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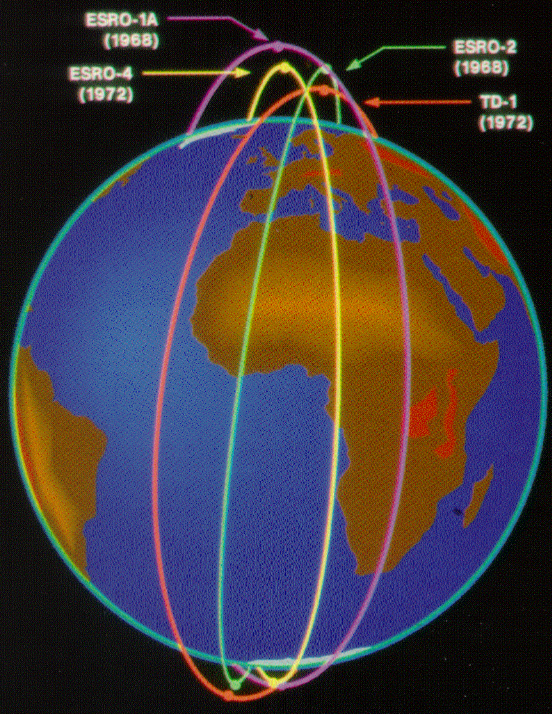
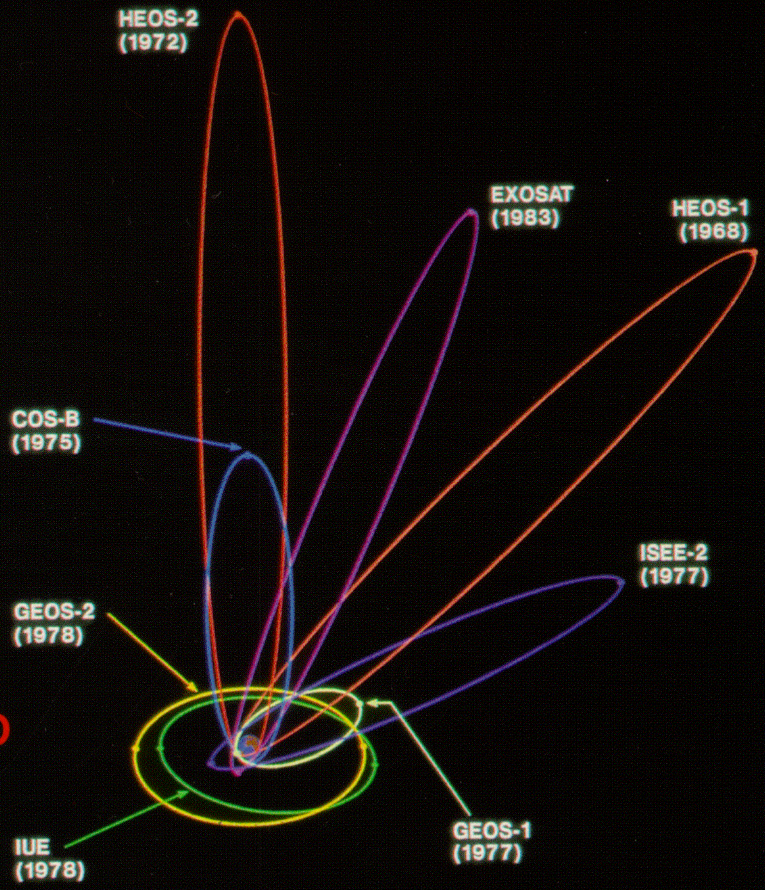
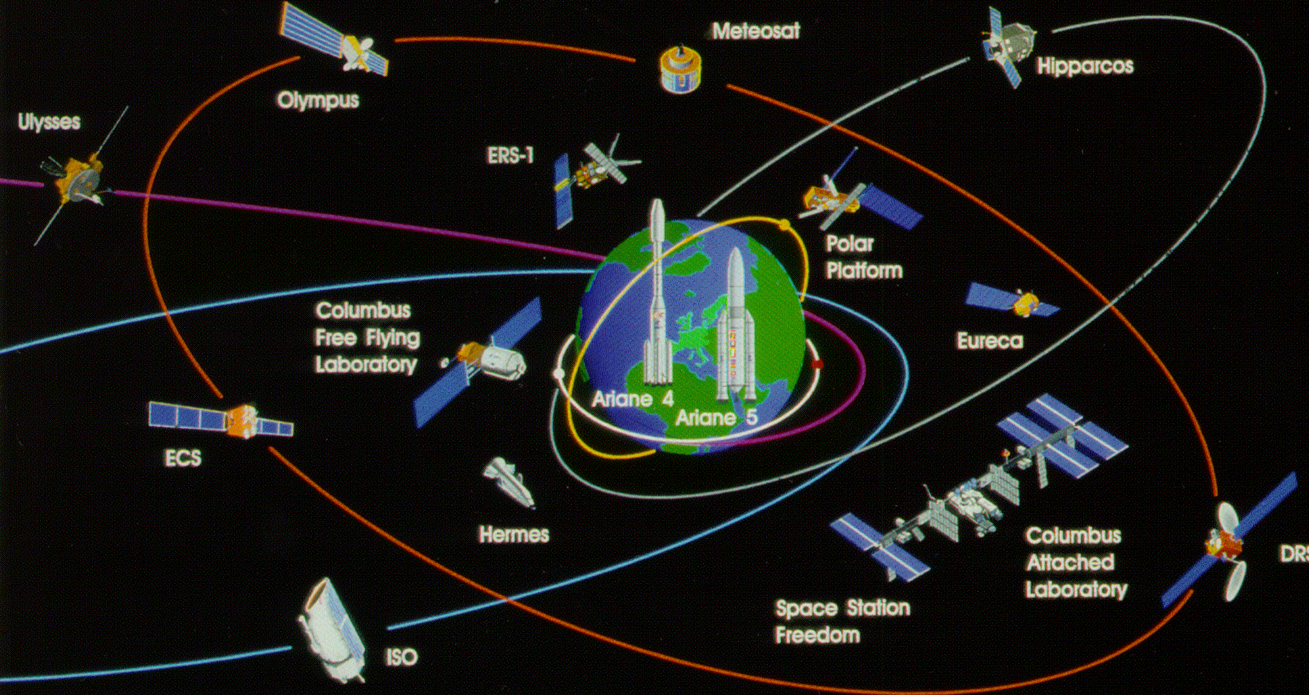




The early development of the Telecommunications Satellite Programme in ESRO (1965-1971)

by Arturo Russo



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The ESA History Study Reports are preliminary reports of studies carried out within the framework of an ESA contract. As such they will form the basis of a comprehensive study of European Space activities covering the period 1959-87. The authors would welcome comments and criticism which should be sent to them at the appropriate address below.

The opinions and comments expressed and the conclusions reached are those of the authors, and do not necessarily reflect the policy of the Agency.

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THE EARLY DEVELOPMENT OF THE TELECOMMUNICATIONS SATELLITE PROGRAMME IN ESRO (1965-1971)

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Arturo Russo

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THE EARLY DEVELOPMENT OF THE TELECOMMUNICATIONS SATELLITE PROGRAMME IN ESRO (1965–1971) [1]

Arturo Russo

> Europe's initiative in the field of telecommunications satellites is a story of political determination, of industrial motivation and of high tech employment. It is a story of technological leapfrogging – we were at least ten years behind the United States when we started. It is also a story of national feelings and competition, the pendulum swinging between cooperation at a European level and egocentrism at the national level. It is still swinging today. And it is a story of confrontation between the USA and Europe.[2]

The European Space Research Organization (ESRO) was created in the early 1960s as an organization solely devoted to space science. Its convention, in fact, made no reference to the possibility of carrying out work on application satellites such as for telecommunications, meteorology, navigation, etc.[3] At the end of 1966, however, after a request from the European Conference on Satellite Communications (known by its French initials CETS), the ESRO Council accepted to undertake "a six-month study to evaluate the technical and financial implications involved in the development and launching of a few experimental communications satellites and to indicate other developments of interest in the

[1] This paper is mainly based on the ESRO documents included in the ESA collection at the Historical Archives of the European Communities, European University Institute, Florence. Most of these documents (as well as those of ELDO) are arranged in a master set according to their date and code number, and we do not need to refer to specific folder numbers. Other useful documents related to the early history of the ESRO telecommunications programme have been located in a few files from the ESRO Directorate specially devoted to ESRO/CETS relations. Proper reference to these will be given when necessary. I wish to thank Mr. G. Bonini, of the Florence Archives for his help in locating these files. I also wish to thank M.me M.A. Lemoine for her help in the main library at ESA Headquarters, Paris.

[2] Collette (1992), p. 83.

[3] On the birth of ESRO and its first programme, see Krige (1992a) and (1993), and Russo (1992a).

field of application satellites."[4] This event marked the beginning of ESRO's involvement in the field of application satellites, in particular in what appeared as the most promising sector from the commercial point of view, namely communications satellites. Today the telecommunications programme demands about 10 per cent of the budget of the European Space Agency (ESA), the Organization which succeeded ESRO and ELDO (the European Launcher Development Organization) in 1975. The percentage rises to about 20 per cent with the inclusion of the other main application programme, earth observation, to be compared to the 9 per cent devoted to the scientific satellite programme.[5] The last satellites developed within these two application programmes, the communications satellite *Olympus*, launched in 1989, and the earth observation satellite *ERS-1* (*Earth Resources Satellite*), launched in 1991, are by far the most expensive in the ESA satellite family. Their cost in fact is over 700 MAU, i.e. twice the cost of *Hipparcos*, ESA's space telescope for astrometric measurements, and 4.5 times the cost of ESA's scientific space probes *Giotto* and *Ulysses*.[6]

At the time when ESRO undertook its studies on behalf of the CETS, the first experimental phase of satellite telecommunications was at its end. The American satellites *Telstar* (1962) and *Early Bird* (1965) had well demonstrated the technical feasibility and economic profitability of space links for long distance telephony; and the first television transmissions across the oceans and continents had dramatically shown the social relevance of live TV on a planetary scale. Plans were under development to build a satellite system for global coverage of the earth. It took several years however for the European space organization to go from those preliminary studies to the start of the first development programme. It was only at the end of 1971 that the ESRO member states definitely approved that the organization be formally engaged in a communications satellite programme and provided the necessary funding. The analysis of this difficult beginning of

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[4] ESRO, *General Report*, 1966, p. 12.

[5] ESA, *Annual Report*, 1991. By far the highest percentage of the ESA budget was demanded by the space transportation programme, about 43 per cent.

[6] The acronym MAU stands for Million Accounting Unit, ESA's conventional monetary unit based on a gold standard. In the period covered by this paper, its value was about 1 US dollar. *Giotto* is the name of the well-known space mission to Halley's comet in 1986 and *Ulysses* is the name of the spacecraft launched in 1990 into an orbit extending outside the ecliptic plane to observe the solar poles.

ESRO's telecommunications programme is the subject of this paper. In a later paper we will discuss the actual implementation of this programme up to 1978, when the first experimental satellite (*OTS-2*) was successfully launched.[7]

The transformation of ESRO from an organization solely devoted to scientific research into one involved in application programmes as well was not the main reason for this long delay. On the contrary, the ESRO staff was much interested in the new undertaking and was soon ready to integrate the new tasks into the managerial and technical framework of the Organization. Nor were the national delegations in the ESRO Council worried about this sort of "genetic change": by the mid-sixties it was evident that pure research alone was not the only good reason for launching satellites (leaving apart military interests) but important economic and commercial aspects were also involved. And it made no sense to create a new organization to cover these aspects when one existed already that had proved its capability and reliability. Space scientists did express concern and even opposition, fearing that work on applications would jeopardize the scientific programme, but they could hardly resist the drift.

The reason why it took five years to start a telecommunications programme in ESRO lies rather in the political and institutional framework in which such a programme had to be defined and agreed on, namely the possible definition of a coherent space policy for Western European countries. Defining a strategy in satellite telecommunications implied in fact important choices regarding international relations, industrial policy, defence of economic and commercial interests, control of areas of cultural influence. Does Europe need a space policy defined at continental level, how is coherency defined at this level, what is the place of telecommunications in this frame? Answers to these questions were different in different countries, because governments had different visions of Europe's role in a USA-USSR dominated world and because various interest groups held conflicting views about the importance and mutual relationship of the various sectors of space activities - science, telecommunications and other application fields, and launchers.

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[7] The first OTS satellite was lost in September 1977 due to the failure of the *Thor-Delta* rocket. ESRO's first application satellite successfully in orbit was thus the meteorological satellite *Meteosat*, launched in November 1977.

The long and controversial process which led to the adoption of the telecommunications programme in ESRO, the story we are telling in this paper, is but one aspect of the emergence of such a European space policy out of the experience of ESRO and ELDO. The compromise reached at the end of 1971, which we discuss in the last section of this paper, cleared the situation regarding ESRO and finally gave a start to the telecommmunications programme. It did not resolve the main controversial issue, however, namely whether Europe should develop and use its own rockets to launch its application satellites or rely on American launchers. To answer this question required two more years of difficult negotiations whose outcome marked the origin of the European Space Agency.

THE BEGINNING OF THE SPACE TELECOMMUNICATIONS ERA

The prophet

In the ideal portrait gallery of satellite telecommunications the first place would be occupied by one of the world's best-known and bestselling popular science writers: Arthur C. Clarke, the author of *2001: A Space Odyssey*. A prophet of the space age and an amateur communications scientist, Clarke suggested for the first time, in an article published in 1945, the idea of geo-synchronous communications satellites. In that article, Clarke noted that a satellite in an orbit with a radius of 42,000 km (i.e. 36,000 km above the earth's surface) has a period of exactly 24 hours:

> A body in such an orbit, if its plane coincided with that of the earth's equator, would revolve with the earth and would thus be stationary above the same spot on the planet. It would remain fixed in the sky of a whole emisphere and unlike all other heavenly bodies would neither rise not set.[8]

If a space station were built in this orbit, continued Clarke, and were equipped with suitable receiving and transmitting equipment, it could act as a repeater to relay transmissions between any two points in the hemisphere beneath. Moreover, a transmission originating from any point on the hemisphere could be broadcast to

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[8] Clarke (1945), as reprinted in Pierce (1968), p. 38.

the whole of the hemisphere itself, "and thus the requirements of all possible services would be met." Three satellite stations would ensure complete coverage of the globe (Fig. 1).

Clarke wrote his article twelve years before the first artificial satellite of any kind was actually launched, and space stations appeared to most people not far from real science fiction. At that time, the only way to provide long distance telephone communications was by high-frequency radio waves. Long submarine cables in fact, established since 1858 for telegraphic communications across the Atlantic, could transmit the dot and dashes of telegraph messages but were unsuitable to handle the high-frequency signals required to transmit the fine modulations of the human voice.[9] Fortunately, radio waves are reflected by the ionospheric layers of the atmosphere and by the earth's surface, thus allowing the transmission of signals along the curved surface of our planet by a series of successive reflections. The transmission, however, suffered from the irregular behaviour of the ionosphere and its quality depended on such phenomena as weather conditions, solar flares and magnetic storms. Establishing a voice circuit always required the great skill of operators, and often was much disturbed.

Unsatisfactory though long-distance telephony was in 1945, the position of the new-born television was far worse, as Clarke stressed in his article. In order to transmit images, in fact, much higher frequencies are required than to transmit sound, and the corresponding waves are not reflected by the ionosphere. A complex network of VHF repeaters in sight of one another was thus required to provide television coverage over a large area, while coverage of a whole continent appeared prohibitively expensive and transoceanic links impossible.

In the second half of the 1950s the situation of long-distance telephony changed significantly, thanks to the great technical advances in electronics stimulated by World War II. The first transatlantic telephone cable (TAT-1) went into service in 1956, and it was soon followed by a succession of transoceanic cables of ever-increasing capacity. Then, in the following two decades, transistors replaced the vacuum tubes and it became possible to handle several thousand

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[9] A popular account of the wiring of the Oceans for communications purposes is in Clarke (1992).

voice circuits in a single telephone cable.[10] Cable television came later but it is still limited to limited land regions.

The laying of the first transoceanic telephone cables happened just when the launch of the first satellites made Clarke's vision appear to be a real possibility. In fact, the competition between these two communication systems started from the very beginning. Satellites have three obvious advantages over cables. Firstly, they allow multiple access from several ground stations (fixed or, eventually, mobile) while cables can only provide point-to-point circuits; secondly, the cost of satellite circuits is independent of the distance of the earth stations while the cost of cable circuits increases with their length; finally, satellite transmissions can leap over physical and political barriers that can hardly or cannot at all be passed by cables. On the other hand, the advocates of cables argued that the technology of satellite telecommunications was still in its infancy while cables had a century-old history behind them. Live world-wide television, direct calling service to and from any place on earth, and the need to transmit huge amounts of data in real time were still in an uncertain future, while the high costs, technical difficulties and not rare failures of satellites and launchers were in the actual present. Any forecast about the future demand of long-distance telephone circuits and TV channels was unreliable and no guarantee existed that the enormous investment required to realize an operational system could be profitable from the commercial point of view.[11] And if satellite telecommunications could overpass geographical and political barriers, their massive use implied nevertheless a strong dependence on those very few countries which had the technological and financial means to build such satellites and, principally, to launch them into the suitable orbit.

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[10] The TAT-1 cable had an initial capacity of 36 voice circuits and it was thought that this would be enough to carry all the transatlantic telephone traffic for some years ahead. In fact, the demand for calls grew very rapidly and the cable was fully loaded almost from the day it went into service. By the time of the launch of *Early Bird* (1965), the new, high-performance TAT-4 cable had a capacity of 408 voice circuits. In 1982 the individual submarine cable capacity was 4000 circuits. These data are respectively from Dalgleish (1989), p. 6; Smith (1976), p. 152; and Astrain (1984), p. 3.

[11] As an example of the difficulty of foreseeing future trends, we can note that, according to Galloway (1972), in 1961 there were only 550 overseas telephone circuits and the projected global need for 1980 was about 8000 circuits. As a matter of fact, a single *Intelsat V* satellite, the first of which was in fact launched in 1980, had a traffic capacity of 12,000 circuits plus two TV channels. And in 1982, the total world transoceanic telephony service amounted to 40,000 circuits: Astrain (1984), p. 3.

Finally, one must not forget that big investments had been made in the communications business and therefore the competition between cables and satellites also involved important economic and commercial interests.[12]

The first experimental communications satellites: Echo, Telstar, Syncom

The importance of satellites for military communications was recognized from the very beginning of the space age. The first programmes were started by the U.S. Department of Defence as early as 1958 and in December that year an *Atlas* rocket launched the first communications satellite, SCORE (Signal Communications by Orbiting Relay Equipment). It recorded a transmission at a frequency of 150 MHz while passing over one earth station and then played it back at 132 MHz when requested by another station. The maximum message length was 4 minutes, and the spacecraft capacity was either one voice channel or seven teletype channels. The satellite was used to broadcast a tape recording of a Christmas message from the U.S. President D. Eisenhower and this first "voice from space" dramatically demonstrated the potential of communication satellites.[13]

SCORE was followed in 1960 by another military satellite, *Courier*, an improved version of the delayed repeater Score-type satellite. NASA, on its part, also developed a satellite telecommunication programme based on the passive satellite *Echo*, an orbiting balloon 30 mt in diameter, made of plastic coated with alluminium and used as a passive reflector of telephone and television signals at a height of about 1500 km. The first *Echo* satellite was launched in August 1960 and a second one, somewhat larger and more rigid, followed in January 1964. *Echo I* provided the first real-time satellite transmission of a transatlantic signal between America and Western Europe; *Echo II* performed communications experiments between the United States and the Soviet Union.[14]

For the general public the era of space communications was actually opened on 10 July 1962, when a *Thor-Delta* rocket launched *Telstar I*, the first real-time

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[12] Kinsley (1976) has analysed how interest groups linked to the common carriers in the United States have endeavoured to control innovation in the field of satellite telecommunications in order to protect investments in traditional cable facilities. See also Galloway (1972), p. 148.

