بسم تعالی

سیستم‌های عامل پیشرفته

تمرین دوم

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تمرینات عملی

****نکته : برای حل این سوالات از دو ماشین مجازی گرفته شده از آزمایشگاه DSN استفاده شده ****

سوال 1.1 .

برای حل این سوال ابتدا کد زیر را که همان کد قسمت ۱.۳ سوال عملی تمرین ۱ است در دو ماشین مجازی کپی می‌کنیم، قسمت اصلی کد که در شکل زیر آورده شده.

```c
void* thread_function() {
    for (int i = 0; i < NUMBER_OF_ITTERATIONS; i++) {
        void* ptr;
        size_t size = 2 * PAGE_SIZE; // allocate two pages of memory
        int ret;

        // Allocate memory using mmap()
        ptr = mmap(NULL, size, PROT_READ | PROT_WRITE, MAP_PRIVATE | MAP_ANON, -1, 0);
        if (ptr == MAP_FAILED) {
            perror("mmap failed");
            exit(EXIT_FAILURE);
        }

        // Use madvise() to advise the kernel about memory usage
        ret = madvise(ptr, size, MADV_SEQUENTIAL);
        if (ret == -1) {
            perror("madvise failed");
            exit(EXIT_FAILURE);
        }

        // Deallocate the memory using munmap()
        if (munmap(ptr, size) == -1) {
            perror("munmap failed");
            exit(EXIT_FAILURE);
        }
    }
    pthread_barrier_wait(&barrier);
}
```

سپس از اسکریپت زیر استفاده می‌شود تا ارزیابی را با کمک perf انجام دهیم.

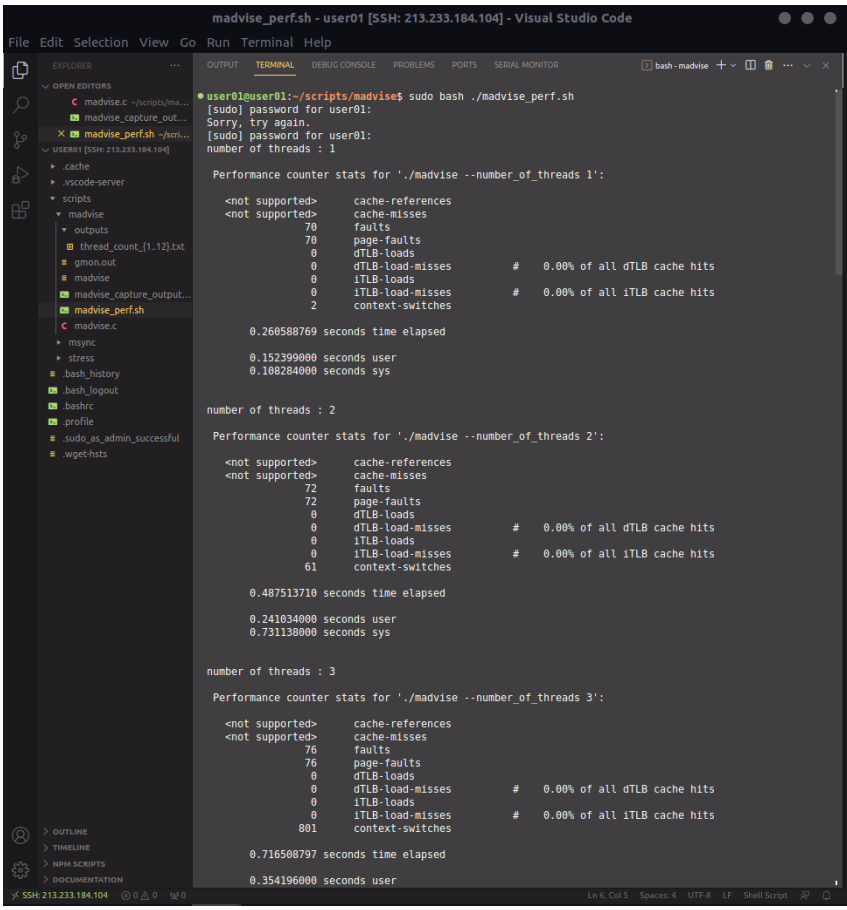
```
madvise > madvise_perf.sh
gcc ./madvise.c -o madvise -pg -lpthread
for VAR in {1..12}
do
    sudo perf stat -e cache-references,cache-misses,faults,page-faults,dTLB-loads,dTLB-load-misses,iTLB-loads,iTLB-load-misses,context-switches \
     ./madvise --number_of_threads $VAR
    sleep 1
done
```

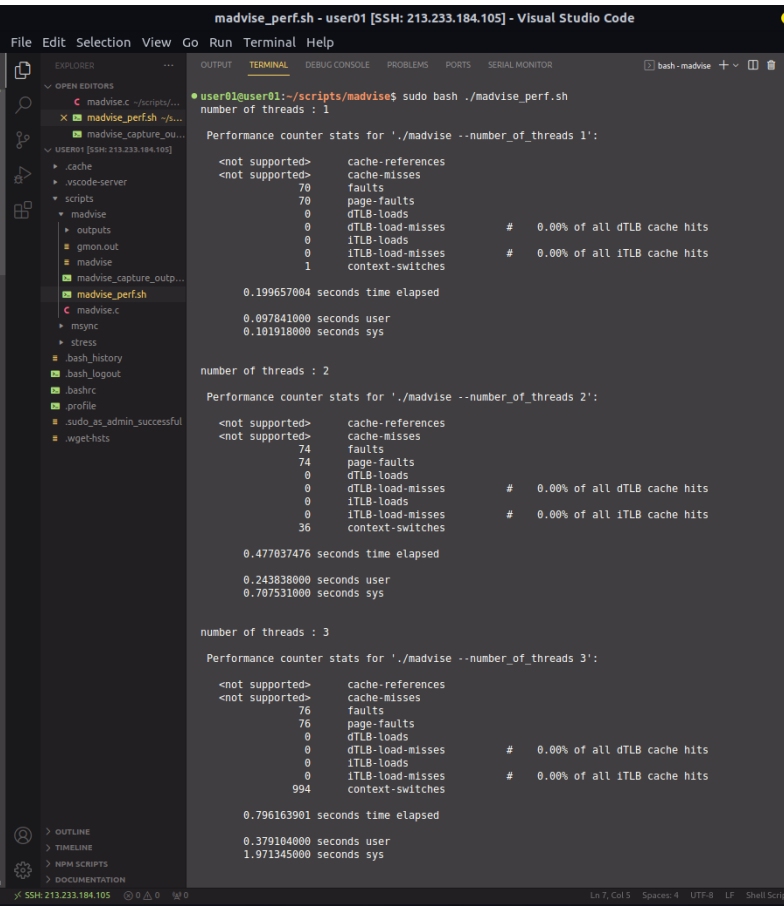
این اسکریپت کتابخانه ریسمان را هنگام کامپایل به برنامه لینک می‌کند و سپس با فلگ pg آنرا برای perf قابل تحلیل می‌کند.

حال در تمرین ۱ از ۱ تا ۱۲ ریسمان کرنل برای اجرای برنامه در نظر گرفتیم پس به همین خاطر از این اسکریپت استفاده می‌کنیم تا ۱ تا ۱۲ ریسمان را برای ما اندازه بگیرد.

حال اسکریپت را به صورت همزمان در دو ماشین مجازی اجرا می‌کنیم و نتایج را تحلیل می‌کنیم.

برای اینکه نتایج همزمان نشان داده شوند از اکستنشن vscode استفاده می‌کنیم که قطعا برای کار کردن با سرور مجازی پیشنهاد می‌شود. عکس‌ها به صورت بزرگ‌تر و کامل‌تر نیز در صفحه بعد نشان داده شده‌اند.





madvise_perf.sh - user01 [SSH: 213.233.184.104] - Visual Studio Code

File Edit Selection View Go Run Terminal Help

OUTPUT TERMINAL DEBUG CONSOLE PROBLEMS PORTS SERIAL MONITOR

```
user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
[sudo] password for user01:
Sorry, try again.
[sudo] password for user01:
number of threads : 1

 Performance counter stats for './madvise --number_of_threads 1':

   <not supported>      cache-references
   <not supported>      cache-misses
                 70      faults
                 70      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                  2      context-switches

       0.260588769 seconds time elapsed

       0.152399000 seconds user
       0.108284000 seconds sys


number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

   <not supported>      cache-references
   <not supported>      cache-misses
                 72      faults
                 72      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 61      context-switches

       0.487513710 seconds time elapsed

       0.241034000 seconds user
       0.731138000 seconds sys


number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                 76      faults
                 76      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                801      context-switches

       0.716508797 seconds time elapsed

       0.354196000 seconds user
```

madvise_perf.sh - user01 [SSH: 213.233.184.105] - Visual Studio C

File Edit Selection View Go Run Terminal Help

OUTPUT TERMINAL DEBUG CONSOLE PROBLEMS PORTS SERIAL MONITOR

```
user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
number of threads : 1

 Performance counter stats for './madvise --number_of_threads 1':

   <not supported>      cache-references
   <not supported>      cache-misses
                 70      faults
                 70      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                  1      context-switches

       0.199657004 seconds time elapsed

       0.097841000 seconds user
       0.101918000 seconds sys


number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

   <not supported>      cache-references
   <not supported>      cache-misses
                 74      faults
                 74      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 36      context-switches

       0.477037476 seconds time elapsed

       0.243838000 seconds user
       0.707531000 seconds sys


number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                 76      faults
                 76      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                994      context-switches

       0.796163901 seconds time elapsed

       0.379104000 seconds user
       1.971345000 seconds sys
```


```
user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
number of threads : 1

 Performance counter stats for './madvise --number_of_threads 1':

   <not supported>      cache-references
   <not supported>      cache-misses
                 70      faults
                 70      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                  1      context-switches

       0.199657004 seconds time elapsed

       0.097841000 seconds user
       0.101918000 seconds sys


number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

   <not supported>      cache-references
   <not supported>      cache-misses
                 74      faults
                 74      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 36      context-switches

       0.477037476 seconds time elapsed

       0.243838000 seconds user
       0.707531000 seconds sys


number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                 76      faults
                 76      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                994      context-switches

       0.796163901 seconds time elapsed

       0.379104000 seconds user
       1.971345000 seconds sys
```



```
user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
[sudo] password for user01:
Sorry, try again.
[sudo] password for user01:
number of threads : 1

 Performance counter stats for './madvise --number_of_threads 1':

   <not supported>      cache-references
   <not supported>      cache-misses
                 70      faults
                 70      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                  2      context-switches

       0.260588769 seconds time elapsed

       0.152399000 seconds user
       0.108284000 seconds sys


number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

   <not supported>      cache-references
   <not supported>      cache-misses
                 72      faults
                 72      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 61      context-switches

       0.487513710 seconds time elapsed

       0.241034000 seconds user
       0.731138000 seconds sys


number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                 76      faults
                 76      page-faults
                  0      dTLB-loads
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                  0      iTLB-loads
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                801      context-switches

       0.716508797 seconds time elapsed

       0.354196000 seconds user
```

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                76      faults
                76      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
               801      context-switches

       0.716508797 seconds time elapsed

       0.354196000 seconds user
       1.770982000 seconds sys


number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 1      context-switches

       0.001915970 seconds time elapsed

       0.001719000 seconds user
       0.000000000 seconds sys


number of threads : 5
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 5':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 0      context-switches

       0.001588346 seconds time elapsed

       0.001514000 seconds user
```

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                76      faults
                76      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
               994      context-switches

       0.796163901 seconds time elapsed

       0.379104000 seconds user
       1.971345000 seconds sys


number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

   <not supported>      cache-references
   <not supported>      cache-misses
                67      faults
                67      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 0      context-switches

       0.001663374 seconds time elapsed

       0.001804000 seconds user
       0.000000000 seconds sys


number of threads : 5
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 5':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 0      context-switches

       0.000797269 seconds time elapsed

       0.000825000 seconds user
```

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                76      faults
                76      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
               994      context-switches

       0.796163901 seconds time elapsed

       0.379104000 seconds user
       1.971345000 seconds sys


number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

   <not supported>      cache-references
   <not supported>      cache-misses
                67      faults
                67      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 0      context-switches

       0.001663374 seconds time elapsed

       0.001804000 seconds user
       0.000000000 seconds sys


number of threads : 5
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 5':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 0      context-switches

       0.000797269 seconds time elapsed

       0.000825000 seconds user
```

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

   <not supported>      cache-references
   <not supported>      cache-misses
                76      faults
                76      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
               801      context-switches

       0.716508797 seconds time elapsed

       0.354196000 seconds user
       1.770982000 seconds sys


number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 1      context-switches

       0.001915970 seconds time elapsed

       0.001719000 seconds user
       0.000000000 seconds sys


number of threads : 5
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 5':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-loads
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                 0      iTLB-loads
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits
                 0      context-switches

       0.001588346 seconds time elapsed

       0.001514000 seconds user
```

چند تحلیل جالب درباره نتایج بالا :

1. اولا که مشاهده می‌کنیم وقتی از ۴ ریسمان یا بیشتر استفاده می‌کنیم برنامه **خارج می‌شود** چرا که در صورتی که بیشتر از ۴ ریسمان استفاده کنیم عملا انگار از **تعداد بیشتری نسبت به چیزی که واقعا داریم** استفاده می‌کنیم و برنامه این اجازه را به ما نمی‌دهد.
2. مشاهده می‌کنیم در برنامه ما تعداد **میس و لود TLB برابر ۰** است در صورتی که به وضوح این تست دارای مشکل است. حال علت را بررسی می‌کنیم :

می دانیم در ماشین‌های مجازی یک لایه اضافه بین سیستم‌عامل اصلی و guestOS وجود دارد که عملا همان Virtual Manager ما است و می‌دانیم perf برای گرفتن اطلاعات خود مستقیما از سخت افزار می‌گیرد و اگر Virtual

Manager به ما اجازه این کار را ندهد عملا perf نمی‌تواند هیچ اطلاعاتی از آن قسمت سخت‌افزار کسب کند.

حال برای اثبات ادعای خود می‌بینیم که آیا perf دسترسی برای کپچر کردن TLB دارد و یا خیر.

```
user01@user01:~/scripts/madvise$ perf list | grep dTLB
user01@user01:~/scripts/madvise$ perf list | grep iTLB
user01@user01:~/scripts/madvise$
```

لیست دسترسی‌های perf در perf list آورده شده و می‌بینیم که هیچ اثری از dTLB و یا iTLB نیست که ادعای ما را مبتنی بر عدم اجازه Virtual Manager برای کپچر کردن خروجی TLB توسط perf را نشان می‌دهد.

حال برای این که تمامی اپشن‌های perf مبنی بر TLB را بگیریم، از دستور زیر استفاده می‌کنیم و عملا تمامی اپشن‌ها را بروت فورس می‌کنیم.

```
user01@user01:~/scripts/madvise$ sudo perf list | grep -i tlb
```

لیست تمامی اپشن‌های ممکن در صفحه بعد آمده که عملا تمامی آنها را نهایتا وارد اسکریپت می‌کنیم.

```
gcc ./madvise.c -o madvise -pg -lpthread
for VAR in {1..12}
do
    # sudo perf stat -e cache-references,cache-misses,faults,page-faults,dTLB-loads,dTLB-load-misses,dTLB-stores,dTLB-store-misses,iTLB-loads,iTLB-load-
    sudo perf stat -e dTLB-load-misses,dTLB-loads,dTLB-store-misses, \
    dTLB-stores,iTLB-load-misses,iTLB-loads,mem_uops_retired.stlb_miss_loads, \
    mem_uops_retired.stlb_miss_stores,dtlb_load_misses.miss_causes_a_walk,dtlb_load_misses.stlb_hit, \
    dtlb_load_misses.stlb_hit_2m,dtlb_load_misses.stlb_hit_4k,dtlb_load_misses.walk_completed,dtlb_load_misses.walk_completed_1g,\
    dtlb_load_misses.walk_completed_2m_4m,dtlb_load_misses.walk_completed_4k,dtlb_load_misses.walk_duration,dtlb_store_misses.miss_causes_a_walk,\
    dtlb_store_misses.stlb_hit,dtlb_store_misses.stlb_hit_2m,dtlb_store_misses.stlb_hit_4k,dtlb_store_misses.walk_completed,dtlb_store_misses.walk_compl
    dtlb_store_misses.walk_completed_2m_4m,dtlb_store_misses.walk_completed_4k,dtlb_store_misses.walk_duration,itlb.itlb_flush,itlb_misses.miss_causes_a
    itlb_misses.stlb_hit,itlb_misses.stlb_hit_2m,itlb_misses.stlb_hit_4k,itlb_misses.walk_completed,itlb_misses.walk_completed_1g,itlb_misses.walk_compl
    itlb_misses.walk_completed_4k,itlb_misses.walk_duration,page_walker_loads.dtlb_l1,page_walker_loads.dtlb_l2,\
    page_walker_loads.dtlb_l3,page_walker_loads.dtlb_memory,page_walker_loads.itlb_l1,page_walker_loads.itlb_l2,page_walker_loads.itlb_l3,\
    tlb_flush.dtlb_thread,tlb_flush.stlb_any,hyperv:hyperv_mmu_flush_tlb_others,swiotlb:swiotlb_bounced,tlb:tlb_flush,xen:xen_mmu_flush_tlb_one_user,\
    xen:xen_mmu_flush_tlb_others ./madvise --number_of_threads $VAR

    sleep 1
done
```

- dTLB-load-misses
- dTLB-loads
- dTLB-store-misses
- dTLB-stores
- iTLB-load-misses
- iTLB-loads
- mem_uops_retired.stlb_miss_loads
- mem_uops_retired.stlb_miss_stores
- dtlb_load_misses.miss_causes_a_walk
- dtlb_load_misses.stlb_hit
- dtlb_load_misses.stlb_hit_2m
- dtlb_load_misses.stlb_hit_4k
- dtlb_load_misses.walk_completed
- dtlb_load_misses.walk_completed_1g
- dtlb_load_misses.walk_completed_2m_4m
- dtlb_load_misses.walk_completed_4k
- dtlb_load_misses.walk_duration
- dtlb_store_misses.miss_causes_a_walk
- dtlb_store_misses.stlb_hit
- dtlb_store_misses.stlb_hit_2m
- dtlb_store_misses.stlb_hit_4k
- dtlb_store_misses.walk_completed
- dtlb_store_misses.walk_completed_1g
- dtlb_store_misses.walk_completed_2m_4m
- dtlb_store_misses.walk_completed_4k
- dtlb_store_misses.walk_duration
- itlb.itlb_flush
- itlb_misses.miss_causes_a_walk
- itlb_misses.stlb_hit
- itlb_misses.stlb_hit_2m
- itlb_misses.stlb_hit_4k
- itlb_misses.walk_completed
- itlb_misses.walk_completed_1g
- itlb_misses.walk_completed_2m_4m
- itlb_misses.walk_completed_4k
- itlb_misses.walk_duration
- page_walker_loads.dtlb_l1
- page_walker_loads.dtlb_l2
- page_walker_loads.dtlb_l3
- page_walker_loads.dtlb_memory
- page_walker_loads.itlb_l1
- page_walker_loads.itlb_l2
- page_walker_loads.itlb_l3
- tlb_flush.dtlb_thread
- tlb_flush.stlb_any

حال نتایج را مشاهده می‌کنیم :

```
OUTPUT   TERMINAL   DEBUG CONSOLE   PROBLEMS   PORTS   SERIAL MONITOR                                   bash - madvise

● user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
 number of threads : 1

  Performance counter stats for './madvise --number_of_threads 1':

                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.87%)
                 0      dTLB-loads                                                    (8.43%)
                 0      dTLB-store-misses                                             (9.99%)
                 0      dTLB-stores                                                   (11.55%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (12.50%)
                 0      iTLB-loads                                                    (12.50%)
                 0      mem_uops_retired.stlb_miss_loads                                     (12.50%)
                 0      mem_uops_retired.stlb_miss_stores                                     (12.50%)
                 0      dtlb_load_misses.miss_causes_a_walk                                    (12.50%)
                 0      dtlb_load_misses.stlb_hit                                     (12.50%)
                 0      dtlb_load_misses.stlb_hit_2m                                     (12.50%)
                 0      dtlb_load_misses.stlb_hit_4k                                     (12.50%)
                 0      dtlb_load_misses.walk_completed                                     (12.50%)
                 0      dtlb_load_misses.walk_completed_1g                                     (12.50%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (12.50%)
                 0      dtlb_load_misses.walk_completed_4k                                     (12.50%)
                 0      dtlb_load_misses.walk_duration                                     (12.50%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (12.50%)
                 0      dtlb_store_misses.stlb_hit                                     (12.50%)
                 0      dtlb_store_misses.stlb_hit_2m                                     (11.90%)
                 0      dtlb_store_misses.stlb_hit_4k                                     (10.34%)
                 0      dtlb_store_misses.walk_completed                                     (8.77%)
                 0      dtlb_store_misses.walk_completed_1g                                     (7.21%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                     (6.25%)
                 0      dtlb_store_misses.walk_completed_4k                                     (6.25%)
                 0      dtlb_store_misses.walk_duration                                     (6.25%)
                 0      itlb.itlb_flush                                               (6.25%)
                 0      itlb_misses.miss_causes_a_walk                                     (6.25%)
                 0      itlb_misses.stlb_hit                                          (6.25%)
                 0      itlb_misses.stlb_hit_2m                                       (6.25%)
                 0      itlb_misses.stlb_hit_4k                                       (6.25%)
                 0      itlb_misses.walk_completed                                    (6.25%)
                 0      itlb_misses.walk_completed_1g                                     (6.25%)
                 0      itlb_misses.walk_completed_2m_4m                                     (6.25%)
                 0      itlb_misses.walk_completed_4k                                     (6.25%)
                 0      itlb_misses.walk_duration                                     (6.25%)
                 0      page_walker_loads.dtlb_l1                                     (6.25%)
                 0      page_walker_loads.dtlb_l2                                     (6.25%)
                 0      page_walker_loads.dtlb_l3                                     (6.25%)
                 0      page_walker_loads.dtlb_memory                                     (6.25%)
                 0      page_walker_loads.itlb_l1                                     (6.25%)
                 0      page_walker_loads.itlb_l2                                     (6.25%)
                 0      page_walker_loads.itlb_l3                                     (6.25%)
                 0      tlb_flush.dtlb_thread                                         (6.25%)
                 0      tlb_flush.stlb_any                                            (6.25%)
                 0      hyperv:hyperv_mmu_flush_tlb_others
                 0      swiotlb:swiotlb_bounced
                17      tlb:tlb_flush
                 0      xen:xen_mmu_flush_tlb_one_user
                 0      xen:xen_mmu_flush_tlb_others

        0.256402909 seconds time elapsed

        0.164321000 seconds user
        0.092180000 seconds sys

SSH: 213.233.184.104   Ln 8, Col 5 (1782 selected)   Spaces: 4   UTF-8   LF   Shell Script
```

```
OUTPUT   TERMINAL   DEBUG CONSOLE   PROBLEMS   PORTS   SERIAL MONITOR

● user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
 [sudo] password for user01:
 number of threads : 1

  Performance counter stats for './madvise --number_of_threads 1':

                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (8.74%)
                 0      dTLB-loads                                                    (10.72%)
                 0      dTLB-store-misses                                             (12.71%)
                 0      dTLB-stores                                                   (14.69%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (15.86%)
                 0      iTLB-loads                                                    (15.86%)
                 0      mem_uops_retired.stlb_miss_loads                                     (13.93%)
                 0      mem_uops_retired.stlb_miss_stores                                     (11.95%)
                 0      dtlb_load_misses.miss_causes_a_walk                                    (9.97%)
                 0      dtlb_load_misses.stlb_hit                                     (7.99%)
                 0      dtlb_load_misses.stlb_hit_2m                                     (7.93%)
                 0      dtlb_load_misses.stlb_hit_4k                                     (7.93%)
                 0      dtlb_load_misses.walk_completed                                     (7.93%)
                 0      dtlb_load_misses.walk_completed_1g                                     (7.93%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (7.93%)
                 0      dtlb_load_misses.walk_completed_4k                                     (7.93%)
                 0      dtlb_load_misses.walk_duration                                     (7.93%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (7.93%)
                 0      dtlb_store_misses.stlb_hit                                     (7.93%)
                 0      dtlb_store_misses.stlb_hit_2m                                     (7.93%)
                 0      dtlb_store_misses.stlb_hit_4k                                     (7.93%)
                 0      dtlb_store_misses.walk_completed                                     (7.93%)
                 0      dtlb_store_misses.walk_completed_1g                                     (7.93%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                     (7.93%)
                 0      dtlb_store_misses.walk_completed_4k                                     (7.93%)
                 0      dtlb_store_misses.walk_duration                                     (7.93%)
                 0      itlb.itlb_flush                                               (7.93%)
                 0      itlb_misses.miss_causes_a_walk                                     (7.93%)
                 0      itlb_misses.stlb_hit                                          (7.93%)
                 0      itlb_misses.stlb_hit_2m                                       (7.93%)
                 0      itlb_misses.stlb_hit_4k                                       (7.93%)
                 0      itlb_misses.walk_completed                                    (7.93%)
                 0      itlb_misses.walk_completed_1g                                     (7.93%)
                 0      itlb_misses.walk_completed_2m_4m                                     (7.93%)
                 0      itlb_misses.walk_completed_4k                                     (7.93%)
                 0      itlb_misses.walk_duration                                     (7.93%)
                 0      page_walker_loads.dtlb_l1                                     (7.93%)
                 0      page_walker_loads.dtlb_l2                                     (7.94%)
                 0      page_walker_loads.dtlb_l3                                     (7.93%)
                 0      page_walker_loads.dtlb_memory                                     (7.93%)
                 0      page_walker_loads.itlb_l1                                     (7.93%)
                 0      page_walker_loads.itlb_l2                                     (7.92%)
                 0      page_walker_loads.itlb_l3                                     (7.93%)
                 0      tlb_flush.dtlb_thread                                         (7.92%)
                 0      tlb_flush.stlb_any                                            (7.92%)
                 0      hyperv:hyperv_mmu_flush_tlb_others
                 0      swiotlb:swiotlb_bounced
                17      tlb:tlb_flush
                 0      xen:xen_mmu_flush_tlb_one_user
                 0      xen:xen_mmu_flush_tlb_others

        0.202161248 seconds time elapsed

        0.093015000 seconds user
        0.109192000 seconds sys

SSH: 213.233.184.105   Ln 8, Col 5
```

