Editor: Alberto Broggi
University of Parma, Italy
broggi@ce.unipr.it

Telematics: Safe and Fun Driving

Yilin Zhao, *Motorola*

In this installment, Yilin Zhao describes current and future wireless applications that will likely become our companions in future journeys. This interesting article shows how the concept of personal vehicles has changed in the last decades. Our vehicles will become not only a safe and comfortable means of transportation but also a digital platform for entertainment and access to a vast quantity of information while traveling.

If you have any comment on this department, feel free to contact me. I also seek contributions on the current status of ITS projects worldwide as well as ideas on and trends in future transportation systems. Contact me at broggi@ce.unipr.it; www.ce.unipr.it/broggi.

—Alberto Broggi

As our society rapidly advances toward an information age, more and more people and their vehicles will depend on wireless technologies to keep them connected with others and to facilitate safe, efficient travel.

Europeans have coined a term for this exciting field: *telematics*—that is, the use of computers to receive, store, and distribute information over a telecommunications system. The automotive industry quickly adopted the term to describe any system that provides location-based services for a vehicle over the wireless telecommunications network. In other words, telematics now generally refers to any automotive system that combines wireless technology with location-based services.

With more than 40 million vehicles sold worldwide each year and more than 935 million cellular customers by the end of 2001, the automotive telematics market is poised for explosive growth. Strategy Analytics estimates that by 2007, approximately 55 percent of all new cars will have a telematics-capable terminal, as compared to approximately 7.5 percent in 2000.[1] As Figure 1 shows, the revenue for the world market of in-car telematics terminals is expected to increase from $5.5 billion in 2000 to $19.9 billion by 2007. Meanwhile, telematics systems should increase from 4 million units in 2000 to 27.4 million units by 2007 (including both original-equipment-manufacturer and aftermarket units). In the US alone, according to a Strategis Group study, revenues from automotive telematics equipment and services are projected to rise from less than $100 million in 1999 to over $5.3 billion by 2005.[2] The number of subscribers will likely grow from under 0.2 million at year-end 1999 to more than 17 million by 2005. All these market studies indicate that telematics systems have a promising future and should be economically rewarding.

Mayday systems

A typical example of an automotive telematics system is a *mayday* (or emergency call) system.[3,4] This system instantly connects vehicle occupants to a service center for emergency assistance or roadside services while automatically reporting the vehicle's position. Many people in the US view such a system as their top priority when adding new equipment to their vehicles. It can expand to include many other services such as remote door unlocking, remote engine diagnosis, theft detection and notification, stolen-vehicle tracking, airbag deployment notification, automatic route guidance, travel information, and hands-free or voice activation of a mobile phone or pager.

An ATX Technologies survey of their telematics subscribers has confirmed the popularity of telematics systems.[5] Approximately 70 percent of the subscribers indicated they would require a telematics system on the next vehicle they purchase. Over 80 percent would recommend the system to a friend or acquaintance. Because of this popularity, many automobile manufacturers have been and are now bundling it as an original-equipment-manufacturer unit for new cars. In the future, such systems will be able to add even more safety, security, and fun features, including connection to the Internet, control by enhanced voice recognition, and interfaces to entertainment equipment.

A mayday system uses a cellular phone for voice and data communications and an onboard global positioning system (GPS) receiver for positioning. (For a list of abbreviations used in this article, see the sidebar.) The system's key features are its ease of use, cost-effective location capability, and on-demand wireless communication capability. Users can manually activate a mayday system by pushing a button, or the system can activate automatically when one of the vehicle's safety sensors detects an emergency event. With on-demand communications, the system does not need to communicate with the remote host on a regular basis, unlike most automatic-vehicle-location systems. This drastically reduces silent air time and its associated expenses.

