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REPORT OF SURVEY RESEARCH OF WAYS OF USING SECOND GENERATION PRACTICAL BROADCASTING SATELLITES

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16. Abstract

The purpose of this investigation was to determine the state of development of satellite broadcasting in Japan, and to make recommendations for the future regarding what organisations would use it and what kind of results could be forthcoming. Concludes that primary use at this stage should be for television broadcasting, and secondary use for testing new broadcasting methods and for use by Japan's new Broadcasting University.

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PREFACE

Plans are to launch the BS-2, our nation's first practical broadcasting satellite, using an N-11 rocket at the end of 1983. For practical use, we have to launch the succeeding BS-3 in approximately 1988 when the BS-2's life span is at an end so as to prevent broadcasting interruption. At that time it will be possible to use the H-I rocket which can launch larger satellites. Thus we will be able to use more channels, and we expect the users, and the fields of use will broaden. If the BS-2 is called the first generation practical broadcasting satellite, the BS-3 is the second generation practical broadcasting satellite.

We assume the design and production of the BS-3 will take about five years. Before that, we have to discuss and decide such important matters as how to use them, what fields will use them, etc. Satellite production, launching techniques, and broadcasting methods have progressed remarkably. On the other hand, the popular needs for broadcasting have tended to increase. So we need a serious discussion from a broad point of view in order to make decisions about the second generation broadcasting satellites.

Considering this situation, in June 1980 the Survey Research Commission for Development of Uses for Radiowaves, Practical Satellite Committee was established as a private committee of the Director of the Radiowaves Regulatory Bureau, Ministry of Postal Services. This committee has investigated and studied the use of second generation broadcasting satellites for the past two years; its findings will be summed up in this report.

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REPORT OF SURVEY RESEARCH OF WAYS OF USING SECOND GENERATION PRACTICAL BROADCASTING SATELLITES

Survey Research Commission for Development of Uses for Radiowaves, Practical Satellites Subcommittee

Chapter 1. The Significance of the Uses of Broadcasting Satellites and the Broadcasting Satellites Plans of Japan and Other Countries

1. The Significance of the Uses of Broadcasting Satellites.

The broadcasting satellite transmits broadcasting waves from a stationary orbit 36,000 km above the equator to the islands of Japan. The whole country of Japan can be covered by one beam. Also, since the broadcasting satellite's radiowave comes from such a high angle, there is not much influence from the landscape or buildings. Using the high cycle area, we can broadcast with good quality, and do broadcasting which needs a wide band of cycles. Considering these characteristics, the broadcasting satellite has the following significance in our country. /3*

(1) An Increase of Broadcasting Channels.

At the World Alliance of Radiowaves Controllers--Broadcasting Satellites (WARC-BS) conference about plans in the 12 GHz field in 1977, Japan was assigned 8 channels for television broadcasting waves, and the position of an orbit. Thus it became possible to broadcast 8 channels nationwide. On

*Numbers in the margin indicate pagination in the foreign text.

the earth's surface, most VHF and UHF bands--for television broadcasting--are already being used. It has become difficult to assign any new nationwide broadcasting channels. The broadcasting satellite plays an important role in the development of an increased number of waves.

(2) Possibilities for New Styles of Broadcasting. /4

Using the broadcasting satellites in the field of broadcasting service, new styles of broadcasting, such as highly efficient television broadcasting which needs wider band width than the present television broadcasting, PCM voice broadcasting which specializes in television broadcasting 1 channel, and stationary picture broadcasting will all be possible. Moreover, broadcasting of letters and facsimiles will be possible. Thus the popular demand can be satisfied.

(3) The Realization of Short-Term and Economical Nationwide Broadcasting.

In order to broadcast nationwide from the earth transmit systems, it is necessary to construct many relay stations. But with the broadcasting satellite, after sending the satellite into orbit, and providing a minor transmission and control system, it is possible to realize a good quality, nationwide broadcasting system, and with less cost. However, it is necessary to note that the broadcasting receiver must be equipped with a receiver for satellite broadcasting, and that it will be difficult to broadcast elaborate local broadcasts as with earth broadcasting.

(4) Contribution to Domestic Industry.

Since we have to use the most advanced technology extensively to develop satellite broadcasting, it will contribute to the advancement of the technological level of industry in our country. Also, as satellite broadcasting spreads widely, industries related to the receiver will develop, and our competitive position internationally in this field will be strengthened. /5

As mentioned above, satellite broadcasting use is greatly significant as a means of broadcasting nationwide, to meet the various popular demands for broadcasting, to help industrial development, and to improve the broadcasting culture.

2. Japan's Broadcasting Satellite Plan.

Our broadcasting satellite plans include BS (a middle-sized, test broadcasting satellite) sent up in 1978, and BS-2 (the first generation practical broadcasting satellite) which is scheduled to be sent up in 1983.

(1) Plan to Test a Middle-Sized Broadcasting Satellite (BS).

Investigation into the development of broadcasting satellites began in around 1965, just before and after the communications satellite.

The purpose of BS was to establish the various techniques for a practical broadcasting satellite. In the 1973 Space Development Project it was decided to send it off using a Delta style rocket made by NASA of the U.S. This project was promoted by the Ministry of Postal Services with the help of related agencies. Production of the satellite was promoted by the Space Development Agency, and the earth equipment--the central and working stations--were established by the Radiowaves Research Office of the Ministry of Postal Services. NHK equipped a portable transmitter and receiving station, a station only for reception, and simple reception /6 equipment.

The outline of BS is shown in Table 1.

The BS was sent into orbit on 8 April, 1978, using the Delta style rocket, and the Ministry of Postal Services, NHK, and other agencies did various tests. As a result, it was approved that the satellite functioned with efficiency as expected, and it was possible to satisfactorily receive the various styles of broadcasting.

The items tested on the BS are shown in Table 2.

Since BS ended its efficiency as a television broadcasting transmitter, tests have been conducted since June 1980 on the satellite control technology.

Table 1. The Outline of BS

ITEM	CONTENTS
Orbit Position	110° east longitude, stationary satellite orbit
Shape	Box type about 1.3 m long, 1.2 m wide (about 9 m when sun battery panel opens), 3.1 m high
Weight	about 355 kg in the first period on stationary satellite orbit
Control Style	3 axis control form
Power Generated by Sun Battery	about 780 W (3 years after summer solstice)
Communication Antenna	Shaped Beam Antenna Advantage: to mainland Japan, over 37 dB to Okinawa and Ogasawara, over 28 dB
Transmission Frequency	12 GHz band
Transmission Electrical Power	100 W per one channel
Transmission Channels	Simultaneous transmission of two color television channels
Service Area	Throughout Japan (In the central part of mainland Japan, reception is possible with a 1 m diameter parabolic antenna; on other islands such as Ogasawara a 4.5 m diameter antenna is needed.)
Life Span	3 years
Launching Rocket	NASA's Delta style rocket

(2) Plan for the First Generation Practical Broadcasting Satellite (BS-2). /8

A. Details of Development Plan Decisions.

Affirming the success of the BS experience, we aimed to realize the broadcasting satellite earlier than had been planned. In 1979 the Space Development Project decided to push forward the technical development of the broadcasting satellite. At the same time, we aimed to solve the audio and vision problems of NHK television broadcasting. Our nation's first practical broadcasting satellites, BS-2, are to be launched into orbit using the domestically made N-II Rocket—the presently used satellite (BS-2a) in 1983, and the orbit reserve satellite (BS-2b) in 1985.

Accordingly, we began to develop the BS-2 in 1980, and at present we are progressing with the production and launch preparation. BS-2 is basically the same scale as the BS, but changes in the production design are being made to fit the N-II Rocket, and to comply with the technical standards decided on at WARC-BC.

The differences between BS and BS-2 are shown in Table 3.

Moreover, since the BS-2 has the dual purposes of development and use, the expenses for production and launching of the satellite will be covered 40% by the national government, and 60% by NHK, the organization which is to use it.

B. Outline of Plan for Use.

Since television broadcasting began in Japan in 1953, it has made remarkable progress. Today it has high value as an information media which provides programs of news, education, recreation, etc., and has become an essential part of the life of the nation's people.

Since then, NHK has tried to spread television broadcasting nationwide by establishing relay stations and collective reception equipment. But still reception is difficult in some areas. We estimate there will be /10
some 400,000 households with audio and visual reception difficulties in 1983 when the BS-2 is scheduled to be sent into orbit. Solving the audio and visual problems of NHK television broadcasting is a subject of urgent policy. If we are to attempt the solution with an earth system as in the past, since there are many isolated areas and islands, we will need more funds and time.

Table 2. Items Tested on the BS

1. Tests related to the Satellite Broadcasting System's Basic Technology.
   (1) possible reception area
   (2) transmittal methods
   (3) transmission waves
   (4) frequency bands
   (5) characteristics of the satellite
   (6) characteristics of the earth equipment
2. Tests related to the Satellite Control and Satellite Broadcasting System Functioning Methods.
   (1) satellite control techniques
   (2) satellite broadcasting system functioning
   (3) satellite access from multiple stations
3. Tests related to Reception of Broadcasting Satellite Waves.
   (1) evaluation of reception of broadcasting satellite waves
   (2) improvement of reception technology for satellite broadcasting

(Note) Taken from the BS Test Basic Planning Report (March 4, 1978).

Table 3. The Differences between BS and BS-2 /9

ITEM	BS	BS-2	COMMENTS
Number of launchings	110° east longitude, stationary satellite orbit—one (earth preparatory satellite—one)	presently at 110° east longitude, stationary satellite orbit, and preparatory satellite —one each	
Antenna System and Directional Fine Degree	direct antenna degree within $\pm 0.2°$ (within $\pm 2°$ degree of revolution)	clockwise wave antenna directional degree within $\pm 0.1°$ (within $\pm 0.6°$ of revolution)	to comply with WARC-BC technical standards
Life Span	3 years	estimated 4-5 years	
Launch Rocket	Delta style	N-II Rocket	
Other		light-weight communication system, and improved efficiency; improved telemetry and collective system use	

Taking this into consideration, in order to resolve the difficult audio and vision of NHK television broadcasting, and simultaneously to assure broadcasting in case of emergencies, and improve the quality of television broadcasting reception, we decided to launch the BS-2.

Moreover, the stationary orbit position of the satellite, and the communication and broadcasting systems which were established in August 1979, will be controlled according to the Communications and Broadcasting Satellite Systems Law.

The construction of the BS-2 system is outlined in Fig. 1.

(3) Development Schedule of the Second Generation Practical Broadcasting Satellite (BS-3). /12

It is necessary to launch the second generation broadcasting satellite (BS-3) in 1988 when the life span of BS-2 is nearly completed.

BS-2, which is of the same size and capacity as BS, is being constructed based on the development results of BS. We plan to take about 4 years from basic design to the launch. It is necessary for BS-3 to be bigger, with a greater capacity and longer life span than BS-2, so it might take 5 years to develop. Accordingly, development must begin in 1984. Before than, in 1982, we plan to outline the design, and in 1983 we assume that the preparatory design will be completed.

