

SIS – SoftUni Information Services

SIS is a combination of a Web Server and a MVC Framework. Ultimately it is designed to mimic Microsoft's IIS and ASP.NET Core. Following several Lab documents you will build all components of the SIS.

SIS: Handmade HTTP Server

Problems for exercises and homework for the [“C# Web Development Basics” course @ SoftUni](#).

Following to the end this document will help you to create your own very simple HTTP Server. Later in the course we will extend it by adding sessions, cookies etc. We will eventually build a MVC Framework, with which we can build MVC Web Application which will be hosted on the Handmade HTTP Server.

But before that, let's have a little practice on asynchronous tasks.

1. Chronometer

The Chronometer is one of the easiest examples of an asynchronous processes. Let's implement a simple Chronometer.

Create an interface IChronometer like this:

```
0 references
public interface IChronometer
{
    0 references
    string GetTime { get; }

    0 references
    List<string> Laps { get; }

    0 references
    void Start();

    0 references
    void Stop();

    0 references
    string Lap();

    0 references
    void Reset();
}
```

... and implement a class Chronometer, that implements it.

Implement a program which provides a Chronometer functionality, that responds to several commands from the user input:

start – starts counting time in milliseconds, seconds and minutes.

stop – stops the process of counting time, but the counted time remains.

lap – creates a lap at the current time.

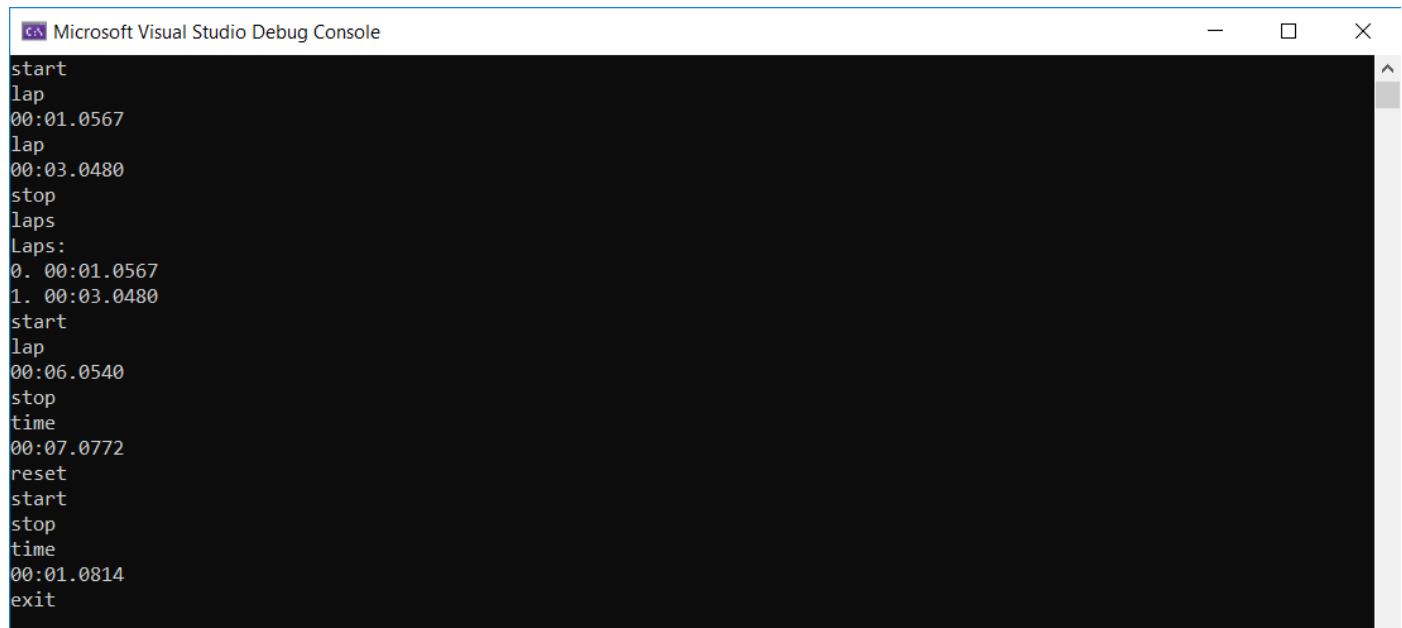
laps – returns all of the currently recorded laps.

time – returns the currently recorded time.

reset – stops the Chronometer, resets the currently recorded time and deletes all of the currently recoded laps.

exit – stops and exits the program.