و اما تصاویر با وضوح بیشتر

```
● user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
 number of threads : 1

  Performance counter stats for './madvise --number_of_threads 1':

                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.87%)
                 0      dTLB-loads                                                    (8.43%)
                 0      dTLB-store-misses                                             (9.99%)
                 0      dTLB-stores                                                   (11.55%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (12.50%)
                 0      iTLB-loads                                                    (12.50%)
                 0      mem_uops_retired.stlb_miss_loads                                     (12.50%)
                 0      mem_uops_retired.stlb_miss_stores                                     (12.50%)
                 0      dtlb_load_misses.miss_causes_a_walk                                    (12.50%)
                 0      dtlb_load_misses.stlb_hit                                     (12.50%)
                 0      dtlb_load_misses.stlb_hit_2m                                     (12.50%)
                 0      dtlb_load_misses.stlb_hit_4k                                     (12.50%)
                 0      dtlb_load_misses.walk_completed                                     (12.50%)
                 0      dtlb_load_misses.walk_completed_1g                                     (12.50%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (12.50%)
                 0      dtlb_load_misses.walk_completed_4k                                     (12.50%)
                 0      dtlb_load_misses.walk_duration                                     (12.50%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (12.50%)
                 0      dtlb_store_misses.stlb_hit                                     (12.50%)
                 0      dtlb_store_misses.stlb_hit_2m                                     (11.90%)
                 0      dtlb_store_misses.stlb_hit_4k                                     (10.34%)
                 0      dtlb_store_misses.walk_completed                                     (8.77%)
                 0      dtlb_store_misses.walk_completed_1g                                     (7.21%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                     (6.25%)
                 0      dtlb_store_misses.walk_completed_4k                                     (6.25%)
                 0      dtlb_store_misses.walk_duration                                     (6.25%)
                 0      itlb.itlb_flush                                               (6.25%)
                 0      itlb_misses.miss_causes_a_walk                                     (6.25%)
                 0      itlb_misses.stlb_hit                                          (6.25%)
                 0      itlb_misses.stlb_hit_2m                                       (6.25%)
                 0      itlb_misses.stlb_hit_4k                                       (6.25%)
                 0      itlb_misses.walk_completed                                    (6.25%)
                 0      itlb_misses.walk_completed_1g                                     (6.25%)
                 0      itlb_misses.walk_completed_2m_4m                                     (6.25%)
                 0      itlb_misses.walk_completed_4k                                     (6.25%)
                 0      itlb_misses.walk_duration                                     (6.25%)
                 0      page_walker_loads.dtlb_l1                                     (6.25%)
                 0      page_walker_loads.dtlb_l2                                     (6.25%)
                 0      page_walker_loads.dtlb_l3                                     (6.25%)
                 0      page_walker_loads.dtlb_memory                                     (6.25%)
                 0      page_walker_loads.itlb_l1                                     (6.25%)
                 0      page_walker_loads.itlb_l2                                     (6.25%)
                 0      page_walker_loads.itlb_l3                                     (6.25%)
                 0      tlb_flush.dtlb_thread                                         (6.25%)
                 0      tlb_flush.stlb_any                                            (6.25%)
                 0      hyperv:hyperv_mmu_flush_tlb_others
                 0      swiotlb:swiotlb_bounced
                17      tlb:tlb_flush
                 0      xen:xen_mmu_flush_tlb_one_user
                 0      xen:xen_mmu_flush_tlb_others

        0.256402909 seconds time elapsed

        0.164321000 seconds user
        0.092180000 seconds sys
```

```
Performance counter stats for './madvise --number_of_threads 1':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (8.74%)
                0      dTLB-loads                                                    (10.72%)
                0      dTLB-store-misses                                             (12.71%)
                0      dTLB-stores                                                   (14.69%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (15.86%)
                0      iTLB-loads                                                    (15.86%)
                0      mem_uops_retired.stlb_miss_loads                                     (13.93%)
                0      mem_uops_retired.stlb_miss_stores                                     (11.95%)
                0      dtlb_load_misses.miss_causes_a_walk                                     (9.97%)
                0      dtlb_load_misses.stlb_hit                                     (7.99%)
                0      dtlb_load_misses.stlb_hit_2m                                     (7.93%)
                0      dtlb_load_misses.stlb_hit_4k                                     (7.93%)
                0      dtlb_load_misses.walk_completed                                     (7.93%)
                0      dtlb_load_misses.walk_completed_1g                                     (7.93%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (7.93%)
                0      dtlb_load_misses.walk_completed_4k                                     (7.93%)
                0      dtlb_load_misses.walk_duration                                     (7.93%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (7.93%)
                0      dtlb_store_misses.stlb_hit                                     (7.93%)
                0      dtlb_store_misses.stlb_hit_2m                                     (7.93%)
                0      dtlb_store_misses.stlb_hit_4k                                     (7.93%)
                0      dtlb_store_misses.walk_completed                                     (7.93%)
                0      dtlb_store_misses.walk_completed_1g                                     (7.93%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (7.93%)
                0      dtlb_store_misses.walk_completed_4k                                     (7.93%)
                0      dtlb_store_misses.walk_duration                                     (7.93%)
                0      itlb.itlb_flush                                               (7.93%)
                0      itlb_misses.miss_causes_a_walk                                     (7.93%)
                0      itlb_misses.stlb_hit                                          (7.93%)
                0      itlb_misses.stlb_hit_2m                                       (7.93%)
                0      itlb_misses.stlb_hit_4k                                       (7.93%)
                0      itlb_misses.walk_completed                                     (7.93%)
                0      itlb_misses.walk_completed_1g                                     (7.93%)
                0      itlb_misses.walk_completed_2m_4m                                     (7.93%)
                0      itlb_misses.walk_completed_4k                                     (7.93%)
                0      itlb_misses.walk_duration                                     (7.93%)
                0      page_walker_loads.dtlb_l1
                0      page_walker_loads.dtlb_l2
                0      page_walker_loads.dtlb_l3
                0      page_walker_loads.dtlb_memory
                0      page_walker_loads.itlb_l1
                0      page_walker_loads.itlb_l2
                0      page_walker_loads.itlb_l3
                0      tlb_flush.dtlb_thread
                0      tlb_flush.stlb_any
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               17      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

      0.202161248 seconds time elapsed

      0.093015000 seconds user
      0.109192000 seconds sys
3.233.184.105   ⊗ 0 ⚠ 0   ⚑ 0                                                    Ln 8, Col 5
```

```
number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.86%)
                0      dTLB-loads                                                    (7.58%)
                0      dTLB-store-misses                                             (8.43%)
                0      dTLB-stores                                                   (9.28%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (10.14%)
                0      iTLB-loads                                                    (10.28%)
                0      mem_uops_retired.stlb_miss_loads                                     (10.27%)
                0      mem_uops_retired.stlb_miss_stores                                     (10.28%)
                0      dtlb_load_misses.miss_causes_a_walk                                     (10.28%)
                0      dtlb_load_misses.stlb_hit                                     (10.26%)
                0      dtlb_load_misses.stlb_hit_2m                                     (10.27%)
                0      dtlb_load_misses.stlb_hit_4k                                     (10.27%)
                0      dtlb_load_misses.walk_completed                                     (10.27%)
                0      dtlb_load_misses.walk_completed_1g                                     (10.28%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (10.22%)
                0      dtlb_load_misses.walk_completed_4k                                     (10.23%)
                0      dtlb_load_misses.walk_duration                                     (10.20%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (10.20%)
                0      dtlb_store_misses.stlb_hit                                     (10.25%)
                0      dtlb_store_misses.stlb_hit_2m                                     (10.24%)
                0      dtlb_store_misses.stlb_hit_4k                                     (10.27%)
                0      dtlb_store_misses.walk_completed                                     (10.27%)
                0      dtlb_store_misses.walk_completed_1g                                     (10.27%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (10.28%)
                0      dtlb_store_misses.walk_completed_4k                                     (10.28%)
                0      dtlb_store_misses.walk_duration                                     (10.28%)
                0      itlb.itlb_flush                                               (10.28%)
                0      itlb_misses.miss_causes_a_walk                                     (10.19%)
                0      itlb_misses.stlb_hit                                          (9.45%)
                0      itlb_misses.stlb_hit_2m                                       (8.60%)
                0      itlb_misses.stlb_hit_4k                                       (7.74%)
                0      itlb_misses.walk_completed                                     (6.97%)
                0      itlb_misses.walk_completed_1g                                     (6.85%)
                0      itlb_misses.walk_completed_2m_4m                                     (6.85%)
                0      itlb_misses.walk_completed_4k                                     (6.85%)
                0      itlb_misses.walk_duration                                     (6.84%)
                0      page_walker_loads.dtlb_l1                                     (6.85%)
                0      page_walker_loads.dtlb_l2                                     (6.85%)
                0      page_walker_loads.dtlb_l3                                     (6.84%)
                0      page_walker_loads.dtlb_memory                                     (6.84%)
                0      page_walker_loads.itlb_l1                                     (6.84%)
                0      page_walker_loads.itlb_l2                                     (6.84%)
                0      page_walker_loads.itlb_l3                                     (6.85%)
                0      tlb_flush.dtlb_thread                                         (6.86%)
                0      tlb_flush.stlb_any                                            (6.86%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               17      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

      0.469811845 seconds time elapsed

      0.257551000 seconds user
      0.676073000 seconds sys
```

```
number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.62%)
                0      dTLB-loads                                                    (7.34%)
                0      dTLB-store-misses                                             (8.16%)
                0      dTLB-stores                                                   (8.96%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (9.73%)
                0      iTLB-loads                                                    (9.85%)
                0      mem_uops_retired.stlb_miss_loads                                     (9.85%)
                0      mem_uops_retired.stlb_miss_stores                                     (9.87%)
                0      dtlb_load_misses.miss_causes_a_walk                                     (9.88%)
                0      dtlb_load_misses.stlb_hit                                     (9.88%)
                0      dtlb_load_misses.stlb_hit_2m                                     (9.88%)
                0      dtlb_load_misses.stlb_hit_4k                                     (9.87%)
                0      dtlb_load_misses.walk_completed                                     (9.87%)
                0      dtlb_load_misses.walk_completed_1g                                     (9.87%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (9.87%)
                0      dtlb_load_misses.walk_completed_4k                                     (9.86%)
                0      dtlb_load_misses.walk_duration                                     (9.87%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (9.87%)
                0      dtlb_store_misses.stlb_hit                                     (9.86%)
                0      dtlb_store_misses.stlb_hit_2m                                     (9.88%)
                0      dtlb_store_misses.stlb_hit_4k                                     (9.88%)
                0      dtlb_store_misses.walk_completed                                     (9.88%)
                0      dtlb_store_misses.walk_completed_1g                                     (9.88%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (9.88%)
                0      dtlb_store_misses.walk_completed_4k                                     (9.87%)
                0      dtlb_store_misses.walk_duration                                     (9.86%)
                0      itlb.itlb_flush                                               (9.86%)
                0      itlb_misses.miss_causes_a_walk                                     (9.87%)
                0      itlb_misses.stlb_hit                                          (9.87%)
                0      itlb_misses.stlb_hit_2m                                       (9.88%)
                0      itlb_misses.stlb_hit_4k                                       (9.87%)
                0      itlb_misses.walk_completed                                     (9.87%)
                0      itlb_misses.walk_completed_1g                                     (9.59%)
                0      itlb_misses.walk_completed_2m_4m                                     (8.77%)
                0      itlb_misses.walk_completed_4k                                     (7.95%)
                0      itlb_misses.walk_duration                                     (7.13%)
                0      page_walker_loads.dtlb_l1                                     (6.58%)
                0      page_walker_loads.dtlb_l2                                     (6.58%)
                0      page_walker_loads.dtlb_l3                                     (6.59%)
                0      page_walker_loads.dtlb_memory                                     (6.59%)
                0      page_walker_loads.itlb_l1                                     (6.59%)
                0      page_walker_loads.itlb_l2                                     (6.59%)
                0      page_walker_loads.itlb_l3                                     (6.58%)
                0      tlb_flush.dtlb_thread                                         (6.58%)
                0      tlb_flush.stlb_any                                            (6.58%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               16      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

      0.487989859 seconds time elapsed

      0.260129000 seconds user
      0.712354000 seconds sys
```

```
number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.86%)
                0      dTLB-loads                                                    (7.58%)
                0      dTLB-store-misses                                             (8.43%)
                0      dTLB-stores                                                   (9.28%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (10.14%)
                0      iTLB-loads                                                    (10.28%)
                0      mem_uops_retired.stlb_miss_loads                                     (10.27%)
                0      mem_uops_retired.stlb_miss_stores                                     (10.28%)
                0      dtlb_load_misses.miss_causes_a_walk                                     (10.28%)
                0      dtlb_load_misses.stlb_hit                                     (10.26%)
                0      dtlb_load_misses.stlb_hit_2m                                     (10.27%)
                0      dtlb_load_misses.stlb_hit_4k                                     (10.27%)
                0      dtlb_load_misses.walk_completed                                     (10.27%)
                0      dtlb_load_misses.walk_completed_1g                                     (10.28%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (10.22%)
                0      dtlb_load_misses.walk_completed_4k                                     (10.23%)
                0      dtlb_load_misses.walk_duration                                     (10.20%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (10.20%)
                0      dtlb_store_misses.stlb_hit                                     (10.25%)
                0      dtlb_store_misses.stlb_hit_2m                                     (10.24%)
                0      dtlb_store_misses.stlb_hit_4k                                     (10.27%)
                0      dtlb_store_misses.walk_completed                                     (10.27%)
                0      dtlb_store_misses.walk_completed_1g                                     (10.27%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (10.28%)
                0      dtlb_store_misses.walk_completed_4k                                     (10.28%)
                0      dtlb_store_misses.walk_duration                                     (10.28%)
                0      itlb.itlb_flush                                               (10.28%)
                0      itlb_misses.miss_causes_a_walk                                     (10.19%)
                0      itlb_misses.stlb_hit                                          (9.45%)
                0      itlb_misses.stlb_hit_2m                                       (8.60%)
                0      itlb_misses.stlb_hit_4k                                       (7.74%)
                0      itlb_misses.walk_completed                                    (6.97%)
                0      itlb_misses.walk_completed_1g                                     (6.85%)
                0      itlb_misses.walk_completed_2m_4m                                     (6.85%)
                0      itlb_misses.walk_completed_4k                                     (6.85%)
                0      itlb_misses.walk_duration                                     (6.84%)
                0      page_walker_loads.dtlb_l1                                     (6.85%)
                0      page_walker_loads.dtlb_l2                                     (6.85%)
                0      page_walker_loads.dtlb_l3                                     (6.84%)
                0      page_walker_loads.dtlb_memory                                     (6.84%)
                0      page_walker_loads.itlb_l1                                     (6.84%)
                0      page_walker_loads.itlb_l2                                     (6.84%)
                0      page_walker_loads.itlb_l3                                     (6.85%)
                0      tlb_flush.dtlb_thread                                         (6.86%)
                0      tlb_flush.stlb_any                                            (6.86%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               17      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

      0.469811845 seconds time elapsed

      0.257551000 seconds user
      0.676073000 seconds sys
```

```
number of threads : 2

 Performance counter stats for './madvise --number_of_threads 2':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.62%)
                0      dTLB-loads                                                    (7.34%)
                0      dTLB-store-misses                                             (8.16%)
                0      dTLB-stores                                                   (8.96%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (9.73%)
                0      iTLB-loads                                                    (9.85%)
                0      mem_uops_retired.stlb_miss_loads                                     (9.85%)
                0      mem_uops_retired.stlb_miss_stores                                     (9.87%)
                0      dtlb_load_misses.miss_causes_a_walk                                     (9.88%)
                0      dtlb_load_misses.stlb_hit                                     (9.88%)
                0      dtlb_load_misses.stlb_hit_2m                                     (9.88%)
                0      dtlb_load_misses.stlb_hit_4k                                     (9.87%)
                0      dtlb_load_misses.walk_completed                                     (9.87%)
                0      dtlb_load_misses.walk_completed_1g                                     (9.87%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (9.87%)
                0      dtlb_load_misses.walk_completed_4k                                     (9.86%)
                0      dtlb_load_misses.walk_duration                                     (9.87%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (9.87%)
                0      dtlb_store_misses.stlb_hit                                     (9.86%)
                0      dtlb_store_misses.stlb_hit_2m                                     (9.88%)
                0      dtlb_store_misses.stlb_hit_4k                                     (9.88%)
                0      dtlb_store_misses.walk_completed                                     (9.88%)
                0      dtlb_store_misses.walk_completed_1g                                     (9.88%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (9.88%)
                0      dtlb_store_misses.walk_completed_4k                                     (9.87%)
                0      dtlb_store_misses.walk_duration                                     (9.86%)
                0      itlb.itlb_flush                                               (9.86%)
                0      itlb_misses.miss_causes_a_walk                                     (9.87%)
                0      itlb_misses.stlb_hit                                          (9.87%)
                0      itlb_misses.stlb_hit_2m                                       (9.88%)
                0      itlb_misses.stlb_hit_4k                                       (9.87%)
                0      itlb_misses.walk_completed                                    (9.87%)
                0      itlb_misses.walk_completed_1g                                     (9.59%)
                0      itlb_misses.walk_completed_2m_4m                                     (8.77%)
                0      itlb_misses.walk_completed_4k                                     (7.95%)
                0      itlb_misses.walk_duration                                     (7.13%)
                0      page_walker_loads.dtlb_l1                                     (6.58%)
                0      page_walker_loads.dtlb_l2                                     (6.58%)
                0      page_walker_loads.dtlb_l3                                     (6.59%)
                0      page_walker_loads.dtlb_memory                                     (6.59%)
                0      page_walker_loads.itlb_l1                                     (6.59%)
                0      page_walker_loads.itlb_l2                                     (6.59%)
                0      page_walker_loads.itlb_l3                                     (6.58%)
                0      tlb_flush.dtlb_thread                                         (6.58%)
                0      tlb_flush.stlb_any                                            (6.58%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               16      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

      0.487989859 seconds time elapsed

      0.260129000 seconds user
      0.712354000 seconds sys
```

3.233.184.105 ⊗ 0 ⚠ 0 0 Ln 5, Col 1454 Sp

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (8.43%)
                0      dTLB-loads                                                    (8.45%)
                0      dTLB-store-misses                                             (8.64%)
                0      dTLB-stores                                                   (8.90%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (8.91%)
                0      iTLB-loads                                                    (9.16%)
                0      mem_uops_retired.stlb_miss_loads                                     (9.29%)
                0      mem_uops_retired.stlb_miss_stores                                     (9.29%)
                0      dtlb_load_misses.miss_causes_a_walk                                     (9.27%)
                0      dtlb_load_misses.stlb_hit                                     (9.02%)
                0      dtlb_load_misses.stlb_hit_2m                                     (8.87%)
                0      dtlb_load_misses.stlb_hit_4k                                     (8.85%)
                0      dtlb_load_misses.walk_completed                                     (8.86%)
                0      dtlb_load_misses.walk_completed_1g                                     (8.85%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (8.86%)
                0      dtlb_load_misses.walk_completed_4k                                     (8.86%)
                0      dtlb_load_misses.walk_duration                                     (8.87%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (8.90%)
                0      dtlb_store_misses.stlb_hit                                     (8.91%)
                0      dtlb_store_misses.stlb_hit_2m                                     (8.94%)
                0      dtlb_store_misses.stlb_hit_4k                                     (8.91%)
                0      dtlb_store_misses.walk_completed                                     (8.91%)
                0      dtlb_store_misses.walk_completed_1g                                     (8.90%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (8.87%)
                0      dtlb_store_misses.walk_completed_4k                                     (8.88%)
                0      dtlb_store_misses.walk_duration                                     (8.89%)
                0      itlb.itlb_flush                                               (8.89%)
                0      itlb_misses.miss_causes_a_walk                                     (8.92%)
                0      itlb_misses.stlb_hit                                          (8.92%)
                0      itlb_misses.stlb_hit_2m                                       (8.91%)
                0      itlb_misses.stlb_hit_4k                                       (8.91%)
                0      itlb_misses.walk_completed                                    (8.91%)
                0      itlb_misses.walk_completed_1g                                     (8.93%)
                0      itlb_misses.walk_completed_2m_4m                                     (8.94%)
                0      itlb_misses.walk_completed_4k                                     (8.94%)
                0      itlb_misses.walk_duration                                     (8.92%)
                0      page_walker_loads.dtlb_l1                                     (8.92%)
                0      page_walker_loads.dtlb_l2                                     (8.91%)
                0      page_walker_loads.dtlb_l3                                     (8.91%)
                0      page_walker_loads.dtlb_memory                                     (8.91%)
                0      page_walker_loads.itlb_l1                                     (8.90%)
                0      page_walker_loads.itlb_l2                                     (8.87%)
                0      page_walker_loads.itlb_l3                                     (8.83%)
                0      tlb_flush.dtlb_thread                                         (8.67%)
                0      tlb_flush.stlb_any                                            (8.40%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               25      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

