# US MILITARY ACTIVITES IN SPACE - 1984

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## 1. INTRODUCTION

1984 was a year of several successes and some failures for the US military space effort. This paper describes the events of the year and considers their implications. It follows an earlier article by the author which covered the year 1983 [1].

This review follows the subdivisions of the 1983 review, but nuclear explosion detection is not included as a separate section, since this function is now carried out by other host satellites. Also the ASAT category has been introduced, as testing involving satellite launches was planned to start in 1984. The status at the start of the year and the events of the year are described for each category in turn.

## 2. AVAILABILITY OF ORBITAL DATA

Any analysis of the US military space effort is confronted by a major problem - the amount of orbital data now made public is severely limited. Traditionally NORAD has released full orbital data for all classes of US spacecraft except eccentric orbit communication and synchronous orbit ELINT satellites. This data appears in the form of Two Line Orbital Elements. In June 1983 NORAD stopped releasing data for photo reconnaissance, early warning, moderate altitude ELINT, and ocean surveillance craft. The only classes for which data is still released are weather, synchronous orbit communication, navigation, and some R&D.

The Satellite Situation Report, which used to be a useful subsidiary source, is now also of limited value. Orbital parameters for those satellites in the newly-proscibed classes which were in orbit in June 1983 have not been updated, and satellites in those classes launched since then are listed as "elements not available". As a result, the identification of the missions of some cannot be certain.

## 3. PHOTO RECONNAISSANCE

At the start of 1984 there were three photo reconnaissance satellites in orbit, as follows:

Photo Reconnaissance Satellites at 31 December 1983

| Satellite | Type | Months in Orbit |
|---|---|---|
| 1981-85A | KH-11 | 28 |
| 1982-111A | KH-11 | 13 |
| 1983-60A | Big Bird | 6 |

The duration record at the start of 1984 for the KH-11 class was 1166 days, a figure which 1981-85A would reach on 12 November. It therefore seemed likely that the satellite would be de-orbited in the last few months of the year. Past practice has been to launch a replacement within a couple of weeks of a KH-11 de-orbit. Such a replacement for 1981-85A would tie in well with the debut of the advanced KH-11, which had been reported for 1984. On the other hand, as 1982-111A had amassed only 409 days in orbit its operation well into 1985 seemed highly probable. 1983-60A was the eighteenth Big Bird, and based on the lives of its predecessors a de-orbit in February or March seemed to be the most likely outcome.

The first event of 1984 in the photo reconnaissance field was a report in mid-January which stated that only two film return spacecraft remained in the inventory [2]. It also disclosed that the KH-9 designation, which had been used previously for the "close look" class, in fact refers to the Big Birds, with the "close looks" being designated KH-8.

1983-60A was finally de-orbited on 21 March, after a life of 275 days, a new record for its class. Less than a month later, on 17 April, a "close look" satellite was launched. According to the RAE Tables of Earth Satellites 1984-39A went into a 127km by 311km orbit, inclined at 96.40° and with a period of 88.90 minutes [3].

In a pattern very similar to the preceeding year, the next event was the launch of a Big Bird while the "close look" was still active. 1984-65A was launched on 25 June, entering a 170km by 263km, 96.43° 88.85 minute orbit. As with most Big Birds, an ELINT subsatellite was ejected into a higher orbit (see Section 5). Assuming that the report mentioned earlier was correct, 1984-65A must have been the last film return spacecraft. This would coincide with the introduction of the advanced KH-11, which it was claimed would take over the role of the film return vehicles.

In October 1980 the Secretary of the Air Force had stated that only four "close look" spacecraft remained [4]. Three of these were clearly 1981-19A, 1983-32A and 1984-39A, but what was the fourth? The only candidate for this can be 1982-06A. This had initially been identified as a "close look", but when it went into a high circular orbit a day after launch doubts on this were raised [5]. Although its mission does not seem to have been close look photography, it does now appear that the actual spacecraft used was one of the "close look" class.

The mission of the "close look" 1984-39A came to an end when it was de-orbited on 13 August, after a life of 118 days. Next was the Big Bird 1984-65A, which was de-orbited on 18 October after a life of 115 days. This was surprisingly short, rather less than half that of its predecessor. The third de-orbit was that of the KH-11 1981-85A on 23 November, after a remarkable 1177 days of service. True to expectations its replacement, 1984-122A, was launched 11 days later, on 4 December. Its initial orbit, as submitted to the UN, was 300km by 650km, inclined at 97.1° and with a period of 93.5 minutes. To date there have been no indications whether it is the first advanced KH-11 or one of the standard type.

During the year the US had achieved 1035 mission days with photo reconnaissance satellites.

