The Networked Car

Wireless Bluetooth technology to convert cars into mobile networked multimedia devices

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If you have ever heard the term &quotcar infotainment&quot and wondered what it meant, picture yourself on a long drive, stuck in endless traffic, or in search of directions in a strange city, and suddenly the need for both information and entertainment becomes obvious. We already employ basic forms of car infotainment &#151 most cars have radios, and most people keep maps on hand &#151 but advancements in technology have given rise to more sophisticated systems. Today, satellite-based navigation systems can help motorists avoid traffic by processing data in real time and by calculating alternative routes in seconds, and car audio systems based on digital technology can produce crystal-clear sound that equals studio quality.
In the future, motorists will find themselves using portable computers, mobile phones, and other electronic devices to communicate with each other and the Internet without wires, and while they are actually driving &#151 safely. In essence, network connectivity continues to increase throughout the car to now include multimedia devices. This article gives developers an inside look at SiemensVDO multimedia systems for the car, currently installed in Alfa Romeo, BMW, Lancya Lybra, Land Rover, Opel (GM), Peugeot, Porsche, and Renault cars, and the steps the company is taking to plan for new and exciting features made possible by the latest wireless technologies based on Bluetooth&#153 specifications.

Today's Automotive Multimedia Systems
High-end automotive multimedia systems typically include components that act as fully functioning tuners and CD players, as well as in-car navigation systems. For audio, digital data transmission produces astonishingly high sound quality. Navigation systems provide automatic route planning and directional guidance in the form of acoustic and visual signals, eliminating the need for paper maps. A

traffic message channel (TMC) ensures that the system's radio searches for stations that broadcast ongoing traffic information. The system can then help motorists avoid traffic jams by recommending alternate routes. Some infotainment systems offer visual elements for the car, including high-performance TV tuners and screens that enable mobile TV reception. Back-seat &quotdrivers&quot can connect entertainment elements such as video-game consoles, video recorders, or DVD players for additional in-car entertainment.

The emerging field of vehicle-based information systems is called telematics, which encompasses four technologies: the automobile, computing, wireless communications, and the Global Positioning System (GPS). Several car manufacturers already offer factory-installed telematics systems that offer emergency assistance, navigational aids, and access to personalized communications, like concierge services or voice-synthesis stock quotations.

The most significant developments in car infotainment will enable motorists to use their mobile phones, portable computers, and other electronic devices to communicate with each other via the Internet. This capability is made possible by a combination of wireless technologies such as Bluetooth, increased data transmission rates for mobile devices, and the wireless application protocol (WAP), which means more Internet content can be translated into Wireless Markup Language (WML) for display on mobile phones and devices. In the future, mobile services such as music download, multimedia messaging, interactive games, and mobile commerce (i.e., ordering and paying for purchases via the mobile phone); location-based services, such as hotel-finder; and mobile office applications, such as video conferencing, will become commonplace activities while traveling.

Wireless Communication in the Car

In order to facilitate communication between the various devices in a car, audio, video, graphics, and other data streams have to be transmitted using high bandwidth. Today, data transmission rates are 9.6 - 14.4 kbits per second but they are expected to soar up to 100 kbits per second with 2.5 generation wireless technologies such as General Packet Radio Service (GPRS), which would provide enough bandwidth to enable compelling mobile services. A quantum leap in mobile data transmission is expected to take place by 2003 with the introduction of the Universal Mobile Telecommunications System (UMTS) data standard, which will provide sufficient speed to enable multimedia services with complex color graphics.

The rapidly evolving technology for mobile services while traveling is WAP, the de facto standard for data communication developed by a forum of several hundreds of companies. New capability negotiation schemes will make the output of Internet messages acceptable for the small displays of cellular mobile telephones and for the larger information system displays used in the car, making mobile content easier to develop, manage, and most of all, easier to use.

Bluetooth wireless technology is perhaps the most important breakthrough needed to facilitate wireless connectivity among devices in a car. Bluetooth is an inexpensive wireless interface between computers, mobile telephones, and other portable devices, and as such, it also is suitable for many automotive applications. It is essentially a low-cost, low-power radio interface for personal area networks (PANs) that transmit digital data in asynchronous links and voice signals in real time. Bluetooth is fast, enables seamless device discovery, and eliminates the line-of-sight problem inherent in Infrared wireless technology on the market today. Bluetooth will accommodate distances of up to 30 feet or with additional power

amplifying even 300 feet between peripherals.
Bluetooth also allows devices to become a node on a network of up to seven other devices in a so-called &quotpiconet.&quot As such, Bluetooth enables PANs, with multiple connections to devices throughout the car and beyond.

