

~~TOP SECRET~~

HANDLE VIA
BYEMAN
CONTROL SYSTEM

~~181~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

THE NRO STAFF

11 December 1969



MEMORANDUM FOR DR. F. P. ADLER, HUGHES AIRCRAFT COMPANY

SUBJECT: Distribution of Documents

The attached documents are provided by the NRO Staff at Mr. Davis's request for your use while a member of the Fubini Panel.



Major, USAF

Attachments

- 1. BYE-78258-69, Cy *SF*
- 2. BYE-78460-69, Cy *10F*

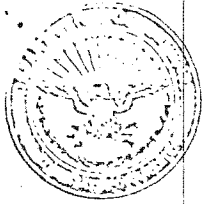


HANDLE VIA
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THE DEPUTY SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

8, AUG 1959

MEMORANDUM FOR MR. HELMS
DR. DUBRIDGE
MR. SCHLESINGER
DR. McLUCAS ✓

SUBJECT: Read Out

The paper on read out systems which I requested from
Herb Benington is attached for your use in preparing for the
15 August EXCOM meeting.

Attachment



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Series "F"

CONSIDER BUREAU GAMBIT MANSON

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[] REAL OUT SYSTEMS

Introduction

As requested by the Deputy Secretary of Defense, this paper discusses options that are available at this time with regard to initiating development of read-out satellite reconnaissance system that would:

- have one or more satellites continuously in orbit, and,
- produce photographic-type imagery [] 24 hours after collection.

Specifically, in accordance with EXCOM discussions in May on possible acceleration of read out system definition and development, CIA has requested [] in FY 1970 funding beyond the President's Budget of [] During FY 70 this program would continue or initiate engineering development of components and initiate competitive system definition studies. Total system development would require [] with the heaviest expenditures in FY 71-73.

When first operational, such a system would provide continuous intelligence on conventional forces including warning of some kinds of mobilization and deployment. It would also improve intelligence on technical, military, and economic matters. When more mature (at least five or more years off), the system might replace the GAMBIT spotting system. Eventually, this kind of read-out technology might be used for virtually all imaging systems; however, this would require very sophisticated image analysis, zooming techniques, and very high bandwidths.

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signal that can be [redacted] transmitted to the ground (possibly via a relay satellite) or stored on board the imaging satellite for later transmission.

3. Definitely, the most promising candidate technology for a transducer uses a linear array of solid state devices - photo transistors or photo-diodes. The next most promising technology at this time is an electronic camera that stores the image on a dielectric tape and later reads it off with an electron gun. The basic feasibility of both these techniques has been demonstrated during the past year. The solid-state array technology is most promising because it is very likely feasible and because its simplicity should allow very high reliability. The tape system is complex with moving parts, hot cathodes and electron guns. However, it can provide a hedge to array failure and, as a parallel development, it may allow a smaller and cheaper satellite system. During the next year or two, engineering models of both these devices could be developed to demonstrate performance, reliability, related system needs, and cost. (The final section discusses technology more fully.)

4. With regard to the characteristics of a read-out system that might be developed in FY71-FY74 for initial operation in FY74-FY75, there is agreement that the system should be a spotting rather than a search system and should have a best resolution of 2-3 feet. The United States Intelligence Board has also specified other desirable characteristics such as a

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evaluation and selection, and (3) determination of detailed operating characteristics desired for initial system. For the most ambitious system with optics, the NRO considers that this program has high cost and schedule risks because of the advanced technology needed including: (1) the optics, (2) the wide-band data-relay satellite, and (3) the precise attitude control system. On the other hand, several members of the Land Reconnaissance Panel feel that the program estimates are too conservative about the progress that can be achieved.

6. With regard to intelligence value, there is agreement that, a photographic read-out system would be uniquely capable of detecting and monitoring the mobilization, redeployment, status, and equipage of conventional ground, air, and some naval forces. As such, it would provide a unique intelligence contribution for warning, crises, and conventional combat operations. There is also agreement that such a system could provide timely information on current events (in much the same way that COMINT does today). An early motivation for developing a real-time read-out system was that it might provide warning of an attack by Soviet strategic nuclear forces against the United States. There is agreement now that the current and projected nature of strategic forces makes this contribution very questionable. However, there are divergent views about the value and feasibility of additional functions the system might perform. The United States Intelligence Board studies consider that a real-time satellite would also have significant capabilities including improved intelligence production on technical, economic and military areas;

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and verification of arms limitation agreements. Although DoD representatives agree that there would be some intelligence gain in these areas, they also feel that there are sufficient questions concerning the value or feasibility of these contributions that system development at this time must be primarily justified from the point of view of intelligence value, by the capability to monitor conventional forces before and during a crisis, and during combat.

7. The read-out systems discussed above would allow significant reductions in the size of aircraft and drone photographic collection systems and in the need for new systems. Off sets as high as \$25 million a year in operations might be achieved. Also, new aircraft and drone developments might be cancelled.

