

# 中山大學

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1.

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2.

best-fit, first-fit .

3.

FIFO, LRU .

4.

“ ” , , .

1.

(1) Bitmap

Bitmap , , , Bitmap. Bitmap , , char .  
 Bitmap , ( best-fit). :

```
typedef struct {
    int length;
    char *bitmap;
    IntervalHeap heap;
    QueueInt q;
} Bitmap;

void bm_init(Bitmap *bm, char *bitmap, int length);

Bool bm_get(Bitmap *bm, int index);

void bm_set(Bitmap *bm, int index, Bool status);

int bm_size(Bitmap *bm);

int bm_allocate(Bitmap *bm, int count);

void bm_release(Bitmap *bm, int index, int count);
```

1: Bitmap

```
void bm_init(Bitmap *bm, char *bitmap, int length) {  
    bm->bitmap = bitmap;  
    bm->length = length;  
  
    int bytes = ceil(length, 8);  
    memset(bitmap, 0, bytes);  
  
    // ih_init(&bm->heap);  
    // qi_init(&bm->q);  
}  
  
Bool bm_get(Bitmap *bm, int index) {  
    int pos = index / 8;  
    int offset = index % 8;  
  
    return (bm->bitmap[pos] & (1 << offset));  
}
```

2: Bitmap    get

```
void bm_set(Bitmap *bm, int index, Bool status) {  
    int pos = index / 8;  
    int offset = index % 8;  
  
    bm->bitmap[pos] = bm->bitmap[pos] & ~(1 << offset);  
  
    if (status) {  
        bm->bitmap[pos] = bm->bitmap[pos] | (1 << offset);  
    }  
}
```

3: set

```

int bm_allocate(Bitmap *bm, int count) {
    if (count == 0) {
        return -1;
    }

    int index, empty, start;

    index = 0;
    while (index < bm->length) {
        while (index < bm->length && bm_get(bm, index)) {
            ++index;
        }

        if (index == bm->length) {
            return -1;
        }

        empty = 0;
        start = index;

        while ((index < bm->length) && (!bm_get(bm, index)) && (empty < count)) {
            ++empty;
            ++index;
        }

        if (empty == count) {
            for (int i = 0; i < count; ++i) {
                bm_set(bm, start + i, true);
            }

            return start;
        }
    }
    return -1;
}

```

4:

(2)

Bitmap      PCB      ,      ,      ,      Bitmap      ,      .  
 Bitmap      ,      .      Bitmap      .      :

```
typedef struct {
    Bitmap resources;
    int start_addr;
} AddressPool;
```

5:

```
void ap_init(AddressPool *ap, char* bitmap, int length, int start_addr) {
    bm_init(&ap->resources, bitmap, length);
    ap->start_addr = start_addr;
}

int ap_allocate(AddressPool *ap, int count) {
    uint32 start = bm_allocate_with_fifo(&ap->resources, count);
    return (start == -1) ? -1 : (start * PAGE_SIZE + ap->start_addr);
}

void ap_release(AddressPool *ap, int addr, int amount) {
    bm_release(&ap->resources, (addr - ap->start_addr) / PAGE_SIZE, amount);
}
```

6:

(3)

, , , mbr , ( , ) , .

(4)

, . x86 , 4KiB . 32 , . , :

1. , .
2. 1MiB (0x00000000 ~ 0x000fffff), , “ ”.
3. 3GiB . 768 , , .
4. cr3 , cr0 PG 1, .

:

```
enum AddressPoolType {
    USER,
    KERNEL
};

typedef struct {
    int total_memory;
    AddressPool kernel_phy;
    AddressPool user_phy;
    AddressPool kernel_vir;
    QueueInt fifo_pages;
} MemoryManeger;
```

7:

```
int mm_allocate_physical_pages(MemoryManeger *mm, enum AddressPoolType type, int count) {
    int start = -1;

    if (type == KERNEL) {
        start = ap_allocate(&mm->kernel_phy, count);
    } else if (type == USER) {
        start = ap_allocate(&mm->user_phy, count);
    }

    return (start == -1) ? 0 : start;
}

void mm_release_physical_pages(MemoryManeger *mm, enum AddressPoolType type, int paddr, int count)
{
    if (type == KERNEL) {
        ap_release(&mm->kernel_phy, paddr, count);
    } else if (type == USER) {
        ap_release(&mm->user_phy, paddr, count);
    }
}
```

8:

```

void mm_open_page_mechanism(MemoryManeger *mm) {
    int *directory = (int *)PAGE_DIRECTORY;
    int *page = (int *) (PAGE_DIRECTORY + PAGE_SIZE);

    memset(directory, 0, PAGE_SIZE);
    memset(page, 0, PAGE_SIZE);

    int addr = 0;
    for (int i = 0; i < 256; ++i) {
        page[i] = addr | 0x7;
        addr += PAGE_SIZE;
    }

    directory[0] = ((int)page) | 0x07;
    directory[768] = directory[0];
    directory[1023] = ((int) directory) | 0x7;

    asm_init_page_reg(directory);

    printf("page mechanism enabled\n");
}

```

9:

, .

