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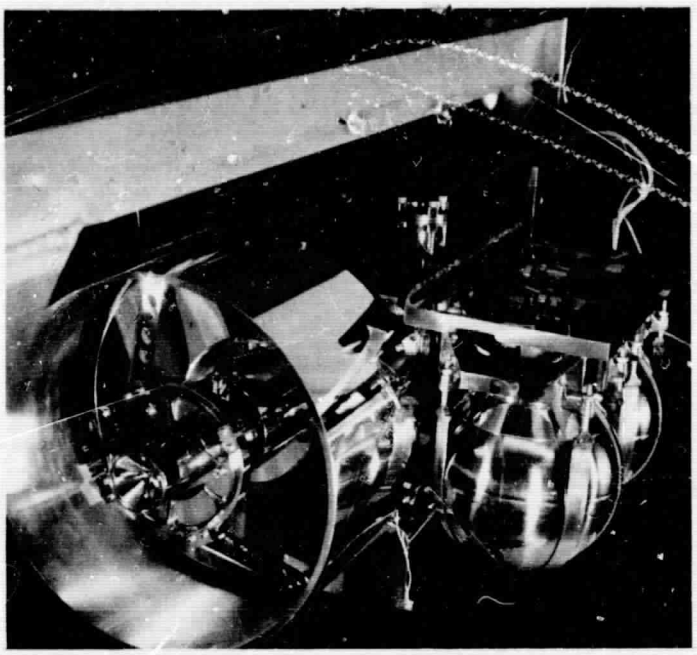
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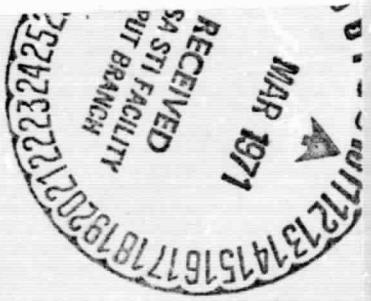
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PRERELEASE FOR DECEMBER 1970

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

Prepared Under Contract No. NAS 7-100
National Aeronautics and Space Administration

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COVER: *Mariner* Mars 1969 infrared spectrometer. This instrument was included as part of the science equipment on the *Mariner VI* and *VII* spacecraft to detect the presence and amount of all polyatomic atmospheric constituents; determine the compositional variations of atmospheric constituents; and obtain data concerning surface composition, albedo, and temperature and gas temperature. The design, development, and test of the *Mariner* Mars 1969 science, science support, and engineering equipment are described in Technical Report 32-1460, Vol. I. See Jet Propulsion Laboratory.

PREFACE

The JPL Bibliography describes and indexes the formalized technical reporting resulting from scientific and engineering work performed, or managed, by the Jet Propulsion Laboratory. Four classes of publications are included:

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Volume I. *Flight Projects*

Volume II. *The Deep Space Network*

Volume III. *Supporting Research and Advanced Development*

Volume IV. *Flight Projects and Supporting Research and Advanced Development* (contents classified)

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JPL BIBLIOGRAPHY 39-12

PRERELEASE FOR DECEMBER 1970

AUTHOR INDEX

ABEL, J.

A01 Attitude Control and Structural Response Interaction
J. Abel
Technical Report 32-1461, November 15, 1970

This report presents an assessment of the problem of the interaction between the structural or elastic response of a spacecraft and the attitude control system dynamics. A general discussion of the problem modes of interaction provides a means of classifying a given spacecraft with respect to the interaction problem. A model spacecraft system is studied and some parameters characterizing the interactions are identified. The question of system stability in the mathematical sense is discussed and the idea of a definition of a practical stability criterion is presented. This concept is applied to the model spacecraft system. Some comments on the adequacy of present methods of evaluating the significance of interactions between attitude control systems and structures are given with particular regard to the concept of frequency separation.

AKSNES, K.

A02 A Second-Order Artificial Satellite Theory Based on an Intermediate Orbit
K. Aksnes
Technical Report 32-1507, November 1, 1970

An analytical second-order theory is developed for the motion of a satellite of an oblate planet whose gravitational potential includes the second, third, and fourth zonal harmonics. It is assumed that J_2 is a small quantity of the first order and that J_3 and J_4 are of the second order.

The secular and the periodic perturbations are obtained to the third and to the second order, respectively. The former are contained in the Delaunay variables l'', g'', h'', which are linear functions of the time, while the latter are given as additions to the Hill variables i'', r'',

G'', u'', h'' in the form of trigonometric series with constant coefficients.

The theory is distinguished by a relative simplicity and compactness of the final algorithm achieved by the use of the following special devices and techniques: (1) an intermediate orbit, (2) Hori's perturbation method, and (3) the Hill variables.

A comparison with the results of numerical integration of the equations of motion indicates that the theory is capable of predicting the position of a near-earth satellite to better than one meter over one hundred revolutions.

ALLEN, J. E.

A03 [DSN] Monitor System

J. E. Allen

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 6–13, September 30, 1970

The Deep Space Network (DSN) Monitor System provides the capability to determine failures to the facility subsystem level and distribute data to the DSN Tracking Telemetry, Command, and Operations Control Systems. This article describes the DSN Monitor System for the Mark III era, with emphasis on the monitor criteria data set generation. The interface between the monitor system and the other DSN systems at both the system level and the facility level is described.

ARNETT, J. C.

A04 Evaluation of 26–32 AWG Wire for Outer Planet Mission Applications

J. C. Arnett

Technical Memorandum 33-463, December 1, 1970

Tests were performed establishing dimensional, physical, electrical, and handling characteristics of small-gage wire for outer planet mission applications. Environmental tests in vacuum and low temperature were made to evaluate exposure-related degradation effects. The most promising candidates for electronic packaging applications on future spacecraft were selected.

BATELAAN, P. D.

B01 A Noise-Adding Radiometer for Use in the DSN

P. D. Batelaan, R. M. Goldstein, and C. T. Stelzried

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 66–69, September 30, 1970

The communication requirements for deep space missions necessitate the use of high-gain antennas and

sensitive receivers on the ground. Because of their unusually good sensitivity, these receiving systems are also well-suited to radio astronomy applications. However, most gain compensation techniques normally employed for radio astronomy, such as the Dicke scheme, would degrade the communication capability of a Deep Space Network (DSN) receiver. A radiometer which is compatible with the DSN communication requirements is described in this article. With this radiometer, the effect of gain instability is eliminated by a noise injection technique. Included are a block diagram, experimental recordings, and performance comparisons (both theoretical and experimental) with a total power radiometer.

BENESH, M.

B02 Extraterrestrial Convergent Photogrammetric Mapping System—An Error Analysis

M. Benesh

Technical Memorandum 33-455, December 1, 1970

An effort to define specific photogrammetric parameters that could be incorporated into an extraterrestrial television mapping system through investigations of convergent photogrammetric steromodels is described. Also described are error analyses of direct and external relative orientation, and practical tests that investigated: (1) aspects of television image quality and its resulting influence upon mapping accuracy, and (2) the design of an effective analytical method for complex interior orientation calibration.

BERMAN, A. L.