Heres an example screenshot of the functionality:



```
start
lap
00:01.0567
lap
00:03.0480
stop
laps
Laps:
0. 00:01.0567
1. 00:03.0480
start
lap
00:06.0540
stop
time
00:07.0772
reset
start
stop
time
00:01.0814
exit
```

The time is outputted in the following format: "{minutes}:{seconds}:{milliseconds}", each of them should be **padding** with **zeros**.

Upon **making** a **lap** you should print the **time** at which it was made.

Requesting **all laps** should print them in the following format:

Laps:

0. {lap1}

1. {lap2}

...

In case there are no laps, you should print "**Laps: no laps**".

2. Parallel MergeSort

MergeSort is one of the fastest and most efficient sorting algorithms. It dissolves a collection into 2 halves and then dissolves each half into 2 halves, and so on it repeats the process, until the halves are made up of 1 element. Then it merges them back in a sorted way, eventually merging the whole collection back. It is a Divide and Conquer recursive algorithm. Due to its recursiveness, which essentially represents running several instances of the same process, it can be distributed into several threads – making it a parallel merge sort. A very fast algorithm in the hands of a casual processor.

- Implement a simple merge sort, you can find the algorithm's description and pseudocode anywhere in the net, but here's a [link](#).
- Here's a [link](#), for generating large sets of random numbers, in a formatted form, so that you can have test data. Test your algorithm with atleast **10000** elements.

Implement a Parallel MergeSort algorithm, but be careful, put a limit to the threads distribution. You don't want to put **int.MaxValue** threads into work, or your computer will hate you.

3. Asynchronous SIS WebServer

SIS.WebServer Project Architecture

The **WebServer Project** holds the main classes that **establish** the **connection** over **TCP Link**. These classes are used the ones from the **HTTP Project**. The Project expose several classes, which should be used from the outside, in order to **implement** an **application**.

Server class

The **Run()** method should be used to **start** the **listening process**. The listening process should be **asynchronous** to ensure **concurrent client functionality**.

```
public void Run()
{
    this.listener.Start();
    this.isRunning = true;

    Console.WriteLine(value: $"Server started at http://{LocalhostIpAddress}:{this.port}");

    while (this.isRunning)
    {
        Console.WriteLine(value: "Waiting for client...");

        var client = this.listener.AcceptSocketAsync().GetAwaiter().GetResult();

        Task.Run(() => this.Listen(client));
    }
}
```

We also have a little message notifying us that nothing has exploded brutally in the process.

The **Listen()** method is the main processing of the **client connection**:

```
public async Task Listen(Socket client)
{
    var connectionHandler = new ConnectionHandler(client, this.serverRoutingTable);
    await connectionHandler.ProcessRequestAsync();
}
```

ConnectionHandler class

The **ConnectionHandler** class is the **client connection processor**. It receives the **connection**, **extracts** the **request string data** from it, **processes** it **using** the **routing table**, and then **sends back** the **Response** in a byte format, throughout the **TCP link**.

```
public class ConnectionHandler
{
    private readonly Socket client;

    private readonly IServerRoutingTable serverRoutingTable;

    public ConnectionHandler(
        Socket client,
        IServerRoutingTable serverRoutingTable) ...

    public async Task ProcessRequestAsync() ...

    private async Task<IHttpRequest> ReadRequest() ...

    private IHttpResponse HandleRequest(IHttpRequest httpRequest) ...

    private async Task PrepareResponse(IHttpResponse httpResponse) ...
}
```

The **constructor** should just **initialize** the **socket** (the **wrapper object** for a **client connection**) and the **routing table**.

```
public ConnectionHandler(
    Socket client,
    IServerRoutingTable serverRoutingTable)
{
    CoreValidator.ThrowIfNull(client, name: nameof(client));
    CoreValidator.ThrowIfNull(serverRoutingTable, name: nameof(serverRoutingTable));

    this.client = client;
    this.serverRoutingTable = serverRoutingTable;
}
```

The **ProcessRequestAsync()** method is an **asynchronous** method which contains the main functionality of the class. It uses the other methods to **read** the **request**, **handle** it, **generate** a **response**, **send** it to the **client**, and finally, **close** the **connection**.

```
public async Task ProcessRequestAsync()
{
    try
    {
        var httpRequest = await this.ReadRequest();

        if (httpRequest != null)
        {
            Console.WriteLine(value: $"Processing: {httpRequest.RequestMethod} {httpRequest.Path}...");

            var httpResponse = this.HandleRequest(httpRequest);

            await this.PrepareResponse(httpResponse);
        }
    }
    catch (BadRequestException e)
    {
        await this.PrepareResponse(new TextResult(e.ToString(), HttpStatusCode.BadRequest));
    }
    catch (Exception e)
    {
        await this.PrepareResponse(new TextResult(e.ToString(),
            HttpStatusCode.InternalServerError));
    }

    this.client.Shutdown(how: SocketShutdown.Both);
}
```

