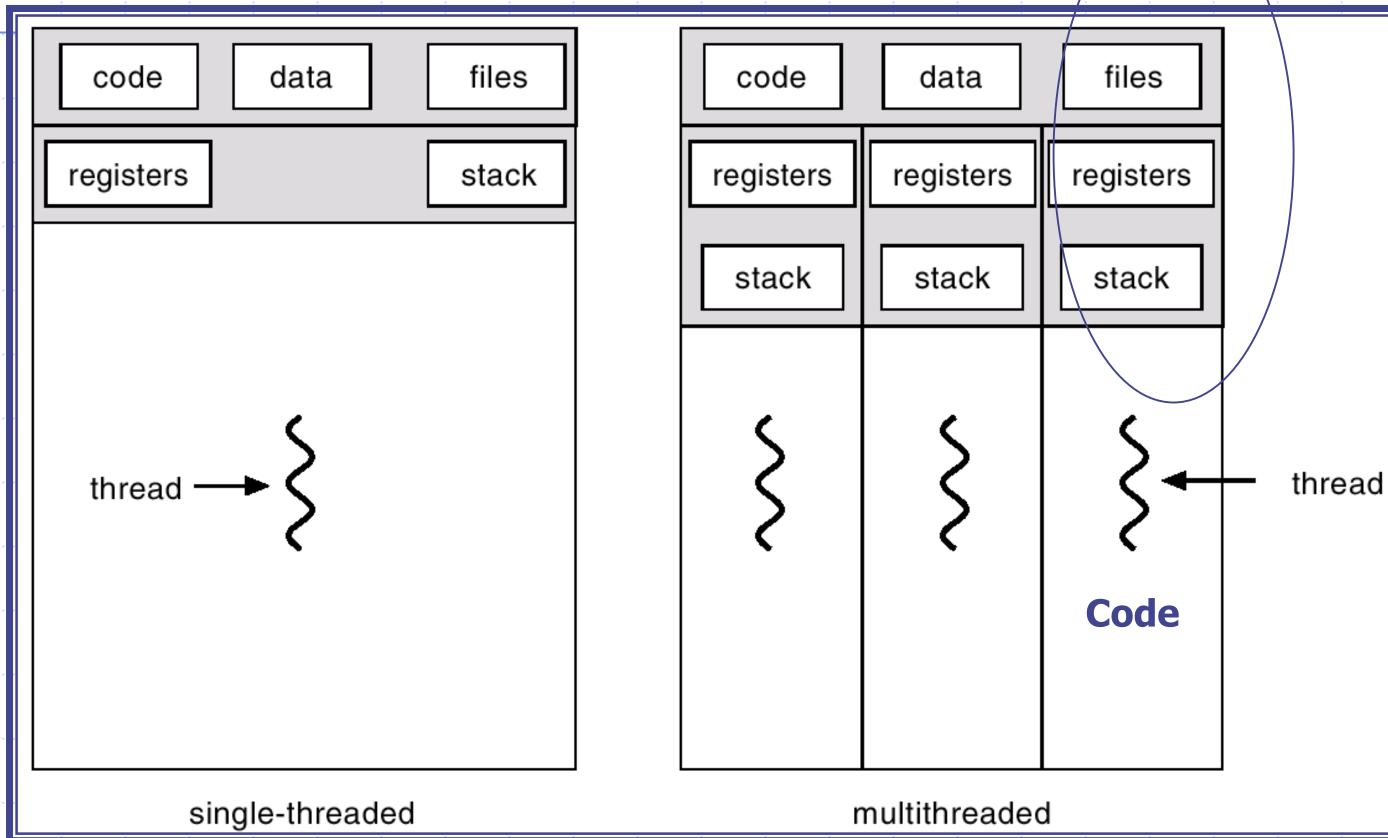
Threads

Chapter 5

Chapter 5: Threads

- Overview
- Multithreading Models
- Threading Issues
- Pthreads
- Solaris 2 Threads
- Windows 2000 Threads
- Nachos Threads

Single and Multithreaded Processes



User Threads

- Thread management done by user-level threads library
- Examples

  \- POSIX *Pthreads*

  \- Solaris *threads*

  - Nachos Thread

Kernel Threads

- Supported by the Kernel
- Examples
  - Windows 95/98/NT/2000
  - Solaris
  - Tru64 UNIX
  - BeOS
  - Linux

