

CPU modes

From Wikipedia, the free encyclopedia

CPU modes (also called *processor modes*, *CPU states*, *CPU privilege levels* and other names) are operating modes for the central processing unit of some computer architectures that place restrictions on the type and scope of operations that can be performed by certain processes being run by the CPU. This design allows the operating system to run with more privileges than application software.

Ideally, only highly trusted kernel code is allowed to execute in the unrestricted mode; everything else (including non-supervisory portions of the operating system) runs in a restricted mode and must use a system call to request the kernel perform on its behalf any operation that could damage or compromise the system, making it impossible for untrusted programs to alter or damage other programs (or the computing system itself).

In practice, however, system calls take time and can hurt the performance of a computing system, so it is not uncommon for system designers to allow some time-critical software (especially device drivers) to run with full kernel privileges.

Multiple modes can be implemented—allowing a *hypervisor* to run multiple operating system supervisors beneath it, which is the basic design of many virtual machine systems available today.

Mode types

The unrestricted mode is often called *kernel mode*, but many other designations exist (*master mode*, *supervisor mode*, *privileged mode*, etc.). Restricted modes are usually referred to as *user modes*, but are also known by many other names (*slave mode*, *problem state*, etc.).

In kernel mode, the CPU may perform any operation allowed by its architecture; any instruction may be executed, any I/O operation initiated, any area of memory accessed, and so on. In the other CPU modes, certain restrictions on CPU operations are enforced by the hardware. Typically, certain instructions are not permitted (especially those—including I/O operations—that could alter the global state of the machine), some memory areas cannot be accessed, etc. User-mode capabilities of the CPU are typically a subset of those available in kernel mode, but in some cases, such as hardware emulation of non-native architectures, they may be significantly different from those available in standard kernel mode.

Some CPU architectures support multiple user modes, often with a hierarchy of privileges. These architectures are often said to have *ring-based security*, wherein the hierarchy of privileges resembles a set of concentric rings, with the kernel mode in the center. Multics hardware was the first significant

implementation of ring security, but many other hardware platforms have been designed along similar lines, including the Intel 80286 protected mode, and the IA-64 as well, though it is referred to by a different name in these cases.

Mode protection may extend to resources beyond the CPU hardware itself. Hardware registers track the current operating mode of the CPU, but additional virtual-memory registers, page-table entries, and other data may track mode identifiers for other resources. For example, a CPU may be operating in Ring 0 as indicated by a status word in the CPU itself, but every access to memory may additionally be validated against a separate ring number for the virtual-memory segment targeted by the access, and/or against a ring number for the physical page (if any) being targeted. This has been demonstrated with the PSP handheld system.

Hardware that supports the Popek and Goldberg virtualization requirements makes writing software to efficiently support a virtual machine much simpler. Such a system can run software that "believes" it is running in supervisor mode, but is actually running in user mode.

References

Retrieved from "https://en.wikipedia.org/w/index.php?title=CPU_modes&oldid=770008868"

Categories: Central processing unit | Computer security

- This page was last edited on 12 March 2017, at 22:17.
- Text is available under the Creative Commons Attribution-ShareAlike License; additional terms may apply. By using this site, you agree to the Terms of Use and Privacy Policy. Wikipedia® is a registered trademark of the Wikimedia Foundation, Inc., a non-profit organization.