B03 A New Tropospheric Range Refraction Model

A. L. Berman

***The Deep Space Network*, Space Programs Summary 37-65, Vol. II, pp. 140–153, September 30, 1970**

This article describes a new tropospheric range refraction model. Previously, the dry component of range and range rate refraction (signal retardation component) was assumed to be a linear function of surface refractivity. This appears to be a result of assuming an isothermal atmospheric model and then failing to consider the functional dependence required of the "scale height" by that assumption. Consideration of the hydrostatic equation and the gas law led inescapedly to the conclusion that range refraction (at least at reasonable elevation angles) is linearly dependent upon surface refractivity. The derivation of the functional basis of the "dry" component, a method of integrating the "wet" component, and an error analysis of the model are presented in this article.

BOGNER, R. S.

B04 Battery Storage Optimization and Design Studies
R. S. Bogner and R. E. Patterson
Technical Memorandum 33-462, December 15, 1970

Sealed Ag–Zn cells with five different separator systems from four different vendors, and one group of Ag–Cd cells, were tested to evaluate their capability of maintaining a predictable output after long periods of inactivity. Electrolyte concentration was included as a variable in two of the cell designs. The cells were grouped into sets of three for storage at six different temperatures and four different time intervals. Extrapolation of rate capacity loss data at low temperature storage (0 to −20°C) indicates that after ten years of storage most of the cell designs would deliver 75% of their original capacity. Cells with the RAI-116 separator system showed the best charge retention. Cells of the one Ag–Cd design did not maintain charge retention as well as most of the Ag–Zn cells.

BUNCE, R. C.

B05 Block IV Receiver Automatic Carrier Acquisition
R. C. Bunce
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 107–116, September 30, 1970

A new method to automatically acquire spacecraft down-link carriers for the Block IV receiver–exciter subsystem is described in this article. The design combines the frequency-sweep capability of a programmed local oscillator with an automatic acquisition detector. The design of the acquisition detector is described in detail, and considerations leading to the choice of design parameters are derived. The mathematical expressions involved are, in general, transcendental, and machine calculation and plot are used extensively. Theoretical results are verified by comparison with actual waveforms obtained during a feasibility study. The theory is applied to obtain the numbers used for the Block IV acquisition system hardware design and operation.

CARD, D. C.

C01 [DSN] System Simulation Models
D. C. Card
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 4–6, September 30, 1970

The Deep Space Network (DSN) can be considered a complex communications network system that handles many distinct types of traffic. As a supporting system to space flight projects, the DSN operates under requirements and objectives reflected by the various mission profiles. This article describes the application of a

Monte Carlo simulation program, the general-purpose Simulation System program, as an analysis and design tool in the DSN system analysis area. This program is a powerful tool because it has been designed for the modeling and simulation of traffic flow systems, and because its high-level language permits rather direct interpretation of system flow diagrams into coded blocks for program execution.

CASPERSON, R. D.

C02 Overseas 210-ft-diam Antenna Project

R. D. Casperson and W. W. Lord

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 154–158, September 30, 1970

This article reports on the progress made on the two overseas 210-ft-diam antenna projects. The fabrication and construction of the antenna structural–mechanical subsystem and the design and construction of the power generation, distribution, and facility subsystems are described. These antennas, one in Australia and one in Spain, coupled with the 210-ft-diam prototype antenna operational at the Mars Deep Space Station in California, will comprise the three-station subnetwork of the Deep Space Instrumentation Facility.

CLARK, B. G.

C03 High-Resolution Observations of Compact Radio Sources at 13 Centimeters

K. I. Kellermann (National Radio Astronomy Observatory), B. G. Clark (National Radio Astronomy Observatory), D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis

Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

For abstract, see Kellermann, K. I.

COHEN, M. H.

C04 High-Resolution Observations of Compact Radio Sources at 13 Centimeters

K. I. Kellermann (National Radio Astronomy Observatory), B. G. Clark (National Radio Astronomy Observatory), D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis

Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

For abstract, see Kellermann, K. I.

CONEL, J. E.

C05 Spectral Reflectance and Albedo of *Apollo 11* Lunar Samples: Effects of Irradiation and Vitrification and Comparison With Telescopic Observations

J. E. Conel and D. B. Nash

Proceedings of the Apollo 11 Lunar Science Conference, Houston, Texas, January 5–8, 1970, Vol. 3, pp. 2013–2023

Spectral reflectance (0.23–2.5 μm) and albedo (0.4–0.7 μm) measurements were made on fresh powders of rock 10020 before and after both proton irradiation and vitrification. Doses of 2 keV protons, equivalent to 20,000 yr exposure to the solar wind, reduced the albedo from 20 to 18%, while artificial vitrification reduced it to 8%. Vitrification is thus a possible lunar darkening mechanism.

The crystalline and glassy materials studied show important differences in spectral reflectivity. Rock powder of 10020 is characterized by prominent absorption features near 1.0 μm and 2.2 μm, and relatively strong reflection in the blue, all attributed to pyroxene. Synthetic glass, on the other hand, has broad absorption bands at 1.02 μm and 1.8 μm and strong reflection near 0.7 μm. Weak structure near 0.95 μm in the spectrum of lunar fines arises mostly from pyroxene.

Lunar rocks and fines and synthetic lunar glass are used to interpret qualitatively color differences for some bright and dark areas of the moon's surface obtained by McCord and others. Reflectance ratios in the visible spectrum are interpreted to indicate that bright craters are covered in part by crystalline rock or crushed debris derived therefrom, and dark areas by material similar to Tranquillitatis fines.

COYNER, J. V., JR.

C06 Parametric Study of the Performance Characteristics and Weight Variations of Large-Area Roll-Up Solar Arrays

J. V. Coyner, Jr. and R. G. Ross, Jr.

Technical Report 32-1502, December 15, 1970

An analysis has been conducted to determine the relationships between the performance characteristics (power-to-weight ratio, blanket tension, structural member section dimensions, and resonant frequencies) of large-area roll-up solar arrays of the single-boom, tensioned-substrate design. The study includes the determination of the size and weight of the base structure supporting the boom and blanket and the determination of the optimum width, blanket tension, and deployable boom stiffness needed to achieve the minimum-weight design for a specified frequency for the first mode of vibration. A computer program has been used to generate a set of plots that provide optimum structural

sizing and estimated weights for arrays with blanket areas ranging from 100 to 400 ft² and for first-mode natural frequencies ranging from 0.03 to 0.7 Hz. Use of these plots enables a quick evaluation of the potential merits of a proposed roll-up array.

EISENBERGER, I.

E01 Communication Statistics: Finite-Sample Quantile Estimation

I. Eisenberger

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 47–50, September 30, 1970

Quantile estimators of the unknown parameters of a normal distribution have been previously derived on the basis of the asymptotic normal distribution of the quantiles used. This article reports the results of an investigation of the effects of a finite sample size on the bias and efficiency of some of the estimators. The exact moments of the quantiles and estimators are computed for sample sizes of $n = 50$, 100, and 200. The results show that, even for n as small as 50, the estimators that were considered can be useful. This closes a gap in the theory of quantiles for efficient estimation and detection of signals.

