The New HTTP Client API in Java 11

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Live for the Code

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About me

- Java/JVM Performance Engineer at Oracle, @since 2010
- Java/JVM Performance Engineer, @since 2005
- Java/JVM Engineer, @since 1996

Intro

GET something

```
try {
    URL url = new URL("http://some.url.you.want.to.get.org");
    HttpURLConnection con = (HttpURLConnection) url.openConnection();
    con.setRequestMethod("GET");
    con.setRequestProperty("User-Agent", "Java 1.1");
    if(con.getResponseCode() == 200) {
        System.out.println(readInputStream(con.getInputStream()));
    } else {
        System.out.println("Something wrong there!");
    }
} catch (IOException e) {
    System.out.println("Something wrong here!");
}
```

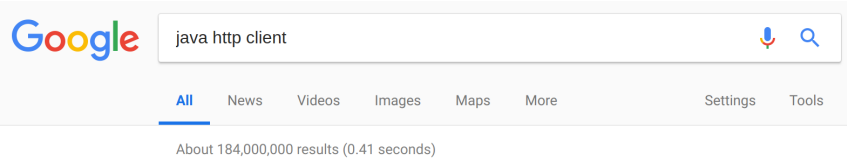
write some utils

```
public static String readInputStream(InputStream is) throws IOException {
    BufferedReader br = new BufferedReader(new InputStreamReader(is));
    String inputLine;
    StringBuffer streamContent = new StringBuffer();
    while ((inputLine = br.readLine()) != null) {
        streamContent.append(inputLine);
    }
    br.close();
    return streamContent.toString();
}
```

POST something

```
try {
    URL url = new URL("http://some.url.you.want.to.post.org");
    HttpURLConnection con = (HttpURLConnection) url.openConnection();
    con.setRequestMethod("POST");
    con.setRequestProperty("User-Agent", "Java 1.1");
    con.setDoOutput(true);
    DataOutputStream dos = new DataOutputStream(con.getOutputStream());
    dos.writeBytes("post=something");
    dos.flush();
    dos.close();
    if (con.getResponseCode() == 200) {
        System.out.println(readInputStream(con.getInputStream()));
    } else {
        System.out.println("Something wrong there!");
    }
} catch (IOException e) {
    System.out.println("Something wrong here!");
}
```

What to do?



- Async Http Client?
- Feign?
- OkHttp?
- ...???

- Spring RestTemplate?
- Jetty HTTP Client?
- Netty HTTP Client?

New Java Http Client

GET something

```
HttpClient client = HttpClient.newHttpClient();
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://some.url.you.want.to.get.org"))
        .GET()
        .header("User-Agent", "Java 11")
        .build();
try {
    HttpResponse<String> response = client.send(request,
                                      HttpResponse.BodyHandlers.ofString());
    if (response.statusCode() == 200) {
        System.out.println(response.body());
    } else {
        System.out.println("Something wrong there!");
    }
} catch (IOException e) {
    System.out.println("Something wrong here!");
}
```

GET something

```
HttpClient client = HttpClient.newHttpClient();
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://some.url.you.want.to.get.org"))
        .GET()
        .header("User-Agent", "Java 11")
        .build();
try {
    HttpResponse<String> response = client.send(request,
            responseInfo -> responseInfo.statusCode() == 200 ?
                HttpResponse.BodySubscribers.ofString(UTF_8) :
                HttpResponse.BodySubscribers.replacing("Something wrong there!")
    );
} catch (IOException e) {
    System.out.println("Something wrong here!");
}
```

GET something

```
HttpClient client = HttpClient.newHttpClient();
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://some.url.you.want.to.get.org"))
        .GET()
        .header("User-Agent", "Java 11")
        .build();
CompletableFuture<HttpResponse<String>> responseFuture = client.sendAsync(request,
        responseInfo -> responseInfo.statusCode() == 200 ?
                HttpResponse.BodySubscribers.ofString(UTF_8) :
                HttpResponse.BodySubscribers.replacing("Something wrong there!")
);
responseFuture
        .thenApply(HttpResponse::body)
        .exceptionally(ex -> "Something wrong here!")
        .thenAccept(System.out::println);
```

