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STUDIES

The aeronautical and space industries of the Community compared with those of the United Kingdom and the United States

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COMPETITION INDUSTRY – 1971 – **4**

Survey carried out on behalf of the **Commission of the European Communities** (Directorate-General for Industry)

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THE AERONAUTICAL AND SPACE INDUSTRIES OF THE COMMUNITY COMPARED WITH THOSE OF THE UNITED KINGDOM AND THE UNITED STATES

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VOLUME 2 The aeronautical and space industry

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PART 1

The space activities in the United States

1. INTRODUCTION

Space activity, like nuclear activity, is a technical legacy of the Second World War. In the immediate postwar decade the stimulus, in both cases, was exclusively military. Interest in civil and scientific applications came later, when the destructive potential of the V2 and the atomic bomb had been developed by the military and combined in the first strategic missiles with nuclear warheads.

The Russians were four years behind the US with their first atomic bomb (1949) and, unlike the US, they had no fleet of intercontinental bombers; this handicap led Russia to develop strategic missiles before possessing nuclear warheads. With their first thermonuclear explosion (1953) the Russians were only a year behind the Americans, but they were already ahead in missile development.

In 1957 the US position can be summarized as follows.

Military missiles: the Army possessed, in the Redstone, the sole operational tactical missile and was developing the Jupiter IRBM; the Air Force was developing the Thor IRBM and the Atlas and Titan ICBMs; the Navy was developing the solid-fuel Polaris IRBM for launching from nuclear-powered submarines.

Scientific space research: in 1955 President Eisenhower had promised government support for American participation in the International Geophysical Year (1 July 1957 to 31 December 1958); projects included the launching of space probes and putting a small research satellite into orbit (Project Vanguard, entrusted to the US Navy laboratories).

Aerospace: the National Advisory Committee for Aeronautics (NACA), created in 1915, when America possessed 23 military aircraft as against 3500 in Europe, was developing the supersonic X15 rocket plane for heights of up to 100 km, in conjunction with the Navy and Air Force. At the end of 1957 the NACA had a budget of $117 million (for the financial year 1957-58 = FY 1958) and equipment worth $300 million, mainly concentrated in the laboratories at Langley, Virginia, founded in 1917, Ames, California, founded in 1940 and Lewis, Ohio, founded in 1941, with a total personnel of some 8000.

The US therefore had no unified and coordinated space programme when the first Russian Sputnik heralded in the space age on 4 October 1957.

Space activity in the US will be briefly described, with particular stress on those aspects most pertinent to the comparison with European activity in the same sector.

The attached Tables 2/B-1 - 2/B-7 show US space expenditure from 1957 to 1967 (totals and by recipient agencies) and the figures for NASA employees.

This serves as a general reference, as the tables are not specifically referred to in Part 1 of this report.

2. FIRST PERIOD OF SPACE ACTIVITY

For the purpose of comparison with Europe it is interesting to analyze how the American decision-making and organizational machinery reacted to the stern technical and political challenge launched by Russia in 1957.

The US immediately realized the political and strategic implications of the first Russian successes in space.

Their reaction was prompt and radical:

- on 7 November 1957 the President's Scientific Advisory Committee (PSAC) was set up at the White House to develop an aggressive coordinated space programme;

- on 9 January 1958 the Advanced Research Projects Agency (ARPA) was set up at the Department of Defence (DoD) to coordinate at last the missile and space activities of the three Services;
- on 31 January 1958 a Jupiter vehicle put into orbit the first US satellite, Explorer 1; six weeks later came the first successful Vanguard launching (17 March 1958);
- on 6 February 1958 and 5 March 1958 the space and astronautics committees of the Senate and the House of Representatives were set up; together with the PSAC, DoD and NACA the Committees critically reviewed the space programmes and prepared the Space Act, which passed through Congress and was signed by the President on 29 July 1958 (Public Law 85-568, 85th Congress, HR 12575, 28 August 1957).

Under the provisions of the Space Act:

(a) The National Aeronautics and Space Administration (NASA) was created as an exclusively civil agency, taking over the technical apparatus of NACA and all the civil space programmes initiated by the military;

(b) All space activities were to be coordinated by the National Aeronautics and Space Council (NASC), consisting of the President, the Secretary of Defence, the Secretary of State, the Administrator of NASA, the Chairman of the Atomic Energy Commission (AEC), one more public servant and a maximum of three private members;

(c) NASA was set up as an "Administration" and not an Advisory Committee like NACA; the Administrator has very wide powers regarding agreements and contracts with industry and the universities[1].

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[1] His annual salary is $22,500 and the job is full-time; in contrast with previous regulations he is empowered to pay salaries of up to $19,000 to a maximum of 260 executives and up to $21,000 to a further 13 executives.

(d) All inventions and patents arising from the use of NASA resources, whether internally or by the industrial supplier, were to remain government property; the same rule applied to the AEC; the DoD applied less strict rules, claiming only royalities for the use of patents already obtained under its contracts;

(e) The technical knowledge gained through space activity was to be published as widely as permitted by security limitations, which are much more liberally interpreted in the US than in Europe;

(f) The President of the United States was to have a temporary right for four years to transfer to NASA all the space activities of other agencies, subject to the veto of Congress, which must be exercised within 60 days of any transfer proposal.

In August 1958 K.T. Glenman was appointed Administrator of NASA, while the former NACA Director, H. Dryden, was appointed Deputy Administrator. The Mercury programme for the first manned satellite was launched straight away, giving an immediate sense of purpose to the nascent organization.

On 1 October 1958, a year after the first Sputnik flight, NASA commenced its official activities.

For FY 1959 NASA had a budget of $305 million, including $235 million for space activities. The sources of finance were: 30% from the regular NACA budget; 45% transferred from civil activities of the DoD; 25% specific appropriations for NASA. The three basic items in the budget were:

* S&E (Salaries and Expenditures), subsequently AO (Administrative Operations),

* CoF (Construction of Facilities),

* R&D (Research and Development).

From the outset, the financial policy of NASA was to spend most of its R&D money outside so as to spread the acquisition of space technology throughout the national industry, avoiding duplication of effort. To permit the utmost flexibility in budget spending, the CoF and R&D appropriations did not expire annually but could be carried over to subsequent years.

The NASA budget for FY 1959 ($305 million was 160% more than the preceding NACA budget ($117 million); the DoD space budget for FY 1959 ($490 million) was even higher than NASA's and was 137% up on the previous year's ($206 million); the AEC's space budget for FY 1959 ($34 million) was 62% more than the previous one ($21 million). Total expenditure on space rose from $344 to 829 million; such was the American financial reaction to the first Soviet successes in space.

As regards missiles, the first Polaris IRBM was tested before the end of 1958, with a contribution from the DoD's non-space budget; Boeing was selected, out of a field of 14; to develop the solid-fuel Minuteman ICBM, to be launched from underground silos. For reasons of quick reaction time and safety, solid propellants were henceforth preferred for strategic nuclear missiles.

The liquid-fuel Jupiter and Thor IRBMs were subsequently assigned to US bases in Europe (Britain, Italy, Turkey). The Thor IRBM was steadily perfected and increased in power, to become a widely-used launching vehicle for satellites. The liquid-fuel Atlas and Titan ICBMs were gradually perfected to become launching vehicles for the Mercury and Gemini capsules respectively, and also for satellites.

Missile expenditure, which had been over $1000 million annually since 1954, reached $5000 million in FY 1959.

The period 1959-60 was one of organizational shake-down for NASA, which was heavily engaged on the Mercury project. The world-wide system of tracking and telemetry stations was developed; the plans for military and civil launchers were rationalized and shared between the DoD and NASA. The start was made on the development of the Scout four-stage solid-fuel civil rocket launcher, the study of nuclear propulsion, in conjunction with AEC, and the development of the Centaur stage for perfecting the use of liquid oxygen and hydrogen, which was to be essential to the success of the Saturn rockets.

In 1959, NASA took over control of the Jet Propulsion Laboratory (JPL)[1] which had successfully collaborated in the Jupiter-Explorer project with the Army Ballistic Missile Agency (ABMA)[2].

In 1960 ABMA, too,was incorporated in NASA along with all its staff, activities and equipment, including the first Saturn project, initiated by the DoD in August 1958.

The transfer of the Navy's Vanguard project to NASA at the end of 1958 had created the nucleus of the Goddard Space Flight Centre (with a staff of 1900 at the end of 1960). The transfer of ABMA from the Army to NASA in 1960 created the nucleus of the Marshall Space Flight Centre (with a staff of 5400 at the end of 1960).

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[1] Founded by T. von Karman at the California Institute of Technology in 1953, the JPL had a staff of 2800 in 1959.

[2] Founded in 1956 and directed by W. von Braun, the ABMA employed 4600 people in 1959.

In the two years up to the end of 1960 the NASA staff was thus doubled (from 8000 to about 16,000). On a purely civil basis, NASA succeeded in fusing together the most advanced skills in the field of aeronautics and propellants; only an organization with a vast range of skills could ensure efficient management of such a highly interlinked activity as that of space.

By the end of 1960, NASA was able to produce its first ten-year plan of post-Mercury programmes, already aiming at man's exploration of the moon, together with systematic projects for satellite applications in the fields of communications, meteorology and navigation. This plan, involving a total expenditure of $12,000-15,000 million, was substantially accepted and amplified by President Kennedy, though only after Gagarin's first flight in orbit (12 April 1961).

In FY 1961, for the first time, NASA's budget ($964 million) exceeded the DoD's space budget ($814 million), even though the 1960 electoral campaign once more gave prominence to the military aspects of space activities and to the missile gap between the US and the Soviet Union.

The transfer of space activities from the DoD to NASA was not unruffled; at the beginning of 1961 NASA went through a time of uncertainty, while the DoD hoped for a more favourable treatment from a non-military President than it had received from a military one. The latter, on leaving office, had given a warning: "In the councils of government we must guard against the acquisition of unwarranted influence whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.... We must never let the weight of this combination endanger our liberties or democratic processes...."

At the beginning of Kennedy's presidency, J.E. Webb and R.S. McNamara became NASA Administrator and Secretary of Defence respectively. L.B. Johnson became chairman of the rehabilitated NASC, and the NASA and DoD space programmes were once again critically re-appraised. While American space policies wavered between NASA and the DoD, the Russians launched the first man into space: Gagarin's orbital flight ushered in the second chapter of the space age.

Space activity in the first period may be summarized as follows: the Russians put 10 Sputniks into orbit (one of them launched a probe towards Venus) and three lunar probes (one of which photographed the hidden side of the moon), while the Americans launched two Pioneer space probes and orbited 39 light satellites with greatly varied missions; 15 were scientific (radiation, magnetism, geodesy); 14 were technological (separation, guidance, re-entry); 10 were applications satellites, of which seven were military (one Midas and one Samos for reconnaissance, three navigational Transits, one Score and one Courier for active communications) and three were civil (two Tiros for meteorology and one Echo for passive communications).

This preponderance of military over non-military satellites continued in the second period.

3. SECOND PERIOD OF SPACE ACTIVITY

This was America's response to the new Soviet challenge:

- after three weeks, the sub-orbital flight by Sheppard (5 May 1961), followed by Grissom's sub-orbital flight (27 July 1961);
- after six weeks, the initiation of the Apollo programme, already prepared by NASA, to land a man on the moon by 1970.

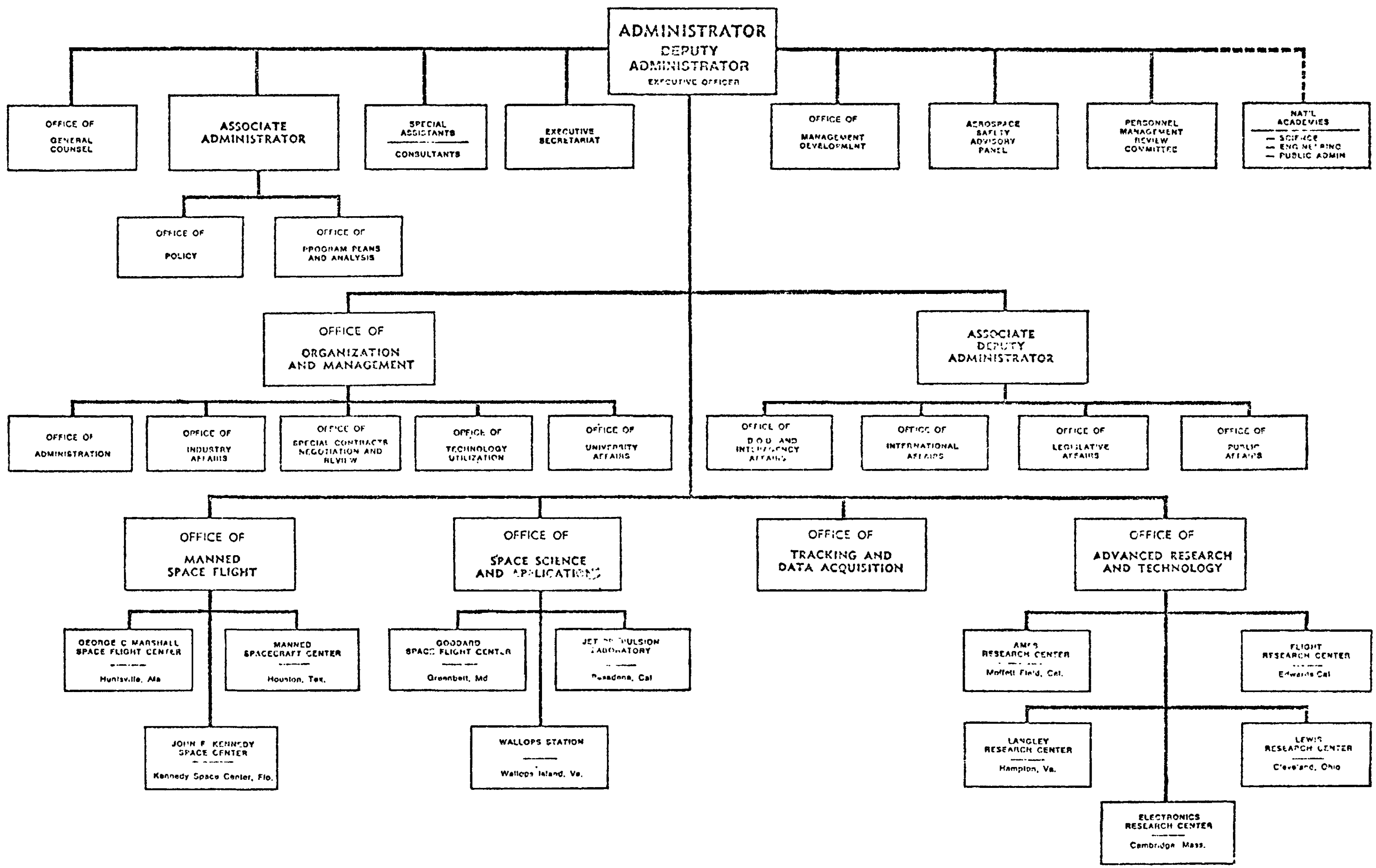
President Kennedy's decision (25 May 1961) to take "longer strides", in full awareness that no space project could be more difficult or costly, had its effects on NASA.

NASA's 1961 FY budget of $946 million was almost doubled in FY 1962, reaching $1825 million of which $1797 million were for space activities. Other notable increases in space budgets were those of the DoD (from $814 million in FY 1961 to $1298 million in 1962) and AEC (from $68 million in FY 1961 to $148 million in FY 1962. Total US expenditure on space went from $1808 million in FY 1961 to $3295 million in FY 1962, rising to $5400 million in FY 1963 and to about $7000 million in the following years.

The number of NASA employees steadily increased, from 16,000 in 1960 to about 33,000 in 1965.

The agency's management organization was modified to meet the new aims until it reached its present shape, which is shown on the following page.

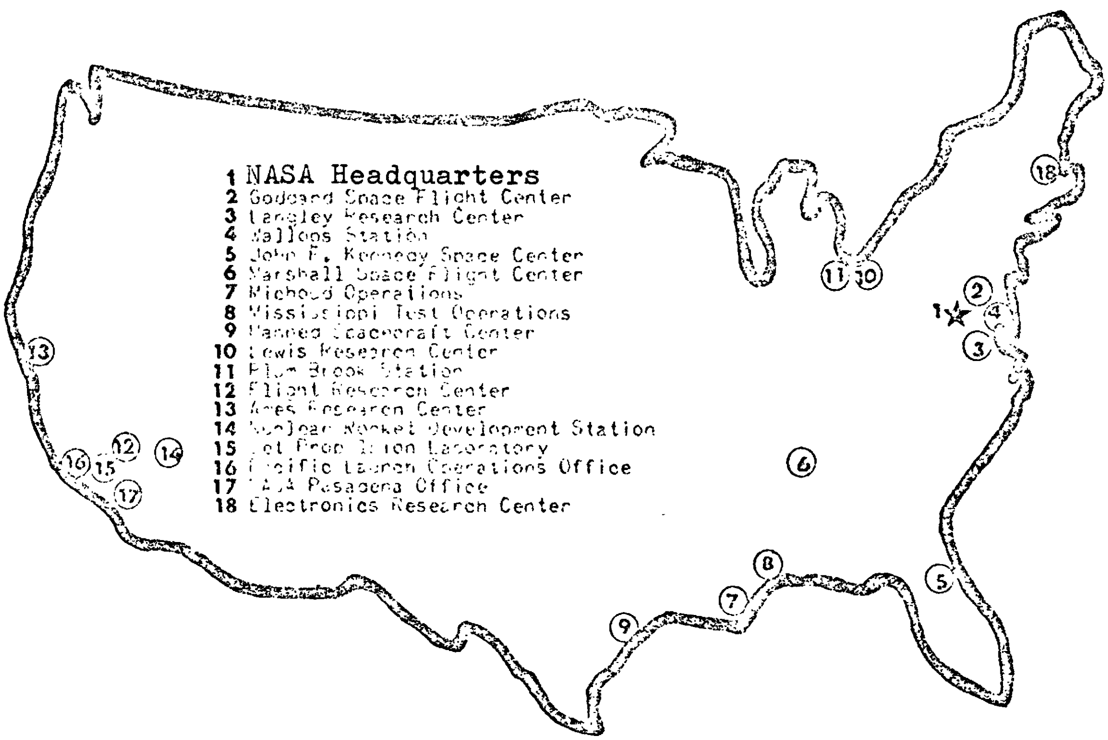
NASA Organization Chart



In summer 1961 work began on expanding the Manned Space Centre (Houston, Texas) and the launching base at Cape Canaveral (Florida) (later re-named Cape Kennedy) so that it could take the gigantic Saturn 5; the plant for building the first stage of the Saturn series was set up at New Orleans, and also the static test base at the mouth of the Mississippi.

Thus the network of NASA centres, scattered over a large part of the US, came into being (see figure below).

<u>NASA Centres</u>
(in 1968)



Still in 1961, there was a re-crganization of NASA involving coordination with the DoD for the Saturn launch vehicle, better quality control and reliability, improved contracting procedures in order to achieve prompt, efficient and controlled collaboration with industry.

On 1 September 1961 the Program Evaluation and Review Techniques system already used by the Navy for the Polaris programme was adopted to set up NASA-PERT in an effort to achieve efficient and logical management of complex projects. In 1962 the costing side was included to form the "NASA-PERT and Companion Cost System": this systematic integration of time and cost factors provided an effective instrument for the comprehensive management of space projects.

4. SPACE PROGRAMMES IN THE UNITED STATES

4.1 Military Programmes

Military interest in space, which was almost the sole spur to initial action, remained absolutely predominant in the US, even in the sector of unmanned terrestrial satellites. While NASA's financial commitments for the Apollo programme were already tapering off, the DoD was heavily committed in the Manned Orbiting Laboratory (MOL) project which began in 1965, with a completion date in the early seventies; a military Titan III launch vehicle was chosen and the capsule, with two astronauts aboard, is to complete a 30-day flight to investigate the military possibilities of space use.

On the military side, with the support of non-space funds from the DoD, the second space period featured the operational development of new land-based ballistic missiles (Atlas F, Titan 2 and 3C, Minuteman 2) and submarine-launched missiles (Polaris A2 and A3); at the end of 1968 the US had 1054 land-based ICBMs (as against the Soviet Union's 900-1000) and 656 SLBMs (USSR 125) carried by 41 nuclear-powered submarines (USSR 38), together with 500 intercontinental bombers (USSR 150).

The Soviet Union had outstripped the US in medium-range strategic weapons (750 IRBMs or MRBMs and 1050 medium-range bombers).

In 1967 Secretary of Defence R.S. McNamara launched the Sentinel programme (about $5000 million for the development of the anti-missile missiles (ABMs) Sprint and Spartan, intended to deter future attacks by China, who had already embarked on ICBM projects.

In August 1968, the first tests were made on the Poseidon C3 and Minuteman 3, both capable of carrying multiple nuclear warheads aimed at different targets (MIRV: Multiple Individually-targetable Re-entry Vehicles). The nuclear-powered submarine fleet had reached the total of 41 units planned in 1961; 31 of these were to be modified for launching Poseidon instead of Polaris missiles. New military missile programmes were under way to counter the new fractional orbit Soviet weapons which can reach almost any target on earth (FOBS: Fractional Orbit Bombardment System).

The strategic nuclear missiles race brings no improvement to the effective security of the super-powers.

4.2 Civil Unmanned Programmes

4.2.1 General summary

The main achievements in civil unmanned space projects in the decade 1957-67, after the initial Explorer and Vanguard programmes, are as follows:

(a) NASA weather satellites: ESSA, Nimbus, Tiros;

(b) NASA communications satellites: ECHO, Relay, Syncom, Telstar;

(c) NASA scientific research satellites OAO (Orbiting Astronomical Observatories), OGO (Orbiting Geophysical Observatories), OSO (Orbiting Solar Observatories);

(d) NASA satellites for automatic lunar exploration (Orbiter, Pioneer, Ranger, Surveyor) and planetary exploration (Mariner);

(e) NASA universal ATS (Applications Technology Satellites) on geostationary orbit acting as communications, weather and navigational satellites and for analysis of the earth's resources;

(f) the Scout four-stage solid-propellant launch vehicle;

(g) the Saturn launch vehicles with their objective "man on the moon".

An overall comparison of Soviet and American unmanned projects in space from 1957 to 1967 shows the following:

	Earth satellites	Moon probes	Planetary probes	Total
USA	468	15	10	493
USSR	212	9	10	231

Whereas the percentage of successful launches during the first period (1957-60) was 46%, in the second period (1961-67) this rose to 88%.

At the end of 1967 the surviving satellites in earth orbit numbered 245 American out of 468 and 51 Soviet out of 212. Breakdown of the 468 US earth satellites: about 49% security-classified military satellites; about 33% unclassified military satellites (in order of importance: technological, scientific, communications, reconnaissance, navigational); only about 18% civil (in order of importance: scientific, weather, communications). In 1965 alone, no less than 70 of the 94 satellites orbited were military.

4.2.2 Civil application satellites

In view of their interest to European activities, an analysis is given of American progress in communications and weather satellites from the beginning of the space age. Such satellites were developed experimentally by NASA and then produced commercially by other agencies.

Weather satellites

The National Academy of Science estimates that long-term weather forecasts could avert at least $2000 million of damage annually in the US alone. On 1 April 1960 NASA launched the first Tiros satellite; another nine satellites in this series were launched by the end of 1965; the last two, equipped with APT system (Automatic Picture Transmission) for transmitting 400 TV pictures a day direct to simple and economical stations on earth, were put into an orbit synchronized with the sun so that they could survey the whole earth in 24 hours by daylight.

On 28 July 1964 NASA launched the first Nimbus satellite on a polar orbit, capable of surveying by night using the HRIR system (High Resolution Infrared Radiometer); at present two are in orbit.

When the experimental phase under the guidance of NASA ended in February 1966, responsibility for the weather satellite service passed to the Environmental Science Service Administration (ESSA) of the Department of Commerce, while NASA continued to supply launch vehicles and launch facilities.

With an annual expenditure of less than $30 million ESSA has already put up six weather satellites (first launch on 3 February 1966).

To date, a total of at least a million pictures have been taken of cloud formations, cyclones, typhoons, sandstorms and iceberg formation; the accurate weather forecasts were of great value to the Mercury and Gemini programmes, as they will be to the Apollo programme, and likewise to air navigation, especially when supersonic air transport arrives.

At present more than 150 stations in some thirty countries receive accurate weather data from the American satellites. Future plans envisage a network of synchronous satellites, investigation of air pollution and a start on active meteorological measures to modify local weather.

Communications satellites

Both NASA and the DoD have had an interest in space communications from very early on.

On the military side the DoD, after the first tests with the active satellites Score (18 December 1958) and Courier (4 October 1960), started on the IDCSP programme (Interim Defence Communication Satellite Programme). From mid-1966 to mid-1967, three Titan III launch vehicles sufficed to put 18 satellites into almost synchronous orbit (17 of them functioning). The high capacity of this network (about 80 channels instead of the 30 initially planned) and the expected length of active life (four years instead of the expected two) caused the subsequent ADCSP programme (Advanced Defence Communication Satellite Programme) to be put off from 1969 to 1971.

NASA's civil programme began in 1959. Echo 1, a spherical balloon (diameter 30 m, weight 85 kg) acting as a passive reflector of radio signals, was launched on 12 August 1960[1]. On 10 July 1962, on behalf of ATT, NASA launched the active satellite Telstar 1 which linked Europe with the US. On 13 December 1962 NASA launched another such satellite, Relay 1, which tested TV transmission between North and South America for two years.

Further experiments followed in 1963 and 1964 with Telstar 2 (7 May 1963), Relay 2 (21 January 1964) and Echo 2 (25 January 1964). The latter satellite effected the first link-up between the United States and the Soviet Union.

The two Telstar satellites cost ATT a total of some $53 million. Meanwhile, with the Syncom satellites built by Hughes, NASA turned its attention to synchronous or geostationary satellites. Syncom 1 was launched on 14 February 1963 in a synchronous orbit, but remained silent; Syncom 2 was launched on 26 July 1963 and, though not perfectly synchronous on the equator, was used from October 1963 linked up to Relay 1 for transmission between the US, South America and Africa.

On 19 August 1964, Syncom 3 was launched perfectly and guided to the preestablished synchronous point over the Pacific; in

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[1] Not until after 1961 was NASA allowed to work on active satellites, which were previously the exclusive concern of the DoD.

the following October it enabled the Tokyo Olympics to be televised direct to the US. The advantage of a synchronous orbit, with fixed-direction stations on the earth, were now confirmed. In April 1965, Syncom 2 and 3 were handed over to the DoD for military communications.

Syncom 3 ended the NASA-led experimental phase of civil communications satellites. NASA retained responsibility for launcher vehicles and launchings but the worldwide communications service now passed on a commercial basis to COMSAT, the US representative in the international organization INTELSAT[1].

4.3 Civil Manned Programmes

For the purposes of comparison with possible space activity in Europe up to 1980 there is no need to analyse in detail the development of the grandiose manned space programmes. We note only the following:

Project MERCURY: began in August 1959 and concluded in May 1963 after two sub-orbital flights (1961) and four orbital flights (three in 1962 and one in 1963); these latter used the single-stage military vehicle Atlas (built by General Dynamics) and the one-man Mercury capsule (built by McDonnell/ Douglas); the total cost was about $400 million.

Project GEMINI: started in December 1961 as a forerunner of Apollo and ended in November 1966 after 10 orbital flights (five in 1965 and five in 1966); use was made of the two-stage military vehicle Titan 2 (built by Martin) and the two-man Gemini capsule (built by McDonnell/Douglas); the total cost was about $1300 million.

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[1] See Part 2 below.

Project APOLLO: started in May 1961, and required above all the painstaking development of the gigantic Saturn launch vehicles under the direct control of NASA.

The following vehicles were built and tested:

- Saturn 1: nine successful launches from 1961 to 1965; 17-ton payload put into earth orbit in January 1964.
- Saturn 1B: four successful launches from 1966 to 1968; payload of 26 tons put into earth orbit in February 1966.
- Saturn 5: two successful launches from 1967 to 1968; payload 126 tons put into earth orbit in November 1967; Saturn 5 stands 110 m high and can send a payload of some 50 tons out of the earth's gravitational field.

Main contractors are as follows:

- Boeing: first stage of Saturn 5
- North American: second stage of Saturn 5
- Chrysler: first stage of Saturn 1 and 1B
- Douglas: third stage of Saturn 5 (= second stage of Saturn 1B)
- IBM: instruments unit
- Grumman: lunar module
- North American: service module and command module
- Lockheed: recovery system.

The intensive experimental phase (1961-68) was followed by a quick succession of manned operational flights with crews of three astronauts:

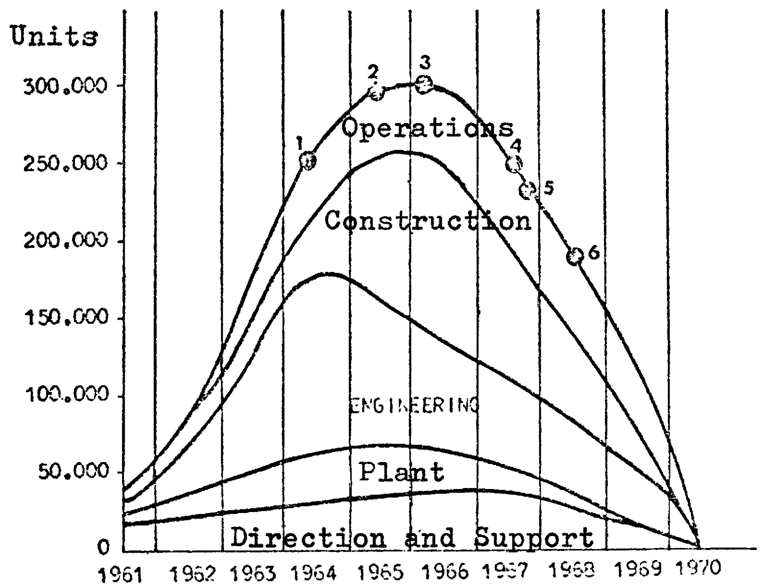
- Apollo 7 (Saturn 1B) in earth orbit in October 1968;
- Apollo 8 (Saturn 5) circumnavigated the moon in December 1968;
- Apollo 9 (Saturn 5) in earth orbit in March 1968;
- Apollo 10 (Saturn 5) in lunar orbit, descending to 15 km above the moon's surface, in May 1969;
- Apollo 11 (Saturn 5) culminating in the grandiose success of man's first landing on the moon in July 1969.

