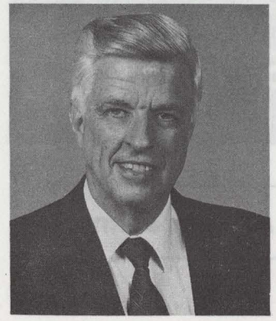
IEEE
VEHICULAR TECHNOLOGY SOCIETY
NEWSLETTER

Vol. 37, No. 1, February 1990 ISSN 0161-7887 Editor: A. Kent Johnson

On the Move in the '90's
May 6–9, 1990
Sheraton Plaza at Florida Mall
Orlando, Florida

President's Message

George McClure
President
IEEE Vehicular Technology Society



The theme for our Fortieth Annual Vehicular Technology Conference is "On the move in the '90s". This is not just a play on our Society's name. The Institute membership records show that ours was the second fastest-growing Society in 1989, in percent membership increase. Papers submitted for our 1990 conference increased by a third over 1989. Competition was keen and an excellent technical program has been the result, as you will see from the advance program information elsewhere in this issue.

1989 was noteworthy in another way: six of our members were elected to the Fellow grade by the Institute. They are:

Professor Kyohei Fujimoto - for contributions to the development and design of small antennas and antennas for mobile communications.

Professor Umberto Mengali - for contributions to the theory of synchronization in digital communication systems.

Dr. Louis L. Nagy - for contributions to the research and development of mobile communications systems for automobile applications.

Mr. Philip T. Porter - for contributions to the planning, definition, and design of mobile cellular radio communications and services.

Mr. Anthony J. Rustako, Jr. - for contributions to the implementation of diversity combining techniques in cellular mobile radio systems.

Dr. Carl-Erik W. Sundberg - for contributions to power- and bandwidth-efficient constant-amplitude modulation methods.

Our congratulations to all these Fellows in achieving this distinction in recognition of their professional achievements. We look forward to their continued association with VTS and to their further contributions to our branch of electrotechnology.

Please take time to review the program for our May 1990 annual conference. This year marks the fortieth anniversary of the founding of our predecessor group, the IEEE Professional Group on Vehicular Communications, and the conference will suitably recognize that fact.

The location for our conference this year is Orlando, Florida, which in terms of family-oriented recreation is striving to become the entertainment capital of the world. An assortment of tours and expeditions is offered for family members during the conference and group hotel rates apply for longer periods than the conference and include spouses in the basic fee.

See you in Orlando!

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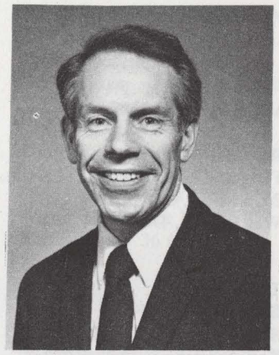

A. Kent Johnson
Newsletter Editor

VTS Conference in Orlando, Florida, May 6-9, 1990

This edition of the newsletter features the upcoming Annual VTS Conference to be held at the Sheraton Plaza Hotel in Orlando, Florida from May 6-9, 1990. Elsewhere in the newsletter you will find the complete advanced program of the conference and as you will see, the committee has arranged an outstanding technical program. You will see that the program is varied, with papers covering the broad spectrum of interests encompassed by the Vehicular Technology Society. There continues to be great interest in cellular technology and land mobile systems with many papers being presented in those areas. It should be an exciting conference and we hope you will be able to make it to Orlando.

Six VTS Members Chosen as IEEE Fellows

This edition of the newsletter includes an input from Al Isberg listing those members of VTS recently elevated to the IEEE rank of Fellow. Al has also included a complete list of VTS Fellow members as of September 1989. We thank Al for this input and congratulate those recently elected Fellows.

Month of Issue	Final Copy to be Rec'd By VTS Editor	Target Mailing Date
May	3-10-90	4-14-90
August	6-9-90	7-14-90
November	9-15-90	10-13-90
February	12-29-90	1-31-91

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Chapter News *(continued from p. 5)*

Subject: Maryland DOT Commuter Rail System
By: Mr. George Payne, Maryland Department of Transportation
MD DOT BWI International Airport
Held: November 14, 1989
Attendance: 43 (16 guests)

Subject: AAR Research and Test Program
By: Mr. George Way, AAR
50 F Street, N.W.
Washington, D.C.
Held: October 10, 1989
Attendance: 35 (19 guests)

Subject: Hot Box Simulator For Railroad Industry Application
By: Mr. Robert A. Carter, CONRAIL
Six Penn Center Plaza
Philadelphia, PA
Held: September 12, 1989 **Attendance:** 29 (13 guests)

New Jersey Coast (Joint AES/EMC, EMC/VT/AP, and Communications)

Subject: Solar Cycle 22 Status
By: Mr. Seymour Krevsky, C 31 Systems Group
69 Judith Road
Little Silver, N.J. 07739
Held: September 25, 1989 **Attendance:** 36 (8 guests)

Professional Activities *(cont. from p. 15)*

contact with the IEEE-USA Office and to respond by writing to your Representatives and Senators when IEEE-USA asks for your help in support of legislation. There's a large number of us out there, and together I believe we can make a difference. I hope we can count on one another."

Any of the material mentioned may be obtained from the IEEE-USA Office. The new address is

1828 L Street N.W., 12th Floor
Washington, D.C. 20036

The phone number remains the same, 202-785-0017. You may also want to keep up to date by listening to the telephone hotline recording on 202-785-2180.

Chapter News

Gaspar Messina
Chapter News Editor

Meetings

Philadelphia Vehicular Technology Society

Subject: Modernization of SEPTA'S Norristown High Speed Line
By: Mr. John Griffith, SEPTA
714 Market Street, 4th floor
Philadelphia, PA 19106
and
Mr. Russell E. Jackson, SEPTA
200 W. Wyoming Avenue
Philadelphia, PA 19140
Held: September 14, 1989
Attendance: 47 (27 guests)

Subject: Tour of SEPTA'S New Solid State Frequency Converters
By: Mr. Robert Fisher
Held: October 12, 1989
Attendance: 31 (17 guests)

Subject Rebuilding the LIRR'S Harold Interlocking
By: Mr. Simon Reich, District Manager,
Thomas K. Dyer, Inc.
21st Floor, 333 Seventh Avenue
New York, N.Y. 10001
Held: November 9, 1989
Attendance: 32 (14 guests)

Subject: CoGeneration on AMTRAK
By: Mr. Ray Lanman, AMTRAK
National Passenger Corp.
60 Massachusetts Avenue, N.E.
Washington, D.C. 20002
Held: December 7, 1989
Attendance: 23 (10 guests)

Cleveland VTS

Subject: Communications Of The Future
By: Mr. Richard Kunath, NASA
Held: December 7, 1989
Attendance: 16 (3 guests and 6 students)

Subject: RFI Interception
By: Mr. Al Markwardt, Retired
826 Sherbrook Drive
Richardson, Texas 25080
Held: November 16, 1989
Attendance: 36 (10 guests)

Toronto Vehicular Technology Society

Subject: Elementary Properties Of Simple Antennas
By: Mr. Gene Dempsey, Threshold Communications
P.O. Box 188
Brampton, Ontario L6V2L1
Canada
Held: October 25, 1989
Attendance: 6 (2 guests)

San Francisco Bay Area Vehicular Technology Society

Subject: Fleet Dispatching Using Automatic Vehicle Location Support
By: Mr. Rama Aysola, ETAK
4830 Williams Road
San Jose, CA 95129
Held: December 12, 1989
Attendance: 22 (5 guests)

Gaspar Messina, Physicist/E.E.
Editor and Chapter Activities Chairman
9800 Marquette Drive
Bethesda, Maryland 20817

Washington, D.C. VTS/Land Transportation Committee

Subject: New York Air Brake Computer Controlled Locomotive
By: Mr. Tom Engle, New York Air Brake
Starbuck Avenue
Watertown, New York 13601
Held: December 12, 1989
Attendance: 26 (13 guests)

(Continued on page 4)

Transportation Systems

Bob McKnight
Transportation Systems Editor

ATCS: A Progress Report

The Advanced Train Control System Project (ATCS) of America's railroads is moving along. Several railroads have test installations in service. They are gaining experience with the operation of various components and parts of ATCS.

Union Pacific has a major installation in Nebraska in which it has been testing the data radio system, transponders, on-board locomotive computer and wayside interface units. Its work order system for train crews has been in operation for several months.

"A system configuration starts with our transportation control system. This is our train management system and our car records, inventory system. It operates on a computer that's located in St. Louis, Missouri. This is where we generate all the work reports that go to the crews for set outs, pick ups, industry spots and industry pulls, right down to the individual conductor. That's connected to what we call an ATCS front end processor cluster controller (FEPCC). It's communications management that handles the dialogue between the host computer in St. Louis and the mobile locomotive.

"From there we go over existing communications networks, fiber, microwave, lease circuits in some cases, to a radio tower, and then over the RF network out to the train. Now, the RF network is 900 MHz data network to the locomotive on-board computer," reports Jeff Young, General Director ATCS, Union Pacific.

"Some of the benefits of work order reporting are increased service reliability through real time communications. We'll get locomotive reportings, train arrival and train departure reportings, in train device reports, etc.

"We need to equip just for work order reporting, 1,620 locomotives. We must have captive locomotives to the degree possible to insure that those jobs are equipped. We need to install 220 base stations.

"We've got one service unit, the Nebraska service unit (about a division of railroad lines) that's got 12 base station radios. We've got 30 locals and yard jobs reporting in that Nebraska service unit.We've cut over to the ATCS Communications Specification 200 using the AMCI-Harris communications package in a production environment."

During this year Union Pacific will probably cut in six more service units, reports Jeff Young.

"One interesting thing that we found is when we turned on forward error correction we're seeing improvements in coverage in some cases up to 5 to 10 miles over what we had previously," reports Young.

Several railroads have tested the digital data radio links operating in the 900 MHz range. CSX has a test installation in Florida with a 900 MHz base station and a locomotive with an on-board computer.

Gordon Mott, Assistant to President, CSX Transportation said: "We've had a small pilot program going down in the phosphate mining area east of Tampa. We are in the process of bringing a couple of additional base stations on line where we will have a network of three. We are equipping additional locomotives. We're wrestling with the question of whether we use a single on-board computer, or whether we use separate vital and non-vital computers and how we integrate the other functions of ATCS with the train control functions.

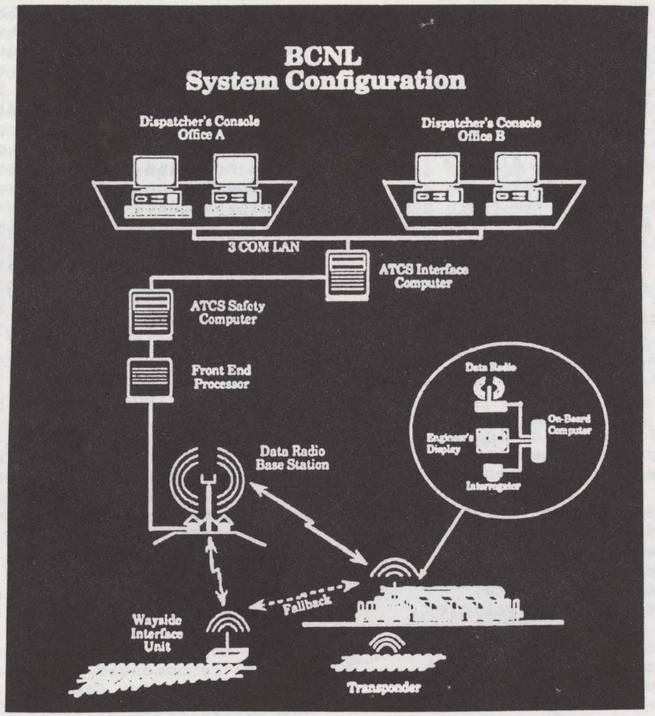
"We've all come to realize that the real key element to ATCS is that data radio network. Once that's established there's a whole number of things that can be applied to it. Train control is one, certainly work order reporting is another. At CSX we have done quite a bit of work on applications of locomotive monitoring as a use of the data radio network," Mott reports.

On the developmental basis, ATCS specifications have been written and approved by the railroads. There are six series of specifications, namely:

--100 Overview of ATCS
--200 Communications
--300 Locomotives
--400 Dispatching of Trains
--500 Field or Wayside Systems
--600 Track Forces

Development work is continuing by consultants ARINC Research, TAD Associates, and Lapp-Hancock & Associates, on testing procedures for the various components and systems of ATCS as well as system safety analysis procedures.

A Communications Interoperability Tester (CIT) has been developed "which will make sure that the communications components, whether from one supply company or from several, will function satisfactorily together," reports Peter J. Detmold, Executive Director, ATCS, for the Association of American Railroads.



Also, AAR has approved work to develop the Control Flow Validator (CFV) which should be available by the end of this year. "Using the computer aided software engineering technology, it will extend the control flow charts to a full mathematical description to check for errors more thoroughly than could possibly be done by manual methods alone," says Detmold. The control flow provides a detailed description of ATCS system operation.

