

# Server-Side Secret Sauce

Rapidly Prototyping  
a WebSocket Application

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# The Recipe

websocketd

+ netcat

+ Tcl

(or your favorite scripting language)

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easy rapid prototyping

# websocketd

- “WebSockets the UNIX way”
- Faster than many languages’ native WebSocket implementation [2]
- Low latency overhead (3 ms roundtrip)
- Neat additional features
  - Static file server (HTTP server)
  - HTTPS
  - CGI
  - Can route different URLs to different programs



## “Party like it’s 1999!”

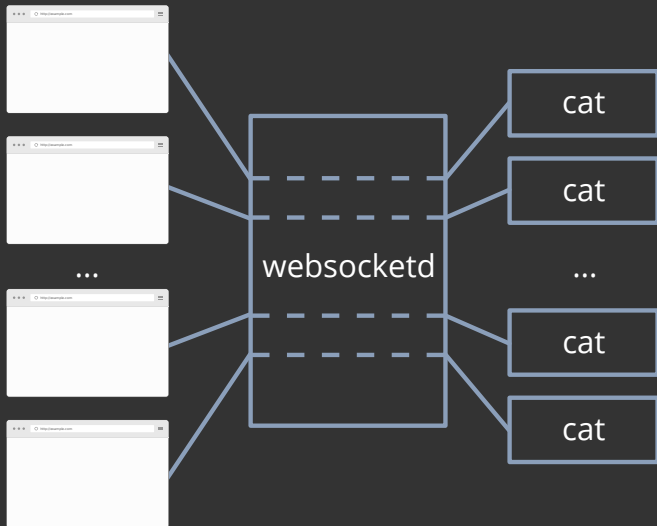
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- CGI (as in `/cgi-bin/`, not as in Michael Bay) is back.
- Wasn't CGI slow and bad?
- Not slow per se but slow and expensive *to start*.
- Doesn't matter because our processes are long-lived.

# “Party like it’s 1999!”

- CGI (as in /cgi-bin/, not as in Michael Bay) is back.
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- Doesn’t matter because our processes are long-lived.

# Example 1 — Chart



# Example 1 — Client

```
<!DOCTYPE html>
<html>
<head>
  <title>Echo</title>
</head>
<body>
  <script type="text/javascript">
    var ws = new WebSocket("ws://localhost:8080/", "ex1");
    ws.onmessage = function(event) {
      window.alert(event.data);
    };
    ws.onopen = function(event) {
      ws.send('Hello !');
    };
  </script>
</body>
</html>
```

# Example 1 — Server

```
#!/bin/sh
```

```
# 'cat' prints its input to standard output.
```

```
../websocketd --port=8080 --staticdir=. cat
```



# Example 1 — Data flow



# Example 1 — Data flow



# Example 1 — Data flow



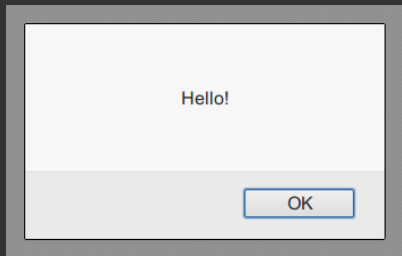
# Example 1 — Data flow



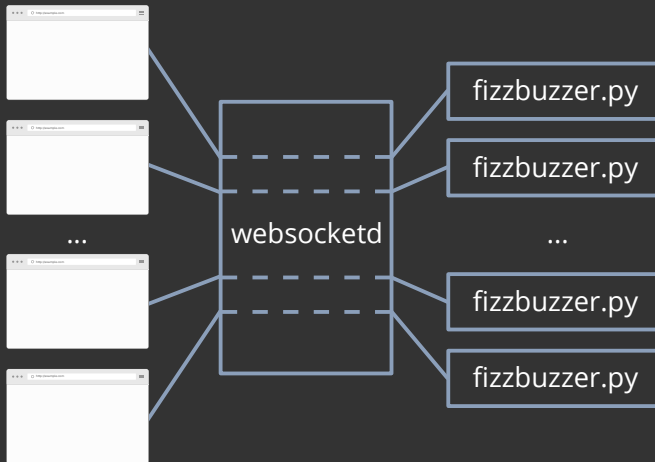
# Example 1 — Data flow



# Example 1 — Screenshot



# Example 2 — Chart



# Example 2 — Client

```
<!DOCTYPE html>
<html>
<head>
  <title>FaaS – FizzBuzz as a Service</title>
</head>
<body>
  <script type="text/javascript">
    var ws = new WebSocket("ws://localhost:8081/", "ex2");
    ws.onmessage = function(event) {
      console.log(event.data);
    };
    ws.onopen = function(event) {
      for (var i = 0; i <= 100; i++) {
        ws.send(i);
      }
    };
  </script>
</body>
</html>
```



## Example 2 — Server (1)

```
#!/bin/sh
```

```
../websocketd --port=8081 --staticdir=. ./fizzbuzzer.py
```

## Example 2 — Server (2)

```
#!/usr/bin/env python3
def to_fizzbuzz(n):
    if n % 15 == 0:
        return "FizzBuzz"
    elif n % 3 == 0:
        return "Fizz"
    elif n % 5 == 0:
        return "Buzz"
    else:
        return n

while True:
    try:
        n = int(input()) # Synchronous. We wait for input.
        print("{0} => {1}".format(n, to_fizzbuzz(n)))
    except EOFError:
        break
    except ValueError:
        print("error: cannot process input")
```

# Example 2 — Screenshot

```
0 => FizzBuzz      localhost:~:10:4
1 => 1             localhost:~:10:4
2 => 2             localhost:~:10:4
3 => Fizz          localhost:~:10:4
4 => 4             localhost:~:10:4
5 => Buzz          localhost:~:10:4
6 => Fizz          localhost:~:10:4
7 => 7             localhost:~:10:4
8 => 8             localhost:~:10:4
9 => Fizz          localhost:~:10:4
10 => Buzz         localhost:~:10:4
11 => 11           localhost:~:10:4
12 => Fizz         localhost:~:10:4
13 => 13           localhost:~:10:4
14 => 14           localhost:~:10:4
15 => FizzBuzz     localhost:~:10:4
16 => 16           localhost:~:10:4
17 => 17           localhost:~:10:4
18 => Fizz         localhost:~:10:4
19 => 19           localhost:~:10:4
20 => Buzz         localhost:~:10:4
21 => Fizz         localhost:~:10:4
22 => 22           localhost:~:10:4
23 => 23           localhost:~:10:4
24 => Fizz         localhost:~:10:4
25 => Buzz         localhost:~:10:4
26 => 26           localhost:~:10:4
27 => Fizz         localhost:~:10:4
28 => 28           localhost:~:10:4
29 => 29           localhost:~:10:4
30 => FizzBuzz     localhost:~:10:4
```

```
70 => Buzz        localhost:~:10:4
71 => 71           localhost:~:10:4
72 => Fizz         localhost:~:10:4
73 => 73           localhost:~:10:4
74 => 74           localhost:~:10:4
75 => FizzBuzz     localhost:~:10:4
76 => 76           localhost:~:10:4
77 => 77           localhost:~:10:4
78 => Fizz         localhost:~:10:4
79 => 79           localhost:~:10:4
80 => Buzz         localhost:~:10:4
81 => Fizz         localhost:~:10:4
82 => 82           localhost:~:10:4
83 => 83           localhost:~:10:4
84 => Fizz         localhost:~:10:4
85 => Buzz         localhost:~:10:4
86 => 86           localhost:~:10:4
87 => Fizz         localhost:~:10:4
88 => 88           localhost:~:10:4
89 => 89           localhost:~:10:4
90 => FizzBuzz     localhost:~:10:4
91 => 91           localhost:~:10:4
92 => 92           localhost:~:10:4
93 => Fizz         localhost:~:10:4
94 => 94           localhost:~:10:4
95 => Buzz         localhost:~:10:4
96 => Fizz         localhost:~:10:4
97 => 97           localhost:~:10:4
98 => 98           localhost:~:10:4
99 => Fizz         localhost:~:10:4
100 => Buzz        localhost:~:10:4
```

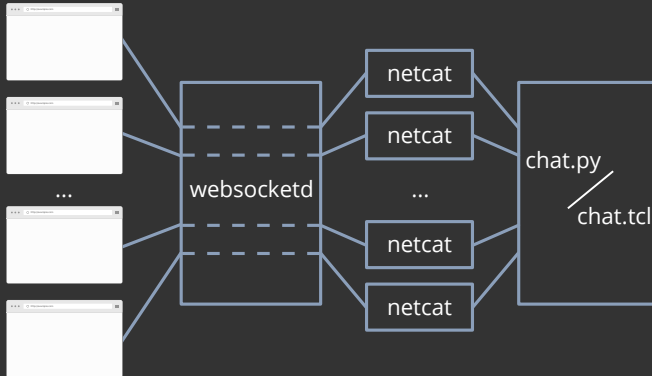
# netcat

- “The TCP/IP Swiss Army knife”
- A universal socket client/server
- Talk to sockets from the command line
  - `printf "GET / HTTP/1.1\r\nHost: example.com\r\n\r\n" | nc example.com 80`
- Probably already there on your Linux, FreeBSD or OS X system, available [3] for Windows

# Plumbing with netcat

- websocketd spawns a separate process for each connection
  - What if you wanted the clients to interact with each other?
- Have a TCP server listen on a regular TCP socket
- Redirect WebSocket connections to it
  - `./websocketd-v0.2.11-linux-x86_64 --port=8080 nc localhost 7777`

# Example 3 — Chart



# Example 3 — Client (1)

```
<!DOCTYPE html>
<html>
<head>
  <style type="text/css">
    #chat {
      width: 700px; height: 500px; overflow: scroll;
    }
  </style>
</head>
<body>
  <div id="chat"></div><br>
  <input type="text" id="input">
  <input type="button" id="send" value="send">

  <script type="text/javascript" src="client.js"></script>
</body>
</html>
```

## Example 3 — Client (2)

```
// client.js
var qs = document.querySelector;
var inputElem = qs('#input');
var chatAreaElem = qs('#chat');
var sendElem = qs('#send');
var post_chat_message = function(text) {
    // ...
};

var ws = new WebSocket("ws://localhost:8082/", "ex3");
ws.onopen = function(event) {
    var sendFunc = function() {
        ws.send(input.value); input.value = '';
    }
    sendElem.addEventListener('click', sendFunc);
    inputElem.addEventListener('keypress', function(event) {
        var key = event.which || event.keyCode;
        if (key === 13) { sendFunc(); }
    });
}
ws.onmessage = function(event) { post_chat_message(event.data); };
ws.onclose = function(event) {
    post_chat_message('Connection closed.')
}
}
```



# Example 3 — Server (1)

```
#!/bin/sh
set -e

# Run chat.py or chat.tcl depending on the command line arg.
if [ "$1" = "py" ] || [ "$1" = "tcl" ]; then
    echo "Starting chat.$1"
    ./chat.$1 &
else
    echo "usage: $0 (py|tcl)"
    exit 1
fi

# Kill the chat server on exit.
trap 'kill $(jobs -pr)' SIGINT SIGTERM EXIT

# Redirect each WebSocket connection to localhost TCP socket.
../websocketd --port=8082 --staticdir=. nc localhost 7777
```

# Example 3 — Server (2)

## Python 3

```
#!/usr/bin/env python3
import asyncio
import socket

class ChatHandler(asyncio.dispatcher_with_send):
    def __init__(self, sock, name, server):
        asyncio.dispatcher_with_send.__init__(self, sock)
        self.name = name
        self.server = server

    def handle_read(self):
        data = self.recv(8192).decode()
        if data != "":
            self.server.broadcast(self.name + ": " + data)

    def handle_close(self):
        del self.server.clients[self.name]
        self.close()
        self.server.broadcast(self.name + " disconnected")

class ChatServer(asyncio.dispatcher):
    def __init__(self, host, port):
        asyncio.dispatcher.__init__(self)
        self.create_socket(socket.AF_INET, socket.SOCK_STREAM)
        self.set_reuse_addr()
        self.bind((host, port))
        self.listen(5)
        self.clients = {}
        self.counter = 0

    def broadcast(self, message):
        print(message)
        messageBytes = (message + "\n").encode()
        for otherName in self.clients:
            handler = self.clients[otherName]
            handler.send(messageBytes)

    def handle_accept(self):
        pair = self.accept()
        if pair is not None:
            sock, addr = pair
            self.counter += 1
            name = "client" + str(self.counter)
            print('Incoming connection from {}: {}'.format(repr(addr), name))
            self.broadcast(name + " connected")
            handler = ChatHandler(sock, name, self)
            self.clients[name] = handler

server = ChatServer('localhost', 7777)
asyncio.loop()
```

## Tcl

```
#!/usr/bin/env tclsh
namespace eval ::chat {
    variable count 0
    variable clients {}
}

proc ::chat::main {} {
    socket -server ::chat::new-connection-handler -myaddr 127.0.0.1 7777
    vwait forever
}

proc ::chat::new-connection-handler {channel clientAddr clientPort} {
    incr ::chat::count
    set name clients::chat::count
    lappend ::chat::clients $channel $name

    puts "Incoming connection from ('$clientAddr', $clientPort): $name"
    ::chat::broadcast "$name connected"

    fconfigure $channel -buffering line
    fileevent $channel readable [list ::chat::readable-handler $channel]
}

proc ::chat::broadcast message {
    puts $message
    foreach {otherChannel $} clients {
        puts $otherChannel $message
    }
}

proc ::chat::readable-handler channel {
    set senderName [dict get $::chat::clients $channel]
    if {[gets $channel line] >= 0} {
        ::chat::broadcast "$senderName: $line"
    }
    if {[eof $channel]} {
        ::chat::broadcast "$senderName disconnected"
        close $channel
        dict unset ::chat::clients $channel
    }
}

::chat::main
```

# Example 3 — Server (2)

## Python 3

```
#!/usr/bin/env python3
import asyncio
import socket

class ChatHandler(asyncio.dispatcher_with_send):
    def __init__(self, sock, name, server):
        asyncio.dispatcher_with_send.__init__(self, sock)
        self.name = name
        self.server = server

    def handle_read(self):
        data = self.recv(8192).decode()
        if data != "":
            self.server.broadcast(self.name, data)
            self.close()

    def handle_write(self):
        self.server.broadcast(self.name, data)
        self.close()

class ChatServer(asyncio.AbstractServer):
    def __init__(self, host, port):
        self.host = host
        self.port = port
        self.clients = {}
        self.counter = 0

    def broadcast(self, message):
        print(message)
        messageBytes = (message + "\n").encode()
        for otherName in self.clients:
            handler = self.clients[otherName]
            handler.send(messageBytes)

    def handle_accept(self):
        pair = self.accept()
        if pair is not None:
            sock, addr = pair
            self.counter += 1
            name = "client" + str(self.counter)
            print("Incoming connection from {}".format(addr))
            self.broadcast(name + " connected")
            handler = ChatHandler(sock, name, self)
            self.clients[name] = handler

server = ChatServer('localhost', 7777)
asyncio.loop()
```

## Tcl

```
#!/usr/bin/env tclsh
namespace eval ::chat {
    variable count 0
    variable clients {}
}

proc ::chat::main {
    socket -server $chan -myaddr 127.0.0.1 7777
    for {
        # Incoming connection from ($clientAddr, $clientPort): $name
        # Incoming connection from ($clientAddr, $clientPort): $name
        ::chat::broadcast "$name connected"
    } {}

    # configure $chan -buffering line
    fileevent $chan readable [list ::chat::readable-handler $chan]
}

proc ::chat::broadcast message {
    puts $message
    foreach {otherChannel} [::chat::clients] {
        puts $otherChannel $message
    }
}

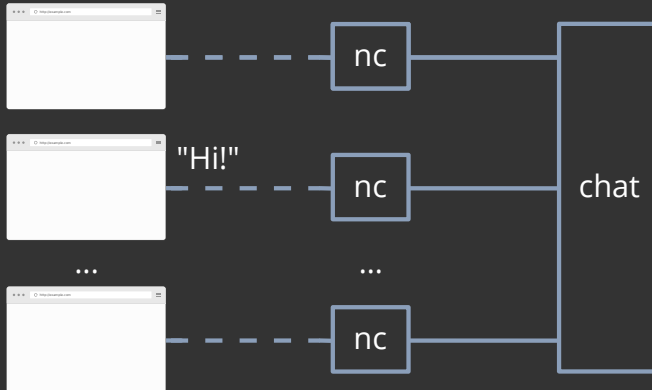
proc ::chat::readable-handler {chan} {
    set {clientAddr clientPort} [::chat::clients]
    if {
        # Incoming connection from ($clientAddr, $clientPort): $name
        # Incoming connection from ($clientAddr, $clientPort): $name
        ::chat::broadcast "$name connected"
    } {}
    if {
        # Incoming connection from ($clientAddr, $clientPort): $name
        # Incoming connection from ($clientAddr, $clientPort): $name
        ::chat::clients $chan
    } {}
}

::chat::main
```

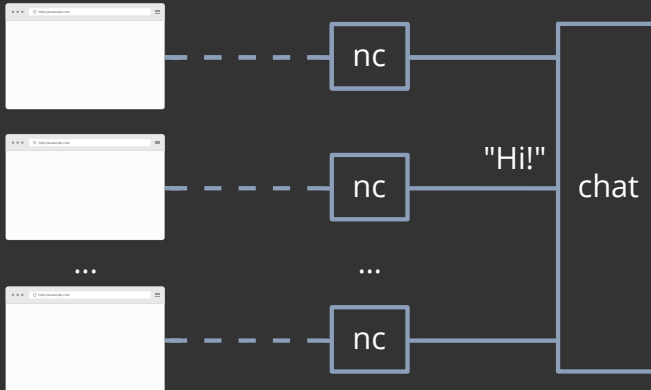
## Example 3 — Server (3)

- The idea
  - Listen for connections on a TCP socket on localhost
  - Forward every message you get to all other clients
    - Prefix the message with the sender's name

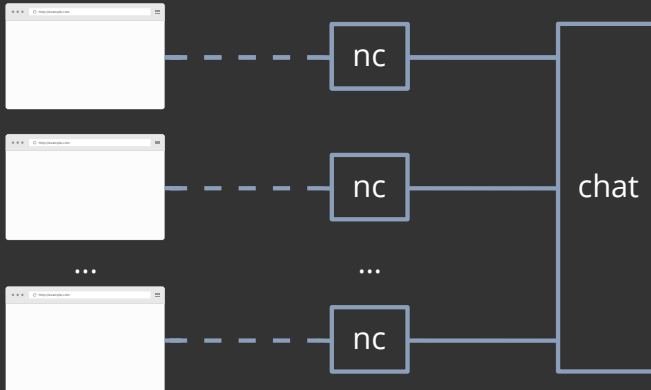
# Example 3 — Data flow



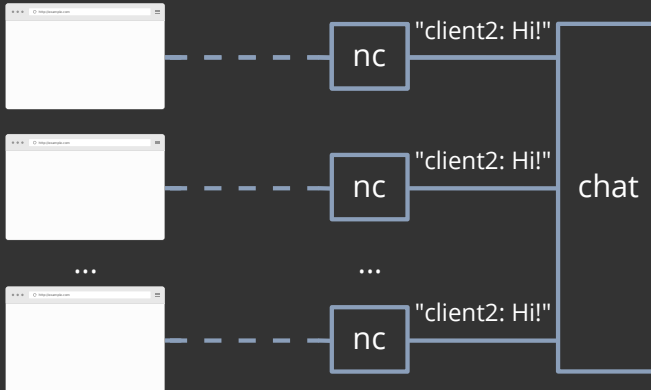
# Example 3 — Data flow



# Example 3 — Data flow

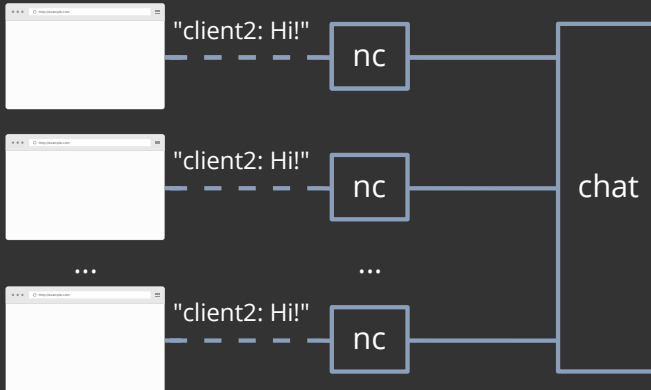


# Example 3 — Data flow

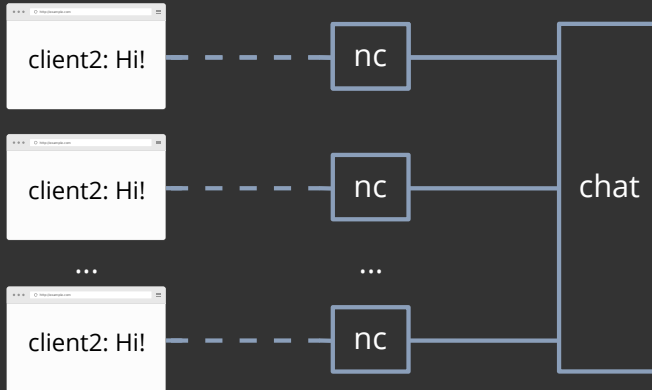




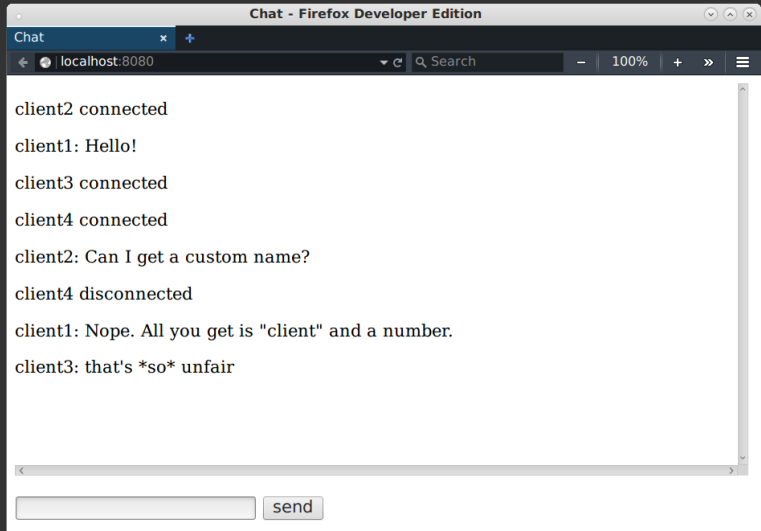
# Example 3 — Data flow



# Example 3 — Data flow



# Example 3 — Screenshot



# The Project

- A multiplayer game state replicator (aka “50% of an [Agar.io](#) server”)
- Tcl [4] on the server
  - Under 250 lines of code
- TypeScript [5] and Phaser [6] on the client
  - Type definitions for WebSocket objects from DefinitelyTyped

# Observations on protocols

- No need to speak JSON (or worse yet, XML) both ways
- What worked
  - A simple plain text client-to-server protocol
    - One command per line
  - A JSON server-to-client protocol
    - Only send state changes to the client

# The Recipe

websocketd

+ netcat

+ Tcl

(or your favorite scripting language)

---

easy rapid prototyping

Thank you!

# References

1. <http://websocketd.com/>
2. See [comment](#) for an example. This matches the speaker's experience.
3. Look [here](#) or [here](#).
4. <https://en.wikipedia.org/wiki/Tcl>
5. <http://www.typescriptlang.org/>
6. <http://phaser.io/>
7. Go to the [GitHub repository](#) for the talk to download the example code.