Operating Systems (OS)
Processes

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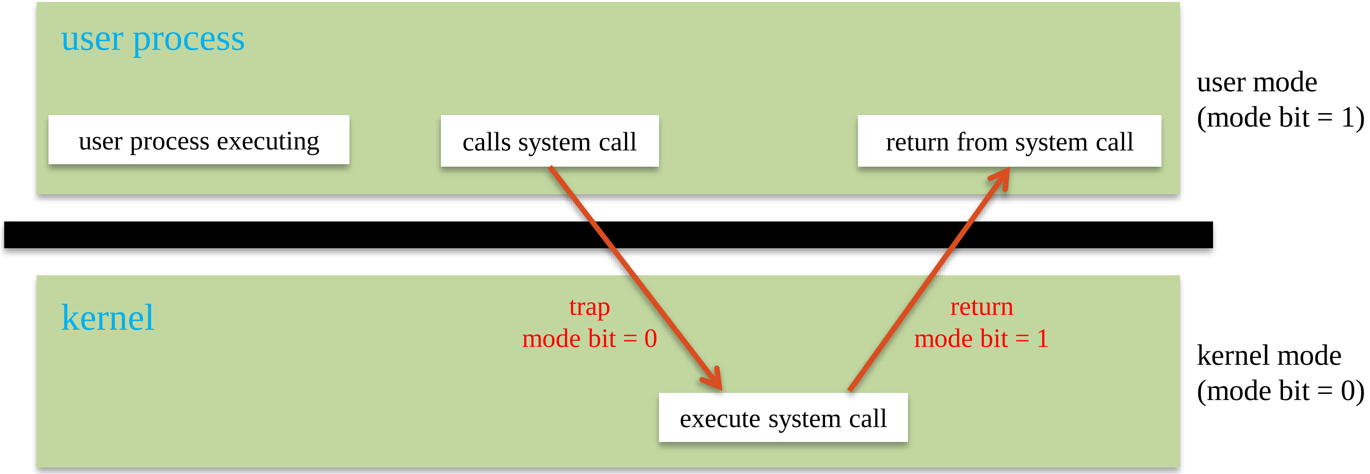
Review ‘System Calls’

용어 개념
확인



user process

user process executing

calls system call

return from system call

user mode
(mode bit = 1)

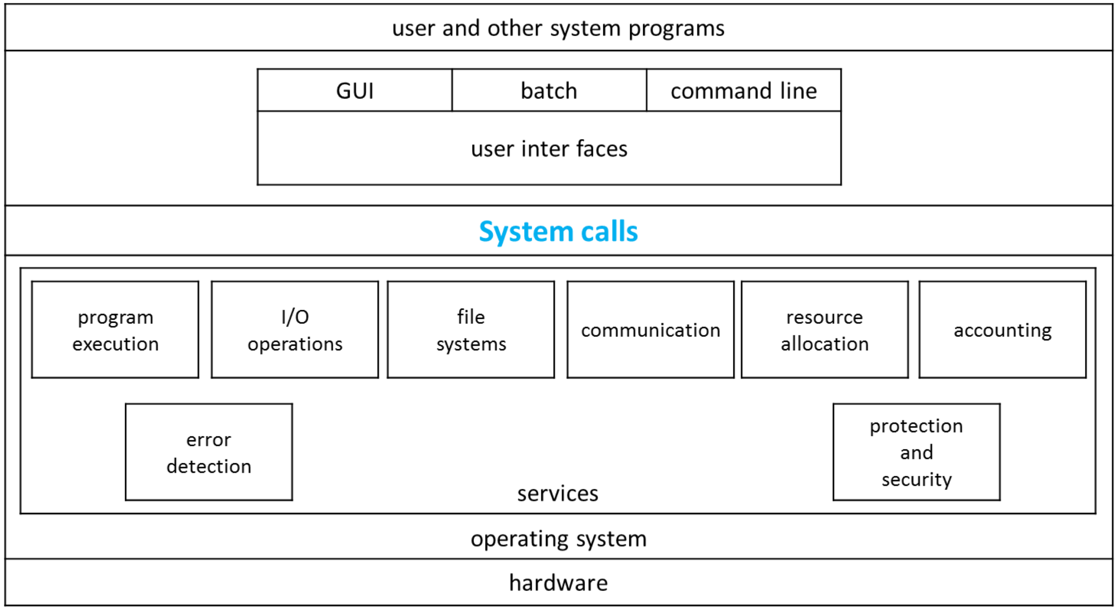
kernel

trap
mode bit = 0

return
mode bit = 1

execute system call

kernel mode
(mode bit = 0)



