M-Commerce: Mobile Applications

Sridhar Iyer
K R School of Information Technology
IIT Bombay
sri@it.iitb.ernet.in
http://www.it.iitb.ernet.in/~sri

Outline

- Mobile applications
- Wireless networking
- Routing in mobile networks
- Transport in mobile networks
- Application adaptation for mobility
- WWW and mobility

Mobile Applications - 1

- Vehicles
  - transmission of news, road condition etc
  - ad-hoc network with near vehicles to prevent accidents
- Emergencies
  - early transmission of patient data to the hospital
  - ad-hoc network in case of earthquakes, cyclones
  - military ...

Mobile Applications - 2

- Travelling salesmen
  - direct access to central customer files
  - consistent databases for all agents
  - mobile office
- Web access
  - outdoor Internet access
  - intelligent travel guide with up-to-date location dependent information

Mobile Applications - 3

- Location aware services
  - find services in the local environment, e.g. printer
- Information services
  - push: e.g., stock quotes
  - pull: e.g., nearest cash ATM
- Disconnected operations
  - mobile agents, e.g., shopping
- Entertainment
  - ad-hoc networks for multi user games

Mobile Applications in Industry

- Wireless access: phone.com
- Alerting services: myalert.com
- Location services: airflash.com
- Intranet applications: imedeon.com
- Banking services: macalla.com
- Web access: wapforum.com
- Mobile agents: tryllian.com

Limitations of Mobile Environment

- Limitations of the Wireless Network
  - heterogeneity of fragmented networks
  - frequent disconnections
  - limited communication bandwidth
- Limitations Imposed by Mobility
  - lack of mobility awareness by system/applications
- Limitations of the Mobile Computer
  - short battery lifetime
  - limited capacities

Effect of Mobility on Protocol Stack

- Application
  - new applications and adaptations
- Transport
  - congestion and flow control
- Network
  - addressing and routing
- Link
  - media access and handoff
- Physical
  - transmission errors and interference

Wireless Networks

- Infrastructure-based networks
  - cellular systems (base station infrastructure)
- Ad hoc networks
  - useful when infrastructure not available, impractical, or expensive
  - military applications, rescue, home networking

Cellular system: GSM

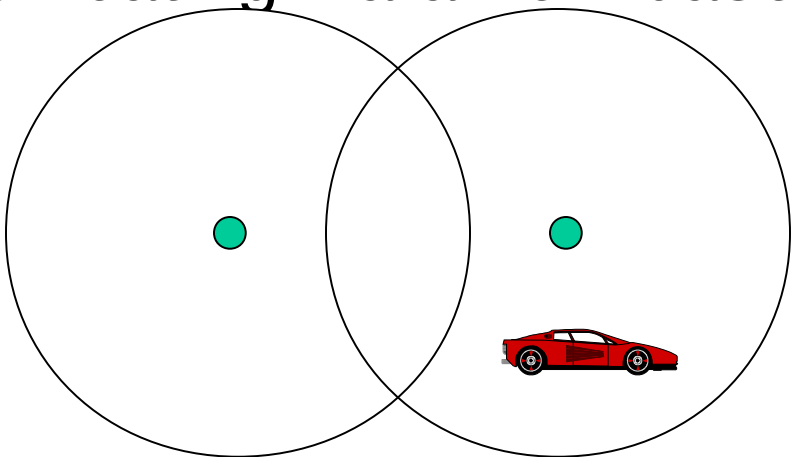
- GSM
  - formerly: Groupe Spéciale Mobile (founded 1982)
  - now: Global System for Mobile Communication
- Communication: voice and data services
- Mobility: International access, access control
- Service Domains:
  - bearer services: transfer of data between points
  - telematic services: telephony, SMS messages
  - supplementary services: forwarding, conferencing

Architecture of the GSM system

- GSM is a PLMN (Public Land Mobile Netwk)
- Components
  - MS (mobile station)
  - BS (base station)
  - MSC (mobile switching center)
  - LR (location register)
- Subsystems
  - RSS (radio subsystem): covers all radio aspects
  - NSS (network and switching subsystem): call forwarding, handover, switching
  - OSS (operation subsystem): n/w management

