Bangladesh Army University of Engineering & Technology

CSE-3215
Data Communication

Lecture-14

Ahmed Salman Tariq
Lecturer
Dept. of CSE

TRANSMISSION IMPAIRMENT

Signals travel through transmission media, which are not perfect. The imperfection causes signal impairment. This means that the signal at the beginning of the medium is not the same as the signal at the end of the medium. What is sent is not what is received. Three causes of impairment are attenuation, distortion, and noise.

Attenuation: Weakening/loss of signal's strength.
Distortion: The wave form or shape of the signal is changed.
Noise: Some kind of unwanted property/energy that is added with the original signal.

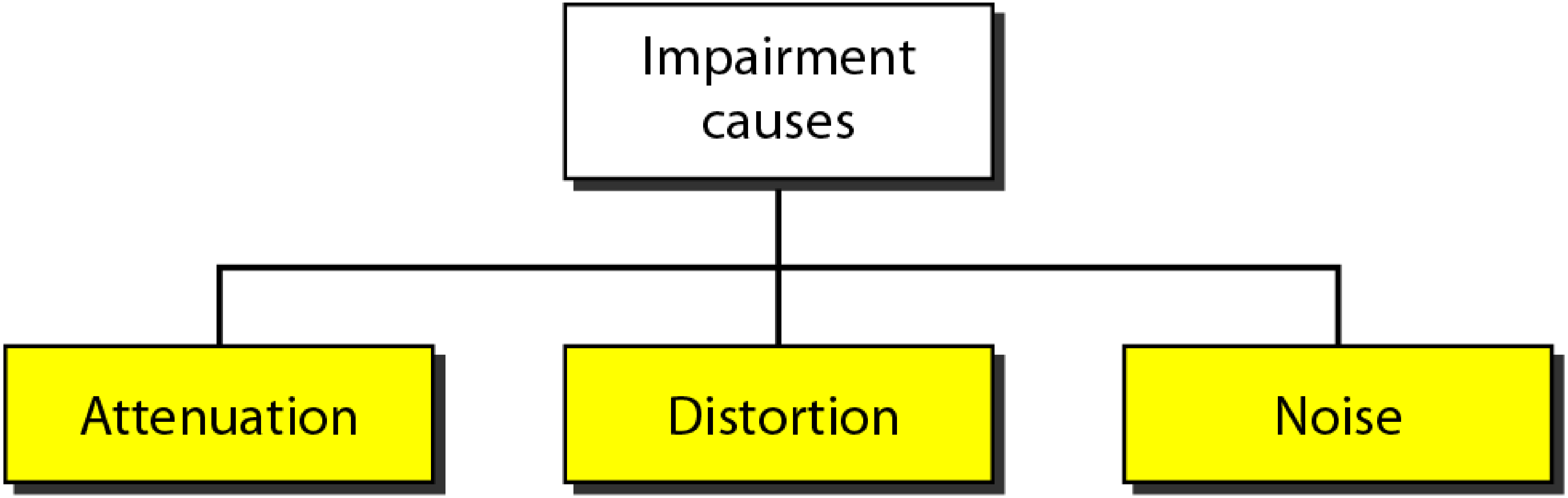


Figure 1: ***Causes of impairment***

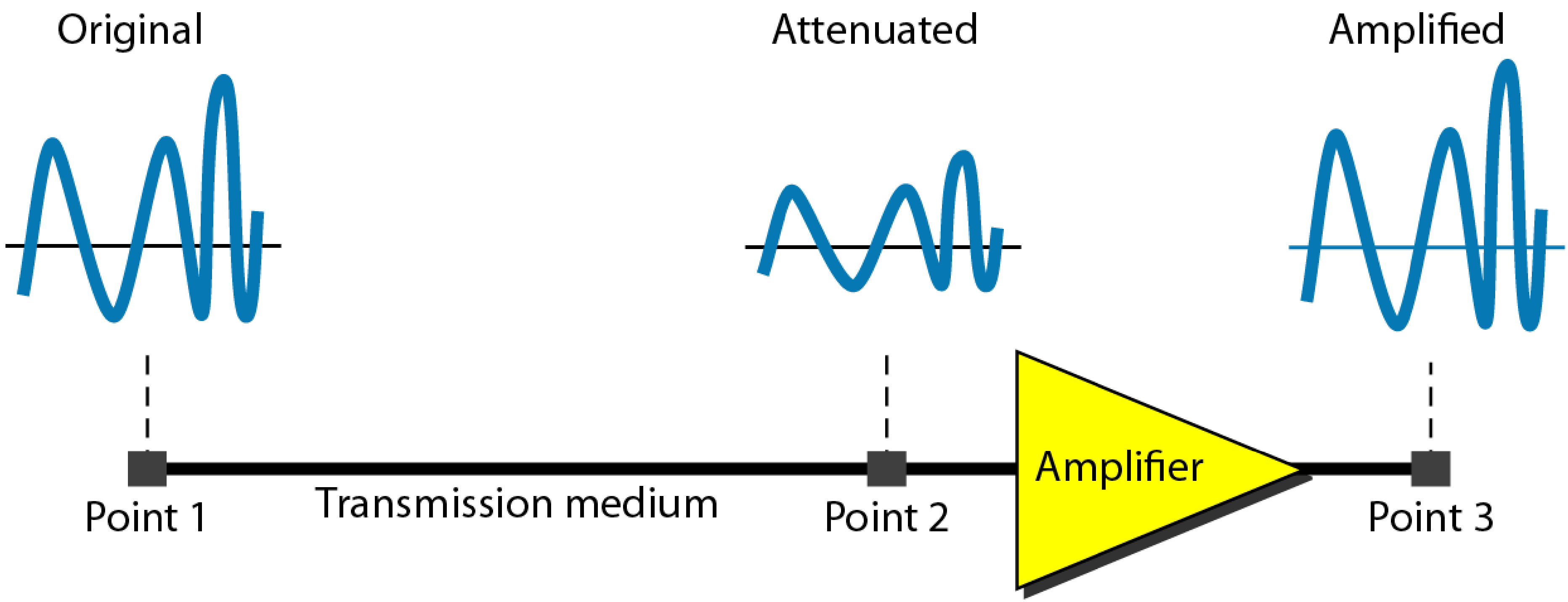


Figure 2: ***Attenuation***

Suppose a signal travels through a transmission medium and its power is reduced to one-half. This means that P2 is (1/2)P1. In this case, the attenuation (loss of power) can be calculated as

$$\boxed{10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \frac{0.5 P_1}{P_1} = 10 \log_{10} 0.5 = 10(-0.3) = -3 \text{ dB}}$$

