Programming With Threads

Thread (computing)

Vyssotsky with the term "thread". The Mach implementation of threads was described in the summer of 1986. OS/2 1.0, released in 1987, supported threads. Digital

In computer science, a thread of execution is the smallest sequence of programmed instructions that can be managed independently by a scheduler, which is typically a part of the operating system. In many cases, a thread is a component of a process.

The multiple threads of a given process may be executed concurrently (via multithreading capabilities), sharing resources such as memory, while different processes do not share these

resources. In particular, the threads of a process share its executable code and the values of its dynamically allocated variables and non-thread-local global variables at any given time.

The implementation of threads and processes differs between operating systems.

== History ==

Thread safety

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In multi-threaded computer programming, a function is thread-safe when it can be invoked or accessed concurrently by multiple threads without causing unexpected behavior, race conditions, or data corruption. As in the multi-threaded context where a program

executes several threads simultaneously in a shared address space and each of those threads has access to every other thread's memory, thread-safe functions need to ensure that all those threads behave properly and fulfill their design specifications without unintended interaction.

There are various strategies for making thread-safe data structures.

== Levels of thread safety ==

Different vendors use slightly different terminology for thread-safety, but the most commonly used thread-safety terminology are:

Thread pool

when we use fewer threads than available. The number of available threads is tuned to the computing resources available to the program, such as a parallel

In computer programming, a thread pool is a software design pattern for achieving concurrency of execution in a computer program. Often also called a replicated workers or worker-crew model, a thread pool maintains multiple threads waiting for tasks to be allocated for concurrent execution by the supervising program. By maintaining a pool of threads, the model increases performance and avoids latency in execution due to frequent creation and destruction of threads for short-lived tasks. Another good property - the ability to limit system load, when we use fewer threads than available. The number of available threads is tuned to the computing resources available to the program, such as a parallel task queue after completion of execution.

== Performance ==

The size of a thread pool is the number of threads kept in reserve for executing tasks. It is usually a tuneable parameter of the application, adjusted to optimize program performance. Deciding

the optimal thread pool size is crucial to optimize performance.

One benefit of a thread pool over creating a new thread for each task is that thread creation and destruction overhead is restricted to the initial creation of the pool, which...

Green thread

operating system threads. The main benefit of coroutines and green threads is ease of implementation. On a multi-core processor, native thread implementations

In computer programming, a green thread is a thread that is scheduled by a runtime library or virtual machine (VM) instead of natively by the underlying operating system (OS). Green threads emulate multithreaded environments without relying on any native OS abilities, and they are managed in user space instead of kernel space, enabling them to work in environments that do not have native thread support.

== Etymology ==

Green threads refers to the name of the original thread library for Java programming language (that was released in version 1.1 and then Green threads were abandoned in version 1.3 to native threads). It was designed by The Green Team at Sun Microsystems.

Pthreads

C programming language types, functions and constants. It is implemented with a pthread.h header and a thread library. There are around 100 threads procedures

In computing, POSIX Threads, commonly known as pthreads (after its header <pthread.h>), is an execution model that exists independently from a programming language, as well as a parallel execution model. It allows a program to control multiple different flows of work that overlap in time. Each flow of work is referred to as a thread, and creation and control over these flows is achieved by

making calls to the POSIX Threads API. POSIX Threads is an API defined by the Institute of Electrical and Electronics Engineers (IEEE) standard POSIX.1c, Threads extensions (IEEE Std 1003.1c-1995).

Implementations of the API are available on many Unix-like POSIX-conformant operating systems such as FreeBSD, NetBSD, OpenBSD, Linux, macOS, Android, Solaris, Redox, QNX, and AUTOSAR Adaptive, typically bundled as a library libpthread. DR-DOS and Microsoft Windows implementations also exist: within the SFU/SUA subsystem which provides a native implementation of a number of POSIX APIs, and also within third-party packages such as pthreads-w32, which implements pthreads on top of existing Windows API.

== Contents ==

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Thread-local storage

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In computer programming, thread-local storage (TLS) is a memory management method that uses static or global memory local to a thread. The concept allows storage of data that appears to be global in a system with separate threads.

