

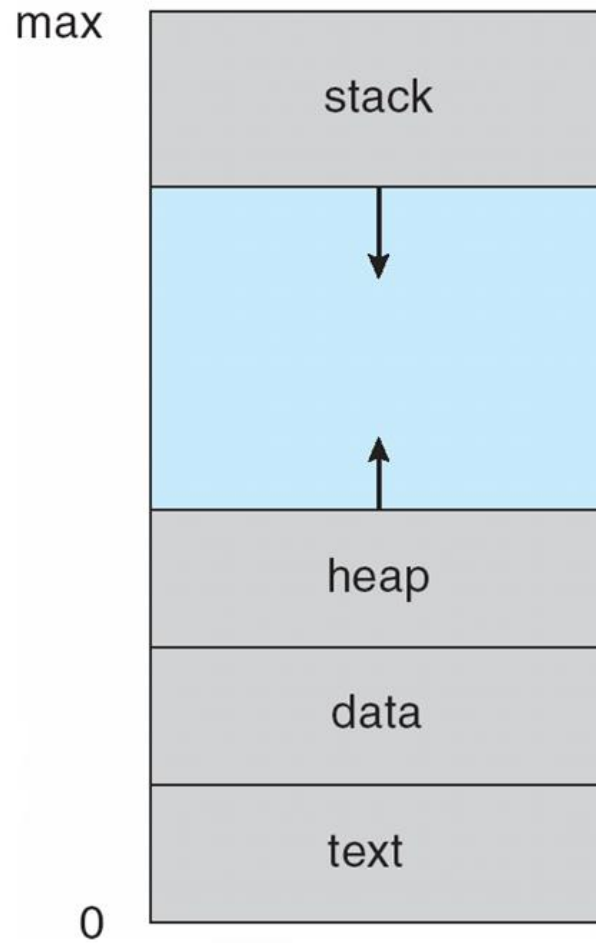
Chapter 3: Processes

Ch3

Process Concept

- **Process** – a program in execution; process execution must progress in sequential fashion
- Multiple parts
 - The program code, also called **text section**
 - Current activity including **program counter**, processor registers
 - **Stack** containing temporary data
 - ▶ Function parameters, return addresses, local variables
 - **Data section** containing global variables
 - **Heap** containing memory dynamically allocated during run time
- Program is **passive** entity stored on disk (**executable file**), process is **active**
 - Program becomes process when executable file loaded into memory

