CS 525M – Mobile and Ubiquitous Computing Seminar

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Overview: PowerScope Paper

- Background
  - Motivation behind the experiment
  - What is PowerScope?
- Experiment Details
- Results
- Conclusions
  - Theirs
  - Mine

Background

Background

- Published in 1999 by Flinn and Satyanarayanan (Carnegie Mellon)
- Battery life is only expected to grow by 10-20% over the next decade
- Computing ability has been growing much faster than that
- Looking for ways to conserve power

Background (cont.)

- Success of traditional profiling tools (ex. `prof` and `gprof`) with processor usage, memory usage
- How about a power profiling tool?

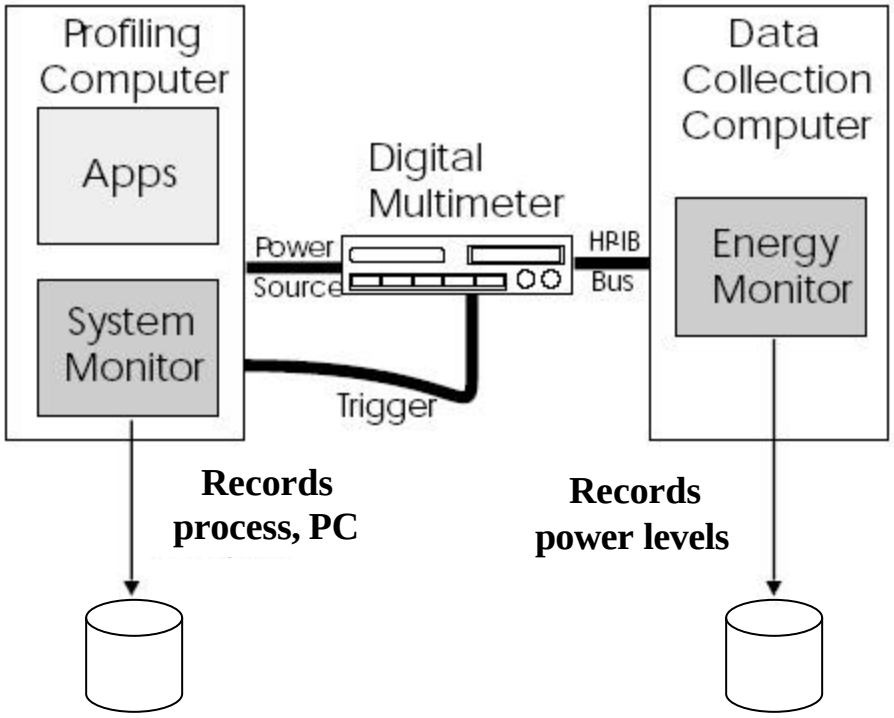
PowerScope

PowerScope

- Idea:
  - Sample power usage of a system at a very rapid rate
    - Multimeter/Data Recorder
  - Record executing process and program counter on profiling machine
  - Correlate data

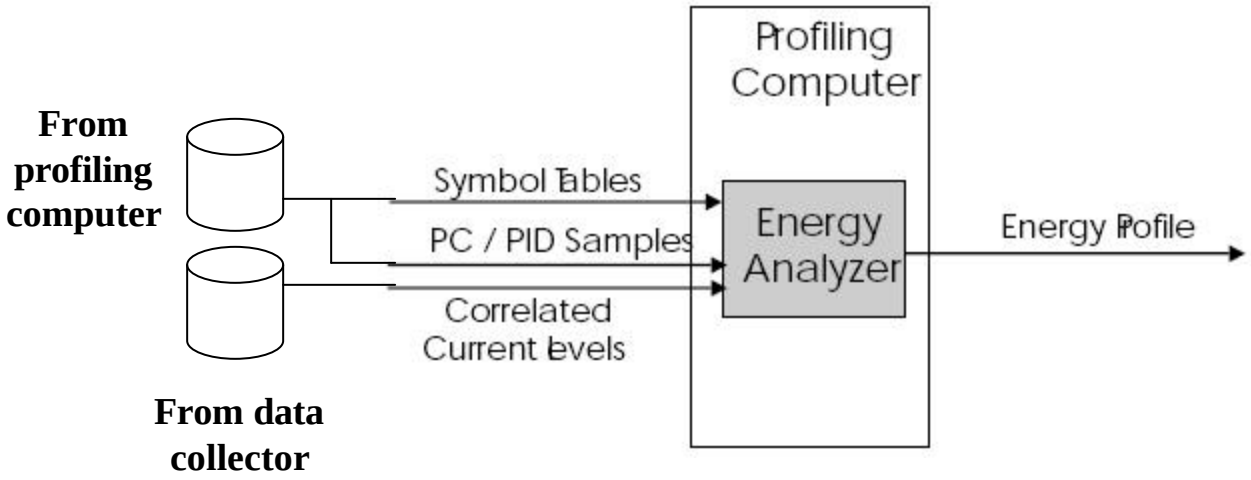
PowerScope (cont.)