A further nine Saturn 5 vehicles are already in preparation to effect two moon landings a year after 1969-73, conducting progressively more advanced missions of direct lunar exploration.

The total cost of the Apollo Project is estimated at $25,000 million.

The manned space flight programmes created an extensive pool of skilled labour which at one time reached a peak of 300,000 workers employed by 20,000 concerns, as shown in the following diagram:

Employment on Manned Space Programmes



1. First flight of Gemini, unmanned
2. First flight of Gemini, manned
3. First flight of Apollo Saturn 1B, unmanned
4. First flight of Apollo Saturn 1B, manned
5. First flight of Apollo Saturn V, unmanned
6. First flight of Apollo Saturn V, manned.

4.4 NASA Joint Programmes

As regards civil space activities, the second American period also showed an increasing willingness to collaborate on international programmes for the peacful use of space.
NASA's rules on such collaboration are as follows:

(a) Designation, by each participating government, of a civil agency responsible for negotiation and supervision of the joint programme;

(b) Agreement on precise and specific projects rather than general scientific or technological collaboration;

(c) Acceptance of financial responsibility by each participant for the share undertaken in the joint project;

(d) Scientific validity of projects and mutual interest;

(e) Publication of scientific results.

On this basis agreements were made with 83 countries by the end of 1967. We shall deal only with cooperation between NASA and the EEC countries and between NASA and the UK. The international Intelsat agreement will be treated separately[1].

NASA's collaboration with Europe comprises:

(a) Making launching vehicles available free of charge to orbit: three UK Ariel satellites (already launched in 1962, 1964, 1967); three Italian San Marco satellites (two already launched in 1964 and 1967); two French FR satellites (one already launched in 1965); one German satellite (planned for 1969); two ESRO satellites (both launched in 1968).

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1 See Part 2.

(b) Accommodating scientific experiments on its own satellites: 11 UK (five already carried out); five French (two already carried out); one Italian; one Dutch.

(c) Launching of sounding rockets (11 for the UK, 22 for Germany, 11 for France, eight for Italy, five for the Netherlands).

(d) Agreements to use UK, French and ESRO networks for telemetry and tracking of American satellites and reciprocal facilities on the US network.

5. CURRENT PROSPECTS

After reaching its peak of $5250 million in FY 1965, NASA's budget has steadily dwindled as the Apollo programme neared completion and doubts arose as to future space programmes and investment priorities in the seventies.

The attitude of Congress towards NASA became critical after the first fatal accident when three astronauts were burned to death in their Apollo cabin at Cape Kennedy (27 January 1967). This disaster, which was followed by the death of Komarov during re-entry over the Soviet Union (24 April 1967), slowed down the Apollo programme and imposed stricter specifications on the supply of the command module (North American) and the lunar module (Grumman), at an increased cost of $100 million.

After that, Congress and the Johnson Administration were led to look more favourably on the application of aerospace technologies in the solution of the earth's industrial, economic and social problems and to support a wider variety of programmes rather than a few extremely costly projects.

NASA drew up, and began developing in 1967, the Apollo Applications Programme (AAP), aimed at fully exploiting the skills achieved in the Apollo programme and ensuring that the country profited financially by them; NASA is now arguing that the AAP is also applicable in the military field.

Congress had already tried to combine into a single programme the AAP and MOL projects, for which NASA and the DoD had requested $440 and $630 million respectively for FY 1969. Previously the DoD had succeeded in justifying the independence of the MOL programme.

Unlike NASA, the DoD has never suffered any reduction of its space budget, which is still rising, if only slowly. If the present trend continues there will be an equal distribution of space budgets between NASA and the DoD within the next five years, for a total of below $6000 million.

On the analogy of the 10-year programme drawn up in the 1960-61 crisis, NASA is now trying to put through a five-year plan requiring a budget that rises from $4500 million in 1970 to $5500 million in 1975. NASA's request for $4370 million for FY 1969 was cut to $3900 million by Congress in 1968, but the final authorization is expected to be $3850 million.

These budget reductions form part of the general cutback of $6000 million on public expenditure which President Johnson asked Congress to approve for FY 1969 as a result of the increasing cost of the war in Vietnam.

The slashing of space funds and the doubts cast on post-Apollo activity led to the resignation of J.E. Webb as NASA Administrator on 7 October 1968, less than a year after the resignation of R.S. McNamara.

NASA's string of successes in the Apollo programme caused Congress to cancel the DoD's military MOL programme at the beginning of 1969, and to plump finally for NASA's civil AAP programme.

This programme is already well-founded and above all it advances further into the new frontiers of technological progress, thus offering greater prospects of economic and industrial fall-out.

The recent decision puts an end to the twin-rule by civil and military agencies in space affairs which had already been eroded by the creation of NASA in 1958. It should lead to useful economies and even more efficient management; the DoD's space activities will supplement NASA's and not compete with them, at least in the forthcoming seventies in the US.

Longer-term uncertainties as to the civil post-Apollo programmes are now diverting the attention of industry and the research centres to various post-space possibilities (oceanography, urban planning, traffic, pollution, hospital organization, etc.) which Europe should soon begin studying if we are not to fall badly behind in these new advanced technologies also.

6. US SPACE AGENCIES ADDITIONAL TO NASA AND THE DoD

Apart from NASA and the DoD the following agencies participate in particular sectors of space activity, with smaller budgets:

Atomic Energy Commission (AEC): collaborates with NASA on nuclear propulsion projects (Rover programme, Nerva experimental reactor) and nuclear power systems on board, through the Space Nuclear Propulsion Office (SNPO); also develops its own electrical propulsion projects in the Space Electric Power Office (SEPO). Total AEC expenditure is shown in Table 2/B-8 and space expenditure in Table 2/B-9.

Department of Commerce: runs the National Bureau of Standards (NBS) and collaborates specifically on space with the Environmental Science Service Administration (ESSA), in which were merged the Weather Bureau, the Coast and Geodetic Survey and the Central Radio Propagation Laboratory (of NBS) in 1965.

This unified administration is responsible for the ESSA and TIROS weather satellites and the PAGEOS geodetic satellites.

COMSAT: responsible for the operation of space communications, by now all commercial, which will be dealt with in detail in Part 2 below.

National Science Foundation (NSF): supports basic research in the universities and non-profit-making establishments; scientifically responsible for American participation in the International Quiet Sun Year (IQSY); NSF runs the National Radio Astronomy Laboratory (West Virginia), Kitt Peak National Observatory (Arizona) and Cerro Tololo Inter-American Observatory (Chile); these observatories collaborate in space research with their powerful telescopes.

Smithsonian Astrophysical Observatory: founded in 1890 at Cambridge, Mass., and has a world-wide network of observers for watching satellites, studying meteorites and comets and observing the planets and solar activity.

Space Science Board: the space section of the National Academy of Sciences, a private research organization used as scientific advisor to the Federal Government. It represents American space science at the Committee on Space Research (COSPAR) which was set up by the International Council of Scientific Unions (ICSU) in 1958.

It coordinates space research contracts awarded by NASA to the universities and directs American participation in international scientific space activities.

National Aeronautics and Space Council (NASC): already mentioned in connection with the 1958 Space Act; politically responsible for superintending the entire aerospace activity; participates in the preparation of budgets and drafts the "President's Annual Report to Congress on Aeronautics and Space Activity".

PART 2

The world space agencies

1. INTRODUCTION

Since 1958 UN has taken an interest in exclusively peaceful uses of space in order to promote world space cooperation for the benefit of all mankind.

In 1961 the Committee for the Peaceful Use of Outer Space was created, with 28 member states including the US, the Soviet Union and the EEC countries. In August 1968 the UN held the World Space Conference in Vienna.

Organizations which actively cooperate with the UN are:

- ITU (International Telecommunications Union)
- WMO (World Meteorological Organization)
- UNESCO
- ICAO
- IAEA

From the outset they extended their traditional fields of activity to include space.

Apart from these inter-governmental agencies there are some private scientific bodies that operate internationally. These are:

- COSPAR (Committee on Space Research), set up in 1958 by ICSU (International Council of Scientific Unions) and used as scientific arbiter in space matters by the UN; 32 international scientific bodies belong to COSPAR;
- IAF (International Astronautical Federation), set up in 1960 as a grouping of space institutions and industries; 50 companies from 33 countries belong to IAF.

Economically speaking the major world space organization is INTELSAT, which therefore merits a detailed analysis, considering also the vital European interests in space communications. In view of COMSAT's vital role within INTELSAT, these two bodies will be dealt with together.

2. INTELSAT AND COMSAT

2.1 Introduction

World interest in space communications was manifested at the UN as far back as 20 December 1961, in connection with the programmes for the peaceful use of space. Resolution No. 1721 (XVI), para. D, outlines a system of communications via satellite "on a world-wide basis and without discrimination", to be worked out in agreement with ITU (International Telecommunications Union).

In the US, the move for a world system practically coincided (June 1961) with the launching of the Apollo programme by President Kennedy. On 31 August 1962, after technical and legal studies lasting about a year, Congress passed the Communications Satellite Act authorizing the creation of a private commercial space communications company, to represent America's share in future world systems.

On 4 October 1962, the preliminary committee started work on the Statute of COMSAT (Communications Satellite Corporation). COMSAT was officially set up on 1 February 1963 with a capital of $200 million, representing 10 million shares, half of them subscribed by private shareholders and the other half by international communications companies (ATT, ITT, RCA, WUI).

COMSAT is run by 15 directors, of whom three are nominated by the President of the United States and approved by the Senate, six are elected by private shareholders and six by industrial shareholders. It is authorized to construct, own, plan and operate, either alone or in collaboration with foreign governments, a commercial system of satellite communications, to supply services to American and foreign distribution agencies of ground communications; to instal its own ground stations on US territory, with the consent of the Federal Communication Commission (FCC).

By the timely creation of COMSAT, the US anticipated and influenced the development of other possible enterprises; it should be noted that COMSAT was set up a year before the entry into operation of ELDO and ESRO, i.e., the agencies which, albeit slowly and behind time, were to develop Europe's space capability.

European reactions to the Communication Satellite Act and COMSAT were in the form of uncoordinated national planning. In the second half of 1962, the UK, hoping to intensify communications with the Commonwealth, discussed with Australia and Canada the creation of a satellite system to be set up in four years, but doubts on investments and profitability deterred Australia; the UK and Canada approached the US, who had meanwhile started negotiations with France and Germany.

In December 1962, the US explained their policy and programmes to the European Conference of Postal and Telecommunications Administrations (CEPT).

Following the creation of COMSAT, on 22 May 1963, nineteen European countries set up the European Conference on Satellite Communications (CETS), open to all member countries of CEPT.

To counter a strong private commercial corporation, promoted and supported by the US Government, Europe set up a purely coordinative ministerial conference without any supranational powers.

2.2 INTELSAT Agreements

In these circumstances international negotiations were rapidly conducted at:

- Rome (February 1964)
- London (April 1964)
- Washington (July 1964).

On 20 August 1964 the International Communication Satellites Consortium (INTELSAT) was set up as an international agency regulated by two agreements, provisionally valid until the end of 1969, when they were to be reviewed and made permanent as from 1 January 1970:

- the first agreement was intergovernmental and defined the general principles of the organization;
- the second agreement was concluded between the agencies responsible for communications, as designated by each participating government.

The second agreement was signed by COMSAT and by the national agencies of each European country, not collectively by CETS.

The initial and current contributions to the financing of the INTELSAT system are shown in the following table (as percentages):

	June 1964	June 1968
Number of member countries	19	61
Germany	6.1	5.4
Belgium	1.1	1.0
France	6.1	5.4
Italy	2.2	1.9
Netherlands	1.0	0.9
EEC	16.5	14.6
UK	8.4	7.4
Europe	30.5	27.0
US	61.0	53.5

The contribution rate is based on the volume of communications traffic; the European share is about half that of the US.

Between 1964 and 1968, as the world membership rose from 19 to 61[1], the contributions listed were reduced by about 12%.

Membership of INTELSAT is open to all 122 member states of ITU; each new member lowers the contribution rates of existing members, but an absolute majority (at least 50.5%) is guaranteed to COMSAT[2].

It is interesting to note that the INTELSAT agreement was signed on 20 August 1964, i.e., the day after the launching of Syncom 3, built by Hughes and destined to prove, once and for all, the superiority of geostationary and synchronous satellites; without these satellites there could have been no development of regional systems, though these are not mentioned in the INTELSAT agreement.

This agreement reserves to COMSAT the running of the satellite system.

INTELSAT is directed by the Interim Communications Satellite Committee (ICSC), comprising 18 representatives from countries whose contributions exceed 1.5%: it has a Secretary and three subcommittees (Financial, Technical and Contracts).

The EEC is represented on the ICSC by Germany, France and Italy.
ICSC decisions are normally by simple majority; more important questions require a majority of 12.5% above the share of votes possessed by the major contributor nation (i.e., 73.5% when

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1 European membership rose from 15 to 19 in this period.

2 This guarantee was obtained by COMSAT in 1964.

the US share was 61%; 63% when the US share falls to 50.5%). In practice this clause entails a necessity for clear agreement among the Europeans.

Article 10 of the second INTELSAT Agreement suggests that the Committee should share out contracts between member countries in proportion to their contribution if possible.

Article 9 of the first Agreement provides for a general review before 1 January 1970:

- to improve the agreements in the light of experience;
- to enable all states who have in the meantime acquired experience of space to participate in INTELSAT contracts;
- to achieve a truly international operating company;
- to revise the contribution rates of member states.

The financial situation of INTELSAT at the end of 1968 may be summarized as follows: total contribution paid by member states in the period 1964-68 amounted to $128 million, including $68 million by the US and $35 million by Europe (EEC $19 million).

In 1968 the revenue from INTELSAT operations began to exceed expenditure.

2.3 INTELSAT Activities

The INTELSAT satellites are all synchronous (geostationary or on a 24-hour orbit) and they operate in the 5.9 - 6.4 Gc/s band to the satellite and the 3.7 - 4.2 Gc/s band earthwards.

INTELSAT 1: This initial system consists of a single Early Bird satellite fixed at 36,000 km above the Atlantic.

Developed by Hughes, on the model of Syncoms, it weighs 42 kg and provides up to 240 telephone channels or one TV programme.

It was launched on 6 April 1965 and went into commercial service on 28 June 1965.

The incomplete utilization of the 128-channel TAT 4 transatlantic cable between the US and France initially prevented saturation of the satellite telephone service. The high television charges also restricted the use of the TV service via satellite (some 30 hours in the second half of 1965 and about 80 hours in 1966).

From mid-1965 to the beginning of 1967, the INTELSAT charge for annual lease of a two-way telephone circuit via satellite fell from $64,000 to $46,000.

INTELSAT 2: This system consists of three satellites (two fixed over the Pacific and one over the Atlantic).

Developed by Hughes, they weigh 95 kg; they still provide 240 telephone channels, but with multiple access, or else one TV programme.

They were launched between January and September 1967, after a launching failure in October 1966.

In 1967, the four INTELSAT satellites (two over the Atlantic and two over the Pacific) totalled about 200 hours of TV transmission, and this rose to about 700 hours in 1968 owing to intensive use by NASA for the Apollo programme; NASA in fact used about 60% of the INTELSAT 2 capacity, almost covering its cost.

The INTELSAT 2 programme, which got under way at the end of 1965, cost a total of $27 million, divided up as follows:

$12 million	for the four satellites
$10.5 million	for launch vehicles and launchings
$4.5 million	for transportable antennas on the ground.

In Autumn 1968, the INTELSAT system was used for televising the Mexico City Olympic Games across the Pacific and the Atlantic.

INTELSAT 3: Aimed at achieving the first "global system". In May 1966 a contract for $32 million was awarded to TRW for the construction of six satellites to be placed over the Atlantic, Pacific and Indian Oceans so as to achieve world-wide cover.

The satellites weigh 150 kg and can provide 1200 multiple-access telephone channels or four TV programmes simultaneously; the average life of the satellites will be five years.

For the first time ever, the contract prescribed that at least 50% of the work on the last two of the six satellites should be sub-contracted to European companies.

After a launching failure in September 1968 (damage costing about $12 million), the first two INTELSAT 3 satellites were launched: one in December 1968 over the Atlantic (to supplement INTELSAT 1 and 2) and one in February 1969 over the Pacific (to supplement the two INTELSAT 2's). The system will be fully operational by the end of 1969; it is estimated that, together with the earlier systems, it will total about 1300 hours of TV transmission during 1969. The charge for annual lease of a telephone circuit might be reduced to $40,000.

INTELSAT 4: Already in 1967, so as to be able to meet communications requirements after 1970 with a technically more advanced and capacious global system, Hughes and Lockheed began competitive studies on the INTELSAT 4 system using satellites providing 5,000 to 10,000 channels. In addition, TRW started work on an intermediate system, INTELSAT 3½, using simpler satellites with 3,500 channels. These three great American corporations vied with each other in sub-letting to European contractors, so as to satisfy Europe's requirement for a fair return on their INTELSAT investments and also to maximize their international content for the benefit of the ICSC (one rule of INTELSAT is that, other things being equal, preference will be given to the most international tender).

- For INTELSAT 3½, TRW collaborated with European industries already working on the INTELSAT 3 programme: LCT Matra, SAT (French); Erno and Lorenz (German); HSD (British); Bell (Belgian); Contraves (Swiss).
- For INTELSAT 4, Hughes collaborated with CFTH (French); Telefunken (German); BAC (British); Selenia (Italy).
- For INTELSAT 4, Lockheed collaborated with LCT and SAT (French); Teldix (German); Ferranti, IMI, HSD, Elliot (British); Bell and MBLE (Belgian); Selenia (Italian); Contraves (Swiss).

In May 1968, the choice fell on the INTELSAT 4 system proposed by Hughes, which should be operating by 1971.

The contract is for $72 million for four satellites weighing 500 kg, providing 6000 telephone channels or else 12 simultaneous TV programmes; the average life of the satellites will be seven years.

Whereas the INTELSAT 1, 2 and 3 satellites, with their less powerful transmitters, required ground antennas measuring 25-30 metres across and costing currently about $4 million, the INTELSAT 4 satellites, thanks to their 3000 W transmitters, only need antennas measuring 9-12 m across and costing about $1 million.

As satellites are perfected, ground costs fall and use of space communications increases, it is estimated that the annual lease of a telephone circuit might drop to 10,000 dollars in 1975 as against 64,000 dollars ten years previously.

Ground stations

At the end of 1968 there were 22 ground stations operating in the INTELSAT system, comprising eight on the Pacific side and 14 on the Atlantic side. The latter include Goonhilly Downs in the UK, Pleumeur-Bodou in France, Raisting in Germany and Fucino in Italy.

A total of 41 stations are envisaged by the end of 1969, and 66 by the end of 1971, for an investment of about $100 million yearly. The potential market is still big, and should also interest the European electronics industry.

2.4 Current Situation and Prospects

COMSAT was set up in 1963 with a capital of $200 million, in the expectation that this would be the probable investment cost of the global system.

After joining INTELSAT, with an initial contribution of 61%, COMSAT gained a surplus of about $80 million representing the contribution of the other member states of INTELSAT.

Furthermore, in 1964 it was thought that the global system would require a large number of random orbiting satellites instead of a few relatively cheaper synchronous satellites.

As a result COMSAT found itself with an uninvested capital of $132 million at the end of 1968.

This large amount of available capital led COMSAT to expand its activities towards other applications and towards the creation of its own space R&D laboratories.

Since INTELSAT was set up, COMSAT has played a triple role:

(a) As a private corporation competing with American communications companies, and on the way to becoming an R&D centre, with its own laboratories, in competition with those of American industry;

(b) As America's representative in INTELSAT, backed by the State Department, staunchly upholding the principle of sharing by volume of traffic and having no truck with political sharing (one country, one vote); opposed therefore to the non-discriminatory system open to the world as desired by UN, and also by the 1962 Space Communication Act;

(c) As manager of INTELSAT, with predominant power of decision in the ICSC and with the right of absolute veto, but a staunch supporter of free competition for INTELSAT contracts.

COMSAT was set up before Syncom 3 had finally demonstrated the superiority of synchronous satellites and therefore, as has been said, before any moves could be made to develop regional systems (each region with its own satellite).

Having ascertained the existence of this possibility, and wanting to maintain its monopoly of space communications not only internationally but also inside the US, COMSAT proposed at the end of 1967 to instal the internal system which was becoming indispensable in the US; the estimated cost was $57 million.
This move by COMSAT raised much doubt and concern in the United States.

Were it to be put into effect, it is obvious that:

- other regions, first and foremost Europe, might claim the right to set up their own system;

- COMSAT could no longer represent the US in INTELSAT, nor could it manage INTELSAT;
- COMSAT's two roles, national and international, would have to be clearly separated, but this would enable COMSAT to trigger off the proliferation of regional systems to the detriment of INTELSAT, a result that would be more displeasing to the State Department than to US industry, which views the regional systems as a potential market.

COMSAT's move was given a very hostile reception by the great communications companies, ITT and ATT, which were concerned over their shares of the home market; COMSAT tried to propose a merger with ITT, RCA and WUI so as to split all internal and intercontinental communications 50-50 with ATT. Furthermore, ATT is concerned, as are the military for reasons of security, in the laying of the new TAT5 transatlantic cable between America and Portugal (as a link with the Mediterranean); it provides 750 channels at an estimated cost of $90 million, though a satellite with twice the capacity would now cost about $15 million. COMSAT's proposal for a regional system in the US is not strictly a violation of the INTELSAT agreements (nor are the similar European moves), but the effect will be to weaken and perhaps jeopardise the powers of INTELSAT.

A more open violation of the clause whereby INTELSAT must "contribute to world understanding and peace" is the military use, by the DoD, of 45 channels of the two INTELSAT 2 satellites over the Pacific, even though for strategic and classified services the DoD prefers to use the satellites of its Initial Defence Communication Satellite Program (IDCSP).

The State Department's persistent plea to Europe to comply loyally with the INTELSAT agreements is therefore not backed by exemplary loyalty on the American side.

To conclude, the INTELSAT agreements should be thoroughly overhauled as they were negotiated at a time when there was complete disparity of space knowhow between the US and Europe.

The technical and political troubles of ELDO, the purely scientific approach of ESRO and above all the failure to start work on the CETS programmes unfortunately weaken Europe's position in re-negotiating the INTELSAT agreements.

PART 3

The European space agencies

1. INTRODUCTION[1]

Europe at present possesses three distinct civil space agencies:

- ELDO (European Launcher Development Organization) for the development of space launchers;
- ESRO (European Space Research Organization) for the development of scientific satellites and space technology;
- CETS (European Conference on Satellite Communications).

19 European countries belong to CETS; 10 of these belong to ESRO and six of them belong to ELDO, together with Australia (see table below).

The three separate agencies were functioning in 1964; the need to coordinate their activities became clearly urgent in 1966 when the European Space Conference (ESC) was set up, comprising the Ministers of Research from all the countries belonging to ELDO, ESRO or CETS.

The three European Space Conferences have taken place at:
- Paris (December 1966)
- Rome (July 1967)
- Bad Godesberg (November 1968).

The decisions of these conferences will be discussed when dealing with European space agencies.

The fourth ESC is planned to take place in Brussels in January 1970 and will be particularly important for the unification

[1] The activities of EEC countries and the UK within the European space agencies are described in detail in the respective national reports (which see).

Member States of European Space Agencies

	CETS	ESRO	ELDO
Austria	x		
Belgium	x	x	x
Denmark	x	x	
France	x	x	x
Germany	x	x	x
Greece	x		
Ireland	x		
Italy	x	x	x
Liechtenstein	x		
Monaco	x		
Norway	x		
Netherlands	x	x	x
Portugal	x		
Spain	x	x	
Sweden	x	x	
Switzerland	x	x	
Turkey	x		
UK	x	x	x
Vatican	x		

of the European space agencies and for the final coordination of their long-term programmes.

At the industrial and banking level, the EUROSPACE group was formed in September 1961; this is a non-profit making body which promotes space research and studies, with special attention to the economic and industrial implications, and which has organized three joint conferences between Europe and the US, held at:

- Rome (June 1964)
- Philadelphia (April/May 1965)
- Munich (June 1968).

At present 150 companies from nine European countries belong to EUROSPACE; American companies figure as corresponding members. EUROSPACE has for years argued the need for a European mixed-economy company (EUROSAT), acting as the operative agency for space programmes under the control of member governments; EUROSAT was in process of being formed at the beginning of 1969.

EUROSPACE is now pursuing technical and economic studies on European meteorological satellites on behalf of the EEC. At the political level, the coordination and aims of European space activities have been systematically discussed and furthered:

- by the Council of Europe, through its Science and Technology Committee, since 1961;

- by the Western European Union, which in 1962 created a special committee on space affairs, now formally constituted as the Committee on Scientific, Technological and Aerospace Questions.

2. ELDO (European Launcher Development Organization)

2.1 Aims and Constitution

ELDO's basic purpose is to provide Europe with her own space launcher equipment for peaceful uses. This independence does not mean competing with the US and the Soviet Union but only the possibility of developing fully independent European programmes for space research and applications.

In April 1960, the UK cancelled her Blue Streak liquid-fuel strategic missile programme and in September offered it to Europe as the first stage of a non-military satellite launcher.

After political soundings by the UK and industrial soundings led by Hawker Siddeley (UK) and SEREB (France), the groundwork for ELDO was laid at the Strasbourg Conference (30 January to 2 February 1961, held under the auspices of the Council of Europe) and the Lancaster House Conference (30 October to 3 November 1961).

The Strasbourg Conference established the following principles:

(a) ELDO's first project was to be the development of a three-stage launcher with appropriate experimental satellites (first stage British, second stage French, with test firing at the Woomera range in Australia); the possibility of further projects was envisaged;

(b) ELDO would have purely peaceful aims and would further the progress of advanced technologies in member countries; all technical information relating to ELDO operations would be made freely available to all member governments;

(c) The British and French governments would freely give to ELDO the results of previous work;

(d) There would be close collaboration with ESRO, which was also in a preliminary phase;

(e) The estimated cost of developing the launcher was $196 million spread over five years;

(f) Contribution rates of member countries would be based on their respective Gross National Products (except that the UK agreed to pay above this rate: 33.33% instead of 25%).

This British concession (Point f above) was decisive in getting ELDO started.

The Lancaster House Conference reviewed and amplified the principles laid down at Strasbourg:

(a) The distribution of projects (Point a above) was completed by assigning the third stage to Germany, the satellites and heat shields to Italy, the ground control stations to Belgium, the long-range telemetry systems to the Netherlands.

(b) Free circulation of technical information (Point b above) was restricted to the needs of member countries in the sector of space technology only;

(c) The first doubts were expressed about the adequacy of the financial ceiling (Point e above);

(d) Budget approval procedures were established, the requisite majority being two-thirds of member countries, provided they represented at least 85% of ELDO's contributions.

In these two conferences, work was shared between member countries on a purely political basis; each country then normally awards contracts to its own industries on the basis of general competence, without any specific call for bids.

The limitation of free circulation of information partly contradicts the principle of general technological progress. At Lancaster House, the politicians failed to assert their rights as sole and public financers of the enterprise, whereas they could have appealed to the strict American practice; as a result the rigid rules of European industry regarding patents eventually prevailed.

The Lancaster House Conference drafted the Agreement, which was later signed by five EEC countries, the UK and Australia by 30 April 1962. It also set up the Preparatory Group with interim powers pending government ratification of the Agreement, which was not completed until 29 February 1964.

Being without juridical status, the Preparatory Group had to make unanimous decisions and rely on the cooperative attitude of member countries.

As Austria, Denmark, Norway, Spain, Sweden and Switzerland did not sign the Agreement (after having attended the two conferences), it was necessary to amend the contributions of the member countries; Germany, France and the UK agreed to share the uncovered 11.9%. Contributions were then shared as follows:

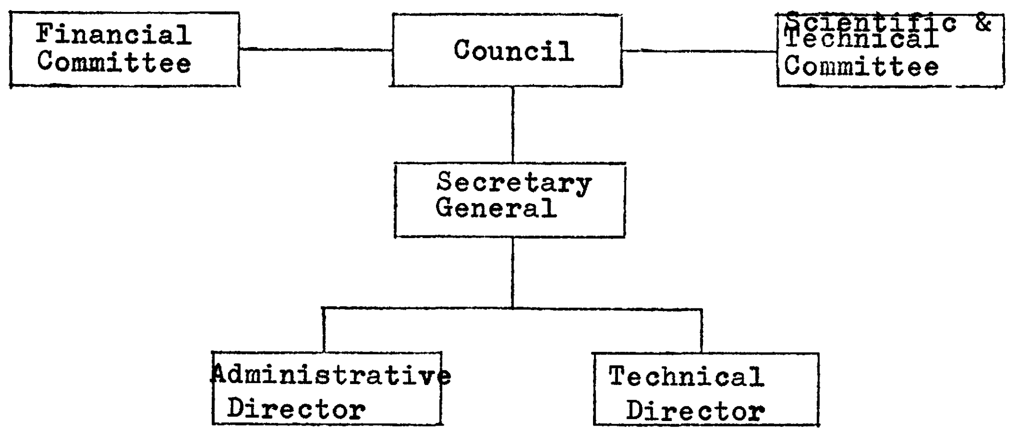
Belgium	2.85%
France	23.93% (instead of 20.57%)
Germany	22.01% (instead of 18.92%)
Italy	9.78%
Netherlands	2.64%
UK	38.79% (instead of 33.33%)
Australia	use of the Woomera range

Compared to a proportionate sharing on the basis of GNP, the UK pays 34% more; France and Germany 11% less; Belgium, Italy and the Netherlands 23% less.