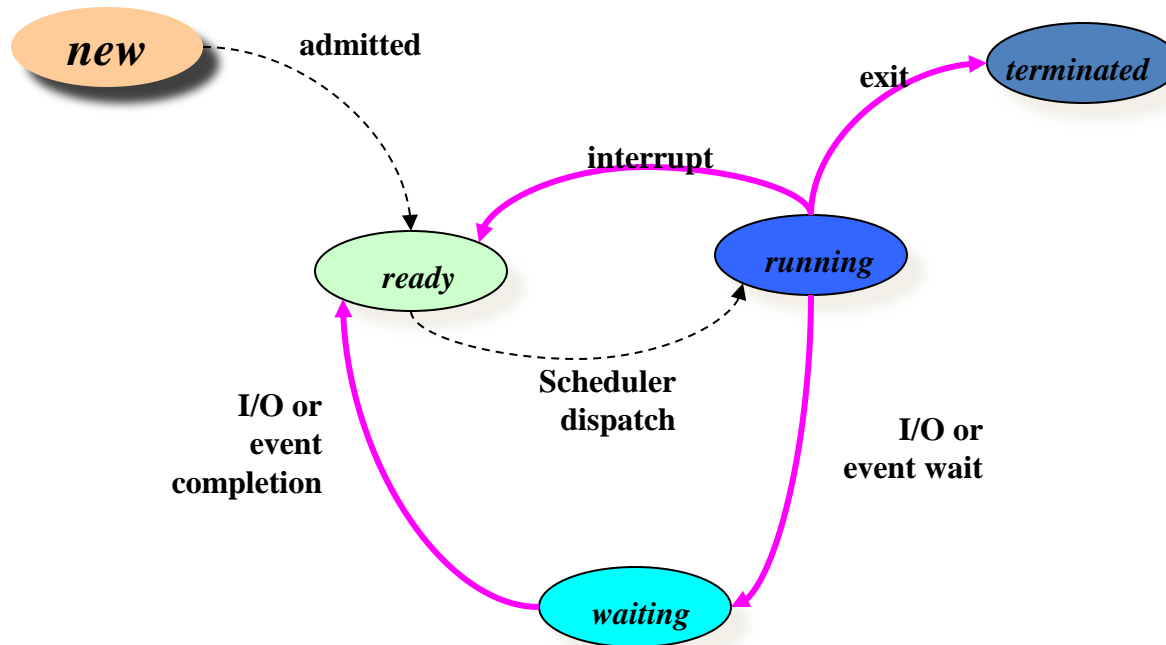
Process in Memory



Process State

- As a process executes, it changes **state**
 - **new**: The process is being created
 - **running**: Instructions are being executed
 - **waiting**: The process is waiting for some event to occur
 - **ready**: The process is waiting to be assigned to a processor
 - **terminated**: The process has finished execution

CPU scheduling decisions

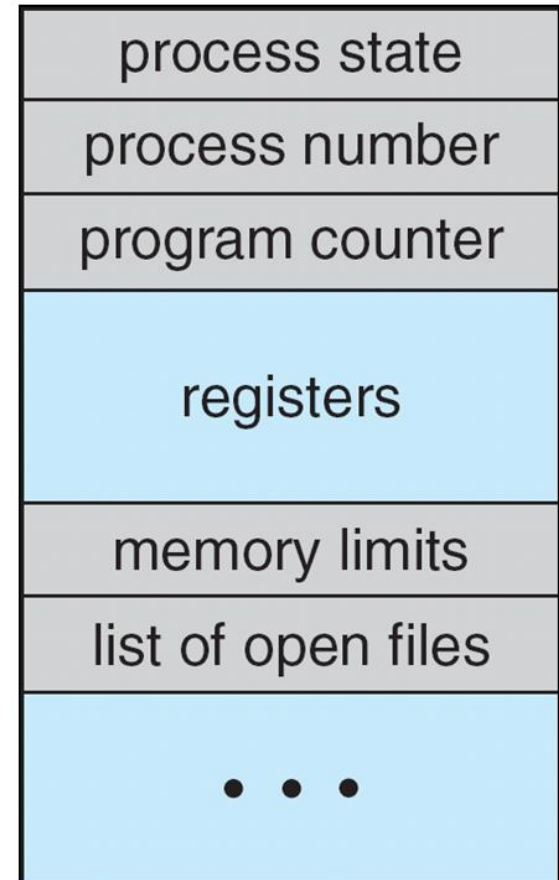


Process Control Block (PCB)

