Earth Station

Lecture 5

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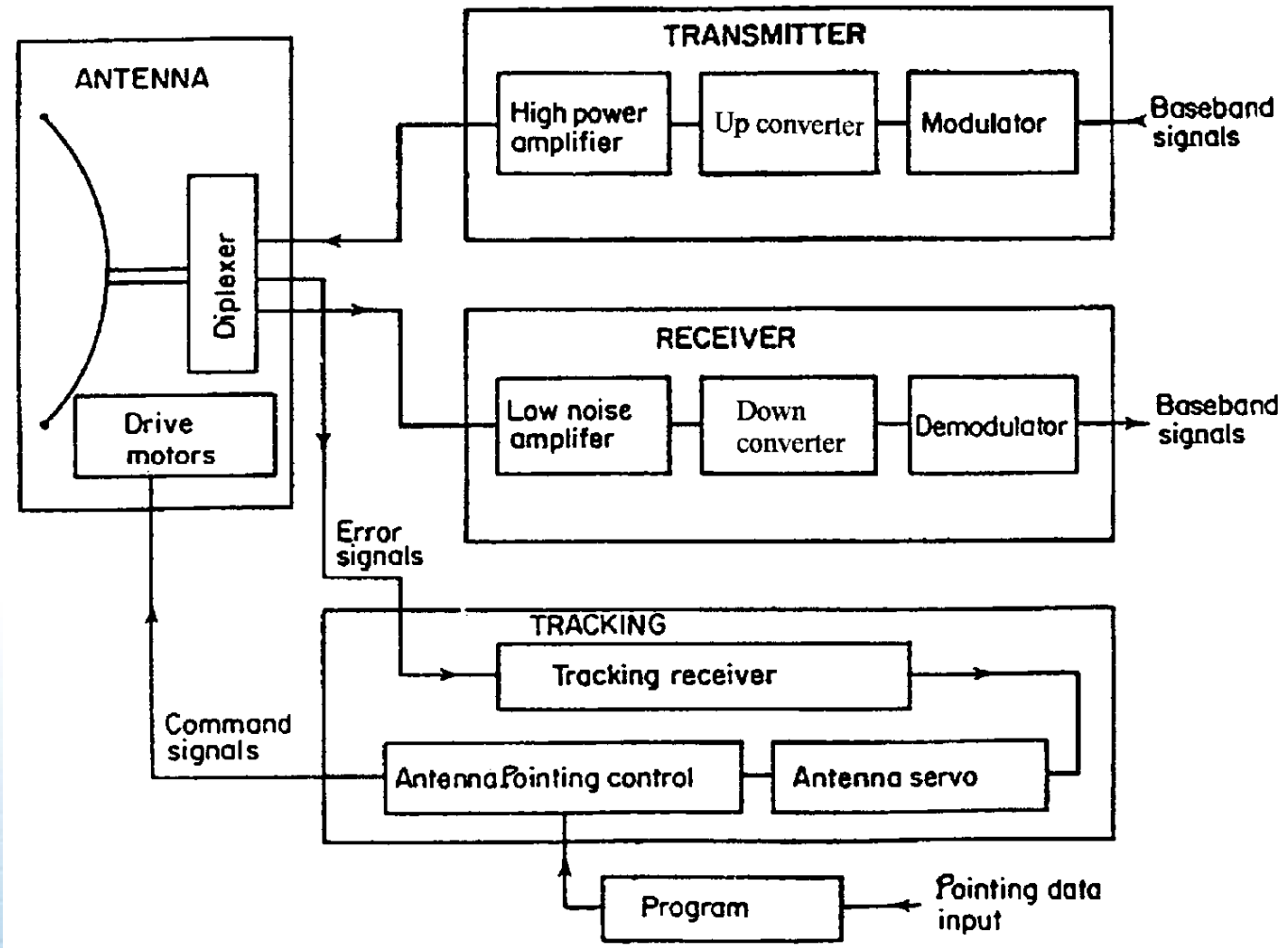
Earth Station

Earth Station Technology: Earth Station Architecture (1)



Earth Station Technology: Earth Station Architecture (2)

