Московский Авиационный Институт

(Национальный Исследовательский Университет) Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

Лабораторная работа №2 по курсу

**«Операционные системы»**

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Постановка задачи

**Цель работы:**

**Целью является приобретение практических навыков в:**

* **Управление потоками в ОС**
* **Обеспечение синхронизации между потоками Задание:**

**Составить программу на языке Си, обрабатывающую данные в многопоточном режиме. При обработки использовать стандартные средства создания потоков операционной системы (Windows/Unix). Ограничение максимального количества потоков, работающих в один момент времени, должно быть задано ключом запуска вашей программы. Так же необходимо уметь продемонстрировать количество потоков, используемое вашей программой с помощью стандартных средств операционной системы. В отчете привести исследование зависимости ускорения и эффективности алгоритма от входных данных и количества потоков. Получившиеся результаты необходимо объяснить.**

**Вариант 3) Отсортировать массив целых чисел при помощи параллельной сортировки**

Общий метод и алгоритм решения

Использованные системные вызовы:

* ssize\_t write(int fd, const void \* buf, size\_t n); – Записывает N байт из буфер(BUF) в файл (FD). Возвращает количество записанных байт или -1.
* void exit(int status); – выполняет немедленное завершение программы. Все используемые программой потоки закрываются, и временные файлы удаляются, управление возвращается ОС или другой программе.
* int pthread\_create(pthread\_t \* restrict newthread, const pthread\_attr\_t \* restrict attr, void \*(\*start\_routine)(void \*), void \*restrict arg) — создаёт поток с

рутиной (стартовой функцией) и заданными аргументами

* int pthread\_join(pthread\_t th, void \*\*thread\_return) — дожидается завершения потока.

Для mutex реализации были использованы:

pthread\_mutex\_t – тип данных;

int pthread\_mutex\_init(pthread\_mutex\_t \*mutex, const pthread\_mutexattr\_t \*mutexattr) – инициализация мьютекса;

int pthread\_mutex\_lock(pthread\_mutex\_t \*mutex) – блокировка мьютекса;

int pthread\_mutex\_unlock(pthread\_mutex\_t \*mutex) – разблокировка мьютекса; int pthread\_mutex\_destroy(pthread\_mutex\_t \*mutex) – удаление мьютекса;

Программа запускается с аргументами – количество элементов массива и число потоков, которые могут работать одновременно. Это число используется для управления созданием потоков.

Инициализируется мьютекс, который будет использоваться для синхронизации доступа к данным.

Создается структура TASK для работы с потоками. Массив из случайных чисел разбивается на несколько диапазонов и в массив потоков передаеются начала и окончания этих диапазонов. Число элементов в каждом массиве определяется по формуле len = MAX\_ARRAY\_ELEMENTS / MAX\_THREADS.

Если количество активных потоков достигает MAX\_THREADS, программа ждёт завершения всех этих потоков перед созданием новых.

После завершения всех вычислений выполняется ожидание завершения оставшихся запущенных потоков. Программа измеряет и выводит затраченное время на выполнение умножения матриц. Это время рассчитывается с помощью стандартной структуры timespec и clock\_gettime.

Уничтожение мьютекса после использования.

Узнаем количество логических ядер

irina@Irina-VivoBook src % sysctl -n hw.logicalcpu

4

|  |  |  |  |
| --- | --- | --- | --- |
| Число потоков | Время выполнения | Ускорение | Эффективность |
| 1 | 49344 | 1,00 | 1,00 |
| 2 | 27614 | 1,79 | 0,895 |
| 3 | 25148 | 1,96 | 0,653 |
| 4 | 22725 | 2,17 | 0,542 |
| 5 | 21403 | 2,31 | 0,462 |
| 6 | 20896 | 2,36 | 0,393 |
| 7 | 19226 | 2,57 | 0,367 |
| 8 | 16373 | 3,01 | 0,376 |

Код программы

**main.c:**

#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#include <stdint.h>

#if defined (WIN32) || (\_WIN64)

#include <windows.h>

#define pthread\_t DWORD

#define pthread\_create(THREAD\_ID\_PTR, ATTR, ROUTINE, PARAMS) CreateThread(NULL,0,(LPTHREAD\_START\_ROUTINE)ROUTINE,(void\*)PARAMS,0,THREAD\_ID\_PTR)

#define sleep(ms) Sleep(ms)

#else // Linux

#include <pthread.h>

#include <unistd.h>

#endif

typedef struct TASK

{

int low;

int high;

int busy;

int\* a;

}TASK;

void merge(int\* a, int low, int mid, int high)

{

int n1 = mid - low + 1;

int n2 = high - mid;

int\* left = (int\*)malloc(n1 \* sizeof(int));

int\* right = (int\*)malloc(n2 \* sizeof(int));

int i;

int j;

for (i = 0; i < n1; i++)

left[i] = a[i + low];

for (i = 0; i < n2; i++)

right[i] = a[i + mid + 1];

int k = low;

i = j = 0;

while (i < n1 && j < n2)

{

if (left[i] <= right[j])

a[k++] = left[i++];

else

a[k++] = right[j++];

}

while (i < n1)

a[k++] = left[i++];

while (j < n2)

a[k++] = right[j++];

free(left);

free(right);

}

void merge\_sort(int\* a, int low, int high)

{

int mid = low + (high - low) / 2;

if (low < high)

{

merge\_sort(a, low, mid);

merge\_sort(a, mid + 1, high);

merge(a, low, mid, high);

