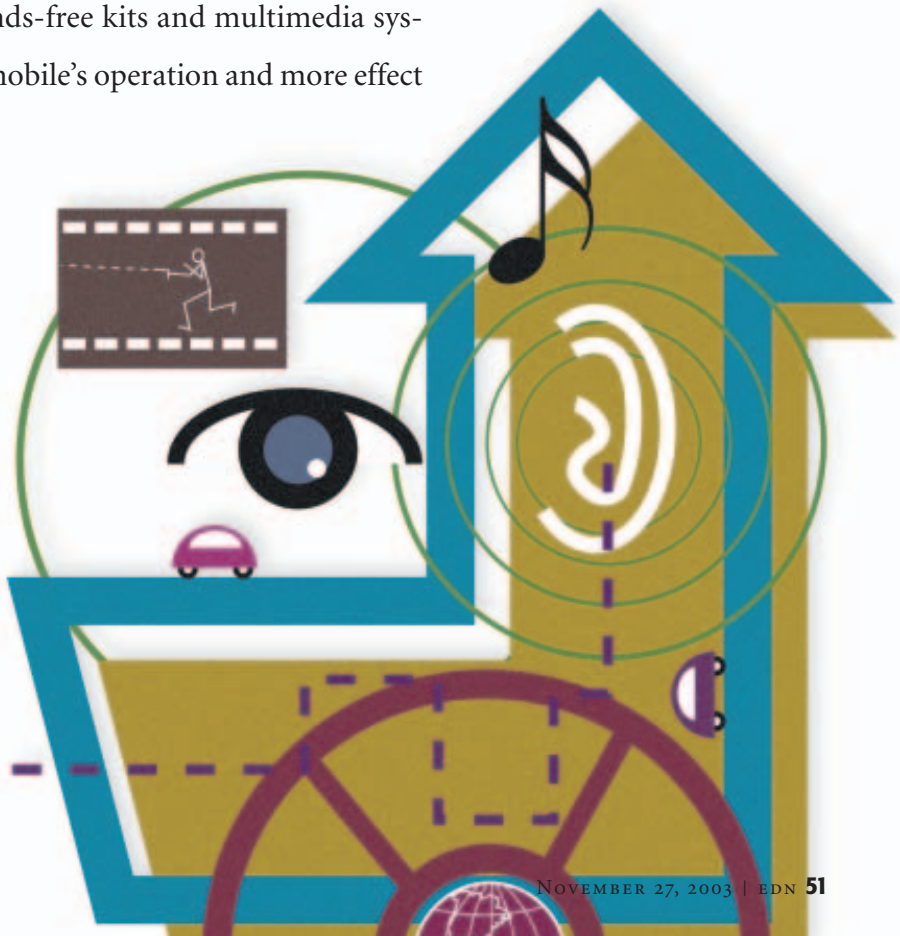
TELEMATICS IS AN UMBRELLA APPLICATION THAT COMBINES LOCATION-BASED INFORMATION SERVICES WITH TWO-WAY WIRELESS CAPABILITY FOR COMMUNICATION WITH THE OUTSIDE WORLD.

A LOOK AT TELEMATICS

Some of the most visible recent innovations in automobiles, such as telematics, have little to do with the automobile's operation itself. The inclusion of hands-free kits and multimedia systems have less effect on the automobile's operation and more effect on improving the drivers' and the passengers' ability to do nondriving activities, such as having a cell-phone conversation or watching a movie. The convergence of communications, entertainment, information, and engine electronics is the driving force behind the emerging telematics industry.

The concept of telematics is one that currently lacks a clear and consistent definition across the industries that support telematics-application development. This inconsistency results from the fact that the definition and expectations are constantly changing about what a telematics system, as an emerging application, can do. Further adding to the uncertainty of what telematics means is that the industry includes under the telematics umbrella other embedded functions, such as pure navigation and multimedia systems. The telematics industry copes with the imprecise definition by focusing on the functions of an application module, such as hands-free, video, and radio, rather



than referring to telematics boxes.

The underlying and fundamental capabilities that make up a telematics system are combining location-based information services with two-way wireless communication with the outside world. A telematics system comprises not only the hardware and software embedded within a vehicle or mobile device, but also the centralized server infrastructure that publishes and collects the data exchanged with a vehicle or mobile device.

To clarify, navigation systems or cell phones separately built into a car do not constitute a telematics system. The navigation system has position information, but data flows only one way. Cell phones provide two-way communication, but they are not location-aware. When you integrate the two, you have combined the essential capabilities for a telematics system that can provide you with information relevant to your current location. This concept applies not only to cell phones and automobiles in consumer electronics, but also to any application in which you can tie dynamic information to a location, such as mobile asset tracking; marine and mass transit; surveying, traffic management; and police-, ambulance-, and fire-service delivery.

