Particular Software

Welcome

Rearchitect your code

towards async/await

Particular Software

Solution Architect
Enthusiastic Software Engineer
Microsoft MVP for systems integration

@danielmarbach
particular.net/blog
planetgeek.ch

Goals

target

CPU-bound vs IO-bound

Threads and Tasks

Async best-practices

Why async is the future

Premise


Terminology
Why
WrapUp

The die

is cast

javascript

ES2015

```
async function chainAnimationsPromise(elem, animations)
{
    let ret = null;
    try {
    for(const anim of animations) {
        ret = await anim(elem);
    }
    catch(e) { /* ignore and keep going */ }
    return ret;
}
```

```
$ npm install babel-plugin-syntax-async-functions
$ npm install babel-plugin-transform-async-to-generator
```

httpclient

```
using (var client = new HttpClient()) {
  var response = await
      client.GetAsync("api/products/1");
  if (response.IsSuccessStatusCode)
  {
    var product = await
      response.Content.ReadAsAsync<Product>();
  }
}
```

Azure SDK

```
var queryable =
client.CreateDocumentQuery<Entity>(...)
    .AsDocumentQuery();

while (queryable.HasMoreResults)
{
  foreach(var e in await
queryable.ExecuteNextAsync<Entity>())
  {
    // Iterate through entities
  }
}
```

