INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE

H4.SMR/585-19

FIRST INTERNATIONAL SCHOOL ON COMPUTER NETWORK ANALYSIS AND MANAGEMENT

(3 - 14 December 1990)

Satellite Networks

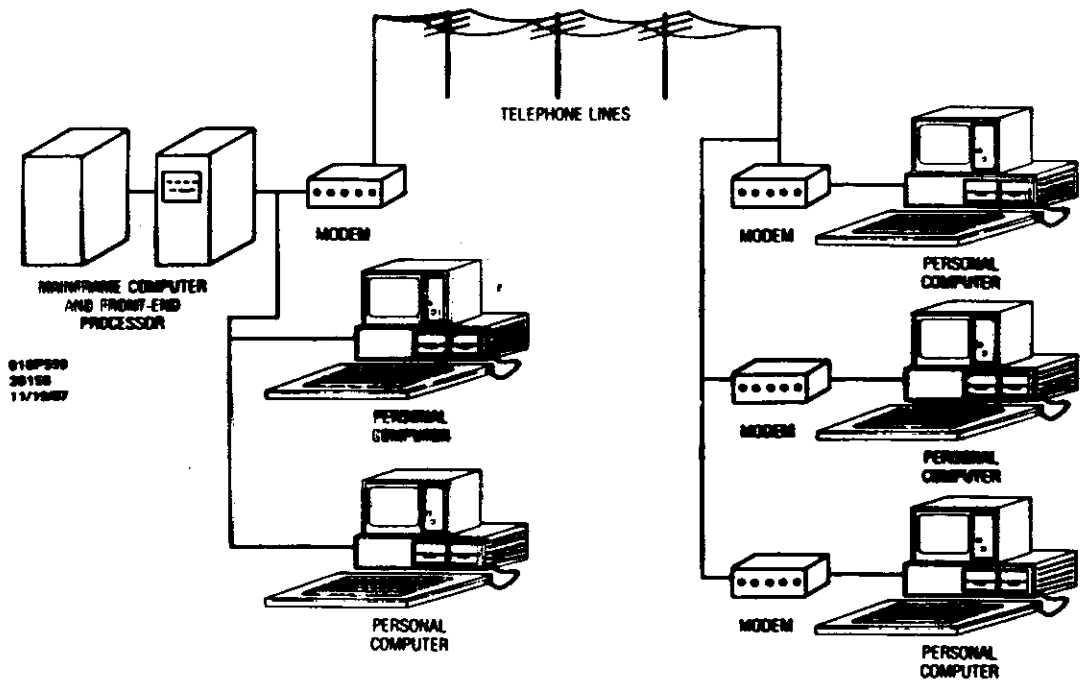
G. Lo Verde

Telespazio
ROMA

SATELLITE NETWORKS

ING. G. LO VERDE
TELESPAZIO

TYPICAL DATA CIRCUIT



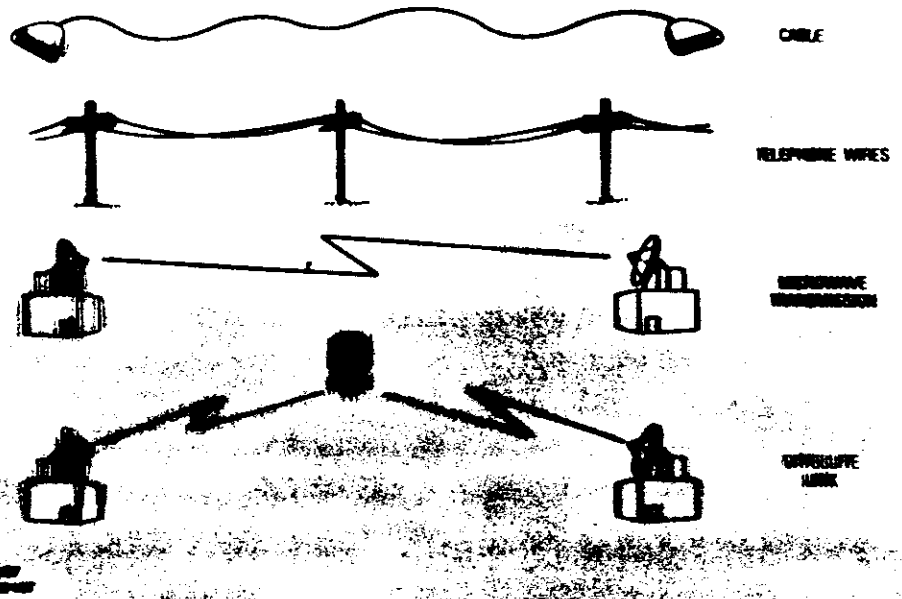
1 – SATELLITE COMMUNICATION SCENARIOS

2 – MULTIPLE ACCESS PROTOCOLS

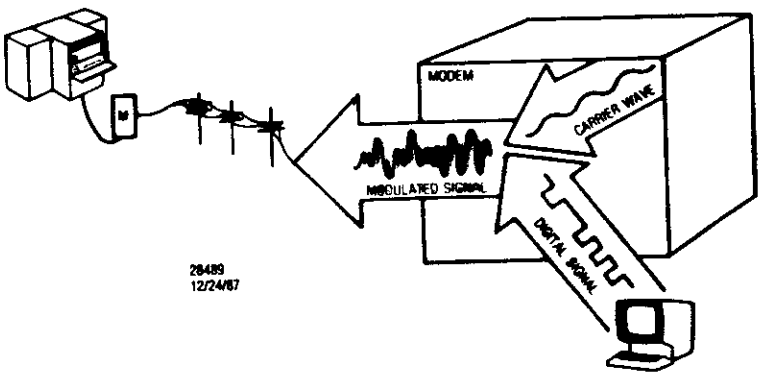
3 – VSAT SYSTEMS : ARCHITECTURES & PROTOCOLS

4 – INTERUNIVERSITY SCPC NETWORK

TYPES OF TRANSMISSION CHANNEL



THE FUNCTION OF A MODEM



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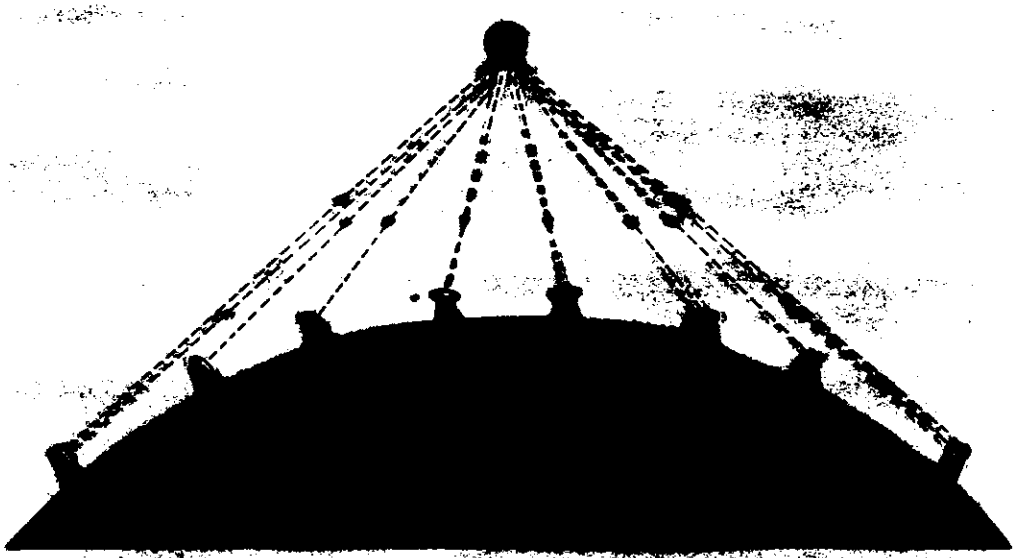
TRANSMISSION PATHS

SATELLITE TRANSMISSION



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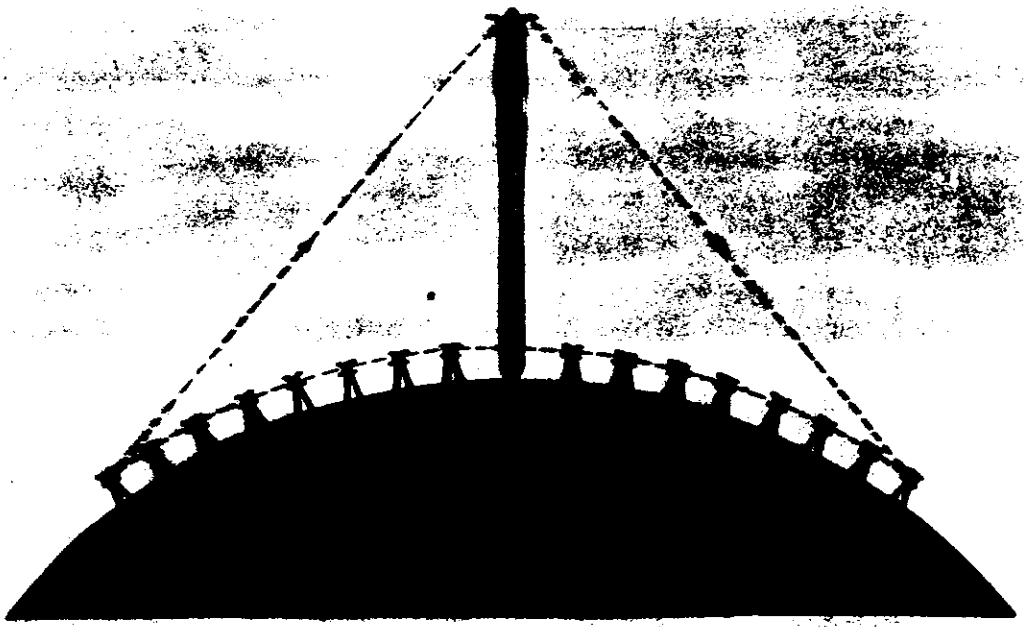
TRANSATLANTIC LINE-OF-SIGHT MICROWAVE RADIO TRANSMISSION



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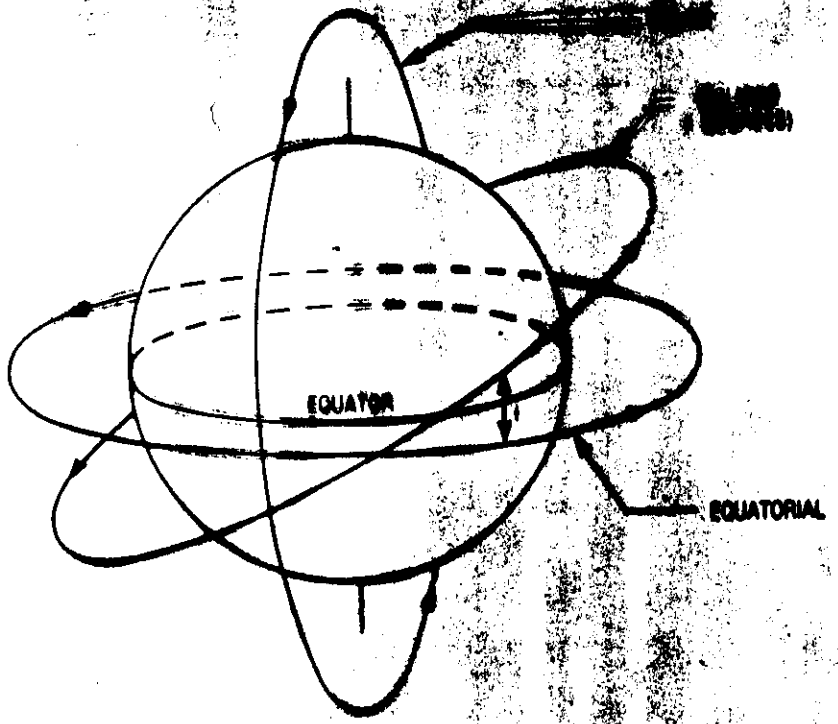
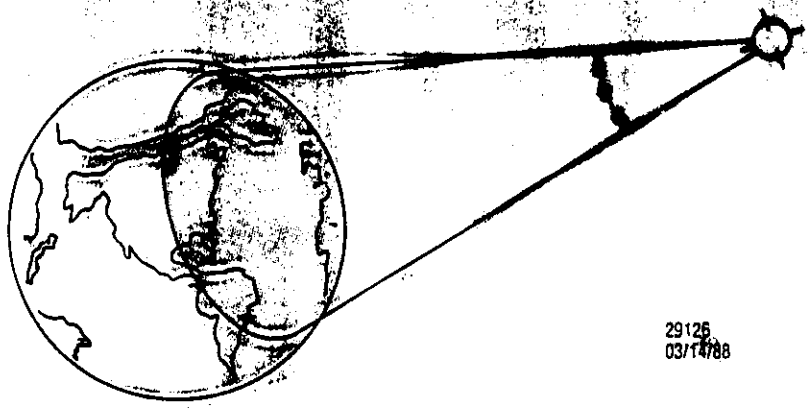
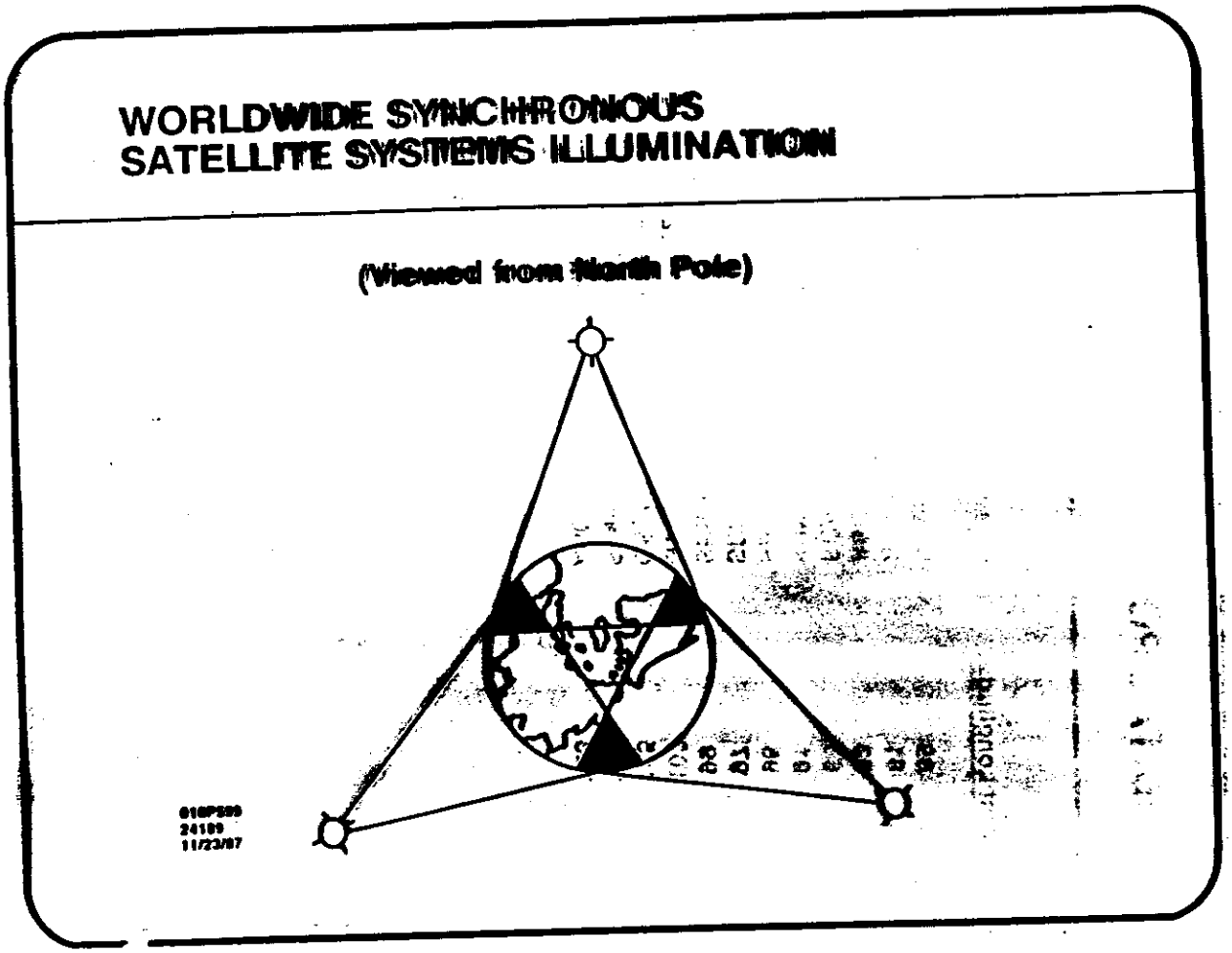
GEOSYNCHRONOUS ORBIT



EARTH COVERAGE





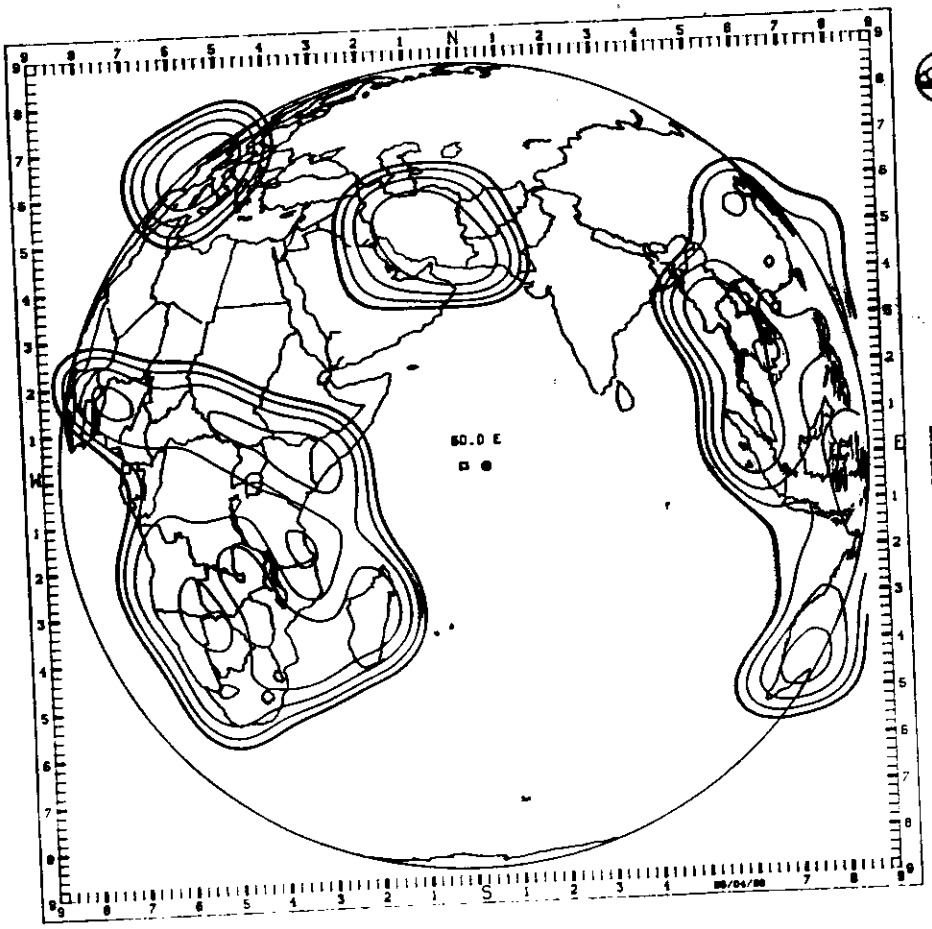


Figure 20

INTELSAT VI

INDIAN 60.0° EAST SATELLITE

PRELIMINARY MEASURED
TRANSMIT COVERAGE
ZONE BEAMS

This satellite antenna coverage diagram illustrates the preliminary spacecraft platform pointing bias for this location. After the final pointing is selected, it or an appropriate pointing range will be used when determining the satellite antenna pattern advantage (Beta Factor) for each earth station as described in IESS-402.

