EVALUATION OF MISSION 7106

R&D SATELLITE, PAYLOAD 176

INTRODUCTION

BYEMAN CONTROL SYSTEM ONLY

Mission 7106 was launched on 30 September 1969 and included in this launch in addition to the four primary spacecraft was the first R&D spacecraft used in the Program "C". The design features of this spacecraft fall into two distinct areas. The extension and advancement of the engineering systems of the Program "C" effort, and the major justification for the spacecraft, the advanced ELINT systems. As a result of the R&D satellite, Payload 176, major new systems were developed and valuable experience was gained with these new systems. Valuable experience was also gained with advanced modified versions of standard Program "C" systems.

BYEMAN CONTROL SYSTEM ONLY

ADVANCED SATELLITE SYSTEMS

Electronic Packaging

A unique modular packaging technique was introduced in Payload 176. A family of modular packages was developed using standard end rails and varying length top and sides. The engineering design is non-recurring and the package can be utilized for practically any NRL satellite electronics requirement. The design will mean a considerable savings in both size of subsystems and in the time required to complete the system since the package design is complete and the parts can be fabricated in advance.

In addition to the mechanical package, the system used a modular construction technique consisting of thick film hybrid, integrated and discrete component (1.2" x .6") modules interconnected on a two sided printed circuit motherboard. All module lead terminations are interconnected through the use of bifurcated terminals. The terminals are swaged and soldered into plated thru holes in the motherboard, and spaced 0.10 inch on centers. The module leads are inserted through 0.025 inch clearance holes, bent at the prescribed radius and soldered to the terminals on the opposite side of the board. The interconnections are accessible and provide the key to module serviceability. The proper use of the miniature terminals effectively gives a third level of interconnect to a two side board. The technique provides an excellent compromise between size and serviceability.

The packaging designs will result in a 4 to 1 reduction in the size of command, control, telemetry and video processing equipment flown on the Mission 7106 primary spacecraft and future NRL spacecraft.

Data Link Modulator Design

An area in past payloads where considerable time has been spent has been in the flight qualifying of threshold detectors and down link transponder timing circuitry. Requirements of wide temperature and voltage variations had to be met.

A new ELINT Data Link modulator-threshold detector circuit was designed and developed for Payload 176. The design performance variation in pulse-width is no greater that 0.5% over a temperature range of 100°C and 30% variation in supply voltage. The design does not use voltage regulators or temperature compensation. The size is small and the stand-by power is low.

Because of the reduction in size and the ease in flight qualifying the circuitry, it will be used redundantly in the Mission 7107 primary payloads. This particular circuitry is a crucial link in the data chain of all NRL spacecraft; therefore this redundant failsafe circuitry will be used in all 7107 spacecraft.

PAM TM

The 176 PAM TM system's multiplexers were a flight prototype of units to be flown on Mission 7107 payloads using the new packaging technique and resulting in a considerable savings in size.

Command System

The 176 command system was a different design from units flown in the primary payloads. Certain critical circuits vital to successful operation had been redesigned using quad redundant techniques. Portions of the Payload 176 command system are being incorporated into the design of units to be flown on the 7107 series.

Digital Encoder

A low power, video pulse encoder was developed for use with the frequency measurement system on Payload 176. The unit was used in a comparison of pulse width modulation versus pulse code modulation on the down link transmission. The experiment provided a means for measuring data quality through the entire data processing link.

ADVANCED ELINT SYSTEMS

Frequency Measurement System

This system was designed to meet the USIB requirements to accurately measure RF frequency of intercepted radars. The system consisted of two special purpose crystal-video receivers that were capable of automatic and unattended frequency measurement of pulsed UHF signals. Specifically the frequency ranges covered were 820 MHz-920 MHz and 365 MHz-435 MHz. Frequency measurements were made on a monopulse basis, to allow operation in a multi-emitter environment. These receivers measure the frequency of any pulse signal which (1) falls within its frequency band, (2) has an amplitude within its dynamic range, (3) has a minimum pulse width of 0.5 μs, and (4) has a maximum rise time of 1 μs. The coded output of the receivers was transponded to the POPPY ground station utilizing

This system clearly demonstrated that the techniques used will give excellent frequency measuring capability to this program without departing from the basic concepts of Program "C".

