NASA SP-7004(04)

COMMUNICATIONS SATELLITES

A CONTINUING BIBLIOGRAPHY

WITH INDEXES

JULY 1968

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7004(04)

COMMUNICATIONS SATELLITES

A CONTINUING BIBLIOGRAPHY
WITH INDEXES

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA Information System during the period April, 1967–December, 1967.

Scientific and Technical Information Division
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. JULY 1968

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INTRODUCTION

What *Communications Satellites* is

This publication is the fourth supplement to the continuing bibliography *Communications Satellites* (NASA SP-7004). It contains references to reports and journal articles announced in the NASA abstract journals during the period April, 1967 through December, 1967. 100 references are included.

Previous bibliographies in this series are NASA SP-7004 (January 1962–April 1964), NASA SP-7004(01) (May 1964–January 1965), NASA SP-7004(02) (February 1965–January 1966), and NASA SP-7004(03) (February 1966–March 1967).

Scope of Bibliography

References are included for all aspects of communications satellite theory and technology. Examples of topics covered are television broadcasting, telemetry, and multistation systems. The economic and legal implications of communications satellites are represented. References to specific communications satellites, e.g., Syncom and Telstar, are also included.

Organization of Bibliography

The bibliography is arranged in Abstract and Index Sections. The Abstract Section contains bibliographic citations and informative abstracts for the references selected from *STAR (Scientific and Technical Aerospace Reports)* and *IAA (International Aerospace Abstracts)*. The *STAR* abstracts are listed first, followed by the *IAA* abstracts. Each set of abstracts is arranged in ascending accession number order.

The Index Section contains two indexes, subject and personal author, in that order.

How to Use this Bibliography

Reports are referenced in the *STAR* Abstracts section. Published literature items are referenced in the *IAA* Abstracts section. The subject index may be used to locate references to specific topics or technical areas; the personal author index may be used to locate references to reports or articles written by a particular individual.

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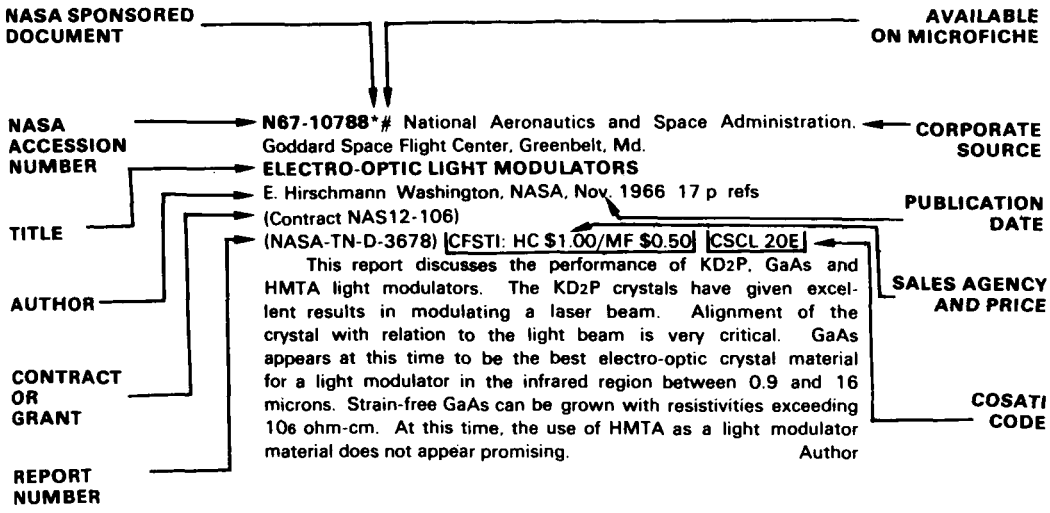
TYPICAL *STAR* CITATION AND ABSTRACT



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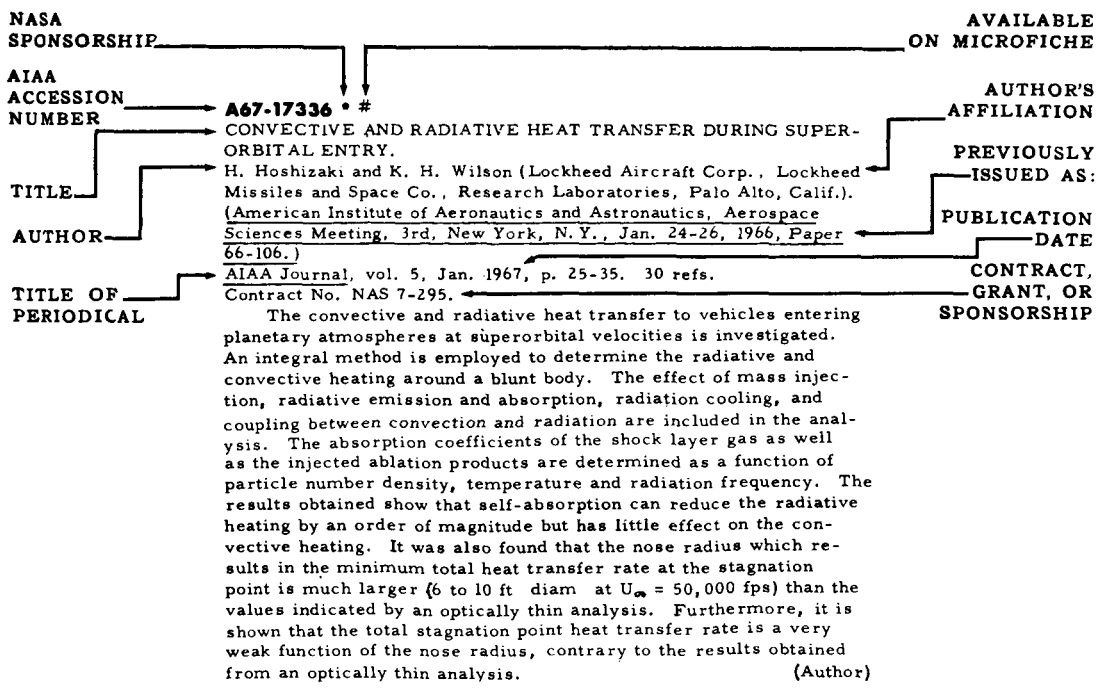

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COMMUNICATIONS SATELLITES

a continuing bibliography with indexes JULY 1968

STAR ABSTRACTS

N67-23816# Royal Aircraft Establishment, Farnborough (England).
ATTITUDE CONTROL OF COMMUNICATION SATELLITES
J. K. Abbott *In* ESRO Spacecraft Technol. Vol. II Jul. 1966 12 p refs

It is proposed to discuss first attitude control of communication satellites in general terms and then to refer in more detail to particular systems either of existing satellites or of the proposed satellites. Two basic schemes of control feasible for communication satellites; the maintenance of full earth-pointing and the spin stabilization are considered. ESRO

N67-23915*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT OF THE FABRICATION AND PACKAGING TECHNIQUES FOR THE ECHO II SATELLITE
James P. Talentino Dec. 1966 169 p refs
(NASA-TM-X-55764; X-724-66-568) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This document describes the techniques developed and used in processing the Echo II satellite from raw material to flight-ready hardware. The design concepts, fabrication and packaging techniques, improvements in techniques, and test methods are discussed. Author

N67-25002*# National Aeronautics and Space Administration, Washington, D. C.
EUROPEAN SPACE VEHICLE LAUNCHER DEVELOPMENT ORGANIZATION ACTIVE COMMUNICATIONS SATELLITES [DIRECTION DES PROGRAMMES ULTERIEURS ET DES ETUDES AVANCES]
M. Gilli Apr. 1967 46 p Transl. into ENGLISH from Tech. Memo. F-37
(NASA-TT-F-10841; F-37) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Data sheets are presented on both launched and projected active communications satellites. The information given includes the weight, shape, dimensions, launch date, and booster; orbital data; type of power source; weights of structure, power source, stabilization system, and telecommunications equipment; communications facilities; and costs. The satellites are also classified according to those intended for civilian or military use. M.G.J.

N67-25044*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SYNCOM ENGINEERING REPORT, VOLUME II
Washington, NASA, Apr. 1967 202 p refs
(NASA-TR-R-252) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Details are given on the launch of the Syncom III satellite, its performance during the first 100 days in orbit, the televising of the 1964 Summer Olympic Games by means of the satellite, and various communications tests conducted with it. Syncom III was launched on 19 August 1964. All three stages of the thrust-augmented Delta vehicle performed satisfactorily and subsequent orbital maneuvers placed the satellite into a nominally synchronous equatorial (stationary) orbit over the International Date Line. Live television of the Olympic Games from Japan via Syncom III was a technical success. The satellite also enabled the establishment of the first 24-hour-per-day, 7 day-per-week reliable communications network across the Pacific Ocean. The attainment of a stationary orbit, which permits the use of fixed ground antennas without the expense of costly tracking systems, and Syncom III's excellent performance indicate the operational and economic advantages of the synchronous communication satellite. Author

N67-25050* Westinghouse Electric Corp., Baltimore, Md. Defense and Space Center.
HANDBOOK OF ORBIT POSITION CONTROL FOR PASSIVE COMMUNICATIONS SATELLITES
Washington, NASA, May 1967 204 p refs
(Contract NAS1-5194)
(NASA-CR-730) CFSTI: $3.00 CSCL 22B

An introductory discussion is presented of orbit position control techniques using direct solar pressure and thermal reradiation forces to control the orbit energy and the relative angular position of satellites in orbit. Complete parametric data are presented related to these techniques, along with derivations of scaling factors and other related information. Author

N67-25455# Naval Research Lab., Washington, D. C.
A NELIAC-N COMPUTER PROGRAM TO CALCULATE THE COMPONENTS OF THE EARTH'S MAGNETIC FIELD
G. Chayt, G. Flenner, and M. Brinkman 25 Jan. 1967 26 p refs
(NRL-6477; NAREC-32; AD-647355) CFSTI: HC $3.00/MF $0.65

Experiments with the Lofti series of satellites have demonstrated that propagation can take place in the ionosphere at very low frequencies. In this frequency range the nature of the wave propagation depends critically upon the orientation of the wave with respect to the earth's magnetic field; therefore the orientation of both the magnetic field and the satellite, relative to the earth, must be known before satellite data can be analyzed in detail. Since the steady-state magnetic field of the earth at a given point in space can be calculated as the gradient of a potential function that satisfies Laplace's equation, this potential can be expressed as a spherical harmonic expansion and its gradient

computed analytically. A computer program, written in NELIAC-N language, was developed that calculates the magnitude and direction of the earth's magnetic field lines corresponding to a given spatial location of the satellite, using a spherical harmonic expansion with Jensen and Cain 1960 Schmidt-normalized coefficients. Author (TAB)

N67-25759* Schjeldahl (G.T.) Co., Northfield, Minn.
DEVELOPMENT OF A 425 FOOT DIAMETER PASSIVE COMMUNICATION SATELLITE WITH SELF-ERECTING PROPERTIES Quarterly Report, Sep.–Nov. 1966
William Jacobi Nov. 1966 28 p refs
(Contract NAS5-3943)
(NASA-CR-83807; PR-30M; QR-10) CSCL 22B