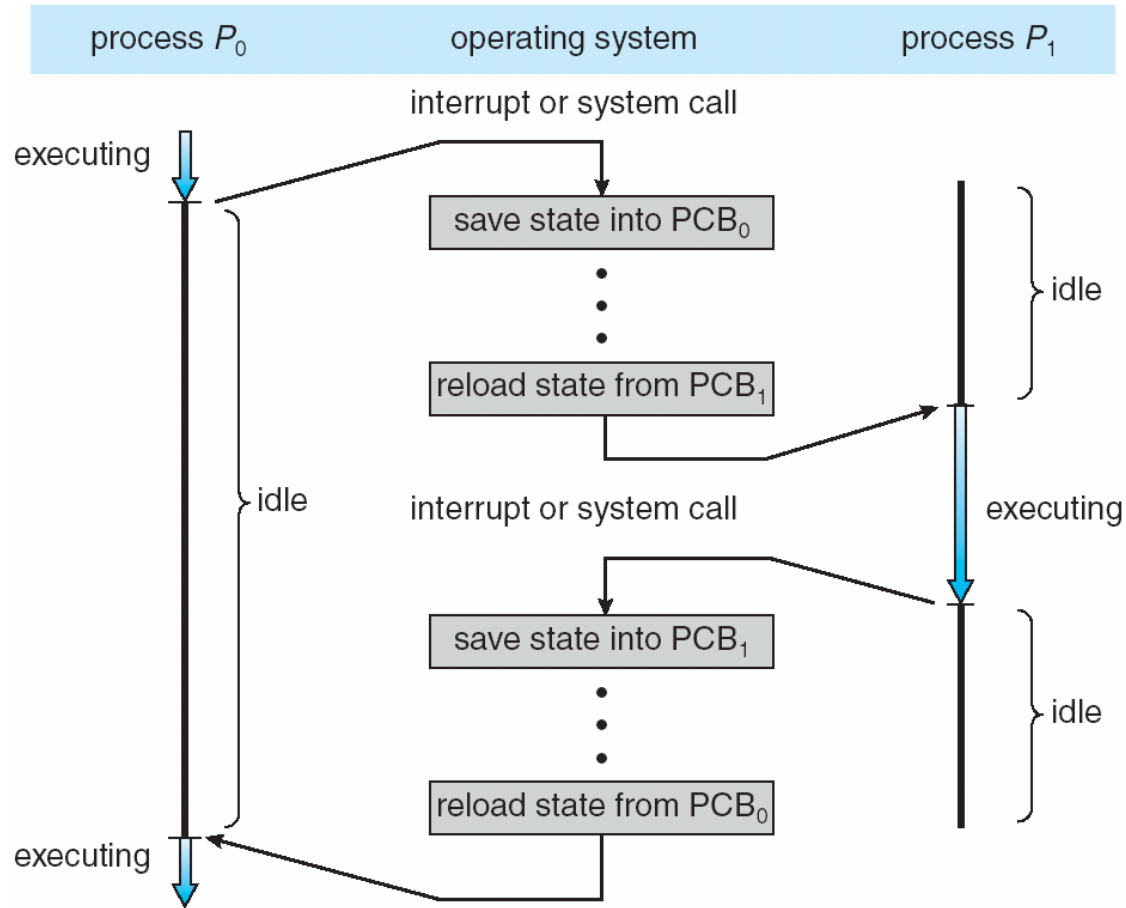
Information associated with each process

(also called **task control block**)

- Process state – running, waiting, etc
- Program counter – location of instruction to next execute
- CPU registers – contents of all process-centric registers
- CPU scheduling information- priorities, scheduling queue pointers
- Memory-management information – memory allocated to the process
- Accounting information – CPU used, clock time elapsed since start, time limits
- I/O status information – I/O devices allocated to process, list of open files

