ValueTask. Что, зачем и почему

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Мы с вами поговорим про:

- Какая проблема есть с Task
- Почему это проблема
- Вспомним механизм работы async
- Рассмотрим task-like типы
- Рассмотрим ValueTask
- Рассмотрим IValueTaskSource

ValueTask. Что, зачем и почему

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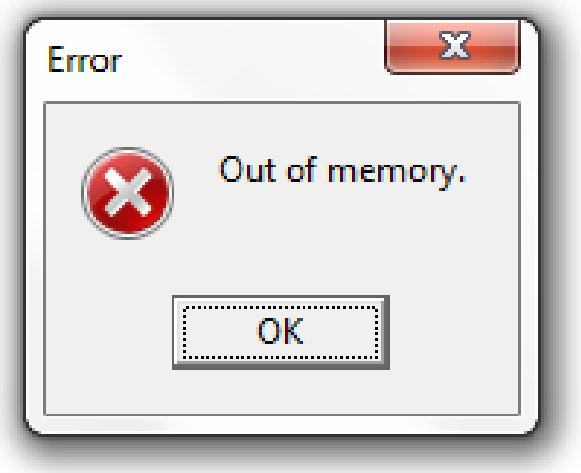
ОСТОРОЖНО



ЗЛЫЕ

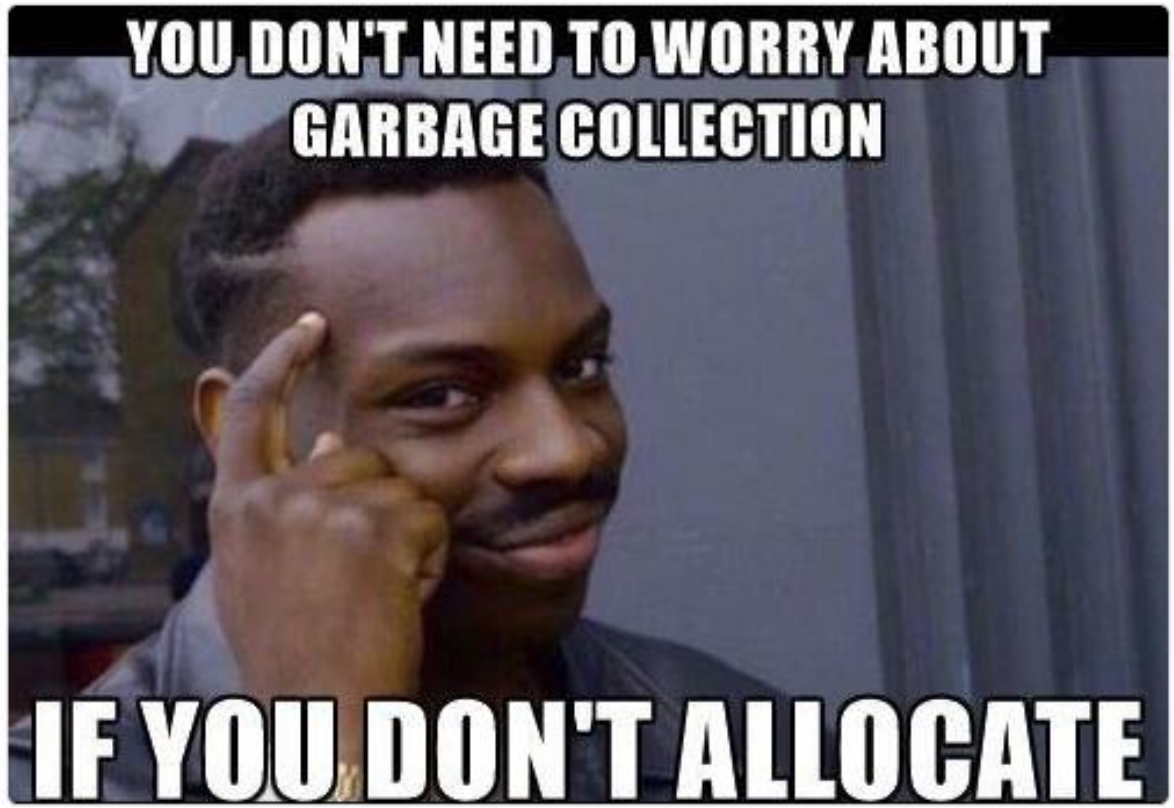
АЛЛОКАЦИИ

Ben Adams
@ben_a_adams

Читаю

You don't need to worry about garbage collection; if you don't allocate!

Перевести твит

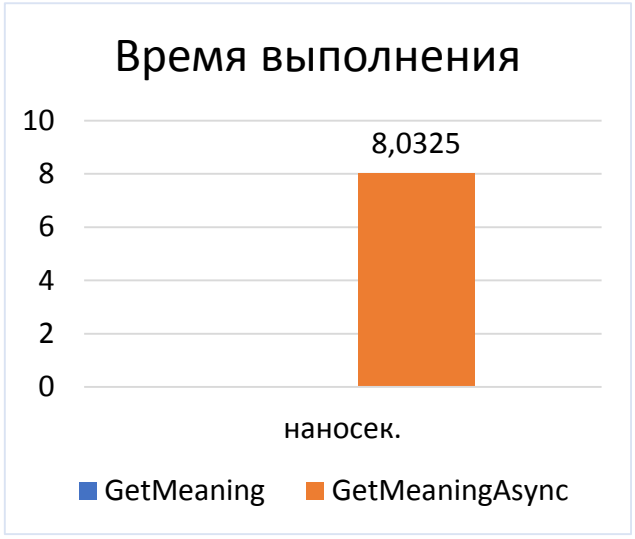


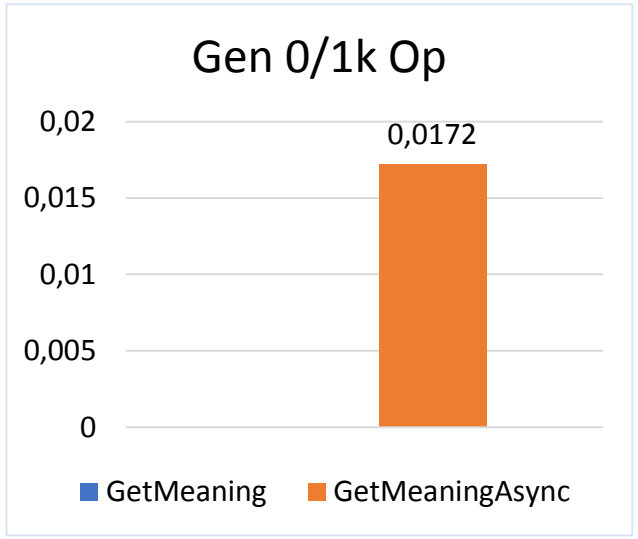
16:33 - 8 авг. 2017 г.

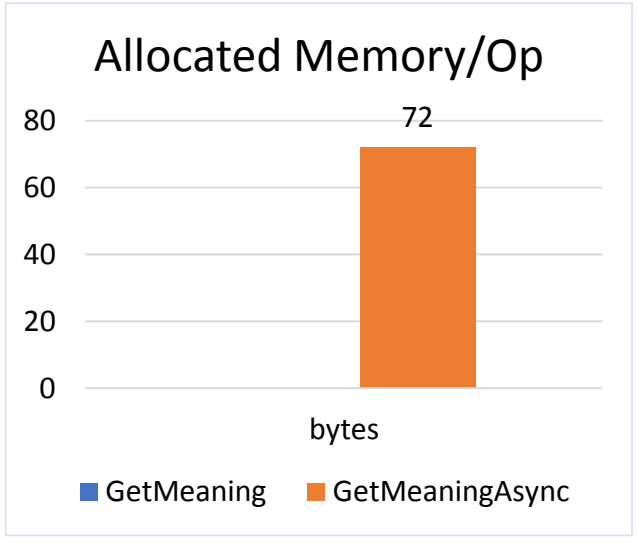
С Task что-то не так?


```
public class TheMeaningOfLife
{
    public int GetMeaning()
    {
        return 42;
    }

    public Task<int> GetMeaningAsync()
    {
        return Task.FromResult(42);
    }
}
```

Побенчмаркаем?







