

# Middleware in ASP.NET Core

Complete Guide to the Request Pipeline

## What is Middleware?

Middleware is software that sits between the web server and your application logic.  
Each piece of middleware:

- Receives an HTTP request
- Performs some operation (logging, authentication, etc.)
- Either responds immediately OR passes the request to the next middleware
- Can also modify the response on the way back

***Think of middleware as a chain of components that process every HTTP request and response.***

## Middleware in Express vs .NET

Express.js	ASP.NET Core
<pre>app.use((req, res, next) =&gt; {   console.log('Request');   next(); });</pre>	<pre>app.Use(async (context, next) =&gt; {   // Before   await next();   // After });</pre>

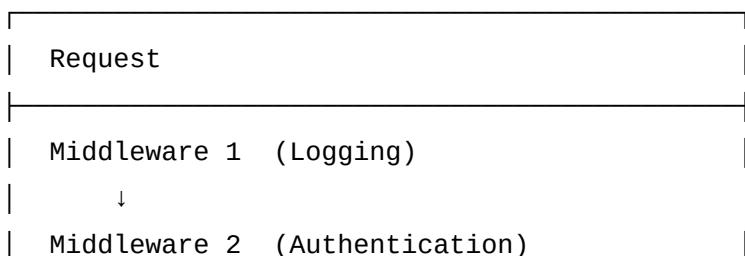
**Key difference:** .NET middleware can execute code BOTH before and after calling `next()`, allowing you to wrap the entire request/response cycle.

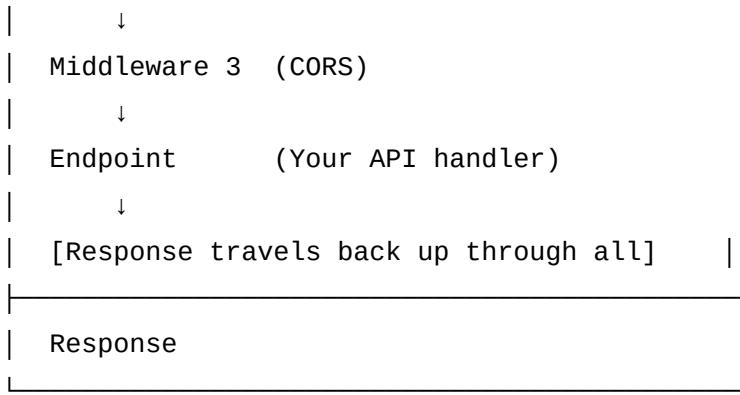
## The Middleware Pipeline

Middleware components are executed in the order they're added to the pipeline:

Request → M1 → M2 → M3 → Endpoint → M3 → M2 → M1 → Response

**Visual representation:**





## How to Use Middleware

### 1. Using Built-in Middleware

ASP.NET Core provides many built-in middleware via `app.UseXxx()` methods:

```

var app = builder.Build();

app.UseHttpsRedirection(); // Redirects HTTP → HTTPS
app.UseCors();           // CORS policy
app.UseAuthentication(); // Authentication
app.UseAuthorization(); // Authorization
app.UseStaticFiles();   // Serve static files

app.MapControllers();    // Endpoint routing
  
```

### 2. Inline Middleware with `app.Use()`

Quick middleware for simple tasks:

```

app.Use(async (context, next) =>
{
    // BEFORE the next middleware
    Console.WriteLine($"Request: {context.Request.Path}");

    await next(); // Call the next middleware

    // AFTER the next middleware (on the way back)
    Console.WriteLine($"Response: {context.Response.StatusCode}");
});
  
```

### 3. Terminal Middleware with `app.Run()`

**Terminal middleware** never calls `next()` - it ends the pipeline:

```

app.Run(async (context) =>
{
  
```

```

        await context.Response.WriteAsync("Pipeline ends here");
        // No next() - nothing else runs after this
    });

```

 **Warning:** app.Run() should always be the LAST thing in your pipeline.

## 4. Conditional Middleware with app.Map()

Branch the pipeline based on the request path:

```

app.Map("/api", apiApp =>
{
    // This middleware only runs for /api/* paths
    apiApp.Use(async (context, next) =>
    {
        Console.WriteLine("API middleware");
        await next();
    });
});

