

SATELLITE COMMUNICATIONS

QUICK REFERENCE GUIDE FOR BUSINESS AVIATION PROFESSIONALS

Version 1.0

This quick reference guide is intended to introduce pertinent concepts relating to satellite communication for business aviation professionals. This guide is not intended to replace any of the aircraft manuals but rather provide an aviation manager with the necessary knowledge to understand how the satellite communication systems work in most business aircraft. A qualified aviation maintenance technician should always be consulted when making an operational decision regarding these systems.

Satellites

A satellite is an object that orbits a planet or star. The moon is a natural satellite to the earth. Most man-made satellites are used for communication such as TV, phones, and internet data.

A satellite's orbit is balanced by its speed versus the pull of the earth's gravity.

Satellite Constellations

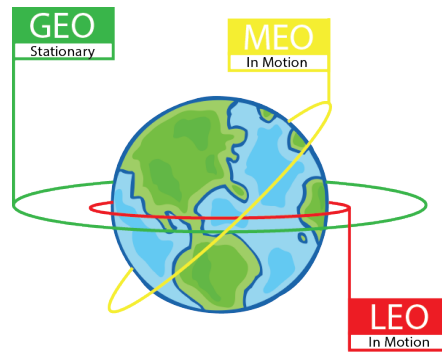
A collection of satellites working together by communicating with one another and with ground stations.

Types of Orbits

Low Earth Orbit: the satellite travels between 160 km - 1,000 km above the earth's surface. This orbit pattern will require more satellites to fully cover the earth. Examples of Low Earth Orbiting satellites are the Iridium Constellation & Starlink.

Medium Earth Orbit: the satellite orbits between between 1,000 km - 20,000 km above the earth. This orbit pattern is mostly used for navigation satellites like GPS.

Geostationary Orbit: the satellite orbits approximately 35,786 km above the earth's surface. Satellites in this orbit pattern are positioned along the equator at an elevation and speed that keeps the satellite at a constant position with respect to the earth's surface. These satellites are always at the same location in the sky when viewed from the earth. Examples of satellites that use this orbit pattern are satellite TV and Inmarsat.

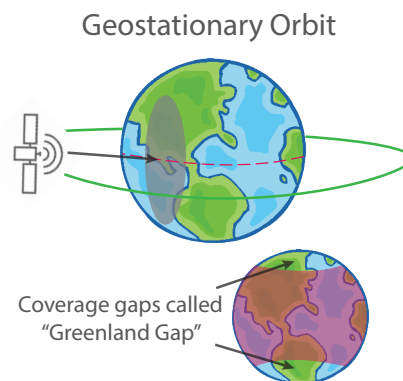


Low Earth Orbit (Iridium, StarLink)

This system requires more satellites to provide global coverage due to the low altitude which prevents covering larger areas of the earth.

Medium Earth Orbit (GPS)

This system provides a larger footprint coverage area due to the higher altitude of satellites. The Global Positioning Systems (GPS) constellation used for navigation use this orbit pattern.



Geostationary Orbit (SatTV, Inmarsat, Viasat, Intelesat)

In this system, the satellite stays at the same point over the equator. Most geostationary systems use multiple satellites as a constellation in order to provide the greatest single satellite coverage.

Satellite Frequency Bands

Understanding what frequency a satellite uses helps to understand the types of services they will provide.

Common Frequency Bands

L, S, C: this frequency band is considered "low" frequency. These frequencies have lower bandwidth and are capable of carrying less information than high frequency bands. These lower frequency bands are used for safety & services (voice and cockpit datalink services) types of communication and are considered very reliable for transmitting data with minimal signal loss or rain fade due to atmospheric conditions.

Ku, Ka: this larger bandwidth capability allows much greater data transfer at higher speeds than the low frequency bands. This band is used for TV broadcasting services and high speed, satellite-based internet data service. This band is highly susceptible to rain fade and therefore cannot be used for safety & services.



NOTE: when installing a cabin WiFi network in the aircraft, industry standard practice is to keep the antenna away from galley microwaves as they use similar frequencies and can interfere with each other.

Understanding Speed

In reference to satellite communication, speed is how fast data moves between satellites and a receiver.

Broadband: the size of the conduit (pipe) that the data travels through

Bit: the smallest unit of data.

Byte: 8 bits of data

1,000 Bytes: Kilobyte (Kbps)

1,000 Kilobytes: Megabit (Mbps)

1,000,000 Kilobits: Gigabit (Gbps)

Latency: the time required to send and receive internet data between the satellite and receiver.

Speed Comparisons

Dial-up - up to 56 Kbps

DSL - 768 Kbps - 6 Mbps

Cable Modem - 1 Mbps - 1 Gbps

Internet Speed Recommendations

The following are minimum speed recommendations for seamless use of each type of service. These minimum internet speeds are for each device.

Email: 1Mbps

Web Browsing: 3-5 Mbps

Social Media: 10 Mbps

Video Conferencing: 10-20 Mbps

HD Video Streaming: 10-20 Mbps

4K Video Streaming: 35 Mbps

Passenger Best Practices

In order to save data costs and improve speed, the following steps will reduce unnecessary data usage on aircraft WiFi systems:

- Turn off cloud services.
- Turn off background App refresh on Apple Devices.
- Disable OS updates.
- Disable Anti-virus updates.

Common Satellite Services

Iridium: a low earth orbit communication system that uses many satellites for complete global coverage. Several spare satellites are in orbit with several more on the ground that can be launched in order to minimize a disruption in service. Newer versions of the satellites are being launched called Iridium Next which will continue to provide safety & services but will also provide higher speed data than previous generations. This new constellation uses "L" band for safety & services and "Ka" band for inter-satellite communication.

Inmarsat: a geostationary orbit communication system that uses a variety of different satellites to provide a variety of services. Older satellites (referred to as I-3 and I-4) provide communication services, while the latest constellation uses new satellites (I-5) which continues to provide safety & service but also provides high speed data service. This constellation uses "L" and "C" band for safety & service and "Ka" band for high speed data.

Intelsat: this geostationary constellation provides in-flight WiFi services. These satellites operate on the "Ku" band.

Viasat: this geostationary constellation provides in-flight WiFi services. These satellites operate on both "Ka" and "Ku" bands.

Satellite Service Terms

Data Filtering: is a way of limiting access to certain types of network traffic such as social media or streaming services. This practice prevents large data costs by preventing users from watching a streaming service in high resolution which uses a large amount of bandwidth and drives up data costs. Data costs can very quickly add up is streaming service in high resolution by multiple passengers. Many workplaces use data filters to limit employee internet activity on company internet connections.

Captive Portal: is a webpage that a user must interact with before gaining access to the internet. Many hotels and public WiFi networks use this tool in order to authenticate the use and prevent unauthorized access. This can also be used on board aircraft for internet access via satellite or air-to-ground applications for similar purposes or to "charge back" to a billing account after the flight is complete.

Using this tool prevents expensive data charges from falling exclusively on the aircraft operator and allows for billing of each individual passenger or group of passengers who use the data services in flight. For example, an aircraft charter company could charge passengers who use in-flight data after the flight is complete.

Satellite Constellation with Worldwide Coverage

