17th D A S C

The AIAA/IEEE/SAE Digital Avionics Systems Conference

Bellevue, WA

Oct. 31 – Nov. 7, 1998

Proceedings

Volume II

IEEE Catalog Number 98CH36267
ISBN: 0-7803-5086-3 (Softbound)
ISBN: 0-7803-5087-1 (Casebound)
ISBN: 0-7803-5088-X (Microfiche)
ISBN: 0-7803-5089-8 (CD-Rom)
LIBRARY OF CONGRESS: 98-86916

Prepress Production By:

ISOGEN International Corp.
2760 N. Academy Blvd, Suite 301
Colorado Springs, CO 80917
719 572-1706
sgml@isogen.com

Printed in USA by:

Lucent Technologies
Customer Information Center
2833 N. Franklin Road
Indianapolis, IN 80917

17th DASC
Presentations

Track F - Air Traffic Mgmt Systems

Session F1: Air Traffic Management

1	Vertical Path Trajectory Prediction for Next Generation ATM	Mr. Anthony Warren
2	Advances in Flight Data Acquisition and Management Systems	Mr. Tom McDade
3	CNS/ATM Aircraft Customization Task (Not Published)	Mr. Arnold Oldach
4	USAF Initiatives for Global Air Traffic Management and Navigation Safety	Mr. Leo La Forge
5	A Simplified Aeronautical Telecommunications Network (ATN) Avionics Router	Mr. T. Signore
6	Avionics Architecture For Air Force Mobility Command Aircraft To Meet Cns/Atm And GATM Requirements	Mr. Donald Happel
7	A Pseudo Ramp Manager Workstation for the Laboratory Development of Airline-ATC Collaborative Arrival Planning Tools	Ms. Susan Dorsky

Session F2: Surface Movement 1: Display & Datalink

1	Airport Surface Movement Technologies - Atlanta Demonstration Overview	Ms. Denise R. Jones
2	Description and Flight Test of a Rollout and Turnoff (ROTO) Head-Up Display (HUD) Guidance System	Mr. Richard Hueschen
3	Field Evaluation Of T-NASA: Taxi Navigation And Situation Awareness System	Mr. Anthony D. Andre Ph.D.
4	Airport Surface Operations Data Link Communications and DGPS	Mr. Steve Koczo
5	Controller-Pilot Data Link Statistics from NASA's 1997 Atlanta Flight Test	Dr. James Rankin

Session F3: Surface Movement 2: Surveillance

1	Runway Incursion Reduction Program (RIRP) Surveillance System - NASA / FAA Atlanta Demonstration	Mr. Vincent Capezzuto
2	Development of Airport Surface Surveillance Performance Requirements	Mr. Rick Cassell
3	Analysis of ADS-B, ASDE-3 and Multilateration Surveillance Performance -- NASA Atlanta Demonstration	Mr. Carl Evers
4	Application of ADS-B for Airport Surface Surveillance	Mr. Dan Hicok
5	Comparison of A-SMGCS Requirements with Observed Performance of an Integrated Airport CNS System	Mr. Steven Young
6	What's Next for LVLASO: Status of Plans for a Year 2000 Flight Test and Demonstration (Not Published)	Mr. Wayne H. Bryant

Session F4: Communication, Navigation, Surveillance

1	Bancroft's Algorithm for Solving Passive Multilateration Equations	Dr. Michael Geyer
2	An Integral Flight Director and Surveillance System for Helicopters in Metropolitan Service	Prof. Chin Lin
3	Data Processing Methods For Autonomous On-Board Surveillance And Collision Avoidance	Mr. Juan Besada Portas
4	Implementation of a Low-Cost SSR/ADS-B Aircraft Receiver Decoder	Mr. Alex Smith
5	Loop Technology (LOT) as an Alternative Surface Surveillance System	Mr. Vern Edwards
6	Broadcast Data Link Range Performance as a Function of Aircraft Size-Experimental Results (Not Published)	Robert Strain

Session F5: CNS/ATM Human Factors

1	How Data Link Communication Might Affect Controller Workload in a Terminal Option	Dr. O. Veronika Prinzo PhD
2	Simulation Study of Vocoder Communication In Air Traffic Control	Dr. Earl S. Stein
3	Survey of In-Flight Replanning Performed on the Flight Deck	Mr. James K. Kuchar
4	Introducing New Technology to the Air Traffic Controller: Implications for Skill Acquisition and Training	Mr. Alfred L. Smith Jr.
5	Human Factors Issues in a Future Air Traffic Management System	Mr. Philip J. Smith
6	Man-In-The-Loop Part Of A Study Looking At A Free Flight Concept	Jacco Hoekstra

