API testing in C# with RestSharp

An open source workshop by …

Originally created by Bas Dijkstra - bas@ontestautomation.com - https://www.ontestautomation.com

What are we going to do?

_RESTful APIs

_RestSharp

_Hands-on exercises

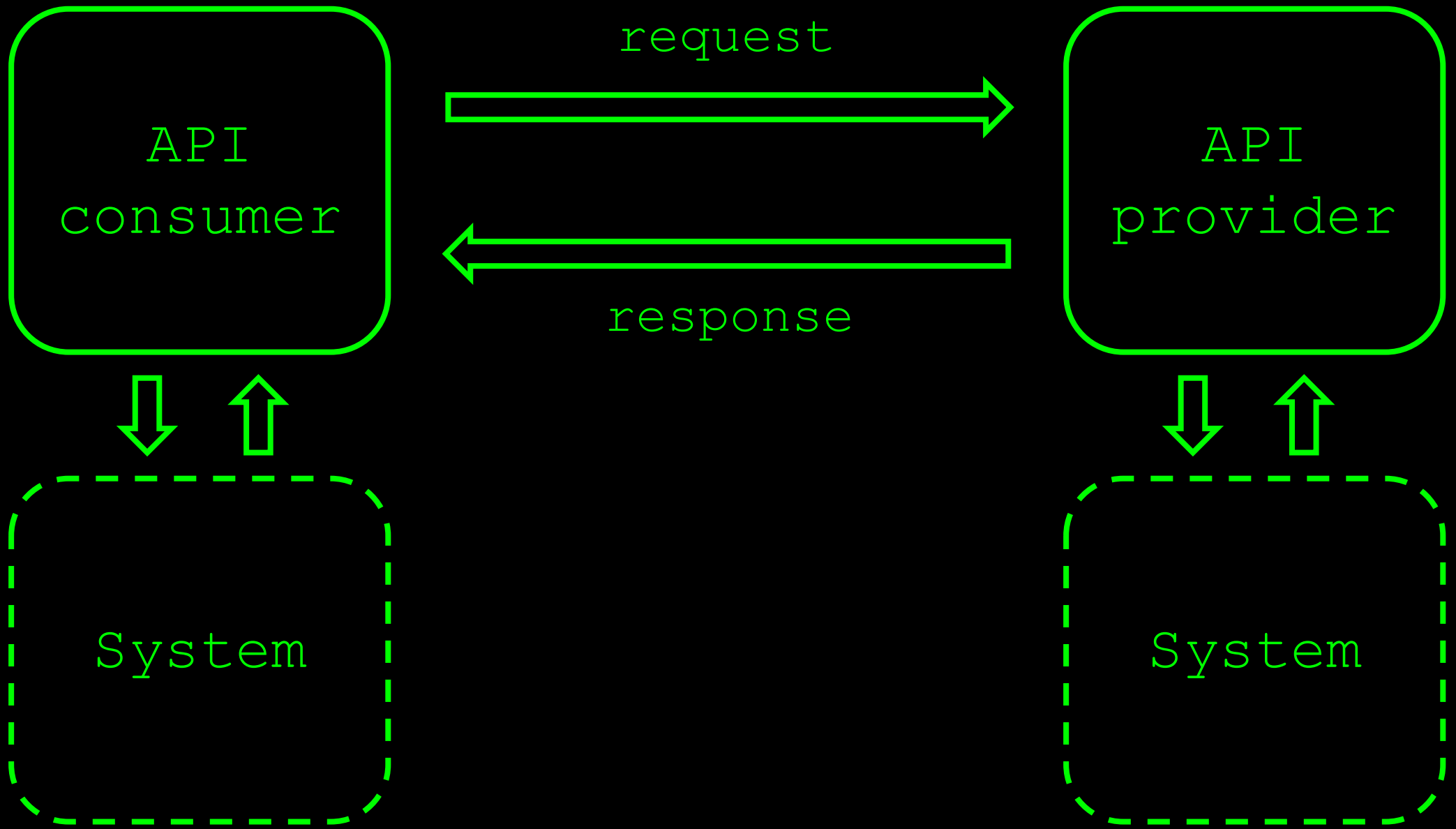
Preparation

_Install .NET 6

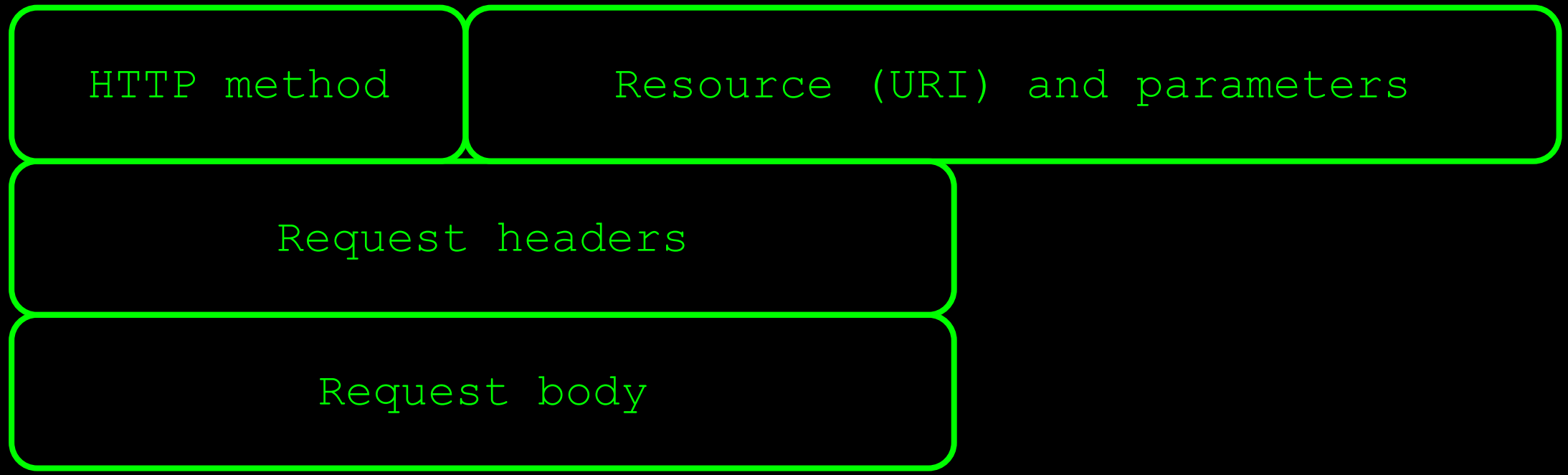
_Install Visual Studio 2022 (or any other IDE)

