

# Exploiting Logical Mobility in Mobile Computing Middleware

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# Outline

- Motivation
- 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

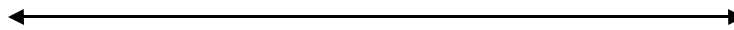


# Case Studies

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

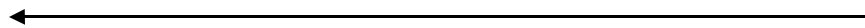


# Case Study (1, continued)

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



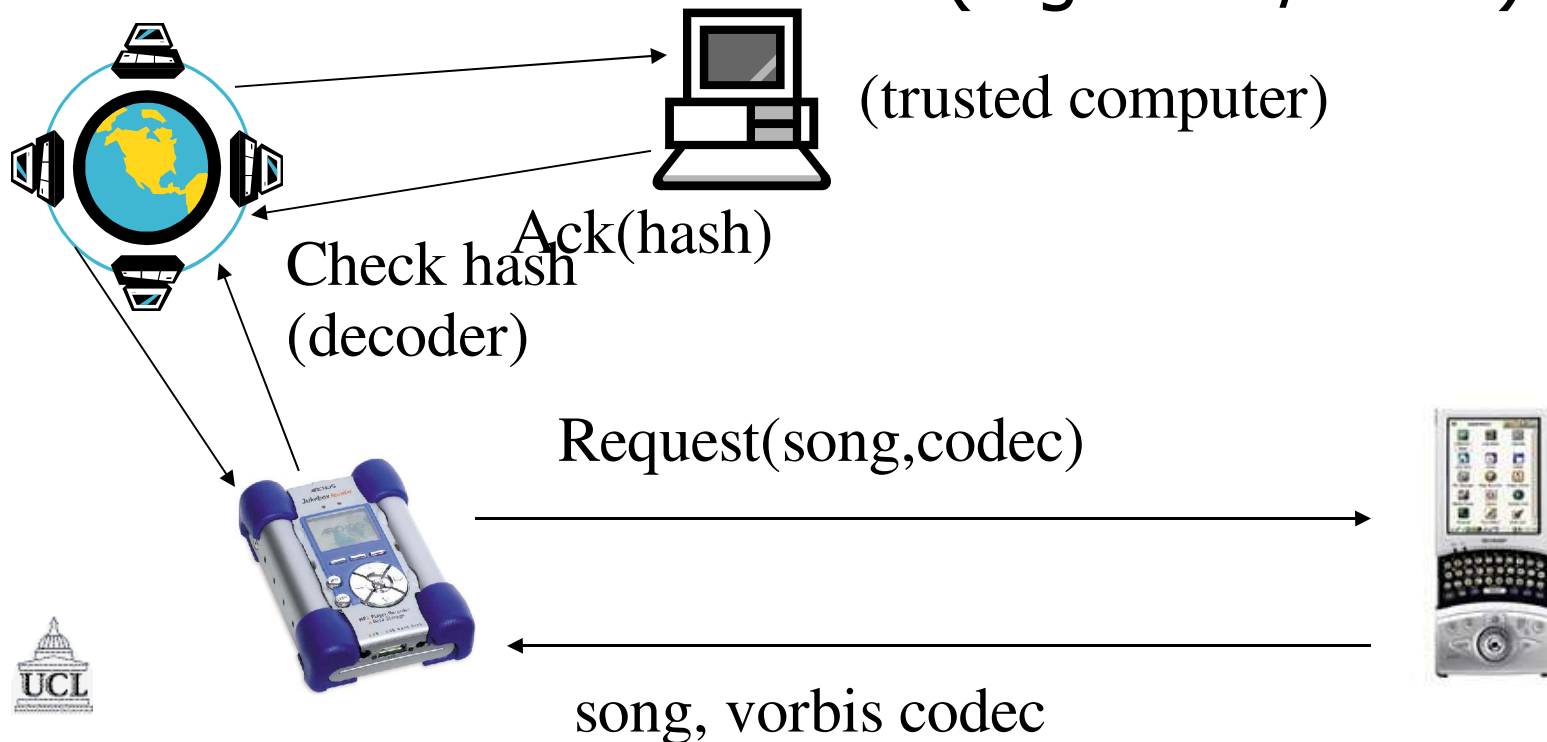
Request(song,codec)