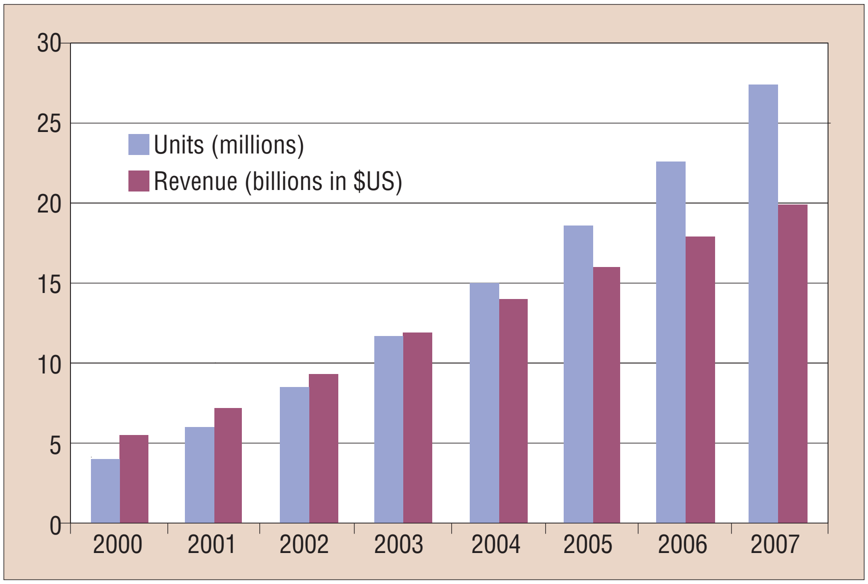

Figure 1. The telematics forecast for North America, Western Europe, and Japanese markets (source: Strategy Analytics).

How they work

Figure 2 depicts the basic modules or subsystems for first-generation mayday systems. Both ends of the system can include additional modules to expand its functionality.

General Motor's OnStar and Ford's Vehicle Communication System are good examples of mayday systems. With OnStar, the user activates the system by pushing one of three buttons on an overhead console. The OnStar button connects the user to an OnStar advisor, the emergency button places a priority call to an advisor, and the answer/end button either answers or ends a call from an advisor.

Once the user presses the OnStar or emergency button, a system status light in the overhead console flashes. On certain vehicles, a multifunction display in an instrument cluster then shows status messages. The vehicle's cellular phone automatically calls the service center. Immediately after the communications channel is established, the system sends the vehicle identification number (VIN), position information obtained from the GPS receiver, and other user and request-related data to the host over the cellular phone network's voice channel. Preferably, the system then confirms the vehicle's location using a map from the service center's map database. Without the VIN and the position and user data, locating the caller and obtaining vital information on time are difficult. Thus, the data sent over the wireless communications channel must be reliable. In general, other telematics systems have a similar working mechanism but might use a data channel to transmit the VIN and the position and user data.

On receiving the data transmitted from the in-vehicle telematics system, the service center converts the GPS coordinates to a local map grid, contacts the proper service providers, and directs them to the vehicle. For instance, in a medical emergency, the

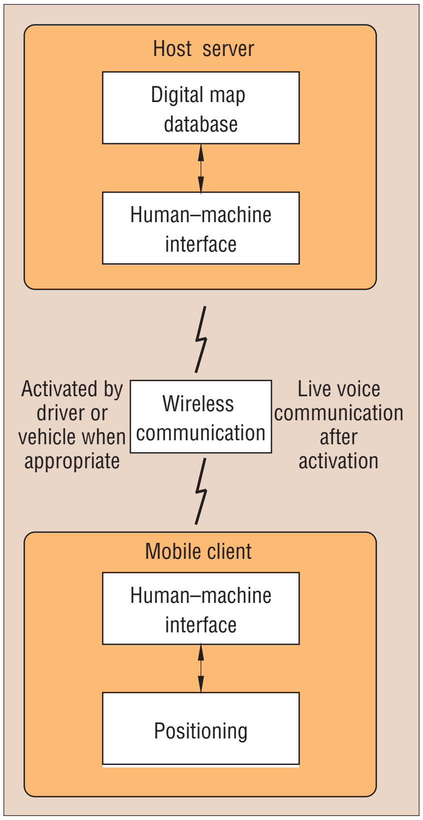

Figure 2. A simplified mayday system's architecture.

