Introduction of Mobile Data Management and Privacy

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Lecture 01

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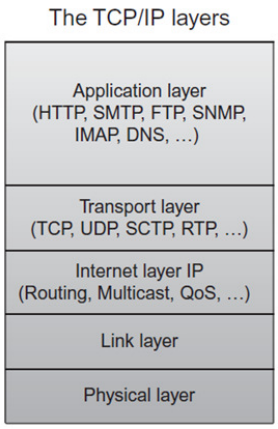
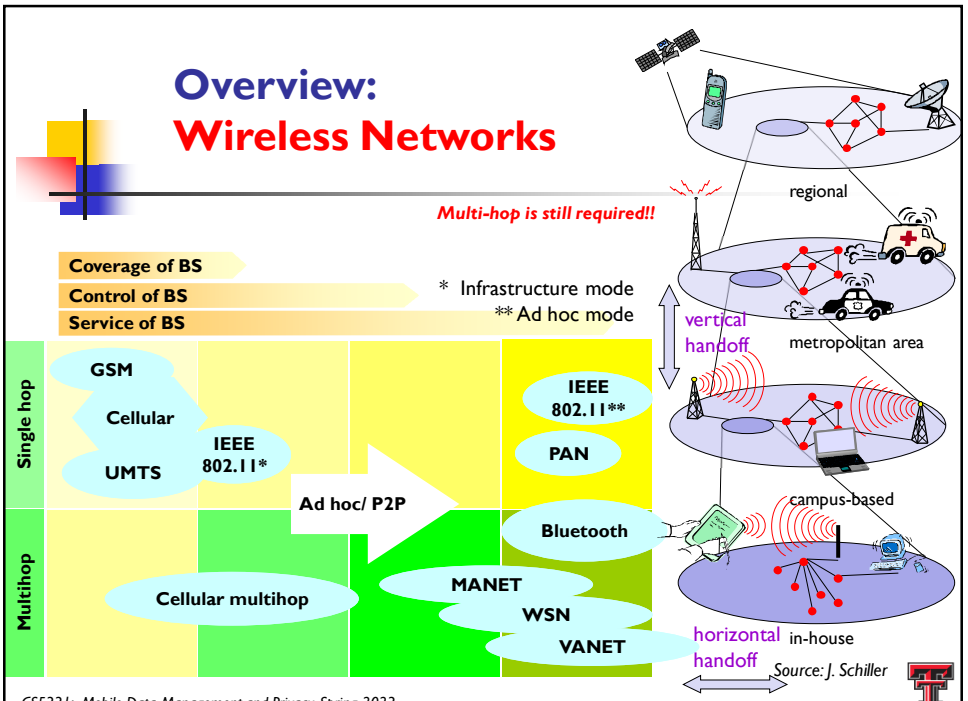
https://courses.cs.duke.edu/, Dr. Jeffrey R.N. Forbes; etc.

In this class…

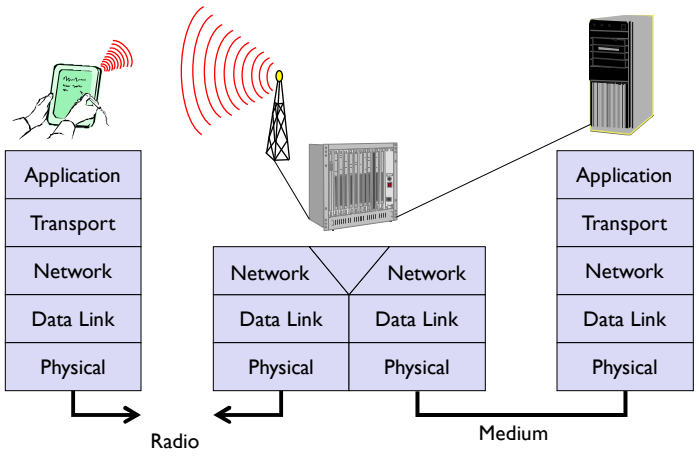
- Focus on **algorithms and communication protocols** embedded at the level of,
  - The link, network, transport, and application layers
- **wireless networks** and **mobile users**
- Learn a new tool, i.e., CSIM
- Read technical papers & try to find a research topic



Overview: Wireless Networks



Simple Reference Model used here



Mobile Communication

- Two aspects of mobility:
  - ***user mobility:*** users communicate (wireless) "anytime, anywhere, with anyone"
  - *device portability*: devices can be connected anytime, anywhere to the network
- **Wireless Vs. mobile**; Examples

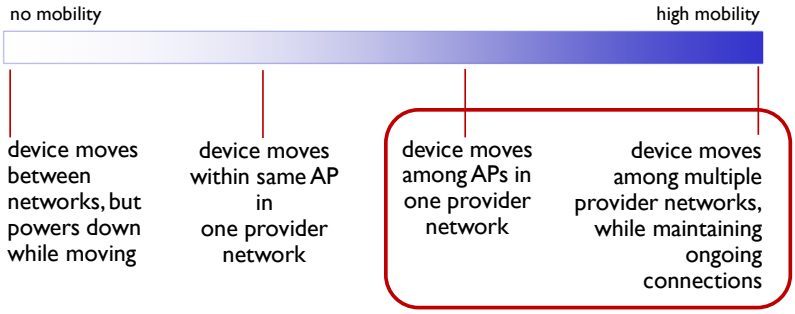
×	×	stationary computer with wired connected
✓	×	wireless LANs in historic buildings
✓	✓	Smartphone

- The demand for mobile communication creates the need for **integration** of wireless networks into existing fixed networks:
  - local area networks: standardization of IEEE 802.11
  - Internet: Mobile IP extension of the Internet protocol IP
  - wide area networks: e.g., internetworking of GSM and ISDN

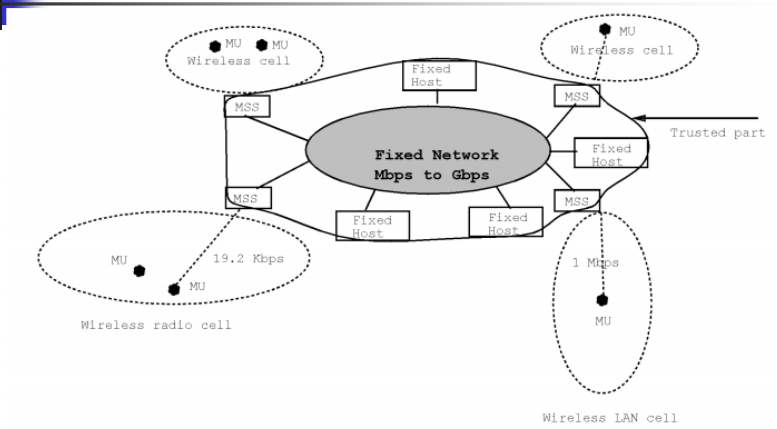
What is mobility?

hand-off mechanism

- spectrum of mobility, from the network perspective:



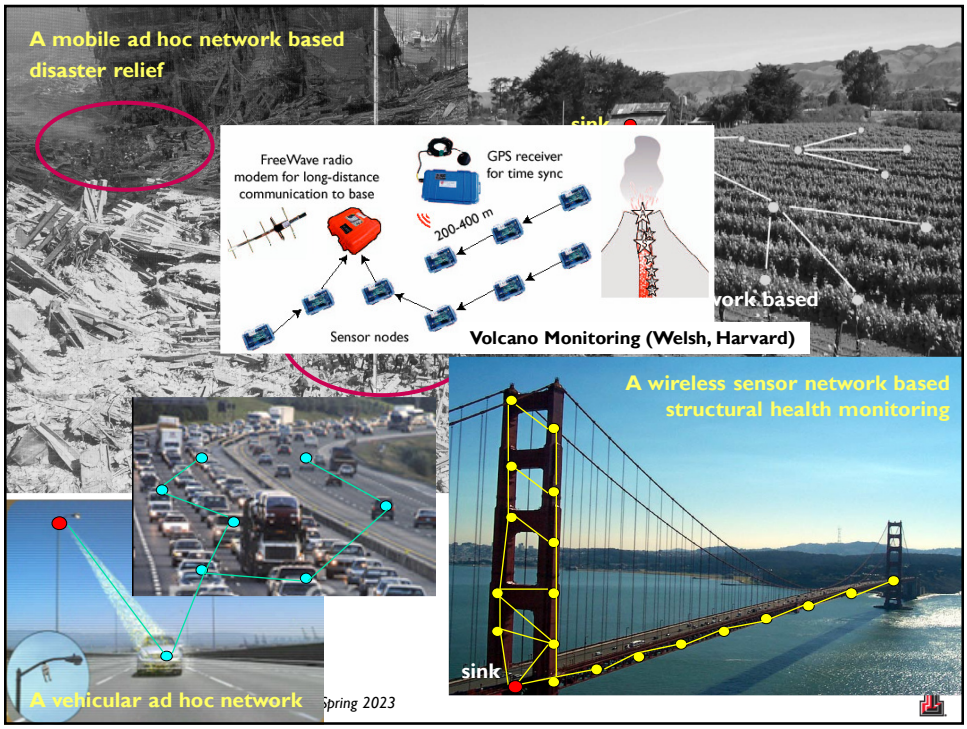
A Mobile Environment



MU **Mobile unit** (can be either dumb terminals or walkstations)
MSS **Mobile Support Station (has a wireless interface)**
Fixed Host **(no wireless interface)**

Mobile Data Management (MDM)

- **Mobile Computing + Data Management**
  - **Mobile users** in **wireless and/or networks**
  - Mobility data acquisition, management, processing, and protection
  - Location-based Services (LBS) – User query/cache/privacy/etc.
  - Mobile cloud computing and data management
  - etc.
- Diverse wireless and/or mobile networks:
  - Cellular Networks
  - Wireless Local Area Networks (WLANs)
  - Wireless Sensor Networks (WSNs)
  - Mobile Ad hoc Networks (MANETs)
  - Vehicular Ad hoc Networks (VANETs)
  - etc.
- Ubiquitous **Internet-of-Things (IoT)**
  - Blended with heterogeneous wireless sensors and devices

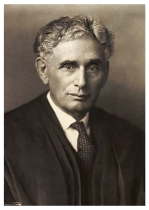


What makes MDM unique?: Wireless Networks vs. Mobile Users

- A distributed system…
- **Asymmetry link**
  - Difference between downlink (server-to-client) and uplink (client-to-server) bandwidth
  - bw(downlink) >> bw(uplink)
- **Frequent disconnections**
  - Actively or passively
  - Roaming, disconnecting from a cell to connect to another
  - **Handoff**, noise, etc.
- **Resource-constrained**
  - Battery-powered, limited computing power, limited memory, etc.

Privacy:
What do we mean by privacy?

- Louis Brandeis (1890)
  - "right to be left alone"
  - protection from institutional threat: government, press



- Alan Westin (1967)
  - "right to control, edit, manage, and delete information about themselves and decide when, how, and to what extent information is communicated to others"

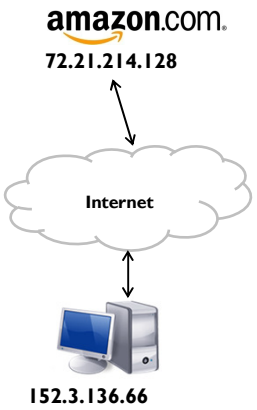
Privacy: (cont.)
What do we mean by privacy?

- Definitions:
  - **Protection** of an individual's **personal information**.
  - **Rights and obligations** of individuals and organizations with respect to the collection, use, retention, disclosure and disposal of personal information.
  - Privacy != Confidentiality

- **Privacy-sensitive** information
  - Identity
    - name, address, SSN
  - **Location**
  - Activity
    - web history, contact history, online purchases
  - Health records
  - …and more

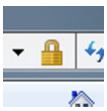
Example: Tracking on the web

- IP address
  - Number identifying your computer on the Internet
  - Visible to site you are visiting
  - Not always permanent
- Cookies
  - Text stored on your computer by site
  - Sent back to site by your browser
  - Used to save preferences, shopping cart, etc.
  - Can track you even if IP changes



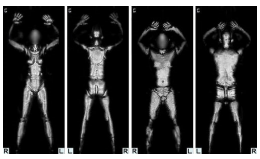
Privacy vs. Security

Privacy: what information goes where?



Security: protection against **unauthorized access**

- *Security helps* enforce privacy policies
- Can be *at odds with each other*
  - e.g., invasive screening to make us more "secure" against terrorism



Areas of Privacy

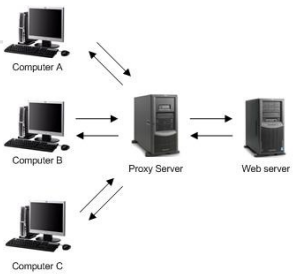
- Anonymity
  - **Anonymous communication**
- Web privacy
  - Understand/control what web sites collect, maintain regarding personal data
- **Mobile data** privacy
  - **Location privacy**
- Privacy-preserving data usage
- etc.

Privacy Preserving Data Sharing

- The need to sharing data
  - For research purposes
    - e.g., social, medical, technological, etc.
  - Mandated by laws and regulations
    - e.g., census
  - For security/business decision making
    - e.g., network flow data for Internet-scale alert correlation
  - For system testing before deployment
  - etc.
- However, publishing data may result in **privacy violations**

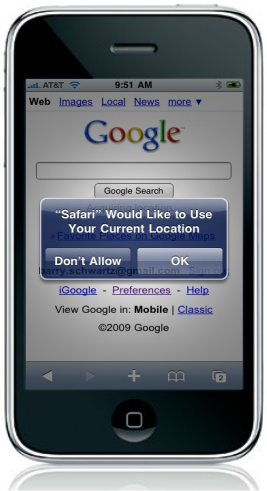
Alternatives?

- **Anonymization**
  - Hide identity, remove identifying info, e.g., do not use real names
  - Proxy server: connect through a third party to hide IP
  - Health data released for research purposes: remove name, address, etc
- Encryption
- Decentralization
  - Issues,
    - True ownership of data
    - Maintenance burden
    - Cost



Location Privacy

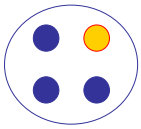
- Smartphones:
  - Always in your pocket
  - Always connected
  - Always knows where it is: GPS
- Location-based services
- Location-based ads
- What are we giving up?



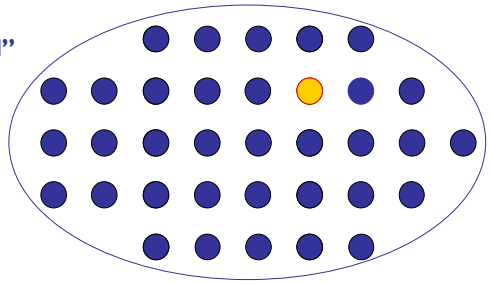
Need for Data Privacy Research

- Develop theory and techniques to **anonymize data** so that they can be beneficially used without privacy violations:
  - How to define privacy for anonymized data?
  - How to publish data to satisfy privacy while providing utility?

"Hiding in a crowd"



"Less" anonymous (1/4)



"More" anonymous (1/*n*)