



CMPE 257: Wireless and Mobile Networking

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Computer Engineering

UCSC Baskin Engineering

Lecture 1

CMPE 257 Winter'11

Welcome to CE 257!

- Class information:
 - When: MW 5-6:45.
 - Where: BE 156.
 - Class Web page:

<http://www.soe.ucsc.edu/classes/cmpe257/Winter11/>

About the Instructor

- Katia Obraczka.
 - Office: E2 323.
 - E-mail: katia "at" soe.ucsc.edu
- Internetworking Research Group (I-
NRG): E2 311
- For more info, visit:
 - *inrg.soe.ucsc.edu*



Class Web Page

- www.soe.ucsc.edu/classes/cmpe257/Winter11.
- Students need to check the Web page frequently!
 - Lecture notes.
 - Readings.
 - Assignments.
 - News.
 - Project information.

Course Focus

- From the Web page:

“This class covers various topics relevant to wireless networking and mobile computing. It focuses on communication protocols for wireless networks (in particular, multi-hop ad-hoc networks) from medium-access control to end-to-end transport.”

Pre-requisites

- CE 252A.
- Or instructor's consent (need permission code).

Audience and Requirements

- Advanced grad class.
- Lots of reading.
- Programming project: strong programming skills.
- In-class discussions and student participation is a must!
- In-class student presentations.

Course Format

- Lectures + student presentations.
- Material based on research papers.
 - “Ad Hoc Wireless Networks: Architectures and Protocols” by C. Siva Ram Murthy and B.S. Manoj can be used as a reference.
- In-class discussions are critical.
 - Papers must be read before each class.

Grading

- Grades will account for:
 - In-class participation: 5%
 - In-class presentation: 15%
 - Reading reports: 15%
 - Project: 40% (Content: 20%; Report: 10%; Presentation/Demo: 10%)
 - Exam: 25%

Disclaimer: Don't expect automatic B's!

Project

- Project is a major part of the grade.
- Chance to start looking into possible thesis research directions.
- List of suggested projects will be provided.
 - Implementation.
 - Simulation.
 - Project suggestions welcome!
 - Need instructor's approval.
- Project proposal required.

Project Proposal

- Project proposal should contain:
 - Project title
 - Motivation.
 - Brief description of proposed approach.
 - Basic design.
 - Evaluation and testing methodology.
 - Demo plan.

Student Responsibilities:

Academic Integrity

- All work must be individual (unless otherwise agreed with instructor).
 - OK to have discussions on ideas but turn in **your own** work.
 - Ask instructor if there are any questions.
 - For more info, go to:

www.ucsc.edu/academics/academic_integrity/

Students Responsibilities

- Papers to be covered in class must be read before lecture.
 - Brief summaries of the papers need to be submitted prior to class.
 - Have summaries handy during class to help in discussions.
- Web page must be checked frequently for updates.