Many systems impose restrictions on the size of the thread-local memory block, in fact often rather tight limits. On the other hand, if a system can provide at least a memory address (pointer) sized variable thread-local, then this allows the use of arbitrarily sized memory blocks in a thread-local manner, by allocating such a memory block dynamically and storing the memory address of that

block in the thread-local variable. On RISC machines, the calling convention often reserves a thread pointer register for this use.

== Usage ==

While the use of global variables is generally discouraged in modern programming, some older operating systems such as UNIX were originally designed for uniprocessor hardware and often use global variables to store important values. An example is the errno used by many functions of the C library. On a modern machine, where multiple threads may be modifying the errno variable, a call of a system function on one thread may overwrite...

Thread block (CUDA programming)

A thread block is a programming abstraction that represents a group of threads that can be executed serially or in parallel. For better process and data

A thread block is a programming abstraction that represents a group of threads that can be executed serially or in parallel. For better process and data mapping, threads are grouped into thread blocks. The number of threads in a thread block was formerly limited by the architecture to a total of 512 threads per block, but as of March 2010, with compute capability 2.x and higher, blocks may contain up to 1024 threads. The threads in the same thread block run on the same stream multiprocessor. Threads in the same block can communicate with each other via shared memory, barrier synchronization or other synchronization primitives such as atomic operations.

Multiple blocks are combined to form a grid. All the blocks in the same grid contain the same number of threads. The number of threads in a block is limited, but grids can be used for computations that require a large number of thread blocks to operate in parallel and to use all available multiprocessors.

CUDA is a parallel computing platform and programming model that higher level languages can use to exploit parallelism. In CUDA, the kernel is executed with the aid of threads. The thread is an abstract entity that represents the execution...

Threading (manufacturing)

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In manufacturing, threading is the process of creating a screw thread. More screw threads are produced each year than any other machine element. There are many methods of generating threads, including subtractive methods (many kinds of thread cutting and grinding, as detailed below); deformative or transformative methods (rolling and forming; molding and casting); additive methods (such as 3D printing); or combinations thereof.

== Overview of methods (comparison, selection, etc.) ==

There are various methods for generating screw threads. The method for any one application is chosen based on constraints—time, money, degree of precision needed (or not needed), what equipment is already available, what equipment purchases could be justified based on resulting unit price of the threaded part (which depends on how many parts are planned), etc.

In general, certain thread-generating processes tend to fall along certain portions of the spectrum from toolroom-made parts to mass-produced parts, although there can be considerable overlap. For example, thread lapping following thread grinding would fall only on the extreme toolroom end of the spectrum, while thread rolling is a large and diverse...

Virtual thread

knowledge of multi-threaded programming to avoid torn writes,

data races, and invisible writes by other threads. Virtual threads can hop over the execution

In computer programming, a virtual thread is a thread that is managed by a runtime library or virtual machine (VM) and made to resemble a kernel thread to code executing on it, while requiring substantially fewer resources than the latter.

Virtual threads allows for tens of millions of preemptive tasks and events on a 2021 consumer-grade computer, compared to low thousands of operating system threads. Preemptive execution is important to performance gains through parallelism and fast preemptive response times for tens of millions of events.

Earlier constructs that are not or not always preemptive, such as coroutines, green threads or the largely single-threaded Node.js, introduce delays in responding to asynchronous events such as every incoming request in a server application.

== Definition ==

Single instruction, multiple threads

Single instruction, multiple threads (SIMT) is an execution model used in parallel computing where a single central "control unit" broadcasts an instruction

Single instruction, multiple threads (SIMT) is an execution model used in parallel computing where a single central "control unit" broadcasts an instruction to multiple "processing units" for them to all optionally perform simultaneous synchronous and fully-independent parallel execution of that one instruction. Each PU has its own independent data and address registers, its own independent memory, but no PU in the array has a program counter. In Flynn's 1972 taxonomy this arrangement is a variation of SIMD termed an array processor.

The SIMT execution model has been implemented on several GPUs

and is relevant for general-purpose computing on graphics processing units (GPGPU), e.g. some supercomputers combine CPUs with GPUs: in the ILLIAC IV that CPU was a Burroughs B6500.

The SIMT execution model is still only a way to present to the programmer what is fundamentally still a predicated SIMD concept. Programs must be designed with predicated SIMD in mind. With instruction issue (as a synchronous broadcast) being handled by the single control unit, SIMT cannot by design allow threads (PEs, lanes) to diverge by branching, because only the control unit has a program counter. If possible…

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