```

## 5. Custom Middleware Class

For reusable, testable middleware, create a class:

```

public class RequestLoggingMiddleware
{
    private readonly RequestDelegate _next;
    private readonly ILogger _logger;

    // Constructor: DI injects next and any services
    public RequestLoggingMiddleware(
        RequestDelegate next,
        ILogger<RequestLoggingMiddleware> logger)
    {
        _next = next;
        _logger = logger;
    }

    // InvokeAsync: the method that runs on each request
    public async Task InvokeAsync(HttpContext context)
    {
        _logger.LogInformation($"Request: {context.Request.Path}");

        await _next(context);
    }
}

```

```

        _logger.LogInformation($"Response:
{context.Response.StatusCode}");
    }
}

```

Use it in Program.cs:

```
app.UseMiddleware<RequestLoggingMiddleware>();
```

## Middleware Parameters Explained

You're correct! Middleware has TWO key parameters, and the Host provides both:

### Parameter 1: HttpContext (context)

The current HTTP request/response:

```

context.Request.Path          // /api/users
context.Request.Method        // GET, POST, etc.
context.Request.Headers       // All headers
context.Request.Query         // Query string
context.Request.Body          // Request body stream

context.Response.StatusCode   // 200, 404, etc.
context.Response.Headers     // Response headers
context.Response.Body         // Response body stream

context.User                  // Authenticated user
context.RequestServices       // DI container

```

### Parameter 2: RequestDelegate (next)

A delegate (function pointer) to the next middleware in the pipeline:

```
await next(context); // OR simply: await next();
```

#### What happens when you call next():

- Passes control to the next middleware
- Waits (await) for all subsequent middleware to finish
- Returns control back to your middleware
- You can then execute code AFTER the response is generated

#### If you DON'T call next():

- The pipeline stops
- Your middleware must handle the response
- Nothing else in the pipeline runs

## How the Host Injects These Parameters

### For inline middleware (app.Use):

```
app.Use(async (context, next) => { /* ... */ });
```

The Host automatically provides both parameters.

#### For class-based middleware:

```
// Constructor: Host injects 'next' + any DI services
public MyMiddleware(RequestDelegate next, ILogger logger)
```

```
// InvokeAsync: Host injects 'context' + scoped services
public async Task InvokeAsync(HttpContext context, IScopeService
    svc)
```

**Key insight:** Constructor gets singleton/scoped services; InvokeAsync gets context + scoped services for THAT request.

## Important Built-in Middleware

Middleware	Purpose	Usage
<b>UseHttpsRedirection</b>	Redirects HTTP to HTTPS	app.UseHttpsRedirection();
<b>UseCors</b>	Handles Cross-Origin requests	app.UseCors("policy");
<b>UseAuthentication</b>	Authenticates users (JWT, Cookies)	app.UseAuthentication();
<b>UseAuthorization</b>	Checks permissions/roles	app.UseAuthorization();
<b>UseStaticFiles</b>	Serves static files (CSS, JS, images)	app.UseStaticFiles();
<b>UseRouting</b>	Matches requests to endpoints	app.UseRouting();
<b>UseEndpoints</b>	Executes matched endpoint	app.MapControllers();
<b>UseExceptionHandler</b>	Global exception handling	app.UseExceptionHandler();
<b>UseResponseCompression</b>	Compresses responses (gzip, brotli)	app.UseResponseCompression();

# ⚠️ Middleware Order MATTERS!

The order you add middleware determines the order they execute.

## Recommended Order

```
var app = builder.Build();

// 1. Exception handling (catch everything)
app.UseExceptionHandler("/error");

// 2. HTTPS redirection
app.UseHttpsRedirection();

// 3. Static files (no need for auth)
app.UseStaticFiles();

// 4. Routing (determines which endpoint)
app.UseRouting();

// 5. CORS (after routing, before auth)
app.UseCors();

// 6. Authentication (who are you?)
app.UseAuthentication();

// 7. Authorization (are you allowed?)
app.UseAuthorization();

// 8. Custom middleware
app.UseMiddleware<RequestLoggingMiddleware>();

// 9. Endpoints (LAST - execute the handler)
app.MapControllers();
```

