The Earth Segment

- Introduction
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- The outdoor unit
- The indoor unit for analog (FM) TV
- Community Antenna TV System

- **Introduction:**

❖The earth segment of a satellite communications system consists of the transmit and receive earth stations.

❖The simplest of these are the home TV receive-only (TVRO) systems, and the most complex are the terminal stations used for international communications networks.

❖Earth stations that are used for logistic support of satellites, such as providing the telemetry, tracking, and command (TT&C) functions, are considered as part of the space segment.

- Receive-Only Home TV Systems:

❖Broadcasting directly to home TV receivers takes place in the Ku (12-GHz) band. This service is known as direct broadcast satellite (DBS) service.

❖Large satellite receiving dishes [ranging in diameter from about 1.83 m (6 ft) to about 3-m (10 ft) in some locations], which may be seen in some "backyards" are used to receive downlink TV signals at C band (4 GHz).

❖Equipment is now marketed for home reception of C-band signals, and some manufacturers provide dual C-band/Ku-band equipment.

❖A single mesh type reflector may be used which focuses the signals into a dual feedhorn, which has two separate outputs, one for the C-band signals and for the Ku-band signals.

❖Master broadcast quality signals are transmitted via satellite in the C band to the network headend stations, where they are retransmitted as compressed digital signals to cable and direct broadcast satellite

- The most widely advertised receiving system for C-band system appears to be 4DTV manufactured by Motorola. This enables reception of:
- 1. Free, analog signals and "wild feeds"
- 2. VideoCipher ll plus subscription services
- 3. Free DigiCipher 2 services
- 4. Subscription DigiCipher 2 services.

- VideoCipher is the brand name for the equipment used to scramble analog TV signals. DigiCipher 2 is the name given to the digital compression standard used in digital transmissions.
- Systems lies in the frequency of operation of the outdoor unit and the fact that satellites intended for DBS have much higher equivalent isotropic radiated power (EIRP).

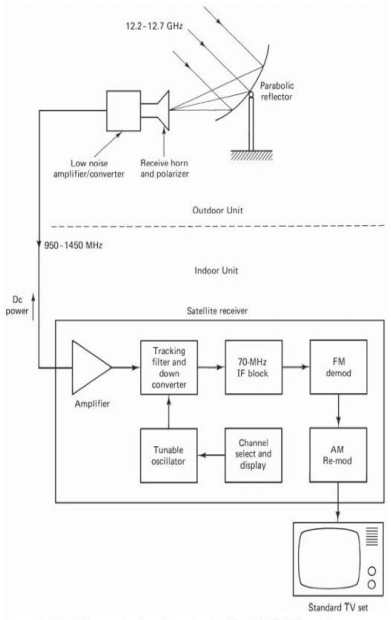

Figure 8.1 Block diagram showing a home terminal for DBS TV/FM reception.

- ❖ Figure shows the main units in a home terminal DBS TV receiving system.
- ❖ <u>The outdoor unit:</u>
- ❖ This consists of a receiving antenna feeding directly into a low-noise amplifier/converter combination.
- ❖ A parabolic reflector is generally used, with the receiving horn mounted at the focus.
- ❖ A common design is to have the focus directly in front of the reflector, but for better interference rejection, an offset feed may be used as shown.
- ❖ The downlink frequency band of 12.2 to 12.7 GHz spans a range of 500 MHz, which accommodates 32 TV/FM channels, each of which is 24-MHz wide.
- ❖ Obviously, some overlap occurs between channels, but these are alternately polarized left-hand circular (LHC) and right-hand circular (RHC) or vertical/horizontal, to reduce interference to acceptable levels.
- ❖ This is referred to as polarization interleaving. A polarizer that may be switched to the desired polarization from the indoor control unit is required at the receiving horn.

- The receiving horn feeds into a low-noise converter (LNC) or possibly a combination unit consisting of a low-noise amplifier (LNA) followed by a converter.
- The combination is referred to as an LNB, for low-noise block.
- The LNB provides gain for the broadband 12-GHz signal and then converts the signal to a lower frequency range so that a low-cost coaxial cable can be used as feeder to the indoor unit.
- The standard frequency range of this down converted signal is 950 to 1450 MHz, as shown in Fig.
- The low-noise amplification must be provided at the cable input in order to maintain a satisfactory signal-to-noise ratio.
- Having to mount the LNB outside means that it must be able to operate over a wide range of climatic conditions.

