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SUBJECT

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NRL CONTROL RECORD

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have comments on request ← 7900 Read - 3-16-71
7910 Read 3-16-71
7904 JW 3/9/71

BACKGROUND

1. The accomplishments and capabilities achieved under Program "C" are well documented. In general the basic orientation of this program is to obtain the operational parameters and the locations of fixed emitters for a variety of national requirements. In the last two-years, POPPY has demonstrated an impressive capability to localize and track emitters on Soviet Naval platforms. This effort has had significant success and has on many occasions provided fleet units with near real time information on the deployment of enemy surface forces. In view of these successes one is lead to speculate about variant or alternate configurations of POPPY which might be developed to augment the ocean surveillance resources available to the U.S. Navy and to provide information that may not be available from other sensor systems.

2. Currently POPPY is configured as a multiband ELINT collection device. As such it is a relatively complex satellite. While it is considerably cheaper than alternate ELINT satellites, it is still rather expensive for the application considered herein. In addition, the data handling and signal recognition techniques which have been evolved for POPPY collection stations are appropriate for an ELINT oriented operation rather than for a real time intelligence or off-board sensor application.

CONCEPT

1. The objective of the POPPY variant system proposed herein is to achieve a capability to provide to fleet units, in real time, an identification and localization of all major Soviet surface combatants, which are operating early warning radars within a radius of 1700 miles. In a sense, this variant

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of POPPY is conceived of as a system which would provide [redacted] intelligence in much the same way that a shipboard radar is used to develop intelligence with regard to a ships local environment. There does not appear to be any reason why the receiving site of a variant POPPY cannot be mounted aboard selected major combatants (i.e. Flag Ships, CVAN or CVA, etc.). If satellite tasking, data collection, signal recognition, and emitter location can be accomplished at sea, then the communications problems inherent in [redacted] intelligence are greatly simplified and the time late problem will be totally eliminated.

2. It is the thesis of this note, that it is possible to configure a variant of POPPY Flight Hardware which would be optimized for the rapid identification and localization of major Soviet Naval combatants. The proposed system would be based on the fact that all Early Warning Radars on major Soviet combatants fall within two frequency bands. Rapid signal processing would be achieved by making use of the fact that each Soviet radar is very specific to each hull and thus constitutes a fingerprint which can be recognized and identified rapidly if a properly designed signal processing system is utilized.

3. The principle limitation of this system is the fact that it is a cooperative system in that an enemy must radiate in order to be detected. A secondary limitation of such a system is the fact that unless a relatively large number of satellites are employed 24 hours a day, coverage will not be achieved. The % of daily coverage which can be achieved is a rather complex function of the latitude of the observing station and of the number of satellites in orbit. These and other trade-offs will be discussed below.

4. Ultimately the system that is envisaged herein will be composed of a number of components:

a. Constellations of POPPY variant satellites.

b. Receiving facilities.

c. Data processing systems.

d. Information dissemination systems.

e. Data plots and displays.

To one degree or another the techniques required to implement each of these system components is either in being, under development, or is within state of the art technology. Comments on each of these items are included below.

PROPOSED APPROACH

1. Satellite design factors.

a. The Early Warning Radars on major Soviet surface combants are shown in Table 1. These lie in two bands:

Thus a satellite which receives only in the bands between .820 - .920 GHZ. and 2.680 - 2.930 GHZ will be adequate to detect all presently deployed Early Warning Radars on major Soviet surface combatants. The unit cost, the size, the weight and the complexity of a two band POPPY variant would be considerably less than for a full POPPY satellite. However, the on-board electronics of the proposed variant POPPY would be identical with existing POPPY in the two bands that would be used. Thus in these bands, the sensitivity,

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NICKNAME	FUNCTION	FREQ GHZ	TRANSMITTED POWER IN MW	DEPLOYED ON
BIG NET	E.W.	.820-.850	1.0	CLG SVERLOV CLGM KRESTA I DLG KASHIN CL SVERDLOV PFR T-43
HEAD NET A & C	E. W.	2.765-2.862	1.0	CLGM KYNDA DLG KASHIN DDGS KRUPNYY DDG KOTLIN
C	E. W.			CHG MOSKOVA CLGM KRESTA I CLGM KRESTA II DDG KANIN DDG KASHIN DDGS KRUPNY DDG KOTLIN
TOP SAIL		.825-.920		CHG MOSKOVA CLGM KRESTA II
FLAT SPIN		2.774-2.844	.75	DDGS KILDIN
SLIM/NET HAIR		2.814-2.845	.9	CLG SVERDLOV DDGS KILDIN OCA KIROV CL SVERDLOV DL CHAPAYEV DD KATLIN DD TALLIN DD SKVRYY DE RIGA PCE MIRKA PCE PETYA I AS DON
BOAT SAIL		2.820-2.855	.5	SSR - WHISKEY CANVAS BAG

