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Informationsteknologi

Today's class

- Finish operating system overview
- Review of more C

Finish operating system overview

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Major Achievements

- Processes
- Memory Management
- Information protection and security
- Scheduling and resource management
- System structure

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Processes

- A program in execution
- An instance of a program running on a computer
- The entity that can be assigned to and executed on a processor
- A unit of activity characterized by a single sequential thread of execution, a current state, and an associated set of system resources

Difficulties with Designing System Software

- Improper synchronization
  - Ensure a process waiting for an I/O device receives the signal
- Failed mutual exclusion
- Nondeterminate program operation
  - Program should only depend on input to it, not on the activities of other programs
- Deadlocks

Process

- Consists of three components
  - An executable program
  - Associated data needed by the program
  - Execution context of the program
    - All information the operating system needs to manage the process

Process

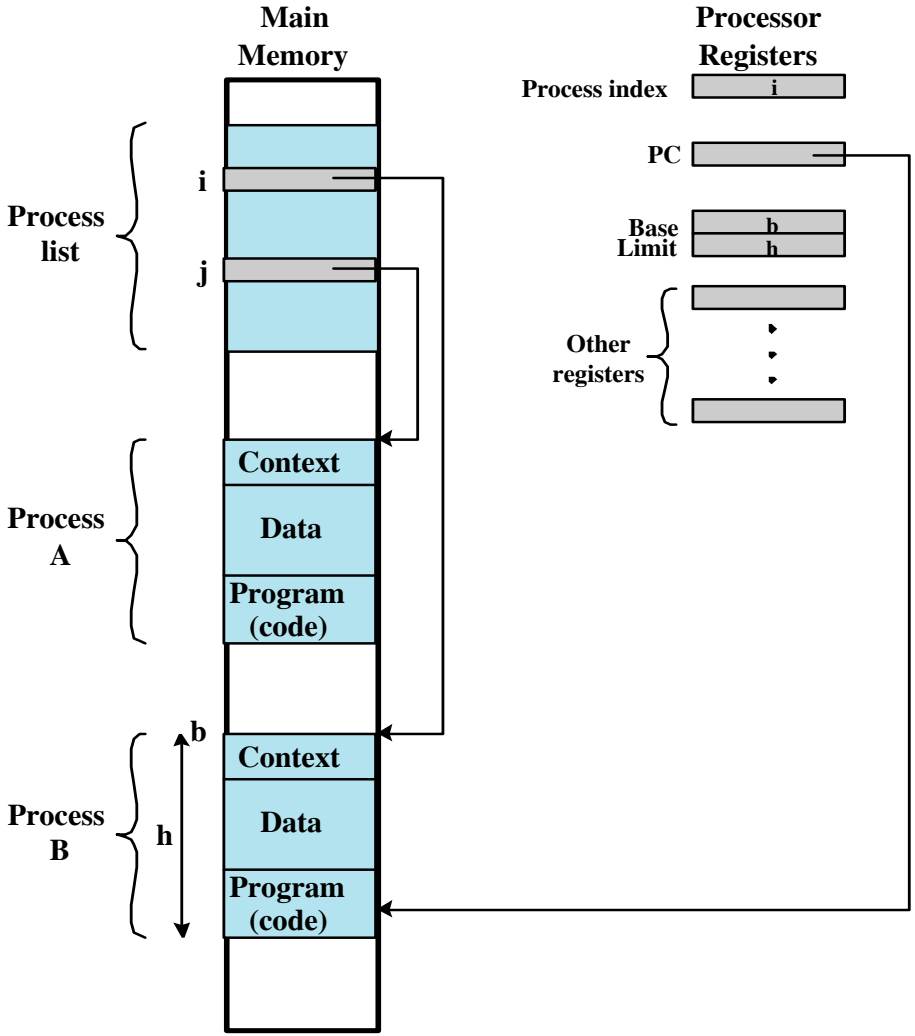

Figure 2.8 Typical Process Implementation

Memory Management

- Process isolation
- Automatic allocation and management
- Support of modular programming
- Protection and access control
- Long-term storage

Virtual Memory

- Allows programmers to address memory from a logical point of view
- No hiatus between the execution of successive processes while one process was written out to secondary store and the successor process was read in

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Virtual Memory and File System

- Implements long-term store
- Information stored in named objects called files

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Paging

- Allows process to be comprised of a number of fixed-size blocks, called pages
- Virtual address is a page number and an offset within the page
- Each page may be located anywhere in main memory
- Real address or physical address in main memory

