SNS COLLEGE OF TECHNOLOGY

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COURSE NAME : OPERATING SYSTEMS

II YEAR/ IV SEMESTER

UNIT – II PROCESS SCHEDULING AND SYNCHRONIZATION

Topic: Process Synchronization-Critical Section Problem

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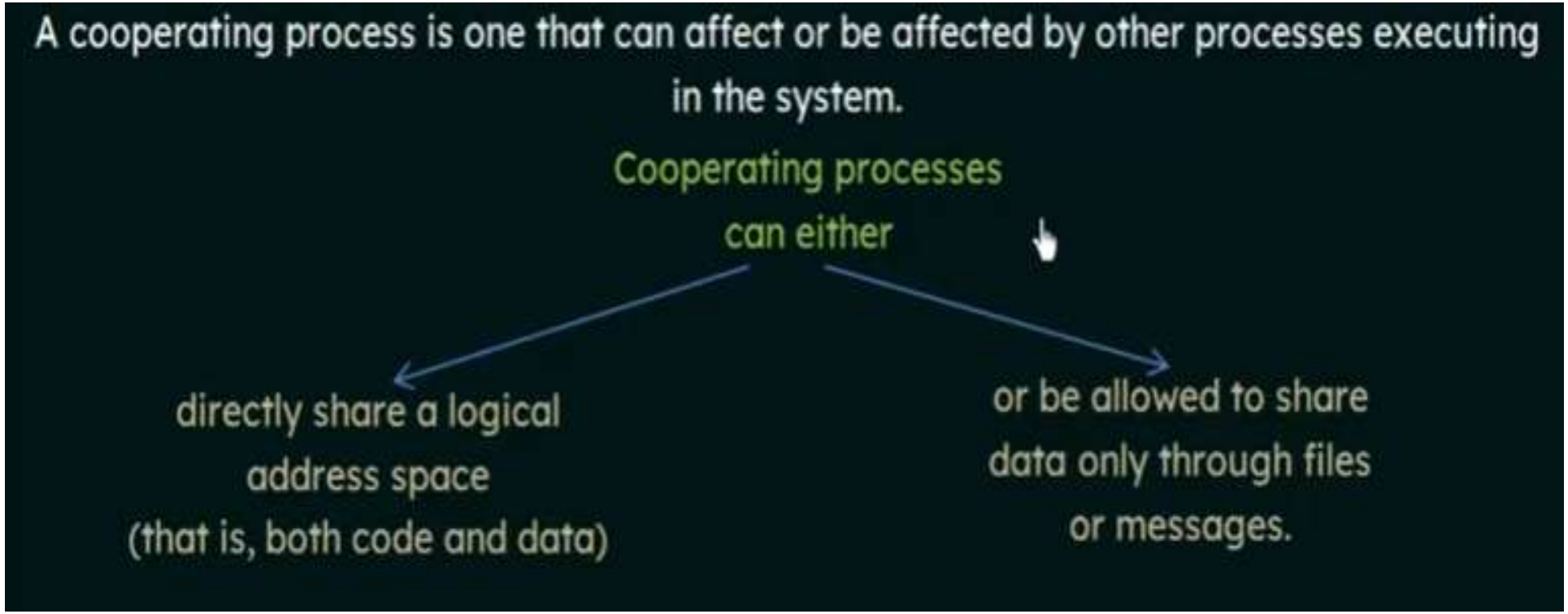
Process Synchronization



- Concurrent Access to shared data may result in data consistency

- Various Mechanisms to ensure orderly execution of Cooperating Processes that share a logical address space

