

Operating Systems

Assignment 3

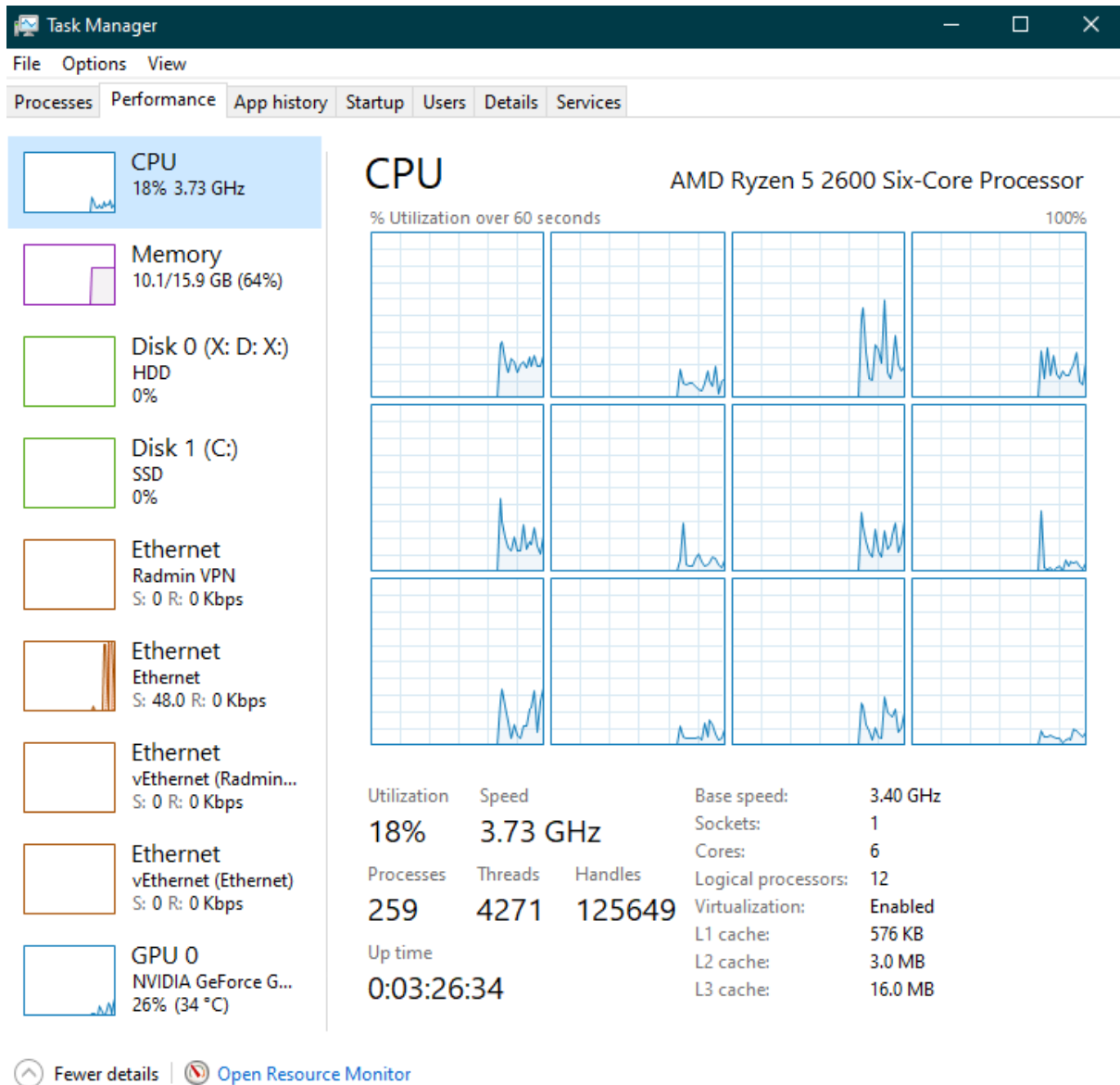


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Merge Sort using Threads

CPU Cores and Threads:

Our processor has 6 cores, and each core is capable of running 2 threads at one time.



