

# Software at Scale

## *Software Architecture*

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March 23, 2026

*Question*

How many concurrent users can your software handle?

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*Answer*

Maybe *400*? Maximum.

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How many concurrent users can your software handle?

*Answer*

Maybe *400*<sup>1</sup>? Maximum.

---

<sup>1</sup>HTTP server on a t2.micro EC2 instance

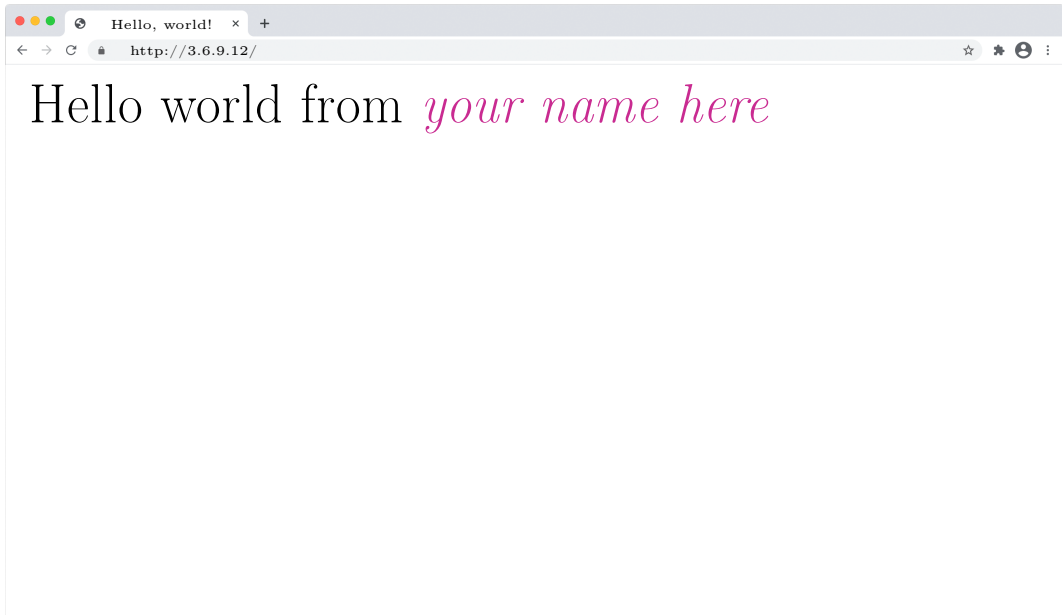
*Definition 0.* Stress Testing

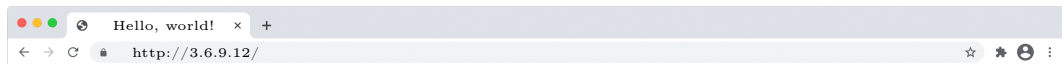
Measure the robustness of software by pushing usage to an extreme.

*Demonstration*

Let's build 'hello world'

## Our Goal





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
```

```
1  #!/bin/bash
2  yum -y install httpd
3  systemctl enable httpd
4  systemctl start httpd
5  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 }
```

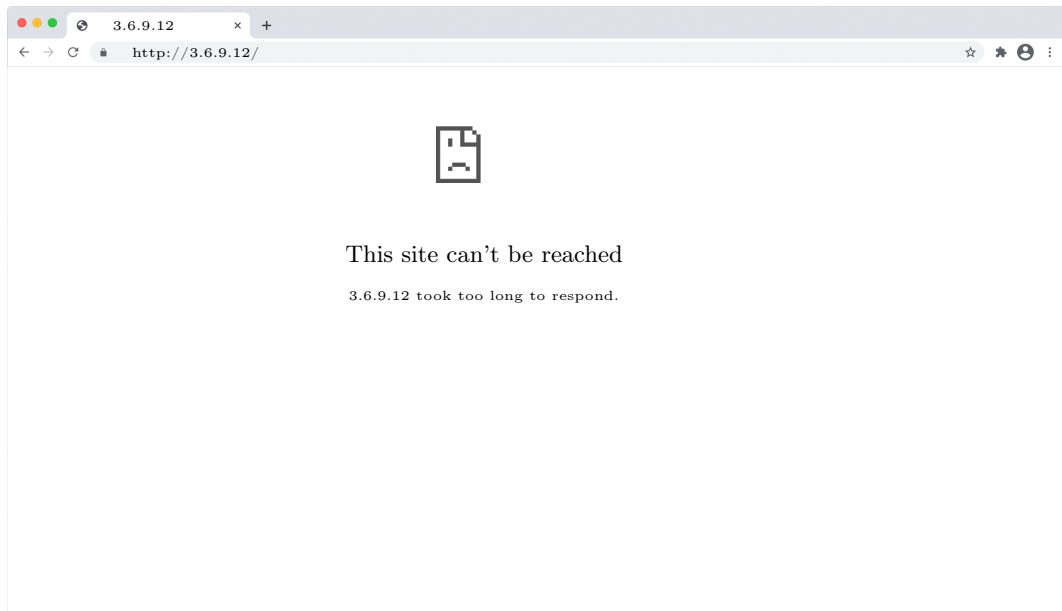
```
» cat hello-server.tf
```

