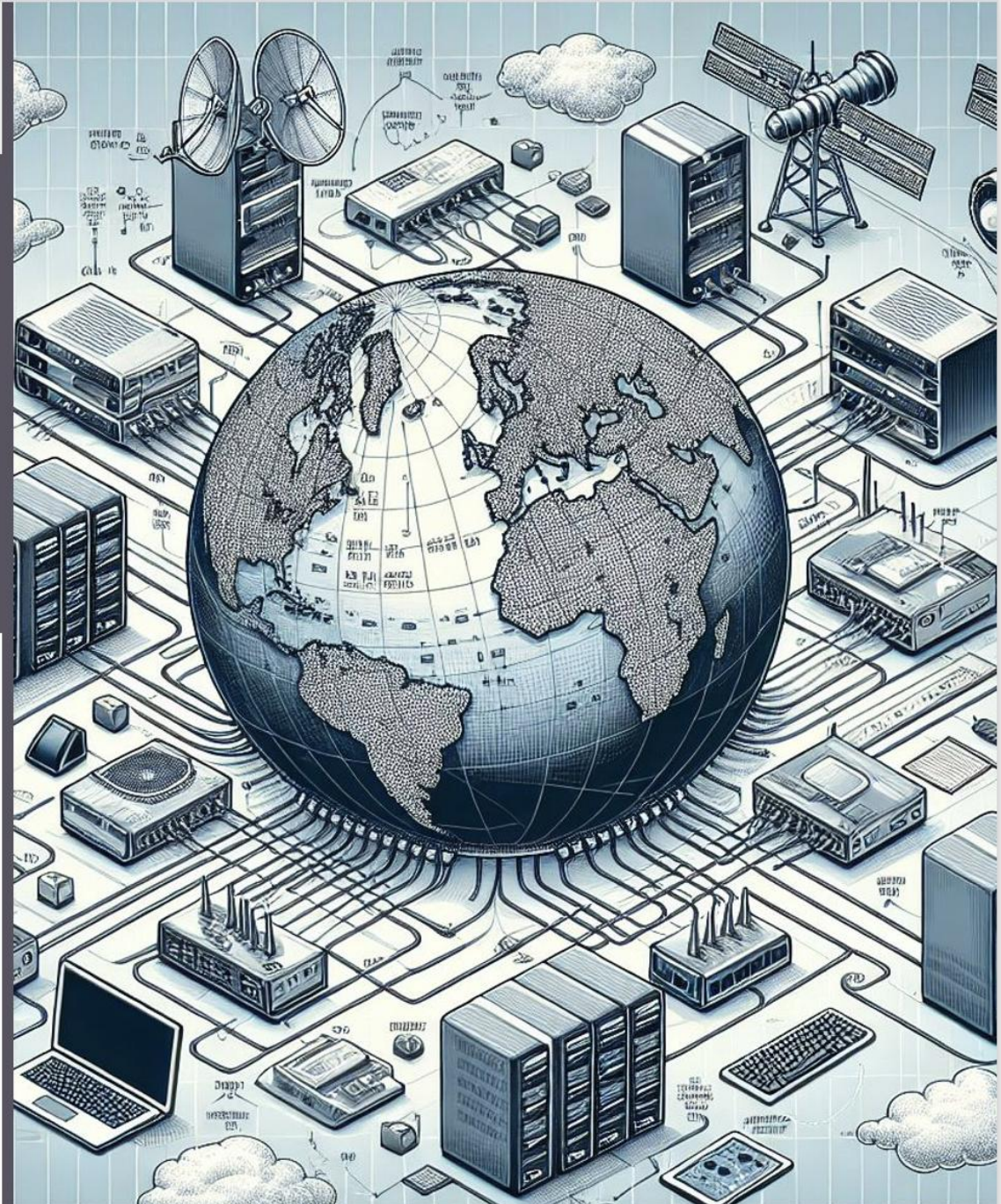


# CS 334/534 NETWORKING

**Dr. Ragib Hasan**

**Lecture 4.1:**  
Introduction to Radioland

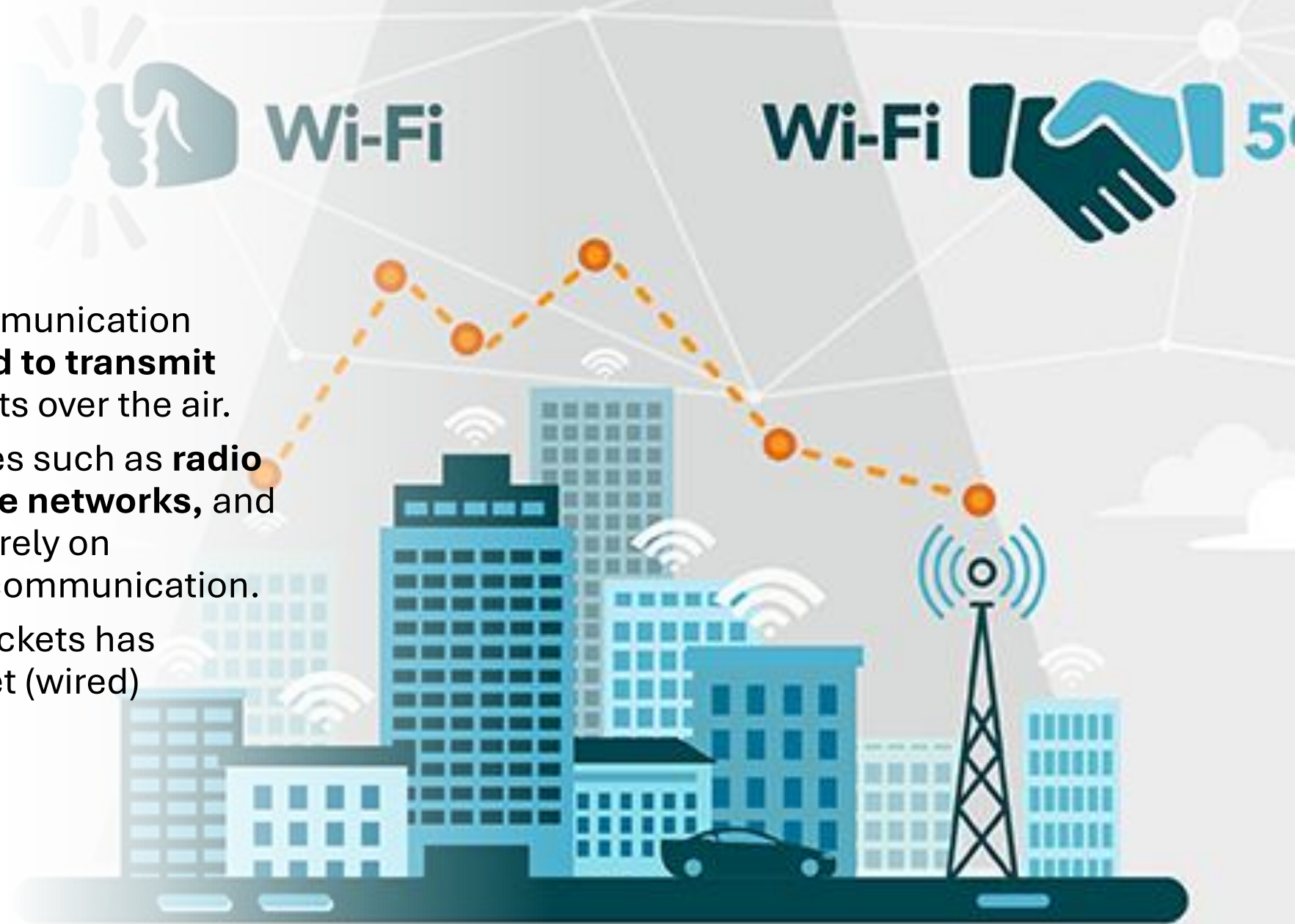


# Lecture goals

- Introduce Radioland
  - Privacy issues of Radioland
  - Bandwidth and Data rate
  - Multipath
- 
- Book reference: Chapter 4, section 4.1.1 to 4.1.8



# Radioland



- The domain of wireless communication where **radio waves are used to transmit data**, signals, and broadcasts over the air.
- It encompasses technologies such as **radio broadcasting, Wi-Fi, mobile networks**, and other wireless systems that rely on electromagnetic waves for communication.
- Wireless transmission of packets has several changes the Ethernet (wired) transmission.

