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DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
May 1971

INTELLIGENCE MEMORANDUM

TELESAT: THE CANADIAN DOMESTIC COMMUNICATIONS SATELLITE SYSTEM

Introduction

1. Canada is the first country in the world to establish a national communications satellite (comsat) system based on the use of geostationary satellites.(1) At present the Canadian telecommunications network consists primarily of microwave radio relay lines supplemented by tropospheric scatter links and open wirelines. The existing systems provide adequate telecommunications services to the more heavily populated areas in the south but are not adequate for northern Canada, where many small communities are widely scattered throughout the vast and hostile terrain. The Canadians are convinced that, in this type of environment, a comsat system will provide the full range of telecommunications services (television, telephone, telegraph, data, and facsimile) more economically than would the construction of thousands of miles of conventional terrestrial media, such as microwave radio relay and cable.

2. This memorandum outlines the major operating and geographical characteristics of the Canadian national comsat network, compares the Canadian system with the domestic comsat network operating in the USSR, and briefly addresses the question of compatibility between Canada's domestic comsat plans and the operations of the International Telecommunications Satellite Consortium (Intelsat).

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1. Geostationary satellites are positioned over the equator in orbits synchronized to the speed of the earth's rotation and thus appear to be "stationary" in relation to a fixed point on earth. The USSR has been operating a national comsat system since 1967 using satellites inserted into highly elliptical orbits.

Note: This memorandum was prepared by the Office of Economic Research and coordinated within CIA.

Discussion

Background

3. To establish a domestic comsat system, the Canadian Parliament created the Canadian Satellite Corporation (Telesat), which came into existence on 1 September 1969 as a mixed corporation owned approximately equally by the government, 13 common carriers, and the public. Telesat was authorized to provide satellite communications commercially throughout Canada and was assigned responsibility for the design, construction, operation, and maintenance of the system.

4. Canada had taken initial steps toward a domestic satellite system in 1968 when the government had system design studies prepared by two consortiums. After the design proposals stage, RCA Victor of Canada was designated prime contractor for the project definition phase and appeared to be the company that would build the satellites. In April 1970, however, Hughes Aircraft Company – builder of the Intelsat I, II, and IV satellites – submitted an unsolicited bid less than half that of RCA for a satellite having twice the channel capacity. In August 1970, Hughes was awarded a $31 million prime contract to build three comsats for Telesat. Two Canadian firms -- Northern Electric Company and Spar Aerospace Products Ltd. – are the major subcontractors.

5. Progress on the earth segment of the system began in July 1970, when Telesat sent requests for bids to 18 companies, ten of which responded. After reviewing the bids, Telesat in June 1971 awarded prime contracts totaling $16 million to three firms: RCA Victor of Canada ($11 million), Raytheon of Canada ($3.2 million), and Philco-Ford of Canada ($1.8 million). The RCA and Raytheon contracts require that 66% of the work be done by Canadian firms, while Philco-Ford's contract stipulates only 33% Canadian participation.

Characteristics of the System

Space Segment

6. The three satellites forming the space segment of the Telesat system are designed for a useful active lifetime of seven years. Two of them will be launched and placed in geostationary orbits, but only one will be active while the other will be an in-orbit spare. The third satellite will be an on-the-ground spare. Each satellite, with 12 radio frequency carriers (or transponders), will be capable of relaying either 12 television programs or 11,520 telephone channels. The satellite will be 12 feet in

length and 6 feet in diameter and will weigh approximately 1,200 pounds at launch. Because it is being equipped with a transmitting antenna designed for relatively narrow beam width, its coverage of the earth's surface will be effectively limited to Canada.

7. Delivery of the first satellite to Telesat is scheduled for October 1972 with the others to be delivered at four-month intervals thereafter. Under agreements reached with the United States, the satellites will be launched by the National Aeronautics and Space Administration (NASA) with thrust-augmented Thor-Delta rockets at a cost (to be paid by Telesat) of approximately $7 million each. Launching of the first satellite is scheduled for November 1972 and, following sucessful checkout tests, Telesat expects the Canadian domestic communications satellite system to become operational by the end of this year. Launching of the second satellite is planned for February 1973.