Video Amplifier and Thresholding Technique Comparison

This package was designed to evaluate the errors contributed to the total system error by the thresholding techniques used in the satellite. The package consisted of two types of video amplifiers and two types of thresholding schemes. There was a linear video amplifier, a log video amplifier, a 50% thresholder, and a fixed thresholder. The experimental package was designed to allow the comparison of the 50% thresholder to the fixed thresholder using the same type of receiver and video amplifier now being employed in the primary payloads. In addition it allowed the comparison of the two types of video amplifiers using either one of the two thresholding schemes.

The following observations were noted during an evaluation of this system.

1. Arrival times via the 50% thresholder lagged the fixed thresholder arrival times by approximately 9.5 μs. This represents the delay inherent in the design of the dynamic thresholder.

2. Arrival times via the logarithmic amplifier appear to lead those via the linear amplifier by approximately .1 to .4 μs.

3. The narrow distributions of arrival times indicate little, if any, fluctuations caused by varying signal strength.

This experiment renewed confidence in the video amplifiers and thresholding techniques being used in the primary satellites. It demonstrated that under normal signal conditions the video amplifiers and thresholders now being used contribute no significant errors to the system. This is attributed to the very fast rise times of the incoming radar pulses. The difference in measurement between a fixed thresholder and a 50% thresholder will not exceed one half the rise time of the incoming pulse. For most radar pulses this is less than 50 ηs. However, for radars demonstrating slow rise time the 50% thresholder could be of value in the satellite.

[redacted] Recognizer

This system consisted of a very high sensitivity receiver directed specifically against the narrow portion of the spectrum containing [redacted] radars. Its purpose was threefold. To be capable of intercepting side lobes as well as make

main beam intercepts. [redacted] The system also contained a logic package that would recognize [redacted] radars only and transpond a pulse when one is recognized.

1. The high sensitivity receiver portion transponded data normally.

2. The portion of the experiment to measure the [redacted] radars were intercepted during the evaluation period.

3. The recognizer portion of the experiment malfunction due to apparent thresholding problems.

No conclusions are available on this experiment at this time.

CONCLUSION RECOMMENDATION

The concept of utilizing extra space and weight capability on the Program C launch vehicles for R&D was first implemented on Mission 7106. Although the time available for planning and implementation was short and the space available was limited to the smaller aft rack, a number of important advanced concepts were investigated in the flight environment. This type of effort is essential to realistic advanced planning, and NRL intends to persue an expanded effort along these lines in the future. A memo describing alternatives available for the fifth spacecraft in Mission 7107 is being prepared and will shortly be forwarded to the program office.

8-28-70

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CHOP LINE

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Op-092BA

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HANDLE VIA BYEMAN CONTROL SYSTEMS

