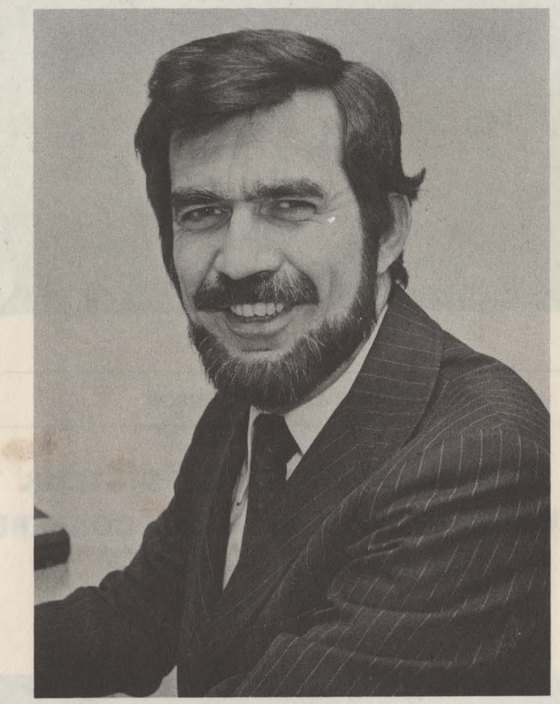
IEEE VEHICULAR TECHNOLOGY SOCIETY NEWSLETTER

VOL. 26, NO. 1 | EDITOR: A. KENT JOHNSON | NOVEMBER 1978

NEW GUIDEWAY TRANSIT SYSTEMS DISCUSSED AT 29th ANNUAL VTS CONFERENCE

ARLINGTON HEIGHTS, ILLINOIS
MARCH 28-30, 1979

PRESIDENT'S MESSAGE



ROGER D. MADDEN

John Cassidy has been an able leader of IEEE-VTS. Under his direction the 1978 VTS Conference far exceeded the expectations of the Administrative Committee. John has, during his tenure on the Administrative Committee (ADCOM), been an active promoter of the automotive and transportation electronics aspects of our charter. I trust we'll enjoy John's participation in VTS for years to come.

The new year is bringing some exciting events to VTS. The 1979 Conference will be in Chicago March 28-30, with several "Spinoff" events. We are once again publishing a newsletter, with Dr. Kent Johnson of Bell Laboratories as the editor. George McClure, editor of "Transactions on Vehicular Technology" has promised special issues on Automated Guideway Transit and on Public Safety Communications.

We on the VTS Board of Directors want your participation in VTS affairs. Get active in your local chapter. Contact a Board of Directors member near you. Write articles for publication in "Transactions" or the "Newsletter". Contact me with your ideas for improvement of your Vehicular Technology Society.

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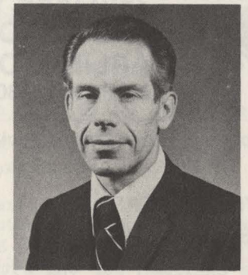
EDITOR'S NOTES



For the past four years Olin Giles has done an excellent job as Newsletter Editor and I would like to begin my tenure in the same position by commending him for a job well done and thanking him on behalf of all VTS members. It is always a difficult challenge to follow in the footsteps of someone who has done an excellent job. I recognize that the fine newsletter staff which Olin assembled has contributed greatly to the recent success of the newsletter, and I look forward to working with them to continue a high standard of quality.

This issue of the newsletter will focus on the upcoming 29th Annual VTS Conference to be held at the Arlington Park Hilton in Arlington Heights, Illinois. The theme this year is "Tomorrow's Technology for a Mobile Society" and will feature papers in the general areas of Transportation, Automotive Electronics, Automatic Vehicle Locating and Monitoring, and Mobile Communications. Conference Chairman, Al Goldstein and his staff have done a fine job in assembling what looks to be an outstanding conference.

Month of Issue	Final Copy To be Rec'd. By Editor*	Target Mailing Date
May	4-2-79	5-4-79
August	7-2-79	8-6-79
November	10-1-79	11-5-79
February	1-7-80	2-8-80

*Inputs for newsletter staff editors should be received 1-2 weeks before these dates.

IEEE Vehicular Technology Society Newsletter is published quarterly by the Vehicular Technology Society of the Institute of Electrical and Electronics Engineers, Inc. Headquarters: 345 East 47th Street, New York, NY 10017. Sent automatically and without additional cost to each member of the Vehicular Technology Society. Printed in U.S.A. Second-class postage paid at New York, NY and at additional mailing offices.

29th IEEE VEHICULAR TECHNOLOGY CONFERENCE
ARLINGTON PARK HILTON
ARLINGTON HEIGHTS, IL
MARCH 28-30, 1979

Tomorrows Technology for a Mobile Society

29th IEEE-VTS CONFERENCE CHAIRMAN'S MESSAGE

As conference chairman for the 29th IEEE-VTS conference, I want to extend a sincere invitation for your attendance at this conference. The committee has worked very hard and very productively the past year organizing this conference and I know that those of you that attend will be overwhelmed with the quality of papers, exhibits, and supporting programs and meetings. The information contained in the remainder of this advanced program attests to the state of the art advances made in the science of vehicular technology. Fellow engineers and scientists, 1978 truly has been a leadership year for those that share our interests in on-board automotive communications and electronics. To miss this conference would not keep you up to date with the technology, but would, even worse, cause you to fall behind. None of us can permit ourselves or our people to be so degraded.

The theme of the conference is "Tomorrow's Technology for a Mobile Society". This conference truly speaks to Tomorrow's Technology. The formal papers will deal in depth with a wide variety of leadership subjects consistent with our theme. Such subjects are cellular technology, satellite communications, vehicular collision avoidance and guidance systems, new methodology for R.F. propagation and interference prediction, new modulation techniques for the mobile environment, automated highway and vehicle technology, micro-processor applications to automotive electronics, new regulatory approaches, advanced devices to enhance vehicle communications and safety, new computer simulations models, and much more.

An all-day service seminar is planned, speaking to the maintenance aspects of this new technology. There will be on line demonstrations of the new 800 MHz Chicago cellular communications systems. A fully instrumented van will be available for the measurement of R.F. fields and the determination of their effect on vehicle electronics. A very exciting non-technical program is planned at the banquets and lunches. All this and more is described in the following pages.

Ladies and Gentlemen, don't foresake this great educational opportunity to meet your fellow engineers and scientists at the conference. See you in Arlington Heights, Illinois, USA, on March 27, 28, 29, and 30th.

Alvin M. Goldstein
Chairman-VTS Conference-'79

TOP EXECUTIVES TO SPEAK

Two of the world's leading electronics executives will discuss "Tomorrow's Technology for a Mobile Society" during separate luncheon meetings being held as a part of the 29th Vehicular Technology Conference, scheduled for March 27-30 at the Arlington Park Hilton, Arlington Heights, Illinois.

Sponsored by the Institute of Electrical and Electronics Engineers Inc., a not-for-profit organization sharing advances in electronic technology, the conference is expected to draw about 1,5000 attendees from the world scientific community.

Scheduled to discuss the new technology are Martin J. Caserio, a General Motors Vice President, and William J. Weisz, President of Motorola Inc.

A member of GM's Administration Committee, Caserio is the group executive in charge of the Electrical Components Group. During his 41 year career at GM he has held several engineering and management positions including general manager of the AC Spark Plug Division, and general manager of GM's former Delco Radio Division (now Delco Electronics Division). Caserio had been a metallurgical chemist for a division of United States Steel Corp., when he left to join the metal research department of GM's AC Spark Plug Division. Subsequently, he served as the division's chief metallurgist, supervisor of process and development, military contracts engineer and assistant chief engineer.

Mr. Caserio was made chief engineer of AC's automotive products in 1953 and was appointed director of engineering and sales in 1956. In that position, he was also responsible for reliability and quality control. Mr. Caserio was named manager of the AC Spark Plug Division's Milwaukee, Wisconsin, operations on September 1, 1957.

As President and Chief Operating Officer for Motorola Inc., William J. Weisz is responsible for an organization having nearly $2 billion in sales annually. Motorola's diversified product line include two-way radios and other forms of electronic communications systems; semiconductors, including integrated circuits and microprocessor units; electronic equipment for military and aerospace use; data communications products and automotive equipment.

Beginning his career with Motorola as a junior development engineer, Bill Weisz worked on early versions of the company's portable two-way radios. In his rise to the presidency at age 43, Weisz performed in a number of increasingly responsible posts. From chief engineer for all mobile and portable communications products in 1946, he became manager of these product lines in 1958. In 1960, he added traffic light controls and closed circuit TV products to his responsibilities.

Weisz was elected a Motorola vice president in 1961, was named assistant general manager of the Communications Division in 1964 and general manager the following year. In 1968, Weisz was elected to the Motorola Board of Directors, becoming executive vice president in September 1970, adding chief operating officer to his responsibilities in May 1972.

He has authored numerous papers and received patents related to two-way radio communications. He is a past chairman of the Communications and Industrial Electronics Division of the Electronic Industries Association (EIA) and is currently chairman of the EIA Board of Governors. He is a Fellow of the Institute of Electrical and Electronics Engineers and the Radio Club of America.

Throughout the conference, papers will be presented which outline major technological advances. For more information about the seminar or the conference, contact Conference Chairman Al Goldstein at (312) 576-4903.

ABSTRACTS OF TECHNICAL PAPERS

WEDS. MORNING

Session: NEW COMMUNICATION TECHNIQUES AND TECHNOLOGIES - I

Session Chairman: Jona Cohn, Motorola

Time: Wednesday Morning 8:30 to 12:00 Noon

Spectrum Efficiency of Single Sideband Radio with Amplitude Compandors

Bruce Lusignan, Mark Herro and Fernando Nocedal
Stanford University

In order to realize the advantage of Single Sideband Modulation over Frequency Modulation for mobile communications, the spurious emissions of the radios must be controlled by amplifier linearity. The purpose of this paper is to study the linearity, adjacent channel separation, and frequency efficiency of SSB and amplitude compandored SSB radios by means of computer analyses and bench and field tests. The relationship between adjacent channel interference and the two-tone amplifier linearity test is established. The use of amplitude compandors to reduce spurious emissions and the effects of co- and adjacent-channel interference in SSB radios is analyzed and demonstrated. Maintenance of emission performance during normal field operation is proposed, and the spectrum efficiencies of FM, SSB, and amplitude compandored SSB are compared in a fading environment.

