Large Models and Related Memory Issues

Overview

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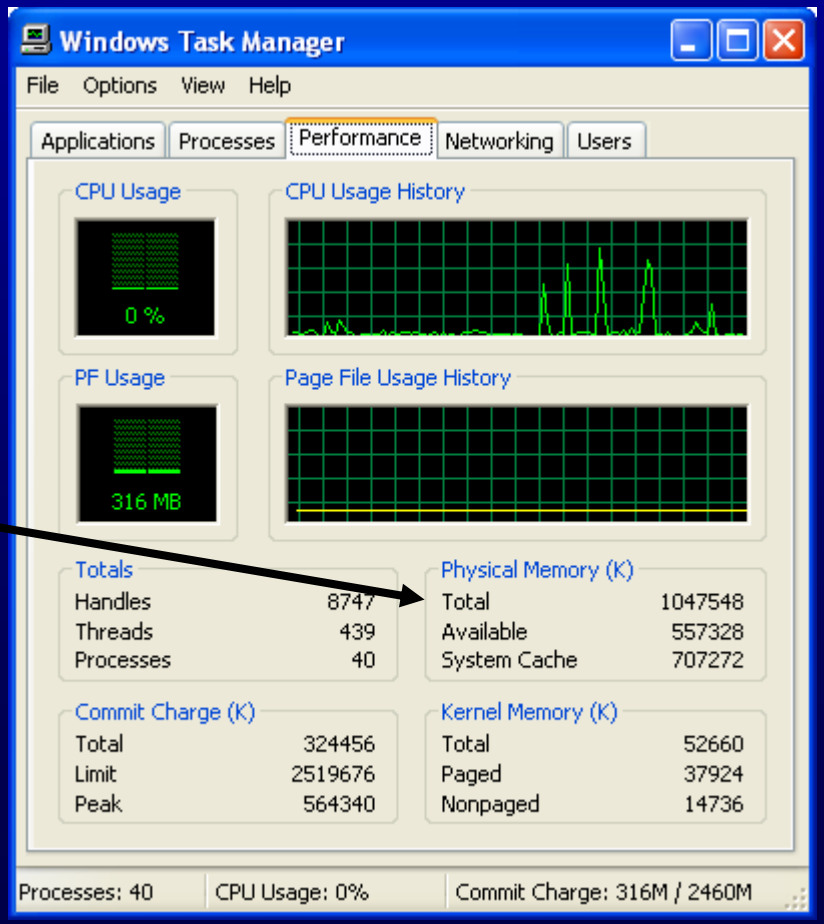
Physical and Virtual Memory

- Physical memory (RAM); typically 512M, 1G, 2G or 4G; “fast”
- Virtual memory (on disk, in a page file); expandable; “slow”

How Much Memory Do I Have?

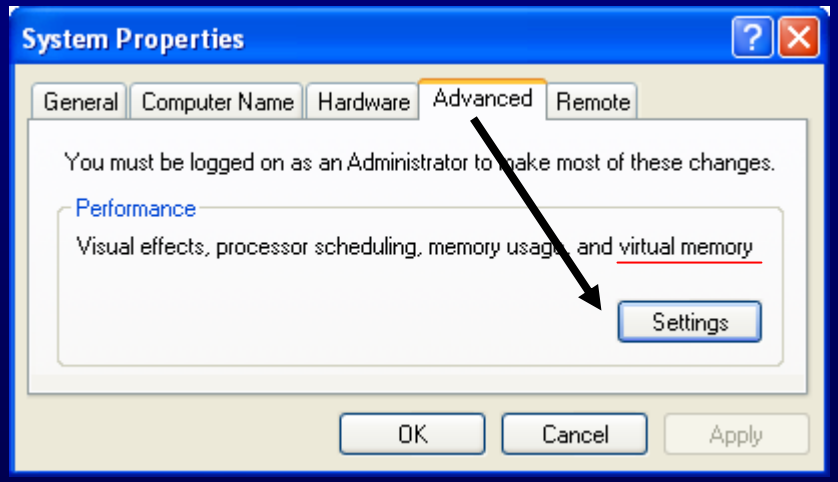
- Windows - Physical
- Task Manager

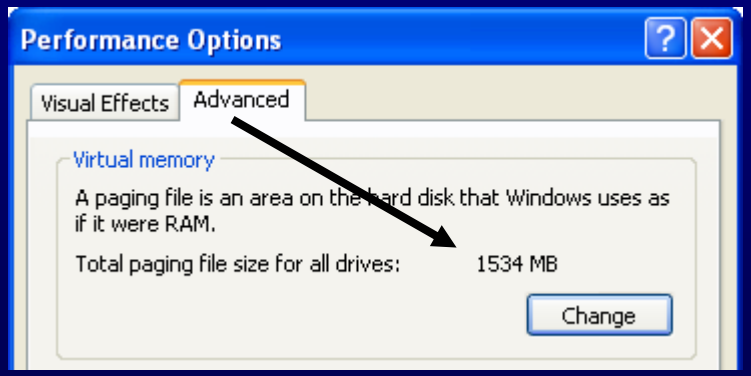
Physical



How Much Memory Do I Have?