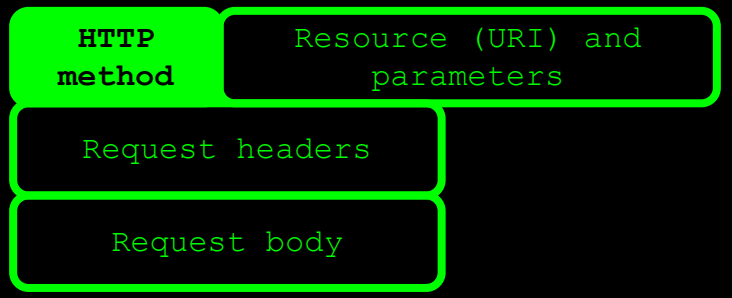
_Import project into your IDE
  _https://github.com/basdijkstra/restsharp-workshop

(RESTful) APIs are commonly used to exchange data between two parties


API
consumer
request
response
API
provider
System
System

A REST API request





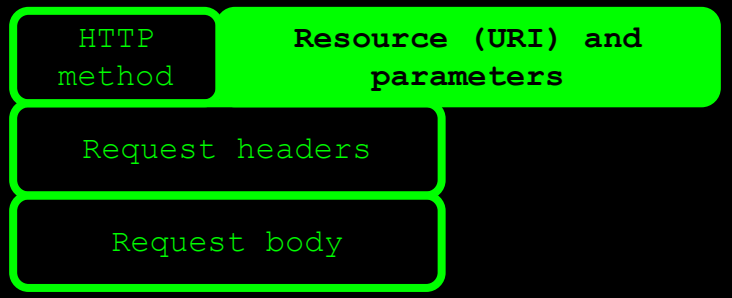
HTTP methods

_GET, POST, PUT, PATCH, DELETE, OPTIONS, …

_CRUD operations on data

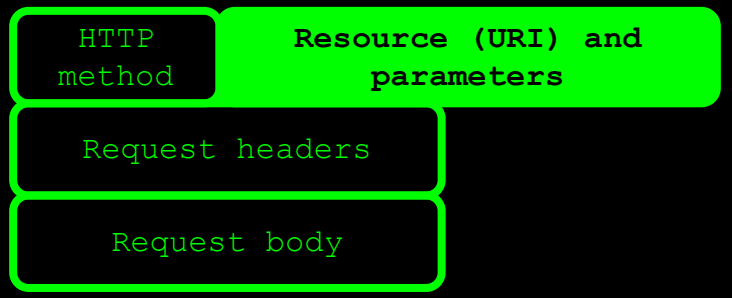
POST	Create
GET	Read
PUT / PATCH	Update
DELETE	Delete
…	…

_Conventions, not standards!



Resources and parameters

- Uniform Resource Identifier
- Uniquely identifies the resource to operate on
- Can contain parameters
  - Query parameters
  - Path parameters

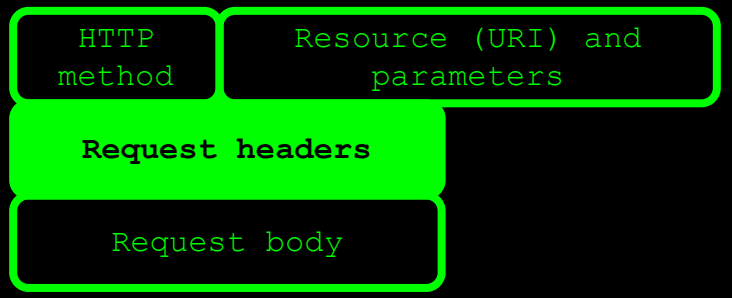


Resources and parameters

- Path parameters
  - http://api.zippopotam.us/us/90210
  - http://api.zippopotam.us/ca/B2A

- Query parameters
  - http://md5.jsontest.com/?text=testcaseOne
  - http://md5.jsontest.com/?text=testcaseTwo

- There is no official standard!

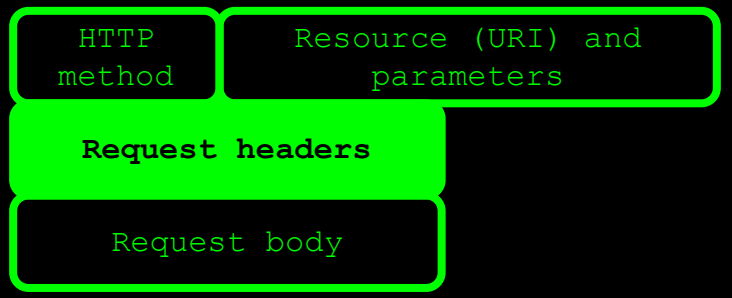


Request headers

- Key-value pairs

- Can contain metadata about the request body
  - Content-Type (what data format is the request body in?)
  - Accept (what data format would I like the response body to be in?)
  - …

