Data Management for Mobile Computing

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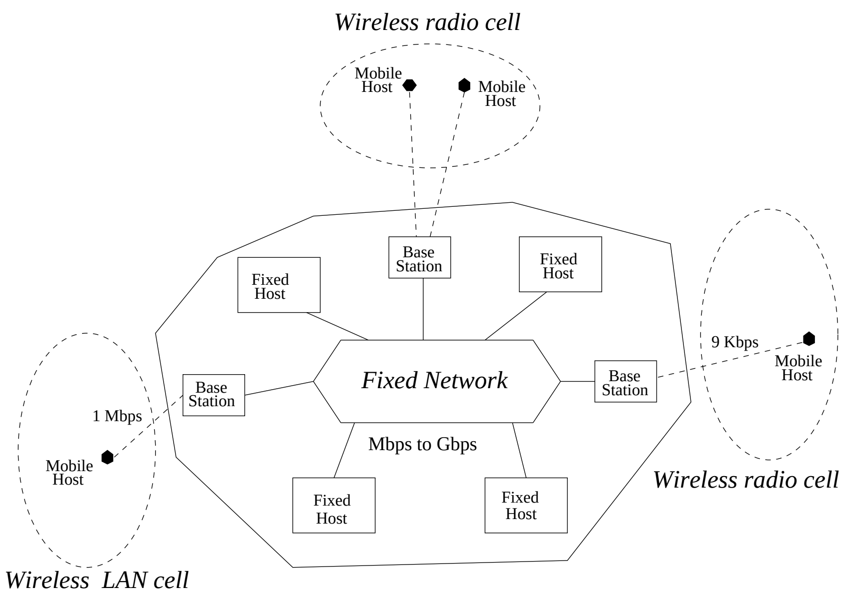
Introduction

- *mobile* or *nomadic* computing
- *wireless*
- *ubiquitous*
- *personal*

Architecture



Issues

Key Issues: Mobility, Wireless Communications, Portability [7, 2, 4, 1]

Mobility

The location of mobile elements and therefore their point of attachment to the fixed network change as they move.

The consequences of mobility are numerous.

- The configuration of a system that includes mobile elements is not static. Thus,
  1. In designing distributed algorithms, we can no more rely on a fixed topology.
  2. The center of activity, the system load, and locality change dynamically.
- Location management
  1. The search cost to locate mobile elements is added to the cost of each communication involving them.
  2. Efficient data structures, algorithms, and query execution plans must be devised for representing, managing, and querying the location of mobile elements, which is a a fast changing data.

Issues

Mobility (continued)

- Heterogeneity

  1. *Connectivity* becomes highly variant in performance and reliability. For instance, outdoors, a mobile client may have to rely on low bandwidth networks, while inside a building it may be offered reliable high-bandwidth connectivity or even operate connected via wireline connections. Moreover, there may be areas with no adequate coverage resulting in disconnections of various durations.
  2. The number of devices in a network cell changes with time, and so do both the load at the base station and bandwidth availability.
  3. There may be also variability in the provision of specific services, such as in the type of available printers or weather reports.
  4. The resources available to a mobile element vary, for example, a docked computer has more memory or is equipped with a larger screen.

Mobility also raises very important security and authentication issues.

Issues

Wireless Medium

— *(Weak and Intermittent Connectivity)*

Wireless networks are more expensive, offer less bandwidth, and are less reliable than wireline networks.

Wireless communications face many obstacles because the surrounding environment interacts with the signal.

Thus, while the growth in wired network bandwidth has been tremendous (in current technology Ethernet provides 10 Mbps, FDDI 100 Mbps and ATM 155 Mbps), products for wireless communication achieve only 19 Kbps for packet radio communications, and 9-14 Kbps for cellular telephony. The typical bandwidth of wireless LANs ranges from 250 Kbps to 2 Mbps and it is expected to increase to 10 Mbps [5].

Since the bandwidth is divided among the users sharing a cell, the deliverable bandwidth per user is even lower.