* * * *

The Potential of SSB for Land Mobile Radio

R. W. Gibson and R. Wells
Philips Research Laboratories

The pilot carrier SSB technique removes fast fading effects, greatly increases the permissible tuning error in receivers and completely eliminates the "Donald Duck Effect" associated with mistuned SSB. Good quality speech with lower battery consumption in portables can be achieved with 5 kHz channel spacing. SSB transceiver operation is compared with conventional commercial equipment in the urban environment. The performances are examined and presented for various conditions of fading and ignition noise. FM/SSB cochannel interference effect differences in the fading environment and modifications caused by amplitude companding and audio processing are also discussed. No modification to existing signaling schemes are required for good quality speech transmission.

* * * *

Spread Spectrum for Personal Communication

George R. Cooper and Ray W. Nettleton
Purdue University

A cellular technique utilizing spread-spectrum signals is proposed for personal communication systems and some of the requirements for the system are analyzed. Specific items that are discussed include bandwidth requirements, number of unique addresses, limits on the number of active users, power requirements, signal penetration and self-regulating features. It is believed that this approach to personal communications offers many advantages such as greater user density, overload capability, privacy and priority service. Furthermore, the proposed system is considered to be technologically feasible.

* * * *

Probability of Error Performance of the Spread-Spectrum Mobile Communications Receiver in a Non-Rayleigh Fading Environment

David P. Grybos, George R. Cooper and Ray W. Nettleton
Purdue University

The spread-spectrum mobile communication system utilizes frequency diversity to combat the effects of frequency-selective fading occurring in the urban mobile channel. In previous studies this rapid fading has been assumed to have Rayleigh statistics. The present study investigates the effects of deviations from the Rayleigh fading assumption. In particular, it is shown that an upper bound on the probability of error is obtained with an assumption of flat fading over the entire signal spectrum, and a lower bound on the probability of error is obtained with an assumption of independent fading of each component of the signal.

Session: LATERAL AND LONGITUDINAL CONSIDERATIONS OF AUTOMATED HIGHWAY AND GUIDEWAY VEHICLES

Session Chairman: Frank P. Caiati, General Motors

Time: Wednesday Morning 8:30 to 12:00 Noon

Automated Longitudinal Control of Highway Vehicles

William M. Brobeck
William Brobeck & Associates

The requirements of automatic control of vehicles on expressways will be stated and the design of a system to meet the requirements will be described. The system is based on control by equipment (computers) carried by the vehicles responding to information as to the positions and speeds of surrounding vehicles transmitted to the controlled vehicle through road circuits. A suggested design for these circuits will be described. A method for automatic lane-changing will be described and the problem of compatibility of automatic and manually-controlled vehicles using the same lanes will be discussed.

* * * *

Automatic Car-Following -- A Study of Possible Controllers

Arther L. Masson
The BMD Corporation

Systems to allow automobiles or other vehicles to automatically follow one another are becoming increasingly desirable. This paper considers a class of linear controllers to determine their relative suitability for maintaining longitudinal separation between individual vehicles. A modified controller using forward and backward-looking sensors is examined using a transmission line analogy. Stability concepts are defined and clarified and characteristics of a well-behaved system are presented. The relative benefits of the linear models for use in a practical system are discussed and areas of future work outlined.

* * * *

Testing a Prototype Inductive Power Coupling for an Electric Highway System

J. G. Bolger -- Engineering Consultant, Orinda, California
L. S. Ng, D. B. Turner, and R. I. Wallace
University of California, Berkeley

A Dual Mode Electric Transportation (DMET) system is under development in which energy is electromagnetically transferred from a powered roadway to moving vehicles without mechanical contact. Energy from the roadway can be used for high-speed, long range travel, and for replenishing energy stored in the vehicle in batteries or flywheels. The stored energy is then available for short-range travel off the powered highway network.

A static prototype of the inductive power coupling has been built and tested. Power transfer was demonstrated to conform to the models developed in an earlier phase of the project. The prototype was used to study the power of coupling mechanism and resulting design improvements are incorporated. Tests of properties of the coupling included electrical characterization of the prototype equipment, measurements of the magnetic force between power source and pickup, measurements of coupled power versus pickup airgap and offset, measurements of magnetic flux in and around the prototype, and measurements of thermal effects induced by coupled power. The tests resulted in several design improvements which were incorporated into the coupling design.

* * * *

A Study of the Performance of NTS Vehicle Steering Control System

Masato Abe -- Engineering Consultant, Tokyo
Hiroshi Inoue and Norio Wakasa
Niigata Engineering Co., Ltd., Tokyo, Japan

NTS is an Automated Guideway Transit developed by Niigata Engineering Co., Ltd. in Japan.

The performances of NTS vehicle steering control system which is so designed that the clearance between guide wheels and guide-wall is taken intentionally in order to reduce the lateral disturbance from guideway irregularities through guide wheels, is considered. The mathematical model of the lateral motion of the vehicle with the front steering linkage and the rear one connected together by some ingenious rod is derived, and the effects of some design parameters of the steering system on the lateral motion of the vehicle are predicted by making use of computer. The relevant lateral motions of the vehicle are observed after the action of an ideal disturbance force at the front edge of the vehicle-body for one second.

It is found that though, in general, the clearance between guide wheels and guide-wall reduces the steering control stability and causes the oscillatory lateral motion, the connecting rod between the front steering linkage and the rear one restrain the oscillatory lateral motion, when the steering control gains of front and rear are chosen appropriately.

* * * *

Automated Control of Guideway Transit Vehicles

Ronald R. Smisek and Glenn A. Harder
General Motors Transportation Systems Division

The control of vehicles for ground transport is an important element of automated people mover systems. An overview of the system control structure is presented, and attention is focused on individual vehicle longitudinal and lateral control.

A longitudinal and lateral control system which utilizes a fixed guideway reference system has been designed, tested, and developed. The fixed guideway reference system is comprised of guideway-mounted measurement markers and an inductive communication link which provides the means for vehicle state error measurement and control. Vehicle status information and longitudinal commands are transmitted to/from the wayside via the inductive link. In addition, measurements of the electromagnetic field surrounding the communication link are used to obtain estimates of vehicle lateral position error with respect to a prescribed path. These vehicle state error measurements are processed by an on-board vehicle computer, and the proper longitudinal and lateral control commands are generated and applied to the appropriate control equipment to effect the necessary longitudinal and lateral control responses.

* * * *

Airtrans Steering and Suspension System Improvements for Operation in an Urban Application

Van W. Hall, Jr.
Vought Corporation

The Vought Corporation has received Federal grants from UMTA for design and analysis, fabrication and testing of improvements to the AIRTRANS Automated Guideway Transit (AGT) System. These grants, termed AIRTRANS Urban Technology Program (AUTP) Phase I and Phase II, are administered by Dallas/Fort Worth Airport and aimed at extending the AIRTRANS technology to urban AGT applications. Improvements to the AIRTRANS system are intended to allow higher speeds for increased productivity, lower capital and operating costs, better reliability and better all-weather capability.

This paper deals with the selection of steering and suspension system improvements to AIRTRANS for the more demanding urban environment. Phase I test results from an instrumented "baseline" AIRTRANS vehicle were investigated and analyzed prior to these design changes. Design changes were made and guideway testing was again conducted. Data taken before and after each test is presented to give quantitative measures of the design improvements. Power boosted and contactless steering concepts were investigated and tested with results being compared to the "baseline" mechanical steering system. Phase II improvements to the vehicle are primarily in the suspension system. Phase II improvements to the vehicle are primarily in the suspension system. The addition of a softer suspension system and a lateral suspension system are potential improvements that are discussed in the paper also.

Session: Automotive Braking and Safety Related Systems

Session Chairman: John Weller, General Motors

Time: Wednesday morning 8:30 to 12:00 noon

ELECTRONIC CONTROL UNIT FOR PASSENGER CAR ANTI-SKID

- Heinz Leiber & Armin Czinczel, Robert Bosch GmbH, Stuttgart, Germany

By introducing modern technologies for the electronics, Bosch succeeded in developing a high-quality antiskid system for passenger cars. Two well-known German automakers are introducing the system just now, others will follow in the near future. Two wheel speed sensors measure the angular velocity of the front wheels. In order to minimize brake force differences of the rear axle on roadways with split coefficients a common control for the rear wheels has been chosen. The electronic unit is mainly of digital design and consists of a few integrated circuits. The antiskid system comprises many sophisticated functions which result in a high complexity of the circuit. The digital design was chosen because it allows for a greater integration than the analog design.

NEW CONTROLLER FOR ELECTRIC BRAKES

- Daniel L. Neill, Kelsey-Hayes Research & Development Center, Ann Arbor, MI

Control of electric brakes extensively used for recreational and utility trailers has traditionally been provided by electro-mechanical means. The continuing economics afforded by the semi-conductor industry have made practical the application of solid state technology to this control application. This paper discusses the development of a solid state control system for vehicle electric brakes that provides near theoretical optimum performance at competitive costs. Details of the controller and two alternate types of brake sensing transducer and actual operating data are presented.

FIELD DATA RECORDERS

- David A. Thatcher, Instrumentation Engineering General Motors Proving Ground, Milford, MI

The acquisition of large amounts of real-time history data has traditionally involved the use of large, bulky, multi-track, reel-to-reel, analog recorders. These instruments usually require the presence of skilled operators during use. There are many field applications where single parameter, low-frequency, time-history data acquisition capability is desirable. This paper discusses the development of two low-power digital cassette tape recorder systems designed to perform specific vehicular data collection tests; 1) vehicle speed-time history during brake applications, and 2) vehicle accessory-time history. These instruments are capable of operating unattended and independent of the vehicle power system for up to three months. The use of tape cassettes and elimination of many external controls has greatly simplified the operation of these units, so minimal technical training is required. They are also designed to withstand the extreme vehicular environment.

