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The European Meteorological Satellite Programme

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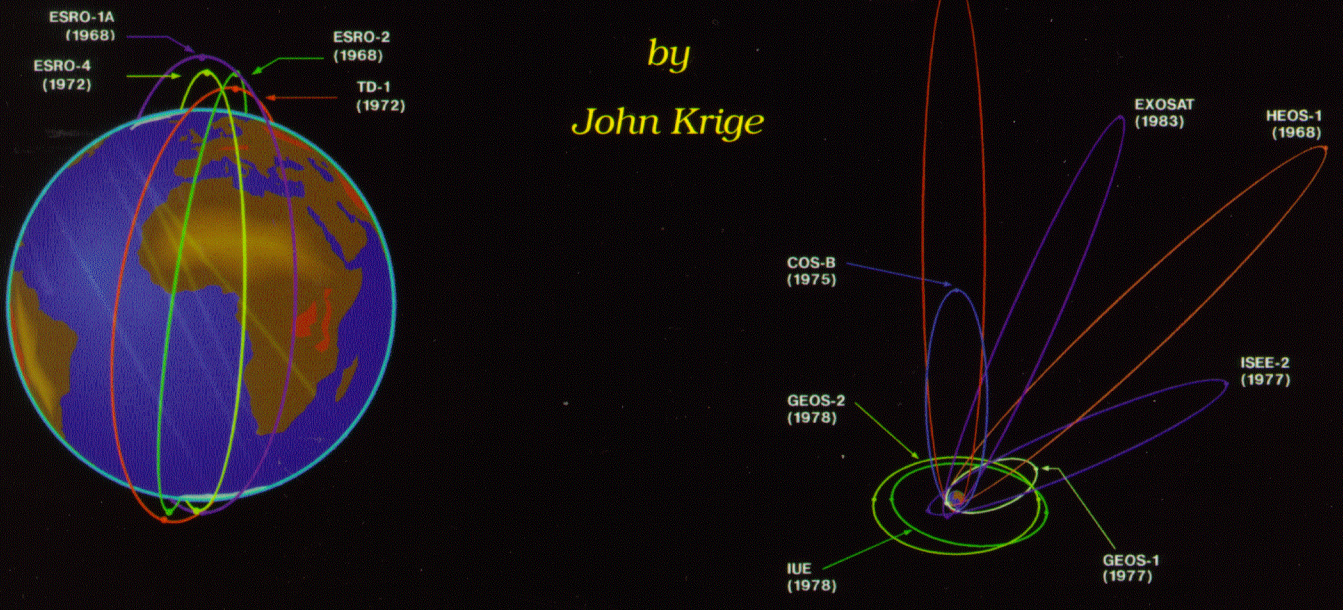

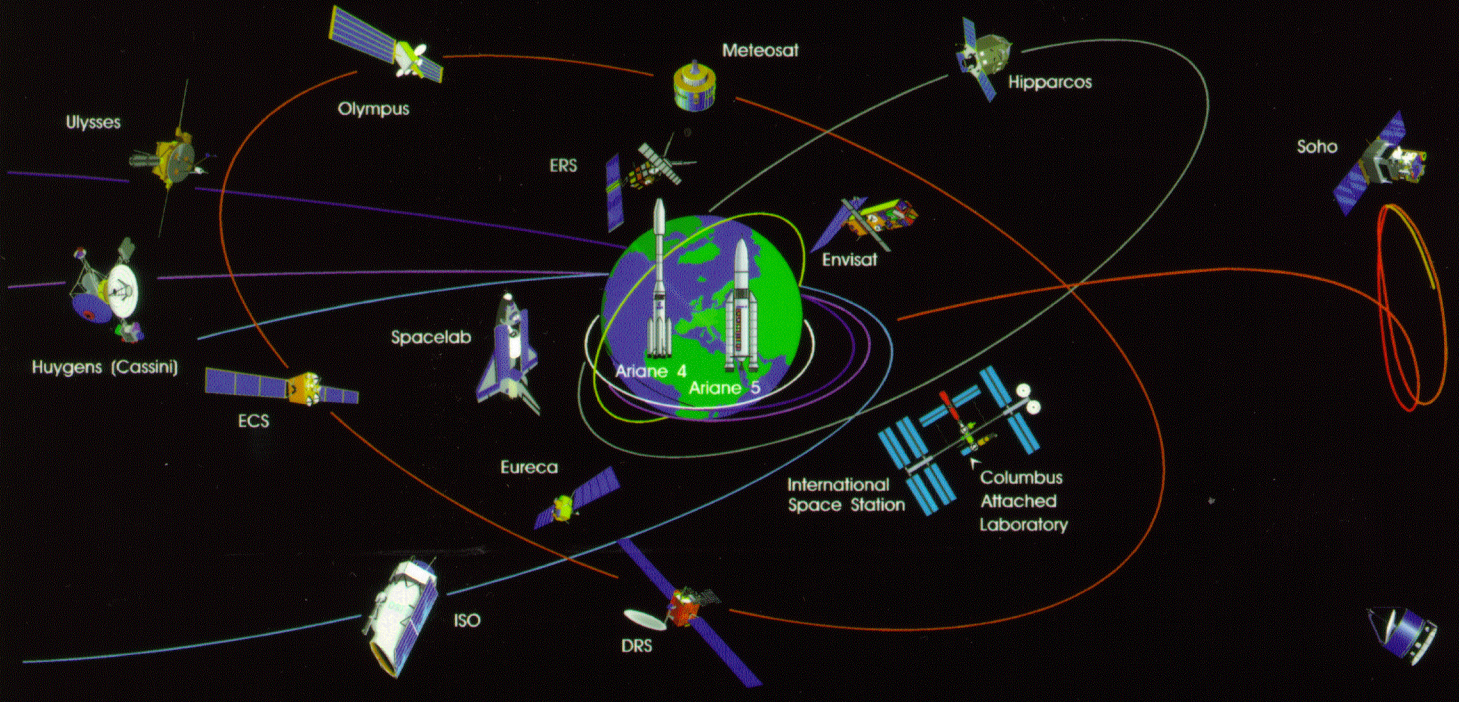

European Space Agency
Agence spatiale européenne

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John Krige

CRHST
Paris
France

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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 1958-1987. 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 views or policy of the Agency.

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Contents

Glossary

AFC	(ESRO/ESA) Administrative and Finance Committee
APT	Automatic Picture Transmission (the direct broadcasting, from a satellite, in the VHF band, of cloud images with a resolution of the order 2-6 km)
ATS	(US) Applications Technology Satellite program
CEMS	Centre de Météorologie Spatiale (Lannion, France)
CII	(French) Compagnie Internationale d'Informatique
CNES	(French) Centre National d'Etudes Spatiales
CST	Centre Spatial de Toulouse
DATTS	Data Acquisition Telecommand and Tracking Station
DCP	Data Collection Platform, the *in situ* environmental observations of which are collected by a satellite on an interrogated or self-timed basis
EARS	European Atmospheric Research Satellite
ECMWF	European Centre for Medium Range Weather Forecasting
EMOS	European Meteorological Operational Satellite
ERTS	Earth Resources Technology Satellite
ESA	European Space Agency
ESOC	European Space Operations Centre
ESRO	European Space Research Organisation
ESTEC	European Space Research and Technology Centre
FGGE	First GARP Global Experiment
GARP	Global Atmospheric Research Programme
GEMS	Geostationary European Meteorological Satellite
GFGMS	Ground Facilities for a Geostationary Meteorological Satellite
GOES	(US) Geostationary Operational Environmental Satellite (also called SMS)
IAPC	(ESRO) Interim Application Programmes Committee
ICL	International Computers Ltd
ICSU	International Council of Scientific Unions
IRTS	Infrared Atmospheric Temperature Sounder
ITOS	(US) Improved TIROS Operational Satellite
Meteosat	French, then European geostationary meteorological satellite
MIEC	(ESRO) Meteorological Information Extraction Centre
MOPWG	Meteosat Operational Programme Working Group
MPO	(ESA) Meteorological Programmes Office (Toulouse)
NOAA	(US) National Oceanic and Atmospheric Administration
PDUS	Primary Data User Station
SDUS	Secondary (or Small scale) Data User Station
SMS	Synchronous Meteorological Satellite (also called GOES)
SMWG	Space Meteorology Working Group
STAG	Scientific and Technical Advisory Group to the Meteorological Satellite Programme Board
WEFAX	WEather FAX : The transmission, through a geostationary satellite, of analogue data receivable by an APT ground station
WMO	World Meteorological Organization
WWW	World Weather Watch

Part I

The Europeanisation, Development and Launch of Meteosat

1. Introduction

On 23 November 1977 a Delta 2914 rocket lifted off from Cape Kennedy carrying aloft Meteosat-1, a meteorological satellite originally conceived at the French Centre des Etudes Spatiales in Toulouse, but 'Europeanised' in the early 1970s.[1] The satellite was separated from the launcher about 25 minutes later, injected into near synchronous orbit at second apogee and reached its nominal position (0° longitude) on 7 December. Two days later images in three spectral bands, visible, infrared and water vapour were received at ESA's ground control station ESOC in Darmstadt, Germany. Meteosat thus became the first European satellite successfully placed in geostationary orbit – an honour it snatched from the grasp of the telecommunications satellite OTS, which had been unceremoniously dumped in the Atlantic only a couple of months before.

This launch proved to be the first of three using hardware prepared in the framework of the Meteosat pre-operational programme.[2] One back-up flight model was orbited successfully on 19 June 1981 as a free-riding passenger on the third Ariane launch, where it accompanied the Indian telecommunications satellite Apple. The second flight model of an even earlier vintage in the development plan was also refurbished and launched successfully on the first flight of Ariane 4 on 15 June 1988. This pre-operational programme laid the foundations for the so-called MOP series, which has seen the launch of four further European operational meteorological satellites, the most recent in September 1997.

A success story then, or so it seems. But we must be careful, for we must not forget that in the late 1970s and early 1980s the pre-operational programme lived precariously. When it got under way in the early 1970s, the plan was to hand over operational responsibility for the original system to the European meteorological community within the decade. In the event the Ministries of research and development which were funding Meteosat became increasingly frustrated at the reluctance of the meteorological community and their supporting Ministries to take over organisational and financial responsibility for an operational meteorological activity. The MOP series which began in the late-1980s attests to the success of the pre-operational programme. But it started far later than was originally hoped, its delay reflecting the hesitations of the prime user community for which the satellite was originally intended, the meteorologists, to mobilise resources for a European operational meteorological system. The transition was slow in coming or, at least, far more tortuous than in the parallel case of telecommunication satellites. It was tortuous because, legal and administrative issues apart, the national services needed to be convinced that continuous coverage could be provided from space and that it required a European operational satellite system before they committed resources to space and ground segments which were far more complex and costly than their traditional technologies.

Several related considerations gave the first phase of the Meteosat programme its stability and continuity, the hesitations of the prime user community notwithstanding. Firstly, the pre-operational programme undoubtedly made optimal use of the resources originally allocated to it when it was agreed upon. Technological success, sound management and good economic house-keeping, along with a fair share of luck – all three pre-operational launches were successful – surely gave the programme some of its stability. Nothing succeeds like success.

Technological and managerial achievement apart, a number of institutional factors also kept the programme going. Firstly and crucially, this was not an isolated, stand-alone programme. Meteosat was

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[1] A description of the Meteosat system, including its interest to meteorology, its technical and managerial dimensions and its launch programme was published in a special number of the ESA Bulletin the month after the launch of Meteosat-1, *ESA Bulletin,* N° 11, December 1977. See also *Summary Report on Progress of Meteosat Programme since 10th ESA PB-MET Meeting,* ESA/PB-MET/MIN/11, Annex II, 16/1/78 (ESA3537).
Most of the primary material referred to in this report is to be found in the ESA archive which is situated in the Historical Archives of the European Community, European University Institute, Florence, Italy. There are about 500 files dealing with various phases of the Meteosat programme from the later 1960s to the early 1980s. They are usually signalled using the format (ESRO- or ESAxxx) where the letters designate the series in question. There is also an important collection covering the early period and known colloquially as the 'Tessier collection' which begins at number 52000. For the middle and late 1980s source material was obtained at ESA headquarters in Paris and at ESTEC in Noordwijk (NL).

[2] From a technical point of view a pre-operational satellite is one designed and developed to be one of a series of identical spacecraft. It is to be contrasted with an experimental satellite, where no such constraint informs the design choices made.

integrated into an international programme sponsored by the World Meteorological Organization, the so-called Global Atmospheric Research Programme or GARP (there is a glossary of abbreviations at the start of this paper). This programme foresaw a joint effort by the USA, the USSR, Japan and Europe to improve computer forecasting and modelling by using data satellites in geostationary and polar orbits. Meteosat was one element of the so-called FGGE (First GARP Global Experiment), first scheduled for 1976, but delayed until 1979. Its key role in this programme (see Figure I.1) provided much of its initial rationale and sealed the commitment of the participating states to it and to making provision for a back-up launch in the event of its failure – an option subsequently exercised despite its initial success.

Meteosat was also protected by the interest which university researchers had in its data. The importance of accurate information about the weather for military and civilian uses, from agriculture to mass jet travel, as well as the availability of new technologies after the war, led to a surge of interest in meteorology and to fundamental changes in its practice. Meteorology in government and academia expanded enormously. To cite US figures, the only ones we have, from the mid-1940s to the mid-1980s there was a ten-fold increase in the number of American universities awarding degrees in meteorology as well as in the number of articles published annually in US journals of meteorology. Civil and military funding for the field also increased enormously. A new style of research was put in place in which numerical modelling became the dominant methodology.[3] The situation in Europe was not dissimilar. In 1975 a European Centre for Medium Range Weather Forecasting was established at Bracknell in the UK within the framework of the European Economic Communities' COST programme. It was dedicated to atmospheric modelling and in 1977, it took delivery of a CRAY I-A Supercomputer, "the first machine that was really adequate for operational global weather prediction[4]". ESA, for its part, organised two meetings of scientific users of Meteosat in June 1979 (in Darmstadt) and in March 1980 (in London). Both were attended by around 80 scientists from a dozen countries.[5]

Finally we cannot overlook the role of the ESA Executive, led by Programme Manager Dieter Lennertz, in promoting Meteosat. For much of the 1970s the ESA team was under constant pressure from the user communities and the participating states, not because of worries over the space segment – the manufacture and testing of Meteosat and its instruments went ahead without any major surprises – but over the inadequacies of the ground segment and the computing facilities in particular. Once this was more or less resolved in 1979, they found themselves with an installation that was working reasonably well, a team at ESOC which had accumulated the requisite expertise in the handling and interpretation of meteorological data, a growing interest in new regions (like Africa) in satellite-derived atmospheric data – and participating states which were increasingly hostile to continuation as the meteorological services dragged their feet over taking charge. Faced with the threat of termination and the disbanding of the teams, the Executive was tenacious and determined. It pushed ahead with organising the launch of the second flight model and the prototype, it drafted and redrafted the legal documents needed to extend the duration of the original arrangement and it did what it could to get the national meteorological services to set up an operating agency. This finally happened with the formal establishment of an organisation called Eumetsat in 1985.

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[3] See F. Nebeker, *Calculating the Weather. Meteorology in the 20th Century* (New York: Academic Press, 1995), 173 and A. Dahan Dalmedico, "L'Essor des mathématiques appliquées aus Etats-Unis: L'Impact de la seconde guerre mondiale," *Revue d'histoire des mathématiques,* **2** (1996), 149-213.

[4] L. Bengtsson, "Development in Atmospheric Modelling and Weather Prediction – The Role and Contribution of ECMWF", in A. Klose and I. Dusak (eds), *Proceedings of the COST Forum on Transnational Cooperation in Science and Technology with new European Partners, Vienna, 22 November 1991* (Brussels: CEC DGXII/G/1, 1992), 59-73. The convention establishing the ECMWF was signed in May 1973 by 17 countries and it entered into force on 1 October 1975. The centre is based in Reading (UK) and its main objectives are (1) the development of numerical models for medium range weather forecasting i.e. up to 10 days ahead; (2) the preparation on a regular basis of medium-range weather forecasts for distribution to the meteorological services of the member states; (3) research directed to improving these forecasts and (4) collection and storage of appropriate meteorological data.The original plans for the Centre foresaw a staff of about 120 people, including 40 graduate scientists and an annual operating budget of some 7.6 MAU – *Summary Report on the Informal Conference of Directors of European Meteorological Services* held on 27/4/72 (52023). See also (52014)).

[5] See (ESA3631) and (ESA3656).

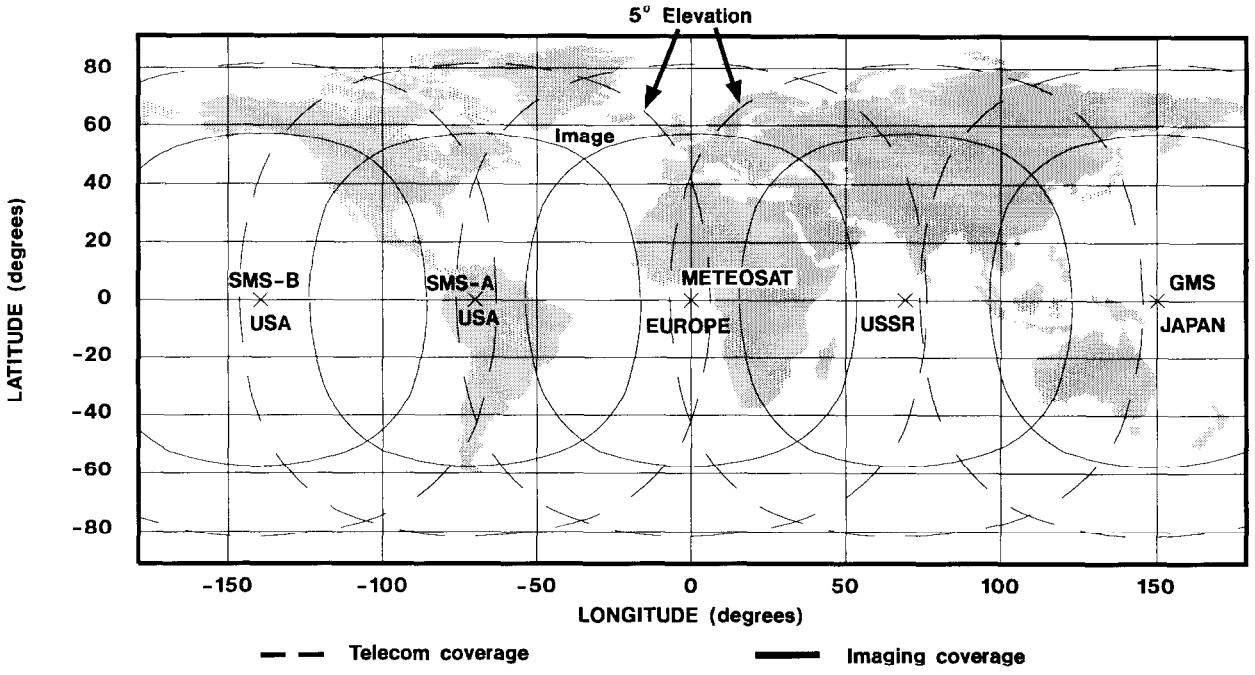

Figure I.1. Coverage of the geostationary meteorological satellites participating in the GARP programme (Source: ESA Bulletin, N° 11, December 1977, p. 11).

This report is divided into two main parts. The first deals essentially with the history of the space and ground segments of Meteosat-1, taking the story up to the launch of the satellite. It focuses mainly on two issues: the process of Europeanisation of the French meteorological satellite and the difficulties surrounding the implantation of the data handling facilities at ESOC. Part II of the report discusses two phases of the transition to the operational programme: the Programme Board's increasing frustration with the reluctance of the meteorologists to establish an operational system and the measures taken between 1981 and 1983 by the MOP Working Group to do just that, measures which led to the official birth of Eumetsat in 1985. Before getting under way I quickly situate the demand for satellite data by meteorologists in the more general framework of the post-war reconfiguration of their field.

2. The changing field of meteorology in the 1960s and 1970s

The science of meteorology underwent fundamental changes during and after the second world war, both in terms of the sources of data available to meteorologists and in the practice of meteorology itself. Traditionally information derived from floating buoys, ships and aircraft were supplemented by upper air observations using instruments carried aloft by balloons. New observing techniques developed during the war, notably radar and then the development of Earth observation satellites by the superpowers in the 1960s allowed not only for the systematic collection of far more information, but also for the inclusion in forecasts of data gathered from remote areas of the globe. To handle all this data, new and powerful techniques of real-time collection and manipulation were needed. The availability of increasingly powerful computers was coupled with the development of mathematical models from which it was hoped to forecast the future state of the atmosphere from a knowledge of its 'initial conditions' and the dynamics of the processes affecting climate. The practice of meteorology was changed completely. Previously, to quote two practitioners, "both the forecaster and the investigator were forced to content themselves with such highly oversimplified descriptions or models of the atmosphere that forecasting remained largely a matter of extrapolation and memory". Indeed "forecasting was essentially a rather simple extrapolation of weather developments over the past few days for another 24 or 48 hours into the future, essentially based on the *experience* of the forecaster."[6] Now a variety of disciplinary regimes: fluid dynamics, physics,

[6] The first quote is from Jule Charney, one of the leaders of numerical modelling of the atmosphere, cf. Nebeker, note 3, p. 178. The latter statement is by Bert Bolin, leading Swedish exponent of this approach, in *The Global Atmospheric Research Programme. A Co-Operative Effort to Explore the Weather and Climate of Our Planet* (Geneva: WMO/ICSU, 1971), 8. The emphasis is Bolin's. The document can be found in (52012).

mathematics etc., were mobilised to build systems of differential equations representing the transfer of heat and moisture in the atmosphere and the behaviour of gases.[7] Armed with values of parameters describing the vertical profile of such atmospheric properties as wind, temperature and moisture and the most powerful computers on the market, the meteorologist aimed to predict more reliably the evolution of the weather over anything from two days to two weeks. Figure I.2 gives one an idea of the complexity of the problem: it illustrates the processes and their interactions which were included in one European mathematical model in the mid-1970s.

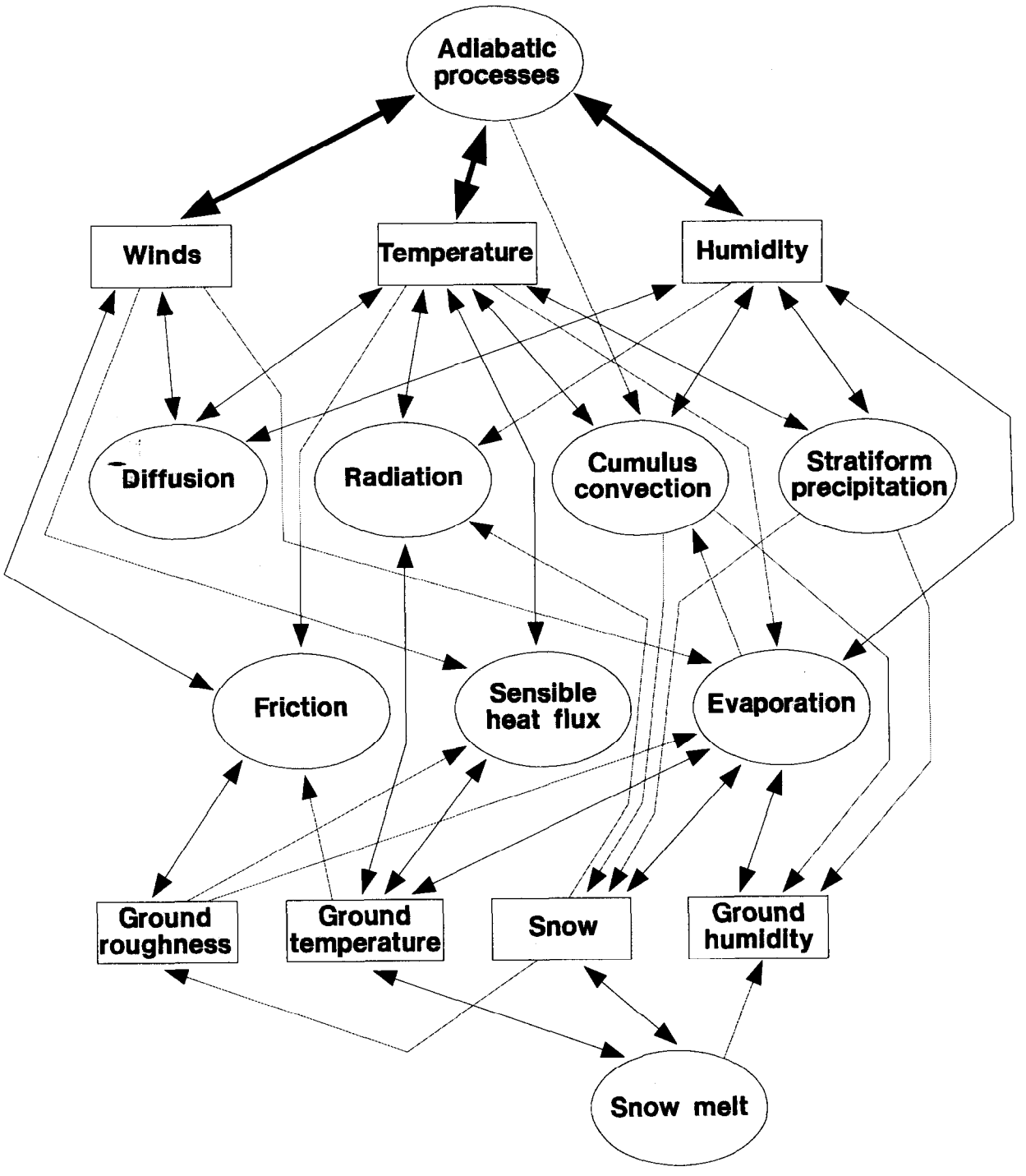

Figure I.2. Schematic of the atmospheric processes and their interactions as in the ECMWF model. The thick arrows identify the main interactions governing the weather; from Bengtsson, cited in note 4.

[7] See ESRO/PB-MET(72)7 and Annex, 1/6/72 (ESRO8961) and L. Bengtsson, note 4.

During the 1960s both the USA and the USSR embarked on satellite programmes intended to improve the quality of weather forecasts. These were used to supplement the data obtained using traditional means, by covering sections of the Earth (deserts, less developed countries) and of the ocean which were not accessible using existing techniques. The improved geographical coverage, the additional kinds of information (e.g. on wind velocity and direction by analysing cloud movements) and the systematic sampling in accordance with a predetermined time-space grid and real-time data dissemination, all gave satellites a unique role in forecasting. They had another advantage: the same satellite could be used for meteorological data transmission between different ground stations.

Two orbits provided complementary information to meteorologists. Satellites in polar orbits provided high-resolution coverage of the whole surface of the Earth, giving 'soundings' of the vertical distribution of temperature and humidity from which other weather-relevant parameters, like pressure, could be inferred. They had two disadvantages, however. Firstly, their coverage was only intermittent – they made observations of a particular area only once per day in the visible range or twice if they were equipped with infrared sensors. This seriously limited their use for short term forecasting, when rapid local changes needed to be tracked at least once an hour. Secondly, they were ill suited to measuring air movements in the tropics, which played a vital role in the evolution of global weather. Geostationary satellites, on the other hand, were able to supply quasi-continuous coverage of the whole area within their field of view, which was what was needed for short-range forecasts. The kind of data of interest to meteorological agencies that these satellites could provide included cloud cover by day and by night, vertical profiles of temperature and water vapour, information on snow and ice cover, the brightness temperature of clouds over continental and oceanic surfaces, the distribution of the total reflected and scattered short-wave radiation and finally, the distribution of the total long-wave radiation emitted by the Earth. Their limitation was that their image quality degenerated from about 60° latitude upwards.[8]

The implementation of global and regional systems to exploit these new possibilities was one of the tasks undertaken by the World Meteorological Organization (WMO) in the framework of its so-called World Weather Watch (WWW) programme. It also conducted, in collaboration with ICSU, a research programme called the GARP (Global Atmospheric Research Programme). This was an international collaborative project similar in concept to, though much larger than, the International Geophysical Year held in 1957. It was organised by twelve scientists under the chairmanship of Bert Bolin (from Sweden), who set about defining one of its elements the so-called FGGE (First GARP Global Experiment). At a planning conference in Brussels in 1970 it was decided that this experiment should be held in 1976. Its main objective was to combine the resources of all the participating countries so as to provide "data on the basis of which the adequacy of numerical models of the atmospheric general circulation [could] be tested". To this end it was to make use of observations from existing or planned networks of surface and upper air stations (including buoys and commercial ships and aircraft) as well as satellites. From its very early planning this group foresaw a European satellite as one element of this global system. Just which satellite that would be was not, however, obvious, as we shall see immediately.[9]

3. First steps towards a European meteorological satellite: From EARS to EMOS to Meteosat

The European Space Conference meeting in Bonn in November 1968 decided that Europe should develop an application satellite programme and authorised ESRO to extend its activities to include studies of e.g. air traffic control, communications and meteorology satellites. Thus mandated, a team at ESTEC began to look into the possibilities for weather satellites. It was led by J. Vandenkerckhove and included P. Blassel, R. Collette and D. Lennertz, to whom was soon added R. Tessier, who had had two years of experience with Earth resources satellites at CNES. The ESRO team decided to explore the costs and benefits of a small (170 kg) geostationary satellite and a low-altitude near-polar orbiter of either

[8] Undated paper prepared for meeting of Europeans with NASA and NOAA in February 1971 (52004). See also K. Stewart, "The Significance of Meteosat for Meteorology", *ESA Bulletin,* N° 11, December 1977, 6 -10.

[9] See Annex 3 to the minutes of the *Premiere Reunion du Groupe 'Ad-Hoc' Meteorologie,* held in Geneva on 13 June 1969, which was written by Bolin (52002) as well Bolin's report for the WMO quoted in note 6. The third component foreseen was a near-equatorial balloon tracking orbital satellite.

about 100 kg (to be launched by a British, French or US rocket) or of 300-600 kg (to be launched by Europa I or an American Delta rocket).

The large polar satellite seemed the best in their eyes. Weight limitations on the instrument payload of both the small geostationary satellite and the small near-polar orbiter would restrict their capability and undermine their reliability (since little redundancy could be provided). By contrast the combination of reliability and "growth potential" of a large polar orbiter enabled it to subsequently incorporate bigger and heavier experiments and gave it the flexibility needed to develop it into an operational system.

These first tentative thoughts on the EARS (European Atmospheric Research Satellite) were presented to a group of ESRO member states' representatives (in fact almost all of them the directors of national meteorological services) present in Geneva on 13 June 1969 to attend the XXIst meeting of the WMO's Executive Committee. This (non-ESRO) group of potentially interested users came to be known as the *ad hoc Group* on Space Meteorology.[10]

The *ad hoc* group confirmed the ESRO team's choice. Their main reason was that the alternatives overlapped with national programmes then under way. Britain planned to launch a small satellite into polar orbit in 1973. It would carry an infrared radiometer and a small interrogation experiment. France was planning a geostationary satellite called Meteosat to carry a camera experiment in the visible and IR ranges for global cloud observation and an interrogation experiment for stationary buoys and platforms. The only doubt raised by those present concerned the cost of a large polar orbiter, though it was felt that if one planned for a pre-operational series of satellites rather than just a single spacecraft one could reduce the unit cost considerably.

A general framework for the further study of EARS was soon defined. A budget envelope of 250 MFF ($50 M) was laid down for the development and launch of the first satellite, costs of the ground segment included. The feasibility study was also to make provision for the launch of three follow-on satellites all carrying the same basic payload. This was to weigh between 45 and 60 kg. It was to comprise a number of measuring instruments whose interest was already proven. These were to be supplemented by experimental payloads intended to explore potential future operational techniques. In defining this package ESRO was to be assisted by a team of experimental and operational meteorologists who would bear in mind the requirements of the national weather services. On the experimental side the names of Drs. Bolle (FRG), Morel (F) and Houghton (UK) were invoked. The meteorological experts were to be nominated by the directors of the weather bureaux. Tessier was nominated in-house mission manager to liaise with this group.