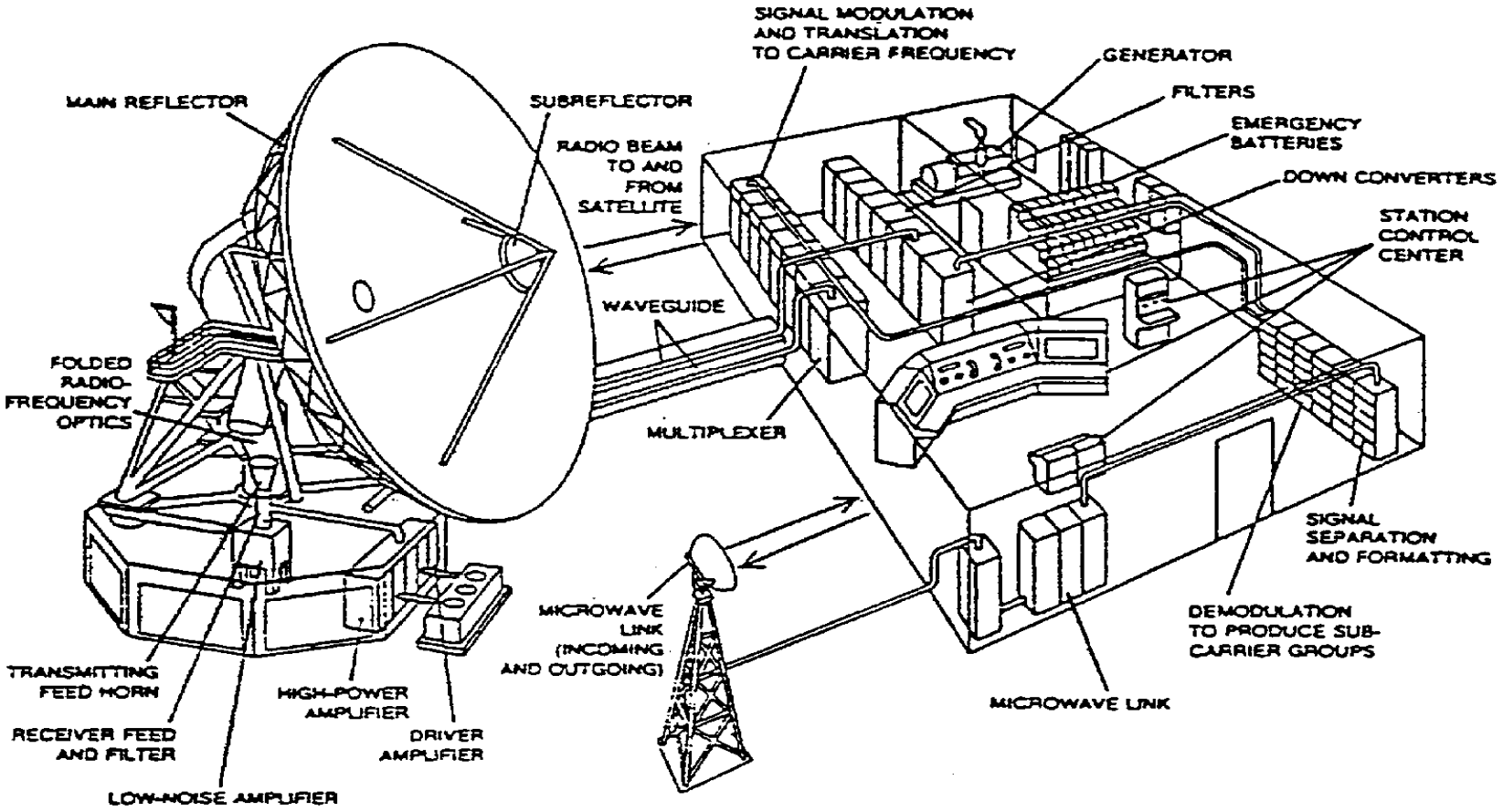
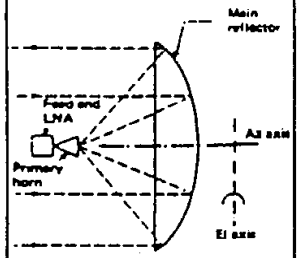
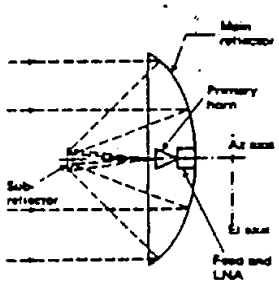
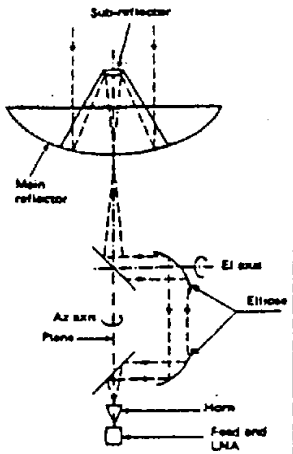
