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Total RF Bands received by(31 Jan to 31 Dec 1968)..16,707 RF BandsAverage RF Coverage/Band = 15,053 MHZ/44 Bands.........Total Collection Hours = # RF Bands X 15 min/Band.......4,176 HoursAverage MHz X Hours of Coverage (1968)...1.43 X 10⁶ MHZ-HrsArea of Instantaneous Collection = (1700)² X 3.149 X 10⁶ Sq.Mi.

TOTAL COVERAGE - RF X AREA X TIME = $1.42 \times 10^{6} \times 9 \times 10^{6} =$ = 12.8×10^{12} MHz-Hrs Sq Mi for 1968

Note: This is on an average tasking of 47.6% of the capability and covers one ground station of the POPPY ground stations in use in 1968.

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COST	SUMMARY FOR MISSION 7107	
<u>OPTION</u> #	SOURCE FY-71 FY-72	
<u>#1</u> 18 Mo.	SAFSP = \$1,300.0K \$3,000.0K* NRL = 8,451.4 8,512.0	
1	TOTALS \$9,7514K \$11,512.0 K*	
<u>#2</u> 24 Mo.	SAFSP = \$700.0K \$5,600.0K NRL = 8,477.6 8,601.0	
1	Total \$9,177.6K \$14,201.0 K	
#3 18 Mo.	SAFSP = \$1,300.0K \$3,000.0K* NRL = 8,811.6 8,512.0	
1	Total \$10,111.6K\$11,512.0K*	
<u>#3</u> 24 Mo.	SAFSP = \$1,300.0K \$5,600.0K NRL = 8,611.6 8,601.0	
Т	Total \$ 9,911.6K\$14,201,0K	
NOTE * Add canceled i	d \$2,000K if Program 846 is in CY-71	ALK. O
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OUTLINE OF MSG TO NRO RELATIVE TO QRC CONCEPT FOR MISSION 7107.

I BACKGROUND;

May concept (SED concept) formulated 12 months ago and now with the experience of recent loss of two of the spacecraft of Mission 7106, it is essential that consideration be given to (1) exercising reasonable care in the operational use of the remaining spacecraft to minimize the danger of their premature loss, and (2) modification of the recent NRO recently approved concept for Mission 7107 so that the schedule can be This latter concern is critical since the spacecraft of accelerated. 7105 will be three years old in May 1970 and in a situation where 7106 spacecraft are severely handicapped by loss of two spacecraft and the loss of a considerable portion of the cooperative type operational capability for geo-positioning emitters. The Mission 7107 Study Group convienned by NRO staff member have met on three ocassions since early Feb and in climate of kke outstanding constructive innovation the following concepts have evolved.

II: Quick Reaction Concept for Mission 7107 (QRC-7107)

Orbital aspects remain the same as would be desired for the Standard concept for Mission 7107 (STD-7107), i.e. 500 n.mi circular orbit at an inclination of 70[°] launched by a Thorad Agena from PMR. 4 primart Birds. Spacecraft Characteristics:

Structure to be similar to those used for Mission 7106 and 7105 befor that...the 27" diameter, 12-sided multiface with estimated weight of about 185 lbs per spacecraft. Structure to be used has been thoroughly documented in Flight so a minimum 66 design problems are anticipated, and a maximum of available spare parts and fixtures are available to further accelerate the production schedule.

GGS **XXXXXX** System Three axis Gravity Gradient with Boom and Reaction wheel for Stabilization is proposed since it represents the best system thus far obtained in the POPRY Program for attitude control...complete with Attitude monitor system and memory so instantaneous spacecraftattitude can be resolved after the data is taken. Design goals will be undertaken to provide for of up-Down and Fore-Aft attitudes of the spacecraft. Reaction Wheel and Rod type third-axis systems are proposed.

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ELINT COLLECTION COVERAGE PROPOSED FOR QRC-7107 concept.