Attempts to protect the thin copper layer from oxidation in a humid atmosphere have failed. At the present, the most effective means of keeping resistance low is the exclusion of moisture when the material is stored or shipped. The buckling of compound curves is discussed briefly and attempts made to measure this tendency. A mathematical derivation of buckling is presented. Author

N67-26585*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A "HUMMINGBIRD" FOR THE L_2 LUNAR LIBRATION POINT
F. O. Vonbun Apr. 1967 22 p refs
(NASA-TM-X-55778; X-507-67-167) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Consider as an example a spacecraft, contrary to all previously published investigations, not in an orbit but in a more or less permanent position in the vicinity of the far-sided lunar libration point L_2, as commonly called. Such a spacecraft would be very useful for a communications relay between the back side of the moon and an earth tracking station. It could be placed "above" the lunar libration point in such a fashion that it is never occulted, thus making the stated communication link a continuous one, independent of time. Obviously, the spacecraft will be in an accelerating force field and thus will need a permanent thrusting to "stay" in place, or move slowly around a predetermined point in space similar to a "Humming Bird." The purpose of this report is to show, in simple analytical form, what the accelerations are in the vicinity of L_2 and what specific impulse values are needed to keep a spacecraft there economically, that is, with a reasonable fuel to useful spacecraft mass ratio ($m_f/m_o = 0.05$ to 0.15). Author

N67-26600*# National Aeronautics and Space Administration, Washington, D. C.
COMMUNICATIONS SATELLITES
May 1967 96 p refs
(NASA-SP-7004(03)) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The contents include references to such topics as television broadcasting, telemetry, outer-space systems, multi-station systems, and medium-height, random-orbit systems. The economic and legal implications of communications satellite systems are represented References are also included which describe the history and operation of individual satellites such as Advent, Courier, Echo, Relay, Score, Syncom, and Telstar, as well as several satellites used for meteorological studies. Each entry in the bibliography consists of a citation and an abstract. A subject index and a personal author index are included. These indexes use the notation of content (NOC), a one-sentence description of the contents of a document, rather than the title to aid the user in locating pertinent entries. Author

N67-26977# System Development Corp., Santa Monica, Calif.
LARGE CAPACITY LASER MEMORY FOR SPACEBORNE COMPUTERS
I. Dlugatch and S. Manus 13 Feb. 1967 11 p Presented at the 1st Ann. Princeton Conf., on Inform. Sci. and Systems, Princeton, N. J., Mar. 1967
(SDC-SP-2665; AD-648752) CFSTI: HC $3.00/MF $0.65

The report discusses the necessity for a spaceborne computer memory of at least 10 to the 7th power bit capacity. It is shown that such a device could minimize computer hardware and, at the same time, make feasible such devices as spaceborne random-multiple-access and synergetic satellites. Author (TAB)

N67-27799 Royal Aircraft Establishment, Farnborough (England)
LONGITUDE DEPENDENCE OF THE GEOPOTENTIAL DEDUCED FROM SYNCHRONOUS SATELLITES
R. R. Allan and B. A. M. Piggott Dec. 1966 18 p refs
(RAE-TR-66397) CFSTI: HC $3.00/MF $0.65

Observations of Syncom 2 and Syncom 3 during seven separate periods of free drift were used to find the effective potential at synchronous height. Although the accelerations are well determined near the two longitudes, 180°E and 300°E, where the observations are clustered, the poor distribution in longitude does not permit a satisfactory determination of individual coefficients. It would be particularly valuable to have observations in the region 0°–40°E or around either of the two stable points near 70°E and 250°E. If there is or has been any significant population of dust particles in distant geocentric orbits, it is likely that a proportion will have been captured in the synchronous resonance, and will have accumulated near the stable positions. It is therefore suggested that it would be worth attempting to observe whether there are clouds of dust particles near the stable longitudes, and in the stable plane for synchronous height. Author

N67-28634# Ghana Univ., Legon. Dept. of Physics.
STUDIES OF THE EQUATORIAL IONOSPHERE USING TRANSMISSIONS FROM ACTIVE SATELLITES Annual Summary Report, 1 Feb. 1964–31 Jan. 1966
John R. Koster, I. Katsriku, and M. Tete 1 Aug. 1966 100 p refs
(Contract AF 61(052-800)
(AFCRL-66-814; ASR-1; AD-650722) CFSTI: HC $3.00/MF $0.65

The theory of correlation analysis of fading records is reviewed and computer programs given for carrying out the analysis. Continuous observations over a period of 81 days of the 136 mc/s signal radiated by Early Bird are described. Results include information on diurnal variation of total electron content, and new information on equatorial scintillation and the irregularities giving rise to it. The pattern on the ground was elongated by 60 - 1. The full correlation analysis of nearly 200 spaced receiver drift measurements made at Tamale, Ghana is presented. Drifts are westward by day, eastward by night, reversal occurring at about 07.30 and 20.00 GMT. A mid-morning maximum of about 200 m/sec. is a prominent feature in the F-region drift velocity. Mean F-Region drift velocity is 115 m/sec during the day, and 70 m/sec at night; E-Region velocity is 67 m/sec by day. Correlation ellipses are elongated with axial ratios of about 6 - 1. The total electron content of the ionosphere is studied as determined from observations of the Faraday Rotation of 20 mc/s signals radiated by S-66 over a period of 6 months. The diurnal variation of the electron content, and the development of the equatorial anomaly are shown. Refraction effects are shown to seriously affect 20 mc/s results at even moderate zenith angles. TAB

N67-29415# RAND Corp., Santa Monica, Calif.
AN EXAMPLE OF THE ANALYSIS OF SATELLITE BUNCHING CHARACTERISTICS

G. M. Northrop Feb. 1967 122 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5156-PR; AD-650905) CFSTI: HC $3.00/MF $0.65

The memorandum presents an ad hoc analytical iterative procedure that can be used to establish a desirable relative spacing scheme for families of satellites in unperturbed, unphased, circular, coplanar orbit. Extension of this analytical technique to families of satellites in noncircular coplanar orbit is straightforward. The threefold aim of the Memorandum includes: extension and illustration of an earlier preliminary study; analysis of a practical example (viz., one launch of the IDCSP), with sufficient detail to afford both system managers and analysts insight into the nature of bunchings of satellites in circular, coplanar orbit; and presentation of some procedures and criteria for determining relative spacing between adjacent satellites in the family to give satisfactory system characteristics. TAB

N67-30733# Institut d'Aeronomie Spatiale de Belgique, Brussels.
TELECOMMUNICATIONS SATELLITES [SATELLITES DE TELECOMMUNICATIONS]
E. Aerts and P. Ville 1967 58 p refs In FRENCH; ENGLISH summary Presented at the B.R.T. Meeting, 28 Mar. 1967 *Its* Aeronomica Acta F-3-1367
CFSTI: HC $3.00/MF $0.65

After stressing the necessity for making use of satellites for telecommunications purposes a review is given of the various systems. Various types of telecommunications satellites are discussed as well as the future projects. Finally a brief review is given of existing or projected networks of communications satellites and the international organizations involved. Author (ESRO)

N67-32255* George Washington Univ., Washington, D. C.
SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME VI: BIOSCIENCE COMMUNICATIONS
Frances Hong and L. A. Kulp *In its* Biol. Sci. Comm. Proj. 30 Jul. 1967 17 p refs

References to literature on bioscience communications research are listed chronologically and according to author in this short bibliography. Also included are author and permuted title indices and addresses of the senior authors and laboratories. R.N.A.

N67-32460# Radiation, Inc., Melbourne, Fla. Radiation Systems Div.
SATELLITE COMMUNICATIONS TERMINAL, AN/TSC-54, VOLUME III Quarterly Report, 15 Sep. 1965–15 Jan. 1966
15 Jan. 1966 375 p
(Contract DA-28-04-AMC-01685(S))
(Doc.-1165-00-4, Vol. 3, App. K; QR-1; AD-372685) CFSTI: HC $3.00/MF $0.65 (Declassified)

The updated design plan for the Satellite Communications Terminal AN/TSC-54 is presented. R.N.A.

N67-34981*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE FEASIBILITY OF A DIRECT RELAY OF APOLLO SPACECRAFT DATA VIA A COMMUNICATION SATELLITE
P. E. Schmid Washington, NASA, Aug. 1967 52 p refs
(NASA-TN-D-4048) CFSTI: HC $3.00/MF $0.65 CSCL 17B

An estimate of the extent to which communication satellites can be utilized in the 1970's for relaying data directly from an Apollo-type spacecraft to a fixed earth station is provided. Both 24-hour synchronous altitude (36,000 km above the earth's surface) and 6-hour orbits (10,400 km above the earth's surface) for the communication satellite are considered. A Unified S-Band type of data transfer is assumed. The relative merit of using frequencies below S-Band for voice communication is also briefly discussed. Author

N67-35023# Telespazio, S. P. A., Rome (Italy).
THE ITALIAN EARTH STATION FOR SATELLITE COMMUNICATIONS AT FUCINO
P. Fanti *In* European Space Vehicle Launcher Develop. Organ. ELDO Tech. Rev., vol. 2, no. 1 1967 22 p

An outline of the history, a technical description and an account of the experiments and operations carried out at the earth station for satellite communications at Fucino are given. Author (ESRO)

N67-35309* Washington Univ., St. Louis, Mo. Dept. of Economics.
SOME ECONOMIC PROBLEMS OF INTERNATIONAL SPACE TELECOMMUNICATIONS, VOLUME I
Edward J. Heiden (Wisconsin Univ.) Aug. 1967 141 p refs *Its* Working Paper No. 6711
(Grant NsG-342)
(NASA-CR-87991, Vol. I) CSCL 17B

The requirements for estimating Intelsat (international telecommunications satellites) rate levels and structures are assessed in terms of the types of coverage which are envisioned: telephone message service, telegraph message service, data (telex) transmission, television broadcast service, and miscellaneous. It is recognized that the requirements are satellite-specific and time-specific, and estimates are given for each hour of an average 24-hour communications day in a given year. Emphasis is focused on the extent to which (1) rate levels over time for Intelsat services are consistent with the cost of providing these services to the general public; (2) the time-specific nature of the distribution of requirements on Intelsat points to a rate structure which takes advantage of the excess capacity available on various satellites; and (3) capacity in excess of estimated requirements for communication between developed regions would be available for use by the underdeveloped areas. The evidence presented is felt to indicate that a lower rate level and variable rate structure are necessary if the full potential of Intelsat is to be realized. M.G.J.

N67-35640# Rome Air Development Center, Griffiss AFB, N. Y. Communications Research Branch.
LOW TEMPERATURE SATELLITE THERMAL STUDY Final Report, Oct. 1963–Oct. 1964
Peter N. Edraos and Mark W. Levi Jun. 1967 76 p refs
(RADC-TR-67-128; AD-654325)

It is known that superior performance can be obtained from various electronic devices operating at very low temperatures. We consider the problem of constructing a communications satellite that contains some volume that can be maintained at low temperature, at least below 77 Kelvin, and the cooling process to be that of radiative emission alone. A worst-case thermal equilibrium analysis is done for a synchronous 24-hour orbit. Assuming heat transfer within a differential satellite volume to be due to both radiation and conduction, a 2nd-degree nonlinear differential equation with a quartic term is obtained, whose solution is described by Emden to be non-analytic. A computer solution to the temperature distribution function is obtained by successive expansion in 6th-order polynomials. The results indicate that the desired low temperatures can be reached and maintained with presently available materials, and if there is a satellite attitude error of less than 5 degrees. Author (TAB)

N67-35865*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

LUNAR FAR-SIDE COMMUNICATION SATELLITES

P. E. Schmid 28 Jul. 1967 31 p refs

(NASA-TM-X-55886; X-507-67-328) CFSTI: HC $3.00/MF $0.65 CSCL 22B

An estimate of the data relay and tracking capability of a lunar communication satellite relaying signals to and from points on or up to 200 km above the lunar far-side surface is presented. Two lunar satellite geometries are considered; namely, a libration point satellite anchored 65,000 km behind the moon and a 1000 km altitude satellite in circular polar lunar orbit. Author

N67-36283 Joint Publications Research Service, Washington, D. C.

