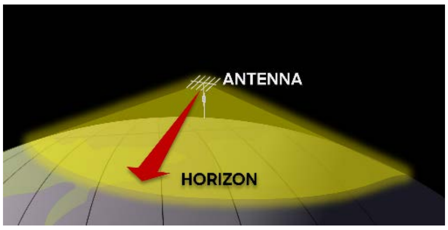
Technical Document

Technical Information to understand the technical terms used in Map View.



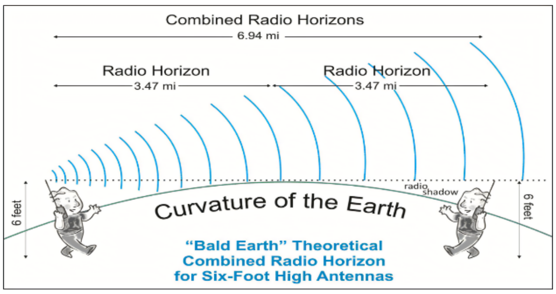
Line-of-sight propagation is a characteristic of electromagnetic radiation or acoustic wave propagation which means waves can only travel in a direct visual path from the source to the receiver without obstacles. Electromagnetic transmission includes light emissions traveling in a straight line. The rays or waves may be diffracted, refracted, reflected, or absorbed by the atmosphere and obstructions with material and generally cannot travel over the horizon or behind obstacles.

In contrast to line-of-sight propagation, at low frequency (below approximately 3 MHz) due to diffraction, radio waves can travel as ground waves, which follow the contour of the Earth. This enables AM radio stations to transmit beyond the horizon. Additionally, frequencies in the shortwave bands between approximately 1 and 30 MHz, can be refracted back to Earth by the ionosphere, called skywave or "skip" propagation, thus giving radio transmissions in this range a potentially global reach.

However, at frequencies above 30 MHz (VHF and higher) and in lower levels of the atmosphere, neither of these effects are significant. Thus, any obstruction between the transmitting antenna (transmitter) and the receiving antenna (receiver) will block the signal, just like the light that the eye may sense. Therefore, since the ability to visually see a transmitting antenna (disregarding the limitations of the eye's resolution) roughly corresponds to the ability to receive a radio signal from it, the propagation characteristic at these frequencies is called "line-of-sight". The farthest possible point of propagation is referred to as the "radio horizon".[2]

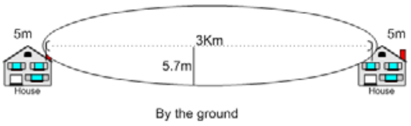
In practice, the propagation characteristics of these radio waves vary substantially depending on the exact frequency and the strength of the transmitted signal (a function of both the transmitter and the antenna characteristics). Broadcast FM radio, at comparatively low frequencies of around 100 MHz, are less affected by the presence of buildings and forests. Courtesy Wikipedia

Radio horizon [2]

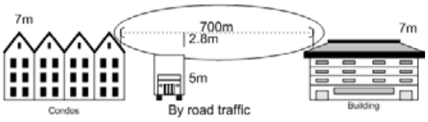


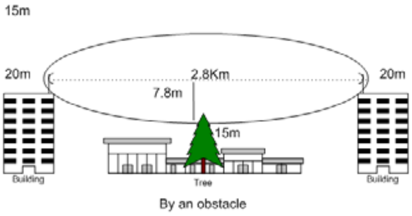
The ***radio horizon*** is the locus of points at which direct rays from an antenna are tangential to the surface of the Earth. If the Earth were a perfect sphere without an atmosphere, the radio horizon would be a circle.

The radio horizon of the transmitting and receiving antennas can be added together to increase the effective communication range.



Objects within the **[Fresnel zone](#)** [1] can disturb line of sight propagation even if they do not block the geometric line between antennas.





The line of sight distance can be affected by several factors, including the heights of the antennas, the curvature of the Earth, and the Fresnel zone[1]. If the line of sight obstructed due to the Fresnel zone, the effective distance for reliable communication will reduced.

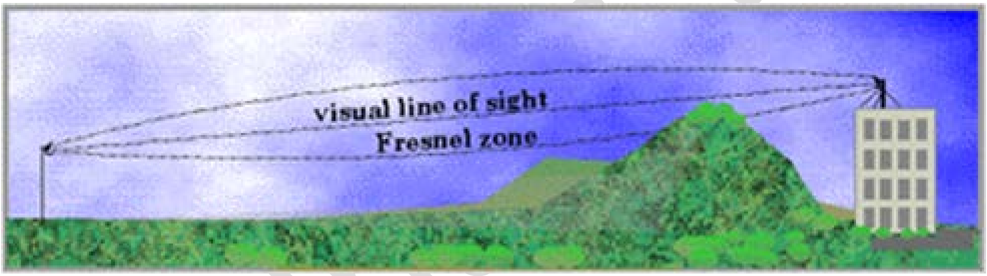
Understanding Line of Sight and Fresnel Zone

