INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
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SECOND WORKSHOP ON TELEMATICS

6 - 24 November 1989

Satellite Communications: Main Concepts

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USES OF COMMUNICATION SATELLITES

TRADITIONAL APPLICATIONS:

1. Toll Traffic
2. Large Cities
3. Multiple Telecommunication Services

RECENT APPLICATIONS:

1. Direct Services to Rural Communities
2. More Transponder Power
3. Small Aperture Antennas
4. Mobil Services
5. Remote Monitoring

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TERMINOLOGY

T K = Noise Temperature, Degrees-Kelvin
G/T = Figure of Merit of a Receiver, dB/K
Geo = Geostationary, meaning an orbit with a period iqual to the
earth's (23h, 56m, 4.09s)
EIRP = Effective Isotropic Radiated Power
FDMA = Frequency Division Multiple Access
PSK = Phase Shift Keying
RFI = Radio Frequency Interference
SCPC = Single Channel per Carrier
TDMA = Time Division Multiple Access

Unique properties of satellite links

A satellite channel is often used simply as a substitute for a point-to-point terrestrial channel. However, it has certain properties which are quite different from conventional telecommunications. It should not be regarded as merely a cable in the sky. New types of communications architecture are needed to take advantage of satellite properties and avoid the potential disadvantages. This is especially so in the design of interactive computer systems.

A satellite channel is unique in the following respects:

1. There is a 270-millisecond propagation delay.
2. Transmission cost is independent of distance. A link from Washington to Baltimore costs the same as a link from Washington to Vancouver. A computer center can be placed anywhere within range of a satellite without affecting transmission costs. It is becoming economical to centralize many computing operations. In an international organization worldwide links can be similar in cost to national links if the regulatory authorities so permit.
3. Very high bandwidths or bit rates are available to the users if they can have an antenna at their premises or radio link to an antenna, thereby avoiding local loops.
4. A signal sent to a satellite is transmitted to all receivers within range of the satellite antenna. Unlike a terrestrial link, the satellite *broadcasts* information.
5. Because of the broadcast property, dynamic assignment of channels is necessary between geographically dispersed users. This can give economies, especially with data transmission, on a scale not possible with terrestrial links but needs new forms of transmission control.
6. Because of the broadcast property, security procedures must be taken seriously.
7. Most transmissions are better sent in digital form. Digital techniques can therefore be used to manipulate and interleave the signals in a variety of ways. The high bit rates make possible new uses of telecommunications not economical on terrestrial links.
8. A transmitting station can receive its own transmission and hence monitor whether the satellite has transmitted it correctly. This fact can be utilized in certain forms of transmission control.

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CLASIFICACION DE LA COMUNICACION SATELITAL

APLICACION ->	TRAFICO INTERNACIONAL	CONDUCCION DE SEÑALES	REDES PRIVADAS	D I F U S I O N VIDEO	DATOS	I N T E R A C T I V A VOZ & DATOS	DATOS
TIPO DE SERVICIO	VOZ DATOS VIDEO	VOZ DATOS VIDEO	VOZ DATOS VIDEO	TELE- CONFER.	DATOS	56 Kbps	1.2- 9.6 Kbps
DIAMETRO DE LA ANTENA	10-30 m.	10 m.	4.5-10 m.	4.5-10 m.	1 m.	1-2 m.	1 m.
BANDA DE OPER.	C & Ku	C & Ku	C & Ku	C & Ku	C	C & Ku	C & Ku
MODULACION	FDM/FM TDMA SSB/AM	FDM/FM TDMA SSB/AM	SCPC TDMA	SCPC	SS	SS TDMA SCPC	SS TDMA SCPC

Designation of radio-frequency bands

Band Number†	Band Name	Frequency Range (including lower figure, excluding higher figure)	Metric Subdivision
4	VLF, very low frequency	3–30 kHz	Myriametric waves
5	LF, low frequency	30–300 kHz	Kilometric waves
6	MF, medium frequency	300–3000 kHz	Hectometric waves
7	HF, high frequency	3–30 MHz	Decametric waves
8	VHF, very high frequency	30–300 MHz	Metric waves
9	UHF, ultra high frequency	300–3000 MHz	Decimetric waves
10	SHF, super high frequency	3–30 GHz	Centimetric waves
11	EHF, extra high frequency	30–300 GHz	Millimetric waves
12		300–3000 GHz	Decimillimetric waves

† Band number N extends from 0.3×10^N to 3×10^N Hz.

Frequency bands are also given letter designations as follows:

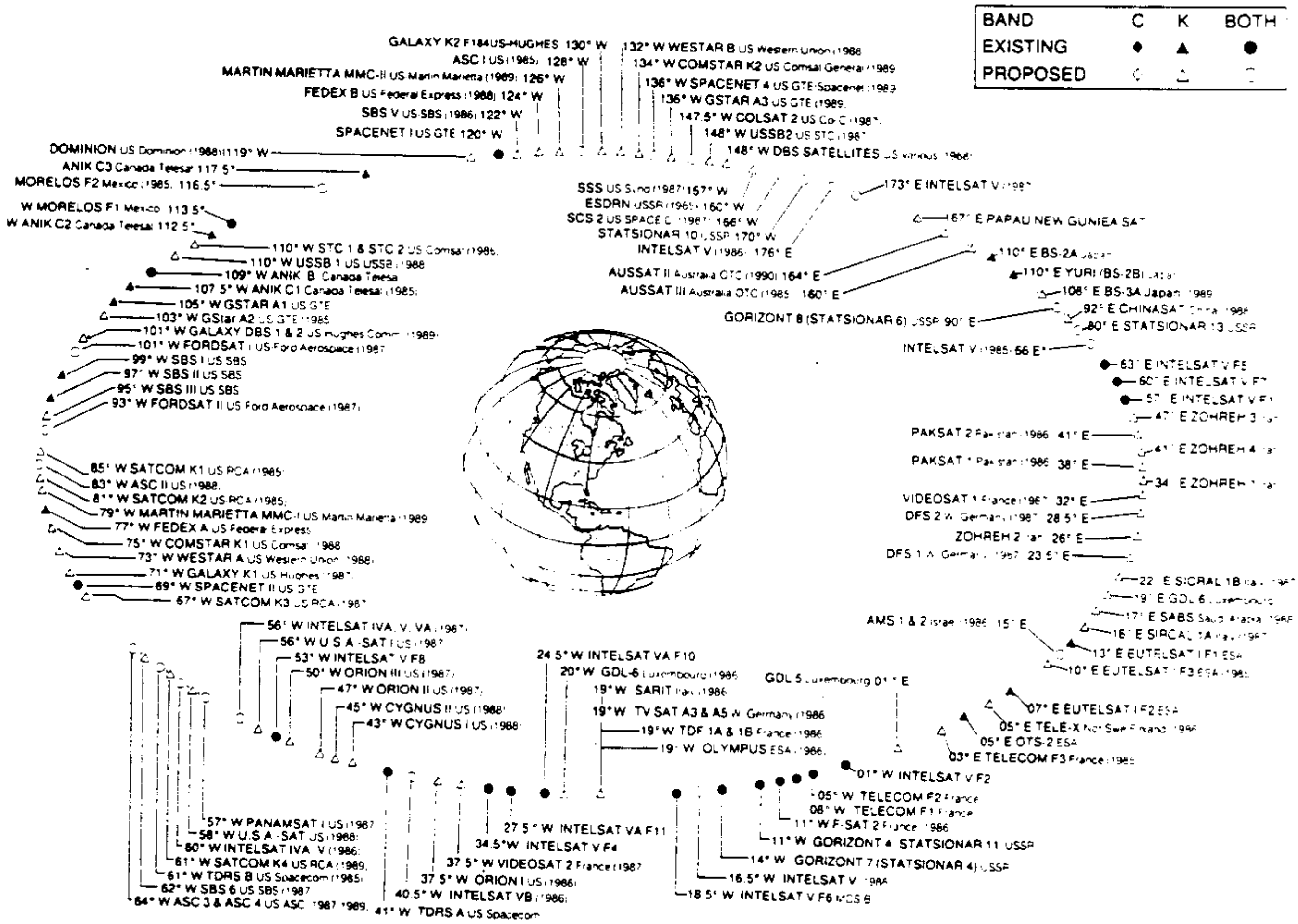
Band	Frequency Range (GHz)
P	0.225–0.39
J	0.35–0.53
L	0.39–1.55
S	1.55–5.2
C	3.9–6.2
X	5.2–10.9
K	10.9–36.0
Ku	15.35–17.25
Q	36–46
V	46–56
W	56–100

Major categories of communications satellite

Categories of Satellite	Examples	Earth Stations	Functions
Intercontinental Satellites	• EARLY BIRD INTELSAT II INTELSAT III INTELSAT IV INTELSAT IVa INTELSAT V • The Russian MOLNIYA & STATSIONAR Satellites • Europe's SYMPHONIE	• Large, expensive, highly reliable, designed for interconnection to circuits of national telephone administrations	• To provide world-wide common-carrier telephone and data circuits • Point-to-point television relays
Traditional Common-Carrier Domestic Satellites	• Canada's ANIK • Western Union's WESTAR • RCA's SATCOM • AT&T and GT&E COMSTAR • Indonesia's PALAPA • ARABSAT	• Large common-carrier earth stations • Medium-size private earth stations • 10 and 4.5 meter • receive-only television earth stations	• To enhance common-carrier telephone networks • To provide leased long-distance circuits at lower cost • Point-to-point television relays • Television broadcasting to local transmitting stations or CATV systems • Music broadcasting (Musak Corporation)
Domestic Multiple-Access Satellites	• SBS (Satellite Business Systems)	• 5 or 7 meter 12/14 GHz installable on corporate premises and on city rooftops	• To provide private networks for corporations and government, relaying telephone, data, and image traffic
Television Broadcast Satellites	• Japanese broadcast satellite (JBS) • Canada's experimental CTS • NASA's experimental ATS-6	• Large transmitting station • Inexpensive receive-only antennas small enough for use in homes and schools	• Television broadcasting direct to homes or schools
Mobile Terminal Satellites	• MARISAT • MAROTS (both for ships) • Military satellites	• Very small shipboard or portable. Use UHF frequencies to give low-cost, low-capacity earth stations	• To provide telephone or data circuits to ships, vehicles, remote sites, or mobile military units

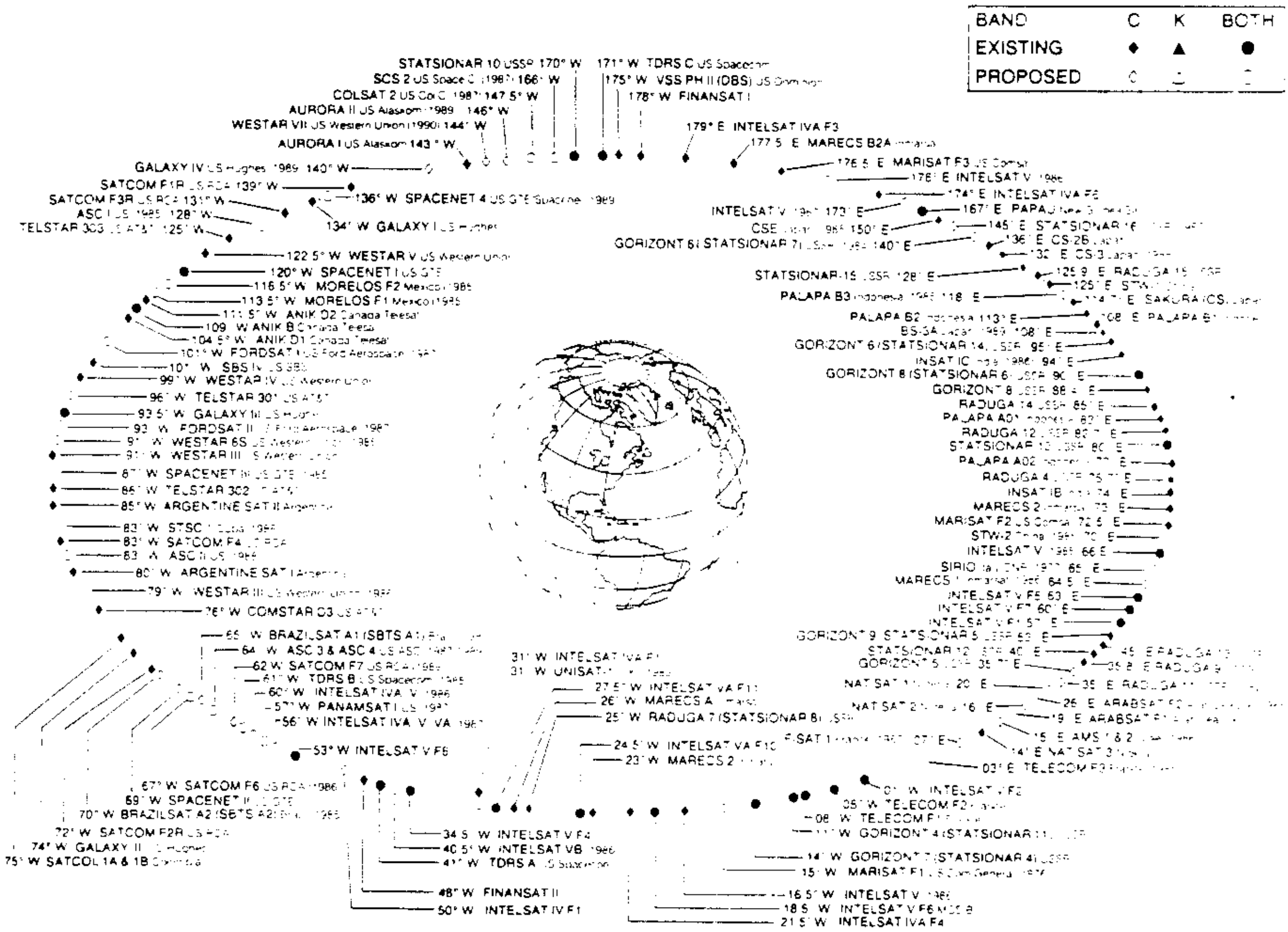
KU-BAND GEOSYNCHRONOUS SATELLITES

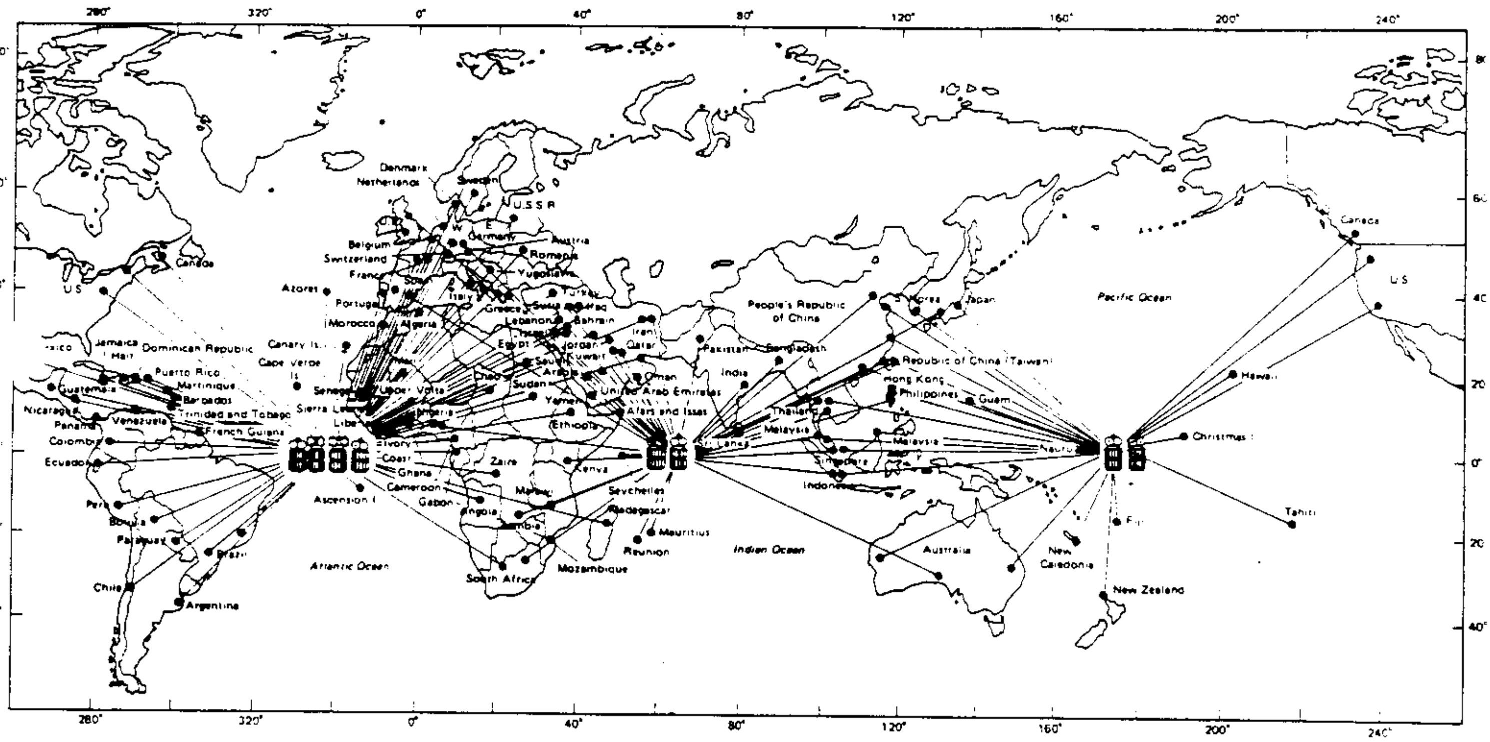
Keep up to date with the latest development in Ku-band satellite systems around the world, including GDL/Coronet, ECS, SBS, I, II, and III, the Aniks, and PanAmSat, *Satellite World* features Ku-band equipment reviews, discusses the pros and cons of true DBS service, and examines volatile issues such as how signal spillover might influence cultural makeups.



