

Communication Systems

Satellite Network Fundamentals

People need access to high-speed voice, and video and data applications **wherever** they happen to be. Satellite connectivity has the power to drive communications advances across a broad range of industries and geographies. Whether it's ship-to-shore maritime communications, Internet access for remote, rural classrooms, or vital data and communications for petroleum operations, satellite applications meet a broad range of needs. Every satellite application achieves its effectiveness by building on the strengths of the satellite link. A satellite is capable of performing as a microwave repeater for Earth stations that are located within its coverage area, determined by the altitude of the satellite and the design of its antenna system.

There are three altitude classifications for satellite orbits:

LEO – Low Earth Orbit

LEO satellites orbit from 160-2000km above the earth, take approximately 1.5 hrs for a full orbit and only cover a portion of the earth's surface, therefore requiring a network or constellation of satellites to provide global, continual coverage. Due to the proximity to Earth, LEO satellites have a lower latency (latency is the time between the moment a packet is transmitted and the moment it reaches its destination) and require less amplification for transmission.

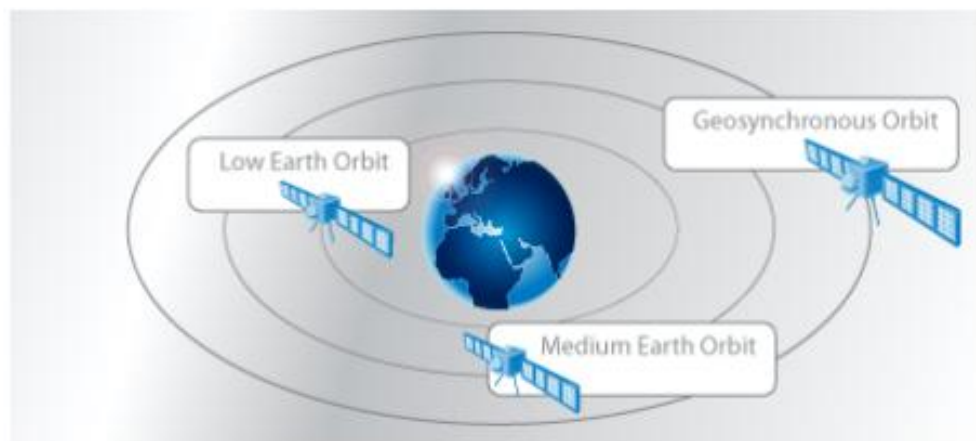
MEO – Medium Earth Orbit

MEO satellites are located above LEO and below GEO satellites and typically travel in an elliptical orbit over the North and South Pole or in an equatorial orbit. These satellites are traditionally used for GPS navigation systems and are sometimes used by satellite operators for voice and data communications. MEO satellites require a constellation of satellites to provide continuous coverage. Tracking antennas are needed to maintain the link as satellites move in and out of the antenna range.

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GEO – Geostationary Orbit

GEO satellites orbit at 35,786 km (22,282 mi) above the equator in the same direction and speed as the earth rotates on its axis. This makes it appear to the earth station as fixed in the sky. The majority of commercial communications satellites operate in this orbit; however, due to the distance from the earth there is a longer latency. A GEO satellite can cover nearly one- third of the Earth's surface, with the exception of the Polar Regions. This includes more than 99% of the world's population and economic activity. The low Earth orbit (LEO) and medium Earth orbit (MEO) approaches require more satellites to achieve this level of coverage. Due to the fact that non-GEO satellites move in relation to the surface of the Earth, a full complement of satellites (called a constellation) must be operating to provide continuous, unbroken service. The trade-off here is that the GEO satellites, being more distant, incur a longer path length to Earth stations, while the LEO systems promise short paths not unlike those of terrestrial systems. The arrangement of three basic orbit configurations is shown in Figure below.