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data rate, detection range and housekeeping electronics would be identical with the performance achieved with conventional POPPY.

b. The POPPY variant envisaged here would be a relatively small and inexpensive satellite. Preliminary design indicates that a 20" diameter satellite would be adequate to house all of the electronics. Based on previous designs, the weight of such a satellite would be about 65 to 70 lbs. If additional batteries are required to allow multiple tasking per orbit, then the weight of each satellite would increase. Even with extra solar cells, it is unlikely that the weight of the satellite will exceed 80 lbs. Stationkeeping could be accomplished either by the present POPPY microthrusters, or if they proved to be excessively expensive, variable drag booms could be used. In the interests of simplicity, no stabilization would be employed. Random tumbling of the satellite would be planned for.

c. A preliminary cost out of such a satellite indicates that it could be constructed quite cheaply. The cost per satellite would probably be about $300 to $400K. These satellites would be sufficiently small and light that a pair of them could be launched from a Scout Vehicle which costs about $1.5 million. Thus the total cost of delivery of a pair of variant POPPY satellites into orbit would be about $2.1 to $2.4 million if a Scout Vehicle is used. If a larger vehicle such as the THOR ADD AGENA or TITAN IIIC were used then the unit cost per satellite in orbit could be reduced significantly. For example the vehicle cost of a THOR ADD AGENA and the associated launch costs total about $10 million. Since the payload of a THOR ADD AGENA is about 1600 lbs it would be possible to place as many as 14 POPPY variants in orbit at a total cost of between $14 and $16 million. The unit cost per satellite in orbit would then be about $1 million.

2. Coverage.

a. Present POPPY provides relatively limited coverage when measured in terms of the % daily coverage. The % daily coverage which can be achieved is a complex function of the orbital parameters, the location of the receiving station and number of satellites in orbit. Figure 1 shows contours of the number of minutes of daily coverage for a station in [redacted] For each receiver latitude these contours change since the shape of the coverage contours varies with receiver location and orbit inclination. It can be estimated that, if 24 hour a day coverage was desired out to ranges of 1750 miles from a receiver at 45 deg. N latitude, [redacted] be required.

[redacted] occur at any convenient sub-orbital point. Potentially this would imply that all POPPY receiving sites could be placed on U.S. owned real estate. The use of a variant POPPY constellation as a communications set should be explored for its operational implications.

c. A number of system trade-offs exist with regard to the % of daily coverage which can be achieved. By making the individual satellites sufficiently small and light, a large number of satellites might be placed

in orbit with a single launch. Thus if enough pairs of satellites were available the perimeter of an orbit could be divided up so that there would always be a satellite within line of sight of a ground station. Alternatively the % of daily coverage would also be modified by increasing the satellites sensitivity and placing them in higher orbits than present POPPY orbits. Since a higher orbit sees more of the earth's surface, the coverage per satellite is greater. However, for a given launch vehicle, the amount of payload which can be placed in orbit is a function of the orbit altitude. Thus while a higher orbit would imply a greater percent of daily coverage per satellite, the number of satellites per launch would decrease. In addition, the detection sensitivity of a satellite must increase with altitude and the accuracy of localization will change. Clearly a rather comprehensive review of all of the available trade-offs should be made in order to achieve an optimum constellation of variant POPPY satellites.

3. Data Processing.

a. Data processing at POPPY collection sites is presently oriented towards obtaining the location and parameters of emitters of interest. An emitter is identified by a process of successive parameter scans, manual editing of printouts, vernier scans and further manual editing. This process eventually isolates the signals from a single emitter that are received by one or more satellites. [redacted] This process can require one or more hours to complete when used against emitters in the more densely occupied parts of the spectrum.