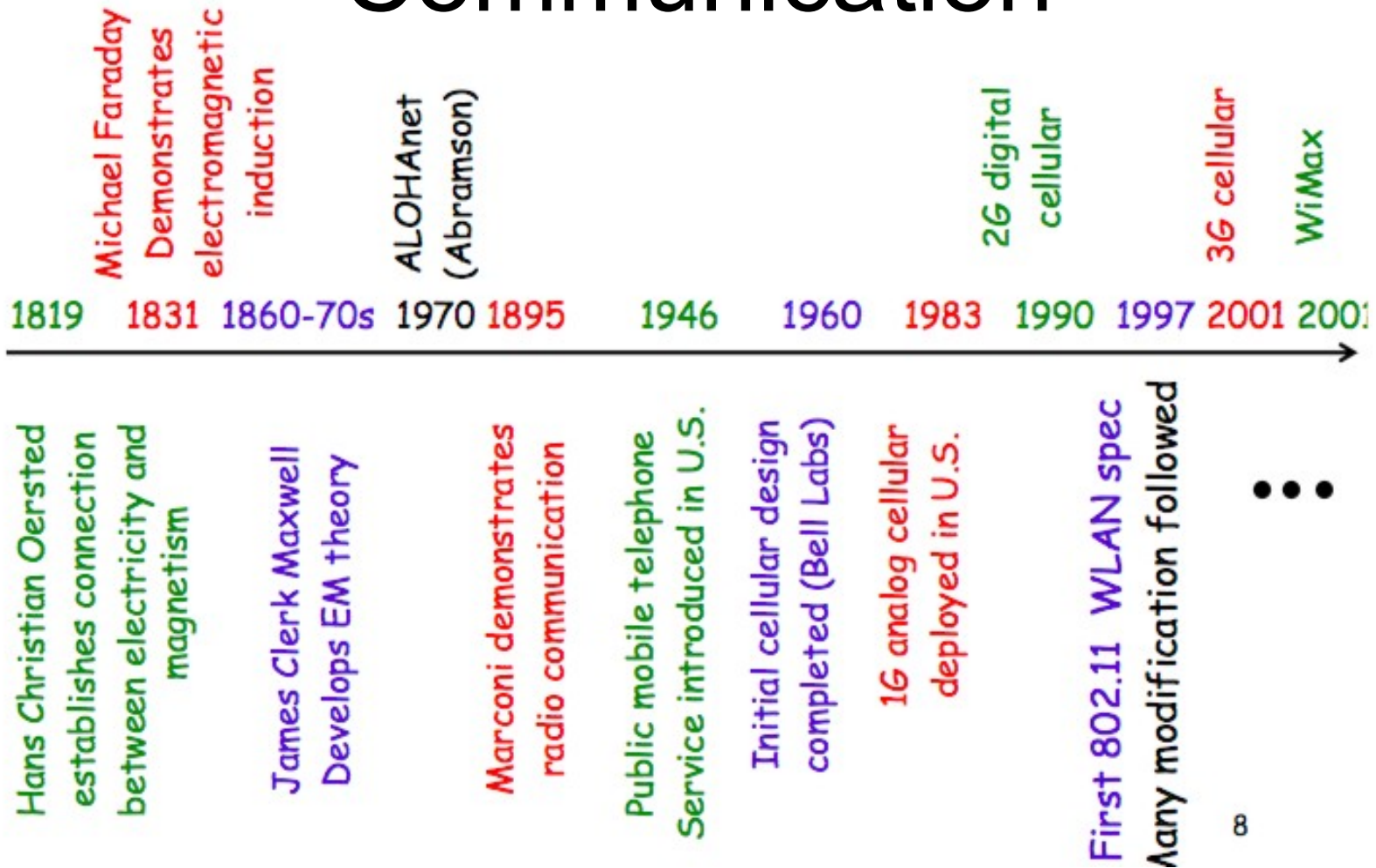
Readings

- Bulk of readings based on recent research papers.
- Reference textbook:
 - "Ad Hoc Wireless Netws: Architectures and Protocols" by C. Siva Ram Murthy and B.S. Manoj.

Course Outline (tentative)

- Wireless MAC.
- Network layer issues.
 - Unicast and multicast routing.
 - Wireless internetworking.
- Capacity of wireless networks.
- E2E protocols.
- Miscellaneous:
 - DTN.
 - Mobility management.
 - New architectures.
 - Hybrid networks.
 - Security.
 - Localization.
 - Power and topology management.

History of Wireless Communication



Today: Wireless Everywhere!

- Remote control
- Cordless telephone
- Headsets
- Garage openers
- Badges
- Cell phones/modems
- Radio!
- Pagers
- Satellite TV
- Wireless LAN cards
- Laptops
- Netbooks
- Tablets
- PDAs
- Smart phones
- Sensor nodes...

Wireless Communication

- Typically, we assume RF communication.
 - This means: sharing of the RF spectrum.
 - Access regulated by the government.
 - Some compatibility issues for world-wide communications.
 - US spectrum allocation chart:
 - <http://www.ntia.doc.gov/osmhome/allochrt.pdf>

ISM Frequency

- From Wikipedia:
 - “The **industrial, scientific and medical (ISM) radio bands** were originally reserved internationally for the use of RF electromagnetic fields for industrial, scientific and medical purposes other than communications. In general, communications equipment must accept any interference generated by ISM equipment.”
 - Spans from 6.8 MHz to 2.4 GHz.
 - Microwaves, cordless phones, WLAN devices.

When did wireless meet the Internet?

Some Internet History

- ARPAnet developed/deployed in late 60's - early 70's.
- 1974: RFC 675: first specification of TCP.
- Early 80's: TCP/IP deployed.

