5 The Air Force AFTRACK and [redacted]

The Origins of Quick Reaction SIGINT in Space

In the summer of 1957, Col Frederic C. E. "Fritz" Oder, Director of the WS-117L Project Office at the Air Force Ballistic Missile Division (AFBMD), Inglewood, California, struggled with a very difficult budgetary crisis. Funds for missile and space activity had fallen victim to an austere DOD budget, providing only $10 million for FY57, with promise of little more in FY58. Oder and BGen Osmond J. Ritland, the Deputy Commander of AFBMD, decided a new approach was required to obtain effective support for the project. Their previous associations with the CIA on the U-2 project led them to the belief that a covert approach would be more palatable and effective, particularly in view of President Eisenhower's desire to secure "Open Skies." The plan would involve the concept of covert overflight from orbit, participation of the CIA, and a definite project acceleration. Oder's secretary Betty Hawkins called it the "second story" because she was required to keep the details in a file separate from the WS-117L documentation.

Col Frederic C. E. Oder

The centerpiece of the plan was a covert photo payload with a recoverable film capsule, to be launched on Thor boosters, earlier than the already planned Atlas launches. On 7 February 1958 President Eisenhower, in a meeting with James Killian, approved the plan. Eisenhower's decision was prompted in part by the launch of Sputnik I in October 1957. Richard Bissell, Assistant Director of the CIA and the U-2 Project Director, had agreed to head the CIA effort that would be responsible for the covert security system and procurement of the photo payload. Also in February 1958, President Eisenhower established the Advanced Research Projects Agency (ARPA) to consolidate all military space systems development. Since ARPA would be responsible for the "white" development of the reconnaissance spacecraft, booster, and all support systems, Oder arranged for his assistant on WS-117L, Capt Bob Truax, US Navy, to be assigned to ARPA to assure adequate coordination between the white support systems and the "black" CORONA payload. ARPA named the cover for the capsule recovery project DISCOVERER and assigned to it biomedical and other scientific activities to disguise its real mission.

In November 1959 the DISCOVERER project was reassigned from ARPA to the Air Force as an "operational" project. When BGen Robert E. Greer became Director of the SAMOS Project in August 1960, he used the authority of his "second hat" as Deputy Commander of AFBMD to incorporate Col Lee Battle and the DISCOVERER Project Office into his organization. To the unwitting ("white") Air Force and to the world at large it appeared that DISCOVERER was an AFBMD scientific project.

Harold Willis

These events set the stage for the invention of the Agena AFTRACK Project. Harold Willis, who worked for George Miller in the Office of ELINT (OEL) at CIA Headquarters in Langley, Virginia, was briefed on the CORONA project in 1959 because of concern in the Intelligence Community about the electronic security of the DISCOVERER Agena spacecraft's commanding and tracking subsystems. It was thought that the Soviets might be constructing antiballistic missile (ABM) or anti-Earth-satellite (AES) radars that could be used to track or even interfere with the US tracking of DISCOVERER satellites.

Willis was aware of the role of the Lockheed Missile and Space Company (LMSC), not only as the system engineer for development of the DISCOVERER Project, but also for the Air Force SAMOS Project, which included an ELINT capability called Subsystem F (S/S F). If a Soviet radio frequency (RF) transmission or interference threat existed, there was a good chance that in several years S/S F would be capable of detecting it. But Willis felt the Soviet RF threat could develop much sooner and that waiting several years to detect it was a very risky proposition. In discussions with Bill Harris of the LMSC S/S F payload staff and Maj John Copley, the Air Force S/S F SAMOS payload manager, Willis concluded that a small, self-contained electronic payload permanently attached to the aft rack of the DISCOVERER Agena vehicle would be capable of detecting any Soviet tracking or interference with the S-band beacon used on the Agena vehicle. This critical beacon was used for tracking and commanding the vehicle through US Verlort ground radars. Copley obtained approval and the minimal funding necessary for the payload development, test, and incorporation on the aft rack of the Agena. Willis briefed Bissell and obtained CIA approval of the scheme in November 1959. The small AFTRACK project was underway.

Although S/S F procurement was done in the white world at the DOD SECRET level, there was general agreement that, in keeping with the covert nature of the CORONA payload, activities associated with the AFTRACK project should be handled on a strict need-to-know basis. In the same way they had provided the Hiller Aircraft Building as a cover for the CORONA development, LMSC arranged office space on Hanover Street in Palo Alto, California, for Bill Harris to conduct payload development and integration activities. Only those people directly associated with the project were made aware of its existence.

From this modest beginning, the concept of a quick reaction capability (QRC) payload that was small, simple, and required minimal development time caught on rapidly. QRC developmental activities for intercept of ELINT had a history in the Air Force dating back to the Korean War, when radar technology was advancing at a rapid rate and collection systems that required years of normal development time were hard pressed to keep up. The plan was to build systems that could be developed in less than nine months, did not necessarily conform to all military standards (even commercial parts were allowed), but could operate reliably for a long enough period to answer urgent questions and provide inputs to the Intelligence Community and to the design of collection systems then under development. The program had started at Wright-Patterson AFB, Ohio, at the Wright Air Development Center (WADC) in the early 1950s for airborne equipment (primarily in the area of electronic warfare). The ground QRC program was initiated at Rome Air Development Center in 1955, and Copley was chosen as the first ground QRC officer. This background provided the necessary basis for the concept of simple, rapidly developed, and effective AFTRACK payloads fixed to the DISCOVERER Agena vehicle.

The aft rack of the Agena vehicle was well suited to this application. There was considerable vacant space available; the real problems were power and weight. Small, simple, lightweight payloads requiring minimal power were ideally suited to this application. A few extra telemetry points were always available for narrowband data to be down-linked and a simple on/off command did not overtax the command system. The Agena vehicle developers had only one mandatory requirement: there must be a fuse in the power line of the SIGINT payload so that there was no way the primary payload power system could be jeopardized. Since the DISCOVERER Agena vehicle flew with its major axis perpendicular to nadir (so that the CORONA camera, mounted at right angles to the long axis of the Agena, would always point toward the Earth), it was no problem to install Earth-pointing antennas on the aft rack.