# Privacy

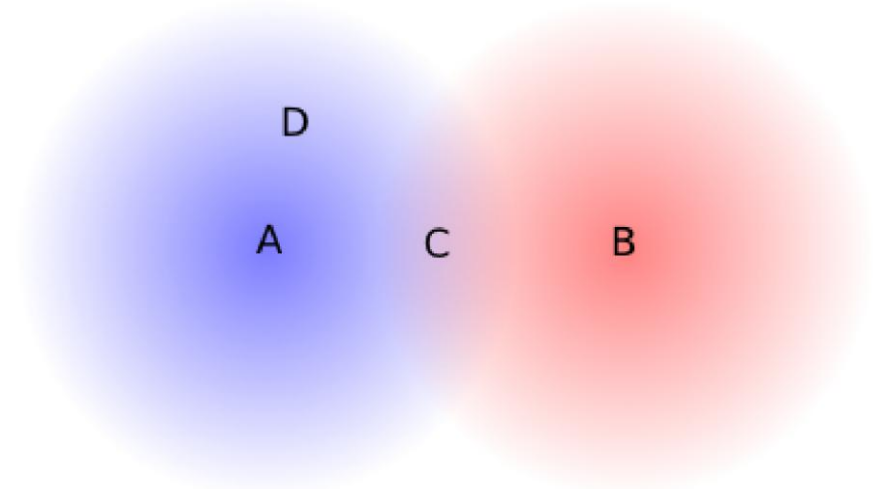
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- **Wired Ethernet vs. Wireless Security**
  - Wired Ethernet is harder to tap into, especially without physical access.
  - Wireless transmissions are easily intercepted, often from a distance.
- **TJX Corporation Breach**
  - Attackers parked outside a building and used a directional antenna.
  - Weak encryption was exploited to access data.
- Internet café users risk exposure **without strong encryption**, highlighting the need for robust security in radio communications.



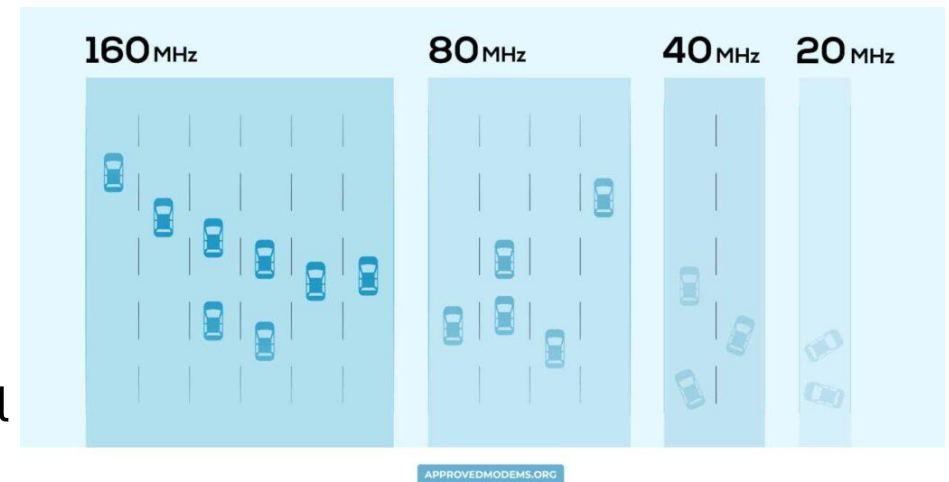
# Collision Detection

- Collision detection is impractical over radio because **remote signals are too weak** compared to the transmitted signal, making them undetectable during transmission.
- **Hidden Nodes:**
  - A and B are not in range of one another
  - If A and B transmit simultaneously then there will be a collision at C
  - Neither A nor B can possibly detect this
  - This creates an additional complication to collision handling