The telematics concept originally applied to cell phones, but the focus has significantly migrated to services integrated into automobiles because of the volume and perceived larger market for location-based safety, security, notification, tracking, and customized infotainment services. Technically, a telematics system does not perform a user function but is an umbrella application that combines and integrates the location or positioning module, the wireless-network-access device, the user interface, and the chassis-level network (**Figure 1**).

AT A GLANCE

- Telematics is location-aware networking.
- The telematics industry lacks interface and interoperability standards.
- Flexibility is key for a telematics system to survive the expected lifetime of a vehicle.
- Preserving personal privacy with location-aware services is an emerging issue.

The location or positioning module is usually GPS-based, but it could employ cell-based methods if you need to provide only local, limited coverage. The wireless-network-access device is often cellular-based. Depending on the application, basic data transfer may occur over existing standards, such as GPRS (General Packet Radio Service). Data transfer can also rely on local wireless hot spots, such as through 802.11- or Bluetooth-access points. The design of the user interface, especially for vehicle systems in the United States, is stressing hands-free-interface and speech-recognition technologies (see **sidebar** "Competing for cognitive cycles"). The user-interface design is beginning to incorporate Bluetooth and USB interfaces to operate with users' mobile devices. The chassis-level network for automobiles, such as through CAN (controller-area-network) and J1850 interfaces, provides a gateway into the vehicle-command, -control, and -diagnostics and infotainment systems.

Telematics-service providers currently base these services on subscription or fee-for-use models because of the significant infrastructure required to make these dynamic services work (**Figure 2**). A telematics-enabled navigation system not only can direct you to your destination, but also, by tracking your location and communicating with the central server, can dynamically reroute you around traffic delays. Some telematics-enabled systems can convey your exact location and assist in contacting emergency services if you experience a breakdown or an accident. A challenge for telematics services is how the infrastructure can provide 100% connectivity. Cellular service is not global within the United States, but it is the most popular and ubiquitous connection mechanism.

CHALLENGES

The telematics industry sees a promising future for embedded telematics. Persistent two-way data transfers enable only relevant information to reach users where and when they need it and allow

COMPETING FOR COGNITIVE CYCLES

According to the NHTSA (National Highway Traffic Safety Administration, www.nhtsa.dot.gov), driver distraction and inattention to the road are significant contributors to automobile accidents. Drivers' handheld-cell-phone use while driving is one of the most visible and controversial sources of driver inattention. As a result, recent legislation efforts are aiming to limit handheld-cell-phone and other similar-device use while users are driving. The Network of Employers for Traffic Safety (www.trafficsafety.org) cites drivers' spilling hot coffee on themselves or dropping something on the floor while driving as the most frequent distractions preceding automobile accidents. The organization cites fiddling with a radio or a climate-control system as the second biggest distraction.

New telematics-system vendors are focusing on providing hands-free interfaces and speech-recognition technology in an attempt to address the driver-distraction and safety issues. However, according to the American Automobile Association Foundation for Traffic Safety (www.aaafoundation.org), hands-free phones are also a source of driver distraction and inattention. The new in-car navigation systems are an additional source of distraction. A computer voice can tell you when to turn or change lanes, but the display screen can still be a source of distraction that takes your attention from the road. Some systems address this source of distraction by denying the driver access to the map display while the vehicle is in motion.

With vendors considering new, nondriving-related functions, such as e-mail and Web browsing, for future telematics systems, can designers provide these functions to the passengers without creating a source of distraction for the driver? An NHTSA test involving a car-following task shows a 30%, or 310-msec, increase in reaction time to a periodically braking lead vehicle when a speech-based e-mail system was present. Subjective workload ratings also indicate that speech-based interaction introduces a significant cognitive load on the driver. Product liabilities aside, a large risk to telematics vendors is devoting significant resources to designing and offering a product that lacks demand because it requires restricted use or is perceived as unsafe.

