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**DIRECTORATE OF
INTELLIGENCE**

Intelligence Memorandum

The Intelsat System: Growth, Problems, and Prospects

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ER IM 72-45
March 1972

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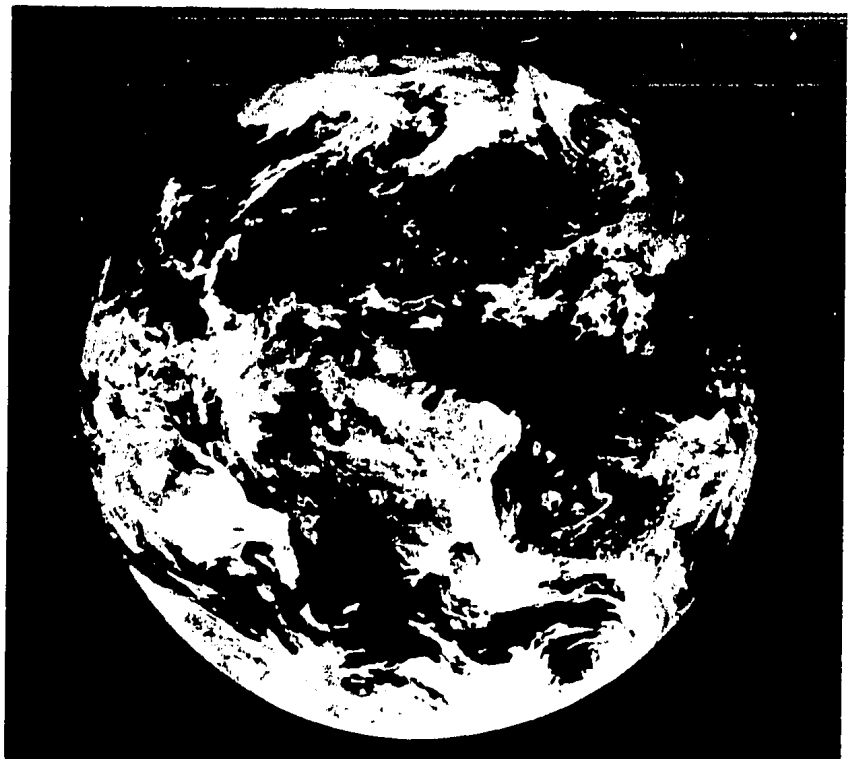
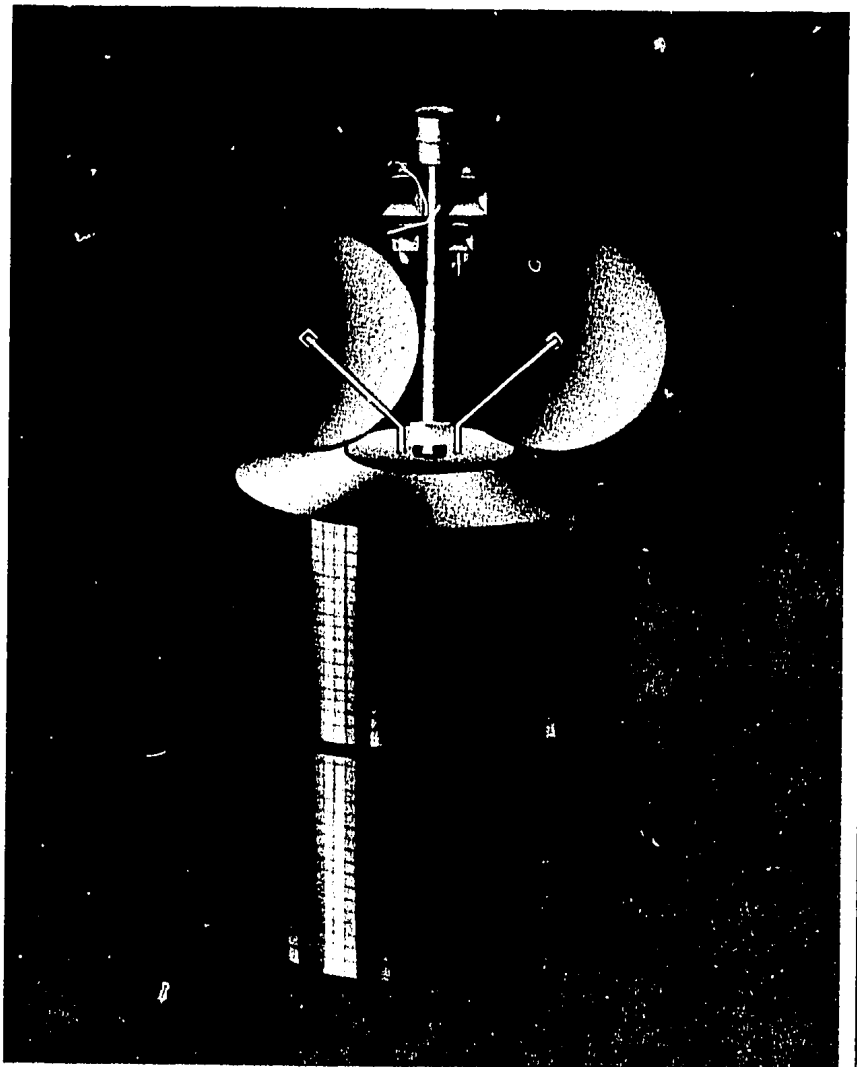
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INTELSAT IV SYSTEM SUMMARY

