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INTRODUCTION

This annotated bibliography is the result of a literature survey conducted for the National Aeronautics and Space Administration, Lewis Research Center (NASA/LeRC) under Project 8680, Application of Advanced Signal Processing Concepts (ASPC) to Future Satellite Communications Systems.

The objective of the ASPC project is to assess the application and performance of on-board processing techniques and technology to communications satellites which will serve a wide range of users during the 1980-2000 period. As part of this study a survey of the technical literature covering on-board satellite processing and related areas was made and published as WP-21962 in October 1978. Additions to the list were made during the course of the ASPC study. This document is the complete bibliography.

Abramson, N., Packet Switching With Satellites, National Computer Conference, 1973, pp. 695-702.

Technological advantages of a packet switching system are explained and operational advantages of a public packet switched service are described.

Abramson, N., Packet Switching with Satellites, AD-761 544, University of Hawaii, NTIS, March 1973.

The beginning of the 1970's witnessed the establishment of new forms of computer-communication networks, with clear advantages over the voice oriented point-to-point, channel switched networks of the 1960's. This paper describes some of the most important properties of these new networks, packet switching, bilateral broadcasting and burst random access capabilities. The advent of easily available, inexpensive satellite communications gives added importance to these properties and promises added capabilities for computer-communications in the future. In this paper we provide a theoretical framework from which we can derive the capacity, delay and average power of these new forms of communication. Finally, we describe how these forms of communication might be employed in some of the planned U.S. domestic satellite systems to provide a public packet switched service.

Abramson, N., Satellite Packet Broadcasting to Very Small Earth Stations, TN 38-75, Defense Communications Engineering Center, September 1975.

This report analyzes the throughput of an ALOHA channel when compared to a conventional satellite point-to-point channel of the same average power. Results show that the limit of large numbers of small earth stations, the ALOHA throughput reaches 100% of the point-to-point capacity.

Abramson, N., Satellite Trends and Defense Communications, TN 20-76, Defense Communications Engineering Center, June 1976.

This report examines some of the long term trends in the economics of satellite communications networks and how these trends are reflected in the architecture of these networks. These trends are examined using data obtained from the INTELSAT series of commercial communications satellites and their effects on military satellite networks are also indicated.

Acampora, A. S., Reliability Considerations for Multiple-Spot-Beam Communication Satellites, The Bell System Technical Journal, Vol. 56, No. 4, April 1977, pp. 575-596.

Reliability considerations associated with multiple-spot-beam satellite systems are explored. If each coverage area is serviced by a single transponder, then loss of transponders due to failure eliminates all service to the areas covered by those transponders. Thus, failures are quite costly compared to a system employing global coverage with multiple transponders, where a limited number of transponder failures results in a slight increase in the traffic demand upon the survivors. Since the total orbital weight of a satellite is fixed, any redundant hardware deployed to improve reliability reduces the number of active transponders that can be supported and a highly efficient redundancy strategy must be employed. Passive standby redundancy with complete spare interconnectivity is studied and appropriate reliability formulas are derived. Finally, a specific satellite concept dominated by final power amplifier failures is studied in detail in this paper.

Acampora, A. S., and Davis, B. R., Efficient Utilization of Satellite Transponders Via Time-Division Multibeam Scanning, The Bell System Technical Journal, Vol. 57, No. 8, October 1978, pp. 2901-2914.

The space segment of a satellite system is proposed wherein a fixed number of identical transponders are shared among a larger number of spot beam regions, thereby establishing full coverage and full inconnectivity. The service is matched to the nonuniform traffic requirements exhibited among the various spot beam regions; reliability can be optimized since all transponders are identical and each transponder is utilized with an efficiency of 100%. A mathematical proof is presented which shows that the traffic can always be assigned on a nonconflicting basis and an effective assignment technique is described.

Acampora, A. S., and Gilmore, R. P., Analog Viterbi Decoding for High Speed Digital Satellite Channels, IEEE Transactions on Communications, October 1978, Volume COM-26, No. 10, pp. 1463-1470.

Analog means for implementing the Viterbi decoding algorithm at high data rates are presented. One approach employs sample-and-hold circuits and voltage adders to store and update the path metrics based upon maximum likelihood decisions. Experimental results obtained from a breadboard realization of such a decoder are reported. An alternate approach employing tapped delay lines to store the analog channel waveform is also described. Analytical results pertaining to each implementation are presented.

Acampora, A. S., and Langseth, R. E., Baseband Processing in a High Speed Burst Modem for a Satellite Switched TDMA System, presented at the Fourth International DSC Conference, 23-25 October 1978, pp. 131-138.

In this paper, designs for the transmit and receive signal processing required to implement high-speed burst modems at each ground station are presented. The main concern is to obtain designs which can be implemented with a minimum of high-speed (EU) devices so as to reduce design and hardware costs. A major consideration in the modem operation is to accurately synchronize it to a reference frame-marker broadcast by a master earth station.

Adlerstein, S., Fiber-Optic Telecom Pushing Ahead in Digital Transmission, Electronic Design 25, 6 December 1978, pp. 25-26.

The future of fiber-optics looks very bright primarily because of the decreasing cost of fiber optics and the improving reliability and performance of digital optical-fiber transmissions.

Adlerstein, S., Tele and Data Comm Advance with Digital Break-Throughs, Electronic Design 1, 4 January 1979, pp. 120-126.

This paper recognizes that new hardware, software architectures and modulation techniques are going to come together in 1979 to help satisfy the personal demands pushing data-communications systems: more capacity and higher quality channels for less money.

Aein, J. M., and Kosovych, O. S., Satellite Capacity Allocation, Proceedings of the IEEE, Vol. 65, No. 3, March 1977, pp. 332 - 342.

Several allocation strategies are investigated for sharing the satellite capacity among user communities requiring circuit-switched or store-and-forward (message switched) communication service. Teletraffic and queueing models are used to obtain analytical results by which the allocation strategies are compared. It is shown that the capacity required to provide a specific grade of service is strongly dependent upon the particular allocation strategy chosen. Therefore, an allocations strategy can be selected which requires less capacity and hence provides more efficient utilization of the satellite capacity for a specified grade of service.

Akima, H. Modulation Studies for Direct Satellite Communication of Voice Signals, OTR-76-108, PB 263 888, U. S. Department of Commerce, Office of Telecommunications, December 1976.

A study has been made on modulation aspects of direct communication of a voice signal from a satellite to individual homes for purposes of natural-disaster warning. A reasonable voice quality required at the final destination has been determined, and required radio frequency signal power at the receiver input has been estimated. Based on this result and the available UHF signal power measurement result, the system margin in the power budget has been discussed for certain system parameter values. The system margin depends on several factors and the results of this study should be useful for such a discussion. Potential use of an existing home radio and television receiver as a part of the system under consideration has been discussed. One result of this study indicates that the possibility of such a use is very remote.

Amoroso, Frank, On the Efficient Use of Voice-Channel Bandwidth in Data Transmission, IEEE Transactions on Communication Technology, Vol. COM-15, No. 5, October 1967, pp. 669-679.

Alternatives to single sideband modulation are sought for the most efficient use of the voice-band channel in data transmission. Under a certain criterion on optimum data pulses, the direct use of the passband is as efficient as the conventional use of single sideband which converts the available passband into an apparent low pass channel. With the simultaneous practical constraints of distortionless transmission, strict passband limitation, and a spectrum free of discontinuities, the principles of pulse-shaping used at lowpass are also applicable for a passband. A class of bandpass pulses is derived which achieves, in addition, a first order immunity to timing jitter in the receiver clock, an important property for multilevel PAM systems. Extension to passband is discussed for duobinary transmission.

Arnold, H. W., An Efficient Digital Satellite Technique for Serving Users of Differing Capacities, presented at the ICC '77, June 12-15, 1977, pp. 116-120.

This paper considers problems of efficiency in time-division communications satellite systems serving users with differing total capacity needs. A traffic model is used to illustrate the disparity in user sizes expected in large multi-user systems. Present time division systems are shown to use time and bandwidth inefficiently under these conditions. A method is proposed for improving this efficiency through division at the satellite of the traffic from higher-capacity users into smaller equal-capacity subchannels. After switching in the satellite, these subchannels are recombined for transmission to the higher-capacity users and sent unchanged to users of lower capacity. This technique allows full time occupancy of all channels, minimizing bandwidth and power requirements.

Balderston, J. M., Multiple Access Telephony for an Australian Satellite System, Case 33003, Report No. 6811, Australian Post Office Research Laboratories, June 1973.

Multiple access telephony is a service intermediate between high capacity trunk telephony and single channel remote subscribers telephony which can extend the coverage and flexibility of a communications satellite system. This paper discusses multiple access systems and techniques, drawing on previous studies by overseas organizations as well as calculations based on parameters which might apply to an Australian system. Topics covered include descriptions of possible multiplexing modulation, and multiple access methods, channel capacities for a number of systems, interference and network control considerations and relative costs. It is concluded that, depending on factors outside the scope of the paper, the most desirable system could be conventional FDM/FM/FDMA, a TDMA system or single channel per carrier FM or PCM.

Ralds, J. W., and Amey, Daniel I., New Chip Carrier Concepts will Impact LSI Based Designs, EDN, 20 September 1978, pp. 119-126.

This article details the effort based on a proposal by Sperry Univac to market a square format similar to the chip carrier. Some of the project's pertinent background and an update on the newest IC packaging schemes are discussed.

Barnla, J. D., and Zitzmann, F. R., Digital Communications Satellite System of SBS, EASCON '77, 26-28 September 1977, pp7-2A/9.

Satellite business systems will implement a domestic satellite system that will provide private-line switched networks for integrated voice, data and image services. The SBS system will employ all digital transmission in the 12 and 14 GHz bands. Each network will have dedicated full-period capacity for integrated services and on-demand (per call) satellite capacity for high-speed digital services. The system features five and seven meter antennas located on customer premises, demand assignment (DA), time-division multiple-access (TDMA) and two in-orbit satellites designed for space shuttle launching.

Bedrosian, Edward, Spectrum Conservation by Efficient Channel Utilization, IEEE Communications Society Magazine, March 1977, pp. 20-27.

The growth of the communication industry has resulted in ever-increasing demands on the radio spectrum. This, in turn, has spurred the exploitation of previously unused frequency bands and the development of technqiues for making better use of those already available. In this paper, spectral utilization is examined using the information-theory techniques of Shannon. The power bandwidth tradeoff for the ideal channel is established and the performance of practical analog and digital modulation techniques is compared with this ideal. It is shown that well-designed systems tend to operate near the "knee" of the power-bandwidth tradeoff curve for the ideal channel and that they are frequently within 10 dB or less of the performance of the ideal.

Beirman, Howard, Optical Communications: Seasoned Systems Complement and Compete with Microwave Methods, Microwaves, November 1978, pp. 69-75.

A staff-written report surveys advances in sources, fibers and applications and discovers some of the similarities between optical and microwave transmission systems. In the last decade, microwave and millimeter wave communication systems have reached plateaus and have become widely accepted.

Belew, W. W., et al., The Public Health Service - Communications Technology Satellite System Evaluation Plan, MTR-7463, The MITRE Corporation, December 1976.

This report presents the System Evaluation Plan for the Public Health Service Communications Technology Satellite program. The Lester Hill National Center for Biomedical Communications engaged the METREK Division of the MITRE Corporation to develop this plan to evaluate the application of broadband communications systems for the dissemination of biomedical information. The emphasis of this system evaluation is to be on a comparison of broadband systems with other systems as a means of communication for purposes of health education and research dissemination, both for use in experimentation and as possible operational delivery systems.

Benedetto, S., Bigheri, E., and Daffara, F., Performance of Multilevel Baseband Digital Systems in a Nonlinear Environment, IEEE Transactions on Communications, October 1976, pp. 1166-1175.

A good deal of effort has been spent, in the past few years, to devise numerical algorithms for evaluating the performance of digital communication systems over noisy linear channels, i.e., in the presence of inter-symbol interference and noise. This paper presents a method for computing the error probability of multilevel baseband digital modulation systems when the channel is nonlinear with memory.

Benedetto, S., et al., Performance Prediction for Digital Satellite Links - A Volterra Series Approach, presented at the Fourth International DSC Conference, 23-25 October 1978, pp. 73-80.

The aim of this paper is to present an analytical treatment for the study of digital satellite communication systems operating over a nonlinear channel. The effects of a nonlinear amplifier located in the satellite are considered in combination with those of transmitting and receiving filters located in the earth stations. In addition, both uplink and downlink noise are taken into account. The method proposed here is based on a Volterra series representation of the overall channel. This technique is applied to the prediction of the performance of a coherent PSK channel, and some numerical examples are worked out.

Berger, H. L., and Poza, H. B., Characterization of High-Rate QPSK Channel with Adaptive Equalization, IEEE Transactions on Aerospace and Electronic Systems, Vol. AES-14, No. 1, January 1978, pp. 151-157.

A computer simulation model capable of predicting the performance of a high-data-rate end-to-end communication system with adaptive equalization is described in this paper. The model is used to characterize the behavior of NASA's proposed tracking and data relay satellite system (TDRSS), while accounting for signal distortion effects due to operational conditions and the required hardware components necessary to fulfill mission objectives. Specifically, the performance of the TDRSS high-data-rate link (300 Mbps) is defined, both with and without adaptive equalization.

Berry, L. A., Output Oriented Measures of Spectrum Efficiency, Symposium Record, International Symposium on Electromagnetic Compatibility, 13-15 July 1976.

There is no generally-accepted definition of spectrum efficiency or a measure of spectrum efficiency. The CCIR has called for such a definition. Several definitions have been proposed for special cases, with more or less specificity. These have taken one of two general forms. The first is called the output/input measure and the other is the ideal/input ratio. The purpose of this paper is to argue that the output/input measure is preferable, primarily because it is more meaningful and easier to justify to non-specialists (non-engineers, non-spectrum managers). It is also easier to compute than the ideal/input ratio, and gives the same relative answer.

Berry, L. A., Probabilistic Tradeoffs for Efficient Spectrum Use with a 'CB' Example, PB-266669, Off. of Telecommun., U. S. Dept. of Commerce, April, 1977.

The aggregate statistical performance of communications systems in congested radio environments is analyzed as a function of the distribution of equipment in frequency and in space, the technical characteristics of the equipment, and the environmental effects on transmission loss and noise. All these parameters are assumed to be known (but not necessarily normal) statistical distributions and the complex interactions between them are expressed as joint and conditional probabilities. A computer program which implements the analysis is applied to a study of the Class D Citizen's Band service. The concepts of courtesy distance and operational range are defined for CB, and the quantitative increase in operational range from increased courtesy is computed. Courteous operation can double the average operational range in highly congested areas, but has little effect in lightly used channels. Curves showing channel capacity as a function of the congestion and courtesy are provided. The increase in operational range with good adjacent channel rejection by the receiver is shown for communicating on channels adjacent to heavily used channels.

Biederman, L., and Omura, J. K., The Computational Cut-Off Rate for Nonlinear ISI Channels, Presented at the NTC '77, 5-7 December 1977, pp 36.5/7.

The computational cut-off rate for a nonlinear bandlimited channel is derived. The nonlinear bandlimited channel is assumed to suffer from two independent noise sources as it occurs in satellite communication links. Expressions for the computational cut-off rates are derived for memoryless and maximum likelihood receivers. Both of the receivers are assumed to implement infinitely soft decision rules.

Bobak, E. T., and Clabaugh, R. G., NATO Phase III Satellite Design, Eascon '77, 26-28 September 1977, pp15-2A/8.

The NATO Phase III Communications satellite is a new-generation design developed to satisfy unique NATO requirements. A general overview is presented to highlight the satellite system design features and their relationship to specific NATO requirements. Following this general system a detailed description of each satellite subsystem and technical performance characteristics of selected components within each subsystems are given. The development, qualification and acceptance test programs are described, showing the scope and sequence of test activities. Following the inplant test sequence is a description of a launch trajectory and on-orbit test program. In conclusion, selected on-orbit test parameters are presented for both the NATO IIIA and IIIB spacecraft.

Bohacek, P. K., The Implementation of CCIS in the Bell System, Presented at the NTC '78, 3-6 December 1978, paper 31.1.

This paper describes the introduction of Common Channel Interoffice Signaling (CCIS) into the Direct Distance Dialing (DDD) network. It covers the philosophy of the introduction of CCIS and describes the major changes that were made to various toll switching systems. The penetration of CCIS has begun the evolution of the network to the Stored Program Controlled network which will make many new features and services possible.

Bouttiaux, B., et al., Ultra High Speed Components for Microwave Modulators, 7th European Microwave Conference (MICROWAVE '77), 5-8 September 1977.

The study of conductance variation is carried out in the first part of this work. First, an analytical approach is given to bring out the main physical mechanisms which occur in the active layer of the semiconducting structure: velocity/field effects, space charge effects, microwave injection and transit-time effects. A computer simulation is used to obtain the conductance evolution versus the bias voltage and to study the transient response of the component. Then, some theoretical predictions and experimental results are compared. In the second part of this work, experimental realizations of a microwave modulator have been carried out with silicon N+ N N+ components and the validity of the theory and the shortness of switching times are shown.

Bordelon, D. L., On Signal Design by the Ro Criterion for Non-White Gaussian Noise Channels, Presented at the NTC '77, December 5-7, 1977.

The use of the Ro criterion for modulation system design is investigated for channels with non-white Gaussian noise. A signal space representation of the waveform channel is developed, and the cut-off rate Ro for vector channels with additive non-white Gaussian noise and unquantized demodulation is derived. When the signal input to the channel is a continuous random vector, maximization of Ro with constrained average signal energy leads to water-filling interpretation of optimal energy distribution in signal space.

Bostian, C. W., et al., The VPI & SU ATS-6 20 GHz Depolarization Experiment, NAS 5-21984, September 1975.

This report describes a depolarization experiment using the 20 GHz downlink from the satellite ATS-6. Its contents include: (1) an operational summary of the experiment, (2) a description of the equipment used with emphasis on improvements made in the ATS-5 signal processing receiver, (3) data on depolarization and attenuation in one snow storm and two rain storms at 45 degrees elevation, (4) data on low angle propagation, (5) conclusions about depolarization on satellite paths, and (6) recommendations for the depolarization portion of the CTS experiment.

Brandinger, P. E., 20-30 GHz Communication Satellite Systems Design, presented at the ICC '78, June 4-7, 1978.

This paper has expanded the issues and system design impacts of satellite communications operation at 30/20 GHz. Areas of prime tradeoffs have been identified, and propagation/frequency dominated aspects of typical system architectures are considered. Those concepts most applicable to satellite communication systems which operate at or above 30/20 GHz are described.

Bridwell, J. D., and Richer, I., A Preliminary Design of a TDMA System for FLEETSAT, Technical Note 1978-2, Lincoln Laboratory, M.I.T., 12 March 1978.

A typical UHF FLEETSAT channel is capable of supporting data rates in excess of 50 kbps. Since the data rate of typical beyond line of sight Navy communications is 2.4 kbps, the data from several users could be multiplexed on a single FLEETSAT channel. The time division multiplexing scheme described in this note would derive about 65 simultaneous 2.4 kbps circuits from the nine 25 kHz channels for a representative mixture of ships, aircraft, submarines, and shore stations. The available circuits would be shared among a much larger pool of users by demand assignment. The system utilizes a central controller to allocate satellite resources, achieving rapid circuit assignments and preemptions with relatively high efficiency. Also described is a preliminary architecture for new equipment which would interface with existing Navy equipment and would perform demand assignment and time division multiplexing functions.

Brown, K. E., and Nyspl, P. P., Early Operational Experience with a New TDMA Synchronization System Through CTS, CRC Technical Note 682, October 1976.

A unique TDMA concept is described. The implementation of the concept as an experimental package on the Communications Technology Satellite (CTS) is briefly discussed. Early operational experience at IF and RF is presented. Centralized synchronization and ranging is demonstrated as feasible. Tests are on-going and the final results will be reported in the literature.

Buie, J. L., LSI Implementation, Final Report, AFAL-TR-77-261, TRW Defense and Space Systems, December 1977.

This program emphasizes practical hardware objectives in LSI form for implementing digital filters as a general class of applications and the FFT algorithm as a specific application. Three LSI chip designs were completed, the SPAV for signal processing arithmetic unit, the SPDL for signal processing delay line and the SPAC for signal processing address control. The most comprehensive design, the SPAV, went through two design iterations and the final version has achieved a high degree of acceptance for general filter processing applications. Twenty-five chips each of the SPAV and SPAC designs were delivered. Fifty units of the SPDL were delivered as well as hardware samples of work in progress from time to time. Insofar as practical, universal designs were sought and believed achieved, particularly in the SPAV. Based on comparative studies of these implementations and SSI/MSI/LSI alternatives, a large saving in board space, power and interconnections results from using these generic type LSI chips developed by this program.