BANE	<u>) # 7107A & 7107B</u>	<u>7107C & 710</u>	7D
1	154 🛱o 165 MHz	200/to 350	MHz
2	165 / 200 /	350 450	
3	550/ 815 /	450 550	
4	81/5 / 970 /	815 970	* * * *
5	970 / 1400 /	970 1205	/
6	/1400/ 1800/	-	
7	1800 2100	1800 2100	***
8	/ 21/00 2580 /	2100 2580	****
9	2/580 / 2680 /	48 <u>50</u> 5250	
10	2680 2800	5250 5850	
11	/ 2800 / 2930 /	6400 6 [,] 725/	****
12	2930/ 3120	6720 79,00	
13	3120 3300	7900/ 8600	
14	3300 3600	860,0 / 9100	
15	3,600 4,650	9100/ 9340	_ .
16	4050 (4850	9340 9400	
17	5850 / 6720	9400 / 9600	
18	<u>14 1/. /141 .</u> /	9600 10 5 00	
		-	

NOTE **** Denotes Commonality of coverage among all four Spacecraft. Band #1 in 7107A & B not included due to space and antenna limitation: # 2 in 7107C & D " " " " " " " " " Band # 5 in 7107C & D to have high sensitivity relative to #% of A & B

SLX to be available in every band of all Spacecraft. All Spacecraft to have Three (3) Data Link Transmitters and each Transmitter to utilize a Pulse Width Coding of 80,120, 160, and 200 / usec duration(W,X,Y,Z)

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The operational philosophy for POPPY has for years provided far more operational, capability and versatility than have been capitalized on during their lifetime. It is better that the spacecraft have more features than needed rather than the limiting case where features are needed that were not built into bhe spacecraft. Still it is a good idea to keep the design features well oriented toward the needs of the community, particularily in a QRC development cycle.

Polarization measurement capability to be of the greatest usefulness requires the signal to be (1) Locatable, (2) relative difference between signals seen on two orthogenal linear polarized collection antennas be made on a pulse by pulse basis. Orthogonal antennas which are linear polerized can be provided in several portions of the spectrum on each spacecraft. However the frequency bands aboe 1800 MHz provide the only practival potential sue to the limited space for the vertical polarized collection monopole mounting.gm@hkmxm

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FACTORS IMPACTING ON PREVIOUS NRL BUDGET SUBMISSION FOR FY-71

1. INFLATION @ 9%

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2. Further Unanticipated Development items.

3. Additional Redundancy.

4. DELAYS in Vehicle and Concept Approval.

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OpSeciel			• •
MISSION	1 7107 COS	STS (SAFS	Ρ)
OPTION	<u>FY-71</u>	<u>FY-72</u>	TOTALS
<u># 1</u> T-A (18 Mo)P.V.	0.5	0.2	0.7 1.1
NOV 71 <u>Laur</u> TOTA	LS 1.3	<u>2.5</u> * 3.0*	<u>2.5</u> * \$4.3 M*
<u>#2</u> T-A	0.4	0.3	0.7
(24 Mo)P.V. May 72 <u>Laur</u> TOTA	0.3 <u>ich 0.0</u> IS 0.7	0.8 <u>4.5</u> 5.6	1.1 <u>4.5</u> \$6.3 M
			#0.5 lvi
<u># 3</u> T-A (18 Mo)P.V. Nov 71 Laur	0.5 0.8	0.2 0.3 2.5*	0.7 1.1 2.5*
<u>тота</u>	LS 1.3	3.0*	\$4.3 M*
<u># 3</u> T-A (24 Mo)P.V.	0.5 0.8	0.5	1.0 1.4
May 72 <u>Laun</u> TOTA	<u>ch 0.0</u> LS 1.3	<u>4.5</u> 5.6	<u>4.5</u> \$6.9 M
* Add \$2.0M NOTE- Based	l if Progr on appro	am 846 c val by l	anceled CY7 May 1970 Dandle Via
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	COMPARISON OF	CONCEPTS FOR MIS	SSION 7107
	ACCELERATED		APPROVED
1.	18 Months	SCHEDULE	30 Months
2.	FOUR PRIME ONE R & D 250 lbs. Multiface	SPACECRAFT Weight Shape	FOUR PRIME ONE R & D 365 lbs. Cylindrical
3.	As 710 6 G	RAVITY GRADIENT STABILIZATION	As 710 6
4.	Improved 7106	Command System	Stored Command