In January 1970 ESRO came up with its preliminary concept for a European Meteorological Operational Satellite. As conceived, EMOS was a 300-400 kg three-axis stabilised Earth-oriented satellite in a circular, near-polar orbit of apogee and perigee about 1700 km and a period of two hours (i.e. 12 orbits per day) (see Figure I.3). EMOS had two main missions: (a) day and night observation of the Earth's cloud cover for short-term weather forecasting and (b) quantitative sounding of the troposphere and lower stratosphere for numerical weather predictions. For the first a scanning radiometer in the visible and infrared ranges with automatic picture transmission and a low-light television camera for Earth and cloud photography, were foreseen. For the second an infrared temperature sounder was provided for. The possibility of including a system for data collection from fixed and mobile platforms was also considered. As for the cost, this was estimated at 73.5 MAU including the launch vehicle but excluding the ground segment.[11]

Faced with an estimate far in excess of the 50 MAU originally foreseen, the *ad hoc Group* insisted that a less ambitious programme be developed, a view repeated during two unofficial meetings of the directors of European meteorological services gathered in Brussels in March 1970 to plan the GARP. They

[10] The debates at this meeting are summarised in the document just cited, in a draft of the minutes for part of the meeting sent by W. Nellessen to J. Vandenkerckhove on 17/6/69 and an internal unsigned and undated report for A. Dattner entitled *Rapport sur les etudes d'ESRO dans le domaine des satellites meteorologiques*, all in (52002)

[11] For this paragraph see the *Report on Studies Carried out in 1969 in the Field of Meteorological Activities*, ESRO/ST/344, 9/2/70, presented to Scientific and Technical Committee at its meeting on 24/2/70.

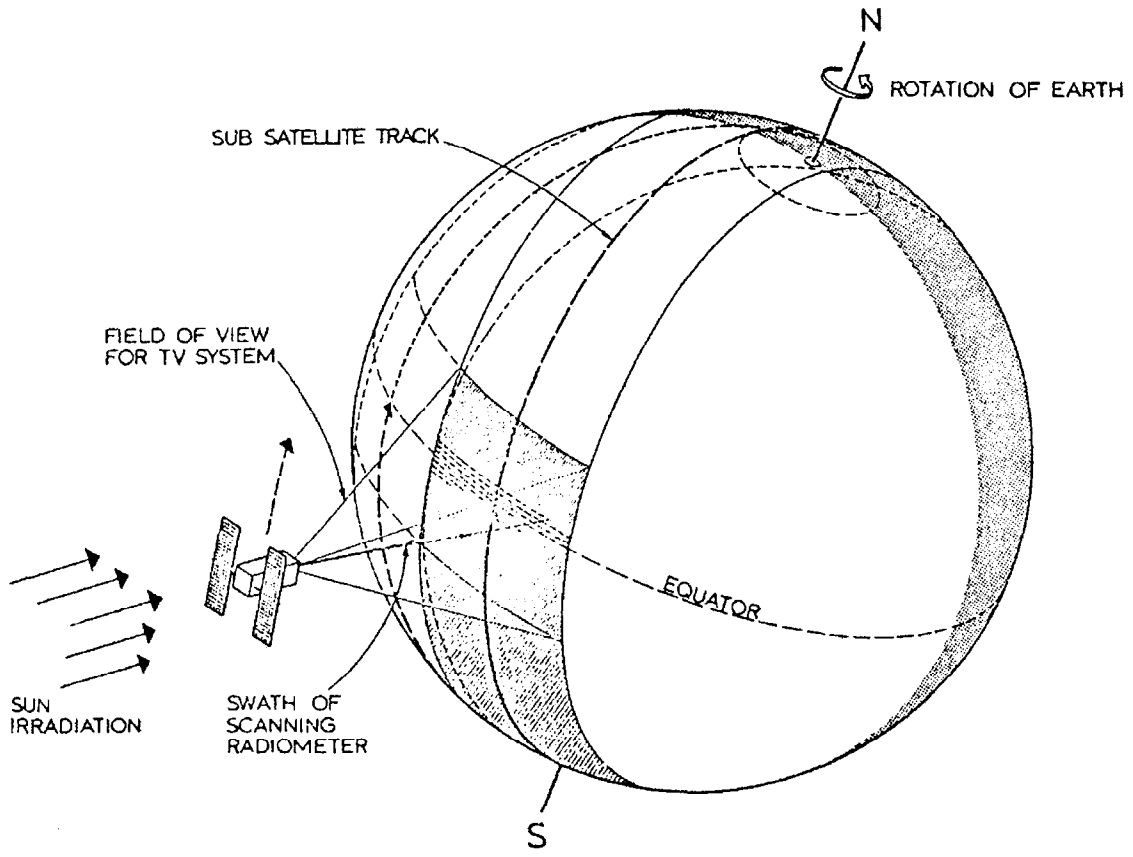

Figure I.3. Schematic of orbit and coverage for EMOS.[12]

suggested that the payload should be cut back to contain only instruments for infrared imaging and for infrared temperature and water vapour sounding. The television system and the interrogation system were to be abandoned and the wisdom of including experimental instruments along with already proven operational instruments in the same payload was questioned. The cost envelope was cut to 40 MAU, excluding the launcher and launch services.[13]

The hesitations in meteorological circles were reflected in the proposals on applications satellites made by the Committee of High Officials to the ministers meeting at the European Space Conference in Brussels in July 1970. They suggested that a meteorological satellite could be delayed for two or three years: Europe should initially concentrate on telecommunications and navigation satellites. Their argument was that Europe did not have the human, industrial and financial resources to start more than two programmes at once. Other concerns, of course, informed their reasoning. If meteorology was downgraded, said ESRO Director-General Bondi, it was because the proponents of the other two application satellites had "lobbied better". The meteorological experts, he went on, had yet to convince their respective governments that they had a programme which was "really European, really worthwhile and really interesting technologically."[14]

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[12] From the report cited in note 11.

[13] For the information in this paragraph see the *Compte rendu des réunions officieuses tenues à Brussels les 18 et 20 mars 1970 à l'Institut Royal Météorologique de Belgique*....(52003), the ESRO interim report on a system study on EMOS dated May 1970 (52005) and the Summary Report produced in October 1970 (52006). Some of the cost data is from a paper by O. Carel (CNES) in his *Note sur la collaboration de la météorologie nationale et de l'ESRO* dated 10/6/1970 (52003)

[14] See the minutes of the meeting of the Meteorology Ad Hoc Group on 11 June 1970 in Paris dated 23/6/70. We have Tessier's handwritten notes on part of the proceedings, from which the quotations are taken (52003)

Operational (low Earth orbit)	
TIROS 1 - TIROS 10	April 1960/July 1965
ESSA 1 - ESAA 9	February 1966/February 1969
ITOS (TIROS M)	January 1970
NOAA 1 (ITOS A)	December 1970
ITOS B,D,E,F, G (NOAA 2, 3, 4...)	To take over from ITOS A when the need arose
TIROS N	To take over from NOAA satellites from 1965
Development (low Earth orbit)	
NIMBUS 1,2,3,4, E,F	1964/1973
EOS	To follow on from Nimbus and ERTS from 1975
Geostationary satellites	
ATS 1,3, F, G	from December 1966
SMS A, B	from 1972
GOES A	from 1975 (1 or 2 satellites over USA)

Table I.1. US meteorological satellites covering the period 1960 - 1980

Here was the crux of the problem. Indeed the meteorologists interested in developing a satellite system were quite unable at this stage to come up with a project which was sufficiently convincing to unite and mobilise them. The low-Earth orbit was dominated by US satellites (see Table I.1). What is more, the commitment to a large and ongoing meteorological satellite programme by various Federal agencies meant that American industry could provide satellites for other clients at prices far below those proposed by European industry: the US manufacturer of an ITOS satellite offered to supply one to ESRO for $5 M, to be compared with the $40 M for a European-built EMOS (which was based on a similar concept). This meant that if ESRO wanted to enter the field it should not preclude a priori the geostationary orbit – an option which had, however, been put aside by the *ad hoc Group* from its inception, to avoid duplicating the French Meteosat programme.[15]

Faced with a loss in priority of their polar orbit project, some (notably British) meteorologists believed that the best way to convince their governments of the interest of a European satellite was by collaborating with the Americans, either by taking a share of global coverage or by alternating launches. The idea that a joint venture with the United States would be preferable to an 'isolated' European satellite like EMOS was reinforced at an informal meeting of directors of meteorological organisations during a WMO Executive Meeting in mid-October.[16] When the *ad hoc Group* met later that month it began to reconsider its priorities: the possibility of including a European geostationary satellite in the newly emerging and very ambitious American SMS (Synchronous Meteorological Satellite) programme seemed distinctly desirable.[17]

The American idea, which was still in the planning stage at the end of 1970, was to put in place a co-ordinated global system of weather satellites. Their scheme had two main components: two or three low-altitude, near-polar orbiting satellites (probably the US's TIROS-N and the Soviet Union's METEOR satellites) and four large (300 kg) geostationary satellites. Two of these were to be the new generation American SMS satellites. Japan was planning a third, while it was open to Europe to supply a fourth. Their main mission would be to photograph the Earth in both the infrared and visible channels, to retransmit these photographs, once processed on the ground, to interested users, to collect and redistribute data from ground platforms and to relay data from other meteorological satellites.

The directors of the European meteorological services saw several advantages in the joint geostationary system. Firstly, unlike the ITOS system, this was still in the planning phase, leaving more scope to define a programme of direct interest to the Europeans. What is more the Americans had foreseen a non-US component from the start. The programme also fitted perfectly into the plans of the WMO's World

[15] The data is from a memo by Tessier prepared for the ESRO mission to NOAA/NASA in February 1971. See also Carel's paper quoted in note 13.
[16] See the minutes cited in note 14.
[17] See the minutes of the third meeting of the Meteorology Ad Hoc Group held in Brussels on 26 October 1970 (52003).

Weather Watch. Unlike EMOS, the data from a European satellite would be part of a co-ordinated programme providing systematic global coverage. The Europeans could include their own instruments in the scheme without difficulty, e.g. a Smith-Houghton temperature probe developed in the UK. The industrial interest in developing an orbiter of this size and complexity was patent. And the coverage provided of Africa would be useful both practically, for long-haul aircraft crossing the continent and politically, as a gesture of solidarity with developing countries who did not have the resources to mount a similar system. In short the only obvious problem – and this was of considerable concern – was that such a satellite might duplicate the French Meteosat programme, though the group felt that this was unlikely since CNES' satellite seemed to be less ambitious than those foreseen for the SMS system.[18]

The French thought otherwise. Apprised of the *ad hoc Group*'s thinking, J. Bessemoulin, Director of the French National Meteorological Service and M. Bignier, on behalf of the President of CNES, immediately sent strongly-worded protests to ESRO DG Bondi. They pointed out that everyone knew that France was developing a geostationary meteorology satellite. Its importance had been confirmed in the VIth national plan then under consideration, which foresaw its extension into a European operational system. Since 1968 the French delegation to ESRO had believed that the Organisation should develop a satellite in low-Earth orbit, arguing that geostationary satellites gave poor photographic cover of Nordic Europe above 60° latitude. The suggestion that ESRO should now place a meteorological satellite in geostationary orbit would necessarily duplicate the French effort and upset the balance between the European and French space programmes. CNES and the French national meteorological service were therefore "at once shocked and disappointed to see the European collaborative effort, which they wanted to be effective, running counter to the development of a national project for which they had high hopes" (Bessemoulin). There was no place for two West European meteorological satellites in geostationary orbit and ESRO's plans to develop one risked upsetting the negotiations between France and NASA on the CNES programme, which were in their final phase. Before taking an irreversible decision, Bessemoulin concluded, ESRO would do well to "weigh all the consequences" of its actions.[19]

These threats were not to be taken lightly. Ministerial conferences in July and November 1970 had revealed the depths of the divisions between Belgium, France and Germany, on the one hand and Britain on the other. The former three were convinced that Europe should develop an autonomous launch capability and that the science programme in ESRO should be cut back and were prepared to go it alone with any partners who shared their priorities. France had gone further and had denounced the ESRO convention with effect from the end of 1971 (though subsequently, with the idea of having 'a la carte' programmes to accommodate different national interests gaining weight, it began to take a more compromising line).[20] In this delicate political context it was essential that nothing be done to harm the French national programme.[21]

Thus forewarned, a European delegation of meteorologists visited NASA and NOAA (the National Oceanic and Atmospheric Administration) in February 1971 to discuss how best to proceed. It was headed by R. Schneider, the director of the Swiss Meteorological Institute and newly-elected chairman of the *ad hoc* Space Meteorology Group. He was accompanied by his homologues from Britain, Germany and France (i.e. Bessemoulin) and a small ESRO contingent. The evolution of the US meteorological and Earth resources programmes were described to them and the possible areas in which Europe could make a contribution were identified.[22] A comprehensive report of the visit was presented to a meeting of the *ad hoc Group* in Noordwijk early in March 1971. Two main conclusions were drawn by the meteorologists.[23]

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[18] Memo Tessier to Dinkespieler, 6/11/1970, *Informations sur le programme français Météosat* (52003)

[19] Letters Bessemoulin to Bondi, 7/12/70 and Bignier to Bondi, 10/12/1970 (52004).

[20] See J. Krige and A. Russo, *Europe in Space, 1960-1973* (Noordwijk: ESA SP-1172, 1994) and meeting of the ESRO Council in December 1970, ESRO/C/MIN/35, 12/1/71.

[21] Letters Bondi to Schneider, 4/12/70 and Dinkespiler to Bessemoulin, 9/12/70 (52004)

[22] The material on the mission to NASA/NOAA, including presentations by Bandeen (on instrumentation), Naugle (on NASA's meteorological satellite programme) and Scull (on ERTS) are in (52010).

[23] The minutes of the meeting are in (52012). The main conclusions were presented by Tessier to the IAPC at its meeting on 11/5/71, ESRO/IAPC/MIN/2, 7/6/71, Annex II (ESRO9329), in which he spoke to his paper ESRO/IAPC(71)2, 19/3/71 (ESRO9339). These two reports by Tessier contain useful potted histories of the meteorologists' deliberations.

Firstly, they agreed that there was an "overabundance" of polar-orbit satellites, as evidenced by the fact that the data-handling capacities on the ground were already saturated so that the existing US satellites in this orbit were not being operated at full capacity. Of course Europe was not adequately covered by the US system. However, the Soviet Union was known to be planning to launch two satellites in polar orbit in its METEOR programme and there were also discussions under way in both Germany and Italy to develop national meteorological satellites of the same kind. (Britain, for its part, had decided to cancel its experimental polar satellite and to fly the instruments on American NIMBUS and TIROS satellites.) The interest of a European geostationary satellite was thus confirmed.

The second point that struck the meteorologists was the cost and complexity of the ground stations, which they had underestimated and which would ultimately have to be borne to some extent by their budgets. The acquisition of information from space and its processing in real-time demanded sophisticated data-processing techniques and a large staff. Indeed their US hosts estimated that for a single geostationary meteorological satellite a complete data acquisition and processing station would need about 150 staff plus the personnel needed to operate a computer equivalent to a CDC-6600. Just where the borderline lay between the space and ground segments in this complex was a matter for negotiation, but in any event it was clear that a major new financial burden for the meteorological services was in the offing.

The ground segment was not a priority at this stage however. What had to be decided first, in the light of the US visit, was the space segment of a European meteorological system. By 3 June 1971, when the meteorologists next gathered, they had specified their ideal package. It had two components. Firstly, there would be a geostationary satellite which complemented towards the east the cover provided by the US system and gathered data in the visible and IR ranges. This would be combined with a polar satellite taking vertical temperature soundings – a mission to which the geostationary satellite was less well adapted. The two spacecraft would be linked by a space-space-ground system transmitting the data from the polar satellite via its partner to Earth, so enabling a single ground station communicating with the latter to obtain sounding data on a global scale. Of course if the twin system were not possible (even making use of a national polar satellite), the meteorologists were prepared to make do with the geostationary satellite only. To avoid duplication with Meteosat it was made abundantly clear that this system would be put in place as a successor to the French programme. As Schneider said emphatically to the second meeting of the IAPC on 11 May, "it is not our intention at all – and we realise that it is practically and technically impossible – to produce something at the European level for 1975-1976" – the year when a European contribution to the FGGE would need to be launched. With a clear gesture towards the French delegation he added that "In this matter we rely completely on the extremely good co-operation that exists with the national services, who are thinking of launching geostationary satellites into orbit at that time".[24] In short the European geostationary satellite was only foreseen for the second half of the decade, when it would take over from Meteosat, the latter playing a full role in the international collaborative programme scheduled at this time for 1977/8.

Schneider's fears of offending the French soon proved to be ill-founded. After hearing several statements on the users' requirements the French delegation to the IAPC meeting in May remarked that they now seemed clearly focused on a geostationary satellite. It went on to say that it "was convinced that it should let the European countries benefit from the work that had already been undertaken in France in respect of a meteorological satellite project". This conviction was substantiated six weeks later. In a letter to the chairman of the ESRO Council dated 25 June 1971 the French delegation proposed that "the ESRO Member States co-operate in the Meteosat project [which] would thus become an ESRO programme [...]". The letter was accompanied with detailed proposals on how to effect the 'Europeanisation' of the national project, which was now at a stage, it was said, when CNES was "ready to issue calls for tender to industry during the coming weeks".[25]

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[24] The quotation is from Annex IV to the minutes, ESRO/IAPC/MIN/2, 7/6/71 (ESRO9329). For the minutes of the meeting of the Space Meteorology Group held in Zurich on 3 June see (52012). The European meteorologists' priorities are specified in ESRO/IAPC(71)12, 1/7/71 (ESRO9349).

[25] The letter and supporting documentation were circulated as Annexes I and II to ESRO/C(71)36 , file (ESRO578).

Several concerns inspired the French proposal. First and foremost it was a political gesture, a proposal explicitly made within the framework of the negotiations then under way between the Member States, which were being orchestrated by the new ESRO Council Chairman Puppi. As the letter of 25 June made clear, it appeared that "one of the main functions of the new Organisation [would] be to provide a forum for consultation which [would] enable duplication between the various programmes to be avoided on the one hand and permit the European community to benefit from developments and studies undertaken in each ESC [European Space Conference] Member State on the other". From this point of view, the letter went on, France hoped that the relationships established between CNES and ESRO around the Meteosat programme "might well serve as a model for other projects". France was thus at once signifying its willingness to collaborate with its partners in a new European space organisation, suggesting one way in which that collaboration could be achieved and by taking the initiative, acquiring considerable moral and political weight to impose its priorities on any eventual European space programme that might be put in place.

Material considerations also played a role of course. Firstly, the cost of the space segment had risen unexpectedly. During previous negotiations between CNES and NASA the French had hoped to persuade the American agency to subsidise their launch costs. However when NASA was apprised of the plans in Europe to launch two geostationary meteorological satellites, one by CNES and one by ESRO, it said that it preferred to support the latter financially – and estimates of the cost of France's national satellite therefore had to be adjusted upwards.[26] Then there was the ground segment. As we mentioned earlier the enormous costs of setting up and running an operational system were brought home to European meteorologists after their visit to the USA in February. All of their plans before then had concentrated on the satellite and its payload: now they appreciated that the ground segment was an essential part of any meaningful programme. And since this would come from their budgets, not from the space budget (meteorological services were typically funded by the Ministries of Transport) they quickly concluded that European collaboration was a must. Bessemoulin was a case in point. Furious in December 1970 that European meteorologists were considering developing a geostationary satellite through ESRO, he had no sooner visited America in February 1971 than he "insisted on the need for European co-operation as soon as possible" as far as data-handling was concerned.[27]

The team of engineers at CNES who were developing Meteosat were stunned by these developments. They had been working for several years on their national meteorological satellite. Its most sophisticated and technically 'noble' component, the radiometer, had been developed to the point where they were ready to place a contract for its fabrication, with Matra. Not party to the political debates which led to the decision to Europeanise Meteosat, they found themselves confronted with a *fait accompli* which they were powerless to change. Their programme, their device, their jobs, their careers were suddenly put at risk from one day to the next. The best that could be done to protect their (and CNES') interests was to suggest that the implementation of the project be entrusted to its Toulouse Space Centre and to demand that the French team continue to play a key role in the development of the project.[28] But would the ESRO engineers and member states accept that?

4. Meteosat: From French to European satellite

CNES engineers began designing a French meteorological satellite in March 1969, to be launched as part of the VIth national plan in the early 1970s. The main reasons for this political choice were three: the wish of France, "the third world space power", to affirm its presence in a field of applications in which it already had some considerable experience; secondly, the immediate interest for France to provide meteorological support in the European-Atlantic zone and along the Europe-Africa air routes; and, thirdly, in the longer term, to increase France's influence in the WMO, particularly the World Weather Watch Programme, as well as in the more limited framework of European collaboration.[29]

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[26] Private communication, R. Tessier.

[27] The quotation is from the minutes of the meeting of the ad hoc Space Meteorology Group on 4-5 March 1971 (52012).

[28] Annex II to ESRO/C(71)36, 5/7/36, p. 3 (ESRO578).

[29] From Villevielle's *Note sur le projet de satellite météorologique français géostationnaire*, dated June 1969 in file (52001). This file contains some useful early documentation about the French project.

To achieve these objectives it was planned to place the satellite between longitude 10°E and 30°E, so permitting coverage of southern Europe and Africa (see Figure I.4). It was to take and transmit photographs of the globe, in the visible and infrared spectral ranges, to a station in France and to serve as a data relay for the retransmission of photographs or meteorological charts to dispersed meteorological stations. Meteosat was a pre-operational satellite which was intended to contribute to the first year of the GARP (foreseen for 1976). It was also intended to demonstrate to the weathermen the feasibility of the technology and the use of the instruments on board and to encourage the meteorological services to gain experience in the collection and diffusion of meteorological information garnered from satellites.[30]

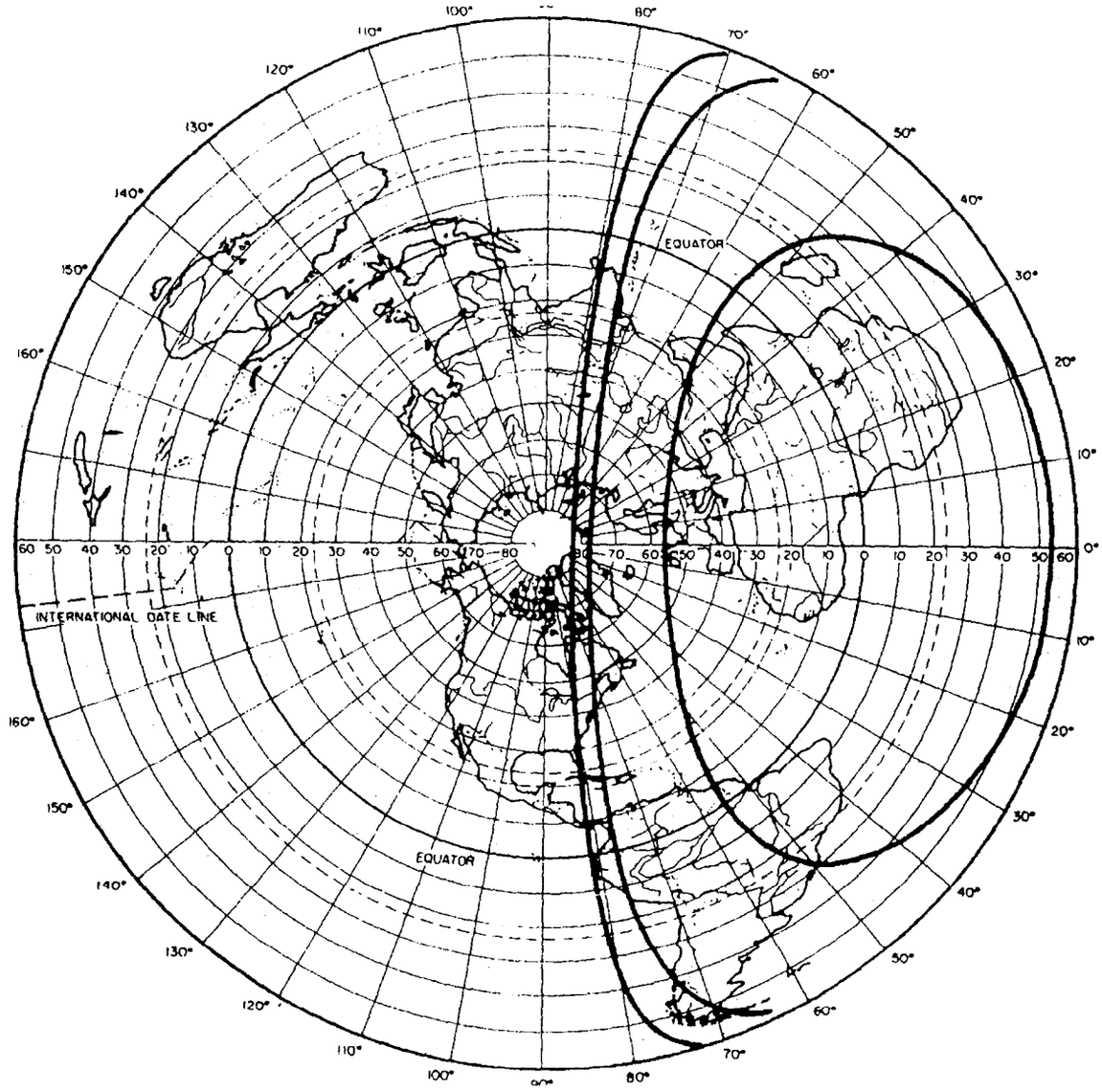

Figure I.4. Coverage of a geostationary meteorological satellite placed at 0° longitude.[31]

[30] See the previous document, the questionnaire drawn up by H. Felix, CNES paper N°7/METEOSAT, 22/4/60 (52001), O. Carel's *Specifications des utilisateurs de Météosat,* CNES/PR/AM-ME/N°70T.124, 2/7/70 (52003) and *Le système Météosat,* prepared by H. Felix, March 1971 (52011).

[31] Figure 1.2 from *Le système Météosat,* prepared by H. Felix, March 1971 (52011). For the version of the satellite made available after the French offer see the *Rapport de Synthèse* of August 1971 (50015).

The Meteosat system offered for Europeanisation made provision for the fabrication of two flight models of the satellite (one being a reserve) and one launch on a Thor-Delta rocket which, as we mentioned, was already the subject of NASA-CNES discussions.[32] It also made provision for the ground segment, which had four elements. Firstly, there was to be a central station equipped with a 12 m diameter antenna: the ESRO Council would decide on its geographical location. This station would control the orbiter as well as receive raw data from it and would retransmit meteorological information to other stations after processing. The raw data would be acquired either from Meteosat's radiometer or from land and sea stations (ships, floating buoys) interrogated by it. This central station would be linked to a pre-processing centre, possibly though not necessarily located at the same place. The pre-processing centre was to convert the raw data from the satellite into a signal that could be exploited by the users, e.g. it was to add a coordinate grid to the image, or to transcribe it into a given cartographic projection. These images could then be distributed to 'main' (4 - 5 m diameter antenna) or 'local' (2 - 3 m diameter antenna) stations via the satellite. The precise nature of the interface with the national meteorological services was not specified: as regards the ground segment the French system costed only the central station, a prototype main station and some ten prototype non-manned stations.

ESTEC engineers and the *ad hoc Group* on Space Meteorology both assessed the French offer from a technical point of view. They confirmed that the basic spacecraft concept proposed, a spinning satellite with a mechanical tilt of the radiometer for scanning the Earth, was valid and that the overall performance of the instrument payload met the requirements of the European meteorologists, at least as far as a geostationary satellite was concerned: "most reasonable requirements will be well met by Meteosat", they confirmed. ESTEC noted however the uneven development of various parts of the system. More attention had been paid to critical components, like the radiometer and further work was required to homogenise the preliminary studies at sub-system level and to bring the definition of the complete Meteosat satellite to the level of detail corresponding to a typical ESRO phase B study. Only then could reliable cost estimates be provided – the French estimate of 35 MAU seemed far too low – and contracts placed with industry.[33] The meteorologists also called for modifications and extensions of the basic system to meet their needs. They wanted minor changes in the visible imaging system of the radiometer and felt that a second high-power data-transmission channel should be added to the spacecraft. They also called for changes to the ground segment. The meteorologists suggested that the tasks foreseen by CNES for the data handling centre be extended to allow the extraction of wind data and more elaborate processing of cloud images and that the number and complexity of the 'principal' ground stations be increased.[34] In short, from a technical point of view, the Europeanisation of Meteosat did not seem to pose any major difficulties.

These lay elsewhere. In the year that it took to formally transform the French satellite into a European project two main issues had to be resolved. Firstly there was the organisation and management of the space segment of the project itself. The initial French proposal was seen by ESRO and the other member states as leaving far too much control over the project in CNES' hands: long and difficult negotiations were required to shift the balance of power on to the 'European' level. Secondly, there were ongoing uncertainties about the functions to be performed by the ground segment and by association about the precise technical (and financial) location of the interface between the national meteorological services and ESRO. This issue was of course tied up with the role and responsibilities of the prime users of the system and the transfer to them of responsibility for operating the satellite.

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[32] The description that follows is based on Annex II to ESRO/C(71)6 of 24/6/71, (French) *Proposal for Europeanising the Meteosat Project* (ESRO578) and the debate at the 7th meeting of the IAPC held on 30/9/71, minutes ESRO/IAPC/MIN/7, 13/10/71 (ESRO9334). All quotations are from this latter document.

[33] For a report on the project see Tessier's first *Réflexions préliminaires sur la proposition d'européanisation de Meteosat* dated 13/9/71 (52014) and the *Summary report concerning the technical evaluation of the Meteosat system*, ESRO/IAPC(71)33, 12/11/71 (ESRO9370).

[34] The meteorologists report is document ESRO/IAPC(71)31, 7/12/71 (ESRO 368). A preliminary version dated 29/10/71 is in (52014).

4.1 The space segment: interfacing with CNES. The management and control of the Europeanised Meteosat

The organisational structure foreseen in the initial French proposal left the execution of the project more or less entirely in the hands of CNES' Toulouse Space Centre (CST). The project would be based there and the project manager would be a member of the CNES staff and responsible to the Director of the CST. More than 50% of the project team would be from the CST, the remainder being ESRO staff "together perhaps with specialists directly detached from the Member States". These participants, the French delegation assured the IAPC, "would be integrated in the team: they would thus have an active status, carrying responsibility and would not be mere observers". CNES would not charge internal costs in respect of its project team personnel or support laboratories, but would charge external costs and overheads relating to system integration and environmental testing. Tendering and the award of contracts for both the space and ground segments would also be handled by Toulouse which would privilege European industry, the spacecraft itself (60% of the total cost) being offered to the three European consortia COSMOS, MESH and STAR.

CNES' relationship to ESRO, the French suggested, would be analogous to that of an industrial prime contractor with the Organisation, although they insisted that "the overall responsibility of the CNES would however be much greater than that of an ordinary contractor" – a feature, said the French delegation, "which was part of the Meteosat proposal and as such was not negotiable". The precise terms of the arrangement would be specified in a contract between the ESRO Director General, acting on behalf of the participating states and the Toulouse Space Centre. The programme would be carried out under his responsibility and it would be up to him to ensure that it was executed within the deadlines and financial envelope fixed by the Council. The programme would be optional and the participating states would be represented on a programme board which would monitor its progress and keep an eye on the geographical distribution of the industrial contracts. An international user group of scientists and national meteorological services, along with members of ESRO's and CNES' Directorates of Programmes and Planning would be set up and would advise, through the ESRO Secretariat, on the "maintenance of the project mission" and on how the system was to be operated once commissioned.

