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A Review of the ELINT

~~PROPOSED~~ NAVY SATELLITE PROGRAM

and the proposed Extension for FY 64

INTRODUCTION

Since 1960 the U. S. Navy has had an ELINT Satellite program which is producing ELINT information in response to National Requirements.

Basically this system is a very simple crystal video collector which is designed to have an estimated minimum life of one year and is carefully tailored to a given intercept band and provides unity probability of intercept in that frequency band. The Satellite responds pulse by pulse in real time, retransmitting the data collected to existing ELINT ground stations on the Soviet periphery which are equipped to track the Satellite and record the data on multi-channel tape recorders. True time is also recorded in digital form to allow later reduction of the data and fixing the location of the emitters. Since the data are recorded in analog form it is amenable to reduction using the regular manual processing techniques. The National Security Agency has also developed a machine processing technique for this data which produces a tape output that is fed directly into a IBM 7090 computer by which reduction of signal parameters and fix computation is done on a very rapid basis.

The intelligence product from this project is presently being sent to all of the ELINT processing agencies, including the Strategic

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Air Command which is utilizing it to provide unique data for updating the Single Integrated Operational Plan. [redacted] emitter locations have been added and revised as a result of the input from this system. In addition to the emitter locations this program has also been the first to detect several new radar types.

One of the startling contributions of this Satellite program was the discovery of a new Radar System thought to be part of the Anti-Ballistic Missile complex of the Soviet Union.

This program has an excellent valid cover in the Solar Radiation Program. Each Solar Radiation experiment is designed to measure characteristics of solar events and correlate them with changes in the earth's ionosphere. U. S. and foreign scientific groups are vitally interested in the cover experiment data collected on an unclassified basis. To author of the cover / Distribution of the ~~cover~~ solar radiation data is being made internationally by Dr. Friedman of the U. S. Naval Research Laboratory, who is a foremost scientist in this field.

ACCOMPLISHMENTS — 3 out of 6 launches successful. — failures due to launching vehicles

LAUNCH I. In June 1960 the Navy launched its first Satellite in this series, an "S" band ball covering 2600 to 3250 Mc and the equipment in the Satellite operated exactly as predicted for a three-month period. Signal densities resulting from this collection effort were several times greater than had previously been anticipated.

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LAUNCH II In November 1960 a second launch was attempted but the rocketry malfunctioned and orbit was not achieved.

LAUNCH III In June 1961 another Navy Satellite was launched into orbit covering 550 to 620 Mc and 810 to 920 Mc with the capability to select either or both of the intercept bands. This Satellite is tasked infrequently but is still operating though at reduced sensitivity.

LAUNCH IV The Navy's first payload for Fiscal Year 1962 was called Composite 1A and was launched on a Thor-Able-Star in January on a 67 1/2° prograde orbit from Cape Canaveral. This launch failed to achieve orbit because of a defective second stage motor. Composite 1A had as a payload a group of five Satellites which were to be placed in orbit simultaneously. The GREB payload was a two band system covering 165 to 185 Mc and 2600 to 3250 Mc.

LAUNCH V In April 1962 the Navy again attempted ~~to~~ launching a Scout Vehicle from the Pacific Missile Range repeating the previous two band experiment covering 165 to 185 Mc and 2600 to 3250 Mc. This vehicle malfunctioned in the ~~fourth~~ third stage and the payload failed to achieve orbit.

LAUNCH VI In December 1962 under the auspices of the National Reconnaissance Office two of the Program "C" 7101 Satellites were placed in orbit by an Air Force Thor-Agena rocket. The orbit was quite eliptical with an

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Apogee of 1485 Nautical Miles and a Perigee of 122 Nautical Miles. Because of the poor orbit and the associated difficult ephemeris calculations, early evaluationcof the [redacted] has not yet been possible. Frequency band coverage in the 7101A Satellite was as follows: (1) 165 to 200 Mc,(2) 320 to 390 Mc,(3) 510 to 610 Mc, and (4) 2000 to 2750 Mc. Satellite 7101B covers (1) 192 to 237 Mc, (2) 380 to 480 Mc, (3) 570 to 710 Mc, and (4) 2600 to 3250 Mc. All portions of the satellite functioned satisfactorily and data is now under analysis by NSA. Tracking of this satellite continues on a programed basis daily.