- The indoor unit for analog (FM) TV:
- The signal fed to the indoor unit is normally a wideband signal covering the range 950 to 1450 MHz. This is amplified and passed to a tracking filter which selects the desired channel.
- As previously mentioned, polarization interleaving is used, and only half the 32 channels will be present at the input of the indoor unit for any one setting of the antenna polarizer.
- The selected channel is again down converted, this time from the 950- to 1450-MHz range to a fixed intermediate frequency, usually 70 MHz although other values in the very high frequency (VHF) range are also used.
- The 70-MHz amplifier amplifies the signal up to the levels required for demodulation. A major difference between DBS TV and conventional TV is that with DBS, frequency modulation is used, whereas with conventional TV, amplitude modulation in the form of vestigial single sideband (VSSB) is used.
- The 70-MHz, FM intermediate frequency (IF) carrier therefore must be demodulated, and the baseband information used to generate a VSSB signal which is fed into one of the VHF/UHF channels of a standard TV set.
- Terminals also may be provided for the insertion of IF filters to reduce interference from terrestrial TV networks, and a descrambler also may be necessary for the reception of some programs.

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- The CATV system employs a single outdoor unit, with separate feeds available for each sense of polarization.
- All channels are made available simultaneously at the indoor receiver.
- Instead of having a separate receiver for each user, all the carriers are demodulated in a common receiver-filter system.
- The channels are then combined into a standard multiplexed signal for transmission over cable to the subscribers.
- In remote areas where a cable distribution system may not be installed, the signal can be rebroadcast from a low-power VHF TV transmitter.
- A remote TV station which employs an 8-m (26.2-ft) antenna for reception of the satellite TV signal in the C band.
- With the CATV system, local programming material also may be distributed to subscribers.

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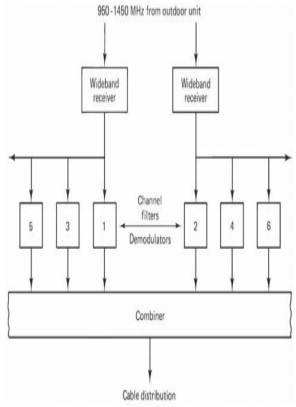

Figure 8.3 One possible arrangement for the indoor unit of a community antenna TV (CATV) system.

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- **The Antenna Subsystem:**
- The antennas carried aboard a satellite provide the dual functions of receiving the uplink and transmitting the downlink signals.
- They range from dipole-type antennas where omnidirectional characteristics are required to the highly directional antennas required for telecommunications purposes and TV relay and broadcast.
- Directional beams are usually produced by means of reflector-type antennas—the paraboloidal reflector being the most common.
- The gain of the paraboloidal reflector, relative to an isotropic radiator, is given by

$$G = \eta_I \left(\frac{\pi D}{\lambda}\right)^2$$

where I is the wavelength of the signal, D is the reflector diameter, and I is the aperture efficiency.

A typical value for I is 0.55. The 3-dB beamwidth is given approximately by

$$\theta_{3\text{dB}} \cong 70\frac{\lambda}{D} \text{ degrees}$$

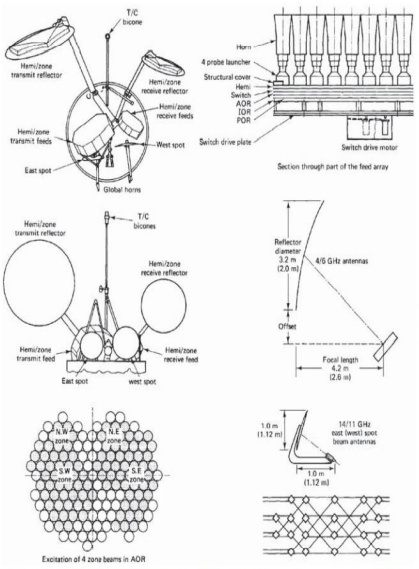

Figure 7.22 The antenna subsystem for the INTELSAT VI satellite. (*Courtesy of Johnston and Thompson, 1982, with permission.*)

- The ratio D/l is seen to be the key factor in these equations, the gain being directly proportional to (D/l) 2 and the beamwidth inversely proportional to D/l.
- Hence the gain can be increased and the beamwidth made narrower by increasing the reflector size or decreasing the wavelength.
- The antenna subsystem of the INTELSAT VI provides a good illustration of the level of complexity which has been reached in large communications satellites.
- These are fed from horn arrays, and various groups of horns can be excited to produce the beam shape required.
- Each array has 146 dual-polarization horns.
- In the 14/11-GHz band, circular reflectors are used to provide spot beams, one for east and one for west.
- These beams are fully steerable. Each spot is fed by a single horn which is used for both transmit and receive.

- The same feed horn may be used to transmit and receive carriers with the same polarization.
- The transmit and receive signals are separated in a device known as a diplexer, and the separation is further aided by means of frequency filtering.
- Polarization discrimination also may be used to separate the transmit and receive signals using the same feed horn.
- For example, the horn may be used to transmit horizontally polarized waves in the downlink frequency band, while simultaneously receiving vertically polarized waves in the uplink frequency.
- The polarization separation takes place in a device known as an orthocoupler, or orthogonal mode transducer (OMT).
- Separate horns also may be used for the transmit and receive functions, with both horns using the same reflector.