Contours are illustrated in 1.0 dB increments from the beam edge (0, +1, +2, and +3 dB). The nominal beam edge contour is darkened.

¤ : Sub-Satellite Point
● : Satellite Antenna Platform Pointing Bias = 0.50° East
0.00° North

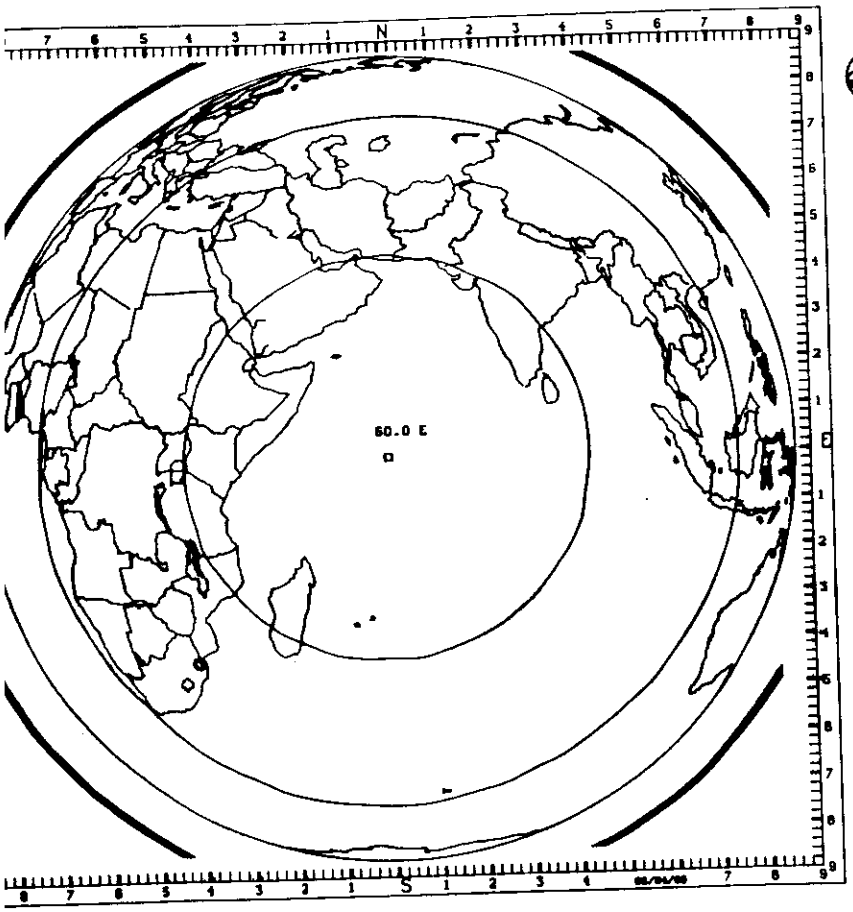


Figure 21

INTELSAT VI

INDIAN 60.0° EAST SATELLITE

PRELIMINARY MEASURED
TRANSMIT COVERAGE
GLOBAL BEAMS

This satellite antenna coverage diagram illustrates the preliminary spacecraft global beam pointing for this location. This pointing may change with time. After the spacecraft is completely tested the pointing will be finalized. In addition, after complete spacecraft testing, the global beam adjustment equation of IESS-402 will be modified if necessary, to reflect the INTELSAT VI spacecraft. The global beam antenna pattern advantage for each earth station can then be calculated from the updated equation to be provided in a future revision of IESS-402.

Contours are illustrated in 1.0 dB increments from the beam edge (0, +1, and +2 dB). The nominal beam edge contour is darkened.

⊕ : Sub-Satellite Point, Global Beam Pointing = 0.00°, 0.00°

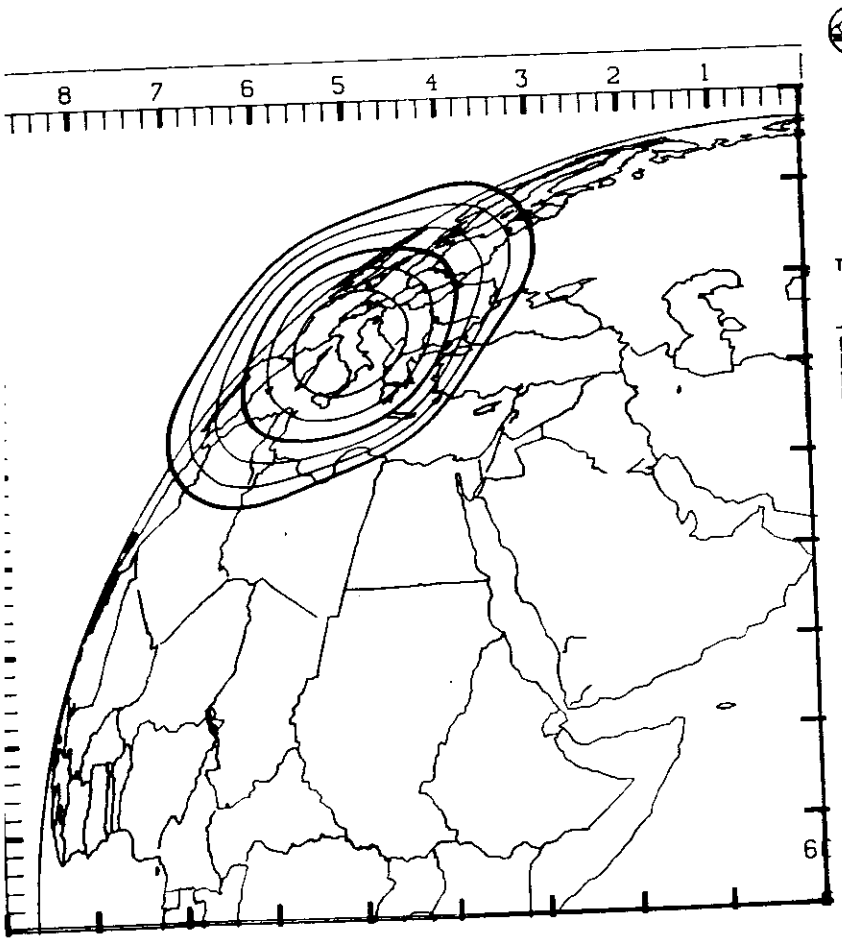


Figure 22

INTELSAT VI

INDIAN 60.0° EAST SATELLITE

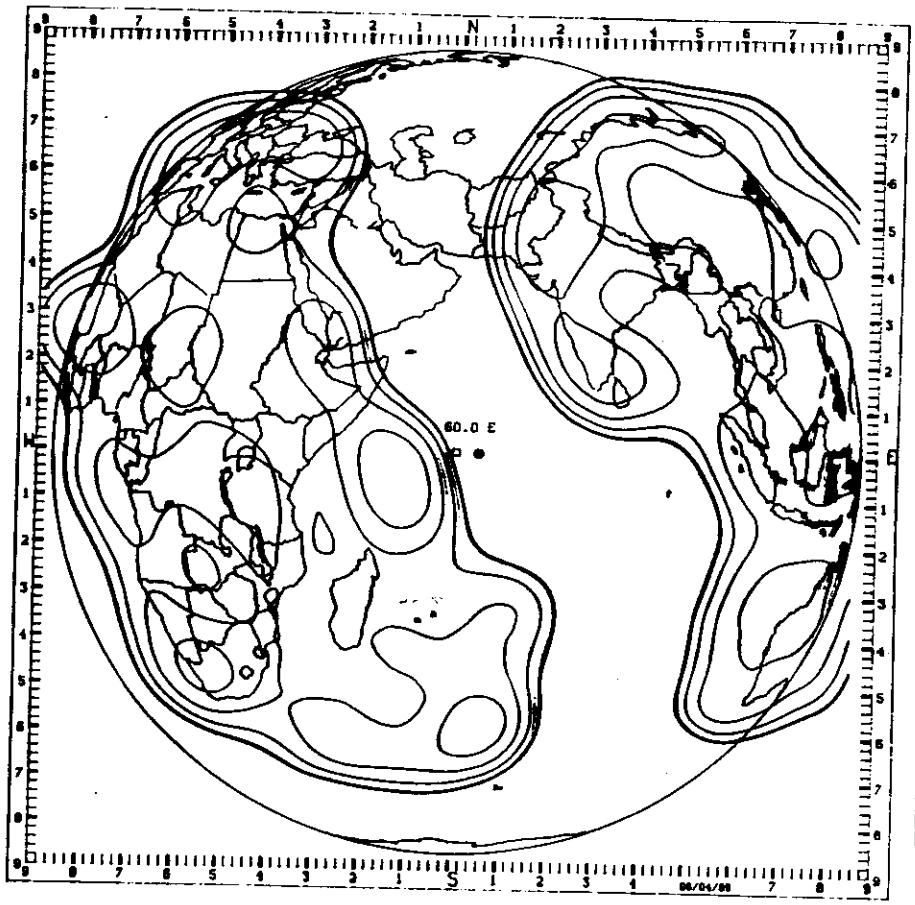
TYPICAL MEASURED TRANSMIT COVERAGE
WEST K-BAND SPOT BEAM

This satellite antenna coverage diagram illustrates the preliminary spacecraft spot beam pointing values for this location. After the spacecraft is completely tested and the service requirements are finalized the spot beam pointing will be selected and will be used when determining the satellite antenna pattern advantage (Beta Factor) for each earth station as described in IESS-402.

Contours are illustrated in 1.0 dB increments from the beam edge (0, +1, . . . and +5 dB). The nominal inner and outer beam edge contours are darkened.

K-Band Spot Beam Pointing

Beam	Coordinates S/C	Lon/Lat
West K-Band Spot	4.88°W 6.41°N	14.0°E 43.5°N



INTELSAT VI

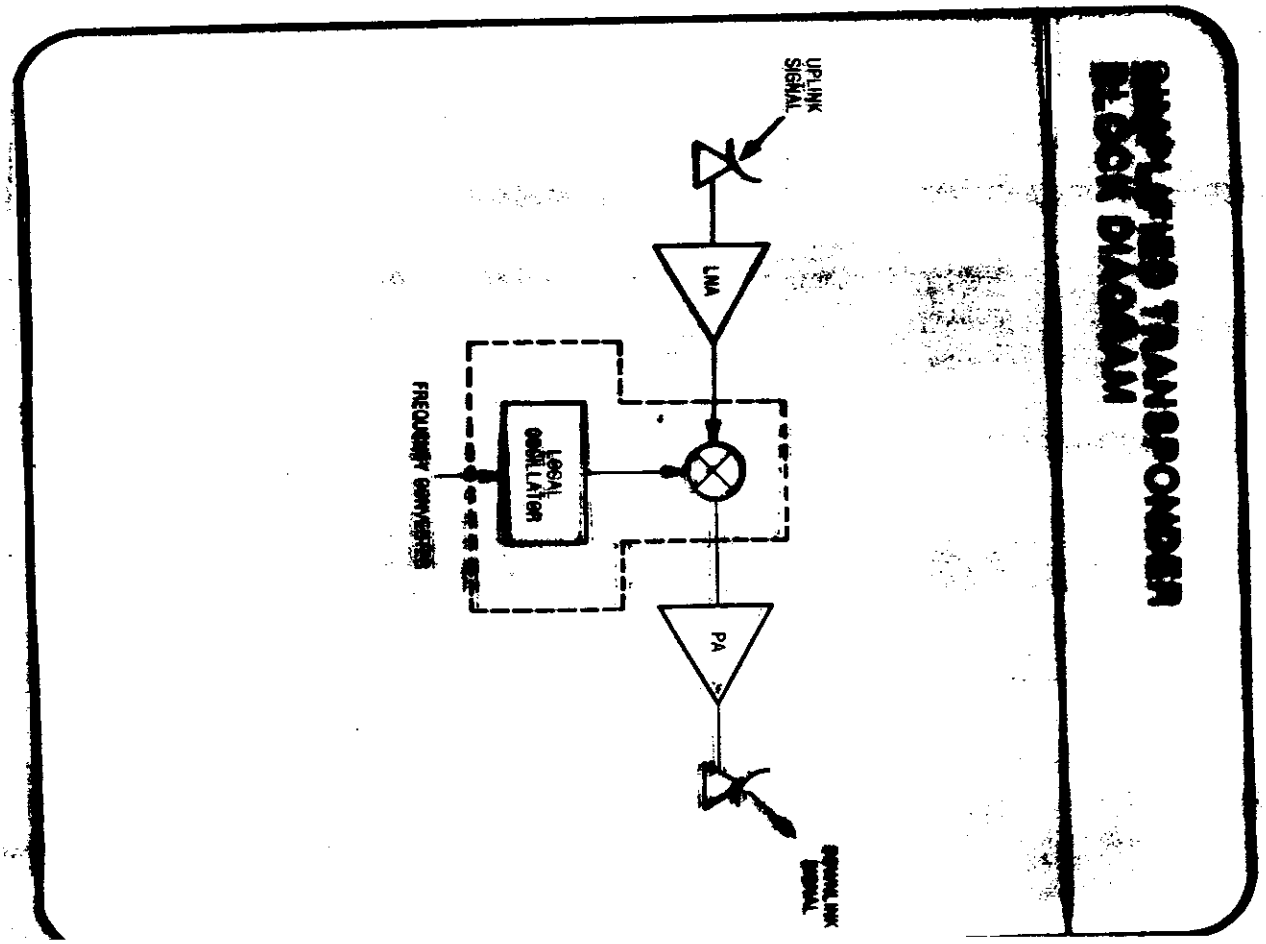
INDIAN 60.0° EAST SATELLITE

PRELIMINARY MEASURED
TRANSMIT COVERAGE
HEMISPHERIC BEAMS

This satellite antenna coverage diagram illustrates the preliminary spacecraft platform pointing bias for this location. After the final pointing is selected, it or an appropriate pointing range will be used when determining the satellite antenna pattern advantage (Beta Factor) for each earth station as described in IESS-402.

Contours are illustrated in 1.0 dB increments from the beam edge (0, +1, +2, and +3 dB). The nominal beam edge contour is darkened.

⊙ : Sub-Satellite Point
⊕ : Satellite Antenna Platform Pointing Bias = 0.50° East
0.00° North



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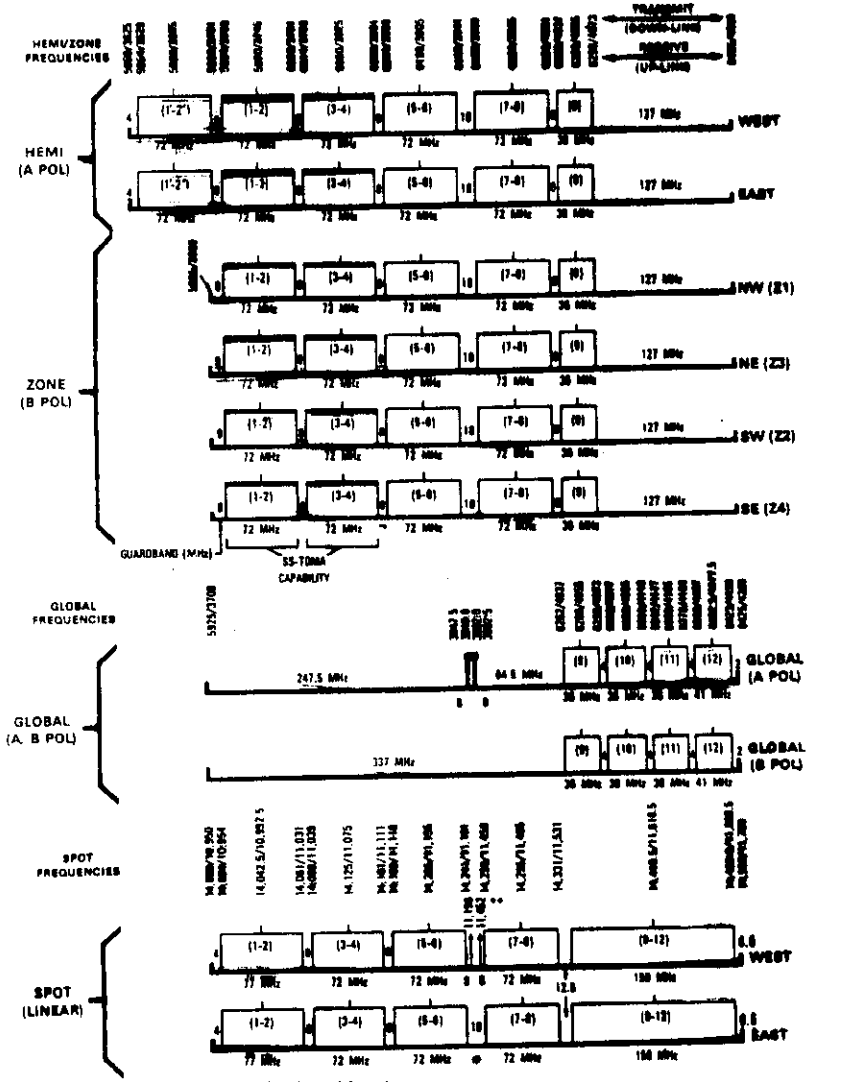

Notes: 1. See Tables 1 and 2 for further information.
2. *On spot down-link there is a 250 MHz gap between (5-8) and (7-8) (11,200-11,450 MHz).
3. **The polarization of the 11 GHz beacons is Right Hand Circular (RHCP).

