

Mobile and Sensor Systems

Lecture I: Introduction to
Mobile Systems

Dr Cecilia Mascolo

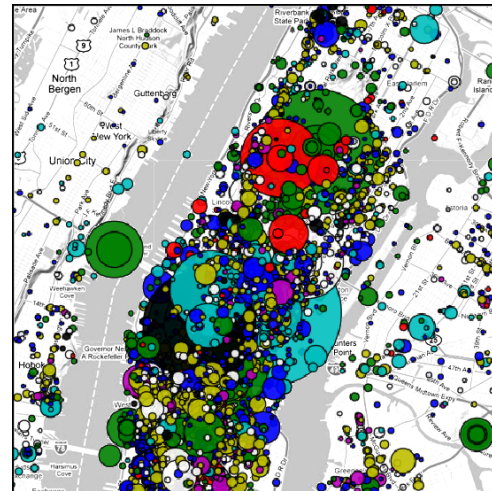
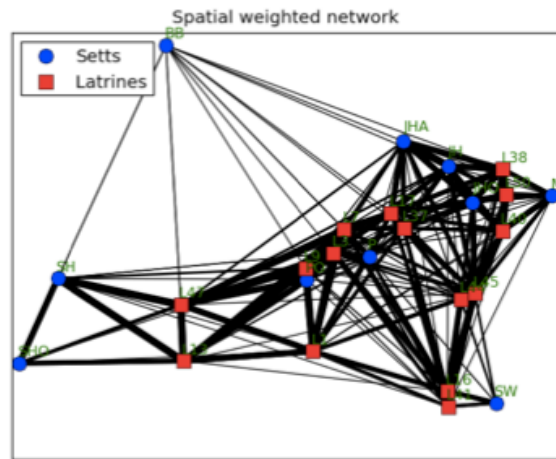
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In this course

- The course will include aspects related to general understanding of
 - Mobile and ubiquitous systems and networks
 - Sensor systems and networks

List of Lectures

- Lecture 1: Introduction to Mobile Systems.
- Lecture 2: Mobile Medium Access Control and Wireless Systems.
- Lecture 3: Infrastructure, Ad-hoc and Delay Tolerant Mobile Networks.
- Lecture 4: Sensor Systems and MAC Layer Protocols.
- Lecture 5: Sensor Networking Routing Protocols.
- Lecture 6: Sensor Systems Reprogramming and Mobile Sensing.
- Lecture 7: Mobile Phone Sensing.
- Lecture 8: Practical: Mobile Phone Programming.

Teaching Material

- No required textbook.
- Some suggested readings:
 - Schiller, J. (2003). Mobile communications. Pearson (2nd ed.).
 - Karl, H. & Willig, A. (2005). Protocols and architectures for wireless sensor networks. Wiley.
 - Agrawal, D. & Zheng, Q. (2006). Introduction to wireless and mobile systems. Thomson.
- Specific lectures will reference research papers which can be used for additional reading.

In this lecture

- We will describe mobile systems and their applications and challenges.
- We will start talking about wireless networks.

