TTH4J3
SISTEM KOMUNIKASI SATELIT

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BAB I
PENDAHULUAN

Topik:

1. Overview Arsitektur komunikasi Satelit
2. Implementasi komunikasi satelit dalam kehidupan sehari-hari
3. Pengaruh komunikasi satelit terhadap sendi-sendi kehidupan modern
4. Overview sejarah komunikasi satelit
5. Overview Regulasi ITU-R

Obyektif Perkuliahan

- Mengenalkan kembali dan memahami blok diagram sistem komunikasi dan mekanisme kerjanya
- Mengenal dan memahami sejarah perkembangan komunikasi satelit, evolusi, dan implementasi serta regulasi dan pengaruhnya.

Referensi :

1. Bruce R. Elbert, “Satellite Communications Handbook”, 2nd Ed., Artech House, 2004
2. Dennis Roddy, “Satellite Communications”, 4th Ed., Mc Graw Hill, 2006.
3. G. Maral & M. Bousquet, “ Satellite Communications Systems, Technology, and Application,” 3 rd Ed., John Wiley & Son, 2002.

Keunggulan Komunikasi Satelit

- Cakupan yang luas: satu negara, region, ataupun satu benua
- Bandwith yang tersedia cukup lebar;
- Independen dari infrastruktur terrestrial;
- instalasi jaringan segmen bumi yang cepat;
- Biaya relatif rendah per site;
- Karakteristik layanan yang seragam;
- Layanan total hanya dari satu provider;
- Layanan mobile/wireless yang independen terhadap lokasi.

Kelemahan Komunikasi Satelit

- Delay propagasi besar.
- Rentan terhadap pengaruh armosfir, dll
- *Up Front Cost* tinggi: Contoh untuk Satelit GEO: Spacecraft, Ground Segment & Launch = US $ 200 jt, Asuransi : $ 50 jt.
- *Distance insensitive:* Biaya komunikasi untuk jarak pendek maupun jauh relatif sama.
- Hanya ekonomis jika jumlah User besar dan kapasitas digunakan secara intensif.

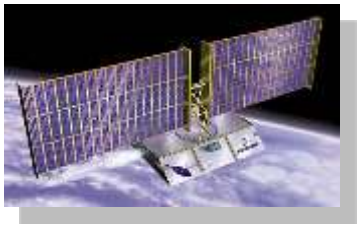
Selective Communications Satellite Chronology

1945 Arthur C. Clarke Article: "Extra-Terrestrial Relays"
1955 John R. Pierce Article: "Orbital Radio Relays"
1956 First Trans-Atlantic Telephone Cable: TAT-1
1957 Sputnik: Russia launches the first earth satellite.
1960 1st Successful DELTA Launch Vehicle
1960 AT&T applies to FCC for experimental satellite communications license
1961 Formal start of TELSTAR, RELAY, and SYNCOM Programs
1962 TELSTAR and RELAY launched
1962 Communications Satellite Act (U.S.)
1963 SYNCOM launched
1964 INTELSAT formed -140 countries
1965 COMSAT's EARLY BIRD: 1st commercial communications satellite
1969 INTELSAT-III series provides global coverage
1972 ANIK: 1st Domestic Communications Satellite (Canada)
1974 WESTAR: 1st U.S. Domestic Communications Satellite
1975 INTELSAT-IVA: 1st use of dual-polarization
1975 RCA SATCOM: 1st operational body-stabilized comm. satellite
1975 ANIK : 1 st Canada domestic satellite comm.
1976 MARISAT: 1st mobile communications satellite
1976 PALAPA: 3rd country (Indonesia) to launch domestic comm. satellite
1979 INMARSAT formed.
1988 TAT-8: 1st Fiber-Optic Trans-Atlantic telephone cable
1988 Cakrawarta 1 launched
1999 Telkom 1 launched
2000 Garuda 1 launched
2016 BRIsat 1 launched
2017 Telkom 3S launched
2018 Telkom 4 (Merah Putih) launched Aug 7th

Time line

http://prezi.com/rxprdmdyno-8/satellite-timeline/

Arsitektur Komunikasi Satelit



Segmen Angkasa

Uplink

Downlink

TT&C

SB TX

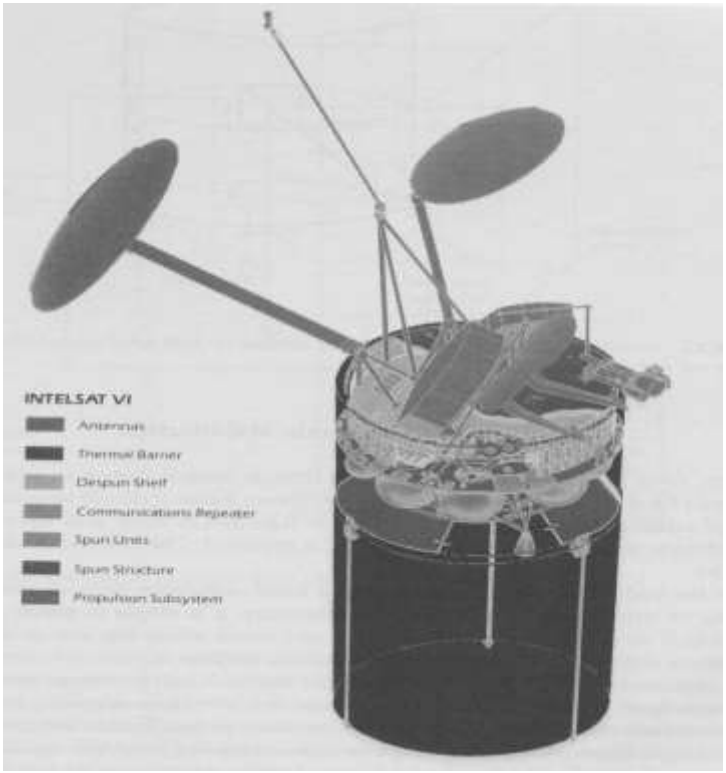
Master Station

SB RX

Arsitektur Komunikasi Satelit

- Segmen Angkasa:
  - Struktur / Bus
  - Payload
  - Power Supply
  - Kontrol temperatur
  - Kontrol attitude dan orbit
  - Sistem propulsi
  - Telemetry, Tracking, & Command (TT&C)
- Segmen Bumi:
  - User Terminal, SB Master, dan Jaringan.

