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G-52/00022-61/jmc
18 January 1961

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From: Technical Operations Group, Project GRAB
To: Director of Naval Intelligence

Subj: Status report on Project GRAB (U)

Encl: (1) NSA (COSA-5) Status Report on analysis program for Phase II dated 1 December 1960
(2) TOG comments

1. The Technical Operations Group of Project GRAB has carefully examined enclosure (1), visited the data processing and analysis operation at NSA (COSA-5), and submits the following overall report on the status of the project.

2. Summary. (For details, see enclosure (2))

a. Background. Project planning, technical feasibility and operational concept proved to be sound and practicable. Policy guidance and security control were adequate and effective. The TOG served as a simple and efficient coordinating mechanism, essential in so sensitive and complex an experiment. Existence of an in-house team with a space project capability has been demonstrated, utilizing existing field facilities with no increase in personnel. Cost of the satellite (less booster) and collection program through 1 December 1960 was approximately $1,100,000.

b. Analysis and Processing. Volume of data collected (four-fold greater than anticipated) taxed existing processing capability. Excellent promise is held for new techniques affording acceleration of analysis and capable of handling mass volumes of data. This technological breakthrough and experience gained will prove invaluable in future projects. Definitive results on data collected should be available by 1 March 1961.

c. Intelligence. The density of Soviet S-band equipment has been found to be surprisingly high overall. and newer types of radars are in greater use than expected. The location of specific radars has been fixed to within 50 miles in two test cases. New equipments and functional irregularities of performance can be detected. radar types have been found to be less numerous than anticipated. Verification of known radar types, including naval radar, has been accomplished.

d. Future Plans.

(1) The original concept of operations remains feasible; only minor changes are anticipated for May and subsequent 1961 operations.

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(2) Configuration of a new satellite encompassing an L-band collection capability is progressing satisfactorily and will be ready for launch in May. Hardware for additional spectrum coverage is under development.

(3) Sophistication of interrogation and collection capability designed to enhance the quality of new data collected has been programmed and will be available for future operations.

(4) Refinement of known techniques and continuing development of new concepts providing rapid read-out and analysis are continuing, with four major processing techniques simultaneously under test.

3. Conclusions.

a. A simple, inexpensive radar-intercept satellite has been flown over the Soviet Bloc, and its ability to collect signal data over a three-month period has been demonstrated in the first effort.

b. Techniques required for analysis of large volumes of electronic intercept data thus gathered are difficult, but problems in processing are being overcome.

c. Tentative intelligence results of importance have been derived, some being confirmations and some novel. Initial results will be ready for limited dissemination within six weeks.

d. Technical and intelligence results warrant implementation of current approved plans for GRAB satellites in the L and S-and-L bands for the period May-July 1961.

4. Recommendations.

a. That in future, operational security restrictions be modified slightly to permit the ELINT collection schedule to be completed faster.

b. That all agencies concerned continue to accord highest priority support to Project GRAB to ensure completion of intelligence production as soon as possible. In particular DIRNSA support is solicited for computer and other equipment time and for additional equipment and personnel as separately recommended by the Technical Operations Group.

c. That some suitable means of technical and intelligence coordination with SAMOS and similar reconnaissance satellite projects be effected.

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d. That no raw data analysis or processing responsibility be delegated to another agency pending development of satisfactory techniques and necessary security controls.

e. That, when feasible, data on U. S. radars be collected to assist in the solution of analysis techniques.

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I - BACKGROUND

1. Concept of Operations. On the basis of experience gained to date it is judged that the planning, technical feasibility, and concept of operations under which Project GRAB was conducted were sound and adequate to the purpose to be achieved. Possibly some undue emphasis was placed upon security in the operational planning, a feature which can be adjusted in future plans; however, international conditions at the time were delicate and extreme caution was necessary. Other aspects of policy guidance and security control were highly satisfactory.

2. TOG Participation. The Technical Operations Group, which assisted the Project Director (RADM L. H. FROST and, after 15 September 1960, RADM V. L. LOWRANCE), has proved to be a simple and effective coordinating mechanism. Senior working level representatives from the Naval Research Laboratory, Naval Security Group, National Security Agency, and Office of Naval Intelligence possessed requisite freedom and authority, provided the important balance of technical and intelligence capabilities, and had the full support of their agency heads. Some such body is essential in a project so sensitive and complex.