GetMeaning ≈ 0.0259 ns

https://blogs.msdn.microsoft.com/seteplia/2018/01/25/the-performance-characteristics-of-async-methods/

С Task что-то не так?


```
public class TheMeaningOfLife
{
    public int GetMeaning()
    {
        return 42;
    }

    public Task<int> GetMeaningAsync()
    {
        return Task.FromResult(42);
    }
}
```

Hot path

Inside a program, the code paths that are executed most often belong to the **hot path** (with the remaining code paths being on the **cold** path). One can look at this at multiple levels: instruction, language statements, features. Over the years, multiple studies have shown how to optimize software for the hot path execution.

https://blogs.msdn.microsoft.com/oanapl/2010/02/04/optimize-for-the-hot-path/

- **DO** avoid allocations in compiler hot paths:
  - Avoid LINQ.
  - Avoid using `foreach` over collections that do not have a `struct` enumerator.
  - Consider using an object pool. There are many usages of object pools in the compiler to see an example.

https://github.com/dotnet/roslyn/blob/fab7134296816fc80019c60b0f5bef7400cf23ea/CONTRIBUTING.md

С Task что-то не так?


```
public class BenchmarkImpl
{
    [Params(100, 1000, 100000)]
    public int Repeats { get; set; }

    [Benchmark]
    public void GetMeaning()
    {
        for(var i = 0; i < Repeats; i++)
            _meaning.GetMeaning();
    }

    [Benchmark]
    public void GetMeaningAsync()
    {
        for(var i = 0; i < Repeats; i++)
            _meaning.GetMeaningAsync().GetAwaiter().GetResult();
    }
}
```

Использовали лишнюю память?

Метод	Повторения	Время	Gen 0/1k Op	Allocated Memory/Op
GetMeaning	100	36.79 ns	-	0 B
GetMeaningAsync	100	688.94 ns	1.7157	7.2 Kb

Метод	Повторения	Время	Gen 0/1k Op	Allocated Memory/Op
GetMeaning	100000	0.029 ms	-	0 B
GetMeaningAsync	100000	0.638 ms	1715.8203	7.2 Mb

Использовали лишнюю память?

Проблема? Проблема.

```
public interface IPriceProvider
{
    Task<decimal> GetByName(string name);
}

public class NetworkPizzaPriceProvider : I PriceProvider
{
    public Task<decimal> GetByName(string name)
    {
        return HttpClient.GetPriceFromNetwork(name);
    }
}

public class MemoryPizzaPriceProvider : I PriceProvider
{
    public Task<decimal> GetByName(string name)
    {
        return Task.FromResult<decimal>(42);
    }
}
```

Проблема? Проблема.

```
public class PizzaPriceProvider
{
    public Dictionary<string, decimal> _cache = new Dictionary<string, decimal>();

    private Task<decimal> GetPrice(string name) => HttpClient.GetPriceFromNetwork(name);

    public async Task<decimal> GetPizzaPriceAsync(string name)
    {
        if (_cache.TryGetValue(name, out var price))
        {
            // Возвращаем кэшированные цены
            return Task.FromResult(price);
        }

        return await GetPrice(name);
    }
}
```

http://blog.i3arnon.com/2015/11/30/valuetask/

Проблема? Проблема.

```
public class PizzaPriceProvider
{
    public Dictionary<string, decimal> _cache = new Dictionary<string, decimal>();

    private Task<decimal> GetPrice(string name) => HttpClient.GetPriceFromNetwork(name);

    public async Task<decimal> GetPizzaPriceAsync(string name)
    {
        if (_cache.TryGetValue(name, out var price))
        {
            // Возвращаем кэшированные цены
            return Task.FromResult(price);
        }

        return await GetPrice(name);
    }
}
```

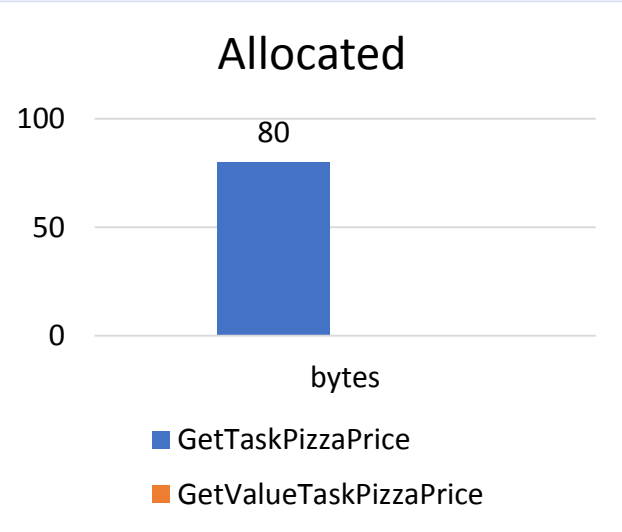
http://blog.i3arnon.com/2015/11/30/valuetask/

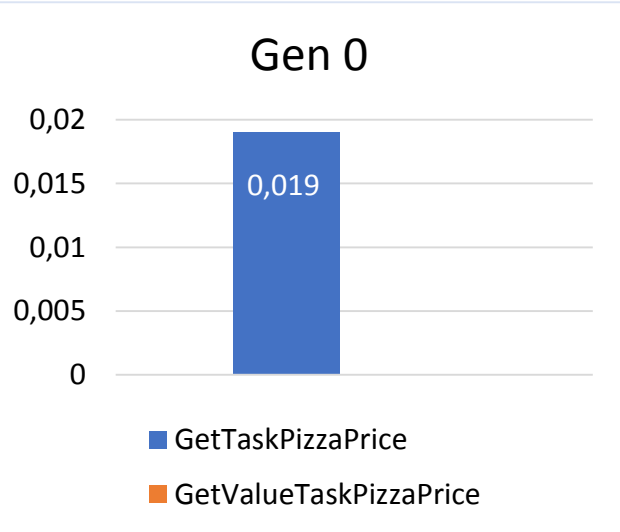
А можно ли не выделять?

PizzaPriceProvider + ValueTask = ❤

```
public class PizzaPriceProvider
{
   public Dictionary<string, decimal> _cache = new Dictionary<string, decimal>();

   private Task<decimal> GetPrice(string name) => …


   public ValueTask<decimal> GetPizzaPriceValueTask(string name)
   {
      if (_cache.TryGetValue(name, out var price))
      {
         // Возвращаем кэшированные цены
         return new ValueTask<decimal>(price);
      }

      return new ValueTask<decimal>(GetPrice(name));
   }
}
```

PizzaPriceProvider + ValueTask = ❤





Task-like типы

Async Return Types (C#)

05/29/2017 • 7 minutes to read • Contributors all

Async methods can have the following return types:

- Task<TResult>, for an async method that returns a value.
- Task, for an async method that performs an operation but returns no value.
- `void`, for an event handler.
- Starting with C# 7.0, any type that has an accessible `GetAwaiter` method. The object returned by the `GetAwaiter` method must implement the System.Runtime.CompilerServices.ICriticalNotifyCompletion interface.

1. Не стоит выделять память в hot-path

2. Память может тратиться в неожиданных местах

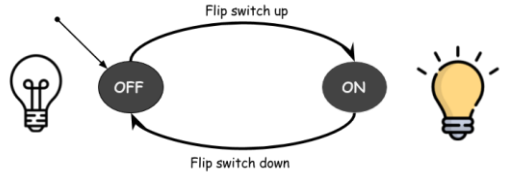
3. Иногда она тратится там, где мы этого не хотим

Простой пример

```
public class TheMeaningOfLife
{
    public async Task<int> GetMeaning()
    {
        await Task.Delay(1);
        return 42;
    }
}
```

1. Task

2. StateMachine



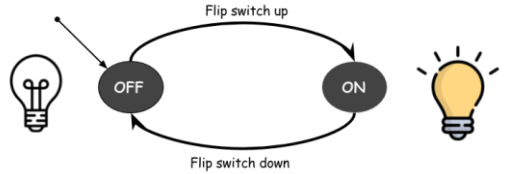
3. AsyncTaskMethodBuilder

4. TaskAwaiter

5. MoveNextRunner

1. Task

2. StateMachine



3. AsyncTaskMethodBuilder

Простой пример

```
public class TheMeaningOfLife
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}
```
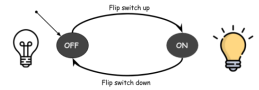
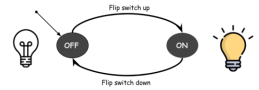

GetMeaning метод



```
public class TheMeaningOfLife
{
   [AsyncStateMachine(typeof(GetMeaningStMch))]
   public Task<int> GetMeaning()
   {
     GetBookPrice stateMachine = default(GetMeaningStMch);
      stateMachine._this = this;
      stateMachine._builder = AsyncTaskMethodBuilder<int>.Create();
      stateMachine._state = -1;
      AsyncTaskMethodBuilder<decimal> _builder =  stateMachine._builder;
      _builder.Start(ref stateMachine);
      return stateMachine._builder.Task;
    }
}
```