## 4. EARLY WARNING

In June 1983, when NORAD stopped releasing orbital data for Defense Support Program (DSP) early warning satellites, there were five operational spacecraft of this type. As no DSP launches were made in the remaining portion of the year, the status of the programme at the start of 1984 appears to have been as follows:

**Early Warning Satellites at 31 December 1983**

| Satellite | Station | Months in Orbit |
|---|---|---|
| Prime | | |
| 1977-07A | 69°E | 83 |
| 1981-25A | 134°W | 33 |
| 1982-19A | 70°W | 22 |
| Back-Up | | |
| 1976-59A | 75°E | 90 |
| 1979-53A | 85°W | 55 |

These spacecraft ages suggested that a launch in 1984 would probably be required. During the year there were three Titan 34D/Transtage launches, and it appears that one of these placed a DSP payload on station. An analysis of the launches is given in Section 6.

5. ELECTRONIC INTELLIGENCE (ELINT)

ELINT subsatellites, sometimes referred to as ferrets, do not manoeuvre or undergo de-orbit at the ends of their lives. Therefore the 1983 review regarded the operational subsatellites to be those with ages of less than five years. At the start of 1984 there were four such craft, listed below:

ELINT Subsatellites at 31 December 1983

| Satellite | Months in Orbit |
|---|---|
| 1979-25B | 57 |
| 1980-52C | 42 |
| 1982-41C | 20 |
| 1983-60C | 6 |

The Big Bird launched on 25 June 1984 carried an ELINT subsatellite, 1984-65C, into orbit. It was deployed in a 690km by 710km orbit, inclined at 96.10° with a period of 98.79 minutes. It has already been noted that this Big Bird was the last of its kind, so future ELINT subsatellites will have to be carried by a different class of vehicle. The obvious choice for this is the advanced KH-11. It will be interesting to see if a new type of subsatellite is introduced, just as a new type was when Big Birds took over the role.

Two classes of ELINT satellite were in synchronous orbit at the start of the year, Rhyolite and Chalet. By then, however, the Rhyolites were all over five years old, and there must be some doubt whether some, or any, were still functional. They are:

Rhyolite Satellites at 31 December 1983

| Satellite | Months in Orbit |
|---|---|
| 1973-13A | 130 |
| 1977-38A | 79 |
| 1977-114A | 72 |
| 1978-38A | 69 |

It now appears that only a single test satellite was launched in the Argus programme before it was abandoned, its role being taken over by the Chalet class. The status of Chalet satellites is:

**Chalet Satellites at 31 December 1983**

| Satellite | Months in orbit |
|---|---|
| 1978-58A | 67 |
| 1979-86A | 51 |
| 1981-107A | 26 |

As with the DSP early warning satellites, the ages of the Chalet vehicles at the start of 1984 suggested that a replacement would need to be launched during the year. One of the Titan 34D/Transtage missions appears to have been this replacement.

## 6. THE TITAN 34D/TRANSTAGE LAUNCHES OF 1984

In 1981 the DoD decided to procure a number of Transtage vehicles as back-ups for use with the Titan 34D launcher, in case there were problems with the Inertial Upper Stage (IUS). The 1983 review describes the failure of the IUS on STS-6 and the postponments in planned launches that ensued. With the prospect of the IUS not being ready until late 1984 the DoD turned to its back-up plans, and the first Titan 34D/Transtage combination was launched from Cape Canaveral at 15:08 GMT on 30 January [6].

The DoD did not release any orbital data for the flight, which received the designation 1984-09. Three objects resulted from the launch, and the RAE Tables show objects A (the payload) and C (the Transtage) as being in an "eccentric transfer or high circular orbit". Object B, the second stage of the Titan core, is listed as having a 145km by 1023km orbit at 29.3°, from which it decayed after 28 days.

The second Titan 34D/Transtage launch, 1984-37, was made at 16:52 GMT on 14 April, but this time only two objects appeared [7]. The payload, object A, was in a 35,530km circular orbit with a period of 1423 minutes. The Transtage, object B, was listed as having an orbit similar to 1984-37A. The fact that the Titan second stage did not reach orbit is not unusual - this has happened with the Titan 3C on a number of occasions. What is unusual, though, is the height of the second stage's apogee from the 1984-09 launch.

The third launch followed at 0:02 GMT on 22 December, and three objects were produced. The payload, 1984-129A, is listed in the submission to the UN as having a 35,915km by 36,190km orbit inclined at 3.4°. The Transtage (1984-129B) entered a similar orbit, while the Titan second stage (1984-129C) went into low parking orbit, from which it decayed on 17 January 1985.

It is possible to deduce the missions of these launches by looking at the payloads for the early DoD Shuttle flights. STS-10 was to have been the DoD's first Shuttle mission, but it was cancelled in June 1983 because of continuing problems with the IUS. Its payload was moved to the next DoD Shuttle slot, STS-15. Rather than slipping STS-15's payload to the next DoD Shuttle slot after that, it appears to have been launched on the first Titan 34D/Transtage in Jaunuary 1984.

The RAE suggested that 1984-09 might have carried a communications payload, but this seems unlikely considering the well-publicised plans for other communications satellite programmes (see Section 9). It also suggested that the Transtage malfunctioned, and the payload never reached its intended orbit. This seems a distinct possibility, with the second Titan 34D/Transtage launch being its back-up.

