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Ser BYE-51910-71
23 August 1971

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From: Director, Naval Research Laboratory
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Subj: Low-Altitude Satellite System Concepts and Capabilities

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LOW-ALTITUDE SATELLITE SYSTEM

CONCEPTS & CAPABILITIES

August 1971

Naval Research Laboratory
Washington, D.C.

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CONTENTS

I. INTRODUCTION

For the past decade U.S. ELINT satellite systems have been successfully employed in a strategic role with a general search mission. In addition, for about the last four years, there has been a secondary but sustained effort to extend these same ELINT capabilities to the growing task of ocean surveillance and other tactical situations. Whereas the requirements under the general search mission were of highest priority and long standing on the national list, it was only recently (1970) that the U.S. Intelligence Board (USIB) approved a statement of requirements for ocean surveillance to be performed by ELINT satellite systems (Ref. (1)). While this USIB statement is general in nature and does not delineate the requirements fully, it does establish the necessity of providing Command with the flow of information which is essential to the prosecution of operational naval missions.

These currently approved requirements are bounded by limits which dictate locating and reporting on the position of threat emitters (with identification implied) within 500 nautical miles of friendly forces within 20 minutes, to an accuracy of [redacted] additionally locating and reporting <u>all</u> shipborne emitters within 6 hours, to an accuracy of [redacted] These bounds are governed by an interplay of a number of variables, appropriately weighted by a variety of factors as described in Ref. (1).

Currently, other Navy efforts[Δ] are developing further refinement of ocean surveillance requirements. As more information is obtained, and state-of-the-art advances in sensor technology are made, the requirements will become more definite. However, even the general statement of requirements, as approved by the USIB, is representative of the near-term ocean surveillance mission of space systems.

Since it appears highly probable that ocean surveillance will in due course become a normal space system function, it is desirable to better define and understand the problems involved in ocean surveillance and to examine the various spaceborne sensors and supporting processing/reporting techniques which can be brought to bear upon them. The present paper is restricted to ELINT and to those foreign military emitters believed to be associated with naval and marine activities of interest. More definitive analysis will be possible after the intelligence and command requirements for ocean surveillance have been defined. Additionally, some of these same factors will assist in defining the requirements for other, similar tactical applications.

[Δ]The PM-16 Ocean Surveillance Requirements Study is currently underway at NRL; final report is scheduled for about October 1971.

II. PHILOSOPHY OF SOVIET RADAR DESIGN

The Soviets began radar development with the Allied lend-lease program following World War II. After a short learning period on British and U.S. radar designs of that time, the Soviets began a steady introduction of native-design radars. A summary of such historical and current Soviet radar capabilities can be found in Ref. (2) through (5).

Soviet progress in radar design and technology since 1960 (U-2 incident) has been impressive and probably represents a national priority and investment without precedent in this field. Beginning with what appeared to be a crash program to develop an air warning and defense perimeter in depth, the Soviets have advanced in both tactical and strategic radar systems to a point where the inventory, technical parameters, rate of development and deployment, innovations of technique and employment, and protection of the systems (e.g. in the form of ECCM) are unequalled in the Western world. As a consequence, ELINT, which is the best suited of the U.S. sensors, to help detect, locate, identify and determine countermeasures for such radars, assumes a critical military importance.

While certain Soviet radars have exhibited great ingenuity and originality in specific cases, the philosophy of Soviet radar design has in general adhered to certain fundamental radar technology practices which ELINT can exploit. These features relate directly to observable radar parameters which include frequency, pulse repetition frequency (PRF), type of antenna scan and scan rate, pulse width, and effective radiated power.[Δ] An overview of Soviet radar design practices is provided in the following paragraphs, with respect to such observable radar parameters, in the context of the ELINT/surveillance satellite system.

A. FREQUENCY

In radar design, generally speaking, the lower frequencies are employed for long range search to optimize probability of detection (propagation loss is proportional to the square of the frequency); higher frequencies are used in applications such as fire control, where range and angular accuracy are important (and more easily obtained due to the shorter wavelengths). Furthermore, since low frequency components tend to be larger and heavier than high frequency ones, airborne and other mobile radar system designs tend towards high frequency usage. Soviet radar designs have in general followed these fundamental considerations of radar frequency usage.

