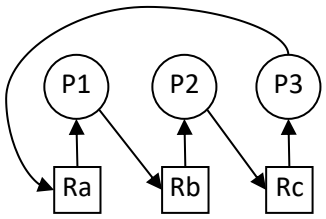
UECS2103/2403/2423 Operating Systems

Tutorial 5

1. Each process is allocated a resource and requests another resource that is allocated to other process.



2. Mutual exclusion, hold and wait, no pre-emption and circulate wait.

3. Resources available: 2, 3, 3, 2

	Needed			
	R1	R2	R3	R4
P1	2	1	1	0
P2	2	1	1	5
P3	2	5	0	3
P4	3	3	1	3

P1 completed, resources available: 3, 4, 4, 3
P4 completed, resources available: 4, 6, 5, 4
P3 completed, resources available: 4, 6, 6, 5
P2 completed, the system state is safe.

4.

a) Resources available after allocation: R1: 2, R2: 3, R3: 3, R4: 2
P1 runs to completion, resources available: 3 3 3 2
P3 runs to completion, resources available: 3 3 4 3
P2 runs to completion, resources available: 4 3 6 3
Neither P4 nor P5 can continue, thus the system state is unsafe.

b) If P4 is allocated 1 unit of R2, the resources still needed by P4 will be 1, 3, 4, 2. From part (a), the resources available after P2 completed are 4, 3, 6, 3, thus P4 can continue and run to completion. Then, the resources available are 6, 4, 7, 7; P5 will be able to continue and run to completion. The system will be in safe state.

5.

Process	Max	Hold	Claim	Free
1	70	45	25	15
2	60	40	20	
3	60	15	45	
4	60	35	25	

Insufficient free memory to guarantee the termination of any process, it is unsafe to grant the request.

UECS2103/2403/2423 Operating Systems
Tutorial 5

6.

a) Resources available after allocation: R1:1, R2:1, R3:0, R4:1
   1. Mark P4 (all zeros in allocation)
   2. W = (1 1 0 1)
   3. Mark P2; W = (1 1 0 1) + (0 1 1 1) = (1 2 1 2)
   4. No process can be marked. P1, P3 and P5 remain unmarked, deadlock occurs.

b) Abort P1, W = (1 2 1 2) + (1 0 0 1) = (2 2 1 3).
   Mark P3, W = (2 2 1 3) + (1 2 1 0) = (3 4 2 3).
   Mark P5. All processes are marked. Deadlock no longer exists.

7. Abort all the deadlocked processes.
   Backup each deadlocked process to some previously defined checkpoint and restart all the processes.
   Successively abort deadlocked processes until deadlock no longer exists.
   Successively pre-empt resources until deadlock no longer exists.

8. P4 is aborted, resources available = 0 0 1 2 + 1 1 1 1 = 1 1 2 3
   None of the processes able to execute, deadlock still exist.
   P2 is aborted, resources available = 1 1 2 3 + 1 1 0 1 = 2 2 2 4
   None of the processes able, deadlock still exist.
   P1 is aborted, resources available = 2 2 2 4 + 1 1 2 0 = 3 3 4 4
   With the resources available, P5 will be able to execute and followed by P3, the deadlock is resolved.

UECS2103/2403/2423 Operating Systems

Tutorial 6

1. Internal fragmentation refers to the wasted space internal to a fixed partition due to the fact that the block of data loaded is smaller than the partition.
   External fragmentation refers to the fact that a large number of small areas of main memory external to any partition accumulates in dynamic partitioning.

2.
```
128K | 128K | 16K | 16K| 32K | 64K | 128K | 256K | 256K
(102)  (120)  (16)             (50)          (200)
```

3. Request A: request 120KB

```
128K | 128K | 256K | 512K |
 A
```

Request B: request 20KB

```
128K | 32K | 32K | 64K | 256K | 512K |
 A      B
```

Request C: request 60KB

```
128K | 32K | 32K | 64K | 256K | 512K |
 A      B           C
```

Request D: request 230KB

```
128K | 32K | 32K | 64K | 256K | 512K |
 A      B           C     D
```

Release B.

```
128K | 64K | 64K | 256K | 512K |
 A            C     D
```

Request E: request 190KB

```
128K | 64K | 64K | 256K | 256K | 256K |
 A            C     D      E
```

Release C.

```
128K | 128K | 256K | 256K | 256K |
 A             D      E
```

Request F: request 100KB

```
128K | 128K | 256K | 256K | 256K |
 A      F      D      E
```

4. Simple paging: all the pages of a process must be in main memory for process to run, unless overlays are used.
   Virtual memory paging: not all pages of a process need be in main memory frames for the process to run; pages may be read in as needed.

5.
   a) 8GB / 8KB = 1 mil. pages
      page table is 1 mil. × 4 bytes = 4 MB

   b) user page table is 4MB, 4MB / 8KB = 500 pages
      Root page table is 500 × 4 bytes = 2KB

6. A phenomenon in virtual memory schemes, in which the processor spends most of its time swapping pieces rather than executing instructions.

7. The TLB is a cache that contains those page table entries that have been most recently used. Its purpose is to avoid, most of the time, having to go to disk to retrieve a page table entry.

UECS2103/2403/2423 Operating Systems
Tutorial 7

1.

i. page # = 156, offset = 117, frame # = 992, real address = 992 + 117 = 1109

ii. page # = 35, offset = 27, frame number = 357, real address = 357 + 27 = 384

iii. page # = 36, frame # is unknown, that means the page is not loaded into memory yet, real address remain unknown until the page has been loaded into memory.