GET something

```
HttpClient client = HttpClient.newHttpClient();
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://some.url.you.want.to.get.org"))
        .GET()
        .header("User-Agent", "Java 11")
        .build();
client.sendAsync(request,
        responseInfo -> responseInfo.statusCode() == 200 ?
                HttpResponse.BodySubscribers.ofString(UTF_8) :
                HttpResponse.BodySubscribers.replacing("Something wrong there!"))
        .thenApply(HttpResponse::body)
        .exceptionally(ex -> "Something wrong here!")
        .thenAccept(System.out::println);
```

Motivation

Motivation

- 1996 - `URLConnection`
- 1996 - HTTP/1.0 (RFC 1945)
- 1997 - `HttpURLConnection`
- 1997 - HTTP/1.1 (RFC 2068)
- 1999 - HTTP/1.1 (RFC 2616)
- 2015 - HTTP/2 (RFC 7540)

Motivation

`HttpURLConnection/URLConnection`:

- outdated API
- API designed before HTTP/1.1
- hard to use, many undocumented behaviors
- blocking mode only

HTTP Client history

- May 2014 - JEP 110: HTTP/2 Client
- Sep 2017 - JDK 9 shipped (Incubator)
- Mar 2018 - JDK 10, updated API (Incubator)
- Sep 2018 - JDK 11, JEP 321: HTTP Client (Standard)

JEP 110 Goals:

- Support HTTP/2
- Asynchronous API
- Usage of new Java features
- ...

HTTP/2

- Binary format
- Single connection. Multiplexing.
- Header compression
- Server Push
- ...

HTTP Client

HTTP Client

- Supports HTTP/1.1 and HTTP/2
- Prefers HTTP/2, by default
  - Upgrade clear text request
  - Negotiate h2 in the APLN for HTTP over TLS

The Java HTTP Client

The Java HTTP Client

- Incubated in Java 9, JEP 110
- Standardized in Java 11, JEP 321
  - Module `java.net.http`
  - Package `java.net.http`
  - Class `java.net.http.HttpClient`
- Part of the Java SE Platorm
  - Classes and types are visible just like any others Java SE
  - Modular applicaton code should `require java.net.http`

java.net.http

- HttpClient
- HttpRequest
- HttpResponse<T>

HttpClient

```
HttpClient client = HttpClient.newBuilder()
        .authenticator(Authenticator)
        .connectTimeout(Duration)
        .cookieHandler(CookieHandler)
        .executor(Executor)
        .followRedirects(HttpClient.Redirect)
        .proxy(ProxySelector)
        .sslContext(SSLContext)
        .sllParameters(SSLParameters)
        .version(HttpClient.Version) // HTTP_1_1,  HTTP_2
        .build();
```

HttpRequest

```
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://openjdk.java.net"))
        .GET()
        .timeout(Duration.ofSeconds(42))
        .version(HttpClient.Version.HTTP_2)
        .build();
```

HttpRequest.Builder

- Build request header

```
header(String name, String value)
headers(String... headers)
setHeader(String name, String value)
```

HttpRequest.Builder

- Build request header

```
header(String name, String value)
headers(String... headers)
setHeader(String name, String value)
```

- Set request method

```
GET()
DELETE()
POST(HttpRequest.BodyPublisher bodyPublisher)
PUT(HttpRequest.BodyPublisher bodyPublisher)
method(String method, HttpRequest.BodyPublisher bodyPublisher)
```

HttpRequest

Once built an HttpRequest is immutable,
and can be sent multple times.