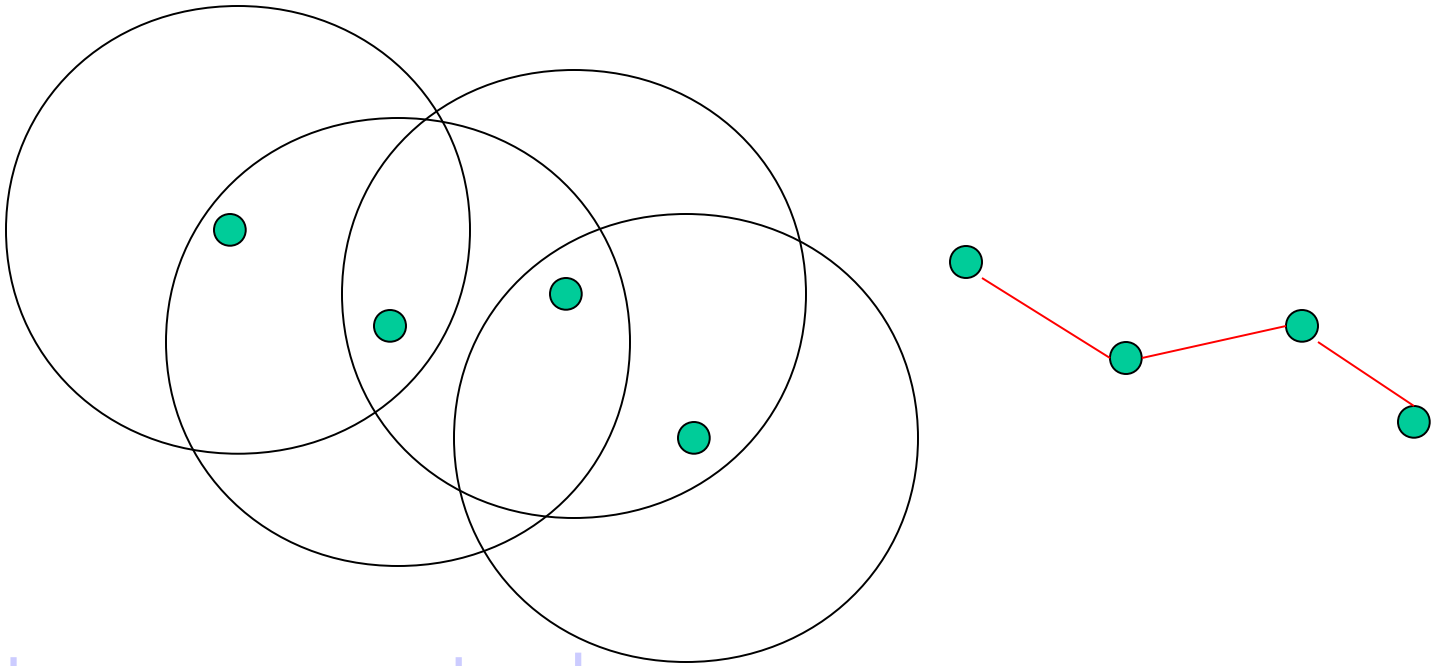
Cellular Wireless

- Space divided into cells
- A base station is responsible to communicate with hosts in its cell
- Mobile hosts can change cells while communicating
- Hand-off occurs when a mobile host starts communicating via a new base station



Multi-Hop Wireless

- May need to traverse multiple links to reach de



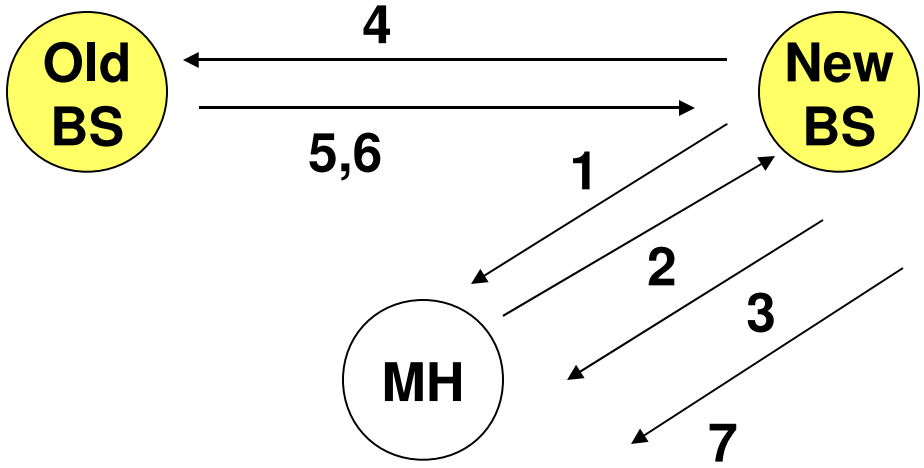
- Mobility causes route changes

Hand-Off Procedure

- Each base station periodically transmits beacon
- Mobile host, on hearing stronger beacon from a new BS, sends it a greeting
  - changes routing tables to make new BS its default gateway
  - sends new BS identity of the old BS
- New BS acknowledges the greeting and begins to route MH's packets