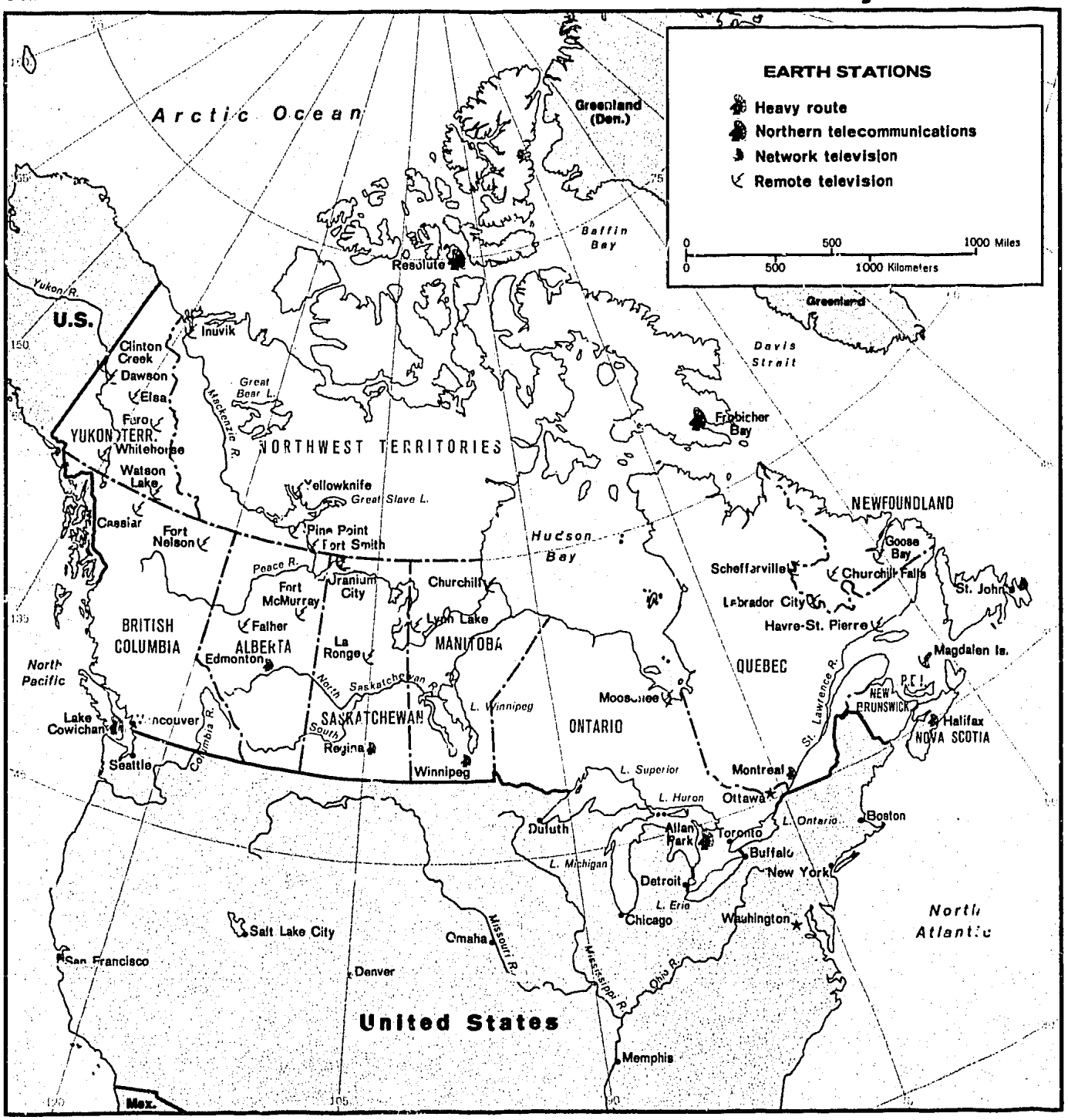
Earth Segment

8. The ground segment of the Canadian comsat system will consist of about 35 earth stations of four different types[2] (see the map). Two types will be designed to transmit and receive both television and message (telephone, telegraph, and data) traffic. With the exception of one station, the other two types will be configured for television reception only. The two categories of earth stations designed to provide the full range of communications services have been designated, respectively, the Heavy Route and the Northern Telecommunications stations. The Heavy Route stations will be located near Victoria at Lake Cowichan, British Columbia, and near Toronto at Allan Park, Ontario. Similar to standard Intelsat earth stations, they will have 95-foot parabolic dish antennas and will be capable of transmitting and receiving television and several hundred channels of message traffic. The much smaller Northern Telecommunications stations will have 30-foot parabolic dish antennas and will be capable of handling television and a relatively small number of channels of message traffic. Initially, there will be two Northern Telecommunications stations -- one at Frobisher Bay and one at Resolute in the Northwest Territories.