FROM: COMNAVINT
TO: CINCUSNAVEUR

~~TOP SECRET~~ BBBBB ~~EARPOP~~ BYEMAN CHANNELS ONLY

HATCH PERSONAL FOR

A. CINCUSNAVEUR 2615482 AUG 70
B. SSO USEUCOM 251320Z AUG 70

1. APPRECIATE YOUR THOUGHTS ON SUBJECT OF TASKING POPPY FOR YOUR SPECIFIC OCEAN SURVEILLANCE TARGETS. AS YOU ARE AWARE, OCEAN SURVEILLANCE HAS BEEN ACCEPTED THROUGHOUT COMMUNITY AS UNIQUE REQUIREMENT BOTH IN TERMS OF DURATION AND APPLICABILITY OF AVAILABLE ASSETS. BASED ON NATURE OF REQUIREMENT, AND ON AUTHORITY RECEIVED FROM USIB FOR PERMANENT TASKING OF POPPY MSNS 7105/7106, PROCEDURES BY WHICH FLEET COMMANDERS NOTIFY FIELD STATIONS OF HIGH PRIORITY TARGETS HAS RECEIVED GENERAL ACCEPTANCE BY DIA. INFORMAL LIAISON WITH (DIAXX) INDICATES THAT EUCOM SUPPORTS DIRECT TASKING OF FIELD SITES FOR HIGH PRIORITY OCEAN SURVEILLANCE TARGETS.

2. I DO NOT NEED TO TELL YOU THAT AUTHORITY FOR TASKING OF OVERHEAD ASSETS IN SUPPORT OF TACTICAL COMMANDERS HAS BEEN HARD FOUGHT BATTLE, AND THAT THIS BATTLE HAS NOT YET BEEN WON. WHILE DIRECT TASKING OF POPPY HAS CONTRIBUTED TO THE IMMEDIATE REQUIREMENT OF THE FLEET COMMANDER, THIS SYSTEM DOES NOT HAVE THE CAPABILITY TO FULFILL THE TOTAL LONG TERM OCEAN SURVEILLANCE REQUIREMENT, OR THE TOTAL REQUIREMENT FOR TACTICAL SUPPORT TO THEATER COMMANDERS. ON THE OTHER HAND, THERE ARE OTHER SYSTEMS, SUCH AS TRIPOS SOUSA, STRAWMAN, WHICH HAVE TREMENDOUS UNTAPPED POTENTIAL FOR PROVIDING TACTICAL SUPPORT ACROSS THE BOARD. AT THE PRESENT, THESE TACTICAL REQUIREMENTS DO NOT GENERALLY RECEIVE HIGH PRIORITY AT USIB, ESPECIALLY IF THEY TEND TO BE PERMANENT IN NATURE, OR OF SUCH MAGNITUDE THAT THEY INTERFERE WITH HIGH PRIORITY USIB TARGETS. AT THE SAME TIME, PRESSURES ARE

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BEING BROUGHT TO BEAR TO REDUCE THE ASSETS OF THE THEATER COMMANDER BELOW [redacted] UM LEVEL NEEDED FOR PROSECUTION OF [redacted] NALE BEING GIVEN FOR REDUCTION OF TACTICAL ASSETS [redacted] NATIONAL ASSETS CAN MEET THE REQUIREMENTS OF THE THEATER COMMANDER.

~~TOP SECRET~~

3. IT APPEARS THAT DIA AND THE OTHER SERVICES ARE JOINING THE NAVY IN ATTEMPTING TO REALIGN THE PRIORITY OF TASKING OF NATIONAL ASSETS, AND ESPECIALLY THE PROCESSING OF THE INTERCEPTED DATA, TO CONFORM TO THE MOST PRESSING PROBLEMS; IE, THE TACTICAL REQUIREMENTS OF THE U&S COMMANDS AND THEIR SUBORDINATES. IN ORDER TO DETERMINE THE MAGNITUDE OF THE REQUIREMENT, AND THE ABILITY OF ALL APPLICABLE SIGINT SATELLITE SYSTEMS TO RESPOND TO THE REQUIREMENT, REF B IS INVALUABLE. IN THE LONG RUN, IT APPEARS DESIGNED TO FURTHER THE NAVY'S OCEAN SURVEILLANCE REQUIREMENTS. IN THAT REGARD, I INTEND TO ACTIVELY SUPPORT DIA AT USIB DELIBERATIONS WITH RESPECT TO THIS REQUIREMENT.