}

}

void\* merge\_sort\_thread(void\* arg)

{

TASK\* task = (TASK\*)arg;

int low;

int high;

low = task->low;

high = task->high;

int mid = low + (high - low) / 2;

if (low < high)

{

merge\_sort(task->a, low, mid);

merge\_sort(task->a, mid + 1, high);

merge(task->a, low, mid, high);

}

task->busy = 0;

return 0;

}

int main(int argc, char\*\* argv)

{

char\* sz;

int MAX\_ARRAY\_ELEMENTS = 100000000;

int MAX\_THREADS = 1;

char msg[1024];

uint32\_t msg\_len;

if (argc < 3) {

msg\_len = snprintf(msg, sizeof(msg) - 1, "usage: %s array\_count thread\_count\n", argv[0]);

write(STDERR\_FILENO, msg, msg\_len);

exit(EXIT\_SUCCESS);

}

if (argc == 3)

{

MAX\_ARRAY\_ELEMENTS = atoi(argv[1]);

MAX\_THREADS = atoi(argv[2]);

}

float time\_sec = (float)clock() / CLOCKS\_PER\_SEC;

long int start\_time;

start\_time = time(NULL);

msg\_len = snprintf(msg, sizeof(msg) - 1, "Now time is: %s", ctime(&start\_time));

write(STDERR\_FILENO, msg, msg\_len);

msg\_len = snprintf(msg, sizeof(msg) - 1, "Array[%d]\nThreads[%d]\n", MAX\_ARRAY\_ELEMENTS, MAX\_THREADS);

write(STDERR\_FILENO, msg, msg\_len);

int\* array = (int\*)malloc(sizeof(int) \* MAX\_ARRAY\_ELEMENTS);

clock\_t time\_start = clock();

srand(time\_start);

int i;

for (i = 0; i < MAX\_ARRAY\_ELEMENTS; i++)

array[i] = rand();

msg\_len = snprintf(msg, sizeof(msg) - 1, "Array Randomized\n");

write(STDERR\_FILENO, msg, msg\_len);

pthread\_t\* threads = (pthread\_t\*)malloc(sizeof(pthread\_t) \* MAX\_THREADS);

TASK\* tasklist = (TASK\*)malloc(sizeof(TASK) \* MAX\_THREADS);

int len = MAX\_ARRAY\_ELEMENTS / MAX\_THREADS;

TASK\* task;

int low = 0;

for (i = 0; i < MAX\_THREADS; i++, low += len)

{

task = &tasklist[i];

task->a = array;

task->busy = 1;

task->low = low;

task->high = low + len - 1;

if (i == (MAX\_THREADS - 1))

task->high = MAX\_ARRAY\_ELEMENTS - 1;

pthread\_create(&threads[i], 0, merge\_sort\_thread, task);

}

#if defined (WIN32) || (\_WIN64)

// ожидаем выполнение всех потоков для windows

for (i = 0; i < MAX\_THREADS; i++)

while (tasklist[i].busy)

sleep(10);

#else // Linux

// ожидаем выполнение всех потоков

// wait for all threads

for(i = 0; i < MAX\_THREADS; i++)

pthread\_join(threads[i], NULL);

#endif

TASK\* taskm = &tasklist[0];

for (i = 1; i < MAX\_THREADS; i++)

{

TASK\* task = &tasklist[i];

merge(taskm->a, taskm->low, task->low - 1, task->high);

}

int last = 0;

for (i = 0; i < MAX\_ARRAY\_ELEMENTS; i++)

{

if (array[i] < last)

{

msg\_len = snprintf(msg, sizeof(msg) - 1, "Array is not sorted!\n");

write(STDERR\_FILENO, msg, msg\_len);

return 0;

}

last = array[i];

}

long int end\_time = time(NULL);

msg\_len = snprintf(msg, sizeof(msg) - 1, "Now time is: %s", ctime(&end\_time));

write(STDERR\_FILENO, msg, msg\_len);

msg\_len = snprintf(msg, sizeof(msg) - 1, "Array sorted in %ld Seconds\n", time(NULL) - start\_time);

write(STDERR\_FILENO, msg, msg\_len);

free(tasklist);

free(threads);

return 0;

}

Протокол работы программы

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ gcc merge\_sort.c

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out

usage: ./a.out array\_count thread\_count

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 1

Now time is: Tue Dec 3 11:08:25 2024

Array[100000000]

Threads[1]

Array Randomized

Now time is: Tue Dec 3 11:09:14 2024

Array sorted in 49344 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 2

Now time is: Tue Dec 3 11:09:21 2024

Array[100000000]

Threads[2]

Array Randomized

Now time is: Tue Dec 3 11:09:48 2024

Array sorted in 27614 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 3

Now time is: Tue Dec 3 11:09:53 2024

Array[100000000]

Threads[3]

Array Randomized

Now time is: Tue Dec 3 11:10:18 2024

Array sorted in 25148 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 4

Now time is: Tue Dec 3 11:10:23 2024

Array[100000000]

Threads[4]

Array Randomized

Now time is: Tue Dec 3 11:10:45 2024

Array sorted in 22725 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 5

Now time is: Tue Dec 3 11:10:49 2024

Array[100000000]

Threads[5]

Array Randomized

Now time is: Tue Dec 3 11:11:11 2024

Array sorted in 21403 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 6

Now time is: Tue Dec 3 11:11:15 2024

Array[100000000]

Threads[6]