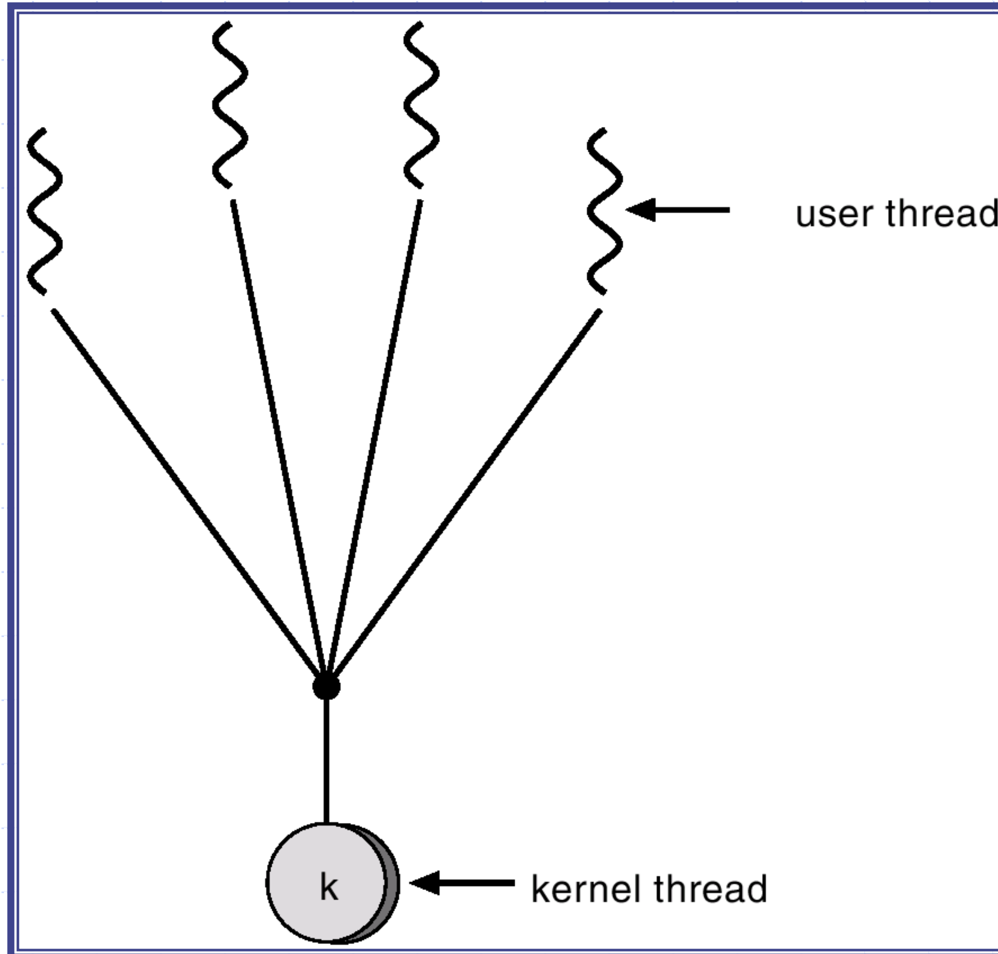
Thread Models

- Many to One:
  - Many user-level threads mapped to single kernel thread.
  - Used on systems that do not support kernel threads.
- One to One
  - Each user-level thread maps to kernel thread.
  - Examples

