CSC 405
Computer Security

Web Security

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(Derived from slides by Giovanni Vigna and Adam Doupe)

The XMLHttpRequest Object

- Microsoft developers working on Outlook Web Access for Exchange 2000
- Scalability problems with traditional web application
- They created a DHTML version (circa) 1998 using an ActiveX control to fetch bits of data from the server using JavaScript
- OWA team got the MSXML team (MSXML is Microsoft's XML library, and it shipped with IE) to include their ActiveX control (hence the XML in the name)
  – Shipped in IE 5, March 1999
- Exchange 2000 finally released in November 2000, and OWA used the ActiveX Object
- Added by Netscape in December 2000 as XMLHttpRequest
- Find the full story here: https://hackerfall.com/story/the-story-of-xmlhttp-2008

The XMLHttpRequest Object

- Allows JavaScript code to (asynchronously) retrieve data from the server, then process the data and update the DOM
- Because of the origin (ActiveX control on Windows and included in Netscape's DOM), used to need two different ways to instantiate the control
  - Most browsers (including Microsoft Edge):
    - `http_request = new XMLHttpRequest();`
  - Internet Explorer
    - `http_request = new ActiveXObject("Microsoft.XMLHTTP");`

Creating an XMLHttpRequest

- Using the `onreadystatechange` property of an XMLHttpRequest object one can set the action to be performed when the result of a query is received

```
http_request.onreadystatechange = function(){
    <JS code here>
};
```

- Then, one can execute the request
- `http_request.open('GET',`
  `'http://example.com/show.php?keyword=foo', true);`
- `http_request.send();`
- Note that the third parameter indicates that the request is asynchronous, that is, the execution of JavaScript will proceed while the requested document is being downloaded

XMLHttpRequest Lifecycle

- The function specified using the "onreadystatechange" property will be called at any change in the request status
  - 0 (uninitialized: Object is not initialized with data)
  - 1 (loading: Object is loading its data)
  - 2 (loaded: Object has finished loading its data)
  - 3 (interactive: User can interact with the object even though it is not fully loaded)
  - 4 (complete: Object is completely initialized)
- Usually wait until the status is “complete”

  -
    ```
    if (http_request.readyState == 4) {
      operates on data} else {
      not ready, return}
    ```

XMLHttpRequest Success

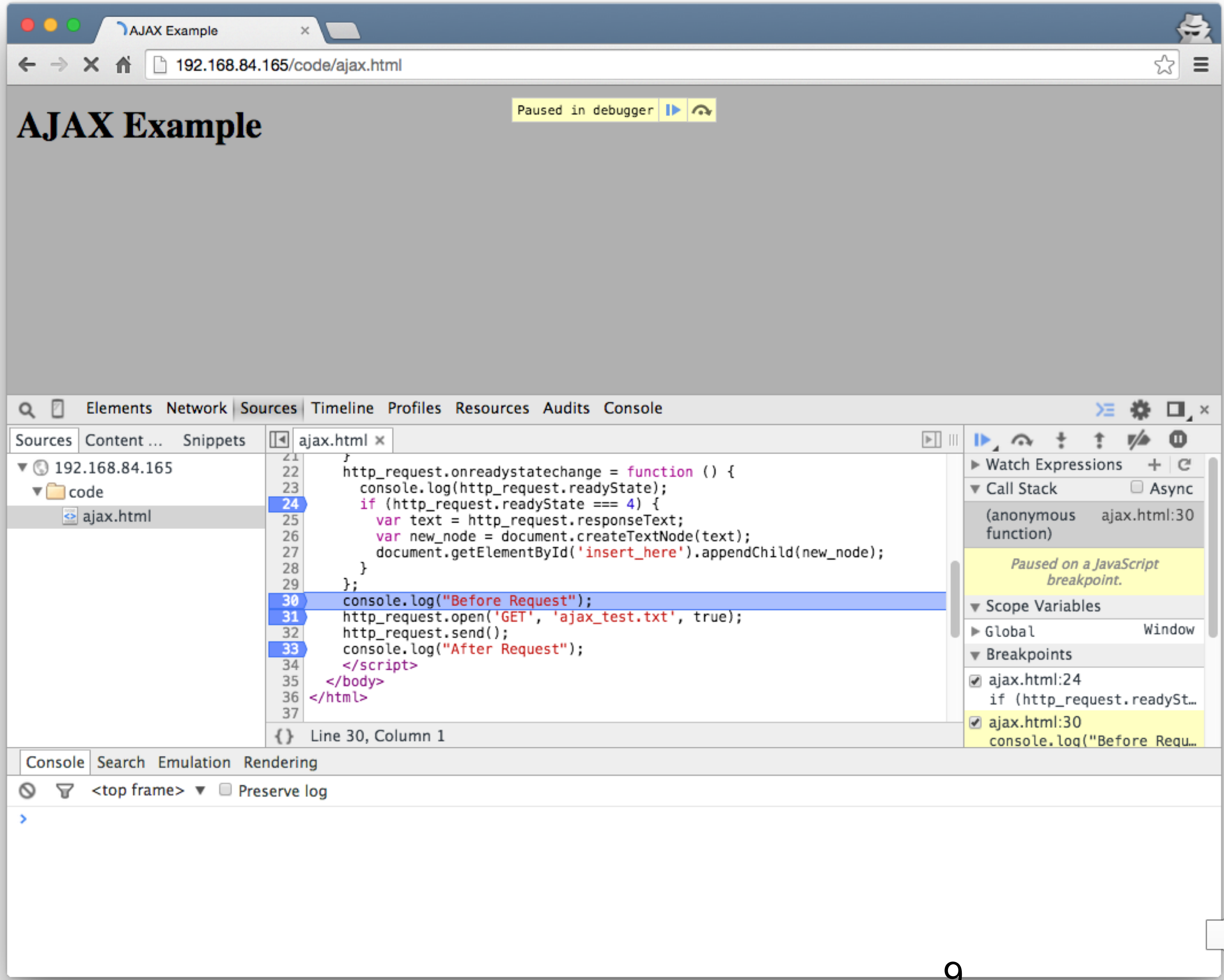
- After having received the document (and having checked for a successful return code – 200) the content of the request can be accessed:
  - As a string by calling: `http_request.responseText`
  - As an XMLDocument object: `http_request.responseXML`
    - In this case the object can be modified using the JavaScript DOM interface

XMLHttpRequest Example