However, in Soviet radars (as well as in radars in general) the function of the individual radar is not critically dependent on frequency; many radars in a given frequency band may be performing different functions, and many radars of like functions can be found operating at widely different frequencies. In addition, most military radars have the inherent capability for limited frequency tuning of the bandwidth of the transmitter tube. This is done

[Δ]Effective radiated power is normally difficult to gauge accurately because of ambiguities in range, atmospheric transmissivity, multipath effects, etc.

typically in four or five discrete steps or even continuously, for two important reasons: First, to avoid mutual interference with other radars, and secondly, to reduce vulnerability to jamming.

Operational Soviet radar systems commonly employ magnetrons as the frequency/power source because of their simple and rugged construction, relatively high efficiency, and lower cost. It is well known that magnetrons may, and frequently do, drift in frequency[Δ] as a result of age, how long they have been turned on, and even due to variations in the (electrical) load with which they work. However, this poses little if any practical problems, because most radars are insensitive to such small (percentage) changes in frequency, and Soviet radar designs, with few exceptions such as in frequency steered radars, do not make any special attempt at frequency stabilization.

Thus, a precise determination of the frequency of an unknown radar system is seldom sufficient to identify even generally what type of radar it is, let alone to identify it as a particular or unique case in a given radar family.

B. PULSE REPETITION FREQUENCY (PRF)

As a general radar design proposition, PRF is directly related to the radar return (data) fidelity; a high PRF produces optimum performance in terms of range resolution. However, since PRF and maximum unambiguous detection

[Δ]The quoted "pulling factor," or maximum observed frequency shift, of typical magnetrons, is usually from 15 to 20 MHz for magnetrons without a stabilizing cavity, and approximately 6 MHz for magnetrons with a stabilizing cavity.

range are inversely related, and because of average power limitations (for a given pulse amplitude and pulse width the average power increases directly with PRF), the choise of PRF usage is tailored to specific operational functions. That is, low PRF (to avoid range ambiguities) is normally associated with long range detection radars; high PRF (to generate high data rate/fideility in high speed situations) is used in short range and high precision radars, such as airborne intercept and fire control. Soviet radar design philosophy has in general followed these basic concepts of PRF usage.

Because of the very nature and/or contribution of PRF to range resolution (range resolution is directly dependent on PRF stability), PRF stability is obviously critical in radar design. In addition, another important aspect of PRF stability is in evidence in Soviet radar design practice: that is with respect to the commonly incorporated capability for Moving Target Indication (MTI); and accurate target speed determination extremely high PRF stability is of paramount importance. Although it is theoretically possible to achieve an MTI capability without highly stable PRF, in Soviet (and common) practice it is usually achieved through he use of highly stable crystal control.$^{\Delta}$

PRF of such (Soviet) radars is not subject to temporal drift; furthermore, it can be assumed that Soviet radar designs will continue to incorporate highly stable crystal controlled PRF. Thus, an extremely attractive means is available to the U.S. for identification and even fingerprinting through very accurate measurement of the radar PRF.

$^{\Delta}$PRF stability greater than one part in 10^9 is within the state-of-the-art of operational radar systems.

C. ANTENNA SCAN

The type of antenna scan and scan rate are normally related to radar system function. For example, a slow circular scan is usually employed in long range detection/surveillance radars. Rapid scan rates or narrow sector scan, on the other hand, are used for accurate (high data rate) target tracking, such as in a fire control radar.

Historically, Soviet radar designs have closely followed these fundamental scan and scan rate principles. Thus, it becomes possible to classify, at least generically, the type of radar solely from its scan and scan rate. Additionally, such scan information -- in concert with the general frequency band employed and high accurate PRF measurement -- can provide unambiguous identification of a specific single radar, i.e. fingerprinting.

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F. POLARIZATION

The direction of polarization of a radar antenna is defined as the direction of the electric field vector (Ref. (6)). Most radar antennas are linearly polarized, with the direction of the electric field being either vertical or horizontal. Another commonly used form is circular polarization, where two linearly polarized waves -- of equal amplitude and 90° out of (time) phase -- are combined for special operational reasons. Elliptical polarization is a further possible form, and is essentially a variation of circular polarization.

Linear polarization is most often used in conventional radars since it is basically the easiest to achieve. Thus, Soviet radar designs have employed linear polarization for the majority of systems of the general purpose types, including search, early warning, navigation, etc. The choice of linear polarization (between horizontal or vertical) depends on certain operational considerations such as the importance of ground reflections or sea clutter. However, in the context of a family of radars, such as naval search systems, for example, once a design choice is made, no further distinction is incorporated.

