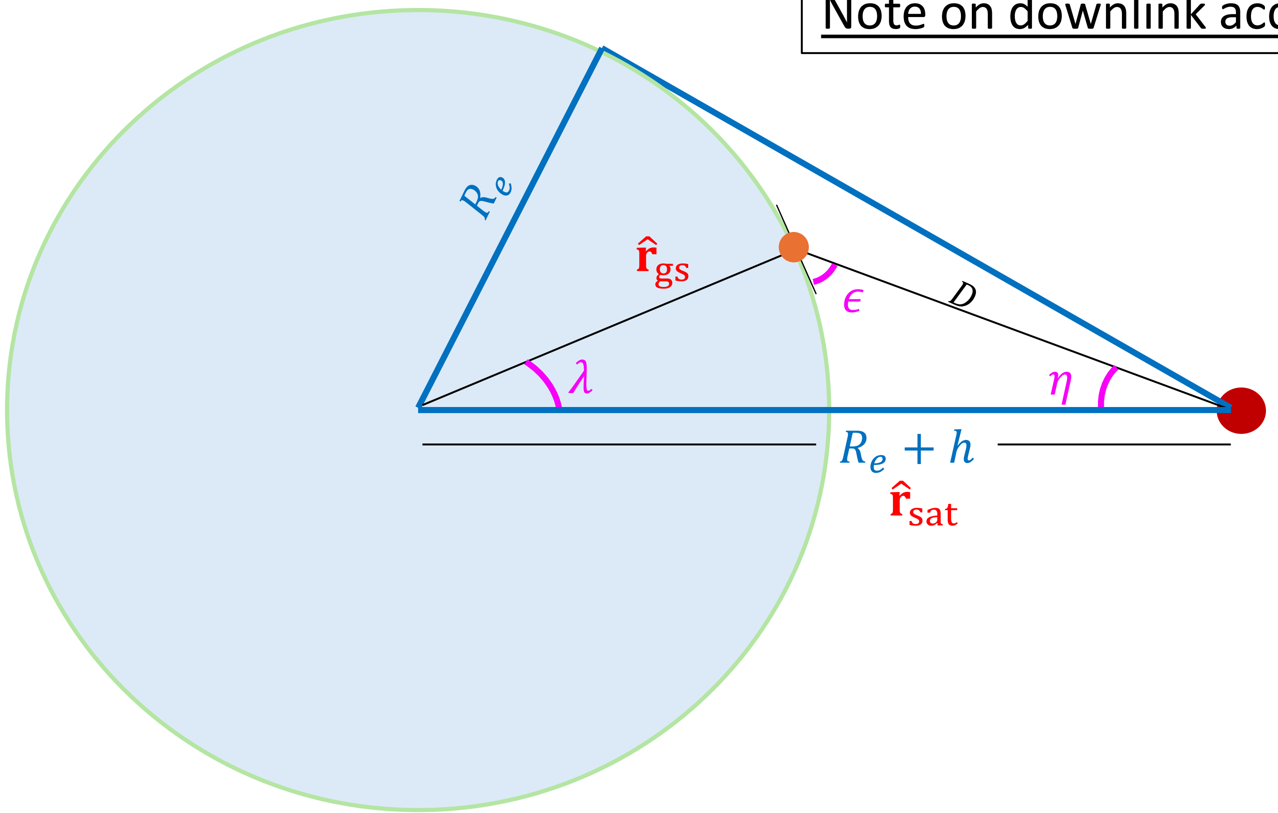
Note on downlink access time, target revisit times.



- Definitions
  - Ground station (gs)
  - Satellite
  - Earth Radius $\equiv R_e$
  - Altitude of Satellite $\equiv h$
  - Slant Range from Sat to Target $\equiv D$
  - Elevation (grazing) angle $\equiv \epsilon$ (angle between line-of-sight vector and local horizontal).
  - Nadir angle to target $\equiv \eta$
  - Earth center angle to target $\equiv \lambda$
    - $\lambda = 90 - \epsilon - \eta$
  - Satellite position in ECI frame $\hat{\mathbf{r}}_{sat}$
  - GS position in ECI frame $\hat{\mathbf{r}}_{gs}$

- Using the Triangle Rules (law of sine and cosine), follows that

$$(R_E + h)^2 = R_E^2 + D^2 - 2R_E D\cos(90+\varepsilon)$$

$$D = R_E\left\{-\sin\varepsilon + \left[(1+h/R_E)^2 - \cos^2\varepsilon\right]^{1/2}\right\}$$

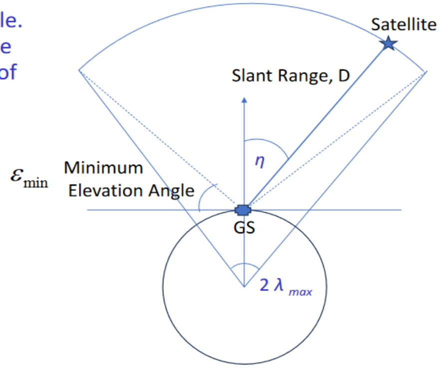
$$\sin\lambda = \frac{D}{R_E}\sin\eta = \frac{D}{R_E+h}\cos\varepsilon,$$