2.

a. LRU

```
1 2 5 1 3 2 4 5 2 4 3 5 6 2 4 1 6
---------------------------------
1 1 1 1 1 1 4 4 4 4 4 4 6 6 6 1 1
- 2 2 2 3 3 3 5 5 5 3 3 3 2 2 2 6
- - 5 5 5 2 2 2 2 2 2 5 5 5 4 4 4
F F F   F F F F     F F F F F F F
```

b. FIFO

```
1 2 5 1 3 2 4 5 2 4 3 5 6 2 4 1 6
---------------------------------
1 1 1 1 3 3 3 3 3 3 3 5 5 5 5 1 1
- 2 2 2 2 2 4 4 4 4 4 4 6 6 6 6 6
- - 5 5 5 5 5 5 2 2 2 2 2 2 4 4 4
F F F   F   F   F     F F   F F
```

c. CLOCK

```
 1  2  5  1  3  2  4  5  2  4  3  5  6  2  4  1  6
 ------------------------------------------------
 1  1 >1  1  3  3 >3  3  2  2  2 >2  6  6 >6  1  1
>-  2  2  2 >2 >2  2  5 >5 >5  3  3 >3  2  2 >2  6
 - >-  5  5  5  5  4 >4  4  4 >4  5  5 >5  4  4 >4
 F  F  F     F     F  F  F     F  F  F  F  F  F  F
```

3.

a) 1052
1052 = 1024 + 28 maps to VPN 1 in PFN 7
physical address = 7 × 1024+28 = 7196

b) 2221
2221 = 2 × 1024 + 173 maps to VPN 2, page fault

c) 5499
5499 = 5 × 1024 + 379 maps to VPN 5 in PFN 0
physical address = 0 × 1024+379 = 379

4. Extract segment number and offset from the virtual address. Get the starting address and the length of the segment from segment table, compare the offset to the length of the segment, if the offset is greater or equal to the length, the address is invalid, else combine the starting address and the offset to get the real address.

5. User's space is divided into segments. Each segment is divided into fixed-size pages.
   To translate virtual address to physical address, extract the segment number, page number and the offset from the virtual address.
   Use the segment number to get the reference to the appropriate page table from segment table entry.
   Use the page number to get the frame number from the page table.
   The physical address is the combination of frame number and the offset.

UECS2103/2403/2423 Operating Systems
Tutorial 8

1.

a)

FIFO		SSTF		SCAN		C-SCAN	
Next accessed	No. of tracks traversed	Next accessed	No. of tracks traversed	Next accessed	No. of tracks traversed	Next accessed	No. of tracks traversed
155	40	109	6	123	8	123	8
21	134	97	12	153	30	153	30
58	37	123	26	155	2	155	2
109	51	153	30	270	115	270	115
123	14	155	2	309	39	309	39
309	186	58	97	397	88	397	8
397	88	21	37	109	288	21	376
270	127	270	249	97	12	58	37
97	173	309	39	58	39	97	39
153	56	397	88	21	37	109	12
Total	906	Total	586	Total	658	Total	746
Average	90.6	Average	58.6	Average	65.8	Average	74.6

b)

SCAN		C-SCAN	
Next accessed	No. of tracks traversed	Next accessed	No. of tracks traversed
109	6	109	6
97	12	97	12
58	39	58	39
21	37	21	37
123	102	397	376
153	30	309	88
155	2	270	39
270	115	155	115
309	39	153	2
397	88	123	30
Total	470	Total	744
Average	47.0	Average	74.4

2. Seek time and rotational latency.

3. If a file is stored in a cluster of nearby blocks, it would be beneficial to SSTF as it always accesses the nearest block.
   C-SCAN is affected by the moving direction of disk arm, if the arm is moving away from the block cluster, the seek time will be longer as C-SCAN always move in the same direction to serve all requests.

4. In early stage, there might be no significant effect to both methods as a lot of blocks available.
   The process of deleting and storing files that occur in long run will cause the contiguous allocation method unable to find contiguous blocks for allocation.
   Compaction, which is time consuming has to be carried out in order to combine all available blocks into a single contiguous block.

Chained allocation will not be affected by the scattered available blocks because the allocation is done by block basis. However, this method will lose the advantage in the principle of locality and might require longer time to access files.

Consolidation, which is time consuming, has to be done so that all files are stored in contiguous blocks in order to gain the advantage of principle of locality.

5.

a) Using the contiguous blocks allocation, there is no issue in the early stage as large number of contiguous blocks are available.

   However, as more files are stored and deleted over the time, it is possible that the available contiguous blocks are insufficient to store a file.

   Time consuming compaction has to be carried out in order to combine free blocks into contiguous blocks.

   The usage of storage is more effective in individual block allocation approach because any unused block can be allocated regardless the location.

   However, contiguous blocks allocation makes I/O more efficient. The seek time is minimal compared to individual block allocation approach.

b) A video file will be stored in contiguous tracks.

   In SSTF policy, most probably the video file will be read without longer delay since its location is the nearest to current location.

   In SCAN policy, the delay is depending on the disk arm direction.

   If the disk arm is moving away from the track that store video, the delay will be longer.

   If the disk arm is moving to the track that store video, then there should be no significant delay between the 2 policies.