HttpRequest.BodyPublishers

Factory methods for common body types

```
noBody()
ofByteArray(byte[] buf)
ofByteArray(byte[] buf, int offset, int length)
ofByteArrays(Iterable<byte[]> iter)
ofFile(Path path)
ofInputStream(Supplier<? extends InputStream> streamSupplier)
ofString(String body)
ofString(String s, Charset charset)
```

HttpResponse

```
interface HttpResponse<T> {

        T            body();

        int          statusCode();

        HttpHeaders  headers();

        HttpRequest  request();

        URI          uri();

        HttpClient.Version  version();

        Optional<SSLSession> sslSession();

}
```

HttpClient

- Synchronous request(blocking)

```
HttpResponse<T>

    send(HttpRequest, HttpResponse.BodyHandler<T>);
```

- Asynchronous request

```
CompletableFuture<HttpResponse<T>>

    sendAsync(HttpRequest,
              HttpResponse.BodyHandler<T>);
```

HttpResponse.BodyHandlers

Factory methods for common body types

```
BodyHandler<Void> discarding();

BodyHandler<U> replacing(U value);

BodyHandler<String> ofString();
BodyHandler<String> ofString(Charset charset);

BodyHandler<Stream<String>> ofLines();

BodyHandler<InputStream> ofInputStream();

BodyHandler<byte[]> ofByteArray();
```

HttpResponse.BodyHandlers

Factory methods for common body types (cont.)

```
BodyHandler<T> buffering(BodyHandler<T> downstreamHandler, int bufferSize);


BodyHandler<Path> ofFile(Path file, OpenOption... openOptions);
BodyHandler<Path> ofFile(Path file);
BodyHandler<Path> ofFileDownload(Path directory, OpenOption... openOptions);
```

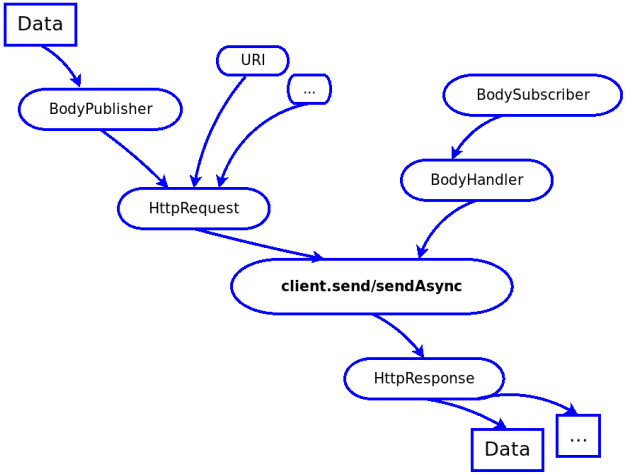
HTTP/2 server push

```
public CompletableFuture<HttpResponse<T>>

sendAsync(HttpRequest request,
          BodyHandler<T> responseBodyHandler,
          PushPromiseHandler<T> pushPromiseHandler);
```

