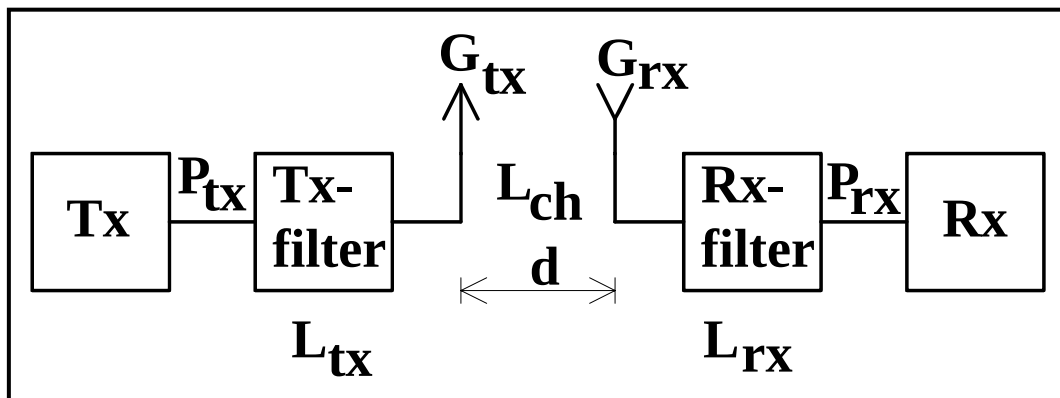


S-72.3220 RADIO COMMUNICATION SYSTEMS
EXERCISE 5, 23.2.2006

P23

As a RLL operator you promise a connection to all subscriber for which can be arranged a link with no more than 25 dB of excess loss L_{add} compared to free space loss and Rice-fading with the parameter $\gamma = 3$.

The system parameters are given in the table below. Determine the maximum subscriber distance to the base station under these conditions.

