COMP327
Mobile Computing

Lecture Set 4 - The Mobile Internet

In this Lecture Set

- Challenges of Mobile access to the Internet
- Early Wireless Internet Systems
  - AT&T PocketNet
  - Palm.Net WebClipping
  - i-Mode
- Wireless Application Protocol
  - Architecture and Application Environment
  - Multimedia Messaging Service
    - Short Messaging Service
    - OTA Programming

The challenges in moving from fixed line PCs to Mobile Devices

- To understand the challenges (and pitfalls) of moving to a Mobile Internet, first consider the fixed line Internet!
  - Initially, most usage was email and web
    - Mostly free, other than modem connection charges
  - Top down content distribution model
    - The web was "read-only" - Web 1.0
    - Early retailers (e.g. Amazon) exposed inventory, but offered few value-based services
  - Evolved slowly over several years ("incubation time"), driven by access and expectation
    - Technologies had the chance to settle and be tested before large-scale adoption

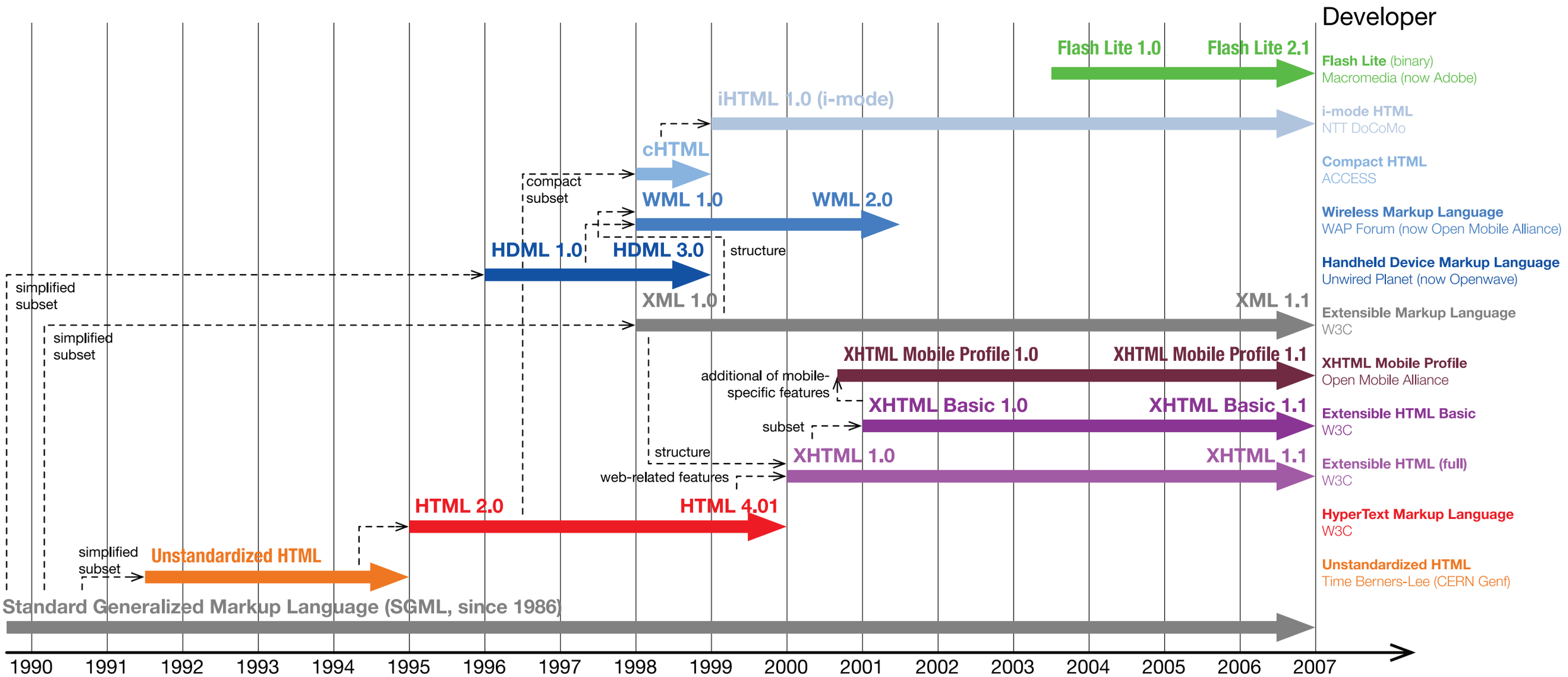
The challenges in moving from fixed line PCs to Mobile Devices