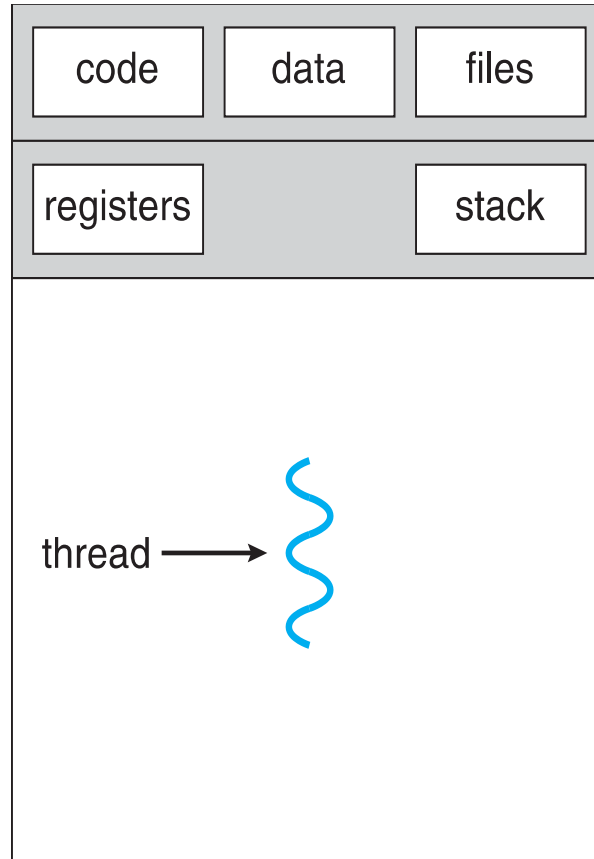


CPU Switch From Process to Process

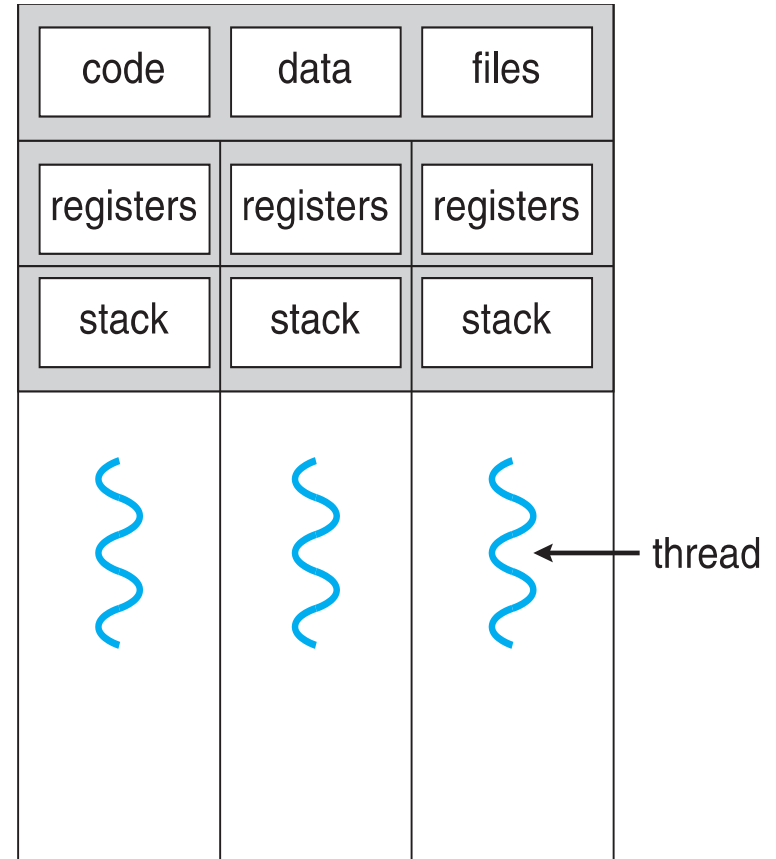


Threads

Single and Multithreaded Processes



single-threaded process



multithreaded process

User Threads and Kernel Threads

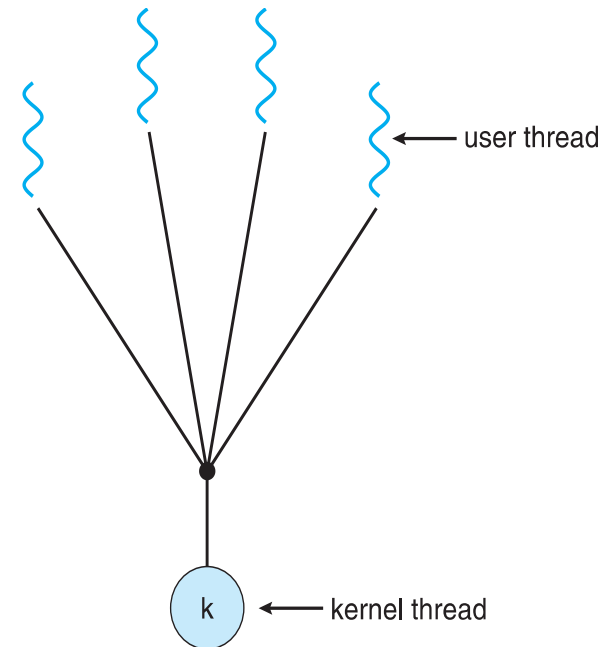
- **User threads** - management done by user-level threads library
- Three primary thread libraries:
 - POSIX **Pthreads**
 - Windows threads
 - Java threads
- **Kernel threads** - Supported by the Kernel
- Examples – virtually all general purpose operating systems, including:
 - Windows
 - Solaris
 - Linux