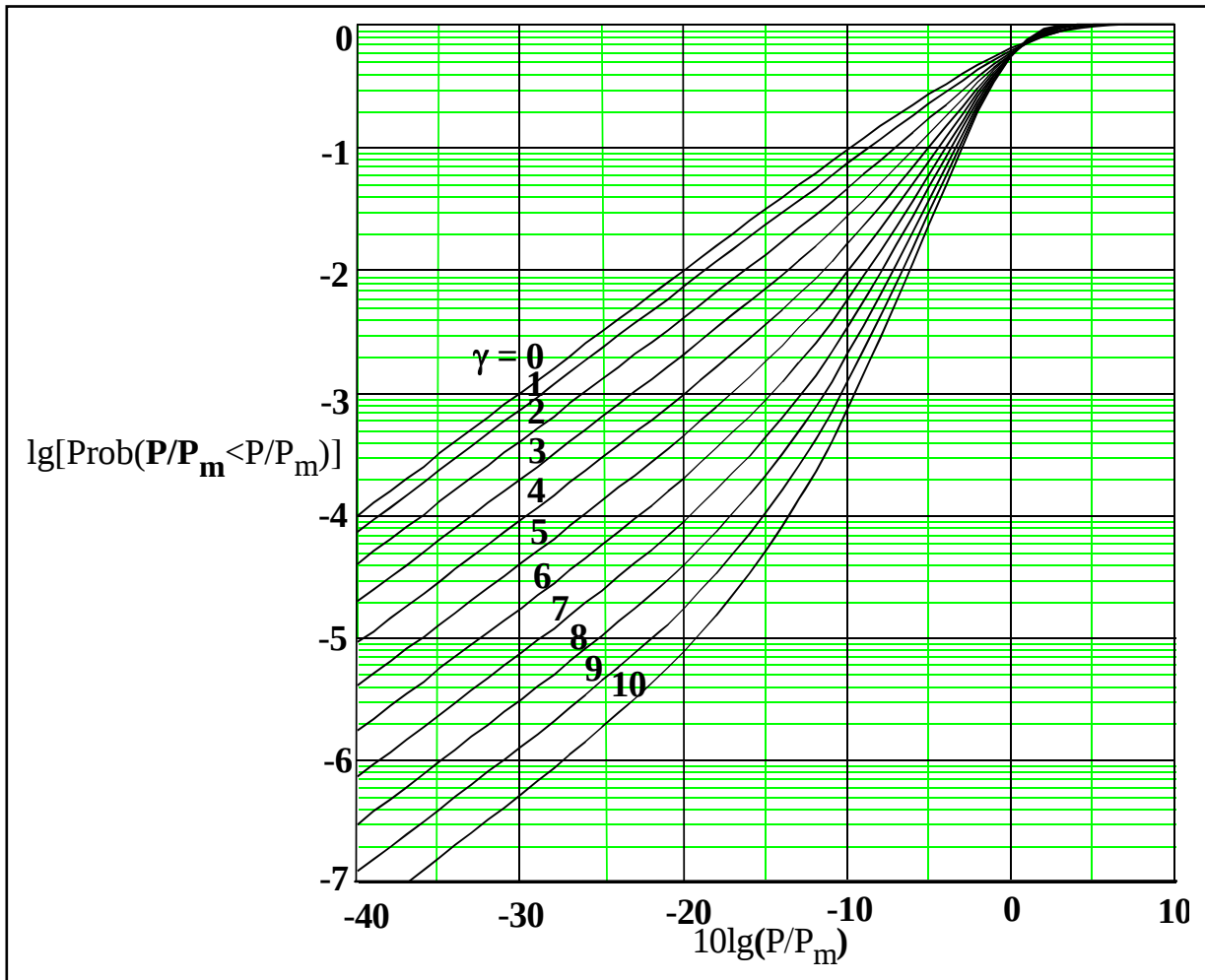


$f = 3.5 \text{ GHz}$ $P_{tx} = 20 \text{ W}$ $L_{tx} = 2.0 \text{ dB}$ $G_{tx} = 7.0 \text{ dBi}$	$G_{rx} = 18.0 \text{ dBi}$ $L_{rx} = 3.0 \text{ dB}$ Receiver sensitivity S_{rx} $= -100 \text{ dBm}$ Implementation margin $L_{impl} = 1.5 \text{ dB}$
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The radio link budget can be expressed as:

$$S_{rx} \leq P_{tx} - L_{tx} + G_{tx} - L_{fs} - L_{add} - RFM + G_{rx} - L_{rx} - L_{impl}, \text{ all in dB.}$$

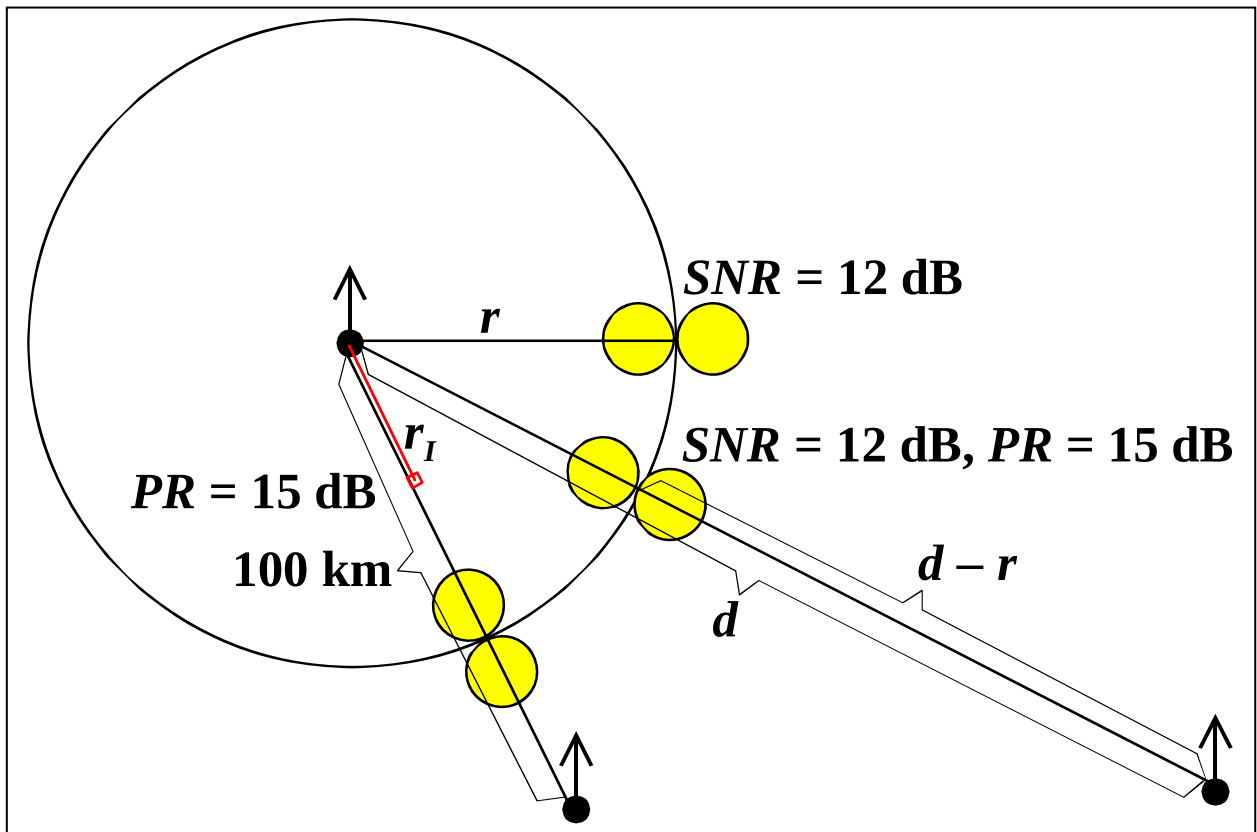
The free space loss formula is $L_{fs} = 92.5 + 20 \log f_{GHz} + 20 \log d_{km}$, and the Rice fade margin RFM should be determined from the graph under the assumption that the fade depth should exceed the margin no more than 0.01 % of time.