Virtual Memory Addressing

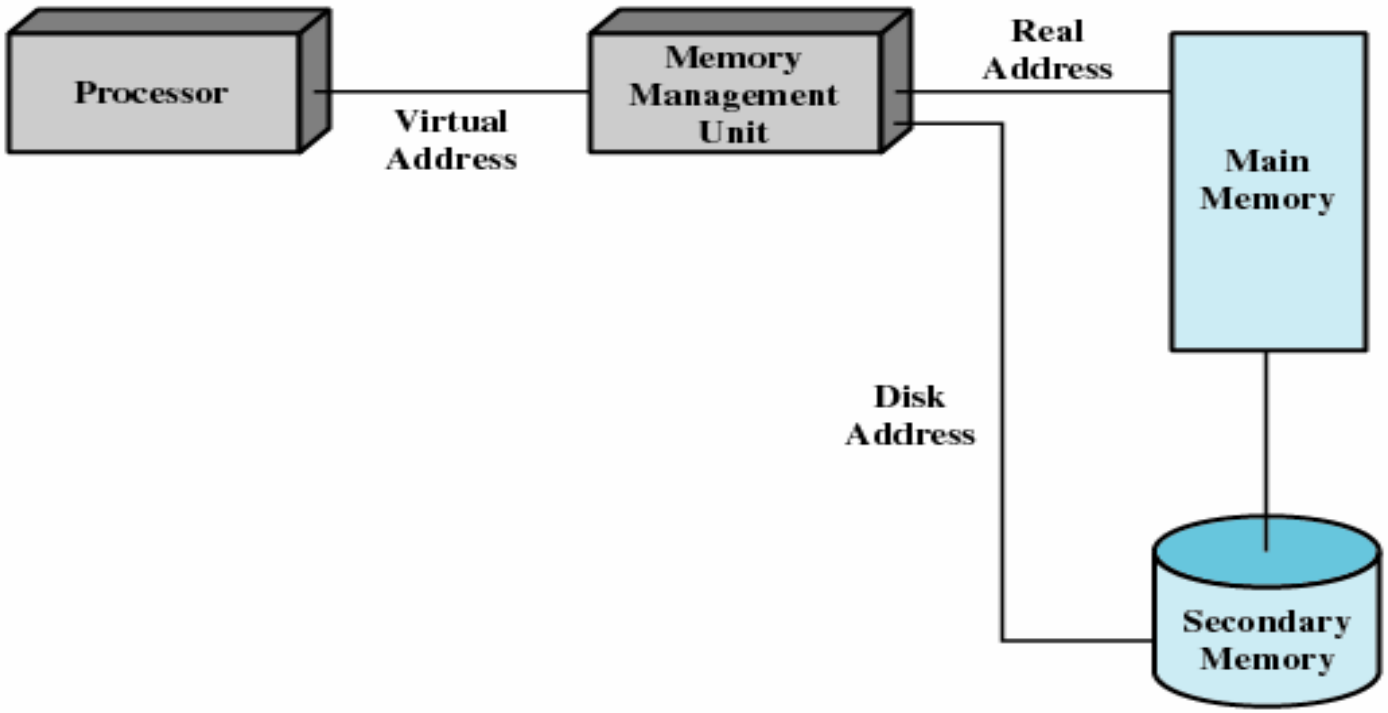

Figure 2.10 Virtual Memory Addressing

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Information Protection and Security

- Availability
  - Concerned with protecting the system against interruption
- Confidentiality
  - Assuring that users cannot read data for which access is unauthorized

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Information Protection and Security

- Data integrity
  - Protection of data from unauthorized modification
- Authenticity
  - Concerned with the proper verification of the identity of users and the validity of messages or data

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Scheduling and Resource Management

- Fairness
  - Give equal and fair access to resources
- Differential responsiveness
  - Discriminate among different classes of jobs
- Efficiency
  - Maximize throughput, minimize response time, and accommodate as many uses as possible