[13] Smith (1976), pp. 49-50.

[14] On NASA's passive satellite experimentation see Smith (1976), pp. 51-55.

transponder, designed and built for NASA by the American Telephone and Telegraph Company (ATT). Two weeks after launch this satellite provided the first live broadcast of television images across the Atlantic, and less than one year later, in May 1963, *Telstar II* established an analogous connection over the Pacific between the USA and Japan.[15]

The *Telstar* satellite weighed 80 kg and presented itself as a sphere with a diameter of about 1 m (Fig. 2). It was launched into a low elliptical orbit inclined at approximately 45° to the equator, with perigee at about 1000 km and apogee at about 6000 km. The period of the orbit was 158 minutes. The communications equipment was based on frequency modulation (FM) of the radio-frequency (RF) carrier: a frequency of 6.39 GHz was used for ground-satellite (uplink) transmissions and 4.17 GHz for satellite-ground (downlink) transmissions. This choice of frequencies, which set the precedent of the 6/4 GHz operation, derived from the fact that they were widely used by terrestrial microwave systems (microwave radio communications, radar) and therefore much of the technical hardware required was already well developed.[16]

NASA's Telstar and Relay projects were research and development projects whose aim it was to demonstrate the technical feasibility of satellite telecommunications and to provide information for the eventual design of operational systems. All these satellites were placed in near-earth orbits and each of them was therefore visible simultaneously to widely-separated earth stations

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15 NASA was also involved in another active communications satellite project, *Relay*, in collaboration with the Radio Corporation of America (RCA). The first satellite of this project, *Relay I*, was launched in December 1962, followed in January 1964 by *Relay II*. Although overshadowed by publicity surrounding the *Telstar* satellite, *Relay* was NASA's most advanced communications satellite before adoption of the entirely new *Syncom* design. Smith (1976), pp. 80–83.

16 An RF carrier is an electromagnetic wave used to transmit some kind of information (voice, video pictures, or data) through free space. The information is recorded by modulating either the amplitude of the carrier wave (AM) or its frequency (FM). In the latter case, that used for satellite communications, the frequency modulation is operated within a bandwidth centered at the carrier frequency and lying within the particular range of frequency band assigned to the transmission. Frequency bands are allocated for various purposes by the International Telecommunication Union (ITU), a United Nations Agency located in Geneva, Switzerland. The 6/4 GHz uplink/downlink operation is within the so-called C band, a band that has the great advantage of having the minimum combination of natural and man-made noice sources. Useful textbooks on satellite communication technology are Pratt & Bostian (1984), Elbert (1987) and Dalgleish (1989). An historical account of the technical development of communications satellites is in Fordyce (1986).

for only a few relatively short periods each day. As a consequence, a large number of such satellites were needed in order to have at least one in the sky at any given time and thus to provide full-time service. Moreover, earth stations had to be equipped with two separate steerable antennas, in order to receive signals from one satellite and to relay them to another. On the contrary, a single geostationary satellite like that envisaged by Clarke could be seen 24 hours a day from about 40 % of the earth surface, and this made it possible to provide direct and continuous communications between a large number of widely separated stations, each equipped with one fixed antenna. Two main problems presented themselves, however, to those who advocated a telecommunications system based on geostationary satellites. The first was the availability of powerful enough rockets to lift heavy payloads to the required altitude of 36,000 km. The second was the foreseeable difficulty in telephone conversations caused by the time delay (about half a second) in the transmission of signals from an earth station to another and back again via such a distant satellite. To these technical problems one should add the then complete ignorance about the environment of the geostationary orbit and the concern that the satellite could not survive long enough to be useful.

The launch by NASA of *Syncom II*, on 26 July 1963, proved that the first problem had a solution even with the then existing rockets. The solution in fact came from two young engineers of Hughes Aircraft Company, H. Rosen and D. Williams, and consisted in launching the satellite into a low-altitude circular orbit in preparation for two major boosts in velocity. The first was provided by the last stage of the rocket and injected the spacecraft into an elliptical "transfer orbit," with the apogee at the geostationary altitude of 36,000 km. From the transfer orbit apogee the satellite could then be injected into a circular orbit at the requested distance from the earth by firing a solid rocket motor ("apogee motor") on board the spacecraft. Small liquid mono-propellant rockets were used to adjust the position and orientation of the spacecraft in the orbit, and a controlled spin system kept the satellite antennas pointed at the earth at all times.[17]

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[17] Podraczky (1979), p. 39; Smith (1976), p. 58-60 and 83-87; Fordyce (1986), pp. 202-203. The *Syncom* project was a joint project of NASA and the Department of Defence; the technical design and the construction of the satellite were realized by Hughes Aircraft Company. The first *Syncom* satellite was launched on 14 February 1963 but it was unsuccessful.

Syncom II (Fig. 3) was the first experimental geosynchronous communications satellite (actually the first geosynchronous satellite of any kind) but its orbit had an inclination of 32°, which caused a daily north–south excursion of the satellite. Its mass was only 39 kg, which was the maximum capacity of the *Thor Delta* rocket at that time, and it was able to relay several voice circuits or one television channel between earth stations provided with large antennas. This satellite had the tragic distinction of carrying across the Atlantic, on 22 November 1963, the television images of the assassination of President J. Kennedy. The next satellite in this series, *Syncom III*, was launched in July 1964 and the orbit inclination was now reduced to zero, so that the satellite was in the earth's equatorial plane and was truly geostationary. The satellite was used to transmit television pictures from the Tokyo Olympic Games in August that year.

The *Syncom* project demonstrated the feasibility of placing satellites in geostationary orbits and maintaining precise station–keeping and attitude control. These two simple, lightweight, spin–stabilized satellites dramatically added new evidence of the political and social importance of world–wide tele-communications, and showed the great economic value of satellite technology for telephony and television. By the end of 1964, in fact, the first demonstration phase of satellite telecommunications was coming to an end and the time was ripe for starting commercial ventures.

Comsat, Intelsat and the beginning of commercial satellite telecommunications

While the engineers were experimenting, the future of satellite tele-communications was also discussed at the political level in the United States. In 1962, after a long period of difficult negotiations involving NASA, industrial lobbies, the Congress and the White House, Congress passed the Communications Satellite Act. By this act, the realization and exploitation of commercial systems for international satellite telecommunications was entrusted exclusively to the newly created Communications Satellite Corporation (later known as *Comsat*), whose ownership was shared in equal parts between the main American communications companies (ATT, ITT, RCA, etc.) and private investors (among which the aerospace industries). While formally a private corporation, Comsat had been created in pursuance of the U.S. national policy in the field of satellite telecommunications and this was reflected in its statute: in fact, three members of the Board of Directors were nominated by the U.S. president, and controls and regulatory powers were entrusted to the Federal Communications Commission (FCC) and the State Department.[18]

The task of Comsat was twofold. Firstly, it had to determine the feasibility of a commercially valuable communications satellite system, and eventually to develop such a system. Secondly, as the system could only be international, it was mandatory for Comsat to involve as many countries as possible in the project and to work out a suitable institutional framework. In order to fulfil the first task, Comsat placed an order with Hughes, the builder of the Syncom satellites, for a geostationary satellite to be used as a demonstration system of such a technology from the commercial point of view. As to its second task, Comsat undertook an important effort to encourage international participation in the new venture.[19] The result of this effort was the formal signing, on 20 August 1964, of the Interim Agreements that established the International Telecommunications Satellite Consortium, later known as *Intelsat*, whose task it was "to design, develop, construct, establish, maintain, and operate the space segment of a single global commercial communications satellite system."[20]

The Intelsat agreements were signed by 13 nations plus the Vatican City but the membership grew rapidly, reaching 48 by the end of 1965, 63 in 1968, and 83 in 1972.[21] The agreements consisted in fact of two different documents: an intergovernmental treaty covering organizational principles and arrangements for an international communications satellite system; and a Special Agreement signed by national entities responsible for telecommunications, dealing with the operating

[18] The political process leading to the approval of the Communications Satellite Act and the creation of Comsat is discussed by Galloway (1972), pp. 47–73, and Smith (1976), pp. 93–120. See also Kinsley (1976), pp. 1–25.

[19] International cooperation in satellite telecommunications had already been established by NASA and ATT in the framework of the Echo, Relay and Telstar projects, in order to build and operate ground stations in a few western European countries.

[20] Colino (1984), p. 61. The negotiations leading to the Intelsat agreements are extensively discussed in Galloway (1972), pp. 75–104, and Smith (1976), pp. 121–141. The term "space segment" refers to the satellites, their launching, and their tracking and operation in orbit. The parallel term "ground segment" refers to the earth station network used to access to the satellite communications system in order to assure the requested services (telephony and telegraphy, television, data transmission, etc.).

[21] The list is given in Galloway (1972), appendix B, pp. 193–198.

aspects of the new organization. Intelsat's ownership shares were assigned to these entities according to the proportional use of the system, on the basis of ITU's projections for the year 1968. This gave Comsat, which represented the U. S., 61 per cent of quotas, while the British Post Office (BPO) was a weak second with about 8 per cent of the share. The combined European share was 30.5 per cent and the total Canadian, Japanese and Australian was 8.5 per cent. It was assumed that new members would acquire their quotas from the shares of existing members on a pro rata basis, with the proviso that Comsat's share would not be reduced under 50.6 per cent.[22]

The governing body of Intelsat was an Interim Communications Satellite Committee (ICSC), whose members were drawn from the signatories of the Special Agreement and represented countries or group of countries with at least 1.5 per cent of the projected 1968 Intelsat traffic level. The voting procedure was based on a complex decision-making formula which gave non-American members some degree of control on the most important decisions. Comsat, however, was by far the dominant member in the new organization, with more than 50 per cent of the voting power while several smaller countries had to share a single vote (the USSR, had it joined Intelsat as Western countries hoped, would have less than a fraction of vote). Moreover, Comsat's position was strengthened by the fact that the American company was appointed as the operating manager of Intelsat.

The Intelsat agreements of 1964 reflected the dominant position of the United States in the technology of satellites and launchers. The other signatories obtained, however, that these agreements should be temporary and that a new accord should be re-negotiated after five years, in order to arrive at a definitive institutional structure more respectful of the interests of other Intelsat members. An international conference was to be called in 1969 to discuss proposals for the new arrangement. By that time, it was expected that much more information would be available about the technical, financial and commercial aspects of satellite

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[22] In 1966, Comsat held 55 per cent of Intelsat quotas while 17 European countries held 27.5 per cent (Britain 7.4 per cent and France 5.5 per cent). By the end of 1970, Comsat's share was 52.6 per cent and European countries' 26.6 per cent (Britain 7.2 per cent, France and Germany 5.3 per cent): Voge (1966), p. 33; Galloway (1972), appendix B, pp. 193–198.

telecommunications, and that other countries would possess the level of technology required to enter the field competitively.

Early Bird and beyond

In the capacity of Intelsat's operating manager, Comsat had responsibility for the design, development and operation of the space segment of the system, while the ground segment was to be provided by the appropriate bodies in the countries in which they were situated. Comsat's satellite under development at Hughes, then known as HS 303, was thus designated as the first operational satellite for use by Intelsat. Renamed *Early Bird* and then *Intelsat I* it was launched on April 6, 1965, and on June 28, twenty years after Clarke's forecast, it successfully inaugurated a commercial communications service between Europe and the United States. What was more important, *Early Bird* definitely demonstrated the acceptability and good quality of telephone communications by geostationary satellites: it was proved in fact that the communication delays associated with such satellites were acceptable as long as any echoes along the communication path were adequately controlled, which could be achieved by the use of suitable electronic devices.

Early Bird (Fig. 4) was very small and involved crude technology. It was a spin stabilized cylindrical spacecraft, 72 cm in diameter and 60 cm long, weighing 38.5 kg. The communications payload included two transponders which received transmissions in the 6 GHz band and re-transmitted in the 4 GHz band. One transponder relayed signals from Europe to North America and and the other operated in the backwards path. The power capability was 240 telephone circuits or one TV channel and multiple access was not possible: this meant, firstly, that when television was transmitted, telephone traffic had to be switched to cables; secondly, that only point-to-point communications were allowed and each earth station on both sides of the Atlantic had to take it in turns to work with the satellite.[23]

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23 Description of *Early Bird* and its operation can be found in Podraczky & Pelton (1984), pp. 95–100. This paper describes all generations of Intelsat satellites up to early 1980s. In the initial period, four stations operated in Europe, at Pleumeur-Bodou (F), Goonhilly Downs (UK), Raisting (G), and Fucino (I); and one in the United States, at Andover, Me. Subsequently a a new station was added at Mill Village, Canada. The European traffic was rotated from station to station on a weekly basis, with the smaller station at Fucino carrying traffic on weekends.

Even though designed "almost as it were a submarine cable in the sky," *Early Bird* dramatically demonstrated the potential of communications satellites from the commercial point of view. Its capacity of 240 voice circuits was comparable with the capacity of ATT's brand new, high performance TAT–4 cable, which held 408 telephone channels, and above all it allowed live television transmission, whose impact on the general public was revolutionizing the world system of information and entertainment. Unfortunately for *Early Bird*, however, the simultaneous going into service of TAT–4 made it impossible to demonstrate the economic competitiveness of satellites over submarine cables for transoceanic telephony. In fact, as *Nature* informed its readers, "communications companies on both sides of the Atlantic wanted to recoup some of their investment first, and the satellite rates were in any case set far too high".[24] This situation would change before the end of the decade.

The success of *Early Bird* led the ICSC to decide, in February 1966, that the Intelsat commercial system should be based on the use of geostationary satellites. Hughes was contracted for a new generation of such spacecraft and in 1967 *Intelsat I* was joined in orbit by three *Intelsat II* satellites. The first provided service to the Pacific Ocean region, the second provided additional trans–Atlantic service, between Europe and South America, and the third became a spare in orbit for the Pacific Ocean satellite. These satellites took advantage of the increased capabilities of the *Thor–Delta* rocket and each of them weighed about 87 kg. The telephone capacity was the same as *Intelsat I* but the communications payload was now designed to allow multiple access, i.e. to carry signals from several earth stations simultaneously. Twenty–five countries in two ocean regions were thus connected by the Intelsat system and this determined both a substantial increase in international telephone traffic and a significant lowering of rates charged by cable carriers. Even though the possibility of launch failures made the economics of satellites still uncertain, it became clear, as *Nature* put it, that "new cables can only add to existing capacity, while satellites can almost multiply it." And in fact, in the last quarter of 1967, Intelsat realized its first net operating profit.[25]

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[24] "World wide satellites", *Nature*, **212**, 554–555 (5 November 1966), on p. 554.

[25] "Double or nothing", *Nature*, **216**, 4–5 (7 October 1967), on p. 4; Smith (1976), p. 152. See also Astrain (1984), p. 4. The *Intelsat II* satellites were realized by Comsat for use by NASA for the *Apollo* missions to the moon but about half of channels remained free for commercial use. The

Finally, in May 1969, the third generation of Intelsat satellites, *Intelsat III*, established the global coverage and world-wide service that Arthur Clarke had envisaged, with one satellite over each of the earth's oceans and many earth stations spread all over the world. It was estimated that 500 million people saw the television pictures, relayed by the *Intelsat III* satellites, of the first landing on the moon in July 1969. And the number of hours for television transmission and reception increased from 1372 in 1968 to 6792 in 1972.[26]

The *Intelsat III* satellites, built by TRW and weighing 152 kg, had significant advantages compared to their predecessors. Their two transponders allowed 1200 telephone circuits or up to four television channels, or 700 telephone circuits and one TV channel handled simultaneously. Like the previous Intelsat satellites, it received transmissions at about 6 GHz and converted them to about 4 GHz for transmission down to the earth. An important improvement was the new type of communications antenna, provided with a despun motor which kept it fixed in the direction of the earth while the spacecraft was spinning. In this way, all the power was radiated towards the earth while in previous satellites, whose antenna rotated with the satellite, most of the power was radiated into space.[27]

The enormous increase in demand for communications satellite service called for new generations of satellites, with much higher capacity and improved performance. Thus, even during the construction phase of the *Intelsat III* satellites, a new series of *Intelsat IV* satellites was contracted with Hughes, to take advantage of a larger launch vehicle, the *Atlas-Centaur*, capable of placing some 700 kg into geostationary orbit. The first *Intelsat IV* went into service in early 1971 over the Atlantic region, and six others followed between 1971 and 1975. These satellites had a mass of about 730 kg and they were provided both with a global-beam antenna oriented towards the earth, like their predecessors, and with two high-gain "spot-beam" antennas, steerable in orbit under ground command

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first satellite, launched in October 1966, failed to reach synchronous orbit because of a malfunction of its apogee motor. This was followed by three successful launches in January, March and September 1967.

26 Smith (1976), p. 153.

27 Podraczky & Pelton (1984), pp. 103–109; Dalgleish (1989), pp. 9–12. Eight *Intelsat III* were launched between September 1968 and July 1970 but three failed to reach the geostationary orbit.

towards a restricted area on the earth's surface. The satellite's twelve transponders allowed a capacity of about 4000 telephone circuits plus two TV channels.[28]

New generation of Intelsat satellites followed in the 1970s and 1980s (*Intelsat IV–A*, *V* and *VI*), together with several experimental and commercial communications satellites developed and launched by other national and international organizations. We are not going to pursue this historical account further, however, as it would go beyond the time span covered in this paper.[29] In the next section we will analyse the position of Europe in the framework we have just described and the first initiatives undertaken on this side of the Atlantic to bridge a gap which seemed to be becoming wider and wider.

1964–1966: THE BEGINNING OF SATELLITE TELECOMMUNICATIONS IN EUROPE

Europe was a latecomer in the communications satellite field. While development work was actively pursued in the U.S., the European space effort was in fact insignificant: ESRO and ELDO existed only in embryo, the very few national programmes were still in their early stages and no plan existed specifically directed towards communications satellites. Early involvement of European countries in the field was limited to the realization of two ground stations to participate in the experimental programme of *Telstar* and *Relay*, the first built by the British Post Office at Goonhilly Downs and the second by the French PTT at Plemeur–Bodou. Subsequently, a large station was built at Raisting in Germany and a smaller one at Fucino in Italy, both used to receive signals from *Early Bird*.

First plans for independent European activity in the space sector started only in 1963, when the results obtained in the U.S. had already shown the technical feasibility and economic interest of communications satellites, and when Comsat

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[28] Podraczky & Pelton (1984), pp. 109–113; Dalgleish (1979), pp. 12–15.

[29] It should also be recalled that in the same period 1965–1975, the USSR also developed her communications satellite system, based on the *Molniya* satellites, the first of which was launched in 1965. In November 1971 the "Intersputnik" organization was created, on the initiative of the Soviet Union and other countries under USSR influence. For the American–Soviet relations concerning satellite telecommunications and the creation of Intersputnik see Galloway (1972), pp. 121–136. We will not deal with this development as it has little or no importance for the history of ESRO in this period.

started its actions to promote an international arrangement for a world–wide system. The growing disparity between the USA and Europe, in fact, gave rise to considerable concern since it would have caused a substantial weakness of Europe both in the control of whatever arrangements might be made and in the industrial competition for the construction of the necessary hardware.

In March, the British Minister of Aviation announced a joint UK–Commonwealth programme for a civilian–military satellite communications system based on geostationary satellites. One month later the consortium of European aerospace industries *Eurospace* presented a comprehensive space programme which gave high priority to the development of an all–European communications satellite system, based on a set of satellites in equatorial orbit.[30] Finally, a European Conference for Satellite Communications (ECSC, better known as CETS from its French initials) was established in May, with the twofold aim of co–ordinating the positions of European countries in the negotiations which were to lead to the Intelsat agreements, and to promote the development of a European programme in satellite telecommunications.