Smart Phones: the Computing Platform of the Future

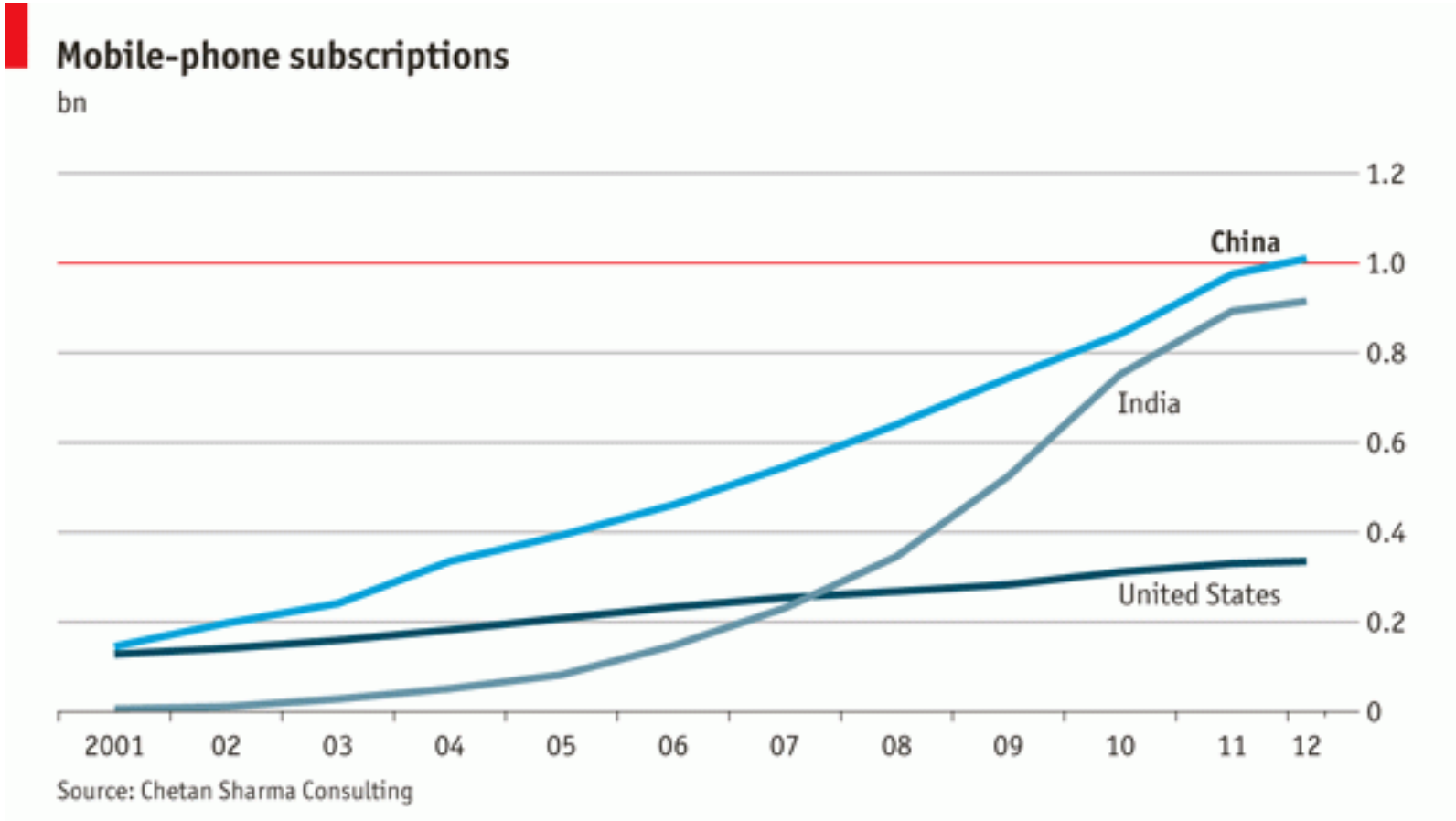


Smart Phones: **the** Computing Platform



Some Numbers

- Number of worldwide mobile cellular subscribers increased from 34 million in 1993 to nearly 5.5 billion subscribers by 2011.
- The number of cellular subscribers surpasses the number of wired phone lines.



