Webpage-Based Benchmarks for Mobile Device Design

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Communication Across the World

- Web pages becoming the standard of information exchange
- Mobile Devices becoming computer of choice
- How do web pages impact mobile device architecture?

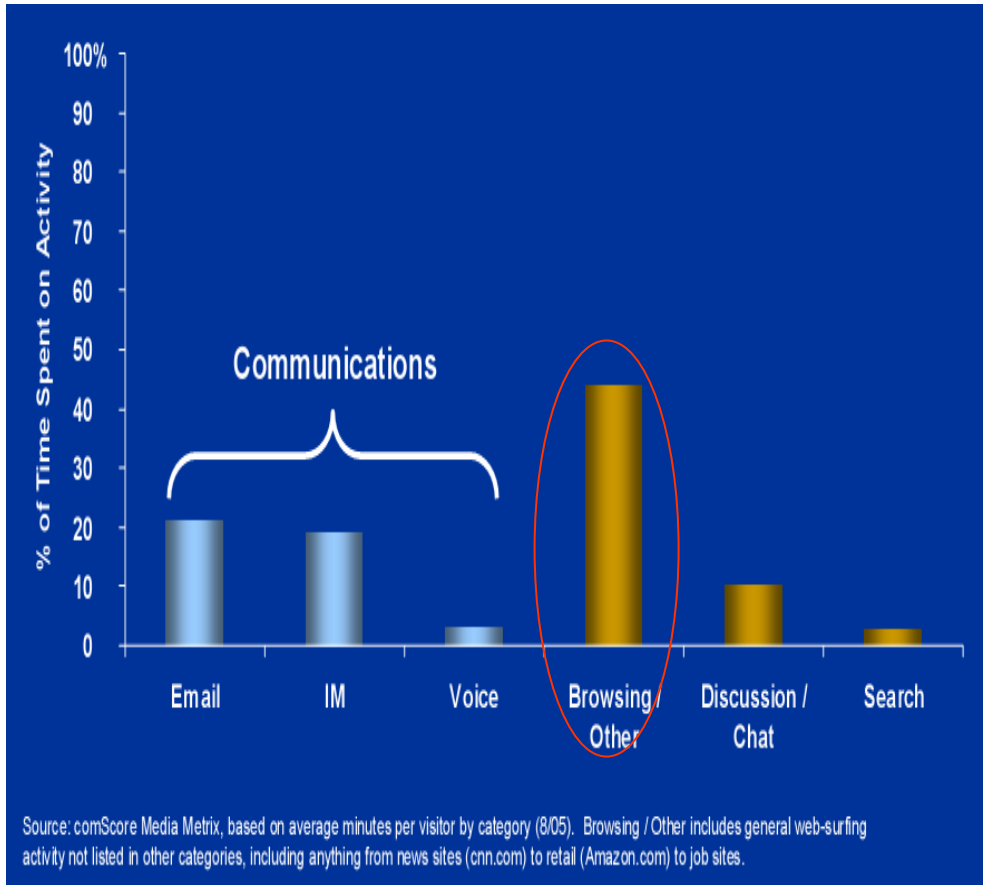


Figure 1. US Online Usage [1]

[1] Meeker, M., Pitz, B., Fitzgerald, B., and Ji, R., "Internet Trends", 12 October 2005,

Complexity of Webpage Content

- Three basic elements
  - Text/scripts
  - Images
  - Movie/animated FLASH
- Three movie/animated FLASH
  - MPEG
  - FLASH Movies
  - Still-image FLASH frame
- Only analyzing FLASH frame
- Heterogeneous content, each providing unique characteristics

