

The Background on Background Tasks in .NET 6

Audience

- .NET Developers
- In need of running a background task

Agenda

- What are background tasks/jobs?
- What type of problems are suitable for a background task/job?
- What options are out there?
 - IHostedService
 - BackgroundService
 - Worker Service
 - Hangfire
- Why would I choose one over the other?
- Deep dive into each
- Demos
- Questions

Goal

- Know all your options for running background tasks
- Why choose one over another

Who am I?

- Director of Engineering at Lean TECHniques
- Co-organizer of [Iowa .NET User Group](#)
- [Friend of Redgate](#)
- Blog at scottsauer.com



What problem do background tasks solve?

- Cron jobs
 - Process messages from a queue every X minutes
 - Clean up database or file system every X minutes
 - Send email notification every X minutes under certain circumstances
 - Refresh cache every X minutes
 - Check for updates to database every X minutes and push updates via SignalR
- Perform some CPU intensive work asynchronously
- Eventual consistency
- Re-train ML datasets

Options

- IHostedService
- BackgroundService
- WorkerService
- Hangfire
- Cloud options



These options are
kind of like
baking cookies



I Hosted Service

“Make Your Own Recipe”

(Cookie Jar Included)

What is an IHostedService?

- Lets you host a background job inside an ASP.NET Core App
 - ASP.NET Core app is your cookie jar
- Interface with StartAsync and StopAsync
- Raw, fundamental building block for other options
- Register via dependency injection and `services.AddHostedService<T>`



Demo

COOKIE
TASTE TEST

How does an IHostedService work?

- Register with DI
- StopAsync's cancellation token has 5 seconds to shutdown gracefully
- StopAsync might not be called if the app shuts down unexpectedly

```
services.AddHostedService<HostedServiceExample>();
```


How does an IHostedService work?

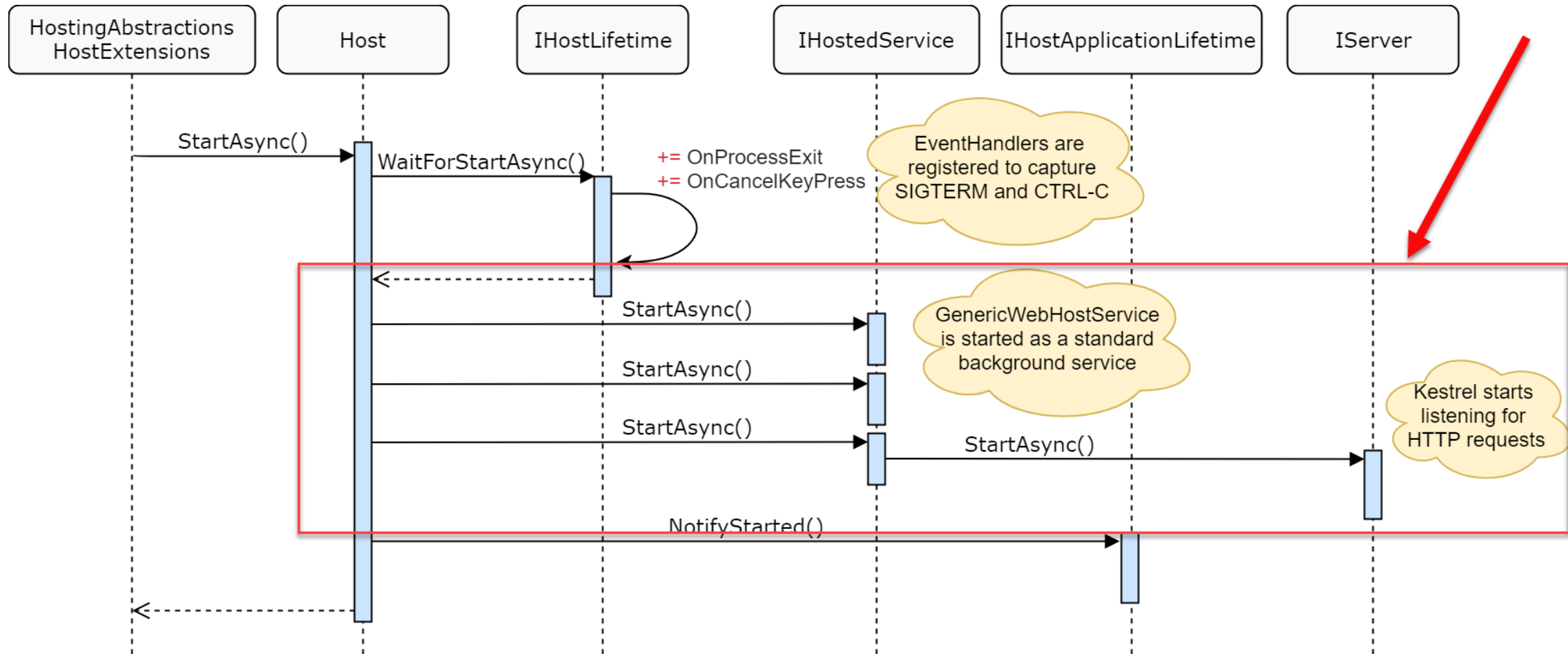


Image Credit: [Andrew Lock](#)

How does an IHostedService work?