async

event-driven

Task

uniform

Task

IO-bound

Task

CPU-bound

Recap

best-practices

Use async Task instead of async void

Async all the way, don't mix blocking and asynchronous code

Async / await

is viral

but

It kicks your

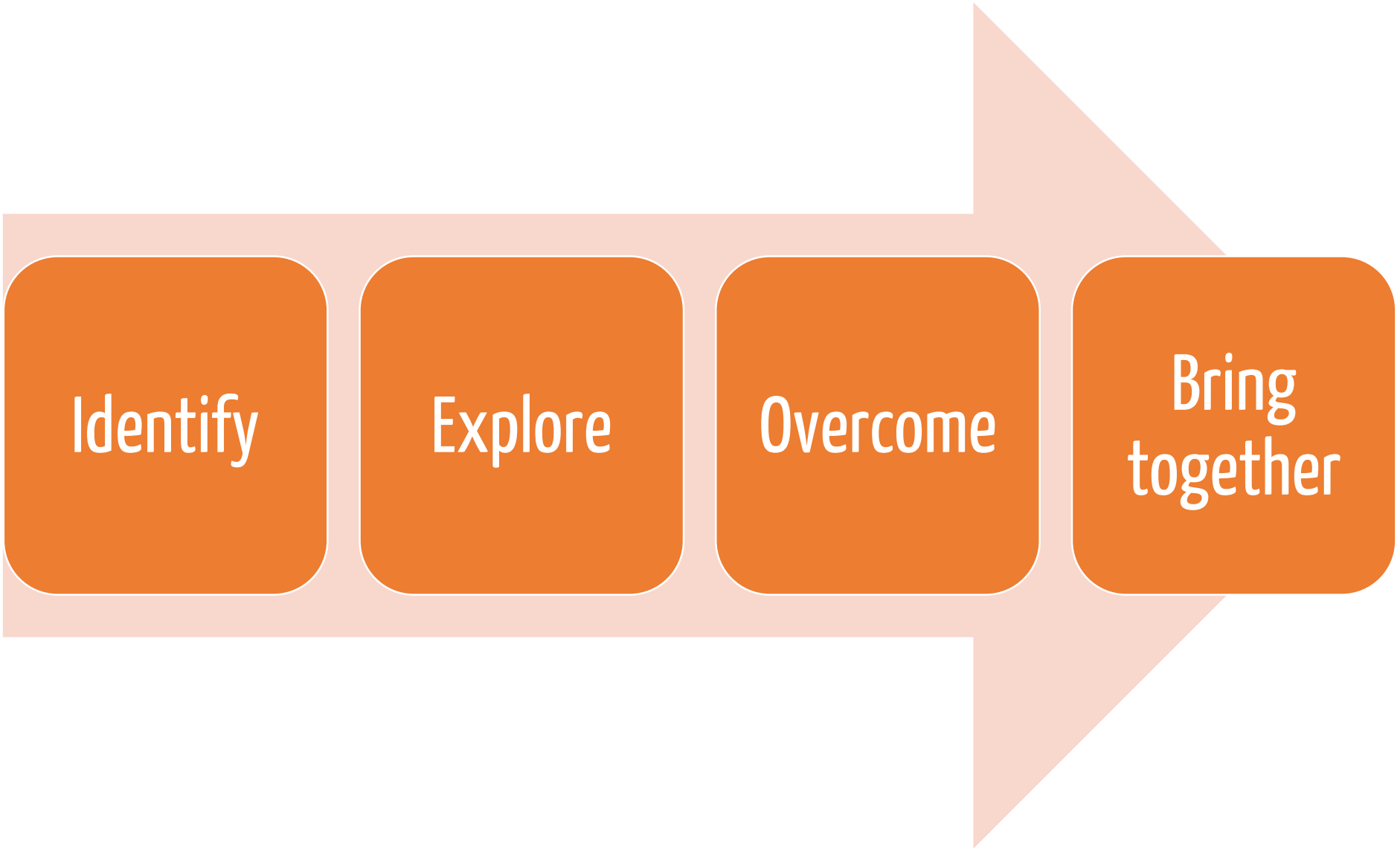
servers

