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1G Wireless Network

- First generation cellular network
- Entirely analog communication, would be replaced in the next generation (2G) by digital
- Calls could easily drop because of interference with other signals
- Materials: analog radio systems, cell towers

Improvements in 2G

- Digital encryption
- Data services for phones included SMS and MMS
- More efficient use of radio frequencies allowing more users per band

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Fading in Wireless Channels

Overview

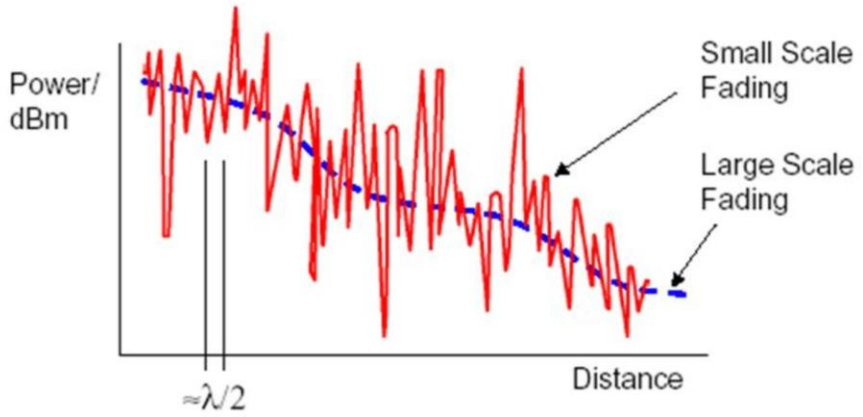
- Fading is the variation in strength of a signal
- Fluctuations in signal strength and quality over time and distance
- Can be caused by multipath propagation, atmospheric conditions, and objects in the transmission path
- 2 types: small scale and large scale

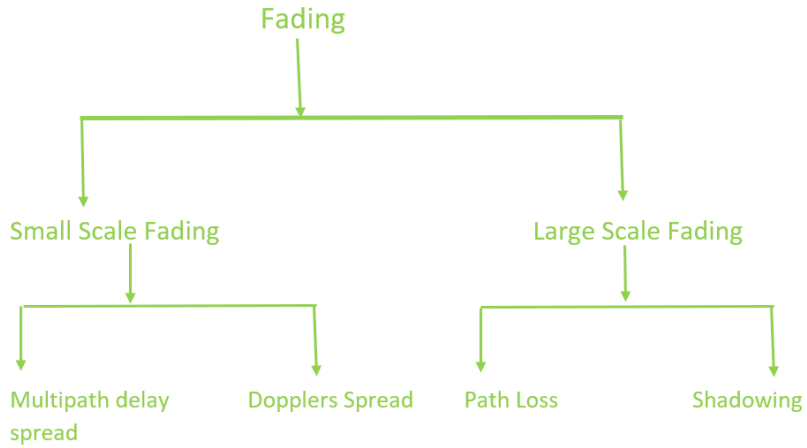
Small Scale VS Large Scale Fading

- Small scale fading occurs over shorter distances and degrades signal quality quickly
- Large scale fading occurs over longer distances and impacts the overall signal intensity

Fading models/distributions

- Rayleigh fading, Rician fading, Nakagami fading, Weibull fading





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IEEE 802.11 Standards

IEEE 802.11

- Original wifi standard from 1997, most widely used wireless computer network protocol
- 2.4GHz

IEEE 802.11b

- Incorporated modulation schemes to reduce interference from other devices, introduced in 1999
- Also 2.4GHz

IEEE 802.11a

- First wifi specification to feature a multicarrier modulation scheme for higher data rates, also introduced in 1999
- Supported 5GHz

IEEE 802.11g

- Allowed for faster data rates on 2.4GHz device, since 5GHz devices were more expensive this appealed to the public
- 2.4GHz

IEEE 802.11n

- Supported both frequency bands and multiple channels within each frequency band
- 2.4 GHz and 5GHz

IEEE 802.11ac

- first Wi-Fi standard to enable the use of multiple input/multiple output (MIMO) technology so that multiple antennas could be used on both sending and receiving devices to reduce errors and boost speed

IEEE 802.11ax

- this standard isn't primarily about boosting Wi-Fi speeds per se. Rather, it addresses the fact that Wi-Fi usage is now so pervasive that network performance can be degraded in areas of dense Wi-Fi traffic