The French proposals were the subject of ongoing negotiations between ESRO and CNES and a number of lively exchanges at meetings of the IAPC, the AFC and the Council during the following months. By the end of November 1971 the basis for a compromise had been reached, though not without difficulty: indeed the management framework of the project had been completely revised. The guiding principle was that, if Meteosat was to be funded at a European level, the technical and financial management of the project had to be entrusted to ESRO. This meant that the project should "remain firmly under international control, the Director General [of ESRO and not the Director of CNES, as the French had originally suggested] assuming responsibility for its management". Furthermore, "the award and management of the contracts should be in accordance with the rules and procedures of the Organisation". ESRO, not CNES, would therefore be responsible for preparing the tender action, evaluating the offers, selecting the industrial prime contractor and the sub-contractors and administering the awarded contract. To execute the project the DG suggested and the French agreed, that an integrated management team, responsible for the entire programme, including spacecraft, payload, ground facilities and operation be set up. The project manager and at least half the staff of some 35 people were to be from ESTEC and not from the CST as CNES had originally proposed. At the same time, to make best use of the experience and expertise already acquired at Toulouse, it was suggested that the remainder of the staff should be engineers then engaged on Meteosat, who would be seconded from the CST and fully integrated into the ESRO project team (in the final agreement with CNES provision was made for up to 14 staff from the CST to be put at the disposal of ESRO).[35]

[35]This material is drawn primarily from the internal memo *Management of the Meteosat programme*, dated 20/10/71 (52014), ESRO/AF(71)96, 26/10/71 (ESRO2282) and ESRO/C(71)63, 2/12/71 (ESRO604). The final agreement with CNES is ESRO/C(72)14, rev. 3, 17/5/72.

The French, of course wanted something in return for these concessions. The first thing that they insisted on was that the project team be based at Toulouse on the premises of the CST. This had certain financial advantages for ESRO: the CNES contribution to functional support (see below) represented an estimated saving to the organisation of about 100 man-years and the CST test facilities would be made available at marginal cost. In addition it had, to quote the Director General of ESRO, "the intangible advantage of situating the project in the technical atmosphere in which it was born".[36] Not everyone was convinced. The British, in particular, felt that the European character of the project would be compromised and that one participating state would gain an unfair advantage by having the project team based in a national institute. The French, however were adamant: "should it be decided not to locate the project team at CST in Toulouse then the whole basis of the project would have to be reconsidered", they warned.[37]

The second key issue on which they dug in their heels was the division of functional support between ESRO and CNES. Formally 'functional support' meant activities normally carried out by ESRO rather than in industry. Concretely functional support came down to the allocation of responsibility to individuals inside the project team for various parts of the programme, including subsystems. It was here that the engineering skills and experience in the design and construction by industry of the meteorological system would be acquired and it was here that France wanted to ensure that it retained its competitive advantage over its partners, consolidating on the base already laid in the national programme.

A small working group with representatives from ESRO and CNES was set up to deal with this matter. They identified three possible levels of interaction by team members with industry: 1) specialised advice e.g. for the preparation of specifications or the analysis of industrial tenders; 2) 'follow-up' of work in industry and 3) supervision of work in industry under the delegated authority of the project manager. These contacts had to respect two guidelines. Firstly in line with the recommendations of the so-called Cooper Report to ESRO, interventions in industry had to be restricted to the system level; in an effort to give industry as much responsibility as possible, there was to be no "interference" at sub-system and component level. Secondly, it was laid down that contacts between industrial staff and team members could only take place with the agreement of the project group and that it was preferable if not essential to have a member of the project team present during such contacts. By these procedures ESRO aimed to submit CST staff to the same discipline as the ESTEC engineers so as to avoid changes being made by the contractors which could affect the cost, quality or time scale of the subsystem.[38]

The functional division of labour between ESTEC and the CST within the project was to respect the experience already acquired in each centre and to keep the interfaces between the different functional support units as 'clean' as possible[39] Two ways of dividing up tasks had been agreed by March 1972, one in the ratio ESRO:CNES of 60:40, the other of 55:45. They were technically equivalent but it was decided to adopt the former as this made the project more "visibly" an ESRO project and was "presentationally preferable".[40] Probably no one was deluded by these cosmetic manoeuvres; as we mentioned earlier, the French engineers had already developed key systems of the spacecraft to an advanced level and it was widely accepted that they maintain control over them. Thus ESRO was to be responsible for power supplies, telecommunications, quality control, part of the ground segment, notably the hardware and some software aspects of the central control station and of course, overall management. The CST on the other hand maintained control over the main subsystem on which the whole Meteosat mission rested, viz. the radiometer instrument package (mechanical-optical system, IR and visible light detectors) along with its electronics for data storage, timing coding/decoding etc., which they had developed to an advanced stage with Matra. Its engineers were also responsible for the equally critical

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36 ESRO/C(71)63, 2/12/71 (ESRO604).

37 ESRO/PB-MET/MIN/1, first meeting of the Meteorological Satellite Programme Board held on 21/3/72, document (ESRO8940), 19/4/72.

38 This paragraph is based on the minutes of the meeting of the working group (Groupe de Travail de Management Technique 'Meteosat') held on 8/2/72 (52018). For the recommendations of the Cooper report see the remark by the director of ESTEC made at the 7th meeting of the IAPC, ESRO/IAPC/MIN/7, 13/10/71 (ESRO9334), at p. 6.

39 E.g. in Macchia's memo to Hocker commenting on the paper to be prepared for the Programme Board meeting of 21/3/72, 8/3/72 (52019). See also ESRO/AF(72)20, 25/1/72 (ESRO2319), point (m).

40 From minutes of the first meeting of the Meteorological Programme Board held on 21/3/72, ESRO/PB-MET/MIN/1, 19/4/72 (ESRO8940).

attitude control thrusters and the nutation damper which oriented and stabilised the satellite in its orbit. CST also developed the technology for the acquisition and processing of the image signal i.e. for the hardware and software necessary for the processing of raw-image data as well as storage and read-out (to tape transmitters) of processed image data. In short the final division of labour in the Europeanised Meteosat preserved the French team in Toulouse intact along with its in-house skills and knowledge of crucial subsystems of the space and ground segments. This would obviously give French engineers and industry an enormous advantage if or when a fully operational system of successive meteorological satellites giving continuous Earth coverage was put in place. [41]

The basing of the project in Toulouse and the allocation of critical subsystems to CST engineers were, in France's eyes, the *sine qua non* for the Europeanisation of the Meteosat project and they were prepared to back their demands with threats. At the Council meeting in December 1971 member states of ESRO, including France declared their intention to participate in the so-called "first package deal" which made provision for three applications satellites, including one for meteorology. The French delegation was heartened, it said, by the spirit of compromise which had reigned during the negotiations leading up to this deal – of which its willingness to accept a structure for Meteosat which "differed very substantially from the one that France had originally put forward" was just one sign. That said, France was now "at the extreme limits" of the concessions that it was prepared to make and the attitude of its partners to its outstanding demands would be taken "as a critical test of the will of the Organisation to translate into practice the principles regarding co-ordination of European space programmes" which it had just enunciated. Put differently the success of the first package deal and indeed the survival of the joint European space effort as a whole was linked by France to having its bottom-line conditions for the Europeanisation of Meteosat respected.[42]

One last little anecdote is indicative of the tensions and ambiguities surrounding the process of Europeanisation. By May 1972 the Meteosat programme had been so completely transformed institutionally, if not technically, that some members of the *ad hoc Group* felt that it should lose all visible trace of its French origins. Even the Project Manager at the time, W. Nellessen began to be unsure about what he was actually manager of: was it Meteosat or GEMS (GEostationary Meteorological Satellite). A near-final version by Tessier of one of the annexes to the formal agreement between participating states hesitated between Metsat and Meteosat.[43] The French engineers at CNES were, needless to say, deeply offended – it seemed as though no efforts would be spared to marginalise and even to humiliate them – and in the event the original name was kept.

4.2 The ground segment: interfacing with the users. The responsibilities of national meteorological services in data analysis and satellite operation

Until mid-1971 the ground segment had been of secondary interest in discussions among European meteorologists on their preferred satellite-based system. Their main concern was to define the most suitable spacecraft and its instrument package, bearing in mind the requirements of the FGGE in 1977/8.[44] This was partly a matter of scheduling: the decision on the appropriate space segment had to be taken by 1971/72 if the satellite was to be launched by 1976. The ground segment would not take as long to put in place and could be defined afterwards. It was also due to scientific uncertainty: the field of meteorological data analysis was evolving rapidly and would certainly make further strides once the first results were available from the new generation of US geostationary satellites. Finally it raised thorny questions about the division of labour, cost and responsibility between those responsible for the space segment and the users who would exploit the meteorological data. The situation in France was typical in

[41] The division of labour is described in ESRO/C(71)63, 2/12/71 (ESRO604), in the memo from Contzen to Hocker *Programme de satellite météorologique – Groupe de négociations ESRO/CNES*, 17/2/72 (52019) and in the formal *Agreement with CNES*, ESRO/PB-MET(72)3, rev.3, 17/5/72 (ESRO8957). For the importance of the various subsystems see ESRO/IAPC/71/33, 12/11/71 (ESRO9370).

[42] Annex III to the minutes of the 44th Council session, 20/12/71, at which the deal was officially announced – it was brokered by Puppi – contains the French delegation's statements, ESRO/C/MIN/44, 6/1/72 (ESRO42).

[43] See memo Nellessen to Tessier, 15/5/72, memo *An Estimation of the GEMS Post-Launch Running Costs* by Wassgren (ESOC), 21/6/72 (52023) and early versions of Table I.2 (below) in (52022).

[44] This is the case, for example, in document ESRO/IAPC(71)12, 1/7/71 (ESRO9349), in which the ad hoc group formulated its priorities for the European meteorological programme – and speaks only of satellites.

this regard. Meteosat had been the baby of engineers at CNES who found in it a viable and technologically challenging programme. The French meteorological service was barely involved in its planning and was indifferent, if not hostile, to a scheme which would ultimately require it to transform old work habits and to spend a lot of money.

The debates over management control ensuing from the French proposal to Europeanise Meteosat forced the European meteorologists to look closely at the organisation of the ground segment. Two additional factors oriented them in this direction. Firstly, there was a symbiotic link between the space and ground elements of Meteosat. Image processing, in particular, depended heavily on the specifications imposed on the satellite's attitude control and stability systems, the images themselves even being able to serve as a parameter for controlling the spacecraft in its orbit.[45] Secondly, it rapidly emerged that, contrary to the impression given by the French delegation in June, virtually no work had been done in France on the ground segment. What is more, according to Tessier, the director of the national meteorological service was not at all keen to have the central station on French soil as it would impose too heavy a load on his budget.[46] It will indeed be remembered that in their initial offer to Europeanise their satellite, the French delegation suggested that the ESRO Council could decide on the location of this station. The *ad hoc Group*, meeting in Paris in September 1971, thus decided to renew its efforts concerning the ground segment. It was proposed that a team of about six people (called the GFGMS group), including engineers from CNES and ESRO and two meteorologists nominated by the chairman, be set up to deal with the preliminary studies needed by industry, possibly liaising with NOAA.[47]

By November 1971 the meteorologists had revised their original statement of needs produced for the IAPC four months before by formally adding a ground segment to the European system. This system would "provide and operate the ground stations required to control the spacecraft, acquire its data and reduce them to meteorological parameters effectively in real time". It would contain a central station, as well as 'principal' stations equipped with antennae up to about 5 m in diameter and 'local' stations which would be as simple as possible. The central station was "taken to mean the complex of telemetry and command, pre-processing and processing centres". The principal stations were to be equipped to see all the image information relating to their own neighbourhood (2000 km × 2000 km), as well as images of the Earth's disc at intervals of not more than three hours. Local stations were to be able to see local images at least once every three hours. Costing these items, the secretariat budgeted for a central station and pre-processing centre equipped with a major computer, as well as for "development of prototype specifications for a principal station". The processing centre(s), the principal and the local stations, as well as data collection platforms would be financed outside the ESRO space programme, though further information was required from the meteorological authorities before a more definite division of labour could be provided.[48]

This division of financial responsibility between the pre-processing and processing of meteorological data was intended to involve the meteorologists directly in the funding and functioning of the ground segment. The Secretariat accepted that a major central computer was needed to transform raw data coming down from the satellite into information which could be analysed by the meteorologists. The processing of that data, they felt, should be under the control of the weathermen, however. The French members of the *ad hoc Group* (Bessemoulin and Morel) supported them. They were emphatic that meteorological data processing could be kept quite distinct from "the technical operations of satellite control, navigation and raw data calibration and gridding". The relationship between the functions could only be decided, they said, once one had a better idea of the requirements for the data processing system itself.

This attempt to give the meteorologists responsibility for a major component of the ground segment failed. The majority of the *ad hoc Group* and notably the British and German representatives of the 'Wetterdienst' (Stewart and Regula), preferred a centralised system combining all the functions in one

[45] See the minutes of the meeting of the working group on the technical management of Meteosat held on 8/2/71 (52018).
[46] See Tessier's memo *Réflexions préliminaires sur la proposition d'européanisation de Meteosat*, 13/9/71 (52014).
[47] The minutes of this sixth meeting are dated 5/10/71 and are in file (52014).
[48] The meteorologist's addendum to their previous statement of needs (IAPC(71)12) was ESRO/IAPC(71)32, 8/11/71 (ESRO9369). See also ESRO/IAPC(71)31, 7/12/71 and a draft dated 29/10/71 (52014). The secretariat's costings are in ESRO/IAPC(71)34, 17/11/71 (ESRO9371).

co-ordinated unit. They accepted, however, that the telemetry and command functions might be executed up to a hundred kilometres away from the pre-pre-processing and processing functions so that the antenna would be free from interference.[49] As the UK delegate to the first meeting of the Programme Board put it, "complete real-time processing of meteorological data is a complex task needing continuous use of a CDC6600 computer and many staff," and was beyond the means of national stations. To "avoid having the satellite produce a large amount of data that could not be exploited by the national agencies for lack of sufficient computer capacity", he said, it was essential to foresee a properly equipped central station in the European programme.[50] In the face of this pressure the French capitulated and the *ad hoc* group decided unanimously in favour of "the lumping of the meteorological and space sections of the central station". This was located at ESOC in Darmstadt, while the DATTS function (see Table I.2) was situated in Odenwald.[51]

Meteorologists could, however, still be involved in some basic tasks of the central system even if the 'meteorological and space sections' were lumped together. A definition of their role required a detailed analysis of just what was involved in treating meteorological data with computers and breaking down the tasks in such a way that a meaningful line could be drawn between European and national activities. To sharpen their thinking on this, some members of the GFGMS subgroup spent a month in the USA visiting NOAA again and having in-depth discussions with leading scientists at the universities of Chicago and Wisconsin "to study fundamental methods involved in the extraction of meteorological data". Their deliberations were complemented by an additional working party chaired by Regula and composed of representatives of the national meteorological services.[52] The GFGMS working group's report was ready in March 1972. It identified the tasks required to "transform spacecraft data into useful meteorological information", bearing in mind the interconnectedness in the "processing of attitude, orbital and meteorological data".[53] By May its findings had been fused with the conclusions of the Regula subgroup.

Table I.2 shows the tasks accorded to the central ground facility as shown in the formal "Arrangement" binding together the participating states in the Meteosat programme, which was ready for signature in July 1972.[54] The Central Facility was "to perform the tasks which [were] too expensive and/or too involved to be performed several times in parallel." The locus of its interface with the national meteorological services was the MIEC (Meteorological Information Extraction Centre). The "general philosophy" here was that the MIEC was to perform data extraction only on a global scale and on a quantitative basis (i.e. data which could be used directly for numerical modelling). This data was to be "as independent as possible" of other meteorological data and was to deal with winds, sea surface temperatures, cloud coverage, cloud top heights and radiation balance. The MIEC was not to concern itself with qualitative applications (the issue of warnings, general surveys of the weather system) or with quantitative applications on less than global scale.[55] These would be considered the task of the national meteorological services who would use their own computers. On the last point the Directors of the national meteorological services insisted that "they would have sufficient computer capacity available to receive and make the best possible use of the meteorological data supplied by the satellite".[56]

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[49] See the *Minutes of the Seventh Meeting of the Space Meteorology Group* held in Brussels on 4-5/11/71, dated 7/12/71 (52016). The quotation is from Appendix 6 which the French insisted be added.

[50] The minutes of the first meeting of the (Provisional) Programme Board, ESRO/PB-MET/MIN/1, held on 21/3/72, are dated 19/4/72 (ESRO8940).

[51] From *Minutes of the Eighth Meeting of the Space Meteorology Group* held on 9-10/2/72, dated 7/3/72 (52018). At this meeting Stewart gave the arguments he felt weighed in favour of centralisation: it would avoid wasting the spacecraft's disseminating capabilities, it would enhance the security and reliability of the system and it would economise on operational exploitation costs.

[52] The terms of this subgroup are spelt out in an undated document in (52019).

[53] The two quotations are from ESRO/PB-MET(72)2, 16/3/72 (ESRO8956). The GFGMS report, *Study of Meteorological Data Processing Methods* is in (52021).

[54] The Arrangement between ESRO and some of its member states "concerning the execution of a meteorological satellite programme" is ESRO/C/13 rev.5, 13/7/72 (ESRO622).

[55] From the Regula group's report on the ground segment ESRO/PB-MET(72)5, 29/5/72 (ESRO8959) and Annex 1 to ESRO/PB-MET(72)7, 1/6/72, *European Contribution to Space Meteorology* (ESRO8961). See also Schneider's description at a meeting in Washington DC on 19-20/9/72 (52025).

[56] From the *Statement by the Chairman of the ad hoc Group on Space Meteorology* to the second meeting of the (provisional) Programme board, ESRO/PB/MET/MIN/2, Annex II, 21/6/72 (ESRO8941).

TERM		ABBREVIATION	MAIN FUNCTIONS
(1)	Ground Facility Meteosat	GFM	Combines (2) to (5)
(2)	Data Acquisition, Telecommand, Tracking Station	DATTS	Data Acquisition (Meteorological and Housekeeping Data) Telecommand Tracking
(3)	Operations Control Centre	OCC	Control of Spacecraft and Operations
(4)	Data Referencing and Conditioning Centre	DRCC	Phase Adjustment of Radiometer Data Gridding and Annotation Orbit and Attitude Computations Editing Imagery: - Rectification - Projection Conversion - Information Transformation
(5)	Meteorological Information Extraction Centre	MIEC	Extraction of Meteorological Information - Sea Surface Temperatures - Wind Fields - Cloud Analysis (coverage and top height) - Radiation Balance - Editing - Handling of Data Collection Platforms (DCP) Data
(6)	Meteorological Terminal	MT	Equipment Required by the GFM to Provide the Interface with the Link with the Global Telecommunications System (GTS) of the World weather Watch (WWW)
(7)	Meteorological Centre	MT	Meteorological Analysis by Users
(8)	Primary Data User's Station	PDUS	Reception and Display of Full Resolution Image Data in digital Form Reception of APT Type Transmissions (in analogue form)
(9)	Secondary Data User's Station	SDUS	Reception and Display of APT Type Transmissions (in analogue form)
(10)	Data Collection Platform	DCP	*In situ* Collection of Meteorological and Related Data

Table I.2. Tasks of the different ground facilities as agreed in the Arrangement between the participating states in the Meteosat programme, July 1972.

The central processing facility was not simply meant to have a data-processing and distribution function; it was also to archive data and have a related research capability intended to improve the methods of extraction of data in the five identified areas. The centre was also to have a "flexible" policy whereby results obtained in universities and national services, once operational, could be fed back to the MIEC and integrated into its systems. In sum the ESRO ground segment was to provide national meteorological services with qualitative data comprising images in suitable formats transmitted to their PDUS and SDUS and quantitative data extracted from raw space data by the central facility on topics like wind field etc., which would be disseminated through existing meteorological telecommunications networks.

Who would pay for what? According to the final "Arrangement" ESRO would bear the entire cost of the ground facilities specified in Table I.2 except for the software of the MIEC and all the modifications it might require and the links between the meteorological terminal and the national meteorological centres. This was taken by Schneider, the *ad hoc Group* Chairman, to mean that "the programme and operating costs of the MIEC will be met by the meteorological services themselves, as well as the cost of a small group of research workers whose major task will be to develop new methods of extraction". This cost, he went on to say, represented 4-5% of the budget of a meteorological service at that time.

Even this arrangement was not to last too long however. One of the first things the meteorologists did after the Meteosat Arrangement was signed in July 1972 was to plan the software effort for the MIEC. This was one main point of entry of users into the system, the point at which they could impose their working requirements on it. The directors of the meteorological services divided the work that needed to be done into several phases: identification of products required, software definition, software specification and writing of computer programmes. The first two phases would require about four meteorologists who could work from their home bases, the last two would involve an increasing number of computer experts and would require a close interaction with ESOC. However it quickly emerged that identifying the tasks was one thing, providing the legal and financial framework for carrying them out was another. Some meteorological services felt unable to finance the travel costs of their experts to the two or three working meetings needed during phases I and II. No one quite knew how to administer or to define the level of contributions to the common fund that was going to be needed to pay for the more costly phases III and IV. It also emerged that no figures were available at all on the cost of development of the MIEC software.[57]

The Programme Board discussed these matters with growing concern early in 1973. It decided that it was essential for ESRO to contribute to the development of the MIEC software too. One way was for the Organisation to sign individual contracts with national meteorological authorities in both participating and non-participating states, an arrangement which would extend the scope of the user community and enable the users to express their interest directly. The other was to revise the Annexes to the Arrangement signed only a few months before, with the associated risk that ESOC would have more room to impose its will on the users. The Programme Manager at the time, De Leo (he would be replaced by Dieter Lennertz very shortly) felt that this was essential anyway. The intimate links between software and hardware, he wrote, meant that the software definition had to be "controlled by the same organism responsible for the hardware".[58] Meeting on 29 March 1973 the Programme Board chose this path in the interests of cost and efficiency. An additional sum of 1.5 MAU was allocated to the Meteosat programme for the "new task of the preparation, development and pre-operational optimisation of the software" for the MIEC.[59]

The reluctance of the meteorologists to play a major role in the processing of data coming from Meteosat was symptomatic of the prudence with which the bulk of the weathermen approached the entire project. Initially they had led their colleagues to believe that they would assume full responsibility for the ground segment. In September 1971 the Italian delegate to the IAPC had suggested, for example, that "all ground

[57] For reports on their preliminary meetings see ESOC memo Wassgren to Walker, 19/9/72 (ESRO52025), minutes of the Dublin meeting of the ad hoc group on 26-27/9/72, ESRO/SMAHG/MIN11, 6/10/72 (ESRO52025); minutes of the meeting held in Offenbach on 14/11/72, document dated 23/11/72 (ESRO52026),and letters Regula to Tessier, 10/10/72 and Schneider to Hocker, 4/12/72 (ESRO52026).

[58] Memo De Leo to Contzen, 15/11/72 (ESRO52026).

[59] See minutes of the meetings held on 16/2/73 and 29/3/73, ESRO/PB-MET/MIN/4, 13/3/73 (ESRO8943), ESRO/PB-MET/MIN/5, 10/5/73 (ESRO8944) and document ESRO/PB-MET(73)5, 15/2/73 (ESRO8971).

equipment would be placed under the responsibility of the national meteorological services". The meteorologists retreated steadily from this position, however. 'All ground equipment' was first cut back to a share of the costs of the processing centre. In the minutes of the March 1972 meeting of the *ad hoc Group* we read that the meteorologists "agreed that the data acquisition and pre-processing centres should come under the ESRO budget and that the meteorological processing centre should be shared jointly between ESRO and the meteorological services". The British delegate to the next meeting of the group in May revised this further: now it was "agreed that the data acquisition and pre-processing centres should come under the ESRO budget, but that the exact interface between these and the meteorological centres needed to be discussed more fully [...]."[60] That proposal was transformed into a fixed commitment to pay for the MIEC software in the Meteosat "Agreement" signed in July 1972 – but then even that 'Agreement' was revised just nine months later to remove even this task from the shoulders and the budgets, of the meteorological community. It was clear by 1973 that it was going to be a long uphill struggle to enrol the meteorological community fully into an operational meteorological satellite system.

5. The start of the programme

The "Arrangement Between Certain Member States of the European Space Research Organisation and the European Space Research Organisation Concerning the Execution of a Meteorological Satellite Programme," along with its Annexes describing the details of the Meteosat programme and its cost (an envelope of 115 MAU at mid-1971 prices for the period 1972-79) was approved by the ESRO Council at its 47th session on 12 July 1972. The resolution which formalised the decision noted that arrangements still had to be made to cover both the operation of the Central Facility and the operational phase of the programme and that "ESRO could be considered as one possibility" for the latter.[61] The Arrangement came into force before the foreseen deadline (30 September 1972) with two-thirds of the contributions guaranteed. The eight participating states and their contributions were Federal Republic of Germany (25.66%), Belgium (4.06%), Denmark (2.41%), France (23.70%), Italy (15.07%), United Kingdom (20.60%), Sweden (5.02%) and Switzerland (3.48%).[62]

In the first year or two after the Arrangement was signed a number of technical and financial changes were made to the Meteosat programme and the appropriate institutional framework was put in place. We shall quickly summarise these elements before plunging into a discussion of the subsequent evolution of the programme.

5.1 The STAG

One of the first things the meteorologists did was to formalise their relationship as users by suggesting that a group of expert advisers be put in place, in additional to the Programme Board, to represent their interests and to monitor the Meteosat programme. It was felt that such a group was needed to keep an eye on the technical aspects of the programme, including data processing and to co-ordinate relations between the users in meteorological services as well as the scientific research community. This body, the STAG (Scientific and Technical Advisory Group) comprised up to two representatives from each of the participating states.[63] As an advisory body their recommendations to the Programme Board did not tie the hands of the delegations. The STAG held its first meeting on 11 December 1972 and appointed Stewart (UK) its chairman, representing the meteorological services and Morel (F) its vice chairman, representing university research – a combination specifically sought by the French.[64] The *ad hoc Group* on Space Meteorology dissolved itself at the same time and the directors of the national meteorological services decided that they should continue to meet formally in a regular manner, but outside the framework of ESRO.

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[60] For the first quotation, see Annex II to ESRO/IAPC/MIN/7, 13/10/71 (ESRO9334). The minutes of the ninth (March) and tenth meetings of the Space Meteorology Group, dated 6/4/72 and 25/5/72, are to be found in (52019) and (52022), respectively.

[61] ESRO/C/MIN/47, dated 26/7/72; the resolution is ESRO/C/XLVII/Res. 1, 12/7/72 (ESRO45).

[62] The document is ESRO/C(72)13, rev.5, 13/7/72. It will be remembered that during the next year a further 1.5 MAU was provided for preparing the MIEC software, this to be distributed as for the main programme.

[63] The full terms of reference are in ESRO/PB-MET/III/Res. 11, 5/10/72 (ESRO8942). They are a selective fusion of the views of the French delegation, ESRO/PB-MET(62)11, 29/9/72 (ESRO8965) and the meteorological directors, Annex 4 to ESRO/SMAHG/MIN11, 6/10/72 (ESRO52025).

[64] ESRO/STAG(72)4, 11/12/72 (ESRO9042).

The management of the interface at the working level between the meteorologist users and the ESRO Executive proved far more difficult to harmonise and was indeed the source of ongoing friction which was amplified by the difficulties with the ground system that we shall be describing shortly. The first salvos were fired at the second meeting of the STAG. The German delegation asked if the users might receive copies of the specifications sent out to the firms tendering for work. The secretariat refused, insisting that "the execution of the technical aspects and the control of the industrial consortia" were its responsibility. The French delegate to the STAG could not accept this. That policy may have been acceptable for scientific satellites, he said, but the Agency should recognise that applications opened "a new era", as the spacecraft also had to satisfy customers who had a right to know what they were getting and who wanted to acquire for themselves the requisite competencies in the new technologies. At the very least the Executive should be prepared to make a presentation of the project to the users before the final designs were frozen so that they might propose changes.[65] A year later the French delegate went further, suggesting specifically that the Organisation's secretariat be obliged to report to both the STAG and the Programme Board "to present in details the substance of the specifications before putting out calls for tenders relating to major parts of the programme". He also wanted the internal assessments of the industrial proposals after the calls for tenders to be divulged to the two bodies.[66]

As far as policy as a whole was concerned the French delegation gathered little support. At a meeting of the Programme Board in November 1973 the consensus was that it should not be standard practice to make a technical presentation of industrial proposals to the delegations. This was likely to undercut the authority of the Administrative and Finance Committee, the only body authorised to award major contracts and to encourage firms to lobby national delegations directly, to the detriment of the Organisation.[67] These formal arguments notwithstanding, there were ongoing tensions over specific cases in which the meteorologists felt that their views were being ignored. For example, in November 1973 the plans for the central building, in which they had requested an increase of office space, had been "completely changed" to the detriment of the meteorologists and there had been no discussion with the users concerning the tasks to be undertaken in important sections of the ground facility.[68] In February 1975 the German delegate to the STAG was "surprised" that the Group had not been asked to monitor work on the software specifications more closely, while the British delegate "deplored the fact that during the dialogue with industry the necessary adjustments had been made on the advice of the MIEC group" without consulting the STAG, which was accordingly unable to advise the Programme Board correctly. Two months later it was the turn of the French to "deplore the fact that the Secretariat's work schedule for the placing of the software contract for the Meteosat computer system did not make sufficient provision for the users to intervene".[69]

ESRO/ESA staff, of course, made what efforts they judged reasonable to meet the users' objections while defending themselves stoutly, even if with growing frustration: typically Programme Manager Lennertz "again asked the Group not to interfere with the normal process of the [tender] procedure which was in strict conformity with the Organisation's rules; an intervention by the STAG in order to modify the specifications which it had previously approved could, in the extreme, invalidate the call for tenders causing it to be done afresh [...]".[70] It is not the task of the historian to adjudicate in this affair. What is important is that each party in this dispute was defending its own interests and felt that the other was behaving unreasonably and – and this is the most important point to retain here – that the feeling that they were being unjustifiably excluded led the meteorologists to become increasingly hostile towards ESA. That hostility was exacerbated by the difficulties with the ground facility which plagued Meteosat-1 throughout its active life.

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[65] ESRO/STAG/MIN/2, meeting on 29/1/73, document 19/3/73 (ESRO9026).
[66] ESRO/PB-MET/MIN/8, meeting on 6/2/74, document 15/3/74 (ESRO8947).
[67] ESRO/PB-MET/MIN/7, 7/11/73, document, 20/12/73 (ESRO8946)
[68] ESRO/PB-MET(73)19, 16/11/73 (ESRO8984).
[69] ESRO/STAG/MIN/12, meeting on 19/2/75, document 8/4/75 (ESRO9036); ESRO/PB-MET/MIN/14, meeting on 25/2/75, document 18/4/75 (ESRO8953).
[70] ESRO/STAG/MIN/12, meeting on 19/2/75, document 8/4/75 (ESRO9036).

5.2 The third channel and the Lannion ground station

Two developments, both of them promoted by the French delegation, were adopted to improve the quality of the data from the Meteosat system. Firstly, an additional infrared channel conceived by P. Morel and corresponding to the water vapour absorption band, was added to the two channels originally foreseen on the radiometer.[71] Its main scientific functions were to give additional information on winds in the upper troposphere, particularly in the tropics, where coverage from existing observing systems was very inadequate. This would be done using newly available sensors to observe cloud movements and the configurations of cirrus, as well as to detect and locate jet streams and to measure temperature contrasts. Other information available from the channel – water vapour distribution, inference of vertical motion, cloud analysis and improvements in the determination of cloud-top temperature in the mid-troposphere – was of an experimental nature and would be of value for research.