MICROWAVE AUTOMATIC VEHICLE IDENTIFICATION (AVI) SYSTEM

- J. Sakuragi, Y. Kimura, K. Kameda, & S. Kamata, Toshiba Corporation, Toshiba Komukai Works, Kawasaki, Japan

In recent years, in step with the significant progress of highway and railroad transportation systems, high speed and high volume of traffic has become the general trend. This trend has brought about an urgent need for means to automatically identify vehicles while in motion, as to their type or vehicle number. The new microwave carrier identifying system developed by the authors utilizes a microwave carrier containing the interrogating signal or the response signal. The distance between the interrogator antenna and the transponder can be considerable and moreover the transponder can be a completely passive device that is small in size, of flat construction, and light in weight. Thus providing an ideal system for the identification of automotive vehicles and containers, etc.

WEDS. AFTERNOON

Session: NEW COMMUNICATION TECHNIQUES AND TECHNOLOGIES - II

Session Chairman: Jona Cohn, Motorola
Time: Wednesday Afternoon 1:30 - 5:00

Spectrum Efficiency of a Frequency-Hopped-DPSK

Paul S. Henry
Crawford Hill Laboratory
Bell Laboratories

We estimate the spectrum efficiency (bits/sec. per unit bandwidth) of a Frequency-Hopped-DPSK modulation technique proposed for use in urban mobile radio systems. The analysis is based on simple models for the factors influencing system performance, and requires no computer simulation. It permits straightforward evaluation of spectrum efficiency over a broad range of system parameters. For an isolated service area (cell) with no propagation impairments, the efficiency is 0.12 at a bit error rate of 10^{-3}. When interference from nearby cells is considered (assuming centrally located base stations with omnidirectional antennas), the efficiency falls to 0.03 - 0.05, depending on how much performance degradation can be tolerated near the cell boundaries. Finally, the effects of multipath (Rayleigh) fading reduce system efficiency to 0.02 - 0.04.

* * * *

The Effect of Redundant Coding on Throughput in a Mobile Data Terminal System

Thomas A. Freeburg
Motorola, Inc.
Communications Divisions

Many papers have been written concerning the application of error-correcting codes to mobile data systems. However, various workers in the field continue to question the relative performance of such a scheme, prefering instead a much simpler code structure (limited error-detecting only), depending on retransmission to supply the necessary correction. This paper presents the results of an investigation carefully designed to provide insight into the relative performance of these two schemes, and the conditions affecting that relative performance. Primary focus is on a complete system, and the effects examined include multi-path fading, terrain variations, mobile population distribution, transmitter power vs. range, and some simple local noise effects. The final conclusions are a set of concise trade-off rules that very clearly show the impact of the coding decision on the factors that control system cost and performance, and the limits within which these conclusions are valid.

* * * *

A New Modulation Scheme for Multitransmitter Simulcast Digital Mobile Radio Communication

T. Hattori and S. Ogose
Electrical Communication Laboratories
Nippon Telegraph and Telephone Public Corporation

For efficient frequency utilization and a simplified receiver in a multi-station digital mobile radio system, each base station should transmit the same signal simultaneously. To realize this, a scheme called frequency offset has often been proposed, but this scheme requires high stability of the carrier frequency. A new scheme is proposed in this paper which uses a synchronous sinusoidal signal to modulate the digital signal, and the composite signal then frequency modulates the carrier. Each base station has a different phase offset between the digital and simusoidal signals. Experimental tests conducted on a two base station system at 800 MHz with standard FM receivers and a 600 b/s signalling rate showed that the proposed system provides the necessary diversity with much greater tolerance to frequency offset than in systems proposed earlier. Sensitivity to variations in system parameters such as frequency drift, deviation, fading rate and signal level are provided.

* * * *

Feasibility of Digital Voice Transmission in Mobile Radio

Kenkichi Hirade and Mitsuru Ishizuha

Electrical Communication Laboratories
Nippon Telegraph and Telephone
Public Corporation

The feasibility of digital voice transmission in VHF and/or UHF mobile radio communications using a single-channel-per-carrier (SCPC) transmission technique is analyzed. Adjacent channel separation is determined as a function drift, coding method, and modulation type. It is shown that a 16 kb/s adaptive coding technique and a 1 b/s/Hz modulation technique are needed to realize conventional 25 kHz channel separation. A modulation method similar to QPSK gives results close to conventional narrow-band FM systems, with performance improvements obtained via forward error correction. It is shown that an analysis-synthesis coding technique at less than 10 kb/s and a modulation technique of more than 2 b/s/Hz are needed to achieve channel separation of less than 25 kHz, e.g. 12.5 kHz.

* * * *

Session: Regulatory Aspects of Mobile Communications

Session Chairman: Roger Madden, Federal Communications Commision

Time: Wednesday afternoon 1:30 to 5:00

Computerised Frequency Assignment for the Private Land Mobile Services

Dr. J. Durkin and Mr. M. J. S. Hart

This paper describes a computerised method of frequency assignment which has been operational since late 1975 in the United Kingdom. The demand for mobile radio systems is greater in the large conurbations of which London is the best known example in the United Kingdom.

The large amount of data involved in assessing the channel sharing possibilities and the number of calculations required to evaluate potential interference can only be processed by computer methods. The computerised system incorporates a method of enabling several users within a given area to share the same channel on a basis of traffic occupancy. Other features of the computer system include a management information retrieval system for determining the growth patterns and providing statistical data on private land mobile radio users. The system described is a general purpose system and modular in design; the concepts could be readily applied to other radio services.

The computer system has now assigned over 20,000 radio frequencies without any problems and work is now in hand to fully automate the complete licensing procedure to incorporate licence renewals and all accounting procedure.

* * * *

The Effect of Mobile Radio Channel Bandwidth Reduction on Spectrum Usage

W. M. Pannell
Pye Telecommunications Ltd.

The author introduces the paper by briefly reviewing the trend in bandwidth reduction that has taken place and compares the present bandwidth in use for both frequency and amplitude modulated systems.

The possibility of further reductions in both bandwidth and mode using single sideband transmission techniques at 5kHz is given. The paper analyses intermodulation, reuse distances, and spectrum efficiency.

* * * *

Alternative Decision Processes for Creating Telecommunications Policy

Ronald S. Stone
Federal Communications Commission

The FCC has lately come under increasing attack for many of its policy decisions. The courts have found it necessary to overturn several Commission decisions, and individuals and organizations have filed petitions for reconsideration on many major Dockets. Therefore, it seems appropriate to evaluate alternative decision processes that could be used to create telecommunications policy. This paper presents an evaluation of several alternative processes in order to ascertain whether there are any potential benefits to be gained from a new process.

The paper begins with a description of a basic "ideal" decision process model. The model illustrates the basic factors that stimulate a need for a decision, and the elements that provide for the resolution of a decision. Then, the traditional FCC approach, a referendum approach, and the proposed National Telecommunications (NTA) and Communications Regulatory Commission (CRC) approach are evaluated. Each decision process is evaluated on a set of criteria which include: cost of the process; time needed to resolve an issue; quality of decisions; and how well the decisions reflect the social values of society.

The basic conclusion is that there is no optimal decision process among the set of alternatives that were explored. However, the citizens panel approach, although probably being the most costly, could be the best overall approach, if carefully designated and implemented.

* * * *

Session: PEOPLE MOVER PROGRAMS -- PRESENT AND PLANNED

Session Chairman: Dale G. Shellhorn, Boeing Aerospace Company

Time: Wednesday Afternoon 1:00 to 5:00 p.m.

Five Generations: Skybus to Orlando

John Tucker
Westinghouse Electric Corporation

The shuttle system at the Orlando International Airport, scheduled for operation in early 1981, is the 5th generation of Westinghouse's airport people movers.

The system at Orlando connects the main terminal and two satellite terminals via 1940 feet of dual guideways. It provides service every two minutes during peak demand periods and arrives on demand during evening hours. It carries as many as 16,000 passengers per hour. There are four people mover vehicles running along four roadways (two per guideway). (Fully coordinated by an automatic train control system.)

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Morgantown People Mover Service Availability and O&M Costs -- History and Projections

Richard M. Hacker -- Boeing Aerospace Company
Robert J. Bates -- West Virginia University

The history of the service availability and operating and maintenance (O&M) costs of the Morgantown People Mover is summarized. Projected availability and O&M

costs for the expanded Phase II system are also documented.

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Evolution of AIRTRANS -- A Successful AGT System

Conrad M. Schultz
Vought Corporation

A brief description of the AIRTRANS people mover system as installed at Dallas/Fort Worth (D/FW) Airport is presented. The development and operation of this system from January 1974 through December 1975 is described with specific emphasis on design and operational changes required and the effects of these changes on system availability and performance.

The status and results to date of the UMTA AIRTRANS Urban Technology Program are presented. This program is directed to implementing those design changes and performance improvements required to adapt the AIRTRANS design to successfully operate in an urban scenario.

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AIRTRANS: Now through 2001

Dalton Leftwich
Dallas-Ft. Worth Airport Authority

* * * *

DPM -- Urban Application of Today's Technology

John J. Marino
Urban Mass Transit Administration

* * * *

Mag-Transit -- Magnetic Levitation and Propulsion Combined

Richard G. Gilliland
Boeing Aerospace Company

Mag transit is a unique combination of magnetic levitation and propulsion for people mover applications. Linear electric motors are used for levitation, propulsion, braking, guidance and suspension. Since there are a minimum of moving parts there is a potential for a substantial increase in system reliability and availability as compared to conventional systems.

Modern solid state technology provides the capability to condition sufficient quantities of electrical energy to control motor excitation, and thereby levitation, within a closed loop servo system. Real time measurements of air gaps and vehicle accelerations are used to compute the desired levitation force. In addition the solid state electronics provides the ability to independently control the speed of the vehicle by a continuously variable excitation frequency to the motors.

Session: Automotive Microprocessor Applications and Supporting Electronics

Session Chairman: John Cassidy, General Motors

Time: Wednesday afternoon 1:30 to 5:00 p.m.

MULTIPROCESSOR SYSTEM FOR DEVELOPING CONTROL STRATEGIES OF CAR ENGINES
- M. Beltrami, E. Pellegrino, R. Scalet, & M. Scarnera, C.R.F. (Fiat Research Center), Torino, Italy

During the last ten years the automotive industry devoted large research efforts to the development of engine control systems based on microprocessors. Several control strategies are potentially advantageous for the proposed goals. They require a heavy experimental commitment for setting up and evaluating static-dynamic trials in engine test-rooms and final driveability trials on the road. Therefore the microprocessor electronic controller must have special characteristics of changeable configuration and compactness in order to be applicable to different strategies. On such a basis, the C.R.F. (Fiat Research Center) developed a new electronic controller ("MULTIP") devoted to experimental investigation of a broad class of engine control strategies, which can be used during the typical phases in test-rooms and on the road.

