

## Objectives:

- 1) the basic conception of mobile computing;
- 2) a quick overview of wireless technologies

## Readings:

1. Satyanarayanan, M., Fundamental challenges in mobile computing, PODC '96: Proceedings of the fifteenth annual ACM symposium on Principles of distributed computing, pp. 1--7, ACM, New York, NY, USA, 1996
2. Mark Weiser, Some computer science issues in ubiquitous computing. Commun. ACM 36, 7 (July 1993), 75-84

# INTRODUCTION

# Top 10 Strategic Technology in 2012-2013\*

## 2012

1. Media **tablet** & beyond
2. **Mobile**-centric apps and interfaces
3. Contextual and social user experience
4. **Internet of Things**
5. **App stores and marketplaces**
6. Next-generation analytics
7. Big data
8. In-memory computing
9. Extreme low-power servers
10. Cloud computing

## 2013

1. **Mobile** devices battles
2. **Mobile** applications & HTML5
3. Personal cloud
4. **The Internet of Things**
5. Hybrid IT and cloud computing
6. Strategic big data
7. Actionable analytics
8. Mainstream in-memory computing
9. Integrated ecosystems
10. Enterprise app stores

# Mobile Computing

- Bob Metcalfe, 1995
  - “Mobile wireless computers are like mobile pipeless bathrooms – portapotties. They will be common on vehicles, and at construction sites, and rock concerts. My advice is to wire up your home and stay there.”
- Mobile computing is a form of human-computer interaction where a computer is expected to be transported during normal usage
  - Mobile (wireless) communication
  - Mobile hardware: wearable computers, smart phones, tablets, mobile laptops
  - Mobile software: system and application