Key Elements of an Operating System

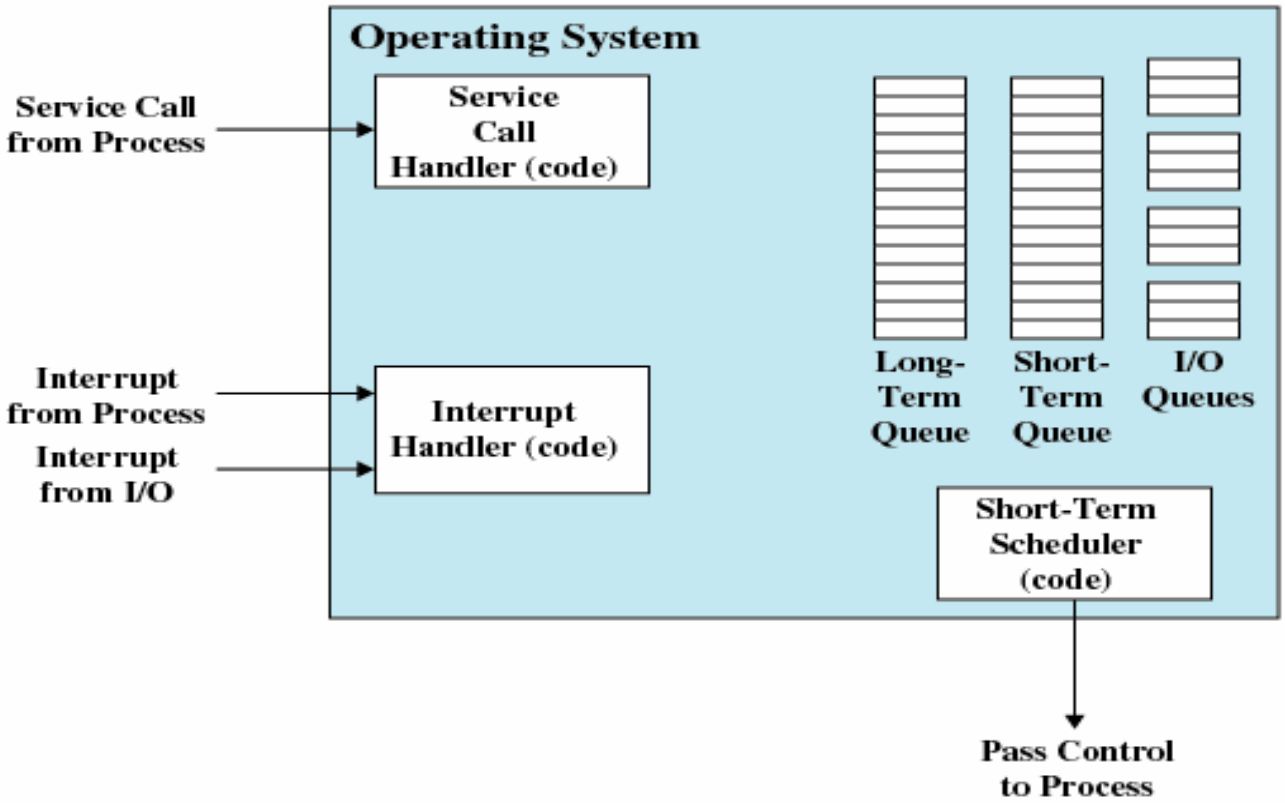

Figure 2.11 Key Elements of an Operating System for Multiprogramming

System Structure

- View the system as a series of levels
- Each level performs a related subset of functions
- Each level relies on the next lower level to perform more primitive functions
- This decomposes a problem into a number of more manageable subproblems

Process Hardware Levels

- Level 1
  - Electronic circuits
  - Objects are registers, memory cells, and logic gates
  - Operations are clearing a register or reading a memory location
- Level 2
  - Processor's instruction set
  - Operations such as add, subtract, load, and store

Process Hardware Levels

- Level 3
  - Adds the concept of a procedure or subroutine, plus call/return operations
- Level 4
  - Interrupts

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Concepts with Multiprogramming

- Level 5
  - Process as a program in execution
  - Suspend and resume processes
- Level 6
  - Secondary storage devices
  - Transfer of blocks of data
- Level 7
  - Creates logical address space for processes
  - Organizes virtual address space into blocks

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Deal with External Objects

- Level 8
  - Communication of information and messages between processes
- Level 9
  - Supports long-term storage of named files
- Level 10
  - Provides access to external devices using standardized interfaces

Deal with External Objects

- Level 11
  - Responsible for maintaining the association between the external and internal identifiers
- Level 12
  - Provides full-featured facility for the support of processes
- Level 13
  - Provides an interface to the operating system for the user

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Modern Operating Systems

- Microkernel architecture
  - Assigns only a few essential functions to the kernel
    - Address spaces
    - Interprocess communication (IPC)
    - Basic scheduling

Modern Operating Systems

- Multithreading
  - Process is divided into threads that can run concurrently
    - Thread
      - Dispatchable unit of work
      - executes sequentially and is interruptable
    - Process is a collection of one or more threads

Modern Operating Systems

- Symmetric multiprocessing (SMP)
  - There are multiple processors
  - These processors share same main memory and I/O facilities
  - All processors can perform the same functions

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Modern Operating Systems

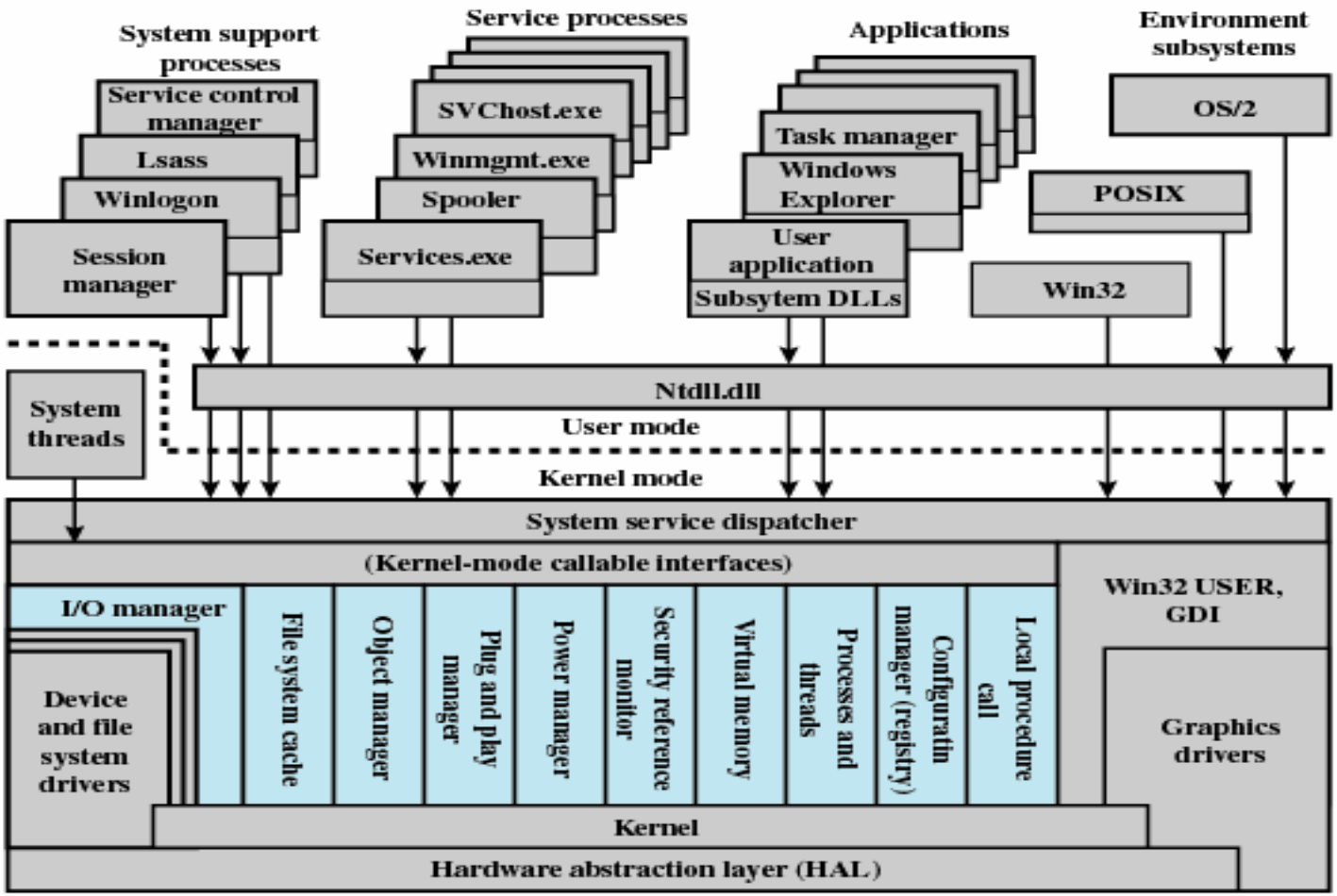
- Distributed operating systems
  - Provides the illusion of a single main memory space and single secondary memory space

