Satellite communications in the Pacific hemisphere

Wedemeyer, Dan.

1984

Wedemeyer, D. (1984). Satellite communications in the Pacific hemisphere. In AMIC-ISEAS-EWC Workshop on Information Revolution in Asia-Pacific : Singapore, Dec 10-12, 1984. Singapore: Asian Mass Communication Research & Information Centre.

https://hdl.handle.net/10356/86383

Satellite Communications In The Pacific Hemisphere

By

Dan J Wedemeyer

Satellite Communications in the Pacific Hemisphere

Dan J. Wedemeyer, Ph.D.
Associate Professor
University of Hawaii-Manoa

Introduction

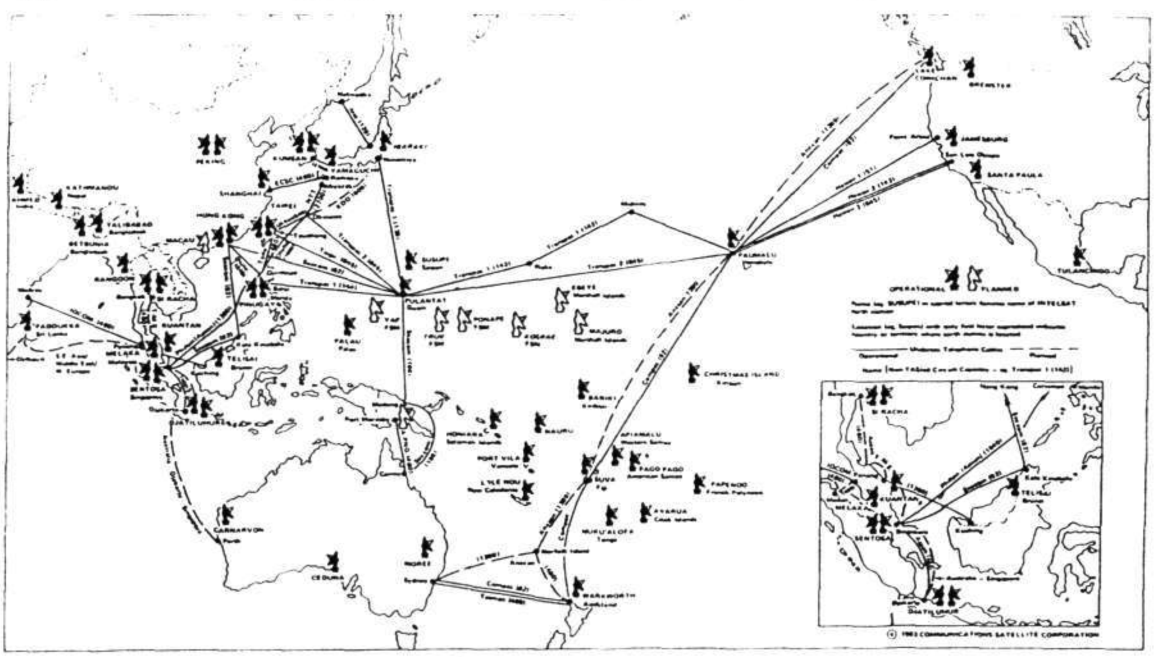
Satellite communications, along with other telecommunication technologies, hold great implications for the future of commerce, cultures and communication in the Pacific hemisphere. The technology and the expanding services base are engineering a connectiveness that is so rich that we now speak in terms of a Pacific Telecommunity. The vastness of the Pacific is being "bridged" electronically to solve problems, share information and trade our wares. The communication satellite resources have the ability to promote information-oriented opportunities on an equal basis regardless of location or traffic volume within a basin encompassing 64 million square miles (40% of the Earth's surface) and one-half of the world's population (17). This is done, on the surface in a purely technical manner, but a rich array of domestic, regional and global organizations have coordinated the development of these linking resources. This paper sets out the technical and organizational aspects of satellites serving within and around the Pacific hemisphere.

The long-haul communication network in the Pacific is comprised of two basic systems: satellites and undersea cables. This configuration provides the pathways and redundancies required to serve basic and enhanced telecommunication services for a wide range of users. Undersea cables link nearly 25 locations and provide services to a large number of thick-route locations. Presently the Pacific hemisphere's cable systems are being expanded by the addition of the ANZCAN (Australia/New Zealand/Canada) coaxial copper cable providing 1380 circuits and the Japan-Hawaii-U.S. mainland undersea fiber-optic system forecast to provide up to 40,000 circuits by the end of this decade. While undersea cables are essential to Pacific-wide communication, the focus of this paper is on satellites, their technical aspects and the national activities organizing their use.

Global satellite communication in the Pacific is only 18 years old. The earliest system, INTELSAT II (Lani Bird), dates back to October 26, 1966. Presently there are seventeen communications satellites (excluding North American domestic satellites and military systems) and more than 80 transponders serving the Pacific hemisphere. These serve domestic, regional and global users.

COMSAT WORLD SYSTEMS

PACIFIC REGION CABLE & SATELLITE FACILITIES



By 1987 it is estimated that seven countries in the region will have ationally-dedicated satellite services, and many more will be leasing NTELSAT circuits for domestic telecommunication. These countries with dedi-ated domestic satellites include: Australia (2), Canada (5), India (2), ndonesia (2), Japan (2), Mexico (2), Pakistan (2) and the United States (42).

While dedicated domestic satellite service is particularly important in erving national needs and identity, some countries have chosen cooperative entures. The leading example of this is the Palapa system based in Indone-ia. Palapa I and II have transponders leased to Thailand, the Philippines, ingapore, and Malaysia. AUSSAT is another system which projects shared atellite resources between Austrailia and Papua New Guinea.

Global systems which serve within the Pacific hemisphere includes, NTERSPUTNIK, INTELSAT and INMARSAT. This paper will include sections on NTELSAT and INMARSAT, but will not deal in much detail with the military or ublic telecommunication systems provided by INTERSPUTNIK. In short, though, NTERSPUTNIK has 14 signatories: The Soviet Union, 6 Warsaw Pact nations, fghanistan, Laos, Mongolia, South Yemen, Syria, Vietnam, and Cuba. The Gori-ont satellite operates in the C-Band (6/4 Ghz) and voice circuits to reach he limited number of earth stations are leased at about 60% of what it would ost to lease INTELSAT circuits(4).

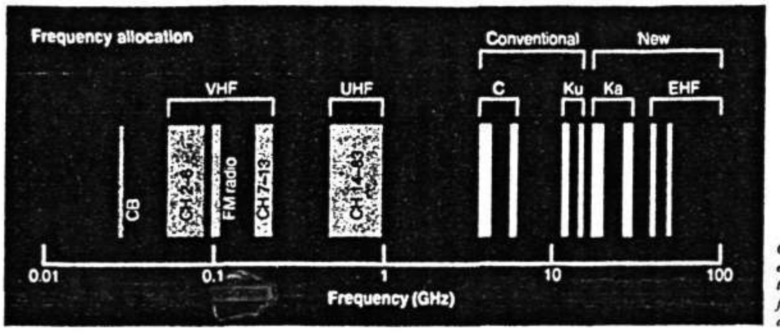
The remainder of this paper describes some technical aspects of ommunications satellites and satellite systems, major international and omestic satellite activites and some of the future plans for satellite-based ystems in and around the Pacific.

Technical Overview of Communication Satellites

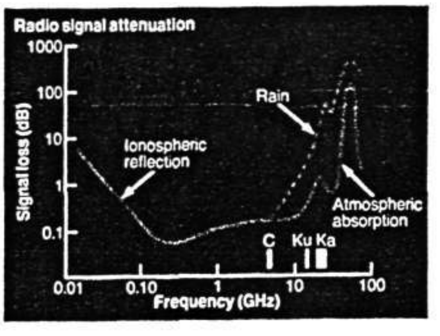
Communication satellites are artificial satellites which amplify and convert the frequency of signals received from earth stations. The resulting signal is then retransmitted back to ground-based receivers. Communication satellites operate in geostationary orbit 36,000 km. (22,300 miles) in space. Today's communication satellites primarily operate in two frequency bandwidths, the C-Band and the Ku-Band. The C-band satellites utilize frequencies in the 6/4 Ghz range, while the Ku bands are much higher, operating in the 14/11 GHz range. Frequency bands which are less often used for satellite communication include the S-band (2.5 GHz), X-band (8/7 GHz, military use only) and the Ka-Band (30/20 GHz).

	TELECOMMUNICATIONS SATELLITE FREQUENCIES (GHz)		
LETTER BAND	EARTH TO SPACE (UPLINK)	SPACE TO EARTH (DOWNLINK)	SHORT NAME
S	2.655 - 2.690	2.500 - 2.655	2.5
C	5.925 - 6.425	3.700 - 4.200	6/4
X	7.900 - 8.400	7.250 - 7.750 *	8/7
Ku	14.000 - 14.500	10.950 - 11.200 ** 11.450 - 11.700 **	14/11
Ku	14.000 - 14.500	11.700 - 12.200 ***	14/12
	17.300 - 18.100	12.200 - 12.700	DBS ****
Ka	27.500 - 30.000	17.700 - 20.200 20.200 - 21.200 *	30/20 30/20 *
	30.000 - 31.000	42.500 - 43.500 *	30/44 *