GOLDSTEIN, R. M.

G01 A Noise-Adding Radiometer for Use in the DSN

P. D. Batelaan, R. M. Goldstein, and C. T. Stelzried

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 66–69, September 30, 1970

For abstract, see Batelaan, P. D.

GREER, R. T.

G02 Luminescence Properties of *Apollo 11* Lunar Samples and Implications for Solar-Excited Lunar Luminescence

D. B. Nash and R. T. Greer

Proceedings of the Apollo 11 Lunar Science Conference, Houston, Texas, January 5–8, 1970, Vol. 3, pp. 2341–2350

For abstract, see Nash, D. B.

GULKIS, S.

G03 High-Resolution Observations of Compact Radio Sources at 13 Centimeters

K. I. Kellermann (National Radio Astronomy Obs .vatory), B. G. Clark (National Radio Astronomy Observatory),

D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis
Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

For abstract, see Kellermann, K. I.

HAMILTON, G.

H01 The Recording of SDA Outputs for *Mariner* Mars 1971
G. Hamilton
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 116–117, September 30, 1970

The necessity for recording subcarrier demodulator assembly (SDA) outputs is discussed. Included in the article are descriptions of the problems concerning analog recording of the outputs, signal specifications of the outputs pertinent to magnetic tape recording, and the FM multiplexing scheme chosen, as well as a data path block diagram for the *Mariner* Mars 1971 Project.

HELLER, J.

H02 DSN Tracking System Operations
J. Heller and R. B. Miller
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 122–125, September 30, 1970

This article describes the operations of the Deep Space Network (DSN) Tracking Operations Analysis Group in the Mark IIIA era. Most of the functions described are being performed at the present time by manual procedures and with the use of the software available on the IBM 7044/7094 computer system. The design of the IBM 360/75 software is geared towards minimizing manual operations in the accountability and validation of tracking data and towards using computer displays to monitor data flow and system performance. A functional diagram illustrating the Space Flight Operations Facility tracking subsystem software design is included in the article.

HORIUCHI, H. H.

H03 *Mariner* Mars 1969 Scan Control Subsystem Design and Analysis
T. Kerner and H. H. Horiuchi
Technical Report 32-1506, October 30, 1970

For abstract, see Kerner, T.

HUESMANN, L. R.

H04 Man–Machine Interaction in the Post-1971 SFOF

L. R. Huesmann

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 126–131, September 30, 1970

In the post-1971 period, the changing nature of space missions will raise some serious problems for man–machine interaction in the Space Flight Operations Facility (SFOF). To remedy these problems, it is proposed in this article that: (1) the onboard computer should be upgraded to assume a portion of the functions previously executed by ground-based machines and decision makers, (2) crucial human decision-making be executed in parallel, (3) the ground-based system be designed to disperse information in a way that improves human reliability and efficiency, and (4) the computing systems assume a greater portion of the decision-making and planning functions. Such alterations should improve the reliability of performance, reduce the time required for a planning cycle, and permit real-time control of some activities.

JACKSON, E. B.

J01 DSS 13 Operations [July–August 1970]

E. B. Jackson

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 84–85, September 30, 1970

From mid-June to mid-August 1970, the Venus Deep Space Station (DSS 13) activities included a special clock synchronization experiment, routine pulsar observations for 24 h each week, cooperative planetary radar activities, and continued development of the ephemeris update tracking program. This article describes these activities, as well as the completed installations of the Model IV receiver–exciter and the 100-kW, 2115-MHz transmitter.

JAUNCEY, D. L.

J02 High-Resolution Observations of Compact Radio Sources at 13 Centimeters

K. I. Kellermann (National Radio Astronomy Observatory), B. G. Clark (National Radio Astronomy Observatory), D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis

Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

For abstract, see Kellermann, K. I.

JET PROPULSION LABORATORY

J03 ***Mariner* Mars 1969 Final Project Report: Development, Design, and Test**
Jet Propulsion Laboratory
Technical Report 32-1460, Vol. I, November 1, 1970

This is the first of three volumes of the *Mariner* Mars 1969 Final Project Report. This volume describes the pre-operational activities including planning, development, design, manufacture, and testing. Volume II describes the performance of the mission by flight and earth-based elements during the launch and spaceflight phases. Volume III deals with the scientific program, including experiment results.

The *Mariner* Mars 1969 Project was organized around four functional systems: (1) the *Mariner* spacecraft, based on the *Mariner C* design, (2) the *Atlas/Centaur* launch vehicle, (3) the Tracking and Data Acquisition System, and (4) the Mission Operations System. Four spacecraft were prepared: one proof test model, two flight spacecraft, and a spare. The spacecraft were divided into nineteen functional subsystems which were subcontracted by JPL and the launch vehicles were adapted and built by a contractor under the cognizance of the NASA Lewis Research Center.

JET PROPULSION LABORATORY: ASTRIONICS DIVISION

J04 ***Mariner* Mars 1971: Astrionics [July–August 1970]**
Jet Propulsion Laboratory: Astrionics Division
Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 23–31, September 30, 1970

The *Mariner* Mars 1971 flight telemetry subsystem performs the data conditioning, multiplexing, encoding, and modulation of spacecraft engineering parameters and the modulation and block coding of science data for transmission to earth. The design requirements, and the design, test, and performance of the mechanization implemented to meet these requirements are described here. Block diagrams of the s bsystem are included.

JET PROPULSION LABORATORY: ENGINEERING MECHANICS DIVISION

J05 ***Mariner* Mars 1971: Engineering Mechanics [July–August 1970]**
Jet Propulsion Laboratory: Engineering Mechanics Division
Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 42–55, September 30, 1970

Mariner Mars 1971 propulsion support structure problems have involved a low-strength beryllium tube, local ring buckling, cracked/failed upper bipod fittings on center and end trusses, failed upper truss fittings, cracked W-truss upper fitting, beryllium strut fracture, cracked lower pressurant support fittings, and cracked threads around threaded inserts. A solar panel deployment/damper mechanism problem was a less-than-minimum critical damping at lower specification temperatures during simulated ¼-*g* motor firings. These problems and their solutions are described in this article.

Also discussed are the design and operation of the medium-gain antenna RF plug assembly. This assembly attenuates the radiated energy that impinges on the *Centaur* forward electronics platform prior to separation.

A decision was made to launch the spacecraft with the ullage gas at low pressure inside the propellant tank bladders. As a result, tests were made to determine the effects of ullage gas placement on the fluid dynamics of the propellant tank. The implementation and results of these tests are reported.

Results are also presented for investigations of two separate cracked solder joint problems: one in the inertial electronics subassembly in which an electrical open was recorded, and the other involving both the flight command subsystem and the data storage electronics subsystem.

