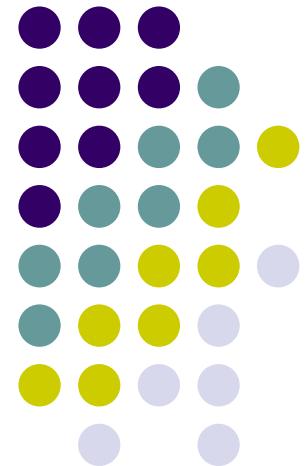


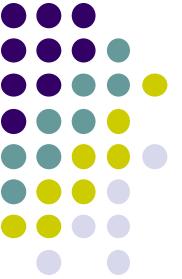
Ubiquitous and Mobile Computing

CS 528: *Cost-Aware Mobile Web Browsing*

Chen Lin

*Electrical and Computer Engineering Dept.
Worcester Polytechnic Institute (WPI)*





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

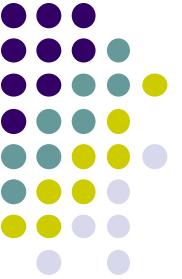


Introduction(Contd)

- International data roaming charges for mobile broadband

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

Service provider	Roaming charges per Mbyte (US\$)
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

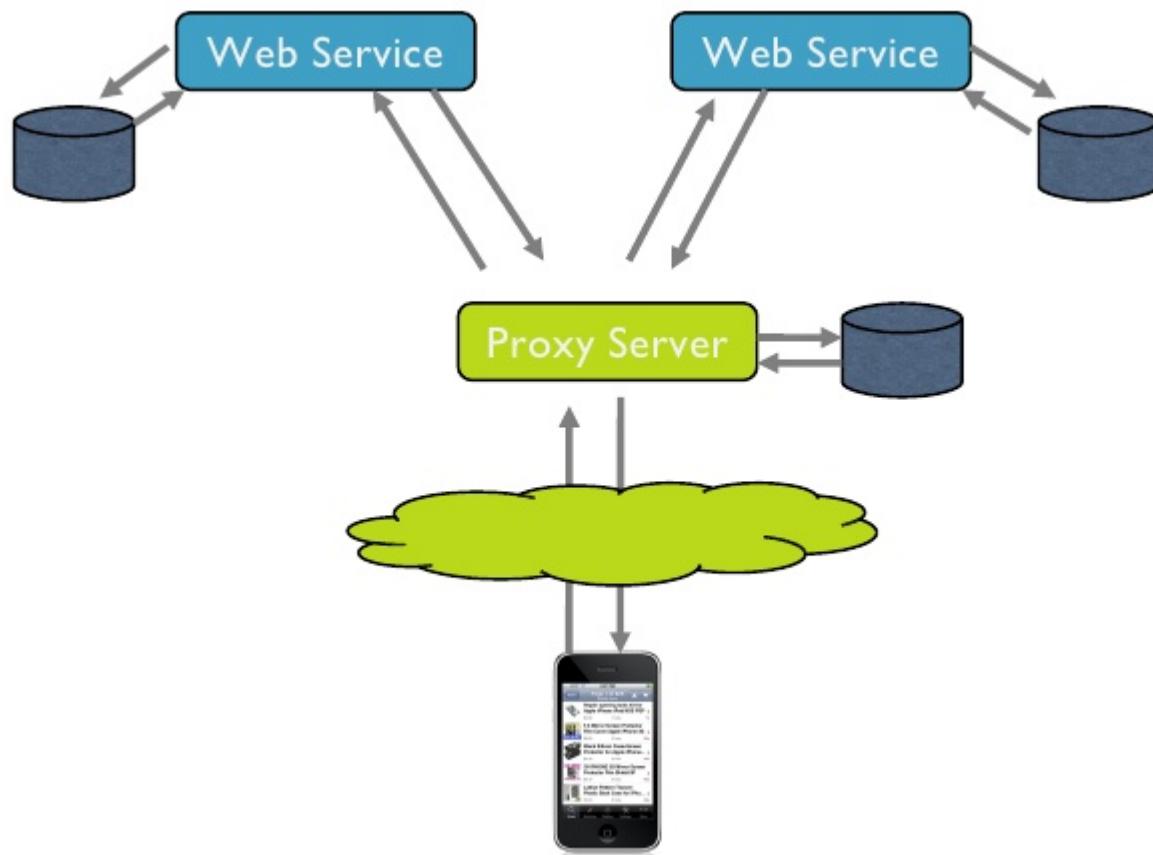
Data volume	Price (Ksh)	Price per Mbyte (Ksh)
50 Mbytes	100	2.00
200 Mbytes	250	1.25
500 Mbytes	499	1.00
1.5 Gbytes	999	.65
3 Gbytes	1,999	.65
4 Gbytes	2,499	.61
8 Gbytes	3,999	.49
20 Gbytes	9,999	.49
30 Gbytes	14,999	.49

