IEEE

VEHICULAR TECHNOLOGY SOCIETY

NEWSLETTER

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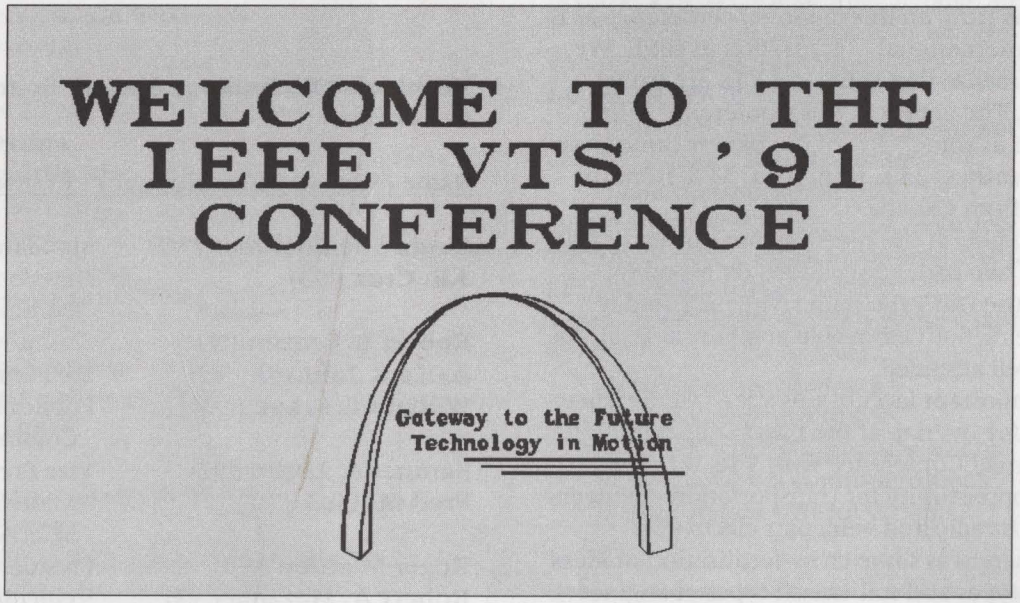


Over 700 attend VTS '91 and IEEE/ASME railroad conferences

Madden's Message

Roger Madden
President

VTC '91 was the best conference ever. That statement is really the consensus of those who attended this meeting in the Westport section of St. Louis, Missouri just west of the city.

Jay Underdown and his various VTC '91 committees did a superb job in putting on this Conference. Everything went very smoothly and as he noted, the Sheraton hotels did an excellent job in handling the over 700 people in attendance and providing for four great luncheons with a different menu at each.

VTC '91 was truly an international conference as is fitting to an international organization as IEEE. We don't always realize that IEEE and VTS are truly international. The papers at this Conference reflect that character as some 34% of the papers came from European countries, 24% from Asia, 34% from the U.S. and 8% from Canada.

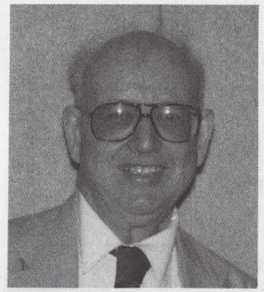
Many highlights at the meeting, but one can easily point out the two panel discussions on Monday evening and the Old Type Radio Nite on Tuesday evening as being both enjoyable and educational. All three were well attended.

Another important facet of this year's Conference was the one day overlap of the Land Transportation Division Railroad Conference with VTC '91. This provided an opportunity for transportation engineers to mingle with radio and vehicular electronics engineers. There was some cross-fertilization of ideas among radio types and rail-transit types of engineers.

Heartiest congratulations to all who worked so hard and well to make this VTC '91 such a great success. And thanks are also due to all who attended who also made this 1991 VTC and Railroad Conference so successful.

Just a reminder: VTC '92 will be held in Denver, Colorado on May 11-13 at the Hyatt Regency Hotel. The ASME/IEEE Joint Railroad Conference will be held March 31-April 2, 1992 in Atlanta, Georgia at the Atlanta Hilton & Towers. ✦

Editor's Corner



Robert W. McKnight

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 better 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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Put them all together in a name becomes just too long and complicated. If you want to have some fun, take key letters and make an acronym, especially one that means anything.

One suggestion is to keep the present name and more specifically define the areas of interest, and so state in the Newsletter. This might be worthwhile to have a policy or area interest statement in each issue to tell readers and potential members who we are and what we do. Another thing to think about and consider.

Recently I received from IEEE's computer and its Member Services Department a printout of the Technical Interest Profile of VTS members. These are the 4-digit numbers you put in a form and send to IEEE when renewing your membership. The breakdown I received gives totals in the entire category, such as 0600 for VTS. Here comes the "shocking news" (as of 5/6/91):

- Only 690 VTS members listed Vehicular Technology Society as their FIRST choice interest.
- Communications Society was First choice of 563 VTS members.
- Antennas and Propagation Society was First choice of 157 VTS members.
- Computer Society was First choice of 112 VTS members.

Thus we must realize that out of a membership of 3,000 about 23% select VTS as their First choice in technical interest. If one takes First, Second and Third choices of VTS members, this is what the count of technical interest shows:

Vehicular Technology	Antennas & Propagation	Computer	Communications
1,766	553	422	1,455

When one looks at the details of the Technical Interest Profile, it is not hard to see why some VTS members pick other societies.

Antennas & Propagation are quite obvious. But under Communications Society we find such interest areas as Radio Communication, Satellite & Space Communications, Data Communications, Communications Systems Engineering and Communications Networks & Maintenance.

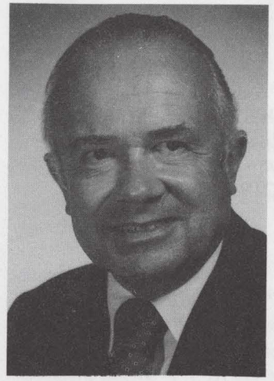
In the Computer Society are Microprocessor and Minicomputers. Transportation Systems is in Control Systems (119 VTS members checked this as either 1st, 2nd or 3rd choice). Transportation is also in interdisciplinary and New Activities Society (109 VTS members checked this as 1st, 2nd, or 3rd choice).

One version of a Vehicular Technology Society statement of areas of interest might be as follows:

> Mobile radio communications, transportation electronics and control systems applying to vehicles and fixed plant including highways, railroads and public transportation systems.

No one name arises from this Editor's Corner, but rather more "food for thought." ✦

Professional Activities



Frank E. Lord
Professional Activities Editor

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 advocate 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 currently chairing the Pension Committee (and leading charges up Capitol Hill?). This year's President, Roger Madden, is a heavy contributor in his position on the Manpower Committee, Bill Whipkey is the Vice Chairman of the Professional Activities Council for Engineers (PACE) and Eric Schimmel 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 Employees." Periodical 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 L 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 combined 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 efforts 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.

Chapter News for August

Gaspar Messina,
Chapter News Editor

News from Philadelphia, Cleveland and Ottawa

Philadelphia Section of Vehicular Technology Society Land Transportation Division hosted two interesting technical sessions, in April and May. They covered "Cross-Linked Polyethylene and Ethylene Propelene Insulated Cables" for rail and transit systems, and "Static Frequency Converters for SEPTA's Commuter Rail Operation using 25 Hz AC."

The April 11 paper was presented by Daniel D. Masakowsri, Rockbestos Corp., with 22 in attendance; and the May 9 paper was presented by Robert Fisher of Southeastern Pennsylvania Transportation Authority, Philadelphia, PA, with 39 in attendance.

Cleveland Chapter VTS met on April 16 at which 11 heard a paper titled "Cellular Radio Site Construction" presented by Douglas Goergen of GTE Mobilnet.

