

A.

In fixed sized partitioning, a process will be assigned a block of contiguous memory.

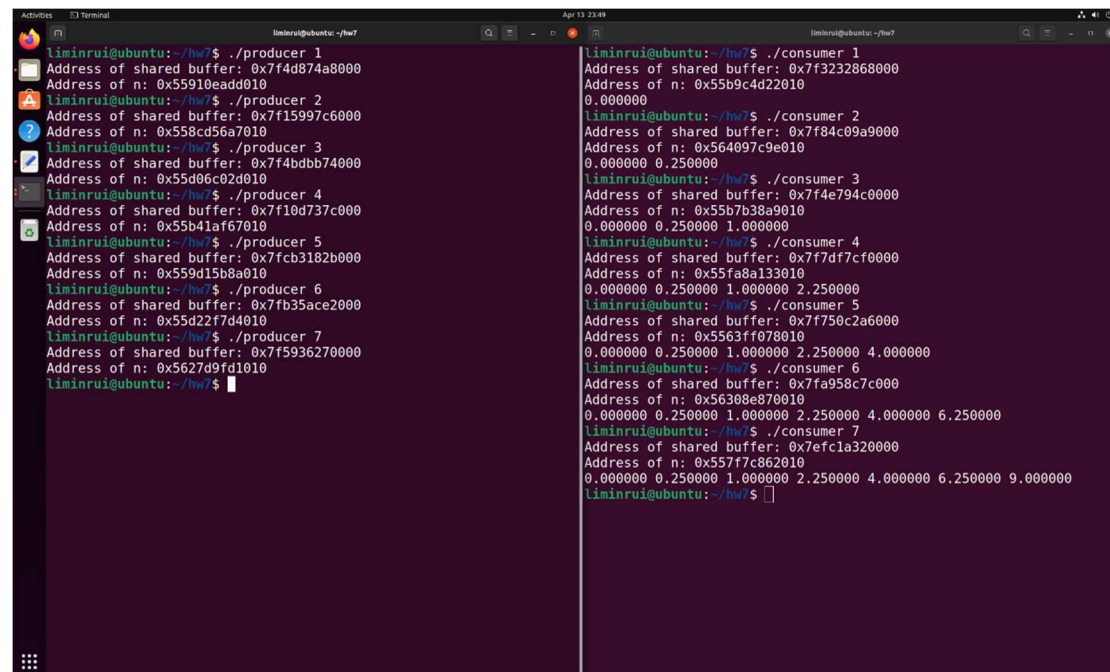
In paging, a process could have multiple non-contiguous blocks of memory.

B.

1) In paging, program is divided into several fixed size blocks. In segment, program is divided into several variable size blocks;

2) Paging has internal fragmentation problem. Segment has external fragmentation problem and may need compaction.

C.



The image shows two terminal windows side-by-side. The left window displays the execution of a producer program with 7 instances. Each instance prints the address of a shared buffer and a unique identifier 'n'. The right window displays the execution of a consumer program with 7 instances. Each instance prints the address of the shared buffer and a sequence of values representing consumed items, with the number of items increasing from 1 to 7 for each instance.

```
liminrui@ubuntu:~/hw7$ ./producer 1
Address of shared buffer: 0x7f4d874a8000
Address of n: 0x55910eadd010
liminrui@ubuntu:~/hw7$ ./producer 2
Address of shared buffer: 0x7f15997c6000
Address of n: 0x558cd56a7010
liminrui@ubuntu:~/hw7$ ./producer 3
Address of shared buffer: 0x7f4bdbb74000
Address of n: 0x55d06c02d010
liminrui@ubuntu:~/hw7$ ./producer 4
Address of shared buffer: 0x7f10d737c000
Address of n: 0x55b41af67010
liminrui@ubuntu:~/hw7$ ./producer 5
Address of shared buffer: 0x7fcb3182b000
Address of n: 0x559d15b8a010
liminrui@ubuntu:~/hw7$ ./producer 6
Address of shared buffer: 0x7fb35ace2000
Address of n: 0x55d22f7d4010
liminrui@ubuntu:~/hw7$ ./producer 7
Address of shared buffer: 0x7f5936270000
Address of n: 0x5627d9fd1010
liminrui@ubuntu:~/hw7$
```

```
liminrui@ubuntu:~/hw7$ ./consumer 1
Address of shared buffer: 0x7f3232868000
Address of n: 0x55b9c4d22010
0.000000
liminrui@ubuntu:~/hw7$ ./consumer 2
Address of shared buffer: 0x7f84c09a9000
Address of n: 0x564097c9e010
0.000000 0.250000
liminrui@ubuntu:~/hw7$ ./consumer 3
Address of shared buffer: 0x7f4e794c0000
Address of n: 0x55b7b38a9010
0.000000 0.250000 1.000000
liminrui@ubuntu:~/hw7$ ./consumer 4
Address of shared buffer: 0x7f7df7cf0000
Address of n: 0x55fa8a133010
0.000000 0.250000 1.000000 2.250000
liminrui@ubuntu:~/hw7$ ./consumer 5
Address of shared buffer: 0x7f750c2a6000
Address of n: 0x5563ff078010
0.000000 0.250000 1.000000 2.250000 4.000000
liminrui@ubuntu:~/hw7$ ./consumer 6
Address of shared buffer: 0x7fa958c7c000
Address of n: 0x56308e870010
0.000000 0.250000 1.000000 2.250000 4.000000 6.250000
liminrui@ubuntu:~/hw7$ ./consumer 7
Address of shared buffer: 0x7efc1a320000
Address of n: 0x557f7c862010
0.000000 0.250000 1.000000 2.250000 4.000000 6.250000 9.000000
liminrui@ubuntu:~/hw7$
```