Figure 1
INTELSAT VI TRANSPONDER LAYOUT

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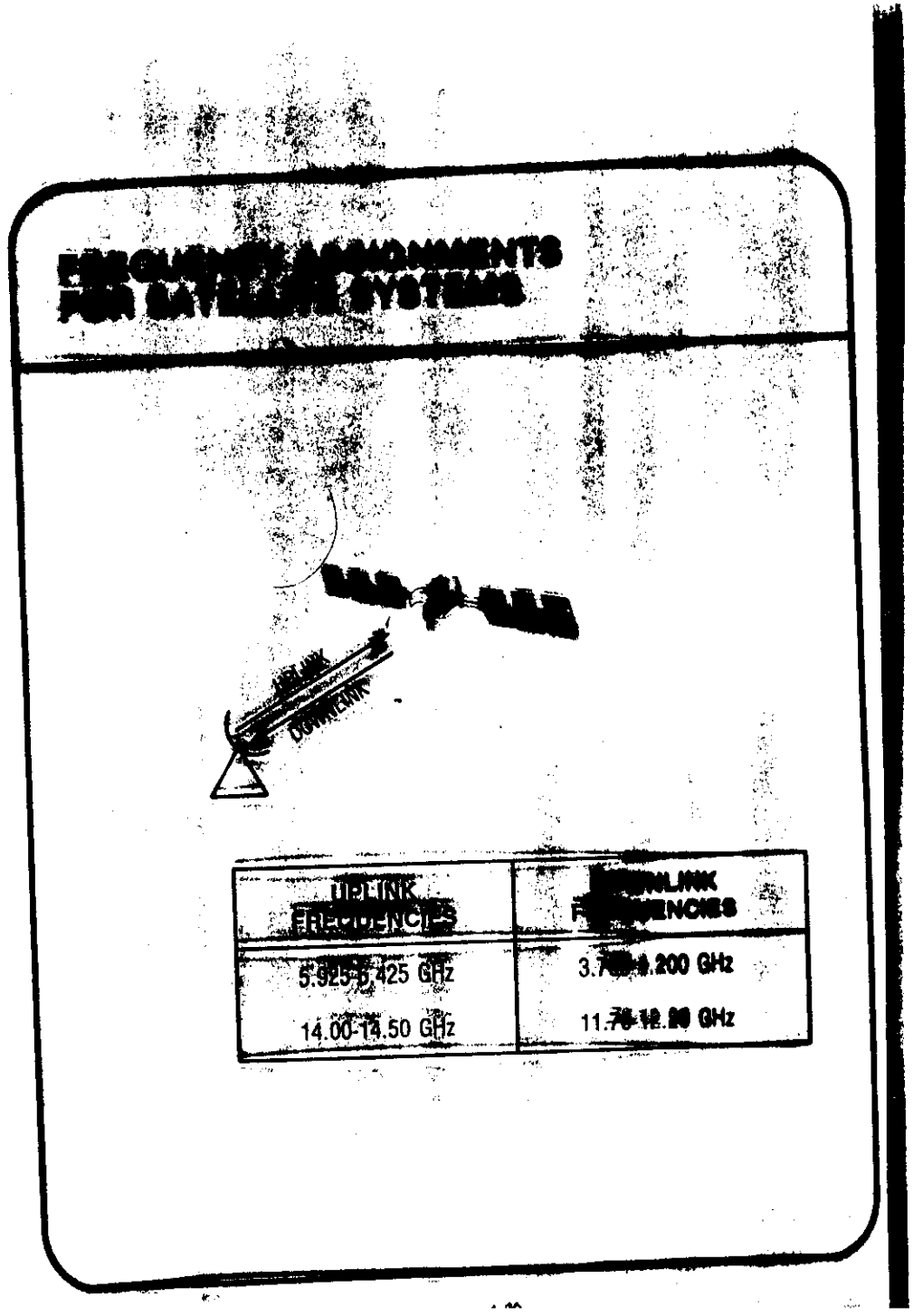
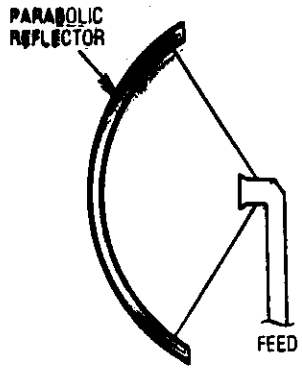
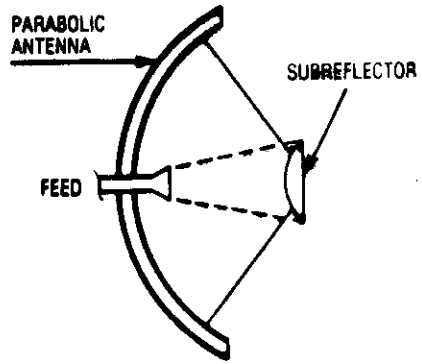


KU-BAND VS. C-BAND

- **Advantages**
  - Ku-band is not generally used for terrestrial common carrier links, so interference in cities and congested areas is not a problem.
  - The beam width of a Ku-band earth station antenna is less than half hat of C-band. Therefore, the number of orbital positions can be increased. Satellite position can therefore be optimized to maintain satisfactory elevation angels (to minimize weather effects).
  - The antenna gain on the satellite is better. (Better performance or smaller earth station antennas.)
  - C-band has an FCC imposed limit on the downlink power to prevent interference with terrestrial common carriers. No limit is imposed on the 12 GHz downlink.
- **Disadvantage**
  - With very heavy rain, fog, or clouds, the received signal strength falls and the noise increases.

ANTENNA





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ADVANTAGES

PRIME FOCUS
LESS CRITICAL
ALIGNMENT
COST

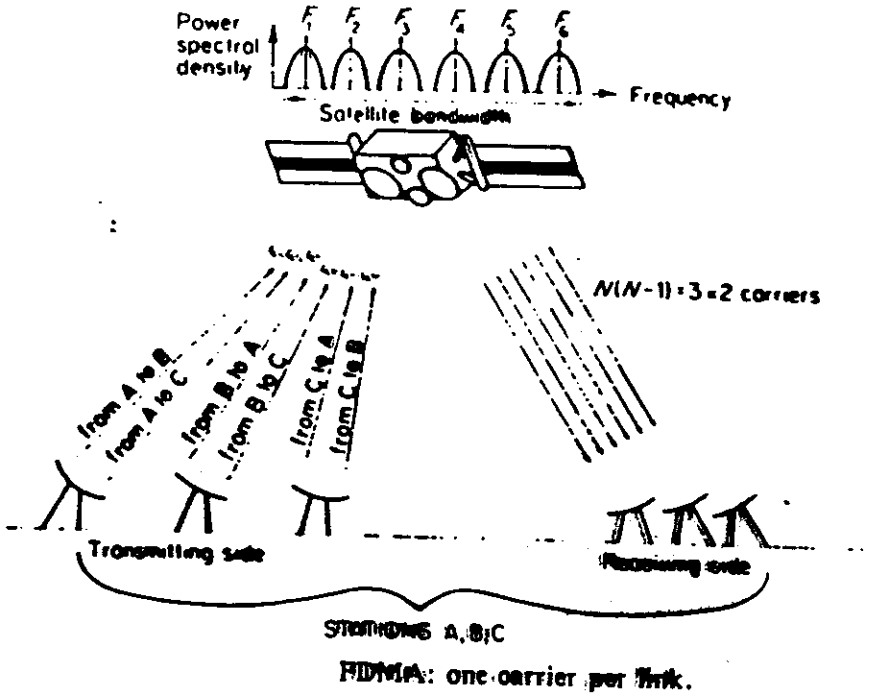
CASSEGRAIN
HIGHER GAIN
SHORTER WAVEGUIDE LENGTH
BETWEEN FEED AND LNA

DISADVANTAGES

LOWER GAIN
LONG WAVEGUIDE LENGTH

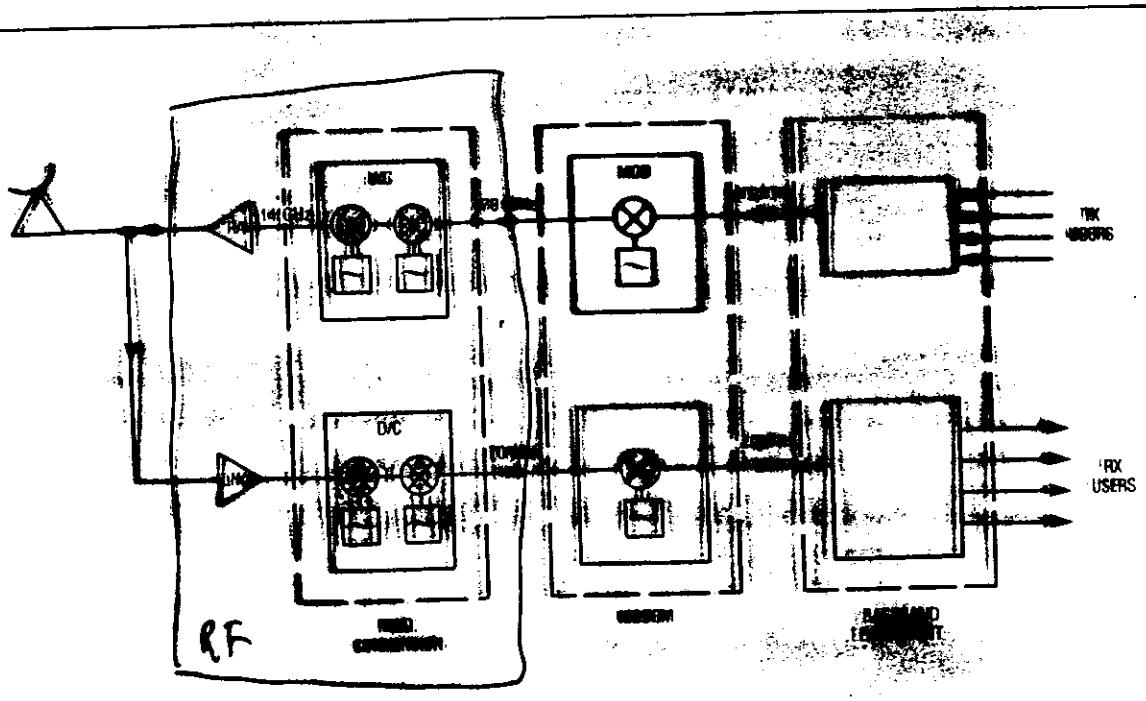
CRITICAL ALIGNMENT BETWEEN
FEED, SUBREFLECTOR AND
MAIN REFLECTOR COST

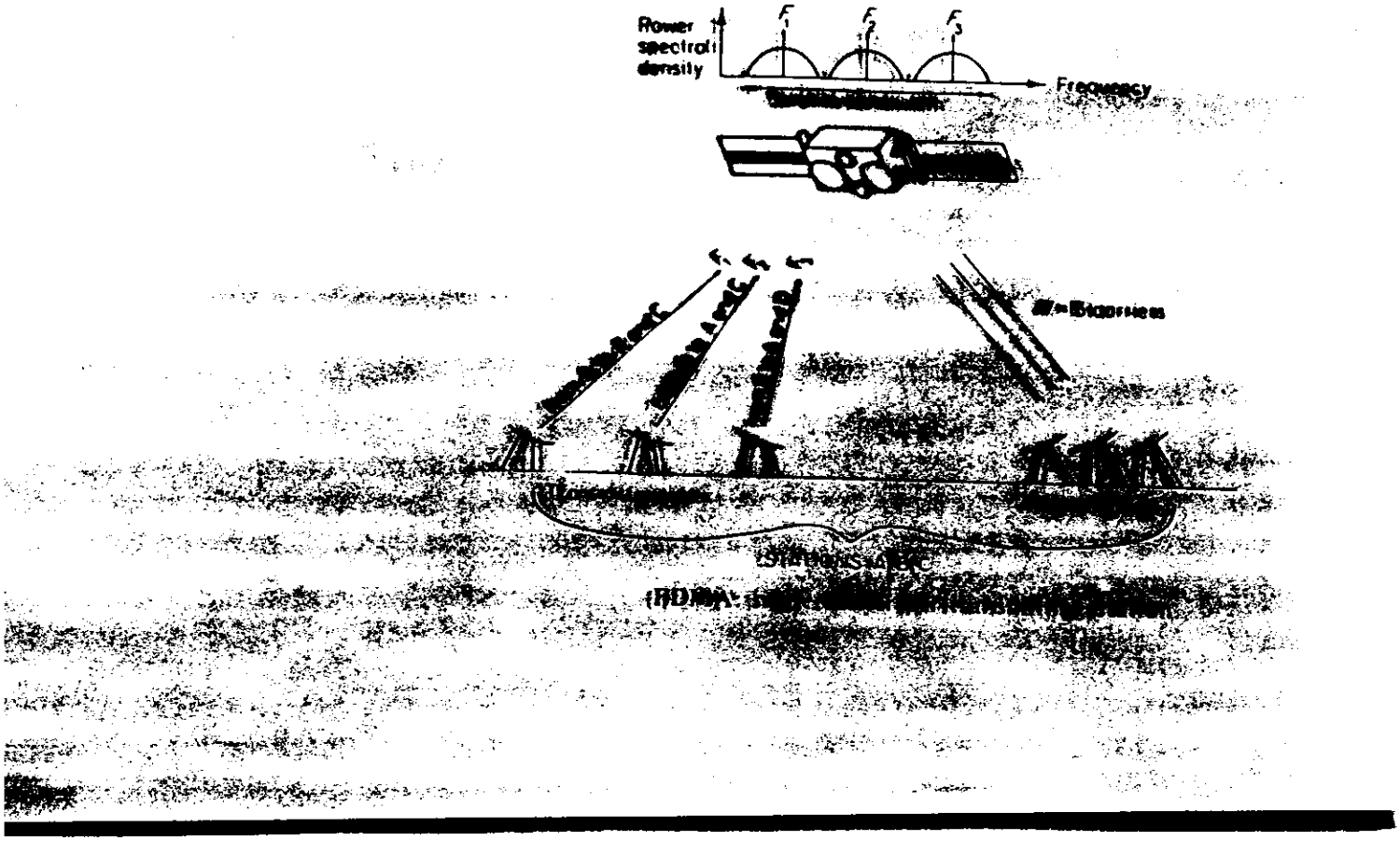
FEED TYPES FOR PARABOLIC ANTENNAS



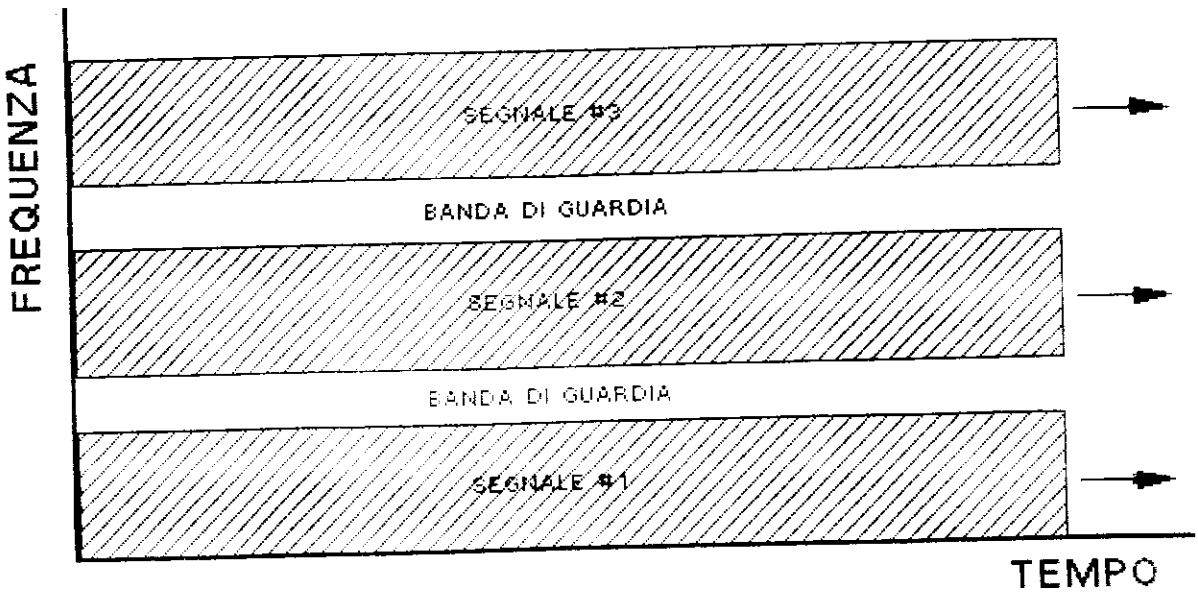
FDMA: one carrier per link.