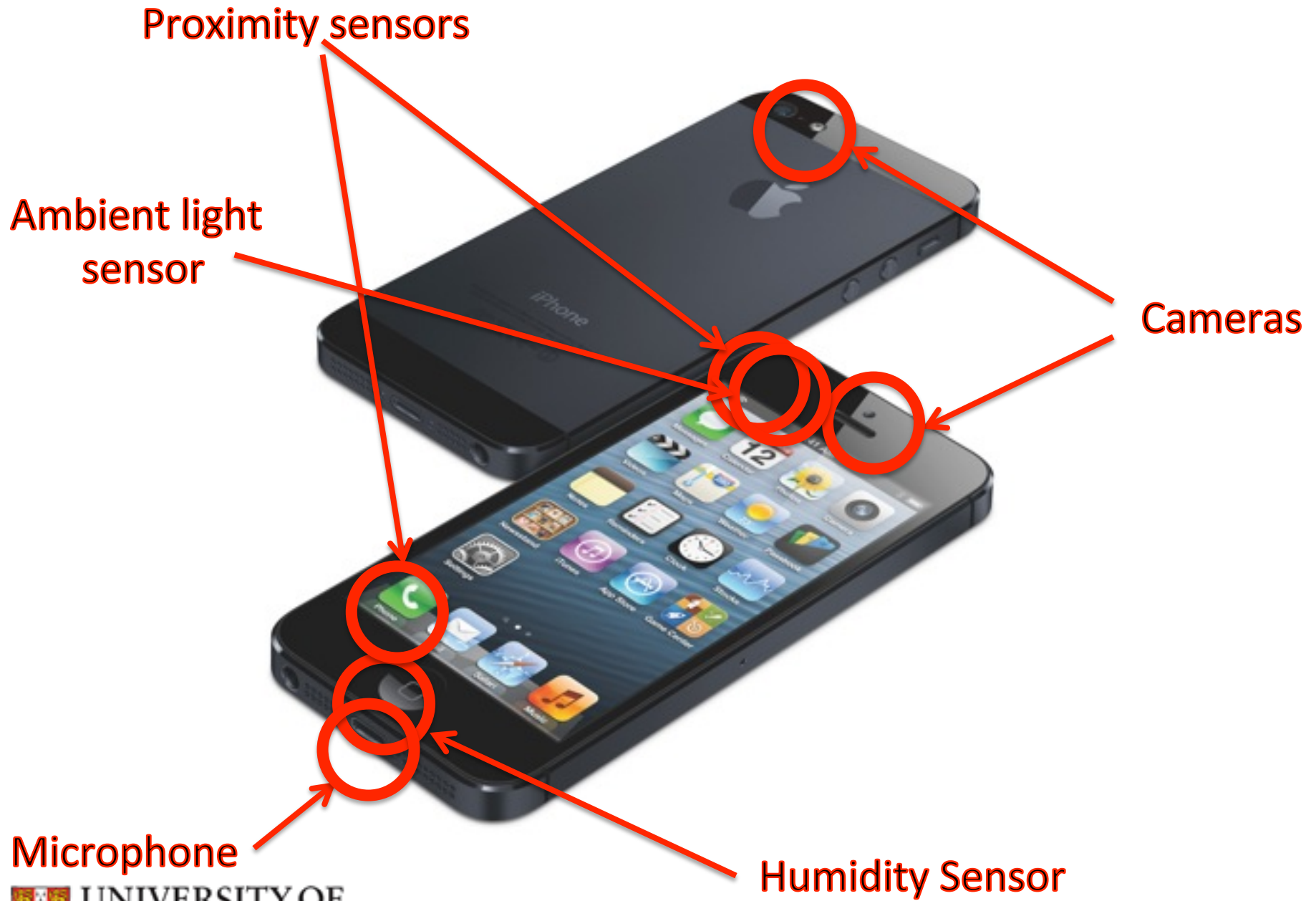
Source: The Economist

Location-based Social Network Systems



Geographic Recommender Systems





Credit: CNet



Accelerometer
GPS



Gyroscope
Bluetooth [colocation]

Fundamental Challenges in Mobile Computing

- Mobile devices are resource-constrained.
- Mobile connectivity is highly variable in performance and reliability.
- Mobile devices are inherently less secure.

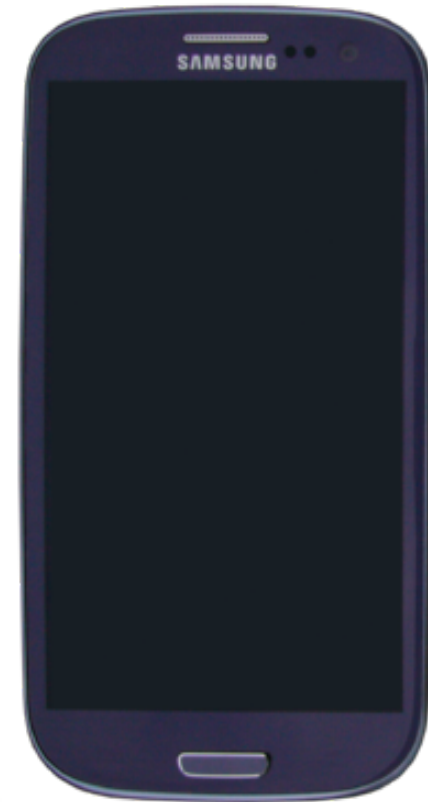
Mobile Devices are Inherently Resource Constrained

- Mobile devices rely on batteries.
- Energy consumption due to:
 - Computation (CPU, co-processors)
 - Display
 - Communication
 - Sensing
- Energy-efficient algorithms are needed.

Mobile Devices are Inherently Resource Constrained

- Computational constraints
 - But, for example, in the Samsung Galaxy SIII you have 1.4 GhZ quad-core Cortex A-9 +GPU
- Memory constraints
 - But, for example, in the Samsung Galaxy SIII you have 1GB or 2GB of RAM

Samsung
GALAXY S III



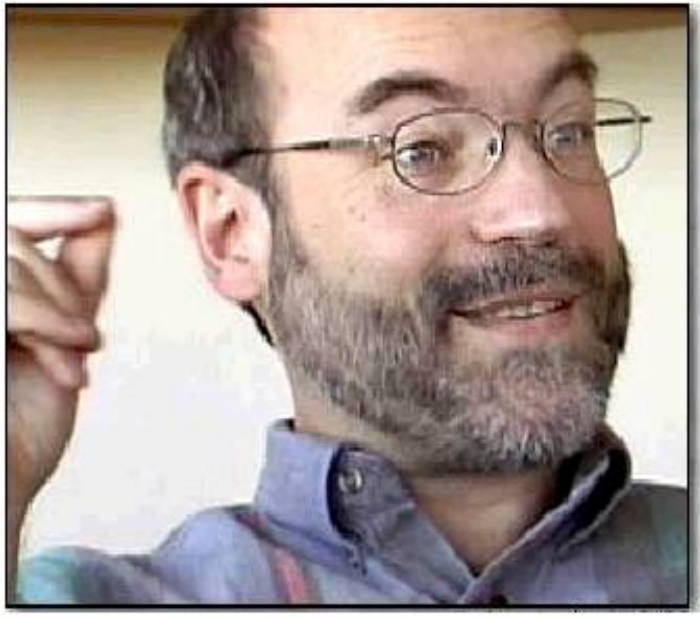
Mobile Connectivity is Highly Variable in Performance and Reliability

- Various types of connectivity:
 - Cellular (GSM, 3G, 4G, etc.)
 - WiFi
 - Bluetooth
 - Near Field Communication (NFC)
 - ...
- Constraints related to:
 - Coverage issues
 - Trade-offs: energy consumption, throughput, costs

Mobile Devices are Inherently Less Secure

- Wireless not wired communication:
 - Eavesdropping.
 - Need for encrypted communication.
- Devices can be stolen:
 - Devices might also be accessible by everyone (for example, sensors).