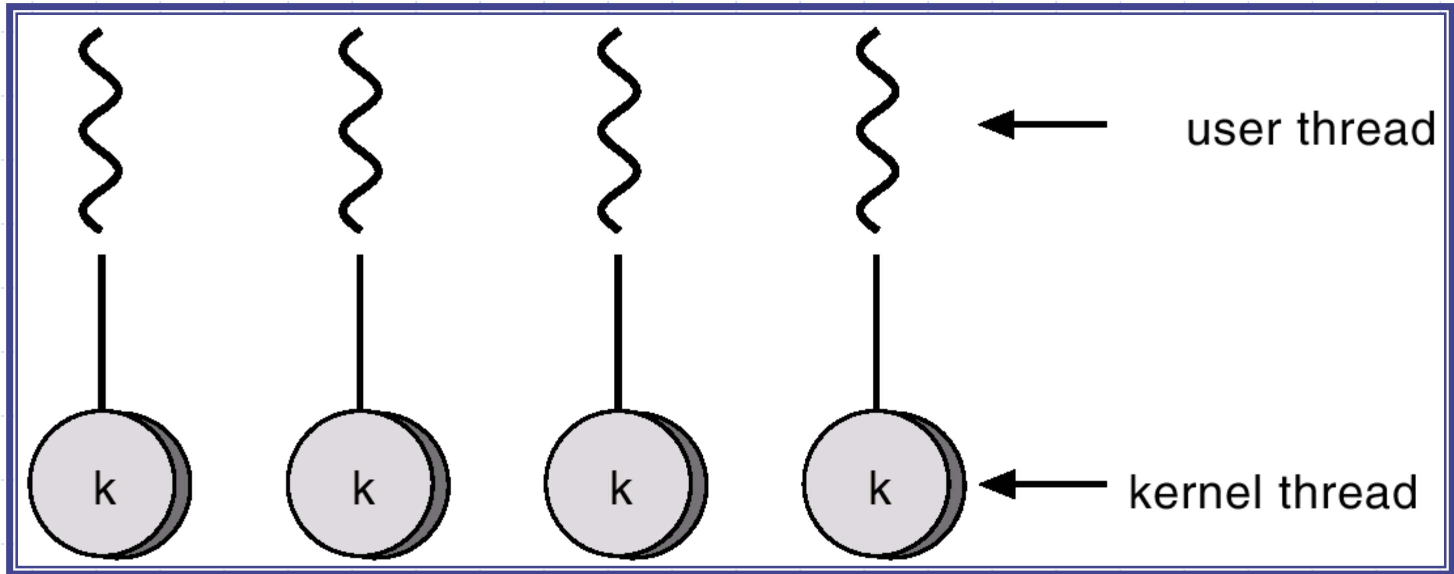
    - Windows 95/98/NT/2000

    - OS/2
- Many to Many

Many-to-One Model



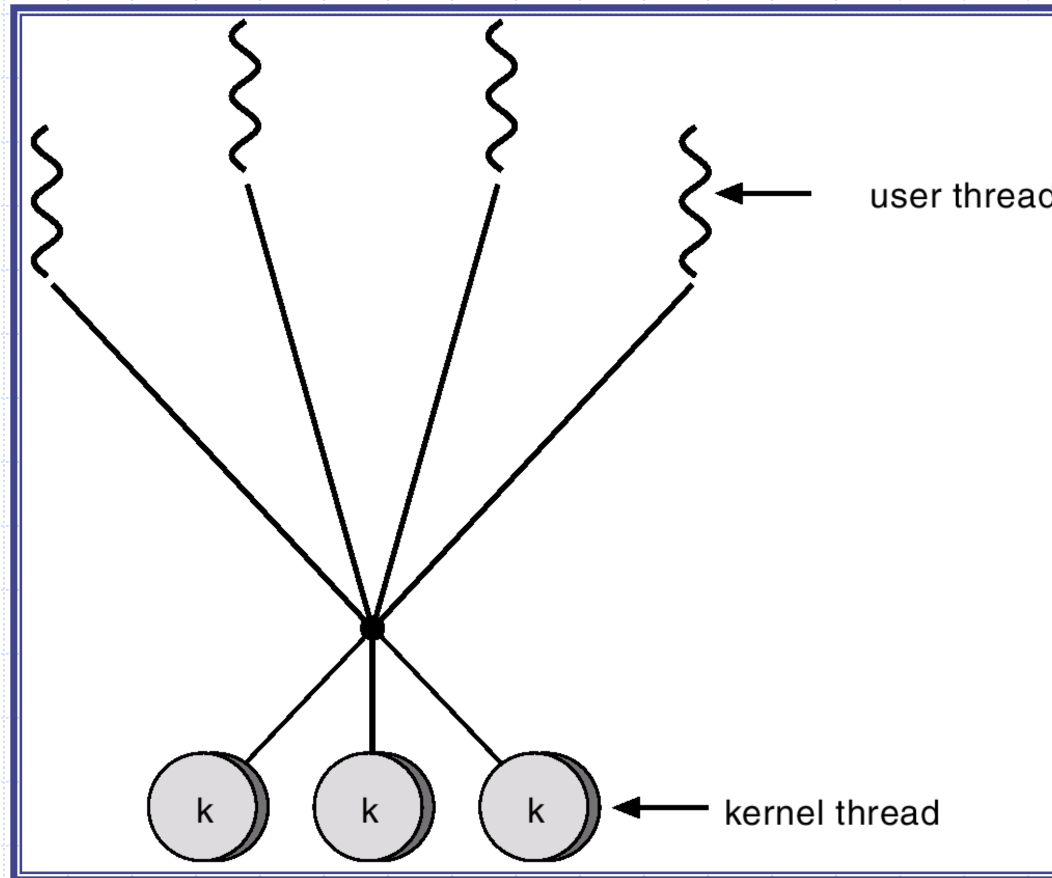
One-to-one Model