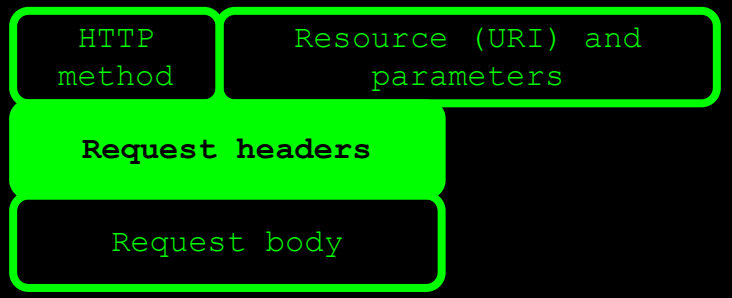
- Can contain session and authorization data
  - Cookies
  - Authorization tokens
  - …



Authorization: Basic

- Username and password sent with every request
- Base64 encoded (not really secure!)
- Ex: username = aladdin and password = opensesame

Authorization: Basic YWxhZGRpbjpvcGVuc2VzYW1l



Authorization: Bearer

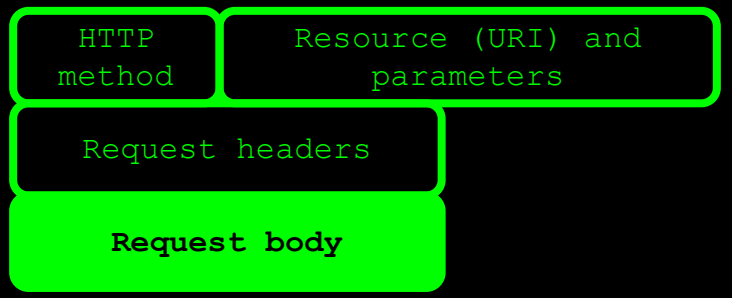
_Token with limited validity is obtained first

_Token is then sent with all subsequent requests

_Most common mechanism is OAuth(2)

_JWT is a common token format

Authorization: Bearer RsT5OjbzRn430zqMLgV3Ia



Request body

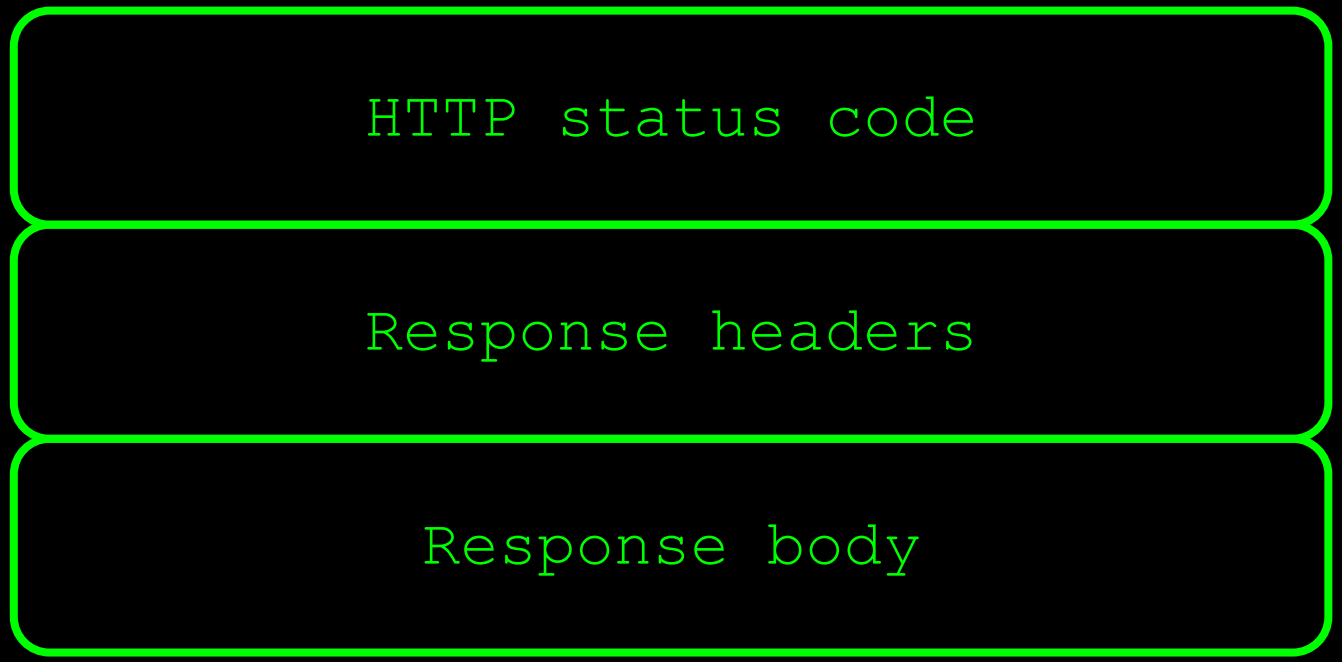
_Data to be sent to the provider

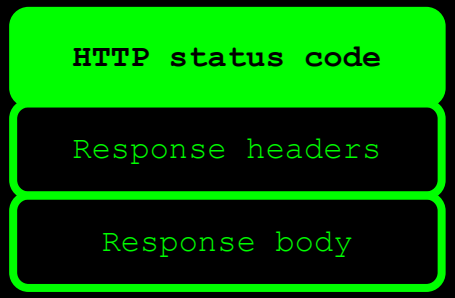
_REST does not prescribe a specific data format

