

# *OFDM project overview*

Claude E. Shannon (1948):

$$C = W \log_2 \frac{P + N}{N}$$

C = Channel capacity (bits/sec)

W = bandwidth (Hz)

P = Signal power (Watts)

N = Noise power (Watts)

~ 3 bps/Hz per every 10 dB SNR



## *Principles of Orthogonal Frequency Division Multiplexing (OFDM)*

1) A single carrier  $x_k[n] = \exp(j \frac{2\pi k}{N} n)$

2) Orthogonality

$$\sum_{n=0}^{N-1} \left[ \exp(j \frac{2\pi p}{N} n) \right] \left[ \exp(j \frac{2\pi q}{N} n) \right]^* = \begin{cases} N, & p = q \\ 0, & p \neq q \end{cases}$$

3) A modulated carrier  $m_k[n] = A_k \exp(j(\frac{2\pi k}{N} n + \theta_k))$

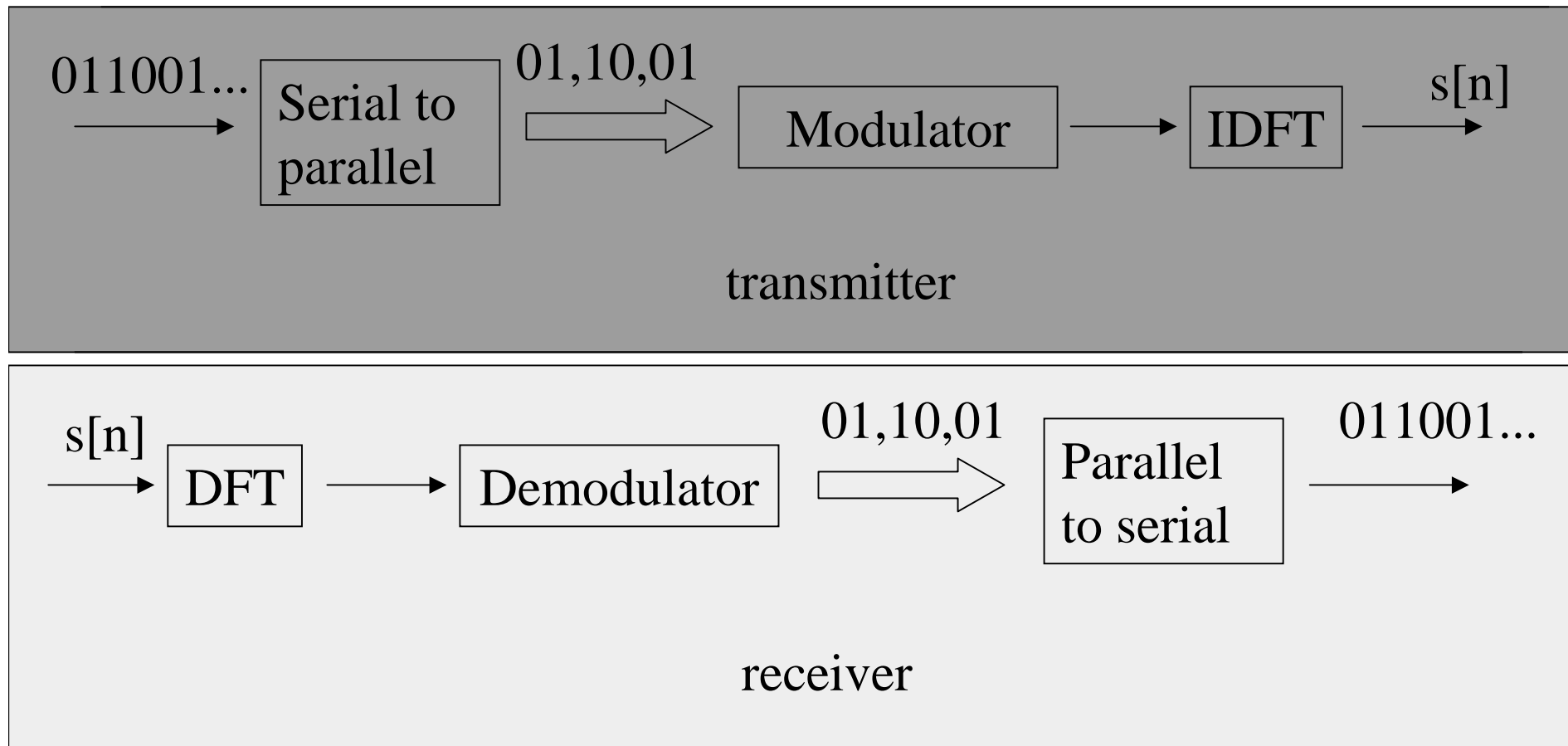
Both  $A$  and  $\theta$  carry information (bits)

