Understanding DTH System

Television broadcasting has undergone significant changes during the last two decades. To begin with, TV broadcasting was through terrestrial transmission in the VHF band. Since this is line-of-sight communication, the coverage area is limited and for covering more regions many transmitters are required at different locations.

During the eighties, in India, with the launch of the INSAT satellites, the TV coverage was increased by installing Television Receive Only (TVRO) stations with low power transmitter (LPT) and high power transmitter (HPT). Here the TV programme was transmitted from Delhi through satellite and is received at various locations using antenna and receive electronics. The receive audio and video is retransmitted terrestrially in VHF band so that normal television receivers can receive it. LPT coverage is less as the transmitter power is less while HPT coverage is wider. Television coverage thus increased.

With the advent of satellite TV transmission, cable TV became popular in the nineties. Cable TV operators installed antennas and receivers to receive signals from the satellite. Separate receivers are used to demodulate each TV signal. Each demodulated video and audio signal is modulated onto a separate frequency for transfer to the cable. The channel frequency and modulation plan is such that they can be received by the normal home TV receiver.

The frequencies are in VHF low, VHF high, superband, hyperband and in UHF band. The cables are routed to individual households and fed to the antenna socket of the TV receiver. In the earlier days, analogue transmission was used and only one TV channel was transmitted per transponder of the satellite. But today with digital transmission approximately almost 15 TV channels can be transmitted per transponder. Thus, from a satellite having 24 transponders, the cable operator can extract 360 channels for distribution.

Amplifiers are installed at appropriate distances along the cable route to maintain adequate signal quality. In the case of free-to-air channels, the cable is directly connected to the antenna socket of the TV receiver and in the case of pay channels it is connected through a set-top box. The subscriber will be authorized to receive the pay channel by the cable operator.

Next came Direct-To-Home (DTH) systems designed to transmit TV programmes directly to home receivers. The broadcaster directly connects to the user and the cable operator does not come into the picture.

The three elements in DTH system are the satellites in geostationary orbit used for transmission of signals, the broadcasting centre where the broadcaster (DTH operator) acquires video signals and transmits to the satellite, the users or subscribers who receive the signals directly from the satellite at their homes using a dish antenna and a set-top box.

The satellite is a geostationary communication satellite, having a number of transponders (channels), orbiting at approximately 36000 kilometer above the equator. The satellite receives the signal transmitted by the broadcaster which is in the range of 14000 to 14500 MHz, converts this signal to the frequency range of 10700 to 12750 MHz, amplifies and retransmits towards the earth.

The transmitting power of the satellite will be such that one can use a 60-cm dish antenna on the ground to receive the signals. These frequencies are called Ku-band frequencies, which make high transmitting power from satellite possible. A small dish antenna can be used on the ground. The power from each transponder of the satellite is termed as Effective Isotropically Radiated Power (EIRP). The higher the EIRP, the more powerful is the satellite. Indian satellites like INSAT-4CR and GSAT-10 have approximately 50 dBWatt of EIRP per transponder in Ku-band frequencies.

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DTH operators transmit the video channels to the satellite and also supply the satellite receiver to the users/subscribers. They take the video signals either from other satellites or terrestrially through optical fibre cable. Each video and audio signal is fed to each encoder for digital compression. As the uncompressed video signal occupies more than 200 mega bits per second (MBPS), which requires large bandwidth for transmission, the encoder compresses the video data to about 2 to 5 MBPS using complex algorithms. The compression is achieved by reducing the redundancy in the signal and also by removing those components that will not be noticed by the human visual system.

In the data stream, service information is added which allows the decoder to tune to a particular service and also to provide on-screen menu of programmes called electronic programming guides (EPG). The programme is scrambled and encrypted so that only authorized subscribers can receive the signal. Each set-top box can be addressed by the broadcaster for receiving the desired channels.

Many broadcasters use advanced compression technology called MPEG-4. This cuts the bandwidth of TV signals to almost half of that used by MPEG-2. Thus, twice the number of channels per transponder can be transmitted. Though the compression ratio is more, the picture quality is not affected and remains almost the same.

The third element is the DTH receiver at the subscriber’s premises, that is, in your home. The receiver consists of a parabolic dish antenna of 50 or 60 cm diameter. This dish is mounted on a wall such that it “looks” at the required satellite. There should not be any obstruction like buildings or trees in the path between the antenna and the satellite.

The signal from the satellite is reflected by the parabolic dish towards a point called focus just like a concave mirror focuses the light. At the focus, a feed horn is mounted that collects the focused signal. At the feed horn is mounted an equipment known as low noise block converter (LNBC). This amplifies the receive signal and converts the Ku-band frequency to 950 MHz to 2150 MHz which is called the L-band. The dish antenna and feed horn with LNBC are outdoor units. The output of the LNBC is connected to the set-top box which is mounted inside the house through a cable.

The receiver decodes the encrypted signal. The digital MPEG-2 or MPEG-4 signal is converted to analogue format so that a standard television can recognize it. The video and audio output is connected to the AV input of the TV receiver.

The Ku-band signals used for DTH are affected by rain. The signal is absorbed by rain drops and hence the signal from the satellite is attenuated when it travels through rain. The signal becomes weak and the set-top box will not be able to decode and there will be loss of picture during rains. This is called rain loss or rain fade. The amount of loss of signal depends on the rain rate (mm/hour).

Normally signal margin is built in the system to withstand some rain loss. If the loss is more than the margin, the picture will be lost. Similarly, in the broadcaster’s station if there is rain, signal reaching the satellite will be less due to rain loss and to compensate this, the transmit power will be increased. This is achieved by uplink power control (UPC) system incorporated in the transmit station.

Some satellites have automatic gain control (AGC) system to keep the satellite transmit power constant. With this when there is rain in the transmit station, receive DTH systems will not be affected. Some broadcasters have two transmitting stations at geographically separated locations. Whenever there is heavy rain at one station, the other station will take over and since they are geographically separated, the probability of having rain simultaneously at both locations is very less. This is called space diversity technique.

Video-on-demand service can be provided in DTH system. The customer can select a movie from a large available video database. Individual customers can watch different programmes they wish. Since each set-top box can be addressed, special information as message can be delivered to individual viewers. For example, disaster warning like cyclone warning and heavy rain warning messages can be transmitted to set-top boxes situated in the cyclone/rain prone areas so that people can take precaution.

Though DTH was envisaged to serve in remote areas, it has become popular in city households also. In future DTH will be operating in Ka-band frequencies (17000 MHz to 21200 MHz and 21400 to 22200 MHz). With the saturation of available satellite spectrum in the Ku-band, attention has now turned to the relatively unused Ka-band frequencies. In these frequencies high bandwidth and high power spot beams will be available. Because of high bandwidth availability, it is possible to transmit high definition TV (HDTV). The rain loss will be more compared to Ku-band frequencies. But it is possible to have powerful satellites so that the service availability will be 99.95% in rain climatic zones.

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