



PowerScope

Talk by
Emmanuel Agu

Adapted from talk by Brian Demers

CS Dept.
WPI





Overview: PowerScope Paper

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

Laptop Improvement

- Recall:

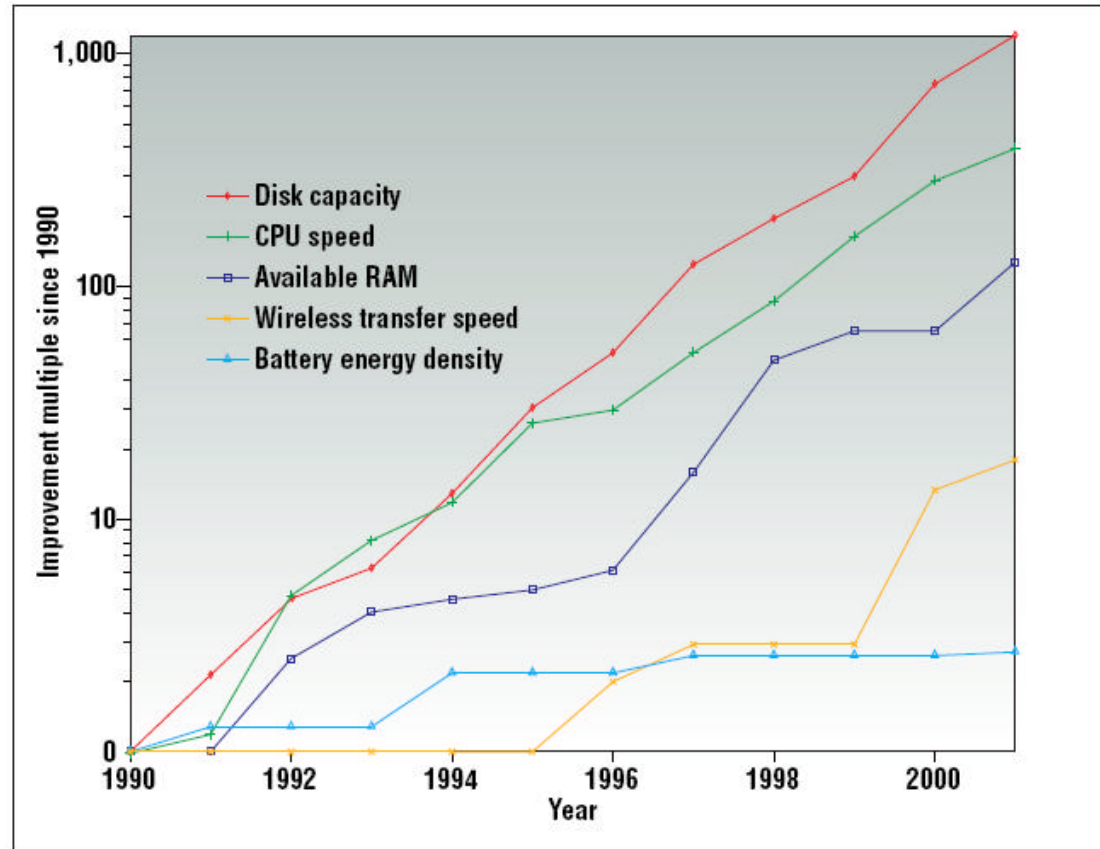


Figure 1. Improvements in laptop technology from 1990–2001.



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?