Ubiquitous and Mobile Computing



Mark Weiser (1952-1999)

“The most profound technologies are those that disappear.”

Copyright: PARC





Issues in Designing Mobile Computing Systems

- Distributed systems issues:
 - Remote communication
 - Fault tolerance
 - Remote information access
 - Distributed security
- Networking issues:
 - Wireless communication
 - Transport layer for wireless channel

Issues in Designing Mobile Computing Systems

- Databases issues:
 - Disconnected operations
 - Weak consistency
- Energy issues:
 - Adaptation in terms of communication
 - Intelligent uploading of data
 - Hardware aspects

Issues in Designing Mobile Computing Systems

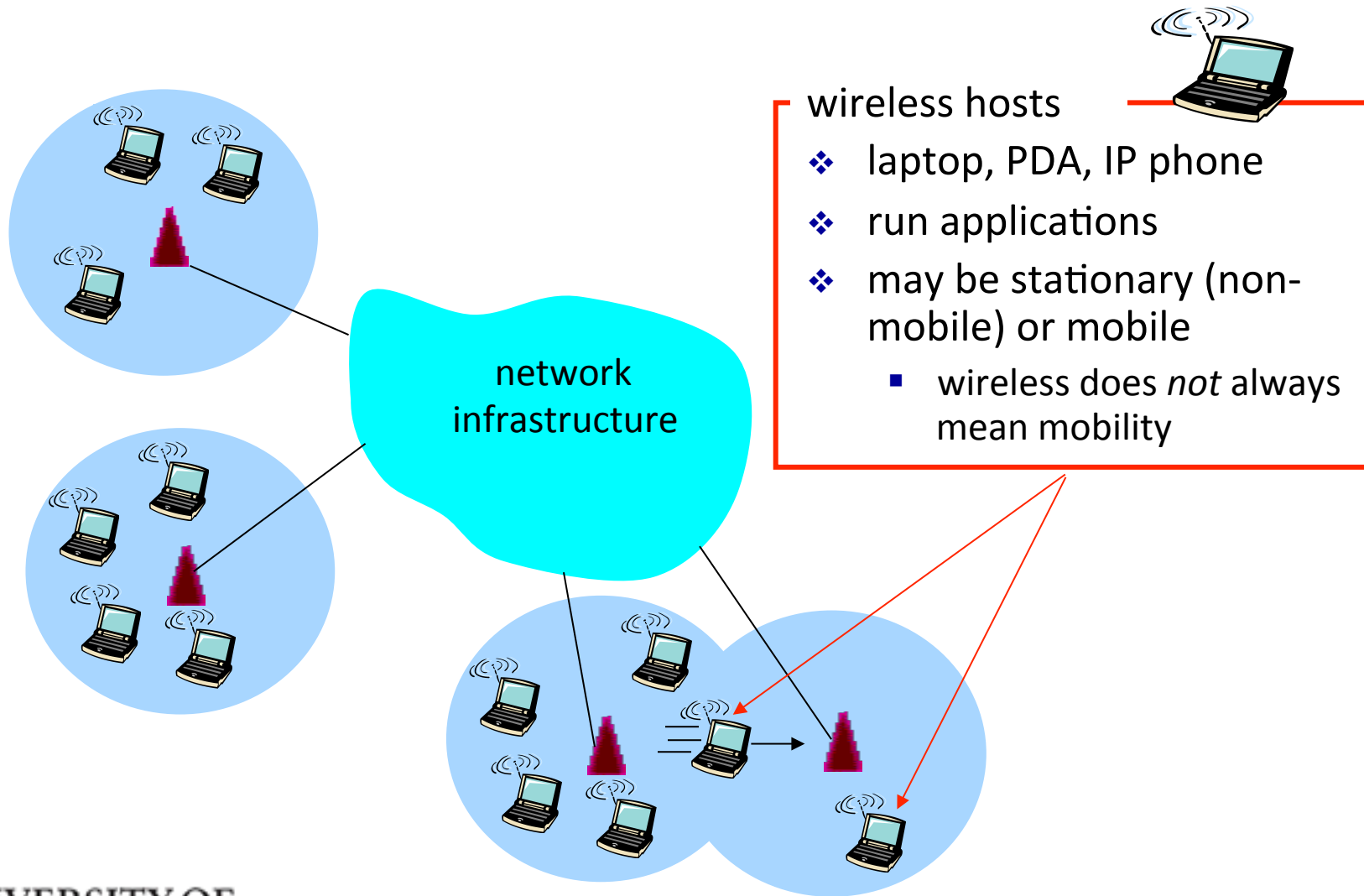
- HCl issues:
 - Limited interface
 - Interaction with the devices (input, etc.)
 - Ergonomics
- Privacy issues:
 - Location sharing
 - Activity recognition
- Security issues:
 - Encrypted communication

