Geo-stationary Satellite

By

Dr.Vinod Kumar Singh

Associate Professor Physics K .S. Saket P G College Ayodhya

Email: vks423272@gmail.com

A geostationary satellite is an earth-orbiting satellite, placed at an altitude of approximately 35,800 kilometers (22,300 miles) directly over the equator, that revolves in the same direction the earth rotates (west to east). At this altitude, one orbit takes 24 hours, the same length of time as the earth requires to rotate once on its axis. The term geostationary comes from the fact that such a satellite appears nearly stationary in the sky as seen by a ground-based observer. BGAN, the new global mobile communications network, uses geostationary satellites.

A single geostationary satellite is on a line of sight with about 40 percent of the earth's surface. Three such satellites, each separated by 120 degrees of longitude, can provide coverage of the entire planet, with the exception of small circular regions centered at the north and south geographic poles. A geostationary satellite can be accessed using a directional antenna, usually a small dish, aimed at the spot in the sky where the satellite appears to hover. The principal advantage of this type of satellite is the fact that an earthbound directional antenna can be aimed and then left in position without further adjustment. Another advantage is the fact that because highly directional antennas can be used, interference from surface-based sources, and from other satellites, is minimized.

Geostationary satellites have two major limitations. First, because the orbital zone is an extremely narrow ring in the plane of the equator, the number of satellites that can be maintained in geostationary orbits without mutual conflict (or even collision) is limited.

Second, the distance that an electromagnetic (EM) signal must travel to and from a geostationary satellite is a minimum of 71,600 kilometers or 44,600 miles. Thus, a latency of at least 240 milliseconds is introduced when an EM signal, traveling at 300,000 kilometers per second (186,000 miles per second), makes a round trip from the surface to the satellite and back.

There are two other, less serious, problems with geostationary satellites. First, the exact position of a geostationary satellite, relative to the surface, varies slightly over the course of each 24-hour period because of gravitational interaction among the satellite, the earth, the sun, the moon, and the non-terrestrial planets. As observed from the surface, the satellite wanders within a rectangular region in the sky called the box. The box is small, but it limits the sharpness of the directional pattern, and therefore the power gain, that earth-based antennas can be designed to have. Second, there is a dramatic increase in background EM noise when the satellite comes near the sun as observed from a receiving station on the surface, because the sun is a powerful source of EM energy. This effect, known as solar fade, is a problem only within a few days of the equinoxes in late March and late September. Even then, episodes last for only a few minutes and take place only once a day.

In recent years, low earth orbit (LEO) satellite systems have become popular. This type of system employs a fleet or swarm of satellites, each in a polar orbit at an altitude of a few hundred kilometers. Each revolution takes between 90 minutes and a few hours. Over the course of a day, such a satellite comes within range of every point on the earth's surface for a certain period of time. The satellites in a LEO swarm are strategically spaced so that, from any point on the surface, at least one satellite is always on a line of sight. The satellites thus act as moving repeaters in a global cellular network. A LEO satellite system allows the use of simple, non-directional antennas, offers reduced latency, and does not suffer from solar fade. These facts are touted as advantages of LEO systems over geostationary satellites.

A geostationary satellite is in an orbit that can only be achieved at an altitude very close to 35,786 km (22,236 miles) and which keeps the satellite fixed over one longitude at the equator. The satellite appears motionless at a fixed position in the sky to ground observers. There are several hundred communication satellites and several meteorological satellites in such an orbit. A few typical meteorological satellites in the geostationary orbit relative to the polar-orbiting satellites.

