Mobile Computing

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Objectives

- Define Mobile Computing and look at current trends
- Distinguish between types of Mobility
- Examine Theory Research in Mobility
- Examine Systems Research in Mobility
What is Mobile Computing?

“The Study of Systems in which computational Components May Change Location”.

Two types: physical and logical

“Context Aware Computing”

Hosts are aware of other hosts in the vicinity and can publish their services and request the services of others.

Types of Mobile Computing

Nomadic Computing

A wired core network with a wireless periphery

Ad Hoc Computing

Opportunistic temporary networks where all hosts are wireless mobile devices
Trends towards Mobile Computing (1)

- Less Computing is being done on ‘Computers’ (according to some schools of thought)
- Software is becoming transparent
  - Most electrical goods (washing machine, microwave, television etc) contain fairly large amounts of software
- Distributed Computing is becoming more mainstream (J2EE, .NET)

Trends towards Mobile Computing (2)

- Software as a service (UDDI, Passport, Hailstorm)
- Mobility of code (RMI)
- Promotion of Components to first class citizens
- Currently most OO software is made up of components wired together at design time
  - To realise the potential of mobile computing components will need to interact across hosts dynamically at run time.
Ubiquitous Computing

❖ Solving the same problem using many devices and interfaces
  ● e.g. using a desktop to send email and dictating an email to a speech to text converter on a mobile.

❖ True Ubiquitous Computing cannot become a reality until mobile computing matures

Current Problems (1)

❖ Security
  ● Who is allowed to access what?
  ● The security in IEEE 802.11b is very lax in most cases anyone with a wireless card can access corporate Intranets

❖ Authentication
  ● How do mobile devices in ad hoc networks verify each others credentials
Current Problems (2)

- Creating a general specification that allows devices to offer rich services
- Creating the right level of middle-ware that addresses the needs of mobile computing such as location and signal strength that is not difficult to program.

Types of Mobility

- Physical
  - Movement of a host in physical space

- Logical
  - Movement of a unit of mobility among hosts
Coordination

Concerned with mechanisms to discover who is around
- E.g. Use of Registries in CORBA
- Passing around acquaintances in Gnutella
- ...Mechanisms to exchange Info
- ...Mechanisms to synchronize actions

Coordination (2)

Mechanisms for coordination are supplied by
- Middleware
- Underlying operating system
Theory Research

- Focus on essential traits of broad classes of mobile systems

- Theory Research in two main areas
  - Models
  - Algorithms

Models

- Enable precise description of existing language/system semantics

- Allow formal reasoning about correctness of such semantics

- Used to highlight parallels and differences among various forms of mobility
Models (2)

*Models are concerned with the formulation of proper abstractions useful in specification and evaluation of mobile systems*

They focus on three aspects
- Who is allowed to move (Unit of Mobility)
- Where it can go (Location)
- Handling context changes (Context)

Unit of Mobility

*Who is allowed to move...*
  - This is the unit of mobility which is the smallest component in the system that is allowed to move.
  - ...A code fragment
  - ...A physical device in the real world

*Choice of mobility unit is central to any mobility model*
Unit of Mobility (2)

- Typical choice of mobility unit coincides with unit of execution. This unit of execution is commonly called a Mobile Agent.
- Finer grained units pervasive in everyday practice.

Location

- Identification of the position of a mobile unit in space
- Location semantics dependent on choice of mobility unit
- Current representations include
  - Cartesian coordinates (e.g. for mobile devices)
  - Host addresses (e.g. for mobile agents)
  - Process Identifiers (e.g. for code fragments)
Context

- Remember “...Mobile computing is context-aware computing”
- Determined by (but different from) current location of unit of mobility
  - E.g. Two Mobile units may be in the same location but perceive different contexts due to different administrative domains

Context (2)

- Context may include resources, services and other system components
- Location changes may lead to sudden context changes and are likely to be abrupt
  - E.g. A mobile agent on different servers has access to different sets of services
Context (3)

Focus on context is to
- Detect change of context
- React to change (often in a timely manner)

Distinction between
- Event Based Systems
- State Based Systems

Context (4)

Event Based Systems

- Consider the occurrence of events that are filtered through a given specification
- The corresponding reaction is usually guaranteed to eventually execute
Context (5)

State Based Systems

- Enabling condition is a particular state of the system
- Reaction is completed before any other state change is performed

Algorithms

- Algorithms used reflect assumptions made about underlying mobile system
- Treatment of space and coordination shapes mobile algorithms
- Current algorithms unsuitable for current shift to mobile computing
Algorithms (2)

*New algorithms needed to address*
- Location changes
- Frequent Disconnection
- Varied Resources
- Power Limitations
- Communication Constraints
- Dynamic changes in connectivity pattern

Systems Research

*Systems research in mobile computing focused increasingly on the end user requirements for ease of use and dependability*

*Also focused on performance*
**Systems Research (2)**

- Two fundamental areas of research
  - Applications
  - Middleware (m/w)

**Applications**

- Current trends include manufacturing of increasingly smaller, more powerful, portable computing devices
- Application uses relate to
  - Non interaction with outside sources e.g. Coda File system
  - Accessing remote resources e.g. Oracle 8i Lite
  - Tracking Devices e.g. Active Badges
Applications (2) - Concerns

- User perception of application with respect to degree of exposure of mobility at application level (e.g. Coda File System)
- Variable Quality of Service
  - Need to provide adaptability

Applications (3) - Concerns

- Security Policies and security demands
  - Movement between administrative domains
- Environmental capabilities
  - Power availability (PDA Vs Notebooks)
  - Connectivity patterns (Base Stations Vs Ad Hoc environment)
Middleware

- Adds mechanisms and services that are much more specialized than those provided by OS within the context of established languages, without modifying syntax or semantics.

- Enhances level of abstraction associated with programming effort.

Middleware (2)

- Most fertile area of systems research in mobility.

- Systems research distinguishable into
  - Middleware for Physical Mobility
  - Middleware for Logical Mobility
Physical Mobility MWare

- Application centred
- Unit of mobility concerned is Mobile Host
- Provision of mechanisms to detect connectivity, variations of Quality of Service, Service Lookups.

Logical Mobility MWare

- New design tool for development of distributed applications
  - Could help improve bandwidth use
  - Could help improve performance
- Provision of object oriented layer on top of Operating System to handle transparent object migration
Logical Mobility Mware (2)

❖ Unit of mobility could be
  ▪ Unit of execution e.g. mobile agents
  ▪ Finer grained units e.g. Java classes
❖ Need for mware support of relocation of code and state
❖ Need for mechanisms that allow different rebinding strategies

Conclusion

❖ Advances in wireless technology, extensive investments in telephony, and the Internet’s ability to provide ubiquitous access to information are the main forces shaping the emergent field of mobile computing
❖ Mobility challenges old assumptions and demands new kinds of solutions.
References

Mobility – Milojicic, Douglas, Wheeler (Addison-Wesley)

Software Engineering for Mobility: A Roadmap – G. Roman, G. Picco, A.L. Murphy