17th DASC
Presentations

Track G Aircraft Systems

Session G1: InFlight Entertainment

1	Total Integrated Management (TIM) (Not Published)	Mr. Joseph R. Winston
2	Availability, Reliability, and Maintainability Prediction Model	Mr. James M. Hansen
3	Reality in Certification of IFE and Telephone Equipment	Mr. Ritch L. Triplett
4	A New Approach to Data Communications Utilizing the North American Terrestrial System (Not Published)	Mr. Mike O'Meara
5	Real-World Implementations of Intra-Aircraft Infrared Data Communications Networks	Mr. Patrick Potega
6	In-Flight Entertainment - Getting From Wishlist To Reality	Mr. Donald B. Lee
7	High Speed Networking of Multimedia Data for Passenger Entertainment (Not Published)	Mr. Greg Henrikson
8	Packet-based Networks	Mr. Steven W. Russert

Session G2: Aircraft & Satellite Avionics

1	Airborne Reception of Data and Direct Broadcast TV using a Phased Array Antenna (Not Published)	Mr. David C. Vacanti
2	Guidance Characteristics of GNSS Landing Systems	Dr. Alex Stratton
3	Managing Aircraft Airworthiness Through Information Technology (Not Published)	Mr. William E. Larsen
4	Pro Line 21 Advanced Avionics System Architecture	Mr. Timothy Rayl
5	Techniques for Improved Reception of 1090 MHz ADS-B Signals	Mr. William Harman
6	Enhanced Ground Proximity Warning System (Not Published)	Mr. Barry C. Breen

Session G3: Commercial-Off-The-Shelf & Open Systems

1	COTS Based Open Systems for Military Avionics	Mr. John Paul
2	Reducing Avionics Software Cost Through Component Based Product Line Development	Mr. David Sharp
3	Introduction to the Electronic Power Specification Standardization Activity	Mr. Sergio Navarro
4	Open System Design for CNI Avionics	Dr. George Mitschang
5	The Application of Commercial Processing Technologies to the Airborne Military Environment	Mr. Hugh S. Perry
6	Telecom Technologies (Not Published)	Brian Graber

Session G4: Unmanned Airborne Vehicles

1	Redundant Control Systems for UAV's (Not Published)	Graham Gyattt
2	Flight Testing Perseus-B (Not Published)	Mr. Tom Clancy
3	Flight Testing a Large, Autonomous, Unmanned Aircraft (Or Global Hawk Begins to Soar) (Not Published)	Robert Ettinger
4	Flight Testing DarkStar (Not Published)	Mr. John Straub
5	X-36 Tailess Agility Aircraft Subsystm Integration (Not Published)	Willard J Harris
6	X-36 Taillless Agility Aircraft Subsystems Integration (Not Published)	Mr. Bill Harris
7	X-38 Avionics System (Not Published)	Christopher Nagy

Track H - Spacecraft Systems

Session H1: Commercial & Defense Space Systems

1	IRIDIUM Low Earth Orbit Satellite Constellation	Mr. Peter Lemme
2	ATM Mobile Switch Requirements, Issues, and Concerns (Not Published)	Mr. Richard H. Paine
3	The 'Take-Off' of MOTS Avionics System for Space/Launch Vehicle Applications	Joe Cecchini
4	Rapid Development of avionic systems	Randy Black
5	Space-Based Wind-Sensing Lidar Design (Not Published)	Dr. Daniel Novoseller
6	Multifunctional Structures: A New Concept For Spacecraft Design Integrating Electronics, Structure And Thermal Control (Not Published)	Mr. Dave Barnett

17th DASC
Presentations

Track H - Spacecraft Systems (Continued)

Session H2: Space Exploration

1	Deep Space One Integration and Test Challenges: Getting to the Launch Pad in the Faster, Better, Cheaper World	Ms. Paula J. Pingree
2	The Mars Microprobe Mission Advanced Micro-Avionics for Exploration of the Martian Surface (Not Published)	Mr Randel Blue
3	From the Sun to Pluto	Ms. Karla B. Clark
4	NASA/JPL Mars Surveyor Program: New Challenges in a New Era (Not Published)	Mr. Robert L. Bunker
5	Interferometer Real Time Control for the Space Interferometry Mission (Not Published)	Mr. Charles E. Bell

