COMOR General file

~~TOP SECRET~~

[redacted]

COMOR-D-65

18 December 1962

MEMORANDUM FOR: Committee on Overhead Reconnaissance

SUBJECT: SIGINT Satellite Capabilities and Requirements

[redacted]

1. In pursuance of the action of the COMOR at its meeting of 13 December 1962 (COMOR-M-124, paragraph 5), the COMOR Working Group met and agreed to the following:

a. To disseminate the attached excerpts from the report prepared for the ~~(S)~~ NRO by the Electronic Reconnaissance Task Group (ERTG) dated 27 July 1962. It is requested that this document be carefully studied prior to the meeting of 27 December at which time Colonel Istvan of the ~~(S)~~ NRO will be present to brief COMOR.

b. To recommend the addition of three tentative collection categories to those originally specified by the ERTG. These categories are located in Section III as b, e, and f.

c. To initiate a SIGINT targeting system analogous to that currently applicable for photography with appropriate adjustments. To permit time for the military agencies to consult theater commands with regard to their SIGINT requirements, a meeting of the Working Group for the purpose of establishing specific targets will be held on 21 January.

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2. It is proposed that, in the light of the briefing on 27 December and any relevant discussion at that meeting, the COMOR-SIGINT Working Group be requested to re-examine the attached document and submit its recommendation to the COMOR as soon as feasible.

James Q. Reber
Chairman
Committee on Overhead Reconnaissance

1 Attachment
Subject paper

Copies 2, 3--State TCO
4--DIA (Col. May)
5, 6, 7, 8--DIA TCO
9--OACSI TCO
10--ONI TCO
11, 12--AFCIN TCO
13, 14--NSA TCO
15, 16--NRO TCO

I. SATELLITE SIGINT - GENERAL CONSIDERATIONS

The Satellite as an SIGINT Platform

SIGINT satellites have advantages over other means of SIGINT collection, as follows:

a. They provide access to areas normally denied to most other collection techniques. Other techniques such as the intercept of signals reflected from the moon or from magnetic field-aligned ions in the E layer can be used to extend SIGINT coverage beyond the line of sight; but at present, none of these techniques has matched the greater probability of intercept or accuracy of measurement afforded by the satellite.

b. They are less vulnerable to physical enemy counteraction than overflight conducted with aircraft or drones. This situation cannot be counted on for the indefinite future, however, the present and potential capability to conduct multiple passes over denied areas free from the risk of capture of personnel or equipment is significant.

c. Continuous and repetitive collection by multiple orbital passes can provide a basis for the determination of significant variations in the ambient electronic environment.

d. If the purpose of the satellite is unknown, it is not likely that target emitters will be shut down for security during the periods in which the collection attempt is being made. The shutting down of emitters is a more likely occurrence in the case of non-satellite reconnaissance operations. It must be noted, however, that for the intercept of some types of emitters, such as GCI and SAM radars, the non-satellite reconnaissance methods have the advantage of exciting an increased signal activity against which to collect.

SIGINT satellites have disadvantages as follow:

a. Space and weight limits place severe restrictions on satellite programs. These limits restrict the number of functions

and the accuracy with which these functions can be performed. Measurement of radio frequency, pulse repetition frequency, pulse width, the location of a target emitter, as well as the length of the operating life and system reliability are all influenced by the space and weight available for the collection payloads.

b. Reliability is difficult to achieve. The more complex the task placed on a Satellite SIGINT system, the more complex the collection system must be with resultant penalties in reliability. The reliability of the collection system may also be reduced as a consequence of making the SIGINT system an adjunct to another operation. Fundamental to a satellite program is the need for reliable boost into proper orbit.

c. SIGINT satellites are relatively inflexible systems. The time required to mount an orbital collection mission is relatively long. Once in orbit, satellites cannot readily be redirected to a specific area at a particular time in order to operate against a target of opportunity. This circumstance is compensated for only in part by the greater area of coverage which can be provided by the satellite.

To intercept a SIGINT signal, a satellite, like other intercept platforms, must: (1) be essentially within the line of sight of the emitter; (2) be present at the time the emitter is radiating; (3) have its receiver covering the frequency of the emitter; and (4) have a receiving system sensitivity great enough to detect that electromagnetic energy (main lobe or side lobe) which is being radiated in its direction. Satellites can readily intercept rotating and search type radars which form the major defensive network of the Soviet Union and which operate a high percentage of the time. They are much more limited in their ability to intercept some of the specialized SIGINT systems such as the ABM detection systems and others having a narrow sector scan. This latter category includes emitters in which highest interest currently exists. It should be noted, however, that the intercept of such emitters poses equally difficult problems for other type intercept platforms.

