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IEEE VTS '91
CONFERENCE

Gateway to the Future
Technology in Motion

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IEEE/ASME railroad conferences
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The week of May 19 was enjoyable, interesting and rewarding for attendees of VTC ’91 and the IEEE/ASME Joint Railroad Conference. Your editor sought comments from attendees concerning a name change for Vehicular Technology Society. "Absolutely not" to ‘maybe’ to ‘we should consider a name change to better define our areas of interest’ were heard from VTS members. Many people said VTS “we” should define our areas of interest, then look at names or identifiers. The situation becomes somewhat more difficult, because VTS has at least three definite areas of interest: 1) Mobile radio or cellular or wireless communications, including personal communications for people not in vehicles, 2) Automotive or vehicular electronics, sometimes called transportation electronics. 3) Land transportation that covers communications, control and electronic or microprocessor control to railroad and rapid transit or urban mass transit systems. 

Key words suggested in a name change include but are limited to the following: • Mobile communications • Transportation electronics • Personal wireless communications • Mobile/personal communications • Transportation control systems

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Professional Activities

Involvement

Most members are convinced that it is worthwhile for all of us as a technical professional group within United States society to devote some of our resources to the non-technical aspects of life as a technical profession. Because of this realization professional activities were voted in by the members yearly twenty years ago to be an integral function of our institute. Of course, there is a small percentage of our membership that has not noticed that the United States is a nation of advocates and advocates organizations and believe that they will not fall by the wayside if they do nothing.

As individuals, we all have competing interests and limited time, but we can help ourselves and society by group activity aimed at improving the engineering community and positioning it to better respond to the challenges of world competition.

Our professional arm, IEEE USA, presently has nearly forty committees addressing professional issues. These committees are appropriately grouped into Councils, namely Technology Policy, Government Activities, Member Activities, Career Activities, and Professional Activities for Engineers (PACE).

Council chairmen also serve on the United States Activities Board. Our Vehicular Technology Society has been well represented among the IEEE-USA participants. For example, George McClure, our 1990 President, is heading a new Vehicular Technology Committee (and leading changes up Capitol Hill?). This year's President, Roger Madden, is a heavy contributor in his position on the Manpower Committee. Bill Whiskey is the Vice Chairman of the Professional Activities Council for Engineers (PACE) and Erickson serves on the Committee on Communication and Information Policy, a constituent of the Technology Policy Council. Incidentally, any member can become a corresponding member of any IEEE - USA Committee. In doing so you will get all the written material that is distributed to regular committee members. It is hoped that corresponding members will submit inputs from time to time. Corresponding membership can lead to regular membership and participation in committee meetings.

Other sources of information include individual pamphlets on specific aspects of professional activities, for example, "Professional Practices for Engineers, Scientists and Their Employers."

Technical publications are also available and include IMPACT, a newsletter of professional activities, and Legislative Report. Publications may be obtained by contacting the Washington Office, 1828 I Street, N.W., Suite 1202, Washington, DC 20036-5104, or calling (202) 785-0017. Another major source is Professional Perspective which we all receive as an insert in some issues of The Institute.

I have pointed out how some members participate in professional activities through membership on national committees. I have also indicated how individual members can obtain information on professional topics. Another source of information is your Section PACE Chairman. Every Section has one, although in a few cases it is held with some other Section Office. You can also communicate upward to IEEE USA through your Section PACE Chairman. Better yet, you can participate in PACE at the local level. Your PACE Chairman either needs help or would be willing to expand local PACE activities with your help and you could be developing into a future Section Officer.

One small, but significant, way that every member can get involved is to stay aware of proposed legislation that will affect technical professionals and write to your legislators expressing your views on each matter. Background material is often available from your IEEE sources. Those who would choose to do only this one activity could add a great deal of clout to our effort with Congress and at the same time provide support and encouragement to their colleagues who are carrying on the work of IEEE - USA. *

In 1832, the New Castle & Frenchtown Railroad installed the first fixed signal system in America. A ball or spherical shaped object was suspended from a mast about 30 ft. high, and was known as a 'ball' signal. The masts were located about 3 miles apart.
VTC '91 is best ever

That headline tells the story of the IEEE Vehicular Technology Society Conference held May 19-22, 1991 at Sheraton Westport Plaza just west of St. Louis, MO.

The VTC '91 theme was symbolized by the program and Proceedings that showed the St. Louis Gateway Arch with the words "Gateway to the Future—Technology in Motion." Approximately 600 were in attendance at presentations of 165 technical papers, panel discussions and demonstrations. By consensus it was the biggest as well as the best VTC ever. As many remarked, Conference Chairman Jay Underdown and the entire Conference Committee membership did a superb job.

Also, as VTC '91 was held on Monday, Tuesday and Wednesday, the Land Transportation Division of VTS held its Institute of Electrical & Electronics Engineers/American Society of Mechanical Engineers Joint Railroad Conference on Wednesday and Thursday, with its near record attendance of 100.