Array Randomized

Now time is: Tue Dec 3 11:11:37 2024

Array sorted in 20896 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 7

Now time is: Tue Dec 3 11:11:41 2024

Array[100000000]

Threads[7]

Array Randomized

Now time is: Tue Dec 3 11:12:04 2024

Array sorted in 19226 ms

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ ./a.out 100000000 8

Now time is: Tue Dec 3 11:12:08 2024

Array[100000000]

Threads[8]

Array Randomized

Now time is: Tue Dec 3 11:12:31 2024

Array sorted in 16373 ms

**Strace:(сортировка 100000000 элементов массива в 8 потоках)**

irina@Irina-VivoBook:~/Prog/Prog\_C/Kurs2/LabOS/Lab02$ strace -f ./a.out 100000000 8

execve("./a.out", ["./a.out", "100000000", "8"], 0x7ffd9625e418 /\* 46 vars \*/) = 0

brk(NULL) = 0x646e9edab000

arch\_prctl(0x3001 /\* ARCH\_??? \*/, 0x7ffede0fd860) = -1 EINVAL (Недопустимый аргумент)

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf0422cb000

access("/etc/ld.so.preload", R\_OK) = -1 ENOENT (Нет такого файла или каталога)

openat(AT\_FDCWD, "/etc/ld.so.cache", O\_RDONLY|O\_CLOEXEC) = 3

newfstatat(3, "", {st\_mode=S\_IFREG|0644, st\_size=63951, ...}, AT\_EMPTY\_PATH) = 0

mmap(NULL, 63951, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7cf0422bb000

close(3) = 0

openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libc.so.6", O\_RDONLY|O\_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0P\237\2\0\0\0\0\0"..., 832) = 832

pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784

pread64(3, "\4\0\0\0 \0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0"..., 48, 848) = 48

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0I\17\357\204\3$\f\221\2039x\324\224\323\236S"..., 68, 896) = 68

newfstatat(3, "", {st\_mode=S\_IFREG|0755, st\_size=2220400, ...}, AT\_EMPTY\_PATH) = 0

pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784

mmap(NULL, 2264656, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7cf042000000

mprotect(0x7cf042028000, 2023424, PROT\_NONE) = 0

mmap(0x7cf042028000, 1658880, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x28000) = 0x7cf042028000

mmap(0x7cf0421bd000, 360448, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1bd000) = 0x7cf0421bd000

mmap(0x7cf042216000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x215000) = 0x7cf042216000

mmap(0x7cf04221c000, 52816, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7cf04221c000

close(3) = 0

mmap(NULL, 12288, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf0422b8000

arch\_prctl(ARCH\_SET\_FS, 0x7cf0422b8740) = 0

set\_tid\_address(0x7cf0422b8a10) = 3456

set\_robust\_list(0x7cf0422b8a20, 24) = 0

rseq(0x7cf0422b90e0, 0x20, 0, 0x53053053) = 0

mprotect(0x7cf042216000, 16384, PROT\_READ) = 0

mprotect(0x646e9ebbf000, 4096, PROT\_READ) = 0

mprotect(0x7cf042305000, 8192, PROT\_READ) = 0

prlimit64(0, RLIMIT\_STACK, NULL, {rlim\_cur=8192\*1024, rlim\_max=RLIM64\_INFINITY}) = 0

munmap(0x7cf0422bb000, 63951) = 0

clock\_gettime(CLOCK\_PROCESS\_CPUTIME\_ID, {tv\_sec=0, tv\_nsec=2310418}) = 0

getrandom("\x99\x7d\x2c\xf5\x15\x51\xfd\x83", 8, GRND\_NONBLOCK) = 8

brk(NULL) = 0x646e9edab000

brk(0x646e9edcc000) = 0x646e9edcc000

openat(AT\_FDCWD, "/etc/localtime", O\_RDONLY|O\_CLOEXEC) = 3

newfstatat(3, "", {st\_mode=S\_IFREG|0644, st\_size=1535, ...}, AT\_EMPTY\_PATH) = 0

newfstatat(3, "", {st\_mode=S\_IFREG|0644, st\_size=1535, ...}, AT\_EMPTY\_PATH) = 0

read(3, "TZif2\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\21\0\0\0\21\0\0\0\0"..., 4096) = 1535

lseek(3, -927, SEEK\_CUR) = 608

read(3, "TZif2\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\21\0\0\0\21\0\0\0\0"..., 4096) = 927

close(3) = 0

write(2, "Now time is: Tue Dec 3 11:12:55"..., 38Now time is: Tue Dec 3 11:12:55 2024

) = 38

write(2, "Array[100000000]\nThreads[8]\n", 28Array[100000000]

Threads[8]

) = 28

mmap(NULL, 400003072, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf02a200000

clock\_gettime(CLOCK\_PROCESS\_CPUTIME\_ID, {tv\_sec=0, tv\_nsec=2952002}) = 0

write(2, "Array Randomized\n", 17Array Randomized

) = 17

rt\_sigaction(SIGRT\_1, {sa\_handler=0x7cf042091870, sa\_mask=[], sa\_flags=SA\_RESTORER|SA\_ONSTACK|SA\_RESTART|SA\_SIGINFO, sa\_restorer=0x7cf042042520}, NULL, 8) = 0

rt\_sigprocmask(SIG\_UNBLOCK, [RTMIN RT\_1], NULL, 8) = 0

mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7cf029800000

mprotect(0x7cf029801000, 8388608, PROT\_READ|PROT\_WRITE) = 0

rt\_sigprocmask(SIG\_BLOCK, ~[], [], 8) = 0

clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf02a000910, parent\_tid=0x7cf02a000910, exit\_signal=0, stack=0x7cf029800000, stack\_size=0x7fff00, tls=0x7cf02a000640}strace: Process 3457 attached