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Fred approve of this I.f. you and type of approach I will develope the cover Letter gout Line y clean up the approach, etc. I feel this is the right type of approach isf; Ohistorical pattern, Ocurrent situation, Specific recommendation QOUER-all plan, and Da summary. Ilcould have compared ... the different approaches, other systems, etc. but, I didn't seel it would be positive. Any comments or supportions are appreciated. The impact of this will be better when it is neat preter but, I think it is better to get comments and suggests. first. Any suggestions or recommendations are appreciated. Handle Via BYEMAN. Control system only

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Jop Secret This proposal submitted by the Director of of Program "C" is to enhance the overall field processing capability of Poppy Program. This is done to meet heavy Wational demends Ser rapid tactical reporting for Air Force SAM systems, Naval Sea Surveilance, Army's Operational field support and The National ABM systems. This is put forth as a consolidated proposal to meet all requests regardless storigin by one single highly efficient system. The overall field processing is improved by adding more computer power where the stations are computer limited and by transferring the small computers now in existing to the surelog sites of the portions of the world. which are now only lightly covered. Bandle Via BYEMAN control septem only 100 Secri FRA FRA

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I. HISTORICAL SUMMARY:

Briefly, the basic concept of POPPY was first concieved at NRL by R.D. MAYO in the fall of 1958 and was born on JUNE 22, 1960 and still continues as a broad band omni-directional main-beam radar intercept system, transponding data directly to multiple collection ground stations around the Sino-Soviet Bloc. There were three successful launches and operations prior to the formation of the National Reconnaissance Office and there have been five successful launches since. The program is multiple agency, multiple service and is organized as is shown on Figure 1. The NRO program budget to NRL is approximately \$6M\$ to \$8M\$per year for all technical phases, such as building and maintaining the satellites,the ground stations, technical studies, etc. The operations costs of NSG anddata processing costs of NSA are budgetted under the CCP and the booster costsare borne directly under the NRO. The satellites fly in a circular 500 NMorbit with a 70° inclination, and the ground stations are located as shown $in the <math>.PL_{0}7 = 1$

Radar intercept history --- POPPY has documented proof of intercepting almost every type of radar signal from the hugh ABM radars down, to the SAM radars and even to the little airborne tail warning radar like the

intercepts is given in Figure 2. The collection is basically designed around "Magnitron Families" and the sensitivities and bandwidths are established to optimize full main-beam collection capability, realizable processing densities and the avoidance of interference such as T.V. POPPY does not collect against IFF Systems, communications systems, etc. The spectrum coverage of current

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A complete list of radar

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Missions 7105 and 7106 are given in Figures 3 and 4.

II. GROWTH OF THE PROCESSING:

1. The early historic processing started as a joint NSA/NRL effort. In the early missions each and every pulse and scan was identified and associated to an emitter. This was done at either NRL or NSA. This early analysis consisted entirely of searching for and identifying unknown radars. Most of the routine Early Warning, Height Finders and other common radar were first heard in space by POPPY.

1. Starting in 1964 the overseas ground stations were equipped by NRL with Quality Control and Limited manual analysis facilities. POPPY's direct transponding and field station capability for recognition of signals of interest (SOI) provided short response time in recognizing and alerting the intelligence community to these important national signals. The first space borne intercepts of the Soviet ABM system such as

as well as many other high interest signals yeld were all recognized by these manual analysis facilities.

The alert aspects of this capability have been able to provide a very quick "tip Off" on ABM activity. For example, when operating under the DEFSMAC ALERT system, in Oct 1968, the following responses to the Nations Highest priority ABM signals were provided Figure \leq . These and other alerts have been provided when requested,

(These times could be improved even

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more as there were some very poor arrangements at the station for these alerts,

such as having the communications facility in another building, etc.