3. Cost. Total cost of the satellite (less booster) and collection operations up to 1 December 1960 was approximately $1,100,000. Funds appropriated for continued Research and Development total $3,000,000. (See Future Plans.)

II - ANALYSIS AND PROCESSING

1. The volume of signal data is over four times anticipated. Furthermore, although high signal densities have been processed by purely manual techniques in prior collection efforts, there is a certain critical level in the use of such techniques beyond which human competence with existing tools becomes overloaded. In portions of these data, particularly those obtained while over the European land-mass, this high density occurs with this satellite. In our prior experience with crystal-video collection techniques, such volume was not reached; thus it is quite apparent that improvement achieved in this satellite program will be equally useful in other collection platforms to make the extraction of data more rapid, timely, and complete.

2. NSA's Status Report is encouraging as to the prospects of automation of the entire analytical process, or; at a minimum of the location and identification of the more common signal types, which comprise about 95% of the signals to date. We are not certain that such an optimistic picture is warranted, although with the number of approaches being attacked by NRL, NSA and CIA, multi-fold acceleration of analysis is inevitable.

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3. Certain processing techniques are being used currently which should permit at least data screening of all unusual signals from all previous missions, complete processing of every single signal on one mission, and an accurate density count on all missions by 1 March. With some automation break-through, more progress may be possible, but should not be counted upon by that date.

4. It is still considered premature to state specific requirements as to additional people and machines required, either for completion of current processing or handling of future data. In handling this material a number of new processing techniques have been developed which should serve to accelerate and make more accurate the processing of ELINT data from other sources.

III - INTELLIGENCE

1. The following are the principal intelligence conclusions derived from the data thus far:

a. Soviet radars are extremely powerful and numerous in S-band, their area or power concentration in this band exceeding that found over the U. S. Density is greatest in the Western USSR and decreases towards the East; no significant gaps in coverage or density are thus far evident over the USSR.

b. [redacted] are in extensive routine use in the USSR. Their radiated power appears greater than had been anticipated and they are used extensively on a grographic basis. Other newer types of Soviet radars are in greater use than was expected.

c. Capacity for location of radars has been demonstrated in several cases, and a predicted accuracy of location of about 50 miles has been verified on known unique Soviet Bloc equipment. New radar sites have been established as well in two test cases.

d. New radar equipments can be detected. The only one thus far indicated to be apparently Soviet is a fixed-beam set detected over the European area on a single pass. Many radars of known Soviet types have been noted. [redacted] radars have been detected. Many irregularities and anomalies in radar pulsing and [redacted] can be observed. It is apparent that our regular ELINT and supporting intelligence need to be more detailed to exploit fully that data derived from satellites, and steps are being taken in other collection efforts to obtain some of this information.

e. Other than the single equipment mentioned above, there has been thus far a striking lack of unidentified Soviet or even suspected Soviet

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equipment types. It is considered very significant that, despite the [redacted] radars of many types intercepted, no more unidentified Soviet radar types appeared in this particular band. This indicates that existing intelligence is quite accurate as to Soviet radar types of significant power in this band.

2. There is a demonstrated capability that a satellite of this type can collect large amounts of data over wide areas on many types of equipment with a minimum security risk and at no risk to personnel. With greater life and improved processing techniques, together with better detailed knowledge on Soviet equipments, a simple earth satellite should be an even more powerful ELINT tool to provide warning of new equipments and deployment and insurance against technological surprise.

IV - FUTURE PLANS

1. Schedule. It is anticipated that testing of data analysis and processing techniques will be completed by 1 February 1961, and if this testing proves successful, by 1 March 1961, all of the standard types of radars (rotating emitters) will have been identified and generally located.

2. Authority has been granted and funds appropriated to launch an L-band ELINT package with a TRANSIT shot in May and a combined S-and-L band satellite in July, also on TRANSIT. Work is on schedule to date. Both these efforts are extensions of the original plans and contain no major changes of technique or equipment.