Abbreviations

AMPS	Advanced Mobile Phone System
CDMA	Code Division Multiple Access
GPRS	General Packet Radio Service
GPS	global positioning system
GSM	Global System for Mobile Communications
iDEN	integrated Digital Enhanced Network
PDC	Personal Digital Cellular
SMS	Short Message Service
TDMA	Time Division Multiple Access
TDOA	Time Difference of Arrival
TOA	Time of Arrival
UMTS	Universal Mobile Telecommunications System
VIN	vehicle identification number
W-CDMA	Wideband Code Division Multiple Access

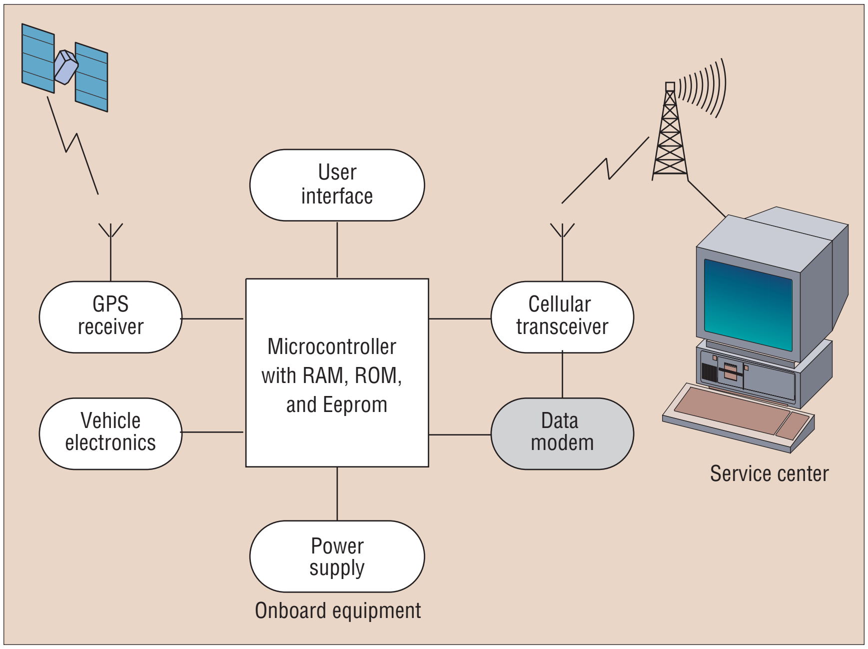

Figure 3. A basic telematics system. An analog system requires a data modem (shown in gray) for the cellular transceiver; a digital system does not.