=> {parent\_tid=[3457]}, 88) = 3457

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3457] rseq(0x7cf02a000fe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 3456] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3457] <... rseq resumed>) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0 <unfinished ...>

[pid 3457] set\_robust\_list(0x7cf02a000920, 24 <unfinished ...>

[pid 3456] <... mmap resumed>) = 0x7cf028e00000

[pid 3457] <... set\_robust\_list resumed>) = 0

[pid 3456] mprotect(0x7cf028e01000, 8388608, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3457] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3456] <... mprotect resumed>) = 0

[pid 3457] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], <unfinished ...>

[pid 3457] mmap(NULL, 134217728, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0 <unfinished ...>

[pid 3456] <... rt\_sigprocmask resumed>[], 8) = 0

[pid 3457] <... mmap resumed>) = 0x7cf020e00000

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf029600910, parent\_tid=0x7cf029600910, exit\_signal=0, stack=0x7cf028e00000, stack\_size=0x7fff00, tls=0x7cf029600640} <unfinished ...>

[pid 3457] munmap(0x7cf020e00000, 52428800strace: Process 3458 attached

) = 0

[pid 3456] <... clone3 resumed> => {parent\_tid=[3458]}, 88) = 3458

[pid 3458] rseq(0x7cf029600fe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 3457] munmap(0x7cf028000000, 14680064 <unfinished ...>

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3458] <... rseq resumed>) = 0

[pid 3456] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3457] <... munmap resumed>) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0 <unfinished ...>

[pid 3458] set\_robust\_list(0x7cf029600920, 24 <unfinished ...>

[pid 3456] <... mmap resumed>) = 0x7cf028400000

[pid 3457] mprotect(0x7cf024000000, 135168, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3456] mprotect(0x7cf028401000, 8388608, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3458] <... set\_robust\_list resumed>) = 0

[pid 3456] <... mprotect resumed>) = 0

[pid 3457] <... mprotect resumed>) = 0

[pid 3458] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], <unfinished ...>

[pid 3458] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3458] mmap(NULL, 134217728, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0) = 0x7cf01c000000

[pid 3458] munmap(0x7cf020000000, 67108864) = 0

[pid 3458] mprotect(0x7cf01c000000, 135168, PROT\_READ|PROT\_WRITE) = 0

[pid 3456] <... rt\_sigprocmask resumed>[], 8) = 0

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf028c00910, parent\_tid=0x7cf028c00910, exit\_signal=0, stack=0x7cf028400000, stack\_size=0x7fff00, tls=0x7cf028c00640}strace: Process 3459 attached

=> {parent\_tid=[3459]}, 88) = 3459

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3459] rseq(0x7cf028c00fe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 3456] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3459] <... rseq resumed>) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7cf023600000

[pid 3459] set\_robust\_list(0x7cf028c00920, 24 <unfinished ...>

[pid 3456] mprotect(0x7cf023601000, 8388608, PROT\_READ|PROT\_WRITE) = 0

[pid 3459] <... set\_robust\_list resumed>) = 0

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], <unfinished ...>

[pid 3459] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3456] <... rt\_sigprocmask resumed>[], 8) = 0

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf023e00910, parent\_tid=0x7cf023e00910, exit\_signal=0, stack=0x7cf023600000, stack\_size=0x7fff00, tls=0x7cf023e00640} <unfinished ...>

[pid 3459] <... rt\_sigprocmask resumed>NULL, 8) = 0

strace: Process 3460 attached

[pid 3456] <... clone3 resumed> => {parent\_tid=[3460]}, 88) = 3460

[pid 3459] mmap(0x7cf020000000, 67108864, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0 <unfinished ...>

[pid 3460] rseq(0x7cf023e00fe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3459] <... mmap resumed>) = 0x7cf018000000

[pid 3456] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3460] <... rseq resumed>) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0 <unfinished ...>

[pid 3459] mprotect(0x7cf018000000, 135168, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3456] <... mmap resumed>) = 0x7cf022c00000

[pid 3460] set\_robust\_list(0x7cf023e00920, 24 <unfinished ...>

[pid 3459] <... mprotect resumed>) = 0

[pid 3456] mprotect(0x7cf022c01000, 8388608, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3460] <... set\_robust\_list resumed>) = 0

[pid 3456] <... mprotect resumed>) = 0

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], [], 8) = 0

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf023400910, parent\_tid=0x7cf023400910, exit\_signal=0, stack=0x7cf022c00000, stack\_size=0x7fff00, tls=0x7cf023400640} => {parent\_tid=[3461]}, 88) = 3461

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], NULL, 8) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7cf022200000

[pid 3456] mprotect(0x7cf022201000, 8388608, PROT\_READ|PROT\_WRITE) = 0

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], [], 8) = 0

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf022a00910, parent\_tid=0x7cf022a00910, exit\_signal=0, stack=0x7cf022200000, stack\_size=0x7fff00, tls=0x7cf022a00640} => {parent\_tid=[3462]}, 88) = 3462

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], NULL, 8) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7cf021800000