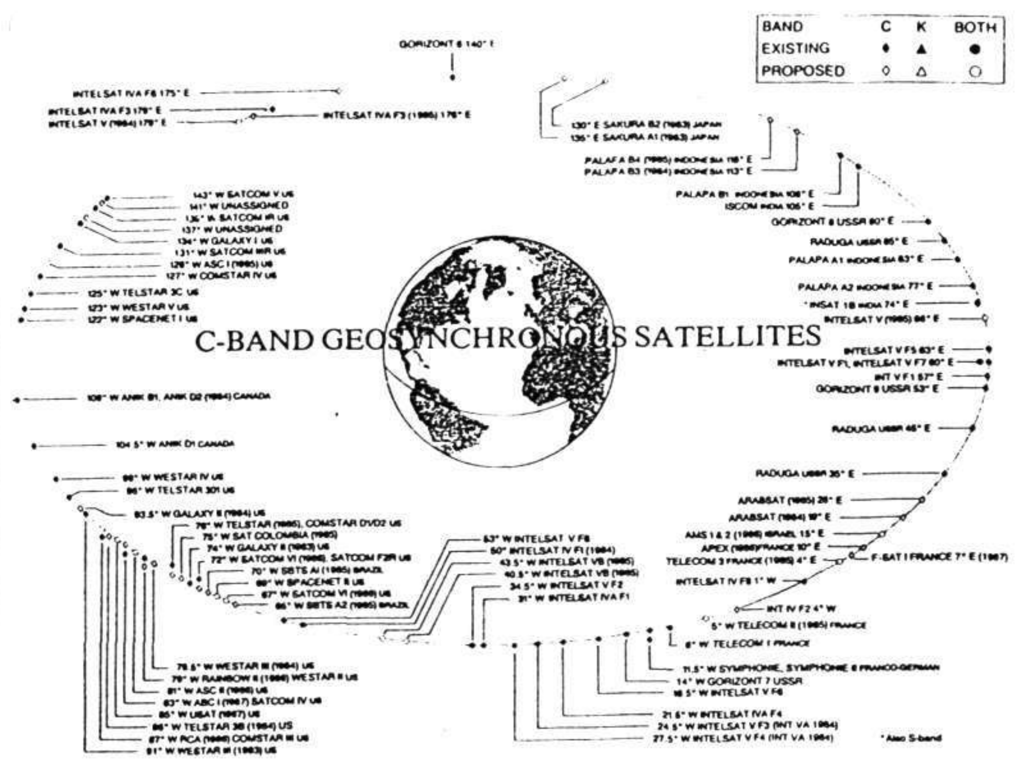
In the Pacific, most international satellites are C-band systems, while most of the domestic satellites and the latest INTELSAT models are operating

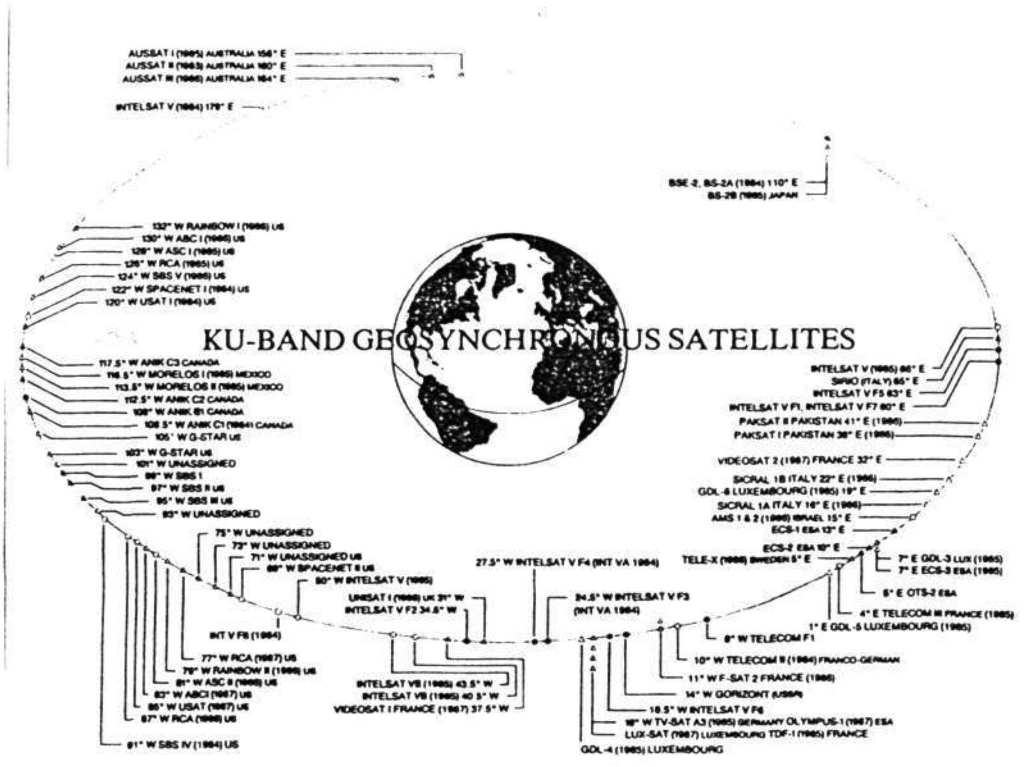


Operating in Ka band will enable future communications satellites to avoid interference with existing C-band and Ku-band satellites.



in the higher frequencies. Many late-model satellites are hybrids, capable of operating in both C and Ku bands. In general, the higher the frequency, the higher the information carrying capacity. However, higher frequency satellites have signficiantly higher signal loss due to atmospheric absorption or rain. The high frequency satellites will require higher transmission power in order to counter signal attenuation. Station keeping, or keeping the satellite in proper orbital position, is also more delicate in higher frequency satellites. For example, a C-band satellite can be "seen" from earth if it occupies an in orbit cube of 90 miles, while a Ku-band satellite must be within an area one-half the size. The following diagram indicates the number and position of C- and Ku-band geosynchronous satellites:




KU-BAND GEOSYNCHRONOUS SATELLITES
INTELSAT V (1984) 179° E
BSE-2, BS-2A (1984) 110° E
122° W SPACENET I (1984) US
120° W USAT I (1984) US
117.5° W ANIK C3 CANADA
112.5° W ANIK C2 CANADA
105° W G-STAR US
103° W G-STAR US
101° W UNASSIGNED
93° W UNASSIGNED
75° W UNASSIGNED
73° W UNASSIGNED
71° W UNASSIGNED US
INT V F8 (1984)
91° W SBS IV (1984) US
27.5° W INTELSAT V F4 (INT VA 1984)
24.5° W INTELSAT V F3 (INT VA 1984)
INTELSAT V F5 63° E
VIDEOSAT 2 (1987) FRANCE 32° E
7° E GDL-3 LUX (1985)
7° E ECS-3 ESA (1985)
4° E TELECOM III FRANCE (1985)
1° E GDL-5 LUXEMBOURG (1985)
8° W TELECOM F1
10° W TELECOM II (1984) FRANCO-GERMAN
18.5° W INTELSAT V F6
GDL-4 (1985) LUXEMBOURG

The required orbital separation or spacing of the C- and Ku-Band satellites also varies. Proper orbital spacing ensures against one satellite signal interferring with an adjacent satellite signal. C-Band satellites have recently changed from 4 to 3 degrees spacing, while the Ku-Band requirement is 2 degrees. Thus, domestic and international technical regulations establish how many satellites can legally occupy the geostationary orbital arc, making it, in this sense, a finite resource.

Other technical characteristics are also important. The power of the satellite, for example, determines the requirements of earth station size. If greater investments in on-board satellite power are made, then the ground stations can be lower powered and less expensive. The relationship is also true in the reverse situation. That is, low power satellites require higher powered, larger and more expensive earth stations. Other technical tradeoffs are evident with regard to narrow-beam and broad-beam "footprints." Spot-beams concentrate the footprint on a relatively small area of the earth, usually high-traffic areas, and therefore perform much the same as a cable would, serving a select group of users. Global-beam coverage on the other hand, is less discriminating, but more costly, in terms of satellite power and groundstation requirements.

Another rule of thumb also prevails with regard to the footprint. That is, the closer one is to the center of the footprint the higher the E.I.R.P., the smaller and less expensive, the earth station can be. Higher latitudes also dictate larger, more expensive groundstations due to atmospheric interference and angle of elevation. The angle of elevation is the angle at the antenna between the satellite and the Earth's horizon. Usually 5^{o} is the minimum practical angle of evaluation for reliable communication. Therefore reception at high latitudes is very different.

Man-made interference is also a problem in lower-frequency satellites. The C-band satellite operates within frequencies that are near to those of terrestrial microwave. This terrestrial interference may require locating earth stations away from urban areas or constructing relatively expensive earth station shields. This means that many users cannot have their own ground stations if they require reliable communication service.

All of these technical tradeoffs and more must be taken into consideration if appropriate satellite systems are to be configured. Each location or application, then, is unique. The system must be designed specifically for each user. With these tradeoffs in mind, it is useful to examine a number of the national, regional or global solutions to these problems.