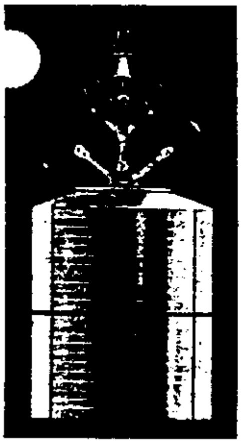
C-BAND GEOSYNCHRONOUS SATELLITES

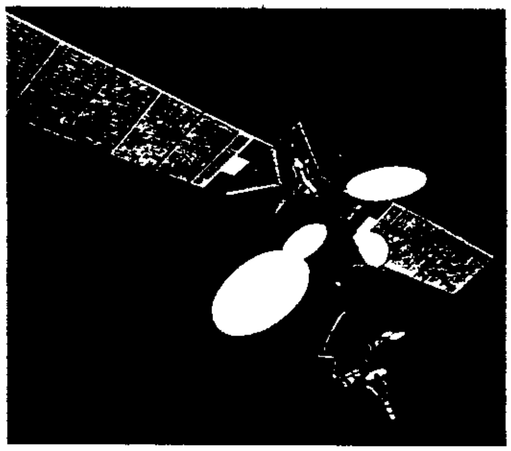
Get on the wavelength with the world's only program guide to C-band satellites around the world. Learn what the Russians are up to with their Gorizont and Molniya systems. Keep informed about new hardware, such as SCPC receivers and better LNAs that can dramatically improve reception. *Satellite World* tells you about the growing worldwide C-band market.





The global network of Intelsat serving over 150 earth stations in 80 countries. More than $1 billion invested in the network generates over $100 million revenue per year. Intelsat traffic is doubling every three years. Many new earth stations of lower cost will be added during the next 10 years.





IV	IV-A	V	V-A/B	VI
1971	1975	1980	1985	1986
Hughes	Hughes	Ford Aerospace	Ford Aerospace	Hughes
2.4	2.4	2.0	2.0	3.[illegible]
5.3	6.8	6.4	6.4	6.4
Atlas Centaur	Atlas Centaur	Atlas Centaur or Ariane 1, 2	Atlas Centaur or Ariane 1, 2	NASA STS (Shuttle) or Ariane 4
7	7	7	7	[illegible]
50[illegible]	8[illegible]	2,300	2,180	3,6[illegible]
4,[illegible]	6,000	12,000	15,000	3[illegible]
2	2	2	2	[illegible]

DEPLOYMENT OF INTELSAT SATELLITES

AS OF 1 DECEMBER 1984

Atlantic Ocean

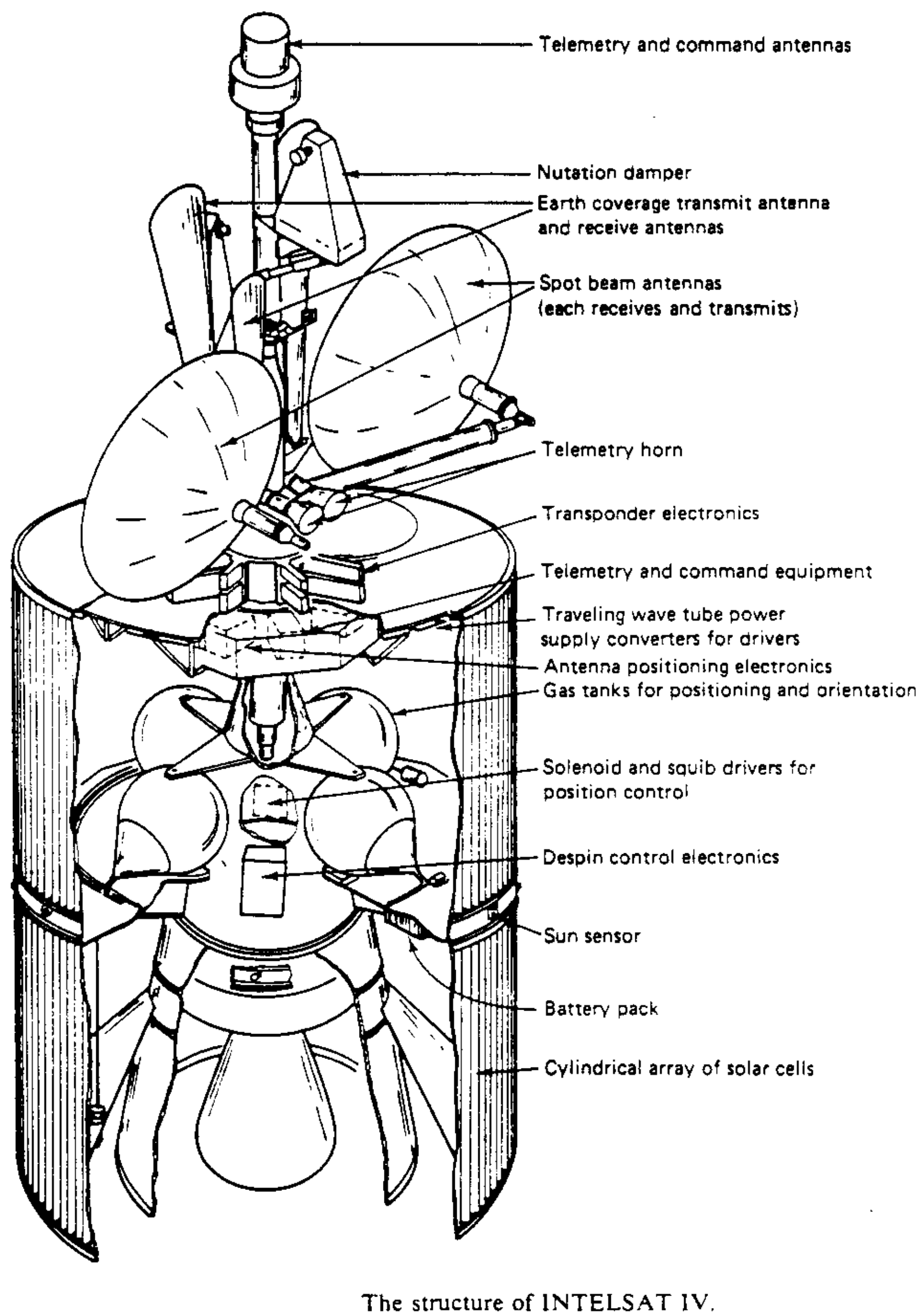
Satellite	Operational Role	Location
[illegible]	Domestic Lease Service and New Service Offerings (IBS, VISTA, INTELNET)	3[illegible] E
[illegible]	Contingency, Domestic Lease Service	3[illegible] E
[illegible]	Major Path 1	325.5°E
[illegible]	Domestic Lease Service	32[illegible] E
[illegible]	Contingency, Domestic Lease Service	33[illegible] E
[illegible]	Primary Path	[illegible] E
[illegible]	Contingency, Domestic Lease Service	33[illegible] E
[illegible]	Major Path 2	34[illegible] E
[illegible]	Contingency, Domestic Lease Service	[illegible] E
[illegible]	International and Domestic Lease Service	[illegible]

Indian Ocean

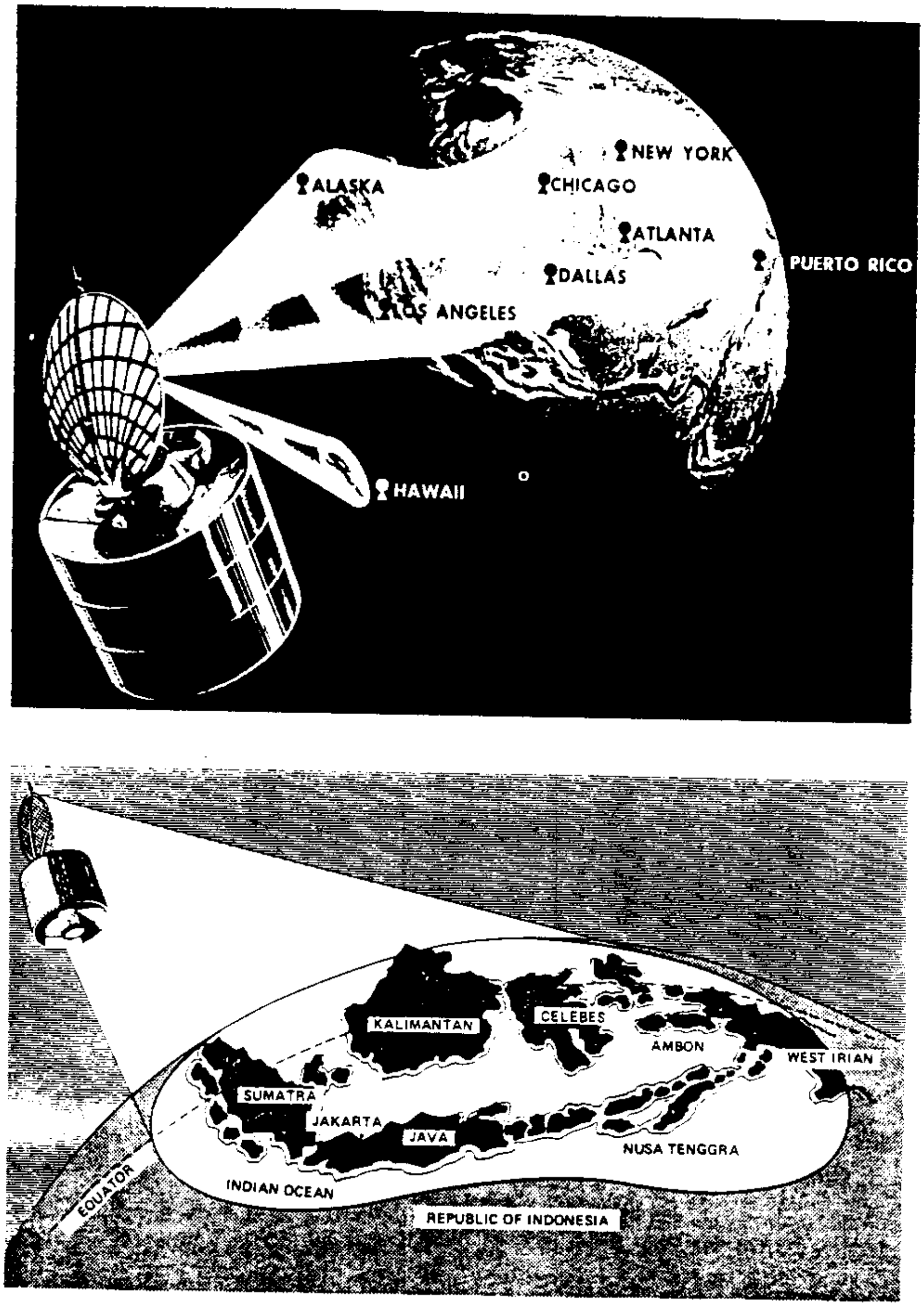
Satellite	Operational Role	Location
INTELSAT V (F-1)	Contingency, Domestic Lease Service	[illegible]
INTELSAT V (F-7)	Primary Path	[illegible]
INTELSAT V (F-5)	Major Path	[illegible]

Pacific Ocean

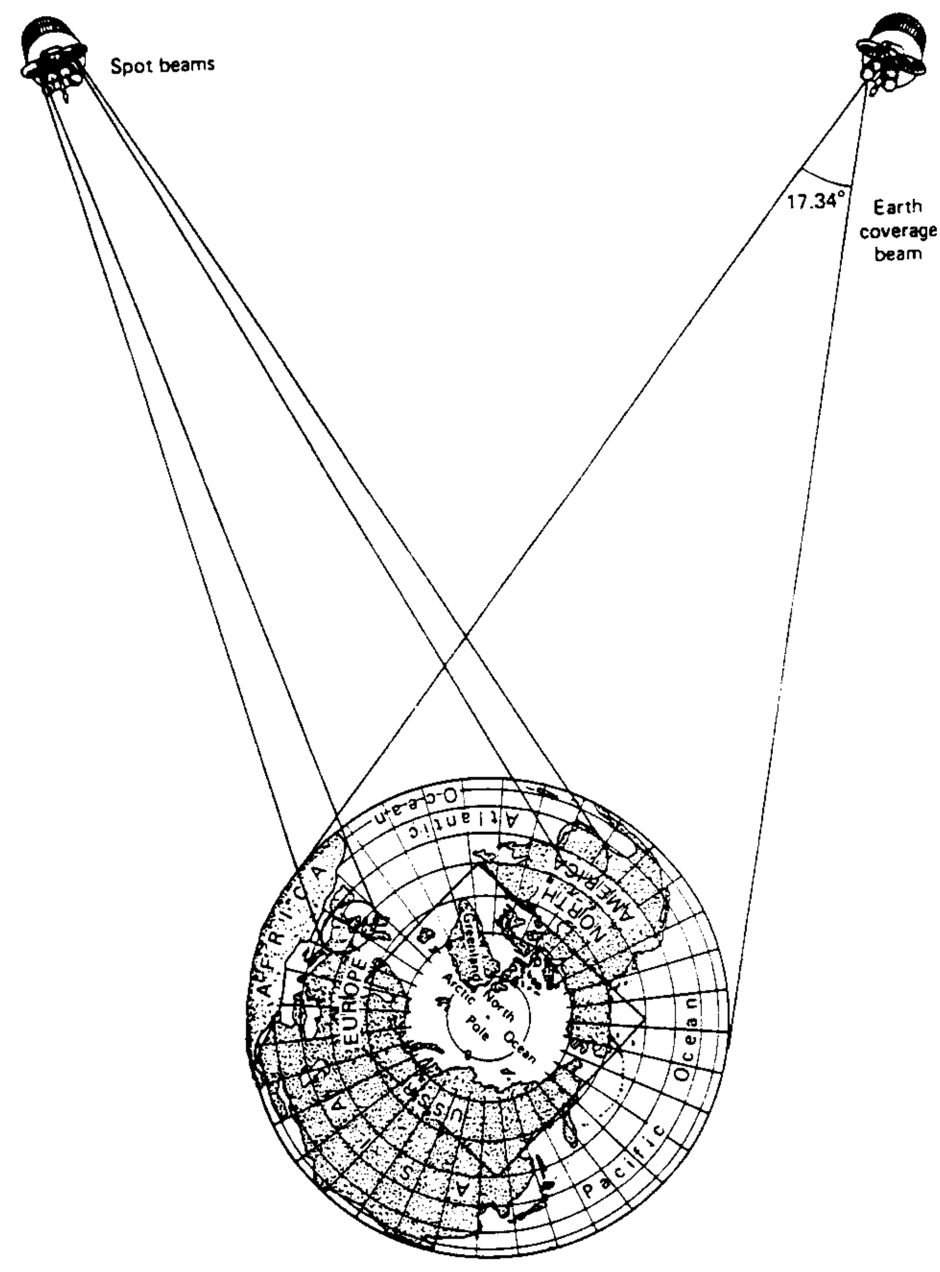
Satellite	Operational Role	Location
INTELSAT-IVA (F-6)	Primary Path	17[illegible]
INTELSAT IVA (F-3)	Contingency, International and Domestic Lease Service	[illegible]