[pid 3456] mprotect(0x7cf021801000, 8388608, PROT\_READ|PROT\_WRITE) = 0

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], [], 8) = 0

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf022000910, parent\_tid=0x7cf022000910, exit\_signal=0, stack=0x7cf021800000, stack\_size=0x7fff00, tls=0x7cf022000640} => {parent\_tid=[3463]}, 88) = 3463

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], NULL, 8) = 0

[pid 3456] mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7cf020e00000

[pid 3456] mprotect(0x7cf020e01000, 8388608, PROT\_READ|PROT\_WRITE) = 0

[pid 3456] rt\_sigprocmask(SIG\_BLOCK, ~[], [], 8) = 0

[pid 3456] clone3({flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, child\_tid=0x7cf021600910, parent\_tid=0x7cf021600910, exit\_signal=0, stack=0x7cf020e00000, stack\_size=0x7fff00, tls=0x7cf021600640} => {parent\_tid=[3464]}, 88) = 3464

[pid 3456] rt\_sigprocmask(SIG\_SETMASK, [], NULL, 8) = 0

[pid 3456] futex(0x7cf02a000910, FUTEX\_WAIT\_BITSET|FUTEX\_CLOCK\_REALTIME, 3457, NULL, FUTEX\_BITSET\_MATCH\_ANYstrace: Process 3461 attached

<unfinished ...>

[pid 3461] rseq(0x7cf023400fe0, 0x20, 0, 0x53053053) = 0

[pid 3461] set\_robust\_list(0x7cf023400920, 24) = 0

[pid 3461] rt\_sigprocmask(SIG\_SETMASK, [], NULL, 8) = 0

[pid 3461] mmap(NULL, 134217728, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0) = 0x7cf010000000

[pid 3461] munmap(0x7cf014000000, 67108864) = 0

[pid 3461] mprotect(0x7cf010000000, 135168, PROT\_READ|PROT\_WRITE) = 0

strace: Process 3464 attached

strace: Process 3463 attached

strace: Process 3462 attached

[pid 3460] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3462] rseq(0x7cf022a00fe0, 0x20, 0, 0x53053053) = 0

[pid 3460] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3462] set\_robust\_list(0x7cf022a00920, 24) = 0

[pid 3462] rt\_sigprocmask(SIG\_SETMASK, [], NULL, 8) = 0

[pid 3462] mmap(0x7cf014000000, 67108864, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0) = 0x7cf00c000000

[pid 3460] mmap(0x7cf014000000, 67108864, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0 <unfinished ...>

[pid 3462] mprotect(0x7cf00c000000, 135168, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] <... mmap resumed>) = 0x7cf008000000

[pid 3460] mprotect(0x7cf008000000, 135168, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3463] rseq(0x7cf022000fe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 3464] rseq(0x7cf021600fe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid 3460] <... mprotect resumed>) = 0

[pid 3463] <... rseq resumed>) = 0

[pid 3464] <... rseq resumed>) = 0

[pid 3464] set\_robust\_list(0x7cf021600920, 24 <unfinished ...>

[pid 3463] set\_robust\_list(0x7cf022000920, 24 <unfinished ...>

[pid 3464] <... set\_robust\_list resumed>) = 0

[pid 3463] <... set\_robust\_list resumed>) = 0

[pid 3464] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3463] rt\_sigprocmask(SIG\_SETMASK, [], <unfinished ...>

[pid 3464] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3463] <... rt\_sigprocmask resumed>NULL, 8) = 0

[pid 3464] mmap(NULL, 134217728, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0 <unfinished ...>

[pid 3463] mmap(NULL, 134217728, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_NORESERVE, -1, 0 <unfinished ...>

[pid 3464] <... mmap resumed>) = 0x7cf000000000

[pid 3463] <... mmap resumed>) = 0x7ceff8000000

[pid 3464] munmap(0x7cf004000000, 67108864 <unfinished ...>

[pid 3463] munmap(0x7ceffc000000, 67108864 <unfinished ...>

[pid 3464] <... munmap resumed>) = 0

[pid 3463] <... munmap resumed>) = 0

[pid 3464] mprotect(0x7cf000000000, 135168, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3463] mprotect(0x7ceff8000000, 135168, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3464] <... mprotect resumed>) = 0

[pid 3463] <... mprotect resumed>) = 0

[pid 3458] mprotect(0x7cf01c021000, 69632, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] openat(AT\_FDCWD, "/proc/sys/vm/overcommit\_memory", O\_RDONLY|O\_CLOEXEC) = 3

[pid 3458] read(3, "0", 1) = 1

[pid 3458] close(3) = 0

[pid 3458] madvise(0x7cf01c022000, 65536, MADV\_DONTNEED) = 0

[pid 3461] mprotect(0x7cf010021000, 69632, PROT\_READ|PROT\_WRITE) = 0

[pid 3461] madvise(0x7cf010022000, 65536, MADV\_DONTNEED) = 0

[pid 3457] mprotect(0x7cf024021000, 69632, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024022000, 65536, MADV\_DONTNEED) = 0

[pid 3462] mprotect(0x7cf00c021000, 69632, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] madvise(0x7cf00c022000, 65536, MADV\_DONTNEED <unfinished ...>

[pid 3461] madvise(0x7cf010022000, 65536, MADV\_DONTNEED) = 0

[pid 3461] mmap(NULL, 196608, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf042288000

[pid 3461] mmap(NULL, 196608, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf042258000