The third channel lived rather precipitously for a few years. Feasibility studies of the device made in 1974 led to a cost increase of 100% over original estimates and it became clear that the chances of having the package ready for the first Meteosat flight unit (F1) were rather remote. Indeed in November 1974 the secretariat reported that the way things stood the third channel could probably not be integrated into F1 without delaying its launch (scheduled for April 1977). The radiometer for F1 would thus be built with just two channels, as originally planned. The three-channel radiometer would be prepared for the spare flight unit F2. A final decision on which payload was to be integrated into the F1 satellite would be taken in mid-1976. This led the Belgian delegation to wonder whether it was worth proceeding with the channel at all if its chances of being used were remote, particularly when money was being cut from the science programme. The French delegation resisted this suggestion, as did the representatives of Britain and Germany. Their overriding argument was that the additional channel was a really novel development and one important way in which Meteosat differed from existing American satellites. [72]

The second modification requested by the French was to extend the geographical coverage of data available to Europe by including meteorological information from the American SMS satellite in the system. The two satellites had a common longitudinal frontier roughly over the middle of the Atlantic Ocean, the US satellite (to be situated at longitude 70-75°W) "seeing" the western part of the ocean, while Meteosat (at 0°) observed the eastern part (see Figure I.1). Data from the former thus complemented that from Meteosat, providing advance information on depressions and frontal systems moving westwards, as well as assisting navigation over transatlantic air corridors from Europe. The French claimed, however, that the Meteosat central facility at Odenwald was too far west to receive signals from SMS. They thus suggested that their existing centre at Lannion, which was about 150 km from the extreme western point of the hexagon, be used instead to relay signals from SMS via Meteosat to European meteorologists at their PDUS and SDUS. A technically well-qualified team with several years of experience of operational work had been built up at the base and France was prepared to invest FF3.7 million to upgrade the station appropriately. A further FF1 million would be required from ESRO

The proposal certainly had scientific and operational advantages. But more was at stake. The French presented their proposal at the meeting of the Programme Board held soon after the Council had agreed to situate the Meteosat central facility at ESOC/ Odenwald. And even if the delegates from Britain and the UK had their doubts about the relevance of the French idea for the Meteosat programme as such, the French made it clear that they would reopen the debate on the site if their offer was refused for "reasons other than the position of the SMS satellite". With that the matter was closed in their favour.[73]

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[71] The proposal is ESRO/STAG(72)6, 28/12/72 (ESRO9044) and the first debate is ESRO/STAG/MIN/3, meeting on 27/3/73, document 15/6/73 (ESRO9027), producing ESRO/STAG(73)11, 30/4/73 (ESRO9055) and ESRO/PB-MET/MIN/6, meeting on 7/6/73, document 23/7/73 (ESRO8945).

[72] See ESRO/PB-MET(74)24, 23/9/74 (ESRO9008), ESRO/STAG/MIN/10, 11/9/74, document 6/12/74 (ESRO9034), ESRO/PB-MET/MIN/13, 26/11/74, document 24/1/75 (ESRO8952), ESA/PB-MET/MIN/4, 29/1/76, document 24/3/76 (ESA3530). The cost increase for having a channel on each radiometer was about 370 kAU, ESA/STAG/MIN/3, 11/2/76, document 7/4/76 (ESA3692)

[73] See ESRO/STAG(72)5, 12/1/73 (ESRO9043); ESRO/PB-MET(73)14, rev.1, 8/11/73 (ESRO8979); ESRO/PB-MET/MIN/4, meeting on 16/2/73, 13/3/73 (ESRO8943); ESRO/PB-MET/MIN/6, 7/6/73, document 23/7/73 (ESRO8945); and ESRO/STAG(73)12 (ESRO9056).

6. The ongoing technical problems with ground facility computer and software

The tender evaluation and the secretariat's recommendation for the ground computer system were discussed at the AFC meeting in Copenhagen on 4-5 July 1974. The committee was faced with a dilemma: none of the European firms bidding for the contract could match the offers made by the American suppliers. The ESRO Secretariat thus proposed that the contract be awarded to the American company CDC whose offer was judged "the best received"[74]. Wishing to promote European technology in this sector however, the AFC decided that the two companies concerned, ICL (UK) and CII (France), be given another chance. Study contracts of 20 kAU were awarded to each and they were invited to resubmit tenders in the light of revised mission requirements to be provided by the meteorologists. As for costs, the AFC also agreed to accept a European offer if it was not more than 10% more expensive than the CDC offer recommended by the Secretariat.[75]

In coming to this decision the AFC clearly had the long-term interests of the European computer industry in mind. As the French delegation to the Programme Board pointed out, a non-European solution should only be adopted if it was "absolutely necessary" since it would impossible to change back once Meteosat became operational as all the systems would have been developed.[76] The AFC had however also been advised by the STAG, which had met the week before to discuss the computer contract. Here, somewhat against their status as independent experts and going beyond their formal role which was limited to making technical judgements, the French and British meteorologists suggested that the European solutions could be saved. While not casting aspersions on the excellence of the work done by the Project Manager and the Tender Evaluation Board, the STAG did feel that the technical specifications in the tender documents sent out by ESRO "did not correspond exactly to the true needs of the meteorologists and that there might be some room for adjustment of the requirements to enable European proposals to meet them." The AFC's decision to reopen the tender procedure thus had at least the appearance of being based not only on political/industrial considerations but also on technical arguments.[77]

Towards the end of July a small group of experts nominated by the STAG met at ESOC to revise the technical specifications of the ground facility. In the light of the difficulties the European computer firms were having, they concentrated their efforts on reducing the demands on the Central Processing Unit (CPU). In particular they sought ways of reducing the total and/or peak load on the CPU imposed by each task, by changing the requirements in terms of geographical coverage, spatial frequency (grid size), extraction method, the frequency with which a product was generated and the time of issue of the product. Their overall aim was to save CPU time by reducing the quantity of the data rather than the quality. Thus typically they recommended that measurement of cloud top height should be restricted to areas used by aircraft, that reference images for wind processing should be provided every second hour rather than every hour and so on.

Changes of this kind had two immediate effects. Firstly, since less data was generated and less frequently there would be a loss of quality control of the meteorological products. Secondly, with the rescheduling of the use of CPU time there would be less spare capacity in off-peak periods, to the detriment of the outside research community for whom such slots had been specifically earmarked.[78] The Programme Board endorsed the report, though it was noted that the two original European proposals were still unacceptable notwithstanding the efforts to adapt the specifications to their capabilities. [79]

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[74] See ESRO/AF(74)67.
[75] ESRO/AF(74)119, 23/9/74 (ESRO2714).
[76] In ESRO/PB-MET(74)19, 17/7/74 (ESRO9003).
[77] For the debate in the STAG see ESRO/STAG/MIN/9, meeting 26/6/74, document 2/7/74 (ESRO9033) and ESRO/PB-MET(74)17, 11/7/74 (ESRO9001).
[78] See ESRO/PB-MET(74)20, 29/7/74 (ESRO9004) for the full report by the STAG expert group.
[79] See ESRO/PB-MET/MIN/11, meeting on 31/7/94, document 12/9/74 (ESRO8950).

Proposal		Adm. Eval.	Techn. Eval.	Weighted score	Cost (MAU)
IBM		72.4	69.2	70.0	15.955
CDC	Option A	53.6	71.3	66.9	12.839
	Option B	53.6	65.3	62.4	10.897
ICL		52.8	64.5	61.6	14.416
CII	Option A	58.4	54.9	55.8	14.390
	Option B	58.4	52.4	53.9	13.194

Table I.3. Scores of the offers made by four firms for the ground computer system and the costs of the hire-purchase option (rent until 1.7.77 and then buy). From ESRO/AF(74)119, Annex, Tables 3 and 6, 23/9/74 (ESRO2714)

Table I.3 summarises the scores achieved for the resubmitted tenders after assessment by the Tender Evaluation Board. Marks were given along three axes: administrative – which covered features like organisation and management, planning and time schedule, costing and contract conditions –, technical and a weighted overall score. Leaving aside the question of cost, IBM came in first, CDC came next, its option A, which involved using two of its Cyber 175 mainframes outscoring its option B which used the less powerful Cyber 174. Of the two European firms ICL was distinctly superior offering to use two P4 computers from its "New Range", though its weighted score was slightly below the lowest US score. The French consortium CII performed very poorly by comparison. Its option A used the IRIS 80 mainframe with Siemens 330 minicomputers; Option B had the less powerful CII Mitra 15 replace the Siemens.

Technical considerations had of course to be combined with those of cost. The immediate purchase of any system was excluded for budgetary reasons. Rental, which the Secretariat favoured because of the flexibility it allowed in terms of future system development, was rejected outright by the meteorologists. They insisted that all capital expenditures were to be borne on the Meteosat programme budget, the national services only being prepared to contribute "relatively moderate running costs".[80] This left the hire-purchase option (see Table I.3, last column). Bearing all considerations in mind the Secretariat again recommended to the AFC that CDC Option B be chosen for the ground facility. If the AFC insisted on a European solution, the only viable option would be ICL. The Secretariat emphasised, though, that there were doubts about the credibility of its delivery schedule, since it had suggested an entirely new and radically different machine to its usual product line. What is more the cost of the British machine was considerably over the 'CDC+10%' criterion laid down by the AFC and its payment profile, which showed a sharp peak early on, was inconsistent with ESRO's planned annual budgetary provisions. If the AFC wanted to recommend ICL despite the superiority of the CDC the British firm would have to give satisfaction on these points.[81]

The AFC duly met on 3 October 1974 – and opted for the European solution. The contract for the computer for the Meteosat ground facility would be awarded to ICL on condition that it satisfied the three conditions specified by the Secretariat. While these were being negotiated, the AFC said, parallel discussions should be started with CII to see if it could not improve its proposals. If after five weeks ICL had not satisfied the Secretariat, the choice would automatically fall on CII subject to the latter having presented a satisfactory offer. If after this time lapse neither European firm could provide the necessary technical guarantees, the contract would be awarded to CDC. As for the 'CDC+10%' cost guideline, the AFC was prepared to waive this if the British and French firms made offers which were acceptable on other grounds. After further cliff-hanging negotiations the contract was, finally, awarded to ICL.[82]

The decision to adopt a European solution for the Meteosat ground computer and to award the contract to ICL for a P4 "New Range" system was a controversial one. Of course, as the French delegate to the Programme Board put it, "in the present economic situation in Europe the industrial preference clause was of the greatest importance and it was highly desirable not to create a precedent that ran counter to

[80] For this see ESRO/STAG/MIN/9, meeting 26/6/74, document 2/7/74 (ESRO9033) and ESRO/PB-MET(74)17, 11/2/74 (ESRO9001).
[81] From ESRO/AF(74)119, 23/9/74 (ESRO2714).
[82] See ESRO/AF(74)119, Add.2, 29/10/74 (ESRO2714).

it".[83] On the other hand, as he also remarked (in an attempt to defend CII), since the P4 embodied a radically new concept and was still under development, the Organisation was running a considerable risk in choosing the British firm. And indeed these sombre warnings, biased as they may have been by the disappointment felt by the rejection of the French consortium, proved to be only too true. For the difficulties surrounding the commissioning of the ICL machine were immense and the Executive was forced on more than one occasion to consider taking drastic measures to have a ground system available at launch. Indeed that the risks incumbent on choosing the ICL computer did not have disastrous effects on the programme was only because there were repeated slippages in the launch date due to a rescheduling of the FGGE window (advanced to the end of 1978) and then to delays at Cape Kennedy. These delays gave the ICL engineers more time to get their system up and running than would otherwise have been the case.

The difficulties that ICL was having with its new system emerged clearly in 1976 and after a number of high level meetings between the supplier and the client a new delivery schedule was drawn up. It shifted the expected delivery date for the complete system forward by twelve months to 31st July 1977. The single most important reason for the delay was the technical problems the firm was having with the operating system software of the new series (now numbered 2980) and with the adaptation to ESA requirements of the complete network. To resolve the problems ICL undertook to strengthen its teams working on the system and to place a senior engineer in overall charge of the development activities. The Executive, for its part, insisted that ICL must provide a certain number of facilities for the Agency by the key date of 15th November 1976. Failing that it suggested that ESA might have to consider replacing the ICL central processor by another. Indeed the Executive was so sceptical about the British firm meeting even the revised schedule that steps had already been taken in October 1976 to explore the possibility of a changeover, with IBM, CDC and CII-Honeywell Bull.[84]

The delays in the delivery of the operating system software had effects downstream on the application software needed for the extraction of meteorological products. A new schedule for the latter was worked out which phased its introduction with the state of readiness of the central system. Four levels were identified. The first allowed for the basic operation and control of the spacecraft, but provided no products for the users. Level II was essentially experimental, its goal being to provide users with significant sets of data in order to enable everybody to start working. To this end it made provision for image processing and wind extraction, though with limitations on quality and quantity, as well as for archiving of nearly all data. The meteorologists hoped that these two functions would be available at launch. Levels III and IV were to be implemented within six months after launch. The former corresponded to the gradual introduction of full-scale processing, while Level IV was the fully operational state.[85]

On the milestone date of 15th November 1976 the situation was not encouraging. ICL was not able to demonstrate successfully all the facilities foreseen for that key day. The magnetic tape handling using standard Fortran was the most serious problem. In addition the operating system software was too large, leaving insufficient CPU capacity for the other functions. However, the threat to replace the ICL2980 with another mainframe proved difficult to implement. Three offers had been received (from CDC, Honeywell Bull and IBM) but all were deemed unacceptable mainly because of late delivery of the integrated system. This meant that it was necessary to continue with ICL despite its limitations. At the same time the Executive decided to take certain precautions: see whether it was possible to transfer the load on the ICL2980 temporarily to other centres in Europe, ask IBM to quote for a link between IBM equipment and the existing peripheral computers, monitor ICL even more closely etc. In any event it was now clear that it would only be possible to attain Level II performance at the nominal launch date (31st August 1977) if ICL managed to improve the performance and stability of the operating system. If another solution had to be adopted it was unlikely that even this minimum performance criterion would be satisfied on time.[86]

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[83] ESRO/PB-MET/MIN/12, meeting 2/10/74, document 13/11/74 (ESRO8951).
[84] ESA/PB-MET(76)13, 15/10/76 (ESA3571).
[85] See ESA/STAG/MIN/5, Annex 2, meeting on 15-6/9/76, document 15/10/76 (ESA3694), ESA/PB-MET(76)14, 18/10/76 (ESA3572).
[86] ESA/PB-MET(76)22, 6/12/76 (ESA3580).

The STAG was asked whether they would be prepared to consider delaying the launch date by three months to ease the pressure and to increase the Executive's margin for manoeuvre with both ICL and other suppliers: it refused. However both the Group and the Programme Board were frustrated and angry with ICL and were strongly tempted to replace the British computer with an IBM. The German representative to the STAG, Professor Bolle, claimed that ICL's method of programming was four or five years behind that of the Telefunken Ti 440 used at his institute. What is more he deplored the fact that the research activities originally planned and in which institutes in the Federal Republic were particularly interested, were being submerged by problems with the data-processing system. After an anguished debate the Programme Board, meeting in April, decided to accept the Executive's claim that "it had no grounds whatever to fear that ICL would be unable to fulfil its commitments" and to maintain the choice of the firm despite their misgivings.[87]

The Executive had undoubtedly stuck its neck out in choosing to maintain the ICL option. One mishap however worked to their advantage. In July 1977 it was announced that the launch of ESA's telecommunications satellite OTS had to be postponed for technical reasons. In the light of the new launch schedule proposed by NASA the ESA DG and the Council decided that, for financial reasons, the foreseen Meteosat launch slot should be accorded to OTS. This meant shifting the launch date of the meteorological satellite backward by about two months. These weeks of grace were invaluable to Meteosat. A programme review held on 12th and 13th September confirmed that at least the minimum requirements would be fulfilled by the data processing system by the time of the rescheduled launch in mid-November.[88]

We shall not trace in detail the evolution of the ground facility in the post-launch period. Suffice it to say that, in September 1978, ten months after launch, the situation was precarious.[89] Despite the Executive's reassurances, the chairman of the *ad hoc* group set up to monitor the operational phase, the French meteorologist Pastre, "was far more pessimistic than [...] the Executive, firstly because, although the satellite had been operating for a year, no mission was functioning nominally and, secondly, because the problems connected with the setting-up of the system were coming to light from day-to-day [...]". It seemed, Pastre concluded, "that it would be very difficult to achieve the expected results". Even if a lot of data was being disseminated, it was disseminated irregularly. As for the extraction of meteorological parameters, the winds product was satisfactory and though software existed for the remainder of the parameters, it was "not much in line with reality". As for archiving, an aspect of the mission which was particularly important for the research community, the situation, said Pastre "gave cause for concern".

A year later the situation had improved but was still far from perfect.[90] Reporting to the STAG in September 1979 Pastre remarked that a number of the Meteosat system missions "had reached a quasi-operational stage", namely the image-taking mission and the dissemination mission. The production of wind vectors was also classed as "operational". The other MIEC products were not, but could be said to be "well under way".[91] They were behind schedule due to calibration problems, lack of staff and the priority given to winds. All the same cloud top heights were expected by mid-November, sea-surface temperature and water vapour measurement a month later. Radiation balance was far from ready. And as for archiving, the Pastre group felt that "the situation was bad" and that "the chances for improvement were slim". In the event two months later one of Meteosat's onboard electronics systems failed, drastically reducing the satellite's capabilities.

The difficulties with the ground system caused immense damage to the relationships between ESOC and the meteorological community. The former, as one would expect, tried to put the best possible interpretation on the difficulties all were having with the ground system, systematically resorting to the central computer as the root cause of the problem. The users were most unhappy with the quality and

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87 ESA/STAG/MIN/7, meeting on 10/2/77, document 7/3/77 (ESA3696) and ESA/PB-MET/MIN/9, meeting on 14/4/77, document 9/5/77 (ESA3535). For a list of research institutes see ESA/PB-MET(79)WP/3, 9/5/77 (ESA3657). See also Annex to letter Luksch to Regula, 30/1/79 (ESA4647).

88 ESA/PB-MET/MIN/10, Annex II, 9/77 (ESA3526).

89 For this paragraph see ESA/STAG/MIN/13, meeting 27/9/78, document 25/10/78 (ESA3702).

90 For this paragraph see ESA/STAG/MIN/16, meeting 12/9/79, document 23/10/79 (ESA3705).

91 See e.g. *Meteosat Operations Report, 1 January - 30 June 1979* (ESA4754) for a detailed description of the products available at this time.

regularity of the products disseminated. They also felt that the Agency was not consulting with them enough, was not taking their priorities into account and was providing specious explanations for the problems they were encountering. Indeed the relationship between the two parties in this period deteriorated so drastically that it would take three or four years of hard work for ESA to regain the confidence of the meteorologists. This is an issue we shall come back to again in part II of our study.

7. The launch of Meteosat

Every launch is a nail-biting affair and none more so than that of Meteosat. The launch campaign started in the second half of September with the shipment to the United States of the F1 flight model. On 13th September the delayed OTS launch took place using a Delta 3914 rocket – which exploded, dropping the European telecommunications satellite in the ocean. The investigation revealed that the problem that had led to the explosion of the 3914 would not affect the 2914 which was to be used for the meteorological satellite. All the same Meteosat's launch date was postponed by 12 days as a result. Other minor problems caused additional delays, but countdown finally got under way on 20th November. And then, quite unexpectedly, just two hours before scheduled lift-off NASA cancelled the launch. Stray radio signals had been picked up in the Cape Kennedy area which were identical to those used to destroy NASA rockets in flight. The US Agency refused to launch until the source of the signals had been identified. Furious, Ernst Trendelenburg, ESA's Director of Scientific and Meteorological Programmes, made an inflammatory statement in which he suggested that NASA was exaggerating the risk. The press had a field day, with speculation running wild: did the signal come from a Soviet spy ship disguised as a trawler which was in the area just when a military Polaris rocket was launched? Was NASA being overcautious because it did not dare have another failure, particularly since the Air Force was lobbying to take over the space programme? Was it a ploy intended to sabotage the European programme and so to ensure that the WMO would choose an American satellite to replace a Soviet meteorological satellite intended for the world system?[92]

Two days later – and after Trendelenburg and the visiting ministers had already left – the source of the signal had been detected. It seemed that the Redstone tracking ship off the coast of Florida had inadvertently sent out launcher destruct signals. NASA was not prepared to accept the explanation, however, without verbal confirmation from the test engineer concerned and he had left for a vacation in Texas in his caravan! Lennertz writes: sitting at Mission Control Centre on 22nd November "about two hours prior to the planned lift-off (our last chance!) I received a phone call on my 'hot-line' from the NASA representative saying "[...] with military help (helicopters?) we found the guy, he confirmed the dummy test, I lift my launch objection, go ahead and good luck!". When I informed the launch team via our intercom system nobody could suppress his tears of joy and of relief – after two aborted launch attempts and two sleepless nights!"[93]

Meteosat was launched without mishap on 23rd November at 1.35 GMT. It separated from the launcher about 25 minutes later and reached its nominal position at 0° in geostationary orbit on 7 December 1977. The first images from the satellite in the three spectral bands, visible, infrared and water vapour absorption, were received on the 9th, 10th and 11th December.[94] Degradation of its IR signals soon thereafter was traced to ice contamination of the radiometer optics and was quickly rectified.[95] A far more serious degradation occurred two years after launch, however. On 24th November 1979 an Undervoltage Protection Unit on-board the satellite switched off some of its loads and all efforts by ESA to bring the satellite back into a fully operational mode failed.[96] Meteosat remained in orbit for several more years, but only its Data Collection Platform mission continued to function correctly.

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[92] See, for example, *Le Figaro*, 23/11/77.
[93] D. Lennertz, private communication with the author. See also *ESA Bulletin*, N° 11, December 1977, pp.59-61.
[94] ESA/PB-MET/MIN/11, Annex II, 16/1/78 (ESA3537) and
[95] ESA/STAG(78)2, 7/4/78 (ESA3737) and ESA/PB-MET(78)9, 10/5/78 (ESA3601).
[96] ESA/PB-MET(79)26, Add.1, 7/12/79 (ESA3636).

Part II

The Transition to an Operational System

1. The first debates: ESRO will operate the system for three years

The moment when a satellite system changes from being pre-operational to operational is negotiable. Different interest groups will define it according to their particular needs. In our case the national meteorological community wanted to interpret the concept of pre-operational as widely as possible so as to leave the hand-over to them of managerial and financial responsibility to the last possible moment. In October 1971 one of the working groups set up by the *ad hoc Group* on Space Meteorology (chaired by the British meteorologist Stewart) suggested that the definition of *pre-operational* should in fact cover the first four to five years of the satellite programme. For meteorologists, he said, a system could only be regarded as operational when "perfect continuity" of data provision was ensured. This involved integrating the European satellite into the global system, making sure that the individual elements interacted properly and making provision for replacing a spacecraft as soon as it failed (e.g. by having one spare geostationary satellite in orbit at any one time and moving it to the required parking orbit when one of the four others broke down). For Stewart's group a satellite could be regularly providing data of value to meteorologists for forecasting purposes and scientific modelling, yet pre-operational in that "continuity of observations in the world system [was] not guaranteed".[97]

The question of who should operate Meteosat preoccupied the Programme Board from the time it first met in March 1972. As the ESRO Secretariat pointed out, the then near-final text of the Meteosat "Arrangement", in line with original French planning, made provision for the production of two flight units of the satellite and a set of spare units, but for just one launch. No second launch had been budgeted for, even in the event that the first one failed. Nor had the stage at which the satellite would be handed over to the users been defined. In addition there was the question of a follow-on programme and the putting in place of a fully operational meteorological satellite system.[98]

Taking the bull by the horns, in June 1972 the German delegation tried to insert two clauses in the draft Arrangement to deal with some of these ambiguities. Firstly it suggested that the document make specific provision for launching a second satellite "if that prove[d] necessary after the launch of the first one". Secondly, it wanted a clause added stating that the programme would include provision for "operating the ground segment from six months after the successful launch of the satellite [the time estimated for 'running in' the first unit] until the end of the programme". Germany realised that these issues were controversial. It coupled the clauses with the provision that if an agreement could not be reached on these provisions by the end of the Project Definition Phase any participant would have the right to withdraw from the programme.[99] Taking its argument further Germany, with the UK's support, said that for practical reasons it would favour ESRO taking responsibility for the operation of the first satellite.[100]

Germany's initiative was inspired by the conviction that it was simply unrealistic to expect the meteorological services to operate the first Meteosat. Rather then, accept forthwith the burden, all the time insisting that the meteorologists put the machinery in place to take over as soon as they could. After all the meteorologists were aware of the problem. Reporting to Programme Board in June 1972 the chairman of the ESRO *ad hoc Group* on Space Meteorology who was also the director of the Swiss national meteorological service, Schneider, remarked that "it appears that the cost of launching a really operational satellite would have to be borne entirely by the meteorological services themselves and represents a considerable sum, the exact amount of which is difficult to estimate". Suggesting that it might amount to about 10% of the budget of national meteorological services from 1978-79 onwards, he

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97 ESRO/IAPC71(31), 7/12/75 (ESRO9368). There is a draft in (52014).

98 The minutes of this meeting are document ESRO/PB-MET/MIN/1, 21/3/72, file (ESRO8940), 19/4/72.

99 See ESRO/PB-MET(72)4, rev. 2 add. 2, 6/6/72, Article 7, (ESRO8958).

100 See ESRO/PB-MET/MIN/3, 5/10/72, document dated 20/11/72 (ESRO8942). From ESRO/PB-MET/MIN/3, q.v. This move was, predictably, welcomed by the meteorologists, though the French delegation was unhappy with the idea, arguing that this was a matter for the Council and not the Programme Board to decide. This was not simply a stalling move; it was also part and parcel of French attempts at this time to clarify the relationships between the Boards and the Council to be defined in the ESA Convention then being discussed.

asked that every effort be made to draw the attention of the ministries concerned to the need for this impending commitment.[101]

The German suggestion received a mixed welcome. No one wanted to tinker with the Arrangement now which, in the event, was opened for signature just a few weeks later on the 12th July 1972. But the source of the problem lay elsewhere: it was financial/institutional. The money for meteorological services came mostly from the Ministries of Transport. The money for space activities came from entirely different government departments: ministries involved in science and technology programmes in the various participating states. As these also happened to be the ministries represented in the ESRO/ESA committee structure, they naturally resented seeing their funds used to finance an operational activity for another government department and that at the expense of the research and development budget. In the event the matter was left to rest. The Council, voting the Arrangement on 12th July 1972, inserted a clause in the preamble to its resolution which stated that "adequate arrangements still have to be made to cover both the operation of the Central Facility and the operational phases of the programme".[102]

No major shift occurred in the positions just described over the next 18 months. The ESRO Secretariat prepared a number of documents showing the managerial, legal and financial implications of its taking responsibility for the operation of the first satellite. In the light of the meteorologist's vacillations this solution, it was stressed, would guarantee Europe's participation in the GARP by ensuring continuity in the management and control of Meteosat and would also be cost-effective. It was understood that this was only a short-term solution driven by pragmatic concerns. The question of who would operate Metosat was a political one, as the French stressed. The long-term aim of the programme was that "the users themselves should acquire the ability to design and manage future systems without further recourse to technological research funds".[103]

Coherent with its position the French wanted the meteorologists to create immediately an entirely new structure with its own juridical personality, budget and staff and having responsibility for the operation of Meteosat. But as the Secretariat pointed out, for all its attraction, "one immediately thinks of all the difficulties inherent in creating an international legal instrument requiring ratification for the establishment of a new legal personality under international law." Better to proceed piecemeal, either by revising the existing Arrangement without changing the ceiling (as had been done when the costs of developing the software for the MIEC had been added in March 1973), or by adopting a protocol to the Arrangement which allowed for calling up additional funds.[104] With the figure of 17 MAU in the air for the operation of Meteosat up to the end of its useful life (as compared to just 1.5 MAU for the software) the Programme Board retained the latter solution.

The first draft of a Protocol to cover the management and control of a "pre-operational" meteorological satellite was laid before the Programme Board in October 1974, where it raised only minor objections. When the Board next met in November the entire atmosphere had changed. The text was violently opposed. The Italian delegation, reversing its previous position, "deplored the fact that under the Protocol the use of the system beyond the first six months of operation would become an ESRO programme, as the Organisation would thus be given tasks its structure was not designed for. The Delegation's view was that the users of the system should be prepared to take responsibility for it".[105] These sentiments were

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101 See Schneider's statement to the second meeting of the (provisional) Programme Board, Annex II to ESRO/PB/MET/MIN/2, the meeting held on 21/6/72, document (ESRO8941), 15/6/72 and the *Summary Report on the Informal Conference of*

102 *Directors of European Meteorological Services...*held on 27/4/72 in (52023)
See ESRO/PB-MET/MIN/2, 15/6/72, document dated 21/6/72 (ESRO8941) and ESRO/PB-MET/MIN/3, 5/10/72, document

103 dated 20/11/72 (ESRO8942). The Council resolution is ESR0/C/XLVII/Res.1, 12/7/72 (ESRO45).
The quotation is from the 8th meeting of the Programme Board, ESRO/PB-MET/MIN/8, held on 6/2/74, document dated 15/3/74 (ESRO8947). See also ESRO/PB-MET(73)17, 2/11/73 (ESRO8982) and ESRO/PB-MET(74)13, 20/6/74

104 (ESRO8997) for various reports on this debate.
See ESRO/PB-MET(74)13, 20/6/74 for this paragraph. A third legal alternative was to have the Organisation conclude bilateral contracts for operating Meteosat with individual national meteorological authorities or to sign a single management contract

105 with one body nominated by those authorities to act on its behalf.
At the 12th meeting of the Board the Italian delegation said that "it was in favour of the Organisation being responsible for operations beyond the first six months of the satellite's life", ESRO/PB-MET/MIN/12, meeting held on 2/10/74, document dated 13/11/74.

echoed by the French delegation, though the British and German delegations felt less strongly about the issue. In the event the Secretariat, which was somewhat taken aback by the sudden change of tack, was asked to draft a new document. The Board also passed a resolution inviting the delegations to put pressure on their governments to bring the users of the system together for the purpose of managing an operational satellite.[106]

The Programme Board turned to the Council for its view on the principle of ESRO/ESA taking responsibility for operational systems. The Council, at its meeting in March 1975 expressed itself in favour, though it was stressed that this was a specific case, justified e.g. by the fact that it was unreasonable to expect the national meteorological services to have organised themselves into an operating agency by 1977.[107] With the objection against the principle lifted, by the end of 1975 a Protocol acceptable to all had been hammered out.[108] It reflected the determination of the participating states to reduce their commitments to the operational satellite to a minimum and to put as much pressure as possible on the meteorological agencies to take over responsibility for the system. On France's insistence and to send a clear message to the meteorologists, who were stalling on the management question, the Preamble specifically identified "the aim to entrust the management of an operational meteorological system composed of a space segment and an associated ground segment to a body representing European meteorological authorities".[109] The period during which the satellite would be under ESA's control was limited to three years in orbit (some delegations preferred two), including six months for checking-out the satellite after launch.[110] This corresponded to "the satellite design goal of 50% survival probability without degradation of any mission".[111] To avoid any misunderstandings the tasks to be undertaken by the Agency were described in great detail in the first Annex to the Protocol, while the cost envelope, which was kept as low as possible, was cut from an originally suggested 17 MAU at mid-1974 prices to 14.15 MAU at mid-1975 prices.[112]

Finally, in response to the great difficulties faced by some of the user ministries to find the sums called for by the Protocol, extremely lax conditions were laid down for terminating the agreement or even for withdrawing from it completely. The Protocol could be terminated before the expiry of the three-year post-launch period by a double two-thirds majority of the Programme Board (some would have preferred unanimity) once "the management of Meteosat ha[d] been entrusted to a body representing European meteorological authorities" – or even if this step had not been taken.[113] Even more destabilising were the withdrawal conditions. The Protocol was to be open for signature from 1st January 1976 to 30th September 1976. Any government was free to withdraw by informing the Agency before the end of that year of its intention to do so and by giving written notice of the same by 31st March 1977. If one government announced its intention to withdraw all others were free to follow suit. Formally then, Meteosat risked being put in orbit without any guarantee that the means could be found to use it.