Burtt, J. E., et al.,Technology Requirements for Communication Satellites in the 1980's Final Report, NAS2-7073, September 1973.

This report defines the key technology requirements for meeting the forecasted demands for communication satellite services in the 1985 to 1995 time frame. Evaluation is made of needs for services and technical and functional requirements for providing services. The future growth capabilities of the terrestrial telephone network, cable television and satellite networks are forecast. The impact of spacecraft technology and booster performance and costs upon communication satellite costs are analyzed. Systems analysis techniques are used to determine functional requirements and the sensitivities of technology improvements for reducing the costs of meeting requirements. Recommended development plans and funding levels are presented as well as the possible cost saving for communications satellites in the post 1985 era.

Caldecott, R., Multifunction TDMA Techniques - Final Technical Report, RADC-TR-76-225, August 1976.

This report presents a background discussion and general overview of the design of prototype equipment fabricated to demonstrate the feasibility of TDMA systems. Problems and options associated with the design of the equipment consisting of prototype TDMA modems and a satellite simulator which employs an adaptive null-steering array (ANSA) are presented in varying degrees of detail. Also, potential applications are identified and discussed briefly. As a result of the work performed during this contract it has been possible to definitely establish that TDMA and ANSA techniques are practical means for improving the efficiency and capability of satellite relay communications systems.

Campanella, S. J., Assal, F., and Berman, A., On-Board Regenerative Repeater, ICC '77, June 12-15, 1977.

This paper addresses the use of regenerative repeaters implemented as part of the satellite transponder system. This configuration is shown to significantly enhance the satellite performance in terms of the energy-per-bit-to-noise ratios required on both the up- and downlinks; consequently, it will reduce the amount of power needed in the earth station and satellite to achieve a given link performance goal.

Capetanakis, J. I., The Multiple Access Broadcast Channel: Protocol and Capacity Considerations, Ph.D. Thesis, MIT, August 1977.

The multi-accessing of a broadcast communication channel by independent sources is considered. Present accessing techniques suffer from long message delays, low throughput and/or congestion instabilities. The objective of this research, therefore, is to develop and analyze high speed, high throughput, stable, multi-accessing algorithms. Contention resolving tree algorithms are introduced, and they are analyzed for specific probabilistic source models. It is shown that these algorithms are stable (in that all moments of delay exist) and are optimal in certain sense. Furthermore, they have a maximum throughput of .430 packets/slot and have good delay properties. It is also shown that under heavy traffic, the optimally controlled tree algorithm adaptively changes to the conventional TDMA protocol. Our work is directly applicable to packet switching broadcast networks, in which packets might contain data from such sources as computer, teletype terminals and vocoders. However, our results may also apply to more general systems, in which a central facility is accessible by a number of independent users. If the number of users that can be serviced simultaneously is less than the number that can demand service, the techniques developed here can be used to resolve the resulting contentions.

Castagne', R., et al., Subnanosecond Operation of a Microstrip Optoelectric Switch, Presented at the 7th European Microwave Conference (Microwave -77), 5-8 September 1977, page 522.

Experimental results and a theoretical model concerning optoelectric switches are reported. These devices mainly consist of a microstrip line, deposited on a high resistivity semiconductor. The upper layer generates an electron hole plasma of high density near the semiconductor surface allowing the signal transmission across the gap.

Caughlin, J.B., et al., Circuit Techniques for Gigabit/s Digital Communication Systems, 7th European Microwave Conference (MICROWAVE '77), 5-8 September 1977.

This paper describes how monolithically integrated transistor pairs are used as hybrid circuit components to produce Gbit/s performance in digital communications equipment. The transistor technology results in a peak fT of 5GHz and includes gold beam-leads for easy circuit assembly. When used as current mode switches the pairs exhibit propagation delays and edge times of 350 ps. The circuit technique is demonstrated in a number of key functions for regenerative repeaters and terminal/test equipment. These include clock extraction (phase detector), data regeneration (decision flip-flop), and multiplexing, all performing at 1 Gbit/s. The multiplex is used to serialize four lower speed data streams generated from a commercially available logic family and it is concluded that a new Gbit/s logic family may be unnecessary for this application.

Chakraborty, D., et al., Digital Modem Design for Nonlinear Satellite Channels, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 123-130.

This paper addresses the elements affecting the degradations associated with high-speed 4 phase PSK signals transmitted through a band limited nonlinear satellite environment with more than one nonlinear element in tandem. Optimization of modem design in a nonlinear environment includes the following strategies: selection of an optimum modulation format (e.g., QPSK, OQPSK and MSK) for a given band limited constraint selection of a channel filter combination for the optimum modulation format, sensitivity of synchronization loops in a nonlinear environment, optimization of the power-bandwidth tradeoff and operating points of the nonlinear elements for a given class of satellite link, and finally a feasibility study of adaptive equalization in a nonlinear environment.

Christopher, J. and Greenspan, D., RCA Satcom Communication Systems, RCA Comm. Inc., EASCON '77, 26-28 September 1977, pp7-4A/5.

RCA American Communications has introduced a number of innovative domestic satellite communication services increasing versatility and bring down the cost of long-haul message and broadcast transmission facilities. This was made possible to a great extent by a number of forward-looking system design descisions which included the first commercially-funded development of an advanced launch vehicle and the first launch of a 24-transponder frequency reuse satellite. This paper summarizes the current mix of RCA Satcom Communication services and systems and discusses some of the highlights of the spacecraft and launch vehicle.

Ciesluk, W. J., Advanced Satellite Repeater Techniques for Nets Comprising Different Terminal Classes, MTP-132, The MITRE Corporation, September 1971.

This paper considers advanced satellite repeater techniques and evaluates their suitability for achieving net control in an interference environment, intentional or otherwise. Techniques such as channelization, steerable narrowbeam antennas and satellite borne signal processing are examined for both SHF and UHF frequency alternatives. The results quantify the trade-offs which can be made in defining advanced communication satellite systems and are extensive enough for evaluation of a large class of satellite communication links.

Common Channel Interoffice Signaling, The Bell System Technical Journal, Vol. 57, No. 2, February 1978, pp. 221-478.

This issue of the Bell System Technical Journal is devoted to Common Channel Interoffice Signaling (CCIS). This is a new interoffice signaling system which was introduced into the Bell System's Direct Distance Dialing (DDD) toll network. It represents a major step forward in signaling systems by providing high speed data links between processors of stored-program-controlled switching offices to carry signaling independent of the communication paths used by customers. As CCIS implementation proceeds it will have an expanding and significant impact on DDD network system performance due to improved speed of signaling and provision of signals to provide a multitude of new network and customer services.

Computer Sciences Corporation, Mobile Terminal Access to the Advanced Command-Control Architectural Test Bed Final Report, N000-39-75-C-0289, May 1976.

The purpose of this report is to define the means for incorporating a mobile terminal into the Advanced Command-Control Architectural Test Bed (herein referred to as the C^2 Test Bed) using the existing capabilities of the Naval Telecommunications System (NTS) and ARPANET.

Computer Science Corporation, Satellite Communications Reference Data Handbook, DCA 100-72-C-0002, Defense Communications Agency, July 1972.

This document provides a general survey of the background and present status of the satellite communications field in general and of Defense Satellite Communications Systems (DSCS) in particular. The main body of the report provides general and technical data on the major subsystems of a satellite communications network. The orbital characteristics of the spacecraft and the performance characteristics of the satellite transponder are explained. The characteristics of earth terminal receivers and transmitters are also covered. An explanation of the basic principles of multiplex, modulation, coding and multiple access techniques is provided and applied to satellite communications. The basic parameters and essential formulas for understanding the analysis and engineering of satellite links and system follows. A series of appendices provides reference data directly relating to the DSCS. This includes descriptions of DSCS Phase I and II satellites, of various DSCS earth terminals (on hard and under development) and a description of the past, present and proposed phases of the DSCS. Also provided is data on future trends in the satellite communications field and numerous nornographs and tables that are helpful in analyzing satellite communications engineering problems.

Cook, C. E., Linear FM Signal Formats for Beacon and Communications Systems, IEEE Transactions on Aerospace and Electronic Systems, AES-10, No. 4, July 1974, pp. 471-478.

This paper examines the capabilities of the class of linear FM spread-spectrum signals within the context of potential communications systems usage in order to establish some performance criteria and bounds that permit comparison with other spread spectrum formats. A systematic basis is provided for parameter selection for this class of signals by examining the interaction among the frequency-modulation indices, time-bandwidth product, and cross-talk criteria that determine the number of effective linear FM signals (or channels) that can be used within the constraints of a bounded time frequency region. A general expression is derived relating N, the number of useful signals, R^2, a cross-talk parameter, ToWo, the mean time-bandwidth product and umax, and umin, the maximum and minimum FM rates of the signal set. Canonic signal processor structures are described for ensembles of linear FM signals that have either constant duration or constant bandwidth. It is then shown that the signal modulation format can be modified in accordance with classical paired-echo theory to expand the utility of this class of signals in both synchronous and nonsynchronous operations to yield the equivalent of time-division and code multiplexing. Possible application for this signal format is discussed.

Cooperman, R., and Dobyns, T., A Distribution Control Unit for Satellite Switched Communications, presented at the International Telemetering Conference, October 10-12, 1972, pp. 26-31.

The next generation of commercial communications satellites strongly indicate the desirability of using highly directive multibeam antennas to increase channel capacity. This antenna configuration allows multiple access via space division and frequency sharing through the isolation inherent in the directive multi-beam antenna. Coupling this technique with a satellite-borne programmable communications distribution subsystem results in a highly efficient system.

Coughlin, J. B., Circuit Techniques for Gigabit/s Digital Communication Systems, Presented at the 7th European Microwave Conference, (MICROWAVE-77), 5-8 September 1977, pp. 532-536.

This paper describes how monolithically integrated transistor pairs are used as hybrid circuit components to produce Gbit/s performance in digital communications equipment. The transistor technology results in a peak fT of 5 GHz and includes gold beam-leads for easy circuit assembly. When used as current mode switches the pairs exhibit propagation delays and edge times of 350 ps. The circuit technique is demonstrated in a number of key functions for regenerative repeaters and terminal/test equipment. These include clock extraction (phase detector), data regeneration (decision flip-flop), and multiplexing, all performing at 1 Gbit/s. The multiplexer is used to serialize four lower speed data streams generated from a commercially available logic family and it is concluded that a new Gbit/s logic family may be unnecessary for this application.

Crane, Robert K., Prediction of the Effects of Rain on Satellite Communication Systems, Proceedings of the IEEE, Vol. 65, No. 3, March 1977, pp. 456-474.

The major propagation effects for satellite communication systems operating above 4 GHz are caused by rain. With the possible exceptions of depolarization and multiple scattering at frequencies above 20 GHz these effects may be calculated if the distribution of rain intensity is known in both time and space. The major effects - attenuation and interference - require information about path and volume averaged rain intensities. Current prediction models are not capable of adequately estimating the statistical distributions of path and volume averaged values. Radar observations could provide the required data. The best information currently available for modeling these distributions are statistical cell or storm models derived from radar observations.

Cuccia, C. L., Communications Satellite Technologies in the Early Twenty-First-Century - A Projection into the Post Intelsat-V Era, IAF-77-34, Ford Aerospace and Communications Corporation, International Astronautical Federation, Sept. 25 - Oct. 1, 1977.

This paper discusses a multiple beam antenna satellite system using baseband switching and demodulations and remodulation technologies which will make these satellite concepts possible in the time scale. It presents candidate designs for large multiple beam satellites which can be assembled in space, and points up unique advantages of very large parabolic antennas in multiple-beam, multiple-horn systems which achieve required beam EIRP by use of gain achieved by use of large antenna structures, rather than the development of on-board high transmitter power as originally pointed out by Morgan and Podraczky of Comsat. The designs of these high capacity satellites are evolved from current projections of both international and domestic traffic and communication systems and include critical aspects of spectrum conservation.

Cuccia, C. L., Modern Transponder Technology for Baseline Designs of Data Processing and Switching Communication Satellites, IAF-76-190, Aeronutronic-Ford, IAF, Oct 10-16, 1976.

Heavy route communication satellites for the 1980's will employ spot-beam downlinks to key communications switching centers and will process and route information transmitted uplink onboard the satellite to the antennas for transmission to various destinations. Such a satellite will function as a "switch board in the sky" and will primarily use time-multiplexed signal techniques such as TDMA in combination with switch transponders or switched beams to perform the routine functions. Many concepts have been developed during the last decade for ways that a SS-TDMA satellite can be switched, including onboard translation, onboard regeneration and store and forward modes of operation. This paper will review the types of SS-TDMA switching satellite systems proposed and the new component technologies which can now make these satellites technologically possible.

Davies, R. S., Use of a Processing Satellite for Digital Data Transmission Between Low Cost Earth Terminals, Ford Aerospace and Communications Corporation, 1977.

When considering the cost of implementing a communication satellite system employing thousands of user terminals, it makes sense to look at configurations where the user terminal is extremely simple, low cost and easy to operate, even at the expense of making the satellite more complicated. Predicted advances in technology make possible the realization of practical satellite designs where data is demodulated, processed and retransmitted to ground. The impact of this new satellite technology on packet communication systems is discussed.

Deal, Joseph H., Study of Functional Requirements for Demand Assigned SHF TDMA Modems, DAAB 07-74-C-0204, Communications Satellite Corporation, May 1975.

The objective of this paper is to establish the operational requirements and to perform a system trade-off analysis to determine the characteristics of a demand-assigned SHF time-division multiple-access (TDMA) modem. This introduction presents a statement of the problem, a discussion of the method of approach and an outline of the organization of the report.

Deal, Joseph, et al., A Demand Assignment Time Division Multiple Access System for Military Tactical Application, presented at the ICC '77 June 12-15, 1977.

Demand-assignment time-division multiple-access (DA-TDMA) offers distinct advantages in terms of traffic capacity and network flexibility that make it a prime candidate for application to tactical military communications. In particular, a single-channel-per-burst (SCPB) DA-TDMA system is compatible with both the tactical communications requirements and the tactical satellite communications systems. This paper describes the capacity modulation and coding schemes, frame and burst formats, data buffering timing and control, and synchronization methods of a candidate DA-TDMA system.

Dehart, W. D., Advanced Concepts for Satellite Communications Systems, paper no. 70-491, presented at the AIAA 3rd CSS Conference, April 6-8, 1970.

This paper examines system concepts made possible by the use of digital techniques in communications satellites. The question posed is, "What are the satellite communications needs of the future and what should the technical features of future satellite systems be in order to meet these needs?" The approach employed to answering this question is to postulate a generalized system requirements model assumed valid for the 1975 through 1980 time frame and examine certain advanced concepts against these requirements. Advanced concepts are defined technically in terms of the amount of change introduced to a system and the effects of these changes. Time division multiple access, narrow steerable beam antennas and satellite-to-satellite communications are assumed to be established technology, as a result of presently scheduled R&D. The paper concludes with suggested guidelines for technology development that will improve satellite communications.

DeRosa, J. K., Control in a Demodulating Satellite with FDMA Uplinks and TDM Downlinks, Lincoln Laboratory, Draft 1, 25 April 1977.

This paper discusses some general control aspects associated with a proposed GPSCS (General Purpose Satellite Communications System) architecture. The system is characterized by the following properties: About 100 FDMA UHF uplinks; SHF to UHF crossbanding; frequency hopped uplinks; on-board dehopping, nulling and demodulation; and a few TDM downlinks. The control aspects to be highlighted deal with Satellite Control, Communications Control and Network Control.

DeRosa, J. K., Packet Switching in a Processing Satellite, IEEE Proceedings, Vol. 66, No. 1, January 1978, pp. 100-102.

This brief note represents a simple but significant change in the thinking that is applied to satellite packet switching. It demonstrates that in a processing satellite there is no fundamental limitation to the efficiency and throughput of packet switching systems. With a minimal impact on spacecraft weight and power, throughput is increased by providing more capacity on the uplink than on the downlink. Efficiency is increased because the power-intensive downlink is more fully utilized. A slotted ALOHA example is given to show how the performance can be made to go from that of conventional slotted ALOHA to that of a TDM system. Several possible variations and far-reaching implications are indicated.

DeRosa, J. K., A Digital Processing Satellite for Widely Disseminated Telecommunications, Proceedings First International Telecommunications Exposition, Atlanta, Georgia, 9-15 October 1977.

This paper discusses some future possibilities in telecommunications systems with a large number of small, inexpensive terminals and a digital processing satellite. The logic for the choice of system architecture is carefully outlined with attention focused on the features of on-board digital processing. Consideration is given to circuit, packet and beam switching with a satellite-based micro-computer shown as the central communications control element. Technical details are minimized although recent results in bandwidth-efficient modulation and packet switching through a processing satellite are indicated.

Despain, A. M., Fourier Transform Computers Using CORDIC Iterations, IEEE Transactions on Computers, Vol. C-23, No. 10, October 1974, pp. 993-1001.

The CORDIC iteration is applied to several Fourier transform algorithms. The number of operations is found as a function of transform method and radix representation. Using these representations, several hardware configurations are examined for cost, speed and complexity tradeoffs. A new especially attractive FFT computer architecture is presented as an example of the utility of this technique. Compensated and modified CORDIC algorithms are also developed.

Dicks, J. L., Design Options for Future Communications Satellites, presented at the International Telemtering Conference, October 10-12, 1972, pp. 880-894.

In this paper, the INTELSAT global system of communications satellites network is examined with a view to determining those technical factors that impact on the design options of communications satellites of the future. The factors and trends expected to influence future satellite designs and configurations are discussed.

Dicks, J. L., and Brown, M. P., Jr., Frequency Division Multiple Access (FDMA) for Satellite Communication Systems, Eascon 74, pp. 167-178.

Many methods of multiple access have been proposed for satellite communications. However, the primary mode found in existing systems such as INTELSAT, TELESAT, DCSC and Molniya/Orbita is FDMA. This paper discusses the basic engineering fundamentals of FDMA, its attributes and problems and specific examples of its application. Both multichannel and single-channel-per-carrier (SCPC) systems are described. Comments on future trends are also provided.

Dicks, J. L., et al., Systems Planning, INTELSAT IV Communications Systems, Comsat Technical Review, Vol. 2, No. 2, Fall 1972.

This section describes the considerations that led to the choice of many of the characters which were introduced into the satellite specification.

DiFonso, D. F., Trachtman, W. S., and Williams, A. E., Adaptive Polarization Control for Satellite Frequency Reuse Systems, Comsat Technical Review, Vol. 66, No. 2, Fall 1976, pp. 253-83.

This paper describes networks for the adaptive restoration of polarization orthogonality. These networks may be used to minimize the mutual interference of a dual-polarized satellite communications link operating in the presence of a depolarizing medium. For a properly designed system, the time-varying depolarization due to a variety of sources may necessitate adaptive network control. As described herein, the circuits to accomplish this objective are based on the assumption that the error voltages for adaptive control are derived from narrowband pilot signals provided within the communications spectrum. In general, four control parameters are required to achieve orthogonality correction, but when differential attenuation may be neglected, a suboptimal control system employing two control parameters leads to a simple and attractive solution.

Dill, G. D., Comparison of Circuit Call Capacity of Demand Assignment and Preassignment Operation, COMSAT Technical Review, V.2, No. 1, Spring, 1972.

A model of the traffic handling of low-density telecommunication trunks is developed. This model is used to derive the relative improvement to be gained on the terrestrial access circuits and in the satellite transponders by using fully variable destination demand-assigned circuits to service the low-density links. The Atlantic Ocean region traffic for the second quarter of 1971 is used to evaluate the model.

Dill, G. D., TDMA, the State-of-the-Art, Eascon '77, 26-28 September 1977, pp.31-5A/9.

Since its initial development, significant advances have been made in the state-of-the-art of time-division multiple access (TDMA), primarily in the areas of acquisition and synchronization, modulation transmission link encoding, baseband processing and implementation techniques. These advances have resulted in an improved capability as well as lower implementation costs. Consequently, TDMA is now being implemented in operational communications satellite system. This paper summarizes the state-of-the-art of selected TDMA subsystem developments.

