

# 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



## Introduction(Contd)

### Data pricing model:

- Usage-Based Pricing: the user pays a standard rate of each downloaded Mbyte

2Mbytes webpage=US\$1



## Introduction(Contd)

- International data roaming charges for mobile broadband

International data roaming charges for mobile broadband (Dec. 2011).

<b>Service provider</b>	<b>Roaming charges per Mbyte (US\$)</b>
AT&T	\$19.96
Verizon	\$20.48
T-Mobile	\$15.00
Sprint	\$19.50



## Introduction(Contd)

### 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

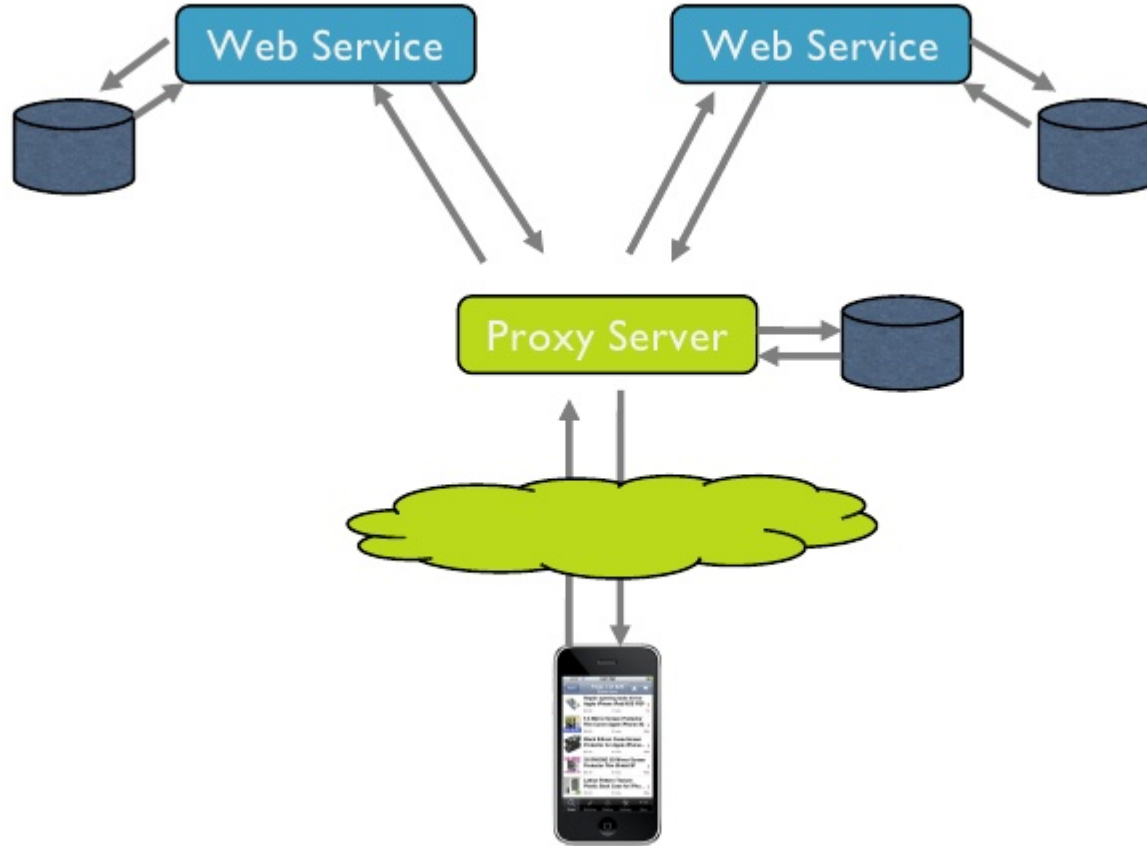
Data volume	Price (Ksh)	Price per Mbyte (Ksh)
50 Mbytes	100	2.00
200 Mbytes	250	1.25
500 Mbytes	499	1.00
1.5 Gbytes	999	.65
3 Gbytes	1,999	.65
4 Gbytes	2,499	.61
8 Gbytes	3,999	.49
20 Gbytes	9,999	.49
30 Gbytes	14,999	.49

\* 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:



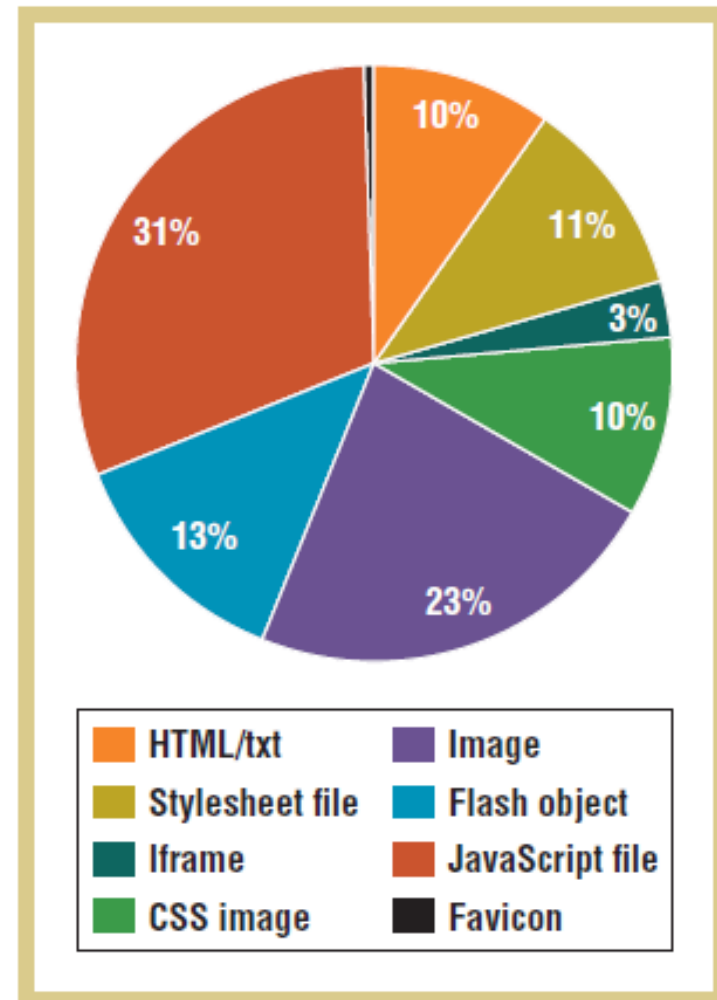


# System Design(Contd)

## 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](http://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

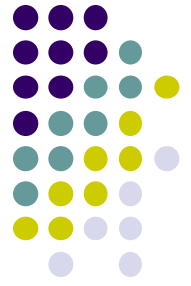
Including HTML, CSS, Iframe, relevant JavaScripts

### 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): Current quota consumed  $\frac{(Q - q(t)) \times t}{n(t) \times (T - t)}$

t: Current elapsed time

T: Billing cycle for one month

n(t): Number of requests made so far

# Evaluation



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

**Masterful Mickelson Wins Third Jacket**

Phil Mickelson's [five-under closing round](#) is just enough to hold off challengers at Augusta.

[Complete 2010 Masters leaderboard](#)

Where did Tiger Woods finish?

Slideshow: See action from Sunday's final round

1 of 5

MUST-SEE NEWS TRAVEL DO THIS!

Obama faces global nuclear realities

Video: What brought down Polish president's jet?

Commander: Apollo 13 was 'successful failure'

Video: Space shuttle era nears the end

Blast rattles U.K. spy HQ in N. Ireland

Senator will fight airline carry-on bag fee

How Glenn Beck Inc. earns millions annually

**TOYOTA'S TACTICS: Deception, evasion**

Denial of documents in past cases may give a glimpse of the automaker's future legal strategy.

CELEBS & GOSSIP SPORTS LOVE LOL

'Date Night' & 'Titans'

Bruckheimer unbound

Advertisement: **WANT TO BUILD MUSCLE?** Chemists Have Developed A New, Natural Supplement That is Getting Guys Ripped Like Never Before. [Learn More](#)

Force Factor

POPULAR SEARCHES

'A successful failure' Forty years ago, Apollo 13 took one wild ride: 'Houston, we've had a problem here.'

Lady GaGa celibate? | Chesney on Zellweger marriage

'Glee' star engaged | Bieber unhappy with mag cover

Klasinger & homicide case | Boy terrified adoptive kin?

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TRAVEL

DO THIS!