MICROPROCESSOR-BASED SYSTEM FOR ROLL-DOWN AND ACCELERATION TESTS
- D. K. Lynn & C. Derouin, Los Alamos Scientific Laboratory, Los Alamos, NM; and P. Lamar, Lamar Instruments, Redondo Beach, CA

A microprocessor-based, road-test system for measuring and recording roll-down and acceleration data has been designed and built. The system provides for rapid testing of vehicles, can be operated by a single individual, and allows detailed data acquisition when required. Digital data storage and output capability allows direct exchange of data with other computers or calculators for data analysis and reduction. System input is distance from a fifth wheel and elapsed time. Detailed data is stored in RAM and is output to magnetic tape at the end of the run. The tapes are used to obtain plots and as input for data reduction programs that calculate rolling friction and aerodynamic drag. The road-test system has been used to test a number of vehicles.

SEALED RECHARGEABLE BATTERIES EXPAND DESIGN OPTIONS FOR AUTOMOTIVE ELECTRONICS
- David W. Dorheim, Battery Department, General Electric Co., Gainesville, FL

Traditionally the automobile has obtained its electrical power from a large flooded lead acid battery. This system has been a cost effective workhorse for the industry and will continue to be the main source of electrical energy for vehicles in the future. However, the increased usage of electronic circuits in the automotive industry is creating a need for an additional source of electrical energy in the automobile. This paper deals with a special class of high performance rechargeable products in the sealed cylindrical category. Two basic electrochemical systems will be discussed, nickel cadmium at 1.2 volts per cell and lead acid at 2.0 volts per cell.

Session 3B: INFORMAL PAPERS

Session Chairman: A. Kent Johnson, Bell Laboratories

Time: Thursday Morning 8:30 to 12:00 Noon

Evaluation of Cellular Mobile Telephone Data Receivers

Roland J. Turner
Bell Laboratories

The Advanced Mobile Phone System (AMPS), is a cellular mobile telephone system presently undergoing service tests in the Chicago metropolitan area. The cellular mobiles utilize duplex transmit and receive channels contained respectively in the 825-845 MHz and 870-890 MHz bands.

This paper describes the laboratory measurement techniques employed to evaluate AMPS mobile telephone data receivers when driven by a Rayleigh fading channel. These performance measurements permitted laboratory evaluation of various bit clock recovery designs without resorting to tedious field trials.

AMPS (Advanced Mobile Phone Service) Chicago Developmental Cellular System

J. T. Kennedy
Bell Laboratories

In March, 1977 the Federal Communications Commission authorized Illinois Bell Telephone (IBT) to construct and operate a developmental cellular mobile telecommunications system in the Chicago area. This talk, which is a follow up of a paper given at the 1978 Vehicular Technology Conference on the AMPS Chicago Developmental System, will review the system description, progress which has occurred this past year and current status of the Developmental Service Test as of March, 1979; including a summary of the results of some of the more significant system performance measurements.

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Session: SIMULATION OF "REAL WORLD" TRANSIT SYSTEMS

Session Chairman: David E. Benjamin, Vought Corporation

Time: Thursday Morning 8:30 to 12:00 Noon

Simulators Used by WMATA

Martin Lukes
Washington Metropolitan Area
Transit Authority

ASIM, The AIRTRANS Simulation Model

Gary M. Jones
Vought Corporation

The D/FW AIRTRANS Simulation Model (ASIM) is a Vought proprietary computer model which simulates the operation of AGT vehicles and their interaction. This model enables one to study different routes or expansion of the guideway to obtain accurate performance characteristics of the system at modest cost.

The model has been continuously updated and modified from 1971 to the present to reflect changes in actual AIRTRANS operation and to improve the efficiency of calculations in the model. Three studies have been performed by an independent consultant to both validate the model and determine the effects of new routes and an augmented Air Mail Facility (AMF) system on AIRTRANS operations. One conclusion of the latest study was that "ASIM represents the actual AIRTRANS results quite accurately and without any apparent significant bias".

* * * *

Electric Power Demand of Multi-Vehicle AGT Systems

G. H. Williams
Union College, Schenectady, New York

In multi-vehicle guideway transit systems three-phase electric current is distributed from propulsion stations along guideway power rails to the vehicles. The system can can be viewed as an electric power distribution system. In particular it is a time-varying system since the vehicles change their power consumption and their position.

Computer models are developed which yield the total power demand for the system and the voltage regulation for the individual vehicles. Model parameters which may be varied include the guideway deployment, the propulsion station locations along the guideway, the vehicle propulsion system components, and the mission profiles. The models have been incorporated into a computer simulation. Results of the simulation are given as plots of system power demand versus time and of voltage fluctuations at the vehicle's versus position along the guideway.

* * * *

Vehicle Simulation for Morgantown People Mover Software Testing

Thomas A. Zimmiewicz
Boeing Aerospace Company

The software controlling the Morgantown People Mover is a major system component and, due to its size and complexity, must undergo extensive testing prior to on-site system integration. This paper describes the software simulator used to provide the test environment. Special emphasis is placed on vehicle simulation due to its applicability to other transit systems.

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Passenger Service Dependability Assessment for a Transit Loop

Robert W. Schaaf
Engineering Consultant -- Columbus, Ohio

For automated guideway transit systems an increasing concern is the probability of passenger delay and its relationship to system availability. For a loop configuration a particular reference response to a failure is hypothesized. For this reference response, the delay probability equation is approximated simply as "lack of availability" divided by "lack of passenger saturation". Alternate failure responses are then

placed in perspective by scaling relative to the reference.

* * * *

Simulation of a High Performance PRT Control System

David Birnbaum
General Railway Signal Co.

In connection with the second phase of the Advanced Group Rapid Transit (AGRT) project sponsored by UMTA, General Railway Signal Company has refined the design of a control system for a high-performance (3-second headway) Personal Rapid Transit (PRT) system. The control system utilizes a variable length moving block control algorithm and features a combination of multiple wayside and vehicle-borne computers that are connected by a wide bandwidth data link to achieve the desired performance. In this phase of the project, a major effort was directed toward developing a highly detailed simulation of the entire control system. This simulation was undertaken to verify that the deployed system would meet previously defined performance specifications.

This paper will discuss the implementation of the simulation and describe its use in verifying system operation at both macroscopic and microscopic levels.

Session: Automotive Transducers and Displays

Session Chairman: Bill Fleming, General Motors

Time: Thursday morning, 8:30 to 12:00 noon

FIBER OPTIC/SOLID-STATE SWITCH SYSTEM DESIGNED FOR SWITCHING 20-AMP INDUCTIVE AND RESISTIVE LOADS
- Joe D. Mings & Joseph P. Bremmer, Texas Instruments, Inc., Dallas, TX

A high-power microelectronic switching circuit is interfaced with a fiber optic data link, whereby inductive or resistive loads up to 20 amperes are switched, with a forward voltage drop of less than one volt. An input signal of one-half milliwatt is passed to the gate of a VMOSFET power device, which drives P-N-P output transistor to switch power supply to load circuits such as a window lift motor, a seat lift motor, a windshield wiper motor, headlights, and turn indicators. Also the switch is useful in nonautomotive control applications. The power switch of this design permits a direct interface with a very low input power command signal, such as is typical of a low-power microprocessor-fiber optic output and the electromechanical interference is eliminated.

A MONOLITHIC LINEAR HALL EFFECT INTEGRATED CIRCUIT
- Michael J. Thorn, Texas Instruments, Inc., Dallas, TX

A low cost magnetic field sensor designed to provide an output voltage proportional to an applied magnetic field is described. Static or dynamic magnetic fields can be sensed. Excellent temperature stability and supply rejection specifications are demonstrated. The device also exhibits excellent rejection of mechanical stress. These characteristics make the TL173 attractive for application in automotive or industrial environments for position or movement detection, rotary motion detection, etc.

A RUGGED NEW TEMPERATURE SENSOR
- Murray Spector & William J. Havey, Alpha Metals, Inc., Newark, NJ

This paper presents a rugged new temperature sensor. The development effort was centered on a cooling system application, but the principles of design and fabrication are broadly applicable. In its simplest form, the sensor is a hybrid circuit potted with epoxy into a threaded steel shell for mounting. The hybrid circuit in turn is basically a porcelain enamel coated steel core on which the electronic elements are printed and fired. The nature of the hybrid circuit will be fully detailed.

HIGH QUANTITY, LOW COST, HIGH ENVIRONMENT AUTOMOTIVE TRANSDUCERS, A NEW BREED FOR USE IN ADVANCED AUTOMOTIVE ELECTRONIC SYSTEMS
- Burton F. Drill, Transducer Systems, Inc., Willow Grove, PA

The automotive related industries having gone into electronic control systems such as Electronic Fuel Injection and a host of other functions, demands high performance, low cost transducers to fulfill not only the specifications for performance, electronically and mechanically and also environmentally. This paper covers some of the important aspects of how this is accomplished with high production techniques and related to electro magnetic technology.

THURS. AFTERNOON

Session 4A VT'79 Mobile Communications Systems Sessions

Session Organizer/Chairperson: W. H. Chriss, Bell Laboratories

Time: Thursday Afternoon 1:00 to 5:00 PM

High Capacity Automomobile Telephone System

H. Kubota and T. Kikuchi

This paper describes the features of the 800 Mhz High Capacity Automobile Telephone System developed by the Nippon Telegraph and Telephone Public Corporation. The system is now under construction in the Tokyo metropolitan area. The major features of the system include: high capacity, efficient spectrum utilization, fully automatic exchange for a nationwide mobile service, vehicle location registration, call hand-off and multichannel access control.

Network Design For A Fully Automatic Wide Area Radiotelephone Service

M. H. Callendar and C. I. Donald

This paper describes the design of a fully automatic wide-area radiotelephone system using a decentralized building block approach. The building blocks are implemented using firmware-based microprocessor techniques. Reliable high speed digital signalling is used over the radio path for call set-up and control. The way in which calls are automatically routed to roaming mobiles without special subscriber-dialled routing digits is explained. Other areas covered include numbering plan, usage sensitive billing and arrangements for interfacing manual switchboards for operator handled calls. Details of offered traffic measured on a pilot automatic system, operated

in Vancouver for the last two years, are also included.

