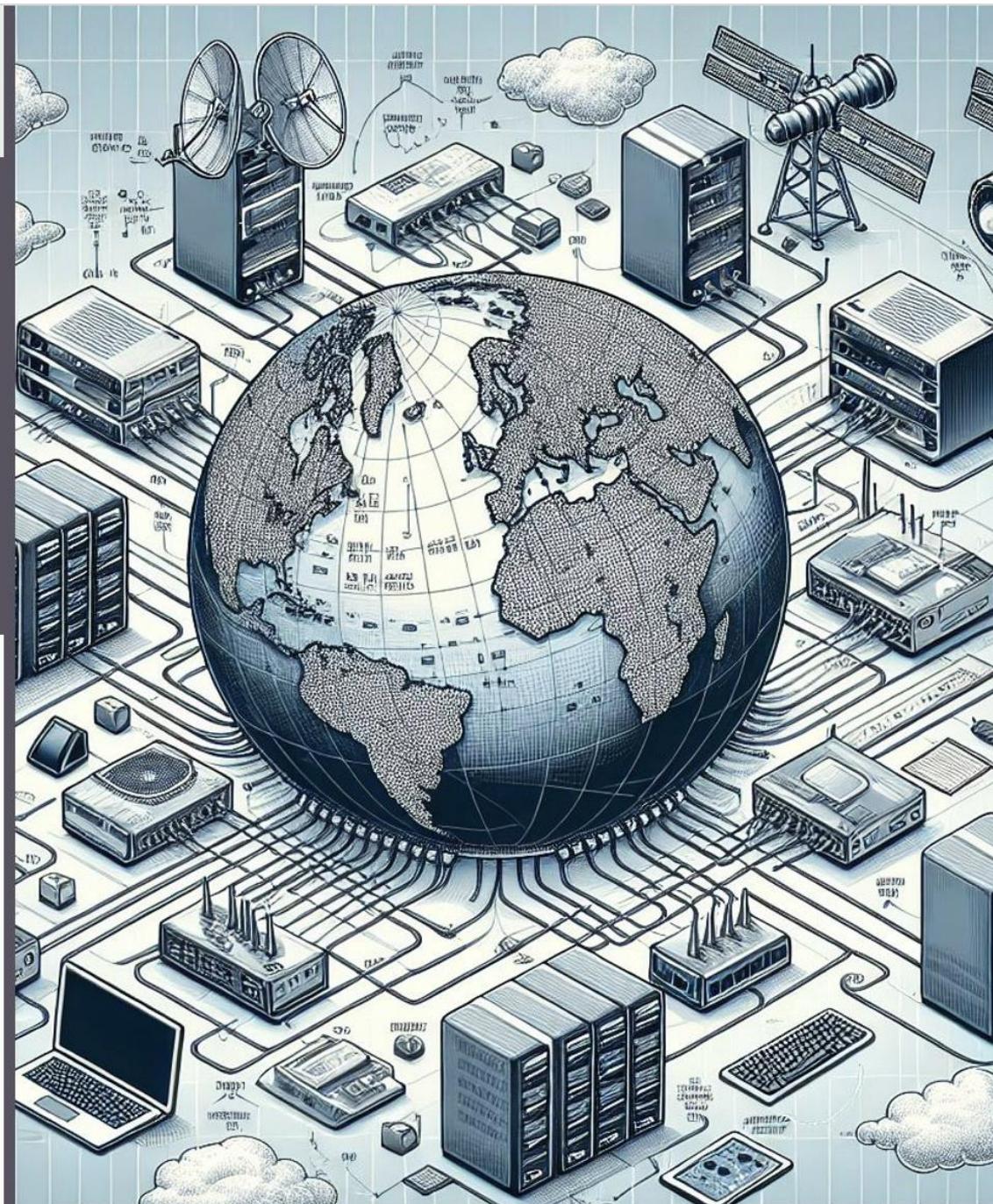


CS 334/534

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.