Total Threads are 12, we will be utilizing them for our merge sort algorithm.

Merge Sort Code:

```
#include <iostream>
#include <thread>
#include <cstdlib>
#include <conio.h>
```

```

using namespace std;

// merge sort function taken from programmiz
https://www.programiz.com/dsa/merge-sort
void merge(int arr[], int left, int middle, int right)
{
    int l, m, r;    //indexes that we use to denote left right and center
    int n1 = middle - left + 1; //name of sub arrays we use for combining
    int n2 = right - middle;

    int* L = new int[n1];
    int* R = new int[n2];    //declaring the sub arrays

    for (l = 0; l < n1; l++)    //copying values of the array from sub
array to the combined array
        L[l] = arr[left + l];
    for (m = 0; m < n2; m++)
        R[m] = arr[middle + 1 + m];

    l = 0;
    m = 0;
    r = left;
    while (l < n1 && m < n2){    //logic to decide whether to combine
the index with left array or right array
        if (L[l] <= R[m]){
            arr[r] = L[l];
            l++;
        }
        else{
            arr[r] = R[m];
            m++;
        }
        r++;
    }

    while (l < n1){
        arr[r] = L[l];
        l++;
        r++;
    }

    while (m < n2){
        arr[r] = R[m];
        m++;
        r++;
    }
}

void mergeSort(int arr[], int left, int right){
    if (left < right){
        int middle = left + (right - left) / 2;

        //assign arrays to separate threads

```

```

        thread leftSorter(mergeSort, arr, left, middle);
        thread rightSorter(mergeSort, arr, middle + 1, right);

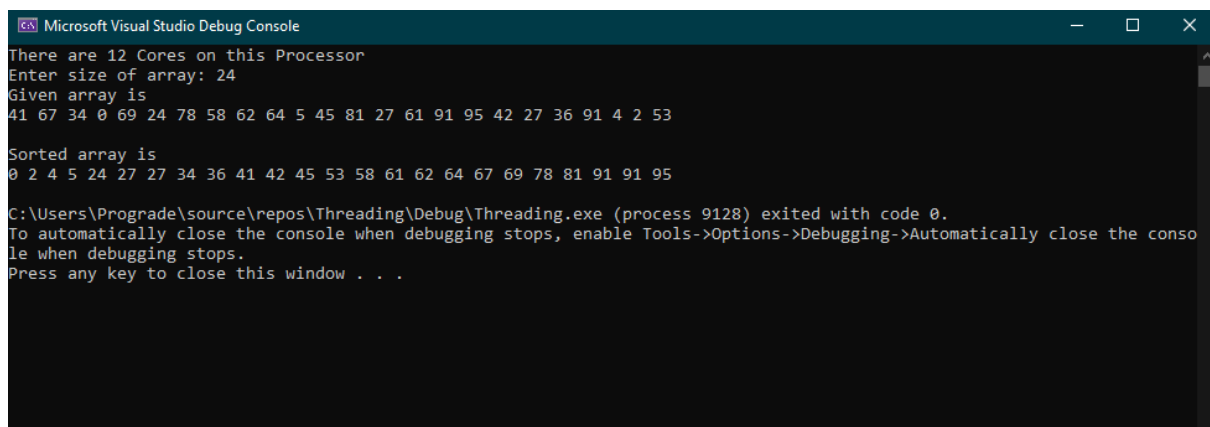
        //merge outputs after join
        leftSorter.join();
        rightSorter.join();
        merge(arr, left, middle, right);
    }
}

int main(){
    int* array1;
    int arr_size;
    cout << "There are 12 Cores on this Processor\n";
    cout << "Enter size of array: ";
    cin >> arr_size;
    array1 = new int[arr_size];
    for (int i = 0; i < arr_size; i++){
        array1[i] = (rand() % 100);
    }
    cout << "Given array is \n";
    for (int i = 0; i < arr_size; i++)
        cout << array1[i] << " ";
    cout << endl;

    mergeSort(array1, 0, arr_size - 1);

    cout << "\nSorted array is \n";
    for (int i = 0; i < arr_size; i++)
        cout << array1[i] << " ";
    cout << endl;
    return 0;
}

```



The screenshot shows the Microsoft Visual Studio Debug Console window. The output of the program is as follows:

```

There are 12 Cores on this Processor
Enter size of array: 24
Given array is
41 67 34 0 69 24 78 58 62 64 5 45 81 27 61 91 95 42 27 36 91 4 2 53

Sorted array is
0 2 4 5 24 27 27 34 36 41 42 45 53 58 61 62 64 67 69 78 81 91 91 95

C:\Users\Prograde\source\repos\Threading\Debug\Threading.exe (process 9128) exited with code 0.
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.
Press any key to close this window . . .

