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MISSION 7300 EVOLUTION

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EARLY ORIGINS

In the early 1960s [redacted] conducted numerous overhead SIGINT collection experiments from which Mission 7300 evolved. The first few were ABM search systems in the Agena aft rack on photo missions for the purpose of detecting Soviet tracking of the Agena starting with the 10 August 1960 launch of Discovery 13. Earlier, the first overhead ELINT mission was the United States Navy 22 June 1960 launch of a 42 pound single ball mainbeam collection system named SOLRAD-I. Subsequent launches evolved into the Mission 7100 POPPY program. 25X1

Several mission series developed from the Agena aft-rank black boxes which recorded radar skin tracking attempts and intercepted Soviet BMEW and other SIGINT emitters. Programs/missions derived from these early missions include:

- Mission 70XX/78XX—Skin tracking/attack verification packages
- Mission 72XX—The 770 program (STRAWMAN (THRESHER/REAPER, etc.))
- Mission 73XX—The spin stabilized P-11 series

The vulnerability monitoring function was one of the first separate mission series (Mission 70XX and later as Mission 78XX) which emerged from the Agena aft rack mission. Subsequent Agena experiments became Mission 7200 and were later named STRAWMAN.

The Mission 7300 low-orbit program developed from Agena aft-rack black boxes which recorded radar skin tracking attempts by other nations. The system intercepted Soviet HEN HOUSE and TALL KING radars, plus other SIGINT emitters, beginning in August 1960, with a total of 23 aft-rack payloads being flown. Early designs were driven by requirements to search for the TALL KING and HEN HOUSE emitters.

SEARCH REQUIREMENTS 1959

In the late 1950s, a radar on the [redacted] was observed coming through the APR-9 and APR-17 receivers in the RB-47s, independent of the frequency the microwave receiver was tuned to. After some investigation, it was determined that the signal was coming into the receiver IF which extends from 150 to 170 MHz. The radar was subsequently 25X1 identified to be a TALL KING which operates at a frequency near 170 MHz. This raised the question "how widely deployed are these TALL KING radars over the Soviet Union?".

During 1960, a receiver was built to pick up the TALL KING radar, count the number of pulses and estimate the number of emitters. An additional capability was a 100 to 500 MHz receiver which would potentially be capable of receiving signals from the large phased array radars which were subsequently to be known as HEN HOUSE. The receiving system, called TAKI, was built by Stanford University, delivered GFE to Lockheed and installed on an Agena aft rack, where they provided an antenna and commutator points for data readout. In this case and the several aft rack examples to follow, the mission requirements were very specific.

The requirement was to search for HEN HOUSE radars and measure the characteristics of radiated signals including frequency. The WILD BILL series was built at Stanford University. Two units were built covering the ranges of 50 to 150 MHz and 40 to 120 MHz. At this time, the POPPY series was providing coverage above 150 MHz for these potential signals. The situation was that the phased arrays had been observed in photography but no radiated signals had been received at the time of the WILD BILL designs.

25X1

MISSION 7300 SERIES 1963

To obtain longer orbit life, the spin stabilized P-11 vehicle was developed to be ejected from the Agena aft-rack. The 200 pound spin stabilized spacecraft was adopted by SAFSP as a longer life alternative to the built-in Agena aft-rack payloads and became Mission 7300. Mission 7301, PUNDIT-I, was a booster telemetry search system launched on 29 October 1963. This mission was terminated by re-entry on 23 May 1965.

From 7301 (PUNDIT-1) through 7349 (FARRAH IV), the 7300 Program had 49 approved SIGINT missions of which 48 were launched (7335 VAMPAN-II was cancelled).

Thirty-nine satellites were used and nine were dual mission launches. Of these 39, 36 provided useful SIGINT collection.

Table I is a list by launch date of early 7300 missions. The first missions were directed coverage parameter measurement systems with no geolocation capability. The six telemetry collection missions (7301, 2, 3, 9, 20, and 36) and an HF/VHF COMINT collection mission (7313) [redacted] The ABM radar search and directed coverage missions (7304, 5, 6, 10, 11, 12, 16, 21, 24, 30, and 31) [redacted] All but one of the remaining 29 missions were primarily SIGINT mapping systems. The exception was the 7339 MABELI ABM mainbeam TI mission (1/20/72), which was the last of the specific signal directed coverage missions. The earlier FANION missions, 7307, 17, and 19 were directed coverage [redacted] mappers. Subsequent single signal directed coverage has been handled by special purpose receivers on TOP HAT II for RUTLEY and add-on pallet payloads or by directed tasking of tunable receivers. 25X1

The initial 7300 orbit perigees were the photo booster apogees (150 to 180 nmi). The 7300 apogees were in the 180 to 300 nmi range. Starting with 7309, back-to-back spacecraft kick motors were needed to achieve nominal 275 nmi circular orbits. Tasking was usually terminated by failure of the spacecraft tape recorders but 7301 and 7305/06 re-entered still healthy. 7303 had a booster failure, and 7310/11 had a spacecraft short circuit at initial turn-on.

TELEMETRY MISSIONS

Six of the early 7300 payloads had requirements to copy Soviet telemetry (7301, 2, 3, 9, 20, and 36). PUNDIT demonstrated the first collection of USSR ICBM booster telemetry [redacted] The spacecraft is shown in Figure 1. The follow-on Mission 7320/36 SAVANT systems were expanded to cover discrete telemetry frequencies from 61 to 250 MHz and provide 1-MHz predetection recordings. [redacted] 3.3(b)(1) 25X1

Table I. Mission 7300 Launches

Mission	Date	Name	Frequency (MHz)	Target Signals	Life (mos)	
7301	10/29/63	PUNDIT-I	61, 66, 71, 76	[redacted]	18	25X1
7302	12/21/63	PUNDIT-II	61, 66, 71, 76	[redacted]	23	
7304	7/6/64	NOAHS ARK	1500–2500	ABM RADAR SEARCH	23	
7303	10/8/64	PUNDIT-III	61, 66, 71, 76	[redacted]	0	25X1
7305	10/23/64	STEP-13	60–70	[redacted]	4	
7306	10/23/64	PLYM. ROCK	500–1000	ABM SEARCH	4	
7309	4/28/65	PUNDIT-IV	61, 66, 71, 76	[redacted]	21	25X1
7307	6/25/65	FANION-I	4800–5200	[redacted]	22	
7308	6/25/65	TRIPOS-I	40008000	GENERAL RADAR SEARCH	22	
7312	8/3/65	MAGNUM	155–165	HEN HOUSE TI	21	
7310	5/14/66	LEIGE	170–175	TALL KING DF/TI	0	
7311	5/14/66	PLICAT	156–163	HEN HOUSE DF/TI	0	
7314	8/16/66	SAMPAN-I	2000–4000	GENERAL SEARCH/DF	14	
7315	8/16/66	SOUSEA-I	8000–12000	RADAR GS/DF	14	
7317	9/16/66	FANION-II	4800–5200	[redacted]	4	25X1
7318	9/16/66	TRIPOS-II	4000–8000	RADAR GS/DF	4	
7319	5/9/67	FANION-III	4800–5200	[redacted]	3	25X1
7316	5/9/67	SLEWTO	156–163	HEN HOUSE TI	3	
7320	6/16/67	SAVANT-I	61–250	TEST RANGE TLM COPY	16	
7321	11/2/67	FACADE	100–2200	ABM RADAR SEARCH	3	
7324	1/24/68	TIVOLI-I	100–2400	ABM RADAR TI	15	
7322	3/14/68	LAMPAN-I	1000–2000	ABM GS/DF	12	
7323	3/14/68	SAMPAN-II	2000–4000	ABM GS/DF	12	
7326	6/20/68	TRIPOS-III	4000–8000	ABM GS/DF	19	
7327	6/20/68	SOUSEA-II	8000–12000	ABM GS/DF	19	
7325	9/18/68	VAMPAN-I	100–1000	ABM GS/DF	12	
7330	3/19/69	TIVOLI-II	100–2200	ABM TI	19	
7328	5/1/69	LAMPAN-II	1000–2000	ABM GS/DF	9	
7329	5/1/69	SAMPAN-III	2000–4000	ABM GS/DF	9	
7336	9/22/69	SAVANT-II	61–250	TEST RANGE TLM COPY	20	
7313	9/30/69	WESTON	60–70/390–420	[redacted] COPY	11	25X1
7331	3/4/70	TIVOLI-III	100–2200	ABM TI	20	
7332	5/20/70	TRIPOS-IV	4000–8000	P&CW GS/EOB	22	
7333	5/20/70	SOUSEA-III	8000–12000	P&CW GS/EOB	22	
7334	11/18/71	TOPHAT-I	470–1000	COMINT MAPPER	45	

Table I. Mission 7300 Launches (Continued)

Mission	Date	Name	Frequency (GHz)	Target Signals	Life (mos)
7337	9/10/71	ARROYO	1.2–2.1/3.4–3.9	LOS TOWER MAPPING	1
7339	1/20/72	MABELI	0.156–2.5	ABM MAINBEAM TI	88
7338	7/7/72	URSALA-I	2–12	P&CW GS/EOB	70
7342	11/10/73	URSALA-II	2–12	P&CW GS/EOB	61
7340	4/10/74	TOPHAT-II	0.47–1	COMINT MAPPER	72
7341	10/29/74	RAQUEL-I	4–18	P&CW GS/TI	63
7343	7/8/76	URSALA-III	2–12	P&CW GS/EOB	133
7345	3/16/78	RAQUEL-IA	4–18	P&CW GS/TI	113
7344	3/16/79	URSALA-IV	2–12	P&CW GS/EOB	35
7346	5/11/82	FARRAH-I	2–18	P&CW GS/EOB/TI	100+
7347	6/18/84	FARRAH-II	2–18	P&CW GS/EOB/TI	75+
[redacted]					
7241	6/17/80	LORRI-I	26–42	P&CW EHF SEARCH	11
7242	4/18/86	LORRI-II	26–42/70–74 90–94, 0.15–0.165	P&CW EHF SEARCH P SEARCH W-BAND ABM MBTI	0
[redacted]					
7245	1992	CARRIE	0.1–0.8	COMINT MAPPER	—

25X1

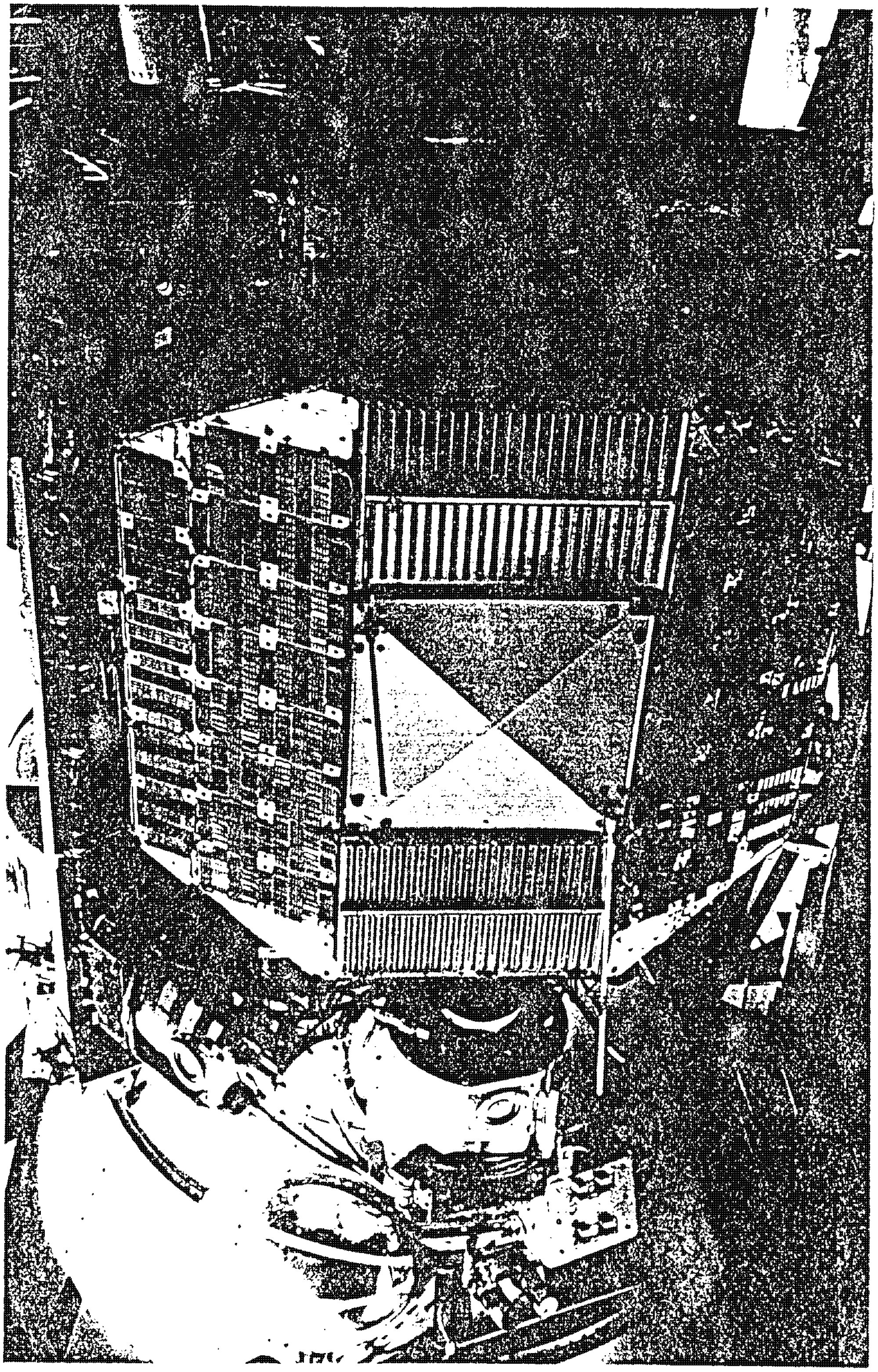

Figure 1. The PUNDIT Spacecraft

PLYMOUTH ROCK (MISSION 7306)—S BAND SEARCH

The PLYMOUTH ROCK requirement was to provide S-band radar coverage of the [redacted] network to replace lost U-2 coverage. A spaceborne receiver to cover S-band was built. It was designed to interface with SAC U-2 processing and was tested in a light aircraft with a prototype antenna and flight tape recorder with an attenuator to simulate both U-2 altitudes and satellite altitudes. It was flown over the San Francisco Bay Area and signals recorded from the receiver. Data tapes made from the flights were delivered to Omaha for compatibility testing with the FINDER processing system. When the system flew, it operated well and the processing interfaces were verified. PLYMOUTH ROCK had the first scanning YIG filter in space, serial no. 1 from Watkins-Johnson. 25X1

This system was somewhat unique in that it went from the chalkboard to on-orbit operation in about 16 weeks. The PLYMOUTH ROCK mission was launched as a dual mission with its companion Mission 7305 (also called STEP-13) using a single P-11 host.