Session H3: Microelectronics for Space

1	Ultra Low Power Rad Hard 12 Bit A/D Converter for Space-Based EO Sensors	Sven Nystrom
2	Integrating PWA Design and Analysis Using a Unix-Based Durability Toolset (Not Published)	Mr. Mostafa Rassaian
3	Amecom Direct Chip Attach Project	Tracey Clay
4	Digital Control of the MIDEX Spacecraft Power System (Not Published)	Ms. Karen Castell
5	Issues To Address In Use of Composite Materials for Electronic Packaging	Mr. Gary Trembley

Session H4: Space System Elements

1	X2000: Avionics for A Multi-Mission Spacecraft	Mr. Savio Chau
2	Applications For A Spacecraft Avionics Functional Model	Mr. Joseph F. Smith
3	A Table-Driven Control Method To Meet Continuous, Near-Real-Time Observation Requirements For The Solar X-Ray Imager	Mr. Kevin Shawn Wallace
4	The TRWIS III Hyperspectral Imager: Instrument Performance and Remote Sensing Applications	Dr. Stephanie Sandor-Leahy
5	Fault Protection Design of the Quikscat and Seawinds Instruments	Mr. Matthew B. Bennett
6	Development of a Low Cost Data Acquisition System for the Space Shuttle Solid Rocket Booster Program	Mr. Kevin Crawford

Track I - Automotive Systems

Session I1: Ground Vehicle Electronics

1	Software Process Improvement in an Automotive Electronics Organization	Mr. Gregory McHugh
2	Automotive System Design: Today and Tomorrow	Dr. Peter Hofmann
3	Specification and Testing of Automotive Powertrain Control System Software Using CACSD Tools	Mr. Steve Toeppe
4	Active Control of Vehicle Dynamics	Mr. Mike Fodor
5	The Next Generation Automotive Electrical Power System Architecture: Issues and Challenges.	Dr. John P. Miller PE, PhD
6	Automotive & Aerospace Circuit Fault Analysis	Mr. Craig Siegel
7	Requirements For A Real-Time Local Area Network Architecture In Land Combat Vehicles	Mr. Paul Richardson

Session I2: Intelligent Transportation System (1)- Vehicle Electronics

1	The Network Vehicle - A Glimpse into the Future of Mobile Multi-Media	Huan-Wun Yen
2	A Demonstration Project for the ITS Data Bus Prototype	Mr. Philip Spelt Ph.D.
3	Signal Processing and Waveform Generation in the Side Zone Automotive Radar	Mr. John C. Reed
4	Adapting Radar and Tracking Technology to an On-Board Automotive Collision Warning System	Dr. Edward Jocoy
5	Use of Map Data Information in an On-board Intersection Violation Detection System	Mr. John Pierowicz
6	SWIFT Project Results	Mr. Larry Senn

Track I - Automotive Systems (Continued)

Session I3: Intelligent Transportation System (2) - Info Management

1	The In-Vehicle Information System Development Center at ORNL, An In-Vehicle Information System for ITS Information Management	Mr. Philip Spelt Ph.D.
2	Decision Making for Road Departure Warning Systems (Not Published)	Dr. Thomas Pilutti
3	Human Factors in Intelligent Transportation Systems in the Vehicle Environment (Not Published)	Mr. Gene Farber
4	Reconfigurable Field Research Vehicle For Human Factors Experiments	Mr. R. Wayne Devereux
5	The Carnegie Mellon TruckSim, The Advanced Human Factors Research and Driver Training Research Facility	Mr. Richard Grace
6	The Drowsey Driver Report from Carniege Mellon	Mr. Richard Grace
7	Determining and Controlling Emergent Behavior in Intelligent Transportation Systems	Mr. James L. Overholt

Session I4: Hybrid Vehicles

1	Energy Power Management in Hybrid Electric Vehicles	Mr. William Morchin
2	Solar Energy for Electrical Vehicles: Systems Analysis	Mr. Henry Oman
3	On-Board Energy and Power Management on Electric Vehicles: Effect of Battery Type	Mr. Henry Oman
4	HybriDriveTM Hybrid Electric Drive System (Not Published)	Mr. Tim Grewe
5	Optimization of Complex Powertrain Systems for Fuel Economy and Emissions (Not Published)	Ilya Kolmanovsky
6	Design of a Low Production Cost Hybrid HMMWV	Mr. Jeff Armfield
7	Fundamental Analysis of a Terminal Voltage Based Battery State Regulation Technique	Mr. Herman L. N. Wiegman

Track J Information Systems

Session J1: Information System Application

1	Communication Technology for Aircraft Cabin Applications (Not Published)	Dr. William Krug
2	Dynamic Interface Management: Negotiating Common Protocols (Not Published)	Jess M. Irwin
3	The Application of Commercial Standards for Local Area Networking into Air Transport Avionics	Mr. Brian Reynolds
4	The Remote Aircraft Flight Recorder and Advisory Telemetry System (RAFT) And It's Application to Unifying The Total Digital Avionics System	Mr. Sy Levine