Initially the DISCOVERER vehicle had a lifetime limited to five or six days, owing to complete reliance on battery power. This limited the collection time for the AFTRACK payloads but it was long enough to collect useful data. When the CORONA Program developed a capability to return two recovery capsules, a system [redacted] For this it was necessary to add an independent programmer and data link. This was done and many later AFTRACK payloads did operate during the [redacted] Very early in the AFTRACK program, recorders had been added (where the telemetry recorder was not adequate) so the payload could collect data over the Soviet Union and return it to the remote tracking stations (RTSs) of the US Satellite Control Facility (SCF) in Sunnyvale.

Security was a serious concern, as mentioned earlier, not only because of the CORONA payload on the same vehicle, but also to avoid providing the Soviets with ammunition to attack President Eisenhower's "Open Skies" efforts in space. Initially the project was handled at the DOD SECRET level and strict need-to-know was enforced. The initial DOD/CIA partnership agreement to participate in a National Reconnaissance Program (NRP) in September 1961 required stricter security. The SAMOS Program Office in El Segundo became the Office of Special Projects (SAFSP). LtCol Ed Istvan, who had been assigned responsibility for Space SIGINT Systems on the SAFSS staff in Washington, was tasked with developing a more secure system-access control. After struggling mightily with Air Force Security Regulation 205-1 (the SIGINT program was still under DOD security control), he came up with the codeword [redacted] to protect AFTRACK payloads. This required all personnel requiring access to sign an [redacted] security agreement, and a list of cleared personnel was maintained. Documents were stamped "SPECIAL HANDLING," in the same manner as the Air Force black GAMBIT photo project. The National Reconnaissance Office (NRO) was formed on 2 May 1962. In December 1962 the BYEMAN system was applied to all SIGINT Programs except [redacted] which remained "SPECIAL HANDLING" until November 1962. A new codeword [redacted] replaced the Air Force [redacted] and Navy POPPY designators. From that time on all space reconnaissance programs have been conducted by the NRO under security control of the BYEMAN system.

In December 1962 Copley was transferred from the DISCOVERER Program Office to the newly formed SIGINT Project Office of SAFSP as Chief, SP-8B Division, responsible for payload development. In November 1963, a new program number, [redacted] was assigned to disassociate the new BYEMAN effort from the previous DOD [redacted] program. Boosters, Agenas, and associated support equipment continued to be procured in the white world, but since that time all payloads have been procured through black BYEMAN contracts.

Five days prior to the launch of the first AFTRACK payload on DISCOVERER 13, 10 August 1960, the US Intelligence

Board (USIB) issued the first national-level SIGINT requirements document, USIB-D-33.6/8, "Intelligence Requirements for a Satellite Reconnaissance System of Which SAMOS is an Example," 5 July 1960. Paragraph 1c. stated: ". . . additional types of directed coverage may be required. Provision should be made to procure such equipment by Quick Reaction Capabilities (QRC)." Also ". . . a close working relationship between the R&D organization and the Intelligence Community is required." The AFTRACK project personnel felt that the program followed this direction very closely.

[redacted]

Work started on the first ARPA [redacted] called [redacted] in the spring of 1962. [redacted] Col Lee Battle and his staff at the DISCOVERER Project Office brought it to the attention of Maj John Copley, who sponsored the [redacted] AFTRACK payloads. [redacted]

[redacted] This development eventually led to the phasing out of the fixed aft rack payloads on the Agena vehicle except for the "vulnerability payloads," which were continued on the aft rack of all photo missions to detect hostile radar tracking of the vehicle. The last of the SIGINT AFTRACK payloads, mission 7225, SQUARE TWENTY, was launched 28 October 1965 on vehicle 1620. [redacted]

The AFTRACK Program

In early 1960, concern was growing in the US Intelligence Community that the Soviet Union was building not only missile systems but also systems to counter US missiles and satellites. U-2 photography had shown that large ground radar sites were under construction at the Soviet Sary

[redacted]

Shagan R&D test site in the vicinity of the missile launch pads. The Soviets also had several ships and trawlers equipped with large radomes whose purpose was not known. In February 1960, Harold Willis of the CIA Office of ELINT (OEL), having recently been briefed on the CORONA photo satellite program, contacted Maj Copley and told him of these concerns. He expressed the national-level fears that the Soviets might in some way interfere with the operation of the CORONA command and tracking subsystems.

Copley was responsible for the contract with LMSD to develop the ELINT subsystem, S/S F of the SAMOS System, for the Air Force with the Airborne Instruments Laboratory (AIL) at Mineola, Long Island, New York, as the subcontractor. Willis had discussed with Bill Harris of the LMSD S/S F office the possibility that support might be available on the aft rack of the CORONA Agena spacecraft for a small electronic "black box" that could detect any electronic interference to the mission. Willis had also discussed the problem with Gene Fubini of AIL, who became an enthusiastic supporter of the AFTRACK concept and suggested a small payload called SOCTOP, which received signals in the 2.5- to 3.2-MHz frequency band in which the Agena S-band beacon operated. It required only an on/off command and a few telemetry points to encode its output. Copley was able to obtain the minimal funding required, and Willis arranged for authority to mount SOCTOP on the aft rack of the DISCOVERER 13 Agena vehicle. The presence of SOCTOP created very little notice when DISCOVERER 13 was launched on 10 August 1960. Most of the attention was focused on the recovery capsule that attained fame as the first object to be recovered intact from an orbiting spacecraft (something the Soviet Union had not yet achieved).