PRESENT PROGRAM

LAUNCH VII In May 1963 the National Reconnaissance Office plans to launch three Program "C" 7102 Satellites into orbit with their Thor-Agena combination. These three Satellites will cover the radio frequency bands as follows:

7102A - (1) 260 to 320 Mc, (2) 450 to 550 Mc, (3) 830 to 1080 Mc, and (4) 2500 to 3150 Mc.

7102B - (1) 230 to 290 Mc, (2) 480 to 580 Mc, (3) 665 to 855 Mc, and (4) 3000 to 3650 Mc.

7102C - (1) 90 to 105 Mc, (2) 170 to 205 Mc, (3) 1300 to 1750 Mc, and (4) 3250 to 4100 Mc.

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The overlapping frequency coverage will provide the [redacted]

[redacted]

problems of ephemeris computation and tracking at the ground stations. Two cover type experiments will be incorporated in these Satellites. In 7102 (A) a Solar Radiation experiment will be flown which covers approximately the following Solar Radiation spectral bands:

(1) 0.1 to 1.6 A
(2) 0.5 to 3.0 A
(3) 2.0 to 6.0 A
(4) 2.0 to 8.0 A
(5) 8.0 to 16.0 A
(6) 44.0 to 60.0 A

These data will be read out on subcarrier oscillators associated with the telemetry (tracking) signal. In 7102 (B) a dosometer type radiation experiment will be incorporated which will readout the total Roentgen dosage accumulated on the detector. This again will be read out on a subcarrier oscillator of the telemetry (tracking) signal.

LAUNCH VIII In September 1963 the National Reconnaissance Office will again launch three program "C" 7103 Satellites into orbit with a similar Thor-Agena combination. These satellites will cover the radio frequency bands as follows:

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7103A - (1) 105 to 125 Mc, (2) 665 to 855 Mc, (3) 1080 to 1350 Mc, and (4) 3800 to 4700 Mc.

7103B - (1) 155 to 180 Mc, (2) 550 to 660 Mc, (3) 820 to 1080 Mc, and (4) 4700 to 5100 Mc.

7103C - (1) 170 to 205 Mc, (2) 320 to 390 Mc, (3) 590 to 730 Mc, and (4) 1600 to 2000 Mc.

Again the overlapping frequency coverage will permit the

a third. Additional these units will contain two R and D experiments. One in the frequency region 1200 to 1350 Mc will permit identification

Band where two varieties of Tall King Radars exist and will demonstrate the ability to identify the two known types of these Radars. A solar Radiation type of experiment somewhat similar to 7102 will also be flown in 7103 (C).

PHILOSOPHY OF CONCEPT FOR PROGRAM "C" SATELLITES

GENERAL AIMS

The first aim of the Navy ELINT Satellite Reconnaissance Program is to determine the electronic Signal environment in the various frequency

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bands of the Sino-Soviet Bloc. If this information is collected using a simple crystal video system, unity probability of intercept will result In collecting data by this system it is possible to measure many of the pertinent parameters of the emitter over a long period of time. These characteristics are sufficient to enable the analysts to note and analyze new equipments as they are introduced into use by the various countries.

Pulse repetition rates, antenna rotation rates, [redacted] are all major parameters which are accurately indicated by this ELINT Satellite system. The simple crystal video system presents these parameters automatically in real time and provides a simple long life collection system capable of providing many thousands of orbits over the target area.

[redacted]

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[redacted] This Satellite system is capable of producing data for dealing with all these questions.

Reliability is a paramount aim of the Program "C" Satellite system. Analog systems satisfy this objective and have the added advantage that they place the interpretive function on the ground where interpretive technical competence is highest. Any design, that causes unreliable data to be generated tends to destroy the confidence of potential users.

Program "C" Satellite systems comprise a compatible series of equipments. The operating and analysis procedure for each unit is essentially the same, in this way competence can be developed to the highest state of efficiency thus insuring a uniform quality intelligence product.

ADDITIONAL OBJECTIVES

[redacted]

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controlled pass band characteristics which do not respond to signals in other than the pass band of frequencies. Therefore it can be stated that the signals received are only in the prescribed pass band.

Identification of certain types of frequency characteristics such as in a radar are important. To cope with this situation an R and D experiment in 7103 is planned which would give additional data required to identify a radar of known type in the 1200 to 1350 Mc Band. Data on additional sub-divided frequency bands will be indicated on one of the subcarriers oscillators of the ~~tracking signal~~ telemetry signal. This additional data can be ignored in the usual analysis processing techniques, however by inspection of the data in this additional channel, indications of the activity in each discrete smaller band width segiment can be easily read. This experiment will demonstrate the ease with which radars can be identified in response to future requirements.

