Load Balancing Node.js Applications with NGINX and Docker

Let's dockerize two instances of a Node.js application and load balance them with NGINX.

 Bruno Krebs

May 22, 2017

TL;DR: In this article we will see how easy it is to load balance *dockerized* Node.js applications with NGINX. We will create a simple Node.js application that serves an HTML file, containerize it with Docker, and containerize an NGINX instance that uses round-robin algorithm to load balance between two running instances of this application.

> "Check out how easy it is to load balance dockerized Node.js applications with NGINX."
>
> TWEET THIS

Docker and Containers

Docker is a software container platform. Developers use Docker to eliminate “works on my machine” problem when collaborating with co-workers. This is done by putting pieces of a software architecture on containers (a.k.a. *dockerize* or containerize).

Using containers, everything required to make a piece of software run is packaged into isolated containers. Unlike Virtual Machines (VMs), containers do not bundle a full operating system—only libraries and settings required to make the software work are needed. This makes them efficient, lightweight, self-contained and guarantees that software will always run on the same configuration, regardless of where it’s deployed.

To learn more about Docker, take a look at this webinar.

Installing Docker

Everything that we will need to test this architecture is Docker. As the instances of our Node.js application and NGINX will run inside Docker containers, we won't need to install them on our development machine. To install Docker, simply follow the instructions on their website.

Creating the Node.js Application

To show NGINX load balancing in action, we are going to create a simple Node.js application that serves a static HTML file. After that, we are going to containerize this application and run it twice. Lastly, we will configure a *dockerized* NGINX instance to dispatch requests to both instances of our application.

In the end, we will be able to reach `http://localhost:8080` on our local machine to "randomly" get results from one or another instance. In fact, the result won't be randomly decided, we will configure NGINX to use round-robin algorithm to decide which instance will respond on each request.

But let's tackle one step at a time. To create this application we will first create a directory for the application, and then create an `index.js` file that will respond to HTTP requests.

To create the directory, let's issue the following command: `mkdir application`. After that, let's create the `index.js` file in this directory and paste the following source code:

```
var http = require('http');
var fs = require('fs');

http.createServer(function (req, res) {
  res.writeHead(200, {'Content-Type': 'text/html'});
  res.end(`<h1>${process.env.MESSAGE}</h1>`);
}).listen(8080);
```

Everything that this Node.js script does is to answer HTTP requests to `http://localhost:8080` with and HTML tag that contains a message defined in the `MESSAGE` environment variable. To better understand how this works, we can run the following commands:

```
export MESSAGE=Howdy!
node index
```

And then open `http://localhost:8080` on a web browser. See? We got simple web page with the `Howdy!` message. Before proceeding, let's stop our application by hitting `Ctrl + C`.

Dockerizing the Node.js Applications

To *dockerize* our Node.js application, we will need to create a file called `Dockerfile` in the `application` directory. The content of this file will be:

```
FROM node
RUN mkdir -p /usr/src/app
COPY index.js /usr/src/app
EXPOSE 8080
CMD [ "node", "/usr/src/app/index" ]
```

> **Note:** If you don't understand how a Dockerfile works, check out this reference.

After that we need to create an image, from this `Dockerfile`, which can be done through the following command:

```
docker build -t load-balanced-app .
```

And then we can run both instances of our application with the following commands:

```
docker run -e "MESSAGE=First instance" -p 8081:8080 -d load-balanced-app
docker run -e "MESSAGE=Second instance" -p 8082:8080 -d load-balanced-app
```

After running both commands, we will be able to open both instances on a web browser by going to `http://localhost:8081` and `http://localhost:8082`. The first URL will show a message saying "First instance", the second URL will show a message saying "Second instance".

Load Balancing with a Dockerized NGINX Instance

Now that we have both instances of our application running on different Docker containers and responding on different ports on our host machine, let's configure an instance of NGINX to load balance requests between them. First we will start by creating a new directory.

```
mkdir nginx-docker
```

In this directory, we will create a file called `nginx.conf` with the following code:

```
upstream my-app {
    server 172.17.0.1:8081 weight=1;
    server 172.17.0.1:8082 weight=1;
```

```
    server 172.17.0.1:8082 weight=1;
}

server {
    location / {
        proxy_pass http://my-app;
    }
}
```

This file will be used to configure NGINX. On it we define an `upstream` group of servers containing both URLs that respond for the instances of our application. By not defining any particular algorithm to load balance requests, we are using round-robin, which is the default on NGINX. There are several other options to load balance requests with NGINX, for example the least number of active connections, or the least average response time.