Canadian National is installing what will eventually be a level 30 ATCS system on 180 miles of track on its British Columbia north line in the northwestern part of that province. This territory is now operated by a computer aided manual block system, in which the dispatcher prepares his train order on a computer with safety software to ensure that an incorrect train order is not sent to the train crew.

During last summer, the ATCS installation work began with SEL Division of Alcatel Canada doing field work consisting of installing 26 power switch machines, transponders (Vapor Corp.) in the track bed for determining the location of trains, as well as bungalows to house equipment and snow melters on all power switches. Also, 54 locomotives will be equipped with on-board computers, digital data radios (Motorola) and wayside base stations operating on the 900 MHz range.

"The on-board terminal display provides the engineer with the text relating to his movement authorities and the graphical display of the territory over which he is operating. Also, he has a keypad with functions rather than a complete keyboard. The functional keypad makes his input more efficient," reports Walter Friesen, Director of Amrketing, SEL Division, Alcatel Canada.

The locomotive on-board computer provides vital supervision, route profile, train tracking including handling inputs from transponders located in the track bed and tachometers mounted on the locomotive axles. Also, the on-board computer processes movement authorities and enforcement covering location, speed and travel direction.

While the above mentioned ATCS system uses transponders for train location Burlington Northern is using the Defense Departments Global Positioning Satellite. GPS will use 21 Navstar navigation (not communications) satellites that are scheduled to be placed in rotating (not geosynchronous) earth orbit during 1989, 1990 and 1991.

The Navstar satellites are broadcast only satellites; the on-board receivers do not transmit any signals back to the satellites.

With BN's Advanced Railroad Electronics System (ARES), road locomotives at the head of trains, switching locomotives, high-rail

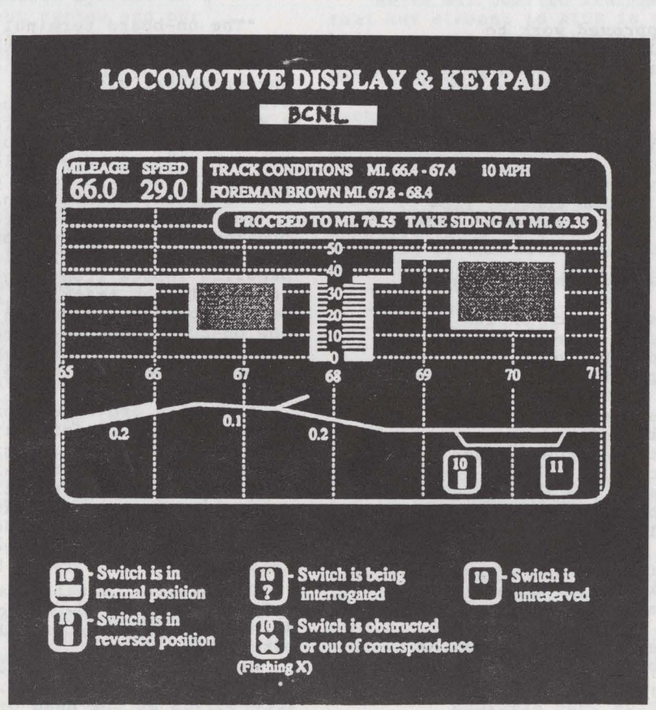
vehicles and sets of maintenance of way equipment will have GPS receivers which will calculate position and speed on the basis of signals received from the Navstar satellites. The position and speed information will then be sent from the vehicle to the control center over the digital data link.

Location is determined to within 150 feet and speed to within 1 mph. Also, a calibrated tachometer which is updated with precise position at switches and wayside detectors is used when satellite coverage is not available (for example, when a train is in a deep cut or a tunnel). Because the 150 foot accuracy is not sufficient for differentiating between a pair of parallel tracks, ARES uses switch position as directed by the control center and as confirmed by the wayside interface unit, to determine what track a vehicle is on.

The key element of ARES is a digital data link system, capable of sending messages in both directions between a control center and a train or any other party on the track. BN is using existing microwave and a new VHF radio system for the data link.The new VHF radio system will consist of dedicated VHF radios that will primarily transmit digital data from the locomotive, track vehicle or wayside interface unit to a VHF receiver located so that it can access the existing communications network. The ARES data link will utilize a modified datagram packet message format and Carrier Sense Multiple Access (CSMA) channel access protocol. CSMA, as implemented in the ARES data link system, optimizes throughput on simplex VHF channels, and has been tested extensively since 1985. BN is using synthesized all-channel radios that have the capability of automatically switching between assigned channels.

"As more and more information goes to and from trains and other vehicles over the digital data link, we expect voice traffic to decrease over time, which in turn, should actually free up additional VHF channels in congested areas. The effective information transfer capacity of a channel assigned to digital data is 20 times greater than that of a channel assigned to voice traffic," reports Steven R. Ditmeyer, Chief Engineer, Research, Communications & Control Systems, Burlington Northern.

Each ARES equipped road locomotive cab has a Train Situation Indicator (TSI) which consists of a pair of cathode ray tube displays to provide train status as well as command and control information to the locomotive engineer. There are two 12-inch screens each providing a full color display. Normally, one TSI screen displays an "operations page" showing train location and speed, the upcoming route profile, actual throttle and brake settings (as well as recommended settings from the Energy Management System), and data from the end-of-train device. This page is

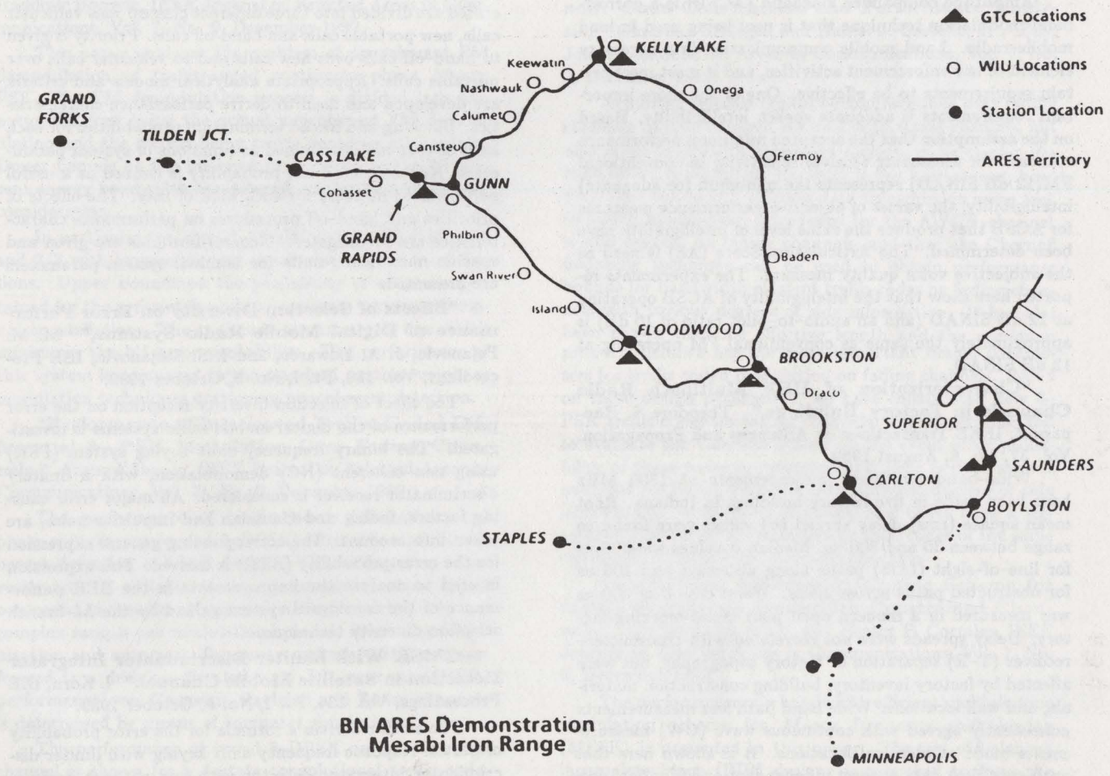


where the engineer will receive movement authorities, including speed limits, from the dispatcher, in lieu of paper train orders, voice-transmitted track warrants, wayside signals or traditional cab signals. An on-board computer will automatically monitor and insure compliance with the movement authorities. The TSI will have an "acknowledge" key for the engineer to use to acknowledge receipt of movement authorities.

The other TSI screen will be used to call up a variety of displays, such as track warrants, track bulletins, train consist, car set-out and pick-up instructions, special handling instructions, locomotive health information (from Locomotive Analysis and Reporting System), and any other information that can be sent over the data link. If either screen malfunctions, all the information described here can be called up on the other screen.

BN has equipped 17 locomotives with ARES hardware for an operational demonstration on 230 miles of track in the Missabe Iron Range in northern Minnesota. All 17 locomotives are equipped with the data links. GPS receivers are on 6 road locomotives designated as "lead" units and on 8 switchers. TSI's have been installed on the 6 "lead" units and simpler displays are on the switchers. Two data link and GPS packages have been placed on high-rail vehicles and 40 wayside interface units have been installed to control and monitor switches and pass on data from wayside detection equipment.

Testing of the system in the Iron Range is continuing. In some instances where conventional signaling is in service, the ARES system is operating in parallel so BN obtains a comparison of the two types of train operations management.



BN ARES Demonstration Mesabi Iron Range

Communications

J. R. Cruz
Communications Editor

ABSTRACTS

"The Intelligibility of Amplitude Companded Sideband Modulation Compared to Conventional Frequency Modulation," W. A. Kissick and L. T. Jones, NIJ Report 201–87, June 1989.

Amplitude companded sideband (ACSB) is a narrowband modulation technique that is now being used in land mobile radio. Land mobile communication is a necessary element of law enforcement activities, and it must meet certain requirements to be effective. One of the more important requirements is adequate speech intelligibility. Based on the assumption that the accepted minimum performance standard for measuring receiver sensitivity in conventional FM(12 dB SINAD) represents the minimum (or adequate) intelligibility, the values of objective performance measures for ACSB that produce the same level of intelligibility have been determined. The Articulation Score (AS) is used as the subjective voice quality measure. The experiments reported here show that the intelligibility of ACSB operating at 12 dB SINAD (and an audio–to–pilot ratio of 10 dB) is approximately the same as conventional FM operating at 12 dB SINAD.

"Characterization of UHF Multipath Radio Channels in Factory Buildings," Theodore S. Rappaport, IEEE Transactions on Antennas and Propagation, Vol. 37, No. 8, August 1989.

Wide–band multipath measurements at 1300 MHz have been made in five factory buildings in Indiana. Root mean square (rms) delay spread (σ) values were found to range between 30 and 300 ns. Median σ values were 96 ns for line–of–sight (LOS) paths along aisleways and 105 ns for obstructed paths across aisles. Worst case σ of 300 ns was measured in a modern open plan metal–working factory. Delay spreads were not correlated with transmitter–receiver (T–R) separation or factory topography, but were affected by factory inventory, building construction materials, and wall locations. Wide band path loss measurements consistently agreed with continuous wave (CW) measurements made at identical locations. It is shown here that such empirical data suggest independent and identical uniform distributions on the phases of resolvable multipath signal components. Average factory path loss was found to be a function of distance to the 2.2 power. Wide–band factory propagation measurements have not been previously reported in the literature.

"Objective Speech Distortion Measures and Their Relevance to Speech Quality Assessments," S. Dimolitsas, IEE Proceedings, Vol. 136, Pt. I, No. 5, October 1989.

The paper presents a review of several commonly employed objective speech distortion measures and their relevance to subjective assessments of speech quality. Since many of the objective measures described in the paper have been covered previously in other reviews, we have concentrated primarily on three aspects. First, the philosophy of progressively constructing objective distortion measures in order to incrementally improve their capability to predict subjective quality (typically done at the expense of computational complexity). Secondly, we have concentrated on the use of objective measures as complementary tools to subjective evaluations, and thirdly, on the methods for evaluating the relative performance of different objective measures.

"Priority Oriented Channel Access for Cellular Systems Serving Vehicular and Portable Radio Telephones," D. Hong, and S. S. Rappaport, IEE Proceedings, Vol. 136, Pt. I, No. 5, October 1989.

A priority oriented channel access scheme for cellular mobile radio telephone systems serving vehicular and portable radio telephone users is described. The calls generated are divided into three different classes: new vehicular calls, new portable calls and hand-off calls. Priority is given to hand–off calls over new calls and to vehicular calls over portable calls. Appropriate analytical models and criteria are developed and used to derive performance characteristics. Blocking and forced termination probabilities for each kind of user are determined as functions of system parameters. Noncompleted call probability is defined as a useful performance measure for each kind of user. The effects of priorities and hand–off procedures on performance characteristics are investigated. General formulas are given and specific numerical results for nominal system parameters are presented.

"Effects of Selection Diversity on Error Performance of Digital Mobile Radio Systems," M. M. Pejanovic, J. A. Edwards, and I. S. Stojanovic, IEE Proceedings, Vol. 136, Pt. I, No. 5, October 1989.

