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COURSE NAME : 19CSB201 – OPERATING SYSTEMS

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UNIT – II Process Scheduling And Synchronization

Topic: Process Synchronization : Classic Problems of Synchronization

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Classic Problems of Synchronization

- The Bounded-Buffer Problem
- The Readers – Writers Problem
- The Dining-Philosophers Problem

The Bounded-Buffer Problem

In our problem, the producer and consumer processes share the following data structures:

```
int n;
semaphore mutex = 1;
semaphore empty = n;
semaphore full = 0
```

```
do {
    . . .
   /* produce an item in next_produced */
    . . .
   wait(empty);
   wait(mutex);
    . . .
   /* add next_produced to the buffer */
    . . .
   signal(mutex);
   signal(full);
} while (true);
```

Figure 5.9 The structure of the producer process.

```
do {
   wait(full);
   wait(mutex);
      . . .
   /* remove an item from buffer to next_consumed */
      . . .
   signal(mutex);
   signal(empty);
      . . .
   /* consume the item in next consumed */
      . . .
} while (true);
```

Figure 5.10 The structure of the consumer process.

- Note the symmetry between the producer and the consumer.

- We can interpret this code as the **producer producing full buffers** for the consumer or as the **consumer producing empty buffers** for the producer.

The Readers – Writers Problem

- Suppose that a database is to be shared among several concurrent processes. Some of these processes may want only to read the database, whereas others may want to update (that is, to read and write) the database. We distinguish between these two types of processes by referring to the former as readers and to the latter as writers. Obviously, if two readers access the shared data simultaneously, no adverse effects will result. However, if a writer and some other process (either a reader or a writer) access the database simultaneously, chaos may ensue. To ensure that these difficulties do not arise, we require that the writers have exclusive access to the shared database while writing to the database. This synchronization problem is referred to as the readers–writers problem.

The readers–writers problem has several variations, all involving priorities.

The simplest one, referred to as the **first** readers–writers problem, requires that **no reader be kept waiting** unless a writer has already obtained permission to use the shared object. In other words, no reader should wait for other readers to finish simply because a writer is waiting.

The **second** readers –writers problem requires that, once a writer is ready, that writer perform its write as soon as possible. In other words, if **a writer is waiting to access the object, no new readers may start reading**.

A solution to either problem may **result in starvation**. In the first case, writers may starve; in the second case, readers may starve.

In the solution to the first readers–writers problem, the reader processes share the following data structures:

```
semaphore rw_mutex = 1;
semaphore mutex = 1;
int read_count = 0;
```

```
do {
   wait(rw_mutex);
      . . .
   /* writing is performed */
      . . .
   signal(rw_mutex);
} while (true);
```

Figure 5.11 The structure of a writer process.

```
do {
   wait(mutex);
   read_count++;
   if (read_count == 1)
      wait(rw_mutex);
   signal(mutex);
      . . .
   /* reading is performed */
      . . .
   wait(mutex);
   read_count--;
   if (read_count == 0)
      signal(rw_mutex);
   signal(mutex);
} while (true);
```

Figure 5.12 The structure of a reader process.

The readers–writers problem and its solutions have been generalized to provide **reader–writer** locks on some systems. Acquiring a reader–writer lock requires specifying the mode of the lock: either *read* or *write* access. When a process wishes only to read shared data, it requests the reader–writer lock in read mode. A process wishing to modify the shared data must request the lock in write mode. Multiple processes are permitted to concurrently acquire a reader–writer lock in read mode, but only one process may acquire the lock for writing, as exclusive access is required for writers.

- In applications where it is easy to identify which processes only read shared data and which processes only write shared data.
- In applications that have more readers than writers. This is because reader–writer locks generally require more overhead to establish than semaphores or mutual-exclusion locks. The increased concurrency of allowing multiple readers compensates for the overhead involved in setting up the reader–writer lock.

The Dining-Philosophers Problem

Figure 5.13 The situation of the dining philosophers.

Thus, the shared data are

semaphore chopstick[5];

```
do {
   wait(chopstick[i]);
   wait(chopstick[(i+1) % 5]);
      . . .
   /* eat for awhile */
      . . .
   signal(chopstick[i]);
   signal(chopstick[(i+1) % 5]);
      . . .
   /* think for awhile */
      . . .
} while (true);
```

Figure 5.14 The structure of philosopher *i*.

Several possible remedies to the deadlock problem are replaced by:

- Allow at most four philosophers to be sitting simultaneously at the table.
- Allow a philosopher to pick up her chopsticks only if both chopsticks are available (to do this, she must pick them up in a critical section).
- Use an asymmetric solution—that is, an odd-numbered philosopher picks up first her left chopstick and then her right chopstick, whereas an even-numbered philosopher picks up her right chopstick and then her left chopstick.

A deadlock-free solution does not necessarily eliminate the possibility of starvation.

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THANK
YOU!