user and other system programs

GUI | batch | command line

user inter faces

System calls

program execution

I/O operations

file systems

communication

resource allocation

accounting

error detection

services

protection and security

operating system

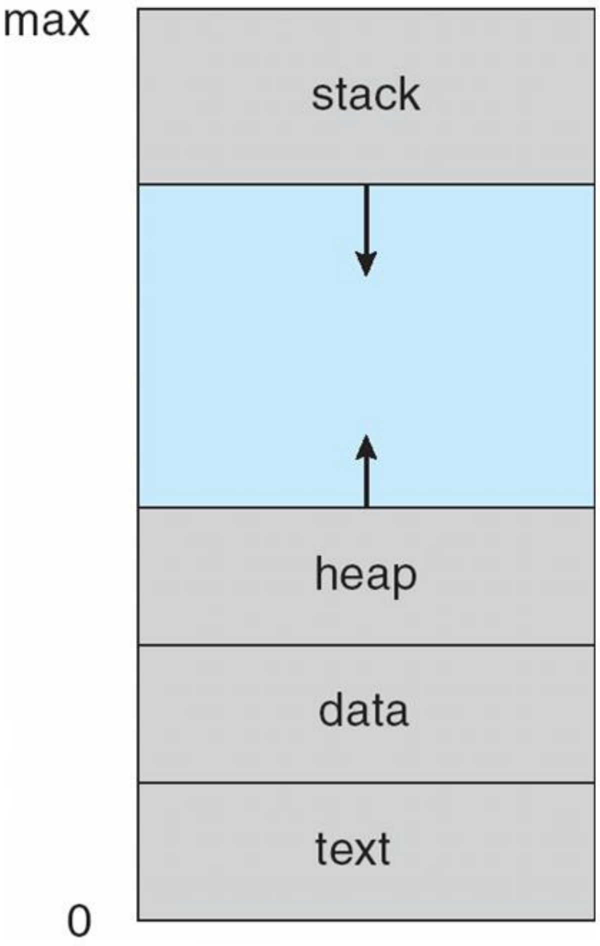
hardware

Process Concept

프로세스/프로그램
개념 중요

- **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

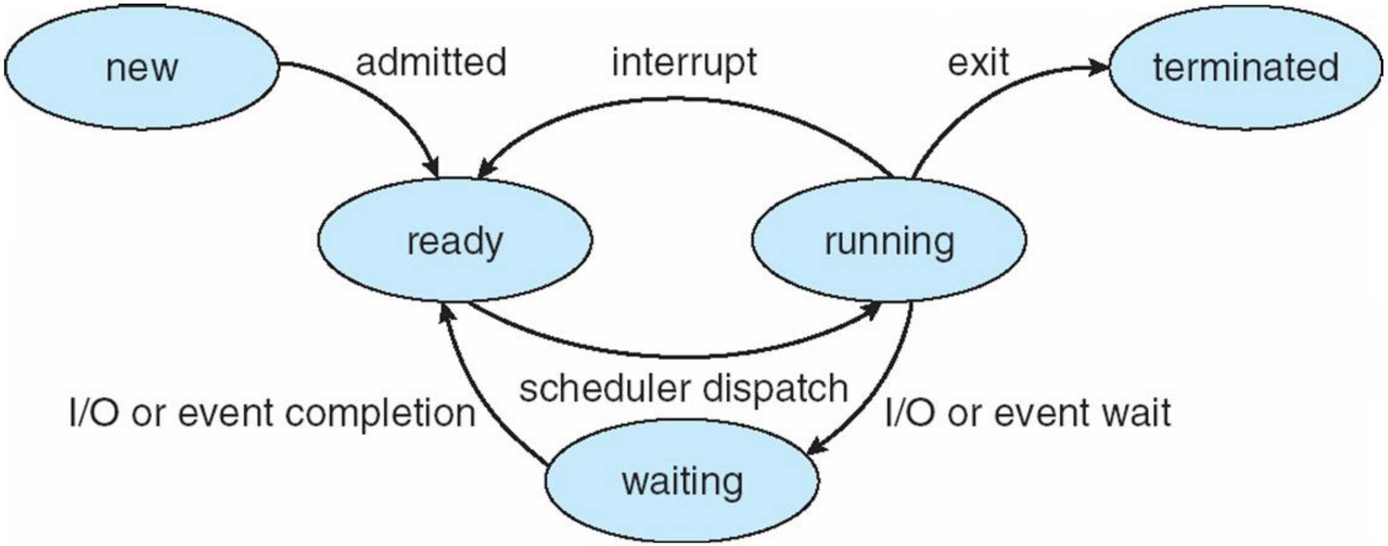


Process State

그릴 수 있는가?

