Tech Topic #6

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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?