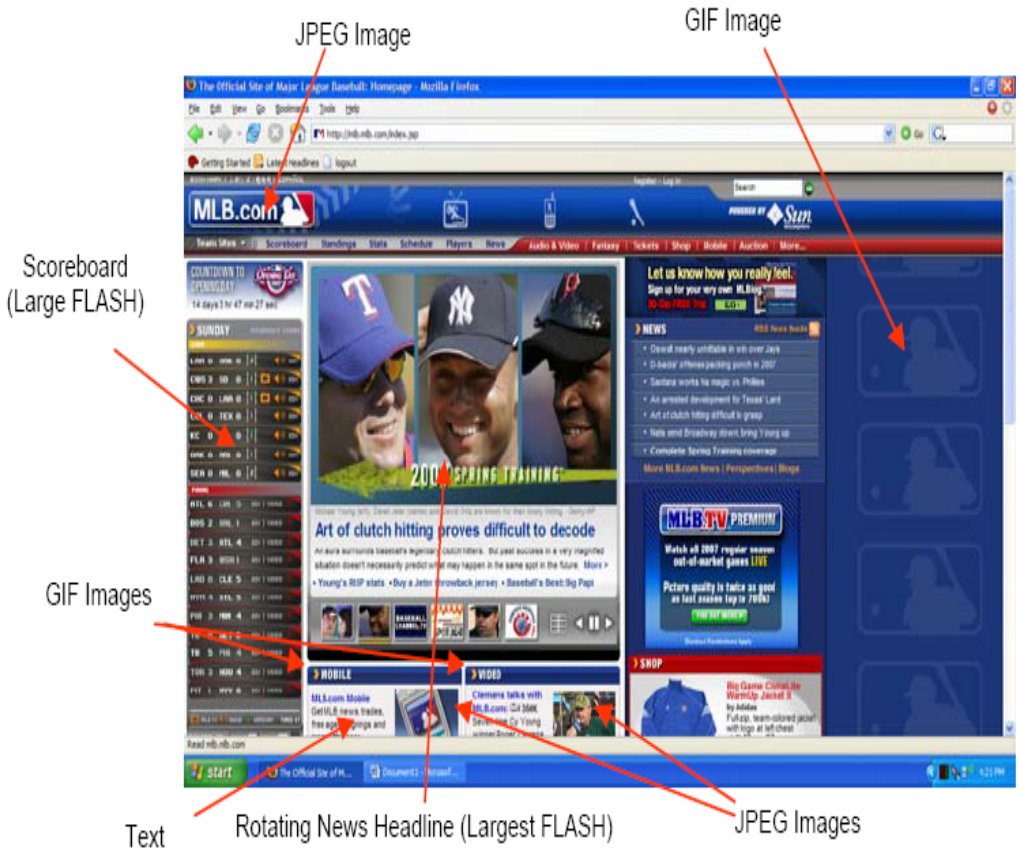


Figure 2. Screenshot of MLB webpage

Benchmark Suites

- SPEC, MediaBench, MiBench, EEMBC
- Benchmarks model applications executing one at a time
- untimed datasets
- Web pages act differently!

