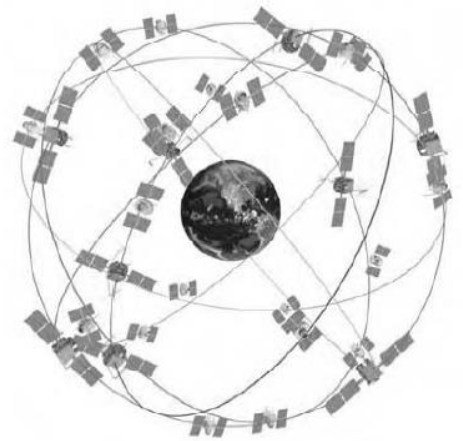
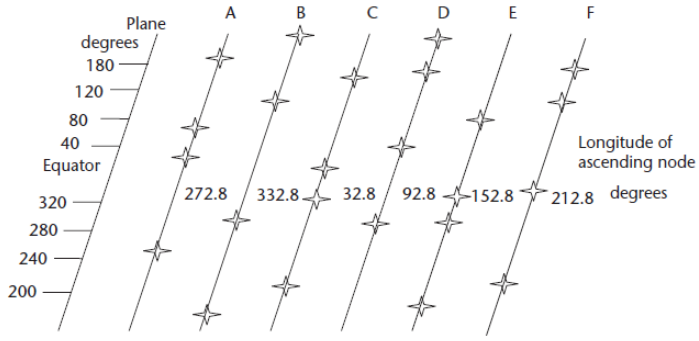
GPS Satellite Constellation Description

the satellites are positioned in six Earth-centered orbital planes with four satellites in each plane. The nominal orbital period of a GPS satellite is one-half of a sidereal day or 11 hours, 58 minutes. The orbits are nearly circular and equally spaced around the equator at a 60° separation with a nominal inclination relative to the equatorial plane of 55°.





GPS constellation planar projection.