The development schedule for BS-3 is shown in Fig. 2.

3. Broadcasting Satellite Projects of Other Countries. /14

(1) Broadcasting Satellite Projects of the United States.

The U.S. launched Application Technology Satellite (ATS) No. 6 in 1974, and tested the collective receiving system for satellite broadcasting using the 2.6 GHz band. Two years later, in 1976, they launched with Canada a communication technology satellite which is able to transmit great quantities of electrical power on the 12 GHz band. They proved it is possible to receive the audio and television broadcasting by satellite using an antenna as small as 1 m in diameter. Although the use of the broadcasting satellite was delayed, they did not wait for the Radio Area Report Conference (RARC-83) on the second area of the broadcasting satellite business scheduled for 1983. They decided to launch broadcasting satellites earlier. Accordingly, 14 companies, including STC which is a subsidiary of Comsat, the Communication Satellite Company, applied to the FCC to realize the broadcasting satellite. By the end of December 1981, the FCC had examined the plans of 9 companies, excluding 5 companies which lacked proper operation plans. The plans for broadcasting satellites of these 9 companies are shown in Table 4.

(2) Broadcasting Satellite Projects in Western Europe and Other Countries. /16

West Germany and France have progressed with the development of a large broadcasting satellite which can transmit 5 channels, as assigned at WARC-BS. These satellites should be launched in May and September of 1985, one to one and one half year after our BS. They presently plan to use 3 channels for preparation. It seems their purpose is to continue examination.

England, Italy, Sweden and other countries have also begun to examine the development of broadcasting satellites. When Japan launches the second generation broadcasting satellite, it is assumed that Western European countries will take initiative to begin in earnest to use broadcasting satellites.

The broadcasting satellite projects of other foreign countries, excluding the U.S., are shown in Fig. 5.

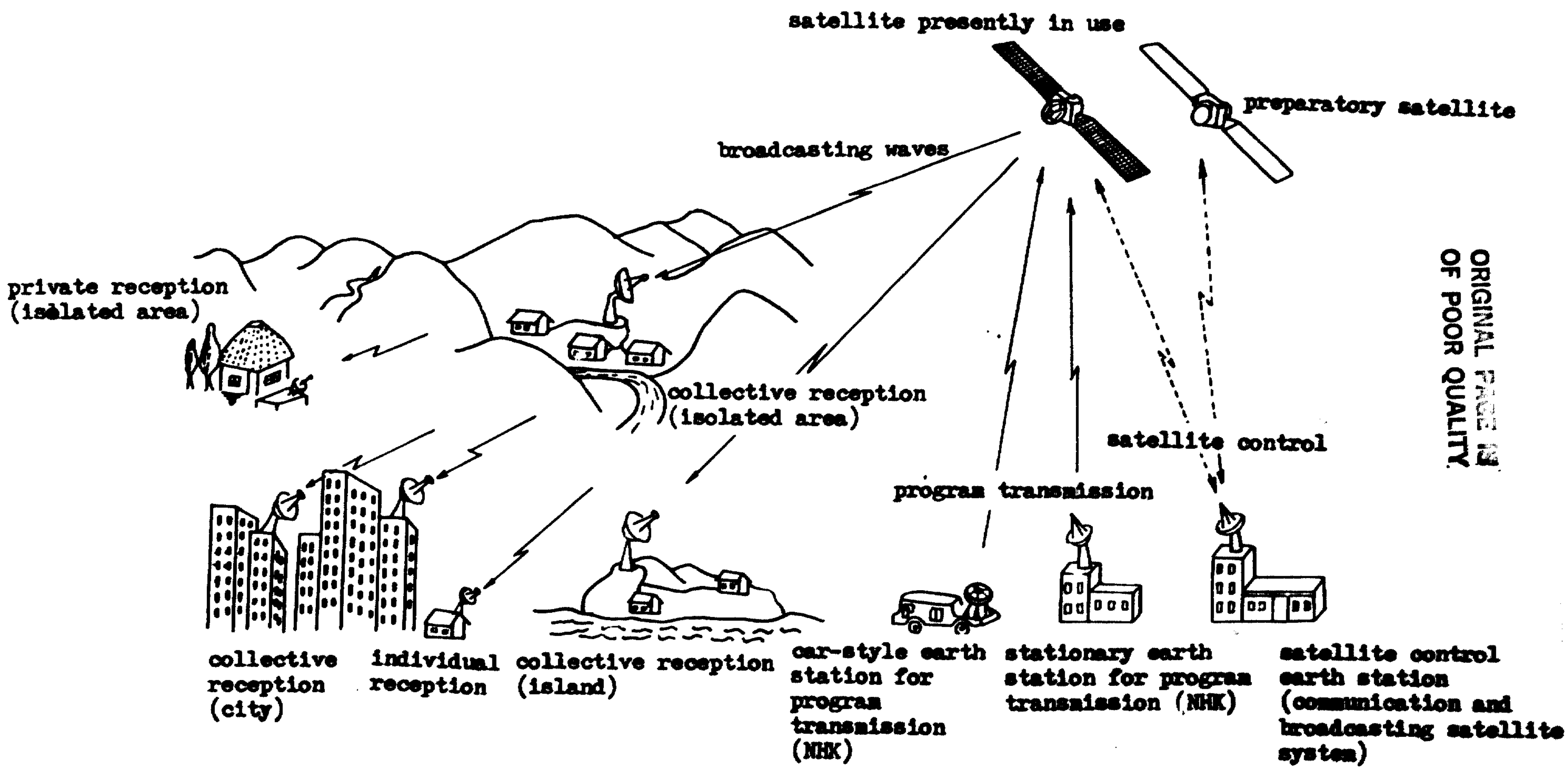

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Fig. 1. BS-2 System Construction Outline Chart

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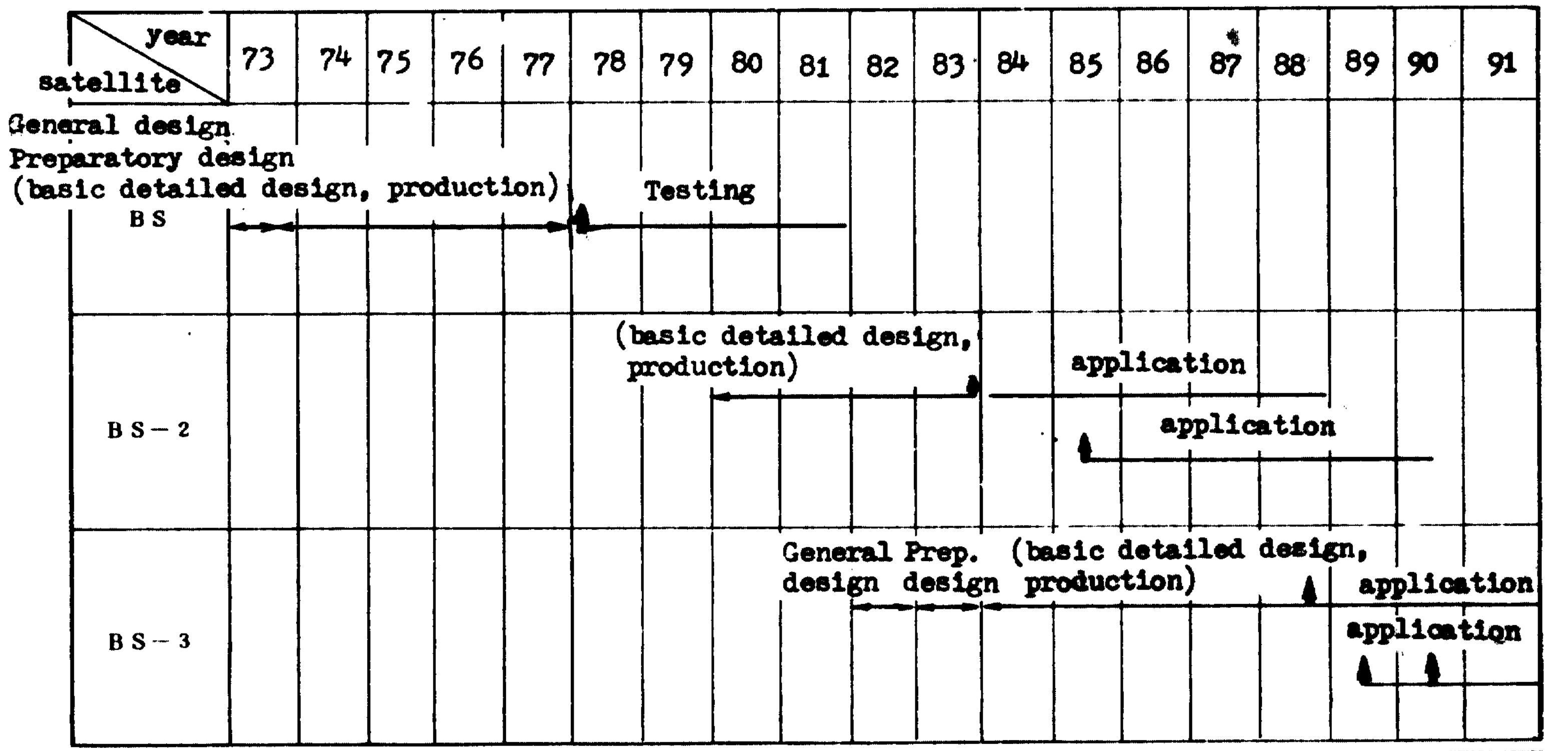

Fig. 2. BS-3 Development Schedule

(Note) General design - examine possible system outlines.
Preparatory design - strengthen the design demand system.
Basic detailed design - examine the hardware and carry out the design.

Table 4. U.S. Broadcasting Satellite Projects

Applicant (company)	Number of Satellites	Orbit (°W)	Life Span (yrs)	Weight at Stationary Satellite Orbit	Number of channels per satellite	Transmission Power per channel (W)	Type of Services Note(A-J)	Program Content
STC	in use 4 reserve 2	115 135 155 175	7	649	3	185	B D F H J	culture, education, movies, sports, etc.
VSS	in use 2 reserve 1	115 135	8	545	2	150-190	A CDEF H	recreation, education, news, public affairs, etc.
USSB	in use 2 reserve 1	115 135	7	1,043	big current- 6 small current -7	big cur.- 230 small cur. -20	A DE GH	public affairs, recreation, children's, educational, news
DBSC	in use 3 reserve 1	103 123 143	7	1,355	big current- 6 small current -8	big cur.- 200 small cur. -20	C HIJ	
RCA	in use 4 reserve 2	110 125 140 155	7	1,095	6	230	C H	
WUTC	in use 4 reserve 2	80 100 120 140	7	533 (end of life span)	4	100	C	
CBS	in use 4 reserve 2	(RARC -83)	7	1,051	3	400	A DEF HIJ	existing TV programs, educational, entertainment, movie transmission to theaters, business, medical
GSC	in use 2 reserve 1	115 143			2	300	B D IJ	teletext, audio service to the visually handicapped, music, etc.
FBS	in use 3-5						AB DEFGHIJ	data, information service, etc.