After that, we define a `server` property that configures NGINX to pass HTTP requests to `http://my-app`, which is handled by the `upstream` defined before. Also, note that we hardcoded `172.17.0.1` as the gateway IP, this is the default gateway when using Docker. If needed, you can change it to meet your local configuration.

Now we will create the `Dockerfile` that will be used to *dockerize* NGINX with this configuration. This file will contain the following code:

```
FROM nginx
RUN rm /etc/nginx/conf.d/default.conf
COPY nginx.conf /etc/nginx/conf.d/default.conf
```

Having created both files, we can now build and run NGINX containerized on Docker. We achieve that by running the following commands:

```
docker build -t load-balance-nginx .
docker run -p 8080:80 -d load-balance-nginx
```

After issuing these commands, let's open a web browser and access `http://localhost:8080`. If everything went well, we will see a web page with one of the two messages: `First instance` or `Second instance`. If we hit reload on our web browser a few times, we will realized that from time to time the message displayed switches between `First instance` and `Second instance`. This is the round-robin load balancing algorithm in action.

> "Learn how to load balancing Node.js apps with NGINX and Docker."
>
> TWEET THIS

> **Note:** To use the other algorithms available on NGINX, check their documentation for more information.

Aside: Securing Node.js Applications with Auth0

Securing Node.js applications with Auth0 is easy and brings a lot of great features to the table. With Auth0, we only have to write a few lines of code to get solid identity management solution, single sign-on, support for social identity providers (like Facebook, GitHub, Twitter, etc.), and support for enterprise identity providers (like Active Directory, LDAP, SAML, custom, etc.).

In the following sections, we are going to learn how to use Auth0 to secure Node.js APIs written with Express.

Creating the Express API

Let's start by defining our Node.js API. With Express and Node.js we can do this in two simple steps. The first one is to use NPM to install three dependencies: `npm i express body-parser cors`. The second one is to create a Node.js script with the following code:

```
// importing dependencies
const express = require('express');
const bodyParser = require('body-parser');
const cors = require('cors');

// configuring Express
const app = express();
app.use(bodyParser.json());
app.use(cors());

// defining contacts array and endpoints to manipulate it
const contacts = [
    { name: 'Bruno Krebs', phone: '+555133334444' },
    { name: 'John Doe', phone: '+191843243223' }
];
app.get('/contacts', (req, res) => res.send(contacts));
```

```
app.post('/contacts', (req, res) => {
    contacts.push(req.body);
    res.send();
});

// starting Express
app.listen(3000, () => console.log('Example app listening on port 3000!'));
```

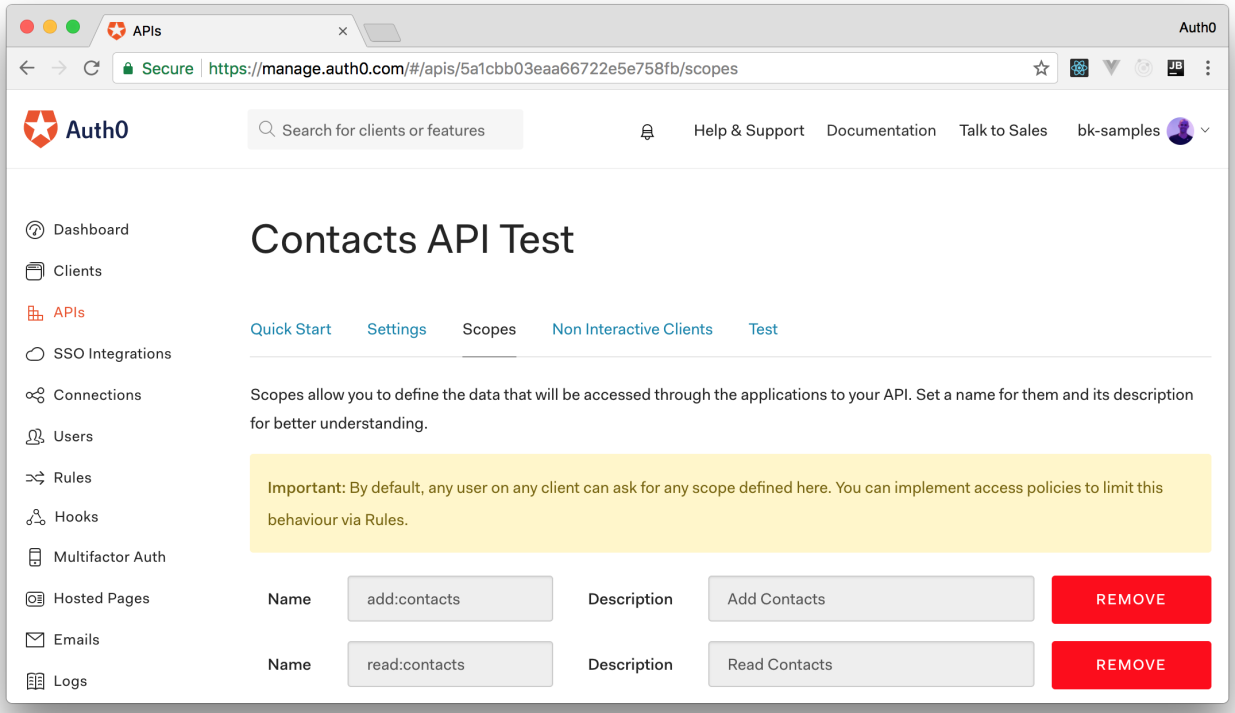
The code above creates the Express application and adds two middleware to it: `body-parser` to parse JSON requests, and `cors` to signal that the app accepts requests from any origin. The app also registers two endpoints on Express to deal with POST and GET requests. Both endpoints use the `contacts` array as some sort of in-memory database.