Ottawa, Ontario, Canada, VTS Chapter in its early developmental stage reported on three meetings. On February 12, Ed Morton of JATON, Ottawa, presented a paper titled "Quiktrak—an Innovative Method for Vehicle Location and Messaging," with 22 in attendance. On March 7, George Davis of Telesat Mobile, presented a paper titled "MSAT—Canada's Mobile Satellite is Moving Forward," with 23 in attendance. On April 30, Dr. Ray Leopold of Motorola, presented a paper titled "Iridium—a Low Earth Orbit Global Cellular Communications Network," with 69 in attendance. ✦

VTC '91 registration was in the lobby of the Sheraton Westport Plaza.

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 hotels 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.

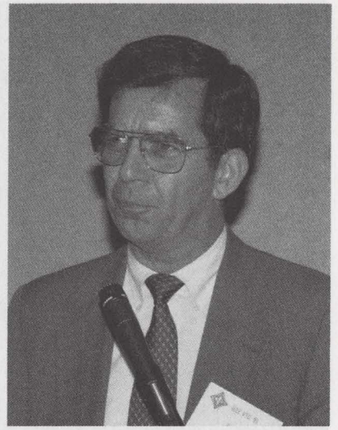
Also, as VTC '91 was held on Monday, Tuesday and Wednesday, the Land Transportation Division of VTS held its Institute of Electrical & Electronics Engineers/American Society of Mechanical Engineers Joint Railroad Conference on Wednesday and Thursday, with its near record attendance of 100.

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 swaps 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.



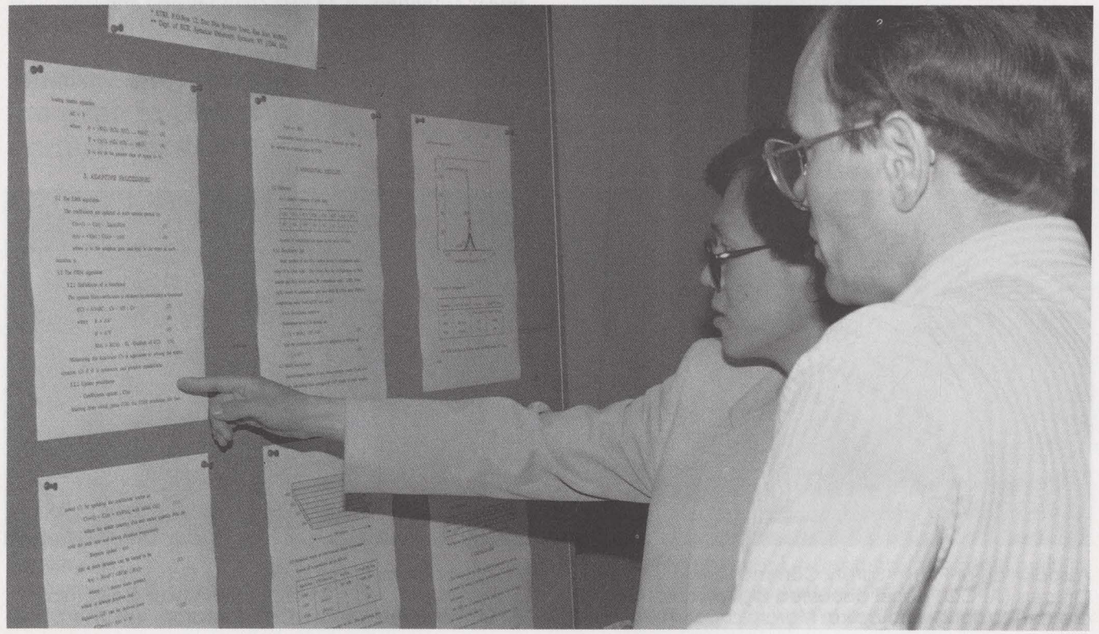
Jay Underdown (left) was the VTC '91 Conference Chairman, who welcomed attendees at the Monday luncheon which featured John Stupka, President Southwestern Bell Mobile Communications. He predicted strong growth for wireless personal communications. Roger Madden (right) is President of the Vehicular Technology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

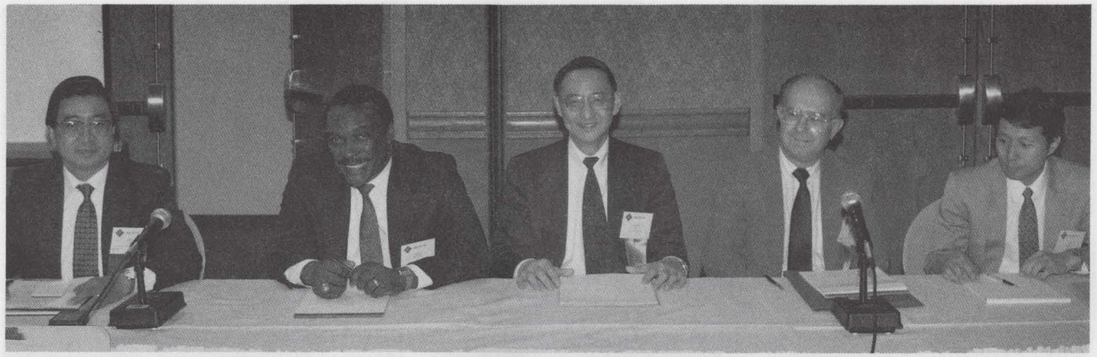
- Channel management, 5 papers.
- Spectrum management, 5 papers.
- Detection techniques, 4 papers.
- Baseband techniques, 6 papers.
- System performance, 4 papers.
- Cordless telephones and pagers, 4 papers.
- Vehicle electronics, 4 papers.
- Train communications and control, 3 papers.

In addition to the above mentioned paper presentations, one room was devoted to poster sessions in which authors' papers were mounted on display boards (each page of the paper) and the authors were available to answer questions or clarify points made in their paper. It provided a one-on-one tutorial for attendees. Poster sessions included the following:

- Antennas, 3 papers.
- Mobile communications equipment design, 4 papers.
- System design, 7 papers.

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.

Personal communications topics included service concepts, network architecture, available technologies, standards and possible service available dates.

Dr. Edward Chien, Chairman Technical Program Committee, moderated the panel discussion which included the following:

- Jesse E. Russell, AT&T Bell Laboratories.
- Dr. William C. Y. Lee, Pactel Cellular.
- Dr. Roger Funge, British Telecom
- Dr. Fumiyuki Adachi, NTT Radio Communications.

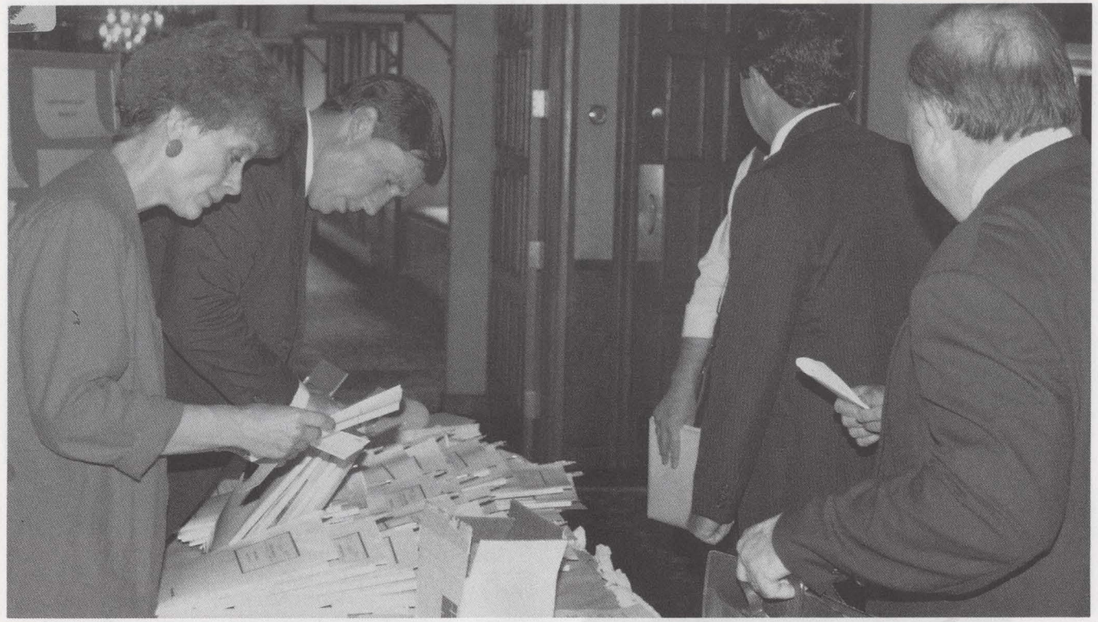
The other panel discussion was concerned with the Associated Public Safety Communications Officers Project 25 Digital Radio.

