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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.
This document is available from the Clearinghouse for Federal Scientific and Technical Information (CFSTI), Springfield, Virginia, 22151, for $3.00
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.


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.

Availability of the Documents Cited

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Technical Information Service
American Institute of Aeronautics and Astronautics, Inc.
750 Third Avenue
New York, N.Y. 10017
This report discusses the performance of KD2P, GaAs, and HMTA light modulators. The KD2P crystals have given excellent results in modulating a laser beam. Alignment of the crystal with relation to the light beam is very critical. GaAs appears at this time to be the best electro-optic crystal material for a light modulator in the infrared region between 0.9 and 16 microns. Strain-free GaAs can be grown with resistivities exceeding 10e ohm-cm. At this time, the use of HMTA as a light modulator material does not appear promising.

**Title**: Conective and Radiative Heat Transfer During Super-Orbital Entry

**Author**: H. Hoshizaki and K. H. Wilson


The convective and radiative heat transfer to vehicles entering planetary atmospheres at superorbital velocities is investigated. An integral method is employed to determine the radiative and convective heating around a blunt body. The effect of mass injection, radiative emission and absorption, radiation cooling, and coupling between convection and radiation are included in the analysis. The absorption coefficients of the shock layer gas as well as the injected ablation products are determined as a function of particle number density, temperature, and radiation frequency. The results obtained show that self-absorption can reduce the radiative heating by an order of magnitude but has little effect on the convective heating. It was also found that the nose radius which results in the minimum total heat transfer rate at the stagnation point is much larger (6 to 10 ft diam. at u = 50,000 fps) than the values indicated by an optically thin analysis. Furthermore, it is shown that the total stagnation point heat transfer rate is a very weak function of the nose radius, contrary to the results obtained from an optically thin analysis.
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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

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.

N67-23915*# National Aeronautics and Space Administration.
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.

N67-25002*# National Aeronautics and Space Administration.
EUROPEAN SPACE VEHICLE LAUNCHER DEVELOPMENT ORGANIZATION ACTIVE COMMUNICATIONS SATELLITES [DIRECTION DES PROGRAMMES ULTERIEURS ET DES ETUDES AVANTES]
(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.

N67-25044# National Aeronautics and Space Administration.
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.

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.

N67-25455# Naval Research Lab., Washington, D. C.
A NELIAC-N COMPUTER PROGRAM TO CALCULATE THE COMPONENTS OF THE EARTH'S MAGNETIC FIELD
(INRL-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

Scheidahl (G.T.) Co., Northfield, Minn.


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

N67-25797

National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.


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 L2, 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 L2 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˙/m0 = 0.05 to 0.15).

Author

N67-26710

National Aeronautics and Space Administration, Washington, D. C.

COMMUNICATIONS SATELLITES May 1967 96 p refs (NASA SP-7004(03)) CSFTI: 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.


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) CSFTI: 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, 100°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.


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 80 – 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.

Author

N67-29415

RAND Corp., Santa Monica, Calif.

AN EXAMPLE OF THE ANALYSIS OF SATELLITE BUNCHING CHARACTERISTICS

Author (TAB)
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.

N67-30733# Institut d’Aeronomie Spatiale de Belgique, Brussels.
TELECOMMUNICATIONS SATELLITES [SATELITES DE TELECOMMUNICATIONS]

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)

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


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

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 (TAB)

N67-35309 Washington Univ., St. Louis, Mo. Dept. of Economics.
SOME ECONOMIC PROBLEMS OF INTERNATIONAL SPACE TELECOMMUNICATIONS, VOLUME I

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.

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 8th-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)
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.

N67-37348# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAMME 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 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)

N67-37573# RAI Research Corp., Long Island City, N. Y.
DEVELOPMENT OF A PROTOTYPE PLASTIC SPACE ERECTABLE SATELLITE
(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 $1.58 \times 10^{-3}$ 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 $15 \times 10^{-6}$ 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.

N67-39029# 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
CFSTI: HC $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

N67-39845*# Stanford Univ., Calif. School of Engineering.

THE SAINT PROJECT: PRELIMINARY DESIGN OF AN INTERNATIONAL SATELLITE COMMUNICATION SYSTEM
Eugene V. Shapiroenko, 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 1970s 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.