4. IN ORDER TO ASSURE THAT COMSIXTHFLT REQUIREMENTS ARE NOT SUBJUGATED TO LESSER PRIORITY REQUIREMENTS, BELIEVE THAT CLOSE LIAISON MUST BE MAINTAINED WITH RADM MAROCCHI AND [redacted] TO ENSURE THAT ANY USEUCOM REQUIREMENT FOR SIGINT SATELLITE SUPPORT CONTAINS LISTING OF THE HIGHEST PRIORITY TARGETS OF THE FLEET COMMANDER, WITHOUT REGARD TO THE SPECIFICITY OF THE U&S REQUIREMENT. IN THAT MANNER, WE CAN ASSURE A MINIMUM LEVEL OF HIGH PRIORITY SUPPORT TO COMSIXTHFLT REGARDLESS OF THE MAGNITUDE OF THE EFFORT REQUIRED TO SATISFY SHORT TERM USEUCOM REQUIREMENTS.

5. IN SUMMARY, DESIRE TO CONTINUE PROCEDURES FOR DIRECT TASKING OF FIELD SITES DURING NORMAL OPERATIONS. IF UNIFIED COMMANDER HAS SHORT TERM, INCLUSIVE REQUIREMENT FOR MAJOR SUPPORT BY ALL SIGINT SATELLITE SYSTEMS, DESIRE THAT HIGHEST PRIORITY FLEET REQUIREMENTS ARE CONTAINED IN UNIFIED COMMANDER'S STATEMENT IN ORDER TO ENSURE UNINTERRUPTED SUPPORT TO FLEET COMMANDERS. IF YOU AGREE I BELIEVE WE SHOULD TAKE THIS OUT OF PERSONAL CHANNELS.

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A / ~~TOP SECRET~~ [redacted] 26 Aug '70

4C1000

cdr Dick Kiefer [redacted]

Ed Zara

Add { Tony

~~30 sorties per~~

use again on platform

(Same freq, Pulse w, PRF)

small field of view, data density less

fewer PRF ambiguities

TOA advant.

Less interference

stability not critical

ant config. not critical

less overall hardware

277 nm alt.

82° incl ≈ 75' / 1° day

match precession of [redacted]

Identical line of nodes to one [redacted] which

40° N to 75° N

Freq. scan in sync with [redacted]

single pulse location

[redacted] sorting easier

1 MBit data rate, ant steering req'd, xmit to [redacted]

data privacy req'd. 2.3 GHz

6' dish

10 watts xmit pwr.

Low alt - no interest

[redacted] up before augmentation

1 MBit
40 Bit word.
25,000 pulse/sec max

KGT/28 [redacted] ant follows bird in low alt. pass.

Coarse location in single pulse

18 to 36 days to provide complete coverage

~~TOP SECRET~~ [redacted] 95% conf - 1-3 miles

1 μs std error Rms

10-30 m

2 birds

Talent-Keyhole

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A/L —

[redacted]

516 – MY-2-762

516 – 595 – 4230

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CONTROL SYSTEMS

SYSTEM CONCEPT

- O ESTABLISH LINK TO CONUS FROM LOW ALTITUDE PLATFORM VIA HIGH ALTITUDE PLATFORM.
- O USE LOW COST EXISTING TECHNOLOGY & SYSTEMS.
- O 3-AXIS STABLE PLATFORM WITH POINTING CAPABILITY FOR MISSION FLEXIBILITY.
- O EXPAND PRESENT MISSION CAPABILITIES & PERFORM COMPLEMENTARY FUNCTIONS.