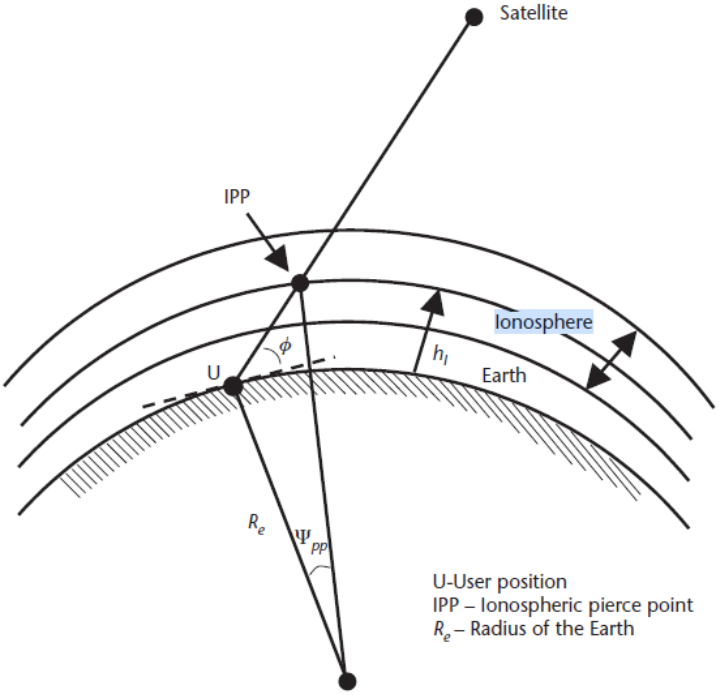
Satellite Block Development

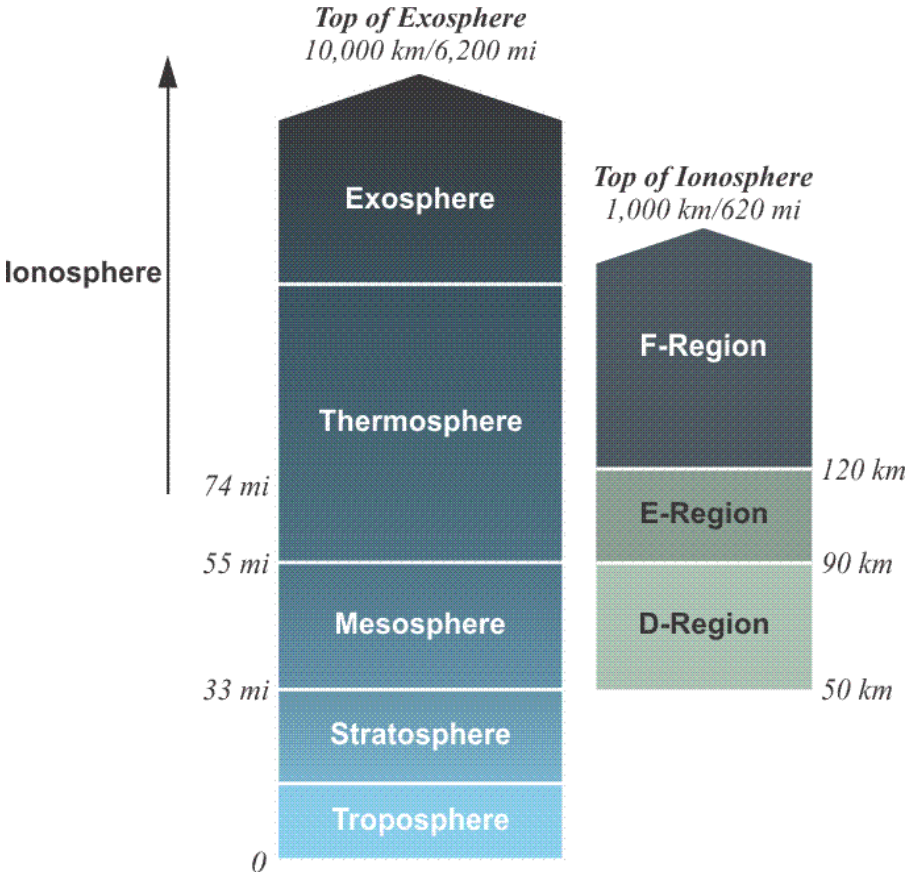
Five satellite blocks have been developed to date. The initial concept validation satellites were called Block I. The last remaining prototype Block I satellite was disposed of in late 1995. Block II satellites are the initial production satellites, while Block IIA refers to upgraded production satellites. All Block I, II, and IIA satellites have been launched. Block IIR satellites, denoted as the replenishment satellites, are being deployed. At the time of this writing, modified Block IIR versions denoted as Block IIR-M were scheduled for launch in 2005. Block IIF satellites, referred to as the follow-on or sustainment satellites, are being built. GPS III satellites are in the planning stage for a post-2010 deployment. Since satellites are launched only as replacements for a satellite failure.

Ionospheric Effects

One of the largest errors in GPS positioning is attributable to the atmosphere. The long, relatively unhindered travel of the GPS signal through the virtual vacuum of space changes as it passes through the earth's atmosphere. Through both refraction and diffraction, the atmosphere alters the apparent speed and, to a lesser extent, the direction of the signal. This causes an apparent delay in the signal's transit from the satellite to the receiver.

The ionosphere is a dispersive medium located primarily in the region of the atmosphere between about 70 km and 1,000 km above the Earth's surface. Within this region, ultraviolet rays from the sun ionize a portion of gas molecules and release free electrons. These free electrons influence electromagnetic wave propagation, including the GPS satellite signal broadcasts.