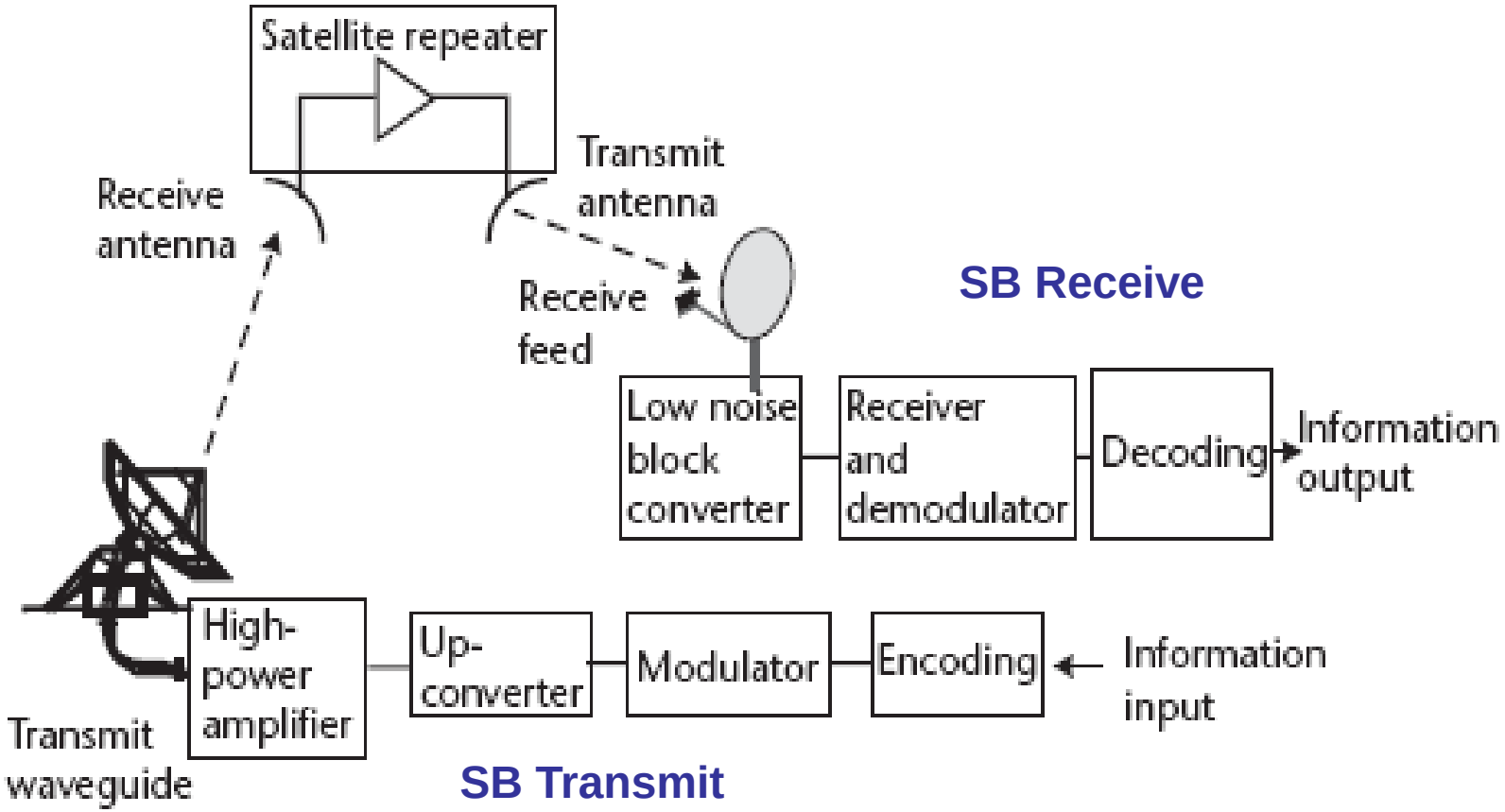
Jenis Spaceraft



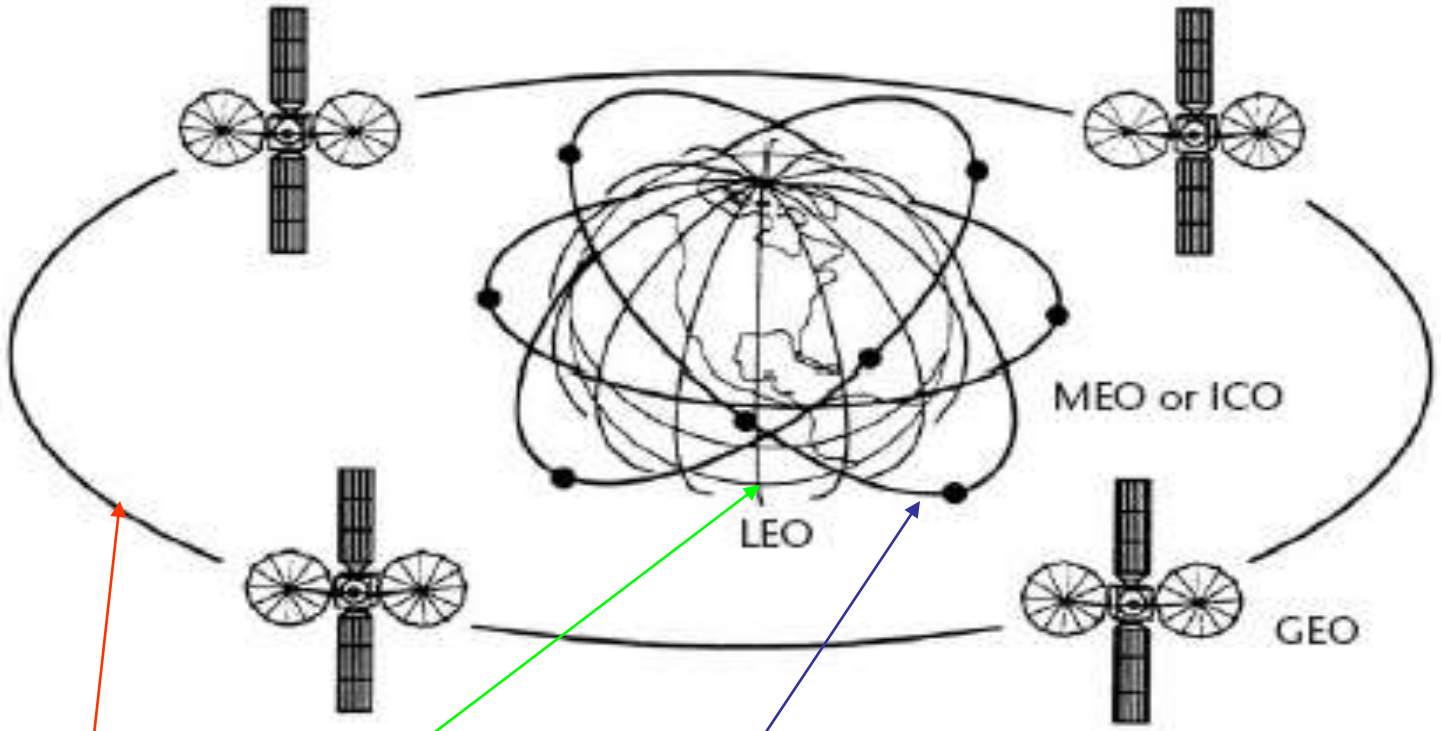
Spinning Stabilized Satellite, misalnya Palapa A, Measat, etc

3-axis Stabilized Satellite, misalnya Telkom-1, Thuraya (UEA), etc

Komponen Dasar Link Satelit

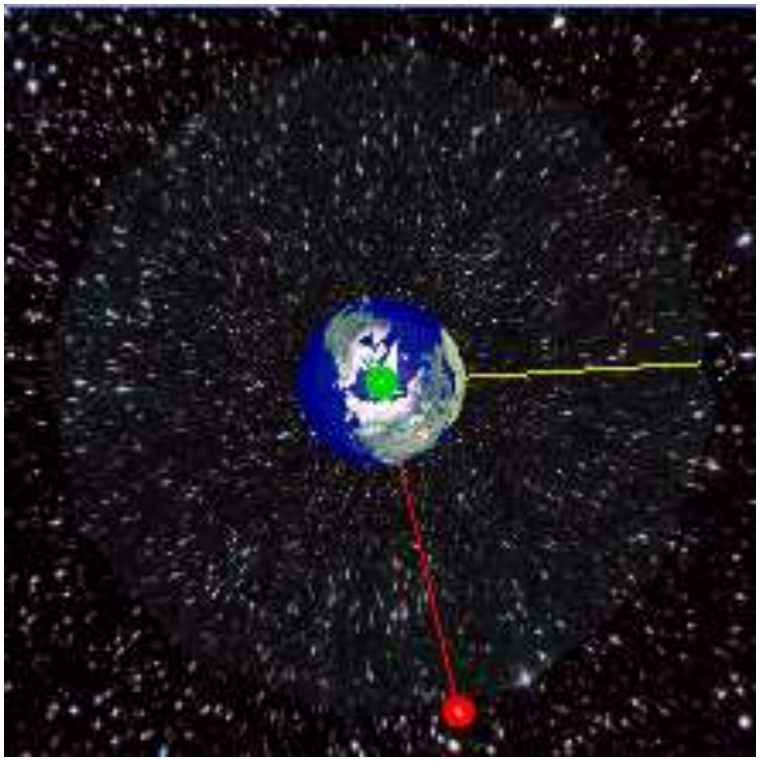


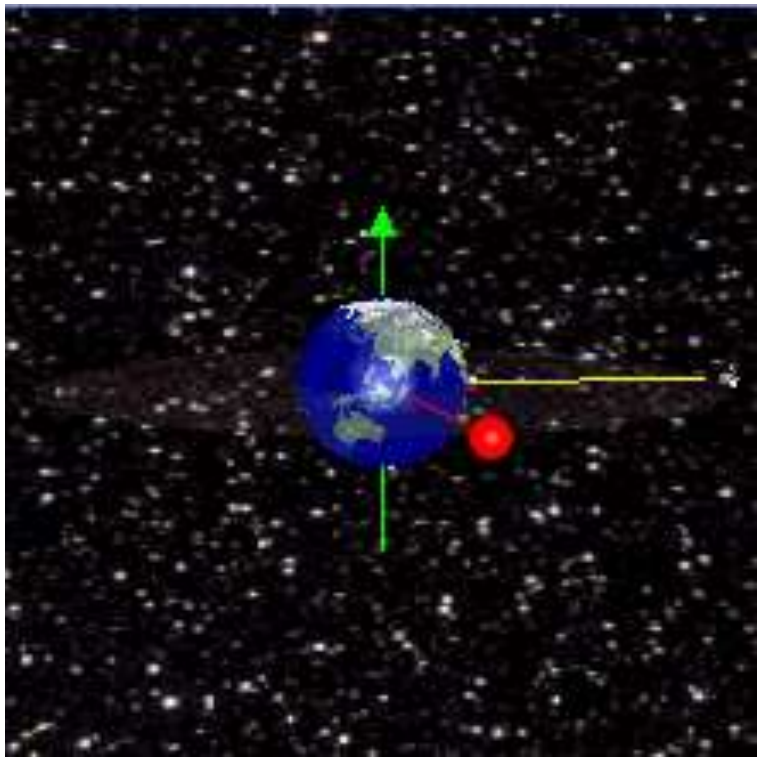
Tipe Orbit



- Equatorial, polar, dan inclined orbit.
- GEO (35,378 km), MEO (5000 km – 12.000 km), dan LEO (300km – 2000km).

