Orbit Formulas

Earth gravity

$$F_g = \frac{GM_{S/C}M_E}{(R_E + h_{orbit})^2} = M_{S/C} \cdot g$$

$$g = \frac{GM_E}{(R_E + h_{orbit})^2} = \frac{\mu}{(R_E + h_{orbit})^2} = g0\frac{R_E^2}{(R_E + h_{orbit})^2}$$

$$g0 = \frac{GM_E}{R_E^2} = \frac{\mu}{R_E^2}$$

$$F_g = M_{S/C} \cdot g = g0\frac{R_E^2}{(R_E + h_{orbit})^2}$$

$$F_C = M_{S/C} \cdot \frac{V_{orbit}^2}{R_E + h_{orbit}}$$

$$F_g = F_C \Rightarrow V_{orbit} = V(h_{orbit}) = R_E\sqrt{\frac{g0}{R_E + h_{orbit}}}$$

$$T = \frac{2\pi(R_E + h_{orbit})}{V_{orbit}}$$

$$F = \frac{Torque}{L}$$

$$a = \frac{F}{M_{Payload}}$$

Orbits

$$r_{sat} = \frac{a(1-e^2)}{1+e\cos(\theta)}$$

$$D = \frac{k \cdot d}{f}\sqrt{\frac{b}{p}}$$

$$f = frequency$$

$$b = bitrate$$

$$D = diameter \cdot antenna$$

Ground systems

$$d = distsat$$

$$E = \frac{P}{4\pi r^2}A$$

$$E = received$$

$$P = transmitted$$

$$r = disttransmitter \Leftrightarrow receiver$$

$$A = areaantenna$$

Atmosphere

$$a = C_D \frac{1}{2} \rho V^2 S / M_{sat}$$

Reduction of semi-major axis: $\Delta a_{2\pi} = -2\pi \frac{C_D S}{M_{sat}} a^2 \rho_p \exp(-c)[I_0 + 2eI_1]$

Reduction of eccentricity: $\Delta e_{2\pi} = -2\pi \frac{C_D S}{M_{sat}} a \rho_p \exp(-c)\left[I_1 + \frac{e}{2}(I_0 + I_1)\right]$

Limit lifetime**:** $L = \frac{H}{\Delta a_{2\pi}}$

Radiation

Total energy radiated by black body: $E_{tot} = \sigma T^4$

$$\sin \lambda = \frac{R_E}{a}$$

$$\lambda = \sin^{-1}\left(\frac{R_E}{a}\right)$$

Eclipse fraction (%): $T_{eclipse} = \frac{2\lambda}{360} \times 100$

Eclipse length(s): $T_{eclipse} = \frac{2\lambda}{360} \times T_{orbit} = \frac{2\lambda}{360} \times 2\pi \sqrt{\frac{a^3}{\mu}}$

$$a = semi - major - axis$$

Solar panel size/solar heat capacity

$$A_a = \frac{P_{req}}{P_\delta}$$

$$P_\delta = \eta \cdot S$$

$$\Delta T = \frac{SA}{CM} \Delta t$$

η=solar panel efficiency
S=solar intensity
C=heat capacity
A=area exposed
M=mass