CS525M Mobile & Ubiquitous Computing
Cost-Aware Mobile Web Browsing

Zhilu Chen

ECE Dept.
Worcester Polytechnic Institute (WPI)
Motivation

- Cellphone data usage is expensive
  - International data roaming is extremely expensive!
  - What can we do if the user’s data plan is known?
- Size of web pages is increasing
  - Compress the page to reduce its size
  - Block non-critical contents
- User controlled metric
  - Be aware of data usage & cost
  - Choose proper settings
Related work

- Proxies for web pre-fetching
- No cost information considered
- Mainly about layout changes and content format reconfiguration
- Filtering & partitioning system, only process & display what is useful
- User-interactive adaptation
Usage-Based Pricing

- Tiered pricing plans rather than unlimited plans.
- *Constant rate model*: the user pays a standard rate per Mbyte.
- *Bundle rate model*: The user pays a fixed cost for a specified amount of downloaded Mbytes. Beyond that the user pays a standard overage fee of $a$ per Mbyte.
Anatomy of a Webpage

- HTML+CSS (including CSS images)
- Javascript
- Images
- Flash
- Embedded objects
- Favicon, iframes, etc
Anatomy of a Webpage

Figure 1. Webpage anatomy of Alexa’s top 100 pages broken down by bytes (www.alexa.com). The average webpage is 551 Kbytes, with 200.41 Kbytes occupied by JavaScript files.
System design

- Use HTTP proxy for Web access.
- Computing the Cost Quota

\[
\frac{(Q - q(t)) \times t}{n(t) \times (T - t)}
\]

- Content Adaptation Ladder
- User Feedback
Content Adaptation Ladder

- Text-only ladder.
  - the snippet page
  - the text-only version
  - the page summarization

- Advanced ladder.
  - Level 1 includes HTML, CSS, Iframe, relevant JavaScripts, and images in headings;
  - Level 2 includes Level 1 plus images (compressed and down sampled);
  - Level 3 includes Level 2 plus embedded objects.
Implementation

● Prototype system in 2,000 lines of Java code.

● Proxy
  ● listens for incoming connections
  ● receives webpages and dynamically computes the cost quota
  ● sends the webpage to the user and updates the user’s cost information

● Local storage
  ● XML files
Evaluation

- Adaptation Ladder.
- Level 2 adaption.
Evaluation

- Level 1 adaption.
Evaluation

- Level 0 adaption.
Evaluation

- Size reduction.

Cumulative distribution of the size-reduction factor from the original page.

<table>
<thead>
<tr>
<th>Type</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snippet</td>
<td>110</td>
<td>200</td>
<td>300</td>
<td>350</td>
</tr>
<tr>
<td>Level 1</td>
<td>3</td>
<td>7</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Level 2</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>16</td>
</tr>
</tbody>
</table>
Evaluation

- Conventional web pages: 42.4M

Figure 5. Distribution of 100 webpage requests, where the remaining quota was (a) 10 Mbytes and (b) 5 Mbytes.
Evaluation

- Small-Scale User Study

User study results.

<table>
<thead>
<tr>
<th>User</th>
<th>Overall satisfaction (0–5)</th>
<th>Use the proxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>3.5</td>
<td>Maybe</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>Maybe</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>No</td>
</tr>
</tbody>
</table>
References

- “Cost-Aware Mobile Web Browsing” Sindhura Chava, Rachid Ennaji, Jay Chen, and Lakshminarayanan Subramanian; New York University
Discussions

- What do you think of this system?
  - Idea
  - Usefulness
  - Efficiency
  - Evaluation
  - Others

- Thank you!