VTC '91 had panel discussions, demonstrations of cellular radio equipment and systems, a nostalgic "radio night," luncheon speakers and an awards luncheon to provide interesting and educational breaks from straight paper presentations. And, as several attendees noted, "we had an opportunity to talk shop and swap ideas informally" at coffee breaks, at dinners and during our free time. With the overlapping Wednesday, it gave attendees at both meetings time to meet, mingle and discuss common subjects.

Mobile Communications, Vehicle Electronics, Transportation Systems

VTC technical papers covered a wide range of communications, electronics and controls. Here is a brief rundown of paper coverage:

- North American digital cellular radio systems, 9 papers.
- Mobile satellite communications, 6 papers.
- Microcellular systems, 11 papers.
- System design, 17 papers.
- Equipment design, 11 papers.
- Indoor systems (radio or wireless), 6 papers.
- Speech processing, 4 papers.
- RF propagation, 12 papers.
- Pan European systems, 8 papers.
- Packet radio system design, 5 papers.
- Handoff (between cellular systems), 6 papers.
- Modulation techniques, 6 papers.
- Vehicle and traffic control systems, 9 papers.
- Japanese digital cellular systems, 6 papers.

Joy Underdown (left) was the VTC '91 Conference Chairman, who welcomed attendees at the Monday luncheon which featured John Stupka, President Southwestern Bell Mobile Communications. He predicted strong growth for wireless personal communications. Roger Marden (right) is President of the Vehicular Technology Society.

Poster session provided one-on-one paper presentation for author and attendee.
Personal communications panel on Monday evening consisted of (left to right): Dr. Edward Chien, Technical Program Chairman and Moderator; Jesse E. Russell, AT&T Bell Laboratories; William C.Y. Lee, Pactel Cellular; Dr. Roger Funge, British Telecom; and Dr. Fumiyuki Adachi, NTT Radio Communications.

NOTE: For anyone wishing to purchase a copy of the VTC '91 papers, the price is $70 to be sent to IEEE Order Dept., 445 Hoes Lane, Piscataway, NJ 08854. At the IEEE/ASME Joint Railroad Conference, the following papers were presented:

- Rail and transit vehicles and components, 6 papers.
- Communications and controls, 5 papers.
- Fixed plant, track, 5 papers.
- Locomotives, 5 papers.

NOTE: For anyone wishing to purchase a copy of the Proceedings of the IEEE/ASME Joint Railroad Conference which contains the papers, $20 is to be sent to IEEE Order Dept. 445 Hoes Lane, Piscataway, NJ 08854.

**Personal Communications and Digital Radio Highlight Panel Discussions**

On Monday evening, May 20, two panel discussion sessions were held covering personal communications and digital radio usage.

Registration for the IEEE/ASME Joint Railroad Conference was in the Sheraton Westpoint Inn.

- Dr. John Gregory of E. J. Johnson Technology Center.
- Satish Kappagantula of Ericsson-GE Mobile Communications.
- Eric Ziolek of Motorola Communications & Electronics.

Monday's luncheon featured a keynote speaker describing the future of wireless personal communications.

**Wireless technologies: the path to personal communications**

"The people I want to talk to you about today are on the average, six steps removed from even an industrial engineer. We call them customers. They don't care about anything other than using a consistently good service." So said keynote speaker John T. Stupka, President and Chief Executive Officer, Southwestern Bell Mobile Systems.

Mr. Stupka was speaking at the Monday luncheon of the 1991 vehicular Technology Conference in St. Louis, MO, which had record attendance of approximately 600.

"The person who desires wireless service wants to be able to place and receive calls anytime, anywhere, with reasonable cost and with acceptable quality," Stupka said.

He went on to comment about what he perceives as the ultimate for personal communications—it will be a pervasive technology. This, he said, was described by Dr. Joel Birnbaum of Hewlett-Packard, a computer maker.

"A pervasive technology is more noticeable by its absence than by its presence in just the way that automobiles, televisions and telephones are in our society. We aren't surprised to find a telephone or TV in a hotel room; we would be amazed to find a PC," says Dr. Birnbaum.

Stupka said "the wireless world is not quite a pervasive technology. If you put a telephone in your car, the response from your friends and neighbors entering the vehicle would tend to be 'you've got a car phone.'"

Dr. Birnbaum also mentioned that "only people that were born before a technology becomes pervasive think of it as technology at all; all others consider it part of the environment."

Mr. Stupka says that today's school children don't think of TV and phones as technology. "They can't imagine their lives without them. I'm hopeful that tomorrow's school children will feel that way about person-centered wireless communications."

**Accessibility and Standards**

To have such widespread usage and acceptance that people think a technology is just part of life, Stupka says that general accessibility and standards are necessary to promote such growth.

Considering general accessibility, you could build a reasonable argument that cellular is generally accessible today. The cost of a cellular phone is less
than $500 in most parts of the country, and in some parts just $100 or $200.

"In the dimension of local use, the phone is definitely friendly to the end user. The only additional task introduced by a cellular phone is pressing of the send button. Outside of pressing the send button, this service is identical to the telephone service enjoyed by the people of the United States for many, many years."

"Two areas that are critical to the growth of cellular are price and capacity—and these two are obviously related."

"We must be able to create additional capacity that is of high quality and yet quite affordable."

