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Reimplementing CoAP for C# with the Task-based Asynchronous Pattern

Is it worth to await?

Philip Wille

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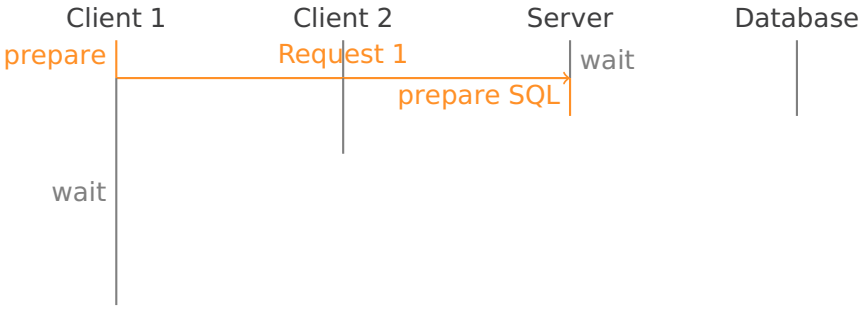
  - Request/response interaction model.

Synchronous server

Synchronous server



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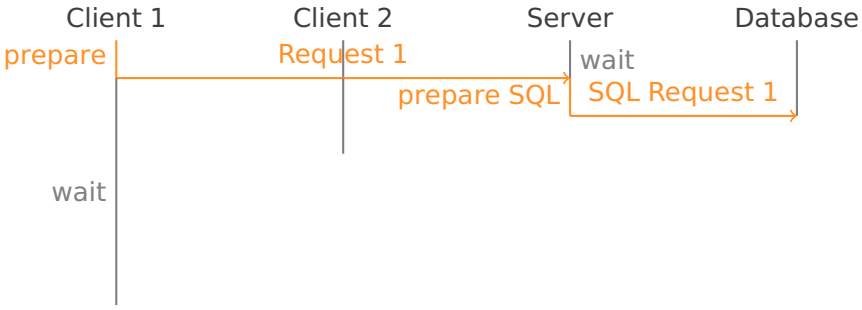

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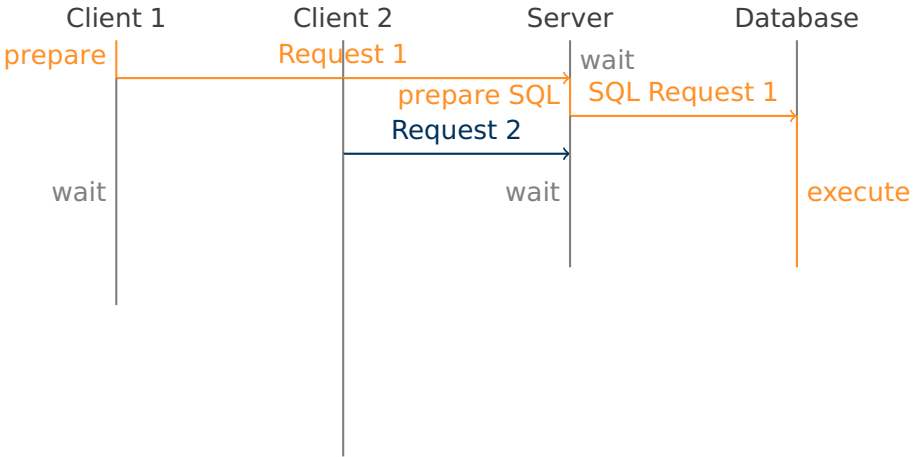

