Types and Methods of Content Adaptation

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Agenda

- Introduction
- Multimedia Content Types
- Types of Adaptation
- Methods of Adaptation
- Conclusion
Introduction
The Problem

- Terminal diversity
  - **Hardware**: display size, resolution, bit rate, CPU power, storage space, user interface, colour depth, ...
  - **Software**: supported encodings, formats and protocols
- Network characteristics and coverage
  - Bluetooth, GPRS, WLAN, UMTS, ...
- User preferences
  - Which tradeoffs to make?
- Research going on under the name **pervasive** or **ubiquitous** computing
Multimedia Content Types

- Media content
- Presentation content
- Application data
- Procedural code
Media Content

- Textual content
  - encoding (ASCII, UTF-8, UTF-16)

- Audiovisual content
  - speech, audio, music, images, video, graphic
  - usually binary encoded
  - **Nonscalable** content ie. the encoded format provides only one representation of the content. Examples: GIF, JPEG, PNG, WBMP, MPEG-4 AAC, MP3, ASF, AMR (+ other speech codecs), MPEG-4, H.263 and so on...
  - **Scalable** content ie. contains many representations in a single bit stream. Examples: JPEG2000, SVG (SVG Basic and Tiny for mobile terminals), etc.
Presentation Content

- Markup languages
  - HTML, WML, XHTML, XHTML Mobile Profile, SMIL
  - HTML in theory device independent, offers possibilities to define alternate content
  - XHTML 2.0 has advanced alternate content object functionality
  - SMIL is a media description language and allows also to define alternatives and to control when to use them

- Stylesheets
  - separation of data and its representation
  - Cascading Style Sheets (CSS)
  - Extensible Stylesheet Language Transformations (XSLT)

- Emerging technologies
  - XHTML 2.0, XForms, CSS Media Queries

- Working groups at World Wide Web Consortium
  - HTML, Mobile Web Initiative, Device Independence
Application Data

- Application specific content
  - calendar entries (vCalendar)
  - contact information (vCard)
  - spreadsheets
  - synchronization data (SyncML)
- Usually XML formatted
- Portability between applications in different devices
Procedural Code

- Software as content
- Device-independent software
  - J2ME (MIDP + CLDC)
- Standard software platforms
  - Symbian, Palm OS, PocketPC
Types of Adaptation

- Format adaptation
- Characteristics adaptation
- Appearance adaptation
- Size adaptation
- Encapsulation adaptation
Format Adaptation

- **Motivation**
  - New formats are emerging all the time
  - Terminal support varies and depends on
    - can terminal be upgraded
    - terminal’s restrictions
    - lack of business opportunity
    - licencing costs

- **Usage**
  - reduce the content size
  - provide the content in the most suitable format
  - provide the content in the supported format

- Has often a big impact on the content quality
Characteristics Adaptation

- Adaptation within a single media format
  - image/video resolution
  - file size
  - sampling rate
  - number of frames in GIF animation
  - frame rate
  - number of colours

- For example, in MMS messaging image resolution is adapted based on the receiving terminal’s capabilities
Appearance Adaptation

- Requires knowledge of object’s semantic type ie. what can be discarded

Examples

- reducing the amount of information on the web page
- splitting content to multiple pages
- landscape versus portrait display differences
Encapsulation Adaptation

- How the content is packaged for transmission
- For example, an email arriving to SMS gateway could be split to several SMS messages
Size Adaptation

- 'Side-effect' of the other adaptations
  - appearance adaptation eg. removal of some objects
  - change the encapsulation eg. split to several messages
  - convert to another format
  - characteristics adaptation
Methods of Adaptation

- Transcoding
- Content selection
- Rendering at the client
- Hybrid approaches
Transcoding

- Modifying the properties of media objects using the various adaptations
- Also known as **dynamic adaptation**
- Done either at the originating server or at the intermediate proxy
- Usually an automatic process
  - Decoding and re-encoding of audiovisual content
  - XSLT or DOM/SAX based manipulations for XML formatted nonaudiovisual content
Transcoding Methods: General Architecture

- **Application specific controller**
  - **Capability Negotiation**
    - Extract capabilities info from protocol
  - **Capability DB**
    - Contains the device capabilities
  - **Adaptation Policies**
    - Decide how the content should be adapted
  - **Media Adaptation Engine**
    - Apply the transformation to the content
  - **Policies Plugins**
    - MMS, SIP, Browsing, ...
  - **Media Plugins**
    - GIF, JPEG, WML, H.263
Transcoding Methods:
Content Adaptation Pipeline

- Three-phase adaptation process forming a pipeline[6]
  - data characterization function (← original content object)
  - adaptation command generator (← content characteristics and client profile, produces adaptation instructions)
  - content adaptation executor (→ adapted object)
- An implementation and performance analysis described in master’s thesis from HUT [1]
- Main foundings
  - feasible
  - transformations were taking most of the time
  - order of transformations have an impact on the latency
Transcoding: pros and cons

- Automated process
- Dynamic
- Storage space benefits

**But**

- Requires a lot of processing resources
- Processing latency
- Quality issues
  - HTML converted to WML might not be usable
  - Information loss
- Copyright issues
Content Selection

- Provide multiple versions of the same media object
- Also known as static adaptation
- Avoids the problems of
  - having a lot of processing resources
  - degraded quality
  - legal issues
- Author has full control over the content
- Selection process can be made automatic

But

- Complicates content creation and management
- Requires a lot of storage space
- Might be infeasible given the amount of devices, capabilities, formats etc.
Content Selection Technologies: InfoPyramid [3,4]
Content Selection Methods: InfoPyramid Framework [3,4]
Content Selection Technologies: Separating the Content and Representation

- Can be seen as static content adaptation
  - one content object
  - several representations created in advance

- Methods
  - CSS - a stylesheet for each client
  - XSLT - generic XML content transformed to number of formats
Content Selection Technologies: Separating the Content and Representation

- Apache Cocoon [7]
- Something similar can be obtained with server-side coding
  - Java servlets and jsp
  - Apache Struts
  - Apache Velocity
Rendering at the Client

- Applications make decisions on how to render the content
  - layout decisions
  - which of the alternatives to use
  - characteristics adaptation
    - image scaling
    - colour depth
    - etc.
- Good because terminal capabilities are known
- Drawback is the requirement for processing power in the low-end terminals
Hybrid Approaches

- Content is selected and transcoded based on the terminal capabilities by the server and/or an intermediate proxy leaving still the final rendering decisions to the terminal.

- A performance study on a hybrid architecture that pre-adapted a set of content variants and left the final generation to a dynamic algorithm executed on request [5].
Conclusions

- Terminals, standards and software develop rapidly, but still often independently of each other, which creates problems in terms of content suitability.
- To increase the usability of mobile internet services, content adaptation is required.
- There are two fundamental methods for content adaptation: static or dynamic adaptation.
- Device independence is also important.
  - separation of the data and its representation.
References

8. The Device Independence Working Group, url: [http://www.w3.org/2001/di/](http://www.w3.org/2001/di/)
9. The Mobile Web Initiative, url: [http://www.w3.org/Mobile/](http://www.w3.org/Mobile/)