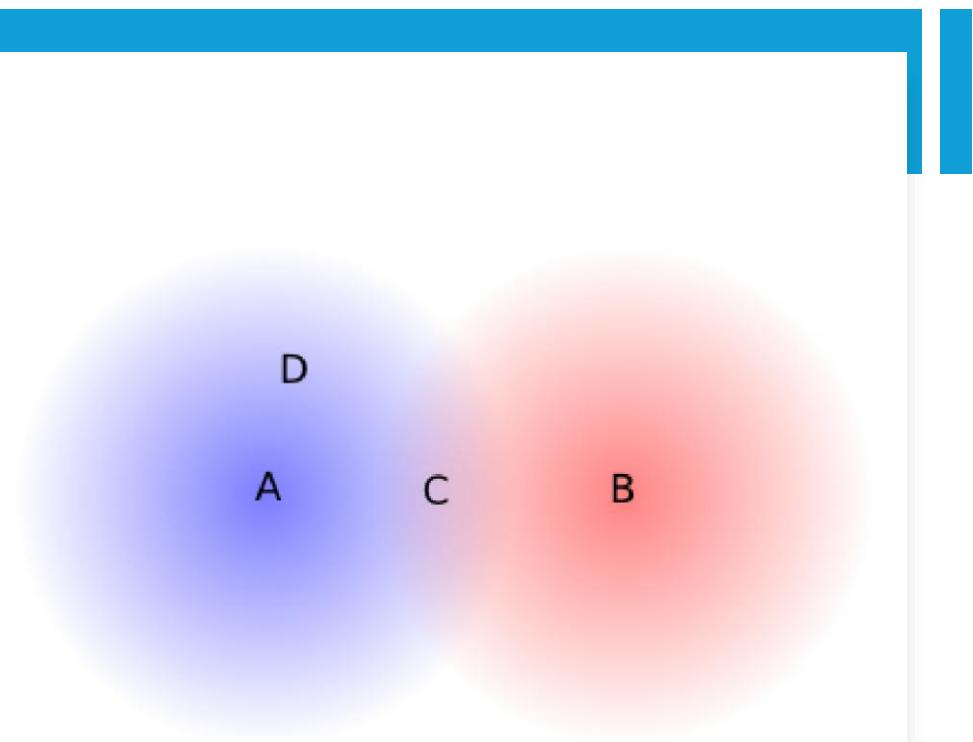
Privacy

- **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.