EFFECTIVE RADIO CROSS-SECTION ANALYSIS FROM EXPERIMENTAL MEASUREMENTS, ECHO I Final Report,
28 Apr. 1967 79 p refs
(Contract NAS5-9548) (NASA-CR-89583: Rept. 523-0759051-001 DIM) 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 echo, 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 showed 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 I 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
IAA ABSTRACTS

A67-21617
CLOCK SYNCHRONIZATION VIA RELAY II SATELLITE.
(Institute of Electrical and Electronics Engineers, Conference on Precision Electromagnetic Measurements, Boulder, Colo., June 21-23, 1966, Paper.)

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 ±0.01 usec. However, systematic effects may be present. It is estimated that the clocks were related to ±0.1 usec on each pass. Measurements were made as a check by use of portable cesium-beam atomic clocks and by use of the vhf transmission of NLK/NPG.

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.

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 I, 2, and 3; the Applications Technology Satellites, Early Bird; and four Intelsat IIIs). 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 insuring 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-shipping 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. [ÜBERTRAGUNGSEIGENSCHAFTEN UND BEMEISSUNG VON AKTIVEN NACHRICHTENSATELLITEN SOWIE STÖRUNGSQUELLEN IM WELTRAUM. 1].

Friedrich Vilbig.
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.

A67-23353
A COMPARISON OF SCINTILLATIONS AT TWO MIDDLE LATITUDE OBSERVATORIES.
P. F. Checacci (Consiglio Nazionale delle Ricerche, Centro Microonde, Florence, Italy), H. E. Whitney, and J. Aarons (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Bedford, Mass.).
Symposium sponsored by the Committee on Space Research, the International Union of Geodesy and Geophysics, and the International Scientific Radio Union.

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 7° 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.

A67-23324
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.).
Symposium sponsored by the Committee on Space Research, the International Union of Geodesy and Geophysics, and the International Scientific Radio Union.

A67-24706
TECHNOLOGY AND OPERATION OF TELEVISION AND VHF COMMUNICATION SATELLITES [ZUR TECHNIK UND NUTZUNG VON FERNSEH- UND UKW-RUNDFUNKSATELLITEN].
E. H. Soderer (Bilkow GmbH, Ottobrunn, West Germany), Deutsche Gesellschaft für Raumfahrttechnik und Raumfahrtsymphonie, Satellitentechnik II, Munich, West Germany, Dec. 8, 1966, Verlag.)
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
A67-24719

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).

The causes of degradation in the speech channels of multi-channel 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)

A67-25532

ROTATION OF ECHO SATELLITES.
F. Link (Československá Akademie Věd. Astronomický Ústav, Ondřejov, Czechoslovakia).
Edited by R. L. Smith-Rose.

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.

A67-25901

SYNCHRONOUS SATELLITE COMMUNICATION SYSTEMS.
D. D. Williams.
IN: ADVANCES IN COMMUNICATION SYSTEMS. VOLUME 2. Edited by A. V. Balakrishnan.

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.

A67-26143

COMMUNICATIONS IN ORBIT - A PROGNOSIS FOR WORLD PEACE.
Jerome Moreoff.
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.

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.

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.

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 antennas 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 variations, 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. [MÖGLICHKEITEN FÜR EINE WEITERENTWICKLUNG DER NACHRICHTENSATELLITEN-TECHNIK. I].
Friedrich Vilbig.

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. Potting (Hughes Aircraft Co., Mathematics Consultation Dept., Culver City, Calif.).
IN: AMERICAN ASTRONOMICAL SOCIETY, SPACE FLIGHT MECHANICS SPECIALIST SYMPOSIUM, UNIVERSITY OF DENVER, DENVER, COLORADO, 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.

A67-28584

POSSIBILITIES FOR THE FURTHER DEVELOPMENT OF COMMUNICATION SATELLITE TECHNOLOGY. II [MÖGLICHKEITEN FÜR EINE WEITERENTWICKLUNG DER NACHRICHTSATELLENTEN-TECHNIK. II].
Friedrich Vilibig.

A67-28593

AN ELECTRONICALLY DESPUN ARRAY FOR VHF COMMUNICATIONS BY SATELLITE.
Conference sponsored by the American Institute of Aeronautics and Astronautics, the Instrument Society of America, and the Institute of Electrical and Electronics Engineers.