BASIC BLOCK DIAGRAM OF AN EARTH STATION

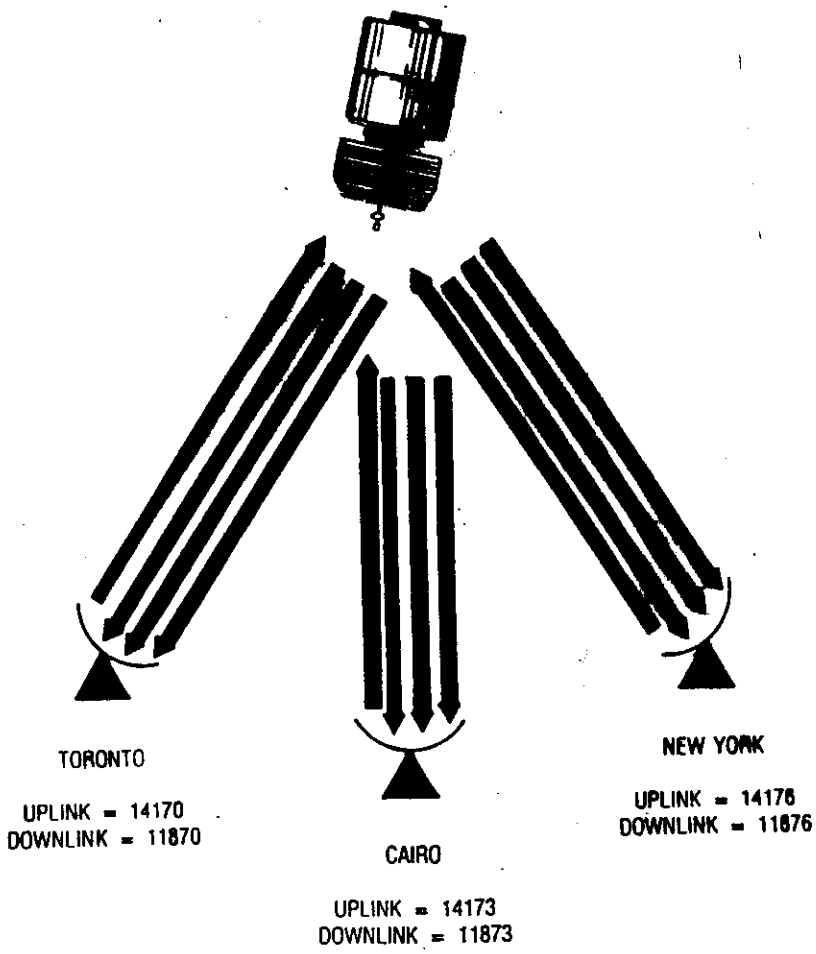




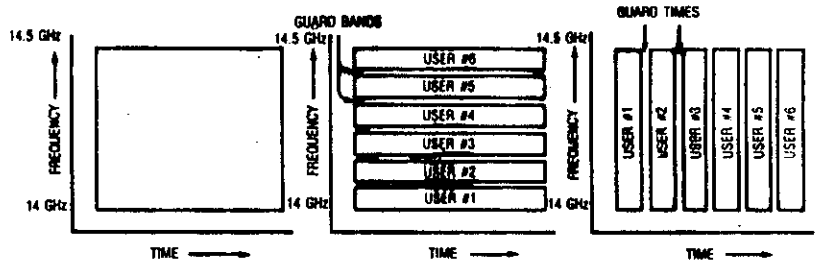
FDMA - Frequency Division Multiple Access



MULTIUSER SATELLITE SYSTEM



MULTIPLE ACCESS



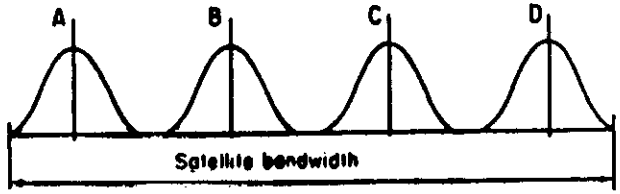
POWER AMPLIFIER

- Interface between upconverter and antenna
- Amplifies signal(s) to power level required by link
- Minimum distortion to spectra
- Types:
  - Solid state
  - Traveling wave tube
  - Klystron

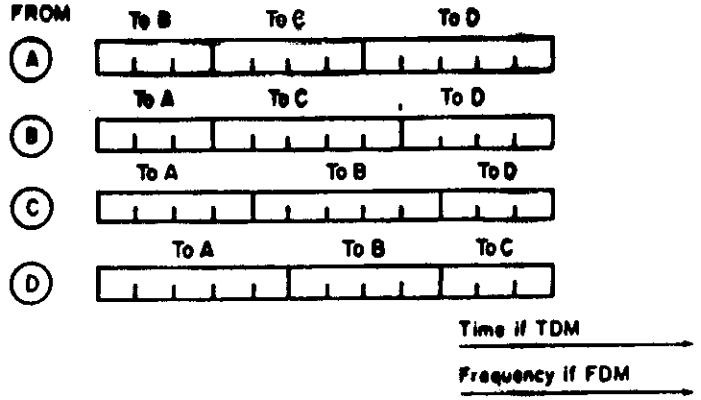
LOW NOISE AMPLIFIER

- Interface between antenna and downconverter
- Amplify very small signals adding very little noise
- Offer dynamic range
- Handle wide bandwidth
- Provide gain
- Minimum distortion to spectra

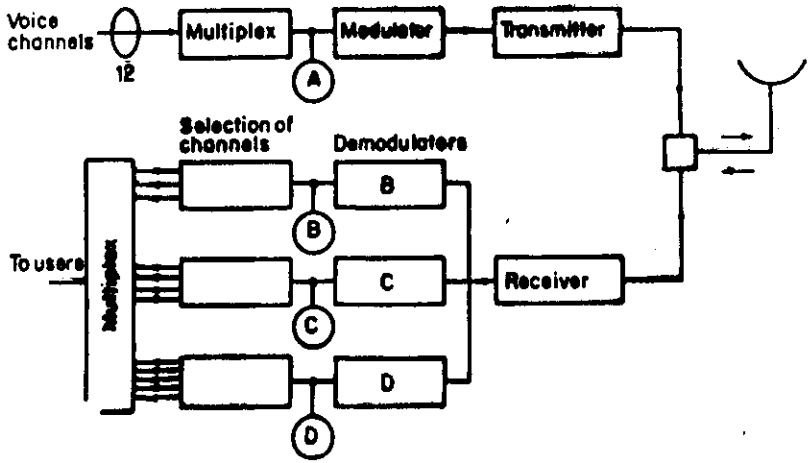
(a) TRANSMITTED CARRIERS



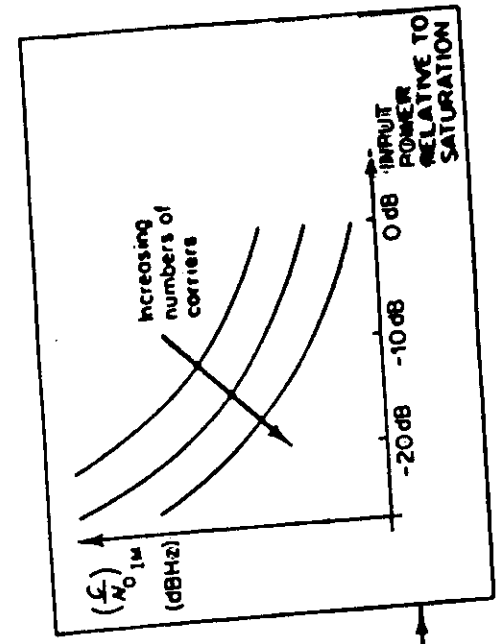
(b) BASEBAND SIGNAL MULTIPLEX (FDM or TDM)

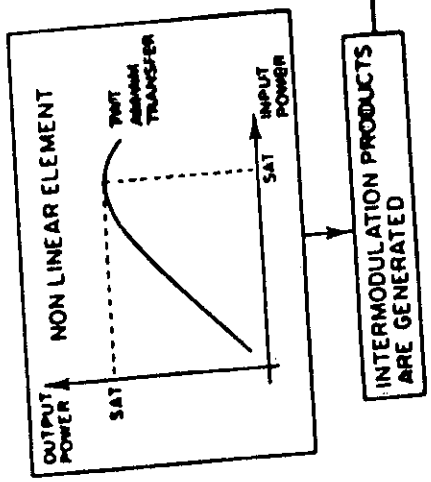


(c) EARTH STATION A EQUIPMENT BLOCK DIAGRAM



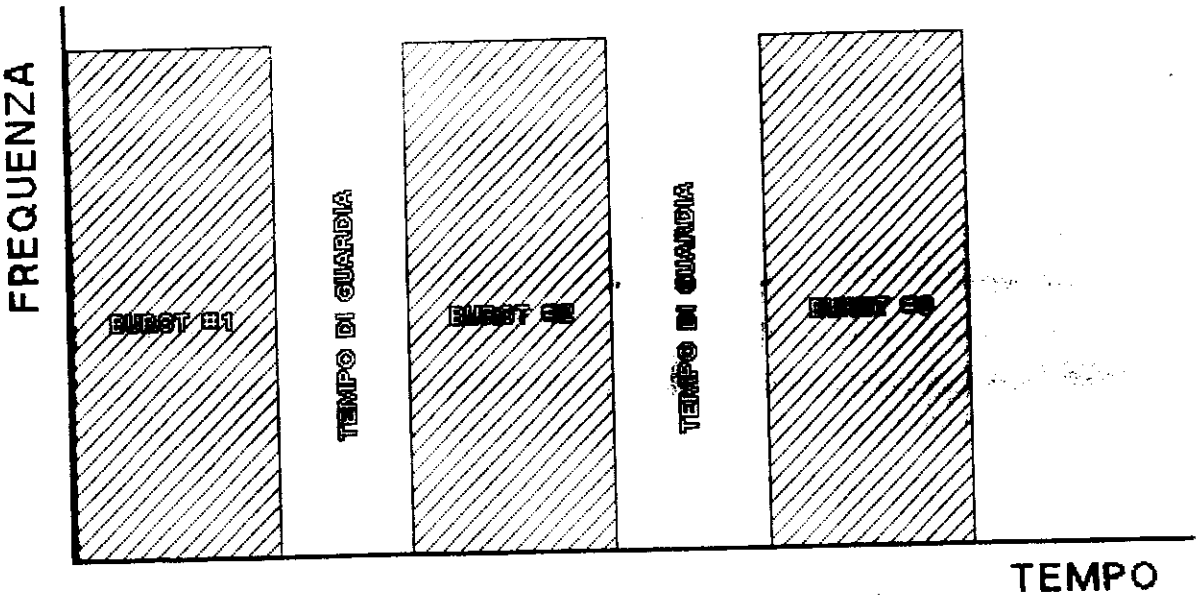
Example of a FDMA system with four earth stations and one carrier per

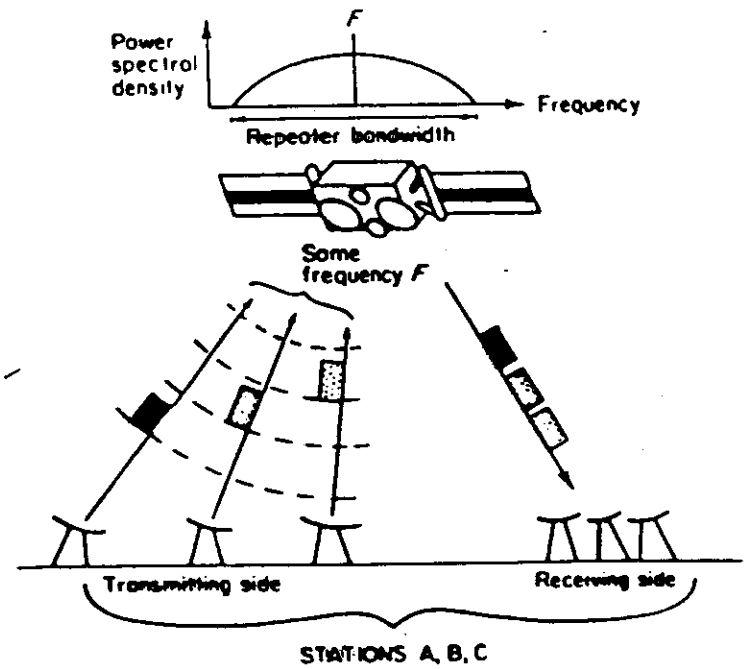




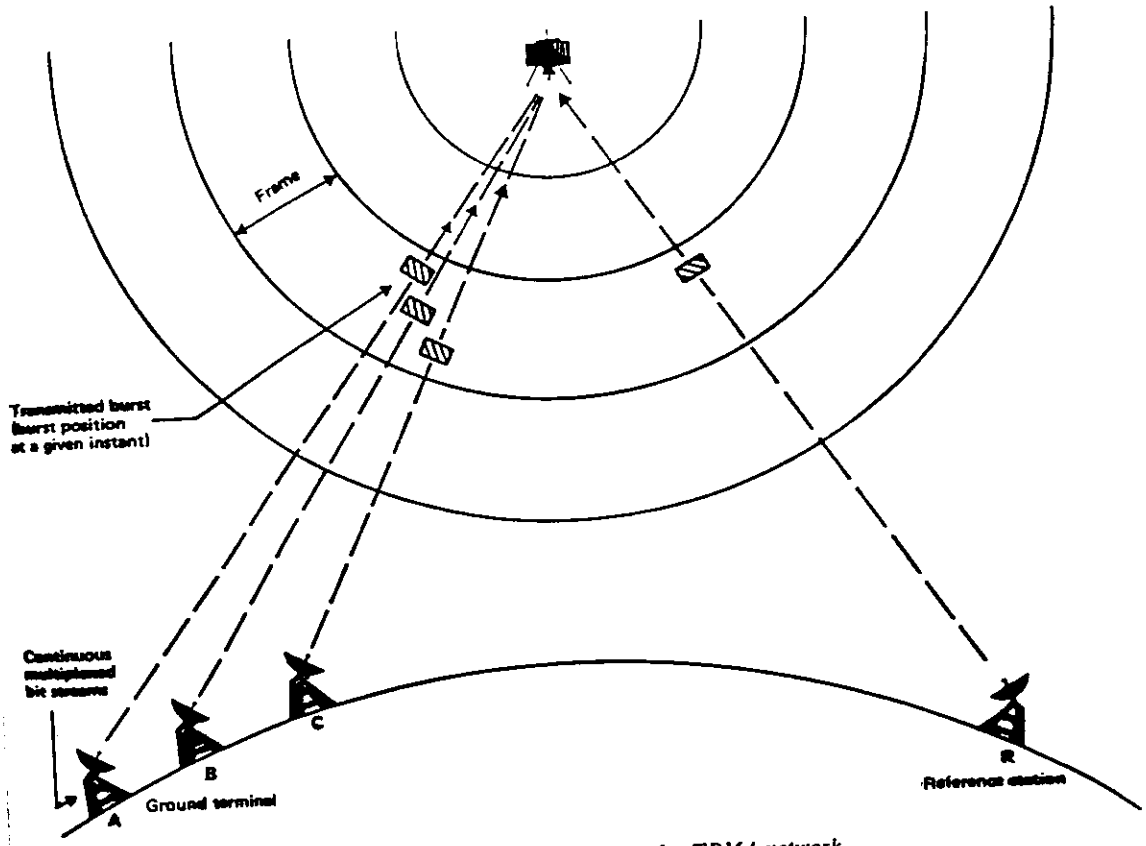
INTERMODULATION PRODUCTS ARE GENERATED

TDMA - Time Division Multiple Access

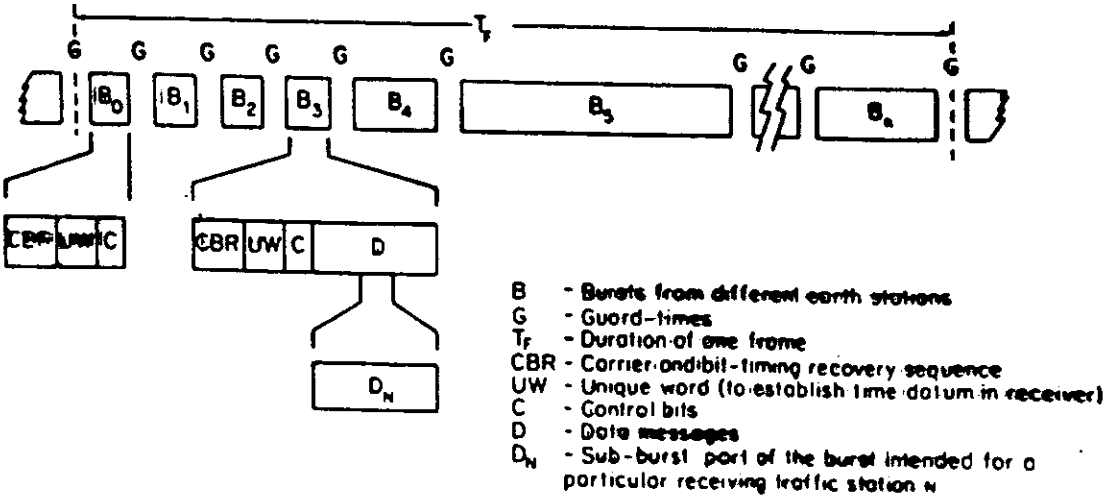




Time division multiple access.



