



What Happens when 3 GB or more RAM is installed with Windows?

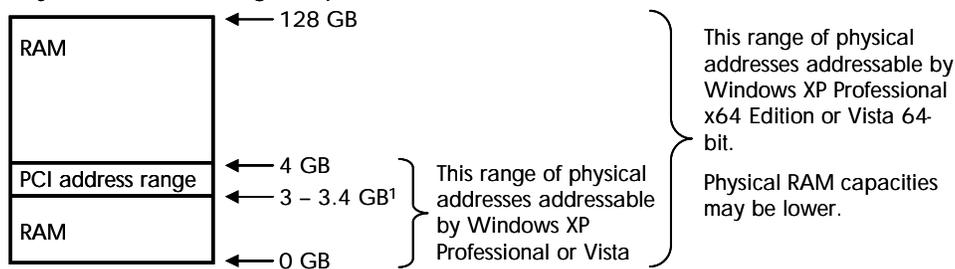
3 GB or more installed RAM can enhance performance and it is now affordable. This paper examines what happens when 3 GB or more RAM is installed in conjunction with Microsoft Windows XP or Windows Vista on x86-based computers, including HP Personal Workstations. It is important to understand that the Windows XP Professional or Windows Vista limit available RAM to noticeably less than 4 GB while Windows XP Professional x64 Edition and Vista 64-bit can eliminate this barrier.

Microsoft Windows XP Professional and Windows Vista are 32-bit operating systems supporting a physical address range of up to 4 GB. However this range is sub-divided to manage both the computer's PCI address range (also known as MMIO) and RAM.

The PCI address range is used to manage much of the computer's components including the BIOS, IO cards, networking, PCI hubs, bus bridges, PCI-Express, and today's high performance video/graphics cards (including their video memory). A high performance x86-based computer typically needs 0.6 to 1 GB for the PCI address range.

On boot up the BIOS allocates PCI addresses down from 4 GB to manage the computer's components, then the BIOS allocates physical user RAM from address 0 up to the bottom of the PCI address range or up to the amount of installed physical RAM, whichever is less. The upper limit on available physical RAM is usually between 3 GB and 3.4 GB.¹

Physical Address Range Map



Installing exactly the amount of RAM that can be made available is often not possible because the available DIMM sizes and the design of high performance memory channels, which need matched sets of DIMMs, limit the choices on a 4 DIMM slot computer to either 3 GB (two 1 GB DIMMs + two 512 MB DIMMs) or 4 GB (four 1 GB DIMMs).

Windows XP Professional x64 Edition and Windows Vista 64-bit enable address ranges above 4 GB on computers with large address infrastructures (where the entire system has more than 4 GB addressing capabilities via the processor, chipset, physical memory capacity, etc). The HP xw4400, xw6400, xw8400, and xw9400 workstations have the required infrastructures.²

The memory remapping feature on the HP workstations (implemented in the HP Workstation BIOS) also recovers the RAM that would normally overlap the PCI address range by remapping it above the top of physical memory. Example: When 8 GB is installed the computer boots as noted above in the 32-bit Windows section, then the HP BIOS remaps the physical RAM in the PCI address range (that would otherwise be unavailable) to addresses above 8 GB so that a 64-bit OS can access it. Thus, roughly 8 GB becomes available.

Conclusion: Windows XP x64 Edition and Windows Vista 64-bit eliminate the 3 GB to 3.4 GB RAM allocation limit on x86-based computers with large address infrastructures like the HP workstations listed above, and the memory remapping feature in the HP Workstation BIOS even recovers the RAM in the PCI address range (MMIO) by remapping it above the top of physical RAM. Therefore, nearly all the physical RAM can be made available.

¹ 3.0 to 3.4 GB is the typical range. The more IO cards and graphics cards with large amounts of video memory, the lower this limit will be.

² These HP workstations (and discontinued HP models: xw4300, xw6200, xw8200, and xw9300) can run 64-bit applications designed for Windows Professional x64 Edition or Windows Vista 64-bit when the workstations are configured with Intel EM64T-enabled or AMD64 Opteron processors and the appropriate HP supported Windows XP Professional x64 Edition or Windows Vista 64-bit operating system.

In contrast, many PCs with 64-bit processors still use 32-bit chipsets so the physical memory addressing remains limited to 4 GB. Even if a 64-bit Windows OS were installed, these 32-bit infrastructure computers would still be typically limited to 3 to 3.4 GB of RAM.