SIGINT satellites are expensive, primarily in terms of cost to achieve proper orbit. It is difficult to determine a basis for valid

comparison of the costs of Satellite SIGINT programs against costs of other type SIGINT programs. SIGINT satellites employ different concepts; their development and employment costs as well as their potential return, are correspondingly different. Overall, their expense may not be greater than that of other collection means.

Probability of Intercept

Probability of intercept is the most fundamental element of a sound satellite signal collection program. Not until a sufficiently high confidence level for the probability of obtaining a useful number of intercepts has been achieved can the determination of parameters such as location, measurement of signal characteristics, etc., be given consideration.

Meaningful criteria have not heretofore been established which would aid in determining the minimum acceptable probability of intercept needed for a useful collection effort. While such criteria are lacking, certain generalized approaches can be of use. For example, it appears reasonable to expect that in fulfilling a requirement for Radar Order of Battle (ROB) there should be a high probability of intercepting a large percentage of particular emitters per program period (i.e., per month, or per quarter). On the other hand, in fulfilling a requirement to determine the activity pattern of a given type of radar, it seems reasonable that a high probability of intercept per orbit must be assured. The significant fact is that "reasonable probability" is different depending upon the nature of the requirement.

Achieving reasonable probability of intercept to satisfy any given requirement has a fundamental influence on the design and employment approach required. To intercept, with reasonable probability, a high powered, circularly scanning radar with a high frequency of usage, calls for a quite different receiver design and orbital employment mode than is needed to intercept a signal estimated to have a limited angular beam coverage, and to be radiating only a small percentage of the time.

Frequency Limits

Many factors, such as space loss, satellite altitude, receiver sensitivity, receiving antenna gain, radio interference, galactic noise,

emitter power, beam structure, and nature of modulation contribute to the establishment of practical limits (upper and lower) for the frequency regime in which Satellite SIGINT can be employed effectively. Because these factors are variable, no exact limits can be set.

It appears reasonable that the lower limit should, in general, be about [redacted] Below this frequency ionoshperic reflections permit beyond line of sight intercepts to be made by ground stations.

The upper limit of the frequency band in which Satellite SIGINT can be expected to be effective is somewhat harder to define. This limit appears to be just above X band. The probability of intercept for the type of signals found at X band and higher is greatly diminished as a consequence of the following:

a. The higher frequencies are employed to gain more directivity, and to be able to utilize a broader band width of the spectrum.

b. Peak and average powers are greatly reduced at the higher frequencies.

To provide a reasonable probability of detecting directional signals in the X band or higher frequencies by Satellite SIGINT, side lobe radiations must be detected, and a fairly large portion of the spectrum must be searched. The lower peak power and the use of greater transmission band widths (narrow radar pulses) contribute to making side lobe detection at these frequencies difficult. There appears to be little to be gained at this time or in the near future in attempting SatelliteSIGINT operations above about [redacted]

II. EVALUATION OF PRESENT PROGRAMS

Three SIGINT satellite programs, [redacted], POPPY, and [redacted] are currently in operation and have provided significant information to intelligence users. The successful payloads of these programs have demonstrated their capability to measure signals with sufficient accuracy to identify new types of radars, to locate radars of importance for incorporation in the SIOP, and to measure changes in signal characteristics such as PRF jitter and variations in scan rate. Though none of the three has approached the optimum capability to meet intelligence requirements, each has contributed substantially to the art of Satellite SIGINT collection. The capability of each is complementary to the others. The three provide a good basis for development of a sound program.

[redacted]

a. [redacted]

b. [redacted]

c. [redacted]

[redacted]

[redacted]

POPPY

a. POPPY, by using a simple real time retransmitter of high reliability on an unstable platform, provides a useful orbital life of many months. The use of a unit probability receiver insures the intercept of main lobes of high power radars within a selected frequency band. Although the receiver does not measure the discrete frequency of a radar, it does respond to the other usual parameters of a signal except pulse width. Project POPPY is commendable for its simplicity, and long operating life. It is limited in its effectiveness by the relatively low sensitivity required for the designed mode of operation.

b. POPPY provides the basis for an ELINT satellite capable of effectively and continuously monitoring the radar environment over many bands of the frequency spectrum.

c. The current disadvantages of POPPY are:

(1) Its effectiveness decreases against signals at frequencies above about 5000 MCS because of the low peak effective radiated power and the general nature of employment of such emitters. In some cases, such as for signals from [redacted] its sensitivity is so low as to preclude intercept even at 3000 MCS.

