EE597 Lecture Notes 4/27/12

3. Overview for final exam

2. Localization in wireless networks

1. Low-power operation

Wireless Sensor Networks

Low power ~~pa~~ wireless personal area network

LOWPAN

IEEE 802.15.4 PHY/MAC standard

Zigbee Alliance - Industry alliance for LOWPAN's.

- Devices typically consume mW of power
- short range: a few feet
  max 10's of feet
- low power radio, processor, on-board sensor
  ↓
  low rate: 250 kbps max for 15.4 radios

If a device is kept on all the time — will use up 2 AA batteries in about 4 days.

Leaving the processor & radio on even in idle mode uses about the same energy.

Radio is the primary source of energy usage.

Solution for a long lifetime system must be to put nodes to sleep when they are not needed (to sense, compute or communicate).

sleep / wakeup process must be automated.

Synchronous Sleep: Periodic sleep wake cycles on all nodes.

Challenge: maintaining synchronization.

clock errors typically on the order of 40 ppm.

86 000 seconds per day,
~ 100 000 s

50 μs/s. ~ 5 s / day.

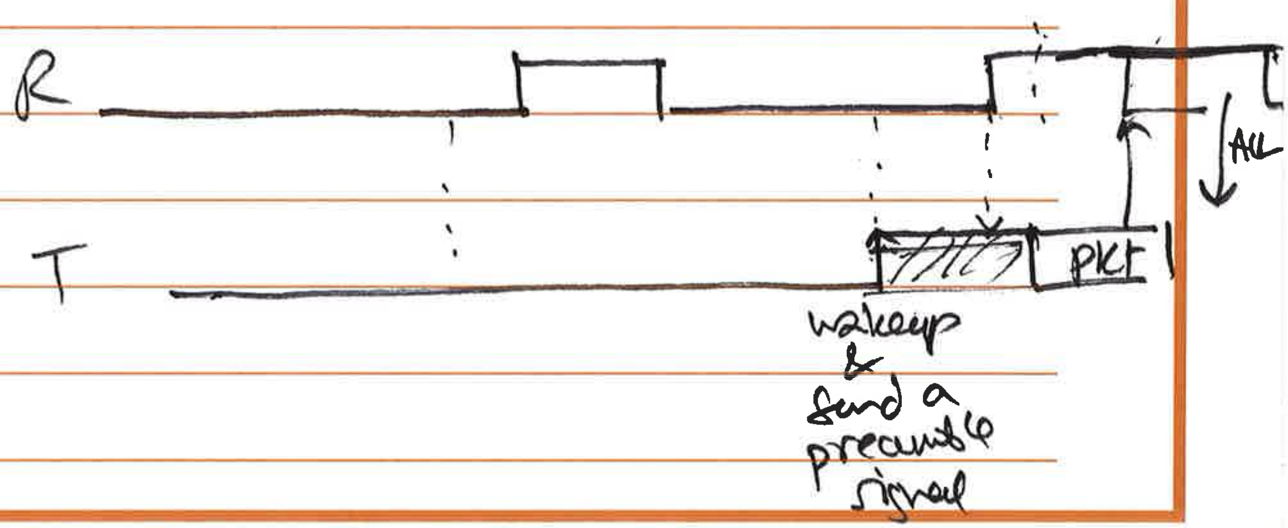
needs to have a time sync protocol to do better.

typically 20 pkts / node every 2 hours is needed for synchronization.

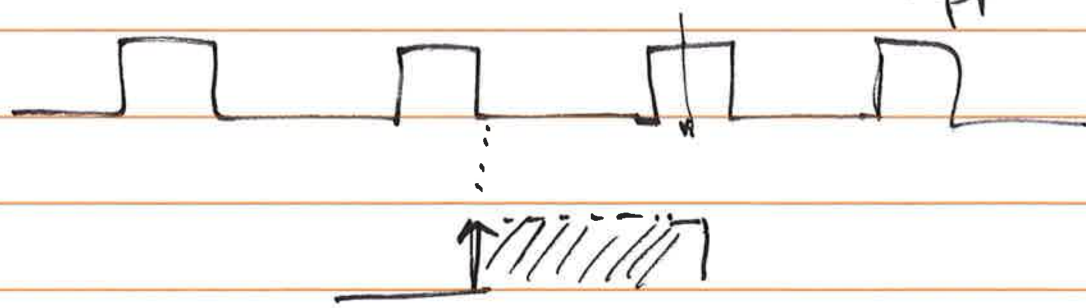
Asynchronous sleep

Receiver - initiated
Transmitted - initiated.