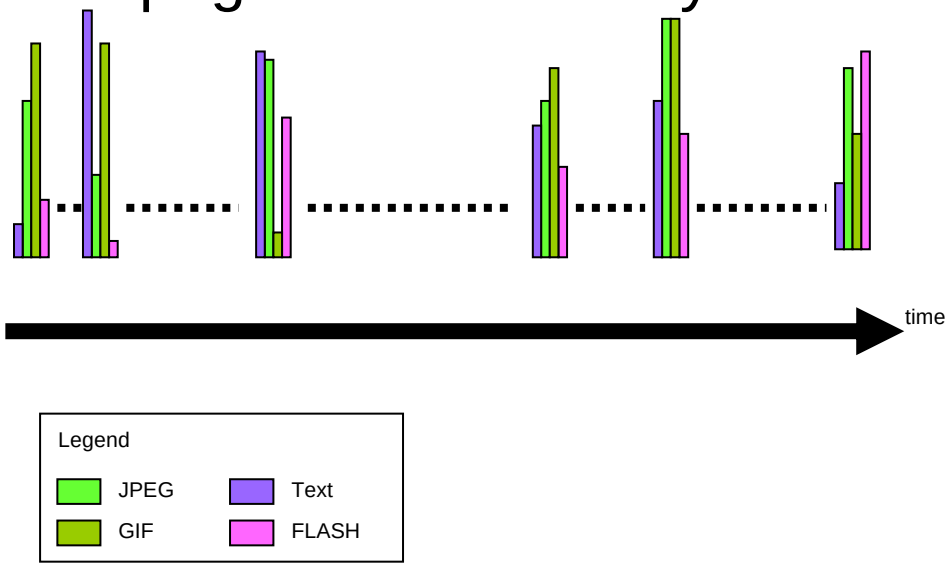


Figure 4. Burst nature of webpage content for mobile devices

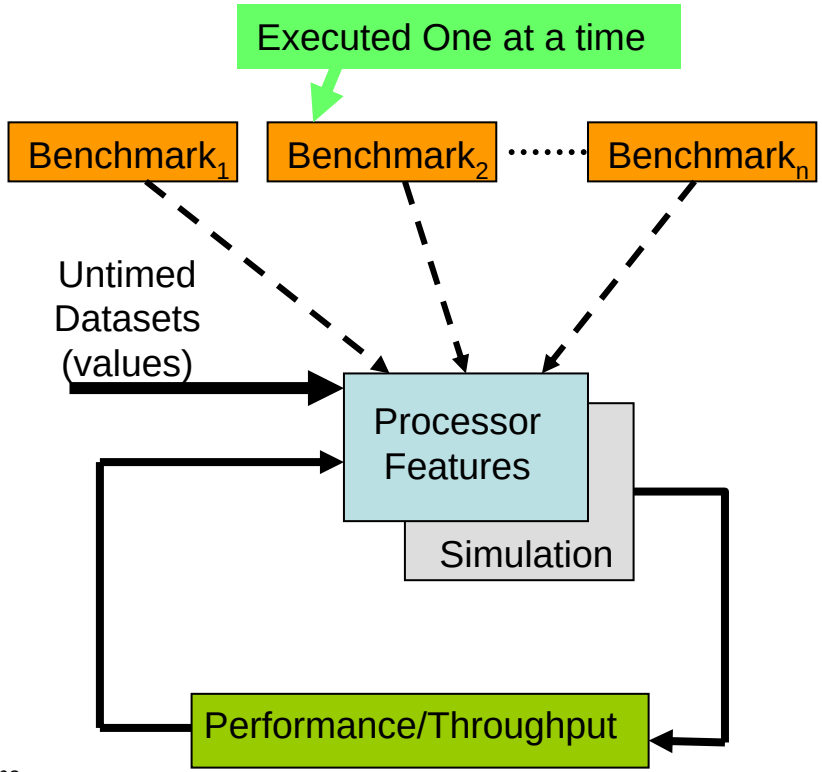


Figure 3. Previous Benchmark Testing Methodology [2]

[2] Paul, J., Thomas, D., and Bobrek, A., "Scenario-Oriented Design for Single-Chip Heterogeneous Multiprocessors", IEEE Transactions on VLSI, vol. 14, no. 8, August, 2006, pp. 868-880.

Webpage Survey

Statistical Data of Websites [3]

Statistics	BBC	CNN	ESPN	MLB	VT.edu
Total Objects	214	414	92	75	124
Total Size	268.99 KB	438.13 KB	343.54 KB	116.54 KB	394.09 KB
Total JPEG	10	8	10	5	24
Total GIF	193	390	61	57	86
Total FLASH	0	0	10	3	1
Total Text	11	16	11	10	13
% Media Content	94.9%	96.1%	88.0%	86.7%	89.5%

Text composition of Websites [3]

File Types	BBC	CNN	ESPN	MLB	VT.edu
TEXT > 50k	1	0	0	0	0
TEXT > 30k	1	3	2	0	0
TEXT > 20k	0	0	3	1	1
TEXT > 10k	0	3	1	0	1
TEXT > 5k	3	6	2	1	5
TEXT > 1k	3	4	1	6	4
TEXT <= 1k	0	0	2	2	2

- Sample Data collected
- More media oriented content
  - Only analyzed 2007
  - Content changed from 5 years ago and will continue to change
- News websites have larger text/script files

[3] Webpage Analyzer, website, http://www.websiteoptimization.com/services/analyze/.

Questions so far…

- Does this mean that we need to re-think the form of the way we evaluate mobile device architectures?
- Can individual usage patterns impact architectures?
  - Sports Fanatic
  - Wall Street Investor
  - Typical College Student
  - International News Junkie
  - College Sports Fanatic
  - Specific Sporting Teams
  - General Web Surfer

Experiment Setup

- Collect Webpage Content Data
  - Model Webpages
  - Predict Webpage Access Patterns
- Collect Processor Data
- Experimental Model
- Simulator

Webpage Access Patterns

- Different users surf different web pages
- Webpage profiling not performed
  - User access patterns estimated
  - Meant to show impact of webpage usage

Webpage Utilization (in %) for Various User Profiles

Type of Person	BBC	CNN	ESPN	MLB	College Homepage
International Political Junkie	90	10			
Web Surfer	20	20	20	20	20
Political and College Sports Enthusiast	25	20	20		35
Political Junkie	75	20	5		
Sports Fanatic	0	0	75	15	10
Typical College Student	65		25		10

Processor Parameters

- EEMBC
- Inadequate benchmarks available for standard mobile processors
- Embedded benchmarks shows performance for all tasks
- Relative performance from different processors reflective of performance for mobile processors

Relative Area and Power Consumption Comparison

Processor	Relative Area	Relative Power
AMD-K6E => 500 MHz	3.40	19.86
PNX1702 => 500 MHz	1	4.03
ADSP-BF533 => 594 MHz	1.58	1

Overall Relative Performance

Task Type	DSP	Media	GPP
JPEG	14.294	127.642	25.868
Text	17.536	5.973	29.952
MPEG	1.28	4.383	1

System Model

- Web pages have links to objects
- Test multiple web pages
- Models for various Processor Types
- Models for Scheduler Input
- Are complex scheduling strategies worthwhile?