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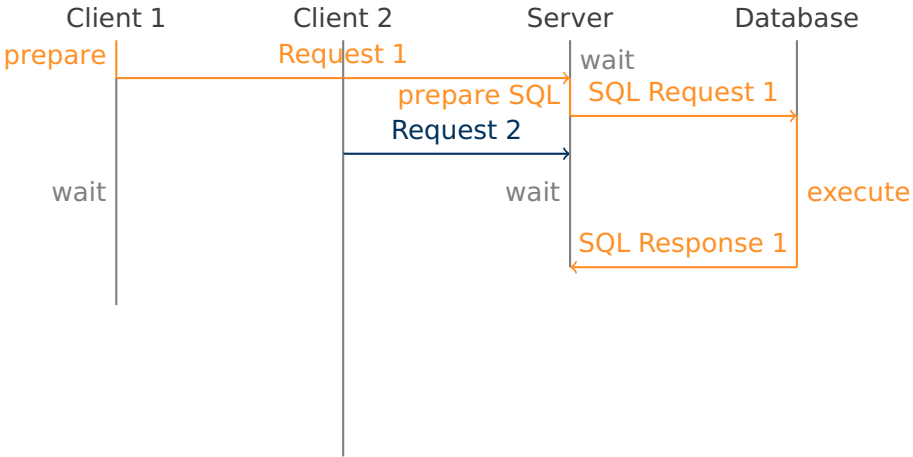

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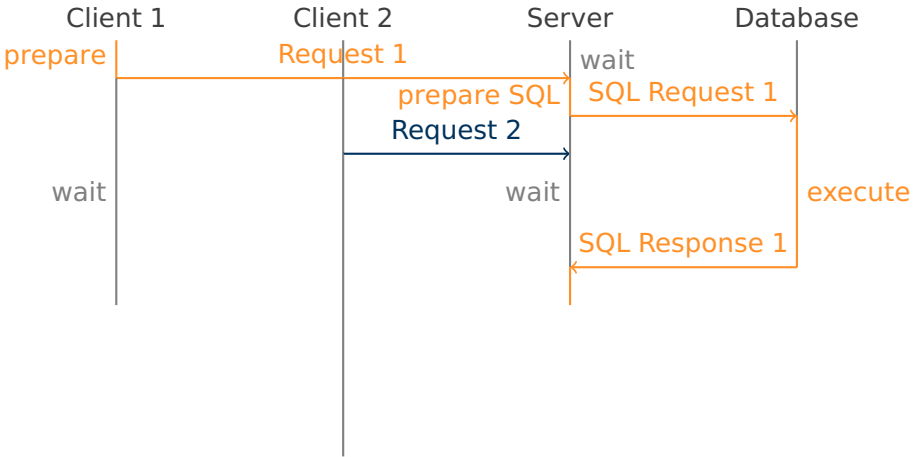

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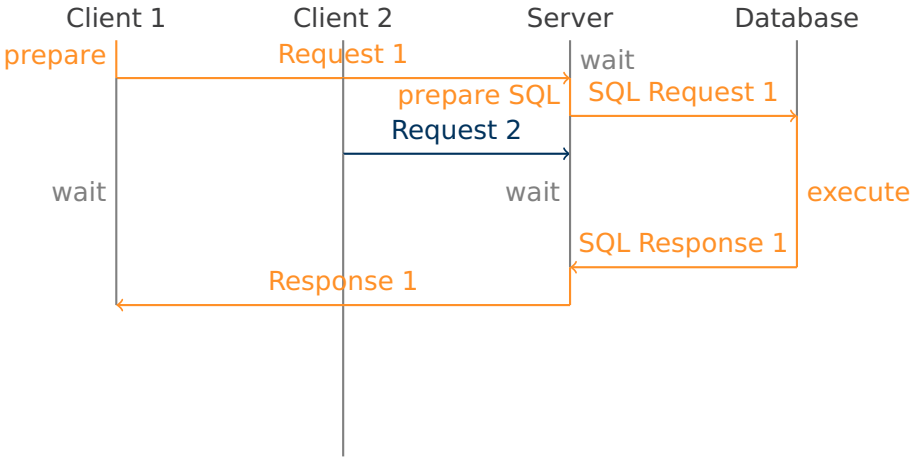