Dill, G. D., and Ali, Z. M., Application of Transmultiplexers at Satellite Earth Stations, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 225-230.

Interconnection between digital and analog telecommunications systems can be accomplished at baseband by using the standard D-3 or CEPT channel banks. The conversion at the voice frequency level has several advantages; e.g., channel dropping, adding, or reordering, companding, channel interpolation, and channel test and calibration can be performed easily. However, conversion to baseband is not always cost effective. In many cases, a direct individual channel analog-to-digital conversion of a multiple channel transmission carrier is desirable. Therefore, COMSAT Laboratories has initiated a project and successfully developed a transmultiplexer which directly converts between a 60-channel frequency-division-multiplexed supergroup and 60 individual 8-bit PCM, time-division-multiplexed channels. This paper describes the design and applications of the COMSAT transmultiplexer.

Dill, G. D., Tsuji, Y. and Muratani, T., Application of SS-TDMA in a Channelized Satellite, IEEE International Conference on Communication 1976, pp. 51-1 - 51-5

International telecommunication satellite systems have experienced a rapid growth over the past 10 years and are expected to continue to grow at a rapid rate over the next 10 years. To fulfill their future needs, new modulation and multiple-access techniques are being considered to meet the projected channel requirements beyond 1986. The use of a new more efficient modulation and multiple-access method has been suggested. This paper presents a hypothetical case for the introduction of SS-TDMA into the INTELSAT Atlantic region. The time of introduction, suggested transponder loading, and SS-TDMA switch sequences, as well as the number of channels requiring conversion to TDMA and the number of TDMA terminals required per year, are indicated.

Dill, G. D., et al., Simulated SS-TDMA System Test Results, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 175-179.

A simulated SS-TDMA system test was conducted via satellite to evaluate the synchronization accuracy that could be achieved. This test, which used existing hardware, confirmed that SS-TDMA can be reliably and efficiently operated in future satellite networks. This paper describes the system configuration used and the performance achieved.

Dintelmann, F., and Rucker, F., Analysis of an XPD Event at 30 GHz Measured with ATS-6, Proceedings of IEEE, Vol. 65, No. 3, March 1977, pp. 477-479.

Power level and phase difference of two linearly polarized wanted and unwanted, 30 GHz signals transmitted by ATS-6 during its European campaign are measured. The analysis of a cross-polar discrimination (XPD) event reveals the possibility of improving XPD by a simple retation of the feed system. The procedure applied could be self-adaptive where the phase difference between both components could serve as the variable criterion.

Dinwiddy, S. E., A Simple TDMA System for Satellite Data Communications Networks, European Space Agency, Noordwijk, Holland, pp. 378-384.

A simple TDMA system is proposed for use in digital data networks which would use a much longer time frame than that required for a digital telephony network. This allows a long guard time between earth station transmissions, which simplifies considerably the acquisition and synchronization equipment in the TDMA terminals. TDMA enables the network to contain channels of different and even variable capacities and also enables groups of users to operate either independently or to share communications capacity. TDMA thus provides the maximum flexibility for allocating network capacity.

Dobson, D. P., and Ring, A. E., An LSI Controller for Satellite Switched TDMA, Hawker Siddeley Dynamics Limited, Stevenage, U.K., 1976, pp. 56-70.

Satellite-switched time division multiple access (SSTDMA) is a high efficiency technique likely to be exploited soon in communications satellites. Besides needing special equipment at the earth stations, two major units are required in the satellite to complete the system, namely, a microwave switching matrix (MSM) and a distribution control unit (DCU). The MSM connects any one uplink to any one downlink in a "telephone exchange" arrangement and the DCU, which can be programmed from the ground, controls the switching of the MSM connection patterns in real time. The DCU also provides the master clock for the complete SSTDMA system. This paper describes an implementation of a DCU using custom large scale integration (LSI), which employs only four chips (two each of two types) for the entire logic to control an 8 x 8 MSM. This offers considerable advantages in terms of mass, power consumption and reliability. Some of the benefits and problems of the LSI implementation are also discussed.

Dostis, I., et al., In-Orbit Testing of Communications Satellites, Comsat Technical Review, Vol. 7, No. 1, Spring 1977, pp. 197-226.

This paper describes the techniques that have been developed and applied by the Communications Satellite Corporation to in-orbit testing of communications satellites. As the spacecraft complexity has increased over the years, the scope of the in-orbit tests has expanded significantly and the present in-orbit test techniques have evolved from relatively simple evaluations to sophisticated measurements of satellite performance. The increased test requirements for the recent INTELSAT IV-A and COMSTAR spacecraft, with their complex antenna and transponder configurations, have led, in an effort to minimize satellite test time, to the development of the semi-automated test setup described in this paper. The specific measurements described are flux density for saturation, spacecraft, EIRP, antenna patterns, beam isolation, gain transfer characteristics, gain-to-noise temperature ratio, receiver local oscillator frequencies, traveling wave tube turn-on transients, in-band and out-band frequency response and cross polarization.

Douville, R. J., A 12 GHz Low Cost Earth Terminal for Direct TV Reception from Broadcast Satellites, IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-25, No. 12, December 1977, pp. 1000-1008.

A low-cost 12-GHz receiver for TV reception from high-power broadcast satellites is described. System designs using 0.6 and 1.2m parabolic dishes with high-efficiency Cassegrain and prime-focus feed configurations have been studied. The front end consists of an MIC image enhanced muxer, 1.2 GHz low-noise amplifier and a Gunn diode LO. The signal is then fed to an indoor unit which has been designed using both surface acoustic wave (SAW) and lumped element 70 MHz bandpass filters and demodulators. Audio and video receiver outputs are fed directly to the baseband circuitry of a standard receiver.

Drouilhet, P. R. Jr., and Bernstein, S. L., TATS - A Bandspread Modulation-Demodulation System for Multiple Access Tactical Satellite Communication, EASCON '69 Record, pp. 126-132.

TATS, a modulation-demodulation system for multiple access tactical stellite communication, is described. The modem utilizes coded MFSK message modulation and frequency-hopping for frequency diversity. The performance of the modem has been analyzed and measured in an extensive laboratory and field test program. Multiple access performance over channels disturbed by Gaussian noise, multipath propagation and RFI is discussed. It was found that interference to a TATS link caused by a large number of other users is approximately equivalent to that caused by Gaussian noise of the same power.

Eckhart, V.G., et. al., A Flexible TDMA System for 100/50 Mbit/s, FTD-HT-23-1564-72, Foreign Technology Division, AFSC, 24 Nov. 1976.

A TDMA system with a capacity of 100/50 Mbit/s developed in Germany is presented. With 25 accesses to the satellite transponder and 8 bit PCM encoding of speech samples the system provides for about 1350 speech channels (100 Mbit/s version) or for about 600 speech channels (50 Mbit/s version). The system allows for direction variable speech circuits and channel capacity per earth station can be adopted automatically on a demand assigned basis. The establishment of fairwire circuits required and the necessary switching function are performed in the time domain. The 100 Mbit/s version is provided for the experimental German-French communication satellite Symphonie. The 50 Mbit/s version is provided for a field trial with Intelsat III satellites using its television channel.

Eavens, H. W., Technical Background of the AT&T Domestic Satellite Proposal, Paper No. 68-411, Bell Telephone Laboratories, AIAA C.S.S. Conference, April 8-10, 1968.

Communication satellite systems must meet simultaneously several sets of diverse requirements. Their capacity must be appropriate to their era, neither so small as to be trivial nor so large as to be unsalable. They must conserve the frequency spectrum and the stationary orbit, yet compete with a well established terrestrial network. They may pioneer new frequency bands, but the risk of poor performance must be minimized. This paper describes and demonstrates how these factors were addressed in a communication satellite system designed in 1966.

Edelson, B. I., Satellite Communications Technology, The Journal of Astronautical Sciences, Vol. 24, No. 3, July - September 1976, pp. 193-219.

The historical basis for today's communications satellite systems is reviewed briefly to show how technology has developed in the global system. Traffic demands have required an ever increasing investment in space and ground equipment. This has been accompanied by substantial reduction (over 70%) in the charges for international telecommunications circuits. Three generations of earth stations are discussed and the form of future stations is explored. Experiments being conducted today give a preview of future satellite telecommunications. In particular, higher frequencies, frequency reuse, spot beams and digital and time-division techniques are discussed as important emerging communications methods. In the spacecraft area improved methods of generating and storing electrical power and electric propulsion are examined. New service offerings (maritime, remote printing, disaster services and digital and unattended highly reliable earth terminals) are reviewed. Future applications include direct satellite to user services, data collection and intersystem satellite links.

Edelson, B. I., and Pollach, L., Satellite Communications, Science, Vol. 195, No. 4283, 18 March 1977, pp. 1125-33.

This paper describes the advances in electronic technology which have contributed to growth in satellite communications.

Eng, K. Y., and Hecht, M., Switch Matrix for TWTA Redundancy on Communication Satellites, Presented at the NTC '78, 3-6 December 1978, paper 40.5.

In this paper, various aspects of implementing switch matrices for TWTA redundancy have been studied. The spacecraft design constraints and reliability considerations often determine the primary configuration for which a switch network has to be designed. The specifics of designing a switch network have been studied using elementary graph theory. Some interesting rules have also been stated, but the general problem for a minimum solution remains unsolved.

Evans, R. O., Computer Technology Trends and Applications - Briefing Charts, presented at the Executive Seminar on the Impact of Current Trends in Computer/Communications Technology, 30 January 1978.

This document contains a set of briefing charts dealing with trends in computer technology.

Feinler, E., and Dustel, J., ARPANET Protocol Handbook, NIC-714-Rev-2, January 1978.

The ARPANET Protocol Handbook is a collection of documents that describe the protocols currently in use on the ARPANET Computer Network as of January 1978. Protocols are the rules of communication between processes on the network. The protocols in use on the ARPANET form a tree structure. The basic protocol is the IMP-to-Host protocol. Directly under that is the Host-to-Host protocol. Spreading out beneath, but still closely related are the process level protocols: TENLET File Transfer Remote Job Entry, and Graphics. Interspersed along the way are a few small protocols such as the Initial Connection Protocol, and the definition of the standard character set.

Fletcher, J. G., Serial Communication Protocol Simplifies Data Transmision and Verification, Computer Design, July 1978, pp. 77-86.

A simple, easily-implemented protocol has been designed to detect and correct noise-induced errors in a bit-serial link, and to hold transmissions at a rate acceptable to the receiver.

Ford Aerospace & Communications Corporation, INTELSAT V and Beyond, January 1978

INTELSAT V, the most complex communications satellite built for the International Telecommunications Satellite Organization (INTELSAT), provides almost three times as much communication capability as its predecessor. Now that the design has matured, most of the risk element has been eliminated and the impact of new technologies can be more fully appreciated, it is time to look into the future and see what additional capabilities can be incorporated with minimal effort.

Freking, R. F., Enhanced Signaling for New Customer Services and Network Features, Presented at the NTC '78, 3-6 December 1978, paper no. 31.2.

The method of routing telephone signaling messages over the Common Channel Interoffice Signaling (CCIS) network involves the use of label numbers. Label numbers are pre-assigned on specific pairs of signaling links thereby defining paths through the network corresponding to voice telephone trunks. Direct signaling is intended to provide a more flexible method of counting messages over the CCIS network. A direct signaling message could be injected anywhere in the CCIS network and be routed properly to its intended destination. The signaling paths for direct signaling messages are not restricted to specifically preassigned signaling link pairs, or link complements, as is the case with messages which contain label numbers.

Frenkel, G., et al., TDMA Network Control Study, Computer Science Corporation, August 1973.

This report presents the results of an effort devoted to the development of network control techniques for a TDMA Tactical Satellite Communications System. The study is subdivided into two major phases. Phase I is devoted to the development of the network control system and the associated computer program required for its implementation. Real time operation of the network control system is possible if an experimental TDMA modem developed in a parallel effort is interfaced to an HP2116C computer to form the network control terminal. In addition to an overview of the software features, flowcharts and detailed functional descriptions of each block are generated in this phase. In this phase it was not possible to achieve total demand access to the system resources because of restrictions imposed by the existing modem design and limited memory size of the available computer. However, a total demand access capability could be realized by incorporating relatively simple changes to the modem and by expanding the memory size of the RADC HP 2116C computer.

Frenkel, G., and Kell, P., TDMA SATCOM System Simulation, RADC-TR-77-354, F30602-76-C-0247, Computer Science Corporation, November 1977.

This document is the final report on "TDMA SATCOM System Simulation". A series of efforts initiated by RADC since 1968 has resulted in concepts, hardware, and supporting software which represent an effective technological base required for the implementation of a TDMA system.

Gabbad, O. G., and Kaul, P., Time-Division Multiple Access, Eascon 74, pp. 179-184.

TDMA is an effective method of significantly increasing satellite channel capacity and improving satellite system flexibility. As a result, there is increasing worldwide interest and a stepped-up hardware development pace in TDMA. This paper discusses the principles of TDMA, its advantages, disadvantages, and operating modes. Also presented are typical link equations for satellite TDMA transmission.

Gaenssmantel, H., TDMA Synchronization for Future Multitransponder Satellite Communication, presented at European Conference on Electrotechnics, EUROCON '74 Digest, 22-26 April 1974 (Netherlands), pp.C11-3/2.

This paper discusses the advantages of frame synchronous TDMA and the compensation of interpath delay differences, with a new initial acquisition procedure for satellite switching.

Gallager, R. G., A Simple Derivation of the Coding Theorem and Some Applications, IEEE Transaction on Information Theory, January 1965.

Upper bounds are derived on the probability of error that can be achieved by using block codes on general-time-discrete memoryless channels. Both amplitude-discrete and amplitude-continuous channels are treated, both with and without input constraints. The major advantages of the present approach are the simplicity of the derivations and the relative simplicity of the results; on the other hand, the exponential behavior of the bounds with block length is the best known for all transmission rates between 0 and capacity. The results are applied to a number of special channels, including the binary symmetric channel and the additive Gaussian noise channel.

Gardner, F. M, Carrier and Clock Synchronization for TDMA Digital Communications, European Space Agency, TM-169, December 1976.

This document reports on studies performed for ESTEC on methods and problems of carrier and clock synchronization in a TDMA digital communications link. It is part of a much larger series of studies that are preliminary to a European telecommunications satellite system.

Ghosh, S., Code Conversion Techniques for Digital Transmissions, Computer Design, August 1978, pp. 103-111.

Systems using delta modulation techiques are becoming popular. Two design approaches for converting delta modulation to pulse code modulation, standard format for digital transmission networks, can be implemented with currently available digital technology.

Gutin, V. S., A Method of Retransmitting Signals with Conversion of the Type of Multiplexing On-Board the Satellite, Telecommunication Radio England, Vol. 31-32, No. 1, January 1977, pp. 63-67.

This paper proposes a method of retransmitting signals involving conversion of the type of multiplexing on-board the satellite, notably by changing from frequency multiplex in the earth-satellite communication section to time-division multiplex in the satellite-earth section. The proposed method combines the advantages of time-division multiplex and frequency multiplex and makes it possible to eliminate some of their shortcomings. The noise immunity of this method is compared with that of the ordinary methods of frequency and time-division multiplexing.

Harrington, E. A., Fiber and Integrated Optics: A New Light on Switching, Presented at NTC '78, 5-6 December 1978, paper 47.4.

Significant advances in fiber and integrated optics technology have been made in industrial and DoD research laboratories during the past few years. The main impact to date has been in the realm of the transmission plant. However, it is expected that fiber and integrated optics will soon be entering the switch plant. This paper addresses the problem of phasing fiber and integrated optics into the existing switching/transmission plant. The impact of fiber and integrated optics on switching network architecture is assessed and various optical switching system configurations are examined in terms of their present and future cost effectiveness.

Harrington, J. V., Commercial Satellite Communications Progress and Prospects, Paper no. 77-349, Presented at the AIAA 13th Annual Meeting, 12 January 1977.

This paper lists and expounds on some of the many goals set for the 1980's by the communications satellite community.

Harris Corporation, Development of Solid-State Transportable Satellite Communications Terminal, 15 March 1974.

This report describes the development by radiation of X-Band solid-state frequency converters as part of a transportable terminal for use with the military DSCS-II communications satellite. This equipment was developed under contract with the U.S. Army Satellite Communications Agency. The converters are fully self-contained in two 3 1/2 inch rack-mounting drawers. They provide the capability for translating a signal anywhere in the 7.25-7.75 GHz receive band down to 70 MHz and, similarly, of translating a 70 MHz signal up to the 7.9-8.4 GHz transmit band. Hybrid microwave intregrated circuit (HMIC) techniques were employed extensively in the terminal converters to aid in minimizing size and weight and in enhancing reproducibility. The actual construction is a blend of microstrip and stripline distributed circuits and miniaturized lumped-element circuits.

Hata, M., et al., A New Direct Regenerative Repeater for PCM-PSK Microwave System, OKI Electric Industry Co., LTD., Research Laboratory, 70-CP-297-COM, pp. 21/41 - 21/48

A new regenerative repeater for microwave PCM-PSK system is discussed. The repeater regenerates the received signal only in the carrier stage without a detection or a base-band regeneration, and so the configuration of the repeater can be greatly simplified and become compact with lower power consumption and higher reliability. The principal function of the direct regenerative repeater is realized by a new parametric amplifier having a phase regenerative effect. In the paper the phase regenerator constructed with a phase coherent parametric amplifier using variable conductance diodes, such as the Esaki diode and the Schotty barrier diode is analyzed and the characteristics are experimentally examined. The new parametric amplifier and the new repeater system for millimeter-wave communication are also discussed.

Hayase, J. Y., Time Division Multiple Access (TDMA) Experimentation, ECOM-0229-F, National Technical Information Service, 1 December 1970.

This report describes an experimental computer-controlled TDMA system which has been developed by IBM. The in-band TDMA system is based on a concept in which a reference station generates the TDMA frame marks and disseminates them through the satellite to all participating earth terminals. The experiment also demonstrates the feasibility of controlling the TDMA process with a computer in a more general sense; the advantages gained by performing computer control of digital communication processes has been demonstrated.

Hecht, H. Collected Papers on Fault-Tolerant Spacecraft Computer Technology, F04701-71-C-D172, The Aerospace Corporation, 28 March 1972.

This report includes nine technical papers which were presented at a meeting on Fault-Tolerant Spacecraft Computers in January 1972 at the Aerospace Corporation. These papers provide a general view of current problems and progress in the application of fault-tolerance techniques to spacecraft computers. The following broad areas are discussed: reliability experience; fault-tolerance techniques; requirements; and fault-tolerant architectures.

Heggestad, H. M., Analysis of UHF MILSATCOM Architecture Alternatives, Volume I: General System Consideration, Technical Note 1976-41, Lincoln Laboratory, M.I.T., Vol. I, 26 October 1976.

The present state of the art in UHF MILSATCOM offers the system designer a considerable range of performance in capabilities and of ways to achieve them. The purpose of this note is to enumerate the available design options and to evaluate their interactions with systems cost, weight and performance objectives. The latter category includes data rates, number of users, match to terminal characteristics modulation and multiple access requirements, and AJ. The design options analyzed include modulation techniques, demand assignment, antenna types, spread spectrum, jammer nulling, and on-board processing. Systematic procedures are discussed for determining the best possible match between system design and requirements. An appendix presents analytic comparison of the performance of various satellite transponder design options. These system architecture design procedures are applied to specific MILSATCOM examples in Volume II.

Heimerdinger, W. L., and Hein, W. Y., A Graph Theoretic Approach to Fault Tolerant Computing Final Report, F44620-75-C-0053, AFSC, September 12, 1977.

This report documents the activities in the second year of a two year investigation of a graph theoretic approach to fault tolerance for the Air Force Office of Scientific Research. This is part of a continuing effort also sponsored by the Office of Naval Research and by Honeywell, Inc., to develop a verified approach to the analysis of fault tolerant digital systems based on graph theory. Earlier efforts have examined existing graphical models and found a number of them to be suitable for fault tolerance modeling. Two models, petri nets and logos, were found to be particularly suitable. A subsequent effort examined available results in petri net theory for properties and relationships applicable to fault tolerance phenomenon.

Herman, J. H., Traveling Wave Tube Amplifiers Above 10 GHz for Space Applications, Paper No. 76-294, Hughes Aircraft Company, presented at the AIAA/CASI 6th C.S.S. Conference, April 5-8 1976.