```
<!DOCTYPE html>
<html>
 <head>
   <meta charset="UTF-8">
   <title>AJAX Example</title>
 </head>
 <body>
   <h1>AJAX Example</h1>
   <div id='insert_here'>
   </div>
  <script>
   …
   </script>
 </body>
</html>
```

XMLHttpRequest Example

```
if (typeof XMLHttpRequest != "undefined") {
   var http_request = new XMLHttpRequest();
 }
 else {
   var http_request = new ActiveXObject("Microsoft.XMLHTTP");
 }
 if (typeof console == "undefined") {
   console = { "log" : function (text) { alert(text); } };
 }
 http_request.onreadystatechange = function () {
   console.log(http_request.readyState);
   if (http_request.readyState === 4) {
     var text = http_request.responseText;
     var new_node = document.createTextNode(text);
     document.getElementById('insert_here').appendChild(new_node);
   }
 };
 console.log("Before Request");
 http_request.open('GET', 'ajax_test.txt', true);
 http_request.send();
 console.log("After Request");
```


AJAX Example
192.168.84.165/code/ajax.html
Paused in debugger
Elements Network Sources Timeline Profiles Resources Audits Console
Sources Content ... Snippets
192.168.84.165
code
ajax.html
Console Search Emulation Rendering
<top frame>
Preserve log

AJAX Example

```
21        }
22      http_request.onreadystatechange = function () {
23        console.log(http_request.readyState);
24        if (http_request.readyState === 4) {
25          var text = http_request.responseText;
26          var new_node = document.createTextNode(text);
27          document.getElementById('insert_here').appendChild(new_node);
28        }
29      };
30      console.log("Before Request");
31      http_request.open('GET', 'ajax_test.txt', true);
32      http_request.send();
33      console.log("After Request");
34      </script>
35    </body>
36  </html>
37
```

Line 30, Column 1

Watch Expressions

Call Stack — Async

(anonymous function)	ajax.html:30

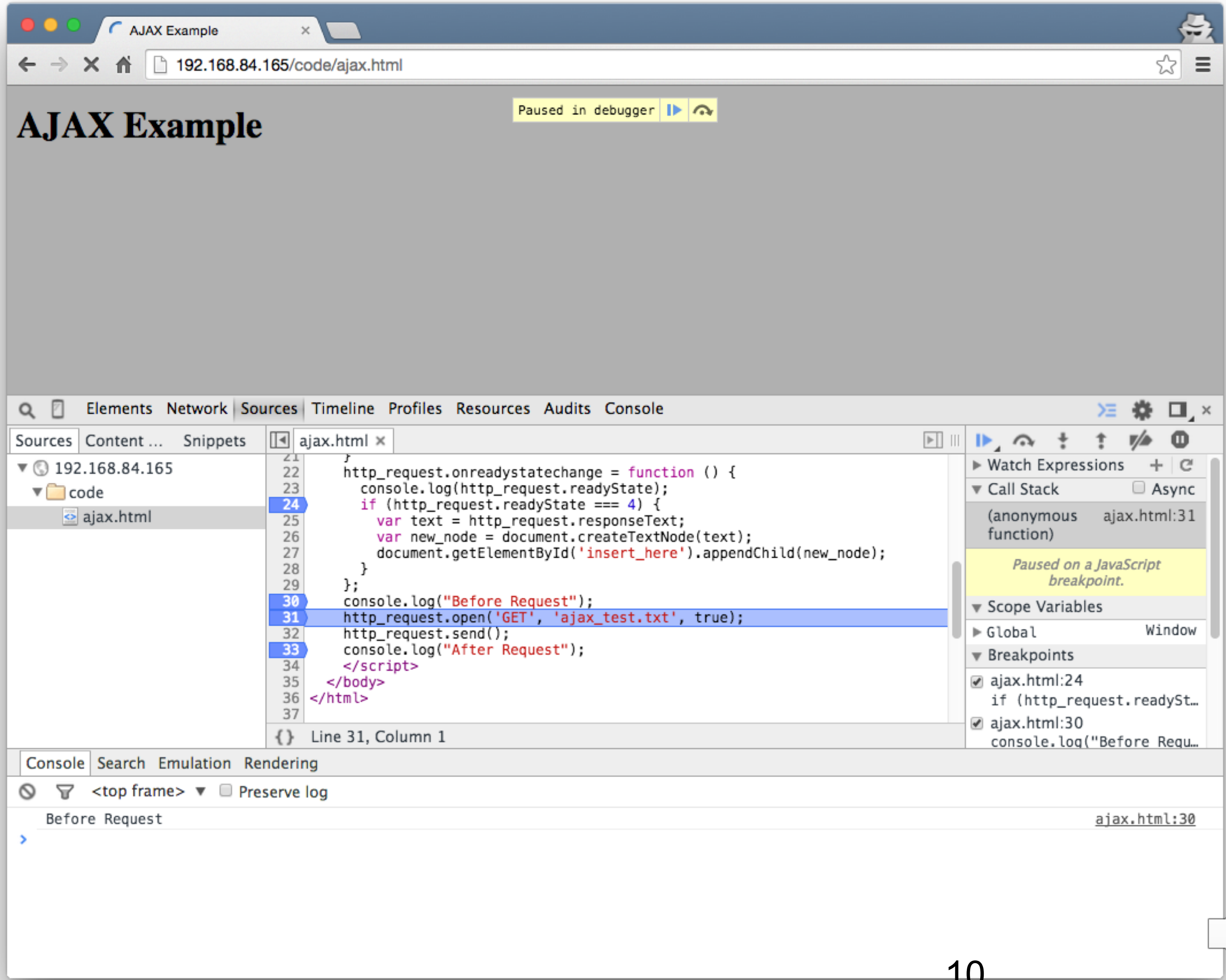
Paused on a JavaScript breakpoint.

Scope Variables

Global	Window

Breakpoints

- ✓ ajax.html:24 `if (http_request.readySt…`
- ✓ ajax.html:30 `console.log("Before Requ…`



AJAX Example