The immediate analysis of the SOCTOP data was almost as remarkable as the capsule recovery. It showed what appeared to be Soviet tracking of the CORONA spacecraft on almost every readout by a US-operated tracking station (there was no recorder, so data could be received only when the spacecraft was in view of the tracking stations). That Soviet tracking was so extensive worldwide was a surprising and alarming discovery; Willis quickly passed the "tracking" story on to the Intelligence Community. However, further analysis of the data revealed that SOCTOP actually was receiving signals from US Verlort radars at the remote tracking stations (RTSs) as they tracked the spacecraft. Despite the embarrassment to Willis and others caused when the error was discovered, the small AFTRACK payload for QRC response to urgent ELINT questions did catch on!

SOCTOP was the first of a long series of "vulnerability" payloads, so called because of their part in an NRO program to determine susceptibility of reconnaissance satellites to hostile Soviet (or other) activities. Eventually this type of payload flew on almost every Program A low-altitude reconnaissance satellite launched. The objective was to determine if Soviet or other hostile radars were actually tracking or trying to interfere with the electronics on the vehicle and the degree of success they achieved. A byproduct of this activity was verification of the tracking radar characteristics or discovery of new variations in their patterns not seen previously. The payload configuration changed as new and improved tracking radars appeared and as collection payload technology improved.

In early 1963, following a series of SOCTOP launches, a competition was held by the Special Projects Office to design a more sophisticated payload capable of receiving and returning characteristics of signals in the [redacted] frequency range. A recorder was to be included, adding the intercept of radars tracking the spacecraft over the Soviet Union to the existing capability to observe tracking and interference in view of the US RTSs. Gene Pitsenbarger and his team at Electronics Defense Laboratory (EDL)-Sylvania in Mountain View, California, won the competition and produced the new version, [redacted]

The initial intercepts of the HEN HOUSE satellite- and missile-tracking radar in the [redacted] frequency region by the WILD BILL and POPPY satellite payloads in June 1963 led to the development of the BIT payloads tailored to this frequency range. By this time the NRO had been formed and the SAFSP in El Segundo, California, had been given responsibility for the development of a survivability program for all NRO vehicles. Accordingly, sponsorship of these "BIT boxes" was transferred from the SAFSP ELINT office to the SAFSP vulnerability office.

Maj Murray J. Sherline developed the concept of tailoring the frequency coverage of the BIT boxes to the known radar threats, rather than duplicating the mission of the ELINT satellites of looking for new threats. The data from the [redacted] missions was processed at the EDL-Sylvania plant at Mountain View, California. [redacted]

Many versions of the BIT boxes were developed as new radar data were received and as payload construction techniques improved. BIT I through [redacted] versions were built as more data on HEN HOUSE, DOG HOUSE, and the TRY ADD radars were collected. [redacted]

[redacted]

[redacted]

The BIT box output was distributed to NSA and other interested agencies and was also used to program the operation of, and sometimes to aid in the design of, other SIGINT satellite payloads. NSA had no responsibility for processing the vulnerability payloads but did benefit from the results. [redacted]

Following the first AFTRACK payload (SOCTOP 1), flown in August 1960, Gene Fubini and his AIL team came up with a simplified version of the forward rack SAMOS Project 102 payload (F-2) that would simply scan the 0.4- to 1.5-GHz band to detect radar activity in the Soviet Union, including suspected ABM/AES radars. Its mission was almost the reverse of SOCTOP (detection of ground radars rather than radar tracking of the satellite) so, naturally, it was named TOPSOC. It used the F-2 high-gain super-heterodyne receivers and, essentially, omnidirectional antennas. Since TOPSOC lacked the directional antenna of the F-2 payload, but still retained the sensitivity, it scooped up a large number of interleaved signals, horizon to horizon, including sidelobes and main beams! Although an RF band had been chosen that was thought to be relatively quiet (400 to 1,600 MHz), the first TOPSOC, launched on 12 September 1961, encountered a signal environment in the Soviet Union that proved far too populated and active to be successfully processed by any automatic or manual techniques available at that time. The first lesson in matching the collection system to the processing system had been learned! It was also clear that, in the 1960s, there were many more radars in the Soviet Union than previously thought. Another thing learned was that unless the intercept is unique and of very high priority, an intercept without a location has very little value (at the same time, Navy POPPY satellites were proving this same axiom).

The TOPSOC launches occurred in the summer and fall of 1961, but sometime before this another approach to the QRC AFTRACK payloads had developed. In those days, the Air Force sponsored an annual review at the Stanford Electronics Laboratories (SEL) in Palo Alto, California, of SEL's activities in support of ELINT, or more precisely, the electronic warfare community. These were called the Technical Advisory Committee (TAC) meetings. Almost all contractors and government agencies involved in the development or use of electronic warfare systems attended regularly, making it one of the premier

ELINT events of the year. Until this time, of course, ground, sea, and airborne platforms were the extent of the discussions.

Bill Harris, the LMSC AFTRACK payload manager; Phil Doersam, LMSC S/S F manager; and Maj Copley attended the TAC meeting in August 1960 in search of concepts for AFTRACK payloads. At the meeting, Jim DeBroekert of SEL demonstrated a newly developed miniaturized receiver. With the receiver connected to a power meter, he had been flying it in his Cessna airplane around the San Francisco Bay area to demonstrate radar-location techniques. Harris asked DeBroekert if his receiver could be adapted to an AFTRACK application. The result was TAKI (named after the TALL KING radars it was intended to intercept), and it used four telemetry points to indicate the intercept of a TALL KING radar. Since it was required to intercept data over the Soviet Union and return the data to US RTSs, it included a tape recorder, making it the first AFTRACK payload with this capability. Bill Rambo, in charge of SEL at the time, was intrigued with the simplicity of the concept and even made a short 8-mm movie to illustrate it. This was the beginning of a long association between SEL, LMSD, and SAFSP that ended only when pacifists protested SEL's involvement with the military during the Vietnam war.

Don Grace, who became the SEL manager for AFTRACK payloads, set up a small lab in the basement of their building on the Stanford campus where Don Eslinger built (essentially single-handed) all the SEL payloads (10 total). Other very capable members of their staff were John Hunter, Tony Taussig, Tom Miles, and Chuck Schoens. DeBroekert, Miles, and Hunter went on to form ARGO Systems when the university gave in to protesters in the spring of 1967 and closed SEL. Eslinger went to Georgia Tech, Schoens to Stanford Research Laboratories (SRI), and [redacted] by way of Applied Technology, Inc (ATI).