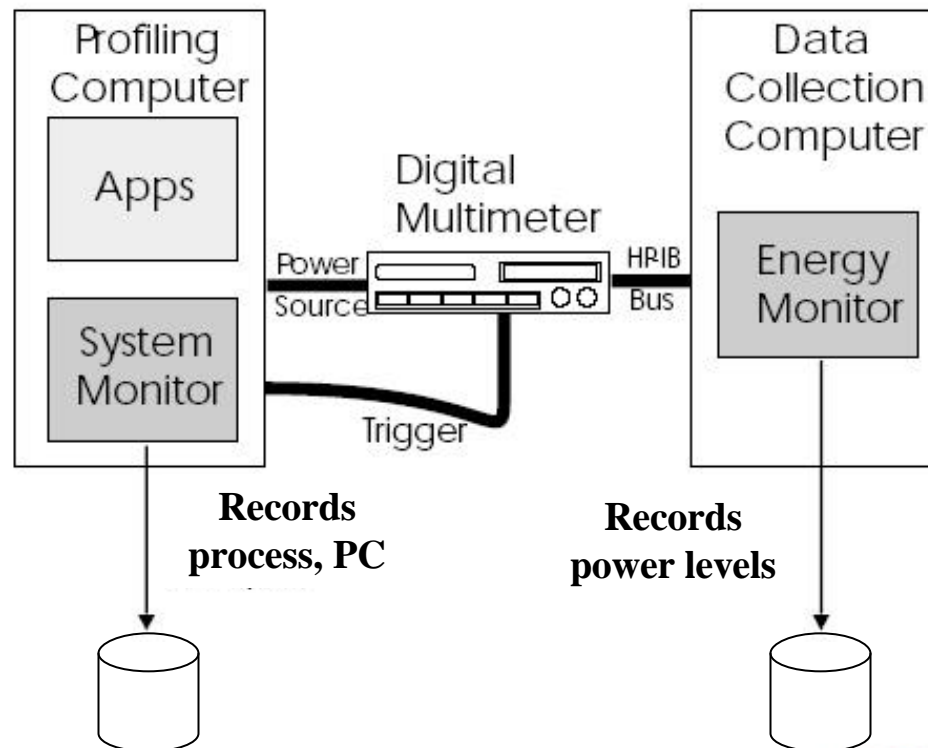


PowerScope

- **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**

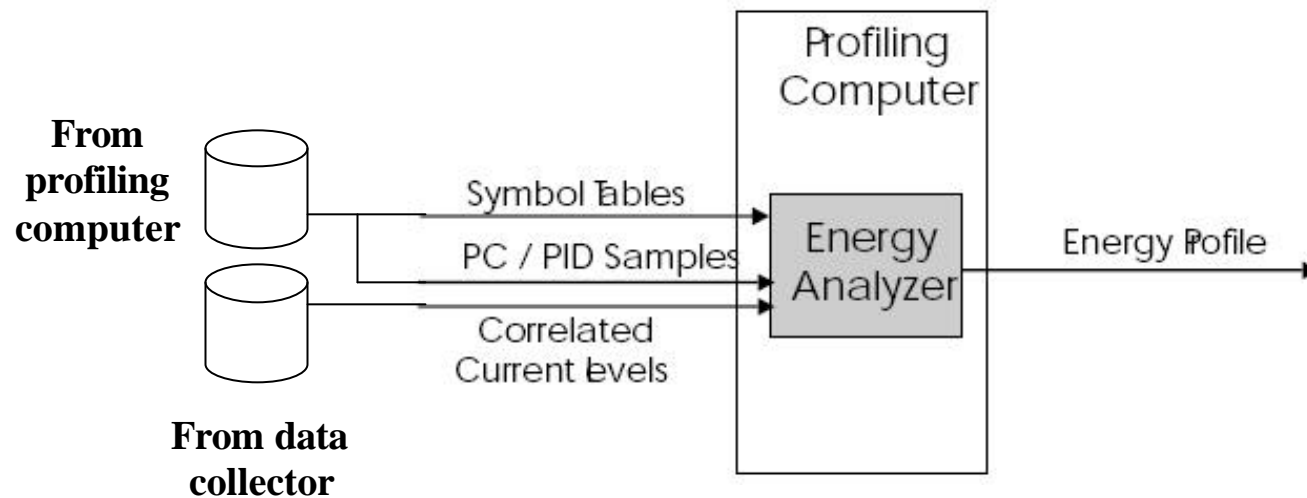
PowerScope (cont.)

- **Stage 1: Data Collection & Synchronization**



PowerScope (cont.)

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



PowerScope (cont.)