A67-28694

DESIGN AND PERFORMANCE OF BLOCK-CODED COMMUNICATION SYSTEMS.
W. C. Lindsey (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
[67-28679 14-07]
A67-28798

SATELLITE COMMUNICATIONS - WHAT NEXT?


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.

P. V. T.

A67-29955

DIRECT SATELLITE BROADCAST.


American Astronautical Society, Annual Meeting, 13th, Dallas, Tex.; May 1-3, 1967; Paper 57-95, 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 airplanes 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 (Philo-Ford Corp., WDL Div., Palo Alto, Calif.).


Consideration of how low-noise amplifiers 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


Congress supported by the United Nations Educational, Scientific and Cultural Organization.


$10.00.

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A BETTER COMSAT SYSTEM AT HALF THE COST OF SYNCHRONOUS SATELLITES. W. F. Hilton, p. 205-212. [See A67-30700 16-31]

A67-30690

SYNCHRONOUS COMMUNICATION SATELLITES. F. P. Adler (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
A67-30691

EARLY BIRD EXPERIMENTAL RESULTS.
R. M. Bentley (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).


Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


A67-30692

THE EARLY BIRD PROJECT.


Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


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.).


Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


A67-30697

THOUGHTS REGARDING THE CONCEPT OF A EUROPEAN TELE-VISION SATELLITE.
E. H. Soderer and W. v. Maydell (Biiakow GmbH, Otobrunn, West Germany).

(IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEP-TEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31])

Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


A67-30698

THE USE OF THE 12 HOUR INCLINED ELLIPSE AS A COMSAT ORBIT.
W. F. Hilton.


Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


A67-30699

DESIGN AND ELECTRICAL CHARACTERISTICS OF THE 25 M ANTENNA OF THE GERMAN GROUND STATION FOR SATELLITE COMMUNICATION IN RAISING, GERMANY.
G. v. Trentini and K. P. Renaissance (Siemens AG, Zentral-Laboratorium für Nachrichtentechnik, Munich, West Germany).


(IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEP-TEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31])

Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


A67-30700

A COMSAT SYSTEM AT 112 F MHZ COST OF SYN-CRONOUS SATELLITES.
W. F. Hilton.

(IN: METEOROLOGICAL AND COMMUNICATION SATELLITES; INTERNATIONAL ASTRONAUTICAL CONGRESS, 16TH, ATHENS, GREECE, SEP-TEMBER 13-18, 1965, PROCEEDINGS. VOLUME 4. [A67-30684 16-31])

Congress supported by the United Nations Educational, Scientific and Cultural Organization.

Edited by Michal Lunc.


Discussion of a plan for launching 9 satellites with 3 rockets into an inclined elliptical orbit to provide continuous dual 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 6hr 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. Department, Seminar on Communication Satellite Earth Station Technology, May 1967, Paper.)

Discussion of antennas to be used in commercial satellite communications 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 ELD-O-PAS TEST SATELLITE BASED ON COMMUNICATIONS REQUIREMENTS.

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 (Confederation Europeenne de Telecommunications par Satellite) experimental satellite designs are described, possible fully stabilized and spin-stabilized designs are compared, and conclusions are drawn. Design and configuration 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.

A67-32397
REGIONAL AND WORLD TELECOMMUNICATIONS BY SATELLITES [TELECOMMUNICATIONS MONDIALES ET REGIONALES PAR SATELLITES].
J. Voce.

Consideration of the consequences of certain tendencies already manifesting themselves with reference to the most favorable choices 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. D. Holmes, R. M. Lookerd, 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 Electronics 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 (MICA) antenna building blocks is expected to result in a high degree of system reliability, because of total semiconductor makeup and distributed-function construction. The nonuniform 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 G. Waddel (NASA, Goddard Space Flight Center, Greenbelt, Md.)

Results of solar-cell radiation-damage studies on Relay i 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 reverse-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 year. 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, expect that exhibited an initial increase in sensitivity before final degradation.

M. F.

A67-33545
COMMERCIAL SATELLITE COMMUNICATION EXPERIENCE.

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.

