Mobile Computing Networks

Dr. Yatindra Nath Singh

EE/ACES, IIT Kanpur

Email: ynsingh@iitk.ernet.in

What is mobile computer?

- A computer which you can take with you all around.

- You can do all the things which can be done with a desktop computer.

- You should be able to use same software, which you use on a desktop computer.

Mobile computer - How?

- One possibility is to have a standalone computer capable of

  - storing large amount of software and data files,

  - processing power to support the required applications.

- Modern day laptop computer are something like this.

- Whenever you are static, connect to internet through an access point and you can do the file transfer, telnet, web browsing etc..

- While on the move, connectivity is desired for using software which require cooperation of at least two machines.

Option for connectivity

- An easy option

    - Use cellular mobile phone network to connect to some Internet Service Provider and hence to internet.

    - What you need - cellular phone/ corresponding modem.

- Not a good option for campus wide mobile network.

    - dependent on the mobile telephone network operator

    - cheaper wireless LAN options available

Other extreme of mobile computer

- Mobile computing device

  - acts as a terminal

  - have wireless connectivity to the network

  - Whatever command or application you run is executed on a remote server.

  - Mobile computing device acts as remote terminal.

Advantages/ disadvantages of this extreme

- Very small, compact and light weight mobile computer

- Less power consumption and large battery life - this may not be true, if radio communication requires more power than to power up all necessary devices for a standalone computer on average basis.

- Higher reliability of data - theft of standalone computer means everything is lost. But here all information is stored on some static server.

  - But data privacy while communicating to servers via the network has to be ensured.

- The performance highly dependent upon network and wireless channel conditions.

Issues in mobile computing networks

- Actual Mobile computer - somewhere in between the two extremes.

- Issues due to

  - nature of medium

  - Mobility

  - Portability

Wireless medium

- Disconnection

    - Common in radio environments - due to noise.

    - due to moving into dark areas

    - Blocking by servers e.g., due to too many requests to a file server.

- Standalone mobile computer can tolerate this kind of problem better.

- Portable terminals will not function

- Asynchronous operations - round trip latency and short disconnections can be taken care of. *(X11 window system operates this way.)*

  - Synchronous remote procedure calls - After each request wait for response.

  - Asynchronous remote procedure calls - After several requests have been sent then acknowledgement is asked for.

- Pre-fetching / lazy write back decouples communication from data usage/ generation.

- Decoupling allows the program to progress even during disconnection.

Coda - distributed file system, developed for notebook computers with less frequent disconnections

- on board cache

- users' profile is used to keep best selection of files in the cache

- Whole files are cached instead of fixed block of data.

- After disconnection, the cache is automatically synchronized with file server.

- File modification are allowed even during disconnection. Probability of having more than two modified versions of a file is less than 1% even when more than one user is given write access to same file.

Low Bandwidth

- typical bandwidth
  - Wireless
    - Infrared - 1 Mbps
    - Radio - 2 Mbps
    - cellular telephony - 9-14 Kbps
  - Wired
    - Ordinary Ethernet - 10 Mbps
    - FDDI - 100 Mbps
    - ATM - 155 Mbps

Network design to cop up with low bandwidth

- More number of cells for a given user area

    - use smaller wireless cells. *The bandwidth is shared by all the mobile computers within a cell.*

    - Use of overlapping cells operating in different part of spectrum

    - Advantages of first technique

        - Simpler technique

        - Reduces power requirements

        - transceivers covering less areas achieves higher bandwidth.

Software techniques to combat low bandwidth

There is no way bandwidth can be increased, it can only be efficiently utilized.

- compression at the two ends of wireless link.

- Logging - since bulk usage more efficient than multiple small usage.

- Logging alongwith compression - still better - *Larger block compress better.*

- The data communication - bursty. The techniques for disconnection can also improve the performance in low bandwidth environment

    - During a burst demand temporarily exceeds the capacity - burst is like short disconnection.