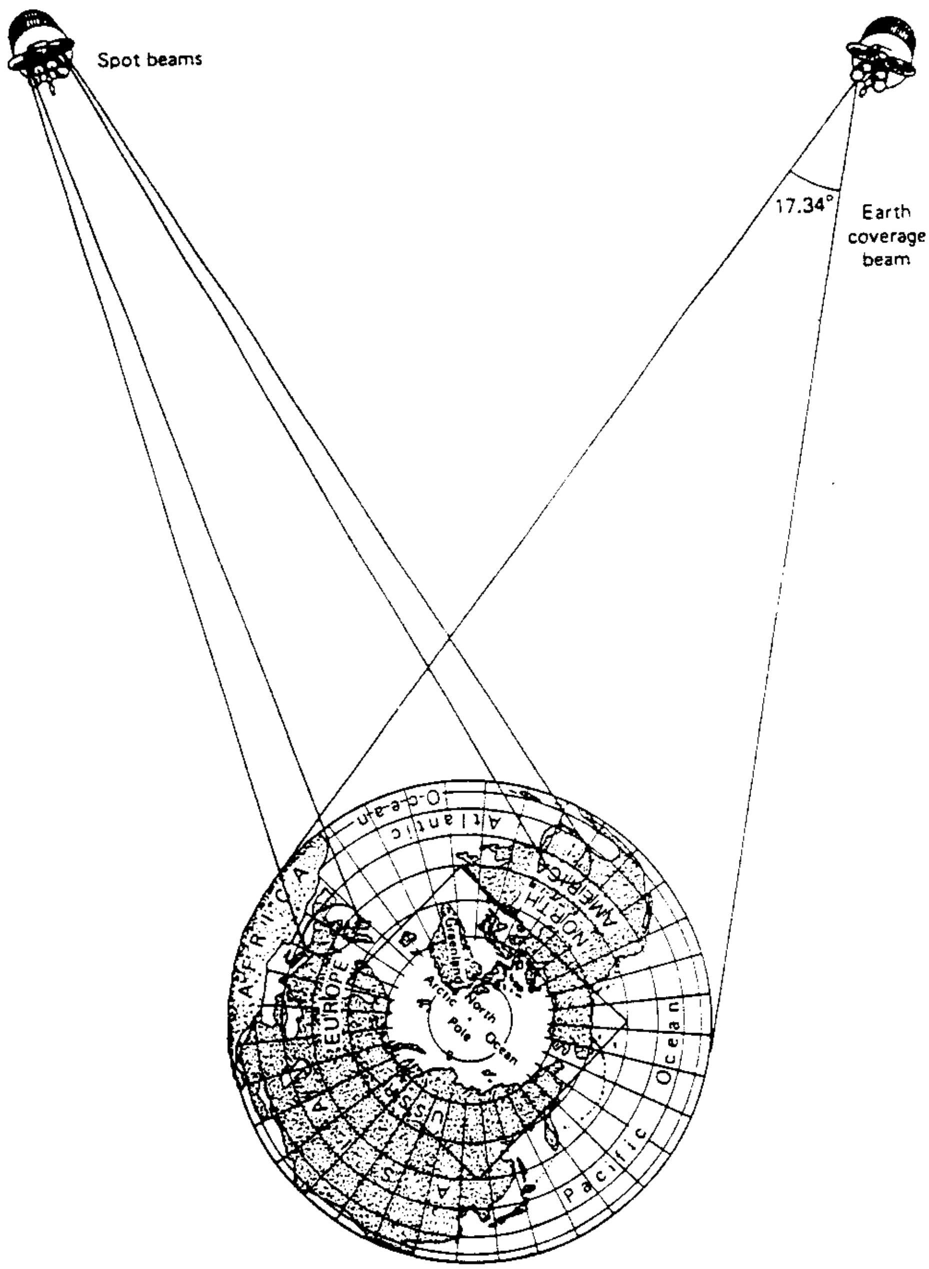
The structure of INTELSAT IV.



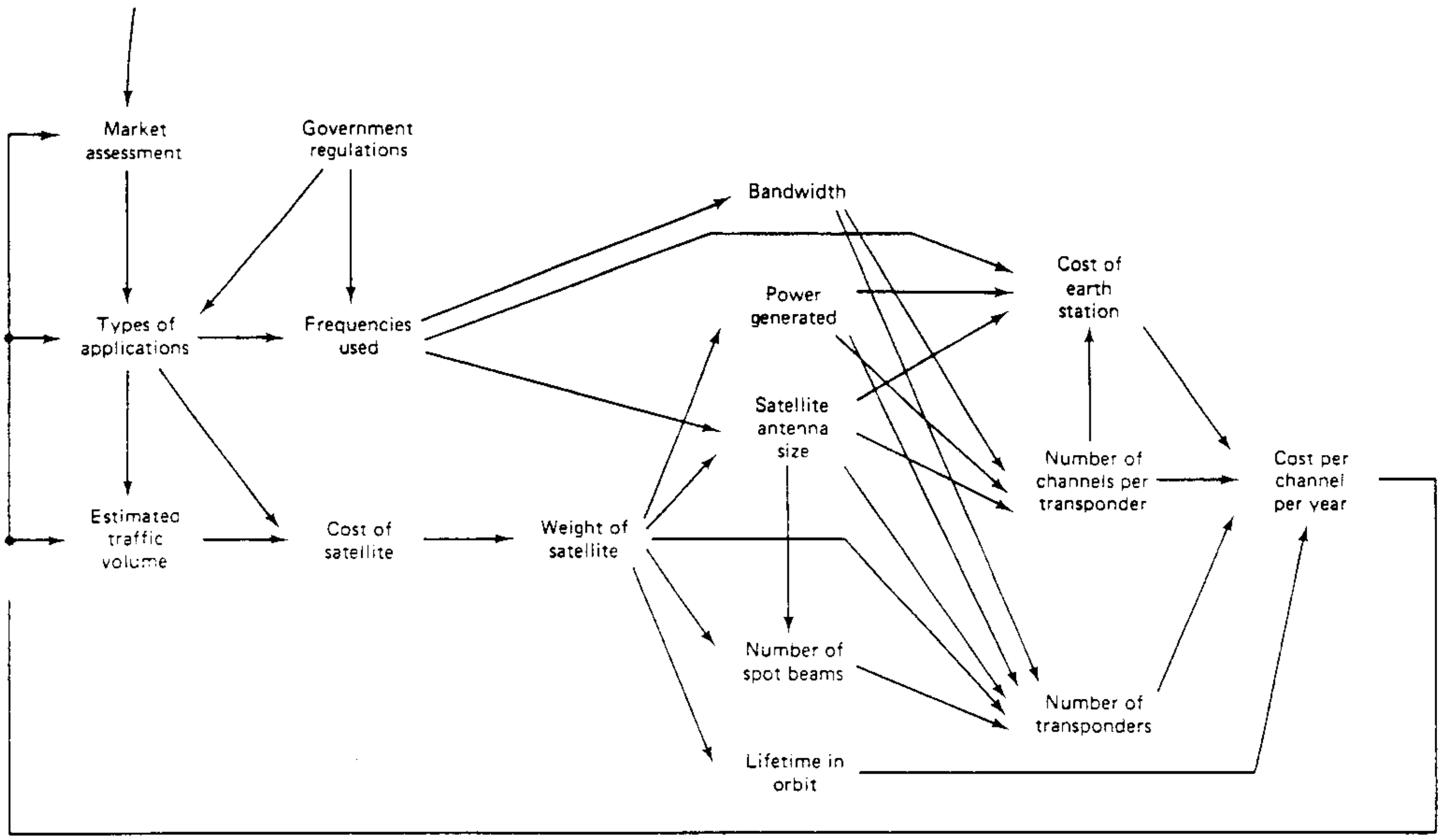
Domestic satellite systems. (*Courtesy Hughes Aircraft.*)



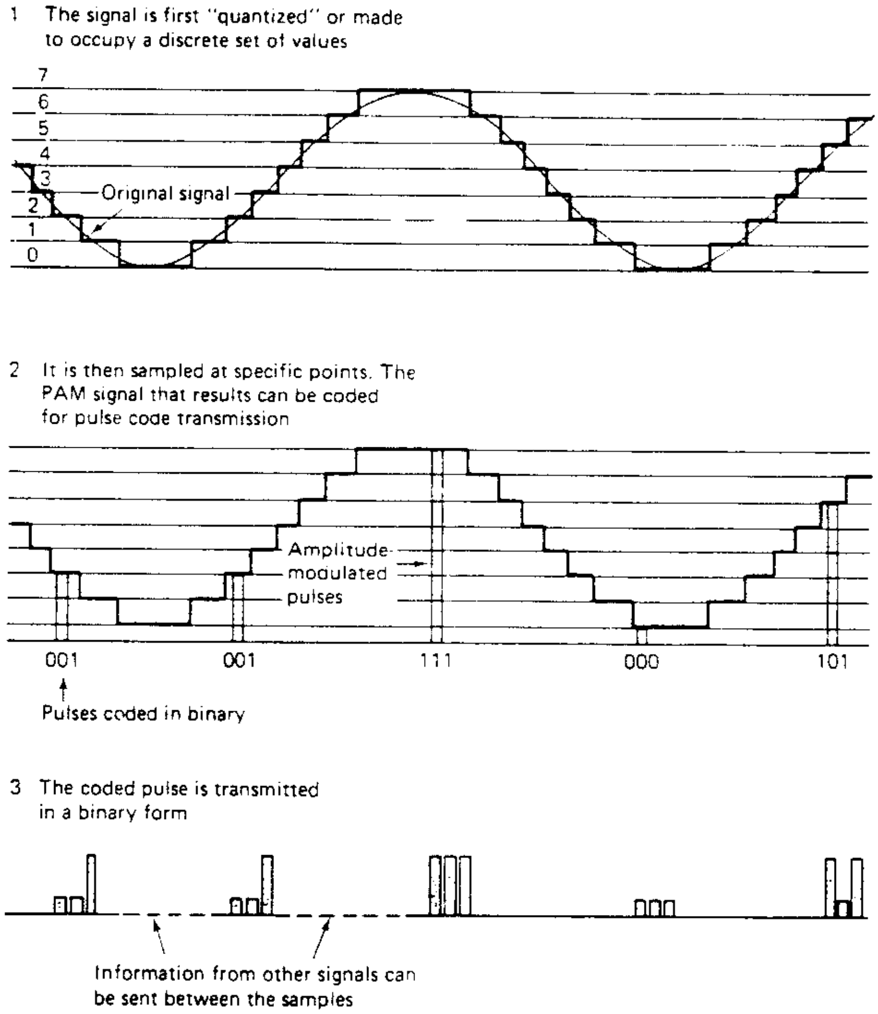
Spot beams and earth coverage beams.



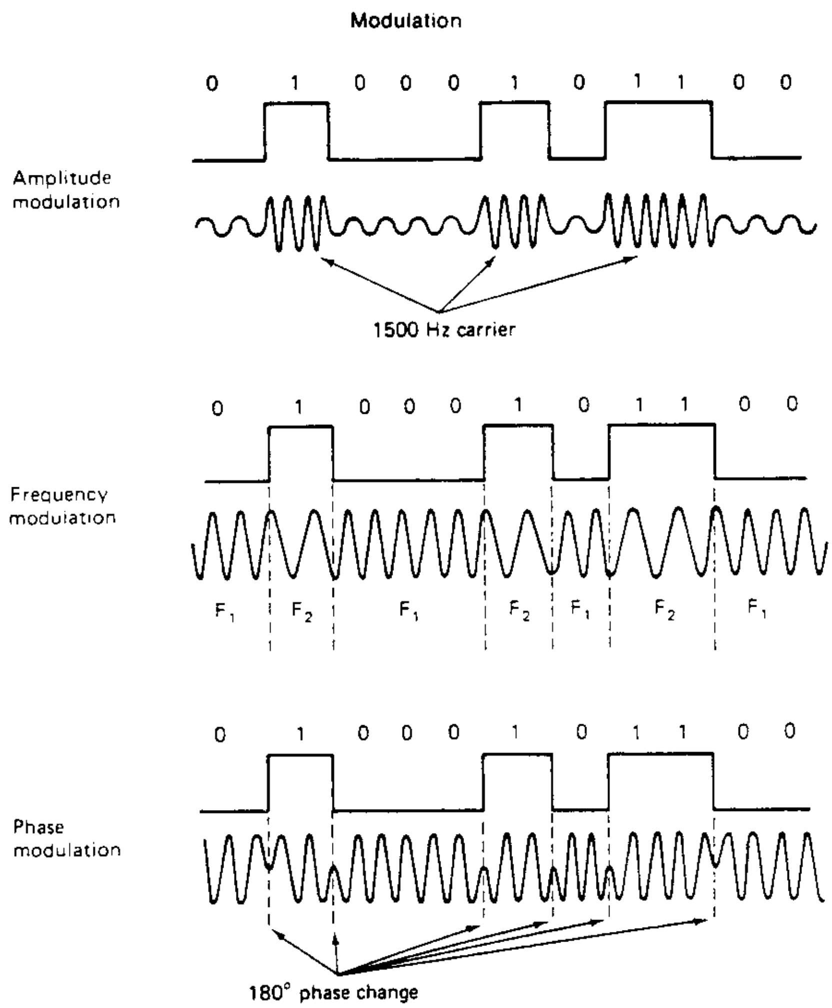
Spot beams and earth coverage beams.



Major tradeoffs in satellite design.



Pulse code modulation (PCM).



The three basic methods of modulating a sine wave carrier with a binary data stream. The amplitude, the frequency, or the phase can be modified to carry the data.