Circular polarization is often useful in minimizing the radar effects of weather disturbances. However, because of the increased complexity of circular polarization, its use is normally restricted to specialized radar functions such as fire control, target tracking, and missile guidance.

It should be noted additionally that normal radar designs attempt to linearize (or circularize) polarization in the main beam only. Polarization integrity is not maintained in the side lobes of a radar antenna.

The above definitions are applications of polarization types are common throughout normal radar design, including that of Soviet origin. A fundamental point to be made, however, is that albeit these distinctions exist in practice, they are only descriptive of the general radar function and not unique enough to permit type definition let alon~~g~~e identification.

III. COMPARISON OF SYSTEM CONCEPTS/CAPABILITIES

The past decade has seen intensive development of U.S. earth orbiting satellite systems for the purpose of collecting ELINT data and ultimately for detection, location, and identification of the military radars of Communist countries. Indications are that the Soviets are utilizing satellites for similar purposes. Current collection and processing techniques are distinguishable on the basis of the fundamentals of their technical concepts.

A. ELINT INTERCEPT CONCEPTS

To provide an overview of the fundamental distinctions between the principal collection techniques alluded to above, the known candidate concepts can be compared in terms of system sensitivity, method for achieving radar location, and respective data handling schemes which are utilized for processing and reporting.

1. System Sensitivity

The basic description of an intercept system can be made in terms of system sensitivity, or the method in which the intercepts are accomplished. Although somewhat oversimplified, two generic concepts can be described in this manner. One concept utilizes a "main beam" approach, with simple crystal video receivers and relatively low-gain collection antennas, resulting in horizon to horizon coverage from a given satellite altitude. Typically such intercept data is transponded to ground processing stations.[Δ]

[Δ]Data handling for this concept is discussed in detail in subsequent paragraphs.

A second concept can be termed a "side-lobe" collection approach in that it utilizes a downward looking antenna system for intercept of radar side lobes, which are typically 25 dB to 30 dB lower (than main beam) signal level, necessitating employment of high-gain collection antennas and narrow-band, superheterodyne receivers to achieve required "system sensitivity." Operationally, this type of system usually relies on data-store and periodic dump to a ground station.Δ As a direct result of such a fundamental distinction between the two concepts -- with regard to system sensitivity or the method in which intercept is accomplished -- further distinction is possible in terms of the resultant system characteristics.

In this context, the principal characteristics of the main beam concept are: The system provides

a. Extremely wide (horizon to horizon) collection swath width and attendant large area coverage;

b. High probability of intercept on azimuth scanning (navigation, surface/air search) radars and somewhat lower probability of intercept on limited or sector scanning (fire control/missile guidance) radars;

c. Utilization of band filters to carefully define the limits of the RF band around known Soviet magnetron limits at the receiver inputs, resulting in moderate data density and rapid radar family classification;

ΔData handling for this concept is discussed in detail in subsequent paragraphs.

d Wide instantaneous frequency coverage (via multiple receivers) and precise definition of the RF bands covered via the narrow-band filters;

e. Extremely accurate PRF measurement achieved mainly because of the long periods during which the signals are present which are possible from horizon to horizon coverage at typical altitudes. This also permits accurate determination of pulse staggers and pulse position modulations;

f. Radar scan characteristics and beam structure information (as an important aid to radar classification).

For comparison, the principal characteristics of the side lobe intercept concept can be stated as:

a. Narrow-beam receiving antennas (to obtain sufficient gain and to prevent signal saturation), resulting in limited swath width and consequently smaller area coverage;

b. Low altitudes (typically around 200-300 miles) are required to achieve the desired location accuracy due to the limited angular accuracy possible with reasonable sized antennas (see Figure III-1);

c. Narrow-band frequency scanning normally employed to reduce typically large number of side-lobe signals and to increase the signal to noise ratio;