2.

worst-fit .

(1)

worst-fit , . , . , .

(2)

. , . :



```

// 内存空隙的起始位置和长度
typedef struct {
    int size;
    int start_addr;
} Interval;

// 优先队列
typedef struct {
    int count;
    Interval intervals[MAX_INTERVAL];
} IntervalHeap;

// 初始化
void ih_init(IntervalHeap* ih);
// 极大堆化
void ih_adjust(IntervalHeap* ih);
// 弹出
Interval ih_pop(IntervalHeap* ih);
// 压入
void ih_push(IntervalHeap *ih, Interval x);
// 输出
void ih_print(IntervalHeap *ih);

```

10: ( )

(3)

, :

1. Bitmap , .

2. , .

## 3. Bitmap .

:

```
// 从bitmap获取空隙的信息
void bm_get_intervals(Bitmap *bm) {
    Bool is_interval = false;
    Interval temp = {0, 0};
    for (int i = 0; i < bm->length; ++i) {
        Bool is_allocated = bm_get(bm, i);
        if (is_allocated && is_interval) {
            is_interval = false;
            ih_push(&bm->heap, temp);
        } else if (!is_allocated && is_interval) {
            temp.size += 1;
        } else if (!is_allocated && !is_interval) {
            is_interval = true;
            temp.start_addr = i;
            temp.size = 1;
        }
    }

    if (is_interval) {
        ih_push(&bm->heap, temp);
    }
}
```

11:

```

int bm_worse_fit(Bitmap *bm, int count) {
    ih_init(&bm->heap);
    bm_get_intervals(bm);
    // ih_print(&bm->heap);

    Interval worse = ih_pop(&bm->heap);

    if (count > worse.size) {
        return -1;
    } else {
        for (int i = 0; i < count; ++i) {
            bm_set(bm, worse.start_addr + i, true);
        }

        return worse.start_addr;
    }
}

```

12: worst-fit

, worst-fit .

3.

FIFO . . . .

(1)

, :

```

typedef struct {
    int data[MAX_QUEUE];
    int count;
} QueueInt;

void qi_init(QueueInt* qi);

void qi_push(QueueInt* qi, int x);

int qi_pop(QueueInt *qi);

Bool qi_empty(QueueInt *qi);

void qi_print(QueueInt *qi);

```

13:

(2) FIFO

:

1. , , .

2. , .

:

```

int bm_allocate_with_fifo(Bitmap *bm, int count) {
    int result = bm_allocate(bm, count);

    while (result == -1) {
        if (!qi_empty(&bm->q)) {
            int popped = qi_pop(&bm->q);
            bm_release(bm, popped, 1);
            result = bm_allocate(bm, count);
        } else {
            return -1;
        }
    }

    for (int i = 0; i < count; ++i) {
        qi_push(&bm->q, result + i);
    }

    return result;
}

```

14: FIFO

4.

(1)

, , 0xc0100000:

(2)

:

1.  $n$  .2.  $n$  ( ).

3. .

:

```

Bool mm_connect_phy_vir_pages(MemoryManeger *mm, int vaddr, int paddr) {
    int *pde = (int *)to_pde(vaddr);
    int *pte = (int *)to_pte(vaddr);

    if (!(*pde & 0x00000001)) {
        int page = mm_allocate_physical_pages(mm, KERNEL, 1);

        if (!page) {
            return false;
        }

        *pde = page | 0x7;

        char *page_ptr = (char *)(((int)pte) & 0xfffff000);
        memset(page_ptr, 0, PAGE_SIZE);
    }
    *pte = paddr | 0x7;

    return true;
}

```

15:

(3)

:

1. .

