.NET Core开发日志——RequestDelegate

本文主要是对.NET Core开发日志——Middleware的补遗，但是会从看起来平平无奇的RequestDelegate开始叙述，所以以其作为标题，t[illegible]情合理。

RequestDelegate是一种委托类型，其全貌为public delegate Task RequestDelegate(HttpContext context)，MSDN上对它的解释，"A[illegible]tion that process an HTTP request."——处理HTTP请求的函数。唯一参数，是最熟悉不过的HttpContext，返回值则是表示请求处理完成的异步操[illegible]。

可以将其理解为ASP.NET Core中对一切HTTP请求处理的抽象(委托类型本身可视为函数模板，其实现具有统一的参数列表及返回值类型)，[illegible]整个框架[illegible]对HTTP请求的处理能力。

并且它也是构成Middleware的基石。或者更准确地说参数与返回值都是其的Func<RequestDelegate, RequestDelegate>委托类型正是维[illegible]ddleware心齿轮。

组装齿轮的地方位于ApplicationBuilder类之内，其中包含着所有齿轮的集合。

```
private readonly IList<Func<RequestDelegate, RequestDelegate>> _components = new List<Func<RequestDelegate, RequestDelegate>>();
```

以及添加齿轮的方法：

```
public IApplicationBuilder Use(Func<RequestDelegate, RequestDelegate> middleware)
{
    _components.Add(middleware);
    return this;
}
```

在Startup类的Configure方法里调用以上ApplicationBuilder的Use方法，就可以完成一个最简单的Middleware。

```
public void Configure(IApplicationBuilder app)
{
    app.Use(_ =>
    {
        return context =>
        {
            return context.Response.WriteAsync("Hello, World!");
        };

    });
}
```

齿轮要想变成Middleware，在完成添加后，还需要经过组装。

```
public RequestDelegate Build()
{
    RequestDelegate app = context =>
    {
        context.Response.StatusCode = 404;
        return Task.CompletedTask;
    };

    foreach (var component in _components.Reverse())
    {
        app = component(app);
    }

    return app;
```

```
}
```

Build方法里先定义了最底层的零件——app，context => { context.Response.StatusCode = 404; return Task.CompletedTask; }，这段意味着，如添加任何Middleware的话，ASP.NET Core站点启动后，会直接出现404的错误。

接下的一段，遍历倒序排列的齿轮，开始正式组装。

在上述例子里，只使用了一个齿轮：

```
_ =>
{
    return context =>
    {
        return context.Response.WriteAsync("Hello, World!");
    };

}
```

那么第一次也是最后一次循环后，执行component(app)操作，app被重新赋值为：

```
context => context.Response.WriteAsync("Hello, World!");
```

组装的结果便是app的值。

这个组装过程在WebHost进行BuildApplication时开始操作。从此方法的返回值类型可以看出，虽然明义上是创建Application，其实生成的是RequestDe

```
private RequestDelegate BuildApplication()
{
    try
    {
        ...

        var builderFactory = _applicationServices.GetRequiredService<IApplicationBuilderFactory>();
        var builder = builderFactory.CreateBuilder(Server.Features);
        ...
        Action<IApplicationBuilder> configure = _startup.Configure;
        ...

        configure(builder);

        return builder.Build();
    }
    ...
}
```

而这个RequestDelegate最终会在HostingApplication类的ProcessRequestAsync方法里被调用。

```
public virtual async Task StartAsync(CancellationToken cancellationToken = default)
{
    ...

    var application = BuildApplication();

    ...
    var hostingApp = new HostingApplication(application, _logger, diagnosticSource, httpContextFactory);
    ...
}

public HostingApplication(
    RequestDelegate application,
    ILogger logger,
```

```
    DiagnosticListener diagnosticSource,
    IHttpContextFactory httpContextFactory)
{
    _application = application;
    _diagnostics = new HostingApplicationDiagnostics(logger, diagnosticSource);
    _httpContextFactory = httpContextFactory;
}

public Task ProcessRequestAsync(Context context)
{
    return _application(context.HttpContext);
}
```

上例中的执行结果即是显示Hello, World!字符。

404的错误不再出现，意味着这种Middleware只会完成自己对HTTP请求的处理，并不会将请求传至下一层的Middleware。

要想达成不断传递请求的目的，需要使用另一种Use扩展方法。

```
public static IApplicationBuilder Use(this IApplicationBuilder app, Func<HttpContext, Func<Task>, Task> middleware)
{
    return app.Use(next =>
    {
        return context =>
        {
            Func<Task> simpleNext = () => next(context);
            return middleware(context, simpleNext);
        };
    });
}
```