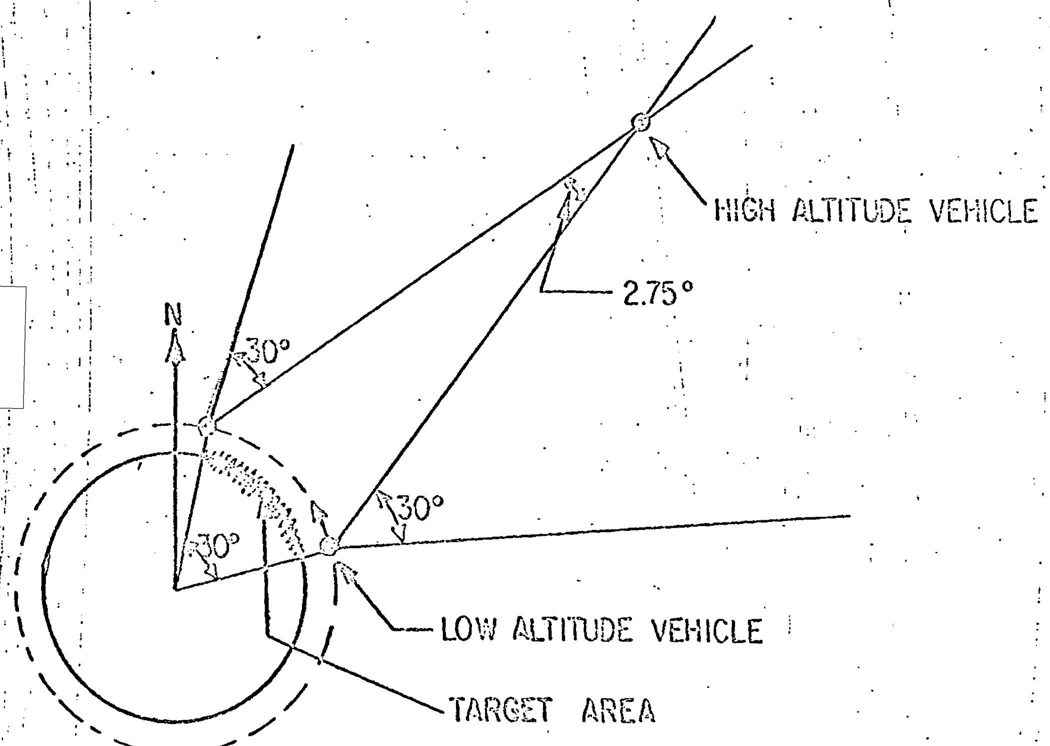
TOP SECRET [redacted]

TOP SECRET [redacted]

~~TOP SECRET~~

DATA LINK ANTENNA REQUIREMENTS

- O WITH STATIONARY ANTENNA, 30° BEAMWIDTH NEEDED ON LOW ALTITUDE VEHICLE.
- O HIGH ALTITUDE VEHICLE BEAMWIDTH $\geq 2 \times 2.75° = 5.5°$



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DATA LINK CALCULATIONS

XMIT. ANT. BW = 30°	GAIN =	15 db	(55 % EFF.)
RCVR. ANT. BW = 7°	GAIN =	27 db	(50 % EFF.)
	TOTAL GAIN =	42 db	

FOR 13 FT. DISH RCVR, FREQ = 760 MHZ

XMIT. POWER (10 WATTS)	= + 40 dbm
ANTENNA GAINS	42 db
	+ 82 dbm
FREE SPACE ATTEN. (760 MHZ)	− 180 db
NET RCVD. SIG.	− 98 dbm

KTB NOISE (1 MHZ)	− 114 dbm
NOISE FIGURE	4 db (Transistor)
	− 110 dbm
SIGNAL	− 98 dbm
S/N	12 db
FM IMPROVEMENT	4 db
OUTPUT S/N	16 db