* 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:



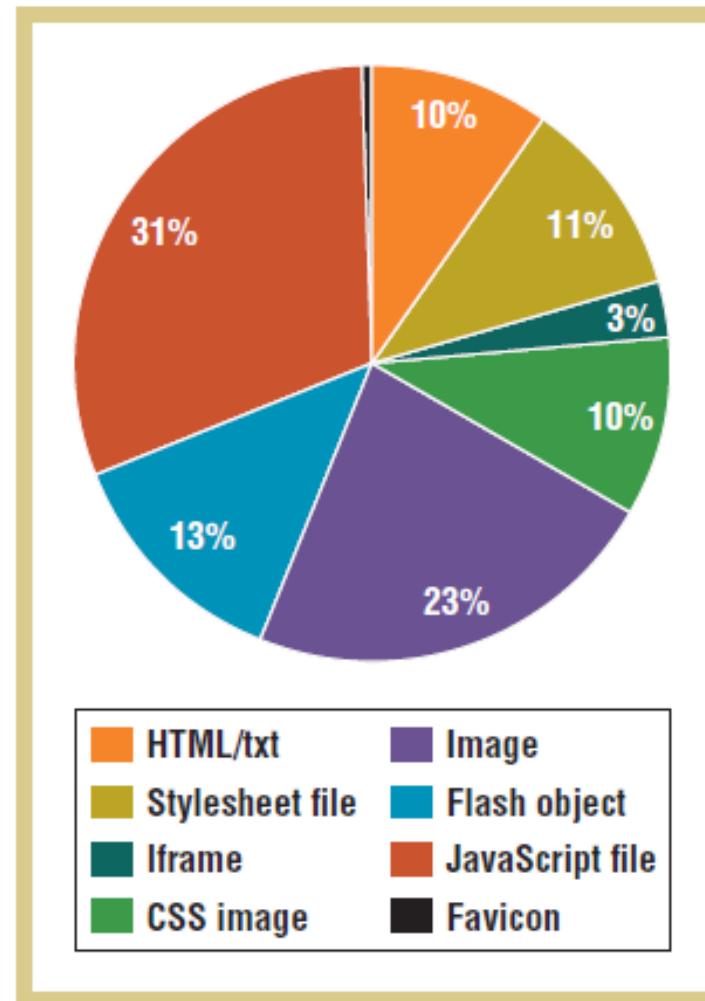


System Design(Contd)

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)





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

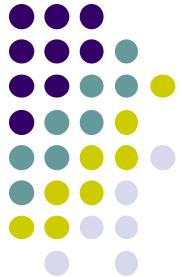
Including HTML, CSS, Iframe, relevant JavaScripts

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!

 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

(a)

 WANT TO BUILD MUSCLE?

Chemists Have Developed A New, Natural Supplement That Is Getting Guys Ripped Like Never Before.

Learn More ▶

FORCE FACTOR

Advertisement Ad Feedback:

Tour the new MSN

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

Kissinger & homicide case | Boy terminated adoptive kin?

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

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MUST-SEE

NEWS

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TRAVEL

DO THIS!

HOTMAIL

Sign in

Windows Live

Facebook

PUBLISHERRIGHTS

Tour the new MSN

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'Glee' star engaged | Bieber unhappy with mag cover

Kissinger & homicide case | Boy terminated adoptive kin?

Elephant kills circus worker | Virus & 40 child deaths

Will Nelson's band & charges? | New Spiderman?