在实际代码中可以这么写：

```
public void Configure(IApplicationBuilder app)
{
    app.Use(async (context, next) =>
    {
        await context.Response.WriteAsync("I am a Middleware!\n");
        await next.Invoke();
    });

    app.Use(_ =>
    {
        return context =>
        {
            return context.Response.WriteAsync("Hello, World!");
        };
    });
}
```

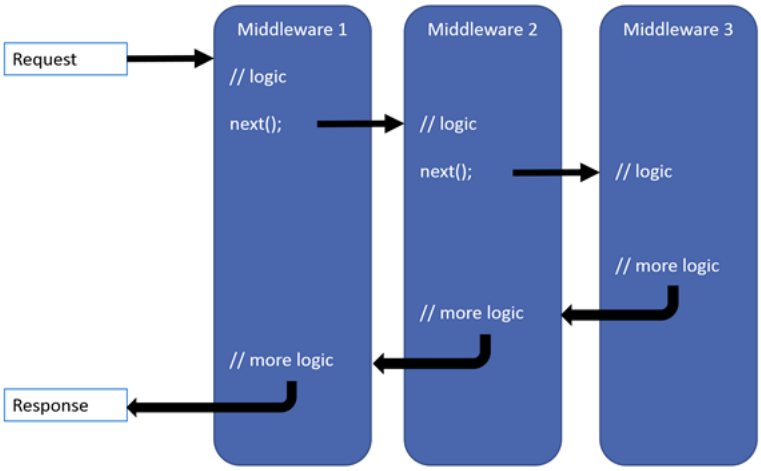
现在多了个Middleware，继续上面的组装过程。app的值最终被赋值为：

```
async context =>
{
    Func<Task> simpleNext = () => context.Response.WriteAsync("Hello, World!");

    await context.Response.WriteAsync("I am a Middleware!\n");
    await simpleNext.Invoke();
};
```

显示结果为：

```
I am a Middleware!
Hello, World!
```

下面的流程图中可以清楚地说明这个过程。



如果把await next.Invoke()注释掉的话，

```
public void Configure(IApplicationBuilder app)
{
    app.Use(async (context, next) =>
    {
        await context.Response.WriteAsync("I am a Middleware!\n");
        //await next.Invoke();
    });

    app.Use(_ =>
    {
        return context =>
        {
            return context.Response.WriteAsync("Hello, World!");
        };

    });
}
```

上例中第一个Middleware处理完后，不会继续交给第二个Middleware处理。注意以下simpleNext的方法只被定义而没有被调用。

```
async context =>
{
    Func<Task> simpleNext = () => context.Response.WriteAsync("Hello, World!");

    await context.Response.WriteAsync("I am a Middleware!\n");
};
```

这种情况被称为短路(short-circuiting)。

做短路处理的Middleware一般会放在所有Middleware的最后，以作为整个pipeline的终点。

并且更常见的方式是用Run扩展方法。

```
public static void Run(this IApplicationBuilder app, RequestDelegate handler)
{
    ...
```

```
    app.Use(_ => handler);
}
```

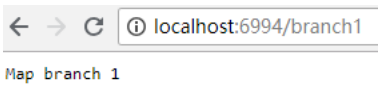
所以可以把上面例子的代码改成下面的形式：

```
public void Configure(IApplicationBuilder app)
{
    app.Use(async (context, next) =>
    {
        await context.Response.WriteAsync("I am a Middleware!\n");
        await next.Invoke();
    });

    app.Run(async context =>
    {
        await context.Response.WriteAsync("Hello, World!");
    });
}
```

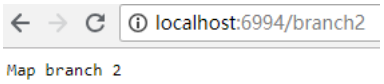
除了短路之外，Middleware处理时还可以有分支的情况。

```
public void Configure(IApplicationBuilder app)
{
    app.Map("/branch1", ab => {
        ab.Run(async context =>
        {
            await context.Response.WriteAsync("Map branch 1");
        });
    });

    app.Map("/branch2", ab => {
        ab.Run(async context =>
        {
            await context.Response.WriteAsync("Map branch 2");
        });
    });

    app.Use(async (context, next) =>
    {
        await context.Response.WriteAsync("I am a Middleware!\n");
        await next.Invoke();
    });

    app.Run(async context =>
    {
        await context.Response.WriteAsync("Hello, World!");
    });
}
```