A time constant of this magnitude is acceptable if the objective is to produce intelligence information which is not required in real-time. However the resultant "time-late" of the present system is unacceptable if the data is to be used to provide fleet units with immediate intelligence about its own environment.

b. The obvious approach to reducing the data processing time that is now required (and still will be required even with considerably faster computers) is to design the equivalent of a hard wire processor which has all modes of signals from all known Soviet EW radars stored in memory. After appropriate pre-filtering, incoming signals would be cross correllated against replicas in the memory. A scan of the outputs of the banks of correlators would identify the specific emitters unambignously in real-time. Presumably the proposed signal recognizer would borrow rather heavily on the well established signal recognizer technology that has been developed for systems such as Short Stop. Indeed the Short Stop signal recognizer would be well suited for such a processing system.

c. In essence, it is proposed that a POPPY receiver station would be operated as the receiving component of a bistatic radar. The transmitter would be on a Soviet combatant, the POPPY satellites would serve as augmented targets, and the U.S. POPPY station would serve as the receiver and data processing site. In this mode of operation POPPY would function in a manner similar to BRIGAND. The basic difference, between this mode of POPPY operation and its operation in a conventional ELINT mode, is that in the rapid recognition mode the system concept is based on the fact that we have very precise information on the nature of Soviet shipboard radars. The

receiving system is thus focussed on capitalizing on our past investments which obtained the excellent intelligence that is now available with respect to Soviet radars. Presumeably the signal recognizer would be designed with sufficient memory and data processing reserve to allow newly identified signals associated with specific combatants to be entered into the library of signals as they become available.

4. Collection sites.

a. Present and projected POPPY collection sites are all shore based. Some of these will be given SEL 810A computers in the near future. While this computer will decrease the processing time quite substantially, it will not be capable of fingerprinting emitters in real-time. In addition, after a signal of interest is detected, the information must be passed to fleet commands via the appropriate secure communications links. This results in a further increase in the time-late.

b. After the initial deployment of the variant POPPY, existing POPPY ground stations would probably have to be employed. Thus each ground station would have to have reliable 24 hour per day communication with appropriate SI circuits to major fleet commands. In this configuration, the information yielded by this system would be one additional input to the OSIS system. Its usefulness and timeliness would be a function of how well and how rapidly information will be disemanated in the OSIS net.

c. A more interesting system configuration would appear to be one which had the receiving sites and processing equipment placed on board ship. There does not appear to be any technical problem which would preclude shipboard emplacement of the tracking antennas, the signal recognizers, the computers and the display. All of the components involved can be packaged so that they would be compatible with a shipboard

environment. If the terminal equipment is placed on board a ship, the communications problems will cease to exist. The system output will be a ship-centered display which automatically plots the position and identification of all major Soviet surface combatants which are employing one of the EW radars listed in Table 1. The display will operate somewhat like a conventional radar display. After a target position is obtained, its location and time of location will be indicated and stored in memory. When the signal is located by the next pair of satellites, it will be updated. A relatively simple addition to the memory will allow target tracks to be displayed.

d. As pointed out above, if 7 or more pairs of satellites are equally spaced around the orbit, then the variant POPPY satellites could be used as relay points in a communications net. If any satellite in the net were within line of sight of U.S. controlled real estate, then it could be the satellite which handled the down link, thus ensuring a measure of security to the down link. Unfortunately, U.S. controlled real estate does not extend over 180 deg. of the earth's surface. The span from Guam to St. Croix is about 152 deg. This would almost but not quite allow all orbits to be queried without dependence on foreign bases.

5. Satellite Tasking

a. Conventional POPPY satellites are not tasking limited in the sense that tasking by the number of existing POPPY ground stations does not require more power per orbit than can be generated by solar batteries as a result of their exposure per orbit to the sun. If a large number of Naval vessels task the satellites, then the design would have to be modified to allow an increased weight per satellite, and there would be a consequent reduction in the number of

satellites per launch. Tradeoff studies must be made to determine the optimum number of vessels on a world-wide basis which can task the system.

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SUBJECT
ACCOMPLISH INFO FOR DOD
RVW OF IN-HOUSE R&D LABS

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1

UNITED STATES GOVERNMENT

Memorandum

TO : All Research Divisions

4010-149:AJH:ecs
DATE:

FROM : Code 4000

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SUBJECT: Accomplishment Information for DOD Review of In-House R&D Laboratories

Encl: (1) DNL letter Lab Contribution/Accomplishments Data of 23 March 1971 and Enclosures

1. A major new study is now underway to review the defense RDT&E Base. One DOD group is reviewing the In-House Laboratories. Enclosure (1) requests information - hopefully quantized - on really significant achievements of CY 1969 - 71 for input to the study.

