocoder cannot reliably determine the side of the street for a location, the initial turn in the routine instructions may send the driver in the wrong direction.

A wide assortment of online partner geocoding services (Mapblast, Webraska, Whereonearth, among others) have been integrated into Oracle9iAS Wireless to enable developers to quickly launch geocoding services. In addition, partner technologies like MapInfo's MapMarker and Xmarc WIISE platform provide geocoding tools that can be directly integrated with Oracle Spatial database to provide local batch and single record geocoding.

### **Mapping**

Mapping enables users with capable devices to visualize location-related data. Technically, mapping usually involves spatial database queries and advanced visualization algorithms. These operations are computationally demanding and require large geographic databases. Existing mapping tool vendors differ in the scalability of their approach, the level of map detail, and the visual appeal of their maps. Conceptually, however, mapping is well understood. Partners that incorporate mapping services into Oracle9iAS Wireless include Airflash, Mapblast, Webraska, and Xmarc. In addition, Oracle has the benefit of having the largest assortment of partner mapping technologies that are pre-integrated with Oracle Spatial and Oracle9iAS Wireless. These mapping tool partners include Autodesk, Caris, ESRI, Ionic, Intergraph, MapInfo, ObjectFX and Star.

## Routing

Routing is more commonly known as *driving directions*. Technically, routing is equivalent to graph search, which is actively investigated in artificial intelligence and other fields.

In addition to turn-by-turn instructions, routers might also provide maps of each turn and of the complete route. The router might also supply a list of point coordinates along the route, to enable the requesting user to perform some spatial analysis (for example, to identify which customers can be visited along the route). Route maps generally offer fewer options than general maps: for example, users typically cannot adjust the map scale. Routing maps are automatically centered on a route or a single maneuver (turn); however, the area of interest might represent only a small percentage of the delivered map.

Interfaces to the leading wireless and Internet routing services have been integrated into Oracle9iAS Wireless, including Airflash, Mapblast, MapInfo, and Webraska. In addition, a number of partners such as Xmarc and TransDecisions can provide local routing services directly inside the Oracle9i Spatial database.

## Proximity Queries

Proximity services can determine a list of businesses matching a specified region and either a business name or a category. The technical aspects of a proximity query are well understood: it involves common database queries, and the speed and complexity of the solution depend on the level of database optimization. However, the semantic aspects pose more challenges.

Semantic categorization of yellow pages data has not yet attained maturity or standardization. Different content providers use different approaches. For example, they use different business categories with differing semantics and names, each in an effort to add value and provide brand recognition. Moreover, the organization of categories in hierarchies varies widely, between flat lists and deep hierarchies, between balanced and unbalanced trees, and with fan-out ratios of 5 to 100. Even non-tree graphs can be used. Keyword searches of categories can be semantic-based, substring-based, or non-existent. For example, a semantic-based search for *restaurant* would return categories containing *restaurant* (such as *restaurant equipment*) but also others, such as *Chinese cuisine*. A substring-based search, on the other hand, would return only categories containing the search term.

Oracle9iAS Wireless attempts to solve the semantic categorization problems by letting users create local custom hierarchies based on their own semantic preferences. This custom hierarchy is defined in an XML document and is completely independent of the existing categories of any external provider. Each category in the custom hierarchy is mapped to one or more external provider categories that have similar semantics. This approach unifies the category

hierarchies of external providers and gives the application implementer the flexibility to use its own branding of categories.

### **LOCATING MOBILE USERS**

The mobile positioning component provided by Oracle9iAS Wireless enables the developers to access a mobile target's real-time positioning through a unified programming interface. The positioning information is critical to many location-based application scenarios, such as:

- Identifying relevant location-dependent services. Mobile positioning is required to automatically determine which location-dependent services are relevant.
- Dynamic routing: routing from a user's current location to a destination.
- Business query: looking for businesses that are close to a user's current location.