Wireless and Mobile Networks

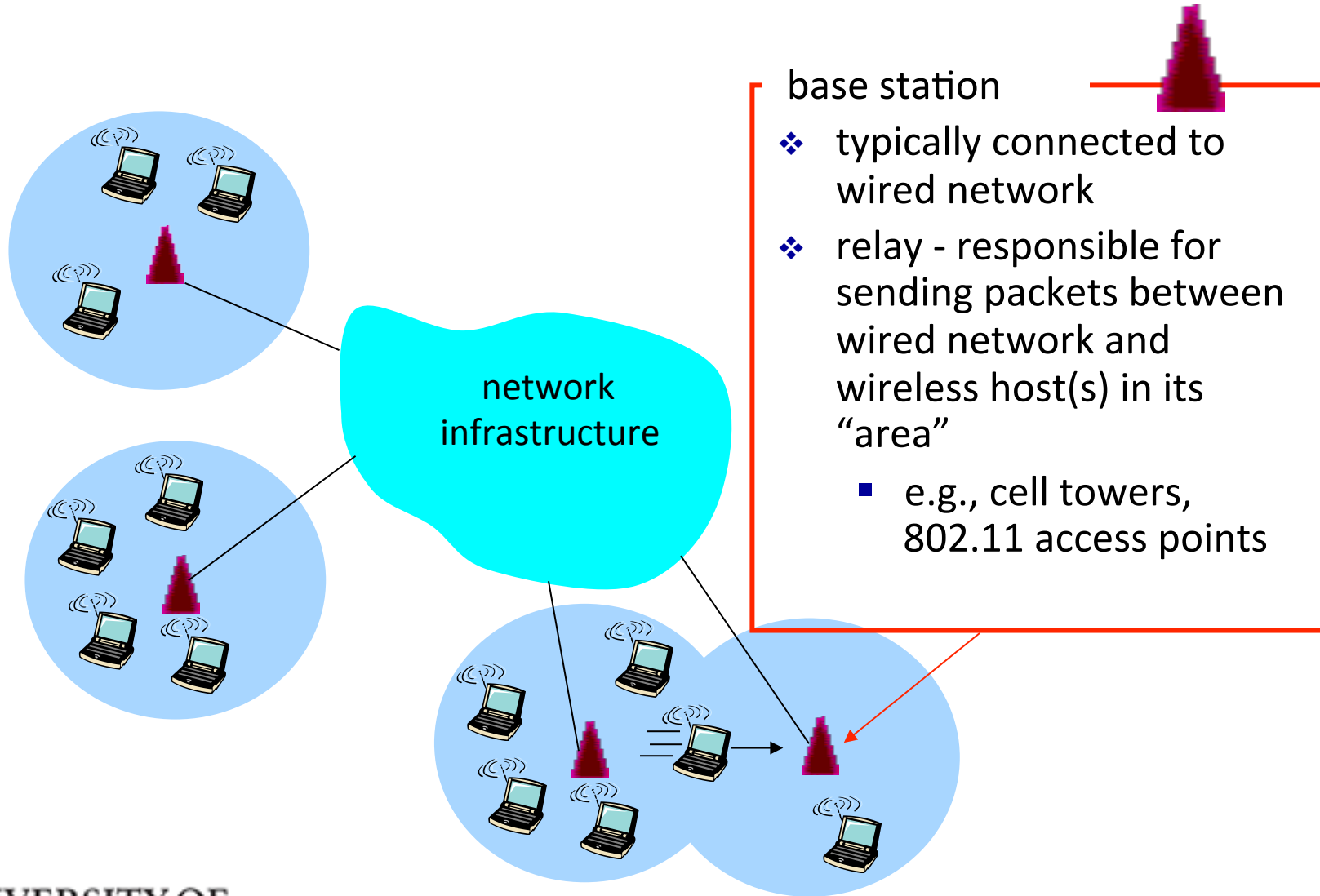
Background:

- Number of wireless (mobile) phone subscribers now exceeds number wired phone subscribers!
- Number of wireless Internet-connected devices soon to exceed number of wired Internet-connected devices
 - laptops, Internet-enabled phones promise anytime Internet access
- Two important (but different) challenges
 - *wireless*: communication over wireless link
 - *mobility*: handling the mobile user who changes point of attachment to network