       0.726089836 seconds time elapsed

       0.345115000 seconds user
       1.801824000 seconds sys
```

13.233.184.104 ⊗ 0 ⚠ 0 0 Ln 8, Col 5 (1782 selected) Spaces: 4 UTF-8 LF Shell Script

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (8.35%)
                0      dTLB-loads                                                    (8.19%)
                0      dTLB-store-misses                                             (8.14%)
                0      dTLB-stores                                                   (8.23%)
                0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (8.72%)
                0      iTLB-loads                                                    (8.87%)
                0      mem_uops_retired.stlb_miss_loads                                     (8.90%)
                0      mem_uops_retired.stlb_miss_stores                                     (8.92%)
                0      dtlb_load_misses.miss_causes_a_walk                                    (8.92%)
                0      dtlb_load_misses.stlb_hit                                     (8.92%)
                0      dtlb_load_misses.stlb_hit_2m                                     (8.91%)
                0      dtlb_load_misses.stlb_hit_4k                                     (8.90%)
                0      dtlb_load_misses.walk_completed                                     (8.89%)
                0      dtlb_load_misses.walk_completed_1g                                     (8.88%)
                0      dtlb_load_misses.walk_completed_2m_4m                                     (8.88%)
                0      dtlb_load_misses.walk_completed_4k                                     (8.84%)
                0      dtlb_load_misses.walk_duration                                     (8.85%)
                0      dtlb_store_misses.miss_causes_a_walk                                     (8.88%)
                0      dtlb_store_misses.stlb_hit                                     (8.88%)
                0      dtlb_store_misses.stlb_hit_2m                                     (8.92%)
                0      dtlb_store_misses.stlb_hit_4k                                     (8.93%)
                0      dtlb_store_misses.walk_completed                                     (8.91%)
                0      dtlb_store_misses.walk_completed_1g                                     (9.11%)
                0      dtlb_store_misses.walk_completed_2m_4m                                     (9.10%)
                0      dtlb_store_misses.walk_completed_4k                                     (9.10%)
                0      dtlb_store_misses.walk_duration                                     (9.09%)
                0      itlb.itlb_flush                                               (8.91%)
                0      itlb_misses.miss_causes_a_walk                                     (8.91%)
                0      itlb_misses.stlb_hit                                          (8.91%)
                0      itlb_misses.stlb_hit_2m                                       (8.95%)
                0      itlb_misses.stlb_hit_4k                                       (8.90%)
                0      itlb_misses.walk_completed                                     (8.91%)
                0      itlb_misses.walk_completed_1g                                     (8.90%)
                0      itlb_misses.walk_completed_2m_4m                                     (8.88%)
                0      itlb_misses.walk_completed_4k                                     (8.90%)
                0      itlb_misses.walk_duration                                     (8.90%)
                0      page_walker_loads.dtlb_l1                                     (8.92%)
                0      page_walker_loads.dtlb_l2                                     (8.93%)
                0      page_walker_loads.dtlb_l3                                     (8.97%)
                0      page_walker_loads.dtlb_memory                                     (8.97%)
                0      page_walker_loads.itlb_l1                                     (8.95%)
                0      page_walker_loads.itlb_l2                                     (9.27%)
                0      page_walker_loads.itlb_l3                                     (9.25%)
                0      tlb_flush.dtlb_thread                                         (9.25%)
                0      tlb_flush.stlb_any                                            (9.16%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               16      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

       0.721905144 seconds time elapsed

       0.389393000 seconds user
       1.752269000 seconds sys
```

```
number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                0      dTLB-loads
                0      dTLB-store-misses
                0      dTLB-stores
     <not counted>      iTLB-load-misses                                                      (0.00%)
     <not counted>      iTLB-loads                                                            (0.00%)
     <not counted>      mem_uops_retired.stlb_miss_loads                                             (0.00%)
     <not counted>      mem_uops_retired.stlb_miss_stores                                             (0.00%)
     <not counted>      dtlb_load_misses.miss_causes_a_walk                                             (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit                                             (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit_2m                                             (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit_4k                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_1g                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_2m_4m                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_4k                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_duration                                             (0.00%)
     <not counted>      dtlb_store_misses.miss_causes_a_walk                                             (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit                                             (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit_2m                                             (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit_4k                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_1g                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_2m_4m                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_4k                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_duration                                             (0.00%)
     <not counted>      itlb.itlb_flush                                                       (0.00%)
     <not counted>      itlb_misses.miss_causes_a_walk                                                (0.00%)
     <not counted>      itlb_misses.stlb_hit                                                  (0.00%)
     <not counted>      itlb_misses.stlb_hit_2m                                               (0.00%)
     <not counted>      itlb_misses.stlb_hit_4k                                               (0.00%)
     <not counted>      itlb_misses.walk_completed                                            (0.00%)
     <not counted>      itlb_misses.walk_completed_1g                                             (0.00%)
     <not counted>      itlb_misses.walk_completed_2m_4m                                             (0.00%)
     <not counted>      itlb_misses.walk_completed_4k                                             (0.00%)
     <not counted>      itlb_misses.walk_duration                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_l1                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_l2                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_l3                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_memory                                             (0.00%)
     <not counted>      page_walker_loads.itlb_l1                                             (0.00%)
     <not counted>      page_walker_loads.itlb_l2                                             (0.00%)
     <not counted>      page_walker_loads.itlb_l3                                             (0.00%)
     <not counted>      tlb_flush.dtlb_thread                                                 (0.00%)
     <not counted>      tlb_flush.stlb_any                                                    (0.00%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               16      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others

       0.002367567 seconds time elapsed

       0.001965000 seconds user
       0.000000000 seconds sys
```

```
number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

                0      dTLB-load-misses          #    0.00% of all dTLB cache hits
                0      dTLB-loads
                0      dTLB-store-misses
                0      dTLB-stores
     <not counted>      iTLB-load-misses                                                      (0.00%)
     <not counted>      iTLB-loads                                                            (0.00%)
     <not counted>      mem_uops_retired.stlb_miss_loads                                             (0.00%)
     <not counted>      mem_uops_retired.stlb_miss_stores                                             (0.00%)
     <not counted>      dtlb_load_misses.miss_causes_a_walk                                             (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit                                             (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit_2m                                             (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit_4k                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_1g                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_2m_4m                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_4k                                             (0.00%)
     <not counted>      dtlb_load_misses.walk_duration                                             (0.00%)
     <not counted>      dtlb_store_misses.miss_causes_a_walk                                             (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit                                             (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit_2m                                             (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit_4k                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_1g                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_2m_4m                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_4k                                             (0.00%)
     <not counted>      dtlb_store_misses.walk_duration                                             (0.00%)
     <not counted>      itlb.itlb_flush                                                       (0.00%)
     <not counted>      itlb_misses.miss_causes_a_walk                                                (0.00%)
     <not counted>      itlb_misses.stlb_hit                                                  (0.00%)
     <not counted>      itlb_misses.stlb_hit_2m                                               (0.00%)
     <not counted>      itlb_misses.stlb_hit_4k                                               (0.00%)
     <not counted>      itlb_misses.walk_completed                                            (0.00%)
     <not counted>      itlb_misses.walk_completed_1g                                             (0.00%)
     <not counted>      itlb_misses.walk_completed_2m_4m                                             (0.00%)
     <not counted>      itlb_misses.walk_completed_4k                                             (0.00%)
     <not counted>      itlb_misses.walk_duration                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_l1                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_l2                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_l3                                             (0.00%)
     <not counted>      page_walker_loads.dtlb_memory                                             (0.00%)
     <not counted>      page_walker_loads.itlb_l1                                             (0.00%)
     <not counted>      page_walker_loads.itlb_l2                                             (0.00%)
     <not counted>      page_walker_loads.itlb_l3                                             (0.00%)
     <not counted>      tlb_flush.dtlb_thread                                                 (0.00%)
     <not counted>      tlb_flush.stlb_any                                                    (0.00%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               16      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one user
                0      xen:xen_mmu_flush_tlb_others

       0.001879448 seconds time elapsed

       0.000000000 seconds user
       0.001864000 seconds sys
213.233.184.105   0 0   0                                                    Ln 5, Col 1454
```

تحلیل اتفاقات رخ داده :

۱. همانطور که از شکل پیداست، تنها موردی که Virtual Manager اجازه دسترسی و بررسی دقیق آنرا می‌دهد **tlb:tlb_flush** است و باقی دسترسی‌ها به guestOs و perf **داده نمی‌شوند**.

۲. اعداد tlb_flush تقریبا **۱۶** هستند به جز وقتی تعداد ریسمان‌های اجرا کننده در یکی از ماشین‌های مجازی **۳ عدد** هستند که در این مورد، عدد tlb_flush **رشد بیش از ۵۰ درصدی** پیدا کرده و به مقدار ۲۵ عدد رسیده.

۳. مانند دفعات قبل، در صورتی که از **بیش از ۳ ریسمان** استفاده کرده باشیم، به دلیل **کمبود منابع** برنامه خارج می‌شود و perf نیز اصلا **ارزیابی** را در این قسمت انجام **نمی‌دهد** و عملا در نهایت **not counted** نشان می‌دهد.

۴. به صورت عجیبی perf تعداد رخدادها را ثبت نکرده اما **درصد رخدادها** ثبت شده. ظاهرا با تعداد ریسمان بیشتر، درصد page walk ها به صورت کلی **کاهش** می‌یابد.

مقایسه با نتایج ماشین bare metal :

هرچند که این مقایسه به صورت کلی مقایسه درستی **نیست** چرا که ماشین مجازی منابع متفاوتی به نسبت ماشین bare metal داشته و نیز اتفاقات رخ داده در ماشین مجازی از لایه Virtual Manager عبور می‌کنند و اکثرا به آنها اجازه نمایش داده نمی‌شود اما می‌توان چند نتیجه گرفت.

۱. طبق نتایج در ماشین مجازی تعداد page fault ها افزایش چندانی نداشته اما در ماشین bare metal تعداد page fault ها **تقریبا به صورت اکیدا صعودی** رشد کرده.

۲. درصد tlb miss در ماشین bare metal ظاهرا خیلی بیشتر از درصد miss در ماشین مجازی است که البته می‌تواند به علت مشکلات نمایشی در ماشین مجازی باشد (؟)

آپدیت :

عکس‌های زیر عکس‌های ماشین مجازی پس از آزاد شدن دسترسی TLBها است.

```
● user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
  number of threads : 1

   Performance counter stats for './madvise --number_of_threads 1':

             970,534      dTLB-load-misses          #    0.73% of all dTLB cache hits   (6.80%)
         133,080,396      dTLB-loads                                                    (7.56%)
              15,082      dTLB-store-misses                                             (8.33%)
          92,737,331      dTLB-stores                                                   (9.09%)
             711,491      iTLB-load-misses          # 2998.53% of all iTLB cache hits   (9.20%)
              23,728      iTLB-loads                                                    (9.20%)
           1,208,974      mem_uops_retired.stlb_miss_loads                                     (9.20%)
           1,204,283      mem_uops_retired.stlb_miss_stores                                     (9.20%)
             922,646      dtlb_load_misses.miss_causes_a_walk                                     (9.20%)
           8,392,295      dtlb_load_misses.stlb_hit                                     (9.20%)
           2,056,652      dtlb_load_misses.stlb_hit_2m                                     (9.20%)
           6,412,340      dtlb_load_misses.stlb_hit_4k                                     (9.20%)
             931,502      dtlb_load_misses.walk_completed                                     (9.20%)
                   0      dtlb_load_misses.walk_completed_1g                                     (9.20%)
               1,838      dtlb_load_misses.walk_completed_2m_4m                                     (9.19%)
             912,014      dtlb_load_misses.walk_completed_4k                                     (9.20%)
           4,302,982      dtlb_load_misses.walk_duration                                     (9.20%)
               2,707      dtlb_store_misses.miss_causes_a_walk                                     (9.20%)
           5,456,979      dtlb_store_misses.stlb_hit                                     (9.20%)
               4,761      dtlb_store_misses.stlb_hit_2m                                     (9.20%)
           5,407,499      dtlb_store_misses.stlb_hit_4k                                     (9.20%)
               2,217      dtlb_store_misses.walk_completed                                     (9.20%)
                   0      dtlb_store_misses.walk_completed_1g                                     (9.20%)
                 228      dtlb_store_misses.walk_completed_2m_4m                                     (9.20%)
               2,207      dtlb_store_misses.walk_completed_4k                                     (9.20%)
             196,031      dtlb_store_misses.walk_duration                                     (9.20%)
               2,696      itlb.itlb_flush                                               (9.20%)
             700,422      itlb_misses.miss_causes_a_walk                                     (9.20%)
              31,610      itlb_misses.stlb_hit                                          (9.20%)
              12,047      itlb_misses.stlb_hit_2m                                       (9.20%)
              12,633      itlb_misses.stlb_hit_4k                                       (9.20%)
              16,982      itlb_misses.walk_completed                                    (9.20%)
                   0      itlb_misses.walk_completed_1g                                     (9.20%)
               1,141      itlb_misses.walk_completed_2m_4m                                     (9.20%)
              25,157      itlb_misses.walk_completed_4k                                     (9.20%)
          11,047,650      itlb_misses.walk_duration                                     (9.20%)
             820,611      page_walker_loads.dtlb_l1                                     (9.20%)
               6,643      page_walker_loads.dtlb_l2                                     (9.20%)
               6,751      page_walker_loads.dtlb_l3                                     (9.20%)
                 532      page_walker_loads.dtlb_memory                                     (9.20%)
             636,166      page_walker_loads.itlb_l1                                     (8.89%)
               2,890      page_walker_loads.itlb_l2                                     (8.13%)
               1,086      page_walker_loads.itlb_l3                                     (7.36%)
             597,890      tlb_flush.dtlb_thread                                         (6.59%)
                 537      tlb_flush.stlb_any                                            (6.13%)
                   0      hyperv:hyperv_mmu_flush_tlb_others
                   0      swiotlb:swiotlb_bounced
                  16      tlb:tlb_flush
                   0      xen:xen_mmu_flush_tlb_one_user
                   0      xen:xen_mmu_flush_tlb_others

         0.522532441 seconds time elapsed

         0.139637000 seconds user
         0.383005000 seconds sys
```

```
● user01@user01:~/scripts/madvise$ sudo bash ./madvise_perf.sh
 number of threads : 1

  Performance counter stats for './madvise --number_of_threads 1':

          1,425,428      cache-references                                                (7.24%)
            171,182      cache-misses              #   12.009 % of all cache refs          (7.24%)
                 70      faults
                 70      page-faults
            979,108      dTLB-load-misses          #    0.73% of all dTLB cache hits       (7.67%)
        134,785,429      dTLB-loads                                                      (8.39%)
              2,781      dTLB-store-misses                                               (8.63%)
         94,036,774      dTLB-stores                                                     (8.63%)
          1,290,188      iTLB-load-misses          # 1505.05% of all iTLB cache hits     (8.63%)
             85,724      iTLB-loads                                                      (8.63%)
          1,195,450      mem_uops_retired.stlb_miss_loads                                        (8.63%)
          1,181,901      mem_uops_retired.stlb_miss_stores                                        (8.63%)
            909,223      dtlb_load_misses.miss_causes_a_walk                                        (8.63%)
          7,261,607      dtlb_load_misses.stlb_hit                                       (8.63%)
          2,607,530      dtlb_load_misses.stlb_hit_2m                                       (8.63%)
          4,748,050      dtlb_load_misses.stlb_hit_4k                                       (8.63%)
            918,537      dtlb_load_misses.walk_completed                                        (8.63%)
                  0      dtlb_load_misses.walk_completed_1g                                        (8.63%)
              2,236      dtlb_load_misses.walk_completed_2m_4m                                        (8.63%)
            903,710      dtlb_load_misses.walk_completed_4k                                        (8.63%)
          4,414,461      dtlb_load_misses.walk_duration                                        (8.63%)
              2,933      dtlb_store_misses.miss_causes_a_walk                                        (8.63%)
          5,426,296      dtlb_store_misses.stlb_hit                                      (8.62%)
              5,669      dtlb_store_misses.stlb_hit_2m                                       (8.62%)
          5,448,106      dtlb_store_misses.stlb_hit_4k                                       (8.63%)
              2,573      dtlb_store_misses.walk_completed                                        (8.63%)
                  0      dtlb_store_misses.walk_completed_1g                                        (8.63%)
                220      dtlb_store_misses.walk_completed_2m_4m                                        (8.63%)
              2,178      dtlb_store_misses.walk_completed_4k                                        (8.63%)
            166,255      dtlb_store_misses.walk_duration                                        (8.63%)
              2,143      itlb.itlb_flush                                                 (8.63%)
          1,404,299      itlb_misses.miss_causes_a_walk                                        (8.63%)
             47,854      itlb_misses.stlb_hit                                            (8.63%)
             13,952      itlb_misses.stlb_hit_2m                                         (8.63%)
             52,922      itlb_misses.stlb_hit_4k                                         (8.63%)
            302,293      itlb_misses.walk_completed                                      (8.63%)
                  0      itlb_misses.walk_completed_1g                                       (8.63%)
                996      itlb_misses.walk_completed_2m_4m                                        (8.63%)
            305,911      itlb_misses.walk_completed_4k                                       (8.63%)
         19,290,875      itlb_misses.walk_duration                                       (8.63%)
            824,522      page_walker_loads.dtlb_l1                                       (8.63%)
              5,736      page_walker_loads.dtlb_l2                                       (8.63%)
              5,225      page_walker_loads.dtlb_l3                                       (8.63%)
                451      page_walker_loads.dtlb_memory                                       (8.63%)
          1,297,308      page_walker_loads.itlb_l1                                       (8.63%)
              2,734      page_walker_loads.itlb_l2                                       (8.63%)
                486      page_walker_loads.itlb_l3                                       (8.63%)
            635,599      tlb_flush.dtlb_thread                                           (8.20%)
                481      tlb_flush.stlb_any                                              (7.48%)
                  0      hyperv:hyperv_mmu_flush_tlb_others
                  0      swiotlb:swiotlb_bounced
                 16      tlb:tlb_flush
                  0      xen:xen_mmu_flush_tlb_one_user
                  0      xen:xen_mmu_flush_tlb_others
                  3      context-switches
```

```
number of threads : 3

 Performance counter stats for './madvise --number_of_threads 3':

        90,108,278      cache-references                                                (7.79%)
           129,150      cache-misses              #    0.143 % of all cache refs      (8.23%)
                72      faults
                72      page-faults
         3,109,790      dTLB-load-misses          #    0.40% of all dTLB cache hits   (8.74%)
       780,190,092      dTLB-loads                                                      (9.11%)
            32,527      dTLB-store-misses                                               (9.36%)
       376,638,001      dTLB-stores                                                     (9.35%)
         3,883,067      iTLB-load-misses          # 3249.89% of all iTLB cache hits   (9.44%)
           119,483      iTLB-loads                                                      (9.44%)
         3,784,831      mem_uops_retired.stlb_miss_loads                                       (9.23%)
         4,620,441      mem_uops_retired.stlb_miss_stores                                       (9.11%)
         3,030,116      dtlb_load_misses.miss_causes_a_walk                                       (8.89%)
        33,026,263      dtlb_load_misses.stlb_hit                                       (9.07%)
         7,026,342      dtlb_load_misses.stlb_hit_2m                                       (9.09%)
        26,203,735      dtlb_load_misses.stlb_hit_4k                                       (9.15%)
         2,953,033      dtlb_load_misses.walk_completed                                       (9.12%)
                 0      dtlb_load_misses.walk_completed_1g                                       (9.03%)
            21,171      dtlb_load_misses.walk_completed_2m_4m                                       (9.05%)
         2,920,311      dtlb_load_misses.walk_completed_4k                                       (9.19%)
        18,164,460      dtlb_load_misses.walk_duration                                       (9.18%)
            30,065      dtlb_store_misses.miss_causes_a_walk                                       (9.17%)
        16,422,731      dtlb_store_misses.stlb_hit                                       (9.04%)
            87,094      dtlb_store_misses.stlb_hit_2m                                       (8.63%)
        16,198,939      dtlb_store_misses.stlb_hit_4k                                       (8.72%)
            28,133      dtlb_store_misses.walk_completed                                       (8.42%)
                 0      dtlb_store_misses.walk_completed_1g                                       (8.30%)
             1,964      dtlb_store_misses.walk_completed_2m_4m                                       (8.30%)
            20,109      dtlb_store_misses.walk_completed_4k                                       (8.04%)
         1,223,272      dtlb_store_misses.walk_duration                                       (8.18%)
            11,686      itlb.itlb_flush                                                 (8.30%)
         3,995,848      itlb_misses.miss_causes_a_walk                                       (8.25%)
           154,374      itlb_misses.stlb_hit                                            (8.16%)
            78,713      itlb_misses.stlb_hit_2m                                         (8.05%)
            79,467      itlb_misses.stlb_hit_4k                                         (7.83%)
           945,734      itlb_misses.walk_completed                                       (7.86%)
                 0      itlb_misses.walk_completed_1g                                       (7.98%)
             7,477      itlb_misses.walk_completed_2m_4m                                       (7.82%)
           958,007      itlb_misses.walk_completed_4k                                       (7.88%)
        57,184,694      itlb_misses.walk_duration                                       (7.87%)
         2,923,863      page_walker_loads.dtlb_l1                                       (7.97%)
            55,620      page_walker_loads.dtlb_l2                                       (7.99%)
            62,021      page_walker_loads.dtlb_l3                                       (8.09%)
             5,343      page_walker_loads.dtlb_memory                                       (8.16%)
         3,693,217      page_walker_loads.itlb_l1                                       (8.03%)
            24,610      page_walker_loads.itlb_l2                                       (8.13%)
            11,323      page_walker_loads.itlb_l3                                       (7.91%)
         1,826,591      tlb_flush.dtlb_thread                                           (7.75%)
             3,533      tlb_flush.stlb_any                                              (7.61%)
                 0      hyperv:hyperv_mmu_flush_tlb_others
                 0      swiotlb:swiotlb_bounced
                14      tlb:tlb_flush
                 0      xen:xen_mmu_flush_tlb_one_user
                 0      xen:xen_mmu_flush_tlb_others
             4,789      context-switches
```

