Computing Dilution of Precision (DOP)
For 4 or More Satellites

For each satellite *n* define:

$$a_{n,1} = \sin az \cos el$$
$$a_{n,2} = \cos az \cos el$$
$$a_{n,3} = \sin el$$

Where:
el = Local elevation angle, and az = Local azimuth angle (from North)

Next, form the line-of-sight matrix A for all satellites used in the solution:

$$A = \begin{bmatrix} a_{1,1} & a_{1,2} & a_{1,3} & 1 \\ a_{2,1} & a_{2,2} & a_{2,3} & 1 \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ a_{n,1} & a_{n,2} & a_{n,3} & 1 \end{bmatrix}$$

and its transpose:

$$A^T = \begin{bmatrix} a_{1,1} & a_{2,1} & . & . & . & a_{n,1} \\ a_{1,2} & a_{2,2} & . & . & . & a_{n,2} \\ a_{1,3} & a_{2,3} & . & . & . & a_{n,3} \\ 1 & 1 & . & . & . & 1 \end{bmatrix}$$

Next, compute the covariance matrix:

$$\mathbf{COV(x) = (A^T \cdot A)^{-1}} = \begin{bmatrix} (s_x)^2 & s_x \cdot s_y & s_x \cdot s_z & s_x \cdot s_t \\ s_x \cdot s_y & (s_y)^2 & s_y \cdot s_z & s_y \cdot s_t \\ s_x \cdot s_z & s_y \cdot s_z & (s_z)^2 & s_z \cdot s_t \\ s_x \cdot s_t & s_y \cdot s_t & s_z \cdot s_t & (s_t)^2 \end{bmatrix}$$

Finally, extract DOPs from the covariance matrix:

$$\mathrm{GDOP} = \sqrt{(s_x)^2 + (s_y)^2 + (s_z)^2 + (s_t)^2}$$

$$\mathrm{TDOP} = \sqrt{(s_t)^2}$$

$$\mathrm{PDOP} = \sqrt{(s_x)^2 + (s_y)^2 + (s_z)^2}$$

$$\mathrm{HDOP} = \sqrt{(s_x)^2 + (s_y)^2}$$

$$\mathrm{VDOP} = \sqrt{(s_z)^2}$$

Note: $\mathrm{PDOP}^2 = \mathrm{HDOP}^2 + \mathrm{VDOP}^2$
$\mathrm{GDOP}^2 = \mathrm{PDOP}^2 + \mathrm{TDOP}^2$