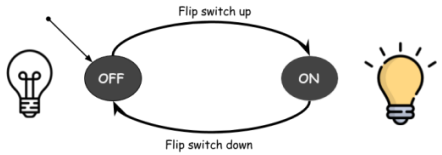
GetMeaning метод



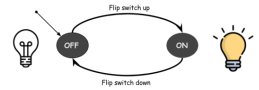
```
public class TheMeaningOfLife
{
    [AsyncStateMachine(typeof(GetMeaningStMch))]
    public Task<int> GetMeaning()
    {
      GetBookPrice stateMachine = default(GetMeaningStMch);




    }
}
```

StateMachine

```
[StructLayout(LayoutKind.Auto)]
[CompilerGenerated]
public struct GetMeaningStMch : IAsyncStateMachine
{
    public int _state;
    public AsyncTaskMethodBuilder<int> _builder;
    private TaskAwaiter _1;

    private void MoveNext(){}
    void IAsyncStateMachine.MoveNext(){}
    private void SetStateMachine(IAsyncStateMachine stateMachine){}
    void IAsyncStateMachine.SetStateMachine(IAsyncStateMachine stateMachine){}
}
```



GetMeaning метод



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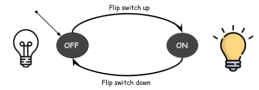
GetMeaning метод



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   public Task<int> GetMeaning()
   {
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       stateMachine._this = this;
       stateMachine._builder = AsyncTaskMethodBuilder<int>.Create();
       stateMachine._state = -1;



    }
}
```

AsyncTaskMethodBuilder ≈ TaskCompletionSource

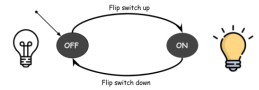
```
public struct AsyncTaskMethodBuilder
{
   public Task Task { get; }

   public void AwaitOnCompleted(ref INotifyCompletion awaiter, ref IAsyncStateMachine stateMachine)
   public void AwaitUnsafeOnCompleted(
                                       ref ICriticalNotifyCompletion awaiter, ref IAsyncStateMachine stateMachine)

   public static AsyncTaskMethodBuilder Create()
   public void SetException(Exception exception)
   public void SetResult()
   public void SetStateMachine(IAsyncStateMachine stateMachine)

   public void Start(ref IAsyncStateMachine stateMachine)
}
```

GetMeaning метод



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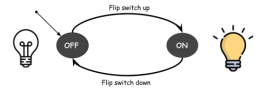
GetMeaning метод



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      stateMachine._builder = AsyncTaskMethodBuilder<int>.Create();
      stateMachine._state = -1;
      AsyncTaskMethodBuilder<decimal> _builder =  stateMachine._builder;
      _builder.Start(ref stateMachine);
      return stateMachine._builder.Task;
    }
}
```
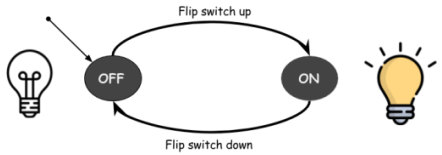

AsyncTaskMethodBuilder ≈ TaskCompletionSource

```
public struct AsyncTaskMethodBuilder
{
   public Task Task { get; }

   public void AwaitOnCompleted(ref INotifyCompletion awaiter, ref IAsyncStateMachine stateMachine)
   public void AwaitUnsafeOnCompleted(
                                       ref ICriticalNotifyCompletion awaiter, ref IAsyncStateMachine stateMachine)

   public static AsyncTaskMethodBuilder Create()
   public void SetException(Exception exception)
   public void SetResult()
   public void SetStateMachine(IAsyncStateMachine stateMachine)

   public void Start(ref IAsyncStateMachine stateMachine)
}
```

StateMachine

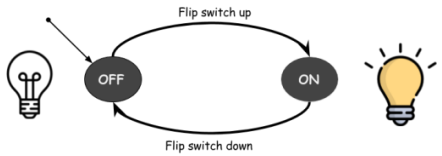
```
[StructLayout(LayoutKind.Auto)]
[CompilerGenerated]
public struct GetMeaningStMch : IAsyncStateMachine
{
    public int _state;
    public AsyncTaskMethodBuilder<int> _builder;
    private TaskAwaiter _1;

    private void MoveNext(){}
    void IAsyncStateMachine.MoveNext(){}
    private void SetStateMachine(IAsyncStateMachine stateMachine){}
    void IAsyncStateMachine.SetStateMachine(IAsyncStateMachine stateMachine){}
}
```



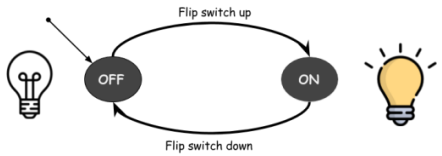
Простой пример

```
public class TheMeaningOfLife
{
    public async Task<int> GetMeaning()
    {
        await Task.Delay(1);
        return 42;
    }
}
```

```
private void MoveNext()
{
      TaskAwaiter awaiter;
       if (state == “Первый запуск”)
       {
          awaiter = Task.Delay(1).GetAwaiter();
          if (!awaiter.IsCompleted) // IsCompleted == false
          {
             _1 = awaiter;
             _builder.AwaitUnsafeOnCompleted(ref awaiter, ref this);
             return;
          }
       }
       else
       {


        }




}
```



```
private void MoveNext()
{
    TaskAwaiter awaiter;
    if (state == “Первый запуск”)
    {
        awaiter = Task.Delay(1).GetAwaiter();
        if (!awaiter.IsCompleted) // IsCompleted == true
        {
            _1 = awaiter;
            _builder.AwaitUnsafeOnCompleted(ref awaiter, ref this);
            return;
        }
    }
    else
    {
        awaiter = _1;
        _1 = default(TaskAwaiter);
    }
    awaiter.GetResult();
    result = 42;

    _builder.SetResult(result);
}
```



Awaiter

Why would you want a custom awaiter?

You can see the compiler's interpretation of `await` here. Essentially:

```
var temp = e.GetAwaiter();
if (!temp.IsCompleted)
{
  SAVE_STATE()
  temp.OnCompleted(&cont);
  return;

cont:
  RESTORE_STATE()
}
var i = temp.GetResult();
```

Edit from comments: `OnCompleted` should schedule its argument as a continuation of the asynchronous operation.

share edit flag

edited Sep 30 '12 at 13:21

answered Sep 30 '12 at 13:00

Stephen Cleary

269k ● 45 ● 452 ● 571

Где ValueTask?