```
22      http_request.onreadystatechange = function () {
23        console.log(http_request.readyState);
24        if (http_request.readyState === 4) {
25          var text = http_request.responseText;
26          var new_node = document.createTextNode(text);
27          document.getElementById('insert_here').appendChild(new_node);
28        }
29      };
30      console.log("Before Request");
31      http_request.open('GET', 'ajax_test.txt', true);
32      http_request.send();
33      console.log("After Request");
34      </script>
35    </body>
36  </html>
37
```

Line 31, Column 1

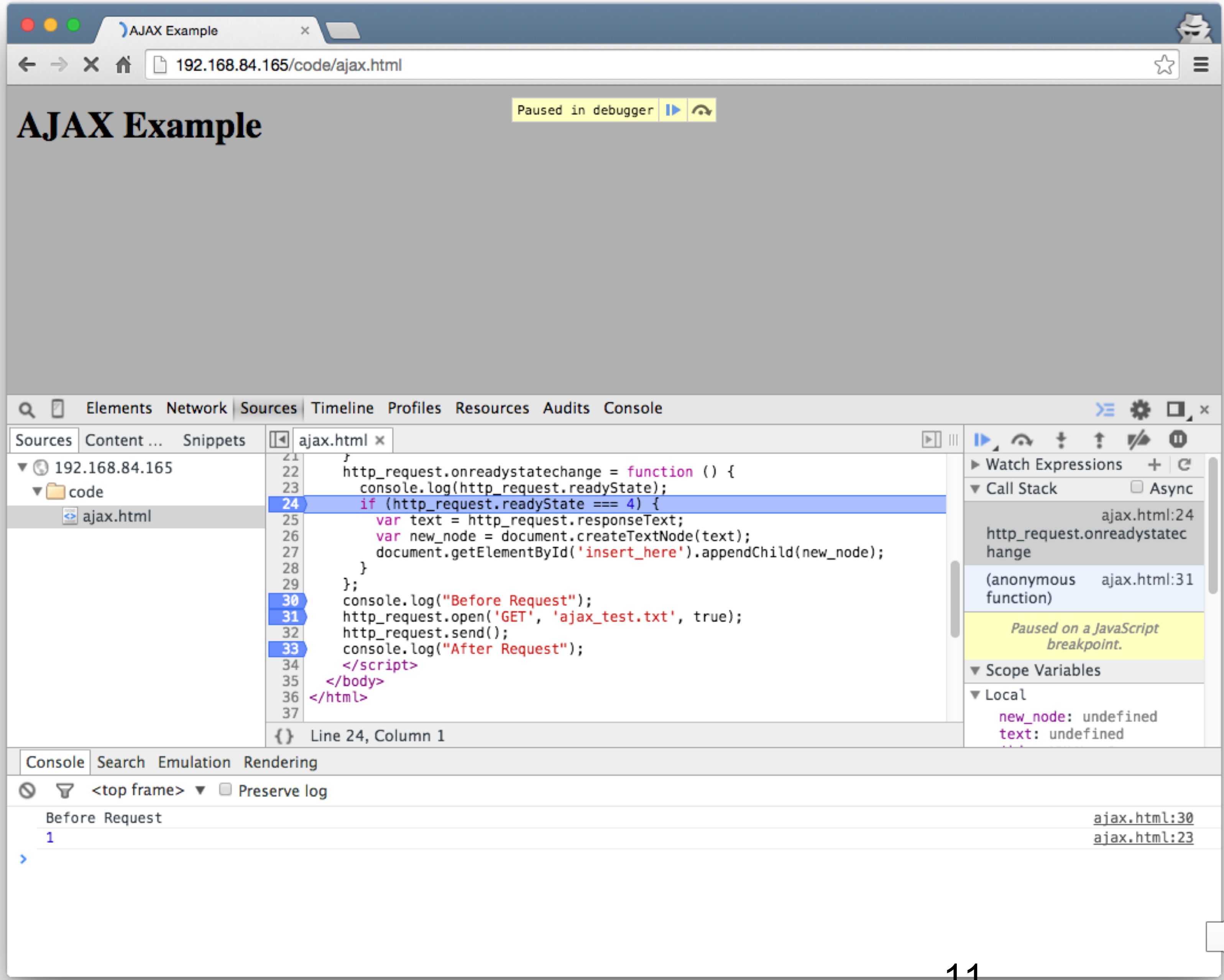
(anonymous function)	ajax.html:31

Paused on a JavaScript breakpoint.

Global	Window

- ☑ ajax.html:24
  `if (http_request.readySt…`
- ☑ ajax.html:30
  `console.log("Before Requ…`

```
Before Request                                                        ajax.html:30
>
```


AJAX Example
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Paused in debugger
Elements Network Sources Timeline Profiles Resources Audits Console
Sources Content ... Snippets
ajax.html
192.168.84.165
code
ajax.html
Watch Expressions
Call Stack
Async
Scope Variables
Local
Console Search Emulation Rendering
<top frame>
Preserve log

AJAX Example