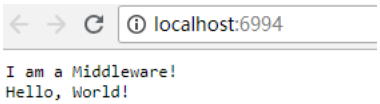
URL地址后面跟着branch1时：



URL地址后面跟着branch2时：



其它情况下：



Map扩展方法的代码实现：

```
public static IApplicationBuilder Map(this IApplicationBuilder app, PathString pathMatch, Action<IApplicationBuilder> configuration)
{
    ...

    // create branch
    var branchBuilder = app.New();
    configuration(branchBuilder);
    var branch = branchBuilder.Build();

    var options = new MapOptions
    {
        Branch = branch,
        PathMatch = pathMatch,
    };
    return app.Use(next => new MapMiddleware(next, options).Invoke);
}
```

创建分支的办法就是重新实例化一个ApplicationBuilder。

```
public IApplicationBuilder New()
{
    return new ApplicationBuilder(this);
}
```

对分支的处理则是封装在MapMiddleware类之中。

```
public async Task Invoke(HttpContext context)
{
    ...

    PathString matchedPath;
    PathString remainingPath;

    if (context.Request.Path.StartsWithSegments(_options.PathMatch, out matchedPath, out remainingPath))
    {
        // Update the path
        var path = context.Request.Path;
        var pathBase = context.Request.PathBase;
        context.Request.PathBase = pathBase.Add(matchedPath);
        context.Request.Path = remainingPath;

        try
        {
            await _options.Branch(context);
        }
        finally
        {
            context.Request.PathBase = pathBase;
            context.Request.Path = path;
        }
    }
    else
    {
        await _next(context);
    }
```

```
}
```

说到MapMiddleware，不得不提及各种以Use开头的扩展方法，比如UseStaticFiles，UseMvc，UsePathBase等等。

这些方法内部都会调用UseMiddleware方法以使用各类定制的Middleware类。如下面UsePathBase的代码：

```
public static IApplicationBuilder UsePathBase(this IApplicationBuilder app, PathString pathBase)
{
    ...

    // Strip trailing slashes
    pathBase = pathBase.Value?.TrimEnd('/');
    if (!pathBase.HasValue)
    {
        return app;
    }

    return app.UseMiddleware<UsePathBaseMiddleware>(pathBase);
}
```

而从UseMiddleware方法中可以获知，Middleware类需满足两者条件之一才能被有效使用。其一是实现IMiddleware，其二，必须有Invoke或者InvokeA
法，且方法至少要有一个HttpContext类型参数(它还只能是放第一个)，同时返回值需要是Task类型。

```
internal const string InvokeMethodName = "Invoke";
internal const string InvokeAsyncMethodName = "InvokeAsync";

public static IApplicationBuilder UseMiddleware(this IApplicationBuilder app, Type middleware, params object[] args)
{
    if (typeof(IMiddleware).GetTypeInfo().IsAssignableFrom(middleware.GetTypeInfo()))
    {
        ...

        return UseMiddlewareInterface(app, middleware);
    }

    var applicationServices = app.ApplicationServices;
    return app.Use(next =>
    {
        var methods = middleware.GetMethods(BindingFlags.Instance | BindingFlags.Public);
        var invokeMethods = methods.Where(m =>
            string.Equals(m.Name, InvokeMethodName, StringComparison.Ordinal)
            || string.Equals(m.Name, InvokeAsyncMethodName, StringComparison.Ordinal)
            ).ToArray();

        ...

        var ctorArgs = new object[args.Length + 1];
        ctorArgs[0] = next;
        Array.Copy(args, 0, ctorArgs, 1, args.Length);
        var instance = ActivatorUtilities.CreateInstance(app.ApplicationServices, middleware, ctorArgs);
        if (parameters.Length == 1)
        {
            return (RequestDelegate)methodinfo.CreateDelegate(typeof(RequestDelegate), instance);
        }

        var factory = Compile<object>(methodinfo, parameters);

        return context =>
        {
            var serviceProvider = context.RequestServices ?? applicationServices;
            ...
            return factory(instance, context, serviceProvider);
        };
```

```
    });
}
```

对ASP.NET Core中Middleware的介绍到此终于可以告一段落，希望这两篇文章能够为读者提供些许助力。

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