liminrui@ubuntu:~/hw7\$ readelf -s producer:

```
CS6233 - VMware Workstation 16 Player (Non-commercial use only)
Player
Apr 13 23:56
liminrui@ubuntu:~/hw7

20: 0000000000000000 0 FUNC GLOBAL DEFAULT UND [...]@GLIBC_2.2.5 (3)
21: 0000000000000000 0 FUNC WEAK DEFAULT UND [...]@GLIBC_2.2.5 (3)

Symbol table '.symtab' contains 54 entries:
Num: Value Size Type Bind Vis Ndx Name
0: 0000000000000000 0 NOTYPE LOCAL DEFAULT UND
1: 0000000000000000 0 FILE LOCAL DEFAULT ABS Scrt1.o
2: 000000000000038c 32 OBJECT LOCAL DEFAULT 4 __abi_tag
3: 0000000000000000 0 FILE LOCAL DEFAULT ABS crtstuff.c
4: 0000000000001270 0 FUNC LOCAL DEFAULT 16 deregister_tm_clones
5: 00000000000012a0 0 FUNC LOCAL DEFAULT 16 register_tm_clones
6: 00000000000012e0 0 FUNC LOCAL DEFAULT 16 __do_global_ctors_aux
7: 0000000000004018 1 OBJECT LOCAL DEFAULT 26 completed.0
8: 0000000000003d38 0 OBJECT LOCAL DEFAULT 22 __do_global_dtor[...]
9: 0000000000001320 0 FUNC LOCAL DEFAULT 16 frame_dummy
10: 0000000000003d30 0 OBJECT LOCAL DEFAULT 21 __frame_dummy_in[...]
11: 0000000000000000 0 FILE LOCAL DEFAULT ABS producer.c
12: 0000000000000000 0 FILE LOCAL DEFAULT ABS crtstuff.c
13: 0000000000002194 0 OBJECT LOCAL DEFAULT 20 __FRAME_END__
14: 0000000000000000 0 FILE LOCAL DEFAULT ABS
15: 0000000000003d40 0 OBJECT LOCAL DEFAULT 23 _DYNAMIC
16: 0000000000002088 0 NOTYPE LOCAL DEFAULT 19 _GNU_EH_FRAME_HDR
17: 0000000000003f40 0 OBJECT LOCAL DEFAULT 24 _GLOBAL_OFFSET_TABLE
18: 0000000000000000 0 FUNC GLOBAL DEFAULT UND __libc_start_mai[...]
19: 0000000000000000 0 NOTYPE WEAK DEFAULT UND __ITM_deregisterT[...]
20: 0000000000004000 0 NOTYPE WEAK DEFAULT 25 data_start
21: 0000000000000000 0 FUNC GLOBAL DEFAULT UND puts@GLIBC_2.2.5
22: 0000000000004010 4 OBJECT GLOBAL DEFAULT 25 n
23: 0000000000004014 0 NOTYPE GLOBAL DEFAULT 25 _edata
24: 0000000000000000 0 FUNC GLOBAL DEFAULT UND pow@GLIBC_2.29
25: 0000000000001618 0 FUNC GLOBAL HIDDEN 17 _fini
26: 0000000000000000 0 FUNC GLOBAL DEFAULT UND strlen@GLIBC_2.2.5
27: 0000000000000000 0 FUNC GLOBAL DEFAULT UND mmap@GLIBC_2.2.5
28: 0000000000000000 0 FUNC GLOBAL DEFAULT UND printf@GLIBC_2.2.5
29: 0000000000000000 0 FUNC GLOBAL DEFAULT UND ftruncate@GLIBC_2.2.5
30: 0000000000000000 0 FUNC GLOBAL DEFAULT UND close@GLIBC_2.2.5
31: 0000000000000000 0 FUNC GLOBAL DEFAULT UND srand@GLIBC_2.2.5
32: 0000000000001329 120 FUNC GLOBAL DEFAULT 16 checkDigit
33: 0000000000004000 0 NOTYPE GLOBAL DEFAULT 25 __data_start
34: 0000000000000000 0 NOTYPE WEAK DEFAULT UND __gmon_start__
```

