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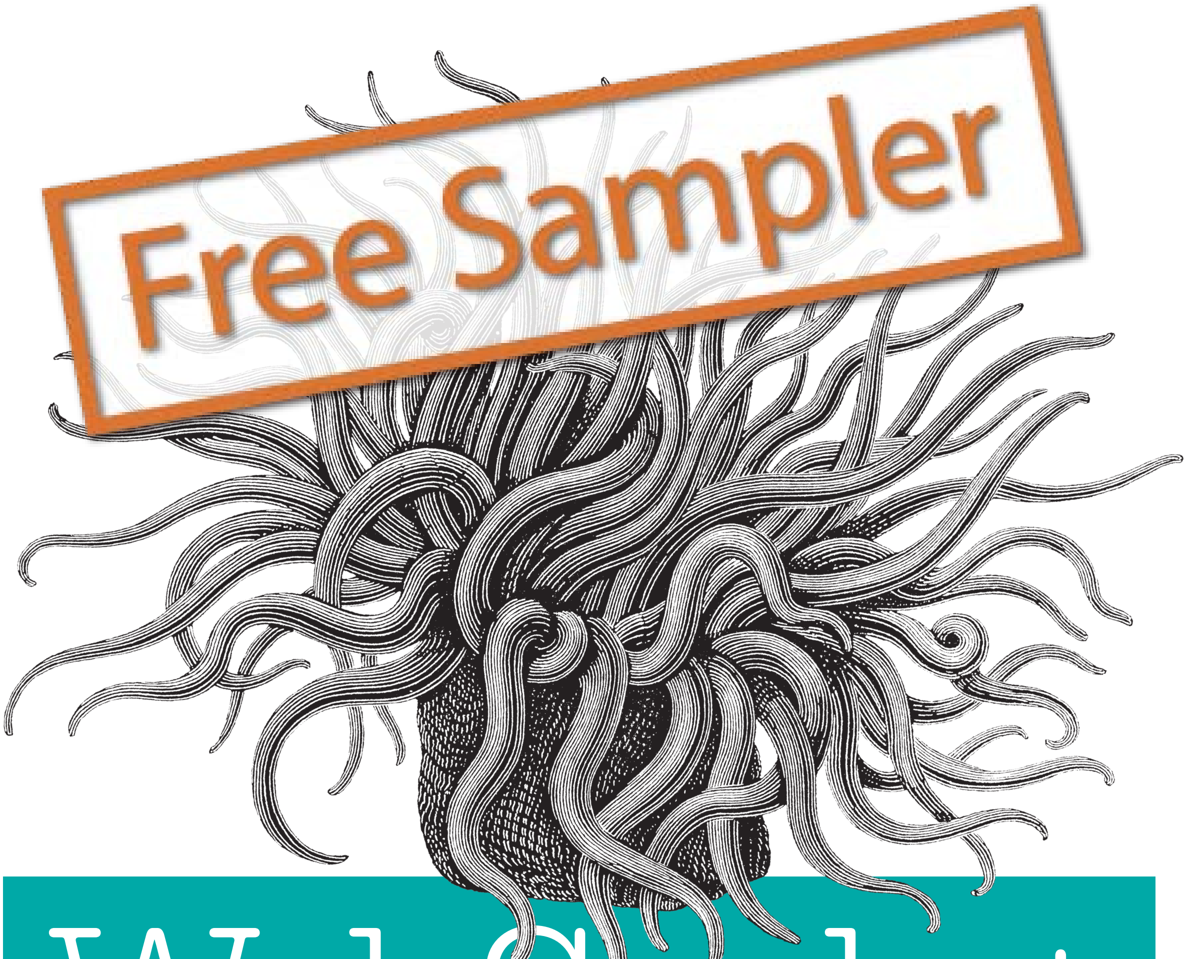

WebSocket

LIGHTWEIGHT CLIENT-SERVER COMMUNICATIONS

Andrew Lombardi

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WebSocket

Until recently, creating desktop-like applications in the browser meant using inefficient Ajax or Comet technologies to communicate with the server. With this practical guide, you'll learn how to use WebSocket, a protocol that enables the client and server to communicate with each other on a single connection *simultaneously*. No more asynchronous communication or long polling!

For developers with a good grasp of JavaScript (and perhaps Node.js), author Andrew Lombardi provides useful hands-on examples throughout the book to help you get up to speed with the WebSocket API. You'll also learn how to use WebSocket with Transport Layer Security (TLS).

- Learn how to use WebSocket API events, messages, attributes, and methods within your client application
- Build bidirectional chat applications on the client and server with WebSocket as the communication layer
- Create a subprotocol over WebSocket for STOMP 1.0, the Simple Text Oriented Messaging Protocol
- Use options for older browsers that don't natively support WebSocket
- Protect your WebSocket application against various attack vectors with TLS and other tools
- Debug applications by learning aspects of the WebSocket lifecycle

"This book walks through a number of useful examples, easily applied to the real world, along with discussions of issues that developers will find when working with the WebSocket protocol."

—Joseph B. Ottinger
Senior Engineer, Edifecs, Inc.

"A complete introduction to WebSocket concepts and implementation details."

—Arun Gupta
Director of Developer Advocacy, Red Hat

Andrew Lombardi, owner of consulting firm Mystic Coders, has spent the past six years giving dozens of talks at conferences all over North America and Europe on topics ranging from backend Java development and HTML5 to building for mobile using only JavaScript.

JAVASCRIPT / PROGRAMMING LANGUAGES

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by Andrew Lombardi

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CHAPTER 1

Quick Start

The WebSocket API and protocol is defined in RFC 6455. WebSocket gives you a bidirectional, full-duplex communications channel that operates over HTTP through a single socket.

Existing hacks that run over HTTP (like long polling) send requests at intervals, regardless of whether messages are available, without any knowledge of the state of the server or client. The WebSocket API, however, is different—the server and client have an open connection from which they can send messages back and forth. For the security minded, WebSocket also operates over Transport Layer Security (TLS) or Secure Sockets Layer (SSL) and is the preferred method, as you will see in Chapter 6.

This book will help you understand the WebSocket API, the protocol, and how to use it in your web applications today.

In this book, JavaScript is used for all code examples. Node.js is used for all server code, and for occasional client code or tests when a browser is extraneous to getting a sense of functionality. To understand the examples, you'll need some level of proficiency with JavaScript. If you'd like to study up on JavaScript, I recommend Douglas Crockford's *JavaScript: The Good Parts* (O'Reilly).

Node.js has been so prevalant in the past several years that the barriers to entry for the examples in this book are remarkably low. If you've done any development for the Web, chances are good that you've developed in JavaScript or at least understand it. The use of Node.js and JavaScript throughout, then, is meant only to simplify the teaching process, and should not be construed as a requirement for a WebSocket project.

Libraries and servers are available that support WebSocket in nearly every possible configuration. Chapter 5 covers several options for deploying a WebSocket-capable

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server, including fallback methods for clients that don't offer support for this technology yet.

Getting Node and npm

To ensure that you can run all of the examples in the book, I strongly recommend that you install Node.js and npm in your development environment. While you can learn all about WebSocket without touching any code, I don't recommend it. The following sections indicate a few simple ways to get Node in your environment.

Installing on Windows

I cover only downloading and installing the precompiled binary available on Windows. If you are masochistic and would like to compile it yourself, you can follow the instructions.

For the rest of you, download the standalone Windows executable. Then grab the latest *.zip* archive of npm. Unpack the npm *.zip*, and place the downloaded *node.exe* in a directory you add to your `PATH`. You'll be able to run scripts and install modules using Node.js and npm, respectively.

Installing on OS X

Two of the easiest methods of installing Node.js and npm are via a precompiled downloadable package, or via a package manager. My preference is to use a package manager like Homebrew to get Node.js onto your machine. This allows for quick and easy updating without having to redownload a package from the Web. Assuming you have Homebrew installed, run this command:

```
brew install node
```

And if you'd rather use the available precompiled binaries, you can find the download at the Node.js site. When you'd like to install an updated version of Node.js, download and install the latest package and it will overwrite the existing binaries.

Installing on Linux

Because there are more flavors of Linux than stars in the sky, I'll outline only how to compile it yourself, and how to get it via apt on Ubuntu. If you're running another distro and would like to use the package manager available on your particular flavor, visit the Node.js wiki for instructions on installing.

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Using apt to install Node.js requires a few simple steps:

```
sudo apt-get update
sudo apt-get install python-software-properties python g++ make
sudo add-apt-repository ppa:chris-lea/node.js
sudo apt-get update
sudo apt-get install nodejs
```

This installs the current stable Node.js onto your Ubuntu distro, ready to free JavaScript from the browser and let you write some server-side code.

If you'd like to compile it yourself, assuming Git is already installed and available on your machine, type the following:

```
git clone git://github.com/joyent/node.git
cd node
git checkout v0.10.7
./configure && make && make install
```

Check *http://nodejs.org/* for the latest version of Node.js to check out onto your system.

Hello, World! Example

When tackling a new topic in development, I prefer to start with an example fairly quickly. So we'll use the battle-tested example across languages—"Hello, World!"—to initiate a connection to a WebSocket-capable Node.js server, and receive the greeting upon connection.

History of Hello, World!

The initial incarnation of everyone's first application in a new language/technology was first written in Brian Kernighan's 1972 "A Tutorial Introduction to the Language B." The application was used to illustrate external variables in the language.

You'll start by writing code that starts a WebSocket-capable server on port 8181. First, you will use the CommonJS idiom and *require* the `ws` module and assign that class to the `WebSocketServer` object. Then you'll call the constructor with your initialization object, which consists of the port definition, or which contains the port definition.

The WebSocket protocol is essentially a message-passing facility. To begin, you will listen for an event called `connection`. Upon receiving a `connection` event, the provided WebSocket object will be used to send back the "Hello, World!" greeting.

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To make life a bit simpler, and because I don't fancy reinventing the wheel, the wonderful WebSocket library called `ws` will be used. The `ws` library can take a lot of the headache out of writing a WebSocket server (or client) by offering a simple, clean API for your Node.js application.

Install it using `npm`:

```
npm install ws
```

Another popular option is to use the WebSocket-Node library.

All of this book's examples will assume that the source code exists in a folder denoted by the abbreviated chapter name, so create a directory called *ch1*. Now create a new file called *server.js* in your editor of choice and add this code for your application:

```
var WebSocketServer = require('ws').Server,
    wss = new WebSocketServer({port: 8181});

wss.on('connection', function(ws) {
    console.log('client connected');
    ws.on('message', function(message) {
        console.log(message);
    });
});
```

Short and to the point. Next, run the server so it's listening for the client you're about to code:

```
node server.js
```

Create a file for the client called *client.html* and place it in the same directory as the server file. With this simple example, the client can be hosted anywhere, even run from the `file://` protocol. In later chapters, you'll use HTTP libraries and require a more web-centric focus for file and directory management.

In this first pass, however, you'll use a basic HTML page to call the WebSocket server. The structure of the HTML page is a simple form, with a text field and a button to initiate the send. The two methods of sending your message will be submitting a form (via Return/Enter) or clicking the Send! button. Then you'll add an action on the form submit and the `onclick` event of the button to call the `sendMessage` JavaScript function. One thing to note is that the code returns `false` in the form's `onsubmit` so the page doesn't refresh.

The WebSocket initialization is rather simple; you initiate a connection to a WebSocket server on port 8181 on `localhost`. Next, because the WebSocket API is event-based (more about this later), you define a function for the `onopen` event to output a status message for a successful connection to the server. The `sendMessage` function merely has to call the `send` function on the variable `ws` and grab the value inside the `message` text field.

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And *voila!* You have your first WebSocket example.

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>WebSocket Echo Demo</title>
<meta charset="utf-8">
<meta name="viewport" content="width=device-width, initial-scale=1">
<link rel="stylesheet" href="http://bit.ly/cdn-bootstrap-css">
<link rel="stylesheet" href="http://bit.ly/cdn-bootstrap-theme">
<script src="http://bit.ly/cdn-bootstrap-jq"></script>
<script>
    var ws = new WebSocket("ws://localhost:8181");
    ws.onopen = function(e) {
      console.log('Connection to server opened');
    }

    function sendMessage() {
        ws.send($('#message').val());
    }
</script>
</head>
<body lang="en">
    <div class="vertical-center">
    <div class="container">
        <p>&nbsp;</p>
    <form role="form" id="chat_form" onsubmit="sendMessage(); return false;">
        <div class="form-group">
        <input class="form-control" type="text" name="message" id="message"
          placeholder="Type text to echo in here" value="" autofocus/>
        </div>
        <button type="button" id="send" class="btn btn-primary"
          onclick="sendMessage();">Send!</button>
    </form>
    </div>
    </div>
<script src="http://bit.ly/cdn-bootstrap-minjs"></script>
</body>
</html>
```

Throughout the book you will use the two wonderful libraries prevalent on the Web for display and interaction:

- Bootstrap 3
- jQuery

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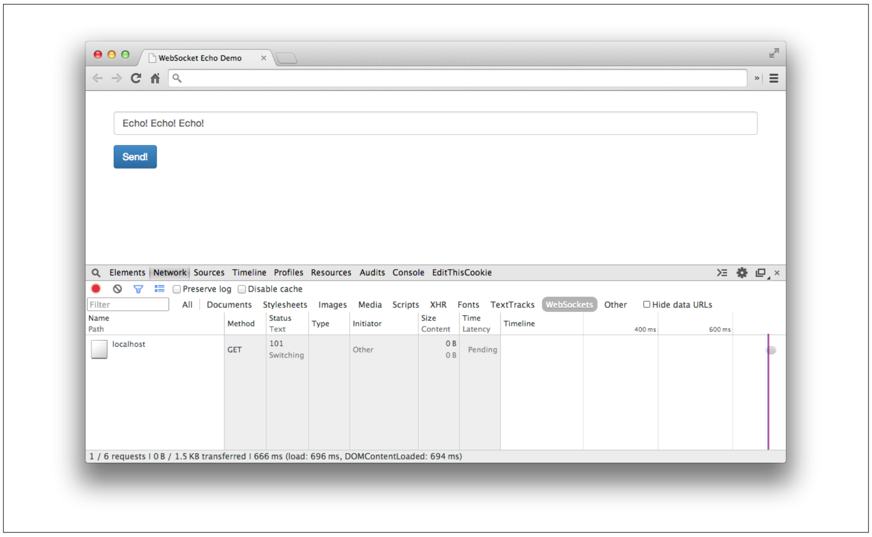
In later examples, we'll dispense with including the script and CSS style tags in favor of brevity. You can use the preceding HTML as a template for future examples, and just remove the content of the custom `<script>` tag and the contents between the `<body>` tags while keeping the Bootstrap JavaScript include intact.

With that, open the HTML page in your favorite browser (I suggest Google Chrome or Mozilla Firefox). Send a message and watch it show up in your server's console output.

If you're using Chrome, it has an excellent facility for viewing WebSocket connections from the frontmost page. Let's do this now. From the hotdog menu, choose Tools → Developer Tools (on Windows: F12, Ctrl-Shift-I; on a Mac ⌥-⌘-I).

Figure 1-1 shows the Google Chrome Developer Tools filtered for WebSocket calls. Echo is the first app to be written in the networking space.


WebSocket Echo Demo
Echo! Echo! Echo!
Send!
Elements Network Sources Timeline Profiles Resources Audits Console EditThisCookie
Preserve log
Disable cache
Filter
All Documents Stylesheets Images Media Scripts XHR Fonts TextTracks WebSockets Other
Hide data URLs
400 ms
600 ms

Name Path	Method	Status Text	Type	Initiator	Size Content	Time Latency	Timeline
localhost	GET	101 Switching		Other	0 B 0 B	Pending	

1 / 6 requests | 0 B / 1.5 KB transferred | 666 ms (load: 696 ms, DOMContentLoaded: 694 ms)

Figure 1-1. Chrome Developer Tools—Network tab

Select the Network tab and refresh the example HTML. In the table you should see an entry for the HTML, and an entry for the WebSocket connection with status of "101 Switching Protocols." If you select it, you'll see the Request Headers and Response Headers for this connection:

```
GET ws://localhost:8181/ HTTP/1.1
Pragma: no-cache
Origin: null
Host: localhost:8181
Sec-WebSocket-Key: qalODNsUoRp+2K9FJty55Q==
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_8_3)...
```

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```
Upgrade: websocket
Sec-WebSocket-Extensions: x-webkit-deflate-frame
Cache-Control: no-cache
Connection: Upgrade
Sec-WebSocket-Version: 13

HTTP/1.1 101 Switching Protocols
Connection: Upgrade
Sec-WebSocket-Accept: nambQ7W9imtAIYpzsw4hNNuGD58=
Upgrade: websocket
```

If you're used to seeing HTTP headers, this should look no different. We do have a few extra headers here, including `Connection: Upgrade`, `Sec-Websocket-Key`, `Upgrade: websocket`, which I'll explain further in Chapter 8. For now, relish in your first WebSocket example, and get ready to learn why WebSocket should be on your radar for your next project.

Why WebSocket?

The ability today to create desktop-like applications in the browser is achieved primarily by using Comet and Ajax. To use either solution, developers have relied on hacks in servers and clients alike to keep connections open longer and fake a long-running connection.

While these hacks technically work, they create resource allocation issues on servers. With existing methods, the perceived latency to the end user may be low, but the efficiency on the backend leaves a lot to be desired. Long polling makes unnecessary requests and keeps a constant stream of opening and closing connections for your servers to deal with. There is no facility for layering other protocols on top of Comet or Ajax, and even if you could, the simplicity is just not there.

WebSocket gives you the ability to use an upgraded HTTP request (Chapter 8 covers the particulars), and send data in a message-based way, similar to UDP and with all the reliability of TCP. This means a single connection, and the ability to send data back and forth between client and server with negligible penalty in resource utilization. You can also layer another protocol on top of WebSocket, and provide it in a secure way over TLS. Later chapters dive deeper into these and other features such as heartbeating, origin domain, and more.

One of the common pitfalls of choosing between WebSocket and long polling was the sad state of browser support. Today, the state of browser support for WebSocket is much brighter for the end user.

Table 1-1 shows the current state of browser support for WebSocket. For the most up-to-date information on WebSocket support, you can reference the Can I Use website.

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Table 1-1. The state of WebSocket browser support

Browser	No support	Partial support	Full support
IE	Versions 8.0, 9.0		Version 10.0 and up
Firefox			Version 27.0 and up
Chrome			Version 31.0 and up
Safari			Version 7 and up
Opera			Version 20.0 and up
iOS Safari	Versions 3.2, 4.0–4.1	Versions 4.2–4.3, 5.0–5.1	Version 6.0 and up
Opera Mini	Versions 5.0–7.0		
Android Browser	Versions 2.1–4.3		Version 4.4
BlackBerry Browser			Versions 7.0, 10.0
IE Mobile			Version 10.0

As you'll discover in Chapter 5, you can mitigate the lack of support in older browsers for native WebSocket by using framework libraries such as SockJS or Socket.IO.

Summary

This chapter introduced WebSocket and how to build a simple `echo` server using Node.js. You saw how to build a simple client for testing your WebSocket server, along with one simple way to test your WebSocket server using Chrome Developer Tools. The next chapters explore the WebSocket API, and the protocol, and you'll learn how to layer other protocols on top of WebSocket to give you even more power.

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