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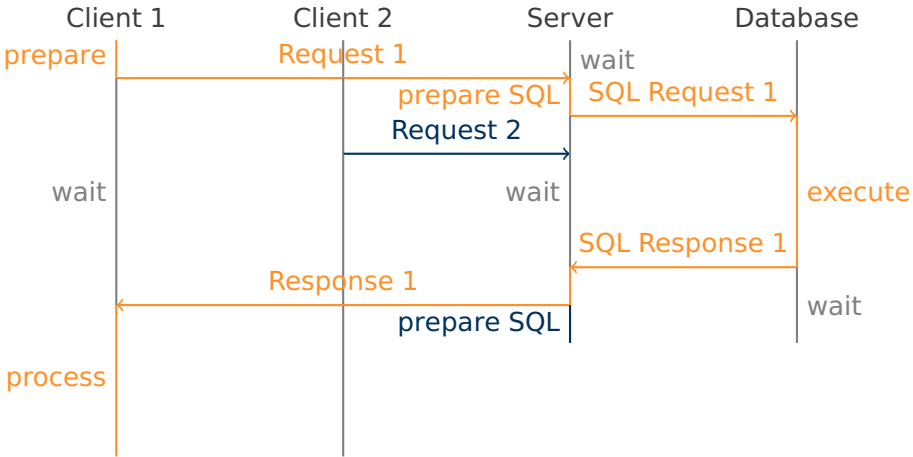

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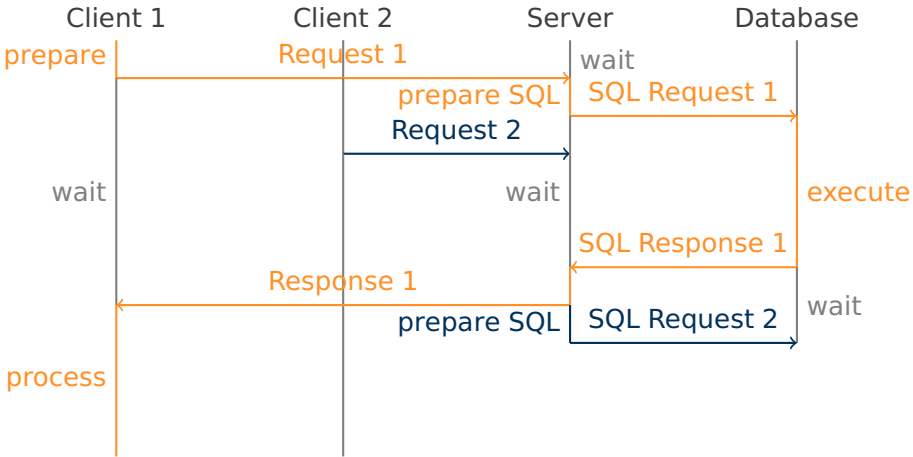

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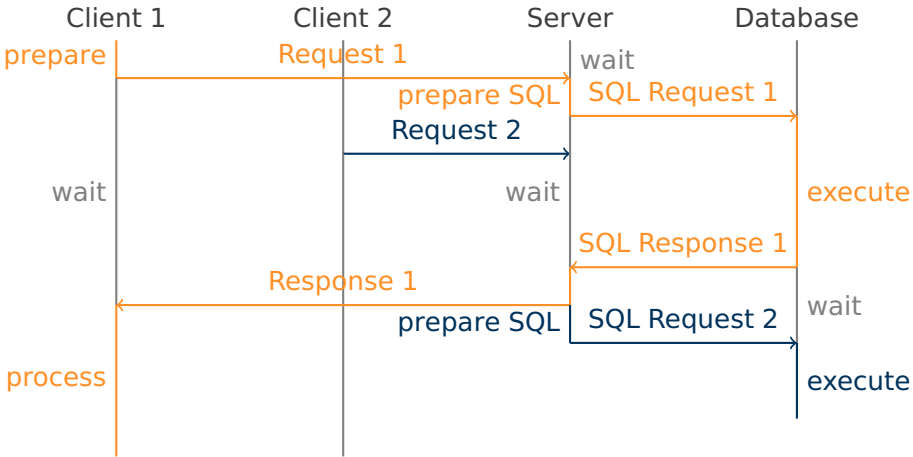