∴ 1 MB/S DIGITAL LINK FEASIBLE

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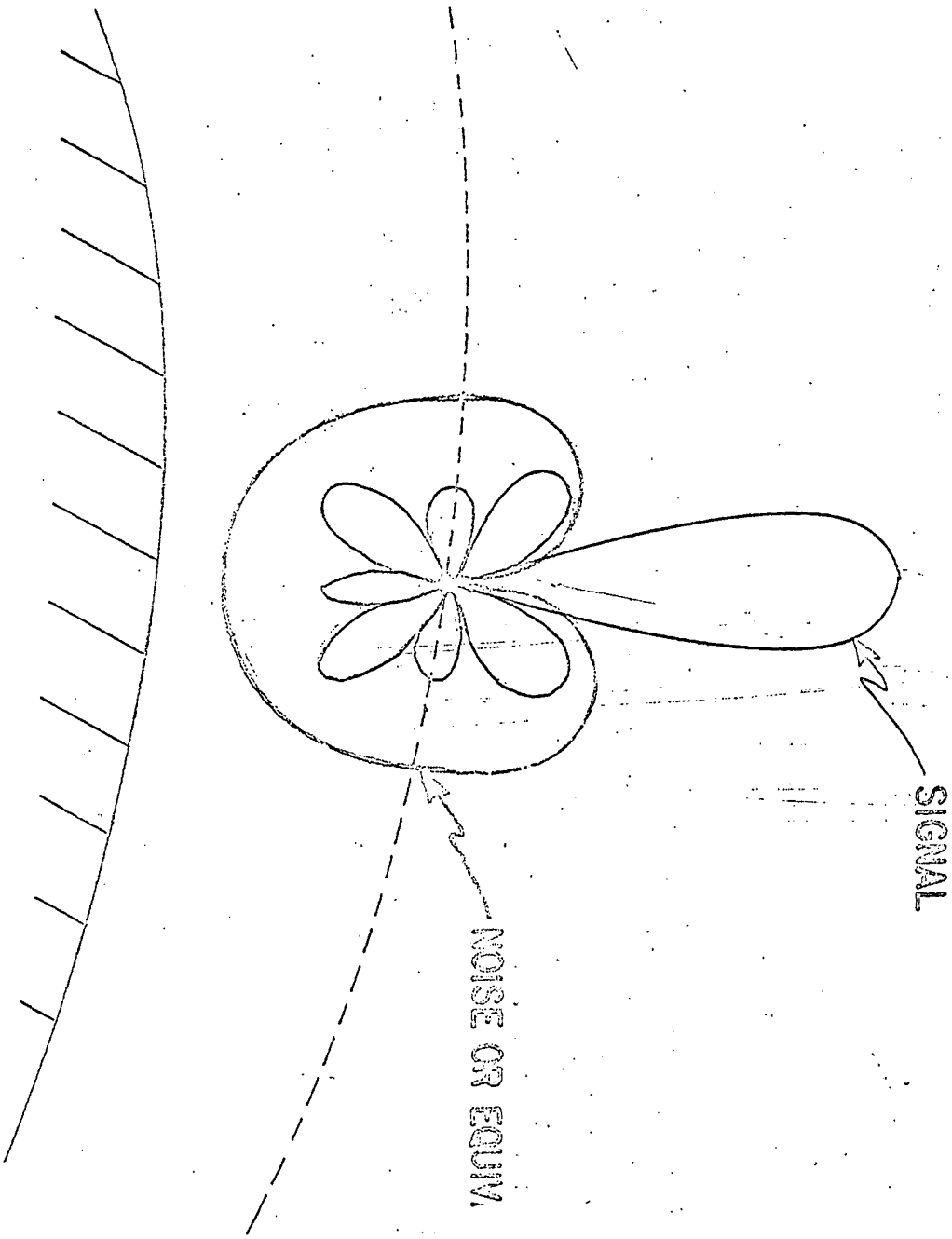
DATA LINK PRIVACY TECHNIQUE



