Processes

Operating System (OS)

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강의자료는 KAIST 원유집 교수님 OS 강의 자료를 참고했습니다.

Recap

OS is in charge of making sure the system operates correctly and efficiently

가상화 동시성 영속성

Virtualization		Concurrency	Persistence
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Recap | Virtualization (CPU)

```
1       #include <stdio.h>
2       #include <stdlib.h>
3       #include <sys/time.h>
4       #include <assert.h>
5       #include "common.h"
6
7       int
8       main(int argc, char *argv[])
9       {
10              if (argc != 2) {
11                      fprintf(stderr,
                        "usage: cpu <string>\n");
12                      exit(1);
13              }
14              char *str = argv[1];
15              while (1) {
16                      Spin(1);
17                      printf("%s\n", str);
18              }
19              return 0;
20      }
```

```
prompt> ./cpu A & ./cpu B & ./cpu C & ./cpu D &
[1] 7353
[2] 7354
[3] 7355
[4] 7356
A
B
D
C
A
B
D
C
A ...
```

Virtualizing the CPU!

→ The illusion that the system has a very large number of virtual CPUS

How to provide the illusion of many CPUs?

- CPU virtualizing
  - OS는 여러 개의 가상 CPU가 존재하는 것처럼 보이도록 할 수 있다.
  - **Time sharing**: 하나의 Process를 실행한 후, 중지하고, 다른 프로세스를 실행
    - 잠재적인 비용은 성능 저하
    - 즉, 각 Process는 느려짐

A Process

Process? → Process는 실행 중인 프로그램이다

- Comprising of a process:
  - Memory (address space)
    - Instructions (Code Segment, 프로그램 명령어)
    - Data section (전역/정적 변수)
    - Stack (지역 변수, 함수 호출 정보)
    - Heap (동적 메모리 할당 영역)
  - Registers
    - Program counter (PC)
    - Stack pointer (SP)
  - File Descriptors (Process가 사용하는 파일, 소켓, 입출력 장치 등)

