

THE NAVSTAR GLOBAL POSITIONING SYSTEM (continued)

Once tracking of the satellite signals begins, delays and offsets become the measurement variables from which position and velocity information is calculated. By measuring the difference between transmission and reception times of the satellite signal and multiplying those values by the speed of light, the apparent range to the satellite may be determined. By measuring the frequency difference between the satellite's clock and the user's clock, the line-of-sight velocity (range rate) between the two may also be determined. Because of the biases in time and frequency of the user's clock, the measured range and range rate contain a bias error and are therefore referred to as pseudorange and pseudorange rate. For this reason, four satellites are required to establish the user's position, velocity and time by removing the residual user equipment clock errors.

It should be noted that if the antenna elevation is known, i.e., antenna mounted on a ship's mast, then only three satellites are necessary to obtain a position.