THE USE OF COMMUNICATION SATELLITES FOR TRANSMISSION OF UNIDIRECTIONAL (SIMPLEX) PROGRAMS

N. V. Talyzin and L. Ya. Kantor 11 Aug. 1967 10 p refs Transl. into ENGLISH from Radiotekhn. (Moscow), no. 6, Jun. 1967 p 1–7

(JPRS-42194; TT-67-32824) CFSTI: HC $3.00

Considered are the basic technical and economic parameters in a system for unidirectional transmission of information with the aid of communication satellites. The effectiveness of such a system is demonstrated. Author

N67-36664# European Space Research Organization, Paris (France).

TECHNICAL STUDY: FACTORS AFFECTING THE DESIGN OF EXPERIMENTAL SYSTEMS FOR TELEVISION DISTRIBUTION BY SATELLITES, PART I, VOLUME II

Jun. 1967 490 p refs

CFSTI: HC $3.00/MF $0.65

The following subjects are examined in detail: The ELDOPAS launch vehicle and the particular features of the type of orbit chosen; the characteristics of the signals to be transmitted and the possibilities and limitations of the ground stations; the different types of possible on-board communications antennas and the variants of on-board receiving and transmitting equipment; attitude control and orbit correction problems; different systems of power supply; thermal equilibrium in a geostationary orbit; and finally the problems of telemetry data transmission and telecommand of the satellite. ESRO

N67-36843# European Space Research Organization, Paris (France).

PROPOSAL FOR A DEVELOPMENT PROGRAMME OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 6. PART II: ORGANISATION AND MANAGEMENT OF THE PROGRAMME. PART III: TIME SCHEDULE. PART IV: FINANCIAL ESTIMATES

Jun. 1967 150 p refs

CFSTI: HC $3.00/MF $0.65

The report deals with the organization and management of the program, the time required for implementing it (first attempt to place the satellite in orbit would be end of June 1971), and the cost analysis of the program. Author (ESRO)

N67-37347# European Space Research Organization, Paris (France).

PROPOSAL FOR A DEVELOPMENT PROGRAM OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 4. PART I: TECHNICAL STUDY

Jun. 1967 127 p refs

CFSTI: HC $3.00/MF $0.65

Placing the geostationary satellite in orbit, positioning, and station keeping are discussed in terms of responsibilities and facilities of the CNES, ELDO, and ESRO participants. Overall design, launch operations, and technical supervision and monitoring are considered. Details are included for the ESRO Redu station and its role in monitoring a geostationary satellite; and mention is made of the French Guiana launching range, the ELDO station at Gove, and the ESRO station at Port Stanley. Details for both control and mobile stations are included. M.W.R.

N67-37348# European Space Research Organization, Paris (France).

PROPOSAL FOR A DEVELOPMENT PROGRAM OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 5. PART I: TECHNICAL STUDY

Jun. 1967 95 p refs

CFSTI: HC $3.00/MF $0.65

Evaluation of the performance of the X92 satellite and ground station system will include confirmation of the suitability of the ELDO-PAS launcher telecommunications satellite missions, technological evaluation of satellite behavior, and performance measurements of the telecommunications link. The research and development program covers systems studies, and considers the directions for technological development. Contracts will be placed for research work concerning systems and orbit studies, energy supply, attitude control and orbit corrections, communications and electronics, and component parts and materials. ESRO

N67-37452# European Space Research Organization, Paris (France).

PROPOSAL FOR A DEVELOPMENT PROGRAMME OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 3. PART I: TECHNICAL STUDY

Jun. 1967 374 p refs

CFSTI: HC $3.00/MF $0.65

A general definition is given of the mission of the satellite, e.g. reception of the program, television distribution to Europe and any point on the globe, intercontinental television relay, simultaneous retransmission of two-colour television programs. For both versions of satellites, the attitude control and orbit correction systems are described in detail as well as the telecommunications antennas and the television frequency translation repeaters. The power supply, telemetry and telecommand equipment, and the structure of the satellite are discussed. A thermal study concludes the report. Author (ESRO)

N67-37573*# RAI Research Corp., Long Island City, N. Y.

DEVELOPMENT OF A PROTOTYPE PLASTIC SPACE ERECTABLE SATELLITE

Vincent F. D'Agostino and Preston Keusch Washington, NASA, Sep. 1967 219 p refs

(Contract NAS5-3923)

(NASA-CR-892) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The development of procedures and data for construction are discussed for a prototype space erectable plastic passive communications satellite of spherical design with a diameter of 425 ft. using the plastic effect. Research resulted in the development of a crosslinked polyethylene metal laminate weighing 1.58×10^{-3} lbs./ft.^{2} (resulting in a satellite weight of 896.6 lbs.) and capable of withstanding solar pressures when fabricated into a sphere with a 425 ft. diameter. Experimental data and theoretical calculation indicate that a 0.30 mil perforated polyethylene film electrolessly plated with 15 ± 10^{-6} inches of copper on both sides would be satisfactory to withstand buckling pressures within the weight conditions specified. Prototype items were constructed and delivered following a detailed testing program on the various materials used in construction. Additionally, the procedures necessary for the

scale-up and production of a 425 foot diameter spherical passive communications satellite were investigated. Author

N67-38039# Royal Aircraft Establishment, Farnborough (England).
AN AUTOMATIC ATTITUDE CONTROL SYSTEM FOR A SPINNING SATELLITE: A THEORETICAL ASSESSMENT
A. J. Sarnecki Nov. 1966 19 p
(RAE-TR-66368) CFSTI: HC $3.00/MF $0.65

A method is described by which a spinning satellite may maintain its spin axis normal to the orbit without the need for a ground-to-satellite command link. The proposal control system uses earth sensors, on-board logic and a jet system to provide the control torques. The report could form the basis of an engineering design of a system capable of accuracy within a fraction of a degree. Author (ESRO)

N67-38108# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAM OF EUROPEAN TELECOMMUNICATIONS SATELLITES. VOLUME I: PREFACE CONTENTS Final Report
Jun. 1967 59 p
CFSTI: HC $3.00/MF $0.65

Technical specifications are outlined for a preliminary design and a program study of a European experimental communications satellite in the final report of a study made by the European Space Research Organization (ESRO) at the request of the European Conference on Satellite Communications (CETS). Time schedules and cost estimates are noted for the program, and factors affecting the design of experimental systems for television distribution by satellites are outlined in a table of contents. Flywheel and three-axis active stabilization versions of the satellite are noted. M.W.R.

N67-39123 Royal Aircraft Establishment, Farnborough (England).
A CONFIGURATION STUDY FOR AN ELDO-PAS TEST SATELLITE BASED ON COMMUNICATIONS REQUIREMENTS
R. W. Bain, J. G. Walker, R. F. West, and W. G. Hughes [1967] 60 p refs
CFSTI: $3.00

The considerations likely to affect the choice of configuration for the ELDO-PAS experimental communications satellite are discussed. In addition to 3-axis stabilized designs, consideration was given to two spin-stabilized designs. The conclusions recommend the 3-axis stabilized design because of its superiority in communication performance, its greater flexibility, and its vastly superior potential for further development. However, based on development cost and timetable estimates, ELDO has decided that the satellite should have a simple spin-stabilized configuration. R.N.A.

N67-39294*# RAND Corp., Santa Monica, Calif.
THE RAND SYNC–SAT CALCULATOR
N. C. Ostrander Sep. 1967 41 p refs
(Contract NASr-21)
(NASA-CR-89343; RM-5228-NASA) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Advancing technology will permit the exploitation of high-gain, narrow antenna beams to greatly increase the capability of communication or broadcast satellites in synchronous orbits. The RAND Sync–Sat Calculator was developed to facilitate the calculation of some of the geometric relations between a synchronous, near-equatorial satellite and one or more earth stations. This Memorandum supplements the instructional information printed on the slide chart, provides some examples of its use, and documents the mathematical background of the slide chart. Author

N67-39645*# Stanford Univ., Calif. School of Engineering.
THE SAINT PROJECT: PRELIMINARY DESIGN OF AN INTERNATIONAL SATELLITE COMMUNICATION SYSTEM
Eugene V. Shaparenko, ed. Aug. 1967 336 p refs
(Contract NSR-05-020-151)
(NASA-CR-89627) CFSTI: HC $3.00/MF $0.65 CSCL 17B

An economical system of synchronous orbit satellites capable of handling the predicted world telecommunications needs in the late 1970's is proposed. The system consists of four satellites designed for international telephone and television communication, and four regional satellites covering the United States and Europe. Included are descriptions of both the international and regional satellite systems, on-board communication subsystems, an economic analysis of ground stations, multiple access techniques, and ground communication subsystems. The satellite configuration and structural design, attitude control system orbit analysis and launch vehicles, and primary and secondary power systems are also described. R.N.A.

N67-39954*# Collins Radio Co., Cedar Rapids, Iowa.
EFFECTIVE RADIO CROSS-SECTION ANALYSIS FROM EXPERIMENTAL MEASUREMENTS, ECHO I Final Report, 21 Jun. 1965–28 Apr. 1967
28 Apr. 1967 79 p refs
(Contract NAS5-9648)
(NASA-CR-89589; Rept.-523-0759051-001DIM) CFSTI: HC $3.00/MF $0.65 CSCL 09F

This report describes the reduction to satellite effective radio cross section of the reflected radio signal power measurements which were made on the Echo I passive satellite. The data reduced were taken from measurements at 810 MHz and consisted of 24 satellite passes. The cross-section mean and median, density histogram, and distribution function are presented for each pass, and the data reduction techniques are described. Conclusions drawn from these data showed that the averaged mean effective radio cross section for Echo I within the first month after launch was about 3 db below the theoretical cross section of 729.64 square meters (or 28.63 db relative to one square meter). A comparison of Echo I measured at 810 MHz with Echo II measured at 2.3 GHz during their first years of life shows that the Echo I effective radio cross section was 3 db less than theoretical while Echo II was only 1.0 db less than theoretical. The fading range (10 to 90 percent) also differed in the first year life period; typically, 2 to 4 db for Echo 1 and 13 db for Echo II. The gradual trends in fading over the three year period made the Echo I passive satellite appear more similar to Echo II fading. Author

N67-40330 Scandinavian Committee for Satellite Telecommunication, Rao (Sweden). Experimental Ground Station.
SOME WIDE-BAND COMMUNICATION EXPERIMENTS PERFORMED WITH COMKAS, JAPAN VIA RELAY II IN JANUARY 1966
Lennart Hansson and Lars Bostroem [1966] 23 p *Its* Working Doc. No. 64

Brief descriptions and the results of some wideband communication experiments conducted with COMKAS, Japan via the Relay II satellite are presented. The experiments included audio and composite video insertion gain stability measurements; continuous random noise-audio, continuous random noise-video, and baseband noise spectrum measurements; field-time, line-time, and short-time linear distortion measurements; nonlinear distortion measurements of differential gain, synchronization nonlinearity, and intermodulation-noise loading; and both monochrome and color television transmission demonstrations with test patterns and moving pictures. R.N.A.