There is a range of estimates on the extent to which the read-out systems discussed above would allow reduced number of GAMBIT and HEXAGON missions. One view is that savings of more than \$60 million per year should be achieved. According to this view, current planning calls for a mix of four GAMBIT's and four HEXAGON's per year when HEXAGON becomes fully operational. A high performance read-out system should replace at least one HEXAGON and one GAMBIT per year, at a savings of approximately \$60 million per year. It may also be possible to reduce one or both of these programs by two launches per year, thus realizing additional savings.

Another view is that a read-out system would offset at most about \$20 million per year by possibly replacing one GAMBIT mission per year.

According to this view, the HEXAGON program is sized solely on the basis of the search need and could be only two or three successful missions per year. Two

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The HEXAGON missions would provide the majority of the current surveillance needs of the GAMBIT system such that after HEXAGON is operational, GAMBIT is needed only for high resolution technical intelligence. This follows because one of the major advantages of the read-out system overlaps an important factor that favored continuation of HEXAGON. They both provide 25,000-75,000 useful target looks per year at medium (2-4 foot) resolution. Because of this capability, HEXAGON will allow the number of GAMBIT missions to be reduced from 6 to 3-4. If HEXAGON were cancelled now and a read-out system developed, the read-out system would also allow a reduction in GAMBIT missions (but 2-3 years later).

It is agreed that if both a very high resolution system (MOL-follow on) and a read-out system are developed, then GAMBIT surely could be cancelled.

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HEXAGON

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9. In its review of the value of a read-out system in monitoring conventional arms during crises the EXCOM should also consider deployment of an interim, much cheaper, lower resolution search or spotting system that could be activated at the time of a crisis and would provide a very limited portion of the information available from the read-out systems discussed above. Such a system would perform for about a month after activation. However, it could be operational two years sooner and would require about starting in FY 70.

10. With respect to the read-out program in FY 70 and out years, there are three options that should be considered:

<u>Option</u>	<u>FY70</u>	<u>FY71</u>	<u>Earliest Availability of Operational System</u>
1			1974
2			1975
3			1976

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Under the first option we would move as quickly as possible to a read-out system using solid state technology (however, maintaining a development program with the electronic camera as back-up). We would, during 1970, develop transducers, optics, system design, relay satellites, and ground processing at a pace that would allow, in early FY 71, selection of a contractor who would develop the read-out system and integrate the efforts of contractors working on relay satellites and ground processing. Under the second option, we would pursue an aggressive technology program in FY 70 and 71 leading to a high confidence system acquisition decision in early FY 72. Decision would be based on image in - image out comparison of competing sensor technologies. Under Option 3, we would pursue basic transducer technology and review the need and opportunity to deploy in a year.

In both Options 1 and 2, once system development were under way, there would be three or more years requiring before the system became operational. For Option 1 this high expense period starts in mid-FY71; for Option 2, a year or more later.

11. There is agreement that a read-out system would be uniquely valuable. There is no consensus on its value with respect to other candidates for development or improvement such as an unmanned, very-high resolution follow-on to MOL or new SIGINT systems such as follow-on. Similarly, there is no consensus on the extent to which one would be willing to cut back current capabilities in the NRP or other intelligence programs in order to pursue a read-out capability.

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The advantages of Option 1 are:

1. It preserves the option of proceeding with a system acquisition program in FY 71 for only more than Option 2 in FY 70.
2. Option 1 leads to an operational capability one year earlier than Option 2 presuming the success of the FY 70 engineering activities. (There is an issue as to the risk in some of these activities.) If one attached very high value to a read-out system and believes that the system should proceed no matter what other systems might be developed or curtailed, then Option 1 is preferred.

The advantages of Option 2 are:

1. During the coming one or two years, judgements as to relative system value can be refined. We will gain insight into intelligence needs as SALT and other related issues develop. We will see how competitive systems such as and a MOL-follow on develop in terms of cost, performance, and value. (These are compatible in the resource sense and, in some cases, in intelligence product.)
2. The Option 2 program will provide better data sooner than Option 3 on component technologies, particularly transducers; on associated systems; and, on whether this is the proper time to crystallize a particular level of technology.

The advantages of Option 3 are:

1. It is the lowest cost, option and remains within presently programmed funds.

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HANDLING INSTRUCTIONS
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2. It will provide more time to refine and analyze the competing technologies and to determine the relative priority of real time read-out systems in the total NRP.

Option 2 seems preferred if one believes that read-out is important but wants more data to judge its relative importance. Option 3 seems desirable if the NRP budget is very limited, and if new, competing systems seem to offer more relative promise.

The next section compares the array and tape storage technologies and the technology programs of the Options.

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Technology

It has long been recognized that it would be desirable to have a reconnaissance system with a lifetime of [redacted] or more on orbit and the ability to return imagery [redacted] or at least daily. Over the past decade of space development, many of the requisite capabilities for such a system have been developed, including: long-lived satellites of considerable complexity; communication relay satellites with lifetimes of [redacted]; optical technology to fabricate very large and precise telescopes for satellites; and highly accurate techniques for navigation, control of satellite attitude, and target acquisition. Until recently the subsystem which seemed least well developed was the transducer which transforms the optical image into an electric signal. During the past six months, there has been very encouraging development of these devices.