A67-34170
USE OF COMMUNICATION SATELLITES FOR TRANSMISSION OF SINGLE-DIRECTION (SIMPLEX) PROGRAMS [OB ISPOL'ZOVANII SPUTNIKOV SVIAZI DLA PEREDACHI ODNOPRAVLJENYKH (SIMPLEXNYKH) PROGRAM].
N. V. Talyzin and L. K. Kantor.

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.

12
Aircraft Establishment, Farnborough, Hants. (18, 1966, Paper.)

of dust particles near the stable longitudes and in the stable plane will not permit a satisfactory determination of the individual coefficients. 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 20^0 to 250^0E. Although the accelerations are well determined near the longitudes 180^0 and 300^0E, where the observations are clustered, the poor distribution in longitude does not permit a satisfactory determination of the individual coefficients.

A67-34354

INTLESAT, COMSAT'S POINT OF VIEW.

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.

A67-34357

TELECOMMUNICATION SATELLITES FOR EUROPE - POLITICAL AND ECONOMIC CONSIDERATIONS.

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 undertake the importance of the development of a European industry for telecommunication 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.

A67-34612

MILITARY COMMUNICATIONS SATELLITE DEVELOPMENT.


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.

A67-35298

SPACE ACTIVITIES IN MEXICO.

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.

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.

Retrospective view of the steps that have led 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 I, 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.

A67-35636

COMMERCIAL SATELLITE COMMUNICATIONS.
IN: PRACTICAL SPACE APPLICATIONS: AMERICAN AERONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966. PROCEEDINGS.
Edited by L. L. Kavanau.

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.

A67-35640

INTERNATIONAL SATELLITE COMMUNICATIONS - A CASE STUDY.
IN: PRACTICAL SPACE APPLICATIONS: AMERICAN AERONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966. PROCEEDINGS.
Edited by L. L. Kavanau.

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.

A67-35646

COMMERCIAL COMSAT APPLICATIONS.
IN: PRACTICAL SPACE APPLICATIONS: AMERICAN AERONAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966. PROCEEDINGS.


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.

JOINT VENTURE APPROACH TO PRACTICAL SPACE UTILIZATION. Donald R. MacQuivey (Stanford Research Institute, Communication Laboratory, Menlo Park, Calif.). IN: PRACTICAL SPACE APPLICATIONS: AMERICAN ASTRO-NAUTICAL SOCIETY, NATIONAL MEETING, SAN DIEGO, CALIF., FEBRUARY 21-23, 1966, PROCEEDINGS. Edited by L. L. Kavanau.


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.


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)


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 interaction 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.
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 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 COMMUNICATION SATELLITES

(Considérations sur la conception des tubes à onde progressive pour utilisation à bord de satellites de télécommunications)

Robert L. Metivier (Thomson-Varian, S.A., Paris, France)


Description of the characteristics of traveling-wave tubes which are successfully used in the field of space communications as hyper-frequency 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.

A67-38749

OPTIMAL CONTROL APPLICATIONS FOR ELECTROTHERMAL MULTIJET SYSTEMS ON SYNCHRONOUS EARTH SPACECRAFT

William C. Isley (NASA, Goddard Space Flight Center, Systems Analysis and Flight Mission Section, Greenbelt, Md.)


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 ±0.1° 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 thruster tests produced 40% degradation.

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.)


A67-40337

COMMUNICATIONS


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.

A67-41248

ELECTRIC THRUSTORS FOR COMMUNICATION SATELLITES

K. R. Schmelzleiter and H. G. Wichmann (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Pozz-Wahn, West Germany)


Consideration of the development of a system of synchronous-orbit communication satellites using electric thrusters 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 thruster 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


Discussion of the INTELSAT I 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 I 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 the equipment did not conform to the equipment which should be used in a fully commercial satellite.

B. B.

A67-42387

LEGAL PROBLEMS RELATING TO MAN MADE OBJECTS IN SPACE

Jelica Simić.


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.).


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.

THE ECONOMICS OF PROGRAMMING FOR INSTRUCTIONAL BROADCAST SATELLITES.


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 programming 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.
Typical Subject Index Listing

Subject: Aberration
Correlations between chromosome aberrations and dose in subjects irradiated for therapeutic purposes

Notation of Content: EUR-3499-1
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