- Things were different when the Mobile Internet launched
  - Access was initially targeted at general public
    - Previous technologies were tried and tested by students and universities, which ironed out problems
  - Access was charged from day one!
    - Reduced adoption, and raised false expectation
  - Content and Services was adapted from the Web, rather than redesigned to exploit mobility
    - Very few sites or services had any appeal or use for users
    - WAP stack required new tools and additional effort, yet served a small user base!
  - Early networks unsuited for packet-switched data
    - Initial usage was expensive, thus limiting uptake

The Mobile Internet: Early Precursors

- Early approaches to providing content had to contend with new technical challenges:
  - Limited Screen Size and limited input capability
    - Not suited for most web pages
  - Limited memory, processor and power
    - May struggle to handle any client-side processing
  - Intermittent connectivity
    - HTTP is stateless
- Web 2.0 was emerging on the fixed-line Internet
  - Placed greater demands on both the device and the interface
  - Greater potential for mobile devices, though this was not realised for years
- Various content markup solutions have emerged

Evolution of Mobile Web–Related Markup Languages



Taken from Wikipedia, at http://en.wikipedia.org/wiki/File:Mobile_Web_Standards_Evolution_Vector.svg

AT&T PocketNet

- A mobile data service introduced in the US in 1996
  - Relied on Cellular Digital Packet Data (CDPD)
    - Built on top of the D-AMPS/TDMA infrastructure
    - Exploited an unused bandwidth previously used by AMPS
    - Provided speeds of up to 19.2kbit/s
    - Provided a basic TCP/IP stack to deliver data
  - Content presented using a stripped-down HTML language
    - Handheld Device Markup Language (HDML)
    - A microbrowser was also developed - UP.View
    - Content was primarily text
    - Introduced the *Deck-of-Cards* metaphor

Inspiration for the "*Deck of Cards*" Metaphor

- Mobile Phones have tiny screens
  - Can only display a limited amount of content
- Many applications assume a dialog-based interaction (i.e. *cards*)
  - Each interaction involves a number of options, leading to further options based on the earlier choice
- By bundling all the cards together (a *deck*) and sending in one transaction, transmission time and delays could be reduced.

Palm.Net - WebClipping

- WebClipping optimises transfer of HTML by caching static web content on the device
  - Introduced in 1998 by Palm
  - Aimed mainly at Palm's PDAs
    - Which had more screen real-estate than mobile phones
  - Only dynamic content is sent over wireless
  - Several hundred web services were adapted
  - Primarily finance, shopping, information, and entertainment

NTT DoCoMo i-Mode

- A service delivery system introduced by DoCoMo in Japan, 1999
  - Uses a variety of protocols to deliver content formatted in a compact variant of HTML (C-HTML)
  - i-mode enabled phones posses a special "i-Mode" button
  - Provides access to more than 12,000 official sites through DoCoMo's portal sites and billing services
    - Over 100,000 unofficial ones!!!
  - Users pay for both up and downlink data, but monthly packages exist
- Operates over DoCoMo's PDC-P packet-switch network
- Over 52 million users worldwide in 2006, but now declining

i-Mode and C-HTML

- Adds several features not available in HTML
  - Introduced:
    - Access Keys to improve navigation
    - Phone number shortcuts for links
    - Emoji characters (Japanese emoticons)
  - No support for JPEG images, tables, image maps, multiple fonts, background colours and images, style sheets etc.
  - Basic operations done through four keys, not mouse movement
    - Cursor forward and backward, select, and back/stop
- Has been overtaken by XHTML

The reason for i-Mode's Success

- Ease of use
  - Early use of packet-switched data, with easy access through the i-Mode button
- Critical mass of compelling content
  - Vast number of legal sites with partnership agreements, all discoverable through the main i-Mode portal.
- Usage/payment agreements pre-arranged through DoCoMo
  - Eliminates the need for provider billing, and hence reduces deployment costs for content providers
  - DoCoMo generate incremental revenue by charging a small commission for the clearinghouse billing system service.

