# DAD 2022-23

## Lab. 1 – Introduction to C# and gRPC

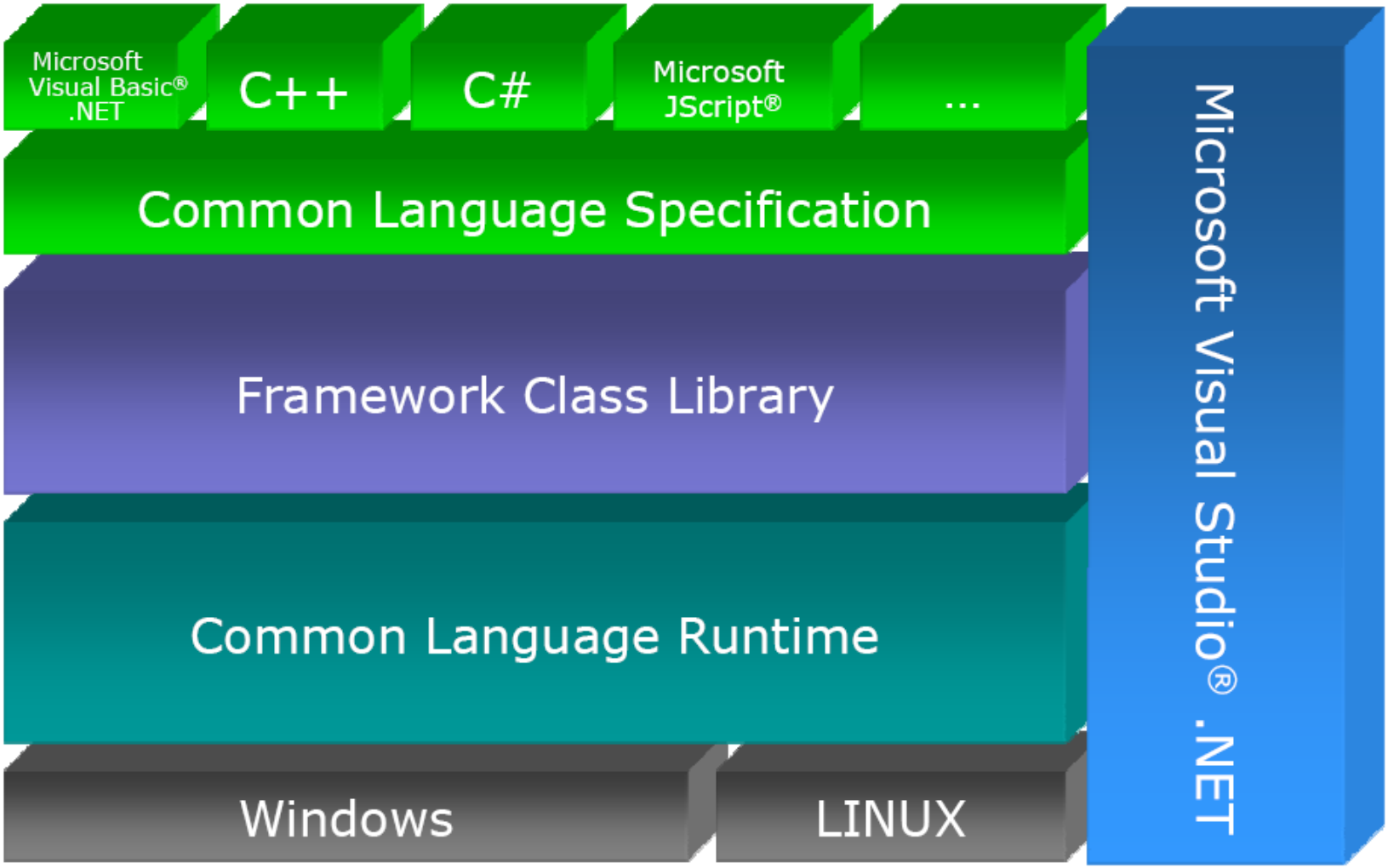
# Summary

1. .NET Framework
2. C# Language
3. IDE: MS Visual Studio
4. Asynchronous Programming
5. gRPC