```

MAC Address for this System:

The screenshot displays two windows from a Windows 10 system. The Command Prompt window on the left shows the output of the 'ipconfig' command, detailing network settings for three adapters: Radmin VPN, Local Area Connection 2, and Ethernet. The Ethernet adapter section shows a link-local IPv6 address of fe80::1d2c:d954:87f8:b4b3%39 and an IPv4 address of 172.29.160.1. The Ethernet Status window on the right provides a graphical overview of the Ethernet connection, including connection status (Internet), media state (Enabled), and activity (Sent/Received bytes). Below the status window, the Network Connection Details window is open, showing a comprehensive list of network properties for the Ethernet adapter, including the physical address (MAC address) A8-A1-59-47-D3-02.

```
Microsoft Windows [Version 10.0.19041.1]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\Prograde>ipconfig

Windows IP Configuration

Ethernet adapter Radmin VPN:

    Connection-specific DNS Suffix  . : 
    IPv6 Address. . . . . : fdfd::1a23:98f5
    Link-local IPv6 Address . . . . . : fe80::84dc:f692:ddff:5cd3%9
    IPv4 Address. . . . . : 26.35.152.245
    Subnet Mask . . . . . : 255.0.0.0
    Default Gateway . . . . . : 26.0.0.1

Unknown adapter Local Area Connection 2:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : 
    IPv6 Address. . . . . : 2407:d000:f:652a:c5f5:d7d5:aea7:86a0
    Temporary IPv6 Address. . . . . : 2407:d000:f:652a:15bf:7f91:8fce:32c
    Link-local IPv6 Address . . . . . : fe80::c5f5:d7d5:aea7:86a0%8
    IPv4 Address. . . . . : 192.168.18.12
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : fe80::1%8
                             192.168.18.1

Unknown adapter Local Area Connection:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

Ethernet adapter vEthernet (Radmin VPN):

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::6820:1633:806d:90cd%35
    IPv4 Address. . . . . : 172.30.208.1
    Subnet Mask . . . . . : 255.255.240.0
    Default Gateway . . . . . : 

Ethernet adapter vEthernet (Ethernet):

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::1d2c:d954:87f8:b4b3%39
    IPv4 Address. . . . . : 172.29.160.1
    Subnet Mask . . . . . : 255.255.240.0
```

Ethernet Status

General

Connection

IPv4 Connectivity: Internet
IPv6 Connectivity: Internet
Media State: Enabled
Duration: 03:34:17
Speed: 1.0 Gbps

Details...

Activity

Sent — Received

Bytes: 42,716,696 | 328,891,756

Properties Disable Diagnose

Network Connection Details

Network Connection Details:

Property	Value
Connection-specific DN...	
Description	Realtek PCIe GbE Family Controller
Physical Address	A8-A1-59-47-D3-02
DHCP Enabled	Yes
IPv4 Address	192.168.18.12
IPv4 Subnet Mask	255.255.255.0
Lease Obtained	Wednesday, 28 December 2022 7:18
Lease Expires	Wednesday, 28 December 2022 11:4
IPv4 Default Gateway	192.168.18.1
IPv4 DHCP Server	192.168.18.1
IPv4 DNS Server	192.168.18.1
IPv4 WINS Server	
NetBIOS over Tcpip En...	Yes
IPv6 Address	2407:d000:f:652a:c5f5:d7d5:aea7:86
Temporary IPv6 Address	2407:d000:f:652a:15bf:7f91:8fce:32c
Link-local IPv6 Address	fe80::c5f5:d7d5:aea7:86a0%8

Close