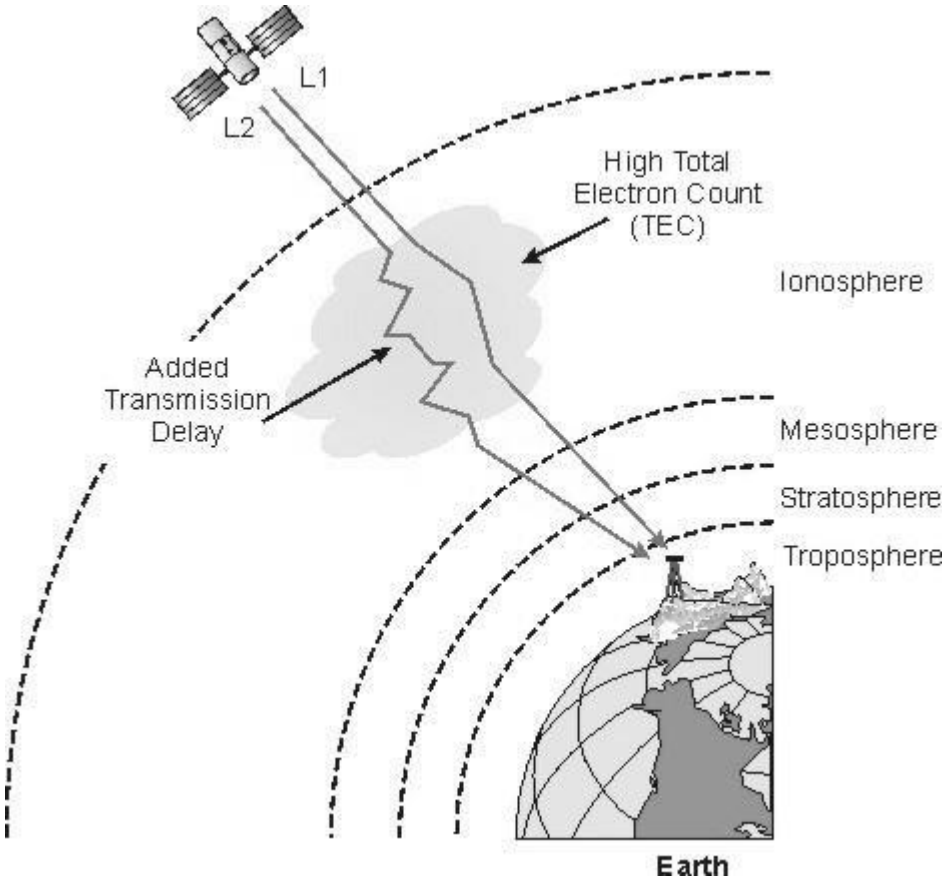


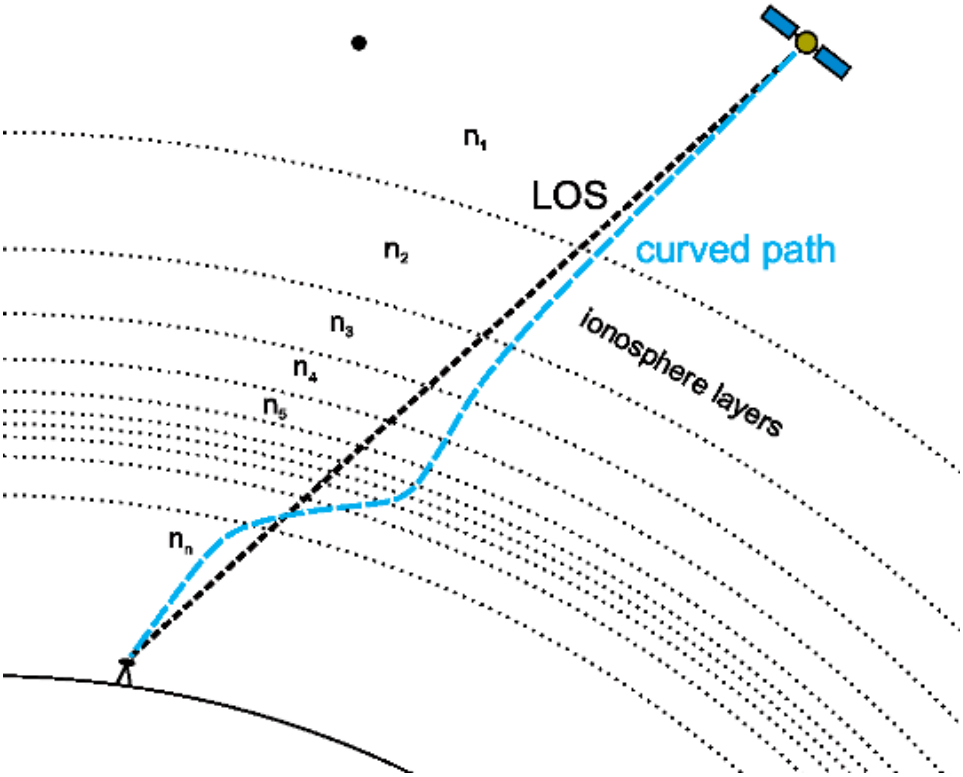
The parameter of ionosphere that produces most of the effects on radio signals is total electron content (TEC). The TEC is defined as the total number of electrons integrated along the path from the receiver to each GPS.