3. New Administration. Arrangements have been made to indoctrinate and brief responsible officials of the Kennedy Administration as they relieve. Requirements for increased clearances are expected.

V - FUTURE REPORTS

1. Future status reports on Project GRAB will be submitted as required, usually monthly.

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STATUS REPORT OF ANALYSIS ON

PROJECT GRAB I

1 May 1961

NSA (COMA-5)

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SUMMARY

1. Since the 1 February Status Report, progress has been made along several of the avenues described in that report. Tentative results of the fully automatic burst-sort/scan-sort programs are being compared with results of manual analysis of Mission 905. The modified GERBER oscillograph Reader at NRL and the BAUSCH & LOMB Film Comparator in COSA-5 are in operation and their uses on the project being checked out. The NRL scan sorting technique of playing accelerated signal tapes into the RAYSPAN has proved useful. These points will be treated more fully in the following paragraphs.

2. Concurrent with efforts to develop new rapid and accurate analytical techniques, processing with means presently available has continued in order to extract intelligence information from the recordings. This processing has taken the form of density studies and search for signals of interest by aural scanning methods and through use of the NRL accelerated RAYSPAN method. The report of initial intelligence results, issued 1 March, summarized the results of these approaches and described the signals isolated by manual analysis of Mission 905.

3. The requirement for additional intercepts of unique radars, mentioned in the 1 February report, has been partially satisfied by the identification in Mission 907 of an [redacted] radar and the discovery in Mission 905 of a unique [redacted] type radar known to be located in the north west CRIMEAN peninsula.

4. Because timely production of GRAB intelligence is largely contingent upon the success of fully automatic processing, primary emphasis has been maintained on the AUDICO I - BOGART program.

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DESCRIPTION:

A. AUDICO I converts analog data from the magnetic recordings into digital form. Its output is a series of numbers representing time between successive pulses. The present SERVO control system, which uses the 1000 cps component of the time channel as a reference to regulate tape speed, successfully compensates for long term speed variations, but short term variations remain a problem. Although reasonably good results have been achieved on this part of the process, amplitude threshold settings are very critical, and optimum settings for varying signal-to-noise ration can only be achieved through experience. At present a method is being developed to reduce timing errors resulting from short term tape speed variations.

B. For burst-selection, the BOGART computer first recognizes and records measurements on all illuminations which comprise [redacted] pulses. (From the digital output of AUDICO) The recorded measurements are: time of the end of each illumination, the average pulse interval expressed in [redacted] units, and the number of pulses in each illumination. Two interlaced signals will be recorded provided at least one pulse interval occurs before the overlap and at least [redacted] intervals of the other signal extend beyond the end of the overlap.

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D. A complete automatic readout of mission 905 has been made, using the above-described process. Although comparison between machine and manual analyses of this mission has not produced fully satisfactory results, it is believed that such discrepancies as have so far come to light may be minimized by improved tape speed regulation and by adjusting the acceptance limits in the BOGART program. The presently-used limits were arrived at empirically and may be altered easily to produce the best results.

LOCATION

5. Assumed Elevation angles - a signal from a rotating radar is first intercepted when the E.S.V. comes over thehorizon of the radar (elevation angle equals zero). The signal ceases when the elevation of the E.S.V. exceeds the angular height of the radar beam. As the E.S.V. continues past the radar, intercept resumes when the vehicles elevation is small enough to permit reentry of the beam and finally ceases when the vehicle passes beyond the horizon. Each of these four situations can, potentially, provide a line of position, and knowledge of the time of any two of them, provided vertical beamvidths is known, will permit emitter location to within two geographical areas, only one of which, of course, is the right one. The 704 computer program which gives the two locations is operational. Following are some limiting factors, some of which can be minimized and some accepted:

a. Because only rarely will a radarrbe looking in the direction of the E.S.V. at the instant it crosses the horizon, an uncertainty exists of up to one half a rotation period in measuring the time of any of the four events described above. For a 3 rpm radar this will result in an uncertainty of up to 100 miles in the lines of position.

b. At present, knowledge of the vertical beamwidths of the different radars is so limited that only the times of the two horizon crossings are usable for location in most cases.

c. Only with unique radars is it possible to correlate the two sets of illuminations intercepted during one orbit. This means that this method will provide reasonably good location of common emitters only in the cases when the E.S.V. passes the emitter at such a distance that its elevation angle exceeds the radar's vertical beamwidth only briefly or not at all.