A variety of space traveling tubes and amplifiers have been developed and manufactured from 10 through 60 GHz. The tubes, which employ either a helix or coupled cavity slow-wave structure, provide output power of 1 to 100 W or more in some cases. High efficiency, lightweight power supplies have been provided with certain amplifiers. Phase and gain performance characteristics are presented which demonstrate applicability to communications systems. Prospects for future increases in power and efficiency offer expanding horizons to the system engineer.

Herz, R., et al., Multiple Access to Communication Satellite in Time Multiplex - Present State and Future Development, FTD-HT-23-1565-72, Foreign Technology Division AFSC, 10 November 1972.

Today speech circuits via communication satellites form an essential part of the world-wide communications network; within this frame work the possibility of multiple access to satellites is of great importance. With FDMA used for the time being the capacity of the satellite transponders cannot be exploited in the most favorable way. Therefore, in recent years, different experimental systems using TDMA have been developed. Based on these experimental systems, and their results the state of the art in this field is shown.

Higbie, L., Application of Vector Processing, Computer Design, April 1978, pp. 139-146.

The vector-scalar processor, a unified supercomputer system that has very high speed computation capabilities, can execute 140 to 200 million operations per second in scientific and industrial vector signal processing applications. Analysis of algorithms associated with various applications leads to successful implementations.

Hilborn, C. G., Jr., et al., Implications of Demand Assignment for Future Satellite Communication Systems, Final Report, Palo Alto, CA: Systems Control, Inc., June 1977.

The objectives of this study are (1) to investigate the system-wide implications of using Demand-Assignment Multiple-Access (DAMA) techniques with communication satellites to serve a diverse community of voice and data communication users, and (2) to explore extensions of the current DAMA techniques to Random Multiple Access (RMA) techniques which are suitable for data and packetized voice. The major emphasis of the study is exploring system-wide cost-performance tradeoffs in order to determine: the most promising DAMA/RMA techniques; the magnitude of potential cost savings; the optimal satellite/terrestrial mix; and areas requiring more definitive study.

Hilborn, G., Random Multiple Access Satellite Packet Switching by Selective Channel Capture, Proceedings First International Conference on Information Science and Systems, August 1976, Patros, Greece, pp 709-713

A new technique called "selective channel capture" is presented and analyzed for the efficient random access of packets to the limited resource of the transmitter power of a communication satellite. The technique utilizes active satellite control, has the uncontrolled ground terminal structure of ALOHA systems but, unlike ALOHA, has stable, monotone throughput characteristics, with 100% throughput limit, no reservation delays, and no randomized retransmission delay.

Hines, M. E., Fundamental Limitations in RF Switching and Phase Shifting Using Semiconductor Diodes, Proceedings of the IEEE, June 1964, pp. 697-708.

When semiconductor diodes are used as variable impedance switching elements in RF transmission networks, the maximum power and minimum attenuation depend upon the characteristics of the diodes and the function being performed. Equations and theorems are derived which define these limits for quantized RF control networks used in on-off switches, selection switches, and phase shift devices. The relationships are quite general and the limits are shown to apply to a wide variety of network configurations. It is shown that the maximum power of a switch is proportional to the maximum RF current of the forward-biased diode and also to the maximum RF voltage when reverse-biased. The maximum power in phase shifters is a sinusoidal function of the phase change required. Minimum attenuation depends upon the switching function performed, the frequency of operation and a newly defined cutoff frequency which includes diode resistance in both forward-bias and reserve-bias states.

Hnatek, E. R., Current Semiconductor Memories, Computer Design, April 1978, pp. 115-126.

Increasingly rapid improvements in density, storage and fabrication of semiconductor memories confront the designer with an ever-changing spectrum of products and capabilities. A comprehensive overview of various technology options assures reliable, efficient and cost-effective memory implementations.

Hooten, P., and Huang R. Y., Communication Satellite Processing Repeaters, "Proceedings of the IEEE", Vol. 59, No. 2, Febuary 1971, pp. 238-251

Two kinds of processing repeaters which may find application on communication satellites in the near future are described in this paper. The type 1 processing repeater is able to discriminate against unauthorized users, to conserve the capacity of the repeater to only those users who possess a predetermined key. At the same time, undesired interference signals are rejected. It appears that such a repeater is most useful in the situation where there are a large number of small receiving terminals to optimize the satellite capacity with respect to these terminals and to simplify the processing otherwise needed at these terminals. The type 2 repeater acts somewhat as a "switchboard in the sky" in being able to route signals transmitted through one antenna at one frequency to another antenna at another frequency where the desired routing may be changed as a function of time. In this way, the satellite capacity is utilized fully in the face of changing traffic demands. Also, transmitting and receiving terminals are simplied. In both of these processing repeaters, complexity is added for two reasons: to fully utilize the satellite capacity and to simplify the user ground terminals.

Hoversten, E. V., and Van Trees, H. L., International Broadcast Packet Satellite Services, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 1-7.

A new international satellite service is described whose primary goal is to provide international computer communication. A representative system concept to provide the service is discussed. The proposed system has two important features. It exploits the unique ability of satellites to provide broadcast and multiple access capabilities over large geographic areas by using a scheme referred to as a broadcast packet satellite channel. Secondly, it provides natural interface boundaries which facilitate, from both a management and technical viewpoint, the provision of international communications between otherwise incompatible networks and/or terminals.

Hsieh, W., Locating Satellite Switches in Mixed Media Packet Switched Networks, presented at the NTC '76, 29 November - 1 December 1976, pp. 16.4/1-8.

This procedure is applied to a large network example to derive general properties and trade-offs of the optimum satellite switched locations. The author briefly presents the various options in packet switched satellite communication. He then discusses the general topological design problem of large distributed data networks and indicates how the satellite switch location problem ties into the overall design problem.

Huff, R. J., Multifunction TDMA Techniques - First Annual Report, AD 778 437, National Technical Information Service, February 1974.

Concepts and techniques needed to incorporate a TDMA satellite communications capability into multifunction avionics systems are being developed under a three year contract with the U.S. Air Force. Progress made during the first year of that contract is described in this report. The work has involved (1) the design and partial fabrication of prototype TDMA satellite communications modems, (2) the development of techniques and associated technological bases needed to instrument an adaptive null-steering array in which a reference signal is derived from the data-carrying signal, and (3) the development of techniques for effectively utilizing capabilities which can be provided by the TDMA satellite communications subsystem in performing satellite navigation and line-of-sight communications functions. An overview of the results obtained to date is given and the tasks to be performed during the remainder of the contract are described.

Huff, R. J., Multifunction TDMA Techniques - Second Annual Report, AFAL-TR-74-196, National Technical Information Service, December 1974.

Concepts and techniques needed to instrument TDMA satellite communication systems containing a larger number of small, highly mobile terminals, e.g., aircraft, are being developed under a three year contract with the U.S. Air Force. Progress made during the second year of that contract is described in this report. The work has involved the development of prototype TDMA satellite communication modems and the evolution of techniques and associated technological bases needed to incorporate adaptive null-steering arrays in TDMA systems. An overview of the results obtained to date is given and the tasks to be performed during the remainder of the contract are described in this annual report.

Huff, R. J., TDMA Space Communications Systems: Concepts and Practical Techniques, RADC-TR-71-255, F30602-69-C-0112, Ohio State University, Columbus, Ohio, November 1971.

In this report the results of investigations conducted over five years directed at the development of practical techniques for instrumenting TDMA systems are placed in perspective. The rationale for selecting the particular TDMA concept developed, the advantages and limitations of the associated techniques, the design options available and potential concept applications are presented in varying degrees of detail. It is shown that, through the use of differential detection to demodulate the data-carrying pulses and sampled-data delay-lock loops to accurately time the uplinks, a TDMA system which is efficient, effective, and flexible can be instrumented. Procedures for using the previously documented technological base to design two hypothetical systems are illustrated. Satellite processing concepts which are compatible with the basic TDMA techniques developed are described.

Huff, R. J., et al., The Synchronization of Time Division Multiple Access Systems on Analytical and Experimental Study, RADC-TR-69-72, F30602-67-C-0119, Ohio State University, Columbus, Ohio, May 1969.

A complete technology for synchronizing the transmissions in TDMA systems is presented. Uplink synchronizers are described which employ two coupled sampled data delay lock loops to provide the time base tracking functions. A sampled data delay lock loop is also used to provide downlink (bit) synchronization. An experimental synchronizer implemented to demonstrate concept feasibility and to check the accuracy of analytical results is described. The experimental results obtained by both bench and IDCSP satellite link testing are given. Based on these results, an assertion is made that the analytical results can be used with confidence in the design of operational TDMA systems.

Huffman, D., An Update on MOS ROMs, Computer Design, September 1977, pp. 95-104.

Relatively overshadowed by the more popularized and reprogrammable RAMs, PROMs and EPROMs, MOS ROM developments continue to show steady progress in improved performance, reliability and cost.

Hughes, C. D., Results of Measurements Made on an Experimental Link Simultating a 180 Mbit/s Satellite Channel, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 116-122.

The experiment involved transmission of 180 Mbit/s DPSK signals over an inclined radio path which simulated an earth station satellite earth station loop. The operating frequencies were 14 GHz up-path and 11 GHz down-path. The results of static and long term propagation measurements made over the path are presented. Correlation between bit error rate and fading is demonstrated on a statistical and real time basis.

Inagaki, K., A New Technique for Data Transmission via TDMA Satellite Link, presented at the NTC '77, December 5-7, 1977.

In the satellite communications systems, the TDMA system is expected to be widely introduced in the near future. Also, the demand of the high-speed data transmission services increases year by year. A high-speed data transmission via a TDMA link, which is very attractive because of its low cost and high efficiency, will require the interface between terrestrial and satellite links. Taking account of these circumstances, a new TDMA interface equipment with which the 56 kbps digital signal can be transmitted through one PCM telephony channel has been developed.

Ito, Y., et al., Analysis of a Switch Matrix for an SS/TDMA System, Proceedings of the IEEE, Vol. 65, No. 3, March 1977, pp. 411-419.

Time slot scheduling problems for a satellite switched/time division multiple access (SS/TDMA) system are discussed and an algorithm called "Greedy Algorithm" is presented. This algorithm guarantees a most efficient utilization of a frame period with n(n-1) (n is the number of beams) number of switchings at most. Another problem discussed is the choice of the type of microwave switch matrix to be put on board the satellite. A switch-matrix structure called re-arrangeable multistage matrix is shown to have high reliability and low-insertion-loss characteristics. Also, brief discussions are made on the experimental results of an engineering model SS/TDMA system.

Ito, Y., and Kyogoku, M., SMDA On-Board Switching System Using Rearrangeable Multi-Stage Network, IEE International Conference on Satellite Communication Systems Technology, April 1975, pp. 227-232.

This paper presents one possible configurations of MSM with higher reliable performance and the minimum insertion loss, using rearrangeable multi-stage (RM) network composed of PIN diodes and Microwave Integrated Circuit (MIC). Experimental results of RM types 8x8 switching matrix, designed for 3.95 GHz + 250 MHz, including error rate measurement, reliability study and system recovery study for the element failure is also discussed.

Iwadare, Y., Some Fundamental Concepts on Communication System Design with Error Control, NEC Research & Development, No. 22, July 1971.

Even though it is expected that the most suitable approach in practical application of error control to communications systems is to treat it as one element in the entire communication system design, error control has quite often been treated as an independent technique of other communication system design considerations. In this paper, an emphasis is placed on algebraic codes to investigate the effect of coding on the relation between modulation and coding, signal energy to noise ratio vs. probabilities of error and so forth. Some fundamental concepts on communication system design with error control are derived based on the analysis when coding is applied to bi-phase and poly-phase modulation systems. Futhermore, a simple review on the use of burst of error corrections is added. These fundamental concepts may not be applied directly in practical communication system design on account of the large variety of modulation and demodulation schemes and noise patterns, but is expected to be useful to serve as a guide line in the complicated practical system design.

Jager, F., and Dekker, C. B., Tamed Frequency Modulation, a Novel Method to Achieve Spectrum Economy in Digital Transmission, IEEE Transactions on Communications, Vol. COM-26, No. 5, May 1978, pp. 534-542.

This paper describes a new type of frequency modulation, called Tamed Frequency Modulation (TFM) for digital transmission. The desired constraint of a constant envelope signal is combined with a maximum of spectrum economy which is of great importance, particularly in radio channels. The out-of-band radiation is substantially less as compared with other known constant envelope modulation techniques. With synchronous detection, a penalty of only 1 dB in error performance is encountered as compared with four-phase modulation. The idea behind TFM is the proper control of the frequency of the transmitter oscillator such that the phase of the modulated signal becomes a smooth function of time with correlative properties. Simple and flexible implementation schemes are described.

Jain, P., et al., Detection of MPSK Signals Transmitted Through a Non-Linear Satellite Repeater, presented at the NTC '77, December 5-7, 1977.

Error probabilities and channel transition probabilities are derived and evaluated for the detection of MPSK signals transmitted through a band limited non-linear satellite communication channel. Two general formulas characterizing the effect of AM-AM and AM-PM distortions exhibited in high power amplifiers such as travelling wave tubes (TWTs) are obtained. Numerical evaluation of the two approaches is carried out for BPSK, QPSK and B-ary signaling and a comparison is made in terms of the accuracy and speed of numerical computation. The theory is required in performing channel throughput (bits/sec/H2) and modulation/coding trade-off studies.

James, J. N., and McDonald, R. R., A Forecast of Space Technology, N76-18005, NASA-SP-387, January 1976

In addressing the enormous task of encompassing a comprehensive forecast of space technology for the period 1980-2000, two major activities were undertaken by the participants. Exploratory forecasting was the first activity. It explored chains of conjecture in terms of what can or might happen and then sought to project technological parameters and/or functional element capabilities into the future, starting from a base of accumulated knowledge in relevant areas. The second activity was the technological feasibility assessment of the various candidate missions and systems which were considered. This activity, which was objective oriented, had the character of normative forecasting. In conclusion, the forecasting data revealed that between now and the year 2000 a great number of advances will occur in technology applicable to space activities. These technological advances will bring about the feasibility of complex missions and systems and can significantly reduce the cost of accomplishing any specific objective in space.

Jarett, D., Meeting the Twin Challenges of Demand and Conservation of Spectrum and Orbit Through Technology, Eascon '77, 26-28 September 1977, pp.25-1A/8.

Most of the future demands for satellite communications can only be met by moving to higher frequency bands. The frequency bands at 30/20 GHz not only provide greater bandwidth but satellites operating in these bands can be spaced more closely. These advantages come at the price of providing increased rain margin. New concepts and technologies (including the use of high-speed digital transmission with on-board processing such as SS TDMA, satellite multiple beam antennas and larger high capacity satellites launched by the space transportation system (STS)) will economically accommodate the increase in demand, while avoiding the spectrum and orbital congestion problems which now limit systematic expansion of the space segment in the lower satellite telecommunication bands.

Joel, A. E., Jr., On Permutation Switching Networks, The Bell System Technical Journal, Vol. 47, No. 5, May-June 1968, pp. 813-822.

Rearrangeable switching networks are considered as permutation generators. Alteration of the permutation being produced by any state of the network configuration may be achieved by rearranging or changing the state of the switching network. By limiting the switches in each stage to binary action devices certain economies have been achieved. This paper describes additional savings, particularly in the number of required operating elements. Some further savings are achieved by introducing break contracts into switching networks.

Johnson, P. M., An Introduction to Vector Processing, Computer Design, February 1978, pp. 89-98.

Execution speed of scientific problems can be considerably enhanced by hardware and software design that provides for efficient execution of program loops. A large scale scientific computer incorporates vector processing for high speed execution of loops without sacrifice of processing speed in non-loop situations.

Jordan, K. L., Jr., The Performance of Sequential Decoding in Conjunction with Efficient Modulation, IEEE Transactions on Communication Technology, Vol. COM 14, No. 3, June 1966, pp. 283-297.

The design of a communications system consisting of a sequential encoder-decoder, working in conjunction with a modulation detection system is considered from the point of view of high information transmission efficiency. Emphasis is placed on M orthogonal signal modulation and a scheme known as list-of-L quantization. The results of a computer study of the computational behavior of the sequential decoder are described and used to predict buffer memory overflow probability. The described design procedure allows prediction of system performance to within a fraction of a decibel. A practical sequential decoder and a list-of-1 modulation-detection system of reasonable complexity, can achieve performance on a white Gaussian channel to within 4.5 dB of the Shannon limit with coherent reception and to within 7 dB with incoherent reception.

Kalet, I., and White, B. E., Suboptimal Continuous Shift Keyed (CSK) Demodulation for the Effident Implementation of Low Crosstalk Data Communications, IEE Trans. on Comm., Vol. COM-25, No. 9, September 1977.

A suboptimal receiver of constant envelope, continuous-frequency MSK-type modulations called continuous shift keying (CSK) is proposed that halves demodulator complexity with no more than a 1.6 dB loss in detectability in AWGN. The technique is especially applicable to a frequency division multiple access system.

Katz, J. L., Performance of Spread Spectrum Modulation in a Multipath Environment, Technical Note 1972-28, Lincoln Laboratory, M.I.T., 21 July 1972.

This study determines analytically the degradation experienced by two forms of spread spectrum modulation techniques, frequency hopped-frequency shift keying, and pseudo noise-phase shift keying, due to multipath occuring in airborne communication channels. Results are obtained for the cases in which coded and uncoded data are used.

Katz, J. L., and Schneider, K. S., On-Board Regeneration Processors for Digital Communication Satellites, AIAA 7th Communication Satellite Systems Conference, April 24-27, 1978.

The rapid increase in the need for communications has created a demand for large-capacity communications satellites with the requirement that the communications systems be used more efficiently. This demand, coupled with the need for cheaper terminals and a more compelx mix of user types, implies that future communications satellites will need technological improvements to support a complex system structure. This paper compares the performance of a satellite communications system in which the satellite element has an on-board processing capability. On-board processing consists of a set of generic tecnniques, involving real or near-real time processing or switching, that can be used on the satellite to provide an improved performance level in the total communications system.

Katz, J. L., and Schnieder, K. S., Processing Methods to Suppress Effects of Uplink Multipath in Satellite Systems, ICC '77, June 12-15, 1977.

Three processing methods of different complexity are discussed for improving end-to-end link performance in a satellite repeater when multipath is present in the uplink. It is assumed that the system already uses channel symbol interleaving and pseudo random carrier frequency hopping to combat multipath. The complete end-to-end link performance for each processor is expressed in terms of the error bound exponent Rcomp.

Kaul, P., and Muzumdar, D., A Flexible Low Cost Interface Between TDMA Common Equipment and Multiple Terrestrial Extensions, presented at ICC '77, June 12-15, 1977.

This paper describes an interface between terrestrial interface modules (TIMs) and TDMA common equipment that is simple and inexpensive. It allows the use of standard off-the-shelf equipment such as TIMs by putting all the complexity into the common equipment.

Kleinrock, L., Computer Network Resource, AD-A008 422, National Technical Information Service, 30 June 1974.

This semiannual technical report describes some results obtained in the author's continuing work in satellite packet switching ground radio packet switching, packetized speech transmission through the ARPANET. Large network design procedures and secure operating systems studies continue to progress and will be reported upon in the future.

Kleinrock, L., et al., Computer Network Research Final Technical Report, UCLA-ENG-7696, APPA, 30 November 1975.

This is the final report for APPA. It provides a sophisticated network measurement facility adequate for a variety of uses such as performance measurement, model validation, and the design of network algorithms; conducting experiments on the network to analyze the effect of transmitting various data sources; defining and extending the tools necessary to analyze and evaluate the performance of computer communication systems; developing models of multiple resource systems and computer networks; studying packet communication systems that incorporate satellite and/or radio communications; and finally designing, and begining implementation of a verifiably secure operation system for the PDP 11/45.

Kleinrock, L., On Communications and Networks, IEEE Transactions in Computers, Vol. C-25, No. 12, December 1976.

Data communications has come of age. In this paper some of the principal events that led up to the revolution in communications among information processing systems are highlighted. Perhaps the most important event was the technological development of packet swiching in the form of ARPANET. Most of the presentation is devoted to a brief summary of the ARPANET experience emphasizing the description functions analysis, design and performance measurement of packet-switching networks. Also discussed are some recent advances in radio packet switching for long haul (i.e., satellite) and terminal-access communications.

Kleinrock, L., and Lam, S. S., Packet-Switching in a Slotted Satellite Channel, AFIPS Conference Proceedings, Vol. 42, 1973, pp. 703-711.