By February it was clear that fixing the IUS was going to be a long process, and STS-15, now renamed 41-E, was cancelled. Its payload was moved to the next DoD slot on the Shuttle, 41-H, and 41-H's payload appears to have been launched on the third Titan 34D/Transtage in December. The fact that STS-10's payload was transfered to 41-E, and then to 41-H, is confirmed by a report in Aviation Week and Space Technology [8].

At this point the DoD was claiming priority use of the first Shuttle/IUS to become available, so when 41-H was itself cancelled in April [7], its payload was transfered to mission 51-C. It had been planned to launch TDRS-B on 51-C, but this was now put back to 51-E, and a new mission, 51-L, was introduced to carry 51-C's original payload, TDRS-C [9].

The obvious question at this stage is why was STS-10's payload not launched on a Titan 34D/Transtage, leaving 41-E's payload where it was. The answer must be that this payload could only be launched on the Shuttle, presumably because its shape was optimised to fit the Shuttle's cargo bay. One recent report states that 51-C's payload was for electronic eavesdropping [10]. The only satellite known of this type which was designed specifically for Shuttle launch is Aquacade, and this would explain the DoD's obvious desire to make a launch as quickly as possible. Aquacade is reported to be a replacement for Rhyolite, and it has already been noted that all the Rhyolites have been in orbit for over five years, and at least some must be in need of replacement.

By the same reasoning the payloads on the Titan 34D/Transtage flights must have been of types able to be launched on expendable boosters or the Shuttle. It has been reported that 1984-09A was an early warning satellite [6], which would certainly agree with the known plans for DSP, and with the apparent need for a launch in 1984. As this mission appears to have been a failure and 1984-37 its replacement, the latter must have carried a DSP satellite as well. Given this there seems little doubt that 1984-129A was a Chalet spacecraft.

## 7. OCEAN SURVEILLANCE

The White Cloud ocean surveillance programme underwent something of a revival in 1983, with two launches after a break of over two years.

One feature of the 1983 launches that has now been resolved is the number of subsatellites that they carried - like earlier ocean surveillance missions, they each carried three. The 1983-08B object, which had been reported to be an additional payload, now seems to be simply an add-on experiment, and unrelated to the launch's primary role [11]. Object 1983-56G, which had earlier been described as a piece of debris, is now known to be that launch's third subsatellite, identified as GB3. Details of the five missions to date are given below.

Ocean Surveillance Satellites at 31 December 1983

| Satellite | Subsatellites | Months in orbit |
|---|---|---|
| 1976-38A | C, D, J | 92 |
| 1977-112A | D, E, F | 73 |
| 1980-19A | C, D, G | 46 |
| 1983-08A | E, F, H | 11 |
| 1983-56A | C, D, G | 7 |

On 5 February 1984 another White Cloud launch was made. Approximately 10 days later two subsatellites, named JD1 and JD2 (objects 1984-12C and D), were released, followed three weeks later by JD3 (1984-12F). In line with NORAD's new policy, no orbital elements were published, but the RAE Tables list parameters derived from visual observations. They show the main satellite in a 1072km by 1147km, 63.43° orbit, and all three subsatellites in 1057km by 1162km, 63.42° orbits.

Following the standard pattern for White Cloud missions, 1984-12 eventually produced eight objects in orbit. Four and a half months later, however, three more objects (J, K and L) were catalogued, and then two weeks after this objects E, G and H were stated to have decayed. Such decays are a physical impossibility, due to the heights of the orbits involved. One must therefore assume that objects E, G and H were mistakenly re-catalogued as J, K and L, and when the error was discovered they were "decayed", so that a total of eight objects in orbit appeared in the catalogue.

The time of launch has been announced for 1984-12 (18:44 GMT [6]), so it is possible to calculate the position of its orbital plane relative to those of the other White Cloud clusters. This is illustrated in Figure 1. The spacings of virtually 90° between 1980-19 and 1983-56, and between 1983-08 and 1984-12, are particularly noteworthy, but the gap of 60° between the two pairs is not easily explicable. From the arrangement shown in the figure it would seem that the first two clusters, 1976-38 and 1977-112, are no longer active, and that the new configuration requires four clusters. Confirmation of this may be provided by future launches.

## 8. WEATHER MONITORING

The Defense Meteorological Satellite Program (DMSP) was returned to full operational service by satellite launches in December 1982 and November 1983. Orbital data for the two satellites is as follows:

DMSP Satellites at 31 December 1983

| Satellite | Perigee (km) | Apogee (km) | Incl (°) | Period (min) | Months in Orbit |
|---|---|---|---|---|---|
| 1982-118A | 809 | 824 | 98.7 | 101.2 | 12 |
| 1983-113A | 810 | 830 | 98.7 | 101.3 | 1½ |

1982-118A was the first use of a new version of satellite, known as Block 5D-2. Besides added sensor capabilities, the new version has a design life of three years, double that of earlier types. Several more Block 5D-2 spacecraft have been ordered, but they will only be launched when problems are experienced with in-orbit spacecraft. Given this, together with the short times that 1982-118A and 1983-113A had been in orbit at the start of the year, it was hardly surprising that no launches were made for DMSP during 1984.