III. LOCATIONS TECHNIQUES:

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1. The first techniques used in POPPY were the changes in scan rate due to the relative movement of the radar and the spacecraft. The most significant result of this was observing the buildup of the ______ and other similar radar along the Chinese-Tibet border prior to the invasion and take over of Tibet.

2. The first capability for precise locations came from Dr. Dick GAVIN of the President's Scientific Advisory Committee in a recommendation to NSA to use the overlapping bands of two satellites 7103A and 7103B as an "Inverse LORAN" hyperbolic location system. This was first tested in May 1964 using data collected from the NRL field station at Hyblevalley, Virginia on a radar in Cuba and is now the technique used to locate almost all radar received by POPPY. NSA has continued this technique to today, locating circularly scanning, stable PRI radar such as

radars. The⁴ computer processing is a batch processing concept which used an IBM-7094 until 1967 and since that time has used a CDC twin 6400 and a CDC 6600 configuration with each of the three big central processors surrounded by 12 smaller satellite computers. This operation is supported by a large staff of professional programmers and engineers.

IV. OVERSEAS PROCESSING:

1. In 1965, L. HAMMARSTROM working at NRL conceived that a small computer supported by enlisted personnel might be able to also perform locations to further enhance the Quick response aspects of the field analysis. In the fall

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of 1965 NRL set up in a simple system of counters and data process to the point up to running the final printers and This data was then location solution were sent back via teletype, to NSA. NSA then ran a solution on this and the results were published within 24 hours showing the first possibilities of the quick response time of the field processing. Work continued at NRL until 1966 when the PSAC declared the unknowns of the Soviet ABM system as the Nations highest intelligence priority and demanded that all the ELINT There was a systems be considered for defining the Soviet ABM systems. A tremendous amount intelligence co of activity and recommendations were made by all aspects of the government. H. O. LORENZEN, the Technical Director of the POPPY Program since the inception, went forth to the highest officials who were studying the problem with a twopronged recommendation for POPPY's spacecraft and ground station enhancement to try to solve this national crisis. This proposal was to augment the POPPY 7105 spacecraft (which was due to be launched in about 4 months) with a location capability in all the possible ABM bands as then defined and to provide the overseas ground stations with a quick reaction location system. After intensive debate this proposal was approved for immediate action, as well as later proposals including systems such as #711. The POPPY's highly successful recognition and definition of the Soviet ABM System from this is history. A brief POPPY ABM summary is shown in Figure • The initial SEL-810A Computer used was deployed in a period of 4 months in 1967, was a delicate system which initially handicapped by being a mini computer. (See various articles on the challenge of programming mini computers) The initial objectives were⁷ methowever, and a summary briefing on the results was presented to the Director NRO and staff.

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SOCI A few of these initial locations were $\frac{1}{2}$ rate near the SA-5 site at Kostroma and the SA-1 located at Kapustin Yar. In the ensuing years the soft ware was developed both by NRL and at the overseas field site under a is now developed to the point where The Poppy Progra very capable LT R. POTTS. The system using only enlisted talent now can locate and process any type of complex radar and is only limited by processing depth in the quantity output. 1 For one station alone The current weekly average number of locations is about 50. This number varies according to the type of radars. For example, between 150-200 can be located in a week, while only 15-20 complex unknowns can be located in a week. The total list of all radars which have been located by is listed on Chart # 2 which Almost all radars are intercepted (not IFF or similar systesm) and can be located. In terms of Weapons Systems the outstanding role against the ABM system in detecting, locating and alerting the intelligence community is well known. The success against the Soviet War Ships is again, well known and several plots are shown on Chart #J+4 which illustrate the tactical tracking capability. The locations of early warning radar have been covered in many reports. A few of these radar are listed to show the broad spectrum coverage.. The surface-to-air systems are listed in Figure 3 There is a demonstrated capability against all of the above radars and shart within the bulk of these radar do not need to be located within a time period blandle Via B-1Emán control suptem only Approved for Release: 2024/06/11 C05025527

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of hours and those which have stable characteristics (circular scan and steady <u>which this proposed uddresses</u> PRF) can be located by NSA. The severe National problem? comes when those high priority emitters field processing requests are compared against the processing capability of the almost "Desk Top" SEL-810A computer which, as previously mentioned, has a current average capability of 50 locations per week. The following is the list of the processing priorities teasked on _______as of 13 April 1970:

* 1. UNIDENTIFIED SIGNALS.