# 1. .NET Framework

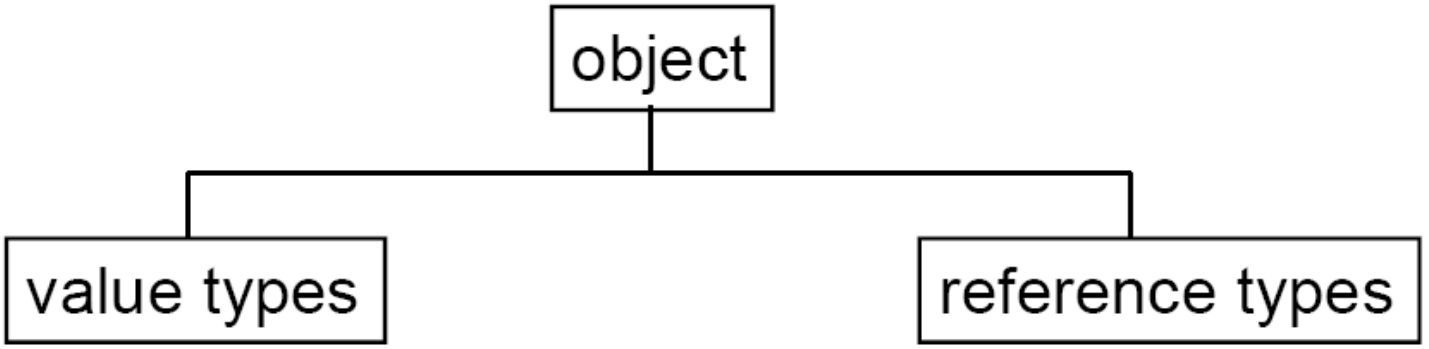
Introduction
Architecture

# .NET Framework Architecture



# Common Language Runtime

- Execution Environment
- Memory Management
- Garbage collection
- Common type system