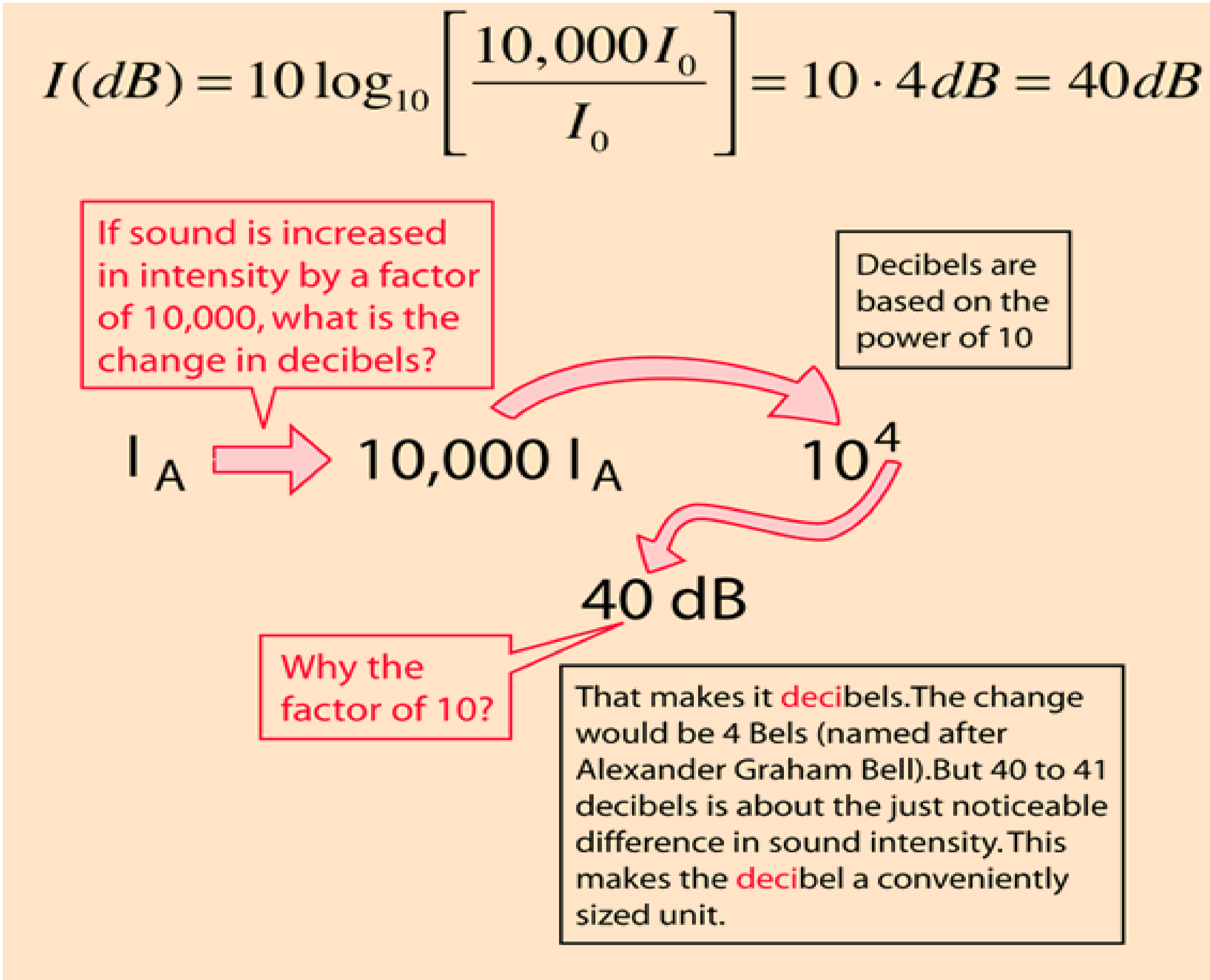
A loss of 3 dB (–3 dB) is equivalent to losing one-half the power.

A signal travels through an amplifier, and its power is increased 10 times. This means that $P_2 = 10P_1$. In this case, the amplification (gain of power) can be calculated as

$$\boxed{10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \frac{10 P_1}{P_1}}$$

$$\boxed{= 10 \log_{10} 10 = 10(1) = 10 \text{ dB}}$$

DeciBel is a unit that is used for comparing the strength of 2 different signals



One reason that engineers use the decibel to measure the changes in the strength of a signal is that decibel numbers can be added (or subtracted) when we are measuring several points (cascading) instead of just two. In *Figure 3* a signal travels from point 1 to point 4. In this case, the decibel value can be calculated as

