Why Wireless Nets Are Different

- Wireless networks have different physical layer properties which cause wide variations in error rates.

- Where once losses were fairly predictable (even TCP assumes losses are due to congestion not network errors), this is not the case with wireless networks.

- With such wide variations in loss conditions, it makes multimedia encoding that much more interesting (again).

- Wireless network also have different properties at other layers...
Why Wireless Nets Are Different

• MAC Layer
  – Environment is a broadcast environment
  – Like Ethernet once was, but with “hidden stations”
  – With greater distance between stations, not only error rates increase, but bandwidth decreases
    • Large variations in network bandwidth means heterogeneity, heterogeneity means varying capabilities to handle larger streams

• Network Layer
  – Network topologies are generally more unstable leading to network outages and frequent path changes

• Application Layer
  – Devices have widely varying capabilities (memory, processing, and display)
Types of Wireless Networks

- Infrastructure Networks
- Multi-Hop: Ad Hoc Networks
- Multi-Hop: Mesh Networks
Types of Wireless Networks

- Infrastructure Networks
  - One or more Access Points (APs)
  - Devices always connect to AP
  - Limited (if any) device-to-device communication

- Some of the research with these kinds of networks
  - How to do seamless handovers (Mobile IP)
  - In dense deployments, how to avoid interference based on channel assignment
  - Load balancing hosts across APs
  - Enhanced transport protocols
  - Standard measurement studies
Types of Wireless Networks

• Ad Hoc Networks
  – One or more gateways to the broader network (Internet)
  – All nodes can act as relays/routers/sources
  – All nodes are mobile

• Ad Hoc networks aren’t very realistic
  – Most evaluation assumes random movement and peer-to-peer communication (sometimes no gateway)
  – There are some real-world deployments, but they are typically military

• Some of the research with these kinds of networks
  – Lots of routing
  – Some energy efficiency (overlaps with sensor networks)
  – In sparse environments, how to achieve end-to-end communication (also called Delay/Disruption Tolerant Networking (DTNs))
  – Some application stuff
Types of Wireless Networks

• Mesh Networks
  – One or more gateways to the broader network (Internet)
  – Intermediate nodes act as relays/routers and are stationary
  – Leaf nodes are sources and are mobile

• Mesh networks are more realistic
  – Typical of city-wide deployments

• Some of the research with these kinds of networks
  – Routing: though most lots of overlap with ad hoc networks
  – Utilization of different PHY/MAC layer technologies
  – Multi-radio networks: how to assign different radios to different frequencies that still allow communication but minimize interference
Misc Other Types

- Vehicular networks
- Sensor networks
- Acoustic networks (underwater)
- Satellite networks
- Interplanetary networks
Major Wireless Network Limitation

• In multi-hop networks, greater density causes greater collisions/congestion

• Particularly problematic for multimedia traffic
  – Given the periodic but frequent, low or high bandwidth packets

• The biggest impact to throughput is the number of hops that have to be traversed

• Lots of other unexpected factors affect performance
  – Auto Rate Fallback (ARF)
  – Routing and link instabilities (though hard to see unless properly evaluated)
One View of Networking

- Everyone is familiar with the protocol stack...

- One view of wireless networks is that it is different MAC/PHY layers but the resulting impact on the upper layers is still delay, loss, and jitter
  - The distributions may be different and span a greater range of possibilities, but the kinds of impairments are the same

- For most traffic, there isn’t a lot that can be done
  - Reliability is reliability
  - But for multimedia traffic, such an assumption doesn’t hold
Adaptations for MM Traffic

• Different kinds of encoding
  – Both of the content itself…
  – …and the kind of Forward Error Correction (FEC)

• Processing along the path
  – Transcoding
    • (Further) down sampling the audio/video
  – One solution that does work for reliable data delivery is TCP proxies at the edge of the wireless network
    • Works for all TCP traffic regardless of type
Adaptations for MM Traffic (cont)

• At the network layer
  – All sorts of new, smarter, better routing protocols
    • Including protocols that do resource reservation, diffserv, and multipath routing
  – Attempts to deal with dynamic conditions (e.g., congestion) through routing
    • Generally hard to do given variability in network conditions
  – Wireless network-wide congestion control, admission control
    • Tend to be heavier-weight mechanisms requiring coordination

• At the MAC layer
  – Something other than 802.11 (e.g., scheduling)
  – Admission control on a per-hop basis
Cross Layer Design

• A fairly new concept that looks at transporting information contained in one layer of the protocol stack to another layer
  – Conceptually, an interesting idea
  – Challenging to break the information hiding principle built into the layers

• Questions
  – What information can be passed between layers?
  – How is information passed between layers?
  – How is information used at a different layer?
  – How much better is performance? (at what tradeoff?)
  – Can upper layers be made responsive enough?
  – What are the deployment challenges?