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"The Network Vehicle – A Glimpse into the Future of Mobile Multi-Media"

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ABSTRACT

The Network Vehicle is the Delphi Automotive Systems' vision for the future convergence of the communications infrastructure, computers, and the automobile. It features many advanced functions such as: satellite video, Internet access, virtual navigation, remote vehicle diagnostics and control, games, mobile office, automotive web site, and customized real-time stock quotes and sports scores. These features are enabled by an integrated planar antenna that is capable of multiple satellite reception, a client-server network architecture, and unique human-vehicle-interfaces. The software application is written in Java, using API's (Application Programming Interfaces) to reduce the complexity and cost of the source code.

INTRODUCTION

The Network Vehicle, a new technology initiative by Delphi Delco Electronics Systems and its partners (IBM, Netscape Communications, and Sun Microsystems) is aimed at offering more productivity tools, convenience, safety, and entertainment to millions of commuters who spend hours each day cruising the roads or stuck in traffic. It is designed to demonstrate what technologies and software can do for the vehicle of the future. The Network Vehicle, pictured in Figure 1, made its debut at COMDEX '97 and has since been all over the world appearing in demos, conferences, and technology shows, including SAE Congress '98, and CeBit '98.

SYSTEM OVERVIEW

The Network Vehicle was created by integrating existing hardware and software technologies including voice recognition, wireless communications, global positioning via satellite, head-up displays, Java™ technology, microprocessors, Web access, and other Internet/intranet features. The voice recognition technology allows drivers and passengers to verbally request and listen to e-mail messages being read out loud, locate a restaurant or hotel, ask for navigation help or for specific music or sports scores, and use voice-activated telephone services, all done safely without interfering with driving. Drivers can use a head-up display projected through the windshield to navigate to their destination or check vehicle functions without taking their eyes off the road.

Figure 1. The Network Vehicle

Passengers using individual terminals next to their seats can do even more, including interacting with the Internet, watching television or playing games. Existing services that could be integrated include theft deterrent technologies and, emergency services. These "smart" features are enabled mainly because of the real-time data-streaming capabilities over a wireless network. The Network Vehicle also has an integrated cellular phone; Netscape Communicator software for Web browsing and e-mail; a removable personal digital assistant (PDA) and docking station; and a vehicle web site which provides driver support for a wide array of customized capabilities such as enabling remote monitoring and control of vehicle systems in emergency situations.

Onboard And Off-Board Communications Networks - The key to the functions of the Network Vehicle is its ability to communicate efficiently both onboard and off-board of the vehicle. Figure 2 depicts the onboard network architecture.

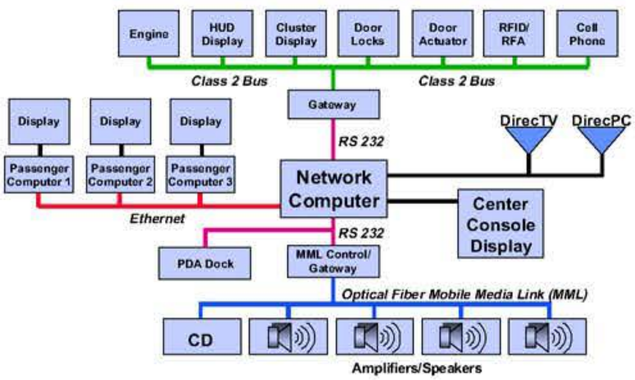


Figure 2. On Board Network Architecture

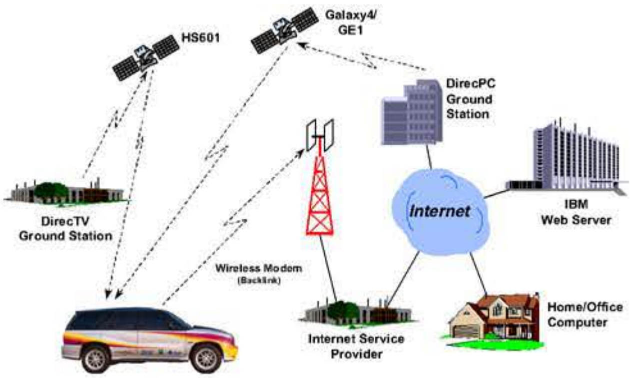
At the heart of the onboard system is a network computer that links up a number of sub-networks, including a Class II bus (for engine, head-up and head-down displays, door lock and door actuator, RFID, and cell phone, etc.), an Ethernet (for passenger computers and displays), and a mobile media link (for speakers and CD players). Since the subnetworks all have different clock speed and functionality, gateways are used to ensure proper isolation and harmonious operations.

The off-board network is shown in Figure 3. The high bandwidth requirement for on-demand audio and video functions was fulfilled with DirecPC and DirecTV satellite links. A wireless modem provides the uplink out of the vehicle directly to Internet service providers. The downlink return path from the Internet to the Network Vehicle can come through either the satellite (higher speed), or through the wireless modem (lower speed). The downlink satellites video and data signals are picked up by the Network Vehicle's roof-mounted antenna.