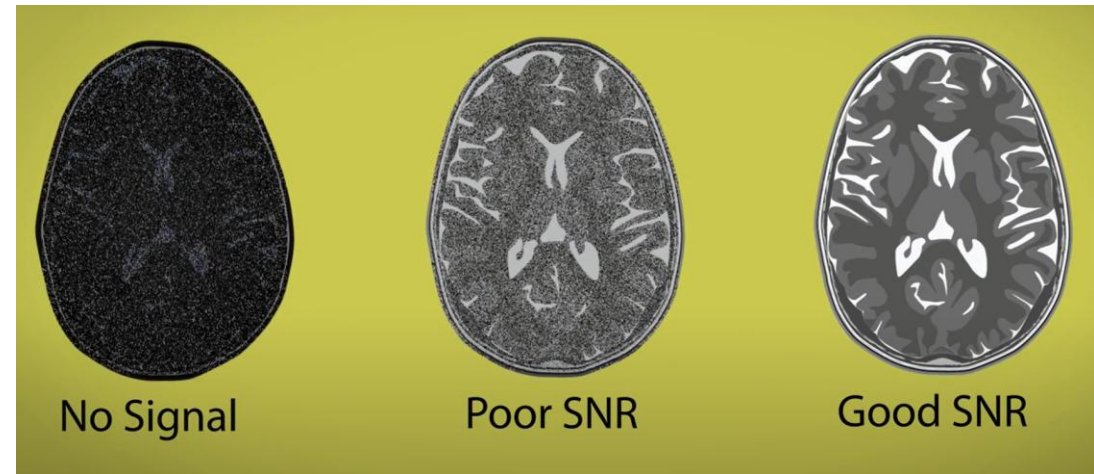
# Bandwidth and Data rate

- Bandwidth is the **frequency range** used by a signal.
- "Channel width" or "width of the frequency band" is the "space" a signal takes up to transmit data in the frequency range.
- Example: FM Radio Stations
  - Each FM radio station broadcasts at a specific frequency (e.g., 101.1 MHz).
  - The channel width for FM radio is typically 200 kHz (0.2MHz), meaning the station uses a small portion of the frequency range.
  - If two stations are too close in frequency (e.g., 101.1 MHz and 101.2 MHz), they might interfere because their signals overlap.



# Bandwidth and Data rate

- SNR (Signal-to-Noise Ratio) is used to compare the **strength of a signal** to the level of background noise.
- It quantifies how much a signal stands out from the noise.
- SNR = 127, Channel Width = 1 MHz, Max Data Rate = 7 Mbps
- SNR = 63, Channel Width = 1 MHz, Max Data Rate = 6 Mbps