Dr. Fumiuki Adachi of NTT Radio Communications, received an award for "the best paper of the year in VTS Transactions."

Joe Gormley's Avant Garde certificate and medal were given to Louis L. Nagy (right) by Sam McConoughy and Roger Madden.

Sam McConoughy (right) shakes Bob McKnight's hand as he received his Avant Garde award.

Rober Madden (center), VTS President, pins Avant Garde medal on Al Gross.

Samuel McConoughy, Avant Garde award; Chairman announced that the following VTS members would receive the Avant Garde Award: Robert L. French, Joseph Gormley, Al Gross, Al Isenberg, Robert W. McKnight, and Lyle B. Saxon.

CTIA endorses the use of dual mode units to allow the technical transition without causing a crisis of consumer confidence. The concept of duality protects past customers and future customers against an obsOLETEness that they don’t understand.

CTIA specification/THA (Telecommunications Industry Association) standards process shall be used to move technologies forward. The standards process ensures that interoperability will be achieved, and that there will be competitiveness in the services and products. Utilizing the standards process tends to minimize the cost of intellectual properties.
William Jacklin (center) received congratulatory handshake from Roger Madden, VTS President. Mr. Jacklin received Motorola's VTS Dan Noble award, announced by Charles Backof (left) Director of Research at Motorola's Applied Research Laboratory. An electrical engineering graduate of Illinois Institute of Technology, William Jacklin will pursue a master's degree at Ill.

In concluding his remarks, Mr. Stupka said: "Two things that I can guarantee about this industry are: First, it will be driven by the marketplace. Secondly, we are most definitely technology dependent. We are counting on each of you to help us deliver on the promise of personal communications."

The Tuesday luncheon was highlighted by award presentations which included the following:

Dan Noble award (Motorola) to William Jacklin of Illinois Institute of Technology in the amount of $7,500 to aid him in graduate work in electrical engineering.

It was announced that the Philadelphia VTS Chapter (LTD) has won the 1990 Chapter of the Year Award.

Avant Garde awards were made to the following: Robert L. Freach, Joseph Gormley, Al Gross, Al Isenberg, Robert W. McKnight and Lyle B. Saxton. Each honoree received a medal and a certificate. The certificate states:

"Be it hereby known that The Institute of Electrical & Electronics Engineers, Inc., Vehicular Technology Society Proudly recognizes (name of individual) for pioneering leadership and continuing contributions in promoting new technology in the field of vehicular communications and electronics, and hereby designates the aforementioned as a member of its AVANT GARDE thus bestowing the Honor and Respect of this Society in grateful recognition thereon (date) by its officers: (Signature) President (Signature) Secretary".

Hysteresis and Eddy Currents on Rail Track Impedance," University of Bath, UK, R. J. Hill, D. C. Carpenter.

**1990 First Place:** "System Considerations for Heavy Haul Diesel-Electric Locomotives with 3-Phase Traction Motors," J. S. Boggs and R. W. Becker, Electro-Motive Division, General Motors Corp.

**1990 Second Place:** "Benefits of a Driver Advice System for Light Rail Commuter Lines," Queens University, Canada, B. R. Benjamin, P. J. Pudney and G. W. English.

**1990 Third Place:** "Low Cost Transponder System for Data Transmission to Trains in Remote Areas," University of Bath, R. J. Hill, J. W. Palmer and R. E. Barnard.

Wednesday's luncheon speaker was William J. Watt, Federal Railroad Administration.

Tuesday evening's program was 'Old Tyme Radio Nite.' The program included Mr. Fred Link, W2ALU, past president of Link Radio and President of The Radio Club of America. With Fred was Mr. Stuart Meyer, W2QHK, who is a member of the VTS Board, as is Fred Link, and past president of VTS. Meyer is also a past director of the Quarter Century Wireless Association. The third speaker was Mr. Al Gross, WPAL, who received the VTS Avant Garde award. A wireless microphone, designed by Al Gross, was the idea behind the Dick Tracy 'Wrist Radio.' The original model of this unit was exhibited. Old commercial, amateur and broadcast radios were exhibited along with other memorabilia such as old handbooks and other radio books. This portion of the Conference was open to the interested public and was well attended.

The Wednesday luncheon included VTC '91 attendees and those from the Land Transportation Division IEEE/ASME Joint Railroad Conference. Six awards for best papers at railroad conferences in 1989 and 1990 were announced by LTD Chairman Tristan A. Kneschke. They were:

**1989 First Place:** "Railway Track Admittance, Earth Leakage Effects and Track Circuit Operation," University of Bath, UK, R. J. Hill, D. C. Carpenter and T. Takar.

**1989 Second Place:** "Tractive Power Supply at German Federal Railway's 400 KmA Run," German Federal Railway, West Germany, W. Harprecht, R. Sollert, and F. Klessing.

**1989 Third Place:** "Effect of Magnetic Saturation, transceivers (older models to the left)."
transportation system, 2- strengthening the financial base of that system, 3- competitiveness, 4- promotion of safety and security, 5- environmental protection, and 6- advancement of U.S. technology.