JET PROPULSION LABORATORY: ENVIRONMENTAL SCIENCES DIVISION

J06 *Mariner* Venus–Mercury 1973: Environmental Sciences [July–August 1970]

Jet Propulsion Laboratory: Environmental Sciences Division

Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 57–58, September 30, 1970

High-intensity solar simulation will be required to perform developmental testing of instruments on the *Mariner* Venus–Mercury 1973 spacecraft that will be exposed to solar radiation. The radiation intensity level expected is 5.4 times that at earth or 700 W/ft². The tests described in this article were conducted in the 10-ft space simulator using a small collimating mirror to produce a small high-intensity beam. The purposes of these tests were to: (1) determine the uniformity of intensity throughout the beam using the existing integrating lenses, which are not geometrically optimized for the optical system thus developed; and (2) gain experience in the operation of instrumentation exposed to high-intensity solar radiation.

JET PROPULSION LABORATORY: GUIDANCE AND CONTROL DIVISION

J07 *Mariner* Mars 1971: Guidance and Control [July–August 1970]

Jet Propulsion Laboratory: Guidance and Control Division

Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 9–23, September 30, 1970

The *Mariner* Mars 1971 mission requirements necessitated several changes to the *Mariner* Mars 1969 power subsystem design. The major modification is a new battery consisting of 26 nickel–cadmium cells. Other modifications in the power subsystem conditioning electronics, including the battery charger, 30-Vdc regulator, power source and logic, power distribution, and power subsystem telemetry, are described in this article.

The scan actuator design is identical to that for the *Mariner* Mars 1969 spacecraft, except for a minor change in the mounting configuration. This change and the present status of the actuators are discussed, and the scan actuator is illustrated.

Also discussed are the operation of the attitude-control subsystem and the sun acquisition performance while the solar panels are in their latched configuration. Sun acquisition performance with latched solar panels is of concern for the late launch opportunities where spacecraft separation will occur in a sunlit condition.

An autopilot system using a 300-lbf gimbaled bipropellant rocket engine powered by hypergolic fuels will control the spacecraft in its midcourse maneuver and later into orbit about Mars. Orientation about each of the two axes of the gimbaled engine is controlled by an electromechanical linear actuator. Since the functional requirements for the actuators were identical, it was possible to design one actuator to be interchangeable on either axis. The design requirements and the actuator design, testing, and performance are described.

The last portion of this article concerns the various design studies and the resulting design for the reaction control assembly, which provides the actuating torques required for spacecraft attitude control. Each *Mariner*-series spacecraft has carried two identical half gas systems consisting basically of a high-pressure storage vessel, a pressure-reducing regulator, a low-pressure distribution system, and six jet valve nozzle assemblies.

J08 *Viking*, Orbiter System: Guidance and Control [July–August 1970]

Jet Propulsion Laboratory: Guidance and Control Division

Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 60–66, September 30, 1970

The *Viking* orbiter system power profile was revised to include a 2% allocation of power required for oper-

ation off the solar panel maximum power point, a 42-W subsystem contingency, and refinements to some subsystems. The preliminary power profile is presented in this article. A solar panel discussion includes the power versus voltage curves for Trajectory A (launch on August 16, 1975; arrival on August 1, 1976) and Trajectory B (launch on August 19, 1975; arrival on September 2, 1976). Battery charging is also discussed.

The reaction control assembly will be essentially a *Mariner*-type, dual-redundant, cold-nitrogen thruster system. The primary changes from the *Mariner* design result from considerations of spacecraft geometry, increased spacecraft inertias, and environmental requirements. A description of this assembly is presented.

Also discussed are the design and tests of the electronic integrator used in the inertial reference unit for the attitude-control subsystem. This integrator is a redesign of that used for the *Mariner* Mars 1971 spacecraft. Three such integrators are used in conjunction with three single-degree-of-freedom gyros to provide angular position information during the inertial-hold mode of spacecraft attitude control.

JET PROPULSION LABORATORY: MARINER MARS 1971 PROJECT

J09 *Mariner* Mars 1971: Project Description [July–August 1970]

Jet Propulsion Laboratory: *Mariner* Mars 1971 Project
Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 1–3, September 30, 1970

The primary objective of the *Mariner* Mars 1971 Project is to place two spacecraft in orbit around Mars that will be used to perform scientific experiments directed toward achieving a better understanding of the physical characteristics of that planet. An engineering objective is to demonstrate the ability of the spacecraft to perform orbital operations in an adaptive mode wherein information from one orbital pass is used to develop the operations plan for subsequent orbital passes. Specific mission objectives, the spacecraft, its scientific experiments, and management responsibilities for the project are briefly described.

JET PROPULSION LABORATORY: MARINER VENUS–MERCURY 1973 PROJECT

J10 *Mariner* Venus–Mercury 1973: Project Description [July–August 1970]

Jet Propulsion Laboratory: *Mariner* Venus–Mercury 1973 Project
Flight Projects, Space Programs Summary 37-65, Vol. I, p. 56, September 30, 1970

The primary objective of the *Mariner* Venus–Mercury 1973 Project is to launch one spacecraft in October 1973 to obtain environmental and atmospheric data for the planet Venus in February 1974 and to conduct exploratory investigations of the planet Mercury's environment, atmosphere, surface, and body characteristics some 7 wk later, with first priority assigned to the Mercury investigations. The secondary objectives are to perform interplanetary experiments enroute to Mercury and to obtain experience with the gravity-assist mission mode. The spacecraft, its scientific experiments, and preliminary project planning are described.

JET PROPULSION LABORATORY: PROPULSION DIVISION

J11 *Mariner* Mars 1971: Propulsion [July–August 1970]

Jet Propulsion Laboratory: Propulsion Division

***Flight Projects*, Space Programs Summary 37-65, Vol. I, pp. 31–42, September 30, 1970**

Following a brief description of the *Mariner* Mars 1971 propulsion subsystem, a description of the desig operation, testing, and performance of the pressurant relief valve is presented. The primary purpose of this valve is to vent off high-pressure gases in the event of gas regulator failure, thereby avoiding possible rupture of the lightweight thin-shell propellant tanks. This valve is basically that used in both the *Apollo* service module and lunar excursion module, modified for the *Mariner* Mars 1971 operating pressures and to incorporate certain design improvements.

Also discussed is an analysis of pressurant gas solubility in the propellant tanks. Plots are presented for both oxidizer tank and fuel tank predicted propellant saturation, pressure, and bubble volume as functions of time.

The scan latch subsystem is a prepressurized gaseous nitrogen system that, when actuated, will unlatch the planetary platform to accurately point the scientific instrument payload. Its manifold assembly consists of a normally closed explosive valve to control the start of flow, a ball-type fill valve, and a flow manifold block. Various modifications made to the *Mariner* Mars 1969 design and the problems that necessitated these modifications are described.

Liquid propellant expulsion Teflon bladder bags have failed due to the formation of tears and cracks near an aluminum seal ring that forms the mouth of the bag. Solvent sensitivity, biaxial stresses, fatigue, and crystallinity were identified as the factors believed to be critical in contributing to the failures. Detailed studies of these factors for the standard laminate bladder bags are being conducted. The last portion of this article reports the results of the solvent sensitivity

study. Also discussed are results obtained on a new experimental material designated "c... dispersion laminate."