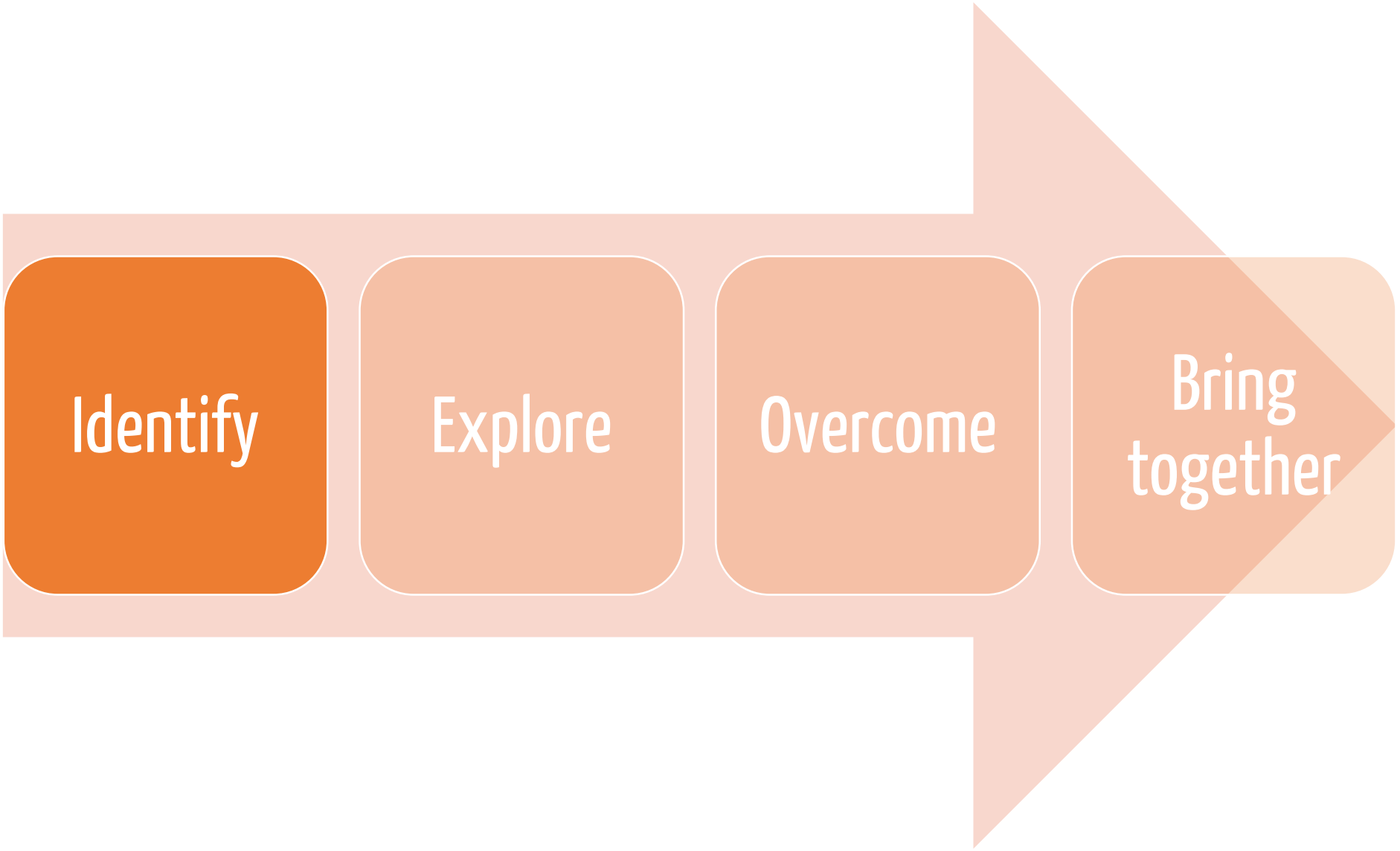
butt

NServiceBus

Azure Service Bus	26 times
Azure Storage Queues	6 times
MSMQ	3 times

more message throughput


Identify
Explore
Overcome
Bring together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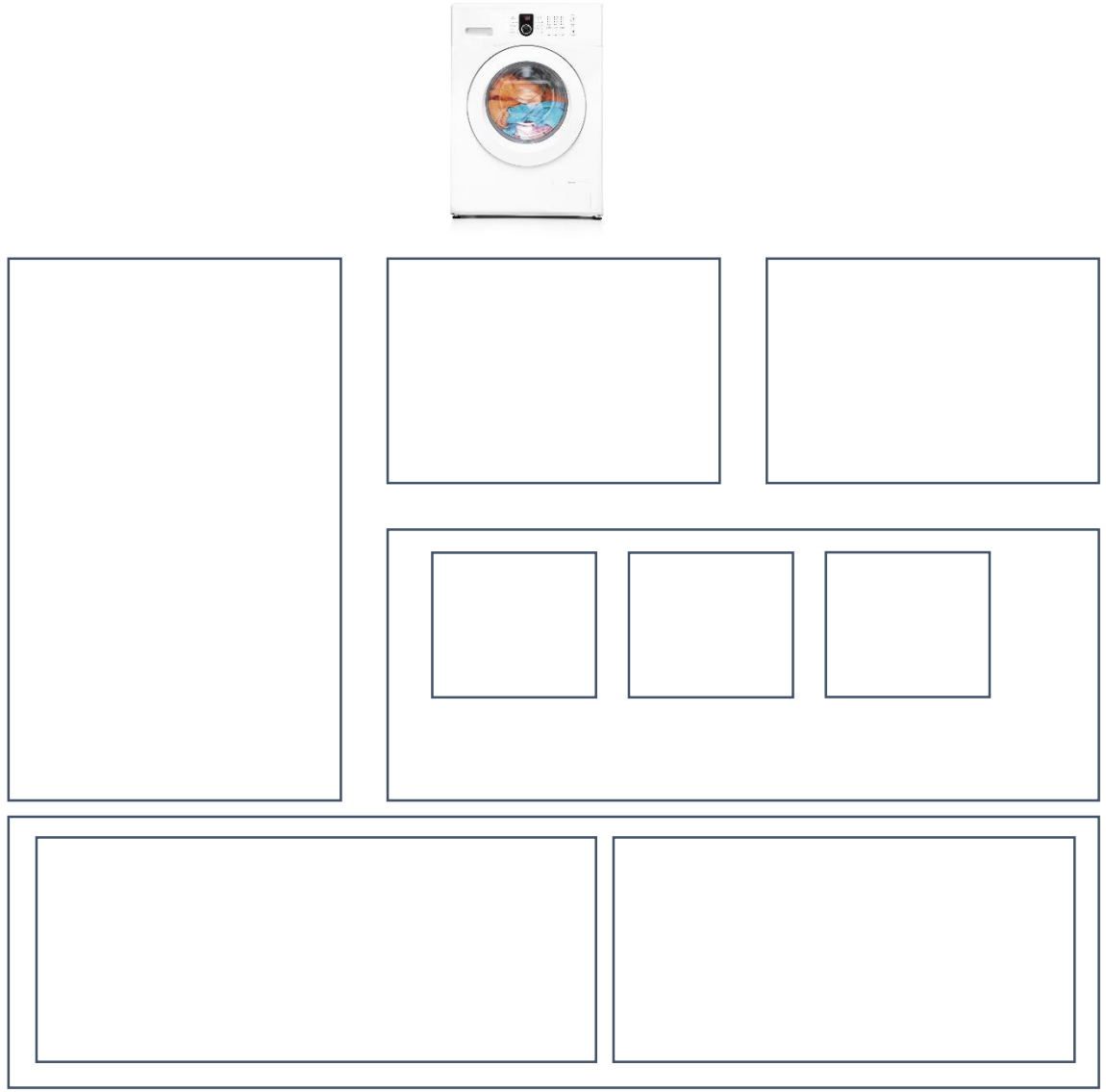
Identify