The STEP-13 system demonstrated intercept of the [redacted] battlefield radio and led to the 7313 WESTON follow-on system being approved. Intercepts by the ABM search systems created a desire for both TI (precision parameter measurement) systems and geolocation systems. Missions 7312 and 7316 were approved for HEN HOUSE TI measurements and 7307/08 became the first spinning pencil beam general search/electronic order of battle (GS/EOB) system. The Mission 7307/17/19 FANION systems provided directed search/EOB of the [redacted] radars for SAC, who processed the resultant intercepts. Prior to 1968, the other 7300 intercepts were all processed at Ft. Meade by NSA with evaluation support by Lockheed, including spin axis determination and status analysis. Intercepts of calibration van radiations were processed to monitor the collection system status and establish measurement error budgets. 25X1 25X1

FANION (MISSION 7307)—[redacted] SEARCH 25X1

In 1964, a new operating frequency range was discovered for the [redacted] system which had previously operated in S-band. The new frequency range was around 5 GHz with two beams usually spaced 105 MHz apart. 25X1

The requirement to locate these emitters still existed and a concept was developed at Stanford which was based on a Lockheed spinning P-11 vehicle. The FANION concept was based on a crossed pair of fanbeam antennas using waveguide arrays, feeding a dual-channel receiver which was named FANION. The spacecraft is shown in Figure 2. The receiver was built at Stanford University and provided the first geolocation capability from the spinning P-11 vehicle. It was also designed to develop a data output format which was compatible with the SAC U-2 processing system.

The system was launched and operated very successfully. Over the first nine months of its life, it located more than 700 [redacted] sites in the Soviet Union. By way of cost comparison, the FANION receiver payload cost $50,000. FANION I flew on a dual launch P-11 vehicle with a companion payload, called TRIPOS I, which covered 4 to 8 GHz with a 3-foot flex rib dish antenna for C-band General Search. TRIPOS I was the first precursor of the current FARRAH collection concept. 25X1

TALL KING AND HEN HOUSE

Mission 7310, LEIGE, was to use a spinning antenna null (azimuth cut) technique to locate TALL KING radars. A TALL KING EOB was subsequently provided by the STRAWMAN gravity gradient Agena mission (726X).

Mission 7311, PLICAT, was to locate HEN HOUSE radars by horizon-to-horizon processing of the pulse TOA Doppler shifts. The NSA Doppler processing software was subsequently used to process single ball POPPY data. The resultant accuracy for constant PRI radars was about [redacted] (limited by large missing segments of the Doppler curves). Later [redacted] 25X1

Two of the Agena aft-rack missions were to collimate a six-foot flex rib antenna with [redacted] and demonstrate a copy capability. The target signals were the 1.5 to 2 GHz [redacted] systems for SQUARE TWENTY and the 3.4 to 3.9 GHz [redacted] series FDM/FM systems for the DONKEY mission. These were followed by studies of using a [redacted] 25X1 25X1 25X1

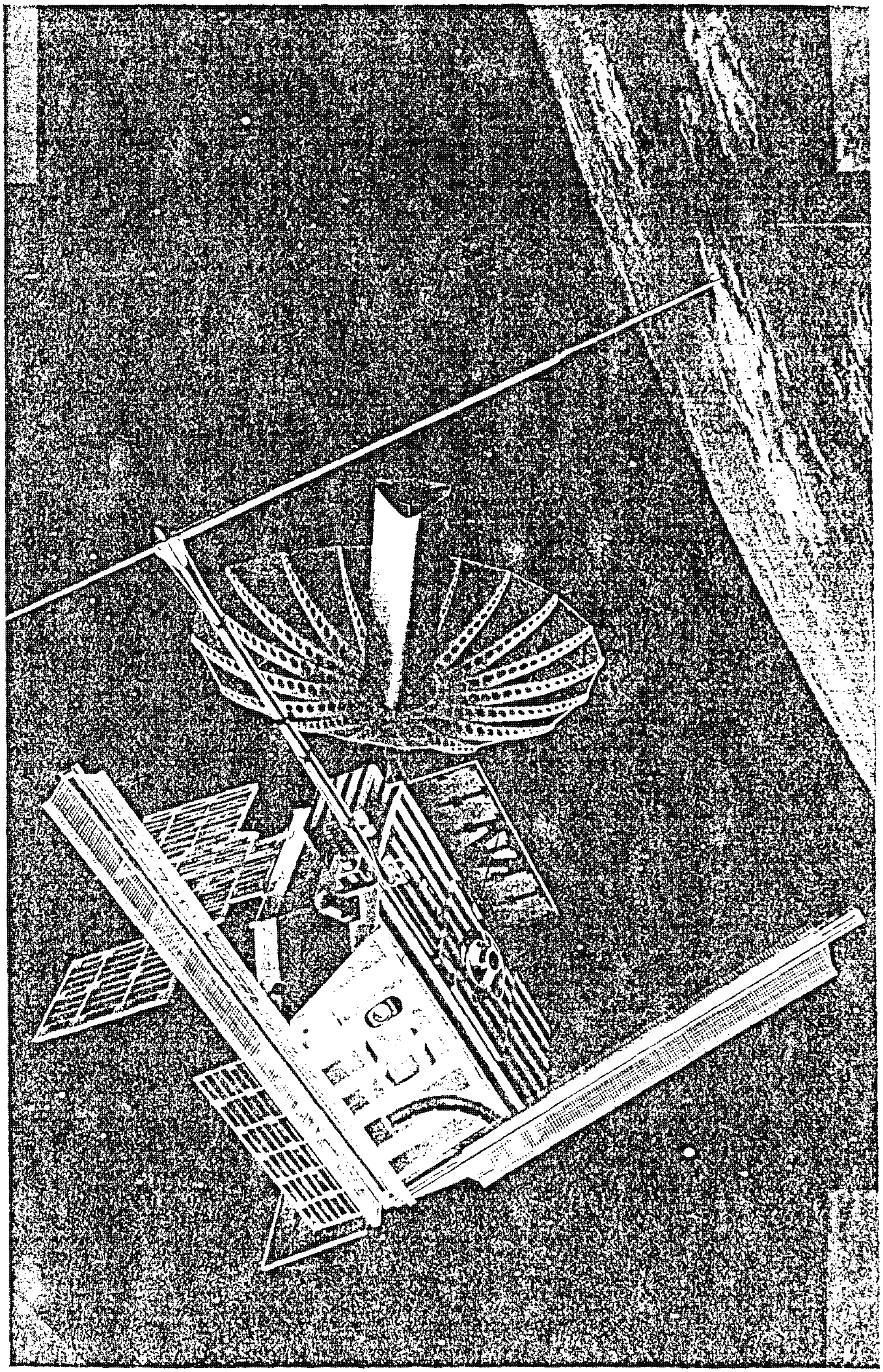

Figure 2. The FANION I/TRIPOS I Spacecraft

[redacted] SEARCH REQUIREMENT 25X1

In 1965, there was a requirement to search for a [redacted] It was known that the Chinese had received the [redacted] before the Sino-Soviet split, and there was speculation that the Chinese may have changed the operating parameters of the radar. The results of this requirement, after some vascillation in the government, was the adoption of the SAMPAN concept. CIA had previously developed a concept based on a spinning pencil beam with sidelobe inhibit by subtracting OMNI signals in two audio bandwidth channels on the ground. Analysis indicated that the pulse data rates in the two channels would be sufficiently high as to overload the channels and result in loss of the sidelobe inhibit function and probably even burial of the desired DF signals in sidelobe poke through. 25X1 25X1

A Stanford concept was to perform the inhibit onboard. It was revolutionary, in the sense that it used both the first wideband onboard inhibit and the first tunnel diode amplifiers in space. Traveling wave tube amplifiers had previously been used for broad band coverage, but there was insufficient weight and power capacity on the P-11 vehicle to put multiple channels onboard. SAMPAN (Mission 7314), covering 2 to 4 GHz, was optimized to the Soviet and Chinese radar environment and flew with SOUSEA (Mission 7315), an 8 to 12 GHz payload on the same vehicle.

SOVIET ABM SEARCH CRISIS

In the mid 1960s, a realization that the Soviets had built a substantial and powerful anti-ballistic missile system worried the defense community. A crisis was declared in order to develop technical information on the Soviet radars seen under construction, including DOG HOUSE, HEN HOUSE, TRY ADD, and BIG SCREEN.

In 1966, increasing concern with the USSR ABM system deployment and the failure of the low altitude programs to intercept some of the radars of concern (DOG HOUSE, BEER CAN, BUGH, SQUARE PAIR, etc.) resulted in the following actions:

1) An acceleration of the P-11 pencil beam radar search and related systems.

2) [redacted]

3) [redacted] 25X1

4) The 1968 cancellation of additional 726X STRAWMAN EOB missions to help suppor[redacted]

As a result of the 1967 ABM radar collection optimization studies (the Harry Davis Committee) recommendations, the Mission 7300 radar search missions were accelerated, Mission [redacted] The resultant 7300 missions for ABM intelligence were 7321, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, and 33 which provided search and mapping from 100 MHz to 12 GHz. Several of these were repeats of the earlier spinning pencil beam Missions 7308, 14, 15, and 18. Also, the launch of WESTON (Mission 7313) was delayed for several years.

ABM SEARCH FAMILY

Returning to the Mission 7300 response, the first vehicle was FACADE (Mission 7321) which was a QRC search receiver that covered from 250 MHz to 2,200 MHz. This build was accomplished in about six months with the receiver built by GTE Sylvania and delivered GFE through the Air Force to Lockheed for installation on a P-11 vehicle. Lockheed provided antennas, tape recorders, telemetry, and the vehicle. There was no DF capability. The first orbit tapes were read out at Vandenburg. [redacted] analysis of this first tape revealed the significant characteristics of the Soviet DOG HOUSE radar as being a frequency scanned CW radar. Scan sector limits, dwells, the fact that there were two transmitters and the frequency versus beam position data were all derived from this first tape. 25X1

The receiver had been built as a pulse receiver; however, because it had an audio recorder output, the analysts were able to reconstruct the CW response of the high and low frequency bandpass of the audio tape recorder and use this reconstructed characteristic to determine the scan, dwell, and flyback portions of the CW beams from the two transmitters. DOG HOUSE radar scan rate and beamwidth were also determined. The FACADE intercept was in November 1967. POPPY had previously reported (July 1967) a 10 pps pulse signal in this RF band, but they did not know what it was and it was not associated with the DOG HOUSE radar.

The rest of the ABM family for Mission 7300 consisted of spinning pencil beam search vehicles LAMPAN, SAMPAN, TRIPOS, and SOUSEA collectively covering the 1 to 12 GHz frequency range L-band, S-band, C-band, and X-band, respectively. Below 1 GHz, a rotating interferometer system called VAMPAN (for VHF) covered from 100 MHz to 1 GHz with two receivers. This was the first rotating interferometer in space and it successfully operated, thereby proving the value of this geolocation concept which was later used successfully in TOP HAT I/II. Figure 3 represents the VAMPAN spacecraft.

The ABM search family architecture was based on search and geolocation vehicles with the predetection technical intelligence function to be covered by a separate vehicles named TIVOLI. TIVOLI had command or step tuned receivers covering 100 MHz to 2.2 GHz and included predetection IF tape recorders and bandwidth compression (BWC) capability for wideband pulse signals. These produced technical intelligence on the ABM family emitters and other pulsed radars.

SAMPAN II used the first six-foot diameter unfurlable flex rib parabolic dish antenna on a spinning vehicle. A six-foot diameter unfurlable flex rib parabolic dish was used later on the URSALA, RAQUEL, and FARRAH series vehicles.

Total ABM family deployment consisted of three TIVOLI, one VAMPAN, two LAMPAN, three SAMPAN, four TRIPOS, and three SOUSEA payloads on vehicles, all launched in the 1965 to 1970 time frame.

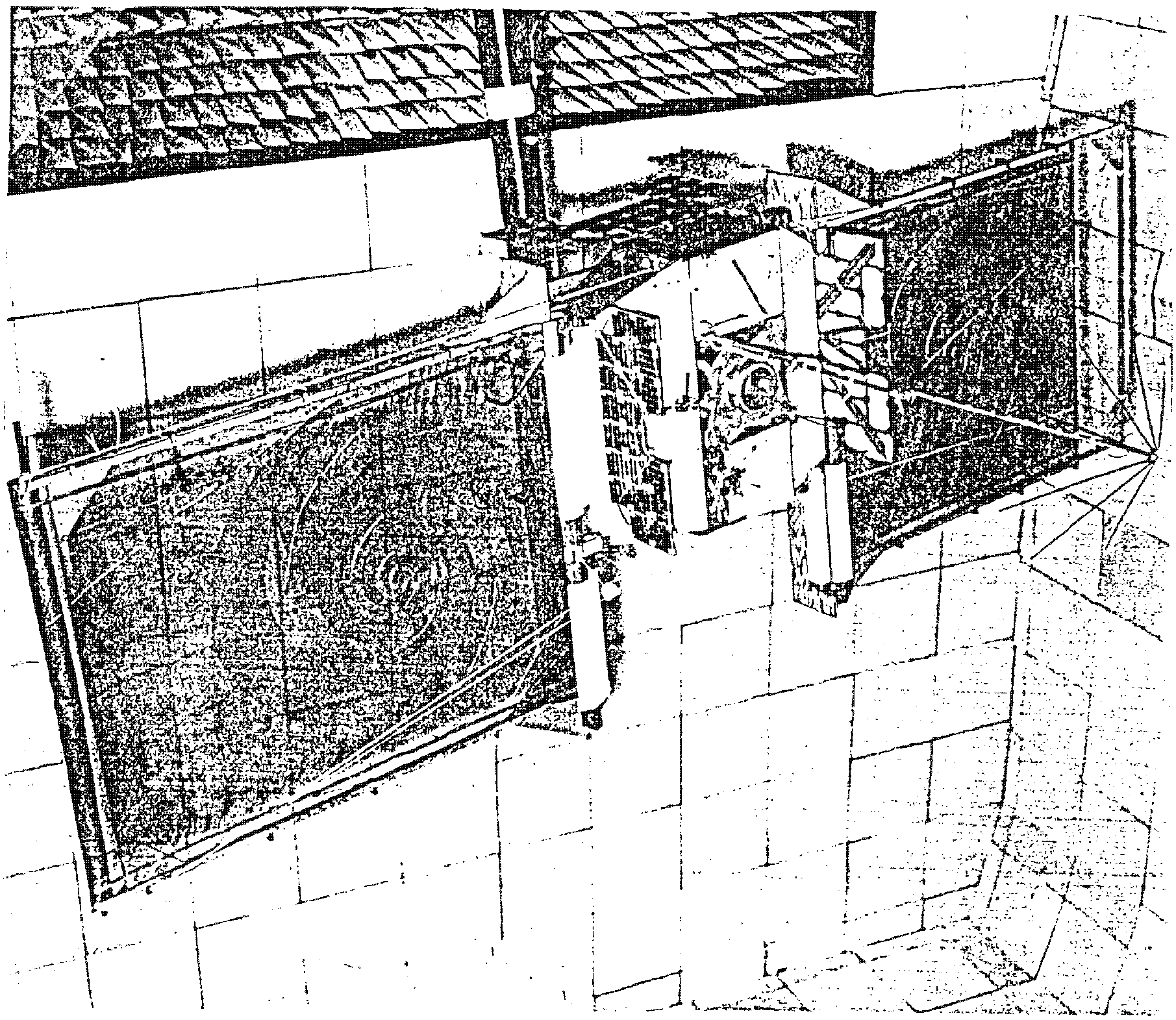

Figure 3. The VAMPAN Spacecraft

TRIPOS/SOUSEA

Missions 7332/33, TRIPOS-IV/SOUSEA-III, had a channelized pulse frequency measurement unit and a swept receiver for CW intercept. The latter obtained the first intercepts of the [redacted] SQUARE PAIR CW radar. A drawing of the spacecraft is shown in Figure 4. Both FACADE and VAMPAN obtained intercepts of the BUGH radar but POPPY provided the first identified intercept. NSA supported a continuation of both low altitude programs for their contributions to a broad area general search/EOB. 25X1

Radio frequency coverage of the various Mission 7300 spacecraft is shown graphically in Table II.