IAA ABSTRACTS

A67-21617
CLOCK SYNCHRONIZATION VIA RELAY II SATELLITE.
W. Markowitz (Marquette University, Milwaukee, Wis.), C. A. Lidback (U.S. Navy, Bureau of Naval Weapons, U.S. Naval Observatory, Precise Time and Synchronization Service, Washington, D.C.), H. Uyeda (Ministry of Posts and Telecommunications, Radio Regulatory Bureau, Tokyo, Japan), and K. Muramatsu (Ministry of Posts and Telecommunications, Radio Regulatory Bureau, Radio Monitoring Engineering Section, Tokyo, Japan).
(Institute of Electrical and Electronics Engineers, Conference on Precision Electromagnetic Measurements, Boulder, Colo., June 21-23, 1966, Paper.)
IEEE Transactions on Instrumentation and Measurement, vol. IM-15, Dec. 1966, p. 177-184.

Joint experiments were carried out Feb. 15 to 20, 1965, by the U.S. Naval Observatory at the NASA tracking station, Mojave, and the Radio Research Laboratories at Kashima, Japan, to synchronize clocks via the communications satellite Relay II. During one part of a pass the pulses from Mojave were retransmitted by Kashima, which also injected its own pulses. A four-trace oscilloscope at Mojave showed the Mojave transmitted, the Mojave retransmitted, and the Kashima pulses, and also time markers. In the other part of the pass Mojave retransmitted the Kashima pulses and injected its own. This gave an independent value of the clock difference, V. The probable error of the difference in the mean values of V for the same pass, after correcting for relative drift of the clocks, is $\pm 0.01\ \mu$sec. However, systematic effects may be present. It is estimated that the clocks were related to $\pm 0.1\ \mu$sec on each pass. Measurements were made as a check by use of portable cesium-beam atomic clocks and by use of the vlf transmission of NLK/NPG. (Author)

A67-22302
DESIGNING FOR RELIABILITY.
Frank A. Barta (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
IN: 1967 ANNUAL SYMPOSIUM ON RELIABILITY, WASHINGTON, D.C., JANUARY 10-12, 1967, PROCEEDINGS. [A67-22286 09-34]
Symposium sponsored by the Institute of Electrical and Electronics Engineers, the Institute of Environmental Sciences, the Society for Nondestructive Testing, and the American Society for Quality Control.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 586-597.

Discussion of the role of reliability in the design of hardware for two major Hughes programs: the lunar soft-landing spacecraft (Surveyor), and the communications satellites (Syncoms 1, 2, and 3; the Applications Technology Satellites; Early Bird; and four Intelsat IIs). Some of the results obtained early in the programs, such as the evolution of the parts program during the various phases of design, are reviewed. Program aspects reviewed include: the savings resulting from elimination of parts failures during system tests; Hughes' derating policy with previously unpublished derating curves for high reliability operation; and levels of parts acceptance. Management controls involving trouble and failure reports, necessary steps to ensure corrective action, and methods of transmitting pertinent information to key management personnel are considered. Operation of the consent-to-ship and consent-to-launch procedures is described. M.F.

A67-22899
TRANSMISSION CHARACTERISTICS AND DESIGN OF ACTIVE COMMUNICATIONS SATELLITES AS WELL AS INTERFERENCE SOURCES IN OUTER SPACE. I [ÜBERTRAGUNGSEIGENSCHAFTEN UND BEMESSUNG VON AKTIVEN NACHRICHTENSATELLITEN SOWIE STÖRUNGSQUELLEN IM WELTRAUM. I].
Friedrich Vilbig.
VDI Zeitschrift, vol. 109, no. 7, 1967, p. 289-294. In German.

Discussion of the methods used to protect the transmission of satellite data against interplanetary interference sources and to achieve long satellite lifetimes. The mechanism of the interplanetary atomic interference sources is examined, together with the effect of the Van Allen belts. A study of the most favorable frequency bands for satellite communications leads to a choice of the 100 MHz to 10-GHz range. The transmission equations for satellite-ground station and ground-station-satellite communications are derived. V.P.

A67-23233
A COMPARISON OF SCINTILLATIONS AT TWO MIDDLE LATITUDE OBSERVATORIES.
P. F. Checcacci (Consiglio Nazionale delle Ricerche, Centro Microonde, Florence, Italy), H. E. Whitney, and J. Aarons (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Bedford, Mass.).
IN: SPACE RESEARCH VII; PROCEEDINGS OF THE SEVENTH INTERNATIONAL SPACE SCIENCE SYMPOSIUM, VIENNA, AUSTRIA, MAY 10-18, 1966. VOLUME 2.
Symposium sponsored by the Committee on Space Research, the International Union of Geodesy and Geophysics, and the International Scientific Radio Union.
Edited by R. L. Smith-Rose.
Amsterdam, North-Holland Publishing Co., 1967, p. 1345-1353.
5 refs.

Observations of amplitude fluctuations of the vhf beacon of the Early Bird synchronous satellite were made from stations in Italy and Massachusetts. Both stations are at approximately the same geographic latitude but the Sagamore Hill Radio Observatory has a magnetic dip angle of 71° while Florence, Italy has a magnetic dip angle of 56°. The two stations showed two maxima in the occurrence of scintillations. A night maximum between 2000 and 0100 hr and a secondary maximum from 0800 to 1300 hr. Since these were summer observations, the midday irregularities are probably similar to those observed in the summer by satellite observations and are associated with 100-600 km clouds of irregularities. The maximum observed before midnight is probably the result of the irregularity structure which covers the auroral zone and which spreads away from the auroral zone during disturbed nights and during the hours before midnight. The percentage of total time scintillations are observed is approximately the same for both stations. (Author)

A67-23234
STUDIES OF THE LATITUDINAL VARIATIONS OF IRREGULARITIES BY MEANS OF SYNCHRONOUS AND 1000 KM SATELLITES.
H. E. Whitney, R. S. Allen, and J. Aarons (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Bedford, Mass.).
(COSPAR, International Space Science Symposium, 7th, Vienna, Austria, May 10-18, 1966, Paper.)
IN: SPACE RESEARCH VII; PROCEEDINGS OF THE SEVENTH INTERNATIONAL SPACE SCIENCE SYMPOSIUM, VIENNA, AUSTRIA, MAY 10-18, 1966. VOLUME 2.
Symposium sponsored by the Committee on Space Research, the International Union of Geodesy and Geophysics, and the International Scientific Radio Union.
Edited by R. L. Smith-Rose.
Amsterdam, North-Holland Publishing Co., 1967, p. 1358-1369. 10 refs.
[For abstract see issue 15, page 2496, Accession no. A66-30071]

A67-24706
TECHNOLOGY AND OPERATION OF TELEVISION AND VHF COMMUNICATION SATELLITES [ZUR TECHNIK UND NUTZUNG VON FERNSEH- UND UKW-RUNDFUNKSATELLITEN].
E. H. Soiderer (Bölkow GmbH, Ottobrunn, West Germany).
(Deutsche Gesellschaft für Raketentechnik und Raumfahrt, Symposion Satellitentechnik II, Munich, West Germany, Dec. 8, 1966, Vortrag.)
Luftfahrttechnik Raumfahrttechnik, vol. 13, Feb. 1967, p. 34-39.
12 refs. In German.

Brief review of high-power transmission satellites that may be used for direct communication with receiving equipment in homes. The use of synchronous satellites for transmission of TV and vhf

signals is treated. Various antennas, stabilizing systems, and weight considerations are discussed. R.B.S.

A67-24719
MULTIPLE-ACCESS COMMUNICATIONS SATELLITES.
R. Hamer (Government Communications Headquarters, Cheltenham, Glos., England).
IEEE, Proceedings, vol. 55, Mar. 1967, p. 431, 432.

The causes of degradation in the speech channels of multichannel telephony FM signals, when several such signals are amplified in a common amplifier - e.g., in a multiple-access communications satellite - are briefly considered. It is shown how previous results on interference between FM systems can be readily applied to this problem. (Author)

A67-25832
ROTATION OF ECHO SATELLITES.
F. Link (Československá Akademie Věd, Astronomický Ústav, Ondřejov, Czechoslovakia).
IN: SPACE RESEARCH VI; PROCEEDINGS OF THE SIXTH INTERNATIONAL SPACE SCIENCE SYMPOSIUM, MAR DEL PLATA, ARGENTINA, MAY 11-19, 1965.
Symposium sponsored by the Committee on Space Research, the International Astronomical Union, the International Union of Geodesy and Geophysics, the International Union of Pure and Applied Chemistry the International Union of Pure and Applied Physics, and the International Scientific Radio Union.
Edited by R. L. Smith-Rose.
Washington, D.C., Spartan Books, 1966, p. 1004-1008. In French.

Results of photometric studies of the eclipses of Echo 1 and Echo 2. The luminosity curves obtained for Echo 1 are found to show rapid fluctuations with a period of 0.93 min, which is regarded as the photometric period of rotation. In the case of Echo 2 the photometric period of rotation is found to increase during a 3-month period from 1.53 to 1.92 min. The presence of two superimposed irregularities with a pronounced 180° phase shift is also noted in the case of Echo 2. A.B.K.

A67-25991
SYNCHRONOUS SATELLITE COMMUNICATION SYSTEMS.
D. D. Williams.
IN: ADVANCES IN COMMUNICATION SYSTEMS. VOLUME 2.
Edited by A. V. Balakrishnan.
New York, Academic Press, Inc., 1966, p. 151-171.

Discussion of synchronous satellite systems and their successful operation and advantages. The problems of systems at lower altitudes which are avoided in synchronous systems are considered. Among the subjects treated are altitude and motion effects, time delay and echo suppression, problems of establishing and maintaining a stationary orbit, control system concept and requirements, ground control equipment, satellite electronics, antenna improvements, satellite repeaters, vhf satellite systems, and improved station-keeping. M.M.

A67-26141 #
JUDICIAL STATUTES APPLICABLE TO SATELLITE COMMUNICATIONS [ESTATUTO JURIDICO APLICABLE A LAS COMUNICACIONES VIA SATELITE].
Sebastién Estradé Rodoreda.
IN: INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL INSTITUTE OF SPACE LAW, COLLOQUIUM ON THE LAW OF OUTER SPACE, 9TH, MADRID, SPAIN, OCTOBER 14, 1966, PROCEEDINGS.
Edited by M. D. Schwartz.
South Hackensack, N.J., Fred B. Rothman and Co.; Davis, Calif., University of California School of Law, 1967, p. 74-77. In Spanish.

Consideration of communications satellites with reference to aspects of territorial competency in space and applicable legal standards. Attention is given to the viability of commercial treaties as they relate to satellite communication. The relationship between communications satellites and the peaceful conquest of space is discussed. F.R.L.