P20

A DAB system uses 200 MHz carrier frequency and 1.5 MHz bandwidth. The modulation method is coherent 4PSK, the receiver noise figure is 10 dB. The SNR-requirement for high quality reception is 12.0 dB and the co-channel protection ratio is 15.0 dB.

- Calculate the required field strength when the receiver input impedance is 75Ω and the receiver $\lambda/2$ dipole antenna has a 2.1 dB gain.
- What is the radius of the coverage area, when the transmitter EIRP is 3.0 kW, the transmitter and receiver antenna heights are 300m and 10 m respectively, and i) 50 % location probability, ii) 95 % location probability is required at the coverage edge? The terrain height variations $\Delta h = 50$ m.
- What is the shortest distance a co-channel transmitter with identical parameters and radiating another set of programs can be used without violating the PR requirement?
- How large is the maximum reduction of the radius of the coverage area if the distance is reduced to 100 km?



P25

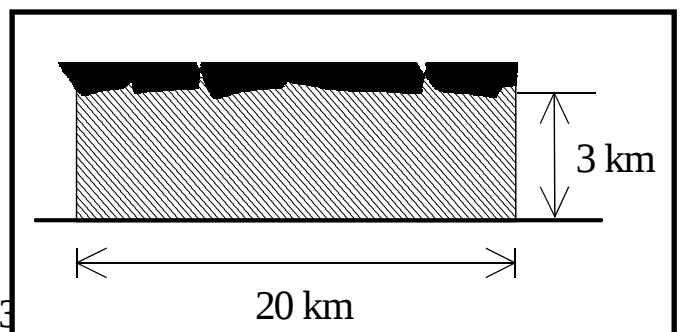
Determine the width ($\pm^\circ$) of the Earth zone where an Earth station antenna elevation angle in a three GEO-satellite system is at least 5° .

P26

The downlink characteristics of a GEO-satellite at longitude 10° W:

- Transmitter parameters:
- frequency 12 GHz
 - transmitter power 100 W
 - antenna feeder loss 1.5 dB
 - antenna diameter 2.4 m, efficiency $\eta=0.55$.
- Receiver parameters:
- location: (1) Hanko; $59^\circ 50' \text{ N}$, $23^\circ 00' \text{ E}$
(2) Utsjoki; $69^\circ 50' \text{ N}$, $27^\circ 00' \text{ E}$
 - antenna feeder 10 m, $\alpha = 30 \text{ dB/km}$
 - other losses 0.5 dB

- a) Determine the receiver $G/T=10\lg(g_{rx}/T_{tot})$ required for a SNR-value 20 dB, when the channel bandwidth is 30 MHz. (Clear air is assumed, and the atmospheric loss and equivalent noise temperature



are obtained from the attached figure. The sky temperature is assumed to be 10 K).

- b) Determine the required receiver antenna diameter ($\eta=0.55$), when the receiver noise temperature is 200 K.
- c) Calculate the rain attenuation with the rain shower in the figure, when the rain rate is $R = 20$ mm/h.
- d) Determine the G/T -degradation caused by the rain shower assuming the rain temperature to be 290 K. How large receiver antenna diameter is needed to compensate the impact of the shower?

HOME WORK 5 Submit your solution before 12:00 o'clock on 6th March

An audio broadcasting network is initially built for FM-transmission. The planning parameters are:

transmitter power: $P_{tx} = 60$ kWEIRP,

transmitter antenna height: $h_{tx} = 300$ m,

required field strength at coverage area border:

$E_{rx} = 54.0$ dB μ V/m.

- a) Estimate the radius of the coverage area.

This broadcasting network should be

utilised for DAB-transmission requiring a field strength of 44.0 dB μ V/m at the coverage area border.

- b) Determine the required transmitter power (kWEIRP) in the case of a single DAB-transmitter.
- c) Estimate the field strength at the receiver place, marked with arrows in the figure, from the other transmitters compared to the field from the transmitter in the centre (all transmitter parameters are identical).
- d) In the DAB-network only one transmitter frequency is used, and it is assumed that the received powers (W) sum up in the receiver. Determine the required transmitter power (kWEIRP) in this case.