Performance of a slotted satellite system for packet switching must be effective at all ranges of traffic intensity, in that no unnecessary delays or loss of throughput should occur because of complicated operational procedures. The slotted satellite system analyzed in this paper meets these criteria.

Kleinrock, L., and Lam, S. S., Packet Switching in a Multi-Access Broadcast Channel: Performance Evaluation, IEEE Transactions on Communications, Vol. COM-23, No. 4, April 1975.

In this paper the rationale and some advantages for multi-access broadcast packet communication using satellite and ground radio channels are discussed. A mathematical model is formulated for a "slotted ALOHA" random access system. Using this model a theory is put forth which gives a coherent qualitative interpretation of the system stability behavior which leads to the definition of a stability measure. Quantitative estimates for the relative instability of unstable channels are obtained. Numerical results are shown illustrating the trading relations among channel stability throughput and delay. These results provide tools for the performance evaluation and designs of an uncontrolled slotted ALOHA system. Adaptive channel control schemes are studied in a companion paper.

Klingman, E. E., Comparisons and Trends in Microprocessor Architecture, Computer Design, September 1977, pp. 83-92.

Concepts of bundled and orthogonal structures are developed and used to place present microprocessor multi-operating level architectures in perspective, as well as to predict future trends.

Koga, K., et al., On-Board Regenerative Repeaters Applied to Digital Satellite Communications, Vol. 65, No. 3, March 1977, pp. 401-410.

In pulse code modulation/time division multiple access (PCM/TDMA) satellite communications, though the number of repeating stage is usually only one, the regenerative repeater will be worthwhile enough to be introduced on-board the satellite. This is because the improvement of the communication quality by the increase of the transmission power is difficult in the satellite link and the regenerative repeater is very effective for removing co-channel interferences which will become a predominant factor of signal degradation in the future. It will also provide great facility for various kinds of on-board processing. This paper first presents basic configurations of the on-board regenerative repeater and discusses simplification of the repeater. Next, various kinds of on-board processing are discussed in connection with the regenerative repeating. Then a concrete regenerative repeater applied to satellite switched/TDMA (SS/TDMA) satellite system which augments the communication capacity by frequency reuse is presented and compared with the conventional frequency translating type in terms of link budget, power dissipation and weight. Lastly, the result of the development of an experimental regenerative repeater is described.

Kosaka, K., et al., Advanced TDMA System for Experimental Study in 30/20 GHz Band, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 333-340.

New TDMA equipment has been developed for experimental study on the multiple access operation in 30/20 GHz band as well as in 6/4 GHz band through the Japanese domestic communications satellite launched in December 1977. Several attempts to overcome the problems encountered in the 30/20 GHz band operation, such as a large C/N degradation due to rainfall, have been tried in its design. Among them are assumption of space diversity configuration, positive utilization of synchronized superframe, adoption of previous notice method, and various protective approaches for TDMA synchronization. These attempts which required rather complicated control were successfully carried out with additional hardware and micro-computers on basic, simplified, and standarized TDMA equipment.

Kratzer, D. L., Code Division Multiple Access, Eascon '75, pp. 185-188.

This paper describes the various concepts employed in code division multiple access systems. It also lays out applications to which this technique is appropriate. Advantages and disadvantages of code division multiple satellites on a common frequency or other distributed users are addressed. Multipath, interference level reduction, privacy and low cost are among the attributes of this approach. The new trends in code division mux are described.

Krechner, K., Integrated Medium Speed Modems into Communications Networks, Computer Design, February 1978, pp. 101-110.

Medium speed modems are being designed into computer terminals, communications, front ends, and data communication multiplexers for transmitting serial-bit information over telephone lines. Hardware, interface and diagnostic protocols are examined for effective and efficient communications.

Kyriakopoulos, N., Control Methodology for Demand Assignment Operation of Satellite Nets, AD-A014-079, Defense Communications Engineering Center, NTISQ, March 1975.

The Defense Communications System (DCS) is an integrated terrestrial and satellite communications system. This report is concerned with the DCS satellite nets which consist of several collections of earth terminals each served by a single spacecraft. There are fundamental differences between the control of commercial and military satellite nets. Network control attains added significance when demand assignment is introduced into the system. As a first step toward the development of a control methodology for the Defense Satellite Communications System (DSCS), a brief review of current and planned multiple access commercial communications systems is presented. It is hoped that subsequent studies will examine similarities and differences between the commercial and military environments. As a result of such analyses, a control methodology can be devised.

Kyriakopoulos, N., Design of a Demand Assignment Satellite Network, AD-A021-937, Defense Communications Engineering Center, NTIS, December 1975.

This report presents a step-by-step procedure for the design of a single-channel per carrier, demand assignment, satellite communications network. The input for the design is the traffic matrix to be handled by the network and the outputs are the bandwidth and power requirements for the satellite system. Although the design approach is general, a specific example chosen to illustrate the technique is the intra-European switched-traffic voice network.

Lam, S.S., Packet Switching in a Multi-Access Broadcast Channel with Applications to Satellite Communication in a Computer Network, UCLA-74-7429, ARPA, April 1974.

This report considers a packet switching technique applicable to packet communication using a satellite or ground radio channel. The objective of this research is to develop analytic models for the evaluation and optimization of the system performance in terms of stability throughput and delay. Advantages of packet switched satellite and ground radio systems over conventional wire communications for large computer-communication networks are discussed.

Lam, S. S., Satellite Multi-Access Schemes for Data Traffic, presented at the ICC '77, June 12-15, 1977, pp. 19-24.

Satellite systems have traditionally been designed for voice traffic. In this paper, satellite multiaccess schemes for data traffic are considered. Three general categories of schemes are identified and described; channel reservation schemes, random access schemes, and packet reservation schemes. Bounds on achievable channel throughput are presented for the three classes of schemes. Finally, numerical examples are used to compare the delay-throughput performance of several specific schemes for a variety of data traffic environments.

Lam, S., and Kleinrock, L., Dynamic Control Schemes for a Packet Switched Multi-Access Broadcast Channel, National Computer Conference, 1975.

This paper studies dynamic channel control algorithms (CONTEST algorithms) which implement the theoretical control policies by using a heurestic schemes to estimate the instantaneous channel state. A heurestic retransmission control algorithm has also been studied which circumvents the state estimation problem. Simulation results indicate that these control algorithms are capable of achieving a channel throughput delay performance close to the theoretical optimum as well as being capable of preventing channel saturation under temporary overload conditions.

Lathi, B. P., A New Method of Signal Multiplexing: The Dual of Time Division Multiplexing, presented at the NTC-74, 2-4 December 1974, pp. 1058-1063.

Time division multiplexing (TDM) and frequency division multiplexing (FDM) are used for transmitting several messages simultaneously on the same channel. In this paper a new method of signal multiplexing is proposed. Instead of sampling the signal in the time-domain, its spectrum is sampled. The transmitted information consists of samples of the spectrum of each signal instead of its samples in the time-domain. Various messages are multiplexed by interleaving the samples of the spectra of the signals. Implementation of multiplexing and demultiplexing is described.

Lee, L., On Optimal Soft-Decision Demodulation, IEEE Transactions on Information Theory, Vol. IT-22, No. 4, July 1976.

Wozencraft and Kennedy have suggested that the appropriate demodulator criterion of goodness is the cut-off rate of the discrete memoryless channel (DMC) created by the modulation system; the criterion of goodness adopted in two papers is the "symmetric" cutoff rate which differs from the former criterion only in that the signals are assumed equally likely. Massey's necessary condition for optimal coherent demodulation of binary signals is generalized to M-ary signals. It is shown that the optimal demodulator decision regions in likelihood space are bounded by hyperplanes. An iterative method is formulated for finding these optimal decision regions from an initial "good guess". For additive white Gaussian noise (AWGN), the corresponding optimal decision regions in signal space are bounded by hypersurfaces with hyperplane asymptotes; these asymptotes themselves bound the decision regions of a demodulator which, in several examples, is shown to be virtually optimal. In many cases, the necessary conditions for demodulator optimality is also sufficient, but a counter-example to its general sufficiency is given.

Lee, M. K., Cross-Polarization Performance of the RCA Satcom System, RCA Review (USA), Vol. 38, No. 2, June 1977, pp. 171-180.

To significantly increase the efficiency of the available spectrum and the use of the orbital arc, the RCA Satcom system employs the technique known as "Spectrum Reuse", whereby two or more separate channels within the same frequency band are transmitted (or received) on two separate orthogonally polarized beams. Some polarization isolation between the orthogonally polarized beams is not perfect due to various depolarization mechanisms; the desired channel will receive some interference from adjacent cross-polarized channels, causing interference to the desired channel which may result in degraded performance. Since this degradation cannot be allowed to compromise the system performance, the amount of interference must be determined so that allowances can be made for its effect on system design. This paper describes the loss of polarization isolation that occurs when a signal travels from transmitter to receiver with emphasis on the depolarization caused by the propagation medium. A statistical estimation (availability) is made of the overall polarization isolation for various earth stations locations throughout the U.S. Some examples of how this isolation is translated into signal interference and then allocated to the overall interference to the signal are given.

Lee, Y. S., Simulation Analysis for Differentially Coherent Quaternary PSK Regenerative Repeater, COMSAT Technical Review, Vol. 7, No. 2, Fall 1977, pp. 447-474.

An on-board regenerative repeater can provide significant improvements in error rate performance of digital satellite communications. This paper presents simulation analysis results for the evaluation of symbol error rate performance with coherent quaternary phase shift keying (CQPSK) and differentially coherent quaternary phase shift keying (DQPSK)detections. Signal degradation mechanisms due to overall intersymbol interference and additive thermal noise are included. Certain critical design parameters have been obtained for the implementation of an uplink DQPSK demodulator. Regenerator system considerations for on-board regenerative repeater applications are discussed with reference to future SS-TDMA systems in which minimum acquisition time is important.

Leon, B. J., An Advanced Concept for the Overseas DCS, TN 18-76, Defense Communications Engineering Center, August 1976.

A digital, time-division-multiplex, multiple access system with primary communications via satellite is proposed for the overseas DCS. This proposed system could be built with current technology (except for the space shuttle needed for launching), would require only four satellites, and would have sufficient capacity for the foreseeable future.

Levit, A. D., Generalized Design and Optimization Techniques for Satellite Communications Networks, paper 74-468, presented at the AIAA 5th Communications Satellite System Conference, 22-24 April 1974.

The designer of a communication network can consider, among other factors, cost, reliability, availability and performance. Satellite technology introduces new opportunities to satisfy these considerations by taking advantage of characteristics inherent in both satellite and terrestrial environments. Processes of network design and optimization involve consideration of system cost and quality of service as a function of distance, traffic distribution and geographic pecularities. Techniques employed may be analytic or heuristic, depending upon degrees of complexity encountered. The procedure, being iterative, requires trade-off decisions along the way as to degree of exactness vs. the cost and time of analysis. The result is that the network designer combines techniques of programming analysis with human interaction and can orient his methods to the characteristics of the problem.

Liao, H., Synchronous Burst Random Access Channels, Systems Research Corporation, 1972.

This note analyzes several modifications of the ALOHA random access channel by considering time synchronization among the users, the primary goal is to improve the random access channel utilization by using a simple clock in the host computer and in each remote terminal for synchronization.

Liccini, R. P., Hardware Trade-offs for a Baseline Spacecraft Switched Time Division Multiple Access (SSTDMA) Communication System, Eascon 77, 26-28 September 1977, pp.25-3A/18.

The key hardware components for an advanced spacecraft switched time division multiple access (SSTDMA) spacecraft communications system are described. Primary emphasis is associated with the switched matrix used for the SSTDMA systems. A basic dual transponder design emerges that meets the desired objectives. An extension of the basic transponder for regenerative repeating is also discussed.

Lindholm, C. R., Multiple-Access Techniques for Communication Satellites: Digital Modulation Time Division Multiplexing and Related Signal Processing, RM-4997-NASA RAND Memorandum, September 1966.

This memorandum examines specific features of digital techniques: time division multiplexing, error correction codes, analog-to-digital conversion methods and synchronization problems. This information is presented in a context which will enable satellite communications systems engineers to design digital, or time-division, multiple-access systems. It will also permit system analysis and comparison of digital techniques with other possible solutions to the multiple-access problem. The memorandum is intended as background material for further study of digital techniques.

Long, W. G., Jr., Effect of Multiple-Band/Service Satellites on Orbit and Spectrum Utilization, paper 74-433, presented at the AIAA 5th Communications Satellite Systems Conference, 22-24 April 1974.

Various possible combinations of bands and services allocated for satellite communications are outlined, and initial analyses of the effect of some possible multiple-band configurations on a single spacecraft are presented. Relationships among the principal parameters of a satellite communications system such as antenna characteristics, noise temperature and margins and the information transfer per unit of orbital arc and RF bandwidth (orbit and spectrum utilization) are developed. Both homogeneous and heterogeneous aspects are introduced. Initial results indicate that use of multiple-band satellites and intersystem heterogeneity may reduce orbit and spectrum utilization. However, additional study is necessary before the definitive conclusions may be made.

Lundquist, L., Optimizing a TDMA Channel Including Synchronization, presented at ICC '74, June 1974, Minneapolis, paper 43A.

The results of a pulse shaping filter optimization study for a 4 phase PSK non-linear satellite channel taking into account the effects of carrier and clock recovery are presented in this paper. The tradeoff between adjacent channel interference and inter-symbol interference is shown and a conclusion is drawn that Nyquist filters with about 50% roll off is optimum and that it is necessary to have a filter before the carrier recovery circuits to suppress adjacent channel interference.

Lusignan, B., Single-Sideband Transmission for Land Mobile Radio, IEEE Spectrum, July 1978, pp. 33-37.

Existing mobile radio bands could be used more effectively to accommodate more traffic in the same bandwidth. With available technologies, from seven to ten times as many channels could be obtained in existing VHF and UHF bands, states a recent study for the UHF Task Force of the U.S. Federal Communication Commission.

Magill, D. T., Investigation of the Use of Frequency Division Multiple Access for Application with a Mix of User Terminals - Final Report - Volume 3, SRI, DCA, December 1973.

The three major multiple-access techniques are compared for a mix of user types, i.e., differing data rates and capacity quotients. The comparison is made with respect to eight performance criteria that are particularly important for the military environment. A general comparison indicates that frequency division multiple access (FDMA) performs better than originally believed. A specific test case of 10 accesses with a variety of data rates and capacity quotients is s elected for detailed evaluation. The quantitative comparison is based on satellite throughput. The performance of the FDMA system is optimized and evaluated using the computer program SYSCON developed under the other tasks of this study. FDMA is found to offer very nearly as much satellite throughput as the other two multiple-access techniques. Furthermore, FDMA offers the advantage of simplicity, low cost, and compatibility with existing equipment. Based on this example, it is concluded that FDMA can offer substantial advantages as compared to the other techniques. Further, more detailed studies are recommended to fully delineate the region of FDMA superiority.

Massey, J. L., Coding and Modulation in Digital Communications, presented at the 1974 Zurich Seminar, 12-15 March 1974.

The use of coding in digital communications, to be effective, requires that the modulation system be designed on an unconventional basis. Rather than using "error probability" as the modulation criterion, this paper argues that the appropriate modulation criterion is the "cut-off rate" Ro of the discrete channel which the modulation system creates. It is then shown that the Ro criterion leads to a rich "communications theory" of its own in which the optimality of the simplex signal set can be proved (rather than conjectured) and in which soft decision demodulators can be systematically designed. At the same time the Ro criterion leads to a modulation system compatible with the use of effective coding techniques in an overall efficient digital communication system.

Massey, J. L., Joint Source and Channel Coding, No. 0014-75-C-1183, MIT Electronic Systems Laboratory, September 1977.

The advantages and disadvantages of combining the functions of source coding ("data compression") and channeling code ("error correction") into a single coding unit are considered. Particular attention is given to linear encoders, both for sources and for channels, because their ease of implementation makes their use desirable in practice. It is shown that, without loss of optimality, a joint source/channel linear encoder may be used when the goal is relaxed to reproduction of the source within some specified non-negligible distortion.

Matthews, E. W., et al., Advances in Multibeam Satellite Antenna Technology, Aeronautics Ford Corporation, Western Division.

This paper surveys the state of the art in multibeam antenna development applicable to communication satellites. It defines three basic forms of multibeam antennas: those providing space diversity, polarization diversity and variable shaped beams. The use of lenses, reflectors and phased arrays in multi-beam configurations is described. Finally, hardware developments in the field are surveyed, including the LES-7 waveguide lens, more recent experimental TEM and waveguide lenses, a dual K-band reflector and off the shelf reflectors for INTELSAT IV-A and V satellites.

McDonald, J. C., and Moed, J. A. R., Communications Applications of Memories, presented at the ICC '77, June 12-15, 1977.

New memories have given communications equipment designers broad latitudes in architecture. We are no longer bound by the economic necessity to centralize memory. In addition, new memory devices have access times which allow old functions to be realized with memory and new functions such as digital time division switching to be practical. This paper examines the pros and cons of various serial and random access memories. Then, a new dual pulse register array using semi-conductor memory is described.

McGarty, T. P., and Schneider, K. S., Processing Voice and Data in Mobile Satellite Communications, presented at the ICC '77, June 12-15, 1977, pp. 63-67.

The use of low cost terminals in a mobile satellite communications environment providing combined voice and data capability requires an increased level of signal processing capability. The method of processing must be transparent to the nature of the source and at the same time matched to the vagaries of the channel. Since voice suffers from delays an on-line self-adaptive scheme is required. This paper discusses a method that is proposed to combat specular multipath. The optimum scheme is developed and the system performance evaluated.

McGarty, T. P. and Singh, K. J., Multiple Access Techniques for Low Data Rate Satellite Communication Systems, presented at the NTC '77, December 5-7, 1977.

There are many applications of low data rate satellite communications that range from data collection to position surveillance. A common characteristic of all these systems is that a low cost design is essential and the maximum throughput should be achieved. This paper discusses a set of multiple access techniques that can be employed for such applications and provides a detailed analysis of a broad set of possibilities for a digital multiple access scheme ranging from a pure random access scheme to a pure spread spectrum. Specific implementation problems are also addressed and the techniques proposed in a data collection system are discussed.

McGarty, T. P., and Warner, T. H., Multiple Beam Satellite System Optimization, IEEE Transactions on Aerospace and Electronic Systems, Vol. AES-13, No. 5, Sept. 1977.

An analytical method is developed for determining the basic RF link parameters that are required in a satellite system design. Certain simplifying assumptions are required and specific system elements are selected. Two differnt design criteria are considered; optimizing the per-beam signal energy to noise spectral density ration (Eb/No) and minimizing the per-user costs. These two criteria are complements of each other subject to coverage and performance constraints. The model can be used to rapidly assess tradeoffs in various system elements. A specific example of a domestic satellite system is considered. The economic analyses are also considered and the ecomony of scale effect is demonstrated for the design example considered.

Mersereau, R. M., and Seay, T. S., The Design of Multiple Access Frequency Hopping Patterns, 1974-32, ESD-TR-74-279, Lincoln Laboratory, 6 September 1974.

A technique is discussed for the design of multiple access frequency hopping patterns which will allow a number of users to communicate reliably over a limited bandwidth in the presence of Doppler and timing asynchronies. The patterns are based on a subset of the Reed-Solomon codewords. They possess nearly flat ambiguity and cross-ambiguity functions and thus could be useful as discrete radar signals. In addition, the structure of the patterns permits a straightforward implementation.

Metz, R. J., An Experiment in Domestic Satellite Utilization, paper 74-444, presented at the AIAA 5th Communications Satellite Systems Conference, 22-24 April 1974.

This experiment in utilization of domestic satellite communications was designed to evaluate performance of various techniques under development to support efficient, flexible use of a full transponder of a geostationary repeater satellite similar to those to be deployed for U.S. domestic service by 1975. The techniques under development are in the following areas generic to satellite communication technology: (1) multiple-access digital communication, (2) network and resource assignment control, and (3) encoding of traffic for digital transmission. The results of the experiment concern the characterization of the equivalent IF channel mode available by the vendor services, the operability of various algorithms and techniques for utilization of the satellite path channel capacity, and performance when handling real and simulated traffic while interconnected with IBM's private line network.

Metzger, L. S., Group 64, On-Board Satellite Signal Processing, Technical Note 1978-2, Vol. 1, Lincoln Laboratory, January 31, 1978.