Geostationary Orbit

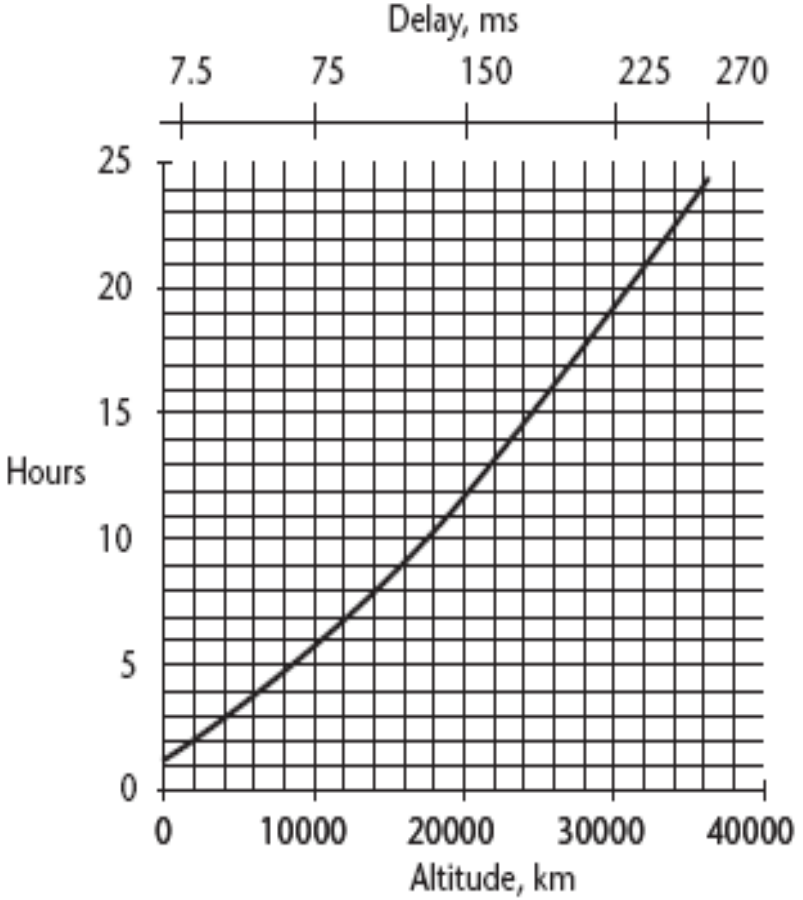




Geosynchronous Orbit : perioda orbit = periode rotasi bumi
Geostasionary Orbit : Orbit geosinkron lingkaran diatas katulistiwa

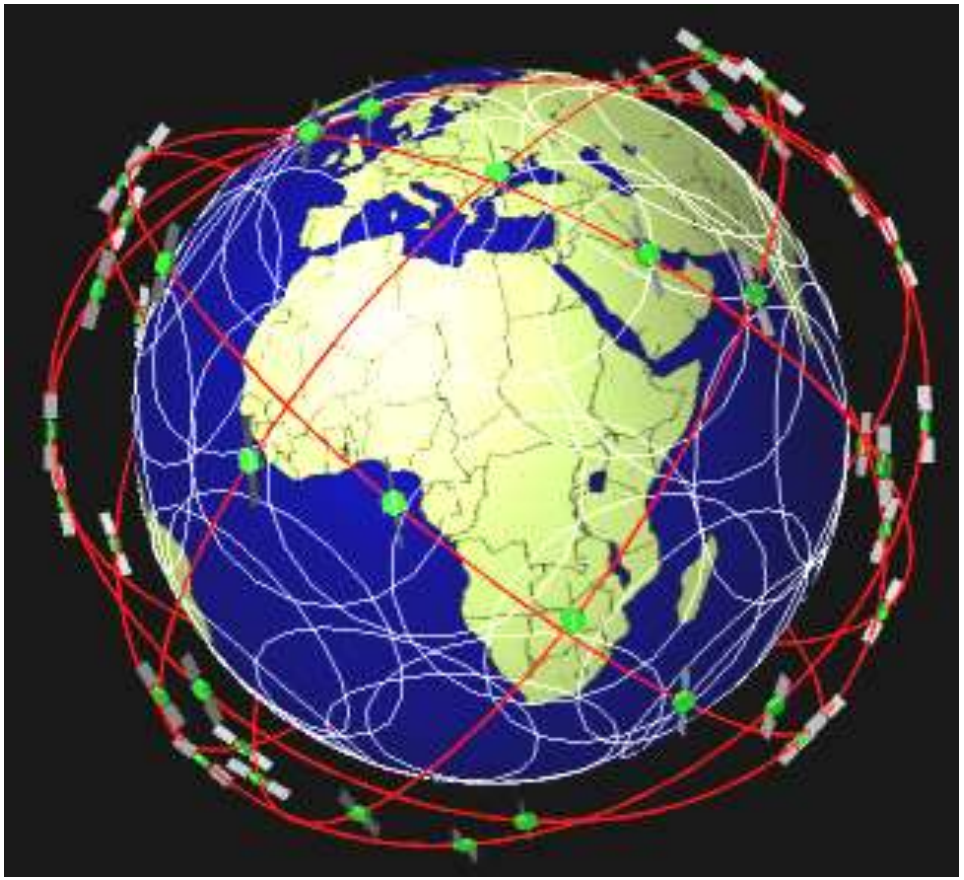
Tinggi Orbit dan delay

- Delay merupakan parameter penting yang menentukan kinerja link komunikasi.
- Periode orbit akan menentukan jenis komunikasi satelit, dan juga konstelasi terkait dengan desain cakupan komunikasi.