In one week's collection any one of the priority signals listed with an * asterisk can almost overload the total capability for the SEL-810A. This is without

processing any of the other radar which are listed on the previous charts. For The National tasking message which established these new priorities which commented

1 = t- tions, n Lack of adequate processing capability at

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Himitations. Over the last 2 monts very few of the hundreds of priority 9, 10, 11, and 12 radar have been located; again due to the small computer limitations. Remember again we are only concerned with the highest priority national requirements which are not being met. Of the estimated 5 to 10 thousand Sino Soviet radar which POPPY collects per week, it is only a small percentage which fall.

into this highest priority category. Other of the high National interest which should be field processed due to the missile and Tip-off polo are ship wheel Wither aspects, are that due to the NSA limitation in making A to D conversions

(Other aspects, are that due to the NSA limitation in making A to D conversions idens of the multile intermediate to the intermediate providence of the making can not be such that

> any more than four of the eight possible collection-bands can be tasked at one time. This restricts the overall collection by the spacecraft to less than 50% of its capability and more seriously limits the RF band combination in looking for different radar working in cooperation. The analog ground stations is currently analog, but funding has been approved

and the computer system will be installed within a few months.

To be able to process all of the high priority signals received in a week, about six to ten times the present SEL-810A basic computer power is needed. There exists many computers in the medium computer category which have more than that processing capability over the existing computer. A few of these are the Sigma 5, the 360-44, System 86, etc. After studying all of the factors and reviewing tests on the different medium scale computers, the POPPY Program is pleased to come forth with a specific proposal to enhance the POPPY field processing to meet the National high priority field processing requirements for SAM's, Sea Surveillance, ABM, etc.

The specific recommendation is an SEL-System 86. The technical details on

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the facts behind this specific selection are quite involved. The strengest weight was attached to the Input/Output design due to the very high τ_{ii} , data rates on this system where over one million pulses may be collected in a period of about 15 minutes. The overall improvement over the existing computer system are tabulated below:

CHARACTERISTIC	EXISTING SYSTEM	SEL SYSTEM 86	Improvement
Word Size	16 bits	32 bit	2 X
Cycle Time	1.86/usec	0.6 /usec	3 X
Input/Output Structure	250,000 Words/sec	l.6 million words/	sec 2X
Memory Access	Cycle stealing	Without cycle stealing	1.5 X
Instructions	limited	powerful	1.5 X
Memory	l6K not directly accessable	64K all direct access	2 X .

The initial improvement is processing power is from 30 to 40 times that which exists today. This will more than handle today's priority list and will allow other radar of high interest particularily in times of crisis to be

processed, such as the SAM systems,

radar, etc. This is a very significant step to having the processing power available to meet the National needs in time of crisis. The intent of this system is not to process all emitters which is NSA's responsibility, but rather to process that high priority 10 to 15% which must be done within minutes or hours, because