- Stage 1: Data Collection & Synchronization



PowerScope (cont.)

- Stage 2: Post-Processing & Analysis
  - Correlating current levels to processes and functions



PowerScope (cont.)

- PowerScope sample output:
  - Energy usage by process

Process	Elapsed Time (s)	Total Energy (J)	Average Power (W)
/usr/odyssey/bin/xanim	66.57	643.17	9.66
/usr/X11R6/bin/X	35.72	331.58	9.28
/netbsd (kernel)	50.89	328.71	6.46
Interrupts-WaveLAN	18.62	165.88	8.91
/usr/odyssey/bin/odyssey	12.19	123.40	10.12
Total	183.99	1592.75	8.66

  - Energy usage by function

Energy Usage Detail for process /usr/odyssey/bin/odyssey

User-level procedures:

Procedure	Elapsed Time (s)	Total Energy (J)	Average Power (W)
_Dispatcher	0.25	2.53	10.11
_IOMGR_CheckDescriptors	0.17	1.74	10.23
_sftp_DataArrived	0.16	1.68	10.48
_rpc2_RecvPacket	0.16	1.67	10.41
_ExaminePacket	0.16	1.66	10.35

Experiment Details

Experiment Details

- Problem to be solved: reducing power consumption of an application
  - Chose xanim, a freely-available video player
- Approach
  - Use Odyssey as a framework for resource management
  - Use PowerScope to show where energy is being used

Experiment Details (cont.)

- Effects studied
  - Video compression levels (initial scope?)
  - Measured the effect of display size
  - Hardware-specific power management
    - Network hardware
    - Disk

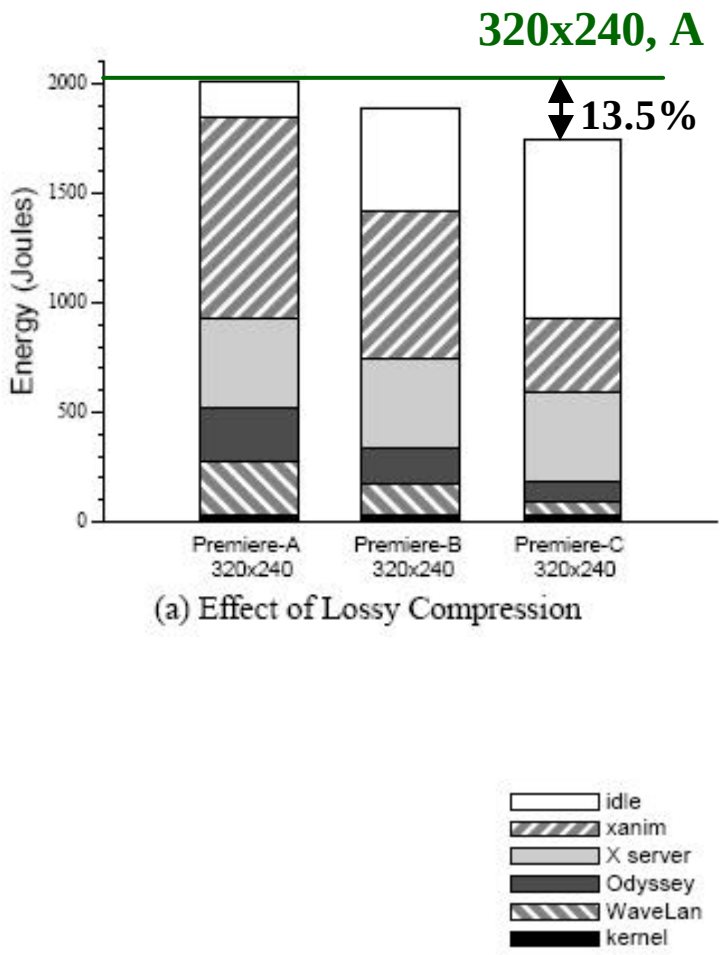
Experiment Details (cont.)