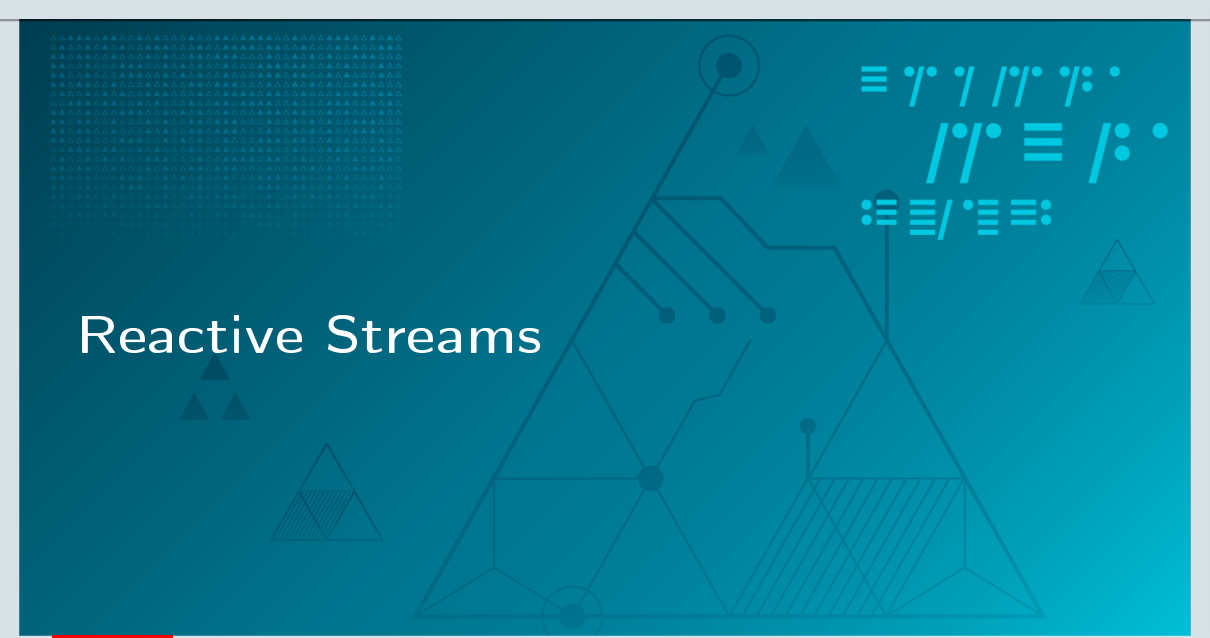
HttpResponse.PushPromiseHandler

```
public interface PushPromiseHandler<T> {

    public void applyPushPromise(
        HttpRequest initiatingRequest,
        HttpRequest pushPromiseRequest,
        Function<BodyHandler<T>,CompletableFuture<HttpResponse<T>>> acceptor
    );


    public static <T> PushPromiseHandler<T>
    of(Function<HttpRequest,BodyHandler<T>> pushPromiseHandler,
       ConcurrentMap<HttpRequest,CompletableFuture<HttpResponse<T>>> pushPromisesMap);

}
```

