SEM - VII - 2022-23
High Performance Computing Lab
Assignment 1
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Q1. Differentiate between Software and Hardware Threads

Hardware Thread:

A "hardware thread" is a physical CPU or core. So, a 4 core CPU can genuinely support 4 hardware threads at once - the CPU really is doing 4 things at the same time. One hardware thread can run many software threads. In modern operating systems, this is often done by time-slicing - each thread gets a few milliseconds to execute before the OS schedules another thread to run on that CPU. Since the OS switches back and forth between the threads quickly, it appears as if one CPU is doing more than one thing at once, but in reality, a core is still running only one hardware thread, which switches between many software threads.

Software Thread:

Software threads are threads of execution managed by the operating system. Software threads are abstractions to the hardware to make multi-processing possible. If you have multiple software threads but there are not multiple resources then these software threads are a way to run all tasks in parallel by allocating resources for limited time(or using some other strategy) so that it appears that all threads are running in parallel. These are managed by the operating system.

Q2. Which type of threads are supported by the processor?

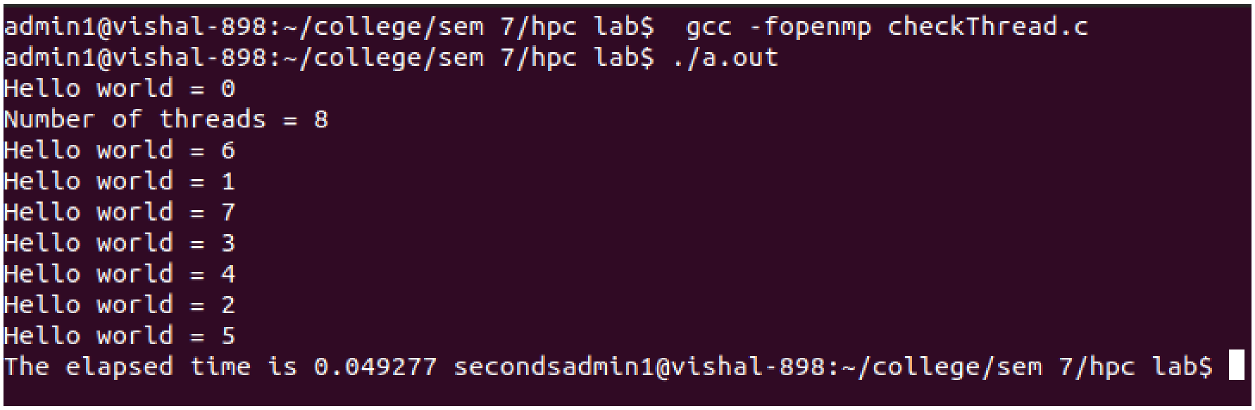
Generally the Hardware Threads are supported by the processor.

The hardware threads are mostly based on the muti-core architecture which is latest architecture to achieve high performance.

A multi-threaded application running on a traditional single-core chip would have to interleave the threads, as shown in Figure 4.3. On a multi-core chip, however, the threads could be spread across the available cores, allowing true parallel processing.

Q3. Program in OpenMP to print “Hello World”.

```
// OpenMP header
#include <omp.h>
#include <stdio.h>
#include <stdlib.h>

#include <time.h>

int main()
{
        int nthreads, tid;

        double time_spent = 0.0;

        clock_t begin = clock();
        // Begin of parallel region
        #pragma omp parallel private(nthreads, tid)
        {
                // Getting thread number
                tid = omp_get_thread_num();
                printf("Hello world = %d\n", tid);

                if (tid == 0) {

                        // Only master thread does this
                        nthreads = omp_get_num_threads();
                        printf("Number of threads = %d\n",
                            nthreads);
                }
        }

        clock_t end = clock();
        time_spent += (double)(end - begin) / CLOCKS_PER_SEC;
        printf("The elapsed time is %f seconds", time_spent);
}
```