Topics discussed included voice coding equipment, linear amplifiers, 6.25 kHz channelizing and compatible modulation techniques.

Moderator was John Powell, University of California at Berkeley, and First Vice President of APCO.

Panelists included:

Association of Public Safety Communications Officers (APCO) panel discussed digital radio. They are (left to right): Eric Ziolko, Motorola; Satish Kappagantula, Ericsson-GE; John Gregory, E. F. Johnson; and John Powell, University of California, APCO Vice President and Moderator.



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 Ziolko 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.'"

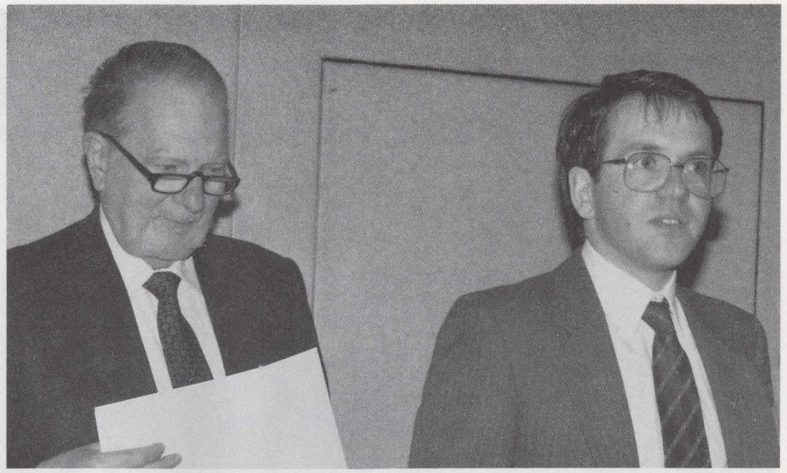
Dr. Birnbaum also mentioned that "only people that were born before a technology becomes pervasive think of it as technology at all; all others consider it part of the environment."

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."

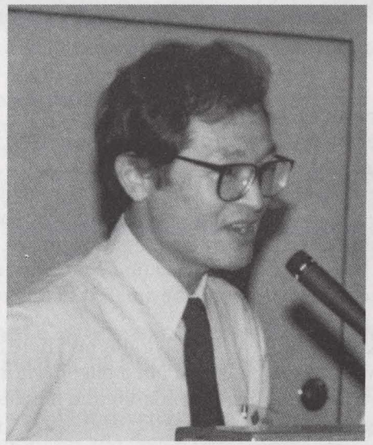
Accessibility and Standards

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



Stuart Meyer, Senior Past president, VTS was master of ceremonies for the Tuesday awards luncheon. Frank A. Thatcher (left in right picture) Chairman, Papers of the Year Awards Committee, reported that Mark Beech (at podium) had received the Neal Shepard award for a paper on RF propagation in the VTS Transactions in 1990.



Dr. Fumiyuki Adachi of NTT Radio Communications, received an award for the Best paper of the Year in VTS Transactions.

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.

"The balancing act between capacity, quality and cost is going to be a key driver during the next decade.

"You must ensure that the air interface, the link between the customer and the network, meets the dimensions of capacity, quality and affordability," Stupka said.

"Unlike the computer industry, there is a standards-based infrastructure for the wireless communications industry. The country today has a uniform standard for a radio interface. A cellular phone built to the 'US standard' will work in any cellular system in the United States.

"Most importantly we have just finished the development of a call delivery standard. This standard is designed to allow a customer to place and receive calls anywhere. This standard utilizes the mobile unit's ability to autonomously register when it senses it is being served by a different system than it last experienced.

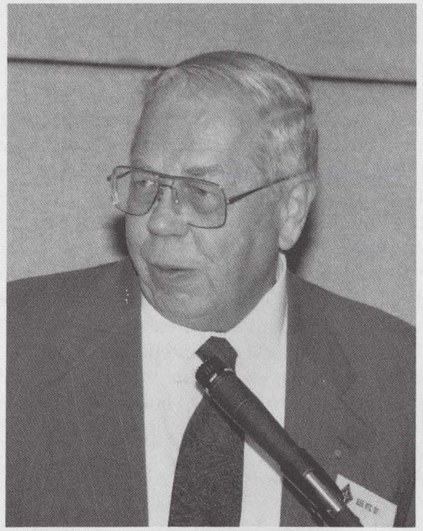
"Another unique feature provided through this profile is that it allows the customer to have his or her calls delivered to the system in which they are now operating. This is the 'anywhere, anytime' component at its finest. The presence of standards nationwide is what has fueled cellular's outstanding growth.

"The cellular industry is now standing as an industrial legend. From no commercial existence in late 1983, the cellular industry has grown to a $7 billion business," Mr. Stupka stated.

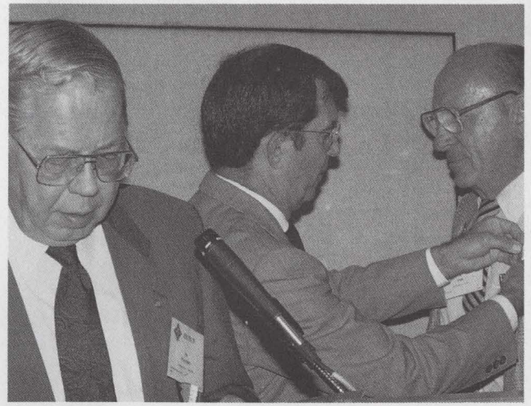
The Cellular Telecommunications Industry Association (CTIA) realizes that technology will continue to evolve. CTIA has a platform designed to gracefully accept change as we move toward the wireless future, Mr. Stupka said, and he described CTIA's platform:

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

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



Samuel McConoughey, Avant Garde awards Chairman announced that the following VTS members would receive the Avant Garde Award: Robert L. French, Joseph Gormley, Al Gross, Al Iseberg, Robert W. McKnight, and Lyle B. Saxton.