The SEL policy was to design and build the first of a new series and then turn production over to industry. Following TAKI, WILD BILL was invented in the spring of 1961. (Neither Grace nor DeBroekert would admit which Bill—Harris or Rambo—it was named after!) WILD BILL's mission was to search for signals from the HEN HOUSE ABM/AES radar that had been seen under construction at Sary Shagan by the photo payloads. The radio frequency on which HEN HOUSE operated was a matter of great speculation. It was certain to be in the 50 to 400 MHz region, based on the size of the antenna and knowledge of the technical parameters it must possess to track missiles and satellites at ranges of many hundreds of miles. SEL built two WILD BILL payloads that covered the frequency range of 50 to 150 MHz, calculated to be the most probable band that HEN HOUSE would utilize. The first WILD BILL was launched on 7 July 1961 and operated for two days with no important intercepts. The second, designated WILD BILL 1, was launched on 27 February 1962 and operated for only two orbits with no significant results. Later versions of WILD BILL were built by ATI, which had been formed in the Palo Alto area by John Grigsby, another former SEL engineer. LMSC had contracted with Grigsby to build the follow-on versions of SEL payloads.

In 1961 and 1962 the Soviets conducted frequent tests of their nuclear weapons. During these tests, an atomic cloud would form that sometimes produced the proper geometry and atmospheric ionization for reflection of radio and radar signals that could be intercepted at the CIA peripheral ground station in Iran on the southern shore of the Caspian Sea. One of the signals received during a test in October 1962 was at approximately 600 MHz and had a format that was thought to possibly originate with HEN HOUSE (these signals were very distorted by the ionized cloud produced by the atomic explosion). For this reason, WILD BILL 2, Grigsby's first copy, launched on 12 December 1962, covered the frequency range of 550 to 620 MHz. Once again the results were nil. Since another signal collected from the reflection from the atomic cloud in October 1962 was at approximately 160 MHz, WILD BILL 3 was designed for 150 to 230 MHz. This worked. WILD BILL 3, launched on 12 June 1963, collecting in the 150- to 230-MHz frequency range, made the first confirmed satellite intercept of the Soviet HEN HOUSE ABM target-tracking radar on 26 June 1963. POPPY also made intercepts of the HEN HOUSE radar in the same time period.

The WILD BILL 3 intercept was the first time that the HEN HOUSE signal had been collected since its first ground intercept in October 1962. The first HEN HOUSE structure was seen in U-2 photography in April 1960 and the HEN HOUSE radar signal, ELINT designator [redacted] was intercepted over two years later on 28 October 1962 by the CIA site on the southern shore of the Caspian Sea. When the signal was identified by intercepts from WILD BILL as coming from the HEN HOUSE radar, the signal designator was changed to [redacted] WILD BILL 3, 4, and 5, collecting in the 150- to 230-MHz range, produced large volumes of HEN HOUSE data that were [redacted] and at the Strategic Air Command (SAC). Manual analysis at NSA of the follow-on LONG JOHN data collected during 1963 and 1964 confirmed the center frequency of [redacted] of the HEN HOUSE scan pattern. This was confirmed shortly thereafter by an intercept by POPPY mission [redacted] launched on 15 June 1963, plus additional intercepts by WILD BILL 4, which was launched piggyback on the POPPY launch vehicle.

Following the WILD BILL missions, John Grigsby (who was quite tall) proposed a payload that would define the center frequency of the HEN HOUSE radar and determine its frequency excursion (HEN HOUSE scanned space with its antenna beam by changing the frequency of its transmissions). The payload was given the name of LONG JOHN and was flown on three very successful missions between 27 November 1963 and 13 June 1964. A fourth LONG JOHN (this was actually LONG JOHN 3, launched on 15 February 1964) suffered a recorder failure immediately after launch. All of the LONG JOHN payloads were launched on [redacted]

* The HEN HOUSE designation changed over time: [redacted]

The last AFTRACK payload designed and built by Don Grace and his SEL team was PLYMOUTH ROCK. It covered the frequency range of 2.0 to 4.0 GHz and was built at the request of SAC. SAC had an urgent electronic order of battle (EOB) requirement to identify and locate as many Soviet S-band tracking radars as possible in the interim prior to the launch of the [redacted] and POPPY missions designed for this coverage. The intent was to provide an output compatible with the ELINT processing system called FINDER, which had been designed to process data from the U-2 and other airborne collection systems. PLYMOUTH ROCK 1 was launched on 24 November 1962 and achieved at least two firsts: it was the first AFTRACK payload to receive a mission number, 7201, in accordance with the new BYEMAN procedures, and it was also the first space payload to use a sweeping yttrium-iron-garnet (YIG) filter for frequency discrimination. Two more PLYMOUTH ROCKs were built by ATI, the last of which had the further distinction of being the only AFTRACK payload [redacted]

The outputs from the AFTRACK payloads included commutated data from selected points on the primary mission telemetry commutator and also, at times, recorder output from the AFTRACK payload. Each payload was unique and produced different processing and analysis challenges. LMSC processed the data to evaluate payload performance and assisted NSA and SAC in their processing and analysis effort.

Data from TAKI, WILD BILL, TOPSOC, PLYMOUTH ROCK, and LONG JOHN were processed at NSA on an electronic machine complex known as [redacted] The differences in data format for each mission required extensive programming effort to write and extensive machine-time to check out the computer programs for each individual package. Frequently more time was spent in developing the processing than was required to process the data. For example, once the basic computer programs for a TAKI mission were written and checked out, it took a relatively small amount of time to process all the formatted data from that TAKI mission and any subsequent identical TAKI mission. Unfortunately, most missions were not identical because the AFTRACK payloads had to compete for points on the primary mission telemetry commutator, so data formats changed frequently. Analysis of the data still required extensive manual effort after or in parallel with the machine processing.