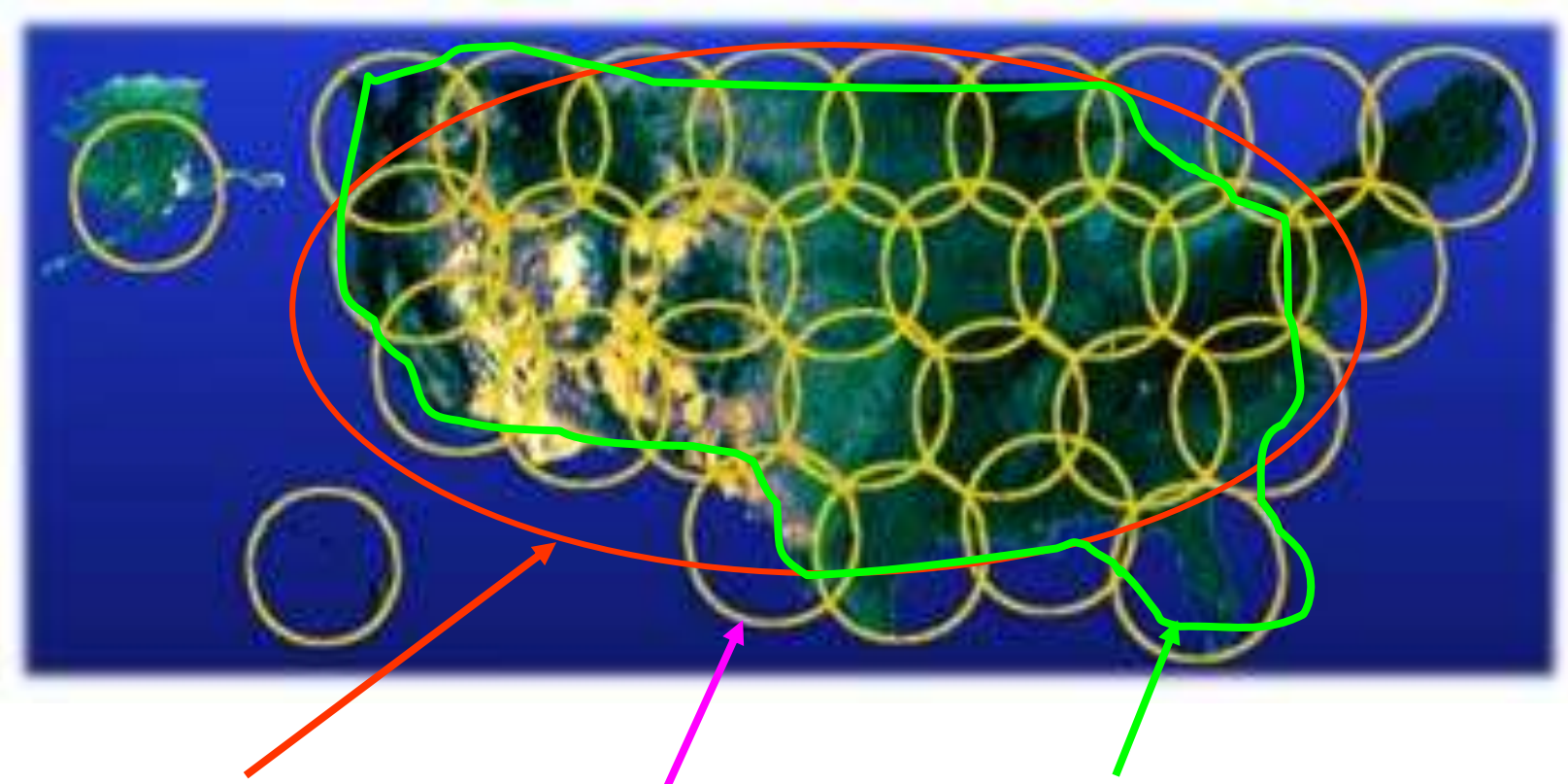


Konstelasi Satelit

- Untuk cakupan Global biasanya dibutuhkan banyak satelit yang ditempatkan dalam beberapa bidang orbit, dan spasi antar satelit ditentukan.



Bentuk Cakupan Satelit

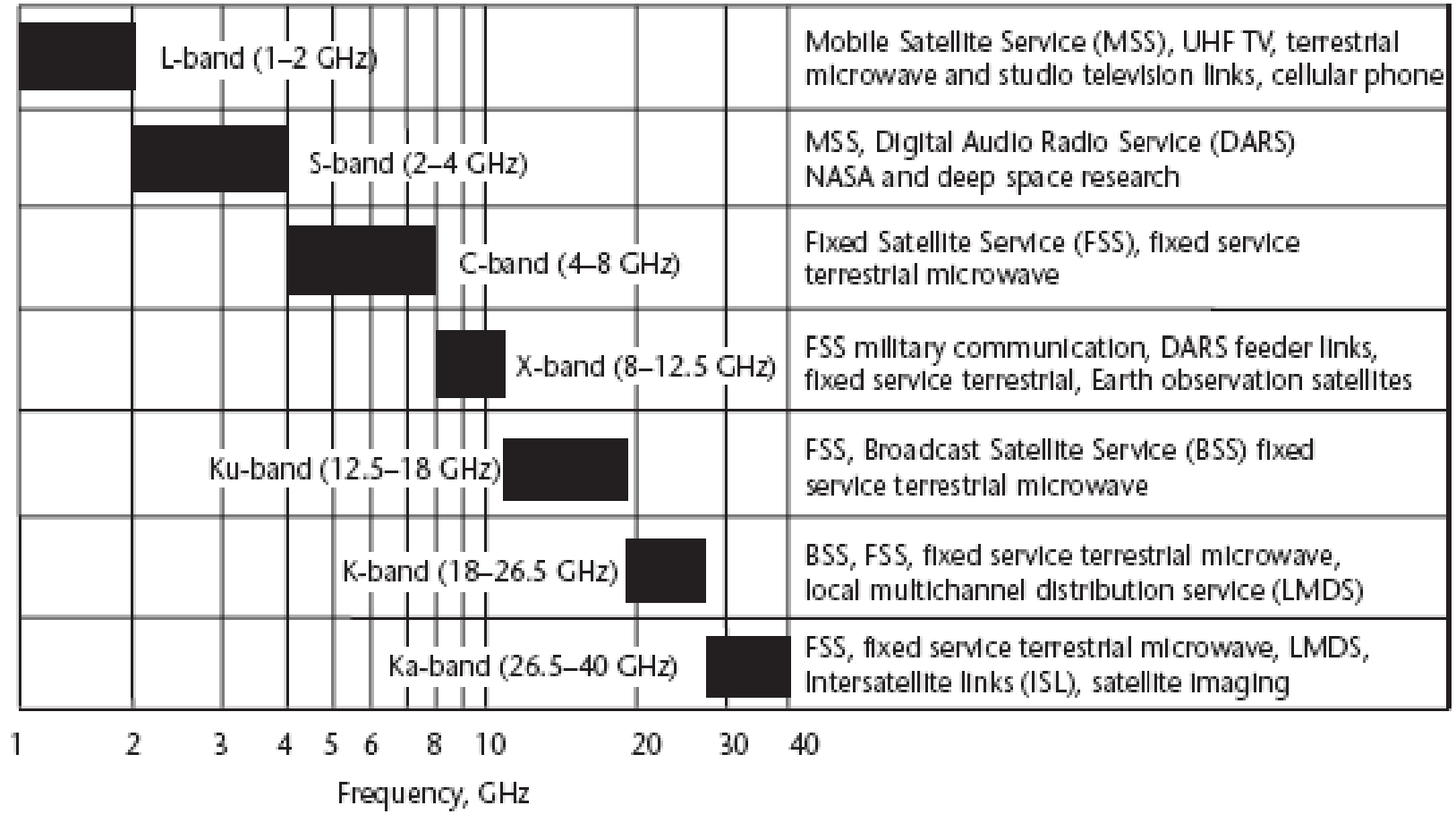


- Global beam, spot beam, dan shaped beam

Frequency Band Designations (ITU-R)

Frequency range, GHz	Band designation
0.1–0.3	VHF
0.3–1.0	UHF
1.0–2.0	L
2.0–4.0	S
4.0–8.0	C
8.0–12.0	X
12.0–18.0	Ku
18.0–27.0	K
27.0–40.0	Ka
40.0–75	V
75–110	W
110–300	mm
300–3000	μm

