How to streamline your life (lessons from computer architecture).

COS 116
4/3/2006
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The Tired Librarian

- 1000 checkouts/returns per day
- Distance covered = $50 \times 2 \times 1000 = 100,000$ feet
  ~ 20 miles
- Please help!!!
80-20 “Rule”

- Pareto [1906]: 20% of the people own 80% of the wealth

- Juran [1930’s]: 20% of the organization does 80% of the work
Better Arrangement

- Distance covered per day?
- Reserves
- "Most popular" shelf:
  20% most popular books
- 50 ft
- 5 ft
Even better arrangement?

- Reserves

- “Most popular” shelf: 20% most popular books

- Top 4%

- Distance covered per day?
Class Discussion

- Is problem solved?
How to predict the 20% most popular books for next day?

- In general, no easy solution

- In practice, use rules of thumb
  - Example: “Least Recently Used”. When you need to create space on the desk (or shelf), move out the book that was used least recently
  - Many others (LRU is computationally expensive)
New and improved

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Processor</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPS 600</td>
<td>Raw Power Unleashed</td>
<td>Intel® Pentium® 4 Processor 640 with HT (3.20GHz, 800 FSB, 2MB L2 cache)</td>
<td>Genuine Windows® XP Media Center Edition 2005</td>
</tr>
<tr>
<td>XPS 200</td>
<td>Small, But Mighty</td>
<td>Intel® Pentium® 4 Processor with Hyper-Threading Technology - 600 Sequence - up to 800 (3.40GHz, 800MHz FSB, 2MB Cache)</td>
<td>Genuine Windows® XP Media Center Edition 2005</td>
</tr>
</tbody>
</table>
Connection to Computer Organization

- Speed vs cost of various memories

<table>
<thead>
<tr>
<th></th>
<th>Cost: $ / GB</th>
<th>Speed: GB/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard drive</td>
<td>&lt; 1</td>
<td>.2</td>
</tr>
<tr>
<td>RAM</td>
<td>200</td>
<td>5</td>
</tr>
<tr>
<td>On-chip memory for CPU (L2 Cache)</td>
<td>80000</td>
<td>15</td>
</tr>
</tbody>
</table>
Often, today’s computers have even more levels of caching
Moral

- **Performance:**
  - Speed is close to that of fastest memory (cache)
  - Overall capacity is that of largest memory (disk)
Question

How does the same program (.exe file) run on different PCs with different memory configurations?

Answer: “Virtual Memory”

- All programs live a fiction: allowed to pretend it has $2^{64}$ bytes of memory
- Illusion is preserved by hardware
Goodbye Lenin
"The German Democratic Republic lives on – in 79 m²!"

(Die DDR lebt weiter – auf 79 qm!)
Virtual Memory

Program’s view:

Underlying truth:
Multitasking

“The Multitasking Generation”
An Evening’s Tasks for a Gen-M’er

- Homework
- Listen to music
- Instant Messaging
- Call Mom (goes to bed by 11 PM!)
- Answer phone
- Read a bit more of Joyce’s *Ulysses*
- Watch the Daily Show

How do you do it all?
Scheduler’s objectives

- Fairness
- Timeliness
- Critical tasks processed promptly
- Low overhead

Class Discussion: How can one achieve these (often conflicting) goals?
Tasks done by my PC last night

- Word processing
- Play CD
- Download news updates
- Download email
- Run clock
- Hidden tasks: handle network traffic, manage disk and RAM traffic, scheduler, etc.

Managed by “Operating System”
(WinXP, Linux, MacOS, etc.)
One main point studied by the judge:

What is an OS?