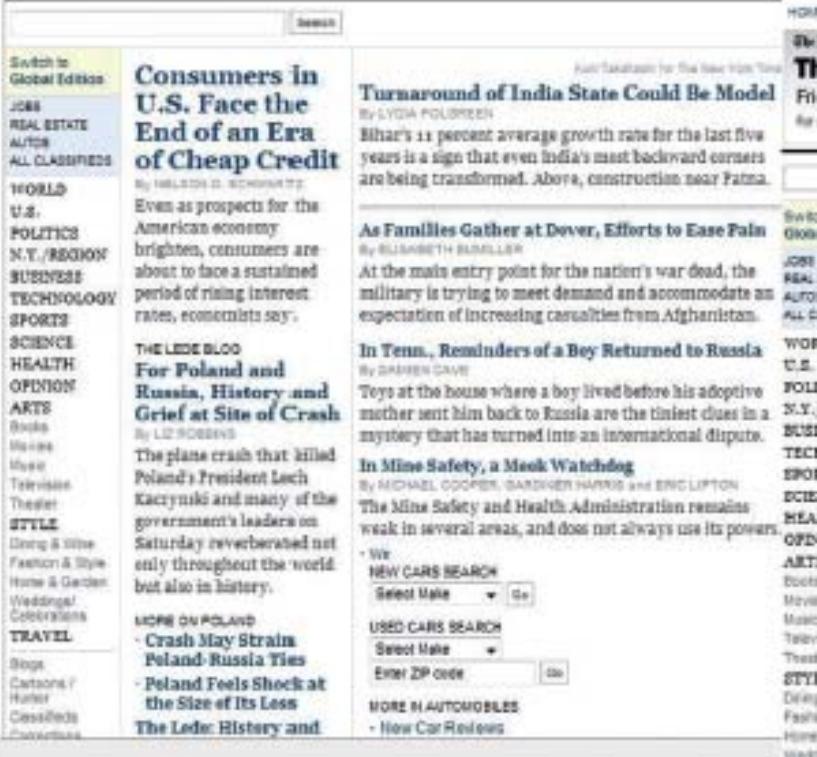
Pirates hijack ship | Former congressman dies

Hal Holbrook mourns | Glenn Beck & \$32M paycheck



Evaluation(Contd)

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



Consumers in U.S. Face the End of an Era of Cheap Credit
By WILSON D. SCHWITZKE

Even as prospects for the American economy brighten, consumers are about to face a sustained period of rising interest rates, economists say.

THE LEDE BLOG
For Poland and Russia, History and Grief at Site of Crash
By LIZ ROBBINS

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.

In Tenn., Reminders of a Boy Returned to Russia
By DAVID CAVE

The plane crash that killed Poland's President Lech Kaczyński and many of the government's leaders on Saturday reverberated not only throughout the world but also in history.

In Mine Safety, a Meek Watchdog
By MICHAEL COOPER, GARDNER HARRIS and ERIC LIPTON

The Mine Safety and Health Administration remains weak in several areas, and does not always use its powers fully.

MORE ON POLAND

- Crash May Strain Poland-Russia Ties
- Poland Feels Shock at the Size of Its Loss
- The Lede: History and

NEW CARS SEARCH
Select Make ▾ Go

USED CARS SEARCH
Select Make ▾ Enter ZIP code ▾

MORE IN AUTOMOBILES

- New Car Reviews

Switch to Global Edition ▾

HOME PAGE | **TODAY'S PAPER** | **VIDEO** | **MOST POPULAR** | **TIMES TOPICS** | **MOST RECENT**

The Weekender
Friday, Saturday, Sunday.
For as low as **\$3.80** a week.

The New York Times
Sunday, April 11, 2010 Last Update: 2:45 AM ET

Switch to Global Edition ▾

HOME PAGE | **TODAY'S PAPER** | **VIDEO** | **MOST POPULAR** | **TIMES TOPICS** | **MOST RECENT**

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THE TEXAS BORDER DRAWS FREQUENT FLIERS
By CLAYNE GLASSCO

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.

TRIBES OF AMAZON FIND AN ALIY OUT OF 'AVATAR'
By ALISON MARCIOLO

(a)

(b)



Evaluation (Contd)

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

The screenshot shows the original Latimes.com homepage. At the top, there's a navigation bar with links for LOCAL, U.S. & WORLD, BUSINESS, SPORTS, ENTERTAINMENT, HEALTH, LIVING, TRAVEL, OPINION, and MORE. Below the navigation, a banner headline reads "Plane crash guts leadership, opens wounds for Poland". To the left of the headline is a photograph of several people, some in military uniforms, standing outdoors. To the right is a sidebar with a real estate advertisement for "HANCOCK LOFTS" featuring an auction starting at \$395,000. Below the main headline, there are several news links: "4 missing miners found dead", "The surprisingly liberal legacy of Justice Stevens", and "Meinhardt Raabe, oldest Munchkin from 'The Wizard of Oz,' dies". On the right side, there are sections for "Entertainment" (with a photo of Jay-Z) and "Health".