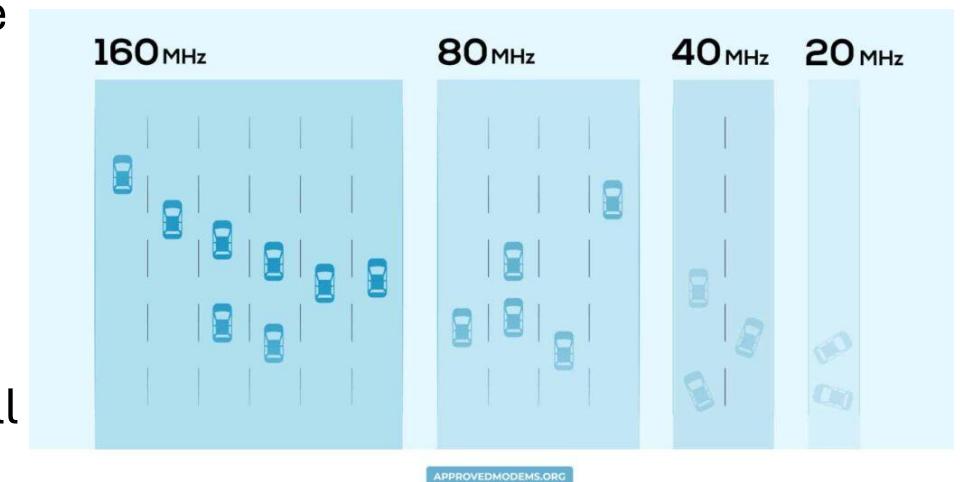
Collision Detection

- 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



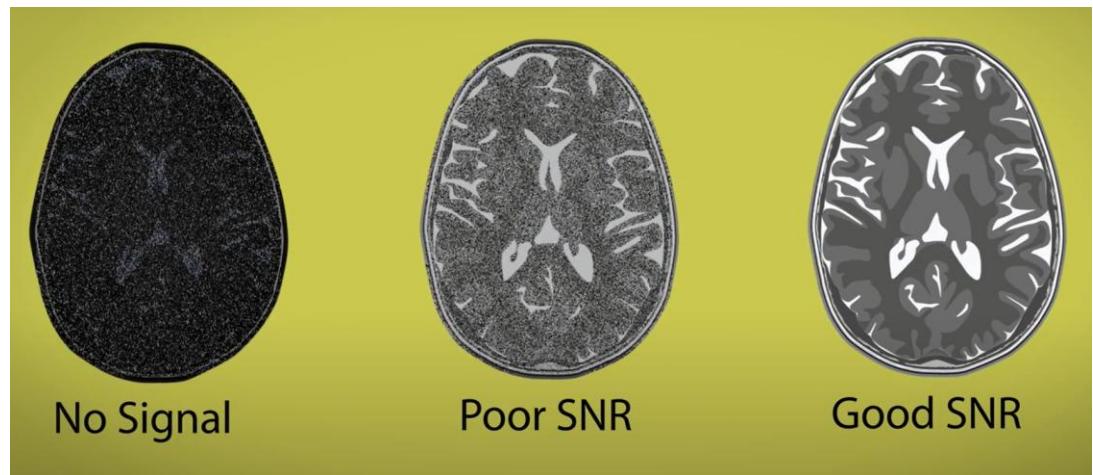
Bandwidth and Data rate

- 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

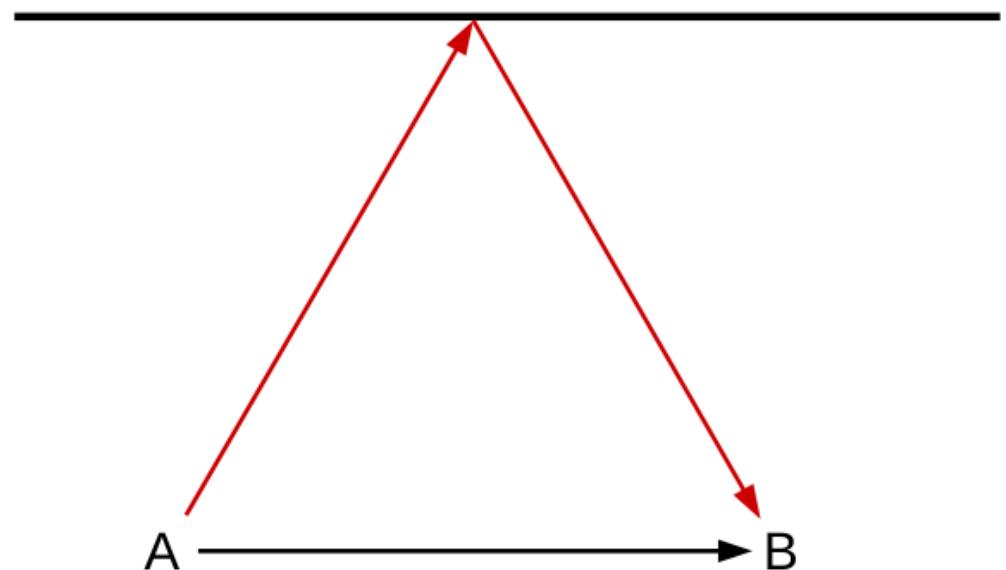
- SNR (Signal-to-Noise Ratio) is used to compare the **strength of a signal** to the level of background noise.
- It quantifies how much a signal stands out from the noise.
- $\text{SNR} = 127$, Channel Width = 1 MHz, Max Data Rate = 7 Mbps
- $\text{SNR} = 63$, Channel Width = 1 MHz, Max Data Rate =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