SAC processing and analysis of data from the AFTRACK payloads were frequently done by LMSC in [redacted] Sunnyvale, for SAC with SAC participation. LMSC provided space and equipment for SAC analysts. NSA analysis of the limited data from the five TAKI flights revealed a high density of TALL KING Soviet early warning radar signals and provided TALL KING signal parameters. This was important at that time since the TALL KING radar was thought by some elements of the US Intelligence Community to function as a part of the Soviet ABM system.

The PLYMOUTH ROCK data were processed at LMSC, NSA, and SAC. SAC, using their FINDER system, was able to produce locations with accuracies, measured as a circular error probable (CEP), of 400 miles or greater for V-beam and height-finder radars.

While the AFTRACK ELINT story was unfolding, other parallel efforts were underway in the COMINT area. Interest in COMINT had surfaced in several places. In August 1959 Roger Thayer of NSA wrote a paper, "Study Report on Collection of COMINT from Satellite Vehicles," Technical Document 33.144, in which he suggested some elements of S/S F of WS-117L might be adapted to COMINT collection, but he felt that feasibility needed to be demonstrated.

It was Capt Don Wipperman and his associates at Air Force Security Service (AFSS), San Antonio, Texas, who came up with the first COMINT satellite concept. Together with the AIL team, they presented an idea for an AFTRACK payload capable of intercepting [redacted] communications signal that was then thought to be from the prevalent air/ground (A/G) communications system in the Soviet Union. This resulted in the TEXAS PINT (AFSS was in Texas). Its only drawback was that when launched on 30 August 1961, it showed that [redacted] had been superseded by more advanced Soviet A/G communications systems. It did provide a good look at the VHF environment over the Soviet Union. These data were used extensively in later payload designs. In the summer of 1961, Sanders Associates at Nashua, New Hampshire, teamed with NSA to exploit the [redacted] signal that was thought to be the follow-on to [redacted] as the Soviet A/G communications signal. Their two NEW JERSEY payloads (the original idea came from ITT in Nutley, New Jersey), launched on 27 July 1962 and 7 January 1963, intercepted and located several [redacted] signals using doppler techniques. The follow-on NEW HAMPSHIRE payload (built by Sanders Associates, Nashua, New Hampshire) never flew, due to contractual difficulties.

In another area of the COMINT scene, Wayne Burnett of HRB-Singer at State College, Pennsylvania, came up with a concept to intercept, encode, and record a radio teletype (RTTY) channel of the Soviet [redacted] point-to-point VHF multichannel communications signal. It was necessary to encrypt this COMINT information on the down-link to safeguard it from Soviet knowledge. This was accomplished by use of NSA-furnished [redacted] encryption equipment, utilized during readout to US tracking stations. The intercept electronics, invented by HRB engineer Conrad Welch, resulted in three GRAPE JUICE payloads, launched on 12 December 1961, 17 April 1962, and 17 September 1962. They brought back only fragments of RTTY messages. The VHF interference environment (mostly European TV and FM stations) was so dense that they were never able to lock on to the desired signal for a long enough time to produce useful results. A stronger (more filtering and better logic) VINO payload launched on 4 December 1962 had pretty much the same results. A final version, OPPORKNOCKITY ("it tunes but once"), was launched on 21 August 1964. It was designed to hold lock on the RTTY signal through dense interference and finally brought back larger segments of data. Still, because of the interference, it was not deemed a practical collector.

Two more payloads, SQUARE TWENTY and DONKEY, launched in 1965 and 1967, completed the story of AFTRACK COMINT collection. With the experience to date, the concept of copying content from low orbiters was losing its attraction, and accurate location was becoming a more important consideration. SQUARE TWENTY, designed to locate the Soviet [redacted] communications links, was launched on 28 October 1965. It had a mission lifetime of 11 days and produced many [redacted] locations using manual hand processing of analog data. It also had a copy capability but could not lock on for periods long enough to be useful.

One other AFTRACK payload that was actually integrated into the front rack [redacted] was DONKEY, launched on 24 July 1967. This payload was part of a program initiated by Col John Copley, who was then assigned to the Manned Orbiting Laboratory (MOL) staff at US Air Force Headquarters. The payload activities were handled under the BYEMAN program, but through a unique management arrangement, the overall effort was managed by the Air Force. Back in February 1965, Copley had been assigned to determine if there were any SIGINT applications that might be enhanced by the manned aspect of the MOL. Several ELINT applications were examined, but in the area of COMINT, the intercept of the Soviet [redacted] communications system was believed to promise the greatest wealth of information about both civil and military activities. Copley realized that at the low orbital altitude of the MOL, intercepts of antenna main beams in the rapidly moving satellite would be too short to yield useful information. If the data could also be collected from the sidelobes, however, intercept times could be lengthened appreciably and might permit intercept of adjacent emitters on the same link, thereby providing the necessary continuity. This is what DONKEY attempted to demonstrate.

A program developed by the team of E-Systems in Garland, Texas, and EDL-Sylvania, using Soviet [redacted] transmitter specifications [redacted] involved airborne testing against a simulated [redacted] terminal installed at the E-Systems facility. An Air Force helicopter was used to fly a payload in an intercept pattern through the main beam and sidelobes of the microwave antenna. Phil Fyre and a team of analysts at EDL analyzed the data and made recommendations for mission profiles. The results were sufficiently encouraging to convince the team that a satellite test should be performed to verify the flight-test data. [redacted] the need for a three-axis-stable platform indicated the Agena vehicle was the appropriate carrier. Vince Henry, the AFTRACK [redacted]