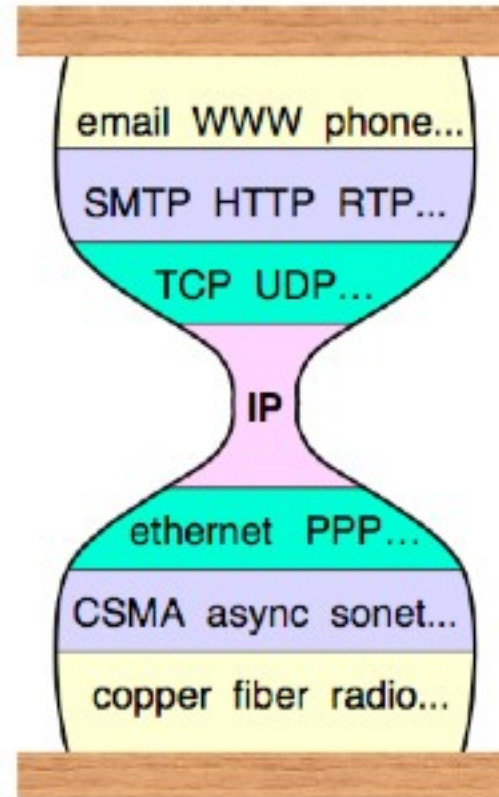
Internet Design Principles

- Layered system design.
 - Simplicity.
 - Modularity, maintainability, extensibility...
- “Minimalist” design.
 - Keep network core simple.
 - Robustness!
 - Place functionality at the edges.
 - E2E argument.

The “Hourglass” Approach

TCP/IP stack

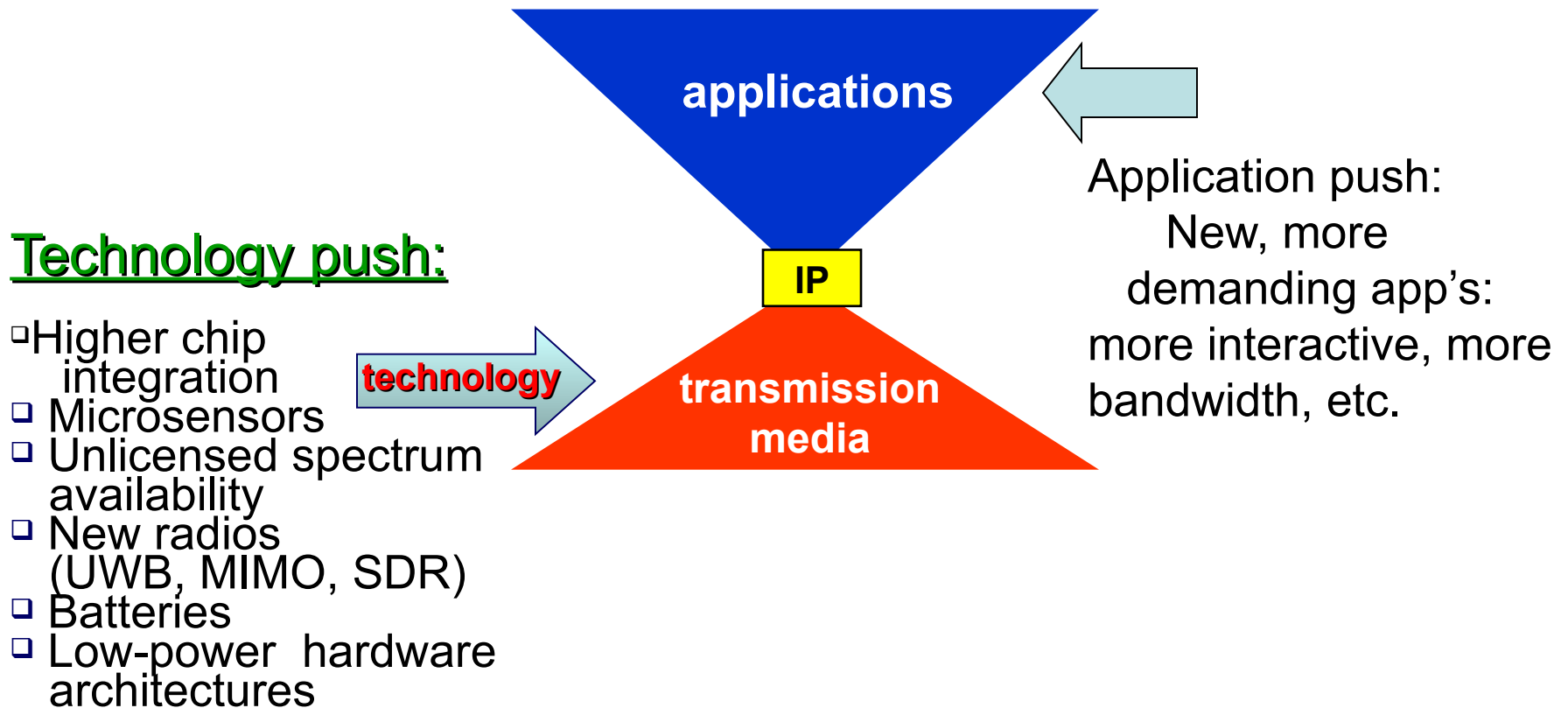
Upper layers
Transport
Network
Link
Physical