```
21          }
22        http_request.onreadystatechange = function () {
23          console.log(http_request.readyState);
24          if (http_request.readyState === 4) {
25            var text = http_request.responseText;
26            var new_node = document.createTextNode(text);
27            document.getElementById('insert_here').appendChild(new_node);
28          }
29        };
30        console.log("Before Request");
31        http_request.open('GET', 'ajax_test.txt', true);
32        http_request.send();
33        console.log("After Request");
34        </script>
35      </body>
36    </html>
37
```

Line 24, Column 1

Call Stack:

```
http_request.onreadystatechange    ajax.html:24
(anonymous function)               ajax.html:31
```

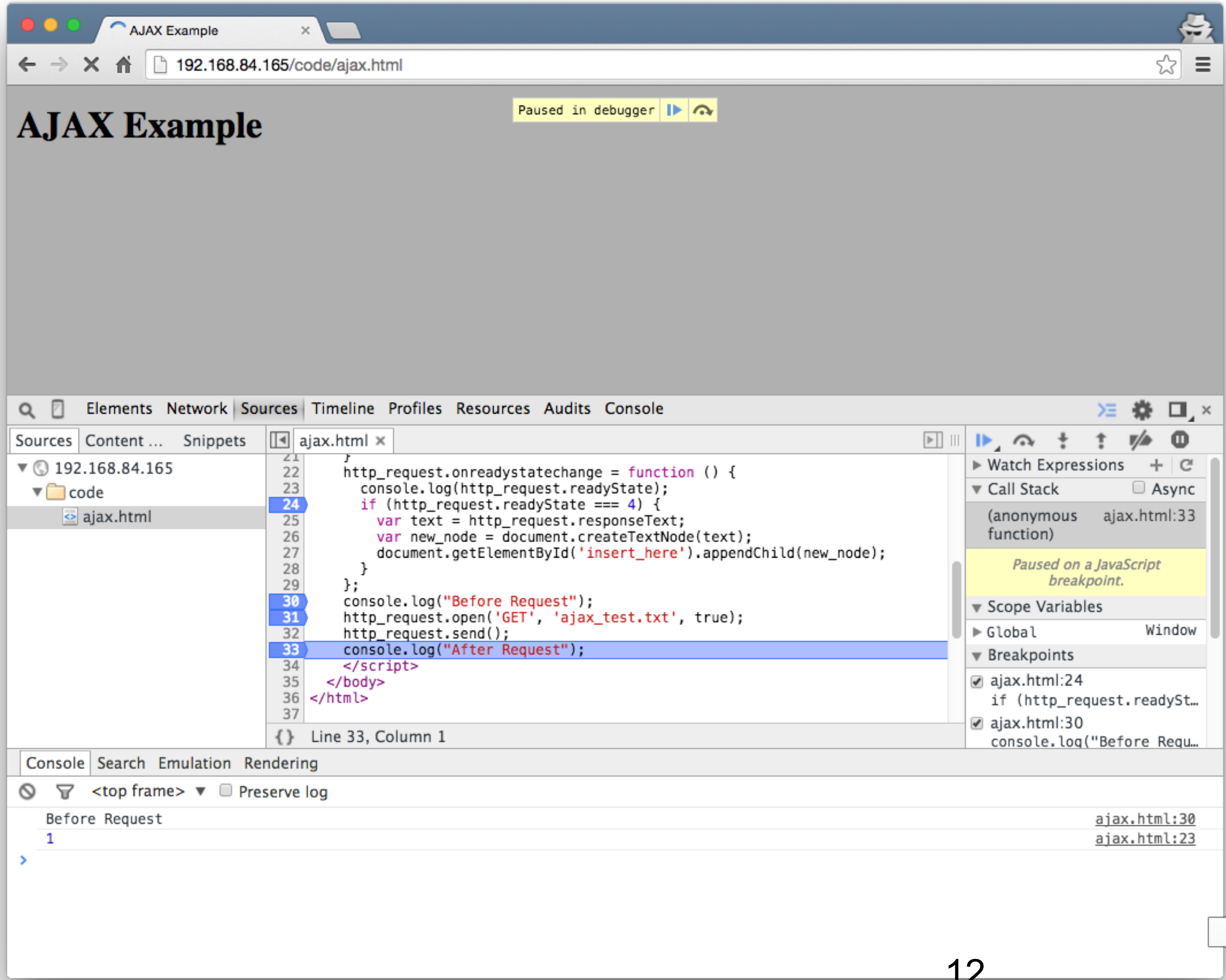
Paused on a JavaScript breakpoint.

Scope Variables – Local:

```
new_node: undefined
text: undefined
```

Console:

```
Before Request                                   ajax.html:30
1                                                ajax.html:23
>
```


AJAX Example
192.168.84.165/code/ajax.html
Paused in debugger
Elements Network Sources Timeline Profiles Resources Audits Console
Sources Content ... Snippets
192.168.84.165
code
ajax.html
Watch Expressions
Call Stack
Async
Scope Variables
Global Window
Breakpoints
Console Search Emulation Rendering
<top frame>
Preserve log

AJAX Example