- Hardware
  - Video server was 200 MHz Pentium Pro
  - Client was 75 MHz 486 running NetBSD
  - Client and Server connected via WaveLAN
  - Multimeter was HP 3548a digital multimeter
    - Also was a data collector (Win95 PC)
- Data Collection
  - Voltage was relatively constant
  - Sampled current usage every 1.6 ms. (approximate)
  - Used interrupts for synchronization

Results

Results (cont.)

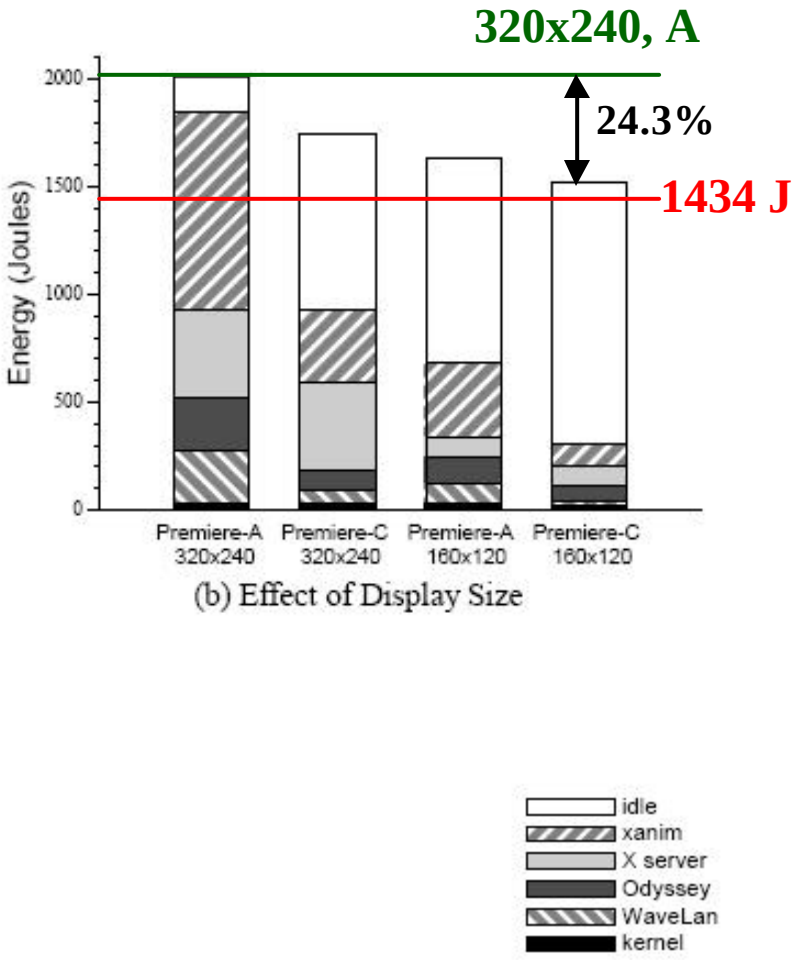
- Video Compression
  - Three compression levels (A, B, and C)
  - Achieved 13.5% power reduction using highest compression
  - Reduced network traffic → lower power
  - X Server is unaffected



(a) Effect of Lossy Compression

Results (cont.)