Nationwide Mobile Telephone Operation

J. D. Wells

The wide area, high capacity mobile telephone systems now being implemented have resulted in a need for automatic roaming service over several systems and service areas. This paper addresses the problem of selecting a numbering and routing plan for mobile users which is compatible with existing land network conventions. The optimum solution is a mobile network which is "overlaid" on the land network and is accessed by a nationwide "area" code. The mobile network then deals with the RF management and user mobility independently of land network hierarchy while maintaining a fully coordinated interface between two systems.

Session: CONTROL AND COMMUNICATION SYSTEMS -- PART I

Session Chairman: Thomas C. Selis, Westinghouse Electric Corp.

Time: Thursday Afternoon 1:00 to 5:00 p.m.

The Vehicle Data Acquisition System for the Seattle Transit System

Peter Stutz
Port of Seattle

The idea was born to develop a system that monitors the vehicle control logic like a flight recorder used on commercial airliners. With a monitoring system, vehicles can be placed back to service in a shorter time. The ability to look at fault conditions of events that happened then allows technicians to spend more time on improving the transit system rather than tracking down repetitious fault conditions.

In late 1976 a program plan is developed and a grant written to obtain federal funding for a Vehicle Data Acquisition System (VDAS). In 1977 UMTA (Urban Mass Transportation Administration) approved the funds for the project. In September 1977, the newly formed Systems Engineering Group at the Port of Seattle started the development of the Vehicle Data Acquisition System.

* * * *

Applications of Microprocessor Technology to Improve the Availability of People Mover Systems

Michael P. McDonald and Alan F. Mandel
Westinghouse Electric Corporation, West Mifflin, Pa.

During the past decade the performance requirements of train control equipment have consistently increased particularly in terms of reduced headways, unattended operation, improved availability and better ride quality. The increased functional complexity of the control equipment has resulted in the broad application of microprocessor-based hardware. This, in turn, has generated new potential problems associated with safety considerations, adequate training of maintenance personnel, special test equipment, and increased diagnostic and repair time.

The microprocessor, however, also provides opportunities to solve these problems by incorporating additional features such as self-diagnostics, dual processor control for safety and switching head-end control of a train to a different car when a failure occurs in the normal head-end control equipment. The microprocessor-based approach also provides additional flexibility by allowing modification of the system operation and diagnostic capability through changes in software rather than in hardware as was the case with previous designs. In other words, the microprocessor-based approach allows more standardization of the system hardware than was previously possible.

* * * *

New Measuring Method for Ride Comfort in Transit Vehicles

Wolfgang Bamberg, N.D. Lea & Associates, Inc.
Washington, D.C.
Hans Ludwig, SNV Studiengesellschaft mbH
Hamburg, Germany

This paper presents the results of ride comfort analysis performed on the Morgantown People Mover system and a comparison of results of measurements for other modern transit vehicles. All ride comfort measurements were performed, employing the new Ride Comfort Meter Type II developed and built by Delft University of Technology in Holland.

Principals of several ride comfort criteria in use are presented and compared. The proposed criterion of exposure duration for given vibration levels by the International Organization for Standardization (ISO) were selected for ride comfort measurements. The portable Ride Comfort Meter provides single value measurements which correspond to ISO weighted RMS values of effective accelerations, Each measurement takes 15 seconds and is called the Ride Index (RI).

To provide a basis for comparison between the Morgantown system and other transit systems, additional ride comfort measurements were made at three other automated guideway systems and five conventional transit systems.

* * * *

An Accident-Severity Analysis for a Uniform-Spacing Headway Policy

Jochen Glimm and Robert E. Fenton
The Ohio State University

Future automatic highway systems should operate at high capacities (3600 vehicles/lane/hr.) over a range of highway speeds (13-30 m/s). Under such conditions, it would be impossible to eliminate accidents. Here, a methodology to ascertain the severity of one especially critical accident -- multi-vehicle collisions resulting from the emergency braking of a platoon of automatically controlled, closely spaced vehicles -- is presented. This includes the specification of a collision model, which was based on reported crash-testing results, the selection of an accident severity measure, a consideration of a corresponding cost function, and a sensitivity analysis to determine those parameters which most heavily impinge on accident severity and/or cost.

The utility of the methodology was demonstrated by applying it to three, platoon-accident scenarios, which would be especially relevant to automated highway operations, and a qualitative measure of the affects of key parameters on accident severity is specified. Such results would be of considerable use to a system designer.

* * * *

Reliability Improvement of BART Vehicle Train Control

David B. Turner
Lawrence Berkeley Laboratory

We report here the two-year effort of a task troup to improve the reliability of the Bay Area Rapid Transit district's vehicle-borne Automatic Train Control equipment. This effort included modifications to the train control equipment designed both by the manufacturer and by the task group. It also included the development and implementation of improved maintenance test procedures and equipment. A significant constraint on this effort was the need to maintain, and where necessary, improve the fail-safe nature of the train control system. Particular attention was paid to reducing the fraction of maintenance diagnoses which resulted in a No Trouble Found report; at the start of the task-team effort, these represented half of the revenue service failures of this system. A substantial improvement in the maintenance capability and decrease in service failures has resulted from this effort.

Session: Automotive Control Systems and Methodology

Session Chairman: John Cassidy, General Motors

Time: Thursday afternoon 1:30 to 5:00 p.m.

THE TRUCK ELECTRONIC GOVERNOR SYSTEM
- J. F. Kennedy & V. E. Welch, Electrical and Electronics Division, Ford Motor Company, Dearborn, MI

The Ford Truck Electronic Governor System was developed to reduce to insignificant levels the transient overshoot-undershoot characteristics and the steady state governing inaccuracies in heavy truck applications with gasoline engines. The new system attains these goals by providing integral and derivative gain, in addition to proportional control for steady state operation, and an external speed derivative loop for transient control.

DETERMINATION OF VEHICLE ROLLING RESISTANCE AND AERODYNAMIC DRAG
- D. K. Lynn, J. B. McCormick, R. E. Bobbett, C. R. Derouin, & J. Nachamkin, Los Alamos Scientific Laboratory, Los Alamos, NM; and W. Kerwin, Department of Engineering, University of Arizona, Tucson, AZ

The retarding forces on a vehicle are characterized by rolling resistance (k_r) and aerodynamic drag (C_dA). These forces determine power requirements for a specified vehicle performance (particularly important for an electric vehicle) and are necessary inputs for any vehicle simulation. Both k_r and C_dA are determined for a number of vehicles and the testing and data analysis techniques are described.

FRI. MORNING

Session 5A

Session Organizer: W. H. Chriss, Bell Laboratories

Session Chairperson: R. L. Peterson, Bell Laboratories

Time: Friday Morning 8:30 to 12:00 Noon

Trunking - A New System Configuration for Fleet Dispatch Communications

S. Thro

As an outgrowth of FCC docket 18262, the already extensive mix of products available to serve the two-way radio communications needs of the business, public, safety industrial and other user groups eligible to operate in the land mobile services has been expanded to include multi-channel trunked systems in the 800 Mhz frequency band This paper will explore several potential user benefits which could result from this type of system and will also describe how a specific trunked system might be implemented.

A Taxi Communication System

O. Billstrom

This paper covers and integrated computer controlled booking and dispatching system for taxi cabs. In the system, the cabs receive printed orders by mobile radio data communication. The system is being developed for the three major cities in Sweden and will be introduced in 1981.

Measurements of Degradation To Intelligibility In Simulcast Systems

T. N. Rubinstein

This paper describes tests that were run to determine the degree of degradation to intelligibility caused by implementation of simulcast versus single transmitter systems. The tests involved running vehicles with observers over predetermined routes through simulcast and non-simulcast systems. Observers ratings show that the degradation to intelligibility due to simulcast was slight.

Implementation Of Digital Communications In Public Safety

S. A. Yefsky

This paper describes the phased development of two programs where digital communication systems were implemented. The two programs provide a contrast between the digital communications for a single police department with ten mobile data terminals and a system which provides service on a regional basis to 34 departments with 750 terminals. The paper discusses the implementation approach for the two systems illustrating the individual nature of each system.

* * * *

Session: RADIO PROPAGATION AND INTERFERENCE

Session Chairman: Neal Shepherd, SRI International

Time: Friday Morning 8:30 to 12:00 Noon

Ignition Noise or Foreign and Domestic Vehicles in Use in the United States

Richard A. Shepherd and James C. Gaddie
SRI International

Electromagnetic noise from the ignition systems of more than 11,000 individual vehicles in service in the United States in mid-1977 was measured at 50 and 153 MHz. We found very little difference between the noise of U.S. domestic and foreign vehicles. Older vehicle groups are noisier than newer vehicle groups -- a fact which may be accounted for by either of two causes: a) some vehicles in a group become noisier with age, b) newer vehicles may have improved noise suppression systems. Measurements made in a single year will not show which effect predominates. We found the greatest noise differences between vehicle types (cars, trucks, and so on).

* * * *

Radio System Performance Model for Predicting Operational Ranges in Irregular Terrain

G. H. Hagn
SRI International

SRI developed a communications system performance model for the U.S. Army Avionics Research and Development Activity that predicts the probability of successful communication in irregular terrain for both analog voice and digital communication systems.

The inputs to the communications system performance model are certain environmental data and radio system technical and operational information. Environmental inputs are terrain roughness (interdecile range), ground constants, vegetation information, and the expected noise environment. Equipment inputs are transmitter power, transmitting and receiving transmission line losses and antenna gains, and the noise figure for the receiving system. Operational inputs are frequency, antenna height, antenna siting, vehicular motion, and the required channel quality. The model output is the probability of a successful communication on any given attempt as a function of range.

* * * *

Radio Communication with a Vehicle Using a Leaky Feeder

Q. V. Davis, R. W. Haining and A. J. Motley
Department of Electronic and Electrical Eng.
University of Surrey

High speed, high integrity data transmission from moving vehicles presents problems in areas of multipath propagation, and in shaded areas such as cuttings, as well as in tunnels. In these situations the use of a leaky feeder is likely to be advantageous, especially since economy of transmitter power is possible, an important factor in spectrum conservation.