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See next page for Types of Service (A-J) and Sources.

Note: Types of Service (A-J)

A: income from advertisements
B: pay television
C: lease channel
D: direct household reception
E: broadcast company use for retransmission of reception
F: UHF television company use for retransmission of reception
G: LPTV station use for retransmission of reception
H: High definition television broadcasting
I: Teletext
J: Supplementary services (stereo sound, bilingual broadcasts, etc.)

Source: Broadcasting Magazine (July 20, 1981), etc.

Chapter 2. Technological Conditions and Expense Estimates for the Second Generation Broadcasting Satellite. /21

1. Technical Conditions.

In recent years, the interest of first Japan, then other countries, in the development and use of broadcasting satellites has greatly increased, and the technology of satellites, launchers, receivers, etc., has advanced rapidly. Accordingly, in order to investigate the uses of the second generation practical broadcasting satellite, it is necessary to consider what uses of technology will be possible in the decade beginning in 1985, when this satellite will be realized.

(1) Usable Frequencies.

Frequencies that can be used by broadcasting satellites, according to the Radio Communications Rules of the International Electrical Communications Pact, are shown in Table 6.

Since the 620-790 MHz, or the 2.5-2.69 GHz, frequencies are presently /22
being used in Japan by the earth broadcasting business (UHF television broadcasting) and fixed businesses, it is difficult for the broadcasting industry to use these frequencies.

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Table 5. Broadcasting Satellite Plans of Other Countries (ex

Country	Satellite Name	Test or Practical Use	Satellite Type	Number of Satellites	Launch Date (Launch Ship)	Orbit	Life span of design (years)
West Germany	TV-SAT (D3)	pre-use	broad-casting	in use 1	1985. 5 Arian	19°W	7
				collective earth reserve -1			
France	TDF-1 (F3)	pre-use	broad-casting	in use 1	1985. 9 Arian	19°W	7
ESA (European Space Association)	L-SAT	test	multi-purpose	in use 1	1986 Arian	19°W	5
England		practical use	multi-purpose	in use 1 reserve in orbit 1 earth reserve 1	1986 (Approx.)	31°W	5-7
Sweden	TELE-X	test and practical use	multi-purpose		1986. 5 Arian	5°E	7
ARABSAT (Arab Satellite Communication Association	Arabsat	practical use	multi-purpose	in use 1 reserve in orbit 1 earth reserve 1	1984. 2 Arian	19°E 26°E	7
Saudi Arabia	SABS	practical use	broad-casting		1984	17°E	
India	INSAT-1	practical use	multi-purpose	in use 1 reserve in orbit 1	1982 (Delta) 1983 (STS)	74°E 94°E	7
Australia	ANSCS	practical use	multi-purpose	in use 1 reserve in orbit 1 earth reserve 1	1985 (approx.)	156°E 164°E (160°E)	7
U.S.S.R.	Ekran	practical use	broad-casting	6	1976. 10~ 1980. 12 (ProtonD)	99°E	

Note: In addition to the above, Luxembourg, Switzerland, and th
are examining broadcasting satellite projects.

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ite Plans of Other Countries (excluding the U.S.)

Launch Date (Launch Ship)	Orbit	Life span of design (years)	Weight in stationary satellite orbit (1st orbit)	No. of channels per satellite	Electrical Power per Channel (W)	Maximum EIRP (dBW)	Frequency (GHz)
1985. 5 Arian	19°W	7	1 ton class	3 TV	230 or 260	65.5	17/12
1985. 9 Arian	19°W	7	1 ton class	3 TV	230 or 260	64	17/12
1986 Arian	19°W	5	1,380-1,430 kg	2 TV other	230	61	17/12 other
1986 (Approx.)	31°W	5-7	600 kg-1 ton class	2 TV other	200-250	65	17/12 other
1986. 6 Arian	5°E	7	1 ton class	2 TV other	230	63	17/12 other
1984. 2 Arian	19°E 26°E	7	680 kg	1 TV other	40	43	6/2.5 other
1984	17°E			2 TV and 1 TV(for Arab area)			14/12
1982 (Delta) 1983 (STS)	74°E 94°E	7	approx. 600 kg	2 TV other	50	42	6/2.5 other
1985 (approx.)	156°E 164°E (160°E)	7	1,140 kg or 1,250 kg	1 TV other	30	47	14/12
1976. 10~ 1980. 12 (ProtonD)	99°E		1 ton class	1 TV	200		6/0.7

, Luxembourg, Switzerland, and the Republic of Korea
ng satellite projects.

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Table 6. <u>The Distribution of Frequencies for the Broadcasting Satellite Industry (since December 1979).</u>

Frequency Band	Width of Frequency Band	Notes
620-790 MHz	170 MHz	
2.5-2.69 GHz	190 MHz	for cooperative reception
11.7-12.2 GHz	500 MHz	Region 1, including Europe and U.S.S.R., is 11.7-12.5 GHz. Region 2, including North and South America, is 11.7-12.7 GHz
12.5-12.75 GHz	250 MHz	Capable of cooperative reception only in Region 2, which includes Japan
22.5-23 GHz	500 MHz	excluding Region 1
40.5-42.5 GHz	2,000 MHz	
84-86 GHz	2,000 MHz	

In addition to the cooperative reception premised for the broadcasting satellite industry in the 12.5-12.75 GHz frequency band, a variety of fixed satellite businesses, and fixed businesses on earth, etc., are able to use this frequency band. Therefore, taking into consideration demand trends and technological progress, investigation into the use field in the future must take place.

In the 22.5-23 GHz, 40 GHz, and 80 GHz frequencies, it is difficult to consider the practical use of the second generation because the basic technology of high voltage transmission which can cope with large decreases caused by rainfall has not yet been accomplished.

Concerning the 11.7-12.2 GHz frequency band, since the WARC-BS in 1977 at which an international agreement was concluded concerning the frequency assignment plan for the broadcasting satellite business, it became possible for Japan to use 8 channel frequencies. The country, orbit position, channel number, intersection point of the beam center and earth's surface, width of antenna beam, beam shape, , maximum radiation, etc. were specified. For example, Table 7 shows the other countries, and channels, to use an orbit position of 110° east longitude together with Japan.

Table 7. The Distribution of Frequencies Among the Broadcasting Satellite Industries of Other Countries Using the Same Orbit Position as Japan. /23

COUNTRY	ORBIT POSITION	CHANNELS		COMMENTS
Japan	110° east long.	1 3 5 7 9	clockwise	The USSR also uses orbit positions of east long. 23°, 44°, 74°, 140°
Republic of Korea	"	2 4 6 8 10 12	counter-clockwise	
D.P.R.K.	"	14 16 18 20 22	counter-clockwise	
Papua New Guinea	"	2 6 10 14	clockwise	
U.S.S.R.	"	19 23 27 31 35 39	clockwise	
	"	25	clcckwise	

This international agreement, issued in January 1979, has been in effect for at least 15 years, and will also be applied to the second generation broadcasting satellite.

Moreover, in Region 1 which includes North and South America, an RARC for Region 1 will be held in June 1983, and similar frequency distribution plans will be made for Regions 1 and 3. It has been 5 years since the WARC-BS meeting in 1977; the distribution of frequencies, which will reflect the technological progress, will be watched with keen interest.

(2) Technical Aspects of Satellite Construction and Launching.

A. Satellite Weight and the Launcher Rocket.

Since the H-I Rocket will be used as our nation's largest man-made /24
satellite launcher starting in 1985, actual development was begun in 1981. The H-I Rocket is a 3-stage rocket. The first stage of the N-II Rocket is used as its first stage; an engine with liquid oxygen and liquid hydrogen

as propellant is used in the second stage; and a large, fixed motor is used in the third stage. Thus, it is now possible to launch a stationary satellite of 550 kg. Presently, it is necessary to use a launcher rocket from another country to lift a stationary satellite of over 550 kg. After 1985 it will be possible to use the following foreign-made launch rockets: U.S. Space Shuttle (Spinning Solid Upper Stage—Delta, SSUS-D, for stationary satellite orbit weight of 600 kg; the SSUS-A for 1,000 kg); Delta Rocket (approximately 600 kg); Atlas/Centaur Rocket (approximately 1,000 kg); the European Ariane Rocket (approximately 1,000-1,400 kg). If the Space Shuttle development progresses satisfactorily, plans are to stop production of the U.S.'s Delta and Atlas/Centaur Rockets after 1987. But depending on the development of the Space Shuttle, there is also the possibility of their continued use. Of course we must thoroughly investigate the economy and reliability of using foreign-made launch rockets. But fundamentally, we must give full concern to the question of how to harmonize with the nation's broad policy of space development which calls for development of domestic production of rockets as part of the nation's basic policy.

B. Satellite Weight and Transmission Power—Number of Channels.

According to the international agreement on broadcasting satellites mentioned above, the maximum sanctioned power at the edge of the coverage region is set at -103 dBW/m^2. This value means that even when a low static receiver attachment with static heat of 500° K is attached to a 75 cm diameter parabolic antenna and 2 dB waves are lost with 20 mm of actual rainfall in one hour, and even though the reception antenna undergoes some deterioration with time, a good television visual image can be received. When using the same antenna pattern as the middle-sized test broadcasting satellite, "Yuri," to attain this -103 dBW/m^2 at the extremes of Kyushu and Hokkaido, it will be necessary to have a transmission power of 300-400 W per channel of the broadcasting satellite. But under normal conditions for the transmitter, we can receive a good visual image even with a value less than -103 dBW/m^2.

Since the launch rocket for the first generation broadcasting /26
satellite, the N-II Rocket, is only capable of launching a stationary

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satellite of about 350 kg, 2 channels are assured, with transmission power of 100 W per channel.

On the other hand, the development of a highly reliable, light, high-success ratio, big electrical generator to take aboard the satellite (TWT) is indispensable; in several countries that development is being carried out. With the strong possibility of development of a TWT generator that exceeds 300 W, it is proper to think of a TWT to take aboard the BS-3 with 100-200 W potential.

