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OPNC-5210-863 (REV. 8/60)

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SECURITY INFORMATION

CODE	DATE	INITIALS	*PURPOSE	REMARKS
5100	9/30	[illegible]		
5400	10/1/63	[illegible]		SEP 30 1963
5430	10/29	Hof	3	Prepare comments. [illegible]
				Comment Attached.-5400-73. HOL:PR
5400	10/29/63	[illegible]		29Oct63. Hof.
5430	11/19	Hof		
				[redacted]

INSTRUCTIONS

Prepare 4 copies of this route sheet and forward ALL copies together with necessary correspondence and other documents.

***PURPOSES**

1. FOR INFORMATION	7. FOR GUIDANCE
2. APPROVED	8. FOR COMPLIANCE
3. PREPARE REPLY	9. DISTRIBUTE ENCLOSURE
4. FOR SIGNATURE	10. RETAIN ENCLOSURES
5. FOR NECESSARY ACTION	11. RETAIN COPY
6. FOR MEMO. COMMENT	12. FILE

A1073-4/62-90M, NAVY FPPO 6ND JAX

FROM Code 5100

DATE OF MATERIAL 9-30-63

BRANCH IDENT. SYMBOL 5100-42:CEC:wdw

ORIG. IDENT. SYMBOL (MAIL ROOM FILL IN)

SUBJECT

Proposal for Localizer Satellite System (U)

DIVISIONS DO NOT FILL IN

DATE MAILED

FILE NO.

R/S NO. (MAIL RM. FILL IN)

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OPTIONAL FORM NO. 10
5010-104

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UNITED STATES GOVERNMENT

Memorandum

SECRET

TO : Code 5400

5100-42:CEC:wdw

DATE: 30 Sept 1963

FROM : Code 5100

SUBJECT: Proposal for Localizer Satellite System (U)

Encl: (1) Copies 4 and 5 of subject proposal

1. Two copies of a proposed satellite system, enclosure (1), prepared at the request of Code 1000 are enclosed. I would appreciate your comments.

Superintendent
Applications Research Division

Copy 1 of 2 copies

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BYEMAN Talent-Keyhole
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24 September 1963

Proposal for Localizer Satellite System

1. Introduction

A Localizer Satellite System is defined as a system which determines the location of a signal source by means of a satellite. The satellite provides data for locating a line of sight source by direction finding. In some systems the data can be reduced in the satellite. In simpler systems the data would be transmitted to the surface for reduction.

The System to be described here is of the simpler type. The basic technique uses rotation of the satellite for scanning. Figure 1 is a sketch depicting the technique. The satellite is provided with two antenna systems. Each antenna system generates a fan shaped beam. As the satellite rotates the fan beams sweep over a wide area. If a signal source exists in this area the antenna system reads out. By dividing the antenna into two halves joined by a hybrid both a maximum signal and a null are produced as the fan sweeps over the source. These readings indicate that a source exists along the intersection of the plane of the fan beam and the surface of the earth. The antennas are oriented in such a fashion that the two beams will produce intersecting planes on the surface of the earth. The location of the source can be inferred as being at the point of intersection of these two planes and earth surface. ? ambiguous??

Figure 2 is a photograph of a mock-up of such a satellite. In its basic form the satellite contains a pair of linear antenna arrays which generate fan beams. Each antenna excites a pair of receivers which detect the signal and read its amplitude on both the sum and difference arms of a hybrid.

In order to determine the direction of the satellite antenna fans the system must be calibrated. One or more beacons located at known points will be provided. The orbit of the satellite will be determined by independent means and therefore its position at any time will be known. When the positions of the satellite and the beacons are known the direction of the fan beams can be computed. The calibration data also determines the rate of spin and the spin axis so that the direction of the fans can be predicted at a later or earlier time.

If the satellite fan beams are 90° in the wide direction, the coverage band will be approximately twice the altitude of the satellite, i.e. 1000 miles wide for a 500 mile height. An antenna 4 feet long at 3000 Mcs has a half power beam width of 4° and a null resolution of approximately 0.4°.

2. Applications

(1) If the frequency of a signal source (radar, beacon, etc.) is known, the system may be designed to determine its location. If very large frequency bands are to be searched the complexity of the system will be increased. The angular accuracy of the system is partly determined by the size of the antenna and therefore the effectiveness of the system is maximum in a frequency band in which a practical size antenna can be flown. The information provided would be source location and frequency. Other characteristics of the signal source can be measured if suitable circuitry is provided.

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3. Accuracy

The accuracy of locating the position of a radio source on the surface of the earth by the observations from a satellite using this technique is a function of many quantities. Among these quantities are the following:

(1) Distance of the source from the satellite.
(2) Spin rate of the satellite.
(3) Orientation of the spin axis of the satellite with respect to the line defined by the positions of the satellite and source.
(4) The orientation of the satellite antenna patterns relative to the spin axis.
(5) The beam width of "thickness" of the satellite antenna.
(6) Signal strength.