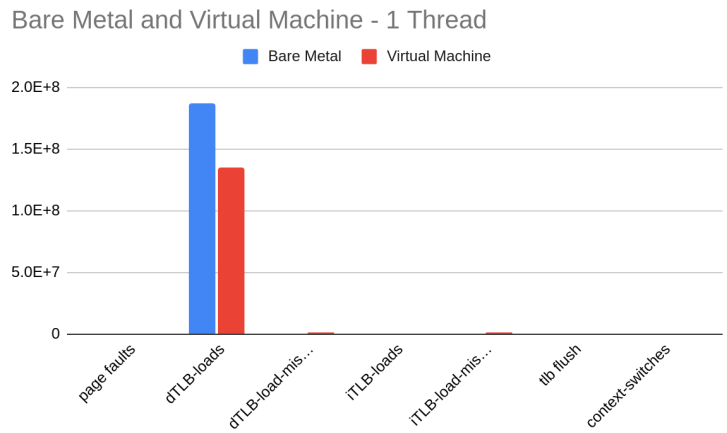
```
Performance counter stats for './madvise --number_of_threads 2':

       35,987,146      cache-references                                                (7.67%)
          122,155      cache-misses              #    0.339 % of all cache refs      (8.15%)
               72      faults
               72      page-faults
        1,951,431      dTLB-load-misses          #    0.50% of all dTLB cache hits   (8.62%)
      387,846,352      dTLB-loads                                                      (9.08%)
           10,432      dTLB-store-misses                                               (9.36%)
      235,391,266      dTLB-stores                                                     (9.38%)
        2,823,589      iTLB-load-misses          # 6850.21% of all iTLB cache hits   (9.38%)
           41,219      iTLB-loads                                                      (9.38%)
        2,570,346      mem_uops_retired.stlb_miss_loads                                       (9.38%)
        2,752,093      mem_uops_retired.stlb_miss_stores                                      (9.38%)
        2,026,959      dtlb_load_misses.miss_causes_a_walk                                    (9.36%)
       22,599,165      dtlb_load_misses.stlb_hit                                       (9.35%)
        6,576,752      dtlb_load_misses.stlb_hit_2m                                       (9.35%)
       15,978,801      dtlb_load_misses.stlb_hit_4k                                       (9.35%)
        1,823,267      dtlb_load_misses.walk_completed                                        (9.33%)
                0      dtlb_load_misses.walk_completed_1g                                     (9.35%)
            6,980      dtlb_load_misses.walk_completed_2m_4m                                  (9.35%)
        1,826,239      dtlb_load_misses.walk_completed_4k                                     (9.35%)
        9,924,051      dtlb_load_misses.walk_duration                                         (9.60%)
            9,405      dtlb_store_misses.miss_causes_a_walk                                   (9.60%)
       10,370,701      dtlb_store_misses.stlb_hit                                      (9.58%)
           36,937      dtlb_store_misses.stlb_hit_2m                                      (9.57%)
       10,454,344      dtlb_store_misses.stlb_hit_4k                                      (9.34%)
            8,980      dtlb_store_misses.walk_completed                                       (9.34%)
               21      dtlb_store_misses.walk_completed_1g                                    (9.20%)
              801      dtlb_store_misses.walk_completed_2m_4m                                 (8.99%)
            8,398      dtlb_store_misses.walk_completed_4k                                    (8.53%)
          588,483      dtlb_store_misses.walk_duration                                        (8.06%)
            4,479      itlb.itlb_flush                                                 (7.75%)
        2,796,346      itlb_misses.miss_causes_a_walk                                         (7.50%)
           38,569      itlb_misses.stlb_hit                                            (7.50%)
           26,380      itlb_misses.stlb_hit_2m                                         (7.50%)
           13,881      itlb_misses.stlb_hit_4k                                         (7.74%)
          663,573      itlb_misses.walk_completed                                      (7.74%)
                0      itlb_misses.walk_completed_1g                                      (7.73%)
            3,116      itlb_misses.walk_completed_2m_4m                                       (7.73%)
          614,478      itlb_misses.walk_completed_4k                                      (7.50%)
       40,579,125      itlb_misses.walk_duration                                       (7.50%)
        1,511,320      page_walker_loads.dtlb_l1                                       (7.50%)
           15,248      page_walker_loads.dtlb_l2                                       (7.48%)
           19,389      page_walker_loads.dtlb_l3                                       (7.48%)
            1,550      page_walker_loads.dtlb_memory                                      (7.48%)
        2,743,661      page_walker_loads.itlb_l1                                       (7.49%)
           11,522      page_walker_loads.itlb_l2                                       (7.51%)
            2,360      page_walker_loads.itlb_l3                                       (7.50%)
        1,211,368      tlb_flush.dtlb_thread                                           (7.50%)
            1,201      tlb_flush.stlb_any                                              (7.49%)
                0      hyperv:hyperv_mmu_flush_tlb_others
                0      swiotlb:swiotlb_bounced
               17      tlb:tlb_flush
                0      xen:xen_mmu_flush_tlb_one_user
                0      xen:xen_mmu_flush_tlb_others
              256      context-switches

      0.856409874 seconds time elapsed
```

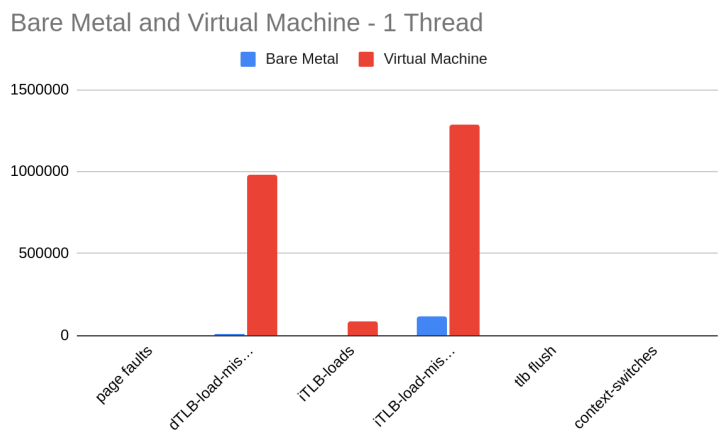
```
number of threads : 4
You have chosen more threads than what you have
 exiting ...

 Performance counter stats for './madvise --number_of_threads 4':

             6,530      dTLB-load-misses          #    2.18% of all dTLB cache hits   (56.49%)
           299,793      dTLB-loads
               819      dTLB-store-misses
           179,790      dTLB-stores
             1,312      iTLB-load-misses          #    0.00% of all iTLB cache hits   (43.51%)
     <not counted>      iTLB-loads                                                    (0.00%)
     <not counted>      mem_uops_retired.stlb_miss_loads                                     (0.00%)
     <not counted>      mem_uops_retired.stlb_miss_stores                                     (0.00%)
     <not counted>      dtlb_load_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit_2m                                     (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit_4k                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_duration                                     (0.00%)
     <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit_2m                                     (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit_4k                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_duration                                     (0.00%)
     <not counted>      itlb.itlb_flush                                               (0.00%)
     <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      itlb_misses.stlb_hit                                          (0.00%)
     <not counted>      itlb_misses.stlb_hit_2m                                       (0.00%)
     <not counted>      itlb_misses.stlb_hit_4k                                       (0.00%)
     <not counted>      itlb_misses.walk_completed                                    (0.00%)
     <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
     <not counted>      itlb_misses.walk_duration                                     (0.00%)
     <not counted>      page_walker_loads.dtlb_l1                                     (0.00%)
     <not counted>      page_walker_loads.dtlb_l2                                     (0.00%)
     <not counted>      page_walker_loads.dtlb_l3                                     (0.00%)
     <not counted>      page_walker_loads.dtlb_memory                                     (0.00%)
     <not counted>      page_walker_loads.itlb_l1                                     (0.00%)
     <not counted>      page_walker_loads.itlb_l2                                     (0.00%)
     <not counted>      page_walker_loads.itlb_l3                                     (0.00%)
     <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
     <not counted>      tlb_flush.stlb_any                                            (0.00%)
                 0      hyperv:hyperv_mmu_flush_tlb_others
                 0      swiotlb:swiotlb_bounced
                16      tlb:tlb_flush
                 0      xen:xen_mmu_flush_tlb_one_user
                 0      xen:xen_mmu_flush_tlb_others

       0.001395906 seconds time elapsed
```

نمودار تحلیل بین ماشین مجازی و ماشین Bare Metal :

۱ ریسه :

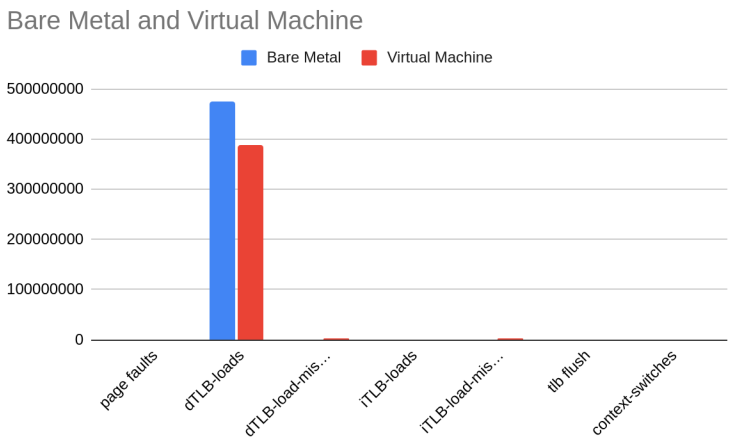
	Bare Metal	Virtual Machine
page faults	72	70
dTLB-loads	187,344,411	134,785,429
dTLB-load-misses	5,741	979,108
iTLB-loads	712	85,724
iTLB-load-misses	115,130	1,290,188
tlb flush	15	16
context-switches	14	3

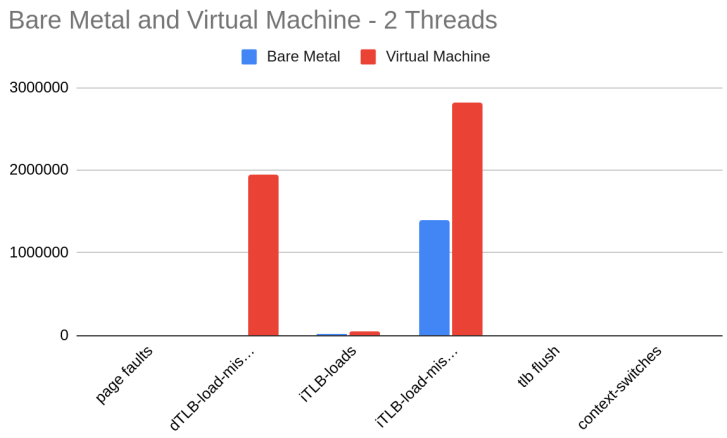




۲ ریسه :

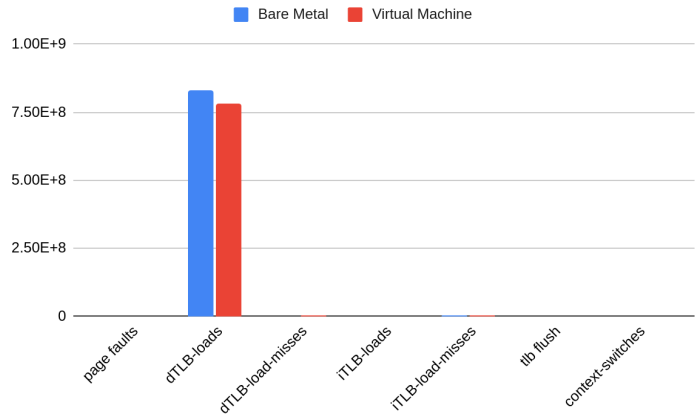
	Bare Metal	Virtual Machine
page faults	73	72
dTLB-loads	474,199,954	387,846,352
dTLB-load-misses	8,900	1,951,431
iTLB-loads	12,765	41,219
iTLB-load-misses	1,397,464	2,823,589
tlb flush	16	17
context-switches	69	256

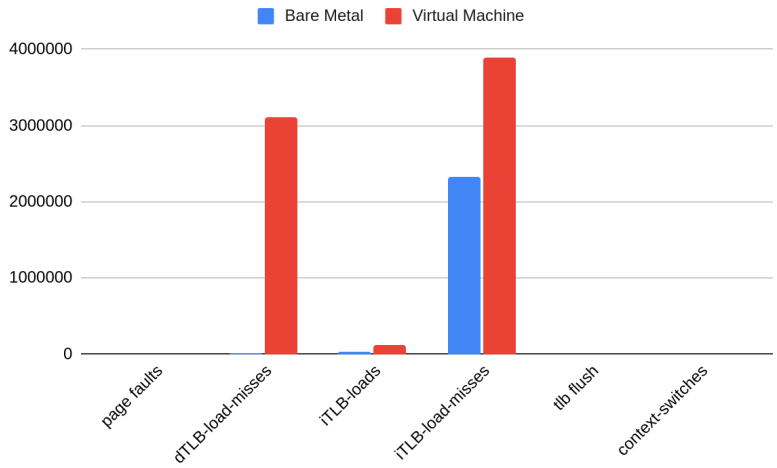




۳ ریسه :

	Bare Metal	Virtual Machine
page faults	77	72
dTLB-loads	830,992,076	780,190,092
dTLB-load-misses	10,447	3,109,790
iTLB-loads	24,871	119,483
iTLB-load-misses	2,322,784	3,883,067
tlb flush	40	14
context-switches	593	4,789





سوال 2 .

برای این سوال ابتدا کد نوشته شده را بررسی می‌کنیم.

```c
#define FILE_SIZE 100
char *mmapped_file;

void *write_to_file(void *arg) {
    int thread_id = *((int *)arg);
    for (int i = 0; i < FILE_SIZE; i++) {
        mmapped_file[i] = (char)(65 + thread_id);
        msync(mmapped_file, FILE_SIZE, MS_SYNC);
    }

    return NULL;
}

int main() {
    int fd = open("example_file", O_RDWR | O_CREAT, S_IRUSR | S_IWUSR);
    if (fd == -1) {
        perror("Error opening file");
        exit(EXIT_FAILURE);
    }

    if (ftruncate(fd, FILE_SIZE) == -1) {
        perror("Error truncating file");
        exit(EXIT_FAILURE);
    }

    mmapped_file = mmap(NULL, FILE_SIZE, PROT_READ | PROT_WRITE, MAP_SHARED, fd, 0);
    if (mmapped_file == MAP_FAILED) {
        perror("Error mmaping file");
        exit(EXIT_FAILURE);
    }

    pthread_t thread1, thread2;
    int thread_id1 = 0, thread_id2 = 1;

    pthread_create(&thread1, NULL, write_to_file, (void *)&thread_id1);
    pthread_create(&thread2, NULL, write_to_file, (void *)&thread_id2);

    pthread_join(thread1, NULL);
    pthread_join(thread2, NULL);

    munmap(mmapped_file, FILE_SIZE);
    close(fd);
    return 0;
}
```

در ابتدا یک فایل می‌سازیم که قرار است دو ریسمان در آن بنویسند. سپس سایز فایل را مشخص می‌کنیم که در برنامه ما آنرا ۱۰۰ بایت درنظر گرفته‌ایم. حال با ftruncate سایز فایل را به ۱۰۰ بایت محدود می‌کنیم.

حال در هر ریسمان،شماره آن ریسمان ثبت شده و کاراکتر آن در فایل نوشته شده و تابع msync صدا زده می‌شود تا داده‌ها با داده‌های حافظه جانبی سینک شوند.

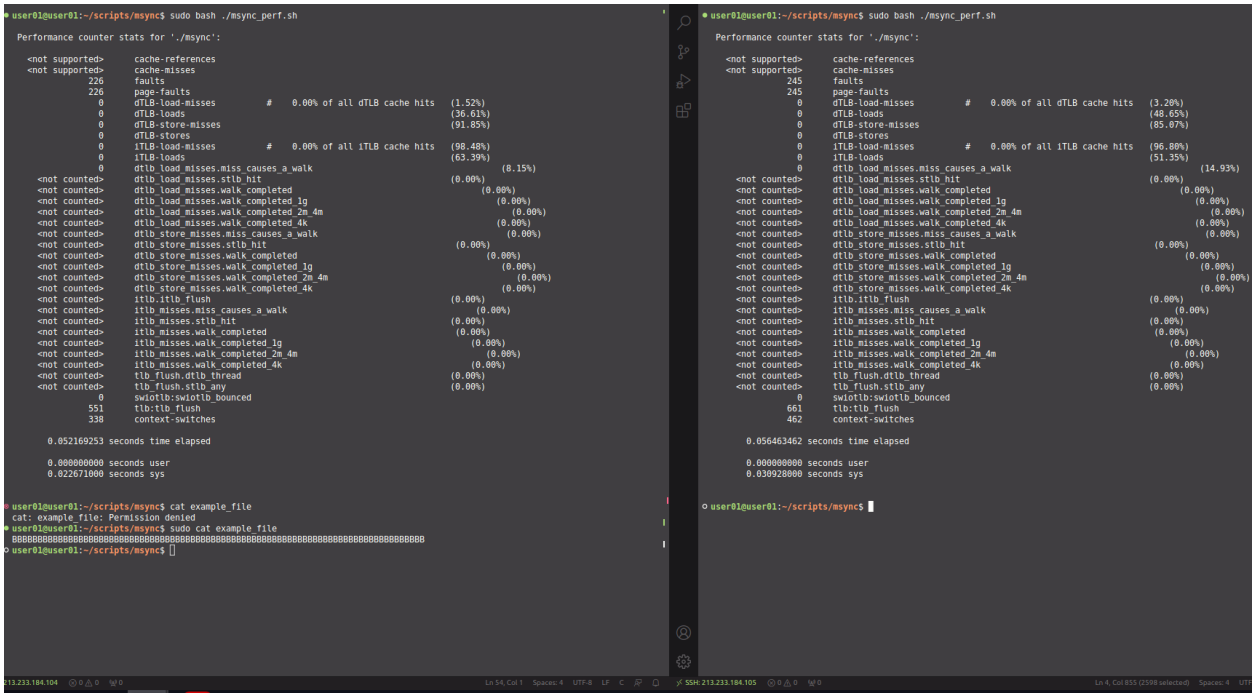
نتایج ماشین bare metal :

حال نتایج را برای ماشین bare metal مشاهده کنیم.

```
Hooman_Keshvari_99105667@bigwhoman-pp /m/b/N/S/t/O/A/H/msync> sudo bash ./msync_perf.sh

 Performance counter stats for './msync':

          825,971      cache-references                                              (93.93%)
          382,729      cache-misses              #   46.337 % of all cache refs
              267      faults
              267      page-faults
           10,613      dTLB-load-misses          #    0.60% of all dTLB cache accesses
        1,771,222      dTLB-loads
            2,107      dTLB-store-misses                                             (62.57%)
        1,069,286      dTLB-stores                                                   (51.47%)
            3,340      iTLB-load-misses          #  124.77% of all iTLB cache accesses  (48.55%)
            2,677      iTLB-loads                                                    (40.52%)
           39,903      dtlb_load_misses.miss_causes_a_walk                                     (25.89%)
           36,479      dtlb_load_misses.stlb_hit                                     (22.43%)
           29,789      dtlb_load_misses.walk_completed                                     (0.56%)
    <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
    <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
    <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
    <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
    <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
    <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
    <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
    <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
    <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
    <not counted>      itlb.itlb_flush                                               (0.00%)
    <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
    <not counted>      itlb_misses.stlb_hit                                          (0.00%)
    <not counted>      itlb_misses.walk_completed                                     (0.00%)
    <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
    <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
    <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
    <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
    <not counted>      tlb_flush.stlb_any                                            (0.00%)
                0      swiotlb:swiotlb_bounced
              502      tlb:tlb_flush
              619      context-switches

     23.927870716 seconds time elapsed

      0.011627000 seconds user
      0.052299000 seconds sys
```

نتایج بر دو ماشین مجازی به صورت همزمان :

حال تست‌های مرحله قبل را در ماشین‌های مجازی نیز به صورت همزمان انجام می‌دهیم.



در عکس بالا هر دو ماشین به صورت همزمان ران شده‌اند و تصاویر کامل هر دو ماشین در صفحه بعد نمایش داده شده است.

```
● user01@user01:~/scripts/msync$ sudo bash ./msync_perf.sh

  Performance counter stats for './msync':

    <not supported>      cache-references
    <not supported>      cache-misses
                226      faults
                226      page-faults
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (1.52%)
                  0      dTLB-loads                                                    (36.61%)
                  0      dTLB-store-misses                                             (91.85%)
                  0      dTLB-stores
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (98.48%)
                  0      iTLB-loads                                                    (63.39%)
                  0      dtlb_load_misses.miss_causes_a_walk                                     (8.15%)
      <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
      <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
      <not counted>      itlb.itlb_flush                                               (0.00%)
      <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      itlb_misses.stlb_hit                                          (0.00%)
      <not counted>      itlb_misses.walk_completed                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
      <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
      <not counted>      tlb_flush.stlb_any                                            (0.00%)
                  0      swiotlb:swiotlb_bounced
                551      tlb:tlb_flush
                338      context-switches

        0.052169253 seconds time elapsed

        0.000000000 seconds user
        0.022671000 seconds sys
```

```
● user01@user01:~/scripts/msync$ sudo bash ./msync_perf.sh

  Performance counter stats for './msync':

    <not supported>      cache-references
    <not supported>      cache-misses
                245      faults
                245      page-faults
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (3.20%)
                  0      dTLB-loads                                                    (48.65%)
                  0      dTLB-store-misses                                             (85.07%)
                  0      dTLB-stores
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (96.80%)
                  0      iTLB-loads                                                    (51.35%)
                  0      dtlb_load_misses.miss_causes_a_walk                                    (14.93%)
      <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
      <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
      <not counted>      itlb.itlb_flush                                               (0.00%)
      <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      itlb_misses.stlb_hit                                          (0.00%)
      <not counted>      itlb_misses.walk_completed                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
      <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
      <not counted>      tlb_flush.stlb_any                                            (0.00%)
                  0      swiotlb:swiotlb_bounced
                661      tlb:tlb_flush
                462      context-switches

        0.056463462 seconds time elapsed

        0.000000000 seconds user
        0.030928000 seconds sys
```

تحلیل نتایج از ماشین‌های مجازی و نیز مقایسه با ماشین Bare Metal

۱. ماشین Bare Metal تعداد 267 عدد page fault دارد و ماشین‌های مجازی به صورت میانگین 235 عدد page fault دارند که یعنی اجرا بر روی Host Os , Virtual Os با تقریب خوبی تاثیری یکسانی بر تعداد page fault ها دارند.

۲. اعداد اجرایی دو ماشین مجازی با وجود این که بر روی یک سخت افزار یکسان اجرا می‌شوند اما با یکدیگر تفاوت دارند که می‌تواند ناشی از لود سرور و نیز مشکلات شبکه‌ای و زمانبندی اجرا باشند.