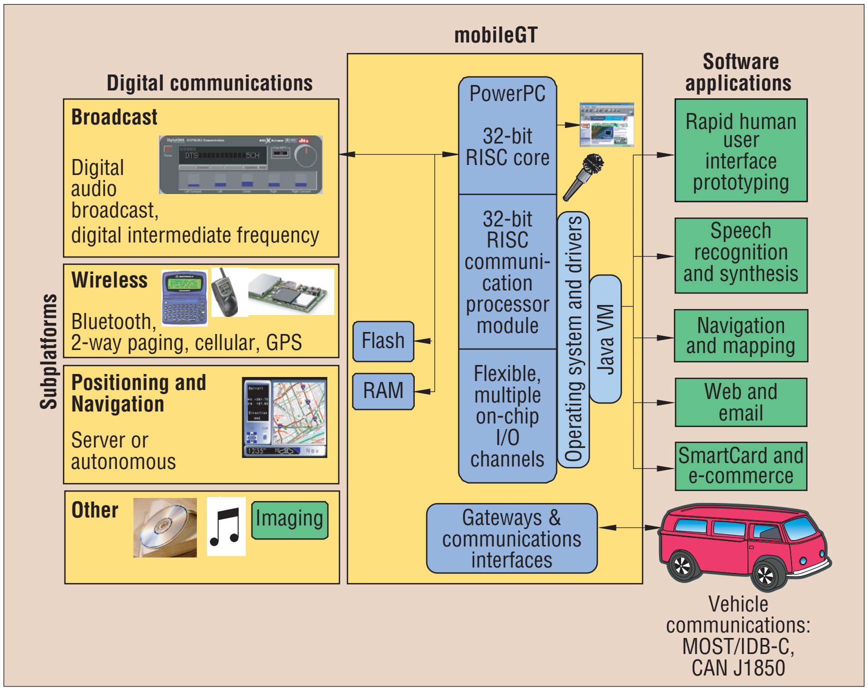

Figure 4. Motorola's mobileGT for telematics systems.

service center will contact the nearest 911 public-safety answering point and dispatch an ambulance. (The US uses the phone number 911 for emergency assistance. Other countries might use a different number, such as 999 for the UK, 17 for France, and 110 for China.) For a vehicle breakdown, the service center notifies a designated roadside service provider, which dispatches a tow truck.

If required, the service center operator can talk with the driver until help arrives and notify designated family contacts in an emergency. When the user requests roadside assistance, the center can provide an estimated time of arrival and call back to confirm that the problem has been resolved.

Analog & digital systems

Mayday systems can be either analog or digital, depending on the cellular network used. Analog mayday onboard equipment typically consists of a microcontroller, a GPS receiver, a cellular transceiver, a data modem, and other control circuits (see Figure 3).[6] In this setup, the system sends the VIN and the position and user data over the cellular network via the modem. Current North American mayday systems use the Advanced Mobile Phone System (AMPS), which is an analog-based cellular network. These analog mayday systems must use the voice channel to transmit the data. GM's OnStar and Mercedes Benz's US version of TeleAid are typical examples of such systems.

Markets other than North America use digital-based GSM (Global System for Mobile Communications) cellular networks. Digital mayday onboard equipment is usually like that for an analog system (see Figure 3), except the digital system does not require a data modem for the cellular transceiver. For data transmission, certain systems might be able to use both the *Short Message Service* and circuit-switched data. Other systems might use SMS only. With SMS, the system can deliver the data without interrupting voice conversations. However, SMS has limited capacity (up to 140 characters) and cannot always guarantee instant message delivery, owing to its store-and-forward nature. Because of the advance of telecommunication systems, future telematics systems will gradually adopt GPRS (General Packet Radio Service), W-CDMA/UMTS (Wideband Code Division Multiple Access/Universal Mobile Telecommunications System), and CDMA2000 as their communications media. BMW's Mayday Phone, Mercedes-Benz's TeleAid, and Renault's Odysline are typical examples that use GSM cellular networks for communication.

Integrating communication and location devices

In current mayday systems, the location device and communication device are separate items integrated into one package. Generally, the cellular phone, its transceiver, and the location device are permanently attached to the vehicle. This will soon change as new mobile phones incorporate location determination in the handset. The US Federal Communications Commission requested manufacturers to begin selling and activating location-capable handsets no later than 1 October 2001. Telecommunication standards organizations have already developed specifications for a variety of location methods, such as Assisted GPS, Time of Arrival (TOA), Time Difference of Arrival (TDOA), and Cell ID.[7] Eventually, the location and communication devices will become a single unit.

Table 1. A comparison of three open telematics protocols: the Application Communication Protocol, Global Automotive Telematics Standards, and the Motorola Emergency Messaging System.