- StartAsync blocks the rest of your app from starting
- Push **blocking** long-running work out of StartAsync
 - This goes for BackgroundService later

DO THIS

```
public Task StartAsync(CancellationTokentoken)
{
    LongRunningThingAsync(cancellationTokentoken);

    return Task.CompletedTask;
}
```

NOT THIS

```
public async Task StartAsync(CancellationTokentoken)
{
    await LongRunningThingAsync(cancellationTokentoken);
}
```

- UNLESS, you truly don't want your app to boot until this finishes
 - i.e. Database Migrations

When do I use IHostedService?

- You will implicitly use it with BackgroundService and Worker Services
- You need full control over Starting and Stopping
 - AND will not use the base BackgroundService implementation

When do I NOT use IHostedService?

- Should be using BackgroundService or WorkerService 95%+ of the time
- Other reasons will be the same as BackgroundService (next)

BackgroundService

“Follow The Recipe”
(Cookie Jar Included)



A Recipe For Chewy Chocolate Chip Cookies

325° F

Ingredients ~ for 16 large cookies

- 2 1/4 c. flour (spooned & leveled)*
- 1 1/2 c. brown sugar (loosely packed)*
- 1/2 c. granulated sugar*
- 1 egg + egg yolk*
- 2 tsp. vanilla*
- 1 c. choc. and white choc. chips*

What is a BackgroundService?

- Lets you host a background job inside an ASP.NET Core App
 - ASP.NET Core app is your cookie jar
- Abstract class, implements IHostedService
- Exposes ExecuteAsync abstract method
- Handles Starting and Stopping



Demo

COOKIE
TASTE TEST

How does a BackgroundService work?

- Register with DI
- Exposes ExecuteAsync abstract method
- Can still override StartAsync and StopAsync

```
services.AddHostedService<BackgroundServiceExample>();
```

```

public abstract class BackgroundService : IHostedService, IDisposable
{
    private Task _executingTask;
    private readonly CancellationTokenSource _stoppingCts = new CancellationTokenSource();

    1 usage 1 override
    protected abstract Task ExecuteAsync(CancellationToken stoppingToken);

    public virtual Task StartAsync(CancellationToken cancellationToken)
    {
        // Store the task we're executing
        _executingTask = ExecuteAsync(_stoppingCts.Token);

        // If the task is completed then return it, this will bubble cancellation and failure to the caller
        if (_executingTask.IsCompleted)
        {
            return _executingTask;
        }

        // Otherwise it's running
        return Task.CompletedTask;
    }

    public virtual async Task StopAsync(CancellationToken cancellationToken)
    {
        // Stop called without start
        if (_executingTask == null)
        {
            return;
        }

        try
        {
            // Signal cancellation to the executing method
            _stoppingCts.Cancel();
        }
        finally
        {
            // Wait until the task completes or the stop token triggers
            await Task.WhenAny(
                params tasks: _executingTask, Task.Delay(Timeout.Infinite, cancellationToken));
        }
    }

    public virtual void Dispose()
    {
        _stoppingCts.Cancel();
    }
}

```

When do I use BackgroundService?

- Need a simple background task runner
 - Either as part of your ASP.NET Core application or by itself
- Less gotchas than IHostedService
 - Can't accidentally prevent app from booting unless override StartAsync
 - Handles cancellations
- Want an ASP.NET Core endpoint to health check your background task
 - Instead of WorkerServices

When do I NOT use BackgroundService?

- Too much co-location with your app/API can get unruly and outweigh the convenience of co-location
 - It Depends
- Scaling out can be a problem if your code isn't idempotent
 - Fix by making code idempotent or not allowing scale out

WorkerService

“Follow The Recipe” (BYO Cookie Jar)

A Recipe For Chewy Chocolate Chip Cookies

325° F

Ingredients ~ for 16 large cookies

- 2 1/4 c. flour (spooned & leveled)*
- 1 tsp. baking soda*
- 1 1/2 tsp. cocoa powder*
- 1/2 tsp. salt*
- 3/4 unsalted butter (melted)*
- 3/4 c. brown sugar (loosely packed)*
- 1/2 c. granulated sugar*
- 1 egg + egg yolk*
- 2 tsp. vanilla*
- 1 c. choc. and white choc. chips*



What is a WorkerService?