۳. در ماشین Bare Metal تعداد ۵۰۲ عدد TLB flush داریم در صورتی که در ماشین‌های مجازی به ترتیب ۵۵۱ و ۶۶۱ TLB flush داریم که می‌توانیم نتیجه بگیریم ماشین Bare Metal احتمالا در این مورد بهتر است.

۴. درصد tlb miss در ماشین مجازی خیلی بالاتر از ماشین bare metal است.

درصد tlb miss ماشین مجازی : ۹۳٪

درصد tlb miss در ماشین Bare metal لوکال : ۴۷٪

التبه همچین نتایجی کاملا مطابق انتظار است چرا که در ماشین مجازی مشکلات tlb بیشتر است و برای گرفتن یک داده مشخص از tlb بعضا تا ۲۰ برابر نیز می‌تواند بدتر عمل کند.

آپدیت :

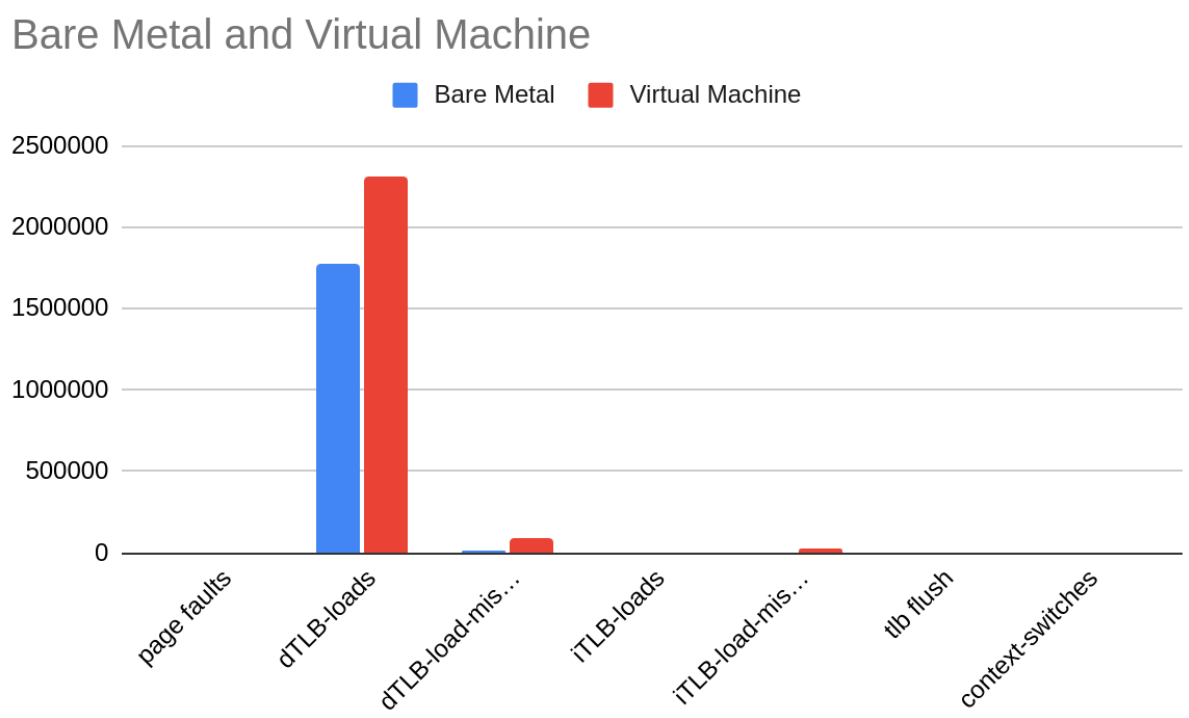
عکس‌های زیر عکس‌های ماشین مجازی پس از آزاد شدن دسترسی TLBها است.

```
● user01@user01:~/scripts/msync$ sudo bash ./msync_perf.sh

  Performance counter stats for './msync':

          1,149,699      cache-references                                              (35.36%)
              9,011      cache-misses              #    0.784 % of all cache refs      (73.28%)
                213      faults
                213      page-faults
             95,802      dTLB-load-misses          #    4.15% of all dTLB cache hits
          2,310,870      dTLB-loads
             14,969      dTLB-store-misses                                             (64.64%)
          1,438,064      dTLB-stores                                                   (26.72%)
      <not counted>      iTLB-load-misses                                              (0.00%)
      <not counted>      iTLB-loads                                                    (0.00%)
      <not counted>      dtlb_load_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
      <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
      <not counted>      itlb.itlb_flush                                               (0.00%)
      <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
      <not counted>      itlb_misses.stlb_hit                                          (0.00%)
      <not counted>      itlb_misses.walk_completed                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
      <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
      <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
      <not counted>      tlb_flush.stlb_any                                            (0.00%)
                0        swiotlb:swiotlb_bounced
              493        tlb:tlb_flush
              318        context-switches

        0.066681913 seconds time elapsed

        0.000000000 seconds user
        0.030922000 seconds sys


  Some events weren't counted. Try disabling the NMI watchdog:
          echo 0 > /proc/sys/kernel/nmi_watchdog
          perf stat ...
          echo 1 > /proc/sys/kernel/nmi_watchdog
○ user01@user01:~/scripts/msync$
```

```
● user01@user01:~/scripts/msync$ sudo bash ./msync_perf.sh

 Performance counter stats for './msync':

           984,775      cache-references                                              (37.29%)
             9,544      cache-misses              #    0.969 % of all cache refs      (70.26%)
               229      faults
               229      page-faults
            96,111      dTLB-load-misses          #    3.83% of all dTLB cache hits   (79.12%)
         2,509,100      dTLB-loads                                                    (84.34%)
            15,970      dTLB-store-misses                                             (52.35%)
         1,386,065      dTLB-stores                                                   (24.44%)
            22,157      iTLB-load-misses          #  344.96% of all iTLB cache hits   (20.88%)
             6,423      iTLB-loads                                                    (15.66%)
           117,029      dtlb_load_misses.miss_causes_a_walk                                     (10.36%)
            82,735      dtlb_load_misses.stlb_hit                                     (5.30%)
     <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
     <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%
)
     <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
     <not counted>      itlb.itlb_flush                                               (0.00%)
     <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      itlb_misses.stlb_hit                                          (0.00%)
     <not counted>      itlb_misses.walk_completed                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
     <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
     <not counted>      tlb_flush.stlb_any                                            (0.00%)
                0       swiotlb:swiotlb_bounced
              477       tlb:tlb_flush
              318       context-switches

       0.056998253 seconds time elapsed

       0.010404000 seconds user
       0.020808000 seconds sys


 Some events weren't counted. Try disabling the NMI watchdog:
        echo 0 > /proc/sys/kernel/nmi_watchdog
        perf stat ...
        echo 1 > /proc/sys/kernel/nmi_watchdog
```

نمودار تحلیل بین ماشین مجازی و ماشین Bare Metal در حالت Sync

	Bare Metal	Virtual Machine
page faults	267	213
dTLB-loads	1,771,222	2,310,870
dTLB-load-misses	10,613	95,802
iTLB-loads	2,677	6,423
iTLB-load-misses	3,340	22,157
tlb flush	502	477
context-switches	619	318

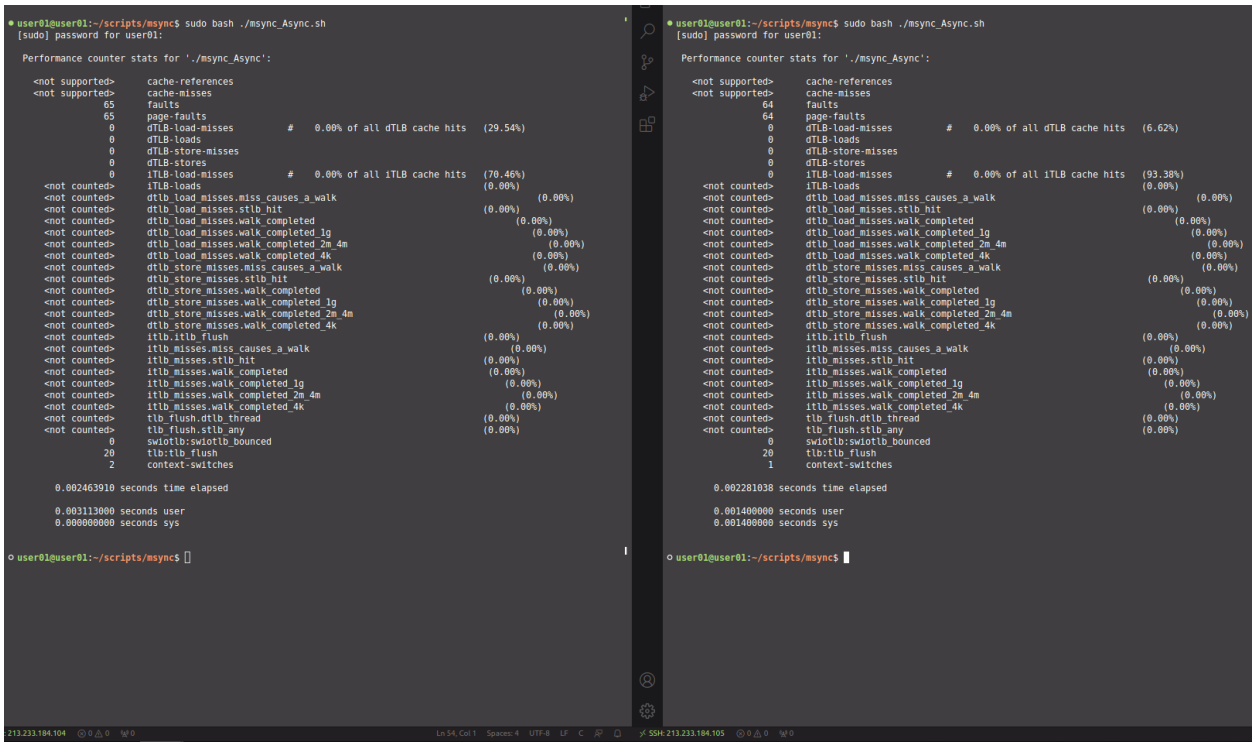


اجرا با پارامتر Async :

ماشین Bare Metal :

```
Hooman_Keshvari_99105667@bigwhoman-pp /m/b/N/S/t/O/A/H/msync> sudo bash ./msync_Async.sh

 Performance counter stats for './msync_Async':

          196,866      cache-references
           32,633      cache-misses              #   16.576 % of all cache refs
               68      faults
               68      page-faults
              586      dTLB-load-misses          #    0.13% of all dTLB cache accesses
          448,278      dTLB-loads
    <not counted>      dTLB-store-misses                                                    (0.00%)
    <not counted>      dTLB-stores                                                          (0.00%)
    <not counted>      iTLB-load-misses                                                     (0.00%)
    <not counted>      iTLB-loads                                                           (0.00%)
    <not counted>      dtlb_load_misses.miss_causes_a_walk                                        (0.00%)
    <not counted>      dtlb_load_misses.stlb_hit                                            (0.00%)
    <not counted>      dtlb_load_misses.walk_completed                                            (0.00%)
    <not counted>      dtlb_load_misses.walk_completed_1g                                         (0.00%)
    <not counted>      dtlb_load_misses.walk_completed_2m_4m                                      (0.00%)
    <not counted>      dtlb_load_misses.walk_completed_4k                                         (0.00%)
    <not counted>      dtlb_store_misses.miss_causes_a_walk                                       (0.00%)
    <not counted>      dtlb_store_misses.stlb_hit                                           (0.00%)
    <not counted>      dtlb_store_misses.walk_completed                                           (0.00%)
    <not counted>      dtlb_store_misses.walk_completed_1g                                        (0.00%)
    <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
    <not counted>      dtlb_store_misses.walk_completed_4k                                        (0.00%)
    <not counted>      itlb.itlb_flush                                                      (0.00%)
    <not counted>      itlb_misses.miss_causes_a_walk                                             (0.00%)
    <not counted>      itlb_misses.stlb_hit                                                 (0.00%)
    <not counted>      itlb_misses.walk_completed                                           (0.00%)
    <not counted>      itlb_misses.walk_completed_1g                                              (0.00%)
    <not counted>      itlb_misses.walk_completed_2m_4m                                           (0.00%)
    <not counted>      itlb_misses.walk_completed_4k                                              (0.00%)
    <not counted>      tlb_flush.dtlb_thread                                                (0.00%)
    <not counted>      tlb_flush.stlb_any                                                   (0.00%)
                0      swiotlb:swiotlb_bounced
               18      tlb:tlb_flush
               22      context-switches

      0.002541856 seconds time elapsed

      0.000000000 seconds user
      0.002402000 seconds sys
```

ماشین‌های مجازی :



```
user01@user01:~/scripts/msync$ sudo bash ./msync_Async.sh
[sudo] password for user01:

 Performance counter stats for './msync_Async':

   <not supported>      cache-references
   <not supported>      cache-misses
                65      faults
                65      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (29.54%)
                 0      dTLB-loads
                 0      dTLB-store-misses
                 0      dTLB-stores
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (70.46%)
   <not counted>      iTLB-loads                                                      (0.00%)
   <not counted>      dtlb_load_misses.miss_causes_a_walk                                     (0.00%)
   <not counted>      dtlb_load_misses.stlb_hit                                       (0.00%)
   <not counted>      dtlb_load_misses.walk_completed                                       (0.00%)
   <not counted>      dtlb_load_misses.walk_completed_1g                                      (0.00%)
   <not counted>      dtlb_load_misses.walk_completed_2m_4m                                      (0.00%)
   <not counted>      dtlb_load_misses.walk_completed_4k                                      (0.00%)
   <not counted>      dtlb_store_misses.miss_causes_a_walk                                      (0.00%)
   <not counted>      dtlb_store_misses.stlb_hit                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed_1g                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed_2m_4m                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed_4k                                      (0.00%)
   <not counted>      itlb.itlb_flush                                                 (0.00%)
   <not counted>      itlb_misses.miss_causes_a_walk                                      (0.00%)
   <not counted>      itlb_misses.stlb_hit                                            (0.00%)
   <not counted>      itlb_misses.walk_completed                                      (0.00%)
   <not counted>      itlb_misses.walk_completed_1g                                      (0.00%)
   <not counted>      itlb_misses.walk_completed_2m_4m                                      (0.00%)
   <not counted>      itlb_misses.walk_completed_4k                                      (0.00%)
   <not counted>      tlb_flush.dtlb_thread                                           (0.00%)
   <not counted>      tlb_flush.stlb_any                                              (0.00%)
              0       swiotlb:swiotlb_bounced
             20       tlb:tlb_flush
              2       context-switches

      0.002463910 seconds time elapsed

      0.003113000 seconds user
      0.000000000 seconds sys

user01@user01:~/scripts/msync$
```

```
user01@user01:~/scripts/msync$ sudo bash ./msync_Async.sh
[sudo] password for user01:

 Performance counter stats for './msync_Async':

   <not supported>      cache-references
   <not supported>      cache-misses
                64      faults
                64      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.62%)
                 0      dTLB-loads
                 0      dTLB-store-misses
                 0      dTLB-stores
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (93.38%)
   <not counted>      iTLB-loads                                                      (0.00%)
   <not counted>      dtlb_load_misses.miss_causes_a_walk                                     (0.00%)
   <not counted>      dtlb_load_misses.stlb_hit                                       (0.00%)
   <not counted>      dtlb_load_misses.walk_completed                                       (0.00%)
   <not counted>      dtlb_load_misses.walk_completed_1g                                      (0.00%)
   <not counted>      dtlb_load_misses.walk_completed_2m_4m                                      (0.00%)
   <not counted>      dtlb_load_misses.walk_completed_4k                                      (0.00%)
   <not counted>      dtlb_store_misses.miss_causes_a_walk                                      (0.00%)
   <not counted>      dtlb_store_misses.stlb_hit                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed_1g                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed_2m_4m                                      (0.00%)
   <not counted>      dtlb_store_misses.walk_completed_4k                                      (0.00%)
   <not counted>      itlb.itlb_flush                                                 (0.00%)
   <not counted>      itlb_misses.miss_causes_a_walk                                      (0.00%)
   <not counted>      itlb_misses.stlb_hit                                            (0.00%)
   <not counted>      itlb_misses.walk_completed                                      (0.00%)
   <not counted>      itlb_misses.walk_completed_1g                                      (0.00%)
   <not counted>      itlb_misses.walk_completed_2m_4m                                      (0.00%)
   <not counted>      itlb_misses.walk_completed_4k                                      (0.00%)
   <not counted>      tlb_flush.dtlb_thread                                           (0.00%)
   <not counted>      tlb_flush.stlb_any                                              (0.00%)
              0       swiotlb:swiotlb_bounced
             20       tlb:tlb_flush
              1       context-switches

      0.002281038 seconds time elapsed

      0.001400000 seconds user
      0.001400000 seconds sys

user01@user01:~/scripts/msync$
```

عکس بالا اجرای اسینک در دو ماشین مجازی به صورت همزمان است. عکس‌های دقیق‌تر در صفحات بعدی گذاشته شده‌اند.

```
● user01@user01:~/scripts/msync$ sudo bash ./msync_Async.sh
  [sudo] password for user01:

   Performance counter stats for './msync_Async':

     <not supported>      cache-references
     <not supported>      cache-misses
                  65      faults
                  65      page-faults
                   0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (29.54%)
                   0      dTLB-loads
                   0      dTLB-store-misses
                   0      dTLB-stores
                   0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (70.46%)
       <not counted>      iTLB-loads                                                    (0.00%)
       <not counted>      dtlb_load_misses.miss_causes_a_walk                                    (0.00%)
       <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
       <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
       <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
       <not counted>      itlb.itlb_flush                                               (0.00%)
       <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
       <not counted>      itlb_misses.stlb_hit                                          (0.00%)
       <not counted>      itlb_misses.walk_completed                                     (0.00%)
       <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
       <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
       <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
       <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
       <not counted>      tlb_flush.stlb_any                                            (0.00%)
                   0      swiotlb:swiotlb_bounced
                  20      tlb:tlb_flush
                   2      context-switches

         0.002463910 seconds time elapsed

         0.003113000 seconds user
         0.000000000 seconds sys
```

```
● user01@user01:~/scripts/msync$ sudo bash ./msync_Async.sh
  [sudo] password for user01:

   Performance counter stats for './msync_Async':

     <not supported>      cache-references
     <not supported>      cache-misses
                  64      faults
                  64      page-faults
                   0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (6.62%)
                   0      dTLB-loads
                   0      dTLB-store-misses
                   0      dTLB-stores
                   0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (93.38%)
       <not counted>      iTLB-loads                                                    (0.00%)
       <not counted>      dtlb_load_misses.miss_causes_a_walk                                    (0.00%)
       <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
       <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
       <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
       <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
       <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
       <not counted>      itlb.itlb_flush                                               (0.00%)
       <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
       <not counted>      itlb_misses.stlb_hit                                          (0.00%)
       <not counted>      itlb_misses.walk_completed                                     (0.00%)
       <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
       <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
       <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
       <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
       <not counted>      tlb_flush.stlb_any                                            (0.00%)
                   0      swiotlb:swiotlb_bounced
                  20      tlb:tlb_flush
                   1      context-switches

         0.002281038 seconds time elapsed

         0.001400000 seconds user
         0.001400000 seconds sys
```

آپدیت :

عکس‌های زیر عکس‌های ماشین مجازی پس از آزاد شدن دسترسی TLBها است.

```
user01@user01:~/scripts/msync$ sudo bash ./msync_Async.sh

 Performance counter stats for './msync_Async':

            99,393      cache-references                                              (70.23%)
             5,719      cache-misses              #    5.754 % of all cache refs
                65      faults
                65      page-faults
             8,554      dTLB-load-misses          #    2.06% of all dTLB cache hits
           416,112      dTLB-loads
               587      dTLB-store-misses                                             (29.77%)
     <not counted>      dTLB-stores                                                   (0.00%)
     <not counted>      iTLB-load-misses                                              (0.00%)
     <not counted>      iTLB-loads                                                    (0.00%)
     <not counted>      dtlb_load_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      dtlb_load_misses.stlb_hit                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_1g                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      dtlb_load_misses.walk_completed_4k                                     (0.00%)
     <not counted>      dtlb_store_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      dtlb_store_misses.stlb_hit                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_1g                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      dtlb_store_misses.walk_completed_4k                                     (0.00%)
     <not counted>      itlb.itlb_flush                                               (0.00%)
     <not counted>      itlb_misses.miss_causes_a_walk                                     (0.00%)
     <not counted>      itlb_misses.stlb_hit                                          (0.00%)
     <not counted>      itlb_misses.walk_completed                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_1g                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_2m_4m                                     (0.00%)
     <not counted>      itlb_misses.walk_completed_4k                                     (0.00%)
     <not counted>      tlb_flush.dtlb_thread                                         (0.00%)
     <not counted>      tlb_flush.stlb_any                                            (0.00%)
                0       swiotlb:swiotlb_bounced
               20       tlb:tlb_flush
                2       context-switches

       0.004011690 seconds time elapsed

       0.000000000 seconds user
       0.004895000 seconds sys


Some events weren't counted. Try disabling the NMI watchdog:
        echo 0 > /proc/sys/kernel/nmi_watchdog
        perf stat ...
        echo 1 > /proc/sys/kernel/nmi_watchdog
```

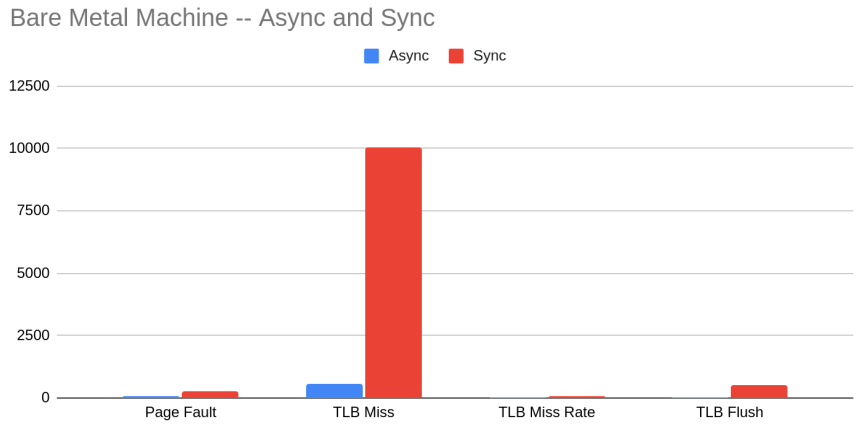
تحلیل نتایج از ماشین‌های مجازی و نیز مقایسه با ماشین Bare Metal

همانطور که مشاهده می‌کنیم در Async به صورت عجیبی تمامی پارامترهای TLB در ماشین مجازی و Bare Metal کمتر از حالت Sync هستند.