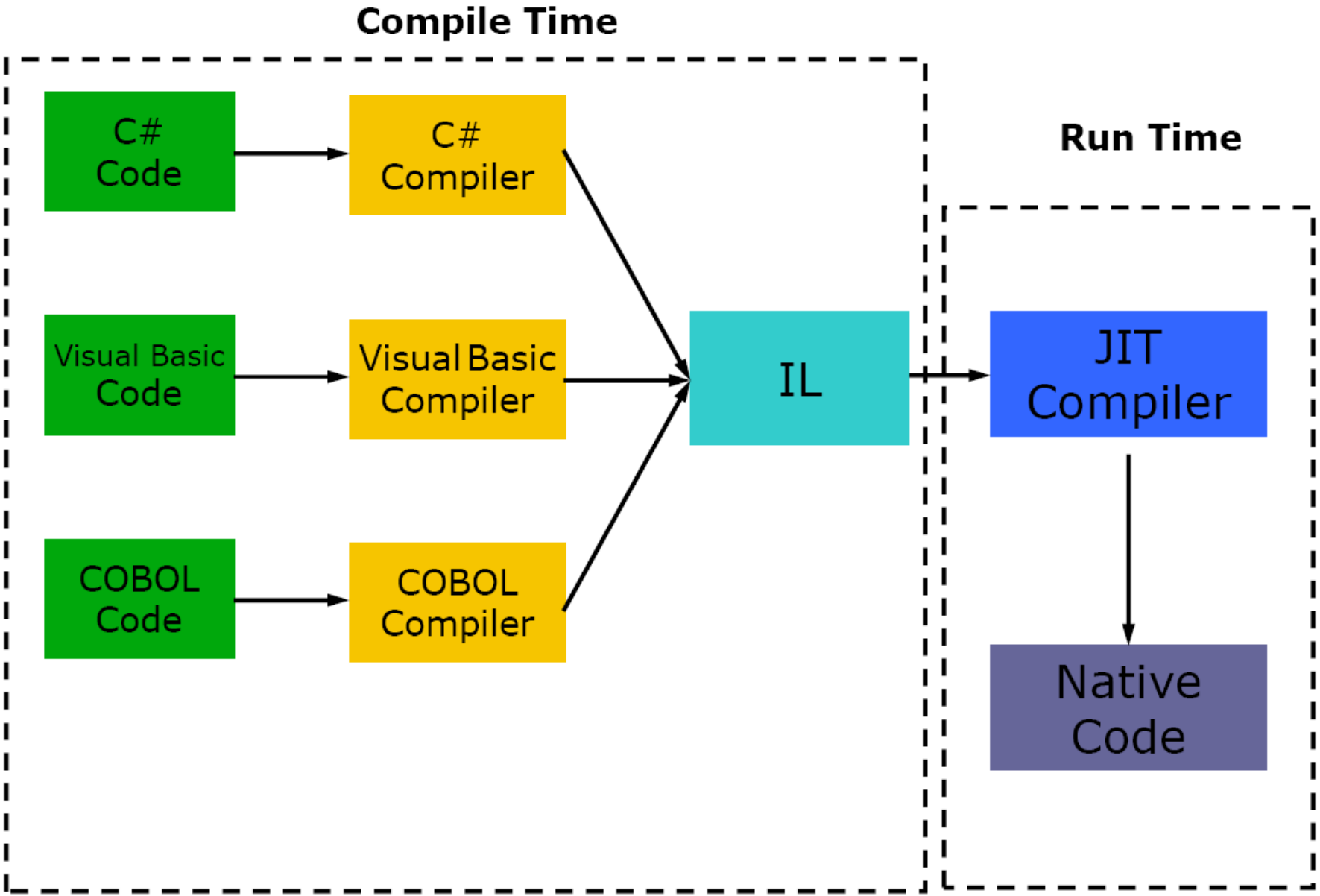



- Primitive types (int,double, tuples, etc..)
- Stack alocated
- Assignment copy values
- Freed at the block's end
- User-defined: struct, enum

- Classes, arrays, ...
- Alocated on heap
- Assignments don't copy values
- Garbage collected

## Framework Class Library

- System
- System.Collections
- System.Drawing
- System.IO
- System.Data
- System.Windows.Forms
- System.Web.UI
- System.Web.Services
- . . .


Compile Time
C# Code
C# Compiler
Visual Basic Code
Visual Basic Compiler
COBOL Code
COBOL Compiler
IL
Run Time
JIT Compiler
Native Code

# .NET: Main Advantages

- Virtual execution environment.
- Many libraries.
- APIs for web development.
- Language interoperability.
- New standard: C#

# C#

Basic Syntax:

It’s very similar to Java...

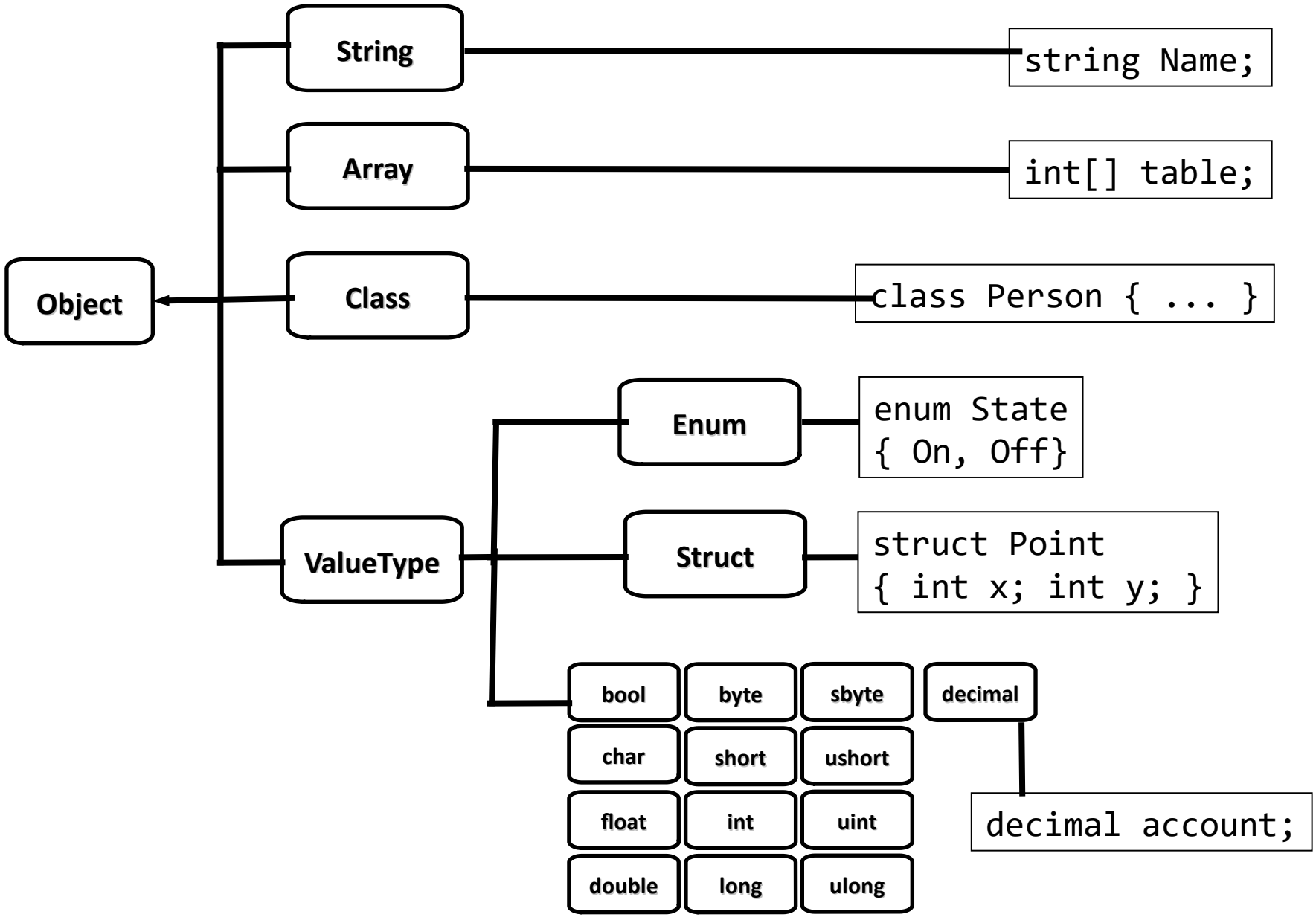
# Hello World

```
using System;

public class HelloWorld {
   public static void Main(string[]
   args) {
      Console.WriteLine(“Hello World!”);
   }
}
```

# A simple Class

```
public class Person {
   private string name;
   private int age;
   public Person(string name, int age) {
        this.name = name;
        this.age = age;
   }

public void ShowInfo() {
   Console.WriteLine(“{0} is {1} years old.”, name, age);
   }
}
[...]
Person client = new Person(“John”, 25);
client.ShowInfo();
```

# C#: Type System



# Execution Control

- if, for, do, while, switch, foreach…
- switch without fall-through (needs break, goto or return):
-

```
switch a {
case 2:
   x = 4;
   goto case 3
// explicit fall-through
case 3:
   ...
```

- Switch with pattern matching:

```
switch (shape) {
   case Square s:
        return s.Side * s.Side;
  case Circle c:
      return c.Radius * c.Radius *
   Math.PI;
}
```

# Classes

- Name hierarchy: `namespaces`
- Simple class inheritance.
- Multiple interface inheritance.
- Class members:
  - Fields, methods, properties, indexers, events,..
  - Access levels: `public, protected, internal, private`
  - Members can be `static` or instance.
  - `abstract` members also possible.

# C#: Inheritance

```
public class Person
{
  private string name;

  public Person(string name) {
    this.name = name;
  }

  public virtual void ShowInfo()
  {
    Console.WriteLine("Name:{0}",
      name);
  }
}
```

```
public class Employee : Person
{
  private string company;

  public Employee(string name,
                  int company)
    : base(name)
  {
    this.company = company;
  }

  public override void ShowInfo() {
    base.ShowInfo();
    Console.WriteLine("Company: {0}",
      company);
  }
}
```

- By default, methods are not virtual!

# C#: Lambda Expressions

A lambda is an anonymous function of the format:
(input-parameters) => expression
or
(input-parameters) => { <sequence-of-statements> }

```
// Example 1
Func<int, int, bool> testForEquality = (x, y) => x == y;
Console.WriteLine(testForEquality(4,4));

//Example 2
int[] numbers = { 2, 3, 4, 5 };
var squaredNumbers = numbers.Select(x => x * x);
```

# C# vs. Java

- **Support for less than one and more than one class per file.**
  - **Only one Main per assembly.** an executable, or a package/library
  - **Filename not related to contained classes.**
- **Output is an executable (.exe) or a library (.dll).**
- **`Namespaces` instead of `packages`.**
- goto
- Operator redefinition.
- Unsafe code.
- Passing value-types by reference using `ref`.
-

# Asynchronous Programming
# +
# Intro to G-RPC

# Async Programming

# Asynchronous Programming

- Asynchronous Programming allows abstract concurrent activities without Thread management.
- Async. Prog. uses the abstraction of **Tasks**.
- Tasks can be waited on until the asynchronous activity (e.g. I/O) is done.
- Tasks can be started explicitly on different threads.