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	Jop Slott
1	The specific plan is to buy two computers immediately, the first a
	domestic computer system to be used to convert the software and to support
	the overseas systems and the second system for deployment to the most severely
	limited station The SEL 810-A Computer in
•	would then be shipped to which currently
	only has an analog capability.
•	The cost of this proposal is as follows:
, , , , , , , ,	2 Computer systems
	INITIAL COST FOR NEW COMPUTER IN B1.670 K
	(Jan 1971) The second phase would be to up-grade the computer in the site in
	the to a new computer system and to deploy the present
	SEL 810-A to the site at
	COST FOR THIS ADDITION AND EXCHANGE OF COMPUTER:
	<pre>l Computer system</pre>
	1:0 7
	ى يېزې دې وې
	COST OF BUYING & DEPLOYING & DOLL COMPUTED ON THE CONTRACT OF BUYING & DEPLOYING & DOLL COMPUTED OF THE CONTRACT OF THE CONTRACT.
	and installing the older system in site
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A third step which should be taken at the same time as number 2, but, which is policically very involved, would be to up-grade the limited collection operation in ______ to include both an analog S.O.I. processing as well as a digital processing capability. Due to the politics involved, it might be best to move this operation from ______ where the supporting man-power is severely limited, to another location in either central or The excellent coverage of the tense middle east and of the

SARY SHAGAN areas make it very desirable to have a computerized location capability in this general area. This station would be much more automated to reduce site manpower requirements to the minimum, (6 men). This site would have a reduced processing capability to handle only those high interest signals unique to this station.

COST FOR Computerized system:

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COST for		· · · ·
l Computer system	**************************************) K
	\$ 1,365	K

In addition to the initial costs there are also support costs at NRL for training, spares, technical feedback, field evaluation, new software for new emitters and other overhead costs. These are as follows:

	1970	0	۰	۰	ò	•	•	0	•	۰	•	•	•	•	٥	•0	•	•	\$170	K
	1971	o	o	0	۰	0	0	•	0	•	•	•	•	o	۰.	•	•	•	190	К
	1972	۰	۰	•	٥	•	•	•	•	٥.	•	•	0-	0	•	•	•	•	215	K
	1973	•	o	0	•	•	•	•	۰.	•	•	•	0	•	o	٥	0	° =	230	K
ŋ	TOTAL	СС)SJ	rs	FC	R	FJ	IVE	C Y	(EA	RS	5.						, ,	•	

<u>1970</u>	1971	<u>1972</u>	1973
1840 K	3360 К	200 K	220 к

\$5,620 K

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The specific implementation of this proposal will previde greatly added computer power at those processing limited stations and the computers which are $e_{xi}(t)$,, currently at these stations will be installed in the analog stations and in areas where there currently is very light coverage. This will then allow: (1) full tasking of the spacecraft (over a two times improvement), (2) provide a high priority POPPY location capability over all the areas of National interest, (3) provide NSA with all digital tapes to remove the Audico analog to digital conversion system as well as greatly reduce the number of tapes required in the system, (4) In addition, this will permit much more of the Mission features on the next launch (mission 7107) to be used over all the areas of the National concern, some of the features are power measurements, polarizat on measurements, pulse width measurements, etc.

The manpower requirements for the stations with the new computer systems will initally remain the same as with the SEL-810A station requirements. However, as many of the routine manual operations are replaced by the new computer system, new spacecraft, and other changes to a parallel operation, the manpower requirements will be reduced.

Last improvement will be the much quicker response times for locating those critical emitters such as warships in the eastern Mediterranean Sea, or the SA-4'ss in crisis time like the Czechslovakian invasion. This response time will be cut from a time of 4 hours to about 30 minutes or less.

Two final points, the first is concerning the capabilities of other programs to undertake the effort. No other program has even begun to <u>demonstrate</u> the type of capability POPPY has had for over **2** years. The future systems which may be able to provide some of the capabilities are not working yet and are much more expensive than the POPPY approach.

The second is that in the ten years from being the Nation's first successful *the jell the technical challened the highly successful Program of today* ELINT program, the successful program of today to POPPY has not incurred any cost overruns or had to go in for additional funding. In addition, almost all of the mission objectives have been met or exceeded. (A summary, report on Mission 7105 *A Mull Mull*

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is being prepared by a SORS subcommittee which will cover these aspects)....

In summary, the proposal will be a logical step in the POPPY system growth. It will much more closely match the spacecraft collection capabilities, the National high priority signal locations and the computer processing capabilities. In addition, all the ground stations will be computerized and those areas which are not now adequately covered will be much more

completely covered.