

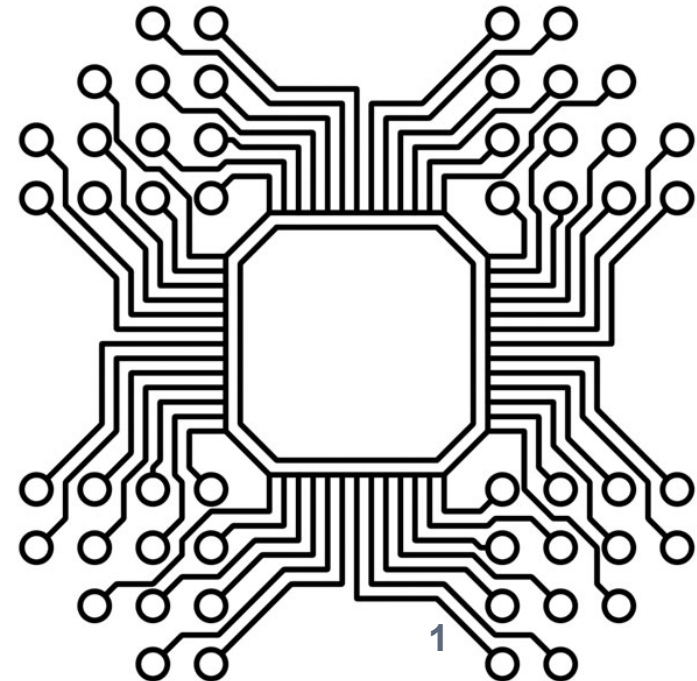
# REVIEW

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# Exercise 1

A wireless system operates at a frequency of 2.4 GHz with the following parameters:

- Transmitter power: 20 dBm
- Antenna gain (transmitter): 5 dBi
- Antenna gain (receiver): 3 dBi
- Free-space path loss at 1 km: 100 dB
- Receiver sensitivity:  $-90$  dBm

Question:

1. Calculate the link budget for the system.
2. Determine if the signal will be successfully received at the receiver.

# Exercise 2

A communication system operates at a frequency of 915 MHz, with the following parameters:

- Transmitter power: 15 dBm
- Antenna gain (transmitter): 7 dBi
- Antenna gain (receiver): 6 dBi
- Path loss over 2 km: 110 dB
- Environmental loss factor: 5 dB
- Receiver sensitivity:  $-85$  dBm

Question:

1. Compute the total link budget, accounting for environmental losses.
2. Will the receiver detect the transmitted signal?

# Exercise 3

A wireless system operates with the following parameters:

- Transmitter power: 25 dBm
- Antenna gain (transmitter): 10 dBi
- Antenna gain (receiver): 8 dBi
- Receiver sensitivity: −95 dBm
- Free-space path loss formula:

$$L_p \text{ (dB)} = 20 \log_{10}(d) + 20 \log_{10}(f) - 147.55$$

where  $d$  is the distance in meters and  $f$  is the frequency in MHz.

**Question:**

1. Calculate the maximum communication range  $d$  if the system operates at 5 GHz.

# Exercise 4

For a wireless link with the following parameters:

- Transmitter power: 30 dBm
- Antenna gain (transmitter): 12 dBi
- Antenna gain (receiver): 9 dBi
- Path loss: 120 dB
- Receiver sensitivity:  $-100$  dBm

**Question:**

1. Compute the link margin for this system.
2. If the link margin is insufficient, suggest possible improvements to increase the link budget.

# Exercise 5

An MQTT publisher sends 10 messages per second to the broker. Each message is 256 bytes. The overhead per message (header + metadata) is 24 bytes.

**Question:**

1. Calculate the total data transferred in 1 minute.
2. If the system operates for 24 hours, how much data is transferred in a day?

# Exercise 6

An IoT sensor node operates using MQTT and sends data to the cloud every minute. Each transmission consumes  $200 \text{ mW}$  for  $2 \text{ s}$ . When idle, the node consumes  $50 \text{ mW}$ .

## Question:

1. Calculate the total energy consumed in one hour.
2. If the device operates on a  $5 \text{ V}$ ,  $1000 \text{ mAh}$  battery, estimate its operational lifespan.