Простой пример

```
public class TheMeaningOfLife
{
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    {
        await Task.Delay(1);
        return 42;
    }
}
```
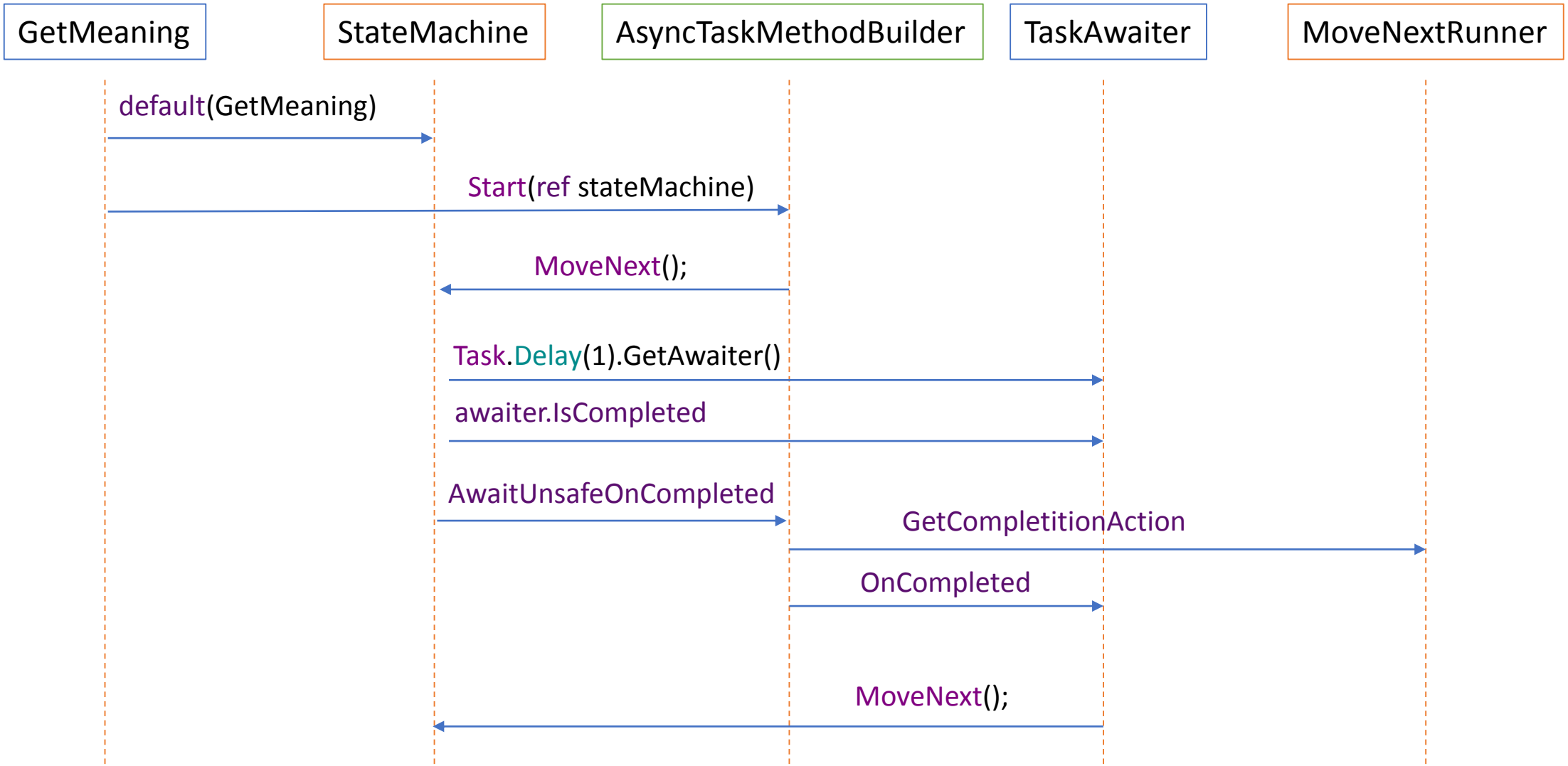
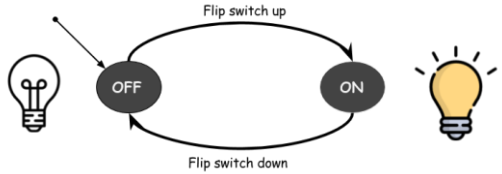

Схема взаимодействия



1. **Task** – контейнер для задачи

2. **StateMachine** – промежуточный слой содержащий логику метода



3. **AsyncTaskMethodBuilder** – контроллер хода работы асинхронного метода

4. **TaskAwaiter** – принимает коллбэк и запускает его

5. **MoveNextRunner** – оборачивает колбэк в мета-информацию

Task-like типы

Async Return Types (C#)

05/29/2017 • 7 minutes to read • Contributors all

Async methods can have the following return types:

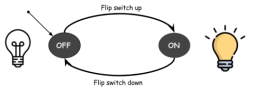
- Task<TResult>, for an async method that returns a value.
- Task, for an async method that performs an operation but returns no value.
- `void`, for an event handler.
- Starting with C# 7.0, any type that has an accessible `GetAwaiter` method. The object returned by the `GetAwaiter` method must implement the System.Runtime.CompilerServices.ICriticalNotifyCompletion interface.

AsyncTaskMethodBuilder ≈ TaskCompletionSource

```
public struct AsyncTaskMethodBuilder
{
    public Task Task { get; }

    public void AwaitOnCompleted(ref INotifyCompletion awaiter, ref IAsyncStateMachine stateMachine)
    public void AwaitUnsafeOnCompleted(
                                        ref ICriticalNotifyCompletion awaiter, ref IAsyncStateMachine stateMachine)

    public static AsyncTaskMethodBuilder Create()
    public void SetException(Exception exception)
    public void SetResult()
    public void SetStateMachine(IAsyncStateMachine stateMachine)

    public void Start(ref IAsyncStateMachine stateMachine)
}
```

https://github.com/dotnet/roslyn/issues/7169 - предложение для Roslyn

GetMeaning метод



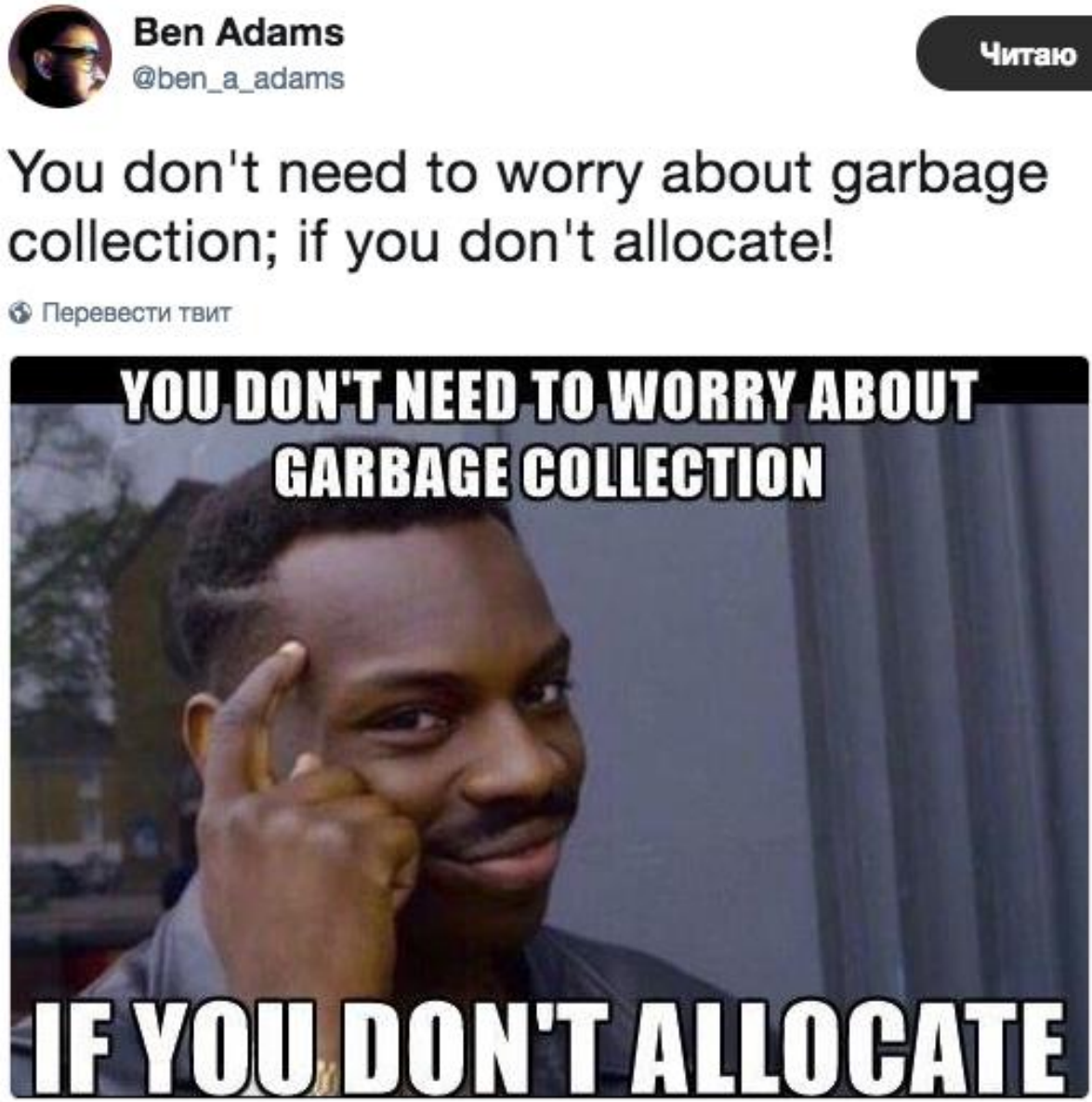
```
public class TheMeaningOfLife
{
    [AsyncStateMachine(typeof(GetMeaning))]
    public Task<int> GetMeaning()
    {
       GetBookPrice stateMachine = default(GetMeaning);
        stateMachine._this = this;
        stateMachine._builder = AsyncTaskMethodBuilder<int>.Create();
        stateMachine._state = -1;
        AsyncTaskMethodBuilder<decimal> _builder =  stateMachine._builder;
        _builder.Start(ref stateMachine);
        return stateMachine._builder.Task;
     }
}
```

Builder и его экземпляры

1. AsyncVoidMethodBuilder
2. AsyncTaskMethodBuilder
3. AsyncTaskMethodBuilder<TResult>

Описание API

Custom TaskBuilder
=== task-like


Ben Adams
@ben_a_adams
Читаю
You don't need to worry about garbage collection; if you don't allocate!
Перевести твит
YOU DON'T NEED TO WORRY ABOUT GARBAGE COLLECTION
IF YOU DON'T ALLOCATE
16:33 - 8 авг. 2017 г.

