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CSCI 4140 – Tutorial 8

WebSocket and Socket.IO

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Outline

- What is WebSocket?
- What is Socket.IO?
- Get started with a chat application
- Namespaces and rooms in Socket.IO
- Socket.IO in Assignment 2

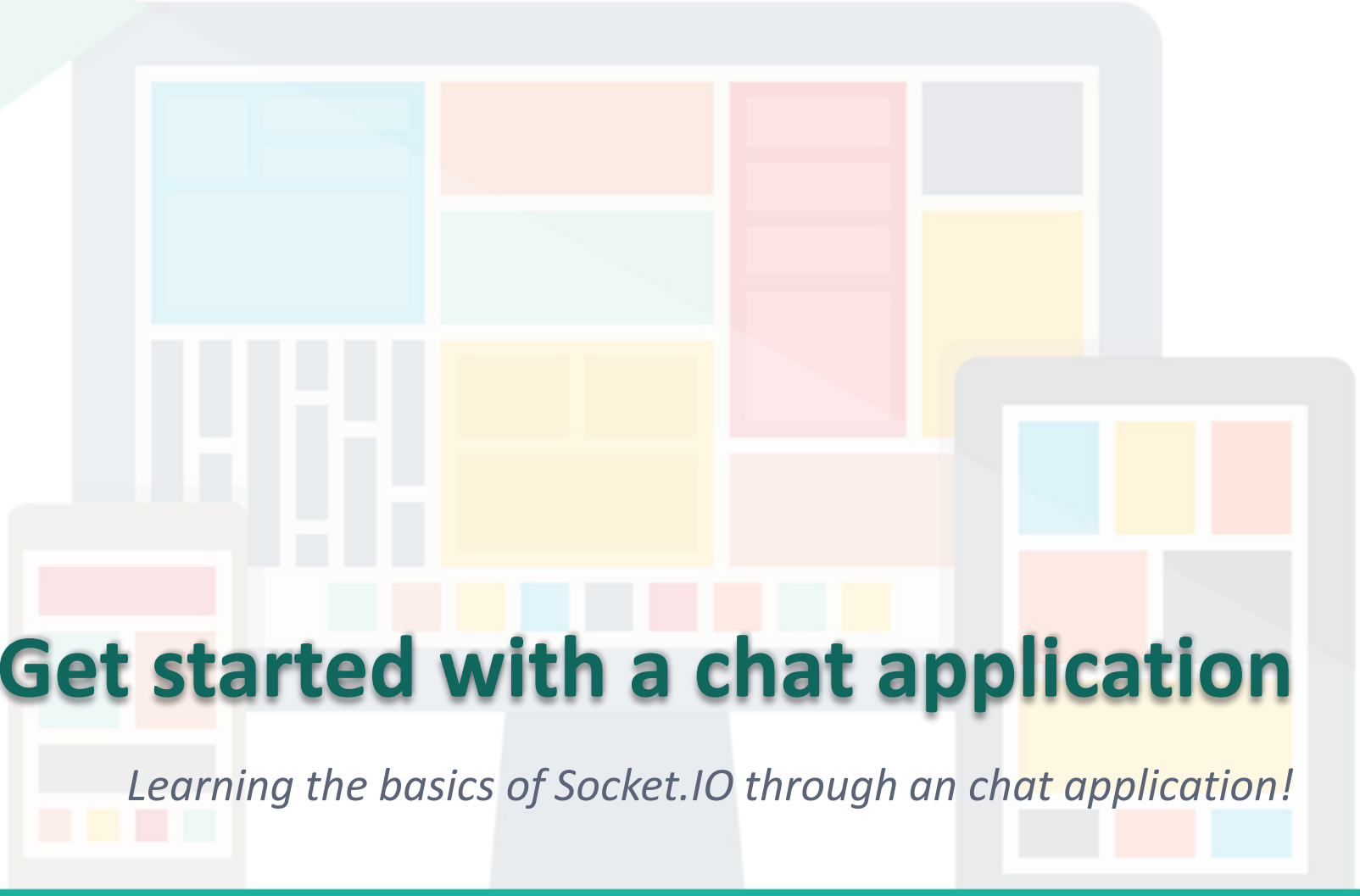
What is WebSocket?