Frequency Bands

There are four radio frequency bands that communication and military satellites operate within:

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C band – uplink 5.925-6.425 GHz; downlink 3.7-4.2 GHz

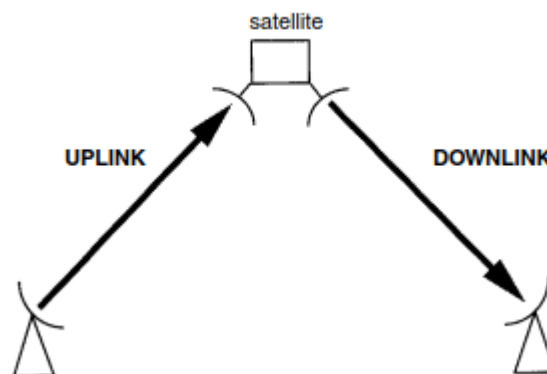
The C band is primarily used for voice and data communications as well as backhauling. Because of its weaker power it requires a larger antenna, usually above 1.8m (6ft). However, due to the lower frequency range, it performs better under adverse weather conditions on the ground.

Ku band– uplink 14 GHz; downlink 10.9-12.75 GHz

Ku band is used typically for consumer direct-to-home access, distance learning applications, retail and enterprise connectivity. The antenna sizes, ranging from 0.9m -1.2m (~3ft), are much smaller than C band because the higher frequency means that higher gain can be achieved with small antenna sizes than C-band. Networks in this band are more susceptible to rain fade, especially in tropical areas.

Ka band – uplink 26.5-40GHz; downlink 18-20 GHz

The Ka band is primarily used for two-way consumer broadband and military networks. Ka band dishes can be much smaller and typically range from 60cm-1.2m (2' to 4') in diameter. Transmission power is much greater compared to the C, or Ku band beams. Due to the higher frequencies of this band, it can be more vulnerable to signal quality problems caused by rain fade.



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Satellite Application

Satellite can provide the right solution for a number of applications, whether extending the edge of the terrestrial networks to remote places or as a stand-alone solution, such as:

- Enterprise Connectivity
- Retail Transactions
- Internet Connections (ISPs)
- Video/TV Direct to Home
- Maritime
- Cellular Backhaul
- Military Defense
- Energy & Utilities
- Oil & Gas
- Business Continuity
- Disaster Recovery/Emergency Relief
- Education & Training
- Aeronautical Connectivity

VSAT Network

Small stations, with antennas in the order of 1.2 – 1.8 m, have become very popular under the acronym VSAT, which stands for 'Very Small Aperture Terminals'. Such stations can easily be installed at the customer's premises and, considering the inherent capability of a satellite to collect and broadcast signals over large areas, are being widely used to support a large range of services.

Network Equipment

A network typically consists of a larger earth station, commonly referred to as a teleport, with hub equipment at one end and a Very Small Aperture Terminal (VSAT) antenna with remote equipment at the other end. The network equipment can be divided into two sets of equipment connected by a pair of cables: the Outdoor Unit (ODU) and the Indoor Unit (IDU).

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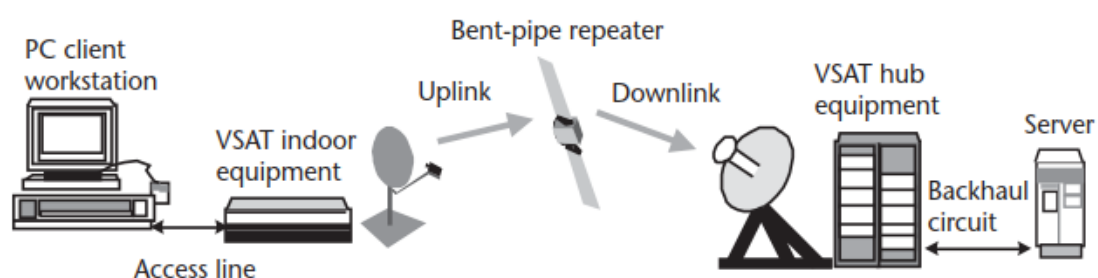
ODU

An ODU is the equipment located outside of a building and includes the satellite antenna or dish, a low noise block converter (LNB), and a block-up-converter (BUC). The LNB converter amplifies the received signal and down converts the satellite signal to the L band (950 MHz to 1550 MHz), while the BUC amplifies the uplink transmission when the antenna is transmitting.