Session J2: Information Integration

1	Safety Relevant Navigation and Certifiable Databases for 3D Synthetic Vision Systems	Jens Schiefele
2	The Role of Documentation in a Concurrent Engineering Environment	Lani Hajagos
3	Multimedia Analysis and Archive System for Joint Analysis Center Molesworth England in support of the Bosnia peace keeping mission	Mr. Michael S. Gaydeski
4	The Aftermarket Integration of Modern Electronic Information Systems in Classic Aircraft - Human Factors Design Considerations	Mr. Charles Adam

F. System Design Track – Air Traffic Management Systems

The ATM track is designed to cover recent developments in technologies and procedures for new air traffic management systems as we move into the 21st Century. The 5 sessions are designed to cover ATC provider plans for research, development, and the introduction of new tools and systems to improve aircraft safety and efficiency in the current ATC system and in a free flight environment.

Track Chair: Alex Smith, Rannoch Corp

Track F - Air Traffic Management Systems

Session F1: Air Traffic Management

Chairs: Steve Hill, Hanscomb AFB; Vu Duong, Eurocontrol Experimental Center

1	Vertical Path Trajectory Prediction for Next Generation ATM	Mr. Anthony Warren
2	Advances in Flight Data Acquisition and Management Systems	Mr. Tom McDade
3	CNS/ATM Aircraft Customization Task (Not Published)	Mr. Arnold Oldach
4	USAF Initiatives for Global Air Traffic Management and Navigation Safety	Mr. Leo La Forge
5	A Simplified Aeronautical Telecommunications Network (ATN) Avionics Router	Mr. T. Signore
6	Avionics Architecture For Air Force Mobility Command Aircraft To Meet Cns/Atm And GATM Requirements	Mr. Donald Happel
7	A Pseudo Ramp Manager Workstation for the Laboratory Development of Airline-ATC Collaborative Arrival Planning Tools	Ms. Susan Dorsky

Session F2: Surface Movement 1: Display & Datalink

Chair: Denise Jones, NASA Langley Research Center

1	Airport Surface Movement Technologies - Atlanta Demonstration Overview	Ms. Denise R. Jones
2	Description and Flight Test of a Rollout and Turnoff (ROTO) Head-Up Display (HUD) Guidance System	Mr. Richard Hueschen
3	Field Evaluation Of T-NASA: Taxi Navigation And Situation Awareness System	Mr. Anthony D. Andre Ph.D.
4	Airport Surface Operations Data Link Communications and DGPS	Mr. Steve Koczo
5	Controller-Pilot Data Link Statistics from NASA's 1997 Atlanta Flight Test	Dr. James Rankin

Session F3: Surface Movement 2: Surveillance

Chair: Steve Young, NASA Langley Research Center

1	Runway Incursion Reduction Program (RIRP) Surveillance System - NASA / FAA Atlanta Demonstration	Mr. Vincent Capezzuto
2	Development of Airport Surface Surveillance Performance Requirements	Mr. Rick Cassell
3	Analysis of ADS-B, ASDE-3 and Multilateration Surveillance Performance -- NASA Atlanta Demonstration	Mr. Carl Evers
4	Application of ADS-B for Airport Surface Surveillance	Mr. Dan Hicok
5	Comparison of A-SMGCS Requirements with Observed Performance of an Integrated Airport CNS System	Mr. Steven Young
6	What's Next for LVLASO: Status of Plans for a Year 2000 Flight Test and Demonstration (Not Published)	Mr. Wayne H. Bryant

Session F4: Communication, Navigation, Surveillance

Chairs: Jim Dieudonne, MITRE; Rick Cassell, Rannoch Corp.

1	Bancroft's Algorithm for Solving Passive Multilateration Equations	Dr. Michael Geyer
2	An Integral Flight Director and Surveillance System for Helicopters in Metropolitan Service	Prof. Chin Lin
3	Data Processing Methods For Autonomous On-Board Surveillance And Collision Avoidance	Mr. Juan Besada Portas
4	Implementation of a Low-Cost SSR/ADS-B Aircraft Receiver Decoder	Mr. Alex Smith
5	Loop Technology (LOT) as an Alternative Surface Surveillance System	Mr. Vern Edwards
6	Broadcast Data Link Range Performance as a Function of Aircraft Size-Experimental Results (Not Published)	Robert Strain