MABELI—THE NEED FOR ERP MEASUREMENT

The ABM series family was quite successful in geolocating and identifying many of the parameters of the Soviet ABM system. More technical detail was needed to assess system capability, particularly mainbeam power, polarization, and modulation characteristics. The MABELI spacecraft (Mission 7339) was launched in January 1972 to do directed search and technical intelligence on four specific emitters: the HEN HOUSE, DOG HOUSE, BIG SCREEN radar, and the TRY ADD missile and target tracking dishes.

The purpose of MABELI was to collect fine grain data, including power measurements, to assess target cross-section capabilities on these radars and to observe the engineering evolution and testing of the systems. MABELI used an all digital downlink with S-band capability. It flew the first polarimeter which could measure polarization with tilt angle and axial ratio of radar mainbeams. The collection requirements were quite specific and the payload was built to do those few things in the four narrow RF ranges with high accuracy. MABELI achieved an on-orbit power measurement accuracy (with on-orbit calibration) of nearly 1 dB (with averaging) except in the lowest frequency range where ionospheric effects in the 151 to 165 MHz band limited the accuracy. The MABELI spacecraft is shown in Figure 5.

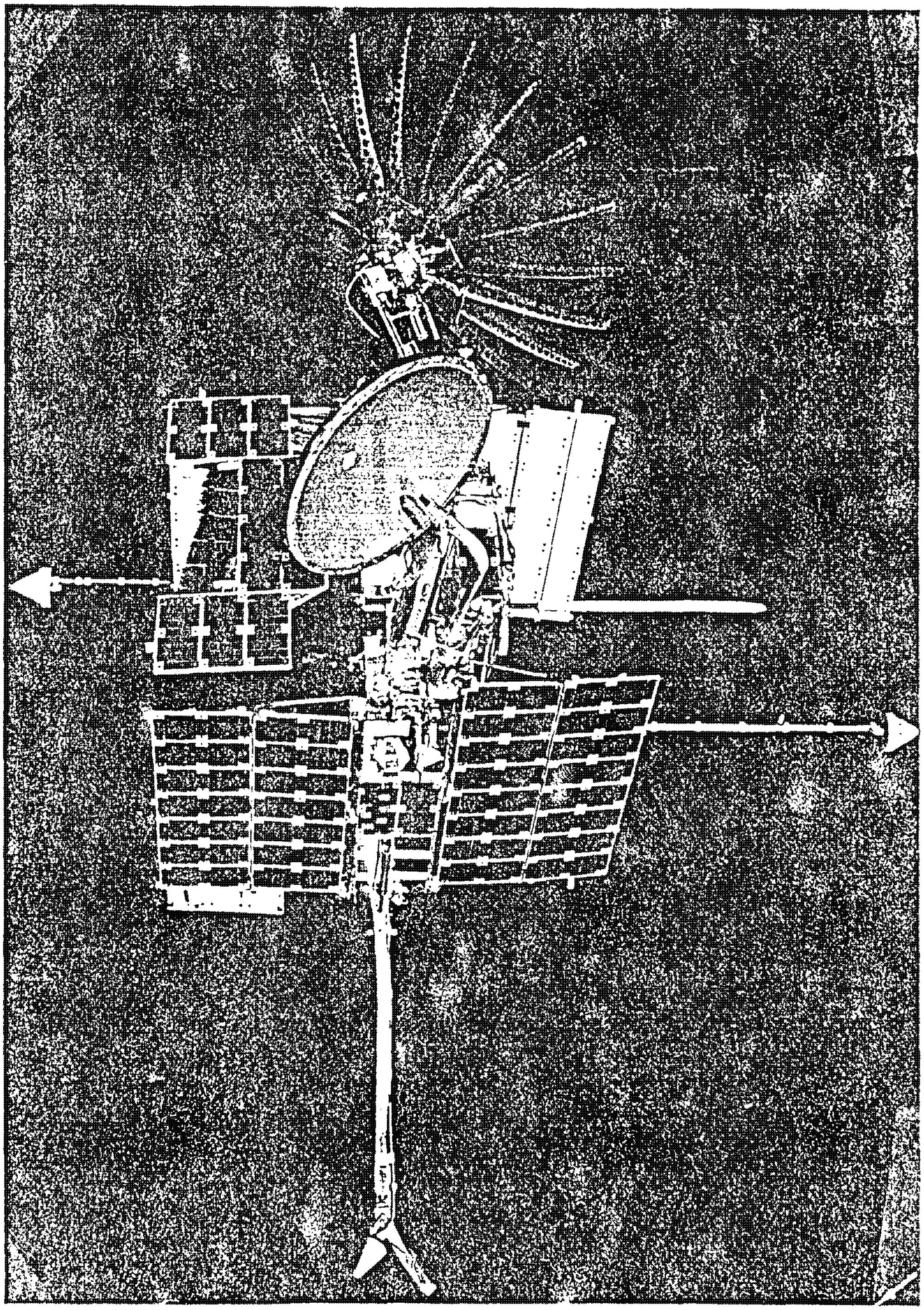

Figure 4. The TRIPOS IV/SOUSEA III Spacecraft

Table 2. Frequency Coverage of Mission 7300 Vehicles

LAUNCH YEAR	SATELLITE	MISSION	FREQUENCY RANGE - GHz (0 5 10 15 20 25 30 35 40 45)
1963	4201 --	MAP INNER VAN ALLEN BELT	
	4001 PUNDIT I	SOVIET TELEMETRY	60-80 MHz
	4101 PUNDIT II	SOVIET TELEMETRY	60-80 MHz
1964	4301 NOAHS ARC	GENERAL SEARCH (VHF)	150-550 MHz
	4202 --	MAP INNER VAN ALLEN BELT	
	4302 STEP 13	ANTISATELLITE RADAR SEARCH	150-230 MHz
1965	4401 PUNDIT IV	TELEMETRY	61-72 MHz
	4402 FANION/TRIPOS	[redacted]/SEARCH	
	4403 MAGNUM	HEN HOUSE	160-250 MHz
1966	4404 LEIGE/PLICAT	TALL KING/HEN HOUSE	153-178 MHz
	4405 SAMPAN/SOUSEA	SEARCH	
	4406 FANION/TRIPOS	[redacted]	
1967	4408 FANION/SLEWTO	[redacted]/HEN HOUSE	153-163 MHz; 4900-5150 MHz
	4409 SAVANT	TELEMETRY	61-240 MHz
	4410 FACADE	ABM SEARCH	
1968	4412 TIVOLI	ABM/TI/SEARCH	
	4411 LAMPAN/SAMPAN	ABM/SEARCH	
	4420 TRIPOS/SOUSEA	SEARCH	
	4413 VAMPAN	ABM SEARCH	
1969	4418 TIVOLI	ABM TI	
	4417 LAMPAN/SAMPAN	ABM/SEARCH	
	4419 SAVANT	TELEMETRY	61-76 MHz, 142-248 MHz
	4407 WESTON	CW SEARCH	60-70 MHz, 360-420 MHz
1970	4422 TIVOLI	ABM/TI/SEARCH	
	4421 TRIPOS/SOUSEA	SEARCH	
	4423 TOPHAT I	CW SEARCH	450-1000 MHz
1971	4427 ARROYO	CW SEARCH	
1972	4424 MABELI	ABM TI	151-156, 387-526, 860-960, 1500-2500 MHz
	4425 URSALA I	OPERATIONAL ELINT/SEARCH	
1973	4426 URSALA II	OPERATIONAL ELINT/SEARCH	
	4428 TOPHAT II	CW SEARCH	450-1000 MHz
1974	4429 RAQUEL I	TI/SEARCH	
1976	4430 URSALA III	OPERATIONAL ELINT/SEARCH	
1978	4432 RAQUEL IA	TI/SEARCH	
1979	4431 URSALA IV	OPERATIONAL ELINT/SEARCH	
1980	- LORRI	GS, DS, PULSE & CW	26,000-42,000 MHz
1982*	4433 FARRAH I	GS, DS, TI & EOB	

*PLANNED LAUNCH DATE

AS OF JUL 1981

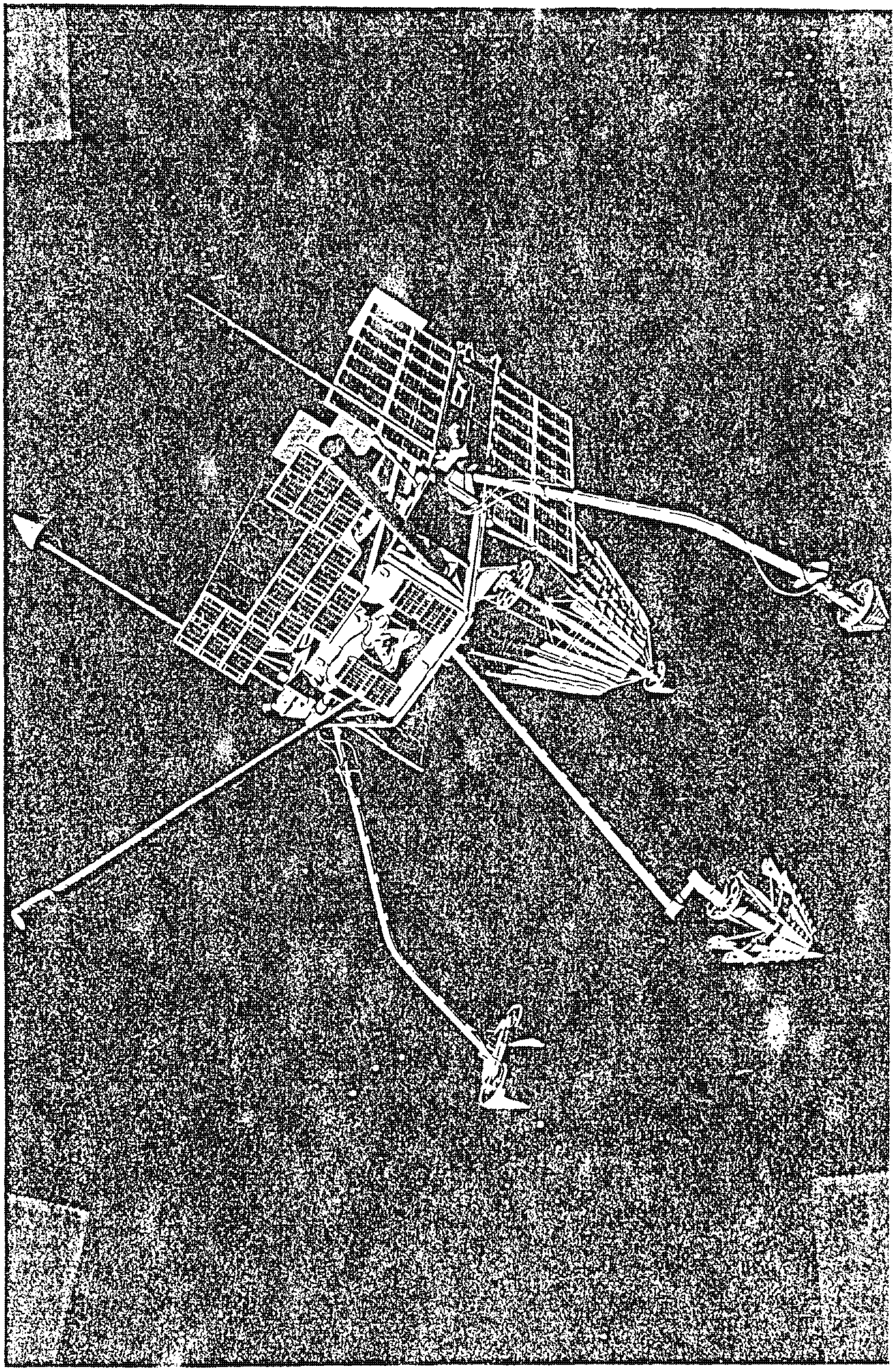

Figure 5. The MABELI Spacecraft

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At this point, the Mission 7300 program was launching up to four vehicles per year with lifetimes ranging from very short to as long as seven years in the case of MABELI. Because of the relatively low-orbital altitude (usually 275 nmi), lifetime was often limited by draglife of the vehicle, particularly those with large antennas such as large low-frequency spiral antennas or large flex rib dish antennas. A typical lifetime from orbit decay was one to four years to burn-in. However, MABELI and TOP HAT II were still functioning when they burned in at seven and six years respectively.

COMINT MAPPING AND SOVIET [redacted] SIGNAL SEARCH 25X1

By 1970, cost overruns on [redacted] photo missions resulted in growing NRO reluctance to grant new approvals to either LEO mission. Nonetheless, Mission 7334, TOP HAT-I, was approved for 0.47 to 1 GHz COMINT mapping. 25X1

The specific requirement to search for Soviet [redacted] in the 450 MHz to 1 GHz band resulted in a second application of the successful VAMPAN rotating interferometer concept on the spinning P-11 vehicle. The systems had onboard recognizers for signals not of interest (SNOI), television and FM specifically, and would frequency step across the band until intercepting a signal that was a possible Soviet [redacted] It would then dwell for one or more rotations of the interferometer (60 rpm) to provide relatively precise geolocation of the emitters. 25X1 25X1

The 7300 program guidance in 1969 was to propose future missions which did not duplicate the capabilities attributed to the other SIGINT programs. The resultant approved missions were the 7337 ARROYO COMINT mapper and, per an NSA request, the TOP HAT I system was replaced with TOP HAT II (7340). The second TOP HAT also had a UHF receiver for the RUTLEY type signal.

The ARROYO system was built to search for specific point-to-point FDM-FM and PCM-FM communications systems in the 1.2 to 2.2 GHz and the 3.6 to 3.9 GHz bands. It used a six-foot parabolic dish with monopulse feed for zenith sidelobe DF together with low gain interferometer spirals for DF on the horizon-based mainbeams. This system, which has the [redacted] which was 25X1 evolving at that time. Unfortunately ARROYO failed shortly into its operational life due to power supply problems.

In the years after the failure of ARROYO, the COMINT mission remained unfulfilled. The community was divided into two major camps with regard to the questions of COMINT mapping, cochannel interference, the scale of any future mission, and the best technique for signal geopositioning.

[redacted] 25X1

Other proponents in the community favored flying a small spin stabilized interferometer like SAMPAN (see Figure 3) or TOP HAT I/II (see Figure 6). The NSA repeatedly requested a system like TOP HAT III to replace the TOP HAT II (Mission 7340) which had burned-in in 1979.

