MEMORANDUM

12 August 1970

From NRL CODE 5614
R.D..Mayo

TO: NAVINTCOM NIC-2

Subj: NRL Response to the questions of the DSB of 10 August 1970.

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QUESTION #1 [redacted] respect to the ability of the system to perform position fixing, Please furnish us with an error Model of the system; this presumably includes, but may not be limited to, (1) the errors due to the ephemeris state vector of each spacecraft, (2) the ability of the system electronics to preserve the accurate measurement of the rise-time of an individual source radar pulse, and (3) the basic timing accuracy of the entire ensemble of hardware and software. Also give us the results of your analysis of the optimum spacing of the two spacecraft, as a function of the ephemeris accuracy and source radar bandwidth:::::::

1.The major sources of error which influence location accuracy are 1) vehicle positioning, 2) data handling variations in the electronics, 3) variable propagation delays due to ionospheric and tropospheric effects, and 4) accuracy of the collection site clock.

At present, maximum vehicle positioning errors are within 1.5 NM (Technical advances under development yield maximum errors of 0.5 NM). Vehicle positioning errors tend to produce comprable errors in the resulting location when both vehicles reflect similar positioning errors. However, errors due to positioning of one vehicle with respect to the other are often amplified when deriving a location.

Present site clock accuracy is retained within 10 milliseconds and the short time stability is within one part in 10^8. Real time errors within these limits reflect negligible errors in location results

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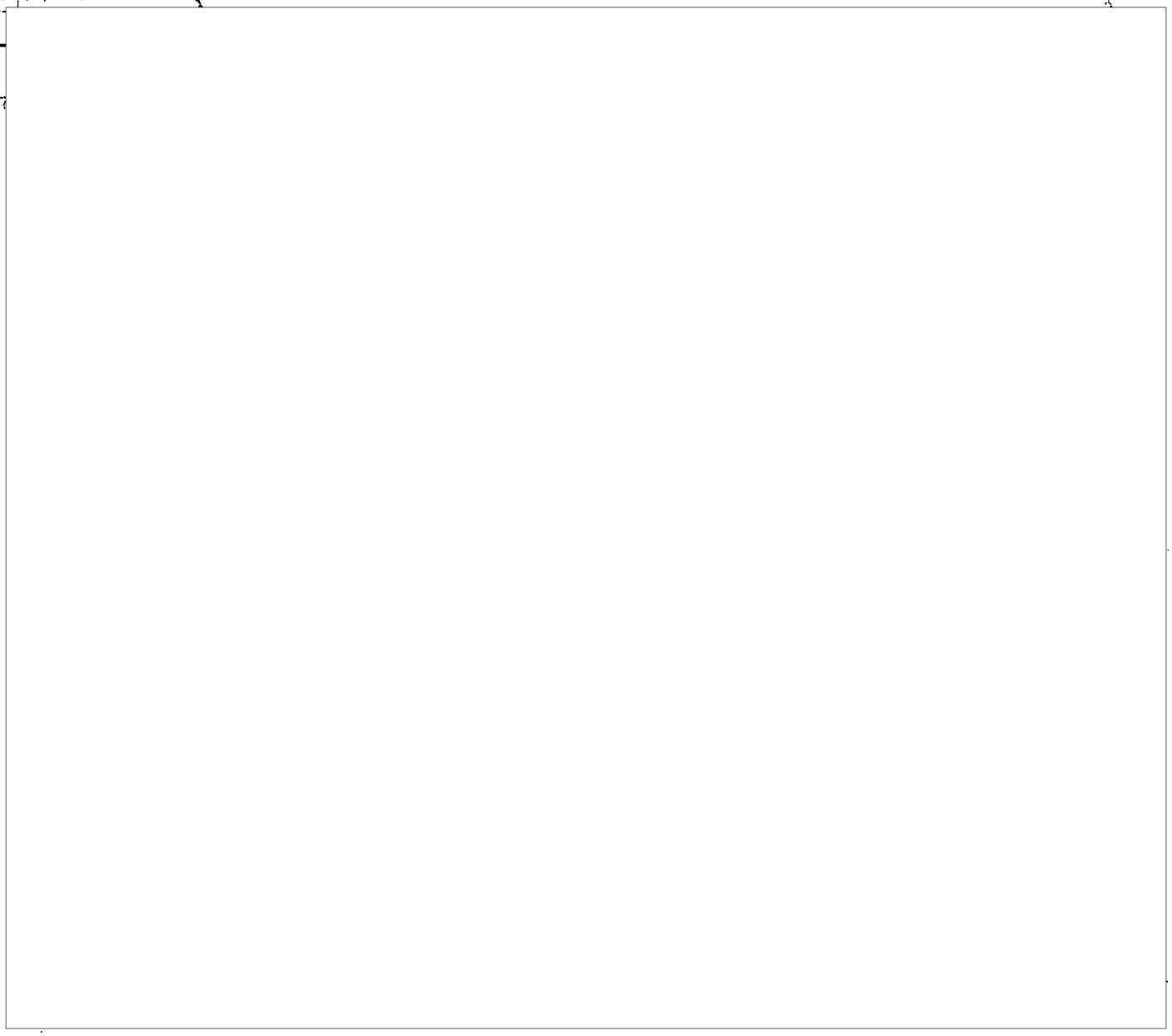
smaller angles. Thus, the accuracy with which a location may be found is highly dependent on the intercept geometry, the number and size of the signal bursts, and the period of time over which intercepts are made.