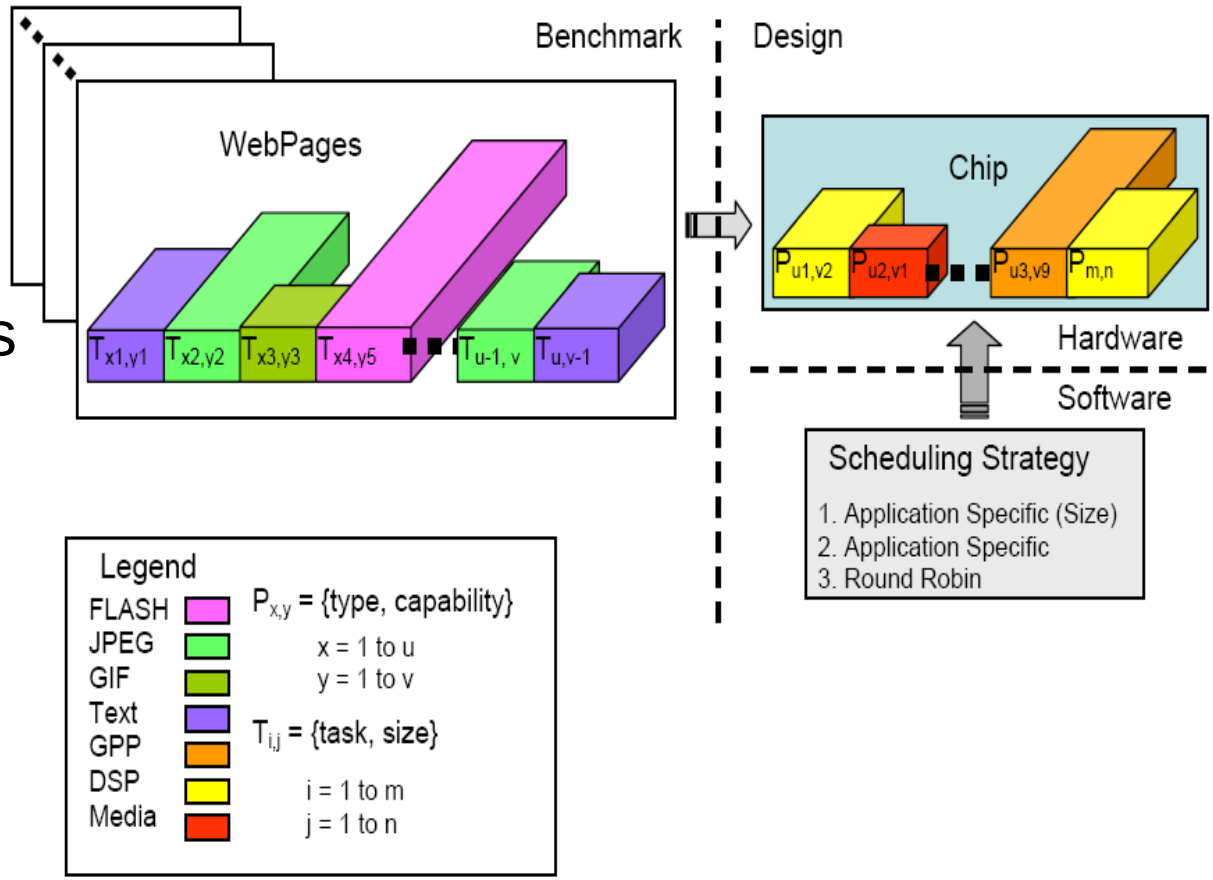


Figure 5. Abstraction model of webpage interaction with chip architecture

Scheduling Strategies

- Static
  - Certain application types execute on certain processors
- Round Robin
  - Assign any task to any available processor (dynamic)
- Application Specific
  - Assign particular task types to particular processors
- Application Specific Size
  - Assign particular task types to particular processors based on task sizes

Scheduler Performance Overhead [4]

Scheduler Overhead	Round Robin	Application Specific Size	Application Specific (Big)	Application Specific (Small)	Static
Cycles	159	4770	1590	1590	159
Time (secs)	5.06E-05	1.52E-03	5.06E-04	5.06E-04	5.06E-05

[4] Yuan, W. and Nahrstedt, K., "Energy-Efficient Soft Real-Time CPU Scheduling for Mobile Multimedia Systems", 19th ACM Symposium on Operating System Principles (SOSP '03), October 19-22, 2003, pp 149-163.

Simulators

- HDLs
  - Do not allow for high-level evaluation
- SpecC
  - Geared towards CAD tool usage, limits user extensibility
- SystemC
  - C++ Extension library, no dedicated compiler – debugging during runtime
- None allow for heterogeneous tasks on heterogeneous hardware
  - Example: Task type A can execute on processor types X, Y, and Z
- Majority are cycle accurate – too slow

Modeling Environment for Software and Hardware (MESH)

- Easily models designs above ISS
- Model heterogeneous architectures and applications
- Timed system inputs => system response over time
- Power/Energy Consumption
  - Multiple methods
  - Single power value
  - Estimated 10% error [5]