MULTIPLEXING

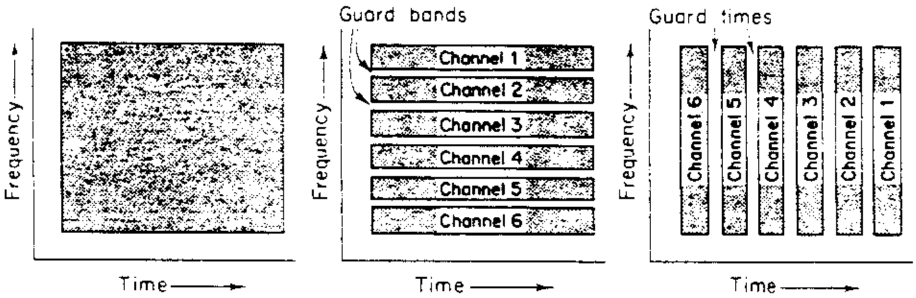
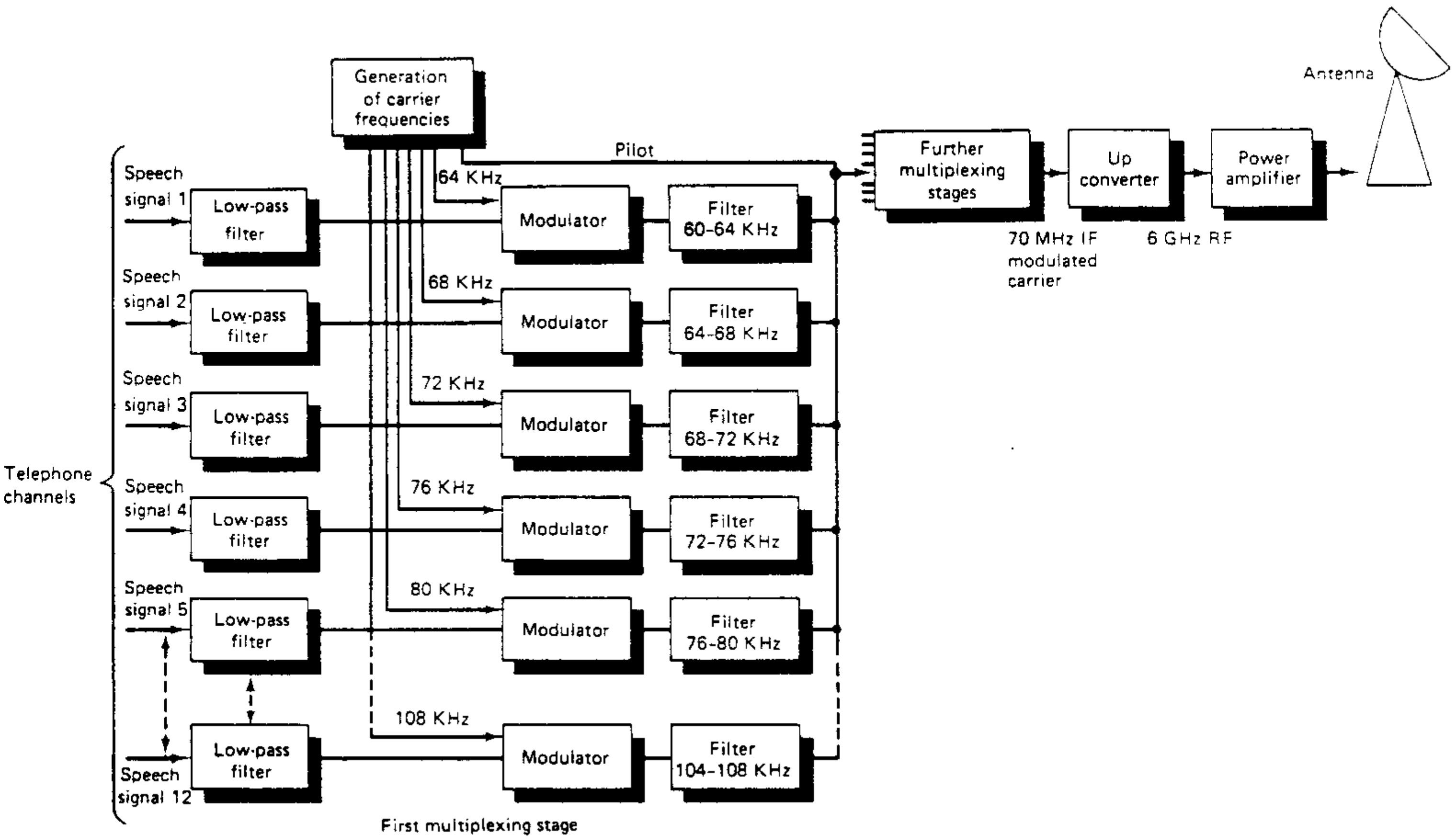
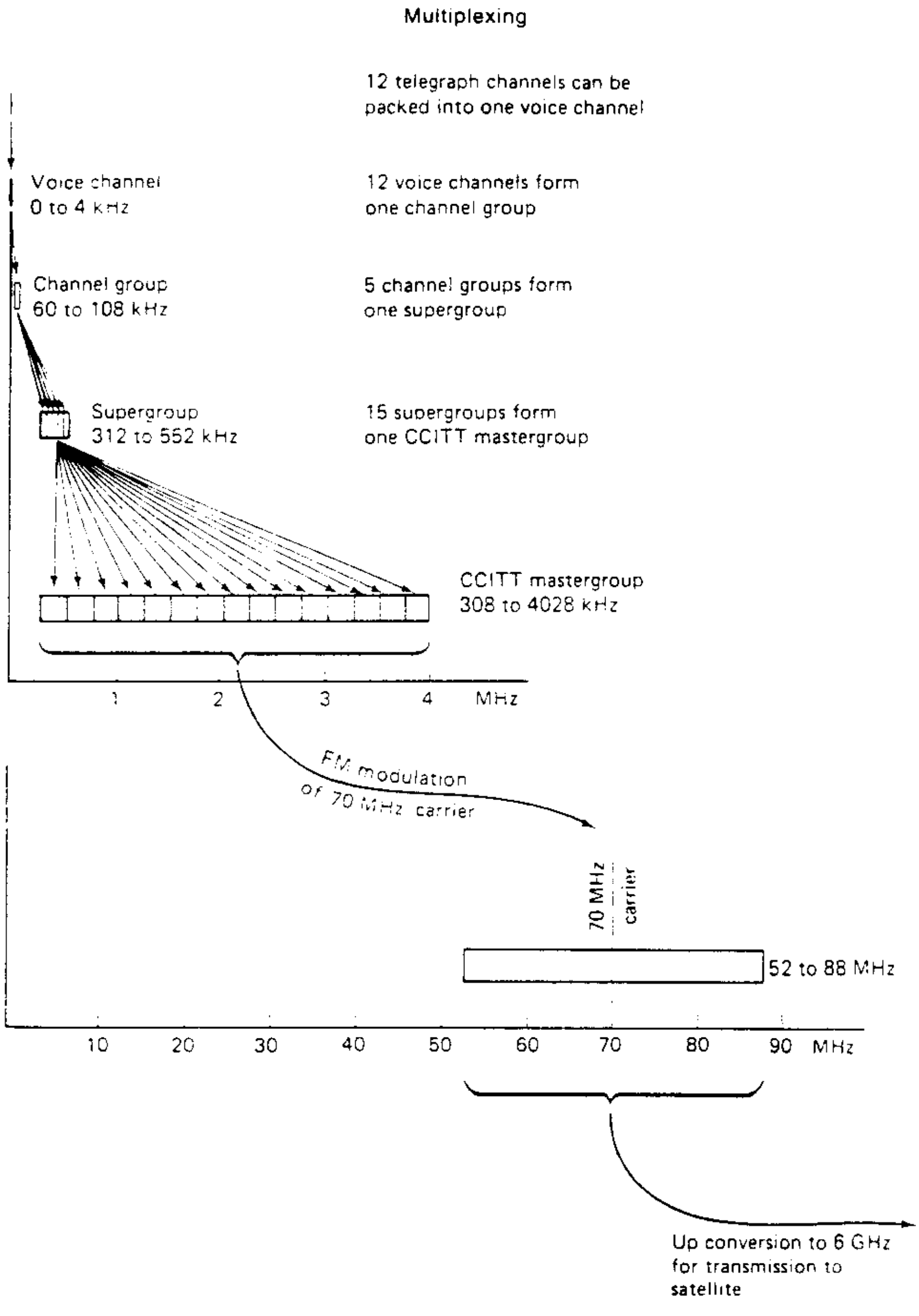


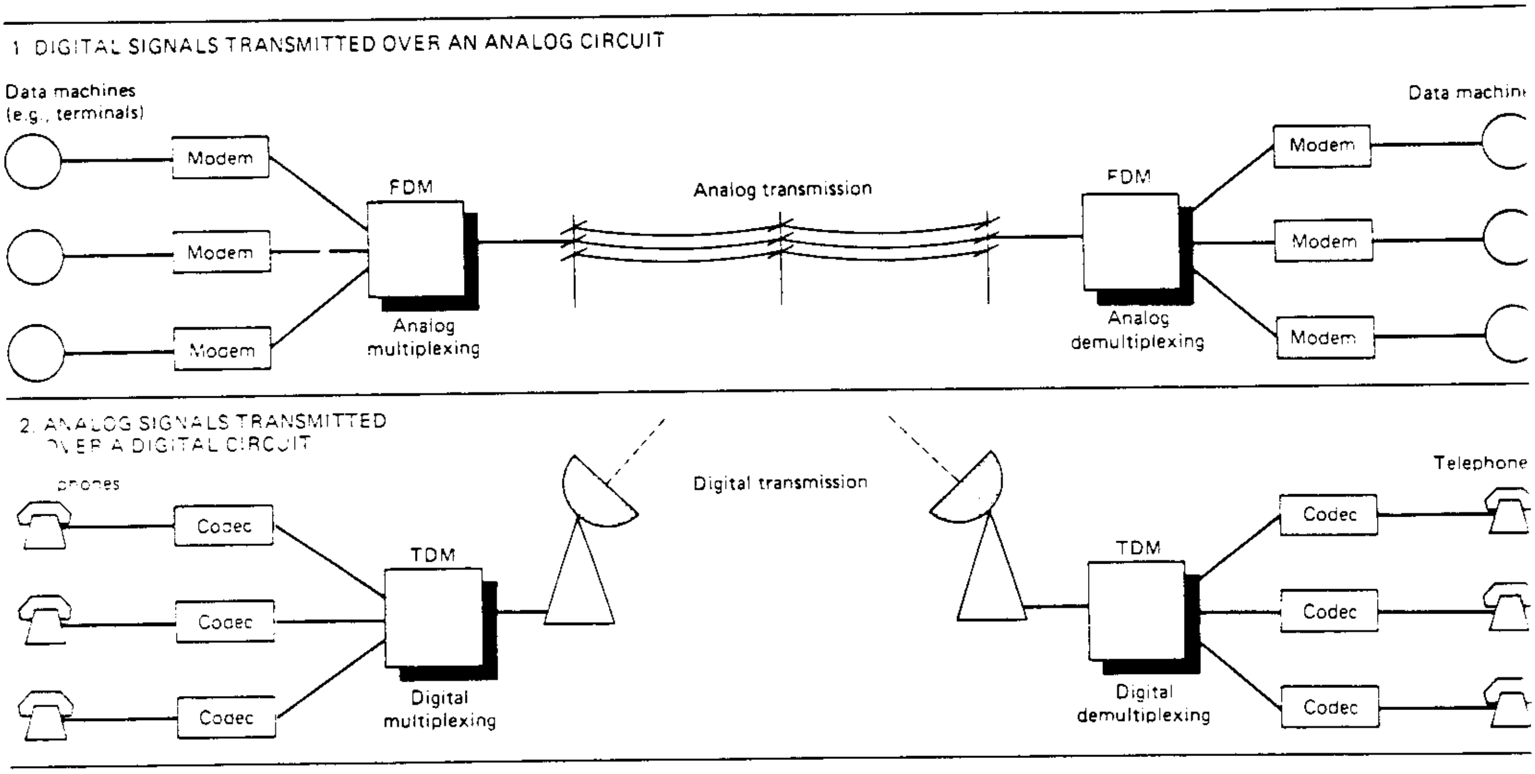
Figure 10.1 (Left) The space available for communication. (Center) Frequency-division multiplexing. (Right) Time-division multiplexing.



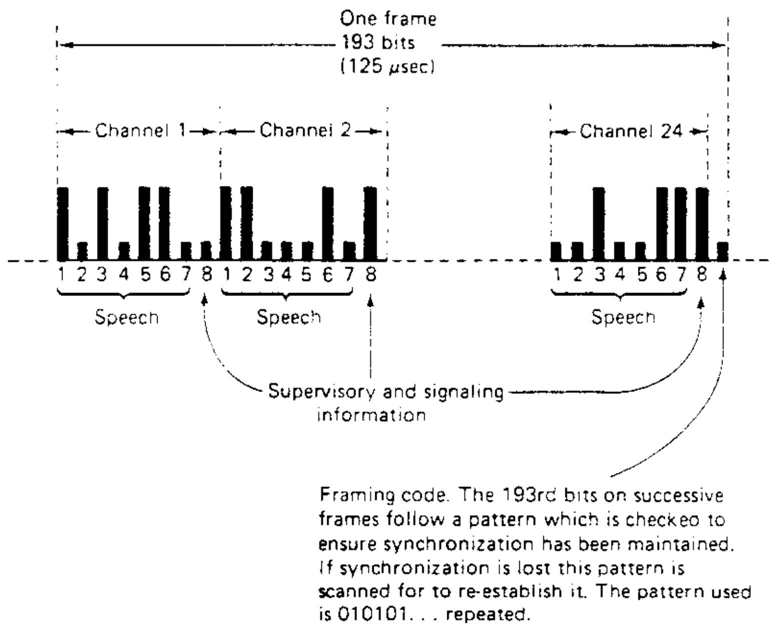
Generation of carrier frequencies
Pilot
Speech signal 1
Low-pass filter
64 KHz
Modulator
Filter 60-64 KHz
Speech signal 2
Low-pass filter
68 KHz
Modulator
Filter 64-68 KHz
Speech signal 3
Low-pass filter
72 KHz
Modulator
Filter 68-72 KHz
Telephone channels
Speech signal 4
Low-pass filter
76 KHz
Modulator
Filter 72-76 KHz
Speech signal 5
Low-pass filter
80 KHz
Modulator
Filter 76-80 KHz
Speech signal 12
Low-pass filter
108 KHz
Modulator
Filter 104-108 KHz
First multiplexing stage
Further multiplexing stages
70 MHz IF modulated carrier
Up converter
6 GHz RF
Power amplifier
Antenna



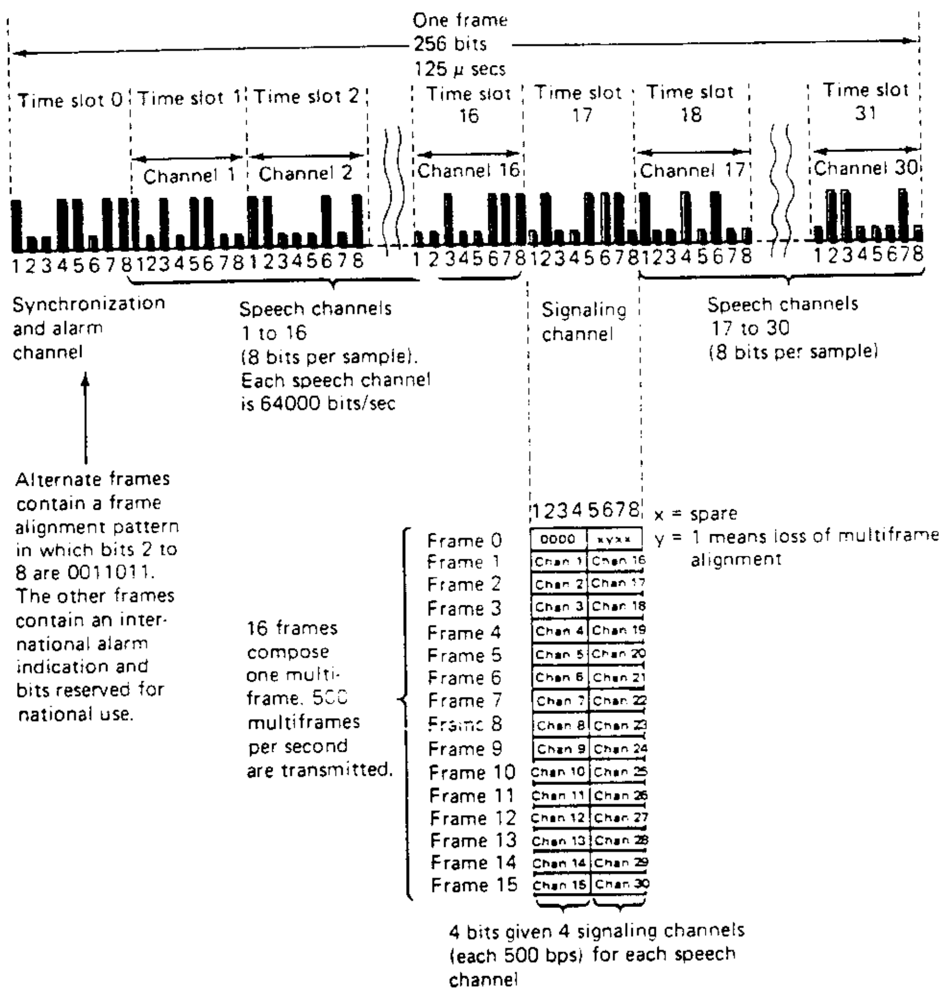
Multiplexing stages when frequency-division multiplexing is used on a transponder carrying a total of 900 voice channels. Each of the 12 transponders of INTELSAT IV can carry such a block at the frequencies shown in Fig. 10.5.