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



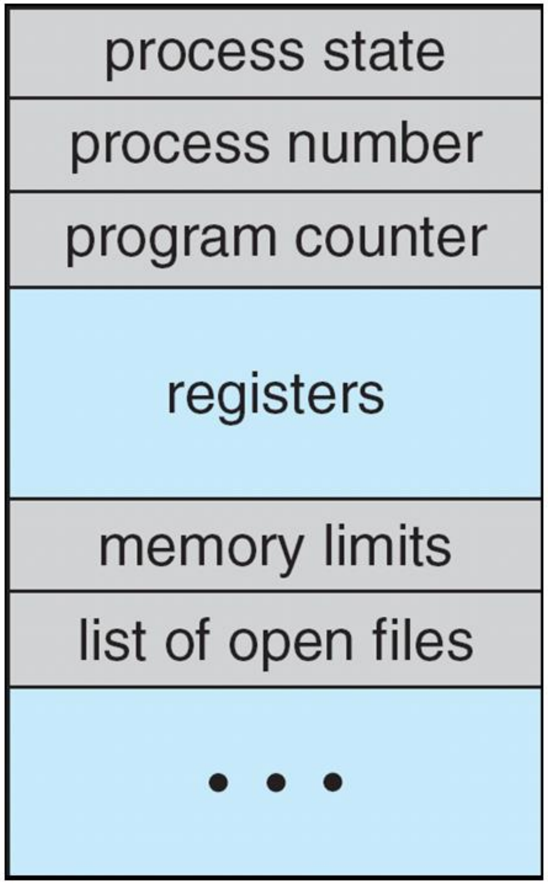
Process Control Block (PCB)

Scheduler를 만든다면 어떤 요소를 사용?

Information associated with each process

(also called **task control block (TCB)**)

- Process state – running, waiting, etc
- Program counter – location (address) 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



process state

process number

program counter

registers

memory limits

list of open files

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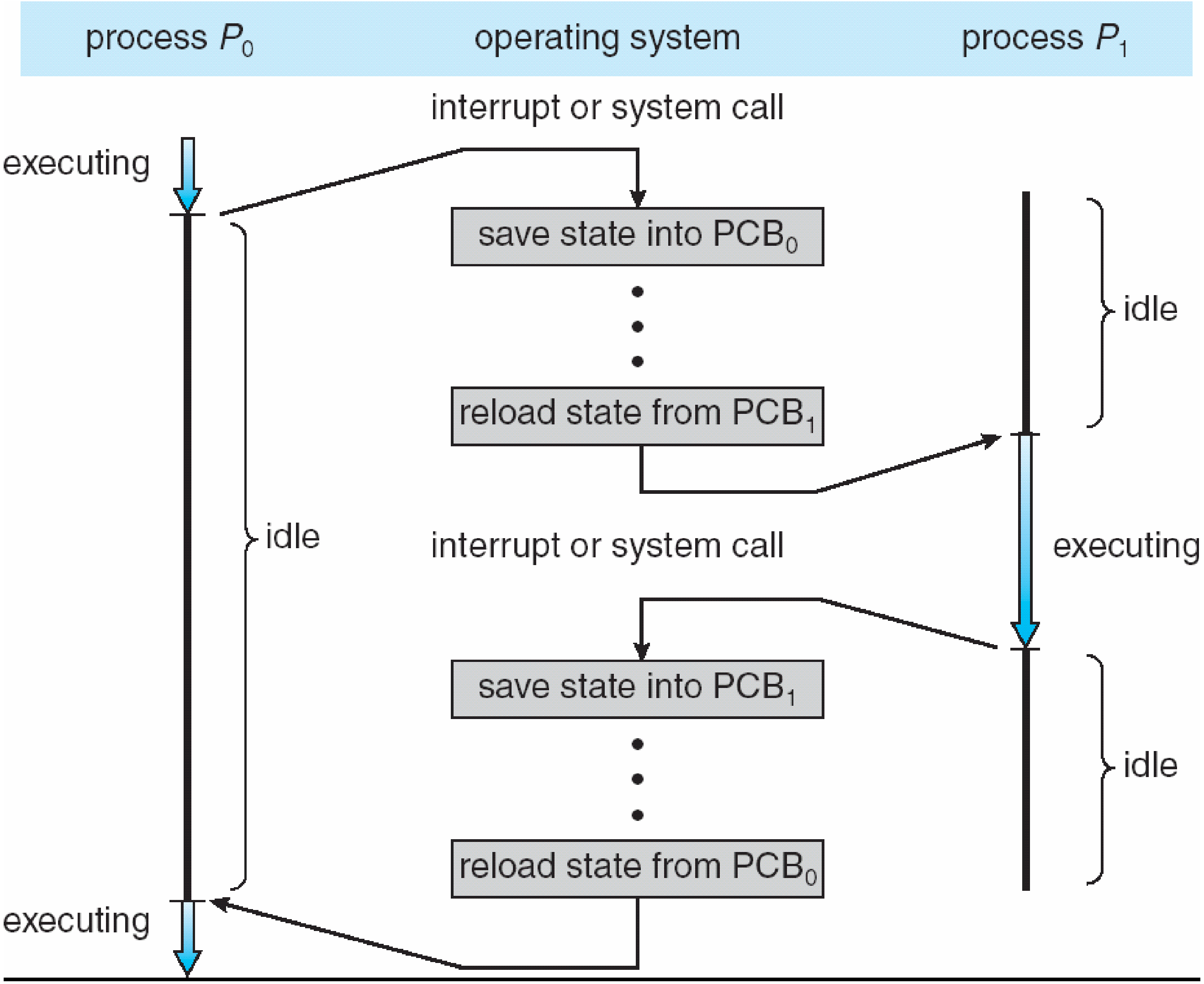
CPU Switch From Process to Process