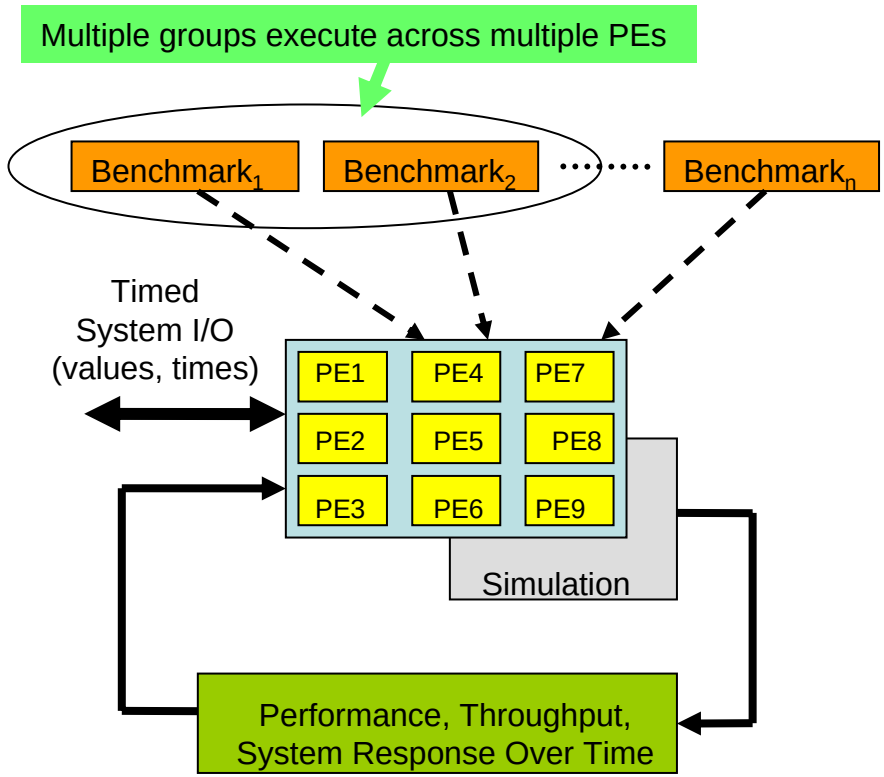


Figure 6. Multiprocessor Design

MESH is now available at www.ece.wisc.edu/~soar

[5] Meyer, B., Pieper, J., Paul, J., Nelson, J., Pieper, S., and Rowe, A., Power-Performance Simulation and Design Strategies for Single-Chip Heterogeneous Multiprocessors, IEEE Transactions on Computers, June 2005.

Experiments

- Two experiments
  - Average performance over all webpage types
  - User accesses web pages of particular types
- Normalized all performance results against the performance of a homogeneous multiprocessor, using GPPs.
- See if scheduling strategy influences webpage benchmark performance
- See if certain user profiles/access patterns prefer certain architectures

