

# Mobile Computing

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# What is Mobile Computing?

- You are speaking to your friend over a mobile phone
- You are using a digital camera to take photographs
- You are accessing social networking site while traveling
- You are using a calculator on your mobile phone
- You are browsing Internet while on move
- You are making a bank transaction while on move
- .....

# What is Mobile Computing?

- What is computing?

Operation of computers (according to oxfords advance learner's dictionary)

**Computing** is the process of using computer technology to complete a given goal-oriented task (Techopedia)

- What is the mobile?

That someone /something can move or be moved easily and quickly from place to place

- What is mobile computing?

Users with portable computers still have network connections while they move

# What is Mobile Computing

- **Mobile Computing** is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link. [Tutorialspoint]
- **Mobile computing** is [human-computer interaction](#) by which a [computer](#) is expected to be transported during normal usage, which allows for transmission of data, voice and video. Mobile computing involves [mobile communication](#), mobile hardware, and mobile software. Communication issues include [ad hoc networks](#) and infrastructure networks as well as communication properties, [protocols](#), data formats and concrete technologies. Hardware includes [mobile devices](#) or device components. [Mobile software](#) deals with the characteristics and requirements of mobile applications. [Wikipedia]

# What is Mobile Computing

- **A simple definition could be:**

*Mobile Computing is using a computer (of one kind or another) while on the move*

- **Another definition could be:**

*Mobile Computing is when a (work) process is moved from a normal fixed position to a more dynamic position.*

- **A third definition could be:**

*Mobile Computing is when a work process is carried out somewhere where it was not previously possible.*

# What is Mobile Computing

- Provides **decentralized (distributed)** computations on diversified devices, systems, and networks, which are **mobile, synchronized, and interconnected** via mobile communication standards and protocols.
- Mobile device does not restrict itself to **just one application**, such as, voice communication
- Offers **mobility with computing power**
- Facilitates a large number of applications on a single device

# What is Mobile Computing

- **Mobile Computing** is an umbrella term used to describe technologies that enable people to access network services anyplace, anytime, and anywhere.

# Ubiquitous Computing

- Refers to the blending of computing devices with environmental objects
- A term that describes integration of computers into practically all objects in our everyday environment, endowing them with computing abilities
- Based on pervasive computing



# Pervasive Computing

- Pervasive means ‘existing in all parts of a place or thing’.
- Pervasive computing— The next generation of computing which takes into account the environment in which information and communication technology is used everywhere, by everyone, and at all times.
- Assumes information and communication technology to be an integrated part of all facets of our environment, such as toys, computers, cars, homes, factories, and work-areas.
- Takes into account the use of the integrated processors, sensors, and actuators connected through high-speed networks and combined with new devices for viewing and display

# Mobile Computing on a Smartphone

- A mobile phone with additional computing functions so as to enable multiple applications
- SMS (short message service), MMS (multimedia messaging service), phone, e-mail, address book, web browsing, calendar, task-to-do list, pad for memos.
- Integrated attachment viewing.
- SureType keyboard technology with QWERTY-style layout.
- Bluetooth capability for hands-free talking via headset, ear buds, and car kits.

# Mobile Computing

- listening to one's favorite tunes anytime and anywhere
- Viewing photo albums
- Slide shows
- Video clips
- Bank transactions
- Retail purchases
- Supply chain management
- e-Ticketing— booking cinema, train, flight, and bus tickets

# Principles of Mobile Computing [Wikipedia]

- Portability: Devices/nodes connected within the mobile computing system should facilitate mobility
  - Devices may have limited device capabilities and limited power supply, but should have a sufficient processing capability and physical portability to operate in a movable environment.
- Connectivity: This defines the [quality of service](#) (QoS) of the network connectivity.
  - In a mobile computing system, the network availability is expected to be maintained at a high level with the minimal amount of lag/downtime without being affected by the mobility of the connected nodes.

# Principles of Mobile Computing [Wikipedia]

- Interactivity: The nodes belonging to a mobile computing system are connected with one another to communicate and collaborate through active transactions of data.
- Individuality: A portable device or a mobile node connected to a mobile network often denote an individual.
  - a mobile computing system should be able to adopt the technology to cater the individual needs and also to obtain contextual information of each node.