The effect of selection diversity reception on the error performance of the digital mobile radio systems is investigated. The binary frequency shift keying system (FSK) using non–coherent (NC) demodulation, with a limiter/discriminator receiver is considered. All major error causing factors, fading and Gaussian and impulsive noise, are taken into account. The corresponding general expression for the error probability (BER) is derived. This expression is used to analyze the improvements in the BER performance of the considered system gained by the M–branch selection diversity technique.

GMSK With Limiter Discriminator Integrator Detection in Satellite Mobile Channel," I. Korn, IEE Proceedings, Vol. 136, Pt. I, No. 5, October 1989.

The author derives a formula for the error probability of partial response frequency shift keying with limiter discriminator integrator detector with and without decision feedback for the satellite mobile channel which contains as special cases the Gaussian channel and the land mobile channel. The author applies the formulae to Gaussian minimum shift keying and compute the error probability as a function of energy to noise ratio and other system parameters (Doppler frequency, maximum Doppler frequency, bandwidth of Gaussian filter and ratio of power in the direct and diffuse signal components).

"Signal–to–Interference Calculations for Balanced Channel Assignment Patterns in Cellular Communications Systems," Szu–Wei Wang, and Stephen S. Rappaport, IEEE Transactions on Communications, Vol. 37, No. 10, October 1989.

The effects of adjacent channel interference, together with cochannel interference, for fixed channel assignment patterns in cellular communications systems are considered. Thorough consideration is given to interference produced by emissions in neighboring channels, including immediately adjacent as well as nonimmediately adjacent channels. An approximate mathematical analysis is presented that permits a more complete calculation of the median mobile–to–base and base–to–mobile signal–to– interference ratios than has been available. Patterns of cell/frequency assignment that have regularity properties with respect to the performance measures are determined. Formulas for comparison of SIR performance for alternative cell/frequency assignment are derived.

"On the Performance of Spectrally Efficient Trellis Coded FM Modulation Employing Noncoherent FM Demodulation," Donald L. Schilling, and Radomir Bozovic, IEEE Journal on Selected Areas in Communications, Vol. 7, No. 9, December 1989.

This paper analyzes the problem of noncoherent FM demodulation of trellis–coded continuous–phase M–ary FSK. The FM demodulation process is divided into two parts, the first being the actual noncoherent FM demodulation and the second being trellis decoding of the data. Upper bounds on the bit error rate as well as the 99 percent energy bandwidth are determined for the codes under consideration.

In particular, we consider trellis codes with rates 1/2 and 2/3 with symmetric and asymmetric signal constellations. Upper bounds on the probability of error are obtained for the symmetric and the optimum asymmetric signal constellation. The optimum asymmetry is one which minimizes the bit error probability. The performance of this system is compared to the standard continuous phase modulation techniques employing noncoherent detection.

"Performance of Interleaved Trellis–Coded Differential 8– PSK Modulation Over Fading Channels," Franz Edbauer, IEEE Journal on Selected Areas in Communications, Vol. 7., No. 9, December 1989.

The performance of trellis–coded differential octal phase shift keying (coded 8–DPSK) with differentially coherent detection and soft decision Viterbi decoding is investigated. A suitable receiver is presented whose signal processing is based on Nyquist signaling requiring only one complex sample per modulation interval. Symbol synchronization and automatic frequency control (AFC) are performed in a decision–directed way. Bit error rate (BER) performance over Gaussian, Rayleigh and Rician channels is determined by means of computer simulations.

The performance of coded 8–DPSK on the Gaussian channel is shown for a 4–state convolutional trellis code. The unquantized outputs of up to 3 symbol detectors with delays of 1, 2, and 3 symbol periods are used for metric computation. The coding gain which includes losses due to timing and frequency synchronization errors is found to be 2.5 dB at BER = 10^{-5} with respect to uncoded 4–DPSK.

Much larger gains are achieved for fading channels if interleaving is applied. Using an 8–state trellis code the performance is determined on Rayleigh and Rician channels for various Doppler spreads and interleaver sizes.

"TCMP–A Modulation and Coding Strategy for Rician Fading Channels," Michael L. Moher, and John H. Lodge, IEEE Journal on Selected Areas in Communications, Vol. 7, No. 9, December 1989.

Conventional digital modulation schemes provide poor performance over moderately and severely fading channels without the use of coding. The drawback of applying recently developed trellis coded modulation schemes to such channels is that they require coherent detection to achieve their full potential. This paper describes TCMP, a novel modulation strategy for Rician fading channels, which multiplexes a time domain pilot sequence with trellis coded data to permit coherent detection. This technique is shown to provide remarkably robust performance in the presence of fading. It is also shown that when choosing trellis codes for fading channels, time diversity is of greater importance than asymptotic coding gain. The motivation for studying this strategy is to find efficient signaling schemes for transmitting data at a 4.8 kbit/s rate over a mobile satellite channel, with 5 kHz channel spacing.

"Bandwidth Efficient Coding for Fading Channels: Code Construction and Performance Analysis," Christian Schlegel, and Daniel J. Costello, Jr., IEEE Journal on Selected Areas in Communications, Vol. 7, No. 9, December 1989.

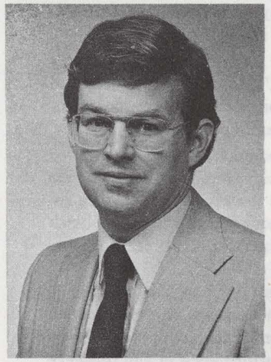
Achieving reliable digital communications over fading channels usually requires not only high signal energies, but also large bandwidth expansion factors, in particular, for time diversity signaling. Recently it has been shown, however, that bandwidth efficient data transmission using trellis coded modulation, introduced for the AWGN–channel, is also feasible on fading channels, and that the Chernoff bounding technique can be used to obtain performance bounds for bandwidth efficient trellis codes on fading channels with various degrees of side information. It has also been shown that the effective length and the minimum product distance are the most important design parameters for trellis coded modulation on fading channels. Based on these design parameters, we have constructed new 8–PSK trellis codes for fading channels. An efficient method to evaluate the Chernoff bound on the event error probability of these codes is presented and their performance is analyzed for fading channels with different degrees of side information. It is shown that the new codes have a significantly better error–performance than codes of the same complexity designed for Gaussian channels.

"An Efficient Modulation/Coding Scheme for MFSK Systems on Bandwidth Constrained Channels," Guillermo E. Atkin, and Hector P. Corrales, IEEE Journal on Selected Areas in Communications, Vol. 7, No. 9, December 1989.

The performance of a bandwidth efficient multiple tone modulation scheme for M–ary frequency shift keying (MFSK) is presented in this paper. The use of balanced incomplete block (BIB) designs is proposed to form the signaling frames. On each symbol interval the modulator selects a group of elements from a BIB design and divides its energy into the orthogonal waveforms corresponding to these elements. The multiple tone FSK scheme based

(Continued on page 21)

Vehicular Electronics



Bill Fleming
Vehicular Electronics Editor

NEW PRODUCTS

Automatic Parking System -- The VW Futura concept vehicle, displayed at the 1989 Frankfurt Auto Show, features an automatic parking system [1]. The driver stops ahead of, next to, or behind a parking space. Laser and ultrasonic sensors provide a "picture" of the parking situation. Laser sensors scan the space while ultrasonic sensors detect obstacles in front or behind the car. Ultrasonic sensors use their broad measuring lobes to detect objects, and also to precisely measure the distance from the curb. It is claimed that the system can also be used to maintain safe distances from other vehicles while driving under poor visibility conditions.

Adjustable Damping Suspension -- The Dodge Daytona Shelby and Chrysler LeBaron 1990 models introduce driver-adjustable damping on their suspension systems [2,3]. The system, supplied by Monroe Auto Equipment Co., can be manually set to either: firm, normal, or soft settings. The hydraulic shock absorbers have three sets of orifices, wherein rotating shutters uncover orifices corresponding to selected damping settings.

The next economical step towards an active suspension control system would be closed-loop damping systems such as the Hyrad (Hydraulically Actuated Remotely Adjustable Damper) System currently being developed by Hyrad Corporation in Tucson AZ [4]. This system utilizes fast-acting servo valves to make large and/or small changes in damping rates within milliseconds, based on sensor inputs from: vehicle brakes, steering, throttle, wheel speed, etc.

Electronic Engine Mounts -- The 1990 Honda Accord includes electronically controlled engine mounts [5]. The engine mount contains two fluid-filled chambers, separated by a valve. Below 850 rpm, the valve opens to allow both chambers to more effectively dampen larger-amplitude, low-speed engine vibrations. At higher engine speeds, the valve shuts and the mount becomes firmer.

Mercedes Mobile Office -- The 1990 Mercedes-Benz S-Class vehicle offers a "mobile office" option [6,7]. This option includes a personal computer, ink-jet printer, telephone, and facsimile machine. Fax messages and phone messages are received even when the vehicle is left unattended. Pricing for this option has not been announced (but then again if you have to ask, it's probably not for you).

Vehicle Security -- The business of deterring vehicle theft keeps getting bigger. The FCC has established a nationwide radio frequency spectrum allocation for use by stolen vehicle tracking systems [8]. The frequency of 173.075 MHz, formerly used by the FBI (and undesirably close to the audio spectrum of television channel 7), has been licensed to LoJack Corporation of Needham MA for use in tracking stolen vehicles.

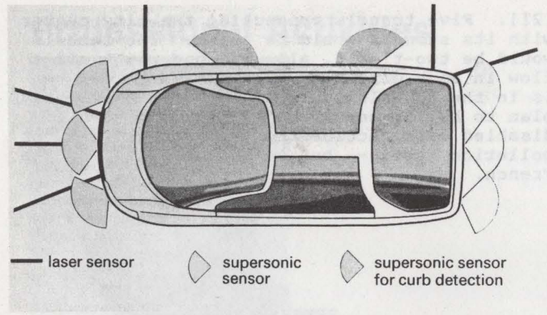
Other companies such as Code-Alarm in Madison Heights MI, TrackMobile in San Diego CA, and PacTel Teletrac in Los Angeles CA -- all sell $500-to-$1000 electronic products designed to electronically track the location of stolen vehicles [9].

Just as these technologies are being developed in an effort to support the law, other technologies ironically appear to be under development for just the opposite reasons.

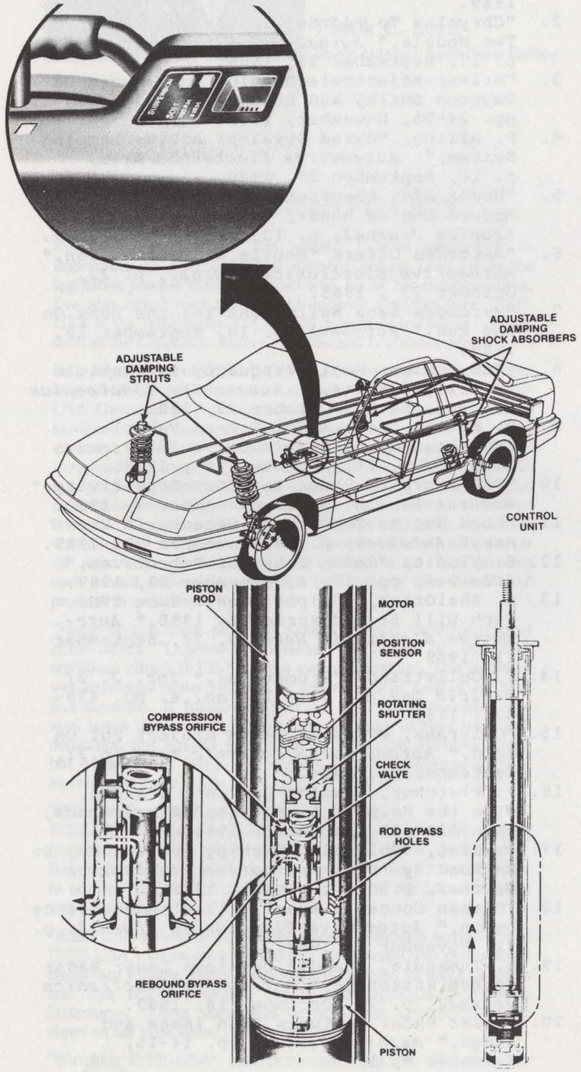
Detector Radar Wars Heat Up --Cincinnati Microwaves has announced its new digital signal processing radar detector which "uses technology currently used by NASA to create detailed space photos [10,11]." This technology has improved the detector's radar detection sensitivity by 9 dB and reduced it's power consumption by a factor of 50. The battery-operated unit, called Solo, supersedes the Escort detector model and retails for $345.

Escalation in Canada -- Meanwhile, Canada has been increasing the war on radar detectors [12]. Canada has made the use of radar detectors illegal in 7 of its 12 provinces. But the Catch-22 was obvious: detectors allow drivers to exceed their 100-km/h speed limit because of their advance warning of radar. This allows avoidance of being stopped for speeding, and therefore protects possession and use of the detector.