Spektrum, Nomenklatur dan Layanan Komunikasi



Alokasi spektrum dan Layanan komunikasi menurut ITU-R

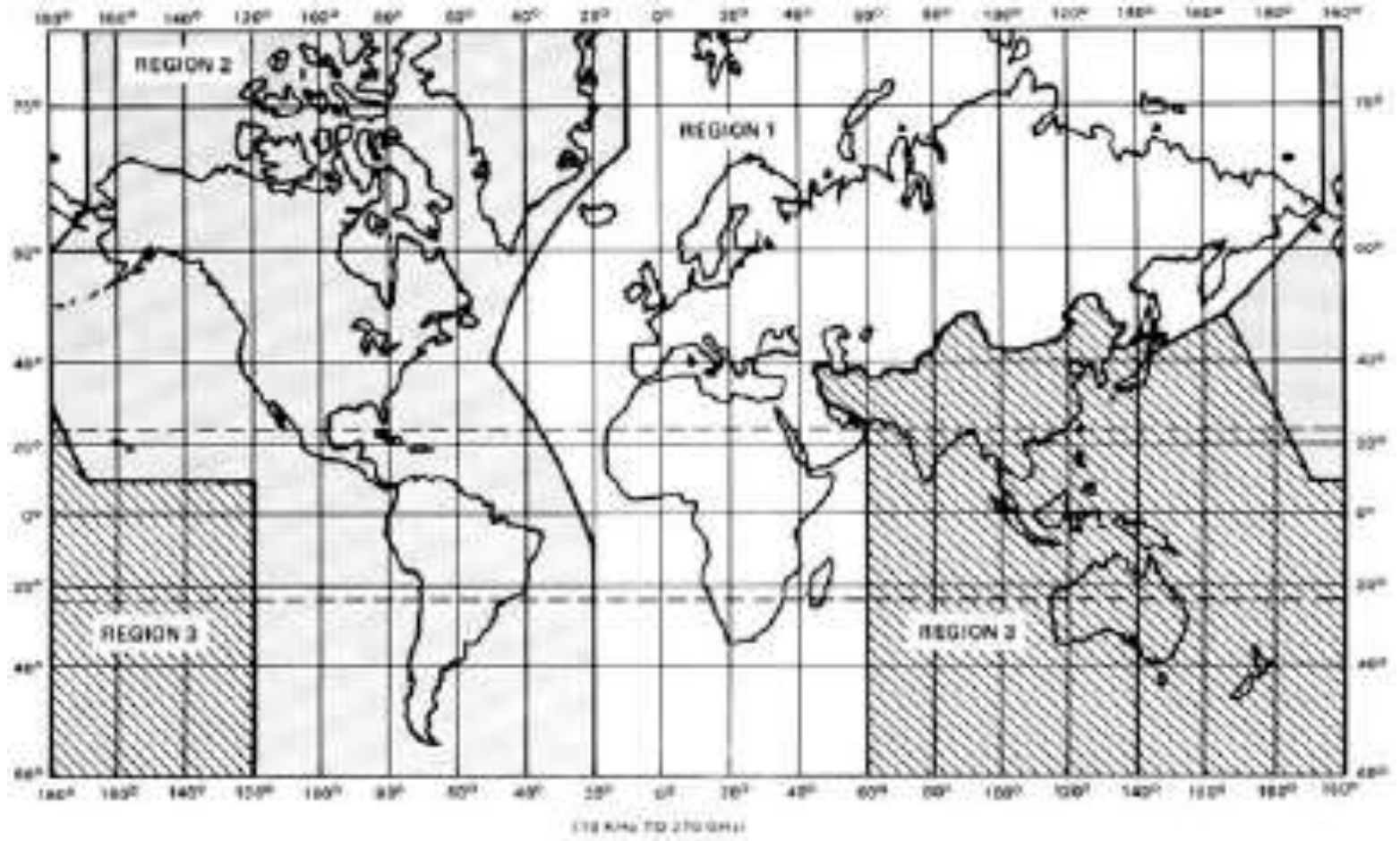
Regulasi dan Koordinasi Frekuensi

- Regulasi slot orbit , terutama GEO, dan frekuensi secara internasional dilakukan oleh ITU-R.
- Karena tiap negara berhak mengklaim wilayah udara (space) diatasnya, maka harus dilakukan koordinasi untuk filing orbit dan alokasi frekuensi supaya tidak terjadi overlaping dan interferensi.

Objektif Regulasi ITU-R

- *To facilitate equitable access to and rational use of the natural resource of the radio-frequency spectrum and the geostationary-satellite orbit;*
- *To ensure the availability and protection from harmful interference of the frequencies provided for distress and safety purposes;*
- *To assist in the prevention or resolution of cases of harmful interference between the radio services of different administrations;*
- *To facilitate the efficient and effective operation of all radiocommunication services;*
- *To provide and, where necessary, regulate new applications of radiocommunication technology.*

Pembagian Alokasi Spektrum ITU



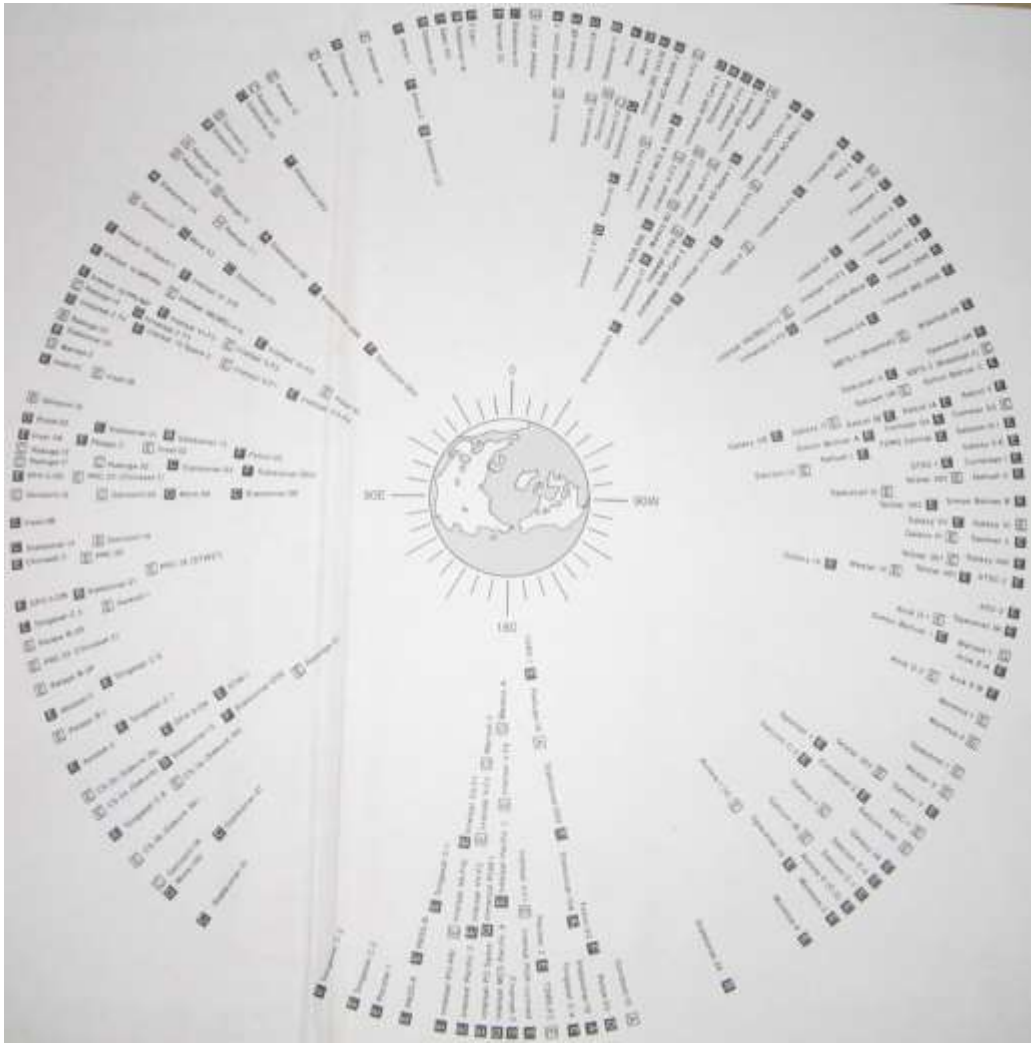
Definisi Layanan dan Alokasi Frekuensi

Service	*Definition*	*Band*	*Typical Frequencies (GHz)*
FSS	Used between a specified fixed point or points within specified areas when one or more satellites are used; in some cases this service includes satellite-to-satellite links, which may also be operated in the intersatellite service; the fixed-satellite service may also include feeder links for other space radiocommunication services.	C	Uplink: 5.85–7.075 Downlink: 3.4–4.2
		X	Uplink: 7.90–8.40 Downlink: 7.25–7.75
		Ku	Uplink: 13.75–14.8 Downlink: 10.7–11.7
		Ka	Uplink: 28.0–30.0 Downlink: 17.7–19.7