A67-26143 #
COMMUNICATIONS IN ORBIT - A PROGNOSIS FOR WORLD PEACE.
Jerome Morenoff.
IN: INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL INSTITUTE OF SPACE LAW, COLLOQUIUM ON THE LAW OF OUTER SPACE, 9TH, MADRID, SPAIN, OCTOBER 14, 1966, PROCEEDINGS.
Edited by M. D. Schwartz.
South Hackensack, N.J., Fred B. Rothman and Co.; Davis, Calif., University of California School of Law, 1967, p. 86-90.

Consideration of the status of communications satellites in the context of an emerging customary law for outer space. A positive trend is indicated which may eventually form the basis for world peace through space law and order. Possible systems of management may be classified as unilateral or multilateral, and the desirable International Global-Cooperative Space Communications System. F.R.L.

A67-26144 #
WORLD-WIDE TELECOMMUNICATION SYSTEM BY SATELLITES - LEGAL ASPECTS.
G. P. Zhukov.
IN: INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL INSTITUTE OF SPACE LAW, COLLOQUIUM ON THE LAW OF OUTER SPACE, 9TH, MADRID, SPAIN, OCTOBER 14, 1966, PROCEEDINGS.
Edited by M. D. Schwartz.
South Hackensack, N.J., Fred B. Rothman and Co.; Davis, Calif., University of California School of Law, 1967, p. 91-95.

Elaboration of legal principles for organizing, administering, and operating a worldwide system of telecommunications by satellites. It is considered that a genuine global system of telecommunication must be created on the basis of understanding between the countries concerned, with the direct participation of official representatives of states. Single or multiple telecommunications systems, the use of space for worldwide radio broadcasting and television, and the protection of satellites are discussed. F.R.L.

A67-26334
TRANSMISSION PROPERTIES AND DESIGN OF ACTIVE COMMUNICATION SATELLITES, AND STUDY OF INTERFERENCE SOURCES IN SPACE. II [ÜBERTRAGUNGSEIGENSCHAFTEN UND BEMESSUNG VON AKTIVEN NACHRICHTENSATELLITEN SOWIE STÖRUNGSQUELLEN IM WELTRAUM. II].
Friedrich Vilbig.
VDI Zeitschrift, vol. 109, no. 10, 1967, p. 441-444. 10 refs.
In German.

Study of several U.S. communications satellites, starting with the Courier IB satellite. Telstar, Syncom II and III, and the Early Bird satellites are also examined. Drawings of the Early Bird and of three types of antenna are included. The parabolic horn antenna used in conjunction with the Cassegrain type is considered to offer the most advantages in terms of interference-free reception. Protection measures against wind pressure, temperature vicissitudes, and icing are listed. European transmitting and relaying stations are shown on a map. R.B.S.

A67-27151
POSSIBILITIES FOR THE FUTURE DEVELOPMENT OF COMMUNICATION-SATELLITE TECHNIQUES. I [MÖGLICHKEITEN FÜR EINE WEITERENTWICKLUNG DER NACHRICHTENSATELLITEN-TECHNIK. I].
Friedrich Vilbig.
VDI Zeitschrift, vol. 109, no. 11, 1967, p. 487-489. In German.

Brief summary of the factors governing the further development of communication satellites. It is shown that the future development of active communication satellites depends primarily on the demand for communication channels and their compatibility with the deep-sea cable network. The future development of passive satellites is found to be governed by the progress made with respect to different types of reflectors. A.B.K.

A67-27522
ORBIT DETERMINATION FOR STATIONARY SATELLITES.
R. E. Balsam (Hughes Aircraft Co., Culver City, Calif.) and
S. E. Dunin (Hughes Aircraft Co., Mathematics Consultation Dept., Culver City, Calif.).
IN: AMERICAN ASTRONAUTICAL SOCIETY, SPACE FLIGHT MECHANICS SPECIALIST SYMPOSIUM, UNIVERSITY OF DENVER, DENVER, COLO., JULY 6-8, 1966, PAPERS.
Symposium sponsored by the American Astronautical Society, the University of Denver, the Office of Aerospace Research of the U.S. Air Force, and the Society for Industrial and Applied Mathematics.
Edited by M. L. Anthony.
Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 11), 1967, p. 123-136. 8 refs.

Discussion of the characteristics of orbit determination of stationary satellites and an analysis of accuracy in orbit estimation for the Early Bird satellite. A commentary is presented on the significant perturbations affecting the orbit of a stationary satellite. The effect of station location errors, measurement errors, and model errors in the orbit determination procedure is analyzed in detail. Of particular significance is the decrease in position uncertainty that can be obtained by estimating measurement biases as unknowns in the orbit determination process. Results of processing actual data from the Andover, Me., tracking station for the Early Bird satellite are presented, and all error sources are analyzed. Results are given concerning the sensitivity of the attainable position accuracy to the number of tracking stations used and the types of tracking data employed. The accuracy attainable in the estimation of the position of the Early Bird satellite is better than 1 n mi.
T.M.

A67-28455 *
RESEARCH ASPECTS OF THE COMMUNICATION SATELLITE PROGRAM.
J. P. Hagen (Pennsylvania State University, Dept. of Astronomy, University Park, Pa.) and John J. Kelliher (NASA, Office of Space Science and Applications, Washington, D.C.).
IN: PROGRESS IN RADIO SCIENCE 1963-1966; INTERNATIONAL SCIENTIFIC RADIO UNION, GENERAL ASSEMBLY, 15TH, MUNICH, WEST GERMANY, SEPTEMBER 5-15, 1966, PROCEEDINGS.
PART 2 - RADIO ASTRONOMY, RADIO WAVES AND CIRCUITS, AND RADIO ELECTRONICS.
Edited by J. W. Findlay, R. C. Hansen, and R. Burgess.
Berkeley, Calif., International Scientific Radio Union, 1967, p. 1672-1705.

Review of the present status of the communication satellite program, with an outline of encountered problems and some of the plans for the future. The eleven U.S. communication satellites, two of which were launched by the DOD and eleven by NASA are discussed in terms of their characteristics and applications. The improvements in the satellites planned in the forthcoming series are directed toward the solution of two problems: one, to develop the needed technology to make higher effective radiated power possible, and two, to use these higher power satellites without destructive interference. The development of stronger power sources, transmitters with higher r.f. power output, and improved-gain antenna systems is stressed. Frequency allocation and transmission techniques are suggested as methods of solving various interference problems. Some of the areas in which URSI could be of great help in research of the conditions under which a communication satellite system must operate are listed.
T.M.

A67-28567
ELECTRICITY AND TELECOMMUNICATIONS IN VEHICLES MOVING IN THE SPACE. III [L'ELECTRICITE ET LES TELECOMMUNICATIONS DANS LES VEHICULES CIRCULANT DANS L'ESPACE. III].
R. Clauvel (Centre National d'Etudes des Télécommunications, Issy-les-Moulineaux, Seine, France).
(Société Française des Electriciens, Semaine de Novembre, France, Nov. 22, 1966, Communication.)
Revue Générale de l'Electricité, vol. 76, Mar.-Apr. 1967, p. 494-498. In French.

Examination of satellite telecommunications projects with a survey of experiments already carried out and those under development. The rapid development of an exploitation phase, started in 1966, is described in terms of the commercial, political, and military implications of a satellite telecommunications network. Various systems under consideration are evaluated by comparison of merits and technical problems.
T.M.

A67-28584
POSSIBILITIES FOR THE FURTHER DEVELOPMENT OF COMMUNICATION SATELLITE TECHNOLOGY. II [MÖGLICHKEITEN FÜR EINE WEITERENTWICKLUNG DER NACHRICHTENSATELLITENTECHNIK. II].
Friedrich Vilbig.
VDI Zeitschrift, vol. 109, no. 13, 1967, p. 590-594. In German.

Analysis showing the further development of active communication satellites depends primarily on their ability to compete with deep-sea cables and the demand for communications channels. An additional factor affecting the further development of passive communications satellites is the future progress in reflector technology.
V.P.

A67-28693 #
AN ELECTRONICALLY DESPUN ARRAY FOR VHF COMMUNICATIONS BY SATELLITE.
A. R. Giddis, G. J. Cloutier, and W. F. Nickerson (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Waltham, Mass.).
IN: NTC 67; PROCEEDINGS OF THE 1967 NATIONAL TELEMETERING CONFERENCE, SAN FRANCISCO, CALIF., MAY 16-18, 1967.
Conference sponsored by the American Institute of Aeronautics and Astronautics, the Instrument Society of America, and the Institute of Electrical and Electronics Engineers.
New York, American Institute of Aeronautics and Astronautics, Inc., 1967, p. 229-234.
Research supported by the Communications Satellite Corp.

The object of this study was to design and test an array of vhf antenna elements which can be adapted for use as an electronically despun antenna aboard a spin-stabilized, synchronous-altitude, communications satellite. The antenna consists of two stacked eight-element circular arrays, one at each end of the satellite. Analytical and experimental investigation of the stacked-array radiation characteristics show that a maximum gain of 11 db, a gain ripple of 1 db, and an axial ratio of 3 db can be achieved using normal-mode helices as the elements. Parametric studies were performed to compare deployment mechanisms used to unfurl the array in orbit from a stowed launch configuration. These studies were based on analyses of the dynamics of deployment in a skew direction relative to the spin axis of the satellite. Two designs, one using a self-extending telescoping boom and the other using a positively-driven, prestressed, storable boom, were evolved. The resulting weights range from 15 to 30 lb. The antenna system can be adapted to several operational satellites in use today.
(Author)

A67-28694 *#
DESIGN AND PERFORMANCE OF BLOCK-CODED COMMUNICATION SYSTEMS.
W. C. Lindsey (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
IN: NTC 67; PROCEEDINGS OF THE 1967 NATIONAL TELEMETERING CONFERENCE, SAN FRANCISCO, CALIF., MAY 16-18, 1967.
[A67-28679 14-07]
Conference sponsored by the American Institute of Aeronautics and Astronautics, the Instrument Society of America, and the Institute of Electrical and Electronics Engineers.
New York, American Institute of Aeronautics and Astronautics, Inc., 1967, p. 290-293. 8 refs.

Consideration of the design and performance of frequency multiplexed, phase-modulated (PM) communication systems. It is shown that, when many digital (channelized communication satellites) signals are combined for transmission from a satellite to the earth by means of a single saturated power amplifier and antenna, frequency multiplexing the signals and using the combined signal to phase-modulate a single rf carrier is very attractive from the point of view of system simplification vs cost and weight. A superheterodyne phase-locked loop receiver is described which tracks the carrier component

of the received signal and generates the receiver's reference signal. Subcarrier extractors, each consisting of a subcarrier tracking loop, a data demodulator (a cross-correlator), and a timing loop, are used to obtain the desired information from the n-th receiver output. F.R.L.

A67-28798
RF DESIGN OF COMMUNICATION-SATELLITE EARTH STATIONS. I.
C. Louis Cuccia, Todd G. Williams, Phil R. Cobb, Allen E. Smoll, and James P. Rahilly (Philco-Ford Corp., WDL Div., Palo Alto, Calif.).
Microwaves, vol. 6, May 1967, p. 30-43. 10 refs.