A complete error analysis covering all possible values of the parameters would be quite lengthy. However an estimate of the errors for any particular case can be readily made. Consider the configuration discussed above, where the resolution in the beam is 0.4°. A source directly below a satellite 500 miles high could be located within an area of uncertainty having the shape of a square with sides approximately [redacted] long. The uncertainties in the position of the satellite, and the spin calibration would be small so that the overall accuracy would be approximately [redacted] for this "best case". If the source, instead of being near the sub-satellite point, were displaced 500 miles from it, the area of uncertainty would be approximately rhombic shapped with a side length of approximately [redacted] The uncertainty in position for other configurations can be estimated in a similar manner.

4. Demonstration System

A demonstration system for finding the positions of potentially hostile radars is proposed on a modest scale to take advantage of existing mechanical structures, power supply capability and telemetering techniques. The frequency bands of these radars are documented at the secret level. When a particular frequency band is chosen, the calibration frequencies will be selected for the same band.

The system will be designed to look at a five Mc frequency band divided into a comb of five 1 Mc teeth. A set of switchable local oscillators will allow the 5 Mc band to be tuned to 10 adjacent bands for a total coverage of 50 Mc.

The one Mc bandwidth parallel filters have been selected on the basis of the following parameters:

a. Sensitivity: For a 10 db noise figure S/N = 1 at -104 dbm. A rotation rate of 6 rpm (36°/sec) and a 4° beamwidth infers a hundred millisecond read time. In order to reproduce the null, the post detection bandwidth (B) will be increased ? 10 to 100 times ($B = \frac{1}{2\pi x .111}$) or 14 to 140 cps. The pre to post detection bandwidth ratio will be $\frac{10^6}{140} = 7000$. The post detection S/N will be approximately 28 db for an input S/N = 1.

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93 - 100 dbm on Telemeter
≈ 40 cycles information Bandwidth

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b. Pulse radar response: $\tau\Delta f = 1.2$ for maximum S/N. Expected pulse widths are in the 1 to 3 μsec. range.

c. Doppler: $\pm$ 78 Kc maximum at 3000 Mc.

d. Local oscillator stability: One part in 10^6 per degree C. A 30°C range yields $\pm$ 45 Kc variation due to temperature about some nominal frequency.

A typical radar may have the following nominal characteristics at 3000 Mcs:

a. Pulse Width: 1 μ sec.

b. PRF: 400 cps

c. Average Power: 100 watts

d. Antenna Gain: 44 db

e. Antenna Side Lobes: -44 db

The assumption of -44 db sidelobes allows us to assign unity gain to the radar antenna for detection under any pointing condition and the calculation of signal level at the satellite is thus independent of the scan or scan rate of the radar. If the satellite antenna gain is 20 db the signal level at the receiver is -90 dbm for a range of 500 statute miles. This is a +14 db pre detection S/N for the receiver described.

The precision of the measurement of rotation rate may be estimated by considering the following parameters:

a. Rotation Rate: 6 Rpm = .1 Rps

b. Antenna HPBW: 4°

c. Resolution of Null Width: 0.4°.

The measurement of time between nulls must be sufficiently accurate so that the measure of rotation rate is limited by the null width. A series of nulls may be averaged to improve this value.

The system will be designed to operate, be calibrated and frequency switched when in line of sight of any "telemetering-calibration" station. This technique allows a station to operate with the satellite, calibrate it and switch its frequency. This technique has been selected to circumvent the problems of time synchronization and calibration correlation encountered in a "record and dump" type of system. A data record will contain data and calibration with time. It is anticipated that the tape recordings will be reduced at the NRL and results computed using the NAREC. The use of a computer is indicated here primarily because of the magnitude of the numerical calculations. The results are obtained through iteration rather than a single calculation.

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5. Operational System

In general, the basic concept can be expanded to provide an operational system. Larger and more complex satellites can cover wide frequency bands and perform functions in addition to localizing such as data gathering.

Additional satellites can provide additional coverage in terms of area and time. A "record and dump" system, however complicated, might be developed for any areas inaccessible to a line of sight telemetry system.

6. Schedule and Budget

The present program is funded in FY 64 at a level of $300.0 k. This is expected to support the work on computational programming, error analysis, and provide final component design and final design of a flight unit.