## 9. COMMUNICATIONS

In May 1983 the Defense Satellite Communications System (DSCS) achieved for the first time a full set of eight working satellites in orbit; four primes, each backed-up by an in-orbit spare. The 1983 review referred to reports that the

DoD intended to launch satellites II-16 and III-2 during the year, and concluded that their non-appearance was due to IUS problems. A subsequent report states that further DSCS satellites would only be launched as required [12]. It would appear, then, that launches cannot be expected in the near future. The status of the eight operational satellites is listed below.

DSCS Satellites at 31 December 1983

| Name | Satellite | Perigee (km) | Apogee (km) | Incl (°) | Period (min) | Station | Months in Orbit |
|---|---|---|---|---|---|---|---|
| Prime | | | | | | | |
| II-4 | 1973-100B | 35,779 | 35,792 | 5.4 | 1436.1 | 60°E | 120 |
| II-13 | 1979-98A | 35,778 | 35,790 | 1.0 | 1436.0 | 175°E | 49 |
| II-14 | 1979-98B | 35,782 | 35,793 | 1.0 | 1436.2 | 12°W | 49 |
| III-1 | 1982-106B | 35,773 | 35,803 | 0.1 | 1436.2 | 135°W | 14 |
| Back-Up | | | | | | | |
| II-8 | 1977-34B | 35,779 | 35,794 | 2.9 | 1436.1 | 180°E | 79 |
| II-11 | 1978-113A | 35,787 | 35,792 | 1.8 | 1436.3 | 130°W | 60 |
| II-12 | 1978-113B | 35,778 | 35,793 | 1.7 | 1436.1 | 66°E | 60 |
| II-15 | 1982-106A | 35,784 | 35,790 | 1.6 | 1436.1 | 15°W | 14 |

There was one event of interest in the DSCS programme during 1984, but it only concerned the swapping of roles between two in-orbit satellites. Between 4 and 10 January satellite number II-12, which had been acting as back-up at the 66°E station, was moved to the 60°E prime slot. On its arrival the satellite which had until then been the prime, II-4, was moved to the back-up station, reaching there on 26 January. This was the last in a long series of manoeuvres which had started the previous January.

The initial phase of the Fleet Satellite Communications System (FLTSATCOM) was to launch four prime satellites and one back-up. The back-up was damaged during separation from its launcher, and by the start of 1984 it seems to have been unusable, although it maintained its station all year. The four usable satellites are listed below.

FLTSATCOM Satellites at 31 December 1983

| Name | Satellite | Perigee (km) | Apogee (km) | Incl (°) | Period (min) | Station | Months in Orbit |
|---|---|---|---|---|---|---|---|
| F-1 | 1978-16A | 35,782 | 35,796 | 2.2 | 1436.2 | 100°W | 71 |
| F-2 | 1979-38A | 35,728 | 35,850 | 0.9 | 1436.2 | 72°E | 56 |
| F-3 | 1980-04A | 35,781 | 35,787 | 1.4 | 1436.0 | 23°W | 47 |
| F-4 | 1980-87A | 35,771 | 35,804 | 0.3 | 1436.2 | 172°E | 38 |

In the next phase the FLTSATCOM function is to be taken over by a new series of satellites called Leasat. Leasat is the first class of satellite designed exclusively for Shuttle launch, and one of the features which distinguish it from previous Shuttle-launched synchronous orbit satellites is the number of manoeuvres it takes to reach that orbit. Other satellites use one burn to produce a transfer orbit with an apogee at synchronous altitudes, followed by a second to circularise the orbit. Leasat makes this journey in five steps, using a Minuteman third stage rocket and a liquid propellant motor.

At the start of 1984 NASA's Shuttle manifest for the year included two Leasats, the first (also known as Syncom IV-1) on 41-D in June, and the second (also known as Syncom IV-2) on 41-F in August. A number of factors contributed to the re-arrangement of this schedule, with flight 41-D carrying part of the original 41-D's payload and part of 41-F's. As a result, Leasat 2 was the first to be launched, aboard Shuttle 41-D on 30 August.

Leasat 2 was released from the Shuttle a day after launch using the "frisbee" mode, and in orbit it became object 1984-93C. The Minuteman third stage raised its orbit from 297km by 314km to 310km by 15,204km. This was followed by three burns of the liquid propellant motor, resulting in orbits of 312km by 19,232km, 316km by 25,216km, and 321km by 36,012km. The fifth burn, on 4 September, raised the perigee to give parameters of 34,087km by 35,953km, and reduced the inclination to 3.56°. Leasat 2 was now drifting eastwards at 10° of longitude a day, and the next day it was stabilised at 105°W. Its orbit was 35,775km by 35,795km, inclined at 3.45° and with a period of 1435.91 minutes.

Published accounts state that Leasat 2 is to be stationed at 100°W [13], but it was still at 105°W at the year's end. It is not clear whether it is still being checked out, or whether it is now acting as back-up to FLTSATCOM 1, which itself is stationed at 100°W.