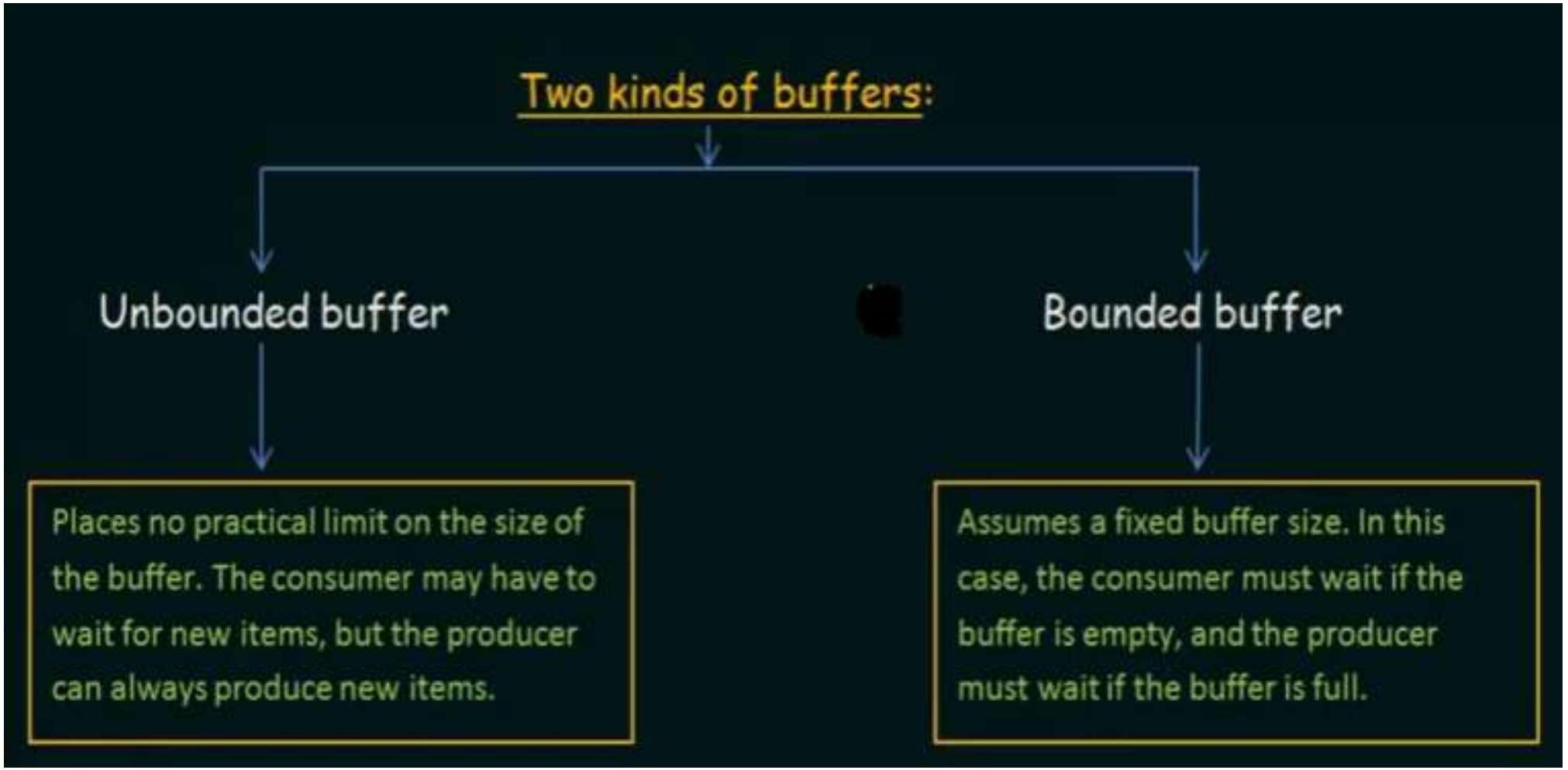
Process Synchronization

A Producer Process produces information that is consumed by a Consumer Process

For example, a compiler may produce assembly code, which is consumed by an assembler. The assembler, in turn, may produce object modules, which are consumed by the loader.

- One solution to the producer-consumer problem uses shared memory.
- To allow producer and consumer processes to run concurrently, we must have available a buffer of items that can be filled by the producer and emptied by the consumer.
- This buffer will reside in a region of memory that is shared by the producer and consumer processes.
- A producer can produce one item while the consumer is consuming another item.
- The producer and consumer must be synchronized, so that the consumer does not try to consume an item that has not yet been produced.