Protocol	ACP	GATS	MEMS
Bearer independence	Yes	No	No
Built-in security	Yes	Yes	No
Centralized route guidance	Yes	Yes	No
Concierge	Yes	Yes	Yes
E-commerce	Yes	No	No
Email	No	No	No
Internet	No	No	No
Mayday call	Yes	Yes	Yes
Multimedia	No	No	No
Points of interest	Yes	Yes	Yes
Remote vehicle control	Yes	No	Yes
Roadside assistance	Yes	Yes	Yes
Traffic information	Yes	Yes	No
Vehicle tracking	Yes	Yes	Yes
Weather	Yes	No	Yes

Standards

The telematics market's growth has posed many challenges. Owing to the large customer base for personal-communications products, there are and will be many different *bearer services* (telecommunications services that let users transfer information over the air), including AMPS, GSM, GPRS, cdmaOne, TDMA (Time Division Multiple Access), W-CDMA, and CDMA2000. Despite the involvement of many highly visible organizations and the clear advantages of open, flexible, and evolving standards over proprietary ones, there are no widely accepted telematics standards. Currently, at least four standards are available for protocols between in-vehicle systems and content providers: the *Application Communication Protocol*, *Air Interface Specification*, *Global Automotive Telematics Standards*, and the *Motorola Emergency Messaging System*. ACP works with a variety of cellular networks, such as GSM, CDMA, TDMA, GPRS, PDC (Personal Digital Cellular), iDEN (*i*ntegrated *D*igital *E*nhanced *N*etwork), and AMPS.[8] AIF is a proprietary protocol for OnStar systems.[9] GATS is for GSM networks.[10] MEMS is a protocol for analog AMPS networks.[11] Table 1 compares ACP, GATS, and MEMS. For standards activities and