2. Although it is realized that the paper work load on the Divisions is already severe, your assistance is urgently requested to provide quality information to meet the DNL request. The results of the present study may well have a very significant impact on the DOD In-House laboratories in years to come.

3. Divisions are therefore requested to develop one, two or at most three of their really significant accomplishments of the past two or three years in the format given in enclosure (1) and to forward them to Code 4000 by the close of business on 7 April next.

1:00 Rough Secret Program "C"
1. Saving
2. Improvements
3. results have counterparts
ABM
U.S.

Acting Director of Research

Bye 059312-94

(26)

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DEPARTMENT OF THE NAVY
DIRECTOR OF NAVY LABORATORIES
WASHINGTON, D. C. 20360

25 MAR 1971

From: Director of Navy Laboratories
To: Distribution List

Subj: TOP SECRET [redacted] Laboratory Contributi[redacted]mplishments Data

Encl: (1) Deputy Director of Defense Memorandum of 16 January 1971
(2) Director of Defense Research and Engineering Memorandum of 4 February 1971
(3) Format for Documentation of Laboratory Contributions

1. On January 16, the Deputy Secretary of Defense recommended a review of the defense RDT&E base. (See Enclosure (1)). This review was prompted by the Blue Ribbon Defense Panel Critique of our RDT&E base and its recommendation for "a joint review to determine which in-house defense laboratories and test and evaluation centers are essential to R&D needs of the Department with the goal of eliminating the non-essential ones and consolidating (across Services) the remainder."

2. The Director of Defense Research and Engineering was asked to assume the overall responsibility for the review and the development of an improvement plan working with the military departments (See Enclosure (2)). The objective will be to identify what actions should be taken, if any, as recommended by the Blue Ribbon Defense Panel.

3. The desired study has begun initial staffing at the Service level. The study will be divided into three categories, covering a review of the in-house laboratories, test and evaluation centers, and Federal Contract Research Centers.

4. As part of the in-house laboratory review now being conducted by DDR&E, a tri-service task group has been established to compile a report on significant contributions/accomplishments by Army/Navy/Air Force laboratories during the CY 1969-1970 time period.

5. In order to support the effort of this group, you are requested to document significant accomplishments by your activity or activities, as appropriate, to the format provided as enclosure (3) and forward same to the Chief of Naval Material (MAT 03T1). Submissions, in triplicate, are due in this command prior to 9 April 1971. Submissions can be classified up to and including Secret.

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6. These accomplishments may be in the area of research, exploratory development, advanced development, engineering development, acquisition, advanced system planning, key assistance to program offices, etc. But the point is -- no matter how close to or how far from inventory -- they must be significant. Outstanding accomplishments that pre-date the CY 1969-1970 time period, i.e., 1968 or that have occurred during CY 1971 to date should also be submitted.

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7. Significance should be quantified if possible. If in the area of performance, how much better is it than its predecessor? Or if more efficient -- how much? Or can it save lots of money during inventory life-cycle? How much? Or will it get into the inventory sooner, with fewer problems?

8. The importance of this exercise cannot be overemphasized. The point of contact for any additional information that may be required is Mr. (MAT 03T1), AC 202-0X2-3788 or 23789.

9. NAVAIR, as an addressee, is requested to provide the information herein for the Naval Air Engineering Center only.

10. By copy of this letter, MAT 04T2 is requested to provide the information herein for the Naval Training Device Center.

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MEMORANDUM FOR THE SECRETARY OF THE ARMY
THE SECRETARY OF THE NAVY
THE SECRETARY OF THE AIR FORCE
DIRECTOR OF DEFENSE RESEARCH AND
GINEERING
STANT SECRETARY OF DEFENSE (I&L)
ASSISTANT SECRETARY OF DEFENSE (COMPT)

SUBJECT: Review of RDT&E Base

As you know, the Blue Ribbon Defense Panel was critical of our RDT&E base and recommended "a joint review to determine which in-house defense laboratories and test and evaluation centers are essential to R&D needs of the Department with the goal of eliminating the non-essential ones and consolidating (across Services) the remainder."