It is recommended that the program be augmented to produce and launch a flight unit at an early date. This unit would be produced by the Satellite Techniques Branch with scheduled as follows:

a. Preliminary design and layout of antennas and solar cells	2 months
b. Final design and layout of complete unit	4 months
c. Construction and test of flight unit	3 months
Minimum time to complete	9 months

Considering the commitments of this Branch for the coming year, the only practical program would be to plan to launch with the fall-winter shot of 1964 and to substitute this payload as one of the presently assumed four payloads. On this basis costs of the "new payload" would be as follows:

	Thousands FY 64	FY 65
1. R&D on System Design (5160)		
a. Under present Weptask	($300.0)	
b. Additional funds	90.0	$195.0
2. Payload construction (5170)		
a. Planned program	($300.0)	($200.0)
b. Increase because of new model	100.0	100.0
3. Flight Electronics (5160)	100.0	--
4. Data Reduction Equipment (5160)	50.0	--
5. Primary Telemetry Stations (5160)	250.0	--
6. Data recording for existing stations (6) (5160)	120.0	--
7. Data Analysis (5160)		90.0
Total additional funds	$710.0	$385.0
Total costs including presently [redacted] funds	$1,310.0	$585.0

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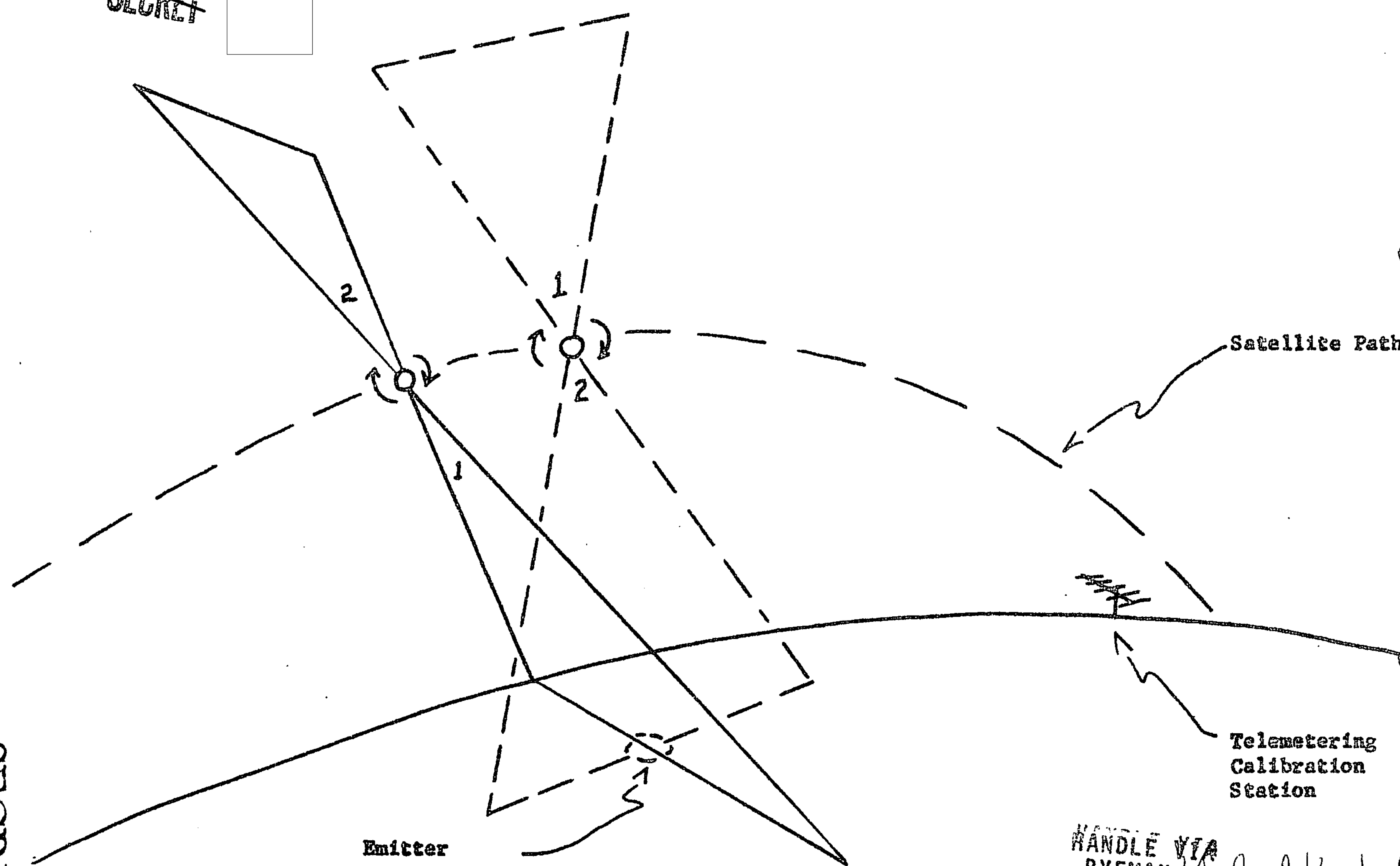

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FIGURE 1

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