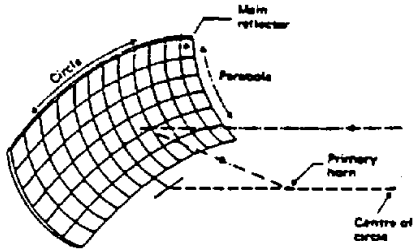
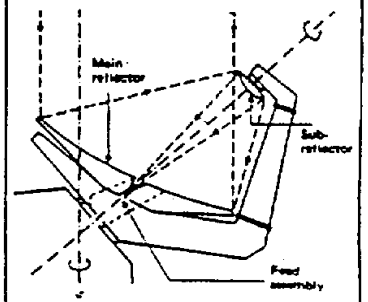
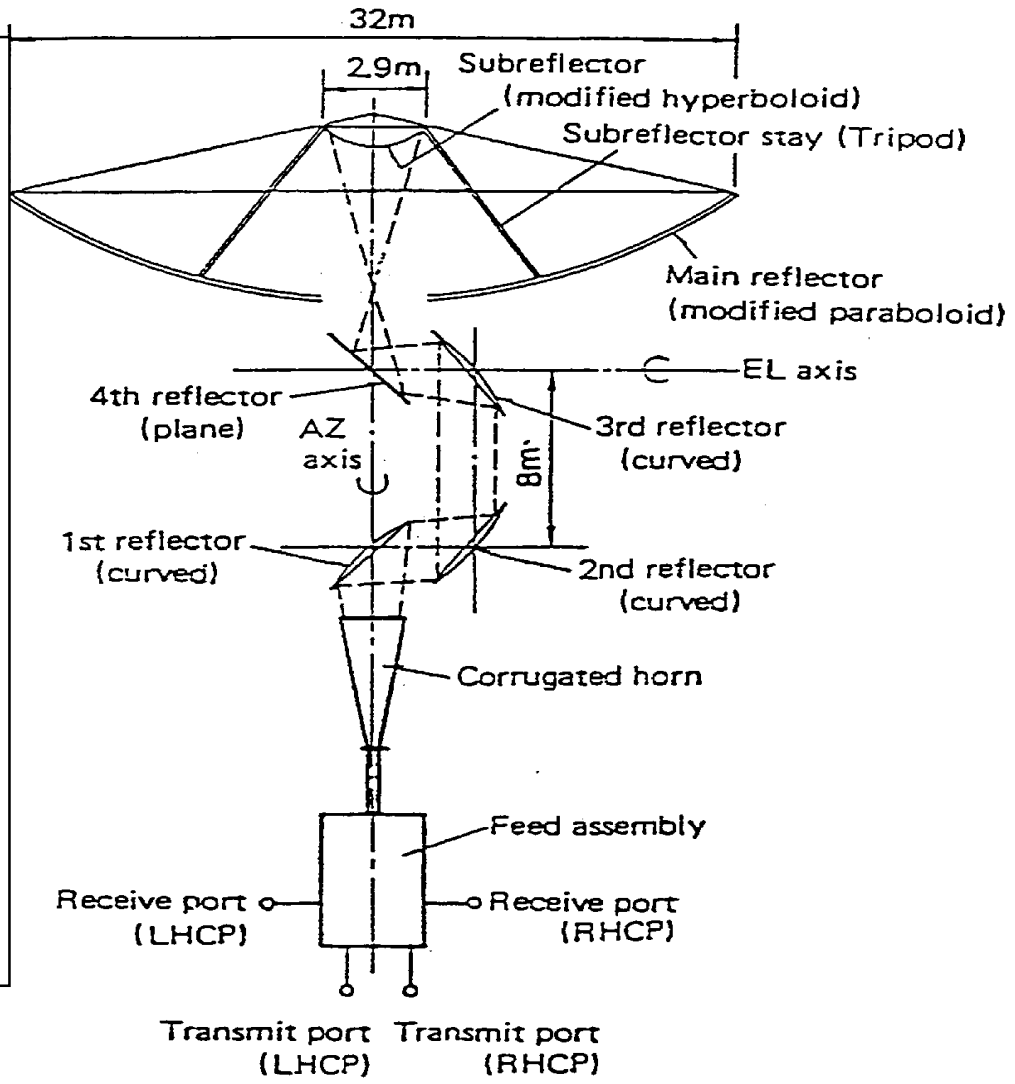