While I have made no judgment on whether it is necessary or desirable to eliminate or consolidate any in-house defense laboratories, I believe that the review recommended is appropriate. I hope to have the opportunity to visit several of these laboratories to gain a greater familiarity with their capabilities. I am asking the Director of Defense Research and Engineering to assume the overall responsibility for the review and development of an improvement plan, working with the military departments. The objective will be to identify what actions should be taken, if any, as recommended by the Blue Ribbon Defense Panel. For those actions necessary, you should develop a time-phased plan for improving the overall quality and effectiveness for our RDT&E base including a determination of the essentiality of the various components of this base.

I am certain that you will cooperate fully with the Director of Defense Research and Engineering in this important task. The plan developed should be available to me in final form not later than 1 July 1971.

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4 FEB 1971

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (R&D)
ASSISTANT SECRETARY OF THE NAVY (R&D)
ASSISTANT SECRETARY OF THE AIR FORCE (R&D)
ASSISTANT SECRETARY OF DEFENSE (I&L)
ASSISTANT SECRETARY OF DEFENSE (COMP)

SUBJECT: Review of RDT&E

Reference is made to Deputy Secretary of Defense memorandum of 16 January 1971, subject as above.

I cannot overemphasize the importance of the task Mr. Packard has assigned, the results of which will shape the future of the Defense RDT&E base system. Since the task is great and the time is short, we must be especially careful to assure a product of the highest quality.

The task as I now see it will be divided into three categories: (1) an examination of the in-house laboratories, chaired by Mr. Edward Glass, (2) an examination of the Defense test and evaluation centers, chaired by Brigadier General George Sylvester, and (3) an examination of the Federal Contract Research Centers, chaired by Mr. Elliott Harwood. I have appointed the Deputy Director (Research and Technology), as chairman of the overall review.

I would appreciate your nominating three top people, one for participation in each of the above three groups, by February 15, 1971.

/s/ John S. Foster, Jr.

John S. Foster, Jr.

Attachment - 1
Memo from DepSecDef
dated 16 January 1971

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ENCLOSURE (2)

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FORMAT FOR DOCUMENTATION OF
ARMY, NAVY, AIR FORCE LABORATORY CONTRIBUTIONS, CY 69-70
(TASK GROUP #5, DDR&E LABORATORIES REVIEW)

1. ORGANIZATION

(Name of Service and Laboratory doing reporting)

2. TITLE

(Short descriptive title of contribution)

3. Program Element(s) involved in funding

4. DESCRIPTION

(Brief description of work in lay language, whether in-house, contract, or mixed. Highlight contribution of government personnel involved, if contract or mixed. Highlight the key accomplishment occurring during CY 69/70, using definitive milestone(s) passed, as appropriate.)

5. SIGNIFICANCE

(Brief description of significance of contribution to DOD; pertinence to near term and/or longer term needs; if a specific in-planning, acquisition, or inventory system, subsystem, or equipment is involved, identify; if information is available to quantify significance of contribution, specify.)

(Hold to 1 page, 8" x 10½", single-spaced, if possible.)

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...SAM system.

3. ...classified at a ... level.

4. ...Work involved a higher classification.

The technical elements of the effort where conceived, and developed within NRL and the operational use is carried out by the Cryptological Community on a world-wide basis.

5. Th NRL Operational system has evolved over the past 3 years to provide a highe degree of flexibility and spped so that the processing cost has gone from over $1000.oo per unit to about $16.oo per unit in late 1970, with further reduction anticipated inthe futuee. This operational system has provided most of the intital definition over the past six years of both the ABM and the Tactical (SAM) systems. Security restraints prevent further disclosure at this level.

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1. Navy - NRL

~~TOP SECRET~~ 2. Satellite systems design construction

~~TOP SECRET~~ 3.

4. NRL has conceived, designed, developed, constructed, tested and operationally maintained over 58 satellites ~~with in the~~ in house ~~laboratory~~. During CY 69/70 the Laboratory Launched 7 satellites and maintained operations with 9 other satellites already in orbit. [These satellites are used worldwide by many agencies.]

5. These Satellites are used for a wide range of DOD + National efforts. A few of these are: Navigation, Geodesy, Solar radiation monitoring, and other classified National priority missions. The satellites have also made many significant contributions to the Apollo Program, space hardware developement, ... which are unique. Further Costs have been reduced on a operational performance basis from over $100,000 per operation to between $100 and $200 per operation.

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