Satellite technologies and services
Examples   - part 1.

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Ľ. Maceková

Example 1. – angular and linear velocity of satellite

- Calculate angular velocity of satellite in GEO system

results: $4{,}17 \cdot 10^{-3}$ °/sec or $72{,}93 \cdot 10^{-6}$ rad/sec

- ...and linear velocity ? ☺

recipe: $v = l / T$, $l = 2 \pi \cdot r$ ....

Example 2. – Time delay t_d

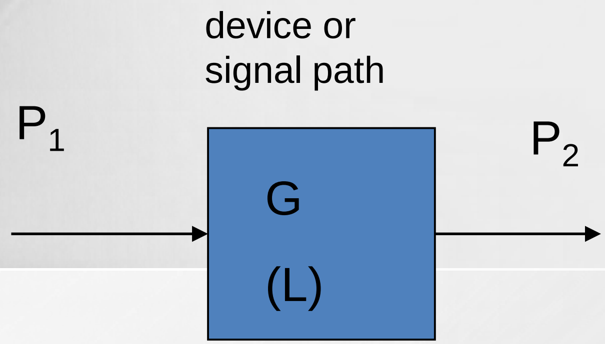
a) Calculate time delay t_d of signal between 2 users A and B on the terrestrial surface at satellite communication by GEO system. Consider A to B path only (over satellite).

b) Calculate time delay of echo $t_{d\ echo}$ at communication of these users (path A-B-A over satellite)

Help: it is only approximate calculation; consider distances A-S, B-S are equal to altitude of satellite above Earth, i.e. 35 784 km

Results: a) 0, 23856 sec., b) 2 x t_d

Decibels



If $P_2 > P_1$

→ **Gain** →

$$\frac{P_2}{P_1} > 1 \quad \rightarrow \quad G_{[dB]} = 10\log\left(\frac{P_2}{P_1}\right) \qquad [\mathrm{dB}]$$

- if we transform:

[W alebo mW]

$$G_{[dB]} = 10\log\left(\frac{P_2 / 1mW}{P_1 / 1mW}\right) \qquad [\mathrm{dB}]$$

…… > 0 dB

and by definition of dBm:

$= 10\log(P_2 / 1mW) - 10\log(P_1 / 1mW)$

$G_{[dB]} = P_{2\,[dBm]} - P_{1\,[dBm]}$

Definition of dBm and dBW

$P_{[dBm]} = 10\log P_{[mW]}$

$P_{[dBW]} = 10\log P_{[W]}$

Then – similarly: **attenuation, diminution, Loss**

$$L_{[dB]} = 10\log\left(\frac{P_1}{P_2}\right) \qquad [\mathrm{dB}]$$

$P_1 > P_2$; $L > 0$ dB

Examples: decibell units (gain, loss, power, voltage) ...

1 W → ? dBW

1mW → ? dBW

1mW → ? dBm

10 mW → ? dBm

35 mW → ? dBm

P_1 = 1mW, P_2 = 10 μW, A = ? (A… Attenuation)

P = 35 dBm → ? mW

P = - 15 dBW → ? W

Calculation of angles EL, AZ of antenna setting (EL-Elevation, AZ-Azimuth):

$$EL = \arctan\left(\frac{\cos h - 0.1513)}{\sin h}\right)\ [^\circ]$$

Intermediate parameter h:

$$h = \arccos[\cos(S-L)\cos B]\ [^\circ]$$

Value 0.1513:

$$\frac{R}{R+H} = \frac{6378.10^3}{(6378+35786).10^3} \cong 0..1513$$

where: S...position of satellite (longitude) in degrees; Easter longitude (° E) must have negative value (minus)

L... longitude of receiver antenna posision; Easter longitude (° E) must have negative value (minus)

B - latitude of receiving position

R - Earth radius

H - altitude of satellite above Earth

$$AZ = 180 + \arctan\left(\frac{\tan(S-L)}{\sin B}\right)\ [^\circ]$$

If we are on south hemisphere:

$$AZ' = \arctan\left(\frac{\tan(S-L)}{\sin B}\right)\ [^\circ]$$

$$AZ = 360 - AZ'\ [^\circ]$$

Correction considering magn. declination:

$$AZ_{real} = AZ - MD, if\ \text{positive MD}\ (E)$$

$$AZ_{real} = AZ + MD, if\ \text{negative MD}\ (W)$$

Calculation of **LNB Skew** (moving round of Low Noise Block):

$$LNB\ skew = -\arctan\left(\frac{\sin(S-L)}{\tan B}\right)\ [^\circ]$$

Homework

- Calculation of angles of antenna setting in selected receiving place for receiving of selected accessible satellite – see example on the next page.

Help for determine of position coordinate of receiving place – see e.g. programme Orbitron, resp. data from Internet applications. Help for determining magn. declination – for example on the web page:

http://www.ngdc.noaa.gov/geomagmodels/struts/calcDeclination

Write on the paper incomming data, calculation process and results and transfer; it is necessary condition to credit.

Example 3 – calculation AZ and EL, and LNB skew of sat. antenna

Earth station has position 18.11°E, 42.64 °N (Dubrovnik). It has to receive signal from GEO satellite with position 21.5 °E. Assume the magnetic declination in the receiving place +3.26 °.

Results : El_t= 40.66°, AZ=175 ° , AZ_{MD}=171.7 °, LNBskew=+3.67 °