_Most common:
  _JSON
  _XML
  _Plain text

_Other data formats can be sent using REST, too

A REST API response



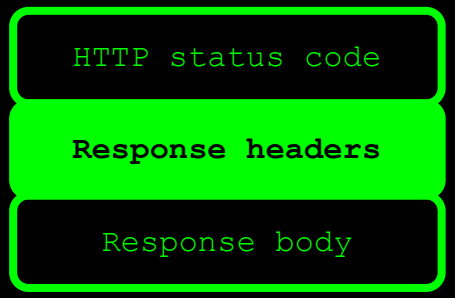


HTTP status code

_Indicates result of request processing by provider

_Five different categories

_1XX	Informational	100 Continue
_2XX	Success	200 OK
_3XX	Redirection	301 Moved Permanently
_4XX	Client errors	400 Bad Request
_5XX	Server errors	503 Service Unavailable

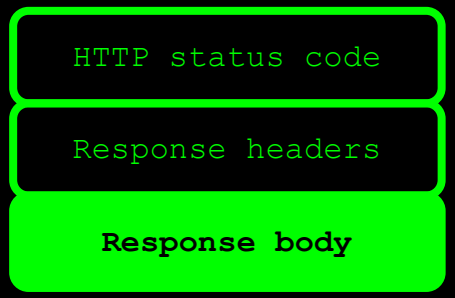


Response headers

- Key-value pairs

- Can contain metadata about the response body
  - Content-Type (what data format is the response body in?)
  - Content-Length (how many bytes in the response body?)

- Can contain provider-specific data
  - Caching-related headers
  - Information about the server type



Response body

_Data returned by the provider

_REST does not prescribe a specific data format

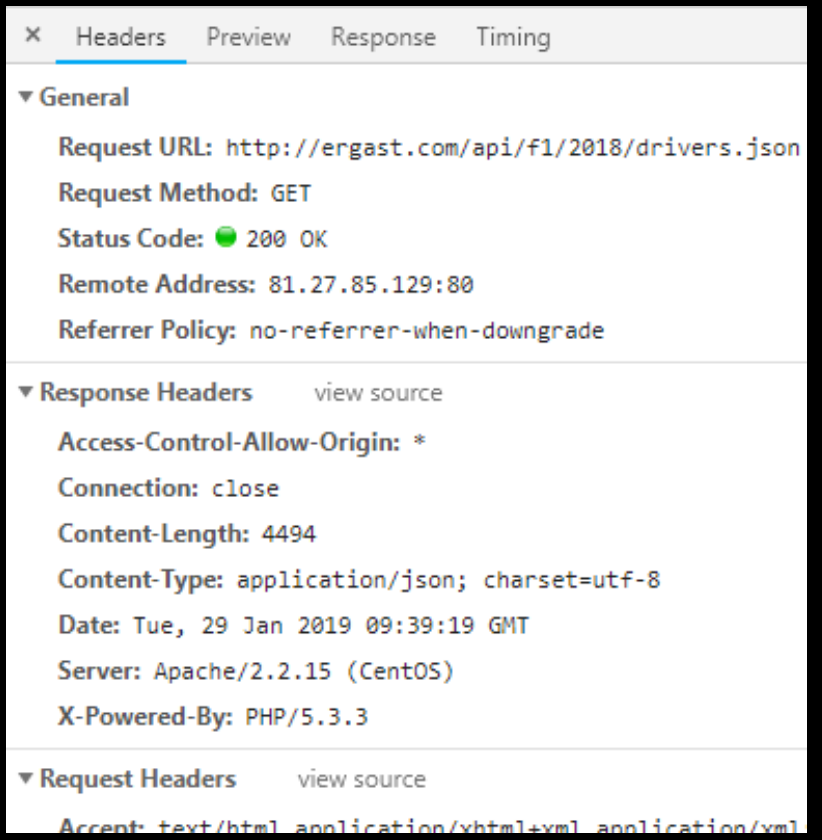
_Most common:
  _JSON
  _XML
  _Plain text

_Other data formats can be sent using REST, too

An example

_GET http://ergast.com/api/f1/2018/drivers.json

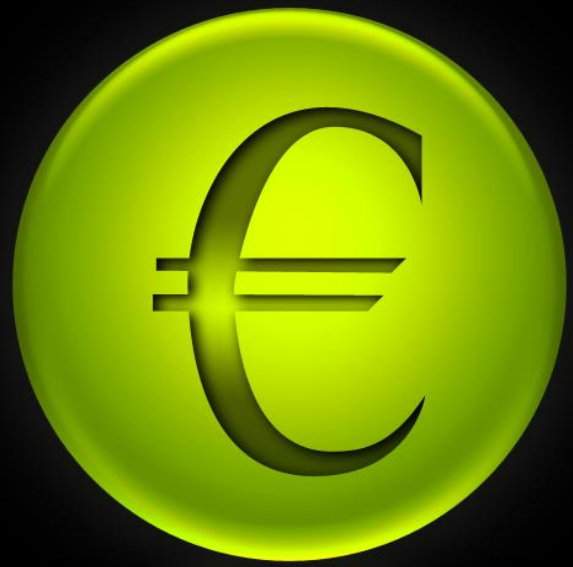

```
{
  - MRData: {
        xmlns: "http://ergast.com/mrd/1.4",
        series: "f1",
        url: "http://ergast.com/api/f1/2018/drivers.json",
        limit: "30",
        offset: "0",
        total: "20",
      - DriverTable: {
            season: "2018",
          - Drivers: [
              - {
                    driverId: "alonso",
                    permanentNumber: "14",
                    code: "ALO",
                    url: "http://en.wikipedia.org/wiki/Fernando_Alonso",
                    givenName: "Fernando",
                    familyName: "Alonso",
                    dateOfBirth: "1981-07-29",
                    nationality: "Spanish"
                },
              - {
                    driverId: "bottas",
                    permanentNumber: "77",
                    code: "BOT"
```

Where are APIs used?

Mobile

Internet of Things



API economy

Where are APIs used?