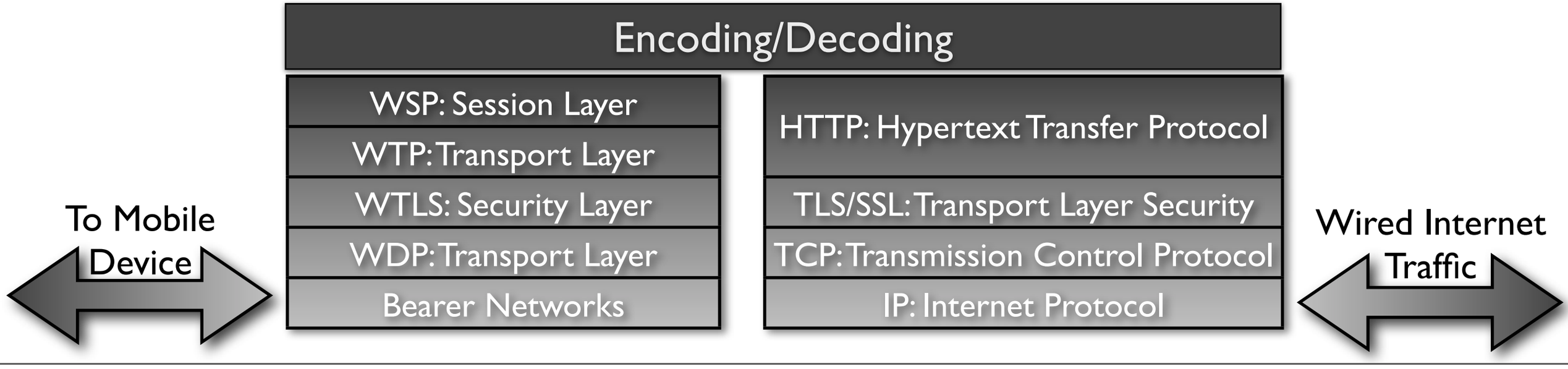
For more details on the i-Mode Business Model, look at
http://www.nttdocomo.com/services/imode/business/index.html

WAP: Wireless Application Protocol

- An open international standard to support access to the Mobile Web
  - Established in June 1997
    - Joint Forum including Ericsson, Nokia, Motorola and Openwave
      - The previous approaches discussed were all proprietry
      - WAP was developed as an open standard
  - Released WAP Specification 1.1 in Summer 1999
    - First services and devices available by the end of that year
    - Based on GSM, it was heavily hyped, but failed to live up to expectation in Europe (although successful in Asia)
      - "*Worthless Application Protocol*", "*Wait And Pay*"

WAP 1.1 Gateway

- A Gateway translated packets from the WAP stack to the Internet stack
  - Overcame the differences in assumptions of each stack
  - Improves communication by
    - Caching content
    - Authenticating users and providing billing support
    - Compressing and encrypting data across the air interface



WAP 1.1 Architecture

- Wireless Datagram Protocol (WDP)
  - Provides an interface between the WAP stack and the bearer networks
- Wireless Transport Layer Security (WTLS)
  - Based on the Internet's TLS
    - Tailored for low-bandwidth, high-latency links
  - Also provides provision for security, privacy, data integrity and authentication
    - True end-to-end security with internet services not possible
- Wireless Transaction Protocol (WTP)
  - Simplified, wireless substitute for TCP with some HTTP functionality
  - Optimised for wireless links
  - Three classes of content delivery

- **WTP Class 0**
  - Unreliable message delivery
- **WTP Class 1**
  - Reliable message delivery without result
    - e.g. push notification
- **WTP Class 2**
  - Reliable message delivery with acknowledgement
    - e.g. banking applications

WAP 1.1 Architecture

- Wireless Session Protocol (WSP)
  - Provides HTTP/1.1 functionality
  - Introduces shared state between client and server to optimise transfer
    - Facilitates session resumption after suspension due to loss of connection, etc
    - Responsible for binary encoding of sessions
- Wireless Application Environment
  - Provides the WAP browser and support for WML, scripting, etc
  - Provides access to Wireless Telephony Applications Interface (WTAI)
    - Supports telephony services from WAP session