IDU

The IDU equipment at the teleport usually consists of a rack-mounted hub system and networking equipment connected to terrestrial networks, like the Public Switched Telephone Network (PSTN) or Internet backbone. There is also a device that converts between satellite and IP protocols for local LAN applications such as PCs, voice calls and video conferencing.

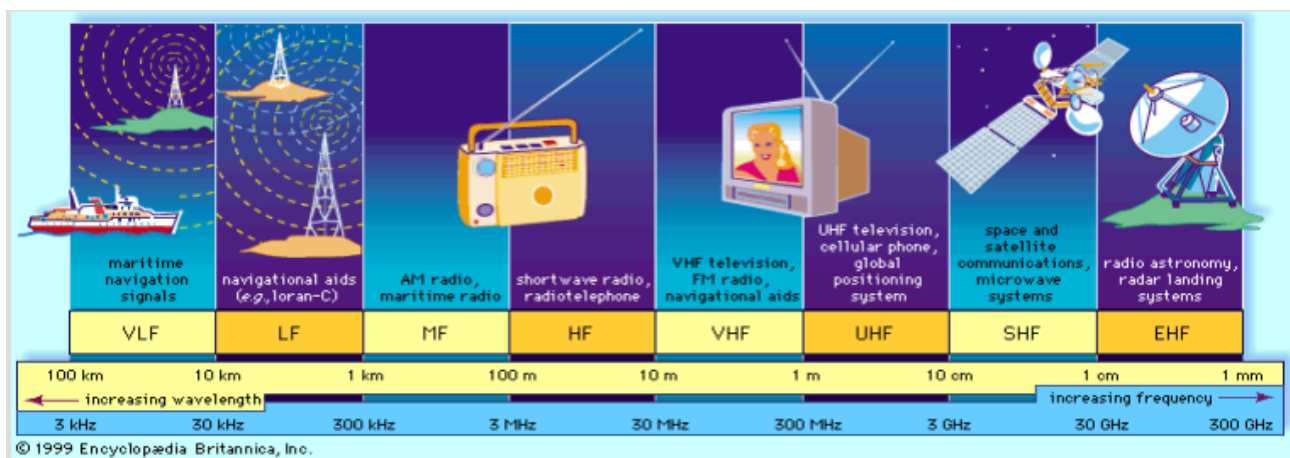
At the remote location, a router connects to a small VSAT antenna receiving the IP transmission from the hub over the satellite and converts it into real applications like Internet, VoIP and data.



Communication Systems

Wireless communication systems:

Wireless is a term used to describe telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or all of the communication path. Communication is one of the integral parts of science that has always been a focus point for exchanging information among parties at locations physically apart. After its discovery, telephones have replaced the telegrams and letters. Similarly, the term 'mobile' has completely revolutionized the communication by opening up innovative applications that are limited to one's imagination. Today, mobile communication has become the backbone of the society. All the mobile system technologies have improved the way of living. The number of cellular telephone users grew from 25000 in 1984 to around 3 billion in the year 2007 and the demand rate is increasing day by day.



Common examples of wireless equipment in use today

1. **Cellular phones:** provide connectivity for portable and mobile applications, both personal and business.
2. **Global Positioning System (GPS):** allows drivers of cars and trucks, captains of boats and ships, and pilots of aircraft to ascertain their location anywhere on earth.

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3. **Cordless computer peripherals:** the cordless mouse is a common example; keyboards and printers can also be linked to a computer via wireless.
4. **Cordless telephone sets:** these are limited-range devices, not to be confused with cell phones.
5. **Home-entertainment-system control boxes:** The TV channel control are the most common examples; some hi-fi sound systems and FM broadcast receivers also use this technology.
6. **Remote garage-door openers:** one of the oldest wireless devices in common use by consumers; usually operates at radio frequencies.
7. **Two-way radios:** this includes Amateur and Citizens Radio Service, as well as business, marine, and military communications.
8. **Baby monitors:** these devices are simplified radio transmitter/receiver units with limited range.
9. **Satellite television:** allows viewers in almost any location to select from hundreds of channels.
10. **Wireless LANs or local area networks:** provide flexibility and reliability for business computer users.
11. **Global System for Mobile Communication (GSM):** a digital mobile telephone system used in Europe and other parts of the world; the de facto wireless telephone standard in Europe.