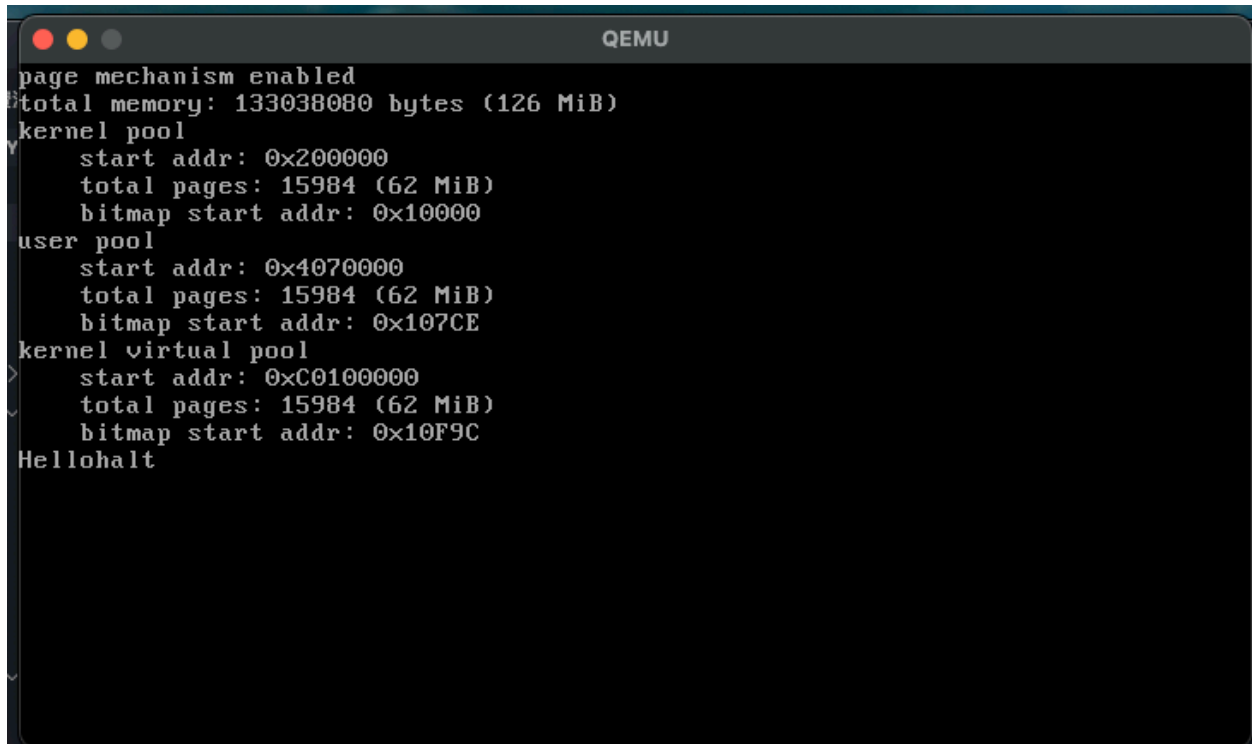
2. .

```

int vaddr2paddr(int vaddr) {
    int *pte = (int *)to_pte(vaddr);
    int page = (*pte) & 0xfffff000;
    int offset = vaddr & 0xfff;
    return (page + offset);
}

```

16:



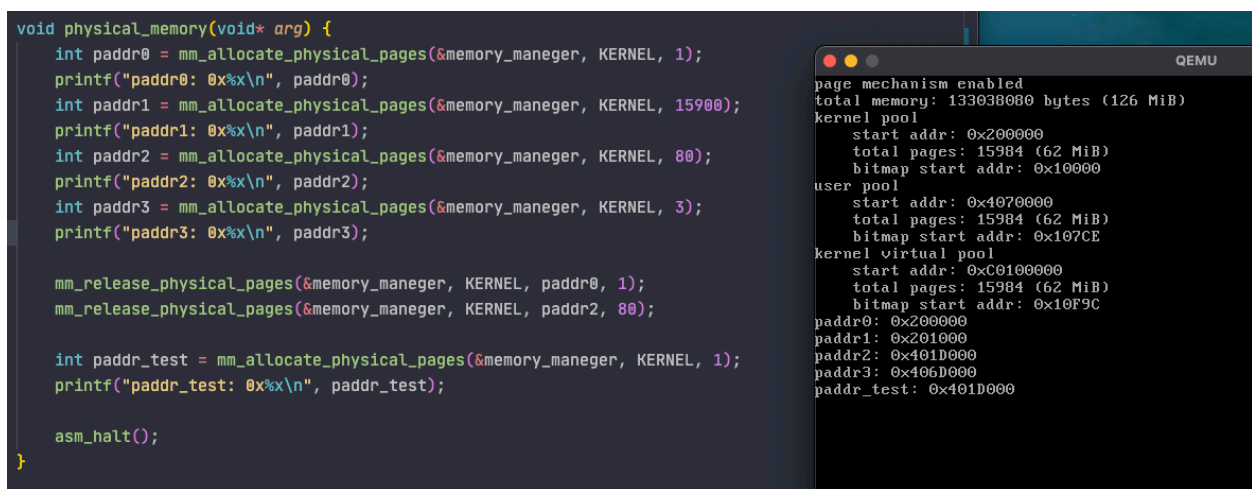
```

QEMU
page mechanism enabled
total memory: 133038080 bytes (126 MiB)
kernel pool
  start addr: 0x200000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x10000
user pool
  start addr: 0x4070000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x107CE
kernel virtual pool
  start addr: 0xC0100000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x10F9C
Hellohalt