Modern Operating Systems

- Object-oriented design
  - Used for adding modular extensions to a small kernel
  - Enables programmers to customize an operating system without disrupting system integrity

Windows Architecture

- Modular structure for flexibility
- Executes on a variety of hardware platforms
- Supports applications written for other operating systems



Lsass = local security authentication server
POSIX = portable operating system interface
GDI = graphics device interface
DLL = dynamic link libraries

Colored area indicates Executive

Figure 2.13 Windows 2000 Architecture [SOLO00]

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Operating System Organization

- Modified microkernel architecture
  - Not a pure microkernel
  - Many system functions outside of the microkernel run in kernel mode
- Any module can be removed, upgraded, or replaced without rewriting the entire system

Kernel-Mode Components

- Executive
  - Contains base operating system services
    - Memory management
    - Process and thread management
    - Security
    - I/O
    - Interprocess communication
- Kernel
  - Consists of the most used components

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Kernel-Mode Components

- Hardware abstraction layer (HAL)
  - Isolates the operating system from platform-specific hardware differences
- Device drivers
  - Translate user I/O function calls into specific hardware device I/O requests
- Windowing and graphics systems
  - Implements the graphical user interface (GUI)

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Windows Executive

- I/O manager
- Cache manager
- Object manager
- Plug and play manager
- Power manager
- Security reference monitor
- Virtual memory manager
- Process/thread manager
- Configuration manager
- Local procedure call (LPC) facility

User-Mode Processes

- Special system support processes
  - Ex: logon process and the session manager
- Service processes
- Environment subsystems
- User applications

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Client/Server Model

- Simplifies the Executive
  - Possible to construct a variety of APIs
- Improves reliability
  - Each service runs on a separate process with its own partition of memory
  - Clients cannot not directly access hardware
- Provides a uniform means for applications to communicate via LPC
- Provides base for distributed computing

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Threads and SMP

- Operating system routines can run on any available processor
- Different routines can execute simultaneously on different processors
- Multiple threads of execution within a single process may execute on different processors simultaneously
- Server processes may use multiple threads
- Share data and resources between process

Windows Objects

- Encapsulation
  - Object consists of one or more data items and one or more procedures
- Object class or instance
  - Create specified instances of an object
- Inheritance
  - Support to some extent in the Executive
- Polymorphism

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UNIX

- Hardware is surrounded by the operating system software
- Operating system is called the system kernel
- Comes with a number of user services and interfaces
  - Shell
  - Components of the C compiler