Threads

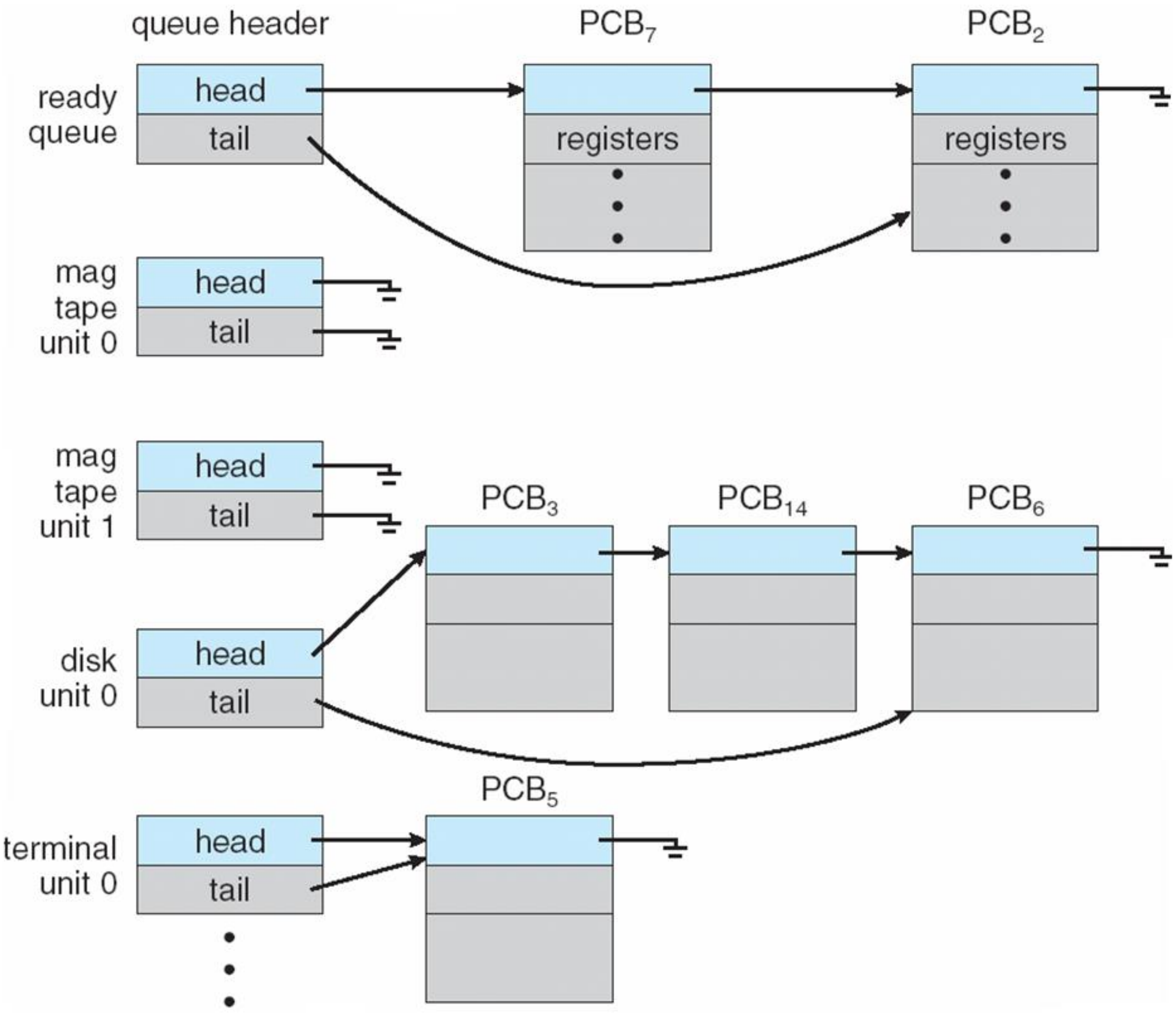
- So far, process has a single thread of execution
- Consider having multiple program counters per proce ss
  - Multiple locations can execute at once
    - Multiple threads of control -> **threads**
- Must then have storage for thread details, multiple pro gram counters in PCB