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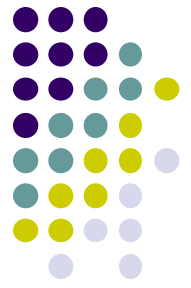
HOTMAIL

Sign In

Windows Live

Facebook

(b)



# Evaluation(Contd)

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

The screenshot shows the original New York Times website layout. The main headline is "Consumers in U.S. Face the End of an Era of Cheap Credit" by Nelson D. Schwartz. The article text begins: "Even as prospects for the American economy brighten, consumers are about to face a sustained period of rising interest rates, economists say." Other visible headlines include "Turnaround of India State Could Be Model" and "As Families Gather at Dover, Efforts to Ease Pain". The website features a search bar, navigation tabs for "HOME PAGE", "TODAY'S PAPER", "VIDEO", "MOST POPULAR", "TIMES TOPICS", and "MOST RECENT". A sidebar on the left lists various categories like "JOBS", "REAL ESTATE", "ALL CLASSIFIEDS", "WORLD", "U.S.", "POLITICS", "N.Y./REGION", "BUSINESS", "TECHNOLOGY", "SPORTS", "SCIENCE", "HEALTH", "OPINION", "ARTS", "Style", and "TRAVEL".

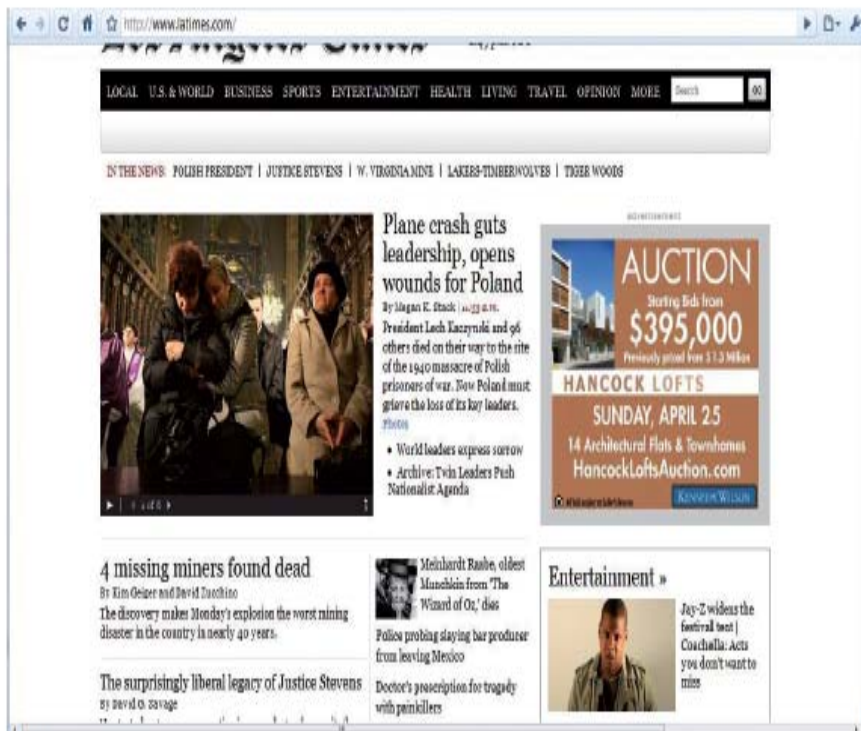
(a)

(b)