Leasat 1 was ultimately launched on Shuttle mission 51-A on 8 November and as object 1984-113C made a similar series of manoeuvres to its predecessor. These culminated on 15 November with it being stationed at 15°W, in an orbit from 35,724km to 35,846km, with an inclination of 3.49° and a period of 1435.91 minutes. Leasat 1 thus appears to be supporting FLTSATCOM 3, which is at the 23°W slot.

The 1983 review commented on how little information about the Satellite Data System (SDS) has been made public, but one item of data that has since been released is the orbit of 1983's SDS launch. 1983-78A was quoted as being in a 1028km by

39,321km, 63.4°, 717.7 minute orbit. This is particularly interesting as it apparently refers to the stabilised orbit, whereas all other published SDS data refers to parking or drifting orbits. Based on this the author generated the groundtrack of a "nominal" stabilised SDS orbit, and this has a very distinctive shape. As the argument of perigee is 270° apogee occurs at the northern limit of travel, and the track is symmetric about the longitude of apogee.

An illustration was then discovered showing two such tracks overlaid on a map of the world [14]. No reference was made to the type of satellite shown, but the tracks match those of SDS so closely that there can be little doubt that it is this. One track has apogees at 60°W and 120°E, while the other has them at 170°W and 10°E.

The fact that the tracks of just two satellites were shown, rather than the three usually quoted for SDS, led to an analysis being made of the coverage each satellite could provide. This revealed that all points north of 60° latitude would be visible from an SDS satellite for three and a half hours either side of apogee, i.e. for 60% of its period. The AFSATCOM function is carried out by SDS in conjunction with the FLTSATCOM series of satellites, and the latter provides full coverage up to 60°N (see Figure 4 of the 1983 review). Therefore an SDS configuration of two satellites would be adequate to provide the coverage required by AFSATCOM.

For the SDS's role as a relay between the stations of the Satellite Control Facility an analysis was made of the satellite visibility at each of the SCF ground stations. This showed that the optimum spacing of the satellites is to have one reach its apogee at 60°W four and a half hours before or after the other reaches its at 170°W. This provides an average across the eight stations of a satellite visible for 76% of the time. Greatest coverage occurs at Thule (100%), while the least occurs at Mahe Island in the Seychelles (22%). The groundtracks of the SDS satellites and the positions of the SCF stations are shown in Figure 2.

Using the criterion of active satellites being those which have been in orbit for five years or less suggests that there were three active SDS satellites at the start of 1984:

<u>SDS Satellites at 31 December 1983</u>

| Satellite | Months in Orbit |
|---|---|
| 1980-100A | 36 |
| 1981-38A | 32 |
| 1983-78A | 5 |

A further launch, of the ninth operational satellite, was made on 28 August. The satellite received the International Designation 1984-91A, and is listed at the UN as having an orbit from 287km to 38,156km, with an inclination of 63.6° and a period of 702.8 minutes.

## 10. NAVIGATION

The Navy Navigation Satellite System entered 1984 with six operational satellites, five Transits and one Nova. Their status was as follows.

**Transit and Nova Satellites at 31 December 1983**

| Name | Satellite | Perigee (km) | Apogee (km) | Incl (°) | Period (min) | Months in Orbit |
|---|---|---|---|---|---|---|
| Transit O-12 | 1967-34A | 1041 | 1069 | 90.3 | 106.3 | 200 |
| Transit O-13 | 1967-48A | 1062 | 1094 | 89.7 | 106.8 | 199 |
| Transit O-14 | 1967-92A | 1032 | 1104 | 89.2 | 106.6 | 195 |
| Transit O-19 | 1970-67A | 945 | 1211 | 90.2 | 106.8 | 160 |
| Transit O-20 | 1973-81A | 888 | 1133 | 90.0 | 105.4 | 122 |
| Nova 1 | 1981-44A | 1167 | 1189 | 90.0 | 109.0 | 31 |

The last two Nova satellites (numbers 2 and 3) had been delivered to the US Navy in October 1983 [12], and reservations had been made with NASA for two launch slots in 1984 [15]. The bookings were on a call-up basis, only to be used if circumstances required them. In the event, one launch was made - Nova 2 in October.

Nova 2 was launched from Vandenberg AFB on 12 October and its Scout launcher placed it in a 323km by 1061km, 89.79°, 98.67 minute orbit. This was gradually raised over the next seven days using the satellite's Orbit Adjust Transfer System, until an orbit of 1158km by 1199km, with an inclination of 90.07° and a period of 109.02 minutes, was achieved. With less than a third of a degree between the orbital planes of Nova 2 and Transit O-12 it was clear that the former was a replacement for the latter. By this time O-12 had been in use for over 17 years, one of the most long-lived satellites of any nation. Figure 3 shows the orbits of the operational Transits and Novas at the end of 1984.

The Navstar programme was approaching the end of its R&D phase at the start of 1984, with just three of its 11 developmental Block 1 vehicles left to launch. Of the eight already launched, seven were in orbit, but the first two could only be used for limited types of testing. Their orbital data was as follows.