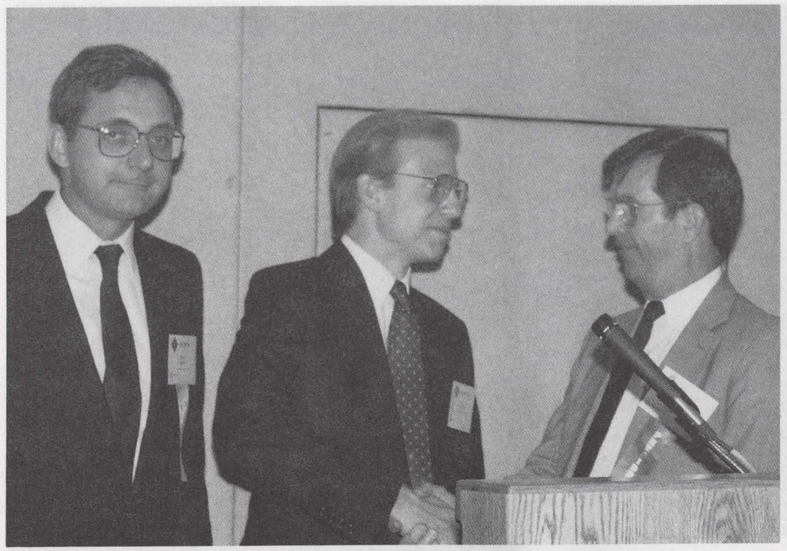


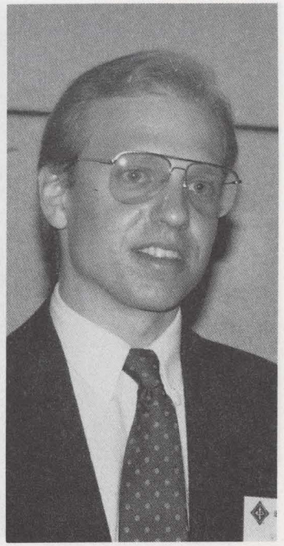
Rober Madden (center), VTS President, pins Avant Garde medal on Al Gross.

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 obsolescence that they don't understand.

CTIA specification/TIA (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.

The seamless North American network will be promoted and fostered through any technical changes. The concept of 'anywhere, anytime' or 'nationwide seamless service' is the strongest ally we have in ensuring that our product is viewed as simple, and thus generally accepted.





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 graudate of Illinoise Institute of Technology, William Jacklin will pursue a master's degree at IIT.

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 awards 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 doing 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. French, Joseph Gormley, Al Gross, Al Iseberg, 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 on (date) by its officers:

(Signature) President

(Signature) Secretary"

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, W2GHK, 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, W8PAL, 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. Tasar.

• 1989 Second Place: "Tractive Power Supply at German Federal Railway's 400 Km/h Runs," German Federal Railway, West Germany, W. Harprecht, R. Seifert, and F. Kiessling.

• 1989 Third Place: "Effect of Magnetic Saturation, 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. Boggess 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.

Markets drive National Transportation Policy

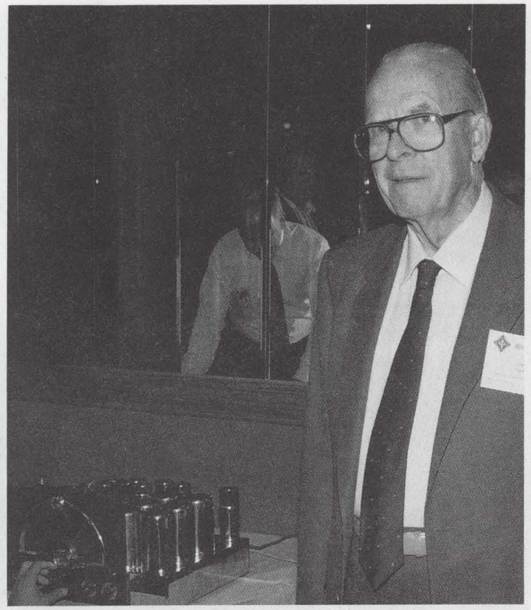
Speaking of the present Administration's National Transportation Policy, Associate Administrator for Policy, Federal Railroad Administration, William J. Watt, said that policy developers focused on markets, not modes.

On Wednesday, May 22, Mr. Watt, was the luncheon speaker to over 650 attendees of both the 1991 IEEE Vehicular Technology Society Conference and the opening of the two-day IEEE/ASME Joint Railroad Conference.

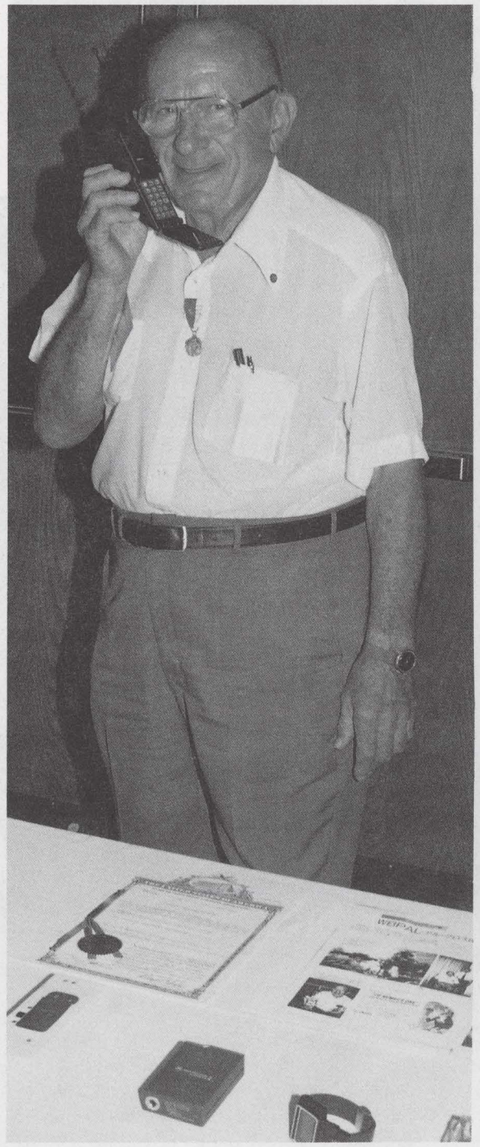
An abstract of Mr. Watt's talk is presented herewith.

Six themes guided the National Transportation Policy: 1- maintaining and expanding the nation's

George Shindler (left), Al Gross and Jay Underdown (right) look at the progress in portable radio transceivers (older models to the left).



Jim Evans stands by one of the early radio receivers.



Al Gross uses the latest small cellular telephone ("radio"), one of the exhibits at Tuesday evening's "Old Tyme Radio Nite."

Al Gross, Fred Link (center) and Stuart Meyer described their experiences in developing, selling and operating two-way radio in the 30's, 40's and 50's.

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 intermodalism, 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%.

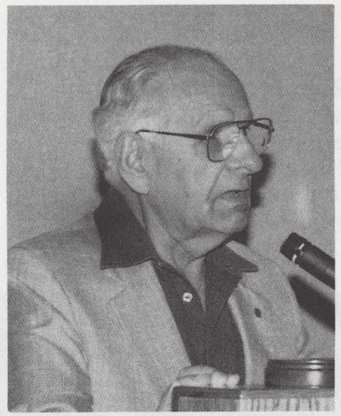
The current federal aid highway program covers a system of 850,000 miles. We propose to restructure it to a new National Highway System of about 150,000 miles that carries more than 70% of truck-borne interstate commerce and some 40% of all highway travel. The aim is to target federal funding to priorities, 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.

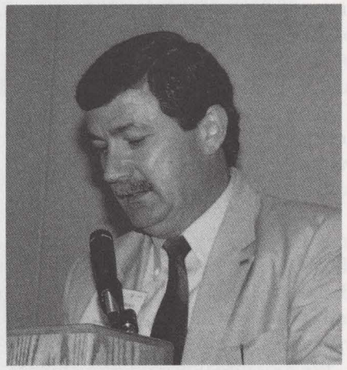
Under a revised urban and rural highway program, the department proposes that state and local officials have the authority to use trust fund money for both highway and transit. States also would be able to use as much as 5% of their funds for highway safety improvement or for eliminating grade crossing 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.

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.

R. 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.

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.