Conventional communication satellites using transponders can provide high efficiency communications in an unstressed (low noise) environment between terminals of the same type. However, such satellites are not suitable for providing such capabilities as anti-jam protection or inter-connectivity of messages between terminals of different types, both important for military communications purposes. On-board satellite signal processing can provide these and other capabilities. This report discusses on-board processing's advantages and costs, and shows how it can be incorporated into a system concept.

Metzner, J. J., Conservation of Satellite Transmitter Energy with Propagation and Demand Variation, Presented at the NTC '78, 3-6 December 1978, paper 40.6.

This paper is concerned with the discussion and evaluation of strategies which may significantly reduce satellite average power requirements for data communication with propagation and demand fluctuations. Assumptions of signal- and message-processing capabilities beyond current practice are made. Also, an unconventional downlink modulation format which emphasizes transmitted energy usage roughly proportional to amount of data transmitted is assumed.

Microwave Components Catalog, 1978, Omni Spectra Microwave Component Division, Merrimack, New Hampshire.

Omni Spectra is a leading manufacturer of microwave components offering a broad range of products from simple terminations and attenuators to complex microwave integrated circuit assemblies.

Microwave Semiconductor Handbook, HB-400B, Microwave Associates, Inc., August 1976.

This is Microwave Associates 1976 catalog for receiving diodes, control diodes, power generation, and amplification devices, and other special more complex products.

Miller, D. L., Military Satellite Communications Systems, presented at the NTC '76, 29 November - 1 December 1976, pp. 25.1/1-4.

This paper is a brief summary of satellite communication systems used for military application. The subject is presented as a clarification of the numerous military systems and to offer insight as to how and why these systems exist in their current form.

Mittra, R., A Review of Performance Characteristics of Satellite Antennas and Some Observations on Future Directions in Satellite Antenna Design, Eascon '77. pp. 25-2A/8, 26-28 September 1977.

A general review of the state-of-the art and new directions in research and development of spacecraft antennas is presented. Three general classes of antennas are discussed: phased arrarys, lenses (dielectric and waveguide), and reflector antennas. Presently, the antenna with most applications is the reflector with considerable research being performed to improve its scan and multiple beam characteristics. Future applications for spacecraft antennas and research goals to meet these projected needs also are discussed.

Mohanty, N. C., Multiple Frank-Hiemiller Signals for Multiple Access Systems, IEEE Transactions on Aerospace and Electronic Systems, Vol. AES-11, No. 4, July 1975, pp. 622-628.

In view of the fact that the Frank-Hiemiller (FH) signal has the property that its periodic autocorrelation is zero, it is desirable to generate multiple FH signals for possible use in a multiple-signal environment and, in particular, in multiple-access communication systems. These multiple FH signals are generated by tranformation of an FH matrix whose consecutive rows describe an FH signal. The periodic and nonperiodic autocorrelation and cross correlation of the multiple FH signals are derived. It is shown that the periodic autocorrelation of multiple FH signals preserves the ideal properties of FH signals, and nonperiodic cross correlation is bounded by $1/\sin(n/\pi)$, where n is the number of phases. In this context, a formula for nonperiodic autocorrelation for FH signals is derived and plots of the autocorrelation of FH signals of length 81,100 and 121 are given. The bound derived for the periodic and nonperiodic cross correlation is applied to find the performance of multiple-access spread-spectrum satellite communications.

Mohanty, N. C., Spread Spectrum and Time Division Multiple Access Satellite Communications, IEEE Transactions on Communications, Vol. COM-25, No. 8, pp.810-815, August 1977.

Although TDMA satellite communications provides the highest traffic capacity per satellite and offers efficient transmission of a wide variety of services, it suffers from network timing and ranging requirements and message security. On the other hand, spread spectrum multiple access (SSMA) satellite communications is suited for reliable random access and factual transmission systems. Orthogonal functions such as Rademacher, Haar, and Walsh or pseudonoise sequent coding of amplitude and phase of the analog message or code division of baseband signals, frequency and time hopping are among the several methods employed for spread spectrum communications. A combination of TDMA and SSMA can be used for asynchronous and reliable transmission of digital or analog signals.

Morrow, W. E., Jr., Communications Satellite Systems in the 1980's, Lincoln Laboratory, presented at the NASA 14th Annual Goddard Memorial Symposium, 12 March 1976.

Initially the objective in the communication satellite efforts was that of transoceanic multi-channel voice and TV transmission between fixed locations. There is general agreement today that this objective has been successfully achieved with the operation of the INTELSAT system. In addition initial efforts have begun on various types of domestic multi-channel communications satellite systems.

Morrow, W. E., Jr., Technology for Future Satellite Communication Systems, Space Applications Board Committee on Satellite Communications, Lincoln Laboratory, 1976.

This paper discusses technology opportunities for advanced satellite communications systems. E. Rechtin's ideas have been incorporated in this discussion.

Muratani, T., Satellite Switched Time - Domain Multiple Access, Eascon 74, pp. 189-196.

Three key elements of the SS-TDMA system are discussed. For the microwave switch matrix various types of redundance are presented and evaluated. The distribution control unit, consisting of a small number of MOS/LSI chips, will be able to achieve reliability objective with small weight and power consumption. The frame synchronization techniques are also categorized and evaluated. A capacity comparison of SS-TDMA and FDMA/TDMA satellites shows an increase of over 30 percent in available capacity through the adoption of the SS/TDMA system.

Nackoney, O. G., CTS 11.7 GHz Propagation Measurements - First Year Data Report, TR 78-471.1, GTE Laboratories, Waltham, MA, September 1978.

This report gives the results of a project conducted by GTE Laboratories to measure the 11.7 GHz CTS beacon rainfall induced attenuation at Waltham, MA. It includes a description of the receiver terminal and data collection system. A summary of the first year's data is reported and statistics for attenuation and rainfall are presented. Prediction techniques which may be useful in determining attenuation from rainfall statistics are discussed. Also covered are general observations concerning the character of fade events, including signal enhancement observed at the GTE Labs terminal.

Nakatani, D. T., and Flateau, S. L., Multiple Beam Antenna Design for Satellite Communication Systems, presented at the ICC '77, June 12-15, 1977, pp. 317-321.

A lightweight, low loss antenna system that adapts on command to changing communication scenarios is described. The heart of the antenna system is a low loss, thermally stable beam forming network which in conjuncation with a wideband focusing lens provides variable average beams. The beam forming network is fully flexible in transmitting or receiving or receiving energy from 61 feed horns to create narrow spot beams, area coverage beams, on earth coverage beam and combinations of area coverage with multiple spot beams.

NATO, The Impact of Future Developments in Communications, Information Technology and National Policies on the Work of the Aerospace Information Specialist, AGARD Conference Proceedings, No. 228, September 1977.

The role of the information specialist is undoubtedly changing with the advent of the rapid development of new communication techniques combined with greatly reduced unit costs of communication hardware and it may also be desirable for him to influence their future course. The theme of this meeting was to identify the main trends in communications and information technology, to assess their impact on the information specialists, and to consider what other developments might be desirable, particularly in relation to aerospace scientific and technical information. To this end, it brought together those in the forefront of these technologies and the information specialists who will have to make use of them, or provide complementary services, in order that each may benefit from the others knowledge and experience. In addition, a number of papers outlined national plans for the future of their scientific and technical information activities.

Ng, S. F. W., and Mark, J. W., A Multiaccess Model for Packet Switching With a Satellite Having Some Processing Capability, IEEE Transactions on Communications, Vol. COM-25, No. 1, January 1977, pp. 128-169.

A multi-access model for packet switching with a satellite having the capability of interrogating the uplink header and creating the downlink header is proposed. The satellite broadcasts slot assignments, based on the users' reported queue status, to the users for transmission in the next frame. With the protocols being done at both the earth stations and at the satellite, the proposed multi-access model avoids collisions that are prevalent in schemes of the ALOHA type.

Ng, S. F. W. and Mark, J. W., A New Multi-Access Model for Packet Switching With an Intelligent Satellite, International Conference on Computer Communications, 1976, pp. 117-122.

A new multi-access model for packet switching with an intelligent satellite is proposed. The satellite broadcasts slot assignments, based on the users' reported queue status, to the users for transmission in the next frame. With the protocols being done at both the earth stations and at the satellite, the proposed multi-access model avoids collisions that are prevalent in schemes of the ALOHA type. The actual model is too complex to handle analytically. Analytical equations for a two-group model are derived. Calculated and simulated buffer overflow probabilities as a function of traffic intensity and buffer size are compared. Also evaluated by means of computer simulation is the performance of the actual model in terms of average system delay as a function of traffic intensity.

Nichols, S., et al., Alternative Communication - Satellite Configuratins, Volume 1 - System Concepts and Evaluations, Naval Research Laboratory, September 13, 1977, Washington, DC.

A review of potential threats and the vulnerability of spacecraft followed by an examination of potential reductions in vulnerability obtainable through a departure from orthodox systems and orbital parameters is pursued. Alternative configurations are presented based on the premise that the space shuttle will provide opportunities for a more creative approach to space-system design. Relative vulnerabilities of six classes of satellite constellations along with the conventional synchronous equatorial orbit are compared in light of the more likely threats. Establishment of communication links, complexity of networks and system performance are assessed with respect to proliferation and alternative routing as means of decreasing system vulnerability. A conceptual spacecraft design is developed to illustrate a space subsystem meeting the typical communications requirements with decreased vulnerability. Conclusions and recommendations are offered to suggest a departure from the present evolutionary trends and identify new concepts to be pursued for Navy communications satellites.

Nosaka, K., and Muratani, T., G5 - New Satellite Transponder with Regenerative Repeater and Higher Order DPSK for TDMA/SDMA System, Telecommunications Numeriques par Satellite, pp. 460-468.

A new satellite transponder with a regenerative repeater and the associated transmission system of double differential encoded PSK (2nd order DPSK) signal are proposed and they are applied to the TDMA/SS/SDMA system. This newly proposed system has many advantages in respect to the satellite configuration and earth station equipment.

Noweck, H. E., A Prospectus for the Evolution of the CCIS Network, Presented at the NTC '78 Conference, 3-6 December 1978, paper 31.4.

This paper gives the planned evolution of the signaling network starting with the existing toll Common Channel Interoffice Signaling (CCIS) network and ending with a hierarchical signaling network configuration comprising a toll signaling traffic level and a metropolitan signal traffic level which are interconnected. Conceptually, the configurations for each level are identical.

Nuspl, P.P., Proposed Experiments in Regional TDMA With Demand Assignment, Communications Research Centre Canada, Les Systemes, (c. 1974), pp. 18-25.

The Communications Research Centre is planning to carry out a series of experiments to investigate the application of Time-Division Multiple Access (TDMA) to satellite communications. These experiments will make use of the Communications Technology Satellite to be launced into geostationary orbit in 1975. The spacecraft development is a joint program between Canada and the United States to explore the application of developments in advanced technology to satellite communication systems. Recently, ESRO (European Space Research Organization) has joined the program to space-test some key hardware items. This paper is confined to discussions of the proposed TDMA experiments and relevant spacecraft and ground station parameters.

Nuspl, P. P., et al., Synchronization Methods for TDMA, Proceedings of the IEEE, Vol. 65, No. 3, March 1977, pp. 434-444.

A survey is given covering synchronization techniques for large-capacity time-division multiple-access (TDMA) systems using geosynchronous satellites. Five important classes are identified and compared. Also, several methods of initial acquisition are described. The fundamentals of multiple access and TDMA in particular are presented. Summary descriptions and comparisons of the TDMA systems developed to date are given for experimental, prototype and operational systems. Some important related technologies are introduced. It is concluded that TDMA is in a maturing period.

Opferman, D. C., and Tsao-Wu, N. T., On a Class of Rearrangeable Switching Networks - Part I: Control Algorithm, The Bell System Technical Journal, Vol. 50, No. 5, May-June 1971.

An algorithm is developed to control a class of rearrangeable switching networks, particularly with the base-2 structure. Various methods of implementing this algorithm are also described. System organization and processing time for rearranging the network are studied and shown to be practical. This paper begins with a brief discussion of the general structure of RSNs, followed by the development of a method for the control of these networks and its practical implementation. The relationship between the network structure and the ease (or difficulty) with which it can be controlled are also be discussed.

Payne, J. W., CCIS Network Administration, Presented at the NTC'78, 3-6 December 1978, Paper 31.5.

With the introduction of the Common Channel Interoffice Signaling (CCIS) Network direct signaling and processing implementation, there is an increasing need to allocate more resources to the administration of the network and the services it provides. The Bell System has given a high priority to this effort and is devoting considerable resources toward the development of systems and methods which will insure that the administration of these services and the CCIS network in general will be performed efficiently and effectively.

Petschacher, R., and Russer, P., Demultiplexer Using Fast Hybrid Integrated ECL-Gates for 1 Gbit/s PCM Signals, 7th European Microwave Conference (MICROWAVE '77), 5-7 September 1977.

This paper describes a demultiplexer combined with a clock regenerator for 1 Gbps PCM signals. The demultiplexer divides the incoming signal into four parallel 250 Mbps channels using fast hybrid integrated ECL-gates with rise time of less than 400 ps. All clock signals needed to drive these gates are extracted from the input signal by a phase locked loop using two frequency doubler stages between the local oscillator and the phase detector. Since the logic levels and supply voltages of the hybrid integrated ECL-gates are fully compatible with those of monolithic integrated ECL circuits, such ECL-circuits can be directly connected to the outputs of the demultiplexer.

Philco-Ford Corporation, Computer to Computer SATCOM Link-Final Report, WPL-TR 2437, 15 July 1970.

This final report describes the work performed on the SATCOM Computer-to-Computer Data Link. The system is a high data rate (> 50 kbps), extremely low error rate communications link accomplishing the transmission of large quantities of computer data between two mutually remote locations via a satellite link. The system was designed with four major goals in mind: (1) provide an efficient and reliable hardware design, (2) provide a good software design, both in terms of proper and efficient data handling and in terms of providing an efficient and easy man-machine interface, (3) provide a high-efficiency, high-speed tape data transmission system, and (4) provide a low error rate link to provide almost error free data transmission. All four goals were achieved in this study.

Philco-Ford Corporation, Time Division Multiple Access Modem for Communication Satellite Links - Final Report, WDL-TR 4361, 25 November 1970.

This final report summarizes the work performed on an experimental TDMA communications link for use with the Defense Satellite Communications System (DSCS). The principal goals in this program were to: (1) develop a system to improve the efficiency of existing communication satellite links, (2) design, develop, fabricate, test and deliver two complete modems capable of satisfying the first goal, and (3) develop the system to accomodate a broad range of users (small and large). All three goals were achieved in this study.

Pool, S., et al., The Implementation for American Foreign Policy of Low-Cost Non-Voice Communication, A Report to the Department of State, PB-256 064, M.I.T., October 1975 (3 Volumes).

The paper is about the possible effects on international relations of certain new technologies of communication specifically, data communication via computer networks, packet switching and satellites. Technology exists today that would, if used, reduce the cost of global teletypewriter communication to levels apprxoimately like the present costs of the mails or local telephoning. Such low cost, high speed, long distance communication facilities would if implemented, profoundly modify patterns of international interaction in business, science, and government. The report attempts to outline, for the benefit of the State Department some facts regarding the technology of low cost transmission of text and their implications. It also outlines policy alternatives that the Department should consider.

Ramasastry, J., et al., Advanced Westar SS/TDMA System, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 36-43.

This paper presents an overall description of Western Union's Satellite Switched/Time Division Multiple Access (SS/TDMA) system. This combined C/K band satellite system is based on a shared mission concept with NASA's Tracking and Data Relay Satellite System. This paper also presents a system design and equipment description that is cost effective and efficient.

Reber, E. E., et al., On Rainfall and Space Diversity for Millimeter-Wave Earth-Satellite Communications Systems, NTIS AD-757-506, Aerospace Corporation, 15 March 1973.

Space diversity, i.e., the use of several widely spaced terminals, is examined as a means of reducing the probability of simultaneous rainfall in milimeter-wave earth-satellite communications systems. The concept of space diveristy, both as a function of the distance between terminals and the number of terminals is examined on the basis of hourly rainfall data for the 10 year period from 1 January 1960 through 31 December 1970. The probabilities of simultaneous rainfall occuring in a space diversity system are shown to be a systematic function of the spacing and number of terminals in the system.

Reinhard, K. L., Analysis of a Pseudo-Random Network Timing Systems for Time-Division Multiple Access Communications, RADC-TR-67-364, September 1967.

A technique for establishing time synchronization in a Time-Division Multiple Access communications system is described and analyzed. The technique involves the transmission and correlation reception of a network timing signal. The timing signal consists of a pulsed envelope carrier bi-phase modulated by a maximum-length pseudo-random sequence. Tracking of the pseudo-random timing signal is accomplished in an envelope correlation delay-lock receiver. Expressions for the rms timing error in the presence of additive Gaussian noise are derived. The expressions indicate the dependence of timing error on pseudo-random bit duration and code length, receiver IF bandwidth, and the ratio of input signal power to noise power density.

Reinhart, E. E., Multiple Access Techniques for Communications Satellites: Analog Modulation, Frequency-Division Multiplexing, and Related Signal Processing Methods, RM-5117-NASA, RAND Memorandum, December 1966.

This memorandum provides an elementary comparison-oriented description of analog modulation methods and the techniques of multiplexing and signal processing normally employed with them.

Reudink, D. O., Problems and Challenges in Satellite Communications Frequency Reuse - Antennas and Components, Microwave Symposium, IEEE MTT-5 International 1976.

There are at present three frequency bands allocated for communication satellites in the U.S. The first frequency is at 4/6 GHz with a 500 MHz bandwidth available. These satellites are basically frequency translators with saturating amplifiers using 40 GHz wide channels. The second frequency is from 11.7 - 12.2 GHz downlink and 14.0-14.5 GHz uplink. Although this band is also 500 GHz wide, it is possible to achieve moderately high capacity systems through polarization and spatial frequency reuse. The third and highest frequency band allocated for communication satellites has 2.5 GHz bandwidth with the uplink nominally at 30 GHz and the downlink at 18 GHz. This paper shows how highly reliable service can be provided without the need for diversity earth stations.

Reudink, D. O., Spot Beams Promise Satellite Communication Break Through, IEEE Spectrum, September 1978, pp. 36-42.

In satellite communications, wide-area coverage and high antenna gain are generally mutually exclusive. For wide-area coverage, the emergency technology of TDMA utilizes a satellite's resources very efficiently, but at a cost of straining today's satellite technology to improve signal gain. High antenna gain is possible using another emerging technology, spot-beam antennas, but their coverage is limited to smaller geographic areas. Now a technique has been found that uses TDMA to provide high antenna gain over a wide area of coverage. This technique uses scanning spot-beam antennas.

Reudink, D. O. and Yeh, Y. S., A Scanning Spot-Beam Satellite System, The Bell System Technical Journal, Vol. 56, No. 8, October 1977, pp. 1549-1560.

Proposed is a satellite with a high gain, movable spot beam to communicate with individual earth stations time-sharing a single channel in the TDMA mode. It is estimated that this approach could readily save some 20 dB in the link budget while still providing full U.S. coverage. When this 20 dB is apportioned with the objectives of reducing the earth-station antenna size, increasing the satellite capacity and reducing transmitter power, the effects are dramatic. This technique can be combined with a fixed-spot beam serving major traffic areas. This combination can provide both full area coverage as well as multiple reuse of the frequency band. A TDMA burst organization is proposed and estimates of burst lengths, beam switching intervals and buffer storage size are made for a 100 earth-station networking operating on a 600 Mbps channel. A phased array antenna with each element irradiating the entire U.S. is employed to form the movable spot-beam. This provides an attractive solution even though a closed-loop beam-forming algorithm may be required. It appears feasible to construct such an antenna with nearly 50 dB gain capable of forming a spot beam toward any position within the continental United States with a switching time of a few nanoseconds.

Reudink, D. O., and Yeh, Y. S., A Rapid Scan Area-Coverage Communication Satellite, Paper no. 78-548, Presented at the AIAA 7th CSS Conference, 24-27 April 1978.

A TDMA burst organization is proposed, and estimates of burst lengths, beam switching intervals, and buffer storage size are made for a network operating on a 600 Mb/s channel. Antenna configurations forming rapidly scanned spot beams are discussed. A phased array with each element radiating over the entire U.S. appears to provide an attractive solution. An antenna capable of forming 100 spot beams with nearly 50 dB gain toward any point on the continental U.S. appears feasible.