Flight summary: Program A, Project AFTRACK SIGINT payloads

MISSION* NUMBER	PROJECT and PAYLOAD	MISSION	OPERATIONAL LIFETIME 3rd Quarter 1960	4th Quarter 1960	1st Quarter 1961	2nd Quarter 1961	3rd Quarter 1961	4th Quarter 1961	1st Quarter 1962	2nd Quarter 1962	3rd Quarter 1962	LIFETIME Days
N/A	SOCTOP 1**	VULNERABILITY DETECT HOSTILE JAMMING OR TRACKING	08/10-11									1
N/A	TAKI 1	ELINT-GS TALL KING				06/16-17						2
N/A	WILD BILL	ELINT-GS ABM					7/7-8					2
N/A	TEXAS PINT	COMINT COPY [redacted] SIGNAL					8/30-9/1					2
N/A	TOPSOC 1	ELINT-GS ABM					9/12-9/19					5
N/A	TOPSOC 2	ELINT-GS ABM					9/17-9/21					4
N/A	TOPSOC 3	ELINT-GS ABM						10/13-10/15				2
N/A	TOPSOC 4	ELINT-GS ABM						11/5-11/7				2
N/A	GRAPE-JUICE 1	COMINT COPY [redacted]						12/12-12/13				1
N/A	WILD BILL 2	ELINT-GS ABM							2/27			2 orbits; 0.15
N/A	GRAPE-JUICE 2	COMINT COPY [redacted]								4/18-4/22		5
N/A	TAKI 2	ELINT-GS TALL KING								6/28-7/5		7
N/A	NEW JERSEY 1	COMINT COPY [redacted]									7/27-8/2	5
N/A	GRAPE JUICE 3	COMINT COPY [redacted]									9/17-9/22	5

GS = General Search ABM = Antiballistic Missile COPY = Lock-on Copy Content

* Mission number not assigned to AFTRACK payloads until November 1962

** Follow-on vulnerability payloads listed on separate table

Flight summary: Program A, Project AFTRACK SIGINT payloads *(continued)*

MISSION NUMBER	PROJECT and PAYLOAD	MISSION	OPERATIONAL LIFETIME 4th Quarter 1962	1st Quarter 1963	2nd Quarter 1963	3rd Quarter 1963	4th Quarter 1963	1st Quarter 1964	2nd Quarter 1964	LIFETIME Days
7201	PLYMOUTH ROCK 1	ELINT GS	11/24-12/01							5
7202	WILD BILL 2	ELINT-GS HEN HOUSE	12/12-12/15							3
7203	VINO 1	COMINT COPY [redacted]	12/4-12/7							3
7204	TAKI 3	ELINT-GS TALL KING	12/4-12/7							6
7205	NEW JERSEY 2	COMINT COPY [redacted]		1/7-1/14						6
7206	VINO 2	COMINT COPY [redacted]		2/28	(Failed to orbit)					0
7207	WILD BILL 3	ELINT-GS HEN HOUSE			6/12 6/26					13
7216	WILD BILL 4	ELINT-GS HEN HOUSE			6/15	7/20				35
7208	PLYMOUTH ROCK 2	ELINT GS			6/29	7/11				12
7219	LONG JOHN 2	ELINT DC/TI HEN HOUSE					11/27 12/12			15
7218	LONG JOHN 1	ELINT DC/TI HEN HOUSE					12/21	1/10		20
7210	HAYLOFT	ELINT-GS ABM						1/11 1/30		19
7222	LONG JOHN 3	ELINT DC/TI HEN HOUSE						2/15 3/9		23
7224	LONG JOHN 4	ELINT DC/TI HEN HOUSE							6/13 6/25	13

DC = Directed Coverage
GS = General Search
TI = Technical Intelligence
ABM = Antiballistic Missile
COPY = Lock-on Copy Content

Flight summary: Program A, Project AFTRACK SIGINT payloads *(continued)*

MISSION NUMBER	PROJECT and PAYLOAD	MISSION	OPERATIONAL LIFETIME									LIFETIME
			1964	1964	1965	1965	1965	1965	1967	1967	1968	Days
7215	OPPOR-KNOCKITY	COMINT COPY [redacted]	8/21	10/23								53
7223	NEW HAMPSHIRE	COMINT COPY [redacted]	Cancelled due to technical problems									0
7225	SQUARE TWENTY	COMINT COPY/LOC [redacted]					10/28	11/8				20
7231	DONKEY	COMINT COPY/LOC [redacted]							7/24		1/28	190

Note [redacted]

COPY = Lock on Copy Content
LOC = Locate < 15 miles

manager at LMSC, determined that a location on the forward rack was the only practical place to mount the 6-foot expandable parabolic antenna required for the mission. Agena vehicle 2732, scheduled to launch the [redacted] payloads in July 1967, would have new, more powerful CASTOR II solid rockets, providing greater thrust than the previously used thrust-augmented Thor (TAT) booster. This made it a logical choice for the addition of DONKEY. Installation of [redacted] payloads (including three outboard expandable antennas) required very innovative engineering. This may have been the point at which the payload was named DONKEY (for lack of a better explanation). In any case DONKEY boasted an independent down-link and when launched on 24 July 1967 operated 30 days longer (for a total of 182 days) than the other payloads following the failure of their data link transmitter.

DONKEY was unable to perform the sidelobe intelligibility mission on orbit due to the failure of the pointing mechanism on the 6-foot dish antenna. This did not prevent mapping of the [redacted] emitter locations, resulting in the development of a grid involving a large majority of the [redacted] emitters in the Soviet Union. These preliminary COMINT data were valuable in mission planning for the [redacted] In fact, the initial airborne intelligibility program convinced Gene Pitsenbarger of EDL and Vince Henry (and his boss, George Minalga) of LMSC [redacted] emitter as the low-orbiting MOL flew swiftly over the Soviet Union (this may be another explanation for the name of the DONKEY COMINT AFTRACK payload). [redacted] The locations produced by SQUARE TWENTY, DONKEY, and the [redacted]

All of the data from the COMINT payloads were analyzed at the contractor facilities and at NSA, mostly by rather laborious manual processing. The information gained from the early TEXAS PINT, NEW JERSEY, GRAPE JUICE, and VINO payloads was minimal except for the development of a healthy respect for the interference environment over eastern Russia. OPPORKNOCKITY made 12,000 intercepts of recognized [redacted] signals that contained several teletype and some voice modes. [redacted]