Detailed study of the microwave aspects of earth-station design. The receiving sensitivity parameters of a communication-satellite earth station are discussed, showing how rf aspects of the antenna and feed system affect the earth station's sensitivity. Methods of increasing the efficiency of Cassegrain antenna systems are considered. P.v.T.

A67-28912
SATELLITE COMMUNICATIONS - WHAT NEXT?
T. R. Sheridan (Radio Corporation of America, Defense Electronic Products, Moorestown, N.J.).
IN: DEFENSE ELECTRONIC PRODUCTS: SEARCH RADAR, SUPERCONDUCTOR DEVICES, DATA COMMUNICATIONS, SPACECRAFT COMMUNICATIONS, SPEECH RECOGNITION.
Camden, N.J., Radio Corporation of America, 1967, p. 13-17.
14 refs.

The demand, applications, and technology for future satellite communications is discussed by the type of service. Transoceanic and military point-to-point telecommunication is described as the natural extension of the worldwide trunking networks. Intranational service is portrayed as a high capacity trunk or a TV distribution network. Direct-to-home TV and radio are examined under the broadcasting service application. The broadgathering service, exemplified by the worldwide weather network, emphasizes the needed growth in satellite receiver and antenna technology. The mobile service application indicates some of the unique possibilities offered by satellite communication. Key technological growth areas are identified in each service. (Author)

A67-29955 #
DIRECT SATELLITE BROADCAST.
Samuel Gubin (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
American Astronautical Society, Annual Meeting, 13th, Dallas, Tex., May 1-3, 1967, Paper 67-95. 16 p.
Members, $0.75; nonmembers, $1.50.

Study of the technical feasibility and potential uses of five classes of TV satellites. Shared use by various government agencies of one or more satellite channels to homes and institutions of various kinds is considered, as well as time sharing of a satellite to permit broadcasts on a regular basis to specialized and professional groups. Broadcasts to airlines and ships at sea by satellites are also discussed. P.v.T.

A67-30473
RF DESIGN OF COMMUNICATION-SATELLITE EARTH STATIONS. II.
C. Louis Cuccia, Todd G. Williams, Phil R. Cobb, Allen E. Smoll, and James P. Rahilly (Philco-Ford Corp., WDL Div., Palo Alto, Calif.).
Microwaves, vol. 6, June 1967, p. 27-37. 26 refs.

Consideration of which low-noise amplifier is best for earth-station receivers. Designers can choose among masers, paramps, tunnel-diode amplifiers, traveling wave tubes, and transistors. Each type is analyzed for its application to communication-satellite systems. Each type is useful depending on overall system requirements. Specifications and performance data are tabulated for each type of device, and drawings showing the construction and design of typical units are given. F.R.L.

A67-30684
METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4.
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966. 212 p.
In English and French.
$10.00.

CONTENTS:

A67-30690
SYNCHRONOUS COMMUNICATION SATELLITES.
F. P. Adler (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).

(International Astronautical Federation, International Astronautical Congress, 16th, Athens, Greece, Sept. 13-18, 1965, Paper.)
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 85-89.

A67-30691
EARLY BIRD EXPERIMENTAL RESULTS.
R. M. Bentley (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
(International Astronautical Federation, International Astronautical Congress, 16th, Athens, Greece, Sept. 13-18, 1965, Paper.)
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 91-102.

A67-30692
THE EARLY BIRD PROJECT.
M. J. Votaw (Communications Satellite Corp., Spacecraft Projects Div., Washington, D.C.).
(International Astronautical Federation, International Astronautical Congress, 16th, Athens, Greece, Sept. 13-18, 1965, Paper.)
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 103-109.

A67-30695
A SATELLITE SYSTEM FOR NAVIGATION AND COMMUNICATION.
E. B. Mullen (General Electric Co., Electronics Laboratory, Syracuse, N.Y.) and R. E. Anderson (General Electric Co., Advanced Technology Laboratories, Schenectady, N.Y.).
(International Astronautical Federation, International Astronautical Congress, 16th, Athens, Greece, Sept. 13-18, 1965, Paper.)
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 139-149.

A67-30697
THOUGHTS REGARDING THE CONCEPT OF A EUROPEAN TELEVISION SATELLITE.
E. H. Soiderer and W. v. Maydell (Bölkow GmbH, Ottobrunn, West Germany).
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 171-182.

Discussion of the most important principles for the design of a television satellite, with emphasis on coverage area, carrier frequency selection, quality of the video channel, and the required transmitting power and its generation. Problems concerning power supply, attitude control, and stabilization are briefly dealt with. For a comparison between AM and FM video modulation, an example is calculated and discussed for each case in order to emphasize the difference in the required transmitting power. M.M.

A67-30698
THE USE OF THE 12 HOUR INCLINED ELLIPSE AS A COMSAT ORBIT.
W. F. Hilton.
(International Astronautical Federation, International Astronautical Congress, 16th, Athens, Greece, Sept. 13-18, 1965, Paper.)
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 183-190.

A67-30699
DESIGN AND ELECTRICAL CHARACTERISTICS OF THE 25 M ANTENNA OF THE GERMAN GROUND STATION FOR SATELLITE COMMUNICATION IN RAISTING, GERMANY.
G. v. Trentini and K. P. Romeiser (Siemens AG, Zentral-Laboratorium für Nachrichtentechnik, Munich, West Germany).
(Frequenz, vol. 19, Dec. 1965, p. 402-421.)
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 191-204.

A67-30700
A BETTER COMSAT SYSTEM AT HALF THE COST OF SYNCHRONOUS SATELLITES.
W. F. Hilton.
IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL FEDERATION, INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEPTEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31]
Congress supported by the United Nations Educational, Scientific and Cultural Organization.
Edited by Michał Łunc.
Paris, Gauthier-Villars, Dunod; New York, Gordon and Breach; Warsaw, Państwowe Wydawnictwo Naukowe, 1966, p. 205-212.

Discussion of a plan for launching 9 satellites with 3 rockets into an inclined elliptical orbit to provide continuous double communications coverage in civilized areas and continuous triple coverage between latitudes 30°N and 50°N. It is claimed that the proposed system will function with any one of its satellites out of service. The choices of orbit and of apogee latitude are discussed, and it is decided that the 6-hr ellipse inclined at 63.4° to the equator with an apogee at about 20°N should prove more economical than a 24-hr stationary orbit for a worldwide communications system. B.B.

A67-31532
COMMUNICATION SATELLITE GROUND STATION ANTENNAS.
H. H. Reed, Jr. (Collins Radio Co., Dallas, Tex.).
(U.S. State Department, Seminar on Communication Satellite Earth Station Technology, May 1966, Paper.)
Microwave Journal, vol. 10, June 1967, p. 63-69. 20 refs.

Discussion of antennas to be used in commercial satellite communication networks and of their basic requirements. There are several basic antennas which meet the requirements of large aperture, low noise, and adequate steerability. The most popular of these fall into the following categories: single-reflector antennas, dual-reflector antennas, horn reflectors, and array antennas. The parabolic-reflector focal-point feed antenna is described as the most familiar type of large microwave antenna. The Cassegrain system is basically a double-reflector antenna system composed of a parabola of revolution (main reflector), hyperbola of revolution (subreflector), and a feed. The horn-reflector antenna is basically an offset-parabolic-section reflector with a horn feed, the sides of which are extended to meet the edges of the reflector. Although array antennas have been proposed for satellite communication, none meeting the high-gain, low-noise criteria have yet been built.
P.v.T.

A67-32396
A CONFIGURATION STUDY FOR AN ELDO-PAS TEST SATELLITE BASED ON COMMUNICATIONS REQUIREMENTS.
R. W. Bain, J. G. Walker, R. F. West, and W. G. Hughes (Ministry of Technology, Royal Aircraft Establishment, Farnborough, Hants., England).
Société Française d'Astronautique, Symposium Spatial Européen, 7th, Bordeaux, France, May 22-24, 1967, Paper. 60 p.

Review of a configuration study of a three-axis stabilized communications satellite made by the Space Department of the Royal Aircraft Establishment for the purpose of comparing it with a spin-stabilized configuration. Design considerations are outlined, possible CETS (Conférence Européenne de Télécommunications par Satellite) experimental satellite designs are described, possible fully stabilized and spin-stabilized designs are compared, and considerations affecting ELDO-PAS (Perigee Apogee System) test-satellite design are discussed. Two alternative designs are described and compared. It is considered that the three-axis stabilized design offers greater flexibility and superior potential for further development.
F.R.L.

A67-32397 #
REGIONAL AND WORLD TELECOMMUNICATIONS BY SATELLITES [TELECOMMUNICATIONS MONDIALES ET REGIONALES PAR SATELLITES].
J. Voge.
Société Française d'Astronautique, Symposium Spatial Européen, 7th, Bordeaux, France, May 22-24, 1967, Paper. 11 p. In French.

Consideration of the consequences of certain tendencies already manifesting themselves with reference to the most favorable choice of orbits, zones of coverage, and satellite weights for establishment of a future worldwide satellite telecommunications network. A network of stationary satellites is the most economical, requiring only three satellites instead of 12 or 15 for a moving network. Other advantages are enumerated. Factors affecting the zone of coverage are discussed. It is shown that the world network will have a tendency to divide itself into two categories - intercontinental telecommunications and regional telecommunications. The weights and classes of satellites and their performances are discussed. F.R.L.

A67-32497 #
APPLICATION OF MICROWAVE BUILDING BLOCKS TO COMMUNICATIONS SATELLITES.
R. E. Cooper, J. O. Holmes, R. M. Lockerd, and M. W. Smith (Texas Instruments, Inc., Dallas, Tex.).
IN: NAECON '67; PROCEEDINGS OF THE NINETEENTH ANNUAL NATIONAL AEROSPACE ELECTRONICS CONFERENCE, DAYTON, OHIO, MAY 15-17, 1967, TECHNICAL PAPERS.
Conference sponsored by the Dayton Section, and the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronics Engineers.
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 207-211.
USAF-supported research.

Discussion of some of the problem areas involved in the design of a narrow-beam, microwave integrated circuit, phased-array system configured to meet tactical communication-satellite requirements. An X-band, synchronous altitude satellite with at least a 5-year lifetime is considered. It is pointed out that the use of the microwave integrated-circuit (MECA) antenna building blocks is expected to result in a high degree of system reliability, because of total semiconductor makeup and distributed-function construction. The noninertial beam steering characteristics of the phased array should be ideally suited to satellite operation, because of its lack of interaction with the attitude stabilization system.
M.M.

A67-32840 * #
SOLAR CELL RADIATION DAMAGE ON SATELLITES RELAY I AND RELAY II.
Ramond C. Waddel (NASA, Goddard Space Flight Center, Greenbelt, Md.).
Journées d'Electronique, Colloque sur l'Action des Rayonnements sur les Composants à Semiconducteurs, Toulouse, France, Mar. 7-10, 1967, Paper. 11 p.

