

### Project 3 “Satellite Link Budgets and $P_E$ ”

The objective of this project is to construct a Matlab script for link budget determination and  $P_E$  for a satellite-relay communication link, as shown in [Ziemer, 2015] Figure A.7 page 705.

The script should include the following primary parameters for a satellite-satellite link:

- $d$  Distance between the two satellites.
- $\lambda$  Transmission wavelength.
- $B$  Bandwidth of the transmission between the two satellites.
- $P_T$  Transmitted power from satellite antenna.
- $G_T$  Power gain of transmitter antenna over the isotropic radiation level.
- $A_R$  Receiving antenna aperture area.
- $G_R$  Power gain of receiving antenna.
- $L_0$  Atmospheric absorption.
- $T_R$  Receiver noise temperature.

The script should allow for the determination of the SNR at the receiver output and the probability of bit error probability  $P_E$  for the satellite link. The link budget model is explained, including the definition of free space loss, the effective radiated power in dBW and link budget margin.

The script is initially used to demonstrate experimentally the relation between  $P_E$  and varying  $d$ ,  $\lambda$ ,  $B$ ,  $P_T$  parameters by appropriately selected examples. Explain qualitatively how changes in the respective parameters influence the final  $P_E$ . The Examples A.8 and A.9 at pages 706, 707 [Ziemer, 2015] are used as starting point for examples.

Keeping all other parameters unchanged, then determine the  $P_E$  for the following relay satellite transmission powers 50W, 5W and 500mW.

Chose two alternative modulation methods, different from the binary BPSK. Explain the methods and determine the system properties for these two method under the conditions above.

#### The Project Report

The report should have a title page, with author(s), date, course title, table of contents, sections and list of references. The most important formulas for explaining the solutions should be included in the report together with the respective results. Furthermore the Matlab code developed should be included in the appendix of the report.

#### Handing in Report

Email the project report to the following: [jaas@dtu.dk](mailto:jaas@dtu.dk). The project report is submitted in pdf. The project pdf file is named with Project\_3

#### References

[Ziemer, 2015] Rodger E. Ziemer, William H. Tranter, “Principles of Communications”.  
John Wiley & Sons, Seventh Edition, 2015.

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