Bursty nature of data
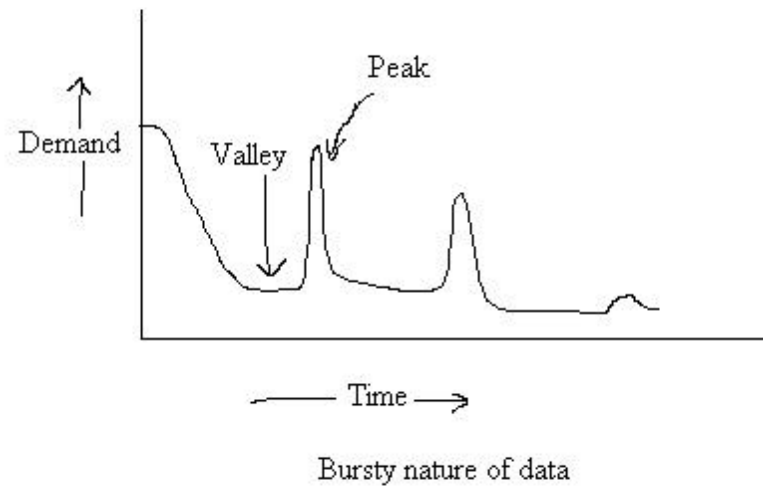
- Prefetching/ Lazy write back can use valleys to reduce demand at peaks - *leading to effective usage of bandwidth.*

- Scheduling communication intelligently

  - When demand exceeds the capacity, give priority to the processes waiting for a response.

  - The jobs like writing backups to the server etc. should be done in leftover bandwidth.

  - Coming Emails can be notified to user once it has fully come to mobile computer. It can be transferred as low priority traffic over the wireless link.

These techniques don't increase bandwidth but improves user's satisfaction

Bandwidth variability

- Within a cell number of mobile computers can vary. Thus bandwidth varies with time.

- The mobile computer when possible can be connected to wired network (plugged). Bandwidth variation between plugged and wireless access is large.

- A mobile computer can assume

    - high bandwidth connection and operates only when plugged.

    - Low bandwidth and don't take advantage of high bandwidth when plugged.

- Variable bandwidth and adapt to currently available resources

- Variable bandwidth means larger delay variation

- Subnet should be preferably connection oriented (e.g., virtual circuits)

  - for connectionless subnet due to bandwidth variability, delay variations will be large leading to large unnecessary retransmissions at transport level.

Heterogeneous networks

- Switching between interfaces

  - Infrared LANs

  - Wireless Radio LANs

  - Cellular networks

- Switching between various access protocols

- Mechanism in software & hardware needed for the above

Mobility

- Address Migration

  - Current wired networks - not designed for dynamically changing addresses.

  - Each host name is bound to a network address (in TCP/IP world DNS server does this binding)

  - Moving to new location means acquiring new network address. The binding need to be modified.

- The binding info

  - cannot be cached with long expiration time in the network.

  - The address of mobile host is changing much faster due to mobility.

- To communicate with mobile host - message should be sent to its most recent address.

- For all active connections, mobile host should keep on informing about change in address to all the hosts at other ends.

Four mechanisms for finding mobile host addresses

- selective broadcast

- central services

- home bases

- Forwarding pointers

Selective broadcast

- Broadcast - a message is sent to all cells requesting the mobile host to respond with its new network address.

- Expensive method for large networks

- If available a priory knowledge of group of cells where host is likely to be there - do selective broadcast to these cells.

Central services

- current address of each mobile host kept in logically centralized database

- Every mobile host when changes address - a update message is sent and database is updated

- Database is logically centralized, but can be physically distributed using replication and caching for better efficiency.

Home bases

- limiting case of distributing central service.

- Only a single server (home base) knows the current address of mobile host. *(Each mobile host may have separate or common homebase for keeping track of its network layer address)*

- Mechanism for tracking the mobile host is same as in central server.

Problems

- If home base is down, how to track the mobile host.

  - Back up home bases - keep the replica of database in home base.

- Mobile host can change home base itself. This happens on long duration basis. The mobile host have to notify all of its servers regarding this change.

Forwarding pointers

- Whenever a mobile host changes address, copy of new address left at old location

- Each message - sent along the chain using these pointers

- To avoid long chains hence inefficient routing, pointers updated at source hosts and home base periodically.

- Agents are required which receives and forwards the message.

Portability

- Minimize power consumption - larger battery life, smaller battery size - lesser weight

- Smaller user interface - handwriting, voice recognition, pens, virtual reality screens.

- Small storage capacity - Compressed file systems

Summary

Mobile computing systems have different constraints and hence different solutions. Main challenges are due to

Wireless - unreliable.

Mobility - dynamism of information.

Portability - limited resources

Resource list for further information on mobile computing.

1 http://www.cs.purdue.edu/research/cse/scipad/mobicomp.html