Copy from Capt [redacted]

(March 1962)

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PROPOSED NAVY SATELLITE PROGRAM

INTRODUCTION

The U. S. Navy presently has a Satellite program in being which is producing ELINT information in response to National Requirements.

Basically this system is a very simple crystal video collector system which 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 with the only modification being the stretching of the pulses to minimize the transmission power and band width required. Readout is effected at [redacted] ground stations which are equipped to track the Satellite and record the data on seven channel tape recorders. True time is also recorded in digital form to allow later reduction of the data and fixing of the emitters. Since the data is 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 the IBM 704 computer where a reduction of signal parameters and fix computation is done on a very rapid basis using those computers.

The Intelligence product from this project is producing a product which is presently being utilized by all of the ELINT processing agencies. Strategic Air Command is utilizing this product in updating the Single Integrated Operational Plan. Some hundreds of emitter locations have been added and revised as a result of the input from this system.

This program has an excellent valid cover in the Solar Radiation Program. Each Satellite has a Solar Radiation collection system which is used to collect data on the wavelengths of the lethal radiations in the Van Allen Belt and their rel[redacted] solar flare activity. Project Mercury

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and other scientific [illegible] are [redacted] interested in the cover experiment data collected on an unclassifi[redacted]. Distribution of the cover data is being made internationally by [redacted] who is the foremost scientist in this field.

PRESENT PROGRAM

In June 1960 the Navy launched its first Satellite in this series, an "S" band ball covering 2600 to 3250 Mc. Equipment in the Satellite operated exactly as predicted for a 3 month period. and signal densities resulting from this collection effort were several times more than had previously been anticipated.

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

In June 1961 another Navy Satellite was launched into orbit and this unit covered 550 to 620 Mc and 810 to 920 Mc with the capability to select either or both of the intercept bands.

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REQUIREMENTS FOR SATELLITE ELINT RECONNAISSANCE

General Aims of Sat[redacted]Reconnaissance

Probably the first aim of Satellite Reconnaissance is to obtain information on what Frequency Bands the Sino-Soviet Block electronic equipment is operating in. In collecting this type of information data will be obtained automatically on new equipments. If the data is collected using a simple crystal video system unity probability of intercept will result. Utilizing this system will permit the obtaining of many of the pertinent parameters of the radar signals such as Pulse Repetition rate, Antenna Rotation Period, [redacted]

A second requirement is to determine information on Soviet Radar Order of Battle. This particularly important in those areas of the Soviet Block where it is not technically feasible to collect the ELINT data with any other vehicle. This collection effort should be capable of covering all types of radar systems from the earliest warning types to the final fire control system used to direct the final missile to its targets. As a matter of special concern is the changes in the radar order of battle from day to day, month to month as well as changes throughout the hours of the day and days of the week. Does the enemy "stand down" at certain periods? If so, what are these periods? Also how much does the ambient electronics atmosphere change when some provocatory action takes place? Satellite systems must be capable of dealing with all these questions.

What frequency coverage should be attempted in a Satellite, is a good question. In general, it is conceded that first priority is those higher power longer range systems used in the Defensive effort. These, might be located anywhere in the frequency spectrum from perhaps 20 Mc to 7000 Mc. Beyond this frequency the difficulty in generating high

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powers and the absorption in the atmosphere are serious limitations and generally relegate these systems to the shorter range assignments. At the lower end of the frequency spectrum television, FM, communications and other service functions dominate the spectrum. These restrictions being recognized, the first priority should be to cover the entire spectrum as rapidly as possible so the frequency band indicating major activity can be inspected in as much detail as desired.

Frequency resolution in general is a second order objective. For radar order of battle a resolution of about 20% is all that is required. Past experience has indicated that Soviet Electronics appear at the periphery and the interior simultaneously. Therefore, conventional reconnaissance usually provides accurate data on frequency spread for given electronics equipments. Ultimately in planning strike missions it might be desirable to know the exact frequency of each radar however in time of hostility these frequencies would be changed regularly as a countermeasures technique. In any Satellite system the engineering must be so carefully done that there is no possibility of the system generating or responding to any ambiguity.

Pulse Repetition Rates, Antenna rotation rates, [redacted] must be accurately indicated in any Satellite system. Simple analog, crystal video system present these parameters automatically in real time.

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Location of Emitters is an important requirement of any Satellite system. Though early locations may be satisfactory systems must ultimately have t[redacted]sibility of refining their product to a value useful for military planning.

System reliability is a paramount requirement in any Satellite system. Any design which causes data to be generated which is not reliable destroys all confidence and is useless. Analog systems have an advantage here since they place the interpretive function on the ground where human technical competence is highest.