- PowerScope sample output:

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 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

- **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**

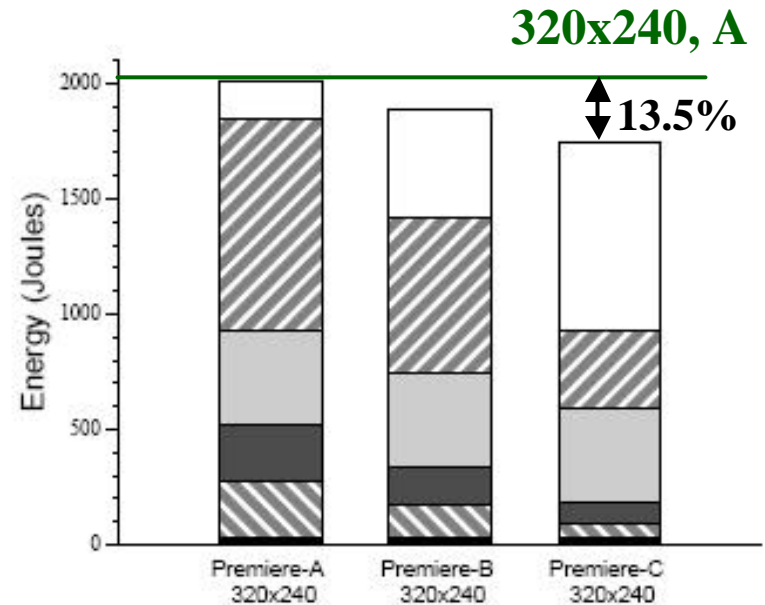
- Video server was 200 MHz Pentium Pro
- Client was 75 MHz 486 running NetBSD
- Client and Server connected via WaveLAN
- Multimeter was HP 3548a digital multimeter
 - Also was a data collector (Win95 PC)

- **Data Collection**

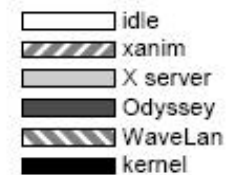
- Voltage was relatively constant
- Sampled current usage every 1.6 ms. (approximate)
- Used interrupts for synchronization

