Vehicular Mobile Commerce

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Telematics systems combine communications and information technologies. For example, General Motors' GPS-based OnStar system connects subscribers with a call center advisor who can remotely give map directions, diagnose mechanical problems on the road, unlock a door if the keys are locked inside, track a stolen vehicle, direct emergency support to the driver's location, and provide other useful services. The system also offers hands-free calling and access to e-mail, stock quotes, sports news, and other data on the Internet.

In recent years, growing interest in mobile commerce among users, service providers, content developers, businesses, and researchers has spawned many new applications—including location-based services, mobile financial services, multiparty interactive games, and mobile auctions. Most of these applications are designed to be accessible via personal digital assistants or cell phones, but handhelds have limited capabilities and are impractical or dangerous to use while driving.

Increased computing and communications power, coupled with advances in wireless networking technology and the explosive growth in wireless local area network (WLAN) deployments, have the potential to enable new m-commerce applications for drivers or passengers in motor vehicles. These applications range from entertainment and business services to diagnostic and safety tools. However, for vehicular m-commerce to become a reality, researchers must address a number of technical challenges.

Emerging motorist-oriented applications face difficult technical obstacles.

CURRENT TECHNOLOGIES

Many vehicles today already offer wireless communication systems that can facilitate vehicular m-commerce. For example, Bluetooth short-range connectivity is currently available in more than 30 car models in North America, and by 2008 will be fitted in more than 20 million vehicles worldwide (www.phonecontent.com/bm/news/gnews/351.shtml). With these systems, drivers can use Bluetooth-enabled cell phones—which can remain conveniently stored away in a briefcase or purse—while keeping their eyes on the road and their hands on the wheel.

Once a luxury item, satellite navigation systems are now available at more modest prices. These systems—which can be installed or ported from one vehicle to another—use Global Positioning System (GPS) signals to help drivers get where they want to go, displaying up-to-date maps and route information on an LCD screen. Newer systems give drivers turn-by-turn verbal guidance over the vehicle's radio speakers.

Two satellite radio systems, Sirius Satellite Radio (www.siriusradio.com) and XM Satellite Radio (www.xmradio.com), currently provide US subscribers with more than 120 channels of commercial-free, digital-quality music, news, sports, traffic and weather information, and entertainment.

EMERGING APPLICATIONS

Figure 1 shows emerging vehicular m-commerce applications that would serve consumer, business, and government needs.

Wi-Fi hot spots. Automakers are exploring ways to cost-effectively turn vehicles into wireless hot spots capable of providing occupants, and even users outside the vehicle while it is stationary, with Internet access. The problem is the lack of a backhaul connection: An in-car base station or WLAN—soon to appear in select BMW limousines (www.vnunet.com/news/1154973)—requires the installation of bulky and expensive hardware.

As one step toward this goal, Ford is prototyping a Lincoln Navigator with a stereo system that contains a Wi-Fi antenna hidden in the dashboard (www.freep.com/money/tech/mwend24_20040624.htm). Users can upload MP3 files to the SUV's entertainment system from a computer within range running on a local wireless network—for example, a home computer system or a laptop in a Wi-Fi-enabled coffee shop.

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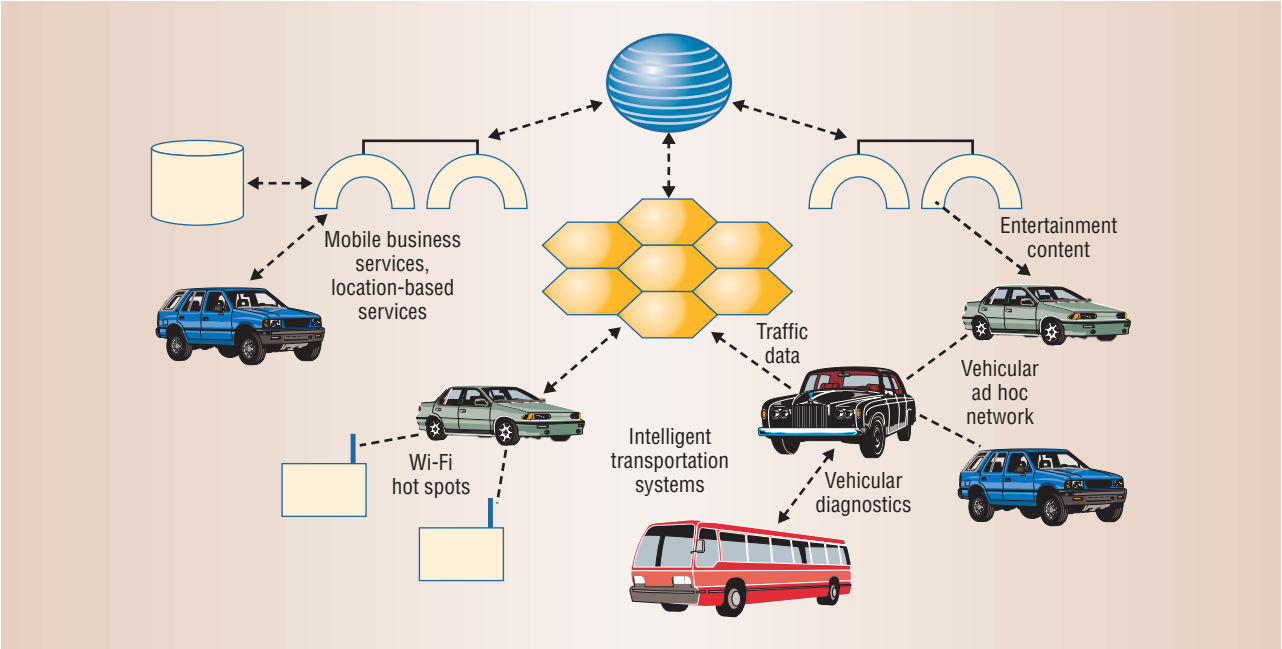

Figure 1. Increased computing and communications power may soon enable a wide range of vehicular m-commerce activities.