The CETS had been called after the conclusions of a meeting of the Conference of European Postal and Telecommunications Administrations (CEPT), held in Cologne in December 1962. Participants in this meeting had discussed the American proposal of establishing a single global system and had agreed that Europe would take a regional approach to this initiative rather than negotiate a series of bilateral arrangements, as proposed by Comsat. The CETS was thus intended to be the instrument for Europe to speak with one voice in the forthcoming negotiations.[31] As we have seen, the first institutional organization of Intelsat, as defined in the 1964 Interim Agreements, could only reflect the position of strength of the United States and of Comsat. The problem for Europe was now to develop its own satellite telecommunication programme in order to arrive in a better position at the re–negotiations for the definitive arrangement, and this was the CETS's second aim.

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[30] De Maria & Krige (1992).

[31] Bignier (1966); Galloway (1972), pp. 93–94; Smith (1976), pp. 135–136. The CETS met for the first time in May 1963 in Paris and following meetings were held in July 1963 (London), October 1963, March and June 1964 (Rome), and October 1964 (Bonn).

Two main reasons pushed CETS member states to get actively involved in the space sector of satellite telecommunications. The first was the economic interest of European industries in participating in the Intelsat development and procurement contracts at a level consistent with Europe's financial contribution to the consortium. By 1966, in fact, it was evident that European firms were unable to compete successfully with their American counterparts and Comsat was thus awarding most of the Intelsat money to American firms. In 1967, for example, the British Parliament's Estimates Committee lamented that "the US share of contracts was overwhelmingly high" and stressed that in the contracts allotted for six (*Intelsat III*) satellites worth 32 million dollars, the value of contracts allotted in the U.K. was only 500,000 dollars, i.e. less than 1.6 per cent, well below Britain's 7.41 per cent share of Intelsat quotas.[32] One year later, *Nature* recalled that the share of contracts placed by Intelsat in Europe was only 4 per cent, and commented:

> It is precisely in the field of satellite construction, satellite sub-systems, onboard power supplies and such things that European tenders have done badly, in part, of course, because they lack the experience of their American competitors. It is a cogent argument of CETS advisers that the inequality will not be rectified without more direct European participation in the launching and designing of satellites.[33]

The second reason in favour of an autonomous European involvement in communications satellites was political. By the mid-Sixties, when the cold war had overcome its hottest phase, a good deal of international competition took place on the ground of scientific and technical achievements, commercial success, and cultural influence. And this kind of competition existed not only between the two sides of the iron curtain but also on the western side of it. With the Americans heading to the moon and the Soviets lifting heavier and heavier payload beyond the atmosphere, space no longer appeared as merely a new frontier for esoteric scientific investigation. It was definitely a key element for technological innovation, for industrial development and for national prestige. And with Japan,

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32 Estimates Committee (1967), p. xi. See also *ibidem*, p. 64.

33 "More negotiation for Intelsat", *Nature*, **218**, 714 (25 May 1968).

China and Canada already on their way to space, Europe could not remain sitting on its very limited programmes in space research and launcher development. Satellite communications rather than basic science appeared more and more as the privileged area of application of space technology, with a potential market as large as the world and with a political interest as important as free communications in the so-called "global village". As *Le Monde* would eventually comment: "The transmission of radio and television programs is one of the most supple and diversified means to assure a presence and influence abroad".[34]

Three main difficulties presented themselves regarding the achievement of an independent European capability in space communication. The first derived from the fact that two multinational space organizations already existed in Europe, one to develop launchers and another to build scientific satellites, but none had been created for building and operating applications satellites. While the creation of a third organization appeared unwise, any eventual involvement of those existing in the new field implied changing their charter and operational programme. This problem was made more difficult by the fact that, both at national level and in international negotiations, the different aspects of space activities were dealt with by bodies as different as Ministries of Industry, Ministries of Aviation, Ministries of Science and Technology, Ministries of Foreign Affairs, National Research Councils, National Committees for Space Activities, PTT agencies, and so on. The CETS itself did not have an official statute as an independent organization but was rather a series of meetings of governmental and PTT representatives, with a small secretariat serving ad interim. This rendered the task of defining a coherent space policy a hard task not only at European level but very often at the level of individual countries.[35]

The second difficulty lay in the situation created by the Intelsat agreements. As this international consortium was to provide for a global space communications

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[34] *Le Monde*, 29/1/67, quoted in Hochmuth (1974), p. 158. ESRO's deputy Director General stressed that the first decade of the space age had been "the era of scientific satellites"; now a new phase was opening, "the era of application satellites", and telecommunications represented the most important sector of application satellites: Bertrand (1966), p. 26. See also Giarini (1968), pp. 95–107.

[35] As an example, in the U.K. the different bodies responsible for space were the Ministry of Defence (military satellites), the Ministry of Aviation (space technologies and launchers), the Department of Education and Science through the Science Research Council (scientific satellites), the General Post Office (telecommunications): Estimates Committee (1967), p. 1.

network, its members were committed not to build systems that could compete with such a network on the commercial ground. This left them two possible policies in space telecommunications: to compete in the international market for supplying satellites or important technical hardware to Intelsat or to develop communications satellites for national use. But European space industries were not in a position to tender successfully against American ones, and European countries were not large enough to require the use of satellites for domestic tele-communications. A third way did exist, in fact, for Europe to foster an industrial policy in the communications satellite field, but its political implications were rather delicate. This was the development of a space communication system at regional level, namely covering a large part of the European continent and the Mediterranean area, whose geographical extent would be comparable with that included within the national borders of the United States or Canada. The limitation of such a policy was twofold. Firstly, this regional system could take over some of the Intelsat traffic and thus undermine the commercial interests of this organization. Secondly, it had to win approval and support from its potential users, i.e. the national PTT administrations, whose attitude, in fact, was very cautious. On the one hand, these considered that satellite links within the European continent would not be economical compared with the ground network, in which they had invested so much and which was rapidly expanding. On the other hand, they were reluctant to get involved in matters where political negotiations between foreign offices were more important than the usual technical agreements between telecommunications administrations.[36]

The third difficulty was the lack of a European launcher capable of putting a satellite in the geostationary orbit. The *Europa* rocket (or ELDO A), under development in ELDO, was not qualified for this and any independent European programme in space telecommunications by geostationary satellites therefore implied either the use of American rockets or an important change in ELDO's programme. The availability of launching facilities for scientific satellites had been assured by the American authorities but it was not evident that this would be granted even when commercial interests were at stake. As to ELDO, we shall see

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36 This last aspect was noted by the US representative during the early negotiations with the CEPT in 1964: Galloway (1972), p. 93.

in a while how the "original sins" which had characterized its creation were already negatively affecting its activity.[37]

The definition of a suitable institutional framework, the emergence of an important and reliable customer, and the building of a European launcher with geostationary capability were thus the necessary preconditions for the success of a communications satellite programme in the Old Continent. And this is the key to understand the difficult process we are going to discuss in the following sections.

The first definition of the CETS programme

In July 1963, at its second meeting, the CETS decided to create two subordinate bodies, a Committee on Organization (CO), to cover juridical, administrative and financial matters, and a Space Technology Committee (STC), with the aim of defining a programme capable of qualifying the European industry to participate in the Intelsat procurement contracts. The latter worked out a five–year plan which foresaw two phases: a three–year phase of research and development starting in January 1965, financed on a national basis and co–ordinated by the STC itself; and a phase with multinational funding starting by the end of 1966. The plan was discussed at the CETS meeting held in Bonn in October 1964, the first after the signature of the Intelsat agreements, and it was agreed to recommend to the member states the start of the first phase, and to undertake a detailed study on the scientific, technical, economical and financial aspects of the proposed second phase. The Conference also set up a Technical Planning Staff (TPS), composed of experts from industry and governmental bodies under the direction of N. Simmons, of the British Ministry of Aviation, whose task it was to review the work on space technology in Europe and to propose a joint development programme for a European experimental communications satellite capable of meeting the requirements of the Intelsat global system.[38]

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37 De Maria & Krige (1992).

38 Bignier (1966); Blassel & Collette (1968). The terms of reference, the composition and the organization of work of the TPS are reported in the notes on the first TPS meeting (12–14/1/65), SCL/TPS/6E, 15/1/65, folder 1240.

The report of the TPS was issued in December 1965. After surveying the current and potential European capability in space and communications technologies, the TPS summarized its views:

> Europe has the potential capability necessary for development of communication satellites, but to realise this potential will require the purposeful execution of a well-planned co-operative programme.[39]

The proposed programme was to be developed in five years at a cost of 370 million French francs (MFF), and consisted of three stages:

1) The use of the ELDO test launchings F9 (planned in Ocotober 1968) and F10 (planned in mid-1969) for testing telecommunication components;
2) The realization of an all-European experimental communications satellite;
3) The study of other application satellites such as for television broadcasting, navigation, and meteorology.

Three or four experimental satellites were foreseen, to be launched into a low inclination orbit at an altitude of 14,000 km (8-hour period) by the use of an improved ELDO launcher (ELDO A/S) or an American launcher. The realization of such satellites, together with the development of a more advanced launching vehicle (ELDO B), was considered by the TPS a necessary step in order to put Europe "in a position to participate fully in any competition to supply equipment for the global system, or any sub-system required, from 1970 onwards."[40]

The TPS objectives were more ambitious, however, than securing European industry a share of Intelsat procurement business. They recommended in fact that other applications be considered, besides long-distance telephony, as more interesting objectives of the European joint effort in space. In particular, satellites for direct television broadcast, navigation assistance to ship and aircraft, and meteorology were suggested, and the TPS went as far as to consider that developing one of these alternative application satellites should be the real

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[39] *TPS Report on European Potential and Recommended Development Plan*, SCL/TPS/116E, 15/12/65, p. 20; folder 401.

[40] *TPS Report* (fn. 39), p. 22. ELDO's programme is discussed in the following section. The ELDO A/S project consisted in the addition of a fourth stage (apogee) motor to the ELDO A launcher under development, in order to achieve orbits at higher altitudes. ELDO B was a project for a completely new rocket with geostationary capability.

primary objective of the recommended telecommunications programme. The reason:

> Since these other functions are ones which in general have a specifically regional interest, as opposed to the world-wide application of long-distance telephony, and since they are not at present the subject of international agreements giving a single organization a monopoly of their exploitation, they may be particularly appropriate for European development effort.[41]

CETS, ESRO and ELDO

While the TPS was working out its plan for a joint European communications satellite programme, a CO/STC working group discussed the institutional and financial aspects of such a programme, and in particular the possible use of the existing space organizations for its implementation.[42] In fact, both ESRO and ELDO had been invited to the various CETS meetings and had participated in the work of the STC. In September 1964, the Chairman and Vice-Chairman of the STC, W. Stephens and M. Bignier, had visited ESTEC to discuss with ESRO's Technical Director A. Lines the prospects for possible collaboration.[43] The definition of a formal arrangement was not an easy task, however, for three main reasons. The first regarded the institutional aims of the two organizations. ELDO's convention defined as the sole objective of the Organization: "the development and construction of space vehicle launchers and their equipment suitable for practical applications and for supply to eventual users." In the view of the CO, this excluded the possibility of ELDO developing a communications satellite programme, unless important changes were made in its statute and organization. No difficulty existed, of course, for ELDO to provide the vehicles for launching the satellites themselves.

41 *TPS Report* (fn. 39), p. 31.

42 Reports on two meetings of this working group are available (1/4/65 and 6–7/9/65): SCL/JWG/3F, undated, and SCL/JWG/10E, 20/9/65. A CO working group charged to study the conventions of ESRO and ELDO was also set up and met on 20–21/5/65, SCL/CO.13/3F, undated. All these documents are in folder 1240.

43 ESRO/36, 14/10/64, p. 2.

A somewhat better situation presented itself in the case of ESRO. Article II of its Convention stipulated in fact that "the purpose of the Organization shall be to provide for, and to promote, collaboration among European States in space research and technology." This formulation could be interpreted as allowing the realization of an experimental communications satellite. This, however, required a special approval from the Council and the proper integration of such an undertaking in the organizational, financial and technical framework of the Organization. And, in any case, the ESRO convention definitely excluded the eventual continuation of the programme towards commercialization.

The second difficulty derived from the different membership of the various organizations involved. Only six European countries, plus Australia, were members of ELDO; ten were in ESRO; nineteen participated more or less regularly in the CETS meetings; and twenty-three belonged to the CEPT, five of which, however, had not signed the Intelsat agreements (Table 1). It was still unclear whether all ESRO member states would be willing to participate in the communications satellite programme while, at the same time, some non-ESRO countries would certainly do so. This circumstance implied difficult problems regarding the legal arrangement of the collaboration, the management and financing of the programme, and the definition of the industrial policy.

Finally, there was the problem of the financing of the programme, i.e. whether only governments shuld contribute or whether private investments should also be considered, in particular for the operational phase of the programme, when profits might be produced by commercial activities. In this case, the CO/STC working group argued, one could envisage the formation of a Comsat-like European company, capabale of challenging the American exclusive role in the management of the global system. This implied, however, the loss of governmental control over the telecommunications system, a prospect not as easily acceptable in Europe as it was in the US. Moreover, doubts were expressed as to "whether such financing would be practicable since such operation would require considerable investments and could derive only long-term profits, and perhaps, in the early stage, funds invested might be lost."[44]

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[44] SCL/JWG2/10E, p. 3.

Concluding this phase of its work, the working group recommended that governments and industries should be requested to give their views on the method of financing the European communications satellite programme, and on the kind of institutional framework to be established for the experimental and the operational phase of such a programme. At the same time, it was decided that the ESRO and ELDO Councils should be formally approached, in order to know their opinions on the TPS report, now near completion, and how the programme described there could be carried out.[45]

The answer of ESRO was immediate and positive: two weeks after the CETS's letter the ESRO Secretariat had already elaborated plans for the technical and financial management of the CETS programme, and ten days later the Council agreed that "an encouraging reply should be sent to the CETS, declaring the Organization's interest in close co-operation".[46] As a consequence, at the following meeting of the CO/STC working group, held in February 1966 with the participation of delegations from ESRO and ELDO, a large majority emerged in favour of appointing ESRO in the role of manager of the telecommunications programme.[47] Four reasons were explicitly given for this choice: (a) the requirements for a communications satellite would determine the design and the requirement of the launching vehicle and not the opposite; (b) the facilities available to ESRO were more apt to deal with telecommunication problems; (c) the membership of ESRO included all countries likely to be interested in participating in the execution of the programme; (d) it appeared easier to have the co-operation of the other organization as sub-contractor than if ELDO were chosen.[48]

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[45] ESRO/C/145, 8/11/65, with attached copy of a letter, dated 28/10/65, sent by the Chairmen of the CETS Committees on Organization and on Space Technology to the Chairman of the ESRO Council and to the President of the ELDO Council.

[46] ESRO Council, 9th session (24–26/11/65), ESRO/C/MIN/9, 31/1/66, p. 25. The document of the Secretariat is ESRO/C/150, 13/11/65.

[47] Three reports on this meeting (10–11/2/66) are available: the "Conclusions of the Chairman", SCL/JWG4/1E, 14/2/66; a "Summary report" dated 25/2/66; and the ELDO document ELDO/C(66)14, 21/2/66. The first two documents are in folder 1240. See also Bignier's report at the 21st AFC meeting (8–11/3/66), ESRO/AF/MIN/21, 16/5/66, pp. 9–10. It must be noted that in any case the possible use of the ELDO launchings F9 and F10 for telecommunications experiments was to be negotiated directly by ELDO and CETS.

[48] With respect to the last point, ESRO director general P. Auger had made it clear to CETS that ESRO would not accept a position of sub-contractor of ELDO.

ELDO, however, was the main problem in the path towards an autonomous European communications satellite programme. In fact, in spite of the conclusions of the TPS report, no telecommunication programme could start before bringing to solution the crisis that ESRO's sister organization was living in 1965–66.

The ELDO crisis of 1965–1966 and the start of the ELDO–PAS project

The problem of the European launcher was hotly debated in 1965–1966, both in the ELDO Council and in the wider political circles involved in discussions and negotiations on European space policy. ELDO's initial programme called for the development of a three-stage rocket, called *Europa* (or ELDO A), with the capability of launching a large satellite into a near-earth circular orbit (e.g. 800 kg payload at 550 km). The construction of this rocket was entrusted to the Organization's principal member states: the first stage was based on the British former military rocket *Blue Streak*, the second stage was to be built in France, and the third stage in Germany. As to the other member states, Italy was given the task of building a series of test satellites, Belgium was to provide down-range ground guidance stations, and the Netherlands the long-range telemetry links. In addition to these European countries, Australia had also joined ELDO, making its launching base of Woomera available to the Organization.[49]

By the beginning of 1965, however, it was recognized that much of ELDO's initial programme needed to be revised. Firstly, the cost of completing the programme had risen up to more than twice the original estimate (£ 143 million as compared to £ 70 million). Secondly, the objective of the initial programme appeared obsolete *vis-à-vis* the recent development of space activities: the *Europa* rocket in fact was not powerful enough to launch into a geostationary orbit the payload necessary for a telecommunications mission. The crisis burst in January 1965, when the French delegation in the ELDO Council called for the abandonment of the initial programme and the start of a new programme for a more powerful rocket (ELDO B), aimed at providing Western Europe with launching capability into the geostationary orbit.

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[49] The origin of ELDO is analysed in detail in Krige (1993). ELDO's "sad parable" up to 1968 is discussed in De Maria & Krige (1992). See also Pfaltzgraff & Deghand (1968); Hochmuth (1974), 59–98; and Schwarz (1979).

A Working Group was set up with the task of formulating proposals for a reorientation of ELDO activities, and in the course of 1965 plans for the realization of the ELDO B vehicle were elaborated at technical level. The political aspects were far from being resolved, however, and negotiations lasted a year and a half. France, on the one hand, strongly advocated an independent European launcher capability, following President de Gaulle's policy of national independence in strategically important areas of science and technology. Britain, on the other hand, felt that its heavy investment in ELDO was not worth the results to be expected and cast doubt both on the validity of the initial programme and on the possibility of successfully developing any future programme like ELDO B. In June 1966 the new (Labour) British government went as far as to anticipate the withdrawal of the United Kingdom from ELDO.[50]

A compromise was eventually reached at a Ministerial Conference of ELDO member states held in July. Here, in return for a dramatic reduction of Britain's financial contribution to the budget of ELDO (from 38.79 to 27 per cent), it was agreed to undertake a new launcher project, called ELDO-PAS or *Europa II*, designed to launch a 150 kg satellite into geostationary orbit when fired eastwards from the equatorial base of Kourou, in French Guyane. *Europa II*, however, was not a really new rocket, as ELDO B was intended to be, but rather a modification of the *Europa* launcher (now called *Europa I*) in order to make it capable of injecting a satellite into geostationary orbit. Its design in fact consisted of the addition of the so-called "perigee-apogee stages" (PAS) to *Europa I*, namely a fourth stage (perigee motor) capable of injecting the satellite into a transfer orbit, and an apogee motor in the satellite itself to fire it into geostationary orbit (Fig. 5). The ELDO-PAS programme thus allowed ELDO to take advantage of the work already done on the initial *Europa* programme, whose continuation up to completion was also approved. A new management scheme was also defined, in order to solve some of the problems which had beset the Organization since its beginning.[51]

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50 De Maria & Krige (1992); Krige (1992c).