```

17:

worst-fit , : 1 80 , , 80 .



```

void physical_memory(void* arg) {
    int paddr0 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 1);
    printf("paddr0: 0x%x\n", paddr0);
    int paddr1 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 15900);
    printf("paddr1: 0x%x\n", paddr1);
    int paddr2 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 80);
    printf("paddr2: 0x%x\n", paddr2);
    int paddr3 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 3);
    printf("paddr3: 0x%x\n", paddr3);

    mm_release_physical_pages(&memory_maneger, KERNEL, paddr0, 1);
    mm_release_physical_pages(&memory_maneger, KERNEL, paddr2, 80);

    int paddr_test = mm_allocate_physical_pages(&memory_maneger, KERNEL, 1);
    printf("paddr_test: 0x%x\n", paddr_test);

    asm_halt();
}

```

```

QEMU
page mechanism enabled
total memory: 133038080 bytes (126 MiB)
kernel pool
  start addr: 0x200000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x10000
user pool
  start addr: 0x4070000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x107CE
kernel virtual pool
  start addr: 0xC0100000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x10F9C
paddr0: 0x200000
paddr1: 0x201000
paddr2: 0x401D000
paddr3: 0x406D000
paddr_test: 0x401D000

```

18: worst-fit

FIFO , : , 4 . 0-7 .

```
void physical_memory(void* arg) {
    int paddr0 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 1);
    printf("paddr0: 0x%x\n", paddr0);
    int paddr1 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 15988);
    printf("paddr1: 0x%x\n", paddr1);
    int paddr2 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 88);
    printf("paddr2: 0x%x\n", paddr2);
    int paddr3 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 3);
    printf("paddr3: 0x%x\n", paddr3);

    int paddr4 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 4);
    printf("paddr4: 0x%x\n", paddr4);
    int paddr5 = mm_allocate_physical_pages(&memory_maneger, KERNEL, 4);
    printf("paddr4: 0x%x\n", paddr5);

    mm_release_physical_pages(&memory_maneger, KERNEL, paddr0, 1);
    mm_release_physical_pages(&memory_maneger, KERNEL, paddr2, 88);

    int paddr_test = mm_allocate_physical_pages(&memory_maneger, KERNEL, 1);
    printf("paddr_test: 0x%x\n", paddr_test);

    asm halt();
}
```

```
page mechanism enabled
total memory: 133038080 bytes (126 MiB)
kernel pool
  start addr: 0x2000000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x100000
user pool
  start addr: 0x4070000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x107CE
kernel virtual pool
  start addr: 0xC0100000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x10F9C
paddr0: 0x2000000
paddr1: 0x2010000
paddr2: 0x4010000
paddr3: 0x4060000
paddr4: 0x2000000
paddr4: 0x2040000
paddr_test: 0x2000000
```

## 19: FIFO

```
void virtual_memory(void* arg) {
    int vaddr0 = mm_allocate_pages(&memory_maneger, KERNEL, 1);
    printf("vaddr[0]: 0x%x, paddr[0]: 0x%x\n", vaddr0, vaddr2paddr(vaddr0));

    int vaddr1 = mm_allocate_pages(&memory_maneger, KERNEL, 1);
    printf("vaddr[1]: 0x%x, paddr[1]: 0x%x\n", vaddr1, vaddr2paddr(vaddr1));

    int vaddr2 = mm_allocate_pages(&memory_maneger, KERNEL, 1);
    printf("vaddr[2]: 0x%x, paddr[2]: 0x%x\n", vaddr2, vaddr2paddr(vaddr2));

    mm_release_physical_pages(&memory_maneger, KERNEL, vaddr2paddr(vaddr0), 1);

    int vaddr3 = mm_allocate_pages(&memory_maneger, KERNEL, 1);
    printf("vaddr[3]: 0x%x, paddr[3]: 0x%x\n", vaddr3, vaddr2paddr(vaddr3));

    asm halt();
}
```

```
page mechanism enabled
total memory: 133038080 bytes (126 MiB)
kernel pool
  start addr: 0x2000000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x100000
user pool
  start addr: 0x4070000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x107CE
kernel virtual pool
  start addr: 0xC0100000
  total pages: 15984 (62 MiB)
  bitmap start addr: 0x10F9C
vaddr[0]: 0xC0100000, paddr[0]: 0x2000000
vaddr[1]: 0xC0101000, paddr[1]: 0x2010000
vaddr[2]: 0xC0102000, paddr[2]: 0x2020000
vaddr[3]: 0xC0103000, paddr[3]: 0x2000000
```

## 20: