Wireless Networks

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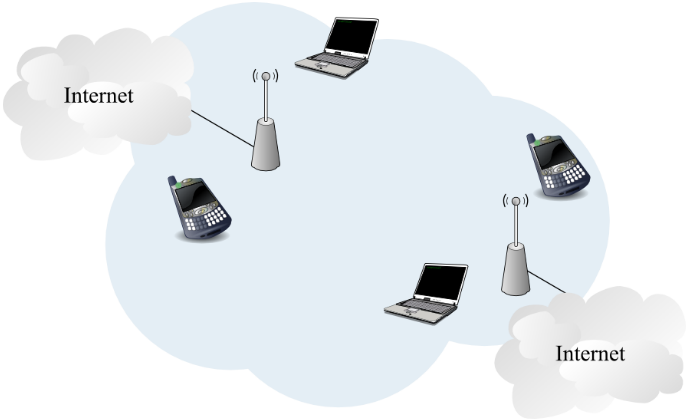
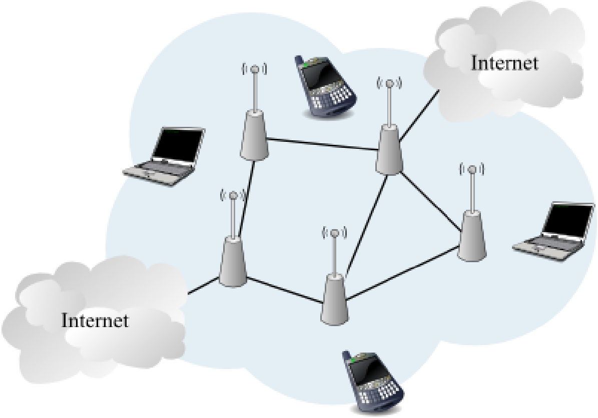
Wireless Access Points

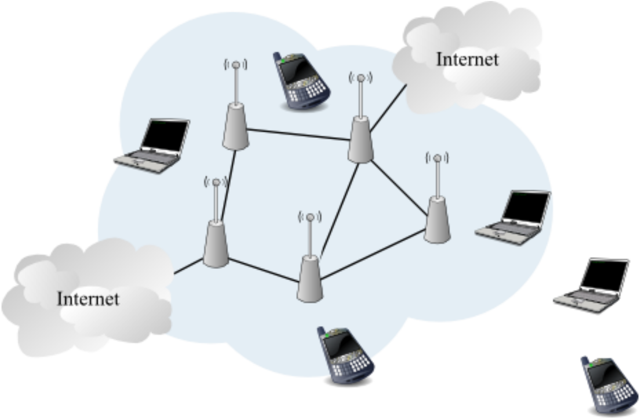


Wireless Mesh Networks



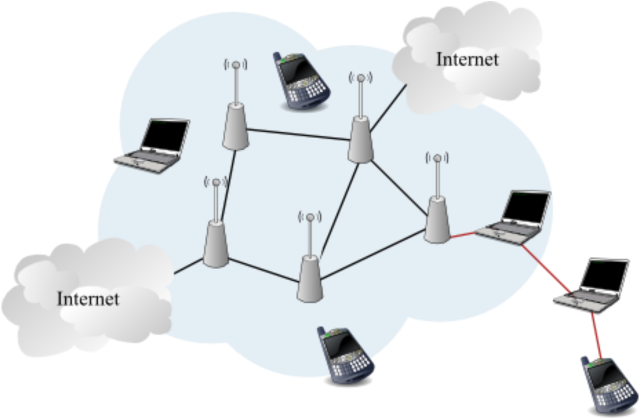
- extend the wireless network, just need power, not power+Internet
- provide Internet access to a city without laying fiber to the home ($100K per mile)

Ad Hoc Links



- what happens when users are out of range?
- why not extend the network using other users?