- Enhanced .NET Console App template
 - `dotnet new worker -o my-custom-worker`
- Allows you to have an IHost
 - Configuration, Dependency Injection, Logging, etc.
- Registers a Worker class as a HostedService
- Does not take an opinion on how to host console app
 - No cookie jar
 - Console app called from scheduler
 - Windows Service
 - systemd



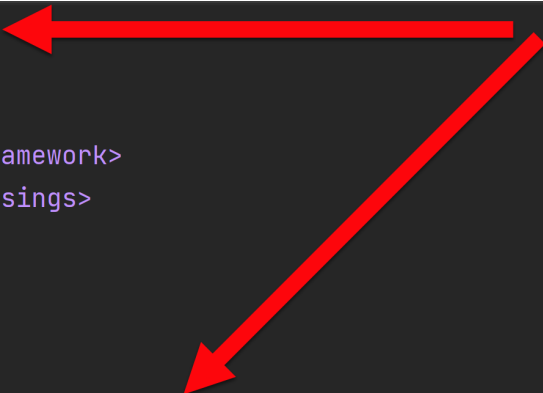
Demo

COOKIE
TASTE TEST

How does a WorkerService work?

- Project Sdk of Microsoft.NET.Sdk.Worker
- PackageReference to Microsoft.Extensions.Hosting

```
1  <Project Sdk="Microsoft.NET.Sdk.Worker">
2
3    <PropertyGroup>
4      <TargetFramework>net6.0</TargetFramework>
5      <ImplicitUsings>enable</ImplicitUsings>
6      <Nullable>enable</Nullable>
7    </PropertyGroup>
8
9    <ItemGroup>
10     <PackageReference Include="Microsoft.Extensions.Hosting" Version="6.0.1" />
11     <PackageReference Include="Microsoft.Extensions.Hosting.Systemd" Version="6.0.0" />
12     <PackageReference Include="Microsoft.Extensions.Hosting.WindowsServices" Version="6.0.0" />
13   </ItemGroup>
14
15   <ItemGroup>
16     <ProjectReference Include="..\Shared\Shared.csproj" />
17   </ItemGroup>
18 </Project>
```

Two red arrows are drawn on the code snippet. One arrow points from the right towards the `Sdk="Microsoft.NET.Sdk.Worker"` attribute on line 1. The other arrow points from the top right towards the `<PackageReference Include="Microsoft.Extensions.Hosting" Version="6.0.1" />` line on line 10.

How do I host WorkerServices?

- Scheduler calls Console App
 - Windows Scheduled Tasks, k8s cron jobs, Azure Logic Apps, AWS Scheduled Tasks, GCP Cloud Scheduler
- Windows Service or Systemd (Windows or Linux)

```
public static IHostBuilder CreateHostBuilder(string[] args) =>
    Host.CreateDefaultBuilder(args)
        .UseWindowsService() // Microsoft.Extensions.Hosting.WindowsService
        .UseSystemd() // Microsoft.Extensions.Hosting.Systemd
        .ConfigureServices((hostContext, services) => { services.AddHostedService<Worker>(); });
```

Pick one

When do I use WorkerServices?

- Want an out-of-proc way of running background tasks
- Prefer hosting background services outside of a web app
 - Avoid app pool recycles
- Natural migration for a full .NET framework Windows Service

When do I NOT use WorkerServices?

- Prefer deploying as a web app
- Want to co-locate with existing web app/API
- Want a healthcheck endpoint



Hangfire

“Buy pre-packaged cookies”

What is Hangfire?

- Full featured library for running jobs in ASP.NET Core
 - Free for commercial use but paid if you want support (\$500-\$4500/yr)
- Comes with UI for monitoring and history
- Supports Cron and ad-hoc running of jobs
- Allows for continuations
- Automatic retries
- Supports concurrency limiting
- Persists job state to database



Demo

COOKIE
TASTE TEST

How does Hangfire work?

- Serializes method call and all arguments
- Creates background job based on that information
- Saves job to persistent storage
- Starts background job if immediate

When do I use Hangfire?

- Want to host jobs in ASP.NET Core
- Need features Hangfire offers
- Don't want to write plumbing code
- Ok with relying on a 3rd party library

When do I NOT use Hangfire?

- Do not want to host jobs in ASP.NET Core
- Have basic needs and do not need Hangfire's features
- Do not want to rely on 3rd party library
- More control over what happens

Cloud options

- Azure Functions
- Azure WebJobs
- AWS Lambdas
- GCP Cloud Scheduler + Cloud Functions
- Didn't cover these to avoid cloud specific

Takeaways

- Awareness to all the options available to you
- More information to make the best decision for you and your company

Resources

- <https://docs.microsoft.com/en-us/dotnet/architecture/microservices/multi-container-microservice-net-applications/background-tasks-with-ihostedservice>
- <https://www.hangfire.io/>
- <https://app.pluralsight.com/library/courses/building-aspnet-core-hosted-services-net-core-worker-services/>
- This slide deck

Questions?

Thanks!