For radio transmission the error rate is so high that the effective bandwidth is limited to less than 10 Kbps [6].

Thus, bandwidth is a scarce resource.

Furthermore, data transmission over the air is currently monetarily expensive [3].

Mobile elements may voluntary operate disconnected.

Issues

Wireless Medium (continued)

– *(Variant Connectivity)*

Wireless technologies vary on the degree of bandwidth and reliability they provide.

– *(Broadcast Facility)*

There is a high bandwidth broadcast channel from the base station to all mobile clients in its cell.

– *(Tarrifs)*

For some networks (e.g., in cellular telephones), network access is charged per connection-time, while for others (e.g., in packet radio), it is charged per message (packet).

Issues

Portability of Mobile Elements

– *Mobile elements are resource poor when compared to static elements.*

Mobile elements must be light and small to be easily carried around. Such considerations, in conjunction with a given cost and level of technology, will keep mobile elements having less resources than static elements, including memory, screen size and disk capacity.

This results in an asymmetry between static and mobile elements.

– *Mobile elements rely on battery.*

Even with advances in battery technology, this concern will not cease to exist.

Concern for power consumption must span various levels in hardware and software design.

Mobile elements are easier to be accidentally damaged, stolen, or lost.

Thus, they are less secure and reliable than static elements.

Issues

Summary

Characteristics of wireless communications	Characteristics of mobile elements
Frequent disconnections	Limited resources:
Predictable disconnections	Limited memory
Physical support for broadcast	Limited computational power
Asymmetry	Small screen
Monetarily expensive	Limited battery life
Relatively unreliable	Relatively unreliable
High bandwidth variability	Variability in resources
Low bandwidth	Frequent location updates

Network Disconnections

voluntary or *forced*

predictable or *sudden.*

short disconnections and *long*

Disconnected operation

An Example

Satya's vision of a hypothetical trip in the year 2000 [8]:

Imagine you are sitting at your office working on a report stored in a shared file system. Soon, it is time to leave. You use your machine to call for a taxi. You continue working as necessary files are prefetched in your notebook. When the taxi arrives, you pick up your notebook and leave.

On the ride to the airport, you continue working. Your notebook recognizes that it is no longer on a LAN, but continues communicating via a cellular modem. There are some gaps in communication, but they remain completely transparent to you. You finish editing, save the file, and send email to your coauthor. At the airport, while waiting for boarding, you use your notebook for web-browsing. While on board, you start working on your slides. Although each seat is equipped with an outlet for air-to-ground telephone service, your notebook discovers that telephone charges are very high. Thus, it wisely decides to let you operate disconnected and defer all communication. Your requests for some old figures are also postponed for later service.

When you arrive at your hotel room, your notebook discovers that the hotel's late-night telephone charges are low. It therefore propagates the changes you have made so far, fetches new versions of the files you had cached, and picks up your mail and the figures you have requested.

An Example (continued)

Next morning, you present your talk. Your notebook senses the presence of a large wall-sized display and shows your slides on it through an infrared link. Since your talk is about a new piece of user-interface software, your are able to give a live demo of it using your notebook.

Next day, you decide to do some sightseeing and rent a car. The car is provided with a navigating interactive screen map that you use to tour the city. The map is intelligent enough to avoid traffic jams by listening to periodically broadcasted traffic information. When you arrive, you grab your notebook that downloads a guided tour of the site. As you walk around, a video describing the features of the site is seen and the accompanying commentary is heard. Before leaving, you purchase a t-shirt at the gift shop. The store clerk obtains your travel itinerary from your notebook and arranges for your duty free purchase to be delivered to the correct gate.

Next morning you take the metro to the airport. On the metro, you use your notebook to watch CNN. From time to time, as the train goes through regions of poor reception, the displayed image degenerates from full-motion to slow-scan black and white. When you arrive at the airport, you pick up your gift at the gate. During the flight you can relax: your notebook has been recording your purchases and is now automatically preparing an expense report to be transmitted to your secretary for reimbursement.

References

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