GPS Almanacs

A set of quasi keplerian parameters to predict the orbit of a GPS satellite

Low accuracy, useful to investigate in advance (1 week / 1 day) the constellation visibility in a specific point / specific day

Orbit is considered as Keplerian
Rotation angles variations in time are expressed by a linear precession

Orbit computation from almanac

$$n = \sqrt{\frac{GM_E}{a^3}} \Rightarrow M(t) = M_0 + n(t - t_0)$$

$$\eta(t) = M(t) + e\sin(\eta(t))$$

$$\psi(t) = \tan^{-1}((\sqrt{1-e^2}\sin(\eta(t))) / (\cos(\eta(t)) - e))$$

$$r(t) = \frac{a(1-e^2)}{1 + e\cos(\psi(t))} \cong a(1 - e\cos(\eta))$$

$$x(t) = r(t)\cos(\psi(t))$$

$$y(t) = r(t)\sin(\psi(t))$$

Rotations are directly from Orbital Reference System to ITRF

$$\begin{bmatrix} X_S(t) \\ Y_S(t) \\ Z_S(t) \end{bmatrix}_{ITRF} = \mathbf{R}_3(-\Omega(t))\mathbf{R}_1(-i(t))\mathbf{R}_3(-\omega(t)) \begin{bmatrix} x_S(t) \\ y_S(t) \\ 0 \end{bmatrix}_{ORS}$$

where

$$\Omega(t) = \Omega_0 + (\dot{\Omega} - \dot{\Omega}_E)(t - t_0)$$

$$\dot{\Omega}_E = 7.2921151467 \text{ x } 10^{-5} \text{ rad/sec}$$

$\dot{\Omega}_E$: Earth rotation angular velocity

$$\omega(t) = \omega_0 + \dot{\omega}(t - t_0),$$

$$i(t) = i_0 + \dot{i}(t - t_0)$$