[redacted]

Sattellite Systems should be a compatable series of equipments. By this technique operting and analysis competence can be developed to the highest state of efficiency insuring a uniform quality intelligence product.

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PROPOSED ACCELERATED PROGRAM

1. Booster Requirements proposed To accelerate

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~~The Navy is capable of accelerating~~ its ELINT Satellite program to meet anticipated requirements by utilizing Thor-Able-Stars on all future launches and by placing in orbit two [redacted] ...ch Satellites simultaneously. This ~~would~~ will allow for coverage of eight RF bands simultaneously with some band coverage overlap [redacted]

The Thor-Able-Star rocket combination has been selected because of its ready availability, excellent suitability from pay load handling and environmental point of view; adaptability to multiple payload operations, launch reliability, payload field crew familiarity, and relatively moderate cost. Also since the Navy's Transit program has selected the Thor-Able-Star as an interim operational launch vehicle these two programs would be utilizing the same vehicle with resultant reduction of costs and improved vehicle reliability.

Launch vehicles ~~would~~ will be procured by the Space Systems Division of the Air Force Systems Command in the usual manner. Depending on Thor booster availability seven months lead time is presently required from procurement initiation to launch. An expanded program requiring continuing production will provide stability to the program by increased numbers to sustain continuous production.

Launch operation from Complex 17 at the Atlantic Missile Range will be utilized ~~because~~. Two pads are available, and because of the facilities availability; proximity to payload assembly; thoroughly trained launch crews, lower costs and more reliability should ensue.

An orbit of 67 1/2 degrees prograde would (is) be required for this operation with an altitude of 450 nautical miles in a circular orbit.

The schedule of Satellite launches could be met with the new vehicle program starting six months after the firm availability of vehicle schedules and procurement at three month [redacted] ...rval. ~~Hopefully this interval would be shortened after receipt of the second or third unit.~~

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2. Satellite Instrumentation

Continuing under the present Solar Radiation "cover", the accelerated Navy program would contain a series of Solar Radiation experiments of increasing scope under Dr. [redacted]n's guidance. This would complement on an international scope, the work of other experimenters in this field.

The ELINT portion of these Satellites launches would employ the unity probability system already described and would consist of two balls launched simultaneously with a small incremental difference in velocity to accomplish the [redacted] as proposed by NSA. A total of eight RF frequency bands would be covered in relatively small increments of band coverage so as to pinpoint the actual bands being utilized by the Sino Soviet Block countries for radar coverage. Overlap between the various frequency bands would be provided on a planned basis [redacted] on as large a portion of the Soviet occupied frequency spectrum as possible.

Each Satellite would consist of a 24-inch ball having an ultimate maximum individual weight of perhaps 100 pounds. Within the shell would be the conventional solar cell chemical battery charging system and two separate data transmitters. Each data transmitter would be capable of being modulated by two completely separate intercept, video amplifiers and modulation systems. Which system is providing the pulse modulations would be determined by the differences in the lengths of the modulator pulses coming from the two systems. Two associated interrogation receivers would provide redundancy in the system to improve its component reliability. These receivers would allow any combinations of data intercept systems to be turned on by choosing the proper commands. Also they would allow for turning off the "cover" transmitter which is also used by the ground stations for tracking. The Solar Radiation "Cover" transmitter would transmit continuously.

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The entire system would be housed in a 24-inch sphere. Mechanical design would be such to permit the maximum flexibility and interchangeability in the instrumentation p[redacted]s. It is visualized that these future Satellite pro[illegible] complete configuration changes to take place in the ELINT portions of the Satellite to meet changing national requirements with a minimum effort. Reliability will be stressed in this new design concept and all the units will be subjected to the usual severe environmental tests as in the past Navy programs.

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A preliminary schedule of proposed band coverage ~~as~~ is shown in Figure 1. These would be varied and modified in keeping with the changing national requirements.

A continuing research program will be carried with the Satellite development program outlined above. In these research studies such things as improved reliability of components will be stressed. Operation in high radiation fields will be studied with a view to further increasing the life of the present instrumentation packages and insure their operation at high sensitivity levels over a longer period of time.

Another phase of the research will be directed at instrumentation [location finding & techniques to improve collection] to ~~highlight~~ obtain other pertinent parameters of the radar systems not now indicated in the analog presentation of data such as frequency determination,

[redacted]

3. Operational Ground Support Complex

Since the future GRAB satellites will involve a multiplicity of data channels and involve the tracking of two Satellites simultaneously modifications to existing ground station equipment will be required. ~~It is anticipated that~~ An updating at all intercept data receiving stations will be necessary to handle the increased flow of ELINT data. Separate antennas to track two Satellites simultaneously will be required with one having a complete servo loop remotely controlled from the hut. Due to the increase number of operations required simultaneously an increase in the hut size will be necessary as well as modernization of the instrumentation. Also this increase will be required to accommodate the additional personnel needed to op[redacted]he separate data taking positions required in the more complicated overall concept.