Wireless Application Environment (WAE)

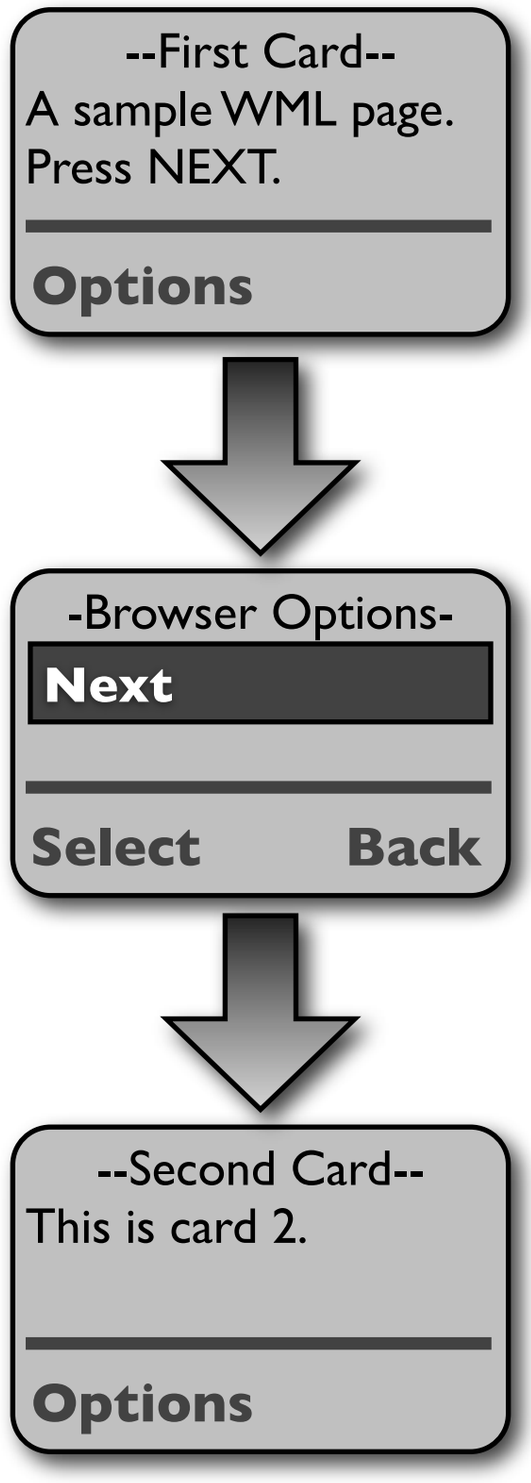
- Consists of the following specifications:
  - Wireless Markup Language (WML)
    - Based on HTML and HDML (originally from AT&T's PocketNet)
  - WAP Binary XML Format (WBXML)
    - Binary encoding and transfer of XML to reduce traffic size across air interface
  - WMLScript
    - Based on JavaScript, to execute client-side services and reduce repeated comms such as validating user input
  - Wireless Telephony Application (WTAI)
    - Telephony-specific for call and feature control mechanisms
  - Content Formats
    - Data formats such as calendar entries, images, and address book records

Wireless Markup Language (WML)

- Based on the *Deck of Cards* Metaphor
  - All cards sent simultaneously
  - User then navigates content without bursty comms
    - Overcomes GSM/GPRS latency problems with "bursty" browsing behaviour
  - Uses soft keys, where the semantics change as the context changes
- Includes client-side logic through WMLScript
  - Simplified variant of JavaScript
  - Avoids unnecessary round-trip comms
    - e.g. validating user-entered data
  - Supports functions for digital signing
- WAP 2.0 supports XHTML Basic
  - Separates the data (XML) from the presentation (CSS)