Table 5.1 Classification of antennas (Radio-electrical design)

Antenna type / Example	Axisymmetric type			Offset type	
	Single reflector type	Dual reflector type		Single refrector type	Dual reflector type
	Parabolic antenna	Cassegrain antenna	Cassegrain antenna fed by 4-reflector beam waveguide	Torus antenna	Offset Cassegrain antenna
Schematic views					
Features	Simple configuration Low aperture efficiency because reflector-shaping cannot be applied High noise temperature due to large spill-over power from main reflector Bad accessibility for large diameter antenna because feed and LNA should be adjoined to primary radiator (horn)	High efficiency and low noise temperature because reflector-shaping can be applied Feed and LNA can be installed in the equipment room behind the main reflector, so rather good accessibility can be obtained Frequency range is narrower than that of 4-reflector beam waveguide feed type Fairly good radiation pattern (Fig.5.6a)	High efficiency and low noise temperature over super-broadband Good accessibility because feed and LNA can be installed in the room free from El- and -Az rotations No waveguide run and rotary joint is required, so transmit power can be about 2 dB higher at 6 GHz band for 30 m diameter antenna Good radiation pattern (Fig. 5.6b)	Tracks a quasi-stationary satellite without moving its main reflector at all Beam steering can be made by moving only the primary radiator Poor aperture efficiency Rather poor radiation pattern	Excellent radiation pattern because of no blocking (Fig. 5.6c) High efficiency and low noise temperature because of no blocking Excellent VSWR Small windload if limited steerable amount is selected Good accessibility because feed and LNA can be installed in the room free from El- and Az-rotations
Applications	Small size earth-station antenna	Earth-station antenna	Large size earth-station antenna such as INTELSAT Standard A station (D/λ about 300)	Medium size earth station antenna such as INTELSAT Standard B station	Medium size earth-station antenna such as a domestic satellite communication

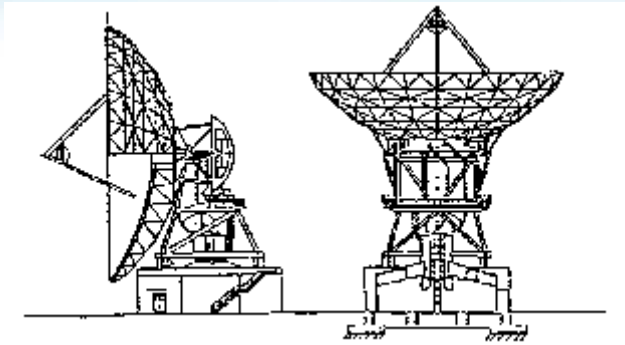
Earth Station Technology Antennas (1)

