Buffers

TCP Reminder

- TCP creates a persistent connection
- Bytes are streamed over this connection
- Data can be sent and received until one side closes the connection

- With small GET requests
  - Read from the TCP socket once to read the entire request

Buffering File Uploads

- To read an HTTP request:
  - First, read data from the TCP socket

```
received_data = self.request.recv(2048)
```

```
POST /form-path HTTP/1.1
Content-Length: 746
Content-Type: multipart/form-data; boundary=----WebKitFormBoundarycriD3u6M0UuPR1ia

------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="commenter"

Jesse
------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="upload"; filename="discord.png"
Content-Type: image/png

<bytes_of_the_file>
------WebKitFormBoundarycriD3u6M0UuPR1ia--
```

Buffering File Uploads

- Call the receive method with an int
- The value of this int is the **maximum** number of bytes that will be read from the TCP socket

```
received_data = self.request.recv(2048)
```

```
POST /form-path HTTP/1.1
Content-Length: 746
Content-Type: multipart/form-data; boundary=----WebKitFormBoundarycriD3u6M0UuPR1ia

------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="commenter"

Jesse
------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="upload"; filename="discord.png"
Content-Type: image/png

<bytes_of_the_file>
------WebKitFormBoundarycriD3u6M0UuPR1ia--
```

Buffering File Uploads

- What if we receive a fairly large POST request?
  - Might not be able to read the entire request in one read from the socket

```
received_data = self.request.recv(2048)
```

```
POST /form-path HTTP/1.1
Content-Length: 91320
Content-Type: multipart/form-data; boundary=----WebKitFormBoundarycriD3u6M0UuPR1ia

------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="commenter"

Jesse
------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="upload"; filename="flamingo.jpg"
Content-Type: image/jpeg

<bytes_of_the_file>
------WebKitFormBoundarycriD3u6M0UuPR1ia--
```

Buffering File Uploads

- What if a very large file is uploaded?

```
received_data = self.request.recv(2048)
```

```
POST /form-path HTTP/1.1
Content-Length: 1884206
Content-Type: multipart/form-data; boundary=----WebKitFormBoundarycriD3u6M0UuPR1ia

------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="commenter"

Jesse
------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="upload"; filename="hq_image.png"
Content-Type: image/png

<bytes_of_the_file>
------WebKitFormBoundarycriD3u6M0UuPR1ia--
```

Buffering File Uploads

- When we call receive in this example, we read **at most** 2048 bytes from the connection
- We *could* increase this value, but there's no guarantee that al the bytes will be ready when we call receive

```
received_data = self.request.recv(2048)
```

```
POST /form-path HTTP/1.1
Content-Length: 1884206
Content-Type: multipart/form-data; boundary=----WebKitFormBoundarycriD3u6M0UuPR1ia

------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="commenter"

Jesse
------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="upload"; filename="hq_image.png"
Content-Type: image/png

<bytes_of_the_file>
------WebKitFormBoundarycriD3u6M0UuPR1ia--
```

