The Ruby on Rails _json Juggling Attack

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Content

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Luke Jahnke9 December 2024

Ruby on Rails is a web framework which mostly provides access to user-provided data via the `params` object. The object is an instance of ActionController::Parameters, which can be used similar to a Hash - a collection of key-value pairs in Ruby. The contents include values from the request body, the query string, and for routes such as `get "/users/:user_id"`, the path.

Introducing the _json juggling attack

The _json juggling attack is an in-band signaling attack targeting JSON parsing within Ruby on Rails. The vulnerability exists in code that handles the conflict between the following:

- Rails parses JSON request bodies into `params`, which is always a Hash-like object.
- Rails accepts JSON request bodies that are arrays, strings, numbers, etc which are not Hash-like.

The code responsible for JSON parsing and resolving this conflict can be found inside actionpack/lib/action_dispatch/http/parameters.rb and looks as follows:

```
DEFAULT_PARSERS = {
  Mime[:json].symbol => -> (raw_post) {
    data = ActiveSupport::JSON.decode(raw_post)
    data.is_a?(Hash) ? data : { _json: data }
  }
}
```

We see that to maintain the Hash-like nature of `params`, a hash is created with a key of `_json` that references our not-a-Hash object. The critical thing to notice about the above code is the not what is there, but what is missing. There is nothing preventing the supply of a JSON object with a `_json` key. Supplying a key of the string `"_json"` will be functionally equivalent to the Ruby symbol `:_json` (from the above code snippet), as parameters are stored as a HashWithIndifferentAccess.

For a simple example of how this enables a vulnerability, consider a Rails application that has a delete item endpoint. The code handles both deleting a single item and deleting multiple items. The single item JSON is `{"id": 123}` and the multi-item JSON is `[456, 789]`. The _json juggling attack is where an attacker submits JSON structured to be acceptable in both cases at the same time:

```
{
  "id": 123,
  "_json": [456, 789]
}
```

An authorisation bypass vulnerability then results when an application's authorisation code is inconsistent with the action execution code. For example, the authorisation code preferencing the multi-item form and the action execution code preferencing the single-item form.

Rails Parameter Testing Setup

The following Dockerfile can be used to create a Rails application that sends the applications view of `params` back in the response.

```
FROM ruby:3.3

RUN gem install rails:7.1.3.3

RUN rails new param_dumper --minimal --api --skip-active-record

WORKDIR param_dumper/

RUN cat <<"EOF" > route_create_template.rb
 route "root 'dump#index', via: :all"
 route "match '/users/:user_id', to: 'dump#index', via: :all"
EOF

RUN ./bin/rails app:template LOCATION=route_create_template.rb

RUN cat <<"EOF" > app/controllers/dump_controller.rb
class DumpController < ApplicationController
 def index
  render plain: params.inspect
 end
end
EOF

ENTRYPOINT ["./bin/rails", "server", "--binding=0.0.0.0"]
```

It can be used as follows after placing the above in a file named `Dockerfile`:

```
$ docker build -t rails-param-dumper .

$ docker run --name rails -p 127.0.0.1:3000:3000 -d --rm rails-param-dumper

$ curl -d 'b=frombody' http://127.0.0.1:3000/users/frompath?q=fromquery
#<ActionController::Parameters {
 "b"=>"frombody",
 "q"=>"fromquery",
 "controller"=>"dump",
 "action"=>"index",
 "user_id"=>"frompath"
} permitted: false>

$ docker stop rails
```

If you wish to send a JSON request with `curl`, do not forget to set an appropriate `Content-Type` header. This can be achieved with a command such as `curl -H 'Content-Type: application/json' -d '{}' http://127.0.0.1:3000/`

Bonus questions about `params`

There are a number of other interesting security-related questions that can be asked:

Q: What is the precedence order of the three sources? A: Path is highest, then query string, followed by request body.

Q: What is the `permitted` attribute in `ActionController::Parameters`? A: This is used to protect against https://brakemanscanner.org/docs/warning_types/mass_assignment/ attacks.

Q: Can you clobber the values of `controller` or `action` that are included in `params`? A: I tried and was unsuccessful :(

Q: Are there any query strings that cannot be parsed into `params`? A: Yes, examples can be found in Rack's test code, such as `x[y]=1&x[y]z=2` and `x[y]=1&x[y][][w]=2`. These can be useful to fingerprint the usage of Rack. It used to be possible to use `a&a[]`, as covered in blog post by bjeanes in 2010.
