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Special Report:

GEO Satellite Markets and Functions

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United States Department of Transportation •Federal Aviation Administration
Associate Administrator for Commercial Space Transportation
800 Independence Ave. SW Room 331
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GEO Satellite Markets and Functions

The information revolution has transformed telecommunication markets. The explosive demand for global communication has spawned accelerating technical innovation and fierce competition for telecommunication revenues. Deregulation of telecommunications in the U.S. and in other countries combined with advances in technology have contributed to enhancements in computer capability and affordability, an explosion in use of the Internet, and the wide availability and use of mobile phones, facsimile machines, smart pagers, and other electronic communication tools.

Satellites in geosynchronous orbit (GEO) are a vital link in the world's telecommunication infrastructure. This Special Report summarizes the functions of satellites in geosynchronous orbit and describes the current satellite population in terms of the markets it serves.

Table 1. GEO Satellite Services, Markets, and Functions

GEO Satellite Communication Services	Markets
Telephone	International Relay
	Intra-national Relay
	Mobile Telephone Services
Television	Broadcast and Cable Relay
	Direct-to-Home Television Services
	Direct Radio Services
Data Communications	Personal/Mobile, VSAT, Broadband Data Communications Services
GEO Satellite Government-Dedicated Functions	
Military Intelligence	
Military Communications	
Civil Meteorological	
Civil Technology Research	
Civil Scientific	

GEO Satellite Functions

Geosynchronous orbit (GEO) is the orbit at 22,282 miles above the Earth in which a satellite completes its orbit in 24 hours -- the period of the Earth's rotation. Geosynchronous orbit is advantageous for communication services because satellites in GEO can always "see" their ground stations and just three satellites can provide coverage of most of the globe. More than 500 GEO satellites have been launched since the first geosynchronous satellite launch of Syncom 1 in 1963.

GEO satellites provide several different kinds of telephone, television, radio, and data communication services. They are also used by governments for military, weather, and science applications. GEO satellite functions are listed in Table 1.

Telephone Services

GEO satellites relay telephone signals via the terrestrial telephone network and also provide phone-to-satellite mobile telephone services.

- International and Intra-national Telephone Relay. GEO satellites relay telephone calls across oceans or large land masses that lack terrestrial telephone line infrastructure. Today, most satellite relay of international telephone calls is provided by the international organization, Intelsat. Additional intra-national telephone relay is provided by satellites owned by countries such as Indonesia and China, which have widely dispersed populations.

- Mobile Telephone Services. GEO satellites also provide some mobile telephone services. The vast majority of mobile telephones today use ground-based cellular networks, but satellites provide telephone services to ships at sea through the international organization, Inmarsat. There is also a limited market today for satellite mobile telephone services to augment cellular services. There are many planned and proposed systems to provide satellite mobile telephone services in the future, using satellites in both GEO and low Earth orbit (LEO).

Television and Radio

There are three television transmission media: broadcast, cable, and direct-to-home. The services provided using these media compete and overlap. Broadcast and cable entities produce their own programming. Broadcast and cable channels are typically transmitted via the same satellites and the signals transmitted via satellite are very similar. Some cable signals are also re-packaged and re-transmitted by direct-to-home (primarily by direct broadcast satellite) TV providers. GEO satellites also currently relay a number of radio channels.

- Broadcast and Cable Television Relay. GEO satellites relay broadcast and cable TV signals to ground stations that then transmit them to customers. Broadcast TV typically involves microwave transmissions to rooftop antennas. Cable TV services use coaxial cables attached directly to homes. Broadcast and cable channels are typically transmitted via the same satellites; the signals are very similar.

- Direct-to-Home Television. Many broadcast and cable channels can also be received directly by outdoor satellite dishes attached to the home. Generally, standard broadcast and cable signals were never intended for direct reception at the home. However, this approach to television distribution became popular in geographic regions where reception of normal broadcast signals was difficult. Today, some cable programming is also received, repackaged, and retransmitted digitally to homes using direct broadcast satellites (DBS), also in GEO. DBS is provided by dedicated or near-dedicated satellites.