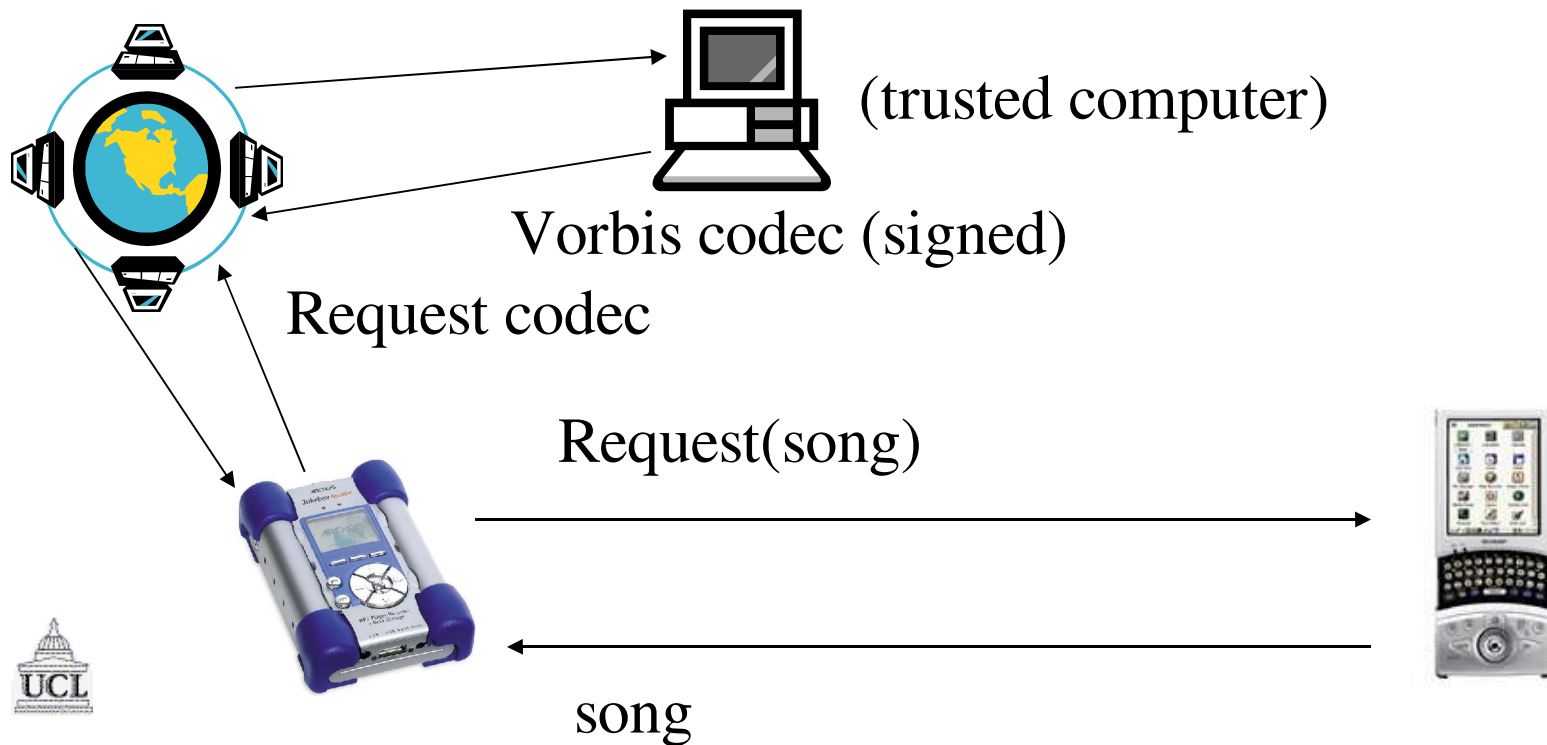
song, vorbis decoder

# Case Study (1, continued)

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



# Case Study (1, continued)



# 