Chapter 4: Thread and Concurrency

Summary

• A thread represents a basic unit of CPU utilization, and threads belonging

to the same process share many of the process resources, including code

and data.

• There are four primary benefits to multithreaded applications: (1) responsiveness, (2) resource sharing, (3) economy, and (4) scalability.

• Concurrency exists when multiple threads are making progress, whereas

parallelism exists when multiple threads are making progress simultaPractice Exercises 197

neously. On a system with a single CPU, only concurrency is possible;

parallelism requires a multicore system that provides multiple CPUs.

• There are several challenges in designing multithreaded applications.

They include dividing and balancing the work, dividing the data between

the different threads, and identifying any data dependencies. Finally, multithreaded programs are especially challenging to test and debug.

• Data parallelism distributes subsets of the same data across different computing cores and performs the same operation on each core. Task parallelism distributes not data but tasks across multiple cores. Each task is

running a unique operation.

• User applications create user-level threads, which must ultimately be

mapped to kernel threads to execute on a CPU. The many-to-one model

maps many user-level threads to one kernel thread. Other approaches

include the one-to-one and many-to-many models.

• A thread library provides an API for creating and managing threads. Three

common thread libraries include Windows, Pthreads, and Java threading.

Windows is for the Windows system only, while Pthreads is available for

POSIX-compatible systems such as UNIX, Linux, and macOS. Java threads

will run on any system that supports a Java virtual machine.

• Implicit threading involves identifying tasks—not threads—and allowing

languages or API frameworks to create and manage threads. There are

several approaches to implicit threading, including thread pools, fork-join

frameworks, and Grand Central Dispatch. Implicit threading is becoming

an increasingly common technique for programmers to use in developing

concurrent and parallel applications.

• Threads may be terminated using either asynchronous or deferred cancellation. Asynchronous cancellation stops a thread immediately, even if it

is in the middle of performing an update. Deferred cancellation informs

a thread that it should terminate but allows the thread to terminate in an

orderly fashion. In most circumstances, deferred cancellation is preferred

to asynchronous termination.

• Unlike many other operating systems, Linux does not distinguish between

processes and threads; instead, it refers to each as a task. The Linux

clone() system call can be used to create tasks that behave either more

like processes or more like threads

Chapter 3: Sending and receiving data

We have seen how primitive types can be represented as sequences of bytes for transmission

“on the wire.” We have also considered some of the subtleties of encoding text strings, and

some basic methods of framing and parsing messages. We saw examples of both text-oriented

and binary-encoded protocols.

It is probably worth reiterating something we said in the Preface: this chapter will by no

means make you an expert! That takes a great deal of experience. But the code from this chapter

can be used as a starting point for further explorations.

Chapter 4: Beyond the basics

We have discussed some of the ways Java provides access to advanced features of the sockets

API, and how built-in features such as threads and executors can be used with socket programs.

In addition to these facilities, Java provides several mechanisms (not discussed here) that

operate on top of TCP or UDP and attempt to hide the complexity of protocol development. For

example, Java Remote Method Invocation (RMI) allows Java objects on different hosts to invoke

one another’s methods as if the objects all reside locally. The URL class and associated classes

provide a framework for developing Web-related programs. Many other standard Java library