ValueTask

```
[AsyncMethodBuilder(typeof (AsyncValueTaskMethodBuilder<>))]
public readonly struct ValueTask<TResult>
{
    public bool IsCompleted { get; }

    public TResult Result { get; }

    public Task<TResult> AsTask();

    public ConfiguredValueTaskAwaitable<TResult> ConfigureAwait(bool continueOnCapturedContext);

    public ValueTaskAwaiter<TResult> GetAwaiter();
}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {

    }


}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {
        cachedConnection = GetFromPool();









    }


}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {
        cachedConnection = GetFromPool();

        HttpConnection conn = cachedConnection._connection;

    }

}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {
        cachedConnection = GetFromPool();









        HttpConnection conn = cachedConnection._connection;
        if (cachedConnection.IsUsable)
        {


        }
    }



}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
   // Try to find a usable cached connection.
   while (true)
   {
      cachedConnection = GetFromPool();

      HttpConnection conn = cachedConnection._connection;
      if (cachedConnection.IsUsable)
      {
         // We found a valid connection.  Return it.
         return new ValueTask<HttpConnection>(conn);
      }
   }

}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {
        cachedConnection = GetFromPool();

        if (_associatedConnectionCount > _maxConnections)
        {
            waiter = EnqueueWaiter();
            break;
        }

        HttpConnection conn = cachedConnection._connection;
        if (cachedConnection.IsUsable)
        {
            // We found a valid connection.  Return it.
            return new ValueTask<HttpConnection>(conn);
        }
    }



}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {
        cachedConnection = GetFromPool();

        if (_associatedConnectionCount > _maxConnections)
        {
            waiter = EnqueueWaiter();
            break;
        }

        HttpConnection conn = cachedConnection._connection;
        if (cachedConnection.IsUsable)
        {
            // We found a valid connection.  Return it.
            return new ValueTask<HttpConnection>(conn);
        }
    }

    // We are at the connection limit. Wait for an available connection.
    return new ValueTask<HttpConnection>(waiter.WaitWithCancellationAsync());
}
```

HttpConnectionPool.cs


```
private ValueTask<HttpConnection> GetOrReserveHttpConnectionAsync()
{
    // Try to find a usable cached connection.
    while (true)
    {
        cachedConnection = GetFromPool();

        if (_associatedConnectionCount > _maxConnections)
        {
            waiter = EnqueueWaiter();
            break;
        }

        HttpConnection conn = cachedConnection._connection;
        if (cachedConnection.IsUsable)
        {
            // We found a valid connection.  Return it.
            return new ValueTask<HttpConnection>(conn);
        }
    }

    // We are at the connection limit. Wait for an available connection.
    return new ValueTask<HttpConnection>(waiter.WaitWithCancellationAsync());
}
```

FileStream.cs


```
public override ValueTask<int> ReadAsync(
  Memory<byte> buffer,
  CancellationToken cancellationToken = default (CancellationToken))
{
   // Всякие валидации

  int synchronousResult;
  Task<int> task = this.ReadAsyncInternal(buffer, cancellationToken, out synchronousResult);
  if (task == null)
      return new ValueTask<int>(synchronousResult);
  return new ValueTask<int>(task);
}
```

MemoryStream.cs


```
public override ValueTask<int> ReadAsync(
  Memory<byte> buffer,
  CancellationToken cancellationToken = default (CancellationToken))
{
    ……..

    ArraySegment<byte> segment;
    return new ValueTask<int>(
       MemoryMarshal.TryGetArray<byte>((ReadOnlyMemory<byte>) buffer, out segment) ?
       this.Read(segment.Array, segment.Offset, segment.Count) :
       this.Read(buffer.Span)
      );

      …….
}
```

System.Net.WebSockets


```
internal static ValueTask<int> ReadAsync(
    this Stream stream,
    Memory<byte> destination,
    CancellationToken cancellationToken = default)
{
    if (MemoryMarshal.TryGetArray(destination, out ArraySegment<byte> array))
    {
        return new ValueTask<int>(stream.ReadAsync(array.Array, array.Offset, array.Count, cancellationToken));
    }
    else
    {









    }
}
```

System.Net.WebSockets


```
internal static ValueTask<int> ReadAsync(
   this Stream stream,
   Memory<byte> destination,
   CancellationToken cancellationToken = default)
{
   if (MemoryMarshal.TryGetArray(destination, out ArraySegment<byte> array))
   {
      return new ValueTask<int>(stream.ReadAsync(array.Array, array.Offset, array.Count, cancellationToken));
   }
   else
   {
      byte[] buffer = ArrayPool<byte>.Shared.Rent(destination.Length);
      return new ValueTask<int>(FinishReadAsync(stream.ReadAsync());

      async Task<int> FinishReadAsync(Task<int> readTask)
      {
         // Много кода
      }
   }
}
```

1.**async** – не только Task, Task<T> и void

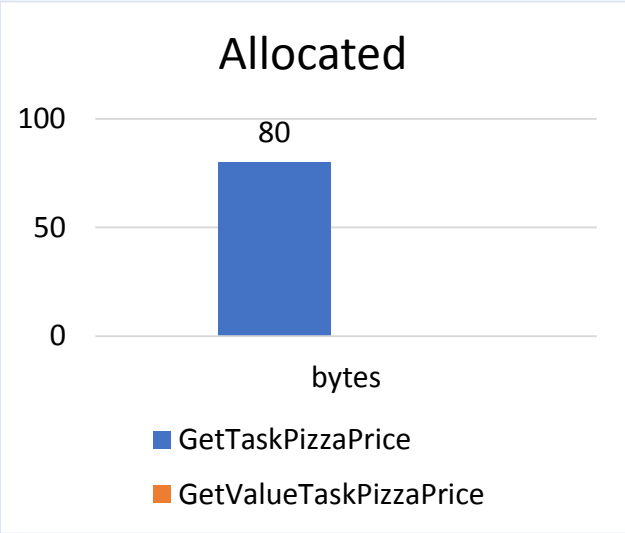
2. **task-like –** это типы с кастомным taskbuilder

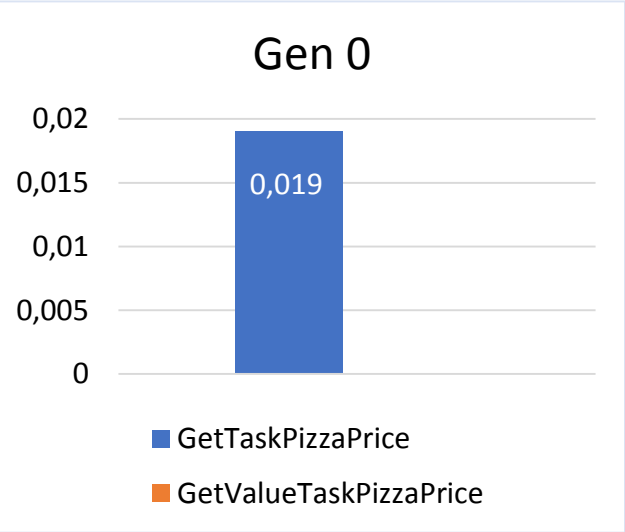
3. **ValueTask –** реализация task-like типа без выделения памяти в heap