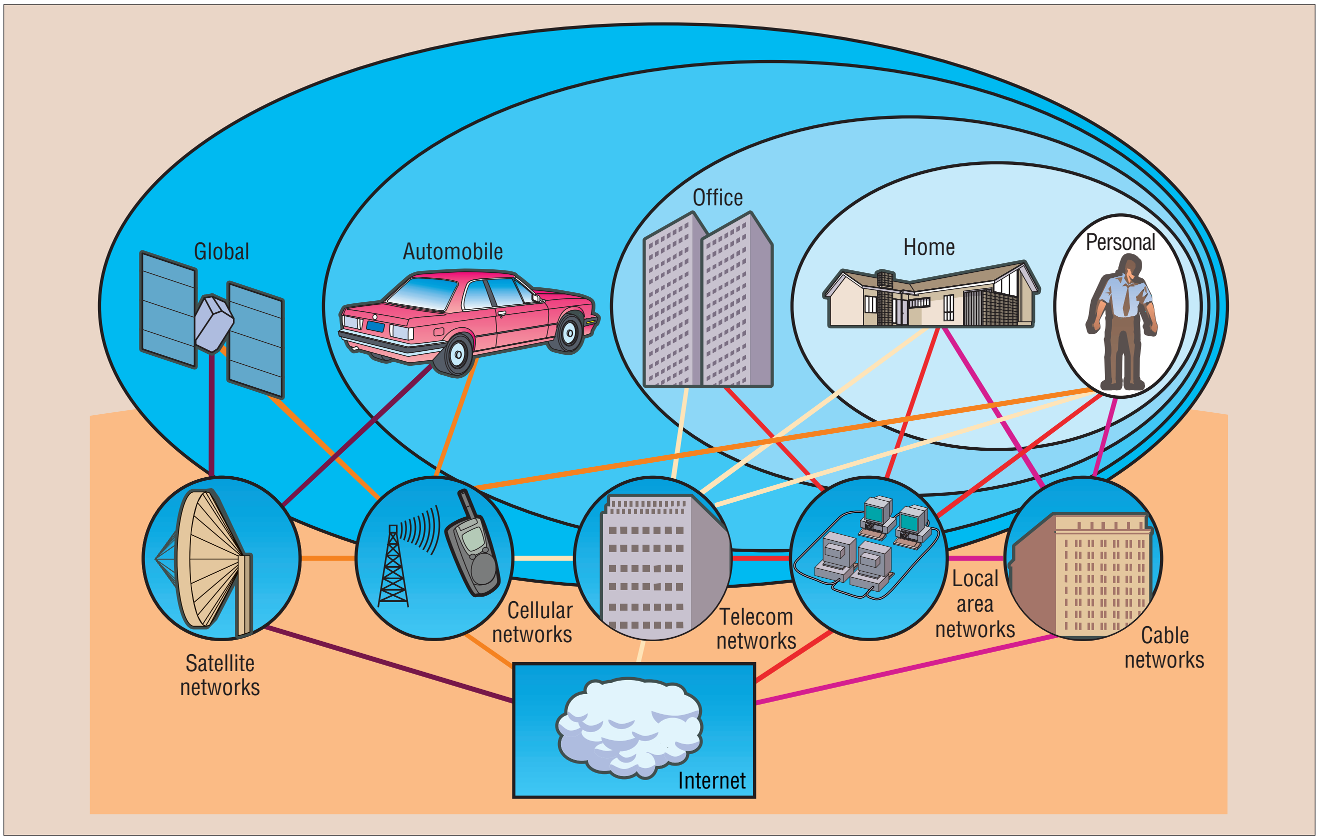

Figure 5. The connected society.

other relevant information, see "Evolving Telematics Systems and Standards."[12]

A single-platform example

As an example of future telematics systems, consider one based on Motorola's mobileGT (see Figure 4). mobileGT aims to provide a hardware development platform that lets tier-one suppliers (those primarily responsible for supplying goods directly to automotive manufacturers) create products based on Motorola's PowerPC microprocessor family.

Installed in the automobile, mobileGT along with its supporting software will handle all the tasks that cellular phones, pagers, PDAs, Web servers, GPS receivers, and security systems now control. It will also offer an audio entertainment system enabled for digital-audio broadcast and CD-quality sound. Through natural speech recognition, a simple voice command will initiate an emergency telephone call or summon roadside assistance. Without drivers having to take their hands off the wheel, the system will help them find the nearest gas station, hotel, or ATM machine. Embedded software modules, such as a digital map database, route planning, and route guidance, will achieve these tasks.[4] If all the major functions are fully activated, the system will let both driver and passengers check email, consult a personal calendar, and review vehicle maintenance schedules. When the vehicle is due for an oil change or new air filter, the car dealership will be able to simply send a reminder through the system.

In certain circumstances, the platform's software can be a part of the iRadio Telematics System software. This software provides a higher-level applications framework for automotive manufacturers, service providers, wireless carriers, and third parties to create services for the telematics market. However, both mobileGT and iRadio can be used independently as well. For example, Motorola's navigation server, part of the iRadio navigation application, together with Trafficmaster's real-time, traffic flow data create the Trafficmaster Smartnav service. Smartnav delivers turn-by-turn routing instruction and dynamic route guidance through many device types, from cellular telephones to fully embedded telematics units.

As the mobileGT example shows, future telematics systems will be offered in a single platform and will include many customized services such as information and entertainment (or infotainment, for short) and wireless Web connection. These systems will be an integral part of a connected society (see Figure 5). The Internet will play the key role of providing a backbone for data delivery. A global backbone with countless local access points will give the mobile community easy access to vast amounts of information services not previously available. Not only the automobile, home, and office but even the person will become an access point. All these wired and wireless connections and technology advances will make our cars safe and fun to drive. They will also make our transportation systems operate more safely and efficiently, with less congestion, pollution, and other environmental impact. ■

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The Author

Yilin Zhao is a Distinguished Member of the Technical Staff at Motorola. His research interests include intelligent transportation systems, mobile-phone architecture and its positioning systems, vehicle location and navigation systems, integrated-circuit place-and-route systems, and real-time computer systems. He received his BE from Dalian University of Technology and his MS and PhD in electrical engineering: systems from the University of Michigan. He is a senior member of the IEEE, vice president of the IEEE ITS Council, and associate editor of the council's *Transactions on Intelligent Transportation Systems*. Contact him at Motorola, 600 N. US Hwy. 45, Libertyville, IL 60048; yilin.zhao@motorola.com.