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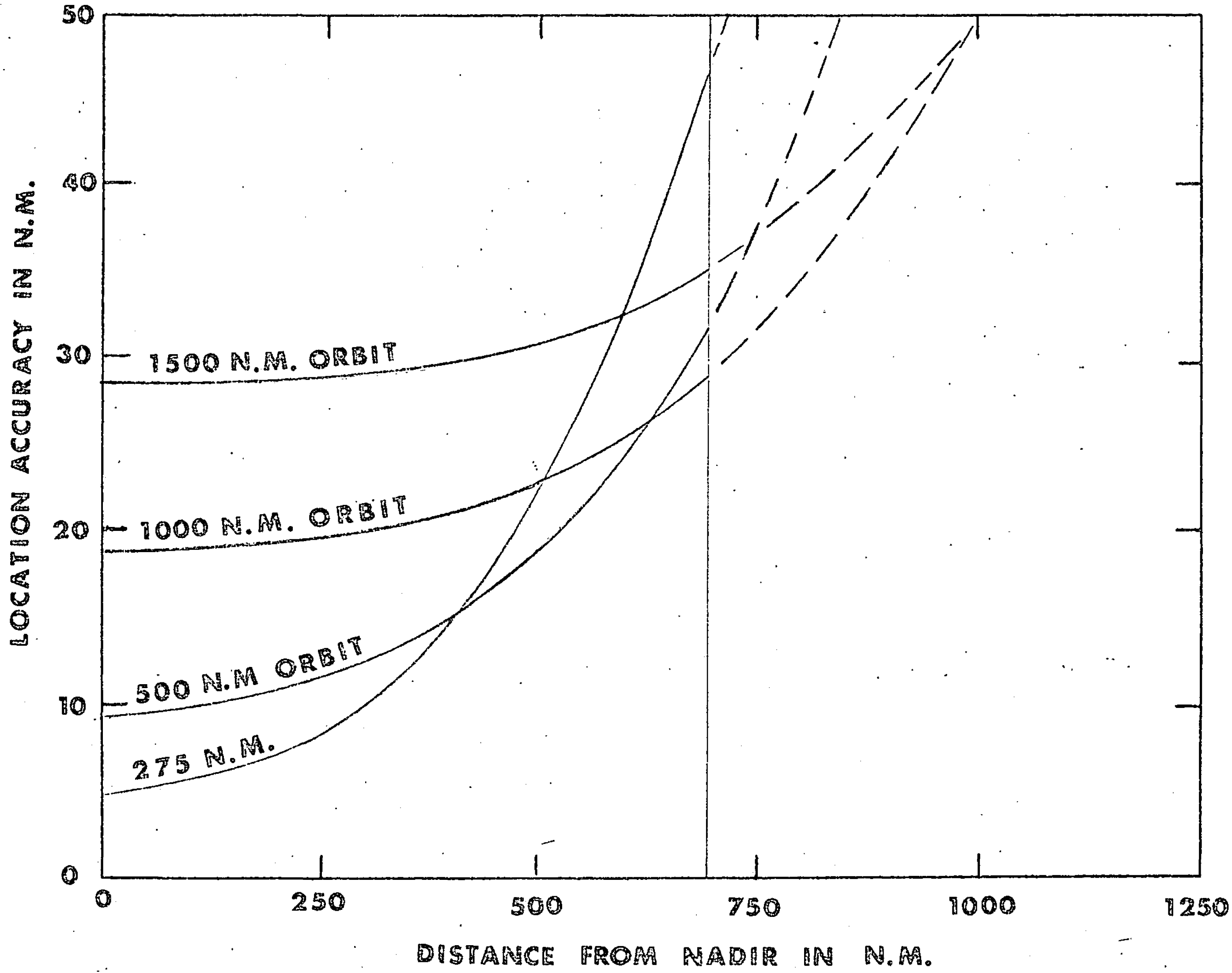

Figure III-1: LOCATION ACCURACY FOR ONE DEGREE SIDE LOBE SYSTEM

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d. Moderate probability of intercept, albeit independent of emitter antenna scan because of the high gain, narrow beam antenna and the narrow band frequency scanning;

e. For the reasons stated in b. and c., and because of the attendant short dwell times available with this approach, intercept of a given emitter limited to a small number of radar pulses, making highly accurate PRF measurement difficult; and resulting in lost or erroneous results on the newer missile associated radars employing pulse staggers and pulse position modulations. This is even further compounded if the system employs lock out or recognition circuitry to reduce density;

f. In addition to the limitations described in items b., c., and d., a deliberate reduction of total pulses accepted from a given emitter in order to prevent saturation of the limited on-board processing and data storage normally employed in this type of system;

g. Although good RF frequency measurement is possible, total frequency coverage limited by the requirement for narrow band frequency scanning. (See Section II, Para. A for identification utility.)

h. Neither scan characteristics nor beam structure information available (as an aid in classification).