Channel capacity	
Telephone only	9,000
Television only	12
Multiple access capability	Yes
Weight (pounds)	1,587
Design lifetime (years)	7
Frequencies (gigahertz)	
Uplink	6
Downlink	4
Number of repeaters	12
Bandwidth per repeater (mega- hertz).	36
Effective radiated power per re- peater (watts depending on antenna beamwidths).	200 to 4,000
Total effective radiated power (watts depending on antenna beamwidths).	2,100 to 25,200
Stabilization method	Despun antenna
Contractor	Hughes Air- craft Com- pany
First launch	25 Jan 71
Launch vehicle	Atlas Centaur



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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
March 1972

INTELLIGENCE MEMORANDUM

**THE INTELSAT SYSTEM:
GROWTH, PROBLEMS, AND PROSPECTS**

Introduction

1. Since its formation in 1964, the International Telecommunications Satellite Consortium (Intelsat) has grown from a North Atlantic-oriented organization of 11 member countries with five earth stations and one 240-channel communications satellite (comsat) to a global system currently numbering 83 members, 52 earth stations, and many satellites with thousands of communications channels. Intelsat has operated under an interim charter, and negotiations leading to permanent arrangements have been long and arduous. The primary areas of disagreement have been over the West European attempts to reduce US influence within the organization and the role of regional comsats in the Intelsat system. This memorandum assesses Intelsat's growth, structural changes, major problems, and future prospects.

Discussion

Background

2. A revolutionary new era for communications began in July 1962 with the launching by the United States of the first active communications satellite, the AT&T-built Telstar I. Following Telstar a number of other experimental comsats were orbited. These experiments demonstrated the feasibility of using comsats for long-distance transmission of telephone and

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television traffic and the practicality of positioning them in a geostationary orbit.⁽¹⁾

3. Comsats possess several advantages over high frequency (HF) point-to-point radio and submarine cable, the only other means of transoceanic telecommunications. The latest comsat can provide up to 9,000 voice channels, compared with 845 for the latest transatlantic submarine cable and only a few for HF radio links. Also comsats are the only means for transmitting television across an ocean. They compare favorably with submarine cables in reliability and signal quality and are far superior to HF radio in both respects. Comsats permit simultaneous links between many different points, while submarine cables can directly link only two points.

Intelsat

4. Intelsat was formed on 20 August 1964 "to establish a single global commercial communications satellite system" open for use by all nations. It finances and coordinates the development and operation of the system's space segment -- comsats and their tracking, telemetry, and control stations. Intelsat buys comsats built to its specifications from private firms (principally Hughes Aircraft Co.) and has them launched by NASA on a cost-reimbursable basis. Intelsat also is responsible for the leasing of circuits⁽²⁾ through the comsats to both members and non-members of the Consortium. The ground stations are owned and operated by individual member countries, rather than the Consortium, although the latter sets technical standards for them.

5. Intelsat is financed by the space segment charges levied for leasing circuits through the satellites and the investment quotas assigned to each member. The amount of the investment is proportionate to the member's use of the system, while the space segment charge is set to cover operating expenses, amortize the investment quotas, and provide a reasonable return on investment. Net investment in Intelsat now totals more than \$230 million, and operating revenues in 1971 amounted to about \$78 million.