IO-bound



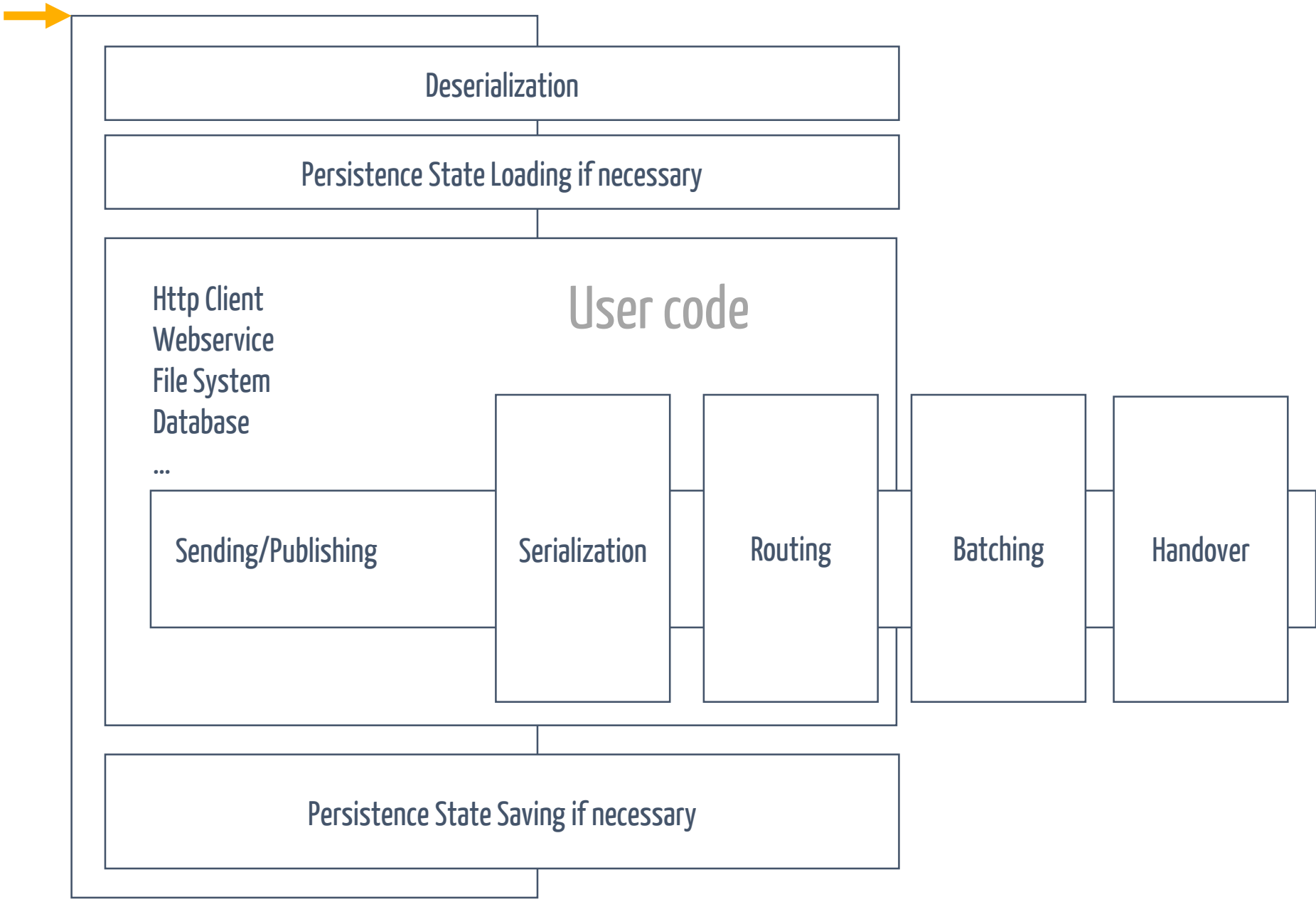
NServiceBus

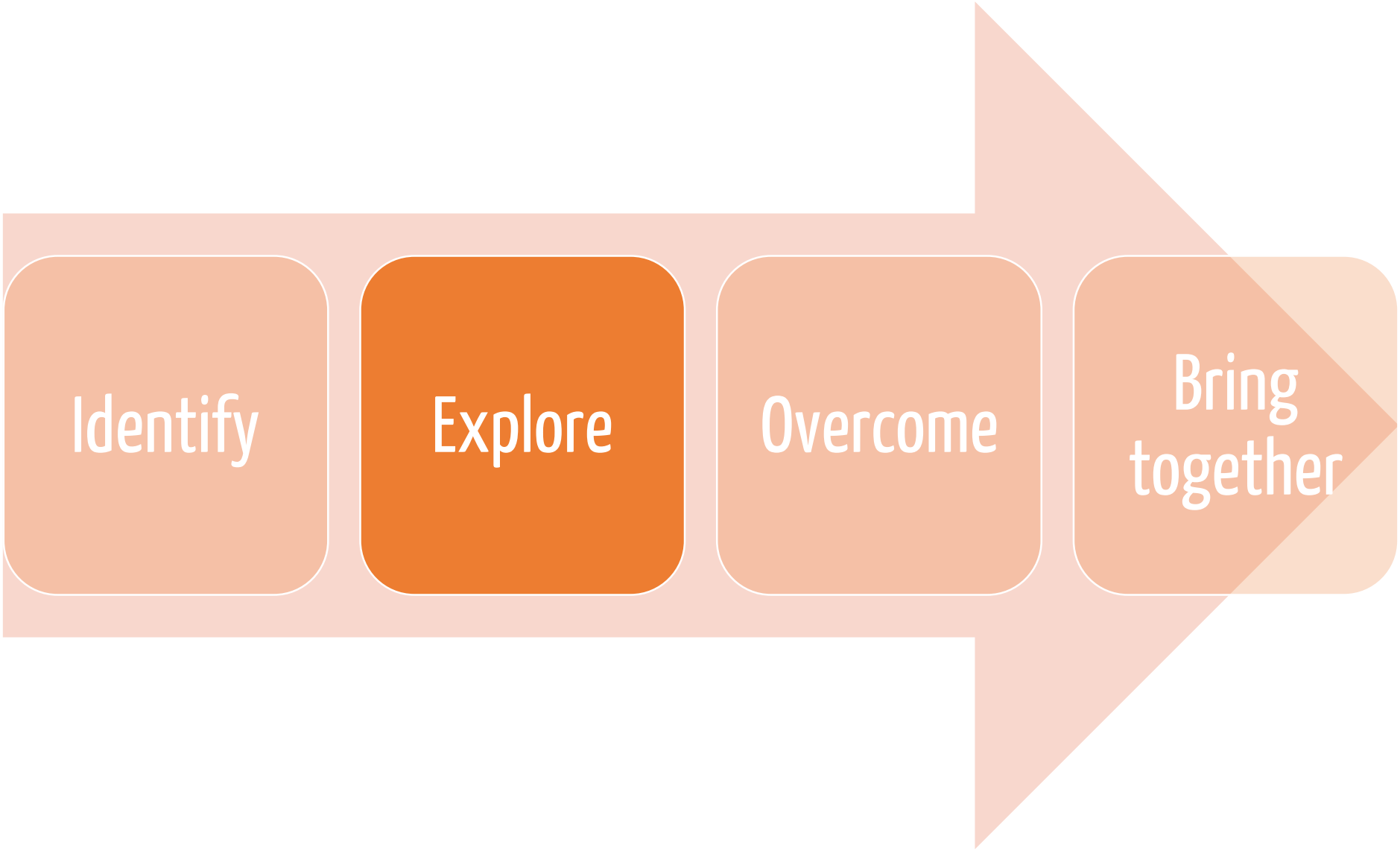
IO-bound

Queue

NServiceBus

IO-bound

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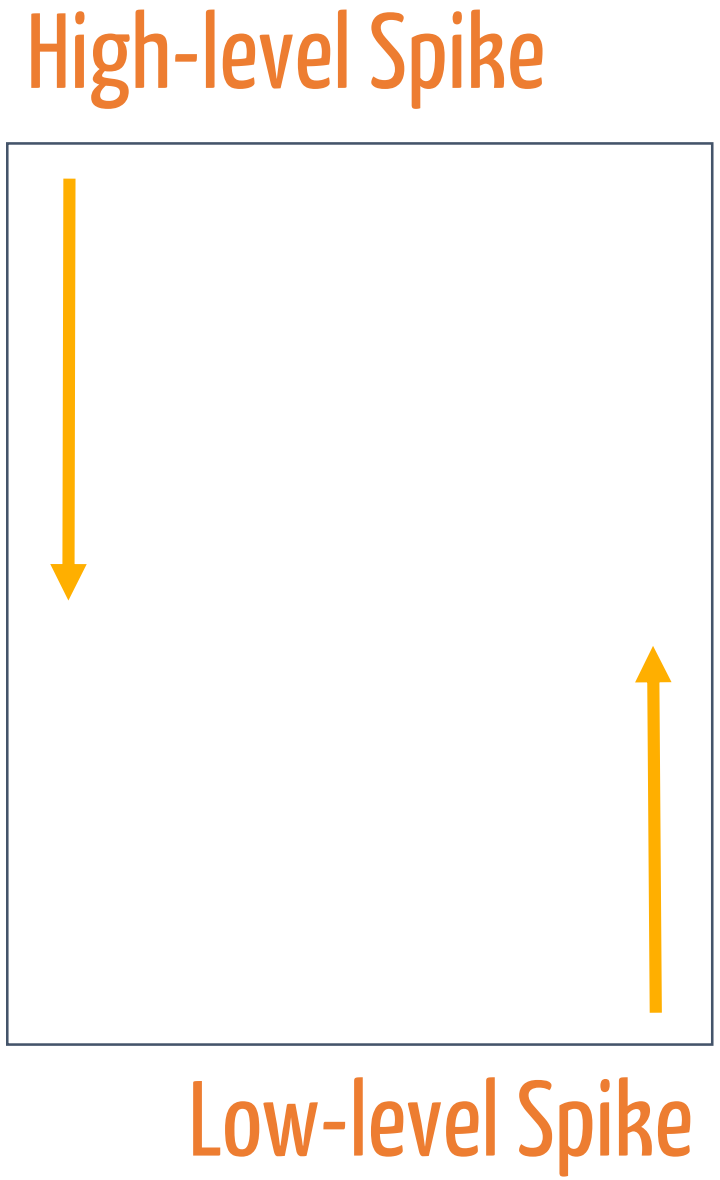
Explore