One concept worth mentioning is that of a relatively mature highway transportation system, whose primary challenge is proper maintenance, rather than broad-scale expansion.

A second important concern is the realization that in a time of competing priorities and budget deficits, there won't be enough public money to finance all of the desirable and some of the necessary transportation infrastructure projects traditionally viewed as a public responsibility.

We look for alternatives such as privatization, toll financing, new intergovernmental or private sector relationships, a harder line on priority-setting.

A third important theme is intermodality, and one that we are struggling with because of the mode-specific functionality DOT has been historically cast.

Perhaps our most significant contribution would be to create an environment in which state and local governments can plan or act intermodally or multimodally, instead of the current arrangement which has favored selection of a highway solution to transportation needs, simply because that money is easier to get. We have moved strongly in the direction of giving state and local governments more choices in connection with the department's surface transportation reauthorization proposal.

Agenda for Safety Research

Safety is a priority responsibility at DOT, but we realize that the nature of safety emphasis is changing. Railroads provide a good illustration. The combination of technology, capital investment, management focus, government prodding and the like have reduced dramatically the rate of safety lapses accountable to failure of track, equipment or signaling devices. The result is a lump of causal factors that stands out because it accounts for 40% of the total number of operational accidents, and they are called "human factors." This sets the agenda for safety research, development, investigation and enforcement during the 1990s.

Five key principles in the Transportation Policy relate to research and development:

- Increase the federal transportation budget for research and technology. In coordination with the efforts of private industry, academia and other levels of government.
- Conduct a comprehensive program of research on human factors, their relationship to accidents, and the role of design and operating changes that could reduce these effects.
- Provide seed money for research on new transportation systems and technologies, and assess their feasibility.

- Reassert U.S. international technical leadership in transportation.

Transportation Reauthorization

The Administration's proposal calls for a better focus on managing existing systems including:

- A recognition of the public's growing concern about environment and energy issues.
- Increased federal capital investment coupled with a deliberate strategy to increase state government participation.
- Strengthened highway safety programs.
- Improved support to mass transit by focusing federal support on capital investment, while broadening transit's funding base.
- An enhanced and targeted program of research, development and technology initiatives.

Our proposal would increase federal highway funding by 39% from 1992 through 1996. Overall transit capital investment would increase 25%. Funding for highway safety would rise by 34%.

The current federal aid highway program covers a system of 850,000 miles. We propose to restructure it to a new National Highway System of about 150,000 miles that carries more than 70% of truck-borne interstate commerce and some 40% of all highway travel. The aim is to target federal funding to priorities, to build on the investment already in place (the Interstate System is virtually complete) and to provide states with increased funding flexibility. A new approach is needed to recognize the enormous demographic and travel demand changes which have occurred over the past four decades.

Under a revised urban and rural highway program, the department proposes that state and local officials have the authority to use trust fund money for both highway and transit. States also would be able to use as much as 5% of their funds for highway safety improvement or for eliminating grade crossing hazards on local roads that otherwise are not eligible. States could divert funds from their national system maintenance to the urban and rural programs. Toll facilities would be eligible for inclusion in the National Highway System. The Administration proposal would allow up to 35% of the cost of a toll road project to be borne by federal aid funds.

The bill places special emphasis on technology, such as Intelligent Vehicle Highway Systems. Operational trials will be conducted in the areas of advanced traffic management systems, advanced traveler information systems, advanced control systems, and commercial vehicle operations.

With respect to high-speed ground transportation projects, multimodal intercity corridor studies would be eligible for highway planning funds. Highway rights-of-way could be used for high-speed rail or maglev (magnetically levitated vehicles) without charge by private sponsors if states approved.
Fred M. Link (left) radio pioneer and VTS Board of Governors member, thanked everyone for making VTS '91 Conference the best ever. Tristan A. Kneschke (center) Chairman Land Transportation Division VTS, was master of ceremonies at Wednesday's luncheon. D. R. Campion, Chairman IEEE/ASME Conference General Arrangements Committee, introduced luncheon speaker William J. Watt, Associate Administrator for Policy, FRA.

William J. Watt, Associate Administrator for Policy, Federal Railroad Administration, described the Bush Administration’s National Transportation Policy at the Wednesday luncheon.

Highway adjustments or realignments to accommodate advanced technology rail systems would be an eligible use of national highway program funds.

Rail Initiatives at FRA
Federal Railroad Administration is actively at work carrying out the technical evaluations of both high-speed rail and magnetic levitation transport systems. It is beginning a process that leads to appropriate safety standards. The National Maglev Initiative is carrying this process forward in connection with that technology and at the same time is pressing ahead with economic feasibility and market analyses. Maglev still has to overcome both technological and marketing skepticism to forge a role in the domestic market.

Unlike a high-speed rail system such as the TGV, which has more than a decade of operating experience and marketing and financial experience that may be applicable to a North American setting, maglev must overcome concerns about construction costs and technology, uncertainties about operating costs and economic feasibility.

