UNIT I

INTRODUCTION

Introduction

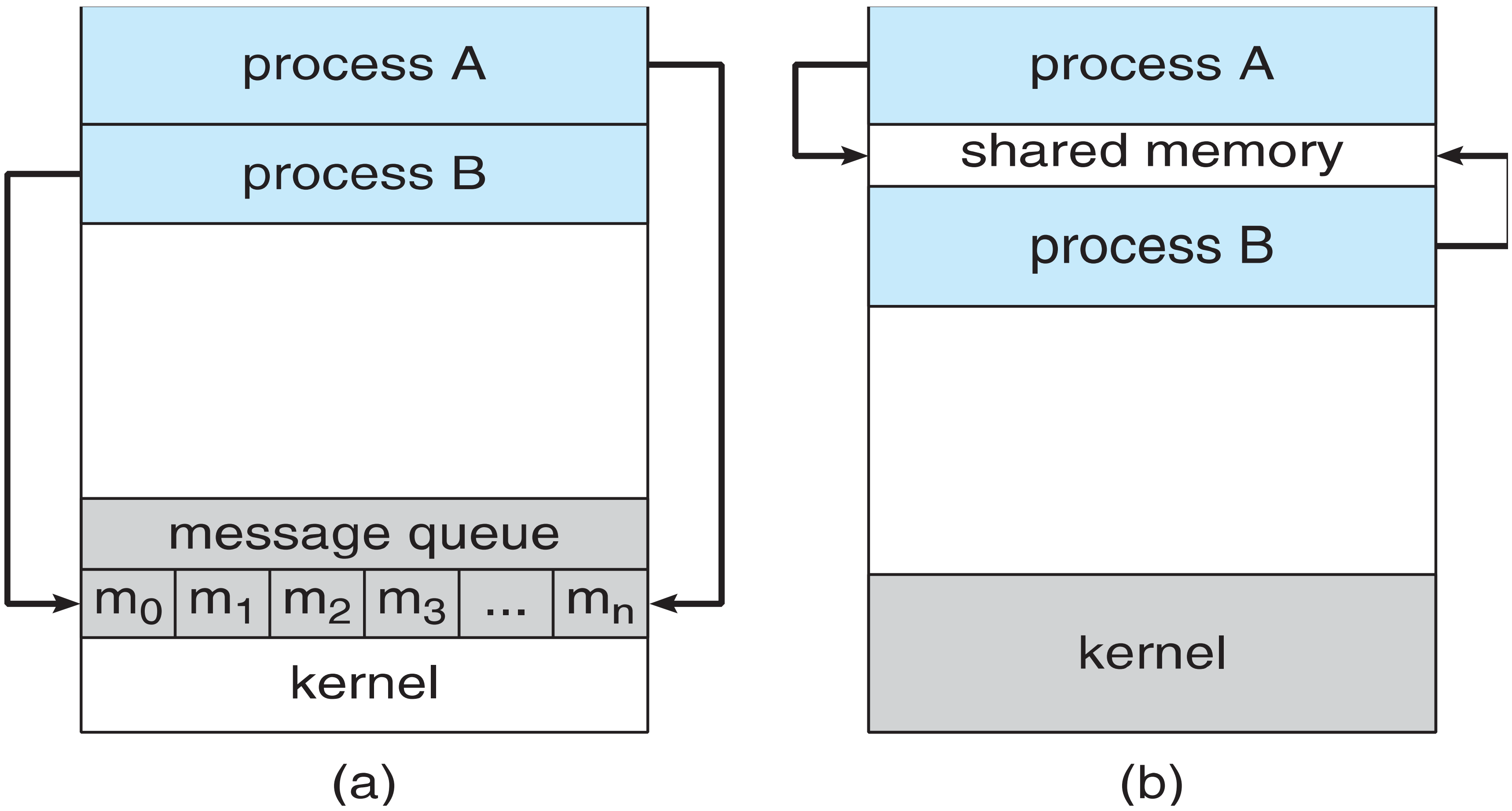
- **Introduction**
  - What Operating Systems Do
  - Computer-System Architecture
  - Operating-System Structure
  - Operating-System Operations
  - Operating-System Services
  - User Operating System Interface
  - System Calls
  - Types of System Calls
  - System Programs
  - System Boot
- **Process Concept**
  - Process Scheduling
  - Operations on Processes
  - **Interprocess Communication**

Interprocess Communication

- Processes within a system may be ***independent*** or ***cooperating***
- Cooperating process can affect or be affected by other processes, including sharing data
- Reasons for cooperating processes:
  - Information sharing
  - Computation speedup
  - Modularity
  - Convenience
- Cooperating processes need **interprocess communication** (**IPC**)
- Two models of IPC
  - **Shared memory**
  - **Message passing**

Communications Models

(a) Message passing. (b) shared memory.



