

# CS525M Mobile & Ubiquitous Computing

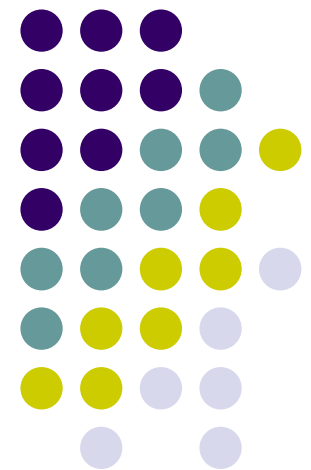
## Cost-Aware Mobile Web Browsing

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# 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

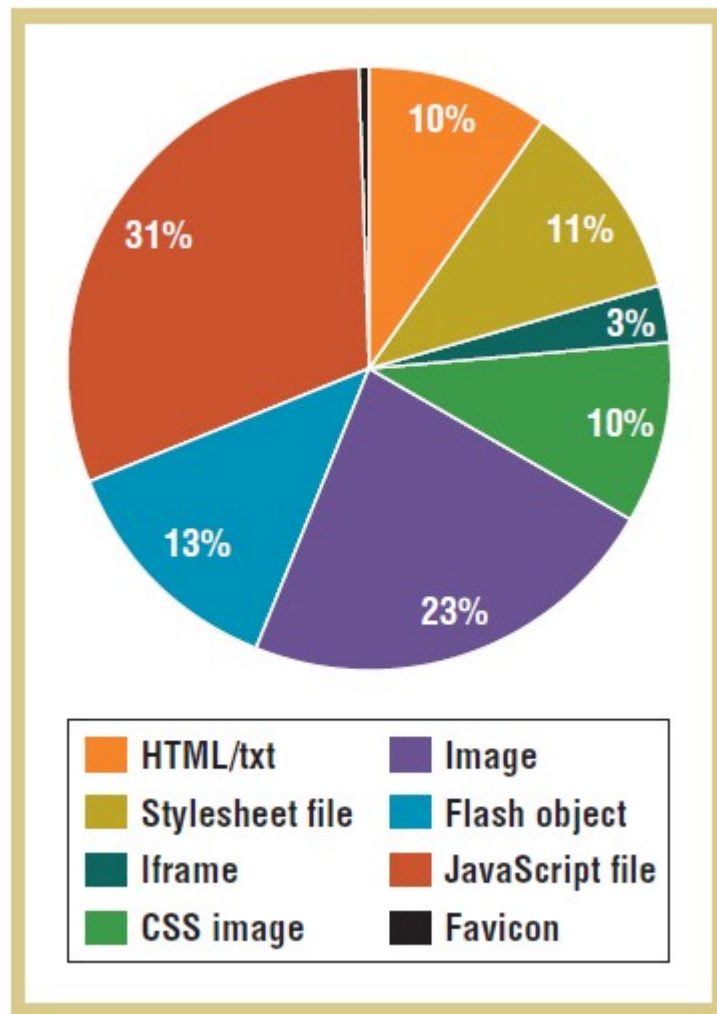


Figure 1. Webpage anatomy of Alexa's top 100 pages broken down by bytes (www.alexa.com). The average webpage is 551 Kbytes, with 200.41 Kbytes occupied by JavaScript files.



# 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. →



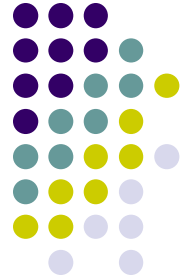
The image shows two versions of a news website layout, labeled (a) and (b), illustrating an adaptation. Both versions feature a main article titled "Masterful Mickelson Wins Third Jacket" with a photo of Tiger Woods. Below the article is a "MUST-SEE" section with a video thumbnail and a "NEWS" section with a list of headlines. To the right, there is an advertisement for "WANT TO BUILD MUSCLE?" and a "POPULAR SEARCHES" section. The layout is clean and modern, with a focus on readability and user navigation.

**(a)**

**(b)**

# Evaluation

- Level 1 adaption.



The image shows two versions of the New York Times website layout for the article "Consumers in U.S. Face the End of an Era of Cheap Credit".