This division remained unchanged for the three-year period 1964-66; it was modified in 1966 and again in 1969.

2.2 Organization and Budget

From the start the organization of ELDO has been as follows:



The Council is the legislative and political organ. It meets at least twice a year. Each member country has two representatives on it. The President (General Aubinière in 1968) is elected by the Council, and cannot be re-elected for more than two consecutive terms.

Since 1965, the President has reported on ELDO's activity annually to the Council of Europe.

The Secretary General has executive functions and is the highest permanent official of ELDO (Mr R. di Carobbio since 1964); he has a private secretariat, which has steadily increased; the Public Information Service is now flanked by a Legal and Foreign Affairs Service and a Financial Comptroller Service.

The administrative and technical directors act as Deputy Secretary General; their departments have progressively been developed to cope with ELDO's growing activities.

The Secretariat staff numbered 53 in 1962, 130 in 1964 and 320 in 1968.

Headquarters of the Secretariat: Neuilly-sur-Seine, Paris. After the initial period, ELDO's budget has remained almost stationary, as shown in the following table (in millions of dollars):

1961-64	1965	1966	1967	1968	1969
125	85	83	85	95	81

During 1961-64 the funds were divided up roughly as follows: $21 million in 1961-62, $36 million in 1963, $68 million in 1964. A ceiling of $626 million was established in 1966 and re-confirmed in 1968; this would leave $72 million available for the final two years (1970-71).

2.3 Activity of ELDO

2.3.1 In 1964 and 1965

ELDO's official life, under the eight-year Convention, began at the end of February 1964 and should continue until the end of 1971.

When official activity began, it became clear that the plans made in 1961 were unrealistic. These had envisaged a total of ten launchings in four years at a total cost of $196 million, as follows:

- 1962-63: four launchings (F1, F2, F3, F4) of first stage alone;
- 1964: three launchings (F5, F6, F7) with live first stage and inert upper stages;
- 1965: three orbital launchings (F8, F9, F10) with complete vehicle.

After reviewing the situation and the cost estimates, a new plan was prepared in 1964 for 11 launchings in seven years[1], at a cost of $400 million, as follows:

- 1964-65: three launchings (F1, F2, F3) of the first stage alone;
- 1966-67: four launchings (F4, F5, F6/1, F6/2), comprising two with both upper stages inert, one with only the third stage inert, and one with three live stages;
- 1968-70: four orbital launchings (F7, F8, F9, F10) of the complete vehicle to put satellites of increasing complexity and weight (up to 1000 kg) into a low orbit (500 km).

This slow-down in the programme led certain countries to speed up their own development of more advanced launchers, capable of meeting European requirements in communications. 1964 saw the first successful US experiments with geostationary satellites (apogee 36,000 km), but ELDO took another two and a half years (mid-1964 to end of 1966) before getting started in this vital field.

Meanwhile research continued on advanced techniques (liquid oxygen/liquid hydrogen propulsion, inertial guidance, apogee motors, utilization of an equatorial launching range).

Economic and legal studies also proceeded concerning the supply of launchers to possible users (member countries, other countries, European organizations such as ESRO and CETS).
In 1964-65, the three launchings of the first stage alone took place successfully at Woomera:F1 (June 1964), F2 (October 1964) and F3 (March 1965). This concluded the first phase of operations, confirming the reliability of Blue Streak.

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[1] The 1964 plan provided for a maximum of two launchings a year.

2.3.2 In 1966

The Convention ratified at the start of 1964 had specified that the progress of work should be reviewed after the first two years of activity.

The beginning of 1966 coincided with a period of serious crisis for ELDO, which was temporarily resolved in 1967, but returned even more severely in 1968, despite high-level intervention at three European Space Conferences (1966, 1967 and 1968) which met to coordinate the entire field of European space activities.

Since 1965, France had pressed for the development of advanced launchers capable of putting application satellites into geostationary orbit, whereas the UK, at the beginning of 1966, sent a memorandum to the other members of ELDO expressing concern at the increasing costs, the delays experienced and the impossibility of producing European launchers at a cost to compete with the Americans.

The first two points, though valid industrially, took no account of the lack of European experience in space; the third overlooked the fact that without independent launchers one must follow the space policy dictated by those who supply the vehicles.

In 1966 there was the first Ministerial Conference of ELDO member countries, held in four sessions (April, June, July, December).

The following basic resolutions regarding ELDO's future were approved:

1. Continuation of the Initial Programme (Europa 1) with certain improvements: starting of a Supplementary Programme (Europa 2) for development of a launcher derived from

Europa 1 with the addition of the Perigee-Apogee System (PAS), capable of putting communications satellites weighing 150 kg into geostationary orbit. ELDO's expenditure up to the end of 1966 (about $295 million) was to be supplemented by about $331 million for the development of these programmes up to the end of 1971; a limit of $626 million was thus set for all ELDO's activities until completion of the Initial and Supplementary programmes (1971).

2. Contributions to ELDO were modified as from 1 January 1967, as follows:

Belgium	from 2.85%	to 4.5%
France	from 23.93%	to 25.0%
Germany	from 22.01%	to 27.0%
Italy	from 9.78%	to 12.0%
Netherlands	from 2.64%	to 4.5%
UK	from 38.79%	to 27.0%

Member countries were also guaranteed work worth:

- at least 80% of contributions on the programmes overall;
- at least 50% on the supplementary programme alone.

3. The budget voting rules were modified: a majority of two thirds of member countries was still required, but their contributions only had to total 66.66% (instead of 85%), so as to avoid the possibility of veto by a single country.

4. To improve programme management the Secretary General's powers were extended and it was recommended that an international industrial group be set up to give technical support to the Secretary General and ensure the coordination and integration of activities relating to the Supplementary Programme.

The Supplementary Programme provided for three launchings (F11, F12, F13) into geostationary orbit, to be completed by the end of 1971; the work was distributed as follows:

Great Britain

Inertial guidance. Modifications and improvements to Blue Streak. Construction of the first stage for orbital launching. (Propulsion of experimental satellite in orbit).

France

Construction of equatorial launching range at Kourou in French Guiana. Perigee stage.
Construction of second stage for orbital launchings. (Four suborbital launchings with French vehicles.)

Germany

Construction and improvement of third stage for orbital launchings. (Instrument capsule for suborbital launchings.)

Italy

Heat shields for orbital launchings. (Apogee motor.) (Experimental satellites.)

Belgium

Auxiliary ground equipment. (Ground installations for launchings into geostationary orbit.)

Netherlands

Telemetry equipment. (Checking attitude of experimental satellites.)

Projects given in parenthesis are those which were to be cancelled by the austerity plan of 1968, which banned further increases in expenditure over the ceiling established in 1966.

Apart from these decisive internal resolutions, the ELDO Conference of Ministers also recommended (at its June and July sessions) that a European Space Conference be called, open to all member countries of ELDO, ESRO or CETS, in order to coordinate and plan all European space activity.

The first European Space Conference took place in Paris in December 1966; it arranged to meet again in 1967 and established a Working Party under Mr Bignier (France) to draw up a list of cooperative space programmes, national space programmes and European resources and requirements in the field of space activities.

In 1966, the three firings of the complete vehicle, with only the first stage live, were successfully accomplished at Woomera: F4 (May 1966), F5 (November 1966).

The last launching successfully tested the separation between first and second stages.
The halfway point in the second operational phase of the Europa 1 launcher was thus reached without mishap.

2.3.3 <u>In 1967</u>

The Bignier report formed the basis of discussion at the second European Space Conference in Rome (July 1967).

The Conference set itself up as a permanent coordinating agency, to meet annually.

The need to coordinate the activities of ELDO, ESRO and CETS and to avoid wasteful duplication of space enterprises (and also of national programmes) led to the creation of a Consultative Committee on Programmes, chaired by Mr Causse and charged with the preparation of a coordinated long-term European Space programme. The Causse Report, published in December 1967, recommended:

(a) cooperative European space investment, increasing by 10% annually in the decade 1968-77;

(b) a constant annual budget of $90 million for ELDO, with the development of a Europa 3 launcher throughout the decade and a start on a Europa 4 launcher by about 1972 (after completion of the Europa 2 supplementary programme);

(c) all the extra investment should be devoted to scientific satellites in the first five years, up to a ceiling of about $60 million, as part of ESRO's activities;

(d) all the extra investment should be devoted to application satellites in the second five years, up to a ceiling of about $40 million, as part of the activities of CETS;

(e) in the applications programme, top priority should be given to communications satellites; the Europa 3 launcher should put a payload of 500 kg into geostationary orbit and meet the needs of semi-direct TV broadcasting; the Europa 4, to be operative by about 1980, would have to lift 2000 kg into position and permit direct telecast tests;

(f) lastly, all European space agencies should be unified under the aegis of the European Space Conference.

The report on ELDO's activities in 1967, which came out in June 1968, confirmed the rules of financial return established in 1966 and gave the following estimate of the situation at the end of 1971 (in millions of dollars):

		Bel.	Fr.	Ger.	It.	NL	UK	Total
Contrib.	(1) IP	15.62	109.68	107.61	47.82	15.03	155.03	450.79
	(2) SP	6.46	35.89	38.77	17.23	6.46	38.77	143.58
	(3) Total	22.08	145.57	146.38	65.05	21.49	193.80	594.37
Contracts	(4) IP	15.50	67.26	150.68	34.31	8.02	144.70	375.47
	(5) SP	3.53	44.95	24.52	15.80	7.78	26.61	122.74
	(6) Total	19.03	112.21	130.20	50.11	15.80	170.86	498.21
	Ratio (6)/(3) (80% rule)	0.86	0.77	0.89	0.77	0.74	0.88	0.84
	Ratio (5)/(2) (50% rule)	0.55	1.25	0.63	0.92	1.20	0.67	0.85

IP = Initial Programme
SP = Supplementary Programme

The report envisaged the placing of further contracts for $7.57 million in France, Italy and the Netherlands to reach the overall return of 80% established in 1966.

At the end of 1967 it was thus estimated that contracts for a total of $498.21 + 7.57 = 505.78 million would be awarded in the member countries; the remainder (about 19.2% of the $626 million ceiling) went partly for operating expenses during eight years of activity, and were partly put aside for contingencies.

In 1967, France and Germany initiated their joint project Symphonie, for which they will require two Europa 2 (ELDO/PAS) launchers for use in 1971-72, thus becoming ELDO's first customers.

The need to use a European launcher will further strengthen French and German support for ELDO's programmes.
While work was being started on the supplementary programme, the two final launchings in the second operational phase of Europa 1 took place.

In the launching of F6/1 (August 1967) the first and second stages were live and the third inert; the first stage functioned and separated properly but the second stage failed to ignite.

The launching of F6/2 (December 1967) was a repetition of the first; again the second stage failed to ignite, owing to a failure in its sequencers.

2.3.4 In 1968

1 January 1968 saw the inauguration of SETIS (Société d'études et d'intégration de systèmes spatiaux), set up as recommended by the first European Space Conference (1966) to give technical support to the Secretary of ELDO in the coordination, supervision and integration of the supplementary ELDO/PAS programme.

The initial capital of $0.5 million was shared among 11 companies or consortia of the six member countries as follows:

Belgium	6%	(2% MBLE, 2% ACEC, 2% Bell)
France	29%	(SEREB)
Germany	24%	(12% ERNO, 12% Bölkow)
Italy	13%	(CIA)
Netherlands	4%	(3.2% Philips, 0.8% Fokker)
UK	24%	(12% HSD, 12% Rolls-Royce)

The President and Secretary of SETIS are those of SEREB, which is the major shareholder.

In mid-1968, the staff numbered 85, including 50 highly skilled technicians and engineers.

In January 1968, the ELDO Council and the Technical Committee unanimously approved the Causse Report; in the Finance Committee the UK made some reservations.
On April 1968, the UK sent to all members of the ESC a message expressing disagreement with the proposals contained in the

Causse Report:

(a) further extension of ELDO's activities after the Europa 2 launcher (i.e., after 1971) was not accepted, being considered uneconomical;

(b) participation in the CETS programme for experimental TV satellites was refused on the grounds that they would not be profitable enough;

(c) extension of ESRO's scientific activity was accepted, with an annual budget increase of 6% in the three years 1969-71.

At the same time ELDO was faced with increased budget requirements of about $100 million to complete the initial programme (Europa 1) and supplementary programme (Europa 2) by the end of 1971.

The ELDO Conference of Ministers met in three sessions (11-12 July, 1-2 October, 11 November.

Having acknowledged the need to sacrifice programmes in order to keep within the ceiling of $626 million approved in 1966, thus retaining the full collaboration of all member states, the Conference entrusted the Chairman, Mr T. Lefèvre (Belgian Minister of Scientific Policy and Planning), with the task of restoring agreement between the first and second sessions.

In the second session a group of senior officials, led by Dr J. Spaey (Belgium), was appointed to draw up in broad outline a 10-year European space programme in time for the third session. At the third session, after note had been taken that the UK undertook to supply the Blue Streak stage to ELDO or its members until 1976, for scientific and application projects, it was resolved that the existing programme would be solidly pursued within the limit of $626 million and would terminate with the three launchings of Europa 1 from Woomera (F7, F8, F9) and the two launchings of Europa 2 without the apogee stage from Guiana (F11, F12).

This austerity programme cancelled the final launchings (F10 and F13) and reduced the work of member countries on the supplementary programme (Section 2.3.1).

These programme cuts had the effect of further weakening European cooperation.

Owing to the cancellation of the PAS sub-orbital launchings, France decided to use the Amethyste launcher for the national PEOLE (Préparatoire à Eole) programme and for the joint Franco-German DIAL programme.
In this latter programme, Germany would make up for ELDO's cancellation of the work on the instrument capsules.

Italy reacted to the cancellation of the apogee motor and the experimental satellite by starting the national communications programme Sirio, using an American launcher.

The third session of the ELDO Council of Ministers was followed by the Third European Space Conference (Bad Godesberg, 12- 14 November 1968[1] which passed the following resolutions:

(1) <u>Space programme</u>

ESRO: three-year ceiling of $172 million for 1969-71.
CETS: programme of experimental TV satellites, costing $103 million.
ELDO: programme drawn up by the Conference of Ministers to be pursued in 1969.

(2) <u>Institutions</u>

Study on the amalgamation of European space agencies en-

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[1] The text is given in the annexes.

trusted to a Committee of Senior Officials, to be submitted by 1 October 1969.

(3) Europa-Intelsat

Member states recommended to instruct Intelsat negotiators in conformity with the attitude of CETS.

(4) European Space Cooperation

Need to draw up a minimum programme whose acceptance would be a condition of membership. Practical aim: space telecasts direct to the individual users. Scientific aim: projects beyond national possibilities.

(5) Production of launchers

Continued production of launchers for application and scientific purposes, on the assumption of two launchings a year for the five years 1972-76; determination of the price of European launchers, excess in price over equivalent non-European launchers to be split 50-50 between manufacturing country and buyer; the latter would in no case pay more than 25% above the price of the non-European launcher.

On 19 and 20 December, the ELDO Council met to approve the 1969 budget.
The contrary votes of the UK and Italy prevented approval.

At the end of 1968 the European space effort was split in two: the group consisting of France, Belgium, Holland and Germany collaborated, after April, in a study of possible alternatives to Blue Streak for future European launchers; the UK and Italy, on the other hand, were beginning to pull out.

On 15 April 1969, a new ELDO Conference of Ministers took note of this situation and agreed that Italy's total contribution to the ceiling amount of $626 million would be $57.60 million (9.2%), the UK would pay $187.93 million (30%) and the other four members would share the remaining $380.47 million by mutual agreement.

On this condition, with proportionally diminished voting rights for the UK and Italy, the 1969 budget of $81.4 million was belatedly approved.

On 30 November 1968 the complete Europa 1 vehicle was launched at Woomera (F7).

The first and second stages functioned and separated properly but the third stage failed. This first launching in the third and final phase of Europa 1 tests could be reckoned an 80% success.

2.4 Contributions of ELDO Member Countries

Excluding Australia's commitment (provision of the launching range at Woomera for Europa 1 tests), the progressive European contributions to ELDO up to the latest decisions of 15 April 1969 have been tabulated. Since ELDO's annual reports do not show budget progress or the contributions received from individual member states, the table is an approximation.

European Contributions to ELDO (1961-71)

(Millions of dollars)

	1961/1963	1964	1965	1966	1967	1968	1969/1971	TOTAL	%
Belgium	1.85	1.94	2.42	2.37	3.83	4.28			
France	13.37	16.27	20.34	19.86	21.25	23.75			
Germany	12.30	14.97	18.71	18.27	22.95	25.65	120.04	380.47	60.8
Netherlands	1.71	1,80	2,24	2,19	3.83	4,28			
Italy	6,36	6.65	8,31	8.12	10.20	11,40	6.56	57,60	9.2
EEC	35.59	41,63	52.02	50,81	62,06	69,36	126.60	438.07	70.0
UK	21.67	26,38	32,97	32.20	22,95	25,65	26.11	187.93	30.0
TOTAL	57.26	68,01	84.99	83.01	85.01	95.01	152,71	626.00	100.0

3. ESRO (European Space Research Organization)

3.1 Origins and Purpose

The organization was created with the aim of ensuring and developing European collaboration in the field of space research and technology, for purely peaceful purposes.

The European Preparatory Commission for Space Research (COPERS) was created at Meyrin on 1 December 1960 on the initiative of European scientific groups working with CERN.
A Convention was drawn up envisaging a period of activity of eight years; it was approved by a plenipotentiary conference on 14 June 1962 but not ratified by the governments until 20 March 1964.
The Convention provided for the wide publication of ESRO's scientific, technical and technological results so as to give member countries the maximum benefit from space experience.

3.2 Initial Programmes

ESRO's programmes were intended to accomplish projects that were beyond the means of national space programmes. As the budget was limited to $306 million over eight years, the Convention had already been forced to cut the over-ambitious programmes envisaged by COPERS.

The Convention provided for:

(a) the creation of European space research facilities, consisting of two technical centres, a laboratory, a scientific institute, a launching range for sounding rockets, a satellite tracking and telemetry network;

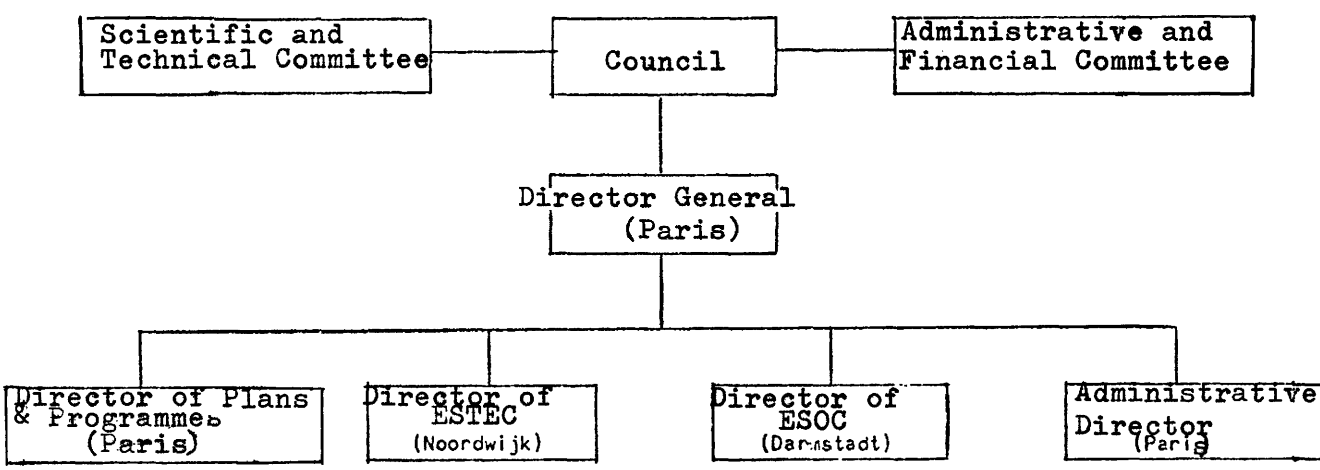
(b) the launching of 50 sounding rockets in the two years 1964-65; then 65 launchings a year in the period 1966-71 (440 in all);

(c) the launching of two small scientific satellites a year from 1967 to 1971 (10 in all);

(d) the launching of two large scientific satellites a year from 1969 to 1971 (six in all), including at least one Large Astronomical Satellite (LAS).

3.3 Organization and Personnel

Since the 1967 overhaul, carried out at the suggestion of the Bannier report, ESRO's structure has been as follows:



With the 1967 reorganization ESRO gave greater authority, responsibility and speed of decision to the peripheral agencies, eliminating the initial rigid and over-centralized machinery that had been too slow-moving for a scientific body with agencies spread all over Europe.

The Council is the legislative and political organ. It meets at least twice a year and each country has two representatives on it.

The President (Prof. H.C. Van de Hulst in 1968 and 1969) is elected by the Council and may not be re-elected more than twice consecutively.

Dr A. Hocker, who was President from 1966 to 1967, is an honorary member of the Council.

The Director General (Prof. H. Bondi since 1 November 1967) is the highest permanent official in ESRO.
Headquarters: Neully-sur-Seine, Paris.

ESRO comprises the following agencies and facilities:

(1) ESTEC (European Space Research Technology Centre), with its headquarters at Noordwijk (NL), responsible for the study and development of space vehicles and the useful payloads on sounding rockets, as well as applied research on space technologies.

Under ESTEC comes ESLAB (European Space Research Laboratory), also based at Noordwijk, which acts as a link between ESTEC and scientific bodies in the ESRO countries.

(2) ESOC (European Space Operations Centre) with headquarters at Darmstadt (Germany) coordinates the activites of:

- ESRANGE (European Sounding Rocket Launching Range) located at Kiruna, Sweden;
- ESDAC (European Space Data Centre), also located at Darmstadt and equipped for space data processing and as a computing centre;
- ESTRACK (European Satellite Tracking, Telemetry and Telecommand Network) consisting of four stations: Fairbanks (Alaska), Ny-Alesund (Spitzbergen), Port Stanley (Falkland Islands) and Redu (Belgium), with a common control central at Darmstadt;

(3) ESRIN (European Space Research Institute), with headquarters at Frascati, Italy, responsible for basic reseach, particularly on plasma physics.

A breakdown of ESRO personnel, by year and by agency, is given below.

At year's end	1964	1965	1966	1967	1968
Central headquarters	161	170	184	184	189
ESTEC	240	364	483	548	585
ESOC	48	76	139	187	288
ESRIN	-	4	21	34	57
TOTAL	449	614	827	953	1,119

A total staff of 1347 is planned for the end of 1971.

3.4 Budget and Contributions

The Convention provided for a total expenditure of $306 million over eight years, within the following limits: $78 million for the three years 1964-66; $122 million for the three years 1967-69; $120 million for the two years 1970-71.

In the three years of initial activity only $62.8 million were spent, but unanimous agreement was not obtained to carry the difference over into the next three years; the budgets for 1967 and 1968 were approved year by year ($48 million for 1967, $50 million for 1968); only after the third European Space Conference (November 1968) was it possible to establish a commitment of $172.million for the three years 1967-71 ($52 million in 1969, $56 million in 1970 and $64 million in 1971).

The total commitment up to the end of 1971 was thus $332.8 million.

But the withdrawal of Italy from special projects TD1 and the reduction in contributions obtained from Spain brought the total commitment down to $321 million, i.e., only 5% over the initial estimate.

As the progress of activities increasingly revealed the inadequacy of the estimated budget, and no agreement on budget increases was reached, it became necessary to delay and then substantially cut the programme of operations.

At the end of 1968 ESRO's total expenditure broke down as follows:

Running expenses	30%
Capital expenditure	31%
Operations	39%

The second item corresponds to the notable initial expenditure on facilities. At the end of 1971 the breakdown of total accumulated expenditure should be more in line with the 1964 estimate:

Running costs	30%
Capital expenditure	12%
Operations	58%

but without really being able to reach.

Percentage contributions of member countries, revised every three years on the basis of GNP, was established as follows by the ESRO Council:

	1964-66	1967-69	1970-71
Belgium	4.42	3.72	3.71
France	19.14	20.17	19.60
Germany	22.56	24.31	22.93
Italy	11,17	11.72	12.70
Netherlands	4.24	4.04	4.36
UK	25.00	23.13	21.44
Denmark	2.21	2.15	2.23
Spain	2,66	3.29	5.36
Sweden	5.17	4.23	4.52
Switzerland	3.43	3.24	3.15

The contribution from EEC countries went from 61.53% (1964-66) to 63.96% (1967-69) then down to 63.30% (1970-71).

Allowing for the reduction granted to Spain and the withdrawal of Italy from the special TD1 project, the actual contributions are as shown in the following table:

Contributions of European Countries to ESRO (1961-71)

(Millions of dollars)

	1961-1963	1964	1965	1966	1967	1968	1969-1971	TOTAL	% FINAL
Belgium	0.19	0.26	0.73	1.59	1.79	1.87	6.39	12.82	4.0
France	0,84	1,21	3.08	6.89	9.68	10.10	34.01	65.81	20.5
Germany	0.95	1.35	3.76	8.12	11.67	12.20	40.16	78.21	24.5
Italy	0,47	0,67	1.86	4.02	5.63	5.88	16,67	35,20	11,0
Netherlands	0.18	0.25	0,70	1,53	1,94	2.02	7,33	13,95	4,3
EEC	2,63	3,74	10,13	22.15	30,71	32,07	104,56	205,99	64,3
UK	1,05	1,50	4,16	9.00	11,10	11,60	37,76	76,17	23,7
Others	0,52	0,76	2,31	4,85	6,19	4,83	19,38	38,84	12,0
TOTAL	4,20	6,00	16.60	36,00	48,00	46,50	161,70	321,00	100,0

3.5 ESRO Contracts

The cumulative totals for contracts distributed by ESRO are shown in the following table (in millions of dollars):

	Contracts placed in member countries	Contracts placed in non-member countries	TOTAL	% in non-member countries
31 Dec. 1965	38.3	3.5	41.8	8.4
31 Dec. 1966	54.1	7.4	61.5	12.0
31 Dec. 1967	81.7	18.3	100.0	18.3
31 Dec. 1968	92.8	20.5	113.3	18.1

Procurements in non-member countries reached a peak in 1967, for an amount of (18.3 - 7.4)/(100 - 61.5) = 28.3%. By far the major non-member country was the US.

ESRO, however, applies weighting factors to the value of contracts, as follows:

- 100% on High Technology contracts (space activities, advanced equipment, etc.).
- 25% on Low Technology contracts (construction, etc.).

This modifies the preceding table as follows (in millions of dollars):

	Contracts placed in member countries	Contracts placed in non-member countries	TOTAL	% in non-member countries
31 Dec. 1965	28.6	3.0	31.6	9.5
31 Dec. 1966	42.7	6.7	49.4	13.6
31 Dec. 1967	69.1	16.4	85.5	19.2
31 Dec. 1968	76.0	17.4	93.4	18.6

Peak procurements in non-member countries is still in 1967, reaching (16.4 - 6.7)/(85.5 - 49.4) = 26.9%.

The results of these two tables differ little in their indication of the large amount spent in the US.
Of the total volume of contracts up to the end of 1968, 76% were high technology and 24% low technology.
At the end of 1965 the proportions were 67 and 33% respectively. This shows the heavy initial commitment of ESRO in building up infrastructure, and the subsequent progress to more advanced activities.

3.6 Geographical Distribution of Contracts

The table below shows the cumulative returns obtained by the various member countries:

- the upper part gives the "real" ratio between total contracts received and contributions paid;
- the lower part gives the "corrected" ratio using the following ESRO procedures:
  (1) applying weighting factors of 100 and 25% to high or low technology contracts respectively;
  (2) dividing the contract percentage relative to member countries alone by the contribution percentage.

The first procedure levels down the average return, especially in countries receiving a large number of low technology contracts: thus the Netherlands, where ESTEC and ESLAB are located, drop from first place in the "real" classification to fourth place in the "corrected" classification at the end of 1968.

The second procedure, by basing the percentage on contracts distributed in member countries alone, raises the average return but totally ignores the purchases made in the US.
In 1967, because of the disparity in returns up to the end

of 1966, the Council decided to guarantee a "corrected" return of at least 70% to all member countries by the end of 1971.

Under ESRO procedures this can be done without placing any limit on procurements in the US, which do not enter into the calculation.

Overall Returns Obtained by Member Countries of ESRO

	ESRO										
	ELDO										
	CEE										
	Belgium	France	Germany	Italy	Netherlands	UK	Denmark	Spain	Sweden	Switzerland	
31 DEC. 1965	2.74	2.04	0.90	0,48	7.26	0,66	1,79	0.03	1.59	1,93	Actual returns
31 DEC. 1966	1,26	1.51	0.38	0.55	3.19	0,45	0,80	0.26	1,05	1,24	
31 DEC. 1967	1.15	1.28	0.40	0,44	1,97	0,47	0,70	0.16	1,11	0,83	
31 DEC. 1968	0,90	0.97	0.36	0,37	1,52	0,34	0,48	0.14	0,88	0,70	
31 DEC. 1965	2.17	1.68	0.78	0,45	2,46	0.61	0,42	0.03	0,49	1,81	Returns according to ESRO evaluation procedures
31 DEC. 1966	1,54	2.06	0.49	0,81	1,72	0.59	0,32	0,38	0,68	1.83	
31 DEC. 1967	1.60	1.95	0.61	0,66	1,15	0,71	0,36	0,25	1,13	1,33	
31 DEC. 1968	1,66	1.92	0.66	0.64	1,17	0,65	0,30	0,30	1.10	1,42	

Source: based on RAPPORTS D'ACTIVITE ESRO 1965-1968

3.7 Projects Completed

By the end of 1967 ESRO had completed its basic facilities (centres, laboratories, telemetry network and bases); in 1968 work began on building the ESRIN institute.