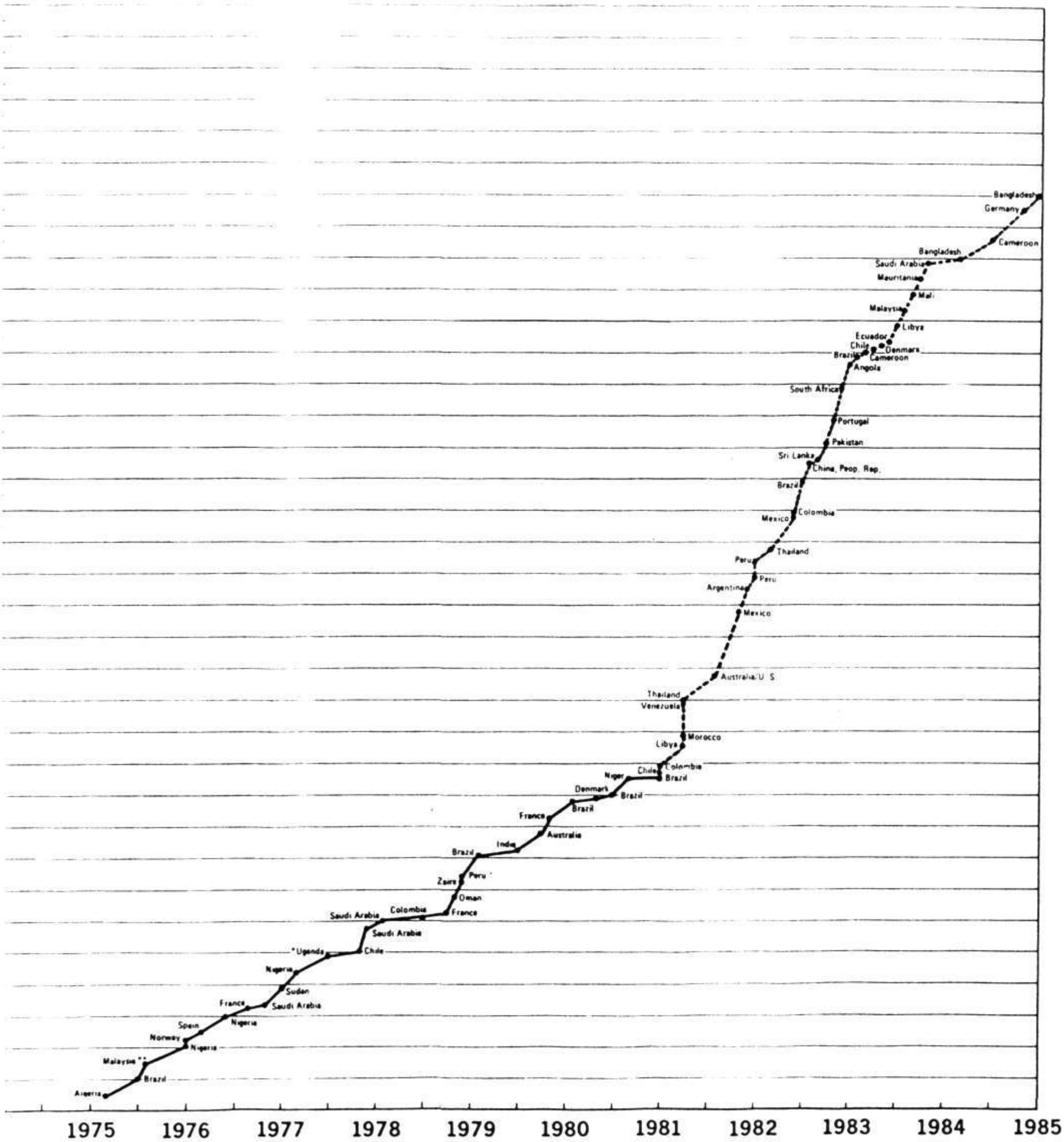
The INTELSAT System

The International Telecommunication Satellite Organization (INTELSAT) originated in August of 1964 when 11 countries agreed to form a global commercial communication satellite system. In 1984 the number of countries holding investment in INTELSAT totals 108 with an equity of $1.4 billion (U.S.). Each shareholder is required to invest based upon use, with a minimum of 0.05%. Presently the largest owner of Intelsat is the Communication Satellite Corporation (COMSAT) with 24.35%, British Telecom follows with 12.99% and France owns 5.45% (6).

INTELSAT is headquarted at 490 L'Enfant Plaza, N.S., Washington, D.C. 20024, U.S.A. The present Director General is Richard Colino.

The organization is responsible for the space segment, design, development, construction, operation and maintenance of communication satellites. The ground stations are owned and operatd by entities within the country where they are located. INTELSAT provides service to 170 countries, territories and possessions (thirty-two) of these locations are within the Pacific hemisphere. In order to participate, most locations purchase a standard A, B, C earth station. The Standard A earth station is 29.5 - 32 meters, and operates at 6/4 GHz, Standard B 11 - 13 meters and operate at 6/4 GHz and, Standard C is 16.7 - 18.9 meters and operates at 14/11 GHz, and are designed to function with increased spot beam coverage of INTELSAT V and future satellites. Two other standard earth stations are available, the Standard Z antennas, designed for leased domestic service and Standard E's for operations with INTELSAT's international business service. Costs vary significantly, but as an example, a Standard E (large, 11 - 13 meters) would cost $1.0 - 1.5m (U.S.) and a Standard E (small, 6-8 meters) $150 - $300k (14). A T.V. receive-only (TVRO) runs about $20k. All require $50 - $75k additional equipment costs. Growth of INTELSAT Domestic lease has been rapid--from 10 transponders in 1980 to nearly 60 by 1985.

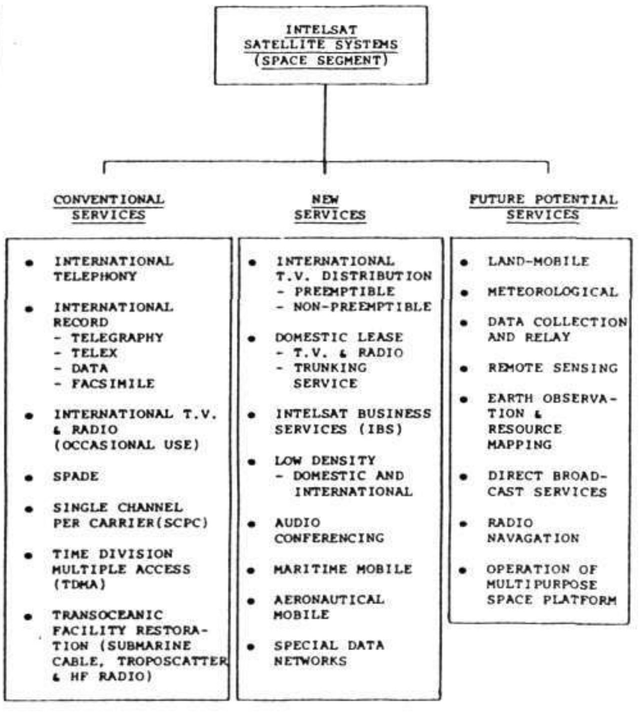
GROWTH OF INTELSAT DOMESTIC TRANSPONDER LEASES



* TERMINATED LEASE EFFECTIVE APRIL 1979

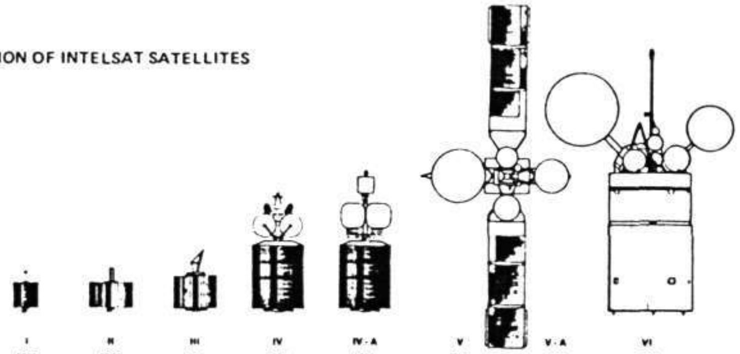
** TERMINATED LEASE EFFECTIVE 31 JULY 1980

Three classes of services are provided/planned by INTELSAT. These are the conventional services, new services and future potential services. (7)



All conventional and new services are available in the Pacific. These are offered on the current satellite serving the region, the INTELSAT IV-A, located at 175 E and 179 E degrees.

EVOLUTION OF INTELSAT SATELLITES



INTELSAT DESIGNATION	I	II	III	IV	IV-A	V	V-A	VI
YEAR OF FIRST LAUNCH	1965	1966	1968	1971	1975	1980	1983	1986
PRIME CONTRACTOR	HUGHES	HUGHES	TRW	HUGHES	HUGHES	FORD AEROSPACE	FORD AEROSPACE	HUGHES
DIMENSIONS (Undeployed)								
WIDTH, m.	0.7	1.4	1.4	2.4	2.4	2.0	2.0	3.6
HEIGHT, m.	0.6	0.7	1.0	5.3	6.8	6.4	6.4	5.3
LAUNCH VEHICLES	THOR DELTA			ATLAS CENTAUR		ATLAS CENTAUR, OR ARIANE 1, 2		STS OR ARIANE 4
SPACECRAFT TRANSFER ORBIT MASS, Kg	[illegible]	182	293	1,385	1,400	1,946	2,140	12,100/3,720
COMMUNICATIONS PAYLOAD MASS, Kg	13	36	56	185	190	235	280	[illegible]
POWER EOL EQUINOX, Watts	40	75	134	480	[illegible]	1,270	1,270	2,200
DESIGN LIFETIME, YEARS	1.5	3	5	7	7	7	7	10
RATED VOICE CHANNEL CAPACITY IN AOR	480	480	2,400	8,000	12,000	25,000	30,000	80,000
BANDWIDTH, MHz	50	130	300	500	[illegible]	2,300	2,100	[illegible]
ANTENNA BEAM COVERAGES								
C - BAND	TOROIDAL NORTHERN ONLY	TOROIDAL ALMOST FULL EARTH	DESPUN EARTH COVER	DESPUN EARTH COV AND 2 SPOTS STEERABLE	DESPUN EARTH COV. AND 2 HEMI	3 - AXIS EARTH COV 2 HEMI, 2 ZONE	3 - AXIS DUAL POL EARTH COV 2 HEMI, 2 ZONE 2 SPOTS	DESPUN DUAL POL EARTH COV, 2 HEMI, 4 ZONE
Ku - BAND	N.A.	N.A.	N.A.	N.A.	N.A.	2 SPOTS STEERABLE	2 SPOTS STEERABLE	2 SPOTS STEERABLE
L - BAND	N.A.	N.A.	N.A.	N.A.	N.A.	EARTH COV	N.A.	N.A.

This satellite has a capacity of 6000 circuits and two TV channels, yielding the equivalent of 20 transponders. Built by Hughes, launched in January and March 1978, they have a design life of seven years.

INTELSAT IV-A

Size
2.4 m (7.8 ft) diameter
2.8 m (9.2 ft) solar panel height
6.8 m (22.9 ft) in overall height

Weight
1,515 kg (3,340 lb) at launch
793 kg (1,745 lb) after apogee motor firing

Characteristics
Capacity: average of 6,000 circuits plus two TV channels. Design life: seven years. Has 20 transponders, each with a 36-MHz bandwidth. Employs a design permitting the simultaneous use of the same frequencies through the use of directional antennas for both reception and transmission, effectively yielding the equivalent of 20 transponders. The satellite has twin 1.3 m (4.42 ft.) transmit dish-shaped antennas. The receive and transmit antennas utilize two sets of feed horns working in conjunction with a third dish-type reflector.

Launch Vehicle
Atlas Centaur, General Dynamics, Convair Division

Spacecraft Contractor
Hughes Aircraft Company

Two INTELSAT IV-A's are in orbit, one acting as primary and the other in back-up position, offering pre-emtable service.

The INMARSAT System

Headquartered in London, England, the International Maritime Satellite Organization (INMARSAT) is an international joint venture charged with providing satellite communication to shipping and offshore industries around the globe. Created in 1979, operations began in 1982 and utilized the existing MARISAT satellites to serve maritime communications needs. Today, much higher capacity satellites, MARECS and INTELSAT V MCS, provide telephone, telex, facsimile and data communication to membership totaling 40 nations. The United States is the largest shareholder in the system (23.4% is owned by COMSAT General), the Soviet Union owns 14.1%. Others holding major shares include

Japan, U.K. and Norway. Globally, more than 85% of all commercial ship tonnage is carried by members of INMARSAT (2).

