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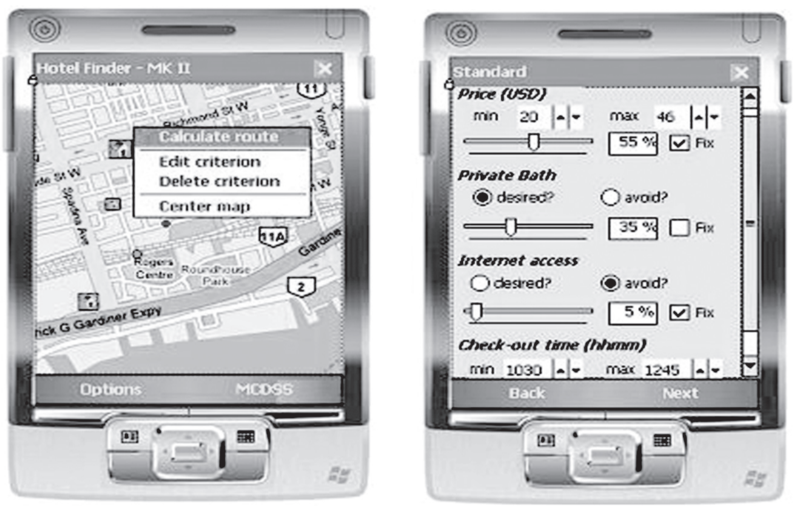
Location-based decision support

Over the years, we have become a mobile information society. Increased mobility has affected many areas of our daily lives, such as travel, communication, consumerism, social behavior, and the environment. Mobile people face challenging problems in space and time. These problems need to be solved on the spot, such as navigating an unfamiliar city or deciding on the fastest public transportation mode to a destination. Location-based decision support facilitates people's mobile decision making. It is based on location-based services (LBS)—information services that are sensitive to the location of a mobile user. These services allow a user to query a location from a mobile terminal, such as a mobile phone or personal digital assistant (PDA), and to exploit spatial information about the user's surrounding environment, such as his or her proximity to other entities in space.

Location-based decision services. Personalization is an essential aspect of making mobile decisions that are valuable to the user. It concerns the personal management of space through user preferences and characteristics. Customizing and adapting LBS to users is important because people differ in their spatial and cognitive abilities, and their information needs depend highly on the personal and situational context. Disabled people require different wayfinding instructions, for example. And route elements for people using wheelchairs must not include stairs.

Recent research has focused on the development and design of mobile location-based decision services (LBDS), which provide personalized spatial decision support to users. These services are built on the integration of multicriteria decision analysis (MCDA) and can provide analytic evaluations of the attractiveness of alternative destinations and choices being offered. MCDA is based on the idea that humans use multiple decision criteria to determine the best solution to a problem. The following description of a mobile hotel finder service illustrates how a LBDS functions.

The hotel finder service features multicriteria location-based decision support for the task of finding suitable hotels in an unfamiliar environment, depending on the user's location and preferences. It integrates the ordered weighted averaging (OWA) decision rule, which allows users to choose a decision strategy as part of their decision-making preferences. This leads to different answers by the location-based decision service depending on the decision maker's level of risk taking. Decision strategies range from optimistic (that is, risk taking) to pessimistic (that is, cautious), and allow for full trade-off to no trade-off between the different decision criteria. For example, with the optimistic strategy, the decision maker focuses on the higher outcomes, thus incurring the risk of accepting an alternative with excellent values on some criteria but potentially poor values on other criteria. Users navigate through the steps of an MCDA process that includes determining decision



(a) (b)

User interface for the Toronto hotel finder, showing (*a*) standardization and weighting of criteria and (*b*) presentation of the results, with the additional option of calculating the route to the optimal hotel.

alternatives (hotel destinations), selecting decision criteria (such as room rate and Wi-Fi access), standardizing the criterion values for all alternatives, determining importance weights for the criteria, and using a multicriteria decision rule to aggregate the weighted standardized criterion values to an evaluation score and rank for each alternative. The user interface of the mobile device provides both the functionality for displaying the geographic data and a dialogue component to elicit the user's input of MCDA parameters. The **illustration** shows the service for the city of Toronto, Canada. The map window can be provided by map servers such as Google Maps or Microsoft Virtual Earth.

Benefits and critical issues. The widespread adoption of location-based services is expected to lead to great benefits by providing large segments of the population with real-time, location-based decision support for purposes ranging from trivial (navigation and friend-finder services) to critical (emergency response). A major advantage of LBDS is that such decision support can be tailored to the user of the service, thereby providing an individual with the optimal information, as needed. Further benefits include real-time (24/7) data access and potential time savings compared to traditional decision-making approaches. The gradual reduction in the cost of mobile devices and application access over time will broaden the accessibility and distribution of these services.

On the other hand, one must be aware of the security and privacy issues that modern technology brings with it, and location-based decision services are no exception. In extreme cases, the capacity for real-time integration of location information and personal data can lead to so-called geoslavery—monitoring and exercising control over the physical location of an individual. As a response to this potential danger, various initiatives have called for the implementation of location privacy protection methods and laws to regulate and restrict the use of existing human tracking systems. Finding the right balance between customer service and privacy invasion will be a major goal for the future.

Applications. The application areas for location-based decision support are many. Currently, the most popular services are mobile guides and navigation services. Mobile guides provide users with a wealth of information about their surrounding environment, and many expect that they will gradually replace traditional analogue tour guides. Wayfinding and navigation services provide route instructions to both car drivers and pedestrians. One of the challenges in providing optimal wayfinding instructions for pedestrians is the representation of the navigable space, because, unlike car drivers, pedestrians are not bound to street networks, which leads to more complex calculations. Recent research has focused on the integration of analog and digital media, such as the combination of static paper maps and digital displays. This integration can be accomplished through the use of mobile phones that are equipped with cameras. In this way, digital information, such as the location of nearby automated teller machines or restaurants, can be displayed on top of an analog map. Future mobile guides will be able to access knowledge from online repositories and use this content to create educational audio tours starting and ending at stationary city maps.

Emergency services are another key application of location-based decision support. Automatic positioning methods and communication technology help to save critical time during rescue operations, such as in car accidents when injured people are unable to report their location. Mobile emergency services can help rescue teams improve their response operations by receiving location-sensitive information and instructions from an emergency operations center. Such a center locates and coordinates its emergency crews in the field through Global Positioning System (GPS) technology and provides up-to-date information and decision-making parameters to them.

Location-based decision support can be used in a wide range of applications for businesses and administrations. Mobile commerce allows people to make transactions on the move and receive location-based advertisements, such as electronic discount coupons for restaurants in the surrounding area. Commercial enterprises use LBS to calculate optimal delivery routes for shipping goods based on their customers' locations and up-to-date traffic information. Administrations are supported by location-based technology in the areas of asset management and local commerce.

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Recently, a novel form of location-based services has emerged in the area of social networking. These services can determine the locations of friends and family members, and a user is notified by the service when one of her friends comes within a certain geographic proximity. Decision support includes the selection and suggestion of meeting points and activity locations, such as a restaurant to spontaneously meet for dinner.

For background information *see* AUTOMATED DECISION MAKING; DECISION SUPPORT SYSTEM; DECISION THEORY; MOBILE COMMUNICATIONS in the McGraw-Hill Encyclopedia of Science & Technology.

Martin Raubal

Key Words: LBDS; LBS; location-based decision services; location-based services; mobile decision making

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