تست‌ها :

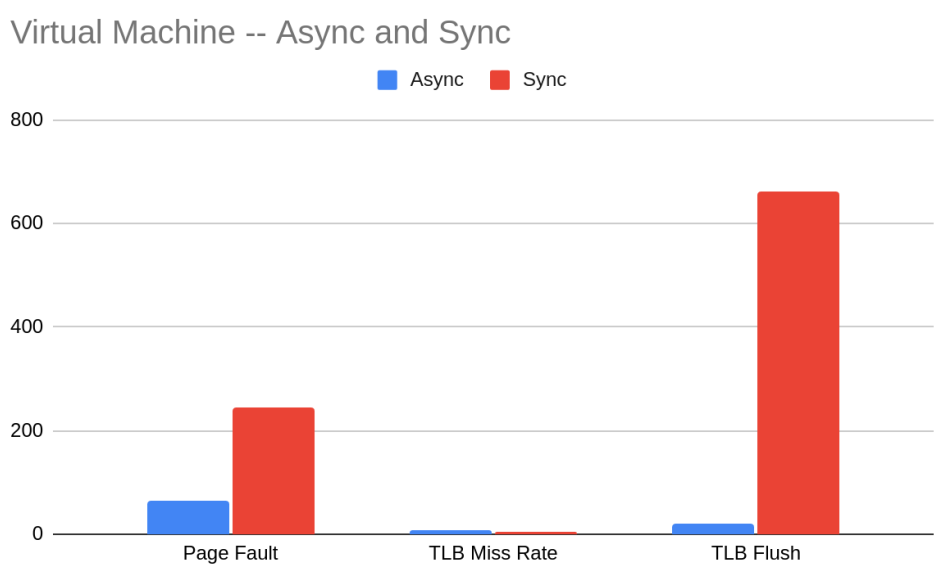
Bare Metal Machine

1. Async
    a. Page Fault = 68
    b. TLB miss = 586
    c. TLB miss rate = 0.13%
    d. TLB Flush = 18
2. Sync
    a. Page Fault = 267
    b. TLB miss = 10,613
    c. TLB miss rate = 0.60%
    d. TLB Flush = 502



Virtual Machine

1. Async
    a. Page Fault = 65
    b. TLB miss = ?
    c. TLB miss rate = 6.62%
    d. TLB Flush = 20
2. Sync
    a. Page Fault = 245
    b. TLB miss = ?
    c. TLB miss rate = 3.2%
    d. TLB Flush = 661



** این تفاوت فاحش به این علت وجود دارد که در تابع با پارامتر Async عملا بعد از اتمام نوشتن کلی عملیات سنکرونیزیشن را انجام می‌دهد که یعنی تعداد عملیات سینک با حافظه جانبی تعداد قابل چشم‌گیری کاهش می‌یابد**

تحلیل نتایج از ماشین‌های مجازی و نیز مقایسه با ماشین Bare Metal در حالت Async

۱. مانند قسمت‌های قبل تعداد page fault های هر دو تقریبا مشابه یکدیگر است.

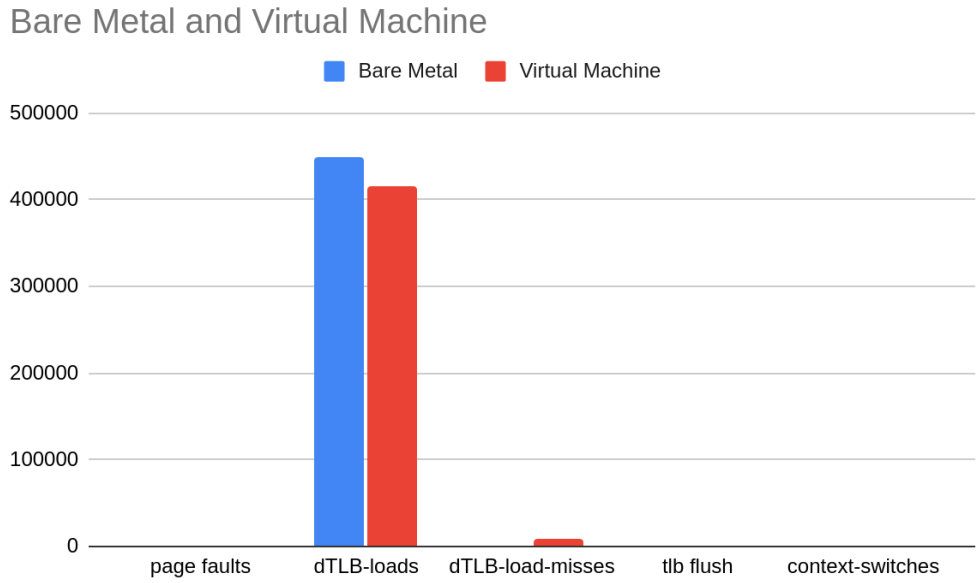
۲. درصد TLB miss در ماشین مجازی در حالت اسنکرون تقریبا 60 برابر ماشین Bare Metal است.

۳. تعداد TLB Flush ها نیز در دو ماشین با یکدیگر تقریبا برابر است.

۴. عملکرد ماشین مجازی و Bare Metal در حالت آسنکرون به یکدیگر نزدیک می‌شود.

نمودار تحلیل بین ماشین مجازی و ماشین Bare Metal در حالت Async

	Bare Metal	Virtual Machine
page faults	68	65
dTLB-loads	448,278	416,112
dTLB-load-misses	586	8,554
tlb flush	18	20
context-switches	22	2



سوال 3.1 .

اسکریپت برای اندازه‌گیری مانند اسکریپت بالا صرفا برنامه‌های ران شده به صورت زیر

```
stress --cpu 10 -t 30s

stress --vm 4 --vm-bytes 512M -t 30s

stress --io 5 -t 30s
```

نتایج روی ماشین Bare Metal : در صفحه بعدی عکس‌ها آورده شده‌اند.

در هر مرحله ۳ تست انجام شده.

```
Hooman_Keshvari_99105667@bigwhoman-pp /m/b/N/S/t/O/A/H/stress> sudo bash ./stress.sh
stress: info: [10839] dispatching hogs: 10 cpu, 0 io, 0 vm, 0 hdd
stress: info: [10839] successful run completed in 30s

 Performance counter stats for 'stress --cpu 10 -t 30s':

        43,462,411      cache-references                                              (13.80%)
         3,998,174      cache-misses              #    9.199 % of all cache refs      (13.81%)
               237      faults
               237      page-faults
           118,583      dTLB-load-misses          #    0.00% of all dTLB cache accesses  (13.82%)
   297,315,090,408      dTLB-loads                                                    (13.82%)
           487,859      dTLB-store-misses                                             (13.82%)
   156,501,211,808      dTLB-stores                                                   (13.82%)
           572,114      iTLB-load-misses          #  113.01% of all iTLB cache accesses  (13.82%)
           506,241      iTLB-loads                                                    (13.82%)
           193,633      dtlb_load_misses.miss_causes_a_walk                                 (13.82%)
         3,533,937      dtlb_load_misses.stlb_hit                                     (13.82%)
            90,752      dtlb_load_misses.walk_completed                                     (13.83%)
                14      dtlb_load_misses.walk_completed_1g                                  (13.82%)
            24,483      dtlb_load_misses.walk_completed_2m_4m                               (13.82%)
            71,464      dtlb_load_misses.walk_completed_4k                                  (13.81%)
           493,985      dtlb_store_misses.miss_causes_a_walk                                (13.81%)
           790,969      dtlb_store_misses.stlb_hit                                    (13.81%)
           484,703      dtlb_store_misses.walk_completed                                    (13.81%)
                 0      dtlb_store_misses.walk_completed_1g                                 (13.81%)
               369      dtlb_store_misses.walk_completed_2m_4m                              (13.81%)
           485,726      dtlb_store_misses.walk_completed_4k                                 (13.81%)
            51,204      itlb.itlb_flush                                               (13.80%)
           692,248      itlb_misses.miss_causes_a_walk                                      (13.80%)
           504,523      itlb_misses.stlb_hit                                          (13.81%)
           524,543      itlb_misses.walk_completed                                    (13.80%)
                 0      itlb_misses.walk_completed_1g                                       (13.80%)
             5,478      itlb_misses.walk_completed_2m_4m                                    (13.80%)
           503,489      itlb_misses.walk_completed_4k                                       (13.80%)
                28      tlb_flush.dtlb_thread                                         (13.80%)
                57      tlb_flush.stlb_any                                            (13.80%)
                 0      swiotlb:swiotlb_bounced
               126      tlb:tlb_flush
             8,109      context-switches

      30.002242399 seconds time elapsed

     299.360809000 seconds user
       0.028017000 seconds sys
```

```
stress: info: [10950] dispatching hogs: 0 cpu, 0 io, 4 vm, 0 hdd
stress: info: [10950] successful run completed in 30s

 Performance counter stats for 'stress --vm 4 --vm-bytes 512M -t 30s':

     9,453,929,604      cache-references                                              (13.79%)
     7,588,123,325      cache-misses              #   80.264 % of all cache refs      (13.80%)
        88,614,473      faults
        88,614,473      page-faults
        87,096,126      dTLB-load-misses          #    0.08% of all dTLB cache accesses  (13.82%)
   112,695,571,315      dTLB-loads                                                    (13.83%)
       772,806,204      dTLB-store-misses                                             (13.83%)
    72,237,418,567      dTLB-stores                                                   (13.84%)
         8,514,027      iTLB-load-misses          #  821.99% of all iTLB cache accesses  (13.84%)
         1,035,778      iTLB-loads                                                    (13.84%)
       114,021,799      dtlb_load_misses.miss_causes_a_walk                                     (13.84%)
       344,554,421      dtlb_load_misses.stlb_hit                                     (13.84%)
        92,607,506      dtlb_load_misses.walk_completed                                     (13.83%)
               346      dtlb_load_misses.walk_completed_1g                                     (13.84%)
         6,295,672      dtlb_load_misses.walk_completed_2m_4m                                     (13.83%)
        81,937,641      dtlb_load_misses.walk_completed_4k                                     (13.83%)
       910,718,018      dtlb_store_misses.miss_causes_a_walk                                     (13.82%)
       107,098,941      dtlb_store_misses.stlb_hit                                     (13.82%)
       764,195,092      dtlb_store_misses.walk_completed                                     (13.82%)
                86      dtlb_store_misses.walk_completed_1g                                     (13.81%)
         1,018,835      dtlb_store_misses.walk_completed_2m_4m                                     (13.81%)
       761,872,598      dtlb_store_misses.walk_completed_4k                                     (13.81%)
           113,297      itlb.itlb_flush                                               (13.80%)
         9,260,623      itlb_misses.miss_causes_a_walk                                     (13.80%)
         1,055,322      itlb_misses.stlb_hit                                          (13.79%)
         8,748,798      itlb_misses.walk_completed                                     (13.78%)
                 7      itlb_misses.walk_completed_1g                                     (13.77%)
           168,865      itlb_misses.walk_completed_2m_4m                                     (13.76%)
         9,001,339      itlb_misses.walk_completed_4k                                     (13.77%)
             9,861      tlb_flush.dtlb_thread                                         (13.79%)
        87,553,873      tlb_flush.stlb_any                                            (13.79%)
                 0      swiotlb:swiotlb_bounced
             9,488      tlb:tlb_flush
             2,654      context-switches

      30.025249438 seconds time elapsed

      12.193502000 seconds user
     107.701295000 seconds sys
```

```
stress: info: [11086] dispatching hogs: 0 cpu, 5 io, 0 vm, 0 hdd
stress: info: [11086] successful run completed in 30s

 Performance counter stats for 'stress --io 5 -t 30s':

     5,429,087,308      cache-references                                              (13.83%)
        11,478,617      cache-misses              #    0.211 % of all cache refs      (12.88%)
               136      faults
               136      page-faults
         1,536,417      dTLB-load-misses          #    0.02% of all dTLB cache accesses  (13.29%)
     8,060,348,365      dTLB-loads                                                    (13.74%)
            63,739      dTLB-store-misses                                             (13.77%)
     6,273,937,862      dTLB-stores                                                   (14.41%)
        13,427,813      iTLB-load-misses          #  931.23% of all iTLB cache accesses  (14.31%)
         1,441,950      iTLB-loads                                                    (14.34%)
         2,617,176      dtlb_load_misses.miss_causes_a_walk                                     (14.55%)
       371,706,304      dtlb_load_misses.stlb_hit                                     (14.22%)
         1,724,562      dtlb_load_misses.walk_completed                                     (14.00%)
               147      dtlb_load_misses.walk_completed_1g                                     (13.60%)
           206,757      dtlb_load_misses.walk_completed_2m_4m                                     (13.69%)
         1,202,498      dtlb_load_misses.walk_completed_4k                                     (14.12%)
         2,608,105      dtlb_store_misses.miss_causes_a_walk                                     (14.64%)
        94,768,470      dtlb_store_misses.stlb_hit                                     (14.60%)
            50,068      dtlb_store_misses.walk_completed                                     (14.15%)
                14      dtlb_store_misses.walk_completed_1g                                     (13.69%)
             3,259      dtlb_store_misses.walk_completed_2m_4m                                     (13.56%)
            46,623      dtlb_store_misses.walk_completed_4k                                     (13.56%)
            19,978      itlb.itlb_flush                                               (13.70%)
        14,478,362      itlb_misses.miss_causes_a_walk                                     (13.97%)
         1,399,620      itlb_misses.stlb_hit                                          (13.85%)
        13,339,584      itlb_misses.walk_completed                                    (14.00%)
                 0      itlb_misses.walk_completed_1g                                     (14.12%)
             6,164      itlb_misses.walk_completed_2m_4m                                     (13.37%)
        13,609,247      itlb_misses.walk_completed_4k                                     (14.12%)
             2,764      tlb_flush.dtlb_thread                                         (13.82%)
             1,251      tlb_flush.stlb_any                                            (13.43%)
                 0      swiotlb:swiotlb_bounced
             2,583      tlb:tlb_flush
           346,797      context-switches

      30.191664708 seconds time elapsed

       0.062944000 seconds user
      24.706572000 seconds sys
```