51 ELDO, *Report to the Council of Europe for 1966*. A technical description of the ELDO-PAS system is in Blanc (1966) and Nouaille (1968). The launch eastwards from an equatorial base made it possible to take advantage of the rotation of the earth. The ELDO-PAS project was approved by ELDO member states as a "supplementary programme", in addition to the "initial programme" described in the ELDO Convention. The project also included the installation of an

ESRO's first studies of communications satellites: CETS A and B

The compromise worked out for ELDO promised to provide Europe by 1970 with a launcher capable of putting a communications satellite into geostationary orbit. This element, as well as the most recent developments of Intelsat, changed the framework of the TPS plan. The TPS therefore prepared a supplementary report in which the new possibilities were assessed in the light of the most recent developments in the field of application satellites, in particular after the success of *Early Bird* and the growing political and social importance of real time television distribution.[52]

The first important aspect put into evidence was the decision of Intelsat to base its system on geostationary satellites. Plans for the new generation of *Intelsat III* satellites were already under development, noted the TPS, with a view to establishing a world-wide service of satellite communications by the end of the decade. The European share in the procurement contracts for such a system would be only 4.5 per cent of the total cost, and in this perspective the place of Europe could only be very limited:

> The yield to Europe in communication satellite technology from *Intelsat III* procurement is limited in both quality and quantity, e.g. it involves mainly repetitive work and little of the creative element. It falls short by an order of magnitude of the minimum programme recommended in [the original report] and *cannot, by itself, generate the required capability, nor the envisaged European potential*.[53]

At the same time, the TPS concluded, it was difficult to forecast the specification for an eventual successor to *Intelsat III* and it could not confidently predicted that the payload capability of the ELDO-PAS launcher would be adequate for this purpose.

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inertial guidance system in the third stage of the *Europa* rocket, the establishment of an operational firing range in Kourou suitable for equatorial launchings and the development of a suitable ground network. The reduction of the British financial contribution was balanced by the other member states: France (from 23.93 to 25 %), Germany (from 22.01 to 27 %), Italy (from 9.78 % to 12 %), Belgium and the Netherlands (from 2.85 and 2.64 % respectively to 9 % jointly).

[52] This supplementary report (SCL/TPS/116/Supplement, 6/9/66) is attached as Appendix 3 to ESRO/C/225, 14/9/66.

[53] TPS/116/Supplement (fn. 52), p. 4, underlined in the original.

Against this background a re–definition of the CETS objectives was called for, leaving aside the field of transoceanic telephonic communications where so little room existed to compete successfully, and taking into account the specific needs and interests of Europe. After discussing the most recent developments and trends in the various fields of application satellites (aeronautical and maritime communications, television distribution and broadcasting, navigation, meteorology, regional telephonic communications), the TPS experts indicated television distribution and broadcasting as the most promising field of activity for Europe and urged the CETS to start an experimental programme in this field.

At the 6th meeting of the CETS, on 22–24 November 1966 in The Hague, two years had elapsed since the previous Bonn meeting, the TPS proposal was finally accepted by the Conference as the basis of a joint European programme in communications satellites. At the same time, a tentative institutional framework was agreed for the implementation of this programme, which foresaw that ESRO be entrusted with its management in close co–operation with ELDO.[54] The Conference then decided to commission ESRO to undertake a feasibility study of the programme described in the TPS reports and, on this basis, a formal agreement between the two organizations was defined and duly approved by the ESRO Council.[55]

The agreement with the CETS foresaw that ESRO should prepare a technical feasibility study of a European communications satellite programme aiming at the development of an experimental satellite for telephony and television distribution, comparable to the Intelsat III satellite then under development. Three satellites

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[54] CETS, 6th Plenary Meeting (22–24/11/66): "Summary of conference decisions", SCH(66)21E, (Revised), 28/11/66; "Provisional summary record", SCH(66)23E, 30/11/66; folder 1240. It must be noted that the meeting decided to enlarge the terms of reference of the CETS, in order to include other application fields besides conventional telecommunications. The meeting was attended by representatives of Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Monaco, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, Vatican City. Observers attended from Greece, Australia, ELDO (the deputy secretary general W. Stephens), ESRO (the director general P. Auger) and the CEPT.

[55] ESRO Council, 14th session (30/11–2/12/66), ESRO/C/MIN/14, 20/1/67, p. 45–46. The development of ESRO/CETS negotiations, including correspondence, draft agreements, technical specifications and the CETS November resolution, are reported in ESRO/C/221, 27/7/66 (with add. 1, 16/9/66; add. 2, 13/9/66; add. 1, rev.1, 21/9/66); ESRO/C/225, 14/9/66 (with 3 appendixes); ESRO/C/245, 29/11/66 (with 3 appendixes). On ELDO side, see ELDO/C(66)57, 6/10/66, and ELDO/C(66)62, 29/11/66. For ESRO/ELDO negotiations, see ELDO/C(67)24, 31/3/67, ESRO/C/279, 24/4/67, and the correspondence in folder 402.

were to be built and launched into geostationary orbit by *Europa II*, the first launching being scheduled in 1971. The study was also to include development plans, financial estimates and proposals for the organization of work. Finally, the study was to provide indications about further developments on second generation telecommunications systems and other application fields. The total cost of the programme was not to exceed 435 MFF, i.e. 280 MFF for the experimental satellites (including 135 MFF for the provision of the launchers), 55 MFF for the associated programmes of research and development, and 100 MFF for studies of other applications. The sum of 1.5 MFF was made available to ESRO by CETS Member States for the realization of this study, and a report was expected by the end of May 1967.

Thanks to the work of a team of about 30 engineers under the direction of P. Blassel, the study was completed in due time and the final report was sent to the CETS delegations.[56] Two types of experimental satellites meeting the mission specification defined by the TPS were presented. The first satellite (CETS A) could be developed in four years, taking advantage of the industrial capabilities existing in Europe. The second (CETS B) involved more advanced technological developments and thus belonged to a later stage in the series of future objectives.[57]

1967: POLITICAL SETBACKS AND TECHNICAL OPTIMISM

ESTEC's study was discussed in the various CETS committees and arrived on the tables of the second meeting of the European Space Conference (ESC), held in Rome on 11–13 July 1967. The ESC had been convened for the first time in December 1966, after an initiative of the ELDO ministerial conference of July that year, to establish a political forum for discussions and decisions about a coherent European space policy. Indeed, at the time of the Rome Conference the prospects for such a policy could hardly be considered with optimism. As to ESRO, this Organization was virtually without a programme and was living a dramatic institutional and financial crisis. ESRO Member States in fact could not agree unanimously (as demanded by the Convention) on the level of resources for the

[56] Letter, P. Auger to A. Hartog (President of the CETS), 30/5/67, folder 401.

[57] Blassel & Collette (1968), Collette (1992).

second three-year period (1967-69) and the Organization was thus prevented from making any long-term plan. Its most important and ambitious project, the Large Astronomical Satellite (LAS) for high resolution studies of stars in the ultraviolet, seemed definitely jeopardized and a drastic reduction of its initial programme was inevitable.[58]

With regards to ELDO, the approval of the *Europa II* programme had not removed the reasons for conflicts between the various national interests. While giving Europe an adequate degree of independence in the capability of launching application satellites, the ELDO-PAS system in fact could not be considered the last word in the path towards real European autonomy. Foreseeable developments in space communications technology and other application fields called for much heavier satellites and therefore for more powerful rockets. And here the disagreement sharpened between the countries sceptical about the prospects of a launcher development programme and those firmly committed to achieving European autonomy in this field. Britain and France, as expected, led the opposite camps. For the British Estimates Committee, the ELDO programmes had no future: the only firm prospective buyer of *Europa II* was the French Government (two launchers), while Intelsat would hardly have used a rocket costing about two and half times an equivalent American launcher. As to *Europa I*, the likely abandonment of the LAS by ESRO implied the loss of the only foreseeable client for this launcher. In conclusion, the Committee recommended that Britain should oppose any proposal to further develop the ELDO-PAS programme, not to say undertake more advanced projects, and should rather invest mostly on the all-British light satellite launcher *Black Arrow*.[59] France, on the contrary, insisted that Europe could not sustain a credible space policy in commercially interesting application fields without the availability of its own launchers.

This disagreement over launchers paralleled that regarding the prospects of the joint European communications satellite programme. While agreeing on the

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[58] Krige (1992b).

[59] Estimates Committee (1967), pp. xxvi-xxvii. The *Black Arrow* project for a three-stage satellite launcher had been started in 1964 but the decision to proceed with this programme was taken by the British government only in 1966. The programme was to be completed within three or four years. The programme, in fact, was cancelled even before the first and last operational launch of the rocket in October 1971: "Britain will cancel Black Arrow space programme", *The Times*, 30/7/71; "Choosing Britain's place in the space race", *ibidem*, 29/10/71.

financing of ESRO's feasibility study, CETS member states were far in fact from being equally convinced of the opportunity of undertaking the programme itself, due to the great uncertainty about the economic aspects.

According to the TPS, which had been requested by the CETS meeting in The Hague to make a study of the economic aspects of application satellites, the investment required for the development of the experimental communications satellites would not be amortised in the period 1970–75. They stressed, however, that in the long-term period (i.e. in 10–15 years) the whole foreseeable field of satellite applications would cover important economic sectors and would lead ultimately to benefits many times the investment involved. Besides the eventual direct economic benefits, the TPS also underlined that it was important for Europe to control the technological development of application satellites instead of relying exclusively on U.S. technology.[60]

Against the TPS's otpimistic vision, however, an economic study made by the CEPT concluded that a European communications satellite system would be more expensive than the conventional ground links and, moreover, would not be competitive in comparison with the cost of using the Intelsat system. In contrast, the *Eurospace* consortium found that an operational system for telephony and television transmission would be profitable *vis-à-vis* conventional systems already in the second half of the 1970s.[61]

The doubtful arguments about the economic and financial aspects, as well as the lack of a unifying political and institutional framework, made the CETS incapable of establishing clear guidelines. And the distance bewteen its principal members was becoming wider and wider. In the United Kingdom, the Post Office was adamantly against any direct involvement in communications satellites, considering that the best way the country could secure its interests in the future of space telecommunications was by building and commercializing ground stations within the Intelsat system. For the Estimates Committee, the CETS was "not an organization but a continuing conference [whose] continued existence in its

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60 TPS, *Economic Potential for Europe of Application Satellites*, SCL/TPS/217E, 30/5/67; folder 401 bis.

61 The CEPT study had also been requested by the CETS at its The Hague meeting. Both this study and that of *Eurospace* are referred to in the TPS study. A comparative analysis of the three studies is in the *Causse Report* (fn. 79). See also Müller (1991), pp. 110–112.

present form would appear unlikely to achieve any useful purpose." The Committee then recommended that Britain should not take part in the CETS programme for a television distribution satellite but should rather undertake a project to build an all-British satellite in the framework of the Anglo-American military space communications system *Skynet*.[62]

France and Germany, on the contrary, were the most active among the advocates of European autonomy in space. Both countries in fact managed to come down to business without waiting for the outcome of pan-European ventures. France announced at the Hague conference the decision of its government to undertake a national programme for a 3-axis stabilized communications satellite, called *Saros II*, designed for launching by ELDO-PAS. The mission of this satellite was very similar to that of the CETS project, i.e. to provide telephone circuits and television distribution over an area covering Europe and Africa, and this caused a great deal of worry to some delegations which feared that the French project would jeopardize the joint European project.[63] Germany, on its part, started a national project for a spin-stabilized satellite, called *Olympia*, designed to relay television pictures of the Münich Olympic Games in 1972. Eventually, the two countries combined their efforts and reached agreement on a bilateral project which they called *Symphonie*. Italy too decided in 1968 to develop its own national programme in satellite telecommunications, project *Sirio*, based on the work made on the experimental satellite originally designed for ELDO-PAS.[64]

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[62] Estimates Committee (1967), pp. xix and xxvi-xxvii. The definition of the CETS as a "continuing conference" was suggested to the Committee by the Head of the Foreign Office's Scientific Relations Department, E.G. Willan, on p. 103. The BPO's position is presented in a memorandum, pp. 48-51, and in the witness of two top officials, pp. 52-74. The *Skynet* programme started in 1965 and a satellite was launched in 1969 over the Indian Ocean, mainly for maintaining communications with British forces east of Suez. The satellite had been manufactured in the United States while Britain provided the ground stations. The programme contemplated the launch of two satellites of an improved type in 1973: Select Committee (1971), pp. xxv-xxvi and 164-165.

[63] CETS, 6th plenary meeting (22-24/11/66), SCH(66)23E, 30/11/66, pp. 21-23, folder 1240. Such worries were expressed with particular vigour by Belgium and were repeated at the STC meeting on 12-13/1/67. A report on this meeting was prepared by A. Dattner for Auger, 17/1/67, *ibidem*.

[64] On Symphonie, see Hochmuth (1974), pp. 157-171. On Sirio, Ragno & Amatucci (1978), pp. 63-122.

The discussions about launchers and communications satellites naturally involved important political aspects of the relationship with the United States and the role of European countries in the Intelsat framework. Facing the strong American position in satellite telecommunications and heavy satellite launchers, France was determined to prevent a US monopoly of communications satellites and to develop regional systems covering the area of French (and European) cultural influence. They pressed for the development of a vigorous European programme in satellite telecommunications, which could not leave out the development of suitable launching vehicles. This insistence on European independence in space was consistent with President de Gaulle's policy of political, economic, military and technological independence from the superpower beyond the Atlantic, and the French government was able to co-ordinate the actions of all its bodies within the framework of this policy.[65]

Britain, instead, moved within the Anglo-American "special relationship," reinforced by de Gaulle's veto against Britain's membership in the European Community in May 1967. They thought that very few possibilities existed for an autonomous European action in the space sector of space communications, both because of the strength of the American presence and because of the foreseeable small commercial demand for the kinds of communications satellites that Europe could build and launch. Europe, according to the British, should concentrate all effort on obtaining more favourable conditions for its industrial interests in the Intelsat framework.

In conclusion, looking at the main European countries, France regarded space as a key element in its political strategy; Germany as an important element for the country's technological development, especially in key fields where its industry was highly competent, like communications electronics; Britain as a business to be pursued as long as it produced an economic return.[66] As H. Bondi plainly put it for the benefit of the British *Select Committee on Science and Technology*:

> As usual, the two opposite poles were France and the U.K. The French motivation was very strongly a European presence in space, a European independence of America, never mind what the cost benefit

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[65] McDougall (1985).

[66] Schwarz (1979).

analysis shows, and the British attitude was if you could not show – if I may exaggerate a little – that it was the sort of project that the bank would be happy to finance, then it should not be done anyway.[67]

At the Rome ESC meeting, the ESRO study of the CETS satellites found itself in the framework of this complete lack of agreement about European space policy and, moreover, it had to confront the challenge of *Symphonie*.[68] The German delegation stressed that this project was "not an alternative, but a complement to the CETS project, aiming towards the advanced satellite which is the objective of the European nations."[69] The French, on their part, stressed the importance of solidarity amongst the European states engaged in space activities and insisted that they should give priority to the development of technologically advanced communications satellites. The other delegations' opinions regarding the Franco–German project were much variegated: from the open hostility of Belgium, which advocated a European joint project and feared that *Symphonie* would undermine the CETS undertaking; to the Italian call for further development of the PAS satellite they were preparing for ELDO as an element of the European communications satellite programme; to the British insistence that any such programme should be assessed from the economic and commercial point of view.[70]

In the event, as is usual the case when big controversial issues are on the table, the Conference decided not to decide. It agreed instead to create an Advisory Committee on Programmes, with the task of elaborating a coherent space policy in Europe and proposing programmes in the framework of such a policy. The head of the French CNES centre at Brétigny J.–P. Causse was appointed as the chairman of the Committee, whose work produced a report by the end of the year.[71] Before discussing it, however, we must report on an important development which happened just after the closing of the Rome conference.

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67 Select Committee (1971), p. 186.

68 ESC, Rome meeting (11–13/7/67), CSE/CM/(July 67)PV/1–6, 11–13/7/67.

69 CSE/CM/(July 67)PV/2, p. 2.

70 CSE/CM/(July 67)PV/2, pp. 2, 6–7, and Annex I; CSE/CM/(July 67)PV/3, pp. 2–5.

71 *Report of the Advisory on Programmes* (hereafter *Causse Report*), European Space Conference, CSE/CCP(67)5, December 1967.

The European Broadcasting Union and the Eurafrica (CETS C) project.

While *Symphonie* was being developed and ESRO was studying its communications satellite projects for Europe, the need arose of finding a client, i.e. a user able to transform an experimental technical device into an operational system and a commercial article. Most PTTs, as we have seen, had a more than lukewarm attitude towards satellite telecommunications for Europe. But a "frustrated customer of the PTTs" offered ESRO a possible alternative.[72] This was the European Broadcasting Union (EBU), the association of television companies which operated Eurovision. The transmission of Eurovision programmes was realized by the EBU through a network of wide-band cables provided by the PTT administrations on a commercial basis. The establishment of such a network, however, required several hours, the cost of the service was considered too high, and the distribution was limited to the countries connected to the existing network. The use of a satellite relay system could provide the EBU with its own distribution network, which could be operated in real time at short notice, and capable of reaching all countries from which the satellite was visible, in particular African countries in the European cultural area.

As early as January 1967, when ESRO was starting its study of the CETS programme, the President of the EBU, J.B. Broeksz, had expressed to Auger the great interest of his organization for this work and specified the requirements of a possible satellite for the Eurovision system.[73] Then, at the CETS meeting held immediately after the Rome conference, the EBU Director General officially confirmed the interest in ESRO's work and requested that it should be pursued with consideration of the EBU requirements. As a consequence, the CETS agreed to grant ESRO 1 MFF to continue the studies already executed, and to design an experimental communications satellite programme, distinct from *Symphonie* and meeting the needs of the Eurovision system. The cost of such a programme had to be limited to 450 MFF.[74]

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72 Collette (1992), p. 89. Also Blassel & Collette (1968).

73 Broeksz to Auger, 20/1/67, folder 1240. Auger's reply, 6/2/67, is also *ibidem*.

74 Letter from the CETS President A. Hartogh, to ESRO Director General P. Auger, 19/7/67, folder 402. Also in ESRO/C/302, 26/7/67, Annex 1.

The opportunity offered by the EBU presented several advantages to the European organizations involved in space. Firstly, it allowed ESRO to keep its technical team united and working on the communications satellite project instead of dispersing it pending the decision on its actual development.[75] Secondly, it offered the CETS a way out the embarrassing situation of having a "European" project too similar to that developed by two of the most important European countries. Finally, it provided ESC delegations with the example of a communications satellite more oriented towards operational activity than towards experimentation.

The CETS request was duly approved by the ESRO Council and work was resumed in ESTEC by Blassel's team.[76] Two projects were studied in particular. The first was a system satisfying the requirements of the EBU (satellite CETS C or *Eurafrica*), namely the replacement of ground circuits with space links to provide simultaneous distribution of two Eurovision-type television programmes within Europe and Africa. The second was an experimental system for semi-direct television broadcast (satellite CETS D or *Geovision*). Both projects required development time scales of about five years, but only the first satellite fell within the financial limits of 450 MFF fixed by the CETS and was within the launching capability of *Europa II*.[77]

In December 1967 ESTEC's study was sent to the CETS delegations and to the Causse Committee, and in its report the latter strongly recommended the *Eurafrica* project as the application satellite project to be initiated in the immediate future. In the words of the report:

> The problem set by the EBU has, in fact, considerable attraction. It sets a target for technological studies that is sufficiently ambitious while at the same time being almost capable of attainment; it makes it

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[75] The worry about "breaking brutally" the work of the technical team was expressed in a letter from Auger to Hartogh, 21/3/67, folder 1240.

[76] Council, 18th session (27/7/67), ESRO/C/MIN/18, 14/8/67, p. 8. Auger to Hartogh, 28/7/67, folder 402.

[77] Letter from the new Director General of ESRO, H. Bondi to Hartogh, 30/11/67, folder 402. A satellite for television distribution has the same role as a normal TV repeater, namely its signals are collected in the normal TV network and re-transmitted by standard UHF waves. A satellite for semi-direct television broadcast sends signals that can be collected by an antenna and redistributed by cables within a small community. Direct television broadcast by satellite means that signals from the spacecraft can be collected by small antennae by individual users.