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NAVY'S PRESENT PROGRAM

1. Satellite [illegible] TOP SECRET

First Payload [redacted]

The Navy's ~~prese~~ [redacted] s for Fiscal Year 1962 ~~consisted~~ was called Composite I-A and was launched ~~of one~~ Thor-Able-Star launch ~~called "Composite I"~~, which was scheduled for January on a ~~70°~~ 67½° prograde orbit from Cape Canaveral. This launch failed to achieve orbit because of a defective ~~manifold causing the rocket to fail to function properly~~ second stage motor. Composite I had as its pay load a group of five satellites which were to be placed in orbit simultaneously. The GREB pay load was a two band system covering 155 to 185 Mc and 2600 to 3250 Mc.

In April the second launch is scheduled. This is to be a Scout vehicle launched ~~on~~ in a ~~retrograde~~ prograde orbit of 75° from the Pacific Missile Range. Since the Scout has limited weight carrying capacity the GREB Satellite will be a 60 pound ball which will be identical to the one which was scheduled to go in January on the Navy's Composite I.

In June a second Scout launch will take place similar to that outlined above except the Greb Satellite will cover the frequency bands: 182 to 237 Mc; 685 to 855 Mc and 2000 to 2735 Mc.

As a further part of the 62 program the Navy planned two more ~~Scout~~ launches ~~from the Pacific Missile Range. The schedule of these is September and December subject to the availability of Scout vehicles. An alternate would be to launch these two Satellites Packages and single Thor-Able-Star available as a back up from other Navy Space programs.~~ these payloads would ~~It~~ would cover the following frequency bands:

a. 230 to 300 Mc - 575 to 710 Mc and 1600 to 2000 Mc.

b. 300 to 380 Mc - 490 to 600 Mc and 3600 to 4400 Mc.

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[redacted] This would ~~utilize the~~ require a Thor-Able-Star ~~back up vehicle for the~~ [redacted] ~~if it is successful~~. Frequency coverage for the ~~GRAB~~ Satelli[redacted]ld consist of two units configured as follows:

a. 165 to 185 Mc: 665 to 855 Mc: 1000 to 1350 Mc: and 2600 to 3250 Mc.

b. 172 to 216 Mc: 380 to 490: 830 to 1080 Mc: and 3000 to 3650 Mc.

There is a possibility that the Navy could have available a Scout vehicle as excess from its other Space programs which would allow a final Scout launched package covering 100 to 125 Mc: 550 to 620 Mc: and 1300 to 1650 Mc.

2. Operational Data Collection Network

In connection with tasking the GRAB Satellite system for data collection the Navy has developed an operational control system for this function under the direction of the Director of Naval Security Group. The principal control station in the network is the Navy Security Group Station [redacted] At this station all prograde orbits are interrogated. Utilizing the Naval Communications System it is possible to interrogate the Satellite for a "target of opportunity" over the Soviet Union in a matter of an hour or less.

For retrograde orbits the Navy will utilize the Navy Security Group Station at [redacted] for interrogation. Similar instrumentation and communication facilities will exist for operational employment of this Station also.

Data readout is effected in real time by [redacted] operational intercept sites. Each of these sites are equipped with a "readout" hut capable of tracking the Satellite on the cover and data frequencies with steerable antennas. Receiving and recording equipment are available

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to record the data on the several frequencies employed. A seven channel recorder is provided for recording the signal data and an associated digital time code which places time on the tape each second.

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The [redacted] sites utilized [redacted] rding the data are U. S. Navy Stations

[redacted]

All of these stations have demonstrated exceptional ability to collect excellent data utilizing enlisted station personnel for this collection effort. Cooperation from the Air Force [redacted] station has been excellent.

An up dating of these stations to collect data from more than one data channel simultaneously is underway and will be completed in the near future.

3. Processing Status

Data from this Satellite system since it is in analog form is amenable to processing by usual manual methods or by complete machine processing. NSA ~~has~~ is developed [ing] both systems of readout and has equipment on hand which is capable of handling the presently contemplated flow of data. Also NSA has various computer sort programs which will accomplish the sorts necessary to identify a specific emitter in the emitter location program. Locations ~~have been~~ can probably be made to an estimated accuracy of [redacted] on certain high interest types of radars and t[redacted] alties in the case of ~~the majority~~ a fairly % of the ~~remainder~~. Great strides in the processing art ~~have been~~ are being made by NSA in dealing with this type of analog data.