## Why this order?

- **Exception handler first:** Catches errors from ALL other middleware
- **Static files before routing:** No need to authenticate for CSS/JS
- **CORS after routing:** Needs to know which endpoint matched
- **Authentication before authorization:** Must identify user before checking permissions
- **Endpoints last:** Only run after all checks pass

# Practical Middleware Scenarios

## Scenario 1: Request Timing

Measure how long each request takes:

```
app.Use(async (context, next) =>
{
    var watch = System.Diagnostics.Stopwatch.StartNew();

    await next();

    watch.Stop();
    Console.WriteLine($"Request took {watch.ElapsedMilliseconds}ms");
});
```

## Scenario 2: API Key Authentication

```
app.Use(async (context, next) =>
{
    var apiKey = context.Request.Headers["X-API-Key"].FirstOrDefault();

    if (string.IsNullOrEmpty(apiKey) || !IsValidApiKey(apiKey))
    {
        context.Response.StatusCode = 401;
        await context.Response.WriteAsync("Unauthorized");
        return; // Stop pipeline
    }

    await next();
});
```

## Scenario 3: Request ID for Tracing

```
app.Use(async (context, next) =>
{
    var requestId = Guid.NewGuid().ToString();
    context.Items["RequestId"] = requestId;

    await next();

    context.Response.Headers["X-Request-ID"] = requestId;
});
```

## Scenario 4: Global Error Handling

```
app.Use(async (context, next) =>
{
    try
    {
        await next();
    }
    catch (Exception ex)
    {
        context.Response.StatusCode = 500;
        await context.Response.WriteAsJsonAsync(new
        {
            error = ex.Message,
            timestamp = DateTime.UtcNow
        });
    }
});
```

## Scenario 5: Rate Limiting

```
public class RateLimitingMiddleware
{
    private readonly RequestDelegate _next;
    private static Dictionary<string, DateTime> _requests = new();

    public RateLimitingMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    public async Task InvokeAsync(HttpContext context)
    {
        var ip = context.Connection.RemoteIpAddress?.ToString();

        if (_requests.TryGetValue(ip, out var lastRequest))
        {
            if ((DateTime.UtcNow - lastRequest).TotalSeconds < 1)
            {
                context.Response.StatusCode = 429; // Too Many Requests
                return;
            }
        }
    }
}
```

```

        }

        _requests[ip] = DateTime.UtcNow;
        await _next(context);
    }
}

```

## Advanced Middleware Concepts

### Accessing Scoped Services in Middleware

You can inject scoped services into `InvokeAsync`:

```

public class MyMiddleware
{
    private readonly RequestDelegate _next;

    public MyMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    // Inject scoped services here!
    public async Task InvokeAsync(
        HttpContext context,
        DbContext db,           // Scoped
        ILogger<MyMiddleware> logger) // Singleton
    {
        // Use db and logger
        await _next(context);
    }
}

```

### Short-Circuiting the Pipeline

Sometimes you want to stop the pipeline early:

```

app.Use(async (context, next) =>
{
    if (context.Request.Path == "/health")
    {
        context.Response.StatusCode = 200;
        await context.Response.WriteAsync("OK");
        return; // Don't call next()
    }
}

```

```
    }

    await next();
});

});
```

## Conditional Middleware with UseWhen()

```
app.UseWhen(
    context => context.Request.Path.StartsWithSegments("/api"),
    appBuilder =>
{
    // Only runs for /api/* requests
    appBuilder.Use(async (context, next) =>
{
    Console.WriteLine("API request");
    await next();
});
});
```

## Summary: Key Takeaways

1. **Middleware = chain of components** processing every HTTP request
2. **Two parameters:** HttpContext (request/response) and RequestDelegate (next)
3. **Host injects both:** You don't create them manually
4. **Order matters:** Exception handling → Static files → Routing → Auth → Endpoints
5. **Three ways to add:** Built-in (UseXxx), inline (Use), class-based (UseMiddleware)
6. **Can execute before AND after:** Code before next() and after next()
7. **Short-circuit when needed:** Don't call next() to stop the pipeline

**Now you understand the middleware pipeline!**