Results – Performance

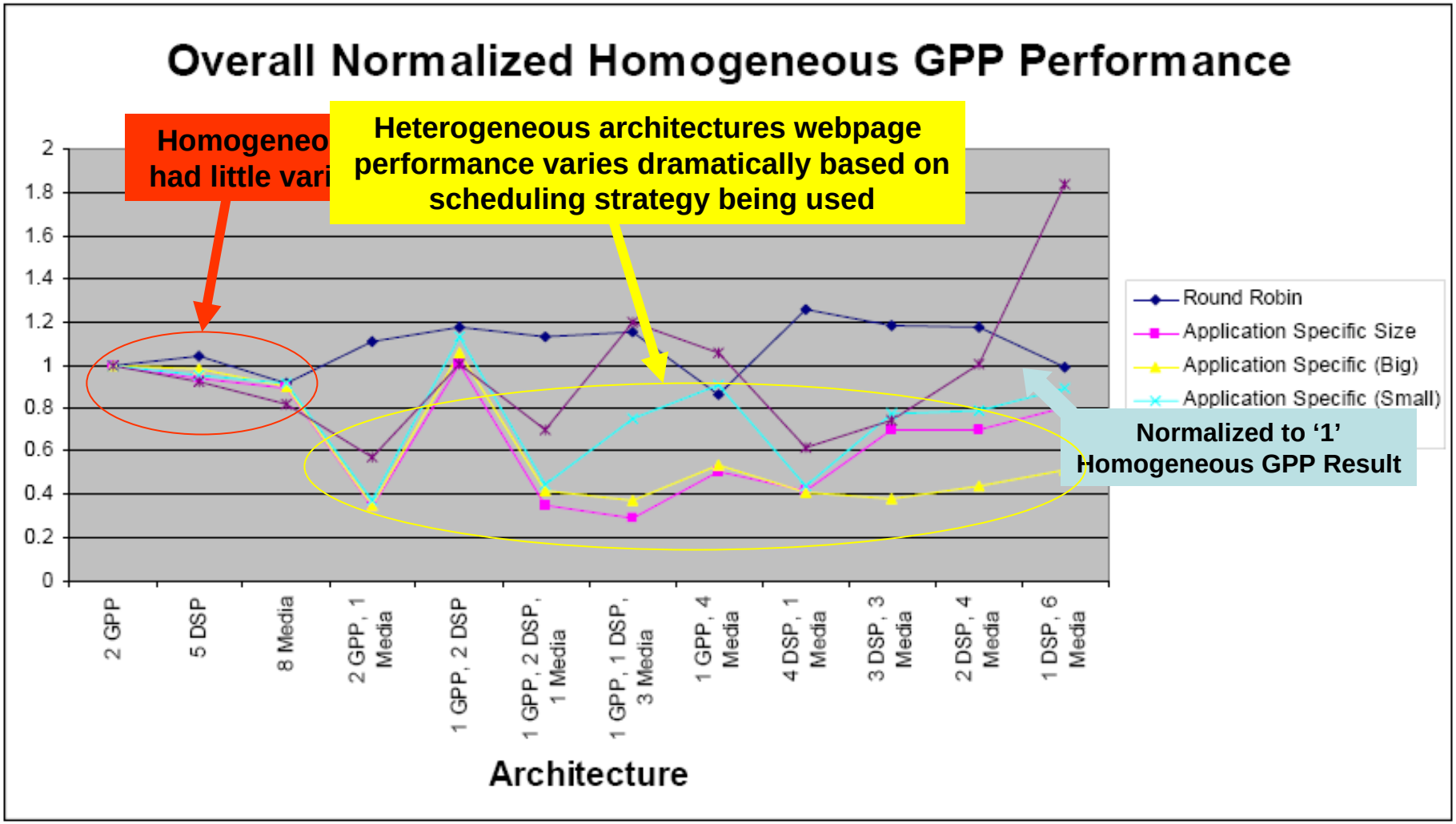


Figure 7. Overall Webpage Normalized Performance

Results – Webpage Utilization

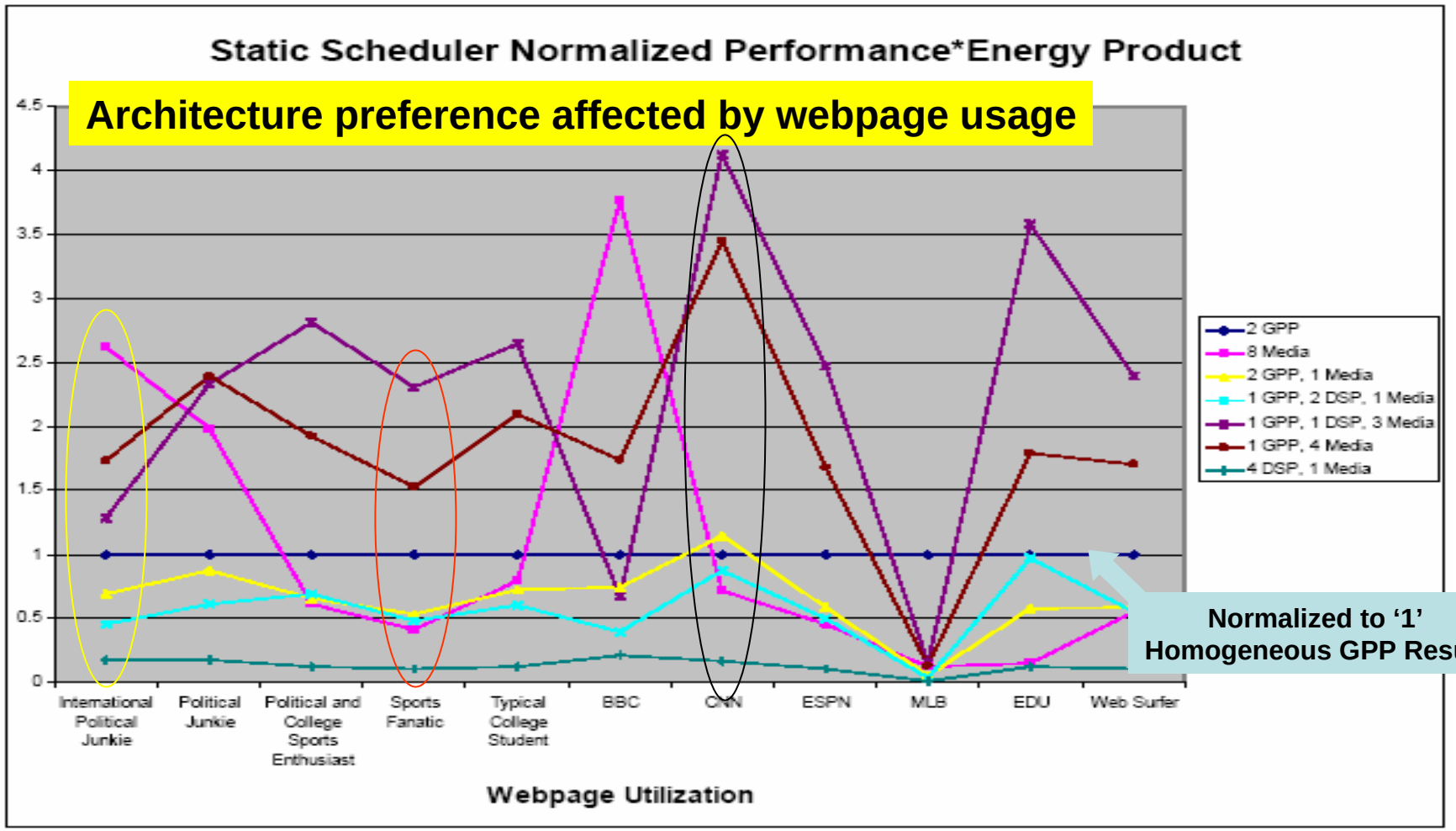


Figure 8. Static Scheduler Webpage Utilization

Results – Webpage Utilization

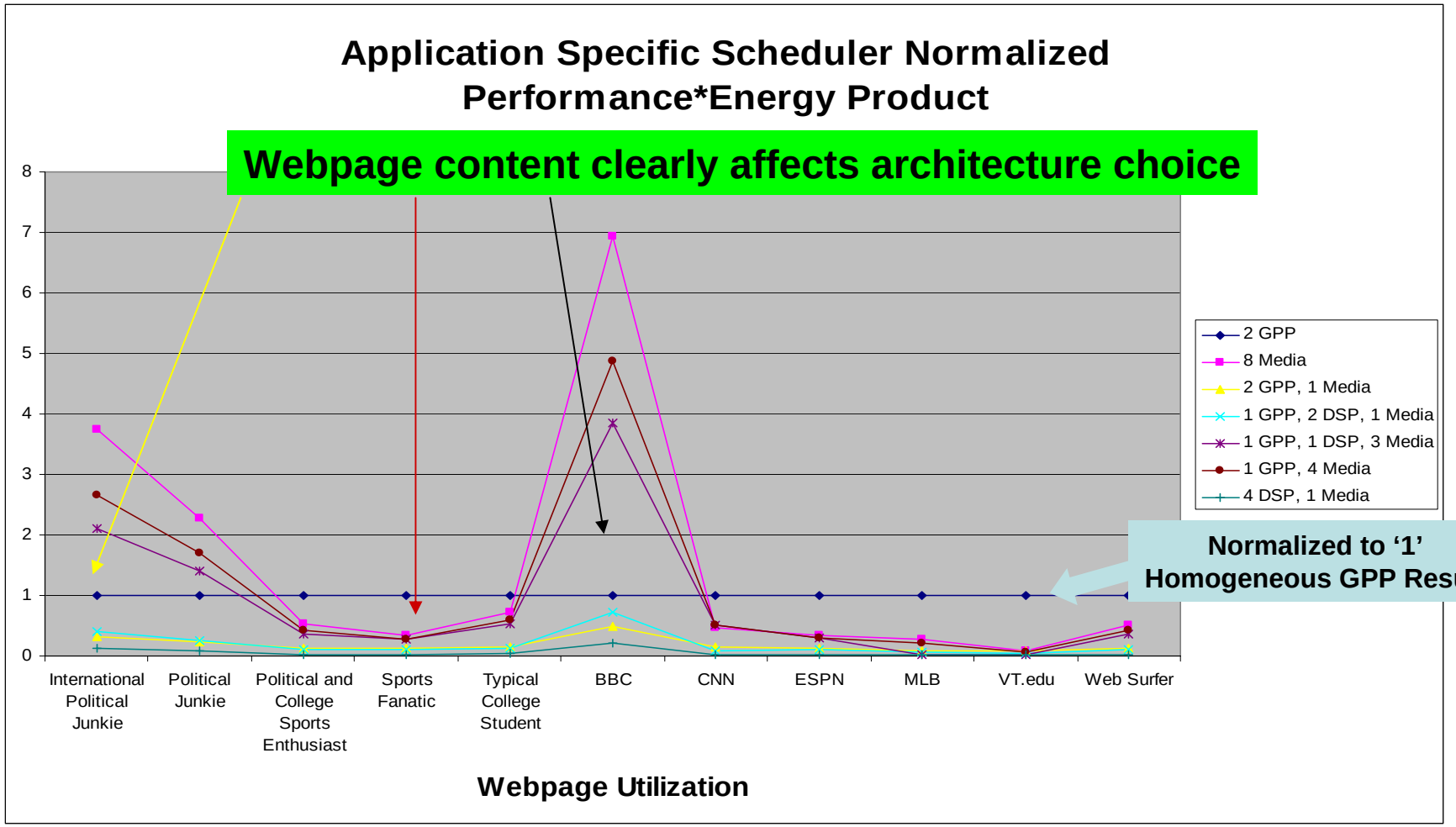