Meanwhile, I think it would be a mistake to overlook conventional rail passenger operations. Either Amtrak or commuter services. The Bush Administration is supportive of a national railroad passenger system, and is working with Amtrak management to devise an orderly program of self-sufficiency that would include adequate capital to give the corporation an even stronger role in the intercity travel market.

Advanced train control systems represent a collection of issues that compel us to weigh the potential of new technology against the reality of cost-benefit ratios, and in light of the need to assure the safe operation of the national’s railroads. As far as the industry is concerned, one of the key issues in the future of ATCS is the extent to which it can be a stand-alone replacement for other communications and control devices now in place. If ATCS benefits center on system redundancy and operational monitoring, it may not do all that you’d like. FRA must be certain that its safety regulations are based on the realities of current safety issues, not rail industry traditions, and that we not impose arbitrary barriers to new technologies.

Growth fosters Technology Changes on Burlington Northern Railroad
Thursday’s luncheon speaker was Donald W. Henderson, Vice President Technology, Burlington

R. J. Hill, (left) University of Bath, UK, receives checks from Tristan Kneschke for one First Place and Two Third Place awards for best papers at the 1989 and 1990 IEEE/ASME Joint Railroad Conferences.

B. A. Becker (left) Electro-Motive Division, General Motors Corp., receives a check from Tristan Kneschke, LTD VTS Chairman, for First Place paper award at the 1990 ASME/IEEE Joint Railroad Conference.

Norman A. Berg (left) American Steel Foundries, received a plaque from the American Society of Mechanical Engineers honoring him for his leadership and service to the Rail Transportation Division. ornament. (podium) Traile Train Co., and Chairman RTD, ASME, made the presentation. Donald W. Henderson (right) Vice President Technology, Burlington Northern Railroad, discussed technological changes in the rail industry at Thursday’s IEEE/ASME Joint Railroad Conference luncheon.

August 1991
Call for Papers

VTC 1992

The vehicular Technology Society 1992 Technical Program issues its call for Papers. VTC '92 will be held May 11-13, 1992 at the Hyatt Regency Hotel in Denver, Colorado.

Summary of a proposed paper should be approximately 150 words and submitted by September 15, 1991 to Jim Schroeder, Technical Chairman IEEE VTC '92, Department of Engineering/CMK 214, University of Denver, Denver, CO 80208-0177. Tel: (303) 871-3519, Fax (303) 871-4450 e-mail: JSCROEHED@BATHENA.CAIR.DU.EDU. Note: authors please FAX number and e-mail address, if possible. Authors will be notified of acceptance by Dec. 1, 1991 and complete text must be submitted by Feb. 1, 1992.

Papers are invited concerning the following subjects:
- Cellular telecommunications: Hand off, traffic handling, new technology and new generation technology.
- Satellite technology: Mobile, Maritime and Positioning.
- Digital transmission techniques: Data communications with vehicles, portable data terminals, modulation, voice synthesis, voice recognition, channel coding and voice coding.
- Specialized systems: Simulcast transmitting, receiver selection, specialized mobile repeaters, special purpose systems.
- Manufacturing technology: Components, surface mount technology, super conductors, filters and battery systems.
- Antenna systems: Vehicular, station and satellite.
- New highway systems: Radio guidance and information, traffic monitoring and control.
- Vehicular electronics: Control, safety, comfort, information display, multiplexed signaling, guidance, propulsion, and multiplexed control.
- Integration: Radio frequency interference, diagnostics, efficiency, and entertainment.
- Public transportation: Safety related, navigation, vehicle location and headway management.
- Guided radio systems: Distributed antenna systems, linear amplifier technology, multi-band antennas, and on-frequency repeaters.
- Computer enhanced communications: Computer aided dispatch, trunked systems, telemetry, control consoles, vehicle location and display, and public safety.

ASME/IEEE 1992 Joint Railroad Conference

ASME/IEEE issues its call for paper for its 1992 Joint Railroad Conference to be held March 31-April 2, 1992 at the Atlanta Hilton & Towers in Atlanta, Georgia.

A summary or abstract of the proposed paper should be approximately 150 words and be submitted by September 15, 1991 to Aaron C. James, Technical Papers Chairman, Booz, Allen & Hamilton, Inc., 707 North First St., St. Louis, MO 63102. Phone (314) 982-1400, FAX (314) 982-1470. Note: Authors please include photos and FAX numbers, if possible. Authors will be notified later in the year if proposed papers are accepted, and will be given details for preparation and date for submission of complete text. Papers should cover topics of current interest in the areas of system design, hardware development, and transportation technology advances with the aim to improve the operation of railroad and transit systems and increase cost-effectiveness. Topics may include the following:
- AC and DC propulsion systems.
- Electromagnetic compatibility.
- Automation and microcomputer controlled.
- Signal and communication systems innovations.
- Maintenance procedures.
- Monitoring and fault detection.
- Safety and assurance programs.
- High speed transportation systems.
- Training of operating and maintenance personnel.
- Magnetic levitated systems.
- People mover systems.
- Transportation systems, the next generation.
- Traction electrification system alternatives.
- Energy efficient systems and energy conservation methods.
- New transit system starts.
- Computer modeling and simulation of transportation systems.