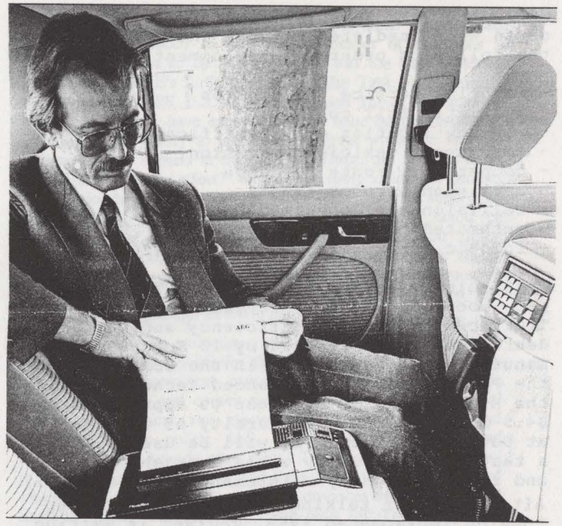
Radar detector wars have, however, escalated. The Ontario Provincial Police now use the



VW Futura Automatic Parking System Sensor Layout



Chrysler Adjustable Damping Suspension System



Mercedes Mobile Office Center Option

VG-2, affectionately called the "vee-gee" [12]. This device detects leakage radiation of the local oscillator frequency in the driver's radar detector. The VG-2 is therefore essentially a radar detector *detector*.

Due to cost, and the need to detect both X-band and K-band police radar, all radar detectors use the very same 11.55-GHz local oscillator frequency. This makes it much easier to build an effective VG-2 detector *detector*. Added cost and added size will prevent most detector manufacturers from redesigning their units to avoid police detection.

It's Not a Game -- Over 10,000 illegally operated detectors were seized in Ontario and Quebec in 1988. Radar detectors are confiscated in Canada for one main reason. "On the congested highway 401, use of detectors has contributed to higher speeds and an accident rate well surpassing last year's rate [12]."

Technologies For and Against the Law -- To summarize, there are technologies for and against the law. Vehicle tracking and radar detector *detector* technologies are definitely designed for use in enforcing the law. While police-radar digital-signal-processing detection technology is definitely against the spirit of the law.

As far as I know, it is not, and never has been, a constitutional right in the USA to have the freedom (and the tools, i.e., radar detectors) to break speed limits --and it certainly isn't so in Canada [12].

INTELLIGENT VEHICLE HIGHWAY SYSTEMS

Delphi Prediction -- Under the coordination of the University of Michigan Transportation Research Institute, a delphi panel of 30 experts predicted that the full intelligent vehicle highway system (IVHS) would not be implemented

until the year 2050 [13]. Proposed IVHS concepts were predicted to come into practice in the following order of development:

- motorist service information
- automatic toll collection
- vehicle location and identification
- autonomous vehicle navigation
- cooperative route guidance
- collision warning (1995)
- collision avoidance (2000)
- automated highway cruise control
- robotic total guideway control (2050)

Continuing IVHS Efforts -- Most VTS readers know about PROMETHEUS, Program for European Traffic with Highest Efficiency and Unprecedented Safety, initiated by 13 European car manufacturers [14]. And in the USA, there is the PATH, Program on Advanced Technology for the Highway, which is close to appropriating $4.5 million to the University of California at Davis. This funding will be used to build a test track to study vehicle crash behavior and robotic highway maintenance machines [15].

After years of talking, and as a first step towards implemented IVHS, England is setting up a vehicle navigation system in London, called Autoguide [16]. With Autoguide, drivers equip their vehicles with $400 in-car units consisting of an LCD screen and a two-way infrared transmitter/receiver. Once the driver enters the zip code of his desired destination, a series of roadside beacons interrogate the passing vehicle and transmit back updated directions based on current traffic conditions.

Collision Warning/Avoidance -- Collision warning devices may appear on cars by 1995, whereas collision avoidance devices will probably not appear until the year 2000. For collision warning, sensors utilizing machine vision, laser range-finding, sonar, infrared detection, and laser scanners are under study at General Motors and at Martin Marietta [17].

Moreover, at the 1989 Tokyo Auto Show Nissan showed it's Neo-X concept car. The Neo-X is equipped with infrared night vision and a "blind spot" detection system based on a miniature laser radar sensor [18]. Both these systems are designed to provide collision warning functions.

New Laser Radar System -- Sandia National Laboratories has announced a new type of laser radar that potentially could be used for collision avoidance [19,20]. It combines the advantages of microwave radar with video imaging. A laser signal is modulated at 4 MHz and is mechanically scanned both vertically and horizontally, while measurements of the phase angles of return signals provide range information.

Three-dimensional images of detected objects in the vehicle path and their distances are provided. This combination of information can better discriminate the exact hazard nature of a detected obstacle and therefore has obvious application to collision avoidance systems.

What's Next? -- To relieve traffic congestion in the city of Paris, the French may build a 50-km network of underground vehicle tunnels [21]. Five tunnels connecting the city center with its suburbs would be built. The tunnels would be two-tiered, allowing one-way traffic flow in each direction. What I want to know is in the 50 kilometers of tun-nels that they plan to build, how are they going to handle disabled cars, accidents, earthquakes, exhaust pollution, etc. -- but let's leave that to the French.

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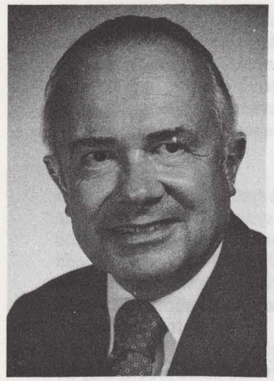
Professional Activities



Frank E. Lord
Professional Activities Editor

WE ALL NEED TO PITCH IN

From time to time in this column I have mentioned the importance of each individual member getting involved in the legislative process through contact with his or her representatives. I've also called your attention to material available from IEEE-USA at the Washington D.C. office on current legislative matters, such as the *Legislative Report*, *Hotlines* and *Legislative Alerts*.

In a recent piece in IEEE IMPACT, a newsletter for those active in professional activities, Jack Lubowsky, Chairman of the IEEE-USA Government Activities Council, urged everyone to become involved. Dr. Lubowsky's participation in IEEE has been extensive, and he also brings to us his 1983 experience as an IEEE Congressional Science Fellow with Senator John Glenn's staff. In his article he explains the process of creating the IEEE-USA *Federal Legislative Agenda* and how an Initiative is derived from it. He also makes us aware of the extensive work that volunteers are doing on our behalf. Further he firmly makes clear the importance of the involvement of each of us. Jack presents such a well defined view of this vital subject that I shall just proceed to quote from his article.

"Many of you have probably already learned something about IEEE-USA's "Legislative Initiative." It's one of the most ambitious efforts IEEE-USA has ever undertaken. This Initiative was developed collectively by representatives of each of USAB's five councils. It focuses on pensions and competitiveness, two vital issues that concern US. members. A lot of hard work and dedication has already gone into the legislative initiative effort, but its success of failure will depend on participation by all U.S. members, not just a few.

"Why Pensions and Competitiveness?
IEEE-USA is concerned with a wide range of issues, all of them important to some segment of the U.S. IEEE membership. Before focusing on pensions and competitiveness, it is important to not how IEEE-USA's legislative agenda for the 101st Congress was developed.

"IEEE-USA's *Federal Legislative Agenda* combines summaries of IEEE-USA's views on a wide range of technical and professional issues into a single, short document. It includes an index of terms and lists IEEE's Position Papers and IEEE-USA's Position Statements. These statements delve further into IEEE-USA's views on the nine broad *Agenda* topics.

"Watching IEEE-USA's leaders narrow down into nine areas the breadth of U.S. members' interests was like seeing a miniature congress at work. Prior to meeting, a Task Force composed of two representatives of each of the five IEEE-USA councils examined all IEEE and IEEE-USA positions. Task Force members were asked to consider a number of questions in assigning priorities to the issues. First, was the issue generally important to IEEE's U.S. members? The Task Force referred mainly to the *IEEE U.S. Member Opinion Survey* for answers. Second, did IEEE have expertise in the issue being considered? Obviously, our ability to influence Congress would be reduced unless we were experts in the subject. Third, did it make sense for IEEE to lead the effort? Would it be more logical for another organization to promote that issue while IEEE played a supporting role? Fourth, was this an issue in which results could be achieved? That is, if there was no legislative solution to the problem, why bother Congress with it? And fifth, since IEEE-USA's *Federal Legislative Agenda* is intended to last through a Congressional session (two years), it must be organized and written generally enough so it will not be outdated quickly.

"Armed with these guidelines, the Task Force produced the *Federal Legislative Agenda* for the current Congress. The group chose U.S. technological competitiveness; retirement income policy; computers and communications; energy; the professional careers of electrical and electronics engineers; research and development; tax policy; U.S. civilian space program; and education as the Agenda issue areas. The *Agenda* was distributed to all members of Congress and their staffs to inform them of where IEEE stands on these issues. It describes what IEEE is and reminds readers that there are more than 240,000 U.S. IEEE members--American voters. The Agenda promotes IEEE as a source of expertise in a number of technical fields. This document, as well as follow-up communication with Congress, has helped boost IEEE's reputation as a group of pre-eminent spokespersons for electrical, electronics and computer issues.

"From the Agenda to the Initiative
The National Government Activities Task Force agreed, however, that in order to be successful in promoting legislative action, IEEE-USA would have to concentrate on one or two issues that are most critical to IEEE members in the United States. Simply distributing the *Federal Legislative Agenda* is not enough. If IEEE-USA was going to get meaningful legislation passed to help U.S. members and the public, it would have to intensify efforts on major issues. They found pensions to be the issue of greatest concern to members, and they realized that if the country doesn't stay competitive in world markets, engineers may soon be out of the jobs from which they earn pensions.

"IEEE-USA's leaders will concentrate their activities in these two issues. We will track legislation that's favorable to IEEE U.S. members, and we'll help develop new legislation. We will establish liaisons with organizations with similar interests. We will set up briefing sessions to educate members of Congress and their staffs about technical issues and about our point of view. We will add to our key contracts list of IEEE U.S. members who already know members of Congress, and we will be increasing the number of our visits to Capitol Hill.

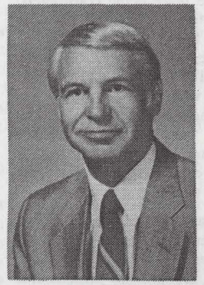
"Success Depends on You
As I mentioned earlier, the success of these efforts depends on more active participation by IEEE's U.S. members. The bottom line for a Congressman is to get re-elected by satisfying his constituents. That's you. I believe the more important element of the legislative initiative is to alert U.S. IEEE members to voice their opinions about these two major issues.

"Many of us have never contacted our elected representatives. Perhaps we've been too busy at our jobs. Perhaps we have not felt the confidence in our knowledge of the issues to be a strong voice for them. Perhaps we have felt uncertain about how to communicate with Congress. IEEE-USA's Office in Washington, D.C. will help you become informed by sending you a copy of the *Federal Legislative Agenda* and a brochure on *How to Communicate with Members of Congress*. Call or write for these free publications.

"Members of Congress prefer to find out what their constituents think from the letters, telegrams and calls they receive. The only other way they learn constituents' views is by counting ballots, which may be too late to change their viewpoints. If you have not been active, I urge you to keep informed of the issues through

(Continued on page 4)

News From Washington



Eric Schimmel
Washington News Editor

AN INTERESTING YEAR AHEAD FOR MOBILE RADIO

Following a hiatus of activity while the lame duck FCC was cleaning out its drawers, a stream of interesting proceedings has begun to flow from the newly constituted Commission. Among items of particular interest to the land mobile radio community are two Notices of Inquiry (NOI's). Docket 88-441 (reproduced below) poses 25 questions regarding the desirability of encouraging the use of digital technology in the Public Safety Services. With the introduction of digital cellular equipment just around the corner, the regulatory pressure for the traditional FM services to adopt more spectrum efficient technologies is inevitable. Interested parties may file comments in the proceeding by March 16.

A second NOI (Docket 89-554), is the first proceeding to prepare a U.S. position to the 1992 World Administrative Radio Conference (WARC) which will make global spectrum allocation decisions, primarily in the 1 to 3 GHz range. Comments and reply comments are due February 16 and March 16 respectively. If you have a strong interest in this matter, I urge you to consider participating with the U.S. CCIR delegation and preparatory advisory committees.

Another spectrum related proceeding is an NOI issued by the U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA) which proposes to study spectrum use and management and may lead to some reallocation or sharing of government bands. NTIA seeks comment in five major policy areas:

The Regulatory Process - NTIA requests comment on improving the regulatory process by which NTIA and the FCC manage the spectrum. It asks for comments on such areas as improving FCC and NTIA domestic management practices, coordination, and U.S. preparations and participation in international agencies such as the International Telecommunications Union. In particular, NTIA is interested in improving procedures that hinder the introduction of new services and technologies, in order to promote efficient access to the spectrum and to enhance U.S. international competitiveness.

Block Allocation - The current system of allocating radio frequencies in blocks -- a system in use since the invention of radio -- has a number of problems. The present system can be overly rigid and can impede innovation and the introduction of new technologies, especially when a new radio communication application is developed that does not conform to one of the existing defined radio services. There may be excess demand for particular blocks, while other blocks may be underused. NTIA's Notice requests comment on the extent of these problems and ways of addressing them.

Alternatives for Apportioning Spectrum - NTIA's notice requests comment on a number of alternatives to the current criteria that it and the FCC use for allocating and assigning spectrum, with the goal of identifying more efficient and equitable alternatives. The notice examines such alternatives as "flexible use" concepts, auctions, and leasing arrangements. These latter proposals would increase government revenues.