We can run and test our application by issuing `node index` in the project root and then by submitting requests to it. For example, with cURL, we can send a GET request by issuing `curl localhost:3000/contacts`. This command will output the items in the `contacts` array.

Registering the API at Auth0

After creating our application, we can focus on securing it. Let's start by registering an API on Auth0 to represent our app. To do this, let's head to the API section of our management dashboard (we can create a free account) if needed) and click on "Create API". On the dialog that appears, we can name our API as "Contacts API" (the name isn't really important) and identify it as `https://contacts.mycompany.com/` (we will use this value later).

After creating it, we have to go to the "Scopes" tab of the API and define the desired scopes. For this sample, we will define two scopes: `read:contacts` and `add:contacts`. They will represent two different operations (read and add) over the same entity (contacts).



Securing Express with Auth0

Now that we have registered the API in our Auth0 account, let's secure the Express API with Auth0. Let's start by installing three dependencies with NPM: `npm i express-jwt jwks-rsa express-jwt-authz`. Then, let's create a file called `auth0.js` and use these dependencies:

```
const jwt = require('express-jwt');
const jwksRsa = require('jwks-rsa');
const jwtAuthz = require('express-jwt-authz');

const tokenGuard = jwt({
  // Fetch the signing key based on the KID in the header and
  // the singing keys provided by the JWKS endpoint.
  secret: jwksRsa.expressJwtSecret({
    cache: true,
    rateLimit: true,
```

```
    jwksUrl: `https://${process.env.AUTH0_DOMAIN}/.well-known/jwks.json`
  }),

  // Validate the audience and the issuer.
  audience: process.env.AUTH0_AUDIENCE,
  issuer: `https://${process.env.AUTH0_DOMAIN}/`,
  algorithms: ['RS256']
});

module.exports = function (scopes) {
  const scopesGuard = jwtAuthz(scopes || []);
  return function mid(req, res, next) {
    tokenGuard(req, res, (err) => {
      err ? res.status(500).send(err) : scopesGuard(req, res, next);
    });
  }
};
```

The goal of this script is to export an Express middleware that guarantees that requests have an `access_token` issued by a trust-worthy party, in this case Auth0. The middleware also accepts an array of scopes. When filtering requests, this middleware will check that these scopes exist in the `access_token`. Note that this script expects to find two environment variables:

`AUTH0_AUDIENCE` : the identifier of our API (`https://contacts.mycompany.com/`)
`AUTH0_DOMAIN` : our domain at Auth0 (in my case `bk-samples.auth0.com`)

We will set these variable soon, but it is important to understand that the domain variable defines how the middleware finds the signing keys.

After creating this middleware, we can update our `index.js` file to import and use it:

```
// ... other requires
const auth0 = require('./auth0');

app.get('/contacts', auth0(['read:contacts']), (req, res) => res.send(contacts));
app.post('/contacts', auth0(['add:contacts']), (req, res) => {
  contacts.push(req.body);
```

```
    res.send();
});
```

In this case, we have replaced the previous definition of our endpoints to use the new middleware. We also restricted their access to users that contain the right combination of scopes. That is, to get contacts users must have the `read:contacts` scope and to create new records they must have the `add:contacts` scope.

Running the application now is slightly different, as we need to set the environment variables:

```
export AUTH0_DOMAIN=bk-samples.auth0.com
export AUTH0_AUDIENCE="https://contacts.mycompany.com/"
node index
```

Let's keep this API running before moving on.