```
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 }
```

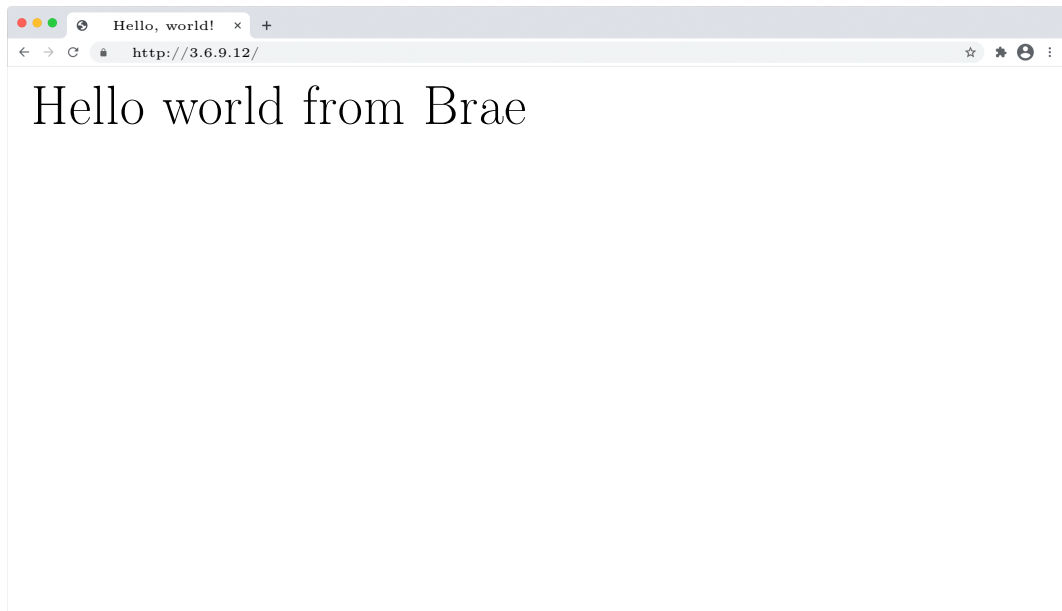
## Starting the server

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

*Before*



*After*





*Question*

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
```

```
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

```
1 >> 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
```

```
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

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

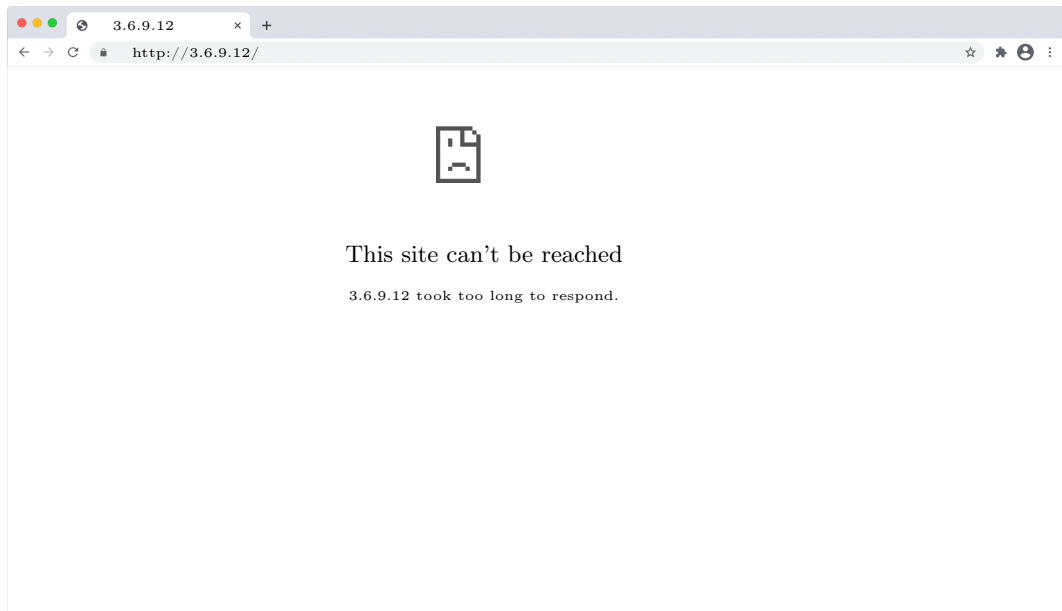
Oh no...

```
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
```



*Back to square one*



*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
6
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
```

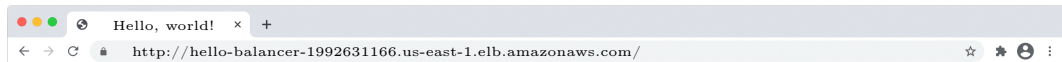
```
1 data "aws_subnet_ids" "nets" {
2     vpc_id = aws_security_group.hello-server.vpc_id
3 }
4
5 resource "aws_lb" "hello-balancer" {
6     name = "hello-balancer"
7     internal = false
8     load_balancer_type = "application"
9     subnets = aws_subnet_ids.nets.ids
10    security_groups = [
11        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 }
```

*We're live!*



Hello world from Brae

*Exercise*

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