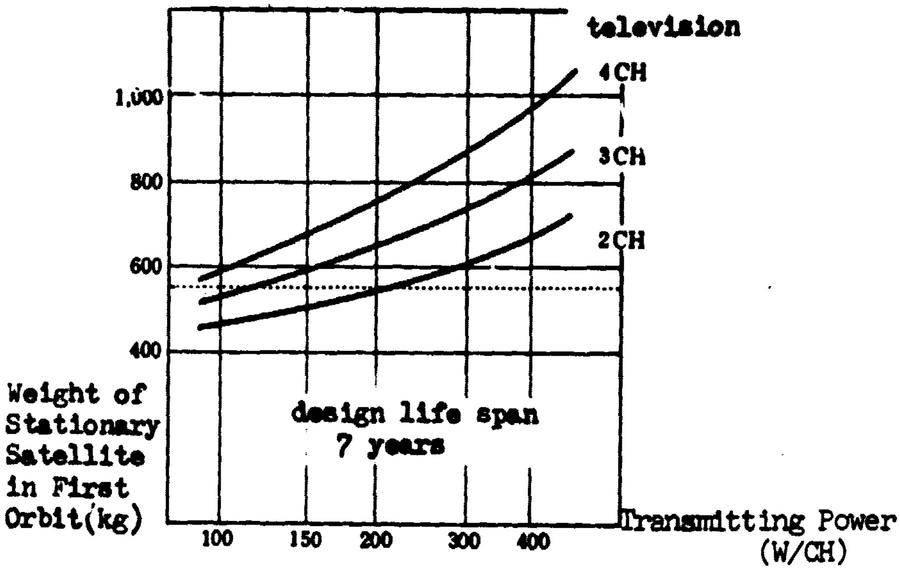

Fig. 3. Satellite Weight and Transmission Power—Number of Channels.

Note: Graph done based on the assumption of the CCIR IWP PLEN/3 Report

In order to decide how much transmission power to allot for each channel, after deciding the weight and shape of the satellite that is launchable, it is necessary to do a detailed investigation of the number of channels to be used, the satellite's life span and reliability (redundancy). Fig. 3 shows the approximate relationship between satellite weight, transmission power and the number of channels, based on a life span of 7 years. If the satellite weight is set at 550 kg, this figure indicates a satellite which is capable of 3 channels at 100 W each, or with difficulty 4 channels at 100 W each. To guarantee more than 3 channels, while giving transmission power of over 100 W per station, two or more 550 kg satellites can be used. Or, rather /27 than presuming the use of foreign-made launchers, the development of a larger satellite should be investigated.

C. Effective Use of the Reserve Satellite.

With a practical satellite, in order to avoid long periods of transmission interruption due to breakdown of the apparatus aboard the satellite, the normal method is to send a reserve satellite into orbit. But since it is very costly to produce and send a reserve satellite into orbit, it is desirable to thoroughly investigate the effective use of the reserve satellite. For example, while the practical satellite is functioning normally, it is possible to temporarily use the reserve satellite to make use of a channel for test broadcasting, etc. But in order to do this, /28 the frequency range that can be used by the relay equipment on board can be broadened, or it is necessary to carry separately on the satellite relay equipment for a reserve channel.

D. The Carrying of Relay Equipment to Relay Non-regular Programs.

As larger satellites become possible, we can consider the possibility of heavier satellites with higher electrical power. But in order not to damage the functions of broadcasting satellites of the future, we need to plan to increase the satellite's functions, and to investigate how to increase the rate of their efficient use. As one way to do this, in addition to powerful broadcasting relay equipment, we can put on board the satellite lower-power relay equipment for relaying to non-regular stations, to relay local coverage programs to the central broadcasting station by using car-based local stations to be sent throughout the nation. However, aside from problems of the satellite design and production of the second generation broadcasting satellite, in order to use relay equipment for relaying broadcasts to non-regular stations we must thoroughly investigate the frequencies, orbits, etc. to be used.

(3) Receiving Systems.

There are two kinds of receiving systems for satellite broadcasting: individual reception and cooperative reception.

A. Individual Reception.

The normal individual receiver for household use for reception of satellite broadcasting consists of a parabolic antenna, and outdoor and indoor apparatus, as shown in Fig. 4. The outdoor apparatus reduces the status of weak radiowaves, and transfers the radiowaves to the UHF band to transmit them inside the house. The indoor apparatus is for channel selection by video signals, with a hook-up to the video attachment terminal of the existing television receiver, or by retransforming these signals and hooking up to the antenna terminal of the television receiver. /29

To broadcast letters, still pictures, and PCM sound, other additional equipment will need to be added. To promote the spread of satellite broadcasting, it is important to attain the simplest reception with the smallest possible antenna. It has been proven in broadcasting satellite tests that good reception is possible with clear skies in Kyushu and Hokkaido with 100 W per channel using a 1 m diameter parabolic antenna. When it rains hard, according to calculations a 1 m diameter antenna will be needed in the central part of mainland Japan, and a 1.5 m antenna in Kyushu and Hokkaido. If the power is increased to 200 W per channel, even when it rains it will be sufficient to use an antenna of about 75 cm diameter in the central part of Japan, and one as small as about 1 m diameter in Kyushu and Hokkaido.

B. Cooperative Reception. /31

Another possible form of satellite broadcasting reception is cooperative reception. In Japan, already about 10% of all households, or about 3,000,000 households, receive earth broadcasting through cooperative receivers. There are over 28,000 such installations. If radiowaves from a broadcasting satellite are also received cooperatively as with earth broadcasting, and the existing coaxial cables are distributed to individual families, satisfactory and economical satellite broadcasting reception will be possible. However, since most of the existing equipment uses systems restricted to a maximum of 11 channels using the VHF bands, when there are not enough unused channels for satellite reception, it will be necessary to change over to a wide-band amplifier with the potential for multi-channel reception.

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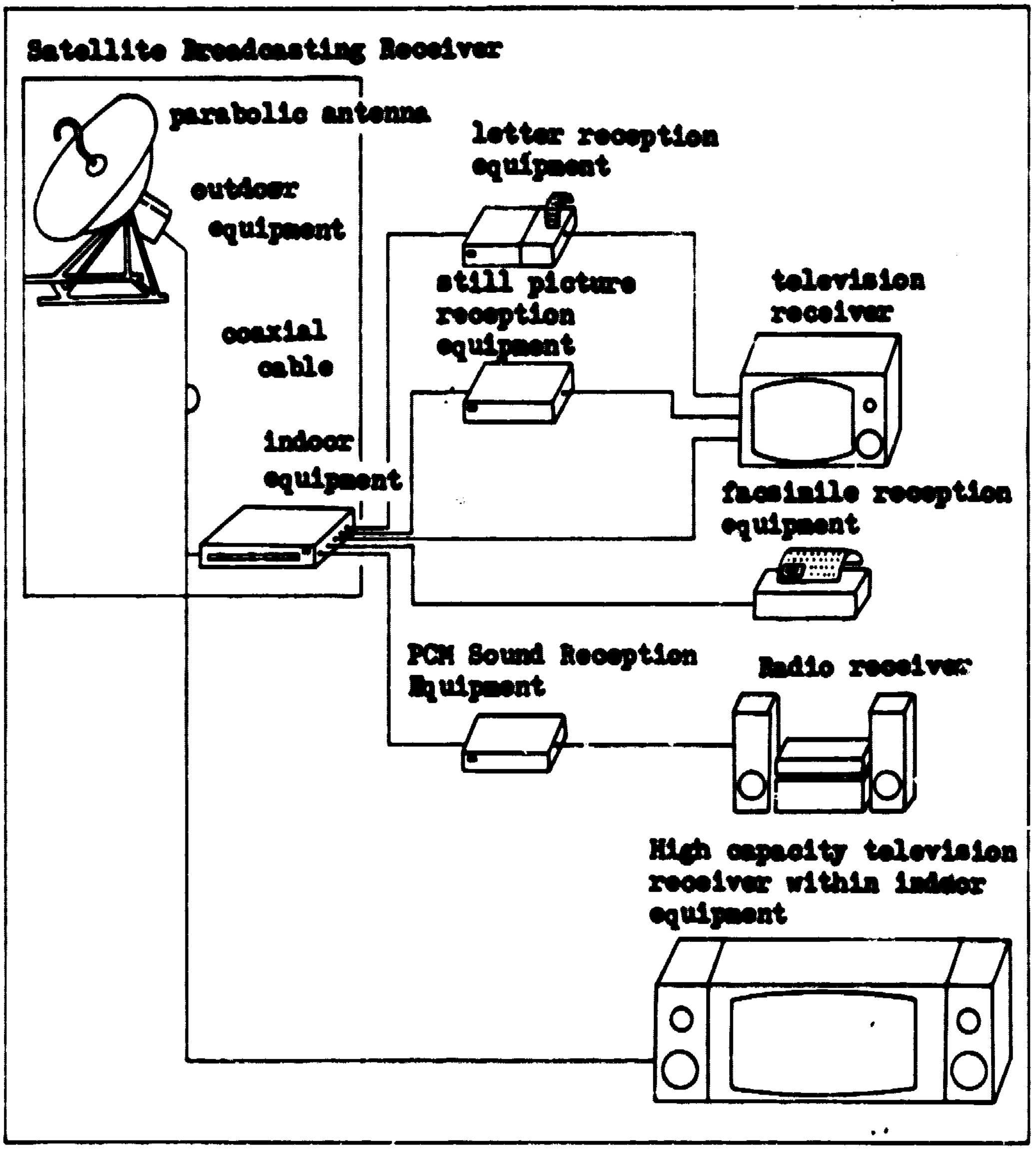

Fig. 4. Individual Reception Apparatus for Satellite Broadcasting

On the other hand, it is also possible to consider relatively low-powered satellite broadcasting with a large receiver antenna and high capacity reception apparatus. According to the Radio Transmission Rules of the International Radio Transmission Pact, this kind of broadcasting satellite is called a broadcasting satellite for Cooperative Reception. When attempting to serve a large area with limited transmission power, taking into consideration program distribution and methods of use similar to communication satellites, and when there is a communication policy of promoting a nationwide television network, it would be advantageous to /32
construct a broadcasting satellite for cooperative reception and launch it into orbit. However, considering the insufficient diffusion of cooperative receiving equipment in our country, in planning for the increased use of broadcasting satellites, it would be better to use a broadcasting satellite with powerful transmitter for individual reception than a broadcasting satellite with low-powered transmission for cooperative reception, thus resulting in benefit for more of the people of Japan.

2. Cost Estimates.

Here we have calculated the estimated costs of procuring the space parts of the program, and compared that with the costs of constructing nationwide broadcasting using earth level broadcasting. We also investigated the costs connected to receivers for satellite broadcasting. Although it is desirable to publicize and use reliable data on cost estimates in the future, it is difficult to come up with a correct budget because our nation lacks such data and there are presently many undecided variables. So this cast estimate is to give us an approximate standard for use in this investigation.

(1) Cost of Procuring the Parts in Space.

The space parts include the satellite and its control system. For this test budget we must estimate satellite construction, launching and /33
satellite control related costs.

A. Costs of Satellite Construction and Launching.

(a) Hypothetical Models.

As is explained in Part 1 of Chapter 4, the use of 3 or 4 channels is hypothesized for the second generation broadcasting satellite. Accordingly, in this cost estimate, we used the following two representative models, both 550 kg-scale satellites which can be launched using the H-I Rocket.