The satellite and sounding rocket launching programmes had to be considerably reduced below the estimates of the initial Convention:

3.7.1 Sounding rockets

By the end of 1968 only 76 rockets had been launched out of the 245 planned in the initial Convention; it is hoped to launch a total of 195 rockets within 1971, out of the originally planned total of 440.

Of the 76 rockets launched up to the end of 1968, 43 were purchased in France (Sud-Aviation series), 25 in the UK (Skylark) and eight in the US (Arcas); of the 52 scientific experiments performed with these launchings, 25 were British and only three French.

As regards sounding rockets, France and the UK were the most active members, as shown below:

Sounding rockets	France	UK
Rockets supplied 1964-68	57%	33%
Scientific experiments 1964-68	3%	48%

- France was the major supplier of ESRO rockets but a sparse scientific user; both facts are explained by the national research programme under way in this field since 1961;

- the UK was the second biggest supplier of ESRO rockets, but the biggest scientific user.

3.7.2 Satellites

Construction was awarded by competitive tender to European companies, with ESTEC responsible for specifications, costing and technical supervision.

The Convention specified the launching of four small satellites by the end of 1968; three were actually launched.

ESRO 2: scientific satellite weighing 83 kg; launching offered free by NASA, with a Scout vehicle; after one abortive launching (29 May 1967) due to failure of the American launcher, it went into orbit on 17 May 1968 with the operational name of IRIS; after feasibility studies carried out by ACEC and the Zurich Polytechnic in 1963, a call for bids was issued in June 1964. Tenders were submitted by 31 European companies grouped into 12 consortia.

In November 1964, the initial contract for $4 million was awarded to the group led by Hawker Siddely Dynamics (UK), formed of HSD (56%) and the French company MATRA (44%).

HSD collaborated with the British firms Ferranti and Sperry and was assisted by TRW (US); MATRA collaborated with the French firms Air-Equipement, Intertechnique, CSF, CFTH and IER.

Test equipment and batteries were supplied by the American firms Gulton and Dynatronics. The Italian firm LABEN provided the monitoring equipment for the telemetry package.

The total cost of the satellite was about $6.2 million.
Of the seven experimental flight sets carried on the satellite IRIS, five were British, one French and one Dutch.

ESRO 1: a scientific satellite weighing 85 kg; free launching offered by NASA on the Scout launcher; went into orbit on

3 October 1968 with the operational name of AURORA.

After feasibility studies by SAAB (Sweden) and CRA (Italy) in 1963, bids were called for in November 1964; there was a response from 44 European firms in 13 groups. In March 1965 the initial contract of $4.2 million was let to the group led by LCT (France) and formed of LCT (57%), the Swiss firm Contraves (33%) and the Belgian firm Bell (10%). LCT collaborated with the French firms Compagnie des Compteurs, CFTH, SAT, CSF, IER, SAFT and Sud-Aviation.

The batteries, test equipment and solar grids were supplied by the US firms Gulton, Dynatomics and Adcole.

Total cost of the satellite was about $6.6 million.
Of the eight experimental flight sets carried on AURORA, five were British, two Danish and one Swedish.

HEOS-A: a sonde weighing 108 kg with a highly eccentric orbit; launching by a Thor Delta vehicle, to be paid to NASA; orbited on 5 December 1968.

After feasibility studies by ESTEC and ESLAB in 1964, tenders were invited in June 1965; 44 European firms took part, in eight groups.

In November 1966 the initial contract for $5.8 million was awarded to the group led by Junkers (Germany) and made up as follows:

- 40% by Junkers
- 32% by ETCA (ACEC) (Belgium)
- 11% by SNECMA (France)
- 8% by BAC (UK)
- 9% by Lockheed (US) providing technical assistance.

This was ESRO's first contract of the "cost plus interest" type. The distance of the apogee from the earth (225,000 km) imposed strict specifications for telemetry.

In 1965 a separate contract of $1.1 million was awarded to CFTH (France), selected from six bidders, for the telemetry encoders.
The Italian firm LABEN supplied the monitoring equipment.
The total cost of the probe was $9.4 million, plus the $4 million spent on the launching and vehicle.

Of the eight experimental flight sets carried on HEOS/A, three were British, one German, one French, one Italian and one Franco-Italian.

As regards ESRO satellites up to the end of 1968, France and the UK once again played the main part, as shown below:

Satellites	France	UK
Value of contracts	39%	16%
Scientific experiments	11%	57%

As in the case of the sounding rockets it may be stated that:

(a) France was the major supplier for ESRO satellites but only a minor scientific user: both facts are explained by the national research programme already conducted in this sector since 1965;

(b) the UK was the second biggest supplier for ESRO satellites, and the biggest scientific user.

The position of France, with the benefit of a strong national programme for both sounding rockets and satellites, explains her lion's share of the "returns".

The industrial story of the first three ESRO satellites, all launched in 1968, indicates the large-scale mobilization of industrial consortia promoted in Europe by ESRO.

The Convention provided the launching of six medium or large satellites in the final three years 1969-71.

These would be the first projects that really exceeded the national possibilities of member countries.

In 1964 the plans included two medium TD scientific satellites and one Large Astronomical Satellite (LAS); the TDs were scheduled for launching by NASA with Thor Delta vehicles, but the LAS was to be the first European satellite to be orbited with the ELDO launcher.

Satellites TD1 and TD2: weight 450 kg, carrying a total of 18 scientific experimental sets.

After preliminary studies, tenders were invited in March 1966: in June, five European consortia responded, and were then reduced to the three shown below:

	Belgium	France	Germany	Italy	Netherlands	UK	Sweden
MESH	-	Matra	ERNO	-	-	HSD	Saab
BAC	ETCA	Nord	Boelkow	Fiat	-	BAC	-
EST	-	CFTH	Dornier		Fokker	Elliot	ASEA

Germany, France and the UK were represented in all three consortia. In January 1967 the MESH tender was selected.

The initial contract for $22 million was distributed as follows: 83% to MESH (33% Matra, 23% ERNO, 9% Saab, 18% HSD), 4% to Belgian industry and 13% to TRW (US). The cost of launching and the two launchers came to $8 million.

In April 1968 the expenditure on the satellites had already risen to $15 million and it seemed likely that the total cost would be twice the estimate.

On 25 April 1968 the TD1 project was cancelled by the Director General of ESRO.

In October 1968 the TD1 programme was resumed, but without Italian participation, thus creating an ESRO precedent; the possibility of preparing "spacial programmes" without the participation of all members. The TD/special satellite was to be built by the MESH consortium; the expenditure ceiling for the satellite was set at $39 million; the launching cost was estimated at $4 million; the satellite, which is the most complex yet designed in Europe, will carry seven experimental sets for solar astronomy and cosmic rays and will be launched in February 1972.

LAS satellite: the most ambitious project of ESRO, for astronomical research on a competitive level with that of the US. Starting in 1964, preliminary studies were conducted by the Culham Laboratory (UK), the Franco-Belgo-Swiss consortium "Groupe d'Etudes Spatiales" and the "German-Dutch Group". In 1967 Dr W.G. Stroud of NASA worked for six months as consultant to the Director General to establish a realistic estimate.

When it appeared that the LAS programme would take up 40% of ESRO's operating resources for six years the project was suspended and deferred until after 1971.

This meant the cancellation of the sole European ESRO project that would have used a European ELDO launcher.

Communications satellites: at the end of 1966, CETS awarded ESRO a contract worth $0.3 million for preliminary studies of the prospects for experimental European communications satellites; the study was concluded in June 1967 and set forth two alternatives (CETS/A and CETS/B) to be achieved in three or four years at a cost not exceeding $104 million.

The Franco-German Symphonie programme necessitated a review of the situation to avoid useless and costly duplication.

In July 1967 CETS gave ESRO a contract worth $0.2 million to conduct further studies; in December 1967 ESRO submitted the CETS/C project for the geostationary satellite EURAFRICA, whose purpose was determined by EBU: to carry two TV programmes to two areas - Europe and Africa.

The estimated cost of the project was $90 million over five years, for a satellite weighing 210 kg, i.e., just within the possibilities of a stepped-up version of the ELDO/PAS launcher.

The current estimate stands at $103 million (including $25 million for launching), spread over six years. The project was warmly supported at the third European Space Conference in 1968. A final decision is to be taken in 1969.

These intensive studies in the field of communications satellites gave valuable experience to the technical and scientific teams at ESTEC.

3.8 Current Programmes and Prospects

Using funds approved in November 1968 for the three years 1969-71, the following scientific satellite programmes were started in March 1969:

- HEOS A/2 ($11 million, including $5 million for launching), ordered from Junkers, the makers of HEOS A/1; it will be launched in December 1971;
- ESRO 1/B ($3.4 million, including 2 million for launching), ordered from LCT, the makers of ESRO 1; the low cost is due to the use of the ready-made second flight model; it will be launched in October 1969;
- ESRO 4 ($8 million, including 2 million for launching), ordered from HSD, the makers of ESRO 2; it is designed to take over certain experiments scheduled for the cancelled TD2; it will be launched in September 1972.

These relatively unambitious short-term projects hand out work to the same old firms, they are not beyond the possibilities of a national programme, they do not lead ESRO into the sector of applications and they fail to promote the development and use of European launchers. A budget of some $200 million (1968 values) is envisaged for the three year period 1972-74, with emphasis on observatory-satellites and/or multi-experiment satellites to be decided on and initiated by 1970-71. These commitments beyond the expiry date of the Convention in 1971 have led ESRO to concentrate exclusively on the scientific sector, whereas greater flexibility would facilitate the formation of the unified Space Agency, as was urged at the Third European Space Conference.

4. CETS (European Conference on Communications Satellites)

At the end of 1962 the US started negotiations to set up the international INTELSAT system as soon as possible, while at the same time creating the private COMSAT corporation with a monopoly in US space communications.

The European side was represented by CEPT (European Conference of Postal and Telecommunications Administrations), to whom the US presented their programmes in December 1962.

The new space projects led 19 European countries to set up CETS (Paris, 22 May 1963).
CETS has a permanent secretariat in London and is open to all members of CEPT; its primary object was to coordinate the positions of the various European countries in view of the INTELSAT negotiations.

The first conditions for participation in the talks were:

(1) Europe would only deal with the US through CETS, avoiding bilateral contacts;

(2) Europe would share in the design, ownership, operation and procurement of the INTELSAT system.

The first condition would only work if CETS were given supranational authority; the second assumed a certain degree of space experience in Europe, which scarcely existed at the time.

To face the strong private commercial firm of COMSAT, backed by the US government, Europe put up a Ministerial Conference, a purely coordinating body without any real supranational power. This was the background to the INTELSAT agreements, concluded in Washington on 20 August 1964, though valid only for a provisional period (until the end of 1969).

Whereas COMSAT signed the INTELSAT agreements in the name of the US, it was not CETS that signed on behalf of Europe: the signatories were the British Postmaster General, the French Government, the Deutsche Bundespost, Telespazio Italiano, the Régie Belge des Télégraphes et Téléphones, the Netherlands Government, etc.

In October 1964, the Committee on Space Technology (CST), set up by CETS in July 1963, submitted to the CETS conference in Bonn an initial five-year plan, in two phases:

(1) in the three years 1965-67 space communications R&D would be financed by each state on a national basis, but coordinated by the CST;

(2) in the three years 1967-69 the European effort would be conducted with multinational funds.

The CETS Conference in Bonn decided to start off the first phase, urging the member countries to implement it, and created a Technical Planning Staff (TPS) to plan the operations for the second phase. As ELDO and ESRO were by then functioning in

Europe, the TPS was able to present a five-year programme at the end of 1965, covering the following projects for an expenditure of $74 million:

(a) use of the ELDO F9 and F10 launchings for the first tests on communications satellites;

(b) design and construction of a more advanced European experimental satellite;

(c) design and production of operational European satellites.

The TPS programme relied on ELDO for launchers and on ESRO for the production of satellites.
When the ELDO crisis was solved in 1966 by means of the supplementary ELDO/PAS programme for geostationary communications satellites, a CETS conference was held in The Hague in November 1966.
The basic policies proposed by the TPS were accepted and a contract worth $0.3 million was placed with ESRO for feasibility studies on the first experimental European communications satellites. The ESRO study was submitted on 5 June 1967, giving two alternative proposals:

(1) CETS/A satellite for relaying a colour TV programme in Europe, to be completed in four years;

(2) CETS/B satellite of more advanced design, but taking longer to develop.
Estimated expenditure $104 million; to be launched in 1971.

The initiation of the Franco-German Symphonie project, inspired by the delays in CETS decisions, led to a review of the situation in mid-1967 in order to avoid useless and costly duplication.

CETS then awarded ESRO a contract of $0.2 million for a further study:

- along the lines indicated by the European Broadcasting Union (EBU) at the Second European Space Conference (Rome, July 1967);
- with a ceiling expenditure of $90 million in five years.

The new ESRO study was submitted on 4 December 1967, proposing a geostationary CETS/C or EURAFRICA satellite with the purpose, as specified by the EBU, of relaying two TV programmes to two areas: Europe and Africa.

The CETS/C project kept within the limit of $90 million in five years; it envisaged a satellite weighing 210 kg, which was just within the possibilities of a stepped-up version of the ELDO/PAS launcher.

The project was supported in the Causse Report and confirmed as being of first importance to Europe at the Third European Space Conference (November 1968); the current cost estimate is $103 million, including $25 million for launching, to be spent over six years.
The operational phase cannot begin until 1975, i.e., twelve years after the creation of CETS.

The Third European Space Conference (November 1968) also urged member states to follow CETS policies during re-negotiation of the INTELSAT agreement, which must be concluded within 1969.

PART 4

The space programmes of the United Kingdom and the member countries of the European Economic Community

1. UNITED KINGDOM

By 1955, the successful development of nuclear activity in Britain posed, as it had for the US and USSR some years earlier, the problem of having ballistic missiles armed with nuclear warheads. Work then began on the IRBM Blue Streak, developed on the basis of American technology by de Havilland under licence agreements with General Dynamics for the structure, and by Rolls-Royce, under similar agreements with North American Aviation, for the liquid propulsion.

A launch base was already available from 1947 on at Woomera in Australia, built in collaboration with the UK at a capital cost to Australia of about $200 million. A test centre was fitted out by the Ministry of Aviation at Spadeadam in Cumberland.

In 1957 the final stage of development had also been reached for the research rocket Black Knight, designed by the RAE with a view to studies of the atmospheric reentry of ballistic missile warheads; it was used for this purpose as well as for scientific missions in 22 launchings, all successful, between 1958 and 1964.

The solid-fuel sounding rocket Skylark developed in the UK in connection with the International Geophysical Year was first launched in 1957 and is still being used, in an improved and stabilized version, by ESRO also.

At the dawn of the space era (4 October 1957) the UK therefore had an opportunity of making itself the third space giant as it had just become the third nuclear power. Taking Blue Streak as a first stage and Black Knight as a second, or at any rate the latter as a first stage, might have resulted in useful launchers for civilian purposes. Uncertainties as to the cost of a national space programme for a single country, small in comparison to the US and USSR, followed by the advent of solid fuel IRBMs and ICBMs which robbed the liquid-fuelled Blue Streak of much of its military usefulness, occasioned the cancellation in April 1960 of this project, on which about $235 million had been spent.

Shortly afterwards began the long drawn out negotiations for ELDO, based on finding a peaceful use for Blue Streak at a European level.

Britain's good start (alone among the European countries) in space at the time of the first Sputnik (1957) was endangered by the time of the first Vostok (1961) when, instead, it was France, already engaged upon military rocket programmes, that started its own national space programme for civilian requirements.

Albeit with much stronger political and military motivations, the two Soviet rockets had given an exceptional boost to space progress in the United States.

One valid indirect space activity begun by Britain in 1957 was the setting up of a network of radar, radio and optical satellite tracking stations. The radio telescope at Jodrell Bank (75 m in diameter) has been an invaluable auxiliary instrument for both Russians and Americans thanks to its coordinated operation with other observatories throughout the world.

This same radio telescope went on to establish the first space telecommunications link between the US and the USSR through the passive satellite Echo 2 on 21 November 1964.

Another noteworthy indirect space activity for Britain was the establishment at Slough in October 1958 of World Data Centre C (Centre A is at Washington, and Centre B in Moscow) for collecting and transmitting satellite trajectory data and predictions.

During 1961-63, in the absence of national space programmes and pending the establishment of the European cooperative projects, Britain signed (September 1961) an agreement with NASA for the free launching of three Ariel satellites; the first two, built in the US were to carry British scientific experiments as passengers and were successfully launched in April 1962 and March 1964; the third satellite, entirely British in design and equipment and also intended for scientific experiments, was launched in May 1967. The British outlay on this programme breaks down as follows (millions of dollars):

	Satellite	Scientific payload	Total
Ariel 1	-	0.56	0.56
Ariel 2	-	0.66	0.66
Ariel 3	3.50	0.66	4.16
Total			5.38

A fourth satellite in this series was on the drawing board in 1968.

In 1962 the UK established an experimental centre at Goonhilly Down for the purpose of the communications satellite Telstar.

In connection with the subsequent INTELSAT programmes the station was to become operational and capable of communicating with geostationary satellites above the Atlantic and Indian Oceans. This activity, more commercial than scientific in outlook, absorbed $1.6 million in 1965-66, $4.0 million in 1966-67 and $6.5 million in 1967-68.

Also in 1962, the Nassau agreements gave Britain, alone among the rest of the nations of the world, the United States' Polaris strategic missiles, at a cost of $638 million by 1966; this figure is around half the whole of United States world sales of missiles (non-strategic, however) during the same period.

The purchase of Polaris put paid to the British military missile programmes, an end foreshadowed ever since 1960. There was a genuine resumption some time later of the national space programme for peaceful purposes, shortly after the start of European cooperation in ELDO and ESRO, and the first successful firings at Woomera on behalf of ELDO of the Blue Streak lower stage.

In September 1964 a start was made on the Black Arrow project for a three stage launcher, planned to be operational in 1969.

This rocket makes use of previous experience with the Black Knight's liquid propellant Gamma motors. The total project cost was estimated at $28 million, with 40% for the structure, and 33% for the engines; these costs were spread among the contracting bodies as follows: 67% to British firms and 33% to the RAE: the 1967-68 budget allocated $7.2 million to Black Arrow, to finance completion of the prototype and the first three launchers.

The following firms collaborate in this project: Westland Aircraft for the structures of all three stages, Bristol Siddeley for the liquid-fuel engines of the two lower stages, and Bristol Aerojet for the solid-fuel motor of the third stage.

The programme cautiously provided for one satellite launch a year only from 1969 onwards.

The general engineering of Black Arrow is similar to that of the two upper stages of the ELDO vehicle, i.e., it is capable of being mated to the Blue Streak lower stage; such a combination would form an entirely British three-stage launcher competitive with ELDO's Europa 1. In 1965 Britain signed an agreement with the US for the establishment and use of the IDCSP (Interim Defence Communications Satellite Project) network of military satellites; by mid-1966 the first seven satellites were placed in orbit by a single Titan launcher, followed by 10 more (placed in orbit by only three launchers) in 1967.

The UK spent $38 million on the procurement and launching of two satellites and associated ground stations. The British share of this bilateral programme goes by the code name of Skynet.

The military budget is almost entirely swallowed up by the telecommunications programme, as shown by the following table:

Britain's Military Space Budget

(Millions of dollars)

	Investments	Expenditures[1] 1967-1968
IDCSP trials programme	5.60	1.10
IDCSP operational use (Skynet)	38.00	16.20
R&D support programme	1.70	0.30
Total military telecommunications	45.30	17.60
Other space items	0.80	0.80
Total military space activities	46.10	18.40

[1] Estimate, February 1967

Source: 13th Report, Estimates Committee (July 1967)

A feasibility study is currently in hand for a 100% British system to take the place of Skynet in the seventies.

For purposes of scientific space exploration at national level development programmes are also proceeding for the small and low-cost solid fuel sounding rockets Skua (cost $2,000) and Petrel (cost $7,000), less advanced than Skylark but capable of being launched from British sites instead of having to be transported to Woomera.

In 1965 again, with a view to a rational and programmed co-ordination of space activity, the SBAC, the Electronic Engineering Association and the Telecommunication Engineering Manufacturing Association joined forces in the NISC (National Industrial Space Committee), which became the sole representative of British industry's space interests.

At government level, however, there is much fragmentation of responsibilities, as the following table shows:

Departments Responsible for Britain's Space Programmes up to 1967

Dept. / Programme	SCIENCE AND EDUCATION	MINTECH	MIN. of DEFENCE	GENERAL POST OFFICE	BOARD OF TRADE	COMMONWEALTH OFFICE	FOREIGN OFFICE	DEP. of ECONOMIC AFFAIRS	Treasury
Military space systems		x	*				x		x
Reconnaissance		x	*				x		x
Military telecommunications		x	*				x		x
Civilian telecommunications	x	x		x	x	x	x	x	x
Scientific research	*	x							x
Meteorology	x	x	x			x	x	x	x
Air traffic control		x	x		x		x	x	x
Navigation		x	x		x			x	x
Earth resources	x	x			x	x	x	x	x
Technological			x	x	x				x
ELDO		*							x
ESRO	*	x					x		x
CETS	x	x		x	x		*		x
INTELSAT		x		*		x	x	x	x

x = Departments concerned
* = Coordinating departments

Source: 13th Report, Estimates Committee (July 1967

Only the Ministry of Technology, besides of course the Treasury, is concerned in the whole range of space activities. From the beginning of 1967, the Ministry of Technology took over responsibility for the space activities of the Ministry of Aviation. From early 1968 Mintech started to become the sole coordinating body for Britain's space activities.

From February 1966 to May 1967 a thorough survey of "Space Research and Development" was conducted on behalf of the House of Commons by the Estimates Committee, whose findings were published in its Thirteenth Report of July 1967.

During 25 sessions and numerous visits to research centres, representatives of all the bodies concerned in space activity, as shown in the preceding table, together with the Science Research Council and National Industrial Space Committee, were given repeated hearings.

Reviewing the whole field of space activities past and present, the report concludes, with the utmost candour: "On the whole it has been a story of wasted opportunities brought about by lack of purpose and the absence of any coherent organization".

It goes on to acknowledge the prior claims of space telecommunications in the immediate future, also as a specific sector in which Britain can play a leading technological role. The report ends with the following recommendations:

(1) A space programme with a budget of its own should be framed and agreed for future years;

(2) Mintech should assume overall responsibility for the space programmes ...;

(3) A firm figure should be set for the country's space budget over the next five years;

(4) The larger proportion of the total space budget should be allocated to the national programme, and a smaller share to international programmes;

(5) The UK should oppose any proposition to increase the number of ELDO/PAS firings;

(6) The UK should not take part in the CETS television relay satellite programmes;

(7) Project studies should be put in hand forthwith with a view to producing a British military telecommunications satellite to replace the existing Skynet satellites in 1971;

(8) The annual expenditure on the Black Arrow should be stepped up from $8.5 to 17 million and an independent start be made on a development programme for electrical propulsion ...;

(9) The UK should ensure that the definitive agreement for an international system of telecommunications satellites after INTELSAT includes the establishment of an international management company in place of COMSAT; provides for abandonment of the USA's guaranteed minimum share of 50.6%; and allows for regional and national systems separate from and non-competitive with the global system.

The report has annexed to it the following financial estimate for the three years 1965-68, in millions of dollars:

Financial year	1965-66	1966-67	1967-68
International programmes	29.85	38.78	40.38
(%)	(57.5)	(58.5)	(47.5)
National programmes	22.12	27.64	45.16
(%)	(42.5)	(41.5)	(52.5)
Total	51.97	66.42	85.54
(%)	(100.0)	(100.0)	(100.0)

As a result, Britain's spending on its national programmes would in 1967-68 already exceed that on the international ones (as was becoming the case in Germany in 1967 and occurred in France from 1962).

In 1963-64 and 1964-65, expenditure on the national programme did not exceed 12% of the total spending on space.

In an ensuing systematic analysis of the report, the NISC objected that for the purpose of estimating the true amount of R&D work by the British aerospace industry the following should be subtracted: from the international programmes, funds spent on INTELSAT and not repatriated; from the national programmes, costs sustained in the United States for the IDCSP/ Skynet system; corresponding figures are inserted in the following table (in millions of dollars):

Financial year	1965-66	1966-67	1967-68
INTELSAT	0.39	3.36	1.68
IDCSP	10.61	10.14	20.89
Total expenditure in the United States	11.00	13.50	22.57

By working out the differences, NISL arrives at the following table as representing Britain's true R&D effort in space:

Financial year	1965-66	1966-67	1967-68
International programmes ($million)	29.46	35.42	38.70
(%)	(72)	(67)	(61.5)
National programmes ($million)	11.51	17.50	24.27
(%)	(28)	(33)	(38.5)
Total ($million)	40.97	52.92	62.97
(%)	(100)	(100)	(100)

In the NISC report the percentages for 1967-68 are wrongly given as a total of 38.70 + 27.78 = 66.48, instead of 38.70 + 24.27 = 62.97. Nevertheless the true expenditure on national space programmes is growing, both absolutely and relatively, but still falls far short of that on the international programmes.

It is interesting to sum up the preceding figures in a single table of Britain's total space expenditure: (in millions of dollars)

Financial year	1965-66	1966-67	1967-68
R&D international programmes	29.46	35.42	38.70
(%)	(57)	(53)	(45)
R&D national programmes	11.51	17.50	24.27
(%)	(22)	(26.5)	(28.5)
Expenditure in United States	11.00	13.50	22.57
(%)	(21)	(20.5)	(26.5)
Total	51.97	66.42	85.54
(%)	(100)	(100)	(100)

This shows the high and growing percentage of direct expenditure in the United States, not far short of total R&D expenditures for national programmes.

Seven of the report's recommendations are substantially supported by the NISC, which rejects, however, the fifth and sixth, already indicating for 1967 a disengagement of Britain from ELDO and CETS.

About recommendation 5, NISC notes that the ELDO programme is the only one offering Europe an opportunity of independence from total domination by the United States in space, and that only more launchings, used, however, for the purposes of ESRO's scientific missions and CETS applications missions, can lower the cost of launchers.

About recommendation 6, NISC points out the contradiction between disengagement from CETS and the acceptance (explicitly stated in recommendation 9) of the principle of regional space communications systems. NISC suggest following the example of Franco-German collaboration on the Symphonie project by inviting other European countries to cooperate in an international consortium in the vital space telecommunications sector. These two points of profound disagreement illustrate the continuing sharp conflict in Britain between industry and government on space matters.

The NISC papers further argue the necessity of raising space expenditure to an annual level of $85-100 million; the figure of $63 million (less expenditure in the US) for 1967-68 represents only about one-third of Britain's nuclear expenditure, and compares unfavourably with the percentages for the same year in France and the United States:

	UK	France	US
Space/GNP	0.08%	0.11%	0.95%
Defence/GNP	6.90%	6.10%	9.20%
Space/Defence	1.16%	1.80%	10.30%

The annual space investment of $85-100 million would represent 3% of government R&D expenditure and would not only allow an active presence to be maintained and augmented in this sector, but would also staunch the considerable brain drain, estimated at an annual wastage of $170 million, corresponding to 2,000 engineers, scientists and qualified technicians emigrating to the US, where they find, especially in the space area, more sophisticated and satisfying activities and programmes, not to speak of higher pay.

2. FRANCE

2.1 Military Activity in the Missiles and Space Area

France's space programmes have, albeit on a smaller scale, passed through the same chronological sequence as the US and Soviet programmes:

- liquid rockets, V2 type
- sounding rockets and solid-fuel missiles
- strategic and tactical missiles with nuclear warheads
- civilian satellite launchers
- scientific satellites
- application satellites

2.1.1 LRBA (Laboratoire de Recherches Balistiques et Aérodynamiques)

In 1945-46 the Direction des Etudes et Fabrication d'Armement (DEFA) of the Délégation Ministérielle pour l'Armement (DMA) embarked upon a research programme in the field of liquid propellant rockets based on the technology of the V2. For the future pursuit of this programme the Laboratoire de Recherches Balistiques et Aérodynamiques (LRBA) was set up at Vernon, under DEFA auspices, in 1949.

The first task assigned to the LRBA was development of the liquid-fuelled Véronique, of a lower class than V2: some 40

Germans cooperated on this project, together with about 250 French engineers. The LRBA's staffing strength was and still is about 1,000. From 1950 to 1954 about 20 development firings of Véronique took place.

Improved series of the same rocket, Véronique AGI (L 1.0)[1] and Véronique 61 (L 1.5) were launched as France's contribution to the scientific activity of the International Geophysical Year in 1959, and thereafter, with the Vesta rocket (L 4.0) for scientific missions of CNES since 1962.

An upgraded Véronique was to inaugurate France's new equatorial civilian base at Kourou, French Guiana, in April 1968.

During 1955-60 the limitation of liquid-fuel rockets used for military purposes and the superiority of solid propellants, more practical and readily usable, were acknowledged.

From that time on LRBA's activity was mainly directed towards civilian rocket engine programmes:

- in 1962 LRBA initiated development of the motors for the French stage Coralie (L 10) of ELDO's Europa vehicles;
- during the same period, R&D work began on the Vexin thruster for the first stage Emeraude (L 13) of the civilian satellite launcher Diamant A;
- in 1967 R&D work was begun on the Valois engine for the first stage Améthyste (L 17) of Diamant B.

LRBA currently owns:

- a space laboratory
- an inertial laboratory
- an environmental laboratory

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[1] The figure preceded by L indicates liquid propellant, by tonnes.

- a hyperballistic tunnel
- a department of advanced studies on the use of liquid fluorine as an oxidant for future thrusters.