6. Intelsat's 83 members include all of the developed countries and most of the less developed countries of the non-Communist world (see

1. By orbiting the earth with the same speed and direction as the earth rotates, a geostationary satellite remains fixed over one point on the earth's equator. From the satellite's altitude of 22,500 miles, one-third of the earth is constantly visible. Only three geostationary comsats are therefore needed to provide worldwide coverage.

2. Members lease "half circuits" (the uplink and downlink between their earth station and the satellite).

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Figure 1). Yugoslavia is the only Communist member.⁽³⁾ The USSR, although not a member, will soon use the Intelsat system in connection with a new Moscow-Washington "hot-line" arrangement, and Czechoslovakia and Hungary each lease one Intelsat half-circuit on full time. The People's Republic of China (PRC) is continuing to use the transportable earth station installed for President Nixon's visit but is unlikely to join the Consortium as long as Taiwan remains a member.

The Space Segment

7. A spectacular growth in the space segment of the system (see the table) has accompanied the rapid expansion of Intelsat membership. Early Bird (Intelsat I), the world's first commercial comsat, was launched in April 1965. It was limited to relaying either 240 voice channels or one television channel, and its coverage was restricted to the North Atlantic region; nevertheless, its channel capacity nearly equaled that of all the then existing transatlantic submarine cables combined.

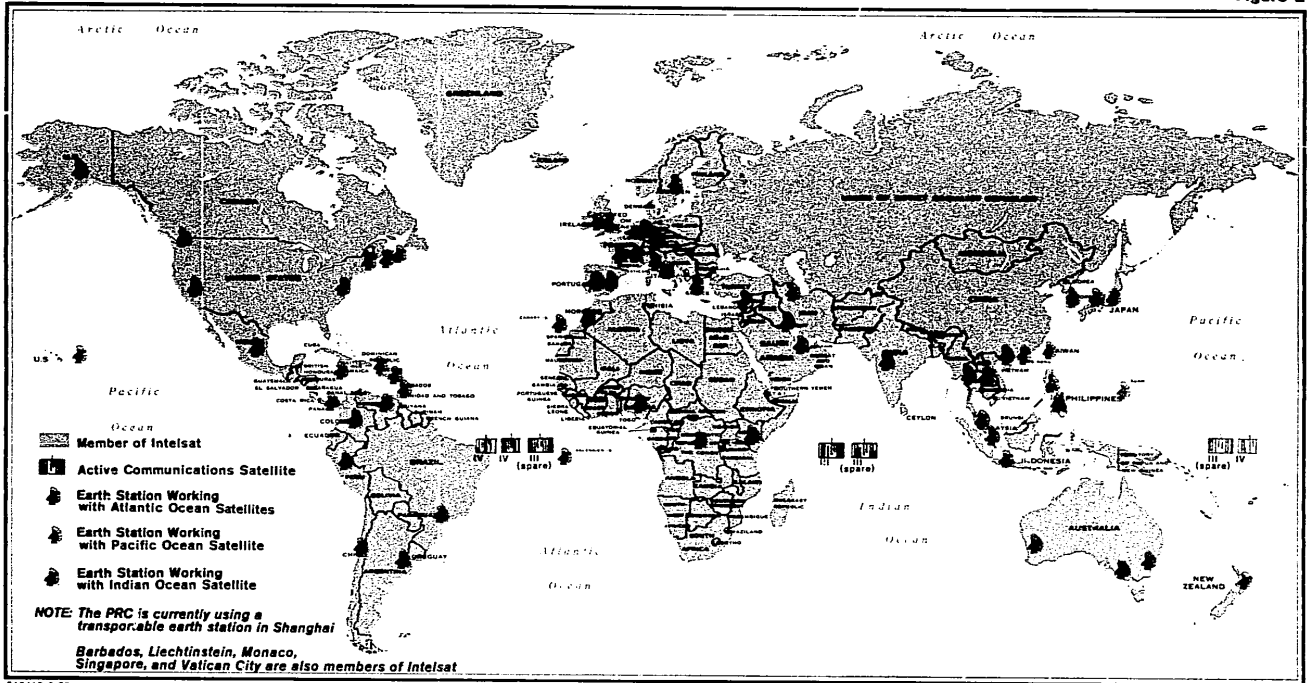
8. The Intelsat II series had the same channel capacity as Early Bird but could cover both northern and southern hemispheres and had multiple access capability -- that is, three or more earth stations could work with the satellite simultaneously. Four Intelsat II satellites were launched between October 1966 and September 1967. The first was lost when it failed to attain proper orbit; one was stationed over the Atlantic Ocean, and two were placed over the Pacific. None are currently in use, although all three could be activated if needed.