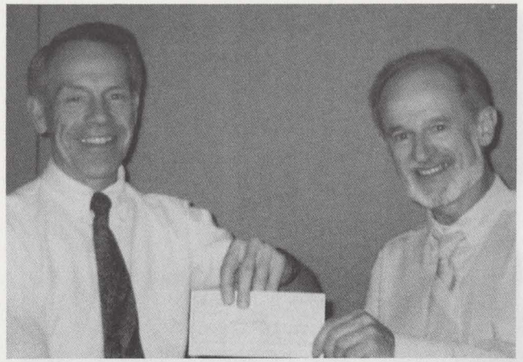
Meanwhile, I think it would be a mistake to overlook conventional rail passenger operations, either Amtrak or commuter services. The Bush Administration is supportive of a national railroad passenger system, and is working with Amtrak management to devise an orderly program of self-sufficiency that would 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

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. Orm R. Pendy (podium) Trailer 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.



Vehicular Navigation & Information Systems (VNIS) 1989 Conference committee member Rye Case (right) presents final payment check to A. Kent Johnson, VTS Treasurer for VTS' sponsorship. Presentation was made at the May 18, 1991 Board of Governors meeting in St. Louis, Mo.

Northern Railroad, who discussed the application of technology to the railroad industry and cited specifics concerning BN.

Data is expected to grow 15-20% per year, he said, which is driving BN to increase capacity of its land line transmission systems, such as fibre optic cables, and microwave rather than satellite communications links.

For the future, he sees the day when "throw away" $100 radios will be available so such units will not have to be maintained. He foresees big maintenance cost savings to more than cover the cost of new radios.

Automatic equipment identification is here and BN is installing scanners for reading tags that it is installing on its locomotive fleet.

BN has several acoustic bearing detectors in service. Of the 2,500 bearings removed and examined as a result of acoustic bearing detector actuation, Henderson said that 89% were condemnable according to AAR interchange criteria. Placement of acoustic bearing detectors in approach to yards and terminals with maintenance facilities is most effective.

BN along with Carnegie Mellon University and General Railway Signal Co., is developing a "smart bolt" to be installed in roller bearings on freight cars. When the bearing overheats, the "smart bolt" pops out (part way) and sends a radio signal to the locomotive cab alerting the train crew that a bearing has overheated. After the train is stopped, a train crew member with a hand-held receiver can find the overheated bearing, also seeing the extended bolt. BN expects to have some "smart bolts" in test service this summer.

Henderson predicts that ultimately if all freight cars and locomotives were equipped with "smart bolts", the need for wayside hot bearing detectors could probably be eliminated.

Also, BN is equipping 100 locomotives with health-monitoring systems that in real-time send status reports via digital radio links to maintenance centers. Thus these centers can better plan their work, and can also via radio advise the locomotive engineer corrective action he might take to solve any immediate problems with locomotive operation.

On the safety side, BN is equipping its locomotives with strobe lights up front that turn on when the whistle is blown. This is to provide more visibility to motorists at rail-highway grade crossings.

In Jonesboro, AR, BN installed video cameras at a rail-highway grade crossing equipped with flashing-light signals and automatic gates. Pictures are taken of the rear of motor vehicles including the license plates at crossings, especially those vehicles that are driven around the ends of gates in the down position. Henderson said six motorists have driven around lowered gates, have been apprehended by police and paid a $140 fine each. None protested the police action. BN plans to make a similar video camera installation at a rail-highway grade crossing in Oklahoma. ✦

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. Phone: (303) 871-3519, FAX (303) 871-4450; e-mail: JSCHROED@ATHENA.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 telephones: 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 phone 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 their cost-effectiveness. Topics may include the following:

- AC and DC propulsion systems.
- Electromagnetic compatibility.
- Automation and microcomputer control.
- 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. ✦

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 MHzk) should be kept for the use of railroads 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 radios manufactured specially for the railroads.

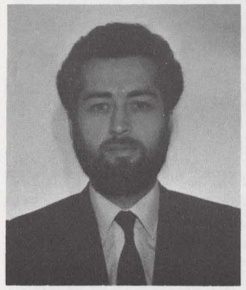
Migration path from analog to digital radios should be developed and followed.

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

Also, the above should be applicable for the UHF band. ✦

In 1927 centralized traffic control was first installed on 37 miles of single track and 3 miles of double track between Stanley and Berwick, OH on the New York Central. This was the unit-wire system in which one wire from the control office to each power switch (in connection with a line common) served to control the switch and signals at the end of a siding, and to carry back the necessary indications.

Communications Abstracts



J. R. Cruz,
Communications Editor

"Soft RS Codes for Half Rate GSM Channel," *Electronic Letters*, S. A. Atungsiri, P. Sweeney, R. Soheili, A. M. Kondoz, and B. G. Evans, Vol. 27, No. 2, 1991.

After the adoption in 1987 of the RPE-LTP coder as the 22.8 KBPS Pan European Mobile Speech Communication standard (full rate GSM or F-GSM), the next stage in the project is the development of a CODEC (source and channel) operating at 11.4 KBPS (half rate GSM or H-GSM). Many speech coding algorithms under evaluation are expected to meet the stringent quality specifications of H-GSM. However, during operation the channel perturbations are expected to be twice as bad for H-GSM as for F-GSM. Despite this, an error control scheme which uses less redundancy and provides performance which for the most part is superior to the scheme for F-GSM is expected. A high performance FEC scheme is presented which employs soft decoded Reed-Solomon (RS) codes on the H-GSM channel.

"Spectrum Efficiency Analysis for Microcellular Mobile Radio Systems," R. Prasad, A. Kegel, and J. Olsthoorn, *Electronics Letters*, Vol. 27, No. 5, 1991.

Spectrum efficiency is analyzed in a microcellular mobile radio environment considering an appropriate model for UHF ground-wave path loss. The influence of cluster size and reuse distance on the spectrum efficiency is investigated by obtaining the probability of cochannel interference for uncorrelated Rayleigh fading interferers and Rician fading desired signal. The effect of traffic intensity is also considered in evaluating the spectrum efficiency.

"Performance of Direct Sequence Spread Spectrum Multiple-Access Systems in Mobile Radio," W. H. Lam and R. Steele, *IEE Proceedings-I*, Vol. 138, No. 1, 1991.

The performance of coherent direct-sequence spread-spectrum multiple-access (DS/SSMA) communications over different mobile radio channels is investigated. Analytical techniques and numerical methods were used for a channel having a number of resolvable, discrete Rayleigh fading paths, while simulations were employed for transmissions over urban mobile radio channels. We found that even a flat Rayleigh fading channel caused a severe degradation in system performance compared with the additive white Gaussian noise channel, and that the system was unusable even for a few users when a wideband urban mobile radio channel was used. By transmitting a sounding sequence of chip length N_S = 511 to allow the receiver to estimate the channel impulse response, spreading the symbol over N = 127 chips, and on deploying fifth-order combinative space diversity equipped with adaptive correlation diversity of K_b = 10 (CD/ACD), we were able to obtain a residual probability of bit error P_R of less than 10^{-3} for 10 users, in spite of the urban mobile radio channel having 19 resolvable fading paths. By increasing N to 511 and deploying fifth-order maximal-ratio-combining (MRC) space diversity, a P_R of 4×10^{-5} for 20 users was achieved when the radio channel consisted of 10 resolvable independent Rayleigh fading paths.

"Performance Evaluation of a Composite Microscopic Plus Macroscopic Diversity System," A. M. D. Turkmani, *IEE Proceedings-I*, Vol. 138, No. 1, 1991.

Closed-form analytical solutions are obtained for the performance of M-branch maximal-ratio and selection microscopic diversity system with a class of continuous phase and constant amplitude modulation schemes for Rayleigh and log-normal fading. The results indicate that diversity improvement is related to the standard deviation of the log-normal component and the improvement decreases as the standard deviation increases. Since microscopic diversity only mitigates the effect of fast (Rayleigh) fading, other means are needed to mitigate the effect of the slow (log-normal) component. Further development of the theory indicates that a composite microscopic plus macroscopic diversity system can substantially improve the performance by counteracting the two facing components simultaneously. Analytical results are produced for two-branch microscopic selection or maximal-ratio plus N-branch macroscopic selection diversity systems.