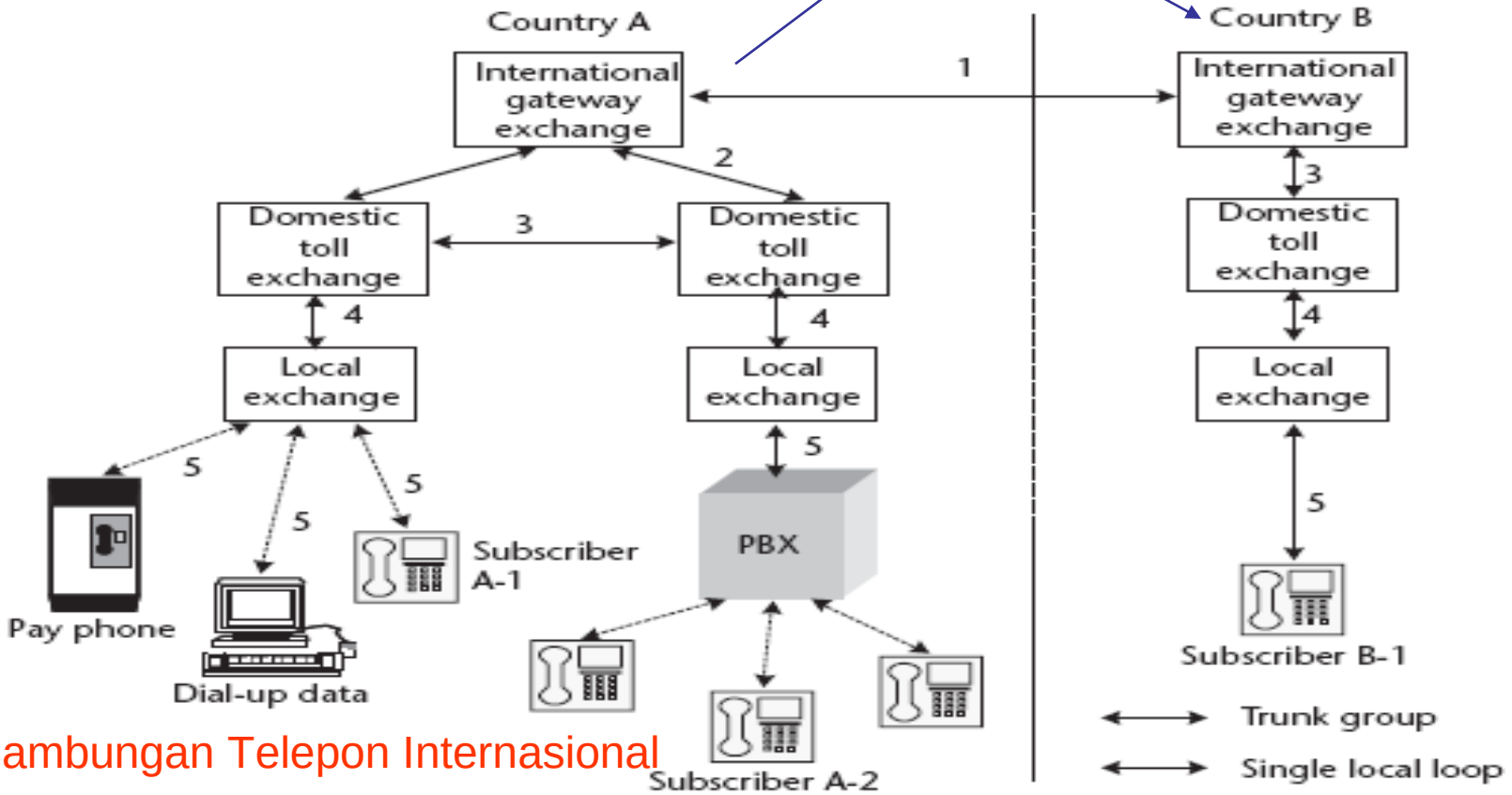
Definisi Layanan dan Alokasi Frekuensi

Service	*Definition*	*Band*	*Typical Frequencies (GHz)*
BSS	Used to transmit signals by space stations that are intended for direct reception by the general public. In the BSS, the term "direct reception" shall encompass both individual reception and community reception.	S	Uplink: 2.65–2.69 Downlink: 2.5–2.54
		Ku	Uplink: 17.7–18.2 Downlink: 11.2–12.2
		Ka	Uplink: 24.75–25.25 Downlink: 21.4–22.0
MSS	Used between mobile Earth stations and one or more space stations, or between space stations used by this service. This service may also include feeder links necessary for its operation.	L	Uplink: 1.626–1.66 Downlink: 1.525–1.56
		L/S	Uplink*: 1.61–1.626 Downlink*: 2.483–2.5
		S	Uplink*: 2.67–2.69 Downlink*: 2.5–2.52

Satelit di Orbit GEO (mid-1990)