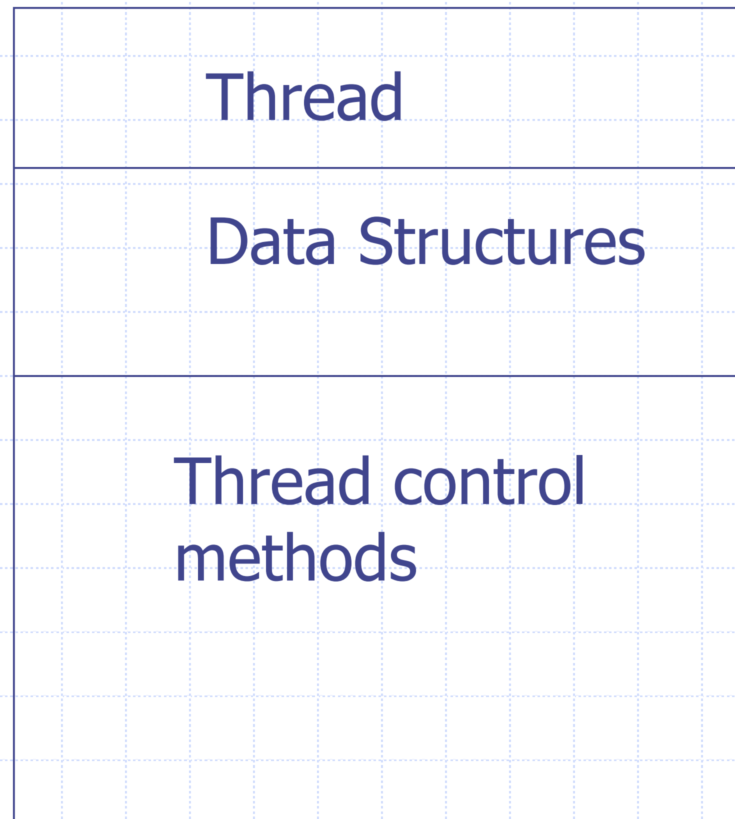
Many-to-Many Model

- 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 2
- Windows NT/2000 with the *ThreadFiber* package

