C/A Code Position

Using the concept that distance equals rate times a time interval, the distance to each satellite is computed by multiplying the speed of light (radio wave) times the measured time interval.

To do that, time must be measured very precisely. For example, in one millionth of a second (10^{-6}), light will travel 300 meters. Three magnitudes better, light will travel 0.30 meters in one billionth (10^{-9}) of a second. Modern measurement methods are very precise and use Cesium clocks which have oscillators that are stable to 10^{-13} seconds but the clocks are very expensive. Hydrogen maser clocks are even more precise. (Leick, 1990)

c = Speed of light = 299,792,458 meters per second

With distances measured to 3 satellites, a three dimensional position could be computed. However, since a correction to the receiver clock must also be computed and applied, it takes measurements to 4 satellites to solve for 4 unknowns - 3 position (X_A, Y_A, Z_A) and 1 clock correction (Δt). Using the geocentric coordinate system, the 4 equations (Wolf & Brinker, 1994) are:

$$D_1 + \Delta t(c) = \sqrt{(X_1 - X_A)^2 + (Y_1 - Y_A)^2 + (Z_1 - Z_A)^2}$$

$$D_2 + \Delta t(c) = \sqrt{(X_2 - X_A)^2 + (Y_2 - Y_A)^2 + (Z_2 - Z_A)^2}$$

$$D_3 + \Delta t(c) = \sqrt{(X_3 - X_A)^2 + (Y_3 - Y_A)^2 + (Z_3 - Z_A)^2}$$

$$D_4 + \Delta t(c) = \sqrt{(X_4 - X_A)^2 + (Y_4 - Y_A)^2 + (Z_4 - Z_A)^2}$$