(b) Indication

In the identification of certain types of emitters there often is a requirement for In 7103 a R and D experiment is planned which will indicate the additional data on in one of the subcarrier oscillators of the telemetry channels. Here again this data can be ignored in the normal processing but if this

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additional information is desired it can readily be obtained from the telemetry channel. To demonstrate this capability it is planned to instrument the Tall King Band to 1555 to 1580 Mc with this capability thus providing an additional sorting parameter for the Tall King to differentiate between the 10 ~~MS~~ microsecond and 2 ~~MS~~ microsecond Sets.

Later it is hoped that this capability can be selected so it can be applied to any of the frequency bands in a given Satellite by Command.

(c) Position Fixing

From the beginning of this project the necessity for fixing the position of the emitters was recognized as an important objective. Crude positioning was possible using the forward scan duration and the backward scan ~~deviation~~ duration and the time period between them. However, considerable manipulation was required and a more positive system was sought.

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[redacted]

(d) Ground Station Improvement

There continues to be a requirement at some stations with inexperienced personnel to develop more foolproof systems to insure correct antenna pointing and correct receiver tuning. With poor ephemeris data antenna pointing is always a difficult problem. From the same cause, prediction of receiver tuning is difficult. Presently

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the shape of the ~~transmitted~~ received pulse provides an indication of correct ~~receiving~~ or tuning though with inexperienced personnel some additional aid may be required.

In the interests of providing the data from the field to NSA with a minimum of overall variations it is planned to conduct research to devise improved instrumentation for hut operation for the future.

Present recorder level setting and monitoring does not provide a sufficiently comprehensive analysis of system performance overall, therefore it is planned to provide a recorder monitoring system more all inclusive than presently available. This new system will be capable of being integrated into the existing recorder system without major modifications but should assure earlier indication of recorder problems which may occur in the future.

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The desirability of providing at least a couple of locations with the capability for early identification and analysis of any new type signals is under investigation. The philosophy of whether trained analysis experts would be available to man this equipment from existing station personnel is the major matter of concern. Presently the ELINT Stations restrict their operations to a radius of perhaps some 100 miles from the station. Rarely do they hear signals beyond this horizon. Therefore it is contended in certain quarters that the analysis operator rarely encounters any new signals in the day-to-day operation of a typical station. However, with the Satellite the Stations horizon is lifted often to as much as 3500 to 4000 miles thus providing a much wider selection of new signal types. Therefore the analysis operator would be gaining valuable training on new signal types not available otherwise, thus his general level of training could be markedly improved by having him scan the tapes from this project looking for the new and unusual signal types.

A program of investigation of simple operator aids to accomplish the task of new type signal recognition and evaluation is being undertaken in connection with this project and it is planned in the future to undertake a field evaluation of the effectiveness of this effort on a limited basis. This effort will be no way supplant the effort at NSA for complete analysis but it is hoped will provide early alerts to possible new signal types.

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Proposed Extension of the program for FY64.

~~Review of Proposed FY 64 Program~~

Since it appears the desire of the intelligence community to cover as much of the frequency spectrum as possible in every launch, it is proposed that program "C" consist of two launches of four satellites each in FY 64 in addition to the ~~September~~ OCTOBER launch planned in the present FY 63 program. This concept would require a minimum of rocketry to support the program and would concentrate the major portion of the payload capability in this program.

ORBIT

An Orbit of 500 nautical miles altitude on a prograde 70° inclination will be required as in the past. In addition it is desired that studies be conducted to ascertain if the

Inasmuch as rocketry control is becoming more certain, this requirement would seem to be in consonance with the state of the art ~~in~~ in this field.