$$\boxed{dB = -3 + 7 - 3 = +1}$$

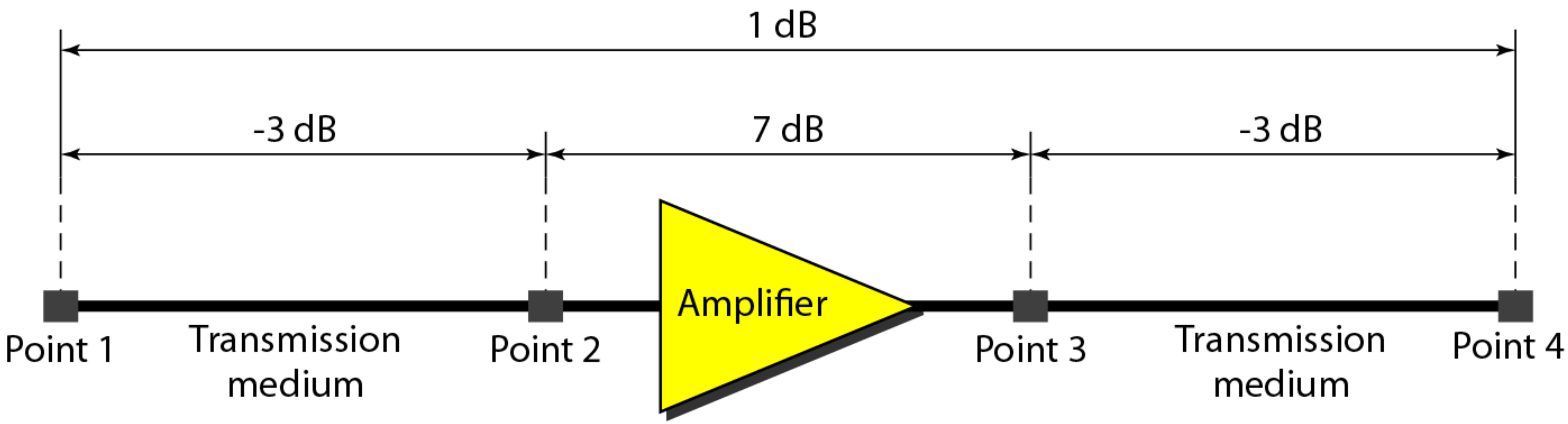


Figure 3: Decibels for the previous example

Sometimes the decibel is used to measure signal power in milliwatts. In this case, it is referred to as dB_m and is calculated as $dB_m = 10 \log10 P_m$, where P_m is the power in milliwatts. Calculate the power of a signal with $dB_m = -30$.

Solution

We can calculate the power in the signal as

$$\boxed{\begin{array}{c} \mathrm{dB_m} = 10 \log_{10} P_m = -30 \\ \log_{10} P_m = -3 \qquad P_m = 10^{-3}\ \mathrm{mW} \end{array}}$$

The loss in a cable is usually defined in decibels per kilometer (dB/km). If the signal at the beginning of a cable with −0.3 dB/km has a power of 2 mW, what is the power of the signal at 5 km?

Solution

The loss in the cable in decibels is 5 × (−0.3) = −1.5 dB. We can calculate the power as