Despite all these precautions it proved extremely difficult for some of the participating states to find the resources needed to finance the operational programme. The deadline for the opening period was first extended from 30th September 1976 to 28th February and then to 30th April 1977. Three days before the

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106 ESRO/PB-MET/MIN/13, meeting held on 26/11/74, document dated 24/1/75 (ESRO8952). The draft protocol is

107 ESRO/PB-MET(74)21, rev. 1, 12/11/74 (ESRO9005).
ESRO/C/MIN/73, 14/3/75, document dated 27/3/75 (ESRO70). In 1977 the Council meeting at Ministerial level officially expressed its desire "to take a positive attitude in relation to the management of operational systems" and undertook to "encourage the potential users of operational space systems to take over the management of these systems and to organize

108 their exploitation" in those cases where organised users did not yet exist; see ESA/C-M(February 77) Res. 3, 15/2/77.
The various version of the Protocol are document ESRO/PB-MET(74)21, with its revisions the first of which is dated

109 12/11/74 (ESRO9005). The final version is ESRO/PB-MET(74)21, rev. 8, 23/12/75, or ESA/C(75)62 rev. 1, 23/12/75.
The directors of the national meteorological services meeting in January 1975 suggested that "in the longer term it was not perhaps necessary to set up a European body representing the meteorological authorities, since the management of the operational Meteosat system was to be integrated into the framework of the global observation system and, in liaison with the WMO, be studied in the light of the results of the FGGE", ESRO/PB-MET(75)4, 18/2/75 (ESRO9017). For France's

110 position see ESA/PB-MET/MIN/1, 17/6/75, document dated 21/7/75 (ESA3527).

111 See ESA/PB-MET(75)5, 24/3/75 (ESRO9018).

112 ESA/PB-MET(74)21, rev.1, Annex A, 12/11/74 (ESRO9005).
For the details on the Annexes see ESA/STAG(75)3 , 22/8/75 (ESA3711) and ESA/PB-MET(75)4 (ESA3555). The earlier

113 cost estimate is proposed in ESRO/PB-MET(74)21, rev. 1.
France's resistance to the unanimity condition is clear from her interventions in ESA/PB-MET/MIN/1, 21/3/72, document 19/4/72 (ESRO8942).

second deadline had expired only Belgium, Germany, Switzerland and the UK had signed the Protocol. France and Denmark came in two days later, so that the Protocol entered into force on 29th April 1977, though without the signatures of Italy and Sweden.[114] The former signed shortly thereafter, but Sweden was still unsure of its position. Arguing that the operational system was of little interest to it as the country was on the limits of Meteosat's direct vision (although of course the Scandinavians also could use the data on surrounding countries provided by the satellite), it first suggested that it might ask for a reduction in its percentage contribution (foreseen to be 5.02%) and then it refused to sign the Protocol altogether.[115]

Sweden's defection brought to a head another issue which had been simmering under the surface even before the Protocol was opened for signature, i.e. the scale of contributions. The Protocol, basing itself on the original Arrangement, simply took over the scale of contributions from the original document, based on GNP figures for 1967 to 1969. At the third meeting of Programme Board in November 1975, the UK, supported by Italy and Sweden, opposed this. It was argued that the operational phase covered by the Protocol was a new programme since it directly involved the users and that the old scale of contributions was obsolete. The Swiss delegation, for its part, baulked at this suggestion since it had just persuaded its authorities to sign the Protocol on the grounds that the operational phase was a logical extension of the development phase. With the Protocol due to be opened for signature in six weeks time no one wanted an additional delay now. The Board thus accepted to keep the original scale 'for the time being' and to reconsider the matter later.[116] Sweden's refusal to sign provided the opportunity to reconsider the affair since some steps had to be taken to make good the shortfall. The time had now come, the British said, to update the scale using current GNP figures and taking only seven instead of the original eight participants. This reduced the UK's percentage contribution by about 3% and Italy's by a little over 1%. Everyone else's share of the costs went up, Germany's by over 7%.[117]

Two factors worked against the changes proposed by the British. Firstly, to change the scales now would upset the industrial return figures. Secondly, as the Executive pointed out, technically no participating state should pay more than 25% of the total cost of a programme in which costs were divided on a GNP basis.[118] With Germany contributing almost 33% under the changed British scheme (and even a little over 25% in the original division of financing which included Sweden), it was obviously not in the UK's financial interest to press this point too hard at this stage. This did not settle the issue, however. Indeed the scale of contributions was to resurface as a bone of contention a few years later when a further extension to the Meteosat Arrangement was sought. That story is one to which we shall return later.

2. The second launch

The Arrangement for launching Meteosat was anomalous, if not incoherent in that, even if it allowed for the production of two flight units and a set of spares, it did not formally provide for the launch of a second satellite. While the rectification of this omission might appear, at first sight, to be a mere formality, it inevitably became tangled up with another question: Who would pay for the second flight unit and for its operation? The problem faced by the Programme Board was that the decision had to be taken well before F1 was launched in order to maintain industrial commitments and book launch windows, while, at the same time the meteorological services were far from willing or able to take financial or institutional responsibility for an operational system. The Programme Board thus feared that it would be pressured by technical deadlines to agree to launch F2 only to find itself having to find even more money to operate it and that from a science and technology budget. The meteorological services, for their part, would only rejoice at this saving to them – and the pressure on them to take over would be further reduced.

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[114] See ESA/C(77)34, 27/4/77 and ESA/C(77)34, add. 1, 5/5/77.
[115] ESA/PB-MET/MIN/3, 12/11/75, document dated 30/12/75 (ESA3529); ESA/PB-MET/MIN/7, 7/12/76, document dated 21/1/77 (ESA3533); ESA/PB-MET(78)2, 1/2/78 (ESA3594).
[116] ESA/PB-MET/MIN/3, 12/11/75, document dated 30/12/75 (ESA3529).
[117] The UK delegate's position is spelt out in ESA/PB-MET(78)2, 1/2/78 (ESA3594).
[118] ESA/PB-MET/MIN/11, 12/12/77, document dated 16/1/78 (ESA3537) and ESA/PB-MET(78)8, 21/4/78 (ESA3600).

The question of flying F2 first became an important issue when the STAG was made aware of slippages in the planned dates of the GARP. Reporting on a WMO meeting in mid-May 1974, the French delegate (Prof. Morel) said that, to satisfy the proposed launch dates of the American TIROS-N system, the general campaign would now take place between January 1978 and the end of 1979, with two periods of peak observation in November-December 1978 and in May-June 1979. This slippage from 1977 to 1978/9 would enable Meteosat, scheduled for launch in late 1976 to be 'run-in' properly. But it also meant that the satellite would need to function satisfactorily in orbit for about three years – and its overall reliability in orbit was estimated to decrease exponentially from about 75% to 40% in this time frame. It was therefore necessary to make provision for more hydrazine on F1 and to consider following it up with F2, not simply as a hedge against launch failure but also as a protection against in-orbit failure. Only by doing so could Europe play its proper role in the GARP which was, after all, the main objective of the Meteosat programme.[119]

Of course if there was a chance that F2 would be launched, it was only to be expected that the users would begin to think of how to improve its performance on the basis of the experience gained with F1. The STAG discussed this matter in depth at its meeting in May 1975. A range of improvements within the basic satellite concept were suggested, but bearing in mind the need to launch the satellite by the end of 1978 and to limit expenditure, only a few were retained: improvements to the temperature control and ground calibration of the radiometer, to the power supply system and to the UHF antenna.[120] These initiatives were coupled with a strong recommendation from the STAG to the effect that if the Programme Board did not make provision to launch F2 (costing about 12.5 MAU) there was a risk that "none of the investments made in the spacecraft or in the ground installation would produce benefits to technology or to meteorology; ten years of planning and five years of intense technical effort would be wasted; even if the failure was not its fault, a question mark would be placed against Europe's ability and determination to carry space projects through to a successful conclusion".[121]

The Programme Board accepted these arguments insofar as the use of F2 as a replacement for F1 was concerned. It was clear that some steps had to be taken to insure against loss on launch and that for that reason alone F2 should be made flight ready. The launch costs, the Secretariat assured the Board, could come from the 20% contingency in the budget (classically the Arrangement made automatic provision for this level of cost overrun). But, as the German delegate put it, the problem was not there. It only arose if F1 was launched successfully and performed as planned. In that event the money for F2 would have to be found by the meteorological services. As if to stress the point, the Board refused to accept even the limited number of changes to the satellite proposed by the STAG. Putting each improvement to the vote at its meeting in June 1976, it only adopted the modification to the temperature control of the detector and to the power supply.[122]

Over the next few months the pressure mounted on the Programme Board to launch F2 come what may. The offensive came from the Executive and from a Space Meteorology Working Group set up at the request of the Council and under the chairmanship of J. Mason, Director General of the British Meteorological Service (who was soon succeeded by R. Mittner, head of the French meteorological service). Meeting on 29th September 1976 the SMWG asked the ESA Director General to "address a strong request to the Programme Board" at its meeting in October to place an order for a launcher within the next few months.[123] NASA's launch windows were becoming crowded and the US Agency would now only order launch vehicles for which there existed firmly committed customers, so a definite decision had to be taken quickly.[124] More to the point, the Group felt that this launcher should not only be available as a backup if the launch of F1 failed. It "was unanimous in the view that it would be very wasteful having built F2 and procured a rocket, not to launch it". It therefore wanted ESA to prepare a

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[119] See ESRO/STAG/MIN/8, meeting held on 22/5/74, document dated 26/6/74 (ESRO9032). The reliability estimates are in ESRO/PB-MET(74)25, 3/9/75 (ESRO9009). Later studies increased the 40% to 50% after three years, as we saw earlier.

[120] See ESRO/STAG/MIN/14, 27-8/5/75, document dated 19/8/75 (ESRO9038), ESRO/PB-MET(75)3, 26/8/75 (ESRO3554) and ESA/PB-MET(76)8, 24/5/76 (ESRO3567).

[121] ESRO/PB-MET(76)5, 16/1/76 (ESRO3564) [=ESRO/STAG(75)8, 17/12/75]

[122] ESA/PB-MET/MIN/4, 29/1/76, document dated 24/3/76 (ESA3530), ESA/PB-MET/MIN/5, 22/6/76, document dated 30/7/76 (ESA3531).

[123] All the quotations in this paragraph are from the notes on this meeting, document ESA/SMWG(76)8 (ESRO4668).

[124] ESA/PB-MET(76)15, 15/10/76 (ESA3573).

document "setting out clearly the advantages of launching F2 *given that F1 is successful* [...]" (my italics), it being understood that this would be a new programme lying outside the scope of the existing Arrangement and Protocol.

But the SMWG did not stop at that. It also strongly endorsed a new suggestion by the ESA Executive that the qualification model built for Meteosat (prototype P2), refurbished at little extra cost, could be launched as an Ariane passenger experiment, to fill "any gap that might develop between F1/F2 and a fully operational F3 sequence onwards". This too, the SMWG said, would be a new programme. A week later the Council accepted that the L03 launch of Ariane, scheduled for May 1980, could be used in this way. The launch would have the Indian Telecommunication's Satellite *Apple* as its central passenger and one or other Meteosat was one of several options for the principal passenger and indeed the one favoured by the Executive.[125] The Programme Board was given two months to exercise this option.

The Programme Board, confronted now with the demand to launch not just one or two, but three meteorological satellites, did what it could to resist this onslaught. At its meetings in October and December it authorised the DG to open negotiations immediately with NASA for a back-up launcher to cover the eventuality that F1 was destroyed on launch or failed within six months of being in orbit. Europe's participation in the GARP was thus protected. The Board also agreed that this launcher could be used for flying F2 if F1 worked satisfactorily – but in that case a new agreement would have to be drawn up by the States that wanted to participate in the launch. They would have to reimburse the funds already paid in advance to NASA by the Meteosat programme and would also have to bear the cost of launching the second flight unit. If they could not agree to do this, the option would be sold.

As for the Ariane option, the Board took a slightly more flexible line in order to ensure that it could book its place on L03. This launch could be treated as an "extension" of the Meteosat programme. The Board however was not willing at this stage to discuss the "new financial and administrative arrangements" that that extension would involve. Nor did it want to commit itself now to the model to be used: if F1 was a success, F2 would be the Ariane passenger, otherwise it would be P2.[126]

The Council, however, needed better guarantees than that. Meeting on 16th February 1977 it accepted to fly F2 on L03 – but gave the Board until midnight on 12th March to take a "decision concerning the financing". Failing that the slot would go to *Symphonie*.

The Programme Board capitulated at its meeting on 11th March 1977. To avoid losing the Ariane flight opportunity it voted a number of amendments to the Meteosat Protocol allowing for the launching of F2 on L03 and accepting to pay for it from its budget. The Board's agreement was hedged around with a number of tight qualifications. Firstly, as Belgium insisted, this agreement was restricted to the use of F2 on Ariane and the 5.6 MAU estimated for the launch costs would have to come out of the 20% contingency margin. No extra money would be found for it. It was "in that event and only in that event, [that] the persons responsible, as regards technology, had the means and the will to finance the launch whereas the meteorological services did not have them". But what if F1 failed and F2 had to be used as a back-up with a Thor-Delta launcher? Could P2 fly on Ariane L03? No, said the French delegation, the agreement to use Ariane would become null and void in its eyes "If an accident occurred with the first launch, thereby causing the whole programme to be called into question", the delegate said, "France must be freed from this undertaking" to fly a meteorological satellite on Ariane. In addition it was understood by all that the Board was only committing itself to launching F2, not to operating it. That would be the task of the meteorologists.[127]

With this decision the Board's determination not to go down the road of operation was further undermined. They had now not only made provision for a backup launch from NASA in the event that

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[125] The Executive's proposal is ESA/STAG(76)12, 1/9/76 (ESA3727) and the Council's recommendation is described in ESA/PB-MET(76)24, 30/11/76 (ESA3582). See also ESA/C(76)114.

[126] For this paragraph and the one before see ESA/PB-MET/VI/Res. 1, of 27/10/76 (ESA3532) and ESA/PB-MET/VII/Res. of 7/12/76, (ESA3533). See also ESA/PB-MET(76)21, 27/10/76, (ESA3579) for the French view on a second launch.

[127] For the debate see ESA/PB-MET/MIN/8, meeting held on 11/3/77, document dated 29/3/77 (ESA3534) and for the Amendments to the Arrangement see ESA/PB-MET(77)2, rev. 1.

the launch of F1 failed. They had also agreed to launch F2, using Ariane if necessary. They had been trapped from the start by an Arrangement that was illogical in that it only explicitly provided for the launch of one satellite though two were built. Since that satellite was part of an international programme of considerable scientific interest and in which Europe wanted to show that she was a good partner, it was obviously necessary to make provision for a second launcher. So far so good. But then there was also great interest to be had in using Europe's own new launcher at discounted prices to orbit a flight model which had already been built. The problem was that the Ariane launch was only scheduled for May 1980. What if the meteorologists were still not organised by then? Who would pay for operating the second satellite? The Board could have said no to the Ariane offer, as they obviously risked stretching their commitment to a Meteosat system for yet another three years after the launch of the first satellite, scheduled for Autumn 1977. If they said yes, it was because of intense pressure from the Executive and the STAG, because they had paid for the satellite anyway, because they feared to lose the Ariane slot to someone else and because they were sensitive to the argument that continuity in the programme was essential.

The determination of both the ESA Executive and the STAG to persist in the face of the Programme Board's resistance to any extension of the programme deserves further analysis. It reflects two different definitions of the problem of Meteosat operations, definitions which were inherent to the institutional logics of the actors concerned. The Programme Board's main preoccupation was to ensure that Meteosat and Europe fulfilled their obligations to the GARP. Funds had been put aside in the national ministries of science and technology for that purpose and for no other. If the system was to be used in the medium to long term as the basis of an operational European meteorological service, the funds had to come from another government department. The interface between these objectives was, of course, slippery and some overlap between missions was inevitable. But the Programme Board was determined not to let the meteorological services piggyback for too long on the original programme. If they wanted an operational system they had to be prepared to set up the structure that it required and to find the money to pay for it. The Board feared that the more concessions it made to a possible follow-on programme the less inclined the meteorological ministries would be to confront the issue, to decide what they wanted and to take the steps needed to get it.

The Executive, supported by the STAG, saw matters differently. What they feared above all was a break in the continuity of the Meteosat programme. Such a break would necessarily entail a dispersal of the teams at ESOC and elsewhere, teams which were developing the know-how needed to manipulate and interpret meteorological data and to put it in a form useful for scientific model-building and everyday weather forecasting. They were aware of the reluctance of the meteorological services to take charge of the system, but they were convinced that once it was providing data, once "users bec[a]me accustomed to the various products coming from Meteosat, they [would] desire that these useful tools continue unabated".[128] It was also likely that other countries would come on board. Spain was interested, the African countries, who were particularly well covered by Meteosat were very keen to use its data, there was talk that the Saudi Arabian prince was seeking to associate his country with a prestigious international meteorological project and so on.[129] In short the Executive was convinced that once the feasibility and the attractions of an operational meteorological system had been demonstrated to the users, once they saw cloud images on their terminals, their doubts and hesitations would be swept away and they would become enthusiastic supporters of the system. Unfortunately for the administrators results were only expected in 1978 and to ensure continuity a number of commitments had to be entered into well beforehand – precisely those commitments that the Programme Board was hostile to.

3. Extending the Protocol to cover the exploitation of F2

With Meteosat safely launched on 23 November 1977 and with a malfunction in its radiometer corrected from the ground in January 1978, the Executive thought it as well to capitalise on the recent successes and to push ahead immediately with securing funding for the exploitation of F2, due to begin at the end of 1980. Despite the negative attitude of the Programme Board they hoped that it would be not too

[128] ESA/STAG/76(12), 1/9/76 (ESRO3727), ESA/SMWG(76)8, notes on a meeting held on 29/9/76 (ESA4668)..
[129] See memo from Tessier to the ESA DG concerning discussions at the WMO, 29/11/77 (ESA5532).

difficult to extend the operational phase foreseen in the Protocol for 30 more months to cover the orbital lifetime of F2. Of course they realised that this version would have to be more explicit about the interim role of the Agency pending the transfer of operational responsibility to an appropriate user Organisation. Apart from ensuring that the document was clear on this point, they saw no reason for "any delay in decisions being taken on the extension of the Protocol concerning the exploitation of Meteosat".[130] They were to be rudely surprised.

Indeed the debate on the extension of the Protocol to cover F2's operation was even more ferocious than that on the operation of F1 – if that is possible. The French again took the lead in sending every possible signal to the national meteorological authorities that they expected them to take over responsibility for the satellite system.[131] Britain and Italy again took the lead in objecting to the scale of contributions. Many delegations were furious to find that the Executive's proposed costs for the second operational phase were higher than they were for the first by about 25%. As a British administrator put it, "I should have thought that the experience gained during the first phase would have enabled some streamlining to take place which would allow a reduction in costs".[132] The Executive thus found itself unexpectedly assailed from many sides and it proved so difficult to find a compromise that at one stage in 1980 it looked as though F2 might be launched without the funds being available to operate it.

To analyse this process, in what follows we shall not again give a blow-by-blow account of the debates, which extended over more than two years, since some of the main issues have already been explored. We shall rather concentrate on the new element – the cost factor. Added to this and for variety, we shall describe the exchanges at one of the Programme Board meetings in some detail (the 21st, held in May 1980), so as to give the reader an idea of the intensity of the feelings aroused by the debate over the costs of operating F2.

Early in 1979 the cost to completion of the exploitation phase of F1 was estimated by the ESA Secretariat to be 20.77 MAU at mid-1978 price levels and 1979 conversion rates.[133] The Executive suggested that the cost of operating F2 for the same length of time (30 months) would be 26.27 MAU in the same monetary terms, i.e. 5.5 MAU higher. About 60% of this cost increase was attributed to "a more equitable distribution of the charges to be borne by the users of the Darmstadt Control Centre and the Odenwald Station". What had happened was this. The Council had insisted that from 1976 the user programmes should bear the entire costs of the ground facilities that they used. This was mostly waived in the case of the operation of F1 but, said the Executive, was to be applied to F2. This meant, for example, that since Meteosat would use four out of five of Odenwald's telecommunication links to and from space, the "Protocol will be charged 4/5 of the cost of the Odenwald station". What is more since all such links originated in the Control Centre, the operational programme would have to be charged for four of Darmstadt's available channels.[134]

The Programme Board was incensed. Challenged to make savings, the Executive managed to reduce the envelope to 23.52 MAU by October 1979. Some steps had to be taken anyway to cover a shortfall in the cost-to-completion of F1 operations due to Sweden's non-participation and it carried some of these measures over to the new programme (reduction in on-site maintenance and in staff, selling computer time to other ESA users, etc.).[135] The Programme Board was still not satisfied however. Taking an entirely new approach, it asked the STAG to establish "which tasks related to the exploitation of Meteosat should be performed by the Agency and which could possibly be executed elsewhere, in order to reduce the cost of the central facilities". The idea was obviously to transfer some of the data management functions now performed in-house over to the national meteorological stations.

The STAG took on the burden reluctantly. It identified some services which could possibly be done elsewhere – data collection system support, extraction of cloud wind vectors, perhaps extraction of cloud

[130] ESA/PB-MET(78)5, 12/5/78 (ESA3597); ESA/PB-MET/MIN/13, 19/5/78, document dated 3/7/78 (ESA3539).
[131] For their first salvo see ESA/PB-MET/MIN/14, meeting held on 28/9/78, document dated 27/11/78 (ESA3540).
[132] Letter J.C. Hawkes to W. Luksch, 10/4/79 (ESA5533).
[133] ESA/PB-MET(78)17, 5/2/79 and *Explanatory Note* on the budget structure, 15/1/79 (ESA5533).
[134] See ESA/PB-MET(78)18, rev. 1, add. 1, 7/5/79.
[135] ESA/PB-MET(79)20, 18/9/79.

top height and radiation balance – but insisted that even these were best left at ESOC. What is more, the Group demanded that these activities should not be suppressed until the Board was sure that someone else could undertake them. As to alternative locations, the STAG stalled, arguing that they did not "consider it within their present terms of reference to explore where, by whom and at what cost these services could be provided".[136]

The French Delegation was very positive about this development. It followed up the STAG report with its own suggestions for cost savings, both by streamlining in-house practice (archiving procedures, image rectification procedures) and by transferring tasks to the meteorological services (extraction of meteorological parameters from the basic data, direct collection of data by SDUs). Citing an Executive suggestion that the costs of exploitation of F2 could be down to 6 MAU annually by 1987, the French argued that this latter figure should be the maximum annual expenditure for F2 exploitation from 1980 onwards. The French concluded by saying that they would only consider signing the Protocol if it included a detailed timetable making provision for the progressive implementation of the measures that it demanded during the period covered by the agreement.[137]

Undaunted the Executive laid its draft Protocol before the Board's 21st meeting in May 1980. It made no changes to the tasks to be undertaken by the Agency in the exploitation of F2, put no time limit (and so proposed no financial envelope) for the duration of the programme and it fixed annual expenditure at 10.5 MAU at mid-1979 prices and 1980 conversion rates.[138] We shall follow the debate on this proposal rather more closely than usual so as to give the reader a feel for the atmosphere then prevailing at the Programme Board meeting.[139]

The first major issue discussed at the meeting was the scale of contributions. A majority of delegations were content to maintain the scale used in original Arrangement and in the first Protocol, increased pro rata by the amount of the Swedish shortfall. However, at the meeting Denmark announced that she was not likely to participate in this next phase of the programme to cover F2 operations. This created considerable disarray. Contributions at the upper limits which some countries could accept (because figures had already been accepted by their authorities) left a funding shortfall of about 7% – and France said it was opposed to accepting any budget that was not 100% financed.

The Executive's proposal to have an open-ended fixed annual envelope rather than a global envelope for a programme of a certain duration also caused difficulty. Their argument for doing this was that it gave added flexibility to the arrangement, enabling the delegations to terminate the Protocol at any time and hand over the Meteosat activities to an operational Organisation. It was also obviously intended to avoid having to go through bruising debates each time a new satellite was launched and pending the putting in place of a suitable user Organisation. The idea was abolished under pressure from Germany, France and Italy and it was agreed to revert to a three-year commitment to a global cost estimate.

France also obviously objected to the 10.5 MAU annual budget and wanted to know why the possible cuts recommended by the STAG had not been considered. The Executive defended its proposal by pointing out that the majority of the member states – Germany in particular – did not favour such reductions. France remained unflinching. Hoping to strike a compromise, the STAG chairman said that he would be willing to speak to the Directors of the meteorological services at a meeting to be held the next day to see again what possible reductions could be made. The German delegation, which had made it clear that it would only accept an extension of the Protocol if the tasks assigned to ESOC were left unchanged, opposed this idea; the British and Italian delegations supported him. To break the deadlock and to move on to other matters, the STAG chairman was authorised to try anyway to find a compromise in discussion with his colleagues.
Emerging from this meeting in May 1980 the Executive was desperate and through the chairman of the Programme Board, addressed "to the ESA Council a strong appeal to the Member States' sense of

136 ESA/PB-MET(80)3, 22/1/80 (ESA3642) is the STAG Chairman's report.
137 The French statement to the Board meeting on 8/2/80 is ESA/PB-MET/MIN/20, Annex II, dated 27/3/80 (ESA3546).
138 The Executive's long-range estimates of expenditure are ESA/PB-MET(80)14, 28/4/80 (ESA3653).
139 The Executive's draft is ESA/PB-MET(80)WP/5, 5/5/80 (ESA3689).
See ESA/PB-MET/MIN/21, meeting held on 7/5/1980, document dated 6/6/80 (ESA3547).

solidarity so that the second Meteosat exploitation phase can be decided [...]."[140] But the delegations were not going to rush things now. The launch of F2 on Ariane L03, foreseen for May, had been delayed due to the failure of L02 and the protocol for the exploitation of F1 'only' expired six months later, on 23rd November. So the cost-cutting exercise on the products available from ESOC was repeated by the Executive and was once again reluctantly accepted by the STAG, which yet again insisted that if implemented these measures "would inevitably lead to a reduction in the availability, quality and reliability of the services provided".[141] On 24 October 1980 the Programme Board finally adopted a text making provision for the exploitation of F2.

The Protocol made provision for the exploitation of the Meteosat for a further three years. The financial envelope was 24 MAU at mid-1979 prices and 1980 conversion rates. The scale of contributions saw a sharp drop in the UK's contribution compared to the scale in the original arrangement. However it only covered a little over 90% of expenditure. 9.58% was to be found from as yet uncommitted "Other Participants". As for the products, all the services were left intact after all, though, said the Executive, quantity had been preserved at the cost of quality.[142] The protocol came into force provisionally on 18th December 1980, subject only to the completion of internal formalities in the participating states. On 19th June 1981 Ariane L03 successfully placed the Indian satellite *Apple* and Meteosat flight model F2 in orbit.

It is once again incumbent on us to explore the roots of the French delegation's determination to cut costs in the second exploitation phase, to try to understand the motives for its tenacity. The underlying concern informing its position had not changed of course: it had never wanted the Board to take on this burden anyway and it was as determined as ever to get the national meteorological services to take over legal and financial responsibility for the Meteosat system. At the same time things were moving on this front. In October 1978 the meteorologists began to study seriously the structure of their own operating Organisation, Eumetsat (see below). And even though final agreement could not be reached at an intergovernmental meeting held in January 1981, real progress was being made at that level. Patience was needed. But if most participating states in the Meteosat programme were prepared to be tolerant, France was determined to maintain the pressure relentlessly. Her delegation, like its partners, did not doubt that the programme was in a state of 'transition'. But it wanted that transition to be gradual, not sudden, it wanted the meteorological services bit by bit to take over more of the technical work being done at ESOC and to generate their meteorological products in-house.[143] What it resented most was that this did not seem to be happening. Already in 1973 the Programme Board had amended the original Arrangement to include the development of MIEC software in ESRO's tasks – something originally intended for the meteorological services. Now, it seemed, those same services had simply come to take it for granted that the Agency would do the bulk of the production of meteorological data. Indeed the reluctance of the STAG to recommend any cuts at ESOC and its refusal to consider what tasks might be performed in-house at national institutes, despite the general disappointment with the quality of the ground facility, attest to the technical gulf that had opened up between the ESA establishment and the home institutes.

It was this gulf that France wanted to close. This is why it hounded the Executive and the STAG to find ways to redistribute the technical tasks being done at ESOC, to the national services. At the end of the day it failed in its objectives. Thirty months of debate and thousands of hours and pages later, it had been accepted to pay for the second exploitation phase. Its cost had been aligned with that of the first, the UK and Italy had finally had the scale of contributions adjusted – but the tasks undertaken at ESOC had been left untouched. Insistent French efforts had brought them little satisfaction. But then technical solutions to problems which are essentially political rarely do achieve the hoped-for results.

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[140] For the situation as perceived by the Executive see ESA/PB-MET(80)13, 30/4/80. Its appeal is ESA/C(80)45, 14/5/80. See also ESA/C(80)53, 16/6/80 for the quote. The Protocol is ESA/PB-MET(80)13, rev. 3, 29/10/80 (ESA3652) and ESA/PB-MET(81)7, 20/1/81.

[141] For the two reports see ESA/PB-MET(80)13, rev. 1, add. 1, 19/6/80 and, for the STAG report, ESA/PB-MET(80)29, 4/9/80.

[142] See ESA/PB-MET/MIN/24, 24/11/80.

[143] For an interesting analysis of this dimension of the French attitude see the internal memo signed A. Moritz (?), *Extension du Protocole Meteosat...*, dated 21/5/79 (ESA4647).

4. The first steps towards setting up an operational system: building coalitions, rebuilding trust in ESA

Beginning in the late 1970s the meteorologists seriously discussed the institutional framework best suited to paying for and managing an operational satellite system. Progress was, however, painfully slow. At the heart of the problem was not simply the cost of a technological system which would involve important investments in the space and the ground segments. This was also an entirely new technology whose technical potential was not evident and whose reliability was not guaranteed. What is more the United States "had agreed to accept responsibility for a major part of the global observation system and to guarantee open and cost-free access to the data [...]".[144] If Europe could get most of its satellite-generated meteorological data free of charge from the USA, it was going to be difficult to convince ministries unused to expenditure in this sector to set up an operating agency authorised to spend large amounts of money for an independent European system.

The first tentative discussions concerning an appropriate institutional arrangement were explored by the directors of the meteorological services meeting in December 1972.[145] Various possible frameworks suggested themselves, but it was obviously too early to pursue the issue in depth. Indeed it was not until 1977 that the question was again tackled seriously. Several factors converged to focus the meteorologists' minds on the issue. Firstly, during the gruelling debate on the terms of the Protocol to operate the first Meteosat, which finally came into force in April 1977, it had been made abundantly clear in the Programme Board that this was merely a transitional arrangement and that the meteorologists simply had to take the steps needed to set up their own body if they really wanted an operational system. Secondly, the ESA Council, meeting at ministerial level in February 1977, deemed it important "to adopt a positive attitude in relation to the management of operational systems". In particular, in those cases where organised users did not exist – as in meteorology at that time – it authorised ESA to furnish the users with "all the technical and institutional assistance they may request [...], including the making available of facilities" to help them take over the management and exploitation of an operational system.[146] Pushed by the space ministries, formally offered all the help they needed by ESA and with the next phase of an operational programme due to start in at most three years time, the meteorologists seriously began to face up to their needs.

The ESA Space Meteorology Working Group produced a first survey of the situation in September 1977.[147] What was needed, it argued, was a light and inexpensive structure, available by the end of 1980, which was open to non-member states of ESA and which would enable the meteorological community to enter into legal commitments. There was no ideal way to meet all these requirements simultaneously. One could either create a new legal entity under international law (or, less satisfactorily, under the national law of a particular State), or one could make use of an existing legal entity. The former idea was judged to be the solution which, in the long term, would ensure "maximum flexibility and efficiency". The Group rejected it on account of cost and of the time that it would take to negotiate and ratify the corresponding agreement. As for using an existing entity, four possibilities were indicated. The meteorologists could follow the example of the PTTs. These had chosen one of their number to act as the sole interlocutor with ESA in the transitional phase towards the setting up of an independent telecommunications satellite user agency called Eutelsat. The problem here was: Which national service would take on this responsibility? Alternatively, the users could link up with the European Centre for Medium Range Weather Forecasts in Bracknell (UK), though this seemed a dubious option given the very different mission of the Centre. Finally there were the World Meteorological Organization, which had been involved indirectly in the Meteosat programme from the start through the GARP and ESA itself, authorised by the Ministerial Council in February to be "at the service of the meteorological community" with regard to the latter's setting up of an operational system. Only the last two options – the WMO and ESA – were deemed worthy of further consideration by the Working Group.