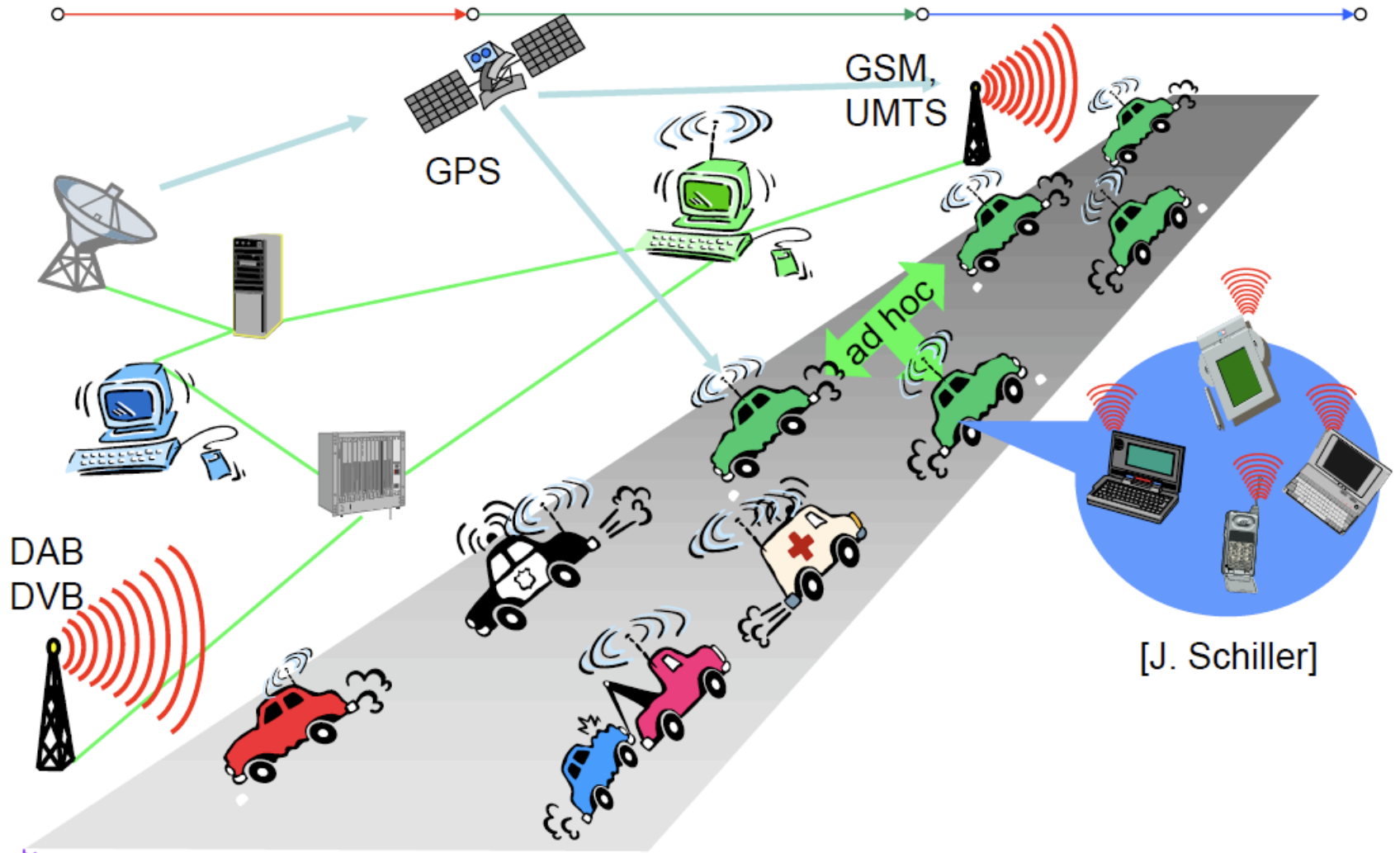
# Pervasive/Ubiquitous Computing

- Different from mobile computing (see Mark Weiser's pioneer paper)
- To make “computer” disappear
  - ▣ Embedded technologies: sensors and actuators
  - ▣ HCI

# Applications

- Vehicles
- Nomadic user
- Intelligent house or office
- Meeting room/conference
- Taxi/Police/Fire squad fleet
- Service worker
- Disaster relief and Disaster alarm
- Gaming
- Military / Security
- ...

# Vehicles



# Smart mobile phone

- Voice calls, video calls
- Social networking
- Email or instant messaging
- Play games
- Up-to-date localized information
  - ▣ Map
  - ▣ Pull: Find the next Pizzeria
  - ▣ Push: “Hey, we have great Pizza!”
- Stock/weather/sports info
- Ticketing
- Trade stock
- etc.



# Object Tracking

- ❑ Book, pallet, packet, airline baggage, container, truck tracking
- ❑ Identification badges for building/car access control or animal identification
- ❑ Electronic toll collection
- ❑ Electronic cash in smart cards or credit cards
- ❑ Prisoner tracking
- ❑ Store checkout as cashier replacement