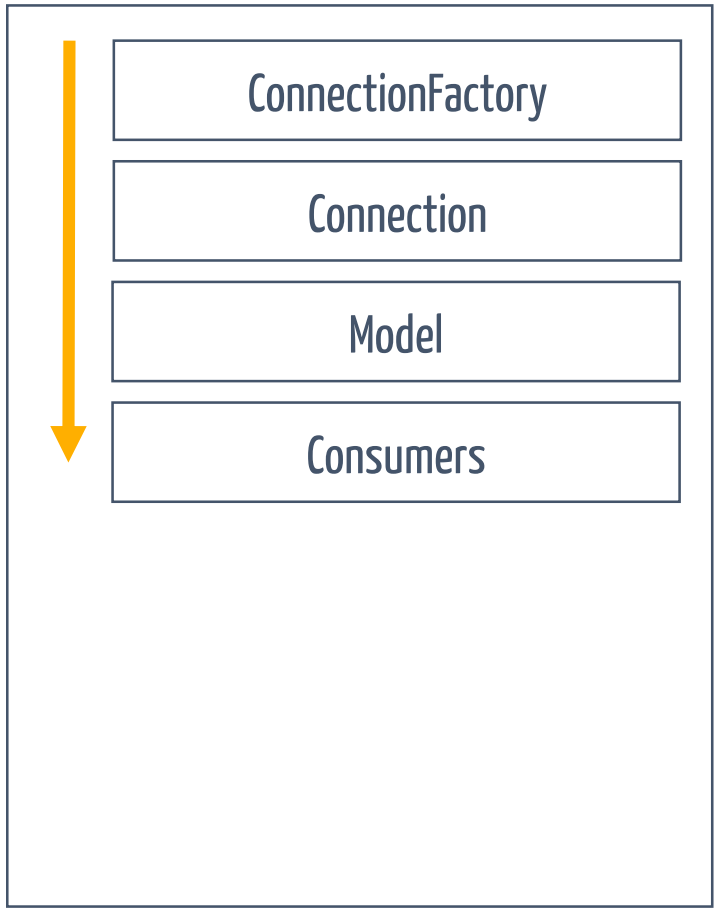
IO-bound



RabbitMQ Client

IO-bound

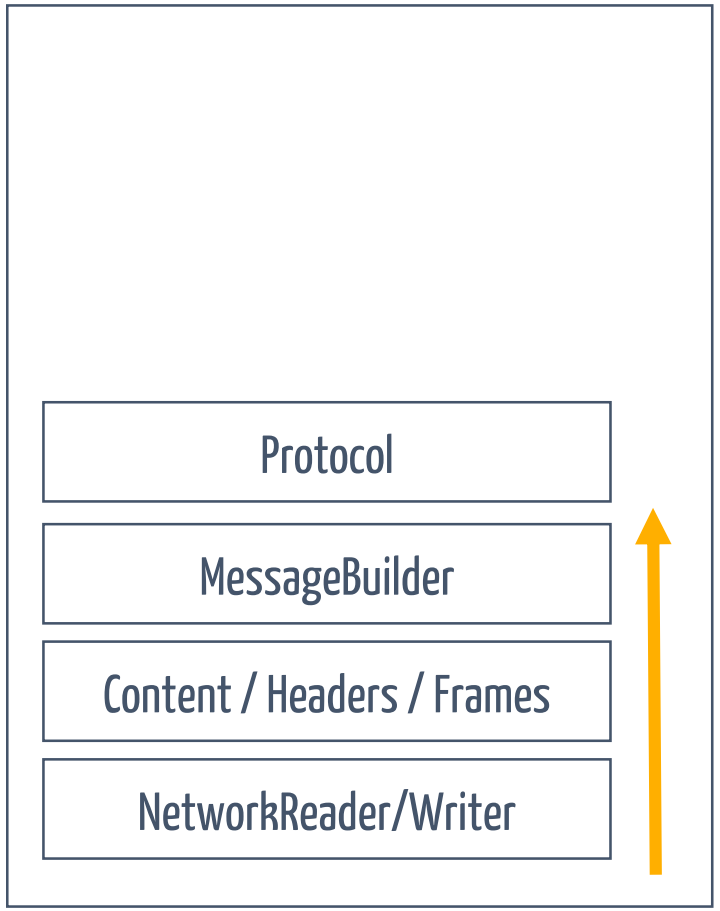
High-level Spike



github.com/rabbitmq/rabbitmq-dotnet-client/pull/151

RabbitMQ Client

IO-bound



Low-level Spike

github.com/rabbitmq/rabbitmq-dotnet-client/pull/149

Event handlers

Locks

Monitor

Semaphore / Mutex

Auto / ManualResetEvent

Ref/Out parameters

Thread

Ambient state

IO-bound calls in 3rd Party libs

Remote Procedure Calls

Event handlers


```
public delegate void EventHandler(object sender, EventArgs e);

public delegate void EventHandler<TEventArgs>(object sender, TEventArgs e);
```

```
async void MyEventHandler(object sender, EventArgs e)
{
    await Task.Yield();
    throw new InvalidOperationException();
}
```

ManualResetEvent


```
var syncEvent = new ManualResetEvent(false);

var t1 = Task.Run(() => {
  "Entering wait".Output();
  syncEvent.WaitOne();
  "Continue".Output();
});

ar t2 = Task.Run(() => {
  Thread.Sleep(2000);
  syncEvent.Set();
});

await Task.WhenAll(t1, t2);
```

```
01:08:14:093: Entering wait
01:08:16:094: Continue
```

void stinks wait smells

Remember

Async all the way means avoid blocking code

locks


```
 var locker = new object();
lock (locker)
{
   await Task.Yield();
}
```

Error CS1996
Cannot await in the body of a lock statement

http://stackoverflow.com/questions/7612602/why-cant-i-use-the-await-operator-within-the-body-of-a-lock-statement

Ref/Out


```
static async Task Out(string content, out string parameter)
{
  var randomFileName = Path.GetTempFileName();
  using (var writer = new StreamWriter(randomFileName))
  {
    await writer.WriteLineAsync(content);
  }
  parameter = randomFileName;
}
```