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[144] See the minutes of the first Intergovernmental Conference on an Operational Meteosat System, 28-9/1/81, CONF/OP/MET/MIN/1, 18/2/81 (ESA5447)

[145] The summary minutes of this meeting are in file (ESRO52027).

[146] See the Resolution on the Agency and Operational Systems adopted by the Ministerial Council meeting on 15/2/77, ESA/C-M(February 77), Res. 3.

[147] See ESA/SMWG(77)5, 7/9/77 (ESA5532) and ESA/SMWG(78)3, 20/3/78 (ESA4937).

4.1 The initiatives taken within the WMO framework

For the next six months there were ongoing discussions between senior representatives of the WMO, ESA and the SMWG[148]. Two main items emerged from these exchanges.

Firstly, the WMO undertook to call a conference of plenipotentiaries who would be invited to set up an Executive Council to define the programme, policy and budget of a European operational system. It was understood that the space segment would be under ESA's control. The ground segment could be managed either by the WMO, by ESA or by one of the national meteorological services reporting to the WMO. The precise modalities would be defined in an Agreement that would need to be ratified by the participating governments. This Agreement would be drawn up beforehand by an Informal Planning Meeting which would prepare the decisions for the intergovernmental conference.

Secondly, the prospect of involving states not already party to the Meteosat agreements in these meetings was enthusiastically pursued. Countries in Africa and the Middle East were particularly relevant, for several reasons. Firstly, the meteorological services were "experiencing difficulties in receiving surface and upper air observation data originating from African regions", data which were essential e.g. for assisting long-haul aircraft flying over the continent.[149] Secondly, by expanding the number of participating states one not only shared costs more widely – even if African countries themselves could not provide much money, regional and world development associations and banks could be expected to contribute.[150] One also added a new political dimension to the programme, giving it additional appeal as aiding 'third world' development. Finally, one strengthened the support of the WMO for the scheme and so could bring even more pressure to bear on national bureaucracies. As an international organisation whose membership extended far beyond that of the Meteosat programme, the WMO particularly welcomed the involvement of a wide spectrum of nations in the operational system, all the more so those from the more deprived regions of the globe.

This attempt to broaden the political constituency by enrolling African countries in the operational system was given added impetus by the prospects of using part of the payload of an Italian satellite for meteorological purposes. The Italian delegation proposed to ESA that an available flight platform of the national *Sirio* satellite (*Sirio-2*) be launched on Ariane in 1980 and be used to receive and distribute meteorological information collected by eight regional meteorological centres and by a number of simplified stations distributed over the African continent. This "meteorological data distribution mission" (MDD) would be carried out within the framework of the World Weather Watch of the WMO and would help improve meteorological communication in Africa. The MDD would be joined on the platform by the LASSO mission, devoted to the synchronisation of atomic clocks using lasers. The ESA Council accepted this programme, which was strongly supported by the WMO, in December 1978, approximately three-quarters of the funding being provided by Italy.[151]

The ESA Executive, for its part, also went out of its way to build interest in Meteosat's products in Africa. In collaboration with the WMO, the United Nations and other bodies it demonstrated the potential of the system by setting up a portable station which received data from the satellite which was then passed on to local meteorological stations and discussed by a European expert. Presentations of this kind were made in Nairobi in February 1978 at a meeting of all African members of the WMO (about 40 governments were represented), between May and June 1978, when stations were taken to Cairo, Athens and Tunis and between September and December 1978 when a second series of demonstrations was made in Upper Volta, the Ivory Coast, Ghana and Morocco.[152] Although the ESA Executive found it difficult to assess the impact, if any, of its efforts, the African states meeting in February 1978 in Nairobi

[148] The relevant documents are letter from Gibson (ESA DG) to Davies (WMO Secretary General), 20/10/77 (ESA5532), memo Tessier to Gibson on discussions at the WMO, 29/11/77 (ESA5532), letter Davies to Gibson, 1/12/77 (ESA4938), memo Schneider to Gibson and summary of decisions taken at ESA/WMO meeting on 16/3/78, 23/1/78 (ESA5532), memo Tessier and Barbance to DG on meeting at WMO on 20-21/2/78, 27/2/78 (ESA5532).

[149] See ESA/SMWG(78)9, 5/4/78 (ESA4667) and also the memo from Tessier to the ESA DG regarding discussions at the WMO and dated 29/11/77 (ESA5532).

[150] An official from the WMO thought that Algeria, Nigeria, Lybia and Saudi Arabia might all be willing to contribute financially – see memo Tessier and Barbance on the meeting held at the WHO on 20-21/2/78, 27/2/78 (ESA5532).

[151] For the Sirio-2 programme and cost see ESA/SIR(78)4, 23/11/78 (ESA3758).

[152] For a survey of these promotional activities see ESA/IRAG(80)37, 23/12/80

did conclude that they would gain considerable benefits from a meteorological satellite system. They added that they would need to make costly investments in ground equipment to reap these benefits and so recommended that the "Meteosat programme becomes a fully operational system and be continued for at least a period of 10 years".[153] The WMO undertook to send this recommendation to the Agency as well as to the states participating in the Meteosat programme.

By February 1978 officials from ESA and the WMO, encouraged by these signs of support, were hoping to move ahead quickly. The directors of the national meteorological services were scheduled to meet in Reykjavik a few months later in May. Here they were, "in principle", to agree on the most suitable structure to put in place for an operational programme. Soon thereafter, at a meeting of the WMO Executive Committee, the Secretariat, stressing the interest of African countries in an operational meteorological system, would suggest that an Informal Planning Meeting for an eventual conference of plenipotentiaries could be arranged for the end of October or November 1978. The conference itself, which would formally set up an operational meteorological programme, would be held in 1979.[154]

All of this proved to be hopelessly optimistic. Meeting in Iceland in June the meteorologists once again discussed the precise form which a Eumetsat – the term now comes into regular use – might take. But they were still unsure how to proceed. And to clarify their thoughts they set up two working groups in October. One, chaired by R. Mittner, the DG of the French meteorological office, was to look into the most suitable legal structure for Eumetsat. The other, chaired by A. Piaget, from the Swiss Meteorological Institute, was a mixed ESA/Eumetsat group charged to look into the relationship between the two bodies so as to ensure the continuation of an operational programme.[155]

The reasons for this slippage are complex. Many members of the meteorological community were unhappy with the WMO structure, believing that it was too heavy and complex for their rather narrower objectives. Certainly the costs of working with it did not seem commensurate with the one significant benefit it brought: formal collaboration with the African states. The weight of the African card, it should be said, was also undermined somewhat by the opposition of the Bundespost to the *Sirio-2* MDD mission, which it felt violated a number of existing telecommunication agreements. Then there the tensions between the meteorologists and ESA.

In 1978 there was a serious deterioration in the relationships between ESA and the national meteorological services which, at least in the view of ESA DG Roy Gibson, possibly explained what he called the latter's "present malaise". At the root of the problem – and this point was also brought to the Executive's attention by the WMO – was the multiplication of contacts between different persons and different directorates in ESA with the user bodies. The ensuing lack of coherence was amplified by the tendency of some staff members to discuss possibilities with users before the Agency had defined its official policy and by the temptation, to quote Gibson again, to tell the meteorological services "how much inferior are the competence and efficacy of other Directorates". This impression of a house divided against itself and lacking a clear policy of its own was reinforced by ongoing dissatisfaction with the management of the central data processing facility at ESOC. In short in summer 1978 the meteorological services, which had been relying heavily on ESA to help lay the foundations of the operational system, were so disillusioned with the Agency that there were "persistent rumours that the Directors of these services dream of nothing better than the day when they can dispense with our services".[156]

4.2 New initiatives from ESA

The decision taken by the meteorological services to set up the Piaget group provided the Agency with an opportunity to set matters right. A. Lebeau, the Director of Future Programmes and Planning and the

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[153] This recommendation is appended to a report by Tessier and Barbance to ESA DG on a meeting held at the WMO on 20-21/2/78, 27/2/78 (ESA5532).

[154] Memo Tessier and Barbance to ESA DG.

[155] See the memo from Lebeau to Gibson dated 11/12/78 (ESA5532).

[156] All of the quotations are from a memo from Gibson to D/PFP, i.e. to A. Lebeau, the Director for Future Programmes and Planning, dated 24/8/78 (ESA4647). See also the memo from Tessier to the DG dated 29/11/77 reporting the impressions which the WMO had of ESA (ESA5532) and a memo from van Reeth to DPFP dated 18/12/78 concerning the *Organisation des services météorologiques*, also in file (ESA5532).

Deputy DG decided to take personal responsibility for the affair. Writing to the Swiss meteorologist early in January 1979 he claimed that the recent steps taken by the directors of the meteorological services "were a turning point in the relationship" between the two bodies and that ESA would need to organise itself internally to deal with the new situation that had arisen. To this end Lebeau reported that he had dissolved the Space Meteorology Working Group, which no longer served a useful purpose. He also indicated that he wanted all earlier, unofficial documents dealing with ESA/meteorological services relations to be ignored forthwith. Instead the Deputy DG promised to provide a set of papers for the first meeting of the Piaget group on 23rd and 24th January 1979 which would take up the whole issue again from scratch and which the Executive would be prepared to defend before the ESA Council. Lebeau himself would head the ESA delegation to this first meeting.[157]

Two documents were prepared for the first meeting.[158] One defined a set of guidelines governing the relationship to be established between ESA and Eumetsat. The other provisionally codified these in outline draft protocols. They were necessarily tentative: since the area of competence and the final structure of Eumetsat were not yet known and were not ESA's affair, Lebeau's group had to make a number of implicit assumptions which might later require revision.

ESA's proposal was structured around two main axes. Firstly, it foresaw a major operational role for ESA, with services provided which would be paid for by the 'client' Eumetsat. The document stressed that the boundary between what was to be done by ESA and what fell under the responsibility of the meteorological services had to be clearly defined by Eumetsat. It was assumed though that ESA provided the satellites as specified by Eumetsat, controlled them in orbit and handled some aspects of data acquisition and data preprocessing. Eumetsat would pay all ESA's internal and external costs in this regard on a *no profit/no loss to the Agency* basis, it being understood that the customer would have complete visibility over the expenditure. It was stressed that once the Council had approved the arrangements made, no ESA committee could 'interfere': "these activities [would] be carried out by the Executive on the basis of direct responsibility vis-à-vis Eumetsat".

The second main activity proposed by the Executive was one of research and development. Lebeau's team suggested that ESA might promote and seek Council approval for, optional programmes, funded from the Agency's budget, which would seek to develop meteorological technologies. These programmes would be monitored by the Council and a Programme Board in the usual way, but would be aligned with the requirements specified by the user, from whom "prior approval" would be sought. In this way the Agency hoped "to enable European meteorology to be ready for the next stage in the evolution of space technology with the help of the development instrument" that was ESA.

These ideas were discussed at the first meeting of Piaget's group at the end of January.[159] While the customer-client dimension raised little difficulty, the R&D aspect caused the meteorologists great concern. They wanted these played down as much as possible: the operational programme and its costing, should be based on a satellite that was identical to the current Meteosat series with only minor modifications. It was particularly desirable to improve the reliability and quality of the data disseminated in the infrared and water vapour channels and of the DCP data collection and transmission function. The ground segment was to remain the same as that of Meteosat at 'Level IV performance' (see part I), although the possibility of funding a control centre without the MIEC should also be envisaged.[160]

After this flurry of activity nothing much happened for a year. There were two reasons for this. Firstly, there were ongoing disputes about the most appropriate legal structure for Eumetsat. The British submitted a draft convention to the Legal Working Group which did not bestow the organ with its own

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[157] For this paragraph see the memos of Lebeau to the DG dated 11/12/78 (ESA5532) and 4/1/79 (ESA5533) and letters Lebeau to Piaget, 4/1/79 (ESA5533 and 11/1/79 (ESA4647).

[158] For the terms of these proposals see documents ESA/Eumetsat nos 1 and 2, dated 11/2/79 and 23/1/79 (ESA5533).

[159] For reports on this meeting see Piaget's minutes sent to Tessier on 30/1/79 and Tessier's own summary dated 2/2/79 (ESA5533). A Draft agreement between ESA and Eumetsat based on these discussions was produced within a month: it is dated 26/2/79 (ESA5533)

[160] Costs were not apparently discussed in detail at this meeting. An internal document produced the week before and which assumed that the programme would comprise three identical satellites launched at three-yearly intervals from 1983 onwards came up with a ballpark figure of about 400 MAU in 1979 prices: see document dated 19/1/79 (ESA5533).

legal identity, thus respecting the UK's wish not to establish a new international Organisation. The French chairman of the Group, Mittner, refused this approach and in May asked the CNES to draw up another draft convention, this time granting legal personality to Eumetsat.[161] Secondly, it took time to provide a realistic estimate of the cost of the programme. Throughout 1979 the Agency sought from industry (for the space segment) and from ESOC (for the ground segment) the data required to provide a considered figure for the cost-to-completion of the kind of programme the meteorologists were interested in. This document was ready at the end of January 1980 and was circulated by ESA DG Gibson to the heads of the meteorological services concerned.[162]

The cost estimates assumed that five satellites would be built and launched by Ariane to provide an operational service for ten years beginning in 1984. To ensure continuity in the system two would be in orbit at once, one operational the other on standby. All satellites were assumed to be identical to Meteosat F2 (i.e. no major R&D programme was provided for, as the meteorologists had requested). At the same time two modifications were proposed: the development of a new transponder to replace an obsolete model and the use of the S-band subsystem to replace the VHF telemetry, tracking and command subsystem. The ground segment was described in detail and a number of changes proposed, though always within the framework of the existing architecture. The overall cost of the system was estimated to be 343 MAU (mid-1979 prices and 1980 conversion rates). Provision was made for suppressing the fifth launch (-37 MAU), suppressing the MIEC component in the ground segment (-11 MAU) and adding a meteorological data distribution subsystem similar to that provided by *Sirio-2* (+30 MAU).

As 1980 wore on the ESA Executive became increasingly alarmed by the slow progress being made with the definition of the operational programme (as too did the Programme Board and France in particular, as we saw above). The final estimate by industry of the costs of the programme were due in by April; it soon emerged that they would not be ready until July. Concerned, in May 1980 the ESA DG suggested that the directors of the meteorological services meet anyway to discuss the timetable of the operational programme in the light of the long delivery times required for certain high reliability components and to define a period of validity for a fixed price industrial bid. No one liked the idea. Taking over the reins, the new ESA DG Erik Quistgaard tried again early in June to set up a meeting for the 23rd of that month. He insisted that he was not seeking "commitment" but only "reactions" to the various outstanding issues concerning the programme. This initiative bore no fruit either.[163] Where did the blockage lie?

Not, we should say at once, with the legal instrument. The majority of the Legal Group had come around to the French position and were willing to endow Eumetsat with its own legal personality (though there was talk of changing its name so as not to prejudice the possibility of non-European participation). The real difficulty concerned the technical content and so the cost of the programme. And here it was Germany (which expected to pay about 25% of the cost, equivalent to some 220 Million DM) that had dug in its heels. The Federal Republic wanted to see cost reductions in the original estimates, wanted to see participation extended and wanted Eumetsat set up before it would commit itself to the scheme. More specifically it wanted the number of satellites reduced to three, a reduction in the Meteosat missions (e.g. a suppression of the DCPs) and the transfer of certain meteorological missions, if possible, to other ESA programmes. As the Italians also remarked, the overall cost of the programme "was very high compared with the budgets of the meteorological services involved" and the meteorologists would have to try to find ways to reduce programme content so as to make savings.[164]

Concerned that so little progress was being made, the Programme Board asked the Agency to take the initiative and to arrange anyway for an inter-governmental conference on an operational meteorological system. Meeting on 26th June 1980 the ESA Council duly authorised the Agency to "offer its good offices

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[161] See memo Tessier dated 18/5/79 on the debates inside the Legal Group (ESA5533). See also his memo of 11/7/79 (ESA5533).

[162] See *Preliminary estimate of the cost of an operational Meteosat programme*, undated but about January 1980 and the memo Tessier to Louis, 7/11/79 (ESA5533).

[163] See letter Gibson to directors of meteorological services, 13/5/80 and the reply from Mittner, 4/6/80 and letter Quistgaard to directors, 10/6/80 and reply Simmen, 12/6/80 (ESA4877).

[164] See memo Tessier to DPFP, 28/3/80 (ESA5533). The Italian reaction is in letter Pirro to Gibson, 22/4/80 (ESA5549)

for the organisation of an Inter-Governmental Conference". Its aim was to allow those who were interested at least "to confirm their willingness to establish an operational meteorological satellite system in Europe and to have preliminary discussions about the technical, financial and institutional parameters of such a system". The letter of invitation was sent by the ESA DG early in October to the Ministers of Foreign Affairs in all countries which might have an interest in such a system (in fact the 18 member states of the ECWMF plus Norway) on the understanding that it would be directed from there to the most suitable post-box.[165]

5. January 1981: The first intergovernmental conference on an operational system and the subsequent deadlock

The conference duly took place at ESA Headquarters on 28th and 29th January 1981.[166] It was attended by representatives from all invited states bar two – Finland and Iceland. Four major points emerged during the proceedings.

Firstly, no one doubted the enormous benefits of a meteorological satellite system, not simply for weather forecasting, but also for agriculture and fisheries, nor did anyone doubt that it was immensely important for Europe to make its own contribution to the world-wide system.[167] As the Chairman (Sir J. Mason, DG of the UK Meteorological Office put it), "it was necessary to realise that whereas in previous years the United States had agreed to accept responsibility for a major part of the global observation system and to guarantee open and cost-free access to the data, it was by no means certain that this would continue to be their attitude if other partners did not agree to make a reasonable effort". China and India were about to embark on meteorological systems and Europe could not afford to be left out of the club.

Secondly, there was general agreement that the most suitable operational programme was one which made use of three standard satellites which were essentially copies of the classical Meteosat model, but which would have improved reliability, increased onboard consumables and so an increased service life (and slightly higher cost). This was 'Option 2' put forward by the Executive and estimated to cost 261 MAU for an exploitation duration of 8.5 years.[168] It was stressed again that no major technological innovations should be incorporated in the space segment. This was not simply to reduce costs. There was a general feeling that the Meteosat system was already very advanced, particularly the water vapour channel and that the data provided by the satellite were ahead of the numerical models that were available for interpreting them. It was, said the Chairman, "the data acquisition aspect that caused the greatest concern" and where the most fundamental improvements had to be made. "Meteosat realistically matched the present state of the art", said the Italian delegate and it would only be worth designing a new generation of satellites when the physical models had been improved.

Thirdly, these positive attitudes notwithstanding, very few countries were in a position to commit resources to the programme at this stage, their decisions being dependent on a further study of the matter and crucially, on the number of other participants sharing the costs. Of the existing participating states in the Meteosat programme, only France and Switzerland were able to make firm commitments. The French delegation affirmed that its government had agreed to take part in an operational satellite programme, which it would finance according to the GNP rule up to a maximum of 25%. The Swiss delegation said that, subject to approval from its authorities, it could pay up to about 2% of a joint programme. Of the states who were not currently participating in the programme, all expressed great interest, some

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[165] See ESA/IRAG(80)26, 6/10/80. The member states of the ECMWF were Austria, Belgium, Denmark, F.R. Germany, Finland, France, Greece, Iceland, Ireland, Italy, The Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, UK and Yugoslavia. See also ESA/PB-MET(80)37, 2/10/80 (ESA3674).

[166] All of the information that follows on this conference is from the minutes and their annexes unless otherwise stated, document CON/OP/MET/MIN/1 and Annexes I-V, 18/2/81 (ESA5447).

[167] For the applications of meteorological data and for a cost-benefit analysis of such a programme see, respectively, CONF/OP.MET/4, 28/11/80 and CONF/OP.MET/5, 20/11/80 (ESA5450).

[168] The other alternatives were the so-called 'Baseline' option, the five-satellite scheme costing 334 MAU which had been circulated earlier, 'Option 1' and a minimalist scheme of three satellites identical to the existing Meteosat spacecraft costing 239 MAU and having an estimated lifetime of 6.5 years in orbit. The possibility of adding an MDD costing 2.5-3.5 MAU similar to that on *Sirio-2* was retained. See CONF/OP.MET/6, 28/11/80 (ESA5451).

expressed a strong desire to become partners, some made it clear that there was no way that they could share in the costs. The possibility of obtaining financial support from the African states was effectively ruled out. As the French delegate pointed out, recent World Bank figures indicated that the GNP of these states together only amounted to 10% of that of the countries represented at the conference. This led to the suggestion that the possibility of getting financial support from international development organisations like the African Development Bank and the World Bank should be explored.

Finally the conference also considered at some length the best institutional arrangement for a future Eumetsat. It went along with the conclusions of the Mittner working group, which were laid before delegates, that "Eumetsat" should have a "light" structure but should be endowed with its own legal personality.[169] Where it differed was that it felt strongly that the organ should be "more or less incorporated in an existing body" and the ECMWF in particular. Mittner's group had ruled this out on the grounds that "the incorporation of these new responsibilities within the framework of an already existing convention would, in fact, involve procedures identical to those for the establishment of a new body". Some delegates felt that, be that as it may, this alternative might be preferable to setting up another international organisation.

To conclude its proceedings the conference passed a resolution whose content was summed up thus in the subsequent press release by ESA: "It was agreed that a working group should be set up to prepare the system requirements and outline specifications and to recommend an appropriate institutional framework for the implementation of a Meteosat operational programme". The conference also agreed to reconvene with a view to calling a meeting at plenipotentiary level once the results of this working group, to be chaired by Mittner and to include representatives from all countries which might be able to participate in an operational meteorological satellite system, were available.[170]

The intergovernmental conference took place in January 1981 under inauspicious circumstances. As the Chairman remarked in the course of the meeting, "General support for Meteosat is universal, but we could not be at a worse time economically for launching a new project and this means that the case we make [to our governments] has to be all the more convincing". More specifically though, the roots of the difficulty lay in Germany and everyone knew that until Germany had resolved the differences of opinion between different departments in the state apparatus it was difficult to make meaningful progress. This does not mean though that a step forward had not been taken. On the contrary the delegates to the conference had accepted the principle that an institution should be set up to take responsibility for an operational meteorological system, had decided to reconvene when an appropriate programme and framework for that institution had won general assent and had agreed to call a conference of plenipotentiaries to ratify their conclusions. It was with these specific goals in mind that the working group set to work immediately. They were covering familiar terrain, to be sure, but at least now they were doing so in the definite hope of arriving at a speedy conclusion – Germany permitting. And there lay the rub. For what the members of the working group did not know as they walked away from the conference in January was that it would take two more years to find a structure and to define a programme which was acceptable to Bonn and her partners

6. The activities of the MOP Working Group

The first meeting of the working group set up to define the operational programme (the so-called MOPWG) was held on 23rd and 24th February 1981. It was chaired by the director of the French meteorological service, M. Mittner and membership was open to all interested countries. In 1981, for example, those taking part in at least one or more meetings were not only from the remaining seven Meteosat participating states – B, CH, D, F, FRG, I, UK – but also from Greece, Ireland, The Netherlands, Portugal, Spain and Yugoslavia.[171] The MOPWG then was not an ESA body: indeed its credibility rested on its maintaining its autonomy vis-à-vis the Agency. ESA was to provide secretarial support, but otherwise to keep a low profile. Régis Tessier – a man who enjoyed both the esteem and the

[169] Their report is CONF/OP.MET/7, 28/11/80 (ESA5452).
[170] The quotation is from the information sheet dated 30/1/81 (ESA5549). The resolution is Annex V to CONF/OP/MET/MIN/1, 30/1/81 (ESA5447).
[171] The participating states and the dates are summarised in MOPWG 5(81)48 (ESA5498).

trust of the meteorologists – , was the Agency's central point of contact with the MOPWG and the community and acted as the 'Co-ordinator of the Meteosat Operational Programme'.

The MOPWG set up two subgroups. One, chaired by the British meteorologist Ken Stewart (replaced later by his colleague John Morgan when Stewart retired), was to define the technical content of the programme. In consultation with Programme Manager Lennertz and a couple of other ESA staff it rapidly converged on a system, improved vis-à-vis the pre-operational spacecraft in terms of satellite reliability and payload performance.[172]

The other MOPWG subgroup, the institutional subgroup chaired by M. Alt (France) had far more trouble in arriving at a consensus. Their task was to define the legal status and structure of Eumetsat and to define criteria for and to fix the scale of contributions to, the new body. In addition and granted the time that would elapse between the signature of the Eumetsat convention and its ratification, the Alt group was called upon to propose interim arrangements which would enable the programme to be started as soon as possible after the conference of plenipotentiaries.[173]

The MOPWG was determined to move rapidly. It was sensitive to the pressure on meteorologists from the Programme Board to take responsibility for the operational system and it was concerned about the long lead times required for the manufacture of some key satellite components. Mittner planned to have four meetings of the MOPWG by June, to reconvene the intergovernmental conference by September and to have the convention creating Eumetsat signed by mid-October 1981.[174]

By June 1981 the MOPWG had prepared all the main legal documents it could and had identified the questions still unresolved pending German agreement, which was expected a few months later. The date of the intergovernmental conference was surely slipping, but it was still hoped to hold it before the year was out. Then on 3rd September came the bombshell. A telex from Bonn informed Tessier that the German decision was postponed to "the beginning of 1982".[175] In an exchange of telephone calls and correspondence it emerged that the main source of the blockage did not lie in the Federal Ministry of Transport (whose Minister, Volker Hauff, was a former Minister of Research and Technology). Everyone in the BMV was in favour of German participation. The problem lay in the Ministry of Finance, which was particularly concerned about the low level of industrial return foreseen in the operational programme: it was about 10% compared to a possible German contribution of as much as 25%.[176] Disappointed, the MOPWG decided to suspend its activities and to postpone the convening of the intergovernmental conference until the German situation had been resolved.[177]

This proved to be extremely time-consuming, primarily due to internal technical difficulties in the Federal Republic. The date on which a German decision was promised thus slipped steadily as 1982 wore on. Finally the Federal government decided in favour of participation in the operational programme at a cabinet meeting on 14th July 1982. It was agreed that the full costs would be borne by the Ministry of Transport and that Germany's contribution to the programme had to be well below 25%.[178]

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[172] The terms of reference are Annex 2 to MOPWG 1(81)6, 4/3/81 (ESA5531).
[173] See MOPWG 1(81)6, 4/3/81 and Annex 1, for the tasks and formal terms of reference of this subgroup.
[174] The calendar is in MOPWG1(81)2, but see also the minutes of the first meeting MOPWG 1(81)6, 4/3/81 (ESA5531). See also Tessier memo on the first meeting dated 26/2/81 (ESA5556).
[175] Telex Schultze to Tessier, 3/9/81 (ESA5543).
[176] See memo Tessier on MOPWG status, 21/9/81 (ESA5557), memo Lennertz on the operational programme, 2/10/81 (ESA4877) and letters Hauff to Quistgaard, 9/12/81 (ESA5541) and reply (ESA5543).
[177] For a summary of their activities and these conclusions see MOPWG 5(81)48, 16/11/81 and rev. 1, 25/11/81 (ESA5498). See also memo Tessier to the DG, 18/11/81 (ESA5543).
[178] See letter Rehm (for the Minister) to Quistgaard, 29/7/82 (ESA5543) and the draft minutes of the ESA Management Board held on 27/7/82 (ESA5542).

With the German position resolved at last, a new round of meetings of the MOPWG got under way. They were now chaired by Dr Mohr of the German weather services, Mittner having retired from his post in France at the end of 1981. Progress was rapid, despite the complexity of some outstanding issues and a successful intergovernmental conference was held on 21st-23rd March 1983. It was followed by a conference of plenipotentiaries held in Geneva on 23rd May 1983 where the Eumetsat convention was opened for signature and a number of other legal declarations were adopted.

In discussing these developments we have decided to divide the material by theme, retaining when necessary a chronological sequence within each topic treated. In this way we hope the reader will gain an idea of the complexity of the issues tackled by the MOPWG and its subgroups without becoming lost in the details of the microprocess of decision making. Before getting under way, however, a few words are in order on the reasons for the hold-up in Germany.

A full analysis of why the Federal Republic's representatives took so long to adopt the operational Meteosat programme is not possible without access to archives which will probably only be opened in a decade or two's time. Some plausible speculations, based on interviews, do however suggest themselves. Firstly, there was the classic problem that the government Ministry involved, the Ministry of Transport, had to introduce a new budget line into its activities, had to come around to the idea that space meteorology was one of its functions and for which it had to be bear the administrative and, above all, financial burden. A second reason was related to this. The national bureaucrats and administrators who would be involved in the operational system were not those who had watched over the earlier development of the system, nor were they attached to a ministry whose central mission was research and development. They thus brought with them an entirely different ethos and persuading them of the merits of the programme also required slowly building up an atmosphere of trust and mutual confidence with them. That took time and it tangibly retarded the rapid adoption of the operational programme. In short the operational programme called for a "cultural revolution" (Tessier) in the attitudes of the civil servants in the ministries responsible for it and they were only prepared to move ahead once they felt they knew what they were committing themselves to.[179]

6.1 The space segment: the satellite and its payload

The technical description of the system was quickly frozen. After all, this was not to be a development project and the aim was to identify those improvements to the performance of the existing Meteosats which experience had shown were desirable and which were not too costly. A first account of the operational system was provided in the draft Eumetsat convention in June 1981. It was only changed slightly in some details as the start of the programme slipped and the industrial situation changed (e.g. some products used in Meteosat F1 and F2 were no longer available).[180]

The technical subgroup proposed to increase satellite lifetime both by increasing the on-board consumables (electric power and propellant) and by improving the reliability of the electronics associated with the radiometer and the telecommunications. As for the payload, an additional channel was added for the simultaneous transmission of the visual, infra-red and water vapour signals. The signal-to-noise ratio of the water vapour channel was also improved. A more accurate calibration scheme, using on-board calibration implemented by temperature control of a black body, was suggested for both the infra-red and water vapour channels. Finally, a frequency band of new high-power transponders was used for a MDD capability provision would be made for an MDD capability similar to that used on *Sirio-2* (which was destroyed on launch). As for ground-sector performance, this was to be at least as good as that of the pre-operational system, though provision was made for improving reliability and reducing operating costs.

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[179] Private communications, Lennertz and Tessier.

[180] For an early system desciption see MOPWG 1(81)4, 11/2/81 (ESA5531), MOPWG 2(81)7, 13/7/81 (ESA5539) and Annex I to the draft Eumetsat convention, MOPWG 4(81)40, 23/6/81. The following paragraph is based on these texts along with the summary report by the technical subgroup to the reconvened intergovernmental conference, CONF/OP.MET/10, 9/2/83 (ESA5455) and memo from Laurentie to D/OPS (ESOC), dated 1/10/82 (ESA5559).