Session F5: CNS/ATM Human Factors

Chairs: James Kuchar, MIT

1	How Data Link Communication Might Affect Controller Workload in a Terminal Option	Dr. O. Veronika Prinzo PhD
2	Simulation Study of Vocoder Communication In Air Traffic Control	Dr. Earl S. Stein
3	Survey of In-Flight Replanning Performed on the Flight Deck	Mr. James K. Kuchar
4	Introducing New Technology to the Air Traffic Controller: Implications for Skill Acquisition and Training	Mr. Alfred L. Smith Jr.
5	Human Factors Issues in a Future Air Traffic Management System	Mr. Philip J. Smith
6	Man-In-The-Loop Part Of A Study Looking At A Free Flight Concept	Jacco Hoekstra

THE NETWORK VEHICLE – A GLIMPSE INTO THE FUTURE OF MOBILE MULTI-MEDIA

R. Lind, R. Schumacher, R. Reger, R. Olney, H. Yen and M. Laur

Delphi Delco Electronics Systems, Kokomo, Indiana

R. Freeman

IBM Corporation, White Plains, New York

ABSTRACT

The Network Vehicle is the Delphi Automotive Systems' vision for the future convergence of computers, the communications infrastructure, 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 such as color reconfigurable head up and head down displays, steering wheel controls, voice recognition, text-to-speech, and large touch screen active matrix liquid crystal displays (LCD's). The software applications are written in Java, using Application Programming Interfaces (API's) 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.

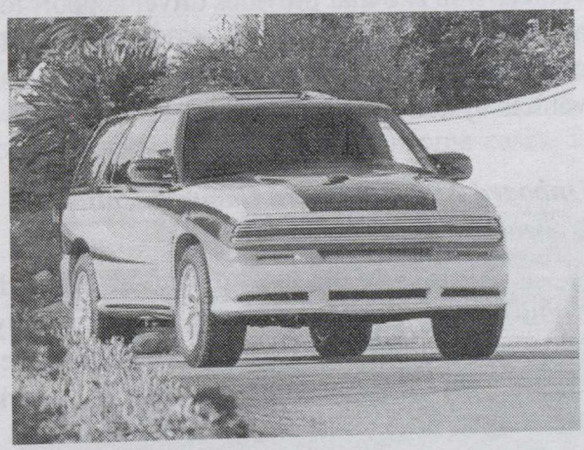


Figure 1. The Network Vehicle

SYSTEM OVERVIEW

The Network Vehicle is 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

0-7803-5086-3 /98/$10.00 ©1998 IEEE

other Internet/intranet features. The voice recognition technology allows drivers and passengers to verbally request and listen to e-mail messages, 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.

Passengers using individual terminals next to their seats can do even more, including interacting with the Internet, watching television or playing games. Existing services such as theft deterrent technologies and emergency services could also be integrated. These "smart" features are enabled mainly because of the real-time data-streaming capabilities over a wireless network using Java-based technology. 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. There is also a vehicle web site that 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 of the vehicle.

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 translate the messages from one sub-network to another so as to ensure harmonious operations.

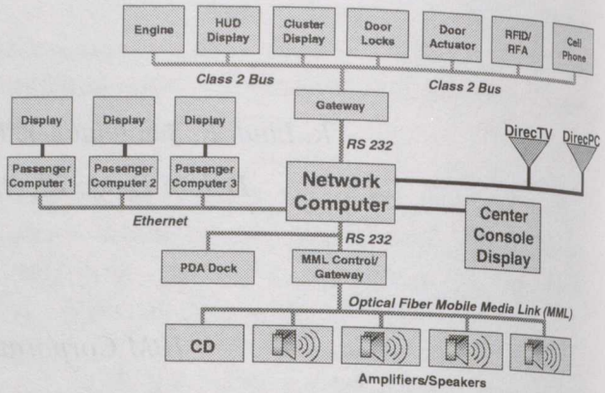
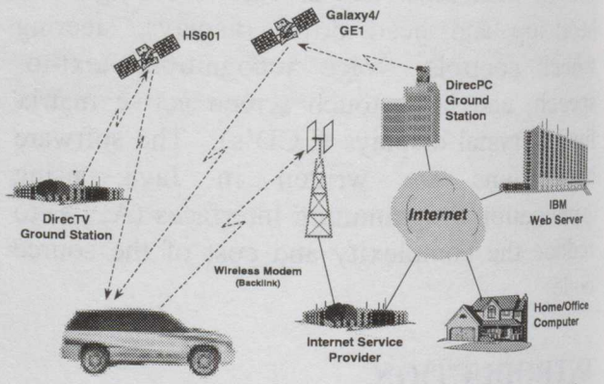


Figure 2. Onboard Network Architecture

The off-board network is shown in Figure 3. The high bandwidth requirements for on-demand audio and video functions are fulfilled with DirecPC and DirecTV satellite broadcasts. 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 (400 kbps), or through the wireless modem. The downlink satellite video and data signals are collected by the Network Vehicle's roof-mounted antenna and processed by their respective receivers.