- A protocol providing **full-duplex** (read & write) communications channels over a single **TCP connection**
- Designed to be implemented in **web browsers** and **web servers**
- A **dedicated server** is needed because an **application-level handshaking** is needed
- Other than that, WebSocket programming is the same as ordinary **socket programming**
- URI scheme: **`ws:`** and **`wss:`** for unencrypted and encrypted connections respectively (just like `http:` and `https:`)

What is Socket.IO?

- A JavaScript library for **realtime** web applications
- It enables **real-time bidirectional event-based** communications
- It primarily uses the **WebSocket** protocol with **polling** as a **fallback option**
  - It provides many more features than WebSocket, e.g., **broadcasting** to multiple sockets, storing data **associated with each client**, and **asynchronous I/O**
- It has two parts:
  - A **client-side** library that runs in the browser
  - A **server-side** library for Node.js
- Can be installed with the **npm** tool

Adapted from http://socket.io/get-started/chat/



Get started with a chat application

Learning the basics of Socket.IO through an chat application!

Create an Express application skeleton

- Let's use the **Express** framework for simplicity
- Create an Express application called "`socket-io-chat`" and install dependencies:

```
$ express socket-io-chat
(Output omitted)
$ cd socket-io-chat
$ npm install
(Output omitted)
```

"Hello World" with server.js

- Setup our application by creating **server.js**:

server.js

```
var app = require( 'express' )();

app.get( '/', function( request, response ) {
    response.send( 'Hello World' );
} );

var server = app.listen( 4140, function() {
    var host = server.address().address;
    var port = server.address().port;

    console.log( 'Listening on http://%s:%s...', host, port );
} );
```

- Run "**node server.js**" and visit http://127.0.0.1:4140/

[Optional] Deploying to OpenShift

- Modify **`server.js`** for deploying to OpenShift later:

server.js

```
var app = require( 'express' )();

app.get( '/', function( request, response ) {
    response.send( 'Hello World' );
} );

var port = process.env.OPENSHIFT_NODEJS_PORT || 4140;
var host = process.env.OPENSHIFT_NODEJS_IP || '127.0.0.1';

var server = app.listen( port, host, function() {
    console.log( 'Listening on http://%s:%s...', host, port );
} );
```

Implement the UI

- Implement the chat room user interface in HTML (**views/index.html**)
  - Download the HTML from the example code (**views/index-begin.html**)
- Serving HTML in Express:

```
app.get( '/', function( request, response ) {
    response.sendFile( __dirname + '/views/index.html' );
} );
```

server.js

Change this line in **server.js**

- Restart the Node process and refresh the page

Integrating Socket.IO

- Socket.IO is composed of two parts:
  - A server that integrates with (or mounts on) the **Node.JS HTTP Server**: **`socket.io`**
  - A client library that loads on the browser side: **`socket.io-client`**
    - This library is served to the client **automatically**
- Before using the library, we need to install it using npm

```
$ npm install --save socket.io
```

  - That will **install the module** and **add the dependency** to **`package.json`**

Integrating Socket.IO

- Integrate Socket.IO into **server.js**

```
// ... (omitted)
var server = app.listen( port, host, function() {
    console.log( 'Listening on http://%s:%s...', host, port );
} );

var io = require( 'socket.io' )( server );
io.on( 'connection', function( socket ) {
    console.log( 'New user connected' );
} );
```

server.js

Add these lines to the end of the file.

Integrating Socket.IO

- What does these lines do?

Initialize a **socket.io** instance by passing the **server** object.

```
var io = require( 'socket.io' )( server );
io.on( 'connection', function( socket ) {
    console.log( 'New user connected' );
} );
```

Listen on the **connection** event for incoming sockets.

The signature of the event listener is:

```
function (socket) { /* ... */ }
```

Integrating Socket.IO

- Integrate Socket.IO into **views/index.html**

```
<!-- ... (omitted) ... →
        <script src="/socket.io/socket.io.js"></script>
        <script>
            var socket = io();
        </script>
    </body>
</html>
```

Add these lines before **</body>**.

views/index.html

  - The first line loads the **socket.io-client** library which exposes an **io** global
  - Call **io()** without specifying any URL means to connect to the host that serves the page
- Now reload the server and refresh the web page

Integrating Socket.IO

- Try opening several tabs
- Can you see the message "**`New user connected`**" in the terminal?
- Each socket also fires a special **`disconnect`** event:

```
// ... (omitted)
var io = require( 'socket.io' )( server );
io.on( 'connection', function( socket ) {
    console.log( 'New user connected' );
    socket.on( 'disconnect', function() {
        console.log( 'User disconnected' );
    } );
} );
```

`server.js`

Add these lines into **`server.js`** and reload the server. You can see "**`User disconnected`**" upon each disconnection.