LRBA engages in research, prototype development and proving tests; for production it relies on the military workshops of Ateliers de Construction de Tarbes (ATS) with a labour force of 3,000 equipped with up-to-date plant for the spinning of special steels.

2.1.2 Tactical and strategic missiles

Around 1956 the development and production of guided missiles[1] were put in hand by:

- Engins-Matra: Missile R 511 (AA), followed during the next decade by R 530 (AA) and Crotale (GA);
- Nord-Aviation: Missile Entac (AT) and AS 20, followed during the next decade by AS 30, SS 11, SS 12, AS 12 and Harpon (GG).

These missiles were to be greatly in demand on the world export market. For the Navy, Latécoère developed the Malafon (Mks 1 and 2) and the Ruelle Arsenal developed the Masurca.

The capability acquired in the tactical missile sector yielded important international cooperation agreements:

(a) between France, Belgium, Netherlands, Germany and Italy in the SETEL consortium for producing Hawk missiles for NATO under licence (1959);

(b) between France and Germany (Nord-Aviation/Boelkow 1963) for the production of anti-tank missiles Milan, Hot and Roland, now in the industrial production phase;

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[1] (AA) = Air-Air; (AG) = Air - Ground; (GG) = Ground-Ground (GA) = Ground-Air; (AT) = Anti-tank.

(c) between France and Britain (Matra/HSD 1964) for production of the Martel (AG) with anti-radar warhead by Electronique Marcel Dassault (EMD) now in pre-operational testing phase.

Preliminary studies on nuclear ballistic weapons conducted by the Ministry for the Armed Forces during 1956-57 dissuaded France from independent action in this sector and gave the preference to the supersonic strategic bomber: by this decision France's military air strength was raised from 1968 on to 62 Mirage IVs capable of carrying a 6C kt nuclear armament.

Possibly the orbital flight of the first Sputnik (1957), but undoubtedly the assumption of office by President de Gaulle (1958), spurred the French Government to extra effort and expenditure in the nuclear field for military purposes and in the strategic missile sector. A three-phased programme for a Force Nationale Stratégique (FNS) was set up for developing:

(a) First generation: the Mirage IV strategic bomber;

(b) Second generation: ground-to-ground strategic ballistic missiles (GGSB), solid-fuelled, with a range of about 4,000 km and a 250 kt nuclear warhead;

(c) Third generation: sea-land strategic ballistic missile (SLSB), solid-fuelled (powder), with a range of about 2,000 km and a nuclear warhead of 500 kt, capable of being launched from submerged nuclear submarines.

For the execution of this programme based on new technologies, the SEREB (Société d'Etudes et Réalisation d'Engins Balistiques) was set up at the end of 1959.

2.1.3 SEREB (Société d'Etudes et Réalisation d'Engins Balistiques)

SEREB is charged with central executive management of the strategic missiles development and production programme.

It comprises the three nationalized concerns: Nord-Aviation and Sud-Aviation, together with three private undertakings: Avions Marcel Dassault, Engins Matra and SEPR. Each of the six contributed a capital of $0.2 million. Government policy provides for a balanced participation of public and private enterprise: collaboration is efficient and productive.

SEREB's Board of Director's includes representatives of the government bodies CEA, ONERA, Direction des Poudres, under DMA supervision.

Its staff, drawn mainly from the partner firms, numbers about 1050, of whom 400 are engineers; they are divided among the technical services at Puteaux and the Etablissement d'Aquitaine near Bordeaux. SEREB has no workshops and laboratories, but for assembling missiles makes use of the DMA facilities at CAEPE (Centre d'Achèvement et d'Essais des Propulseurs d'Engins), at Saint-Médard.

The ballistic missile programme covers a ten-year period and is based on gradual expansion criteria: a coherent series of experimental rockets for basic ballistic studies (Les Pierres Précieuses) is first required to promote step by step:

- large solid propellant grain technology;
- swivelling motor technique;
- inertial guidance;
- Vascojet steel technology;
- glass filament winding;
- space electronics.

Next comes work on the GGSB and SLSB missiles. At a steady pace the following were put on the stocks in 1960 and subsequently developed by SEREB:

- the single-stage Aigle (P 0.9)[1] launched in 1960-61;

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[1] The number in brackets preceded by P indicates tonnage of solid propellant.

- the single-stage Agate (P 2.3) launched in 1961-62
- the single stage Topaze (P 2.3) launched in 1962-63

The large grains are manufactured at the military workshops under the Direction des Poudres at Saint-Médard; the motors are manufactured by SEPR; Nord-Aviation develops the structures, SAGEM and SFENA supply the inertial guidance and CFTH the electronics. Sud-Aviation produces a small solid stage (P 0.7) in a glass-filament wound container to be the third stage of the civilian rockets Diamant A and B.

SEREB has produced successively:

(a) the two-stage Rubis (P 2.3 + P 0.7) launched in 1964;
(b) the single-stage liquid propellant Emeraude (L 13) using LRBA's Vexin motors produced by SNECMA.

Finally, in 1965, the following were successfully launched:

(a) the single-stage Emeraude (L 13) in February;
(b) the two-stage Saphir (L 13 + P 2.3) in July;
(c) the three-stage Diamant A (L 13 + P 2.3 + P 0.7) in November.

Meanwhile development proceeded on the P 4, P 10 and P 16 stages of the strategic missiles, tested separately in 1966-67. The first proving trials took place at the French base of Hammaguir, in Algeria, but since its evacuation under the Evian Agreements in 1967 further firings have been held at the Centre d'Essais des Landes (CEL) commissioned in the meantime. In July 1968 ground firings were conducted at CEL of:
- the complete GGSB (P 10 + P 4);
- the P 10 + P 10 version of the SLSB pending firings in the definitive configuration of P 16 + P 10, scheduled for 1969.

One month after these firings France's first experimental thermonuclear device was exploded at the Centre d'Essais du Pacifique, again within the framework of the FNS.

Future military programmes provide for:

- production of 27 GGSB to be installed in underground silos in Upper Provence;
- production of 16 SLSB intended for equipping in 1971 the first nuclear missile-launching submarine (SNLE), the "Redoutable", ready for sea trials in 1969;
- similar armament for two more SNLEs: Le Terrible (1973) and Le Foudroyant (1975);
- studies for uprating GGSB and SLSB to make them adequate for "all azimuth" defence.

Still within the framework of the FNS, mention should be made of development of the 10-15 kt nuclear GGTB missile (ground-to-ground tactical ballistic) named Pluton and due to become operational in 1972 as the basic armament for France's tactical nuclear forces; the Styx motor is being developed by SEPR, with Nord- and Sud-Aviation supplying the structure and control system.

On the basis of the two "programme laws" of 1960-64 and 1965-70, and recent budgets of the Ministry for the Armed Forces, it may be estimated that a quarter of the military budget (or about 1.25% of GNP) will be allocated each year to strategic nuclear weapons throughout the decade 1960-70. Of this share, 20% (equivalent to 0.25% of GNP) is earmarked for the GGSB and SLSB missiles, and 60% (equivalent to 0.75% of GNP) for the nuclear warheads and nuclear propulsion of the SNLE.

The civilian launchers have benefited, technologically as well as financially, from the military investments for the FNS. A total of $22 million were spent on Diamant A, half by DMA and half by CNES, but the cost would have been much higher without the military backing.

2.1.4 Military space technology

SEREB-directed activity, under DMA supervision, in the strategic missile field, has been developed on the basis of the country's own technical and scientific resources, calling on the whole of industry - aeronautics, propulsion and electronics - in the public and private sectors.

The initial American embargo (1960) on Boeing and Lockheed licenses and knowhow in the solid propellant technologies used in Polaris and Minuteman was motivated by concern about the proliferation of nuclear ballistic weapons throughout the world; in France it slowed down and added to the cost of the FNS development programme.

Having identified the small number of keypoints of technological weakness, French industry succeeded in obtaining by a few but valid agreements American licenses and knowhow, specifically - according to American sources - on:

- initial guidance (SAGEM from General Precision);
- tracking and telemetry stations (Compagnie des Compteurs from Cubic Corporation);
- on the glass filament winding process (Sud-Aviation from Rocketdyne);
- on Vascojet steels (from Canadium Alloys Steel Corporation).

Interviews in France showed that in these sectors French industry has been successful in developing independent capabilities, and in some cases has made original technological advances; there has been complete independence in the development of a capability in large grain technology, now equipped for even larger projects than the current ones.

2.1.5 Geographical concentration of plants

From 1960 to 1965 the coordinated and purposive activity of SEREB had a powerful impact on the planned industrial decentralization of the Paris area and concentration in the Bordeaux area of all military weaponry activities:

- around the government establishment Poudrerie de St. Médard-en-Jalle, with a labour force of about 1,200, there have been established:
- CAEPE (see previous mention) - 400 employees;
- a glass filament winding shop of Sud-Aviation for the P 4 stage tanks of the SLSB missile (labour force 800);
- a workshop of Nord-Aviation and SNECMA combined in the NORMA consortium for producing large structures of Vascojet and Maraging steel for the P 10 and P 16 stages of the SLSB and GGSB;
- a SEPR R&D centre for propulsion units;
- and more recently, the CNES workshop for integration of Diamant B;
- on the coast there has been established the abovementioned CEL, which has inherited the equipment from Hammaguir and is responsible for development firings of tactical and strategic missiles; CEL has at the moment a staff of 2,400 (1,300 civilians and 1,100 military) compared with a planned strength of 3,000 in 1970; for its operations CEL has a fleet of three DC 7s and the Henri Poincaré floating laboratory, specially equipped for tracking and telemetry; the latter establishments have further enhanced the capability of France's electronic industry.

A similar process of geopraphical concentration of laboratories and research centres in the Toulouse area not far away has been planned and started during 1965-70 for the unified development of civilian space activity.

2.1.6 Other military activities in rocketry and in space

Outside the FNS programmes, the DMA has, through its Direction des Recherches et Moyens d'Essais (DRME), founded in 1961, financed SEPR studies on the H_2O_2 (liquid hydrogen and oxygen) cryogenic motor; 120 technicians have been engaged on the programme since 1964; the motor, bench-tested in 1967-68, is extremely promising for civil space applications, and has interested ELDO for its second generation launchers; the 1969 budget does not provide for any further military funding. Besides the H_2O_2 motor and the Styx motor already referred to for Pluton, SEPR is engaged in research and study on:

- P 40 solid propellant motors, in collaboration with Nord-Aviation;
- small motors for correcting the trajectory of satellites, with the Italian firm Oto-Melara;
- the use of liquid fluorine as an oxidant for future propellants, in collaboration with LRBA;
- hybrid propellants (lithergols), in collaboration with ONERA.

Institutionally financed by DMA through DRME are the government establishments ONERA (Office National d'Etudes et Recherches Aérospatiales) and SECT (Service d'Equipement des Champs de Tir), which have pursued interesting space activities outside the FNS programme on the interface between military and civilian interests.

ONERA has, since 1960, developed a diversidied series of solid sounding rockets for technological and scientific research purposes:

- the four-stage Bérénice, used from 1962 on for research into the hypersonic atmospheric re-entry of warheads, and into ablative materials;
- the single-stage Tacite, already launched in connection with the Cassiopée technological mission in collaboration with CNES; ONERA developed the solar sensors and high-precision star-pointing device;
- the two-stage Titus, produced on behalf of CNES and used for the Eclipse scientific mission to Argentina in 1966;
- for research on the electrical effects of hypersonic re-entry (Operation Electre), ONERA is developing the rocket family: two-stage Titus 2, three-stage Tibère and experimental two-stage vehicle Crapel;
- for studies of Mach 5 propulsion by ramjet, the two-stage vehicle Stataltex was produced, with original telemetry developed by ONERA;
- for research on supersonic aerodynamics of delta winged aircraft, in the framework of the Concorde project, the two-stage vehicle D 6 was developed.

Besides this activity in the field of solid-propellant sounding rockets, ONERA has been working with SEPR since 1964 on hybrid propellants (lithergols); the experimental rocket Lex tested in 1967 proved ONERA's capability in the advanced propulsion techniques sector.

In 1966 SECT launched a programme for producing small aerological probes for measuring wind and temperature at varying heights. Using the experiment developed on Matra's Emma, SNECMA's Aurore and CFTH's Elan rockets, a family of probes called "Les Dieux Gaulois" (Epona, Belisama, Belenos, Toutatis) were manufactured and tested at the beginning of 1968; another called Taramis, planned to be operational in 1972, is under development.

These achievements freed France from the necessity of procuring Arcas rockets from the US or Skuas from Britain; designed with a view to low selling prices, these rockets are sued in meteorology, civil and military aviation and on space launching bases.

2.1.7 Military research

France's notable activity in space missiles has been coordinated on the military side by a coherent and programmed policy pursued by the Ministry for the Armed Forces through the DRME directorate of the DMA delegation.

In 1968 the DMA had, as it would again in 1969, a budget of about $80 million for research alone, exclusive of development expenditures distributed as follows:

* exploratory research 18%
* oriented research 52%
* development-tied research 30%

The DRME administered a share of about $32 million, mainly in the latter two sectors. In aerospace (subsidized together with electronics, solid-state physics, plasmas and computers) DRME's typical action has been concentrated on university departments and on government bodies such as ONERA, SECT, LRBA and the Franco-German fundamental military research institute at St. Louis (ISL).

2.1.8 Launcher prospects

After some ten years (1950-60) of activity on military projects, LRBA had, while still remaining under military sponsorship, mainly directed its activities towards civil launch vehicles

(Coralie and Diamant), to which it brought its considerable experience of liquid propulsion.

After a decade (1959-69) of work for military purposes, SEREB now has a technological capability too vast to be confined to the military sector alone.

Besides expertise in systems engineering and sponsoring modern programme management techniques (PERT, etc.), and general qualification in electronics, from on-board computers to ground space antennas, mention may be made of the specific case of initial guidance, taken over from strategic missiles and first adapted in the military sphere to nuclear submarines, and thereafter in the field of peaceful applications for steering Concorde: such applications will gradually reduce the cost of this system and so permit its wider application to all forms of navigation.

A more spectacular peaceful outlet proposed by SERES is the French satellite launcher Turquoise, an alternative for the ELDO/PAS vehicle making use of the existing operational stages P 16 and P 4 (first stage a cluster of five P 16 units; second stage P 16; third stage P 4). Such a vehicle, which would repeat on a large scale the operation of converting Diamant to peaceful uses, would be capable of placing in geostationary orbit satellites of 220 kg by 1971 and could then be uprated by means of a cryogenic third stage of the type developed by SEPR.

Alternatively LRBA proposes, on the strength of knowhow acquired in liquid propellants, a cluster of seven Améthyste rockets or a new L 95 stage instead of the Blue Streak in the ELDO vehicles; even the former solution could be operational by 1971; the second would above all make possible future uprated versions of the complete launcher.

These projects have developed out of the ELDO crises for fear of seeing compromised the planned launching in 1972 of the Franco-German Symphonie telecommunications satellite, regarded as having absolute priority among France's peaceful programmes.

Independence in the space communications sector now plays the role assigned ten years ago to the will for independence in the strategic nuclear weapons area.

2.2 Civil Space Programmes, National and Cooperative

2.2.1 CNES (Establishment of the Centre National d'Etudes Spatiales)

Whereas shortly after the flight of the first Sputnik (1957) France started its military strategic missile programmes, under DMA's management for overall planning and SEREB's for overall technical supervision, the flight of the first Vostok gave the starting signal for France's civil space activity under the overall planning management of CNES (Centre National d'Etudes Spatiales).

DMA and CNES correspond on a French scale to the DoD and NASA in the United States.

CNES was established by an Act of 19 December 1961, with responsibility to the Minister for Scientific Research and Atomic Matters, for management and coordination of the whole of France's space activities, national and international.

CNES is a public scientific and technical body fulfilling a role of industrial coordination. It has financial autonomy.

Each year CNES has to present to Parliament, before the vote on the budget, a report on its activity and results for the past twelve months.

It is a centralized but streamlined body having its own coherent and planned programmes, designed to foster the widest possible range of space capabilities in scientific laboratories and industry at large, without any duplication of their structures.

Collaboration with laboratories and universities is governed by conventions, while industrial collaboration is based on calls for tender and the award of contracts.

2.2.2 The space centres of CNES

Centre Spatial de Brétigny. Exercises central control over CNES's test and checkout facilities: space simulation chambers, computer centre, telemetry reduction department. It is responsible for the functioning of the French space communication networks, operational since early 1966:

- the Diane tracking network set up by CFTH, comprising the two stations at Pretoria, South Africa and Kourou, French Guiana;
- the Iris telemetry and telecommand network, set up by CSF and comprising the six stations of Brétigny, Canary Islands, Ouagadougou (Upper Volta), Brazzaville (Congo), Pretoria and Kourou.

The centre is also responsible for the integration workshop of Diamant B at St. Médard.

All the abovementioned infrastructures are operational. At the end of 1967 Brétigny has a staff of 394.

The Centre Spatial de Toulouse. Planned in 1963 and officially inaugurated on 1 February 1968, this will have central control of the activities originally set up at Brétigny:

- Satellites Division
- Balloons Division
- Sounding Rockets Division
- Experimental Hardware Division

Completion of the transfer is planned for 1971, with a staff of 550 CNES personnel together with 250 recruited from industry.

In 1970 the Centre will have Europe's biggest space simulation chamber (about 350 m^3), already ordered from the same firm, Société d'Etudes et d'Application Vide Optique Mécanique (SEAVOM), who built similar, less capacious chambers for Brétigny in 1963. The establishment of the biggest CNES operational centre at Toulouse forms part of a vast planning operation for decentralizing research establishments from the Paris area, involving the progressive transfer of:

- the Ecole Nationale Supérieure d'Aéronautique (ENSA), with a new headquarters being built;
- the Centre d'Etudes et de Recherches de Technologie Spatiale (CERTS) founded in 1967 by agreement between CNES and DMA and in 1968 incorporated in the structure of ONERA, with the task of liaising between universities and industry;
- the Centre d'Etudes Spatiales du Rayonnement (CESR);
- the Laboratoire d'Automatique et Applications Spatiales (LAAS);
- the Centre d'Etudes et Recherches en Aérothermie (CERAT);
- the Ecole Nationale de l'Aviation Civile (ENAC).

Between 1968-73 the Toulouse area is to become the home of civil space activity in a highly industrialized environment in the aerospace sector, just as the Bordeaux district has already become the home of military launcher activity.

<u>The Centre Spatial Guyanais</u>. The equatorial base faces east and is operationally ideal for achieving direct geostationary equatorial orbits for applications satellites: there is no such base in the US or USSR.

In 1966 the converging interests of France's space authorities and the European ones of ELDO determined the installation of a launch base at Kourou in French Guiana. The opening of the Guiana coastline over the whole north-easterly sector of the compass also enables direct injection into polar orbits of interest to scientific research.

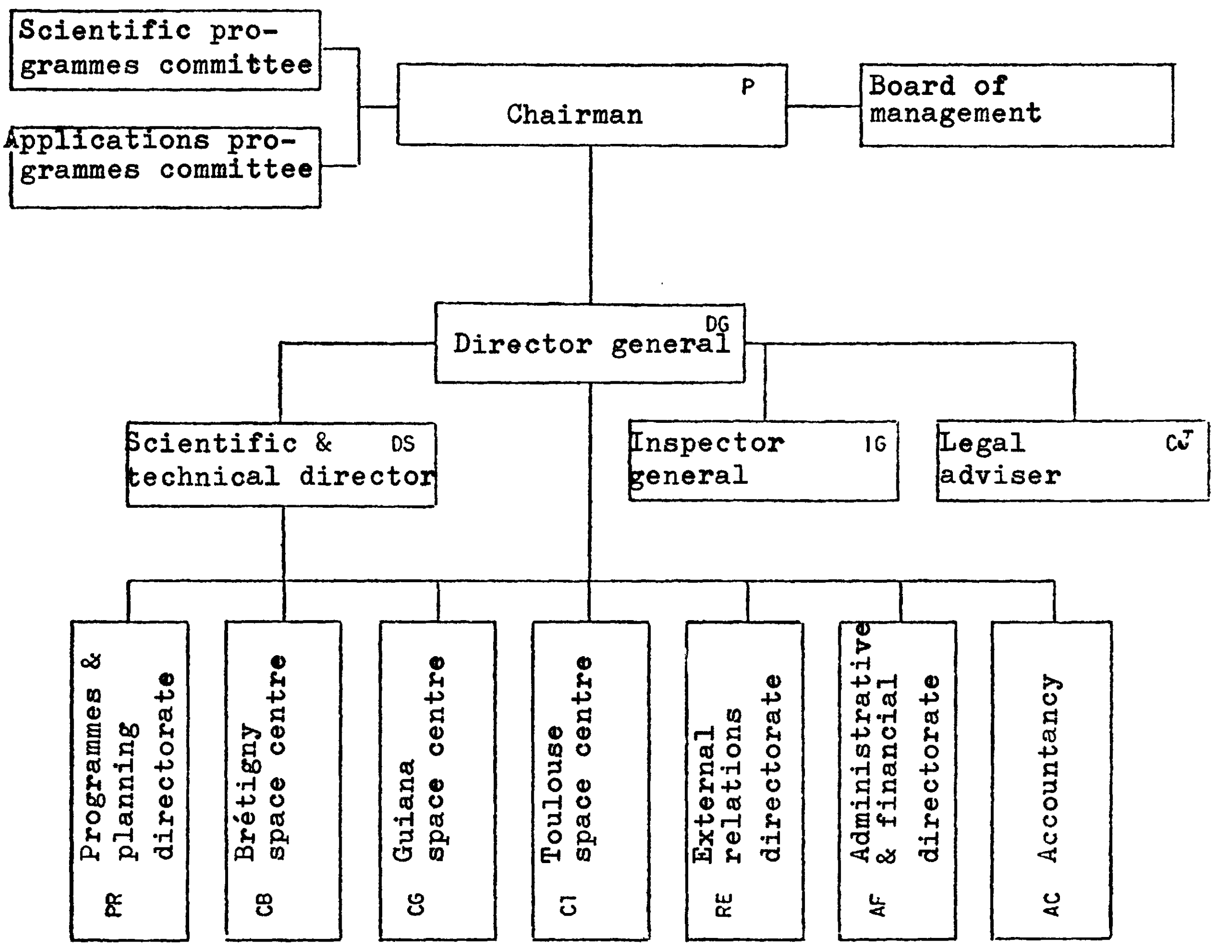
The work has entailed a heavy outlay of capital - the total cost is estimated to be some $108 million, of which $25 million were paid by ELDO for the European launch site and $83 million by CNES; about $54 million have been spent on infrastructure alone (roads, bridges, housing, schools, hospitals, etc.).

The decision to offer the Kourou base to European or foreign space bodies, under agreement to be defined, confers on this undertaking the character of a geographical and technical facility which is well-nigh unique in the world and can be placed at the disposal of every nation.

The launch of a Véronique AGI rocket inaugurated the base on 9 April 1968, while the construction work is still proceeding.

2.2.3 <u>Organization, personnel strength and budget of CNES</u>

The organization chart of July 1968 was as follows:



The managing board comprises the following:

- Délégué général à la recherche scientifique et technique
- Directeur général of the centre national de la recherche scientifique
- Directeur of the Institut National d'Astronomie et de Géophysique
- Directeur de la DRME au Ministère des Armées
- four highly qualified scientists or industrialists
- four senior civil servants appointed by the Prime Minister

- the Contrôleur d'Etat attends Board meetings.

The following table shows the annual growth of CNES's personnel establishment. Executive grades and technicians have an absolute predominance.

	1963	1964	1965	1966	1967
Executive	66	181	225	280	386
Technicians	8	108	100	118	150
Clerical	39	87	128	126	162
Operatives	5	15	21	15	16
TOTAL	118	391	474	539	714

Source: CNES, Rapport d'Activité 1967-1968.

By departments the distribution is as follows:

	1963	1964	1965	1966	1967
PRESIDENCE ET DIRECTION GENERAL	4	6	6	11	18
DIRECTION SCIENTIFIQUE ET TECHNIQUE	57	291	353	429	580
DIRECTION ADMIN. ET FINANCIERE	33	61	78	67	78
DIR. DES RELATIONS EXTERIEURS	24	33	37	32	38
TOTAL	118	391	474	539	714

Source: CNES, Rapport d'Activité 1967-1968.

CNES has a government subsidy for operating costs and another for capital investment; the latter is intended to cover execution of the national programme and to finance work in respect of French participation in the international organizations.

CNES Budgets (1962-69)

(Millions of dollars)

	1962	1963	1964	1965	1966	1967	1968 *
Operating costs	0.35	1.25	2.83	4.56	5.43	8.43	18.90
Investment:							
Authorization of programmes							
(a) national	9,44	21,80	32.20	39,25	44,00	78.35	86.10
(b) international	8,60	13.00	19,80	20.60	28.00	30.25	33,10
TOTAL	18,04	34.80	52,00	59,85	72,00	108.60	119.20
Payment credits							
(a) national	8,26	15,38	25,00	33,85	38.66	66,55	81,90
(b) international	8,60	13.00	14,00	20,60	28.00	33,05	36.10
TOTAL	16,86	28,38	39,00	54,45	66,66	99,60	118,00

Source: Rapport d'Activité 1967-1968, CNES

* The 1968 budget includes the Symphonie and Eole projects under national programmes.

Expenditure on the national programme has invariably and increasingly exceeded that on international programmes. After being practically equal in 1962, the ratio became 2.6 in payment authorizations and 2.3 in payment credits in 1968. This high ratio betokens realistic planning. The net budget increase for the national programme between 1968 and 67 was certainly due to the successes of Diamant A in 1965-66.

Midway in 1962-68 CNES's budget (i.e., for the whole of France's peaceful space activities) accounted for the following percentage of the GNP:

national programme	0.04%
international programmes	0.02%
Total	0.06% GNP

The overall figure is about one-fourth of the appropriation for FNS missile launchers (estimated at 0.25% of GNP for the decade 1960-70).

These mean values are rising sharply. For 1968 the amount for peaceful activities was:

national programme	0.08%
international programmes	0.03%
Total	0.11% GNP

For 1969 the military budget provides further appropriations for FNS missiles amounting to 0.29% of GNP.

2.2.4 Completed programmes

During the early years (1962-65) the activity of CNES was oriented towards the provision of infrastructure and the development of technical programmes for launchers and satellites and their associated scientific missions.

Since 1962 CNES has succeeded in carrying out operational programmes in two sectors: balloons and sounding rockets.

Balloons - Balloon activity was able to make use of projects already completed by the Service Aéronomie of the CNRS; CNES assigned to that service the installation of a balloon-launching base at Air-sur-l'Adour.

By mid-1968 over 500 launches had been made for scientific and technological tasks: 182 between mid-1967 and mid-1968, with balloons of 5,000 to 100,000 m^3 volume. In this area CNES has an expertise unrivalled in Europe, for a moderate capital cost ($1.2 million in 1967, 2.3 million in 1968). This expertise, combined with that in satellites, made possible the launching of the Eole programme, now in the development phase.

Sounding rockets - In this area CNES has been able, since 1962 to utilize LRBA's liquid propellant rockets and the solid propellant rockets developed by Sud-Aviation, under a research programme commissioned in 1957 by CNET (Centre National d'Etudes de Télécommunications).

Sud-Aviation's family of rockets for civilian uses has been designed for simplicity, sturdiness, safety and facility of transport. In 1962 the single stage Bélier and two-stage Centaure were operational, followed in due course by the two-stage Dragon (1964), single-stage Dauphin (1966) and two-stage Eridan (1968).

By the end of 1967, CNES had launched a total of 183 sounding rockets for a great variety of scientific missions:

- 30 Véronique AGIs, 13 Véronique 61s, 4 Vestas, from LRBA
- 4 Rubis from SEREB
- 2 Titus and 1 Tacite from ONERA
- 8 Emmas from Matra.

The capability achieved in the rocket sector has made France ESRO's chief supplier of sounding rockets since 1964.

Launchers - In May 1962 an agreement between CNES and DMA was concluded for the manufacture of France's first three-stage rocket, Diamant A, derived from developments of SEREB's basic ballistic missiles. CNES and DMA contribute $11 million each. Between November 1965 and February 1967 there were four successful firings from the Hammaguir base; the last three placed in orbit the satellites Diadème and Diapason 1 and 2. After a fresh period of study development of the Diamant B launcher began in 1967 (using Améthyste as the first stage instead of Emeraude); the sole contracting authority on this occasion is CNES, which expects to spend $11.4 million. Diamant B will become operational in 1969, for putting up the satellite D2 with a launching from Guiana.

The work on Diamant B is distributed as follows:

LRBA: proving and qualifying the Valois motor

Ateliers de Tarbes: industrial production of the Valois motor

Nord-Aviation: development and manufacture of the first stage (L 17); manufacture of the second stage (L 2.3)

Sud-Aviation: manufacture of the third stage (P 0.7) and heat shielding

Matra: equipment bays

By the end of 1968 CNES had ordered four Diamant Bs.

Scientific satellites

FR 1 - In February 1963 an agreement was signed between CNES and NASA for a free of charge launching of France's first satellite. Nord-Aviation developed the structure and CGE the electronics. CNET collaborated in the passenger experiments. Launched by NASA with a Scout rocket on 6 December 1965, the satellite is still functioning.

Diapason - Prime contractor l'Electronique Marcel Dassault (EMD), structure by Matra. Launched on 17 December 1966 from Hammaguir by a Diamant A rocket. Still functioning.

Diadème 1 and 2 - Prime contractor EMD, structure by Matra. Launched on 8 and 15 February 1967 from Hammaguir by a Diamant A launcher. One of the two satellites is still functioning, the other is being used as a laser reflector.

From the standpoint of space capability, Diapason already shows a marked progress over FR 1, with France providing its own launcher, launch base and tracking and telemetry network.