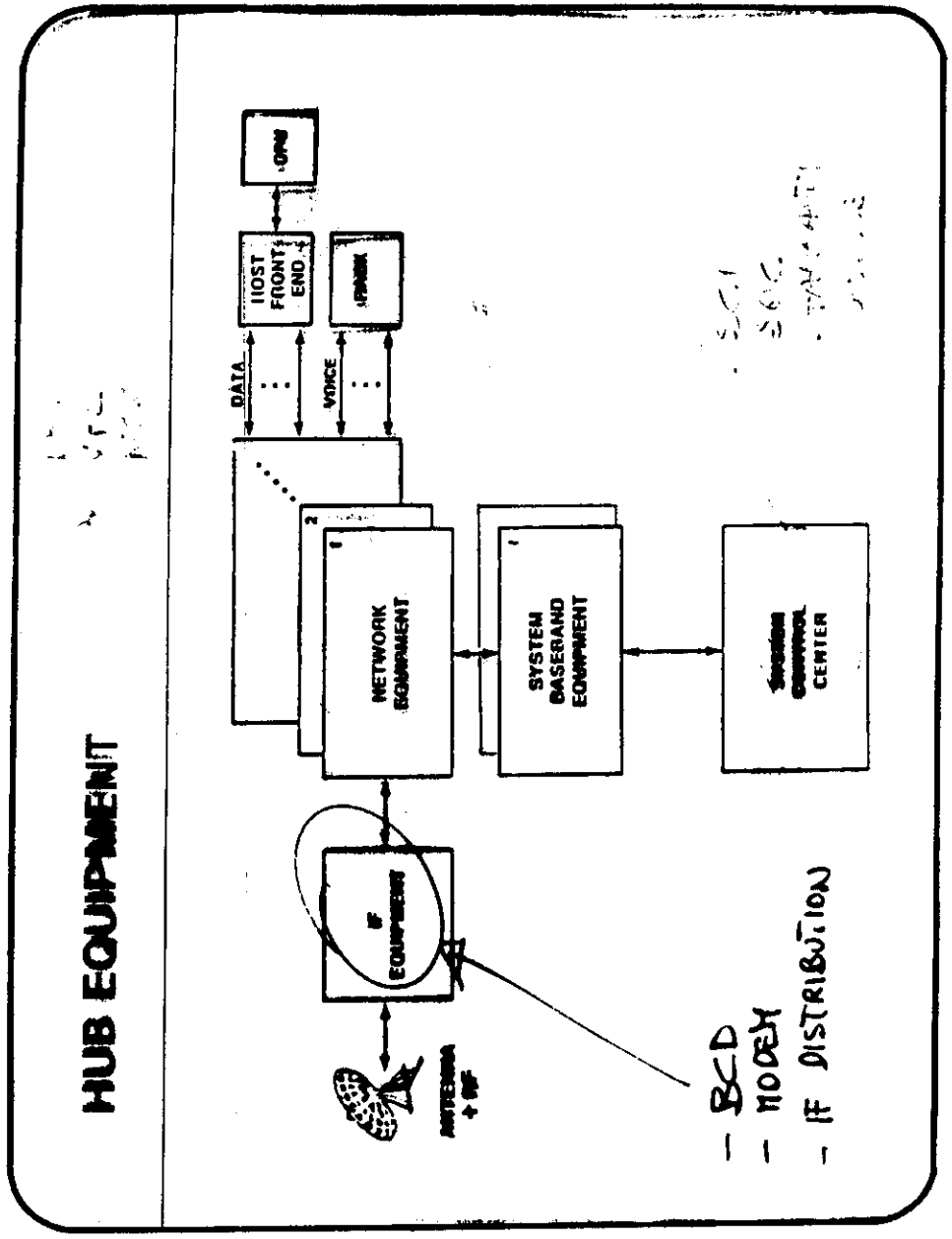
- *Configuration of a TDMA network*



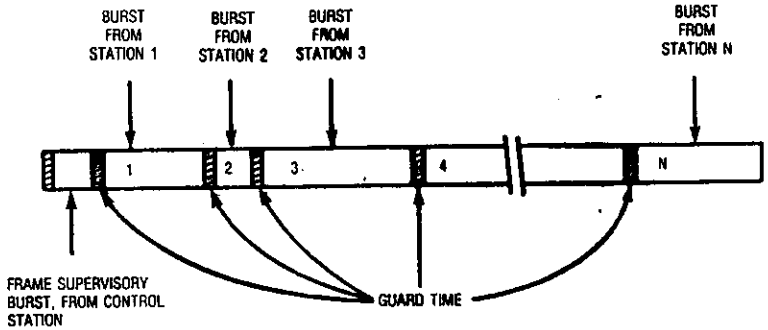
Typical TDMA frame structure.

SATELLITE COMMUNICATION ADVANTAGES

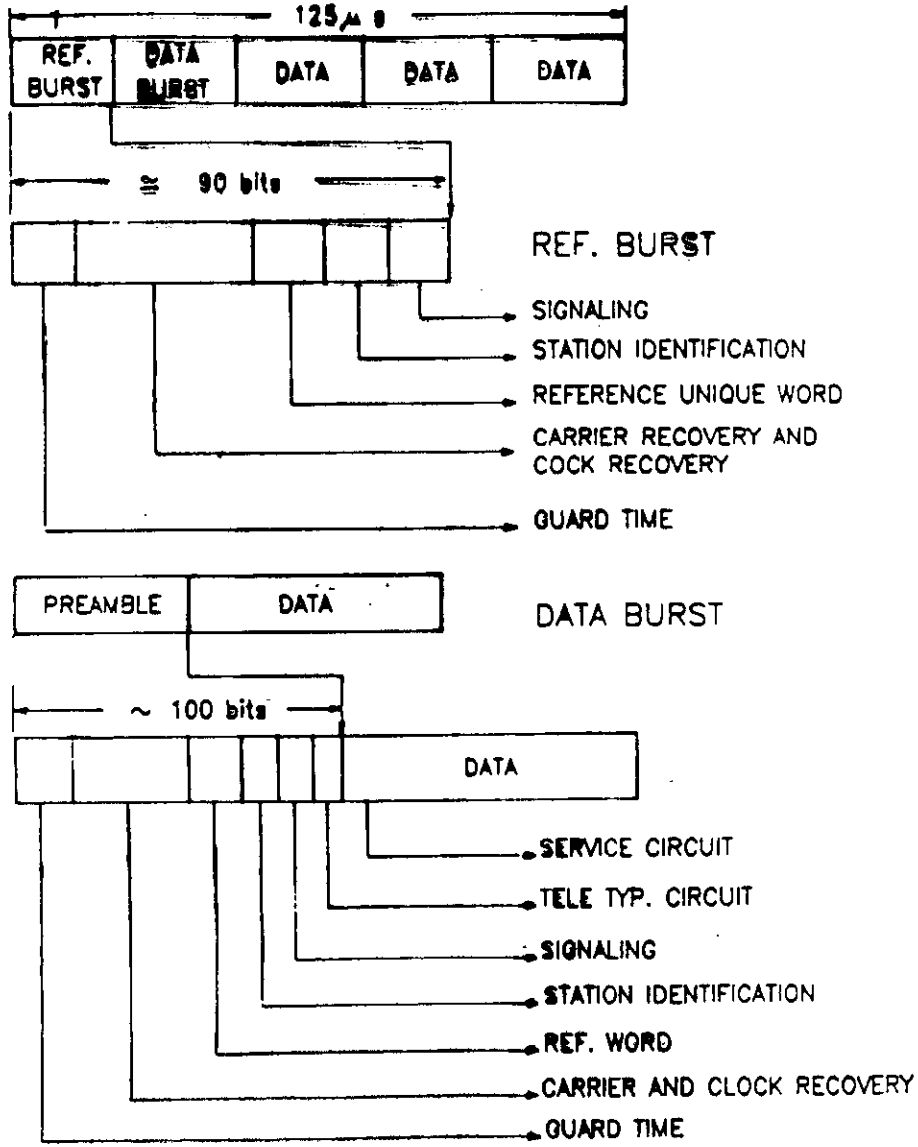
- FAST IMPLEMENTATION
- FLEXIBILITY
- EASY ACCESS
- HIGH RELIABILITY
- WIDEBAND LINKS

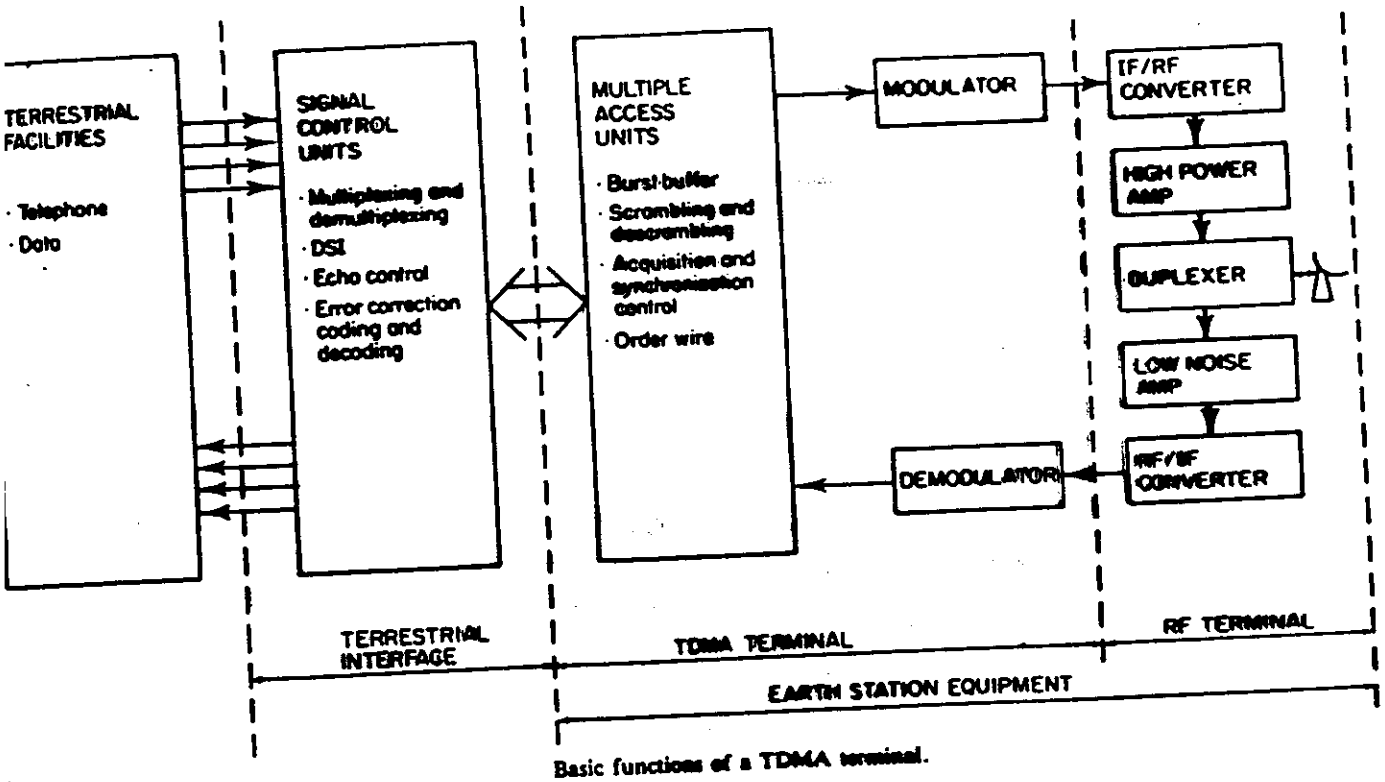


A FRAME IN A TDMA SYSTEM

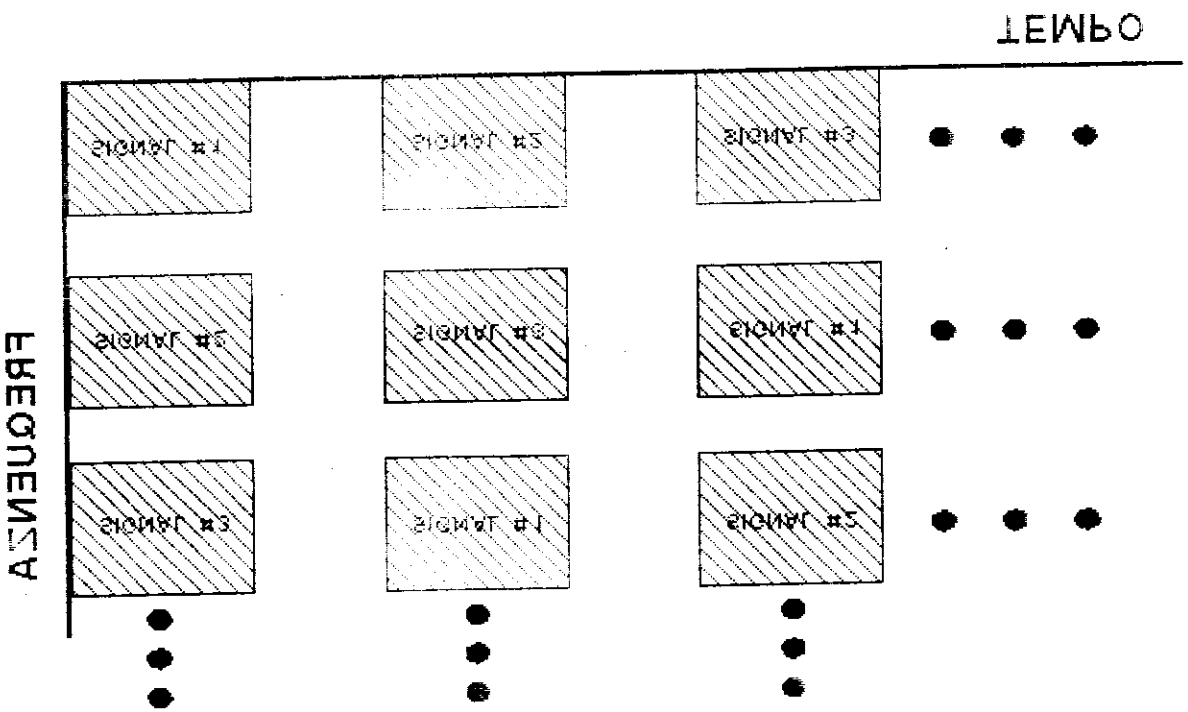


FORMAT OF TDMA FRAME EXAMPLE

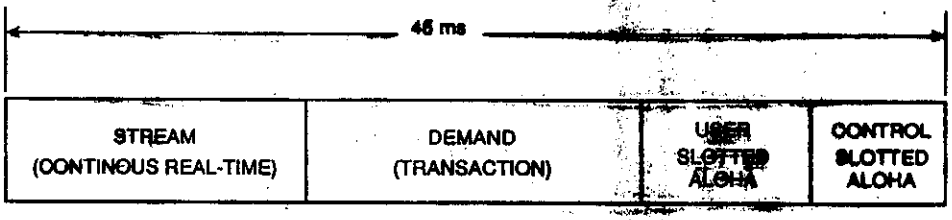




Basic functions of a TDMA terminal.

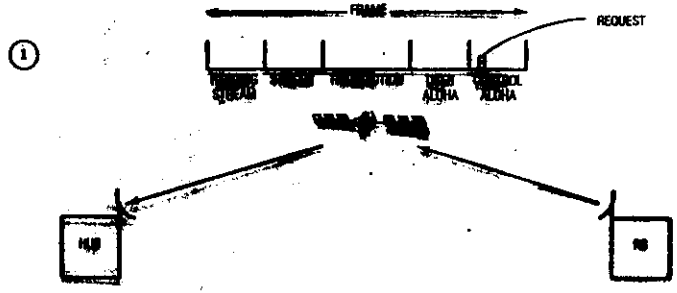


INROUTE FRAME STRUCTURE

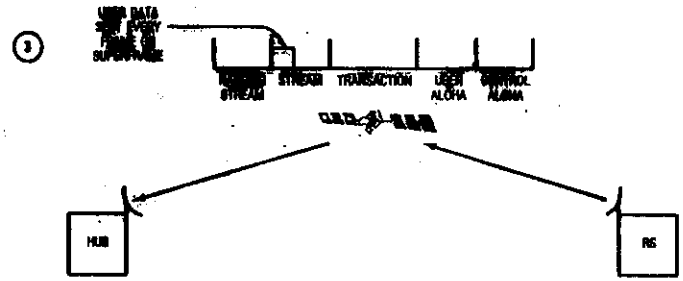


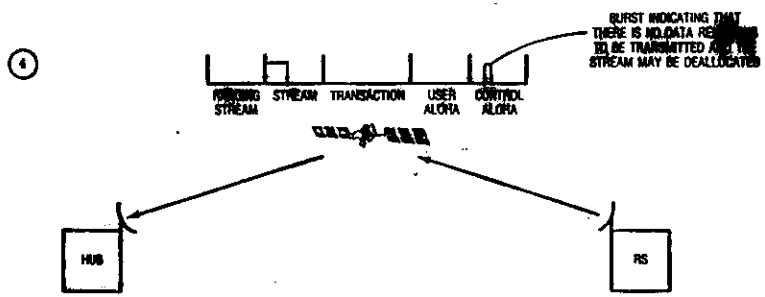
- BOUNDARIES BETWEEN THE VARIOUS TYPES OF BANDWIDTH ALLOCATION TECHNIQUES ARE VARIABLE
- MINIMUM SIZES FOR EACH TYPE CAN BE DEFINED