$$\text{dB} = 10 \log_{10} \frac{P_2}{P_1} = -1.5$$

$$\frac{P_2}{P_1} = 10^{-0.15} = 0.71$$

$$P_2 = 0.71 P_1 = 0.7 \times 2 = 1.4 \text{ mW}$$

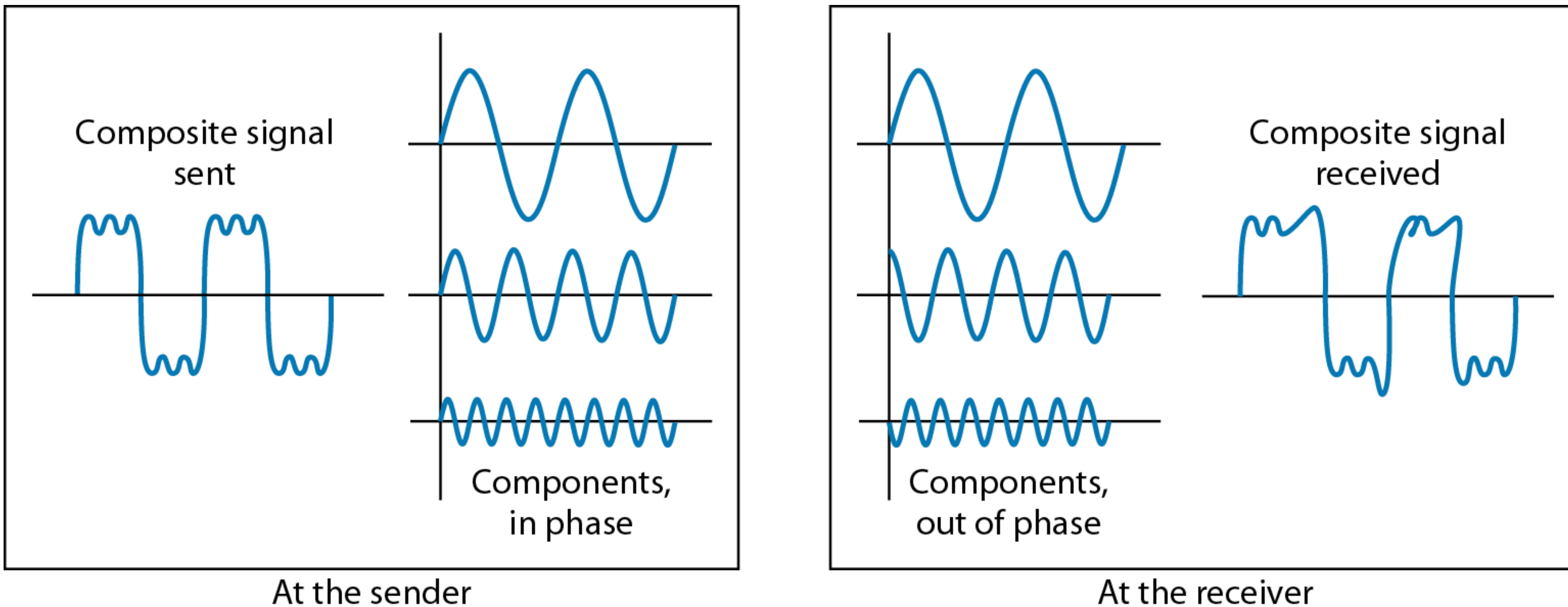


Figure 4: ***Distortion***

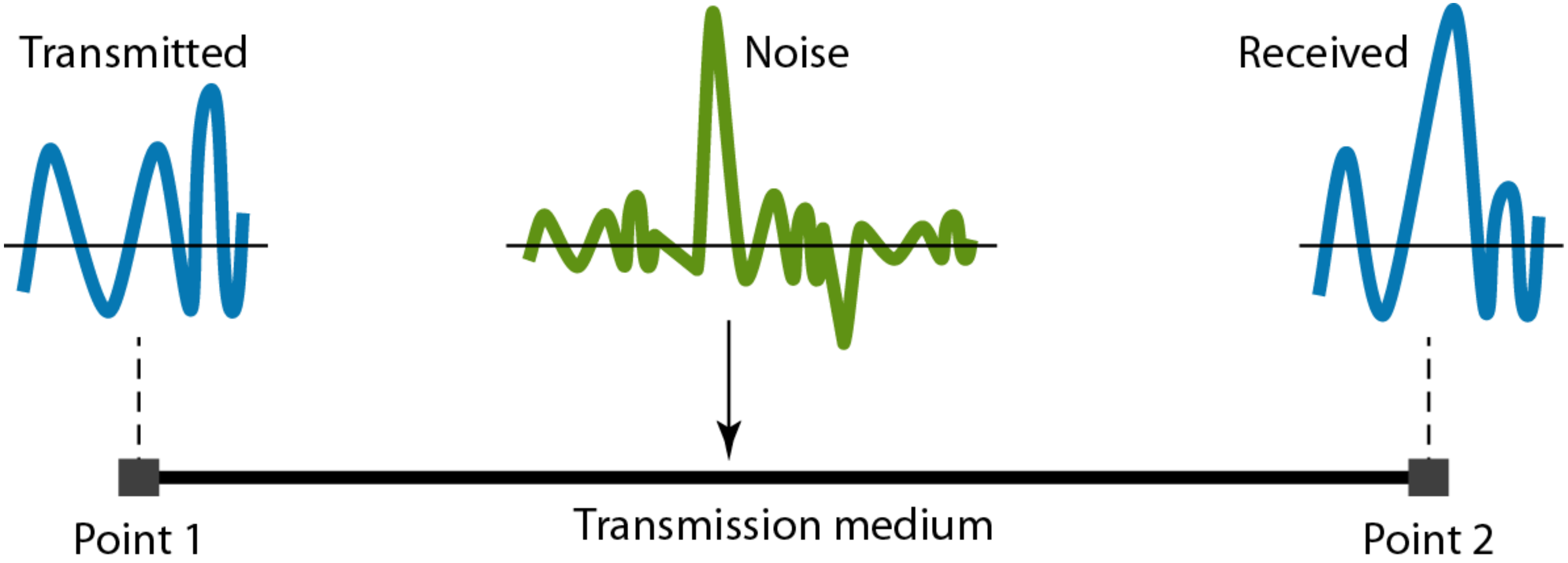


Figure 5: ***Noise***

The power of a signal is 10 mW and the power of the noise is 1 μW; what are the values of SNR and SNR_{dB} ?

Solution

The values of SNR and SNR_{dB} can be calculated as follows:

$$\boxed{\begin{gathered} SNR = \frac{10{,}000\ \mu W}{1\ mW} = 10{,}000 \\ SNR_{dB} = 10 \log_{10} 10{,}000 = 10 \log_{10} 10^4 = 40 \end{gathered}}$$

The values of SNR and SNR_{dB} for a noiseless channel are

$$\boxed{\begin{gathered} SNR = \frac{\text{signal power}}{0} = \infty \\ SNR_{dB} = 10 \log_{10} \infty = \infty \end{gathered}}$$

We can never achieve this ratio in real life; it is an ideal.