Pacific Ocean communications are sent to and from Santa Paula, California (U.S.), Ibariki (Japan), Singapore, Nakhoda (USSR). Planned coastal earth stations include Hong Kong (1985/86) and Lake Cowichan (Canada, after 1985).

On-board ship signals are received and transmitted via a randome-enclosed 1.2 meter antenna. The on-board ship standards for INMARSAT antenna fall into four categories. Each varies with respect to antenna diameter and types of services offered. These can be summarized as (11):

Inmarsat

Satellites

The present array of satellite facilities is:

- Atlantic: Marisat F1, Marecs-A
- Indian Ocean: Marisat F3 & Intelsat V-F5/MCS
- Pacific: Marisat F2

Inmarsat Ship Station Standards

Units	A*	B†	C†	D†
Antenna diam. (m)	0.8-1.2	0.5	0.2	3
Fig. of merit (dBi/K)	−4	−10 to −15	−19 to −26	+6
Services				
Voice				
Multichannel				X
1 channel	X			
Reduced quality		X		
Telex	X	X	X	X
Data				
2400 baud	X	X	X	X
56 kb/s	X	(ship shore)		X

* Current standard

† Possible future standards

Inmarsat Satellite

Satellite	Marisat	Marecs	Intelsat V/MCS
Owner	Comsat Gen'l	ESA	Intelsat
Manufacturer	Hughes	Brit Aero	Ford Aero
Mass at BOL (kg)	327	509	N/A
Lifetime (years)	7	7	7
First Launch	1976	1981	1982
Mid-band Frequencies, MHz & (bandwidth, MHz)			
Receive	1640.5 (4)	1641 (6*)	1640.25 (7.5*)
	6422 (4)	6422.5 (5)	6421.25 (7.5)
Transmit	1539 (4)	1540 (5)	1538.75 (7.5)
	4197 (4)	4197.5 (6*)	4196.25 (7.5*)
EIRP (dBW) in Each Band			
(dBW) @ Edge	27	34.7	32.8
	18.8	16.6	21.2
Oceans Served	All	Atlantic	All
Number of Satellites	3	1†	4
Full Circuits	10	46	30
Lease/Satellite ($US)	5M/3	60M/2	?
Stabilization	Spin	3-axis	3-axis
See *Satellite Comm.*		May 1981	June 1981
VERIFIED		January 1983	

* Including 0.5 MHz for safety & rescue (distress).

† The second Marecs was lost on Ariane L5. A replacement will probably be launched in 1984 for the Pacific Ocean Region.

The two satellites used in the Pacific region are MARISAT, launched in 1976, and owned by COMSAT General; and, INTELSAT V-MCS, launched in 1981, and owned by INTELSAT. MAREC-B2 will be available in January of 1985. The footprint of the Pacific maritime satellite is as follows:

Services are provided to improve the ability to manage maritime and offshore business operations as well as promoting safety of property and life at sea. A wide range of services are offered. General classes of service include telephone, telex, facsimile and voice/data services. Specifically these include (2):

From Ship

Estimated Time of Arrival
Navigation Data
Daily Reports
Weather Routing
Cargo Stowage Plans
Maintenance Scheduling
Spare Parts Inventories
Payroll Data
Passenger/Crew Social Calls
Private Business Calls
Well Log and Mud Log Data
(Measurement While Drilling)
Engine, Fuel Monitoring Data
Emergency and Distress Calls
High-Speed Seismic Data
Offshore Early Warning Data
Slow Scan Television

From Shore

- Weather Forecasts
- Fleet Management
- Ship Agent Coordination
- Group Calling
- Ship Rerouting
- Spot Market Charters
- Cargo Plans
- Fueling Information
- Port Conditions
- Medical Advice
- Provisions
- Crew Rostering
- News Reports (Maripress)
- Voyage Planning

As of September 1984, 2475 ships were listed in INMARSAT Ship Earth Station Directory (6).

Other Major Pacific Satellite Players

There are a number of nations engaged in major satellite activities in and around the Pacific. Each of these national entities deserve mentioning as they are foci of resources and activities which constitute a major telecommunication development effort.

Some of these major players are Japan, South Korea, Pakistan, China, Australia and New Zealand. The scope of this paper precludes detailing the very important and abundant North American satellite resources in Canada, the United States and Mexico. Although I will not specify these systems a matrix of the systems is included here (11).

North American Domestic Satellites

Name	Operator	Launch Date(s)	Number of Transponders per Satellite	Total Bandwidth (MHz)	Uplink (GHz)	G/T (dB/K) edge	Downlink (GHz)	e.i.r.p (dBW) edge	Lifetime (years)	Orbit Location (West Longitude)
ABC1 1 to 2	Adv. Bus. Comm.	86	20	864	14.0-14.5		11.7-12.2	41-47.5	10	83 & 130
Aurora I (formerly Satcom V)	Alascom, Inc.	82	24	864	5.925-6.425	6	3.7-4.2	34 SSPA	10	143
Aurora II-III	Alascom, Inc.	89, 91	24	864	5.925-6.425	4	3.7-4.2	34-38	10	137° & 141°
ASC 1-3	American	85, 86, 87	18	1296	5.925-6.425	4	3.7-4.2	34 & 36	7.5	128, 81, 101°
	Satellite Co.		6		14.0-14.5	2	11.7-12.2	42		
ASC 4-5	American	89, 89	24	3390	5.925-6.425	5	3.7-4.2	34 & 37	9.5	93
	Satellite Co.		19		14.0-14.5	2 to +5	11.7-12.2	42-50		
			3		29.5-30.0	+12	19.7-20.2	51.5		
Anik A2 to A3	Telesat Canada	73 & 75	12	432	5.925-6.425	6	3.7-4.2	33	7	114 & 114
Anik B	Telesat	78	12	864	5.925-6.425	6	3.7-4.2	36	7	109
	Canada		6		14.0-14.5	+0	11.7-12.2	47		
Anik C1 to C3	Telesat Canada	82-84	16	864	14.0-14.5	+3	11.7-12.2		8	112.5, 107.5 & 109
Anik D1 to D2	"	82 & 84	24	864	5.925-6.425	6	3.7-4.2	36	-	104.5, 110
CCC 1 & 2	Columbia		24	1728	5.925-6.425		3.7-4.2	36-47	10	62.5° & 147.5°
	Comm. Corp.		24		14.0-14.5		11.7-12.2			
Comstar D1-D4	Comsat General for AT&T/GT&E	76, 76, 78, 81	24	816	5.925-6.425	4.5	3.7-4.2	33	7	76, 76, 86 & 127
Comstar K1-K3	Comsat General		16	864	14.0-14.5	+2	11.7-12.2	47-50	10	93° & 101°
Digisat IA & II	Digital Telesat	88	24	864	14.0-14.5	0.5	11.7-12.2	44	10	57° & 134°
Digisat IB	Digital Telesat	86	24	864	5.925-6.425	1.5	3.7-4.2	37	10	57°
Equastar	Equatorial	87, 88	24	864	5.925-6.425	1.1 to 7.6	3.7-4.2	30-36	10	93°, 122°
Ford 1 & 3	Ford Aerospace	88	48	1728	5.925-6.425	3	3.7-4.2	35, 40 & 50	10	101°, 93° & 73°
					14.0-14.5	1	11.7-12.2	43-47		
Galaxy I-IV	Hughes Comm.	83, 83, 84	24	864	5.925-6.425	3.4	3.7-4.2	34.5	9	134, 74, 93.5, 137°
Galaxy H5-H7	Galaxy, Inc.	86, 87, 88	16	832	14.0-14.5	0	11.7-12.2	50	10	73°, 75° & 93°
Gstar A-1 to A-3	GTE Satellite	84-87	16	864	14.0-14.5	+1.6	11.7-12.2	43.1	10	103, 105 & 101°
	Martin Marietta	88	28	5132	14.0-14.5	+2 & -2	11.7-12.2	46.5	10	75, 73
Mexico 1 & 2	Mexico	85 +	18	1008	5.925-6.425	-9	3.7-4.2	approx. 35	9	113.5 & 116.5W
			4		14.0-14.5		11.7-12.2			
RSI I-II	Rainbow Satellite, Inc.	85, 86	16 @ 54 MHz	864	14.0-14.5	1	11.7-12.2	40-46	8-10	132 & 79
RSI III-IV	Rainbow	87, 87	20 @ 43 MHz	860	14.0-14.5	0	11.7-12.2	46-49	8-10	75° & 93°
Satcom IIIR & IV	RCA Americom	81, 82	24	864	5.925-6.425	6	3.7-4.2	32 & 34	10	131 & 83
Satcom IR, IIR & VI	RCA Americom	82-85	24	864	5.925-6.425	6	3.7-4.2	34 SSPA	10	139, 86
Satcom VII-IX	RCA Americom	89-91	24	864	5.925-6.425	2	3.7-4.2	36	10	65°, 63°, 61°
Satcom K1-K3	RCA Americom	85-87	16	864	14.0-14.5	+3	11.7-12.2	45	10	77, 67, & 126
Satcom K4-K6	RCA Americom	89-91	16	864	14.0-14.5	+3	11.7-12.2	45	10	65°, 63°, 61°
Satcom Hybrids	RCA Americom	88-91	(Same as Satcoms VII to IX plus K4 to K6)							65°, 63°, 61°
SBS 1-3	Satellite	80, 81, 82	10	430	14.0-14.5	+1.8	11.7-12.2	37-43.8	7	99, 97, 95
SBS 4	Business	84	10	430	14.0-14.5	+1.8	11.7-12.2	37-50	7	89
SBS 5 & 6	Systems	86, 87	14	870	14.0-14.5	1	11.7-12.2	47-49	10	124, 99
SBS 7-9		87, 88, 90	19	785	14.0-14.5	1	11.7-12.2	38-45	10	93°, 97°, 95°
Spacenet 1-3	GTE Spacenet	84-86	12	1296	5.925-6.425	5	3.7-4.2	34 & 36	7.5	122, 69 & 91
			6		14.0-14.5	5	11.7-12.2	39		
Spotnet (K) 1-4	National Exchange, Inc.	87	24	864	14.0-14.5	11.6 & 8.6	11.7-12.2	56.9 & 59.9	10	2 @ 101°, 2 @ 75°
Spotnet (C) 1-2	National Exchange, Inc.	87	24	864	5.925-6.425	3.9	3.7-4.2	34	9	101°, 75°
Telstar 301 to 304	AT&T Comm.	83-88	24	864	5.925-6.425	5	3.7-4.2	32 to 36	10	87, 95, 128, 125°
USAT 1-4	U.S. Satellite Systems, Inc.	85, 86, 88 & 89	20	860	14.0-14.5	+1.5	11.7-12.2	40-48	8	85, 120, 75° & 83°
Westar III	Western Union Telegraph	79	12	432	5.925-6.425	7.4	3.7-4.2	33	7	91
Westar IV-XVII	Western Union Telegraph	82-2000	24	864	5.925-6.425	1	3.7-4.2	34	10	98.5, 119.5, 78.5, 96, 99.5, 81°, 93°, 91°, 79°, 99°, 123°, 130°
Westar A-F	Western Union Telegraph	88-95	16	864	14.0-14.5	0.4	11.7-12.2	45 TWTA	10	93°, 91°, 87°