Creating an Auth0 Client

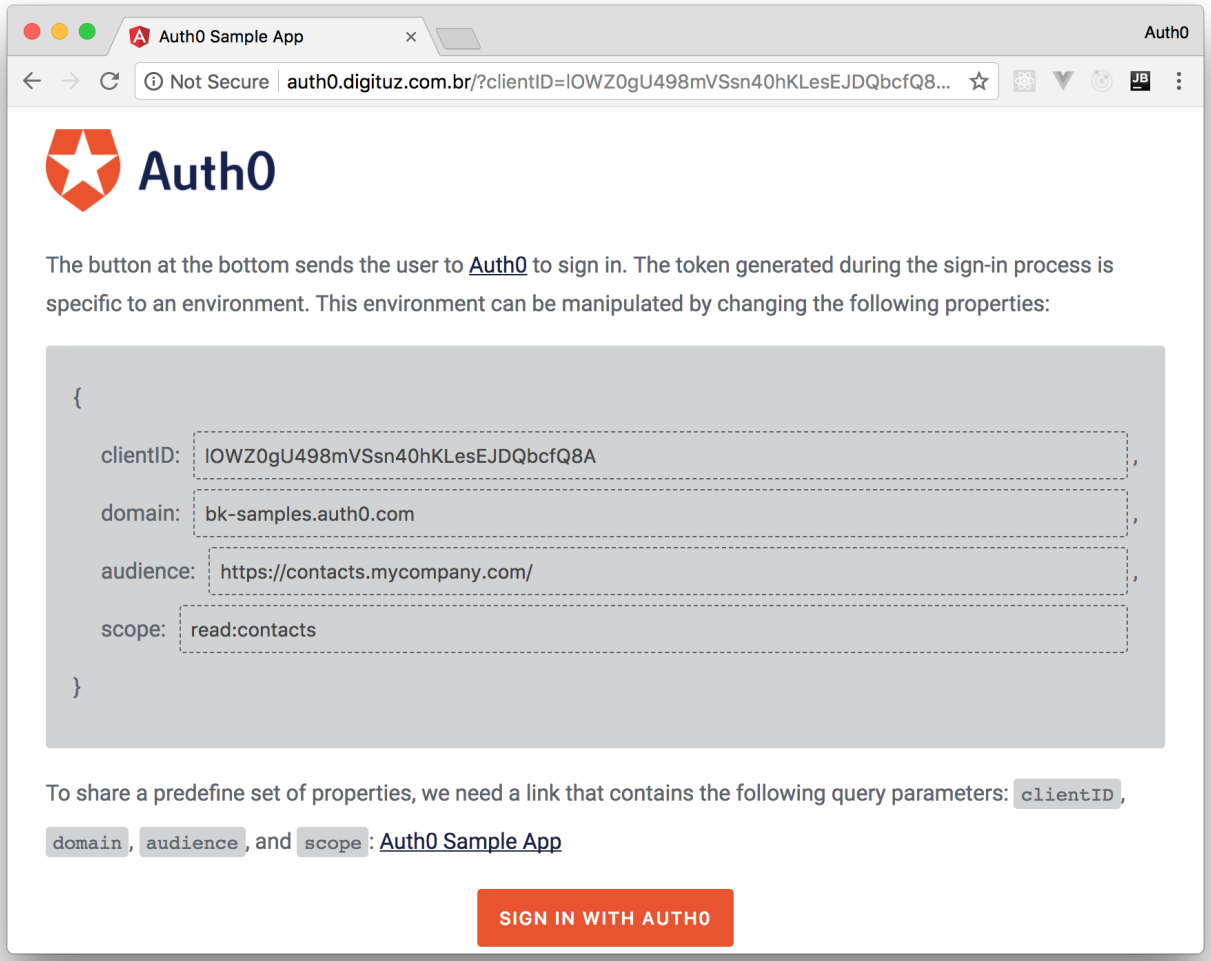
As the focus of this section is to secure Node.js applications with Auth0, we are going to use a live Angular app that has a configurable Auth0 client. Before using this app, we need to create an Auth0 Client that represents it. Let's head to the "Clients" section of the management dashboard and click on the "Create Client" button to create this client.

On the popup shown, let's set the name of this new client as "Contacts Client" and choose "Single Page Web App" as the client type. After hitting the "Create" button, we have to go to the "Settings" tab of this client and set `http://auth0.digituz.com.br/callback` in the "Allowed Callback URLs" field.