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3. Data Handling

A third fundamental differentiation between the various current satellite system concepts can be made on the basis of the data handling and/or processing approach which is employed.

a. Direct Transpond

The simplest and most straightforward data handling technique provides emitter data by transponding directly to a collection site where appropriate processing can be performed. A major benefit of this concept is that selective processing can be performed at the collection station in near-real time on time-critical targets. Also the collection sites are located in the same operational theater as the naval units they serve, hence they are aware of the unique priority problems in that operational area. The results of such processing can be relayed immediately to operational users, minimizing the delay between target acquisition and user notification to the practical limit. Another major benefit of the direct transpond approach is that simplicity of the spacecraft segment can be maintained to improve reliability, increase orbital lifetimes and provide continuous 24 hour a day operation, while processing hardware and software innovations can be introduced at any time at the collection station as they become available by advances in the state of the art. A further benefit is that shifts in data exploitation can be effected readily in response to changes in national or operational priorities.

An obvious prerequisite of a direct transpond approach is that the spacecraft be within sight of the ground station. With the normal horizon coverage of the main beam intercept system concept this is readily achieved; with appropriate site locations, substantially world-wide coverage can be provided with a minimum number of collection sites. If additional geographical coverage is required, it can be provided as required by transportable collection/processing stations located to provide coverage in the new area.

b. On-Board Store/Periodic Dump

An alternative (to direct transpond) technique for data handling involves varying degrees of on-board processing and recording, coupled with periodic dump to a ground site. While the geographic collection capability of this approach is essentially independent of collection station location, the achievable coverage is fundamentally limited by the on-board data storage capacity and the available spacecraft power. The incorporation of processing and recording sub-systems, superheterodyne receivers, a precise time clock which is required and must run continuously -- all carried in the satellite -- requires large amounts of operating power, constraining operational capability for only two or three hours out of a 24 hour day, and greatly complicating the spacecraft segment. Both aspects tend to decrease the reliability and the overall life expectancy of the spacecraft. Obviously the opportunity to modify processing techniques in the spacecraft is greatly restricted.

Operationally, a typical delay of several hours occurs with the store and dump approach -- between target acquisition and the time the data can be dumped, thus increasing the delay until a user can be notified of the locations -- unless more than one ground station is provided. Such delays of several hours are also critical in that processing of high priority targets cannot take place until a data dump is made, and even then additional time-consuming data search must be made serially, not selectively because serial recording is normally employed before user utilization can be achieved.

B. RADAR PARAMETER MEASUREMENTS

Several low altitude ELINT satellite system concepts have been delineated on the basis of their fundamental approach to fulfilling ELINT requirements for national/operational utilization. In order to provide further, more specific, means of distinction, the following material focuses on the various concepts in terms of their approach to radar parameter measurement and the resultant system capabilities and/or limitations. The distinction will be made as to techniques employed and the degree of utility provided by achieving varying accuracies of radar parameter measurements.

1. Frequency Measurement

All of the ELINT satellite systems described previously employ some means for emitter radio frequency measurement.

band pass
Main beam systems normally utilize/filters to achieve relatively coarse exact frequency information, but precise frequency band indication. However, because of the inherent simplicity and capacity of this approach, simultaneous intercept and measurement of many emitters simultaneously is possible on multiple frequency radars and/or a large number of radars operating at different frequencies. With the extremely large horizon-to-horizon coverage of the main beam system, such simultaneous intercipt capability contributes to a relatively high probability of intercept.

As mentioned earlier, side lobe intercept systems normally employ very narrow band, scanning superheterodyne recievers and therefore achieve a somewhat more accurate R.F. frequency measurement than is available by the main beam filter approach. However, the scanning technique in effect reduces the overall probability of intercept in that instantaneously, intercepts are only possible within the frequency "window" of the receiver for the duration of the dwell. Multiple receivers can be used to increase the probability of intercept somewhat, but because of this inherent limitation and other intentional swath width and data limiting measures normally employed with side-lobe intercept systems (see Para. III.A.1.), the probability of intercept remains relatively low.

In addition to the inherent frequency measurement capabilities of the systems described, a further and more precise frequency measurement can be achieved by incorporation of a special frequency discriminator. However, this typically introduces additional complexity to the spacecraft segment with an attendant increase in power consumption and possible reduction of overall reliability.