SQUARE TWENTY made 1,290 intercepts of the Soviet [redacted] communications signals, yielding 209 communications transmitter locations with [redacted] accuracy on multiple intercepts, 10 to

50 miles on single hits. Poke-throughs (ground antenna main beams hitting sidelobes of the payload antenna) were minimized by the payload's ability to measure power levels of incoming signals. Unique information was obtained on the Soviet [redacted] environment, as well as target locations and network routes. SQUARE TWENTY achieved its primary objectives and yielded substantial evidence to support further efforts targeting [redacted] communications, using satellites for collection.[3]

DONKEY mapped [redacted] locations much like SQUARE TWENTY mapped [redacted] During the DONKEY payload's five-month life starting 24 July 1967, it detected Soviet [redacted] signals on over 1,000 tasked orbits. Tasking included command selection of various RFs corresponding to known trunks of the [redacted] communications network. A primary result of the mission was mapping the communications facilities located at the Sary Shagan antimissile test center.[4] The high sensitivity of the system resulted in false readings due to the main beam of the [redacted] transmitter being received in the sidelobes of the DONKEY antenna. However, other data, such as long-intercept durations and amplitude-versus-time profile, were used to validate the true target location.[5]

AFTRACK payloads such as OPPORKNOCKITY, VINO, SQUARE TWENTY, and DONKEY required extensive, time-consuming manual analysis. Typically the NSA analyst would go to LMSC when the payload was launched and work with the payload designers and operators for a week or more to validate the data and methods for analysis. Data would then be shipped on magnetic tape, with any accompanying corrections, to NSA for analysis. At NSA the analog tapes were converted to "visa-corder" paper-roll photographic records of the analog signal. These miles of visa-corder records were manually scanned and sections of interest analyzed using [redacted]

[redacted] The time information with ephemeris data was used to plot the position of the satellite at the time of intercept. It was then possible to use all the manually derived data and make determinations about the location and pointing angle of the transmitting antenna, its signal type, and probable user. These efforts were so time-consuming [redacted] SQUARE TWENTY collection. Five months of DONKEY collection [redacted] even with additional analyst assistance. Most of these data was analyzed by [redacted] of the NSA [redacted] with the able assistance of other members of his group, including [redacted] his chief analyst.

The AFTRACK payloads had run their course by the time of the SQUARE TWENTY launch in 1965. The much more [redacted] by LMSC, took over the original QRC-type missions of the AFTRACKs, and went on to greater capability, utility, and inevitably, the accompanying and ever-increasing cost.

[redacted]

[redacted]

Key accomplishments, Agena AFTRACK payloads

- Revealed high density of Soviet radars for early warning of aircraft, in 1961.
- Proved intercept of low-power, low-VHF communications from space, including automatic recognition of active signals on Soviet [redacted] communications, in 1961.
- Produced locations of Soviet communications transmitters for intelligence database, in 1965, that was later used for [redacted] operations.
- Monitored Soviet radar tracking of US reconnaissance satellites.

Appendix D

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1960							
6/22/60	xxxx	GRAB DYNO 2	Transit IIA Thor Able-Star	NRL	[redacted]	90 days	First SIGINT (ELINT) satellite
8/10/60	xxxx	SOCTOP 1*	Thor Agena DISCOVERER 11	AIL	2.5-3.2	1 day	First aircraft payload vulnerability mission
10/11/60	xxxx	SAMOS 1	Atlas Agena [illegible]	AIL	2.5-3.2 9.0-10.0	-	Failed to orbit
11/30/60	xxxx	GRAB DYNO	Transit IIIA Thor/Able-Star	NRL	2.5-3.2		Failed to orbit
1961							
01/31/61	xxxx	SAMOS 2 [illegible]	Atlas Agena	AIL	2.5-3.2 9.0-10.0	21 orbits	First on-orbit digital processing (ELINT)

*The SOCTOP payloads were the first in a series of vulnerability payloads to be flown on most photo reconnaissance missions. The SOCTOP payloads were intended to determine if the Soviets were tracking or trying to interfere with the commanding of the satellites, either at beacon frequencies in S band (2.5-3.2 GHz) or suspected ABM radar frequencies between 100 MHz and 1.0 GHz. These were followed by [illegible] and [illegible] payloads flown from 1964 to 1966 to determine if the satellites were being tracked by HEN HOUSE radars. [redacted] SOCTOP packages were flown on 10 additional CORONA missions (from mission 9010, launched on [illegible], to mission 9028, launched on [illegible]) and two SAMOS missions (mission 2201, launched on [illegible], and mission 2204 launched on [illegible]). [illegible] packages were flown on 49 CORONA missions (from mission [illegible], launched on [illegible], through mission 1117, launched on [illegible]), on 43 GAMBIT missions (from mission [illegible], launched on [illegible], through mission 4344, launched on 04/18/75), and on 11 HEXAGON missions (from mission 1201, launched on [illegible], through mission 1213, launched on 06/27/77). [redacted] (For further details on these missions, see SIGINT Satellite Mission Log, National Reconnaissance Office, Washington, DC, [illegible] February 1978.)