Spectrum Conservation: Technology Issues - NTIA is examining the role that technology can play in conserving the spectrum resource. As part of its examination, NTIA requests comment on costs and benefits of present technical standards for radio systems, and their effects on innovation. It also is studying the effects of alternatives to spectrum use -- such as fiber optics -- on the availability of spectrum for other purposes.

Forecasting Future Spectrum Requirements - NTIA recognizes that the forecasting of future spectrum requirements and long range planning are fundamental tools for an orderly spectrum management process. NTIA requests comment on how it and the FCC can best identify current and future spectrum needs and jointly determine how these needs can best be accommodated.

Comments are due on February 23, 1990, and reply comments are due on March 30, 1990.

Lastly, the FCC has issued a Notice of Proposed Rulemaking (Docket 89-552) for narrowband operations in the 220-22 Mhz band. Comments to this proceeding are due March 15. Depending on space available and editor's prerogative, excepts may or may not be included in this issue.

Gen. Docket No. 88-441

In the Matter of

Advanced Technologies for the
Public Safety Radio Services

FURTHER NOTICE OF INQUIRY

Adopted: November 28, 1989; Released: December 11, 1989

By the Commission:

I. INTRODUCTION

1. On September 7, 1988, we released a *Notice of Inquiry* (*Notice*) [1] to obtain public comment on the matter of trunking compatibility protocol standards for radio equipment operating in the 821-824/866-869 MHz public safety bands. In that *Notice*, we examined the possibility of establishing standards to increase interoperability among licensees using different types of trunked radio systems. After careful consideration of the comments, we determined that federally-mandated trunking standards were not needed to provide adequate interoperability among 800 MHz public safety entities.[2]

2. Our conclusion was based in part upon our awareness that users of analog-based radio systems can communicate with one another if they transmit on the same frequency and operate in the non-trunked (conventional) mode. We also recognized, however, that the next generation of radios is likely to use digital modulation and transmission techniques, and that digital systems may require some degree of standardization to enable system interoperability. We have initiated this inquiry to explore the important issue of standards as well as the many other technical, economic, and regulatory issues that relate to the use of these advanced technologies in the public safety services.

II. BACKGROUND

3. In 1983, Congress directed us to develop a plan to ensure that the electromagnetic spectrum requirements of state and local public safety authorities would be considered in the allocation of spectrum. [3] In response to this directive, we allocated the 821-824/866-869 MHz bands for use by the public safety services[4] and adopted the National Plan for Public Safety that established the policies, procedures, and rules to govern this spectrum.[5] We decided not to mandate trunking standards for equipment operating in the 800 MHz public safety bands because such standards were not necessary in the public safety services.[6] We also concluded that public safety concerns about interoperability and future spectrum requirements could best be addressed through an examination of the various issues surrounding the use of advanced radio communications technologies. This *Further Notice of Inquiry* (*Further Notice)* is being initiated to explore these issues.

III. PURPOSE

4. Currently, mobile radio systems use analog FM technology, which is characterized by the modulation of the radio frequency carrier by an analog waveform and the transmission of that carrier on analog radio channels. Digital radio communication, however, is accomplished by sampling and encoding the analog waveform, or simply starting with digital information, and modulating the carrier with the resultant digital values. Digital technology is already replacing older technologies in many different areas. In the communications field, digital switches and circuits are becoming commonplace in telephone networks, and in the audio industry digital compact discs (CDs) are competing with analog-based records and cassette tapes. Given this apparent movement toward digital by many industries, the question becomes whether and when the public safety community will adopt digital radio technology, and if it does, what the Commission's role should be in developing this or other advanced technologies for the public safety services. The purpose of this *Further Notice* will be to provide a framework for the thorough exploration of these issues. We pose a number of questions in this *Further Notice* and ask that comments be clearly identified with specific questions. We are hopeful that these questions will help the industry focus on the issues and help us identify the proper direction for the Commission to take in this area.

IV. ISSUES

Digital vs. Analog

5. Analog FM has been used in mobile radio systems for over 50 years. Digital technology, however, may offer a number of significant features that could enhance mobile radio communications. In the following questions, we focus on the various advantages and disadvantages that may result from digital technology and attempt to determine whether a conversion to digital would be appropriate in the near future for the public safety services.

Spectrum Efficiency

6. One of the most significant advantages offered by digital is the capability for increased calling capacity through the use of various multiple access techniques. At the same time, future advancements in analog technologies could also increase capacities to satisfy the spectrum requirements of the public safety services. The following questions focus on the use of these different technologies to achieve spectrum efficiency.[8]

Question 1:

a. Will future advancements in analog technologies[9] (*e.g.*, reduced channel bandwidths) enable a degree of spectrum efficiency equivalent to that of digital? Explain why or why not.

b. Can we expect significant advances in analog technologies in the future, or will most future industry research and development efforts be directed toward digital?

Economic Considerations

8. One of the most important factors that will influence the possible conversion of the public safety radio services to digital technology will be whether the benefits of adopting digital are worth the cost. This issue is explored in the following questions within the context of three areas: the price of digital radio equipment; the investments by users in embedded analog equipment; the decisions of other land mobile services with regard to digital conversion.

Equipment Cost

Question 8:

a. If and when public safety digital radio equipment is introduced, are digital systems (for either voice communication or data transmission) likely to be more expensive than analog systems? How much more? Will the price of digital drop to the level of analog? When?

b. Would public safety users be inclined to continue using analog until the cost of digital drops to the level of analog equipment, or would they be willing to pay extra for the various operational features that may be offered by digital? How much more?

Investments

Many public safety licensees have invested considerable amounts of money in their mobile radio systems, and others will be purchasing new systems in the next few years as regional public safety plans are developed and licensing begins in the 821-824/866-869 MHz bands.

Question 9:

a. Over what period of time do public safety agencies amortize their investments in radio systems, or alternatively, what is the typical replacement cycle for public safety radio equipment?

b. What is the likelihood that users will be willing to exchange their analog equipment for digital before the analog equipment has to be replaced?

c. If the public safety community decides to adopt digital technology, how long after that time could digital radio equipment be manufactured and made available to users?

Land Mobile Influence

Question 10:

a. What is the likelihood that the private land mobile services (other than public safety) will turn to digital in the near future? When is this likely to occur?

b. Most of the manufacturers involved in the production of public safety radio equipment also produce equipment for the other land mobile radio services. If these services, which represent a significantly larger market to manufacturers than does public safety alone, convert to digital, will the public safety community also switch to digital? Conversely, would a move by the public safety community to digital encourage non-public safety services to adopt digital technology?

c. Should public safety delay adoption of digital until other land mobile digital systems are proven to be effective?

d. Would the public safety community, by delaying entry to digital, benefit significantly from economies of scale (resulting from the mass production of digital components) that could occur as other land mobile digital equipment comes into use? Should (or will) public safety users delay conversion to digital for this reason?

General

9. The following question addresses various key issues relating to the possible conversion to digital radio by the public safety services.

Question 11:

a. Is there sufficient justification, from a technical, economic or operational point of view, for the public safety community to switch from analog to digital, or should public safety, at least temporarily, delay conversion to digital? Explain.

b. If conversion to digital is desirable, should it be mandated through Commission action?

c. Should a specific date be set for conversion to digital?

d. Should digital be required on all public safety bands? On all frequencies within these bands? Only in heavily populated areas, where there is a greater need for spectrum efficiency? In sparsely populated areas too, to ensure compatibility among public safety users?

Digital Technology and the National Public Safety Plan

10. The National Public Safety Plan identifies the various technical standards and specifications to be used in the new 821-824/866-869 MHz public safety bands. The following question deals with the relationship between these specifications and the technical requirements of a public safety digital system.

Question 12:

a. What impact, if any, would the development of a digital capability for public safety have on the implementation of the National Plan (*e.g.*, what effect would mixed use of digital and analog radios have on interoperability)?

b. Should consideration be given, in the development of digital, toward mitigating these possible effects?

c. Could or should the development of digital be limited by any of the technical specifications contained in the Plan (*e.g.*, the Plan's channeling scheme)?

d. Will the development of digital require modifications to the Plan? If so, explain.

Equipment Standards

11. All analog FM radios operating in the conventional mode and on the same frequency can communicate with one another. With digital, however, the various design parameters (bit rate, modulation, voice coding) of systems must be the same to achieve intra- and inter-system interoperability. This suggests that uniformity may be appropriate for public safety digital systems.

12. There are differing views, however, on the necessity of standards. Some believe that standards are needed to give manufacturers the assurance that a fairly long-term market will be available for their equipment and to give users the confidence that compatible replacement equipment will be available for a reasonable time. Some manu-

PR Docket No. 89-552

In the Matter of

Amendment of Part 90 of the Commission's Rules to Provide for the Use of the 220-222 MHz Band by the Private Land Mobile Radio Services	RM-6595

NOTICE OF PROPOSED RULE MAKING

Adopted: November 28, 1989; Released: December 15, 1989

By the Commission: Commissioner Quello issuing a separate statement.

TABLE OF CONTENTS

INTRODUCTION

1. On September 6, 1988, we issued a *Report and Order* in General Docket No. 87-14 (*Allocation Order*) [1] reallocating the 220-222 MHz band from the fixed, land mobile, and amateur services solely for private and federal government land mobile use.[2] In the *Allocation Order*, we indicated that we would establish service rules for the newly-allocated band in another proceeding. [3] On November 21, 1988, we received a Petition for Rule Making (UPS Petition) filed on behalf of United Parcel Service of America, Inc. (UPS). The UPS Petition urges that we initiate a rule making to establish those service rules and sets forth proposals that UPS believes will optimize spectrum efficiency in the band. We are issuing this *Notice of Proposed Rule Making* for the purpose of proposing service rules for the band and inviting comments on the proposals.

THE PLEADINGS

UPS Petition for Rule Making

2. In its Petition, UPS notes the ever-increasing demand for channels for the Private Land Mobile Radio Services (PLMRS). UPS also points out that one objective in reallocating the 220-222 MHz band was to provide spectrum to allow for development of narrowband technologies and thus diminish the future spectrum requirements of PLMRS licensees.[4] UPS states that the rules it proposes will promote the development of such technologies, meet the immediate need of PLMRS licensees for additional spectrum, and maximize flexibility to meet varied operating requirements.[5]

3. In general terms, UPS proposes that the 220-222 MHz band be divided into two hundred 5 kHz channel pairs. UPS also proposes that there be no restrictions on access to any of the frequencies based on eligibility under the subparts of Part 90 of our Rules.[6] Rather, UPS proposes that the two hundred channels be divided into twenty 10-channel blocks, with six blocks set aside for nationwide and local assignments to single licensees for a period of two years from the date we begin accepting applications.[7] The remaining channels, pursuant to the UPS proposal, would be available for assignment in twenty 5-channel trunked groups and forty individual or "conventional" channels.[8]

4. Under the UPS proposal, the nationwide channel blocks and thirty-five conventional channels would be set aside exclusively for data use for a period of two years from the date we begin accepting applications.[9] UPS further proposes that the nationwide channel block assignments be made only after a comparative analysis of all interested and qualified applicants.[10] According to UPS, all licensees would be subject to specified loading requirements. UPS suggests, however, that data and voice mobiles count differently toward the satisfaction of loading requirements to account for the greater efficiencies of data over voice operations.[11] UPS also proposes license terms of ten years, at least for nationwide licensees.[12]

5. From a technical standpoint, UPS proposes to establish a maximum transmitter effective radiated power (ERP) of 500 watts and an antenna height above average terrain (HAAT) of 500 feet, resulting in a 70 mile co-channel base station separation.[13] According to the UPS proposal, permissible ERP would be reduced as the HAAT increases to maintain a constant protected coverage contour.[14] Additionally, UPS proposes standards for equipment frequency stability and suggests a transmitter "emission mask" to minimize adjacent channel interference.[15]

DISCUSSION

10. We stated in the *Allocation Order* that spectrally efficient technologies will be essential in meeting this country's future land mobile requirements.[29] Thus, as the UPS Petition points out, we reallocated the 220-222 MHz band to the private land mobile service not only to help meet the immediate need of land mobile operators for additional spectrum but also with the intention of affording spectrally efficient narrowband technology an opportunity to develop and gain acceptance in the marketplace.[30] In developing service rules for use of the band by land mobile operators, it is imperative that we incorporate provisions that will accomplish both goals.

11. The UPS proposals, in general, promote the objectives of our *Allocation Order*. They combine extensions of existing policies and concepts with new, untried approaches to accomplish objectives that the current regulatory framework may not always fulfill. In the discussion that follows, we will set forth the UPS proposals on an issue by issue basis. We will also explain possible modifications of or alternatives to those proposals in cases where we believe such modifications or alternatives might result in the adoption of rules that would better serve the needs of a majority of operators in the PLMRS and the needs of the public. We ask commenters to discuss the benefits or problems they see in all proposals presented under each issue and, when they believe it is appropriate, to suggest other specific alternatives. Because of the large number of issues, we have subdivided our discussion into four sections. The first section discusses issues concerning channelization. The second section addresses licensing procedures, while the third section concerns conditions of license. The last section addresses specific technical issues. We request that comments be structured to follow the same general format.