```
    http_request.onreadystatechange = function () {
      console.log(http_request.readyState);
      if (http_request.readyState === 4) {
        var text = http_request.responseText;
        var new_node = document.createTextNode(text);
        document.getElementById('insert_here').appendChild(new_node);
      }
    };
    console.log("Before Request");
    http_request.open('GET', 'ajax_test.txt', true);
    http_request.send();
    console.log("After Request");
    </script>
  </body>
</html>
```

Line 33, Column 1

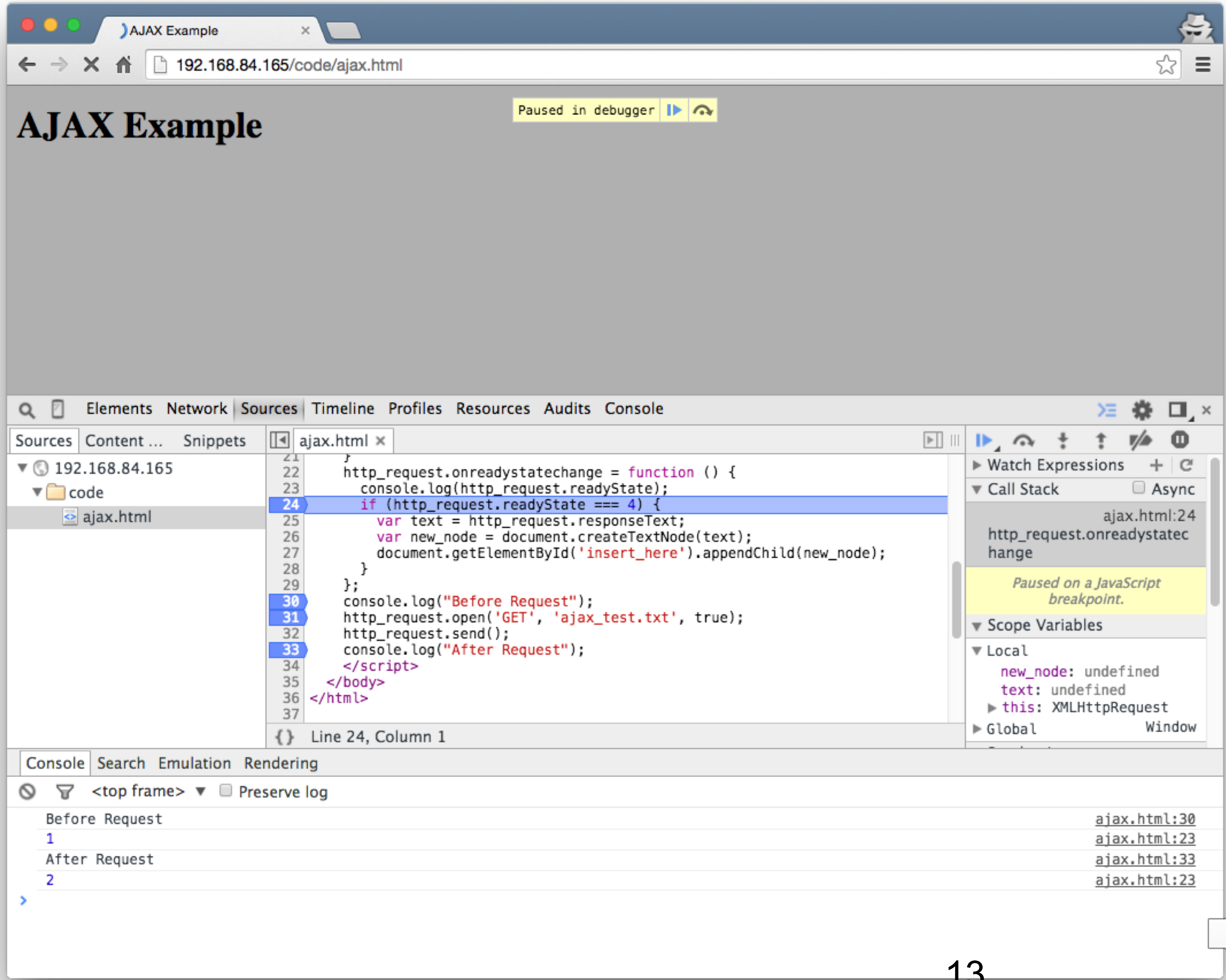
(anonymous function) ajax.html:33

Paused on a JavaScript breakpoint.

ajax.html:24
if (http_request.readySt…

ajax.html:30
console.log("Before Requ…

```
Before Request                                  ajax.html:30
1                                               ajax.html:23
>
```


AJAX Example
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Elements Network Sources Timeline Profiles Resources Audits Console
Sources Content ... Snippets
192.168.84.165
code
ajax.html
Watch Expressions
Call Stack Async
Console Search Emulation Rendering
<top frame> Preserve log

AJAX Example

```
    http_request.onreadystatechange = function () {
      console.log(http_request.readyState);
      if (http_request.readyState === 4) {
        var text = http_request.responseText;
        var new_node = document.createTextNode(text);
        document.getElementById('insert_here').appendChild(new_node);
      }
    };
    console.log("Before Request");
    http_request.open('GET', 'ajax_test.txt', true);
    http_request.send();
    console.log("After Request");
  </script>
</body>
</html>
```

Line 24, Column 1

```
ajax.html:24
http_request.onreadystatechange
```

Paused on a JavaScript breakpoint.

```
Scope Variables
▼ Local
    new_node: undefined
    text: undefined
  ▶ this: XMLHttpRequest
▶ Global                    Window
```