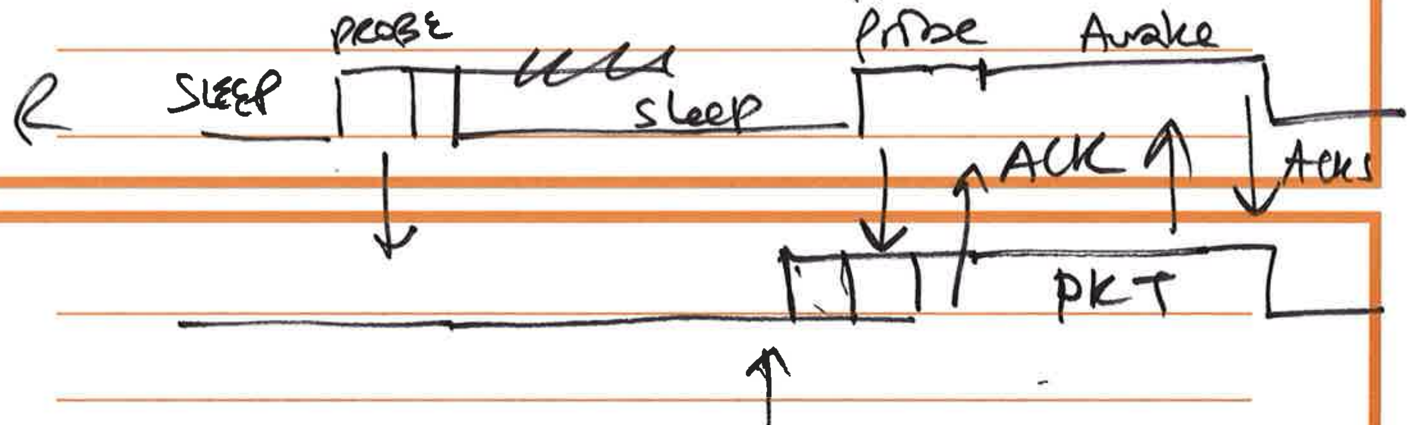
The receiver adopts a sleep-wake cycle
The transmitter, when it has a packet to send, transmits a beacon signal (or series of small probe pkts) to catch the receiver's attention



This was the Transmitter-initiated approach



Receiver-initiated approach



Wireless Localization (Indoor)

- GPS doesn't work indoors

Coarse-grained Location

Simplest: reverse MAC ID lookup based on database of Wifi AP addresses & locations.

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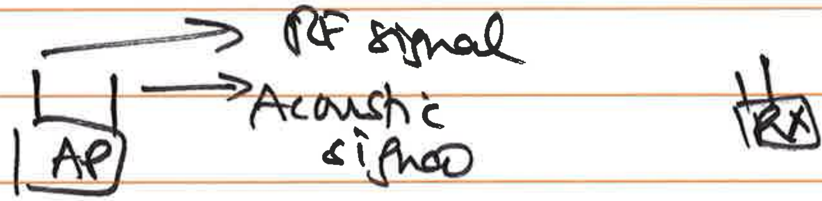
time of Arrival (measure distances based on propagation delay; used in GPS)

doesn't work in indoor settings. because ps-scale time sync could be very costly.

Time difference of Arrival.



estimate distance not based on absolute propagation delay, but the relative delay in receiving RF & acoustic signals.

Sub-meter (10's cm) accuracy.
(ultrasound can be used)

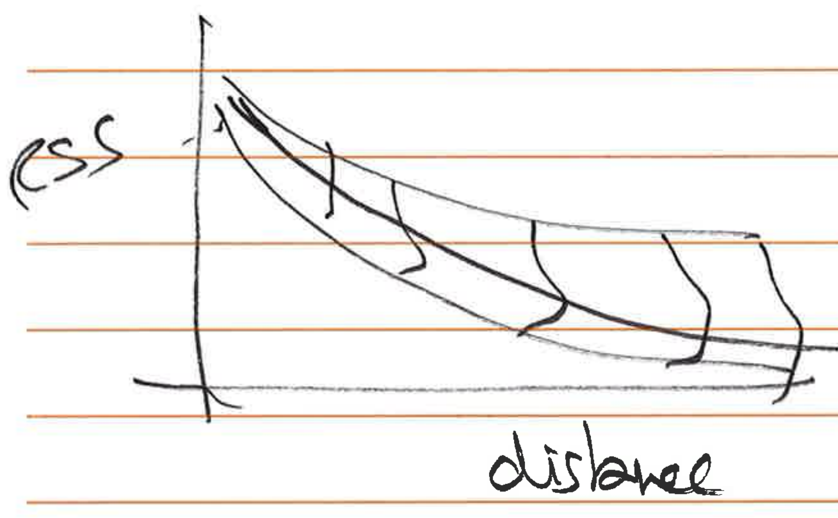
<u>problem</u>: ultrasound needs line of sight, dense deployments & ∴ too expensive for mass deployment