Many-to-Many Model



Thread



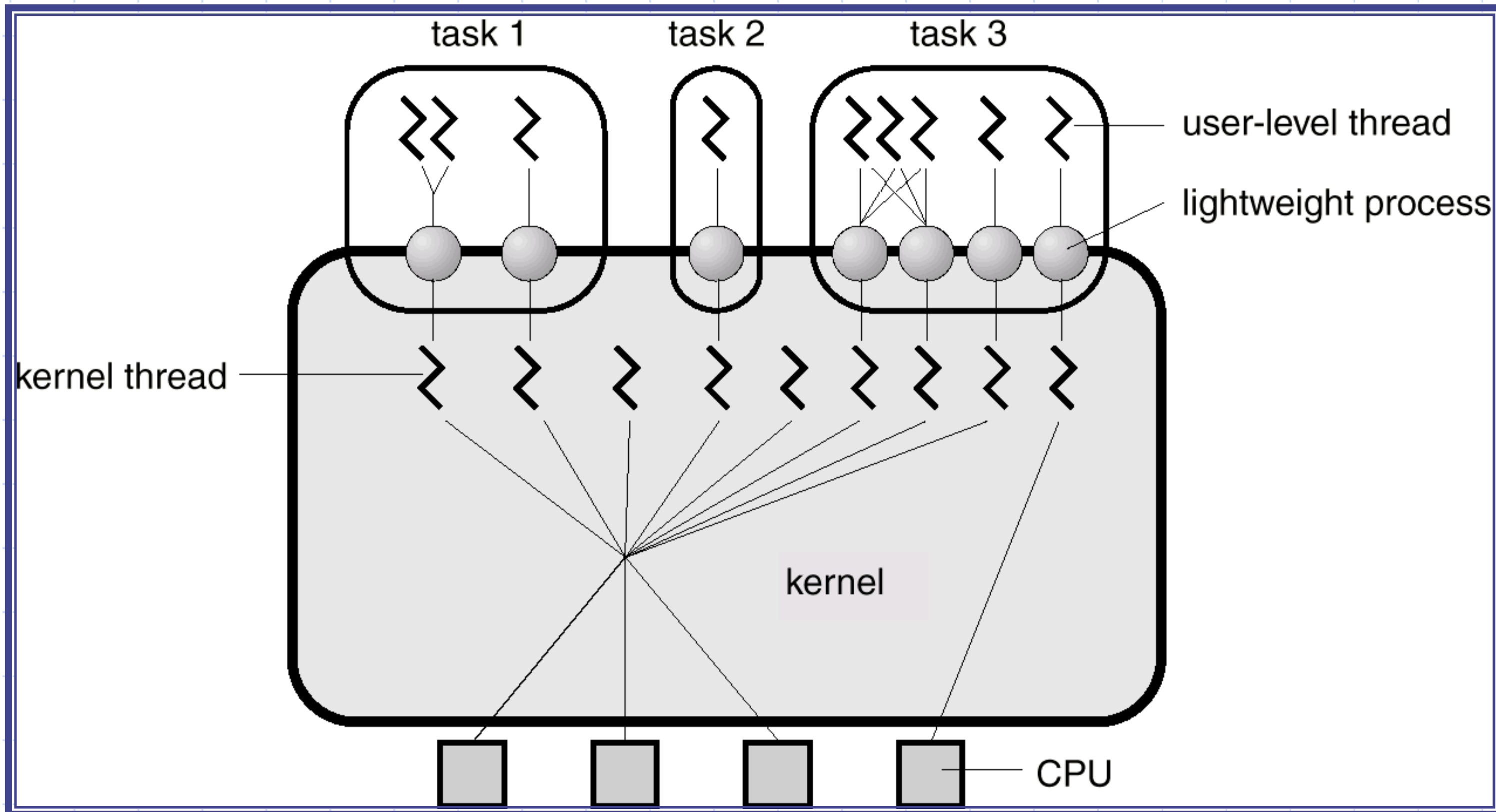
Threading Issues

- Thread life cycle management
  - Thread create, thread suspend, thread yield, thread resume, thread sleep, thread kill, thread start, thread stop
- Thread specific data
- Thread pools
- Signal handling