Cooperating Processes

- ***Independent*** process cannot affect or be affected by the execution of another process
- ***Cooperating*** process can affect or be affected by the execution of another process
- Advantages of process cooperation
  - Information sharing
  - Computation speed-up
  - Modularity
  - Convenience

Producer-Consumer Problem

- Paradigm for cooperating processes, *producer* process produces information that is consumed by a *consumer* process
  - **unbounded-buffer** places no practical limit on the size of the buffer
  - **bounded-buffer** assumes that there is a fixed buffer size

Bounded-Buffer – Shared-Memory Solution

- Shared data

```
#define BUFFER_SIZE 10
typedef struct {
   . . .
} item;
item buffer[BUFFER_SIZE];
int in = 0;
int out = 0;
```

- Solution is correct, but can only use BUFFER_SIZE-1 elements

Bounded-Buffer – Producer

```
item next_produced;

while (true) {

        /* produce an item in next produced */

        while (((in + 1) % BUFFER_SIZE) == out)

                ; /* do nothing */

        buffer[in] = next_produced;

        in = (in + 1) % BUFFER_SIZE;

}
```

Bounded Buffer – Consumer

```
item next_consumed;

while (true) {
        while (in == out)
                ; /* do nothing */
        next_consumed = buffer[out];
        out = (out + 1) % BUFFER_SIZE;
        /* consume the item in next consumed */
}
```

Interprocess Communication – Shared Memory

- An area of memory shared among the processes that wish to communicate
- The communication is under the control of the users processes not the operating system.
- Major issues is to provide mechanism that will allow the user processes to synchronize their actions when they access shared memory.

Interprocess Communication – Message Passing

- Mechanism for processes to communicate and to synchronize their actions
- Message system – processes communicate with each other without resorting to shared variables
- IPC facility provides two operations:
  - **`send`**(*message*)
  - **`receive`**(*message*)
- The *message* size is either fixed or variable

Message Passing (Cont.)

- If processes *P* and *Q* wish to communicate, they need to:
  - Establish a ***communication link*** between them
  - Exchange messages via send/receive
- Implementation issues:
  - How are links established?
  - Can a link be associated with more than two processes?
  - How many links can there be between every pair of communicating processes?
  - What is the capacity of a link?
  - Is the size of a message that the link can accommodate fixed or variable?
  - Is a link unidirectional or bi-directional?

Message Passing (Cont.)

Implementation of communication link

- Physical:
  - Shared memory
  - Hardware bus
  - Network
- Logical:
  - Direct or indirect
  - Synchronous or asynchronous
  - Automatic or explicit buffering

Direct Communication

- Processes must name each other explicitly:
  - **send** (*P*, *message*) – send a message to process P
  - **receive**(*Q*, *message*) – receive a message from process Q
- Properties of communication link
  - Links are established automatically
  - A link is associated with exactly one pair of communicating processes
  - Between each pair there exists exactly one link
  - The link may be unidirectional, but is usually bi-directional

Indirect Communication

- Messages are directed and received from mailboxes (also referred to as ports)
  - Each mailbox has a unique id
  - Processes can communicate only if they share a mailbox
- Properties of communication link
  - Link established only if processes share a common mailbox
  - A link may be associated with many processes
  - Each pair of processes may share several communication links
  - Link may be unidirectional or bi-directional

Indirect Communication

- Operations
  - create a new mailbox (port)
  - send and receive messages through mailbox
  - destroy a mailbox
- Primitives are defined as:

`send`(*A*, *message*) – send a message to mailbox A

`receive`(*A*, *message*) – receive a message from mailbox A

Indirect Communication

- Mailbox sharing
  - P_1, P_2, and P_3 share mailbox A
  - P_1, sends; P_2 and P_3 receive
  - Who gets the message?
- Solutions
  - Allow a link to be associated with at most two processes
  - Allow only one process at a time to execute a receive operation
  - Allow the system to select arbitrarily the receiver. Sender is notified who the receiver was.

Synchronization

- Message passing may be either blocking or non-blocking
- **Blocking** is considered **synchronous**
  - **Blocking send** -- the sender is blocked until the message is received
  - **Blocking receive** -- the receiver is blocked until a message is available
- **Non-blocking** is considered **asynchronous**
  - **Non-blocking send** -- the sender sends the message and continue
  - **Non-blocking receive** -- the receiver receives:

    - A valid message, or Null message

Synchronization (Cont.)

Producer-consumer becomes trivial

```
    message next_produced;
    while (true) {
       /* produce an item in next produced */
    send(next_produced);
    }
 message next_consumed;
 while (true) {
   receive(next_consumed);

   /* consume the item in next consumed */
 }
```

Buffering

- Queue of messages attached to the link.
- implemented in one of three ways

1. Zero capacity – no messages are queued on a link.

   Sender must wait for receiver (rendezvous)

2. Bounded capacity – finite length of *n* messages

   Sender must wait if link full

3. Unbounded capacity – infinite length

   Sender never waits

Examples of IPC Systems - POSIX

POSIX Shared Memory

- Process first creates shared memory segment

```
shm_fd = shm_open(name, O CREAT | O RDWR, 0666);
```

- Also used to open an existing segment to share it
- Set the size of the object

```
ftruncate(shm fd, 4096);
```

- Now the process could write to the shared memory
- `sprintf(shared memory, "Writing to shared memory");`

Examples of IPC Systems - Mach

- Mach communication is message based
  - Even system calls are messages
  - Each task gets two mailboxes at creation- Kernel and Notify
  - Only three system calls needed for message transfer

    `msg_send(), msg_receive(), msg_rpc()`
  - Mailboxes needed for commuication, created via **`port_allocate()`**
  - Send and receive are flexible, for example four options if mailbox full:
    - Wait indefinitely
    - Wait at most n milliseconds
    - Return immediately
    - Temporarily cache a message

TEXT BOOK

1. Abraham Silberschatz, Peter B. Galvin, “Operating System Concepts”, 10th Edition, John Wiley & Sons, Inc., 2018.

2. Jane W. and S. Liu. “Real-Time Systems”. Prentice Hall of India 2018.

3. Andrew S Tanenbaum, Herbert Bos, Modern Operating Pearson , 2015.

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3. P.C.Bhatt, “An Introduction to Operating Systems–Concepts and Practice",4th Edition, Prentice Hall of India., 2013.

THANK YOU