"Estimation of Unreliable Packets in Subband Coding of Speech," W. C. Wong, N. Seshadri, and C.-E. W. Sundberg, ***IEE Proceedings-I***, Vol. 138, No. 1, 1991.

A robust speech communications system over a digital mobile radio channel is considered. We examine a system using 12 Kbit/s embedded subband coding of speech and rate compatible punctured convolutional (RCPC) codes with generalised Viterbi decoding for combined error detection and correction. System performance is improved by exploiting the frame-to-frame redundancy in the subband energy profile used for adaptive bit allocation in the subband coder. Unreliable subband side information about the energy profile is identified through a two-stage process comprising the channel error detector and a source-based 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 main 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," Pooi Yuen Kam, *IEEE Transactions on Communications*, Vol. 39, No. 2, 1991.

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 *L* independent diversity channels with AWGN and show nonselective 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 differentially coherent receivers. 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 MMSE estimates of the quadrature amplitudes of the channel fading processes as a coherent reference. Conventional receivers employing carrier loops to provide the coherent reference are not optimum, and lead to more complicated receiver structures.

"Bit Error Probabilities of MDPSK Over the Nonselective Rayleigh Fading Channel with Diversity Reception," Pooi Yuen Kam, *IEEE Transactions of Communications*, Vol. 39, No. 2, 1991.

Data transmission using MDPSK over the nonselective Rayleigh fading channel with diversity reception is considered. While existing error probability results mostly assume 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 2, 4, and 8 DPSK as well as tight upper bounds are derived. Some applications of the results are discussed.

"Analysis of Equal Gain Diversity on Nakagami Fading Channels," Norman C. Beaulieu and Adnan A. Abu-Dayya, *IEEE Transactions on Communications*, Vol. 39, No. 2, 1991.

An infinite series for the complementary probability distribution function (cdf) of the signal-to-noise ratio (SNR) at the output of *L*-branch 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*-branch 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 unbalance 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 unbalances on FSK modulations are also investigated. Bit error rates for EG combining on Rayleigh fading channels have not been previously obtained for L > 2. These results are obtained and presented here as a special case of the more generalized Nakagami fading model.

"A Radio System Proposal for Widespread Low-Power Tetherless Communications," Donald C. Cox, *IEEE Transactions on Communications*, Vol. 39, No. 2, 1991.

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 exchange access 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 reuse system is described and frequency spectrum needs are indicated.

"Throughput Analysis of CDMA With DPSK Modulation and Diversity in Indoor Rician Fading Radio Channels," H. S. Misser, C. A. F. J. Wijffels, and R. Prasad, *Electronics Letters*, Vol. 27, No. 7, 1991.

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 on the throughput is also investigated.

"Channel Coding/Diversity Reception on Packet Mobile Radio," M. Kitagawa, K. Ohno, and F. Adachi, *Electronics Letters*, Vol. 27, No. 7, 1991.

The capacity of BCH coded π/4-shift QPSK packet mobile radio with postdetection selection diversity reception is investigated by computer simulation taking into account fast Rayleigh fading, shadow fading, and propagation loss. Results presented for 80-bit information packets show that overall capacity can be maximized by the use of high rate codes together with diversity reception.

"An Improved Transmission Protocol for Two Interfering Queues in Packet Radio Networks," Poki Chen and Jin-Fu Chang, *IEEE Transactions on Communications*, Vol. 39, No. 3, 1991.

An improved transmission protocol for two interfering queues in packet radio networks is proposed in this note. This protocol allows a 1.0 transmission probability for newly transmitted packets while p for retransmitted packets. Compared to the protocol in which each packet is always transmitted with the same probability p our protocol shows better performance especially when the channel traffic is light.

"Improved Computation Method for Radio Systems Single-Tone Spurious Prohibited Frequencies List," J. Gavan, *IEEE Transactions on Communications*, Vol. 39, No. 3, 1991.

Single-tone spurious STS effects 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 STS prohibited frequencies. A previous developed STS computation method is significantly improved by applying the comparative results of the former computer prohibited listed prints with the measured values of two UHF receivers engineering models. The new semiempirical concepts considered the nonlinear amplitude dependent correction factor computation effects from the receiver frequency converter stages. The new more realistic STS prohibited list, including accurate values for the system receiver rejection ratio, contribute to improve radio interference immunity from the initial stages of radio systems design and to optimize the frequency allocation management policy.

"Adaptive Rate Error Control Through the Use of Diversity Combining and Majority-Logic Decoding in a Hybrid-ARQ Protocol," Stephen B. Wicker, *IEEE Transactions on Communications*, Vol. 39, No. 3, 1991.

Diversity combining and majority-logic decoding are combined in this paper to create a simple but powerful hybrid-ARQ error control scheme. FEC majority-logic decoders are modified for use in type-I hybrid-ARQ protocols through the identification of reliability information within the decoding process. 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 adapting the effective code rate to channel conditions. Excellent reliability performance coupled with a simple high-speed implementation makes this majority-logic system an ideal choice for high data rate error control over both stationary and nonstationary channels.

"Low-Power Digital Radio as a Ubiquitous Subscriber Loop," Donald C. Cox, Warren S. Gifford, and Howard Sherry, *IEEE Communications Magazine*, Vol. 29, No. 3, 1991.

Digital radio has become an economical technology for implementing subscriber loops in low-density rural areas. The use of digital radio technology for this rural loop 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 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 mi. or so to widely scattered subscribers.

Driven by a strong market for mobility in telecommunications and rapid advances in signal processing and integrated circuit technology, radio is playing an increasing role in providing access to telecommunications services. 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 subscribers in the U.S. 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 combined in the U.S. Specialized Mobile Radio Systems (SMRSs) are growing to provide both voice and packet data services.

New low-power digital radio technologies are being developed and deployed in the U.K. and Europe to provide tetherless access to telecommunications services. Examples are the Cordless Telephone-second generation (CT-2) and Digital European Cordless Telecommunications (DECT) technologies, which transmit at average power levels of about 10 mW. CT-2 has been deployed to provide Telepoint services, which are the equivalent of a public telephone access, over a short wireless loop. DECT is targeted at Private Branch Exchange (PBX)/Centrex loop applications, and may be used for Telepoint too. Several spread-spectrum technologies are available in North America for providing Radio Local Area Networks (RLANs) to interconnect personal computers, and such technologies are also being pursued for cordless telephone/Telepoint applications under Part 15 of the FCC regulations.

The vision of Personal Communications Services (PCS), in which individuals using small lightweight low-power portable digital radio handsets (and data terminals) access the local exchange network to obtain personalized services, is becoming accepted within the worldwide telecommunications industry. Work has been underway within Bell Communications Research (Bellcore) and the regional telecommunications companies since their formation to define and deploy an intelligent network, a key element in providing personalized communications; and define low-power digital radio technology for use in "subscriber loops" to demonstrate technical and economic feasibility for these applications.

High-power digital radio technologies (0.5-5.0 W) have been standardized and are being developed rapidly for deployment in next-generation cellular mobile radio systems. The Special Mobile Group (GSM) of the European Telecommunications Standards Institute (ETSI) has standardized a pan-European Time-Division Multiple Access (TDMA) mobile radio technology. The Telecommunications Industry Association (TIA) and Cellular TIA (CTIA) have standardized an entirely different TDMA technology for North America. Spread-spectrum Code-Division Multiple Access (CDMA) technology is also being researched for possible use in future cellular mobile systems.

Rapid advances in Very Large Scale Integration (VLSI) circuits and radio frequency semiconductor devices, along with the high manufacturing volumes associated with large growth, are rapidly reducing the cost of radio technologies that could be used in subscriber loop applications. Low-power digital radio technology could be configured to economically serve the subscriber densities currently served by wireline telephones, while using a modest amount of radio spectrum (on the order of 50 to 100 MHz).