Error CS1988

Async methods cannot have ref or out parameters

Ambient state


```
class ClassWithAmbientState
{
  static ThreadLocal<int> ambientState =
      new ThreadLocal<int>(() => 1);

  public void Do()
  {
    ambientState.Value++;
  }
}
```

Ambient state

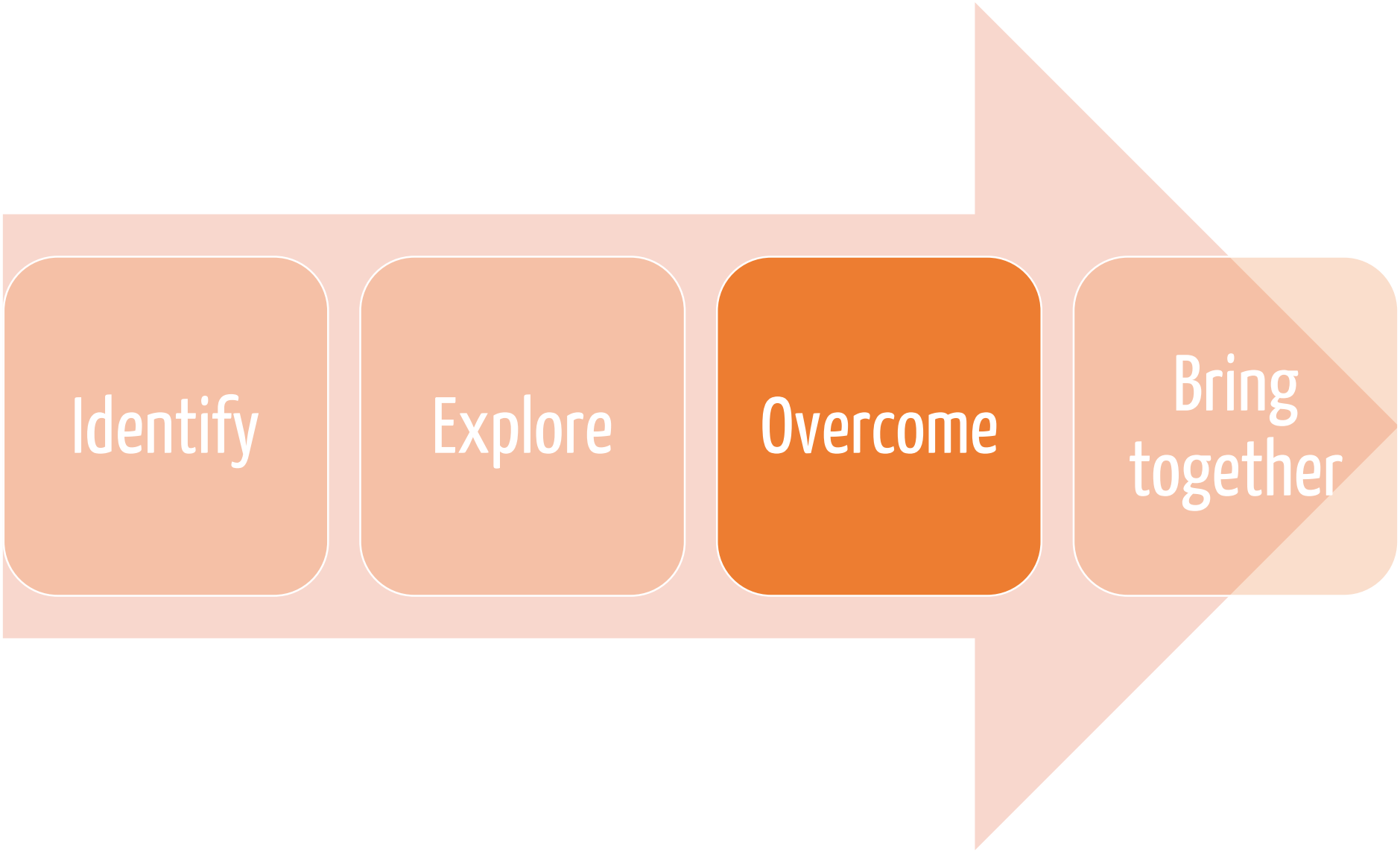

```
 var instance = new ClassWithAmbientState();
var tasks = new Task[3];
for (int i = 0; i < 3; i++) {
  tasks[i] = Task.Run(() => {
    instance.Do();
    Thread.Sleep(200);
    instance.Do();
  });
}

await Task.WhenAll(tasks);
```

Older constructs bound to threads
fall apart in the async/await world

Remember

Forget thread!

think Task


Identify
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Event handlers


```
public delegate Task AsyncEventHandler(object sender, EventArgs e);

async Task MyAsyncEventHandler(object sender, EventArgs e) { }

protected virtual Task OnMyAsyncEvent() {
  ...
  var invocations = handler.GetInvocationList();
  var handlerTasks = new Task[invocationList.Length];

  for (int i = 0; i < invocations.Length; i++) {
   handlerTasks[i] = ((AsyncEventHandler)invocations[i])(...);
  }
  return Task.WhenAll(handlerTasks);
}
```

ManualResetEvent


```
var tcs = new TaskCompletionSource<object>();

var t1 = Task.Run(() => {
  "Entering wait".Output();
  await tcs.Task;
  "Continue".Output();
});

ar t2 = Task.Run(() => {
  await Task.Delay(2000);
  tcs.TrySetResult(null);
});

await Task.WhenAll(t1, t2);
```

```
04:36:52:087:: Entering wait
04:36:54:094: Continue
```

ManualResetEvent

Works for set once events only.
For reset events an approach is available on my github account

locks

Can we change the code so that we don't have to await inside the lock?

locks


```
int sharedRessource = 0;
var semaphore = new SemaphoreSlim(1);

var tasks = new Task[3];
for (int i = 0; i < 3; i++) {
  tasks[i] = ((Func<Task>) (async () => {
    await semaphore.WaitAsync();
    sharedRessource++;
    semaphore.Release();
  }))();
}
await Task.WhenAll(tasks);
```