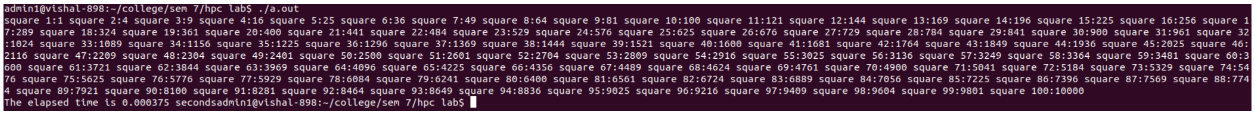
```
admin1@vishal-898:~/college/sem 7/hpc lab$  gcc -fopenmp checkThread.c
admin1@vishal-898:~/college/sem 7/hpc lab$ ./a.out
Hello world = 0
Number of threads = 8
Hello world = 6
Hello world = 1
Hello world = 7
Hello world = 3
Hello world = 4
Hello world = 2
Hello world = 5
The elapsed time is 0.049277 secondsadmin1@vishal-898:~/college/sem 7/hpc lab$ 
```

Q4. Find the squares of first 100 numbers followed by their sum. Compare the speed in sequential and parallel algorithm.

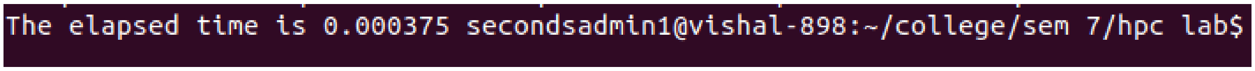
Sequential

```
// OpenMP header
#include <omp.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main()
{
        double time_spent = 0.0;

        clock_t begin = clock();


        long long sum = 0;
        for (int i = 1; i <= 100; i++)
        {
                long long z = i * i;
                printf("square %d:%lld ", i, z);
                sum += z;
        }
        printf("\n");
        clock_t end = clock();
        time_spent += (double)(end - begin) / CLOCKS_PER_SEC;
        printf("The elapsed time is %f seconds", time_spent);
```