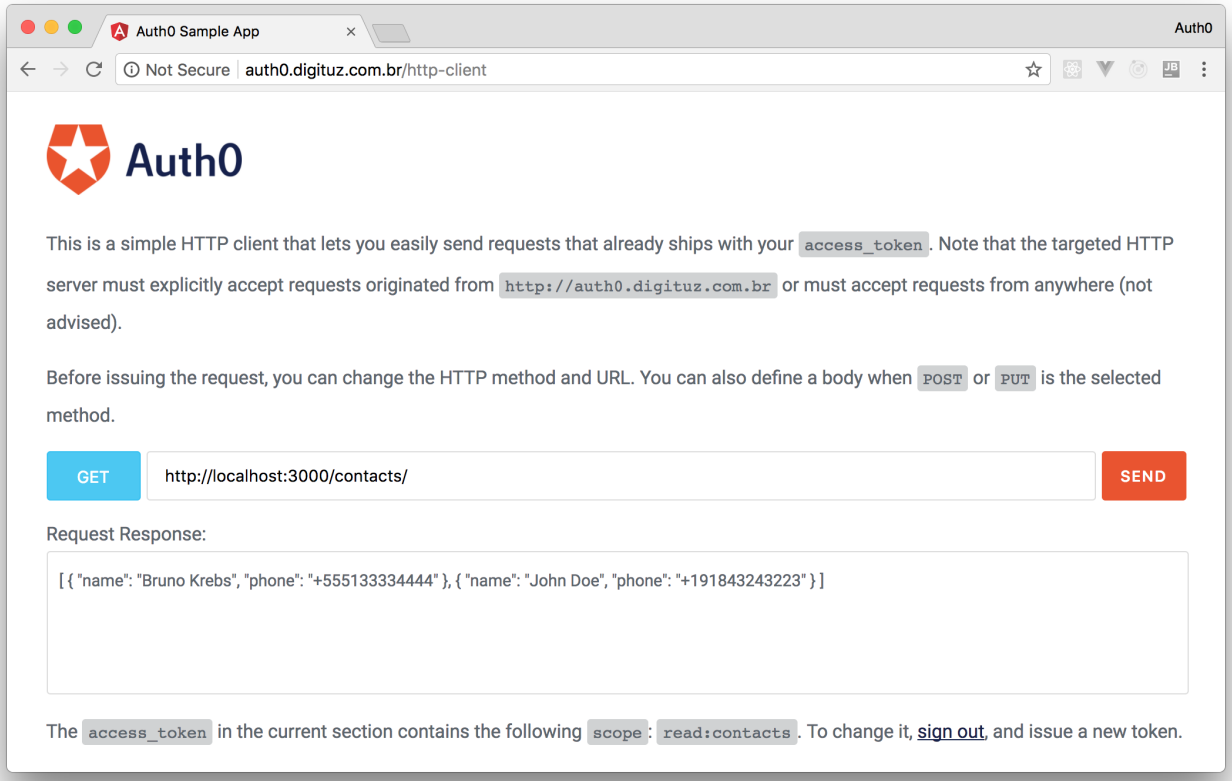
Now we can save the client and head to the sample Angular app secured with Auth0. To use this app, we need to set the correct values for four properties:

- `clientID` : We have to copy this value from the "Client ID" field of the "Settings" tab of "Contacts Client".
- `domain` : We can also copy this value from the "Settings" tab of "Contacts Client".
- `audience` : We have to set this property to meet the identifier of the "Contacts API" that we created earlier.
- `scope` : This property will define the `authority` that the `access_token` will get access to in the backend API. For example: `read:contacts` or both `read:contacts add:contacts` .

Then we can hit the "Sign In with Auth0" button.



After signing in, we can use the application to submit requests to our secured Node.js API. For example, if we issue a GET request to `http://localhost:3000/contacts/`, the Angular app will include the `access_token` in the `Authorization` header and our API will respond with a list of contacts.



Conclusion

Loading balancing applications with Docker and NGINX is an easy process. In this article we have managed to achieve this goal with a few simple steps. All we had to do was to install Docker on our development machine, run two instances of a *dockerized* applications and then configure a *dockerized* NGINX instance to round-robin requests to the application instances.

To learn more about **load balancing, NGINX and Docker**, check out the following resources:

Using nginx as HTTP load balancer
NGINX Load Balancing - HTTP and TCP Load Balancer
How to Set Up NGINX Load Balancing
Docker Swarm Load Balancing with NGINX and NGINX Plus
How to run a load-balanced service in Docker containers