Hand-Off Procedure

- New BS informs old BS
- Old BS changes routing table, to forward any packets for the MH to the new BS
- Old BS sends an ack to new BS
- New BS sends handoff-completion message to MH



Hand-off Issues

- Hand-offs may result in temporary loss of route to MH
  - with non-overlapping cells, it may be a while before the mobile host receives a beacon from the new BS
- While routes are being reestablished during handoff, MH and old BS may attempt to send packets to each other, resulting in loss of packets

Wireless LANs

- Infrared (IrDA) or radio links (Wavelan)
- Advantages
  - very flexible within the reception area
  - Ad-hoc networks possible
  - (almost) no wiring difficulties
- Disadvantages
  - low bandwidth compared to wired networks (1-10 Mbit/s)
  - many proprietary solutions
- Infrastructure v/s ad-hoc networks (802.11)

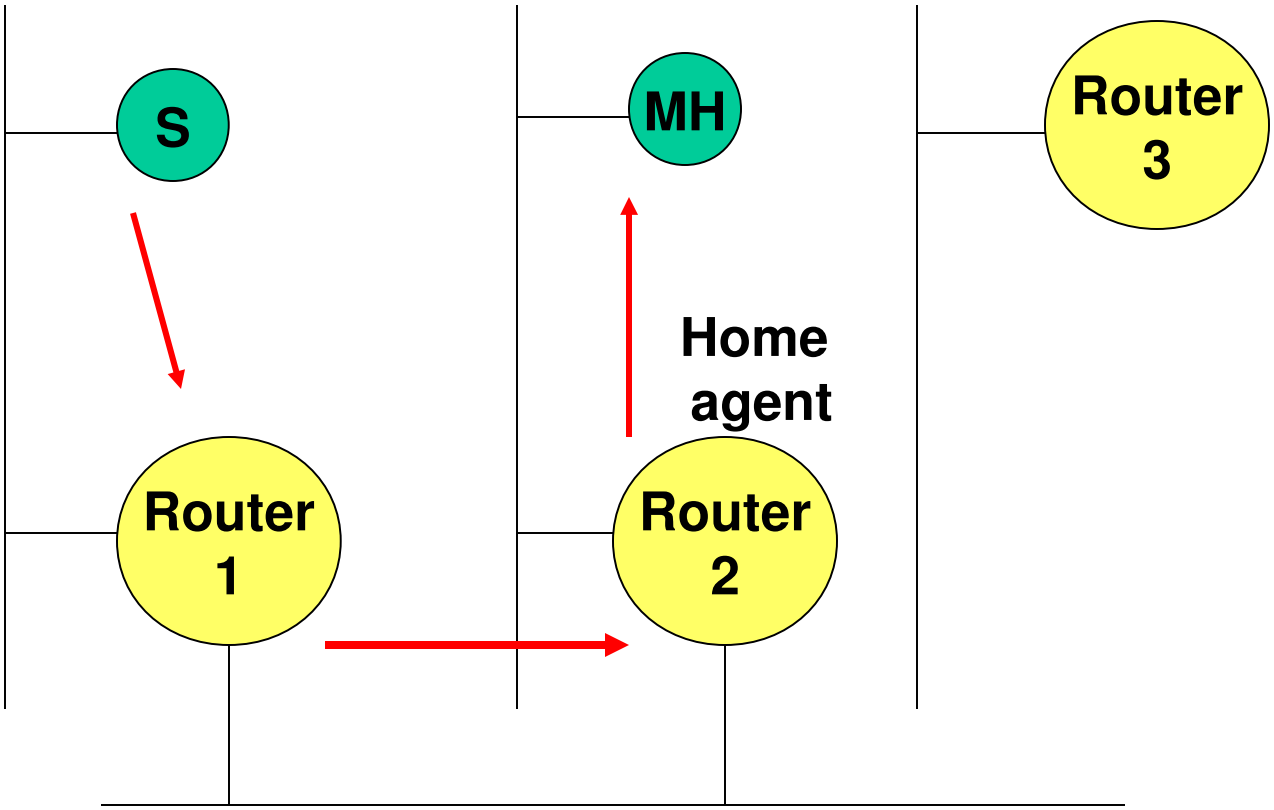
Bluetooth

- Consortium
  - Ericsson, Intel, IBM, Nokia, Toshiba - many members
- Scenarios
  - connection of peripheral devices
    - loudspeaker, joystick, headset
  - support of ad-hoc networking
    - small devices, low-cost
  - bridging of networks
    - e.g., GSM via mobile phone - Bluetooth - laptop