Ref/Out


```
static async Task<string> Out(string content)
{
  var randomFileName = Path.GetTempFileName();
  using (var writer = new StreamWriter(randomFileName))
  {
    await writer.WriteLineAsync(content);
  }
  return randomFileName;
}
```

Ambient state


```
class ClassWithAmbientState
{
  static AsyncLocal<int> ambientState = new AsyncLocal<int>();

  static ClassWithAmbientState() {
    ambientState.Value = 1;
  }

  public void Do()
  {
    ambientState.Value++;
  }
}
```

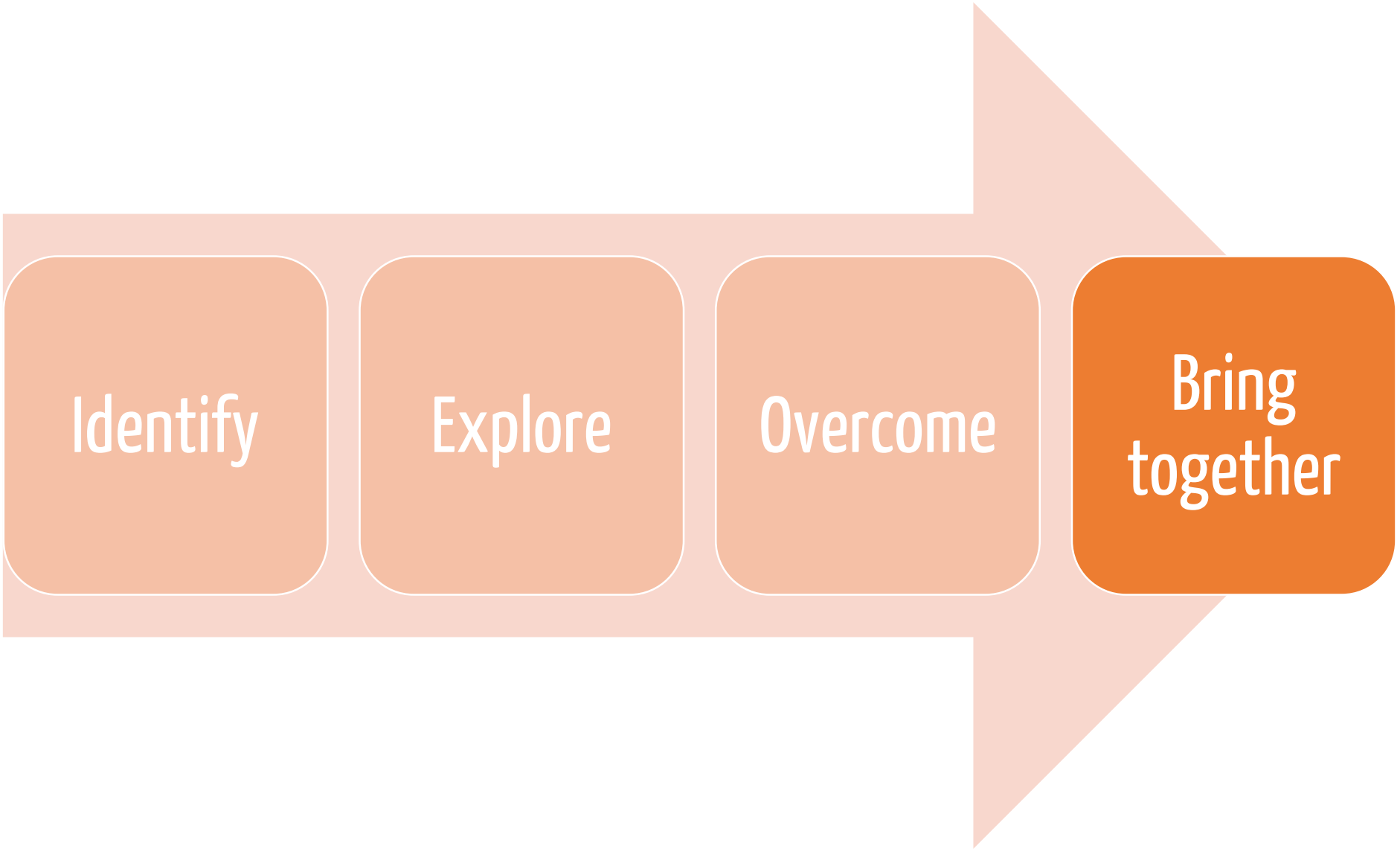
Ambient state

Even better:
Can we change the code so that we float state into methods that need it?

Ambient state


```
var instance = new ClassWithAmbientFloatingStateReturned();

var tasks = new Task[3];
for (int i = 0; i < 3; i++) {
  tasks[i] = ((Func<Task>)(async () => {
    int current = 1;
    current = instance.Do(current);
    await Task.Delay(200).ConfigureAwait(false);
    instance.Do(current);
  }))();
}
await Task.WhenAll(tasks);
```