- Cassegrain Antenna with focussed beam feed

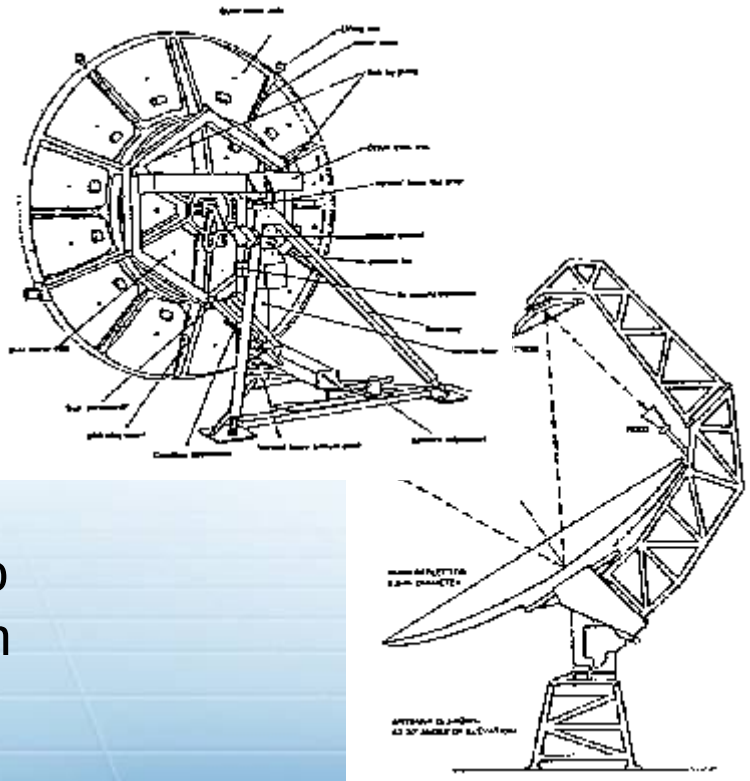


Earth Station Technology Antennas (2)