A proposed mission named CARRIE has recently been supported by DARPA to carry on the VAMPAN/TOP HAT mission. CARRIE's proposed coverage will be 100 to 850 MHz and is similar in appearance to the earlier VAMPAN mission. CARRIE will be flown on a lightweight bus.

THE URSALA AND RAQUEL REQUIREMENT

In the middle of the Vietnam War, around 1969, several urgent search requirements surfaced for threats in the more conventional warfare area. These centered around the [redacted] missile 25X1 system which had been observed through photography for a number of years, but there were no electronic intercepts as of this time. Furthermore, there was essentially no search capability from space for Ku Band emitters in the 12 to 18 GHz range. In addition, there was the impending threat (though unfounded in that timeframe) of double-agile radars in the Soviet inventory, that is, radars that can simultaneously frequency hop from pulse-to-pulse and jitter in PRI from pulse-to-pulse.

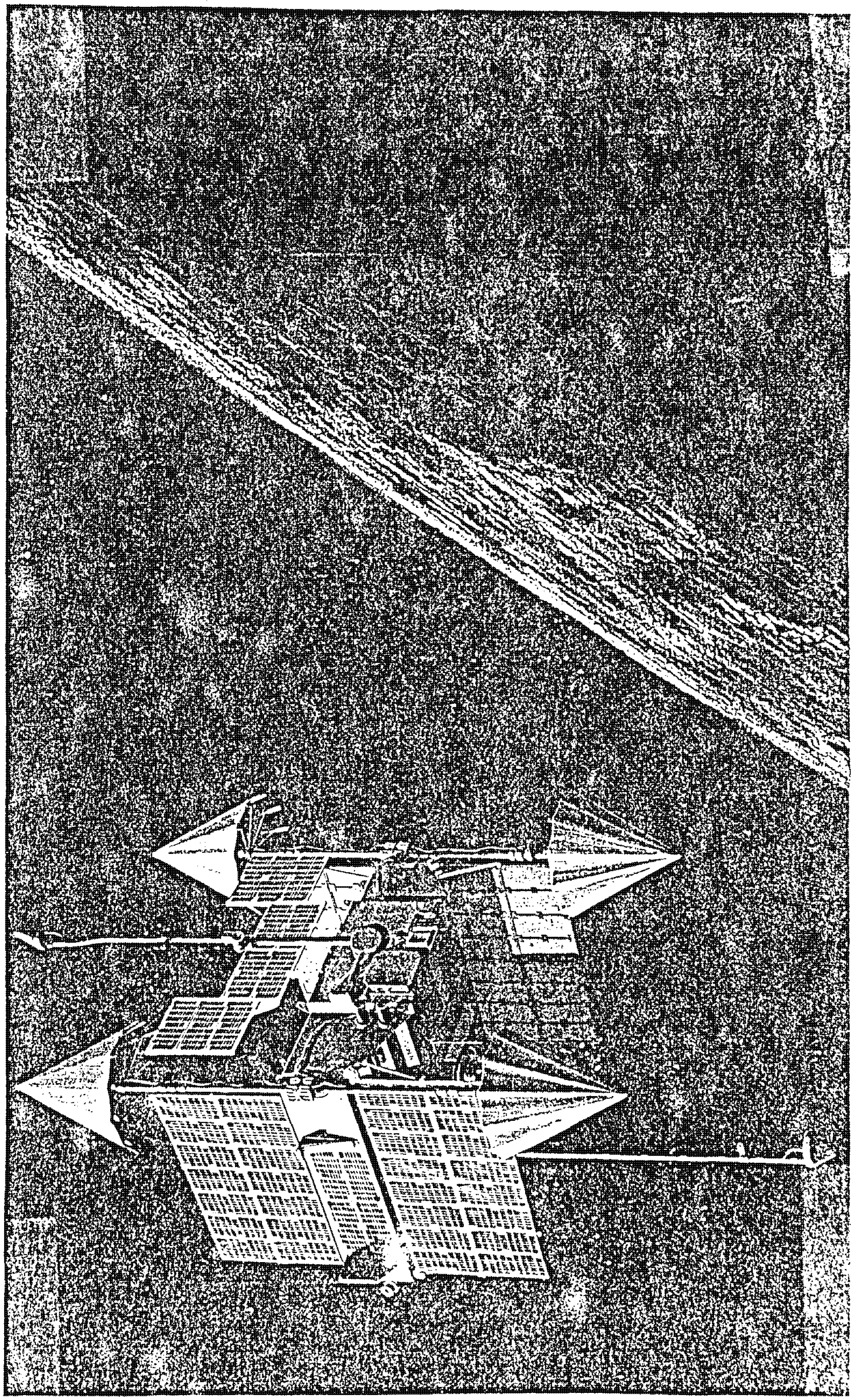


Figure 6. The TOP HAT I Spacecraft

These requirements resulted in the creation of two collection concepts: URSALA and RAQUEL. Two Stanford studies resulted in a single concept which became the RAQUEL vehicle with receivers built by E-Systems. Antenna mounting angles were optimized to maximize the intercept time on relatively short slant range targets with the spinning pencil beam rather than mapping horizon-to-horizon like a wide area search system. The other requirement for the collection of double-agile radars, was addressed with the first wideband monopulse AOA concept with sidelobe inhibit performed onboard. This concept was named URSALA. With these two vehicles, the program names changed to female movie starts rather than acronyms or related to mission objectives as an edict resulting from security concerns. A drawing of the two spacecraft is shown in Figure 7.

The URSALA design was conceived in the 1960s to support sidelobe search in the 2 to 12 GHz bands. The mission used both a six foot flex rib dish and a three foot parabolic reflector with a new monopulse feed for direction of arrival measurement capability. Since the URSALA mission was a sidelobe search mission, it had no mainbeam collection capability and did not carry a predetection TI receiver. The MBTI function was assigned to RAQUEL. The URSALA series consisted of four vehicles:

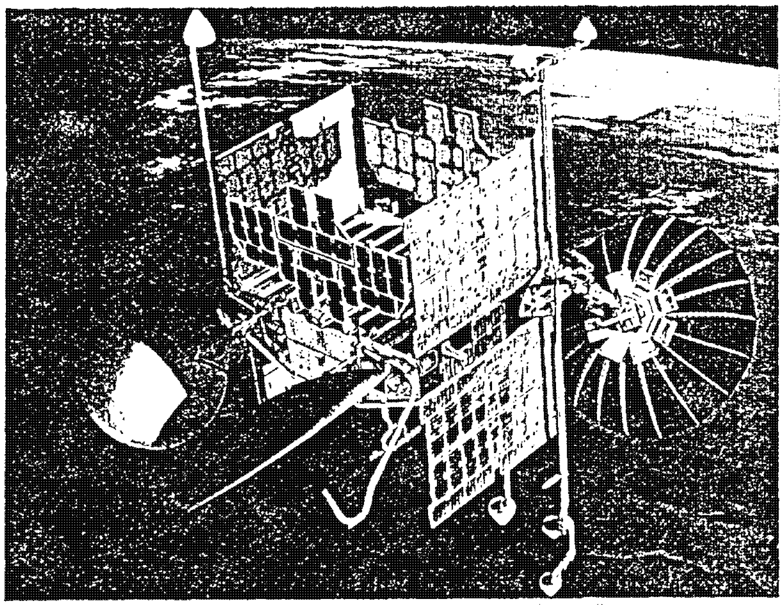
	Mission	Launch
URSALA I	7338	7 Jul 1972
URSALA II	7342	10 Nov 1973
URSALA III	7343	8 Jul 1976
URSALA IV	7344	16 Mar 1979

URSALA I was the first low orbitor to carry a four-arm monopulse feed with improved geolocation accuracy to support pulse search and EOB. The URSALA I/II vehicles were equipped with OMNI antennas which were used to support a sidelobe inhibit function (not a mainbeam collection function). The URSALA OMNI antennas were boresighted in the direction of the DF antennas to enhance the sidelobe inhibit performance .

A total of seven antennas were used for signal intercept in the 2 to 12 GHz range: two high-gain pencil-beam antennas for target emitter sidelobe intercept and geopositioning, and five omnidirectional antennas that provide inhibit protection for the high-gain antennas.

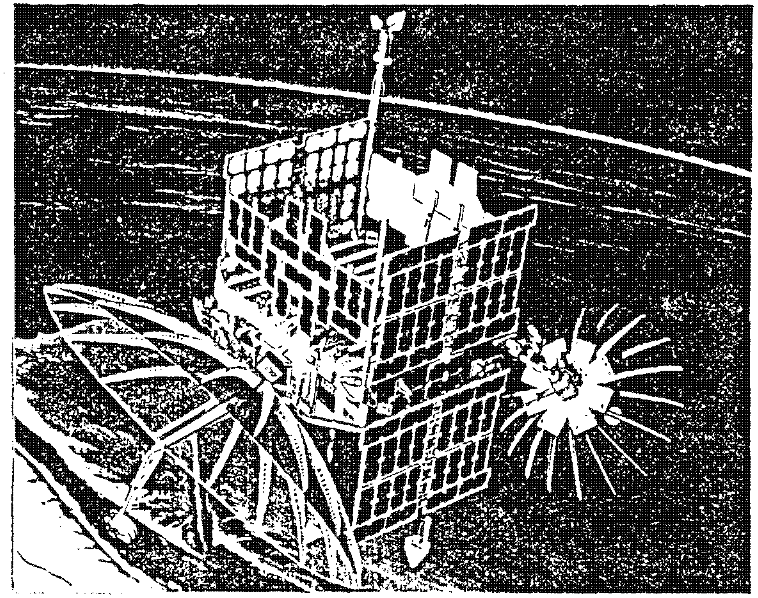
- SEARCH
- TECHNICAL ELINT
- OPERATIONAL ELINT

RAQUEL



FREQUENCY RANGE 4-18 GHz

URSALA III, IV



FREQUENCY RANGE 2-12 GHz

Figure 7. The RAQUEL and URSALA Spacecraft

The two high-gain antennas covered the 2 to 8 GHz band and the 4 to 12 GHz band. The feeds for these dishes were four-arm spirals whose arms are connected to a beamforming network that produces sum and difference signals. The amplitude ratio and the relative phase of these two signals [redacted] of the signal from which the emitter geolocation is derived. The signals from the OMNI-like antennas were combined in the payload to provide the equivalent of two sidelobe inhibit antennas, one covering the 2 to 8 GHz band and the second covering the 4 to 12 GHz band. The inhibit antennas are positioned on three deployable booms so that their amplitude patterns cover the sidelobe and backlobes of the high gain antennas. 25X1

URSALA provided selectable frequency coverage over the RF range of 2 to 12 GHz using the five contiguous bands defined below. In a given collection mode, bands 2 and 3 could be covered with either DF antennas. Bands 1, 4, and 5 are available for use at all times while there was a choice of using either band 2 or 3. The entire 2-GHz frequency range of a selected band is collected simultaneously. A block diagram of URSALA is shown in Figure 8.

Band	Frequency Coverage (GHz)
1	2–4
2A	4–6
2B	4–6
3A	6–8
3B	6–8
4	8–10
5	10–12

URSALA II was a design duplicate of URSALA I.

DIRECT TACTICAL SUPPORT

Due to lack of timely receipt of SIGINT information by Army/Air Force tactical users, the DRSP/ASPO funded the development of a series of mobile processing vans which were developed by [redacted] Experiments were conducted using URSALA III with a prototype van called RTIP which demonstrated feasibility of direct downlink and also OBPS operation. The RTIP consisted of two vans 1) mobile antenna van and (2) a processing van. 25X1

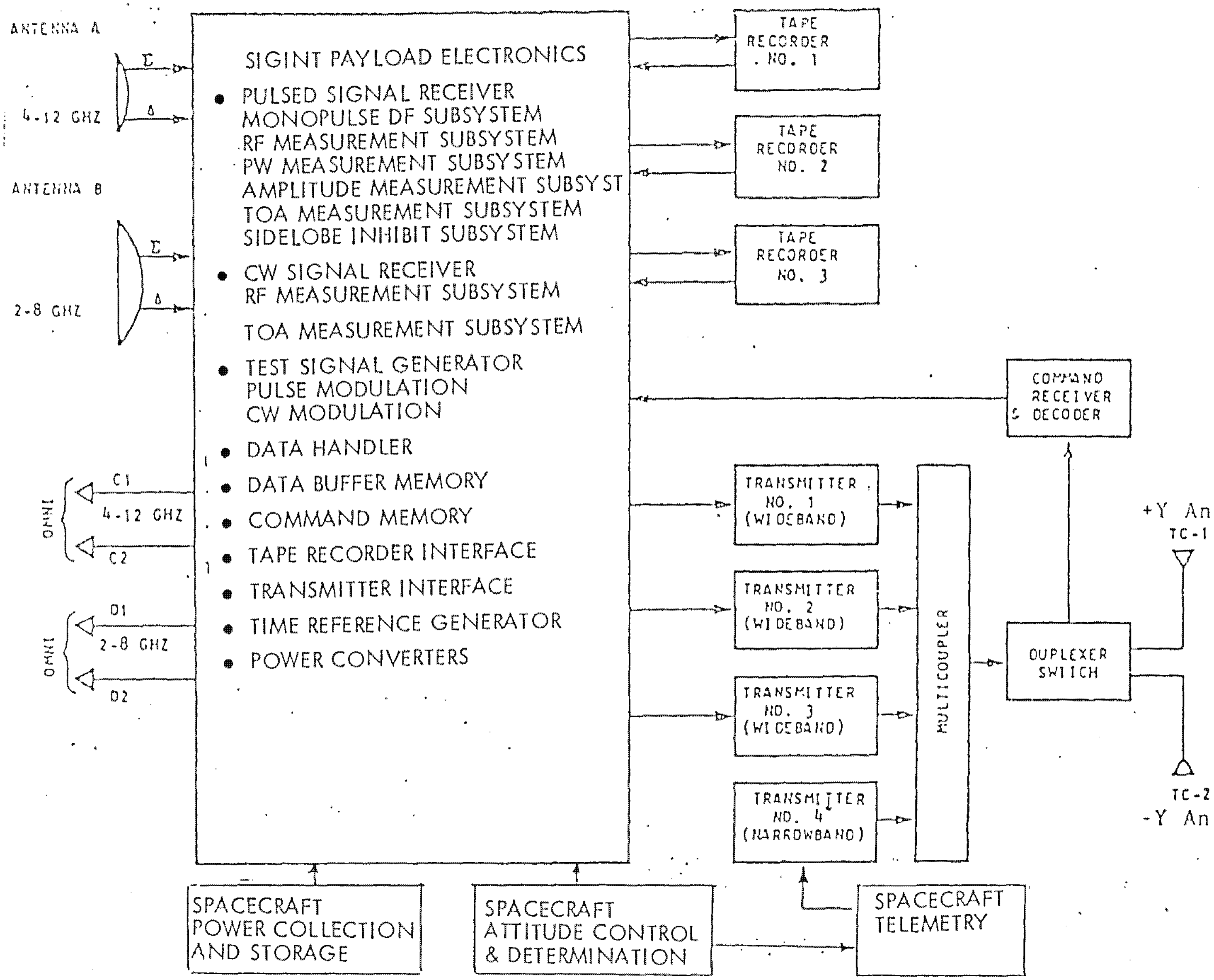


Figure 8. URSALA Intercept Block Diagram

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BIF-771-0334/90

25X1

After proving feasibility using the RTIP, [redacted] developed a series of mobile processing vans named the Interim Tactical ELINT Processor (ITEP) which were first deployed to [redacted] in 1979. The ITEP was originally designed to work with the URSALA and RAQUEL spacecraft. It was then envisioned that a follow-on van, the Tactical ELINT Processor would work with the FARRAH spacecraft and its OBPS. However, due to the similar downlink structure and processing format of the FARRAH data, the ITEP was found suitable for URSALA, RAQUEL, and FARRAH spacecraft. Therefore, a TEP van for FARRAH only was never required. Later, the Air Force ITEP dropped the I from ITEP and now refers to the Air Force vans as TEP. The Army ITEP Vans are currently titled Electronic Processing and Dissemination System (EPDS) and are widely deployed through the world today. [redacted] 25X1

RAQUEL

The RAQUEL spacecraft were assigned the missions of mainbeam technical intelligence, search of the J-band 12 to 18 GHz region. An MBTI mission from space can only be provided by a highly inclined low-orbiting vehicle. In the the RAQUEL design, emphasis was placed on OMNI or low-gain antenna collection of mainbeam of emitters near the horizon and pencil beam collection of J-band emitters at close slant range at mid latitudes. To support these goals, the RAQUEL OMNI antennas were oriented with their boresights along the spin axis to reduce spin modulation at the expense of sidelobe inhibit performance. The dish antennas of the spinning pencil beams were mounted at an angle to emphasize radar collection at the mid latitude region of the Soviet Union.