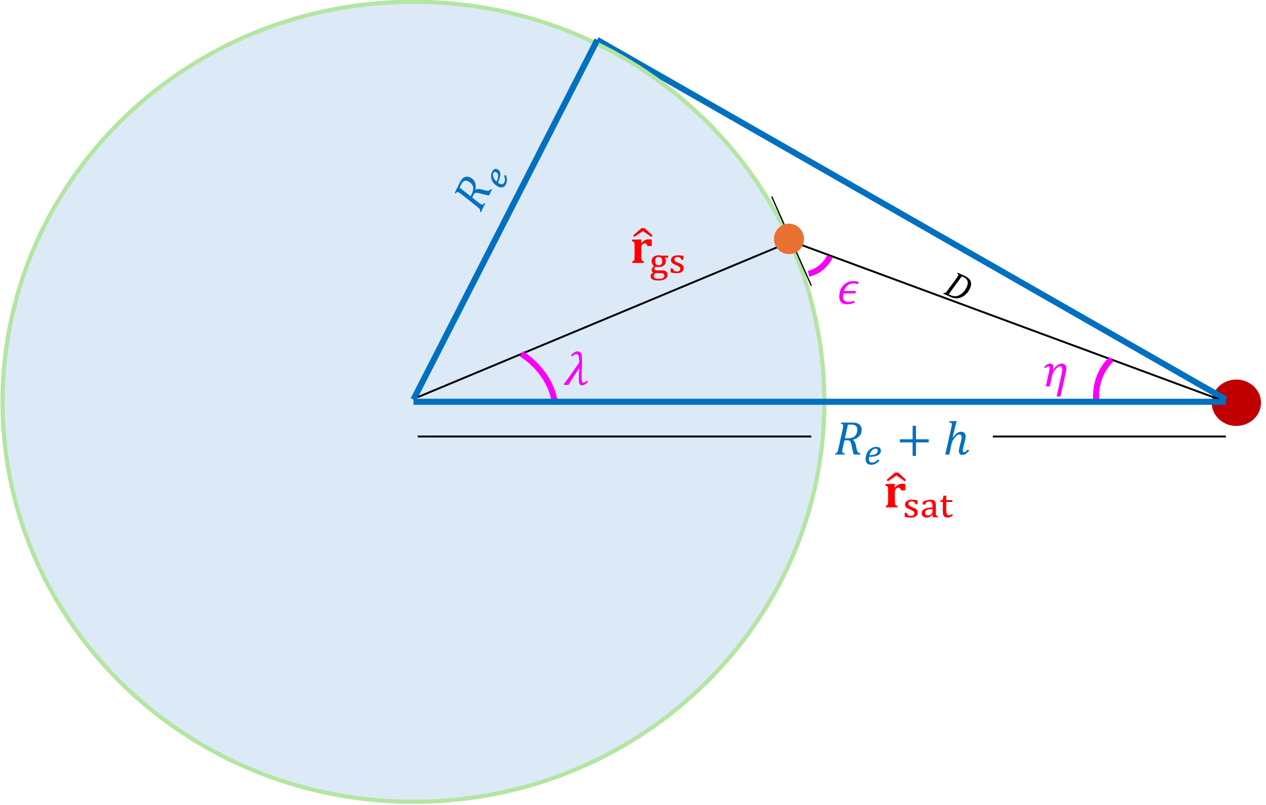
$$\lambda = 90 - \varepsilon - \eta$$

Ground Station (GS) View

- Elevation Angle - equivalent to grazing angle.
- The elevation angle of the satellite must be more than the minimum to be in the field of view of GS.