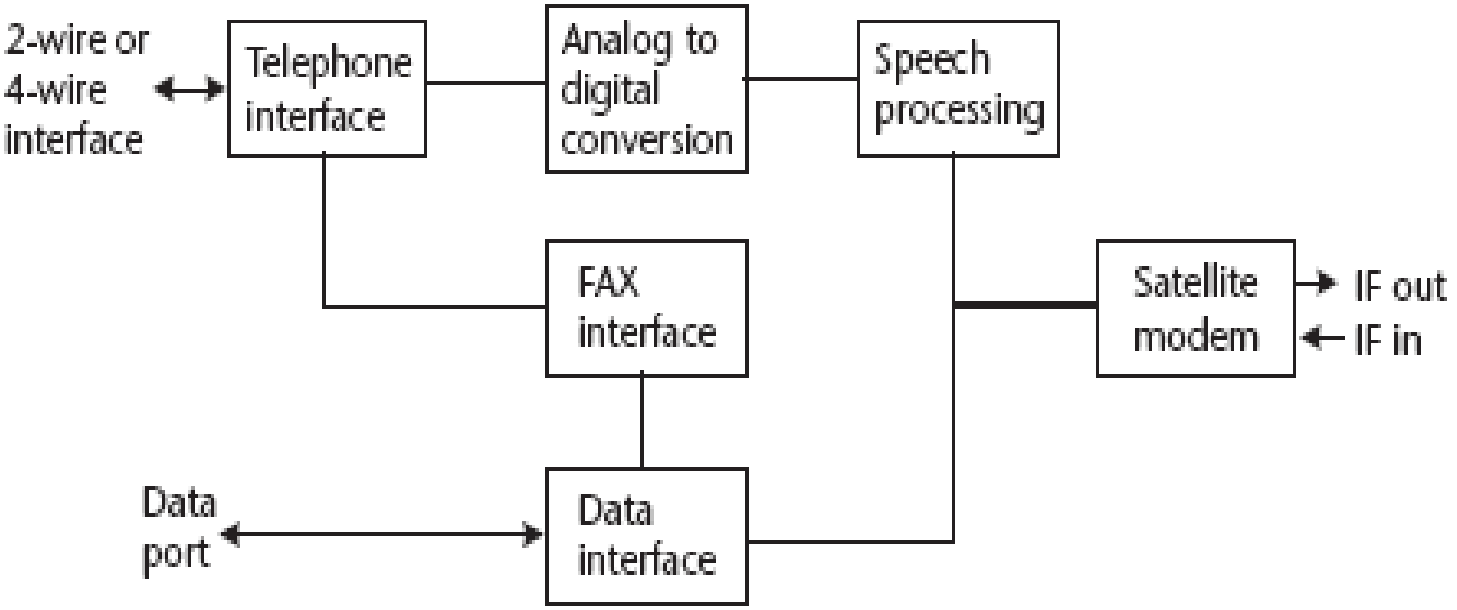


Aplikasi Komunikasi Satelit



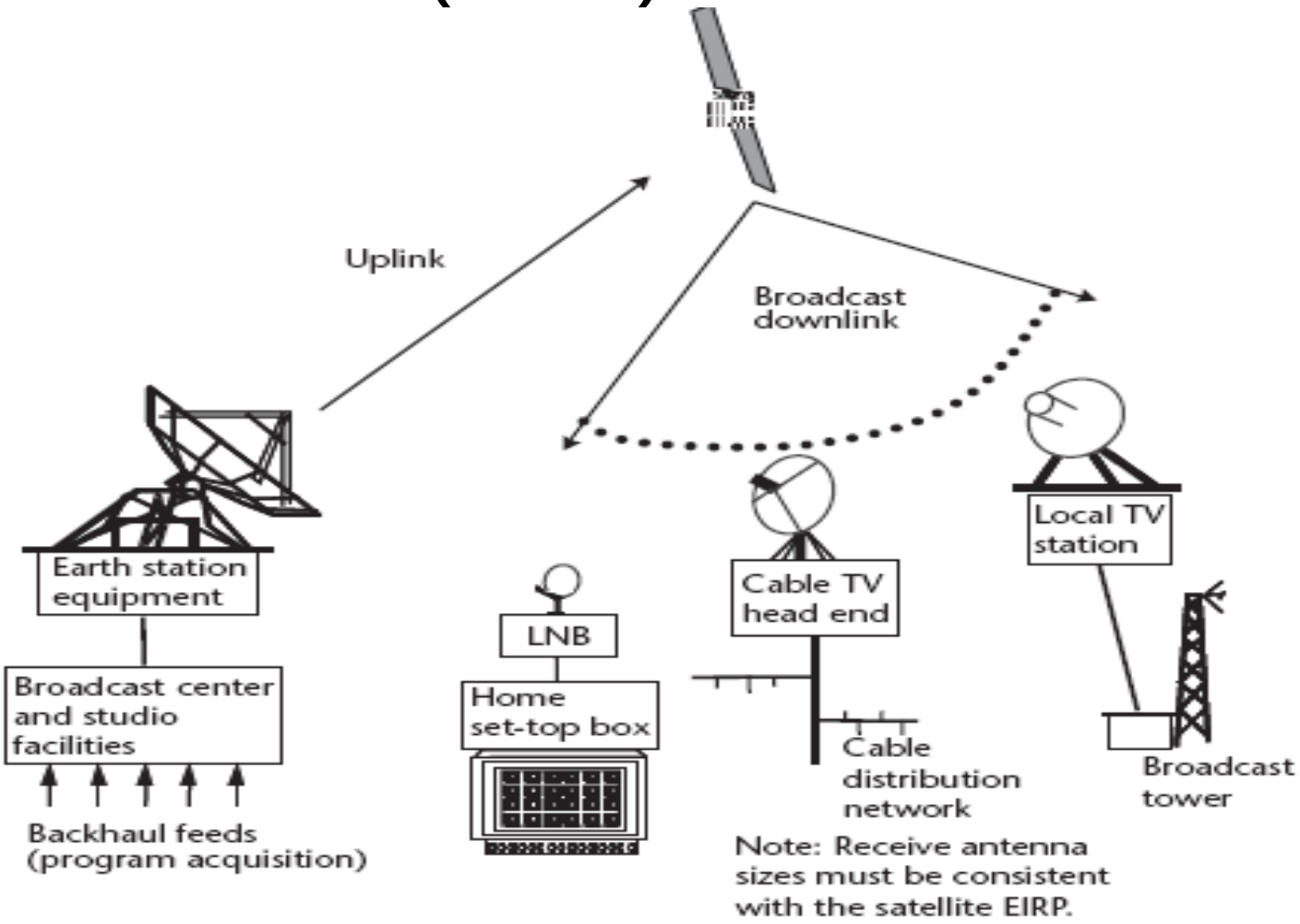
Sambungan Telepon Internasional

Telepon dan Data



- Dial-up voice, fax, dan data di multiplex dan diolah (dikompresi) sebelum diinputkan ke modem satelit.

Direct Broadcasting Services (DBS)



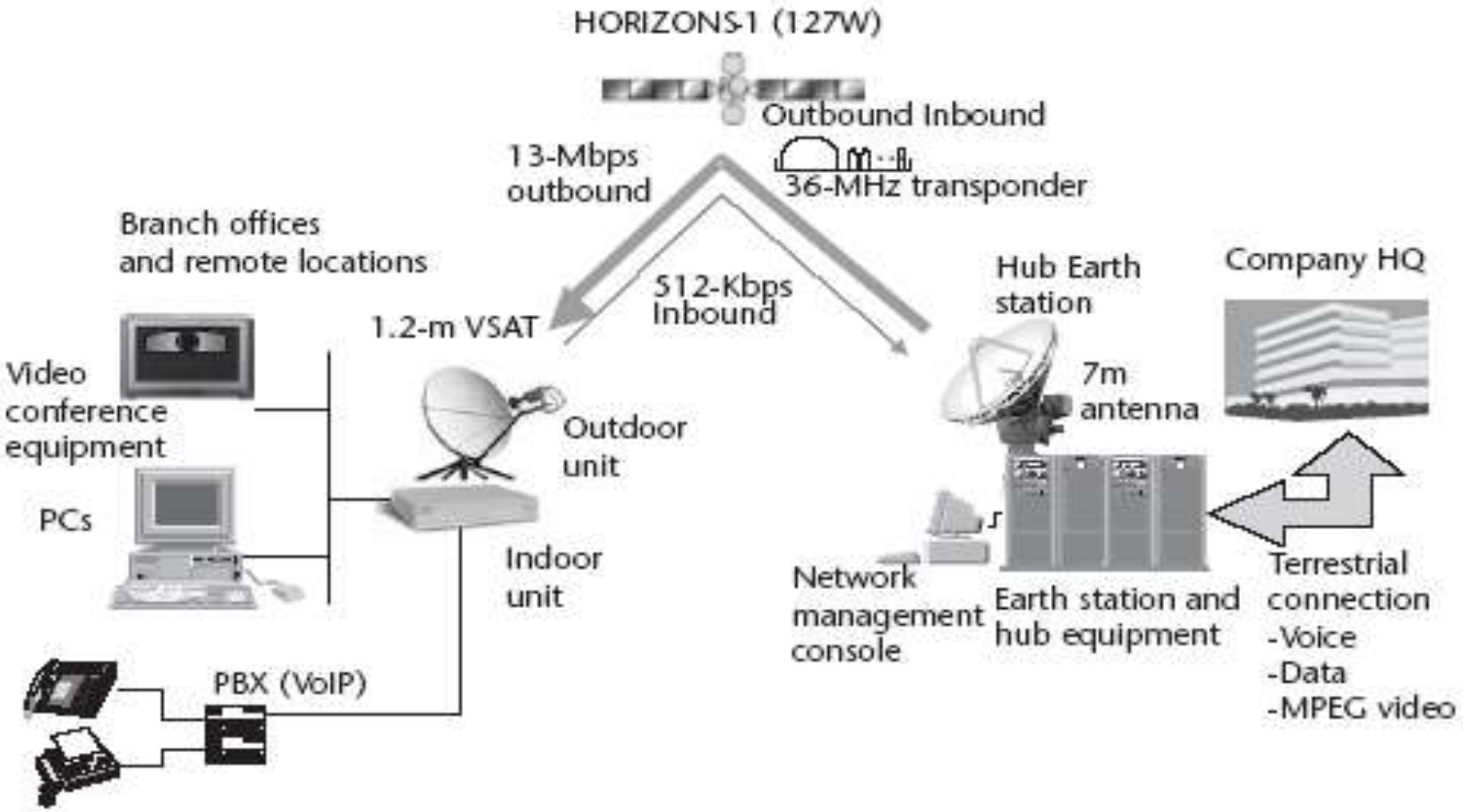
Fungsi Satelit pada TV Broadcasting

- Distribusi Point-to-multipoint programTV dari studio ke stasiun broadcast lokal;
- Transmisi Point-to-point liputan/siaran langsung ke studio (alternatively, from one studio to another studio);
- Distribusi Point-to-multipoint program cable TV dari studio ke cable TV lokal
- Distribusi Point-to-multipoint program cable TV dan/atau jaringan TV langsung dari studio ke customer (i.e., *DTH-direct to home*).

Faktor-Faktor Keberhasilan DTH-DBS

- *Ukuran Antena RX:* makin kecil ukuran antena, makin mudah di instal dan murah. Dewasa ini ukuran antena TVRO berkisar antara 35 cm – 80 cm, dan harga sekitar $100 (Rp 1 jt) termasuk set top box.
- Peralatan simple dan mudah dioperasikan.
- Satu antena RX bisa di gunakan bersama-sama (sharing) untuk beberapa user/TV.
- Jumlah transponder yang bisa dibawa oleh Satelit meningkat (umumnya sekitar 32 Transponder)
- Jumlah kanal per transponder umumnya 2 kanal TV analog dan 10 kanal TV Digital. Dengan teknik kompresi yang makin baik, jumlah kanal TV digital bisa ditingkatkan

VSAT Network

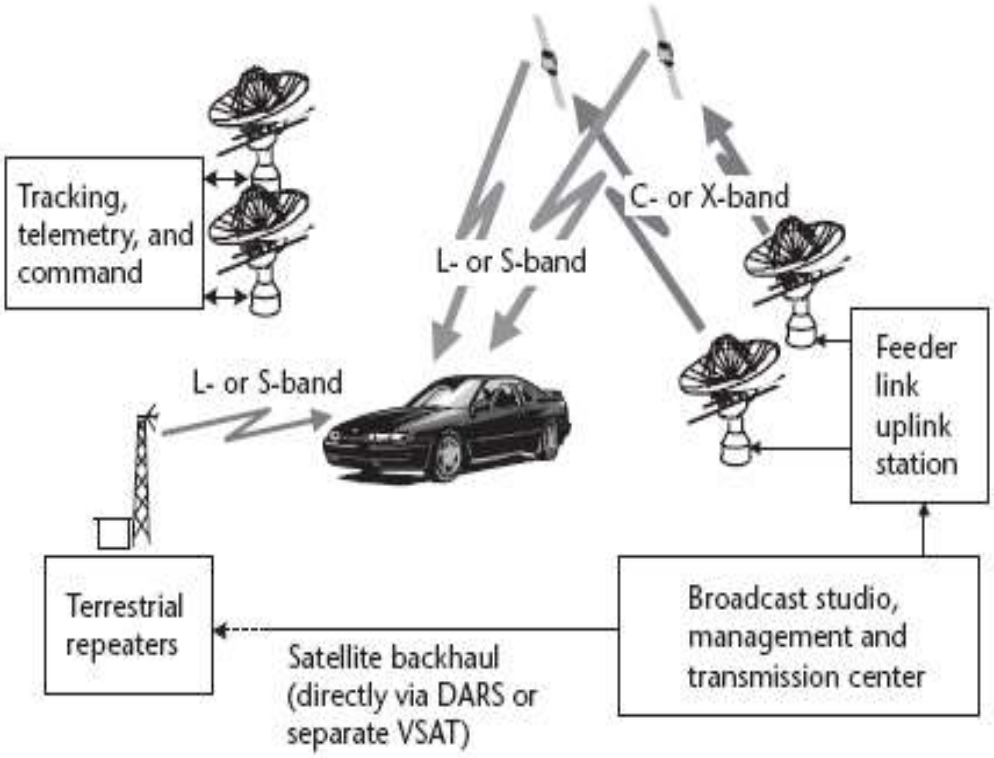


Perangkat VSAT

- VSAT untuk broadband communications.