Process Scheduling

어떤 기능이 필요할지 미리 Q&A

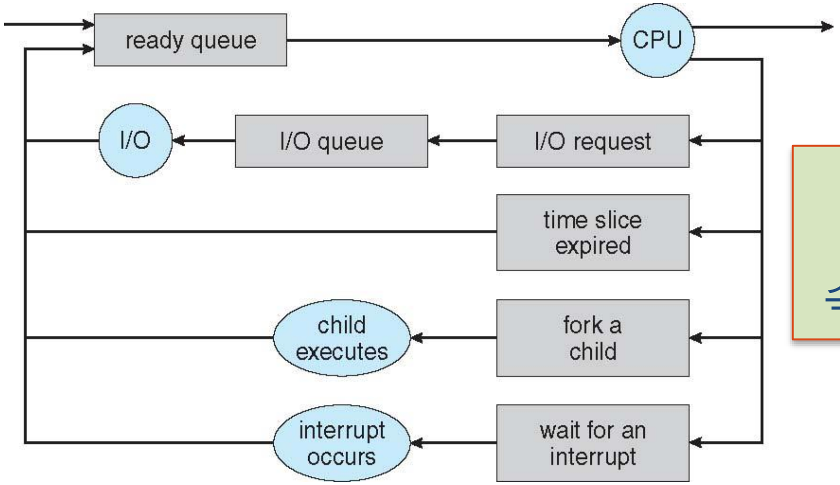
- Maximize CPU use, quickly switch processes onto CPU for time sharing
- **Process scheduler** selects among available processes for next execution on CPU
- Maintains **scheduling queues** of processes
  - **Job queue** – set of all processes in the system
  - **Ready queue** – set of all processes residing in main memory, ready and waiting to execute
  - **Device queues** – set of processes waiting for an I/O device
  - Processes migrate among the various queues

Ready Queue And Various I/O Device Queues



Representation of Process Scheduling

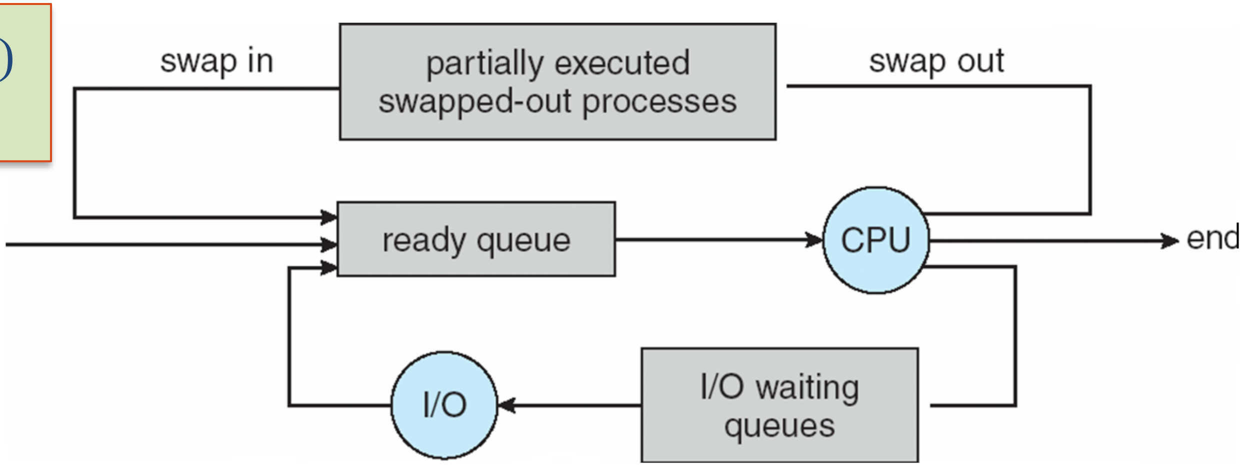
- **Queueing diagram** represents queues, resources, flows



결국, PCB 매니징
Scheduler의 처리
속도(타이머) 최저치 제시

Term Project: Process scheduling simulator implementation

Context(문맥)
Switching



Q&A

- Q1. PCB는 어디에 위치하는가? Kernel
- Q2. PCB 메모리 관리는?
  - Kernel의 Memory allocator인 Slab allocator가 Page(예: 4096 Bytes)단위로 메모리를 가져와서 PCB단위(예: 200 Bytes)로 분할하여 할당할지 말지를 판단 (자세한 것은 Googling 추천)
- Q3. PCB의 scheduling queue pointers는 구체적으로 어떤 형태?
  - Queue의 Next PCB의 주소 정도로 생각
- Q4. Multithread가 CPU 타임을 더 받는가? No
  - 효율이 높은 이유는 > Multi-cores를 활용
- Q5. Scheduler를 Double linked list로 구현하지 않고 Tree를 써도 되는가?
  - Yes, 최근 trend로 확인
  - 이 때, 프로그래밍 언어의 lib/SDK 활용은? 기본 지원 OK.