IEEE Vehicular Technology Society Newsletter
AUGUST 1991

Some thoughts on railroad radio

The following was discussed by some attendees at the Vehicular Technology Conference '91 at St. Louis. The discussion concerns the use of radio by the railroad industry in frequency ranges below 800 MHz. It is presented as part of the conference coverage of things that were said, discussed and talked about at VTC '91.

The 97 channels in the VHF band (160 MHz) should be kept for the use of railways and the extra capacity will be leased to the public. This approach will be achieved by utilizing:
- Channel splitting
- Narrow band radios
- Future digital radios
- Trunking systems
- Simultaneous voice and limited data
- Simultaneous data with limited voice

The establishment of a nationwide digital trunking system will provide service to the public at remote areas and revenue to the railroads.

Each railroad will have a plan to implement the installation of the digital trunking system along its rights-of-way.

A minimum of four pairs of frequencies at each location should be utilized.

Due to the fact that the life cycle for mobile and fixed radios is 5 to 10 years, the completion of the program should be 10 years.

The capital expenditure for the infrastructure for digital trunking will be part of the annual projects and the revenue of servicing the public.

The cost of the digital trunking radios as an off-the-shelf product will be more economical than radio devices specially made for the railroads.

Migration path from analog to digital radios should be developed and followed.

The existing analog infrastructure system should co-exist with the new installations of digital systems.

Also, the above should be applicable for the UHF band.
decoding for combined error detection and correction. System performance is improved by exploiting the frame-to-frame correlation of error detector and a source-subband energy profile error detector. The subband side information deemed unreliable is replaced with the estimates based on frame-to-frame redundancy. This improved error detection capability in the subband side information allows a judicious reassignment of channel error protection bits to the subband side information, leading to an overall improvement in system performance. Using a realistic simulation model of a digital mobile radio communication system, an improvement of up to 4.4 dB in recovered speech segmental SNR is obtained at a channel SNR of 6 dB, compared with a system with only channel error protection.

**Optimal Detection of Digital Data Over the Nonselective Rayleigh Fading Channel with Diversity Reception**


Based on the criterion of minimum symbol error probability, we consider symbol-by-symbol detection of a sequence of digital data transmitted using linear suppressed-carrier modulations over 1 independent diversity channels with AWGN and show noncoherent Rayleigh fading. The optimal receiver is derived, but is found to be difficult to implement in practice because of its exponential growth in complexity as a function of sequence length. Suboptimal decision-feedback approximations are then suggested which are linear, and readily implementable, and can be interpreted as generalized differential decoding. The exact bit error probabilities of these suboptimal receivers are obtained. Tight upper bounds on these error probabilities are also obtained which show simply how they behave as a function of SNR and order of diversity. A main result of our work is that optimal data detection on a fading channel should be performed using the maximum likelihood or MMSE estimates of the quadratic amplitudes of the channel fading processes as a coherent reference. Conventional receivers employing carrier loops to provide the coherent reference are replaced by more complicated receiver structures.


Data transmission using MDPK over the nonselective Rayleigh fading channel with diversity reception is considered. For 12-KHz subband coding, the probability of mostly assuming no fading fluctuation, we consider here, exclusively, the case in which the fading process fluctuates from one symbol interval to the next. Exact bit error probability results for 4, 8 and 16 DPSK, as well as tight upper bounds, are derived. Some applications of the results are discussed.


An infinite series for the complementary probability distribution function (cdf) of the signal-to-noise ratio (SNR) at the output of L-channel equal gain (EG) diversity combiners in Nakagami fading channels is derived. The bit error rate for a matched filter receiver is analyzed for the L-channel EG combiner and different fading parameters. Both coherent phase shift keying (CPSK) and differential coherent phase shift keying (DCPSK) are considered. The effects of gain imbalance between branches on the probability distribution of the SNR and on the bit error rates are investigated. Bit error rate results are also obtained for coherent and noncoherent reception of frequency shift keying (FSK). The effects of gain imbalances on FSK modulations are also investigated. Bit error rates for EG combining on Rayleigh fading channels have been previously obtained for L > 2. These results are obtained and presented here as a special case of the more generalized Nakagami fading model.


Tetherless communications represent the fastest growing segment of the telecommunications industry. Low-power digital radio as an access technology could be integrated into a local exchange network to provide a ubiquitous personal communications network (PCN). High quality tetherless communications services that could be provided by such an exchange network based PCN are described. A possible low-power access exchange digital radio system for providing these exchange network based PCN services is discussed. The radio system uses a spectrum efficient time-division multiple-access (TDMA) architecture made possible by advanced digital signal processing techniques. Control of the frequency is determined by frequency measurements and frequency spectrum needs are indicated.


The throughput of a slotted CDMA system with DPSK modulation is derived, considering selection diversity and maximum ratio, combined in an indoor Rician fading channel. Computational results are
obtained for typical values of maximum RMS delay spread and data rates. The effect of (15, 7) BCH code and the throughput for minimum energy bits per information bit. Diversity combining is then added to reduce the number of retransmissions and their consequent impact on throughput performance. Packet combining has the added benefit of reducing the effective code rate to channel conditions. Excellent reliability performance coupled with a simple high-speed implementation make this diversity-logic system an ideal choice for high data rate error control over both stationary and nonstationary channels.