WML Example

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
   "http://www.wapforum.org/DTD/wml_1.1.xml" >
<wml>
  <card id="Card1" title="First Card">
    <do type="accept" label="NEXT">
      <go href="#Card2"/>
    </do>
    <p mode="wrap">A sample WML page.
     Press NEXT.</p>
  </card>
  <card id="Card2" title="Second Card">
    <p>This is card 2.</p>
  </card>
</wml>
```



WAP 2.0 Architecture

- WAP 2.0 introduced an alternative stack
  - Consisted of variations of the TCP and HTTP protocols which had been configured for wireless comms
    - WAP 1.1 stack now referred to as a *legacy* stack
  - Aimed at 2.5G and 3G bearer networks
  - Gateway significantly simplified
    - Finally supports true end-to-end security
- WML replaced by XHTML Mobile Profile
  - Better transcoding, and use of W3C tools such as CSS
- WAP push introduced, to support server-initiated sessions
  - Good for real-time information, such as stock quotes
- Device capability could be defined using a User Agent Profile

User Agent Profiles

- A protocol to determine the capabilities of the WAP client
  - Introduced in WAP2.0
  - Builds upon W3C's Composite Capability/Preference Profile (CC/PP)
- Represents information such as:
  - Hardware characteristics (screen size and colour capability, bluetooth etc)
  - Software characteristics (OS, A/V codecs, Java support etc)
  - Applications/User preferences (browser type, supported scripting languages)
  - WAP characteristics (WAP version, max WML deck size, etc)
  - Network characteristics (latency, reliability, etc)
- Information typically sent in WSP (Wireless Session Protocol) or HTTP headers, to aid the server in tailoring content for the client
  - Can vary during a session, due to changes in use or cell characteristics

Transcoding HTML to WML

- A variety of microbrowsers have emerged on mobile devices
  - Optimised to display Web content effectively on small devices
  - Often stripped down web browsers, but recent versions handle CSS etc
- However, the variety of markup languages made web maintenance and content provision difficult (especially when supporting legacy devices)
  - HTML, WML, C-HTML, XML etc
- Transcoding addresses this by assuming a canonical source (e.g. XML) which is translated into destination formats, using techniques such as:
  - XSLT (XSL transformation)
  - Java and JAXP (SAX and DOM)
  - External annotations
  - Logical HTML, with CSS based on User Agent Profiles for presentation

Transcoding Challenges

- Various challenges in converting content
  - Ideally, good design practices should be used
    - See HCI slides, and Apple's iPhone Tech Talks Videos on Mobile Safari compatibility
  - Should identify primary / significant content
- May need to:
  - Reduce or eliminate images
  - Reformat HTML content
    - Separating out non-essential content such as navigation bar or banner ads into optional additional pages
    - Multi-column layouts and wide tables need reformatting
  - Separate content into a deck of cards
    - e.g. splitting headed content to produce index page
  - Eliminate functionality for irrelevant interfaces
    - e.g. image maps or mouse-over events

WAP Criticisms

- Idiosyncratic WML language
  - Providers have to either provide WML specific content, or rely on Web-to-WAP transcoders.
    - *"Conceptual Distance"* between PC screens and mobile display too great
- Underspecification of terminal requirements
  - Early WAP standards left many features optional
    - Devices often failed to operate properly; functionality was often inconsistent
- Constrained User Interface Capabilities
  - Early WAP devices had small monochrome screens with limited buttons
  - Even later colour devices lacked conventional PC based interactions
- Lack of Good Authoring Tools
  - Demands of authoring for WML greater than HTML, but poor tool support

The WAP User Experience

- Although WAP introduced a number of features designed to improve the mobile internet experience, many complained of:
  - Slow connections, hence steep bills (pre GPRS)
  - Dead-ends or sites being down
  - Sites with poor sign-posting making search difficult
  - Uneven quality and stale content
  - Small screens
- Studies in late 2000 found that mundane tasks took longer than users could tolerate

The WAP User Experience

- Problems with WAP usage included:
  - Technical limitations due to bearer (GSM) rather than WAP itself
  - Poor site design with little consideration of the user experience.
    - Little in the way of intuitive navigation support
    - Design typically reflected the wired Internet practices with little attempt to understand Mobile Computing constraints
  - Poor content and poorly managed sites
    - Unlike i-Mode, European operators failed to set up business models to encourage the generation of quality content
