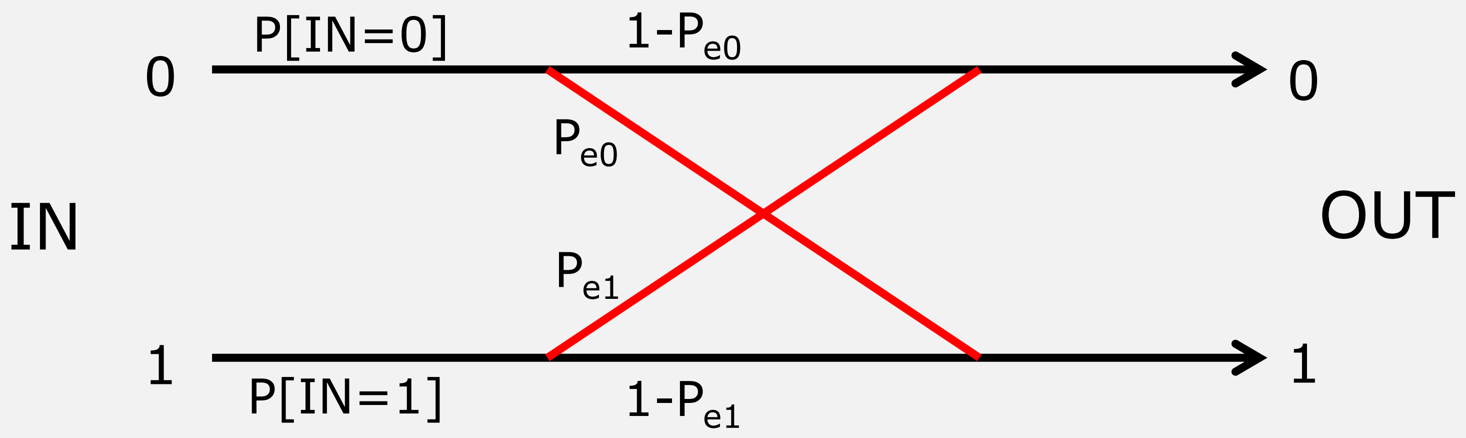
The Effect of Signal to Noise Ratio

Binary Channel Model

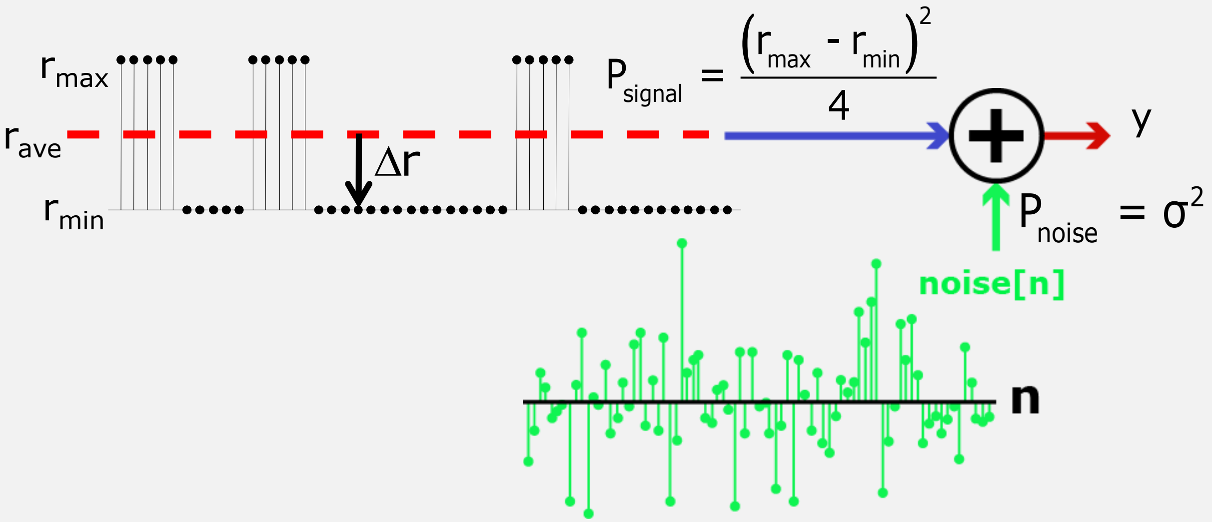


$$\boxed{BER = P_{e0} \cdot P[IN=0] + P_{e1} \cdot P[IN=1]}$$

- **This expression enables us to understand the effect of**
  - **the transmit levels (r_{min}, r_{max})**
  - **the power in the noise (σ^2)**