STREAM TRANSMISSION



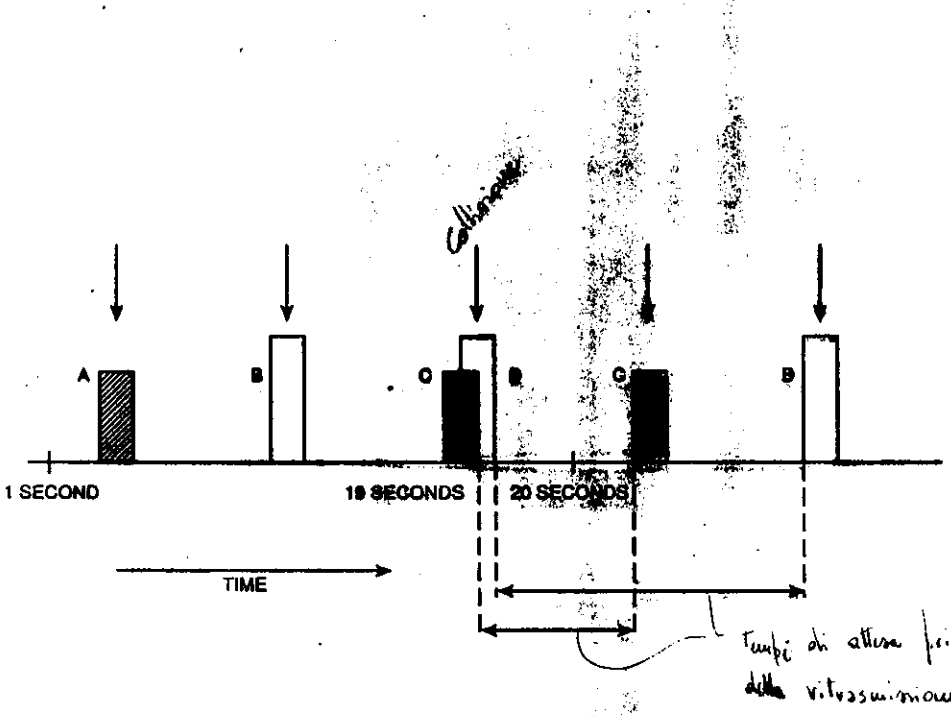
2 HUB ALLOCATES SLOTS AND RETURNS AUTHORIZATION TO TRANSMIT



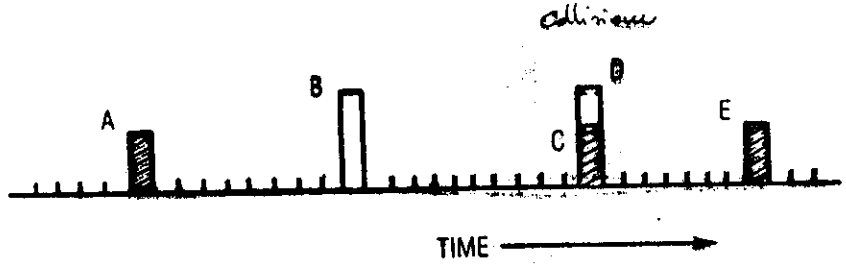


5 HUB DEALLOCATES THE STREAM

THE "CLASSICAL" ALOHA PROTOCOL

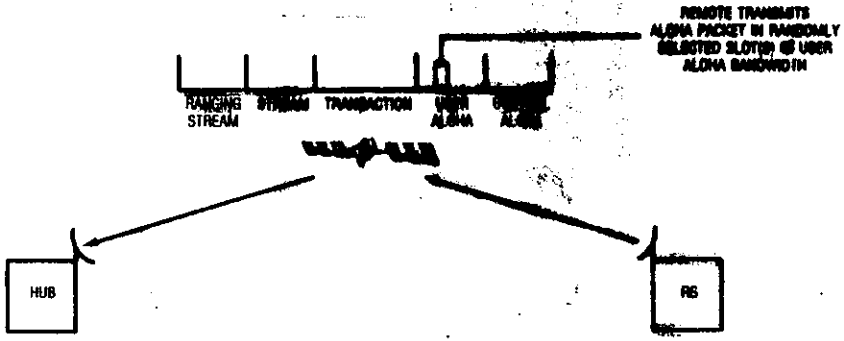


A SLOTTED ALOHA CHANNEL



EACH PACKET MUST BEGIN ON ONE OF THE TIME DIVISIONS

USER ALOHA



(1)

(2) If There is no Collision and the Packet is Received Correctly, then the Hub Returns an Acknowledgment Message to the Remote and the Transmission is Complete. If the Remote Does not Receive the Acknowledgment Within a Certain Amount of Time, the Packet is Transmitted in Slots Randomly Selected from a Larger Pool.

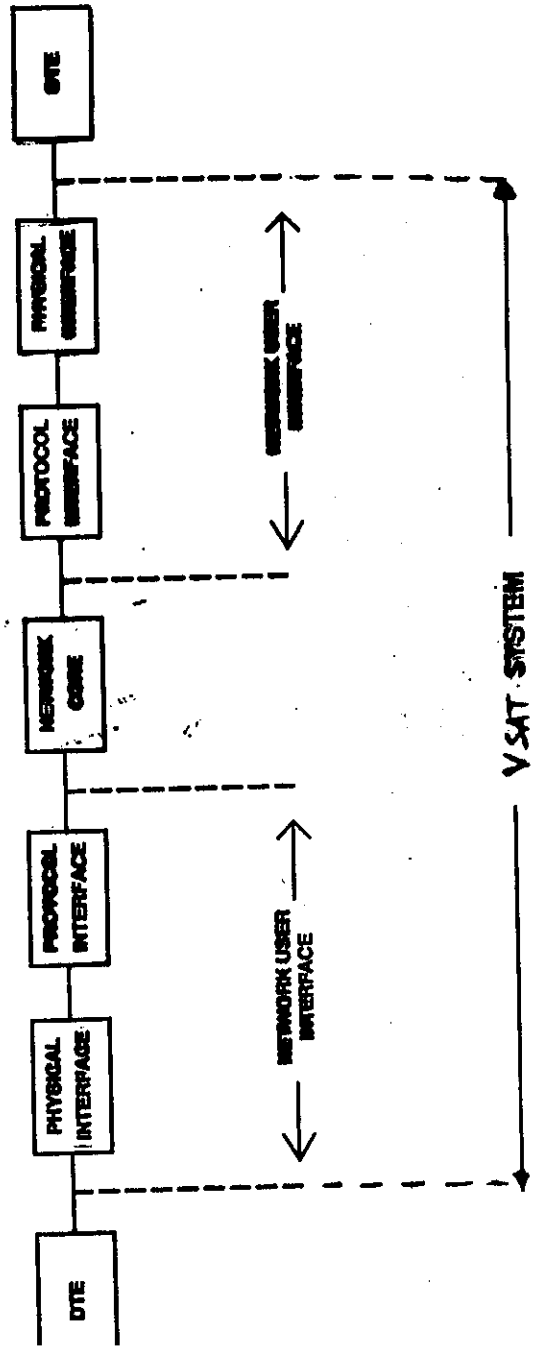
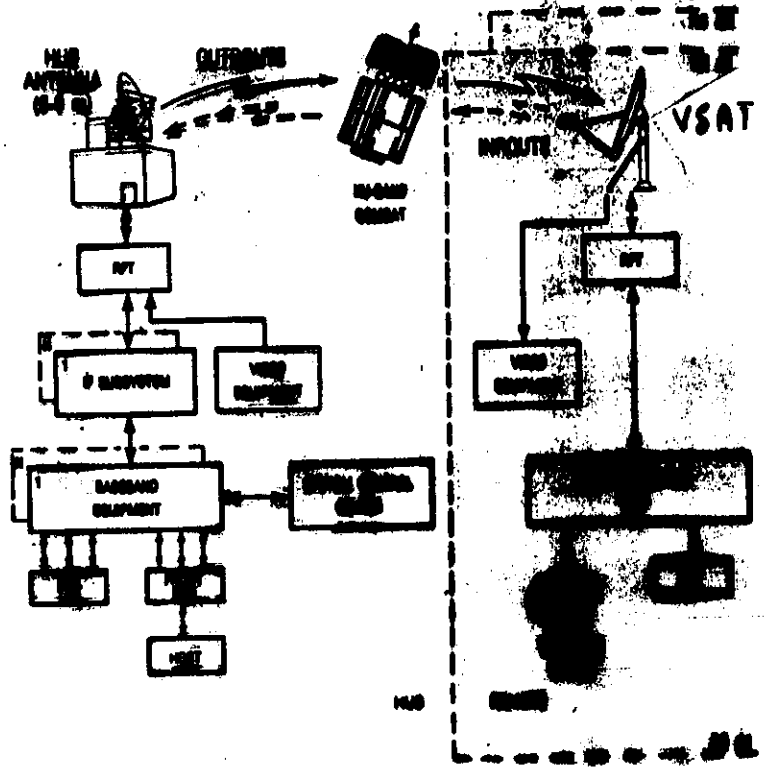
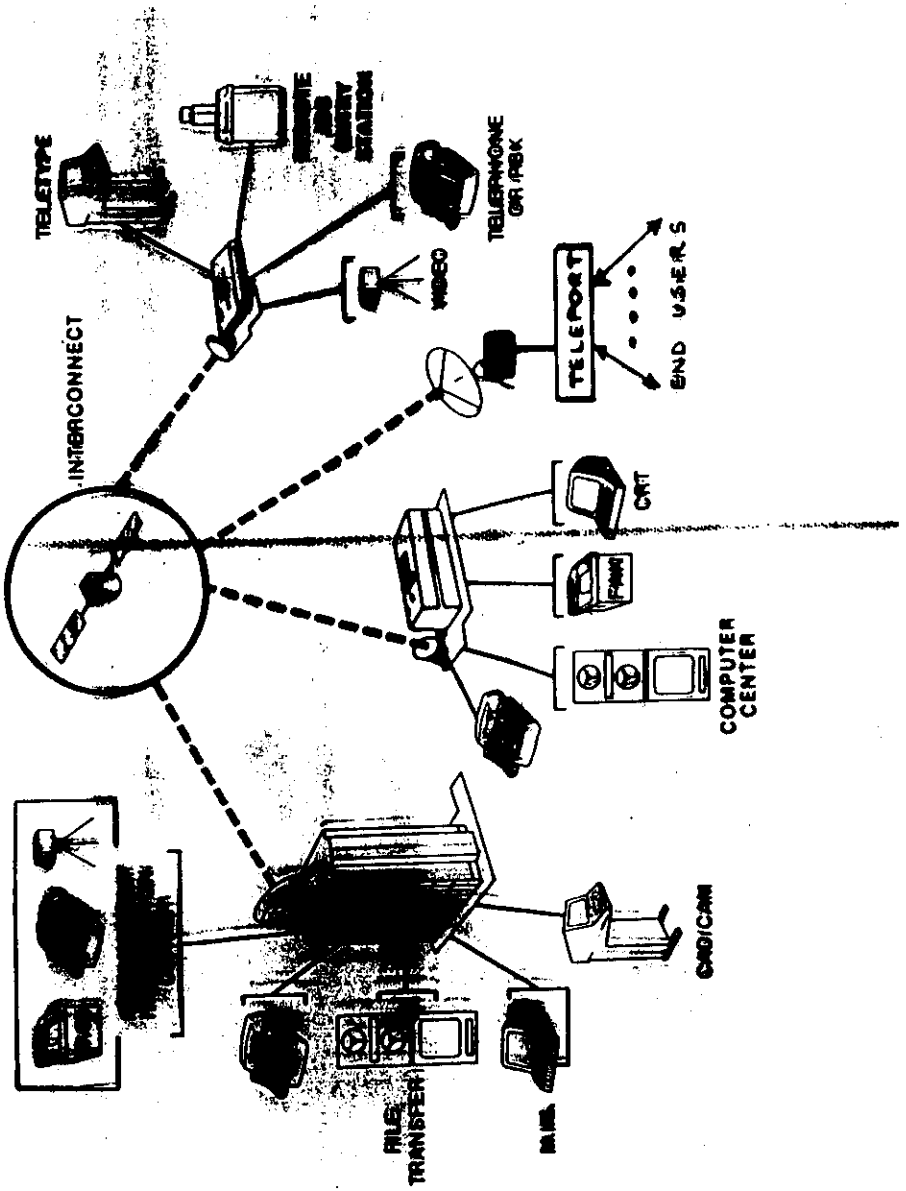


FIG. VSAT SYSTEM ARCHITECTURE

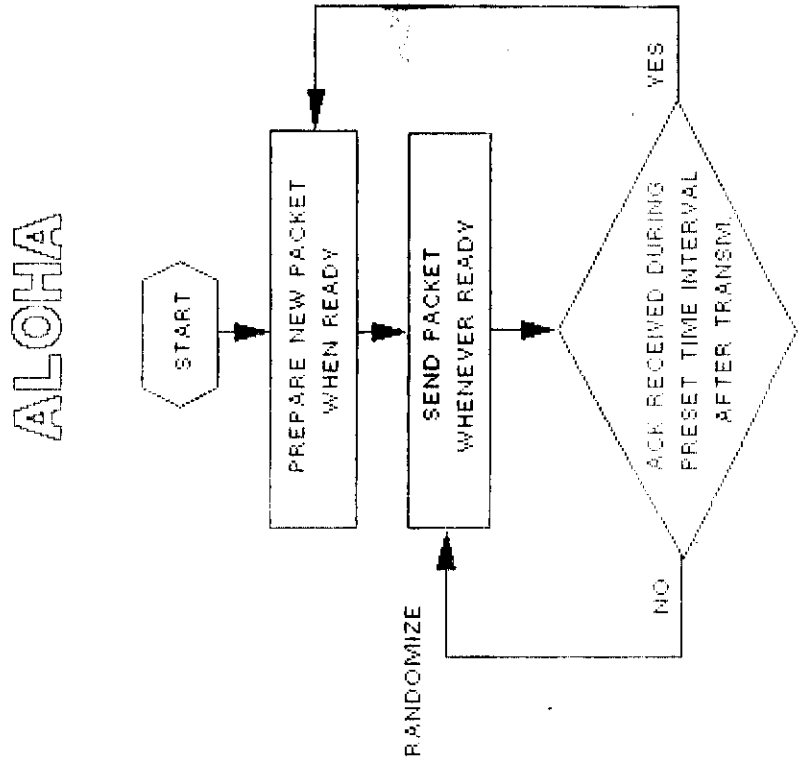
VSAT SYSTEM EQUIPMENT



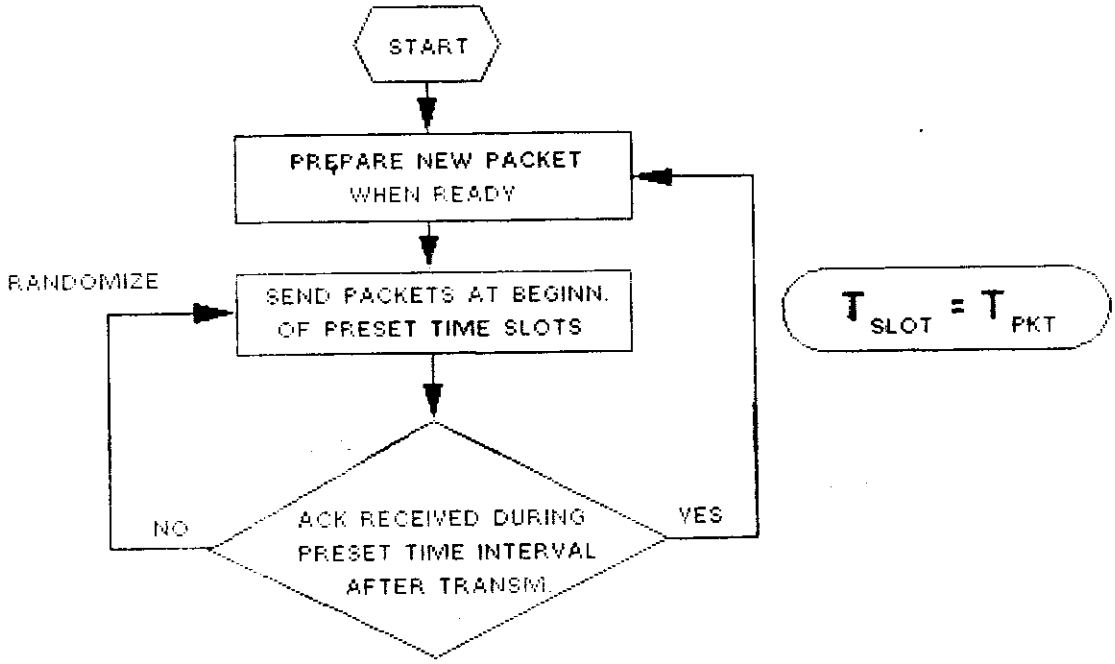


FREQUENCY CONVERTER

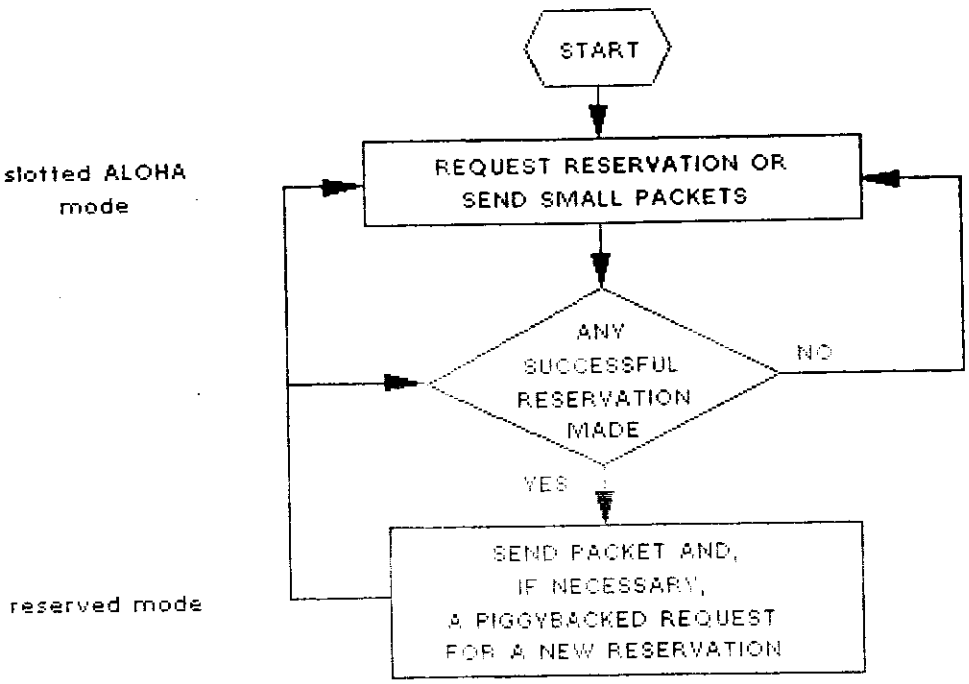
- **Common**
  - Handle transponder bandwidth
  - Provide gain
  - Minimum distortion to spectra
  - Types: dual and single conversion
- **Downconverter**
  - Interface between LNA and baseband equipment
  - Translates signals to IF frequency
- **Upconverter**
  - Interface between baseband equipment and power amplifier
  - Translates signals to RF frequency