  - Device limitations
- However, several of these limitations have faded with time, although some issues remain...!

MultiMedia Messaging Service - MMS

- Often considered a spinoff of SMS and WAP
  - Extends SMS to support transmission of media
    - Driven primarily due to the uptake of camera capabilities within mobile phones
    - Also used to deliver ring tones
  - Developed by the Open Mobile Alliance (OMA)
    - However, was also part of 3GPP and WAP groups
    - Launched in March 2002 across GSM/GPRS and 3G
- But first... SMS!

Short Messaging Service SMS

- The most widely used data application on the planet
  - Generated revenues of US$89B worldwide in 2008, with almost 3.5 trillion messages sent!
    - Initial uptake was low (0.4 messages per month per user in 1995, 35 in 2000)
    - Uses include *Messaging*, *OTA programming*, *Value-added Services*, and *Televoting*
  - Originally defined as part of the GSM series of standards to send up to 160 7-bit character messages
    - Sent over the signalling paths during quiet (non-call) periods
    - Required the inclusion of a Short Message Service Centre node (SMSC).
    - First commercial deployments in 1993
  - Subsequent uptake in other technologies
    - cmda networks, Digital AMPS, 3G, and both satellite and landline networks

Short Messaging Service SMS

- Messages sent to a Short Message Service Centre (SMSC)
  - Provides a store and forward mechanism:
    - Attempts to send messages to recipients
    - If recipient is unavailable, the message is queued for a later retry
    - No guarantees that message will be sent, but delivery reports can be requested
- Messages are 140 octets long (8*140=1120 bits) plus routing data and metadata
  - Concatenated SMS extends this length
    - Split into 153 7-bit messages with a prefixed User Data Header (UDH)
    - Receiving device then re-assembles message

Back to MMS

- Completely different delivery mechanism to SMS
  - Multimedia content is first encoded using MIME format
  - Then sent to the recipient carrier's MMS store and forward server (MMSC)
  - The MMSC determines if the recipient's device is MMS capable:
    - Content is extracted and sent to a temporary HTTP enabled store
    - An SMS control message containing the content's URL is sent
    - The recipient's WAP browser opens and receives content from the URL
  - If the device is not MMS capable (legacy experience):
    - Content is delivered to a web based service
    - URL is forwarded to the recipient as a standard SMS message
  - Differences in device capability may require transcoding of content

Over-the-air programming (OTA)

- One of the main challenges of MMS is the number of handset parameters that need configuring.
  - Bad configuration is often responsible for poor user experience
- Over-the-air programming (OTA) increasingly being used to set configuration parameters
  - New software updates or configurations can be sent directly to the device from network operators
- Several Methods in use
  - A call or SMS alerting the user to a new update. User then dials in (when convenient) triggering an automatic software update.
  - SMS may be sent automatically due to a trigger; e.g. using a service for the first time, or after having signed up for a service
- Typically relies on the device possessing a provisioning client to set parameters.

Exercises...

- Describe the Deck-of-Cards metaphor, and explain its origins and motivation. How does it improve the user experience over GSM networks?
- Describe the challenges of transcoding for mobile devices, and give examples of how a User Agent Profile could guide the transcoding for a given device.
- Why did WAP appear to fail, and why is the future of Mobile Computing more promising? What challenges learned from the WAP experience still need to be overcome?
- Compare and contrast the delivery mechanisms used by SMS and MMS. Describe each, and give details about how MMS messages are sent to legacy (non MMS capable) devices.

To Recap...

- In this lecture set, we covered:
  - Differences between Internet access from a PC over a fixed line vs a Mobile wireless device
    - And how this affected early provision of mobile services
  - Early approaches, which led to WAP
    - The WAP stack, WML and Deck-of-Cards
  - Other content delivery systems
    - SMS, MMS and OTA

Further Reading

- ***M-Commerce***
  Norman Sadeh (Wiley, 2009)
  - Chapter 4

- ***Pervasive Computing: The Mobile World***
  Uwe Hansmann, Lothar Merk, Martin S. Nicklous, Thomas Stober (Springer Professional Computing, 2003)
  - Chapter 11

- ***Beyond 3G: Bringing Networks, Terminals, and the Web Together***
  Martin Sauter (Wiley, 2009)
  - Chapter 6

- ***Wikipedia !!!***