9. The two types of earth stations designed for television reception only are known, respectively, as the Network Television and the Remote Television stations. The Network Television stations will have 40-foot parabolic dish antennas and will be located in six cities: Edmonton, Regina, Winnipeg, Halifax, Montreal, and St. John's. The only one of these stations to be configured at the outset for anything other than television reception is the Montreal station, which will be used to transmit French-language television programs to the rest of Canada. The Remote Television stations will have 25-foot parabolic dish antennas and will be located in 25 small

2. Not including a telemetry, tracking, and control station to be located at Allan Park, Ontario.

Canada: Earth Stations of the Domestic Communications Satellite System



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communities of northern Canada. Compared with an estimated cost of $3 million-$5 million for each Heavy Route station, the cost of the Remote Television station will be about $130,000 per unit.

10. Design and locational factors indicate that the quality and reliability of reception will be better at the Network Television than at the Remote Television earth stations. On the other hand, the Remote Television stations, unlike the Network Television stations, will be unattended and thus should have very low operating costs. Both of these receive-only types of television stations could subsequently be modified to transmit and receive both television and communications traffic.

Comparison of Canadian and Soviet Domestic Satellite Systems

11. The Soviet Union and Canada share many similar geographic features that make a domestic comsat system highly desirable. Both countries have a number of lightly populated but important settlements in the northern latitudes that are separated by vast reaches of difficult terrain. This makes the establishment of conventional means of telecommunications, such as a microwave radio relay and cable links, a prohibitively expensive and time-consuming process. Unlike terrestrial media, the cost of installing a comsat system does not rise proportionately with increasing distance between terminals, nor does the construction of an earth station network involve the arduous traversing of thousands of miles of hostile terrain.

Satellite Differences

12. Despite their geographic similarities, Canada and the USSR have chosen comsat systems with considerably different characteristics. In contrast to the geostationary orbit chosen by Telesat, the Soviet Molniya satellites are injected into highly elliptical orbits, in which apogee is reached over the Northern Hemisphere and which provide 8-10 hours of coverage of the USSR every other orbit.(3) For the USSR, an elliptical orbit has several advantages over a geostationary orbit. First, a comsat in elliptical orbit with a Northern Hemisphere apogee can provide more comprehensive coverage of the Soviet land mass, especially the Arctic regions, than one in geostationary orbit.(4) Second, because the USSR is situated so far north

3. On alternate orbits, the Molniya satellites reach apogee over Canada.

4. At and near apogee, one Molniya comsat in elliptical orbit can cover all of the USSR. Because of the breadth of the northern USSR, two geostationary comsats would be necessary to provide comparable coverage.

of the equator, it is technically easier for Soviet space launching sites to place a satellite into an elliptical rather than into a geostationary (equatorial synchronous) orbit.(5) Finally, with any given launch vehicle, a heavier payload can be placed into an elliptical orbit. Since a heavier satellite permits more onboard transmitting power, smaller and less expensive earth stations can be used.

13. Canada, on the other hand, with much less territory than the USSR, could obtain satisfactory coverage with a geostationary satellite, even for its northernmost earth stations. (The earth station planned by Canada for Resolute at 75° north latitude will be farther north than any Soviet station, but the Canadians do not anticipate any reception problems.) In addition, the difficulties posed for the USSR in placing satellites into geostationary orbit will not be encountered by Canada, owing to US agreement to launch the Canadian satellites from Cape Kennedy.

14. Geostationary comsats offer Canada several technical and economic advantages over elliptically orbiting comsats. Only one geostationary comsat is required to provide 24-hour coverage of Canada, whereas at least two satellites would be needed for round-the-clock coverage if an elliptical orbit were used. Since geostationary comsats remain "fixed" in space relative to the earth, they are easy to track and require only one antenna at the earth stations to maintain continuous 24-hour communications. In contrast, comsats in elliptical orbits must be tracked from horizon to horizon, and for continuous coverage their earth stations require two antennas to accomplish "handover" as one satellite passes out of view and another comes into view. Moreover, comsats in geostationary orbit do not pass through the Van Allen radiation belt, as do elliptically orbiting comsats, and therefore do not require radiation shielding, which would increase both the weight and complexity of the payload. It is believed that the repeated crossing of the Van Allen radiation belt by the Molniya satellites causes a deterioration in their solar cells and electronics system, contributing to the satellites' short operational lifetimes.