(I) to produce 3 satellites capable of 3 or 4 channels with 100 W per channel, and to launch 2 of them using the H-I Rocket.

(II) to produce 4 satellites capable of 2 channels with 150 or 200 W per channel, and to launch 3 of them using the H-I Rocket.

And, for an example using a foreign-made launch rocket we have hypothesized

(III) to produce 3 satellites capable of 4 channels with 200 W per channel, and to launch 2 of them using the Space Shuttle.

Each of these, as a practical satellite system, presumes the production of one reserve satellite in orbit or on earth.

(b) Cost Estimate. /34

The results of cost estimates for each of the hypothetical models are shown in Table 8.

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Table 8. Cost Estimate for Each Hypothetical Model

Model		I	II	III	(for reference) BS-2
Hypothetical Model	Satellite's Transmission Power, No. of Channels	3 100 W or 4 100 W ch.	2 150 W or 2 200 W ch.	4 200 W channel.	2 100 W chan.
	Number to be Produced	PFM: 1 FM: 2	PFM: 1 FM: 3	PFM: 1 FM: 2	PFM: 1 FM: 1
	Stationary Satellite Orbit Weight	550 kg class	550 kg class	800 kg class	350 kg class
	Life Span	7 years	7 years	7 years	5 years
	Launch Missile	H-I	H-I	Space Shuttle	N-II
Cost (in hundred millions of yen)	(1) Satellite Production (*1)	320	450	550	(*e) 230 (*f) (310)
	(2) Launch Rocket Production and Launch (*b)	280	420	150	300
	(3) Follow-up Control, etc. (*c)	90	120	90	90
	(4) Launch Insurance(*d)	35	50	20	50 (40)
	TOTAL	775	1,040	810	670 (740)

(*a) All satellite production costs are presuming domestic production, and we figured with the following methodology.

(1) First, the costs when ordering production in a foreign country were figured using the following formula, from the CCIR, IWP, and PLEN/3 reports.

Satellite Production Cost: $C=C_1 + nC_2=4.145 \times 10^4 W^{1.15} + n \times 6.40 \times 10^4 W^{0.93}$

C_1: Development Cost for PFM (Proto Flight Model) (1979 values, \$)
C_2: Production cost of one FM (Flight Model) (1979 values, \$)
n: number of FMs produced
W: stationary satellite orbit weight (kg)

(2) Next, taking into consideration the lack of technological accumulation in Japan, the cost of domestic production was estimated to be 1.5 times that of foreign production. /35

Moreover, assuming a yearly cost increase of 8%, the figures for BS-2 assume a total unit order in 1980 ($1 = 220 yen).

(*b) The cost estimate for launch rocket production and the launch was figured as follows.

(Models I and II) Cost for the H-I Rocket was set at 14 billion yen, based on the First Report, Second Sectional Meeting, Space Development Committee.

(Model III) Costs for launching an 800 kg class satellite using the Space Shuttle were based on material published by NASA in 1980. Figuring 0.5 for the capacity factor, a cost increase index of 2.0 (compared to 1975) by 1984 when the BS-2 is scheduled to be launched, and adding $8 million for the cost of use of the SSUS-A, the total is 7.5 billion yen ($1 = 220 yen).

(Reference) To launch a 550 kg satellite using the Space Shuttle, with a capacity factor of 0.3, and $6 million for use of the SSUS-D, the total comes to 5 billion yen ($1 = 220 yen).

According to ESA related publications, using the Ariane Rocket would cost 6 billion yen to launch a 550 kg satellite, and 10 billion yen for a 1 ton scale satellite (Fl = 60 yen).

(*c) Tc estimate the costs of follow-up control until the satellite reaches a stable stage, we used a figure proportionate to the costs for the BS-2. With follow-up control costs for one launch at 3 billion yen, we fixed the costs for equipment on the earth at 3 billion yen.

(*d) We estimated launch insurance at 10% of the total cost of launch rocket production, launch cost, and follow-up control cost for each launch.

(For BS-2, the cost of production of the earth reserve satellite is also included.)

(*e) Costs for BS-2 are from 1980 estimates.

(*f) Figures in parentheses for BS-2 costs are to match with hypothetical models (I) - (III) by including the cost of production of an earth reserve satellite.

B. Initial Investment for Each Channel to Procure Space Parts.

According to A above, our estimate for the initial investment for each channel is shown in Table 9.

C. Annual Expenses Per Channel to Procure Space Parts.

In Japan, the status of practical communication satellites and broadcasting satellites, and the use management of altitude control are

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Table 9. Initial Investment for Each Channel /36

Model	**(I) to produce 3 100 W-3 ch. or 100 W-4 chan. Satellite and launch 2 with an H-I rocket**	**(II) to produce 4 150 W-2ch. or 200 W-2 ch satellites and launch 3 with an H-I rocket**	**(III) to produce 3 200 W-4 ch. satellites and launch 2 with a Space Shuttle**	**(for reference) BS-2**
Initial Investment per Channel (hundred millions of yen)	**260-190**	**260**	**200**	**340 (370)**

(Note 1) The national government will bear 40% of satellite production and launch costs from scientific technology development funds. If the government will similarly bear such a fixed percentage of costs for the BS-3, the cost to the user will be reduced proportionally.

(Note 2) If satellite production for Models (I) and (II) were to be contracted in a foreign country and launched using the Space Shuttle we figure the initial investment per channel would be 15-11 billion yen for Model (I) and about 13 billion yen for Model (II).

all conducted as a unit in a communication-broadcasting satellite system. We estimate the control costs for each of the broadcasting satellite models to be around 2 billion yen annually.

Thus, in seeking a control cost per channel, if we were to convert the initial investment of B above into annual costs and add them, the annual cost for procurement of space parts per channel comes out to the figures shown in Table 10.

Table 10. Annual Costs per Channel

Model	**(I)**	**(II)**	**(III)**	**(for reference) BS-2**
Annual Cost per Channel (in hundred millions of yen)	**55-40**	**55**	**45**	**95 (105)**

(Note 1) In converting the initial investment to annual costs, the capital revulsion coefficient is 0.1921 for a 7 year life span, and 0.2504 for a 5 year life span when the interest rate is 8%.

(Note 2) If the satellite production of Models (I) and (II) is contracted in a foreign country, and they are launched using the Space Shuttle, annual costs per channel would be 2.5-3.5 billion yen for (I) and about 3.5 billion yen for (II).

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We can expect the cost per channel for procurement of space parts to be somewhat less than for BS-2 due to increased satellite size and longer life span. Compared to standard satellite production and launch costs in Europe and the U.S., there will be a considerable gap.

We can predict that procurement costs for the space parts will be considerably greater than in the past, with a yearly cost conversion at the level of several billion yen, and with the overall satellite broadcasting enterprise scale (including program production and development costs) much greater than generally imaginable.

(2) Cost Comparison to Earth Broadcasting.

For an example of nationwide broadcasting hypothesized on earth broadcasting, there is the "Report on the Broadcasting University's Basic Plan," published in 1975. That report estimates costs given 196 transmission status nationwide, providing coverage to 80% of Japan's households. Table 11 shows the results of bringing this up to date for cost increases to 1980, and comparing it to costs for satellite broadcasting.

Table 11. A Cost Comparison of Earth-Based Nationwide Broadcasting and Satellite Broadcasting

	Earth-Based Nationwide Broadcasting (covering 80% of households)		Satellite Broadcasting (Models I and II, using the H-I Rocket)	
Initial Costs (hundred millions of yen)	to construct transmitters	670	(1) Initial Investment per channel for Procurement of space parts	190-260
			(2) to construct earth Transmittor Stations	20
			TOTAL	210-230
Annual Costs (hundred millions of yen)	(1) new construction	100	(1) Annual Maintenance of Space Parts, per Channel	40-55
	(2) to maintain transmittors	34	(2) to construct and maintain earth transmittor stations	5
	(3) to use the circuits of the Telephone and Telegraph Corporation	23		
	TOTAL	160	TOTAL	45-60

(Note 1) We corrected the 1975 report's figures to 1980 values by adding 10% annually for transmitter construction, and estimating a 35% cost increase over 5 years for use of the Telegraph and Telephone Corporations' circuits.

(Note 2) We estimated (annual) maintenance costs for the earth-based transmitters at 5% of construction costs. Using the capital revulsion coefficient, construction costs have been converted to annual maintenance costs by estimating the life span of transmitters to be 10 years, and earth stations to be 7 years.

Comparing annual expenses, according to this test budget, satellite broadcasting is about 1/3 the cost of earth broadcasting. These figures presume coverage of 80% of the nation's households with nationwide earth broadcasting; if the service area is to be broadened, the costs would increase progressively. /39

(3) Expenses for Broadcasting Satellite Transmitters.

To transmit satellite broadcasting, receivers for satellite broadcasting as explained in Chapter 2, part 1 (3), are required. There are two forms of receivers, individual and cooperative.

A. Individual Receivers.

(a) Lower Costs due to Mass Production.

We can predict high priced satellite broadcasting receivers with low quantities of production but if mass production is planned the percentage for item design and model costs will diminish successively, as mechanization and the introduction of an assembly line will be possible. As it will also be possible to use monolithic integrated circuits (MIC) with gallium-arsenic semiconductors with low-static amplification which are recently being developed, we can expect a considerable drop in costs.

(b) <u>Lower Costs due to Smaller Antennas.</u> /40

If satellite broadcasting transmission power is increased, reception will be possible with small antennas. Thus, we can look forward to lower-cost antennas, but further detailed research is needed on this point.

(c) <u>Costs to Install Transmitters.</u>

The costs to install not only the receiver itself but also the antenna must be included in the costs related to the receiver. If the antenna is installed in a flat area such as in the garden or on a rooftop, installation of the antenna holder is relatively simple. But when there is not an appropriate location, a support pole can be used and the antenna attached to it. Installation costs include materials and labor. The cost will vary depending on the installation location.

If a large antenna is used, the directional characteristics will be sharper, necessitating $\pm 0.5°$ directional accuracy. So a more solid antenna installation is required to resist wind pressure and it is difficult to use a support pole for installation.

Further detailed research must be done on the costs of installation, including on the problem of installation location.

B. <u>Cooperative Receivers.</u> /41

If satellite broadcasting is to be received cooperatively using wire installation, especially if the number of households increases, larger antennas and more efficient reception equipment is required than for individual reception. It is unlikely that cooperative reception receivers will be mass produced; but with hook-ups to existing wire installations costs per household will be better than for individual reception.

Chapter 3. Types of Satellite Broadcasting Service Possible with the Second Generation. /43

According to the international agreement explained above, the allotment of channels has been decided based on present and future television broadcasting. Use of channels allotted is not restricted as long as it is realized within the agreed upon conditions of broadcasting transmission power, antenna beam width, etc. Accordingly, it is possible for Japan to use an allotted channel not only for television broadcasts, but also for letter broadcasting, facsimile broadcasting, high precision television broadcasting, PCM sound broadcasting, still picture broadcasting, etc.