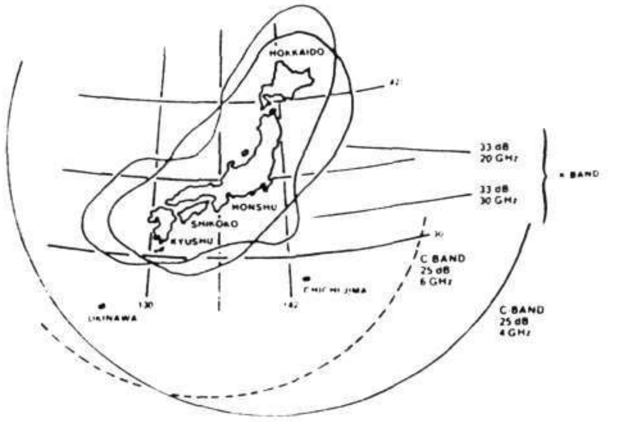
*Applications pending at the FCC 1/15/84

In summary there are more than 80 satellites in operation or already planned before the year 1990. The number of transponders totals 839.

The Japanese Situation

The Japanese are very much the leader in Asian space technology. Japan started experimenting with Direct Broadcast Satellite Technology (DBS) in 1977. At that time the Mitsubishi/Ford Aerospace built satellite named Sakura was launched. This medium capacity broadcasting satellite proved that color video and audio could be received by a simple parabolic antennae. In 1983 CS-2a and 2b were launched. While each of these advanced satellites carried signals in the C-Band, six transponders operated in the Ku-band (30/20 GHz). Future CS-2 satellites will use 30/20 and 50/40 GHz "integrated transponders." This means that multibeam antennas with onboard signal regeneration and satellite switching will be used to obtain a high capacity satellite (11). A summary of CS Antenna Coverage and technical details is as follows:

CS (Sakura) and CS-2a & -2b



CS Antenna Coverage Areas.

Summary Table

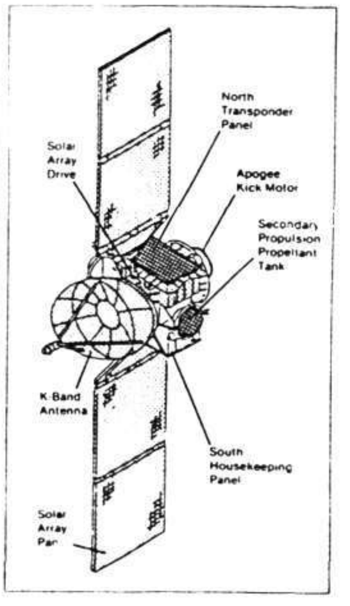
Parameter	CS	CS-2
Owner	NASDA	NASDA & NTT
Launches	1977	1983 (2)
Control Center	Tsukuba	Kimitu & Tateyama
Orbit Locations	135 E	130 & 135 E
Transponders	2 at 6/4 GHz + 6 at 30/20 GHz (each)	
TWTA Power (W) at 4 & 20 GHz	4 & 5	5 & 6
Bol Mass (kg)	350	350

Another series of Japanese Direct Broadcast satellites was launched in 1978. The "Yuri" satellite series, BSE, BS-2a, and BS-2b, can be received on earth stations ranging from 1.6-4.5 meters. The outlying regions of the "footprint," including Korea, require the 4.5 meter dish. Spill-over problems brought protests from the South Korean government. While BS-2a allows reception at remote individual homes far from the main island of Japan, cries of "cultural aggression" were launched from Korea. While transponder failures have quieted Japan's neighbors, a next generation satellite waits to be launched in the summer of 1985. The following figure depicts the footprint of these satellites and summarizes some of the technical characteristics.

Japan's Broadcasting Satellites
BSE (Yuri), BS-2a & BS-2b

Summary Table

Parameter	Value		
	BSE	BS-2	WARC-77
Developer	National Space Development Agency		
Launches	1978	84 & 85	88?
Launcher	Delta	N-2	H or STS
Orbit Locations	110	110	110 East
TV Transmitters	2	2	8
eirp	55.3	55.3	63.2-64.4 dBW
Mass at Beginning of Life	354	350	— kg
Power at End of Life	780	800	15,000 watts
Minimum Lifetime	3	3	— years



Japan now plans to build even more powerful DBS systems in the 22 GHz-27 GHz frequency range and will deploy them in the early 1990's. Accompanying these powerful satellites will be a wide variety of high-performance receiving antennae which are targeted for non-Japanese markets in such locations as Latin America, the Middle East and Western Europe. More about future satellite application will be provided later in this paper.

Indonesia's Satellite Environment

The Indonesian's can be credited with a bold decision regarding national satellite development. As a result, Indonesia was the first Asian country to initiate its own domestic communication satellite system. The Palapa system went into operation in 1976, providing television, telephone and telex services to 5000 widely scattered islands. The Palapa system was planned and is operated by PERUMTEL. Hughes has built the Palapa A and B series which now serves domestic as well as regional communication needs. Presently, the system is being used by other Asean countries, first by Thailand and now by Singapore, Malaysia and the Philippines. The second generation Palapa (B1) was launched in 1983 and recently the B2 was lost after its launch from the U.S. space shuttle. In November 1984, the B2 satellite was recovered from its incorrect orbit and returned to Earth for repair and relaunching.

Presently more than 40 small earth stations (less than five meters) constitute the domestic system serving more than 120 million people. Projections of 100 or more earth stations will be realized in the near future. Financing for the $75 million system comes in part from U.S. banks and Eximbank. The following figure describes Palapa-B's coverage and Palapa-A and B's characteristics (11).

Palapa

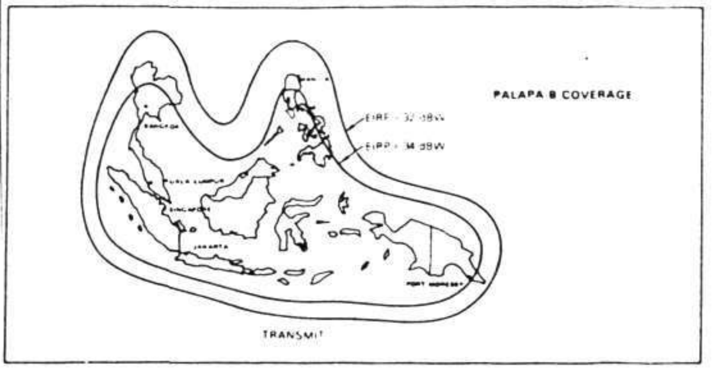


Table of Comparative Performance Summary			
Parameter	**Palapa-A**	**Palapa-B**	**Units**
Transponders	12	24	
TWTAs	12	30	Tubes
Power/tube	5	10	Watts
eirp-Indonesia	32	34	dBW
—ASEAN	27	32	dBW
G/T-Indonesia	−7	−5	dBi/K
Mass on orbit	294	638	kg
DC power (min.)	300	831	Watts
Satellites	2	2	
Locations	83 & 77	108, 113 & 118	E. Long.
Lifetime	7	8	Years

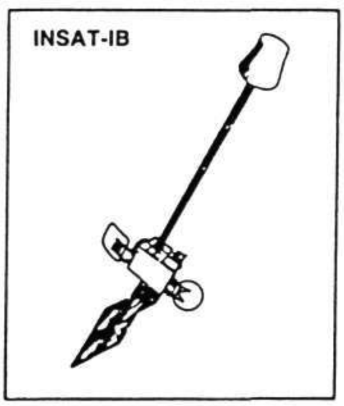
Palapa's success has inspired other countries (e.g. Thailand) to plan in mplement their own national satellite systems.

ndia's Satellite Experience

Satellite experimentation began in India with the SITE project, 1975. ITE stood for Satellite Instructional Television Experiment, a project which eamed health, family planning and farming information into six Indian states ia the NASA ATS-6 satellite. SITE proved that rural areas could successfully eceive television-based information using small antennae (less than three eet) constructed from simple materials (e.g., chickenwire). This led to follow-on experiments in 1981 when APPLE was launched from the European Space Agency's Ariane rocket.

INSAT-1A was launched in 1982, but failed to achieve long-term service. After this malfunction the Soviet Union permitted access to its Statsionair satellite until INSAT-1B was launched by the U.S. space shuttle in 1983.

Insat-



Satellite Names:	Insat-IA, IB & IC*
Owner:	Government of India
Launches:	1982, 1983, & 1986*
Launcher:	Delta, STS & STS*
Locations:	(drifting), 74°E & 94°*
Transponders:	12 of 36 MHz each at 4 GHz, 2 of 36 MHz each at 2.6 GHz (also DCP & meteorological)
Nominal Lifetime:	7 years
TT&C Center:	Hassan, India
Verified:	June 12, 1984

*Respectively

Plans call for a second operating satellite in 1986 financed by insurance money ($65.5 Million) resulting from the loss of INSAT 1. At mid-year, 1984, about 1000 direct reception sets were in operation with plans for 8000 by the end of the year. By mid-1985 India projects it will reach 70 per cent of its population with broadcast satellite programming. By 1990 (INSAT-1B is projected to fail by the first quarter of 1991) the government intends to operationalize a fully domestic-developed, next generation, INSAT system.