From Steve Deering's
IETF 2001 presentation

So?

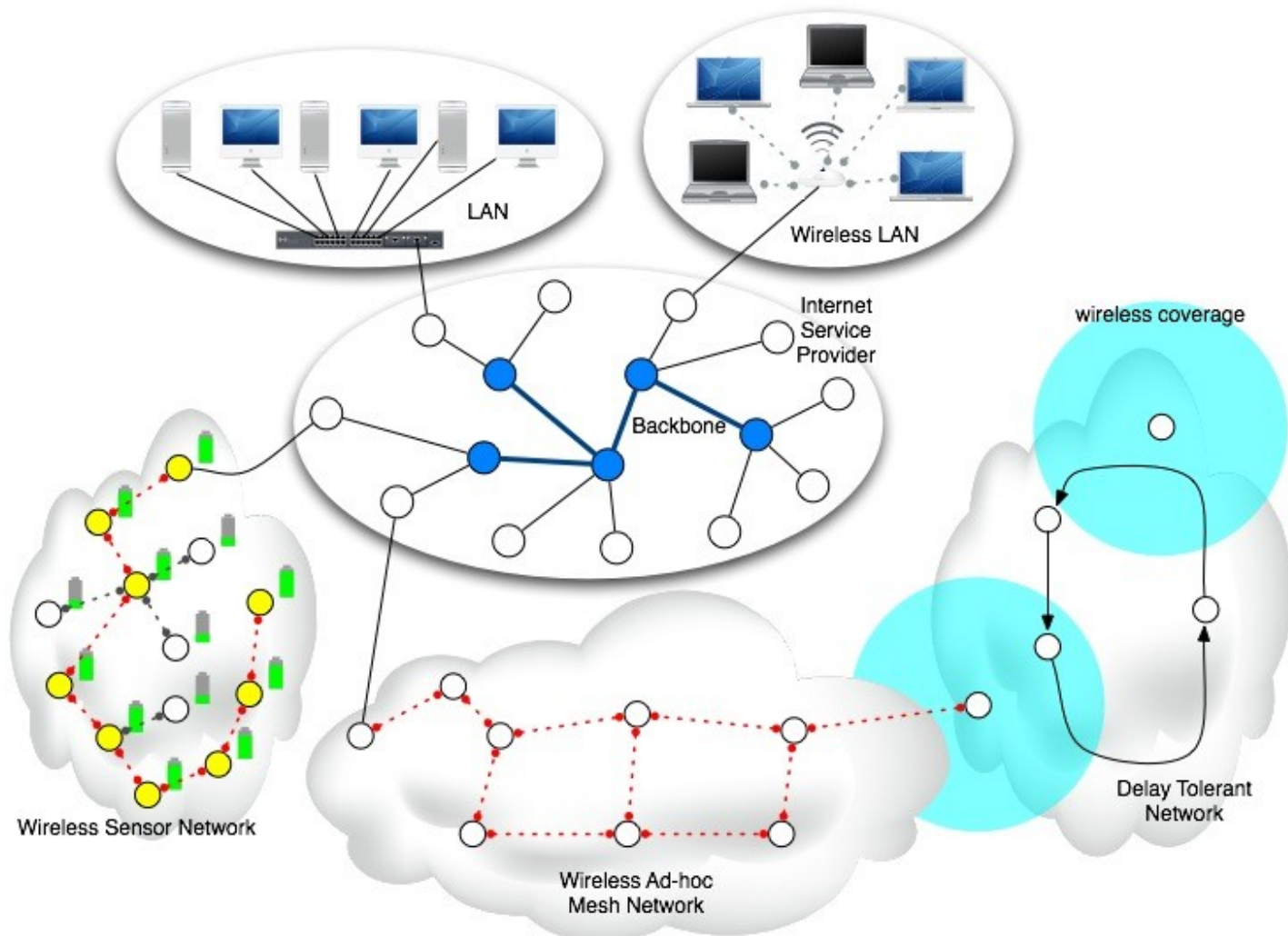
So?