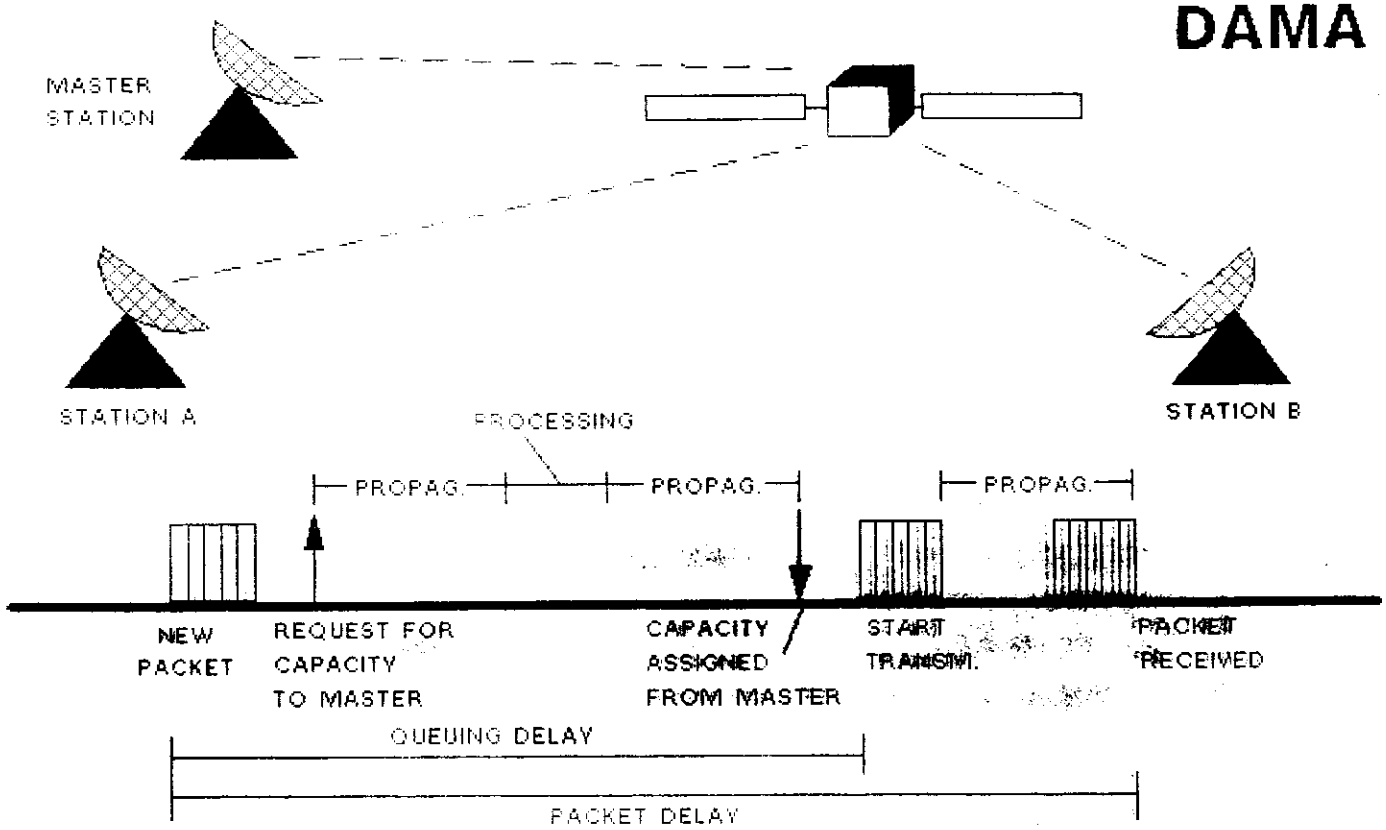
SLOTTED ALOHA



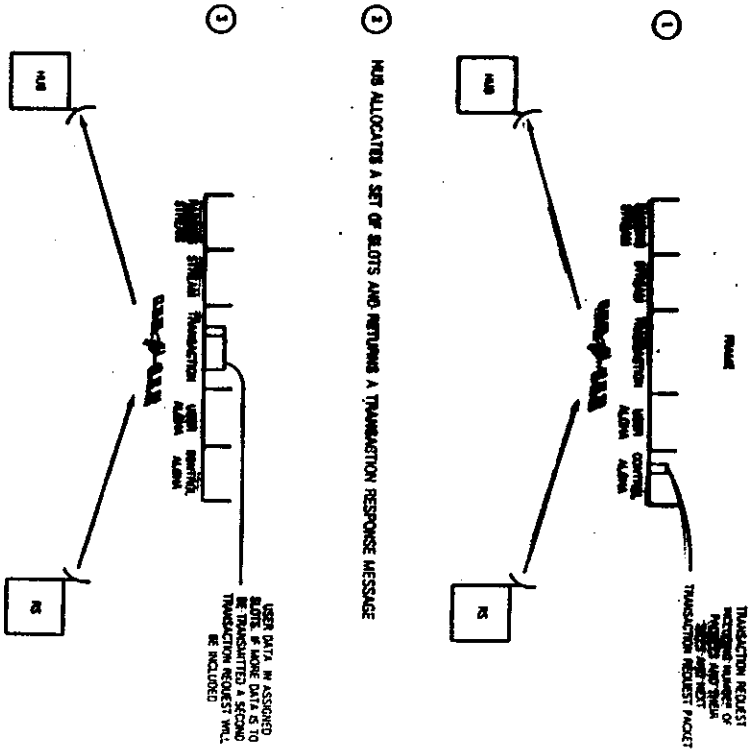
RESERVATION ALOHA



DAMA

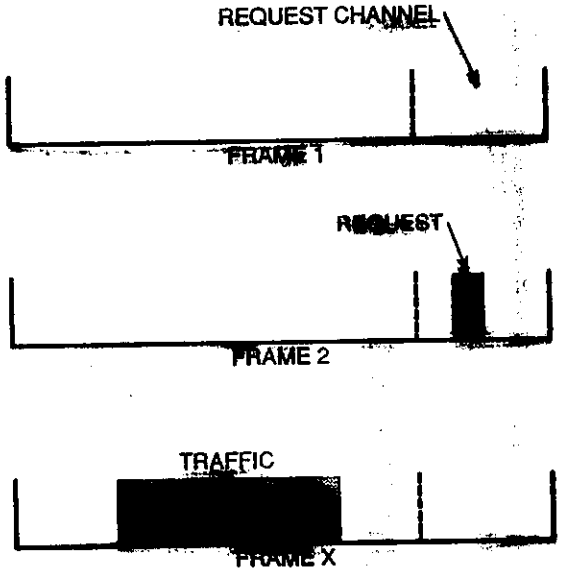


TRANSACTION RESERVATION



D TDMA FRAME

Esempi di burst

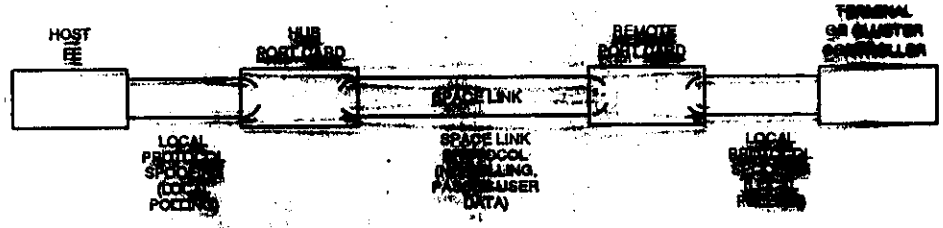


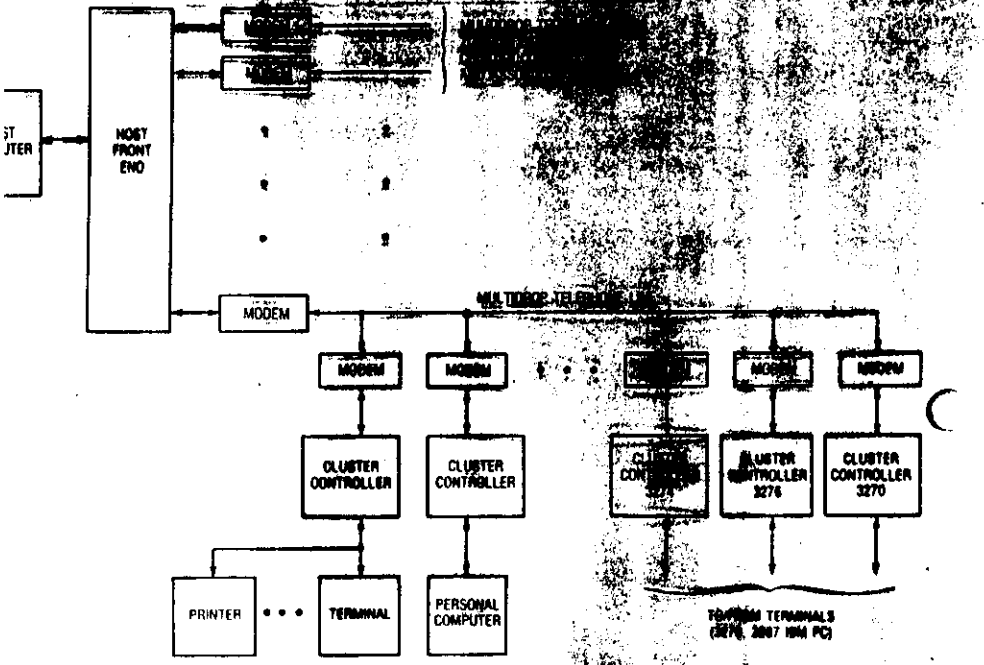
burst vuoto

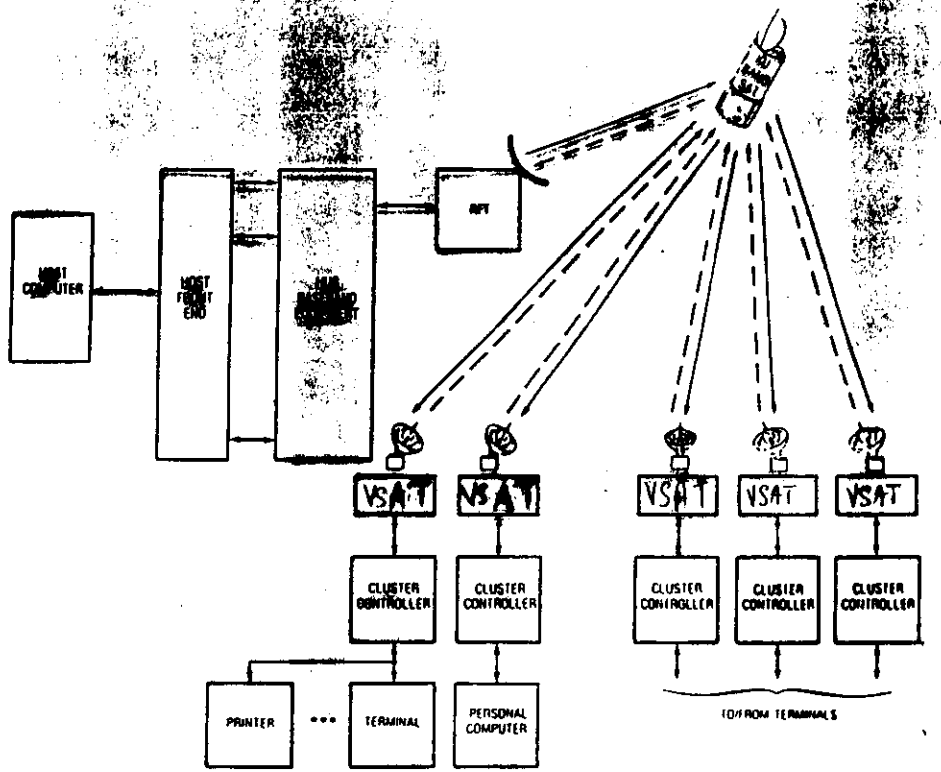
burst con solo una richiesta di trasmissione

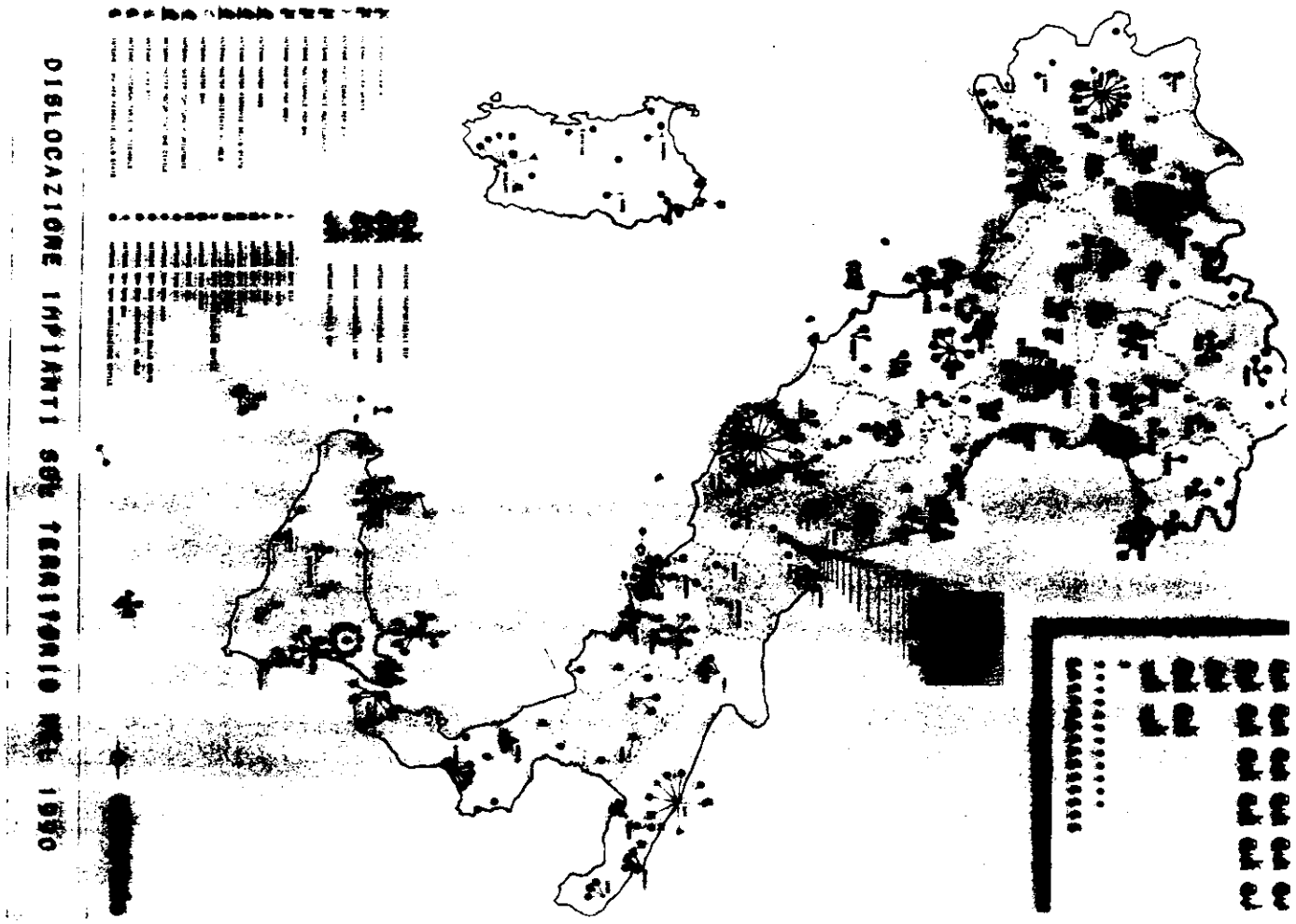
burst di dati

PROTOCOL HANDLING




HOST FRONT END
MODEM
MODEM
MODEM
MODEM
CLUSTER CONTROLLER
CLUSTER CONTROLLER
CLUSTER CONTROLLER 3276
CLUSTER CONTROLLER 3270
PRINTER
TERMINAL
PERSONAL COMPUTER


HOST COMPUTER
HOST FRONT END
RFT
VSAT
VSAT
VSAT
VSAT
VSAT
CLUSTER CONTROLLER
CLUSTER CONTROLLER
CLUSTER CONTROLLER
CLUSTER CONTROLLER
CLUSTER CONTROLLER
PRINTER
TERMINAL
PERSONAL COMPUTER
TO/FROM TERMINALS