Results of solar-cell radiation-damage studies on Relay 1 and Relay 2 designed to study, in orbit, the characteristics of several different kinds of solar cells shielded to various degrees. The solar cells investigated include Si p-n, Si n-p, GaAs p-n, and special Si reversed p-n cells, with various shields. The experiment showed that unshielded silicon and gallium arsenide solar cells degraded, in the orbits of the two satellites, to the 75% initial short-circuit current-response level in less than one day. The degradation rate of the shielded silicon cells was about 16% per decade (factor of ten) of time, in the severe-damage region. Unshielded cells showed early-damage steps associated with individual orbital passages through a highly damaging region of space. These damage steps were caused by protons whose energies were a few hundred kev and above, whereas the damage to shielded cells was caused by both high-energy protons and electrons. The supposedly highly damage-susceptible reversed silicon cells did not degrade as expected, but exhibited an initial increase in sensitivity before final degradation.
M.F.

A67-33545
COMMERCIAL SATELLITE COMMUNICATIONS EXPERIENCE.
E. J. Martin (Communications Satellite Corp., Advanced Systems Analysis Dept., Washington, D.C.) and W. S. McKee (Communications Satellite Corp., Space Segment Implementation Div., Washington, D.C.).
(Institute of Electrical and Electronics Engineers, Northeast Research and Engineering Meeting, Boston, Mass., Nov. 2-4, 1966, Paper.)
IEEE Spectrum, vol. 4, July 1967, p. 63-69.

Summary of the experience obtained with the Early Bird satellite and the second-generation Intelsat 2 satellite, already positioned over the Atlantic and Pacific Oceans. The historical background of these facilities is given, and overall system configuration, satellite design parameters, and the manner of conducting launches and station-keeping maneuvers is described.
B.B.

A67-34176 #
USE OF COMMUNICATION SATELLITES FOR TRANSMISSION OF SINGLE-DIRECTION (SIMPLEX) PROGRAMS [OB ISPOL'ZOVANII SPUTNIKOV SVIAZI DLIA PEREDACHI ODNONAPRAVLENNYKH (SIMPLEKSNYKH) PROGRAMM].
N. V. Talyzin and L. Ia. Kantor.
Radiotekhnika, vol. 22, June 1967, p. 1-7. 8 refs. In Russian.

Examination of the technological and economical parameters of a simplex information transmission system using communication satellites. The particular effectiveness of communication satellites in simplex transmission systems is described. The possibility of reaching difficult locations and the possible wide areas of coverage are studied. Problems connected with live television transmission and the construction of relay systems are considered. Modulation techniques suitable for satellite communications are outlined. T.M.

A67-34251 #
LONGITUDE DEPENDENCE OF THE GEOPOTENTIAL, DEDUCED FROM SYNCHRONOUS SATELLITES.

R. R. Allan and B. A. M. Piggott (Ministry of Technology, Royal Aircraft Establishment, Farnborough, Hants., England).
(British National Committee for Space Research, A Discussion on Orbital Analysis, International Meeting, London, England, Oct. 17, 18, 1966, Paper.)
Royal Society (London), Philosophical Transactions, Series A, vol. 262, July 13, 1967, p. 137-143. 11 refs.

Use of observations of Syncom 2 and Syncom 3 during seven separate periods of free drift in an attempt to find the effective potential at synchronous height. Although the accelerations are well determined near the longitudes 180 and 300°E, where the observations are clustered, the poor distribution in longitude does not permit a satisfactory determination of the individual coefficients. It would be particularly valuable to have observations in the region from 0 to 40°E or around either of the two stable points near 70 and 250°E. If there is or has been any significant population of dust particles in distant geocentric orbits, it is likely that a proportion will have been captured in the synchronous resonance and will have accumulated near the stable positions. It is therefore suggested that it would be worth attempting to observe whether there are clouds of dust particles near the stable longitudes and in the stable plane for synchronous height. F. R. L.

A67-34354 #
INTELSAT, COMSAT'S POINT OF VIEW.
James McCormack (Communications Satellite Corp., Washington, D.C.).
Société Française d'Astronautique, Symposium Spatial Européen, 7th, Bordeaux, France, May 22-24, 1967, Paper. 9 p.

Discussion of the economic, political, and social consequences of communications satellites. Resolutions adopted by the U.N. General Assembly from 1961 to 1963 relating to satellite communications are outlined, and the use of satellite facilities for the distribution of television transmissions to broadcasting stations is considered. B. B.

A67-34357 #
TELECOMMUNICATION SATELLITES FOR EUROPE - POLITICAL AND ECONOMIC CONSIDERATIONS.
Société Française d'Astronautique, Symposium Spatial Européen, 7th, Bordeaux, France, May 22-24, 1967, Paper. 11 p.

Study of the problem of establishing a worldwide communication system by means of satellites, with reference to the effects of such a system on the members of the European Conference of Posts and Telecommunications Administrations (CEPT). The CEPT administrations are engaged both in the domestic and the Intelsat sphere. The administrations do not underrate the importance of the development of a European industry for telecommunications satellites, and hope that such a development will make possible the effective entry of Europe into a new field of competitive activity with relevant economic and political implications. F.R.L.

A67-34612
MILITARY COMMUNICATIONS SATELLITE DEVELOPMENT.
Virgil W. Wall (Aerospace Corp., El Segundo, Calif.).
(Armed Forces Communications and Electronics Association, Annual Convention and Exhibition, 21st, Washington, D.C., May 23-25, 1967, Paper.)
Signal, vol. 21, July 1967, p. 53, 54.

Brief description of the Initial Defense Communications Satellite Program. Payload characteristics and orbit analyses are given of the 15 military communication satellites which have been launched to date. R.B.S.

A67-35298 #
SPACE ACTIVITIES IN MEXICO.
COSPAR, Plenary Meeting, 10th, London, England, July 24-29, 1967, Paper. 4 p.

Survey of recent space-research activities in Mexico. Studies in the fields of meteorology, aeronomy, solar radiation, cosmic radiation, communications, tracking, astronomy, and geomagnetism are reviewed. Available space-research courses and scholarships are described, and Mexico's international participation in space programs is outlined. T.M.

A67-35635
A RETROSPECTIVE LOOK AT THE APPLICATION SATELLITE PROGRAM.
Harry J. Goett (Philco-Ford Corp., WDL Div., Palo Alto, Calif.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN AERONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.
Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 3-15.

Retrospective view of the steps that have lead to our present position in the use of satellites for practical space applications. Important successes have been achieved in the two areas of communication satellites and weather satellites. The first truly operational weather satellite was ESSA 1, launched early in 1966. The advances in space technology since the launching of Tiros 1, on Apr. 1, 1960, are striking. A parallel development of communications satellites led to the launching of the Syncom and to a study of the advantages of synchronous or near-synchronous satellites. The question of an extended useful lifetime for satellites is discussed, as well as the possibility of carrying out "maintenance and repair" on a spacecraft from the ground. It is assumed that a phase of the space program is being reached where the emphasis will shift to the development of instrumentation that will bring back the data in a manner such as to make them useful in new applications areas. P.v.T.

A67-35636
COMMERCIAL SATELLITE COMMUNICATIONS.
Spencer W. Spaulding (Communications Satellite Corp., Systems Analysis Div., Washington, D.C.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN ASTRONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.
Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 17-27.

Review of the developments leading up to the first commercial communications satellite. The history of the Early Bird satellite, its design features, its performance in orbit, and its projected use are discussed. A preliminary analysis of commercial COMSAT applications is given. P.v.T.

A67-35640
INTERNATIONAL SATELLITE COMMUNICATIONS - A CASE STUDY.
Richard R. Colino (Communications Satellite Corp., Washington, D.C.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN ASTRONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.
Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 69-85.

Outline of the way in which diverse interests and views were reconciled in the organization of the International Telecommunications Satellite Consortium (INTELSAT). An attempt is made to provide examples of the issues and responses which have occurred in converting the technology of satellite communications into practical realizations for the benefit of mankind. P.v.T.

A67-35646
COMMERCIAL COMSAT APPLICATIONS.
Spencer W. Spaulding (Communications Satellite Corp., Systems Analysis Div., Washington, D.C.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN ASTRONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.

Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 189-198.

Review of the next series of projected satellite launchings by the Communications Satellite Corporation. These satellites will use much of the Early Bird technology, although they will be considerably different in size and capacity. Comparisons between the two types of satellite are given. R.B.S.

A67-35649
ECONOMIC ASPECTS OF OPERATIONAL SATELLITE SYSTEMS.
Richard S. Field (Hughes Aircraft Co., Aerospace Group, Space Systems Div., Advanced Systems Laboratory, Los Angeles, Calif.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN ASTRONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.
Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 269-280.

Review of some of the factors responsible for making certain satellite missions economically feasible. These factors include: (1) improvement in reliability; (2) ability to orbit and control synchronous satellites; (3) improvement in power bandwidth. The discussion is largely concerned with communications satellites, but the conclusions are extended to other areas, such as navigation and meteorology. R.B.S.

A67-35651
JOINT VENTURE APPROACH TO PRACTICAL SPACE UTILIZATION.
Donald R. MacQuivey (Stanford Research Institute, Communication Laboratory, Menlo Park, Calif.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN ASTRONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.
Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 299-318. 6 refs.

Review of the problems of space utilization and satellite development with an account of the successes already achieved. Some of these successes are: the realization of a commercial communication satellite system has been expedited since 1962; earth stations are in operation, under construction, or in design in at least fifteen countries; commercial operations are under way; limited improvement in global communication networks has been realized. As many problems still remain unsolved, the advisability of a joint venture is discussed. P.v.T.

A67-35657
OPERATIONAL TELECASTING BY SPACECRAFT AFTER 1975.
Richard B. Marsten (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
IN: PRACTICAL SPACE APPLICATIONS; AMERICAN ASTRONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS.
Edited by L. L. Kavanau.
Washington, American Astronautical Society, Inc.; Sun Valley, Calif., Scholarly Publications, Inc. (Advances in the Astronautical Sciences. Volume 21), 1967, p. 421-436.

Outline of prospective space telecasting systems of the near future represented by the Vista Satellite concept. These multichannel systems are described as ones in which each channel is independently controllable with regard to its prime transmitter and its territorial coverage. Practical solutions to the major technological problems involved are expected to be solved by the end of 1970 and will be followed by the launch of operational telecasting spacecraft late in 1975. V.Z.

A67-35934 #
ATTITUDE DETERMINATION AND CONTROL OF THE SYNCOM, EARLY BIRD, AND APPLICATIONS TECHNOLOGY SATELLITES.
W. H. Sierer and W. A. Snyder (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Dynamics Conference, Huntsville, Ala., Aug. 14-16, 1967, Paper 67-532. 6 p. 5 refs.
Members, $0.75; nonmembers, $1.50.

Discussion of attitude determination, including the data types and the estimation process, and the use of the hydrogen peroxide control system in changing spacecraft orientation. A normal launch sequence is covered, and the interrelation between attitude determination and control during critical mission phases, including real time analysis during reorientation is explained. The determination of control for final orbit operations, including the long-term effect of solar radiation pressure precession, is discussed. The accuracies achieved by current methods as indicated by operational experience and new techniques in attitude determination are covered. P.v.T.

A67-36121
CHOICES IN SPACE BROADCASTING.
R. P. Haviland (General Electric Co., Philadelphia, Pa.).
IEEE Transactions on Broadcasting, vol. BC-13, July 1967, p. 80-86. 26 refs.

Discussion of policy decisions possible and needed in space broadcasting. Emphasis has been placed on the range of possibilities allowed and the limits imposed by technological factors. The range of possibilities with respect to language, construction of the broadcasting system, operation, sharing, and standards are covered. R.B.S.