[pid 3462] <... madvise resumed>) = 0

[pid 3461] munmap(0x7cf042288000, 196608) = 0

[pid 3461] munmap(0x7cf042258000, 196608) = 0

[pid 3458] mprotect(0x7cf01c032000, 196608, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] madvise(0x7cf01c022000, 262144, MADV\_DONTNEED) = 0

[pid 3459] mprotect(0x7cf018021000, 69632, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] mprotect(0x7cf008021000, 69632, PROT\_READ|PROT\_WRITE) = 0

[pid 3463] mprotect(0x7ceff8021000, 69632, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3457] mprotect(0x7cf024032000, 196608, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024022000, 262144, MADV\_DONTNEED) = 0

[pid 3463] <... mprotect resumed>) = 0

[pid 3462] mprotect(0x7cf00c032000, 196608, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3464] mprotect(0x7cf000021000, 69632, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3462] <... mprotect resumed>) = 0

[pid 3461] mprotect(0x7cf010032000, 196608, PROT\_READ|PROT\_WRITE) = 0

[pid 3464] <... mprotect resumed>) = 0

[pid 3462] madvise(0x7cf00c022000, 262144, MADV\_DONTNEED <unfinished ...>

[pid 3461] madvise(0x7cf010022000, 262144, MADV\_DONTNEED <unfinished ...>

[pid 3462] <... madvise resumed>) = 0

[pid 3461] <... madvise resumed>) = 0

[pid 3461] mmap(NULL, 393216, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf042258000

[pid 3461] mmap(NULL, 393216, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf041fa0000

[pid 3461] munmap(0x7cf042258000, 393216) = 0

[pid 3461] munmap(0x7cf041fa0000, 393216) = 0

[pid 3458] mprotect(0x7cf01c062000, 389120, PROT\_READ|PROT\_WRITE) = 0

[pid 3463] mprotect(0x7ceff8032000, 196608, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] mprotect(0x7cf00c062000, 389120, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] mprotect(0x7cf008032000, 196608, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3459] mprotect(0x7cf018032000, 196608, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] <... mprotect resumed>) = 0

[pid 3457] mprotect(0x7cf024062000, 389120, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3464] mprotect(0x7cf000032000, 196608, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] <... mprotect resumed>) = 0

[pid 3464] mprotect(0x7cf000062000, 389120, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] mmap(NULL, 782336, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf02a141000

[pid 3458] munmap(0x7cf02a141000, 782336 <unfinished ...>

[pid 3463] mprotect(0x7ceff8062000, 389120, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3458] <... munmap resumed>) = 0

[pid 3463] <... mprotect resumed>) = 0

[pid 3459] mprotect(0x7cf018062000, 389120, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] mprotect(0x7cf008062000, 389120, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3461] mprotect(0x7cf010062000, 389120, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3460] <... mprotect resumed>) = 0

[pid 3461] <... mprotect resumed>) = 0

[pid 3461] mprotect(0x7cf0100c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3461] madvise(0x7cf010022000, 1433600, MADV\_DONTNEED) = 0

[pid 3464] mprotect(0x7cf0000c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3464] madvise(0x7cf000022000, 1433600, MADV\_DONTNEED) = 0

[pid 3462] mprotect(0x7cf00c0c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] mprotect(0x7cf0240c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024022000, 1433600, MADV\_DONTNEED <unfinished ...>

[pid 3462] madvise(0x7cf00c022000, 1433600, MADV\_DONTNEED) = 0

[pid 3457] <... madvise resumed>) = 0

[pid 3463] mprotect(0x7ceff80c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3459] mprotect(0x7cf0180c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3463] madvise(0x7ceff8022000, 1433600, MADV\_DONTNEED) = 0

[pid 3459] madvise(0x7cf018022000, 1433600, MADV\_DONTNEED) = 0

[pid 3460] mprotect(0x7cf0080c1000, 782336, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3464] madvise(0x7cf000022000, 1433600, MADV\_DONTNEED <unfinished ...>

[pid 3460] <... mprotect resumed>) = 0

[pid 3464] <... madvise resumed>) = 0

[pid 3464] mmap(NULL, 1564672, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf02a082000

[pid 3464] mmap(NULL, 1564672, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf029682000

[pid 3460] madvise(0x7cf008022000, 1433600, MADV\_DONTNEED) = 0

[pid 3464] munmap(0x7cf02a082000, 1564672) = 0

[pid 3464] munmap(0x7cf029682000, 1564672) = 0

[pid 3461] mprotect(0x7cf010180000, 1560576, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] mprotect(0x7cf01c0c1000, 782336, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] mprotect(0x7cf01c180000, 1560576, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] mprotect(0x7cf024180000, 1560576, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3460] mprotect(0x7cf008180000, 1560576, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3457] <... mprotect resumed>) = 0

[pid 3460] <... mprotect resumed>) = 0

[pid 3462] mprotect(0x7cf00c180000, 1560576, PROT\_READ|PROT\_WRITE) = 0

[pid 3464] mprotect(0x7cf000180000, 1560576, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3463] mprotect(0x7ceff8180000, 1560576, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3464] <... mprotect resumed>) = 0

[pid 3459] mprotect(0x7cf018180000, 1560576, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3463] <... mprotect resumed>) = 0

[pid 3459] <... mprotect resumed>) = 0

[pid 3464] mmap(NULL, 3125248, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf020a00000

[pid 3464] munmap(0x7cf020a00000, 3125248) = 0

[pid 3457] mprotect(0x7cf0242fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024022000, 6119424, MADV\_DONTNEED) = 0