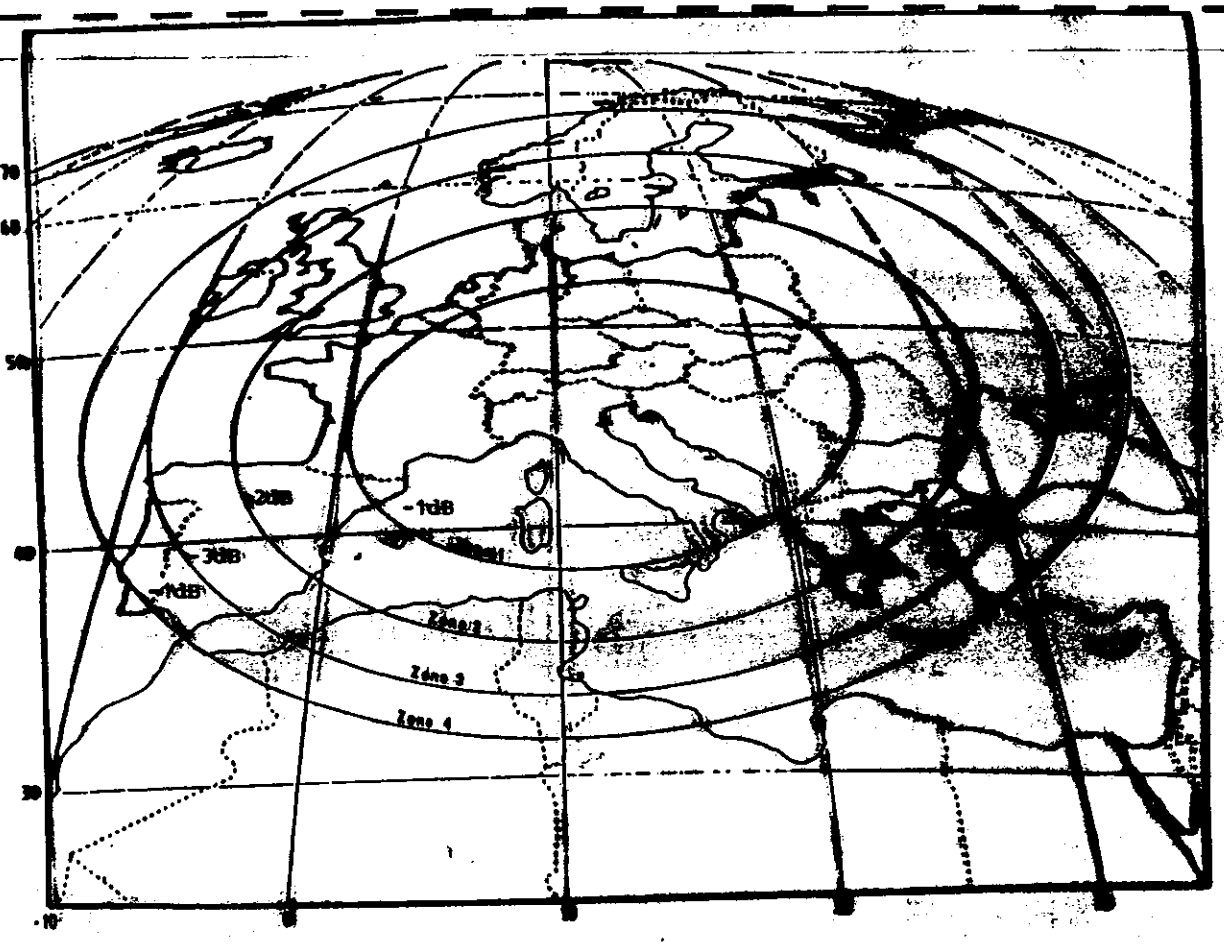
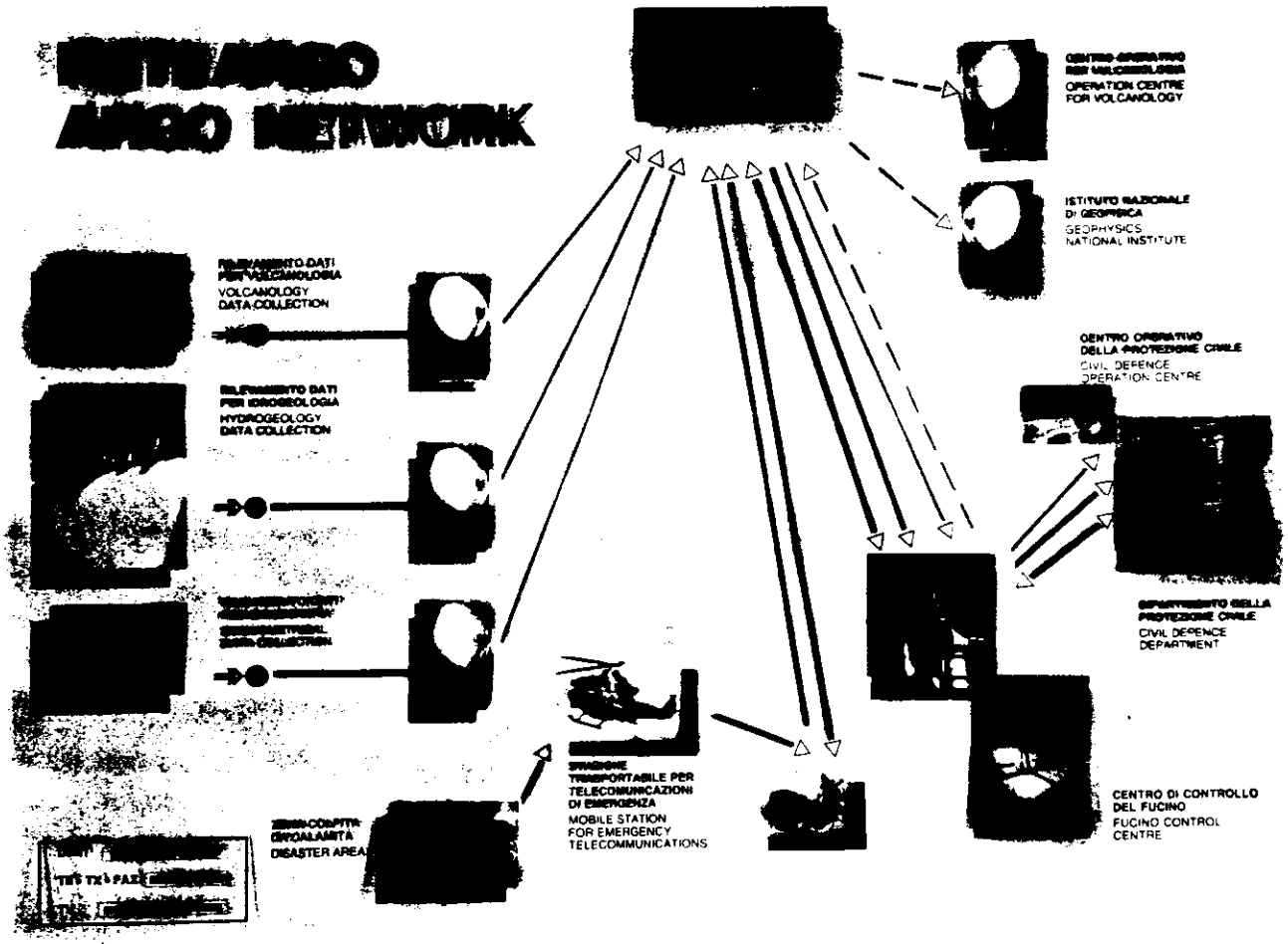
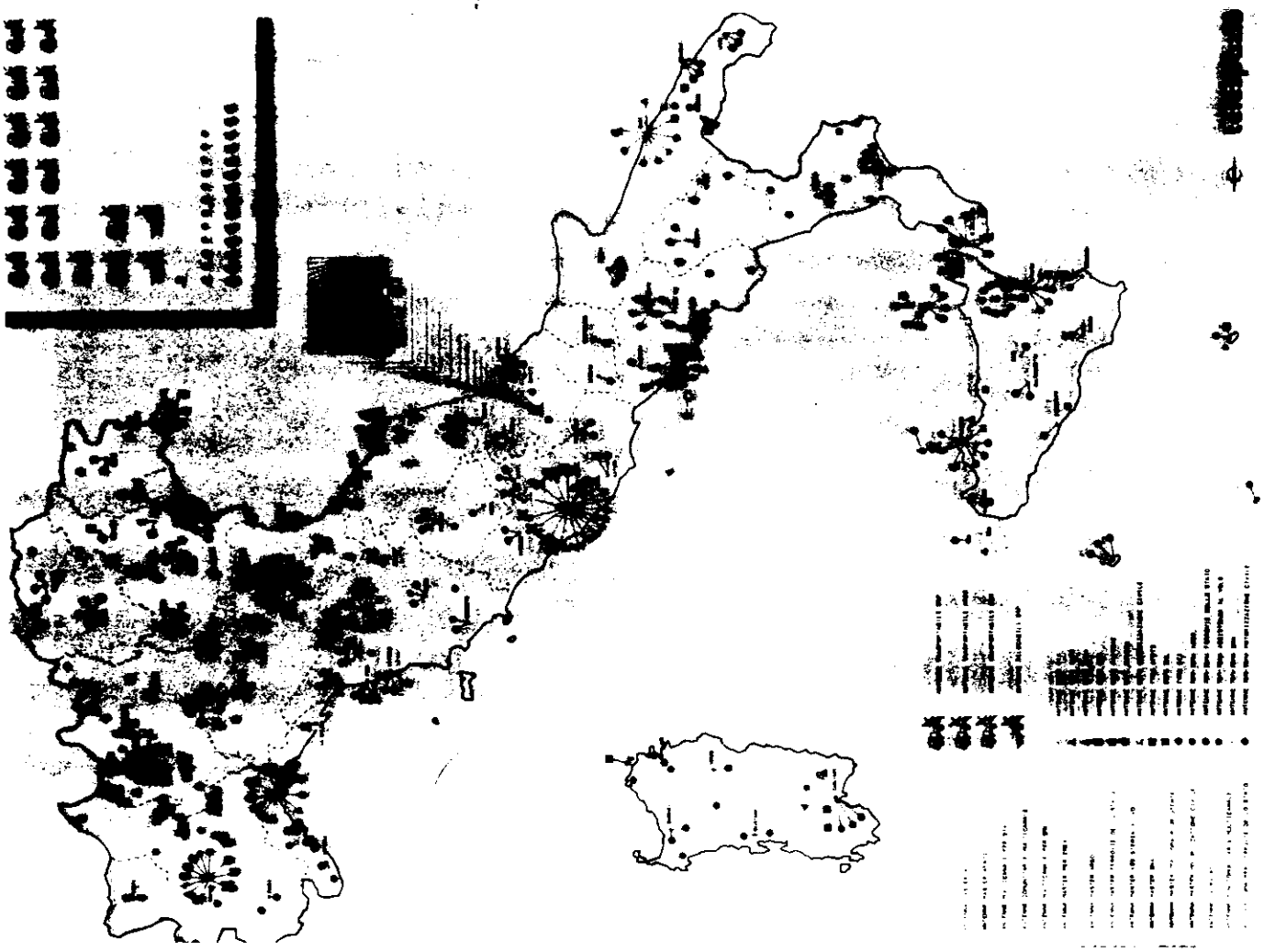


FIGURE 1 : ECS/SMS COVERAGE ZONES


OPERATION CENTRE
FOR VOLCANOLOGY
ISTITUTO NAZIONALE
DI GEOFISICA
GEOPHYSICS
NATIONAL INSTITUTE
VOLCANOLOGY
DATA COLLECTION
HYDROGEOLOGY
DATA COLLECTION
CENTRO OPERATIVO
DELLA PROTEZIONE CIVILE
CIVIL DEFENCE
OPERATION CENTRE
CIVIL DEFENCE
DEPARTMENT
MOBILE STATION
FOR EMERGENCY
TELECOMMUNICATIONS
CENTRO DI CONTROLLO
DEL FUCINO
FUCINO CONTROL
CENTRE
DISASTER AREA



INTERUNIVERSITY SCPC NETWORK

FOR

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

3.7 mt ø dishes antennas

telespazio

OUTLINE OF TELESPAZIO PRODUCTS/SERVICES

- DESIGN, DEVELOPMENT, IMPLEMENTATION AND TESTING OF NEW SPACE SYSTEMS FOR TELECOMMUNICATIONS, EARTH OBSERVATION, EXPERIMENTAL AND SCIENTIFIC MISSIONS.

- DESIGN, DEVELOPMENT, IMPLEMENTATION AND TESTING OF ADVANCED BROADCASTING SYSTEMS

- OPERATIONS CONTROL CENTERS

- EARTH STATION.

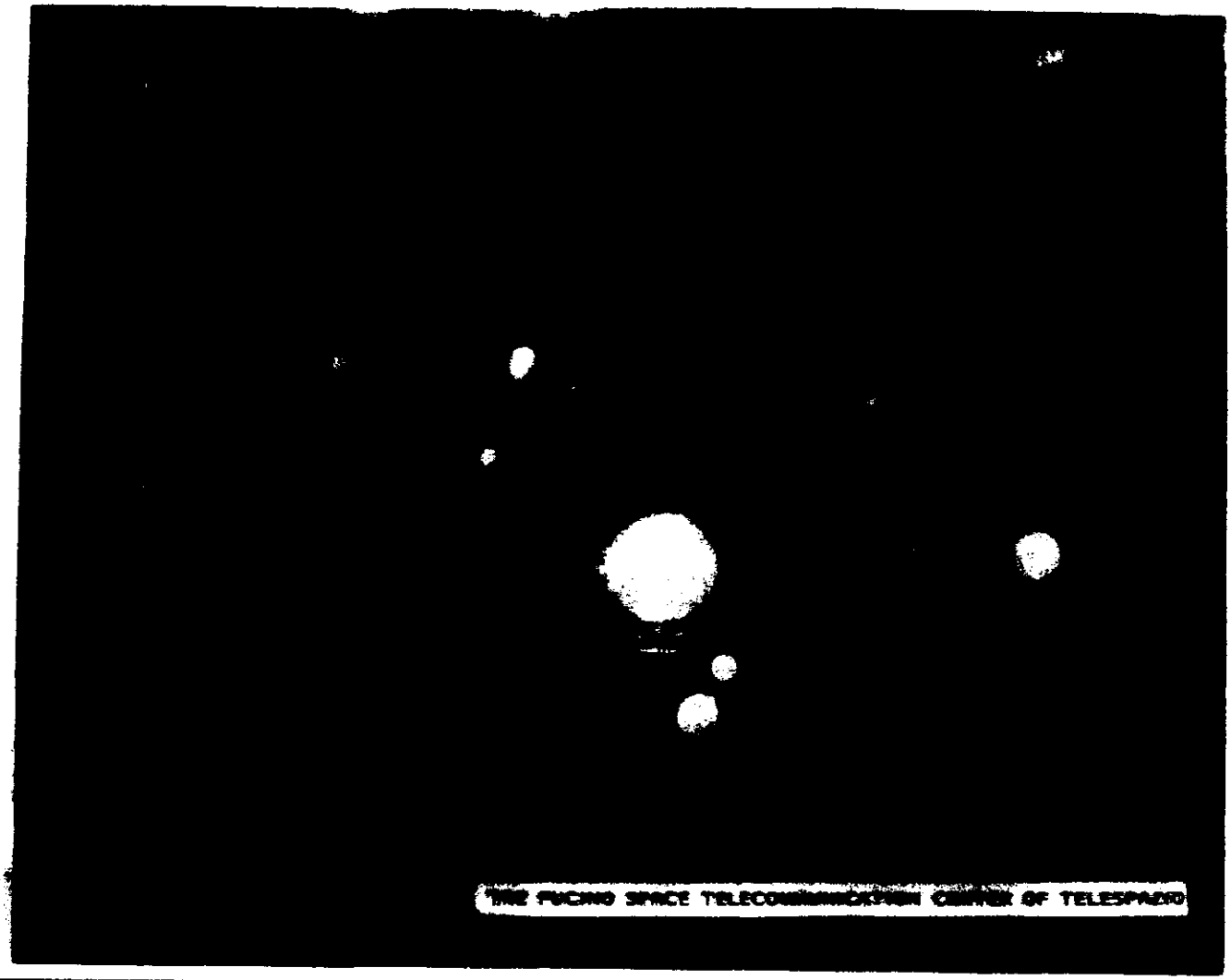
- DOMESTIC SATELLITE SYSTEMS
- NATIONAL TLC NETWORKS

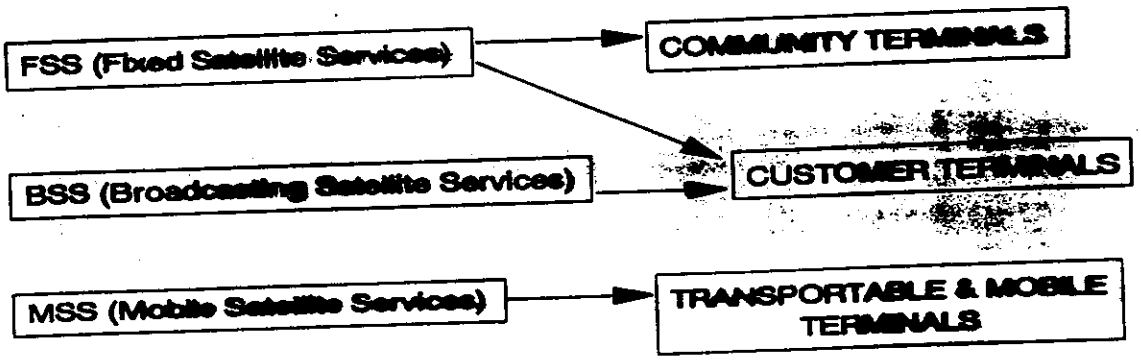
- TLC NETWORKS

- SCIENTIFIC EQUIPMENT FOR LONG RANGE SPACE PROBES FOR ASTRONOMY, ETC.

- TRAINING ACTIVITIES.

DESIGN, DEVELOPMENT, IMPLEMENTATION, TESTING AND OPERATION OF SPACE SYSTEM FOR TELECOMMUNICATION, EARTH OBSERVATION AND SCIENTIFIC MISSIONS.


THE FUCINO SPACE TELECOMMUNICATION CENTER OF TELESPAZIO


FSS (Fixed Satellite Services)
COMMUNITY TERMINALS
BSS (Broadcasting Satellite Services)
CUSTOMER TERMINALS
MSS (Mobile Satellite Services)
TRANSPORTABLE & MOBILE TERMINALS

SERVICE CHARACTERISTICS