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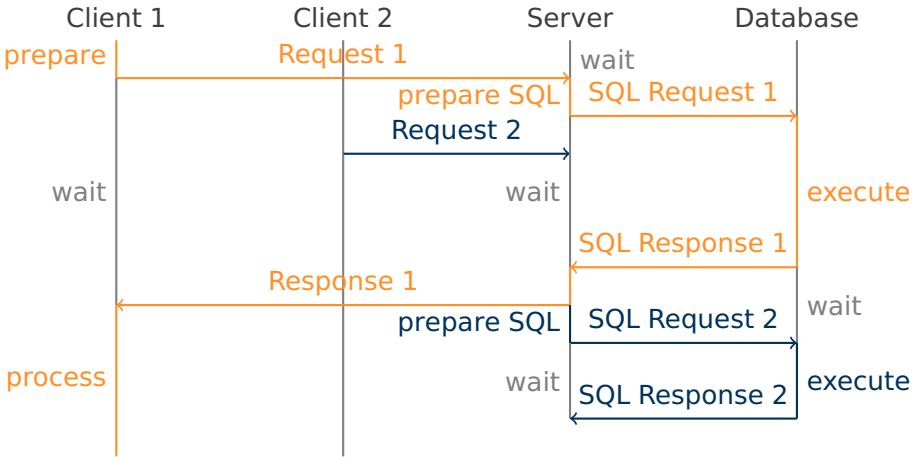

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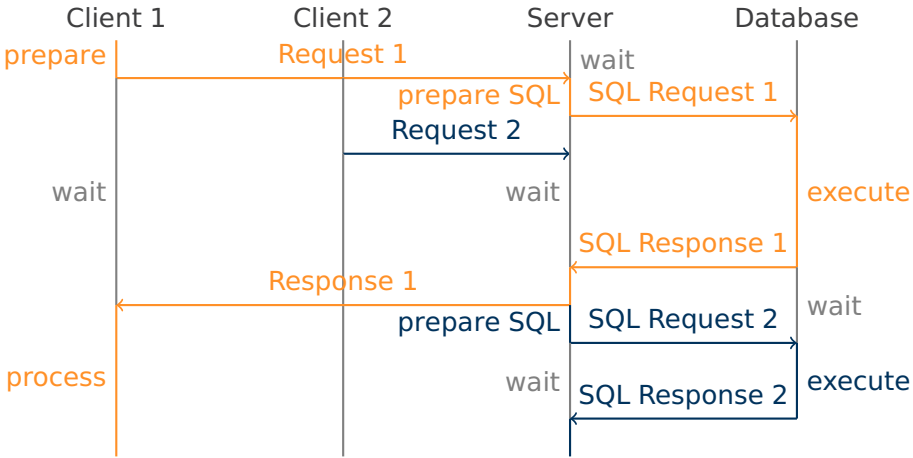