This paper establishes the feasibility of transmitting high integrity data from a vehicle under test to a base station at much higher rates than is normally considered possible over a mobile radio channel, by means of a leaky coaxial feeder.

* * * *

Performing SAE J551D Radio Interference Testing of Automotive Vehicles Using the Programmed Automatic Spectrum Analyzer

James C. Klouda and Norman W. Wehling
Elite Electronic Engineering Company

This discussion will deal with performing radio interference measurements in accordance with SAE J551D requirements on automative vehicles using a programmed automatic spectrum analyzer with a plotter output. This new method of performing these measurements will show how within seconds after having performed the test a semi-log chart with limits will be available to analyze the interference levels present which are being emitted from the vehicle. With this measurement tool an engineering analysis can be made on the spot to determine in which direction suppression techniques should be made. From the standpoint of providing a determination of whether or not various models have met the specification requirements, tests can be performed in just a few minutes with a complete data readout to confirm whether or not the specification requirements have been met.

* * * *

Land Mobile Satellite Margin Measurements

G. C. Hess
Motorola, Inc.

This report describes an experiment conducted with the ATS-6 satellite to determine the link margin necessary for land-mobile communications as a function of (1) local environment, (2) vehicle heading, (3) link frequency, (4) satellite elevation angle, and (5) street side. A link margin model developed from the data shows the first two parameters dominate. Margins on the order of 25 dB are typical in urban situations (90% temporal/spatial coverage), but decrease to under 10 dB in suburban/rural areas. Spaced antenna selection diversity is found to provide only slight improvement (4 dB typically) in the urban margin requirement. Level crossing rates are depressed in satellite links relative to those of Rayleigh-faded terrestrial links, but increases in average fade durations tend to offset that advantage. The measurements show that the margin difference between 860 MHz links and 1550 MHz links is generally negligible.

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Session: CONTROL AND COMMUNICATION SYSTEMS -- PART II

Session Chairman: Neil Patt, Transportation Systems Center

Time: Friday Morning, 8:30 to 12:00 Noon

Development of an Inductive Communications System for Morgantown People Mover

Todd N. Johnstone
Boeing Aerospace Company

The Morgantown People Mover (MPM), located at Morgantown, West Virginia, uses low and medium frequency inductive communications for the wayside-to-vehicle (uplink) and vehicle-to-wayside (downlink) communication links. The system has six uplink and one downlink tones in the low frequency (6-50 kHz) range used to communicate speed, switch, calibration, and stop commands and the collision avoidance "safe to proceed" signal, also downlink switch verification. In the medium frequency range (90 - 130 kHz) uplink (command) and downlink (status) digital data are transmitted using two-tone FSK messages. The vehicle interfaces with inductive loops in the guideway surface which range from ten to one thousand feet in length and are driven through feedlines of up to several thousand feet in length. This paper discusses the development of the MPM Inductive Communication System. Included is a brief history of the Morgantown People Mover and an overview of the Inductive Communications Systems presently in use. Each subsystem is discussed and significant design considerations along with operational data are presented. Emphasis is placed on our experience with this mode of communications.

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Vehicle/Guideway Transmission Systems for Automated Guideway Transit

Philip Yoe
Transportation Systems Center

This paper presents a general overview of the guideway communication systems for an automated guideway transit system. The basic functions and requirements of the communication systems are discussed. A variety of transmission media will be discussed. These media consist of third rail, inductive wires, leaky coaxial cables, leaky waveguide, surface waveguide, and radio transmission. The basic characteristics of each transmission medium will be presented. The possible applications of each transmission such as data communications, audio, and video communications will be discussed as well as their limitations. Finally the general design considerations are to be discussed.

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A PRT Constant Separation Longitudinal Controller

Edmund R. Foster
Charles Stark Draper Laboratory, Inc.

Platooning has been suggested as a way of increasing system capacity over that of a system of independent vehicles. Vehicles within a platoon are mechanically independent but are "electronically" coupled such that a small constant inter-vehicle separation is maintained independent of velocity. The major difficulty with platooning is the problem of string instability that can result in a vehicle-following system operating with a constant separation policy. This report describes a control method for operating a string of vehicles under a constant separation policy which does not result in strong instability.

Each vehicle, rather than looking only at the preceding vehicle, also receives a velocity command which is common to all vehicles. The results of simulations of a platoon of five vehicles are presented to demonstrate the validity of the technique.

* * * *

A "Safe Approach" Tracking Controller for Short Headway AGT Operation

Sidney J. Sklar
Charles Stark Draper Laboratory, Inc.

This paper presents a vehicle following control strategy for short headway AGT systems; it is also applicable to longer headway AGT systems. The strategy handles the vehicle overtake situation with the same basic controller as is used in steady-state string operations. A tight control loop is tied around each vehicle in the string. This control loop is isolated from large transients, such as occur during overtake situations, by constraining the vehicle to follow a well-behaved target trajectory which closes on the vehicle immediately ahead in accordance with a "safe approach" operating policy. By this means, the controller operates on small signals at all times. The safe approach target trajectory is determined by the states of the leading and trailing vehicles, the states of a vehicle which may become a new lead vehicle during merges, and the jerk, acceleration, and velocity constraints of the AGT system.

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The Cabintaxi Asynchronous Vehicle Control System

Peter Kraus
Messerschimitt-Bolkow-Blohm GMBH
Muchen, Germany

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A Control Scheme for Vehicular Strings

Satoshi Handa
Mitsubishi Electric Corp.
Amagasaki, Hyogo, Japan

This paper deals with the two hierarchical control methods on a single guideway in the public transportation system; the upper controls the vehicular strings and the lower controls the individual vehicles.

In the vehicular strings control system, the mathematical model is built as a discrete linear-state regulator problem where the delay time is chosen as state variable and the deviation from the scheduled driving time between adjacent stations is chosen as control variable. The performance index is defined as a quadratic form concerning the delay time, the deviation from the time interval and that from the driving time. We can realize any vehicular string control system with various objectives by selecting the relative importance of the weighting coefficients of the first and the second terms in the performance index.

Next, the controller of the individual vehicle is called AVO (automated vehicular operation) and its

two main functions are to drive a vehicle between stations in the time commanded by the vehicular string controller and to keep an accurate stoppage position at a station. The problem of controlling vehicles is modelled as a discrete linear-state regulator problem, where the deviations from both scheduled time and velocity are chosen as state variables and that from any scheduled driving force is as control variable. The performance index is defined as a quadratic form concerning the state variables and control variable.

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Session: AUTOMATIC VEHICLE LOCATING AND MONITORING

Session Chairman: John S. Ludwick, Jr., Mitre Corporation

Time: Friday Morning, 8:30 to 12:00 Noon

Evaluation of an AVM System Implemented City-Wide in St. Louis

Gilbert C. Larson--Public Systems Evaluation, Inc. Cambridge Massachusetts

An Automatic Vehicle Monitoring system, implemented city-wide by the St. Louis Metropolitan Police Department, has been evaluated. The principal goal of the computer-assisted dead-reckoning system was reduction in response time, while other objectives included improved officer safety, more effective command and control, less voice band congestion and better supervision of the force. The evaluation results were unfavorable for response time reduction, favorable for reduced voice band congestion and mixed in the realization of other objectives. Poor system performance had some influence on the evaluation results; however, full system potential can not be assessed without some change in police procedures and operating methods.

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The Mississauga and Toronto Transit Automatic Vehicle Monitoring and Passenger Information Systems

Josef Kates--Josef Kates Associates Inc. Toronto, Ontario

A slide- tape presentation. The Mississauga system, fully operational for more than a year, uses bus odometers, reset at the end of the routes, to provide location information. A central control system uses this information to determine estimated time of arrival at bus stops and to provide computer generated audio responses to passenger phone requests. Improved rider convidence in schedule data has increased ridership on some routes by fifteen percent. The Toronto system is more complex and sophisticated.

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The UMTA Automatic Vehicle Monitoring Program

Denis Symes--Urban Mass Transportation Administration Washington, D.C.

The Urban Mass Transportation Administration of the Departmnet of Transportation is developing a transit-oriented fleet command and control system. The objectives of this program are to:

1. Conduct a thorough test and evaluation of a fully functional area coverage AVM system.
2. Quantify the benefits to transit and other users.
3. Advance the state of the art of AVM, and
4. Establish the technical and economic bases for future deployments which may be funded through UMTA's Transit Assistance Program.

The UMTA AVM system will be installed in Los Angeles for two experiments and operated for a one year evaluation.

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Vibration Measurements on a Transit Bus

George W. Gruver--Gould I^3
Ft. Worth, Texas

The Los Angeles AVM demonstration will include bus-mounted electronic equipment for communications, display and processing. To determine the vibration environment to which the equipment would be subjected, measurements were taken at three locations on two different types of urban transit buses, under conditions of normal and severe shock. In general, vibrations resulting from operation of the bus are relatively mild; shocks resulting from passengers bumping or kicking the equipment are more severe.

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An AVM Reliability Model

George W. Gruver--Gould I^3
Ft. Worth, Texas

Reliability factors associated with the Los Angeles AVM demonstration system have been modeled. The system model includes vehicle equipment, signposts, communication and data processing equipment. Components critical to reliability are determined and their implications to design approaches and maintenance strategies are explored.

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Characterization of the Air Traffic Control Environment for Performance Evaluation of Modern Surveillance Secondary Radar Systems

G. Benelli and D. Giuli--University of Florence, Italy E. Dalle Mese, University of Pisa, Italy S. Pardini, Selenia S.p.A., Rome, Italy

Monopulse receivers, providing an estimate of aircraft azimuth, have been proposed as a means of improving the performance of the secondary radar systems used for traffic

control. As such systems utilize the monopulse estimate to perform a degarbling function, performance analysis requires a detailed description of interference effects. A complete description of synchronous and asynchronous garbles is presented and analyzed using two approaches: an analytical model and a computer simulation.