> immediately possible to acquire very valuable operational experience in both the space sector and the ground sector; it can lead rapidly, if desired, to operational activity on what appears to be a good economic basis; and in any event it will provide useful data for the study of the future economic aspects of television satellites.[78]

As to the commercial point of view, the Causse Committee had performed a comparative analysis of the three studies prepared respectively by the TPS, the CEPT and Eurospace, with the conclusion that "the proposal for a television relay satellite system comes closest, among the European space projects under discussion, to having a prospect of financial viability in the foreseeable future." As to the other projects, they concluded that a European satellite used exclusively for telephony, telegraphy and data transmission did not appear financially justified in the short term but could become viable in the period 1975 to 1980. No definite conclusion could be arrived at on the economic validity of semi-direct and direct TV broadcast, and on other application fields.[79]

From the technical point of view, the *Eurafrica* satellite (Fig. 6) represented an important step forward in relation to previous American satellites as well as to *Symphonie*. The former, in fact, were based on spinning technology to assure the stabilization of the spacecraft. As to *Symphon*ie, its design foresaw the more sophisticated three-axis stabilization to keep the satellite firmly oriented towards the earth, but its solar cell array was not designed to track the sun.[80] The *Eurafrica* design, on the contrary, adopted "four-axis" stabilization, namely three-axis stabilization of the body of the satellite and sun-pointing solar array.[81] Other characteristics, like a longer operational life (5 years), a higher power output, and a less expensive earth station, made *Eurafrica* a kind of prototype of an

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[78] *Causse Report* (fn. 71), p. 24.

[79] *Causse Report* (fn. 71), p. 75. The comparative analysis of the three studies is presented in annex 6.

[80] Collette (1992). Indeed, two industrial offers had been presented for *Simphonie*, one from the Aérospatiale-MBB consortium, the other from Matra. The latter did foresee sun pointing of the solar array but it was the former, which did not, that won the contract. It must be noted that three-axis stabilization was a rather advanced technology,under development at that time in the framework of NASA's ATS (Applications Technology Satellite) programme. The launching of ATS-6, the first three-axis stabilized satellite, was in 1974, only months before the launching of *Symphonie*: Giget (1992).

[81] A description of the *Eurafrica* satellite and its mission is in Blassel & Collette (1968).

operational satellite designed to meet the requirements of a well defined client, while the Franco–German project still belonged to the experimental stage. The EBU in fact reaffirmed its interest in the project and, in July 1968, its General Assembly officially approved the use of an operational satellite system for Eurovision based on *Eurafrica*. The EBU specified that they were ready to bear the cost of the operational satellites following the experimental one, provided that it should not bear any development costs of the latter and that the annual average expenditure of the operational system did not exceed that of terrestrial circuits or other means of television distribution that might be available at the time of launching.[82]

The Causse Report and its "wholehearted" reception in ESRO

The immediate start of the *Eurafrica* project was an important aspect of the "balanced programme" suggested in the Causse Report, which included the development of scientific and applications satellites and a European launcher to follow *Europa II*.[83] The programme was articulated in four phases, each requiring definite decisions to be taken at different times of its development. The first phase, whose start was to be decided as soon as possible, foresaw the continuation of the *Europa I* and *Europa II* programmes, the start of the Eurovision satellite programme, and the development of a scientific programme according to one of three possible options. The first foresaw the continuation of the LAS project which, however, was "at the limit of Europe's present technical and financial resources."[84] The second option considered the abandonment of the LAS and the realization of some two scientific satellites per year, which was considered a "minimal programme." The third option foresaw the start of an experimental meteorological satellite programme, with a corresponding reduction of the scientific programme.

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[82] Broeksz to Hartogh, 1/12/67, reported in annex 3 to the *Causse report* (fn. 71); Davidson (1970), p. 11.

[83] Our discussion of the *Causse Report* (fn. 71) in this paper will be limited to the topics dealt with here.

[84] *Causse Report* (fn. 71), p. 15, underlined in the original.

The second phase was to start with the decision, to be taken in 1969, to embark on a launcher project with greater capability than *Europa II,* together with a programme for a second generation communications satellite. The *Europa III* rocket, as it was called, was to become operational in 1975–76 and whould have the capability of putting into geostationary orbit a 500–kg satellite for semi–direct TV broadcasting. The following phases three and four were only roughly described, featuring the development of a vehicle for launching a 2–ton payload into geostationary orbit and the start of "a project of major importance in science or a field of application, that would not be a mere repetition of projects already carried out in the US or the USSR."[85]

All decisions about the actual implementation of the programme described in the Causse Report were deferred to the forthcoming meeting of the European Space Conference, planned in Bonn in spring 1968. No major technical or political impediment seemed to exist, however, for the eventual realization of the television relay satellite project. The ESRO staff, in fact, welcomed "enthusiastically" the Causse Report and its suggestion that their Organization should be entrusted with a development programme of application satellites. In fact, with the likely abandonment of the LAS and the growing difficulties in obtaining from member states important resources to develop pure science, the involvement in application programmes appeared as the new *rationale* for ESRO continuing its very existence and the only way to provide ESTEC engineers with challenging enough projects. In the words of the ESRO Secretariat:

> A decision to this effect would enable better advantage to be taken of past and future investments in installations, technical research, and the training of specialist staff.[86]

The message that ESRO's founding father and first director general P. Auger wrote at the moment he left the Organization echoed the general optimism:

> Les programmes opérationnels devront être partagés de façon judicieuse entre les missions à caractère purement scientifique et les missions ayant pour but des applications, telles que télécommunications, météorologie ou navigation. Ce partage tiendra

[85] *Causse Report* (fn. 71), p. 63.

[86] ESRO/C/347, 24/4/68, annex, p. 3.

> compte des besoins des groupes scientifiques dans les Etats Membres comme des besoins technologiques résultant des applications projetées, mais aussi des influences réciproques de ces deux types d'enterprises. Les efforts dans les domaines de la science pure et des applications, loin de se contrarier, devront être harmonisés entre eux, et conduire ainsi à une plus grande efficacité.[87]

Auger's successor, the British scientist H. Bondi, expressed his confidence that the Organization would carry out the communications satellite programme "with the full and enthusiastic support of the whole organization from the management down".[88] The new Director General saw several advantages in the development of a large balanced programme involving scientific and applications projects. The first was a more efficient use of existing capital resources and of new capital investment. Secondly, such a programme would facilitate the attainment of more equitable geographical distribution of contracts, "which is in the forefront of the new ESRO Directorate's preoccupations."[89] Finally, a large and challenging programme would require a substantial increase in ESRO's staff and would make the Organization's technical establishments more attractive in recruiting the best engineers. Bondi knew however that ESRO owed its very existence to the European scientific community and that their support was more than ever necessary in this delicate passage:

> The integration of [the CETS] project in ESRO's scientific activity constitutes one of the most important issues that ever faced ESRO's Council. For a positive decision we require the support of the scientific community which we have gone a long way (but have not succeeded completely) in convincing that the application work is a beneficial complement to our scientific programme and not a dangerous competitor.[90]

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87 Auger (1967), p. 32.

88 ESRO/C/325, 25/1/68, p. 2. This is Bondi's statement at the meeting of the Committee of Deputies of the CETS (22–23/1/68).

89 *Ibidem*, p. 1.

90 *Ibidem*, p. 2.

Bondi in fact undertook the very delicate task of convincing his scientific colleagues that "ESRO could not survive on a very narrow base of pure scientific research." As he recalled later: "There was really not much of a choice."[91] We shall dedicate the following section to describing how the European space scientists involved in the ESRO programme were reacting to this major change in the organization they had given birth to.

THE WORRIES OF THE SCIENTISTS

It was not obvious to ESRO, whose *raison d'être* was the pursuit of pure research, that it should undertake the development of application satellites. At least, it was not so obvious to the scientists as it was to the other direct protagonists of ESRO's activities. We have seen already the enthusiam of the ESRO staff; no major problems existed in the eyes of the Council's Administrative and Finance Committee (AFC) either. The Committee recognized in fact that, from the legal point of view, articles II and XIII of the ESRO Convention provided a sufficient basis for engaging ESRO in the work requested by the CETS: the former mentioned the promotion of both space research and space technology as the aims of the Organization; the latter stated that, by a unanimous decision of the Council, ESRO could cooperate with other international organizations.[92]

The scientists' perspective was different, however. As soon as the ESRO Council gave its first "encouraging reply" to the CETS, in November 1965, the vice-chairman of the Scientific and Technical Committee (STC), the Danish physicist B. Peters, sent a long letter to chairman R. Lüst to express his opinions

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[91] The first quotation is from Bondi's interview with M.S. Hochmuth, reported in Hochmuth (1974), p. 90. The second is from his interview with J. Krige, on 5 November 1992, in the framework of the ESA History Project, p. 14 of the transcript. In the latter interview, Bondi recalled in particular a long discussion on this matter with the influential Dutch scientist H. van de Hulst, at that time the Chairman of ESRO's Scientific and Technical Committee (STC). Typewritten notes on this meeting (24/10/67) are in fact in folder 397, as well as Van de Hulst's "Private notes on CETS", 7/11/67.

[92] AFC, 21st meeting (8–11/3/66), ESRO/AF/MIN/21, 16/5/66, p. 9–12. At this meeting only the Italian delegation expressed concern and aversion towards ESRO's involvement in application satellite work.

about a question that, in his opinion, "will no doubt have a profound influence on the future evolution of European space research".[93]

Peters recalled that ESRO had been funded as an organization solely devoted to pure research and stressed that its policy had to be dictated by scientific considerations only. He indicated the serious disadvantages for scientific research which, in his opinion, could arise out of a merger of scientific, technological and commercial activities. The first regarded the budget: in the long run, argued Peters, the part of the ESRO budget devoted to the application programme would certainly become predominant with respect to that devoted to scientific research. A second disadvantage regarded institutional aspects: important policy decisions, in fact, would depend on elements other than scientific interest. As Peters vividly put it:

> The rate of build up, the future launching programme, the relative scale of efforts going into different ESRO establishments etc. will no longer be governed exclusively by dates such as the solar maximum, an eclipse or the arrival of a comet but may often be overruled by dates such as those of the Washington meeting [for Intelsat negotiations] in early 1969.[94]

ESRO's executive staff would have to be elected taking into account the dual purpose of the organization, Peters continued, and "substantial commercial interests [would] have a more or less direct influence on priorities in the execution of contracts which ESRO places with industry." An important part of the objectives pursued in setting up the ESRO organization might be lost, and "one can even envisage that the scientific effort may become only an appendix". Peters concluded that ESRO should remain a completely independent scientific organization and that the best way to strengthen Europe's position in the Intelsat negotiations was to demonstrate its space capability by launching the Large Astronomical Satellite on schedule by an ELDO rocket.

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93 The letter, dated 1 December 1965, is reported in ESRO/ST/172, 3/1/66. A copy of the original is among the documents on the ESRO history that Professor M. Golay has provided for the ESA History Study Team.

94 We should stress that Peters' argument here is typical of scientists' standard ideology: as a matter of fact, the development of the ESRO scientific programme was hardly dependent only on such "natural" events but always involved many non-scientific factors. See Russo (1992b) and (1992c).

At that time, Peters' views were probably shared by a significant fraction of the scientific community.[95] His drastic position, however, could hardly be defended in front of the clear political drive towards commercial space activities. Scientists had to choose either to defend a rigid position against ESRO's involvement in application satellites, which could only be defeated, or to state as strongly as possible the necessary conditions to safeguard the scientific programme in the new framework.

Lüst circulated Peters' letter among several scientists active in ESRO, and the question of the possible co-operation with the CETS was then discussed at an informal meeting held in Paris in January 1966. The participants chose the second alternative:

> The scientists who participated in the discussion expressed deep concern about the fact that, whatever collaboration agreements ESRO may enter into with other organizations, the scientific purpose of ESRO, its programme and the management of the programme by ESRO, must be fully safeguarded. It was suggested that ESRO express its willingness to consider, in principle, entering into arrangements on a contractual basis with CETS, for the purpose of constructing communication satellites, provided that all necessary steps are taken to ensure that such assistance can be rendered without jeopardizing the extent and time schedule of ESRO's programme.[96]

In a more formal setting, the matter was discussed again in February at the 8th meeting of the STC.[97] The French delegate M. Bignier, speaking in the capacity of chairman of the CETS Space Technology Committee, stressed that "everything would be done to ensure that the programmes of CETS and ESRO did not hinder one another or upset the execution of ESRO's scientific programme in any way." He underlined that the CETS programme, at that stage, did not imply a

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[95] A similar opinion was expressed for example by Golay in a letter to Lüst, 17/1/66, Golay papers (fn. 91).

[96] ESRO/ST/178, 27/1/66. The scientists present were: L. Biermann, J.E. Blamont, R. Boyd, J. Coulomb, R. Frith, B. Hultquist, C. de Jager, R. Lüst, R. Michard, G. Occhialini, B. Peters, P. Swings, A.P. Willmore. Several letters from other scientists involved in space research but not active in ESRO were also available at the time of the discussion.

[97] STC, 8th meeting (14–15/2/66), ESRO/ST/MIN/8, 4/4/66, p. 19–22.

commercial application for the satellite. His arguments, however, did not completely convince the scientists. The Danish Delegation (B. Peters and O. Petersen) expressed their fear that "the size of the CETS project would overwhelm ESRO". The Italians (G. Occhialini and E. Cigerza) said that co-operation with the CETS was outside ESRO's mandate. The British delegation (H. Massey and M.O. Robins) declared that they were in favour of co-operation with the CETS but felt that "this was not an inevitable decision for ESRO to take but rather a special move on ESRO part to assist in the early, exploratory stages of a new European project." Finally, ESRO's scientific director, B. Bolin, listed a few points which had to be taken into account "should co-operation with CETS be seriously envisaged." These were:

> The budgets must be absolutely separate; the programmes must be well defined, with detailed planning to safeguard the priorities of the scientific programme; any commercial aspects must be completely separate from the development phase of the programme; and there must be a clear definition of the body with which ESRO would have to deal and its responsibilities *vis-à-vis* the ESRO Council.[98]

In the event, the STC, with the Italian delegation voting against and the Belgian and Spanish delegations abstaining, adopted a recommendation to the Council essentially identical to the statement issued by the group of scientists one month before.

The subsequent development of discussions about the European space policy made it clear that very little room existed for the scientists' arguments within the framework of the strong political and economic interests in conflict. Just a few months after the STC meeting cited above, the outburst of ESRO's financial crisis and the start of negotiations in view of the planned ESC meeting of July 1967 virtually blocked the decision-making process on ESRO's future scientific satellite programme and cast a shadow on the very implementation of the programme already defined (the TD programme and the LAS project).[99] Nor did

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[98] *Ibidem*, p. 20. The very same conditions had been expressed by Bolin just a few days before at the meeting of the CO/STC working group (fn. 47: "Summary Report", p. 2–3).

[99] Russo (1992a) and (1992b), Krige (1992b). The TD programme consisted of two medium-size satellites for scientific investigation in the field of astronomy and solar-terrestrial relationship, to be launched by a *Thor-Delta* rocket.

the Rome conference clear the situation, as we have seen, pending the conclusions of the Causse Committee. It became clear to scientists that their hopes and expectations could only be satisfied within a framework defined at political level, in which all aspects of space activities found a proper place. In this framework science could only be one, and certainly not the most important, aspect. For national governments and policymakers, space research alone could not justify the enormous technological, industrial and financial stress that the construction and launching of spacecraft demanded. And for the space science community the only possibility to foster their disciplines was to profit as much as possible from the political, economical, and industrial machinery set in motion by the rapid development of applications satellites. "In the real world an isolated scientific programme will not be viable itself," the ESRO General Report commented, and the European space scientists realized that the control over the organization they had created 6 years before was definitely slipping out their hands.[100]

1968–1970: MORE POLITICAL NEGOTIATIONS AND NEW TECHNICAL STUDIES

In spite of their enthusiastic reading of the Causse report in December 1967, Bondi's and the ESRO staff's optimism was not justified. The first negative signs had already manifested themselves in the course of that year: in May de Gaulle's veto against the British application for full membership of the European Community had nullified the main political rationale for Britain to continue supporting ELDO; two launch failures of *Europa I* in August and September, due to malfunction in the French second stage *Coralie*, called the design of the whole project into question; and in the United Kingdom, important political circles insisted that Britain should oppose any further investment in ELDO–PAS and should not take part in the television system proposed by the CETS, arguing that European countries should relinquish their programmes in communications satellites in exchange for a reduction of Comsat's dominant position in Intelsat.[101] Then, in early 1968, the U.K. and the Netherlands firmly opposed a request from the ESRO directorate, supported by Causse and by the majority of the CETS and

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100 ESRO, *General Report*, 1968, p. 11.

101 Estimates Committee (1967).

ESC delegations, to authorize a new expenditure of 0.8 MFF in order to enable ESRO, pending the ESC Bonn meeting, to retain the team of engineers that had carried out the studies of the CETS project and to prepare the pertinent tender documents.[102] Finally, called to give its opinion on the Causse report, the British government announced in April 1968 that the United Kingdom would not undertake further financial commitments to ELDO and would not participate in the CETS project for the Eurovision satellite.[103]

The announcement came as a political bombshell that struck all those who kept advocating a European "balanced space programme". Three meetings of the ELDO ministerial conference were held in four months in order to keep the *Europa* programmes going on, in spite of the expected overspend above the ceilings fixed in July 1966, and to determine the conditions for keeping the Organization alive.[104] As to the CETS, its Committee of Deputies held a meeting in London on 16–17 May to overcome the British position and to define a joint policy document in view of the forthcoming Intelsat negotiations. All efforts aborted, however, and the very legitimacy of CETS' role was put in question. In the words of ESRO's legal adviser, H. Kaltenecker:

> This example shows clearly the inefficiency of the CETS body as such and the need to establish in Europe a strong guidance in this respect. [...] I think that the time is ripe for the ESRO Secretariat to make its position clear. We have the obligation to make clear to Member States, with a view to our future planned activities in the application satellite sector, what legal, administrative, political and technical consequences might arise if the European position with regard to the establishment of regional systems is not strongly safeguarded in future Intelsat arrangements.[105]

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102 ESRO/C/311, 30/11/67, and add. 1, 27/3/68; ESRO/C/327, 5/2/68. Documents and correspondence related to this episode are in folders 397 and 402.

103 "Space cutback by Britain puts ELDO future in doubt" and "ELDO: the booster we can well do without", *The Times*, 17/4/68. See also Krige (1992c).

104 The three sessions of the ELDO ministerial conference were held on 11–12 July, 1–2 October, and 11 November 1968, and are reported on respectively in *ESRO/ELDO Bulletin*, nn. 2 (August 1968), 24–29; 3 (November 1968), 21–32; 4 (January 1969), 39–41.

105 ESRO, Memorandum from Kaltenecker to Bondi, 10/7/68, folder 1143. A note from the ELDO Secretariat expressing similar concern is attached to the memorandum. See also "More

For ESRO (and ELDO) top management a possible way out was that the Intelsat question be discussed within the framework of the ESC, "even if that means that the CETS loses its last reason of being." The situation was not better there, however, given the tight political interlacement between communications satellites and launchers. In this disarray there was no foundation for convening the new meeting of the ESC to discuss the Causse report, and the ESRO telecommunications programme could certainly not start. If we consider that, in the same period, ESRO was still without an agreed level of resources for its second three-year period and, moreover, it was suffering from the dramatic failure of the TD programme, we can fully appreciate Bondi's comment one year later: "In the early summer of 1968, it was hard not to despair of a European space future".[106]

The Bad Godesberg Conference

By the end of the year a possible compromise had been worked out and the third meeting of the European Space Conference could finally be called, on 12–14 November 1968 in Bad Godesberg.[107] This compromise was based on three main elements. Firstly, it was decided that one European space organization should be created out of the existing ESRO, ELDO and CETS, and a Committee of Senior Officials was set up to work out the procedures for the amalgamation. Secondly, it was agreed that the programme of the new organization should consist in a minimum programme, mandatory for all member states, and a number of optional programmes, in which only interested states would participate. While it was clear that launcher development was to be considered as an optional programme, the

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negotiation for Intelsat", *Nature*, **218**, 714 (25 May 1968). The inability of CETS to reach consensus *vis-à-vis* the Intelsat negotiations is again registered by Kaltenecker six month later, in a memorandum dated 24/1/69, commenting on the meeting of the CETS Committee of Deputies of 22/1/69; and again by ELDO's M. Bourély in a report dated 3/11/69, on the meeting of the same body of 29–30/10/69: both in folder 1143.