A technical intelligence receiver with 750 kHz predetection copy capability was added to the RAQUEL series which would tune to mainbeam intercept frequencies provided by the OMNI collection subsystem.

RAQUEL uses a 342 nmi circular orbit (this altitude was also used by URSALA III/IV). The satellite received both pulse and CW signals by intercepting the mainbeam or sidelobe radiation from emitters operating in the 4 to 18 GHz frequency range. The measurements made on each intercept pulse include signal frequency, pulse width, peak power, time of arrival (TOA), and scan rate. For CW signals, measurements include signal frequency, peak power, TOA, and scan rate. Carrier modulation characteristics both in time and frequency domains were also to be determined.

A drawing of the RAQUEL spacecraft is shown in Figure 9. Each set of collection antennas consists of a circularly polarized feed with a parabolic reflector and a pair of low gain OMNI antennas. One set of each is provided in the following bands: 1) 4 to 8 GHz, 2) 8 to 12 GHz, and 3) 12 to 18 GHz. The three high-gain antennas are used to detect and geoposition emitters through intercept of sidelobe emissions. The low-gain antennas are used for collection of emitter mainbeams and for the inhibit of the high-gain DF antennas sidelobes. These three antennas permit target location determination via a time-amplitude centroiding method used on previous missions. The three sets of OMNI antennas are mounted on deployable booms and are positioned so that their amplitude patterns provide omnidirectional coverage of the sidelobes of the high-gain antennas.

A block diagram of the RAQUEL payload is shown in Figures 10 and 11. The pulse receiver includes three channels—one channel is switched between the DF antennas and one channel is connected to each of the low-gain mainbeam/inhibit antennas as the top of the spacecraft. The third channel is connected to the OMNI/low-gain antenna on the bottom side of the spacecraft. The pulse receiver monitors one of the seven 2-GHz bands between 4 to 18 GHz with an instantaneous bandwidth of 2 GHz.

THE PLANNED DEATH OF THE PROGRAM

In 1975, the long range plan on the part of Lockheed and the Air Force, was to continue to build more RAQUELs and URSALAs over the next several years. In that time frame, Mission 7300 was a major contributor to meeting the following 1975 DCI guidance objectives:

1. Provide Sino-Soviet general search, EOB, and event coverage
2. Monitor crises and wars worldwide
3. Provide worldwide general search and EOB
4. Provide direct support to tactical forces (EPDS vans)
5. Provide moving target geolocations (especially aircraft)
6. Process and report variable parameter radar intercepts.

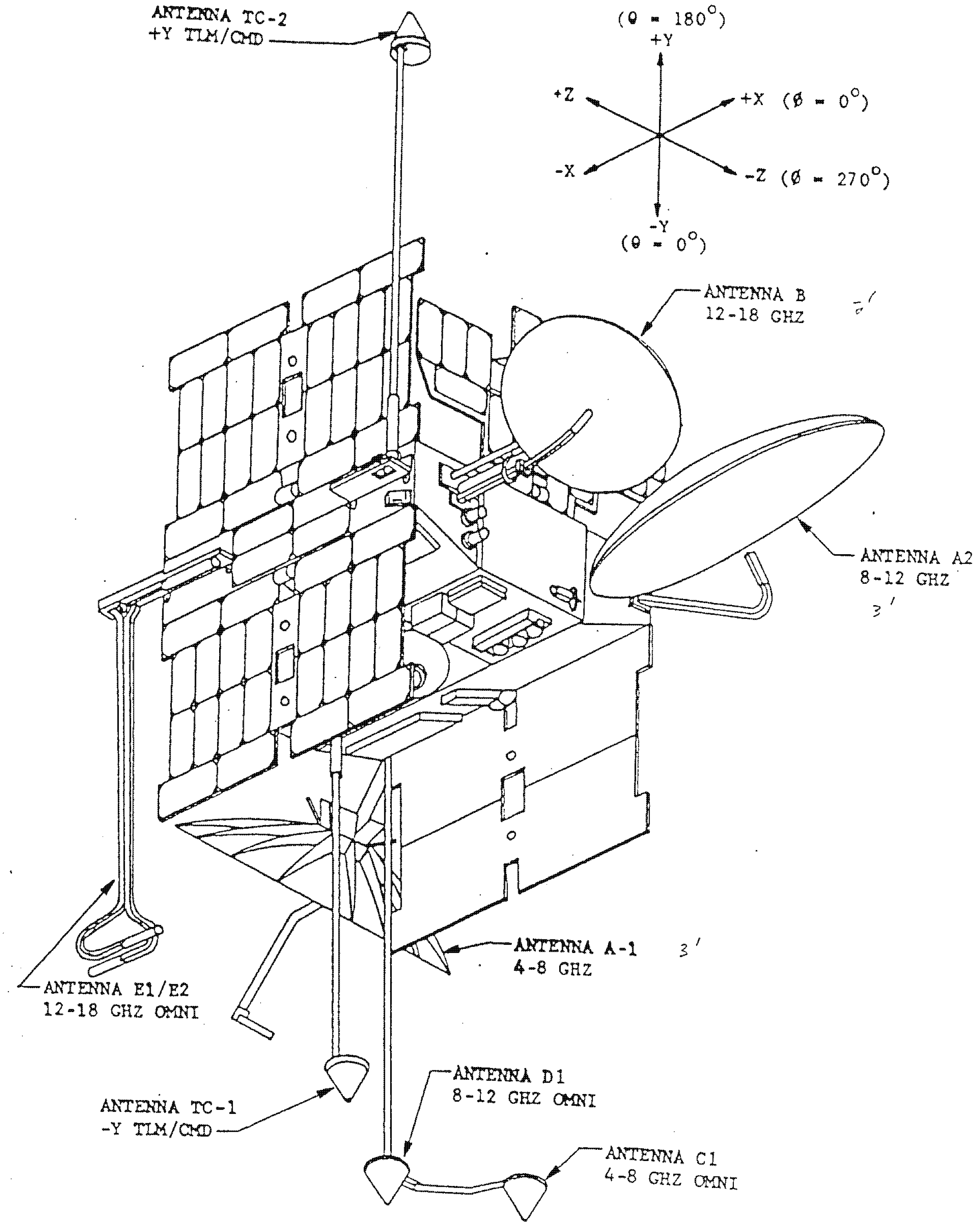

Figure 9. RAQUEL IA On-Orbit Configuration

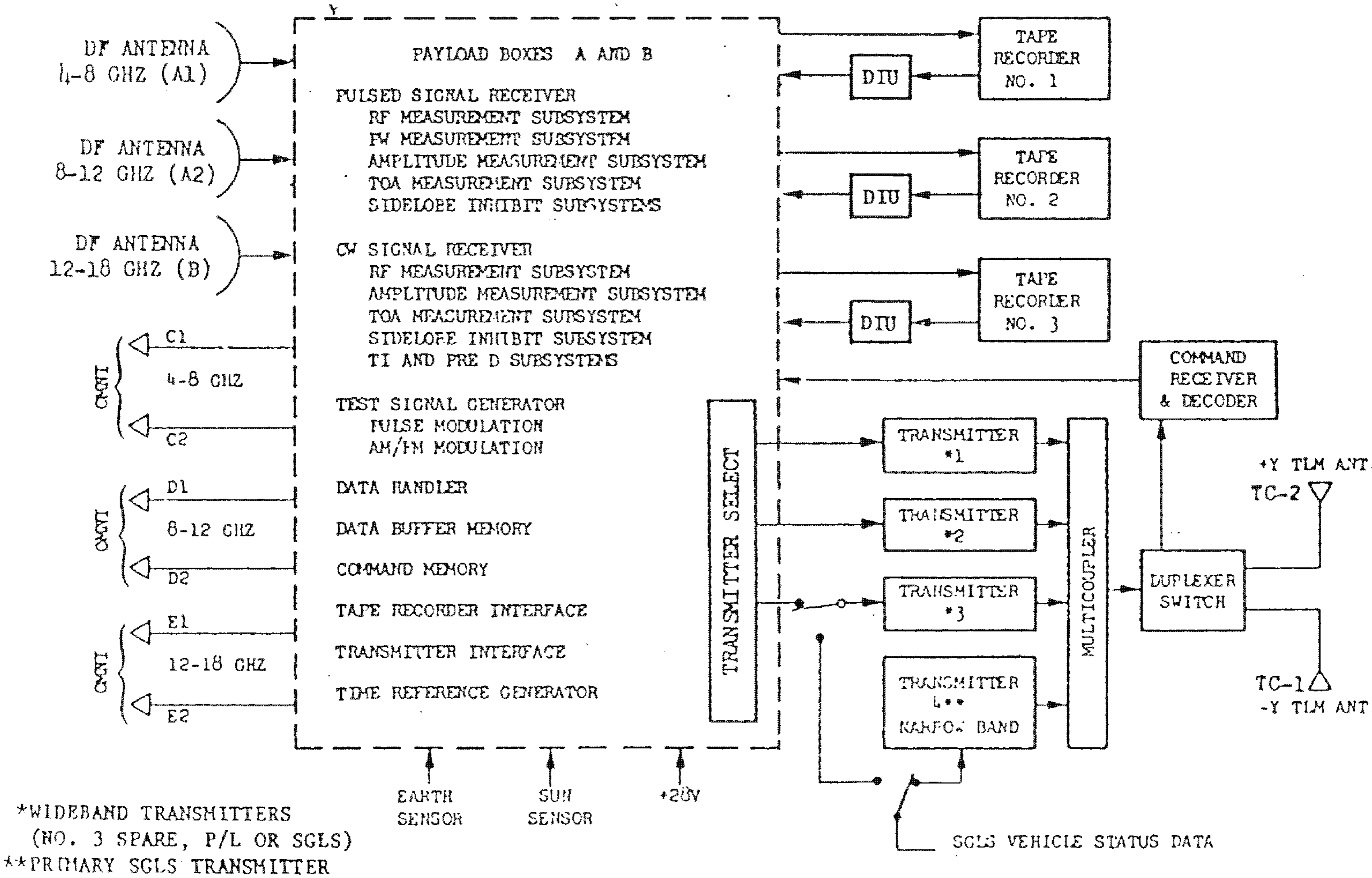

Figure 10. RAQUEL IA Spacecraft Simplified Block Diagram

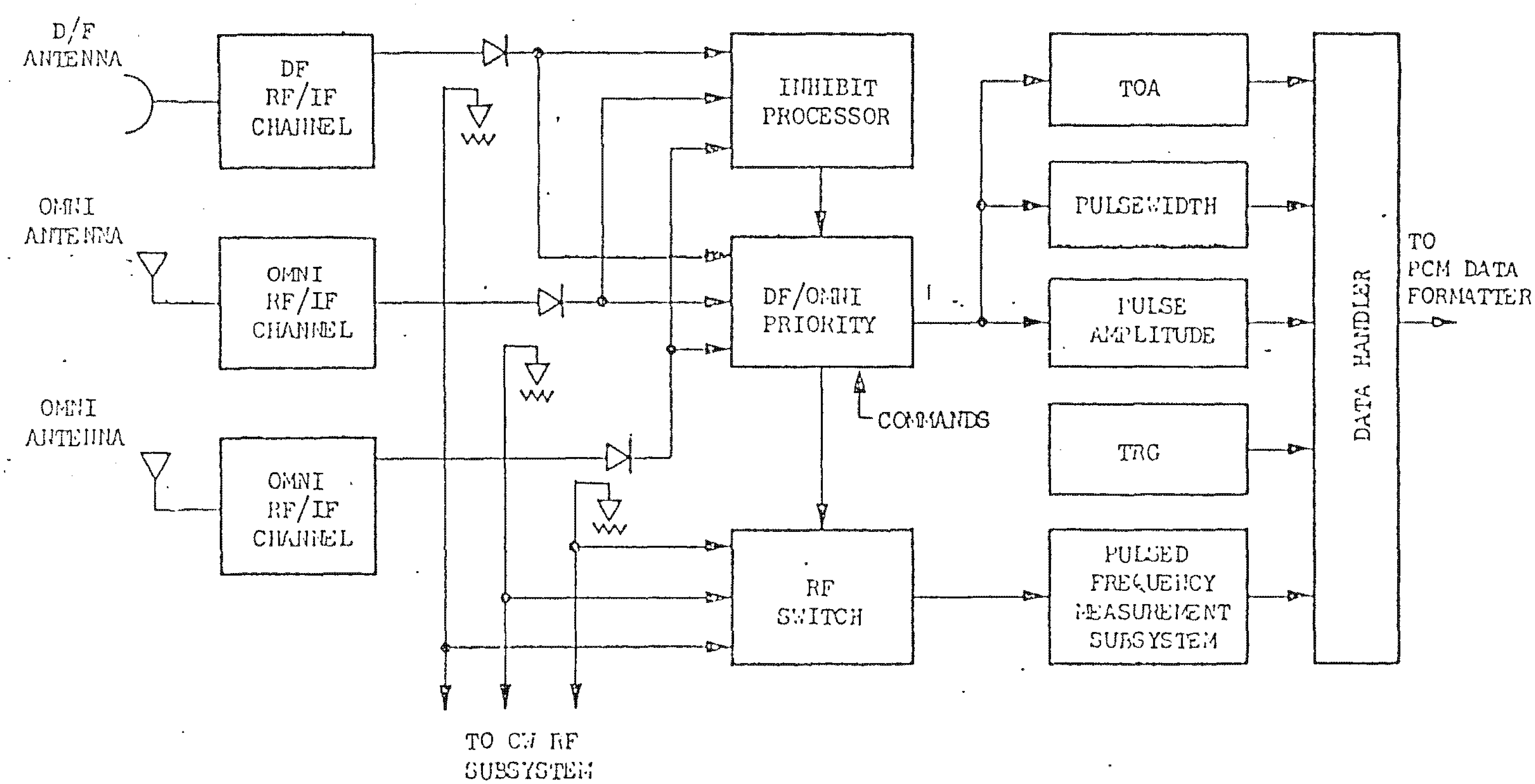

Figure 11. RAQUEL Pulse Receiver Simplified Block Diagram

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In approximately 1976, URSALA III was launched and URSALA IV was in storage in a nitrogen tent to be launched about three years later. Sometime prior, the NRO decided not to continue the program and to let it die with the end of URSALA IV. Due to objections expressed by data users, there was substantial pressure to continue or reinstate the program. In order to do this funding from both the tactical EOB users and the technical intelligence users was needed to cover the costs of a replacement vehicle.