Frequency Coverage

Each Satellite would contain four RF Collection bands and the data collected would be transmitted back to the collection sites by two data link frequencies with the data frequency bands being coded by two different lengths of pulses from the transmitter as in the past. ~~Since~~ All

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of the frequency spectrum between 85 Mc and 5100 Mc will have been covered after the September launch, with the exception of the window from 125 to 155 Mc, (where all the telemetering and command frequencies for the satellite are located), the proposed frequency coverages are shown in Chart A. It is anticipated that in general the frequency bands selected will be responsive primarily to the directed coverage requirements of the ~~USIB~~ United States Intelligence Board ~~COMAR Committee~~ for more data on priority targets and to follow up ~~on~~ with more extensive coverage based on previous general search results on a QRC Basis. It is anticipated that the coverage in any one Satellite could be practically any portions of the band 85 to 5100 Mc desired consistent with the limitations imposed by antenna length configurations and other technical considerations recognized in the past. These satellites will all be designed for long life (a minimum of one year life is anticipated) and are equipped with carefully controlled band pass characteristics which respond only to signals within the pass band (no ambiguities). They also produce an analog characteristic of the signal received, giving a true indication of time of occurrence,

It is anticipated that most of the general search and radar order of battle requirements will be fulfilled ~~directed~~ on a QRC basis as well as the need for identification of any new and unusual signals which ar epted.

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Technical Improvements within the Satellites

Even closer inspection and control will be employed in checking each component of the Satellite. ~~Welded wire construction is being employed in as many units as possible to insure the maximum ruggedness.~~ Each joint in the electronic components will be inspected under a microscope and critical coaxial assemblies are being inspected by X-ray to reveal any hidden flaws in assembly or manufacture.

Improved flexibility in command is being incorporated with a digital system to assure adequate and effective control. With the large number of satellites which will be in orbit soon, a more flexible system with adequate growth potential was required. A new command system has been designed which will provide a unique address for dozens of satellites of the future. Following the address the proper commands will execute all the required functions within the satellite. This will also permit switching of other functions in the satellite like the [redacted] will be available on command for any of the four RF collection bands in each satellite. These data will be available on one or more of the subcarrier oscillators in the telemetry data channel.

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Cover Experiments

It is planned to use Solar Radiation type cover experiments as in the past on a "space available" basis. These experiments will be incorporated as part of the Satellite when the requirements of the experiment are amenable with the space and power available in the ELINT Satellite. Since it is understood that Dr. Friedman expects sizeable support from NSA and BUWEPS for the development of research packages in this area no funding is included in the estimates for this project except a small amount to adapt these units within the ELINT Satellite.

Technical Improvements in the Field Collection Equipment

In addition to the improved antenna pointing equipment and receiver tuning indicators previously described, a better system of quality control of the data recordings is desired. To accomplish this a system of inspecting the recordings made from each of the two machines employed at each site in the field is planned. This will serve two major functions, one, early inspection of tapes to assure their data is consistently of the highest quality possible and permit local correction of any deficiencies, and secondly will permit early monitoring of tapes for detection of new

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and unusual signal types. This procedure will preserve the perishable potential of important intelligence collected and identify new signal types with a minimum delay. Early implementation of this tape inspection capability will be made at one or two stations first to establish the techniques and thus give a field evaluation of the procedure before implementation at all stations is attempted.

Additional Research and Development Planned

Stabilization Systems

Earth stabilization systems are of two types. Active systems expell gas to produce control torques and their life is limited by the gas supply. Passive systems utilize the gravity gradient on an elongated payload to keep one end pointed toward the earth. The latter ~~This system~~ is better suited to long life operation and development on this type is planned using a DeHavilland extendable boom to provide elongation. The effect of a 100 foot boom on a 20 inch diameter payload will be measured with a precise aspect system to determine the limits of the system. This type of stabilization system will weigh less than five pounds and if successful will have indefinite life. It is well suited to small payloads designed for simplicity. By employing stabilization systems of this type simple antenna systems can be provided in the future. Antenna systems giving reasonable gains can also be accommodated which will permit the unity probability

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system to be employed at increasingly high frequencies in the future. Ultimately it is hoped all of the USIB ~~COMAR's~~ requirements could be covered with these high probability systems.

Higher Sensitivity Systems for the Upper Microwave Frequencies

Two presently attractive avenues of research for improving the system sensitivities at the higher microwave frequencies is available in the tunnel diode and improved sensitivity crystal detector systems. Both these approaches are amenable to the low power input requirements of a long life Satellite intercept system. Plans to prosecute these research investigations for future satellites are being formulated.

Improved Satellite Reliability Studies

Investigation of all phases of satellite construction which may contribute to longer life are under research on an active basis. A better understanding of degradation of solid state components and solar cells due to high ion concentrations is required. New concepts of construction to avoid the degradations will continue to be the subject of new research studies.