9. The Intelsat III satellites had a capacity of 1,200 voice channels or four television channels, multiple access capability, and a design lifetime of five years. Moreover, they provided global coverage and were the first comsats capable of passing telephone, television, telegraph, data, and facsimile traffic simultaneously. Eight of these satellites were launched between September 1968 and July 1970. The first and fifth failed to achieve orbit; the third malfunctioned, reducing its capacity by about one-half; the seventh had to use two-thirds of its stationkeeping fuel to achieve synchronous orbit, thus reducing its expected lifetime to three years; and the eighth failed to transmit. The remaining three have performed perfectly. Of the four Intelsat IIIs still in working order, one is in active use and three are spares-in-orbit.

3. Agreements formally establishing Intersputnik, the Soviet-sponsored international comsat system, were signed recently in Moscow. Its signatories include the USSR, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, Cuba, and Mongolia. No satellites have yet been launched under the aegis of Intersputnik.

The Intelsat System: Members, Satellites, and Earth Stations, March 1972

Figure 1



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Comparison of Intelsat Communications Satellites

	Intelsat			
	I	II	III	IV
Channel capacity				
Telephone only	240	240	1,200	9,000
Television only	1	1	4	12
Multiple access capability	No	Yes	Yes	Yes
Weight (pounds)	85	191	334	1,587
Design lifetime (years)	1.5	3	5	7
Frequencies (gigahertz)				
Uplink	6	6	6	6
Downlink	4	4	4	4
Number of repeaters	2	1	2	12
Bandwidth per repeater (megahertz)	25	130	225	36
Effective radiated power per repeater (watts)	10	35	150	200-4,000 ^{a/}
Total effective radiated power (watts)	20	35	300	2,400-25,200 ^{a/}
Stabilization method	Despun antenna	Despun antenna	Despun antenna	Despun antenna
Contractor	Hughes Aircraft Company	Hughes Aircraft Company	TRW	Hughes Aircraft Company
First launch	6 Apr 65	26 Oct 66	18 Sep 68	25 Jan 71
Launch vehicle	Thrust augmented Delta	Thrust augmented improved Delta	Long-tank Delta	Atlas Centaur

^{a.} Depending on antenna beamwidths.

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10. Intelsat IV, the latest series, has the capacity for either 9,000 voice channels or 12 television channels, a design life of seven years, and multiple access. Also, it has two spot beam antennas which, by concentrating the satellite signal on small areas of the earth, increase the number of channels that can be transmitted to those areas with reduced danger of interference with other radio emissions. The first Intelsat IV, launched in January 1971, is now operational in the Atlantic Ocean region. The second in the series, launched in December 1971, also is positioned over the Atlantic. The third was launched in January 1972 and placed in orbit over the Pacific in time to relay television, radio, and message traffic during President Nixon's visit in China. Current plans call for an Intelsat IV to be positioned over the Indian Ocean in 1973.

The Ground Segment

11. The ground segment of the system has undergone equally rapid expansion from five earth stations in 1964 to a current count of 52 with a total of 61 antennas. They are distributed among 38 countries on six continents.⁽⁴⁾ Expansion has been facilitated by a reduction in cost from \$11 million for the earliest stations to about \$4.5 million for the most recent ones. (For an earth station used in the Intelsat system, see Figure 2.)