Navstar Satellites at 31 December 1983

| Name | Satellite | Perigee (km) | Apogee (km) | Incl (°) | Period (min) | Months in Orbit |
|---|---|---|---|---|---|---|
| Navstar 1 | 1978-20A | 20,060 | 20,346 | 63.3 | 718.8 | 70 |
| Navstar 2 | 1978-47A | 19,930 | 20,432 | 64.2 | 717.9 | 67 |
| Navstar 3 | 1978-93A | 20,113 | 20,249 | 63.8 | 718.0 | 63 |
| Navstar 4 | 1978-112A | 20,096 | 20,268 | 63.2 | 718.0 | 61 |
| Navstar 5 | 1980-11A | 20,065 | 20,299 | 63.7 | 718.0 | 47 |
| Navstar 6 | 1980-32A | 19,933 | 20,430 | 63.6 | 718.0 | 44 |
| Navstar 8 | 1983-72A | 19,917 | 20,446 | 62.8 | 718.0 | 6 |

Two launches were planned for 1984, in April and August [16], but this schedule was upset from an unexpected quarter. Shuttle mission 41-B, launched on 3 February, carried two commercial communications satellites, Palapa B-2 and Westar 6. Each satellite was to be injected into transfer orbit by a PAM-D stage, but was left stranded in a useless orbit when the PAM-D's Star 48 motor failed. The relevance of this to Navstar was that the SVS stage used to place Navstar in its transfer orbit employs two Star 48 motors.

In April the USAF postponned the planned Navstar launch [17]. Subsequent failure analysis focused on the motor's exit nozzle, and as detailed examination of those in the SVS revealed no anomalies the decision was then made to proceed with the launch. Navstar 9 lifted off on 13 June, and the Star 48 motors performed exactly as intended. The satellite, 1984-59A, went into a 544km by 20,674km orbit, inclined at 62.39°. Just under 34 hours later it was circularised at 20,318km by 20,619km. After a further 10½ days Navstar 9's groundtrack was stabilised by lowering this to 20,008km by 20,357km, with an inclination of 62.54°and a period of 717.99 minutes.

Navstar 10 was launched on 8 September, and as 1984-97A it followed a similar sequence of manoeuvres. From an initial orbit of 553km by 20,785km it went to a drifting orbit of 20,302km by 20,715km, and then to a stabilised orbit of 19,963km by 20,403km, with an inclination of 63.25° and a period of 718.01 minutes.

With the launch of Navstar 10 the programme had nine satellites in orbit; spacecraft numbers 1, 4, 5, 8 and 9 were in one orbital plane, and 2, 3, 6 and 10 in another, 120° to the West.

## 11. ANTI-SATELLITE (ASAT)

The first US anti-satellite test took place in October 1959, when a Bold Orion rocket was launched from a B-47 bomber to intercept Explorer 6 over Cape Canaveral [18]. In the years that followed a number of different ASAT programmes were started, but all were limited in terms of the range of orbits that could be targetted and the speed of response. In 1977 the US decided to initiate the development of a much more versatile system. It would be restricted to targets at low to moderate altitudes, but could operate against targets in orbits at any inclination. It would also have a very fast reaction time, able to hit a target within a few tens of minutes.

Three parallel approaches were studied, and the Vought Corporation's air-launched Miniature Homing Vehicle (MHV) design was selected for full scale development in September 1978. The MHV design, known as Project 1005, consisted of a two stage missile launched from an F-15 aircraft. The first stage would use a SRAM rocket, and the second stage an Altair 3 (both being solid propellant rockets). The MHV, which would form the actual payload, had originally been developed for the anti-ballistic missile programme.

Following release from the F-15 the two rocket stages would propel the MHV to the general vicinity of the target. The MHV would then guide itself to the target using a set of 56 small solid rockets. Target acquisition and tracking would be performed by infra-red sensors. The target would be destroyed by direct impact - no explosive would be necessary. Total weight of the missile at launch would be 1194kg [19].

The prime targets for the ASAT are to be Soviet ocean surveillance satellites, due to their ability to pass tracking and targetting data to ships in real-time [20]. They orbit at altitudes of 250 to 265km - by comparison the Bold Orion intercept was made at an altitude of about 260km. The system is planned to reach operational status in 1987, with one squadron of ASAT-equipped F-15s based on the West Coast at McChord AFB in Washington, and another on the East Coast at Langley AFB in Virginia.

A programme of 12 ASAT tests has been drawn up. Starting with the third test they will be against specially launched target satellites. The targets will be 2m balloons, but they will be able to alter their infra-red signatures to match those of Soviet satellites, and they will carry radar to assess miss distances. They will be launched in pairs by NASA on Scout rockets from Wallops Island [21].

After many delays the first ASAT test was made on 21 January

1984. Its aim was to verify the performance of the F-15/booster combination, and a simulated MHV was carried. The aircraft took off from Edwards AFB and flew to a positon over Vandenberg AFB, where the ASAT was launched at 18:50 GMT [22]. The launch actually took place outside the planned area, but the booster's guidance system corrected for this and it reached the intended target point in space. The complete missile flight lasted about ten minutes [23].