In the list of suppliers of the on-board telemetry, American firms have given way to French undertakings.

2.2.5 Current programmes

In 1968 it was planned to launch, by 1972, two scientific satellites (D 2 and Roseau) and two applications satellites (FR 2 for meteorology, Symphonie for telecommunications), while longer-term studies on satellites to assist air navigation (Dioscures) - 1973-75 - were also commissioned.

D 2 - Scientific satellite, launching from Guiana by Diamant B rocket planned for 1969. A collaborative effort by the whole French industry (EMD, Sud-Aviation, Nord-Aviation, CFTH, Matra, etc.).

Roseau - A Franco-Soviet agreement concluded in May 1967 provided for a Soviet launch of the scientific satellite Roseau in 1971. Owing to France's financial position, the programme was cancelled at the end of 1968. A mere postponement would have left it devoid of scientific interest, in that it was timed to coincide with the high level of solar activity in 1971.

The applications satellite programmes cover all three space sectors considered the most promising nowadays: navigation, telecommunications, meteorology.

Dioscures project, for navigational aid satellites, planned to be operational in 1972-75, and studied jointly by CNES and the Secrétariat Général à l'Aviation Civil. It is based on a detailed analysis of the trends in air traffic over the North Atlantic, and of the savings in fuel and flight time obtainable by an accurate space control system.

Eole project, combining French expertise in balloons and satellites. The French satellite FR 2 will be in radio contact with 500 balloons launched in the southern hemisphere for the study of atmospheric flows. The project attracted the interest of NASA which, on the basis of the agreement signed with CNES in May 1966, is to offer a launcher and launching in 1971 (cost to France $30 million). Preliminary trials have already been held.

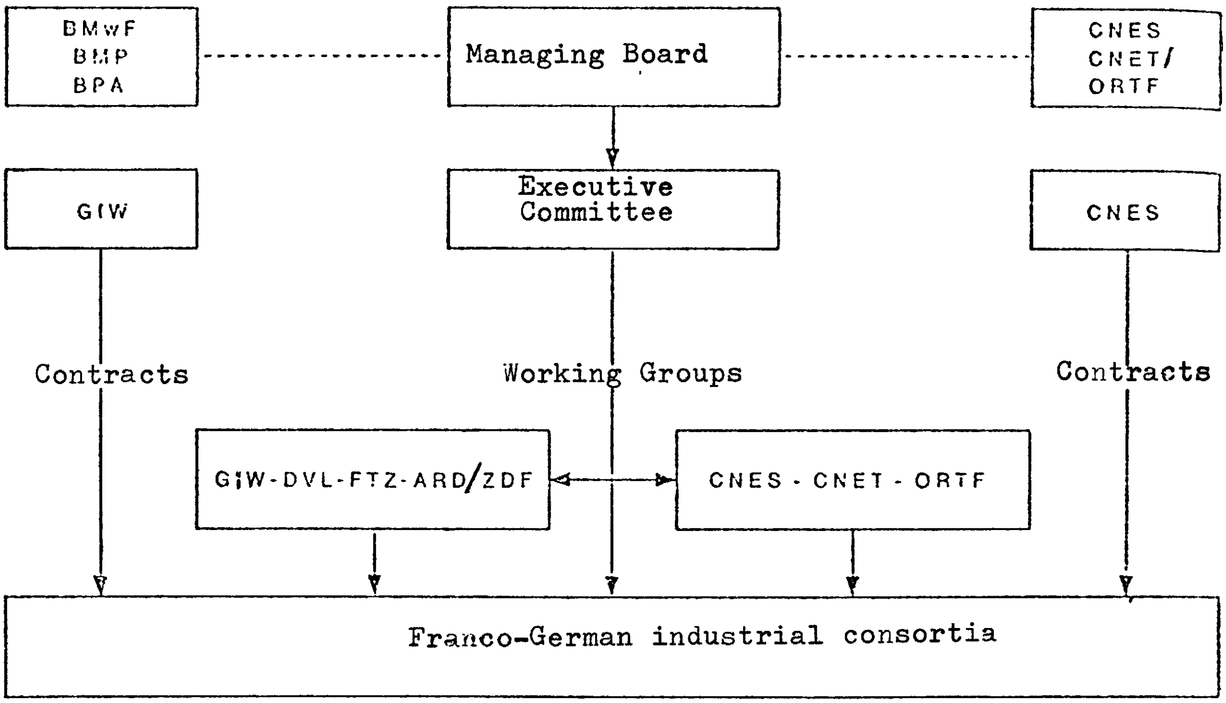
Symphonie project, born of the amalgamation of the French SAROS and German Clympia preliminary projects. In view of the slowness of decision making in CETS and the advisability of securing a strong position for the renegotiation of the INTELSAT agreements in 1969, France and Germany agreed in June 1967 upon the manufacture and launching of geostationary satellites for telecommunications experiments to be completed in 1972.

One prototype and two flight models are planned, equipped for TV, sound broadcasting and telephony. The satellite weight of about 175 kg demands a launcher of ELDO/PAS class, geostationary over the Central Atlantic and placed in orbit from Guiana.
France and Germany have ordered two such vehicles for 1971. ELDO's recent crises have induced France to study possible alternative choices of launcher, granted the absolute priority given to telecommunications among the space programmes.

It is not certain that procurement of US launchers would be possible.

For the management of the Symphonie project a managing board with the following organization chart has been set up:

Organization Chart for the Symphonie Project



ARD/ZDF: Deutsche Rundfunk- und Fernsehanstalten (Offices allemands de radiodiffusion et de télévision - 1re et 2e chaînes).
BMP: Bundesministerium für das Post- und Fernmeldwesen (Ministère fédéral des postes et télécommunications).
BMwF: Bundesministerium für wissenschaftliche Forschung (Ministère fédéral de la recherche scientifique).
BPA: Bundespresseamt (Office fédéral de la presse).
CNES: Centre National d'Etudes Spatiales.
CNET: Centre National d'Etudes des Télécommunications.
DVL: Deutsche Versuchanstalt für Luft- und Raumfahrt (Organisation allemande de recherche aérospatiale).
FTZ: Fernmeldetechnisches Zentralamt (Office central de télécommunications).
GfW: Gesellschaft für Weltraumforschung (Société nationale de recherches spatiales).
ORTF: Office de Radiodiffusion Télévision Française.

After specifications had been defined, calls for tender went out in January 1968. Two consortia were set up, CIFAS (Consortium Industriel Franco-Allemand Symphonie) and Symcosat, as shown in the following chart:

	French	German
Electronics firms	THOMSON HOUSTON HOTCHKISS BRANDT C S F S A T	
Aircraft firms	NORD-AVIATION SUD-AVIATION	BOLKOW JUNKERS

C I F A S

	French	German
Electronics firms		SIEMENS TELEFUNKEN
Aircraft firms	MATRA	ERNO

S Y M C O S A T

Given the preponderance in cost and technical content of the electronics, the managing board was then to "symmetrize" the winning consortium by giving the loser a share in the electronics. At the beginning of 1968 the Belgian Government agreed to take a 4% participation in the Symphonie programme. MBLE was a member of CIFAS, and ACEC of Symcosat.

The absence will be noted of France's LCT, Germany's Lorentz and Belgium's Bell, in which ITT has holdings of 99.96, 95.43 and 99.99% respectively.

Taking the realistic view that access to American knowhow was unlikely, France and Germany had previously put in hand and financed research and development on the technologically most critical points: counter-rotating antennas and travelling wave tubes.

In October 1968 the Managing Board of the Symphonie project selected the CIFAS consortium; the operations for "symmetrizing" the electronics contracts are proceeding. The cost of the satellites alone is estimated at about $56 million. The satellite will be tried out either with antennas conforming to INTELSAT standards (diameter 27.5 m) or with lower antennas (diameter 12-15 m) to analyse the possibilities for cutting down ground infrastructure costs.

2.2.6 Industrial policy of CNES

The distribution of CNES's major expenditure by branches is shown for the last few years preceding the start of the project, in the following table:

	1964	1965	1966	1967
	(%)			
Aerospace (vehicles and on-board electronics)	34	25	38	20
Electronics (ground hardware)	31	33	19	15
Scientific laboratories	9	15	11	12
Purchases from abroad	7	5	2	0,7

The sharp decline in purchases from abroad will be noted; the peak in 1965 for the ground electronics corresponds to construction of the Diane and Iris networks. The apparent decline in 1967 in expenditure in the advanced technology sector is due to a general cut-back owing to the capital costs of infrastructure for the Guiana Space Centre.

In deploying its projects over a wide field CNES has sponsored the latest techniques of system analysis and programme management (PERT, etc.); and has kept the door open to every possible industrial collaboration in order to make full use of space capabilities from their infancy.

Since October 1967, CNES has established an Industrial Policy Division in its External Relations Directorate to improve the efficacy of government intervention in the industrial sector, where the space technology potential is to grow and keep pace with the parallel growth of CNES activities.

3. GERMANY

3.1 Origins and Organization of Space Activity

Unlike what happened in US and USSR and, on the European scale, in France and Britain, the initial interest in space activity in West Germany was not a byproduct of post-war ballistic weaponry. Only at the start of the long-drawn-out negotiations for the establishment of ELDO and ESRO did the German aeronautical industry, through the BDLI (Bundesverband der Deutschen Luft- un Raumfahrtindustrie) and research centres (AVA, DFL, DVL) coordinated in the DGF (Deutsche Gesellschaft für Flugwissenschaften), envisage the need for their own national peaceful space programme.

In August 1961 the BDLI and DGF set up a joint commission called the KfR (Kommission für Raumfahrttechnik), which in July 1962 presented the first four-year space plan taking in industry and scientific research; the plan aimed to secure expert German participation in European space programmes and provided for the creation of adequate modern infrastructures.

The four-year plan's financial proposals break down as follows:

(Millions of dollars)

Year	Research (DGF)	Industry (BDLI)	TOTAL	% GNP
1 9 6 3	10,8	20,7	31.5	0,036
1 9 6 4	12,0	37,5	49,5	0.054
1 9 6 5	13,0	55,0	68.0	0,072
1 9 6 6	10,5	74,0	84,5	0.085
TOTAL	46,3	187.2	233.5	

However, at the political level it was still not accepted that the country had to have a definite space commitment for peaceful ends; the following table compares the appropriations demanded for the four-year plan and actual government expenditure on the national programme:

(Millions of dollars)

Year	Kfr plan	Expend-iture	% Agreed	% Spent
1 9 6 3	31.5	9.0	28.6	0.010
1 9 6 4	49.5	13.8	28.0	0.015
1 9 6 5	68.0	17.5	25.7	0.019
1 9 6 6	84.5	18.0	21.3	0.018

As early as 1963 the KfR realized that the four-year plan had set its sights too high both in absolute figures and in growth rate, and a more realistic plan was worked out for 1964, providing $5.1 million for research and $23.4 million for industry (including $6.5 million for infrastructure).

Not even this curtailed plan ($28.5 million) was accepted by the government in 1964.

That was the year in which ELDO and ESRO began their official activity; the need for expert German participation stimulated the establishment of suitable government agencies.

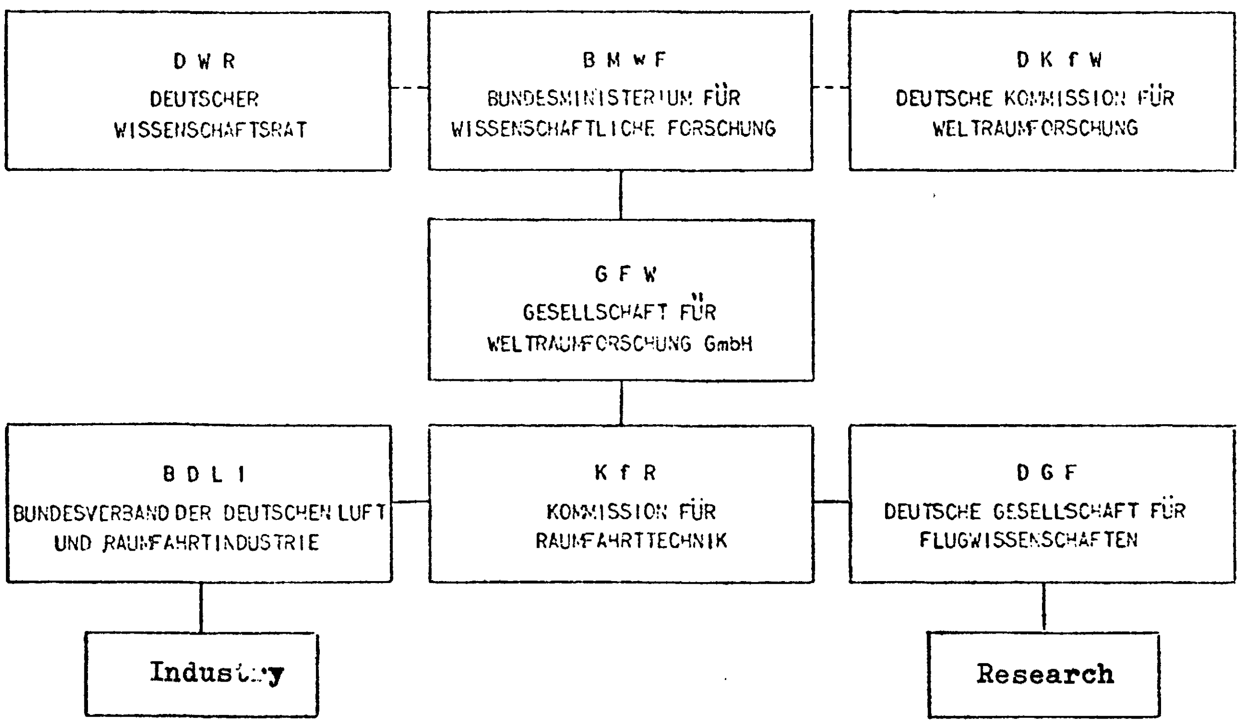
The Bundesministerium für wissenschaftliche Forschung (BMwF) coordinates space activity as a whole, and in 1964 set up:

- Department IV: Space Research, assisted on the technical and scientific planes by the DKfW (Deutsche Kommission für Weltraumforschung) and DWR (Deutscher Wissenschaftsrat);

- the GfW corporation (Gesellschaft für Weltraumforschung GmbH) an operational body financed exclusively by the federal government and non-profit-making; responsible for supervision of industrial activity and research.

The KfR, which already coordinated the space activites of BDLI and DGF, was the executive counterpart of GfW. The following operational framework was the result:

Organization of Space Activities in Germany



In 1965 KfR drafted a new five-year plan (1966-70), setting as a target for 1970 a sum of $66.0 million which under the first four-year plan was to be greatly exceeded already in 1966). The 1966-70 plan provided for a total expenditure of $236.5 million over the five-year period, divided up as follows:

(a)	Research	19%
(b)	Industry	44%
(c)	Space communications	21%
(d)	Ground equipment	16%

This fresh KfR proposal guided the Ministry of Research in drawing up its medium-term five-year plan (1967-71), for a total expenditure of $506 million, broken down as follows:

	1967	1968	1969	1970	1971	TOTAL
Basic national programme	29.7	40.0	55.5	67.0	69.5	261.7
Supplementary national programme	-	-	7.5	15,0	27.5	50.0
Total national programme	29.7	40.0	63,0	82.0	97.0	311.7
Participation in international organizations	38.5	41.2	38.5	38.3	37.8	194.3
<u>Grand total</u>	68.5	81.2	101.5	120.3	134.8	506.0
Ratio national/international	0.78	0.97	1.63	2.09	2.57	1.60

The total capital expenditure on space practically doubles every five years, with an average annual increment of 19%.

In 1971 these appropriations will represent about 0.11% of GNP.

The funding of the plan moves towards an ever greater national commitment compared with the international one, as the last line in the table shows. Actually, already in 1967 and 1968 the figures for the domestic programme were slightly exceeded, while those for the international programmes could not be realized, so that the ratios of 0.78 and 0.97 were in fact 1.03 and 1.11.

The following table compares the KfR and BMwF financial plans with expenditures incurred to date for the national programme alone (millions of dollars):

Year	KfR plan			BMwF plan			Expenditure on national programme
	1962	1964	1965	Basic plan	Supplementary plan	TOTAL	
1963	31.5						9.0
1964	49.5	28,5					13.8
1965	68,0						17.5
1966	84.5		21,0				18.0
1967			36,5	29.7	0,0	29,7	35.0
1968			52,0	40.0	0,0	40,0	42.0
1969			61,0	55.5	7.5	63.0	
1970			66,0	67.0	15.0	82,0	
1971				69.5	27.5	97,0	

A fresh stride towards rationalization of efforts in aerospace was made in July 1968 with the formation of the new Institute "Deutsche Forschung und Versuchsanstalt für Luft- und Raumfahrt" combining the three research centres: AVA (Göttingen), DFL (Brunswick) and DVL (Potz-Wahn).

The new Institute has a staffing establishment of 2,500, including 800 scientists and engineers, and its initial allocation for the first year of operations was $23.2 million.

Its basic purpose is to coordinate both the State's and industry's aerospace R&D policy, besides training new scientific and technical recruits to the sector. A government board supervises the new Institute, with representatives for politics, science and industry.

3.2 Activity and Prospects

Germany's first space achievements were programmed in detail in the KfR plan for 1963-66.

Besides giving its systematic backing to the research bodies coordinated by DGF, the plan provided - still as part of its basic activity - for organic expenditure in the provision of infrastructures and centralized research or manufacturing plant. In the latter direction the following have been particularly active: the firm of IABG (Industrie-Anlagen Betriebs-Gesellschaft) and the ASAT Consortium (Arbeitgemeinschaft Satellitenträger) formed by the firms of Boelkow and ERNO for the ELDO development programme.

The same KfR plan went on to set up the following operational space projects:

(a) Project 621 - Recoverable high altitude sounding rockets. Between 1962 and 1965 two competitive projects were developed by the Dornier-Lorenz-Telefunken group and Boelkow-Junkers. Subsequently, in view of the gradual decline in costs of European and American conventional rockets and the high costs of recovery systems, the project was practically pigeonholed.

(b) Project 622 - High energy propulsion systems. The studies and experiments of the firms Boelkow, ERNO and Nitrochemie in the cryogenic propellant sector were started in 1963 as a contribution to the project for sophisticated upper stages for the future ELDO launchers. The peak funding ($0.8 million) was reached in 1964.

(c) Project 623 - Recoverable space transporter. Backed by EUROSPACE as a possible programme of long-term European cooperation, the project was worked on by the whole of the German aerospace industry: in particular Siemens-Halske contributed part of its own finance; other participants were Junkers, Boelkow, AEG and ERNO. The peak of funding was reached in 1963 ($0.85 million). In 1964

Project 623 was still being given priority by KfR even though it was by then clear that it would have taken at least seven or eight years to develop even on a European collaborative basis.

(d) Project 624 - Non-chemical propulsion. This project, originally centred on electrical and nuclear propulsion, was later extended to the technology of on-board power sources (solar cells, fuel cells, small nuclear reactors) and added to the expertise of a large part of Germany's aerospace industry: in particular Siemens-Schuckertwerke contributed part of its own finance; other participants were AEG, ERNO and International-Atomreaktorbau. Peak finance was reached in 1964 ($2.20 million).

(e) Project 625 - Scientific research satellites. The preliminary studies, mainly conducted by Boelkow, Dornier and ERNO in 1962-65, were oriented towards definition and feasibility. During that period the peak funding ($2.6 million) was in 1964. Only after signature of the 1965 agreement with NASA for free-of-charge launching of German national satellites did the programme set its sights on the AZUR satellite series.

After the initial period (1962-65) of widely differing space activities, the programmes focus on more unified targets, while the government agrees to bear a larger share of the cost.

The BMfR five-year plan (1967-71) realistically excludes any German commitment whatsoever in the manufacture of sounding rockets, a sector where there is now too much competition in Europe itself. In order to have a stake in the sector, the firm Dornier-System will collaborate with Contraves of Switzerland.

Even more realistically, the construction of national launchers is ruled out, an option by which Germany is committed to firm support of ELDO and possibly, to a lesser degree, to suing American or European national rockets. Hence expenditure on propulsion and launcher systems is systematically cut back while that on scientific, technological and applications projects is substantially increased.

(f) Scientific missions - The 1967-71 plan allocates about $20 million for the preparation of scientific payloads to be put up by rockets or balloons in collaboration with France, Canada and ESRO, or carried as passengers on NATO satellites.
In this connection DVL completed in 1968, a campaign of sounding rocket launchings from ESRO's Kiruna base.

(g) Scientific satellites - The 1967-71 plan provides for the manufacture of three satellites: 625-Azur 1, 625-Azur 2, 625-Azur 3 of about 100 kg, for launching by Scout rockets supplied free of charge by NASA.
The estimated cost of the three satellites is $10.5, 8.0 and 5.5 million respectively.
Azur 1 is ready for launching, scheduled for October 1969, into polar orbit.
The partners in the venture, under GfW direction and oversight, are: Boelkow (prime contractor for project management and satellite integration); AEG (on-board power supply); Dornier-System (stabilization and thermal control); ERNO satellite structure); Lorenz (guidance system); Telefunken (telemetry).
Contracts for the other two satellites, due to be orbited after 1970-71, have still to be awarded.

(h) Solar probe - In 1966 a German-American agreement was signed for joint research in interplanetary space.
After preliminary studies carried out jointly by Boelkow and the Jet Propulsion Laboratory of NASA, for the possible construction of a Jupiter probe, the solar probe project ISOS, capable of achieving a heliocentric orbit one-third that of the earth, has been developed.

This project, absolutely original for any country in the world, poses difficult engineering problems of thermal shielding, especially in the case of solar cells and antennas.
The project has greatly interested NASA, which is to supply without charge the improved Centaur launch vehicle.
Boelkow's project is at an advanced phase of preparation, and the launching may be expected in 1973-74. The 1967-71 plan earmarks $24.0 million for the purposes.

The supplementary scientific programme also includes for 1969-71, with a lower priority, a large scientific satellite (625-B2) of 400 kg, and another solar probe.

(i) Space technology - $47.5 million are set aside in the 1967-71 plan for advanced technologies, of cardinal importance for all future space projects, in the special materials, on-board power sources, propulsion, on-board electronics and data transmission and reduction areas.
Great importance is also attached to the extension and modernization of research facilities and test equipment.

The supplementary programme provides for only one possible technological satellite (PT-B1), for trials of space components and sub-assemblies, after 1970-71.

(j) Applications satellites - In the field of satellites for meteorology, navigation and geodesy there are only plans for limited studies of instrumentation and sensors. The capital outlay under the plan 1967-71 is mainly oriented towards space telecommunications.
Besides strongly supporting the CETS programme since their inception, BMwF had begun preliminary studies on an experimental communications satellite (Olympia).

In June 1967 Germany and France signed the agreement for the joint construction of a regional geostationary satellite, Symphonie, for TV and sound radio broadcasting and experimental telephony.
For a description of the Symphonie project, see Section 2. Here we shall simply recall the chief features of Germany's contribution.

The 1967-71 plan allocates $32.5 million for the project, inclusive of launch costs.
The managing board of the Symphonie project comprises, on the German side, BMwF, BMP (Bundesministerium für Post und Fernmeldwesen) and BPA (Bundespresseamt); GfW is responsible for executive control, and together with DVL, FTZ (Fernmeldetechnisches Zentralamt) and ARD/ZDF Deutsche Rundfunk- und Fernsehanstalten) forms the German working group. Of the two tenders by the CIFAS and Symcosat consortia, the managing board accepted the former in October 1968. Accordingly, the German firms helping to produce the Symphonie satellite are Boelkow and Junkers; ERNO, which was in the second consortium, is left out. The second consortium also included the electronics firms Siemens and Telefunken, which will, however, be awarded part of the contract on the basis of the "symmetrization" clause, which apportions among

the Franco-German firms the large amount of work on electronics, requiring the cooperation of all the most advanced capabilities in both countries.

In 1962 interest began to switch to space activities throughout the German aeronautical and electronics industries. The labour force engaged on space numbered about 3,000 in 1966 and 4,000 in 1968[1].

Particularly active in the field were:

- the firm of Boelkow, with widely diversified interests in everything to do with aircraft, rocketry and space, and with a notable international outlook fostered by the financial participation of Nord-Aviation and Boeing;
- ERNO, exclusively interested in space since it was converted in 1967 from a consortium grouping VFW and HF to ERNO Raumfahrttechnik GmbH, with a head office in Bremen and wholly German capital ($2.5 million: 60% VFW, 40% HF). In 1968 it had a staff of 900.

With the development of the Symphonie project and work carried out also by German electronics firms on the ground stations for INTELSAT, especially by Siemens and Telefunken, German industry's space capability is growing.

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1 Including those employed by electronics firms.

4. ITALY

4.1 Origins of Space Activity

Public interest in space activity in Italy dates from 1959-60, when the CNR (Consiglio Nazionale delle Ricerche) allocated $0.5 million for preliminary studies of scientific space programmes. Having examined propositions by the various institutes and research centres, the CNR decided in 1962 to concentrate its intervention on the San Marco project, developed by the CRA (Centro Ricerche Aerospaziali) of Rome in 1961.

For an expanded programme, an Italo-American cooperation agreement was signed on 5 September 1962, whereby NASA was to supply free of cost two Shotput rockets for sub-orbital launchings, together with technical assistance on the project and training for Italian personnel. This agreement preceded by two years the official start on European space cooperation in ELDO and ESRO.

4.2 Organization of Space R&D

The CNR, an offshoot of the Prime Minister's office, promotes and coordinates government activity in fundamental and applied research. In the space sector it has a technical and scientific advisory body, the Commissione Ricerche Spaziali, and an executive body, the Istituto Ricerche Spaziali.

The Commissione Ricerche Spaziali draws up scientific and technical plans, whether for the national programme or for Italy's participation in ESRO; its work is supported by the following sub-committees:

- Physics and astrophysics
- Astronomy
- Geophysics and surveying

- Space vehicles
- Electronics
- Biology

which operate at the level of state institutes, laboratories and observatories.

- The Istituto Ricerche Spaziali, created on 20 April 1963, is presided over by the Chairman of CNR. On the management committee are representatives of the ministers of Foreign Affairs, Defence, Industry and Commerce, state enterprises, Posts and Telecommunications, the Treasury and Scientific and Technical Research. The Executive Secretariat coordinates the work of the Italian delegation to ELDO, ESRO and CETS; it administers the relevant contracts placed in Italy and supervises, technically and financially, their execution at national laboratories and in industry.

The following also contribute to CNR's space activity:

- Centro Nazionale per la Fisica dell'Atmosfera e la Meteorologia, with headquarters in Rome;
- Commissione di Studio per le Telecommunicazioni a mezzo di Satelliti Artificiali, which coordinates the activity of university departments in telecommunications.

During 1962-68, CNR allocated in all \$15.8 million to space activity, approx. 80% (\$12.6 million) for the San Marco programme and approx. 20% (\$3.2 million) for research at national laboratories.

The Ministry of Defence contributed to space R&D by means of:

- subsidies and loans of technical personnel to CRA;
- extraordinary subsidies to the San Marco project;
- running and expanding the Salto di Quirra base in Sardinia for the launching of sounding rockets (Italian, foreign, or

ESRO-owned); during the two years 1964-65, $8.2 million were laid out on this account;

- starting up its own research and development programmes, e.g., national sounding rockets ($4.3 million in the two years 1963-64, 1964-65), meteorological programmes ($1.3 million during the same years) and preliminary studies for a new rocket of 7 t thrust ($0.3 million in 1967).

In 1965, the Italian aerospace industry formed the Compania Industriale Aerospaziale (CIA) with a capital of $0.11 million; its members are: Bombrini-Parodi-Delfino, Breda, FIAR, FIAT, Finmeccanica, Montecatini-Edison, Selenia.

CIA coordinates, at industrial level, Italian supplies for the European programmes. It acts as Italian prime contractor for the ELDO/PAS programme.

4.3 National Programme

As has been stated, CNR has invested $3.2 million in the programmes of the National Laboratories coordinated by the Commissione Ricerche Spaziali. More precisely, the following funds were allocated: $0.5 million in 1965 and $2.7 million for the two years 1967-68. These modest outlays were mainly devoted to the preparation of scientific payloads for mounting on:

- Italian and ESRO sounding rockets;
- ESRO and NASA satellites.

The major finance ($12.6 million from 1962-68) was earmarked by CNR for the CRA's San Marco project, which also benefited from funds from the Aeronautica Militare.

CRA was set up in its present structure in February 1963 with a convention between the University of Rome and Aeronautica Militare. It occupies a site of 28,000 m^2 on the Rome City Airport, and has a current establishment of 300, detached partly from the University of Rome, partly from Aeronautica Militare and partly from CNR.

In 1960 the Centre was equipped with intermittent aerodynamic tunnels:

- supersonic up to mach 4, cross-section 1 x 1 m;
- hypersonic up to mach 8, cross-section 30 cm in diameter;
- hypersonic up to mach 12, cross-section 30 cm in diameter.

Subsequently CRA was equipped with:

- another intermittent hypersonic tunnel, with electric arc (Hot Shot) capable of speeds up to mach 19 in a section of 60 cm diameter;
- a space simulation chamber of about 30 m^2 capacity for ground tests of satellites of dimensions up to 2 m;
- a vibration table for analysing stress loadings of satellites during the launching phase;
- a dynamic balancing unit for satellites.

CNR has at present:

- an electronics laboratory for R&D on space components and integration of satellites;
- a computer and data-processing centre equipped with two IBM 1620 and SDS 920 computers;
- a physics laboratory;
- a mechanical workshop;
- a documentation centre.

During the three years 1961-63, CRA carried out from the military base in Sardinia 15 firings of Nike-Cajum and Nike-Apache rockets for the exploration of atmospheric density by means of sodium and lithium clouds.

Two suborbital testing and development firings of the satellite San Marco A, developed in agreement with NASA in September 1964, took place in April and August 1963 from the NASA base on Wallops Island.