**(a)** This version features a traditional layout with a large main headline, a sub-headline, and a byline. Below the main headline is a short introductory paragraph. To the right of the main headline is a secondary headline: "Turnaround of India State Could Be Model" with a sub-headline "Bihar's 11 percent average growth rate for the last five years is a sign that even India's most backward corners are being transformed. Above, construction near Patna." Below this is another headline: "As Families Gather at Dover, Efforts to Ease Pain" with a sub-headline "At the main entry point for the nation's war dead, the military is trying to meet demand and accommodate an expectation of increasing casualties from Afghanistan." Below this is a third headline: "In Tenn., Reminders of a Boy Returned to Russia" with a sub-headline "Toys at the house where a boy lived before his adoptive mother sent him back to Russia are the tiniest clues in a mystery that has turned into an international dispute." Below this is a fourth headline: "In Mine Safety, a Meek Watchdog" with a sub-headline "By MICHAEL COOPER, GARDNER HARRIS and ERIC LUPTON The Mine Safety and Health Administration remains weak in several areas, and does not always use its powers." Below this is a fifth headline: "The Texas Border Draws Frequent Fliers" with a sub-headline "The Rio Grande Valley of Texas is reputedly one of the best places for bird-watching in the country. Above, the Santa Ana National Wildlife Refuge draws bird-watchers." Below this is a sixth headline: "Tribes of Amazon Find an Ally Out of 'Avatar'" with a sub-headline "By ALEJOSI BARRONCUOVO".

**(b)** This version features a more modern layout with a large main headline, a sub-headline, and a byline. Below the main headline is a short introductory paragraph. To the right of the main headline is a secondary headline: "Consumers in U.S. Face the End of an Era of Cheap Credit" with a sub-headline "Even as prospects for the American economy brighten, consumers are about to face a sustained period of rising interest rates, economists say." Below this is a third headline: "The Texas Border Draws Frequent Fliers" with a sub-headline "The Rio Grande Valley of Texas is reputedly one of the best places for bird-watching in the country. Above, the Santa Ana National Wildlife Refuge draws bird-watchers." Below this is a fourth headline: "Tribes of Amazon Find an Ally Out of 'Avatar'" with a sub-headline "By ALEJOSI BARRONCUOVO".

# Evaluation

- Level 0 adaption.



(a)

(b)

[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](#)

Done



# Evaluation

- Size reduction.

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

Type	50%	75%	90%	95%
Snippet	110	200	300	350
Level 1	3	7	15	20
Level 2	2	5	10	16



# Evaluation

- Conventional web pages: 42.4M

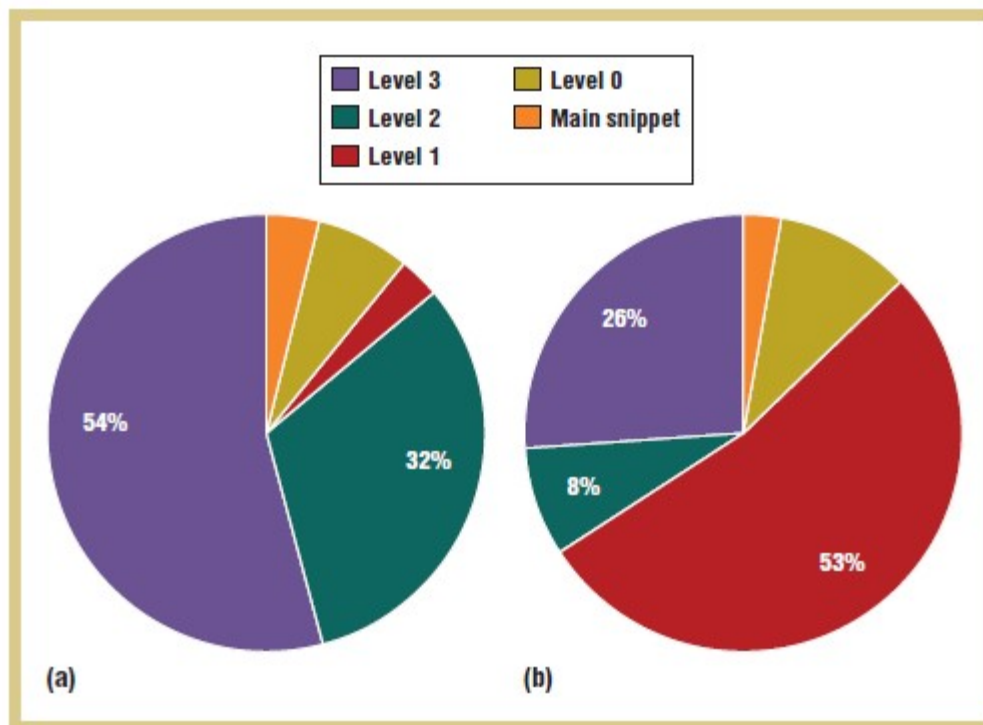


Figure 5. Distribution of 100 webpage requests, where the remaining quota was (a) 10 Mbytes and (b) 5 Mbytes.



# Evaluation

- Small-Scale User Study

User study results.

User	Overall satisfaction (0–5)	Use the proxy
1	4	Yes
2	4	Yes
3	4	Yes
4	3.5	Yes
5	3.5	Maybe
6	3	Maybe
7	3	No



## 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!