Buffering File Uploads

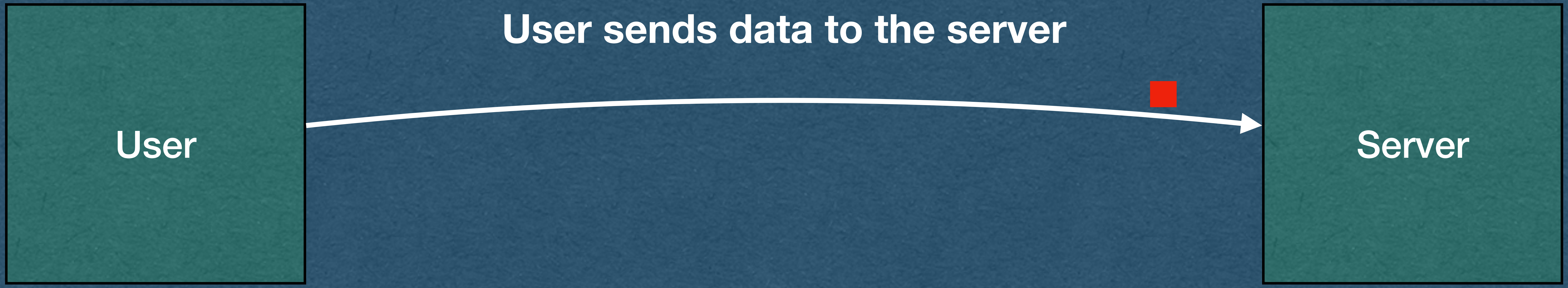
- We **Must** read from the socket multiple times!

```
received_data = self.request.recv(2048)
```

```
POST /form-path HTTP/1.1
Content-Length: 1884206
Content-Type: multipart/form-data; boundary=----WebKitFormBoundarycriD3u6M0UuPR1ia

------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="commenter"

Jesse
------WebKitFormBoundarycriD3u6M0UuPR1ia
Content-Disposition: form-data; name="upload"; filename="hq_image.png"
Content-Type: image/png

<bytes_of_the_file>
------WebKitFormBoundarycriD3u6M0UuPR1ia--
```

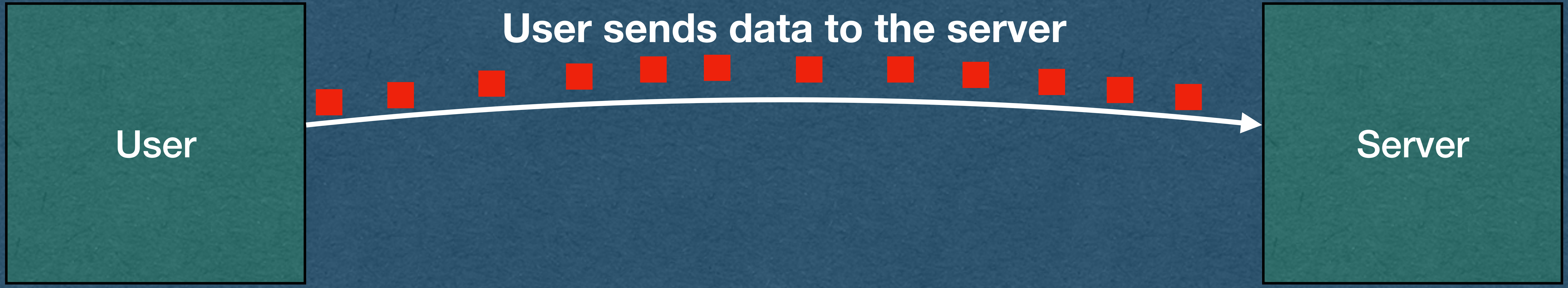
Buffers

- TCP socket libraries will use buffers
- No matter your language/library you will have a method/ function that reads bytes from the socket
  - Called when there are bytes that arrive over the socket
  - Returns *some* bytes of the request



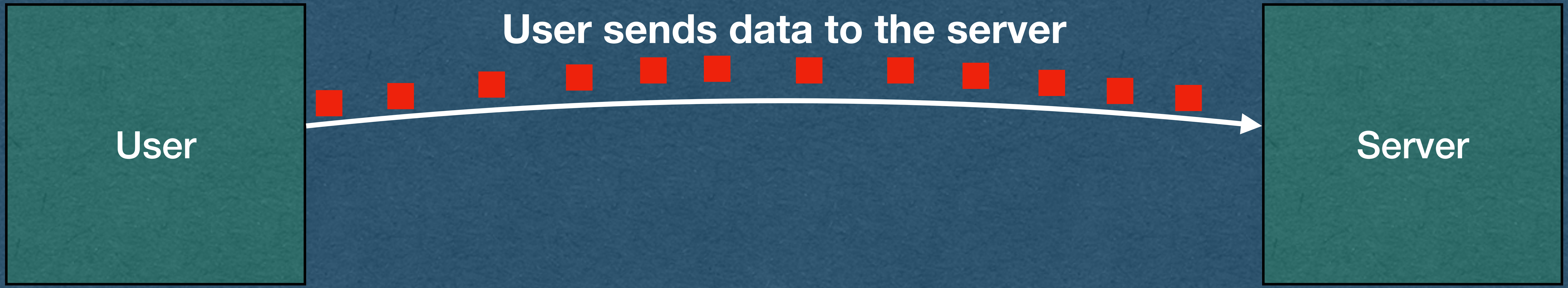
Buffer Questions

- What happens when the user has a lot of data to send?
- What if the user has a slow connection?
- Does the socket server wait for all of the data to be received before calling your code?
- What if the data takes an hour to send?
- What if the data contains streaming video that never ends?