(2) The narrow band width of the channel over which it relays collected signal data limits the amount of signal data that it can furnish.

(3) It does not generally provide, in single package deployment, emitter locations for other than V-beam and nodding height finder type radars. For these radar types, location can be determined to an accuracy of about [redacted]

d. Intelligence Capability - POPPY has a reasonable probability of intercepting some signals of current highest priority, such as [redacted] however in its present configuration and usage it has limited ability to provide the technical details needed to meet the requirements.

[redacted]

[redacted]

[redacted]

[redacted]

III. SATELLITE ELINT REQUIREMENTS

As a general and basic rule, the capability of a collection system should not inhibit the requirer from expressing his needs fully and emphatically. Valid requirements may and do include those beyond the present capability of satellite collection systems, but such requirements must be viewed as indicating the direction toward which basic R &D and new techniques and concepts should be oriented, and not as a basis for defining the near term collection effort. Requirements which have little or no chance of being met by employment of satellite collection methods should not be levied against satellite collection programs for fulfillment.

Satellite ELINT, though having much in common with other ELINT collection efforts, has many inherent limitations which set it apart from other ELINT operations. Some of the requirements, as currently expressed, have virtually no chance of being fulfilled by Satellite ELINT. In particular, those requirements pertaining to active ECM, earth to space command transmissions, frequencies above [redacted] and emitters employing relatively fixed scan with very narrow beams, are not likely to be fulfilled in the near term by Satellite ELINT. Therefore, only those requirements of the very highest priority, for which the Satellite ELINT system is suited, and for which a satellite uniquely can provide coverage, should constitute the basis for development of the Satellite ELINT collection program. The current limitations of Satellite ELINT collection techniques require that the number of parameters to be measured, and the accuracies to which these measurements are made, be held to the very minimum needed to fulfill the need constituting the basis of the requirement.

Requirements and capabilities have been translated into Collection Goals for CY 1963 by the Electronic Reconnaissance Task Group of the (S) NRO (a, c, and d) and tentatively amended by the COMOR SIGINT Working Group (b, e, and f). These goals encompass the following:

a. Detect and Determine the Characteristics of New and Unusual Signals in the Sino-Soviet Bloc. Such signals are not predictable as to employment, deployment, or characteristics. Accord-

ingly, collection against this goal must be as general and as continuous as is practical to achieve. Coverage of the frequency spectrum from 40 to 12,000 MC is desired.

Falling within this goal is the following special case of current highest priority:

Determine the Character of the ABM Systems. Little is known of these systems Due to the apparent infrequent use of these systems at this time, repetitive coverage of suspect areas is indicated. The present need is for extensive general and specific search within selected bands of the frequency spectrum. Many estimates as to the best frequencies for search have been proposed. A composite list of these estimates arranged according to the priority in which satellite collection effort should be assigned is as follows:

500 - 650 MC and 160 - 250 MC

160 - 1500 MC

160 - 4000 MC

40 - 12,000 MC

b. Determine Location and Characteristics of ICBM and IRBM/IRBM Associated Radars. Little is known of these radars. Due to apparent infrequent use of these radars at this time, repetitive coverage of known site deployment areas is required. The following frequencies are recommended for search:

60 - 230 MC

550 - 650 MC

730 - 745 MC

1800 - 2200 MC

2700 - 3200 MC

c. Determine the Characteristics and Locations of Guidance Radars Associated with SAM Sites within the Sino-Soviet Bloc. Particular interest exists in the 100 - 900 MC and 2900 - 10,000 MC bands. Location of these radars to a degree of accuracy permitting their association with known SAM site locations is desired. The infrequent use and high directivity of SAM related guidance radars indicate a need for both sensitive and repetitive coverage.

d. Determine Radar Order of Battle (ROB) for EW/GCI Emitters within the Sino-Soviet Bloc. Particular interest exists in radars operating within the 80 - 90 MC, 200 - 220 MC, 150 - 180 MC, 560 - 580 MC, 800 - 900 MC, and 2600 - 3200 MC bands. Of some interest, but apparently of declining importance, are radars in the 70 - 90 MC band. Coverage providing locational information is desired. As a minimum, the cumulative collection by the end of the year should provide high confidence that comprehensive coverage has been attained.

