Lecture 1: Introduction

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Topics for today

- Course overview and logistics
- Revise basic concepts in networking – layering, protocols
- Challenges specific to mobile systems across various layers
- Examples of mobile systems: wireless LANs, cellular systems, WiMAX, adhoc networks, sensor networks, RFID, Bluetooth, etc.

Networks, layers, protocols...

- Network protocol – a standard mechanism by which two entities can communicate
- Layering – an abstraction by which a protocol can only worry about what it is supposed to, and abstract out the lower level details
- Examples on blackboard
  - Walk through what happens at each layer when you open a web page from your laptop over WiFi, and from your phone over 3G
- Each layers adds its own information in headers (encapsulation), which its peer at the other end processes and removes (decapsulation)

Common examples of mobile systems

- Wireless LANs (802.11a/b/g/n)
- Cellular systems (voice and data, 3G, 4G etc)
- Multihop adhoc networks
- RFID / NFC
- Bluetooth

Layers and challenges in mobile systems

- Physical layer – deals with transmission of information over a single hop
  - Wireless physical layers use radio communication
  - Radio signal suffers losses as it travels through air (channel)
  - Need to build a reliable link using unreliable signals
  - Tradeoff between how much you can send and how many errors you can tolerate
- Link layer / MAC – deals with coordinating multiple transmissions over a link
  - Wireless is broadcast medium, need to share channel efficiently
  - Avoid interference between nodes, also enable channel reuse
  - Contention-based vs scheduling

Layers and challenges in mobile systems (2)

- Network (IP) layer – handles routing
  - Need to handle mobility, changes in IP subnets
  - Multihop routing in multihop wireless networks
- Transport (TCP/UDP) layer – handles end-to-end transport of bytes
  - Need to handle mobility of end points
  - Wireless links add more losses, TCP is highly sensitive
- Application layer
  - Applications must be able to handle disconnected operations

Challenges in mobile systems (across layers)

- Energy conservation
- Localization and service discovery
- Security (wireless makes snooping easier)
- Adapt applications to new platforms (e.g., smartphones)

Overview of mobile systems: 802.11

- Wireless LANs – access point (AP) bridges a wireless node (client) to its IP gateway
- Evolution: 802.11b (2.4 GHz, up to 11 Mbps) → 802.11a (5GHz, 54 Mbps) → 802.11g (2.4GHz, 54 Mbps) → 802.11n (higher rates due to new features like MIMO) → 802.11ac and so on
- Physical layer – provides lots of raw speed
- MAC layer – nodes contend for access to medium, lots of spacing between frames, reduces the raw throughput provided by the physical layer
- We will learn about wireless LANs in great detail in this course

Overview of mobile systems: cellular

- Started for voice communication (1G – analog, 2G – digital voice)
- Initially data was piggypacked over voice channels (2.5G)
- Now, redesigned to have separate voice and data channels (3G and beyond)
- Now, 4G (LTE) moving to flat, all-IP infrastructure
- Radio access network (wireless part) + core → all appear as one IP hop when accessing the internet from your phone. Convergence!
- Data tunnelled from phone to edge of the cellular network using various layers to protocols
- Circuit switched (vs. packet switched in the internet) to provide better QoS
- Control plane (to set up signaling), management plane (billing), in addition to data plane (for voice and data)

Overview of mobile systems: Sensor networks, multihop adhoc networks

- Many applications – military, environment, health, home automation, traffic management
- Design constraints – cheap, low power, scalable communication, self-organizing
- Physical layer – low cost design
- MAC – need to coordinate between many nodes
- Network – discover routes efficiently
- Transport – transfer information with low power and memory
- Requires rethink of many protocols

Overview of mobile systems: RFID, Bluetooth

- Short range communications
- Active (powered nodes like RFID reader) vs passive (tags with no power source)
- Passive tags can be near field (small range of few cm, modulates magnetic field) or far field (up to few metres, modulates and reflects radio signals)
- Open issues – reading colocated tags, privacy
- RFID, Sensors → "Internet of things"
- Bluetooth
  - All layers integrated and designed for low power and cost
  - Master and up to 7 slaves ("piconet") communication
- We won't go into much detail about exact protocols