CONFERENCES

VEHICULAR TECHNOLOGY

Arlington Heights Hilton
Arlington Heights, Illinois

March 28-30, 1979

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INTERNATIONAL MICROWAVE
SYMPOSIUM AND WORKSHOPS

Sheraton Twin Towers
Orlando, Florida

April 30-May 4, 1979

TWENTY-NINTH ELECTRONIC
COMPONENTS CONFERENCE

Hyatt House
Cherry Hill, New Jersey

May 14-16, 1979

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CHICAGO SPRING CONFERENCE
ON CONSUMER ELECTRONICS

Arlington Park Hilton
Arlington Heights, Illinois

June 4-5, 1979

CHAPTER NEWS

Sam McConoughey
Chapter News Editor

NOTICE TO CHAPTER CHAIRMEN

Watch your mail for two important mailings. One will be forms on which you will report your Chapter Activities for the year beginning September 1, 1977 to August 31, 1978. This form will be the basis for determining the "Chapter of the Year" award to be made during the 29th Vehicular Technology Conference. Failure to return these forms means your Chapter will be left out of the competition! Two will be an invitation to attend the Chapter Chairmen's Breakfast to be held at 7:00 - 9:00 a.m., Wednesday March 28 at the Arlington Park Hilton, RSVP required.
If you have not received these two mailings by the time this Newsletter reaches you, please call either myself or Gaspar Messina at (202) 632-6400.

Also, we are not receiving copies of the "Meeting Report" from all Chapters. Remind your Chapter Officer responsible for filing the "Meeting Report" with the IEEE Section Secretary to send a copy to us so that we can report your meetings here.

CHAPTER MEETINGS

CLEVELAND

"An Update on Spectrum Analyzer Technology"
by Mike Dickey
Hewlett - Packard
Held on November 14, 1978 at the Cleveland Engineering Society with 14 attending including 5 guests.

"Expansion of the Ohio Edison Microwave Network"
by Steven F. Lux
Ohio Edison Company
Held on October 10, 1978 at the Cleveland Engineering Society with 30 attending including 18 guests.

"Tour of Dentron Radio Co."
by Mr. Dennis Had, President and Founder
Dentron Radio Co.
Held at the Dentron plant with 53 attending including 17 guests.
Along with the tour of the production and research facilities at Dentron, attendees heard the story of Dentron's phenomenal growth after their entry into the Amateur radio market four years ago. A preview of some newly designed products not yet announced to the public and a door prize drawing for a beautiful MT-3000 Antenna Tuner were highlights of the evening.

COLUMBUS

"Tour of WOSU Earth Station"
by Tom Lahr
Ohio State University
Held on August 9, 1978
with 18 attending including 12 guests.

"Possible Radio Interference"
Open discussion moderated by Al Shirk, Chapter Chairman
Held on September 13, 1978
with 11 attending including 8 guests.

DALLAS

"Early Days of Communications"
by Mr. Fred Link, IEEE Fellow
Communications Consultant
Held on October 17, 1978 at the Plank House
with 50 attending including 27 guests.

SAN FRANCISCO

"Automobile Ignition Noise"
by Dick Shepard
SRI
Held on October 17, 1978
with 27 attending including 8 guests.

"Tour of Mt. Unumhum Radar Station"
by Captain C. E. Skinner,
U. S. Air Force
Held on November 21, 1978
with 25 attending including 12 guests.

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ELECTION RESULTS

SAN FRANCISCO

Mr. Royce D. Detwiler, Chairman
(Term 7/78 thru 6/79)
3668 El Grande Drive
San Jose, CA 95132
Tel. (408) 988-8010

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SPEAKER OF THE YEAR - Fred M. Link

Fred has been very active during the 1978-79 season, and has advance bookings up to the time of our 29th Vehicular Technology Conference. Chapter Program Chairmen should make arrangements now for speakers for the balance of this season and if you haven't yet called upon Fred, do so now.

Mr. Fred Link
Robin Hill
Pittstown, NJ 08867
(201) 735-8310

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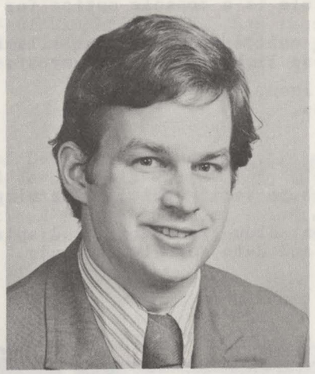
Hope we will see you at the Conference in March!

Sam McConoughey &
Gaspar Messina

AUTOMOTIVE ELECTRONICS



DATELINE: DETROIT

Bill Fleming
Automotive Electronics Editor

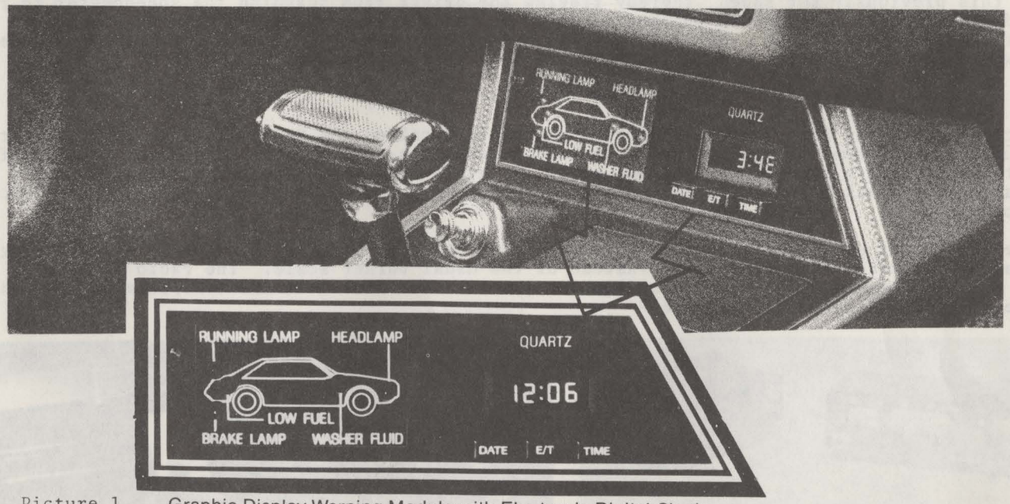
UPCOMING EVENT

By the time this Newsletter appears, the 29th Vehicular Technology Conference will have occurred. In this Conference, some four sessions have been organized, including approximately twenty papers, on the subject of automotive electronics.

Special credits are due to John Cassidy and Ed Weller of General Motors Research Laboratories, who will both be serving as session chairmen for the automotive electronics part of the VTS Conference.

PICTURE NEWSLETTER

The picture Newsletter included in our last issue seems to have worked out fairly well, so I decided to do another one. Picture Newsletter number two is seen below.



Picture 1 Graphic Display Warning Module with Electronic Digital Clock

Picture 1. Ford Motor Electrical and Electronics Division has introduced a new graphic-display warning module. The module is a console option for 1979 Mustang and Capri vehicles.

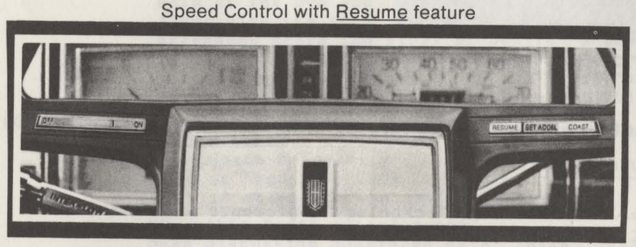
Electronic sensors trigger light-emitting diodes that illuminate appropriate parts of a vehicle silhouette display. These lights warn a driver of:

— Failure of rear running lamp,
— Failure of low beam lamps,
— Failure of brake lamps,
— Low fuel level,
— Low windshield washer fluid level.

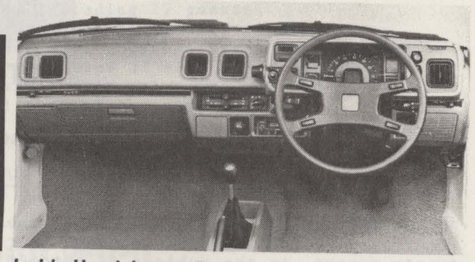
The module includes a test switch to verify that all warning lights are functioning properly.

Additionally, a vacuum fluorescent blue-green digital display shows time. A date button permits momentary display of month and date for five seconds. An E/T button provides stopwatch-like timing of trips.

Speed Control with Resume feature



Picture 2



Inside Honda's new Prelude

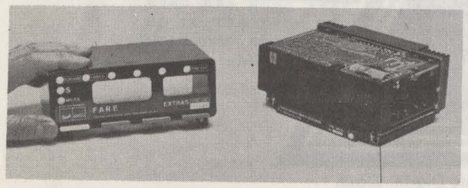
Picture 3

Picture 2. The same Ford Division has also introduced a new Speed Control option for 1979 Mustang, Capri, Fairmont, LTD, Marquis, and Zephyr vehicles.[1] As an industry first, the speed control option is available not only on vehicles equipped with automatic transmissions, but also on those with manual transmissions. In manual transmission versions, a disengage switch operates when the clutch is depressed.

This speed control features a new Resume function which remembers the last speed setting made prior to braking. When the resume switch is pushed, the vehicle automatically accelerates back to this previously set speed, thereby freeing the driver from scanning the speedometer to reset a desired speed. The Resume feature is added to the other previously available controls: On, Off, Set/Accelerate, and Coast. It is also noteworthy that while this new feature was added, new electronic circuitry reduced parts count from 105 last year to 45.[1]

Picture 3. Honda Motor has introduced a new vehicle called the Prelude. This vehicle features a unique instrument panel that has a tachometer-within-a-speedometer. Indicator needles of both readouts are mounted on the same axis. To avoid confusion, the speedometer needle is orange on a black background, while the tachometer has a green pointer on a medium grey background.[2]

The instrument panel also includes a Rotary Radio which is smaller than normal unit, having a channel-indicator readout display instead of the usual turner scale. The radio is located in a lower corner of the instrument cluster where little more than the tone/balance knob and the station indicator are visible.[2]



Picture 4

Picture 5

Picture 4. VDO-ARGO Instruments of Winchester, VA, has recently developed a solid-state taximeter. The taximeter utilizes a microprocessor to compute passenger fares and stores all its information in a memory for later retrieval. Because it is solid state, the unit also features silent operation.[3]

Picture 5. Keycon Corporation of Detroit, MI, has developed a theft-deterrent system. As the driver exits his vehicle and removes his coded card, the system automatically locks the doors, hood, trunk, and ignition, raises windows and shuts the sunroof. Upon entry, with insertion of the driver's magnetized plastic card, a computer reader verifies the card's code. If correct, the system activates relay switches to turn on the ignition and unlock other parts of the vehicle.[4]

REFERENCES

1. "Ford Motor Electronic Convenience Options (Advertisement)," Automotive News, November 27, 1978, pp. 4-5.