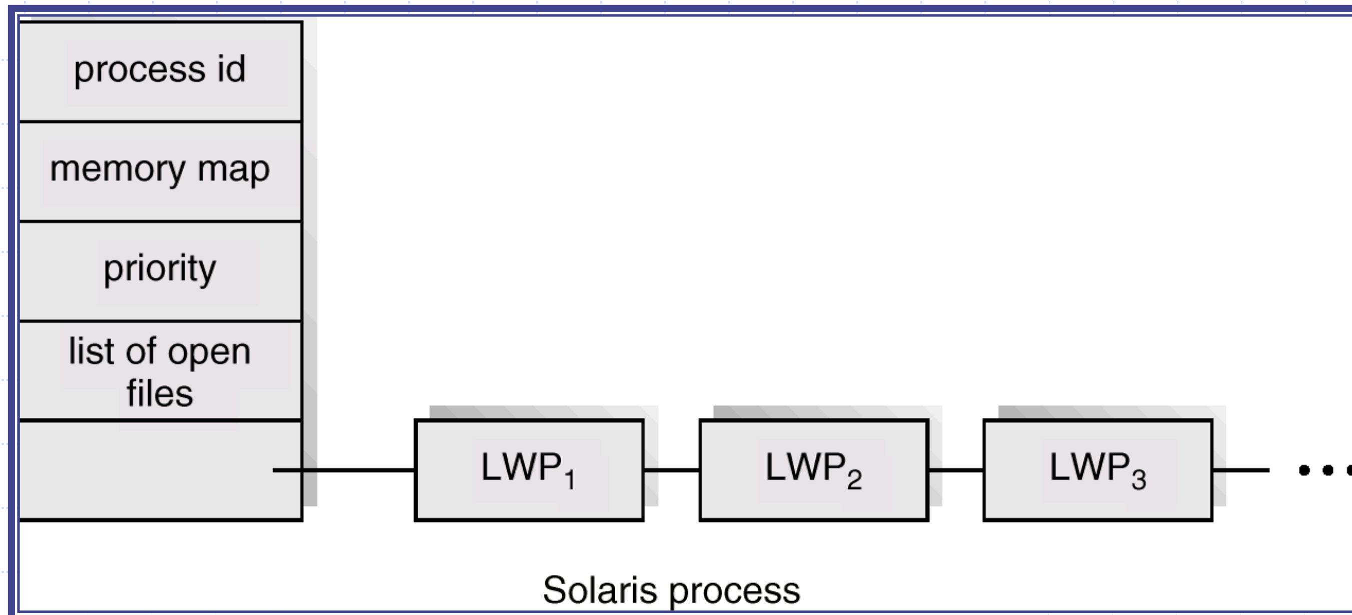
Pthreads

- a POSIX standard (IEEE 1003.1c) API for thread creation and synchronization.
- API specifies behavior of the thread library, implementation is up to development of the library.
- Common in UNIX operating systems.
- Simply a collection of C function.