Multithreading Models

- Many-to-One
- One-to-One
- Many-to-Many

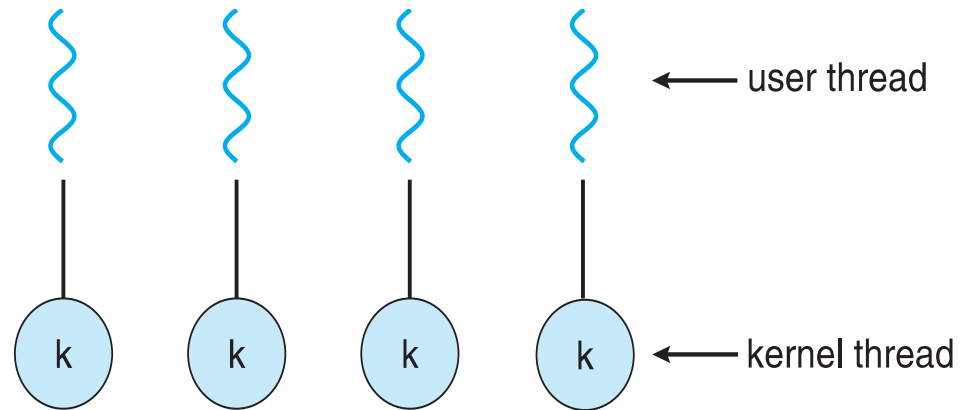
Many-to-One

- Many **user-level threads** mapped to single kernel thread
- One thread blocking causes all to block
- Multiple threads may not run in parallel on multicore system because only one may be in kernel at a time
- Few systems currently use this model
- Examples:
 - **Solaris Green Threads**
 - **GNU Portable Threads**



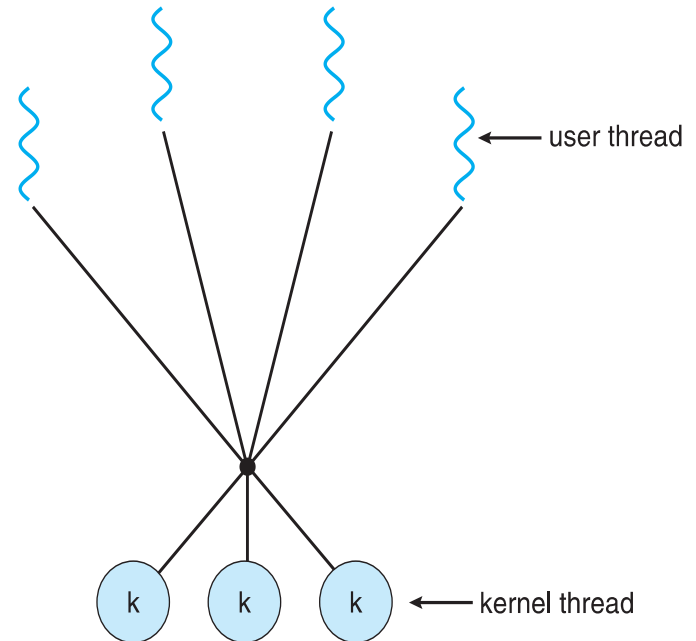
One-to-One

- Each **user-level thread** maps to kernel thread
- Creating a user-level thread creates a kernel thread
- More concurrency than many-to-one
- Number of threads per process sometimes restricted due to overhead
- Examples
 - Windows
 - Linux
 - Solaris 9 and later



Many-to-Many Model

- Allows many **user level threads** to be mapped to many kernel threads
- Allows the operating system to create a sufficient number of kernel threads
- Solaris prior to version 9
- Windows with the *ThreadFiber* package



Two-level Model

- Similar to M:M, except that it allows a **user thread** to be **bound** to kernel thread
- Examples
 - IRIX
 - HP-UX
 - Tru64 UNIX
 - Solaris 8 and earlier