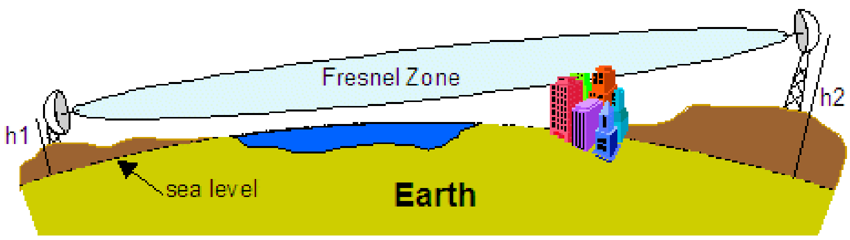
1. **Line of Sight (LOS)**:

- The distance at which two points can "see" each other without any obstructions.
- For radio communications, this is typically calculated using the formula for radio horizon:

  Radio Horizon≈3.57×h , where *h* is the height of the antenna in meters.

2. **Fresnel Zone**:





The Fresnel zone is an elliptical area around the line of sight path that must be clear of obstructions for optimal signal strength.

Calculating Effective Distance

If the Fresnel zone is obstructed, the effective distance for reliable communication can be estimated by considering the height of the antennas and the radius of the first Fresnel zone.

1. **Calculate the Radio Horizon**:

- For each station, calculate the radio horizon using the height of the antennas.

2. **Determine the Fresnel Zone Radius**:

- Calculate the radius of the first Fresnel zone at the midpoint of the path.

3. **Effective Distance**:
- If the Fresnel zone is obstructed, the effective distance can be approximated as: Effective Distance=Radio Horizon−Fresnel Zone Radius

- If the Fresnel zone radius exceeds the line of sight distance, the effective distance will be limited by the Fresnel zone.

Example Calculation

Assuming:

- Height of Antenna 1: 10 meters
- Height of Antenna 2: 15 meters
- Distance between Stations: 50 km
- Frequency: 146 MHz   so λ =300/145 = 2.07 mt.

1. **Calculate Radio Horizon**:

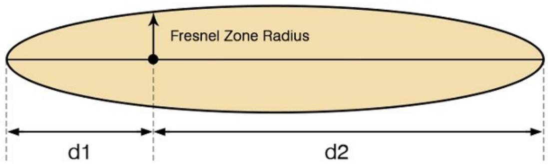
- For Antenna 1:

  $\text{Radio Horizon1} \approx 3.57 \times 10 \approx 11.3$ km

- For Antenna 2:

  $\text{Radio Horizon2} \approx 3.57 \times 15 \approx 14.6$ km

2. **Calculate Fresnel Zone Radius**:



The Fresnel Zone radius is calculated using the formula:

Radius = sqrt((n * λ * d1 * d2) / (d1 + d2))

where:

- n is the zone number. Usualy taken 1
- λ (lambda) is the wavelength, which is the speed of light divided by the frequency.
- d1 and d2 are the distances from each endpoint to the point of interest.

  For simplicity, this calculator arranges the formula considering d1 and d2 as equal halves of the total distance d.

- Assuming the distance is 50 km:

  R = Sqrt [(1x2.07x25x25) /(25+25)] = 5.09 mt.

  Effective Distance:

- If the Fresnel zone radius is obstructed, the effective distance would be:

  Effective Distance=Radio Horizon−rEffective Distance=Radio Horizon−*r*

- If the radio horizon is less than the Fresnel zone radius, the effective distance will be limited by the Fresnel zone.

Conclusion

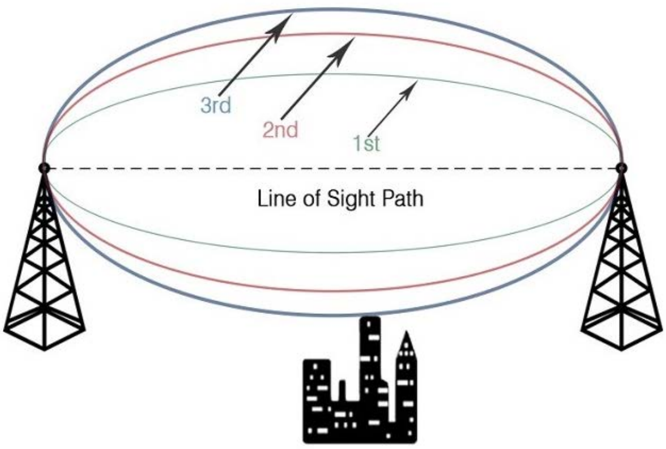
The effective distance for reliable communication will depend on the heights of the antennas, the distance between them, and whether the Fresnel zone is clear of obstructions. If the Fresnel

Distance vs. Radio Horizon: The distance between the two stations is 50 km, which exceeds the radio horizon (25.8 km). This indicates that, based on the radio horizon alone, there is a potential obstruction. even though both stations are elevated.