# Limitations

- Resource constraints: Battery
- Interference: the quality of service (QoS)
- Bandwidth: connection latency
- Dynamic changes in communication environment: variations in signal power within a region, thus link delays and connection losses
- Network Issues: discovery of the connection-service to destination and connection stability
- Interoperability issues: the varying protocol standards
- Security constraints: Protocols conserving privacy of communication

# Wireless Communication

- Radio waves or infrared light
- Sometimes linked to wired network through stationary transceivers
- Area covered by an individual transceiver's signal is known as a cell
- Cell sizes vary widely –
  - E.g. infrared transceivers can cover a small room, cellular telephone transceivers can cover few miles and satellite beam can cover 400 miles in diameter
- Lower bandwidth
- Higher error rates
- More frequent disconnections
- Increased communication latency due to retransmissions
- Retransmission time-out delay
- Error control protocol processing

# Comparisons with wired network

- **Wired Networks**

- high bandwidth
- low bandwidth variability
- can listen on wire
- high power devices (often connected to main)
- high resource availability
- need physical access (security)
- low delay
- connected operation

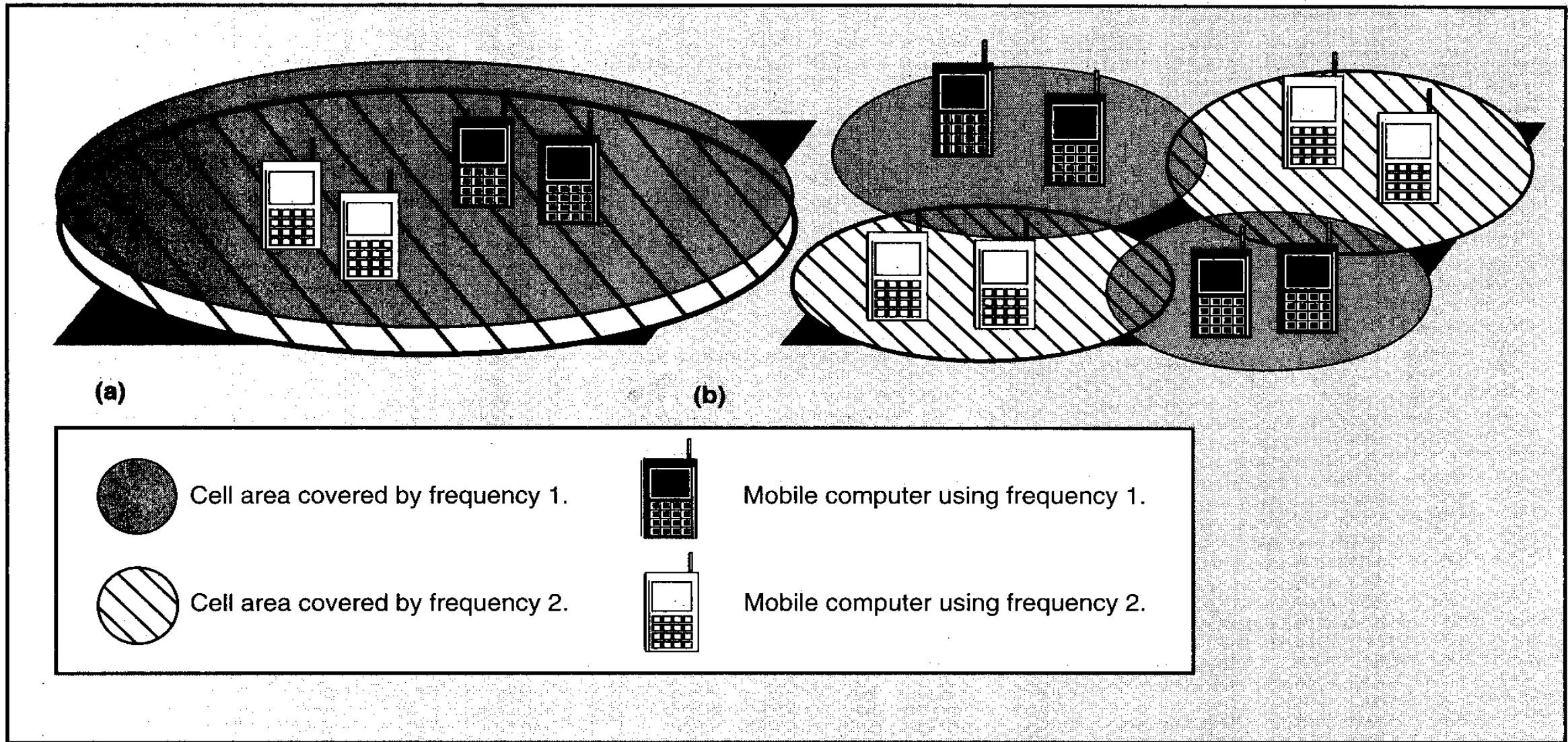
- **Wireless Networks**

- low bandwidth
- high bandwidth variability  
(greater variation in available bandwidth)
- hidden terminal problem
- low power machines (usually battery powered)
- low resource availability
- need proximity
- higher delay
- Higher error rates
- More frequent disconnections



# Low Bandwidth and Bandwidth Variability

- Lower bandwidth than wired networks
- Deliverable bandwidth per user depends on the number of users sharing a cell
- The network's capacity can be improved in two ways:
  - Maintain multiple cells at different frequencies.