Figure 3. Off-Board Network Architecture



In order to take full advantages of the resources and services available to the drivers and passengers, the vehicle must have robust external communications paths. It is also vitally important that the vehicle configuration includes a firewall to ensure the integrity of the

0-7803-5086-3 /98/$10.00 ©1998 IEEE

vehicle operation. This means that regardless of what happens to the multimedia applications that are running in the vehicle, the powertrain system control, the chassis control, brakes, airbags, and other critical functions must maintain their integrity. In the Network Vehicle, this isolation is implemented through multiple gateways as shown in Figure 2.

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 head-up display, high-bandwidth communications that connect the vehicle with the outside world, and a suite of automotive computer software. These elements are described below.

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. For example, 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, sports, and stock information. 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 since these functions vary with the entertainment mode that is selected. The HUD projects a 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 multimedia functions, (office, navigation, entertainment, 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 (see Figure 4). It is reconfigured to display e-mail, navigation maps, Web browser, cellular phone faceplate (shown in Figure 5), 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.

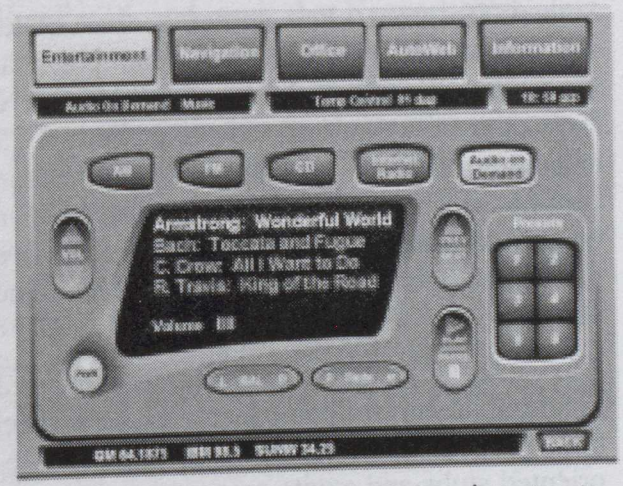


Figure 4. Audio on Demand Faceplate

0-7803-5086-3 /98/$10.00 ©1998 IEEE

Figure 5. 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 all functions.

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 6 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.

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.

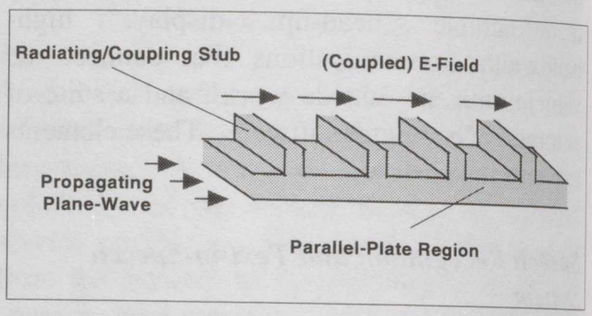


Figure 6. CTS Antenna Cross Section

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. An example of such a web page is shown in Figure 7.

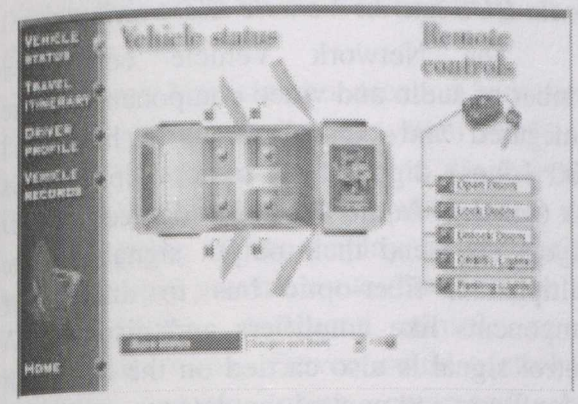


Figure 7. Monitor and Control of Vehicle Status via Internet

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 representative to alert the driver; the alert could be done using text-to-speech and head-up display, and then features of the application, e-mail, and office could be used to arrange a service appointment. Figure 8 illustrates the sensor data that are being monitored through the vehicle web site.