For the past several years the NRO has funded a technology program in image transducers. The emphasis has been placed on two techniques: tape storage cameras and a class of solid-state array imaging devices. The technology programs have now demonstrated their basic feasibility and engineering performance. Breadboard test programs have been completed or are well along, and preliminary transducer design studies have been conducted. It would now be possible to transition and develop engineering models or prototype devices.

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Three contractors are developing solid-state devices: Fairchild, TRW, and Westinghouse. Pre-prototype chips are being tested with very promising results. In one case, a prototype chip is being fabricated. However, it will be 18 months to two years before "image in" to "image out" test results will be available. The pacing item for these tests is image reconstitution and a test facility, not the solid-state chips.

A laboratory model of the CBS tape storage system has been under test for four months. It is being operated in an "image in" to "image out" mode in laboratory tests. The results to date have also been promising but realistic testing has yet to be done. There are several variants to the tape system under study and development. Sufficient data are not available at this time to permit selection of an optimum configuration.

Each of these transducer technologies has its own inherent advantages. At this state, the solid-state systems are definitely the most promising. The promise rests on the high reliability associated with solid state circuitry and the pace of continuing improvement in fabrication techniques and performance. There are no moving parts in the array. It is small and light. We are relatively confident that it can provide an operational transducer within several years. In contrast, the tape storage camera requires a tape drive assembly, a hot cathode for the electron beam read-out gun,

EMERGENCY CONTROL SYSTEM
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and a photocathode which may degenerate in time. An operational model would weigh significantly more than the solid state transducer. In recent years, the tape system has had more development effort applied than the solid state. Due to the complexity of the assembly, it is estimated that engineering development would be a more difficult task with the need for extensive life and performance testing of engineering models to establish confidence that the system offered more than one year's life. This is in contrast with the solid state array where, if prototypes are successful, it is estimated that early confidence in life can be obtained. Because of these numerous engineering problems, we are only moderately confident that the tape storage technology could be sufficiently refined to make an operational satellite system seem worthwhile.

Recognizing these factors, the Land Panel has expressed enthusiasm over the potential of the solid-state device. Most recently, Dr. Garwin headed a subpanel which examined the solid-state technology. Dr. Garwin concluded that the technology is feasible and that in one year it can be brought to the point where a system decision can be made.

Given the developmental and reliability problems that face the tape storage system, nevertheless, a successful tape system might have several significant advantages. Compared with a solid-state transducer, the system may turn out to have higher

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effective sensitivity. First, the image is stored on a tape moving at scene velocity such that exposure times are roughly twenty times those of a solid-state system which must "rock" the entire spacecraft to track the target. (A minor penalty of this rocking is the increased time the satellite is dedicated to each target and the distortion of the image that occurs during this tracking). A second factor which permits smaller apertures to be used is the focal plane resolution in a tape system of

[Redacted]

Even though these factors are somewhat compensated for by the 10-20 times higher quantum efficiency of a solid-state system, a highly successful tape camera system might, for comparable imagery, require a lighter, simpler and cheaper satellite and development program.

The inherent storage of the tape system is also advantageous. It allows readout at a reduced bandwidth. It allows operation without a relay satellite; or if the additional readout time provided by a relay is desired, it eliminates the need for a second relay satellite. It provides more flexibility in system design and initial system deployment.

In summary, the solid-state array definitely has more promise as a transducer because of expected high reliability and our confidence in its feasibility and performance. On

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the other hand, there is agreement that if we continue to pursue readout technology because of the urgency of the intelligence need, we should continue some engineering development of the tape camera system at least for the next year. This would require less than - roughly one-half to one percent of the total development cost of a readout system.

The following table compares the technology programs that would be pursued under the three options.

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FY 70

FY 71

OPTION 1

OPTION 2

OPTION 3

OPTION 1

OPTION 2

OPTION 3

IMAGING SATELLITE

IMAGING SATELLITE

Select SSA Transducer Contractor

SSA Transducer Development

SSA Transducer Development

Satellite Development and Fabrication

SSA Prototype Test Program

Same as Option 2 FY-70

System Definition

TSC Transducer Development

TSC Transducer Development

Component Development and Fabrication

TSC Prototype Test Program

Preliminary Design

Optical Subsystem Studies

Optical System Breadboard and Test (if necessary)

Detail Design

Engineering Studies



Attitude Control System Prototype Test

System Definition

RELAY SATELLITE

RELAY SATELLITE

Study

Component Development

Detail Design

Component Test

Same as Option 2 FY-70

Preliminary Design

Start Satellite Development

System Definition

Start Component Development and Fabrication

OPERATIONS/PROCESSING FACILITY

OPERATIONS/PROCESSING FACILITY

Preliminary Design

Component Development

Complete Design and Development

Component Test

Same as Option 2 FY-70

System Definition

Start Installation and Checkout

System Definition

Start Design and Development

FY 70

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