UNIX

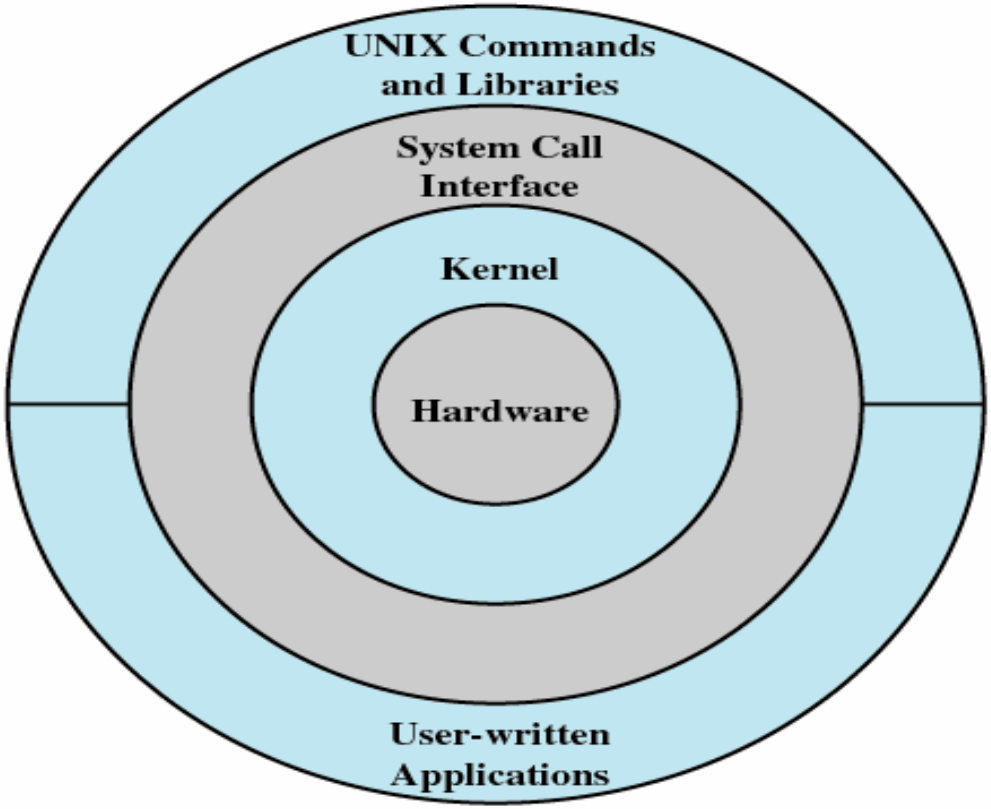

Figure 2.14 General UNIX Architecture

UNIX Kernel

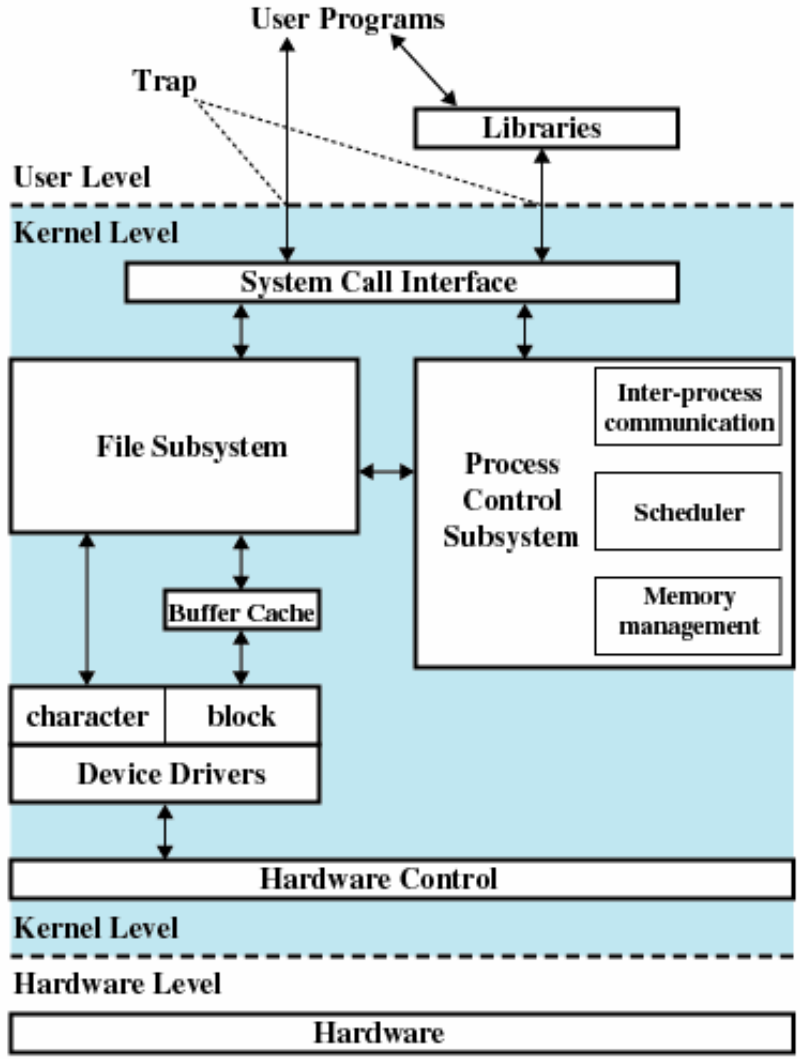

Figure 2.15 Traditional UNIX Kernel [BACH86]