In the meantime development work proceeded on the original floating launch platform:

- Santa Rita, a triangle of 700 m^2, constructed by converting a Scarabeo oil-ring transferred from ENI to CNR and adapted at the Taranto Dockyards;
- San Marco, a rectangle of 30 x 100 m, constructed by converting a floating harbour sold by the US to CNR and adapted at the La Spezia Dockyards.

The two mobile platforms were anchored on the Equator off the territorial waters of Kenya in the Indian Ocean. Before the establishment of the Guiana Base with launching pads for French and ELDO rockets, the Italian platforms constituted the only base in the world for direct launchings into equatorial orbits, capable of reaping the benefit of easterly launches.

In March-April 1964 the Santa Rita platform was used for launching three Nike-Apache rockets; then, when the San Marco platform was fitted out with launch pads for the Scout vehicle, Santa Rita became a support base with a launch control room, radars and telemetry equipment. The infrastructure for the mobile base is supplemented by a telecommand and telemetry station, also mobile on three trucks with electric generator sets, at present stationed at Nairobi.

On 25 December 1964 the San Marco satellite (San Marco A before the launching) was placed in orbit by an Italian team at NASA's Wallops Island base, using a Scout launcher. This was the first entirely European-built satellite. San Marco 1, weighing about 80 kg, was equipped with a resistance balance for estimating atmospheric density on an inclined orbit.

The satellite stayed in orbit for nine months. In 1965-66 work on the equatorial base was finished and the second satellite San Marco B (San Marco 2 after launching) developed, once again equipped for density measurements but in equatorial orbit.

On 26 April 1967 San Marco 2 was launched by an Italian team using a Scout rocket from the San Marco mobile platform. The satellite remained in orbit for six months. San Marco C, weighing 160 kg, is now in the development phase, once more intended for exploring atmospheric density in equatorial orbits. It will carry as a passenger a NASA spectrometer for chemical analysis of the atmosphere. Its launching from the Italian equatorial platform is scheduled for the end of 1969, by means of another Scout rocket presented free of charge by NASA.

4.4 Survey of the National Programme

Excluded, like Germany, Belgium and Netherlands from any kind of initiative in the sector of national launchers, Italy is planning for a sizeable space effort programmed for the three years 1969-71 in more diversified areas than hitherto. For the launchers, direct agreements with NASA are in hand. The 1969-71 programme covers:

- launch of the abovementioned San Marco C satellite;
- maintenance and development of the equatorial platform, offered to NASA for launching two small standard satellites by 1971; these will be the first American firings from a non-American base;

- possible construction of small Italian scientific satellites for launching from the San Marco platform;
- development and construction of the Sirio satellite for SHF telecommunication experiments (12-17 Gc/s) intended for educational TV broadcast between the US and Europe and between European countries. In this manner, Italy's experience on ELDO's experimental satellites can be put to use, and Italy will recover at national level the portion of the ELDO/PAS programme cancelled by ELDO's 1968 austerity plan.

  The satellite of some 300 kg, including 190 for the apogee motor, is to be launched in late 1971 into geostationary orbit over the eastern Atlantic (long. 15° W) by an improved Thor-Delta vehicle purchased by Italy in the US.

  The satellite will carry six passenger scientific experiments from the national laboratories and may possibly also be equipped for meteorological observations.

The overall programme involves an expenditure of:

- $24.5 million for the national laboratories' programmes during 1969-71;
- about $21 million for the Sirio project in the two-year period 1970-71, including satellite, apogee motor, cost of the NASA launcher and launch costs in the US.

This will bring Italy's capital investment in the national programme in 1969-71 to about the same level of expenditure as for the ELDO and ESRO European programmes: an average of about $15 million per annum.

A five-year space programme for 1971-75 is under study.

5. BELGIUM

Belgium has no real national space programme of her own. Expenditure in this respect has consequently been modest[1], and mainly concentrated on infrastructure (space simulation, vacuum and low temperature chambers, anechoic rooms, vibration tables and impact tables) and studies, carried out by the firm of Belgonucléaire, on on-board isotopic power sources.

From January 1968, and with government consent, Belgian industry agreed to bear a 4% share in the Franco-German experimental telecommunications satellite Symphonie (to a total estimated cost of about $65 million).

The Belgian firms concerned are MBLE for the CIPAS (Consortium Industriel Franco-Allemand Symphonie) consortium and ACEC for the Symcosat consortium.

In October 1968, the Managing Board for the Symphonie project accepted the CIFAS tender (cf. French civilian space programmes).

Participation in this multinational project offers Belgian industry a precious opportunity of acquiring a space capability in an applications area whose future, European and worldwide, is assured.

Since the injection into orbit of the Symphonie satellite relies on the ELDO/PAS launch vehicle, Belgian support for ELDO, already whole-hearted, has been further strengthened.

For a coordinated and controlled participation in space programmes, Belgian industry created the Association Belgospace, whose members are aeronautical firms (SABCA, Fairey), electronics firms (MBLE, Bell, ETCA, Cobelda, SAIT), electrical

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[1] $3.75 million during 1964-68.

engineering concerns (Belgonucléaire).

While not having a genuine national programme, Belgium has still managed to secure a footing in bilateral and European collaboration. In particular, Belgium played a delicate role as coordinator of European space policies in 1968 at the ELDO Ministerial Conference and European Space Conference (Lefèvre Mission, Aug.-Sep., Spaey Report, Oct.).

6. NETHERLANDS

Like Belgium, Holland also lacks a real national programme. Consequently expenditure in this field has remained modest, mainly concentrated on infrastructure (space simulation chambers, impact tables) and scientific experiments to be entrusted to the NASA satellites OGO and OSO.

From the beginning of 1968, a study has been in hand for a national scientific satellite intended for the University of Utrecht's planned astronomical research, and its associated ground receiver station; engaged on the project are the firms of Fokker for the satellite structure and Philips for the on-board and ground electronics. For launching it is proposed to use a NASA rocket from an American base, under agreements to be defined.

Studies have also been begun on experimental ground stations for space telecommunications.

PART 5

Conclusions and further outlook

1. SPACE EXPENDITURES IN THE MEMBER COUNTRIES OF THE EUROPEAN COMMUNITY, COMPARED WITH THOSE IN BRITAIN AND THE UNITED STATES

The EEC countries' expenditures on space activities are shown in the attached Table 2/B-8, in comparison with the corresponding figures for the United Kingdom and the United States.

The figures refer to the five-year period 1964-68 following the establishment of the European space organizations ELDO and ESRO; this is also the period of massive civilian spending in the US on the Apollo programme (1966) and a steadily growing military expenditure in the space area. It is therefore clear that a revealing comparison with the US deserves further analysis.

Table 2/B-9 shows the cumulative figures for the five years 1964-68; the leading position in Europe of France, followed by Germany, stands out. US expenditure is 43 times that of the EEC; NASA alone spends 31 times as much as the EEC.

If NASA expenditure for 1964-68 is broken down between manned and unmanned programmes, the respective totals are $17,000 and 8,000 million; the latter figure is still ten times the total space expenditure of EEC member countries for the same period, whereas the ratio of national incomes is 2.3 to 1. Table 2/B-10 shows Europe's space investment related to GNP (both as totals for the five-year period 1964-68), with details of the amount and year of peak expenditure.

For all the EEC countries, expenditure rose steadily from 1964 to 1968; for Britain, on the contrary, the peak of spending was reached in 1966.

Britain's average and maximum figures are lower than the EEC average.

Since the years 1964-68 were substantially the initial period of space activity for the EEC, it has been deemed advisable to quote for the US as well the figures for their corresponding initial period (1959-63).

From the figures shown it is seen that total NASA investments in the United States exceeded in both periods (1959-63 and 1964-68) those of DoD; they represented 43% of the total for 1959-63 and only 24% in 1964-68, thanks to the explosive growth of peaceful expenditure by the US on the Apollo programme.

Seeing that the space expenditures of the EEC countries show only those for peaceful purposes, and that for the EEC no manned programmes are foreseeable at any rate this side of 1980, a reasonable comparison would be between:

- the 0.046% of GNP invested by the EEC in the initial five-year period 1964-68, and
- the 0.093% of GNP invested by the United States in its peaceful, manned programmes alone, during the initial years 1959-63.

A "simultaneous" comparison between EEC (0.046% of GNP in 1964-68) and the US (0.235% of GNP in 1964-68) should among other things allow for the fact that during the second five years of America's space effort, unmanned programmes not yet within the reach of EEC technologies were deployed, such as automatic planetary probes, highly sophisticated scientific and applications programmes, R&D on nuclear propulsion, and so on.

We may sum up the matter by saying that economically expressed in terms of GNP and historically related to similar initial five-year periods, the EEC space investments were one half those of the US.

Yet considering only peaceful and unmanned projects, which in the United States have amply reaped the benefits of other forms of space investment, there is in the final analysis a very serious, but not unbridgeable technological gap.

2. EUROPE'S LAG

As in the US and the Soviet Union, so in Europe, especially in France and Britain, space activity was originally governed by military missile programmes, up to about 1960. The first Soviet space achievement (October 1957) had no appreciable impact in Europe, whereas in the United States it very rapidly triggered off a radical redistribution of military and civil tasks, the foundation of NASA and the launching of the Mercury project.

During the first space period (1957-61) interest was beginning to wane in Britain for having its own independent strategic missile force, while interest for peaceful space activities was beginning to take shape in Europe.

Only in France, where the wish to have its own strategic missiles was gaining strength in the meantime, was a unified civilian body, CNES, set up, furnished with integrated programmes for space launchers, science and applications.

The Soviet Union's second space success (April 1961) did not speed up in Europe the definition of cooperative plans for the two separate organizations ELDO and ESRO, whereas in the United States the unified body NASA had an answer ready in the launching of the Gemini and Apollo programmes, besides fresh military initiatives in space.

It took Europe practically four years of laborious negotiations (1960-64) to breathe life into ELDO and ESRO at a time of exuberant growth for a new advanced technology which ought to have called for promptitude and flexibility of decision-taking. At a time and in a sector of less dynamic growth the negotiations for the creation of the European establishments CERN and Euratom had not been so slow. Europe's tardy decision-making not only widened the technological gap but induced some countries to develop their own national programmes and bilateral collaboration with the US; European space cooperation still labours under the effects of this.

Britain renounced the development of her own strategic missiles, using the now obsolescent liquid propellant technology, and the United States authorized the procurement of Polaris missiles; the ex-military Blue Streak would become the first stage of an ELDO launcher; even in other space activities, Britain came to lean on the United States: for launching the scientific Ariel satellites or setting up the Skynet military communications network.

Italy started up its San Marco space project relying on the US for launchers and launching, under direct agreement with NASA (1962).

In 1961, Germany established the KfR; this body framed the first four-year plan for space, which proved over-ambitious in aiming at an efficient and qualified European collaboration without entering upon bilateral negotiations with the United States. In 1964 the operational activities of ELDO and ESRO were officially started: ELDO comprises six European States plus Australia, ESRO 10 European States. The fear of possible military applications of launcher activity and less interest on the part of the smaller countries were the reasons for ELDO having a smaller membership than ESRO, in which scientific interests predominate.

More expeditiously than for ELDO and ESRO, negotiations for the establishment of CETS, Europe's third space body, solely concerned with communication satellites, lasted a single year, from mid-1963 to mid-1964. Undoubtedly the greater speed in reaching a decision was due to the fact that CETS is only a ministerial conference and that it was an offshoot of the existing CEPT.

It must be added, however, that a further factor in speeding up negotiations was the United States haste to set up Intelsat while Europe was still in its infancy in space.

In Intelsat the United State is represented by the powerful and unified private company Comsat, which has an absolute majority of votes, whereas Europe is represented by a ministerial conference of countries with disparate aims.

3. EUROPE'S INDUSTRIAL POSTURE

From 1960 onwards the world of industry had shown itself much readier and more sensitive than the politicians; having seen and assessed the long term technical and economic implications of space activity, European industry in 1961 gave birth to the consortium Eurospace, comprising the industries of nine countries: aeronautics, electronics, chemistry and metallurgy, public and private concerns having concrete space applications programmes, together with a few banks.

In recent years Eurospace has sponsored the foundation of a semi-public undertaking Eurosat, formed early in 1969, and:

- capable of presenting a united front to Comsat in Intelsat;
- capable of coordinating Europe's space effort at industrial level;
- prepared to agree to spread the financial hazards of space activity over industries and governments.

This promptitude and open-mindedness on the part of industry must not, however, be allowed to obscure the average attitude in Europe of minds absolutely set against American-type contracting procedures.

When European industry develops R&D with public funds, it usually regards the knowhow thus gained as private property. Apparently politicians in Europe have neither the strength nor the willpower nor sufficient interest to impose on industry, in matters of intellectual property, at any rate the rules industrialists themselves impose on their own subsidiaries.

One of the factors in the popularity of space activity in the US incidentally on the wane despite the spectacular and admirable successes scored, has been the practice of keeping the taxpayer informed of the use made of his money in costly enterprises like space ventures.

The mere publication of the list of principal suppliers, together with their turnover figures, regularly issued each year in the US by NASA and even by DoD (without false screens of secrecy) is still unthinkable in Europe at national or international level.

Interviews with European industrialists have demonstrated that a change in attitude could only be brought about by a coherent and long-term commitment by governments to the space sector; it would also help to renovate business practice if international European companies could be formed to consolidate experiments in cooperation already carried out by fits and starts in multilateral consortia for the development of particular military programmes or certain of ESRO's space programmes.

4. US/EUROPEAN RELATIONS

Europe has found the fullest support in NASA for national launchings of scientific satellites: Italy's San Marco 1 and 2, Britain's Ariel 1, 2, and 3 and France's FR 1; the same collaboration continues for San Marco 3, Germany's Azur and a Dutch national satellite, and has been extended into the field of weather satellites: NASA is to cooperate with France for the validated Eole programme. Still in the scientific field, there has been extremely active cooperation between NASA and ESRO, as witness not only the volume of ESRO's purchases in the US but also American assistance especially from Lockheed and TRW in the construction of Europe's first satellites (ESRO 2, HEOS/A) and NASA's offer of cooperation to ESRO for development of the LAS project, free launchings of ESRO 1 and 2 and paid launchings of other scientific satellites. American support for ELDO has been less forthcoming; apart from the licences already acquired by Britain in 1960 from General Dynamic and North American for Blue Streak, the second and third stages and PAS system have mainly had to rely on Continental technologies. SETIS did not even secure the old US licence for the catalyst of hydrazine decomposition for booster rockets.

In the communications satellite area, there have been two concurrent phenomena:

- following the success of the Intelsat 1 and 2 systems, entirely American in technology, European resentment was voiced concerning "fair returns"; in tendering for Intelsat 3 and 4, American firms vied with one another in seeking extra-American collaboration, sometimes even accepting the penalty of higher costs.

  TRW produced the Intelsat 3 system with European assistance, and this is even more the case for Intelsat 4, which is being produced by Hughes;

- for Europe's first regional experimental communications satellite Symphonie, being built by France, Belgium and Germany, no American assistance is foreseen or foreseeable. Nor are any of the European electronics firms with a substantial participation of American capital taking part in the project, although they were very actively engaged in ESRO programmes and the last Intelsat tenders.

The impossibility of recourse to American technology in potentially competitive sectors like launchers or communications satellites is primarily a sign of vitality and commercial acumen in these areas.

The technological history of the development of French strategic missiles nevertheless goes to show that an embargo may end up by being a powerful technical incentive and worth more than any licence, albeit at the cost of greater expenditure and more development time, because it is backed by a firm determination to succeed. With ELDO and CETS Europe has not yet been able to demonstrate such a firm determination in a civilian and peaceful undertaking.

5. THE PRESENT SITUATION

After five years' cooperative effort in ELDO, ESRO and CETS, Europe is substantially split into two camps:

- France, Germany, Belgium and Netherlands are strongly committed to carrying on with the programmes for future independent European launchers; a particular incentive for the first three of these countries is the necessity of completing as a top priority the Symphonie experimental space communications programme;
- Britain and Italy practise a policy of disengagement from ELDO; Italy has also withdrawn from ESRO's current major

programme (TD), whereas Britain strongly supports ESRO. It should be noted that, with the development of Black Arrow, Britain is now able to rely upon its own launch capability, especially by mating it with Blue Streak, while Italy definitely relies upon American launchers for its short term programmes.

This state of affairs has come about not only due to "habits" fallen into during 1960-64 as a byproduct of the long-drawn-out negotiations for the establishment of ELDO and ESRO, but a prime consideration has also been the successive cuts in both organizations' programmes, which have induced individual countries to "salvage" the R&D work already put in at national level on European projects subsequently cancelled.

ELDO and ESRO have had to live from hand to mouth between alternate budget increases and operational programme cutbacks.

From an initial forecast of $196 million in 1962, ELDO moved on, with the supplementary programme added in 1966, to an estimate of $626 million (to be spread over eight years); there followed in 1968 a drastic cut in programmes to keep within that ceiling.

In the case of ESRO, after a modest original estimate of $306 million in 1961, a ceiling of expenditure of only $321 million (spread over eight years) was set in 1968; there have been continuous cutbacks in operational programmes and, especially earlier on, frequent cancellations of contracts in course of execution.

At the present time, having the divergent attitudes of the European countries towards the necessity of having an independent launch capability, and considering European solidarity on the scientific and applications programmes, in view of the urgent need to unify the three organizations

ELDO, ESRO and CETS, the Third European Space Conference at Bad Godesberg in November 1968 has framed future cooperative space programmes up to 1980 on the basis of the proposals in the Spaey Report (October 1968), updating and recasting the carefully thought-out proposals in the Causse Report (December 1967).

The basic programme[1] provides for a ceiling of expenditure of $150 million a year for the twelve years 1969-80.

Within this ceiling:

- work on the launchers Europa 1 and 2 will be completed;
- a launcher for satellites of 500 kg will be produced (1969-78);
- development will be started on a launcher for satellites of 700 kg (1966-82).

The programme for these launchers provides for an overall cost of $717 million spread over twelve years.

Acceptance of this launcher programme need not be unanimous; unanimity is required at least for the "minimum" scientific and applications programme, which provides for an overall expenditure during the twelve years of $1,037 million, broken down as follows:

(a) 40.4% organizational costs, logistics and infrastructure
(b) 3.4% oriented research
(c) 28.9% scientific space research programme
(d) 27.3% applications satellites programme.

The last item, $283 million, takes the form of three successive projects of gradually increasing cost, for communications satellites for direct TV broadcasting (E1, 200 kg,

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1 See Table 2/B-11.

$50 million; E2, 400 kg, $90 million; E3, 700 kg, $143 million; including launch costs).

Joining the "minimum" programme is a necessary condition for acceding to membership of the Unified European Space Organization.

It would be desirable to endow the Unified European Space Organization with powers for coordinating national programmes too, to derive maximum benefit from the modest resources Europe will be able to devote to space in the seventies.

6. GROWTH HYPOTHESES FOR THE 1970'S

The expenditures by EEC member countries, and of these together with the United Kingdom in the initial five year period of European space activity (1964-68), are tabulated below (in millions of dollars):

	1964	1965	1966	1967	1968
EEC	95	122	138	211	236
EEC + UK	124	164	204	276	280

Linear trends (least squares method) are as follows:

EEC	$86 million in 1964 + $37 million a year
EEC + UK	$125 million in 1964 + $42 million a year

Extrapolating the EEC curve for 1964-68, we get for 1980 an overall space expenditure of $680 million (Table 2/B-12).

Considering the annual rise of $37 million in 1968 and comparing systematically with growth of GNP in $million at values ($360,000 million in 1968 and annual growth rate of 5.4%) we arrive at a figure for space expenditure in 1968 of 0.1% of GNP.

This target was, it will be noted, attained and exceeded in 1967 and 1968 by France, i.e., the European country most

heavily engaged in space.
0.1% of GNP is little more than what the US allocated to the first five years of its space activity (1959-63) and rather less than half the figure allocated in the US during the succeeding five year period (1964-68) to unmanned civilian programme alone.

Hence it may be said that such a target figure (prognosticated by the Causse Report for 1975) represents a "minimum" target for an activity rationally limited to Europe's most essential and urgent needs.

Table 2/B-12 also gives an extrapolation to 1980 of the percentage distribution between national (57%) and international programmes (43%) in the EEC countries in 1968.

Among the international programmes the Spaey Report's "basic programme" is broadly slotted in at an overall expenditure of $1,800 million over 12 years.

Such a programme would absorb all the space resources earmarked for international collaboration up to about 1973; only during the succeeding period would it be possible to fix any growing availability of funds for future developments. Adding up the projections shown in Table 2/B-6 for the whole 12-year period 1968-80, we get the following volume of expenditure:

EEC countries only	International programmes	$2,364 million (incl. 1,800 million for Spaey's basic programme)	(43%)
	National programme	$3,132 million	(57%)
	Total	$5,496 million	(100%)

which could be distributed as follows:

$1,900 million for the aeronautics industry		(35%)
$1,900 million for the electronics industry		(35%)
$1,696 million for other industries, administrative costs and university research		(30%)

The inclusion of Spaey's "basic programme" among the international programmes, with a margin beyond 1972, helps to demonstrate the force of the hypothesized 0.1% of GNP target, leaving moreover each country's hands free for its national programmes.

Let us examine the hypothesis of the "minimum" target of 0.1% of GNP being reached in 1980 by all the EEC countries plus the United Kingdom (Table 2/B-13).

The total GNP ($473,000 million in 1968, with an annual growth rate of 4.8%) will by 1980 reach the $840,000 million mark (at 1968 prices).

The target of $840,000 million in 1968 would require an annual growth of expenditure of $47 million, appreciably higher than the average recorded during the five-year period 1964-68.

Table 2/B-7 shows an extrapolation to 1980 of the breakdown between national programmes (50%) and international ones (50%) for the EEC countries plus the UK in 1968. Among the international programmes the Spaey Report's "basic programme" is roughly slotted in about 1970. Adding together the projections in Table 2/B-13 for the whole decade 1968-80, we arrive at the following volume of space expenditure:

EEC countries + UK	International programmes	$3,324	million (incl. 1,800 million for Spaey's basic programme	(50%)
	National programme	$3,396	million	(50%)
	Total	$6,720	million	(100%)

which can be estimated as distributed in the following manner:

\$2,350 million	aeronautics	(35%)
\$2,350 million	electronics	(35%)
\$2,020 million	other industries, organizational costs and organizational research	(30%)

7. TECHNICAL ACTION

The Third European Space Conference (ESC), held at Bad Godesberg from 12 to 14 November 1968[1] drew up, on the basis of the Spaey Report and some delicate technico-political negotiations presided over by the Belgian Minister T. Lefèvre, the minimum European space programmes and the tasks to be set for them.

The deliberations of the third ESC constitute a coherent and integrated fresh start in the three space sectors of launchers, science and applications.

Implementation of the programme demanded urgently:

- the desired unification of the European space bodies;
- a firm collective long-term political commitment capable of giving a decisive boost to industry and the research centres. The story of America's space venture shows that the firmer the programmed commitment, the more severe and exigent the political leaders are likely to be towards industry, which is thus being afforded the chance to achieve such a clear cut expertise in technology and management.

If on the strength of the foregoing investment growth hypotheses there proves to be, from 1973 for the EEC or from

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[1] See text in Annex.

1970 for the EEC + UK, a further availability beyond the Spaey programme, consideration may be given to programmes for weather satellites or air traffic control satellites; or, to avoid a wearisome and constantly ill-starred policy of tagging along behind the US programmes, a direct transition to satellites for analysing earth resources. As in the telecommunications area, in the earth resources area too, the stimulus of economic independence plays a part as well as profitability.

Another investment area for European international programmes might be a committed start on space collaboration between the US, the USSR and Europe.

8. SPACE EXPENDITURE IN RELATION TO TOTAL R&D EXPENDITURE

Lastly we must show how the space target of 0.1% of GNP in 1980 is by no means incompatible with public R&D expenditure even disregarding the possible returns from commercialized space activities in Europe by 1980.

A realistic estimate for 1980 is of a public R&D investment of 2.5% of GNP, either in the EEC, or even more so, in the EEC + UK.

In that case the postulated space investment of 0.1% will be 4% of R&D expenditure.

Without arguing the merits of other advanced technologies, it is, however, obvious that another four areas for investment like space might be developed by assigning to conventional technologies 2% of GNP or 80% of R&D expenditure.

If the 0.5% of GNP could in this way be devoted in 1980 to the advanced technologies, about half on the national plan and about half on European cooperative projects:

- it would be much easier to find country by country a solution to the problems of fair returns, which otherwise remain unthinkable on a sector by sector basis;
- it would ensure a general technological upgrading which would in particular benefit the space sector, so eminently interdisciplinary.

Among the postulated five advanced sectors that might attract investment of 0.1% of GNP, it would be advisable by a European agreement to ensure that at least one should be presently released from commitments and ready in advance to take up the next technological challenge without the delays that have always hampered European initiative.

Indeed, it behoves the Europeans from now on to open their eyes in time, like their wide-awake transatlantic cousins, to future possibilities of cooperation with full public support at supranational level.

TABLES AND DOCUMENTS ANNEXED TO CHAPTER 2

Section B

The space activities

List of Tables

Table 2/B-1 USA - Military, Nuclear and Space Expenditure (1954-68)

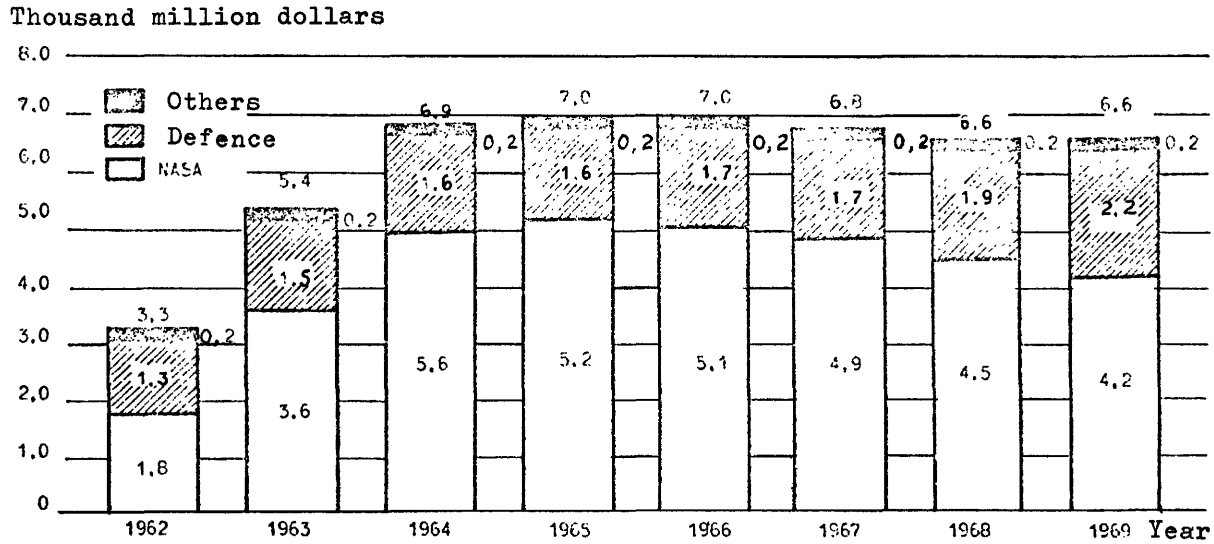
(Millions of dollars)

FISCAL YEAR	GNP	DoD	% GNP	AEC	% GNP	NACA/NASA	% GNP
1954	362,100	45,090	12.5	1,895	0,52	90	0.02
1955	378,600	38,840	10.3	1,857	0.49	74	0.01
1956	409,400	39,070	9.6	1,651	0,40	71	0.01
1957	431,300	41,380	9.6	1,990	0.46	76	0.01
1958	440,300	41,770	9.5	2,268	0.51	89	0.02
1959	469,100	43,940	9.4	2,541	0.54	146	0,03
1960	495,200	43,070	8.7	2,623	0,53	401	0,08
1961	506,500	44,780	8.8	2,713	0,53	744	0.14
1962	542,100	48,300	9.0	2,806	0.51	1,257	0,23
1963	573,400	50,000	8.7	2,758	0.48	2,552	0,44
1964	612,200	51,420	8.4	2,765	0.45	4,171	0.68
1965	653,500	47,540	7.3	2,625	0,40	5,093	0,78
1966	718,700	55,380	7.7	2,390	0.33	5,933	0.82
1967	763,100	68,330	8.9	2,264	0,30	5,423	0,71
1968 E	817,000	74,220	9.1	2,333	0.28	4,803	0,59

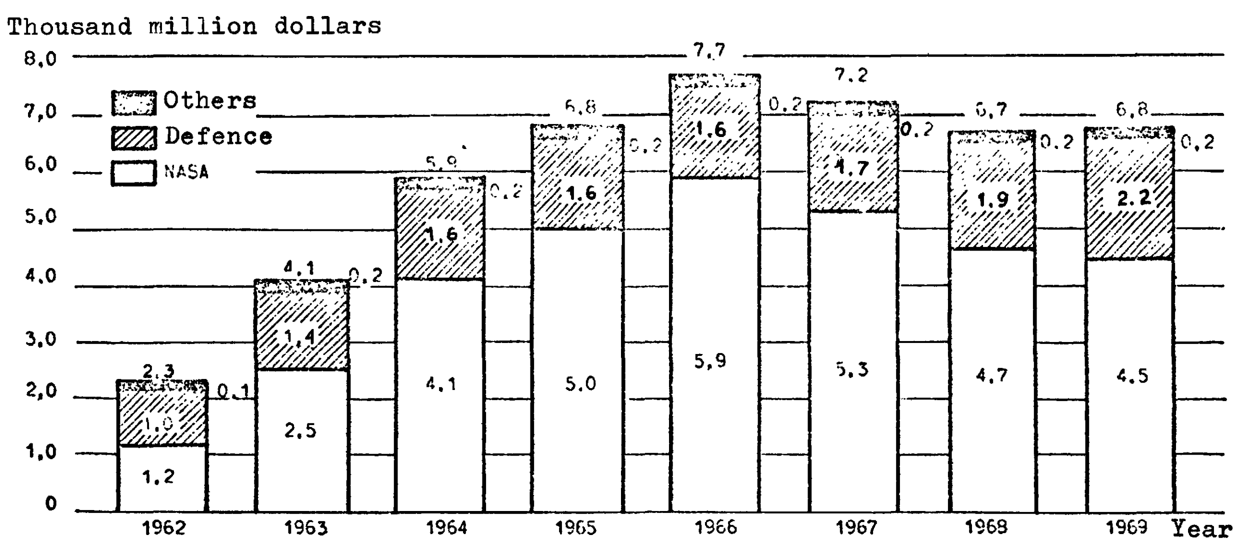
E- estimate

Source : THE BUDGET OF US GOV. FY 1969.