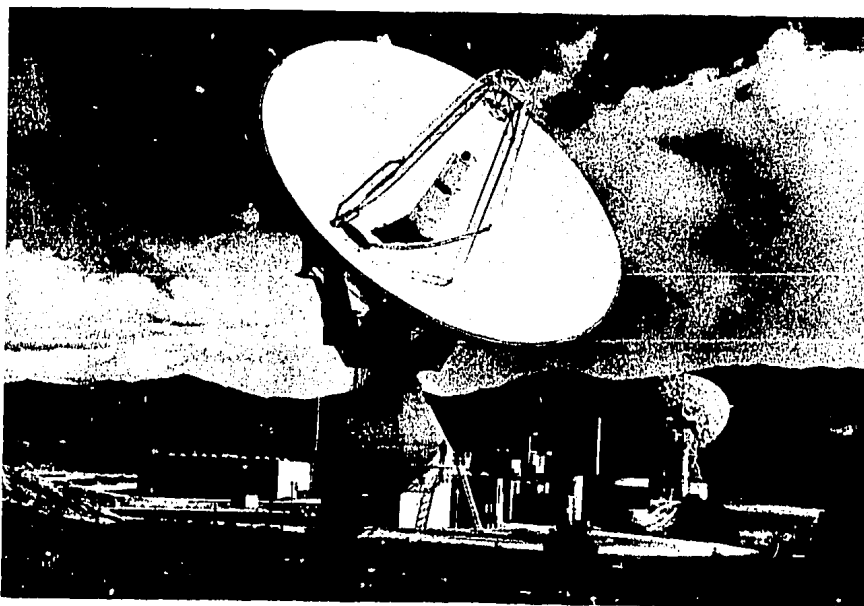


Figure 2. Intelsat Earth Station at Buitrago, Spain. The antenna in the foreground communicates with North and South American countries through one of the Atlantic Ocean satellites. The antenna in the background communicates with African and Asian countries through the Indian Ocean satellite.

4. These data do not include the transportable earth station now in use in the PRC.

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12. International bidding to construct earth stations has become very competitive. In addition to several US firms (General Telephone and Electric International, Page Communications, Philco, Raytheon, TRW, and Hughes), a number of foreign companies have built or are now building them. The most prominent are Nippon Electric Company and Mitsubishi of Japan, Marconi of the United Kingdom, Telespace of France, Siemens of West Germany, and Consorzio per Sistemi di Telecomunicazioni via Satelliti (STS) of Italy. In recent years the Japanese have been particularly successful in underbidding other earth station suppliers.

Use of System

13. Use of the Intelsat system also has grown rapidly. The number of circuits leased on full time rose from only 66 in 1965 to about 750 in 1968 and again to almost 2,200 by the end of 1970. Growth in 1971 was at a substantially lower rate.

14. Almost 80% of Intelsat channel usage is telephony; most of the remainder is record traffic (telegraphy, data, and facsimile). Television transmission still accounts for slightly less than 2% of Intelsat traffic but is increasing rapidly. Approximately 80% of all Intelsat traffic is between the world's developed countries - 60% of it is concentrated in the Atlantic Ocean region. Slightly more than 40% of all Intelsat traffic is accounted for by the United States alone. This pattern probably will shift somewhat as the less developed countries upgrade their national telecommunications systems and more of them acquire satellite earth stations.

Problem Areas

The Definitive Intelsat Agreements

15. One of the Consortium's most serious problems has been to obtain acceptance by its membership of a permanent charter or -- in Consortium parlance -- a set of definitive agreements. Since its creation in 1964, Intelsat has been operating under interim arrangements that provide for a dual-body policy and management structure. Policy is set by the Interim Communications Satellite Committee (ICSC), which consists primarily of representatives from those member nations making the most use of and having the largest investment in the system. Voting quotas in the ICSC have been allocated on the same basis, so that the United States has been far and away the single most powerful member of the Committee. The second body, known as the Manager, has been responsible for operations -- from overseeing the design, building, and launching of satellites to monitoring and controlling their activity in orbit. This post has been filled by the Communications Satellite Corporation (Comsat), a US firm.

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16. The overwhelmingly dominant position of the United States in Intelsat caused serious dissatisfaction among other members, particularly those from Western Europe, and they insisted on substantial changes in organization before they would accede to a permanent charter. The West Europeans especially sought a substantial reduction in US power within Intelsat; an increase in the powers of governments (which have had no role under the interim arrangements) relative to those of the telecommunications administrations; and an Intelsat procurement policy that would ensure more contracts for the aerospace industries of Western Europe.