The tendency is to introduce digital technology to these new forms of broadcasting, known popularly as "new media." We are confident that the technological problems related to the introduction of the various new broadcasting methods due to rapid technological advances will be successively resolved. However, due to the difficulty of establishing standardized transmission, and considering the spread of supplementary equipment for reception, the types of service available with the second generation broadcasting satellites will inevitably be limited. Our studies of the technological practicality of the types of service possible for use with the second generation follows.

1. Television Broadcasting. /44

The picture image using the standard form of broadcasting satellite for television broadcasting is basically the same as for earth broadcasting methods. But it will be possible to apply fundamentally different methods for sounds. But since it will be possible to use superior quality systems for transmission of sound in television broadcasting with broadcast satellites, it is now possible to use the FM2 and PCM supplementary wave transmission methods. Using either of these methods, it will be possible to broadcast quality sound that is suitable for earth-based, super-short wave (FM) broadcasting. Since television reception will be improved simply by attaching receivers for satellite broadcasting to existing receivers, there will be few economic and technological problems. Moreover, television broadcasting by satellites, in addition to the possibility of improving sound quality, will help audience interest grow as increased program organization diversity will be possible. Thus television broadcasting will be the main use of the second generation of broadcast satellites.

2. Letter Broadcasting.

It is possible to broadcast letters by using some of the perpendicular blanking periods in satellite broadcasting as is done in earth television broadcasting. It is also possible to broadcast letters using code transmission in satellite broadcasting. In the reception of broadcast satellite radiowaves, due to the use of reception antennas with a sharp /45 directional sense, the ratio of error due to wave reflection off construction materials, etc., is decreased, adding greatly to the benefits of using coded transmission. If the 1 megabit ROM (Read Only Memory) with a memory of 3000 characters can be built inexpensively, and use of supplemental equipment to receive letter broadcasting with letter reproduction apparatus including this memory element becomes possible, the transmission of lettered data 5 to 10 times the quantity of the pattern transmission method will be possible, using multiplex we will be able to broadcast a suitable volume of letters in reduced waiting time.

Now, when it is necessary to broadcast a large volume of letters, we can use channels by mixing PCM sound broadcasting, facsimile broadcasting, etc. But considering such factors as the economics of using the second generation, the use of multiplex television should be the first priority.

3. Facsimile Broadcasting.

Facsimile broadcasting has the feature of transmitting more detailed characters, graphs and data with light and shaded tones than in letter broadcasting. It can be used as supplement to television programs, e.g. /46 transmission of text book material, or independently with the transmission of various kinds of data. Multiple television broadcasting may be the primary method of broadcasting facsimiles using the second generation practical broadcast satellite. In order to spread the use of facsimile broadcasting, inexpensive facsimile element attachments are needed. Thus, in order to spread the use of facsimile broadcasting within a short period of time, we must investigate the cooperative use of simple, family-use, facsimile element attachments and standard memory paper. If plans are made to lower costs with technological advances in the future, at home use of high-quality, facsimile broadcast element attachments capable of transmitting photographs and in color will be possible.

4. High Precision Television Broadcasting.

As one of the objectives of television development, greatly increasing the number of scanning beams to increase the size of the screen in order to achieve increased viewing time is being investigated. This kind of television is called high precision television or high-grade wide television.

NHK led the world by starting research into high precision television /47 in 1968, playing a leading role in this field. In order to maximize viewing time, since a visual angle of 20° to 30° is necessary, the objective is to attain a big picture of 0.8 to 1 meter high and 1.5 m wide. As the result of research to date, television sets with a large picture tube of 1,125 scanning lines in 30 inches (40 cm high x 60 cm wide), and a 70 inch (90 cm high x 150 cm wide) is being test manufactured. Also, in order to bring about the practical use of high precision television, in addition to producing the programs, magnetic memory equipment capable of recording a wide range of signals is needed. Research into the necessary technology to develop such equipment, and to transmit the programs, is presently being earnestly pursued.

For high precision television a range of image signals about 4 to 5 times (20-30 MHz) that used in the existing NTSC television image signals is needed. Moreover, to transmit these signals to home televisions by broadcast satellite radiowaves, since it is necessary to make FM tone changes, etc., a radio frequency band of 60-100 MHz per channel for high precision television broadcasting is needed. This kind of broadcast which needs such a wide frequency range is particularly suitable for satellite broadcasting. In the future, looking towards the practical uses of such broadcasting, with more research to shorten the frequency range of image signals, it will be possible to meet popular expectations by test broadcasting using the two channels of the second generation practical broadcast satellite at the same time. /48

It was not assumed that the 8 channel frequencies for the broadcast satellite industry of 12 GHz allotted to Japan would be used for high precision television broadcasting. Therefore, for actual introduction of high precision television broadcasting, a new, more logical allotment of frequencies must occur, or the use of 22 GHz as a broadcast satellite industry frequency must be investigated.

5. PCM Sound Broadcasting.

If one of the channels for broadcast satellite television broadcasting is used exclusively, the 10-15 channels of stereo sound programs with excellent sound quality of earth FM broadcasting can be broadcast by PCM. Using this number of channels, radio listeners will always be able to choose what they like from, for example, classical, jazz, opera, popular songs, traditional folk songs, and other traditional Japanese music. Due to advances in digital technology, it is better to transform digital signals into analog signals; and with Digital Audio Discs (DAD) which broaden the radio frequency band to 20kHz, and PCM memory reproduction equipment, are already on the market as equipment for the public welfare. Thus, there /49 are few technological areas that will need new development to introduce PCM sound broadcasting using the broadcast satellite. But we need to examine the degree to which it will be advisable to match the standards of such high-quality digital audio apparatus which is already on the market with the quality of PCM sound broadcasting.

6. Still Picture Broadcasting.

In still picture broadcasting, a still image accompanied by sound is broadcast. Whereas in normal television broadcasting 30 picture frames and 1 sound are broadcast in one second, still picture broadcasting makes exclusive use of one channel for television breadcasting and by digital transmission up to 20 programs with one picture accompanied by high quality sound in each 4 seconds can be broadcast. Thus the viewer/listener can always choose from among these programs as he desires. Still picture broadcasting can cover the range of image-oriented broadcasting to broadcasting devoted to high-quality sound broadcasting.

The technological problem in making still picture broadcasting practical is in the development of inexpensive reception attachments. This equipment must have the capability of recording in its memory the one image which the viewer selects from the many still images sent simultaneously /50 before the next image is sent, and to reproduce that image on the picture tube of a regular television set. Since it will be necessary for the memory to hold tens of times more volumes than the memory capacity of letter broadcasting reception apparatus (64 kilobits), it will be particularly important to plan to improve the degree of integration, and bring down the cost, of integrated circuit memory elements.

Chapter 4. The Main Users and Conditions of Use of the Second Generation Practical Broadcasting Satellite.

1. Basic Philosophy Regarding the Use of the Second Generation.

Satellite broadcasting will make possible the use of new frequency resources. It is a new broadcasting media that will cover the whole nation in one stroke. And as its influence on the livelihood of the people will be large, it will be necessary for all use to be based on the following point of view:

(1) to make use of the specific character of the broadcasting satellite media;

(2) to plan for fair and effective use with participation by all the classes of people; and

(3) while taking into consideration harmony with existing earth broadcasting and reflecting the needs of the people, to plan for the diversification of broadcasting.

Also, investigation will be encouraged regarding use of the second generation based on these two basic tenets regarding the nature of the process of development.

(1) to plan for wide dissemination of satellite broadcasting with television broadcasting service as its main aspect.

Satellite broadcasting reception necessitates special receiving equipment. The first generation of broadcasting satellites were used by NHK for primarily television broadcasting as the difficulties in viewing were resolved. Thus it is important for the present to plan for the further /52 dissemination of satellite broadcasting receivers in this second generation.

For the present, of the several new broadcasting methods, the main service to be provided should be television broadcasting. This conclusion takes into consideration the state of the technology, the needs of the people, and the problems related to the reception attachments, which must all be explored regarding the potential for realization of the various broadcasting methods.

This stage should be seen as the time to plan for the wide dissemination of satellite broadcasting. Premised on the service of television broadcasting it is now appropriate to examine the realization of broadcasting with a content to awaken the needs of the people while planning for the expansion of the main users.

(2) to expand the use of channels gradually.

When considering the expansion of the use of channels with the second generation, although due to frequency allotments there is a maximum number of 8 channels for use.

(a) It is assumed that with the development of a 550 kg scale satellite which can be launched by the H-I rocket, as called for in our nation's space development policy, the maximum number of channels that can be used by one satellite is 4.

(b) We expect the actualization of a variety of new broadcasting methods, such as high precision television broadcasting, PCM sound broadcasting, and still picture broadcasting, in the third generation or later.

(c) It is appropriate to decide the use of all 8 channels after [53] satellite broadcasting has actually begun and the tendencies of the needs of the people have been clearly understood.

Taking all these into consideration, it is appropriate to assume the use of 3 to 4 channels and to expand gradually.

2. Use by NHK.

(1) The Number of Channels to be Used.

NHK will use 2 channels provided by the BS-2, with the objectives of resolving difficulties of sight and sound in general or educational television broadcasting, and to guarantee a broadcast network for use in time of disaster. Since the need to continue such use is recognized, NHK will continue to use 2 channels provided by BS-3.

(2) What that Use Should be.

As a public broadcasting organ, it will be necessary for NHK to continue to plan to resolve the difficulties of sight and sound in television broadcasting by using satellites. At the same time, the wider dissemination of satellite broadcasting must be planned, and the benefits of broadcasting satellites, in which much capital has been invested, must be restored to the general viewer as soon as possible. But the forms of use of the two channels will not be simply the same as in earth broadcasting in the second

generation; while considering ways to resolve the sight and sound /54
difficulties, it is necessary to examine use forms that also benefit the general viewer.

Spcifically, we recommend the following plan.

A. <u>Time Differences, or Encore [illegible] ion of Programs.</u>

Since the time of activity of the nation's people is becoming more diversified, time-difference or repeat programs of earth broadcasting will be developed, the viewing opportunities of the general viewer will be increased, and the desire for re-broadcasting will be met.

B. <u>The Introduction of Independent Satellite Broadcasting Programs.</u>

By including independent satellite broadcasting programs not possible with earth broadcasting, many of the needs of the nation's people for public broadcasting will be satisfied.

In order to introduce these plans, besides making use of the regular broadcasting time periods, it is also possible to have, for example, extended broadcasting after the conclusion of earth broadcasting. It will be desirable from now on to continuously investigate to what extent which of these plans should be implemented.