Web applications

Microservices architectures

Why I ♥ testing at the API level

_Tests run much faster than UI-driven tests

_Tests are much more stable than UI-driven tests

_Tests have a broader scope than unit tests

_Business logic is often exposed at the API level

Tools for testing RESTful APIs

- Free / open source
  - Postman
  - SoapUI
  - Code libraries like REST Assured, RestSharp, requests
  - …
- Commercial
  - Parasoft SOAtest
  - SoapUI Pro
  - …
- Build your own (using HTTP libraries for your language of choice)

RestSharp

- C# library for writing tests for RESTful APIs
- Removes the need for a lot of boilerplate code
- Works with all common unit testing frameworks
  - NUnit, MSTest, xUnit
- https://restsharp.dev/

Configuring RestSharp

_Install as a NuGet package

Hello, World!

```
// The base URL for our example tests
private const string BASE_URL = "http://jsonplaceholder.typicode.com";

// The RestSharp client we'll use to make our requests
private RestClient client;

[OneTimeSetUp]
0 references
public void SetupRestSharpClient()
{
    client = new RestClient(BASE_URL);
}

[Test]
0 references
public async Task GetDataForUser1_CheckStatusCode_ShouldBeHttpOK()
{
    RestRequest request = new RestRequest("/users/1", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    Assert.That(response.StatusCode, Is.EqualTo(HttpStatusCode.OK));
}
```

Create a RestClient that performs the HTTP calls

Initialize the client with a base URL (and potential other common properties such as headers, etc.)

We're using NUnit here (could also be MSTest, xUnit, …)

Create a request using an endpoint and the HTTP method to be used

Execute the HTTP call (async!)

Check the response HTTP status code

Checking status code as an int

```
[Test]
0 references
public async Task GetDataForUser1_CheckStatusCode_ShouldBeHttp200()
{
    RestRequest request = new RestRequest("/users/1", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    Assert.That((int)response.StatusCode, Is.EqualTo(200));
}
```

You can cast the HttpStatusCode enum value to an integer if you prefer to do that / think that this is easier to read

Checking response content type

```
[Test]
0 references
public async Task GetDataForUser2_CheckContentType_ShouldBeApplicationJson()
{
    RestRequest request = new RestRequest("/users/2", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    Assert.That(response.ContentType, Does.Contain("application/json"));
}
```

The ContentType property of the RestResponse object contains the response content type (application/json, application/xml, …)

Checking other header values

```
[Test]
0 references
public async Task GetDataForUser3_CheckServerHeader_ShouldBeCloudflare()
{
    RestRequest request = new RestRequest("/users/3", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    string serverHeaderValue = response.Headers
        .Where(x => x.Name.Equals("Server"))
        .Select(x => x.Value.ToString())
        .FirstOrDefault();

    Assert.That(serverHeaderValue, Is.EqualTo("cloudflare"));
}
```

The Headers property of the RestResponse object is a collection of all response headers.

LINQ queries are very useful here to select the header(s) you're looking for.

Checking response body values

```
[Test]
0 references
public async Task GetDataForUser4_CheckName_ShouldBePatriciaLebsack()
{
    RestRequest request = new RestRequest("/users/4", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    JObject responseData = JObject.Parse(response.Content);

    Assert.That(responseData.SelectToken("name").ToString(), Is.EqualTo("Patricia Lebsack"));
}
```

First, parse the response Content property (a string) to a JObject

Then, use SelectToken() to retrieve a specific JSON element value from the JSON structure and convert it to a string to assert on its value

Checking response body values

```
[Test]
0 references
public async Task GetDataForUser5_CheckCompanyName_ShouldBeKeeblerLLC()
{
    RestRequest request = new RestRequest("/users/5", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    JObject responseData = JObject.Parse(response.Content);

    Assert.That(responseData.SelectToken("company.name").ToString(), Is.EqualTo("Keebler LLC"));
}
```

The argument to SelectToken is a JSONPath query, so you can select nested elements or even collections of elements, too. See https://www.newtonsoft.com/json/help/html/SelectToken.htm for more details

Our API under test

_(Simulation of) an online banking API

_Customer data (GET, POST)

_Account data (POST, GET)

_RESTful API

Demo

_How to use the test suite

_Executing your tests

_Reviewing test results

Now it's your turn!

_Exercises > Exercises01.cs

_Simple checks
  _Verifying status codes and header values
  _Verifying JSON response body elements

_Answers are in Answers > Answers01.cs

_Examples are in Examples > Examples01.cs

Parameters in RESTful APIs

- Path parameters
  - http://api.zippopotam.us/us/90210
  - http://api.zippopotam.us/ca/B2A

- Query parameters
  - http://md5.jsontest.com/?text=testcaseOne
  - http://md5.jsontest.com/?text=testcaseTwo

- There is no official standard!

Using path parameters

- Straightforward string interpolation works fine

```
public async Task GetDataForUser_CheckName_ShouldEqualExpectedName_UsingTestCase
    (int userId, string expectedName)
{
    RestRequest request = new RestRequest($"/users/{userId}", Method.Get);
```

- Alternatively, you can make the path parameter usage more explicit by using AddUrlSegment()

```
public async Task GetDataForUser_CheckName_ShouldEqualExpectedName_UsingTestCase_Explicit
    (int userId, string expectedName)
{
    RestRequest request = new RestRequest("/users/{userId}", Method.Get);

    request.AddUrlSegment("userId", userId);
```

Exchange data between consumer and provider

GET to retrieve data from provider, POST to send data to provider, …

APIs are all about data

Business logic and calculations often exposed through APIs

Run the same test more than once…

… for different combinations of input and expected output values

Parameterized testing

More efficient to do this at the API level…

… as compared to doing this at the UI level

This is more of a unit testing framework feature than a feature of RestSharp!