Digital radio has become an economical technology for implementing subscriber loops in low-density rural areas. The use of digital radio technology for this most frequent application was facilitated by the 1988 Federal Communications Commission (FCC) allocation of radio spectrum at 150 MHz, 450 MHz, and 900 MHz in its Basic Exchange Telecommunications Service Radio Service (BETRS) proceedings. Relatively high-power (greater than 1 W) radio links are used in BETRS to provide subscriber loops of up to 10 miles, or so wide that can be shared by multiple subscribers. Driven by a strong market for mobility in telecommunications and rapid advances in signal processing and integrated circuit technology, radio is playing an increasingly important role in cell mobile radio systems. More than 6 million low-power cordless telephones are now being sold each year in the U.S., and cumulative U.S. sales since their introduction in the late 1970s are approaching 50 million units. Vehicular-oriented high-power cellular mobile radio continues to grow at 40% to 60% per year, with total sales now exceeding 5 million by the end of 1990. The number of radio paging subscribers also continues to increase, with approximately 8 million public and private users combining to provide a network for large metropolitan areas.

Single-tone spurious RF signals may disturb the operation of radio systems. Therefore, it is very useful for reliability purposes to develop a realistic computation method which presents for each desired receiver channel a list of possible interferers. A previous development of realistic and significant results by applying the comparative analysis of the former computer prohibited list with the measured data of the two UHF receivers. The new semisempirical concepts considered the nonlinear amplitude dependent frequency correction factor computed from the dielectric response of the receiver frequency converter stages. The new more realistic list is applied to the urban areas and inclusion accurate values for the system receiver rejection ratio, to improve radio interfering immunity from the initial stages of radio systems design and to optimize the frequency allocation management policy.


Diversity combining and majority-logic decoding are combined in this paper to create a simple yet powerful hybrid-ARQ error control scheme. FEC majority-logic decoders are modified for use in type-1 hybrid-ARQ protocols through the identification of reliable inferences that are also being piled. Diversity combining is then added to reduce the number of retransmissions and their consequent impact on throughput performance. Packet combining has the added benefit of reducing the effective code rate to channel conditions. Excellent reliability performance coupled with a simple high-speed implementation make this diversity-logic system an ideal choice for high data rate error control over both stationary and nonstationary channels.


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The purpose of this article is to review the state of the art of Very Large-Scale Integration (VLSI) as applied to communications. We will discuss the main trends of the present and some extrapolations for the future. A particular emphasis will be on the prospects for fuller VLSI integration of low-power digital radio, for applications such as in-building wireless radio receivers. Although some reference will be made to purely digital/Digital Signal Processing (DSP) contexts, the main emphasis will be on the front end of the receiver, including continuous-time analog and sampled analog VLSI filtering, and technologies both that can mix analog and digital on the same chip.

We will be particularly interested in the prospects for the use of Bipolar Complementary Metal Oxide Semiconductor (BiCMOS) technology in communications. This new VLSI fabrication process can combine bipolar and CMOS circuits on the same chip, allowing the use of bipolar transistors where required for high-analog bandwidth, low noise, and good current drive, and the use of CMOS circuits where required for high density and low power. Such a combination makes it possible to contemplate a one-chip digital radio receiver, and perhaps a transmitter, that is capable of low-power operation at frequencies up to the gigahertz range. Although it is not yet evident that complete success is possible, even partial success could have a major economic impact.

Direct-Sequence Spread-Spectrum Multiple-Access Communications with Random Signature Sequences: A Large Deviations Analysis.

A DS-SMA bit-error probability analysis is developed using the framework of large deviations. Let m denote the number of interfering spread spectrum signals and n denote the signature sequences length. Then the large deviations limit is as n → ∞ with m fixed. A tight asymptotic expression for the bit-error probability is proven, and in addition, recent large deviations results dealing with importance sampling Monte Carlo estimation technique are applied to obtain accurate and computationally efficient estimates of the bit-error probability for finite values of m and n. The large deviations point of view is compared also to the conventional asymptotics of central limit theory and the associated Gaussian approximation. The Gaussian approximation is inaccurate when the ratio m/n is moderately large and all signals have roughly equal power. In the near/far situation, however, the Gaussian approximation is quite poor. In contrast, large deviations techniques are more accurate in the near/far situation, and it is here that these methods provide some important practical insight.

Vehicular Electronics

Satellite-Based 2-Way Truck Communications

Nationally 2-way communications between trucks and their home base has been made possible by the convergence of three key technologies:

1. navigation
2. satellite communications
3. advanced signal processing

A new system called Omnitracs is a good example [1]. This system allows mobile terminals in trucks to report back their position using onboard navigation equipment including the Loran C and global positioning system (GPS).

Omnitracs operates at 12.014 GHz, includes a pair of Ku-Band transponders aboard the Gsat1 satellite, and it serves 50,000 to 100,000 mobile users. The exact number of users depends on lengths of messages transmitted and frequency rates of transmission [1]. As of January 1991, over 12,000 mobile terminals are on the road in operation on trucks.