The previous decision to separate the search and EOB functions (with geolocation) from the technical intelligence functions into different vehicles was reversed at this point and both functions were put into a vehicle that combined basically the functions of RAQUEL and URSALA into a single vehicle at first called SAT 1 in 1976.

The SAT 1 study, with proposed EOB and TI functions plus coverage from 2 to 18 GHz in a single vehicle, was performed by Lockheed. A technical intelligence receiver and a mainbeam capability were provided over the full frequency range together with a set of directional antennas for general search/EOB. The concept was funded in approximately 1977 and construction started in 1978. The vehicle was then renamed FARRAH. FARRAH I provided EOB, general search, TI, and directed search for both pulsed and CW emitters on sidelobes and mainbeams over the 2 to 18 GHz frequency band. In addition, an onboard processing experiment (OBPS) was included for downlink data rate compaction.

The SAT 1 initiatives required the combining of URSALA and RAQUEL into FARRAH plus some mission augmentation including:

1. A 10-MHz A/D/A bandwidth compression (BWC) channel to provide 0.25 msec analog snapshot on tape or transpond.

2. An increase in pulse handling rate from 100K to 400K pps with an increase in high-speed buffer size from 512 to 2,048 IWGs.

3. Improved sidelobe inhibit through the use of guard horns and improved OMNI antennas.

4. A rudimentary OBPS demonstration using the CDC-469 computer as a deinterleaver.

5. DF accuracy and sensitivity improvement studies.

6. Vulnerability hardening studies.

FARRAH

The FARRAH I vehicle was launched in May 1982 and before engineering checkup was completed it began to provide critical intelligence on the Falkland Islands war along with the URSALA and RAQUEL vehicles.

The FARRAH collection system is capable of collecting, processing, analyzing, and reporting signals from pulse and CW emitters in the 2 to 18 GHz frequency range to satisfy the following primary mission objectives:

1. General Search (GS). Search for new or unusual signals from new or modified weapons systems over wide ranges of frequency and broad geographical areas.

2. Technical Intelligence (TI). Determine the operational characteristics and performance capabilities of foreign weapons systems at specific frequencies and locations.

3. General Surveillance/Electronic Order of Battle (EOB). Monitor the operational status and deployment of emitters associated with weapons systems over wide ranges of frequency and broad geographical areas.

4. Directed Surveillance (DS). Monitor the operational status and deployment of emitters associated with weapons systems involved in tactical operations at specific frequencies and locations and provide time critical reporting (TCR) in specific crisis situations.

FARRAH SIGNAL INTERCEPT CONCEPT

The Mission 7300 FARRAH spacecraft was developed to maximize combined geographic and frequency (or geofrequency) coverage. This provides (similar to URSALA and RAQUEL) a 2 GHz instantaneous bandwidth switched in frequency in synchronism with each antennas as it begins a scan of the earth to provide either segmented or contiguous coverage of up to 14 GHz of the spectrum (usually 10 GHz). The highly inclined low-altitude earth orbits give Mission 7300 satellites access to virtually every point on the earth at least once a day, and most areas several times each day. Thus, each satellite searches for emitters operating over any 10 or 14 GHz segment of the 2 to 18 GHz frequency spectrum and maps their locations over many millions of square miles during each day of operation.

Figure 12 shows the RF coverage and tasking plan used in the recent 7300 series vehicles. The FARRAH vehicles use five band tasking which provides a unique time/frequency stepping pattern to provide 10 GHz coverage of the target area on each pass. Seven band tasking is possible with some loss of ground coverage (candystriping).

The FARRAH satellites have the same two intercept modes developed with RAQUEL and URSALA: sidelobe intercept and mainbeam intercept. High-gain dish antennas scan the earth horizon-to-horizon with sufficient sensitivity to intercept sidelobe radiation from most radars and signals from a variety of communications systems. Thus, the probability of intercept is relatively independent of the emitter beam pointing direction. Sidelobe collection occurs when the satellite intercept antenna points toward an emitter operating in the receiver collection band, as illustrated in Figure 13.

Omnidirectional intercept antennas on the satellite provide a lower sensitivity over the entire area to the horizon. These OMNI search antennas intercept primarily mainbeams and strong sidelobes. Mainbeam collection occurs, for example, when the satellite passes through the beam pattern of a horizon search radar. As the spacecraft rises above the horizon and the radar beam points (or scans) in the direction of the satellite, power, and frequency profiles of the radar beams are recorded. In this manner, signal parameters, beam scan characteristics, and radiated power levels are measured for technical analysis of foreign weapon system capabilities and vulnerability to jamming.

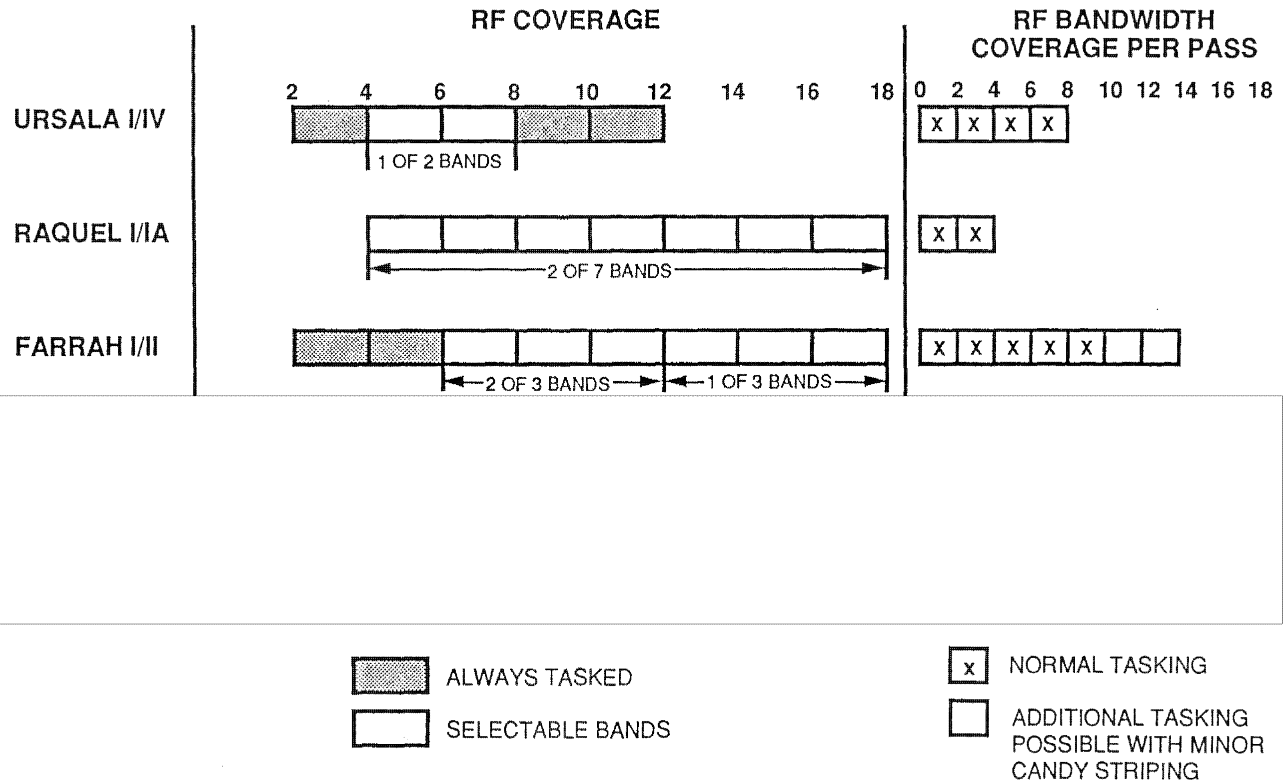


Figure 12. Recent Mission 7300 RF Coverage and Tasking Per Pass Over a Target Area

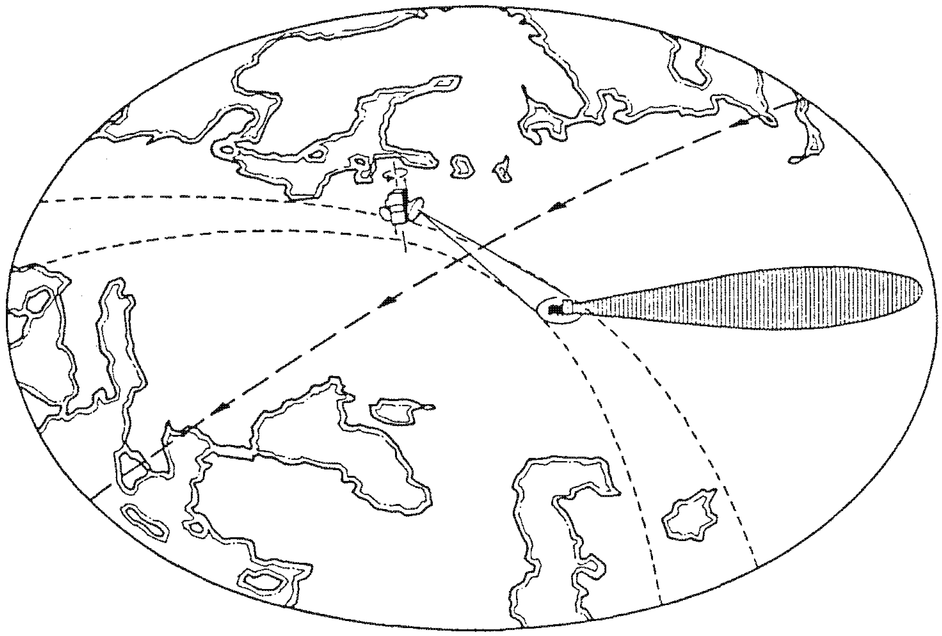


Figure 13. FARRAH Intercept of Emitter Sidelobes

Low power, highly directive signals such as microwave communication transmissions generally require the satellite to pass through the target emitter beam for detection to occur. Mission 7300 low altitude non-repetitive ground track orbits afford numerous intercept opportunities against such difficult targets as periscopic microwave relay towers, for which a portion of the communications antenna beam "spills over" the tower reflector plate and points vertically up from the earth. See Figure 14.

Receivers are of three types: a pulse receiver, which intercepts and extracts parameters from pulsed signals; continuous wave (CW) receiver, which makes measurements on non-pulsed or very high data rate signals; and the Technical Intelligence (TI) receiver, which can either record a snapshot of up to 10 MHz predetection signal bandwidth directly (rather than measuring signal parameters onboard), or perform a spectral analysis of a 13-MHz segment of the spectrum. The FARRAH I/II spacecraft have three recorders [redacted] for redundant storage of digital intercept data from pulse and CW receivers, and compressed bandwidth analog or spectrum analysis data from the TI receiver. Recorders are commanded to replay data through the downlink to a network of remote ground stations. Electrical power is provided by solar cell arrays, with batteries providing power during periods when the satellite is 25X1

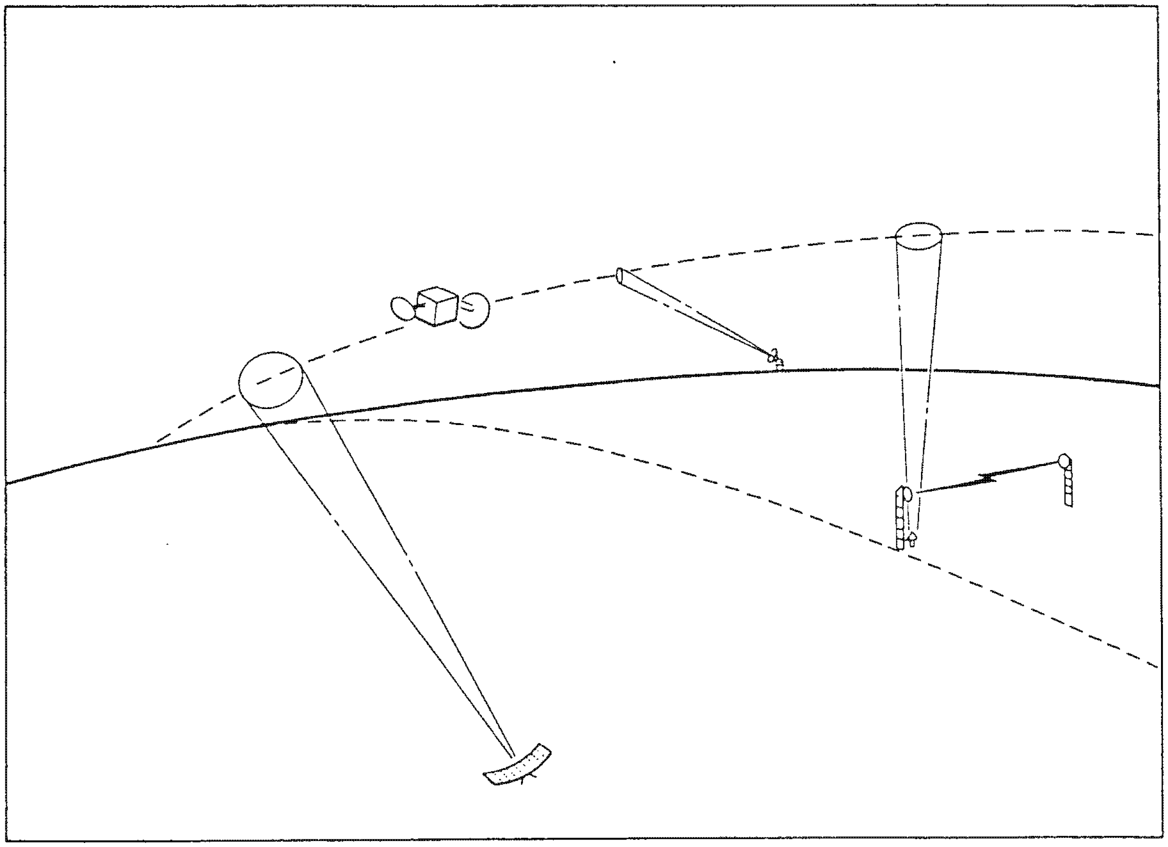


Figure 14. FARRAH Intercept of Communication Links

eclipsed by the earth. The satellite is spin stabilized with its spin axis parallel to the spin axis of the earth, and fine control of the spin axis is maintained by a magnetic attitude control system. Small solid rockets mounted on the periphery of the vehicle spin the satellite after launch. A magnetic spin rate control system maintains a near constant spin rate.