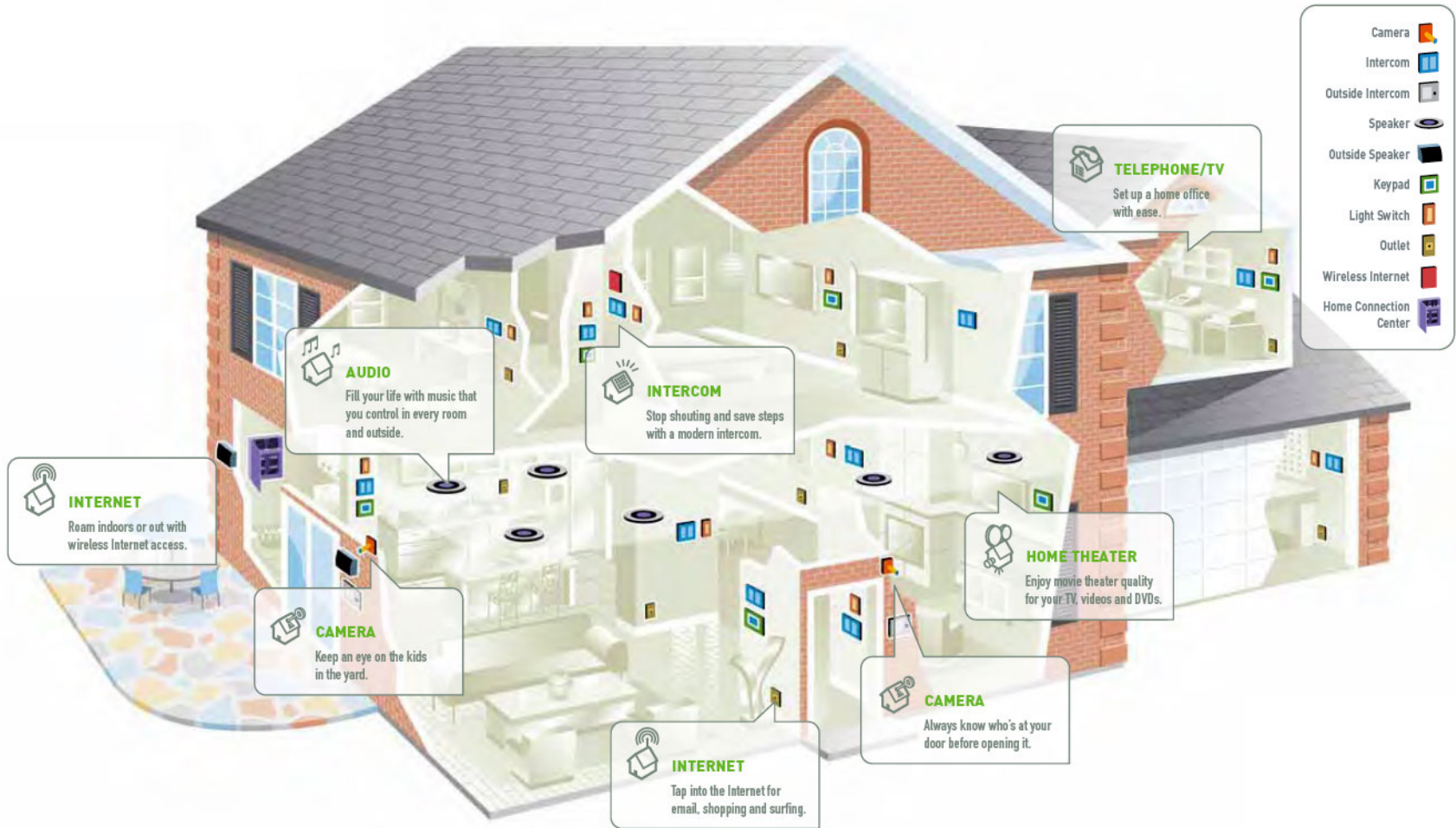




# Disaster Relief

- After earthquake, tsunami, volcano, etc:
- You cannot rely on infrastructure but you need to orchestrate disaster relief
- Early transmission of patient data to hospital
- Satellite
- Ad-Hoc network