  - This technique, although more flexible, is limited by the range of frequencies of the electromagnetic spectrum available for public consumption.
- Limiting transmission ranges so that more cells can fit in a given area.
  - This approach is simpler, reduces power requirements, and may decrease corruption of the signal.
  - It is also known that transceivers covering less area can achieve higher bandwidths.



**Figure 2.** Suppose that a single frequency provides only enough wireless bandwidth for two users. Then two frequencies can support (a) four users with two large coincident cells or (b) eight users with four small noninterfering cells that use the same frequency in nonadjacent cells. The latter scheme requires more transceivers and installation effort but is more scalable and allows higher bandwidth technology and lower transmission power.

# Low Bandwidth and Bandwidth Variability

- Other techniques to cope with low bandwidth
  - Compression
  - logging (making large requests out of several short ones)
  - prefetching (guessing which files will be needed soon)
  - Delayed write-back
- System performance can be further enhanced by scheduling communications intelligently

# Low Bandwidth and Bandwidth Variability

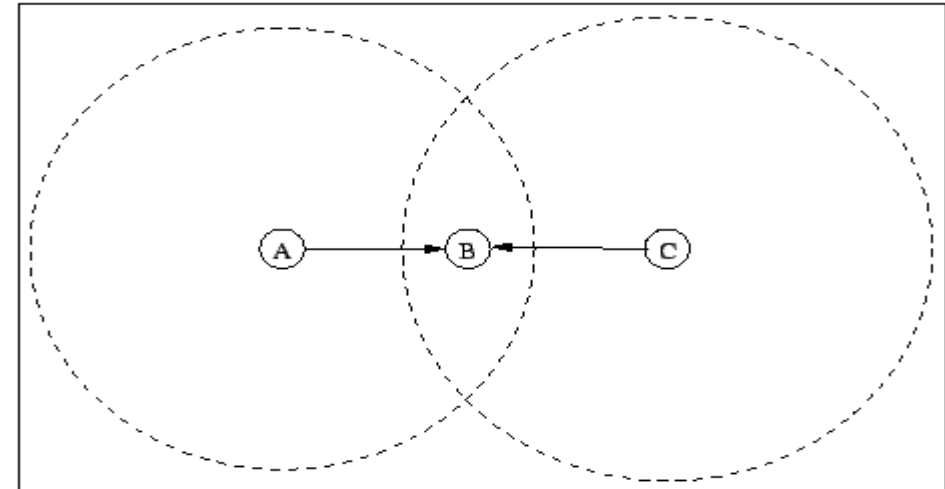
- Mobile computing designs must cope with much greater variations in network bandwidth than traditional designs.
  - It can assume that the entire bandwidth is always available and operate only when plugged in
  - It can assume low bandwidth connection and do not take advantage of high bandwidth though available
  - A good design would be able to adapt to the currently available resources, providing the user with a variable level of quality.
  - E.g. for a video conferencing application, depending on the currently available bandwidth, only the speaker or all participants can be displayed.