```
Before Request          ajax.html:30
1                       ajax.html:23
After Request           ajax.html:33
2                       ajax.html:23
```

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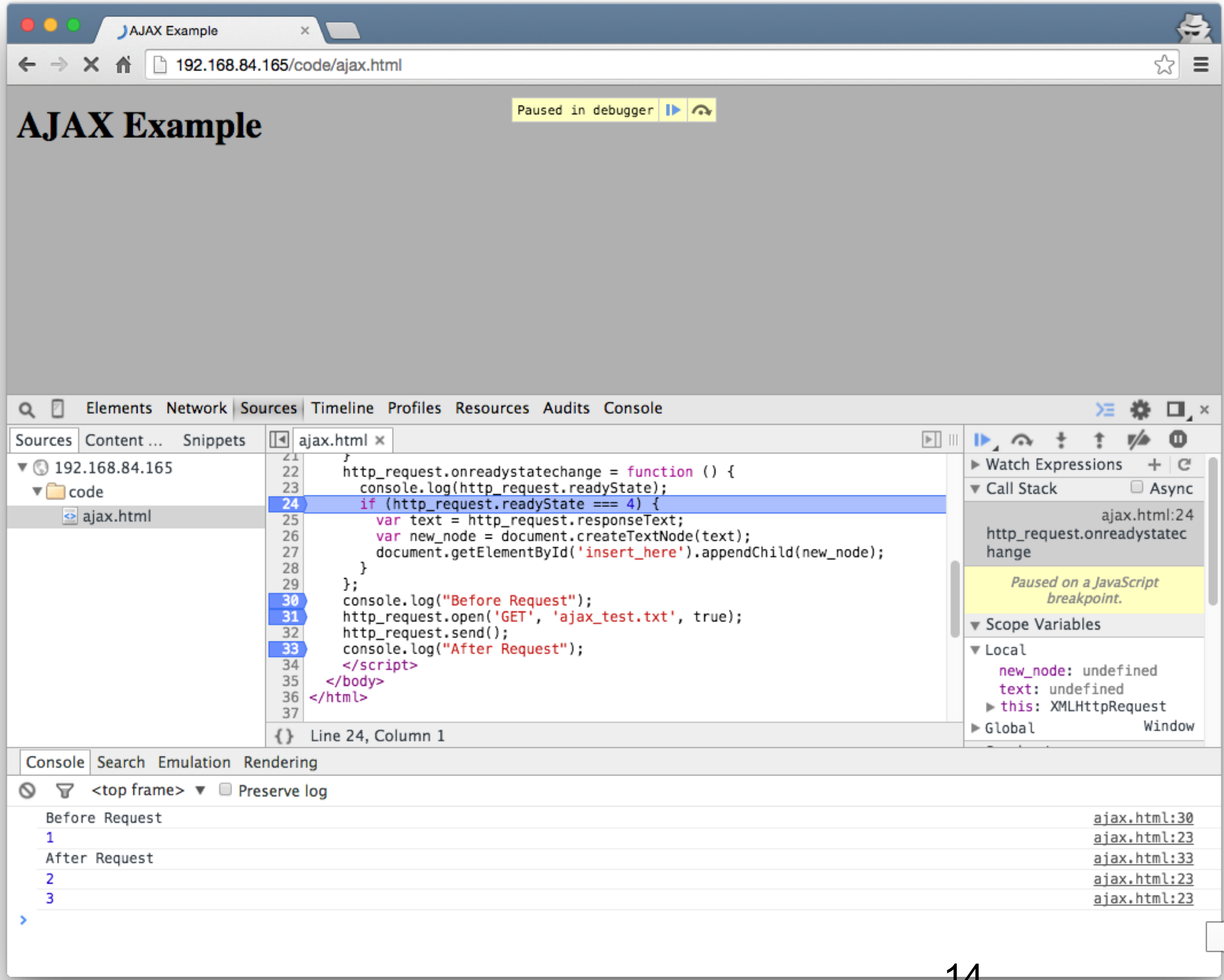

AJAX Example
192.168.84.165/code/ajax.html
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Elements Network Sources Timeline Profiles Resources Audits Console
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ajax.html
Watch Expressions
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AJAX Example

```
        http_request.onreadystatechange = function () {
          console.log(http_request.readyState);
          if (http_request.readyState === 4) {
            var text = http_request.responseText;
            var new_node = document.createTextNode(text);
            document.getElementById('insert_here').appendChild(new_node);
          }
        };
        console.log("Before Request");
        http_request.open('GET', 'ajax_test.txt', true);
        http_request.send();
        console.log("After Request");
        </script>
      </body>
    </html>
```

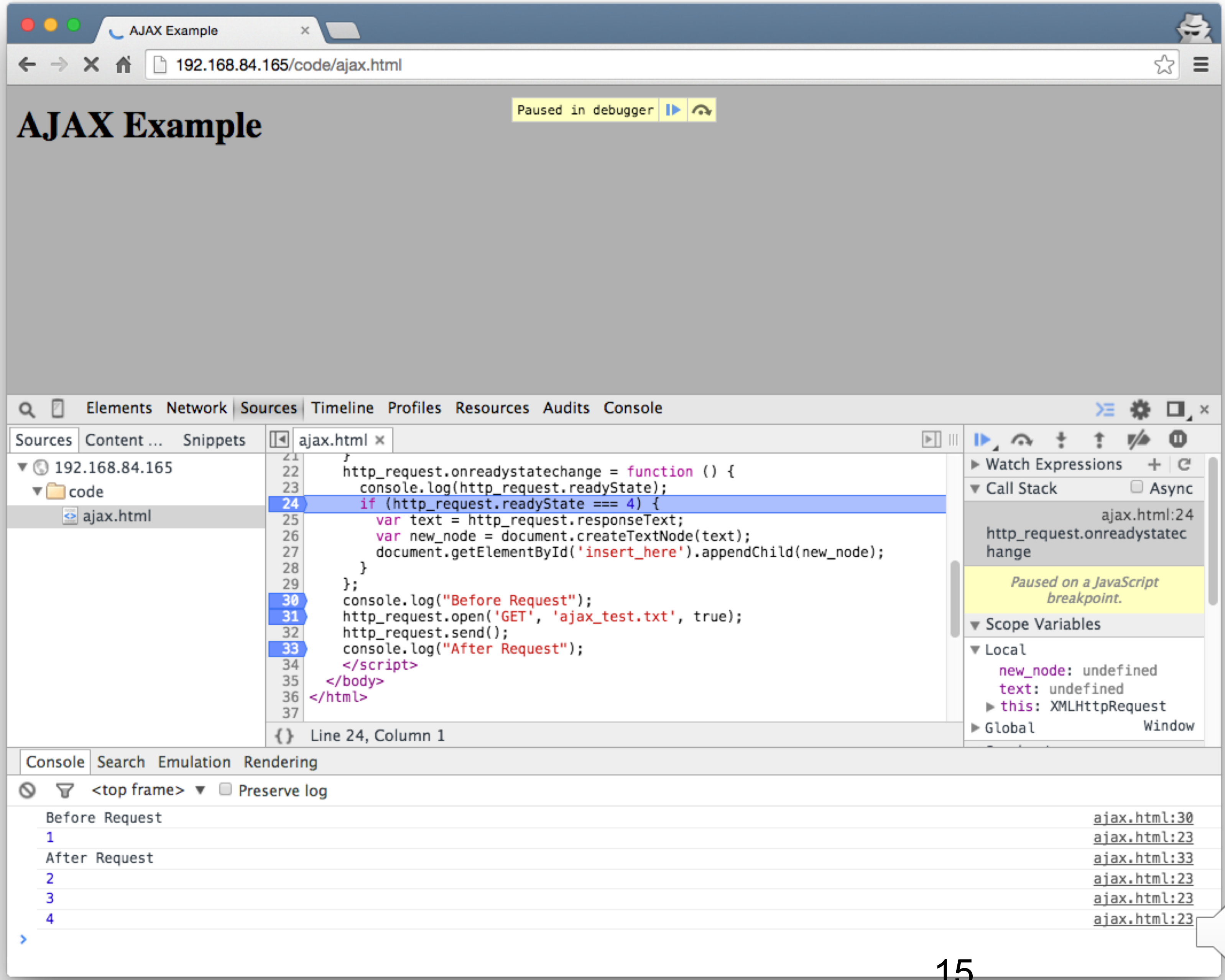
Line 24, Column 1

ajax.html:24
http_request.onreadystatechange

Paused on a JavaScript breakpoint.