[pid 3458] mprotect(0x7cf01c2fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] madvise(0x7cf01c022000, 6119424, MADV\_DONTNEED) = 0

[pid 3461] mprotect(0x7cf0102fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3461] madvise(0x7cf010022000, 6119424, MADV\_DONTNEED) = 0

[pid 3460] mprotect(0x7cf0082fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3463] mprotect(0x7ceff82fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] madvise(0x7cf008022000, 6119424, MADV\_DONTNEED) = 0

[pid 3462] mprotect(0x7cf00c2fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3463] madvise(0x7ceff8022000, 6119424, MADV\_DONTNEED) = 0

[pid 3464] mprotect(0x7cf0002fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3459] mprotect(0x7cf0182fd000, 3125248, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] madvise(0x7cf00c022000, 6119424, MADV\_DONTNEED) = 0

[pid 3464] madvise(0x7cf000022000, 6119424, MADV\_DONTNEED) = 0

[pid 3464] mmap(NULL, 6250496, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf020800000

[pid 3464] mmap(NULL, 6250496, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf020200000

[pid 3459] madvise(0x7cf018022000, 6119424, MADV\_DONTNEED) = 0

[pid 3464] munmap(0x7cf020800000, 6250496) = 0

[pid 3464] munmap(0x7cf020200000, 6250496) = 0

[pid 3458] mprotect(0x7cf01c5f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] mprotect(0x7cf0245f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] madvise(0x7cf01c022000, 12369920, MADV\_DONTNEED) = 0

[pid 3463] mprotect(0x7ceff85f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024022000, 12369920, MADV\_DONTNEED) = 0

[pid 3463] madvise(0x7ceff8022000, 12369920, MADV\_DONTNEED) = 0

[pid 3461] mprotect(0x7cf0105f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] mprotect(0x7cf00c5f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3461] madvise(0x7cf010022000, 12369920, MADV\_DONTNEED) = 0

[pid 3462] madvise(0x7cf00c022000, 12369920, MADV\_DONTNEED) = 0

[pid 3459] mprotect(0x7cf0185f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] mprotect(0x7cf0085f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3459] madvise(0x7cf018022000, 12369920, MADV\_DONTNEED) = 0

[pid 3460] madvise(0x7cf008022000, 12369920, MADV\_DONTNEED) = 0

[pid 3458] madvise(0x7cf01c022000, 12369920, MADV\_DONTNEED) = 0

[pid 3458] mmap(NULL, 12500992, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf020200000

[pid 3458] mmap(NULL, 12500992, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf017400000

[pid 3464] mprotect(0x7cf0005f8000, 6250496, PROT\_READ|PROT\_WRITE) = 0

[pid 3464] madvise(0x7cf000022000, 12369920, MADV\_DONTNEED) = 0

[pid 3464] mmap(NULL, 12500992, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf016800000

[pid 3464] mmap(NULL, 12500992, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015c00000

[pid 3458] munmap(0x7cf020200000, 12500992) = 0

[pid 3458] munmap(0x7cf017400000, 12500992) = 0

[pid 3461] mprotect(0x7cf010bee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3464] munmap(0x7cf016800000, 12500992) = 0

[pid 3464] munmap(0x7cf015c00000, 12500992) = 0

[pid 3461] madvise(0x7cf010022000, 24870912, MADV\_DONTNEED) = 0

[pid 3457] mprotect(0x7cf024bee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] mprotect(0x7cf00cbee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] madvise(0x7cf00c022000, 24870912, MADV\_DONTNEED) = 0

[pid 3463] mprotect(0x7ceff8bee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024022000, 24870912, MADV\_DONTNEED) = 0

[pid 3463] madvise(0x7ceff8022000, 24870912, MADV\_DONTNEED) = 0

[pid 3459] mprotect(0x7cf018bee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3459] madvise(0x7cf018022000, 24870912, MADV\_DONTNEED) = 0

[pid 3460] mprotect(0x7cf008bee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] madvise(0x7cf008022000, 24870912, MADV\_DONTNEED) = 0

[pid 3461] madvise(0x7cf010022000, 24870912, MADV\_DONTNEED) = 0

[pid 3461] mmap(NULL, 25001984, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf016800000

[pid 3461] mmap(NULL, 25001984, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

[pid 3461] munmap(0x7cf016800000, 25001984) = 0

[pid 3461] munmap(0x7cf015000000, 25001984) = 0

[pid 3461] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3461] madvise(0x7cf022c00000, 8368128, MADV\_DONTNEED) = 0

[pid 3461] exit(0) = ?

[pid 3461] +++ exited with 0 +++

[pid 3462] mprotect(0x7cf00d7da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] mprotect(0x7cf0257da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3462] madvise(0x7cf00c021000, 49872896, MADV\_DONTNEED <unfinished ...>

[pid 3458] mprotect(0x7cf01cbee000, 12500992, PROT\_READ|PROT\_WRITE <unfinished ...>

[pid 3462] <... madvise resumed>) = 0

[pid 3458] <... mprotect resumed>) = 0

[pid 3462] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3462] madvise(0x7cf022200000, 8368128, MADV\_DONTNEED) = 0

[pid 3462] exit(0) = ?

[pid 3462] +++ exited with 0 +++

[pid 3464] mprotect(0x7cf000bee000, 12500992, PROT\_READ|PROT\_WRITE) = 0

[pid 3457] madvise(0x7cf024021000, 49872896, MADV\_DONTNEED) = 0

[pid 3457] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3457] madvise(0x7cf029800000, 8368128, MADV\_DONTNEED) = 0

[pid 3457] exit(0) = ?