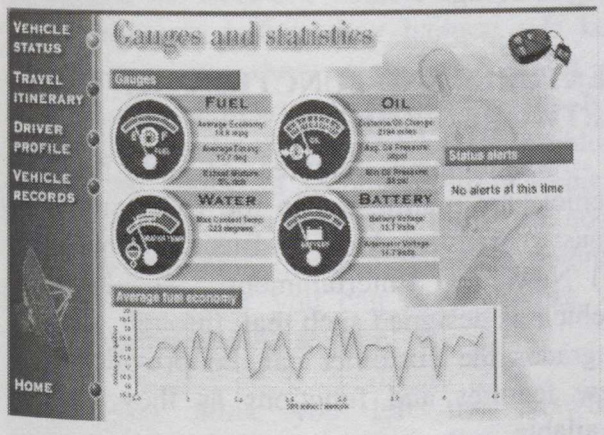


Figure 8. Remote Monitoring of Vehicle Gauges via a Web Site

Other features demonstrated take advantage of Internet service providers' ability to communicate with the Network Vehicle. Trip plans created by vehicle owners or concierge services can be stored at the Internet service provider. By accessing global positioning satellite (GPS) data directly from the vehicle, the driver and passengers can obtain maps, route guidance, fuel, lodging, and restaurant information while traveling. Owners of the Network Vehicle can also use their Web browser to set up a profile, including preferences like radio stations, personalized audio content, service records, and emergency service numbers.

Personal Digital Assistant Docking

An important role of the Network Vehicle is providing office functions to mobile users, using the same data the users have in their office desktop computers. This function is mainly provided through vehicle applications, Internet connectivity, and advanced, voice-based user interfaces. It is important for the Network Vehicle to access and synchronize personal and business data with PDAs, which is becoming increasingly important in our mobile, connected world.

A slot built into the center console of the Network Vehicle accepts the IBM WorkPad™ and uses the Network Vehicle's computer to add speech recognition and text-to-speech functions. This enables the driver to listen to schedules and to update files and other office data stored in the WorkPad. So the driver could, for example, issue a voice command to read calendar entries from the WorkPad or dictate a to-do list while driving. As PDA and smart card technology advances, the Network Vehicle's PDA integration could support the use of PDA-type devices for the secure transport and access of personal, financial, and business information as people move from one network access point to another.

Automotive Computer Software

Virtual machine-based, object-oriented technologies were applied to the Network Vehicle's development because they support the special requirements posed by the vehicle. Smalltalk, a well proven object-oriented environment and the latest Java™ technologies were chosen to develop the Network Vehicle's software.

A command and control application, written in Smalltalk and running on the vehicle's main processor, monitors vehicle status, controls devices such as cell phone and microphone, supplies driver information via head-up display, manages off-vehicle information flow, and controls vehicle software, such as the voice recognition and various convenience passenger applications. This application coordinates with the voice recognition, the head-up display, and the touch screen to provide feedback and control of the various systems, helping to keep the driver's eyes on the road. For driver convenience and safety, this application also interfaces via the Internet to a customer service provider, who can remotely monitor the vehicle status, unlock doors, turn on exterior lighting, etc.

Graphical user interfaces for Network Vehicle's center console and passenger displays are developed with Java to provide access to various in-vehicle and off-vehicle applications, such as navigation, audio/video entertainment, and office. An Internet server application was developed with VisualAge® for Java to provide communication between Internet-based customer applications and the vehicle systems. These applications support a message-based protocol communicating through the Internet to the in-vehicle command and control application, which in turn interfaces to the vehicle systems and the user interface application. Java applets were also developed for the customer site in order to provide animated vehicle status and control graphics.

Media BUS and In-Vehicle Electronics

The Network Vehicle contains a number of audio and video components that are configured and controlled via a high-speed (100 Mbps) digital fiber-optic mobile media link (MML). Audio and video devices like CD players can send their output signals via the multiplexed, fiber-optic bus to drive other components like amplifiers and displays. A control signal is also carried on the MML bus to configure and control the devices - configure the components, switch signals, and adjust variables such as volume, fade, and balance. The MML gives the application full use of the vehicle's multimedia systems to develop functions and user interfaces tailored to driver and passenger use.

Combining a command and control application with the MML in the Network Vehicle made possible features such as context-sensitive volume reduction during the use of the phone and the text-to-speech feature. It also allows "faceplate-style" user interface to integrate Internet radio with the sound system, and common and consistent user interfaces to define, review, and play the audio and video content preferred by the driver and passengers. The vehicle also features a satellite receiver system, which provides DirecTV and DirecPC access. DirecPC offers high-speed (440 kbps) Internet data access while DirecTV offers over 175 channels of digital entertainment programming.