Results

- **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

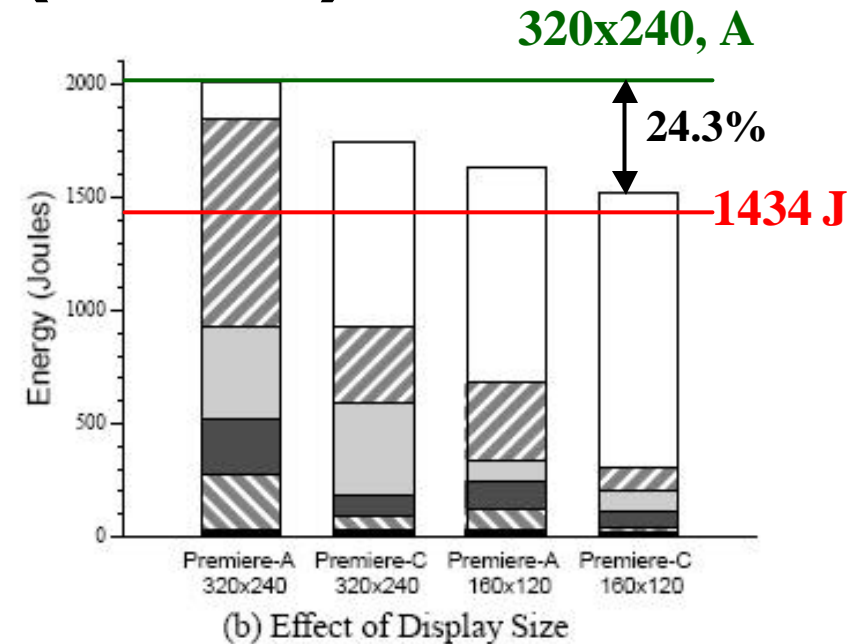


(a) Effect of Lossy Compression



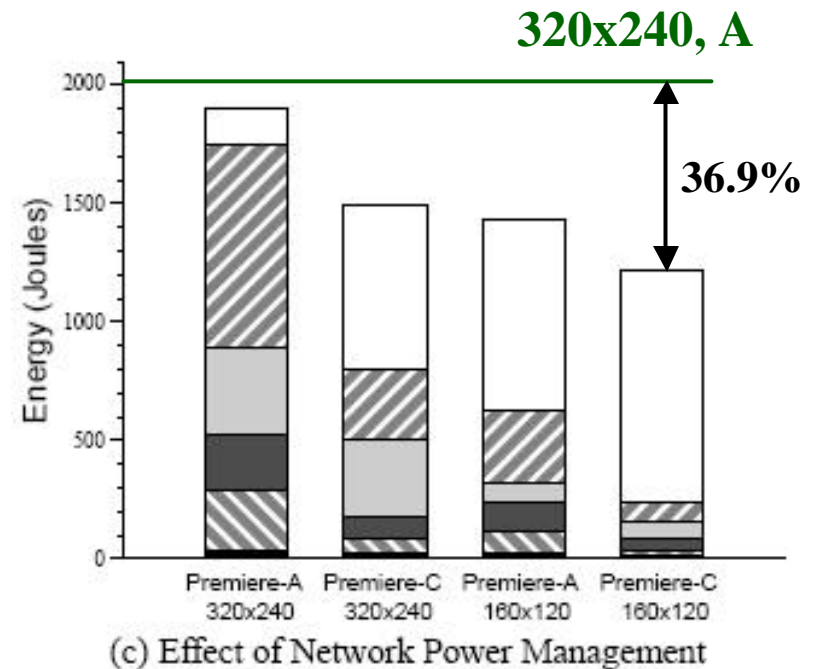
Results (cont.)

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



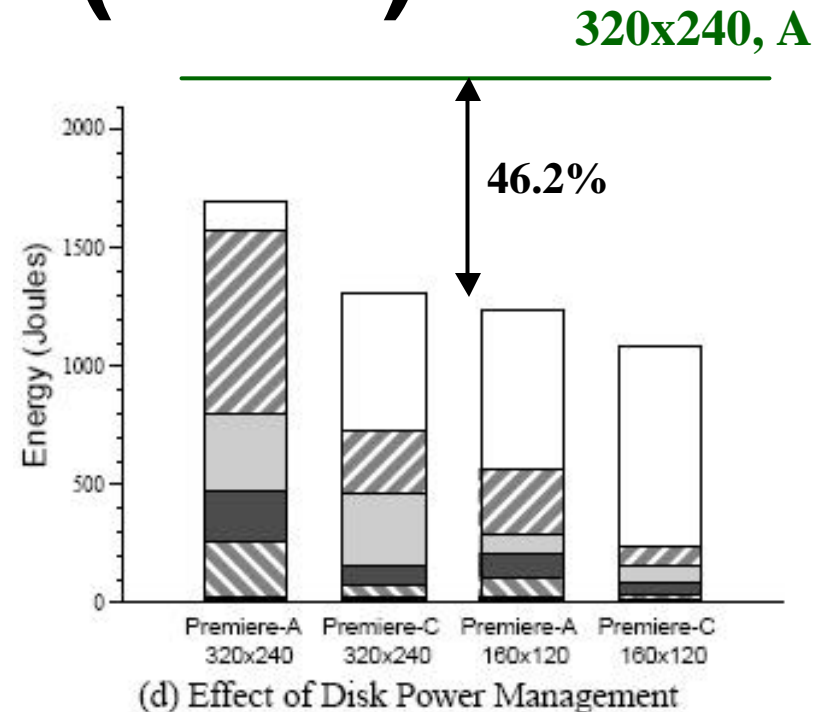
Results (cont.)

- **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

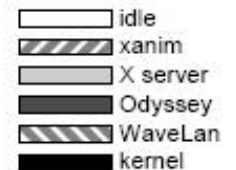


Results (cont.)

- **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

- **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

- **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