IV. *Technical Considerations*

54. *Geographic Separation Requirements*. As described in the UPS Petition, a technical problem with the paired channels in the 220-222 MHz band is that the lower half of the band (220-221 MHz) is immediately adjacent to the upper half (221-222 MHz).[77] If base transmitting frequencies were assigned to the lower half (in the upper part of the 220-221 MHz band) and mobile transmitting (base receiving) frequencies assigned to the upper half (in the lower part of the 221-222 MHz band), interference would exist between those base transmitters and base receivers operating with close geographic spacing on close frequency spacing in the vicinity of 221 MHz. Therefore, UPS suggests and we propose that the band be divided into three sub-bands and that we require geographic spacing between co-channel stations operating in certain sub-bands.[78] Sub-band A includes Channels 1-60, Sub-band B includes Channels 141-200, and Sub-band C includes Channels 61-140. To minimize interference, Sub-band A base station receivers could not be co-located with Sub-band B base station transmitters, but must be geographically separated, as detailed below.[79]

Geographic Separation of Sub-band A Base Station Receivers and Sub-band B Base Station Transmitters

Separation distance kilometers	Effective radiated power, watts[80]
0.0 - 0.3	0
0.3 - 0.5	5
0.5 - 0.6	10
0.6 - 0.8	20
0.8 - 2.0	25
2.0 - 4.0	50
4.0 - 5.0	100
Over 5.0	200

55. *Co - channel Base Station Separation*. Because we propose to assign exclusive licenses, a standard on which to base such exclusivity is necessary. To this end, we are proposing a "maximum size" base station facility to be one that transmits an effective radiated power (ERP) of 200 watts peak envelope power at a height above average terrain (HAAT) of 90 meters. This should be sufficient to provide a service area with radius of about 35 kilometers and will permit 120 kilometer reuse of the frequency. These distances correspond to those in the *Second Report and Order*, Docket 18262, 46 FCC 2d 774 (1974) at note 26. We are also proposing a maximum mobile power of 20 watts ERP. These figures should enable private land mobile licensees to obtain quality service without sacrificing spectrum efficiency concerns.

56. At HAATs in excess of 90 meters, to maintain consistency in our distance separation assumptions, we propose that the permissible ERP decrease in accordance with the following:

Equivalent Power and Antenna Heights

Antenna height above average terrain (HAAT), meters	Effective Radiated power, watts[81]
Up to 90	200
90 to 120	100
120 to 150	75
150 to 200	50
200 to 275	25
Above 275	20

57. We disagree with UPS that different standards are necessary for operation in urban or mountainous areas. Recent advances in transmitter synchronization techniques facilitate operations at secondary sites, thus reducing the need for high-power, high elevation stations to obtain adequate coverage. We would, however, continue to permit secondary sites that may be necessary to provide fill-in coverage. We request comments on this as well as the above technical parameters.

58. *Emission Mask*. UPS proposes a transmitter power spectral density emission mask designed to minimize energy spillover into adjacent channels and thus avoid a coordination requirement for transmitters on adjacent channels. The emission mask proposed by UPS requires no emission attenuation for frequencies up to 1.8 kHz offset from the center of the authorized channel. Attenuation of emissions for frequencies offset beyond 1.8 kHz from the center of the authorized channel would increase until frequencies that are 2.5 kHz offset are attenuated by 70 dB and attenuation for frequencies beyond 2.5 kHz offset from the center of the authorized channel would increase until frequencies 5 kHz and more removed are attenuated by 80 dB. Lacking definitive information at this time, we are proposing to utilize this emission mask for all systems regardless of the modulation technique utilized. However, because there was concern in the comments that the mask was overly restrictive and would result in uneconomical equipment, we are requesting comments on the feasibility of adopting a less restrictive mask that would enable adjacent channel operation with minimal interference. We have also proposed specific measurement requirements and request comments on them as well as suggested alternatives.

59. *Frequency Tolerance*. UPS proposes a frequency tolerance of $\pm 0.0001\%$ for base stations and $\pm 0.00015\%$ for mobile and portable units operating in this band. The comments agreed that these tolerances were reasonable from an economic and a performance standpoint. We are therefore proposing these frequency tolerances for equipment in the 220-222 MHz band.

[8] We encourage the manufacturing community, in this inquiry, to provide information on the radio technologies they are working on and their timetables for marketing those technologies. We are sensitive to the competitive nature of such information and, in order to encourage its submission, would look favorably on requests for confidential treatment under Sections 0.457 and 0.459 of our rules, 47 C.F.R. §§ 0.457 and 0.459.

[9] Such as narrow band FM (NBFM) and amplitude compandered single sideband (ACSB).

[10] Digital encryption is currently accomplished by converting the analog signal to digital, encrypting the digital signal, and reconverting the encrypted digital signal back to analog prior to transmission.

[11] George Calhoun, *Digital Cellular Radio*, Artech House, Norwood, Massachusetts, 1988 at 431-432.

[12] For example, could digital radios be designed to transmit and receive different bit rates, voice coding and modulation schemes, etc., and if so, would this obviate the need for a *single* set of digital standards?

[13] Cellular standards are presently being developed by EIA Subcommittee TR 45.3.

[14] This work is being done by the Federal Telecommunications Standards Committee Land Mobile Radio Subcommittee.

[15] This work is being done by the Ad Hoc Study Group 8A (Land Mobile Services) of CCIR Study Group 8 (Mobile Services).

[16] *See* Report and Order, Gen. Docket No. 87-390, 3 FCC Rcd 7033 (1988).

[17] *See* note 16, *infra*.

Communications *(cont. from p. 11)*

on these block designs is shown to increase drastically the bandwidth efficiency of a conventional *M*–ary FSK system. Also, an implicit diversity is incorporated to the modulation scheme. Thus, a performance improvement comparable to using time or frequency diversity is shown on a Rayleigh fading channel and also on an interference channel with Partial Band Gaussian noise. Finally, the multiple tone scheme based on this design is compared to a multiple tone scheme based on Hadamard matrices, suggested by Pieper et al. in [7]. It is shown that similar performance is achieved on a fading channel, while an advantage close to 4 dB is obtained for the proposed scheme on an AWGN channel.

"Simple Coherent Receivers for Partial Response Continuous Phase Modulation," Ghassan Kawas Kaleh, **IEEE Journal on Selected Areas in Communications, Vol. 7, No. 9, December 1989.**

By using a pulse amplitude modulation representation of the binary continuous phase modulation signals, we develop a new optimum Viterbi sequence detector and a near optimum Viterbi receiver with low complexity. Also, for the modulation index 0.5 where a linear receiver can be used, a minimum mean–squared error linear receiver filter is derived. Their performance is analyzed. The Gaussian minimum shift keying signal (GMSK) is used for illustration. It is shown that a GMSK receiver consisting of two matched filters and a four–state Viterbi algorithm performs with less than 0.24 dB degradation compared with the optimal receiver. The linear receiver is optimum for all values of E_b/N_o (bit energy to noise on–sided spectral density ratio). A design method for its receiver filter is given. The filter is equivalent to a cascade of a matched filter and a Wiener filter estimator. Both an upper and lower bounds for the bit–error probability are calculated. Simulation results which confirm the analysis are also given.

CALL FOR FELLOW NOMINATIONS

Election to the grade of Fellow is an important element in pursuit of the IEEE objective of recognizing excellence among its members in the advancement of the theory and practice of electrical and electronics engineering.

The IEEE Board of Directors and the Fellow Committee are seeking to enhance the recognition accorded to the electrical engineering practitioner for outstanding technical contributions. The practitioner is to be distinguished from the academic who teaches the content of the electrical engineering profession and from the theoretician who deals with the basic science underlying electrical engineering practice. The work of the practitioner can be described as product design and applications, and the construction, operation and evolution into practical use or manufacturing of items or systems. Part of the difficulty in providing recognition to the outstanding practitioner is that proprietary considerations of the corporation in which he practices his profession sometimes prevent full documentation of his contribution in the open literature. Recognition of the practitioner must be based on the product (which is publicly visible), by assurances from those within his company regarding his individual role in creating and developing the product (Fellow references that are suitably specific) and by documentation from within the company which confirms, to a group of evaluators in the IEEE, that the individual's relation to the product is as cited. Some level of disclosure of the nature of the product and the individual's specific technical contribution embodied in it is necessary to assure the integrity of the selection process, but with the passage of time such disclosure is ultimately palatable for most organizations.

It is not the intention of this pursuit of enhanced Fellow recognition for practitioners to reduce the standards for recognition of technical contributions. The goal is to accord to those whose contribution is of a proprietary nature and not immediately publishable, and to those whose contribution is the product and its application, the same recognition now available to those who can publish and/or patent their results and the products that stem from them. The standards for associating the product with the individual and his individual technical contribution must be, if anything, more stringent since the information is not generally available in public documents and errors in attribution and faulty perspective regarding the importance of the contribution must be guarded against.

This note is intended to encourage those who are seeking to nominate outstanding practitioners. Such nominations will be given special attention by the Society Evaluation Committees and by the Fellow Committee. It is strongly urged that those who were discouraged by the previous emphasis on publicly documented individual contributions should proceed to submit practitioner nominations with the assurance that such nominations will be regarded with a positive attitude by the evaluators.

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It is important that qualified Members upgrade their status to Senior Member in order that their peers can nominate them for Fellow membership. Fellow nominations are confidential until a nominee has been elected, preferably the nominee should not be aware of his or her nomination but this is quite difficult because some information is available only from the nominee.

"The qualifications for Fellow Grade are established by the IEEE Bylaws. The grade of Fellow recognizes unusual distinction in the profession and shall be conferred only by invitation of the Board of Directores upon a person of outstanding and extraordinary qualifications and experience in IEEE designated fields (including electrical engineering, electronics, computer engineering and computer sciences), who has made important individual contributions to one or more of these fields, that have been reflected in an improved quality of life for society".

In July 1989 the Vehicular Technology Society had 2,734 active members of all grades; 333 Senior Members and 83 Fellow Members. The six new Fellow Members who were elected in November 1989 are:

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Umberto Mengali, Instituto Di Electtronica, Pisa, Italy.

Carl E. Sundberg, AT&T Bell Labs, Murray Hill, N.J.

For information about nominations, contact:

either R.A. Isberg, Chairman of VTS Fellow Search Committee, 1215 Henry St., Berkeley, CA (415) 526-1446

or Peter McLane, E.E. Dept., Queens University, Kingston, Ontario, Canada K7L 3N6 (613) 545-2937.

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ADVANCE CONFERENCE REGISTRATION

1990 IEEE Vehicular Technology Conference

Sheraton Plaza Hotel/ Orlando, Florida ..... May 6-9, 1990

TO INSURE YOUR CONFERENCE REGISTRATION, PLEASE NOTE: No telephone registrations can be accepted. Do not mail conference registration form without payment; only paid registrants can be processed. Be sure that all registrant names are enclosed with all checks, both personal and company. You will receive a receipt and ID badge on check-in at the conference. Hotel reservations must be made with the hotel. See the attached hotel reservation form.

Registration Fees	Received by Apr. 20, 1990	After Apr. 20, 1990	
Member IEEE [Member No. & Grade_____]	$250	$300	_____
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Advance Conference Schedule - VTC '90

Sunday, May 6	Monday, May 7	Tuesday, May 8	Wednesday, May 9
	8:30 AM - 12:00 PM Session 1: Antennas Session 6: System Design Session 10: Spectrum Efficiency Session 17: Modulation Techniques Session 5: Vehicular Electronics	8:30 AM - 12:00 PM Session 3: Hardware and Circuits Session 8: System Design Session 14: Data Transmission Session 19: Modulation Techniques Session 4: Land Transportation Systems	8:30 AM - 12:00 PM Session 25: Hardware and Circuits Session 11: System Control Session 15: Data Transmission Session 20: Signaling Session 29: Potpourri
	12:00 PM - 1:30 PM Keynote Luncheon	12:00 PM - 1:30 PM Awards Luncheon	12:00 PM - 1:30 PM Memories Luncheon
	1:30 PM - 5:00 PM Session 2: Hardware Circuits Session 7: Microcell Session 26: Channel Assignments Session 18: Modulation Techniques Session 16: Propagation	1:30 PM - 5:00 PM Session 22: Hardware Circuits Session 9: System Design Session 21: Propagation Session 23: Channel Coding Session 28: Mobile Satellite Technologies	1:30 PM - 5:00 PM Session 27: Hardware Circuits Session 12: System Design Session 24: Propagation Session 13: Speech Coding Session 30: Paging/ Potpourri
3:00 PM - 8:00 PM Registration			
5:30 PM - 7:30 PM Reception	7:30 PM - 9:30 PM Panel Discussion on Digital Cellular Technologies	7:30 PM - 9:30 PM Roots of VTS	

The reception and luncheons require tickets which you will find in your registration packet. Extra tickets may be purchased. See the advance registration form.

VTC '90 TECHNICAL PROGRAM

Program subject to change.