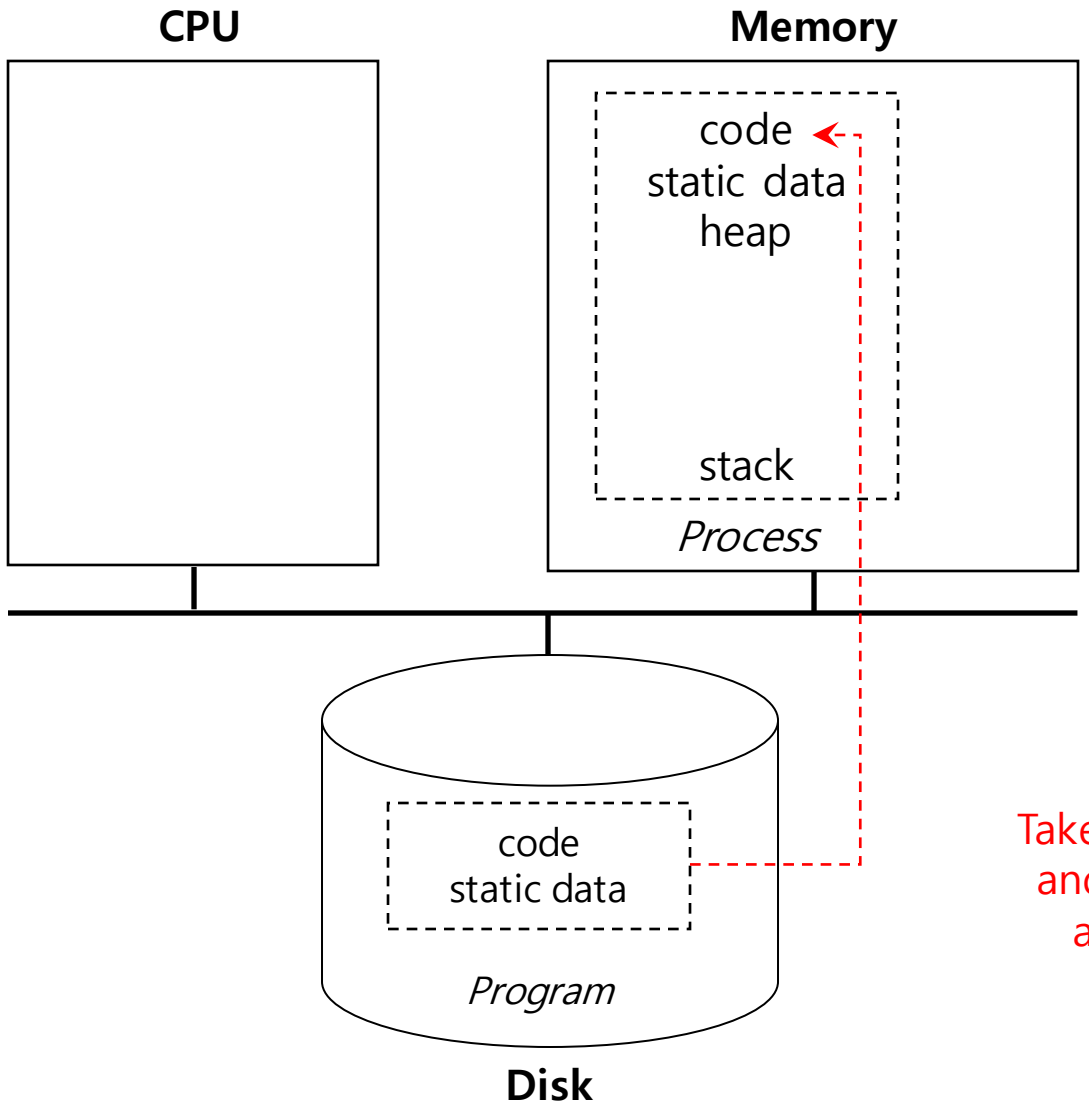
Process API

- 아래와 같은 API는 모든 최신 OS에서 사용할 수 있다.
  - **Create (생성)**
    - 새로운 프로세스를 생성하여 프로그램을 실행
  - **Destroy (제거)**
    - 제어할 수 없는 프로세스를 중지
  - **Wait (대기)**
    - 프로세스가 실행을 멈출 때까지 대기
  - **Miscellaneous Control (기타 제어)**
    - 프로세스를 일시 중단한 후 다시 재개하는 방법 제공
  - **Status (상태)**
    - 프로세스에 대한 상태 정보를 가져옴

Process Creation

1. **프로그램 코드를 메모리에 로드(load)**하여 프로세스의 주소 공간에 배치
   - 프로그램은 처음에 실행 가능한 형식(executable format)으로 디스크에 저장
   - 초기(또는 단순한) OS는 로딩 과정이 즉시(eagerly) 수행되었으며, 즉, 프로그램 실행하기 전에 한번에 모든 코드와 데이터 로드
   - 현대 OS는 지연(lazily) 방식으로 로딩을 수행; 즉, 프로그램 실행 중 필요한 코드나 데이터를 그때그때 로드→Paging & Swapping

Loading: From Program To Process



Loading:
Takes on-disk program and reads it into the address space of process

Process Creation

2. 프로그램의 **run-time stack**을 위한 메모리를 할당
   - Stack은 *local variables*, *function parameters*, and *return address*을 저장하기 위해 활용
   - Initialize the stack with arguments
     - `argc` and the `argv` array of `main()` function

Process Creation

3. 프로그램의 **heap** 생성
   - Heap은 동적 메모리 할당 (dynamic memory allocation)을 위해 사용
   - Program request such space by calling `malloc()` and free it by calling `free()`.

Process Creation

4. OS는 입출력 (I/O) 설정도 수행
   - 각 process는 기본적으로 세 개의 file descriptors(standard input, standard output, and standard error)를 가진다 (Unix 시스템에서) → Persistence

5. **Start the program** running at the entry point, namely `main()`.
   - The OS *transfers control* of the CPU to the newly-created process.