Spin stabilization serves also as the mechanism for moving the intercept swath across the earth, scanning the high-gain antenna beam across the earth from horizon-to-horizon as the spacecraft moves along its orbital trajectory. The high-gain antenna's footprint moves across the earth, intercepting signals from emitters within the intercept swath, as in Figure 14. The next sweep of the antenna beam overlaps the first to give continuous coverage of the surface from the rotational motion of the antenna and the orbital motion of the satellite until virtually the entire earth is mapped during the period of one day.

THE FARRAH I/II SPACECRAFT

The FARRAH I/II spacecraft is shown in Figure 15. It operates on orbit with a spinning, high-gain antenna subsystem capable of providing sidelobe intercept of emitters, and with a low-gain antenna subsystem having near horizon-to-horizon coverage capable of providing intercepts of emitter mainbeams. The antenna subsystem makes the RF spectrum from 2 to 18 GHz available to a receiver subsystem measuring the parameters of pulse and CW signals.

The spacecraft segment was carried into low-altitude orbit on a KH-9 host vehicle. The vehicle is shown in Figure 16. The spacecraft then separated from the host vehicle, spins up, and orbital boost rockets were used to achieve a new higher circular orbit at a nominal altitude of 382 nmi. Solar arrays and antenna subsystems were deployed to provide power for the spacecraft, collection of emitter signals, and communication to and from ground stations.

The FARRAH I/II block diagram is shown in Figure 17. A total of 12 antennas are used for signal intercept in the 2 to 18 GHz range: three high-gain pencilbeam antennas for target emitter sidelobe intercept and geopositioning, six omnidirectional antennas that provide emitter mainbean collection and inhibit protection for the high-gain antennas, and three moderate gain guard antennas for inhibit of the forward lobes of the high gain antennas.

The three high-gain antennas cover the 2 to 6 GHz band, the 6 to 12 GHz band, and the 12 to 18 GHz band. The feeds for these dishes are four-arm spirals whose arms are connected to a beamforming network that produces the sum and the difference signals. The amplitude ratio and the relative phase of these two signals define the [redacted] 25X1 The 25X1 signals from the guard antenna and the back-to-back wide beam antennas, one set covering the 2 to 6 GHz band, a second set covering the 6 to 12 GHz band, and a third set covering the 12 to 18 GHz band. The inhibit signal is used to reject signals received via all but the main lobes of the high-gain antennas. In addition, the widebeam (OMNI) antennas are used for emitter mainbeam intercept measurements.

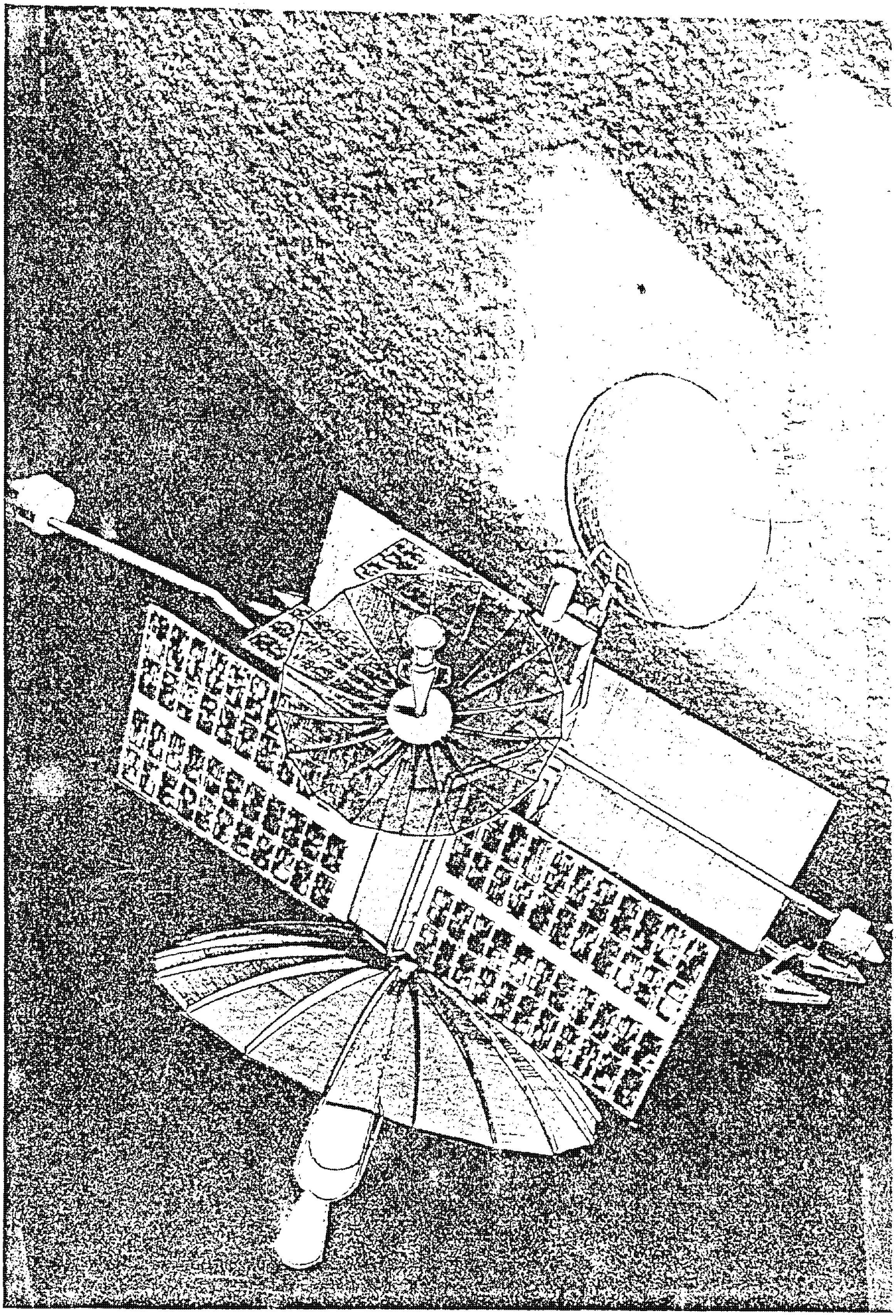


Figure 15. FARRAH I/II Spacecraft

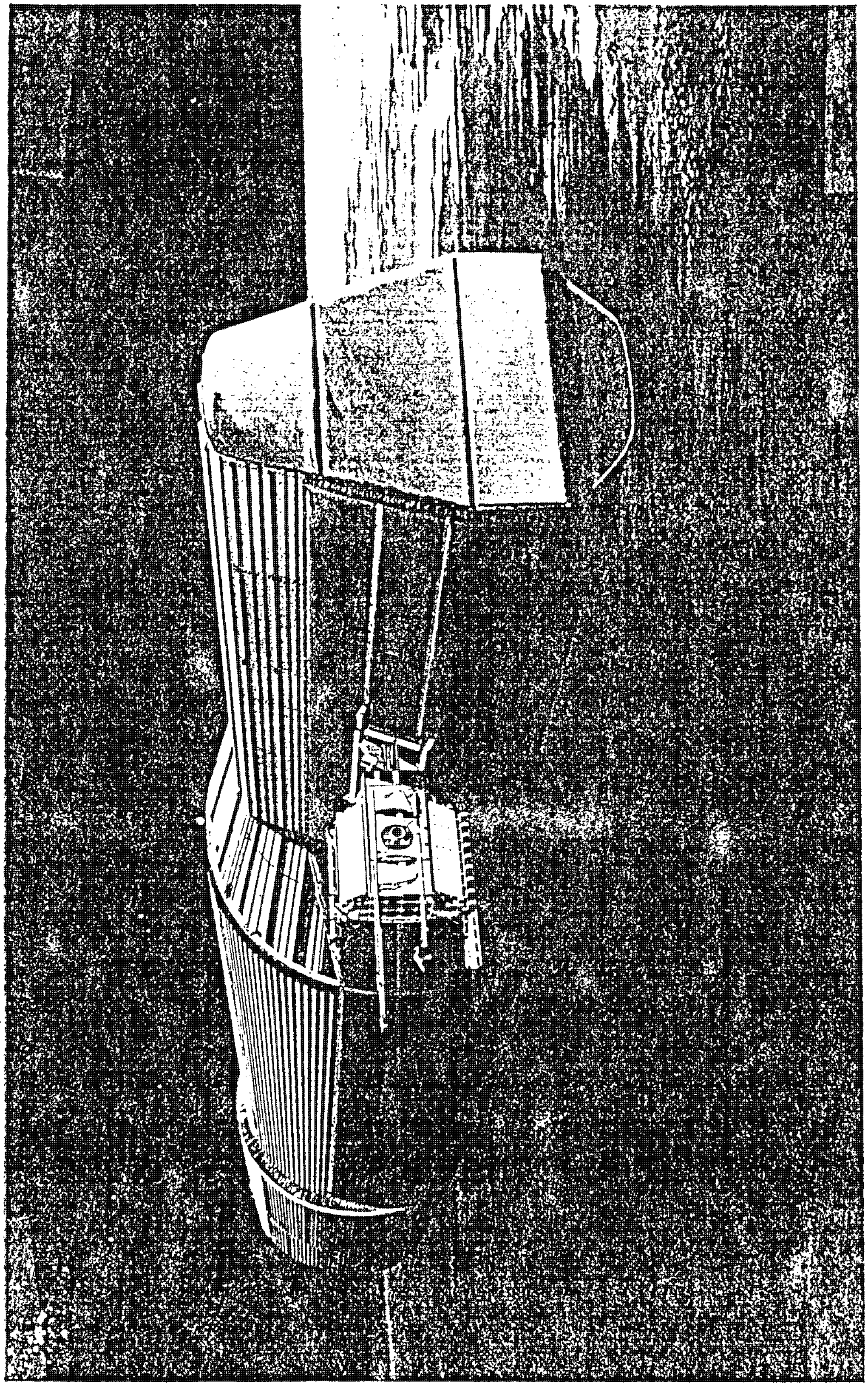


Figure 16. P-11 Spacecraft Mounted on Host Vehicle

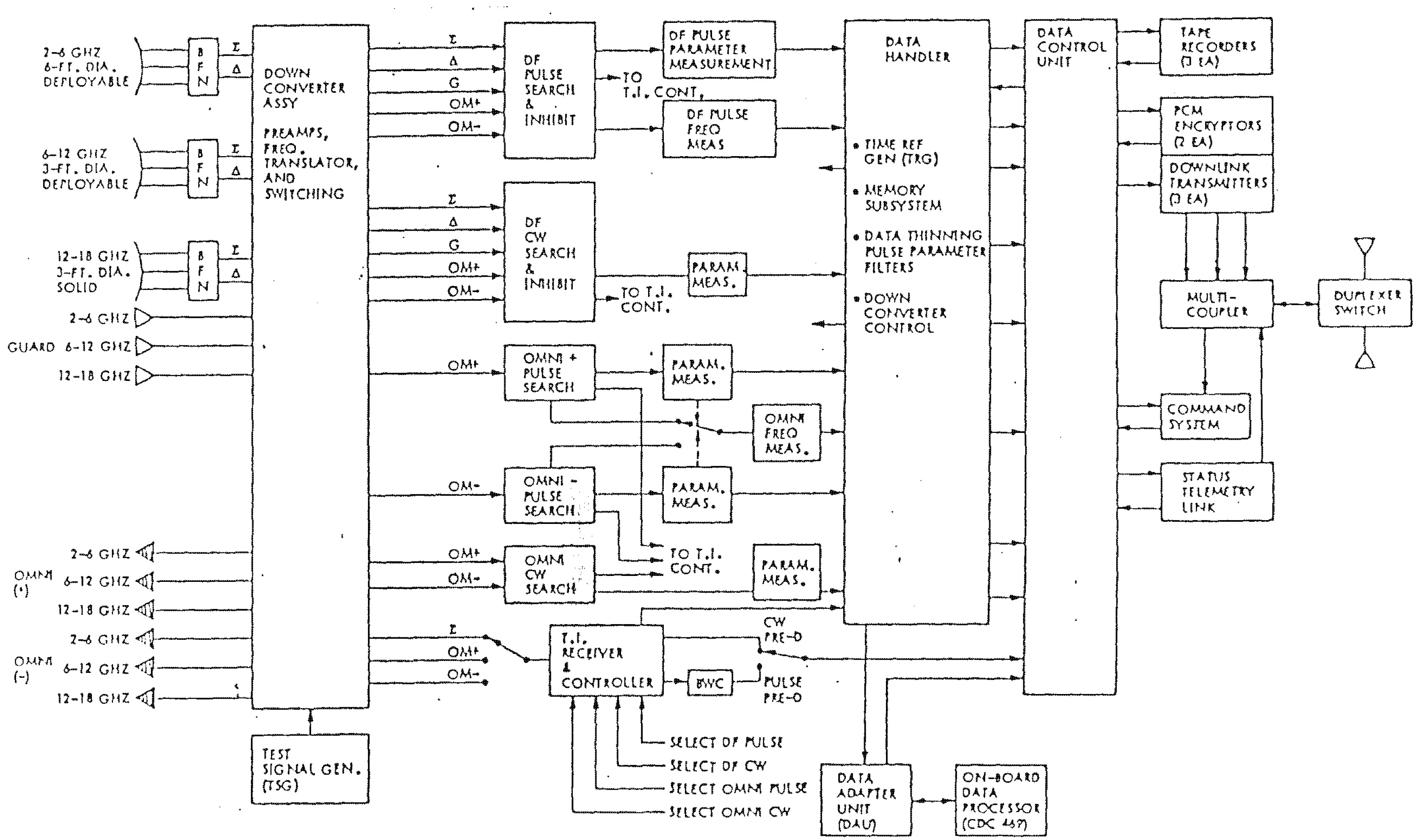


Figure 17. FARRAH Intercept System Block Diagram

The OMNI inhibit antennas are positioned on deployable booms so that their amplitude patterns over the side lobes and back lobes of the high-gain antennas. On two of the booms, one antenna pair covers the band from 2 to 6 GHz and the other antenna pair covers the band from 6 to 12 GHz. A third OMNI antenna pair covers the band from 12 to 18 GHz.

The FARRAH II vehicle is almost identical to the FARRAH I vehicle. At the highest level, the FARRAH payload consists of:

- A five-channel RF to IF downconverter operating in the frequency range from 2 to 18 GHz. The channels consist of two monopulse channels (sum, delta), two OMNIs (top and bottom), and a guard inhibit channel.

- Five receivers operate in the frequency range from 2 to 4 GHz (IF). This represents five DF pulse receiver channels, two OMNIs pulse receiver channels, one TI channel, five DF CW receive channels, and two CW OMNI receiver channels.

- A data handler which stores the desired payload operational command configuration, provides time reference data from a time reference generator (TRG), combines the measured data form the five receivers into digital PCM intercept word groups (IWGs), stores these IWGs in a 2000 IWG solid state buffer memory, and creates a continuous PCM data stream containing these IWGs for delivery to the spacecraft tape recorders or data links.