17. Negotiations on a new charter were long and difficult. It took two years of negotiations, involving three plenipotentiary conferences and six intersessional working groups, to obtain a consensus in May 1971 on a set of draft Definitive Agreements. The new agreements provide for a four-tier organization consisting of an Assembly of Parties, a Meeting of Signatories, a Board of Governors, and an executive organ.

18. The Assembly of Parties will consist of representatives of the governments and have recommendatory (but not decision-making) powers on matters of concern to the governments as sovereign states. The Meeting of Signatories will be made up of telecommunications entities and will establish rules for approval of earth stations, for allotment of Intelsat space segment capacity, and for the setting of rates. In both bodies, members have one vote each.

19. The Board of Governors will have "responsibility for the design, development, construction, establishment, operation, and maintenance of the Intelsat space segment" Membership and voting are based on use of and investment in Intelsat, but the largest investor is limited to 40% of total voting power.

20. The fourth tier of Intelsat will be the executive organ. A Secretary General's office is to manage administrative affairs, and Comsat continues to manage technical and operational matters. Not later than six years after entry into force of the Definitive Agreements, a Director General will come into being, replacing the Secretary General. He will oversee all management operations but is obliged to contract out technical and operational functions to the maximum possible extent. The Director General will be appointed by and be responsible to the Board of Governors. (For the organization of Intelsat under interim arrangements and under Definitive Agreements, see Figure 3.)

21. The final agreements are compromises between the original US and West European positions. The Assembly of Parties partly satisfies the West European desire for greater participation in Intelsat at the

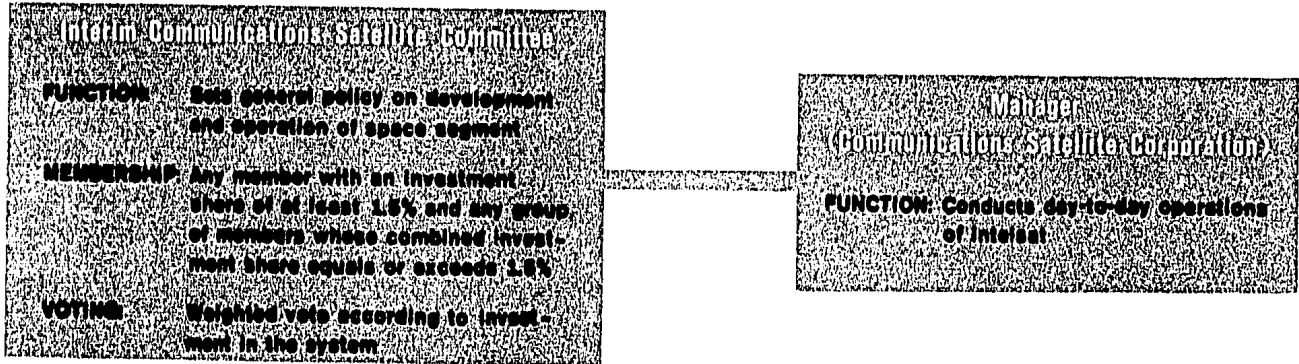
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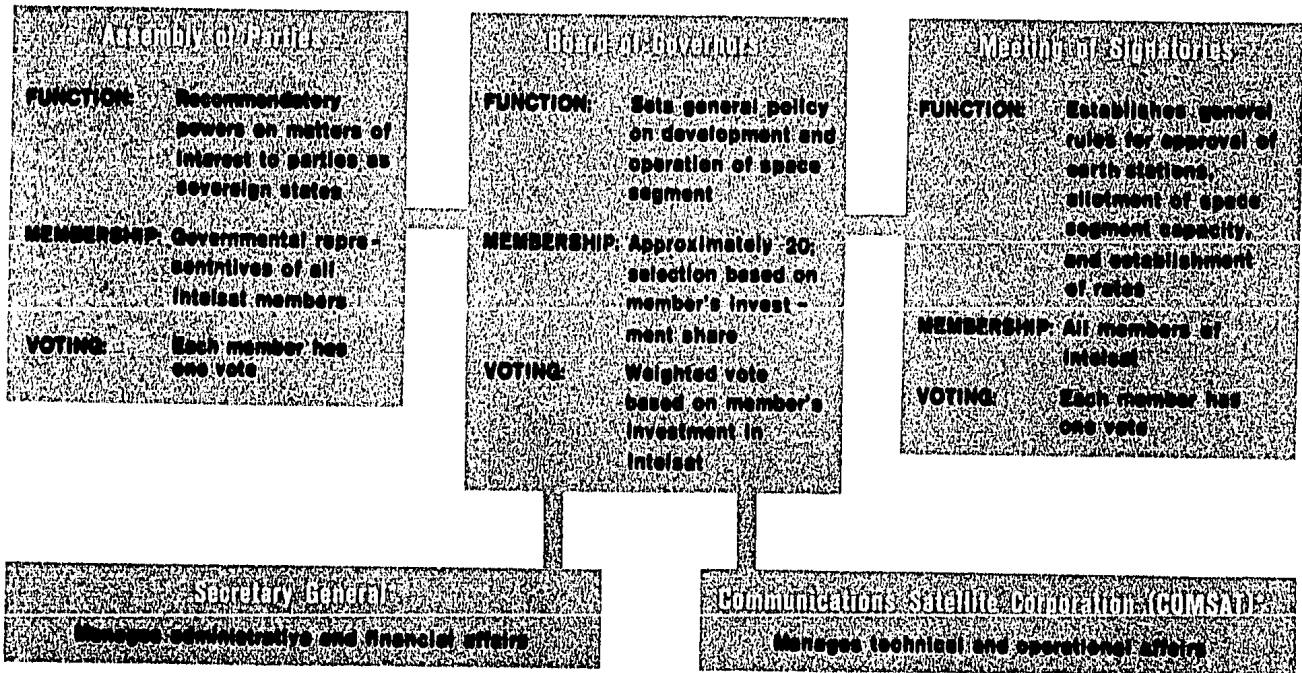
Figure 3