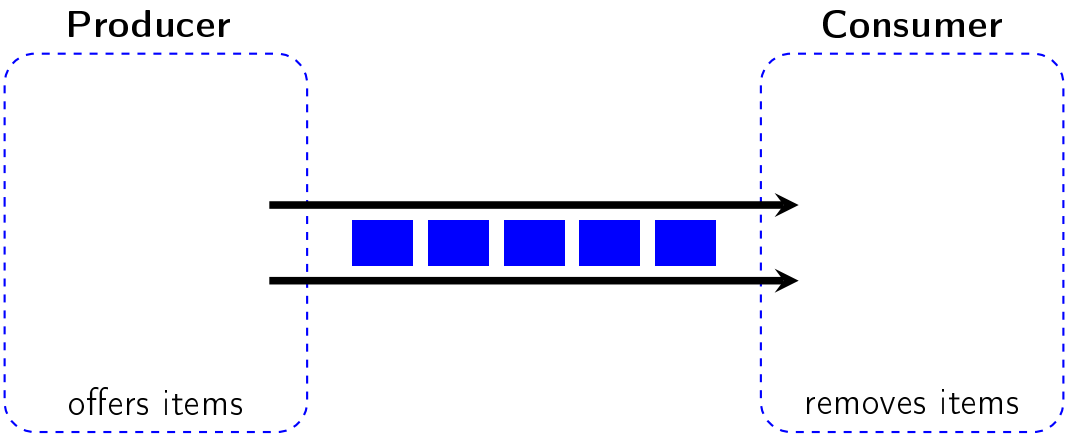
All together



Reactive Streams



Classic Producer-Consumer



Reactive streams

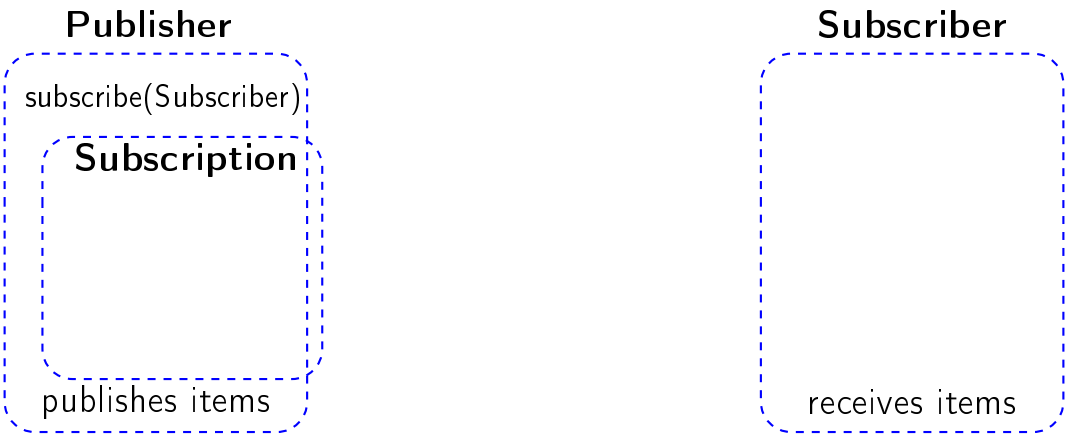
- `java.util.concurrent.Flow`, `@since Java9`
  - `j.u.c.Flow.Publisher<T>`
  - `j.u.c.Flow.Flow.Subscriber<T>`
  - `j.u.c.Flow.Flow.Flow.Subscription`
- One ~~ring~~ interface to rule them all