106 Bondi (1969), p. 4. See also Bondi (1984). For the crisis of the TD programme see Russo (1992b).

107 ESC, Bad Godesberg meeting (12–14/11/68), CSE/CM(November 68)PV/1-4, 12-26/11/68. The resolutions adopted at the Bad Godesberg conference are in *ESRO/ELDO Bulletin*, n. 4 (January 1969), p. 8–13.

actual content of the minimum programme was left open, pending the definition of the new Convention.[108]

Finally, the third element regarded the controversial issue of launchers. It was agreed that the interested member states could continue developing the programme for a European launcher, on the basis of a revision of the ELDO-PAS project made necessary to keep it within the foreseen budget. It was assumed that the European countries should undertake on average two launches per year but, in order to protect the interests of non-launcher states, which feared that the ELDO rocket would be too much expensive, it was agreed that these states should not pay for any price difference higher than 25 per cent of the price of comparable non-European launchings.[109]

Two important decisions were taken by the Bad Godesberg conference regarding ESRO: the first was the authorization to the ESRO Council to approve a level of resources for the scientific programme in the three-year period 1969-71 in the amount requested (860 MFF); the second was the authorization of financial commitments for individual scientific projects extending beyond 1971, i.e. beyond the period covered by the original ESRO Convention. The Conference, however, frustrated ESRO's plans in the application satellite field. It granted in fact the sum of 5 MFF per year to pursue preliminary studies on various application programmes, but it did not authorize the start of development work on the Eurovision satellite and the interested Governments to express their opinion as to their participation by 1 March 1969. Subsequently, a governmental conference would be called "in order to reach a decision on the execution of the project on the basis of the economic and technical information available."[110] This further delay was considered with some disappointment in ESRO: "[It] is bound to have ill

108 An anticipation of optional programmes was the agreement on the TD-1 satellite project, approved by the ESRO Council in October 1968 as a "special project" funded by all member states bar Italy: Russo (1992b).

109 A crude analysis of the conflicting feelings and interests regarding the launcher problem is offered in Bondi's comment on the Bad Godesberg conference: Bondi (1969).

110 *ESRO/ELDO Bulletin*, n. 4 (January 1969), p. 9. The sum of 5 MFF is reported in ESRO, *General Report*, 1968, p. 12. The figure in the conference resolution is 1 MAU. Besides continuing studies on the television satellite, the Conference recommended the start of studies on other application projects such as meteorological satellites, satellites for air and maritime traffic control, semi-direct TV broadcasting, and earth resources.

effects in industry and to lower their confidence in us," Bondi commented in this respect.[111]

More ELDO problems

The lack of decision derived again from the unsolved problems in ELDO. The Bad Godesberg compromise, in fact, was based on a sort of "confidence trick" which would be put to the test at the following ELDO Council meeting.[112] By an important volte-face on its space policy, in fact, the U.K. government, represented at the conference by the Minister of Technology A.W. Benn, announced that it would support application satellite programmes in ESRO, including the CETS relay satellite. Britain however conditioned her financial participation in such programmes on her release from commitments to ELDO under the existing arrangements.[113] This condition was not accepted by other ELDO partners in Bad Godesberg and all decisions were thus deferred to the next ELDO Council meeting which, in turn, was postponed in order to see the outcome of the key F7 test flight of *Europa I*, the first orbital test with all three stages operational.

The test, on 29 November, was a failure, due to a malfunction in the German third stage *Astris*, and the Council meetings held on that same day and then on 19-20 December could not go better.[114] The British and Italian governments formally announced that they were unwilling to pay their full share for the completion of current programmes and were not interested in participating in the future programmes. As a consequence, the 1969 budget could not be voted by the Council and a new ministerial conference of ELDO member states was called.[115]

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111 Bondi (1969), p. 6. The frustration of the ESRO staff regarding the progress of the communications satellite programme is also evident in ESRO, *General Report*, 1968, pp. 89-92.

112 "A key to European future", *Nature*, **220**, 730-731 (23 November 1968). See also, *ibidem*, the pessimistic editorial on the conclusions of the Bad Godesberg Conference: "Europe leaps into the dark", pp. 727-728.

113 CSE/CM(November 68)PV/1, Annex 3.

114 The F7 test flight is described in *ESRO/ELDO Bulletin*, n. 4 (January 1969), 14-19. A very short report on the council meetings is *ibidem*, 40-41. The dramatic development of discussions can be appreciated from the minutes: ELDO/C(68)PV/7, 12/12/68, and ELDO/C(68)PV/8, 17/1/69.

115 Italy's disillusion with ELDO derived from the fact that, in order to keep the project within the 1966 budget, the *Europa* programme had been scaled back by cancelling the apogee motor and the PAS test satellite, both contracted with the Italian *Compagnia Industriale Aerospaziale*.

The conference took place on 15 April 1969 and a solution was found to the Organization's new budgetary crisis, with France, Germany, Belgium and the Netherlands agreeing to make up the difference resulting from the reduction of the British and Italian contribution. At the same time, in adherence to the programme described in the Causse Report, these four countries, together with Australia and Italy, decided to start studies on a new rocket, the two-stage *Europa III*, capable of launching geostationary satellites with a mass up to 700 kg, the size of the communications satellites foreseen in the 1970s. Finally, the Conference authorized ELDO to study the conditions for producing not only prototype rockets but ready-for-use *Europa* launchers on behalf of commercial users. This "production programme" was much sought after by France and Germany, in view of their eventual order for two *Europa II* rockets to launch *Symphonie*.[116]

Dragging on

The uncertainty over ELDO affected negatively the progress of the Eurovision project in ESRO, and the compromise on the ELDO budget reached in April did not ease the situation. In fact, the governments interested in the CETS/EBU experimental satellite were unable to decide on participation in the project by 1 March 1969, as requested by the Bad Godesberg conference, and an attempt by Bondi to convene a governmental conference on the CETS-C project in June or early July aborted because of the ongoing uncertainties.[117]

Although the attitudes of most governments appeared favourable, the time was not ripe yet for a governmental conference to approve the project for at least three reasons. The first naturally regarded the launcher problem: even considering the new compromise reached on ELDO, the PAS satellite project had to be considerably modified in order to be adapted to the requirements of the CETS-C satellite and, moreover, most of the development costs of the system (e.g. ground facilities and the apogee motor) were now to be borne by the CETS programme.

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[116] The resolutions approved at the ELDO ministerial conference are reported in *ESRO/ELDO Bulletin*, n. 5, (May 1969), pp. 19-30. The growing importance of Germany in ELDO is testified by the fact that the Conference agreed that German should become the third official language of the Organization, "enjoying equal status with English and French."

[117] Information for this paragraph derives from correspondence and other documents in folder 1143.

In this situation, ESRO engineers were requested to study the possibility of launching the CETS/EBU satellites by means of a *Thor–Delta* rocket instead of *Europa II* and to compare the two options. The study showed that the use of the American launcher was technically feasible and possibly cheaper.[118] As a matter of fact, the ESRO staff wanted to de-couple the satellite project from the controversial question of the choice of the launcher, but this, of course, was opposed by the French delegation at the CETS. It was then agreed to keep the satellite associate with the ELDO launcher but to consider the possibility of using a *Thor–Delta* after about 2 years after the start of the satellite project. As a consequence, the industrial studies for the definition phase of the project were requested to consider both options as to the launching vehicle. However, given the complete uncertainty about the launching system to be eventually adopted, no reliable information could be obtained on how much money would be tied up in the expensive launcher business and the financing of the programme remained uncertain.[119]

The second reason for uncertainty regarded the selection of prime contractorship for the programme management. ESRO's study foresaw that this should be entrusted to ESRO itself but CETS member states insisted that it should be entrusted to industry. A first compromise was worked out by the ESRO Secretariat in May 1968, which was approved by the CETS. It foresaw a rather muddled procedure which involved complex sharing of responsibility between CETS, ESRO, a prime contractor, and several subcontractors. Eventually, ESRO's usual method of placing a contract for the whole project with one industrial consortium was adopted, but with some modification in order to have a prolonged competitive phase. This involved a first phase where two or three consortia were contracted to prepare design studies of the project, and then a competitive evaluation to select the consortium to carry out full development.[120] The formation of industrial consortia in the field of satellite telecommunication and the definition of appropriate tender actions were thus necessary pre-conditions for further

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118 Telex from P. Blassel to J. Dinkespiler, 14/10/68, in folders 402 and 1143.

119 Simmons to Bignier, 20/12/1968 (reporting on a joint TPS/ESRO/EBU meeting on 18/12/68); ESRO's L.T. Trollope, notes on the CETS STC meeting of 8/1/69: both in folder 1143. CETS STC, meeting of 30/9/69, SCL/ST.35/Report, 20/10/69, folder 397.

120 Information for this paragraph is from documents in folder 402.

actions in the ESRO/CETS programme. This was not plain, however, "since the Member States did not all have a common industrial policy in this respect," as the ESRO staff remarked disconsolately.[121] In fact, the competition regarding industrial leadership to be gained in this new field was added in this case to the ever present problem of fair geographical distribution of contracts. The problem was further complicated by the presence of the already established consortium working on *Symphonie*.

The foreseeable competition with *Symphonie* was in fact the third reason for uncertainty. It was evident that the European market for regional communications satellites could not sustain two competing products and therefore only one project could survive for operational activity after the experimental phase. Delicate technical, industrial, and political issues were thus involved in any decision regarding the "European" project. After the Bad Godesberg conference, the ESRO engineers prepared two documents to confirm the validity of the *Eurafrica* satellite for the Eurovision needs, and to stress the superiority of its design with respect both to the Franco-German project and to the *Intelsat III* satellite.[122] At the same time, however, the *Symphonie* industrial consortium and the executive committee of the project started studying new versions of the satellite, *Symphonie B* and *C*, which satisfyed the EBU specifications and involved a wider range of European industry.[123]

The problem then was whether and how to correlate the *Symphonie* programme and the ESRO/CETS programme, and this involved technical issues (i.e. compatibility between the two designs), industrial competition (i.e. the relationship between the *Symphonie* industrial consortium and other European aerospace and communications industries), and political questions related to the further development of the European space telecommunications programme (from TV relay to semi-direct and direct TV distribution) and of the ELDO launcher

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121 ESRO *General Report*, 1968, p. 90.

122 "The distribution of Eurovision by satellite: the interest of the pre-operational CETS-C project", 31/12/68; and "Comparaison des satellites CETS-C, Symphonie, Intelsat III et Intelsat IV au point de vue de l'Eurovision", 3/1/69: both in folder 1143. The initiative to prepare these documents had been taken at the joint TPS/ESRO/EBU meeting cited in fn. 117.

123 Davidson (1970), p. 12. *Symphonie* and CETS-C were the object of careful comparison by the EBU representative at the 35th meeting of the CETS Space Technology Committee (30/9/69), SCL/ST.35/Report, 20/10/69. See also Collette (1992).

programme (from *Europa II* to *Europa III*).[124] In this respect the position of the CETS remained a very difficult one, as it officially sponsored one project (the *Eurafrica* satellite) but its two most influent members were engaged in a competing project.[125] Nor was ESRO's position easier, for the very same reason.

The PTTs step in

At the end of June, the EBU made an official request to the ESC, "asking to be told the Conference's intentions with regard to the development of a space system for television distribution."[126] Following this move, the Committee of Senior Officials of the ESC asked ESRO to start an industrial consultation in order to obtain definite proposals for the realization of the *Eurafrica* project. It also recommended that a governmental conference should be called by mid–November in order to take a decision, at least, on the execution of the television satellite programme, and to inform accordingly the EBU Administrative Council, whose meeting was scheduled for 20 November.[127] Three large industrial consortia responded to the request of consultation and submitted their proposals which, after proper evaluation, were presented to the Committee of Senior Officials on 3–4 November.[128]

Here, however, two new facts presented themselves that put everything in discussion again. Firstly, the EBU reported on their pessimistic conclusions about the costs of the 1975–1985 operational phase: after their new evaluation, a

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124 These aspects are presented in an unsigned and undated handwritten note with the title "The problem of Europe's telecommunications satellite", in folder 1143. The author is most probably Bondi and it appears that the note was written in spring 1969.

125 An example of this difficulty is given by the discussions at the meeting of the Committee of Deputy of the CETS of 29–30/10/69, as reported by ELDO's M. Bourély to ESRO's and ELDO's directorates, 3/11/69, folder 1143.

126 ESRO, *General Report*, 1969, p. 124. See also "The European Space Conference", *ESRO/ELDO Bulletin*, n. 6 (July 1969), p.15.

127 Resolution adopted by the ESC's Committee of Senior Officials at its meetings of 3–4/7/69 and 28–29/7/69: CSE/HF/(69)28, 29/7/69, in folder 397.

128 The three consortia were led respectively by Hawker Siddeley Dynamics (with Matra, Erno, Saab, Fiat, and LCT), Thomson–CSF (with Fokker, Dornier, Elliot, Fiar, and GEC–AEI), and MBB and British Aircraft (with Nord and Sud Aviation (both merging later in Aérospatiale), ETCA, Selenia, Siemens and AEG–Telefunken). The latter consortium was essentially that of *Symphonie*. ESRO, *General Report*, 1969, pp. 124–127.

television relay satellite system embracing Europe and North Africa would be more expensive than the terrestrial Eurovision network it sought to replace. Secondly, the CEPT announced that they wished to be involved in the definition of a European communications satellite on behalf of PTT administrations. This of course was to provide allowance not only for television but also for other classes of traffic of interest for the PTTs, such as intra-European telephony, telegraphy and telex traffic, and data transmission.

Two main reasons can be identified for this change of attitude by the PTTs. The first is the now demonstrated technical and commercial reliability of communications satellites, and the growth in demand of telephony services they had determined. We should recall in this respect that the PTT move happened just after the new *Intelsat III* satellites started providing world coverage for telephonic traffic and TV links with the moon. The peculiar role of satellites *vis-à-vis* cables (i.e. not only competition but also complementarity) in a world-wide telecommunications system was now evident. Satellites orbiting above oceans and continents, rather than cables laid across mountains and seas, provided easier and less expensive links with underdeveloped countries in large regions of the earth, and allowed greater flexibility in handling large fluctuations in the demand (e.g. when important events like the Olympic Games or the outbreak of a local war called for much more capacity).

The second reason was more political and regarded the on-going negotiations for the definitive Intelsat agreements, started in February 1969. We shall not deal with this matter here but a short comment may be useful.[129] European countries wanted to remove Comsat from its dominant position and advocated the right to establish regional systems of satellite telecommunications besides Intelsat's global network. The European space industry, represented by Eurospace, was very active in supporting these concepts but it was also necessary that the PTT

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[129] The Intelsat negotiations started on 24 February 1969, in the presence of delegations from 63 Intelsat member states (they had become 77 by the time of the closing of the conference, in May 1971) as well as from the United Nations, the International Telecommunication Union (ITU), and ITU member states not Intelsat members. The Conference held three sessions at plenipotentiary level: in February-March 1969, February-March 1970, and May 1971. The final vote for the definitive agreements took place on 21 May and then, after the necessary ratifications, the permanent structure entered into force on 12 February 1973. Alegrett (1979); Galloway (1972), pp. 155-164; Smith (1976), pp. 141-155.

administrations should play their part. Thus, a political pressure likely existed on them to adopt a more sanguine approach to satellite telecommunications. We can recall in this respect that in the autumn of 1969 the United States finally agreed to the establishment of regional systems, provided that a two–thirds vote of the Intelsat Assembly recognized there would be no economic or technical incompatibility between the two systems.[130]

Facing the new situation, the Committee of Senior Officials decided to submit the ESRO/CETS mission to fresh study and set up a joint working group of representatives of ECS, CEPT, EBU, ESRO and ELDO. The terms of reference of the Working Group were to study the possibility of carrying out an economically viable European communications satellite programme that could satisfy the requirements of the CEPT and EBU for the period 1975–1985. In the first phase, the satellite was to be compatible with the capability of the *Europa II* launcher.[131]

By April 1970, the study on the new mission was completed and a report issued. It recommended a two–phase approach: an initial (ca. 200 Kg) experimental satellite carrying about 1000 telephony circuits and one television channel, suitable for launch by *Europa II* in 1975, followed by a major (400 to 500 Kg) satellite carrying up to 4000 telephony circuits and two television channels for launch around 1980. The Ministers of Posts and Telecommunications of the CEPT countries, convened in Brussels on 28 April 1970, endorsed the project.[132]

Again ESRO was ready for the new meeting of the ESC, scheduled on 22–24 July 1970 in Brussels.[133] Three years had elapsed since the Organization's first studies on a communications satellite for CETS, and almost two years since the

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130 Galloway (1972), pp. 155–164; Smith (1976), pp. 141–151. Eurospace's position was expressed in Eurospace (1969).

131 "The European Space Conference", ESRO/ELDO *Bulletin*, n. 8 (January 1970), pp. 10–11; "Studies on application satellites", ESRO/ELDO *Bulletin*, n. 9 (April 1970), pp. 18–19; ESRO, *General Report*, 1969, p. 124;

132 Davidson (1970). A summary of the Joint Working Group's report and of ESRO's comments on it are in Select Committee (1971), pp. 242–244.

133 Together with the developments on the communications satellite programme described above, we should mention that, in accordance with the Bad Godesberg resolutions, first studies were pursued in 1969 and early 1970 on two other kinds of application missions, namely on an air traffic control satellite for the North Atlantic (in co–operation with NASA) and on a meteorological satellite (in consultation with the meteorological offices of member countries): "Studies on application satellites", *ESRO/ELDO Bulletin*, 9 (April 1970), 18–19.

previous ESC session, in Bad Godesberg, which had officially entrusted to ESRO the task of developing application satellite programmes. In the words of the Organization's Director General:

> During this period, although considerable progress has been made in the studies, ESRO has been rather like an athlete "limbering up" in anticipation of the starter's gun, at the same time being somewhat uncertain when the gun would, in fact, be fired.[134]

ESRO, however, felt confident that a reliable partner had now been found and a politically appropriate framework created: the PTT administrations in fact not only held legal monopolies on telecommunications but also were part of the governments of the countries which were to be involved in the programme. In spite of the difficulties and delays in the actual implementation of the Bad Godesberg compromise, the ESRO staff could sound a note of optimism once again:

> In these conditions, it is not unreasonable to expect the first half of 1970 to lead to our governments' eagerly awaited full approval of the development of a telecommunication satellite and to hope for the approval of a second line of applications before the end of the year. [...] Applications stand at the very hinge of Europe's future in space. Without a true involvement in applications, there can be no united political will, no increasing industrial involvement, and no comprehensive or indeed comprehensible direction to the space effort.[135]

1970–1971: The Crisis of the European Space Conference and the ESRO "Package Deal"

Once again, the optimism was not justified. Two sessions of the fourth meeting of the European Space Conference, on 22–24 July and 4 November 1970, did not succeed in fact in reaching an agreement on the critical issues of launcher

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134 Bondi (1970).

135 ESRO, *General Report*, 1969, p. 9.

development and relationship with the United States.[136] The latent crisis that had for some years characterized the European space activities burst out at the second meeting, where "the disunity between the countries favouring a 'coherent policy' including an independent European launcher effort and the others reached such a magnitude that the meeting broke up."[137] By the end of the year the plans for a unified European organization that had dominated discussions for two years had dramatically receded and the future itself of Europe in space appeared rather grim. Denmark and France went so far as to denounce the ESRO Convention in order not to incur financial obligations extending beyond the first eight year period.