Re-think the Internet

- E.g., NSF's clean-slate initiative, IRTF DTNRG working group, etc.

The Vision: The Internet of the Future



Re-think the Internet

- Cross-layer design.
- Use the core.
 - More intelligence.
 - More storage.
 - More bandwidth.

Lots of Interesting New Topics!

- Heterogeneous networking with support for connectivity disruptions.
- Content-centric networking.
- User-centric networking.
 - Ambient computing.
- ...

Wireless Networks

- Infrastructure-based networks.
 - Cellular.
 - WLANs.
 - Mesh.
- Infrastructure-less networks.
 - Aka, self-organizing.
 - Ad-hoc networks.
 - Sensor networks.
- Hybrid networks.

Wireless Local Area Networks (WLANs)

- Infrastructure-based deployment.
- Local area connectivity using wireless communication.
- IEEE 802.11 WLAN standard.
- Wireless LAN may be used for
 - Last hop to a wireless host.
 - Wireless connectivity between hosts on the LAN.

802.11 Evolution

- Working group founded in 1987.
- Standard came out in 1997.
- Includes infrared.
- Originally featured FH and DS.
 - But as of late 2001, only DS-SS modems had been standardized for high rates (11Mbps).
- 802.11a: up to 54 Mbps in 5 GHz band.
- 802.11b: 5.5 and 11 Mbps, and more...

Bluetooth and PANs

- PAN: personal area network.
- Open standard for enabling various devices to communicate short-range (10 m range).
- Named after King Harald Bluetooth (10th century Viking united Denmark and Norway).
- Home appliances, office equipment, “wearable” computing equipment.
- **Now, we have BANs!**

Cellular Networks

Cellular Concept: Motivation

- Early mobile radio systems:
 - Large coverage with single, high-powered transmitter.
 - But, no frequency re-use due to interference.
- Since finite spectrum allocation, need: high capacity (number of users) with limited spectrum and wide coverage.