```
Local
  new_node: undefined
  text: undefined
  this: XMLHttpRequest
Global                  Window
```

```
Before Request                                   ajax.html:30
1                                                ajax.html:23
After Request                                    ajax.html:33
2                                                ajax.html:23
3                                                ajax.html:23
>
```


AJAX Example
192.168.84.165/code/ajax.html
Paused in debugger
Elements Network Sources Timeline Profiles Resources Audits Console
Sources Content ... Snippets
192.168.84.165
code
ajax.html
Watch Expressions
Call Stack
Async
Scope Variables
Console Search Emulation Rendering
<top frame>
Preserve log

AJAX Example

```
    }
    http_request.onreadystatechange = function () {
      console.log(http_request.readyState);
      if (http_request.readyState === 4) {
        var text = http_request.responseText;
        var new_node = document.createTextNode(text);
        document.getElementById('insert_here').appendChild(new_node);
      }
    };
    console.log("Before Request");
    http_request.open('GET', 'ajax_test.txt', true);
    http_request.send();
    console.log("After Request");
    </script>
  </body>
</html>
```

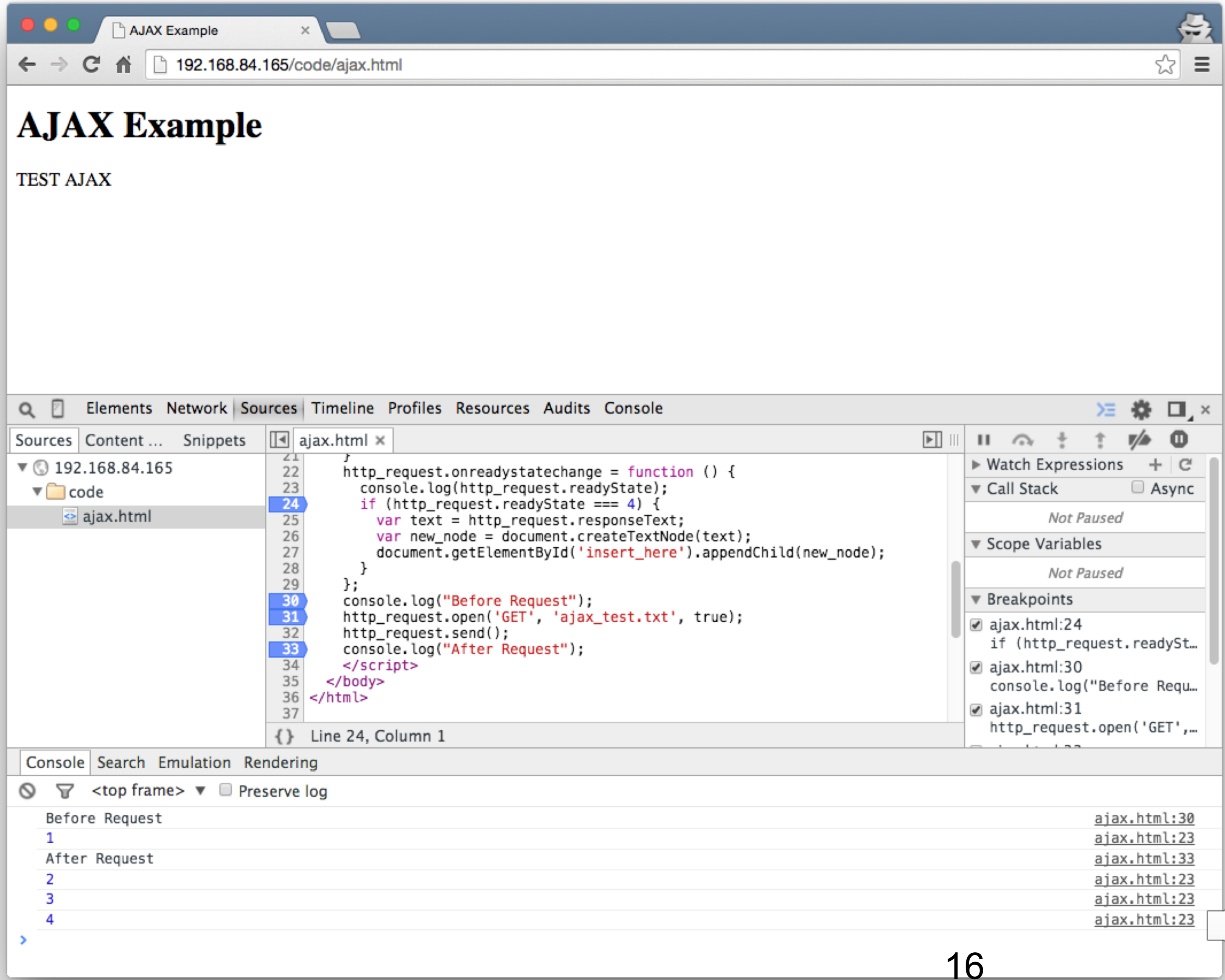
Line 24, Column 1

ajax.html:24
http_request.onreadystatechange

Paused on a JavaScript breakpoint.