The effect of the ionosphere can be described in terms of two components: a **benign** or background component, and , a **disturbed** component.

Benign effects are associated with the undisturbed or background ionosphere and result in errors in the measurement of satellite range.

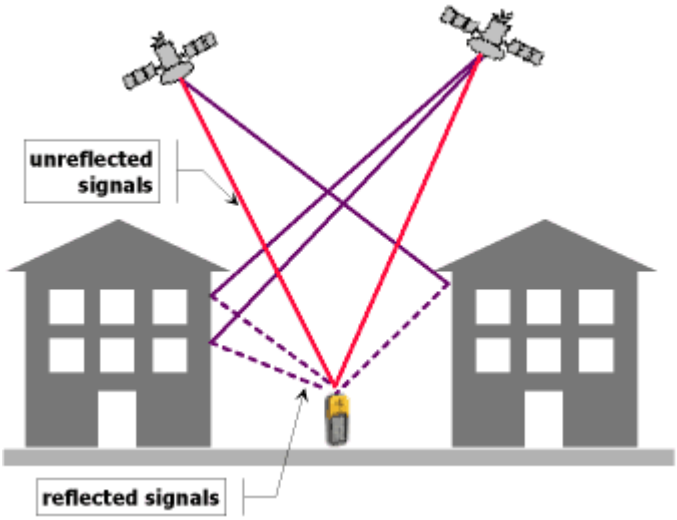
Disturbed effects are associated with irregularities in density of the ionosphere. These irregularities produce fluctuations in the amplitude and phase of GPS signals as they propagate towards the ground.





Multipath of GPS signals

Multipath error is one of the predominant error sources in all GPS applications. When- ever, a signal is transmitted from a GPS satellite it follows a "multiple" number of propagation "paths" on its way to receiving antenna. These multiple signal paths are due to the fact that the signal gets reflected back to the antenna off surrounding objects, including the earth's surface. The GPS receiver tracks both the direct and reflected signal components.



1) No GPS receiver is designed to be used indoors at any time and any operation get is gratituous and likely to have large errors.

2) Multipath results when the direct path to the receiver is blocked (by body, house, roof, trees, mountains, buildings, etc) and the signal from the satellite is REFLECTED by some object. The reflecting surface may be: buildings, mountains, the ground, or any object that happens to be a radio reflector at 1.6Ghz.

3) Multipath are radio signals which have traveled FURTHER to get to the receiver than they should have. This can result in GPS miscalculating its position because the signals may have traveled from feet to miles further to get to the receiver than a direct line of sight signal path would have been.

4) Multipath can cause longer term "stable" errors or it can cause the position to wander at varying rates (even thousands of miles per hour if GPS could follow such speeds).