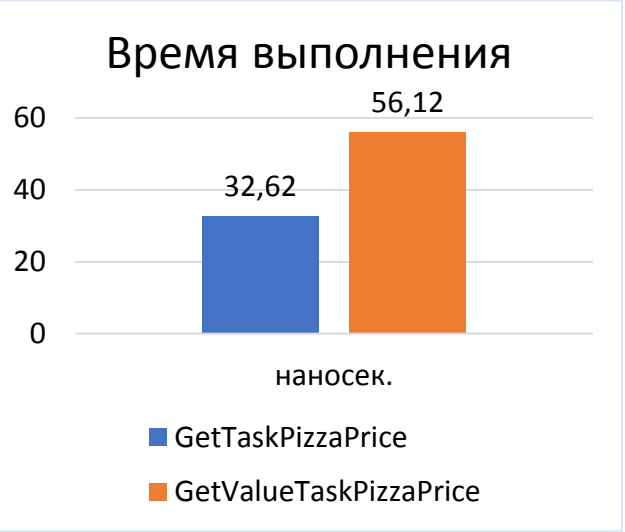
PizzaPriceProvider + ValueTask = ❤

```
public class PizzaPriceProvider
{
   public Dictionary<string, decimal> _cache = new Dictionary<string, decimal>();

   private Task<decimal> GetPrice(string name) => …


   public ValueTask<decimal> GetPizzaPriceValueTask(string name)
   {
      if (_cache.TryGetValue(name, out var price))
      {
         // Возвращаем кэшированные цены
         return new ValueTask<decimal>(price);
      }

      return new ValueTask<decimal>(GetPrice(name));
   }
}
```

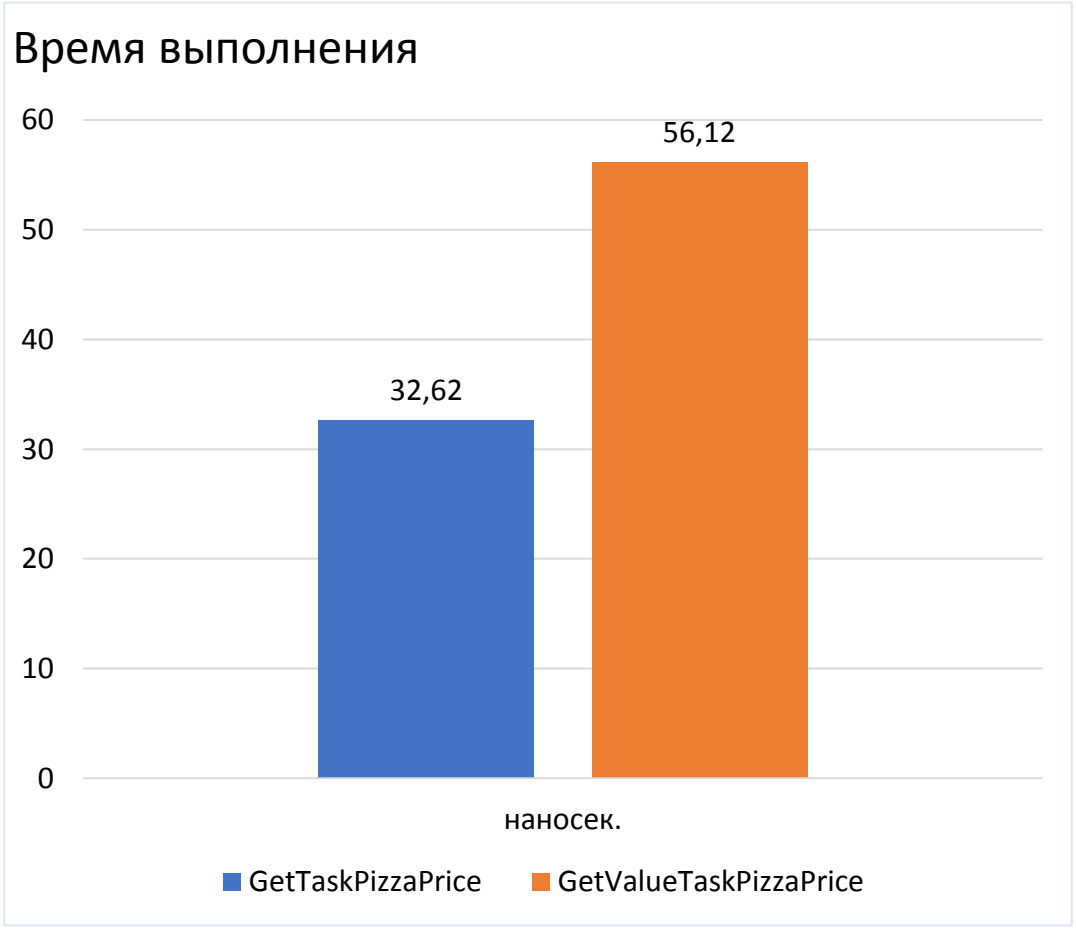
PizzaPriceProvider + ValueTask = ❤







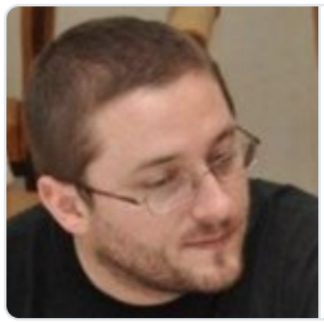
Почему медленнее?



Marc Gravell
@marcgravell

Follow

Very confused by some ValueTask<T> vs Task<T> performance metrics - is it me? gist.github.com/mgravell/c570e … /cc @ben_a_adams @jonskeet @davidfowl



async; ValueTask vs Task

async; ValueTask vs Task. GitHub Gist: instantly share code, notes, and snippets.