Recommendations

1. **Check for Obstructions**: Since the calculation indicates a potential obstruction, it would be prudent to check for any geographical features (like hills or buildings) that could obstruct the line of sight between the two stations.

2. **Consider Fresnel Zone**: Even if the line of sight is clear , the Fresnel zone must also be unobstructed for optimal signal quality.



3. The Fresnel zone consists of multiple zones (1,2, 3,…, n) with zone 1 having a strong signal than the next zones 2,3,…, n.

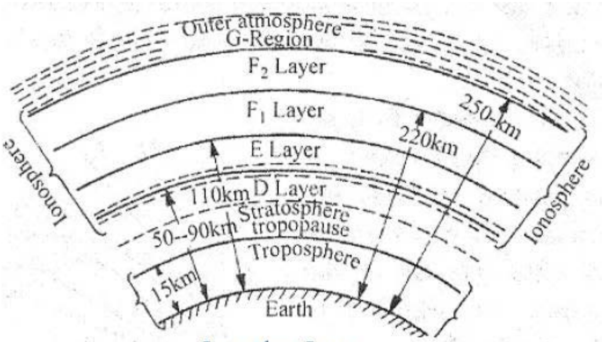
Solar Flux Index (SFI): A measure known as the solar flux is used as the basic indicator of solar activity , and to determine the level or radiation being received from the Sun. The solar flux is measured in solar flux units (SFU) and is the amount of radio noise or flux that is emitted at a frequency of 2800 MHz (10.7 cm). The Penticton Radio Observatory in British Columbia, Canada reports this measure daily. The solar flux is closely related to the amount of ionization and hence the electron concentration in the F2 region. As a result it gives a very good indication of conditions for long-distance communication. The figure for the solar flux can vary from as low as 50 or so to as high as 300. Low values indicate that the maximum useable frequency will be low and over all conditions will not be very good, particularly on the higher HF bands. Conversely, high values generally indicate there is sufficient ionization to support long-distance communication at higher-than-normal frequencies. However, remember that it takes a few days of high values for conditions to improve. Typically values in excess of 200 will be measured during the peak of a sunspot cycle with high values of up to 300 being experienced for shorter periods.

A-index is a daily average of the K-index values, providing a longer-term view of geomagnetic activity over a 24-hour period.

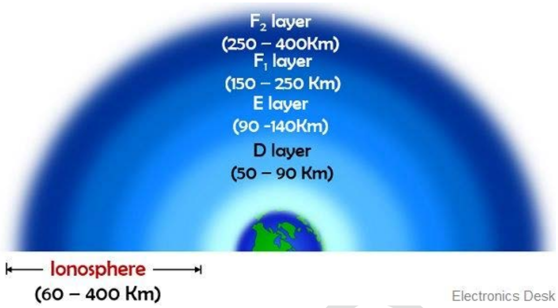
K index—A quasi-logarithmic local index of the 3-hourly range in magnetic activity relative to an assumed quiet-day curve for a single geomagnetic observatory site. First introduced by J. Bartels in 1938. K-index measures geomagnetic activity over a 3-hour period, indicating the level of disturbance in Earth's magnetic field on a logarithmic scale from 0 to 9, with higher values indicating higher disturbances.

HF Propagation conditions		**Best**			**Average**			**Poor**			**BAD**
Geomagnetic activity index (linear)	**A**	0	4	7	15	27	48	80	132	207	400
Geomagnetic activity index (log-scale)	**K**	0	1	2	3	4	5	6	7	8	9
		Quiet	Quiet to unsettled	Unsettle	Active	Active	Minor	Major	Severe storm	Very major	Very major

MUF (F2 Layer) : In radio transmission, **maximum usable frequency** (MUF) is the highest radio frequency that can be used for transmission between two points on Earth by reflection from the ionosphere (skywave or skip) at a specified time, independent of transmitter power.



Ionosphere Layers



1. Solar Flux index SFI, Kp-index for geomagnetic stability, Solar Wind data , Local weather for tropospheric effects are fetched directly from the NOAA Servers . So, permit internet access when using this app.
2. Data Update Frequency at NOAA Server
    - Solar flares: ~5 minute updates
    - Kp-index: ~3 hour updates
    - Sunspots: Daily updates

So, accordingly prediction will be displayed in the prediction section.