Modems and codecs.

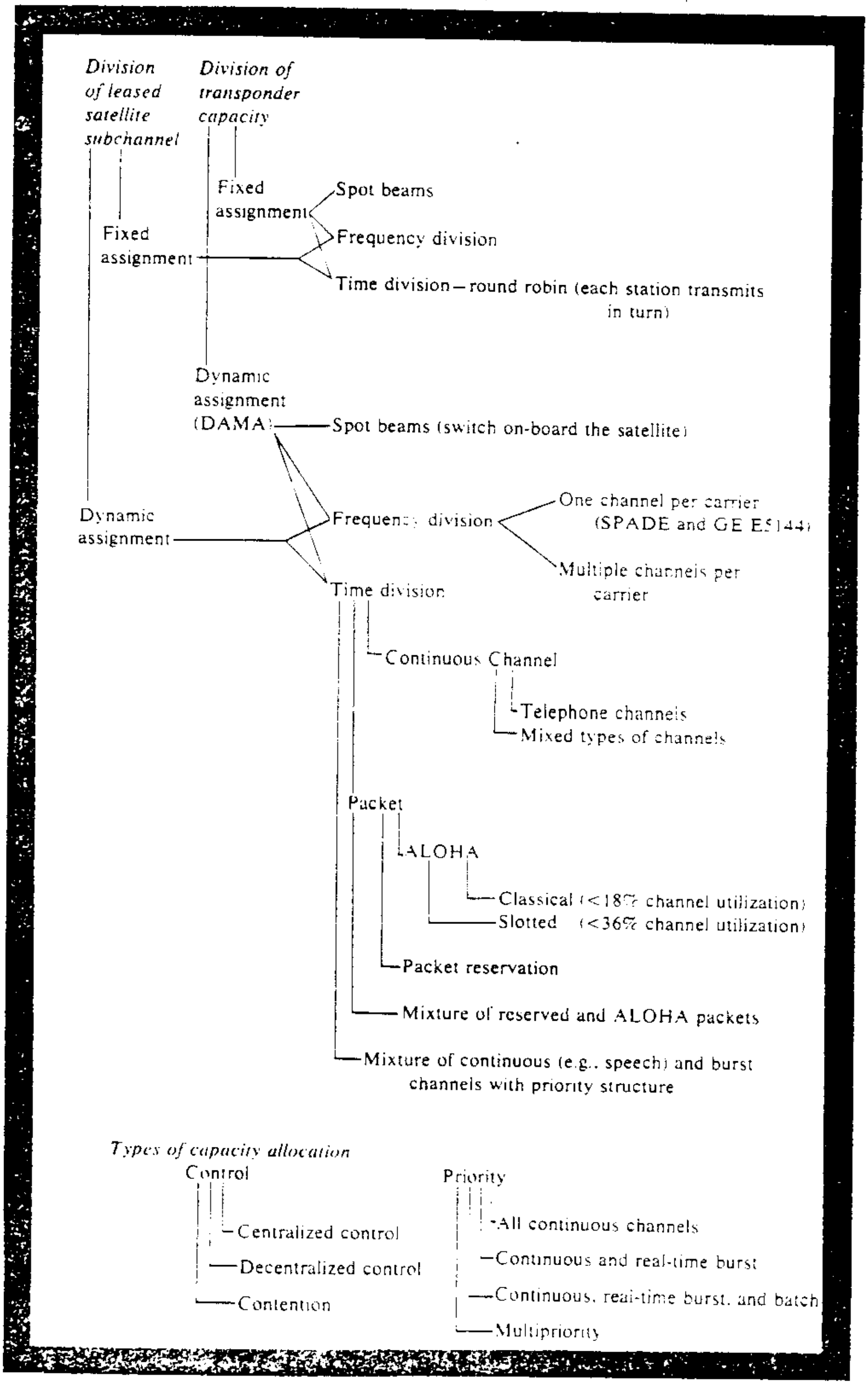


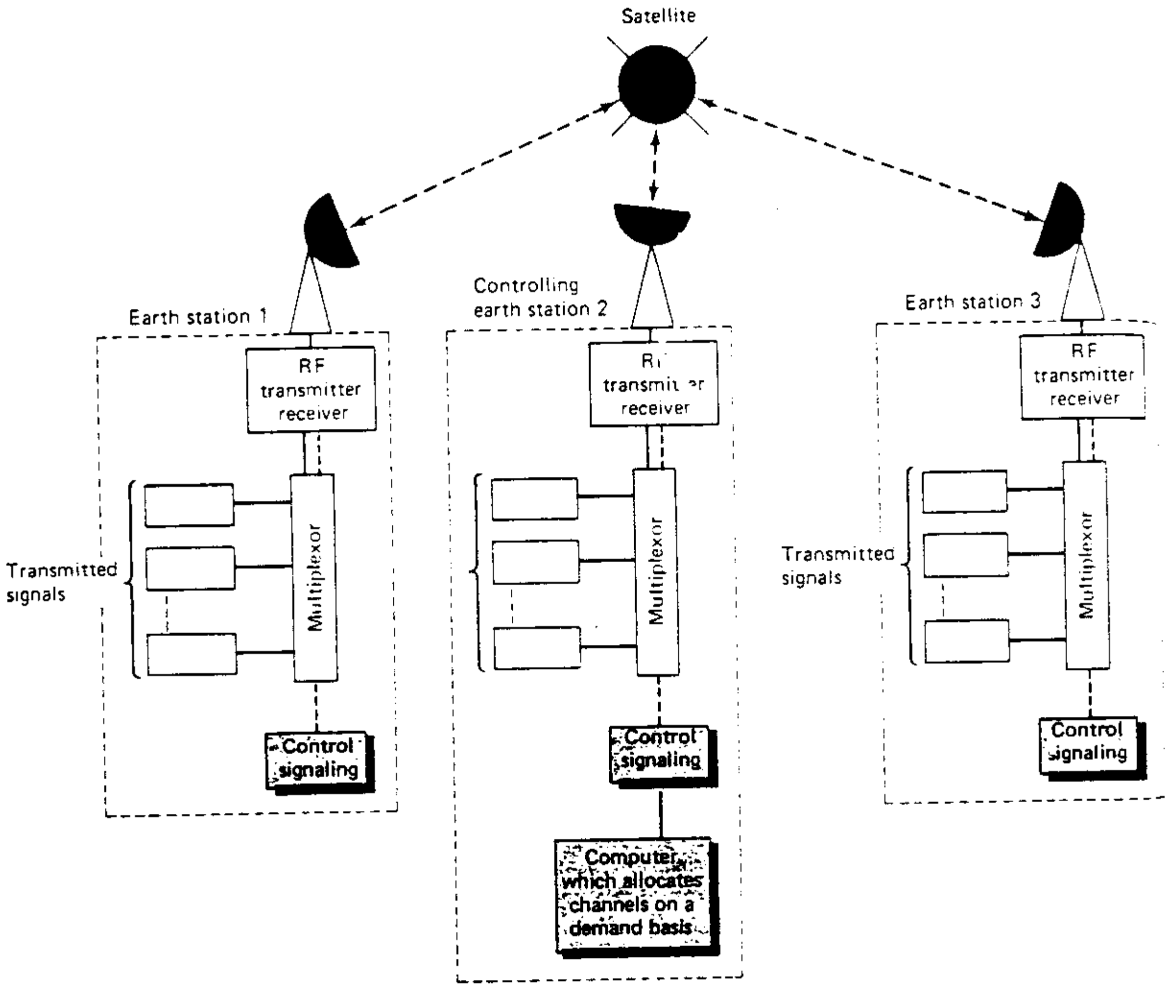
The bit structure of a North American T1 transmission link operating at 1.544 million bits per second. The above frame is repeated 8000 times per second, thus giving 8000 samples per second on each channel plus an 8000 bps bit stream for control signaling. The CCITT Recommendation for 1.544 bps PCM is slightly different



CCITT Recommendation for the structure of PCM channels for transmission at 2.048 million bits/sec. [3]. 30 speech channels of 64,000 bps are derived, each with a signaling channel of 500 bps.

Summary of multiple-access techniques

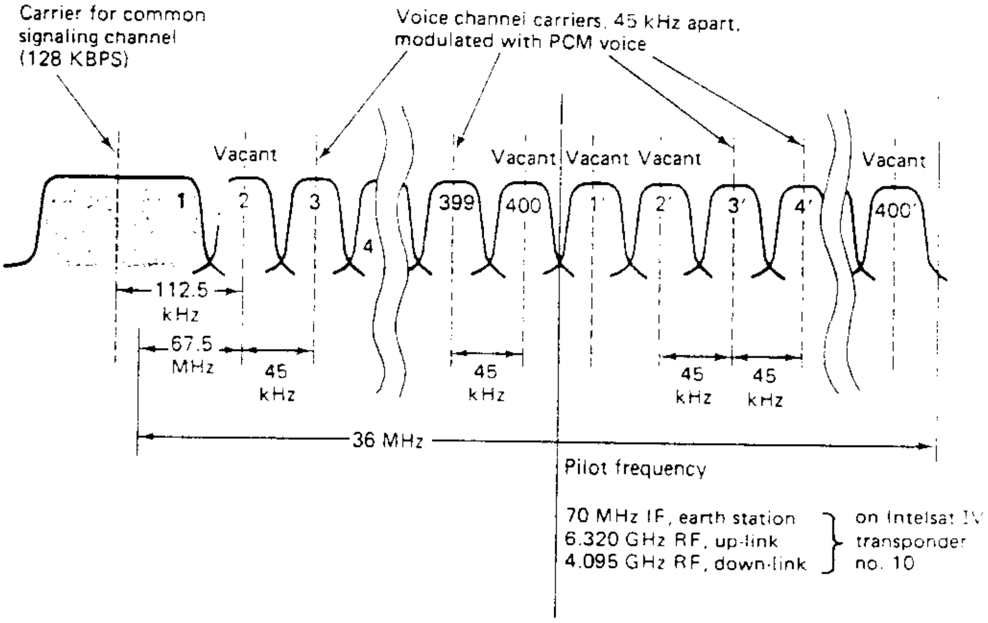


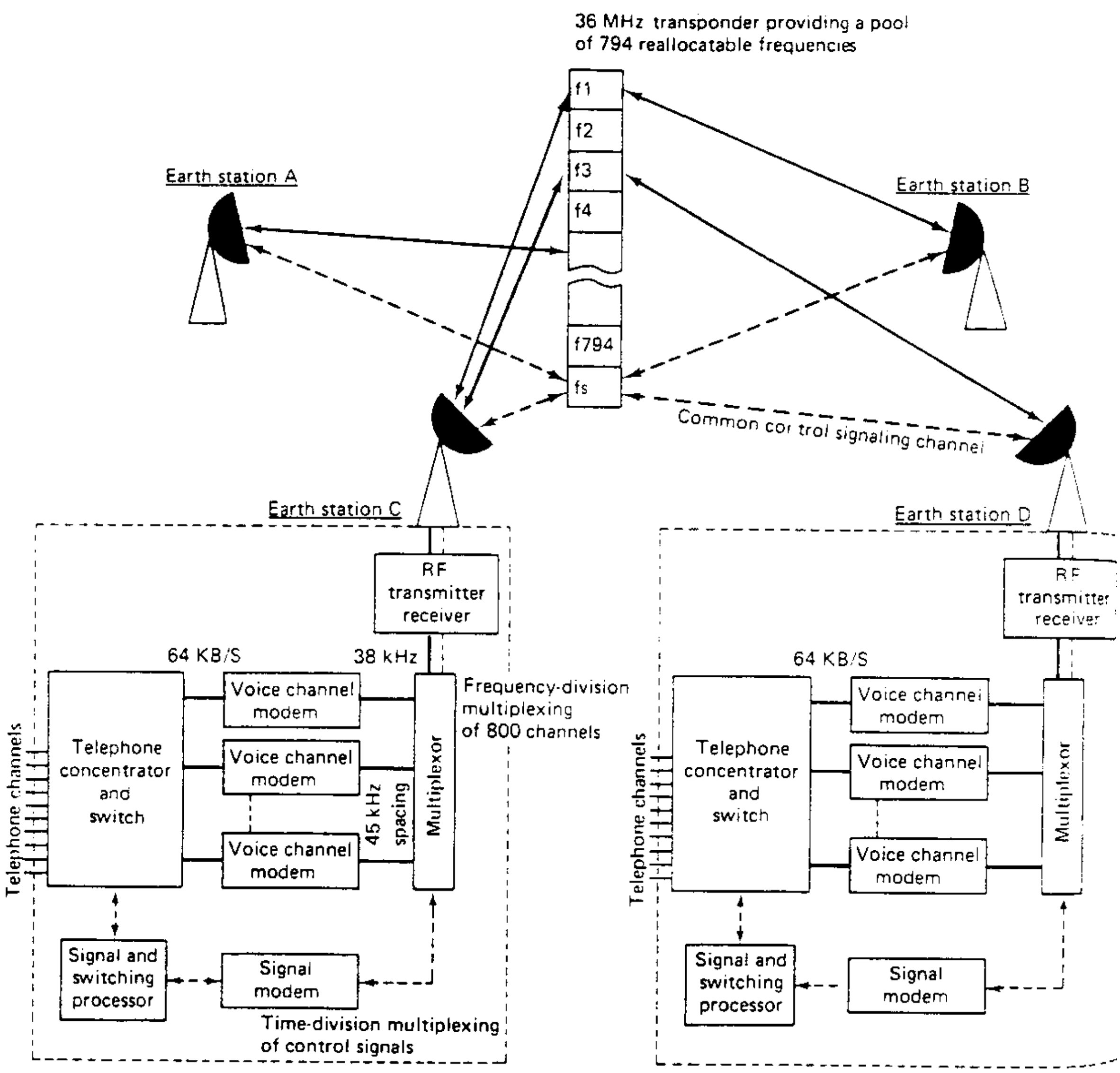


Centralized control of demand-assignment performed by a computer at earth station 2.

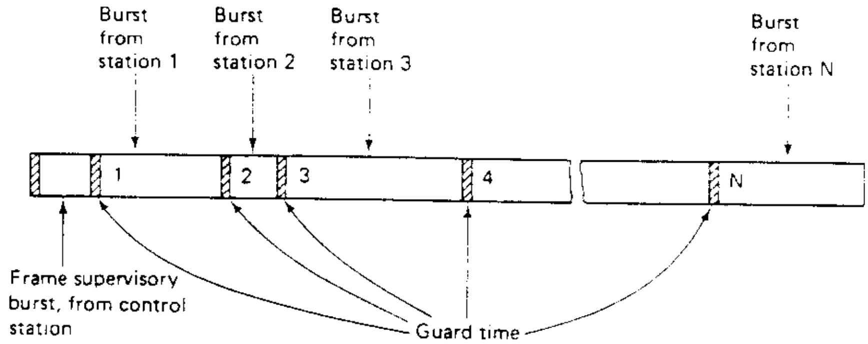
FREQUENCY-DIVISION MULTIPLE ACCESS

The frequency assignments of SPADE, giving 397 pairs of usable voice channels in one 36 MHz transponder.