The Australian National Communication Satellite System

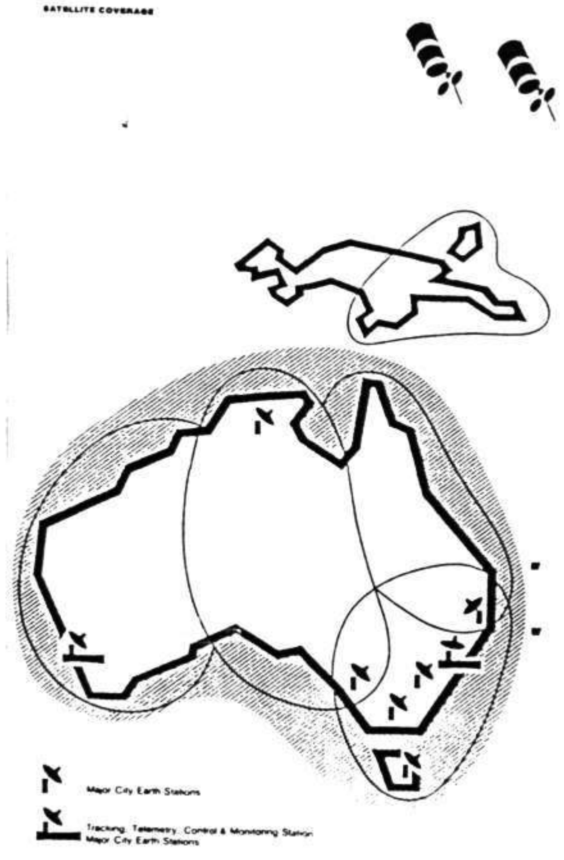
Australia will soon join the national satellite arena with its scheduled U.S. space shuttle launch of the first AUSSAT in July of 1985. A second satellite will be put in orbit in October of the same year. A total of three satellites will be manufactured by Hughes, the third will be kept available on the ground and will serve anticipated future needs as traffic increases.

AUSSAT will provide a comprehensive set of telecommunication services covering all of Australia and selected offshore location. Originally this will include Papua New Guinea (PNG), New Britain and New Ireland, but later decisions may encorporate New Zealand and parts of the South Pacific.

Several classes of services will be provided. The include Homestead Community Broadcast Service (direct-to-home service) and two-way, primarily voice, telecommunication. Voice and data services will also be provided to the Department of Aviation, banks, mining companies, education departments, police and other public sector organizations. The system was designed to complement the existing terrestrial system operated by Telecom Australia (1).

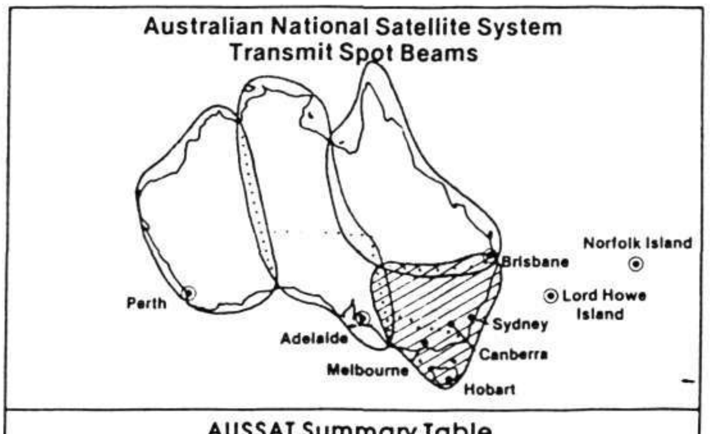
The satellite signal will operate in the Ku-Band and will be accessed using several classes of ground stations. The primary earth station will be smaller than 1.5 meters. Eight larger, major-city earth stations, are being built under contract with Mitsubishi Australia in factories established at North Ryde near Sydney. Telecom Australia will also operate 65 earth stations around the country which allows automatic connection to the existing terrestrial network.

Satellite coverage, which is based upon five spot-beams, is as follows (1):



The entire AUSSAT project was established, owned and operated by AUSSAT Pty. LTD. The Commonwealth Government is the primary shareholder, with options to Telecom Australia of 25%. Other AUSSAT characteristics can be summarized as follows (11):

AUSSAT



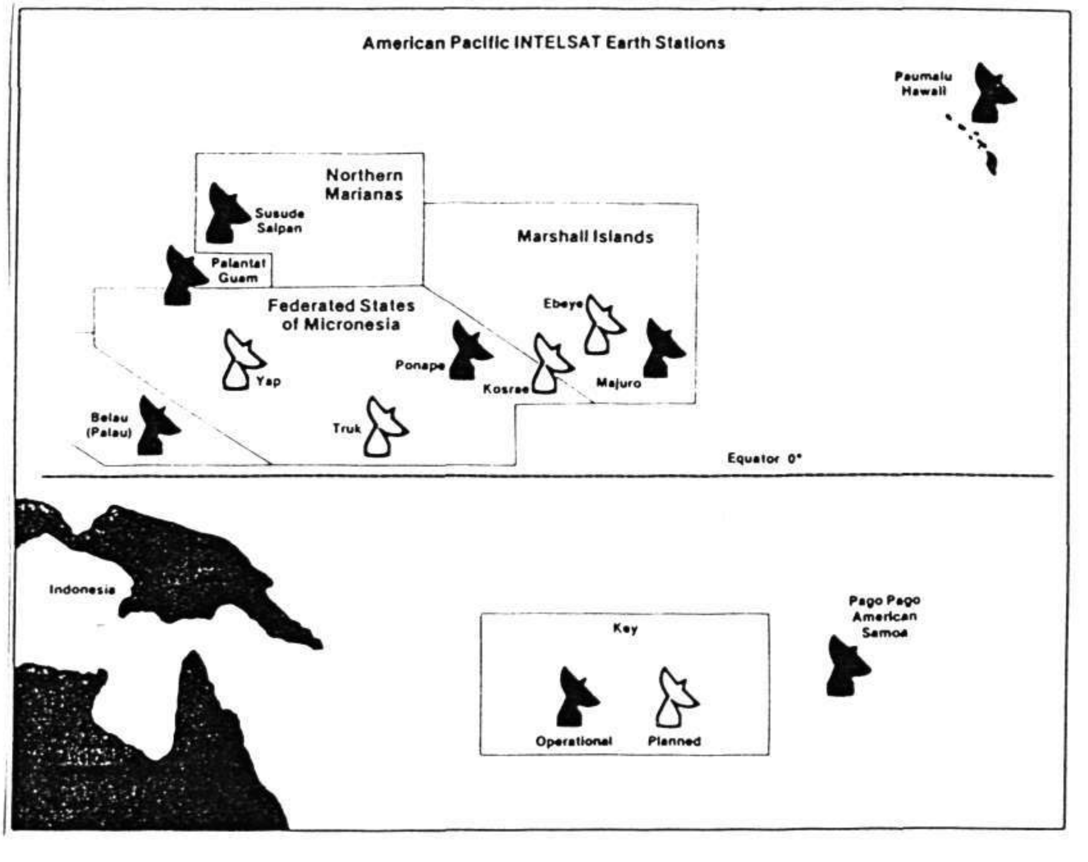
AUSSAT Summary Table

Name of Operator	**Aussat Proprietary Ltd.**	
Manufacturer & Family	Hughes HS-376	
Mass at BOL (kg)	650	
Lifetime (minimum fuel)	7 years	
Planned Launch Date	1985	
Launch Vehicle	Shuttle or Ariane	
Frequency Bands	Uplink	14.0 - 14.5 GHz
	Downlink	12.25 - 12.75 GHz
No. of TWTAs	Active	11 @ 12 watts
		4 @ 30 watts
Stationkeeping (E/W & N/S)	± 0.05 degrees	
Locations	156°, 160° & 164° East	
Solar Array Power	1200 watts (BOL)	
	871 watts (EOL)	
Verfied	June 1983	

The American Pacific

While this paper has not focused on the satellite systems serving the Americas, a substantial amount of U.S. trade and economic growth is now concentrated on the Pacific, primarily north of the Equator. These interests in the Pacific are focused on territories historically tied to the United States: Hawaii, American Samoa, Guam, the Northern Marianas and the Trust Territories/ Federated States of Micronesia.

The American Pacific INTELSAT earth stations as follows (16):



The satellite system used to maintain communication is based upon INTELSAT, Comsat and Hawaiian Telephone resources. Comsat and Hawaiian Telephone have built "standard B" earth stations, utilized INTELSAT circuits and Hawaii-based, Hawaiian Telephone-owned switches to the global telecommunication network. In this way, Hawaii acts as a gateway into international and national networks for a full range of telecommunication services.

Other Nations Considering Satellite Options

There are a number of Asia/Pacific countries planning the acquisition of national satellite systems. These include China, Pakistan, South Korea and New Zealand (21).

CHINA: The China National Satellite Corporation is now established under the Ministry of Radio and Television. Recently, the Chinese established an agreement withh MBB of West Germany to acquire a direct broadcast satellite system in 1986. The system will be a mix of imported and domestic technologies, but China is gaining its own experience in launching orbital spacecraft. On April 8, 1984, China launched the "Long-March'3" utilizing a modified military missle. China has requested the ITU to reserve three slots for national satellites applications. Projections are tha 90% of the population will have DBS by 1990.

PAKISTAN: The Space and Upper Atmosphere Research Commission (SUPARCO) of Pakistan is seriously pursuing the establishment of a satellite system that will support educational and entertainment broadcasting and telephone communication. Orbital slots have been selected (38 and 41 degrees over the equator) and the ITU has been notified. The system could be operational by 1988 if decisions are made this year.

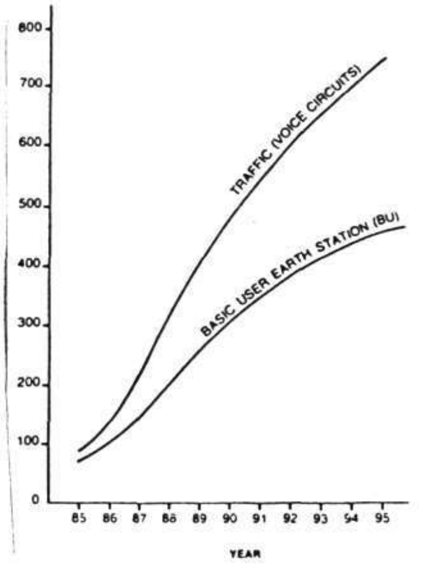
SOUTH KOREA: The South Korean government have been exploring the possibility of developing a domestic satellite system. Preliminary design contracts for a satellite to support three television and 4000 telephone circuits are being sought in the United States and Canada. However, competition for national development funds may delay the project for up to ten years.