- Windows - Virtual
- Settings ➥ Control Panel ➥ System





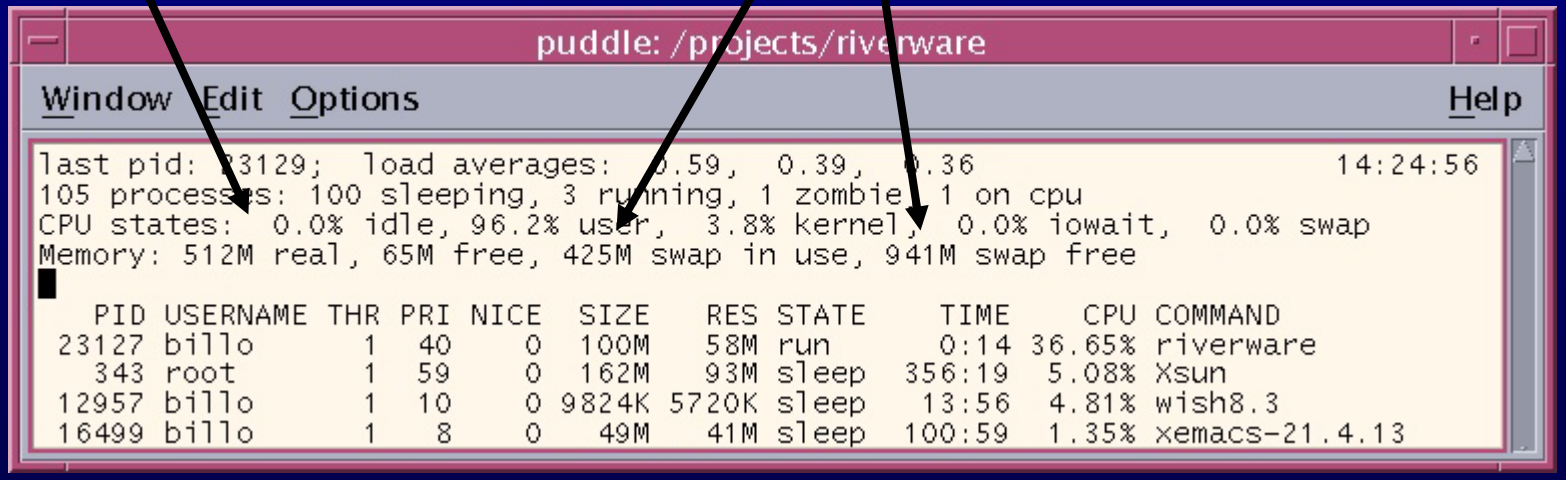
How Much Memory Do I Have?

- Solaris
- ‘top’ command
- www.sunfreeware.com
- Precompiled binaries, no registration

How Much Memory Do I Have?

Physical

Virtual (Sum)



Increasing Virtual Memory

- On Windows and Solaris virtual memory can be increased

Physical Versus Virtual Memory

- Memory allocated in pages
- Large applications have some pages in physical memory, rest in virtual memory (on disk)
- When application references memory address in page in virtual memory, page fault occurs
- Operating system traps page fault, writes pages in physical memory to disk, reads pages from disk to physical memory

Physical Versus Virtual Memory

- Process is known as paging (or swapping)
- Large applications can spend significant time paging, slowing execution down (a condition sometimes called thrashing)

How Much Memory Does RiverWare Need?

- Highly model dependant
- In general, function of space (number of objects) and time (number of timesteps)
- Ideally would have:

  $F(N_{res}, N_{reach}, \ldots, N_{timesteps})$
- Instead recommend 1G or 2G, with the ability to expand

How Much Memory Is RiverWare Using?

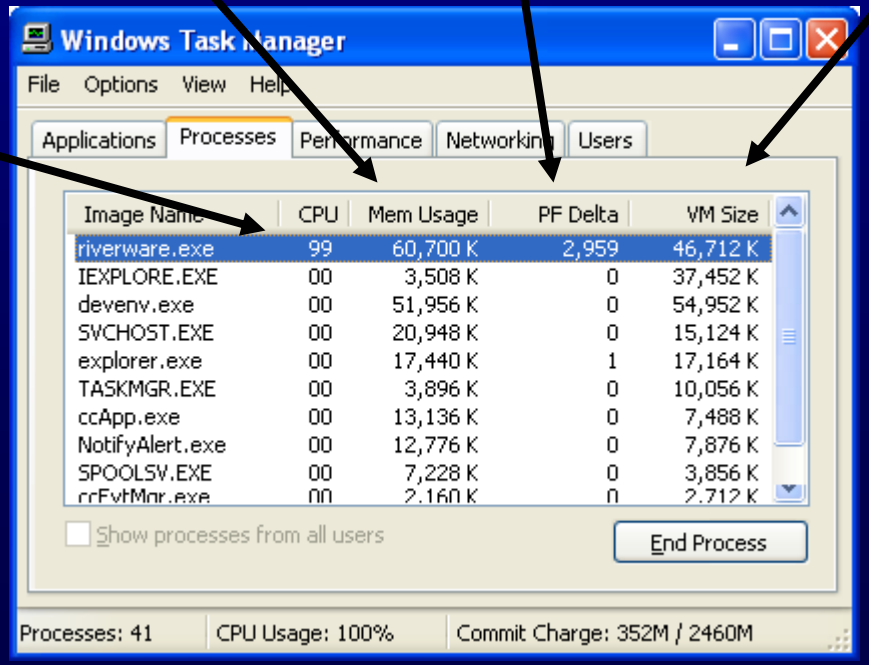
- Windows

Paging

Size in virtual memory

Size in physical memory

CPU Usage



How Much Memory Is RiverWare Using?