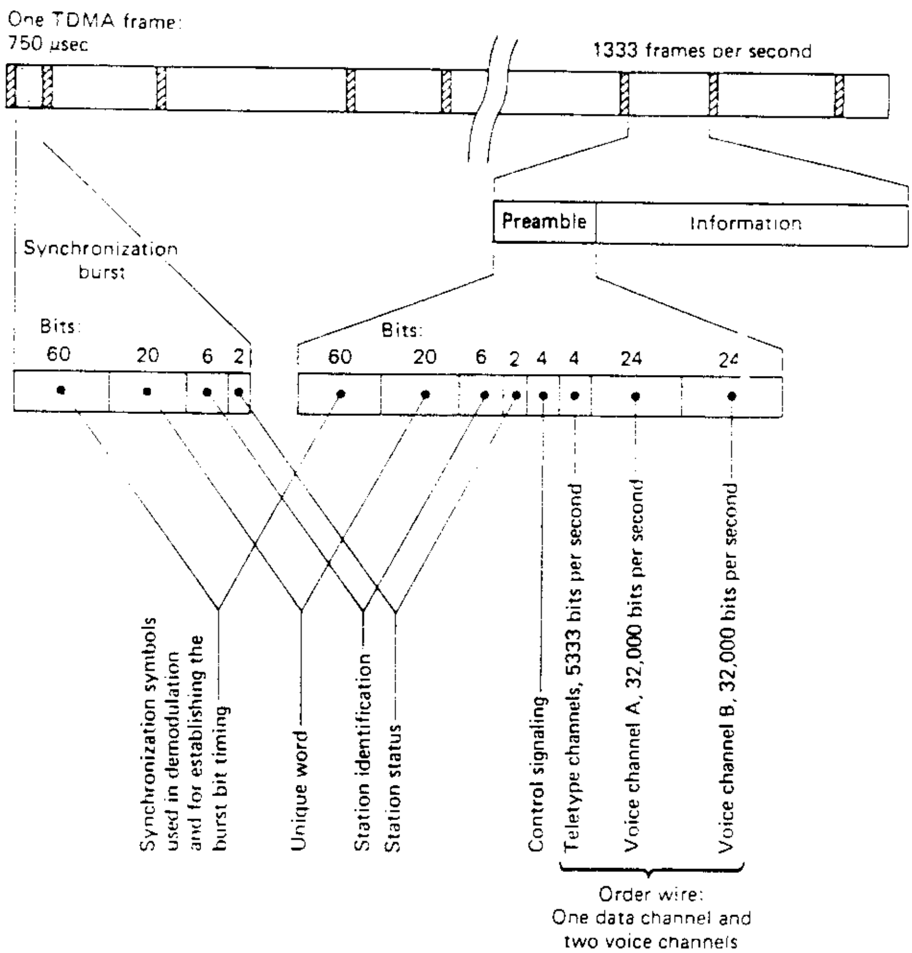




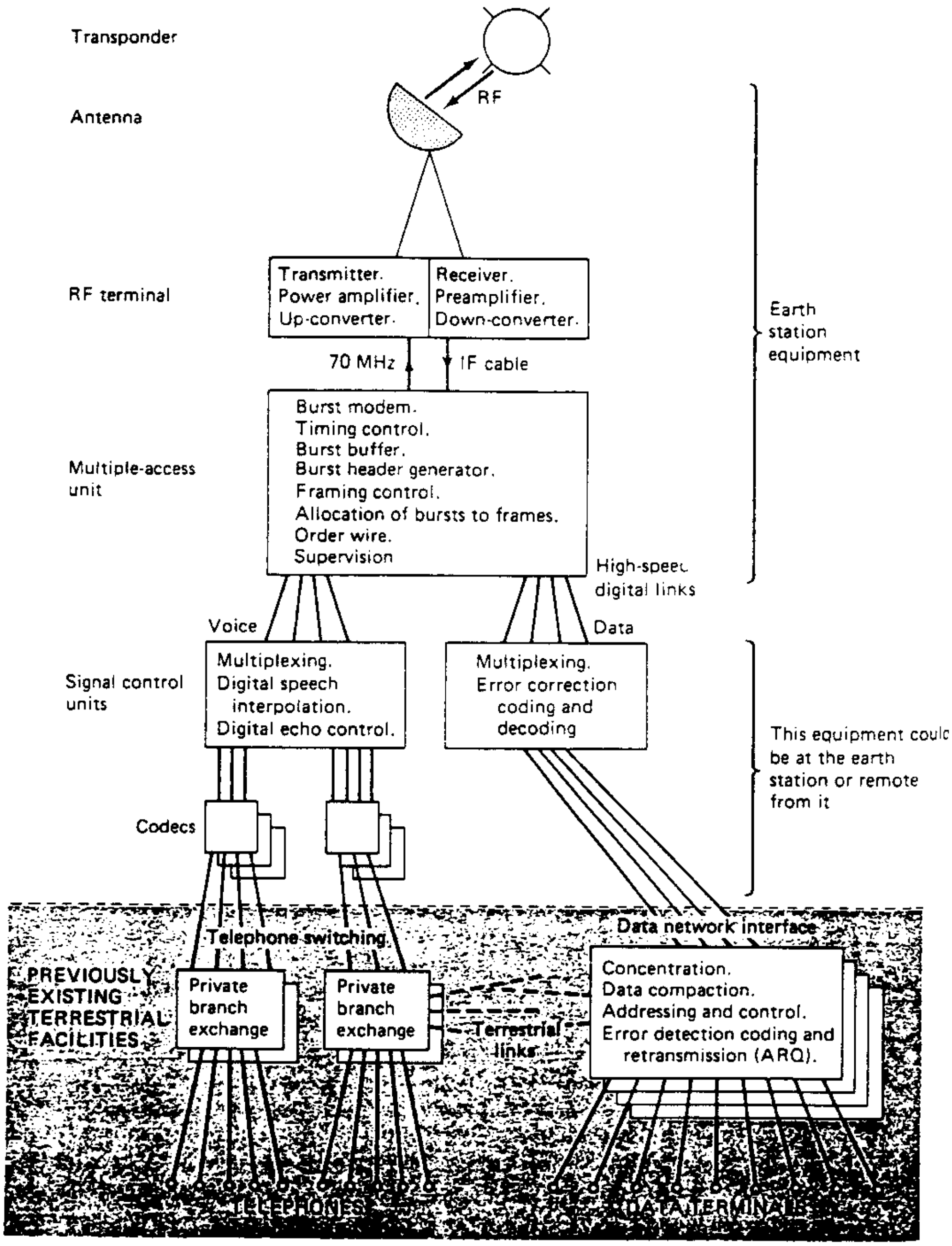
The operation of the SPADE frequency-division demand-assignment system.



A frame in a TDMA system. A typical frame length is on the order of 1 millisecond.



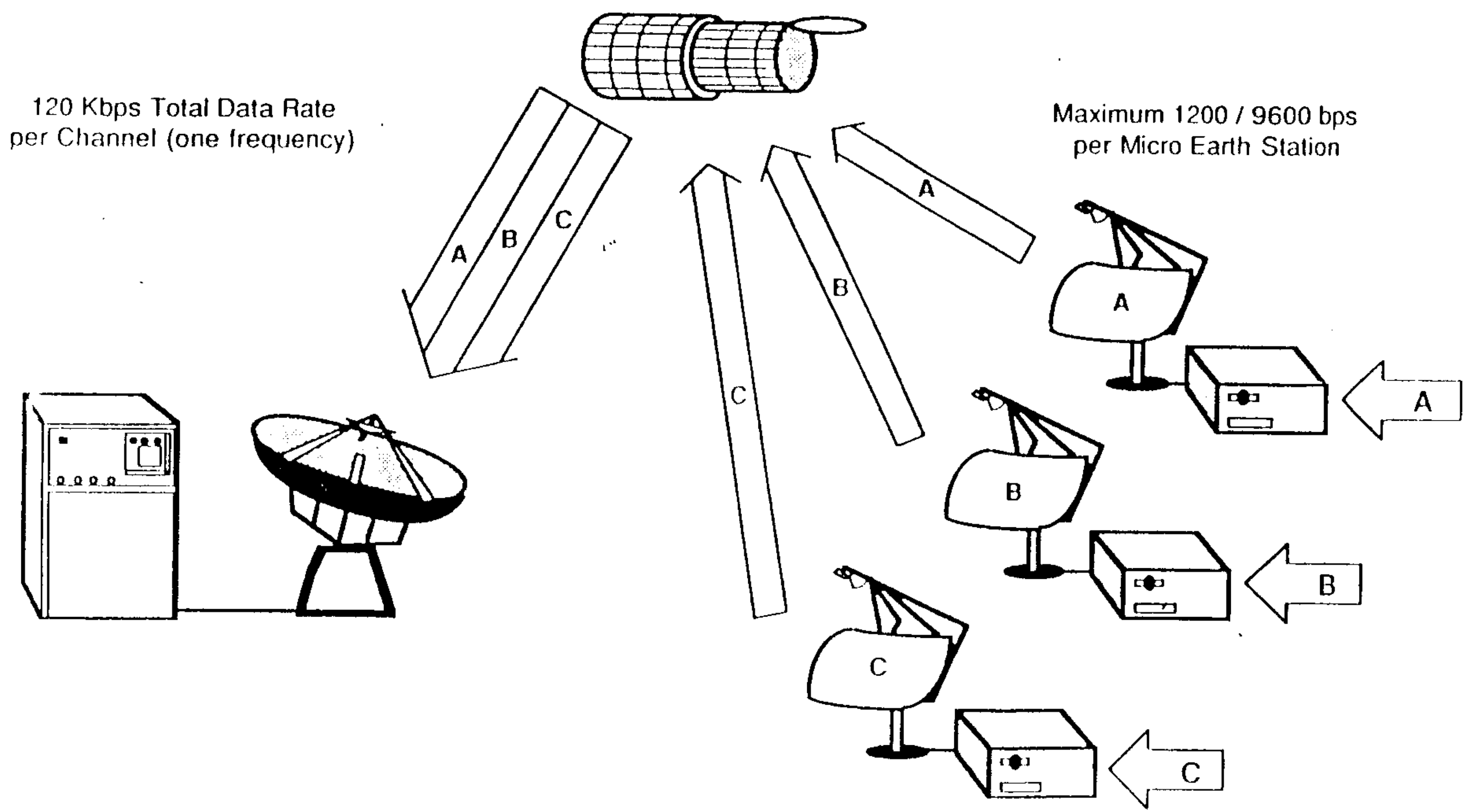
Bits used for synchronization and control of TDMA frames on the Comsat MATE system



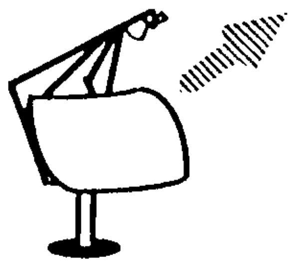
Basic functions of a TDMA system used for telephone and data traffic. The SBS system operates as shown in this diagram.

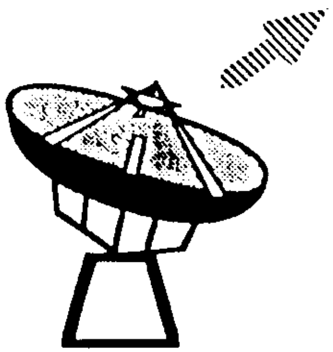
Inbound Transmission

Code Division Multiple Access (CDMA)



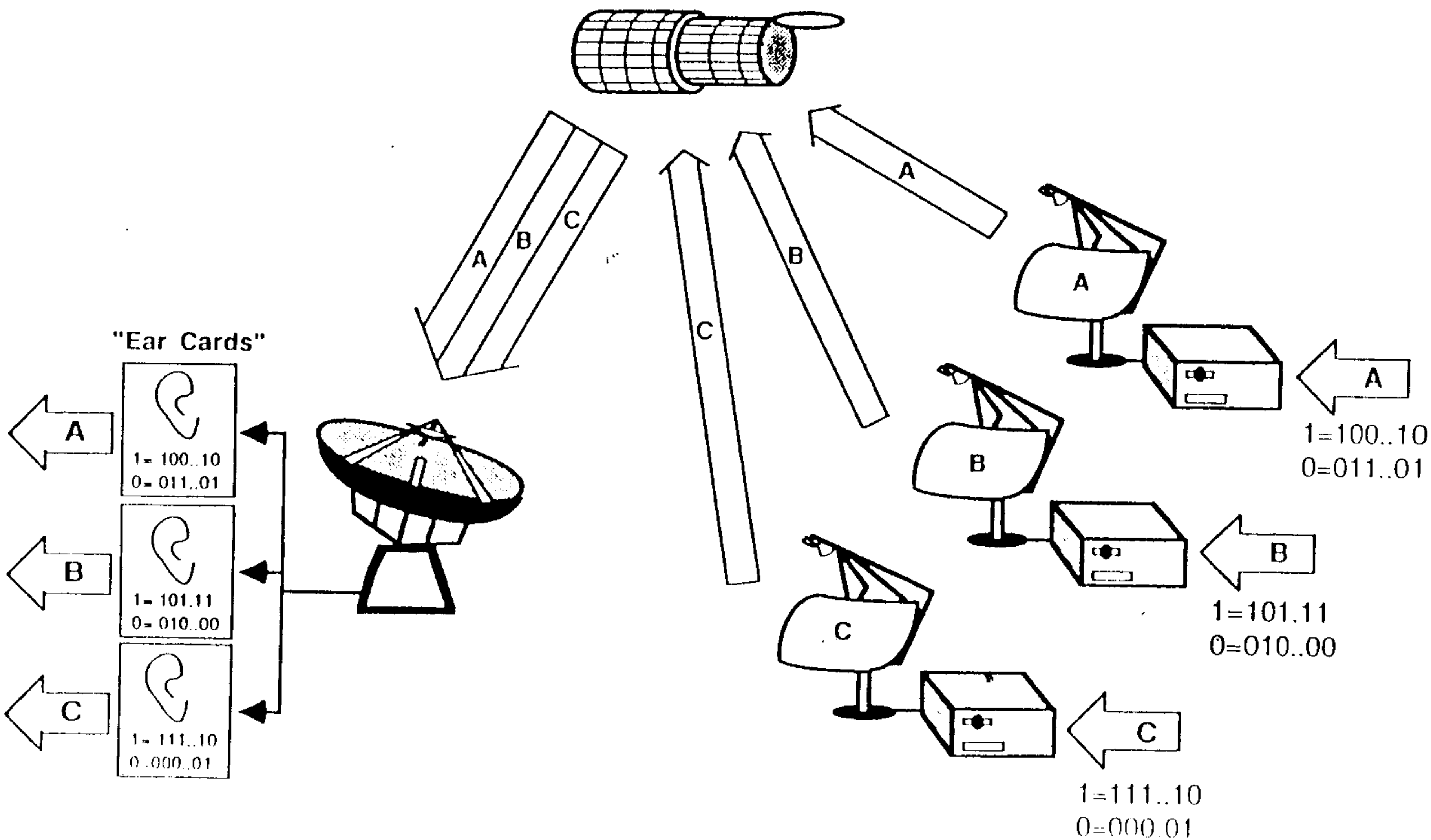
Spread Spectrum





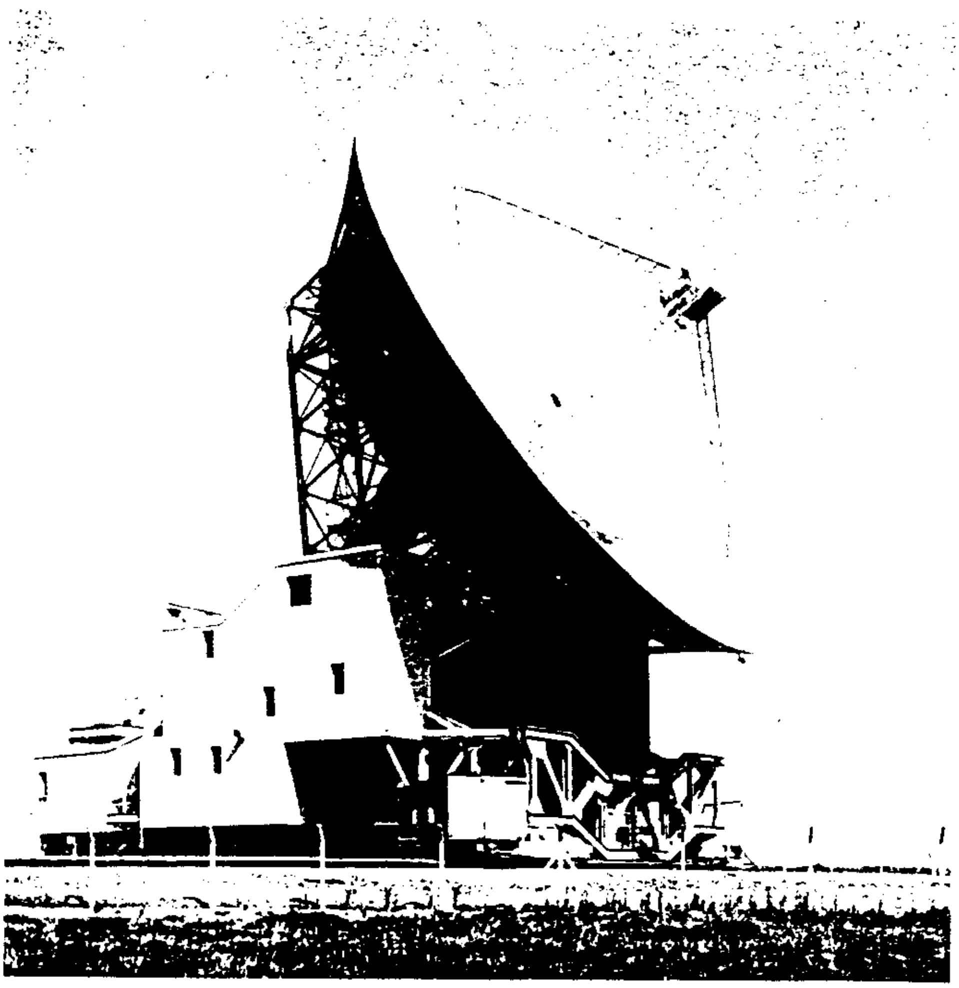
	Data Rate	Chips per Bit
Inbound:	1200 bps	2048
	9600 bps	256
Outbound:	153.6 kbps	16