Reports

- Report #2:
  - Process와 Thread 생성 연습을 하고 이 과정을 정리하여 PDF 포맷 보고서 (3페이지 이내)로 제출 (다음수업일(금요일) 자정까지)

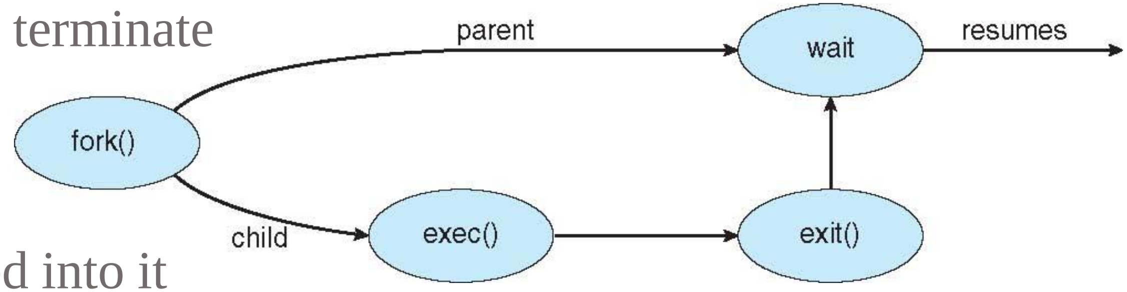
- 9월 22일(금) 수업 – 온라인 사전녹화
- Report #3: Message Passing 방식과 Shared Memory 방식 중 택1 이상으로 간단한 메시지 전송 코드 구현 및 PDF포맷 보고서 작성 (5페이지 이내) (다음수업일(금요일) 자정까지)

Context Switch

- When CPU switches to another process, the system must **save the state** of the old process and load the **saved state** for the new process via a **context switch**
- **Context** of a process represented in the PCB
- Context-switch time is overhead; the system does no useful work while switching
  - The more complex the OS and the PCB → the longer the context switch
- Time dependent on hardware support
  - Some hardware provides multiple sets of registers per CPU → multiple contexts loaded at once