On the other hand, for example, instead of using Telephone and Telegraph Corporation circuitry to relay the same program nationwide through local broadcasting stations, such as for educational television broadcasting, by using a satellite the transmission of the program can occur while the program is happening. But in this case, the broadcasting by satellite of /55
the same programs already broadcast by earth broadcasting is not compatible with efforts to flexibly form programs with satellite broadcasting.

Concerning the various new broadcasting methods, in order to further advance the technological developments to date by NHK, while doing test broadcasting using satellites as necessary, and in order to more clearly understand the needs of the nation's people, the establishment of trial service for the viewers' viewing and listening should be flexibly examined.

Concerning use by NHK, starting with the BS-2 stage, it is desirable to plan towards setting up schemes to develop programs, and by increasing the general viewers' interest, the spread of satellite broadcasting will follow.

3. Use by Broadcasting University.

(1) The Suitability of Satellite Use.

The Broadcasting University was established in July 1, 1981, under the Broadcasting University Law. The plans are to open the Broadcasting University in 1985. In the first period plan (for 4 years beginning in 1985), provisionally the Kanto area (the area reached by UHF television broadcasting waves or FM broadcasting waves from Tokyo Tower or from prefectural broadcasting stations in Gumma Prefecture) will be the target area and students are being accepted. Future plans to broaden the target area will be decided taking into consideration the successes of realization of the first period plan, tendencies in the practical use of broadcasting satellites, etc.

In the "Report of the Broadcasting University's Basic Plan" proposed in 1975, it was presumed that the actualization of the use of broadcasting satellites would take many years. But we are presently ahead of the plan, and in light of recent advances in the development of broadcasting satellites this basic plan must be re-examined. It is now time for us to thoroughly examine the use of broadcasting satellites as a tool to spread the Broadcasting University's broadcast network nationwide.

Use of broadcasting satellites by the Broadcasting University has the following advantages.

A. As it is desirable due to the nature of the Broadcasting University for people throughout the nation to be able to receive the broadcasts, the broadcasting satellite will be applied to accomplish just this.

B. Using broadcasting satellites it will be possible to effectively use the frequencies available.

C. Even when compared to the coverage of 80% of households aimed at by the earth broadcast network, the costs of transmission will be considerably reduced (see Chapter 2, Part 2 (2)) /57

The necessity for the installation of receivers for satellite broadcasting is a problem effecting the use of broadcasting satellites. But since we believe satellite broadcasting will spread in the long run, this is not such a big obstacle.

So the use of broadcasting satellites is appropriate as a tool for the Broadcasting University to spread nationwide.

(2) The Suitability of Use from the Second Generation.

Use of BS-3 will be possible in 1989, 5 years after the beginning of the Broadcasting University. Assuming that classes begin in 1985, we can predict increased viewers' desires throughout the nation; chronologically it will be just after the end of the first period plan. From the point of view of planning for the fast development of the Broadcasting University, it is appropriate to begin use of the satellites at the BS-3 stage.

A. As development of the BS-3 must start in 1984, uses must be determined quickly. So it will be necessary to re-think our future plan to expand the areas to be reached on the basis of the results of the first period plan.

B. If study centers on earth are to be consolidated nationwide, by 1989 when use of the BS-3 is to begin, measures to provide for a considerable budget will be needed. /58

C. In particular, in the first stage of the spread of satellite broadcasting, we should examine some way to defray the costs of receivers for satellite broadcasting.

All these problems need to be constructively examined by related agencies towards the end of introduction of broadcasting satellite use.

(3) Forms of Use.

The Broadcasting University has planned to develop 232 courses using actual broadcasting for the last year of the first period plan. These will include courses in television and sound broadcasting. For the time being, given the possibilities for channel use, it is most appropriate to use most of the radiowaves in the BS-3 stage for television broadcasting.

In the future, taking into consideration the establishment of convenient viewing time, we must investigate more effective methods of use such as still picture broadcasting.

4. Use by Private Broadcasting Companies. /59

(1) The Significance of their Introduction in the Second Generation.

The significance of introducing use by private broadcasters in the second generation is as follows.

First, it will have a great influence on plans to disseminate the use of satellite broadcasting.

If private-based use is to be introduced as well as that of NHK and the Broadcasting University in the second generation, we can look forward to the satisfaction of a broader field of viewer needs, not limited by the viewing difficulties and small number of channels of private broadcasting.

Second, looking towards the future 8-channel age, they will play a pioneering role.

Looking forward to the practical use of a variety of new broadcasting methods in the 8-channel age of satellite broadcasting, they will play an important role as part of the broadcasting industry. But at present it is difficult to make judgments about problems such as technological potential, the needs of the people, and financial management.

As a transition stage into the 8-channel era, if private broadcasters use one channel of the BS-3, it will be even more possible for them to solve such problems, making it possible to switch over smoothly to 8 channels.

(2) ~~Programs that Could be Offered~~.

As reported above (Chapter 4, Part 1), television broadcasting will be the main service to be offered. But we must actively look into new /60' broadcasting methods, and, depending on technological advances, not only test broadcasting but also the establishment of trial services for the viewers.

As for television broadcasting service, in order to encourage the spread of satellite broadcasting and in terms of business management, it is appropriate to develop programs with contents that broadly meet the needs of the nation's people. Also in order to meet the needs of areas which already have a number of earth broadcasting channels, it is necessary to avoid the production of programs similar to those on earth broadcasts. Basically, it is necessary to produce broadcasting and movies, sports, and other broadcasting specials in certain fields--in short, distinctively put-together new programs--that meet the needs of viewers scattered throughout the nation. This is also connected to planning for broadcasting diversification. Since it will not necessitate added expense to produce new programs, the re-broadcasting of already existing private broadcast programs should also be considered.

(3) Form of Administration.

Since satellite broadcasting is a new broadcasting media that can reach the whole country in one swoop, it has a great deal of influence on the livelihood of the Japanese people. Likewise, at the BS-3 stage, the administration of satellite broadcasting use by private broadcasters should not be monopolized by special individuals, but a pluralistic form of organization for program production and development should be guaranteed.

Yet since satellite broadcasting is a broadcasting service with various points that have no precedent in private broadcasting, there will be numerous unknown elements of administration, and until receivers have been disseminated to a certain degree there will be administrative difficulties. Moreover, as this body will be expected to play the role of bridging the gap to the 8 channel era, it will have to take on multiple efforts and tests in the fields of program make-up, resource development, and new broadcasting methods.

Thus, at the BS-3 stage the form of administration for the use of one channel should be one body to plan for wide participation by the nation's people. While bringing out original schemes from the participants, this body should be of an appropriate character and scale to also make possible effective business management.

Since the development of BS-3 will begin in 1984, it is necessary to establish that body quickly to plan for the introduction of use by private broadcasting businesses. And considering the above circumstances, corresponding work within related agencies is needed.

Since a large number of users will be using a small number of channels, and planning for a pluralistic provision of programs, it would also be possible to divide the body into two: one to produce and develop programs,/62 and one to install and manage radio installations. Considering the characteristics of satellite broadcasting, in the future it will be worth it to examine the legal aspects of this, and to divide the businesses into so-called soft and hard ones. However, this is not only true for satellite broadcasting. In the future there will be radical changes in the general thinking of the broadcast industry. And for now, we should plan for the substantial diversification of programs offered by administrative schemes.

(4) Financial Resources.

If private broadcast companies will be using broadcast satellites in the second generation, there is a problem of how to develop the financial resources for such an undertaking.

Assuming there will be 8 channels in the future, it is necessary to assure financial resources with firm growth potential for the development of satellite broadcasting, and for the development of the total broadcasting industry, including ground-based broadcasting. In the second generation, it is desirable to investigate to a certain extent the directions for the future.

For the present, commercial broadcasting and pay television are assumed to be concrete methods to develop financial resources. It is also possible to use both methods together. But further examination is needed.

A. Commercial Broadcasting.

Commercial broadcasting is beneficial to the spread of satellite /63
broadcasting because it does not directly pass the costs to the viewer. After satellite broadcasting receivers have been installed in much greater numbers, commercial broadcasting which uses satellites will attain seperiority over existing private broadcasting companies in the race to acquire sponsors for nationwide broadcasts. If we cannot expect great growth in the commercial market, we must take care about what impact this will have on the existing private broadcasting companies. However, for the time being the number of receivers installed will be limited, and the demand for commercials to sponsor nationwide programs of the traits of satellite broadcasting will be limited in the second generation. Thus it seems that it will be difficult to acquire sufficient revenue from advertisements.

B. Pay Television.

Pay television is a service received when viewers have the desire to watch special television broadcasts, and they make a compensation contract with the broadcasting company.

The introduction of pay television to satellite broadcasting will develop a new financial resource. The advantages are that it will reduce the impact on existing private broadcasters; it is a way to directly acquire income from viewers all over the country, and administration will be possible even without a high rate of viewers. On the one hand, since people contracting for this service will be dispersed throughout Japan, and there will be /64 many of them, the establishment of a large-scale customer service system will be necessary. It will also be necessary to study scramble and other techniques to stop others from listening in, given the increased number of people taking out contracts. It will also be necessary to look into the necessity and ways of regulating fees, as well as unauthorized listeners and the sale of decoders. The relationship to NHK's receiver fee system will also need to be considered.

In the examination of the introduction of pay television, it is necessary to progress with a survey investigation toward the goal of quickly resolving these problems. And at the BS-3 stage trials can be done.

Chapter 5. Recommendations for Use of the Second Generation Practical Broadcast Satellite. /65

We have examined the above aspects of use of the second generation practical broadcast satellite, but there are still a large number of policy topics which must be actively pursued. Among them, the following are our recommendations regarding topics of importance which should be dealt with promptly by related organizations.

1. To Plan for the Gradual Increase of Channel Use.

The use of 2 channels by NHK of the first generation has already been planned for the purpose of resolving visual and audio difficulties of television broadcasting. In the second generation it would be desirable to increase the number of channels used to more sufficiently satisfy the broad needs of the nation's people.

It is necessary to investigate the number of channels to be used with the following information in mind:

(1) Taking into consideration the national space development plan which propels the establishment of autonomous technology, it is necessary to plan for the use of satellites.

(2) We hope that, in addition to the continued development of broadcast related technology, a variety of new broadcasting methods will be realized in the near future.

(3) Presently the needs of the people related to broadcast satellite use fields are not being adequately understood.

Accordingly, all 8 channels Japan has available will not be used immediately, but channel use will be gradually expanded. In addition to NHK continuing to use 2 channels, the Broadcasting University and new broadcasting companies should use one channel, or they should be able to use one channel each.

2. <u>To Plan for More Effective Use of Satellites by NHK</u>.

In the first generation, the purpose of NHK's use of broadcast satellites was to resolve visual and audio difficulties, and to provide a broadcast network for times of emergency. It is appropriate for NHK to continue to use 2 channels for these purposes. Also, from the viewpoint of spreading the use of satellite broadcasting, it would be desirable to look into several plans for the development of programs such as the re-broadcasting of earth broadcasting programs.

