Software at Scale

Software Architecture

Brae Webb

March 23, 2026

How many concurrent users can your software handle?

How many concurrent users can your software handle?

Maybe *400*? Maximum.

Question

How many concurrent users can your software handle?

Answer

Maybe *400*[1]? Maximum.
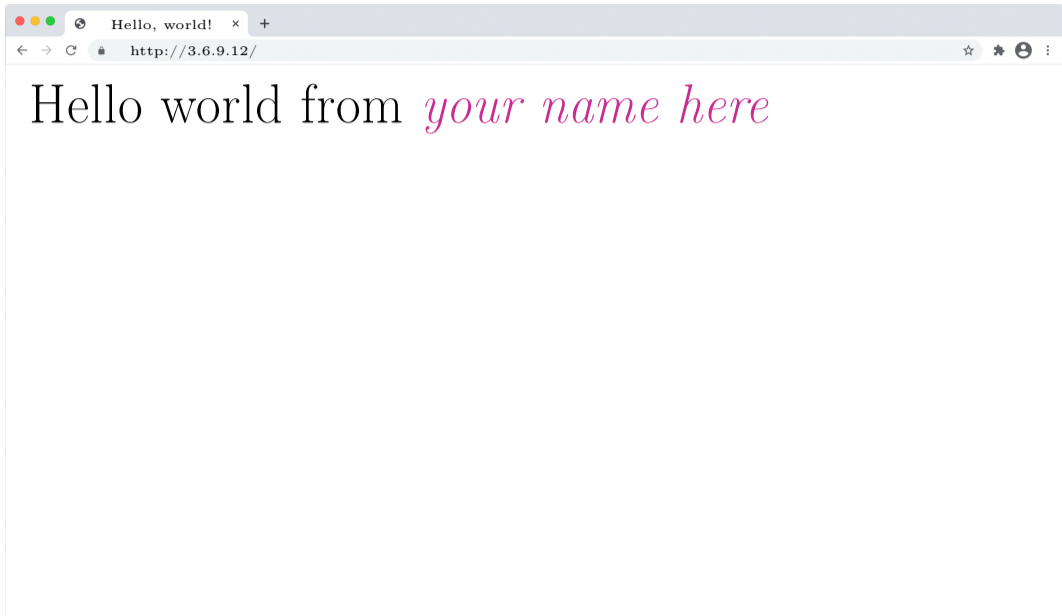

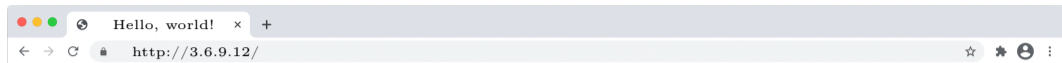[1]HTTP server on a t2.micro EC2 instance

> *Definition 0.* Stress Testing
>
> Measure the robustness of software by pushing usage to an extreme.

Demonstration

Let's build 'hello world'

Hello world from *your name here*

Hello, world!

