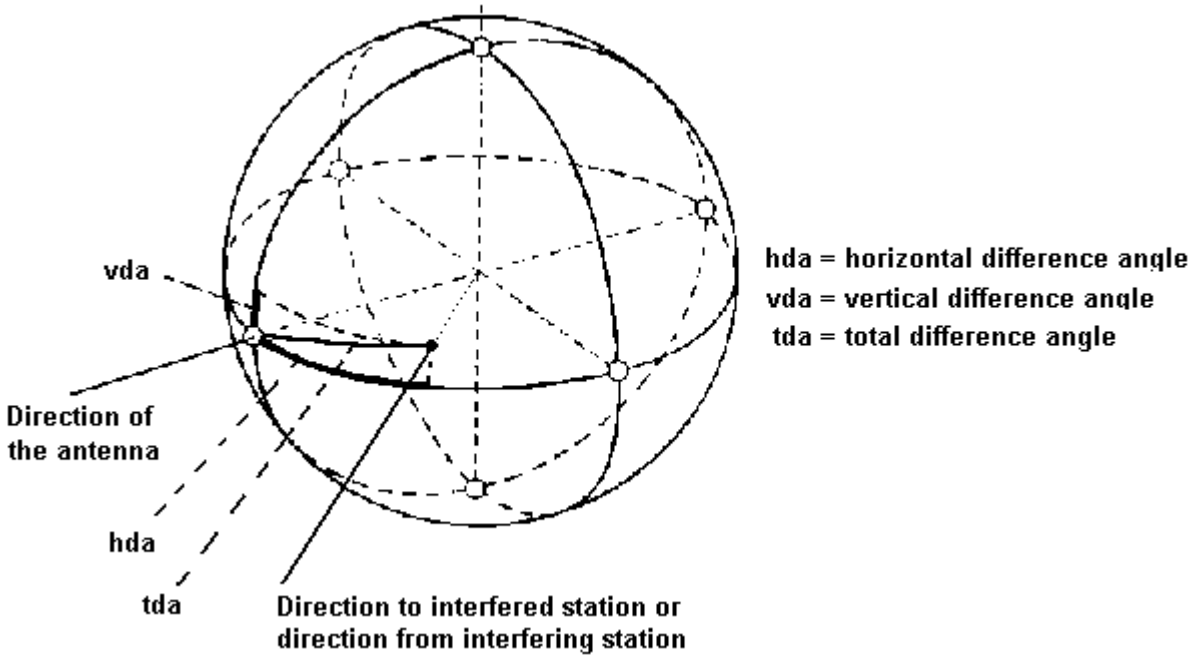
Annex 8B

Method for combining the horizontal and vertical antenna patterns in the Fixed Service

Three dimensional antenna pattern:



Vertical difference angle vda = Antenna_elevation(9B) – E_{TR},

where E_{TR} – vertical angle of the link e.g. between the antennas of interferer and interfered with stations.
In case of line of sight,
for interferer E_{TR} is calculated as follows:

$E_{TR} = (h_r – h_t) / distance – distance / (2\ a_e)$ rad,

where
h_t – interferer (transmitter) antenna height above sea level,
h_r – interfered with (receiver) antenna height above sea level,
a_e – effective Earth radius,
distance – the distance between interferer and interfered with stations,

for interfered with station E_{TR} is calculated as follows:

$E_{TR} = (h_t - h_r) / distance – distance / (2\ a_e)$, rad,

In case of transhorizon path,
for interferer E_{TR} is calculated as follows:

$E_{TR} = \Theta_t / 1000$ rad,

where
Θ_t – interferer (transmitter) radio horizon angle (mrad),

for interfered with station E_{TR} is calculated as follows:

$E_{TR} = \Theta_r / 1000$ rad,

where
Θ_r – interfered with (receiver) radio horizon angle (mrad).

The maximum difference angle in the horizontal plane (hda) is ±180 degrees, the maximum difference angle in the vertical plane (vda) is also ±180 degrees. The resulting total difference angle (tda) is between 0 and 180 degrees. The tda value is calculated using formula:

$$tda = \arccos (\sin(Ant_{vert}) * \sin(vda) + \cos(Ant_{vert}) * \cos(vda) * \cos(hda-Ant_{hor}))$$

where
Ant_{vert} = difference angle between antenna elevation and elevation of the link and
Ant_{hor} = difference angle between antenna azimuth and azimuth of the link.

Because Ant_{vert} and Ant_{hor} are 0, the resulting formula is:

$tda = \arccos (\cos(vda) * \cos(hda))$

Taking into account this total difference angle, the antenna attenuation for the horizontal plane (A_{hor}) and for the vertical plane (A_{vert}) are calculated.

If the horizontal antenna pattern is not symmetrical and the horizontal difference angle (hda) is negative (or between 180 and 360 degrees), the attenuation for the horizontal plane is calculated using the negative total difference angle (-tda).

If the vertical antenna pattern is not symmetrical and the vertical difference angle (vda) is negative (or between 180 and 360 degrees), the attenuation for the vertical plane is calculated using the negative total difference angle (-tda).

If both values for attenuation are equal, the resulting attenuation ($A_{resulting}$) is equal to one of those values:

$A_{resulting} = A_{hor}$ or

$A_{resulting} = A_{vert}$

If the horizontal attenuation is greater than the vertical attenuation, the resulting attenuation ($A_{resulting}$) is:

$$A_{resulting} = A_{vert} + (A_{hor} - A_{vert}) * Abs(hda) / (Abs(hda) + Abs(vda))$$

If the vertical attenuation is greater than the horizontal attenuation, the resulting attenuation ($A_{resulting}$) is:

$$A_{resulting} = A_{hor} + (A_{ver} - A_{hor}) * Abs(vda) / (Abs(hda) + Abs(vda))$$

This value $A_{resulting}$ is used for further calculations.