‘Feeding’ test data to your test

Define test cases using the [TestCase] attribute, and don’t forget to include a clear test name

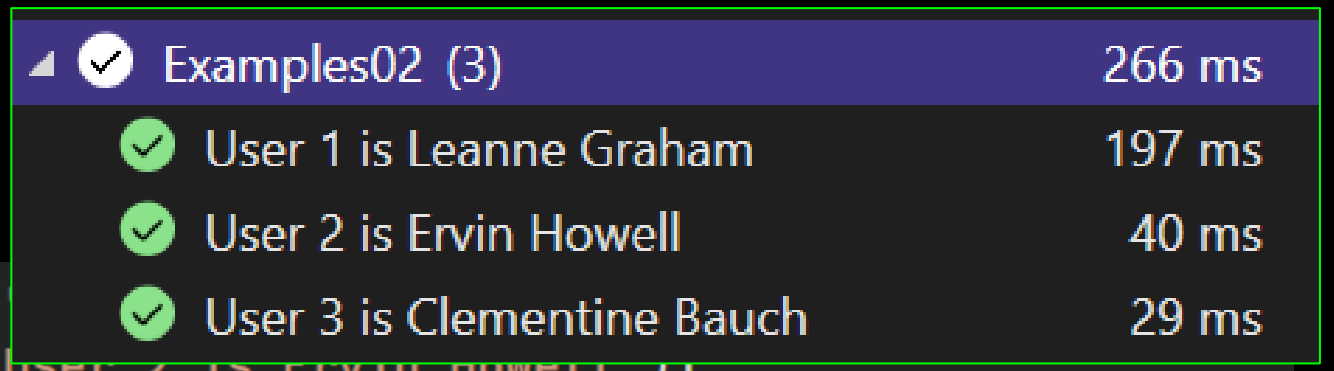
```
[TestCase(1, "Leanne Graham", TestName = "User 1 is Leanne Graham")]
[TestCase(2, "Ervin Howell", TestName = "User 2 is Ervin Howell")]
[TestCase(3, "Clementine Bauch", TestName = "User 3 is Clementine Bauch")]
0 references
public async Task GetDataForUser_CheckName_ShouldEqualExpectedName_UsingTestCase
    (int userId, string expectedName)
{
    RestRequest request = new RestRequest($"/users/{userId}", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    JObject responseData = JObject.Parse(response.Content);

    Assert.That(responseData.SelectToken("name").ToString(), Is.EqualTo(expectedName));
}
```

Use parameters to pass the test data values into the method

Use parameters in the test method where required

Running the data driven test

The test method is run three times, once for each array ('test case') in the test data set




```
[TestCase(1, "Leanne Graham", TestName =
[TestCase(2, "Ervin Howell", TestName = "
[TestCase(3, "Clementine Bauch", TestName = "User 3 is Clementine Bauch")]
0 references
public async Task GetDataForUser_CheckName_ShouldEqualExpectedName_UsingTestCase
    (int userId, string expectedName)
{
    RestRequest request = new RestRequest($"/users/{userId}", Method.Get);

    RestResponse response = await client.ExecuteAsync(request);

    JObject responseData = JObject.Parse(response.Content);

    Assert.That(responseData.SelectToken("name").ToString(), Is.EqualTo(expectedName));
}
```

Alternative: use TestCaseSource

```
[Test, TestCaseSource("UserData")]
0 references
public async Task GetDataForUser_CheckName_ShouldEqualExpectedName_UsingTestCaseSource
    (int userId, string expectedName)
{
    RestRequest request = new RestRequest($"/users/{userId}", Method.Get);
```

Use the [TestCaseSource] attribute (the test method body is the same as the previous example)

Define a static method with the parameter value passed to [TestCaseSource] as its name. The method should return an object of type IEnumerable<TestCase>

```
private static IEnumerable<TestCaseData> UserData()
{
    yield return new TestCaseData(1, "Leanne Graham").
        SetName("User 1 is Leanne Graham - using TestCaseSource");
    yield return new TestCaseData(2, "Ervin Howell").
        SetName("User 2 is Ervin Howell - using TestCaseSource");
    yield return new TestCaseData(3, "Clementine Bauch").
        SetName("User 3 is Clementine Bauch - using TestCaseSource");
}
```

Use *yield* to return new TestCaseData instances one by one. Test names can be set using .SetName() - make sure these are unique!

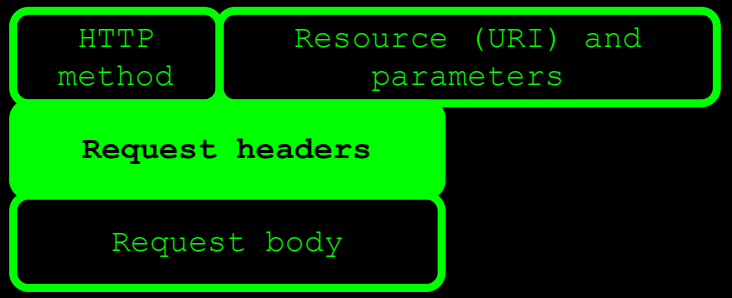
Now it's your turn!