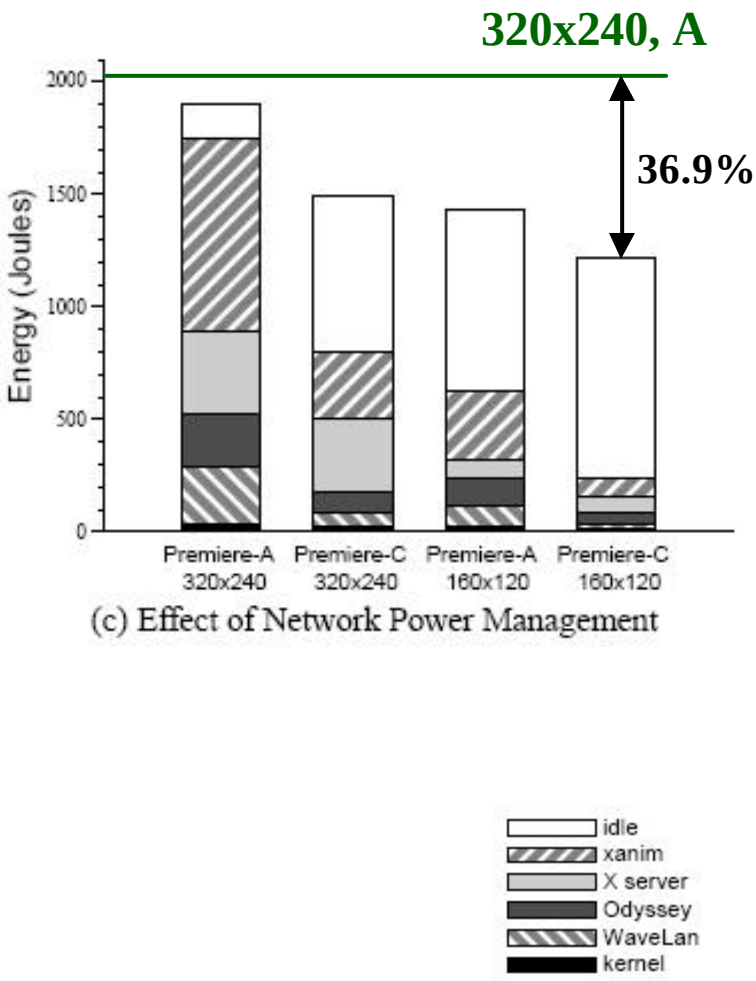
- Display Size
  - Achieved 20-25% energy reduction using display size
  - X Server had a large impact on energy use
  - Measured a baseline configuration



(b) Effect of Display Size

Results (cont.)

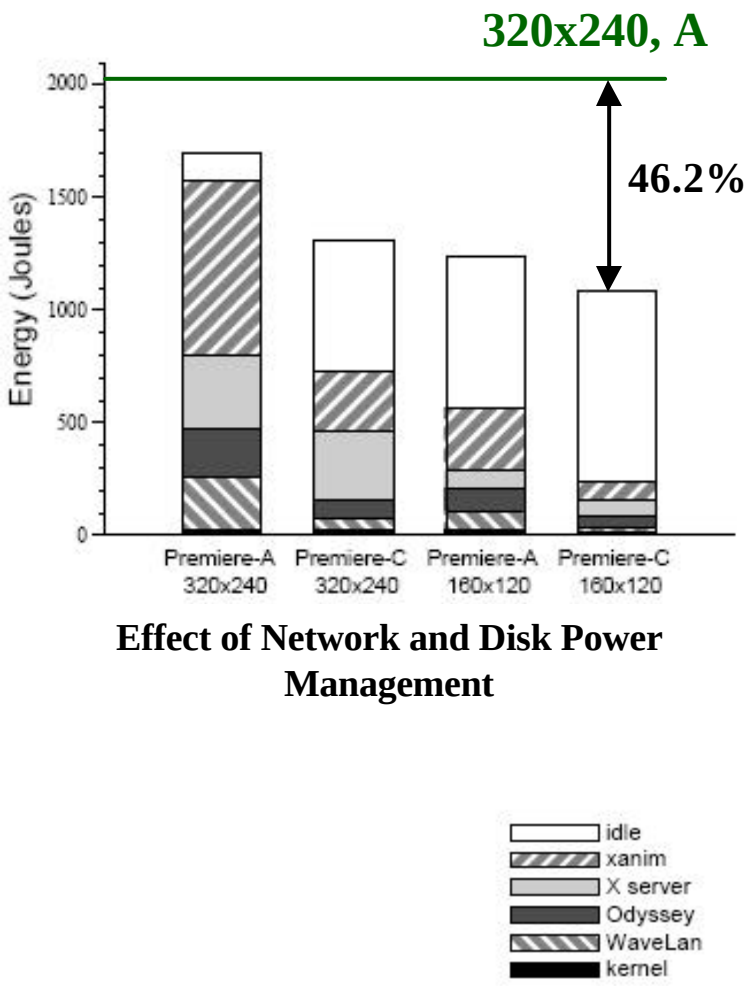
- Network Power Management
  - Modified WaveLAN driver to support a low-power standby mode
  - Modified Odyssey to put device into standby
  - Assumed video player is only app. using network