The second test came on 13 November, and this time an MHV was carried. The objective of the test was to demonstrate the ability of the MHV to acquire and track a target (a star was used). Although very few details of the test have been made public, it appears to have been a success [24]. The next test is to be against a target balloon. At the start of 1984 NASA's launch schedule for the year included the first of these in the fourth quarter, under the designation AF-16 [25]. No such launch has occurred, and a more recent report has suggested that this test will now come in March 1985 [26].

## 12. RESEARCH AND DEVELOPMENT (R&D)

The 1983 review described five R&D launches which had been scheduled for that year - Hilat, Geosat, AF1, AF2 and STS-10. Of these only Hilat was actually launched. The original STS-10 payload of Teal Ruby and ESS-2 was delayed due to development problems, and is now to be launched on the first Shuttle flight from Vandenberg AFB in early 1986 [27]. Its replacement was delayed by doubts over the performance of the IUS, and is now scheduled for mission 51-C (see Section 6).

At the time of the earlier review there was no indication of the missions of AF1 and AF2, but their similarity to AF-16 (Scout launch from Wallops Island) suggests that they were to be ASAT targets. As described in Section 11 the ASAT programme has been subject to several delays, which would explain the non-appearance of AF1 and AF2.

Reports of Geosat in early 1983 stated that it would be launched that March, but more recent comments imply that this has slipped, with September 1984 being the latest date [12]. By the end of 1984 there had been no sign of a launch, but presumably it will come in 1985. Indeed, there were no R&D launches in 1984.

## 13. CONCLUSIONS

Seventeen DoD payloads were placed in orbit in 1984, from ten USAF launches and three NASA launches. They are summarised in the table overleaf.

Having started the year with three DoD Shuttle flights planned it must be a considerable disappointment to have carried out none during the year. The fields of photo reconnaissance and communications, however, sustained high levels of satellite availability, and ocean surveillance, navigation and weather had an untroubled year.

DEFENSE PAYLOADS LAUNCHED IN 1984

| NAME | DATE | LAUNCH VEHICLE | SITE | COMMENTS |
|---|---|---|---|---|
| 1984-09A | 30 Jan | Titan 34D/Transtage | CC | DSP failure? |
| 1984-12A | 5 Feb | Atlas F | VAFB | White Cloud |
| " C | " | " | " | " |
| " D | " | " | " | " |
| " F | " | " | " | " |
| 1984-37A | 14 Apr | Titan 34D/Transtage | CC | DSP? |
| 1984-39A | 17 Apr | Titan 3B-Agena D | VAFB | "Close Look" |
| 1984-59A | 13 Jun | Atlas F/SVS | VAFB | Navstar 9 |
| 1984-65A | 25 Jun | Titan 34D | VAFB | Big Bird |
| " C | " | " | " | ELINT |
| 1984-91A | 28 Aug | Titan 3B-Agena D | VAFB | SDS |
| 1984-93C | 30 Aug | Shuttle 41-D | CC | Leasat 2 |
| 1984-97A | 8 Sep | Atlas F/SVS | VAFB | Navstar 10 |
| 1984-110A | 12 Oct | Scout | VAFB | Nova 2 |
| 1984-113C | 8 Nov | Shuttle 51-A | CC | Leasat 1 |
| 1984-122A | 4 Dec | Titan 34D | VAFB | KH-11 |
| 1984-129A | 22 Dec | Titan 34D/Transtage | CC | Chalet? |

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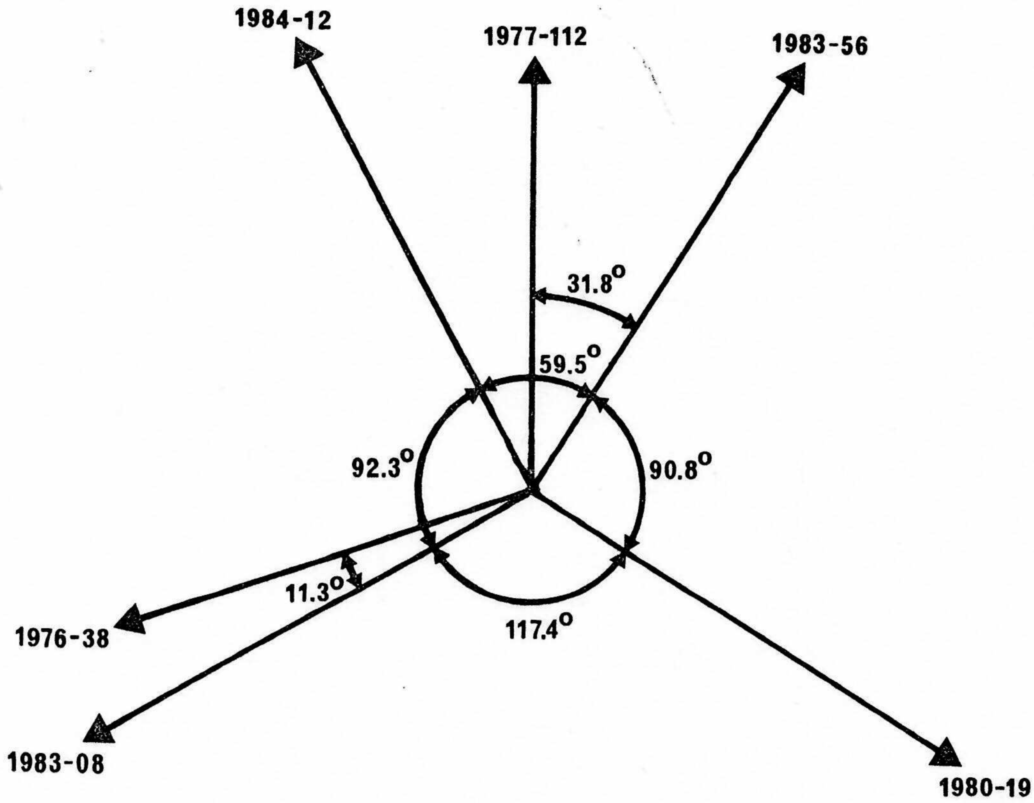