gist.github.com

11:34 AM - 16 Apr 2017

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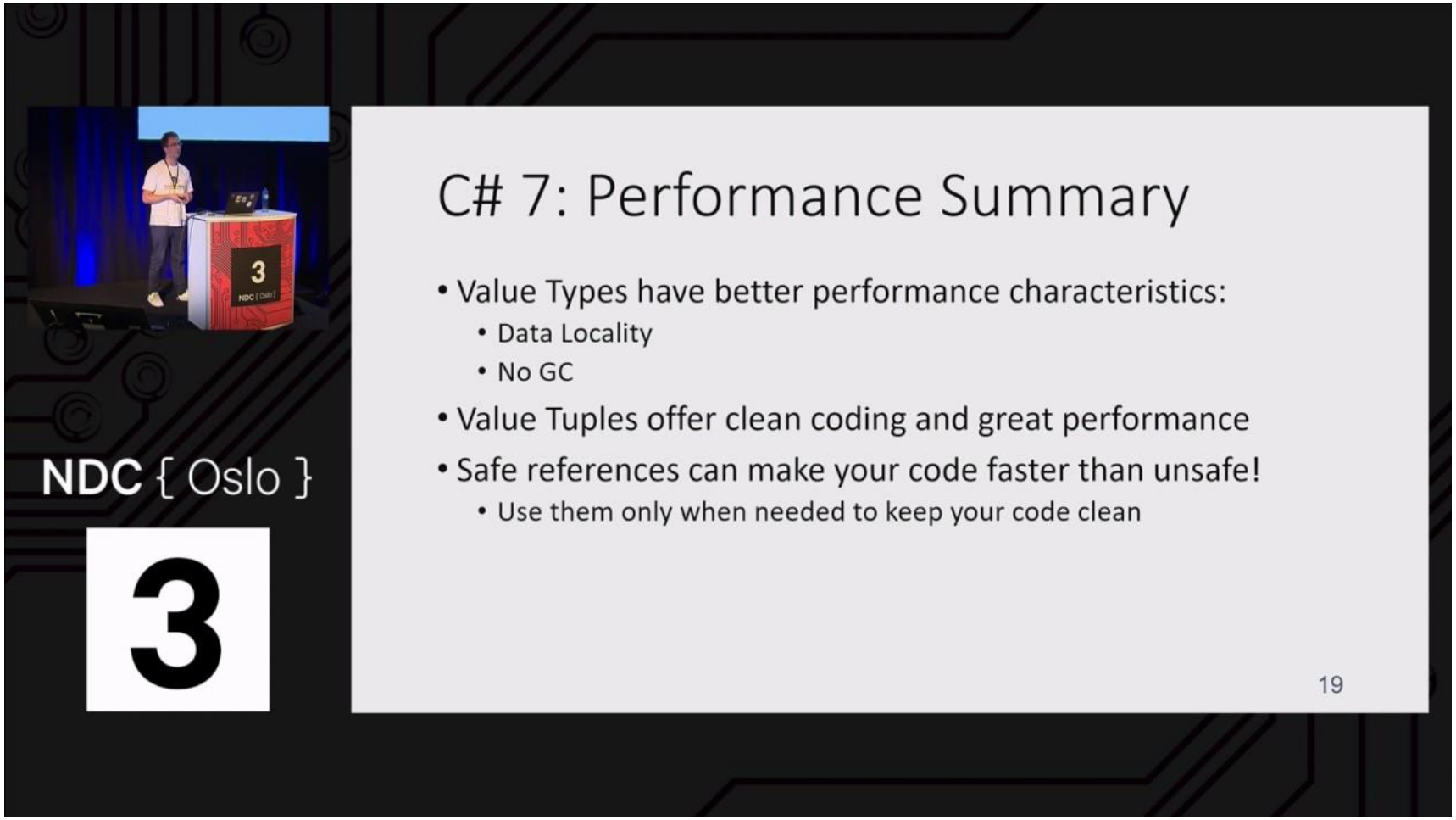
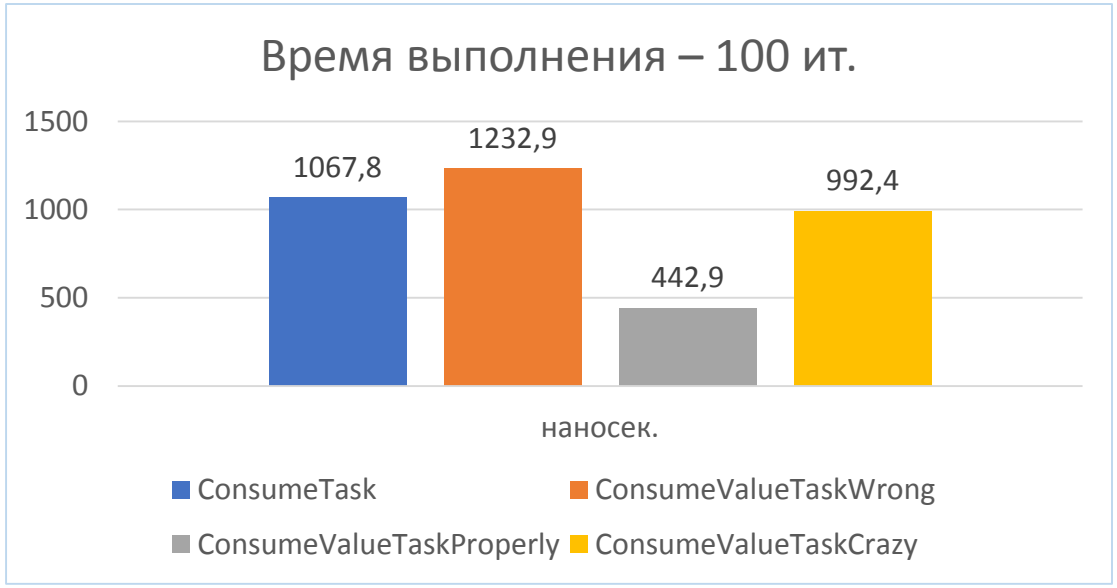
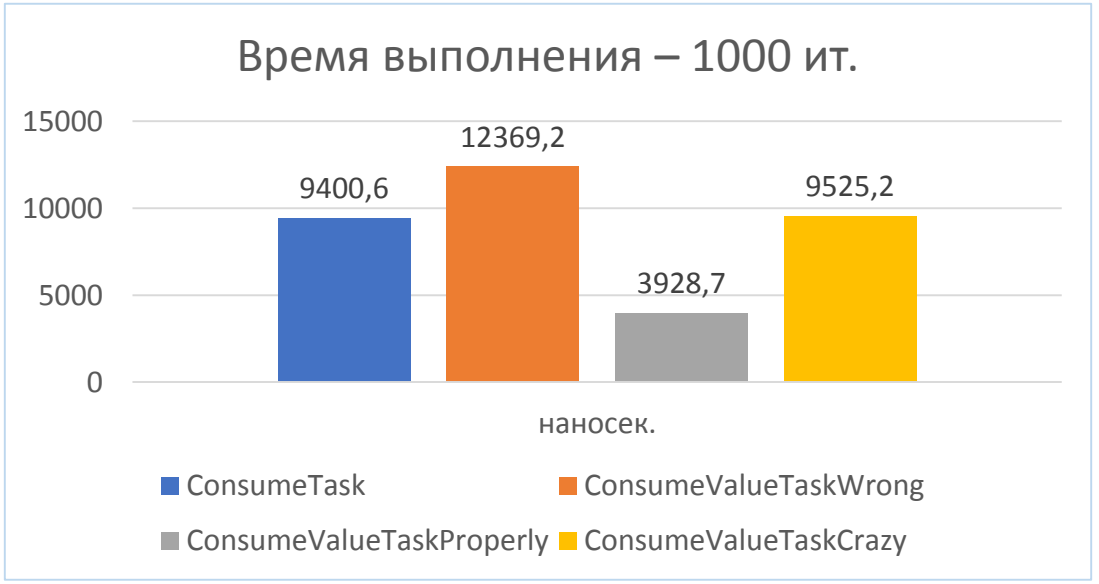


https://www.youtube.com/watch?v=CSPSvBeqJ9c

https://github.com/adamsitnik/StateOfTheDotNetPerformance


LIVE DEMO


Время выполнения – 100 ит.
1500
1000
500
0
1067,8
1232,9
442,9
992,4
наносек.
ConsumeTask
ConsumeValueTaskWrong
ConsumeValueTaskProperly
ConsumeValueTaskCrazy


Время выполнения – 1000 ит.
15000
10000
5000
0
9400,6
12369,2
3928,7
9525,2
наносек.
ConsumeTask
ConsumeValueTaskWrong
ConsumeValueTaskProperly
ConsumeValueTaskCrazy

There are also some minor costs associated with returning a ValueTask<TResult> instead of a Task<TResult>, e.g. in microbenchmarks it's a bit faster to await a Task<TResult> than it is to await a ValueTask<TResult>

https://blogs.msdn.microsoft.com/dotnet/2018/11/07/understanding-the-whys-whats-and-whens-of-valuetask/?utm_source=t.co&utm_medium=referral

Why would one use Task<T> over ValueTask<T> in C#?

As such, **the default choice for any asynchronous method should be to return a `Task` or `Task<TResult>`. Only if performance analysis proves it worthwhile should a `ValueTask<TResult>` be used instead of `Task<TResult>`.**

share edit flag

answered Mar 24 '17 at 15:44

Stephen Cleary

266k ● 45 ● 445 ● 558

Can someone explain when ValueTask would fail to do the job?

The purpose of the thing is improved performance. It doesn't do the job if it doesn't *measurably* and *significantly* improve performance. There is no guarantee that it will.

share edit flag

edited Mar 24 '17 at 18:41

answered Mar 24 '17 at 16:25

Eric Lippert

519k ● 142 ● 1029 ● 1896

https://stackoverflow.com/questions/43000520/why-would-one-use-taskt-over-valuetaskt-in-c

Add ValueTask to corefx

stephentoub commented on 30 Nov 2015 — Member

> Are there plans to let async be used with this?

No concrete plans, but it's being discussed (cc: **@jaredpar**, **@MadsTorgersen**). There is value in doing so. However, using a `ValueTask<TResult>` instead of a `Task<TResult>` isn't a pure win. There is overhead associated with it (for example, it's a field bigger, which means you're not only passing back an extra field from a method, if you're awaiting one of these it's likely going to increase the size of an async caller's state machine object by the size of a field), and that's pure overhead without benefit in the case where the operation does complete asynchronously. That means developers really need to

```
}

private async ValueTask<Something> BarAsynccore(string arg) { ... }
```

There obviously is. I'm simply highlighting it to point out that `ValueTask<TResult>` should only be used after careful consideration, and with such careful consideration, you're likely also considering other optimizations that might lead you away from this. And of course there's cost involved in developing such a feature to the language, in developers needing to learn about it, etc.

https://github.com/dotnet/corefx/issues/4708#issuecomment-160658188

Когда?

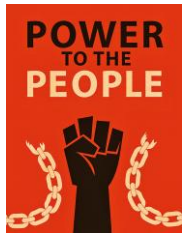
stephentoub commented 21 days ago • edited 21 days ago

We still need to formalize guidance, but I expect it'll be something like this for public API surface area:

- Task provides the most usability.
- ValueTask provides the most options for performance optimization.
- If you're writing an interface / virtual method that others will override, ValueTask is the right default choice.
- If you expect the API to be used on hot paths where allocations will matter, ValueTask is a good choice.
- Otherwise, where performance isn't critical, default to Task, as it provides better guarantees and usability.

From an implementation perspective, many of the returned ValueTask instances will still be backed by Task.