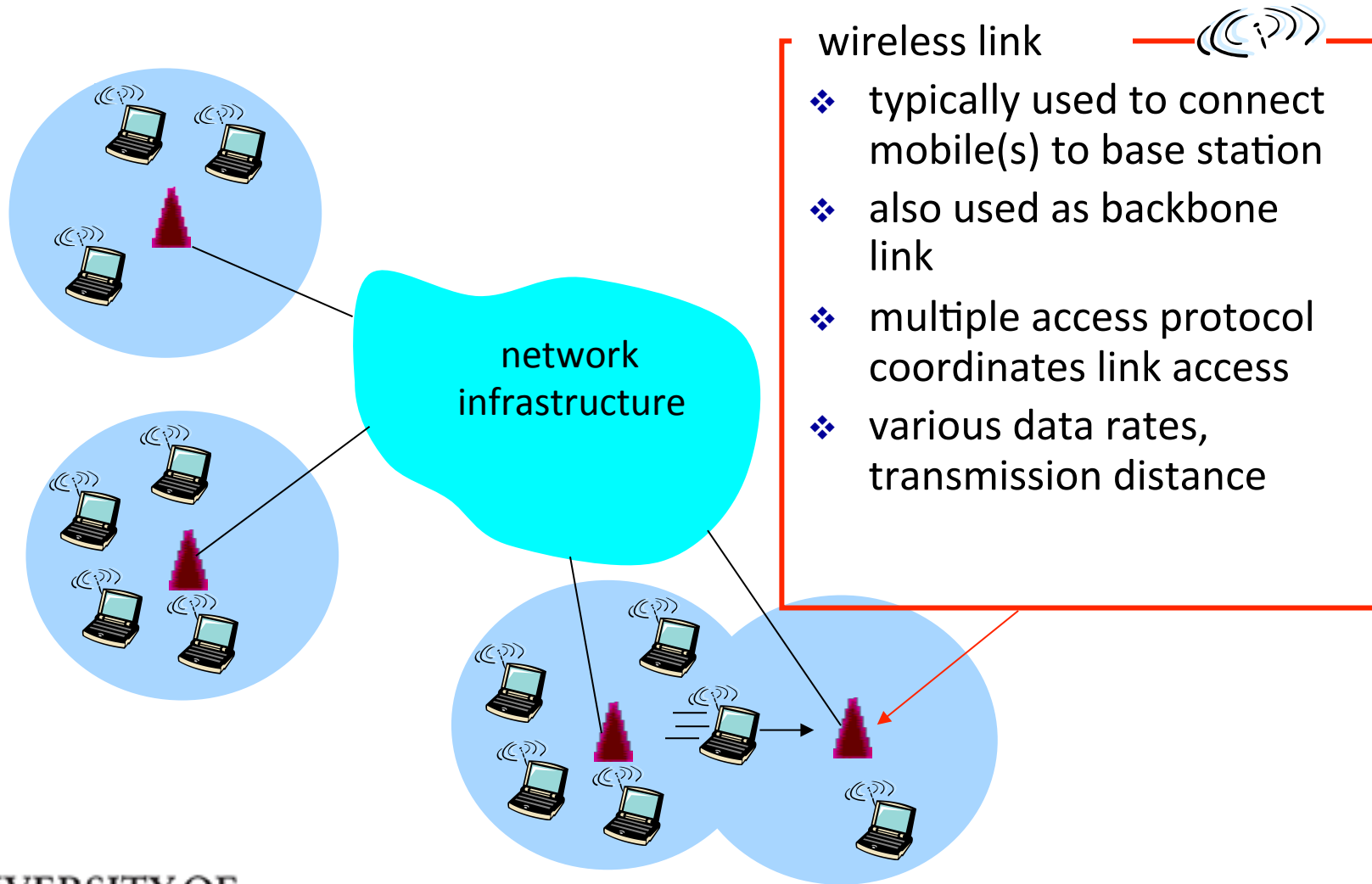
Elements of a wireless network



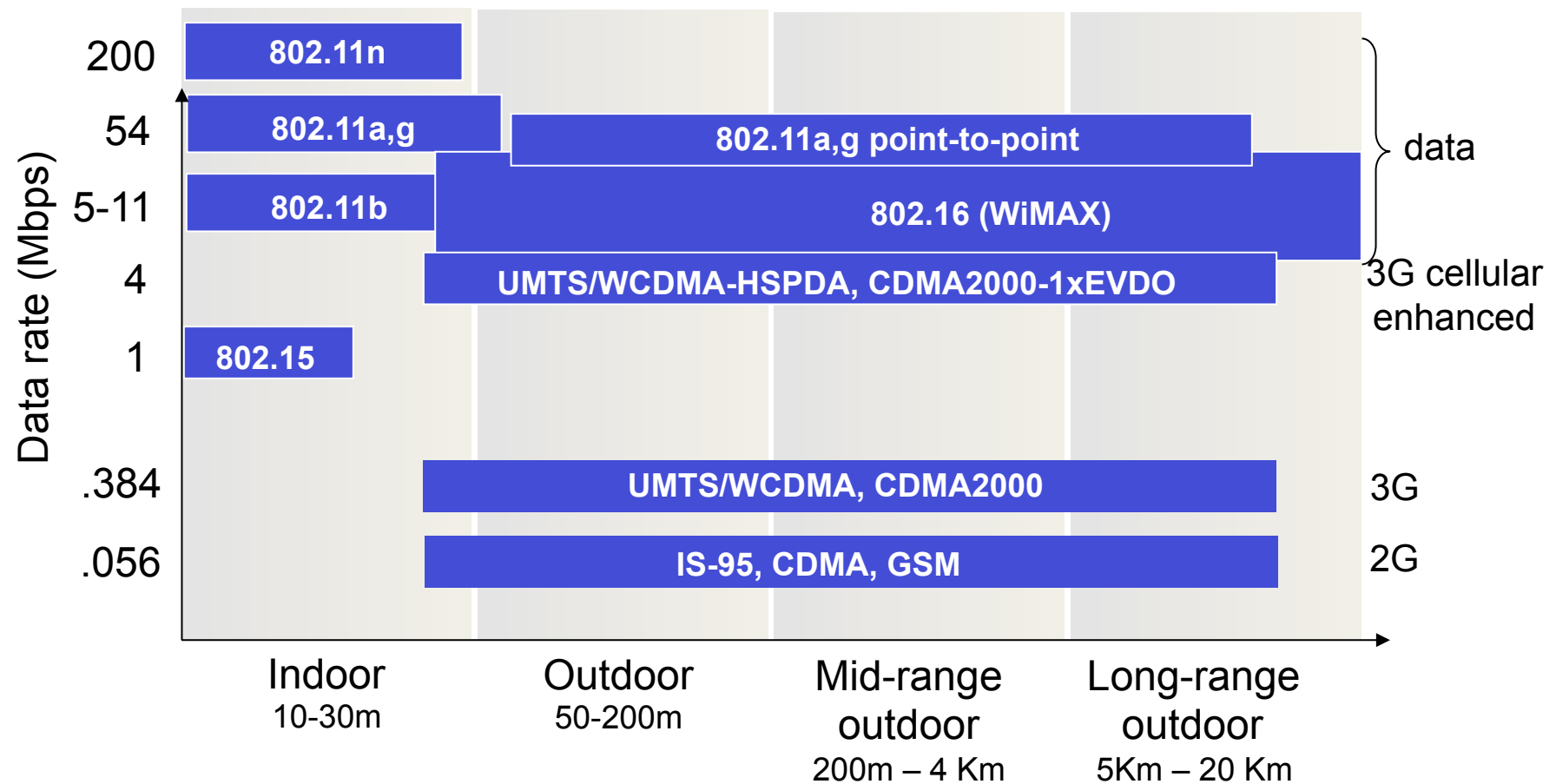
Elements of a wireless network



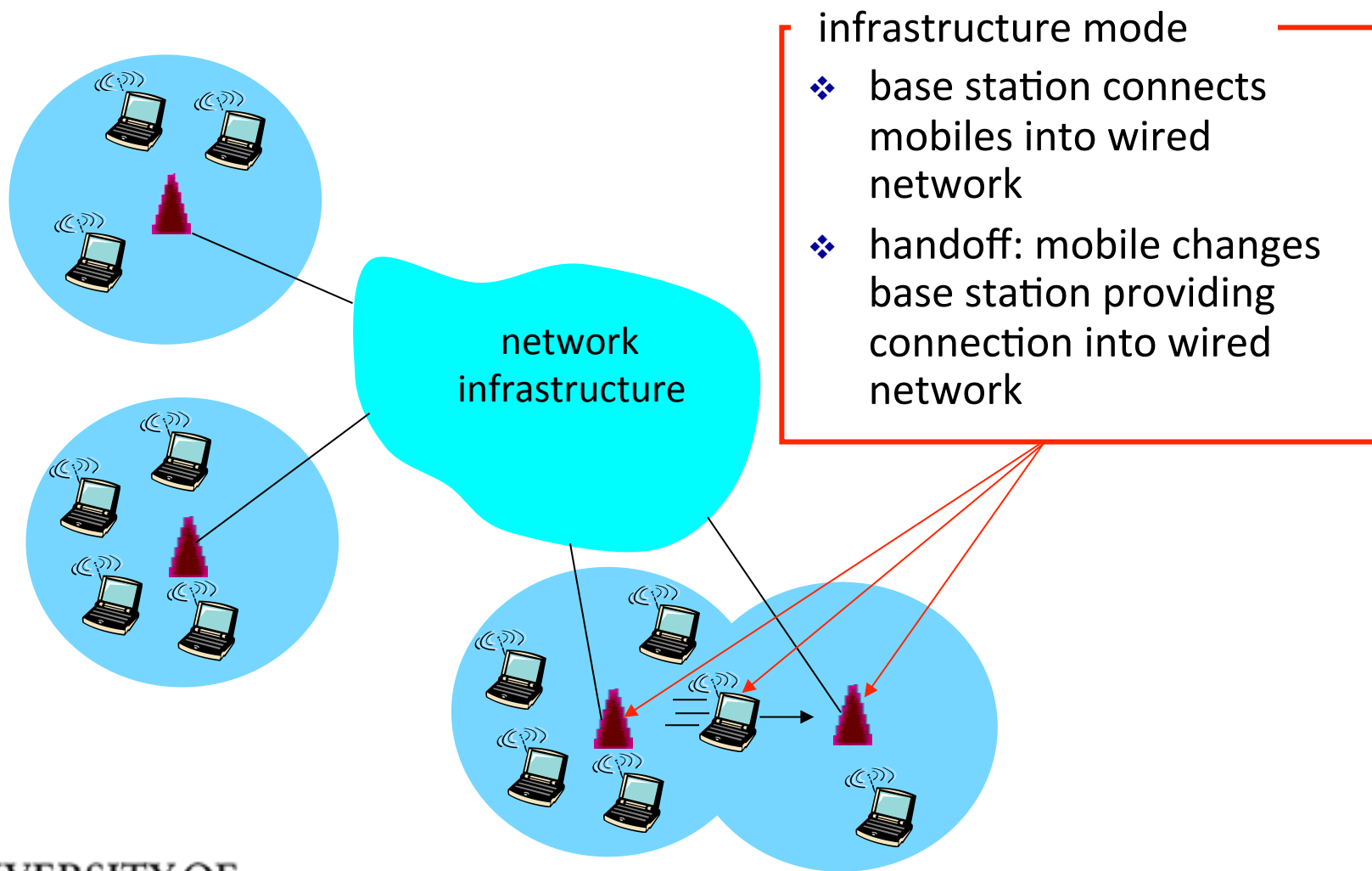
Elements of a wireless network



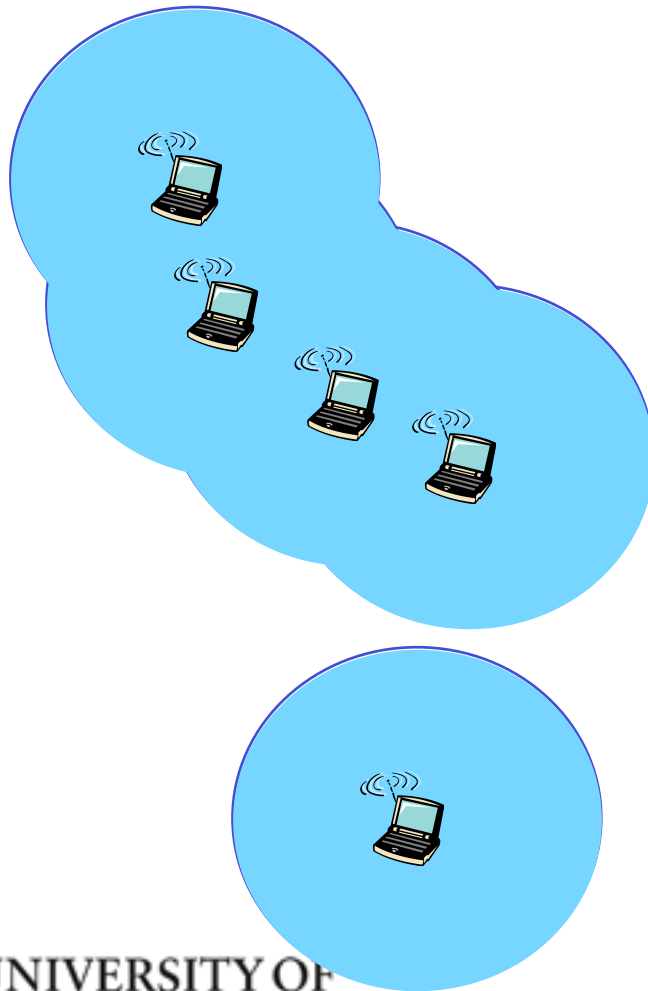
Characteristics of selected wireless link standards



Elements of a wireless network



Elements of a wireless network



ad hoc mode

- ❖ no base stations
- ❖ nodes can only transmit to other nodes within link coverage
- ❖ nodes organize themselves into a network: route among themselves

Wireless network taxonomy

	single hop	multiple hops
infrastructure (e.g., APs)	host connects to base station (WiFi, WiMAX, cellular) which connects to larger Internet	host may have to relay through several wireless nodes to connect to larger Internet: <i>mesh net</i>
no infrastructure	no base station, no connection to larger Internet (Bluetooth, ad hoc nets)	no base station, no connection to larger Internet. May have to relay to reach other a given wireless node MANET, VANET

Suggested Readings

- Mark Weiser. The Computer for the 21st Century. Scientific American. September 1991.
- Mark Weiser. Some Computer Issues in Ubiquitous Computing. Communications of the ACM. Vol. 36. Issue 7. July 1993.
- M. Satyanarayanan. Pervasive Computing: Vision and Challenges. IEEE Personal Communications. Vol. 8 Issue 4. August 2001.
- Chapter 6 of James F. Kurose and Keith W. Ross Computer Networking. A Top Down Approach. 6th Edition. Pearson 2012.

Ack

- Some material for the slides of this course has been contributed by:
- Dr Mirco Musolesi, Dr Christos Efstratiou, Dr Sarfraz Nawaz