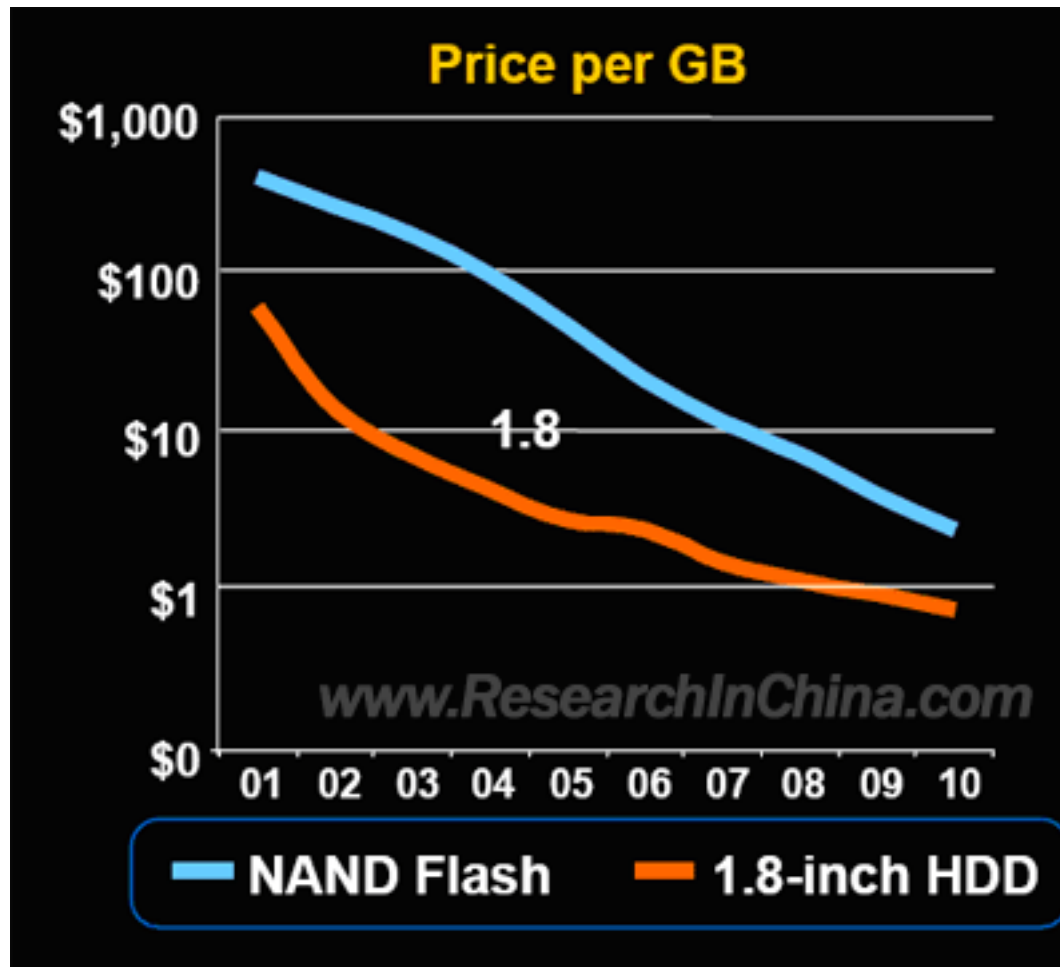
# Home Automation



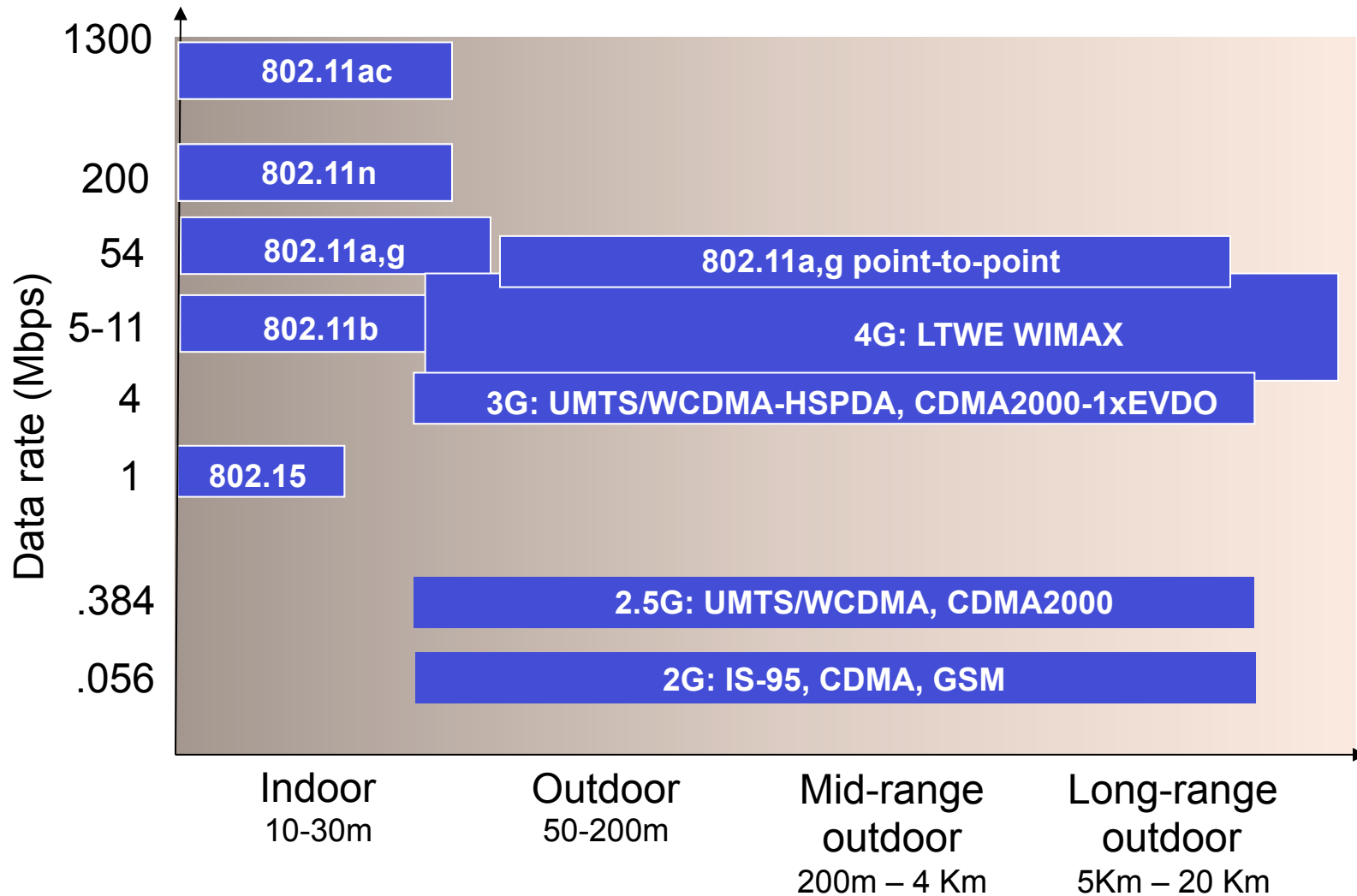
# Drivers of Mobile Computing

- Ubiquitous connectivity (infrastructure or ad hoc)
- Reduced cost of storage, access, computing
- Location services (GPS, cellular, WiFi, ...)
- Display technologies
- Microelectromechanical systems (MEMS)