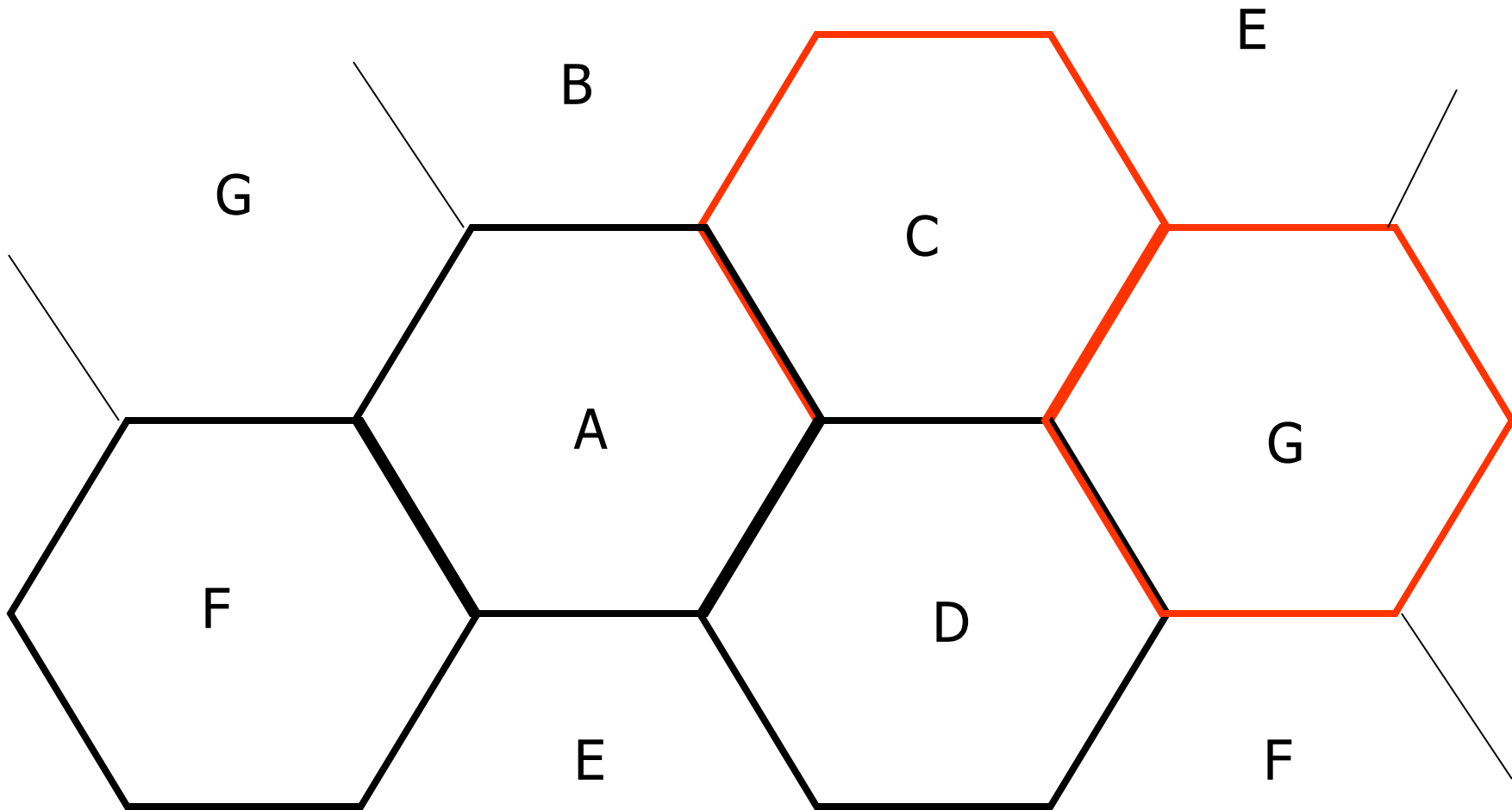
Some Cellular Terminology

- Cell.
- Mobile.
- Base station.
- Mobile Switching Center (MSC).
- Handoff.

Cellular Fundamentals

- System-level idea, no major technological changes.
 - Many low-power transmitters instead of single, high power on (large cell).
 - Service area divided into small cells covered by each low power transmitter.
 - Each transmitter (or base station) allocated a portion of the spectrum.
 - Nearby BSs assigned different channel group to minimize interference.
 - Scalability: as more users subscribe, more BSs can be added using lower transmission power).

Frequency Reuse



Handoff/Handover

- Mobile hosts can change cells while communicating.
- **Hand-off** occurs when a mobile host starts communicating via a new base station.
- Handoff decision made based on signal strength.

Handoff Strategies: Network-Initiated

- Used in 1G.
- Based solely on measurements of received signals from MH.
- Each BS monitors signal strengths of mobiles with calls in progress.
- MSC decides if handoff necessary.