Reactive streams

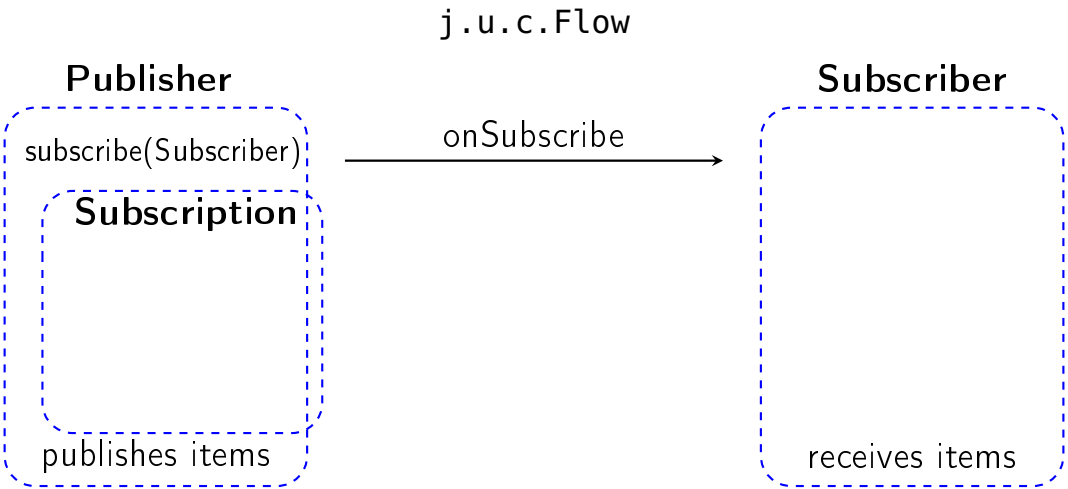
`j.u.c.Flow`

Reactive streams

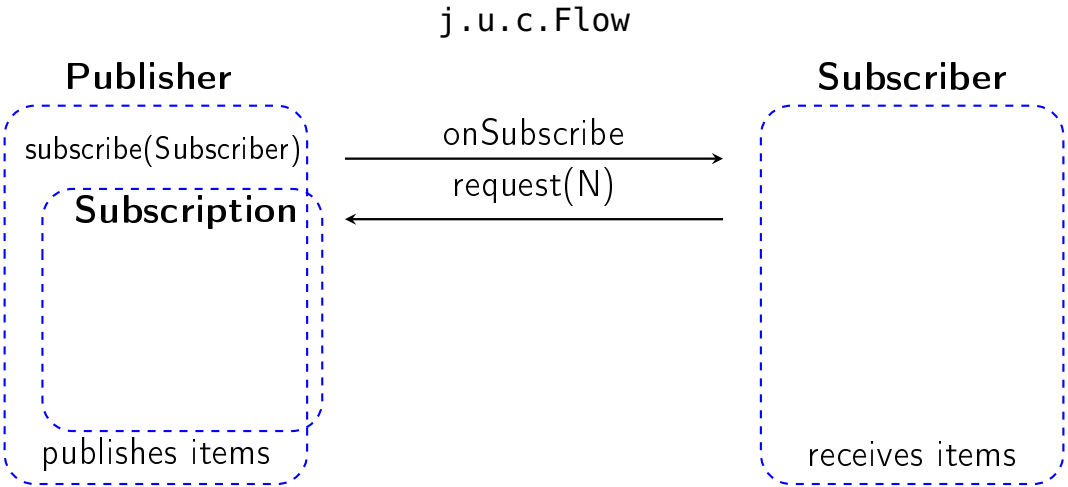
`j.u.c.Flow`



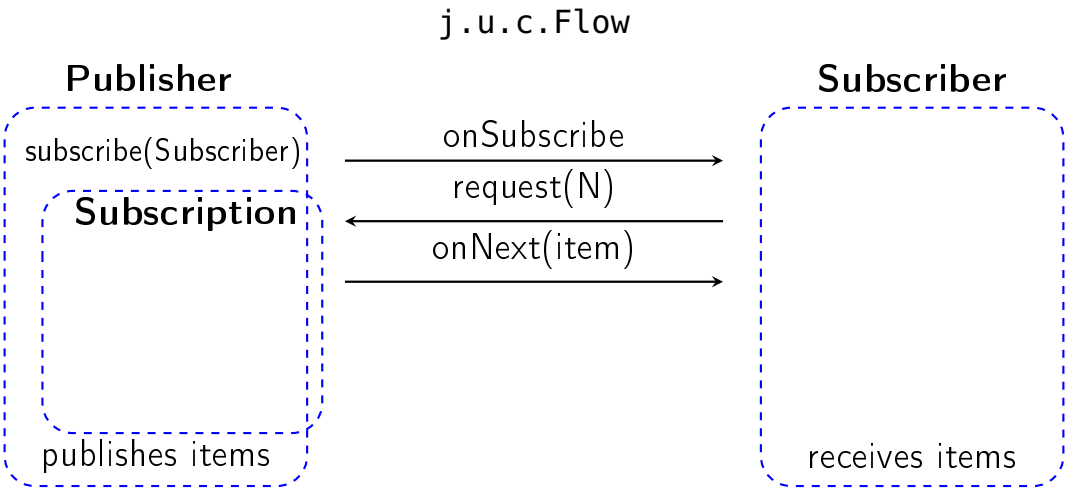
Reactive streams



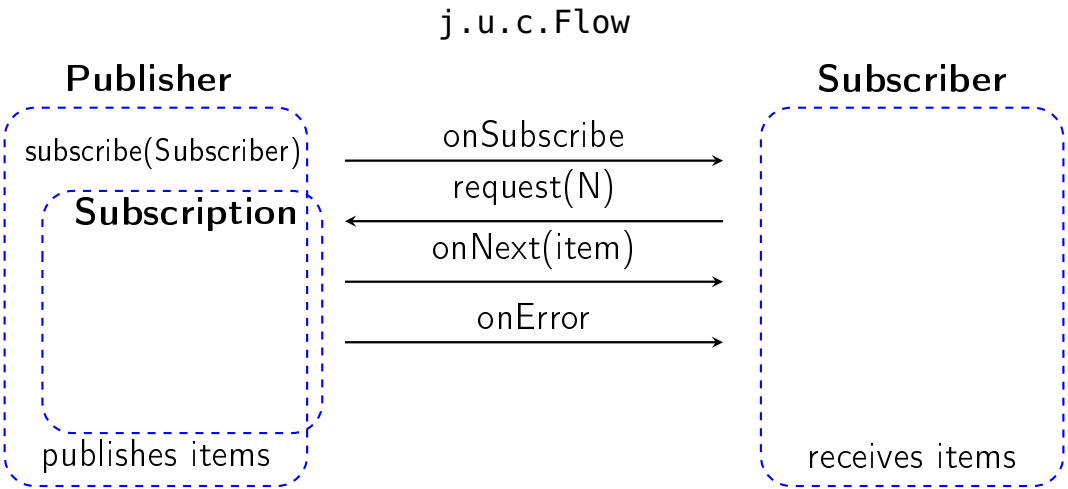
Reactive streams



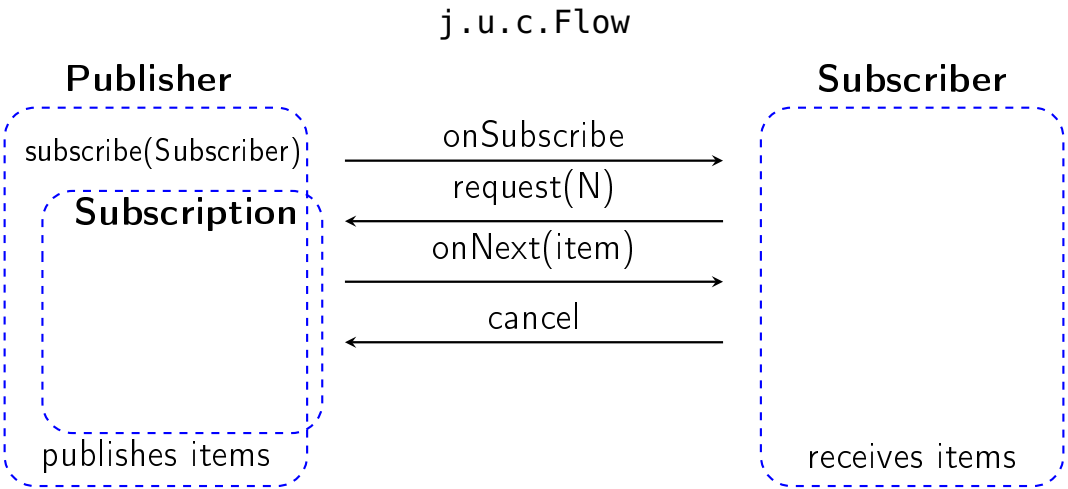
Reactive streams



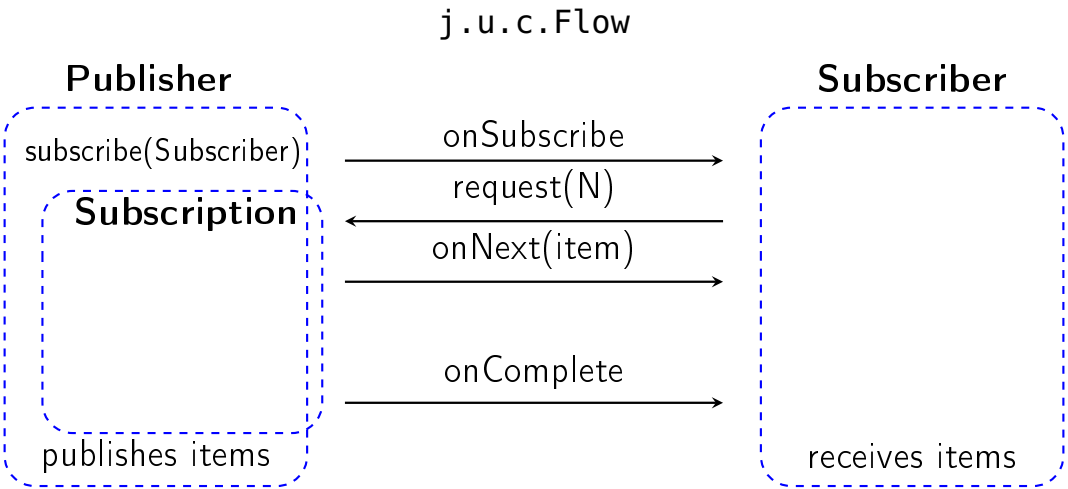
Reactive streams



Reactive streams



Reactive streams



Data as reactive streams

- `HttpClient` sends data to the server
- `HttpClient` receives data from the server

Data as reactive streams

- ~~`HttpClient` sends data to the server~~
- `HttpClient` publishes data to the server
- ~~`HttpClient` receives data from the server~~
- `HttpClient` subscribes to data from the server