Soviet radar design philosophy, and particularly their demonstrated radar frequency utilization, as described in Para. II.A., has a significant fundamental effect on the overall utility of frequency measurement accuracy. In most instances, even relatively coarse radar frequency measurement information is a useful parameter in the classification of particular emitter families. However, more accurate and even very precise frequency measurements usually are not sufficient to classify emitter types uniquely: basically because Soviet radar designs do not provide close or repeatable frequency control. It is therefore of little additional value to measure radar emitter frequencies to high accuracy, the only known exception being the initial/early collection of technical information on a new radar design for inclusion in the technical-scientific intelligence library.

2. Pulse Repetition Frequency (PRF) Measurement

The PRF of radar emitters can be described in terms of the nominal pulse repetition frequency, its short and long term stability, and any intentional pulse-to-pulse modulation which may be present. Every ELINT system provides some measure of PRF in the normal process of sorting the pulses of one emitter from the pulses of all other emitters collected at the same time. However, the utility of PRF measurement in a classification or even identification context is directly related to the accuracy of the PRF measurement which is consistently achievable by a particular system.

precision measurements (to 10^{-6} accuracy) are demonstrated. This degree of accuracy, for durations on the order of 100 seconds, additionally provides unique information about short term (pulse interval) variation as well as longer term instability. Such data is often sufficient for classification, and in conjunction with other (scan and scan rate) information makes fingerprinting or unique emitter identification possible. Further, as mentioned earlier, complex pulse staggers and modulations are easily determined.

If, as is the case for monopulse DF and spinner systems (see Para. III.A.1.), there is no opportunity for long-duration of intercept, precision measurements of PRF are difficult to make and pulse interval variations are often missed completely. It is also not possible to determine PRF stability with short observation times. Thus monopulse DF and spinning intercept systems are in general not able to provide PRF data with either sufficient precision or completeness for unique radar emitter identification and, as mentioned previously, may miss or provide erroneous results on complex stagger and pulse position modulations of the newer Soviet radars.

3. Scan Characteristics

It has been shown in Para. II.C. how the means used to control the position of a radar emitter beam in space is related to its intended operational function. Thus, surface/air search and navigation radars for example, normally use circular scan and can be frequently classified as to family type by measuring their scan rate. A similar example of scan rate information utility can be made for limited or sector scanning radars, as well as for the case of multiple beam radars. Such scan rate measurement can, in conjunction with radar frequency and PRF information, serve to identify an emitter uniquely.

The main beam intercept technique, has an inherent capability to provide scan rate information. Additionally, from the normal field of view at typical satellite altitudes, the main beam system is also able to provide additional scan characteristics information such as radar beam width and shape which can contribute significantly to unique emitter identification.

Fundamentally, in order to obtain accurate scan information it is necessary to distinguish between main beam and side lobe signals. Since neither the monopulse DF or spinner technique attempts to do so, and furthermore since their observation interval is normally less than a typical radar scan period, no information of scan rate is obtained by these systems. Obviously, they also cannot provide any other scan characteristic information such as radar beam width or shape.

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6. Polarization

As indicated in Para. II.F., polarization usage in radar designs is to a large degree functionally dependent. However, it is not a unique characteristic within functional types or families of radars. Thus, information of polarization could be utilized by an ELINT system for functional categorization of radar emitters, but more often polarization data is utilized for purposes of scientific and technical intelligence.

Main beam ELINT systems are inherently able to measure polarization, and typically have such a capability incorporated. Conversely, side lobe intercept systems are unable to provide meaningful polarization information because typical radar designs do not attempt to control side lobe polarization. Furthermore, polarization integrity would be essentially destroyed in side lobe signals because of multipath and atmospheric transmissivity effects.

7. Overview of Parametric Measurement

The principal impact of the preceding discussion on parametric measurements is summarized in Table III-1, in that contributions of the various parametric measurements are related to their utility in achieving required ELINT data. Interpretation of this table can be made as follows:

a. Categorization

It is assumed that radar emitters will be categorized according to radar function by means of what could be termed a baseline accuracy of measurement (in frequency, PRF, etc.). For example, frequency measurement accuracy could be achieved by band-pass filtering.

b. Classification

Radar family classification can be accomplished by means of increased measurement accuracy of the parametric categories which are cross-hatched in the second row of Table III-1. [redacted] even with greater accuracy than the baseline indication of emitter polarization is achieved, further increased accuracy is of questionable utility to classification.

c. Identification

Further increase in measurement accuracy in the PRF and scan categories provides the possibility for identifying the radar type. No such contribution is made by further increased accuracy of frequency, [redacted] or polarization measurement.

d. Unique Fingerprinting

Unique identification of radar emitter can be accomplished by increased accuracy of PRF (to 10^{-6}) and scan characteristics (including accurate scan rate and beam width/beam shape measurements).