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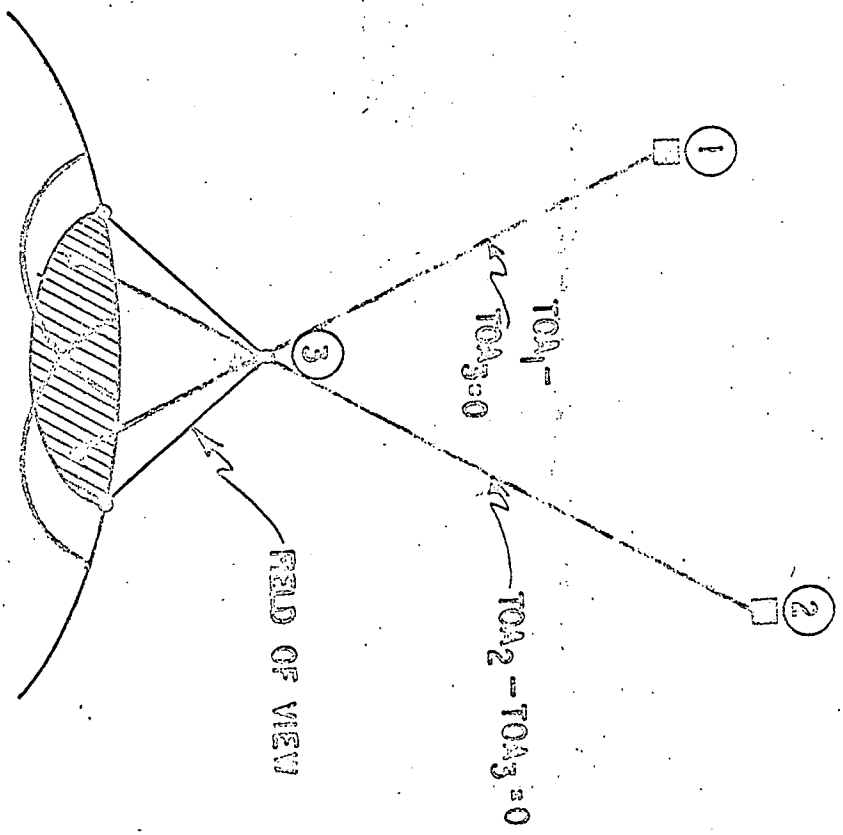
USE OF LOW ALTITUDE VEHICLE IN H.A. SYSTEM

- PRE-SORT EOB DATA TO LOW ALTITUDE FIELD-OF-VIEW.
- SINGLE PULSE LOCATION VIA 3 VEHICLE TOA.
- MAIN BEAM INTERCEPT FOR TI
- HIGH SENSITIVITY INTERCEPT

TOP SECRET

FOR LOCATION & SORT AID



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Talent-Keyhole
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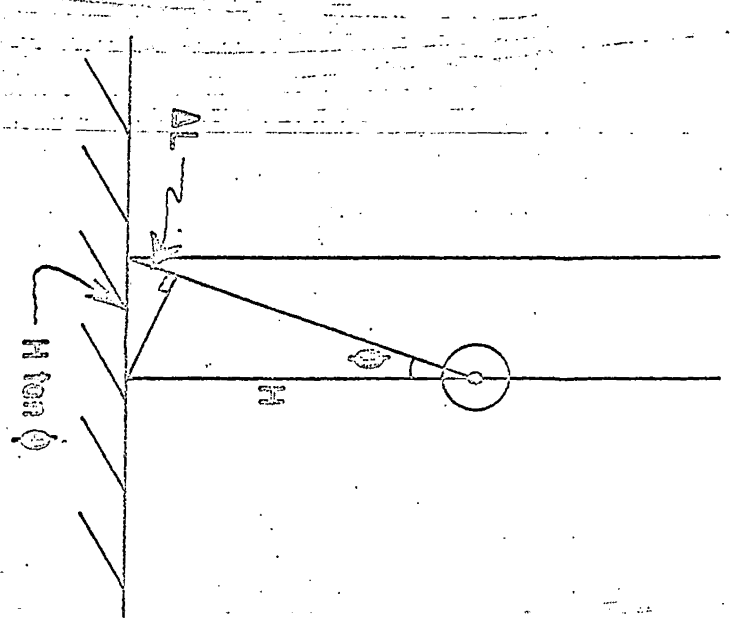
TOA LOCATION RESOLUTION



FOR ϕ SMALL

$\Delta L \approx \frac{1}{2}(H\cos\phi)\sin\phi\,\Delta\phi^2$

FOR $\Delta TOA = 1\,\mu sec$, $\Delta\phi \approx 1.4°$

$\Delta L = \frac{1}{8}$ N.MI.