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)

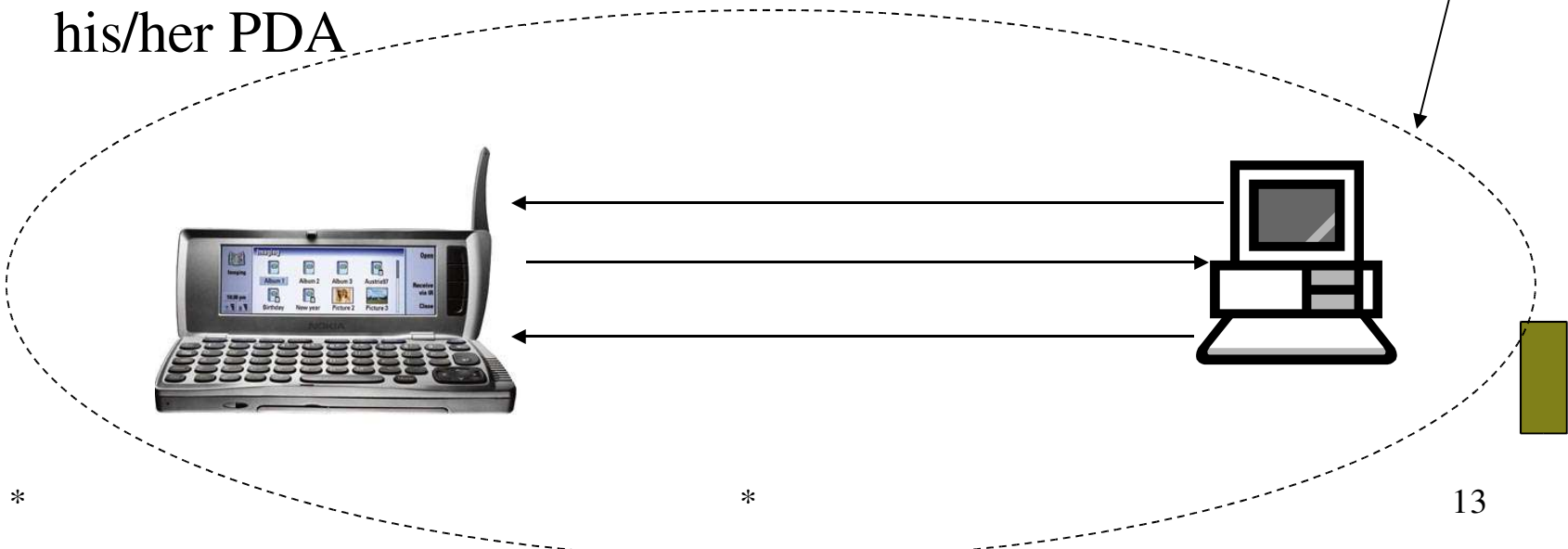
User (with a PDA) enters vicinity of cinema's network  
Cinema's central computer asks permission to send code to PDA