Fig 1. Relative Spacing of the Orbital Planes of the Ocean Surveillance Satellites

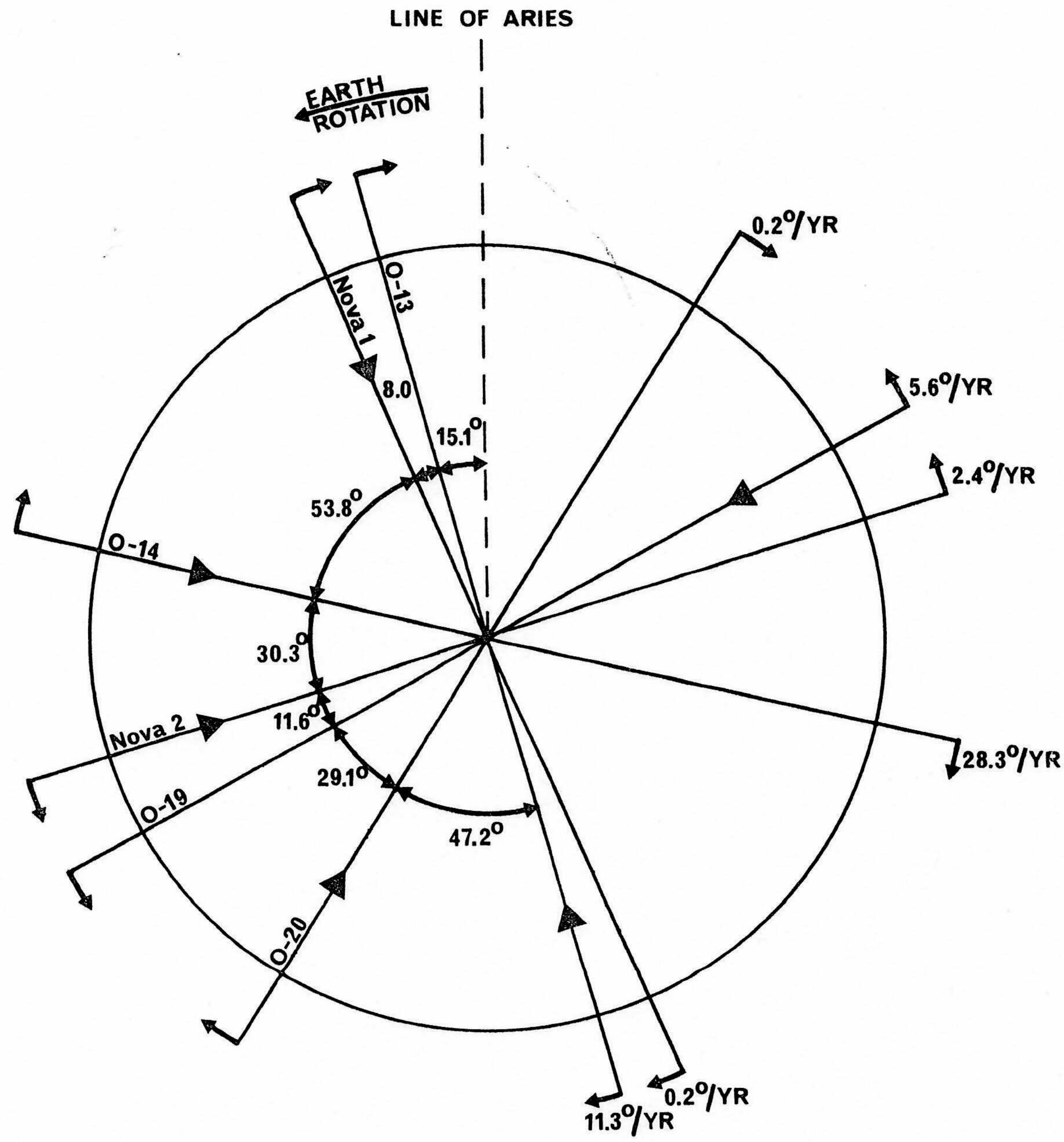


Fig 3. Orbits of the Transit and Nova Satellites on 31 December 1984, Viewed from above the North Pole