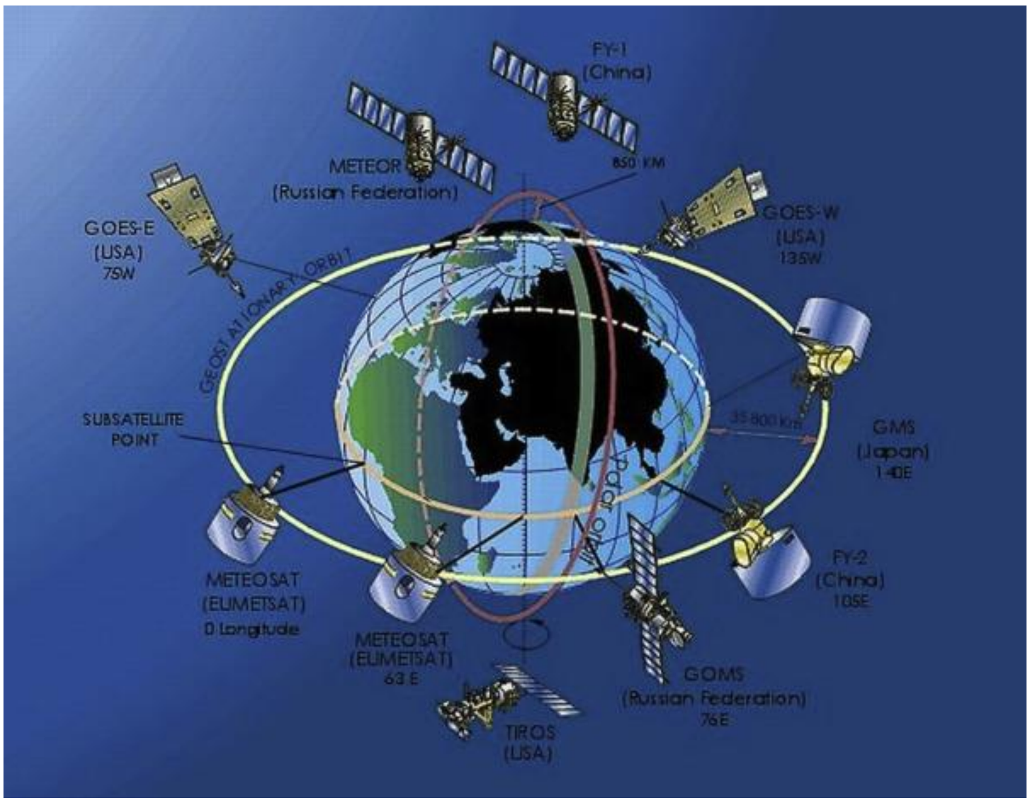

Figure :Illustration of the distribution of a few common geostationary satellites compared to the polar-orbiting satellites.

US operational weather satellites include the Geostationary Operational Environmental Satellite (GOES) used for short-range warning and "now-casting" primarily to support the National Weather Service requirements. The procurement, design, and manufacturing of GOES are overseen by the National Aeronautics and Space Administration (NASA), while all operations of the satellites once in orbit are effected by the National Oceanic and Atmospheric Administration (NOAA). Before being launched, GOES satellites are designated by letters (-A, -B, -C). Once a GOES satellite is launched successfully, it is redesignated with a number (−1, −2, −3). Normally two GOES satellites are operational. Information on the GOES series is shown in Table 1.1. The third generation of GOES, the new GOES-R satellite series program, consisting of four satellites (from GOES-16), represents a significant improvement in spatial, temporal, and spectral observations over the capabilities of the previously operational GOES series. For example, the Advanced Baseline Imager (ABI) is the primary instrument on the GOES-R Series for imaging Earth's weather, oceans, and environment. The ABI provides three times more spectral information, four times the spatial resolution, and more than five times faster temporal coverage than the previous system.

Table : Information on GOES satellite series.

Satellites	Launch day	Status
1	October 16, 1975	Decommissioned
2	June 16, 1977	Decommissioned
3	June 16, 1978	Decommissioned
4	September 9, 1978	Decommissioned

Satellites	Launch day	Status
5	May 22, 1981	Deactivated on July 18, 1990
6	April 28, 1983	Decommissioned
G	May 3, 1986	Failed to orbit
7	February 26, 1987	Used as a communications satellite; decommissioned 2012
8	April 13, 1994	Decommissioned 2004
9	May 23, 1995	Decommissioned 2007
10	April 25, 1997	Decommissioned 2009
11	May 3, 2000	Decommissioned 2011
12	July 23, 2001	Decommissioned 2013
13	May 24, 2006	On-orbit storage

Satellites	Launch day	Status
14	June 27, 2009	On-orbit spare
15	March 4, 2010	Operational West backup
16 (GOES-R)	November 19, 2016	Currently operating as GOES East
17 (GOES-S)	March 1, 2017	Currently operating as GOES West
GOES-T	Planned to launch in 2020	
GOES-U	Planned to launch in 2024	

European operational missions are currently operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). EUMETSAT's geostationary satellite programs include the Meteosat First Generation system (up to Meteosat-7) from 1977 to 2017, four Meteosat Second Generation (MSG) satellites (MSG-1,2,3,4 or Meteosat-8,9,10,11) from 2004 to 2025, and six Meteosat Third Generation (MTG) satellites from 2021 to 39. The MSG satellites carry an impressive pair of instruments: the Spinning Enhanced Visible and Infrared Imager (SEVIRI), which has the capacity to observe the Earth in 12 spectral channels and provide image data every half hour, and the Geostationary Earth Radiation Budget (GERB) instrument supporting climate studies.

The Japanese Geostationary Meteorological Satellite (GMS) series had five satellites from 1977. The Multifunctional Transport Satellites (MTSAT) are the successors to the GMS 1–5 satellite series. The MTSAT-2 from 2010 was also known as Himawari-7. Himawari-8 was operational from July 2015, and Himawari-9 started backup operation on March 2017. Both satellites are located in orbit at around 140.7 degrees east and will observe the East Asia and Western Pacific regions for a period of 15 years. The Advanced Himawari Imager (AHI), similar to ABI, has six channel multispectral bands in the visible to near-infrared spectrum with 500m spatial resolution and provides full disk observations every 10 min and images of Japan every 2.5 min.

China has launched eight of the first-generation geostationary satellites named Fengyun (FY-2) from FY-2A to FY-2H since 1997. The second generation of geostationary meteorological satellites FY-4 was launched in December 2016, and multiple FY-4 satellites have been planned to provide service through 2037 when a successor program will be inaugurated. The Advanced Geosynchronous Radiation Imager (AGRI) aboard FY-4 is the corresponding version of ABI in the GOES-R series. It has 14 spectral bands, delivering full disk images every 15 min at a significantly improved resolution of 0.5–4 km.