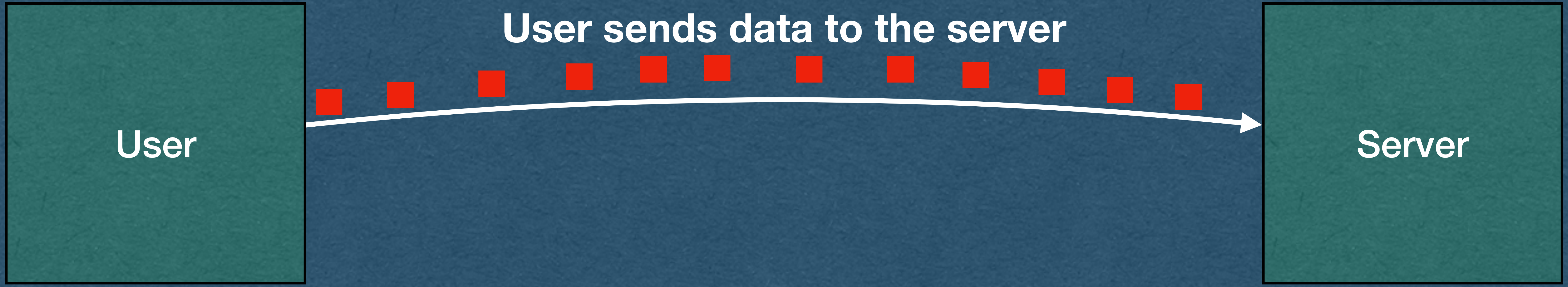
Buffer Answer

- The socket notifies your code when there is data to read - even if it's not the entire request
- The socket server will have a buffer size, typically a few kB, and will read **at most** that many bytes in a single call
    - For GET requests the entire request is smaller than the buffer (Safe assumption *in this course*)



Buffers

- Now that we're handling file uploads, we must be aware of these buffers
- The server will need data that persists across multiple calls that read bytes from a socket
  - Create data structures that store the bytes read from a request
  - Combine the bytes from multiple calls to receive the entire file



HTTP Buffers

- When receiving a large HTTP request:
  - Read bytes from the socket
  - Parse the headers
  - Find the Content-Length header and store this value
  - Keep reading bytes from the stream until you have Content-Length number of bytes in your data structure
  - Process the request

Assumptions

- Assumptions you may make on the Homework:
- The first read from your buffer will contain all the headers of the HTTP
  - If you're not currently buffering, you can safely parse the first bytes as the headers of the request
  - This allows you to read the Content-Length
- We will test with files larger than your TCP buffer size
  - ie. Do not do this:

```
received_data = self.request.recv(1048576)
```

WebSocket Buffers

- You will also receive WebSocket frames that are large enough that they need to be buffered
- When receiving a large WebSocket Frame:
  - Read bytes from the socket
  - Parse the headers
  - Read the payload length from the headers
  - Keep reading bytes from the stream until you have payload length number of bytes in your data structure
  - Process the request

WebSocket Buffers

- Multiple WebSocket frames can be sent back-to-back on the same connection
- If you read more bytes than you expect, you have read the headers of the next frame
- To test for this:
  - Edit the front end JavaScript to send a message multiple times when the user sends a message
  - Make sure each message is duplicated the correct number of times

Buffers

- For HTTP and WebSockets
- Remember that the Content-Length and payload length do not include the bytes for the headers
  - ie. The total number of bytes read for one request/frame will be larger than the Content-Length/Payload length

Demos