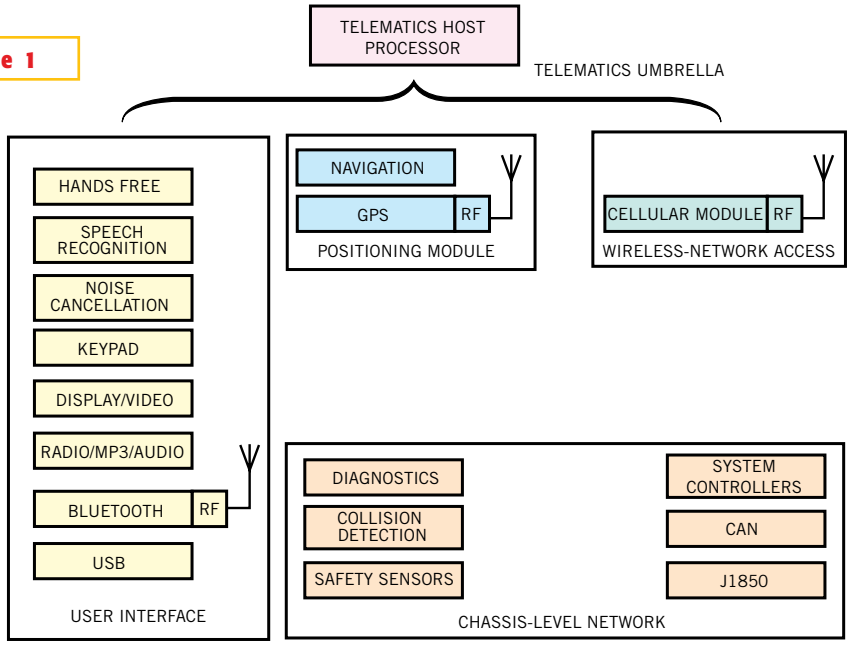
the telematics-service provider to collect and act on trend data in a way that was previously impossible. Two important aspects of persistent two-way data connectivity are the availability and type of wireless services. The challenge is that, even though densely populated regions may have extensive coverage, many gaps in service still exist in other areas. Some design approaches to address that challenge include boosting the transmitting power in remote areas, relying on multiple communication methods, and notifying users when service is unavailable.

Another challenge is that the telematics industry is still in its infancy, and no global standards exist for an industry-unified architecture or interoperability requirements. Each component of an automotive-telematics system may use a different interface—even among vehicle models from the same manufacturer. This lack of a common interface requires developers to create custom designs that make it difficult to extend and update the systems across many platforms. The IDB (Intelligent Transport Systems and Services Data Bus) Forum, OSGI (Open Services Gateway Initiative), AMI-C (Automotive Multimedia Interface Collaboration), and Ertico are focusing on standards issues.

Telematics-system integrators are using modular architectures to allow them to maintain flexibility and to be able to choose modules from multiple sources. They are transferring some module functions from other high-volume consumer markets, but they may have to qualify these modules for quality, reliability, operating temperature, and manufacturing requirements in an automotive environment. Maintaining these modules as separate components allows the system integrator to more easily replace them if a new technology becomes available.

In conflict with design flexibility, decreasing system and ownership costs is a prerequisite to driving a high-volume telematics market. To address ownership costs, telematics designers are exploring whether to combine a user's cellular serv-

Figure 1



A telematics system is an umbrella application that integrates the functions from the user interface, the positioning module, the network-access device, and the chassis-level network.

FOR MORE INFORMATION...

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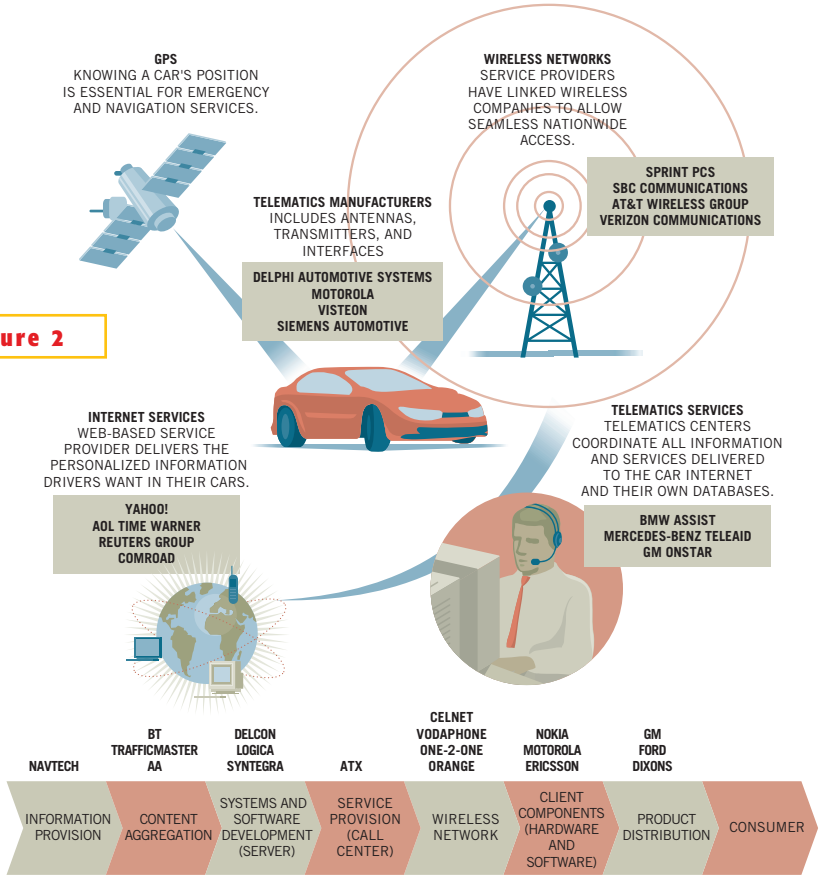
ice with that in the vehicle to avoid paying for redundant services. Relying on the user's cellular handset rather than a dedicated, embedded system in the vehicle for connectivity can avoid the cost of redundant service, but it introduces problems if you need to rely on that handset for emergency-notification functions, because you cannot assume the handset is powered on or even operational in the event of an accident.