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FUNDING REQUIRED

1. Vehicles

Recent estimates prepared by the Space Systems Division of AFSC indicates the following figures for a schedule of five Thor-Able-Star operations per year. It is estimated that a total of at least four successful launch operations can be conducted on an annual basis with this program. Launch operations are planned to occur at three month's intervals. Launch failures will be backed up by following operations. Cost estimates for Vehicles are estimated as follows:

	FY 63	FY 64
1st Stage Thor and DAC Launch	5.275	5.275
2nd Stage Able Star and A/J Launch	7.500	7.500
BTL Guidance	1.250	1.250
Technical Assistance	.800	.800
Propellants, Transportation Communications, Administration, Etc.	.800	.800
Total Vehicle Costs	15.625K	15.625K

Other possible additional costs are anticipated from the requirement for an improved Able-Star stage. The least complex improvement that promises significant increases in orbital weight capability involves merely a change in propellants. The vehicle currently utilizes unsymmetrical Dimethyl Hydrazine with Inhibited Red Fuming Nitric Acid as an oxidizer. The proposed improvement will use Mono-Methyl Hydrazine and Nitric Tetroxide as an oxidizer. The new fuel will provide relatively large improvements in specific impulse and since optimum mixture ratios are the same for both fuel combinations there is no change in tankage required.

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Costs for this improvement are estimated at approximately 1.2 million dollars and will require an estimated ten months to accomplish. Program share of either AMR or PMR Able-Star capability is estimated at approximately 1.0 million.

Totals for Boosters are as follows:

	FY 63	FY 64
Vehicles	15.625K	15.625K
Improvement Program	1.2	1.2
Launch Program Share	1.0	1.0
	17.825K	17.825K

2. Satellite Instrumentation

Though the Satellite structure will have the greatest possible mechanical flexibility to accommodate interchangeability of the various electronic unit, selection of best performing components, standby components which must be available at the launch site will require development of more than just the bare minimum of components. Complete mechanical design of the launching support mechanism to properly release the Satellites into orbit will require continuing mechanical design support and coordination. Cost estimates for the eight satellites and backup units required per year are as follows:

	FY 62	FY 63
Satellite Structures	3.0	3.5
Mechanical Design	1.0	1.0
Electronics	5.0	4.0
Environmental Tests	1.5	1.5
Technical Check Out at Launch Site	1.5	1.5
Technical Research	2.850	2.0
	14.850K	13.500K

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3. Ground Support

Modifications at the ground stations to accommodate several Satellites in Orbit simultaneously and track them individually will require modification of the ground instrumentation. Estimates to cover this cost are as follows:

	FY 63	FY 64
Ground Support Modernization	1.150K	250K

4. Project Totals

	FY 63	FY 64
Vehicles and Launching	17.825K	17.825K
Satellite Instrumentation	14.850K	17.500K
Ground Support Modernization	1.150K	250K
TOTALS FOR PROJECT	33.825K	31.575K

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FUNDING REQUIRED

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2. Satellite Instrumentation

Though the satellite structure will have the greatest possible mechanical flexibility to accomodate interchange ability of the various electronic unit, selection of best performing components, standby components which must be available at the launch site will require development of more than just the bare minimum of components. Complete mechanical design of the launching support mechanism to properly release

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Totals for Boosters are as follows:

	FY 63	FY 64
Vehicles	15,625 K	15,625 K
Improvement Program	1,200 K	1,200 K
Launch Program Share	1,000 K	1,000 K
	17,825 K	17,825 K

2. Satellite Instrumentation

Though the Satellite structure will have the greatest possible mechanical flexibility to accommodate interchangeability of the various electronic unit, selection of best performing components, standby components which must be available at the launch site will require development of more than just the bare minimum of components. Complete mechanical design of the launching support mechanism to properly release the Satellites into orbit will require continuing mechanical design support and coordination. Cost estimates for the eight satellites and backup units required per year are as follows:

	FY 63	FY 64
Satellite Structure	1,500 K	2,000 K
" Power Supplies	1.500 K	1.5
Mechanical Design	1,000 K	1,000 K
Electronics	7,000 K	6,000 K
Environmental Tests	1,500 K	1,500 K
Technical Check Out at Launch Site	1,500 K	1,500 K
Technical Research	2,850 K	2,000 K
	15,850 K	15,500 K

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3. Operational Ground Support Complex

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