[pid 3457] +++ exited with 0 +++

[pid 3456] <... futex resumed>) = 0

[pid 3456] futex(0x7cf029600910, FUTEX\_WAIT\_BITSET|FUTEX\_CLOCK\_REALTIME, 3458, NULL, FUTEX\_BITSET\_MATCH\_ANY <unfinished ...>

[pid 3458] mprotect(0x7cf01d7da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3464] mprotect(0x7cf0017da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3458] madvise(0x7cf01c021000, 49872896, MADV\_DONTNEED) = 0

[pid 3458] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3458] madvise(0x7cf028e00000, 8368128, MADV\_DONTNEED) = 0

[pid 3458] exit(0) = ?

[pid 3458] +++ exited with 0 +++

[pid 3456] <... futex resumed>) = 0

[pid 3456] futex(0x7cf028c00910, FUTEX\_WAIT\_BITSET|FUTEX\_CLOCK\_REALTIME, 3459, NULL, FUTEX\_BITSET\_MATCH\_ANY <unfinished ...>

[pid 3464] madvise(0x7cf000021000, 49872896, MADV\_DONTNEED) = 0

[pid 3464] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3464] madvise(0x7cf020e00000, 8368128, MADV\_DONTNEED) = 0

[pid 3464] exit(0) = ?

[pid 3464] +++ exited with 0 +++

[pid 3459] mprotect(0x7cf0197da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3463] mprotect(0x7ceff97da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3459] madvise(0x7cf018021000, 49872896, MADV\_DONTNEED) = 0

[pid 3459] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3459] madvise(0x7cf028400000, 8368128, MADV\_DONTNEED) = 0

[pid 3459] exit(0) = ?

[pid 3456] <... futex resumed>) = 0

[pid 3459] +++ exited with 0 +++

[pid 3456] futex(0x7cf023e00910, FUTEX\_WAIT\_BITSET|FUTEX\_CLOCK\_REALTIME, 3460, NULL, FUTEX\_BITSET\_MATCH\_ANY <unfinished ...>

[pid 3463] madvise(0x7ceff8021000, 49872896, MADV\_DONTNEED) = 0

[pid 3463] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3463] madvise(0x7cf021800000, 8368128, MADV\_DONTNEED) = 0

[pid 3463] exit(0) = ?

[pid 3463] +++ exited with 0 +++

[pid 3460] mprotect(0x7cf0097da000, 24997888, PROT\_READ|PROT\_WRITE) = 0

[pid 3460] madvise(0x7cf008021000, 49872896, MADV\_DONTNEED) = 0

[pid 3460] rt\_sigprocmask(SIG\_BLOCK, ~[RT\_1], NULL, 8) = 0

[pid 3460] madvise(0x7cf023600000, 8368128, MADV\_DONTNEED) = 0

[pid 3460] exit(0) = ?

[pid 3460] +++ exited with 0 +++

<... futex resumed>) = 0

munmap(0x7cf029800000, 8392704) = 0

munmap(0x7cf028e00000, 8392704) = 0

munmap(0x7cf028400000, 8392704) = 0

munmap(0x7cf023600000, 8392704) = 0

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf005000000

munmap(0x7cf015000000, 50003968) = 0

munmap(0x7cf005000000, 50003968) = 0

mmap(NULL, 100003840, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7ceff2000000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

munmap(0x7ceff2000000, 100003840) = 0

munmap(0x7cf015000000, 50003968) = 0

mmap(NULL, 150003712, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cefef000000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

munmap(0x7cefef000000, 150003712) = 0

munmap(0x7cf015000000, 50003968) = 0

mmap(NULL, 200003584, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cefec000000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

munmap(0x7cefec000000, 200003584) = 0

munmap(0x7cf015000000, 50003968) = 0

mmap(NULL, 250003456, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cefe9000000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

munmap(0x7cefe9000000, 250003456) = 0

munmap(0x7cf015000000, 50003968) = 0

mmap(NULL, 300003328, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cefe6000000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

munmap(0x7cefe6000000, 300003328) = 0

munmap(0x7cf015000000, 50003968) = 0

mmap(NULL, 350003200, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cefe3200000

mmap(NULL, 50003968, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7cf015000000

munmap(0x7cefe3200000, 350003200) = 0

munmap(0x7cf015000000, 50003968) = 0

newfstatat(AT\_FDCWD, "/etc/localtime", {st\_mode=S\_IFREG|0644, st\_size=1535, ...}, 0) = 0

write(2, "Now time is: Tue Dec 3 11:13:18"..., 38Now time is: Tue Dec 3 11:13:18 2024

) = 38

write(2, "Array sorted in 23 Seconds\n", 27Array sorted in 23 Seconds

) = 27

exit\_group(0) = ?

+++ exited with 0 +++

Вывод

В ходе написания данной лабораторной работы я научилась создавать программы, работающие с несколькими потоками, а также синхронизировать их между собой. В результате тестирования программы, я проанализировала каким образом количество потоков влияет на эффективность и ускорение работы программы. Оказалось, что большое количество потоков даёт хорошее ускорение на больших количествах входных данных, но эффективность использования ресурсов находится на приемлемом уровне только на небольшом количестве потоков, не превышающем количества логических ядер процессора. Лабораторная работа была довольно интересна, так как я впервые работал с многопоточностью и синхронизацией на СИ.