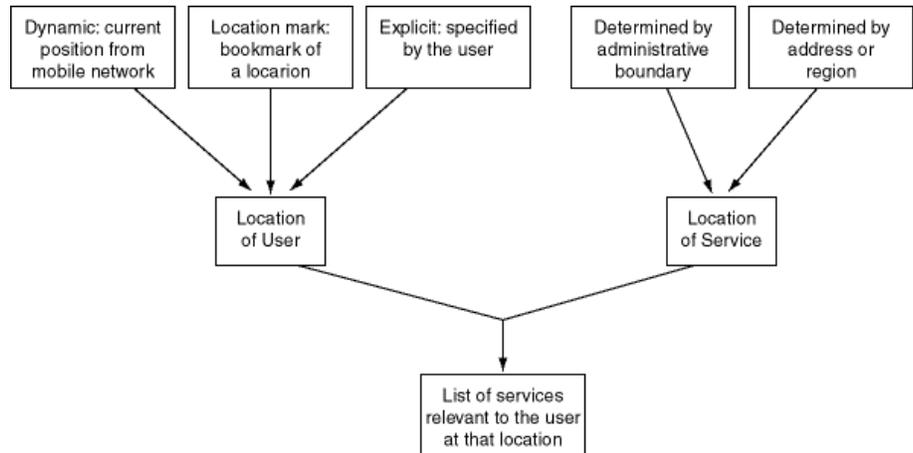
Oracle has been working with the leading positioning technology vendors like Airbiquity, CellPoint, Ericsson, Nokia, SignalSoft, and TruePosition to ensure interface interoperability between Oracle9iAS Wireless and their positioning technologies. In addition, Oracle is participating in various industry consortia (LIF, OGC) attempting to define standard interfaces for positioning information.

### **LOCATING AND ORGANIZING SERVICES**

A Web portal is often loaded with as much information as possible, usually in the form of jumping-off points to other information repositories. Providing mobile users with access to these portal services means more than just converting Web information to match the characteristics and limitations of the device, such as the small screen and low bandwidth. Web clipping is too limited when one considers mobile devices that, by definition, can be anywhere. However, when one adds the capability of the Web server to recognize the geographical location of a mobile device, the server can then adapt itself and provide services or information that are relevant to the current location.

Extending this model, services can then be built with content that is more or less local to specific locations. For example, one service might monitor local buses and trains for a specified city, while another might monitor inter-city trains and commuter airline traffic. This model can extend to local restaurants advertising their menu, hotels announcing room availability, theaters listing last-minute tickets for sale, and many other applications. Eventually, services could themselves be physical devices that just advertise their availability, such as retail establishments offering coupons, ATMs, and vending machines. Clearly, in such a model the number of services potentially relevant for a given location and personal profile can be very dynamic, with new services appearing and disappearing, constantly.

Figure 2 illustrates such a model, in which the user's location and the service provider's location determine which services are germane to a user.



**Figure 2: Location of User and Service**

As shown in Figure 2, the location of the user can be determined by or interpreted as any of the following, depending on the application:

- The user's actual current position, determined dynamically by the mobile network
- A location mark defined by the user (Similar to a bookmark in a Web browser, a location mark is a predefined geocoded location with a name, which is likely to be used often. For example, *Home* or *Office*.)
- Any location specified by the user (not necessarily the current position)

Moreover, the location of the service can be determined by or interpreted as any of the following, depending on the application:

- An administrative boundary defined by the service provider (for example, *Greater Chicago area* or *wireless billing territories*)
- A specific address or area (for example, *Atlanta Airport* or *Essex County*)

### IMPLEMENTATION USING REGION MODELING

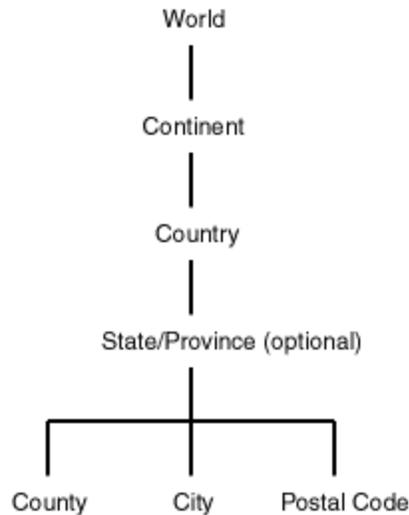
Oracle's implementation adds flexibility to the concept of a location-aware service, by allowing for location relevance or availability to be an attribute of the service and by allowing automatic detection as well as manual specification of the user's location.