Different Codes for Different Nodes

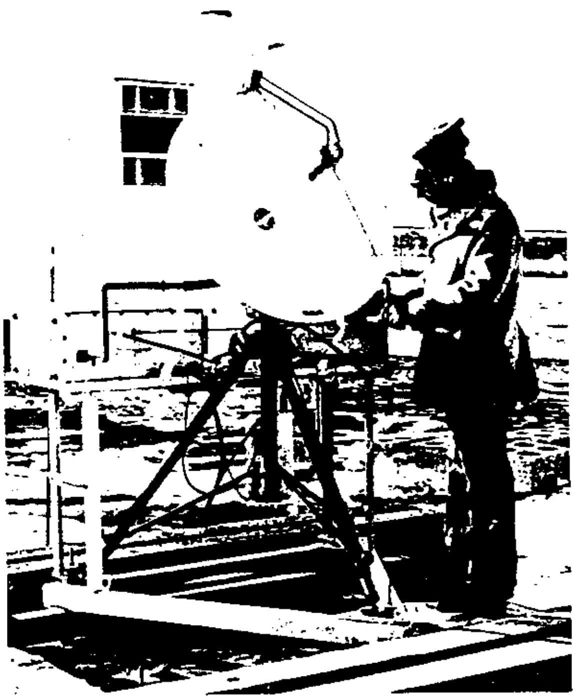


Comparison of Access Techniques

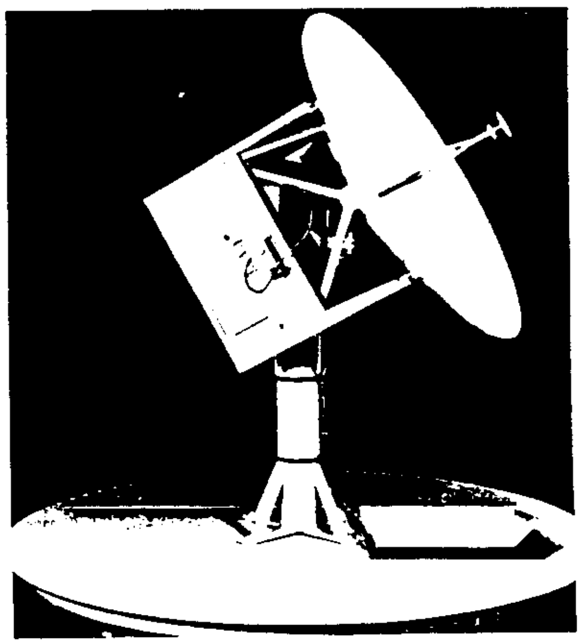
Access Technique	Typical Throughput Efficiency	95th Percentile Inbound Transit Time	Comments
Preassigned	98%	3.3 seconds	☐ Lowest complexity ☐ Excellent efficiency ☐ Excessive response time
Random (Slotted Aloha)	5%	0.50 seconds	☐ Low complexity ☐ Poor efficiency ☐ Good response time
Reservation TDMA	50%	2.0 seconds	☐ High complexity ☐ Moderate efficiency ☐ Poor response time
CDMA with Thresholding	95%	0.25 seconds	☐ Low complexity ☐ Best combination of efficiency and response time



The earth stations of the 1960s were huge and very expensive. (*Courtesy British Post Office.*)



Canada's CTS (Communications Technology Satellite) makes possible excellent quality television reception with this 32-inch earth station. *(Photo courtesy Canadian Department of Communications.)*



This earth station is 4 feet in diameter. It is used on board ships for worldwide voice and data communications using the Marisat satellite. (Its protective dome is removed in this photograph.) *(Photo courtesy Comsat General.)*

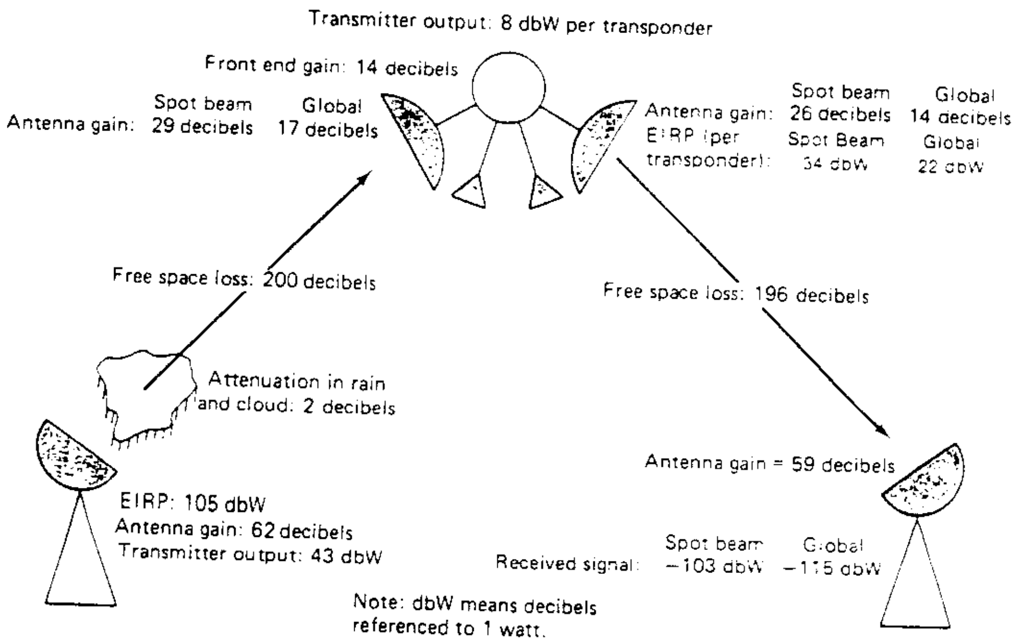
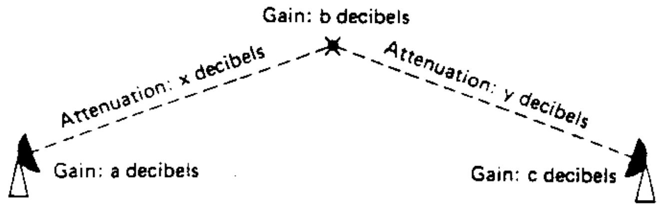


Figure 6.10 Typical figures for losses and gains in a 4-6 GHz system with large earth station antennas.

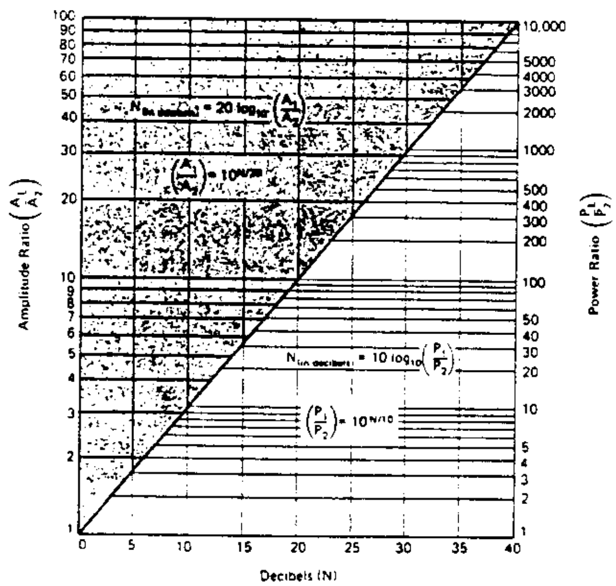


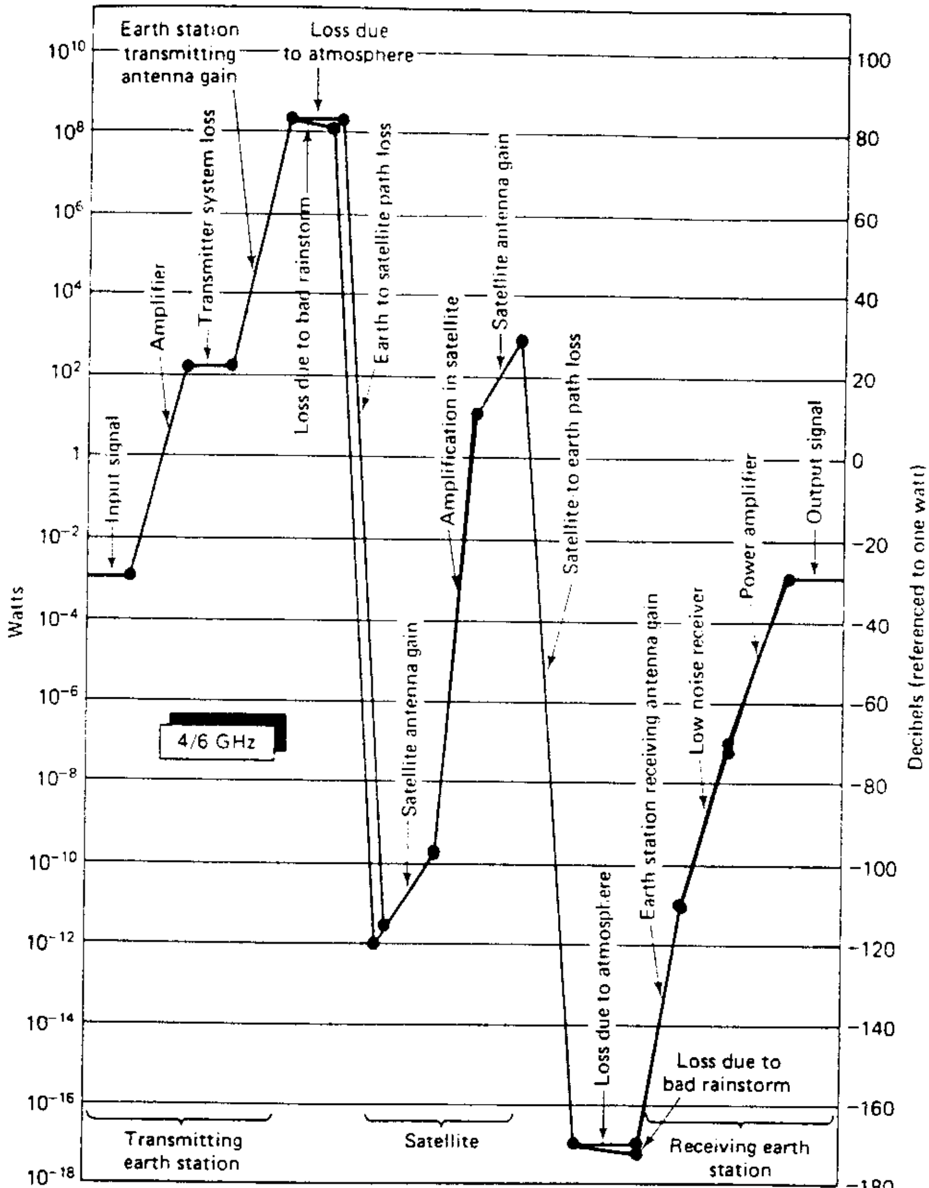
Total gain = (a + b + c − x − y) decibels

Suppose a signal is transmitted over a line which reduces it in power in a ratio 20 to 1. It then passes over another section of line which reduces it in a ratio 7 to 1. The net reduction is in the ratio 140 to 1. Expressing this in decibels, the first reduction is $10 \log_{10} 20 = 13.01$ decibels; the second reduction is $10 \log_{10} 7 = 8.45$ decibels. The net reduction is the sum of these: 21.46 decibels. ($10 \log_{10} 140 = 21.46$ decibels).

Similarly, if we say that line loss is 2 decibels per mile, then the loss at the end of 25 miles of line is 50 decibels. We therefore need an amplifier of gain 50 decibels to produce a signal of the original power.

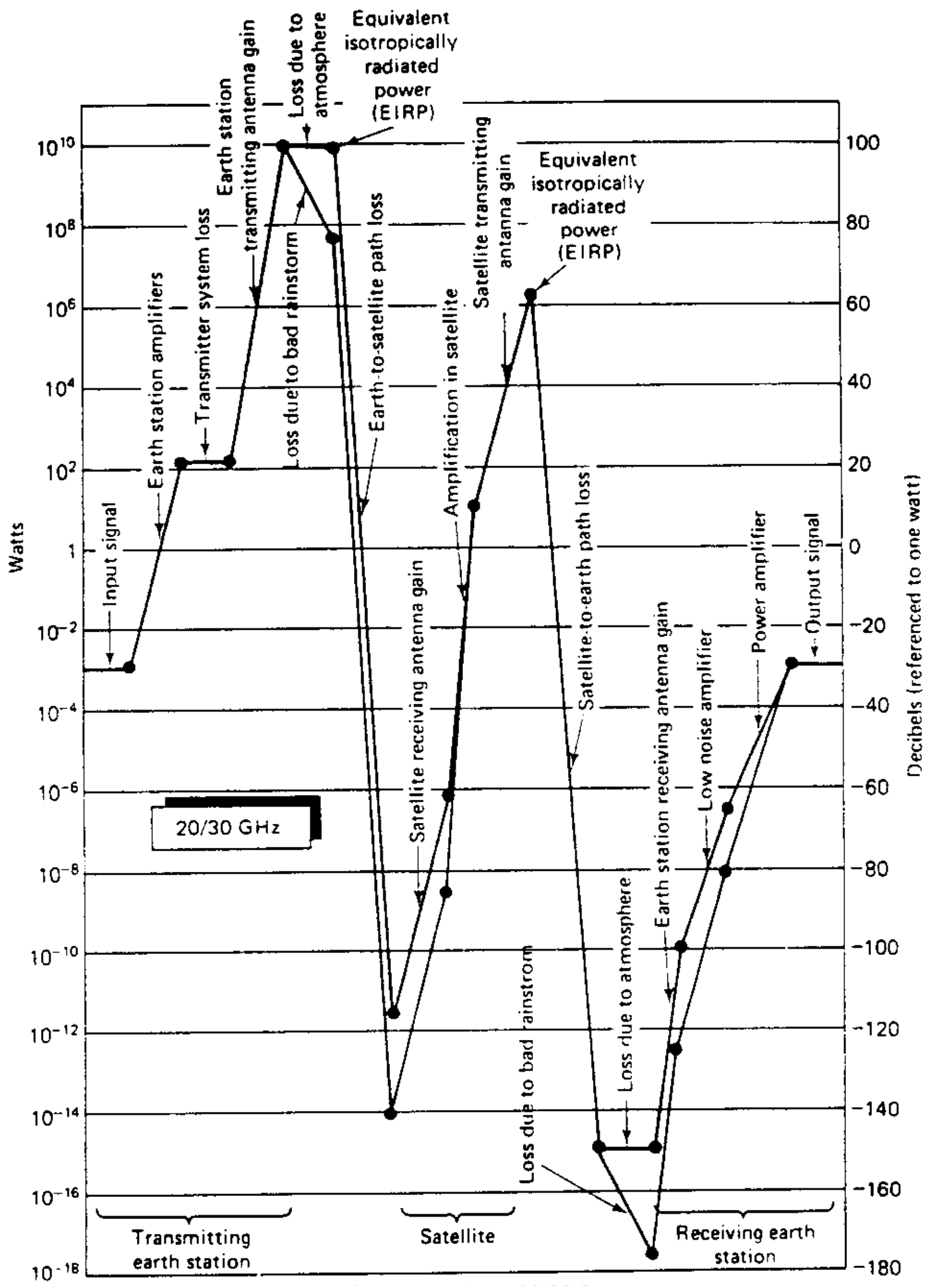
The chart below will enable the reader to quickly convert power or amplitude ratios to decibels and vice versa.