Signal-to-Noise Ratio

- **It is not the absolute signal or noise power that is important, but rather the Signal-to-Noise Ratio (SNR).**



$$SNR = \frac{P_{signal}}{P_{noise}}$$

$$= \frac{(r_{max} - r_{min})^2}{4\sigma^2}$$

- **SNR is often measured in decibels (dB):**
  - **0dB signal power is equal to noise power**
  - **10dB signal power is 10 times noise power**
  - **20dB signal power is 100 times noise power**
  - **30dB signal power is 1000 times noise power**

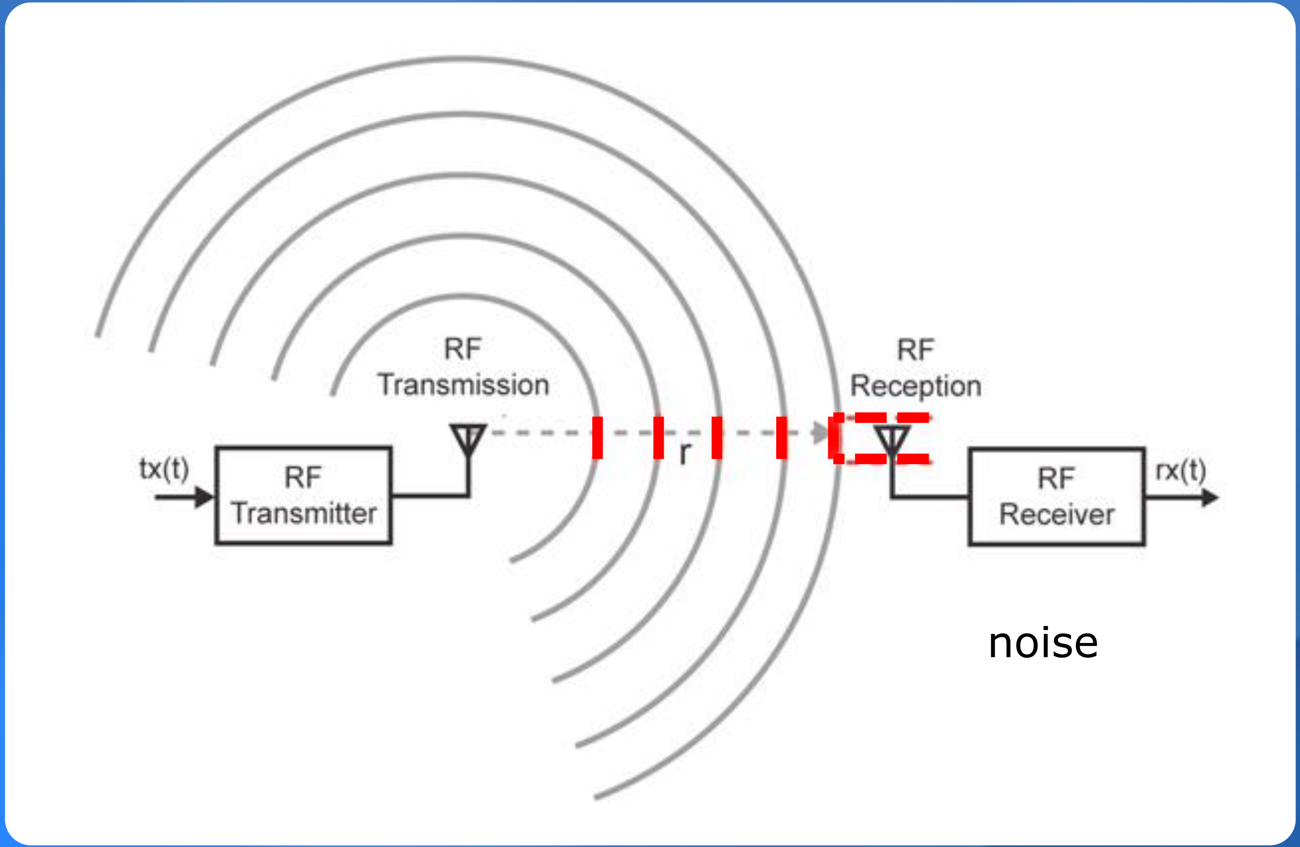
$$SNR\ (dB) = 10\log_{10}\frac{P_{signal}}{P_{noise}}$$