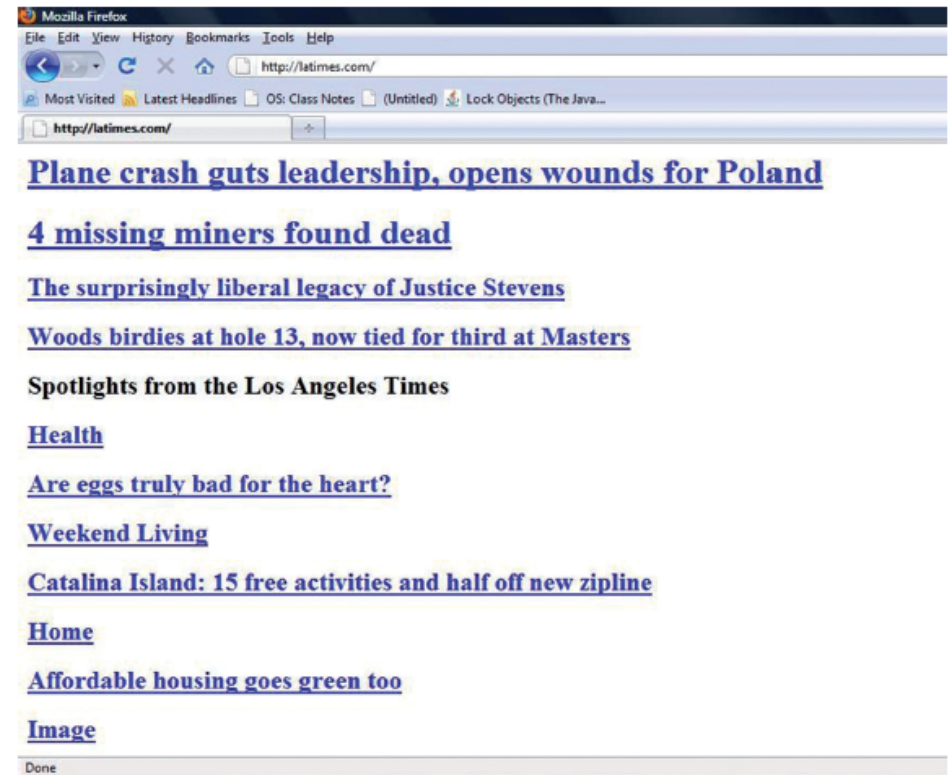


# Evaluation (Contd)

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



(a)



(b)



# Evaluation (Contd)

- **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

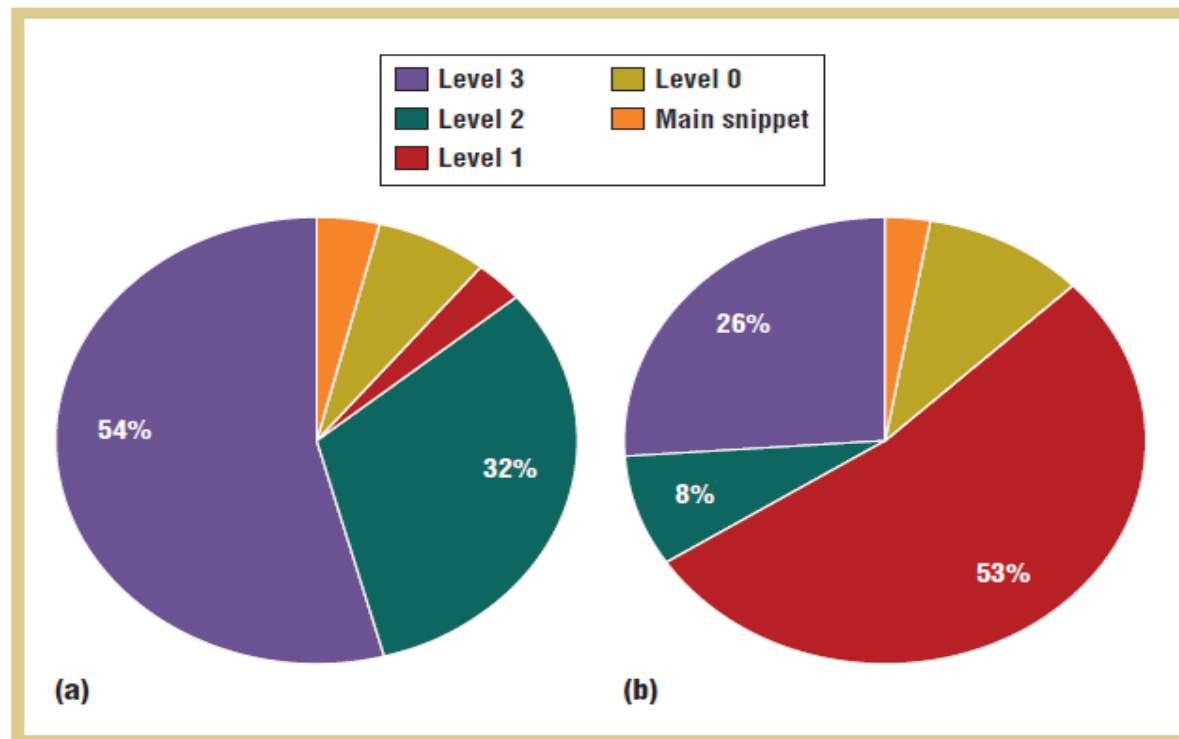




# Evaluation (Contd)

- **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

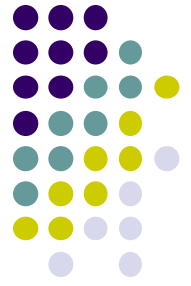
User study results.

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

# 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

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2. J. Domènech et al., “A User-Focused Evaluation of Web Prefetching Algorithms,” *Computer Comm. Rev.*, vol. 30, no. 10, 2007;  
<http://dx.doi.org/10.1016/j.comcom>. 2007.05.003.
3. J. Charzinski, “Traffic Properties, Client Side Cachability and CDN Usage of Popular Web Sites,” *Measurement, Modelling, and Evaluation of Computing Systems and Dependability in Fault Tolerance*, LNCS 5987, Springer, 2010, pp. 136–150.



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<http://code.google.com/speed/articles/web-metrics.html>.
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# Q&A