The Bluetooth Car Profile

The Bluetooth special-interest group (SIG) sponsors the technology, and includes leading telecommunications and computer companies such as Wind River. They have defined the Bluetooth specification, a de facto standard containing the information required to ensure that diverse devices supporting the Bluetooth wireless technology can communicate with each other worldwide. The document is divided into two parts &#151 Volume 1, Core; and Volume 2, Profiles.
The Core section specifies components such as the radio, baseband, link manager, service discovery protocol, transport layer, and interoperability with different communication protocols. The Profiles section specifies the protocols and procedures required for different types of Bluetooth applications with the intent to promote out-of-the-box interoperability between devices from different manufacturers. Of particular interest is the Bluetooth Car Profile because it sets a standard for the automotive industry. It includes the following features:
Hands-free and Phone Access - This feature enables the operation of a mobile phone in conjunction with a hands-free device (installed in the car), with Bluetooth as a wireless means for both remote control of the mobile phone by the hands-free device and voice connections between the mobile phone and the hands-free device. It also enables the ability to access a phonebook database, transfer phone status and short message service (SMS) indication.
Remote Subscriber Identity Module (SIM) Access - This feature is used to personalize the car and its devices. It allows access to a SIM card via a Bluetooth link and it enables car phones to use SIM subscription data.

An Architecture for the Future

SiemensVDO has taken a leadership role by defining a top-level architecture (TLA) to start the design and development phase of next-generation car infotainment systems for major car manufacturers. The TLA defines all of the parameters, including system set-up, interfaces, network architectures, and functional modules of a car infotainment system, making sure to allow for the future integration of new features and functions during the life-span of an automobile. The TLA is based on leading technologies, so major car manufacturers can use it to develop automobiles with the latest features.
This overarching architecture will expedite software development in that software and hardware components can be re-used, enabling developers to spend more time creating value-added services as opposed to system interconnect structure. By providing a clear understanding of the basic components needed for next-generation car infotainment systems, the TLA reduces risk and increases productivity.
The TLA also encourages the use of modern development tools, an open operating environment based on industry standards, and third-party integration. In short, it establishes a process for car manufacturers to control the nature and quality of the services developed for TLA-compliant platforms. In particular, third-party developers can create options with the same look and feel as car manufacturers. With the TLA, SiemensVDO hopes to implement standards for car manufacturers worldwide so that third-party vendors can develop options that will operate on TLA-compliant

automobiles.

The Technology Behind the Scenes

A central computer serves as the mastermind of the car infotainment system, offering computation and connectivity and providing access to resources in a controlled environment. This computer is controlled by Wind River's VxWorks real-time operating system (RTOS).

Because the VxWorks RTOS includes drivers with a hardware-independent application programming interface (API), many available device drivers for Bluetooth, control area network (CAN), media-oriented systems transport (MOST), ITS data bus (IDB), or other automotive connectivity protocols can be integrated. Adding other devices to the system is simply a matter of writing drivers to the open API. The VxWorks RTOS provides support for a wide range of popular networking protocols, offers a significant level of system support for threading and resource control, and is fully pre-emptive, which means that mission-critical tasks can pre-empt tasks with lower priority levels in case of emergencies. In summary, the VxWorks RTOS enables developers to integrate new modules in a generic and flexible manner based on the most widely used standards.

Wind River also offers development and run-time tools especially designed for Java&#153-technology-based environments. The Java development and runtime environment with its &quotwrite once, run anywhere&quot paradigm brings enormous advantages to the embedded industry. Java code is highly reliable, easily ported, and includes features such as Internet-readiness, security, and the ability to download code at run-time to upgrade or extend applications. As such, it is ideal for Internet appliances such as set-top boxes, Internet screen phones, or handheld devices that might be used in a car. In order to ensure compatibility with the Internet, SiemensVDO uses Wind River's Personal JWorks(tm) embedded Java solution, which ports PersonalJava to Wind River's VxWorks RTOS.

Another technological highlight of the TLA system is an Open Services Gateway Initiative (OSGi)-compliant framework developed by SiemensVDO, which leads to an open and scalable system architecture. The OSGi is an independent, non-profit corporation working to define and promote open specifications for the delivery of multiple services over wide area networks to local networks and devices. The OSGi specification defines an open framework that enables multiple software services to be loaded and run on a services gateway, such as a set-top box or car infotainment system.

Wind River provides a Bluetooth software stack that is tightly integrated with its VxWorks RTOS, called BlueThunder&#153, which contains a pre-qualified embedded host stack, core Bluetooth protocols and profile support, and host controller interfaces for popular Bluetooth modules. Wind River's development tools will enable manufacturers to control and monitor Bluetooth applications throughout the development process. SiemensVDO integrates Wind River's BlueThunder software into the OSGi-based software foundation. This will enable TLA-compliant manufacturers to incorporate new Bluetooth applications based on future car profile specifications.

Summary

The Internet, which has surged ahead in all areas of life, also will introduce new forms of communication for motorists. Wireless communication between various devices in a car will essentially turn vehicles into mobile-networked multimedia devices. These new features will be made possible by advancements in wireless

technologies, including Bluetooth.
SiemensVDO has taken a leadership role in the car manufacturing industry by defining a top-level architecture that includes cutting-edge technology, setting the standard for car manufacturers the world over. SiemensVDO collaborated with Wind River for embedded technologies, including the company's VxWorks RTOS, the Personal JWorks Java-technology-based development and run-time environment, and the BlueThunder networking module. SiemensVDO TLA with integrated Wind River products will speed the time to market for next-generation car infotainment systems.

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