15. Important differences also exist between the Canadian and Soviet satellites in channel capacities and expected lifetimes. The Molniya-1 satellites used in the Soviet system have had a standard operating capacity of relaying either one television channel or 60 telephone channels, whereas the Canadian satellites will be capable of handling either 12 television channels or 11,520 telephone channels, or a lesser number of both in

5. As one moves away from the equator, the launching of satellites into geostationary orbit requires progressively more powerful launch vehicles and technically more complicated guidance and control maneuvers.

combination.(6) Also, the useful lifetime of Canada's comsats -- designed for seven years -- is likely to exceed considerably those in the Soviet system, which currently have an average useful lifetime of about two years.

Earth Segment Comparisons

16. Both the Canadian and Soviet domestic comsat systems are heavily oriented toward television distribution. In the Canadian system, all 35 earth stations will be able to receive television signals from the satellites, and all but five will be receive-only television stations. In the USSR, 38 of the 40 earth stations currently operating in the domestic comsat system are receive-only television stations.

17. Despite generally similar system objectives, the Canadian earth station network will be somewhat more diversified than that in the USSR. As noted above, Canada will have four differently configured types of earth stations, while the Soviet system features only two types: the Molniya stations (located at Moscow and Vladivostok), which are capable of transmitting and receiving both television and multichannel communications, and the Orbita stations, capable of television reception only.

18. Canada's Remote Television earth stations will be very similar to the Soviet Orbita stations in that they will be used only for television reception, will be the most numerous stations in the system, and will provide service to the country's more isolated communities. Unlike the Orbita stations, which require a permanent operations crew, the Canadian Remote Television stations will operate unmanned. Canada's six Network Television earth stations, like the Orbita stations, will be manned, receive-only facilities but will be located exclusively in regional population centers. The two Northern Telecommunications stations at Frobisher Bay and Resolute will also be similar to the Soviet Orbita facilities in terms of antenna size, but they will be configured to transmit and receive a few channels of telephone and telegraph traffic in addition to receiving television.

19. The two Canadian Heavy Route stations near Toronto and Victoria, British Columbia, will be roughly analogous to the two Soviet Molniya stations at Moscow and Vladivostok. In each case, the stations form transcontinental links between a major city in the interior and the country's principal city on the Pacific. Like the Molniya facilities, the Heavy Route stations will provide two-way television and multi-channel communications service, supplementing the existing terrestrial facilities.

6. In November 1971 the USSR successfully orbited the first of its Molniya-2 (second-generation) comsats. Molniya-2 has substantially more advanced capabilities than Molniya-1, but accurate estimates of these capabilities are not yet possible. The Molniya-2 satellites, however, probably will not be as advanced as those being built for Telesat.

Telesat and Intelsat

20. As a sovereign state, Canada requires no outside approval to establish and operate a domestic comsat system. Although not specifically obligated under the present Intelsat interim arrangements to do so, Canada has conferred with Intelsat to ensure technical compatibility of the two systems, especially with respect to the use of the radio frequency spectrum and orbital space. Although Canada's comsats will be using the same frequencies as Intelsat, they will be sufficiently separated in space from Intelsat's to preclude any mutual interference. The Canadian system should be economically as well as technically compatible with Intelsat because it is designed to handle domestic traffic, whereas Intelsat is for international communications. To the degree that Canadian telecommunications as a whole are stimulated by the availability of this new network, Telsat may in fact contribute to an increase in Intelsat traffic.

Outlook and Conclusions

21. Telesat will give a substantial boost to the Canadian national telecommunications system. The two dozen or so Remote Television stations will greatly expand reception coverage in Canada's more thinly populated areas. Telesat will also make possible for the first time distribution of French-language television programs on a national scale. Apart from television, the new comsat network will permit a major expansion of transcontinental multichannel communications between two major cities, Toronto and Vancouver, and will extend high-quality telephone and telegraph links to two of Canada's important but more isolated communities, Resolute and Frobisher Bay. In the future, the Telesat system will be further expanded and upgraded by constructing receive-only television stations in more of Canada's smaller settlements and by adding two-way telephone and telegraph capabilities to some of the stations originally configures for television reception only.

22. Telesat's operation will be followed with interest by many countries because it is the first of several national and regional comsat systems planned for deployment in the coming years. The developed countries will be observing Telsat closely for ideas that will prove useful in establishing their own systems. The less developed countries will be especially interested in Canada's unmanned and relatively inexpensive receive-only television stations as models that could be used in educational television systems several of them are planning to build.