# Cost of Storage



# Wireless Bandwidth



# Cost of Bits

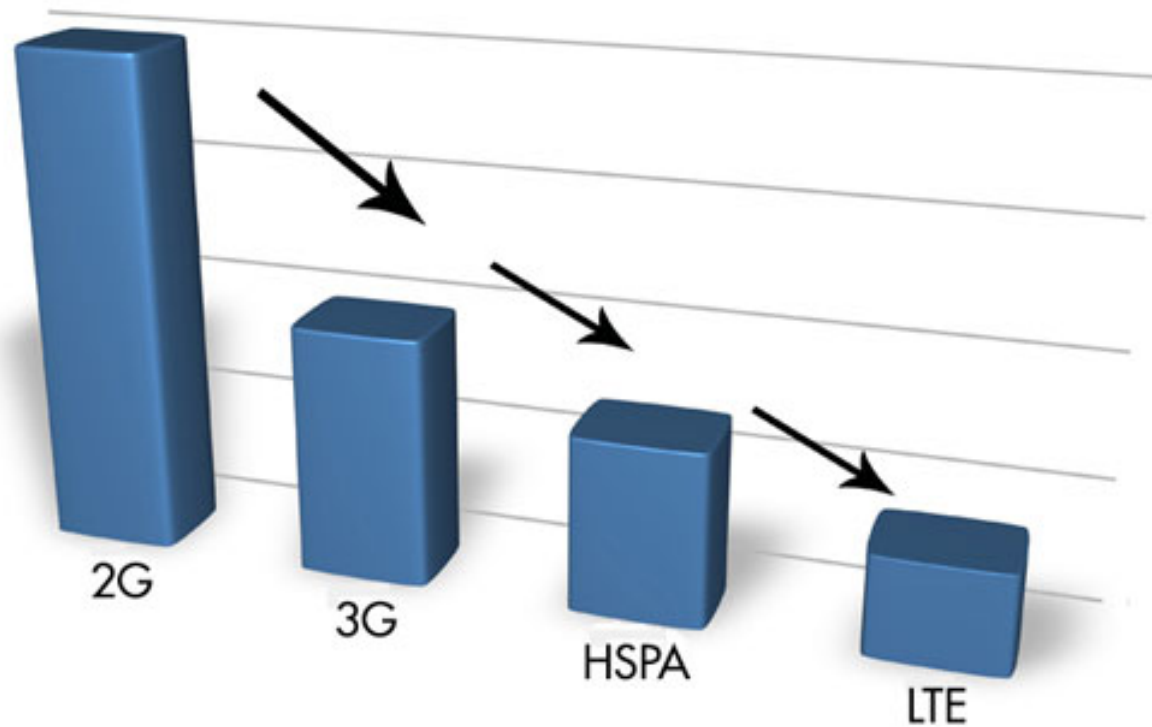
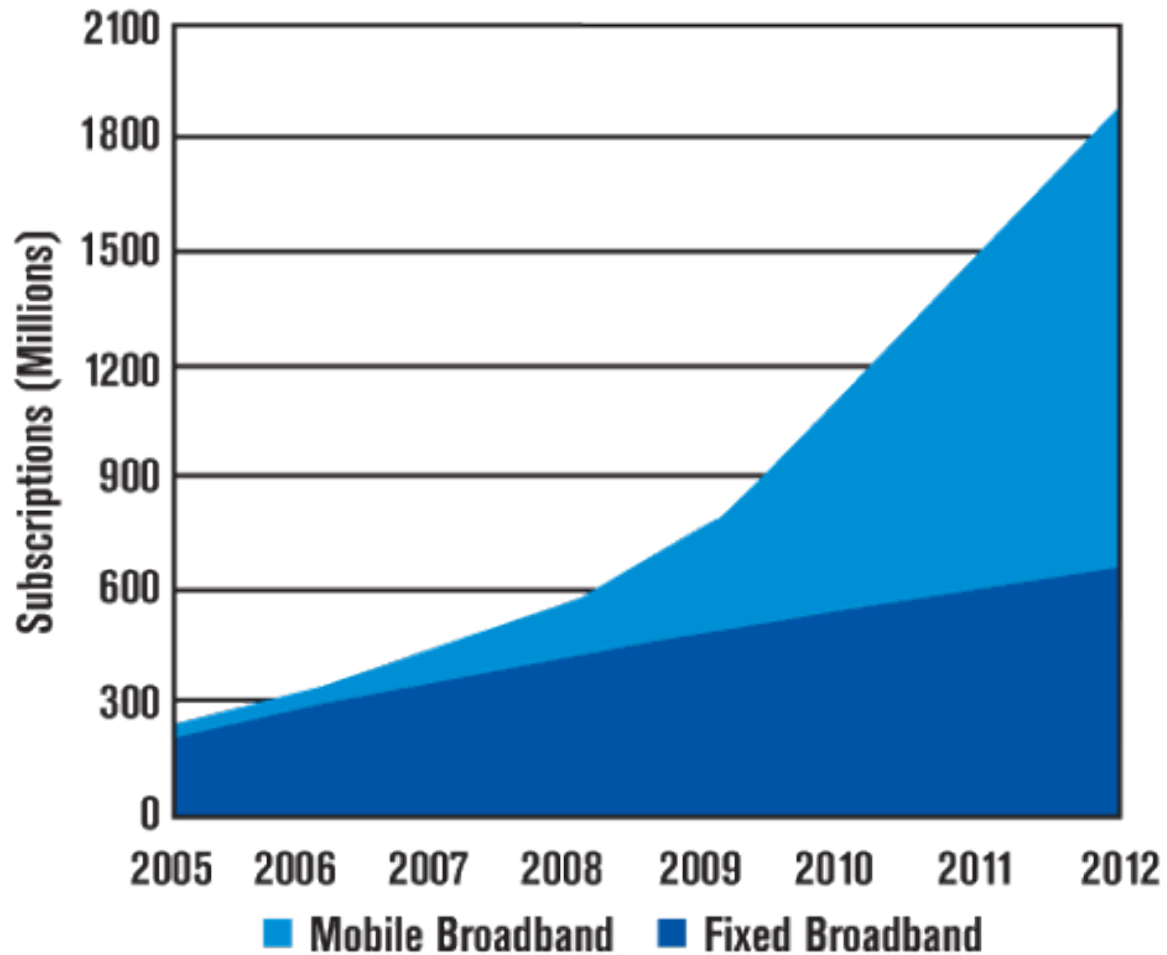


Figure 1: The cost per bit of wireless data declines with each new generation of cellular technology—as much as 80% less when moving to LTE from the original WCDMA 3G. (courtesy of Nokia Siemens Networks)

# Growth of Mobile subscribers



# Battery Technologies

- No Moore's law for batteries or solar cells
- CPU: power consumption  $\sim CV^2f$ 
  - ▣ C: total capacitance, reduced by integration
  - ▣ V: supply voltage, can be reduced to a certain limit
  - ▣ f: clock frequency, can be reduced temporally