6. [redacted] Back Plotting - a 704 computer routine is operational for locating [redacted] radars from beam separation. There exists a need for intercepts of distinctive [redacted] radars of known location for checking the program.

7. Rotation Rate Doppler - If the rotation period of a radar is sufficiently constant, it is possible to reduce the size of the probable area of location by using the method of least squares to analyze the complete record of illuminations. The program for this is not yet completed, but research into rotation rate stability, from other source data is being conducted.

8. [redacted] - A method of determining location by back-plotting when satellite altitude is known appears to show promise. The SAC method applied to another collection platform has not yet been received.

9. Semi-automatic Processes

The modified KERNER oscillograph reader is now installed and tested at NRL and readout has started. In this process, real time and PRF values for each illumination are measured from RAYSPAN charts. Using the NAREC computer this information can be presented (a) in chronological sequence, (b) as histograms of numbers of illuminations versus discrete PRF values and

(c) as quantized histograms of members of illuminations having PRFs within pre-selected PRF ranges. Each of these PRF ranges can be processed separately using an X-Y plotter to produce ORC-26 type displays, which can be used for scan sorting and, ultimately, for location.

10. Readout of one mission from film has started using the BAUSCH & LOMB Film Comparator. In addition to providing time and PRF measurements for each illumination, this method has the advantage of enabling the operator to observe pulse peculiarities such as staggering and other pulse position variations. It is superior also in that it permits analysis of two or more simultaneous illiminations and detection of rapid modulation such as conical scan.

11. The above processes are slow but may provide acceptable inputs to BOGART, should AUDICO I prove inadequate.

12. The NRL process of playing highly accelerated tape into the RAYSPAN has proven to be a useful quick look tool. By using it with filters it is possible to determine approximate values of a signal's time of occurrence, PRF and scan rate.

Intelligence Information

13. The report "Initial Intelligence Results", issued 1 March, was based on the manual analysis of Mission 905, on density studies of the other missions of Phase I and on signals of interest extracted from Phase I missions by means of aural scanning and the NRL high-speed RAYSPAN process. Graphs in which minute-by-minute density data are plotted against satellite altitude, time of day and subsatellite coordinates have been made for all of the 21 missions for which ephemeris information is available. Aural scanning, which was found to be a quick means of isolating signals of interest in Phase I material, is being applied to Phase II missions. Missions coinciding with periods of known ICBM range activity have been rechecked for intercepts

[redacted] Results were negative.

Signals of interest

14. Aural scanning has turned up a number of non-routine signals since the 1 March intelligence report. Most of these have either proved to be from friendly radars or were of insufficient duration for certain identification. Several signals, however, are of considerable interest as follows:

a. Mission 907, 25 August - [redacted] - 432 pps signal showing 29 second rotation with 11 cps modulation superimposed. There are believed to be at least two of these equipments in [redacted] Although only three illuminations were detected, one was by the leading and two by the trailing edge of the annulus. The origin of this signal was fixed by hand plotting methods to within about 150 miles of the known location of the nearest of the two radars. Several bursts from two different emitters of this type have been isolated in Mission 1286 of 21 September.

b. A 618 pps signal sectoring at 1.8 seconds per cycle also occurred in Mission 907. This corresponds with the group of unknown Soviet signals designated [redacted] There is some indication that this intercept emanated from central Russia, possibly in the ARAL Sea region.

c. Mission 905, 25 August - a 10 minute intercept of [redacted] a unique [redacted] type signal with PRF of 395 pps and 20.4 s/r. Hand plotting provides a location in northern CRIMEA. Computer location has not yet been obtained.

Future Plans

15. Efforts are continuing toward the development of fully automatic processing in the production of intelligence information. At the same time, work is going ahead on the GERBER and BAUSCH & LOMB processes to determine their accuracy and feasibility. A bank of filters optimized for the project