To address system costs, many telematics-platform providers are offering highly integrated platforms that may span multiple providers for hardware, operating systems, software architectures, API specifications, and application software. These platforms provide chip- and board-level resources and processing capacity to implement multiple telematics functions on a single device. However, the lack of clear interface standards creates a high-risk integration challenge for platform providers. As a result, the platforms are including integrated support for multiple wireless-communication standards to support immediate interfacing opportunities and to mitigate the early obsolescence that would occur if designers were to choose an interface that became ultimately unpopular.

Figure 2



The telematics value chain includes multiple players that provide the infrastructure for telematics services (courtesy Xilinx).

Obsolescence is a specific concern for telematics designers because the design and life cycles of consumer products do not match those of automotive products. The life cycle for a vehicle is one to two decades, whereas the life cycle for consumer electronics is much shorter. The challenge is how to develop a system that can provide useful services based on the common infrastructure and that also can evolve to support new infrastructure capabilities as they become available. One strategy is to specify resource headroom and resource-expansion capacities into the hardware. Another is to implement software with Java to enable some platform independence.

Automotive upgrades differ significantly from consumer-product upgrades. Automotive upgrades may require a new qualification effort and new source of liability risk for the vehicle manufacturer for each vehicle model. Upgrades may also mean additional ownership costs to users. Because of the liability risk to the vehicle manufacturers, telematics systems will probably remain independent and isolated from critical vehicle functions. Vendors may be able to deliver software upgrades on demand and wirelessly without visiting a car dealership. However, wireless upgrades will have to be able to accommodate security and privacy concerns, including how to prevent malicious upgrades.

Power consumption is generally not a concern for automotive-telematics systems while the vehicle is active. However, irregular, interrupted, and poor-quality power are concerns. Nominal 12V vehicle power can range from about 6V dc during engine start-up to more than 40V if you disconnect the battery while the engine is running. Power from the alternator system can be full of spikes and noise.

When the vehicle is inactive or in standby mode, the power-management challenge for these systems becomes similar to that of any other mobile application. The vehicle battery represents a limited and diminishing power source and is the source of power for the telematics system to perform periodic activities. These activities allow services such as vehicle recovery in the event of theft or the ability for you to remotely unlock the doors using your cell phone. The system must also be able to retain active memory while someone is replacing the vehicle battery.

The telematics systems needs to be able to maintain a low standby power consumption to provide an extended operational period that will not interfere with starting the vehicle even when someone has parked it for several weeks or months. Strategies for doing this maintenance include using systems that can place the CPU and peripherals in standby mode and maintain the program and data memories in low-power mode between periodic checks with the outside network. As the battery charge drops, you can adjust the polling to extend the operational life of the system at the expense of slower responsiveness.

OTHER CONSIDERATIONS

Although automotive telematics is currently the largest area of focus, telematics' scope goes beyond automobiles.

You can also apply location-aware services to cell phones; PDAs (portable digital assistants); airlines; railroads; shipping; mobile asset management; and commercial fleet vehicles, such as trucks, vans, and taxis. Companies such as United Parcel Service and Federal Express provide detailed tracking and monitoring of shipments by using GPS (Global Positioning System) tracking on their delivery trucks, bar-code scanners, and portable signature recorders.

The region you are in primarily drives which telematics features service providers offer. The communication infrastructure is part of any telematics system, and the in-place options vary geographically. The types of services can also vary geographically. In Japan, telematics-system providers base their services on more visual features, such as 3-D wire frames of buildings in a navigation system. Telematics providers in the United States, on the other hand, focus more on safety and security.

The security technology these systems employ should be able to protect against unauthorized access to a vehicle or a mobile device. It needs to authenticate a user's identity before transmitting personal data, and it must protect the system against malicious intrusions. Detected security threats—whether within the vehicle, in the communication infrastructure, or at the service provider—should initiate automatic processes and mechanisms.

As the types of wireless location services expand, users must feel that the system adequately protects the privacy and security of any personal and telematics data. These systems provide telematics-service providers and others information regarding the physical location of their subscribers. The telematics system should allow users to control what private information the system collects, stores, processes, and provides to others. In the end, the widespread adoption of telematics systems that include expanding personal services relies on the confidence of the users that the system will protect their personal information.□

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