Organization of the International Telecommunications Satellite Consortium (Intelsat)

A. UNDER INTERIM AGREEMENTS



B. UNDER DEFINITIVE AGREEMENTS



*Not later than six years after the Definitive Agreements enter into force a Director General will assume all management functions, replacing the Secretary General and Comsat. However, the Director General will be obliged to contract out technical and operational functions to the maximum possible extent.

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governmental level, but its limited powers meet the US desire to maintain the commercial-technical character of Intelsat and thereby minimize its use for political leverage. The executive organ is a compromise between the West European desire to have Comsat replaced immediately by an international secretariat and the US wish to retain Comsat as manager for as long as possible. Even when the office of Director General is established, Comsat probably will continue to play a significant role, since it is by far the most qualified organization to act as contractor.

22. The West European bloc reduced US influence through the 40% restriction on any one member's investment and voting quota on the Board of Governors⁽⁵⁾ and a requirement that at least four members must vote against a proposal before it can be rejected. The West Europeans also succeeded in achieving a compromise on procurement policy. Although it is less than they had originally sought, they believe it can be construed to call for wider participation by their firms in future contracts for development and manufacture of satellites.

23. In actual practice, however, the Definitive Agreements will not greatly change the operations of Intelsat or the US role. The new voting arrangements in the Board of Governors are not very different than they were under the interim arrangements, since the United States has avoided using its veto power anyway. Also, US usage of the system (and thus voting strength on the Board of Governors) is expected to fall below 40% by the end of 1972, so that US strength would have been diminished even under the interim arrangements. Finally, on procurement matters, the United States in the past has usually accommodated West European desires for a larger share in satellite construction contracts. For example, the non-US (principally West European) share of contracts for successive generations of Intelsat satellites rose as follows: Intelsat I, nothing; Intelsat II, 3%; Intelsat III, 6%; and Intelsat IV, slightly more than 20%.

Regional Comsat Systems

24. Although the Definitive Agreements, unlike the interim arrangements, explicitly accommodate regional comsat systems, the issue remains essentially unresolved. Under the new agreements, members desiring to set up regional comsat systems must submit their plans to Intelsat for approval. Such approval requires a finding that the regional comsat will be technically compatible with the global Intelsat system and will not cause Intelsat "significant economic harm." For the West Europeans, the approval

5. Under the old interim arrangements, the US voting quota had never been lower than 52%.

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issue could assume critical importance inasmuch as a US launcher probably will be needed to place their planned regional comsat into orbit. Under current US policy, launch services for a regional comsat will be made available on a cost-reimbursable basis if either Intelsat or the United States approves. However, if both Intelsat and the United States disapprove, the latter will not supply launch services but will discuss with the requestor modifications needed to obtain Intelsat approval.

