Ubiquitous and Mobile Computing
CS 528: Cost-Aware Mobile Web Browsing

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Introduction

- Since 1999, the average webpage has increased in size by a factor of 22 and there’s been a 30- to 50-fold increase in webpage complexity

- Manually redesigned large web for different users is impractical
Data pricing model:

- **Usage-Based Pricing:** the user pays a standard rate of each downloaded Mbyte.  
  2Mbytes webpage = US$1
International data roaming charges for mobile broadband

<table>
<thead>
<tr>
<th>Service provider</th>
<th>Roaming charges per Mbyte (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
<td>$19.96</td>
</tr>
<tr>
<td>Verizon</td>
<td>$20.48</td>
</tr>
<tr>
<td>T-Mobile</td>
<td>$15.00</td>
</tr>
<tr>
<td>Sprint</td>
<td>$19.50</td>
</tr>
</tbody>
</table>
Data pricing model:

- *Bundle rate plan*: The user pays a fixed cost for a specified amount of downloaded Mbytes.
Introduction (Contd)

Prepay data bundles for Safaricom, Kenya’s largest mobile network.

- Within the data plans: $0.02 to $0.006 per Mbyte
- Exceed: $0.1 per Mbyte

<table>
<thead>
<tr>
<th>Data volume</th>
<th>Price (Ksh)</th>
<th>Price per Mbyte (Ksh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Mbytes</td>
<td>100</td>
<td>2.00</td>
</tr>
<tr>
<td>200 Mbytes</td>
<td>250</td>
<td>1.25</td>
</tr>
<tr>
<td>500 Mbytes</td>
<td>499</td>
<td>1.00</td>
</tr>
<tr>
<td>1.5 Gbytes</td>
<td>999</td>
<td>.65</td>
</tr>
<tr>
<td>3 Gbytes</td>
<td>1,999</td>
<td>.65</td>
</tr>
<tr>
<td>4 Gbytes</td>
<td>2,499</td>
<td>.61</td>
</tr>
<tr>
<td>8 Gbytes</td>
<td>3,999</td>
<td>.49</td>
</tr>
<tr>
<td>20 Gbytes</td>
<td>9,999</td>
<td>.49</td>
</tr>
<tr>
<td>30 Gbytes</td>
<td>14,999</td>
<td>.49</td>
</tr>
</tbody>
</table>

* All plans cost 8 Kenya shilling (Ksh) per Mbyte after the bundle volume (83.7 Ksh equals US$1; Dec. 2011).
System Design

- Main idea:
Webpage Anatomy
Analysis of the top 100 global webpages, the average webpage is 551 Kbytes, with 200.41 Kbytes occupied by JavaScript files.

(According to www.alexa.com)
System Design (Contd)

Content Adaptation Ladder

- *Text-only ladder.*
- the snippet page
- the text-only version
- the page summarization (level 0)
System Design (Contd)

Content Adaptation Ladder

- *Advanced ladder*
  - Level 1
    Including HTML, CSS, Iframe, relevant JavaScripts
  - Level 2
    Including Level 1 plus images (compressed and downsampled)
  - Level 3
    Including Level 2 plus embedded objects
System Design (Contd)

Computing the quota of a new Web request

Q: Target budget

\[ q(t) : \text{Current quota consumed} \]

\[ n(t) : \text{Number of requests made so far} \]

\[ T : \text{Billing cycle for one month} \]

\[ t : \text{Current elapsed time} \]

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

- The (a) original page and (b) Level 2 adaptation
Evaluation (Contd)

- The (a) Level 1 adaptation and (b) original page
Evaluation (Contd)

- The (a) original page and (b) Level 0 adaptation

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**Plane crash guts leadership, opens wounds for Poland**

**4 missing miners found dead**

**The surprisingly liberal legacy of Justice Stevens**

**Woods birdies at hole 13, now tied for third at Masters**

**Spotlights from the Los Angeles Times**

**Health**

**Are eggs truly bad for the heart?**

**Weekend Living**

**Catalina Island: 15 free activities and half off new zipline**

**Home**

**Affordable housing goes green too**

**Image**
**Evaluation (Contd)**

- **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 (Contd)

- **Cost Savings**

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

- Small-Scale User Study

<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>
Conclusion

- Cost-Aware Mobile Browsing lets the client dictate the download limit for each Web request and forwards the best possible version of a page for a given data allowance.
References


References (Contd)


References (Contd)


Q&A
Thank You