Reudink, D. O., et al., Spectral Reuse in 12 GHz Satellite Communication Systems, presented at the ICC '77, June 12-15, 1977, pp. 32-35.

This paper examines the system implications of multiple spot beam frequency - reuse satellite systems. Several problems unique to such systems are identified and possible solutions are discussed.

Reudink, D. O., et al., Methods for Achieving High-Capacity Universal Service Satellites, Presented at the NTC'78, 3-6 December 1978, Paper 8.2.

A scanning beam which scans the entire country utilizes the frequency spectrum only once and is therefore limited in its capacity. It is possible to combine fixed spot beams together with a scanning spot beam to create a very large capacity satellite system. This would be achieved by having the spot beam utilize one polarization and the scanning beam the other. Interconnection would be accomplished through an on-board satellite switch. Several of the details of a hybrid spot beam scanning beam system are examined. If one envisions multiple scanning spot beams, then it is possible to achieve not only high capacity but also high transponder efficiency. Those things required to achieve a satellite system which has multiple, fully steerable scanning spot beams are examined and the implications and advantages of such a system in serving a broad spectrum of temporally and spatially varying traffic are discussed.

Rhodes, S. A., Preamble Requirements for Burst-Type QPSK Satellite Communications Under Low Es/No Conditions, COMSAT Laboratories presented at the NTC '77, December 5-7, 1977.

Preamble requirements for carrier synchronization are investigated for QPSK burst communications via satellite in which carrier phase is acquired independently on each received burst. Typically, a fourth-power operation is used for modulation removal so that the carrier phase may be tracked throughout the modulated message burst. When synchronization must be acquired under low Es/No conditions which might be the case when FEC coding is necessary for reliable communications, use of the fourth-power method of modulation removal results in very long preamble requirements. A combined modulation removal technique that utilizes squaring during a BPSK preamble and squaring plus decision feedback during the QPSK message burst allows reliable carrier synchronization with preambles of moderate length even with low Es/No.

Roberts, L. G., Dynamic Allocation of Satellite Capacity Through Packet Reservation, National Computer Conference, 1973, pp.711-716.

If one projects the growth of computer communication networks like the ARPANET to a worldwide situation, satellite communication is attractive for intercommunicating between the widespread geographic areas. For this variable demand, multi-station, data traffic situation, satellites are uniquely qualified in that they are theoretically capable of statistically averaging the load in total at the satellite, rather than requiring each station or station-pair to average the traffic independently. However, very little research has been done on techniques which permit direct multi-station demand access to a satellite for data traffic. For voice traffic statistics, COMSAT Laboratories has developed highly efficient techniques: the SPADE system currently installed in the Atlantic which permits the pooled use of 64 kb PCM voice channels on a demand basis, and the MAT-1 TDMA (Time Division Multiple-Access) experimental system. Both systems permit flexible demand assignment of the satellite capacity, but on a circuit-switched basis designed to interconnect a full duplex 64 kb channel between two stations for minutes, rather than delivering small blocks of data here and there. This work forms the technical base for advanced digital satellite communication, and provides a very effective means for moving large quantities of data between two points. However, for short interactive data traffic between many stations, new allocation techniques are desirable.

Rozec, X., and Assal, F., Microwave Switch Matrix for Communications Satellites, IEEE International Conference on Communications, 1976.

A lightweight, low-power-consuming, 16x16 microwave switch matrix has been designed for communications satellites at 3.95 GHz center frequency. The design approach has adopted a cross-bar configuration in MIC to provide full interconnect flexibility within the 500 MHz communications band.

Rubin, I., Group Random Access Disciplines for Multi-Access Broadcast Channels, UCLA-ENG-7745, University of California, School of Engineering and Applied Science, June 1977.

A Group Random-Access (GRA) access control discipline for a multi-access communication channel is presented and studied. A GRA scheme uses only certain channel time periods to allow some network terminals to transmit their information-bearing packets on a random access basis. The channel can thus be utilized at other times to grant access to other terminals, or other message types by applying, as appropriate, group random-access, reservation or fixed access-control procedures. GRA schemes could also be utilized to provide channel access to various network protocol packets. The average packet delay under a GRA discipline is evaluated by a Markov ratio limit theorem. To stabilize the channel the GRA procedures is controlled dynamically by a control policy which repeats any newly arriving packets within certain time periods. Studying the associated Markov decision problem, the optimal control policy is characterized as yielding a minimal average packet delay under a prescribed packet probability of rejection. This policy is shown to be a single-threshold scheme for which there exists a threshold value which attains the minimum probability of rejection. Performance curves are presented to demonstrate the excellent delay-throughput characteristics induced by GRA procedures.

Rubin, I., Integrated Random-Access Reservation Schemes for Multi-Access Communication Channels, UCLA-ENG-7752, University of California, School of Engineering and Applied Science, July 1977.

Integrated Random-Access Reservation (IRAR) access-control schemes, for multi-access communication channels, are presented and studied. Under an IRAR scheme, newly arrived packets can be designated for reserved or random-access transmission. In the latter case, if a collision occurs, each colliding packet is assigned for transmission by reservation, rather than attempt another random-access transmission.

Rusch, R. J. et al., INTELSAT V Spacecraft Design Summary, Ford Aerospace & Communications Corporation, 1978.

This paper describes the technical aspects of the Ford Aerospace & Communications Corporation's current design of INTELSAT V, the largest commercial communications satellite ever designed and built for the INTELSAT. The spacecraft system design concept is described with emphasis on key technologies utilized to configure the total spacecraft. Key systems aspects include a design summary with discussion of the communications, controls, telemetry, command and ranging, power, propulsion and thermal subsystems as well as spacecraft-peculiar operational characteristics. Key technologies include use of graphite fiber reinforced plastics, contiguous band output multipliers, dual-polarization multiple-shaped antennas, dual-collector 11 GHz traveling wave tubes and electrothermal thrusters.

Rydbeck, N., and Sundberg, C. E., PCM/TDMA Satellite Communications Systems with Error Correcting and Error Detecting Codes, Sweden: Ericson Tech, Vol. 32, No. 3, pp. 195-247.

The effects of digital errors are analyzed for both uncoded and coded nonlinear PCM systems. Simple formulas for the digital noise are derived. The formulas are applicable for both block codes and convolutional codes. The effects of digital errors change with the input signal level. This is investigated for both natural binary PCM and binary folded PCM. The effects of digital errors in PCM systems modulated with differentially encoded 4 phase modulation are investigated. Both differentially coherent and coherent demodulators are considered.

Sanborn, P. M., USN, Unique Words for Identification and Synchronization in TDMA Satellite Communications Systems, Master's Thesis, Naval Post-Graduate School, Monterey, California, AD-784-762, June 1974.

In a TDMA system, many transmitting stations time share the same RF spectrum. Individual transmissions must be identifiable to distant receiving stations and must be synchronized so that no interference overlap occurs. A unique word sequence can serve both purposes. The basic concepts of a satellite communications TDMA system are briefly reviewed, with emphasis on functional receiver requirements. A correlation detection scheme is hypothesized from which false and misdetection probability expressions are derived. Criteria are then established for the selection of sequences suitable for use as unique words. Representative unique words of length 15 through 20 are included, along with an explanation of the difficulties encountered in devising an efficient computer search routine.

Saruwatari, T., et al., Digital Transmission Experiments with the CS Satellite, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 283-290.

The Japanese medium-capacity communications satellite for experimental purpose (CS) was launched on December 15, 1977 and put into the geostationary orbit on 24 December. There are six K-band (30/20 GHz) transponders and two C-band (6/5 GHz) transponders on the CS equipment platform. An experimental plan has been prepared by the Radio Research Laboratories (RRL), Ministry of Posts and Telecommunications of Japan and involves many kinds of digital communications experiments. They are PSK fundamental transmission tests, PCM-PSK (telephone) communication experiments, HO-DPCM-PSK (television) communication experiments, PCM-PSK-TDMA communications experiments involving site diversity switching techniques, M-PSK-SCPC experiments, and digital SSRA experiments.

Schmidt, W. G. and Cooperman, R. S., A Satellite Switched SDMA/TDMA System for a Wideband Multibeam Satellite, presented at Proc. Inter. Conf. Comm., June 1973.

Communications traffic studies indicate that the next generation of INTELSAT satellites can be expected to utilize wideband multibeam communications equipment. This paper outlines a complete satellite switched SDMA/TDMA communications system designed to operate with this next generation of satellites. Three major topics are discussed: the earth terminals, the spaceborne equipment, and the traffic allocation techniques. The interconnectivity between the various spot beams and between different communications bands is provided by a spaceborne distribution center.

Schmidt, W. G., An On-Board Switched Multiple Access System for Millimeter Wave Satellites, in Proc. INTELSAT/IEEE Conf. 1969, pp. 399-407.

As the spectrum allocations in the 46 GHz region become less available and more precious, there is considerable interest in the possibilities afforded by use of the millimeter wave region for satellite communications. While the spectrum allocation potentially available in this region is significantly greater than that of the 4-6 GHz region, there are a number of technical problems associated with millimeter wave communications systems. However, one bright spot is that antennas in this region can be smaller with equivalent gain and more amenable to the development of multiple highly directive spot beam patterns. A satellite employing such multiple spot beam antennas for both receive and transmit functions would be capable of effective reuse of portions of the spectrum that would not be available if only global coverage antennas were utilized by the satellites. This paper describes a multiple access technique which enables optimal use to be made of the highly directive properties of millimeter wave technology to achieve this saving in frequency spectrum.

Schmidt, W. G., Satellite Time-Division Multiple Access Systems: Past, Present and Future, Telecommunications, Vol. 7, No. 8, August 1973, pp. 21-24.

As both satellite and earth station technologies associated with commercial satellite communications mature, there is a noticeable trend toward digital transmission for a variety of reasons. For the terminals with medium to heavy traffic loads, the use of TDMA promises a maximum utilization of existing satellite capacity, minimum uplink power control and a highly flexible means for handling any type of traffic (e.g., voice data, facsimile, or TV) in any required mode of operation (preassignment, time assignment or demand assignment). A brief survey is presented of the development of TDMA technology and a glimpse into the future of such work, such as satellite-switched TDMA.

Schmidt, W. G., Satellite Switched TDMA Transponder Switched or Beam Switched, Paper No. 74-460, AIAA 5th Communications Satellite Systems Conference, Los Angeles, CA, April 1974, pps. 22-24.

For satellite communications in the 1980's there is a strong trend toward wideband communications packages utilizing a multiplicity of narrow high powered beams. There are numerous advantages to this trend; a disadvantage, however, is the burden this technology places on the interconnection flexibility of the satellite. To restore this interconnection flexibility, an on-board real-time time division multiple access (TDMA) communications system linking the stations has been proposed. This approach has been broadly termed satellite-switched TDMA (SS-TDMA) and is based upon the switching occuring between multiple transponders, each with fixed antenna pointing, Another class of SS-TDMA incorporates individual transponders with variable antenna pointing (beam-switched). This paper explores and develops the conceptual configuration and technology base for both types, considers the use of on-board regeneration, and closes with a treatment of the advantages of SS-TDMA to mobile and military satellite communications.

Schnieder, K. S., and Katz, J. L., A Comparison of Satellite Processing Techniques for the Coherent Additive White Gaussian Noise Channel, NTC 77.

With conventional repeater satellites uplink performance is not independent of downlink performance. Deleterious effects occurring on the uplink are translated to the downlink. By carrying out signal processing on-board the satellite the dependence between uplink and downlink performance can be reduced. Such processing adds to the complexity of the satellite. It also inherently denies the downlink user statistical information about the uplink transmission process. However, its net result may possibly be to provide an increase in overall communication efficiency.

Schneider, K. S., Optimum Demodulation of Code Multiplexed Signals, Presented at the NTC '78, 3-6 December 1978, Paper 20.2.

In this work two new receiver processors are derived for code division multiplexed signals. The first addresses the situation in which the code division multiplexed signals are all synchronized. The second addresses the asynchronous case. Both operate by demodulating all signals together. The performance attained in both cases is optimum. The processors provide a significant advantage over the commonly employed technique of demodulating each signal individually.

Schreiber, H. H., Communications with Walsh Waves, presented at the 1976 IEEE International Symposium on Electromagnetic Compatibility, Symposium Record, 13-15 July 1976, pp. 258-263.

The spectra of unmodulated Walsh waves radiated from a small electric dipole are computed for ideal and trapezoidal approximations to Walsh function excitation. A link analysis based upon matched filter detection of the radiated Walsh waves received in thermal noise is presented.

Schwartz, J. W., Modulation Techniques for Multiple Access to a Hard-Limiting Satellite Repeater, Proceedings of the IEEE, Vol. 54, No. 5, May 1966, 763-777.

This paper considers the problem of devising modulation techniques that allow a large number of earth stations to use, simultaneously, a satellite repeater with the transfer characteristics of a wideband hard-limiting amplifier. Four distinct classes of modulation techniques and their singular properties are described. Three important design considerations are discussed: repeater bandwidth and power sharing, network timing and operational considerations. The paper provides a framework for further study of the multiple access problem. The hard limiting repeater is shown to accommodate a wide variety of signal designs. No single class of multiple access modulation techniques is found to be uniformly best in satisfying all needs of the diverse networks which can use communications satellites.

Schwartz, R., et al., Theoretical and Experimental Results of a Distributed Serial to Parallel and Parallel to Serial Converter for Gigabit Rates, Presented at the 7th European Microwave Conference (MICROWAVE 77), 5-8 September 1977, p. 537.

This paper presents experimental and theoretical results of an application of the SSL-principle (Series-gate Sampling Line) to the regeneration of fast digital signals. As demonstrated in this document, this procedure allows high speed data processing at gigabit rates by means of a spatial parallel to serial and serial to parallel conversion using Schottky diodes as fast switches between pieces of microstrip lines. Some results of a two year intensive theoretical and experimental investigation of the SSL principle are shown including experiences with a laboratory model of a base-band repeater operating at 1.25 Gbit/s. Preliminary experimental results demonstrate that the bit rate can be extended to 2.5 Gbit/s.

Scott, W. G., et al., Design Tradeoffs for Multibeam Antennas in Communications Satellites, Aeronautic Ford Corporation, 1976.

A TEM lens antenna is described that provides the capability of generating 61 low-sidelobe dual-polarized beams over a 17 degree field of view, at both 4 and 6 GHz. Isolation between these beams is examined and it is concluded that six of the available 61 beams may be used simultaneously in many different positions, while maintaining at least 27 dB isolation, for a total of 12 times frequency reuse.

Sekimoto, T., et al., A Time Division Multiple Access Experiment, ED-17-66, PB 179 201, Computer Sciences Corporation, Washington, DC, 23 April 1968.

This report contains the results of an experiment designed to determine the feasibility and practicality of TDMA as a solution to the problem of multiple access to a communications satellite. Although the concept of TDMA as applied to satellites is well known, experimental data or equipment was not available. Hence, this experiment was necessary in order to judge and compare TDMA to other methods of achieving multiple access.

Shaft, P. D., and Roberts, J. A., Optimum Allocation of Multibeam Communications Satellite Resources, IEEE Transactions on Communications, Vol. COM-24, No. 10, October 1976, pp. 1195-1200.

Future communications satellites can be expected to employ multibeam antennas for both receiving (uplink) and transmitting (downlink). The use of multibeam satellite transmitting antennas raises the question of how to assign the transmitted power and antenna gain to each of the N beams so that optimum use is made of satellite resources. This problem is referred to as the downlink allocation problem.

Sherwin, R. P., and Castro, A. A., Functional Requirements for On-Board Satellite Signal Accessing, Presented at NTC '78, 3-6 December 1978, Paper 40.1.

On-board satellite signal processing (demodulation, remodulation, demultiplexing, combining, decoding) has been utilized on a number of existing and planned military communications spacecraft to perform, for the most part, single specific communications functions. This paper discusses the general functional requirements for satisfying a number of different spacecraft communications applications including: (1) interference rejection, (2) baseband demodulation, combining and remodulation, and (3) on-board switching and rerouting. Each of these capabilities can be treated as common functions and utilized to perform a wide variety of communications applications, possibly on a combined basis.

Shindo, S., et al., A 4-, 6-, 20- and 30-GHz Band Branching Network Using a Multi-Layer Dielectric Filter for a Satellite Communications Earth Station, IEEE Trans. Microwave Theory and Tech., Vol. MTT-24, No. 12, December 1976, pp. 953-8.

This paper describes a four-frequency broad band branching network for transferring microwave (4 and 6 GHz) and millimeter wave (20 and 30 GHz) band signals between an antenna and transmitter/receivers in a satellite communication earth station. A filter for separating the microwave band from the millimeter wave band employs a multilayer dielectric filter with matching layers and is included in the primary antenna feed system. The design method used for the multilayer dielectric filter and the construction and experimental results of the four-frequency broad band branching network are described. Measurements show that its insertion loss, VSWR, and axial ratio are less than 1.2, 1.2, and 2.1 dB respectively.

Shub, L., et al., System Access Control Study, AD-782-256, National Technical Information Service, June 1974.

This report presents a summary of a study conducted for the Transportation Systems Center of promising access control techniques which are applicable to an aeronautical satellite system. Several FDMA and TDMA configurations are analyzed and compared which are capable of providing voice, data, and independent surveillance services. One of the FDMA concepts and a burst TDMA system are rated highest and are presented in greatest detail. Procedures are outlined for different types of entry, beam switching, and handling various types of interconnections. Included are preliminary designs of the avionics instrumentation.

Sinha, A. K., A Model for TDMA Burst Assignment and Scheduling, Comsat Technical Review, Vol. 6, No. 2, Fall 1976, pp. 219-51.

This paper presents a simple mathematical formulation of the problem of time-division multiple-access (TDMA) burst assignment and scheduling for a general communications satellite system including an arbitrary earth station network, beam coverage pattern, and transponder configuration. Relevant concepts of beam overlap (over earth stations) burst overlap (in time) and earth station equipment requirements are introduced and precisely defined. In addition, useful parameters for evaluating the efficiency of system utilization are identified. Finally, a semianalytical algorithm is proposed for scheduling TDMA bursts so that earth segment equipment requirements are minimized and achievable scheduling efficiencies are optimized for a given traffic data base and system configuration. An example of a schedule obtained from a newly prepared computer program based on this approach is presented.

Smart, F. H., The ANIK C 90 Mb/s Digital Service, Presented at the 4th International DSC Conference, 23-25 October 1978, pp. 30-35.

This paper describes some of the features of the ANIK C system and the design choices which Telesat has made in providing message services for heavy-route interconnection between major Canadian cites.

Smith, W. R., Saw Filters for CPSM Spread Spectrum Communication, 77CH 1264-1 SU, presented at the 1977 Ultrasonics Symposium Proceedings, 26-28 October 1977, pp. 524-528.

CPSM spread spectrum wave forms consists of a sequence of contiguous pulses each of which is a short burst at one of two different frequencies. They have the advantage of lower special sidelobes and thus lower cross-channel interference than phase shift key (PSK) waveforms. This paper describes the use of SAW filters in a simple, cost effective modulator and a matched filter for CPSM communications sytems. The modulator converts a baseband binary coded pulse train to PSK and then by means of a SAW filter to CPSM. In the receiver, another SAW filter is used as a matched filter for maximizing the signal-to-noise ratio. It is often desirable to use alternate receiver filter design for additional suppression of spectral sidelobes in order to enhance rejection of interference and jamming signals with only a minimal penalty in signal-to-noise ratio. The SAW filter is ideally suited for this purpose because it is capable of good stopband rejection while maintaining low dispertion in a compact, cost-effective device.

Soref, R. A., Secure Optical Matrix Switch, RADC-TR-78, CR-78-35, July 1978.

Novel fiber-optic switching arrays have been developed to control the network configuration of a secure fiber-optic intercom system. A fiber-linked system containing six optical data terminals was built and has been matrix-switched by a multimode 3 x 2 array constructed in an 80-μm-thick single-crystal $LiTaO_3$ plate. Commercial multimode 0.15 NA fibers, 85-μ-core diameter, have been directly and permanently coupled to the plate ends at the matrix input and output ports, one strand for each data channel. Using oblique incidence, the fiber light cone was collimated by a factor of 2.6 in the crystal. The optical data sources consisted of GaAs LEDs emitting at the 0.90 μm wavelength. Electrically controlled optical switching has been obtained with unpolarized TE- and TM-mode light launched in the crystal.

Stevens, G., and Wright, D., 20/30 GHz Satellite Systems Technology Needs Assessment, National Aeronautics and Space Adminstration - Lewis Research Center, pp. 207-216.