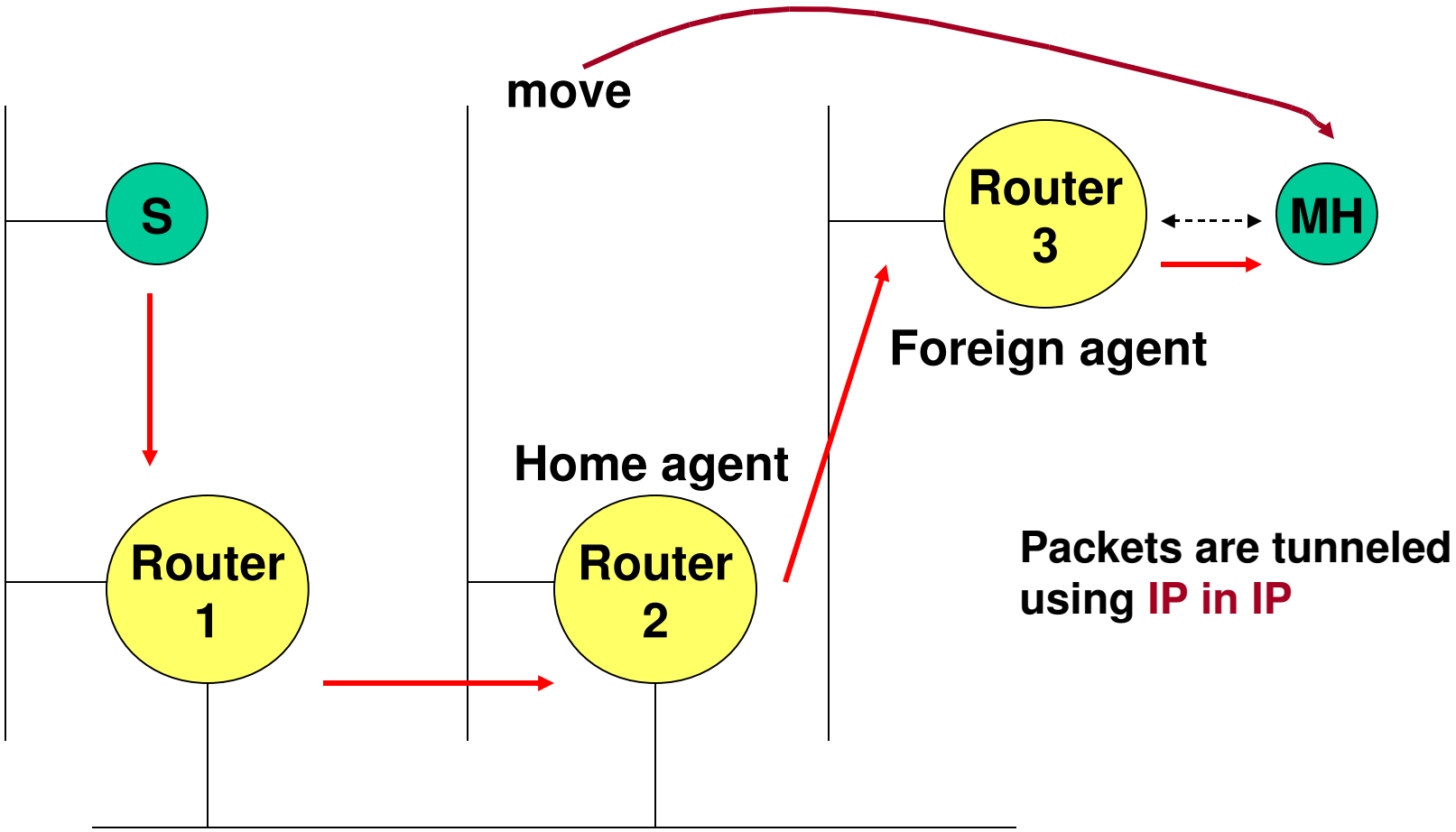
Mobility and Routing

- Finding a path from a source to destination
- Issues
  - Frequent route changes: amount of data transferred between route changes may be much smaller than traditional networks
  - Route changes related to host movement
- Goal of routing protocols ?
  - decrease routing-related overhead
  - find short routes
  - find “stable” routes