Identify
Explore
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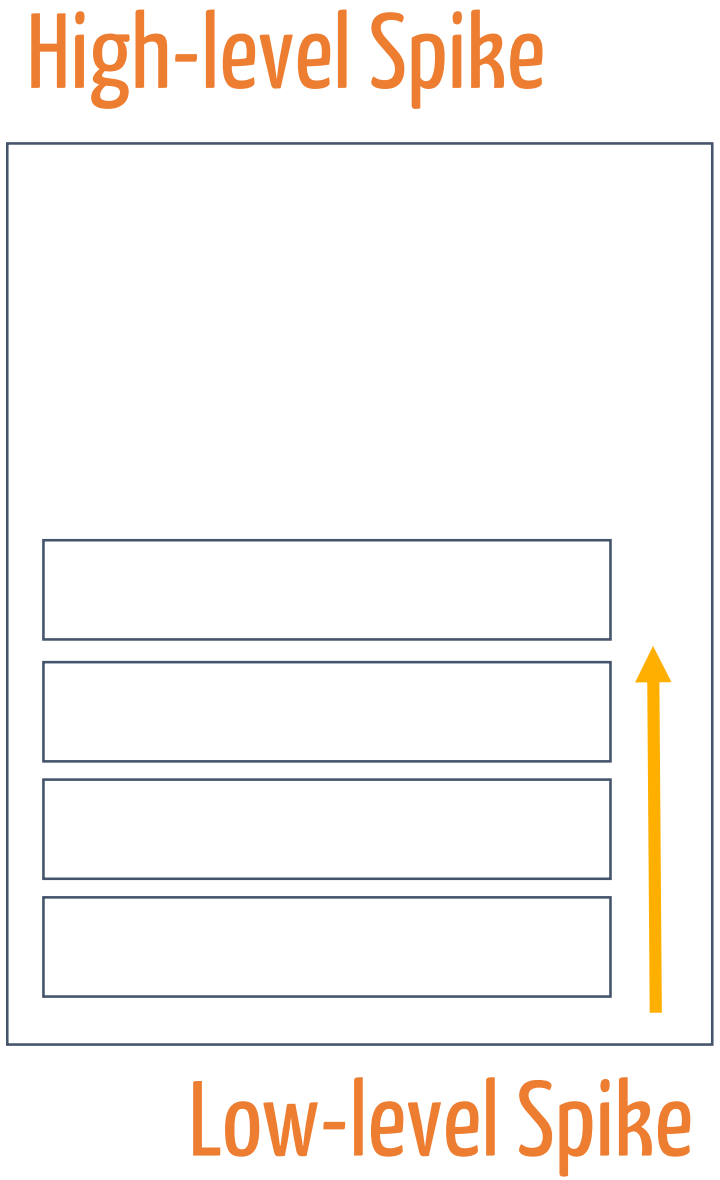
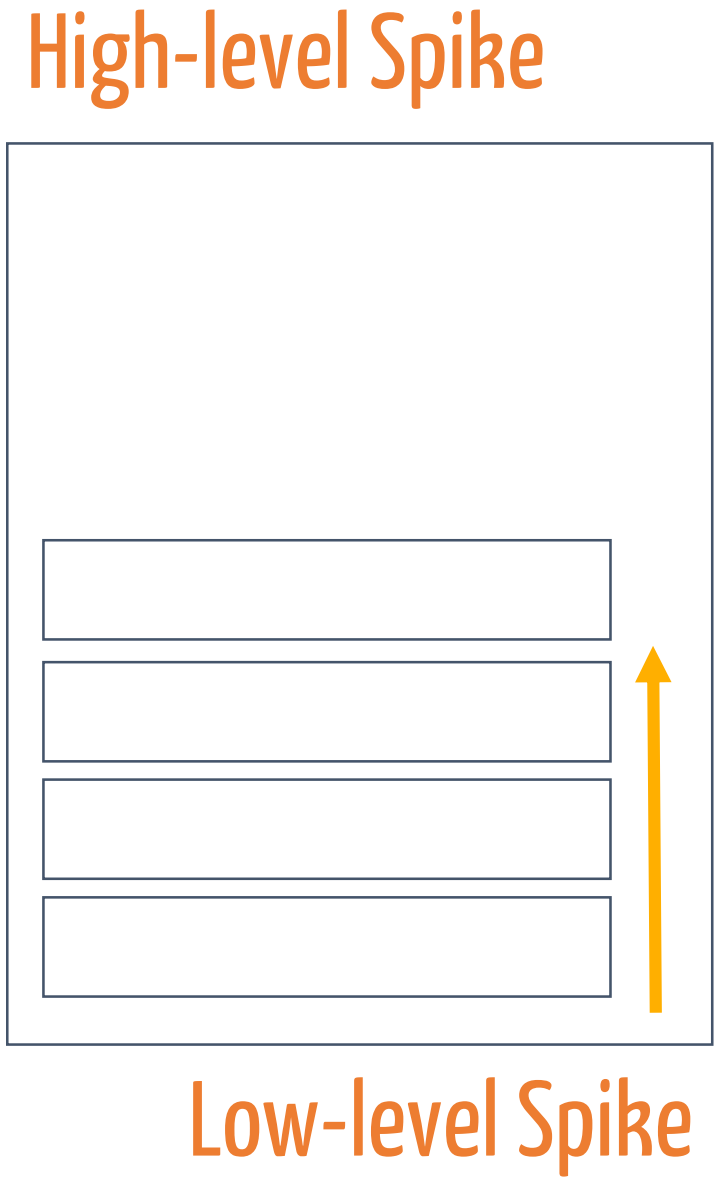
Bring together

Bring it together



Bring it together



Bring it together

```
void HighLevel() {
  try {
    MidLevel();
  } catch(InvalidOperationException) { }
}

void MidLevel() {
  ...
  LowLevel();
  ...
}

void LowLevel() {
}
```

Bring it together

```
void HighLevel() {
  try {
    MidLevel();
  } catch(InvalidOperationException) { }
}

void MidLevel() {
  …
  LowLevel().GetAwaiter().GetResult();
  …
}

async Task LowLevel() {
}
```

Commit. Push.

Bring it together

```
void HighLevel() {
  try {
    MidLevel().GetAwaiter().GetResult();
  } catch(InvalidOperationException) { }
}

async Task MidLevel() {
  …
  await LowLevel().ConfigureAwait(false);
  …
}

async Task LowLevel() {
}
```

Commit. Push.

Bring it together

```
async Task HighLevel() {
  try {
    await MidLevel ().ConfigureAwait(false);;
  } catch(InvalidOperationException) { }
}

async Task MidLevel() {
  ...
  await LowLevel().ConfigureAwait(false);
  ...
}

async Task LowLevel() {
}
```

Yehaa!

Async all the way


Terminology
Why
WrapUp

Recap

reminder

Use Task.Run, Factory.StartNew for CPU-bound work

Use Task directly for IO-bound work

Use async Task instead of async void

Slides, Links...

github.com/danielmarbach/RearchitectTowardsAsyncAwait

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await Q & A

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Thanks