Direct Audio Broadcasting (DAB)

WorldSpace Receiver

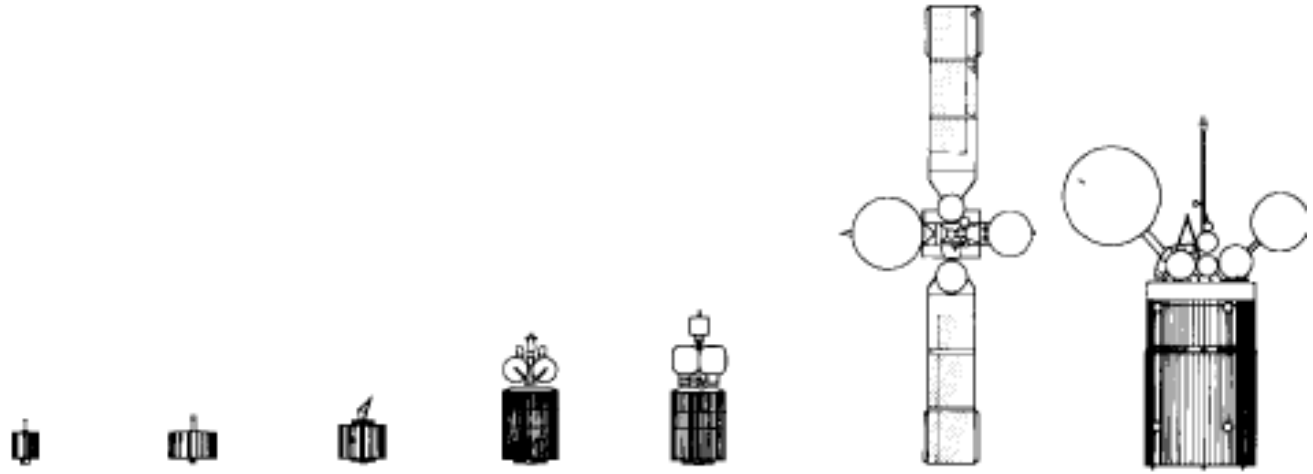


Basic arsitektur DAB

Intersatelit Link (ISL)

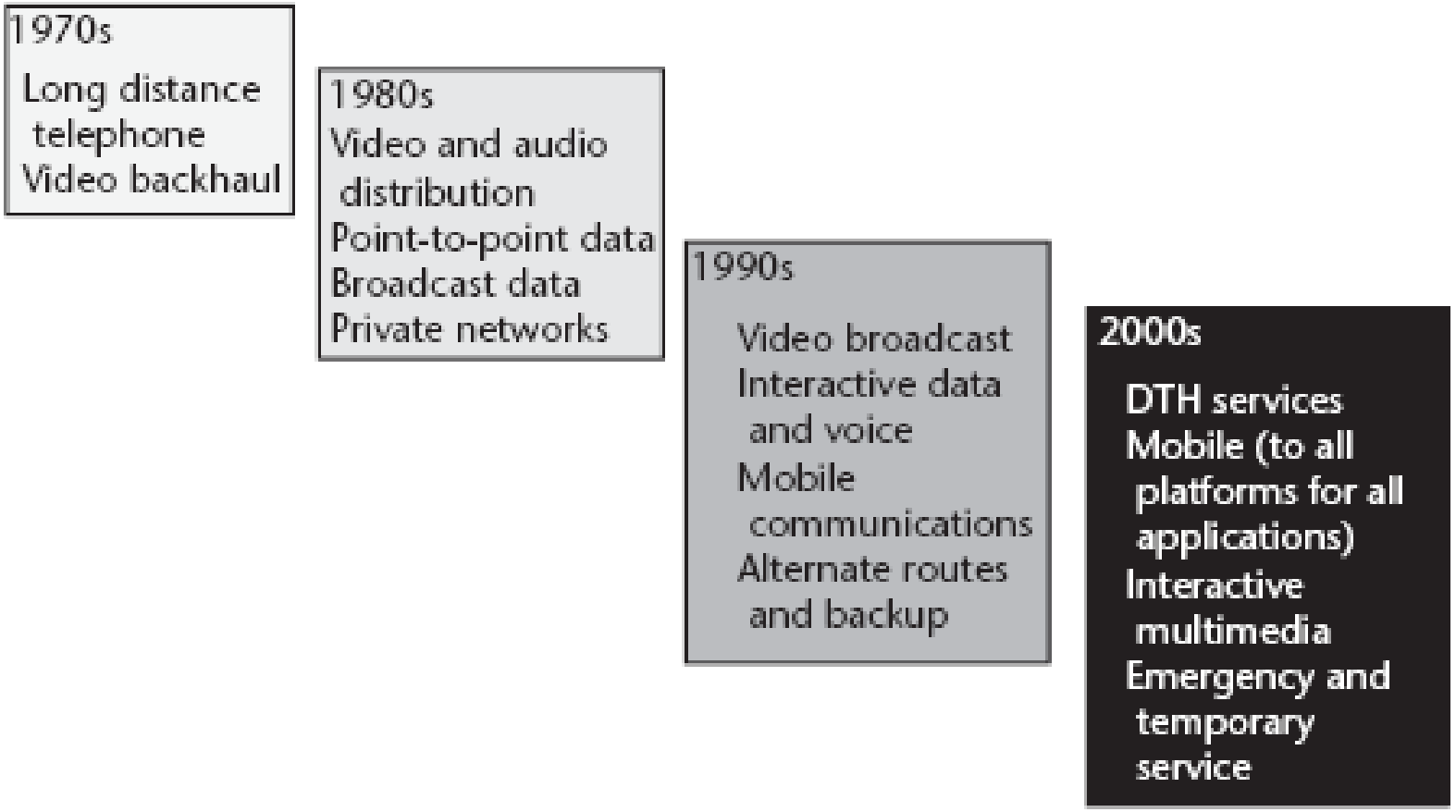
- Ilustrasi laser intersatellite link oleh satellite Artemis.

Evolusi Satelit Intelsat



Designation: Intelsat	I	II	III	IV	IV A	V	V A/V B	VI
Year of first launch	1965	1966	1968	1971	1975	1980	1984/85	1986/87
Prime contractor	Hughes	Hughes	TRW	Hughes	Hughes	Ford Aerospace	Ford Aerospace	Hughes
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	6.4
Launch vehicles		Thor Delta		Atlas-Centaur		Atlas-Centaur and Ariane	Atlas-Centaur and Ariane	STS and Ariane
Spacecraft mass in transfer orbit (kg)	68	182	293	1385	1489	1946	2140	12,100/3720
Communications payload mass (kg)	13	36	56	185	190	235	280	800
End-of-life (EOL) power of equinox (W)	40	75	134	480	800	1270	1270	2200
Design lifetime (years)	1.5	3	5	7	7	7	7	10
Capacity (number of voice channels)	480	480	2400	8000	12,000	26,000	30,000	80,000
Bandwidth (MHz)	50	130	300	500	800	2137	2480	3520

TREND EVOLUSI PASAR KOMUNIKASI SATELIT KOMERSIAL



Soal-soal

1. Describe briefly the main advantages offered by satellite communications.
2. Explain what is meant by a *distance-insensitive communications system.*
3. Comparisons are sometimes made between satellite and optical fiber communications systems. State briefly the areas of application for which you feel each system is best suited.
4. Describe the development of SKSD Palapa and its evolution to the present day.
5. Describe briefly the development of INTELSAT starting from the 1960s through to the present. Information can be found at Web site *http://www.intelsat.com/*
6. Define the terms: S/N , C/No, Eb/No, dB, dBm, dBW, and dBmo.
7. Reading : https://issuu.com/equatorspace/docs/equatorspace_02