KEY TECHNOLOGIES AND SYSTEM COMPONENTS

The key technologies and system components behind the Network Vehicle are advanced speech recognition software, mobile media link (high-speed fiber optic data bus), reconfigurable HUD, high-bandwidth communications that connect the vehicle with the outside world, and a suite of automotive computer software. These elements are described below.

Figure 3. Off-Board Network Architecture



Speech Recognition and Text-to-Speech System - IBM has modified its advanced speech recognition and text-to-speech system, ViaVoice™, for the automotive environment. ViaVoice allows the driver to access virtually all the vehicle's features through voice commands and enables the vehicle to talk back using synthesized speech. The driver can: execute vehicle system commands such as lock doors, play CD, and change radio station, request travel directions and traffic updates from the Web or other sources, check e-mail and voicemail, request news, stock information and sports. The speech recognition system can understand most drivers instantly, with no system training required, and it has been tuned to offer optimal performance even in a potentially noisy vehicle environment.

Driver and Center Console Displays - The Network Vehicle is equipped with three displays for the driver: the head-down display (HDD), the head-up display (HUD), and the center console display. The HDD system displays standard graphics for an instrument panel: road speed, engine speed, engine status, door lock/ajar, and fuel level. It also displays the functions for the steering wheel buttons. For example,the same button can be "change track" for CD mode or "tune up" for radio mode. The HUD projects an virtual image through the windshield that gives information to drivers without requiring them to take their eyes off the road. It displays road speed, engine status, waiting e-mail indication, navigation information, microphone on/off, and a text message area for giving feedback to the driver.

The center console's touch-screen LCD serves as a user interface for controlling nearly all of the Network Vehicle's functions (entertainment, navigation, office, and information). When in entertainment mode, the display is configured as a radio- or CD-style faceplate whose buttons and controls are activated by touch. This display is reconfigured to display e-mail, navigation maps, Web browser, cellular phone faceplate (shown in Figure 4), and more. Voice-activated commands can be used with all of the center console functions and, in some cases, is combined with text-to-speech input to minimize driver distraction.

Figure 4. Cellular Phone Faceplate Display

Passenger Displays - The Network Vehicle has color LCD touch panels for the back-seat and front-seat passengers. As with the center console display, the passenger displays serve as user interfaces for controlling nearly all of the functions on the Network Vehicle. Unlike the center console display, however, the passenger displays can show video from DirecTV or DVD players, and they allow touch-screen access to entertainment, navigation, office, and information. When in entertainment mode, the display is configured as a radio- or CD-style faceplate with touch-activated buttons and controls.

Planar Satellite Antenna - The antenna technology used in the Network Vehicle is the Continuous Transverse Stub (CTS) array. It is chosen because of its simplicity, planar construction, and potential for being an inexpensive product. Figure 5 shows the cross sectional view of a typical CTS antenna, realized as an array of broad continuous transverse radiating stubs, finite in height, extending from the upper conductive plate of an open parallel-plate transmission-line structure.

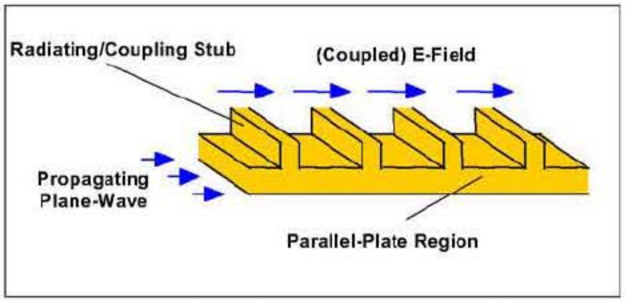


Figure 5. CTS Antenna Cross Section

As a receiving antenna, the induced longitudinal current components in the parallel plate structure are interrupted by the transverse-oriented stubs and excite propagating waves in the parallel-plate structure. This simple architecture allows for a complex two-dimensional planar array to be realized as an "extrusion" of a one-dimensional (constant cross-section) geometry. This has the effect of replacing a conventional "$NxN=N^2$" element structure (of discrete radiators, couplers, etc.) with a less complex "monolithic" array comprised of "N" integrated coupler/radiator features. The simple "tee" cross-section of the integrated CTS coupler/radiator forms an inherently low-"Q" (non-resonant) element which exhibits significant advantages (as compared to slot or patch radiators) in terms of wide-angle scanning capability, polarization purity, bandwidth, and dimensional insensitivity.

Customer Application Web Site - The driver and passengers of the Network Vehicle can take advantage of Internet services provided by automotive-oriented ISPs (Internet Service Providers). The customer service site developed for the Network Vehicle showcases the types of features that could be offered when intelligent vehicle systems are connected to the Internet.

Because the Network Vehicle's systems are accessible via its command and control application, which also has secure access to the Internet, many scenarios are possible. Functions like parking lights and door locks on the Network Vehicle can be controlled remotely, providing safety and convenience. Under voice control of the driver, the Network Vehicle can upload vehicle status according to a profile set up in advance. An application monitors the diagnostic information available from components in the engine compartment. Should the diagnostics indicate that the latest reading from engine sensors falls outside a normal range, the application can notify the customer service Web site, where the severity of the reading can be determined. According to this determination, the control on the Network Vehicle could be used by the service

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