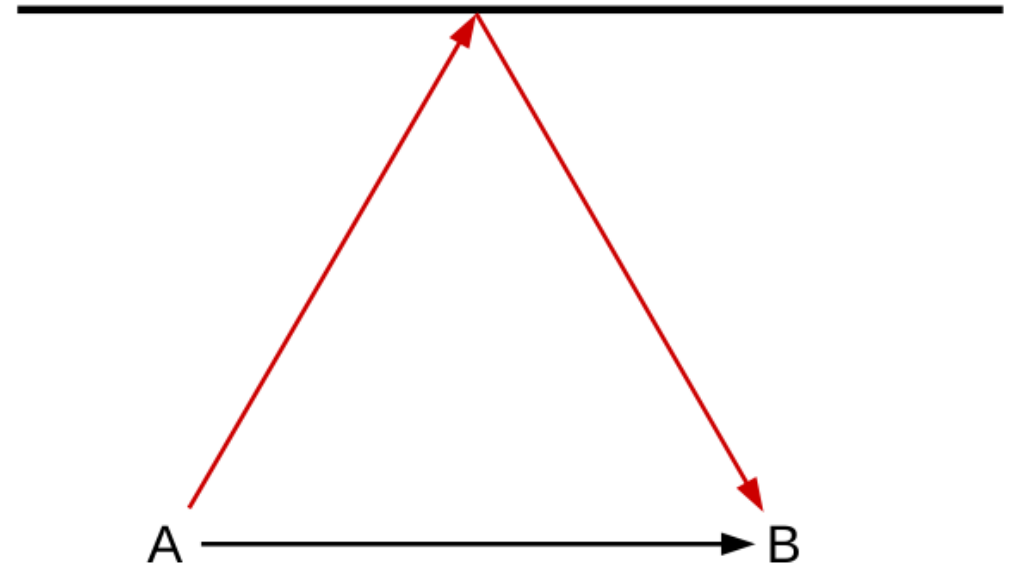


$$\text{Max Data Rate} = \text{Channel Width} \times \log_2 (1 + \text{SNR})$$

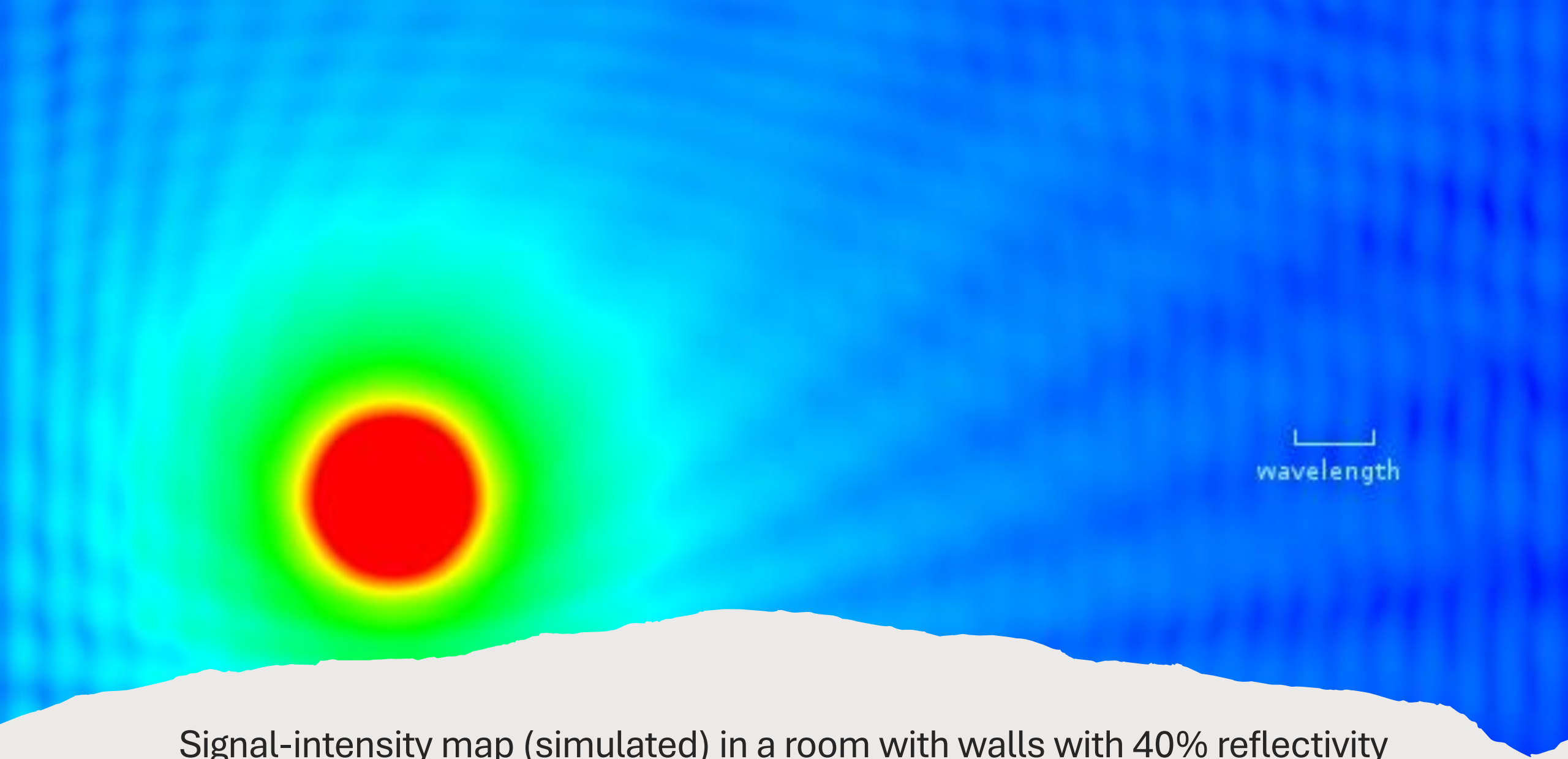
# Multipath

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- **A signal may reach a receiver through several ways**
  - A line-of-sight path
  - Reflected paths







Signal-intensity map (simulated) in a room with walls with 40% reflectivity

# Other Challenges

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- **Costs:** The shared radio spectrum leads to high costs for mobile providers and congestion for Wi-Fi users, with strategies like smaller coverage zones and directional antennas used to manage demand.
- **Power usage:** When replacing network and power cables with wireless, power consumption becomes crucial, and technologies like Wi-Fi's "dozing" and the 6LoWPAN project help minimize energy use.
- **Tangle:** Wireless technologies like Bluetooth and ZigBee replace cords and connectors, offering low-power alternatives for devices like mouse and headsets, with ranges of about 10 meters.