Noise Levels in Mobile Phones

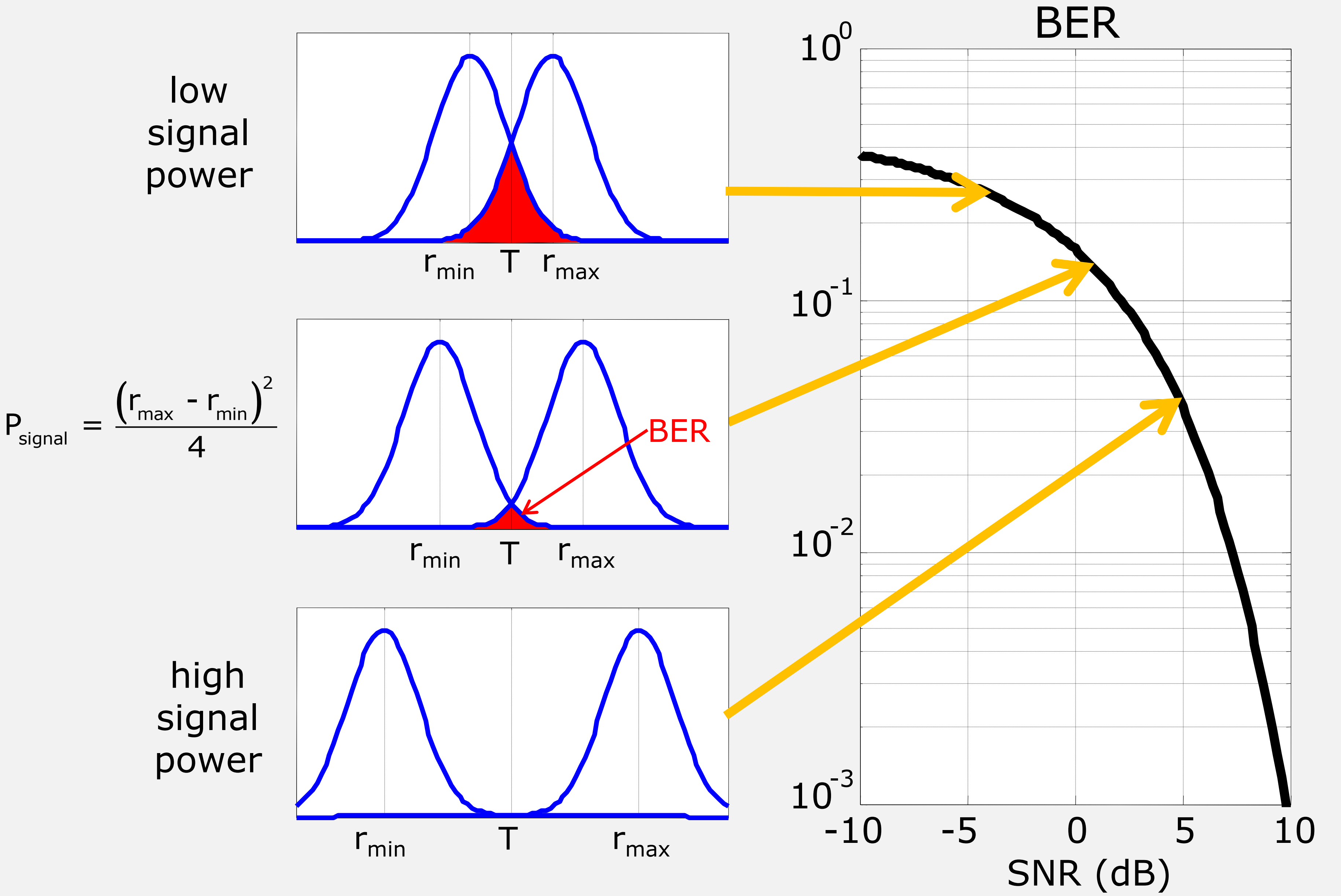
- It determines the minimum signal that can be received by radios and receivers
- What is the typical noise power present at the input of a mobile phone?
- Extremely, extremely small 10^{-15}W
- When your received signal falls to about this level your phone will lose its connection
- The exact level is determined by
  - Quality of circuits and components
  - Symbol (bit) rate

Factors affecting SNR

- Received power decreases as the receiver moves away
- Decrease in received signal power leads to decreased SNR
- Once SNR falls below around 10dB, the receiver will stop functioning- for a mobile phone this is around 10^{-14}W



BER under Changing Signal Power



BER under Changing Noise Power