- Large earth station antenna with wheel-and-track mount

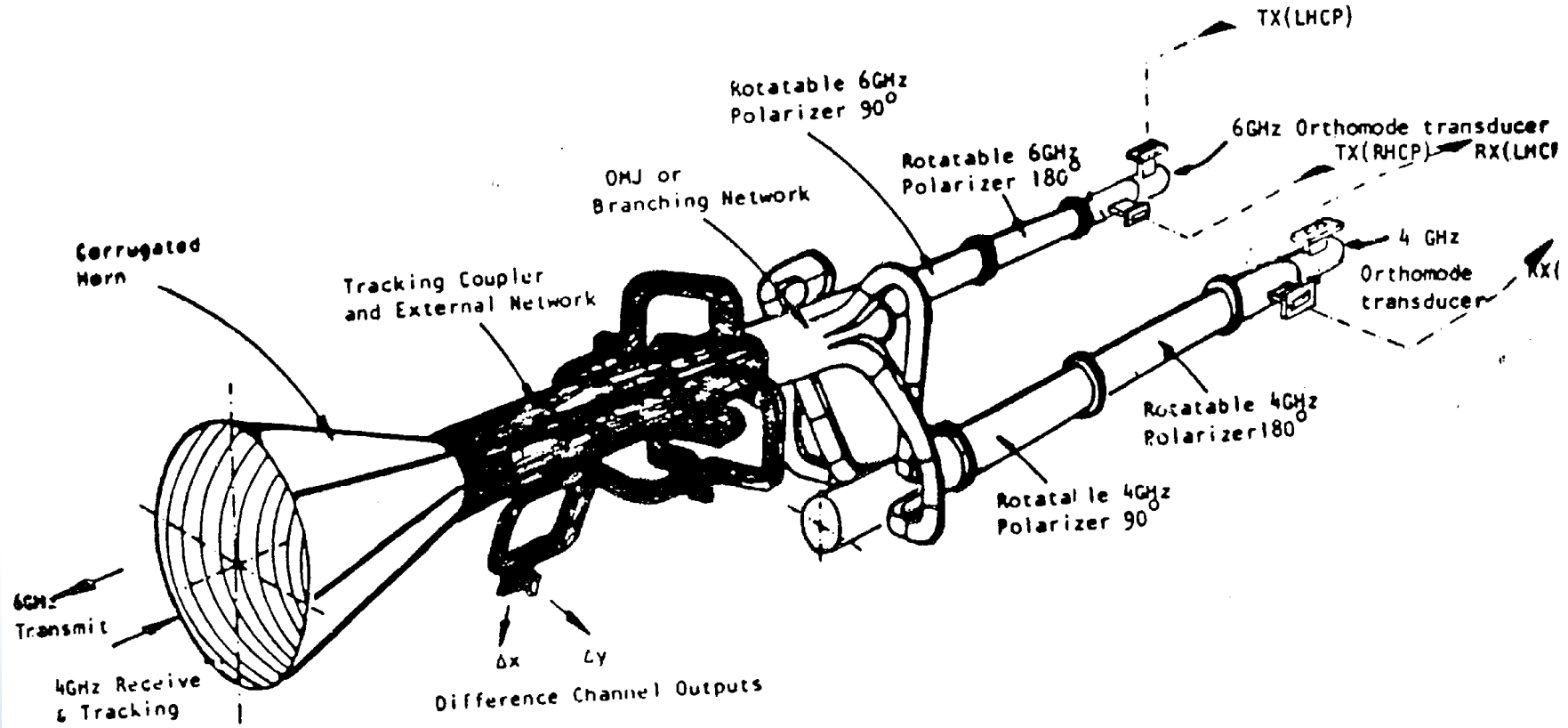


- Small earth station antenna employing an elevation-over-azimuth mount



- Dual-offset Gregorian antenna for British Telecom Satstream business communications services

Typical Earth Station Antennas
Primary feedchain



Earth Station G/T

Tsys = Tout + T feeder + T_{LNA} + T Rx

G = Gain antenna LNA input

G/T = Gain – 10log(T_{SYS}) dB/K

→ major figure of merit; specified by oper ators

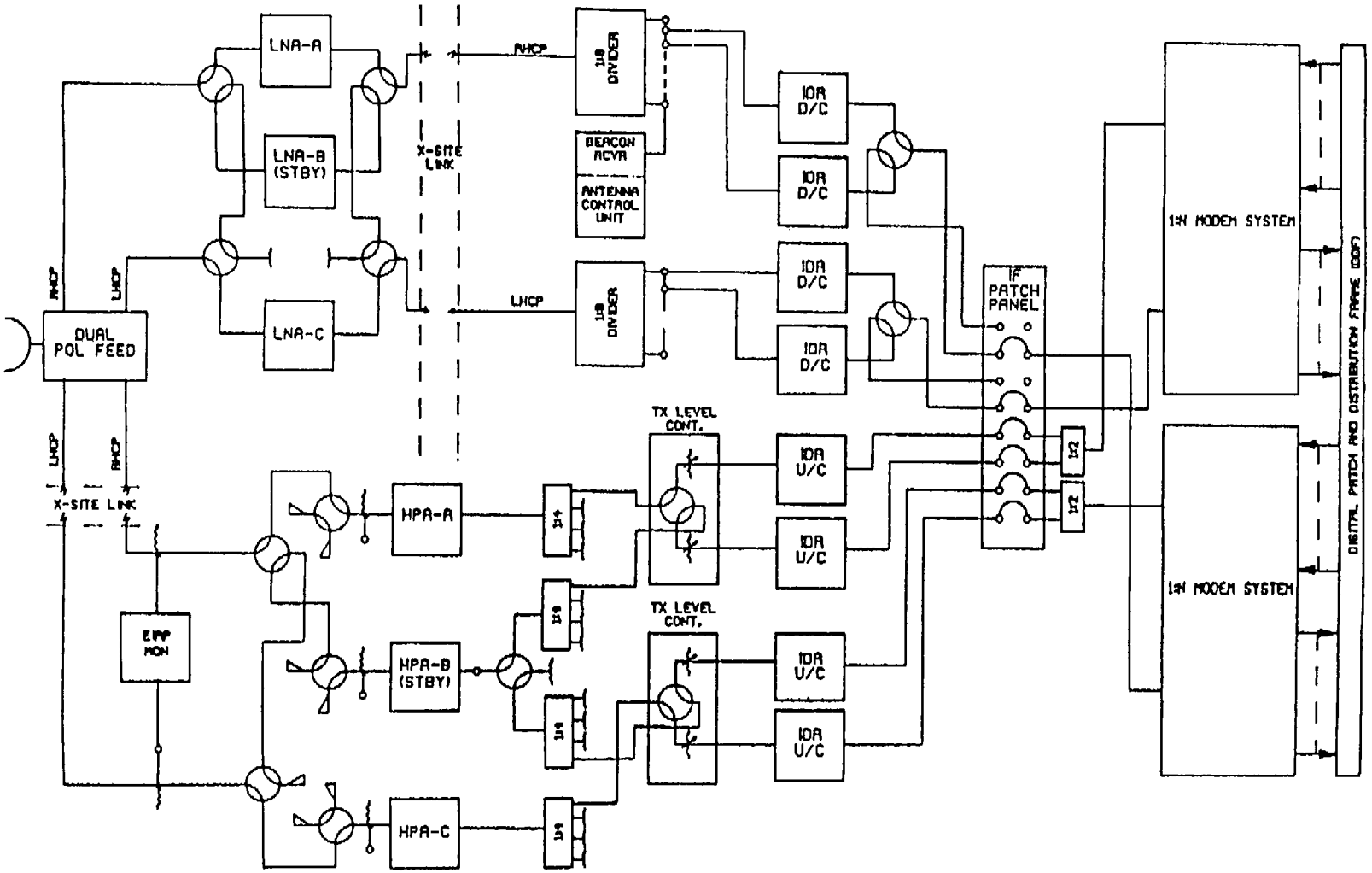
Earth Station Technology
- RF Equipment -

