Mobile Networks Introduction

→ Telephone System

Uses switched circuits, low bandwidth, multiplexing

→ The communication network

- **Internet structure**:

Administrative borders define AS (intra-domain routing, internal policies, RIPv2 and OSPFv2) and AS interconnections (inter domain routing, using BGP).

- **Real structure**:

Apparently hierarchal but hierarchy is not respected (private connection agreements, users connect to multiple ISPs)

- **Packet loss** → some apps handle losses, others require 100% success. (audio/video vs file transfer)

- **Bandwidth** → some apps required a minimum bandwidth (multimedia)

- **Timing** → some need low delays.

Elastic operations: elastic apps (interactive data transfers, bulk data transfers)

Inelastic operations: interactive apps, sensitive to packet delay, maximum delay may be limited.

→ Wireless systems

Mobile users communicate through fixed ports (APs), rely on radio transmission (finite resource, interference)

Problems?

- Wireless limitations
- Spectrum limitations
- Mobile device limitations (low power, loss of data, limited UI, small storage)
- Scaling considerations

Why is mobile hard? Spectrum is a scarce good, power is still a problem

→ Physical layer

Why wireless? No need to install and maintain wires, supports mobile users.

Problems? Quality of transmission, interference and noise, capacity of network. effects of mobility

- Wireless communication is based on broadcasting

Increasing wireless network capacity increases interference (frequency problems).

Channel capacity

Data rate (bps), bandwidth (hertz), noise and error rate.

Propagation modes

- line-of-sight (LOS), most common form of propagation. (above 30 MHz)

- Ground-wave propagation (up to 2 MHz), follows the contour of the earth.

- Sky-wave propagation, used for amateur radio and international broadcasts.

Noise sources

Thermal, intermodulation, cross talk, impulse noise, absorption of energy in atmosphere.

Propagation mechanisms

reflection, diffraction and scattering.

Introducing redundancy

Block codes provide Forward Error Correction (FEC) for blocks of data.

Convolutional codes provide protection for a continuous stream of bits.

Why not always high bandwidth signal?

Channels have a limit on the type of signal it carries, distortion can make it hard for the receiver to extract the information.

Its important to spread spectrum, transmit over a wider bandwidth, avoiding various kinds of noise, used for hiding/encrypting signals.

→ ## Satellite networks

Effects of satellite mobility: dynamic topology, predictable and periodic, dynamic traffic.

Limitations: power and onboard processing is limited, satellites have a broadcast nature.

limited, ...

Nature of satellite constellations: high propagation delays, fixed number of nodes, highly symmetric.

↳ transmission links

earth stations communicate by sending signals to the satellite on an uplink. (highly directional)

satellites repeat that signal on a downlink. (more coverage).

Types of satellites:

GEO: no handover, delay 250-280 ms, video broadcasting, well suited for broadcast services, but have long delay.

MEO: 100-130 ms, mostly used in navigation (GPS)

LEO: 5-20 ms, frequency handover, used in earth observation

↳ Overview:

- GEO have good broadcasting, bad delay.
- LEO low latency, low power requirements, frequent hand-over
- Inter-satellite links and on-board processing for increased performance.

↳ routing:

inter satellite links (ISL) → less gateways, forward connections, only one uplink and downlink.

However, more complex, high fuel, shorter lifetime.