_Exercises > Exercises02.cs

_Create data driven tests
  _Use the [TestCase] attribute
  _Use the [TestCaseSource] attribute and a private static
  _method yielding new TestCaseData instances

_Answers are in Answers > Answers02.cs

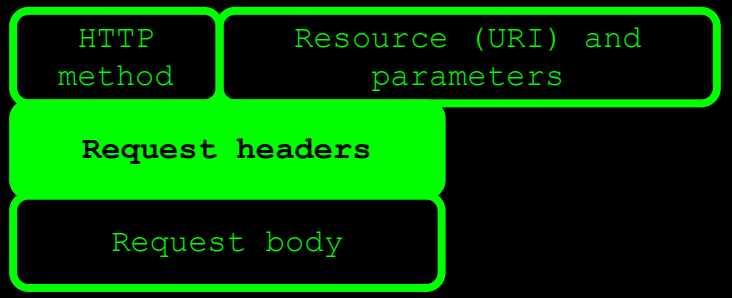
_Examples are in Examples > Examples02.cs



Authorization: Basic

- Username and password sent with every request
- Base64 encoded (not really secure!)
- Ex: username = aladdin and password = opensesame

Authorization: Basic YWxhZGRpbjpvcGVuc2VzYW1l



Authorization: Bearer

_Token with limited validity is obtained first

_Token is then sent with all subsequent requests

_Most common mechanism is OAuth(2)

_JWT is a common token format

Authorization: Bearer RsT5OjbzRn430zqMLgV3Ia

Authentication in RestSharp

Set up basic authentication when creating the RestClient

```
var options = new RestClientOptions(BASE_URL)
{
    Authenticator = new HttpBasicAuthenticator("username", "password")
};

var client = new RestClient(options);
```

Set up OAuth2 (token-based) authentication when creating the RestClient

```
var options = new RestClientOptions(BASE_URL)
{
    Authenticator = new OAuth2AuthorizationRequestHeaderAuthenticator("access_token", "Bearer")
};

var client = new RestClient(options);
```

Now it's your turn!

_Exercises > Exercises03.cs

_Use authentication mechanisms
  _Create RestClient objects with authentication options
  _Get a token using basic auth
  _Extract token from response and store it
  _Reuse token in OAuth2

_Answers are in Answers > Answers03.cs

_Examples are in Examples > Examples03.cs

(De-)serialization of POCOs

- RestSharp is able to convert C# object instances directly to JSON (and XML) and back

- Useful when dealing with test data objects
  - Creating request body payloads
  - Processing response body payloads

Example: serialization

_POCO representing a Post object (think blog posts)

```
public class Post
{
    [JsonProperty("userId")]
    1 reference | 0/1 passing
    public int UserId { get; set; }
    [JsonProperty("title")]
    1 reference | 0/1 passing
    public string Title { get; set; }
    [JsonProperty("body")]
    1 reference | 0/1 passing
    public string Body { get; set; }
}
```

RestSharp respects the [JsonProperty] attribute from Newtonsoft.Json, so you can use these to map C# property names to their JSON element equivalents

Example: serialization

```
[Test]
0 references
public async Task PostNewPost_CheckStatusCode_ShouldBeHttpCreated()
{
    Post post = new Post
    {
        UserId = 1,
        Title = "My new post title",
        Body = "This is the body of my new post"
    };

    RestRequest request = new RestRequest($"/posts", Method.Post);

    request.AddJsonBody(post);

    RestResponse response = await client.ExecuteAsync(request);

    Assert.That(response.StatusCode, Is.EqualTo(HttpStatusCode.Created));
}
```

Create a new object in your test and assign the desired property values

```
{
    "userId": 1,
    "title": "My new post title",
    "body": "This is the body…"
}
```

Add that object as the request payload using AddJsonBody() and RestSharp handles the rest for you

HTTP 201 (Created) is a typical HTTP status code for a successful POST operation

Example: deserialization

This tells RestSharp to try and deserialize the response body to an object of type User (which is another POCO like Post from the previous example)

```
[Test]
0 references
public async Task GetDataForUser1_CheckName_ShouldEqualLeanneGraham()
{
    RestRequest request = new RestRequest($"/users/1", Method.Get);

    RestResponse<User> response = await client.ExecuteAsync<User>(request);

    User user = response.Data;

    Assert.That(user.Name, Is.EqualTo("Leanne Graham"));
}
```

This extracts the deserialized response body into its own object

You can now refer to specific properties of the POCO like you would do with any other regular C# object

Now it's your turn!