(Table continues)

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1961 (cont)							
06/16/61	xxxx	TAKE 1	Thor Agena B DISCOVERER 25	SEI	0.16-0.17	2 days	First ELINT mission to record/playback data
06/29/61	xxxx	GRAB/ DYNO-2	Transit IIIB Thor Able-Star	NRL	0.55-0.61 0.81-0.92	6 months	Failed to separate. Limited L-band ELINT.
07/07/61	xxxx	WILD BILL 1	Thor Agena B DISCOVERER 26	SEI	0.050-0.150	2 days	HEN HOUSE search. Wrong frequency band.
07/17/61	xxxx	TOPSOC 2	Thor Agena B DISCOVERER 31	AIL	0.40-1.60	4 days	See TOPSOC 1
08/30/61	xxxx	TEXAS PINT	Thor Agena B DISCOVERER 29	AIL	0.10-0.15	2 days	First COMINT payload. Sampled VHF environment. Target inactive.
09/12/61	xxxx	TOPSOC 1	Thor Agena B DISCOVERER 30	AIL	0.40-1.60	5 days	ABM search - high gain receiver clogged data processing.
10/13/61	xxxx	TOPSOC 3	Thor Agena B DISCOVERER 32	AIL	0.40-1.60	2 days	See TOPSOC 1
11/05/61	xxxx	TOPSOC 4	Thor Agena B DISCOVERER 35	AIL	0.40-1.60	2 days	See TOPSOC 1
12/12/61	xxxx	GRAPEJUICE 1	Thor Agena B DISCOVERER 36	HRB Singer	0.06-0.07	1 day	COMINT: Gained a channel of [redacted] with interference
1962							
01/13/62	xxxx	TAKE	Thor Agena B DISCOVERER 37	SEI	0.160-0.175		Failed to orbit

(Table continues)

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1962 (cont)							
[illegible]	xxxx	[illegible]	[illegible]	NRL	[illegible]		[illegible]
[redacted]							
[illegible]	xxxx	[illegible]	Thor Agena B [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	xxxx	[illegible]	Thor Agena B [illegible]	HRB-Singer	[illegible]	[illegible]	[illegible] [redacted] [redacted] [illegible]
[illegible]	xxxx	[illegible]	Thor Agena B DISCOVERER 40	[illegible]	[illegible]	2 days	Sampled [illegible]
[redacted]							
[illegible]	xxxx	[illegible]	Scout	NRL	[illegible]		[illegible]
[illegible]	xxxx	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] [redacted] [illegible]
[illegible]	xxxx	[illegible]	Thor Agena B [illegible]	HRB Singer	[illegible]	[illegible]	[illegible]

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1962 (cont)							
[illegible]	[illegible]	PLYMOUTH ROCK 1	Thor Agena B CORONA [illegible]	SEL	[illegible]	[illegible]	[illegible]
[illegible]	7203	[illegible]	Thor Agena B CORONA [illegible]	HRB Singer	[illegible]	[illegible]	[illegible]
12/13/62	[redacted]	POPPY [redacted] (2 satellites)	Thor Agena B Vehicle 2151	NRL	0.165-1.2 (8 bands)	[redacted]	[illegible]
[illegible]	7202	[illegible]	Thor Agena B POPPY [redacted]	AII	[illegible]	15 days	[illegible]
12/14/62	7204	[illegible]	Thor Agena B CORONA 9050	AII	[illegible]	6 days	ELINT - [illegible] radar search and location
1963							
01/07/63	7205	NEW JERSEY 2	Thor Agena B CORONA [illegible]	Sanders	0.1-0.2	6 days	COMINT - doppler locations by contractor processing
[redacted]							
02/28/63	7206	[illegible]	Thor Agena D CORONA [illegible]	HRB Singer	[illegible]		Failed to orbit

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1963 (cont)							
[illegible]	[illegible]	[illegible]	[illegible]	AIL	[illegible]	[illegible]	[illegible] [redacted]
[illegible]	[redacted]	POPPY 4 [redacted] (satellites)	[illegible]	NRL	[illegible]	[redacted]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] [redacted]	AIL	[illegible]	[illegible]	[illegible]
[redacted]							
06/29/64	7208	PLYMOUTH ROCK 2	TAT Agena D 698BK 2354	AIL	2.0-4.0	12 days	HINT CS. Processed by SAC for EOB input
[redacted]							
11/22/64	7210	LONG JOHN	TAT Agena D CORONA 9061	AIL	[illegible]	[illegible] days	[illegible]
[redacted]							

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1963 (cont)							
12/21/63	7319	LONG JOHN 3	TAT Agena D CORONA 9062	AIL	[illegible]	[illegible] days	LONG JOHN: Same as LONG JOHN 2
1964							
03/11/64	[redacted]	POPPY [redacted] (3 satellites)	TAT Agena D Vehicle 2351	NRL	[illegible]	[redacted]	First [illegible] radar [illegible]
03/11/64	7240	HAYLOFT	TAT Agena D POPPY [redacted]	HRB-Singer	[illegible]	19 days	Test flight of ASR wideband recorder with 10 megahertz [illegible] down link
02/15/64	7222	LONG JOHN 4	TAT Agena D CORONA 1004	AIL	[illegible]	23 days	No data collection. Tape recorder failed
[redacted]							
[redacted]							
06/13/64	7224	LONG JOHN 4	TAT Agena D ARGON [illegible]	AIL	[illegible]	[illegible] days	[illegible] Recorder [illegible]

(table continues)

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1964 (cont)							
[redacted]							
07/21/64	7215	OPPOR-KNOCKITY	TAT Agena D ARGON 9066A	HRB-Singer	0.066-0.072	53 days	COMINT: improved [redacted] copy voice and TTY
[redacted]							

(Table continues)

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1 AUGUST 2015

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1964 (cont)							
[redacted]							
1965							
[illegible]	[redacted]	[illegible] [redacted]	[illegible] Agena D [illegible]	[illegible]	[illegible]	[redacted]	[illegible] [redacted]
[redacted]							

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1965 (cont)							
[illegible]	[illegible]	[illegible]	[illegible] CORONA [illegible]	[illegible]	[illegible]	[illegible]	[illegible] [redacted] [illegible]
1966							
[redacted]							

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1966 (cont)							
[redacted]							
1967							
[redacted]							
[illegible]	[redacted]	[illegible] [redacted]	[illegible]	[illegible]	[illegible]	[redacted]	[illegible]

SIGINT Satellite Mission Summary

Date	Mission	Payload	Launch Vehicle	Contractor	Frequency Range (GHz)	Life	Features, Mission, Accomplishments
1967 (cont)							
[redacted]							
07/24/67	7231	DONKEY	TAT Agena D [redacted] 7162	EDL	1.456-1.814	5 months	COMINT located [redacted] links
[redacted]							
1968							
[redacted]							

(Table continues)