SESSION 1 ANTENNAS

"Multiple FM Window Antenna System for Scanning Diversity with an Integrated Processor"
H. K. Lindenmeir, L. M. Reiter, J. F. Hopf - Universitat der Bundeswehr Muchen, Germany

"A New Enhanced-Bandwidth Internal Antenna for Portable Communication Systems"
Josef Rasinger, Arpad L. Scholtz, Ernst Bonek - Technical University, Vienna

"An Elevated Microstrip Antenna for Cellular Radio Handhelds"
Andy McGirr, Paul Camwell - Novatel Communications, Canada

"Vehicle Terminal Antennas for Mobile Satellite Applications"
A. Kumar - AK Electromagnetic Inc., Canada

"A Multipurpose Flush-Mounted Antenna System for Satellite-Land Mobile Communications and Positioning"
J. Badenes, Q. Garcia, M. L. Hernanz, C. Martin, J. Vassal'lo - C.S.I.C., Madrid, Spain

SESSION 2 HARDWARE AND CIRCUITS I

"A New Generation of High-Power Cellular Boosters"
Ronald J. Jakubowski - The Antenna Specialists Co., Cleveland, Ohio

"On the Behavior of the LINC Transmitter"
Fernando Casadevall, Juan J. Olmos - Universitat Politecnica de Catalunya, Barcelona, Spain

"Amplifier Linearization Using Pre-Distortion"
M. Faulkner, T. Matteson, W. Yates - Footscray Institute of Technology, Australia

"A Linearizing Predistorter with Fast Adaptation"
James K. Cavers - Simon Fraser University, Canada

"Acoustic Noise Suppression Using Regressive Adaptive Filtering"
R. A. Goubran, R. Hebert, H. M. Hafez - Carleton University, Canada

SESSION 3 HARDWARE AND CIRCUITS II

"Dielectric Receiving Multi Band Fitting Filter for Cellular Base Stations"
Toshio Nishikawa, Kikuo Wakino, Jun Hattori, Youhei Ishikawa - Murata Manufacturing Co., Japan

"Dielectric Filter with Attenuation Poles"
Tomokazu Komazaki, Katuhiko Gunji - Oki Electric Industry Co., Japan

"Miniaturized RF-Circuit Modules for Land Mobile Communication Equipment"
Yoshikazu Mori, Hiroyuki Yabuki, Motio Ohba, Morikazu Sagawa, Mitsuo Makimoto, Ichiro Shibazaki - Matsushita Electric Industrial Co., Japan

"A Multi-Emission Frequency Domain Modulator"
Ladimer S. Nagurney - University of Hartford, West Hartford, Connecticut

"Facsimile Adapter for Cellular Mobile Telephone"
Tatsumasa Yoshida, Manubu Kawabe, Takahiro Maeno, Chusei Takahashi - Oki Electric Industry Co., Japan

SESSION 4 LAND TRANSPORTATION SYSTEMS

"An Interactive Train Operations Simulator for Integrated Applications in Transit Systems"
Stuart R. McKay, Vilayil I. John, Graham E. Dawson - Queen's University, Canada

"Mobile Data Transmission in a Railway Transit Environment"
Alfred F. Mautschke, Ramsay P. Decker - Automated Monitoring and Control Intl., Omaha, Nebraska

"Electromagnetic-Induction Vehicle Sensor Detecting the Gradient of Magnetic Flux"
Takuya Fujimoto, Masao Mizuno, Kenji Kanayama - Omron Tateisi Electronics Co., Japan

"ATCS RF Channel Modeling Using Computer Aided Engineering"
Edward L. Furman, Hamid R. Sharif - Automated Monitoring and Control Intl., Omaha, Nebraska

"Inductive Power Transfer to an Electric Vehicle--Analytical Models"
Manochehr Eghtesadi - Systems Control Technology, Inc., Palo Alto, California

SESSION 5 VEHICULAR ELECTRONICS

"Vehicle Distance Sensor Using a Segmented IR Laser Beam"
J. Tiedeke, P. Schabel, E. Rille - Wild Leitz Ltd., Switzerland

"Indoor Wireless LAN Access Methods for Factories"
Edward Lo, R. H. S. Hardy - Simon Fraser University, Canada

"Development of an Autonomous Guided Vehicle for Indoor Propagation Measurements"
Lynn H. Ailes, Theodore S. Rappaport - Virginia Polytechnic University, Blacksburg, Virginia

"Development of Input Interface IC for Automotive Electronic Control Unit"
Norio Fujiki, Koichi Murakami, Masahiko Shimamura - Nissan Motor Co., Japan

"A PS/2 Based General Purpose Engine Analyzer"
Giorgio Rizzoni, Francis T. Connolly, Yibing Dong, Peter M. Olin - University of Michigan, Ann Arbor, Michigan

SESSION 6 SYSTEM DESIGN I

"European Perspectives on Search Generation Personal Communication Systems"
Davide Grillo, Gerald MacNamee - Fondazione Ugo Bordoni, Rome, Italy

"A Study on System Compatibility of Cellular Systems"
Kunio Watanabe, Kenji Imamura, Kiyoto Nagata - Nippon Telegraph and Telephone, Japan

"A Consideration of TDMA Cellular Radio System"
Yoshihito Shimazaki, Shigeru Ono, Toshihisas Nakai, Noriaki Kondoh - Oki Electric Industry Co., Japan

"Design of a Subsurface Radio Communication System Using Several Types of Distributed Radiators"
Alan Burton, Frank Thatcher - Frank Thatcher Associates, San Francisco, California

SESSION 7 MICROCELL SYSTEMS

"A Conceptual Design of Microcellular Radio Communication Systems"
Yoshihiki Akaiwa - Kyushu Institute of Technology, Japan

"Personal Intelligence Communication"
Takeshi Hattori, Hideo Sekiguchi, Kenji Kohiyama - Nippon Telegraph and Telephone, Japan

"A Digital TDMA/FDMA Micro Cell System for Business Cordless Telephones"
Izumi Horikawa, Masahiko Hirono - Nippon Telegraph and Telephone, Japan

"An Experimental Digital Cellular System"
Toshihito Kanai, Masanori Taketsugu, Seiji Kondo - NEC Corporation, Japan

"Design Features of a Premises Cordless Telephone"
Minori Kawano - Mitsubishi Electric Corp., Japan

SESSION 8 SYSTEM DESIGN II

"Rapid Deployment Customed Cell Sites"
James Proffitt, Joseph Cylwik - PacTel Cellular, Irvine, California

"The Transition to Digital Cellular"
Hilbert Chan, C. Vinodrai - Bell Cellular, Inc., Canada

"Northern Telecom TDMA Digital Cellular Demonstration System"
Michael Maragoudakis, Tod Switzer, Melinda Smith - BNR Inc., Richardson, Texas

"Frequency Planning Considerations for Digital Cellular Systems"
Hazen Tawfik - BNR Inc., Richardson, Texas

"Outage Predictions for Digital Cellular Radio Systems"
Gordon Stuber, Lih-Bor Yiin - Georgia Institute of Technology, Atlanta, Georgia

SESSION 9 SYSTEM DESIGN III

"Transmission Techniques for Terrestrial Aeronautical Public Correspondence Systems"
Giovanna D'Aria, Valerio Zingarelli - Centro Studi e Laborati Telecomunicazioni, Torino, Italy

"Applications Systems Based on Mobile Satellite Services"
Thomas Wrappe - Teknekron, Berkeley, California

"A Proposal of Time-Division, Time-Compressed Multiplexing FM Mobile Radio System"
Sadao Ito - Iwatsu Electric Co., Japan

"Integration of Air Ground ATC Data Links"
Walter Sobkiw, Paul Payne - E-Systems Inc., St. Petersburg, Florida

"Mobile Satellite Broadcast System Design"
Gary Noreen - Satellite Radio Corp., Pasadena, California

SESSION 10 SPECTRUM EFFICIENCY

"Narrowband FM Cellular System"
Steve Levine, Scott Carney, James Baker - Motorola, Inc., Schaumberg, Illinois

"On Spectrum Efficiency in Terrestrial Cellular Air-to-Ground Communication Systems"
Moshe Margalit - Goeken Group, Brookline, Massachusetts

"Evaluation of VHF FM, SSB, and ACSSB Radio Systems in the Interference Context of the Land Mobile Bands"
Luc Boucher, H. M. Hafez - Department of Communications, Canada

"Bandwidth Efficient Signal Sets with Partitioned Equicorrelated Properties for the AWGN Channel"
Guillermo Atkin, Ramon Khalona - Illinois Institute of Technology, Chicago, Illinois

"Rayleigh Fade Compensated QPRS Coherent Mobile Radio Modems Operated at a Practical 2 b/sHz Efficiency"
Saraswathy Gurunathan, Kamilo Feher - University of California, Davis, California

SESSION 11 SYSTEM CONTROL

"Evaluation of a Proposed Handover Algorithm for the GSM Cellular Telephone System"
Wolf Menda - Fern University, West Germany

"Control Channel Structure and Radio Link Control for Narrow Band TDMA Digital Radio Systems"
Seizo Onoe, Jun Tajima, Takanori Utano, Narumi Umeda - NTT Radio Communications Laboratories, Japan

"Handover Criteria for a City Microcellular Radio System"
S.T.S. Chia, R. J. Warburton - British Telecom Research Laboratories, United Kingdom

"Time-Slot Management In Frequency Reuse Digital Portable Radio Systems"
Richard Bernhardt - Bellcore, Red Bank, New Jersey

"Multiple-Call Hand-Off Procedures for High-Capacity Cellular Communications Systems"
Stephen Rappaport - State University of New York, Stony Brook, New York

SESSION 12 SYSTEM DESIGN IV

"Design Concepts for a TDMA Mobile Radio System"
Minoru Kuramoto, Nobuo Nakajima, Kota Kinoshita, Masaharu Hata - NTT Radio Communication Systems Labs, Japan

"In-building Portable Telephone System"
Kazuhide Okamura, Akihiki Suzuki, Sadao Ito - Tokyo Electric Power Co., Japan

"Traffic Statistics In a Self-Organizing Cellular Telephone System"
Ray Nettleton - Booz-Allen & Hamilton, Inc., Arlington, Virginia

"An Improved Integrated Voice/Data Mobile Radio System"
Harold Stern - University of Texas at Arlington, Texas

"Future Pan-European Digital Private Mobile Radio Services"
Ghassan Freij - Virginia Polytechnic Institute, Blacksburg, Virginia

SESSION 13 SPEECH CODING

"Data Compression of Voiceband Modem Signals"
D. Lin, S.D. Kurtz, B. M. McCarthy, J. M. Kresse - International Mobile Machines, Philadelphia, Pennsylvania

"Design, Implementation and Evaluation of a 8.0 Kbps Celp Coder on a Single AT&T DSP32C Digital Signal Processor"
Kumar Swaminathan - AT&T Bell Labs, Whippany, New Jersey

"Multipulse Speech Codec for Digital Cellular Mobile Use"
D. Millar, R. Rabipour, P. Yatrou, P. Mermelstein - Bell Northern Research, Canada

"Design of a Medium Rate Linear-Predictive Speech Coder for Digital Portable Radio Communications"
David Lin, Vijay Varma - Bellcore, Red Bank, New Jersey

"An Efficient Search Strategy for Stochastic Coding of Speech"
Dale Veeneman, Baruch Mazor - GTE Labs, Waltham, Massachusetts

SESSION 14 DATA TRANSMISSION I

"Performance Assessment of Data Transport Alternatives for Digital Cellular"
G. Mony, B. Toplis, J. Michaelides - Bell Northern Research, Canada

"An Error Control Protocol Based on Trellis-Coded Modulations"
Paul Ho, Yan Wu - Simon Fraser University, Canada

"On the Performance of Error Control Coding with Diversity for Mobile Channels"
Francois Gagnon, David Haccoun - University of Montreal, Canada

"TRADAMO Protocol: Experimental Results"
Miguel Rodriguez-Palanca, Jaime Bustillo - Telettra España S.A., Spain

"Type II ARQ Schemes with Multiple Copy Decoding for Mobile Communications"
S. Kallel, C. Leung - University of British Columbia, Canada

SESSION 15 DATA TRANSMISSION II (Packet Transmission)

"Packet Reservation Multiple Access over Slow and Fast Fading Channels"
Louay Jalloul, Sanjiv Nanda, David Goodman - Rutgers University, Piscataway, New Jersey

"Variable Length Packet Mobile Aloha Networks"
Joseph McCartin, Tri T. Ha - Naval Post Graduate School, Monterey, California

"Reliable Multicast Over the Mobile Packet Radio Channel"
Yukiji Yamauchi - Osaka Institute of Technology, Japan

"The Channel Error Effect on Contention-based Multibit Reservation TDMA Protocol"
Lung-Sing Liang, Jin-Fu Chang - Ministry of Communications, Taiwan

"Comparative Study of Protocols"
Ho-Young Kim - Electronics and Telecommunications Research Institute, Korea

SESSION 16 PROPAGATION I

"MSRFM - A Prediction Tool for Radio System Design"
Philip Notestine, Don Larsen - NovAtel Communications, Ltd., Canada

"A Computer Algorithm for Prediction of Service Area in a Mobile Radio Communication System"
P. S. Mundra, T. L. Singal, T. S. Kamal - Punjab Engineering College, India