(c) Effect of Network Power Management

Results (cont.)

- Disk Power Management
  - Video frames are read from memory
  - Modified Odyssey to power down disk when video begins playing.
  - 46.2% energy reduction when using all optimizations



Effect of Network and Disk Power Management

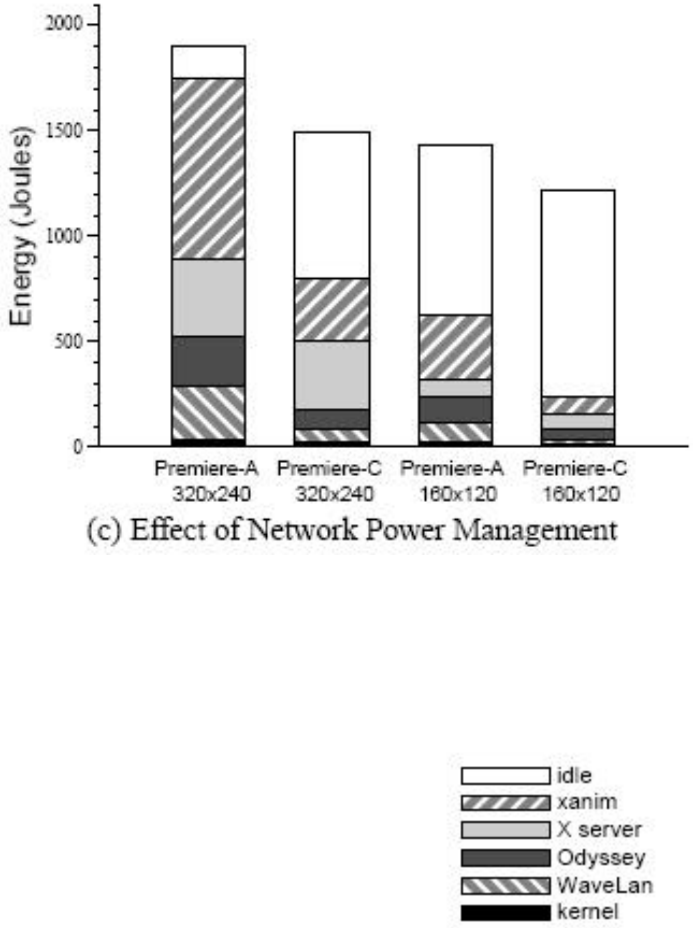
Conclusions

Conclusions

- From the authors:
  - Encouraged by initial results – 46% energy reduction using PowerScope
- Future work
  - Experiments to “carefully calibrate the performance of” PowerScope
  - Enhancements to analyzer (post-processor)
  - Multiple application situations

Conclusions (cont.)

- Reading between the lines... How useful was PowerScope?
  - No function-level power measurements
  - Questionable process-level power measurements
  - Measurement resolution? (1.6 ms)



(c) Effect of Network Power Management

Conclusions

- Accomplishments
  - Measured system-level power usage
  - Were able to improve system-level power usage using system-level improvements (hardware, Odyssey)
  - Showed that attributing that power usage to processes and functions is hard/misleading

Questions/Comments?