RECEIVERS :

Amplifier type :	Frequency	Noise temp.	Cost	Use
CRYOGENIC PARAMETRIC	4 GHz	15 K	High	First-built large stations
COOLED PARAMETRIC	4 GHz 12 GHz	35 K 100 K	Medium High	Standard A&B Standart C
UNCOOLED PARAMETRIC	4 GHz 12 GHz	50 K 120 K	Medium Medium	Large domestic st. EUTELSAT st.
COOLED FET GaAs	4 GHz 12 Ghz	50 K 130 K	Low Low	Domestic st.
AMBIENT FET GaAs	4 GHz 12 GHz	75 K 250 K	Low Low	Small domestic st.

POWER AMPLIFIERS :

Amplifier type :	Output power	Bandwidth	Cost per Watt
KLYSTRON	500 to 5000 W	Small (40 MHz)	Low
TRAVELING WAVE TUBE (TWT)	100 to 2500 W	Large (500 MHz)	Medium
FET(6 GHz) (14 GHz)	5 to 50 W 1 to 6 W	Large	High



BLK 2272

TYPICAL STANDARD 'A' EARTH STATION IDR COMMUNICATIONS SYSTEM

Cost Summary for a standard Earth Station

MODULE	DESCRIPTION	AMOUNT (STERLING)	Q'TY	TOTAL (STERLING)
ANTENNA	15.5m ANTENNA	122,500	1	122,500
TRACKING	STEP TRACKING & DRIVE SYSTEM	35,500	1	35,500
FEED	DUAL POLARISATION FEED	39,000	1	39,000
LNA	55K FET 1:2 REDT SYSTEM	13,000	1	13,000
HPA	400W TWT 1:2 REDT SYSTEM	113,000	1	113,000
U/C	1:1 REDT DIGITAL UPCONVERTERS	40,000	2	80,000
D/C	1:1 REDT DIGITAL DOWNCONVERTERS	40,000	2	80,000
MODEM	1:4 REDT IDR MODEMS	116,500	2	233,000
WG/COMB	FOR DUAL POLARISATION OPERATION	30,000	1	30,000
SPLIT	4 GHz SHF DIVIDER	5,000	1	5,000
CONTROL	CONTROL & SUPERVISORY SYSTEM	161,000	1	161,000
INST MATS	INSTALLATION MATERIALS FOR A STD 'A'	135,000	1	135,000
SPARES	ONE LOT FOR A STD 'A' E/S	82,000	1	82,000
DOC	DOCUMENTATION FOR A STD 'A' E/S	20,500	1	20,500
		SUB TOTAL		£1,149,500
INST & COMM	INSTALLATION & COMMISSIONING	195,000	1	195,000
CIF	CARRIAGE, INSURANCE & FREIGHT	30,000	1	30,000
CIVILS/POWER	ESTIMATE FOR STD 'A' E/S	500,000	1	500,000
PROJ MAN	PROJECT MANAGEMENT BY CUSTOMER	150,000	1	150,000
TEST EQPT	FOR STD 'A' DIGITAL E/S	100,000	1	100,000
		GRAND TOTAL		£2,124,500

Satellite Subsystems

- Communications Payload
  - Antennas
  - Repeater
- Bus
  - Structure
  - Electrical power subsystem
  - Satellite attitude control subsystem
  - Propulsion subsystem
  - Thermal control subsystem
  - Telemetry, tracking and command (TTC)