System Parameter Measurements

Continued research into simpler and more reliable methods of indication and measurement of the intercepted system parameters is planned. Basic parameters of RF Frequency, Pulse Repetition Frequency, [redacted] all continue to receive study as to the best method of measuring the basic components of

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the system and accurately retransmitting these data to the readout stations on the ground.

Ground Station Analysis

To preserve the perishable product of timely intelligence a need exists in the field for simple analysis tools which can be utilized by field personnel to assess the technical parameters of the signals intercepted and thereby recognize the bits of new and unusual intelligence. Several avenues of investigations and research appear fruitful in this effort. Early reduction to practice of these techniques is planned to secure a field evaluation as early as possible.

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Budgetary Requirements

Since the FY 63 program has been delayed until the present schedule calls for a launching in ~~September~~ October 63, the funds presently available at the Laboratory for this program will have to be carried over ~~x~~ into FY 64 to cover the ~~September~~ October launching. In addition funds to cover the two new launches in the FY 64 program outlined, ~~and~~ presently postulated as perhaps March and July (5 FY 64) will be required as shown below:

Satellite Costs

Fabrication	4,570K
Launch Site	320K
Operational	350K
R and D	490K

Ground Station Costs

Fabrication and Updating	860K
R and D	210K
TOTAL	$6,700K

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DIRECTOR OF NAVAL INTELLIGENCE

The Director of Naval Intelligence is responsible to the Secretary of the Navy for the administration of the Navy's electronics intelligence collection program. The DNI has appointed a Deputy Director for ELINT matters and has established a Navy ELINT Advisory Group (NEAG) to advise and assist him in meeting these responsibilities.

DEPUTY DIRECTOR FOR ELINT MATTERS

The Deputy Director acts for the Director in supervising and administering the Navy's ELINT program subject to the approval of the Director. He is the principal adviser to the Director in all ELINT matters and is the Chairman of the Navy ELINT Advisory Group (NEAG)

NAVY ELINT ADVISORY GROUP

The Navy ELINT Advisory Group is composed of representatives from cognizant offices within the Navy. This group periodically reviews the Navy's ELINT requirements, determines the manner in which these requirements can be met, advises the DNI in all associated matters, and takes appropriate action to assist him in the administration of the ELINT program.

PROGRAM COORDINATOR AND FISCAL ADVISER

The Program Coordinator and Fiscal Adviser provides the Director with information about required ELINT equipment which cannot be produced within the facilities of the U. S. Naval Research Laboratory. He makes arrangements to procure this equipment when authorized to do so by the Director, and he coordinates such procurement with the output of NRL to assure final-product completeness. In addition, he is responsible for the administration of all the ELINT program finances including the disbursement of funds from the Bureau of Naval Weapons to NRL for the ELINT program. In the performance of his duties he will be guided and directed by the Director, his Deputy and the NEAG.

DESIGN AND CONSTRUCTION ADVISER

The Design and Construction Adviser is responsible for assuring that the capability of the U. S. Naval Research Laboratory is utilized to the fullest in support of the Navy ELINT program. These duties involve both design and construction work. He is further responsible for providing funding estimates and expenditure data to the Fiscal Adviser. In performing his duties he will be guided and directed by the Director, his Deputy and the NEAG.

OPERATIONS ADVISER

The Operations Adviser is responsible for preparing and promulgating operational directives which will permit collection of the maximum amount of required ELINT. His duties require keeping apprised of the capability of all responsive ELINT resources and issuing timely instructions to them as appropriate. In performing his duties he will be guided by the Director, his Deputy and the NEAG.

PRODUCT CONTROL ADVISER

The Product Control Adviser is responsible for providing ELINT requirements to the Director, disseminating quality control technical data to the appropriate ELINT resources, and monitoring the signal analysis process. His duties include assuring that the recorded data is handled promptly from point-to-point, and as expeditiously as possible within the processing area. In performing his duties close liaison will be required with the Operations Adviser and the National Security Agency. He will receive guidance from the Director, his Deputy and the NEAG.

DESIGN ASSISTANT

The Design Assistant is responsible for the design of all equipment which can be constructed within the facilities of the U. S. Naval Research Laboratory. This includes intercept, direction finding, signal analysis, data storage, jamming, deception and passive reflector equipment.

CONSTRUCTION ASSISTANT

The Construction Assistant is responsible for the construction and assembly of all ELINT equipment produced by the U. S. Naval Research Laboratory.

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