Mobile IP



Mobile IP


move
S
Router 3
MH
Foreign agent
Home agent
Router 1
Router 2
Packets are tunneled using IP in IP

Mobile IP

- Mobile IP would need to modify the previous hand-off procedure to inform the home agent the identity of the new foreign agent

- Triangular optimization can reduce the routing delay
  - route directly to foreign agent, instead of via home agent

Mobility and Transport

- Transport protocols typically designed for
  - fixed end-systems, wired networks
- Issues
  - packet loss due to wireless characteristics
  - packet loss due to mobility
  - TCP assumes congestion if packet dropped
  - acks, retransmissions and performance
  - TCP cannot be changed fundamentally

Mobile TCP

- I-TCP segments the connection
  - no changes to the TCP protocol for hosts connected to the wired Internet
  - optimized TCP protocol for mobile hosts
  - splitting of the TCP connection at, e.g., the foreign agent into 2 TCP connections, no real end-to-end connection any longer
  - hosts in the fixed part of the net do not notice the characteristics of the wireless part

Mobile TCP

- Advantages
  - no changes in the fixed network necessary
  - transmission errors on the wireless link do not propagate into the fixed network
  - simple to control, mobile TCP is used only for one hop between, e.g., a foreign agent and mobile host
- Disadvantages
  - loss of end-to-end semantics
  - higher latency possible due to buffering of data within the foreign agent and forwarding to a new foreign agent

Application Adaptations for Mobility

- System-transparent, application-transparent
  - the conventional, "*unaware*" client/server model
- System-aware, application-transparent
  - the client/proxy/server model
  - the disconnected operation model
- System-transparent, application-aware
  - dynamic client/server model
- System-aware, application-aware
  - the mobile agent model

The Client/Proxy/Server Model

- Proxy functions as a client to the fixed network server, and as a mobility-aware server to the mobile client
- Proxy may be placed in the mobile host (Coda), or the fixed network, or both (WebExpress)
- Enables *thin client* design for resource-poor mobile computers

The Mobile Agent Model

- Mobile agent receives client request and moves into fixed network
- Mobile agent acts as a client to the server
- Mobile agent performs transformations and filtering
- Mobile agent returns back to mobile platform, when the client is connected

Mobile Data Management

- Pull data delivery: clients request data by sending uplink msgs to server
- Push data delivery: servers push data (and validation reports) through a broadcast channel,to a community of clients
- Client caching strategies and cache invalidation algorithms are critical

World Wide Web and Mobility

- HTTP and HTML have not been designed for mobile applications/devices
- HTTP Characteristics
  - stateless, client/server, request/response
  - connection oriented, one connection per request
  - primitive caching and security
- HTML Characteristics
  - designed for computers with “high” performance, color high-resolution display, mouse, hard disk
  - typically, web pages optimized for design, not for communication; ignore end-system characteristics

HTTP and Mobility

- HTTP
  - designed for large bandwidth and low delay
  - big protocol headers (stateless, ASCII)
  - uncompressed content transfer
  - TCP 3-way handshake, DNS lookup overheads
- Caching
  - often disabled by information providers
  - dynamic objects, customized pages, generated on request via CGI
- Security problems
  - how to use SSL/TLS together with proxies?

System Support for Mobile WWW

- Enhanced browsers
- Client proxy
  - pre-fetching, caching, off-line use
- Network proxy
  - adaptive content transformation for connections
- Client and network proxy
- Enhanced servers
- HDML (handheld device markup language)
- HDTP (handheld device transport protocol)

WAP - Wireless Application Protocol

- Forum: wapforum.org
  - co-founded by Ericsson, Motorola, Nokia, Unwired Planet
- Goals
  - deliver Internet services to mobile devices
  - independence from wireless network standards
- Platforms
  - e.g., GSM (900, 1800, 1900), CDMA IS-95, TDMA IS-136, 3rd generation systems (IMT-2000, UMTS, W-CDMA)

WAP Overview

- Browser
  - “micro browser”, similar to existing web browsers
- Script language
  - similar to Java script, adapted to mobile devices
- Gateway
  - transition from wireless to wired world
- Server
  - “wap server”, similar to existing web servers
- Protocol layers
  - transport layer, security layer, session layer etc.

Wireless Markup Language (WML)

- Cards and Decks
  - WML document consists of many cards, cards are grouped to decks
  - a deck is similar to an HTML page, unit of content transmission
  - WML describes only intent of interaction in an abstract manner
  - presentation depends on device capabilities
- Features
  - text and images
  - user interaction
  - navigation
  - context management

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