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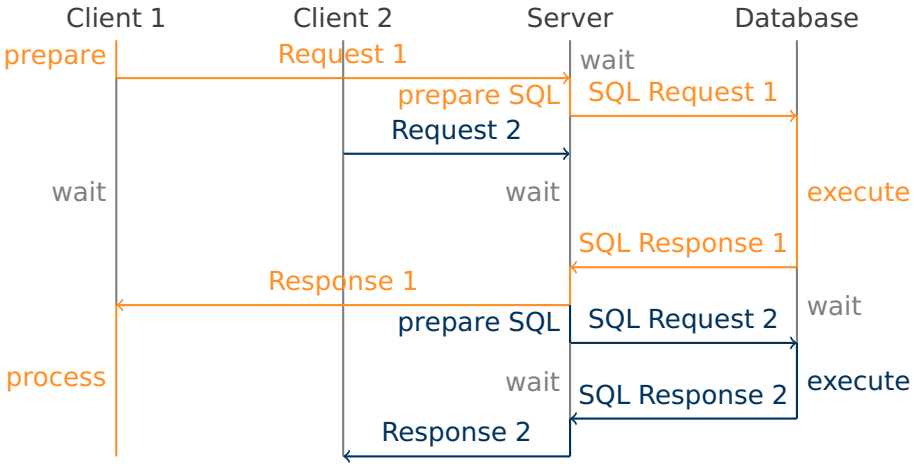
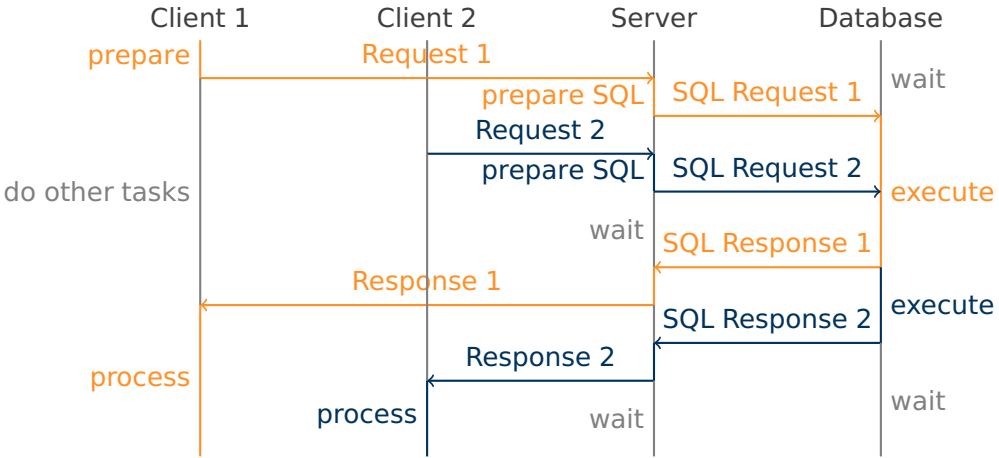


Asynchronous server



Synchronous execution in C#

```
1  public string Download(Uri uri) {
2      var client = new DownloadClient();
3      var result = client.Download(uri);
4
5      return result;
6  }
```

Listing 1: Synchronous usage in C#

Execute synchronous code asynchronously in C#

```
1  public async Task<string> DownloadAsync(Uri uri) {
2      var client = new DownloadClient();
3      var result = await Task.Run(() => client.Download());
4
5      return result;
6  }
```

Listing 2: Synchronous code executed asynchronously in C#

Event-based execution in C#

```
1  public class DownloadResult {
2      string result = null;
3
4      bool IsComplete() {
5          return result != null;
6      }
7
8      public void SetComplete(string result) {
9          this.result = result;
10     }
11
12     public string GetResult() {
13         return this.result;
14     }
15 }
```

Listing 3: DownloadResult to get string

Event-based execution in C#

```
17  public DownloadResult Download(Uri uri) {
18      var client = new DownloadClient();
19      var result = new DownloadResult();
20
21      client.DownloadComplete += (content) => result.SetComplete(content);
22      client.StartDownload(uri);
23
24      return result;
25  }
```

Listing 4: Usage of events in C#

Asynchronous execution in C#

```
1  public async Task<string> DownloadAsync(Uri uri, CancellationToken ct) {
2      var client = new DownloadClient();
3      var result = await client.DownloadAsync(uri, ct);
4
5      return result;
6  }
```

Listing 5: Asynchronous usage in C#

Short introduction into CoAP

- URI scheme based
  - "coap:" "//" host [":" port] path-abempty ["?" query]
  - "coaps:" "//" host [":" port] path-abempty ["?" query]
- REST-like
  - GET, PUT, POST, DELETE, PATCH, ...
- Specialized for using with constrained nodes and constrained networks.
- Works with HTTP.
- Fulfills requirements of environments like energy, building automation, and other machine-to-machine (M2M) applications.
- Several implementations for many programming languages like C# (CoAP.NET), Java (Californium), Python (CoAPthon), C (FreeCoAP) ...