e. Determine Characteristics of Electronic Equipment Associated with the Soviet Space Program. Particular interest exists in the 60 - 76 MC, 100 - 400 MC and 2760 - 2840 MC bands. The infrequent use and high directivity of some of the equipment indicate a need for both sensitive and repetitive coverage.

f. Determine Characteristics of Submarine Launched Missile Telemetry. Particular interest exists in the 55 - 90 MC, 130 - 170 MC, 200 - 250 MC and 2500 - 3000 MC bands. The infrequent use of the equipment indicates a need for repetitive coverage.

SUGGESTED CRITERIA FOR SPECIFYING REQUIREMENTS FOR SATELLITE SIGINT

The SIGINT satellite should be configured in response to the requirements of the intelligence community. Inasmuch as satellites are expensive and once in orbit become quite inflexible as to the tasks they might do, it is necessary that the program planners make every effort to insure that the maximum number of requirements are being satisfied with each successful launch. If the program planners are to achieve this goal and maximize the usefulness of the product of Satellite SIGINT, they must have: (a) as much pertinent background information on each requirements target as possible; (b) a clear understanding of that which is actually wanted (i. e., what is absolutely essential in comparison to that which would be nice to know); and (c) the allowable tolerances to which parameters must be measured.

As an aid to the program planners in obtaining this type of information, the following guide for specifying collection requirements for satellite SIGINT reconnaissance is proposed. The guide consists of a requirement format comprising four major subdivisions:

I. General Statement of Requirements
II. Background Information
III. Specific Search Parameters
VI. Parameter Tolerances

A brief explanation of these subdivisions along with a sample format follows:

I. General Statement of Requirements. A statement to tell the collector the basic job to be done. This may be as specific as:

"Determine the location of [redacted] radars in the vicinity of OMSK " or as general as:

"Determine the employment of the 2000-2500 mc band for radars in the Soviet Union"

II. Background Information. This should include a concise statement of known facts about the target and those estimates that have been made about it.

III. Search Parameters. These parameters will determine what the collection operation is to encompass. These vary with the technical demands of the requirement. For example, a requirement expressing interest only in a radar with a particular nickname or IBM code designation immediately delimits the collection parameters to the signal of interest while a broad coverage requirement may only delimit a particular frequency band. Some parameters listed in the format may be neither known nor applicable to a particular requirement. Only those that are clearly pertinent should be included. A discussion of various types of parameters follows:

a. Frequency Frequency may be the sole signal parameter to be specified. It can be stated as a band throughout which search is required, or it may be indicated by the use of a nickname or IBM code designation of a radar.

b. Ranges of PRF, PW, Antenna Scan Rate and Beam Width and Kind of Modulation or Type of Polarization. These are necessary to indicate the capabilities the collection systems should possess. Such parameters are also useful in establishing limits which would be satisfactory to enable the rejection of unwanted signals.

c. Estimated Power and Beam Pattern. The estimated power of the emitters for which search is to be conducted is necessary to determine the required sensitivity of the system. The estimated power of the side and back lobes as well as the main beam of the signal are also pertinent. This factor, along with frequency, perhaps most greatly influences the design of the satellite receiving system. Of similar nature, because these also affect the probability of intercept, are the estimated beam width and the size of the sector scanned.

d. Geographical Area. A satellite can collect selectively by being told when and for how long to collect. This control can often be reprogrammed from the ground, but once launched, significant increases in "on" time may not be feasible due to data storage and transmission, or power limitations. A geographical requirement should

specify areas that are normally impractical to cover by other types of collection platforms. The satellite must be integrated into the overall collection program, thus periphery collection that can be done by less exotic means should only be assigned to the satellite as extensions of collections over more inaccessible areas. Such extensions could, however, conceivably reduce the need for other collection efforts. The geographical area in which search is desired may be as large as a country or as small as the metropolitan area of a particular city, but different requirements may require different collection and transmission techniques.

e. Periodicity of Cover. As it is anticipated that electronic signal environments will continue to change constantly, the collector must be told the desired periodicity with which repetitive data must be collected. On a signal of high interest, a collection effort on every available orbit, or even a special mission, would well be required; while an up-dating of data once every few months may be adequate for other requirements. A periodic requirement might be indicated for Radar Order of Battle (ROB) statistical studies to determine radar usage by hour/day.

f. Collateral and Miscellaneous Requirements. These take many forms and further serve to define the collection effort desired. An example might be that in addition to a routine periodic up-dating as indicated in the preceding subparagraph, it may be desired that a special collection effort should be conducted during a period of unusual interest such as a launch or recovery of a space vehicle.