Modern UNIX Kernel

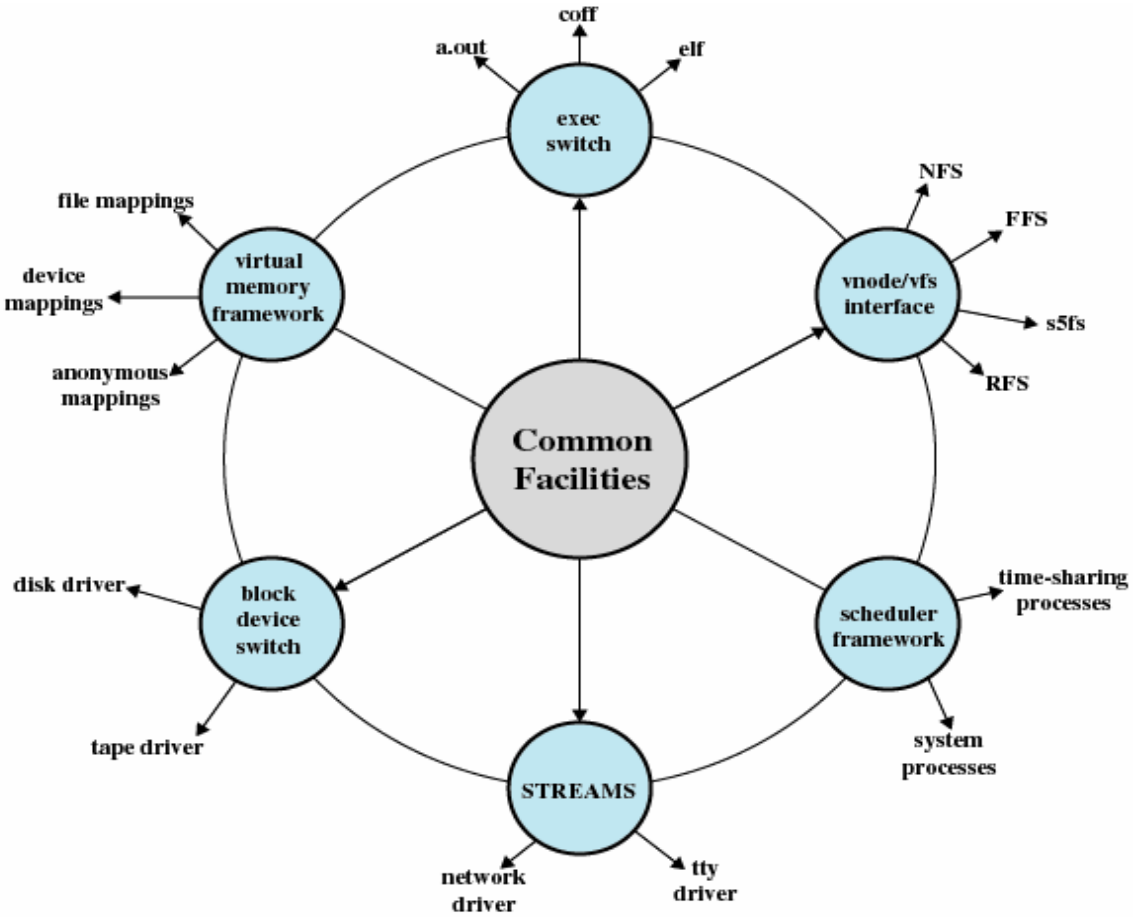

Figure 2.16 Modern UNIX Kernel [VAHA96]

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Modern UNIX Systems

- System V Release 4 (SVR4)
- Solaris 9
- 4.4BSD
- Linux

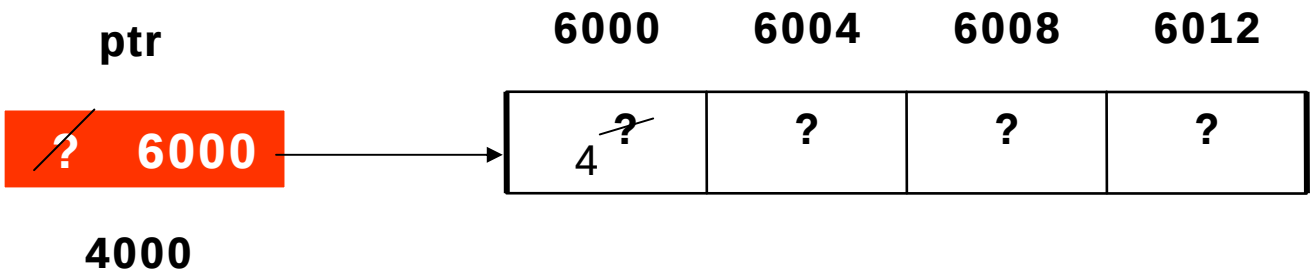
Review of more C

Dynamic memory allocation

- Explicit allocation and de-allocation

```
Example 11
#include <stdio.h>

int
main(int argc, char *argv[])
{
    int *ptr;  /* allocate space to hold an int */

    ptr = (int*)malloc(4 * sizeof(int));

    /* do stuff with the space */
    *ptr=4; //ptr[0] = 4;

    free(ptr);  /* free up the allocated space */
    return 0;
}
```

```
int *ptr;
ptr = (int*)malloc(4 * sizeof(int));
*ptr=4;
```




```
free (ptr);
```