### Services and Regions

Oracle9iAS Wireless associates services with geographical areas, or regions. A region can be defined as a member of a hierarchical structure (country, state or province, postal code, county, city or municipality). However, this model may be too simple to represent reality, particularly where regions must be defined in more

flexible and user-defined ways. For example, a metropolitan area can spread over state or even country boundaries, or a company-specific sales area can cover areas over multiple counties, or the path of a bus can follow multiple roads irrespective of their location.

The region-modeling scheme provides system-defined regions and allows user-defined regions. In the system-defined region model, the entire world is divided into sub-regions with the following hierarchy:



**Figure 3: Hierarchy in System-Defined Regions**

In addition to the system-defined regions, the administrator of the system could create custom user-defined regions that can contain and/or intersect multiple system-defined regions. The application developer could also create a custom region as an area around an address.

Given a particular set of longitude/latitude coordinates, the application can easily determine all the intersecting regions at different levels of the hierarchy. Also, given a particular user-defined region, the tools can locate all system-defined regions in one or all hierarchy levels that are contained in it.

### **Service Discovery**

Oracle9iAS Wireless goes beyond the limitations of many current services by making location an inherent attribute of a service and by allowing both manual and automatic as well as manual discovery of relevant services.

Many existing services that are called "location-aware" accept one or more location-related input parameters. For example, a weather service might ask the user to input a ZIP code. The service then checks a hard-coded internal table that associates each ZIP code with the nearest weather station, and it presents weather for that station.

Using the Oracle9iAS Wireless Region Modeling capability, location relevance or availability becomes an attribute of the service. The location attribute is in addition to a service's ability to accept optional input parameters. For example, a BART (Bay Area Rapid Transit) subway schedule service would define its location attribute as the Bay Area: San Francisco and the surrounding area. That is, BART subway schedules are relevant only within that location. In addition, the service could allow several optional input parameters, such as a station name for users who want to know when the next train to a particular station leaves from their current station.

The following table provides additional examples of services that could be created using this implementation.

<b>Service</b>	<b>Location Attribute</b>	<b>Optional Parameters</b>
Virginia attractions	Virginia (U.S. state)	type (history, arts, specialized categories)
U.S. sport stadiums and arenas	Selected points across the United States (user-defined)	sport name; team name
Art museums	Selected cities (user-defined)	genre; event type

**Table 1: Services with Location Attributes - Additional Examples**

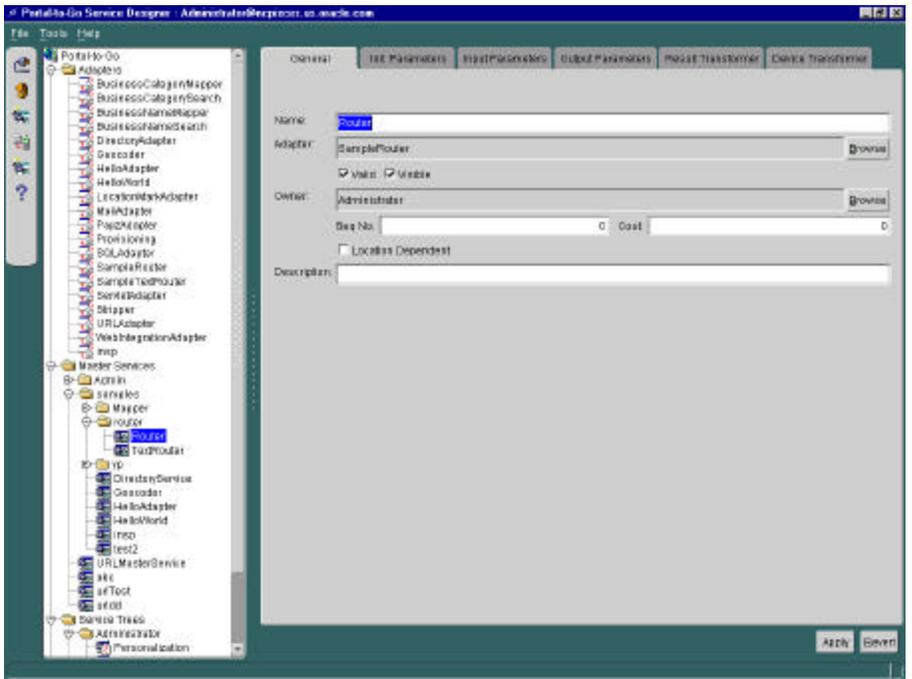
The location, moreover, could be automatically detected or manually specified, or the service could allow either option:

With automatic detection, the user's position is received from a GPS (Global Positioning System) or MPS (Mobile Positioning System). When the user's position is within the service's region, the service would be automatically enabled. For example, if the user had subscribed to a BART subway schedule service and drove or flew into the service's region, the subway schedules would be available.

With manual specification, the location of interest could be a user-defined location mark (for example, *My house*), or it could be some other location specified in any of several ways (such as a city, intersection, street address, or set of longitude/latitude coordinates).

### **Associating a Region with a Service**

When you define a service, you can also specify a location attribute: that is, associate a region with the service. For example, in the following implementation shown in Figure 4, to associate a region with the service being created, select (check) the Location Dependent box in the Service Designer of Oracle9iAS Wireless.

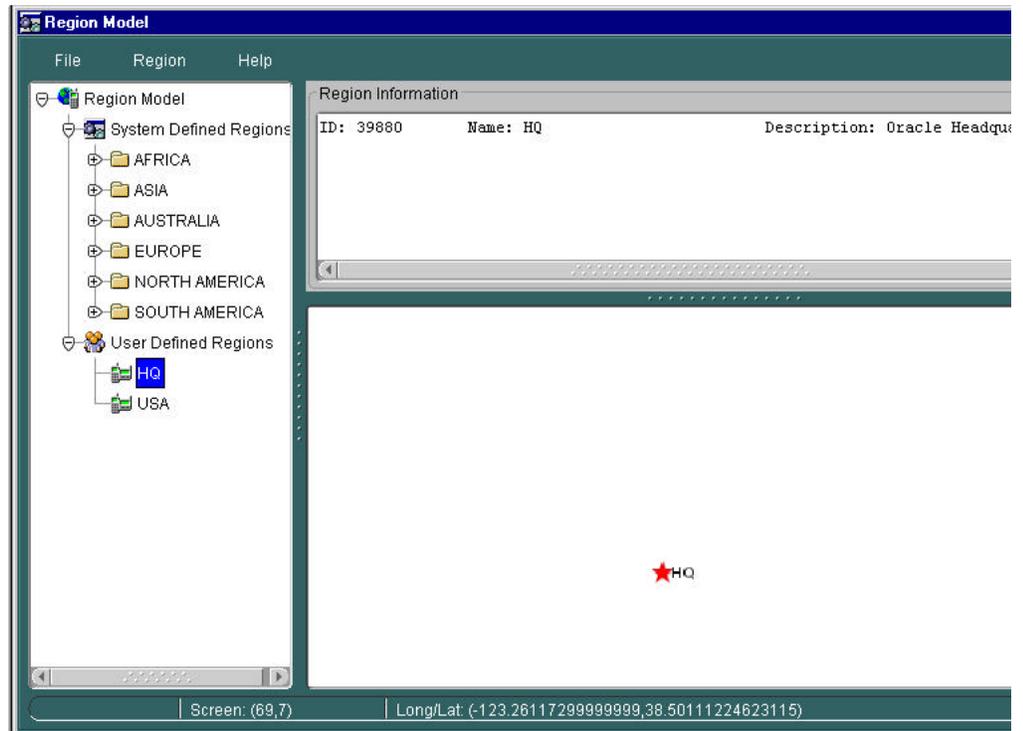


**Figure 4: Creating a Service**

When a service is selected as location-dependent, the application developer uses a region modeling tool to select a region to be associated with the service and to create user defined regions, as described in the next section.

