Wireless Media

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CS 294-1

Lecture 4
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Outline

- Scribe?
- Projects
  - Two weeks to proposal deadline
  - Anthony's office hours
    - M 10-11 (10-12 next week)
- IR Local Area Networks
  - ParcTab, Rednet
- Using the ICEBERG testbed

Overview

- Two approaches to building IR LANs
  - ParcTab: An Infrared Network for Mobile Computers
  - Rednet: a wireless ATM local area network using infrared links
- Both are interesting
  - Low cost, ad hoc wireless networking
- Neither was successful
  - Lots of issues

IR LAN Characteristics

- Infrared light: 850 – 950 nanometers
- Range is function of:
  - Xmit power (Received optical power varies as $1/r^2$)
  - Background noise (fluorescent lights, sunlight)
  - Type of link
    - Directed, non-directed, line of sight, diffuse
- Two types of light-based links
  - Directed (very narrow capture angle)
    - Requires precise alignment
    - Not practical for handheld environment
  - Non-directed (15 – 75° capture half angle)
    - IRDA, Rednet, ParcTab

Non-Directed IR Links

- Diffuse: Can use reflections
  - Most desirable from user point of view
  - But, reflections are very attenuated
    - Need to use lower speed or higher power
- Line of sight
  - Limited range (4 m → small room)
  - Ceiling mounted transceivers
  - Rednet: 3 LEDs under hemisphere lens
  - ParcTab: circular array of wide-angle LEDs

IR LAN Comparison

	ParcTab	Rednet
IR encoding	Pulse position	On-Off
Power	low power (short transmit)	500 mW (~1/2 of RF LAN)
Link speed	9.6 or 19.2 Kb/s	2 Mb/s
MAC	CSMA/CA (simple) Small cells → hope 1 user/cell	Binary countdown (complex) Basestation broadcasts synchronization beacon, everyone counts down (use color / local contention address to provide fairness)

Media Access Control

- ParcTab uses simple CSMA/CA
  - Vulnerable to hidden terminal problem, but cells are small
  - CSMA/CA doesn't scale to large users per collision domain
    - What about this classroom?
- Rednet uses complex binary countdown protocol
  - Very powerful, precise control

Rednet MAC

- Goals:
  - Simplicity (not really, actually more complex)
  - Efficiency (avoid wasting bandwidth from collisions)
  - Fairness (can control and guarantee bandwidth allocation)
  - Low latency (rapid selection cycle)
- Operation
  - Computers that want to send, transmit their contention address bit-by-bit from MSB
  - Basestation retransmits a wired-OR of all the addresses of computers that want to send →
    - At each bit, like musical chairs: someone knows that they are not the one to transmit, last one remaining gets to send
    - BTS controls what address it retransmits, so it can send its own address if it wants (win whenever it wants)
    - Basestation can prioritize certain users
      - Ex: allocating a fixed bandwidth share

Network Topology

- ParcTab
  - IR gateways connected via serial cable to a computer
    - Serial cables are slow, really takes > 15 min. to install (need computer, site survey, etc.)
  - Tab generated beacons used to track tab's cell
- Rednet
  - Transceivers are wired directly to ATM network
    - Much faster system, but more complex
  - Color used to number cells (no two adjacent have same number)
    - Classic graph coloring problem!
    - Color provides a way for nodes to know when they've entered a different cell and have to reregister for a new contention address/countdown

Mobility

- ParcTab model
  - Tab → IR → Transceiver → (serial) Gateway → (Ethernet) Agent →Application
  - Agent tracks Tab's cell location
    - Provides level of indirection and handles tab-specific logic
- Rednet model
  - GSM-like model with HLR and VLR

Applications

- ParcTab
  - Tab-RPC for reliably sending commands to tabs
  - Unreliable events from tabs to apps
- Rednet
  - ATM-based connections
  - Handled by connection mgr, location server, and HLR

System-Level Measurements

- Critical to understanding overall network and application performance
- ParcTab
  - Identified bottlenecks in Sun serial driver
  - Clustering commands into one packet to reduce latency and increase throughput
  - Breaking time down into components
  - Overall: acceptable response time
- Rednet
  - Measuring network performance
    - Bit Error Rates (important for understanding reliability)
    - Latency for handover between cells

IR LAN Lessons Learned

- Feasible to build low-cost IR LAN devices
  - Possible to support wide range of speeds from 9.6Kb/s to 4 Mb/s
- Many interfering light sources
  - New energy-efficient fluorescent lights
- Only limited commercial success
  - IRDA: point-to-point, not LAN

5-minute Break