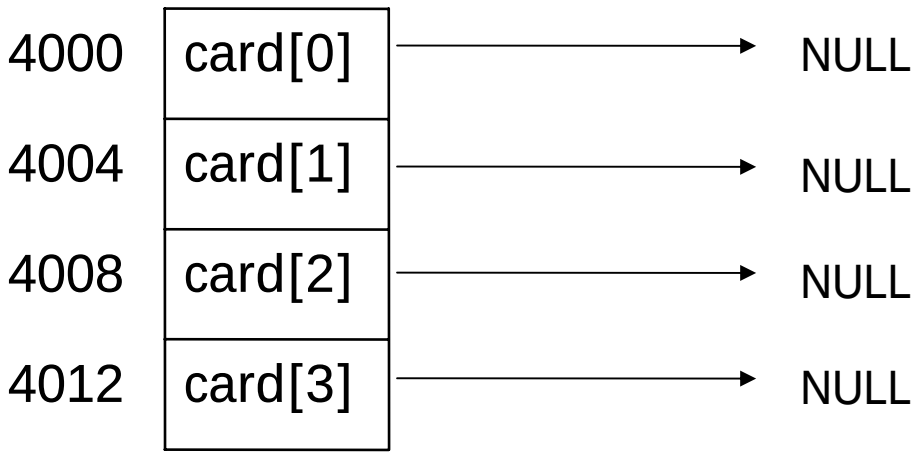
Dynamic array

```
int *ptr, i, size;

printf(“Enter the size of the array”);
scanf(“%d”,&size)

ptr = (int*)malloc( size x sizeof(int) );
for(i=0; i<size; i++){
     ptr[i] = i;
}
```

Array of pointers

- Variable length strings

```
char *card[4]; //card[4] => array of 4 elements
               //char* => element is a pointer to
               //a character.
               //*card[4] => array of 4 pointers
```



```
card[0] = (char*)malloc(6*sizeof(char));
card[1] = (char*)malloc(3*sizeof(char));
```

and so on

Static allocation of a 2D array:

```
char card[4][10];  //waste of space
```

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Common errors – memory leak

```
int *ptr, x;
ptr = (int*)malloc(10*sizeof(int));
  //ptr gets space starting at address 3000
ptr = &x;
```

- The space allocated through malloc is no longer available for use by the program.
- Released only when program quits.
- Becomes a problem in large programs where a large number of variables are created and destroyed during the execution of the program.

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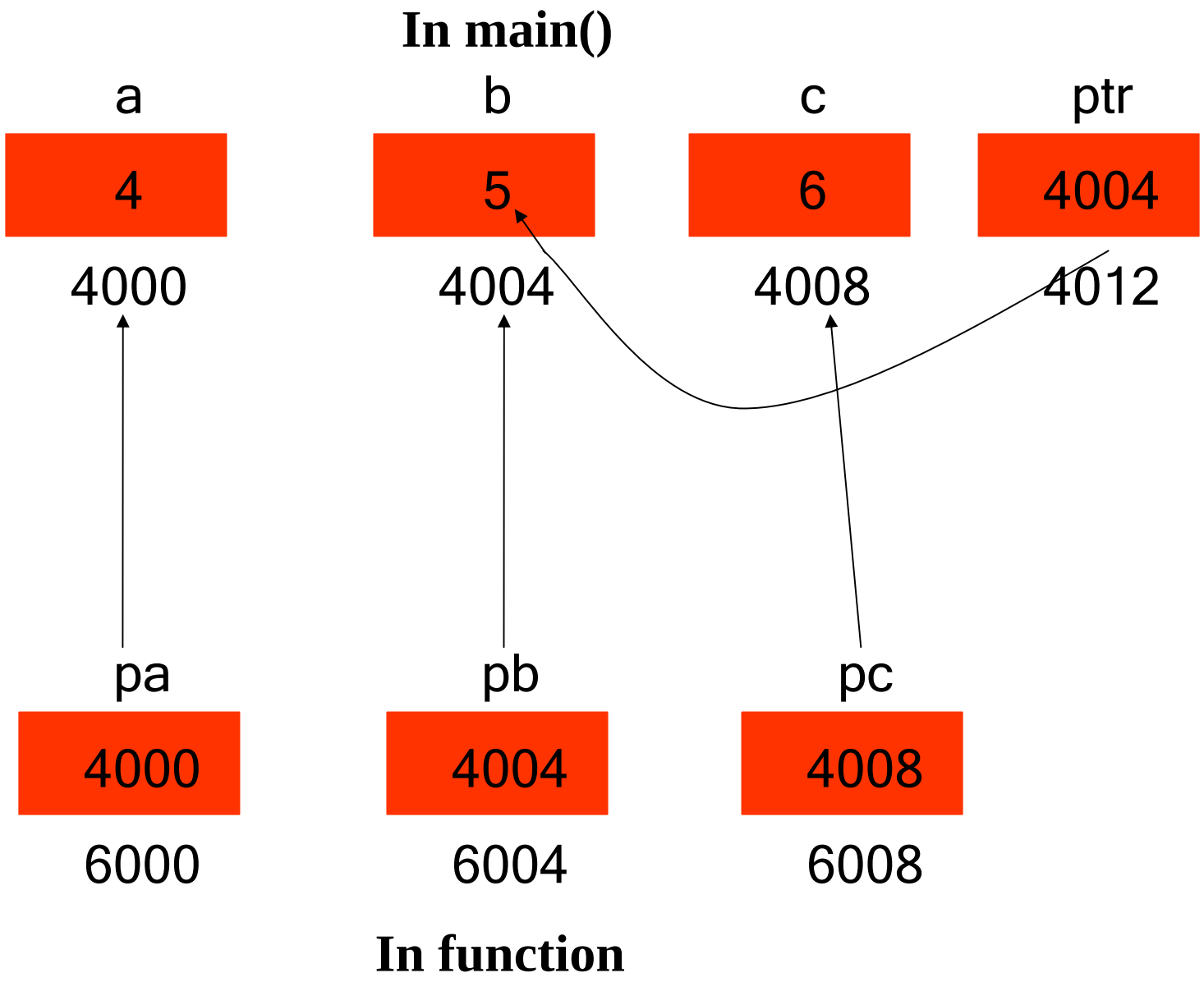
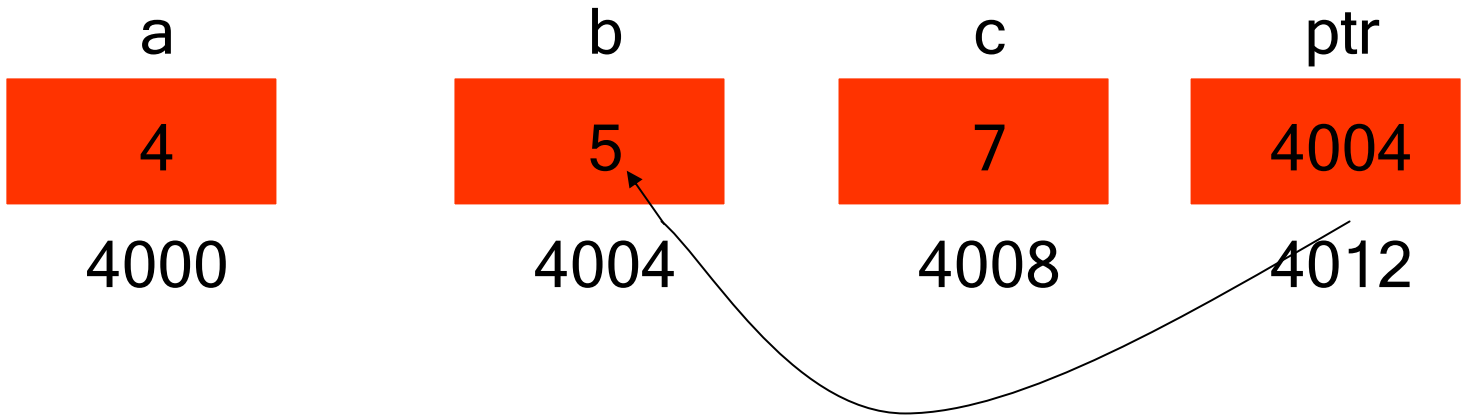
Common errors – dangling pointers

```
int *i, *x;

i = (int*)malloc( 5 x sizeof(int));
x = i;     // both point to the same address.

free(x);  /* both i and x are dangling pointers
             and trying to access either of them
             can cause logical errors
           */

x = NULL;  /* One way to prevent incorrect access */
i = NULL;
```