TABLE III-1: CONTRIBUTIONS OF PARAMETRIC MEASUREMENTS

		PARAMETRIC MEASUREMENT					
		FREQUENCY	PRF	SCAN			POLARIZAT[ION]
I	CATEGORIZATION (RADAR FUNCTION)	///	///	///	///	///	///
II	CLASSIFICATION (RADAR FAMILY)	///	///	///		///	
III	IDENTIFICATION (RADAR TYPE)		///	///			
IV	FINGERPRINTING; UNIQUE (INDIVIDUAL RADAR)		///	///			

/// Applicable Parametric Measurements (See text)

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IV. SUMMARY

From the evaluation of ocean surveillance requirements to date and predicted for the near-term future, and from the history of ELINT space system technology and operations over the past decade, it is possible to generate a statement of capabilities that are required to fulfill a time-critical search and surveillance role. It is noted that the common demoninator is time, and the spectrum of end-products and their uses spreads from national to tactical echelons, all areas of the northern hemisphere, and a wide variety of ELINT content. Because of the nature of present and forecast threats, however, the most urgent application of the time-critical role is to such problems as antiship missile defense, antiair warfare, strike warfare, and antisubmarine warfare.

A. ESSENTIAL CAPABILITIES FOR TIME-CRITICAL ROLE

The essential capabilities derived are listed under the same headings used in Section III: system sensitivity, location accuracy, data timeliness, and parametric measurement.

1. System Sensitivity

- Large swath and large area coverage per orbit with frequent revisit capability.
- "Zoom" feature to identify and perform tactical area and fixed target coverage with quick response to user and without undue loss of broad, regular coverage.

- High probability of intercept, tailored to types, numbers, and priorities of threats.
- Rapid and accurate means of classifying and identifying (fingerprinting) threat emitters over wide range of operational requirements and in heavy signal densities.
- High capacity, adaptable sensor and data subsystems.

2. Location Accuracy

- Strategic and tactical location determinations over all areas of coverage, as tasked; flexibility of response to requirements in both time and accuracy domains, to meet user needs.
- Minimum of blind spots and fade areas.
- Multiple, concurrent fix capability.
- Fine-grain measurement capability for targeting and ability to cue other sensors.

3. Data Timeliness

- Selective intercept and/or processing programmable for special and changing requirements.

[redacted]

- Simplified, long life, reliable, continuous 24 hour per day operation and rapid data functions in spacecraft segment.
- No degradation because of heavy signal environment or multiple targets.

4. Parametric Measurement

- Exploitation of emitter characteristics/operation geared to user needs, whether national or tactical level, with ability to re-program to meet new operational/changing requirements.
- Suitable built-in checks and balances and redundancies to reinforce target classification/identification.
- System adaptability to changes in tactics and technology, both U.S. and enemy.
- Capacity to generate indicators -- early warning, operational readiness, R&D status, etc.

B. CONCLUSIONS AND RECOMMENDATIONS

The foregoing technical-engineering analysis has attempted to relate various known ELINT system techniques to time-critical requirements of national and naval interest. In all three principal system-characteristic areas -- system sensitivity, location accuracy, and data timeliness -- the main beam intercept/ [redacted] is fundamentally and demonstra~~ta~~bly superior with the highest probability of intercept, the greatest location accuracy potential, and the closest fit to current definitions of time-critical/tactical reporting capability. Moreover, the radar parameter measurement techniques principally employed with this system concept -- radar frequency band indication, high accuracy PRF data, and scan rate/beam characteristics -- all contribute to assured detection, location, classification, and unique identification of highest priority threat-associated radar emitters. On an overall basis, this system is flexible in its inherently wide coverage as well as technically adaptable to new and changing operational situations, regardless of the signal densities encountered.

The sole recommendation is that the engineering assessment of ELINT techniques presented here, considered sound on the basis of fundamental principles and well supported by operational experience to date, be utilized for fulfilling the most critical national and operational needs in light of current priorities and resources.

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