$\Rightarrow$ 6.8 N.MI. SINGLE PULSE

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OTHER MISSION POSSIBILITIES

0 HIGH BAND EOB & TI (MATRIX)

0 SENSITIVE SEARCH & TI

0 COMM. LINK SAMPLING & MAPPING

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VEHICLE TRADE OFFS

- AGENA —— TAT BOOST
- P-69x —— P-95 PIGGY-BACK
- —— ATLAS BOOST

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HANDLE VIA Talent-Keyhole
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CONTROL SYSTEM

SYSTEM TRADEOFFS

- O LINK BANDWIDTH
  - INCREASE XMIT POWER
  - USE XMIT ARRAY FOR HIGHER GAIN
  - DATA RELAY AT RGS
- O USE OF PRE-D
- O COMMAND & CONTROL — REAL TIME vs STORED
- O DATA STORAGE FOR WORLD-WIDE TARGETTING

DCK
24 Aug '70

~~SECRET~~ [redacted] Schedules

1. Overall schedule
   07, A, B, C, D & R+D

2. Separate schedules.
   a. 07 A
   b. 07 B
   c. 07 C
   d. 07 D
   e. 07 R+D

3. Subsystem schedules.
   a. Command.
   b. Telemetry
   c. Structure
   e. Power supply
   f. Stabalization & Control
   g. RF
   h. Collection bands
   i. Collection antennas

4. Site schedules
   a. [redacted]
   b.
   c.

~~SECRET~~ [redacted]

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DIX
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5. Priority Date ~~Boo~~ Extractor

6. SEL System 810A
   a. Hardware
   b. Software
7. SEL System 86
   a. Hardware
   b. Software
8. Analog QC replate

9. Antenna pointing control

10. Command status display up-date

11. Digital Buffered Tape System

12.

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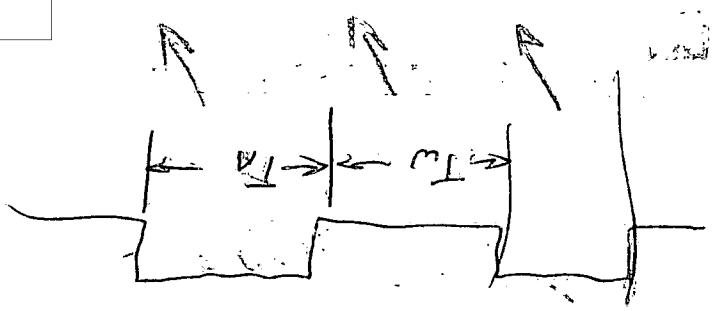
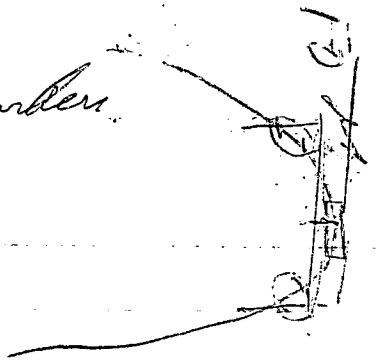


Lack of detailed schedule puts too much reliance on individual initiative. Some do not respond, creating very unequal work loads, and attendant morale problems.

Careful schedule control can provide the required sense of urgency needed to meet the promised launch date.

1. Better visibility for Supervisors
2. Daily goals for individual workers (Key supervisory req'd.)
3. Establish lead times



1) Managers of people
2) Technical managers
3) Specialists

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