- Direct Radio. A related category of service is radio. GEO satellites currently relay a very small number of some audio signals, much as they relay television signals. In the future, GEO satellites will provide mobile audio services broadcast directly from a dedicated satellite to the end-user via handsets or automobile tuners.

Data Communications

Satellite data communications is a diversified market that serves many users. Many service areas fall under the category of data communications, including broad categories of computer networking, video, facsimile, paging, and voice communications. These services do not require a dedicated satellite and can be delivered from the satellite to one point or multiple points. Data delivery can be fixed or mobile. The users for the various types of data communication services are primarily business but also include personal and educational users.

Civil Government Applications

Three general civil mission areas take advantage of GEO: meteorology, technology research, and communications.

- Meteorology. GEO provides a near ideal platform for long-duration Earth observations, but the relatively large distance to GEO limits the resolution of imaging data. Most civil meteorological programs (e.g., US, China, Russia) use a combination of GEO and polar-orbiting LEO systems to provide complete coverage of developing weather systems.

- Technology Research. Civil and military space authorities have a long history of sponsoring research dedicated to developing and advancing communications satellite technology. Most US communication satellite technology research was terminated in the 1970s (NASA's Advanced Communications Technology Satellite, launched in 1993 to study multiple antenna beam communications and satellite-switched operations in the Ka-band is an exception). Japan, France, and the European Space Agency continue to sponsor the development of systems to study advanced communication technologies. New entrants to the space field also use experimental communication satellites to establish the basic infrastructure for a space industry.

- Communications. Many governments are substantial consumers of communications

services. As the market value of GEO communications satellites was established during the 1970s and 1980s, most civil authorities transferred control of their GEO communications programs to governmental and quasi-governmental post, telegraph and telephone (PTT) organizations. These organizations provided services to the remainder of the government, as well as to meet non-governmental requirements. In some instances, these PTTs are virtually indistinguishable from government organizations. In other cases, they possess many of the characteristics of private commercial concerns. However, in almost all cases, the use of PTT assets in GEO are subject to at least some sort of commercial market. As a result, for the purpose of this study, PTTs are incorporated into all analyses of the commercial communications marketplace.

Geosynchronous orbit is of limited value for other kinds of civil space activities. For example, no current or planned space science missions (e.g., in the disciplines of astrophysics, space physics, and planetary science) require the use of GEO. Similarly, human space activity to date has been confined to LEO and trans-Lunar and Lunar orbits.

Military Government Applications

There are two primary uses of GEO for defense/military purposes: communications and intelligence gathering.

- Military Communications. Military organizations frequently use the unique characteristics of GEO to facilitate strategic and tactical communications. (These systems generally employ military-reserved frequencies and are not considered in this forecast to be part of the larger category of commercial and quasi-commercial communications.) The US, Russia, NATO, the United Kingdom, Saudi Arabia, Italy, and the People's Republic of China have all deployed, or are considering deploying, GEO assets for military communications.
- Intelligence. Both the US and Russia use GEO satellites to provide early warning of missile launches. Use of GEO allows these satellites to "stare" at the Earth for extended periods, providing constant monitoring of launches and other major thermal events (e.g., above-ground nuclear explosions). Similarly, GEO assets are used to gather intelligence on radio and radar transmissions from areas of military activity. Information about electronic intelligence satellites (ELINTS) is particularly closely held, and the details available in open sources are sketchy at best.

Ownership and Operation

This analysis has yielded an estimate of 238 currently active operational GEO satellites. It is important to remember that in estimating the number of GEO satellites, the population changes frequently. There are two or three launches of GEO satellites each month and inactive GEO satellites may sometimes be sold and reactivated. (For the purpose of this report, the cut-off for listing satellites as current (or operational) was December 31, 1995. Since that time, several GEO systems have been launched.)[1]

Of the 238 operational GEO satellites, 168 are communications satellites and 70 are military or civil/non-communications satellites. A listing by ownership shows that 68 of the communications satellites are also owned by government organizations. Many communications satellite systems are administered on a partial to full for-profit basis by governmental and quasi-governmental PTT organizations. Similarly, international non-profit consortia (e.g., Intelsat, Inmarsat) compete in the growing commercial marketplace for satellite communications capabilities.