**Region Modeling Tool: An Integrated Component of Oracle 9iAS Wireless Service Designer**

The region modeling tool lets administrators of a wireless portal service identify specific areas for services, as shown in the illustration in Figure 5.



**Figure 5: Region Modeling Tool - Associating a Region with a Service**

In this illustration, the user has selected a previously created user-defined region named *Oracle HQ* (for Oracle headquarters) to be associated with the service.

A region is simply a geographic entity, or location. A region can be small (such as a street address) or large (such as a country or continent). A region can be represented by a point, as is often done for addresses and locations of interest (such as airports and museums), or by a polygon, as is usually done for wireless cell boundaries and administrative areas.

Service providers may want to define specific regions for a variety of applications and services, such as:

- Wireless billing according to cell-id boundaries, providing finer grained billing capability as defined by carriers and/or customers
- City guides for selected metropolitan areas, so that users in those areas receive only services and information (such as restaurant listings or advertisements) relevant to them
- Art museums in a city or a multistate area, so that art lovers can plan trips to museums

A company may provide many specialized services, and customers may be able to subscribe to and pay for individual services tied to regions. For example, one

customer might subscribe to city guides for the entire United States, while another customer might subscribe only to city guides for southeastern states.

#### **Folders and Hierarchies of Regions**

Regions are stored in folders. Folders can be in a hierarchy (that is, there can be folders in folders). There are two top-level folders: System-Defined Regions and User-Defined Regions:

- System-defined regions are arranged in a hierarchy of predefined areas: continents, which contain countries. Countries further contain states, which contain many postal codes, counties, and cities.
- User-defined regions are regions created by administrators, based on the location of a geocoded address or on the geometry of the regions such as cell-ID boundaries. The geometries are loaded into Oracle Spatial and are accessed by Oracle9iAS Wireless.

#### **DEMONSTRATION APPLICATIONS**

Examples of two applications based on Oracle9iAS Wireless are below: a business-to-consumer application providing location recall, and an enterprise application providing static and dynamic routing of delivery trucks.

##### **Location Recall**

The location recall application finds businesses based on names or categories and on spatial associations. It performs proximity queries on a yellow pages dataset stored in Oracle Spatial or accessed remotely. For example, a user might remember visiting a Gallo winery near Los Angeles and later dining at a sushi restaurant not far from the winery. (Or, a user might want to visit such a winery and then dine at a sushi restaurant.) The user could ask the application for all possible pairs of Gallo wineries and sushi restaurants that are within a specified distance of each other in Los Angeles. The application performs the following logic:

1. Within Los Angeles, perform a yellow pages lookup by name for *Gallo*, and return all winery locations.
2. Within Los Angeles, perform a yellow pages lookup by category for *sushi restaurants*, and return all matches.
3. Geocode each location returned from both lookups.
4. Perform spatial analysis in Oracle Spatial to find all pairings where a winery and restaurant are within the specified distance of each other.
5. Generate driving directions with maps: from the user's current or specified location, to each location (or only locations selected by the user).

All of this appears to the consumer as a single application. The application internally, of course, calls various services, and integrates the results of several external providers. This allows for selection of "best of breed" for each service type and for failover in case of any service outages.