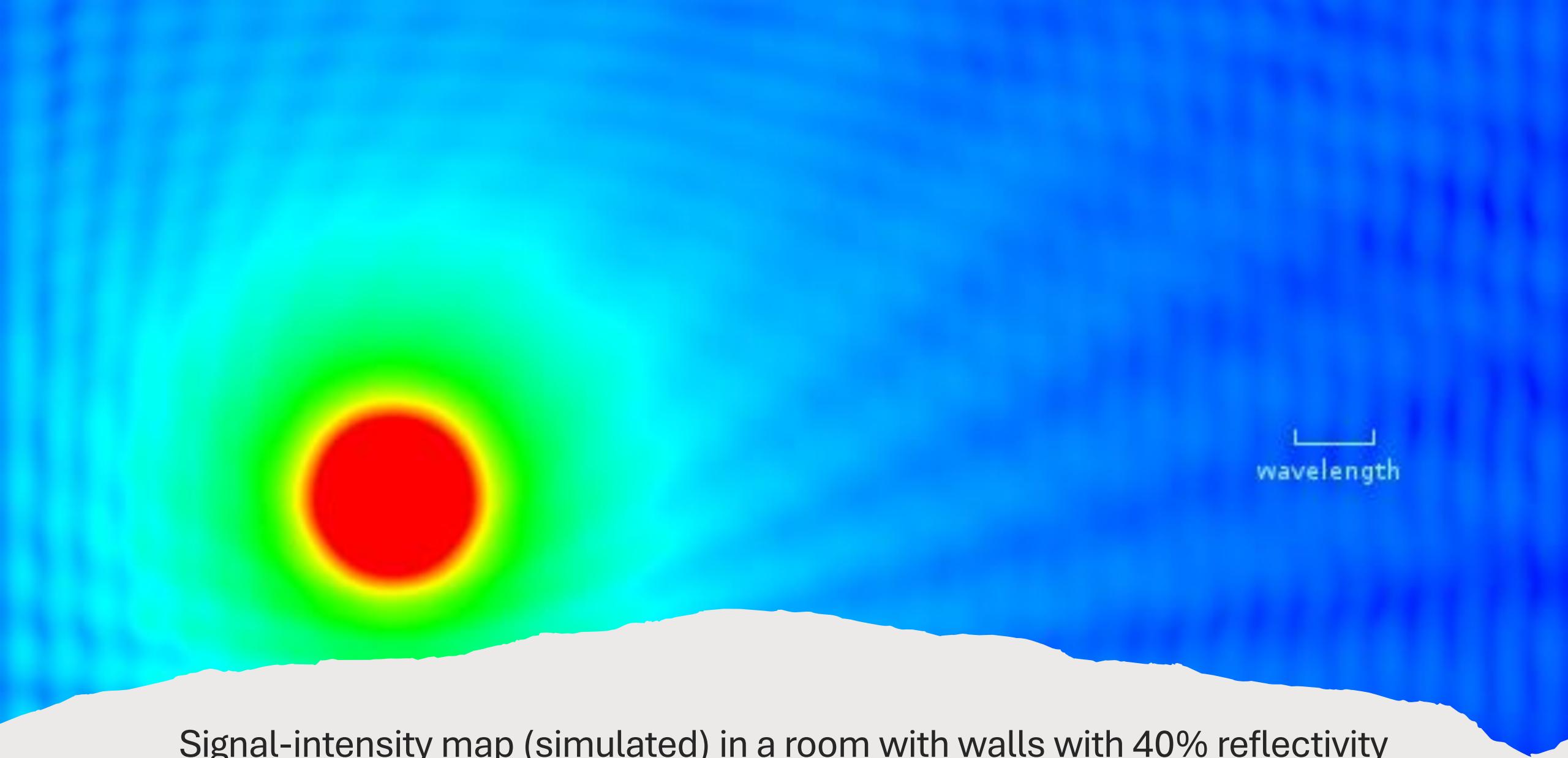


$$\text{Max Data Rate} = \text{Channel Width} \times \log_2 (1 + \text{SNR})$$

Multipath

- 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

- **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.

