

Quiz of L3 - PHY

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1. What are the two units of the signal strength?
Decibel-milliwatt (dBm) and Watt (W)
2. Consider the Gaussian distribution $Z \sim N(0, 1)$. What is the mean of Z? What is the variance of Z?
mean = 0
variance = $1^2 = 1$

3. Consider a complex random variable $a+bi$ with both a and b following the complex Gaussian normal distribution $N(0,1)$. What is the average power of $a+bi$?
average power = $E[a^2] + E[b^2] = 1 + 1 = 2$

4. What is path loss? What are the factors that could determine the amount of path loss?
Path loss refers to the phenomenon of power density decrease of an electromagnetic wave, as it propagates through space.

There are various factors that can cause path loss, including environment, distance, refraction, diffraction, free-space loss, reflection and more.

5. What is the propagation delay of a link of 300m? Considering a 2.4GHz band traveling along a 300m link, what is the received phase angle? (assume the initial phase from the transmitter is 0)

$$\text{propagation delay} = \frac{300}{3 \times 10^8} = 1 \times 10^{-6}$$

$$\varphi^\circ = 360^\circ \cdot f \cdot \Delta t$$

$$\text{phase angle} = 360^\circ \times 2.4 \times 10^9 \times 10^{-6} = 864000^\circ$$

6. What is the wavelength of the 2.4GHz band? What is the wavelength of the 60GHz band?

$$\lambda_{2.4GHz} = \frac{3 \times 10^8}{2.4 \times 10^9} = 0.125$$

$$\lambda_{60GHz} = \frac{3 \times 10^8}{60 \times 10^9} = 0.005$$

(1) 0.125 m (2) 0.005 m

7. What is the multipath effect? What does LoS mean?

Multipath effect is a propagation phenomenon that happens when signals propagate by different path due to atmospheric ducting, ionospheric reflection, landscape or other factors. It describes the phenomenon of interference or distortion of the signal when the antenna receive the same signal over multiple paths.

LoS is "line of sight," which refers to an unobstructed straight path between a transmitting antenna and a receiving antenna.

8. Explain why a cosine wave and a sine wave are orthogonal to each other?

Two functions are considered orthogonal to each other over a specific interval if their inner product over that interval is zero.

$$\int_0^T \sin(\omega t) \cdot \cos(\omega t) dt = 0$$

Therefore, a cosine wave and a sine wave are orthogonal to each other.