QUESTION # 2= Realizing that it depends on circumstances, please give us some data as to the ability of additional, but presently available, hardware and software to reduce the present processing time. In this context processing time is defined as the time from [redacted]

 The present [redacted]ware and software in operationaluse at the overseas sites has been [redacted] continued evolution for improvement in both accuracy and reduction in processing time since first deployed in April 1967. The Data Format used for the digital magnetic tape going to NSA is made as brief and concise as possible so that it may be moved electrically if the need should ever occur. The on-site processing however, requires that this data be reformatted so that the precise time of each pulse is available in digital form and not the time relative to a one-second benchmark as given in the NSA format. The reformatting is essential when ever data is to be processed at the site. The major goals for the operational software can be broken down into the following categories:

1) Isolation of the single emitter family from a background of other families contained in the same data task.

2) Isolation of a single emitter from others of the same type or family by sorting out the periodic antenna scans or bursts.

3) Determination of the center time of each burst and the Average Pulse Repetition Interval (PRI).

4) Emitter Location routines.

The major area of expediting present software lies in the potential for chaining certain of the present software routines into a series which operates from start to finish with little human interface or intervention. This technique is contrary to the existing philosophy of selective processing as opposed to Batch processing, and thus has not enjoyed a very high priority in software development. At such time as the processing goals for the site become stereotyped and routines established this chaining of programs into series can become cost effective.

In the Hardware area there is now underway a development of a simple extension of the present Analog to Digital Data System (ADD/S), which will extract certain channels of the data stream and will automatically reformat them into the language required for local processing. This Priority Data Extractor (PDE) will operate in parallel with the established system for production of NSA tape. It is considered that this PDE system will when deployed, allow the local processing of selected data from all three (L-band, S-band and X-band) portions of the ocean surveillance frequency spectrum except in the Eurpean portion of the world where the data population is excessive.

In order to successfully process X-band in Europe and keep up with the data collection, it will be necessary to accomplish all the required data sorts given above within the period of one hour after the data is taken. This will require additional computational power and speed. Such a system , with outstanding attributes of Processing Speed and I/O flexibility [redacted]eed, is currently available from the same manufacturer of our [redacted] computer system, Systems Engineering Laboratory of Fort Lauderda[redacted]orida. This computer is named the SEL System-[redacted] [redacted]rial i[redacted] at $125,000.00

The rist for attaining the present SEL-810 processing capability with the new System-86 is minimal since the two instruments are designed and manufactured by the same company a continuity of operational, training and logistic background already is in existence. The major area of advantage of the System-86 is in the tremendous potential which it manifes[redacted] being able to process data in real-time. Therefore, with the a[redacted]on of presently available hardware and software the national processing capability can be increased by a factor of 4 and the special interest (Navy) Ocean Surveillance processing could be increased by at least a factor of 10.

12 Aug '70

MEMO From HRB
ans to Kerzfeld Questions

This memo is in response to your recent request for information on 1) factors that influence the accuracy of [redacted] techniques and 2) processing advanta[redacted]be gained by employing additional "presently available" hardware.

In lieu of a formal analysis report it was decided to address the accuracy question by:

1. Presenting those factors that influence locations and discussing their relative significance.
2. Describing the field-employed location rating technique and giving examples of confidence.
3. Listing the number of Outstanding, Excellent, Good, etc. shipborne locations that have been reported in a recent period to illustrate the quality of present accomplishments against shipborne targets.

(Information for number 3 above would be derived from recent location reports in your file.)

Our comment on employing additional "presently available" hardware is meant as backup to support the proposals already in your hands.

Please use this information at your discretion and feel free to contact us if we may be of help in editing it.

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Response to Request 1

The major sources of error which influence location accuracy are 1) vehicle positioning, 2) data handling variations in the electronics, 3) variable prop[redacted] delays due to ionospheric and tropospheric effects, and 4) accuracy of t[redacted]ection site clock.

At present, maximum vehicle positioning errors are within 1.5 nm. (Techniques under development yield maximum errors of 0.5 nm.) Vehicle positioning errors tend to produce comparable errors in the resulting location when both vehicles reflect similar positioning errors. However, errors ~~in~~ due to positioning of one vehicle with respect to the other are often amplified when deriving a location.

Present site clock accuracy is retained within 10 milliseconds and the short term stability is within one part in 10^8. Real time errors within these limits reflect negligible errors in location results.

Adaptive thresholding techniques in the receive electronics permit calibrating out the significant system delays, leaving a time of arrival (TOA) standard deviation less than 2 usec. TOA errors are also introduced by variations in propagation delays. The magnitude of these errors does not exceed 0.5 usec.

The extent to which each of the sources of error affects the calculated location, however, depends very strongly on the geometry of the intercept.

[redacted]

located

TO

Response to Request 2

Recent activities to pursue [redacted] processing have revealed many areas where time savings can be achieved. Presently, routine data is processed in 3 to 4 hours. Selectively sorted high interest data fed directly to an on-line computer could certainly produce locations for up to ten emitters of the same t[redacted] in an hour.

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The DSB panel would like the following basic information on the Program Charlie [redacted] system, both spaceborne & ground hardware & software, as it presently exists.

1) with respect to the ability of the system to perform position fixing, please furnish us with an error model of the system; this presumably includes, but may not be limited to, the errors due to the ephemeris state vector of each spacecraft, the ability of the system electronics to preserve the accurate measurement of the true time of an individual source radar pulse, and the basic timing accuracy

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of the entire ensemble of hardware & software.

2.) Realizing that it depends of on circumstances, please give us some data as to the ability of additional, but presently available, hardware & software to reduce the present processing time. In this context, processing time is defined as the time from point intercept by two spacecraft to a position fix ready for the transmission to ours.

Also, please give us the results of your analysis of the optimum spacing of the two spacecraft, as a function of the ephemeris accuracy & source radar beamwidth

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