RF-only Localization

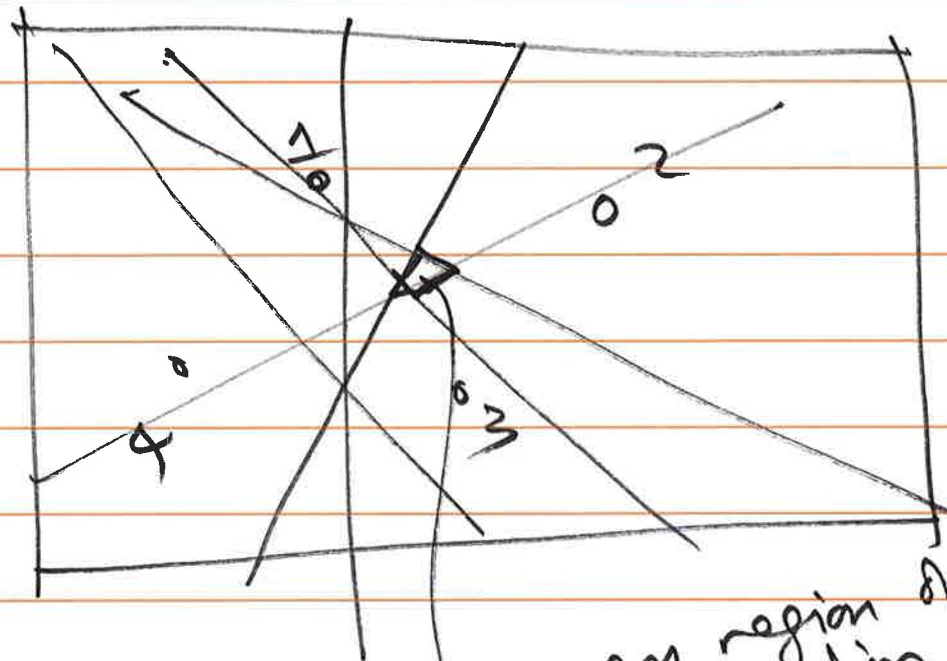
→ Fingerprinting : Database of Signal Strength from all reachable AP's & location
early 1990's (MIT)

→ Maximum Likelihood Estimation : based on a RF model of the environment
(early 2000's) Michigan.

→ Sequence-based Localization
(mid 2000's USC)



all approaches fine ~ 2m accuracy.



every region obtained from intersection of perp. bisectors yields a unique permutation in order of distances to the access point

1 2 3 4
2 1 4 3

out of n! possible permutations, only $O(n^4)$ are geometrically feasible in 2D.

UWB-based localization techniques
10cm-scale accuracy.

Scope of the final exam
& overview.

Network Layer:

- ETX as a metric &
  shortest path routing using
  existing protocols with
  this metric
- Anypath routing
- On-demand routing for MANET's:
  AODV, DSR
- Backpressure scheduling
  MaxWeight Algorithm

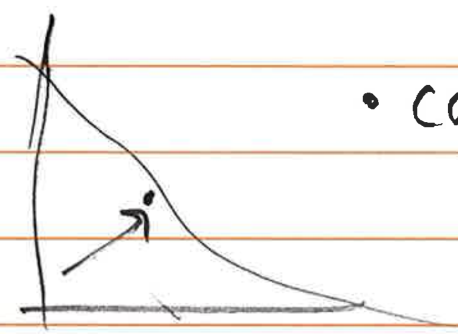
- BCP - Backpressure-based routing protocol
- Barrage Relay (explicit transmit diversity for broadcast)
- Epidemic Routing
- Spray & Wait
- Deterministic routing for ICMN's.

Transport Layer

Congestion control

- Loss Differentiation & the use of ECN
- Congestion sharing for fairness
- (Backpressure-based MAC as a way to address fairness)
- Explicit & precise rate allocation

- Utility optimization as a way to do rate allocation.
  - linear & log utilities over slotted Aloha saturated throughput region
- Backpressure based rate control (utility optimization over stability region) provides for a tradeoff between utility & delay.



- combines rate allocation based on local utility & local queue with maxWeight Algorithm

- sleep scheduling & - Localization

Recommended additional reading:
Browse through papers for

(BCP, AODV, Anypath Routing,
WCP, Barrage Relay, Spray & Wait)