نتایج روی ماشین‌های مجازی :

```
● user01@user01:~/scripts/stress$ sudo bash ./stress.sh
  stress: info: [407079] dispatching hogs: 10 cpu, 0 io, 0 vm, 0 hdd
  stress: info: [407079] successful run completed in 30s

   Performance counter stats for 'stress --cpu 10 -t 30s':

     <not supported>      cache-references
     <not supported>      cache-misses
                 192      faults
                 192      page-faults
                   0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.75%)
                   0      dTLB-loads                                                    (14.76%)
                   0      dTLB-store-misses                                             (14.83%)
                   0      dTLB-stores                                                   (14.83%)
                   0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.88%)
                   0      iTLB-loads                                                    (14.90%)
                   0      dtlb_load_misses.miss_causes_a_walk                                   (14.86%)
                   0      dtlb_load_misses.stlb_hit                                     (14.88%)
                   0      dtlb_load_misses.walk_completed                                     (14.89%)
                   0      dtlb_load_misses.walk_completed_1g                                    (14.88%)
                   0      dtlb_load_misses.walk_completed_2m_4m                                   (14.88%)
                   0      dtlb_load_misses.walk_completed_4k                                    (14.89%)
                   0      dtlb_store_misses.miss_causes_a_walk                                    (14.87%)
                   0      dtlb_store_misses.stlb_hit                                     (14.87%)
                   0      dtlb_store_misses.walk_completed                                    (14.88%)
                   0      dtlb_store_misses.walk_completed_1g                                   (14.86%)
                   0      dtlb_store_misses.walk_completed_2m_4m                                  (14.84%)
                   0      dtlb_store_misses.walk_completed_4k                                   (14.81%)
                   0      itlb.itlb_flush                                                (14.79%)
                   0      itlb_misses.miss_causes_a_walk                                      (14.76%)
                   0      itlb_misses.stlb_hit                                           (14.77%)
                   0      itlb_misses.walk_completed                                      (14.76%)
                   0      itlb_misses.walk_completed_1g                                     (14.73%)
                   0      itlb_misses.walk_completed_2m_4m                                    (14.71%)
                   0      itlb_misses.walk_completed_4k                                     (14.69%)
                   0      tlb_flush.dtlb_thread                                          (14.68%)
                   0      tlb_flush.stlb_any                                             (14.74%)
                   0      swiotlb:swiotlb_bounced
              13,109      tlb:tlb_flush
              16,934      context-switches

        30.004601843 seconds time elapsed

        89.627354000 seconds user
         0.024745000 seconds sys
```

```
● user01@user01:~/scripts/stress$ sudo bash ./stress.sh
  stress: info: [413661] dispatching hogs: 10 cpu, 0 io, 0 vm, 0 hdd
  stress: info: [413661] successful run completed in 30s

   Performance counter stats for 'stress --cpu 10 -t 30s':

     <not supported>      cache-references
     <not supported>      cache-misses
                 189      faults
                 189      page-faults
                   0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.77%)
                   0      dTLB-loads                                                    (14.78%)
                   0      dTLB-store-misses                                             (14.80%)
                   0      dTLB-stores                                                   (14.84%)
                   0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.86%)
                   0      iTLB-loads                                                    (14.85%)
                   0      dtlb_load_misses.miss_causes_a_walk                                   (14.87%)
                   0      dtlb_load_misses.stlb_hit                                     (14.87%)
                   0      dtlb_load_misses.walk_completed                                     (14.88%)
                   0      dtlb_load_misses.walk_completed_1g                                    (14.86%)
                   0      dtlb_load_misses.walk_completed_2m_4m                                   (14.85%)
                   0      dtlb_load_misses.walk_completed_4k                                    (14.83%)
                   0      dtlb_store_misses.miss_causes_a_walk                                    (14.82%)
                   0      dtlb_store_misses.stlb_hit                                     (14.85%)
                   0      dtlb_store_misses.walk_completed                                    (14.84%)
                   0      dtlb_store_misses.walk_completed_1g                                   (14.82%)
                   0      dtlb_store_misses.walk_completed_2m_4m                                  (14.82%)
                   0      dtlb_store_misses.walk_completed_4k                                   (14.79%)
                   0      itlb.itlb_flush                                                (14.75%)
                   0      itlb_misses.miss_causes_a_walk                                      (14.77%)
                   0      itlb_misses.stlb_hit                                           (14.77%)
                   0      itlb_misses.walk_completed                                      (14.78%)
                   0      itlb_misses.walk_completed_1g                                     (14.81%)
                   0      itlb_misses.walk_completed_2m_4m                                    (14.80%)
                   0      itlb_misses.walk_completed_4k                                     (14.79%)
                   0      tlb_flush.dtlb_thread                                          (14.78%)
                   0      tlb_flush.stlb_any                                             (14.76%)
                   0      swiotlb:swiotlb_bounced
              13,038      tlb:tlb_flush
              16,817      context-switches

        30.002792058 seconds time elapsed

        89.640958000 seconds user
         0.020342000 seconds sys
```

```
● user01@user01:~/scripts/stress$ sudo bash ./stress.sh
  stress: info: [407079] dispatching hogs: 10 cpu, 0 io, 0 vm, 0 hdd
  stress: info: [407079] successful run completed in 30s

   Performance counter stats for 'stress --cpu 10 -t 30s':

     <not supported>      cache-references
     <not supported>      cache-misses
                 192      faults
                 192      page-faults
                   0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.75%)
                   0      dTLB-loads                                                    (14.76%)
                   0      dTLB-store-misses                                             (14.83%)
                   0      dTLB-stores                                                   (14.83%)
                   0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.88%)
                   0      iTLB-loads                                                    (14.90%)
                   0      dtlb_load_misses.miss_causes_a_walk                                     (14.86%)
                   0      dtlb_load_misses.stlb_hit                                     (14.88%)
                   0      dtlb_load_misses.walk_completed                                     (14.89%)
                   0      dtlb_load_misses.walk_completed_1g                                     (14.88%)
                   0      dtlb_load_misses.walk_completed_2m_4m                                     (14.88%)
                   0      dtlb_load_misses.walk_completed_4k                                     (14.89%)
                   0      dtlb_store_misses.miss_causes_a_walk                                     (14.87%)
                   0      dtlb_store_misses.stlb_hit                                     (14.87%)
                   0      dtlb_store_misses.walk_completed                                     (14.88%)
                   0      dtlb_store_misses.walk_completed_1g                                     (14.86%)
                   0      dtlb_store_misses.walk_completed_2m_4m                                     (14.84%)
                   0      dtlb_store_misses.walk_completed_4k                                     (14.81%)
                   0      itlb.itlb_flush                                               (14.79%)
                   0      itlb_misses.miss_causes_a_walk                                     (14.76%)
                   0      itlb_misses.stlb_hit                                          (14.77%)
                   0      itlb_misses.walk_completed                                     (14.76%)
                   0      itlb_misses.walk_completed_1g                                     (14.73%)
                   0      itlb_misses.walk_completed_2m_4m                                     (14.71%)
                   0      itlb_misses.walk_completed_4k                                     (14.69%)
                   0      tlb_flush.dtlb_thread                                         (14.68%)
                   0      tlb_flush.stlb_any                                            (14.74%)
                   0      swiotlb:swiotlb_bounced
              13,109      tlb:tlb_flush
              16,934      context-switches

         30.004601843 seconds time elapsed

         89.627354000 seconds user
          0.024745000 seconds sys
```

```
● user01@user01:~/scripts/stress$ sudo bash ./stress.sh
 stress: info: [413661] dispatching hogs: 10 cpu, 0 io, 0 vm, 0 hdd
 stress: info: [413661] successful run completed in 30s

  Performance counter stats for 'stress --cpu 10 -t 30s':

    <not supported>      cache-references
    <not supported>      cache-misses
                189      faults
                189      page-faults
                  0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.77%)
                  0      dTLB-loads                                                    (14.78%)
                  0      dTLB-store-misses                                             (14.80%)
                  0      dTLB-stores                                                   (14.84%)
                  0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.86%)
                  0      iTLB-loads                                                    (14.85%)
                  0      dtlb_load_misses.miss_causes_a_walk                                     (14.87%)
                  0      dtlb_load_misses.stlb_hit                                     (14.87%)
                  0      dtlb_load_misses.walk_completed                                     (14.88%)
                  0      dtlb_load_misses.walk_completed_1g                                     (14.86%)
                  0      dtlb_load_misses.walk_completed_2m_4m                                     (14.85%)
                  0      dtlb_load_misses.walk_completed_4k                                     (14.83%)
                  0      dtlb_store_misses.miss_causes_a_walk                                     (14.82%)
                  0      dtlb_store_misses.stlb_hit                                     (14.85%)
                  0      dtlb_store_misses.walk_completed                                     (14.84%)
                  0      dtlb_store_misses.walk_completed_1g                                     (14.82%)
                  0      dtlb_store_misses.walk_completed_2m_4m                                     (14.82%)
                  0      dtlb_store_misses.walk_completed_4k                                     (14.79%)
                  0      itlb.itlb_flush                                               (14.75%)
                  0      itlb_misses.miss_causes_a_walk                                     (14.77%)
                  0      itlb_misses.stlb_hit                                          (14.77%)
                  0      itlb_misses.walk_completed                                     (14.78%)
                  0      itlb_misses.walk_completed_1g                                     (14.81%)
                  0      itlb_misses.walk_completed_2m_4m                                     (14.80%)
                  0      itlb_misses.walk_completed_4k                                     (14.79%)
                  0      tlb_flush.dtlb_thread                                         (14.78%)
                  0      tlb_flush.stlb_any                                            (14.76%)
                  0      swiotlb:swiotlb_bounced
             13,038      tlb:tlb_flush
             16,817      context-switches

       30.002792058 seconds time elapsed

       89.640958000 seconds user
        0.020342000 seconds sys
```

```
stress: info: [407233] dispatching hogs: 0 cpu, 0 io, 4 vm, 0 hdd
stress: info: [407233] successful run completed in 30s

 Performance counter stats for 'stress --vm 4 --vm-bytes 512M -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
        36,024,724      faults
        36,024,724      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.80%)
                 0      dTLB-loads                                                    (14.80%)
                 0      dTLB-store-misses                                             (14.81%)
                 0      dTLB-stores                                                   (14.84%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.84%)
                 0      iTLB-loads                                                    (14.85%)
                 0      dtlb_load_misses.miss_causes_a_walk                                     (14.85%)
                 0      dtlb_load_misses.stlb_hit                                     (14.83%)
                 0      dtlb_load_misses.walk_completed                                       (14.85%)
                 0      dtlb_load_misses.walk_completed_1g                                      (14.84%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (14.84%
)
                 0      dtlb_load_misses.walk_completed_4k                                      (14.84%)
                 0      dtlb_store_misses.miss_causes_a_walk                                      (14.83%)
                 0      dtlb_store_misses.stlb_hit                                     (14.82%)
                 0      dtlb_store_misses.walk_completed                                       (14.81%)
                 0      dtlb_store_misses.walk_completed_1g                                     (14.82%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                    (14.80
%)
                 0      dtlb_store_misses.walk_completed_4k                                     (14.80%)
                 0      itlb.itlb_flush                                               (14.81%)
                 0      itlb_misses.miss_causes_a_walk                                          (14.81%)
                 0      itlb_misses.stlb_hit                                          (14.80%)
                 0      itlb_misses.walk_completed                                     (14.79%)
                 0      itlb_misses.walk_completed_1g                                     (14.76%)
                 0      itlb_misses.walk_completed_2m_4m                                        (14.76%)
                 0      itlb_misses.walk_completed_4k                                     (14.78%)
                 0      tlb_flush.dtlb_thread                                         (14.80%)
                 0      tlb_flush.stlb_any                                            (14.80%)
                 0      swiotlb:swiotlb_bounced
             7,081      tlb:tlb_flush
             7,965      context-switches

       30.033728077 seconds time elapsed

       18.760541000 seconds user
       70.690373000 seconds sys
```

```
stress: info: [413815] dispatching hogs: 0 cpu, 0 io, 4 vm, 0 hdd
stress: info: [413815] successful run completed in 30s

 Performance counter stats for 'stress --vm 4 --vm-bytes 512M -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
        36,392,121      faults
        36,392,121      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.82%)
                 0      dTLB-loads                                                    (14.82%)
                 0      dTLB-store-misses                                             (14.82%)
                 0      dTLB-stores                                                   (14.80%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.82%)
                 0      iTLB-loads                                                    (14.83%)
                 0      dtlb_load_misses.miss_causes_a_walk                                     (14.83%)
                 0      dtlb_load_misses.stlb_hit                                     (14.84%)
                 0      dtlb_load_misses.walk_completed                                       (14.86%)
                 0      dtlb_load_misses.walk_completed_1g                                      (14.86%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (14.86%)
                 0      dtlb_load_misses.walk_completed_4k                                      (14.85%)
                 0      dtlb_store_misses.miss_causes_a_walk                                      (14.83%)
                 0      dtlb_store_misses.stlb_hit                                     (14.81%)
                 0      dtlb_store_misses.walk_completed                                       (14.79%)
                 0      dtlb_store_misses.walk_completed_1g                                     (14.80%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                    (14.80%)
                 0      dtlb_store_misses.walk_completed_4k                                     (14.79%)
                 0      itlb.itlb_flush                                               (14.80%)
                 0      itlb_misses.miss_causes_a_walk                                          (14.79%)
                 0      itlb_misses.stlb_hit                                          (14.78%)
                 0      itlb_misses.walk_completed                                     (14.79%)
                 0      itlb_misses.walk_completed_1g                                     (14.79%)
                 0      itlb_misses.walk_completed_2m_4m                                        (14.78%)
                 0      itlb_misses.walk_completed_4k                                     (14.79%)
                 0      tlb_flush.dtlb_thread                                         (14.82%)
                 0      tlb_flush.stlb_any                                            (14.83%)
                 0      swiotlb:swiotlb_bounced
             7,062      tlb:tlb_flush
             8,064      context-switches

       30.019488490 seconds time elapsed

       18.774101000 seconds user
       70.656265000 seconds sys


stress: info: [413897] dispatching hogs: 0 cpu, 5 io, 0 vm, 0 hdd
stress: info: [413897] successful run completed in 30s
```

```
stress: info: [407233] dispatching hogs: 0 cpu, 0 io, 4 vm, 0 hdd
stress: info: [407233] successful run completed in 30s

 Performance counter stats for 'stress --vm 4 --vm-bytes 512M -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
        36,024,724      faults
        36,024,724      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.80%)
                 0      dTLB-loads                                                    (14.80%)
                 0      dTLB-store-misses                                             (14.81%)
                 0      dTLB-stores                                                   (14.84%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.84%)
                 0      iTLB-loads                                                    (14.85%)
                 0      dtlb_load_misses.miss_causes_a_walk                                     (14.85%)
                 0      dtlb_load_misses.stlb_hit                                     (14.83%)
                 0      dtlb_load_misses.walk_completed                                     (14.85%)
                 0      dtlb_load_misses.walk_completed_1g                                     (14.84%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (14.84%
)
                 0      dtlb_load_misses.walk_completed_4k                                     (14.84%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (14.83%)
                 0      dtlb_store_misses.stlb_hit                                     (14.82%)
                 0      dtlb_store_misses.walk_completed                                     (14.81%)
                 0      dtlb_store_misses.walk_completed_1g                                     (14.82%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                     (14.80
%)
                 0      dtlb_store_misses.walk_completed_4k                                     (14.80%)
                 0      itlb.itlb_flush                                               (14.81%)
                 0      itlb_misses.miss_causes_a_walk                                     (14.81%)
                 0      itlb_misses.stlb_hit                                          (14.80%)
                 0      itlb_misses.walk_completed                                     (14.79%)
                 0      itlb_misses.walk_completed_1g                                     (14.76%)
                 0      itlb_misses.walk_completed_2m_4m                                     (14.76%)
                 0      itlb_misses.walk_completed_4k                                     (14.78%)
                 0      tlb_flush.dtlb_thread                                         (14.80%)
                 0      tlb_flush.stlb_any                                            (14.80%)
                 0      swiotlb:swiotlb_bounced
             7,081      tlb:tlb_flush
             7,965      context-switches

      30.033728077 seconds time elapsed

      18.760541000 seconds user
      70.690373000 seconds sys
```

```
stress: info: [413815] dispatching hogs: 0 cpu, 0 io, 4 vm, 0 hdd
stress: info: [413815] successful run completed in 30s

 Performance counter stats for 'stress --vm 4 --vm-bytes 512M -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
        36,392,121      faults
        36,392,121      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.82%)
                 0      dTLB-loads                                                    (14.82%)
                 0      dTLB-store-misses                                             (14.82%)
                 0      dTLB-stores                                                   (14.80%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.82%)
                 0      iTLB-loads                                                    (14.83%)
                 0      dtlb_load_misses.miss_causes_a_walk                                    (14.83%)
                 0      dtlb_load_misses.stlb_hit                                     (14.84%)
                 0      dtlb_load_misses.walk_completed                                      (14.86%)
                 0      dtlb_load_misses.walk_completed_1g                                     (14.86%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                    (14.86%)
                 0      dtlb_load_misses.walk_completed_4k                                     (14.85%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (14.83%)
                 0      dtlb_store_misses.stlb_hit                                     (14.81%)
                 0      dtlb_store_misses.walk_completed                                     (14.79%)
                 0      dtlb_store_misses.walk_completed_1g                                    (14.80%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                   (14.80%)
                 0      dtlb_store_misses.walk_completed_4k                                    (14.79%)
                 0      itlb.itlb_flush                                               (14.80%)
                 0      itlb_misses.miss_causes_a_walk                                     (14.79%)
                 0      itlb_misses.stlb_hit                                          (14.78%)
                 0      itlb_misses.walk_completed                                     (14.79%)
                 0      itlb_misses.walk_completed_1g                                    (14.79%)
                 0      itlb_misses.walk_completed_2m_4m                                   (14.78%)
                 0      itlb_misses.walk_completed_4k                                    (14.79%)
                 0      tlb_flush.dtlb_thread                                         (14.82%)
                 0      tlb_flush.stlb_any                                            (14.83%)
                 0      swiotlb:swiotlb_bounced
             7,062      tlb:tlb_flush
             8,064      context-switches

       30.019488490 seconds time elapsed

       18.774101000 seconds user
       70.656265000 seconds sys
```

```
stress: info: [407314] dispatching hogs: 0 cpu, 5 io, 0 vm, 0 hdd
stress: info: [407314] successful run completed in 30s

 Performance counter stats for 'stress --io 5 -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
               122      faults
               122      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.82%)
                 0      dTLB-loads                                                    (14.81%)
                 0      dTLB-store-misses                                             (14.84%)
                 0      dTLB-stores                                                   (14.86%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.86%)
                 0      iTLB-loads                                                    (14.87%)
                 0      dtlb_load_misses.miss_causes_a_walk                                     (14.87%)
                 0      dtlb_load_misses.stlb_hit                                     (14.87%)
                 0      dtlb_load_misses.walk_completed                                         (14.88%)
                 0      dtlb_load_misses.walk_completed_1g                                      (14.87%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                      (14.84%
)
                 0      dtlb_load_misses.walk_completed_4k                                      (14.82%)
                 0      dtlb_store_misses.miss_causes_a_walk                                       (14.78%)
                 0      dtlb_store_misses.stlb_hit                                     (14.76%)
                 0      dtlb_store_misses.walk_completed                                        (14.78%)
                 0      dtlb_store_misses.walk_completed_1g                                       (14.77%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                       (14.78
%)
                 0      dtlb_store_misses.walk_completed_4k                                       (14.80%)
                 0      itlb.itlb_flush                                               (14.80%)
                 0      itlb_misses.miss_causes_a_walk                                    (14.80%)
                 0      itlb_misses.stlb_hit                                          (14.78%)
                 0      itlb_misses.walk_completed                                     (14.76%)
                 0      itlb_misses.walk_completed_1g                                     (14.76%)
                 0      itlb_misses.walk_completed_2m_4m                                     (14.78%)
                 0      itlb_misses.walk_completed_4k                                     (14.81%)
                 0      tlb_flush.dtlb_thread                                         (14.81%)
                 0      tlb_flush.stlb_any                                            (14.81%)
                 0      swiotlb:swiotlb_bounced
             6,520      tlb:tlb_flush
            11,575      context-switches

       30.002985302 seconds time elapsed

        0.283197000 seconds user
       89.059609000 seconds sys
```

```
stress: info: [413897] dispatching hogs: 0 cpu, 5 io, 0 vm, 0 hdd
stress: info: [413897] successful run completed in 30s

 Performance counter stats for 'stress --io 5 -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
               120      faults
               120      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.78%)
                 0      dTLB-loads                                                    (14.78%)
                 0      dTLB-store-misses                                             (14.78%)
                 0      dTLB-stores                                                   (14.78%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.82%)
                 0      iTLB-loads                                                    (14.83%)
                 0      dtlb_load_misses.miss_causes_a_walk                                     (14.82%)
                 0      dtlb_load_misses.stlb_hit                                     (14.83%)
                 0      dtlb_load_misses.walk_completed                                         (14.84%)
                 0      dtlb_load_misses.walk_completed_1g                                        (14.84%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                       (14.86%)
                 0      dtlb_load_misses.walk_completed_4k                                      (14.87%)
                 0      dtlb_store_misses.miss_causes_a_walk                                       (14.81%)
                 0      dtlb_store_misses.stlb_hit                                     (14.82%)
                 0      dtlb_store_misses.walk_completed                                        (14.81%)
                 0      dtlb_store_misses.walk_completed_1g                                       (14.81%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                       (14.86%)
                 0      dtlb_store_misses.walk_completed_4k                                       (14.84%)
                 0      itlb.itlb_flush                                               (14.83%)
                 0      itlb_misses.miss_causes_a_walk                                    (14.82%)
                 0      itlb_misses.stlb_hit                                          (14.79%)
                 0      itlb_misses.walk_completed                                     (14.80%)
                 0      itlb_misses.walk_completed_1g                                     (14.79%)
                 0      itlb_misses.walk_completed_2m_4m                                     (14.79%)
                 0      itlb_misses.walk_completed_4k                                     (14.80%)
                 0      tlb_flush.dtlb_thread                                         (14.81%)
                 0      tlb_flush.stlb_any                                            (14.81%)
                 0      swiotlb:swiotlb_bounced
             6,349      tlb:tlb_flush
            11,431      context-switches

       30.003195321 seconds time elapsed

        0.284015000 seconds user
       88.810151000 seconds sys
```

```
stress: info: [407314] dispatching hogs: 0 cpu, 5 io, 0 vm, 0 hdd
stress: info: [407314] successful run completed in 30s

 Performance counter stats for 'stress --io 5 -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
               122      faults
               122      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.82%)
                 0      dTLB-loads                                                    (14.81%)
                 0      dTLB-store-misses                                             (14.84%)
                 0      dTLB-stores                                                   (14.86%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.86%)
                 0      iTLB-loads                                                    (14.87%)
                 0      dtlb_load_misses.miss_causes_a_walk                                     (14.87%)
                 0      dtlb_load_misses.stlb_hit                                     (14.87%)
                 0      dtlb_load_misses.walk_completed                                     (14.88%)
                 0      dtlb_load_misses.walk_completed_1g                                     (14.87%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (14.84%
)
                 0      dtlb_load_misses.walk_completed_4k                                     (14.82%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (14.78%)
                 0      dtlb_store_misses.stlb_hit                                     (14.76%)
                 0      dtlb_store_misses.walk_completed                                     (14.78%)
                 0      dtlb_store_misses.walk_completed_1g                                     (14.77%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                     (14.78
%)
                 0      dtlb_store_misses.walk_completed_4k                                     (14.80%)
                 0      itlb.itlb_flush                                               (14.80%)
                 0      itlb_misses.miss_causes_a_walk                                     (14.80%)
                 0      itlb_misses.stlb_hit                                          (14.78%)
                 0      itlb_misses.walk_completed                                    (14.76%)
                 0      itlb_misses.walk_completed_1g                                     (14.76%)
                 0      itlb_misses.walk_completed_2m_4m                                     (14.78%)
                 0      itlb_misses.walk_completed_4k                                     (14.81%)
                 0      tlb_flush.dtlb_thread                                         (14.81%)
                 0      tlb_flush.stlb_any                                            (14.81%)
                 0      swiotlb:swiotlb_bounced
             6,520      tlb:tlb_flush
            11,575      context-switches

      30.002985302 seconds time elapsed

       0.283197000 seconds user
      89.059609000 seconds sys
```

```
stress: info: [413897] dispatching hogs: 0 cpu, 5 io, 0 vm, 0 hdd
stress: info: [413897] successful run completed in 30s

 Performance counter stats for 'stress --io 5 -t 30s':

   <not supported>      cache-references
   <not supported>      cache-misses
               120      faults
               120      page-faults
                 0      dTLB-load-misses          #    0.00% of all dTLB cache hits   (14.78%)
                 0      dTLB-loads                                                    (14.78%)
                 0      dTLB-store-misses                                             (14.78%)
                 0      dTLB-stores                                                   (14.78%)
                 0      iTLB-load-misses          #    0.00% of all iTLB cache hits   (14.82%)
                 0      iTLB-loads                                                    (14.83%)
                 0      dtlb_load_misses.miss_causes_a_walk                                    (14.82%)
                 0      dtlb_load_misses.stlb_hit                                     (14.83%)
                 0      dtlb_load_misses.walk_completed                                     (14.84%)
                 0      dtlb_load_misses.walk_completed_1g                                     (14.84%)
                 0      dtlb_load_misses.walk_completed_2m_4m                                     (14.86%)
                 0      dtlb_load_misses.walk_completed_4k                                     (14.87%)
                 0      dtlb_store_misses.miss_causes_a_walk                                     (14.81%)
                 0      dtlb_store_misses.stlb_hit                                     (14.82%)
                 0      dtlb_store_misses.walk_completed                                     (14.81%)
                 0      dtlb_store_misses.walk_completed_1g                                     (14.81%)
                 0      dtlb_store_misses.walk_completed_2m_4m                                     (14.86%)
                 0      dtlb_store_misses.walk_completed_4k                                     (14.84%)
                 0      itlb.itlb_flush                                               (14.83%)
                 0      itlb_misses.miss_causes_a_walk                                     (14.82%)
                 0      itlb_misses.stlb_hit                                          (14.79%)
                 0      itlb_misses.walk_completed                                     (14.80%)
                 0      itlb_misses.walk_completed_1g                                     (14.79%)
                 0      itlb_misses.walk_completed_2m_4m                                     (14.79%)
                 0      itlb_misses.walk_completed_4k                                     (14.80%)
                 0      tlb_flush.dtlb_thread                                         (14.81%)
                 0      tlb_flush.stlb_any                                            (14.81%)
                 0      swiotlb:swiotlb_bounced
             6,349      tlb:tlb_flush
            11,431      context-switches

      30.003195321 seconds time elapsed

       0.284015000 seconds user
      88.810151000 seconds sys
```

آپدیت :

عکس‌های زیر عکس‌های ماشین مجازی پس از آزاد شدن دسترسی TLBها است.

```
stress: info: [50420] dispatching hogs: 10 cpu, 0 io, 0 vm, 0 hdd
stress: info: [50420] successful run completed in 30s

 Performance counter stats for 'stress --cpu 10 -t 30s':

        15,994,534      cache-references                                              (13.75%)
           276,578      cache-misses              #    1.729 % of all cache refs      (13.77%)
               190      faults
               190      page-faults
         5,644,671      dTLB-load-misses          #    0.00% of all dTLB cache hits   (13.81%)
   189,903,599,412      dTLB-loads                                                    (13.84%)
           645,764      dTLB-store-misses                                             (13.87%)
    90,028,687,770      dTLB-stores                                                   (13.88%)
         4,100,502      iTLB-load-misses          #  196.21% of all iTLB cache hits   (13.84%)
         2,089,801      iTLB-loads                                                    (13.87%)
         5,447,645      dtlb_load_misses.miss_causes_a_walk                                     (13.85%)
         6,375,938      dtlb_load_misses.stlb_hit                                     (13.82%)
         3,493,603      dtlb_load_misses.walk_completed                                     (13.82%)
                79      dtlb_load_misses.walk_completed_1g                                        (13.78%)
           301,744      dtlb_load_misses.walk_completed_2m_4m                                       (13.79%
)
         3,162,795      dtlb_load_misses.walk_completed_4k                                        (13.78%)
           618,400      dtlb_store_misses.miss_causes_a_walk                                        (13.77%)
         4,978,222      dtlb_store_misses.stlb_hit                                     (13.77%)
           449,307      dtlb_store_misses.walk_completed                                     (13.77%)
                 0      dtlb_store_misses.walk_completed_1g                                       (13.78%)
            30,703      dtlb_store_misses.walk_completed_2m_4m                                      (13.77
%)
           415,719      dtlb_store_misses.walk_completed_4k                                       (13.77%)
           228,155      itlb.itlb_flush                                               (13.76%)
         4,104,293      itlb_misses.miss_causes_a_walk                                     (13.75%)
         2,060,914      itlb_misses.stlb_hit                                          (13.77%)
         1,604,588      itlb_misses.walk_completed                                     (13.74%)
                 0      itlb_misses.walk_completed_1g                                     (13.76%)
           180,057      itlb_misses.walk_completed_2m_4m                                     (13.78%)
         1,430,096      itlb_misses.walk_completed_4k                                     (13.77%)
           493,120      tlb_flush.dtlb_thread                                         (13.80%)
            65,527      tlb_flush.stlb_any                                            (13.78%)
                 0      swiotlb:swiotlb_bounced
            12,742      tlb:tlb_flush
            16,733      context-switches

      30.006312726 seconds time elapsed

      89.587349000 seconds user
       0.041163000 seconds sys
```

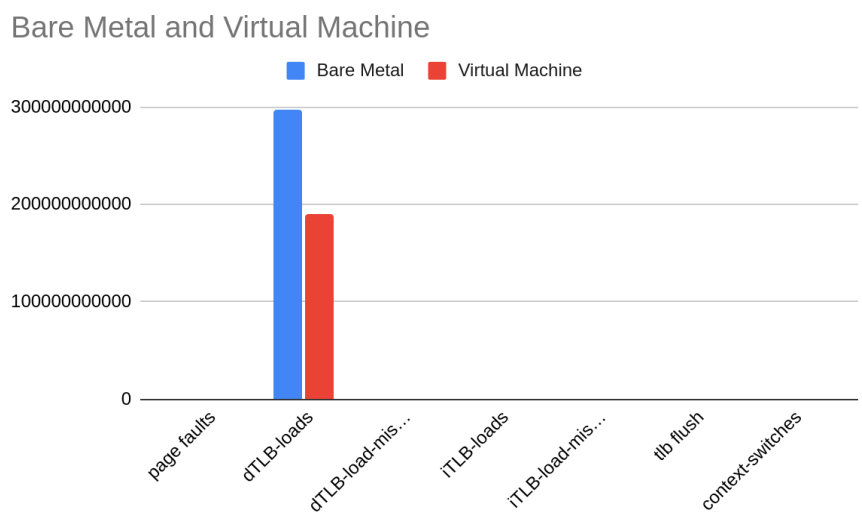
```
stress: info: [50576] dispatching hogs: 0 cpu, 0 io, 4 vm, 0 hdd
stress: info: [50576] successful run completed in 30s

 Performance counter stats for 'stress --vm 4 --vm-bytes 512M -t 30s':

     2,522,450,195      cache-references                                              (13.77%)
     1,200,888,369      cache-misses              #   47.608 % of all cache refs      (13.80%)
        23,318,107      faults
        23,318,107      page-faults
       185,781,234      dTLB-load-misses          #    0.78% of all dTLB cache hits   (13.80%)
    23,879,351,741      dTLB-loads                                                    (13.84%)
       456,791,244      dTLB-store-misses                                             (13.86%)
    27,593,320,748      dTLB-stores                                                   (13.84%)
       201,381,893      iTLB-load-misses          # 5191.49% of all iTLB cache hits   (13.84%)
         3,879,079      iTLB-loads                                                    (13.82%)
       178,639,752      dtlb_load_misses.miss_causes_a_walk                                     (13.80%)
     1,059,622,869      dtlb_load_misses.stlb_hit                                     (13.79%)
       125,705,658      dtlb_load_misses.walk_completed                                         (13.81%)
            22,317      dtlb_load_misses.walk_completed_1g                                      (13.80%)
           521,916      dtlb_load_misses.walk_completed_2m_4m                                         (13.81%
)
       126,714,617      dtlb_load_misses.walk_completed_4k                                      (13.80%)
       454,038,357      dtlb_store_misses.miss_causes_a_walk                                          (13.79%)
       564,564,269      dtlb_store_misses.stlb_hit                                    (13.78%)
       145,188,333      dtlb_store_misses.walk_completed                                        (13.78%)
            11,384      dtlb_store_misses.walk_completed_1g                                     (13.76%)
            76,965      dtlb_store_misses.walk_completed_2m_4m                                        (13.76
%)
       146,281,896      dtlb_store_misses.walk_completed_4k                                     (13.77%)
           253,313      itlb.itlb_flush                                               (13.76%)
       199,577,265      itlb_misses.miss_causes_a_walk                                      (13.78%)
         3,902,552      itlb_misses.stlb_hit                                          (13.78%)
        45,466,154      itlb_misses.walk_completed                                    (13.77%)
                 0      itlb_misses.walk_completed_1g                                     (13.77%)
           316,254      itlb_misses.walk_completed_2m_4m                                    (13.78%)
        45,309,762      itlb_misses.walk_completed_4k                                     (13.78%)
        47,124,936      tlb_flush.dtlb_thread                                         (13.78%)
        23,545,843      tlb_flush.stlb_any                                            (13.77%)
                 0      swiotlb:swiotlb_bounced
             5,656      tlb:tlb_flush
             8,276      context-switches

      30.058444313 seconds time elapsed

      15.379922000 seconds user
      73.774045000 seconds sys
```