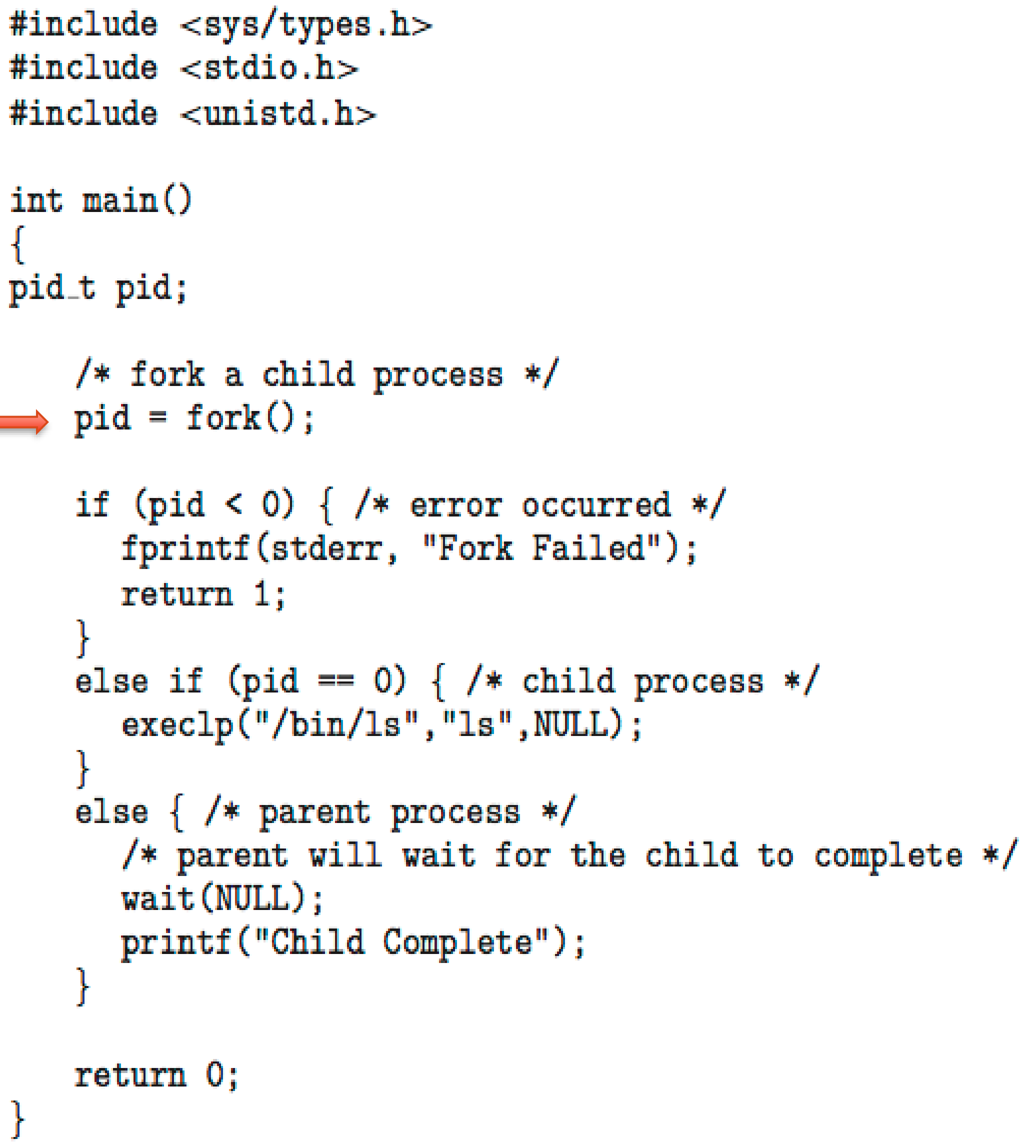
Process Creation

- **Parent** process create **children** processes, which, in turn create other processes, forming a **tree** of processes
- Generally, process identified and managed via a **process identifier** (**pid**)
- Resource sharing options
  - Parent and children share all resources
  - Children share subset of parent's resources
  - Parent and child share no resources
- Execution options
  - Parent and children execute concurrently
  - Parent waits until children terminate



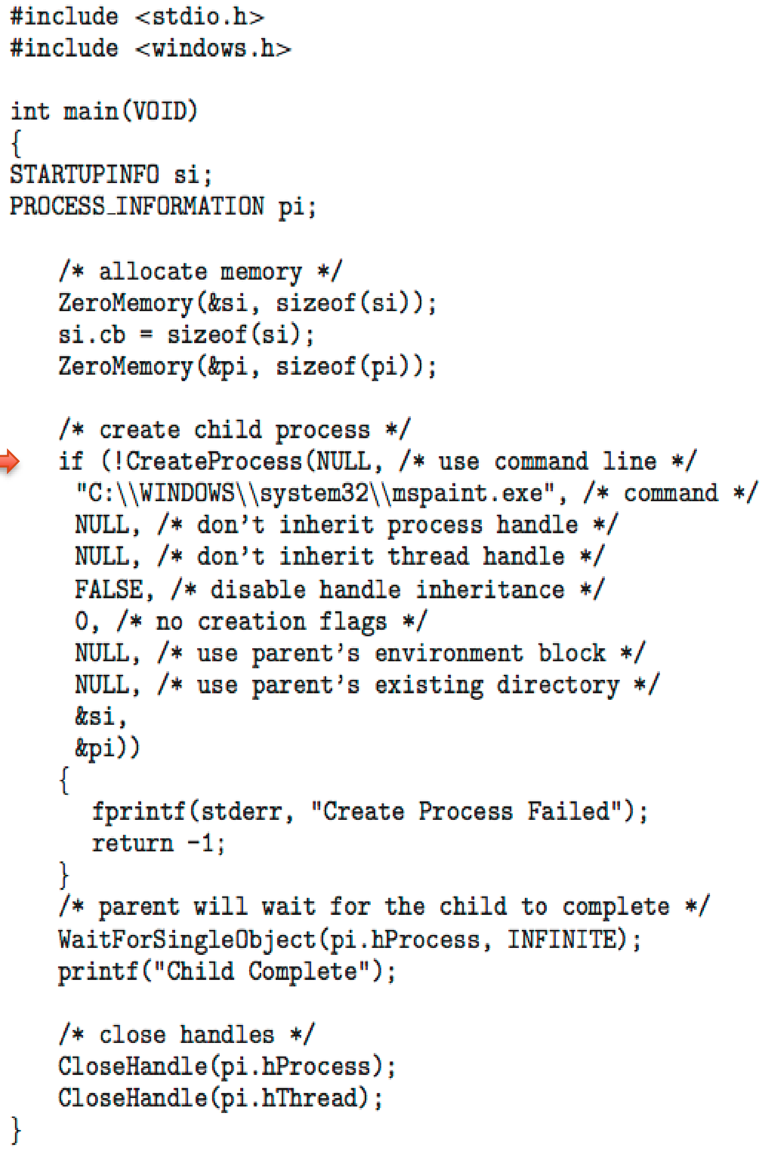
- Address space
  - Child duplicate of parent
  - Child has a program loaded into it
- UNIX examples
  - **fork()** system call creates new process
  - **exec()** system call used after a **fork()** to replace the process' memory space with a new program

C Program Forking Separate Process



```c
#include <sys/types.h>
#include <stdio.h>
#include <unistd.h>

int main()
{
pid_t pid;

   /* fork a child process */
   pid = fork();

   if (pid < 0) { /* error occurred */
      fprintf(stderr, "Fork Failed");
      return 1;
   }
   else if (pid == 0) { /* child process */
      execlp("/bin/ls","ls",NULL);
   }
   else { /* parent process */
      /* parent will wait for the child to complete */
      wait(NULL);
      printf("Child Complete");
   }

   return 0;
}
```