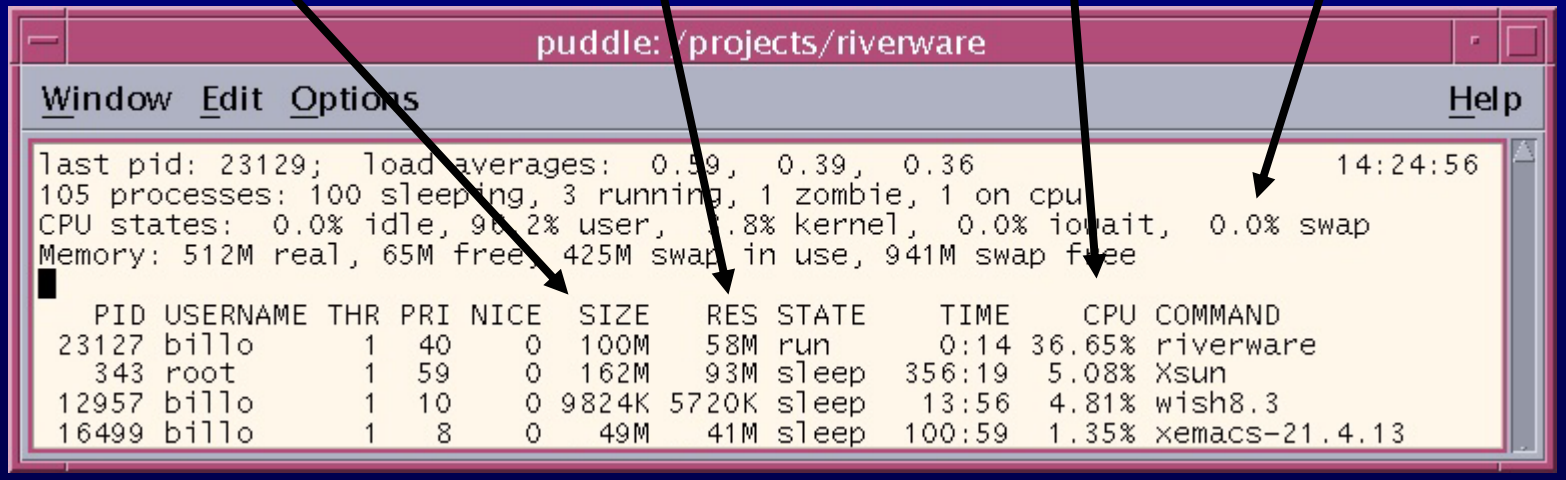
- Solaris

Total Size

Size in physical memory (rest in virtual memory)

CPU Usage

Paging



Memory Limits

- 32-bit architectures provide 4G of addressable memory
- Solaris separates system memory from application memory – RiverWare has 4G available
- Windows doesn’t separate system memory from application memory – RiverWare has (by default) 2G available

Increasing Memory Limits

- Windows – 4 Gig Tuning (4GT)
- Windows – Physical Address Extension (PAE) and Address Windowing Extensions (AWE)
- Windows and Solaris –RiverWare as 64-bit application

Increasing Memory Limits (cont)

- Windows – 4 Gig Tuning
- 3G for RiverWare, 1G for system
- Windows XP Professional, Windows Server 2003, Windows NT 4.0 Enterprise
- May not work with Windows XP SP1 (Microsoft Knowledge Base article 328269)
- boot.ini switches (/3GT and /USERVA)
- As of Release 4.4 RiverWare is “large address aware” for 4 Gig Tuning (no code changes)

Increasing Memory Limits (cont)

- Windows – Physical Address Extension and Address Windowing Extensions
- Allow RiverWare to directly address “huge” amounts of memory while continuing to use 32-bit pointers
- Windows Server 2003 Enterprise Edition, Windows Advanced Server, Windows 2000 Datacenter/Advanced Server
- RiverWare would need custom memory allocation routines (substantial code changes)

Increasing Memory Limits (cont)

- Windows and Solaris – RiverWare as 64-bit application
- Windows Server and Solaris support 64-bit applications
- RiverWare would have to be “64-bit clean” (unknown code changes)
- Third-party libraries would have to be either acquired or replaced

Increasing Memory Limits (cont)

- Third-party libraries (cont)
  - ☞ CPLEX – acquire
  - ☞ FlexLM – acquire
  - ☞ Qt – acquire
  - ☞ RogueWave – replace
  - ☞ Galaxy - ???