JET PROPULSION LABORATORY: SPACE SCIENCES DIVISION

J12 *Mariner* Mars 1971: Space Sciences [July–August 1970]

Jet Propulsion Laboratory: Space Sciences Division
Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 3–8, September 30, 1970

The vidicon used in the *Mariner* Mars 1971 television subsystem is a specialized version of a common photoconductive sensor. Its key component is a target consisting of a transparent conductive coating on an optically flat faceplate covered by a thin film of a photosensitive semiconductor material. Described in this article is the vidicon screening program established for the *Mariner* Mars 1971 Project. This program has been used in selecting reliable vidicons for space flight and to increase understanding of the performance characteristics of the slow-scan vidicon used in the *Mariner* Mars 1969 and 1971 television subsystems.

JET PROPULSION LABORATORY: VIKING PROJECT

J13 *Viking*: Project Description and Status [July–August 1970]

Jet Propulsion Laboratory: *Viking* Project
Flight Projects, Space Programs Summary 37-65, Vol. I, pp. 59–60, September 30, 1970

The primary objective of the *Viking* Project is to significantly advance current knowledge of the planet Mars by direct measurements in the atmosphere and on the surface and by observations of the planet during approach and from orbit. Particular emphasis will be placed on obtaining information concerning biological, chemical, and environmental factors relevant to the existence of life on the planet at this time or some time in the past or the potentials for the development of life in the future. Two spacecraft, each consisting of an orbiter system and a lander system, are planned for launch during the 1975 opportunity. The orbiter system is being developed by JPL; Langley Research Center is responsible for the lander system, being developed under contract by the Martin-Marietta Corporation. Langley Research Center also has overall management responsibility for the project. The specific objectives for the orbiter system and the lander system are described. Status information includes documentation and engineering breadboard testing and integration.

KATOW, M. S.

K01 30-ft-diam Reflector Upgrade Study

M. S. Katow

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 70–72, September 30, 1970

The tipping assembly of the 30-ft-diam antenna at the Venus Deep Space Station, which is an example of a practical arrangement of trusses using rigid bars, was analyzed for possible improvement in the gravity distortion mode by use of a passive compensator (spring).

The analytical results presented in this article show that the rms distortion for the symmetric (zenith look, gravity off-to-on) loading case can be reduced from 0.017 to 0.002 in. without affecting the antisymmetric distortion of 0.002 in. However, additional bracings for wind loading may be desirable.

KELLERMANN, K. I.

K02 High-Resolution Observations of Compact Radio Sources at 13 Centimeters

K. I. Kellermann (National Radio Astronomy Observatory), B. G. Clark (National Radio Astronomy Observatory), D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis

Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

Two antennas of the NASA Deep Space Network at Goldstone, California, and Canberra, Australia, have been used as elements of an interferometer. The baseline length is 10592 km, or 81×10^6 wavelengths ($\lambda = 13.1$ cm). Sources larger than 0".001 are well resolved. Fifty-six sources show clear interference fringes, which indicate the presence of structure on a scale of 0".001 or less. Five sources appear to be completely unresolved; seven others probably have a relatively simple structure and are assigned an angular size. The other 44 have more complex structure. Twenty-four sources are reported as showing no fringes, and a lower limit to their diameter is given. It is estimated that about 15% of the stronger sources at decimeter wavelengths have appreciable structure 0".002 or smaller in angular size.

KERNER, T.

K03 *Mariner* Mars 1969 Scan Control Subsystem Design and Analysis

T. Kerner and H. H. Horiuchi

Technical Report 32-1506, October 30, 1970

The scan platform control system designed for the *Mariner* Mars 1969 spacecraft is described. The platform, which acts as a mounting base for the science instruments, has two deg-of-freedom about a set of spacecraft fixed coordinates. The system controls the platform movement and position. This report covers the detailed system design, the servo analysis, and the system error analysis.

KINDER, W.

K04 Real-Time Selection and Validation of Telemetry Data in the SFOF

W. Kinder and W. Kizner

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 118–121, September 30, 1970

An historical appraisal of telemetry data validation techniques was undertaken for the adoption of an automatic real-time algorithm utilizing the new IBM 360/75 computer plant in the Space Flight Operations Facility (SFOF). This article describes an interim algorithm for incorporation into the 1971-era telemetry system, the possible application of discriminant analysis to data validation, and possible future work with discriminant analysis for the evaluation of the telemetry system partial status observables.

KIZNER, W.

K05 Real-Time Selection and Validation of Telemetry Data in the SFOF

W. Kinder and W. Kizner

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 118–121, September 30, 1970

For abstract, see Kinder, W.

KOLBLY, R. B.

K06 Switched-Carrier Experiments

R. B. Kolbly

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 81–84, September 30, 1970

The Deep Space Instrumentation Facility has a requirement, in support of the *Viking* Project, for simultaneous transmission of two carriers from one antenna. These carriers would be separated by approximately 5 MHz and carry ranging modulation. The power level required is a minimum of 40 kW in each carrier and its associated sidebands. The 400-kW transmitter can supply this easily if excitation is supplied at the two frequencies, but past experience and test data have shown that intermodulation products in the receiver

passband well above threshold are generated by this approach. These products are generated whenever two carriers exist in the nonlinear klystron; there is even evidence that they may be generated in the waveguide equipment or the antenna structure.

If the excitation could be switched so that the klystron and antenna see only one carrier at a time, these products would not be generated. This article describes initial experiments to investigate the feasibility of time-sharing a klystron amplifier between two uplink channels in order to simultaneously track two spacecraft. Design of a suitable diode switch is described.

K07 Waveguide Switch Protector

R. B. Kolbly

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 105–106, September 30, 1970

The waveguide switches used by the Deep Space Instrumentation Facility are driven by a gear-reduced dc motor, with no power supplied to the motor armature with the switch in its operating position. If, for any reason, the motor operates with the switch rotor "hung up," the motor will destroy itself. A fuse is provided, but it is required to protect several switches and does not reliably protect an individual switch motor. This article describes a device to protect the waveguide switches from failure due to overload of the drive motor. This protection is achieved by detection of the amount of time the motor is receiving power and removal of the power if the time is excessive, while signaling the operator at the same time.

LAESER, R. P.

L01 *Mariner* Mars 1971 Mission Support [by DSN, July–August 1970]

R. P. Laeser

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 19–23, September 30, 1970

The calibration of radio metric data [generated by the Deep Space Network (DSN) while tracking a spacecraft] to compensate for the effects of propagation phenomena and the variations of a deep space station location in space is a DSN responsibility in some cases; in other cases, the DSN provides analytic calibration assistance to each supported project. This effort, called Tracking System analytic calibration, has been formalized for support starting with the *Mariner* Mars 1971 Project. This article describes how Tracking System analytic calibration will provide the necessary accuracy, especially through the calibration of trosospheric and charged-particle effects, to meet the *Mariner* Mars 1971 requirements.

LEVY, R.

L02 A Method for Selecting Antenna Rigging Angles to Improve Performance

R. Levy

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 72–76, September 30, 1970

Given the half path-length surface deviations from the best-fitting parabola for only two gravity loading positions, a new closed-form computational procedure will give the best-fit rms surface deviation at any arbitrary antenna elevation attitude. This procedure, described in this article, greatly facilitates the selection of antenna rigging angle to minimize the peak rms deviation or to optimize RF performance with respect to an elevation-attitude weighting function.