liminrui@ubuntu:~/hw7\$ readelf -s consumer:

```
Apr 13 23:56
liminrui@ubuntu:~/hw7

19: 0000000000000000 0 FUNC WEAK DEFAULT UND [...]@GLIBC_2.2.5 (2)

Symbol table '.symtab' contains 51 entries:
Num: Value Size Type Bind Vis Ndx Name
0: 0000000000000000 0 NOTYPE LOCAL DEFAULT UND
1: 0000000000000000 0 FILE LOCAL DEFAULT ABS Scrt1.o
2: 000000000000038c 32 OBJECT LOCAL DEFAULT 4 __abi_tag
3: 0000000000000000 0 FILE LOCAL DEFAULT ABS crtstuff.c
4: 0000000000001210 0 FUNC LOCAL DEFAULT 16 deregister_tm_clones
5: 0000000000001240 0 FUNC LOCAL DEFAULT 16 register_tm_clones
6: 0000000000001280 0 FUNC LOCAL DEFAULT 16 __do_global_ctors_aux
7: 0000000000004020 1 OBJECT LOCAL DEFAULT 26 completed.0
8: 0000000000003d60 0 OBJECT LOCAL DEFAULT 22 __do_global_dtor[...]
9: 00000000000012c0 0 FUNC LOCAL DEFAULT 16 frame_dummy
10: 0000000000003d58 0 OBJECT LOCAL DEFAULT 21 __frame_dummy_in[...]
11: 0000000000000000 0 FILE LOCAL DEFAULT ABS consumer.c
12: 0000000000000000 0 FILE LOCAL DEFAULT ABS crtstuff.c
13: 0000000000002184 0 OBJECT LOCAL DEFAULT 20 __FRAME_END__
14: 0000000000000000 0 FILE LOCAL DEFAULT ABS
15: 0000000000003d68 0 OBJECT LOCAL DEFAULT 23 _DYNAMIC
16: 0000000000002078 0 NOTYPE LOCAL DEFAULT 19 _GNU_EH_FRAME_HDR
17: 0000000000003f58 0 OBJECT LOCAL DEFAULT 24 _GLOBAL_OFFSET_TABLE
18: 0000000000000000 0 FUNC GLOBAL DEFAULT UND putchar@GLIBC_2.2.5
19: 0000000000000000 0 FUNC GLOBAL DEFAULT UND __libc_start_mai[...]
20: 0000000000000000 0 NOTYPE WEAK DEFAULT UND __ITM_deregisterT[...]
21: 0000000000004018 8 OBJECT GLOBAL DEFAULT 26 stdout@GLIBC_2.2.5
22: 0000000000004000 0 NOTYPE WEAK DEFAULT 25 data_start
23: 0000000000000000 0 FUNC GLOBAL DEFAULT UND puts@GLIBC_2.2.5
24: 0000000000004010 4 OBJECT GLOBAL DEFAULT 25 n
25: 0000000000004014 0 NOTYPE GLOBAL DEFAULT 25 _edata
26: 0000000000001548 0 FUNC GLOBAL HIDDEN 17 _fini
27: 0000000000000000 0 FUNC GLOBAL DEFAULT UND strlen@GLIBC_2.2.5
28: 0000000000000000 0 FUNC GLOBAL DEFAULT UND mmap@GLIBC_2.2.5
29: 0000000000000000 0 FUNC GLOBAL DEFAULT UND printf@GLIBC_2.2.5
30: 0000000000000000 0 FUNC GLOBAL DEFAULT UND ftruncate@GLIBC_2.2.5
31: 0000000000000000 0 FUNC GLOBAL DEFAULT UND close@GLIBC_2.2.5
32: 00000000000012c9 120 FUNC GLOBAL DEFAULT 16 checkDigit
33: 0000000000004000 0 NOTYPE GLOBAL DEFAULT 25 __data_start
34: 0000000000000000 0 NOTYPE WEAK DEFAULT UND __gmon_start__
35: 0000000000004008 0 OBJECT GLOBAL HIDDEN 25 __dso_handle
```

1.

i) They should be different, because the printed addresses are always virtual addresses. They point to the same physical address but the physical addresses are hidden to us.

ii) The printed addresses are virtual addresses.

2.

i) They don't match, the addresses printed from running program are virtual addresses, however, the addresses in elf file are the offsets (they are relocatable).

ii) They are relocatable object file. Because they start from address 0.