Exploiting Logical Mobility in Mobile Computing Middleware

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Outline

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- Introduction to Logical Mobility
- Case Studies: Logical Mobility over Physical Mobility
- Limitations of Current Approaches
- Choosing a Logical Mobility Paradigm
- Future Work
Introduction

• 15.5 million PDAs to be shipped this year
  - State of the art hardware includes 400MHz X-Scale (ARM) CPU, 64MB of RAM, integrated wireless connectivity (802.11b or Bluetooth). e.g. Toshiba’s e740

• 2001: Desktop computer shipments fell by 2.2%
  - Laptop shipments increased by 10.4%

• Bluetooth shipments to reach 30 million this year, 700 million by 2005

• 802.11(a,b) shipments to grow by 55% annually through 2005

[source: Gartner]
Observed Trends

- Further decentralisation of computing
- Computers: Smaller, faster, more resources, more personal, ubiquitous
  - Users are starting to carry portable processing environments of respectable computing ability
- Networking is pivotal
  - Devices can connect to various different types of networks at different situations: ad-hoc (Bluetooth, IrDA), the Internet (GSM/GPRS, 802.11b, ...)
Motivation

• Investigate the use of Logical Mobility in Mobile Computing Middleware

• Prove that logical mobility can bring tangible benefits to mobile application developers and users
  – Benefits include faster operation, less user-interaction, services offered based on context and location, reduced cost, better user experience

• Why isn’t Logical Mobility widely adopted in the Mobile Computing Industry?
Introduction to Logical Mobility

• The process of moving programme functionality from one processing environment (host) to another.
  - Can be anything from interpreted scripts, binary code, code targeting virtual machines, migration of full applications etc.
  - Can include state information
• Popularised by the emergence of Java
• Categorisation into various Paradigms [Fuggetta, Picco, Vigna 98]
  - Client/Server
  - Code on Demand
  - Remote Evaluation
  - Mobile Agents
Case Studies

1. Limited Resources and Dynamically Updating the System
2. Location-Based Reconfigurability and Services
3. Electronic Shopping or Limiting User-Interaction
Case Study (1)

Bluetooth-enabled MP3 player

Bluetooth-enabled OGG-Vorbis player

In reach, and wish to share music
Case Study (1, continued)

- Although transferring files is feasible, players lack appropriate audio codec
- COD allows for transferring codec along with file

Request(song, codec)

song, vorbis decoder
Case Study (1, continued)

- Assume requesting player can also connect to a centralised network (e.g. GSM/GPRS)

  Request(song, codec)

  song, vorbis codec

  (trusted computer)

  Ack(hash)

  Check hash (decoder)
Case Study (1, continued)

Request(song)

Vorbis codec (signed)

Request codec

(trusted computer)

Request(song)

song
Case Study (1, continued)

Numerous advantages of Logical Mobility

- Transparent dynamic (and potentially secure) update of an application
- Allows devices to function in scenarios that manufacturers have not anticipated
- Applications can drop code based on frequency of use if resources are tight
Case Study (2)

User (with a PDA) enters vicinity of cinema’s network
Cinema’s central computer asks permission to send code to PDA
The user accepts
Central computer transfers code to the PDA
User is presented with a user interface to buy tickets from his/her PDA
Case Study (3)

- Electronic shopping in Europe worth € 97.8 billion in 2002 [Gartner]
- <0.04% estimated through wireless devices [amazon.com]
- Suggested reasons:
  - Small screen size (Typical PDA has a resolution of 160x160 pixels. Typical desktop: 1024x768)
  - Expensive connectivity
Case Study (3, continued)

User wishes to shop for a particular item

Application encapsulates data as a Mobile Agent

Agent is sent to the Internet
Case Study (3, continued)

- Agent hosted at a processing environment (e.g. ISP)
  - Contacts retailers and finds the best price
  - Notifies the user of the best deal
  - User acknowledges purchase
Case Study (3, continued)

Logical Mobility (Mobile Agents) used to

- Decrease User Interaction
- Decrease Cost of Network Access
- Lends itself to Batch Processing
- Application can effectively appear to work faster
Case Studies

More Examples

- Communication & Messaging in Disaster Scenarios
- Distributing Computations & Exploiting peer resources
- Securing Communications over potentially hostile networks
Deficiencies of Related Work

• Current approaches use (paradigms of) Logical Mobility for specific purposes
  – Jini uses COD to offer dynamic services

• Others are not geared for ad-hoc networks
  – In Fargo-DA disconnections are announced
Adopting Logical Mobility & Physical Mobility

Reasons for which logical mobility is not widely used in the mobile industry:

• Lack of a mobile middleware that can operate over a variety of IP-based networking infrastructures, offering transparently all Logical Mobility paradigms to application developers.

• Lack of a design-stage methodology that can help developers evaluate the use of Logical Mobility early in the design stage of their application.
Choosing a Logical Mobility Paradigm

- **User & context related parameters**
  - E.g. maximum connectivity cost the user is prepared to pay, expected user location, current network configuration etc.
  - Former can be stored in user-profiles on the device and latter can be made available to applications through reflection techniques

- **Logical Mobility related parameters**
  - E.g. size of mobile code unit, number of hosts it will need to interact with etc.
  - Can be modelled at the design stage
Our Approach

- Mobile Computing Middleware exposing Logical Mobility primitives to Applications
  - Will support ad-hoc & fixed infrastructure connectivity
  - Targeted at resource-constraint devices
  - Use reflection techniques to expose context to applications

- Design methodology, extending UML, allowing developers to model the use of Logical Mobility in a Mobile Environment
Conclusion

• We believe that Logical Mobility can bring innovative solutions to Mobile Computing applications

• Lack of flexible Middleware exposing Logical Mobility primitives to application developers

• Lack of methodology to evaluate the different approaches
Any Questions?

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