LINNES, K. W.

L03 *Mariner* Mars 1969 Extended Operations [Mission Support, by DSN, July–August 1970]

K. W. Linnes

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 14–19, September 30, 1970

As described in this article, the Deep Space Network (DSN) has supported the *Mariner* Mars 1969 Extended Operations Mission with the 210-ft-diam-antenna Mars Deep Space Station, a new experimental high-power transmitter, a new experimental sequential acquisition ranging system, and the 85-ft-diam-antenna Echo and Cebreros Deep Space Stations. The tracking coverage of this unique equipment has enabled meeting of the objectives of the mission to test relativistic gravitational theories, measure solar coronal and interplanetary electron density profiles, demonstrate a highly accurate ranging system at 2.6 AU, and determine the utility and accuracy of the differenced range versus integrated doppler (DRVID) method of charged-particle calibration of metric radio tracking data. The support was provided during the critical period of superior conjunction of the *Mariner VI* and *VII* spacecraft around April 29 and May 10, 1970. Doppler and ranging data were obtained within 2 deg of the Sun.

LOBB, V. B.

L04 Low-Frequency Low-Level Stress Reversals on an Assembly of Bolted Joint Specimens

V. B. Lobb

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 77–81, September 30, 1970

In previous joint integrity research, JPL found that the inorganic zinc coating used as a corrosion barrier on the 210-ft-diam antennas broke down on the contact surfaces when undergoing stress reversals. To ensure

that this desirable coating could be used without joint slippage, research was initiated to determine which design parameter and stress level would warrant use of inorganic zinc-painted coatings on specimens undergoing low-cycle, low-load complete stress reversals. Bolted structural assemblies with plain mill scale faying surfaces were assigned the role of a control surface by which the inorganic zinc-painted surface was to be compared. This research investigated the effect of surface conditions, bolt design, bolt strength level, and applied stress versus joint slip displacement. Another objective of the program was to confirm previous stress reversal studies concerning the effect of load level and the type of fastener. The research program and the test procedures and results are described in this article.

LORD, W. W.

L05 Overseas 210-ft-diam Antenna Project
R. D. Casperson and W. W. Lord
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 154–158, September 30, 1970

For abstract, see Casperson, R. D.

MACIE, T. W.

M01 Solid-State Switching Matrix for Solar Electric Propulsion
T. W. Macie
Technical Memorandum 33-461, December 15, 1970

To reconnect an ion thruster from one power conditioner to another, a mechanical switching matrix is presently utilized. The current study compares the mechanical solution to a solid-state solution using thyristors. The comparison of the two systems is based on a discussion and analysis of the following parameters: (1) configuration, (2) thyristor characteristics, (3) losses, (4) heat radiators, (5) total weight, and (6) reliability. Comparative conclusions are in terms of weight, size, reliability, and efficiency of the two systems. The study also includes an Appendix outlining the tradeoffs relating to choice of thyristors as a further effort of system optimization.

McCLURE, J. P.

M02 GCF Wideband Digital Data System
J. P. McClure
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 102–103, September 30, 1970

The Ground Communications Facility (GCF) will install a 50-kbit/s wideband digital data capability between the Space Flight Operations Facility, the Mars Deep Space Station, and the JPL Compatibility Test

Area. This new capability, as described in this article, will become operational in the fall of 1970 and will initially be used in support of the *Mariner* Mars 1971 missions. The wideband system will permit simultaneous transmission of two digital video streams of 16 kbits/s.

MILLER, R. B.

M03 DSN Tracking System Operations
J. Heller and R. B. Miller
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 122–125, September 30, 1970

For abstract, see Heller, J.

MOFFET, A. T.

M04 High-Resolution Observations of Compact Radio Sources at 13 Centimeters
K. I. Kellermann (National Radio Astronomy Observatory), B. G. Clark (National Radio Astronomy Observatory), D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis
Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

For abstract, see Kellermann, K. I.

MORRIS, G.

M05 Digital Acquisition and Detection: Digital Frequency Doubler
G. Morris
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 40–42, September 30, 1970

A digital frequency doubler is described which uses only three integrated circuits and six discrete components. This frequency doubler, a broad-band device, can perform with input frequencies up to 10 MHz. At all frequencies, the output pulses have constant width. Waveshaping is provided to convert the input sine wave into fast rise-time pulses to drive digital circuits.

MULHALL, B. D.

M06 The Effect of the Diurnal Variation of the Earth's Ionosphere on Interplanetary Navigation
B. D. Mulhall and K. L. Thuleen
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 35–39, September 30, 1970

Described in this article is a parametric study to determine the effects of the diurnal variation of the charged particles in the earth's ionosphere on interplanetary spacecraft navigation. Model ionospheres representing diurnal variations for different seasons and solar cycle phases were used to estimate the ionospheric effect. The seasonal and solar cycle variations in the model parameters were determined by fitting the model to actual ionospheric measurements. The sun–earth–probe angle was varied to represent various mission geometries.

MULLEN, P. G.

M07 High-Speed Data, SFOF Outbound Communication

P. G. Mullen

The Deep Space Network, Space Programs Summary 37-65, Vol. II, p. 101, September 30, 1970

A new capability being developed to transmit high-speed data from the Space Flight Operations Facility (SFOF) computers to distant sites via the Ground Communications Facility is described in this article. This effort has necessitated JPL in-house development of a high-speed-data converter and certain interface switching between the 360/75 computers and the block multiplexer in the Ground Communications Facility.

NASH, D. B.

N01 Spectral Reflectance and Albedo of *Apollo 11* Lunar Samples: Effects of Irradiation and Vitrification and Comparison With Telescopic Observations

J. E. Conel and D. B. Nash

Proceedings of the Apollo 11 Lunar Science Conference, Houston, Texas, January 5–8, 1970, Vol. 3, pp. 2013–2023

For abstract, see Conel, J. E.

N02 Luminescence Properties of *Apollo 11* Lunar Samples and Implications for Solar-Excited Lunar Luminescence

D. B. Nash and R. T. Greer

Proceedings of the Apollo 11 Lunar Science Conference, Houston, Texas, January 5–8, 1970, Vol. 3, pp. 2341–2350

Luminescence measurements of Tranquillity samples indicate that energy efficiencies for laboratory excitation by protons and ultraviolet radiation are in the range 10^{-6} or below; natural and induced thermoluminescence is even weaker. If these samples are typical, lunar surface luminescence cannot occur at reported levels. Comparison of proton luminescence spectra from

the exterior and interior of rocks and fine fragments provides evidence of solar wind impingement on the moon's surface.

ONDRASIK, V. J.

O01 Variations in the Zenith Tropospheric Range Effect Computed From Radiosonde Balloon Data

V. J. Ondrasik and K. L. Thuleen

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 25–35, September 30, 1970

For many years, it has been recognized that the passage of a tracking signal through the troposphere will significantly corrupt the data used in determining the orbit of a distant spacecraft. At the present time, a tropospheric refractivity model, which is independent of time, is being used in attempts to reduce the tropospheric errors. In this article, some idea of the temporal behavior of errors in radio tracking data due to the troposphere is obtained by calculating the tropospheric zenith range effect from measured refractivity profiles collected during 1967. In addition, a cursory examination of the surface weather measurements is undertaken to see if it may be worthwhile to try to predict the variations of zenith range effect from such measurements.