(a)

The screenshot shows the Level 0 adapted version of the Latimes.com homepage. The overall layout is identical to the original, but the content is heavily redacted with blue underlined text. The main headline "Plane crash guts leadership, opens wounds for Poland" is present, along with its accompanying image. Below it, the headline "4 missing miners found dead" is shown. Further down, the headline "The surprisingly liberal legacy of Justice Stevens" is visible. On the right side, the "Entertainment" section is present with the headline "Jay-Z withdraws from festival last minute" and the "Health" section with the headline "Are eggs truly bad for the heart?".

(b)



Evaluation (Contd)

- **Size Reduction**

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

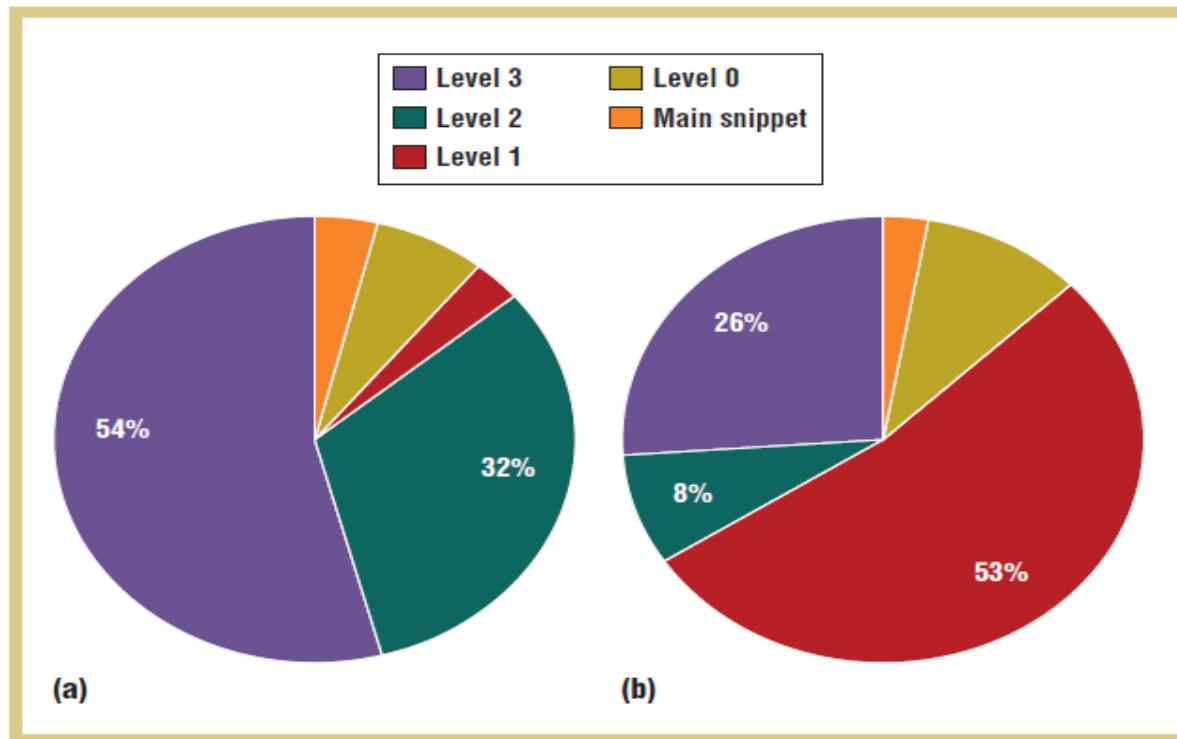
Type	50%	75%	90%	95%
Snippet	110	200	300	350
Level 1	3	7	15	20
Level 2	2	5	10	16



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

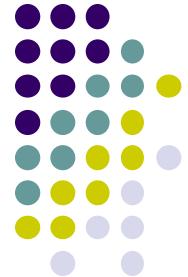


- Cost-Aware Mobile Browsing lets the client dictate the download limit for each Web request and forwards the best possible version of a page for a given data allowance.



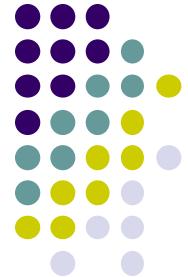
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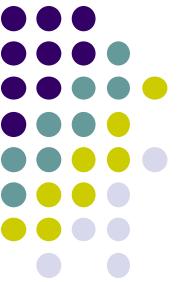
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Q&A