NASA is involved in exploring the potential of the 20/30 GHz bands as evidenced by the propagation work in the ATS series by NASA-Goddard and, more recently, by the systems and market effort by NASA-Lewis. This paper focuses on the system and market work done by NASA-Lewis. Included are results of previous contractual and in-house studies as well as preliminary results of on-going market and system studies. Baseline concepts for evaluating technology needs are also included.

Sullivan, D. P., Future Trends in Military Communication Satellites Repeaters, IEE Trans. Aerospace Electron. System, Vol. AES 6, March 1970, pp. 129-136.

The future development trends in military communication satellite repeaters will be dictated by greater spacecraft capability in terms of payload size, weight, power and complexity. These attempts are to better satisfy the satellite user's needs and desires. This paper presents the basic repeater configurations that have been employed and those that can be expected in the future, along with the user and development constraints on advanced repeater designs. The discussion points out diverging trends in RF frequency to allow easy user pointing and provide greater capacity, the trend toward channelization within the repeater and the various methods used to reduce susceptibility to interference. Examples are given of advanced repeaters which demodulate and process received signals and which route RF signals between antennas. Also discussed is the possibility of employing a large processing ground station and the impact of future repeater configurations on terminal designs.

Tangonan, G. L., Low Power High Data Rate Modulator, Technical Report AFAL-TR-78-74, June 1978, F33615-77-C1007.

This program showed that the present approach to the development of a low-power high data-rate modulator is promising. The critical areas of optical damage, efficient coupling, and electro-optic modulator defection efficiency were addressed, and the state of the art in these areas was advanced significantly.

Taylor, R. C, and Huff, R. J., A Modem/Controller for TDMA Communications Systems, RADC-TR-76-362, December 1976.

This report discusses the design operation and capability of prototype TDMA modems developed for RADC. The applicable acceptance test procedures and both bench and link test data which demonstrate that the modems operate with a high degree of effectiveness are also presented.

Technological Priorities for Future Satellite Communications, Office of the Director, Goddard Space Flight Center, July 1978.

This paper reports an intensive study of technological priorities for future satellite communications performed by GSFC from January through May 1978. A high technology program is recommended for areas such as multibeam antennas component technology and intersatellite links.

Teramura, H., et al., Field Trial for the Digital Facsimile Service Over The Satellite Circuit, Presented at the 4th International DSC Conference, 23-25 October 1978.

This paper describes the international field trial and test results, the features of the Quick-FAX system, and some improvements.

Theis, D. J., Memory Technology Update, TOR-0078 (3475-20)-2, Contract No. F04701-77-C-0078, Los Angeles, CA: The Aerospace Corporation, December 28, 1977.

Both memory chip devices and magnetic memory storage equipment have made significant improvements in the last few years especially in the areas of lower cost per bit and higher disk unit capacity. RAM's dominate the computer main memory designs while disk and tape units predominate the secondary memory needs. The gap in between is characterized by access times of a few milliseconds or less and many devices such as CCDs, Bubbles, EBAM and head memory systems which all use some form of magnetic tape media are surveyed to complete this memory technology update for 1978.

Threewitt, B., Characteristics of CCD Memories with Applications to Communications Systems, presented at the ICC '77, June 12-15, 1977.

The availability of dense, low-cost semiconductor memories has aided the development of sophisticated, reliable intelligent communications networks. Several technologies have emerged for use in computers tailored to communications system needs. Among the lowest in cost is the Charge-Coupled Device (CCD) technique. This paper describes the nature of CCD memories, their architectural characteristics, and some areas where the technique might be applied to network designs.

Utlaut, W. F., Spread Spectrum Principles and Possible Application to Spectrum Utilization and Allocation, Telecommunication Journal, Vol. 45-I/1978.

Because of the continuing demand for more telecommunication capacity, to serve the worlds need for commerce and public safety, there is a continuing need for more efficient ways of sharing the radio spectrum. The conventional way of allocating the spectrum is by frequency division; however, for many kinds of services this is inefficient. Hence, it seems desirable to re-examine whether alternative procedures might not be necessary if the benefits of telecommunications are to be assured in the face of increased demand. Spread spectrum techniques, which are based on principles antithetic to those currently used in spectrum allocation for reducing necessary bandwidth, seem to offer benefits for spectrum sharing, for some applications, superior to those of frequency division. This paper provides a tutorial summary of some of the principles upon which spread spectrum systems have developed.

Uzunoglu, N. K., et al., Scattering of Electromagnetic Radiation by Precipitation Particles and Propagation Characteristics of Terrestrial and Space Communication Systems, Proceedings of IEE, Vol. 124, No. 5, May 1977, pp. 417-424.

The results of applying the Fredholm integral equation method of solution to the scattering of electromagnetic radiation from oblate spheroidal raindrops for the communication bands 4, 6, 11, 14, 20 and 30 GHz are presented in this paper. These scattering amplitudes are then used to calculate propagation characteristics such as attenuation, phase rotation and cross polarization of a rain filled medium. The validity of using the Van de Hulst single-scattering equation is considered and conditions for its use presented. A new and more general relationship between horizontal and oblique propagation characteristics is presented which uses only the horizontal and zenith conditions to derive all others. Using Baussard's meteorological model for raindrops a new and more general model for the medium containing canted raindrops is presented. Attenuation and cross polarization equations are derived for both linear and circular polarization for this model, which assumes a stochastic model for the counting-angle variations. Finally, the specific cases of terrestrial radio relay links and satellite communication links are considered and detailed results presented for each. A comparison of the theoretical results with experimental results for linear and circular depolarization at 11 GHz is also given.

Van Tuyl, R., and Liechti, C., Galleum Arsenide Spawns Speed, IEEE Spectrum, March 1977, pp. 41-47.

High-frequency circuit and system designers now have an important new tool in their arsenal of technologies. Monolithic galleum-arsenide (GaAs) digital ICs have emerged, bringing with them the promise of milligigabit and higher data rates beyond the reach of present silicon-based integrated circuits. Applied to future systems, the new circuits would go a long way toward slashing the size, weight and eventually the cost of high-frequency electronic equipment, and, in the process, vastly enhancing the capabilities of equipment spanning the commercial and military worlds. The subject of this article is digital monolithic ICs built with the GaAs MESFET, (metal-semiconductor field-effect transistor) a type of junction field-effect transistor particularly suited to fabrication of GaAs, and one that can function as a microwave amplifier or subnanosecond switch.

C-2

Verma, S. N., and Fraley, D., Sixty-Two Mb/s Transmission Via Westar Satellites, presented at the NTC '78, 3-6 December 1978, paper 11.2.

This paper describes the test system configuration major subsystems, including the developed digital speech interpolations, TDMA MU/DUX and the CITE simulator. Test results are also briefly described.

Viterbi, A. J., Modulation Considerations for Processing Satellites, presented at the 1976 IEEE Region Six (Western USA) Conference on Energy for the Future, 7-9 April 1976, p. 210.

Present day communication satellites employ linear or limiting repeaters with virtually no signal processing capabilities. In constrast, the future military satellite repeater will generally contain a signal processor capable of acquiring signal parameters and using these to reduce the effects of interference. Demodulation and even decoding of coded signals in the satellite will improve performance and decrease uplink and downlink transmitter power and antenna gain requirements. The choice of modulation is critical to performance enhancement by a processing repeater, particularly in an airborne environment perturbed by fading, scintillation and international interference. Multiple frequency shift keying (MFSK) with time and frequency diversity is shown to be a rugged modulation technique for all these forms of interference. A comparison between simple binary FSK and diversity MFSK is drawn which shows dramatic improvements (on the order of 10 to 15 dB) possible with the latter in a processing satellite demodulator. Simple coding with decoding by the satellite processor provides further improvements of 3 to 4 dB. This additional processing also has the advantage of decoupling the uplink and downlink interference and their cumulative effect on the link, which demodulation processing alone does not achieve.

Viterbi, A. J., Error Bounds for Convolutional Codes and an Asymptotically Optimum Decoding Algorithm, IEEE Transaction Information Theory, Vol. IT-13, No. 2, April 1967.

The probability of error in decoding an optimal convolutional code transmitted over a memoryless channel is bounded from above and below as a function of the constraint length of the code. For all but pathological channels the bounds are asymptotically (exponentially) tight for rates above Ro, the computational cutoff rate of sequential decoding. As a function of constraint length the performance of optimal convolutional codes is shown to be superior to that of block codes of the same length, the relative improvement increasing with rate. The upper bound is obtained for a specific probabilistic non-sequential decoding algorithm which is shown to be asymptotically optimum for rates above Ro and whose performance bears certain similarities to that of sequential decoding algorithms.

Viterbi, A. J., and Odenwalder, J. P., On-Board Signal Processing Satellites, presented at the NTC '77, December 5-7, 1977.

This paper is a summary of several important ways in which on-board signal processing increases the utilization capabilities and system flexibility of multiple access communication satellites.

Ward, W. W., et al., The Results of the LES 5 and LES 6 Experiments, Technical Note 1970-3, Lincoln Laboratory, 6 February 1970.

The RFI environment near synchronous orbital altitude in the band 255-280 MHz was measured by subsynchronous Lincoln Experimental Satellite #5 (LES 5). Similar measurements covering the band 290-315 MHz have been made by Station-Kent LES 6. These experiments are a joint effort between the MIT Lincoln Lab and/or Aerospace. The success of the LES 5 and LES 6 RFI experiments shows that it is practical to monitor the level of activity in selected bands of the communication spectrum, throughout wide portions of the earth from synchronous orbit. This capability may be useful in the management of portions of the electromagnetic spectrum where frequency allocations are at a premium.

Waser, S., State-of-the-Art in High Speed Arithmetic Integrated Circuits, Computer Design, July 1978, pp. 67-76.

Use of bipolar technology to construct arithmetic ICs has resulted in devices with increased switching speed and gate density and low power dissipation. Future technological advances should have an even greater impact through larger chip diameters and sharper pattern fabrication.

Washburn, C. L., Westar Operations as Part of the Western Union Integrated Transmission System, presented at the AIAA 7th COMSAT System Conference in San Diego, 1978, pp. 86-96.

Most of the common carriers currently offering communications services specialize in satellite facilities or terrestrial facilities but not both. In selected cases common carriers have neither satellite nor terrestrial facilities, lease facilities from others and provide communication services on an "added value" basis. It is becoming increasingly clear that the broad spectrum of communication services required by the user dictates that the common carrier have available satellite facilities, terrestrial facilities and in addition, local distribution facilities. All three types are generally required to provide end-to-end user service. In fact, ownership of local distribution facilities is becoming increasingly important because of the increasing user cost to lease these facilities. This paper covers Western Union's response to these requirements with a brief description of its satellite terrestrial and local distribution facilities. Also presented is the manner in which these facilities have been developed into an integrated transmission and switching system for end-to-end service. Some specific examples are given of innovative services which have only been possible through a full integration of these facilities.

Watanabe, T., et al., Space Diversity System for TDMA Satellite Links, presented at the 4th International DSC Conference, 23-25 October 1978, pp. 319-326.

This paper discusses space diversity techniques for overcoming deep fades due to precipitation in TDMA satellite links operating at frequencies above 10 GHz. Diversity operation with error-free switching can be realized by using digital delay circuits to equalize diversity path lengths without changing the TDMA terminal. Prime and backup logic and the constant number method of BER, which has good response to fade variation, are preferrable for diversity switchover. A proposed diversity system using a microwave link is presented as an example.

Waylan, C. J., Intermodulation Degradation to PSK Signals in a Communication Satellite, presented at the NTC 76, 29 Nov. - 1 Dec. 1976, pp. 43.5/1-5.

Advanced satellite designs employing techniques other than the traditional FDMA/FDM transponder signalling (e.g., FDMA uplink, processing and TDM downlink) offer promise in mitigating intermodulation product effects. However, the terminal modifications required are likely to be costly and the technology for this type of satellite may be a decade or more away. The remaining techniques that are effective for UHF tactical military satellites are related to satellite construction.

Webb, P. R. W., Military Satellite Communications Using Small Earth Terminals, IEEE Transactions on Aerospace and Electronic Systems, Vol. AES 10, No. 3, May 1974, pp. 306-318.

Satellite communications technology has reached the stage at which it is feasible to develop military tactical communications systems using small transportable earth terminals. This paper discusses the design considerations involved for a multiple-access system with particular reference to the earth terminals.

Weber, W. J., III, et al., A Bandwidth Compressive Modulation System Using Multi-Amplitude Minimum Shift Keying (MAMSK), IEEE Transactions on Communications, Vol. Com. 26, No. 5, May 1978, pp. 543-551.

A bandwidth compressive modem making use of multi-amplitude minimum shift keying (MAMSK) has been designed and implemented in a laboratory environment at microwave frequencies. This system achieves a substantial bandwidth reduction over binary PSK and operates within 0.5 dB of theoretical performance. A number of easily implemented microwave transmitters have been designed to generate the required set of 16 signals. The receiver has been designed to work at 1 Mbps and contains the necessary phase tracking, AGC and symbol synchronization loops as well as a lock detector, SNR estimator and provisions for differential decoding. This paper describes the entire system and presents the experimental results.

Welti, G. R., and Kwan, R. K., Comparison of Signal Processing Techniques for Satellite Telephony, presented at the NTC '77, December 5-7, 1977.

This paper presents some preliminary results of an advanced modulation study performed for INTELSAT. This study first identified various potential systems based on a system model discussed in the paper. Next, the bandwidth and power requirements of these systems are determined and the results tabulated. Finally, several attractive options which could potentially improve the present operational satellite capacity are discussed.

Werth, A. W., Recent Developments in DAMA Systems, presented at the NTC 76, 29 November - 1 December 1976, pp. 21.3/1-5.

The status of INTELSAT's international system, SPADE, is presented and contrasted with currently operating and proposed systems particularly with regard to implementation of control systems and channeling equipment. Future trends are then briefly reviewed.

Wheelon, A. D., The Future Outlook for Communication Satellite Applications, 1975 World Telecommunications Forum.

The next 10 years will be an extraordinarily active and revealing period for satellite communications. Two new satellite service - aeronautical and maritime - will receive decisive tests of economic viability. Broadcast satellites will come into sharp focus and probably begin to proliferate. The greatest expansion will occur in domestic systems, used for telephone, data and television. Their growth will begin to be limited by the orbital arc and pressure will develop to move systems to higher frequencies. International service provided by INTELSAT will expand steadily and call for both technical and operational developments to keep pace with the demand. It will be the second decade of communication satellite service and probably its most important from a historical viewpoint.

White, B. E., A Digital Spectral Limiter for Asynchronous Multiple-Accesss Satellite Communications, Technical Note 1974-25, DDC AD-A000425, Lincoln Laboratory, 8 August 1974.

A satellite processing concept for automatically power balancing the simultaneous accesses of non-cooperative users was investigated. Basically, the scheme consists of a forward and backward fast Fourier transformation with an intermediate clipping operation on spectral magnitudes exceeding an adaptive threshold. The clipper is suitable for applications involving many low-cost mobile terminals wehre the transmitting terminals need not or cannot pre-correct Doppler shifts or fine timing. As a satellite component preceding a bandpass hard-limiting transponder, the spectral clipper presents an easier alternative to complete in-satellite demodulation of the user signals. Computer simulations of ten pseudo randomly specified users indicate a significant improvement in the performance of the weaker users compared to a hard-limiting transponder. Both an orthogonal block code and a convolutional code with maximum likelihood decoding were simulated. The spectral-clipping scheme would also be effective with PSK modems and in strong narrowband interference. Implementations composed of 100 integrated circuit packages consuming 10 watts of power are feasible.

White, B. E., A Worst Case Crosstalk Comparison Among Several Modulation Schemes, IEE Transaction on Communications, Vol. COM-25, No. 9, September 1977.

The effects of worst case crosstalk (from a time-domain point of view) on unsynchronized frequency division multiplexed (FDM) constant envelope modulations are considered assuming coherent hard-decision receivers and no filtering for bandwidth constraint. Continuous-phase frequency shift keying (FSK) is found to be superior to various forms of phase shift keying (PSK).

White, B. E., Simulation of a Narrow Bandpass-Limited Satellite Channel, Technical Note 1976-10, Lincoln Laboratory, 28 July 1976.

The effects of a bandpass limiting satellite channel, such as a B = 25 kHz hard-limiting FLEETSAT channel, on several modulation techniques were simulated. The modulations included BPSK and various forms of QPSK, including offset QPSK and continuous-phase minimum frequency shift keying (MSK). Coherent match-filter receivers and both uplink and downlink noise were assumed. For a bit error probability of 0.005 and a SNR loss of less than 1 dB caused by the non-linearity in the FLEETSAT case, the maximum standard data rate R was 19.2 kbps for BPSK bu 32 kbps for offset QPSK, MSK, QPSK. Rates of 24 kbps for BPSK and 48 kpbs for offset QPSK and MSK were attainable at this same reliability with a SNR degradation of about 4 dB and 2.5 dB, respectively. Larger degradations are expected at lower error rates.

White, W., and Holmes, H., The Future of Commercial Satellite Telecommunication, DATAMATION, July 1978, pp. 94-102.

The spectrum is becoming crowded, available orbit slots are being filled, and yet there seems no end to the demand for more satellite telecommunications capacity. New transmission techniques may ease the problem. Some of the proposed new techniques are best adapted to digital communications, which are made possible by the rapid advances in microelectronics and are being adopted increasingly for other reasons as well.

Wittmayer, W. R., Array Processor Provides High Throughput Rates, Computer Design, March 1978, pp. 93-100.

A low cost, high speed array processor coupled to a minicomputer matches the processing throughput and accuracy of larger more expensive systems for scientific computations.

Wolfe, M. G., Advanced Space Program Studies - Overall Executive Summary, ATR-77 (7379-01)-1, NASW-2884, 30 June 1977.

This document is an overall executive summary of work accomplished from 1 September 1976 through 30 June 1977 on seven Advanced Space Programs Studies. The objectives of these studies were to provide NASA with multidisciplined advanced planning studies that involved space operations and the associated system elements (including man), identification of potential low cost system approaches, vehicle design, cost synthesis techniques, technology forecasting and opportunities for DoD technology transfer and the development of near-, mid-, and far-term space initiatives and development plans with emphasis on domestic and military use commonality.

Wozencraft, J. M., and Kennedy, R. S., Modulation and Demodulation for Probabilistic Coding, IEEE Transaction on Information Theory, Vol. IT-12, No. 3, July 1966.

Research in coding theory has resulted in the determination of bounds, as a function of the rate of communication on the probability of error, that can be attained over a memoryless transmission facility. These results are reviewed, and their implication with regard to the evaluation of modulation and demodulation systems is discussed. The objective is to describe some of the interrelations that affect the performance of a communication system used with probabilistic coding.

Yamaguchi, M., et al., 4 GHz, 8 x 8 Switching Matrix for SDMA-System, pp. 170-172.

An engineering model of an on-board rearrangeable 8 x 8 switch matrix has been developed using 168 PIN diodes and MIC technique. The matrix shows 14 $\pm$1 dB insertion loss and 40 dB isolation over the frequency range of 3.7 to 4.2 GHz.

Yariv, A., Guided Wave Optics, Scientific American, January 1979, pp. 64-72.

Progress is reported in the design of devices for manipulating laser beams in thin transparent films. The goal is to provide tiny, efficient components for communication by light waves.

Yasuda, H., et al., 1.544 Mbits/s Transmission of TV Signals by Interframe Coding System, IEEE Transactions on Communications, October 1976, pp. 1175-1180.

As a powerful tool for economizing on digital transmission of video-telephone signals, interframe coding techniques have known increasing attention, and various interframe coding schemes have been proposed recently. However, many problems remain to be studied in establishing technical feasibility for these techniques and schemes. This paper reports on field trials in which a 1.544 Mbits/s digital transmission of video-telephone signals was conducted over Nippon Telegraph and Telephone's Public Corporation's PCM 100M digital repeated line between Tokyo and Yokohoma, Japan.

Yeh, Y. S., and Reudink, D. O., The Organization and Synchronization of a Switched Spot-Beam System, presented at the 4th International DSC Conference, 23-25 October 1978, pp. 191-196.

In an attempt to address the difficulties of a spot-beam system, a scanning spot beam concept was recently proposed which together with several fixed spot beams provides total domestic service, while enjoying the full gain advantage of a narrow antenna beam. In this paper, the systems aspect of the interconnection of many spot beams through a satellite switch using TDMA concepts is addressed.