}



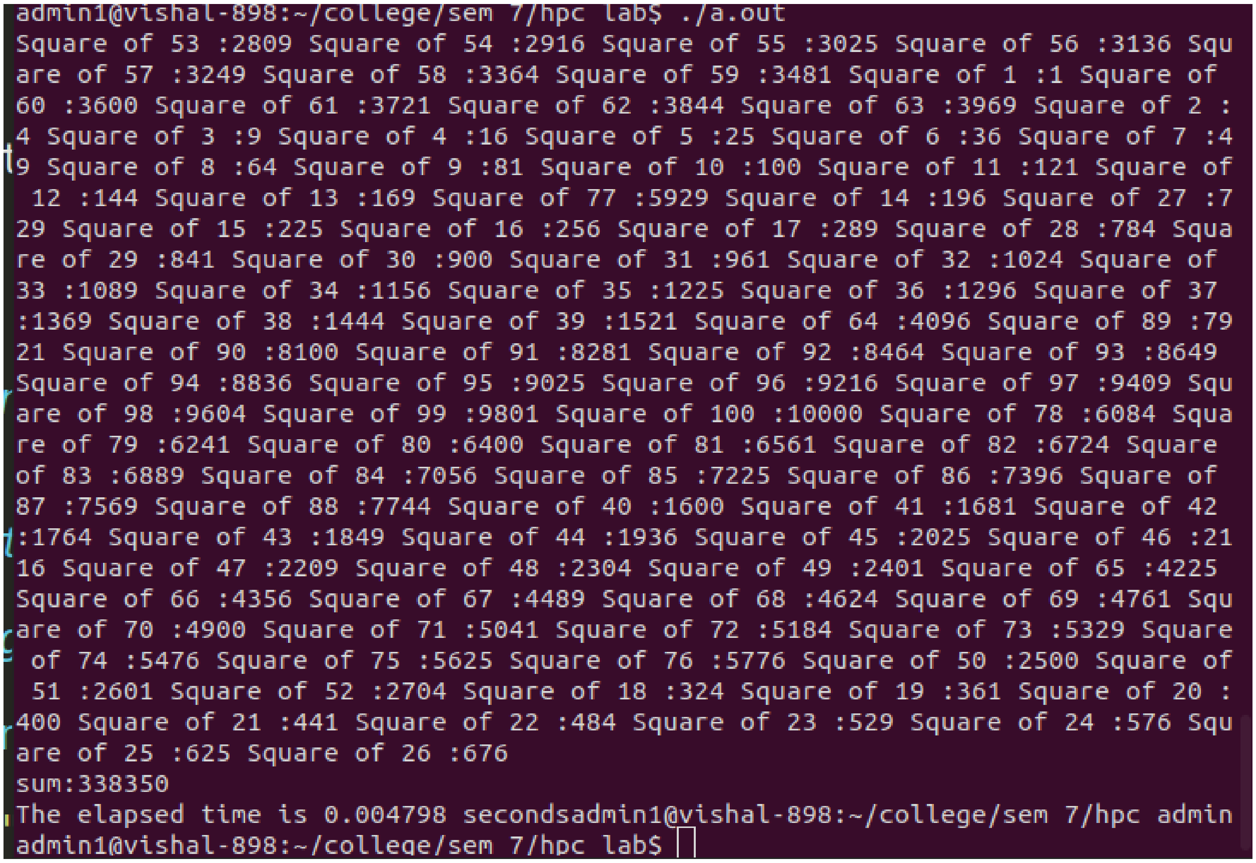
```
admin1@vishal-898:~/college/sem 7/hpc lab$ ./a.out
square 1:1 square 2:4 square 3:9 square 4:16 square 5:25 square 6:36 square 7:49 square 8:64 square 9:81 square 10:100 square 11:121 square 12:144 square 13:169 square 14:196 square 15:225 square 16:256 square 1
7:289 square 18:324 square 19:361 square 20:400 square 21:441 square 22:484 square 23:529 square 24:576 square 25:625 square 26:676 square 27:729 square 28:784 square 29:841 square 30:900 square 31:961 square 32
:1024 square 33:1089 square 34:1156 square 35:1225 square 36:1296 square 37:1369 square 38:1444 square 39:1521 square 40:1600 square 41:1681 square 42:1764 square 43:1849 square 44:1936 square 45:2025 square 46:
2116 square 47:2209 square 48:2304 square 49:2401 square 50:2500 square 51:2601 square 52:2704 square 53:2809 square 54:2916 square 55:3025 square 56:3136 square 57:3249 square 58:3364 square 59:3481 square 60:3
600 square 61:3721 square 62:3844 square 63:3969 square 64:4096 square 65:4225 square 66:4356 square 67:4489 square 68:4624 square 69:4761 square 70:4900 square 71:5041 square 72:5184 square 73:5329 square 74:54
76 square 75:5625 square 76:5776 square 77:5929 square 78:6084 square 79:6241 square 80:6400 square 81:6561 square 82:6724 square 83:6889 square 84:7056 square 85:7225 square 86:7396 square 87:7569 square 88:774
4 square 89:7921 square 90:8100 square 91:8281 square 92:8464 square 93:8649 square 94:8836 square 95:9025 square 96:9216 square 97:9409 square 98:9604 square 99:9801 square 100:10000
The elapsed time is 0.000375 secondsadmin1@vishal-898:~/college/sem 7/hpc lab$ 
```



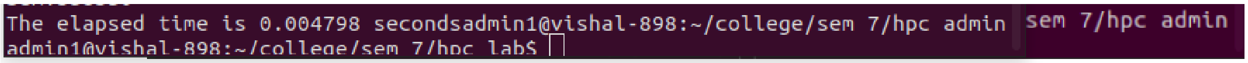
```
The elapsed time is 0.000375 secondsadmin1@vishal-898:~/college/sem 7/hpc lab$
```