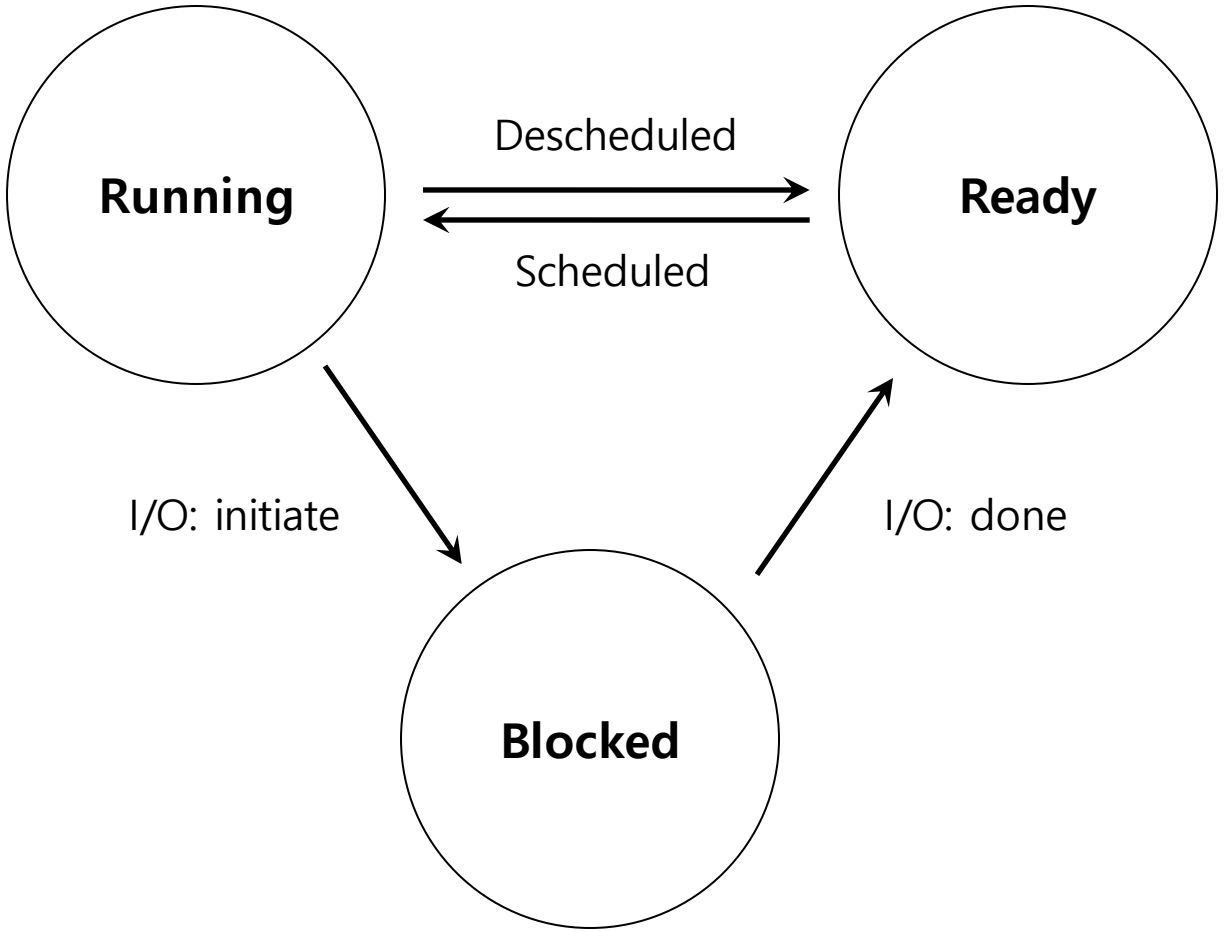
??? → Limited Direct Execution

Process States

- Process가 실행되는 동안 다양한 상태(States)를 가질 수 있음

- A process can be one of three states.
  - **Running**
    - A process is running on a processor.
  - **Ready**
    - A process is ready to run but for some reason the OS has chosen not to run it at this given moment.
  - **Blocked**
    - A process has performed some kind of operation.
    - When a process initiates an I/O request to a disk, it becomes blocked and thus some other process can use the processor.

Process State Transition



Process State Transition

Time	Process_0	Process_1	Notes
1	Running	Ready	
2	Running	Ready	
3	Running	Ready	Process_0 initiates I/O
4	Blocked	Running	Process_0 is blocked,
5	Blocked	Running	so Process_1 runs
6	Blocked	Running	
7	Ready	Running	I/O done
8	Ready	Running	Process_1 now done
9	Running	–	
10	Running	–	Process_0 now done

Data structures

- PCB(Process Control Block)
  - A C-structure that contains information about each process.
  - **Register context:** a set of registers that define the state of a process

- **Process list**
  - Ready processes
  - Blocked processes
  - Current running process

Example) The xv6 kernel Proc Structure (Cont.)

```
// the information xv6 tracks about each process
// including its register context and state
struct proc {
    char *mem;                  // Start of process memory
    uint sz;                    // Size of process memory
    char *kstack;               // Bottom of kernel stack
                                // for this process
    enum proc_state state;      // Process state
    int pid;                    // Process ID
    struct proc *parent;        // Parent process
    void *chan;                 // If non-zero, sleeping on chan
    int killed;                 // If non-zero, have been killed
    struct file *ofile[NOFILE]; // Open files
    struct inode *cwd;          // Current directory
    struct context context;     // Switch here to run process
    struct trapframe *tf;       // Trap frame for the
                                // current interrupt
};
```

Example) Register Context in xv6

```
// the registers xv6 will save and restore
// to stop and subsequently restart a process
struct context {
    int eip;   // Index pointer register
    int esp;   // Stack pointer register
    int ebx;   // Called the base register
    int ecx;   // Called the counter register
    int edx;   // Called the data register
    int esi;   // Source index register
    int edi;   // Destination index register
    int ebp;   // Stack base pointer register
};

// the different states a process can be in
enum proc_state { UNUSED, EMBRYO, SLEEPING,
                  RUNNABLE, RUNNING, ZOMBIE };
```