Process Synchronization



Process Synchronization

counter variable = 0

counter is incremented every time we add a new item to the buffer — counter++

counter is decremented every time we remove one item from the buffer — counter--

----------Example----------

- Suppose that the value of the variable counter is currently 5.
- The producer and consumer processes execute the statements "counter++" and "counter--" concurrently.
- Following the execution of these two statements, the value of the variable counter may be 4, 5, or 6!
- The only correct result, though, is counter == 5, which is generated correctly if the producer and consumer execute separately.

Process Synchronization

"counter++" may be implemented in machine language (on a typical machine) as:

$register_1$ = counter
$register_1$ = $register_1$ + 1
counter = $register_1$

"counter--" may be implemented in machine language (on a typical machine) as:

$register_2$ = counter
$register_2$ = $register_2$ - 1
counter = $register_2$

T_0:	producer	execute	$register_1$	=	counter	{ $register_1$ = 5 }
T_1:	producer	execute	$register_1$	=	$register_1$ + 1	{ $register_1$ = 6 }
T_2:	consumer	execute	$register_2$	=	counter	{ $register_2$ = 5 }
T_3:	consumer	execute	$register_2$	=	$register_2$ - 1	{ $register_2$ = 4 }
T_4:	producer	execute	counter	=	$register_1$	{ counter = 6 }
T_5:	consumer	execute	counter	=	$register_2$	{ counter = 4 }

Process Synchronization

T_0:	producer	execute	$register_1$	=	counter	{ $register_1$ = 5 }
T_1:	producer	execute	$register_1$	=	$register_1$ + 1	{ $register_1$ = 6 }
T_2:	consumer	execute	$register_2$	=	counter	{ $register_2$ = 5 }
T_3:	consumer	execute	$register_2$	=	$register_2$ - 1	{ $register_2$ = 4 }
T_4:	producer	execute	counter	=	$register_1$	{ counter = 6 }
T_5:	consumer	execute	counter	=	$register_2$	{ counter = 4 }

We would arrive at this incorrect state because we allowed both processes to manipulate the variable counter concurrently.

A situation like this, where several processes access and manipulate the same data concurrently and the outcome of the execution depends on the particular order in which the access takes place, is called a race condition.

Process Synchronization

The Critical-Section Problem

Consider a system consisting of n processes $\{P_0, P_1, \ldots, P_n\}$.

Each process has a segment of code, called a

critical section

in which the process may be changing common variables, updating a table, writing a file, and so on.

When one process is executing in its critical section, no other process is to be allowed to execute in its critical section.

That is, no two processes are executing in their critical sections at the same time.

The critical-section problem is to design a protocol that the processes can use to cooperate.

Process Synchronization

- Each process must request permission to enter its critical section.
- The section of code implementing this request is the entry section.
- The critical section may be followed by an exit section.
- The remaining code is the remainder section.

```
do {
        entry section
            critical section
        exit section
            remainder section
} while (TRUE);
```

Figure: General structure of a typical process.

Process Synchronization

A solution to the critical-section problem must satisfy the following three requirements:

1. Mutual exclusion:

If process P_i is executing in its critical section, then no other processes can be executing in their critical sections.

2. Progress:

If no process is executing in its critical section and some processes wish to enter their critical sections, then only those processes that are not executing in their remainder sections can participate in the decision on which will enter its critical section next, and this selection cannot be postponed indefinitely.

3. Bounded waiting:

There exists a bound, or limit, on the number of times that other processes are allowed to enter their critical sections after a process has made a request to enter its critical section and before that request is granted.

Process Synchronization

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References

1. Silberschatz, Galvin, and Gagne, “Operating System Concepts”, Ninth Edition, Wiley India Pvt Ltd, 2009.
2 . Andrew S. Tanenbaum, “Modern Operating Systems”, Fourth Edition, Pearson Education, 2010.


Thank
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