NHK should also continue with the technological developments it has been pursuing in the field of high precision television broadcasting and other new broadcasting methods. Examination of trial broadcasting in these areas to promptly realize their practical use to meet the needs of the people is also needed.

3. <u>To Plan for the Early Use of Satellites by the Broadcasting University.</u>

In order to realize the early nationwide diffusion of the Broadcasting University, it is both timely and economically appropriate to begin use of the BS-3 in 1989 when such use will be possible.

We believe it is appropriate to allot one channel to the Broadcasting University which will be providing broad opportunities for quality education to the nation's people. So it is necessary for related agencies and /67
organizations to actively examine this with the goal of early use of satellites by the Broadcasting University.

4. <u>To Promptly Establish a Business Organization of Private Broadcasting Companies.</u>

If new, private broadcasting companies are to use broadcast satellites, rather than just helping to solve visual and audio difficulties, and not limited to areas where there are only a small number of channels, it will add to the satisfaction of viewer needs, and to the spread of satellite broadcasting. On the other hand, satellite broadcasting will have a great influence on the livelihood of the people, considerable initial investments will be necessary, and a variety of trial programs will be expected. Thus it is appropriate to allot one channel for the present to new, private broadcasting companies with participation by broad sectors of the population.

Since BS-3 is scheduled to be launched in 1988, it is necessary to form the business organization by 1984 when production will begin, and to start looking into a variety of issues. It is necessary for the related organizations to actively and effectively take proper steps towards this end.

As for the administration of this body, taking into consideration such things as the broadcasting of distinctively new programs, and while engaging in a diversity of efforts to develop financial resources through pay television and commercial broadcasting, the possibility of conducting tests of new broadcasting methods as the occasion demands for technological development should be studied. /68

5. <u>To Make Pertinent Decisions about Transmitting Power for Satellites.</u>

As the transmitting power per channel is increased with satellites, reception with a small antenna will become possible. With a transmitting power of 100 W, receivers will need antennas with a 1 - 1.5 m diameter. With 200 W, 0.75 - 1 m diameter antennas will be sufficient. Thus the price of antennas will come down, and besides the conditions for attaching antennas to more household, the security of the antennas vis a vis earthquakes and strong winds will also be improved.

On the other hand, increasing the needed number of channels by planning for increased transmission power also greatly increases satellite weight and size, so it will be necessary to study a system to use a number of domestic satellites or the broad introduction of foreign technology.

Since a decision about transmission power is closely related to the spread of satellite broadcasting, thorough examination from an overall perspective must be carried out by related government agencies and the user organizations.

6. <u>To Plan for the Reduction of User Costs for Satellite Production and Launching.</u>

In order to encourage space development with stability in Japan, the development of independent technology is being pursued while planning for /69 harmony with the state. However, since the scale of development activities is small, and the number of satellites launched is few, the accumulation fo investment has been low, and the cumulation of technology has been insufficient to date. Therefore, although we must continue plans for use, and development, the costs of production and launching of the satellites that will actually make use possible will be considerably higher than in Europe and the U.S.

Rather than passing all the costs of use for the launcher missile developed with this independent technology on to the users, keeping in mind the standard costs of production and launching in various foreign countries, it is necessary to consider the possibility of the national government actively covering a good portion of the costs for development.

It is also necessary to devise measures for the national government to help defer the cost of launching substitute satellites if there is a faulty launching.

If this is not possible, it will be necessary to study the use of economical foreign launcher missiles or the broad introduction of foreign technology.

7. To Devise a Policy Regarding the Various Receivers to Disseminate Satellite Broadcasting.

In order to spread the use of satellite broadcasting, it is indispensable to offer programs which meet the needs of the people. At the same time, /70 it is necessary to devise for good reception by viewers according to the following steps.

(1) Lowering the Price of Receivers.

We can look forward to a lowering of the price of satellite broadcast receivers for the first time only with mass production. Thus in the first stages of production, we should stimulate the related industries to develop a circuitry element that will make mass production possible, and to make receivers shaped for easy dissemination. It would also be beneficial to devise a good tax scheme.

(2) A Policy to Aid Cooperative Reception Facilities in Remote Areas Where Viewing is Difficult.

Presently, financial aid measures have been taken to promote cooperative reception facilities in remote areas where viewing is difficult. Even with satellite broadcasting in the future, the main form of reception will be cooperative. So when the cost per household gets high, it will be necessary for the national government or local public groups to take on a policy similar in gist to the one now in practice.

(3) Constructive Practical Use of Cooperative Reception Facilities.

When satellite broadcasting is received cooperatively, the reception cost per household may generally be lower than for individual reception. Also, if satellite broadcast programs are received cooperatively, and they are retransmitted using cable television broadcast facilities, it will give rise to an increase in people affiliated with these facilities, and /71 will lead to further development of the business.

Thus it is desirable for the related organizations to study the technology and systems that will promote reception of satellite broadcasting with existing or newly-established cooperative reception facilities.

8. To Encourage Trial Broadcasting of New Broadcasting Forms.

The desires of the people regarding broadcasting are becoming more diversified, and technological progress has been remarkable. So in order to accurately understand viewers' demands for new broadcast forms, and to create the most appropriate, standard receivers so as not to interfere with technological progress, it is necessary to aggressively carry out trial broadcasting before actually broadcasting in the new forms. In order to increase the efficiency of use, and to effectively carry out trial broadcasting, it is desirable to study cooperative efforts by government research agencies, and various satellite broadcast businesses, and to consider the use of unused time on presently existing channels, and the use of reserve satellites, and other possibilities.

Appendix 1. A List of Members of the Survey Research Commission for Development of Uses for Radiowaves, Practical Satellites' Subcommittee. /73

	NAME	OCCUPATION
Chairman	Yujiro Hayashi	Assistant Director, Future Engineering Research Institute (foundation)
Deputy Chairman CS-3 SubComm. Chairman	Noboru Makino	Vice-President, Mitsubishi General Research Institute (corporation)
BS-3 SubComm. Chairman	*Hiroshi Hirayama	Professor, Waseda University
BS-3 SubComm. Deputy Chairm.	** Hiroshi Shiono	Professor, Tokyo University
member	*Makoto Aso	Professor, Osaka University
"	Sumiko Iwao	Professor, Keio Gijuku University
"	Shozo Iwasaki	Director of Planning, Japan Telephone Telegraph Corporation
"	**Jiro Ota	Professor, Ochanomizu Womens University
"	*Yukio Omori	Broadcast Critic
"	Teruhiko Kashiwagi	Director, Captain System Development Institute (foundation)
"	Kimito Kusaka	Consultant, Japan Long-Term Trust Bank (corporation)
CS-3 SubComm. Deputy Chairm.	Kiyosuke Komatsuzaki	Managing Director, Electrical Communications General Research Institute
member	Yoshio Saito	Director, Communication and Broadcasting Satellites Organization
"	Risaburo Sato	Professor, Tohoku University /74
"	*Kazuo Sugiyama	Managing Director, Japanese Federation of Private Broadcasters
"	**Ryo Takahashi	Managing Director, Technical Director, NHK
"	*Shigeru Tateno	Former Director of Broadcasting Division, Ministry of Postal Services, Radiowaves Control Department
"	Tamiya Nomura	Professor, Space Science Research Institute
"	*Yoshio Hasegawa	Managing Director, Oriental Land (corp.)
"	Kihachi Haraguchi	Chairman, Electrical Communication Committee, Japan Newspaper Association (incorporated)

member	*Shoichi Hirai	Director, Space Development Body
"	Kenichi Miya	Vice-President, Kokusai Denshi Denwa (corporation)
"	*Kenya Murano	President, Ken Research
"	*Bonji Morikawa	Director, Development Committee, Federation of Economic Organizations
"	Soji Yamamoto	Professor, Tohoku University

Notes: The names of committee members are listed in (Japanese) alphabetical order, and titles have been shortened.

* indicates members of the BS-3 sub-committee

** indicates members of the drafting committee

Appendix 2. Meetings of the Survey Research Commission for Development of Uses for Radiowaves, Practical Satellites Subcommittee. /75

1. Sectional Meetings.

DATE	DELIBERATIONS	REMARKS
6.4.80	(1) election of chairman, nomination of deputy chairman (2) meeting procedures (3) basic thinking for survey research (4) formation of subcommittees, and nomination of subcommittee chairmen and deputy chairmen (5) plan and schedule for the sectional and subcommittee meetings	
6.5.81	(1) a (proposed) report on survey research on uses of the second generation practical communications satellite (2) BS-3 subcommittee interim report	
3.23.82	A (proposed) report on survey research on uses of the second generation practical broadcasting satellites	

2. BS-3 Subcommittee. /76

6.4.80	Explanation of Japan's Space Communications	CS-3 and BS-3 joint subcommittee meeting
6.30.80	(1) Explanation of the Reality and Future of Space Communications in Foreign Countries (2) Explanation of the Distinct Capabilities of Satellite Communications and Broadcasting (3) Explanation of the System of Communication and Broadcasting in Japan	"
11.14.80	The technological possibilities for satellite Broadcasting (1) Explanation of frequencies and orbit allotted for broadcast satellites (2) Explanation and study of future observations for broadcasting satellite technology	Misao Matsushita (Vice-Chief, NHK General Technology Research Institute)

2.27.81	Cost Estimates for Satellite Broadcasting (1) Explanation and study of cost estimates for the second generation of satellite broadcasting (2) an explanation of an outline of Comset's satellite broadcasting plan	
4.21.81	Explanation and study of Proposed Use Fields after BS-3	Etsuo Kimura (NHK Technical Headquarters, Vice-Chief)
6.5.81	Study of Use by NHK	
7.10.81	Use by Private Broadcasting Companies (1) Explanation of "Survey Report on Broadcasting Satellites," Private Broadcasters Federation (2) Study of Use of Broadcasting Satellites by private broadcasting companies	Eisuke Shibasaki /77 Director of Planning, Private Broadcasters Federation
9.9.81	Use by the Broadcasting University (1) an explanation of the Broadcasting University plan (2) study of use of broadcasting satellites by Broadcasting University	Tohru Aoyanagi General Director Broadcasting University
10.13.81	(1) explanation and study of use for new broadcasting methods (2) study of uses for specialized broadcasting (3) study of the form of organization of private broadcasters	Eiichi Sawabe (NHK General Technology Research Institute, Vice-Chief)
11.11.81	(1) study of the problems related to introducing pay television to satellite broadcasting (2) study of broadcasting satellites for cooperative broadcasting	establishment of the Drafting Committee
12.11.81	Study of the essential points of the (proposed) report	
2.9.82	Consideration of the (proposed) report	
3.4.82	"	

3. BS-3 Subcommittee Drafting Committee /78

12.2.81 Draft of essential points of (proposed) Report

2.1.82	Drafting the (proposed) report
2.19.82	Study of the (proposed) report