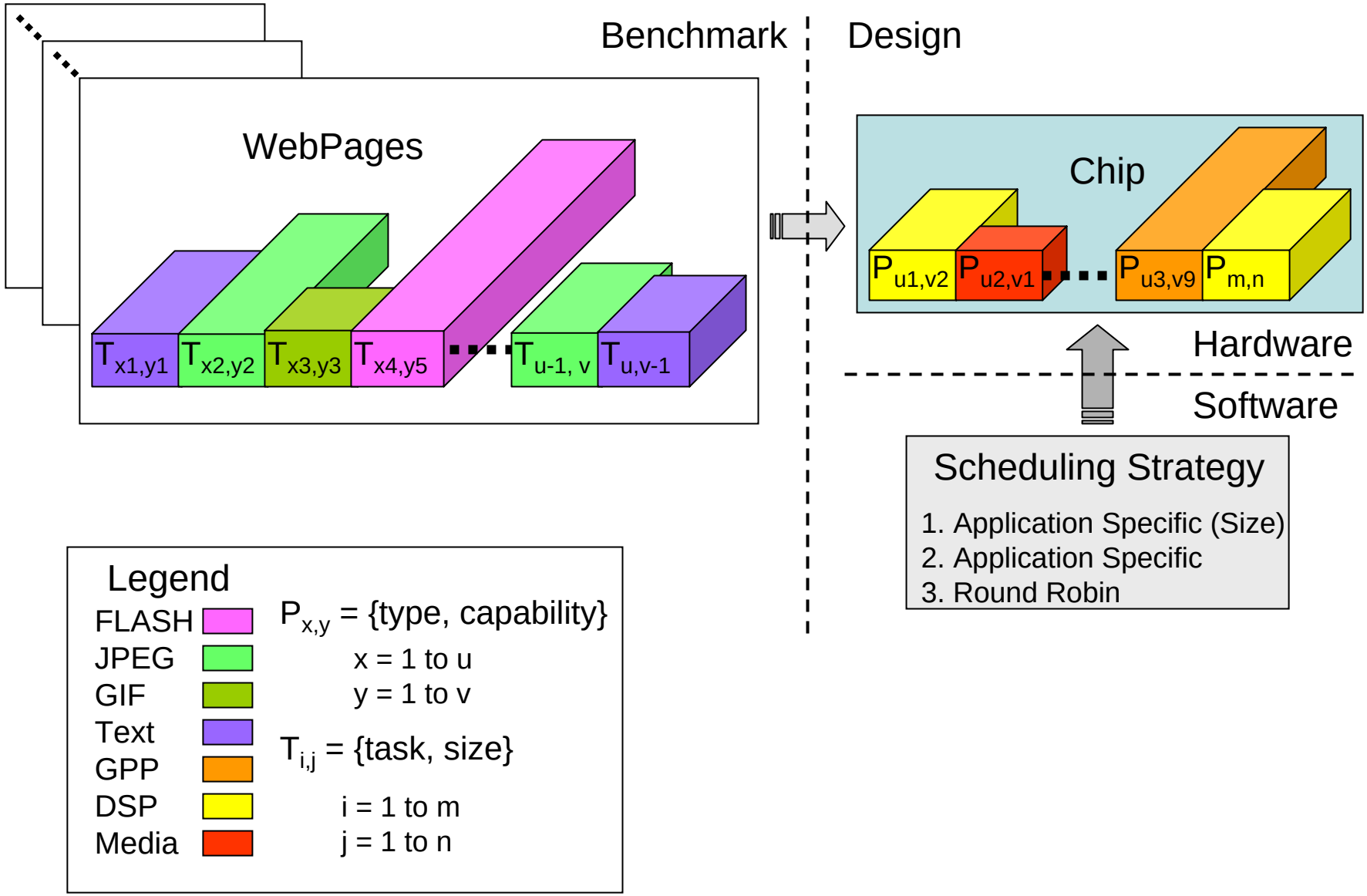


Figure 9. Application Specific Scheduler Webpage Utilization

Conclusion / Future Work

- The structure and content of Webpages can affect the architecture of mobile devices
- User access patterns can additionally affect architecture
- More investigation is clearly warranted
  - Flash
  - Additional user profiles
  - New Design Techniques
- Future Work
  - Incorporate Task Migration
  - Model memory/communication overhead
  - The development of more comprehensive Webpage-based benchmark suite is clearly warranted



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