### **Delivery Routing**

The delivery routing application assumes a package delivery company with pickups and deliveries and a fleet of trucks. At the start of each day or shift, trucks are loaded and the drivers are sent out with a list of scheduled pickups and deliveries. At varying times during the day, important pickups and deliveries are added, and drivers can receive amended route instructions when they check in after each stop. The application performs the following logic:

1. Before the start of the day or shift, geocode the addresses of all scheduled pickups and deliveries.
2. Perform spatial analysis to allocate the pickups and deliveries among the available trucks in a sensible manner using cluster analysis
3. Generate an optimal route with driving directions and maps for each driver.
4. As additional pickup and delivery orders are received, locate the most appropriate driver and modify the remainder of his route (after the next scheduled stop).
5. Generate a revised optimal route with driving directions and maps for drivers affected by the changes. (All drivers check their mobile devices for any messages or changes after each stop.)

The application could be enhanced to incorporate real-time online traffic services that alert fleet operators and drivers of traffic conditions, road construction, accidents and unscheduled traffic events. Where necessary, a rerouting of scheduled fleet activities could be carried out. It could add support for weather services to adjust routing and schedules for such things as snowstorms and flooding. Where necessary, the application could issue instant alerts and rerouting in critical situations, as opposed to waiting until the driver reaches the next stop.

### **FUTURE DIRECTIONS**

Oracle is working closely with its many partners to deliver a robust, flexible, and secure platform for a variety of location-based services. Below are planned features for upcoming releases of Oracle9iAS Wireless.

#### **Location-Based Push Services**

When you arrive in a foreign city, a "middleman" who wants to take you to a hotel may approach you. The hotel pays this person if you agree to stay in that hotel. The same principle could be used in the form of a *digital agent*, where businesses would be willing to pay for pushing targeted messages to clients looking

for a specific service. For example, if when accessing a local wireless network you perform a query looking for Italian restaurants in the neighborhood, your wireless carrier could provide “mobile coupons” from pre-enrolled retail establishments.

### **Location-Based Events**

If you were a busy executive and needed to meet with two of your managers as soon as they arrived at the office, you could define a “region” around your office and define an “event” that triggers when both managers are detected to be within the defined office region. The action of the event could be to send messages to the managers requesting a meeting.

### **Personal Location Information Management**

Oracle9iAS Wireless will provide a hierarchical, end-user customizable control for securely managing a person’s confidential location information. A user can choose not to be positioned, or to be positioned by a single user or a group of users. For each level of positioning privilege the user can specify a time range. Further, the user can turn off location cache and location log in the system if he or she does not want location information to be stored in memory or persistent storage.

### **Event-Based Information**

Oracle9iAS Wireless will be incorporating additional interfaces to handle event-based information. Event-based information, such as the provision of real-time traffic and parking information is extremely valuable in the deployment of location-based services. This information can significantly enhance the quality of driving directions. However, traffic information is more technically demanding than demographics because the granularity is much smaller (street segment, as opposed to postal code) and the data must be updated more frequently (hourly or more often, as opposed to at intervals of months or years). In addition, for any non-trivial driving directions request, traffic conditions must be returned for a corresponding list of road segments. Real-time parking information is especially valuable for large cities. When business travelers visit a client in a foreign city, it is important to find a parking lot near the client’s address where parking is available.

### **CONCLUSION**

Application developers can now benefit from an open, scalable, secure, manageable and standards-based technology infrastructure for deploying their location-based services. Oracle9iAS Wireless provides a set of capabilities to rapidly deploy seamless location-based services that are global in coverage. It provides application developers with a set of pre-integrated interfaces that support various sources of location service providers worldwide using a single, consistent API.

An important differentiator to Oracle’s location-based services capability is the extensibility and flexibility with respect to current and future mobile device

technologies. An application can integrate services from internal and external providers. The application is not dependent on specific vendor tools or LBS service providers because Oracle9iAS Wireless acts as a broker or multiplexer. Because multiple providers can be accommodated, any failure by providers is transparent to the application and its users.

Oracle9i AS Wireless has the proven ability to handle peak site traffic common to large enterprises, Internet portals and wireless application service providers. It provides a robust framework for the integration of core enterprise systems, local databases, and third-party online services. The leading vendors and providers of mapping, geocoding, and online services support Oracle9iAS Wireless, enabling application developers with a rich set of tools and services to deploy rich, differentiable solutions.

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