The user accepts

Central computer transfers code to the PDA

User is presented with a user interface to buy tickets from his/her PDA

Cinema network



# 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

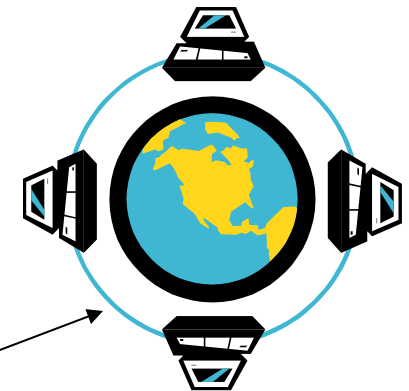


# Case Study (3, continued)

User wishes to shop for a particular item

Application encapsulates data as a Mobile Agent

Agent is sent to the Internet



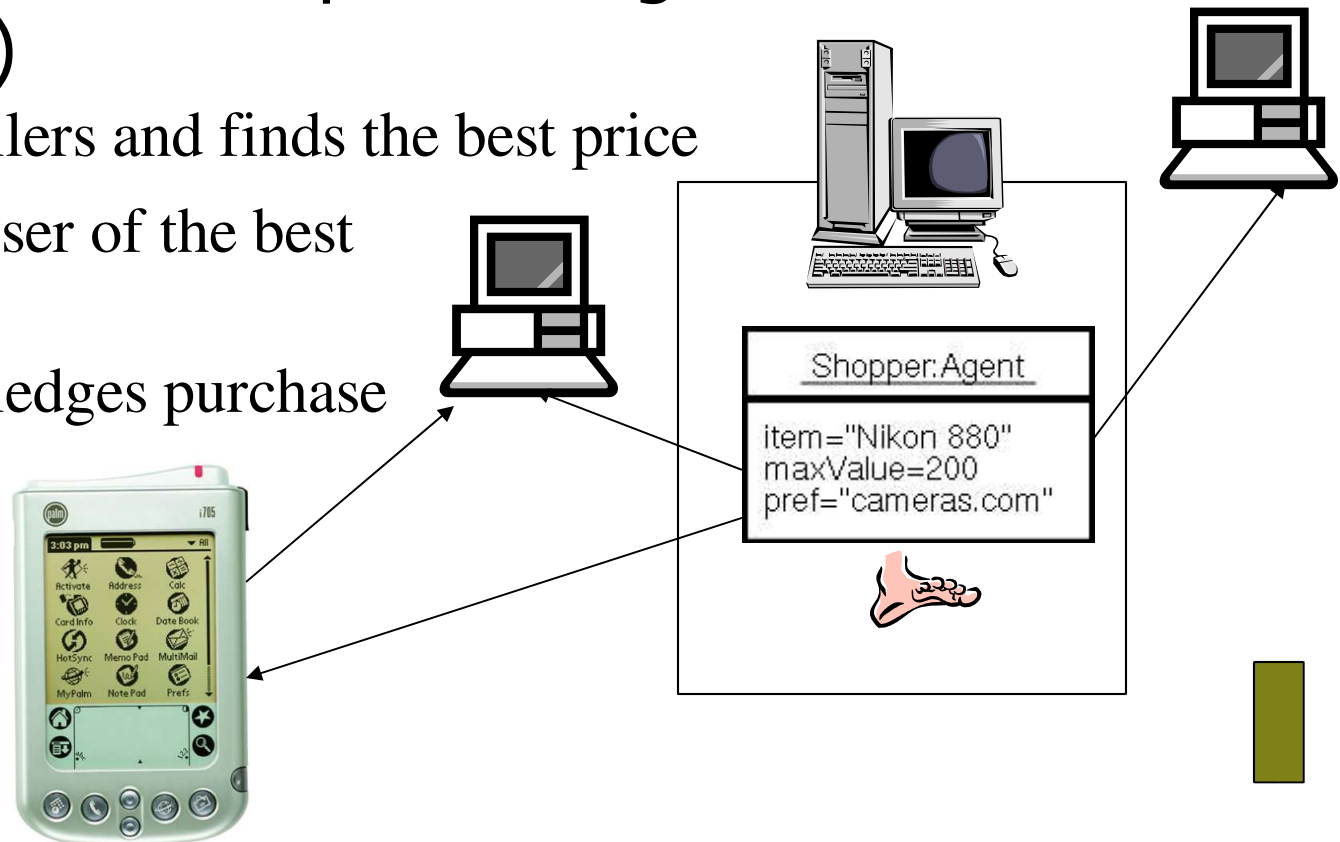
# Case Study (3, continued)

- 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?

For more information visit

<http://www.cs.ucl.ac.uk/staff/s.zachariadis/>

