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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

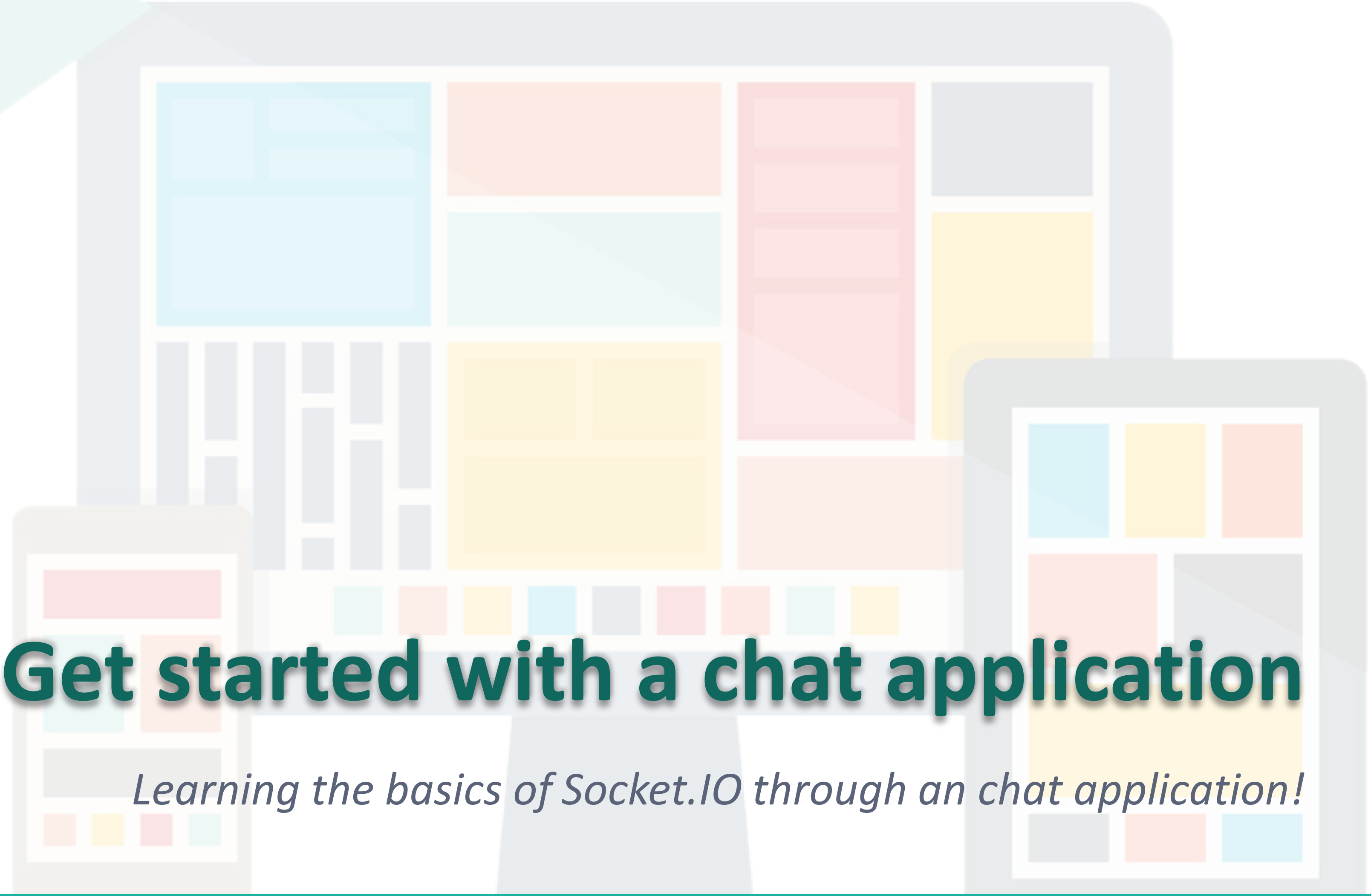
What is WebSocket?

- 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)
```

Updated

"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( 8000, function() {
    var host = server.address().address;
    var port = server.address().port;

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

Let's use port 8000 such that we don't need to modify our ***client side program*** when deploying to OpenShift (on server side, you still need to eliminate the hard-coded values).

- Run "**node server.js**" and visit http://127.0.0.1:8000/

[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 || 8000;
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

Updated

Integrating Socket.IO for OpenShift

- If you want to deploy your application on OpenShift, you need to specify the URL (with port number 8000) when you call **`io()`**:

```
<!-- ... (omitted) ... →
        <script src="/socket.io/socket.io.js"></script>
        <script>
            var socket = io( 'ws://' + window.location.hostname +
                             ':8000/' );
        </script>
    </body>
</html>
```

views/index.html

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

- 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>
```

x.html

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

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

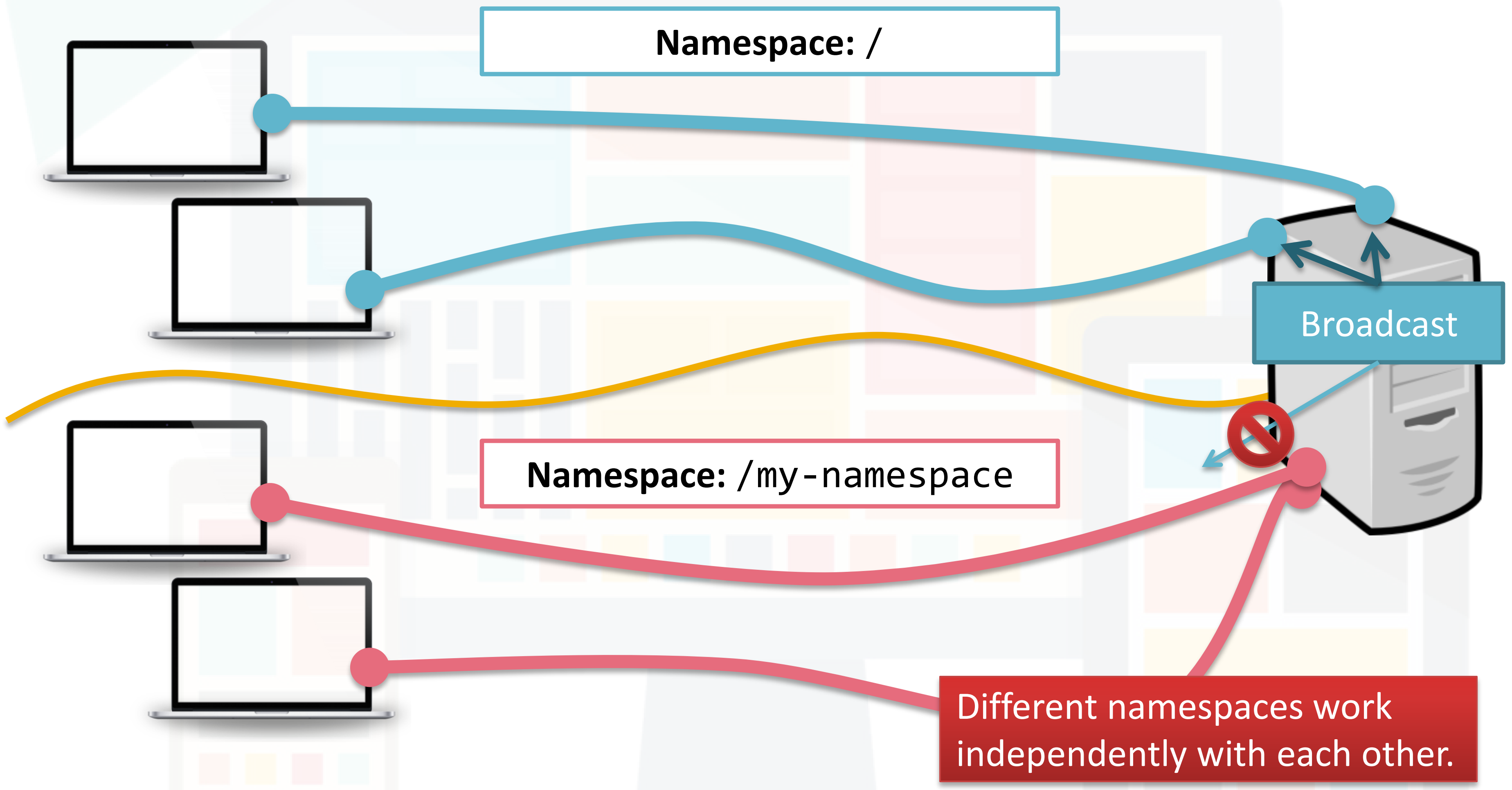
Namespaces and rooms in Socket.IO

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!

Updated

Rooms

- 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' );
} );
```

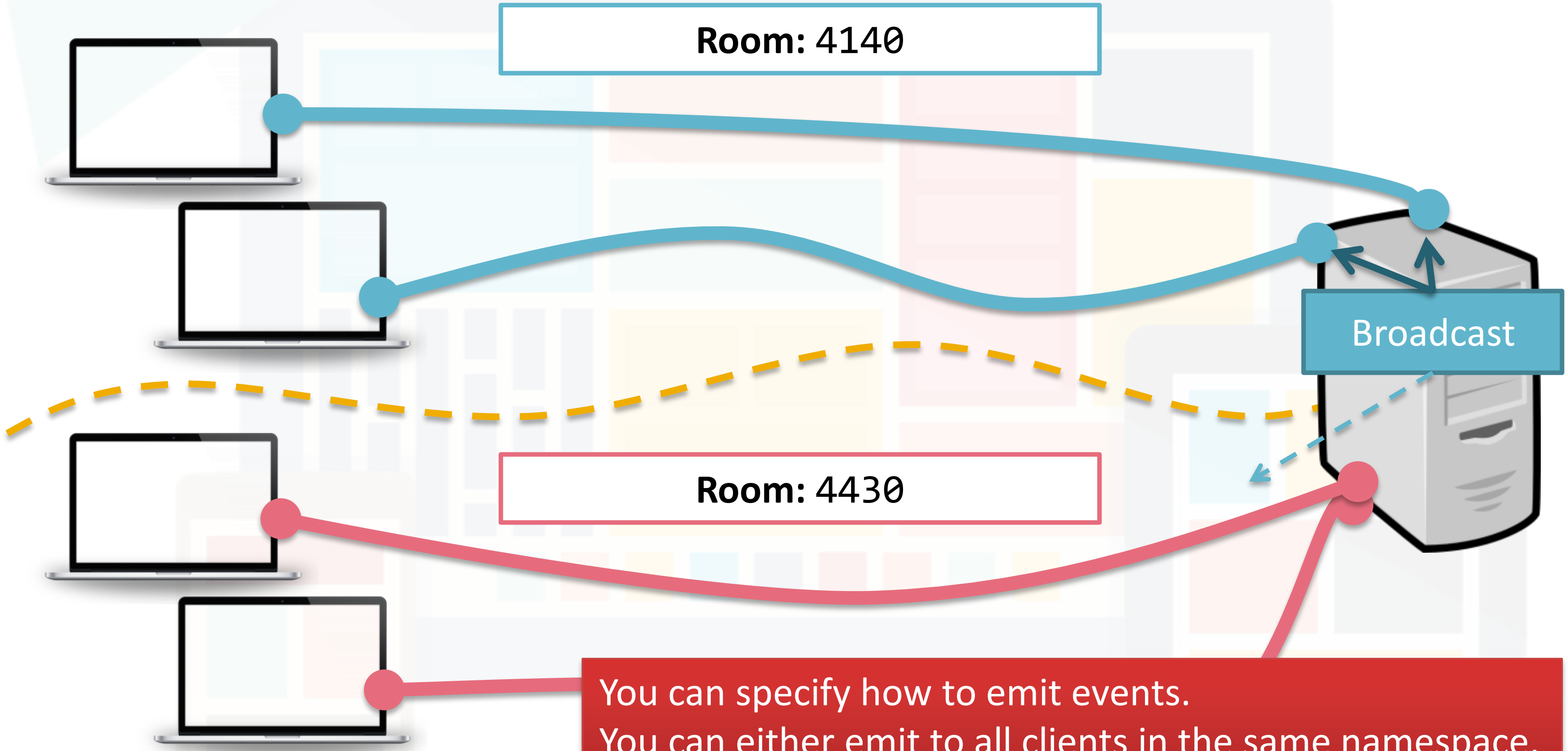
Of course, you can also call `join()` (i.e., subscribe the socket to a given channel) when other events are emitted, e.g., "**register**" event

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

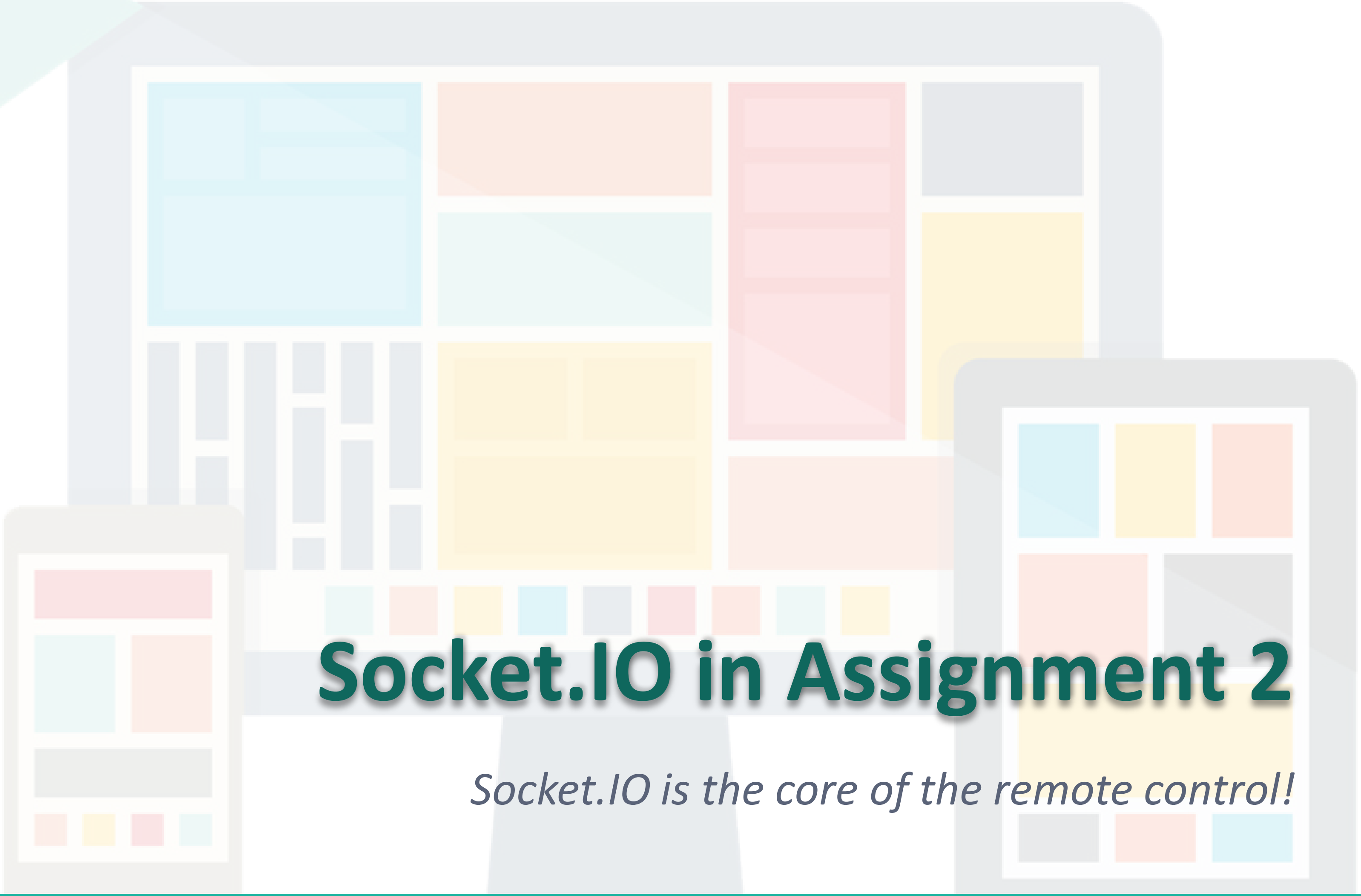
```
io.to( 'some room' ).emit( 'some event' );
```

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

Rooms under the same namespace



You can specify how to emit events.
You can either emit to all clients in the same namespace, or just emit to the clients in the same room.



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 –