Functions – pointers as arguments

```
#include <stdio.h>
int sumAndInc(int *pa, int *pb, int* pc);

int
main(int argc, char *argv[])
{
   int a=4, b=5, c=6;
   int *ptr = &b;
   int total = sumAndInc(&a,ptr,&c);
                        /* call to the function */
   printf("The sum of 4 and 5 is %d and c is %p\n", total, c);
}
int sumAndInc(int *pa, int *pb, int *pc ){
                        /* pointers as arguments */
      *pc = *pc+1;      /* return a pointer value */
                        /* NOT *(pc+1) */
      return (*pa+*pb);  /* return by value */
}
```

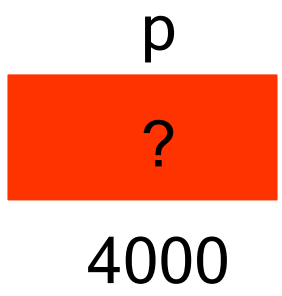

In main()
a
b
c
ptr
4
5
6
4004
4000
4004
4008
4012
pa
pb
pc
4000
4004
4008
6000
6004
6008
In function



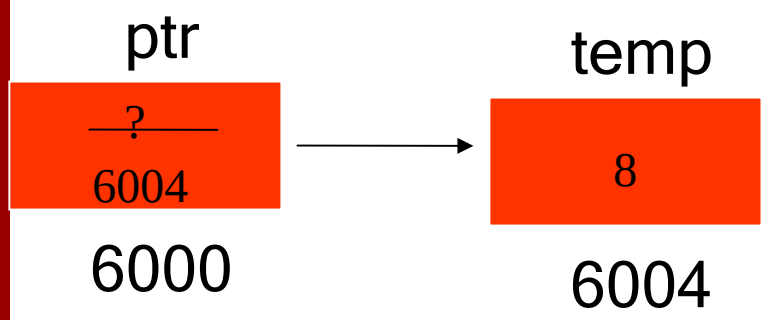
In main() after the function call

What's wrong with this?

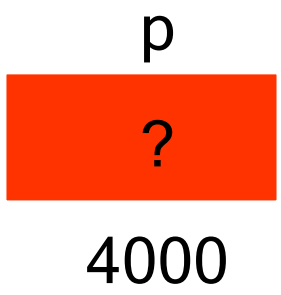
```
#include <stdio.h>

void DoSomething(int *ptr);

int
main(int argc, char *argv[]) {
   int *p;
   DoSomething(p);
   printf("%d", *p);      /* will this work ? */
   return 0;
}

void DoSomething(int *ptr){ /* passed and returned by
                                        reference */
  int temp= 5+3;
  ptr = &(temp);
}

/* compiles correctly, but gives incorrect output */
```



In main()



In the function



In main() after the function call