Emitting a chat event

- You can send (or emit) and receive any events, with any data in Socket.IO
- Let's emit an "**chat**" event when the user types in a message
- Modify the last **<script>** tag in **views/index.html**:

```
<script>
    var socket = io();
    var form = document.querySelector( '#form' );
    var m = document.querySelector( '#m' );
    form.addEventListener( 'submit', function( e ) {
        e.preventDefault();
        socket.emit( 'chat', m.value );
        m.value = '';
    } );
</script>
```

views/index.html

Emitting a chat event

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    var socket = io();
    var form = document.querySelector( '#form' );
    var m = document.querySelector( '#m' );
    form.addEventListener( 'submit', function( e ) {
        e.preventDefault();
        socket.emit( 'chat', m.value );
        m.value = '';
    } );
</script>
```

Get the DOM element using **querySelector()**.

Add an event listener for the form's **submit** event.

Emit a "**chat**" event with the message (**m.value**) as the data with Socket.IO

x.html

Emitting a chat event

- Use `socket.on( <event>, function( data ) { /* ... */ } )` to handle our newly defined event

```
// ... (omitted)
var io = require( 'socket.io' )( server );
io.on( 'connection', function( socket ) {
    console.log( 'New user connected' );
    socket.on( 'disconnect', function() {
        console.log( 'User disconnected' );
    } );
    socket.on( 'chat', function( data ) {
        console.log( 'Message: ' + data );
    } );
} );
```

server.js

Add these lines into **server.js** and reload the server. You can see the message from the client upon each form submit.

Broadcasting

- Next, we need to emit the event from the server to **all connected users** such that they can see the message
- Modify the **chat** event listener:

```
// ... (omitted)
socket.on( 'chat', function( data ) {
    console.log( 'Message: ' + data );
    io.emit( 'chat', data );
} );
```

server.js

A **chat** event is emitted to all connected clients with the **data**.

Broadcasting

- Listen to the **chat** event in the client side:

```
// ... (omitted)
var messages = document.querySelector( '#messages' );
socket.on( 'chat', function( data ) {
    var li = document.createElement( 'li' );
    li.innerHTML = data;
    messages.appendChild( li );
} );
```

views/index.html

Broadcasting

- Listen to the **chat** event in the client side:

Set up a **chat** event listener to the **socket**.

The signature of the event listener is:

```
function ( data ) { /* ... */ }
```

```
// ... (Omitted)
var messages = document.querySelector( '#messages' );
socket.on( 'chat', function( data ) {
    var li = document.createElement( 'li' );
    li.innerHTML = data;
    messages.appendChild( li );
} );
```

Display the incoming message by updating the DOM tree.

views/index.html

- That completes our chat application!
  - It already supports multiple clients

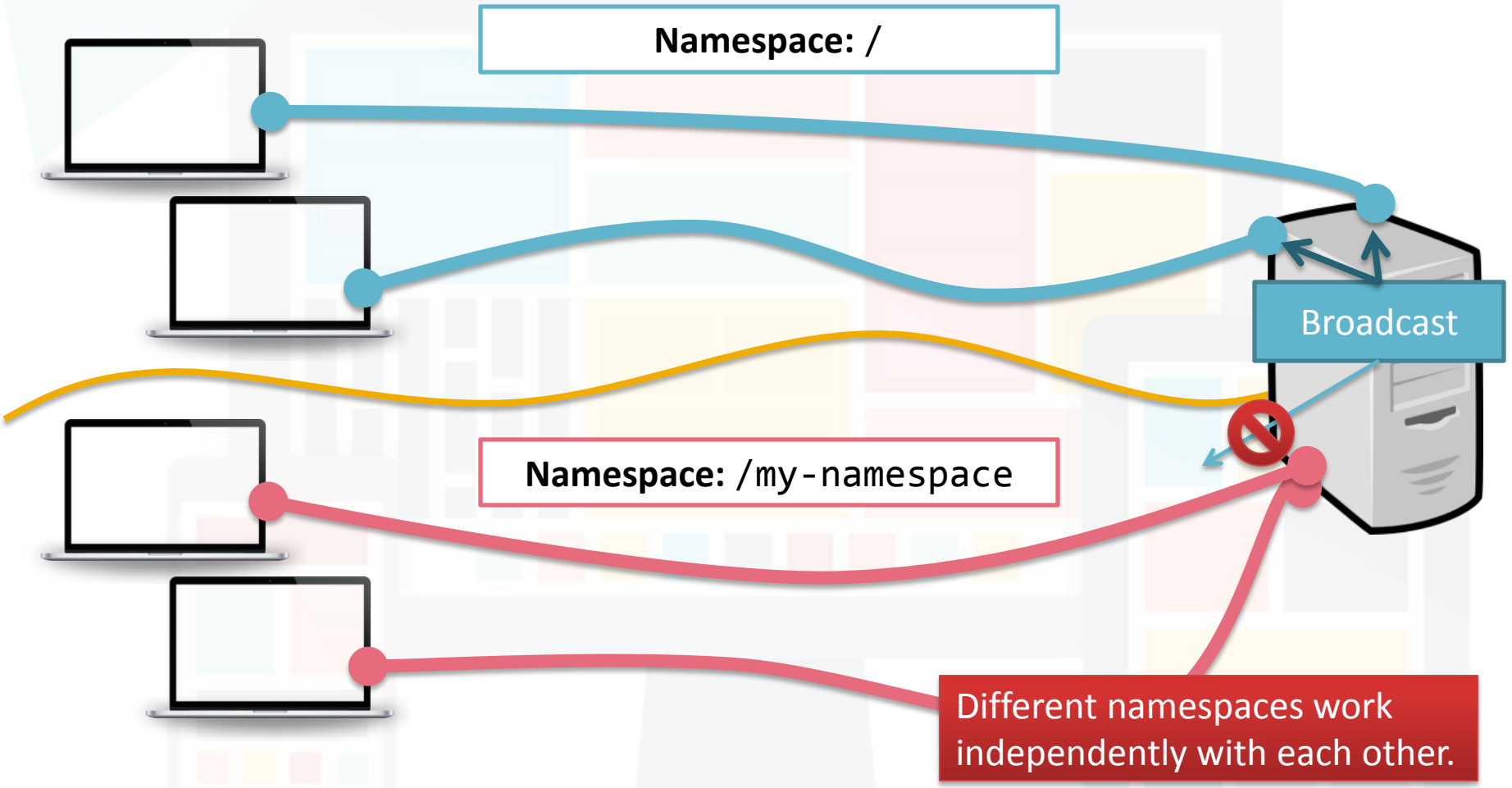
Namespaces and rooms in Socket.IO

We can broadcast among clients in the same namespace / room only!

Namespaces

- Socket.IO allows you to "**namespace**" your sockets, which essentially means assigning different **endpoints** or **paths**
- Useful for
  - **Minimizing** the number of **resources** (e.g., TCP connections)
  - Introducing **separation** between **communication channels**
- The default namespace is "**/**"
  - The clients connect to this namespace by default
  - The server listens to this namespace by default

Namespaces


Namespace: /
Broadcast
Namespace: /my-namespace
Different namespaces work independently with each other.

Custom namespaces

- To set up a custom namespace, call the **of** function on the **server-side**:

```
var nsp = io.of( '/my-namespace' );
nsp.on( 'connection', function ( socket ) {
    console.log( 'someone connected' );
});
nsp.emit( 'hi', 'everyone!' );
```

- On the **client side**, specify the namespace in the **io** function:

```
var socket = io( '/my-namespace' );
```

For your information, my implementation does not use custom namespaces to separate different sessions. I use "room" instead!

Rooms

Updated

- Within each namespace, you can also define arbitrary channels (denoted as "**room**") that sockets can **`join`** and **`leave`**
- To assign the sockets into different rooms on the server side:

```
io.on( 'connection', function( socket ) {
    socket.join( 'some room' );
} );
```

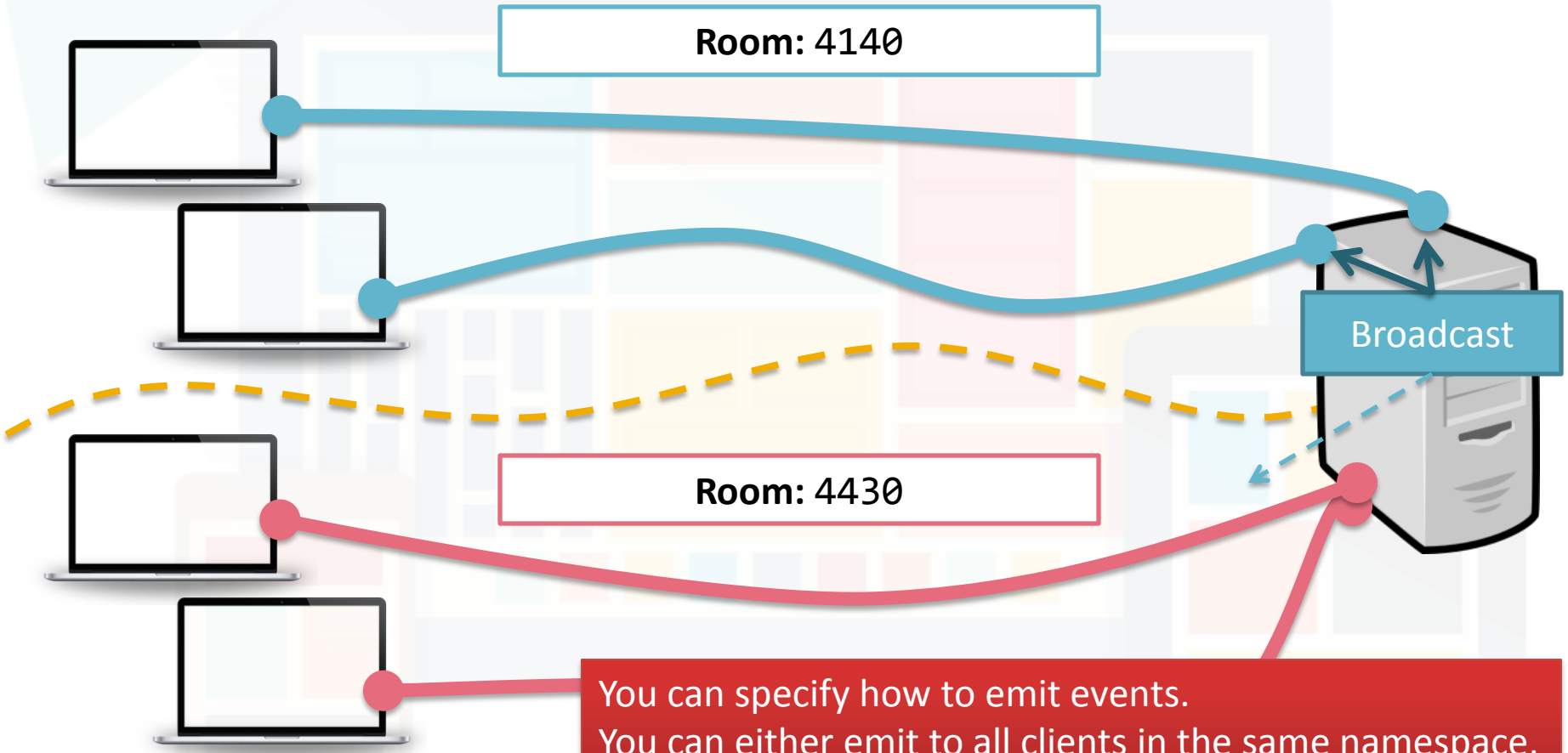
Of course, you can also call `join()` (i.e., subscribe the socket to a given channel) when other events are emitted, e.g., "**`register`**" event

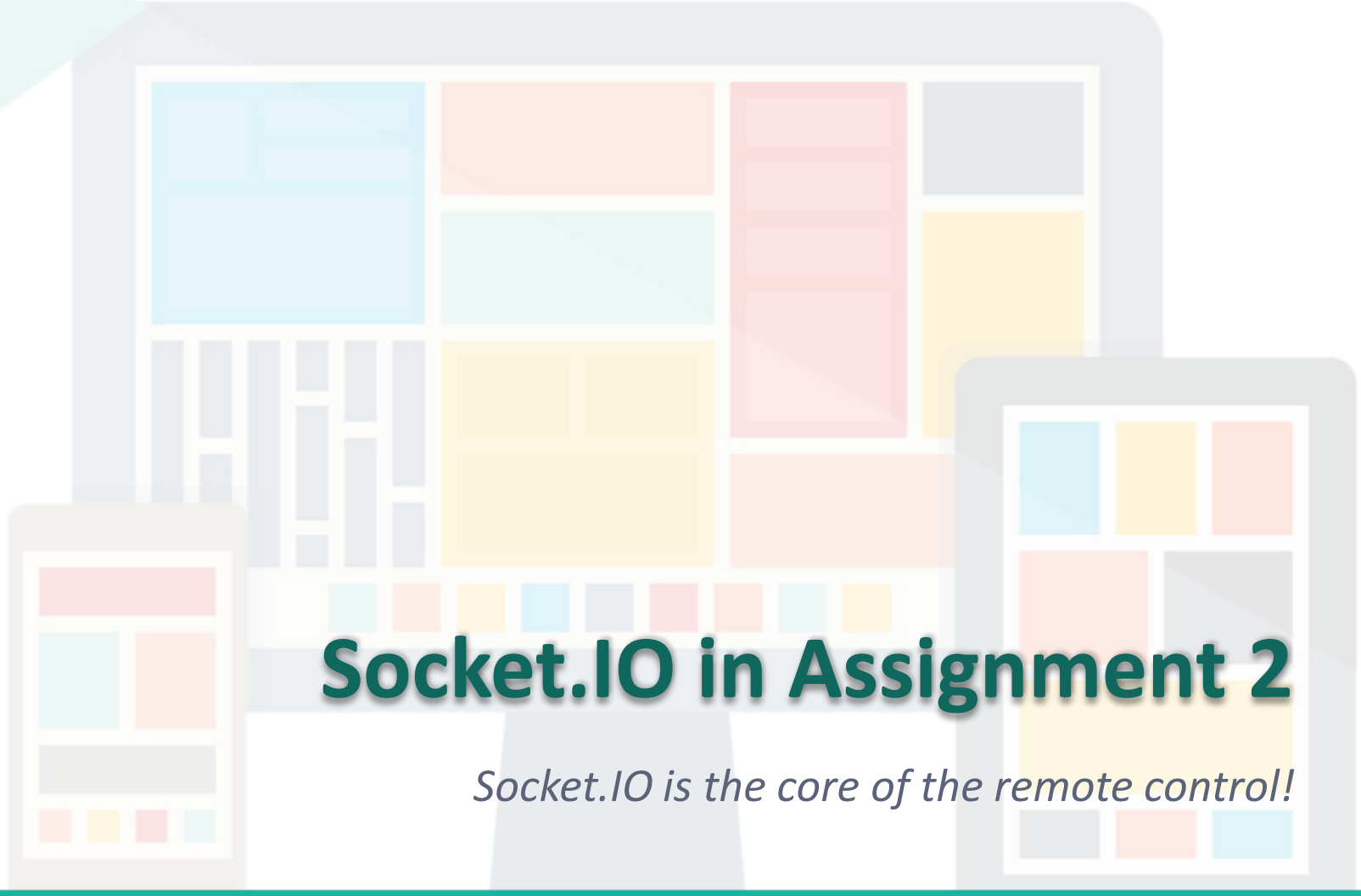
- To broadcast or emit, call **`to()`** or **`in()`**:

```
io.to( 'some room' ).emit( 'some event' );
```

- To leave a channel: `socket.leave( 'some room' );`
  - This is automatically done upon disconnection

Rooms under the same namespace





Socket.IO in Assignment 2

Socket.IO is the core of the remote control!

Socket.IO in Assignment 2

- Socket.IO is used for
  - **Connecting** the clients to the server
  - **Broadcasting control signals** to the desktop clients
  - **Synchronizing** the playlist
- Emitted events in my implementation *(for your reference only)*
  - `register` (***data***: session ID) – Assign a socket to a room
  - `sync` / `download` / `upload` (***data***: `null` or `playlist`) – Playlist synchronization request and response
  - `command` (***data***: control signal to the player)
  - `add` / `remove` (***data***: video ID to be added or removed)
  - **Feel free to design your own protocol!**

References

- Get Started: Chat application
  - http://socket.io/get-started/chat/
- Server API:
  - http://socket.io/docs/server-api/
- Client API:
  - http://socket.io/docs/client-api/
- Rooms and Namespaces:
  - http://socket.io/docs/rooms-and-namespaces/

– End –