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Handoff/Handover

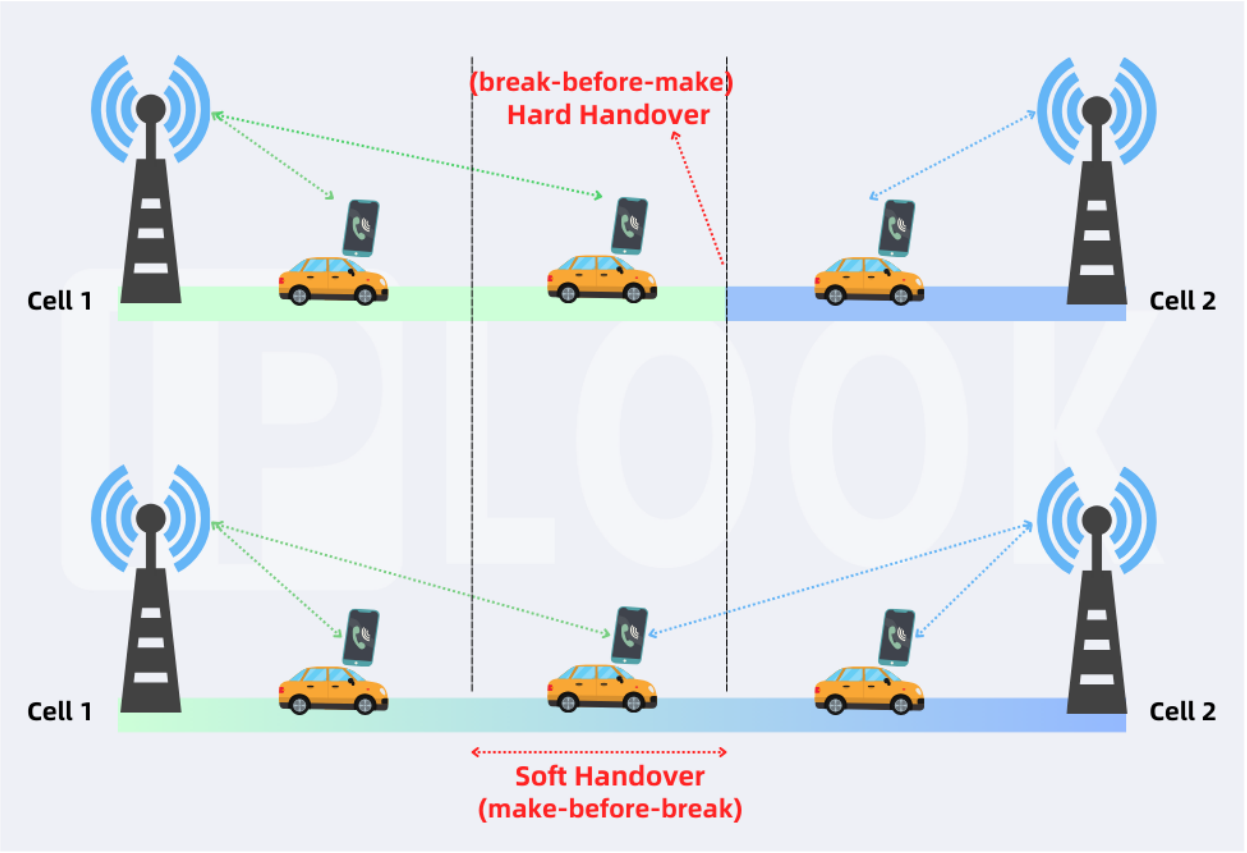
- Handover, or handoff, is when voice or data from a cellular transmission must transition from one base station to another
- Connection should not be interrupted for the mobile users

Hard Handover

- Releases the source connection before making connection with the new tower
- Brief interruption in connectivity

Soft Handover

- Both towers operate in parallel for a time before switching
- Parallel connection enhances service quality



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Routing Protocols for Wireless Sensor Networks

- WSNs are made of hundreds of miniscule nodes which are expanded as masses or deployed one at a time
- The nodes must work together through wireless communication techniques to achieve their task
- Four classifications of routing protocols:

Datacentric

- Information is diverted between the origins to the sink, during the route, routing nodes analyze the nature of the information and integrate or synthesize data from distinct origins
- Protocols: directed diffusion, SPIN, GBR