A67-36542 #
AN APPROACH TOWARD INCREASING THE DATA RATE OF FUTURE DEEP SPACE COMMUNICATION SYSTEMS.
S. N. C. Chen (System Sciences Corp., Falls Church, Va.).
Canaveral Council of Technical Societies, Space Congress on the Challenge of the 1970's, 4th, Cocoa Beach, Fla., Apr. 3-6, 1967, Paper. 12 p.

An indirect approach toward increasing the data rate of a deep-space communication system involving the use of a relay satellite was studied. A simple frequency translation type repeater was assumed for the relay satellite. In addition, the repeater was said to possess the characteristics of constant output with signal-to-noise power sharing and also suppression effects due to the repeater's inherent nonlinearity. The data rate capability of the indirect approach was compared with that of the direct approach (no relay satellite). In the comparison the earth terminal characteristics were assumed to be the same for both approaches. The results were expressed in terms of the merit function M(r), which is the ratio of the signal-to-noise spectral density of the direct approach to that of the indirect. The calculations of the merit function indicate that the data rate improvement possesses a limiting value given by the ratio of the effective radiated power of the relay satellite to that of the mission vehicle of the direct link. Due to the relay satellite power-sharing characteristics it should be placed closer to the mission vehicle than to the earth, and there also exists between the earth station and the relay satellite a minimum desirable separation beyond which the limiting value of improvement can be obtained. (Author)

A67-38205
DESPUN ANTENNA FOR COMMUNICATION SATELLITES [ANTENNE CONTRE-ROTATIVE POUR SATELLITE DE TELECOMMUNICATIONS].
J. Salmon (Compagnie Générale de Télégraphie sans Fil, Paris, France).
Société Française des Electroniciens et des Radioélectriciens, Colloque International sur l'Electronique et l'Espace, Paris, France, Apr. 10-15, 1967, Paper. 20 p. In French.

Study of the design, functioning, and performance of the despun antenna for communication satellites. This antenna is designed to equip a communication satellite stabilized by rotation. Three main points of the project are considered - the formation of the equatorial pattern, the formation of the vertical pattern, and the electronic scanning apparatus. The model proposed is based on the insertion

of a hyperfrequency matrix (of the Butler type) between quantized phase shifters and dipoles illuminating a toroidal reflector. The phase computer used is very simple, because the variation from a phase shifter to the following one is linear and proportional to the rotation angle of the beam. The use of a hyperfrequency matrix gives flexibility to the despun antenna. M.F.

A67-38212 #
CONSIDERATIONS ON THE DESIGN OF TRAVELING-WAVE TUBES FOR USE ON BOARD COMMUNICATIONS SATELLITES [CONSIDERATIONS SUR LA CONCEPTION DES TUBES A ONDE PROGRESSIVE POUR UTILISATION A BORD DE SATELLITES DE TELECOMMUNICATIONS].
Robert L. Metivier (Thomson-Varian, S.A., Paris, France).
Société Française des Electroniciens et des Radioélectriciens, Colloque International sur l'Electronique et l'Espace, Paris, France, Apr. 10-15, 1967, Paper. 13 p. In French.

Description of the characteristics of traveling-wave tubes which are successfully used in the field of space communications as hyperfrequency amplifiers on board satellites. These tubes possess the highest gain characteristics, instant pass-band width and the greatest efficiency of all known devices. Extensive experience in the field of classic communications and numerous studies have proved that this type of tube can offer a reliability on the same order as that of semiconductors, or that of amplifier tubes for submarine telephone cable repeaters. M.M.

A67-38748 • #
OPTIMAL CONTROL APPLICATIONS FOR ELECTROTHERMAL MULTIJET SYSTEMS ON SYNCHRONOUS EARTH SPACECRAFT.
William C. Isley (NASA, Goddard Space Flight Center, Systems Analysis and Ion Propulsion Section, Greenbelt, Md.).
American Institute of Aeronautics and Astronautics, Electric Propulsion and Plasmadynamics Conference, Colorado Springs, Colo., Sept. 11-13, 1967, Paper 67-723. 11 p.
Members, $0.75; nonmembers, $1.50.

The application of multijet electrothermal systems for three-axis attitude control and station-keeping of 24-hr synchronous communication satellites is studied in a versatile system simulation that uses operational propulsion system hardware in closed-loop tests. Mission parameters require precise slewing capability to meet antenna fine pointing to $\pm 0.1^{\circ}$ in limit cycle mode over the full earth disk. Using coupled three-degree-of-freedom attitude equations and disturbance torques, an optimal control policy is synthesized for the slewing maneuver having a performance index based upon time optimal, propellant/power optimal, and weighting of attitude rates. For constant mass flow propellant feed systems, thrust level degradation was shown to influence drastically both maneuvering time and propellant consumption. A typical case involved a nominal 3-min slewing time for a pointing vector excursion of 6°. With constant mass flow feed, actual thrustor tests produced 40% degrada-

A67-40085 #
DETERMINATION OF THE PACIFIC EQUILIBRIUM POINT FOR A STATIONARY ORBIT.
Richard E. Balsam and Bernard M. Anzel (Hughes Aircraft Co., Systems Analysis Laboratory, El Segundo, Calif.).
(American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 5th, New York, N.Y., Jan. 23-26, 1967, Paper 67-91.)
Journal of Spacecraft and Rockets, vol. 4, Oct. 1967, p. 1289-1294. 7 refs.

A67-40337
COMMUNICATIONS.
S. W. Spaulding (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
Space/Aeronautics (Research and Development Issue), vol. 48, July 31, 1967, p. 92-95.

Discussion of the designs and performance of current typical communications satellites, with a projection of future technological and operational trends in the field of satellite broadcasting. Cooling, long life, and efficiency of communications satellites are considered. Larger future satellites, antennas, and arrays are visualized, with direct transmission to home receivers. V.Z.

A67-41428 #
ELECTRIC THRUSTORS FOR COMMUNICATION SATELLITES.
K. R. Schreitmüller and H. G. Wichmann (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Porz-Wahn, West Germany).
Société Française d'Astronautique, British Interplanetary Society, Associazione Italiana Razzi, and Deutsche Gesellschaft für Raketentechnik und Raumfahrt, Symposium Spatial Européen, 7th, Bordeaux, France, May 22-24, 1967, Paper. 31 p. 23 refs.

Consideration of the development of a system of synchronous-orbit communication satellites using electric thrustors with a transmission power high enough to permit direct reception by small radios and television sets. It is thought that a space-charge-neutralized ion accelerator might be a suitable thrustor for orbital transfer; at the present state of development these may prove competitive in the 15 to 30-km/sec velocity range. Two possible satellite applications are examined, one of which could be realized within the next three years. B.B.

A67-41430 #
U.S. DOMESTIC SATELLITE PROGRAMME.
Edwin J. Istvan (Communications Satellite Corp., Washington, D.C.).
Société Française d'Astronautique, British Interplanetary Society, Associazione Italiana Razzi, and Deutsche Gesellschaft für Raketentechnik und Raumfahrt, Symposium Spatial Européen, 7th, Bordeaux, France, May 22-24, 1967, Paper. 43 p.

Discussion of the INTELSAT 1 communications satellite, the communications gear of which is composed essentially of two hard limited 25-Mc-bandwidth transponders, which provide an equivalent communications capacity of about 240 simultaneous duplex voice channels. INTELSAT 1 was emplaced to gather experience and assurance regarding the utility of a satellite in synchronous orbit for communications purposes, with the idea that if experimental conclusions were favorable it could be put into commercial use, even though its equipment did not conform to the equipment which would be used in a fully commercial satellite. B.B.

A67-42387 #
LEGAL PROBLEMS RELATING TO MAN MADE OBJECTS IN SPACE.
Jelica Simić.
International Astronautical Federation, International Astronautical Congress, 18th, Belgrade, Yugoslavia, Sept. 24-30, 1967, Paper. 14 p.

Investigation of legal problems associated with telecommunications and meteorological satellites, and with the launching and retrieval of manned spacecraft. Problems relating to the distribution of frequencies for communications satellites to prevent broadcast interference are detailed, and the implications of a tendency toward military use of information gathered by weather satellites are discussed. B.B.

A67-42906 #
LINCOLN EXPERIMENTAL SATELLITE PROGRAM - LES-1, -2, -3, -4.
H. Sherman, D. C. MacLellan, R. M. Lerner, and P. Waldron (Massachusetts Institute of Technology, Lincoln Laboratory, Cambridge, Mass.).
Journal of Spacecraft and Rockets, vol. 4, Nov. 1967, p. 1448-1452. 9 refs.

Description of the Lincoln experimental satellite program, a program designed to test techniques for future communications satellites. New techniques and apparatus useful in communications satellites are described and include the following: generating X-band

rf power in a small, all solid-state transponder, a switched high-gain antenna pointing system at X-band frequencies, highly sophisticated logic to drive the antenna switch, earth and sun sensors operating at "visible" wavelengths to provide inputs to the switching logic, a magnetic torquing system to align the satellite spin axis for thermal control, a follow-on magnetic torquing system to align the satellite spin axis normal to the orbit plane, and the use of micropower logic in a space radiation environment. Technique development was oriented toward a satellite operating in a circular, synchronous, equatorial orbit. R. B. S.

A67-42950 #
THE ECONOMICS OF PROGRAMMING FOR INSTRUCTIONAL BROADCAST SATELLITES.
Dean Jamison (Harvard University, Cambridge, Mass.).
American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 4th, Anaheim, Calif., Oct. 23-27, 1967, Paper 67-787. 7 p. 13 refs.
Members, $1.00; nonmembers, $1.50.

Recommendation of methods of programming instructional-broadcast satellites to reduce the cost of education involved in students' time. For fixed satellite ERP (effective radiated power) and ground-station cost, 600 audio channels could replace a TV channel. If a 100-hr course were broken into 10-min blocks, each could be transmitted simultaneously. Students would listen through earphones and follow the course in illustrated workbooks. At the end of a block, a student would answer questions by resetting dials before him to choose the block he hears. If he answers correctly, he branches ahead; otherwise, back. Continuous 12-year sequences of math, science, and verbal-skills instruction could be available. The advantages of radio programing are that, with no ground-to-satellite feedback, a student can: (1) be obliged to actively respond; (2) have feedback on his accuracy; (3) begin at his own level; (4) advance at his own pace; (5) miss school and resume where he left off; and (6) spend extra time without waiting for his class. M. M.

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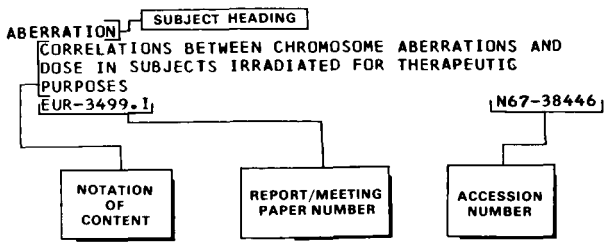

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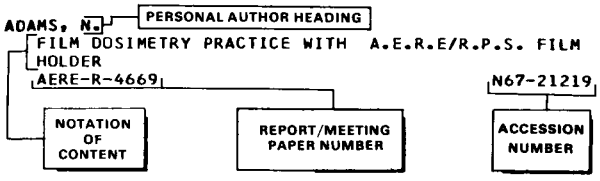

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