2. "Honda Unveils Prelude: U.S. Debut in Early '79," Automotive News, December 25, 1978, p. 3 and p. 25.

3. "VDO-ARGO Prepares Number of New Items," Automotive News, November 27, 1978, p. 39.

4. "VISA Card Won't Work on This Anti-Theft Device," Wards' Auto World, October 1978, p. 87

TRANSPORTATION SYSTEMS

Ronald Rule
Transportation Systems Editor

Don't forget the 29th Vehicular Technology Conference which will be held at the Arlington Park Hilton, Arlington Heights, Illinois (March 28, 29 and 30, 1979). There will be five Transportation System sessions:

WEDNESDAY (March 28)

Morning	Lateral and Longitudinal Considerations of Automated Highway and Guideway Vehicles
Afternoon	People Mover Programs --Present and Planned

THURSDAY (March 29)

Morning	Simulation of "Real World" Transit Systems
Afternoon	Control & Communications Systems --Part I

FRIDAY (March 30)

Morning	Control & Communications Systems --Part II

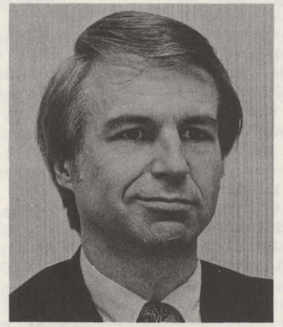
Abstracts for many of the papers to be presented are contained elsewhere in this issue of the Newsletter. The five Transportation System session chairmen have done an excellent job in organizing their respective sessions. There will be twenty-nine transportation system papers.

There will be conference participants from many companies, agencies, and institutions including:

- Messerschimitt-Bolkow-Blohm GMBH (Germany)
- Mitsubishi Electric Corp. (Japan)
- Charles Stark Draper Laboratory, Inc.
- Transportation Systems Center
- Urban Mass Transportation Administration
- Westinghouse Electric Corporation
- Boeing Aerospace Company
- Vought Corporation
- GM Transportation Systems Division
- William Brobeck & Associates
- Niigata Engineering Co., Ltd. (Japan)
- Dallas-Ft. Worth Airport Authority
- Washington Metropolitan Area Transit Authority
- Port of Seattle
- West Virginia University
- The Ohio State University
- General Railway Signal Company
- The MITRE Corporation
- N.D. Lea and Associates, Inc.
- S. and V. Company (Germany)
- Universität Carolo (Germany)
- Lawrence Berkeley Laboratory
- Robert Schaaf Engineering Consultants
- The BMD Corporation

We expect attendees from many other affiliations and believe this year's conference will be one of the best from the standpoint of technical paper content and opportunity for interaction with other people involved in development and/or application of transportation systems. Hope to see you there!

THE WASHINGTON SCENE



Eric Schimmel
Washington News Editor

RFI - THE DIRTY ACRONYM

Probably the most pervasive regulatory issue which the electronics industry will have to face during the next few years, is that of controlling the emission and reception of RF interference. The issue will be addressed not only by the FCC, but also by Congress, and probably other agencies such as the Dept. of Commerce. As the availability of radio spectrum becomes increasingly acute, the government will increase pressure on industry to eliminate any technical inefficiencies in the way products utilize that spectrum.

Another facet of this issue, will be an effort to reduce complaints of interference from the public, by controlling not only those products which radiate RF energy, but also those which are susceptible to interference because they lack adequate rejection capability. As such, this issue will be an important one to essentially the entire electronics industry, encompassing audio and video, as well as RF products.

As part of the present administration's interest in generating greater public participation in the regulatory rulemaking process, the FCC has issued a formal Notice of Inquiry on the above subject, and has formated it to elicit a broad response from industry and the public. Included are sepatate sections which pose specific questions which the FCC would like the consumer and professional communities to address. Several of these sections are reprinted for your consideration. If you fell inclined to participate in this proceeding, you must submit your comments to the FCC by May 1. You may request the entire document by refering to General Docket 78-369.

Engineering Issues

Any program adopted as result of this inquiry will succeed only if it is technically sound. Therefore, we seek answers to the questions listed below regarding the electromagnetic environment. We request information and comments to enable us to examine this problem from many views, and any responses should not be thought of as limited to these questions.

- How may we characterize the radio frequency environment? (A bulletin describing the radio environment and established "immunity grades" in Canada is attached as Appendix A. Would a similar plan serve the interest of the U.S. public? If so, to what extent?)
- Should the FCC or another agency/group have the responsibility for modeling or determining the environment?
- What types of electronic equipment should be included in any plan evolved from this inquiry?
- Should the environment be characterized differently for different types of electronic equipment?
  - how can this be accomplished?
- Is measurement of the environment necessary?
  - what should be the complexity of such measurements?
  - what methods of measurement should be considered?
  - what different measurement methods would be needed for different types of equipment?
- What measurement data are there presently available which would be appropriate to this inquiry? (Although data may already have been informally submitted to the Commission, such data should still be filed with comments to this inquiry.)
- What will be the costs of these measurements? (This should be in terms of both initial capital outlay and continuing operating costs.)
- What problems might be expected with measurement reliability and repeatability?
- What means should be used to determine the environment? What agency or group, in addition to the FCC, should be involved in the effort?
- Would severity and probability of interference be confined to certain geographic and operational areas? If so, where might these areas be?
- What types of measurement and testing procedures now exist?
- what others might be necessary?
- What special problems might be caused by the cumulative effect of many transmitter signals arriving at a single electronic device?
- What technical methods now exist to protect electronic equipment from interference?
  - can interference rejection features be maintained or improved without hindering equipment performance or future innovations?
- What are the advantages and disadvantages of requiring explicit electronic designs vs requiring explicit levels of immunity from interference?
- To what extent would designs which increase the level of immunity to interference affect other performance characteristics of electronic entertainment equipment and the possibility of future technological changes and improvements in equipment design?

Consumer Issues

The FCC recognizes the problem encountered by consumers in dealing with interference to their home electronic equipment (TVs, radios, stereos, telephone, and electronic organs, etc.). We consider it critical that consumers comment on this inquiry, and therefore, we seek answers to the following.

- How serious is the problem of interference to consumers?
- What do consumers know about the technical reasons for interference and common solutions to the problem?
- Are consumers aware that interference may be caused by deficiencies in receiver and other home entertainment design, rather than by deficiencies in transmitter design?
- What information is presently available to consumers about interference and where is it obtained?
- Is better or more technical information about interference desired by consumers?
- If so, how much are consumers willing to pay for this information?

- Can consumers or consumer groups test equipment for susceptibility to interference, and would it be feasible to devise simple tests for the consumer to do this?
- How significant a factor is interference for consumers when purchasing a TV, radio, stereo, etc.?
- Would consumers prefer:
  - Equipment manufactured to be less susceptible to interference prior to purchase, or
  - To be provided add-on filtering devices after purchase of equipment if equipment does receive interference? (It must be understood that correction after manufacturing may be more costly and may or may not be effective.)
- Would consumers be willing to accept increase costs for equipment manufactured with less susceptibility to interference?
- For consumers who have equipment already receiving interference from a transmitter (CB, Amateur, etc.), were filters added to their equipment, and if so, did the filters resolve the problem?
- Was information received on how to install filters and was it adequate?
- What information do consumers feel they need in order to make an intelligent decision about products and their potential susceptibility to interference?
- Would consumers prefer voluntary solutions from manufacturers versus government mandated solutions or no change?
- To what extent have consumers been involved in other consumer-orineted, voluntary or government programs (e.g., the labeling of the energy efficiency of air conditioners) and how successful have these programs been?

Equipment Manufacturing Issues

Manufacturers of equipment (transmitting and receiving) will clearly be involved in commenting on any decisions proposed as a result of this inquiry. Therefore, we request comments on the following questions, and any additional information pertinent to this inquiry.

- How serious do manufacturers consider radio frequency interference to home electronic equipment and is it a serious enough problem to warrant government intervention or implementation of a self-regulatory program?
- What would be advantages, disadvantages, of:
  - a government regulated program?
  - a self-regulated program?
- Should any regulatory program prescribe specific components and equipment design which would be required to be incorporated in the product to eliminate interference?
- Alternatively, should any regulatory program only prescribe general levels of immunity to interference?
- What would be the costs [7/] involved in administering:
  - a government regulated program?
  - explicit technical standards?
  - information on immunity to interference?
  - a self-regulated program?
- What would be the relationship between improved interference immunity, equipment performance and equipment costs?
- Are there any current self-regulatory programs (such as labeling) that can be adapted to the consumer electronics area? If so, how effective have these programs been?
- To what extent would government intervention affect:
  - diversity of equipment supply?
  - other aspects of the industry structure?
- What equipment design methods are currently used for providing equipment with immunity to interference?
  - to what extent are they effective?
  - what are the costs to provide this immunity?
  - are costs volume dependent or volume independent?
  - what performance features were affected if any?
- Did the market place influence the decision to incorporate immunity features and to what extent?
  - do product advertisements feature interference immunity design as a selling feature?
  - if so, does this influence consumer purchasing decisions and to what extent?
- What other measures should be taken to provide effective electromagnetic shielding?
- Would manufacturers prefer:
  - to provide consumers with adequate in-

formation about the level of immunity to interference of their equipment?

- equipment to be manufactured with less susceptibility to RF interference?
- to provide consumers with adequate add-on devices after purchase of equipment?
- What are the relative merits of design solutions incorporated at the time of manufacture versus modifications after point of sale?
- To what extent have current retrofit solutions, such as filters, been successful in eliminating interference?
- If interference immunity designs are incorporated into equipment, what performance features might suffer?
- Do manufacturers presently have any interference awareness programs?
  - general consumer awareness which might serve as a model for an interference awareness program?
  - what are costs and benefits of such consumer awareness programs?
  - If all newly manufactured electronic equipment were required to be immune to interference after some specific date, how long would it take unitl these new pieces of equipment became significantly large part of equipment in use in the market-place?