Hierarchical

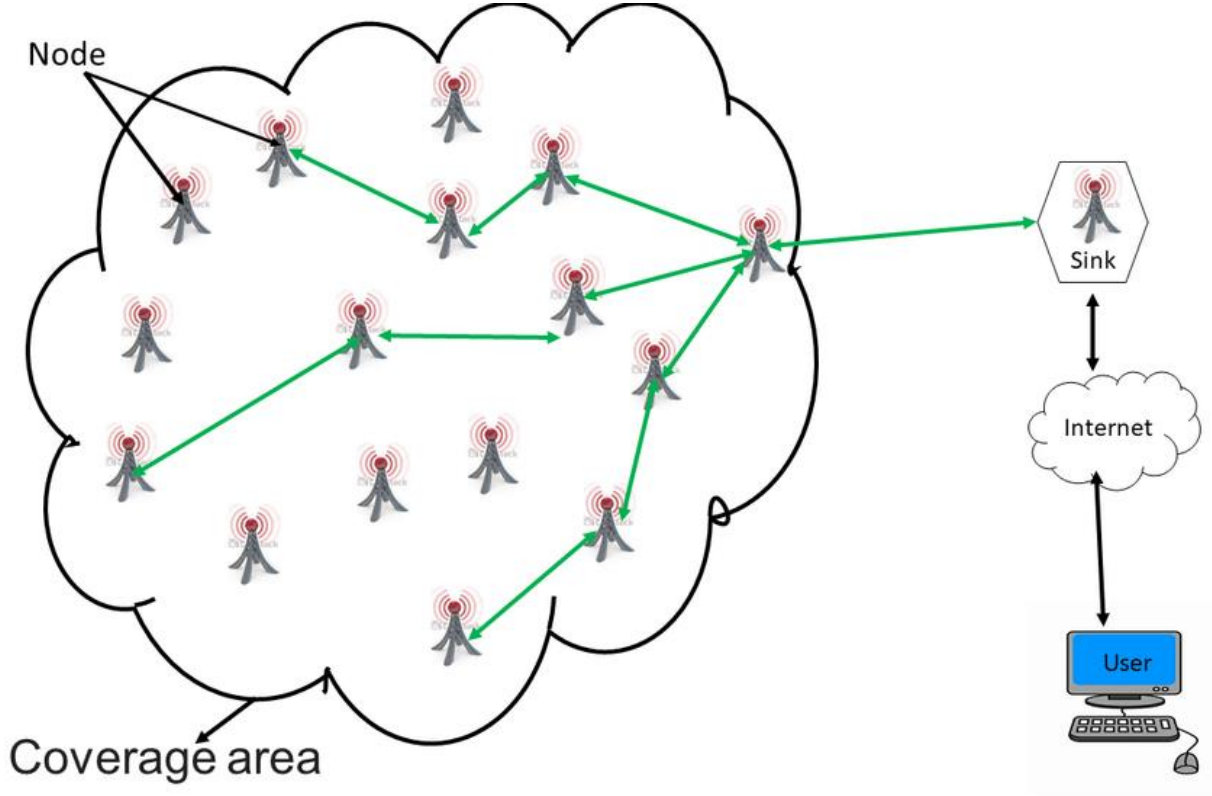
- re- balances sensor node energy consumption by engaging sensors in multi-hop transmission across a definite cluster and involves data synthesis and aggregation to lessen the amount of delivered messages to the sink
- Protocols: LEACH, PEGASIS, HEED, TEEN, AP TEEN

Location Based

- due to the scalability factor, location-based routing in WSNs is gaining a lot of attention in the academic community. WSN use these routing methods to communicate by using node locations as a communication metric
- Protocols: SPAN, GAF

QoS Based

- Along with cutting down on energy use, it's quite challenging to design such a QoS-based routing proto- col that would maintain energy efficiency and achieve the reliability and latency guarantees of essential events
- Protocols: SAR, SPEED



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AD HOC Networks

What is it

- Temporary LAN connection between devices
- Allows two or more devices to connect without normal network infrastructure (router, access point)

Types of Ad Hoc Networks

- MANET, IMANET, SPAN, WMN, Vehicular Ad Hoc networks

Security

- If cyber-attackers are within signal range, they can easily access the devices on the network. This can also be an advantage since they are inaccessible from greater distances and attackers must get close to get into the network

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https://www.comptia.org/content/guides/what-is-an-ad-hoc-network
https://www.techtarget.com/searchmobilecomputing/definition/ad-hoc-network

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Wireless Intrusion Detection Systems

Security solution designed to detect anomalous activities, intrusion attempts, and vulnerabilities in a wireless network.