"Investigation of Radio Propagation and Macroscopic Diversity in Indoor Microcells at 1700 MHz"
Peter Karlsson - Lund University, Sweden

"Investigation of Propagation Characteristics Above 1 Ghz for Microcellular Land Mobile Radio"
Tsukasa Iwama, Eimatsu Moriyama, Hirofumi Ryuko, Shinya Sekizawa, Taiji Saruwatari - Communications Research Lab, MPT, Japan

"Multipath Delay Estimation for Indoor Wireless Communication"
Tsutomu Takeuchi, Masahiro Sako, Susumu Yoshida - Kyoto University, Japan

SESSION 17 MODULATION TECHNIQUES I

"Noncoherent Block Demodulation of PSK"
Harry Leib, Subbarayan Pasupathy - University of Toronto, Canada

"BER Performance of Anti-Multipath Modulation PSK-VP and Its Optimum Phase-Waveform"
Hitoshi Takai - ATR Communications Research Labs, Japan

"Performance Evaluation of Differential pi/4-Shift QPSK Systems in a Rayleigh Fading/Delay Spread/CCI/AWGN Environment"
Yanpeng Guo, Kamilo Feher - University of California, Davis, California

"Error Performance of pi/2-TFSK 2-bit Differential Detection Over the Band Limited Multipath Interfering Mobile Radio Channel"
Jun Horikoshi - Gunma University, Japan

"Postdetection Diversity Reception of QDPSK Signals Under Frequency Selective Rayleigh Fading"
Fumiyuki Adachi, Koju Ohno - NTT Radio Communications Labs, Japan

SESSION 18 MODULATION TECHNIQUES II

"Linear Prediction Aided Differential Detection of CPM Signals Transmitted Over Rayleigh Flat Fading Channels"
R. J. Young, J. H. Lodge - Communications Research Centre, Canada

"Short-Term Variations of the Mobile Channel and the GSM Signal"
P. E. Mogensen, B. L. Andersen, J. B. Andersen - University of Aalbord, Denmark

"Bit Error Rate Field Test Results for Digital TDMA"
Robert Malupin, Irving McNair - AT&T Bell Labs, Whippany, New Jersey

"Design of an Adaptive Coding and Retransmission Strategy of a Multipath Fading Channel"
Son Le-Ngoc, R. Liyanapathirana - Memorial University of Newfoundland, Canada

"Performance of Trellis Coded Modulation Using Multi-frequency Channels in Land Mobile Communications"
Yukiyoshi Kamio - Communications Research Lab, MPT, Japan

SESSION 19 MODULATION TECHNIQUES III

"Performance of Multi-level QAM with Maximum Ratio Combining Space Diversity for Land Mobile Communications"
Seiichi Sampei, Terumi Sunaga - Communications Research Lab, MPT, Japan

"Miller Coded Pilot Aided Modulation Schemes for Digital Mobile Radio"
Dileeka Subasignhe-Dias, Kamilo Feher - University of California, Davis, California

"Performance of Trellis Coded QPSK in Mobile Radio Channels"
Said Elnoubi, Eman Fahmy, El-Sayed Elbadawy - Wichita State University, Wichita, Kansas

"Switched-Diversity Trellis-Coded 8-DPSK for Mobile Radio Applications"
G. Femenias, R. Agusti - Universitat Politecnica de Catalunya, Spain

"A New Generation of Rayleigh Fade Compensated pi/4-QPSK Coherent Modems"
Chia-Liang Liu, Kamilo Feher - University of California, Davis, California

SESSION 20 SIGNALING

"The Signalling Protocol Structure on the Radio Link for the Digital Mobile Communications System"
Koji Yamamoto - NTT Mobile Communications Division, Japan

"Performance of GMSK-Transmission Under Typical Urban and Rural Channel Conditions using Coherent and Noncoherent Reception"
Robert Merssaros, Franz J. Seifert - Technical University, Austria

"The Implementation of the Mobile Channel Simulator in the Baseband and its Application to the Quadrature Type GMSK Modem Design"
Myoung Seob Lim, Hank Kyu Park - Yonsei University, Korea

"The Error Probability Performance of Gray Encoded QPSK Scheme with Co-channel Interference in a Slow Fading Indoor Channel"
Rajeev Krishnamurthi, Someshwar Gupta - Southern Methodist University, Dallas, Texas

"An Adaptive Pilot Tone Filtering Technique for Pilot Aided Transmission Systems"
Henry Li, James Cavers - Simon Fraser University, Canada

SESSION 21 PROPAGATION II

"An Improved Channel Sounding Technique Applied to Wideband Mobile 900 MHz Propagation Measurements"
Armand J. Levy, Jean-Pierre Rossi, Jean-Pierre Barbot, Jacques Martin - National Center for the Study of Telecommunications, France

"Equalization of a Hard-Limited Slowly-Fading Multipath Signal Using a Phase Equalizer with a Time-Reversal Structure"
Sirikiat Ariyavisitakul - Bellcore, Red Bank, New Jersey

"High Bit-Rate Field Transmission of an Anti-Multipath Modulation Technique PSK-RZ"
Susumu Yoshida, Tsutomu Takeuchi, Michiharu Nakamura - Kyoto University, Japan

"Selection Diversity Reception Based on a Novel Multipath Delay Spread Estimation Method for Digital Mobile Radio"
Hong Zhou, Susumu Yoshida, Tsutomu Takeuchi - Kyoto University, Japan

"Propagation Measurements for Microcells in Central Stockholm"
Fredrik Lotse, Anna Wejke - Ericsson Radio Systems, Sweden

SESSION 22 HARDWARE III

"Backoff Improvement of an 800 MHz GaAs FET Amplifier Using an Adaptive Non-linear Distortion Canceller for QPSK Modulated Signal Transmitter"
M. Minowa, M. Onoda, E. Fukuda, Y. Daido - Fujitsu Laboratories, Ltd., Japan

"A New Spectral Notch Generator for Pilot Tone Systems"
James Cavers, Robert Marchetto - Simon Fraser University, Canada

"Experimental Performance Evaluation of Equalizers Employing RLS Algorithm for Digital Mobile Radio Communications"
Takashi Ueda, Hiroshi Suzuki - NTT Radio Communications Labs, Japan

"GMSK Modulator-Demodulator Design and Implementation"
John McGrath - University of Limerick, Ireland

"Design of an Adaptive Equalizer and its Performance Over Fading Multipath Channels"
Keishi Murakami, Koji Ueda, Michiaki Takano, Tadashi Fujino - Mitsubishi Electric Corp., Japan

SESSION 23 CHANNEL CODING

"Comparison of Two ARQ Protocols in a Flat Rayleigh Fading Channel"
Justin C-I Chuang - Bellcore, Red Bank, New Jersey

"Time Diversity Techniques for Digital Mobile Radio"
A. M. D. Turkmani, A. F. de Toledo - University of Liverpool, United Kingdom

"R-BTMA:a MAC Protocol for Short-range Radio Mobile Communications"
Sami Tabbane, Philippe Godlewski - Ecole Nationale Superiedure des Telecommunications, France

"MPT 1327 Protocol Extension to 900 MHz"
Jaime Bustillo, Miguel Rodriguez-Palanca - Telettra España S.A., Spain

"FEC for Digital Cellular"
C. A. Eryaman - AT&T Bell Labs, Whippany, New Jersey

SESSION 24 PROPAGATION III

"Recovery Effect in Cellular Radio Systems"
T.S.M. Maclean, L. J. Carter - University of Auckland, New Zealand

"Simulation of UHF Indoor Radio Channels for Manufacturing Environments"
Scott Seidel, Theodore Rappaport - Virginia Polytechnic Institute, Blacksburg, Virginia

"Measured Propagation Characteristics of 900 MHz Mobile Radio Channels in Mountainous Terrain"
Peter Driessen - University of Victoria, Canada

"Local Mean Signal Variability in Rural Areas at 900 MHz"
S. Mockford, A.M.D. Turkmani, J. D. Parsons - University of Liverpool, United Kingdom

SESSION 25 HARDWARE IV

"Pulse Design for Linear TDMA Modulation"
Nelson Sollenberger - Bellcore, Red Bank, New Jersey

"Radio Systems Design Using Optical Modulators/Demodulators for RF Transmission over Fiber Optic Cable"
John Clark - Decibel Products, Inc., Hoffman Estates, Illinois

"Fiber Optic Antenna Remoting for Cellular Radio Applications"
Donald Fye - GTE Labs, Waltham, Massachusetts

"Indoor Radio Wideband Propagation Measurement System at 1.33 GHZ and 4.0 GHz"
Dwayne Hawbaker, Theodore Rappaport - Virginia Polytechnic Institute, Blacksburg, Virginia

SESSION 26 CHANNEL ASSIGNMENT STRATEGIES

"Dynamic Channel Assignment in Cellular Radio"
Kumar Sivarajan, Robert McEliece, John Ketchum - Cal Tech, Pasadena, California

"Adaptive Resource Allocation in Metropolitan Area Cellular Mobile Radio Systems"
Herbert Panzer, Reiner Beck - Philips Communications Industry, Germany

"On the Impact of Traffic Burst on the Blocking Probability of High Capacity Cellular Systems"
M. Frullone - Fondazione Ugo Bordoni, Italy

"Practical Channel Assignment Using Neural Networks"
Dietmar Kunz - Philips GmbH Forschungslaboratorium Hamburg, West Germany

"An Adaptive Stop-and-Wait ARQ Strategy for Mobile Data Communications"
Kurtis Guth, Tri T. Ha - Naval Postgraduate School, Monterey, California

SESSION 27 HARDWARE V (Receivers)

"An Adaptive MLSE/VA Receiver for Digital Cellular Radio"
C. Sandeep, J. B. Anderson - General Electric, Schenectady, New York

"A New Incoherent Direct Conversion Receiver for Mobile Communication System"
Gerhard Schultes, Arpad Scholtz, Ernst Bonek, Peter Veith - Technical University of Vienna, Austria

"A Receiver for the Registration of Mobile Communications Traffic Data"
Josef Rasinger, Fritz Lipp, Werner Schladofsky, Arpad Scholtz, Walter Herzog - Technical University of Vienna, Austria

"Performance of a Novel Discriminator-Based Quarternary CPM Receiver"
Mohammed El-Tanany, S. A. Mahmoud - Carleton University, Canada

"A Comparison of Limiter/Discriminator, Delay and Coherent Detection for pi/4 QPSK"
Don Dennis, Steven Goode, Henry Kazecki - Motorola, Schaumburg, Illinois

SESSION 28 MOBILE SATELLITE TECHNOLOGIES

"Experiments on ACSSB Land Mobile Satellite Communications"
S. Taira, T. Ikegami, R. Suzuki, S. Suzuki, H. Kawahara, S. Tada - Communications Research Laboratory, MPT, Japan

"Mobile Satellite System Performance Prediction Through Simulation"
R. M. Barts, J. Kim, R. Porter, T. Pratt, W. L. Stutzman, C. W. Bostian - Virginia Polytechnic Institute, Blacksburg, Virginia

"Communications Service Provision to Land Mobiles in Northern Europe by Satellites in Highly Inclined Orbits - Propagation Aspects"
V.S.M Renduchintala, H. Smith, J. G. Gardiner - University of Bradford, England

"Multichannel Access Protocol for Satellite Mobile Data Services"
Victor Leung - University of British Columbia, Canada

"Error Floors in the Satellite and Land Mobile Channels"
Israel Korn - University of New South Wales, Australia

SESSION 29 POTPOURRI I

"Proof of Performance Testing"
Earl H. Flath, Jr - Consultant, Dallas, Texas

"Error Protection for A 4.8kbps VQ Based CELP Coder"
G. Yang, P. Ho, V. Cuperman - Simon Fraser University, Canada

"A Digital Rayleigh Fade Compensation Technique for Coherent OQPSK Systems"
Jiashi Yang, Kamilo Feher - University of California, Davis, California

"Viterbi Differential Detection for Partial Response Continuous Phase Modulation"
Ghassan Kawas Kaleh - Ecole Nationale Superieure des Telecommunications, France

"Radio Transmission Simulation using a High Performance Graphics Workstation"
Gerald F. G. Ratzer, - McGill Univ., & *Paul Robertson,* - Hydro-Quebec, Canada

SESSION 30 PAGING

"Method for Over-the-Air Programming of Paging Receivers"
Gregg Snowden - Motorola, Boynton Beach, Florida

"Automatic Simulcast Radio Transmission Control System"
Joel E. Sandahl - Glenayre Electronics, Quincy, Illinois

"The Mobitex Public Packet Data System"
James L. Troe - RAM Mobile Data, Woodbridge, New Jersey

"Cluster Paging for Traveling Subscribers"
David M. Rodriguez - Center for Research and Advanced Studies, Mexico

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TWO-WAY RADIO
MOBILE SATELLITE SYSTEM
PUBLIC SAFETY
UTILITY COMMUNICATIONS
RFI REDUCTION
RFI INGRESS SOLUTIONS
ANTENNA TECHNOLOGY
ANALOG AND DIGITAL CELLULAR
PERSONAL COMMUNICATIONS
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