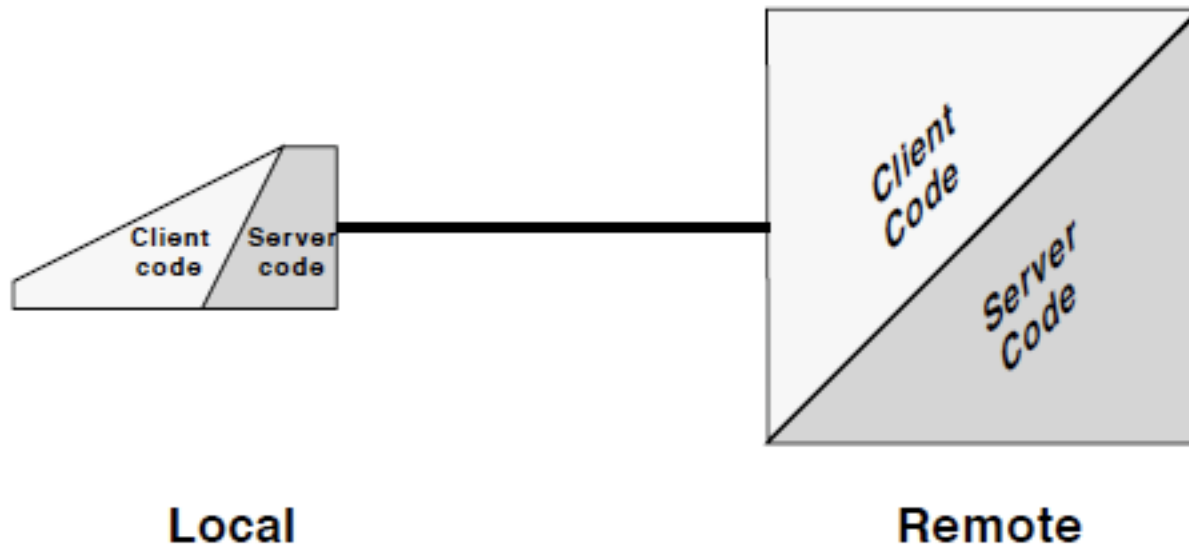


# Limitation of Mobile Computing (a 96's view)

- Mobile elements are resource-poor relative to static elements
- Mobility is inherently hazardous
- Mobile connectivity is highly variable in performance and variability
- Mobile elements rely on a finite energy source
- Bit/Hz cost for mobile data remains to be high

# Tension between Autonomy and Interdependence

- Resource pool devices; safety hazard → needs of server (cloud) supports
- Variability of connectivity → needs for local stor



# Challenges in Mobile Computing (a 96's view)

- Caching metrics
- Consistency
- Resource revocation
- Agility vs stability
- Global estimation from local observations

# Challenges in Mobile Computing (Today's View)

All above but more,

- Energy management
- Privacy and security
- Platform diversity (for development)

# This Course

---

Advanced topics

Context (service discovery,  
location)

Mobile platform (Android)

Wireless networks (WLAN,  
WPAN, ...)

Wireless communication

# Logistics

Date	Content		Note
Sept. 9 <sup>th</sup>	Principles	Introduction	
		Fundamentals of wireless communication	
Sept. 16 <sup>th</sup>	Protocols	Medium access	
Sept. 23 <sup>rd</sup>		WBAN/WPAN/WLAN	
Sept. 30 <sup>th</sup>		Wireless sensor networks/vehicular networks	
Oct. 7 <sup>th</sup>	Systems	Mobility management & service discovery	
Oct. 14 <sup>th</sup>		Thanksgiving	
Oct. 21 <sup>st</sup>		Android programming	Midterm
Oct. 28 <sup>th</sup>	Services	Context-awareness	
Nov 4 <sup>th</sup>		Location, location, location	
Nov 11 <sup>th</sup>		Power efficiency and performance	
Nov 18 <sup>th</sup>		Privacy and security	
Nov 25 <sup>th</sup>		Emulation/Virtualization	
Dec 2 <sup>nd</sup>		Misc	
Dec 6 <sup>th</sup> – 20 <sup>th</sup>		Exam period	

# Logistics

- Prerequisites:
  - ▣ object-oriented programming (Java, C++), computer networks
- Reference books & materials: (not required)
  - ▣ Fundamentals of mobile and pervasive computing
  - ▣ Android Programming: The Big Nerd Ranch Guide

# Logistics

- Grading :
  - ▣ Homework/programming assignments (6 total) 40%, In-class presentation 20%, Midterm 20%, Final project 20%
  
- Programming assignments:
  - ▣ Packet trace analysis (1 week)
  - ▣ Network speed test (1 week)
  - ▣ Data collector (1 weeks)
  - ▣ Orientation and step count (2 weeks)
  
- Final project
  - ▣ Indoor & outdoor navigation/location (3 weeks)