$$\sin(\eta) = \frac{\cos(\epsilon)}{1 + h/R_e}$$





Method 1

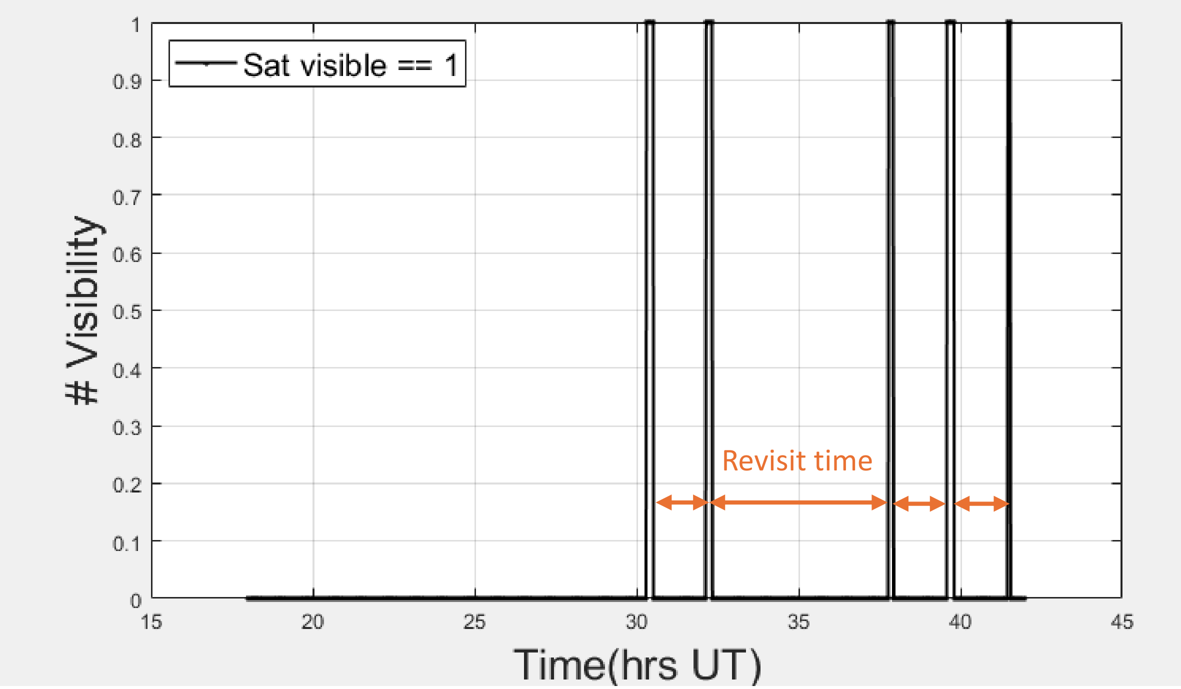
- **If ϵ, the elevation (or grazing) angle is greater than the constraints, the access is achieved.**
- This is the minimum angle at which satellite is visible above the horizon from ground station.
  - a line from the sensor to a surface target.

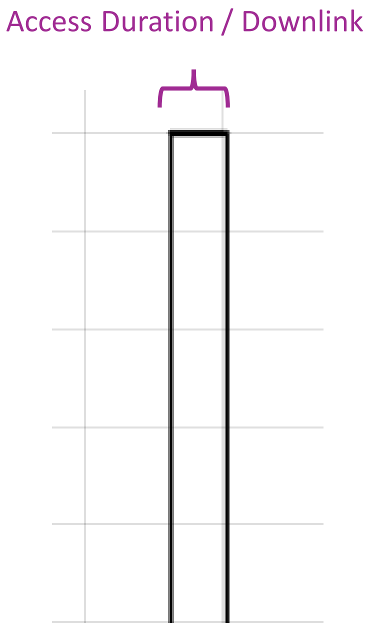
Method 2 (AccessExample.m)

- Also notice that, if $\lambda < \lambda_{max}$, satellite will be visible.
  - $2R_e\lambda_{max}$ is the Swath width
  - Identify $\lambda_{max} = 90 - \epsilon - \eta$
  - The dot product between the satellite position and the ground station position is $\cos(\lambda) = \hat{\mathbf{r}}_{sat}.\hat{\mathbf{r}}_{gs}$
  - If $\lambda \leq \lambda_{max}$
    - **Satellite is visible**
- Alternately (AccessExample.m):
  - If $\hat{\mathbf{r}}_{sat}.\hat{\mathbf{r}}_{gs} < \cos(\lambda_{max})$
    - **Satellite is NOT visible** (because cosine of lower angle is smaller).

- Ground station (gs)
- Satellite
- Earth Radius $\equiv R_e$
- Altitude of Satellite $\equiv h$
- Slant Range from Sat to Target $\equiv D$
- Elevation (grazing) angle $\equiv \epsilon$ (angle between line-of-sight vector and local horizontal).
- Nadir angle to target $\equiv \eta$
- Earth center angle to target $\equiv \lambda$
  - $\lambda = 90 - \epsilon - \eta$
- Satellite position in ECI frame $\hat{\mathbf{r}}_{sat}$
- GS position in ECI frame $\hat{\mathbf{r}}_{gs}$

- Revisit Time – The time between access.
- Access Duration – Time length of an access.





Maximum Coverage Gap or Maximum Revisit Time

This is the longest time between coverage for the point or location specified. This statistic conveys worst case information but sometimes is not a good figure of merit for constellation design. It generally should not be a driver in the design. Usually by changing the phasing of the satellites in the constellation this can be reduced.

Mean Coverage Gap or Mean Revisit Time

This is the average of all the gaps in coverage. It is computed by taking a period of time (at least 24 hours, probably a few days) and computing all the gaps in coverage and dividing by the number of gaps. This is generally a better coverage statistic than the maximum gap.