Example request in CoAP

Figure: GET request

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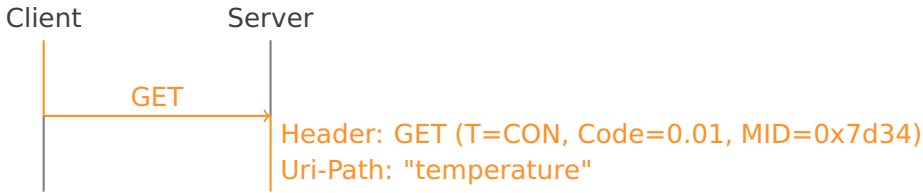

Figure: GET request

Example request in CoAP

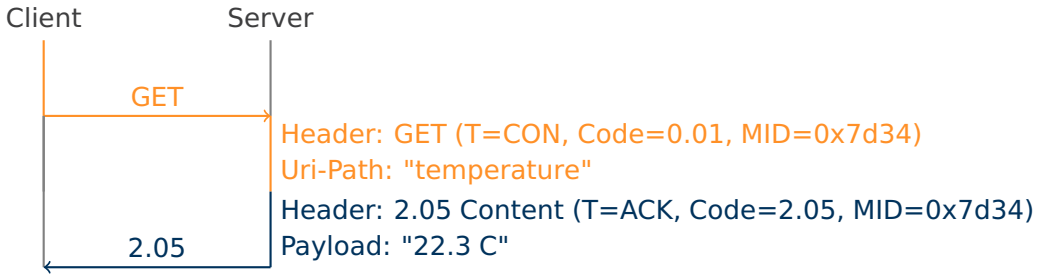

Figure: GET request

Example request in CoAP

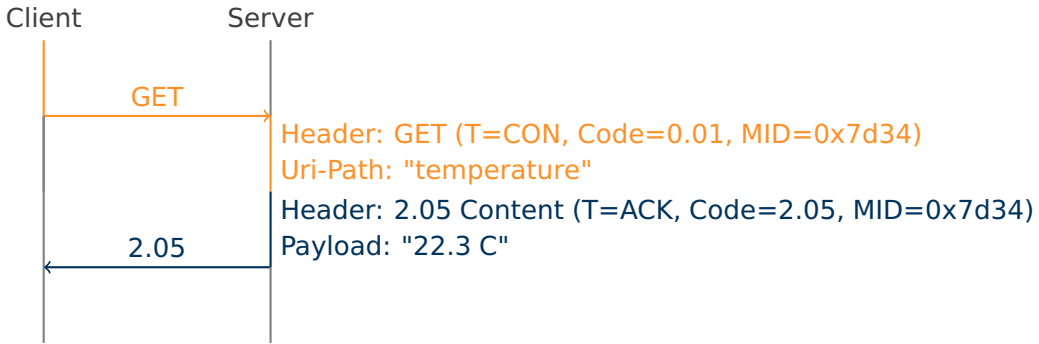

Figure: GET request

CoAP.NET

- Implementation of CoAP for C#.
- Development inactive.
- Partially asynchronous.

Goal thesis

- Goals
  - Rewrite CoAP.NET to fully asynchronous version.
  - Fixing memory leaks.
  - Enhancing diagnostic capabilities.
  - Upgrading to .NET Standard 2.0.
  - Several improvements.
- Supervisors
  - assoc. Prof. Dr. Michael Felderer (University Innsbruck).
  - Andreas Dânek (World-Direct eBusiness solutions GmbH)