OTOSHI, T. Y.

O02 Improved Calibration Techniques: Realizability Conditions on Reflection Coefficients of Unsymmetrical, Passive, Reciprocal 2-Port Networks

T. Y. Otoshi

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 64–65, September 30, 1970

In the microwave calibrations of a reciprocal 2-port network where the waveguide types on each port are different, it is often difficult or inconvenient to measure the reflection coefficient at each of the ports. This article discusses simple limit formulas that can be used to obtain estimates of the reflection coefficient for the second port when the only known quantities are the reflection coefficient for the first port and the dissipative loss of the 2-port network. It is required that the 2-port network be reciprocal, but no restriction is placed on the lossiness of the network.

PATTERSON, R. E.

P01 Battery Storage Optimization and Design Studies

R. S. Bogner and R. E. Patterson

Technical Memorandum 33-462, December 15, 1970

For abstract, see Bogner, R. S.

POLANSKY, R. G.

P02 DSN Mark IIIA Simulation Center Development

R. G. Polansky

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 94–96, September 30, 1970

The simulation center subsystem, a part of the Deep Space Network (DSN) Simulation System, has required extensive increase in capability to support the Mark IIIA DSN and future flight projects. Added capabilities are core memory expansion, EMR-6050/UNIVAC-1108 interface, interactive cathode-ray-tube terminals, and programmed input/output receivers and generators. Block diagrams of the subsystem with and without the added capabilities are included.

PORCHÉ, W.

P03 Computerized Receiver and Telemetry SNR Predictions Program

W. Porché

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 133–135, September 30, 1970

The receiver and telemetry signal-to-noise ratio (SNR) predictions program described in this article provides predicted computations of ground receiver signal strength and telemetry SNR on a daily basis. The receiver signal strength is calculated using the space-loss equation, which requires the known range and frequency of the spacecraft. Once the ground receiver signal strength is calculated, the receiver margin, telemetry SNR, and parity error rate or bit error rate for specific bit rates are determined. The program has the additional capability of predicting either single-station telemetry or dual-station telemetry modes.

RIGGS, R. L.

R01 Low Transmitted Power Operation [of DSIF Antennas]

R. L. Riggs

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 136–139, September 30, 1970

This article discusses a method by which the radiated output power level from a Deep Space Instrumentation Facility (DSIF) antenna may be adjusted while maintaining the transmitter at constant power and bandwidth levels. The constant power output from the transmitter is split into appropriate levels between a dissipative load and the antenna feed horn. Described are two devices that will accomplish the splitting: (1) basically a fixed high-power directional coupler (or combination of couplers), and (2) a high-power microwave power divider that has a capability of being continuously variable. Current instrumentation tech-

niques for monitoring the output power level are not changed with either device, and the overall accuracy of the system is degraded only by the tolerances in the calibration of the added device(s).

ROSS, R. G., JR.

R02 Parametric Study of the Performance Characteristics and Weight Variations of Large-Area Roll-Up Solar Arrays
J. V. Coyner, Jr. and R. G. Ross, Jr.
Technical Report 32-1502, December 15, 1970

For abstract, see Coyner, J. V., Jr.

SATO, T.

S01 Radio Science Support [by DSN, July–August 1970]
T. Sato, L. Skjerve, and D. Spitzmesser
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 132–133, September 30, 1970

Described in this article are three proposed experiments that have completed evaluation by the Radio Astronomy Experiment Selection Panel. The SCO-XR1 (on X-ray source in the constellation Scorpio) observations, the trans-Pacific very-long-baseline interferometer experiment, the X-band pulsar observations, and two X-band planetary radar experiments are summarized. These radio-science experiments supported by the Deep Space Network (DSN) were performed during May–July 1970.

SAVAGE, J. E.

S02 Digital Telemetry and Command: A Collection of Results on Computational Complexity
J. E. Savage (Brown University)
The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 42–47, September 30, 1970

This article discusses: (1) a bound on the maximum time to compute a function, (2) the storage required for autonomous computation, (3) the computation of simple and complex functions, (4) the work potential of a computer, (5) a quantum-mechanical bound on complexity, and (6) the sorting problem. These results on the complexity of computation are tied together by their use of the measure "computational work." The purpose of this research is to define a method for choosing the best telemetry decoding configuration, but the technique has applicability to other Deep Space Instrumentation Facility uses of computers.

SHAFFER, D. B.

S03 High-Resolution Observations of Compact Radio Sources at 13 Centimeters

K. I. Kel'ermann (National Radio Astronomy Observatory), B. G. Clark (National Radio Astronomy Observatory), D. L. Jauncey (Cornell University), M. H. Cohen (California Institute of Technology), D. B. Shaffer (California Institute of Technology), A. T. Moffet (California Institute of Technology), and S. Gulkis

Astrophys. J., Vol. 161, No. 3, pp. 803–809, September 1970

For abstract, see Kellermann, K. I.

SIMMONDS, P. G.

S04 Whole Microorganisms Studied by Pyrolysis–Gas Chromatography–Mass Spectrometry: Significance for Extraterrestrial Life Detection Experiments

P. G. Simmonds

Appl. Microbiol., Vol. 20, No. 4, pp. 567–572, October 1970

Pyrolysis–gas chromatography–mass spectrometric studies of two microorganisms, *Micrococcus luteus* and *Bacillus subtilis* var. *niger*, indicate that the majority of thermal fragments originate from the principal classes of bio-organic matter found in living systems such as protein and carbohydrate. Furthermore, there is a close qualitative similarity between the type of pyrolysis products found in microorganisms and the pyrolysates of other biological materials. Conversely, there is very little correlation between microbial pyrolysates and comparable pyrolysis studies of meteoritic and fossil organic matter. These observations will aid in the interpretation of a soil organic analysis experiment to be performed on the surface of Mars in 1975. The science payload of this landed mission will include a combined pyrolysis–gas chromatography–mass spectrometry instrument as well as several "direct biology experiments" which are designed to search for extraterrestrial life.

SINGLETON, F. L.

S05 SFOF Digital Television Assembly

F. L. Singleton

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 86–91, September 30, 1970

This article describes the Space Flight Operations Facility (SFOF) digital television (DTV) assembly, a part of the user terminal and display subsystem. This assembly affords 60 channels of television for real-time display of graphic and alphanumeric information. The assembly is fully compatible with the Ground Com-

munications Facility television assembly, allowing distribution of DTV throughout the SFOF. Provision is made for capturing a hard-copy print of any selected format. Each of the 60 channels may selectively display several formats. Modular design will permit future expansion of the DTV assembly.

SKJERVE, L.

S06 Radio Science Support [by DSN, July–August 1970]

T. Sato, L. Skjerve, and D. Spitzmesser

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 132–133, September 30, 1970

For abstract, see Sato, T.

SPITZMESSER, D.