In-car Wi-Fi connectivity could be used, in conjunction with high-speed WLANs deployed at gas stations, toll booths, fast food restaurants, parking kiosks, and other drive-through locations, to let drivers order and pay for services—in some cases, in advance—from within a vehicle.

Entertainment content. Full in-car Internet connectivity would enable a wide range of motorist-oriented applications beyond reading e-mail and surfing the Web. For example, passengers could access on-demand news, movies, sporting events, and other types of digital entertainment on built-in TV screens. In addition, vehicles could form ad hoc networks to let occupants communicate with one another or play games.

Mobile business services. Mobile business services would let drivers download company data, purchase products, participate in mobile auctions, and conduct other transactions, helping to reduce the economic losses and frustration associated with long commutes and roadway congestion.

Location-based services. Using a vehicle's current position, location-based services could provide occupants with customized content upon request, such as up-to-date traffic reports and seating availability at nearby restaurants, or they could proactively push user-sensitive advertisements and other types of information—for example, that a friend connected to the same system is in the area. Each geographical region could have its own database that maintains location information of all fixed entities, and the system could perform location tracking of mobile and portable entities on demand.

Traffic data. Vehicles equipped with wireless connectivity and special sensors could collect and transmit real-time traffic and environmental data—for example, information about driving habits, roadway congestion, and pollution levels. Engineers could use this information to better manage highways and to design more intelligent transportation systems. A pilot project along these lines cosponsored by the US Federal Highway Administration, the Georgia Department of Transportation, and Georgia Tech is under way in Atlanta using a fleet of 500 "traffic spies" equipped with an onboard computer and GPS unit (www.spectrum.ieee.org/WEBONLY/wonews/apr04/0404cars.html).

Vehicular diagnostics. Higher-end vehicles with sophisticated computing and communications abilities could act as diagnostic tools by wirelessly exchanging information with both moving and stationary vehicles. This could facilitate preventive maintenance and minimize roadway breakdowns. Vehicles could also transmit safety messages to one another, such as a warning about an accident or highway debris.

INTERVEHICLE COMMUNICATIONS

As a mobile platform, using a motor vehicle presents distinct technical challenges. Although a grid of WLANs could support communications among vehicles traveling at low and medium speeds, the handoffs and processing required to accommodate fast-moving vehicles would overwhelm many smaller cells.

In addition, creating an ad hoc network among nearby vehicles is difficult due to factors such as brief contact time, high speeds, interference with

other devices using ISM bands, fading, network traffic congestion, and unpredictable obstacles such as a large passing truck or tunnel.

Nodes rapidly joining and leaving vehicular ad hoc wireless networks would also create substantial processing and membership overhead. A major problem with using moving vehicles as routers is determining how many are needed to create a reliable intervehicular wireless network.

Unreliable intervehicle communication could interrupt transactions and disrupt applications that require continued group connectivity, such as interactive mobile games. Until researchers can overcome this obstacle, many service providers will be hesitant to invest in these technologies.

DISTRACTIONS

Some are concerned that adding a range of new motorist-oriented mobile services will only make the roads less safe. Studies indicate that a high percentage of collisions occur when drivers are eating, grooming, conversing with passengers, fumbling with dashboard controls, reading a fold-out map, and engaging in other distracting activities. For this reason, most countries and several US states and cities already prohibit or restrict handheld use while driving (www.iii.org/media/hottopics/insurance/cellphones).

However, integrating vehicular m-commerce services with voice-activation technology would let drivers keep their hands on the wheel and their eyes on the road. Advertisements could also be made context-sensitive to avoid distracting the driver.

It is important to keep in mind that many vehicular m-commerce services will actually enhance highway safety—for example, by announcing road closings or bad weather ahead, helping to diagnose a mechanical problem, or keeping chatty passengers occupied browsing the Web or watching a movie.

OTHER OBSTACLES

Vehicular m-commerce will require some form of mobile money system to pay for entertainment content, electronic tolls, diagnostic services, and so on. "V-money" could also be used to locate another nearby vehicle capable of broadcasting required information.

Developing appropriate pricing—flat-rate, per-transaction, or subscription-based—for vehicular m-commerce applications will be a major hurdle for service providers. Pricing schemes must be flexible to accommodate a wide range of potential services, yet clear to the common user. In the case of group applications, in which demand for services can fluctuate significantly, determining how to divide costs among multiple users is also a challenge.

Many vehicular m-commerce services would require the installation of expensive new electronics and sensors that will be beyond the means of most consumers, at least in the near future. In addition, any applications must avoid compromising the primary role of onboard computing and communications systems—to improve driving performance, reliability, and safety.

Competing wireless standards may limit deployment of many promising systems, while other applications will require further study—for example, in the case of systems that must be left on continuously, how to avoid draining excessive power from a parked car's battery.

New security and privacy concerns must also be addressed. For example, mechanisms must be in place to prevent hackers from introducing viruses affecting vehicular operation. In addition, law-enforcement authorities could potentially snoop on vehicles transmitting wireless data to monitor compliance with speed limits and other laws.

If researchers can meet the many challenges in protocol design, message routing, retransmission support, and so on that are required to ensure reliable in-car wireless connectivity, vehicular applications could become an important part of emerging m-commerce. With increased computing and communications capabilities, and considerable idle time, vehicles offer a powerful and largely untapped resource. ■

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