Given this situation, progress in the field of application satellites could only be very slow, in spite of the fact that, at the first session of the Conference, "there was unanimous recognition of the fact that applications satellites – in particular television satellites – must form the central element of any space program worthy of Europe."[138] In July, in fact, the ESC did finally decide to undertake a programme aimed at the launch of the CEPT/EBU satellite, but the Conference authorized and funded only the very first stage of the programme. Of the total cost of the project, estimated at 450 MAU, only a sum of 5 MAU was made available to ESRO up to mid–1971. This was certainly "a considerable step forward from the 1 MAU per annum previously available for the whole application programme," Bondi commented, but not yet a definite green light to programme development. Positive decisions were also taken regarding two other application programmes, namely the start of an aeronautical satellite programme, in

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136 ESC, Brussel meetings (22–24/7/70 and 4/11/70), CSE/CM(July 70)PV/1–3 rev., 30/7/70; CSE/CM(November 70)PV/1–2, 4/11/70 and 19/11/70.

137 ESRO, *General Report*, 1970, p. 9. The November meeting concluded with a press release because the participants could not agree on a formal resolution: *ESRO/ELDO Bulletin*, n. 12 (November 1970), pp. 6–7. It must be recalled that the July meeting of the ESC was held about one month after the F9 launch of *Europa I*, which failed again because of the accidental disconnection of a plug during the powered flight of the first stage. The nose fairings were not jettisoned and, moreover, a deficiency of third–stage thrust occurred in its flight. As a result, "the planned orbit was not achieved [and] the combined third stage and nose fairings enclosing the satellite flew over the North Pole zone and came down in the Caribbean north of Guiana." The satellite carried a communications experiment built by a number of CETS member states. *ESRO/ELDO Bulletin*, n. 10 (June 1970), 10–11, on p. 11.

138 Foreword of T. Lefèvre, President of the ECS, to *ESRO/ELDO Bulletin*, n. 11, September 1970, p. 4. This issue of the Bulletin is entirely devoted to the July meeting and reports the resolutions approved.

cooperation with NASA, and the study of an operational meteorological satellite programme, in consultation with the European meteorological authorities. The sums of 5 MAU and 2.5 MAU were allocated for these programmes, respectively, up to end 1971.[139]

The persisting uncertainty about the future of Europe in space did not allow the participants in the ESC July meeting to enter into a more resolute commitment. It was decided that decisions to proceed to the next stages of the application programmes would be taken later by a "double qualified majority", namely a positive vote of two-thirds of the states and two-thirds of the contributions. This was enough to justify Bondi's prudent optimism in September; the dramatic conclusion of the November meeting showed that much still had to be done.

Europe and the United States: launchers and post-Apollo programmes

The 1970 crisis marked the highest point of conflict between European countries regarding their space policy.[140] Two correlated areas of controversy can be identified. The first regarded the everlasting launcher problem, i.e. whether Europe should build its own vehicle or rely on American launchers. This question was tightly intertwined with the degree of involvement in satellite communications and with Europe-USA relationships. The United States, in fact, had always been available to provide launching facilities for European scientific satellites; its position however was quite ambiguous regarding application satellites and it appeared that the U.S. would hardly launch communications

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139 The quotation is from Bondi (1970), p. 28. It was also agreed that the aeronautical satellite programme should be given the same priority as the communications satellite programme, and that the CETS should no longer concern itself with the question of the CEPT/EBU satellite under development with ESRO and ELDO. Finally, it must be recalled that studies on other application satellites (earth resources, and direct and semi-direct television broadcasting) were also authorized within the budget allocated to the meteorological programme. For a description of progress work in these application satellite programmes by the end of 1970, see ESRO *General Report* 1970, 9-17.

140 A contemporary account of the crisis, as seen by an advocate of a joint European effort in space between the July and the November ESC meetings, is given in Tassin (1970). A detailed analysis of the political and institutional aspects of this turning point in the history of Europe in space will be the object of a future report. See, however, Krige (1992c). We limit ourselves here to aspects related to the topic of this paper.

satellites competing with the Intelsat system.[141] For Britain the situation was plain: Americans should be trusted, the Intelsat system was as reliable and economical as the American launchers, and it made no sense to embark on uncertain and expensive programmes to achieve European independence.[142] For the pro-launcher countries (France, Germany, and Belgium), on the contrary, independence was a political need which did the economic considerations justice. While recognizing Intelsat's monopoly over transoceanic communications, these countries were not prepared to waive their willingness to operate a regional system covering Europe, Africa and the Middle East. The implementation of such a system was considered politically necessary to keep control over television distribution in countries under European cultural influence; useful from the industrial point of view because it permitted to master the technology of communications satellites; and commercially interesting in view of the potential market for regional communications satellites in Third–World countries. Unlike the British, they were sceptical about the American willingness to launch European application satellites, and insisted that a coherent European space policy without launching capability would be meaningless. But a European launcher development programme without the UK was impossible, for technical reasons (*Blue Streak*, *Europa I* and *II*'s first stage and the only one that had performed successfully, was British), for financial reasons (the need to share the costs for the more ambitious *Europa III*), and for commercial reasons (the assurance of a suitable market). And as Britain refused to be involved in any further development of the *Europa* programme, the situation came at a deadlock.

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141 Report of the ESC president T. Lefèfre on his mission to the U.S., *ESRO/ELDO Bulletin*, n. 12 (November 1970), pp. 4–6. See also the letter from the US Undersecretary of State A. Johnson to Lefèvre, 1/9/71, in ELDO, *Rapport Annuel au Conseil de l'Europe pour 1971*, Annex VII, pp. 48–51. See also Schwarz (1979), p. 219–220. M. Lévy, at that time scientific counsellor of the French Embassy in Washington and official French representative to NASA, recalled that when he officially requested the use of an American launcher *to put Symphonie* in orbit, he was told by NASA top officials that they would provide the launcher only after formal assurance that this was only an experimental satellite, with no commercial future: Lévy's interview with J. Krige (in the framework of the ESA History Project), 6/11/1992, p. 2 of transcript.

142 For the British position on Intelsat, see Select Committee (1971), pp. xxviii–xxx and 240–242. It should be noted that the British government decided to cancel its lightweight satellite launcher *Black Arrow* since the American *Scout* rocket (less costly and better performing) was available without limitations for scientific experiments, while in Europe the French launcher *Diamant B* provided similar capacity: Schwarz (1978), p. 223; Bondi's witness in Select Committee (1971), p. 194.

The second area of controversy regarded Europe's position *vis-à-vis* the American post-Apollo programme. The issue had originated when, in October 1969, NASA's Administrator T. Paine presented to the ESC Committee of Senior Officials their plans and programmes for the 1970s, and invited Europe to co-operate in the development of a space transportation system based on a reusable space shuttle.[143] The attitude of the various European countries towards NASA's offer was much variegated and reflected interests and concerns deriving from national policies. France was rather lukewarm towards collaboration with the United States and argued that any participation in post-Apollo projects should not hamper the European launcher development programme. The United Kingdom had little interest in any substantial participation in the post-Apollo programmes, because of financial constraints, but it would accept some commitment within the framework of a joint Europen participation as this would certainly imply the relinquishment of the launcher programme. Finally, Germany became the main advocate of a substantial European contribution to the post-Apollo programme. Following internal political changes (with the coming to power of the Social Democrats and the start of the "Ostpolitik"), the German government wanted to strengthen its political ties with the United States and to foster collaboration in the most advanced scientific and technological domains. In the event, Germany made it clear that participation in post-Apollo was definitely more important for her than continuing in the *Europa III* programme.[144]

With France, Britain and Germany providing about three-quarters of the total ESRO and ELDO budget, no progress could be made without finding a compromise satisfying these three countries' interests. The deadlock about the possible definition of a coherent European space policy was to last for more than two years, and only in 1973 was a solution finally written in the so-called "second package deal". In the meantime, a first "package deal" had been agreed on by ESRO member states.

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143 Paine's address is in *ESRO/ELDO Bulletin*, n. 8 (January 1970), pp. 12-16.

144 Schwarz (1970).

The ESRO "package deal" of 1971

Commenting on the grim events of 1970, the Chairman of the ESRO Council, the Dutch scientist H. van de Hulst, wrote:

> If the metaphor is correct, that the European Space Conference is the roof covering the various space activities and organizations in Europe, then ESRO has in 1970 been working under a leaky roof. This had no immediate effects on the quality or quantity of the work done internally but by the end of the year staff and delegations were making ready to push the furniture around once it became clear where the drip would come through the ceiling.[145]

In fact, facing the failure of the European Space Conference, ESRO member states agreed that their delegations to the Council should negotiate further, leaving aside the problems which had led the ECS to deadlock. In spite of the difficulties and setbacks in the definition of a global space policy for Europe, and against the failure of ELDO and CETS, ESRO had proved to be sufficiently reliable and successful in its work, acquired maturity and competence in managing industrial contracts, and already established a firm basis for the development of applications satellites, which appeared to be the true political and economic *rationale* for European co-operation in space.[146]

The new Chairman of the Council, the Italian physicist G. Puppi, who had been the Chairman of the ESC Committee of Senior Officials, was given the task of negotiating a suitable compromise in order to drive the Organization, as smoothly as possible, to its new institutional obligations in the application field and, at the same time, to offer European space policymakers new ground for negotiations. After one full year of intense negotiations and several Council meetings, the compromise was worked out and it became known as the "first package deal".[147]

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[145] H. van de Hulst's "Foreword" to ESRO, *General Report*, 1970, p. 5.

[146] "Statement by the Director General" at the 35th session of Council (22/12/70), ESRO/C/483, 18/12/70. See also van de Hulst's letter to the ESRO Council delegations (5/12/70), ESRO/C/473, 10/11/70.

[147] ESRO Council, 44th session, (20/12/71), ESRO/C/MIN/44, 6/1/72. The Council resolution is reported in ESRO, *General Report*, 1971, p. 129–132, and in *ESRO/ELDO Bulletin*, n. 17, (February 1972), p. 6–11.

From the point of view of this paper, the main aspect of the deal is the decision that ESRO should finally cease to be an organization solely devoted to scientific research and undertake three application satellite programmes with different sets of Member States involved (optional programmes), namely:

a) An aeronautical satellite programme, with the participation of Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom, in co-operation with the U.S. Federal Aviation Administration. The maximum level of resources made available by European states for this programme was not to exceed 100 MAU.[148]

b) A meteorological satellite programme, with the participation of Belgium, France, Germany, Italy, the Netherlands, Sweden, Switzerland and the United Kingdom. The maximum level of resources made available by these States was fixed at 115 MAU.[149]

c) A communications satellite programme, with the participation of Belgium, France, Germany, Italy, Sweden, Switzerland and the United Kingdom, according to plans already established for the CEPT/EBU mission.[150]

These three programmes were to be executed simultaneously and, at the same time, ESRO would also carry out exploratory studies in other application fields. In particular these studies regarded satellites for earth resource survey, for maritime navigation, and for semi-direct and direct TV broadcasting.[151]

The dramatic growing importance of application programmes in the work of the Organization can be appreciated if one considers that for the years 1972, 1973 and 1974 these were to be provided for by the participating Member States at 22.8 MAU, 48.5 MAU and 63.4 MAU respectively, eventually reaching an annual level of resources of 72 MAU in the period 1975–1977. ESRO's four major countries (France, Germany, the United Kingdom and Italy) agreed in principle to contribute to a minimum total level of resources of 70 MAU per year from 1974 to 1980 for the application programmes. In comparison, the budget for the

[148] Canada was also involved in the programme and eventually Denmark joined the other ESRO member states. All figures are at mid–1971 prices.

[149] The agreement to proceed with the Meteosat Programme was eventually signed in 1972 by Belgium, Denmark, France, Germany, Italy, Sweden, Switzerland, and the United Kingdom.

[150] Eventually Denmark joined the programme.

[151] Studies on such missions had already started in 1971 and are described in ESRO, *General Report*, 1971, pp. 53–56

scientific satellite programme for 1972, 1973 and 1974 was fixed at 42.7 MAU, 37.0 MAU and 32.7 MAU respectively, eventually reaching the level of 28 MAU in the years 1975–1977 (Tables 2 and 3, and Fig. 7).[152]

The 1971 package deal for ESRO was made possible by essentially two key elements: the implementation of the optional programme system announced at the Bad Godesberg conference of November 1968, and the exclusion of the controversial launcher problem from the negotiations. As to the former, it was agreed that only the scientific programme and the basic activities should be included in the mandatory programme, to which all member states had to contribute according to their gross national product.[153] This mandatory programme was significantly reduced, as we have seen, in order to release funds for application programmes. Participation in the latter was based on a single scale of contributions derived from the mandatory budget, with the only modification that shortfalls due to the non-participation of some member states were distributed between the participating states pro rata to their normal share.[154]

As to the hot question of launchers, the ESRO Council re-affirmed the Bad Godesberg agreement that the Organization would give priority to European launchers, "on the condition that the cost of a launching does not exceed 125 % of the cost of the relevant non-European launching." It also stated, however, that if an appropriate launcher for a specific mission were denied from outside Europe, ESRO would procure the necessary launcher for this mission in Europe, contributing to its development costs if necessary. The guidelines to be followed in this eventuality were carefully defined in the Council resolution.

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[152] All figures given above are at mid-1971 prizes and include contingency. Information for this paragraph is taken from G. Puppi's and A. Hocker's comments to the Council resolution of December 1971, *ESRO/ELDO Bulletin*, n. 17, February 1972, p. 11–14 and 14–19. For the implications of the 1971 package deal on the scientific programme see Russo (1993).

[153] The basic activities included mainly technological studies, technical information and education programmes, and common costs that could not be allocated to individual scientific and application programmes. The inclusion of technological studies in the basic activities was a matter of controversy, as reported in Hocker's comment on the council decisions: *ESRO/ELDO Bulletin*, n. 17 (February 1972), 14–19, on p. 18.

[154] This was the first step towards the concept of *à la carte* programmes, adopted in 1973 with the second package deal, according to which participating countries would negotiate between them their respective percentage contributions.

The 1971 package deal marked "the beginning of a new period in the life of ESRO."[155] The Organization was definitely transformed into a space agency mainly devoted to applications satellites with just a minor fraction of its activity and its funds devoted to science. It also represented the most important element in the ongoing discussions over the European space policy which were to lead to the package deal of 1973 and eventually to the creation of the European Space Agency (ESA) in 1975. With the spectaculiar failure of the first – and actually the last – launch of the *Europa II* rocket, on 5 November 1971, and the eventual cancellation of ELDO's *Europa* programme in early 1973, ESRO became the very core and model of the new agency.

EPILOGUE: THE STATUS OF ESRO'S TELECOMMUNICATIONS PROGRAMME BY THE END OF 1971

With the package deal of December 1971, ESRO's communications satellite programme finally entered the development phase, after 5 years of discussions and mission definition studies, and almost ten years after *Telstar*. We shall discuss the development of this programme in the 1970s in a subsequent paper; we want to conclude here with a description of the status of the programme at the time of the package deal.[156]

The telecommunications programme was the first and by far the most expensive of the application programmes. Its overall aim was "to satisfy, by the end of the present decade, a proportion of the CEPT's telecommunications requirements, including those of the EBU."[157] This included the routing by satellite up to half the total amount of telephone traffic (including telegraphy and telex); the absorption of future public telecommunications requirements for data transmission; the total replacement of the terrestrial circuits in use for television transmission between countries in Europe, and between Europe and North Africa; and the extension of the geographical coverage of Eurovision to EBU member

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155 ESRO, *General Report*, 1971, p. 9.

156 This section is essentially based on ESRO, *General Report*, 1970, pp. 9–14, and 1971, pp. 45–48; and on ESRO Director General A. Hockers' "Implementation of the Council's decisions", *ESRO/ELDO Bulletin*, n. 17, (February 1972), pp. 14–19.

157 ESRO, *General Report*, 1970, p. 10.

countries which were outside the zone of real-time television transmission (Iceland, Cyprus, Lebanon, etc.).

The estimated cost to completion was some 400 MAU, but the Council had decided that the programme should be financed in stages. In fact, phase 1 (programme definition) was nearing completion and the participating Member States had agreed to finance phase 2 (experimental phase), extending from 1972 to 1976, to the extent of 100 MAU, and to decide about the succeeding phases by mid-1975 by a double two-thirds majority (i.e. two-thirds of participating countries contributing at least two-thirds of budget). Plans for the second phase foresaw the development of the communications techniques and the spacecraft technology required for the programme, and their qualification aboard an experimental satellite. In 1975 a decision was to be taken about the content and timing of two subsequent phases: phase 3, devoted to the development of the operational satellite, including the launching and evaluation in orbit of a prototype model; and phase 4, devoted to the production of the first two operational flight units to be made available to the users.

By the end of 1970 the main technical characteristics of the CEPT-EBU mission had been defined. In particular, the use of operating frequencies above 10 GHz had been agreed on (K_u band) as well as accurate three-axis stabilization combined with sun-tracking solar array. The satellite was to be fully compatible with the projected capability of the *Europa III* rocket, i.e. about 800 kg in geostationary orbit. Then, in July 1971 three industrial studies became available, prodeuced respectively by the industrial consortia COSMOS, MESH and STAR.[158] All these studies demonstrated the feasibility of such a satellite but, at the same time, this set the stage for the eventual competition between these consortia to win the contract for building the satellite. It took two more years before a decision was reached on the final design of the satellite and contractorship. By that time, the new "package deal" within the framework of the

[158] The MESH consortium was made up of Matra (F), ERNO (D), HSD (UK), SAAB (S), FIAT (I) and TRW (USA); the COSMOS consortium of MBB & Siemens (D), Aérospatiale & SAT (F), Marconi (UK), Selenia (I) and Boeing (USA); and the STAR consortium of BAC (UK), Thomson-Houston CSF (F), Dornier (D), CGE-FIAR (I), Contraves (CH), SABCA (B), Fokker (NL) and Ericsson (S). Hochmuth (1974), pp. 91-93. The composition of these consortia evolved during the years: Dondi (1980).

European Space Conference had resolved the long controversy about the European launcher and overall space policy.

CONCLUDING REMARKS

The difficult start of satellite telecommunications in Europe which we have discussed in this paper calls for a few considerations. The first is about the importance of the political dimension in the whole story. From the technical point of view, designing and developing a communications satellite programme was an interesting and stimulating job for ESTEC engineers and an important opportunity for the European industry. The challenge was accepted and good results obtained. The economics of a European communications satellite system was quite a different matter, however, and the lack of enthusiasm among those responsible for telecommunications derived not only from their generally conservative attitude but also from the great uncertainty about the actual possibility that such a system might become more economical in comparison with the expanding ground network. As late as 1970, the estimates of the total number of telephone circuits in Europe to be routed via the satellite varied from 3000 to 5000 for 1980, 5000 to 10000 for 1985, and 8000 to 20000 for 1990. And the satellite system was expected to become more economical than the terrestrial network not before 1989 according to the pessimists, and by 1982–83 according to the optimists. And the UK Ministry of Posts and Telecommunications insisted that satellites could never be cheaper than cables for intra-European links.[159]

Here is how one of the protagonists, who was to become the Secretary General of Eutelsat, saw the situation in his recollections:

> The size of the European continent, and the relations within the countries in its western part, meant that a satellite system would only be able to involve links carrying low-density traffic. The distribution of television programmes seemed more promising, but the EBU in its

[159] The figures are from Davidson (1970), p. 13. The pessimistic view was that of the joint working group set up by the ESC at the end of 1969; the optimists were in ESRO: Select Committee (1971), pp. 242–244. The forecasts varied according to different estimates about the growth rate in total telephone traffic, the minimum distance between centres to be linked by satellite circuits, and the proportion of total traffic to be routed via the satellite.