FEATURES AND FUNCTIONS OF THE NETWORK VEHICLE

The main features of the Network Vehicle are manifested in the following three areas: (1) Driving Aids, (2) Business Tools, and (3) News and Entertainment. The Network Vehicle is designed such that, through software upgrades the customer can be provided with new features and functions as they become available.

0-7803-5086-3 /98/$10.00 ©1998 IEEE

Driving Aids - Get Where You're Going Efficiently

The Network Vehicle can access a simulated integrated global positioning system and hence advanced navigation capabilities via Internet. Therefore, it literally knows where it is and where it's going. It can display the appropriate maps or simply provide route directions on the head-up display, command console or as spoken instructions. Drivers could control the navigation system using commands like "destination" to select a new destination or "route guidance" to get turn-by-turn instructions. An example of such a display is shown in Figure 9.

Figure 9. Example of a Navigation Function Display

The ability to monitor key vehicle systems means that the Network Vehicle can detect and avoid problems before they happen. If key vehicle systems show signs of failing, a warning light appears on the head-up display, or the vehicle tells the driver what the problem is. In the future, a technician or a vehicle manufacturer could take a look under the hood remotely to identify and diagnose problems, determine whether you can keep driving, or recommend obtaining service.

If you think you left the Network Vehicle's doors unlocked or the lights on, just visit the vehicle web site from your home or office computer to check, then fix the problem remotely. The Network Vehicle's future remote control capabilities not only could allow you to actually start the vehicle in the parking lot from the office, but also to set the heater or air conditioner from your office computer, so that the vehicle is comfortable and ready to roll when you are. You could even plan trips on the vehicle web site, then download them to your vehicle. Figure 9 shows an example page of the vehicle web site where remote control parameters can be set.

Business Tools – You're Never Out of Touch

The Network Vehicle is on the Web, with a DirecPC satellite link beaming the Internet to the vehicle at 400 kbps, more than 15 times the speed of a standard 28.8 kbps modem. Web sites can be viewed on the color reconfigurable displays at each of the three passenger seats, and the Network Vehicle can download selected information to the driver such as maps for navigation.

The Network Vehicle is an extension of your office, seamlessly offering access to everything from e-mail and address book to the critical files you need. The driver can be alerted to new e-mail via the head-up display and can ask the vehicle to read e-mail. With voice commands, a to-do list can be called up from the docked Workpad. E-mails and appointments can be downloaded to the docked Workpad PDA, for review after leaving the vehicle. In the future, the Network Vehicle will be able to communicate pages and play voice mail. The driver will be able to use voice commands to call up a personal address book, then dictate e-mail messages which the vehicle can turn into text and send. Passengers will be able to view faxes on their LCD displays.

The Network Vehicle's cell phone is fully integrated with other systems, so a simple voice command tells the phone to dial any number. The Network Vehicle uses its own in-vehicle audio system as a speakerphone, allowing hands-free conversations.

News and Entertainment - Getting There is More Than Half the Fun

Via the DirecTV satellite link, passengers will be able to view hundreds of broadcast and cable channels. Each passenger can watch a different channel at the same time, with headsets to keep the noise level to a minimum. Using the Network Vehicle web site, you can preprogram your favorite channels and shows. In the future, the Network Vehicle will include a DVD player so you'll be able to watch the latest movies on disc.

The Network Vehicle offers AM/FM radio, a CD player and audio from the Internet, all accessible with voice commands. From the Network Vehicle web site, one can program personal radio presets. Or, take advantage of various capabilities on the Internet, such as downloadable audio books, or audio-on-demand for an infinite choice of music selections or radio stations worldwide that are now broadcasting over the Web. Each passenger can also use an LCD display to watch movies, surf the Net or play the latest computer games. Using Netscape Communicator, the Network Vehicle will allow you to speak "Read Stocks" and hear the current value of each stock in your portfolio. In the future, the vehicle will read you the latest news from Web sites, or provide customized news from the vehicle web site.

CONCLUSION

The Network Vehicle has proven that by properly integrating several existing functions and technologies one can get a good glimpse of what the future of mobile multimedia holds. The range of applications enabled by the availability of wideband communications to the car is enormous. Reconfigurable displays and upgradable software will allow vehicle owners to take advantages of the latest applications and services. However, to make this vision a reality, a great deal of improvement and development is still needed. For example, an affordable and robust mobile satellite tracking antenna system is yet to be realized. It is clear though, the integration of computer, communications, and software technologies with vehicles will have a dramatic impact on the future of automotive industry.

0-7803-5086-3 /98/$10.00 ©1998 IEEE