Space, rocket and aerospace technologies in science and programming.

Author, MSc: Adrian Szklarski: 11.2023

Subject: Satellite technologies, part 1.

Temat: Technologie satelitarne, cześć 1.

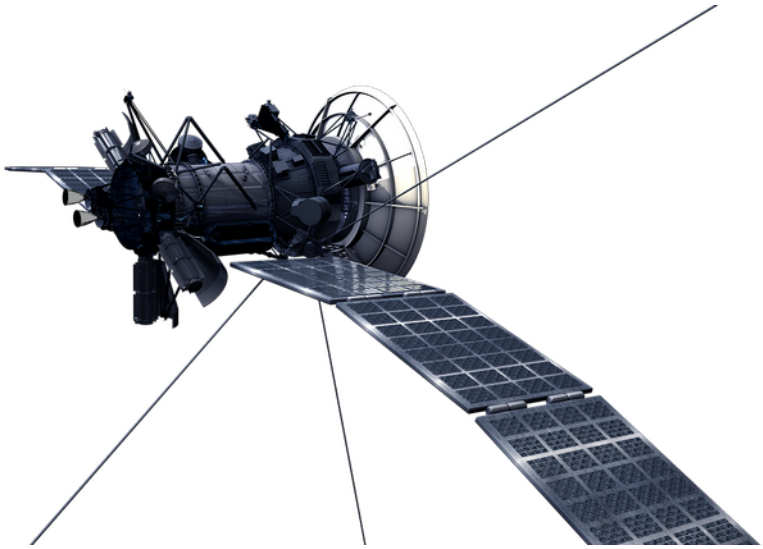

Fig.1.: Satellite, [1]

Space, rocket and aerospace technologies in science and programming.

A ground station with a 4m diameter parabolic antenna and an efficiency of 0.6 to which a signal of 100W and a frequency of 14GHz is fed radiates toward a satellite 40.000km away. Determine the power received by the satellite antenna with a 3dB main beam width of 2° and an efficiency of 0.55. Data: PT [dBW], η_T, f_u GHz, R [km], D_T [m], α_{3dB_R} [°], η_R.

Stacja naziemna z anteną paraboliczną o średnicy 4m i sprawności 0,6 do której doprowadzono sygnał o mocy 100W i częstotliwości 14 GHz promieniuje w kierunku satelity odległego o 40.000km. Wyznaczyć moc odbieraną przez antenę satelity o 3dB szerokości wiązki głównej równej 2° i sprawności 0,55. Dane: P_T [dBW], η_T,f_u GHz, R [km], D_T [m], α_{3dB_R} [°], η_R.

Solution:

Rozwiązanie:

$$G_T = \eta_T \left(\frac{\pi D_T}{\lambda_u} \right)^2 = \eta_T \left(\frac{\pi D_T f_u}{c} \right)^2$$

$$G_R = \eta_R \left(\frac{\pi \cdot 70^o}{\alpha_{3\,dB_R}} \right)^2 = 0,55 \cdot \left(\frac{\pi \cdot 70^o}{2^o} \right)^2$$

$$L_{FS} = \left(\frac{4\pi R}{\lambda_u} \right)^2 = \left(\frac{4\pi R f_u}{c} \right)^2$$

$$P_{R[dBW]} = P_{T[dBW]} + G_{T[dBi]} + G_{R[dBi]} - L_{FS[dB]}$$

sat1.py

```
'''
Determination of power received by a space satellite antenna

Created by @AdrianSzklarski, 11.2023
'''

import math

class Antena:

    def __init__(self, Pt, tetaT, fu, R, Dt, alfa3, tetar, c):
        self.Pt = Pt
        self.tetaT = tetaT
        self.fu = fu
        self.R = R
        self.Dt = Dt
        self.alfa3 = alfa3
        self.tetar = tetar
        self.c = c

    def calculation(self):
        self.GT = round(10 * math.log10((self.tetaT * math.pow((math.pi * self.Dt * self.fu * 1e9 / self.c), 2))), 2)
        self.GR = round(10 * math.log10(self.tetar * math.pow((math.pi * 70 / self.alfa3), 2)), 2)
        self.LFS = round(10 * math.log10(math.pow((4 * math.pi * self.R * 1e6 * self.fu * 1e9 / self.c), 2)), 2)
        self.Pr_dBW = self.Pt + self.GT + self.GR - self.LFS
        return self.GT, self.GR, self.LFS, self.Pr_dBW

    def __str__(self):
        return f'{self.GT}, {self.GR}, {self.LFS}, {self.Pr_dBW}'

if __name__ == '__main__':
    # input data
    Pt = 20
    tetaT = 0.6
    fu = 14
    R = 40
    Dt = 4
    alfa3 = 2
    tetar = 0.55
    c = 3e8

    # --- run program ---
    hear = Antena(Pt, tetaT, fu, R, Dt, alfa3, tetar, c)
    print('GT:', hear.calculation()[0], 'dBi')
    print('GR:', hear.calculation()[1], 'dBi')
    print('LFS:', hear.calculation()[2], 'dBi')
    print('Power received by the antenna: ', hear.calculation()[3], 'dBW')
```

```
GT: 53.15 dBi
GR: 38.23 dBi
LFS: 207.41 dBi
Power received by the antenna:  -96.03 dBW
```

[1] https://pixabay.com/pl/illustrations/satelita-wszech%C5%9Bwiat-atmosfera-t%C5%82o-3977166/

Programming language:
Python

Contact me:

No.5, 5/2023