# Task & Task<TResult>

- A Task represent an asynchronous operation.
- They can be waited on.
- Task<TResult> return a TResult.

```
  // Create a task and supply a user delegate by using a
lambda expression.
  Task taskA = new Task( () => Console.WriteLine("Hello  from
taskA."));
    // Start the task.
  taskA.Start();
  taskA.Wait();
```

# async

- Allows running code asynchronously on a runtime managed thread pool.
- Async methods can contain await-ed operations.
- Async methods return a Task or Task<TResult>
- See: https://docs.microsoft.com/en-us/dotnet/csharp/programming-guide/concepts/async/

# await

- Can be called on anything implementing the GetAwaiter method.
- Blocks the current thread until an asynchronous result is returned.
- For example:

```
Task<int> downloading =
DownloadWebpageAsync();
// do something else and then get the
results  int bytesLoaded = await
downloading;
```

# G-RPC in C#

# G-RPC Proto Buffers

- Specify the protocol between client and server: the service interfaces in a language agnostic syntax (see https://developers.google.com/protocol-buffers/docs/proto3)

```
syntax = "proto3";

service ChatServerService {

  rpc Register (ChatClientRegisterRequest) returns
 (ChatClientRegisterReply);

  }

message ChatClientRegisterRequest {

   string nick = 1;

string url = 2;

}

message ChatClientRegisterReply {

     bool ok = 1;

}
```

# Server (1)

- Implements Services described in Protobuf:

```
// ChatServerService is the namespace defined in the protobuf
   // ChatServerServiceBase is the generated base implementation of the service
   public class ServerService : ChatServerService.ChatServerServiceBase {
      // example of Server data structure
      Dictionary<string, string> clientMap = new Dictionary<string, string>();

      public ServerService() {
      }

      public override Task<ChatClientRegisterReply>
         Register(  ChatClientRegisterRequest request, ServerCallContext
         context) {  return Task.FromResult(Reg(request));
}
```

# Server (2)

```
  public ChatClientRegisterReply Reg(ChatClientRegisterRequest request) {
    lock (this) {
      clientMap.Add(request.Nick, request.Url);
    }
    return new ChatClientRegisterReply
    {
       Ok = true
    };
  }
}
```

# Server (3)

- Responds to client requests.
- Grpc.Core.Server is multithreaded!

```
static void Main(string[] args) {  int Port = 50051;
Server server = new Server
   {
      Services = { ChatServerService.BindService(new
                  ServerService()) },
      Ports = { new ServerPort("localhost", Port,
                  ServerCredentials.Insecure) }
   };
               server.Start();  Console.ReadKey();
                        server.ShutdownAsync().Wait();
                     }
```

# Client

- Can do calls to a server.
- Steps:
  - Disable HTTPS (optional):

```
AppContext.SetSwitch("System.Net.Http.SocketsHttpHand
 ler.Http2UnencryptedSupport", true);
```

  - Create Channel:

```
GrpcChannel channel =
GrpcChannel.ForAddress("http://localhost:50051");
```

  - Create Client:

```
var client = new
ChatServerService.ChatServerServiceClient(channel);
```

  - Do calls:

```
client.Register(registerRequest);
```

# Server Development

- Create Visual Studio Project
- Add code package (Tools->NuGet Package Manager):
  - Grpc.Core, which contains the .NET G-RPC Core.
  - Google.Protobuf, which contains protobuf message APIs for C#.
  - Grpc.Tools, which contains C# tooling support for protobuf files.
- Add proto folder and protobuf file
- Add protobuf to project by adding following line to the G-RPC ItemGroup in the project file:

```
<Protobuf Include="protos\ChatServices.proto"
 GrpcServices="Server" />
```

- Implement services
- Add server start code. Done! ;-)

# Client Development

- Create Visual Studio Project
- Add code packages (Tools->NuGet Package Manager):
  - Grpc.Net.Client, which contains the .NET Core client.
  - Google.Protobuf, which contains protobuf message APIs for C#.
  - Grpc.Tools, which contains C# tooling support for protobuf files.
- Add protos folder and copy of server protobuf file
- Define client namespace in protobuf file:

```
option csharp_namespace = "ChatClient";
```

- Add protobuf to project by adding following line to the G-RPC ItemGroup in the project file:

```
<Protobuf Include="Protos\ChatServices.proto"
GrpcServices="Client" />
```

- Add client code: create Channel, Client and server calls. Done! ;-)