Parallel

```
// OpenMP header
#include <omp.h>
#include <stdio.h>
#include <stdlib.h>

#include <time.h>
int main()
{
	double time_spent = 0.0;

	clock_t begin = clock();


	long long sum = 0;

	#pragma omp parallel for reduction( + : sum)
	for (int i = 1; i <= 100; i++)
	{
		long long z = i * i;
		sum += z;
		printf("Square of %d :%lld ", i, z);
	}
	printf("\n");
	printf("sum:%lld\n", sum);
	clock_t end = clock();
	time_spent += (double)(end - begin) / CLOCKS_PER_SEC;
	printf("The elapsed time is %f seconds", time_spent);
}
```



```
admin1@vishal-898:~/college/sem 7/hpc lab$ ./a.out
Square of 53 :2809 Square of 54 :2916 Square of 55 :3025 Square of 56 :3136 Squ
are of 57 :3249 Square of 58 :3364 Square of 59 :3481 Square of 1 :1 Square of
60 :3600 Square of 61 :3721 Square of 62 :3844 Square of 63 :3969 Square of 2 :
4 Square of 3 :9 Square of 4 :16 Square of 5 :25 Square of 6 :36 Square of 7 :4
9 Square of 8 :64 Square of 9 :81 Square of 10 :100 Square of 11 :121 Square of
 12 :144 Square of 13 :169 Square of 77 :5929 Square of 14 :196 Square of 27 :7
29 Square of 15 :225 Square of 16 :256 Square of 17 :289 Square of 28 :784 Squa
re of 29 :841 Square of 30 :900 Square of 31 :961 Square of 32 :1024 Square of
33 :1089 Square of 34 :1156 Square of 35 :1225 Square of 36 :1296 Square of 37
:1369 Square of 38 :1444 Square of 39 :1521 Square of 64 :4096 Square of 89 :79
21 Square of 90 :8100 Square of 91 :8281 Square of 92 :8464 Square of 93 :8649
Square of 94 :8836 Square of 95 :9025 Square of 96 :9216 Square of 97 :9409 Squ
are of 98 :9604 Square of 99 :9801 Square of 100 :10000 Square of 78 :6084 Squa
re of 79 :6241 Square of 80 :6400 Square of 81 :6561 Square of 82 :6724 Square
of 83 :6889 Square of 84 :7056 Square of 85 :7225 Square of 86 :7396 Square of
87 :7569 Square of 88 :7744 Square of 40 :1600 Square of 41 :1681 Square of 42
:1764 Square of 43 :1849 Square of 44 :1936 Square of 45 :2025 Square of 46 :21
16 Square of 47 :2209 Square of 48 :2304 Square of 49 :2401 Square of 65 :4225
Square of 66 :4356 Square of 67 :4489 Square of 68 :4624 Square of 69 :4761 Squ
are of 70 :4900 Square of 71 :5041 Square of 72 :5184 Square of 73 :5329 Square
 of 74 :5476 Square of 75 :5625 Square of 76 :5776 Square of 50 :2500 Square of
 51 :2601 Square of 52 :2704 Square of 18 :324 Square of 19 :361 Square of 20 :
400 Square of 21 :441 Square of 22 :484 Square of 23 :529 Square of 24 :576 Squ
are of 25 :625 Square of 26 :676
sum:338350
The elapsed time is 0.004798 secondsadmin1@vishal-898:~/college/sem 7/hpc admin
admin1@vishal-898:~/college/sem 7/hpc lab$ 
```



```
The elapsed time is 0.004798 secondsadmin1@vishal-898:~/college/sem 7/hpc admin   sem 7/hpc admin
admin1@vishal-898:~/college/sem 7/hpc lab$ 
```