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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 (other operational) 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 [redacted] 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, [redacted] 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

EARPOP

of POPPY is conceived 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 (1) for the rapid identification and (2) localization of major Soviet Naval combatants. The proposed system would be based on the fact that (1) 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. fingerprint/Hull

3. The principle limitation of this system is the fact that (1) 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 (2) 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.

principal

Control System

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:

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Ftm shows: is 2765 to 2862. wide enough ???

Thus a satellite which receives only in the bands between .820 - .920 GHZ. 2.765 to 2.862 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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data rate, detection range and housekeeping electronics would be identical with the performance achieved with conventional POPPY. Thus highly predictable.

b. The POPPY variant envisaged here would be a relatively small and inexpensive satellite. Preliminary design indicates that a 20" ? PGW. 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 PGW. 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, in cost, weight or power. variable drag booms could be used. In the interests of simplicity, ~~stabilization~~ is not ~~would be employed~~ Mandatory except to reduce antenna (collection) problems & pwr & weight constraints. Random tumbling of the satellite ~~would~~ could be planned for.

c. A preliminary cost out of such a satellite indicates that it could be constructed quite cheaply. The cost per satellite could in its simplest form ~~would~~ probably be about $300 to $400K each. These satellites would be sufficiently small and light-weight 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 III C 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] 18 30 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 [redacted] 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. The time difference of arrivals is then plotted as a function of time and a localization is subsequently effected by an inverse LORAN calculation. This process can require one or more hours to complete when used against emitters in the more densely occupied parts of the spectrum.

Lee?

A time constant of this magnitude is acceptable if the objective is to produce intelligence information which is not required [redacted] 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 [redacted] 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 [redacted] 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 [redacted] 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.

Concept:
in real-time, provide I.P. Applications
for all Sov Mig combatants
Rx on ship CVAN or CVA
Trans-late proc eliminated.

2- Fast All EW on maj Sov comb fall into 2 freq bands.
Each Radar/Hull = I.D. if properly designed
sig proc system is utilized.

3- Lim Limitations -- [illegible] radiate
[illegible] day coverage attained only by many birds

4- a constellation of birds
b R.F. Electronics
c Data Proc. Syst.
d Surf. dissemination.
e. Data plots + displays
all [illegible] in being or under development in
within Stan Ford.

-1-

Prop Approach

[redacted]

chns 820-920 & 2680-2930

the unit cost size & weight & complexity of 2-bands
less than a full Poppy-
in 2 bands like pres" ∴ same data rate etc.

b. rel small 65 to 70 lb. < 80 lbs.
micro thrusters / drag booms.
or if too expensive then Tumbling OK

$ 300 to $400/bird } 2.1 to 2.4 M
Scout $1.5 M
$10M @1600 lbs. up to 14 birds ∴ $1M/ea
Thor Add/Agena or Titan III

2. Coverage
3. Data processing. (well suited)
a. Hard wire processor Sig mog of Short Stop.
c. ~~Pictorial~~ no comp data values. Kids. Sea Ship birds. Targets Site. Rx + Processor.

Chris New Poppy like Brigand,
rapid recognition mode of system
Rec system focused on Ship reqs.

4. Collection Reqs:
a) 810 not cap of fingerprinting in real time
b) ST link to Ship. 24 hrs/day (OSIS.)
c) Ship-site. no tech problem.
∴ no com prob.
Guam & St Croix = 152° queried from No foreign soil

5. Not Task limited / excess pwr available

Trade off studies must be made to determine if there is ... world wide basis.