"BER Performance Owing to Random FM Noise for QDPSK Mobile Radio With Diversity Reception," F. Adachi and K. Ohno, *Electronics Letters*, Vol. 27, No. 8, 1991.

BER performance owing to random FM noise is investigated for QDPSK with postdetection selection diversity reception in a multiplicative Rayleigh fading environment. Experimental results for l6Kbit/s QDPSK using a Rayleigh fading simulator are reported. It is shown that diversity reception can significantly reduce the impact of random FM noise.

"Depolarisation and Field Transmittances in Indoor Communications," E. Vilar, *Electronics Letters*, Vol. 27, No. 9, 1991.

Measurements of copolar and crosspolar field amplitudes in an indoor cordless communications environment are presented. Measurements of narrowband and wideband transmittance magnitude are also presented for vertical and horizontal polarisations. An important longitudinal component is identified and the general concepts of co- and crosspolar (transversal and longitudinal) frequency/distance transmittance H (jw, d) are introduced and defined.

"Enabling Technologies for Wireless In-Building Network Communications—Four Technical Challenges, Four Solutions," Thomas A. Freeburg, *IEEE Communications Magazine*, Vol. 9, No. 4, 1991.

Despite the advances in power and performance we now enjoy thanks to modern solid-state electronics, we are still shackled with the problems—physical, logistical, and financial—of wire- and cable-based communications within buildings. Anyone familiar with installing, maintaining, and changing building cabling has no need to be convinced that it is a nightmare crying for a viable wireless alternative. What is needed is a high- performance, easy-to-deploy, user-transparent, reliable, wireless in-building communications network technology. Such a system would also have to be compatible with present and future cable-based voice/data communications performance, standards, and protocols.

Unfortunately, to date no such system has been developed. Spread-spectrum Ultra High Frequency (UHF) and Infrared (IR) Local Area Network (LAN) systems have been introduced, but they suffer from inherent problems and performance limitations.

Now, however, the hardware and software technology that could make high-speed wireless communications within an office, factory, or other in-building environment truly practical, cost-effective, and achievable has been developed. This development lies in a part of the electromagnetic spectrum that only recently has been opened for in-building communications by the Federal Communications Commission (FCC), namely, the 18 GHz band. The very properties of 18 GHz that are disadvantageous to its use in traditional long-distance, broadcast-type radio communications become advantages that make it ideal for networked cellular communications within buildings. This frequency band offers the bandwidth to handle the higher data speeds expected of future systems, as well as propagation characteristics almost perfectly suited to low-power in-building cellular networks where high spectrum reuse is a critical issue.

In this article the basic set of problems this technology addresses is described, namely: the minimum performance and features required of a viable in-building wireless technology, the range of options available in selecting a design approach for

such a system, and finally, the technical problems that were faced in developing a microcellular wireless in-building system using 18 GHz radio technology and how they were addressed.

"Spread Spectrum for Commercial Communications," Donald L. Schilling, Laurence B. Milstein, Raymond L. Pickholtz, Marvin Kullback, and Frank Miller, *IEEE Communications Magazine*, Vol. 9, No. 4, 1991.

Spread spectrum has a long and interesting history. It has been, and still is, used extensively in military communications systems, both to permit communications which are not detectable by enemy jamming systems (this property of spread spectrum is called Low Probability of Interception (LPI)), and resist jamming by an enemy desiring to disrupt communications.

What is "spread spectrum"? Until the early 1980s, many members of the IEEE had not heard these words. Indeed, spread spectrum techniques were used almost exclusively in military communications systems, and R&D in these areas were performed primarily with such applications in mind.

In 1983, this changed. The U.S. Federal Communication Commission (FCC) opened three frequency bands, 902-928 MHz, 2,400-2,483.5 MHz, and 5,725-5,850 MHz, to commercial spread spectrum users. The number of users that might operate within any of these bands was not specified, and so theoretically at least, there is a possibility that many users might operate simultaneously and in the same location, thus interfering with each other and preventing reliable communication. The FCC undoubtedly thought that the probability of such an event was near zero. Alternately, if it did occur, the occurrence would then prove that there are many spread spectrum users and therefore, there is a market for spread spectrum. The FCC would then be able to allocate these users additional spectrum without undue political difficulty. In response to this frequency allocation, literally hundreds of small business ventures were started and spread spectrum products were produced and sold. The new spectrum is not congested with thousands of spread spectrum users proving that indeed there is a marketplace for spread spectrum. Now the FCC must review and regulate the band to insure that all users can operate without excessive interference.

How does spread spectrum operate? Why did the FCC allocate several spectral bands for spread spectrum? What is wrong with the spectrum allocations the way they are now? Who is using and will use spread spectrum? Why? These questions will all be answered in the remainder of this article!

"VLSI for Analog/Digital Communications," Miles A. Copeland, *IEEE Communications Magazine*, Vol. 29, No. 5, 1991.

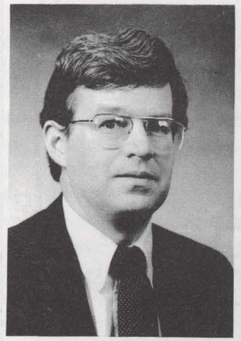
The purpose of this article is to review the state of the art of Very Large-Scale Integration (VLSI) as applied to communications. We will discuss the main trends of the present and some extrapolations for the future. A particular emphasis will be on the prospects for fuller VLSI integration of low-power 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 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," John S. Sadowsky and Randall K. Bahr, *IEEE Transactions on Information Theory*, Vol. 37, No. 3, 1991.

A DS-SSMA bit-error probability analysis is developed using *large deviations theory*. Let m denote the number of interfering spread spectrum signals and let n denote the signature sequences length. Then the large deviations limit is as $n \to \infty$ with m fixed. A tight asymptotic expression for the bit-error probability is proven, and in addition, recent large deviations results dealing with the 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 accurate 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



Bill Fleming,
Vehicular Electronics Editor

Satellite-Based 2-Way Truck Communications

Nationwide 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-to-14 GHz, includes a pair of Ku-Band transponders aboard the Gstar1 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:

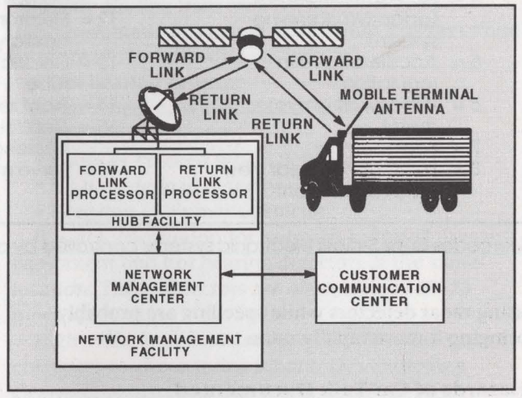
1) dispatching
2) shipment scheduling
3) vehicle arrival time confirmation
4) accident location
5) hijack detection
6) vehicle recovery

52-Percent of All Highway Trucks Use Radar Detectors

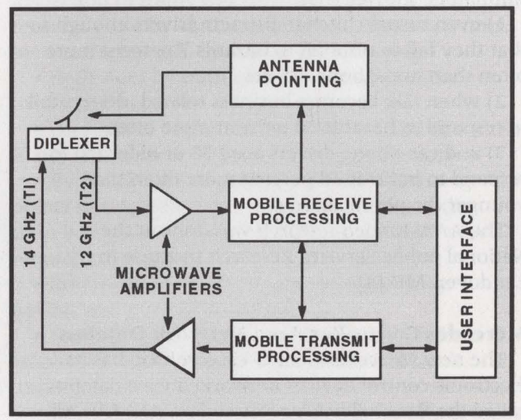
Yes, surveys show that 52 percent of all highway trucks have, and use, radar detectors [2,3].