The **ReadRequest()** method is an **asynchronous** method which reads the **byte data** from the **client connection**, **extracts** the **request string data** from it, and then **maps** it to a **HttpRequest** object.

```

private async Task<IHttpRequest> ReadRequest()
{
    var result = new StringBuilder();
    var data = new ArraySegment<byte>(array: new byte[1024]);

    while (true)
    {
        int numberOfBytesRead = await this.client.ReceiveAsync(data.Array, SocketFlags.None);

        if (numberOfBytesRead == 0)
        {
            break;
        }

        var bytesAsString = Encoding.UTF8.GetString(data.Array, index: 0, count: numberOfBytesRead);
        result.Append(bytesAsString);

        if (numberOfBytesRead < 1023)
        {
            break;
        }
    }

    if (result.Length == 0)
    {
        return null;
    }

    return new HttpRequest(result.ToString());
}

```

As you can see the **Requests** are quite limited to **1024 bytes**. This is intentional.

The **HandleRequest()** method checks if the **routing table** has a **handler** for the **given Request**, using the **Request's Method** and **Path**.

- If there is **no such handler** a “**Not Found**” **Response** is returned.
- If there is a **handler**, its **function** is **invoked**, and its resulting **Response** – returned.

```

private IHttpResponse HandleRequest(IHttpRequest httpRequest)
{
    if (!this.serverRoutingTable.Contains(httpRequest.RequestMethod, httpRequest.Path))
    {
        return new TextResult(content: $"Route with method {httpRequest.RequestMethod} and path \"{httpRequest.Path}\" not found.", HttpStatusCode.NotFound);
    }

    return this.serverRoutingTable.Get(httpRequest.RequestMethod, httpRequest.Path).Invoke(httpRequest);
}

```

The **PrepareResponse()** method **extracts** the **byte data** from the **Response**, and **sends** it to the **client**.

```

private async Task PrepareResponse(IHttpResponse httpResponse)
{
    byte[] byteSegments = httpResponse.GetBytes();

    await this.client.SendAsync(byteSegments, SocketFlags.None);
}

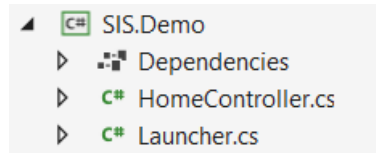
```

And with that we are finished with the **ConnectionHandler** and the **WebServer Project** as a whole. Now, before we embark on a journey to implement applications with our **SIS**. Let's first check a very simple **Hello World! Demo app**.

4. Hello, World!

Implement a third project called **SIS.Demo**. Reference both the **SIS.HTTP** and **SIS.WebServer** projects to it.

Create the following classes:



HomeController

The **HomeController** class should hold a single method – **Index()** which looks like this:

```
public class HomeController
{
    public IHttpResponse Index(IHttpRequest request)
    {
        string content = "<h1>Hello, World!</h1>";

        return new HtmlResult(content, HttpStatusCode.Ok);
    }
}
```

Launcher

The **Launcher** class should hold the **Main** method, which instantiates a **Server** and configures it to handle requests using the **ServerRoutingTable**.

Configure only the **"/** route with a **lambda function** which invokes the **HomeController.Index** method.

```
public static void Main(string[] args)
{
    IServerRoutingTable serverRoutingTable = new ServerRoutingTable();

    serverRoutingTable.Add(
        HttpRequestMethod.Get,
        path: "/",
        func: request => new HomeController().Index(request));

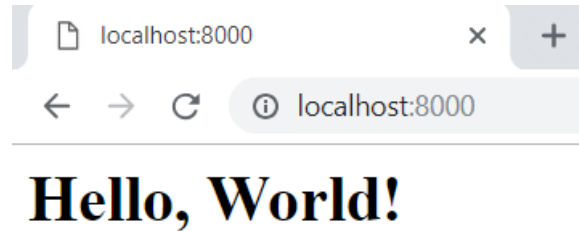
    Server server = new Server(port: 8000, serverRoutingTable);

    server.Run();
}
```

Now run the **SIS.Demo** project, and you should see this, if everything up until now was done correctly:

```
C:\WINDOWS\system32\cmd.exe
Server started at http://127.0.0.1:8000
```

Open your browser, then go to **localhost:8000**. And you should see this.



Congratulations! You have completed your async **Hello World app** with the **SIS**!