HttpRequest.BodyPublisher

```
public interface BodyPublisher extends Flow.Publisher<ByteBuffer> {

    long contentLength();

}
```

HttpResponse.BodyHandler

```
@FunctionalInterface
public interface BodyHandler<T> {

    public BodySubscriber<T> apply(ResponseInfo responseInfo);

}

public interface ResponseInfo {

    public int statusCode();

    public HttpHeaders headers();

    public HttpClient.Version version();

}
```

HttpResponse.BodySubscriber

```
public interface BodySubscriber<T> extends Flow.Subscriber<List<ByteBuffer>> {

    public CompletionStage<T> getBody();

}
```

Making Custom Subscriber

e.g. I don't need a file, just MD5

```
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://some.url.you.want.to.md5.org"))
        .GET()
        .build();

HttpResponse<byte[]> response = client.send(request,
                        HttpResponse.BodyHandlers.ofByteArray());
if(response.statusCode() == 200) {
    MessageDigest digest = MessageDigest.getInstance("MD5");
    byte[] md5 = digest.digest(response.body());
    ...
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    public CompletionStage<byte[]> getBody();

    public void onSubscribe(Flow.Subscription subscription);

    public void onNext(List<ByteBuffer> item);

    public void onError(Throwable throwable);

    public void onComplete();

}
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    private final CompletableFuture<byte[]> future = new CompletableFuture<>();

    private MessageDigest digest;

    private Flow.Subscription subscription;

    public MD5Subscriber() {
        try {
            digest = MessageDigest.getInstance("MD5");
        } catch (NoSuchAlgorithmException e) {
            // do something here
        }
    }
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    private final CompletableFuture<byte[]> future = new CompletableFuture<>();

    private MessageDigest digest;

    private Flow.Subscription subscription;

    @Override
    public CompletionStage<byte[]> getBody() {
        return future;
    }
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    private final CompletableFuture<byte[]> future = new CompletableFuture<>();

    private MessageDigest digest;

    private Flow.Subscription subscription;

    @Override
    public void onSubscribe(Flow.Subscription subscription) {
        this.subscription = subscription;
        subscription.request(1);
    }
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    private final CompletableFuture<byte[]> future = new CompletableFuture<>();

    private MessageDigest digest;

    private Flow.Subscription subscription;

    @Override
    public void onNext(List<ByteBuffer> item) {
        item.forEach(digest::update);
        subscription.request(1);
    }
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    private final CompletableFuture<byte[]> future = new CompletableFuture<>();

    private MessageDigest digest;

    private Flow.Subscription subscription;

    @Override
    public void onError(Throwable throwable) {
        future.completeExceptionally(throwable);
    }
```

e.g. MD5Subscriber

```
public class MD5Subscriber implements HttpResponse.BodySubscriber<byte[]> {

    private final CompletableFuture<byte[]> future = new CompletableFuture<>();

    private MessageDigest digest;

    private Flow.Subscription subscription;

    @Override
    public void onComplete() {
        future.complete(digest.digest());
    }

}
```

e.g. I don't need a file, just MD5

```
HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://some.url.you.want.to.md5.org"))
        .GET()
        .build();

HttpResponse<byte[]> response =
                        client.send(request, ri ->  new MD5Subscriber());
byte[] md5 = response.body();
...
```

Appendix

advanced client configuration

Client settings frame (HTTP/2)

Property (`jdk.httpclient`)	Client default value	HTTP/2 standard value
`hpack.maxheadertablesize`	16K	4K
`enablepush`	1	1
`maxstreams`	100	
`windowsize`	16M	64K-1
`maxframesize`	16K	16K

Property (jdk.httpclient)	HTTP	default value
bufsize	1.1, 2	16K
connectionWindowSize	2	32M
auth.retrylimit	1.1, 2	3
redirects.retrylimit	1.1, 2	5
keepalive.timeout	1.1	1200 secs
connectionPoolSize	1.1	0 (unbounded)

Q & A ?