Messages are keyboard-entered and transmitted as data, thus avoiding the more consuming bandwidth and capacity demands of voice connections.

Automatically relayed position reports, derived from Loran C or GPS, are used for the following vehicle management purposes:

1. dispatching
2. shipment scheduling
3. vehicle arrival time confirmation
4. accident location
5. hijack detection
6. vehicle recovery

52-Percent of All Highway Trucks Use Radar Detectors

Yes, surveys show that 52 percent of all highway trucks have, and use, radar detectors [2,3]. Just because truckers have detectors, does that mean they speed? Well, for the record, this study showed that on interstates with 55 mph speed limits, 50 percent more trucks with radar detectors were traveling at least 10 mph faster than the speed limit compared with trucks not equipped with radar detectors [2,3]. And when the speed limit was 65 mph, 200 percent more trucks with radar detectors were traveling at least 10 mph above the speed limit compared with trucks not equipped with them.

Are these the same truckers who want 3-trailer rigs used throughout our highway system? Do you think this question is unfair? I don't think so. It occurs to me that the combination of precise navigation and time-log data, now available from the aforementioned Omnitracs system [1], could be used to automatically identify and ticket speeding truckers. One thing is for sure, the age of "big brother" isn't that far away, and all those truckers showed that on interstates with 55 mph speed limits, 50 percent more trucks with radar detectors were traveling at least 10 mph faster than the speed limit compared with trucks not equipped with radar detectors [2,3]. And when the speed limit was 65 mph, 200 percent more trucks with radar detectors were traveling at least 10 mph above the speed limit compared with trucks not equipped with them.

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Thus, the frequency and distance intervals of enroute visual inspections are subject to wide variation from day to day in the same territory and the opportunity for such observations is greater during the hours that roadway maintenance forces are actively working. In addition, the efficiency of visual inspection is related to train speed, the experience and diligence of the observer and to weather conditions. Potential journal defects on equipment having roller bearings are more difficult to determine by visual inspection of a passing train.

The use of automatic train inspection devices assures that both sides of each train are monitored with optimum efficiency at selected distance intervals under all weather conditions. These devices when properly spaced, give advance warning of impending failure before it occurs and thereby prevent costly derailments. Nevertheless, though the automatic devices perform the primary inspection function, visual inspection should be continued to the extent available.

**Economic benefits**

The resultant economic benefits thus include the avoidance of:

- Loss of revenue due to service disruptions
- Costs to repair track and equipment
- Claims for loss of lading and damage to adjoining private property.
- The cost of clearing derailments resulting from undetected equipment failures.
- Added freight car hire for all per diem cars delayed due to disruption of service.
- Added non-productive crew costs for crews adversely affected by the disruption of service.
- Detour expense, if involved
- Potential personal injuries to employees and outsiders.

By reducing accidents, a reduction in the public and governmental perception that railroads constitute a public menace which should be closely regulated. (For example, speed restrictions could be imposed on freight trains during rush hours on tracks adjacent to highways, commuter or transit tracks.) Also, reduced insurance costs could result from fewer accidents.

Each of these cost categories would be magnified in degree should the damaged cars contain toxic and/or highly flammable lading. While they are not subject to precise quantification, they are potentially substantial and could significantly impact net income. Likewise, the adverse effect of derailments on customer relations is not measurable but is a real factor for consideration. With the continuing advent of intermodal and double stack business, which is a service oriented and competitive market, the railroad industry cannot afford service disruptions. Additionally, many contracts are now written with bonuses or penalties for performance, which could be affected by derailments.

Other savings from the use of automatic inspection stations include:

- Reduction in personnel to inspect rolling stock.
- Reductions in clerical costs to prepare and/or handle inspection reports by automatic reporting to train crews and dispatchers via radio.
- Preparation of written reports automatically by microprocessors.
- Reduction in record keeping and elimination of paper chart recorders, paper supplies and maintenance of the recording devices through data transmission and computer usage.
- Reduction in maintenance costs due to the ability to remotely test and check on the condition of the wayside detectors from a central location via microprocessors and self-diagnostic equipment. (Some hot bearing detectors do a diagnostic self-check periodically.)

Although it is not possible to accurately predict savings, equipping detector locations with "talker" or voice radio to alert train crews has resulted in their being notified promptly as soon as the train clears the detector site and avoiding further train delay in cases where no defect is found, such notification is made to the train crew via the "talker" so they can proceed.

One major railroad installs hot bearing and dragging equipment detectors at the same location with a microprocessor to handle and analyze the data from the detectors. Although it is a stand alone system (the alarm decision is made at trackside) and the results are sent via digitized voice radio to train crews, the entire data results are sent to the dispatcher's office and displayed on a video display unit or CRT. Data from all detectors on a division are sent to the division headquarters where the information is stored and analyzed by a larger computer so maintenance and diagnostic practices can be reviewed or revised. Other data automatically generated includes number of axles in train, length of train, date and time of train passing inspection station, speed and direction.

Automatic train inspection stations are a practical tool for safer and more efficient railroad operations.