4) OFDM signal (known as inverse DFT), for  $n=0,1,\dots,N-1$

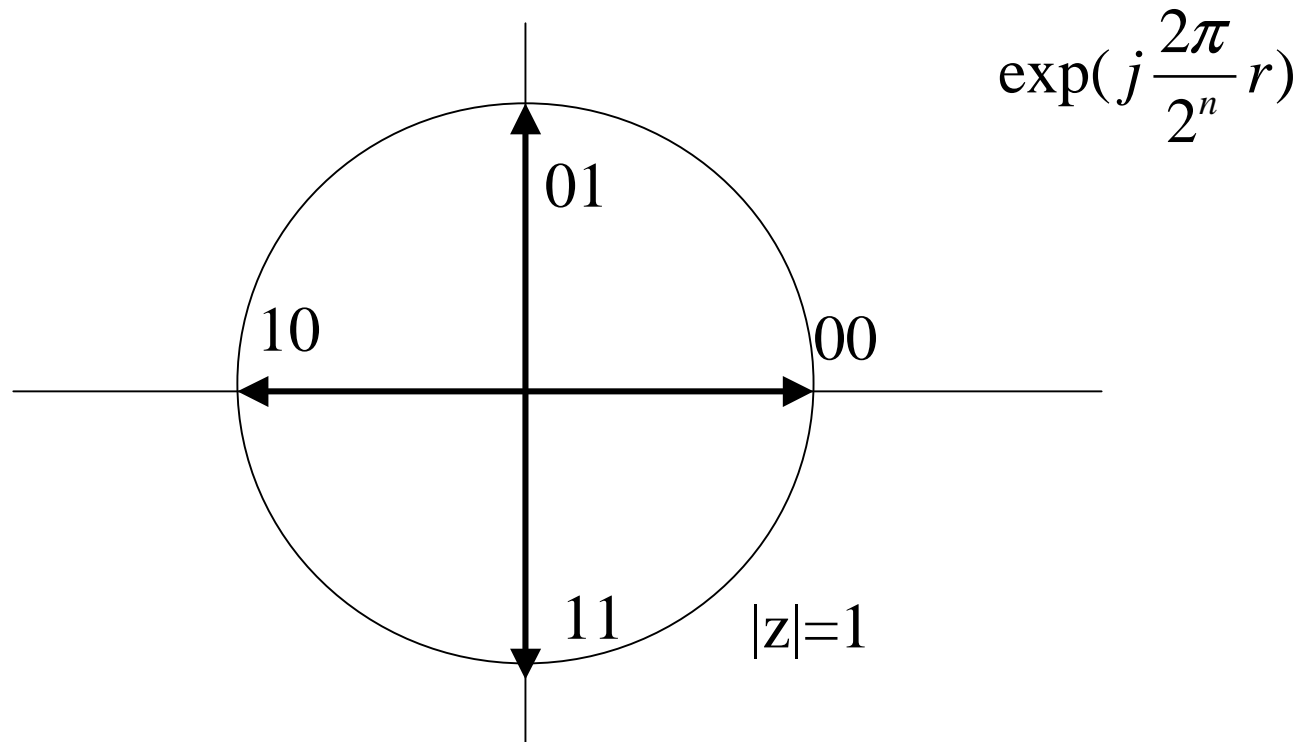
$$s[n] = \frac{1}{N} \sum_{k=0}^{N-1} A_k \exp(j(\frac{2\pi k}{N} n + \theta_k))$$

5) Message recovery (known as DFT): for  $k=0,1,\dots,N-1$

$$\sum_{n=0}^{N-1} s[n] \exp(-j \frac{2\pi k}{N} n) = A_k \exp(j\theta_k)$$



# Phase modulation ( $2^n$ PSK)



Case  $n=2$  (QPSK) shown