Creating a Separate Process via Windows API



```
#include <stdio.h>
#include <windows.h>

int main(VOID)
{
STARTUPINFO si;
PROCESS_INFORMATION pi;

    /* allocate memory */
    ZeroMemory(&si, sizeof(si));
    si.cb = sizeof(si);
    ZeroMemory(&pi, sizeof(pi));

    /* create child process */
    if (!CreateProcess(NULL, /* use command line */
     "C:\\WINDOWS\\system32\\mspaint.exe", /* command */
     NULL, /* don't inherit process handle */
     NULL, /* don't inherit thread handle */
     FALSE, /* disable handle inheritance */
     0, /* no creation flags */
     NULL, /* use parent's environment block */
     NULL, /* use parent's existing directory */
     &si,
     &pi))
    {
      fprintf(stderr, "Create Process Failed");
      return -1;
    }
    /* parent will wait for the child to complete */
    WaitForSingleObject(pi.hProcess, INFINITE);
    printf("Child Complete");

    /* close handles */
    CloseHandle(pi.hProcess);
    CloseHandle(pi.hThread);
}
```

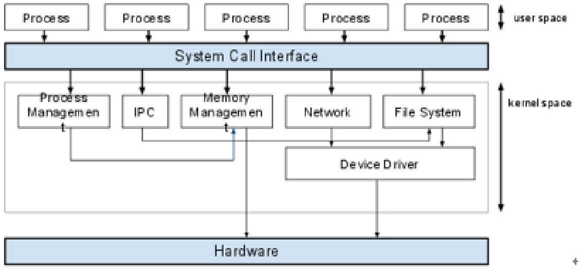
Process Termination

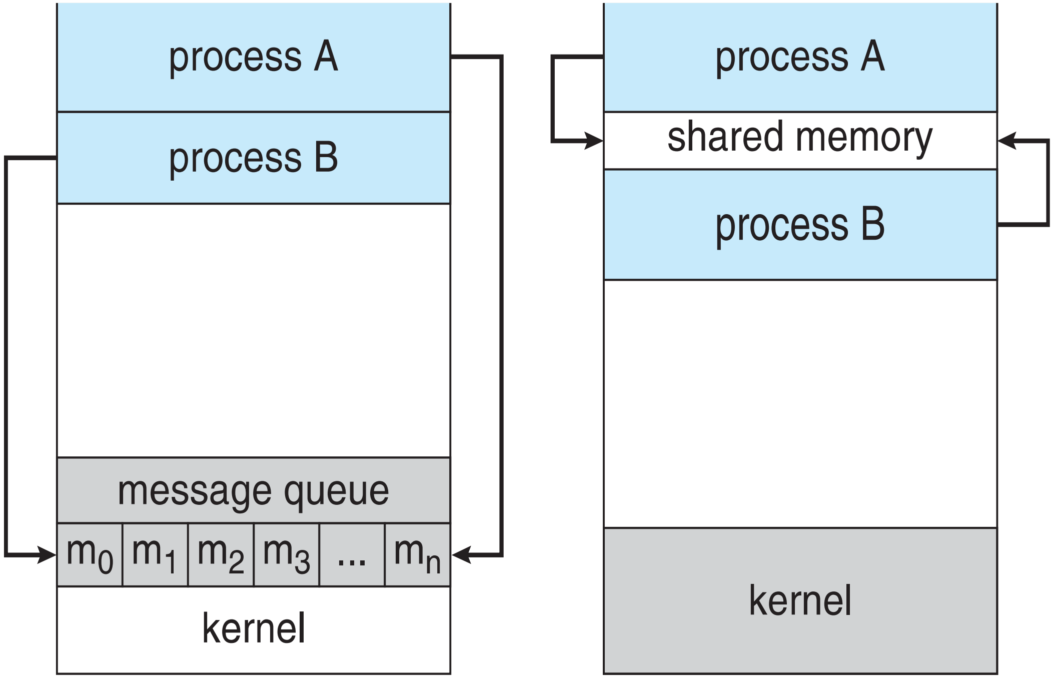
- Process executes last statement and then asks the operating system to delete it using the **exit()** system call.
  - Returns status data from child to parent (via **wait()**)
  - Process′ resources are deallocated by operating system
- Parent may terminate the execution of children processes using the **abort()** system call. Some reasons for doing so:
  - Child has exceeded allocated resources
  - Task assigned to child is no longer required
  - The parent is exiting and the operating systems does not allow a child to continue if its parent terminates
- The parent process may wait for termination of a child process by using the **wait()**system call**.** The call returns status information and the pid of the terminated process

  pid = wait(&status);
- If no parent waiting (did not invoke **wait()**) process is a **zombie**
- If parent terminated without invoking **wait** , process is an **orphan**

Interprocess Communication

- Processes within a system may be ***independent*** or ***cooperating***
- Cooperating process can affect or be affected by other processes, incl uding sharing data
- Cooperating processes need **interprocess communication** (**IPC**)
- Two models of IPC
  a. **Message passing**
  b. **Shared memory**





(a)

(b)