1. Теперь можно **влиять** на async/await



2. Для этого мы можем создать свои **AsyncЧтоУгодноBuilder**

3. **ValueTask** – пример такого **AsyncЧтоУгодноBuilder**

4. Помогает убрать лишние **аллокации** в hot paths

5. ValueTask необходимо **применять** с умом и после измерений

Кусочек большого пазла

- Span<T>
- Memory<T>
- in parameters
- ref locals и ref returns
- ref readonly returns
- readonly struct
- ref struct
- stack-allocated objects (merged)

Pipe.cs


```
internal ValueTask<ReadResult> ReadAsync(CancellationToken token)
{
  ValueTask<ReadResult> valueTask;
  try
  {
    if (_readerAwaitable.IsCompleted)
    {
      ReadResult result = new ReadResult();
      GetReadResult(ref result);
      valueTask = new ValueTask<ReadResult>(result);
    }
    else

  }
  return valueTask;
}
```

Pipe.cs


```
internal ValueTask<ReadResult> ReadAsync(CancellationToken token)
{
  ValueTask<ReadResult> valueTask;
  try
  {
    if (_readerAwaitable.IsCompleted)
    {
      ReadResult result = new ReadResult();
      GetReadResult(ref result);
      valueTask = new ValueTask<ReadResult>(result);
    }
    else
      valueTask = new ValueTask<ReadResult>((IValueTaskSource<ReadResult>) _reader);
  }
  return valueTask;
}
```

А что, если?


```
public class WhatIf
{
    public ValueTask<int> DoSomething()
    {
        if(можетБытьСинхронным)
            return new ValueTask<int>(42);

        // Хочу, чтобы здесь не было аллокаций
        return new ValueTask<int>(Task.FromResult(42));
    }
}
```


SWIM

IValueTaskSource


```
public readonly struct ValueTask<TResult>
{
  public ValueTask(IValueTaskSource<TResult> source, short token);

  public ValueTask(Task<TResult> task);

  public ValueTask(TResult result);
}
```

IValueTaskSource

```
public interface IValueTaskSource<out TResult>
{
  TResult GetResult(short token);

  ValueTaskSourceStatus GetStatus(short token);

  void OnCompleted(
            Action<object> continuation,
            object state,
            short token,
            ValueTaskSourceOnCompletedFlags flags);
}
```

А что, если?


```
public class WhatIfV2
{
   public ValueTask<int> DoSomething()
   {
      if(можетБытьАсинхронным)
         return new ValueTask<int>(42);

      // Используем пул
      IValueTaskSource<int> vts = …;
      return new ValueTask<int>(vts);
   }
}
```

```
/// <summary>A SocketAsyncEventArgs that can be awaited to get the result of an operation.</summary>
internal sealed class AwaitableSocketAsyncEventArgs : SocketAsyncEventArgs, IValueTaskSource, IValueTaskSource<int>
{
    internal static readonly AwaitableSocketAsyncEventArgs Reserved = new AwaitableSocketAsyncEventArgs() { _continuation = null };
    /// <summary>Sentinel object used to indicate that the operation has completed prior to OnCompleted being called.</summary>
    private static readonly Action<object> s_completedSentinel = new Action<object>(state => throw new Exception(nameof(s_completed
    /// <summary>Sentinel object used to indicate that the instance is available for use.</summary>
    private static readonly Action<object> s_availableSentinel = new Action<object>(state => throw new Exception(nameof(s_available
    /// <summary>
    /// <see cref="s_availableSentinel"/> if the object is available for use, after GetResult has been called on a previous use.
    /// null if the operation has not completed.
    /// <see cref="s_completedSentinel"/> if it has completed.
    /// Another delegate if OnCompleted was called before the operation could complete, in which case it's the delegate to invoke
    /// when the operation does complete.
    /// </summary>
    private Action<object> _continuation = s_availableSentinel;
    private ExecutionContext _executionContext;
    private object _scheduler;
    /// <summary>Current token value given to a ValueTask and then verified against the value it passes back to us.</summary>
    /// <remarks>
    /// This is not meant to be a completely reliable mechanism, doesn't require additional synchronization, etc.
    /// It's purely a best effort attempt to catch misuse, including awaiting for a value task twice and after
    /// it's already being reused by someone else.
    /// </remarks>
    private short _token;
```

https://github.com/dotnet/corefx/blob/61f51e6b2b26271de205eb8a14236afef482971b/src/System.Net.Sockets/src/System/Net/Sockets/Socket.Tasks.cs#L808

```
/// <summary>The representation of an asynchronous operation that has a result value.</summary>
/// <typeparam name="TResult">Specifies the type of the result.  May be <see cref="VoidResult"/>.</typeparam>
internal partial class AsyncOperation<TResult> : AsyncOperation, IValueTaskSource, IValueTaskSource<TResult>
{
    /// <summary>Registration with a provided cancellation token.</summary>
    private readonly CancellationTokenRegistration _registration;
    /// <summary>true if this object is pooled and reused; otherwise, false.</summary>
    /// <remarks>
    /// If the operation is cancelable, then it can't be pooled.  And if it's poolable, there must never be race conditi
    /// which is the main reason poolable objects can't be cancelable, as then cancellation could fire, the object could
    /// and then we may end up trying to complete an object that's used by someone else.
    /// </remarks>
    private readonly bool _pooled;
    /// <summary>Whether continuations should be forced to run asynchronously.</summary>
    private readonly bool _runContinuationsAsynchronously;
```

https://github.com/dotnet/corefx/blob/89ab1e83a7e00d869e1580151e24f01226acaf3f/src/System.Threading.Channels/src/System/Threading/Channels/AsyncOperation.cs#L37

```
/// <summary>
/// Default <see cref="PipeWriter"/> and <see cref="PipeReader"/> implementation.
/// </summary>
public sealed partial class Pipe
{
    private sealed class DefaultPipeReader : PipeReader, IValueTaskSource<ReadResult>
    {
        private readonly Pipe _pipe;

        public DefaultPipeReader(Pipe pipe)
        {
            _pipe = pipe;
        }

        public override bool TryRead(out ReadResult result) => _pipe.TryRead(out result);
```

https://github.com/dotnet/corefx/blob/a10890f4ffe0fadf090c922578ba0e606ebdd16c/src/System.IO.Pipelines/src/System/IO/Pipelines/Pipe.DefaultPipeReader.cs#L16


LIVE DEMO

IValueTaskSource

Most developers should never have a need to see this interface: methods simply hand back a ValueTask<TResult> that may have been constructed to wrap an instance of this interface, and the consumer is none-the-wiser. The interface is primarily there so that developers of performance-focused APIs are able to avoid allocation.

https://blogs.msdn.microsoft.com/dotnet/2018/11/07/understanding-the-whys-whats-and-whens-of-valuetask/

Как это работает?

Most developers should never need to implement these interfaces. They're also not particularly easy to implement. If you decide you need to, there are several implementations internal to .NET Core 2.1 that can serve as a reference, e.g.

https://blogs.msdn.microsoft.com/dotnet/2018/11/07/understanding-the-whys-whats-and-whens-of-valuetask/

Как начать этим всем пользоваться?

	.NET Core	.NET FX
Task-like types	C# 7.0	C# 7.0
ValueTask	1.0	System.Threading.Tasks.Extensions
IValueTaskSource	2.1	System.IO.Pipelines

Ссылки

1. https://blogs.msdn.microsoft.com/dotnet/2018/11/07/understanding-the-whys-whats-and-whens-of-valuetask/ - кратко и про все
2. https://blog.scooletz.com/2018/05/14/task-async-await-valuetask-ivaluetasksource-and-how-to-keep-your-sanity-in-modern-net-world/ - еще раз кратко и обо всем
3. http://blog.i3arnon.com/2015/11/30/valuetask/ - одно из первых упоминаний
4. http://tooslowexception.com/implementing-custom-ivaluetasksource-async-without-allocations/ - IValueTaskSource
5. https://blogs.msdn.microsoft.com/seteplia/2017/11/30/dissecting-the-async-methods-in-c/ - классная серия про async
6. https://github.com/adamsitnik/StateOfTheDotNetPerformance - StateOfTheDotNetPerformance
7. https://github.com/dotnet/roslyn/blob/master/docs/features/task-types.md - дока из Roslyn
8. https://github.com/dotnet/corefx/issues/4708#issuecomment-160658188 – issue в corefx
9. https://stackoverflow.com/questions/43000520/why-would-one-use-taskt-over-valuetaskt-in-c - Why would one use Task<T> over ValueTask<T> in C#?


Ben Adams
@ben_a_adams
Читаю
You don't need to worry about garbage collection; if you don't allocate!
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IF YOU DON'T ALLOCATE
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