25. In addition to the "approval" issue, the meaning of "significant economic harm" to Intelsat is still to be resolved: does it mean a threat to the financial viability of Intelsat or only a lowering of the Consortium's profits? These issues are sure to arise when regional comsats now only in the planning or development stage approach completion. The first of these is likely to be the West European plan for a regional comsat system covering Western Europe, North Africa, and part of the Middle East.

Underutilization

26. Underutilization of the system is another potentially serious problem. Six Intelsat IVs - each with a capacity to handle 5,000 voice channels plus television - are scheduled for launching by 1974: two over the Atlantic, which has the heaviest traffic; one over the Pacific; one over the Indian Ocean; and two as spares-in-orbit. At present, however, the loading of the busiest Intelsat IV operating over the Atlantic is only around 1,100 channels, and traffic over the Indian Ocean is being handled adequately by a crippled Intelsat III operating at about one-half of capacity. Such underutilization requires the charging of higher tariffs, since the total costs of the system must be spread over a lower traffic base. Underutilization of the system could be mitigated if demand develops for additional services, such as domestic communications for large countries like Australia or Brazil or educational television for less developed countries.

27. Underutilization results not only from advances in comsat technology that have outpaced the growth in demand but also from the uniform design of satellites for use in all three regions, even though traffic demand varies greatly according to region. Current use of satellite capacity in the Atlantic Ocean region, for example, is around 1,700 voice channels; for the Indian Ocean region it is only about 300 voice channels. Moreover, Intelsat must compete with submarine cables. Although comsats offer substantially greater channel capacity than submarine cables, the importance placed by international carriers on the availability of alternative means of communications ensures that exclusive dependence on satellites is highly unlikely, at least in this decade.

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28. In less than seven years, Intelsat has dramatically improved and expanded the global telecommunications network. Comparable with submarine cables in quality and reliability of performance, the Intelsat system links many more countries directly, has provided an exponential increase in international channel capacity, and has proved more flexible than cables in accommodating shifting geographic patterns of demand. Moreover, Intelsat links provide the only means for transoceanic television transmission. For the United States and other developed countries, Intelsat has made communicating abroad less costly, faster, and much more convenient -- as a result of which international telecommunications is one of the world's most dynamic growth industries. For many of the developing countries, Intelsat has provided them for the first time with direct access to high-quality international television and telephone circuits. As a virtually global organization, Intelsat at times has been the arena for contending national and regional interests but has nevertheless functioned successfully as a mechanism for the orderly and coordinated diffusion of communications satellite technology. In terms of membership -- now up to 83 nations -- Intelsat is probably the largest commercial partnership in the world.

29. The Intelsat Definitive Agreements thus far have been ratified by 25 countries, including the United States. The requisite minimum of signatories (54) probably will be obtained by the end of 1972, and the agreements would then go into force. The new structure will not greatly affect the US position, since the United States has avoided exercising its full power in the past. Continued expansion of the global system is assured; more than 80 Intelsat earth stations in more than 60 countries are expected to be operating by 1974. The capacity of the space segment will be greatly increased as Intelsat IVs replace older satellites over the Atlantic, Pacific, and Indian Oceans. A still more advanced fifth-generation Intelsat satellite probably will be under development by 1975.

30. Further improvements in comsat technology should result in satellites that will make better use of the limited radio-frequency spectrum and will have higher transmitting power and better stationkeeping capabilities. These improvements will, in turn, allow the use of less-sophisticated earth stations. This development would substantially lower the cost of constructing and operating earth stations, thereby encouraging more less developed countries to join Intelsat and permitting many more Intelsat members with small international communications requirements to build earth stations.

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31. Over the next several years Intelsat will become increasingly involved with the controversial question of regional comsats. In addition, underutilization of the Intelsat system probably will become a sensitive issue. The total channel capacity of all the Intelsat IVs currently scheduled for launching is likely to be greatly in excess of anticipated demand for some years. Moreover, regional satellites, such as the West European system, are apt to take business from Intelsat. Also, the still-expanding submarine cable network will continue to compete with Intelsat, especially on heavy-traffic routes.