Mobile-Assisted Handoffs

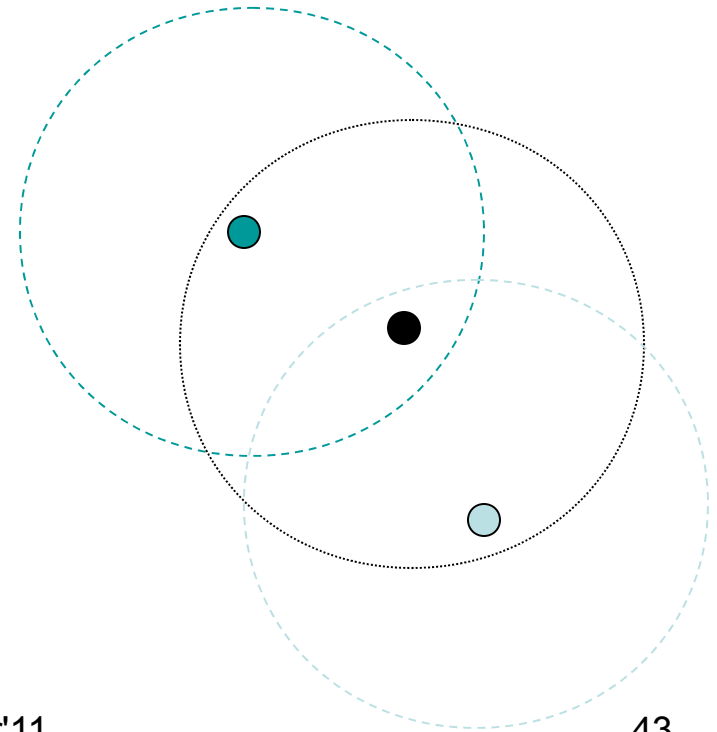
- MAHO.
- 2G.
- Mobile measures received power from close-by BSs; continually reports to serving BS.
- Handoff begins when power received from neighbor BS exceeds power from serving BS.

MANETs

- Mobile, (wireless), multi-hop ad-hoc networks.
- **Infrastructure-less!**
- Formed by wireless hosts which may be mobile.
- Hosts are both sources and destinations of traffic as well as routers!
- Routes between nodes may potentially contain multiple hops.
- Challenges posed by wireless medium accentuated.
- Mobility cause routes to change.

Multi-Hop

- May need to traverse multiple hops to reach destination.



Why MANETs ?

- Ease of deployment.
- Speed of deployment.
- Decreased dependence on infrastructure.

Self-* Networks

- Self-organizing.
- Self-managing.
- Self-healing...

Many Applications

- Personal area networking.
 - Cell phone, laptop, ear phone, wrist watch.
- Military environments.
 - Soldiers, tanks, planes.
- Civilian environments.
 - “Smart” environments.
- Emergency operations
 - Search-and-rescue
 - Policing and fire fighting
 - Monitoring and surveillance.

Many Variations

- Fully Symmetric Environment
 - All nodes have identical **capabilities** and **responsibilities**.
- Asymmetric Capabilities
 - Transmission ranges, battery life, processing capacity, and speed of movement may vary.
- Asymmetric Responsibilities
 - Only some nodes may route packets.
 - Some nodes may act as **leaders** of nearby nodes (e.g., cluster head).

Many Variations (cont'd)

- Traffic characteristics may differ in different ad hoc networks.
 - Bit rate,
 - Timeliness constraints,
 - Reliability requirements,
 - Unicast / multicast / geocast.
- May co-exist (and co-operate) with an infrastructure-based network

Many Variations (cont'd)

- Mobility patterns may be different
 - People sitting at an airport lounge,
 - New York taxi cabs,
 - Students moving on campus,
 - Military movements,
 - Personal area network.

Many Variations (cont'd)

- Mobility characteristics
 - Speed,
 - Predictability
 - direction of movement
 - pattern of movement
 - Uniformity (or lack thereof) of mobility characteristics among different nodes

Sensor Networks

- Special case of MANETs.

What are sensor networks?

- Typically connects a large number of small nodes capable of:
 - Processing information.
 - Storing information.
 - Wireless communication.
 - Sensing.
- Main challenges?

DTNs

- Networks prone to arbitrarily frequent and long-lived connectivity disruptions.

Challenges

- Limited wireless transmission range.
- Broadcast nature of the wireless medium.
 - Hidden terminal problem.
- Packet losses due to transmission errors.
- Mobility-induced route changes.
- Mobility-induced packet losses.
- Battery constraints.
- Potentially frequent topology changes.
- Ease of snooping on wireless transmissions.

Research on MANETs

Variations in capabilities & responsibilities *

Variations in traffic characteristics, mobility models, etc. *

Performance criteria (e.g., optimize throughput, reduce energy consumption) *

Increased research funding

=

Significant research activity

One-size-fits-all?

- Perhaps using an adaptive/hybrid approach that can adapt to situation at hand.
- Difficult problem.
- Solutions usually try to address a subspace of the problem domain.