_Exercises > Exercises04.cs

_Practice serialization by sending an Account object

_Practice deserialization by extracting an API response into a C# object

_Answers are in Answers > Answers04.cs

_Examples are in Examples > Examples04.cs

A challenge with ‘traditional’ REST APIs

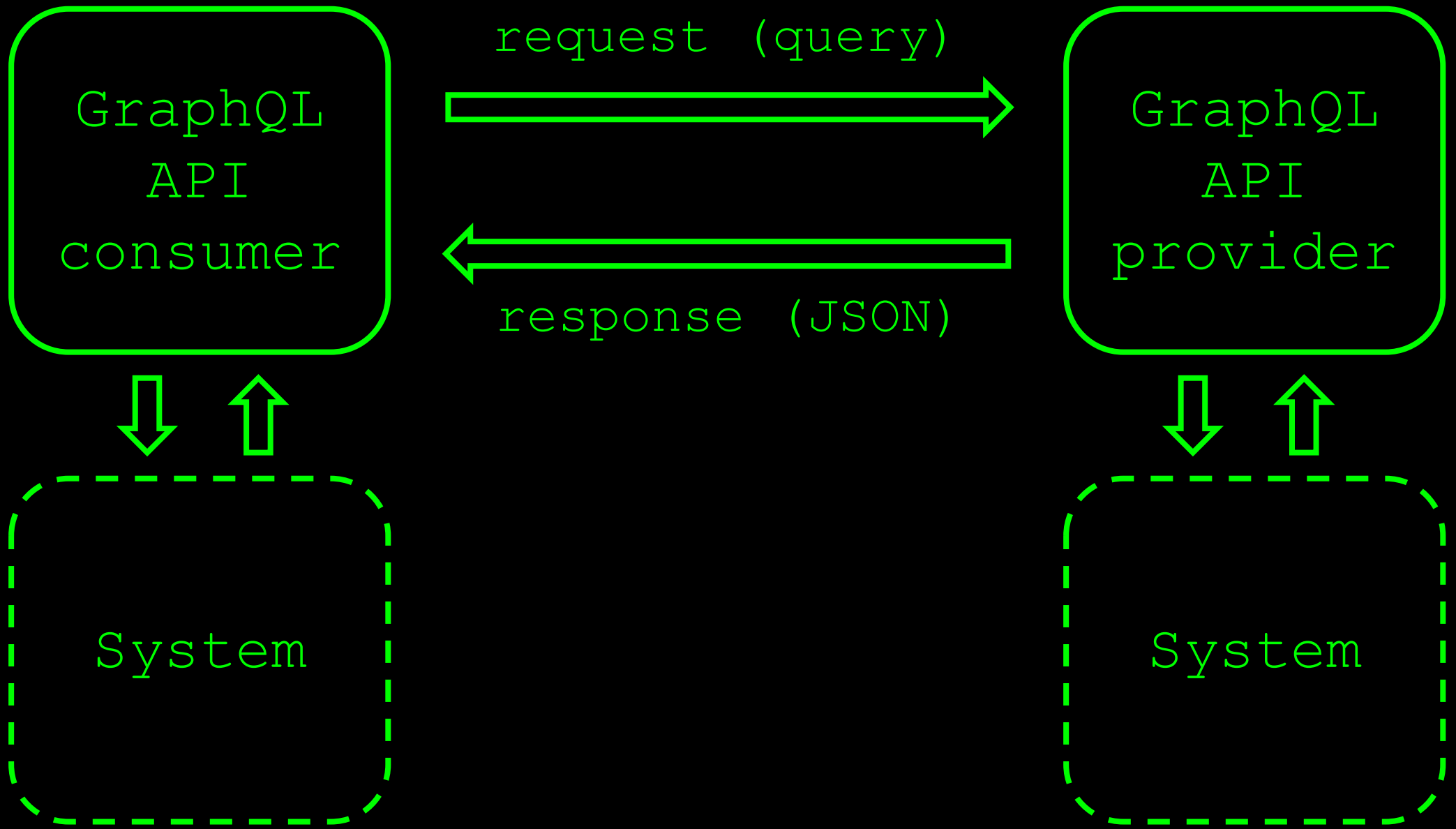
Query language for APIs…

… as well as a runtime to fulfill them

GraphQL

"Ask for what you need,
and get exactly that"

https://graphql.org


GraphQL API consumer
request (query)
response (JSON)
GraphQL API provider
System
System

Create a valid GraphQL query…

… and send it in the request body (*query*)

Sending a GraphQL query

"Ask for what you need,
and get exactly that"

These are ‘regular’ REST responses, with…

… an HTTP status code, …

GraphQL API responses

… response headers…

… and a JSON response body
containing the requested data

Sending a basic GraphQL query

```
string query = @"
    {
        getCityByName(name: ""Amsterdam"") {
            weather {
                summary {
                    title
                }
            }
        }
    }
";
```

The query can be a simple (multiline) string

We've seen how to serialize and send the payload in the previous section

```
public class GraphQLQuery
{
    [JsonProperty("query")]
    2 references | 1/1 passing
    public string Query { get; set; }
    [JsonProperty("variables")]
    1 reference
    public string Variables { get; set; }
}
```

Using this POCO simplifies creating the GraphQL payload

```
GraphQLQuery graphQLQuery = new GraphQLQuery
{
    Query = query,
};

RestRequest request = new RestRequest("/", Method.Post);

request.AddJsonBody(graphQLQuery);

RestResponse response = await client.ExecuteAsync(request);

JObject responseData = JObject.Parse(response.Content);

Assert.That(
    responseData.SelectToken("data.getCityByName.weather.sum
    Is.EqualTo("Clouds")
);
```

A GraphQL API response is plain JSON

Parameterizing GraphQL queries

```
string query = @"
    query GetWeatherForCity($name: String!)
    {
        getCityByName(name: $name) {
            weather {
                summary {
                    title
                }
            }
        }
    }
";
```

GraphQL queries can be parameterized, too

```
var variables = new
{
    name = "Amsterdam"
};

GraphQLQuery graphQLQuery = new GraphQLQuery
{
    Query = query,
    Variables = JsonConvert.SerializeObject(variables)
};
```

Values for these variables can be sent to a GraphQL API in JSON format, which we're doing here by serializing an anonymous type object

A data driven GraphQL test

As we've done with 'regular' REST APIs, we can use this to create a data driven GraphQL test.

This example checks the weather in Amsterdam, Berlin and Rome.

```
[TestCase("Amsterdam", "Clouds", TestName = "In Amsterdam the weather is cloudy")]
[TestCase("Berlin", "Clouds", TestName = "In Berlin the weather is cloudy")]
[TestCase("Rome", "Clear", TestName = "In Rome the weather is clear")]
0 references
public async Task GetWeatherForAmsterdam_CheckSummaryTitle_UsingParameterizedQuery
    (string city, string expectedWeather)
{
    string query = @"
        query GetWeatherForCity($name: String!)
        {
            getCityByName(name: $name) {
                weather {
                    summary {
                        title
                    }
                }
            }
        }
    ";

    var variables = new
    {
        name = city
    };

    GraphQLQuery graphQLQuery = new GraphQLQuery
    {
        Query = query,
        Variables = JsonConvert.SerializeObject(variables)
    };
```

Now it's your turn!

_Exercises > Exercises05.cs

_Work with the SpaceX GraphQL API
  _Create and send a fixed (static) GraphQL query and assert on the response
  _Create a parameterized GraphQL query and use that in a data driven GraphQL API test

_Answers are in Answers > Answers05.cs

_Examples are in Examples > Examples05.cs

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