III. Parameter Tolerances. These should be provided as (1) "desired" parameters accuracy, (2) "minimal" parameters accuracy, without which requirement cannot be satisfied, and (3) "nice to know" or "of interest" parameters. For example, if TOKEN radars are simply to be identified from S-band data, exact frequency, PRF and scan rate might be "desired" but PRF and scan rate would be "minimal", while PW and similar data would fall in the "nice to know" catagory. The parameters listed under the three categories or priorities may be any combination of emitter parameters with the minimum acceptable accuracy needed to satisfy the requirement.

It should be noted that the accuracy with which intercepted signal parameters need to be measured varies according to the purpose for which the intercept is intended, (i.e., identification of known types of

radar, location of specific emitters, detection of new and unusual emitters, evaluation of capability of a given type of radar or for giving targeting information to another collection facility). Though the responsibility for designating desired accuracy of parameter measurements rests with the levier of the requirement, analysis experience with various collection systems has shown that the degree of the accuracy of intercept does not need to be as great as normally specified by the consumer.

The following is a suggested guide as to the needed accuracy for such measurements.

a. For identifying known types of radars:

1. Freq 10%
2. PRF 2%
3. Scan rate 5%
4. P. W. $\pm$ 100% (if needed at all)

b. For locating specific radars:

1. PRF 1% or better) Depending upon signal
2. Frequency 1% or better) density and lapse of
3. Scan rate 1% or better) time between intercepts
4. Mean real time of intercept $\pm$ 1 sec.

c. For identifying a new and unusual type of radar:

1. Freq 10 - 20%
2. PRF 10 - 20%
3. Scan rate 10%
4. P. W. 100% (if needed at all)

d. For evaluation of radar capability of an isolated radar: (The listed variations in each parameter will give a 10% variation in radar range.)

1. Freq (not jump type) 20%
2. PRF 40%
3. Scan rate 20%
4. Pulse width 40%
5. Peak power 40%

Tab A

For all requirements, there is a need for a statement as to the accuracy needed for the determination of the location of a particular emitter, even if merely to state that only the general geographical area need be determined. Although the satellites themselves do not now compute the location of a signal, the collection effort must make sufficient measurements to permit computation on the ground to the accuracy specified.

SAMPLE REQUIREMENT

I. General: A requirement exists for technical intelligence data on the signal designated as [redacted] to determine electronic characteristics and performance capabilities of the emitter and system associated with this signal:

II. Background Information: The signal was first intercepted emanating from the Soviet Zone of Germany in September 1961. To date, all intercepts of this signal have emanated from this area. There are four probable locations asscciated with this signal. The locations are reported to be in the area of Jena, Lothen, Rathenow and Wereneuchen, Soviet Zone of Germany. No known emitter has been associated with this signal.

III. Specific SEARCH Requirements:

A. Emitter Nickname: [redacted]

B. Signal Parameters

1. Frequency: 1770-1800 mc

2. PRF:

a. 715-725 PPS

b. 835-845 PPS

c. 280 PPS

d. 560 PPS

3. P. W. .5-1.0 sec.

4. Beam Characteristics: Complex at 26-28 cps.

5. Additional Information: Signal is keyed ON and OFF with an ON period 3.6-4.0 seconds and an OFF period 1.0-2.6 seconds.

C. Periodicity of Coverage. Daily coverage desired, minimum coverage of once a week. For coverage outside of Soviet Zone of Germany, once a month is sufficient.

D. Geographical Coverage. Primary coverage Soviet Zone of Germany. Secondary interest is all of Sino-Soviet Bloc.

III. Specific Collection Parameters.

A. Desired

Parameters	Accuracy
RF	10%
PRF	1%
PW	10%
Scan Rate	1%
Beam Width	5%
Pulse Modulation Character	--

B. Minimal

Parameters	Accuracy
RF	10%
PRF	1%
Scan Rate	1%

C. Of Interest

Parameters	Accuracy
1. Polarization	---
2. Nature of Scan	---
3. Simultaneous operation on two or more PRFs	---

D. Location

1. Desired $\pm$ 25 miles

2. Minimum $\pm$ 100 miles