NEW ZEALAND: The New Zealand Communications Advisory Council completed in July of 1984 a Report on Satellite Services for the Cabinet Committee on Communication. The report considered the use of satellites for telecommunication and remote sensing and discusses the benefit potential for satellite technologies. The conclusions of the report were that "within the immediate future there will not be sufficient demand for satellite capacity to justify a satellite exclusively for New Zealand's requirements." Nevertheless it foresees the "early need for provision of satellite facilities using shared satellites." Shared facilities for telecommunication services would be appropriate, but not for domestic direct broadcast satellites. "This would require either a dedicated domestic satellite for New Zealand, or negotiation of appropriate facilities on AUSSAT II due to be launched in early 1990's."

Future Satellite Services in the Pacific

Scenarios for the future of satellite services in the Pacific Hemisphere are, for the most part, optimistic. It still remains to be seen to what extent undersea optical fibers will impact the projected growth of satellite circuits and user earth stations. Trends point to higher and higher powered satellites and with them, the development of smaller and less-expensive ground terminals. For Pacific Basin Island countries, INTELSAT projects almost an eight-fold increase in voice circuits from the period 1985-1995 and a five fold increase in basic user earth stations (14).

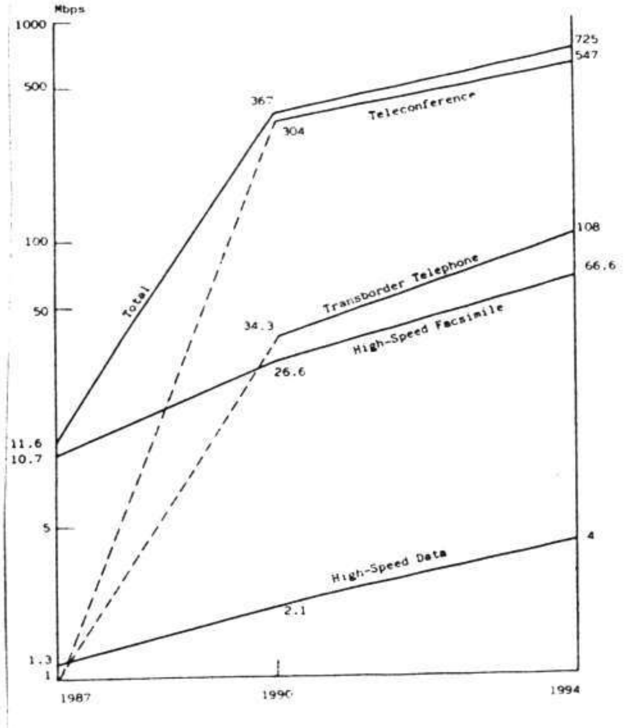
A TYPICAL GROWTH SCENARIO FOR THE PACIFIC BASIN ISLAND COUNTRIES



Economic studies conducted by the Maitland Commission, IDATE, RITE and others point out that good international links are vital to future economic growth. Pelton (14) has pointed out that the projected growth of ASEAN countries' overseas communication traffic over the next 15 years (1999) will be nearly equivalent to the total U.S. overseas traffic today--about 20,000 equivalent voice channels.

The Japanese, too, have projected tremendous increases in intercity traffic involving teleconferencing, transborder telephone, high-speed facsimile and high-speed data (18). They have forecast that by 1994 that 75% of the band-width available will be utilized for teleconferencing applications. Half of the required band-width after 1990, they project, may be supplied by satellite.

From 1987 to 1994 they have estimated that Pacific region intercity traffic will grow from 11.6 Mbps to 725 Mbps (one way). All classes of service are projected to contribute to this growth.



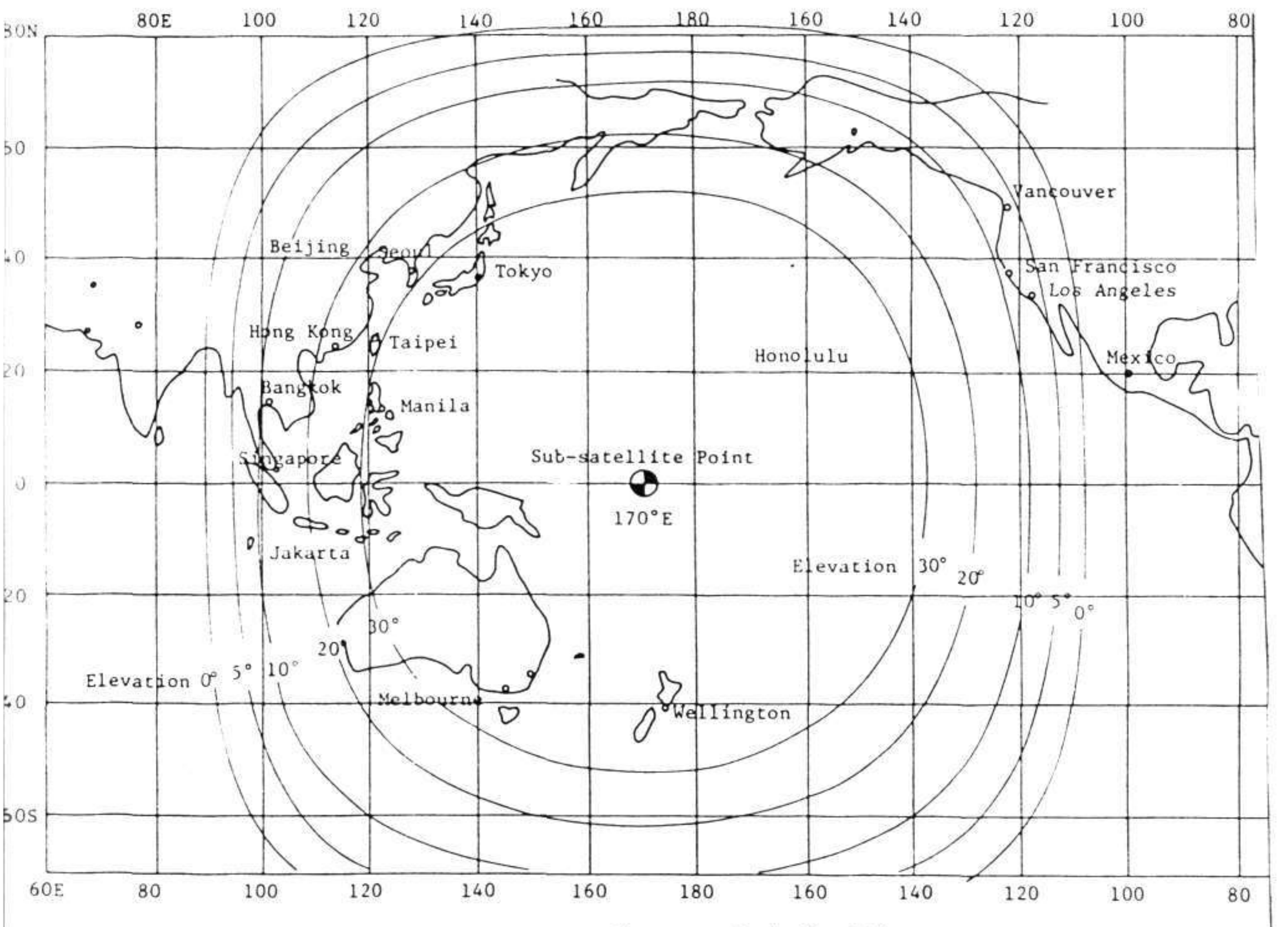
Intercity Traffic (Mbps, one way)

In line with these optimistic outlooks, it is no wonder that INTELSAT and the Japanese, just to name two, are looking to the Pacific hemisphere with a number of new services in mind. INTELSAT has great hopes for the new service introductions which include IBS (INTELSAT BUSINESS SERVICE), data services (INTELNET), video services which include preemptible and non-preemptible services and proposed digital T.V. distribution and integrated video and data. Other new services included leased domestic transponder service, cable restoraton services, VISTA (thin route telephony for isolated towns and villages, etc.), proposed electronic document distribution, diversified telephony service and mobile services (7).

INTELSAT seems increasingly aware of the needs of developing countries. Specifically, INTELSAT has proposed a number of new services which point to their concern for thin-route services. Beyond VISTA, Pelton (14) points out that INTELSAT is exploring the possibility of very small microterminals. These may be as small as 1.2 meters and capable of transmitting data communication from remote locations at a per terminal cost of $5000 to $10,000.

During a period from January 1985-April 1986 INTELSAT has introduced a 20th anniversary program called "Project Share." Satellite capacity, during these 16 months, will be available free of charge for service organizations around the world for projects involving tele-education and tele-health in developing countries.