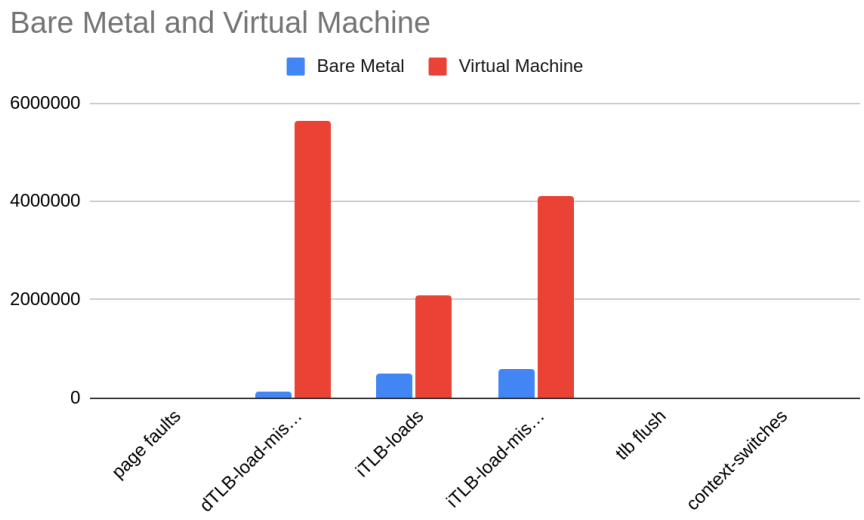
```
 Performance counter stats for 'stress --io 5 -t 30s':

     2,116,830,283      cache-references                                              (13.76%)
           196,882      cache-misses              #    0.009 % of all cache refs      (13.77%)
               125      faults
               125      page-faults
         7,961,600      dTLB-load-misses          #    0.10% of all dTLB cache hits   (13.79%)
     7,674,854,262      dTLB-loads                                                    (13.83%)
           547,661      dTLB-store-misses                                             (13.84%)
     5,118,471,098      dTLB-stores                                                   (13.86%)
         6,634,967      iTLB-load-misses          #  131.40% of all iTLB cache hits   (13.82%)
         5,049,576      iTLB-loads                                                    (13.81%)
         7,792,613      dtlb_load_misses.miss_causes_a_walk                                     (13.81%)
       209,156,316      dtlb_load_misses.stlb_hit                                     (13.79%)
         6,342,693      dtlb_load_misses.walk_completed                                     (13.82%)
                 7      dtlb_load_misses.walk_completed_1g                                        (13.79%)
           310,096      dtlb_load_misses.walk_completed_2m_4m                                        (13.81%
)
         6,089,124      dtlb_load_misses.walk_completed_4k                                        (13.81%)
           545,202      dtlb_store_misses.miss_causes_a_walk                                        (13.79%)
        91,243,191      dtlb_store_misses.stlb_hit                                    (13.81%)
           451,055      dtlb_store_misses.walk_completed                                    (13.79%)
                14      dtlb_store_misses.walk_completed_1g                                       (13.79%)
            32,958      dtlb_store_misses.walk_completed_2m_4m                                       (13.78
%)
           422,118      dtlb_store_misses.walk_completed_4k                                       (13.78%)
           226,883      itlb.itlb_flush                                               (13.79%)
         6,586,050      itlb_misses.miss_causes_a_walk                                     (13.79%)
         4,938,014      itlb_misses.stlb_hit                                          (13.81%)
         1,641,811      itlb_misses.walk_completed                                    (13.80%)
                 0      itlb_misses.walk_completed_1g                                     (13.79%)
           158,650      itlb_misses.walk_completed_2m_4m                                     (13.76%)
         1,493,761      itlb_misses.walk_completed_4k                                     (13.75%)
         1,933,276      tlb_flush.dtlb_thread                                         (13.75%)
            63,351      tlb_flush.stlb_any                                            (13.74%)
                 0      swiotlb:swiotlb_bounced
             6,115      tlb:tlb_flush
            11,572      context-switches

      30.005448470 seconds time elapsed

       0.451578000 seconds user
      88.970420000 seconds sys
```

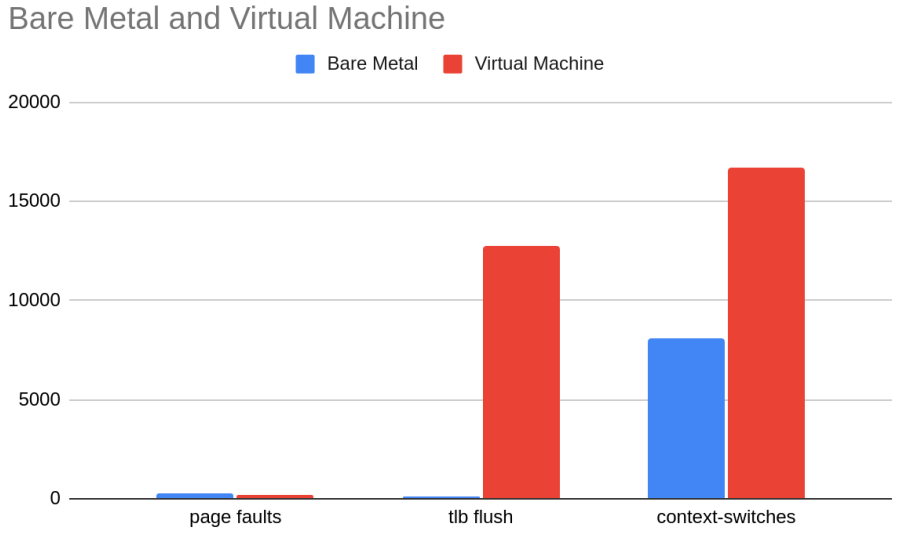
نمودار تحلیل بین ماشین مجازی و ماشین Bare Metal در تست‌های stress :

بار کاری بر cpu :

	Bare Metal	Virtual Machine
page faults	237	190
dTLB-loads	297,315,090,408	189,903,599,412
dTLB-load-misses	118,583	5,644,671
iTLB-loads	506,241	2,089,801
iTLB-load-misses	572,114	4,100,502
tlb flush	126	12,742
context-switches	8,109	16,733

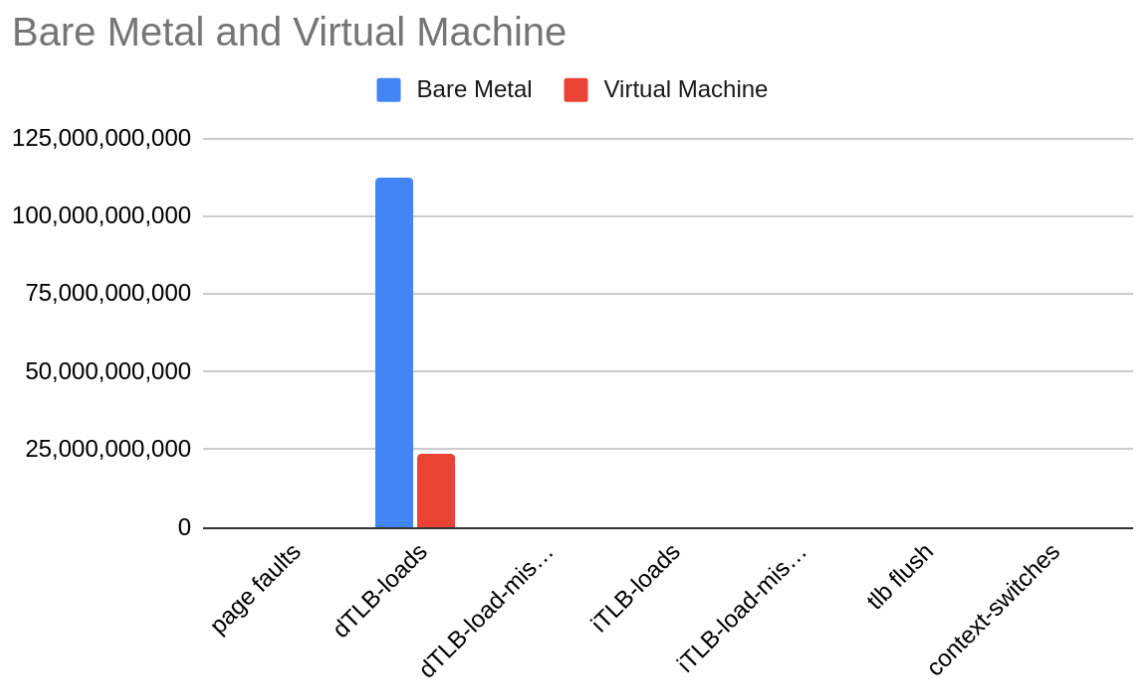


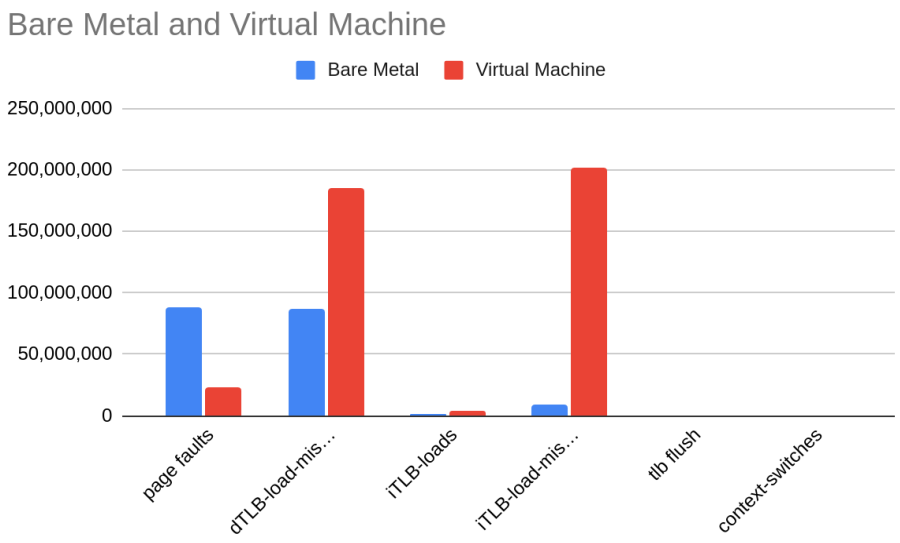

Bare Metal and Virtual Machine
Bare Metal
Virtual Machine
6000000
4000000
2000000
0
page faults
dTLB-load-mis...
iTLB-loads
iTLB-load-mis...
tlb flush
context-switches

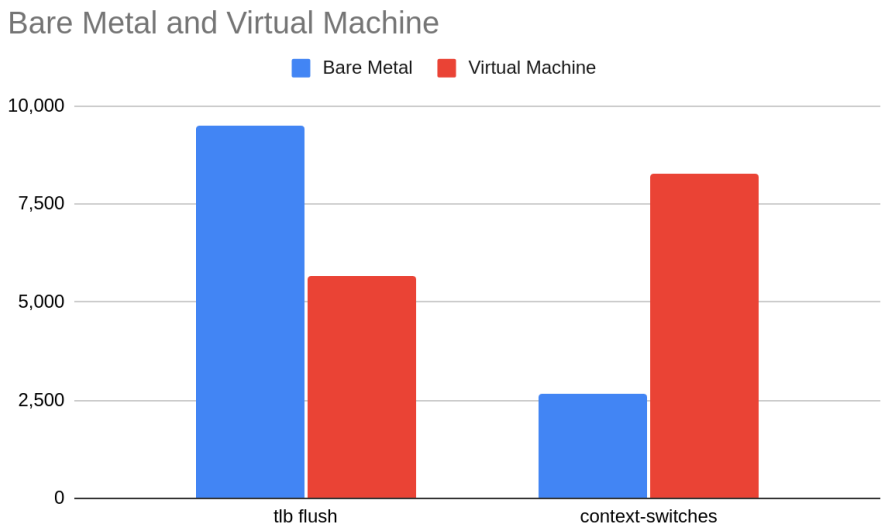

Bare Metal and Virtual Machine
Bare Metal
Virtual Machine
20000
15000
10000
5000
0
page faults
tlb flush
context-switches

بار کاری بر memory :

	Bare Metal	Virtual Machine
page faults	88,614,473	23,318,107
dTLB-loads	112,695,571,315	23,879,351,741
dTLB-load-misses	87,096,126	185,781,234
iTLB-loads	1,035,778	3,879,079
iTLB-load-misses	8,514,027	201,381,893
tlb flush	9,488	5,656
context-switches	2,654	8,276

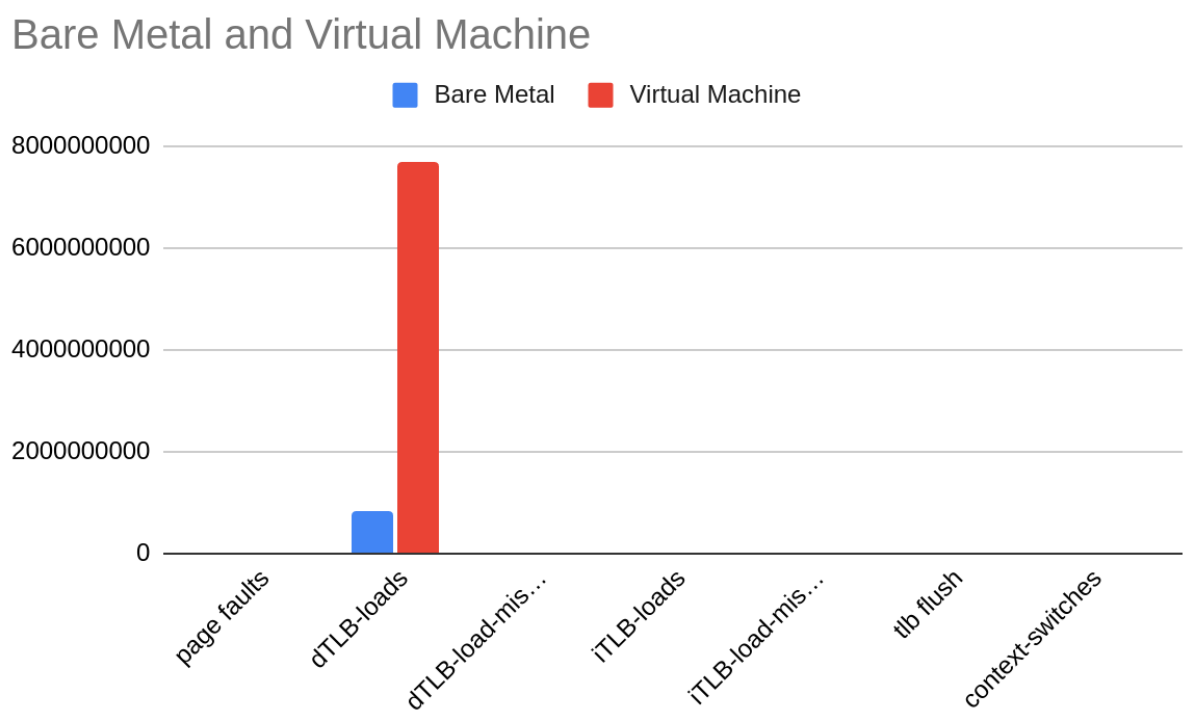


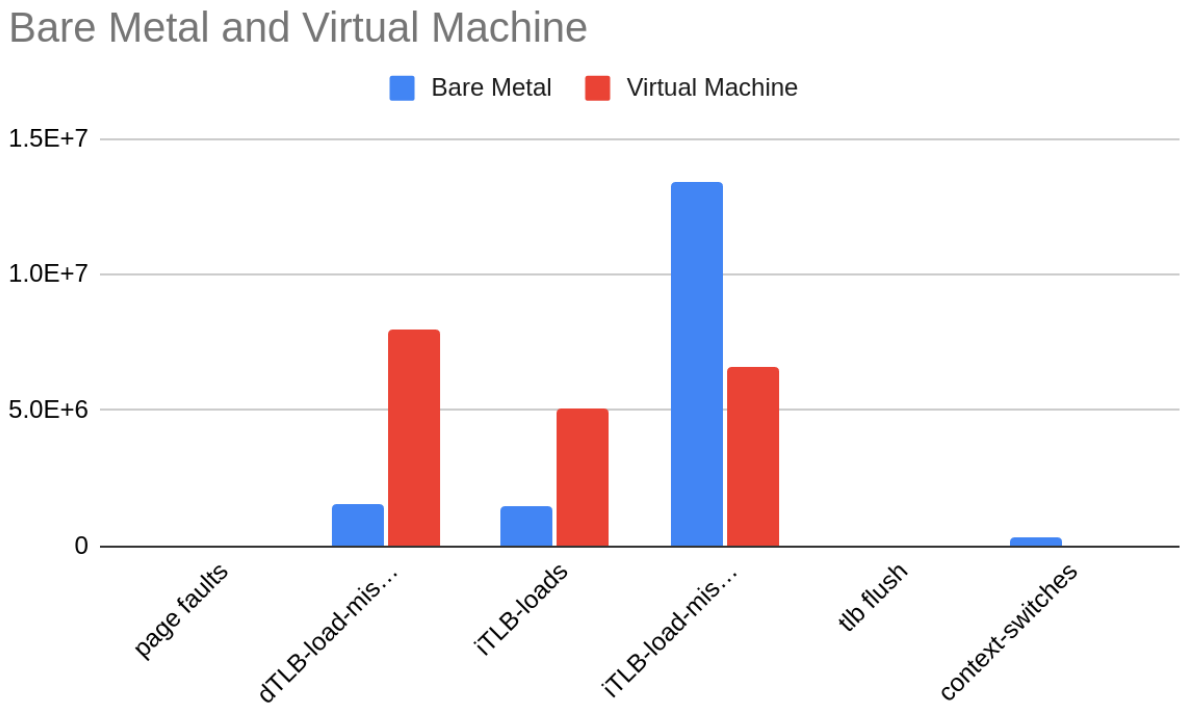

Bare Metal and Virtual Machine
Bare Metal
Virtual Machine
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
page faults
dTLB-load-mis...
iTLB-loads
iTLB-load-mis...
tlb flush
context-switches

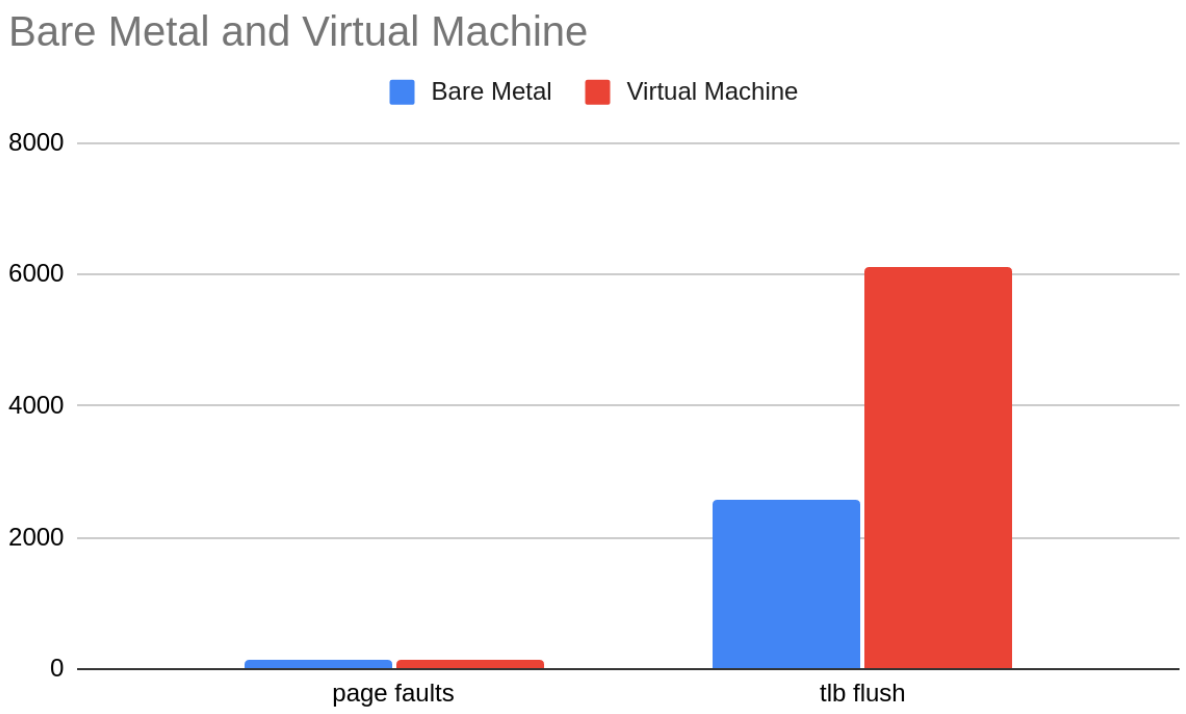

Bare Metal and Virtual Machine
Bare Metal
Virtual Machine
10,000
7,500
5,000
2,500
0
tlb flush
context-switches

بار کاری بر io :

	Bare Metal	Virtual Machine
page faults	136	125
dTLB-loads	806,034,836	7,674,854,262
dTLB-load-misses	1,536,417	7,961,600
iTLB-loads	1,441,950	5,049,576
iTLB-load-misses	13,427,813	6,634,967
tlb flush	2,583	6,115
context-switches	346,797	11,572




Bare Metal and Virtual Machine
Bare Metal
Virtual Machine
1.5E+7
1.0E+7
5.0E+6
0
page faults
dTLB-load-mis…
iTLB-loads
iTLB-load-mis…
tlb flush
context-switches


Bare Metal and Virtual Machine
Bare Metal
Virtual Machine
8000
6000
4000
2000
0
page faults
tlb flush