Mobile Commerce: Concepts, Technology, and Applications

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Agenda

Information systems
IS1. Information systems concepts: Review

E-commerce systems
EC1. E-commerce systems: Characteristics and functions
EC2. E-commerce systems: Case study

M-commerce systems
MC1. M-commerce systems: Characteristics and functions
MC2. M-commerce technology
MC3. M-commerce applications
MC4. M-commerce application development
MC5. M-commerce trust, security, and payment
MC6. M-commerce issues

Beyond m-commerce
UC1. U-commerce: The next step after m-commerce?

Lecture MC2
Mobile commerce technology

Objective:
- To describe the special technology used in mobile commerce
M-commerce model: Review

Three main parts

Mobile client (terminal)          M-commerce service
Wireless communications link

M-commerce technology

- Special technology used in m-commerce:
  - Mobile client technology
  - Wireless communications technology
- M-commerce service technology is essentially the same as that used for wired e-commerce
  - Servers
  - E-commerce software, web server software, database software
  - Etc.

Mobile client technology

Mobile client:
- A mobile device and its client software used by individuals to communicate with m-commerce services through wireless communications networks
- Also called mobile commerce terminal
- Common types:
  - Mobile phone
  - Handheld computer (PDA)
  - Laptop computer
  - Vehicle mounted device
  - Hybrid device
Mobile client technology:
Types of mobile devices

- **Mobile phones**
  - Most common type of mobile device
  - Many types of phones
  - Many incompatible standards (CDMA, GSM, TDMA, HSCSD, GPRS, EDGE, UMTS)

- **Handheld computers (personal digital assistant or PDA)**
  - Requires wireless communication capability (e.g., wifi)
  - Palm-based: Palm, etc.
  - Pocket PC-based: Compaq iPaq, HP Jornada, etc.
  - Special purpose: Blackberry

- **Notebook computers**
  - Requires wireless communication capability
  - Less mobile than other devices
  - More processing and storage capabilities than other devices
  - PC (IBM compatible, Windows/Intel - Wintel)
  - Apple

- **Vehicle-mounted devices**
  - Computer with wireless capability housed in automobile, truck, train, etc.

- **Hybrid devices**
  - Mobile phone/PDA – smartphone (Treo)
  - Mobile phone/Internet browser (Nokia Communicator)
  - Mobile phone/Digital camera
  - Mobile phone/MP3 player (Apple iPhone)

Mobile client device:
Mobile device limitations

- **Many mobile client devices have limitations that affect what they can do**

- **Limited screen**
  - Size
  - Resolution
  - Lines of text
  - Graphics capability
  - Color

- **Limited input capabilities**
  - Keyboard
    - May be numeric only with complex text input procedures (e.g., mobile phone)
    - May not have keyboard (e.g., PDA)
  - Screen navigation keys
  - Voice input
    - Slow and inaccurate
### Mobile client device: Mobile device limitations

- **Limited processing capability**
  - Processor speed (e.g., 400 MHz)
  - Memory capacity (e.g., 256 MBytes)
  - Limited data storage
  - Data may share memory with software
  - May have external storage (e.g., memory stick, 64 MBytes to 1 GBytes): provides more storage
- **Limited battery life**

### Mobile client device: Device location technology

- Technology that identifies location of mobile device
- Needed for applications that are specific to device location
  - Emergency services
  - Location-dependent marketing
- **Main technologies:**
  - GPS
  - Cellular triangulation

### Mobile client device: Device location technology

**GPS: Global Positioning System**
- Based on 24 U.S. satellites
- Accurate to within 10 meters
- Requires GPS receiver for mobile client device
- Can work with any type of mobile device

**Cellular triangulation**
- Based on three-way positioning using cellular telephone towers
- Accurate to within 100 meters
- Requires minimal technology for mobile client device
- Only works with mobile phone
Mobile client technology: Client software

- Software in the mobile client device that provides functionality for the device
- Device cannot function without software
- Main types:
  - Operating system
  - Microbrowser
  - Communications software
  - Applications software

Client software: Operating system

- Software that provides basic operating capabilities for the mobile client device
- Must use minimal memory
- Mobile phone operating systems:
  - Symbian OS (Symbian)
  - Pocket PC Mobile (Microsoft)
- PDA operating systems:
  - Palm OS (Palm)
  - Pocket PC (Microsoft)
- Notebook computer operating systems:
  - Windows XP (Microsoft)
  - Mac OS (Apple)
  - Unix/Linux

Client software: Microbrowser

- Browser software that functions on mobile client devices
- Must be designed for small screens and limited input devices
- Provides Web browsing capabilities
- Common microbrowsers:
  - Mobile Browser (OpenWave)
  - Pocket Internet Explorer (Microsoft)
Client software: Applications software

- Software that provides user-oriented functions for the mobile client device
- Must use minimal memory
- Examples:
  - E-mail
  - Personal information management (PIM)
    - Address book
    - Date book (agenda)
    - Task list
    - Memo pad
  - Other applications
- Most user-oriented functions are provided by server-based application software (on demand software)

Communications software

- Software that provides communications capabilities and protocols for the mobile client device
- Some alternative approaches:
  - WAP: Wireless Application Protocol
  - i-Mode: NTT DoCoMo
    - Complete wireless system with protocol and wireless services
- Related software: page description (markup) language
  - cHTML: compact HTML (i-Mode)
  - HDML: Handheld Device Markup Language (pre-WAP)
  - WML: Wireless Markup Language (WAP 1)
  - XHTML: eXtensible HTML (WAP 2)

WAP

- Fixed Internet protocol:
  - IP – Internet Protocol: controls movement of individual pieces of information (packets) by means of routers
  - TCP – Transmission Control Protocol: controls movement of messages consisting of multiple packets
  - TCP/IP – main set of protocols used by the Internet
- Problems with using TCP/IP on wireless internet:
  - Not developed for wireless links or mobile devices
  - IP: router assumes next network node is in same area of network; with mobile network this may not be the case
  - TCP: deals with lost packets by requesting that lost packet be resent; with wireless networks connections are lost regularly and packets need to be resent often, thus congesting the system
- Solution: Wireless Access Protocol (WAP)
  - WAP is a set of protocols or protocol stack
WAP gateway

![Diagram](image)

WAP security problem

- WAP gateway is weak link in security
- WAP gateway provides interface between WAP protocol stack and regular internet protocol stack (includes TCP/IP)
  - WAP uses WTLS (Wireless Transport Layer Security) for security over wireless links
  - Wired internet uses SSL (Secure Socket Layer) for security
  - WTLS and SSL are incompatible
- Requires that wireless communication be decoded from WTLS and then encoded by SSL for communication to web server at WAP gateway
- Creates potential security problem at WAP gateway
- Solution: WAP 2

WAP 2

- Uses an alternative protocol stack with SSL for security
- Message is encoded using SSL from mobile client to web server with not decoding/encoding required in between
- WAP gateway not needed (in theory)
- Provides end-to-end security
- Only works with faster wireless services (2.5G, 3G) that use a type of IP designed for mobile devices called Mobile IP
### Wireless communications technology

#### Three main categories:
- Technology that supports wireless telecommunications or wireless wide area networks - WWAN
- Technology that supports wireless local area networks - WLAN
- Technology that supports wireless personal area networks - WPAN

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![Wireless communications technology diagram]

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### Wireless telecommunications technology

(Wireless wide area network technology)

- Wireless telecommunications is wide area communications with maximum range of 30 to 60 km
- Wireless Wide Area Network or WWAN
- Principle wireless telecommunications technology used in m-commerce is mobile (cellular) telephone communication
Wireless telecommunications technology: Mobile phone technology

- Many mobile phone technologies
  - Not compatible
  - Vary in speed
- First generation (1G) mobile phone technology - analog:
  - AMPS: Advanced Mobile Phone System
- Second generation (2G) mobile phone technologies - digital:
  - TDMA: Time Division Multiple Access (US)
  - CDMA: Code Division Multiple Access (US, Japan)
  - GSM: Global System for Mobile (US, Europe)

TDMA and CDMA

<table>
<thead>
<tr>
<th>Time division multiplexing (TDM)</th>
<th>Code division multiplexing (CDM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple users share the same frequency by using it at different times</td>
<td>Multiple users share the same frequency and time by using different codes</td>
</tr>
</tbody>
</table>

Each band represents a user at the same frequency using a different time
Each band represents a user at the same time and frequency using a different code

TDMA vs CDMA

- TDMA is slower than CDMA
  - TDMA: max speed 14.4 kbps
  - CDMA: max speed 64 kbps
- CDMA is more complex than TDMA
  - Requires code allocation, careful synchronization
- CDMA is more secure than TDMA
  - Different codes are used by different users
TDMA varies throughout the world

GSM

GSM uses a sophisticated variation of TDMA in which users get very short time slots – .577 microseconds

<table>
<thead>
<tr>
<th>TDMA Technologies</th>
<th>Frequency (MHz)</th>
<th>Number of slots</th>
<th>Bit rate</th>
<th>Capacity</th>
<th>BER (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM</td>
<td>900</td>
<td>5</td>
<td>200 kbps</td>
<td>6.5 MB</td>
<td>27 dB</td>
</tr>
<tr>
<td>TDMA</td>
<td>1800</td>
<td>2</td>
<td>120 kbps</td>
<td>3.6 MB</td>
<td>25 dB</td>
</tr>
<tr>
<td>Digital Frequency</td>
<td>1900</td>
<td>1</td>
<td>60 kbps</td>
<td>1.8 MB</td>
<td>24 dB</td>
</tr>
<tr>
<td>Mobile Telephony</td>
<td>800</td>
<td>1</td>
<td>30 kbps</td>
<td>0.9 MB</td>
<td>24 dB</td>
</tr>
<tr>
<td>1G</td>
<td>850</td>
<td>1</td>
<td>15 kbps</td>
<td>0.4 MB</td>
<td>24 dB</td>
</tr>
</tbody>
</table>

Circuit switching vs. packet switching

Circuit switching
- User is assigned one circuit during the entire connect time
- Requires long setup time (15-30 seconds)
- Inefficient use of bandwidth because communications channel must be maintained for entire session duration
- 1G and 2G systems use circuit switching

Packet switching
- User sends voice/data in small groups called packets
- User does not have circuit assigned during entire session duration
- Circuit is only used when a packet is sent
- More efficient use of bandwidth than circuit switching
- 2.5G and 3G systems use packet switching

Wireless telecommunications technology:

Mobile phone technology

Two-and-a-half generation (2.5G) mobile phone technology:
- HSCSD: High-Speed Circuit-Switched Data
- GPRS: General Packet Radio Service
- EDGE: Enhanced Data GSM Environment

Third generation (3G) mobile phone technology:
- WCDMA or UMTS: Wideband CDMA or Universal Mobile Telecommunications System
- CDMA2000
- TD-SCDMA: Time Division Synchronous Code Division Multiple Access

Fourth generation (4G) mobile phone technology:
- ?
2.5G

- **GPRS**
  - Uses TDMA like GSM but channels can be allocated more than one time slot
  - Maximum speed: 100 kbps theoretically but 40 kbps in reality
  - Does not require hardware upgrade from GSM: relatively inexpensive upgrade

- **EDGE**
  - Uses TDMA like GSM/GPRS but uses a technique that sends more data per time slot
  - Maximum speed: 384 kbps
  - Requires minor upgrades from GPRS system: relatively inexpensive

3G

- **WCDMA/UMTS**
  - Uses CDMA
  - European standard
  - Maximum speed: 2 mbps in theory, 400 kbps in reality
  - Requires new spectrum (license must be purchased)
  - Requires new equipment

- **CDMA2000**
  - Uses CDMA
  - US standard
  - Maximum speed: 114 kbps to 2 mbps

- **TD-SCDMA**
  - Uses CDMA and TDMA
  - China standard
  - Maximum speed: ?

## Wireless telecommunications technology: Mobile phone technology

<table>
<thead>
<tr>
<th>Generation</th>
<th>Technology</th>
<th>Maximum speed (Kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>TDMA</td>
<td>9.6</td>
</tr>
<tr>
<td>2</td>
<td>CDMA</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>GSM</td>
<td>9.6</td>
</tr>
<tr>
<td>2.5</td>
<td>HSCSD</td>
<td>56</td>
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<tr>
<td>2.5</td>
<td>GPRS</td>
<td>115</td>
</tr>
<tr>
<td>2.5</td>
<td>EDGE</td>
<td>384</td>
</tr>
<tr>
<td>3</td>
<td>WCDMA/UMTS</td>
<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>CDMA2000</td>
<td>2000</td>
</tr>
<tr>
<td>4</td>
<td>TD-SCDMA</td>
<td>1 000 000?</td>
</tr>
</tbody>
</table>
Wireless telecommunications technology:
Mobile phone technology

Wireless local area network technology
- Wireless Local Area Network (WLAN): a Local Area Network (LAN) in which local communication is accomplished by wireless means
- Common WLAN technology: IEEE 802.11 (Wi-Fi)

Wireless local area network technology: IEEE 802.11b, g (Wi-Fi)
- Designed originally for notebook and desktop computer wireless communication
- Maximum speed:
  - 802.11b: 11 Mbps
  - 802.11g: 54 Mbps
  - 802.11n: 540 Mbps
- Maximum range: 100 meters
  - Can be extended with special antennas
- Has become very popular in creating wireless "hot spots" where wireless users can connect within a small radius
- Most laptop computers come with built-in Wi-Fi capability
- Used for
  - Commercial WLANs (e.g., Starbucks)
  - Public neighborhood area networks (NANs)
Wireless personal area network technology

- Wireless Personal Area Network (WPAN): a wireless local area network with range limited to an individual's workspace
- Common WPAN technology: Bluetooth
  - Developed by Ericsson for short range communication
  - Maximum speed: 721 Kbps
  - Maximum range: 30 meters

Wireless metropolitan area network technology: IEEE 802.16e (WiMax)

- Wireless technology for distances within a metropolitan area (i.e., within a city)
- Could be used for a metropolitan area network (MAN)
- Could be used for 3G mobile phones
- Maximum range: 5-15 km (50 km with reduced data rate)
- Maximum data rate: 75 Mbps
- Not widely available so far
  - Limited to telecommunications companies in France
  - Not limited in US

M-commerce applications

- What applications are commonly used in m-commerce?
- What are the characteristics of applications that are appropriate for m-commerce?
- Are there applications that are unique to m-commerce?