GEO assets used to conduct strictly civil missions – meteorology or government-sponsored communications technology research – are categorized as "civil" in Figure 1 below and as "government/non-communications" in Figure 2.

[1] Currently, these systems include: PanAmSat (PAS) 3R (1/12), Measat 1 (1/12), Koreasat 2 (1/14), Gorizont 31 (1/25), Palapa C1 (2/1), N-Star B (2/5), and Intelsat 707 (3/14).

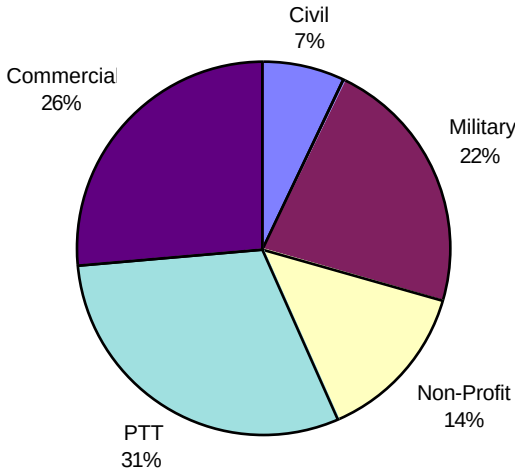

Figure 1. Operational GEO Satellites by Sponsor

The functions performed by these satellites were determined based on a compilation of many sources of information about current transponder use.[2] This information was then analyzed to determine typical use patterns (in terms of television, telephone, and data communications and backup transponders) for five classes of on-orbit satellites. Transponder-by-transponder data were very good for television uses but sketchier for telephone and data communication. Percentage values for each service were determined based on this analysis. These percentage values were modified somewhat for television and data communication to reflect additional information generated through analyses of market trends and industry revenues.

The capability of the currently active, on-orbit communications and government-owned satellites identified in this analysis is used for about 23% telephone, 35% television, 5% data communications, 29% government non-communications functions, and about 8% unused capacity (which can represent both backup capability and unleased transponders that are "on the market"). These percentages are based on capability normalized to 36-MHz transponder equivalents.

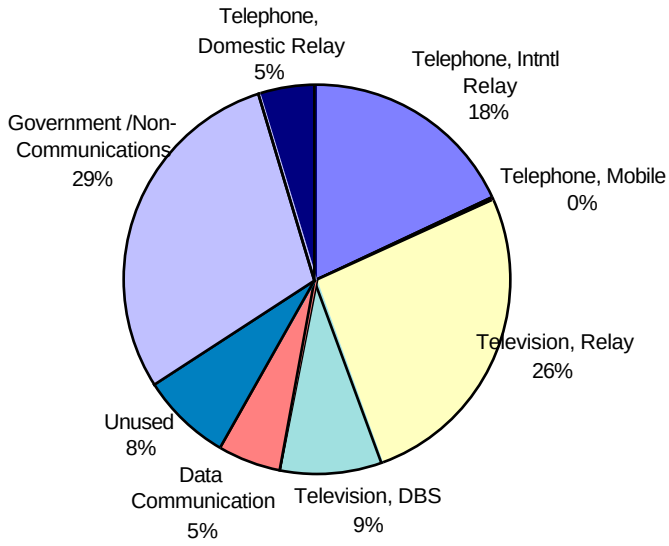

Figure 2. Current Satellite Functions (Percentage of On-Orbit Capability, 1996)

The current active GEO satellite population was estimated by comparing and integrating data from a range of sources. The FAA Office of Commercial Space Transportation's STAR database was used as the basis for accounting for operational GEO systems. Information on operational satellites was supplemented by data from open sources, particularly the International Satellite Directory (Design Publishers, 1996 Edition), Jane's Space Directory (11th Edition, 1995-1996) and The World Satellite Directory (Phillips Business Publishing, Inc., 1995).

The analysis presented in this Special Report was conducted by Futron Corporation.

[2] A transponder is the active telecommunications component of a satellite that is responsible for converting the signal from its up-link frequency to its corresponding down-link frequency and then amplifying the signal for retransmission. The usual bandwidth capacity of a transponder is in the 36-54 MHz range but can be as wide as 500 MHz.