A LINK OPERATING AT 4/6 GHz

Gains and losses in power of signals being relayed by satellite. The signal falls to about one hundred billion billionth of its strength (10^{-20}) on each of its 25,000-mile journeys through space. This great loss is balanced by the gains of the antennas and amplifiers.



A LINK OPERATING AT 20/30 GHz

At the higher frequencies of the above illustration, antennas provide more gain in signal strength. However, the loss caused by bad rain storms is worse. As discussed in the following chapter, bad weather causes not only loss but also noise which degrades the signal.

A summary of the gains, losses and noise in the satellite link. The figures can be varied as trade-offs between the design parameters are explored.

	A 4/6-GHz Link. Satellite Antenna: Earth Coverage. Earth Antenna: 12 meters. Moderately Low-Cost Electronics in Earth Station.	A 12/14-GHz Link. Satellite Antenna: 1.8 Meters. Earth Antenna: 1.8 Meters. Low-Cost Earth-Station Receiver.	A 20/30-GHz Link for Common Carrier Use. Satellite Antenna: 2 Meters. Earth Antenna: 27.5 Meters. Cryogenically Cooled Receiver.	A 12/14-GHz Link on a Broadcast Satellite. Satellite Antenna: 9 Meters. Earth Antenna: 1.8 Meter Receiver-only; 12-Meter Transmit. Low-Cost Earth Station.
Up-Link				
Transmitter power, dBw*	35	25	20	20
Transmitter system loss, decibels	−1	−1	−1	−1
Transmitting antenna gain, decibels	55	46	76	62
Atmospheric loss, decibels	0	−0.5	−2	−0.5
Free space loss, decibels	−200	−208	−214	−208
Receiving antenna gain, decibels	20	46	53	60
Receiver system loss, decibels	−1	−1	−1	−1
Received power, dBw*	−92	−93.5	−69	−68.5
Noise temperature, °K	1000	1000	1000	1000
Received bandwidth, MHz	36	36	350	36
Noise, dBw*	−128	−128	−118	−128
Received SNR, decibels	36	34.5	49	59.5
Loss in bad storm, decibels	2	10	25	10
Received SNR in bad storm, decibels	34	24.5	24	49.5
Down-link				
Transmitter power, dBw*	18	20	8	10
Transmitter system loss, decibels	−1	−1	−1	−1
Transmitting antenna gain, decibels	16	44	49	58
Free space loss, decibels	−197	−206	−210	−206
Atmospheric loss, decibels	0	−0.6	−2	−0.6
Receiver antenna gain, decibels	51	44	72	44
Receiver system loss, decibels	−1	−1	−1	−1
Received power, dBw*	−114	−100.6	−85	−96.6
Noise temperature, °K	250	1000	250	1000
Received bandwidth, MHz	36	36	350	36
Noise, dBw*	−131	−128	−121	−128
Received SNR, decibels	17	27.4	36	31.4
Loss in bad storm, decibels	2	10	25	10
Received SNR in bad storm, decibels	15	17.4	11	21.4

*dBw means decibels referenced to one watt, I. E. 1 watt = 0 dBw; 100 watts = 2 dBw, etc.

Typical numbers of bits needed for different types of messages.

	Message Type	Bits
1.	A high-quality color photograph	2 million
2.	A newspaper-quality photograph	100,000
3.	A color television frame	1 million
4.	A Picturephone frame	100,000
5.	A brief telephone voice message	1 million
6.	A vocoder telephone voice message	100.000
7.	A voice message of code-book words	400
8.	A document page in facsimile form	200.000
9.	A document page in computer code	10,000
10.	A typical interoffice memo	3,000
11.	A typical telegram	2.000
12.	A typical flip chart	1.000
13.	A typical computer input transaction	500
14.	A typical electronic fund transfer	500
15.	A typical airline reservation	200
16.	A coded request for a library document	200
17.	A fire or burglar alarm signal	40

categories of end-to-end delivery time:

1. Almost immediate (as with telephone speech).
2. A few seconds (as with interactive use of computers).
3. Several minutes.
4. Several hours.
5. Delivery the following morning.

Demand trends for transmission of records (from a study about satellite uses commissioned by NASA [1])

		1950	1960	1970	1980	1990
Stolen vehicle information transfer	Cases/yr $\times 10^3$	160	320	820	1950	4600
Facsimile transmission of "mug shots," finger prints, and court records	Cases/yr $\times 10^6$	2	4	7	13	25
Stolen property information transfer	Cases/yr $\times 10^3$	430	880	1700	3500	7000
Motor vehicle registration	Items/yr $\times 10^6$	49	74	110	164	245
Driver's license renewal	Items/yr $\times 10^6$	38	48	60	75	90
Remote library browsing	Accesses/yr $\times 10^6$	0	0	Neg.	5	20
Remote title and abstract searches	Searches/yr $\times 10^6$	0	0	Neg.	8	20
Interlibrary loans	Books/yr $\times 10^6$	–	–	Neg.	40	100
Remote medical diagnosis	Cases/yr $\times 10^6$	0	0	20	60	200
Remote medical browsing	Accesses/yr $\times 10^6$	0	0	20	60	200
Electrocardiogram analysis	Cases/yr $\times 10^6$	0	Neg.	20	60	200
Patent searches	Searches/yr $\times 10^6$	6	6	6.5	7	7
Checks and credit transactions	Trans/yr $\times 10^9$	11	25	56	135	340
Stock exchange quotations	Trans/yr $\times 10^9$	0	0	1	2	4
Stock transfers	Trans/yr $\times 10^6$	290	580	1200	2500	4900
Airline reservations	Pass/yr $\times 10^6$	19	62	193	500	1400
Auto rental reservations	Reserv/yr $\times 10^6$	0	Neg.	10	20	40
Hotel/motel reservations	Reserv/yr $\times 10^6$	–	–	25	50	100
Entertainment reservations	Reserv/yr $\times 10^6$	–	–	100	140	200
National Crime Information Center	Trans/yr $\times 10^6$	0	0	6	20	70
National legal information center	Trans/yr $\times 10^6$	0	0	Neg.	5	30

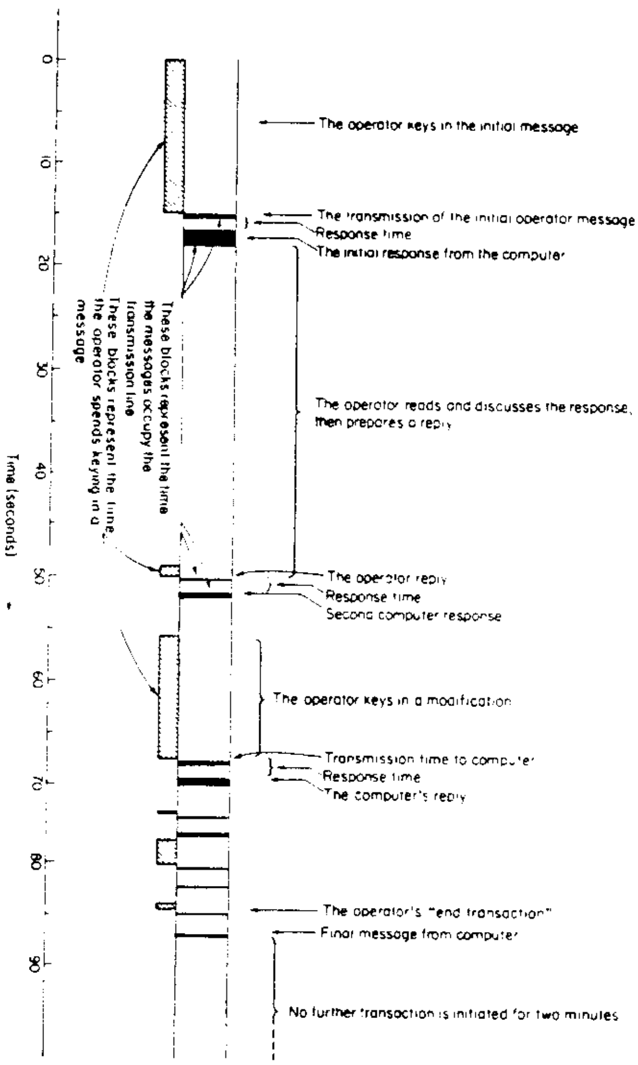
The composition of the U.S. mail, with an indication of which mail is potentially deliverable by satellite or other digital channels

Type of Mail	Percentage	
Individual households to:		
Business	5.8	
Individual households	14.0	
Government	0.4	
TOTAL		20.2
Government to:		
Business*	1.8	
Individual households*	3.8	
Government*	0.6	
TOTAL		6.2
Business to business:		
To suppliers*	3.9	
Intracompany*	1.4	
To stockholders*	0.7	
To customers: order acknowledgement*	0.2	
bills*	6.7	
product distribution	1.3	
promotional materials	5.4	
Other*	6.2	
TOTAL	25.8	
Business to households:		
Letters:		
Bills*	10.1	
Transactions**	1.2	
Advertising	12.6	
Other**	4.5	
TOTAL LETTERS	28.5	
Postcards:		
Bills**	0.7	
Advertising**	2.1	
Other**	0.4	
TOTAL POSTCARDS	3.2	
Newspapers and magazines	13.6	
Parcels	1.3	
TOTAL BUSINESS TO HOUSEHOLDS	46.7	
Business to government	1.2	
TOTAL BUSINESS		73.6

*: Potentially deliverable by satellite to the end user (22.7%).
**: Potentially deliverable by satellite, sorted, to a post office (22.8%).
(Shown by the red bands)

SPORADIC TRANSMISSION

Uses of Satellites for Interactive Computing



In man-computer conversations, transmission takes place sporadically.

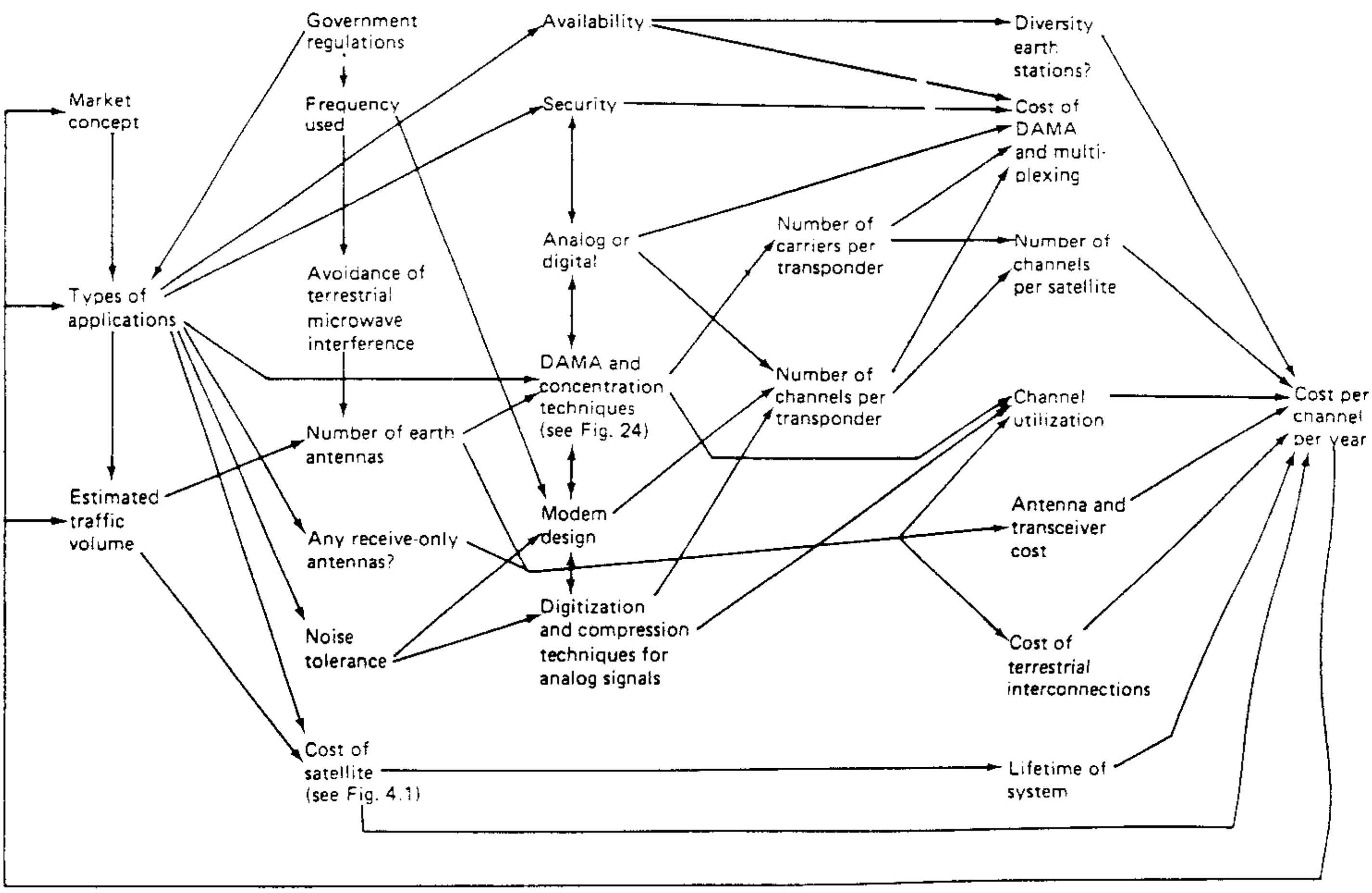
Specimen	Application	Average Quantity of Bits Transmitted in 1000 Seconds	Typical Line Speed (bps)	Efficiency
1	Calculation in BASIC	8,000	100	0.08
			4,800	0.0017
2	Stock analysis	10,000	150	0.067
			4,800	0.0021
3	Airline reservations	10,000	4,800	0.002
4	Sales order:			
	a. With simple terminal	40,000	4,800	0.0094
	b. With programmable terminal	2,000	4,800	0.0004
5	Data entry	15,000	4,800	0.003
6	Circuit design	200,000 (only new panels are transmitted)	56,000	0.0036

Specimen	Application	Average Rate (bps)	Desirable Peak Rate (bps)	Peak/Average Ratio
1	Calculation in BASIC	8	100	12.5
2	Stock analysis	10	150	15
3	Airline reservations	10	2,000	200
4	Sales order:			
	a. With simple terminal	40	4,000	100
	b. With programmable terminal	2	4,000	2000
5	Data entry	15	1,500	100
6	Circuit design	200	200,000	1000

TERRESTRIAL LINE CONTROL

1. Frequency-division multiplexing.
2. Time-division multiplexing.
3. Polling.
4. Concentration.
5. Loop control.
6. Packet switching.

TRADE-OFFS IN SYSTEMS DESIGN



COSTOS DE MICROESTACIONES

	EQUATORIAL	TELCOM GENERAL	M/A-COM	TRIDOIM
P R E C I O S:				
50 - 99	$9.5K-$11K	$8.5K-$9.5K	$13K	$7.5K-$8.5K
100 - 499	$8.2K-$9.2K	$8.0K-$9.0K	$11K	$7.5K-$8.5K
METODO DE ACCESO:	ESPECTRO ENSANCHADO	ESPECTRO ENSANCHADO	ALOHA RANURADO	ALOHA
VELOCIDAD SALIDA:	120,000 bps	56,000 bps	128,000 bps	32,000 bps
UTIL. EFECTIVA	96,000 bps	48,000 bps	12,800 bps	3,200 bps
VELOCIDAD ENTRADA:	153,600 bps	56,000 bps	512,000 bps	512,000 bps
MAX/CRT	19,200 bps	19,200 bps	19,200 bps	19,200 bps