Implemented in two main ways

- Standalone- independent of infrastructure devices, configured to stay in scanning mode. Continuous monitoring without burdening existing infrastructure
- Integrated- WIDS functionality is integrated with existing wireless infrastructure. More cost-effective and streamlined, but devices are used for connectivity and monitoring so there is reduced performance

Components and Architecture

- Sensors, central server/console, software

Limitations of WIDS

- High resource consumption, high false alarms, updates, limited detection techniques, complex management, limited scope, attack prevention, monitoring encrypted traffic

References:

https://nilesecure.com/network-security/what-is-a-wireless-intrusion-detection-system-wids
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MQTT Protocol

What it is

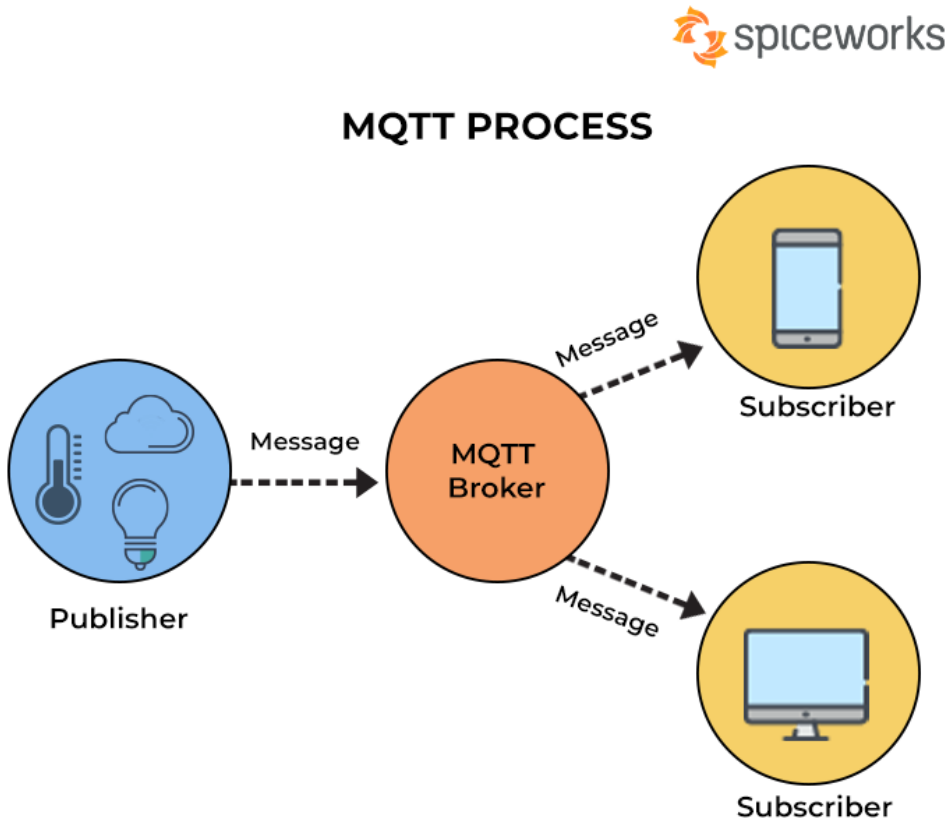
- Standards-based messaging protocol used for machine-to-machine communication
- Easy to implement and communicates IoT data efficiently, between devices to the cloud and from the cloud to the devices

Benefits

- Lightweight, efficient, scalable, reliable, secure, and well-supported

Components

- MQTT client, MQTT broker, MQTT connection
- Clients and brokers communicate over MQTT connection, clients initiate by sending CONNECT message, brokers respond with CONNACK message
- Clients always connect with the broker, never with one another
- Client establishes connection with broker, once connected the client can either publish messages, subscribe to specific messages, or both, when the broker receives a message, it forwards it to subscribers



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