- A data control unit (DCU) which controls the flow of all payload data to the spacecraft tape recorders and wideband data links.

- A data adapter unit (DAU) which controls the flow and form of all data between the receivers and an onboard general purpose digital computer (advanced spacecraft computer (ASC)).

- A test signal generator (TSG) which supplies test signals to the payload in order to verify proper operation of the downconverter, receivers, and data handler.

- Power supplies, cabling, connectors, and other essentials.

Pulse and CW signals collected by the high-gain antennas have the following measurements made: amplitude, frequency, and direction of arrival (DOA). The pulse width and [redacted] Pulse and CW signals collected by the low-gain antennas have these same measurements made except for DOA. A predetection analog output makes information available on carrier modulation (frequency and/or phase) and other possible unique characteristics of both CW signals and pulsed signals. 25X1

TRACKING, COMMAND, AND CONTROL

Telemetry, tracking, and control is provided by a standard S-band space-ground link system (SGLS). Both digital and analog data readout is through a wideband downlink and [redacted] 25X1

TASKING

General intelligence collection guidance is provided by the National Foreign Intelligence Board (NFIB) through the SIGINT Overhead Reconnaissance Subcommittee (SORS) to the Director of NRO. Detailed tasking is developed within the NRO Detachment, Ft. Meade (NDF) component of the National Reconnaissance Office. Specific guidance from the NDF and the National Security Agency (NSA) as well as the general guidance from SORS is used by the mission planning group [redacted] for developing a daily tasking plan. 25X1

Tasking is relatively insensitive to geographic priorities (as compared to some collection systems) because antenna pointing does not have to be decided on a priority basis. Rather, primary tasking is in the selection of broad geographic areas and frequency bands to be searched. Currently operational satellites are capable of accepting intercept segment tasking in any four of the five bands over which they operate. Mission 7346 can be tasked on each intercept segment to search any five or seven of eight bands within its operating frequency span of 2 to 18 GHz.

The daily tasking plan is converted to a series of satellite commands [redacted] 25X1
Intercept and downlink commands are transmitted via relay satellite to selected remote tracking stations for retransmission to the satellites when they come into view.

<u>INTERCEPT</u>

Whenever the satellite payload is commanded to activate, receivers tune to selected frequency bands and recorders are activated. Intercept segment lengths are varied to optimize collection and processing under constraints of the time-criticality of reports from the are being accessed [redacted] spacecraft power consumption, [redacted] efficiency. Typical intercept segments for one day's operation of a FARRAH satellite is shown in Figure 18. Solid lines indicate the portion of the orbit trace over which the payload was activated.

<u>DATA RETURN</u>

Signals intercepted by the satellite payload are either transponded, or recorded and stored onboard until the spacecraft passes in view of a remote tracking station. When the tracking station commands a data readout, onboard recorders dump stored data through a wideband downlink. [redacted] 25X1

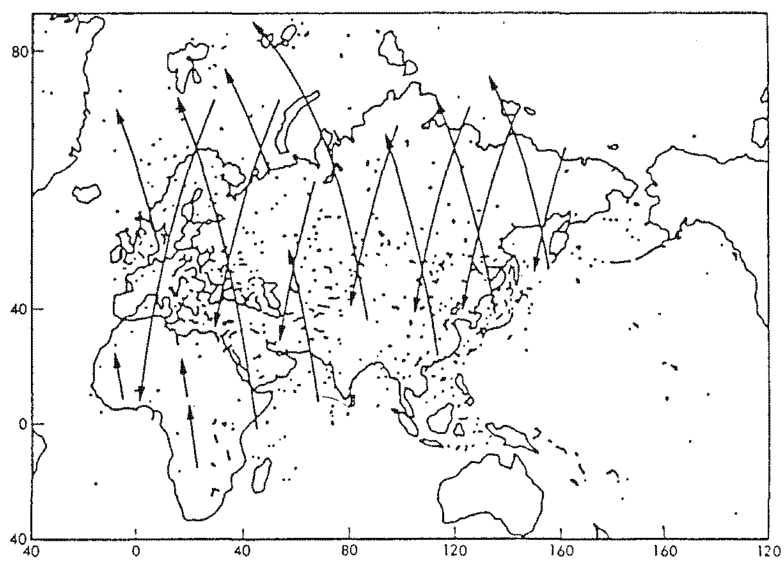
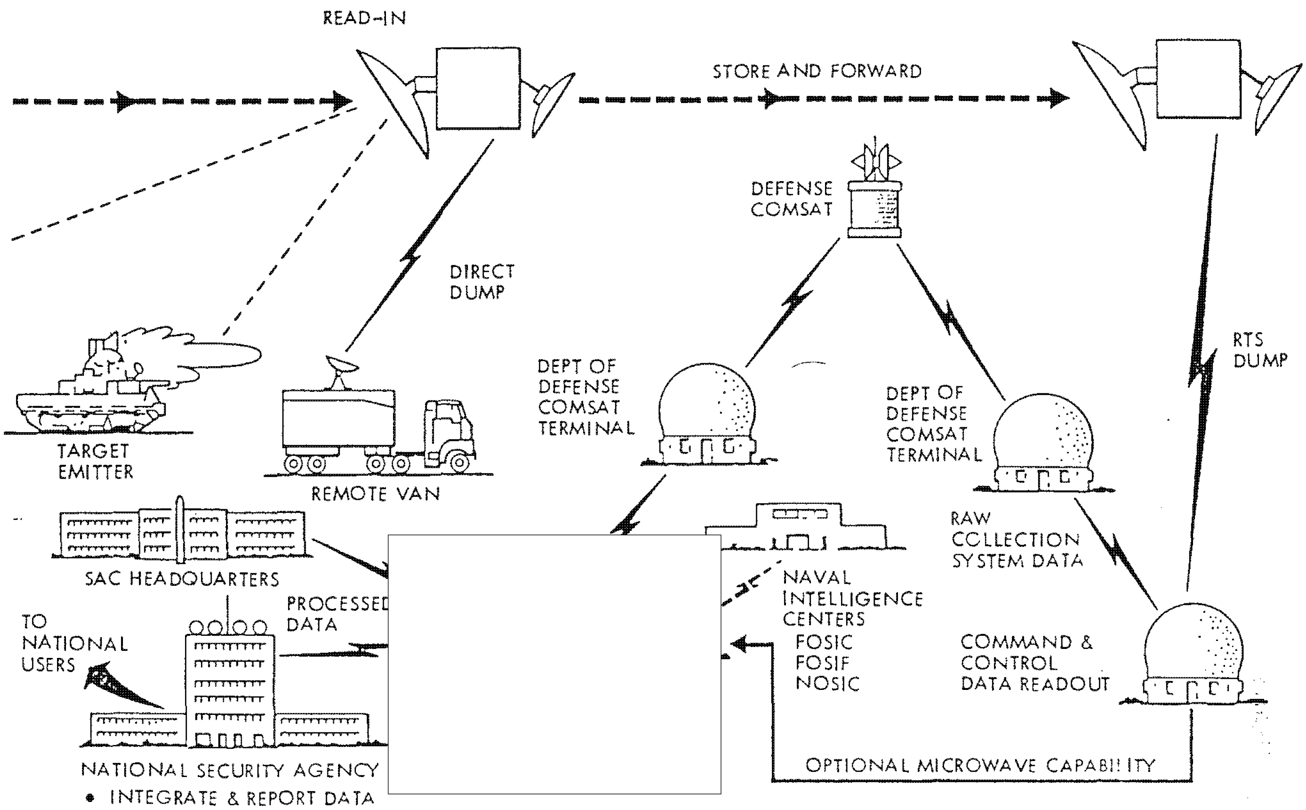


Figure 18. FARRAH Orbital Ground Traces

verification, and reporting. Transponded data can also be transmitted to Tactical ELINT Processing (TEP) and Electronic Processing and Dissemination System (EPDS) Vans for direct tactical exploitation. Communication links used for data flow throughout the FARRAH system are shown in Figure 19.

PROCESSING AND REPORTING

[redacted] intercepts are sorted by geographic regions into time-critical areas and non-time-critical areas, with time-critical data being analyzed, verified, and reported within three hours of intercept in the FARRAH I timeframe (now within 10 minutes). The remainder of the data from areas outside operationally time-critical geographic areas are processed on a routine basis and reported within 24 hours. Both time-critical and routine reports are transmitted directly to Strategic Air Command (SAC) headquarters in Omaha, Nebraska, to NSOC at Fort Meade, Maryland, and the Defense Intelligence Agency (DIA) in Washington, DC.



25X1

Figure 19. Data Links Diagram for the FARRAH I/II System

The National SIGINT Operations Center (NSOC) merges intercepts from Mission 7300 with data from other sources for reporting to operational forces, worldwide; to NSA for signal analysis; to CIA for general intelligence analysis; or to the services' Foreign Technology Centers for detailed weapons system analysis; and other users. [redacted] 25X1

Technical capabilities of the system include coverage of the RF spectrum from 2 to 18 GHz with up to 14 GHz of the total range accessible on each intercept segment; adequate sensitivity for sidelobe intercept and location of most radars; narrowband sensitivity adequate for intercept and location of a variety of communications and uplink signals; access to virtually every point on earth at least once each day, with more than four daily accesses to the Soviet Union, Europe, and the Middle East assuming two operational FARRAH I/II satellites were maintained on orbit continuously.

THE BLOCK CHANGE

The loss of the last KH-9 and the KH-9 host changed the nature of the FARRAH spacecraft. A new means to get Mission 7300 vehicle in orbit was necessary. Unfortunately, the [redacted] 25X1

In the redesign of the FARRAH III spacecraft following improvements were incorporated:

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[redacted] 25X1

EHF SEARCH REQUIREMENTS

From time to time, coverage of other frequency ranges was needed for suspected Soviet weapons systems developments. An example of this was the LORRI I system which covered 26 to 42 GHz and was flown in June 1980. This concept was developed in the 1973 to 1974 time frame, and through funding stretch-outs took a long time to complete. It provided general search, EOB, and TI for both pulse and CW emitters and rode on a stable platform host vehicle (KH-9). The original LORRI concept also covered the 18 to 26 band and had a higher frequency resolution handover receiver based on a compressive spectrum analyzer that would hand over from intercepts in the individual coarse filter cells for much higher sensitivity measurements, particularly on the CW signals. Both the 18 to 26 coverage and the handover receiver were eliminated for cost reasons. Although the LORRI system was not the first EHF space-based system (Program C flew an earlier, largely unproductive mission) provides numerous intercepts of Soviet and Chinese emitter.

The LORRI II pallet was expanded to cover three additional frequency ranges. These included two W-band collection ranges (92 to 96 GHz and 70 to 74 GHz) and a VHF collection window centered at 158 MHz to collect signals from the [redacted] and HEN HOUSE 25X1 radars. Unfortunately, a Titan launch failure resulted in the loss of the LORRI II mission and the destruction of its KH-9 host.

Shortly thereafte[redacted] SP-6 began to explore the concept of alternative low 25X1 cost collection options, which led to the GLORIA series of satellite. GLORIA I was originally conceived for a search mission to collect signals in the 18 to 26 GHz region. However, due to the loss of the LORRI II mission, the collection window was raised to 30 to 38 GHz. Like the LORRI I collector GLORIA also implemented channelized receivers; however the GLORIA receiver covers the entire 8 GHz band instantaneously. Gloria is a spin stabilized satellite with a single one foot parabolic collection antenna. Due to the small budget and short build schedule, GLORIA used an available command decoder and 6 MHz solid state memory. GLORIA carried a 64-channel 250-MHz channelized receiver with 32 channels each of two cross linear polarizations. This was four times the collection bandwidth and twice the instantaneous RF coverage of the LORRI system at a small fraction of the cost.

Early in flight, the solid state memory suffered from radiation and latch up problems which have been overcome. GLORIA I is still performing its collection mission and has intercepted a larger number of DF signals than the earlier LORRI missions. Collection highlights include the [redacted] various battlefield radars, nine new unidentified signals, 25X1
and the EHF signals associated with the [redacted] 25X1

[redacted] GLORIA II is planned to be launched. It will survey the 25X1
original 18 to 26 GHz frequency range. GLORIA II is similar to GLORIA I with the major exception of the different band of operation, 18 to 26 GHz. In addition, its memory, command decoder, and mass memory controller have been upgraded to overcome early flight deficiencies. GLORIA II will be the initial overhead search capability in the unexplored 18 to 26 GHz range. See Figure 21.

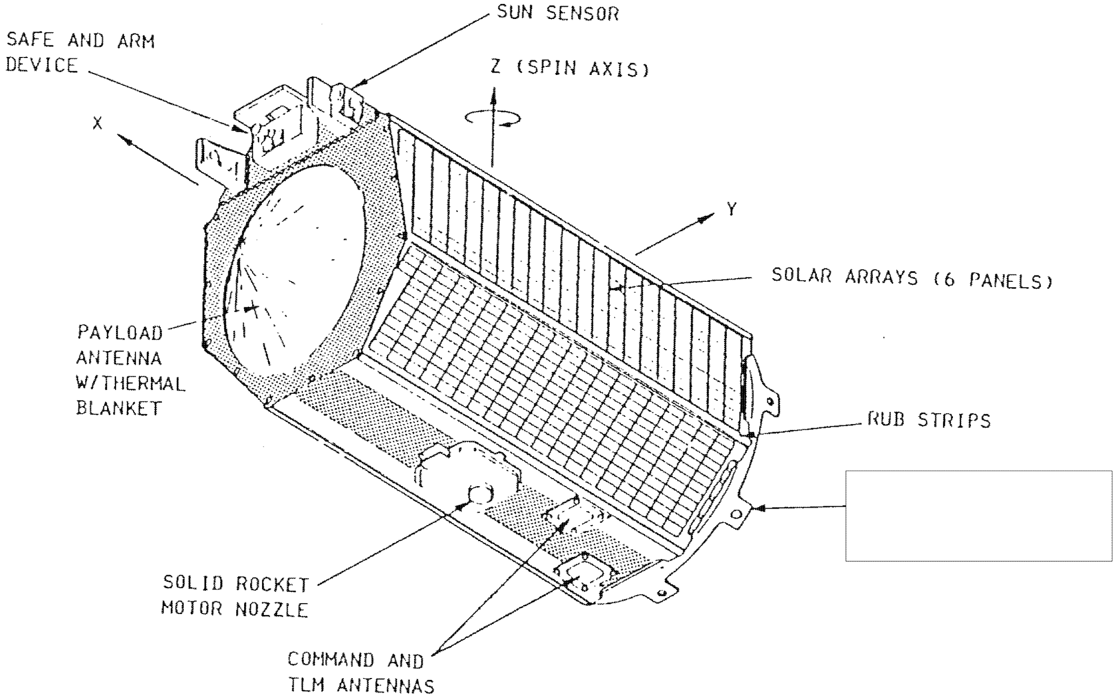

Figure 21. GLORIA II Space Vehicle

~~TOP SECRET~~ ~~ZARF/UMBRA~~

HANDLE VIA
BYEMAN-TALENT-KEYHOLE-COMINT
CHANNELS JOINTLY

25X1

25X1

BIF-771-0334/90