S07 Radio Science Support [by DSN, July–August 1970]

T. Sato, L. Skjerve, and D. Spitzmesser

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 132–133, September 30, 1970

For abstract, see Sato, T.

STELZRIED, C. T.

S08 A Noise-Adding Radiometer for Use in the DSN

P. D. Batelaan, R. M. Goldstein, and C. T. Stelzried

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 66–69, September 30, 1970

For abstract, see Batelaan, P. D.

SWARD, A.

S09 Frequency Generation and Control: Analysis of Random Modulation in Amplifier Circuits

A. Sward and G. Thompson

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 50–55, September 30, 1970

The development of the hydrogen maser as a frequency standard for the Deep Space Network requires that the performance of distribution circuitry be re-evaluated. The hydrogen maser output is so nearly an ideal sinusoid that degradation of the signal in an amplifier becomes important. In this article, a theoretical analysis of random amplitude and phase modulation of a sinusoidal carrier is developed. A measure, $\mathcal{J}$, of the degradation from the ideal signal is defined. In amplifiers, power spectra with a $1/f$ behavior are of primary interest; for these spectra, the functional behavior of $\mathcal{J}$ indicates a design criterion to minimize the contributions of undesirable amplitude and phase modulation.

THOMPSON, G.

T01 Frequency Generation and Control: Analysis of Random Modulation in Amplifier Circuits

A. Sward and G. Thompson

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 50–55, September 30, 1970

For abstract, see Sward, A.

T02 Frequency Generation and Control: Angle Demodulation Using State-Variable Techniques

G. Thompson

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 55–61, September 30, 1970

Deep space communication receivers for multiple-sideband angle modulation become difficult to analyze as the number of sidebands increases. Analysis that uses state-variable techniques is ideally suited to formulating problems involving large systems of random processes. When applied to sinusoidal angle modulation, the state-variable approach yields a realizable demodulator that is optimum in the minimum-mean-square-error sense at high signal-to-noise ratios. The receiver structure and error covariance above threshold are the direct results of the analysis.

This article applies the state-variable concept to the problem of sinusoidal angle modulation and shows that the resulting receiver is optimum at high signal-to-noise ratios. Two examples are given to illustrate the technique and show its equivalence in the steady state to the Wiener optimum filter.

THULEEN, K. L.

T03 Variations in the Zenith Tropospheric Range Effect Computed From Radiosonde Balloon Data

V. J. Ondrasik and K. L. Thuleen

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 25–35, September 30, 1970

For abstract, see Ondrasik, V. J.

T04 The Effect of the Diurnal Variation of the Earth's Ionosphere on Interplanetary Navigation

B. D. Mulhall and K. L. Thuleen

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 35–39, September 30, 1970

For abstract, see Mulhall, B. D.

TIMOR, U.

T05 An Upper Bound on the Estimation Error in the Threshold Region

U. Timor

IEEE Trans. Information Theory, Vol. IT-16, No. 6, pp. 692–699, November 1970

An upper bound on the estimation error in the threshold region (probability of threshold effect and mean-square error) is obtained for nonlinear pulse modulation systems. The problem is viewed in an N-dimensional Euclidean space. The space of all received signals is divided into two regions, corresponding to the two types of error: weak-noise approximation and threshold effect. The threshold region is geometrically upper bounded by a larger region, and the estimation error is obtained as a sum of incomplete Γ functions. The resulting bounds on the mean-square error were found to be quite close for the cases calculated. An extension of the method to a PPM system is also presented.

TRUBERT, M. R.

T06 A Frequency Domain Solution for the Linear Attitude-Control Problem of Spacecraft With Flexible Appendages

M. R. Trubert

Technical Report 32-1478, November 15, 1970

The three-dimensional linear interaction problem between attitude control of spacecraft and the flexibility of spacecraft is solved in the frequency domain by using the concept of Fourier transform. The transfer-function matrix of the system formed by the linear structure and the linear control circuit is determined from the modal characteristics of the structure, using the modal combination concept and the electrical characteristics of the control loop. A large number of elastic modes can be used for the structure. Time histories are obtained by inverse Fourier transformation. The three angles of the attitude of the spacecraft with respect to an inertial frame of reference are computed for any disturbance torques applied about the three axes of the spacecraft. A stability study is made by direct inspection of the responses to unit impulse for the three attitude angles or, alternatively, by the display of a determinant. A computer program has been written to compute all of the necessary transfer functions, and the last Fourier transform algorithm has been used to compute Fourier transforms. The program is used on a teletype terminal.

VOLKOFF, J. J.

V01 Contrast Ratio Determination for the SFOF Video Image Display

J. J. Volkoff

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 91–93, September 30, 1970

The Space Flight Operations Facility (SFOF) Mark III central processing system will include a video image

display subsystem that will display and print tonal images through video processing of digital image data. The images will be displayed on high-resolution monitors having the capability to display a large number of discernible grayshades requiring a minimum contrast ratio for a given monitor configuration and ambient light condition. This article is concerned with the effect of ambient light upon the contrast ratio and upon the output light of the display.

WELLS, R. A.

W01 Diagnostics for the SFOF Mark IIIA Central Processing System: Standalone Acceptance and Maintenance Routines

R. A. Wells

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 97–99, September 30, 1970

This article summarizes the history and current status of diagnostic development for Space Flight Operations Facility (SFOF) central-processing-system subsystems having main processors that can be operated independently of the 360/75 computers. These routines are employed for hardware checkout and equipment acceptance where vendor-furnished diagnostics are unavailable. Particular attention is given to the digital TV assembly, the mission display board, the simulation center, and the SFOF/Ground-Communications-Facility high-speed/wideband data interfaces.

WIEBE, E. R.

W02 Low Noise Receivers: Microwave Maser Development [July–August 1970]

E. R. Wiebe

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 62–63, September 30, 1970

An instrument for automatically recording the reserve heat capacity of maser closed-cycle refrigerators that has been built and tested at JPL is described. Using this device, the overall health of closed-cycle refrigerator systems in the field can easily be monitored between tracking periods. The measurement of reserve heat capacity is performed with higher accuracy and greater speed than is possible with the manual methods generally in use.

WYATT, M. E.

W03 CTA 21 to TRW Passive Microwave Link

M. E. Wyatt

The Deep Space Network, Space Programs Summary 37-65, Vol. II, pp. 104–105, September 30, 1970

To establish compatibility between the Deep Space Network and various spacecraft prior to launch, Com-

patibility Test Area 21 (CTA 21) was implemented at JPL to represent a standard Deep Space Instrumentation Facility station. However, the *Pioneer* Project has determined it impractical to bring the *Pioneer F* and *G* spacecraft to JPL for the necessary compatibility tests. Therefore, it has been proposed that an S-band microwave link be established between CTA 21 and TRW Systems, Inc. in Redondo Beach so that the compatibility tests may be integrated with the presently scheduled tests at TRW. The preliminary work towards establishing such a link is the subject of this article.

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IEEE Trans. Information Theory **Entry**
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Proceedings of the Apollo 11 Lunar Science Conference, Houston, Texas, January 5–8, 1970 **Entry**
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