Ad Hoc Links



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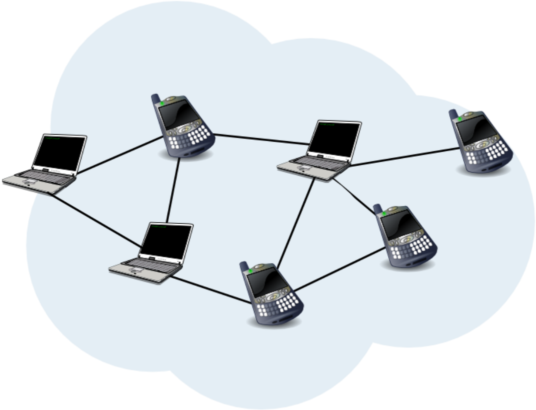
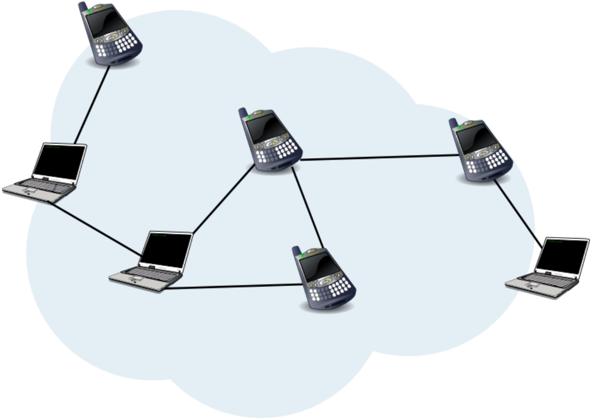
Mobile Ad Hoc Wireless Networks



- what if there is no infrastructure at all: natural disaster, developing country
- depend only on mobile, wireless nodes
- the network can change at any time!

Mobile Ad Hoc Wireless Networks



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Ad Hoc Routing

- **How do you route packets in an ad hoc network?**
  - source and destination are not necessarily in range of each other – must rely on other nodes to relay packets
  - nodes are mobile – network constantly changes
  - fixed infrastructure is not necessarily present

DSDV: Destination Sequence Distance Vector

- Perkins and Bhagwat, ACM SIGCOMM 1994
- proactive
- based on Bellman-Ford routing algorithm
- each node maintains a list of all destinations and the number of hops to each destination, plus a sequence number
  - periodically send routing vector (may be an incremental update) to neighbors
  - destination periodically increments sequence number to allow new routes to propagate
  - nodes choose shortest route with highest sequence number
  - nodes use a *settling time* to avoid reacting immediately to each routing change

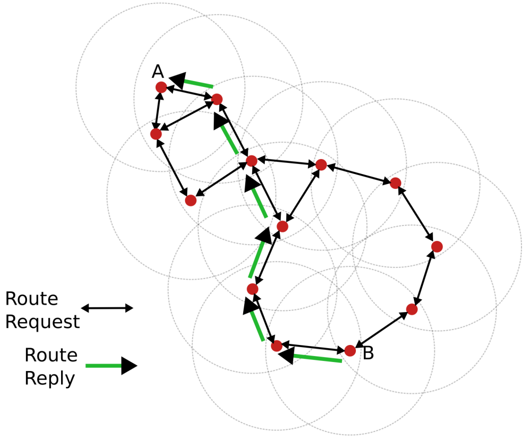
OLSR: Optimized Link State Routing Protocol

- RFC 3636, www.olsr.org, www.olsr.net
- proactive
- tailors a link-state routing protocol for use in ad hoc networks
- based on efficient flooding
  - MPRs (multipoint relays) selected as nodes that will forward broadcast messages
  - cover the whole network, but without every node retransmitting each packet
- uses link-state advertisements
  - only MPRs generated LSAs to reduce number of control messages
  - LSA may contain only links to nodes that have selected the MSR as their local MSR
  - nodes form link-state map using LSAs
- Flash MPR demo

AODV: Ad Hoc On-Demand Distance Vector

- Mobicom 2000, RFC 3561, moment.cs.ucsb.edu/AODV/aodv.html
- reactive
- find route to destination with broadcast
  - broadcast a *route request* message
  - node that receives it sets a pointer back to source
  - node that has a route may respond to first *route request* with a *route reply*, otherwise forward the request
  - destination will always answer first request with *route reply*
  - *route reply* follows pointers back to source, establishes routing tables
- routes maintained as long as they are used

AODV Route Request/Reply



- may not always be shortest route – packet loss due to bit errors or collisions (congestion) may cause a route request to be delayed or dropped

Approaches to Unicast Routing

- flooding
  - broadcast all packets, detect duplicates with sequence numbers
  - high overhead, good fault tolerance at low data rates
- proactive
  - pre-compute and maintain all routes to all destinations
  - high overhead to maintain routes that won't be used
- reactive
  - compute routes on demand
  - low overhead, increased latency
- hybrid
  - aggregate nodes into zones
  - proactive routing inside each zone
  - reactive routing between zones
  - may provide better compromise between overhead, latency

Unicast Routing Architecture

- flat
  - all nodes treated equally
  - simple but may not scale well
- hierarchical
  - aggregate nodes into multiple levels of clusters
  - nominate nodes as heads of a cluster
  - better scalability
  - more complex, single point of failure (cluster head)
- zone
  - aggregate nodes into zones based on location (2-level hierarchy)
  - run flat or hierarchical within each zone
  - compromise between flat and hierarchical