# Heterogeneity of networks

- When a mobile element leaves the range of one network transceiver, it switches to another.
- There may also be places where they can access multiple transceivers on different frequencies.
- Concurrent use of a wired network and a wireless network maybe possible too.
- There may be a need to change access protocols, for example when switching from cellular coverage to satellite coverage (or to Wifi connection).

# hidden terminal problem

- The transmission range of A reaches B but not C.
- Similarly, the range of C reaches B but not A.
- However the range of B reaches both A and C.
- Now, the node A starts to send something to B and C doesn't receive this transmission.
- Now C also wants to send data to B and senses the carrier. As it senses it to be free, it also starts sending to B.
- Thus, data from both parties A and C will be lost during the collision.



Hidden terminal problem occurs when two nodes that are outside each other's range perform simultaneous transmission to a node that is within the range of each of them resulting in a collision.

# Disconnection

- Instead of trying to prevent disconnection, a good design puts effort to tolerate disconnections
  - Run locally on mobile unit (operate as stand alone computer as much as it can)
  - Operate asynchronously – a client sends multiple requests before asking for an acknowledgement
  - pre-fetching and delayed write-back – decouples communication from the actual time a program produces or consumes data
    - Thus allowing the program to execute even during disconnection

# Mobility

- A mobile computer changes its location
- While on move it uses different network access points, or 'addresses'
- To find its current address, the following techniques may be used
  - Selective Broadcast: If a mobile computer is known to be within a set of cells or networks in close proximity, then a message could be 'broadcast' to these known cells asking the required mobile unit to reply with its current network address.
    - Too expensive for a large network
  - Central Services: A logically centralised database contains the current addresses of all mobile units. Whenever a mobile computer changes its address, it sends a message to update the database.
    - Problem with a centralized system and a single point of failure



# Mobility

- Home Bases: Only a single server, the 'home' of the mobile device knows the current location of a mobile computer.
  - If the home base is down, the mobile devices it tracks cannot be contacted
- Forwarding Pointers: This method places a copy of the new address at the old location. Each message is forwarded along the chain of pointers leading to the mobile computer.
  - Inefficient routing due to long chain of pointers
  - Prone to failure anywhere along the trail of pointers
  - Requires an active entity at the old address to receive and forward messages – does not fit with standard networking model

# Mobility

- Location dependent Information
  - Such as local name server, time zone, available printers etc.
  - Static configuration does not work – need to configure dynamically
  - It is required to factor out information and provide mechanisms to obtain configuration data appropriate to present location
  - Need to cope up with different administrative domains
  - Need access to location sensitive information
    - “Where is the nearest taxi?/ nearest ATM?”
    - “Where is the nearest open gas station heading north on Hwy 69?”
  - Privacy of the other mobile users whom a mobile (or static) user contacts is another major issue which needs to be handled

# Mobility

- Migrating locality
  - Network distance versus physical distance
  - Communication distance may often increase disproportionately – small movement leading to long network distance when network boundary is crossed
  - More intermediaries, longer latency, greater risk of disconnection
  - Might be necessary to transfer connections to servers that are closer
  - Loadbalancing issues come up when several users within a small boundary

# Portability

- Portability (design pressures)
  - Low power
  - High risk of data loss
  - Small user-interfaces
  - Limited on-board storage

# Portability

- Portability – low power
  - Power management software (power consumption profiles)
- Portability – risk of data loss
  - External copies
  - replicated file systems
- Portability – small user interface
  - Handwritten recognition
  - Voice recognition
  - Pointing devices

# Portability

- Portability – small storage capacity
  - Hard drives are a liability, since they consume more power
  - Solutions
    - Compressing file systems
    - Accessing remote storage over the network
    - (contradictory to network unavailability due to disconnection)

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