Solaris 2 Threads



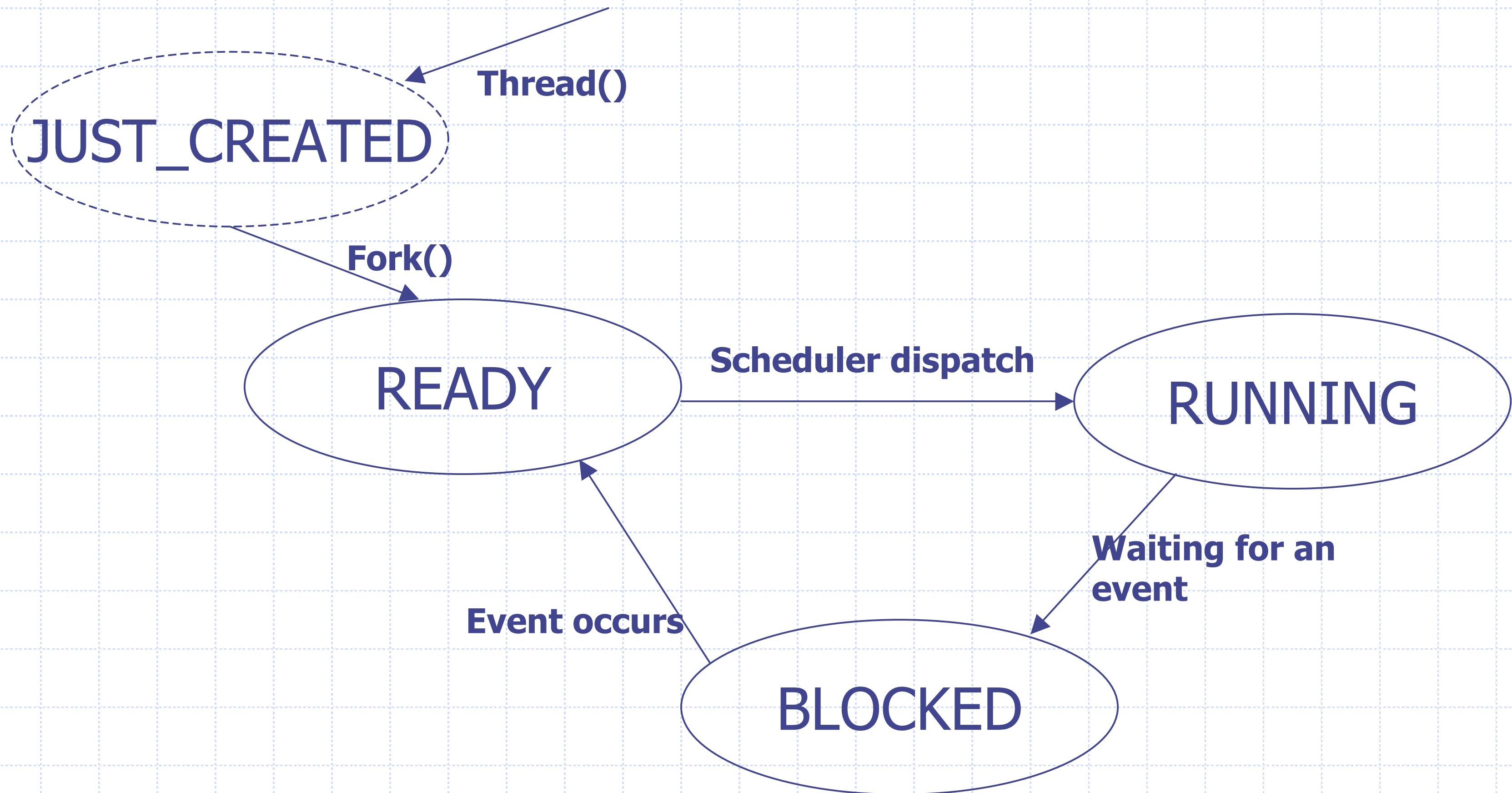
Solaris Process



Nachos Thread

- Nachos process consists of
  - An address space
    - Executable code
    - Stack space for automatic (local) variables
    - Heap space for global variables
  - A single thread of control
  - Other object such as file descriptors
  - We allow multiple threads of control to execute concurrently.

Thread States



Nachos Thread Operations

- Creation:
  - Thread *Thread(char *debugName);

  Create a thread but no code attached yet.
  - Fork (voidfunctionPtr func, int arg);

  Associate a function to be executed by the thread.
- Control:
  - void Yield()

  Suspend the current thread (calling thread..self) and select a new one for execution from the Ready queue

Nachos Thread Operation

- void Sleep()

Suspend the current thread, change its state to BLOCKED; It will return to READY on when a particular event takes place.

- void Finish()

Terminate current thread. Return all data structures held to the system; Finish sets the gloabal variable threadToBe Destroyed to point to current thread, then calls sleep to effectively terminate the thread. Scheduler will start running another thread, this thread will examine threadToBeDestroyed and finish it off.

Mechanics of Thread Switching

- Switching the CPU from one thread to another involves suspending the current thread, switching its state (eg: registers), then restoring the state of the thread being switched to. Thread switch is complete the moment the program counter is loaded into the PC.

SWITCH routine

- Routine switch(oldThread, newThread) actually performs a thread switch.
- Routine switch is written in assembly language and therefore is machine dependent.
- Semantics of switch:

1. Save all registers in oldThread's context block.
2. Save the return address in the context block.
3. Load new values into the register from the context block of next thread.
4. Replace PC with the saved PC in the process table; now switch is done.
5. Context switch has taken place.

Threads and Scheduling

- Threads that are ready to run are kept in a ready to run queue.
- Scheduler is invoked when ever time slice is over or if the current thread wants to give up the CPU.
- Threads suspended move to the end of the ready list.

Scheduler Routines

- Void ReadyToRun(Thread *thread)

Make the thread ready to run and place it in the ready to run list

ReadyToRun is invoked for example by the Fork routine.

- Thread FineNextToRun()

Select a ready thread and return it.

Run() scheduler method

- void Run(Thread *nextThread)

Suspend the current thread and switch to the new one.

Semantics:

1. Check if the current thread overflowed its stack. If yes, reset it.
2. Change the state of new thread to RUNNING.
3. Invoke switch to switch to the next thread.
4. If the previous thread is to be destroyed then do it. (Threads cannot terminate themselves.)

We will discuss thread synchronization later.