> turn regarded the project as far too expensive, and rejected it. In 1967, then, it was still madness to talk in terms of a satellite system within Europe. Unlike INTELSAT, which was meeting a real need in improving communications between continents, a telecommunications satellite for Europe seemed on the evidence available to be a 'luxury' which Europe did not need and the telecommunications administrations could not afford.[160]

In the event, it was politics that provided the necessary impulse, and the long negotiating process that eventually led to the start of the programme was a matter of policy. The decision not to rely on the American dominated Intelsat system within the area of European cultural influence, the decision not to be dependent on American or Soviet launchers, and the decision to qualify the European industry for prime contractorship in the promising market of satellite telecommunications were all aspects of a wider political initiative which involved foreign policy, technological and industrial policy, and general economic interests. The French government was the most convinced advocate of such decisions, with the important support of Germany and Belgium; the United Kingdom was their main opponent, backed by Switzerland and the Scandinavian countries; a way out could only be found on the political ground and had to cover not just telecommunications but all aspects of space policy.

The second consideration regards "the pendulum swinging between cooperation at a European level and egocentrism at the national level."[161] Here again the issue was mainly political. Facing the American initiative in the early 1960s, the European countries felt they had to define a united position and created the CETS. This, however, was a rather hybrid forum, involving foreign ministries, PTT agencies, ministries of industry, etc. Thus, after the conclusion of the 1964 Intelsat Interim Agreements, the conflict between different interests and concerns made discussions frustrating and decisions useless, and both CETS's tasks could not be fulfilled, namely the definition of a common European position *vis-à-vis* the negotiation for the definitive Intelsat arrangement and the realization of a joint European communications satellite project. With the crisis of ELDO and the

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160 Caruso (1984), p. 107.

161 Collette (1992), p. 83.

successes of the first Intelsat satellites, in 1967–1970, the pendulum swung towards national or bi-national projects. France and Germany started *Symphonie* and Italy *Sirio*; Britain got involved in the Anglo-American defence system *Skynet*. But *Symphonie* needed a launcher, and France and Germany needed Britain to get it. The ELDO pendulum had therefore to stay in the "European" field; and in this field the ESRO directorate and ESRO's smaller member states (Belgium in particular) could play their best cards. Politics demanded that both European ventures and national programmes be protected. Finding a compromise required a long time and laborious negotiations but it had to be reached for Europe to keep a decent role in space. The 1971 package deal was an important step forward for the joint European effort, and it paved the way for the more important compromise of 1973. ESRO's project, however, still had to fight on the commercial terrain against the Franco-German project. In the event, two industrial consortia in the space telecommunications field emerged in Europe, one which was building *Symphonie* and one which was eventually contracted to build ESRO's *Orbiting Test Satellite* (OTS).[162]

Finally, a last consideration regards the "genetic change" in ESRO. The transition from a scientifically oriented programme to one primarily directed towards applications raised concern among scientists but eventually gave them the assurance that scientific investigation in space was firmly anchored to wider political and economic interests. The fact that the scientific programme was made mandatory within the framework of strong institutional and financial commitments freed the development of scientific projects from the uncertainties that had plagued the first phase of ESRO's history. Less money was available, unfortunately, but long-term planning was finally possible. From the organizational point of view, pending the outcome of ESC negotiations and the birth of the new space agency, ESRO member states had to define a new institutional framework, with new bodies delegated to deal with application matters, and the ESRO management had to re-arrange its internal organization to confront the new tasks.

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162 Collette (1992). Both satellites and their follow-ups were highly successful and confirmed Europe's technological catch-up in spite of its ten-year lag: Giget (1992).

Many important questions about the role of Europe in space remained open after the 1971 package deal, the most important being of course the ever-present problem of the launcher policy and the relationship with the United States. But the decision of the ESRO Council that the Organization should assume a multiple role was a real turning point for the history of the European space effort. The path was now open for the establishment of an organization responsible for the execution of scientific and applications satellite programmes and related industrial policy on the continental scale. Much still had to be done, but it was now impossible to go back.

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TABLE 1

	CEPT	CETS +	ESRO	ELDO
Australia *				x
Austria *	x	x		
Belgium *	x	x	x	x
Cyprus	x	x		
Denmark *	x	x	x	
Finland	x			
France *	x	x	x	x
Germany *	x	x	x	x
Greece *	x	x		
Iceland	x			
Ireland *	x	x		
Italy *	x	x	x	x
Liechtenstein	x			
Luxembourg	x	x		
Monaco *	x	x		
Netherlands *	x	x	x	x
Norway *	x	x		
Portugal *	x	x		
Spain *	x	x	x	
Sweden *	x	x	x	
Switzerland *	x	x	x	
Turkey	x			
United Kingdom *	x	x	x	x
Vatican City *	x	x		

+ All states listed below participated in the CETS meeting but some did not attend regularly

* Signatories of the Intelsat Interim Agreements

TABLE 2

	1972	1973	1974	1975	1976	1977
Scientific Programme and Basic Activities	*54.2*	*49.0*	*43.7*	*38.0*	*38.0*	*38.0*
Scientific Satellites	35.0	33.8	30.6	25.8	26.5	26.6
SAS-D	—	0.5	1.1	1.2	0.5	0.4
ESRIN and ESRANGE	6.7	1.7	—	—	—	—
Basic Activities	11.5	12.0	11.0	10.0	10.0	10.0
Contingency	1.0	1.0	1.0	1.0	1.0	1.0
Application Programmes	*22.8*	*48.5*	*63.4*	*72.0*	*72.0*	*72.0*
Aeronautical	4.0	17.9	20.5	18.0	18.8	6.2
Meteorological	2.1	7.9	16.3	26.8	25.8	25.0
Telecommunications	15.7	20.7	24.6	25.2	25.4	29.0
Other Applications	—	—	—	—	—	9.8
Contingency	1.0	2.0	2.0	2.0	2.0	2.0
Total Expenditure	*77.0*	*97.5*	*107.1*	*110.0*	*110.0*	*110.0*

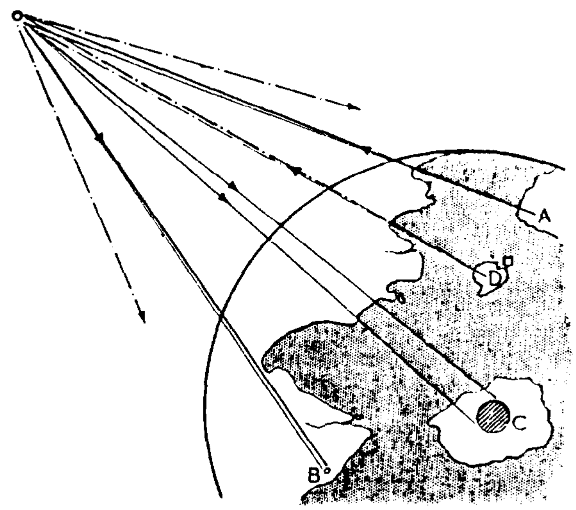
TABLE 3

	End 1971	End 1972
Scientific Satellites	181	116
Space Science	53	45
Applications Satellites:		
Telecom	35	73
Aerosat	26	49
Meteosat	3	20
Sounding Rockets & ESRANGE	137	8
ESRIN	75	60
Basic Activities (*)	339	323
Common Costs (non-fixed part)	272	28C
Support (**)	230	221
	1351	1195

(*) *Includes Studies, Space Technology, Technical Information, Education and the Fixed Part of Common Costs.*

(**) *Includes Workshops and Design Office, Testing, Data Acquisition and Data Processing.*

Fig. 2. Typical extra-terrestrial relay services. Transmission from A being relayed to point B and area C; transmission from D being relayed to whole hemisphere.



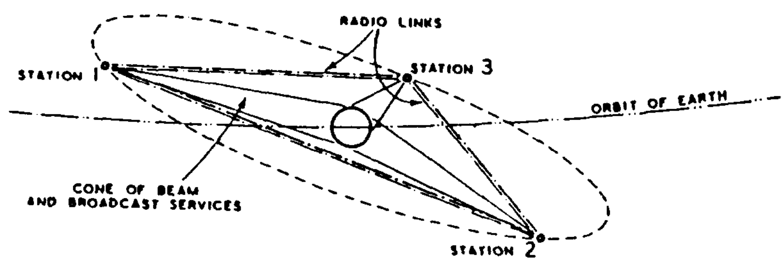


Fig. 3. Three satellite stations would ensure complete coverage of the globe.

Figure 1

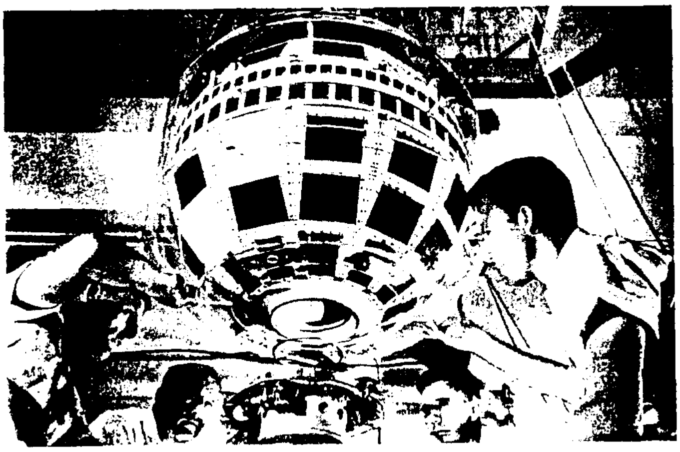


Figure 2

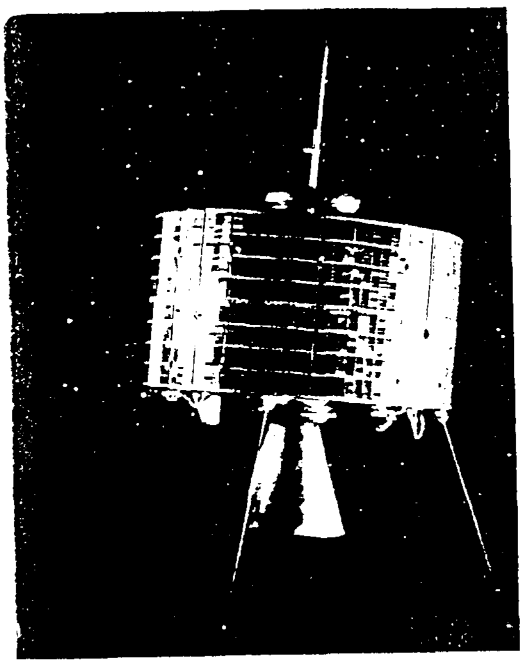


Figure 3

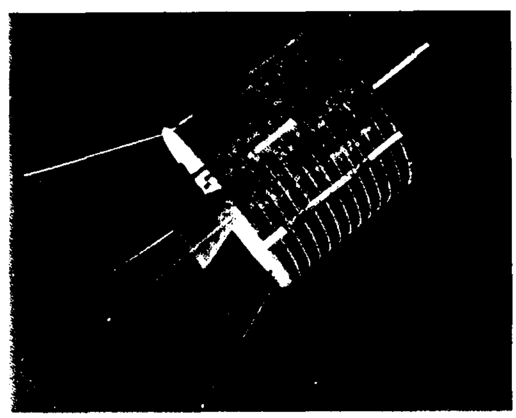
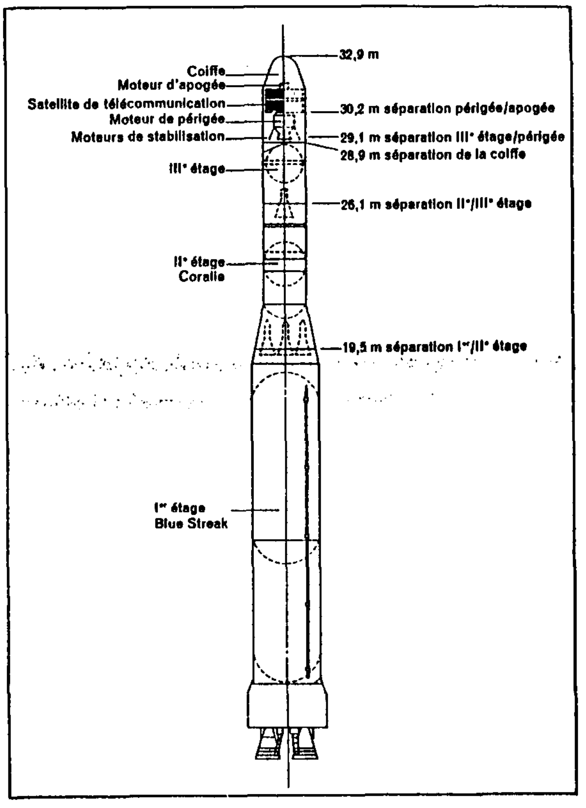
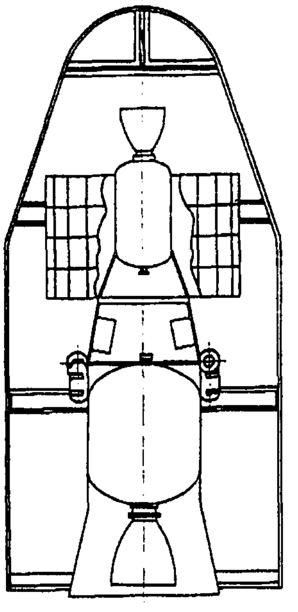


Figure 4


32,9 m
Coiffe
Moteur d'apogée
Satellite de télécommunication
Moteur de périgée
Moteurs de stabilisation
III^e étage
II^e étage
Coralie
I^{er} étage
Blue Streak
30,2 m séparation périgée/apogée
29,1 m séparation III^e étage/périgée
28,9 m séparation de la coiffe
26,1 m séparation II^e/III^e étage
19,5 m séparation I^{er}/II^e étage



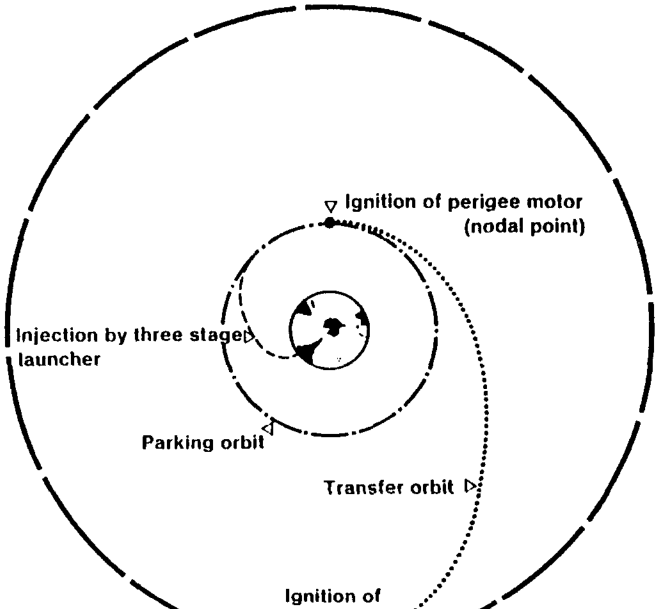

Ignition of perigee motor
(nodal point)
Injection by three stage
launcher
Parking orbit
Transfer orbit
Ignition of
apogee motor

Figure 5 (a, b, c)

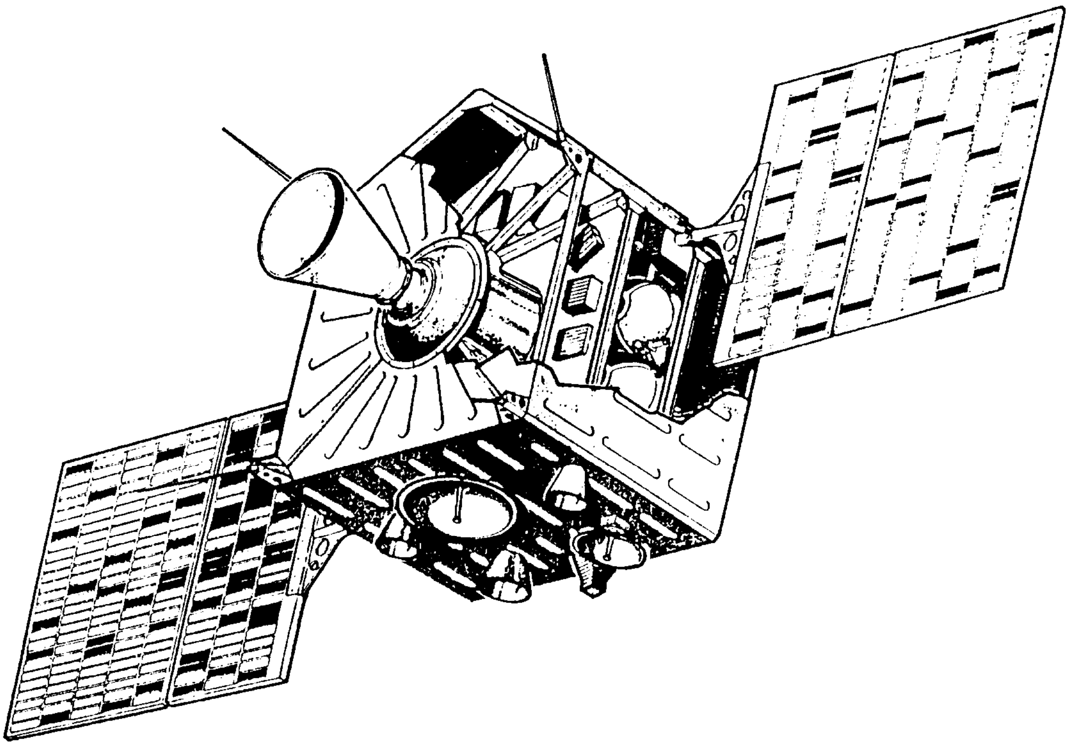
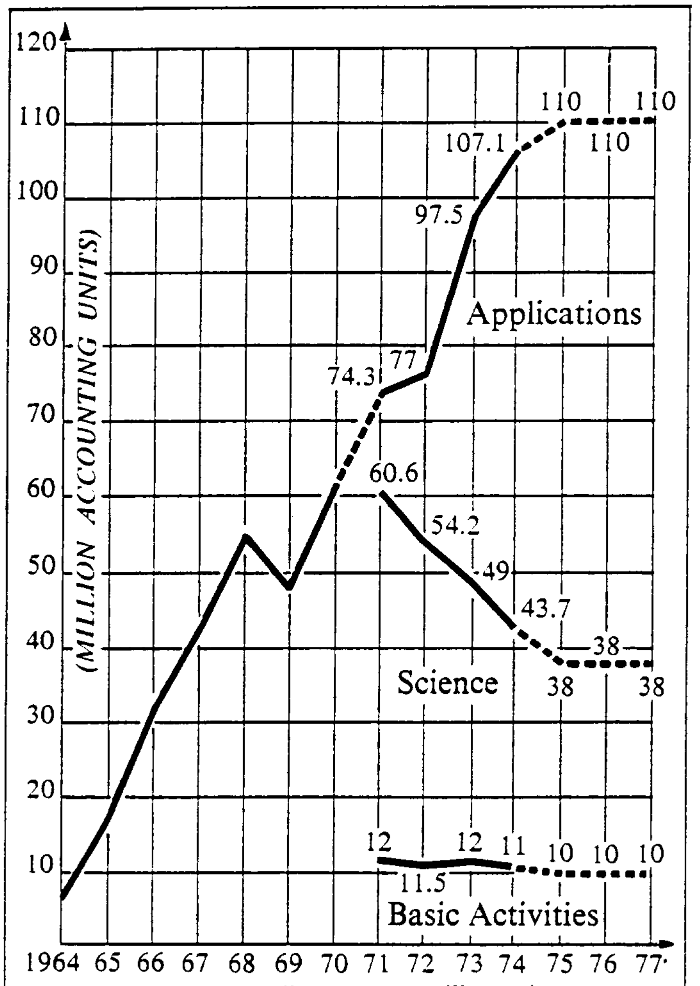


Figure 6



1964-70: actual expenditure at prevailing prices
1971 : estimated expenditure
1972-4: agreed level of resources (at mid-1971 prices)
1975-7: provisional level of resources (at mid-1971 prices)

Figure 7

European Space Agency
Agence spatiale européenne

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