http://3.6.9.12/

Hello world from Brae

```
» cat hello-server.tf
```

```
1  resource "aws_instance" "hello-server" {
2      ami = "ami-04902260ca3d33422"
3      instance_type = "t2.micro"
4  }
```

```
» cat hello-server.tf
1  resource "aws_instance" "hello-server" {
2      ami = "ami-04902260ca3d33422"
3      instance_type = "t2.micro"

5      user_data = file("./setup.sh")
6  }
```

```
» cat setup.sh
```

```bash
#!/bin/bash
yum -y install httpd
systemctl enable httpd
systemctl start httpd
echo '<html><title>Hello, world!</title><h1>Hello world from Brae</h1></html>' > /
    var/www/html/index.html
```

```
» cat hello-server.tf
```
```
1  resource "aws_instance" "hello-server" {
2      ami = "ami-04902260ca3d33422"
3      instance_type = "t2.micro"

5      user_data = file("./setup.sh")

7      security_groups = [
8          aws_security_group.hello-server.name
9      ]
10 }
```
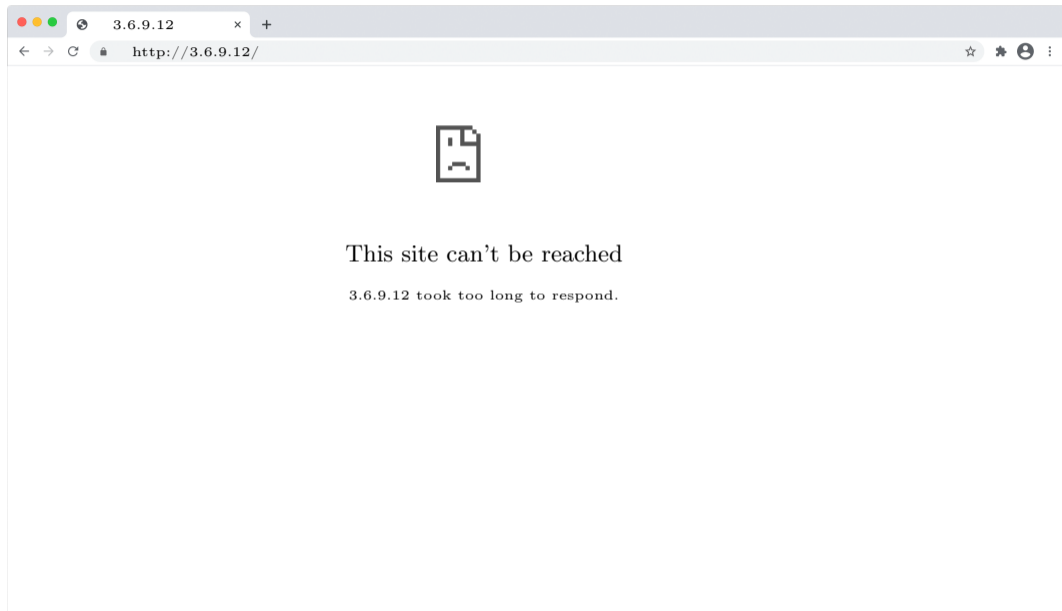
```
» cat hello-server.tf
```

```
1   resource "aws_instance" "hello-server" {
2       ami = "ami-04902260ca3d33422"
3       instance_type = "t2.micro"

5       user_data = file("./setup.sh")

7       security_groups = [
8           aws_security_group.hello-server.name
9       ]

11      tags = {
12          Name = "hello-server"
13      }
14  }
```

Starting the server

```
1  >> terraform init
2  >> terraform plan
3  >> terraform apply
```

3.6.9.12   ×   +

← → C 🔒 http://3.6.9.12/

This site can't be reached

3.6.9.12 took too long to respond.
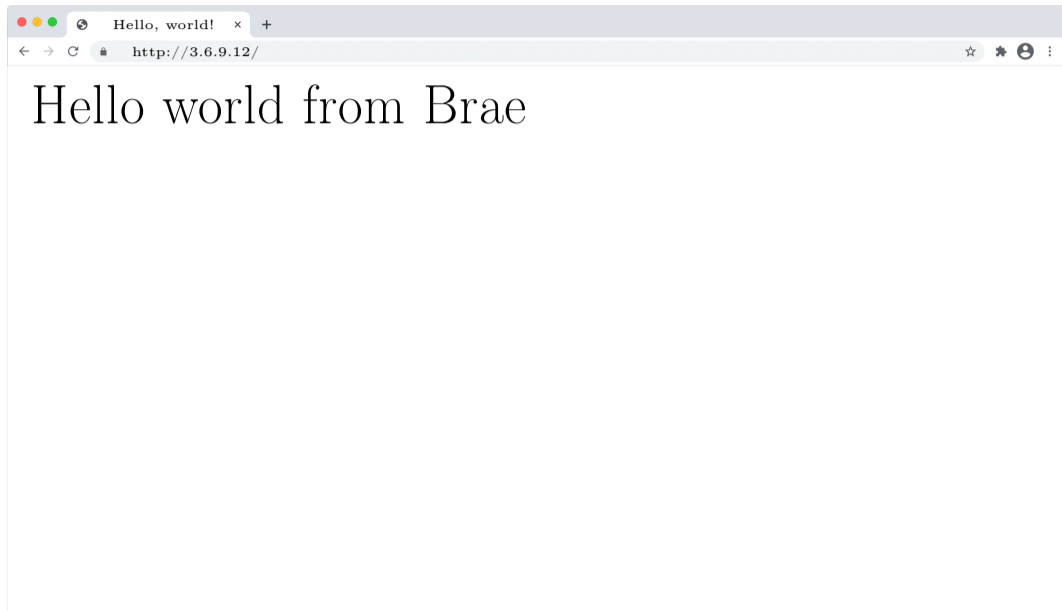
How much traffic can this website handle?

```
» cat stress-test.js
```

```
1  import http from 'k6/http';
2  import { check, sleep } from 'k6';

4  const IP = "http://3.6.9.12/";
5  export default function() {
6      const res = http.get(IP);
7      check(res, { 'status was 200': (r) => r.status == 200 });
8      sleep(1);
9  }
```

```
» cat stress-test.js
```

```javascript
1   import http from 'k6/http';
2   import { check, sleep } from 'k6';

4   const IP = "http://3.6.9.12/";
5   export const options = {
6       stages: [
7           { duration: '2m', target: 100 },
8       ],
9   };
10  export default function() {
11      const res = http.get(IP);
12      check(res, { 'status was 200': (r) => r.status == 200 });
13      sleep(1);
14  }
```

Run the tests

```
>> k6 run stress-test.js
```

Looks good so far

```
1   status was 200
2    100% - 347867 / 0

4   checks...........................: 100%
5   data_received....................: 100 MB 44 kB/s
6   data_sent........................: 27 MB 12 kB/s
7   iterations.......................: 347997 152.552084/s
8   vus..............................: 1 min=1 max=400
```

Let's upgrade the traffic

```
» cat stress-test.js
```

```javascript
1   export const options = {
2       stages: [
3           { duration: '2m', target: 100 },
4           { duration: '5m', target: 100 },
5           { duration: '2m', target: 200 },
6           { duration: '5m', target: 200 },
7           { duration: '2m', target: 300 }, // around the breaking point
8           { duration: '5m', target: 300 },
9           { duration: '2m', target: 400 }, // beyond the breaking point
10          { duration: '5m', target: 400 },
11          { duration: '2m', target: 0 }, // scale down
12      ],
13  };
```
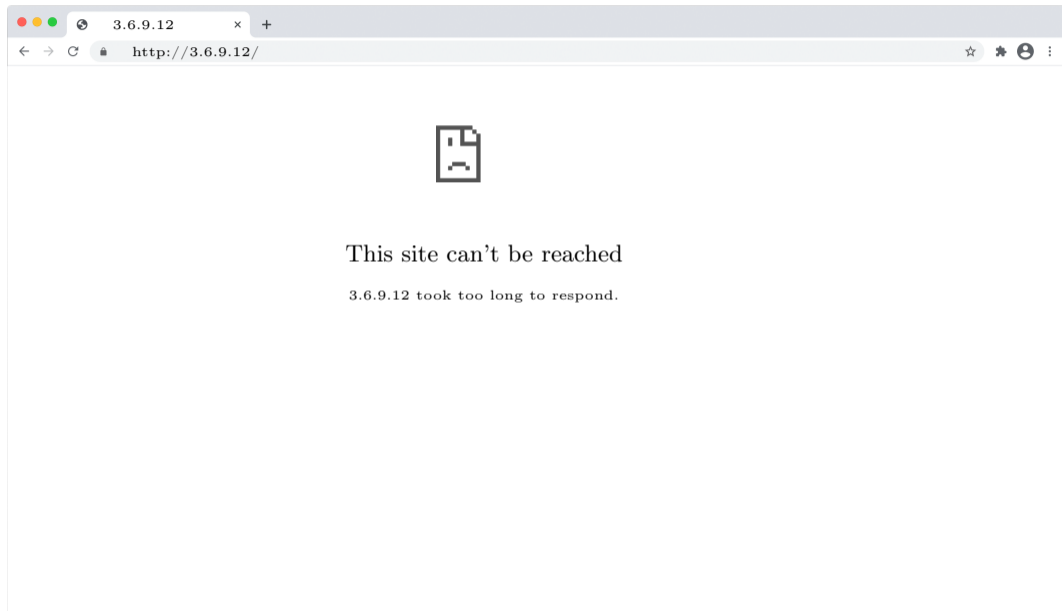
And run the tests again

```
>> k6 run stress-test.js
```

Oh no...

```
1  status was 200
2  99% - 347867 / 130

4  checks...........................: 99.96%
5  data_received....................: 100 MB 44 kB/s
6  data_sent........................: 27 MB 12 kB/s
7  iterations.......................: 347997 152.552084/s
8  vus..............................: 1 min=1 max=400
```

This site can't be reached

3.6.9.12 took too long to respond.

Question

How can we fix this?

Question

How can we fix this?

Answer

More servers?

```
❯ cat hello-server.tf
1   resource "aws_instance" "hello-server" {
2       ami = "ami-04902260ca3d33422"
3       instance_type = "t2.micro"

5       user_data = file("./setup.sh")

7       security_groups = [
8           aws_security_group.hello-server.name
9       ]

11      tags = {
12          Name = "hello-server"
13      }
14  }
```

```
» cat hello-scale.tf
```

```
1  resource "aws_instance" "hello-server" {
2    count = 4
4    ami = "ami-04902260ca3d33422"
5    instance_type = "t2.micro"
6    user_data = file("${path.module}/setup.sh")
8    security_groups = [
9      aws_security_group.hello-server.name
10   ]
12   tags = {
13     Name = "hello-server-${count.index}"
14   }
15 }
```

> *Definition 0.* Target Group
>
> A collection of EC2 instances.
> More specifically, a collection of network connection points to EC2 instances.

An empty HTTP target group

```
» cat hello-scale.tf
```

```
1  resource "aws_lb_target_group" "hello-target" {
2    name = "hello-target-group"
3    port = 80
4    protocol = "HTTP"
5    vpc_id = aws_security_group.hello-server.vpc_id
6  }
```

> *Definition 0.* Health Check
>
> Monitors attributes of hardware or software to detect deficiencies.

Add a health check

```
» cat hello-scale.tf
```

```
1  resource "aws_lb_target_group" "hello-target" {
2    name = "hello-target-group"
3    port = 80
4    protocol = "HTTP"
5    vpc_id = aws_security_group.hello-server.vpc_id

7    health_check {
8      port = 80
9      protocol = "HTTP"
10     timeout = 5
11     interval = 10
12   }
13 }
```

Add our instances to the target group

```
» cat hello-scale.tf
```

```
1  resource "aws_lb_target_group_attachment" "hello-target-link" {
2    count = length(aws_instance.hello-server)
3    target_group_arn = aws_lb_target_group.hello-target.arn
4    target_id = aws_instance.hello-server[count.index].id
5    port = 80
6  }
```

Definition 0. Load Balancer

A networking tool to route and distribute traffic to targets.

Create a load balancer

```
» cat hello-scale.tf
```

```
1   data "aws_subnet_ids" "nets" {
2       vpc_id = aws_security_group.hello-server.vpc_id
3   }

5   resource "aws_lb" "hello-balancer" {
6     name = "hello-balancer"
7     internal = false
8     load_balancer_type = "application"
9     subnets = aws_subnet_ids.nets.ids
10    security_groups = [
11      aws_security_group.hello-server.name
12    ]
13  }
```

Route load balancer traffic to the target group

```
» cat hello-scale.tf
```

```
1   resource "aws_lb_listener" "app" {
2     load_balancer_arn = aws_lb.hello-balancer.arn
3     port = "80"
4     protocol = "HTTP"

6     default_action {
7       type = "forward"
8       target_group_arn = aws_lb_target_group.hello-target.arn
9     }
10  }
```

Use *k6* to determine the new *load limits*