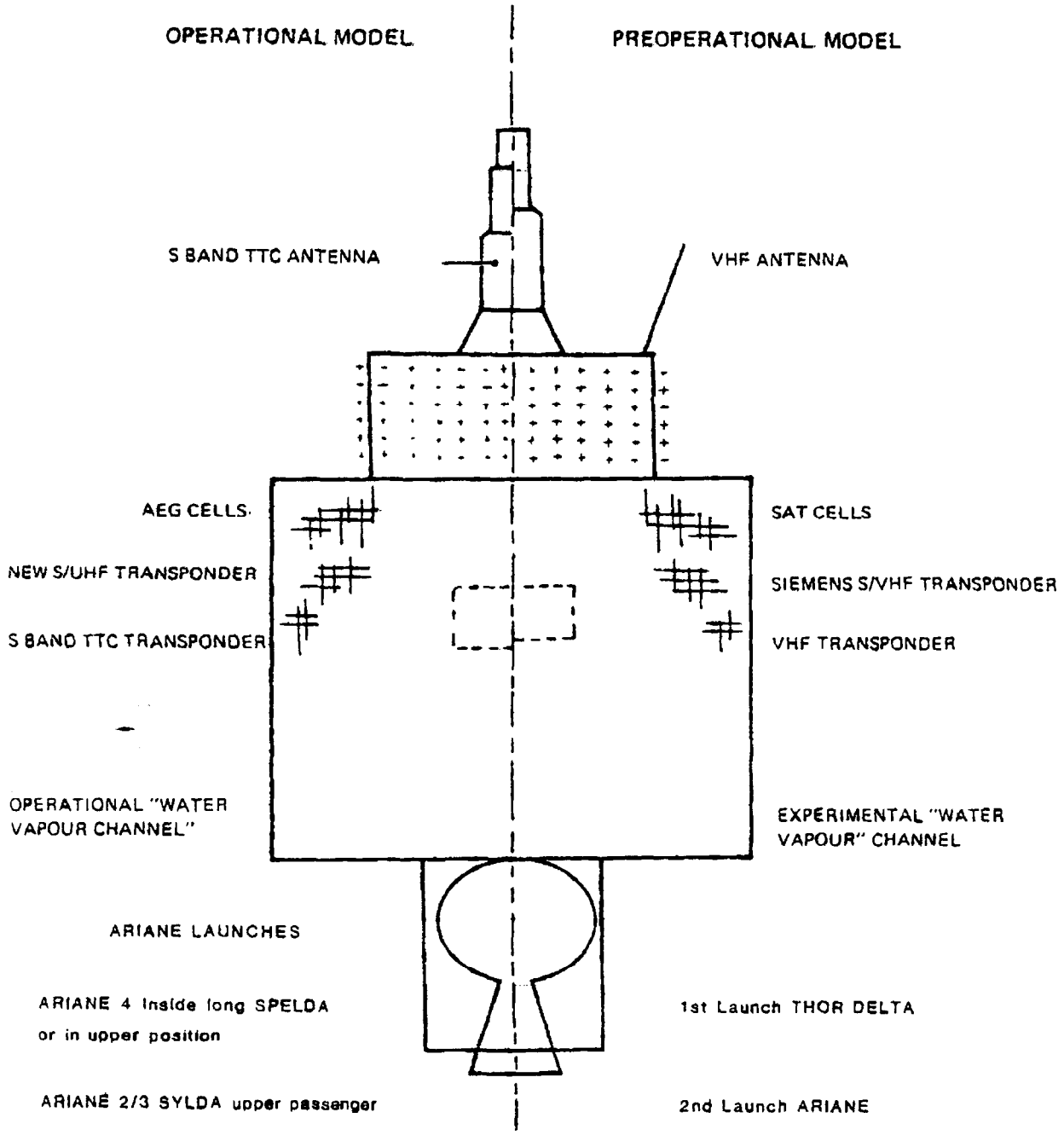

Figure II.1. Schematic of the differences between the pre-operational and operational Meteosats showing the proposed changes and improvements, as presented by ESA to the intergovernmental conference in March 1983 (CONF/OP.MET/13).

Figure II.1 schematically indicates the proposed differences between the pre-operational and operational meteorological spacecraft.

6.2 The space segment: the launch schedule and the revival of P2

In a well designed operational system, each active satellite is complemented by one on stand-by in case of failure. With each satellite having a 50% probability of surviving for at least three years, a decade of 'guaranteed' operations requires building five satellites. This approach was too costly for the intergovernmental conference which, it will be remembered, wanted the number of satellites reduced to three (or perhaps four) and their lifetime extended. To cut costs it was also desirable that only one satellite integration team be used. Within these constraints the technical subgroup decided that a second satellite should be launched as soon as possible after the first, bearing in mind the workload of the team, while the third satellite could be integrated after the first two and launched when justified by the status of

the programme and the availability of dual launch slots on Ariane. This approach provided for a high-probability of an in-orbit spare for all except the first 18 months of the operational programme (i.e. the presumed time gap between the first and second launches).[181]

The launch schedule proposed in mid-1981 reflected this philosophy and the conviction that the convention would be ratified before the year was out. It was proposed to build three satellites and a spare. MO1 would be launched once it was ready, presumably in the second half of 1985. MO2 would follow 18 months later, in the first half of 1987. MO3 would be launched with a somewhat greater delay after MO2 (i.e. in the second half of 1989), though this date was flexible. The launches of MO1, MO2 and MO3 would be insured to cover the costs of launching the spare MO4 in case of need. The overall scheme provided for an operational programme lasting 12.5 years from the end of 1981, or 8.5 years from the launch of MO1. By the end of this period (i.e. 1993/4) the time would be ripe for launching second-generation meteorological satellites using more advanced technologies.[182]

The slippage in the signature of the convention caused by the situation in Germany forced a reconsideration of this launch schedule. By August 1982 it was clear that the operational programme could not be formally started before mid-1983, meaning that MO1 would not be launch-ready until 1987. This not only raised serious questions about the desirable length of the programme: perhaps only two MOs should be developed and the transition then made to the second-generation of satellites?[183] It also meant that there was very likely to be an important break in service between the "pre-operational" and operational systems. After all Meteosat F2 had been launched in June 1981. With a nominal life of four years, this meant that there would be a gap in the operational system between 1985 and 1987. How was this gap to be bridged?

The most cost-effective way to provide for the possible interruption of service between Meteosat F2 and MO1 seemed to be to launch the second model of the Meteosat pre-operational series (labelled P2). P2 had been used as a qualification model for the Thor-Delta launch of F1 and then, after modification, for the Ariane launch of F2. It underwent both of these baseline tests without problems. And though it was unlikely that it would be as reliable as a new spacecraft a decade after manufacture, the ESA Meteorological Programmes Office (MPO) in Toulouse suggested that it could be made flightworthy with only minor refurbishment.[184]

The P2 "bridging" solution was discussed by the technical subgroup meeting on 9 September 1982 and favourably received. In mid-November the Ariane Programme Board agreed to launch P2 as a passenger on the first Ariane-4 test flight towards the end of 1985, at marginal cost.[185] The technical group proposed that this launch be followed by those of MO1 and MO2 at intervals of 18 months each, while MO3 could, if necessary be launched two years later (second half of 1990). The programme now composed P2 plus three satellites and a fourth spare, it being understood that the launch of the old flight model should not under any circumstances delay the launch of MO1.

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[181] The launch philosophy is described in the summary report by the technical subgroup to the intergovernmental conference, CONF/OP.MET/10, 9/2/83 (ESA5455).

[182] For this paragraph see Annex I to the draft Eumetsat convention, MOPWG 4(81)40, 23/6/81.

[183] See letter Mason to Tessier, 15/3/82 (ESA5541)

[184] The idea of using P2 had been discussed by Stewart's subgroup early in 1981 but shelved at that time – see the early draft of Annex I to the Eumetsat convention dated 27/2/81 and signed C.Pastre (ESA5538). The possibilities of its reuse are discussed in ESA/PB-MET(82)12, 24/3/82 and ESA/PB-MET(83)1, 20/1/83.

[185] See memo Orye dated 13/12/82 (ESA5550).

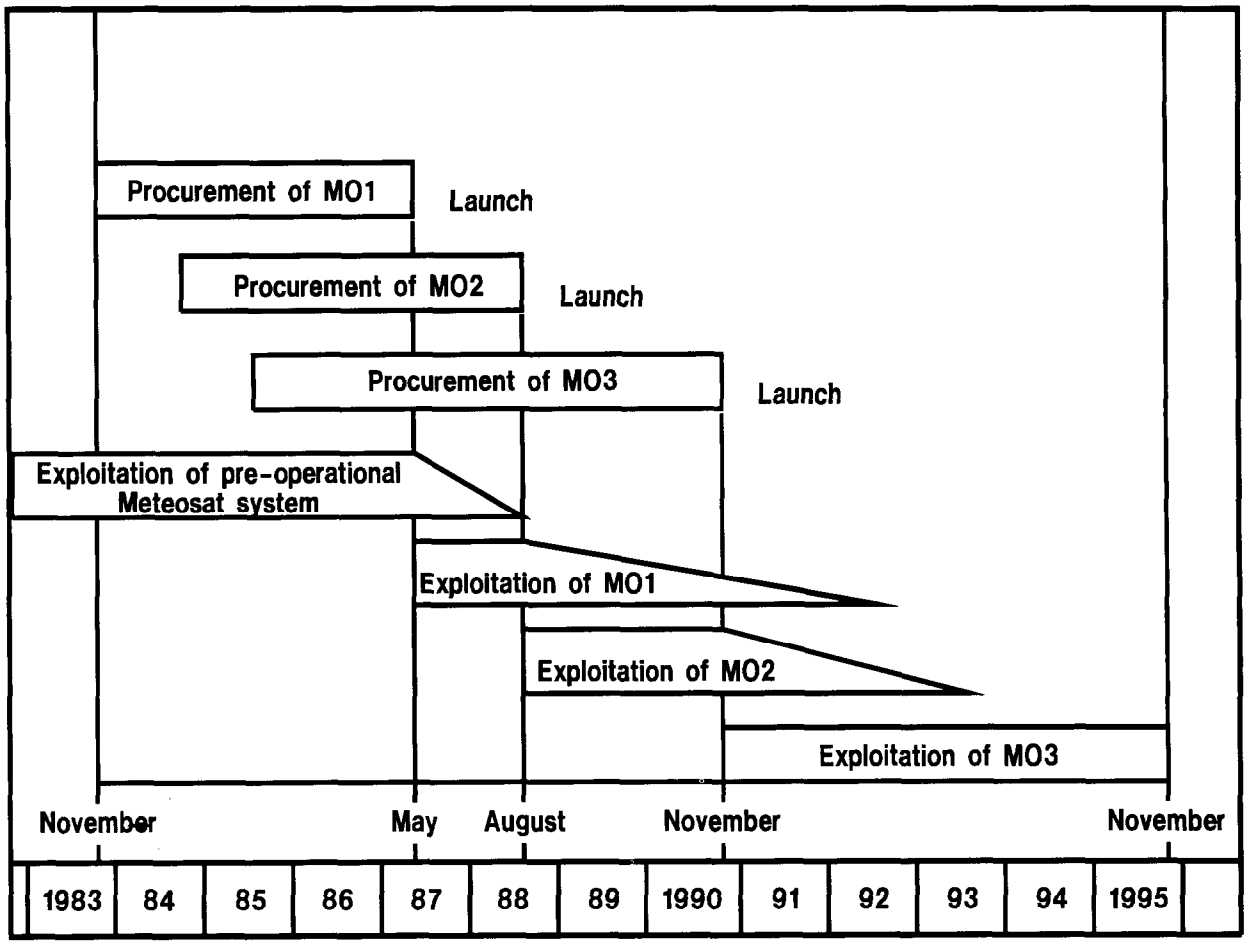

Figure II.2. Information on the operational programme showing the desired launch schedule, presented in a folder prepared by ESA for the delegates to the March 1983 intergovernmental conference and entitled "A way to tomorrow's weather: The Meteosat Operational Programme."

A schematic launch schedule which implicitly assumes that Meteosat P2 would be operated and which was prepared for the intergovernmental meeting, is shown in Figure II.2.

Who would pay for the additional satellite? The Programme Board had made it clear, we will remember, that it would not pay for this. Thus the subgroup decided to add the cost of refurbishing and launching P2 (estimated at 8.6 MAU of which 2.0 MAU for the launch) to the new operational programme.[186] The MOPWG also looked into the arrangements for operational expenditure. The protocol signed by PB-MET for managing Meteosat F1 and F2 was due to expire on 23rd November 1983. The MOPWG subgroup thus suggested that the new programme should take over the cost not only of refurbishing, launching and operating P2, but also of operating these two earlier flight models from 24th November 1983 onwards.[187]

[186] The cost figures are in ESA/PB-MET(83)1, 20/1/83. See also MOPWG 7(82)71, 19/10/82 (ESA5514).

[187] For the technical subgroup's deliberations see the chairman's report its third meeting, MOPWG 6(82)56, 9/9/82 (ESA5504), the MOP space segment description, MOPWG 6(82)57, 9/9/82 (ESA5505), Revision 1 of Annex I to the ESA Convention, 9/9/82 (ESA5534), Revision 2 of same, dated 20/9/82 and attached to MOPWG 7(82)68 rev. 1 (ESA5511).

This elegant solution was short-lived. At a meeting between the German and French Ministers for Transport on 10th December 1982 the former stipulated that the satellite programme had to be restricted to three satellites, so that if P2 was used only two of the improved spacecraft could be launched (i.e. the other two units foreseen at the time would not be integrated except in case of failure).[188] This suggestion, if implemented, seriously threatened the operational reliability of the programme and so was to be avoided at all costs.

Faced with this threat, Tessier discussed an alternative solution with the German delegation: keep the operational programme with its three satellites and pay for flying P2 from the existing pre-operational programme, despite the earlier hostility of the Programme Board. This programme had cost to date 127.8 MAU in mid-1971 prices i.e. 111.13% of its initial financial envelope. The 8.2 MAU for refurbishing and launching P2 could thus be taken from this budget within the 120% cost overrun limit. The German delegation let it be known that it found this alternative acceptable and that it would be prepared to maintain the new programme intact while paying for P2 from the old. Most delegations to the meeting of the MOPWG in mid-January 1983 were willing to go along with them. [189]

Of course the Programme Board for the pre-operational Meteosat had to accept this new burden. Meeting on 9th February 1983 it decided to delay its decision pending the results of the intergovernmental conference scheduled for the end of March. To conclude we need only remark that, in the light of the importance of P2 for guaranteeing continuity of operation and of the intergovernmental conference's decision to take over the operating costs of the pre-operational programme as from 24th November 1983, the Programme Board capitulated and subsequently agreed to bear the costs of refurbishing and launching P2.[190]

6.3: Ground segment management

Although it had always been understood that ESA would be the Agency responsible for setting up an operational system, in November 1982 it was still not evident that it should also be responsible for the exploitation of the in-orbit satellites. As the UK delegate to a meeting of the MOPWG then put it, even if it was agreed that the programme be carried out as an operational activity of the Agency, the Eumetsat Council had to be left the freedom "to determine the body to which it would entrust the ground segment operations which would, in fact, not begin until around 1987".[191] Behind this remark lay the meteorologists' dissatisfaction with ESOC's performance, which had surfaced on more than one occasion in the years before (see Part I) and an ongoing suspicion that they were being overcharged for the services rendered by the establishment.

The suggestion that operational activities as such should be taken away from ESOC had surfaced very early on in the discussions with the meteorologists. Commenting on the debates at the second meeting of the MOPWG in March 1981 Tessier remarked that "a certain consensus" was developing among the community that "system exploitation" as opposed to development might not be attributed to ESA.[192] This idea was given a further twist later that year when the Director General of Eurosat, P. Blassel, suggested that this semi-private company might take over the task of operating the Meteosat system. Indeed the Eurosat solution was one of the main preoccupations of the Executive during the long wait for the German green light.

Eurosat was a European grouping of banks and industries set up in 1972 to facilitate the transition of satellite systems from the development to the operational phase. In May 1976 and in anticipation of the Meteosat operational programme, the ESA Council passed a resolution which specifically identified

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[188] This is reported in MOPWG 8(83)82, 13/1/83 (ESA5523). Tessier claimed afterwards that the German delegation had never supported the P2 + 3 MOPs solution.

[189] Memo Tessier 20/12/82 entitled *Contenu du Programme Opérationnel* (ESA5550), memo Tessier *Option P2 du Programme Opérationnel*, 13/1/83 (ESA5550), the minutes of the 8th MOPWG held on 17-18/1/83, MOPWG 8(83)84, 9/3/83 (ESA5524) and ESA/PB-MET(83)1, 20/1/83.

[190] See the minutes of the 34th PB-MET meeting on 9/2/83 and the resolution it adopted on 16/6/83, ESA/PB-MET/XXXVI/Res. 1(Final). See also memo Tessier to Mallett, 7/3/83, fax Mallett to all PB-MET delegates, 31/3/83 and letter Lafferanderie to the German BMFT, 21/6/83 (ESA5550).

[191] At the seventh meeting of the MOPWG on the 8-10/11/82, MOPWG 7(82)76, 22/11/82 (ESA5517).

[192] See his memos dated 31/3/81 (ESA5556) and 7/4/81 (ESA5555).

Eurosat as the kind of organisation which might serve this purpose in consultation with the Agency. The resolution identified certain tasks which might be suitable in this regard: funding parts of the ground systems of ESA's experimental programmes which might subsequently be used operationally, pre-financing operational systems derived from ESA's experimental systems and making them available to users, etc.[193] Thus authorised, ESA contracted out several parts of the Meteosat system to the company. Eurosat provided control teams to supervise in-orbit operation of Meteosat satellites at ESOC in Darmstadt, was responsible for the promotional activities of Meteosat products in Europe and Africa in 1978/9, etc. On the basis of this experience Blassel wrote to all the heads of the meteorological services in December 1981 offering Eurosat's help. Although the offer was vague it suggested that the firm, in consultation with ESA, might for example set up "an adequate legal entity" for managing the operational system, might make arrangements for pre-financing the operating costs of the system and could also explore with the services ways of raising revenue to cover part of these costs, e.g. by selling some meteorological products to "certain categories of end-users who are not linked to Meteorological Services".[194]

These offers caused considerable consternation in some quarters in ESA, who felt that an activity with which they had had a long historical attachment risked being wrenched from their hands.[195] For one thing, the DG himself seemed seduced by the idea, initially at least. "In my opinion", he wrote when the issue first surfaced in spring 1981, "ESA should try to get away from operational systems, especially when we are talking about an operation time stretching from 7 - 10 years".[196] Secondly, the meteorologists themselves became increasingly interested in the option. Eurosat explained its activities at a meeting of their directors in The Hague on 14th April 1982. Dr Lingelbach of the German weather service was subsequently reported to have found the presentation "impressive and the offer of pre-financing attractive".[197] Finally, the idea of commercialising meteorological products previously provided free of charge was very much 'in the air' at the time. The Reagan administration in the USA was considering taking this path, consistent with its deregulation policies. Indeed in July 1981 Comsat President Dr Joseph V. Charyk told the US Congress that he wanted the firm to "take responsibility for developing, expanding and operating" on a commercial basis the Landsat Earth Resources and the NOAA/GOES meteorological satellite systems which Comsat would combine into a single programme. Indeed, opposition notwithstanding, in March 1983 it was reported that the US President had decided that "the satellites used by the weather bureau will be privately owned".[198]

The Eurosat option effectively evaporated in July 1982: the Federal Government let it be known that it wanted Meteosat operations to be at an existing centre in Germany.[199] The meteorologists, meeting shortly afterwards, formally decided not to make use of Eurosat as they were still not in a position to judge what advantages this might have.[200] Anyway the firm was sold to Matra towards the end of 1982 making "its future intentions [...] unclear", to quote Tessier.[201] With that Eurosat dropped out of the picture. It did not mean that the question of the ground segment was settled, however.

Firstly, there was the question of programme management. The meteorologists wanted "a strong and clean management scheme" with the responsibilities of the Programme Manager clearly defined and with the interface between him and the "customer" clearly identified. "Full visibility" over the running of the

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193 ESA/C/VII/Res. 1, 11/5/76.

194 See letter Blassel to directors of meteorological services dated 23/12/81, copied with letter Blassel to Tessier, 23/12/81. See also letter Blassel to Quistgaard, 23/12/81 and Kuegler to ESA Council Chairman Curien, 6/2/81 (ESA5544). Some of these ideas were further elaborated in a private converstaion with Bourely in the ESA Legal Affairs department – see memo 10/2/82 – and in a meeting at ESOC with Tessier and others on 29/3/82, see memeo dated 31/3/82 (ESA5544).

195 For extensive documentation on the internal debates see the material Tessier's file (ESA5544).

196 Memo dated 22/4/81 in (ESA4877).

197 See Aide Memoire signed by Jensen (ESOC) and dated 23/4/82 (ESA5551). See also document Eurosat, DG/PB/gdm/8826, Genève, 13/6/82 (ESA5544).

198 For information on the US situation see memo Mellors (ESA, Washington D.C.) to Tessier, 16/7/81 (ESA5555), articles in *Aerospace Daily* (pp. 134-5) (for Comsat citations) and *Defence Daily* (p. 130) of 24/7/81, memo Pryke (ESA Washington D.C.) to ESA, 19/11/82 (ESA5543) and the *International Herald Tribune* of 9/3/83 (ESA5543), from which the final quotation is taken .

199 See the draft minutes of the ESA Management Board meeting on 27/7/72 (ESA5542). See also the report on the Instutional sub-group meeting held on 14-15/12/82, MOPWG 8(83)82, 13/1/83 (ESA5523).

200 See the minutes of the Alt subgroup held on 9th-10th September 1982, MOPWG 6(82)58, 13/9/82 (ESA5540).

201 See memo Tessier to the ESA DG dated 27/10/82 (ESA5555).

programme was also called for. The customer was not to be left passively on the sidelines but was to receive regular status reports on the state of the programme and be able, through Eumetsat, to participate in "significant meetings at ESA or with the contractors".[202]

To satisfy these requirements the ESA proposal in March 1983 gave overall control of the programme to a single person, the Programme Manager. He would be located at the Agency's headquarters and would be "the unique point of contact between the Agency and the Customer", centralising the information passing to and from the Agency and organising the monitoring of ESA activities by Eumetsat. Subordinate to him there would be one person responsible for the space segment and one for the ground segment. The space segment project manager and his team would be located at Toulouse would draw support from ESTEC. It would comprise no more than 13 persons up to the launch of the first MOP and this number would be reduced to six by the end of the programme. Exploitation would be handled by a ground segment project manager and his team. This team, numbering 21 persons for the duration of operations, would be located at ESOC. [203] These changes meant, in fact, breaking up the experienced ESA-MPO team in Toulouse which had successfully managed the Meteosat programme until then and relocating some members elsewhere – with the result that Programme Manager Lennertz and some of his colleagues left ESA.

The second major issue concerning the ground segment operations was financial. The meteorologists looked very carefully at ESA's proposal for managing this segment, which originally "did not fully correspond to the stated requirements" in the overall system description "and a time-consuming critical examination [by the Technical Sub-Group] proved necessary".[204] The meteorologists were also most unhappy with the proposed charging policy for the use of ESOC facilities, being suspicious that they were being called upon to "subsidise the European space policy", as the chairman of the MOPWG Dr Mohr put it.[205] In particular they vigorously contested their share of the fixed support costs being proposed by ESA for managing the programme, arguing above all that since this was an operational programme based on a tried and tested system it would be far cheaper to run than a usual ESA programme, which was plagued by many more uncertainties. This issue touched a matter of principle about how ESA calculated charges to users and the Council was called upon to arbitrate. It reduced the Executive's proposed 41 MAU under this budget heading to 29 MAU to meet the meteorologists objections.[206]

These exchanges with the meteorologists were, of course, the historical legacy of the tension which had surrounded the relationships between the partners for years. Striking the right balance of power between them had always been difficult, to the extent that, as we remember, the meteorologists at one stage seriously thought of dispensing with ESA's services entirely. The operational meteorological programme was not only built on the scientific and technical foundations of its predecessor. As Régis Tessier said in speaking of the meteorological community, "Due to their past experience with PB-MET they will insist on having a better control and monitoring of the programme from the administrative, financial and technical point of view, [and] will request that all charges and overheads charged to the programme be fully justified."[207] The pre-operational programme had proved to be a multifaceted learning process for both ESA and its 'client'.

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[202] This paragraph from letter Mohr to Quistgaard, 24/1/83 (ESA5543). For the DGs reassurances on all issues but that of charges see his letter to Mohr, 2/2/83 (ESA5555)

[203] See the *Technical and Financial Proposal of the European Space Agency*, CONF/OP.MET/13, circulated by Quistgaard on 14/2/83 (ESA5458) and the viewgraphs presumably presented to the conference, (ESA5560).

[204] For the quotes see MOPWG 7(82)73

[205] Letter Mohr to Quistgaard, 24/1/83 (ESA5543).

[206] For the material surrounding this issue see the reponse to the Mohr letter of 24/1/83 by H. Frank, ESA Finance, 3/2/83 (ESA5545) and the Executive's explanation to the Council of the consequences for the rest of the programme of conceding the meteorologists a reduction of 24.6 MAU, ESA/C(83)8, 14/2/83 and Add. 1, 18/2/83. The meteorologist's arguments are in Annex II to this document. The Council meeting on 23/2/83 in fact adopted the compromise proposed by the Executive – a reduction of 12 MAU; see letter Quistgaard, CONF/OP.MET/13, add.1, 28/2/83.

[207] Memo to the DG dated 14/1/83 (ESA5555).

6.4 The cost of the operational system

While there may have been squabbles over some budget line items, like the customer's share of the fixed costs at ESOC, by and large there were no major disputes over the global cost of the operational system. Table II.1 depicts the evolution of the overall cost of the programme between the two intergovernmental conferences. The programme was scheduled to start in June 1983 and to last for 12.5 years. Here we shall simply make a few comments on these figures.[208]

Budget item	**Jan. 81 IGC, (79/80)[1]**	**Updated, (81/82)[2]**	**Mar. 83 IGC, (82/83)[3]**
Satellite procurement	98	127	139
Launching activities	67	80	80
Ground segment investments	9	10	13
Exploitation phase	52	57	69
Programme management & support activities	25	31	33
Launch insurance			9
Reserve for contingencies			6
SUB-TOTAL	**251**	**306**	**350**
Bridging activities			29
SUB-TOTAL			**378**
Eumetsat secretariat			10
Eumetsat contingency margin			12
TOTAL			**400**

Table II.1. The evolution of the overall cost of the operational meteorological satellite system between the first and second intergovernmental conferences, January 1981 and March 1983.

Notes:
Since all figures are rounded, totals do not always agree exactly.
1. MAU at 1979 prices, 1980 conversion rates. These data are for the three improved satellites option proposed to the intergovernmental conference in January 1981, CONF/OP-MET/6, 28/11/80 (ESA5451) and as disaggregrated in letter Vandeput to Piaget, 10/5/82 (ESA5559). The latter source has been used for the launching activities cost, i.e. launcher, launch operations and ground station costs during the LEOP (Launch and Early Orbit Phase) as it assumed double Ariane launches.
2. Previous column simply updated to MAU at 1981 prices, 1982 conversion rates. From letter Vandeput to Piaget.
3. MAU at 1982 prices, 1983 conversion rates. Data from the DG's offer to the intergovernmental conference in March 1983, CONF/OP-MET/13, 14/2/83 and, for the Eumetsat expenses, from the Eumetsat Convention, CONF/OP-MET/12, rev.3, Annex , 24/3/83 (ESA5457).

The first point to notice is the increase in the cost of the basic programme from 250 MAU to 350 MAU in two years. Half of this increase is due to inflation and the change in conversion rates. The other half comprises, firstly, the increase in satellite costs, which were anticipated since the earlier figures were based on an outdated (1980) offer from the COSMOS consortium. Secondly, there is a similar increase in the costs to be paid to ESTEC for the exploitation phase, just that item which, as we have seen, was so hotly contested by the meteorologists. Thirdly, launch insurance has also now been budgeted for. This was to cover the cost of insuring both MO1 and MO2 for launch and for the first few weeks in orbit. The sum insured was sufficient to cover the main elements of integration and the launch of MO4.[209] The aim here of course was to avoid a repetition of the situation which had arisen with the pre-operational

[208] The notes to the table give the sources used in what follows.
[209] From meeting of Technical subgroup on 20/10/82, MOPWG 7(82)73, 8/11/82 (ESA5515).

programme, where no provision had been made for launching the spare spacecraft in the event of a threat to the continuity of operations.
Our table also shows that the delay in the start up of the programme cost the meteorologists dear. The (pre-operational) Programme Board had agreed with difficulty to absorb the operational costs of Meteosat F1 and F2 until 23rd November 1983. They were also being asked to pay for the launch of P2, scheduled for 1985. The cost of operating these satellites from 24th November onwards was estimated to be 30 MAU, a cost which the meteorologists necessarily had to bear for 'bridging' the two programmes until MOP1 was launched, in principle in 1986/87.

Finally, 10 MAU was set aside for the Eumetsat secretariat and the same figure for 'contingency' expenditure by the new Organization. The former was calculated on the assumption that there would be a two-year interim period before the secretariat was officially set up and that it would cost 1 MAU/year thereafter until the end of the programme. The latter reflected the wish of the participating states to allow Eumetsat to engage in activities not foreseen in the operational programme - a point we shall return to below.

6.5 The scale of contributions

The scale of contributions of the states participating in the operational programme continued to be an extraordinarily thorny matter. The classical approach was to base this on GNP or, alternatively, on net national product (NNP).[210] However the automatic application of such a formula was strongly resisted by many countries. Some of the smaller countries wanted to restrict their contribution to a fixed sum per annum for fear that their share of costs would otherwise be beyond their means. (They also wanted all voting majorities in the convention decoupled from percentage contributions (i.e. they were against double two-thirds majorities) so as not to find their ability to influence the programme unduly reduced.[211]) In addition several countries were concerned about their low level of industrial return. Since the foreseen operational satellites were essentially 'Chinese copies' of their predecessors it was evident that the same industrial structure would be more or less retained: the consortium COSMOS with SNIAS (i.e. Aerospatiale) as prime contractor. This arrangement not only benefited France, but also made it very difficult for potential new arrivals (e.g. the Netherlands or Spain) to get much industrial work. These differences proved to be simply insoluble in 1981 and the Executive was invited to try to find a way to satisfy the different interests concerned.[212]

With Germany's decision to take part and the decision making process restarted, the Executive formally presented a new concept which had solicited considerable interest when discussed with some of the participating states earlier in the year. They suggested desegregating the budget and applying different scales to different parts of it depending on the interest that a particular state had in that activity.

Two types of scale were used, one *pro rata* to industrial return, the other *pro rata* to the NNP. The costs of satellite procurement, about 38% of the budget envelope, would be distributed *pro rata* to industrial return. The costs of programme management, ground segment and system exploitation, satellite insurance and the technical contingency, another 38%, would be distributed pro rata to the NNP of all the participating states (assumed to be 19) on the grounds that they would all benefit 'equally' from these activities. Finally the costs of launcher activities, the remaining 25% of the budget, would be shared *pro rata* to NNP for the eleven ESA Member States who had invested in the launcher programme.

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[210] GNP represents the value of all the goods produced and services rendered by the factors of production of a given country. It does not take account of capital depreciation; NNP does. A slightly modified version of NNP called NNP at factor cost was used to calculate scales in the ESA mandatory programme. See document *GNP, NNP and GDP scales of contribution*, MOPWG 5(81)47, 20/10/81 (ESA5497).

[211] Second meeting of the Group held on 26-27/3/81, MOPWG 2(81)21, 15/4/81 (ESA5530).

[212] For these issues see minutes of fourth MOPWG, MOPWG 4(81)44, 2/7/81 (ESA5528) and reports MOPWG 5(81)48, 16/11/81 (ESA5498) and *Brief Status of ...MOP Preparatory Activities and Plans*, undated but early January 1982 (ESA5542).

Country	NNP[1]	With Ind. Return[2]
Belgium	3.77	4.36
Denmark	2.11	1.76
France	17.98	27.28
Germany	23.73	23.06
Ireland	0.46	0.30
Italy	10.47	11.38
Netherlands	5.04	3.67
Spain	6.33	4.51
Sweden	3.57	2.33
Switzerland	3.35	2.56
United Kingdom	11.56	14.37
Austria	2.05	0.78
Finland	1.39	0.53
Greece	1.30	0.49
Luxembourg	0.17	0.06
Norway	1.47	0.56
Portugal	0.80	0.30
Turkey	2.20	0.84
Yugoslavia	2.25	0.86

Table II.2. Scales of contributions proposed by the Executive based on NNP only and on a weighted system which took account of industrial return.

Notes:

1. Column 2 assumes a wide participation and calculates contributions on Net National Income at Factor Cost only. Calculated by the Executive in August 1982 using NNP data for 1976-1978 – see MOPWG 6(82)53, 18/8/83 (ESA5501). An updated calculation based on NNP data for 1979-81 is in (ESA5537).
2. Column 3 is from the same source but has weighed satellite procurement *pro rata* to industrial return, launcher costs are shared between ESA member states according to NNP and the remaining services are shared by all participants *pro rata* to NNP.