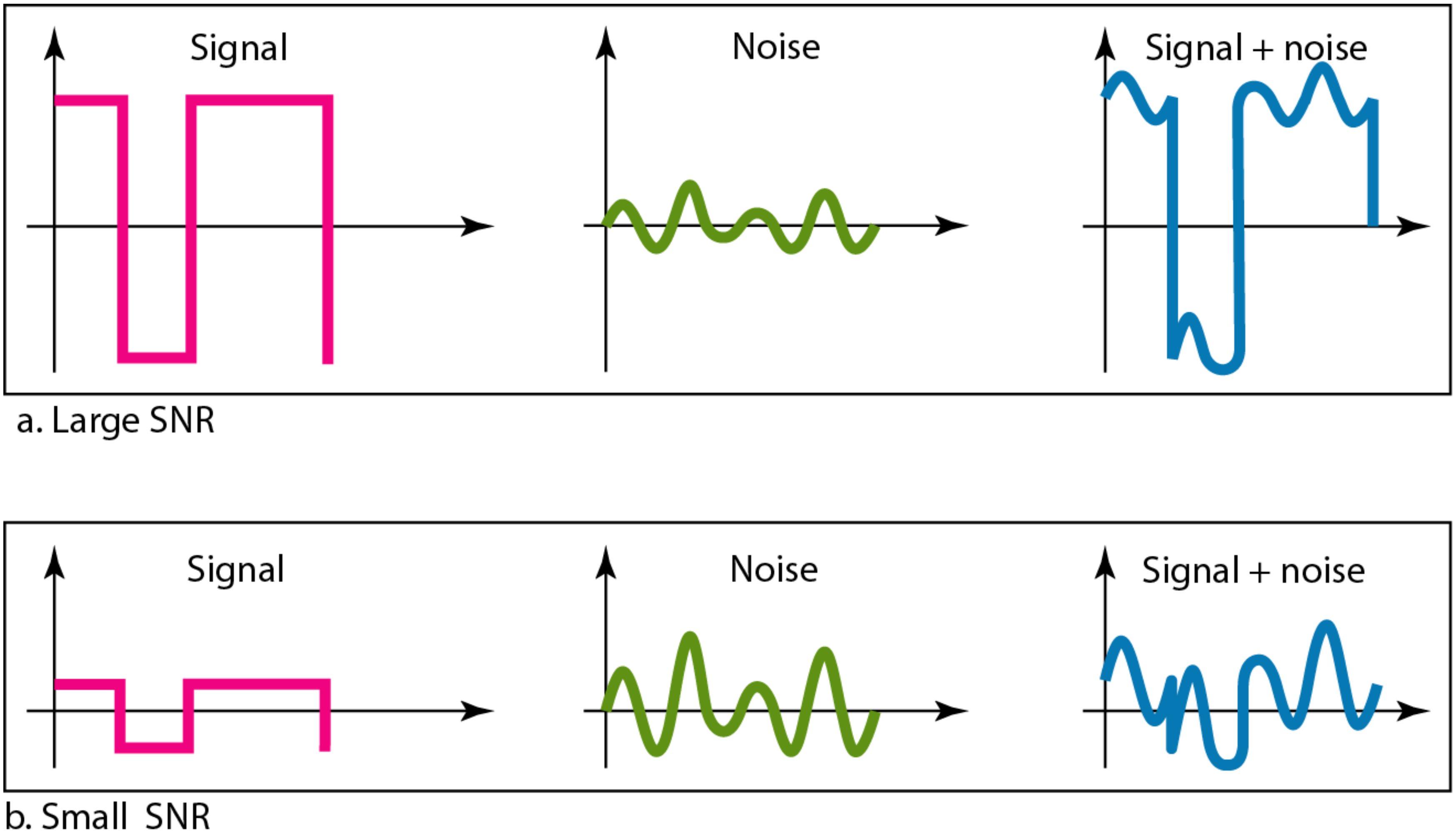


Figure 6: ***Two cases of SNR: a high SNR and a low SNR***

That's all for today

Thank You