Table 2/B-2 USA - Space Budget - Appropriations (1962-69)



Space Budget - Expenditure (1962-69)



Source : REPORT TO THE CONGRESS USA AERON. AND SPACE ACTIVITIES 1967.

Table 2/B-3 USA - Space Expenditure (1957-69)

(In millions of dollars)

FISCAL YEAR	TOTAL NASA	SPACE				
		NASA	DoD	AEC	Others	Total
1957	76	n.a.	48	19	7	n.a.
1958	89	n.a.	136	20	4	n.a.
1959	146	59	341	33	1	434
1960	401	329	518	41	-	888
1961	744	694	710	64	-	1,468
1962	1,257	1,226	1,029	130	2	2,387
1963	2,552	2,517	1,368	181	13	4,079
1964	4,171	4,131	1,564	220	15	5,930
1965	5,093	5,035	1,592	232	27	6,886
1966	5,933	5,858	1,638	188	35	7,719
1967	5,423	5,337	1,673	184	43	7,237
1968 E	4,803	4,672	1,870	151	37	6,750
1969 E	4,573	4,455	2,180	151	40	6,826

E= estimate

Source : ASFF 1968.

Table 2/B-4 USA - Breakdown of NASA Expenditure by Final Use (1959-69)

(Total NASA expenditure = 100)

FISCAL YEAR	Administrative expenses %	R & D %	Equipment expenditure %
1959	60	23	17
1960	23	64	13
1961	21	66	13
1962	17	74	9
1963	16	75	9
1964	10	79	11
1965	11	79	10
1966	10	80	10
1967	12	83	5
1968	13	83	4
1969	14	84	2

Source : AIA: AEROSPACE FACTS AND FIGURES 1968.
NASA: SEMIANNUAL REPORT TO CONGRESS (various years).

Table 2/B-5 USA - Breakdown of NASA Expenditure by Programme (1962-69)

FISCAL YEAR	SPACE	
	MANNED	UNMANNED
1962	44	56
1963	57	43
1964	67	33
1965	70	30
1966	68	32
1967	66	34
1968	63	37
1969	56	44

Source : NASA: SEMIANNUAL REPORT TO CONGRESS (various years).

Table 2/B-6

USA - NASA Personnel (1958-69)

(Units)

	1958	1959	1960	1961	1962	1963	1965	1957	1968	1969
MANNED SPACE FLIGHT	-	-	5,367	7,180	9,840	11,860	14,380	14,510	13,896	13,896
* J.F. Kennedy Space Center (since 1962)	-	-	-	-	604	1,269	2,486	2,720	2,931	2,931
* Manned Spacecraft Center (since 1961)	-	-	-	1,146	2,392	3,364	4,391	4,704	4,579	-4,579
* Marshall Space Flight Center (since 1960)	-	-	5,367	6,034	6,844	7,227	7,503	7,086	6,386	6,386
SPACE SCIENCE & APPLICATIONS	216	1,117	2,178	2,229	3,288	3,945	4,086	4,300	4,183	4,338
* Goddard Space Flight Center	216	1,117	1,881	1,858	2,858	3,443	3,560	3,782	3,686	3,841
* Wallops Station (since 1960)	-	-	297	371	430	502	526	518	497	497
ADVANCED RESEARCH & TECHNOLOGY	7,930	7,994	7,765	8,534	10,585	11,880	12,414	12,417	12,064	12,214
* Ames Research Center	1,427	1,429	1,418	1,529	1,825	2,166	2,236	2,173	2,092	2,092
* Electronics Research Center (since 1965)	-	-	-	-	-	-	340	700	816	966
* Flight Research Center	306	360	416	494	568	618	629	590	566	566
* Langley Research Center	3,501	3,456	3,208	3,460	4,007	4,234	4,263	4,161	3,990	3,990
* Lewis Research Center	2,696	2,749	2,743	3,036	4,118	4,760	4,834	4,676	4,485	4,485
* Space Nuclear Propulsion Office (since 1961)	-	-	-	15	67	102	112	117	115	115
NASA headquarters	274	456	712	1,044	1,954	2,384	2,475	2,499	2,279	2,279
TOTAL	8,420	9,567	16,042	18,987	25,667	30,069	33,355	33,726	32,422	32,727

Table 2/B-7 USA - DoD Expenditure on Guided Missiles (1960-69)

(In millions of dollars)

FISCAL YEAR	TOTAL 1	R & D, TEST & EVALUATION 2	Procurements			
			Total 3	Air Force 4	Navy 5	Army 6
1960	5,086	2,059	3,027	2,021	423	583
1961	5,997	3,025	2,972	1,922	493	557
1962	6,219	2,777	3,442	2,385	593	464
1963	6,058	2,241	3,817	2,676	718	423
1964	5,929	2,352	3,577	2,101	981	496
1965	3,997	1,901	2,096	1,320	821	254
1966	3,870	1,801	2,069	1,313	512	244
1967	4,432	2,502	1,930	1,278	432	220
1968 E	4,562	2,438	2,124	1,320	390	414
1969 E	5,267	2,597	2,670	1,550	560	560

E.- estimate
1 - 2+3
3 - 4+5+6

Source : DoD Rep FAD 584585 /January 1968.

Table 2/B-8 **Space Investment in the EEC Countries, UK and USA** (1964-68)

(In millions of-dollars)

	1964			1965			1966			1967			1968		
	National	ELDO	ESRO	National	ELDO	ESRO	National	ELDO	ESRO	National	ELDO	ESRO	National	ELDO	ESRO
GERMANY	13,80	14.97	1,35	17.50	18,71	3,76	18.00	18,27	8.12	35.00	22.95	11,67	42.00	25.65	12,20
BELGIUM	0,51	1.94	0,26	0.59	2,42	0,73	0.75	2.37	1,59	0.80	3.83	1,79	1.10	4.28	1.87
FRANCE	32,20	16.27	1.21	39,25	20,34	3,08	44,00	19,86	6.89	78.35	21.25	9.68	86.10	23,75	10.10
ITALY	2,40	6.65	0,67	1,84	8,31	1,86	1,72	8.12	4.02	3.28	10,20	5,63	2.96	11,40	5,88
NL	0,58	1,60	0.25	0,68	2,24	0.70	0.91	2,19	1.53	1,10	3,83	1,94	2.20	4.28	2.02
EEC	49,49	41.63	3,74	59.86	52.02	10.13	65,38	50.81	22.15	118.53	62,06	30.71	134,36	69,36	32,07
UK	2,00	26,38	1,50	5.20	32.97	4.16	24.70	32.20	9,00	30.70	22,95	11.10	7.20	25.55	11,60
	NASA	DoD	Others	NASA	DoD	Others	NASA	DoD	Others	NASA	DoD	Others	NASA	DoD	Others
USA	4,131	1,564	235	5,035	1,592	259	5,858	1,638	223	5,337	1,673	227	4,672	1,870	168

Table 2/B-9 EEC Countries, UK and USA - Cumulative Space Investment in the Five-Year Period 1964-68

(In millions of dollars)

	National	ELDO	ESRO	TOTAL	% (EEC=100)
GERMANY	126.30	100,55	37,10	263,95	32,9
BELGIUM	3,75	14,84	6,24	24,83	3,1
FRANCE	279,90	101,47	30,96	412,33	51,4
ITALY	12,20	44,68	18,06	74,94	9,3
NL	5,47	14,34	6,44	26,25	3,3
EEC	427,62 (53,3%)	275,88 (34,4%)	98,80 (12,3%)	802,30 (100,0%)	100,0
UK	69,80 (28,2%)	140,15 (56,7%)	37,36 (15,1%)	247,31 (100,0%)	30,8
	NASA	DoD	Others	Total	
USA	25,033 (72.5%)	8,337 (24,2%)	1,132 (3,3%)	34,502 (100,0%)	4,300,0

Table 2/B-10 EEC Countries, UK and USA - Percentage of Gross National Product Allocated to Space Expenditure (1964-68)

	Average (1964-68)	Maximum
GERMANY	0.044	0,062 in 1968
BELGIUM	0.026	0.036 in 1968
FRANCE	0.078	0.104 in 1968
ITALY	0.024	0,029 in 1968
NL	0,024	0,036 in 1968
EEC	0.049	0.066 in 1968
U K	0.046	0,061 in 1966
USA	Average 1959-1963	Average 1964-1968
NASA (unmanned)	0,093	0,235
NASA (manned)	0,093	0.480
DoD	0.154	0.235
Others	0.018	0.030
TOTAL	0.358	0,980

Table 2/B-11 PROGRAMME SPAEY 1969-80

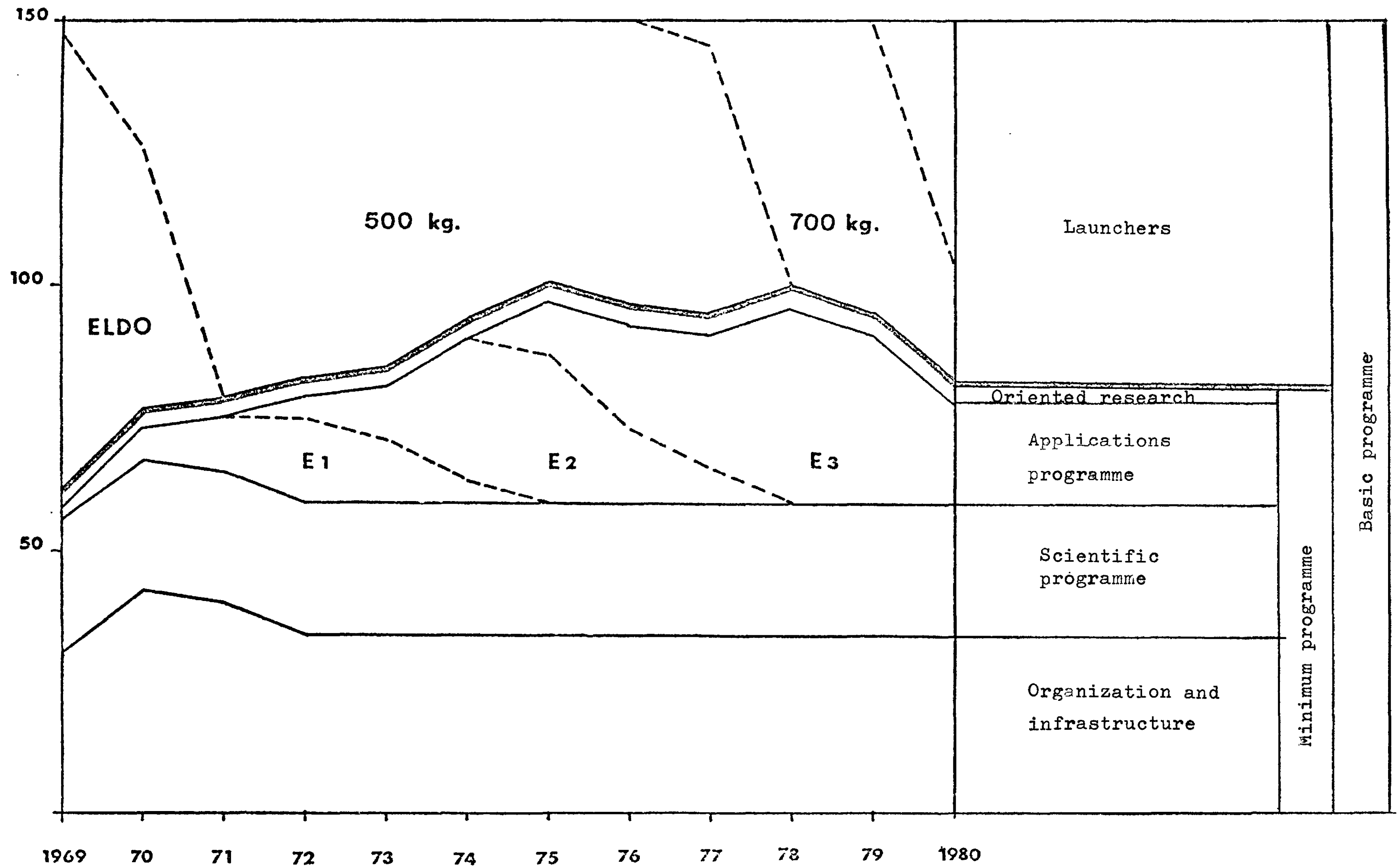


Table 2/B-12 Growth Hypotheses for Space Investment in the EEC Countries in the Seventies

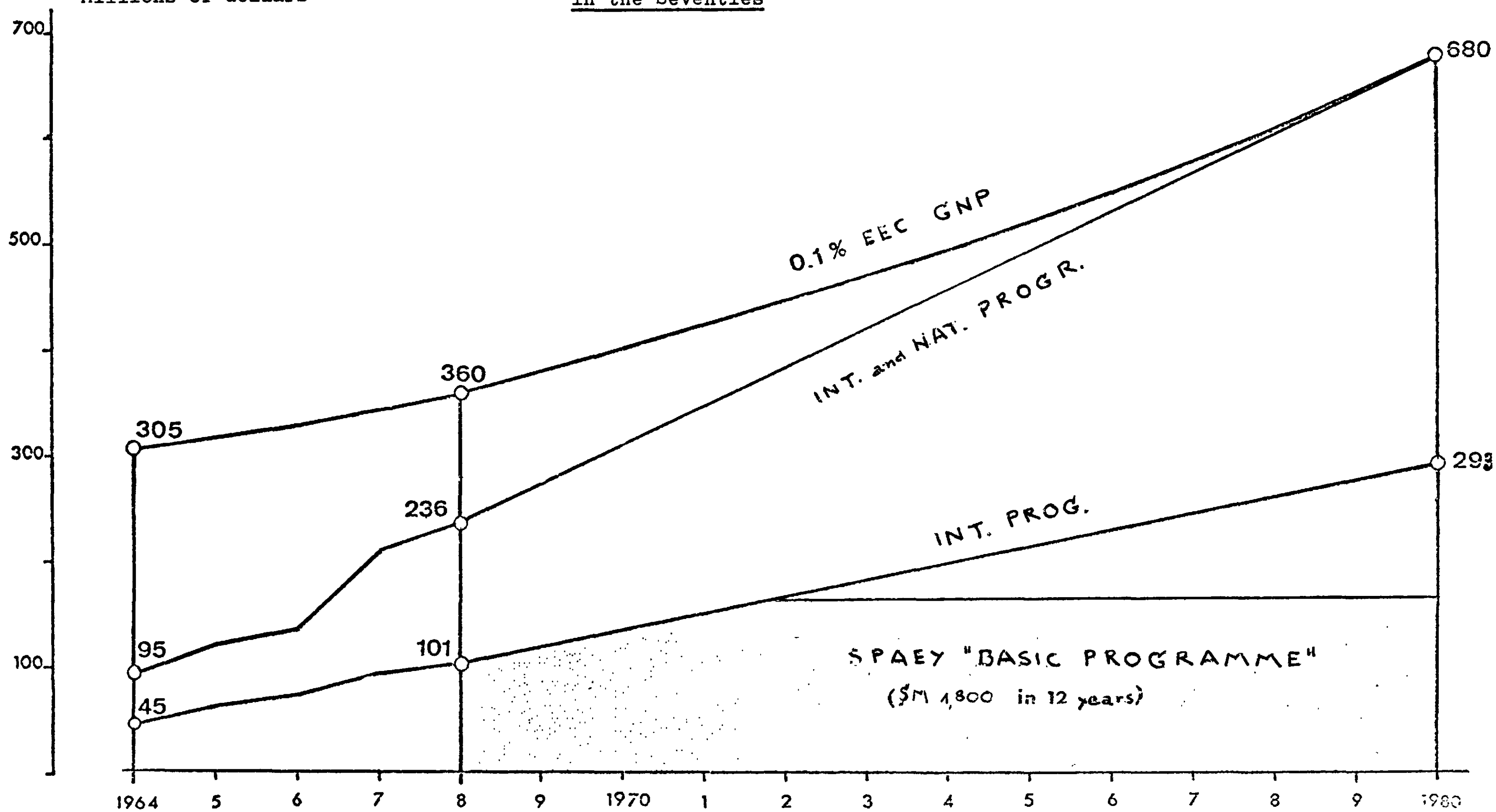
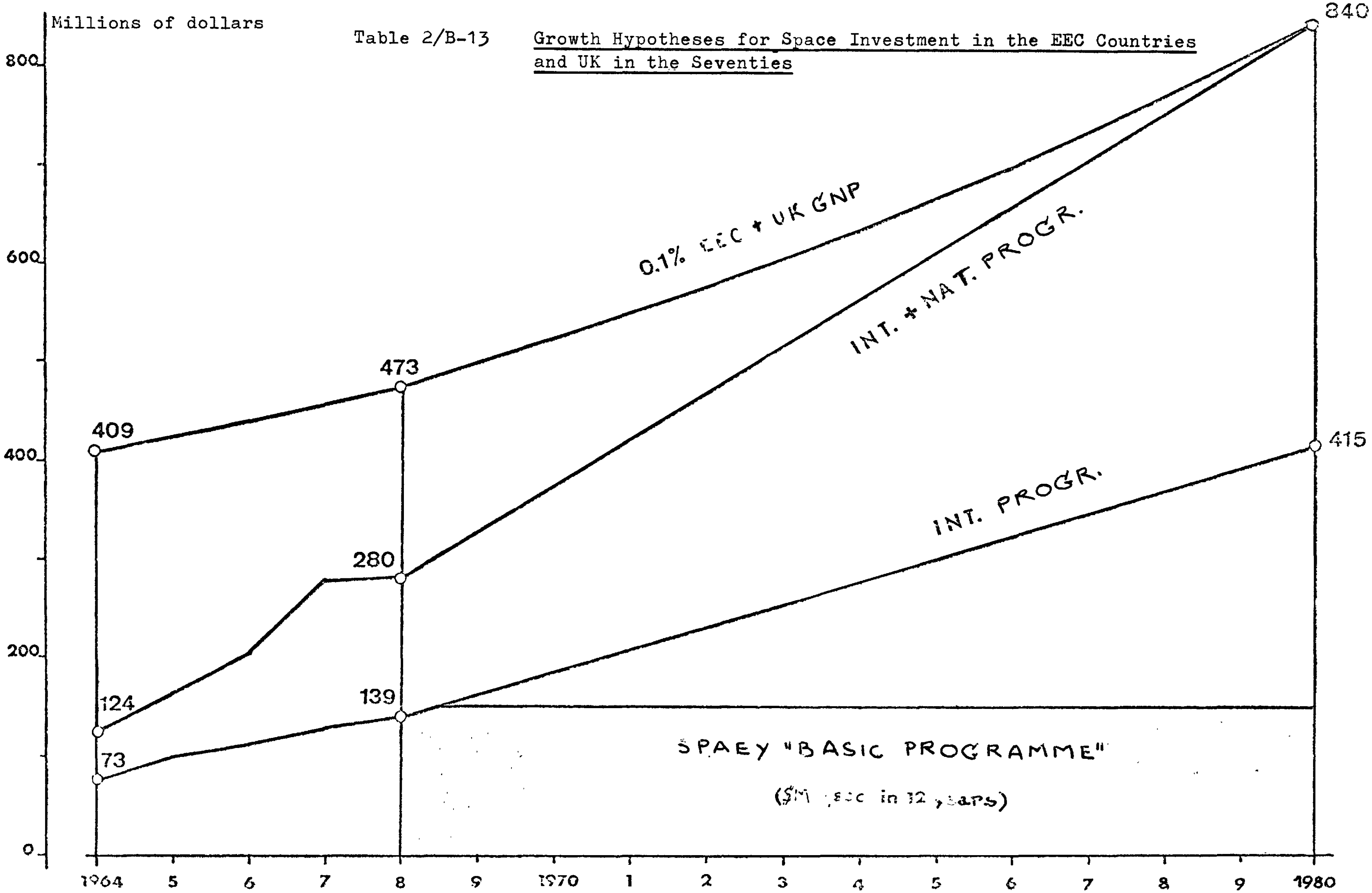


Table 2/B-13 Growth Hypotheses for Space Investment in the EEC Countries and UK in the Seventies



Resolutions adopted at the third ESC

(Bad Godesberg, 12–14 November 1968)

RESOLUTIONS ADOPTED BY THE EUROPEAN SPACE CONFERENCE

At the ministerial meeting of the European Space Conference held at Bad Godesberg on 12-14 November 1968, five resolutions were adopted. The text of these resolutions is given below, with the exception of the preamble to some of them, which is omitted for the sake of concision, and most references to working documents, also omitted to make easier reading. The voting results are given after each resolution.

Resolution No. 1 - Space programme

The Conference pronounces itself, pending a decision on a minimum and basic programme for a new and single organization, in favour of the following provisions:

1. Scientific and research programme

   ESRO shall continue within the provisions of its Convention a scientific research programme, the financial value of which shall, for the period of 1969-71, correspond to a firm ceiling of 172 million u.a. (at summer 1968 prices).

   The provisional ceiling for the period 1972-74 shall be determined by the ESRO Council, it being understood that any commitments for individual projects that would extend beyond 1971 can be authorized by the Council.

2. Space applications programme

   A space applications programme will be executed by ESRO on a preliminary basis up to the next European Space Conference, in close consultation with ELDO where appropriate, and by taking the advice of the Committee of Senior Officials.

   This programme consists in undertaking, in consultation with prospective users, studies leading to economic and technical assessments of application satellite projects such as meteorological satellites, satellites for air and sea traffic control, and satellites for other purposes, the financial value of these undertakings not to exceed on average 1 million u.a. per year, in preparation of timely decisions to be taken on the execution of such projects. The first studies shall be prepared by 31 December 1969.

It is intended to carry out a CETS experimental television relay satellite programme, the cost of which is estimated at 103 million a.a. Some governments have announced their interest in principle in such a project. The interested governments are invited to express their opinion as to the decision on their participation by 1 March 1969 and to forward it to the Director-General of ESRO and the President of CETS. A governmental conference of the interested States will take place in March/April 1969 in order to reach a decision on the execution of the project on the basis of the economic and technical information available.

3. Launcher development programme

The Conference takes due note of the Resolution adopted by the ELDO Ministerial Conference on 11 November 1968 (cf. Press release under the subtitle "News of ELDO").

The Conference also refers, in respect of the production and use of the launchers, to its Resolution No. 5.

The execution of the launcher programme will be pursued during the preliminary phase up until the next European Space Conference by ELDO in close consultation with ESRO where appropriate and taking the advice of the Committee of Senior Officials.

The Conference invites the Member States of the Conference to instruct their national delegations to the Councils of ESRO and ELDO and to CETS to take the necessary decisions in the technical, financial, legal and administrative fields, in order to ensure completion of the programme described above;

Decides to hold its next session in Brussels early in 1970 on a date to be proposed by the Committee of Alternates.

Voting results:

Section 1 (Scientific research programme)

11 in favour
1 reservation (Netherlands)
1 abstention (Norway)

Section 2 (Space applications programme)

10 in favour
1 ad referendum (Sweden)
1 reservation (United Kingdom)
1 abstention (Norway)

Section 3 (Launcher development programme)

9 in favour
1 ad referendum (Italy)**
1 reservation (United Kingdom)*
2 abstentions (Norway & Switzerland)

NB. Netherlands and Sweden have since withdrawn their reservations.

* See Annex 1.

** The position taken by Italy relates to the Resolution of the ELDO Ministerial Conference of 11 November 1968, which Italy only supported ad referendum. (See Press Release on this Conference, under the subtitle "News of ELDO".)

Resolution No. 2 - Institutions

The Conference considers that the implementation of a European space programme may be more efficiently secured by means of a single European space organization committing the solidarity of the participating States until the achievement of the objectives, and designed to allow great flexibility of participation in its projects.

Decides, in order to proceed in due course, if agreed, to the amalgamation of the existing organizations in a single body, to instruct a Committee of Senior Officials to work out the procedure and the text of a Convention for a single Organization, by 1 October 1969. This text shall be examined during a Governmental Conference of the participating States.

This Committee shall take into account all relevant proposals made so far, in particular the reports made by the Causse, Bannier and Spaey Committees.

Voting results:

12 in favour
1 abstention (Norway)

Resolution No. 3 - Europe's position towards international communications systems

The Conference takes note of the report of the Chairman of the European Conference on Satellite Communications (CETS), and in particular of the recommendations made by that Conference with regard to the further negotiations on the definitive arrangements and the participation of European States in a definitive telecommunications system.

Invites the participating States to give their representatives in the negotiations on the definitive arrangements the necessary instructions for the implementation of the recommendations set out in that document.

Voting results:

13 in favour

Resolution No. 4 - Principles of European cooperation in space

The Conference, noting that there exists in Europe a general desire to build competitive industrial structures by means of durable consortia backed by long-term programmes of technological and scientific cooperation, notably in the space field;

Recognizing the fact that, among the European countries, there are different opinions about the necessity of the development of European launchers;

Considering that this difference of conception is not of a nature to prevent the association of the European countries for the applications programmes, the scientific programmes, the relevant infrastructure and long-term research, provided that any divergences of interest arising between these countries in connection with the use of European launchers are covered from the outset by satisfactory arrangements;

Considers

1. That the basis of cooperation between the European countries should be the distinction of a minimum programme within a basic programme, the status of Member State resulting from recognition of the basic programme and from effective participation in a minimum programme to be defined in detail in the Convention;

2. That the basic programme should be the subject of a detailed study with the participation of all the interested countries and after thorough technical and economic studies;

3. That the principal objectives of the basic programme could be:

(a) to construct, launch, experiment and put into operation a synchronous satellite capable of re-transmitting television programmes to individual receivers; a two-ton satellite to be launched in the 1980s could be the last stage in the achievement of this objective if, however, such a stage appeared viable and necessary;

(b) to develop a scientific research programme, for carrying out in particular missions that surpass national possibilities; maximum possible use should be made of the results of the scientific programme for the applications programme and vice versa;

4. That the initial adoption of the basic programme and of the minimum programme being secured by unanimity upon signature of the Convention, the solidarity of Member States should be committed until achievement of the objectives and that the decisions on successive stages should then be made according to the rules (still to be decided after further negotiations) which the Convention shall determine and on the basis of a detailed study of the validity of these successive stages in the light of the overall programme.

Instructs the Committee of Senior Officials set up by Resolution No. 2 to carry out the studies referred to above.

Voting results:

11 in favour
1 reservation (United Kingdom)*
1 abstention (Norway)

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* Cf. Annex 1.

Resolution No. 5 - Production and use of European launchers

The Conference, having agreed that:

1. The funds expended by the European governments for the purposes of European space research in joint organizations should be predominantly used inside Europe with a view to strengthening Europe's technological capacity;

2. With a view to consolidating and extending cooperation among the European governments in all areas of a European space activity, mutual use should be made of the development results of individual sectors;

3. Insofar as it is possible for the aims of the individual programmes to be accomplished, the projects of the different fields should be brought into harmony;

Resolves that:

1. European States interested in the field of launcher development will continue with the development of a European launcher, with a view to making such a launcher available for European application satellites (including those forming part of test programmes) and, as far as mission and payload requirements allow, scientific satellites;

2. Such States will continue with the development of the European launcher either within the framework of ELDO or within the framework of the new research and development organization referred to in Resolution No. 2. It is assumed that, over the period 1972-76, the European countries will undertake, on average, two launchings per year;

3. As regards the European scientific programme, it is, however, essential neither to make undertakings that will prejudice the scientific value of the programme nor to omit the use of the European launcher where this is compatible with the

scientific mission. On the basis of the outline programme proposed on the understanding of financial limits set out in the report by the Director-General of ESRO, it is clear that at least one, and at the most two European launchers, can be used by 1976;

4. The launchings with proven launchers shall be supplied at a reasonable price, based on their economic value and their cost price, by applying the following formula:

   (a) the price of the European launchings shall be compared with the price at which comparable non-European launchings could be purchased on the basis of a genuine, durable and commercial supply. The latter supply is one which is not subject to any conditions of a prohibitive character;

   (b) any price difference will be divided in equal parts between, on the one hand, the producer member countries and, on the other hand, all the countries taking part in the satellite project, it being understood that in no case the latter will be asked to pay a difference higher than 25% of the price of comparable non-European launchings.

Voting results:

8 in favour

1 reservation (United Kingdom)*

4 abstentions (Denmark, Norway, Sweden and Switzerland)

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* Cf. Annex 1.

Annex 1 - Resolution concerning the principles of European cooperation in space, proposed by the Belgian Delegate (United Kingdom reservation)

The United Kingdom acceptance of Resolution No. 4 involving its commitment to the minimum programme, which will permit its wholehearted participation in the applications programme, the long-term technological research programme and the proposed launcher use arrangements (in addition to its declared commitment to the expanded scientific research programme) is conditional upon its release from its existing financial commitments to ELDO.

NB. Although this reservation is maintained, the United Kingdom has since the Conference notified its readiness to contribute in 1969 to the special budget for application studies (cf. Resolution No. 1, Section 2, second sub-paragraph).

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