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.

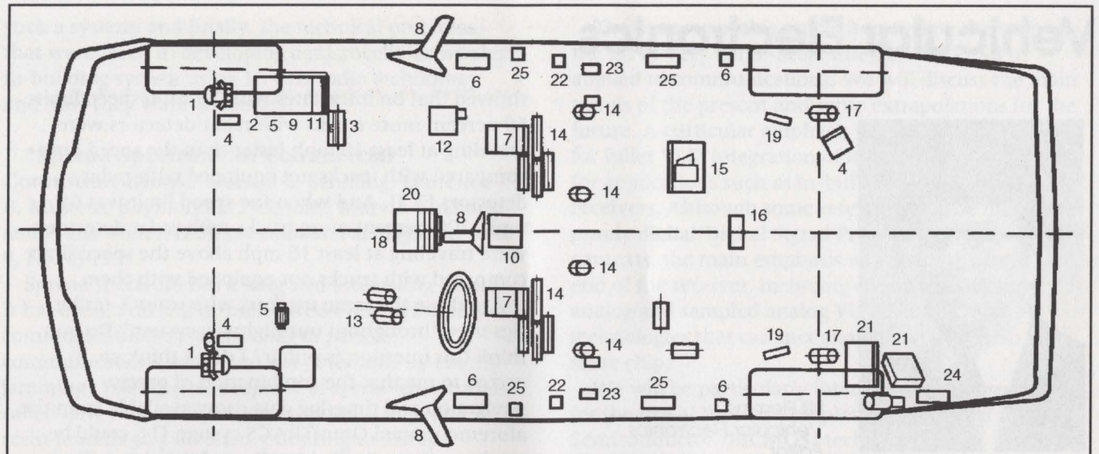
Are these the same truckers who want 3-trailer rigs used throughout our highway system? Do you think this question is unfair? I don't think so. It occurs to me that the combination of precise navigation and time-log data, now available from the aforementioned OmniTRACS system [1], could be used to automatically identify and ticket speeding truckers. One thing is for sure, the age of "big brother" isn't that far away, and all those truckers



Schematic diagram of Ku-band mobile communications satellite system. (1)



Schematic diagram of truck mobile terminal (1)



1 = Electronic ignition control unit
2 = LH-injection system
3 = Mirror and steering column memory
4 = ADS-damper sensor (adaptive damping system)
5 = Acceleration skid regulation
6 = Window lift (servo) motor
7 = Seat memory
8 = Servo motors, rear view mirror adjustment
9 = E-gas, tempomat and idle-control
10 = Airbag/belt tensioner senor
11 = Computer of adaptive damping system
12 = Electronic system of auxiliary heater
13 = Electric motors, jacket tube
14 = Front seat servo motors
15 = Control unit, rear passenger headrests
16 = Servo motors rear seat
17 = Servo motors, rear passenger headrests
18 = Water pump, heater
19 = Interior lights
20 = Control unit, automatic climate control
21 = Radio, CD player, amplifier
22 = Interior compartment infrared remote control, sending and receiving unit
23 = Belt tensioner
24 = Electric driven antenna
25 = Power closing system

Mercedes-Benz S-class electronic systems controlled by databus network (5)

using radar detectors while speeding are probably bringing it more rapidly upon us.

Hazards of Car Talk Documented

Facts to justify your worst fears about people using car phones have been reported [4]. A study, funded by and done using controlled tests on driving simulators, showed that:

1) even casual chitchat distracts drivers enough so that they fail to respond to hazards 7 percent more often than non-phone drivers

2) when talk becomes business related, drivers fall to respond to hazards 30 percent more often

3) and car-phone drivers aged 50 or older fail to respond to hazards 38 percent more often than younger car-phone drivers.

The AAA-funded research was done at the National public Services Research Institute in Landover, MD [4].

Mercedes Controller Area Network Databus

The new Mercedes Benz S-class vehicle has its electronic control devices networked via a databus called the Controller Area Network (CAN) [5]. All important measured values and controlling variables are made available without data-transmission jams or delays, and data transmissions are evenly distributed among the control units.

Electronic Crash-Sensing Breakthrough

A story on electronic crash-sensing work, in the last Newsletter [6], drew a phone call and a letter—both protesting lack of objectivity on this editor's part. In 17 years of writing this column for VTS, I've never before met this kind of reaction. The letter of complaint I received is reprinted below.

"I got very upset while reading the May 1991 IEEE Vehicular Technology Society Newsletter. On page seven, Bill Fleming was out-of-line telling us that: 'everyone's consensus best new sensor development was TRW's new approach to crash-sensing.' First of all, Bill works for TRW, and IEEE should not be used as a billboard for an editor's company. Secondly, I don't know who 'everyone' is, because I was at that speech and there were many skeptical people. As a matter of fact, I asked a pointed question and the answer I received was no answer. I was told that I must wait for patents to issue. I can accept that as a no answer, but then how did 'everyone' get so convinced that this technique was the best if they didn't even know how this new approach would work? Finally, there are other techniques far superior to the TRW method, but I guess we will just have to wait for the patents to issue."—[7]

The phone call and letter were from a TRW competitor, Automotive Systems Laboratory, which is part of Takata Corporation [8].

In reply to Takata's criticism, I stand by my original story. The "everyone" who support the consensus view include: coworkers, customers, the organizer and chairperson of the SAE Sensors & Actuators Session, those performing the federal-certification vehicle crash tests, and myself (based on 20-years experience with sensors and measurements).

Another factor involved in writing the article, [6], was an effort on my part to give credit to coworkers who invented the sensing method, but who were not included as coauthors for the subject SAE paper [9].

Incidentally, my coworkers now tell me that the best is yet to come, and to look forward to more patents issuing. A fair conclusion to all this is to simply say that no matter what, time will tell. We will ultimately, over the next few years, see which one of the TRW, Takata, or other crash-sensing methods actually does prevail. Then "everyone" will finally, and definitely, reach a consensus opinion.

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In 1952, the Baltimore & Ohio Railroad made an extensive test installation of closed-circuit television in Barr yard at Chicago.

Automatic train inspection stations get greater use

The economic considerations in the operation and location of automatic train inspection equipment has been developed by American Railway Engineering Association Committee 16- Economics of Plant, Equipment and Operations. The report is printed herewith.

Automatic train inspection stations are increasingly cost/beneficial because technology has made it possible for wayside detectors to be coupled with microprocessors and communications links such as base radio stations to report inspection results on a real time basis to train crews, dispatchers and maintenance personnel. Additionally, these automatic inspection stations often prevent catastrophic derailments by promptly alerting train crews of potential hazards.

An automatic inspection station may consist of one or more of the following devices:

- Hot bearing detector
- Flat wheel or wheel impact detector
- Hot wheel detector
- Loose or cracked wheel detector
- High, wide load detector
- Dragging equipment detector.

It is not uncommon for railroads to install dragging equipment and hot bearing detectors at the same location. These detectors are often located 20-25 miles apart along main lines.

High-wide load detectors are often located at yard entrances to check trains for any cars exceeding clearance restrictions that might cause problems.

Before automatic detectors

Prior to the advent of the automatic devices, visual inspection of trains was performed by carmen at terminals and by various employees of moving trains between terminals, including the following:

- Both sides by train and engine crews of their own train on curves.
- One side of each train by crews of trains operating in opposite directions in multiple track territory.
- Both sides of one train at meeting or passing points in single track territory by the crew of the train being met or passed assuming that train was required to stop.
- Both sides by roadway maintenance gangs having two or more employees.
- One side by individual roadway maintenance employees such as signal maintainers and track inspectors operating alone.
- One side at stations, open train order offices and interlocking towers manned by a single employee.

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. ✦