A contribution scale based on this system, but using old NNP figures from 1976-1978 and preliminary estimates of programme costs and of industrial return, was provided by the Executive in August 1982. It is shown, along with the unweighted NNP calculations, in Table II.2.

The difference made by the weighted system is immediately apparent from Table II.2. The percentage contribution for a country like France, which gained major industrial returns from the programme, increased by 9%, while some smaller countries, or those with little or no industrial involvement, saw their contributions fall sharply: those of Norway or of Portugal, for example, fell by almost two-thirds while that of the Netherlands fell by about a quarter.

However illuminating this exercise was, however, it was quickly accepted by the institutional subgroup that there was no point in trying to fix a scale of contributions using a formula: France, for example, was obviously opposed to tying contributions to industrial return.[213] That granted, the subgroups decided that this decision which, even if partly informed by the data just provided, was essentially political and was best left to the intergovernmental conference.

[213] See MOPWG 6(82)58, 13/9/82 (ESA5540) and Lafferanderie's report on the same meeting, the 6th of the subgroup (ESA5541). For France see MOPWG 7(82)68, rev.1, 29/10/82 (ESA5511).

6.6 Institutional and legal instruments

The appropriate institutional framework for the future user's organisation, said the chairman of the MOPWG in his final report, "proved to be [the task] most difficult to carry out and the one that entailed the most work".[214] There were, it will be remembered, three alternatives. Some delegations felt that Eumetsat should be an independent organisation having its own legal personality and with the authority to receive and disburse funds on behalf of its members. Its directing body would be a Council that would meet periodically. Its executive would comprise a permanent secretariat of about a dozen people who would support the Council and monitor the programme being carried out by the operating agency or agencies. Against that there were delegations who were not at all keen to create new international organisations. They suggested that Eumetsat might be merged into an existing organisation, like the ECMWF. If this was not possible there was a third way. A new body could be set up, authorised to contract out the operational system to ESA, to the ECMWF, to Eurosat or whatever, but it was not to have legal personality. At the intergovernmental conference in January 1981 the Chairman summed up the debate on this issue in vague terms: "a consensus had been reached", said Sir John Mason, "for the establishment of a body that should be endowed with legal personality even though it might be more or less incorporated in an existing body".[215]

Sir John's definition of the consensus informed the first deliberations of the new institutional subgroup. At the end of March its most favoured solution was the setting up an independent body with its own legal identity and permanent secretariat which relied upon services provided at cost by the ECMWF in Bracknell.[216] The director of the Bracknell centre was not *a priori* against the idea and indicated that he could offer administrative and financial support to the tune of six to eight staff, though he had no office space to house the Eumetsat secretariat.[217] A draft convention for a small international organisation with its own legal personality and a draft agreement between the participating states and the ECMWF were produced.

In June 1981 however, the German delegation insisted that it was against the creation of a new international organisation. The subgroup thus felt obliged to formalise the legal texts creating an independent body that did not have its own legal personality. ESA's legal services produced a 'Eumetsat Agreement' in terms of which the 'Contracting Parties' simply established a Council to administer their affairs. This Council mandated another organisation to carry out the operational programme on its behalf. A draft complementary 'Arrangement' spelling out the terms of the relationship between the Council and the mandated organisation (assumed to be ESA for illustrative purposes) was also produced.

None of these issues had been resolved when the government of the Federal Republic finally decided to contribute to a European meteorological programme in July 1982. What is more, in the interim another possibility had entered the picture: having recourse to Eurosat for operating parts of the system (see above). The deadlock was broken at the end of September. The German delegation to the MOPWG aligned itself with the majority and accepted that Eumetsat be constituted as a new international organisation with its own legal personality and authorised to entrust the operational system to another agency.[218] With this decision taken the working groups rapidly converged on a consensus regarding the institutional and legal modalities of the new organisation.[219]

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[214] In his paper prepared for the intergovernmental conference, CONF/OP-MET/9, 9/2/83 (ESA5454).

[215] From the report of the institutional subgroup to the previous conference, CONF/OP-MET/7, 28/11/80 (ESA5452) and from the minutes of that meeting on 28-29/1/81, CONF/OP/MET/MIN/1, 18/2/81 (ESA5447). See also MOPWG 1(81)6, 4/3/81 and its Annex 1 (ESA5531) and, for the secretariat, MOPWG 2(81)11, rev.1, 8/4/81 (ESA5469).

[216] See Tessier's report on the second WG meeting, memo dated 31/3/81 (ESA5556).

[217] ECMWF DG's offer is in MOPWG 2(81)12, 25/3/81 (ESA5470). For the legal complications surrounding Eumetsat-ECMWF arrangements see the memo drafted by Stewart (apparently) and dated 15/5/87 (ESA5536). See also the report by the Institutional Subgroup to the March 1983 intergovernmental conference, CONF/OP.MET/11, 10/2/83 (ESA5456).

[218] For the FRG position memo Tessier on the meeting of the 6th MOPWG, 24/9/82 (ESA5555). In fact the official decision took longer than expected: in January 1983 it was still not formally taken, though it was evident that this was now only a question of days – see minutes of the 8th MOPWG meeting held on 17-18/1/83, document MOPWG 8(83)84 , 17/2/83 (ESA5524).

[219] At the last minute the Dutch delegation suggested that nothing change at all: that it was not really necessary to set up a new institution to organise the meteorologists and that one should consider continuing the operational programme using the existing arrangements inside ESA for the pre-operational programme. This option was not pursued – see the minutes of the meeting of the institutional subgroup on 9-10/9/82, MOPWG 6(82)58, 13/9/82 (ESA5540) and Lafferanderie's summary (ESA5541). The rapid development now may be gauged from the minutes of the successive meetings: 9-10/9/82, MOPWG

The first question resolved was that of the body to be mandated to operate the system. The Working Group could not see any particular advantage in having recourse to Eurosat. The use of the ECMWF also posed a number of practical problems. The convention of the Centre would have to be interpreted rather broadly to permit it to carry out such tasks, its staff and premises would need to be expanded and since the two activities, those of the ECMWF and of Eumetsat, would be supported by different constellations of member states, they would have to be hermetically sealed from one another administratively and financially. The Working Group thus decided that Eumetsat should entrust the operational system to ESA.

Two other related procedural decisions were taken. The first concerned the arrangements for the interim period between the signature and the ratification of the Eumetsat Convention. If the system was to function from end 1986/early 1987 it was necessary to place industrial contracts and to reserve launch slots immediately. The solution adopted was to make the Meteosat Operational Programme an optional ESA programme scheduled to last about two years and anticipating as much as possible the definitive programme. This programme would be under the control of a Programme Board whose structure and functioning resembled as much as possible that of the Eumetsat Council which would eventually succeed it when the Eumetsat convention came into force.

The second decision concerned the functions, organisation and cost of the Eumetsat secretariat. It was foreseen that this would ultimately comprise about ten people, including a satellite engineer and a space meteorologist, aided by two man-years of outside consultancy support.[220] However, the full complement would only be needed once the organisation came into being. In the interim period ESA would ensure many of the secretarial functions on behalf of the new body. During this time all that was needed then was a shadow Eumetsat secretariat of two meteorologists and a financial expert who would monitor the programme during its initial phases when, in fact, many of the major technical and financial commitments were made.[221] On 9th December 1982 the ESA Council accepted that the new Meteosat programme be carried out as an operational programme of the Agency and that in the interim period it be started as an ESA optional programme with its own Programme Board and small secretariat. Provision was made for non-member states of ESA to be members of this Board.[222]

All of these institutional arrangements were embodied in the appropriate legal texts. It is not our intention to analyse these texts in detail; what we would like to do, though, is to indicate some of those aspects pertaining specifically to the interface between ESA and the meteorological community and its representative bodies.

Firstly, there was the question of whether or not ESA should have a monopoly over the operational system. At the end of 1982 there was considerable reluctance to give the Agency such a role, particularly in the light of ongoing friction over the management and costs of the ground segment. The UK delegation to the MOPWG meeting in November was quite explicit about this: one should not take it for granted that "all the elements of the programme had to be considered as tasks definitely entrusted to the Agency" and the Eumetsat Council would need to be legally empowered to mandate another body to take over this part of the work, which would only begin in 1987 anyway.[223] Nothing quite as explicit emerged in the final legal documents though some provision was made for Eumetsat to develop other meteorological observation systems which made use of space techniques, e.g. a network of drifting buoys or a constant-altitude balloon system, in which tracking and data collection would be performed by satellite.[224]

6(82)58, 13/9/82 (ESA5540), 20-21/9/82, MOPWG 7(82)68, rev.1, 29/10/82 (ESA5511), 20-22/10/82, MOPWG 7(82)73 (ESA5515), 8-10/11/82, MOPWG 7(82)76 (ESA5517)

220 See MOPWG 7(82)70, October 1982 (ESA5513), the discussion at the MOPWG's 7th meeting, MOPWG 7(82)76, 22/11/82 (ESA5517) and CONF/OP-MET/16, 9/2/83 (ESA5461).

221 For the interim unit see MOPWG 8(82)77, 2/12/82, 6/12/82 (ESA5518) and MOPWG 8(83)82, 13/1/83 (ESA5523)..

222 The resolution is ESA/C/LVI/Res. 2 (Final).

223 See the UK intervention at the MOPWG meeting on 8-10/11/82, MOPWG 7(82)76, 22/11/72 (ESA5517). This freedom was quite explicit in the draft Eumetsat Agreement, i.e. the document assuming that it would not have legal personality - see Arts 5.2.a(iv) and 5.2.b(vii), MOPWG 4(81)34 rev.3, 13/9/82.

224 The meteorologist's new ideas were defined in the final report of the institutional subgroup, CONF/OP-MET/11, 10/283 (ESA5456).

The powers of the Programme Board/Eumetsat Council and its interface with ESA also deserve some comment. On the one hand the Board exercised considerable autonomy vis-à-vis ESA. For example it was authorised to approve the award of major industrial contracts, taking the place of the Industrial Policy Committee in this regard. At the same time the Board and its secretariat were given the opportunity to shape ESA activities which directly affected the users. The secretariat, for example, was to be kept "fully and promptly informed of the progress of the work" entrusted to ESA and could "take part in meetings that [were] important for the execution of the programme". The Board, for its part, was to give advice "on the Agency's research and development work in the field of meteorological satellites".[225]

Of course, with the passage of time some of these provisions, which obviously reflected the perception of the ESA/Eumetsat relationship in 1983, needed looking at again. The provisions for the start of new programmes was a crucial case in point. The requirement in the convention that new programmes needed unanimity, as well as the lack of a generally applicable algorithm for calculating scales of contributions were later to be regretted (Eumetsat reverted to GNP for all programmes after the MOP). The precise roles of the two bodies in the development of new technologies also required clearer definition. The conclusion finally agreed was that Eumetsat would define its technical requirements in consultation with ESA and that ESA would be given first refusal to develop a prototype satellite meeting these requirements. Eumetsat would seek alternative means of achieving its objectives only if the two organisations failed to reach a mutually satisfactory agreement.[226]

7. The second intergovernmental conference, the plenipotentiary conference and the birth of Eumetsat

The intergovernmental conference was reconvened by its Chairman, Sir John Mason, on the 21st to 23rd March. The overall tone of the opening statements by the delegations was extremely positive and led those present to hope that the conference of plenipoteniaries to sign the Eumetsat convention could be held two to three months hence. Only three issues related to the draft Eumetsat convention proved controversial

The first concerned the seat and official languages of the new organisation. Germany, appealing to its significant contribution to the programme, offered to house Eumetsat in Darmstadt or Offenbach, while France indicated that its government would like to see the headquarters in Paris. The FRG delegation also wanted German to be one of the official languages, whereupon Italy said that if languages other than English and French were sanctioned Italian would have to be included too. These manoeuvres are of course typical when a new European organisation is being set up. More interesting in this case is that the conference refused to allow them to block progress. It was decided that if France and Germany could not reach agreement the Eumetsat convention would simply state that its headquarters would be on the ESA premises in Paris and that its final location would be a matter for the Eumetsat Council to decide. Conference also agreed that the usual two official languages would be used, but that the same Council would decide on the working languages when it first met.

The conference in March resolved two other difficult, interconnected issues: the scale of contributions and the percentages required for the start up of the programme and the ratification of the convention. These issues had in fact threatened to jeopardise the calling of the meeting. A count made of contributions in November 1982 reached only 77% of firm commitments – and conference Chairman Mason felt that there was no point in reconvening unless the pledged contributions amounted to 85%. [227] Two items of good news followed. Meeting together on 10th December in Paris the German and French Ministers of Transport agreed to propose to their respective governments an increase of 1.5% in their contributions potentially bringing both up to 22% and the total to just over the 80% threshold. Then in

[225] The quotations are from the (draft) Implementing Rules, ESA/C(83)WP/3, rev.2, 8/3/83, Art. 3.1 and Art. 4.2.

[226] From J. Morgan, "Eumetsat. the European Organisation for Meteorological Satellites", in the *Proceedings of the ESA/EUI International Colloquium, The Implementation of the ESA Convention. Lessons from the Past* (Dordrecht: Martinus Nijhoff, 1994).

[227] See letter Mason to Lingelbach, 22/11/82 (ESA5543).

mid-January Spain let it be known that she would contribute with 4.5%: the 85% total required by Sir John was within reach.[228]

Matters did not quite turn out that way at the intergovernmental conference in March, however. A first 'tour de table' brought forth total commitments amounting to about 82% of the costs of the programme, the major contributors being France (22%) and Germany (19%, though she "did not rule out the possibility that fresh efforts might shortly enable [the delegation] to raise the figure to 21%"). In the light of this situation, two delegations, those from Italy and the Netherlands, promptly reduced their previous offers (by 1.4% and 0.45%, respectively), on the grounds that the costs-to-completion of the operational programme were far from covered. The scale of contributions then agreed (see column 4, Table II.3) barely crossed the 80% threshold and left 19.72% to be found.

The shortfall in contributions immediately triggered a debate about the provisions that should apply for the start of the programme and the ratification of the Convention. The Executive pleaded that both be possible with 80% of the contributions guaranteed: other Agency programmes had begun with shortfalls, the commitments were the minima for some countries and it was most likely that others would join over the passage of time. It would be fatal to stop the programme start-up by setting unrealistic thresholds. Not all delegations agreed and various figures ranging from thresholds of 80% to 90% were bandied about. In the event the conference agreed that the programme could get under way with 80% of the contributions guaranteed but that 85% of the contributions would have to be assured for the Eumetsat Convention to enter into force.[229]

The conference of plenipotentiaries for the signature of the Eumetsat Convention was held in Geneva on 24th May 1983.[230] It was attended by representatives from 16 European countries (see Table II.1 – Austria, Luxembourg and Yugoslavia were not represented). Twelve of them announced that they would contribute to the programme at the levels shown in the second last column of Table II.3. Germany had increased her contribution by 2%, bringing it closer to France's. The Dutch and the Italians had also decided to make a greater effort and two new countries (Norway and Turkey) had decided to participate. Finland and Ireland and also Denmark and Greece, had indicated their intention to participate.[231] With just over 85% of the contributions guaranteed work could start on the operational meteorological satellite programme with the knowledge that the creation of Eumetsat now only waited on parliamentary ratification.

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[228] See the report by the chairman of the institutional subgroup, MOPWG 8(83)82, 13/1/83 (ESA5523) and hand- written memo by Tessier, 17/1/83, 18h30 (ESA5557). Also Spanish intervention at the 8th meeting of the MOPWG held on 17-18/1/83, MOPWG 8(83)84, 17/2/83 (ESA5524).

[229] For the debate see items 5 and 6 in the conference minutes, CONF/OP-MET/MIN/2, meeting held on 21-24/3/83, document dated 8/4/83 (ESA5446).The Convention as adopted is CONF/OP-MET/12, rev.3, 24/3/83 and its corr. 1, 19/4/83 (ESA5457), while the terms for the start up are in the Interim Arrangements, covered by draft declaration CONF/OP-MET/14, Annex II, rev. 1, 24/3/83, attached to ESA/C(83)46, 24/3/83. A summary of the proceedings is in ESA/PB-MET(83)8, 12/4/83.

[230] See the draft minutes by Lafferranderie, 4/10/83 (ESA5546) and his memo 26/5/83 (ESA5546).The (draft) Final Act of the conference of plenipotentiaries is CONF/OP-MET/15, rev.1, 24/3/83 (ESA5460).

[231] See memo Lafferranderie, 26/5/83 (ESA5546).

Country	NNP[1]	With Ind. Return[2]	IGC March '83[3]	Prep[y] Conf. May '83[4]	Eumetsat Aug. '86[5]
Belgium	3.77	4.36	4.00	4.00	4.40
Denmark	2.11	1.76			0.58
France	17.98	27.28	22.00	22.00	25.60
Germany	23.73	23.06	19.00	21.00	26.39
Ireland	0.46	0.30			0.11
Italy	10.47	11.38	10.00	11.00	12.00
Netherlands	5.04	3.67	2.55	3.00	3.00
Spain	6.33	4.51	4.50	4.50	5.24
Sweden	3.57	2.33	0.93	0.93	0.93
Switzerland	3.35	2.56	2.60	2.60	3.03
United Kingdom	11.56	14.37	14.40	14.40	16.76
Austria	2.05	0.78			
Finland	1.39	0.53			0.35
Greece	1.30	0.49			0.30
Luxembourg	0.17	0.06			
Norway	1.47	0.56		0.50	0.50
Portugal	0.80	0.30	0.30	0.30	0.30
Turkey	2.20	0.84		0.80	0.50
Yugoslavia	2.25	0.86			
TOTAL	**100**	**100**	**80.28**	**85.03**	**99.99**

Table II.3. Various scales of contributions proposed or adopted at successive phases of the operational programme.

Notes:

1. Column 2 assumes a wide participation and calculates contributions on Net National Income at Factor Cost only. Calculated by the Executive in August 1982 using NNP data for 1976-1978 (see MOPWG 6(82)53, 18/8/83 ESA5501). An updated calculation based on NNP data for 1979-81 is in (ESA5537).
2. Column 3 is from the same source but has weighted satellite procurement *pro rata* to industrial return, launcher costs are shared between ESA member states according to NNP and the remaining services are shared by all participants *pro rata* to NNP.
3. Column 4 gives the firm contributions promised at the intergovernmental conference in March 1983, totalling 80.28% (from CONF/OP-MET/12, rev. 3, 24/3/83 (ESA5457)).
4. Column 5 gives the contributions agreed at the conference of plenipotentiaries on 24 May 1983, totalling 85.03%, memo Lafferranderie, 26/5/83 (ESA5546).
5. Column 6 gives the revised scale adopted by the Eumetsat Council meeting in August 1986. The scale was to apply from 1987 (from Eumetsat Annual Report, 1986/7, p. 45).

Improved industrial returns undoubtedly affected the German and Dutch decisions to increase their share of the costs of the programme. Certainly most of the firms involved had been used for the pre-operational satellites and were responsible for the same tasks. The ESA Executive had made some significant changes, however. In Germany ERNO had replaced an American supplier for the thrusters, AEG had been chosen for the solar generator and ATN (previously Siemens) would build the new transponder. In the Netherlands Fokker had replaced Matra for manufacturing the radiometer structure. The new distribution of tasks is shown in Figure II.3.[232]

A brief word by way of conclusion. The Eumetsat convention finally entered into force on 19th June 1986, five years to the day after the launch of Meteosat F2 and no less than 17 years after the Directors of the meteorological services had formed their first 'Ad-hoc Group on Space Meteorology'. At this time the cost-to-completion of the programme was still only 86% covered. The problem was resolved a few months later at the second meeting of the Eumetsat Council in August 1986. The member states agreed to increase their contributions to make good the deficit, with the results shown in the last column of Table II.3.[233] Significant increases in contribution were registered for Germany (+4.39%), who had won the battle to have the Eumetsat headquarters in Darmstadt, for France (+3.6%), who had a major industrial interest and a satellite team kept intact and gaining experience in Toulouse and for Britain (+2.36%), who had one of her meteorologists, John Morgan, appointed the first Director of Eumetsat.

8. Closing remark: why the sudden acceleration?

The rapid evolution of events between September 1982 and March 1983 and the success of both the reconvened intergovernmental conference and the conference of plenipotentiaries give us pause for thought. The shift from a pre-operational to an operational system and the corresponding shift in responsibility from research and development agencies and budgets to the meteorologists and their ministries, ground to a total halt at the end of 1981 after over a decade of debate and five years of intense deliberations. 18 months later Eumetsat was born. Why this change of pace, why this acceleration in the decision making process?

Germany's decision to participate, which was both financially and politically important, was obviously one key factor. There were also pressing technical arguments. It was important to have the plenipotentiary conference before the end of June 1983, for example. The Ariane launcher cost was governed by a convention between ESA and Arianespace which was due to expire at the end of that month. Arianespace let it be known that it would launch the three operational satellites at a preferential fixed price based on that convention if the launch contract was signed before 1st July 1983; after that date normal market prices would apply. There was also a need to avoid a gap in operations when the current protocol expired on 23rd November 1983, which meant making firm commitments to staff and to computer suppliers by the end of May. These arguments apart, there are others of a more general character which must not be forgotten.[234]

Firstly, there is no doubt that in the early 1980s meteorological satellites 'came of age' as a technology. Meteorological services, initially sceptical about making the major investments required in both the space and ground segments, were now convinced of the value of space-based data, seeing them as "one of the fundamental components of their observation system".[235] Ironically, the partial failure in orbit of Meteosat-1 might have helped this process along. As Eumetsat Director John Morgan put it recently, "At the time it seemed as if this gap in services might arouse some doubts as to the reliability and risks of the

[232] From ESA/PB-OM(83)3, 7/6/83 (ESA5463). A new British firm IGC also entered the scheme as co-contractor for a new task, central parts procurement. CASA (Spain) was another new arrival, having been awarded the apogee booster motor adaptor after industrial competition.

[233] This material from the Eumetsat annual report for 1986/87, pp. 14, 45.

[234] See the memo *Reasons for keeping to the June deadline*, CONF/OP-MET/INF.2, rev.1, 22/3/83 (ESA5547) and the letter from C.A. Daoud (Arianespace) to W.Thoma (ESA), 26/10/82 (ESA5566).

[235] According to the French delegate to the March conference, CONF/OP-MET/MIN/2, 8/4/83 (ESA5446).

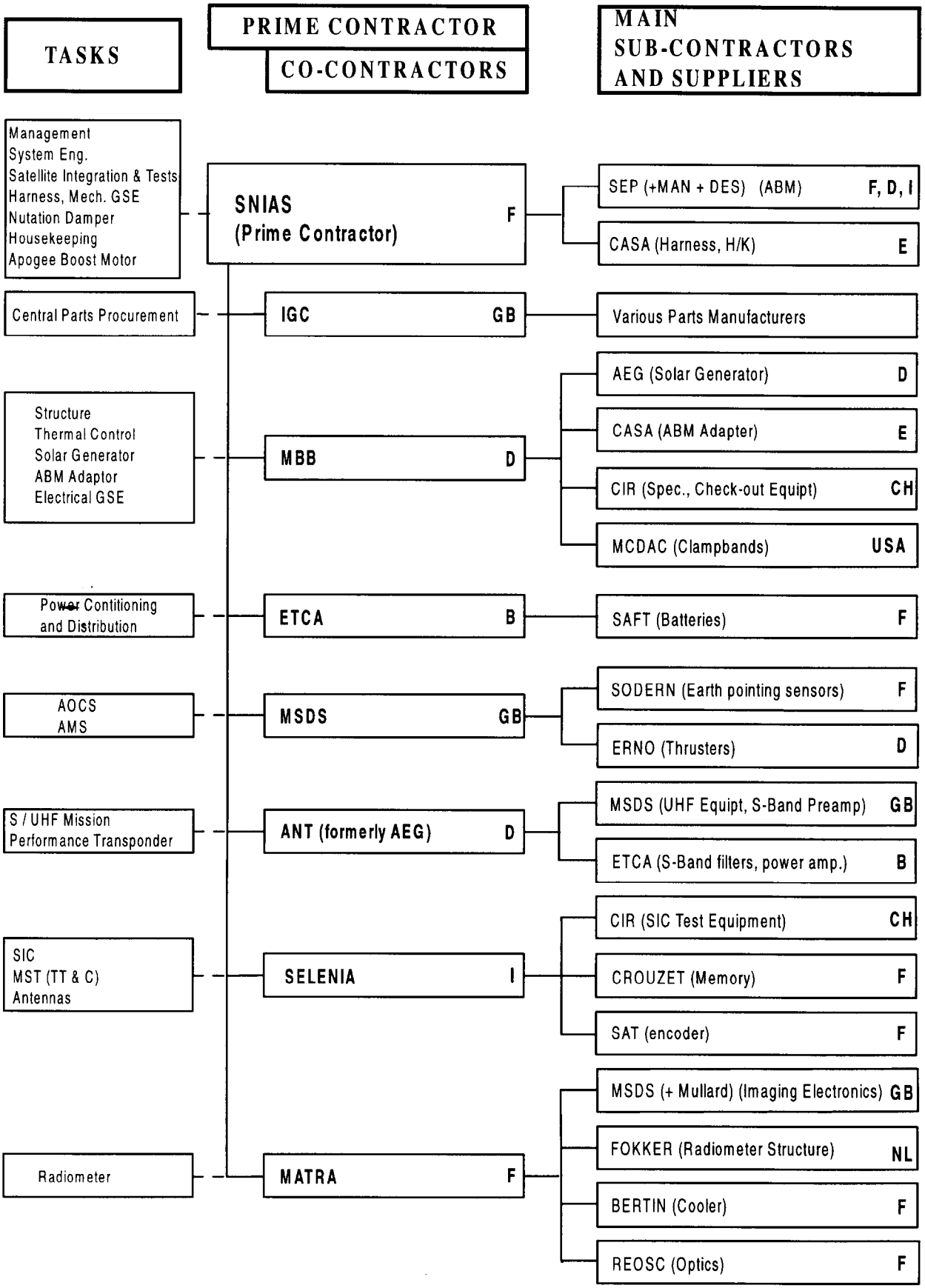

Figure II.3. The industrial set up of the consortium, prime contractor Aerospatiale, proposed for building the operational satellites and their payloads in June 1983 (ESA/PB-OM(83)3, Annex II, 7/6/83, ESA(5483)).

technology, but in fact it seemed to help persuade the meteorological services that a fully operational service was needed, with full in-orbit redundancy".[236] Be that as it may, there was nothing like a successful demonstration of the product. The Finnish delegation to the intergovernmental conference in March explicitly tied his country's decision to participate in the programme to the demonstration organised three months before in Helsinki, with the active participation of the Finnish Meteorological Institute. This showed convincingly, he said, "the usefulness of Meteosat data for our purposes".[237]

But it was not only weathermen 'on the ground' who now wanted satellite data: it was also scientific researchers. Indeed the final version of the Eumetsat convention explicitly made reference in its preamble, to the value of "space technologies applicable to *meteorological research* and weather forecasting" (our emphasis). This research dimension was evident from the active and growing interest of scientific users in the products of Meteosat. ESA organised a number of meetings of this constituency not only to extend the base of support for the programme in the participating states but also to improve the products and to adapt them better to scientific users' needs. The first of such meetings was held in Darmstadt in June 1979 and attracted 48 scientists from eleven countries, 21 from Germany. The second was held in London in March 1980 and attracted 77 scientists from nine countries, including again 21 from Germany and 38 from the UK. This strong scientific interest in satellite data for medium to long-range forecasting was expressed institutionally at a European level in the ECMWF. And it was surely one important consideration persuading the German cabinet to participate in the operational programme. In his opening statement to the intergovernmental conference the German delegate immediately "stressed the progress achieved in exploitation of [Meteosat's] data *for research work purposes* and for applications with very diverse objectives" (our emphasis).[238]

Developments in the USA also surely accelerated the European process. Of particular importance was the Regan administration's interest in commercialising the products of meteorological satellites (a clear sign of the coming of age of the technology). Indeed, as we saw above, in March 1983 it was announced that the President had decided that deregulation should extend to this sphere. The move away from what Sir John Mason called "the sacred principle of the free exchange of data and products" caused great concern in Europe. At the same time the threat that one might have to buy data also gave an enormous boost to the European operational programme. If the US government was to reduce its share in the global meteorological system, leaving the scope of weather coverage provided by the USA to be determined by market forces, it was clearly preferable to spend money on a European system than to buy American. By developing such a system one might not only put a brake on this process before it took root. One could also strengthen one's bargaining position vis-à-vis the USA by showing unambiguously that "Europe intends to take part in the global observing system and to provide meteorological data from satellites to the African and Middle East countries", so capturing markets and winning political influence.[239]

Another factor to consider is the enormous effort made to promote the operational system by the ESA executive and by Tessier and Lafferranderie in particular. As Tessier put it in a memo to his DG Quistgaard in March 1983, "It must be remembered that two years ago the meteorologists were opposed to the execution of the METEOSAT Operational Programme by ESA. Due to the permanent effort and professionalism of some ESA staff members", his memo went on, "the meteorologists have reconsidered their position and the Agency is regaining their confidence".[240] In fact, as we pointed out above, as early as 1978 DG Gibson was concerned by the deterioration of the relationships between the two communities, the meteorological services seeming to want to dispense with the Agency's services as soon as possible. Things were improved but still delicate by the end of 1980. The Mittner subgroup reporting

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[236] J. Morgan, "Eumetsat. the European Organisation for Meteorological Satellites", in the *Proceedings of the ESA/EUI International Colloquium, The Implementation of the ESA Convention. Lessons from the Past* (Dordrecht: Martinus Nijhoff, 1994), p. 168.

[237] On the Finnish demonstration see the memo from R. Wolf (ESOC) to the Meteosat Promotion Group, 14/12/82 (ESA5543). The quotation is from the minutes, CONF/OP-MET/MIN/2, 8/4/83 (ESA5446).

[238] For the scientific users meetings see the reports ESA/PB-MET(79)21, 3/9/79 (ESA3631) and ESA/PB-MET(80)17, 22/4/80 (ESA3656). The German delegation' statement is in CONF/OP-MET/MIN/2, 8/4/83 (ESA5446).

[239] Sir John's comment was made, significantly, in his opening address to the March 1983 intergovernmental conference, see CONF/OP-MET/MIN/2, 8/4/83 (ESA5446). See also the memo *Reasons for keeping to the June deadline*, CONF/OP-MET/INF.2, rev.1, 22/3/83 (ESA5547).

[240] See memo Tessier to Quistgaard, 10/3/83 (ESA5555).

to the first intergovernmental conference with one eye on the running of the ground segment, remarked that "it might be preferable not to ask the Agency to execute all the tasks that the programme would comprise, since some of them might be carried out at less cost by other bodies, certain of them perhaps by the Meteorological Services themselves".[241] By March 1983 trust had been rebuilt by the Executive's willingness to listen to the meteorologists' point of view and to devise a charging and management system for the ground-segment which recognised that their concerns were justifiable and had to be seriously taken into account. Previously ESA seemed to be rather arrogantly indifferent to the requests of the user community. Now, through the enormous efforts and hard work of Tessier and Lafferranderie, it was seen as treating the users as a 'customer' whose wishes had to be respected and who had to be helped in every possible way to bring their system to fruition.

Finally, to understand the rapid agreement reached between September 1982 and March 1983 we must not overlook the political dimension. It was not simply that Germany decided to participate, so guaranteeing, along with France, about 50% of the programme costs. It was also a question of consultation and discussion at the highest levels of power: the meeting between the two Ministers of Transport in Paris in December 1982 is symptomatic of this. In other words the accelerated progress made at the end of 1982 was not simply linked to German willingness to participate, it was not simply a question of money, of pooling resources in a European collaborative effort. The programme in the two countries became identified with Franco-German political collaboration in the European theatre, an element of the foreign policies of both. The launch of the Meteosat operational programme and the creation of Eumetsat, when they finally took place, confirm what former French Research Minister Hubert Curien once said: that you can get nothing done in Europe unless France and Germany agree.

Acknowledgement

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[241] Mittner subgroup report to January 1981 conference, CONF/OP-MET/7, 28/11/80 (ESA5452).

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