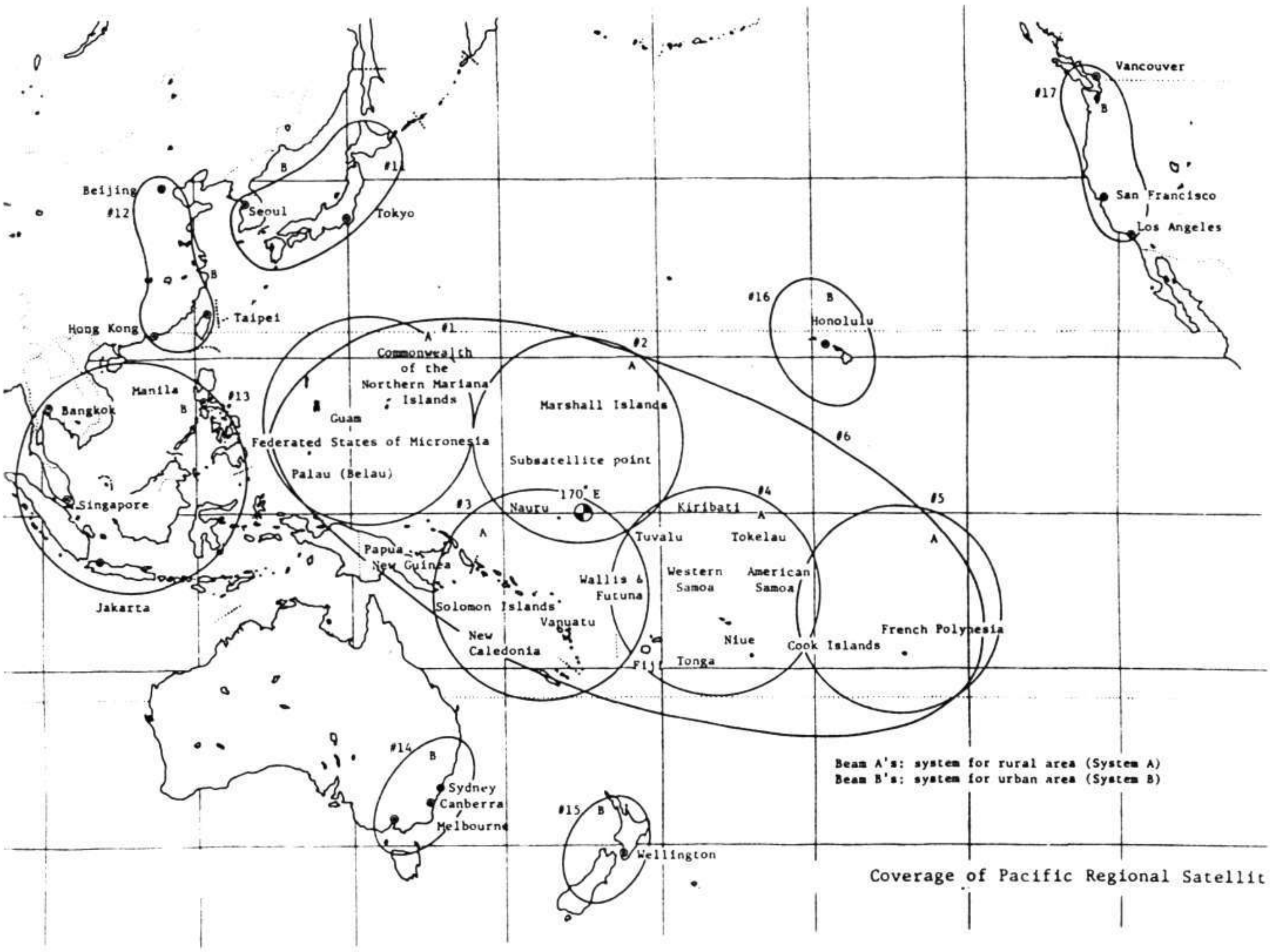
The Japanese are also looking at the Pacific as a hemisphere for increase satellite development. In January of 1983, the Research Institute of Telecommunications and Economics (RITE) released a Study on the Pacific Regional Satellite Communications System (18). This project proposed the creation of a Pacific Region satellite to "enhance communications in the Pacific Hemisphere" with thin-route services as well as thick-route services between major trading points in the hemisphere.



Coverage of the Satellite

The system would be independent from space development programs of any particular nation and have two sub-systems, A and B. The A subsystem would serve the needs of the Mariannas, Marshals, Solomons', Fiji and Tahiti. System A would service remote areas providing telephone, T.V. program relay, health care, disaster warning and tele-education. System A's costs would be subsidized by System B users. System B would be used for intercity, high speed services, (data communications higher than 48 kbps), high-speed facsimile, teleconferencing, T.V. program relay and tele-education. System B locations would include Tokyo, Seoul, Beijing, Hong Kong, ASEAN, Australia, New Zealand, Hawaii and North America. System A and B antenna would be 4 to 5 meters in diameter.

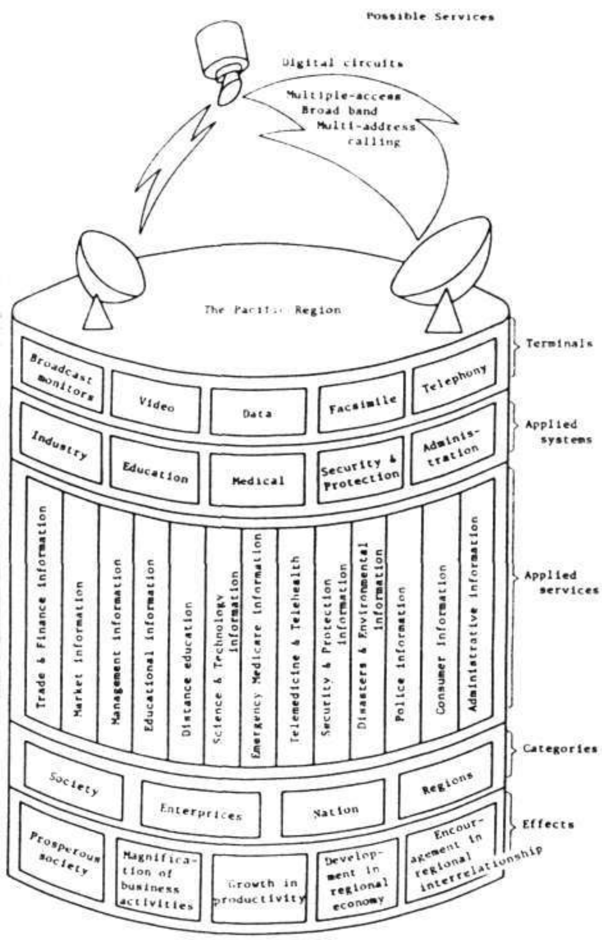
The following diagrams show the coverage areas for both classes of service:



Coverage of Pacific Regional Satellit

The estimated cost of developing the system is between $300 and $400 million dollars (U.S.). The expected revenues are projected to be about $400 million/year.

A full range of services are invisioned. These would be general broadcast video, data, facsimile and telephony as they apply to industry, education, medical, security and protection and administration. These possible services can be depicted as follows (18):

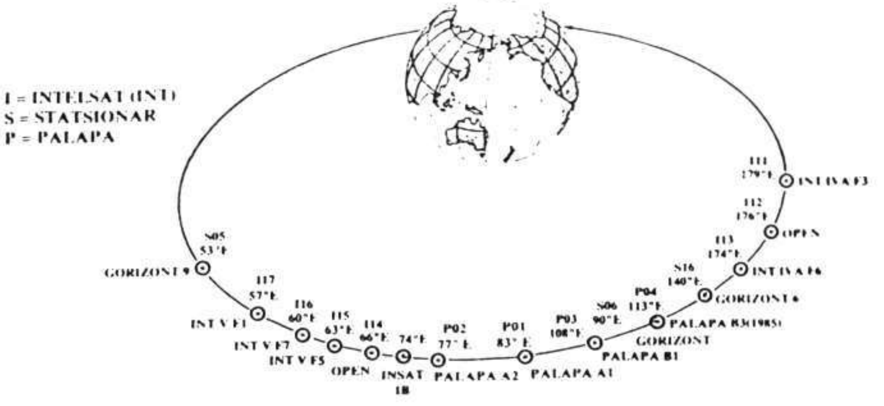


The Japanese believe that by 1994 satellites weighing one ton in geostationary orbit will be required to meet the projected traffic.

Summary and Conclusion

The Pacific hemisphere is a vast area and for that reason satellite communication may play an even more important role in development than it is in other regions of the world. Many countries in the region are already enjoying the benefits of modern communication, others are planning to do so in the near future. Because satellite communication is such a dynamic arena, it is difficult to know where to stop in providing an overview. INTELSAT will no doubt continue to play the leading role in international satellite development. To the extent that the organization can meet the real needs for high-quality, reliable and affordable services, competitors will have a difficult time in launching new offerings. Thin-route communication remains a problem in the Pacific. Many of the new offerings are attempts to address this class of problems. As higher and higher capacity/powered satellites are developed and placed in orbit, earth station size and costs will drop. One thing seems relatively clear, until first-rate communication channels are widely available, economic and social development will be inhibited. Any single location in the Pacific may not be able to cost-justify involvement in satellite communications, however, integrated into a total hemispheric network no one could afford to ignore the combined economic, social and political power.

Pacific Ocean Region



REFERENCES

1. AUSSAT Pty. Ltd. AUSSAT: General information. Australia.
2. COMSAT. COMSAT guide to the INMARSAT satellite systems. Washington, D.C.: COMSAT.
3. Ed. (1984, November). Satellite orbit international.
4. Glatzer, H. (1983). The birds of babel. Indianapolis, IN: Howard W. Sams and Co., Inc.
5. Ed. (1984, November). High Technology, 4(11).
6. INMARSAT. (1984, September). INMARSAT ship earth station directory (4th issue).
7. INTELSAT. (1984). New directions for INTELSAT: Satellite communications for development. Washington, D.C.: INTELSAT.
8. INTELSAT. (1983). Annual Report. Washington, D.C.: INTELSAT.
9. Ed. (1984, March). Intermedia, 12(2).
10. Logue, T.J. (1981, September). Trade and telecommunications in the Pacific: Bridges between East and West. Paper presented at the conference on Telecommunications and Trade Relations in the Pacific Community, Honolulu, Hawaii.
11. Morgan, W.L. (1984). Satellite communications notebook 1984, 8(13).
12. Morgan, W.L., & Petronchak, M. (1984). 1984 satellite performance reference chart. Satellite Communications.
13. New Zealand Communications Advisory Council. (1984, July). Satellite services. Wellington, New Zealand.
14. Pelton, Joseph N. (1984, November). INTELSAT satellite services: New initiations for the world and for the Asia/Pacific region. Paper presented at AMIC Satellite Symposium.
15. Pelton, J.N., Perras, M., & Sinha, A. (1983, January). INTELSAT: The global telecommunications network. Paper presented at the Pacific Telecommunications Council Conference, Honolulu.
16. Pennings, A., & Barber, R. (1983, July). Satellite telecommunications in the American Pacific. Satellite Communications.
17. Rahim, S.A., & Wedemeyer, D.J. (Eds.). (1983). Telecom Pacific. Honolulu, Hawaii: Pacific Telecommunications Council.
18. Research Institute of Telecommunications and Economics (Japan). (1983, January). A study on the Pacific regional satellite communications system. Paper presented at the Pacific Telecommunications Conference, Honolulu, Hawaii.
19. Public Service Satellite Consortium for NASA. (1982, December). Satellite communications for the Pacific Islands second year final project report.

20. Satellite report: Satellite and earth stations. (1982, March). Communications News.

21. They all want DBS of their own. (1984, June-July). Asian Broadcasting, pp. 11-14.

22. Webster, D. (1984, Summer). Direct broadcast satellites: Proximity, sovereignty and national identity. Foreign Affairs.

23. Yurow, J.H. (1983). Issues in international telecommunications policy: A sourcebook. The George Washington University.