```
Local
  new_node: undefined
  text: undefined
  this: XMLHttpRequest
Global                       Window
```

```
Before Request                          ajax.html:30
1                                       ajax.html:23
After Request                           ajax.html:33
2                                       ajax.html:23
3                                       ajax.html:23
4                                       ajax.html:23
```


AJAX Example
192.168.84.165/code/ajax.html
Elements Network Sources Timeline Profiles Resources Audits Console
Sources Content ... Snippets
ajax.html
Watch Expressions
Call Stack
Async
Not Paused
Scope Variables
Not Paused
Breakpoints
Console Search Emulation Rendering
<top frame>
Preserve log

AJAX Example

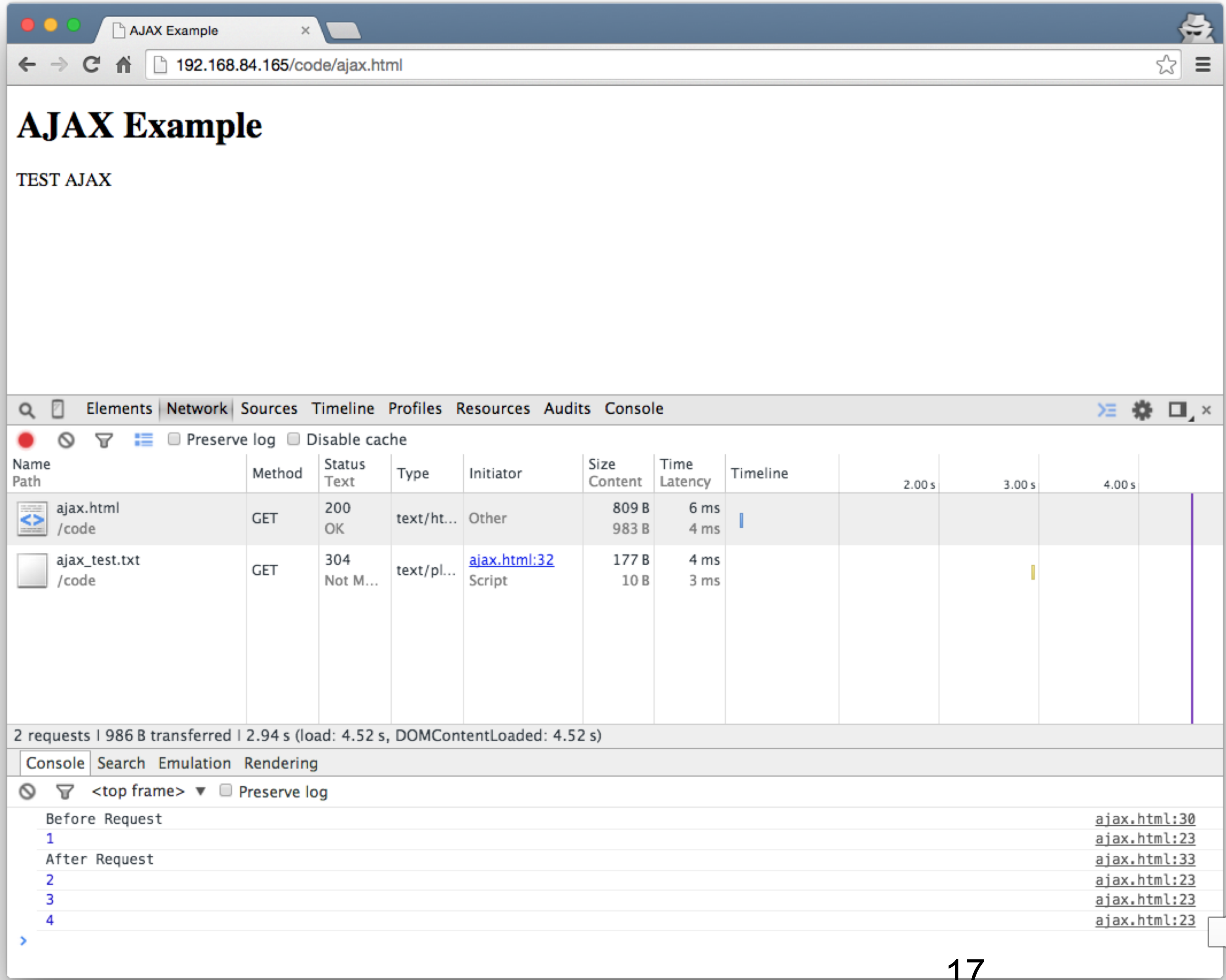
TEST AJAX

```
        }
        http_request.onreadystatechange = function () {
          console.log(http_request.readyState);
          if (http_request.readyState === 4) {
            var text = http_request.responseText;
            var new_node = document.createTextNode(text);
            document.getElementById('insert_here').appendChild(new_node);
          }
        };
        console.log("Before Request");
        http_request.open('GET', 'ajax_test.txt', true);
        http_request.send();
        console.log("After Request");
        </script>
      </body>
    </html>
```

Line 24, Column 1

```
ajax.html:24
  if (http_request.readySt…
ajax.html:30
  console.log("Before Requ…
ajax.html:31
  http_request.open('GET',…
```

```
Before Request                                   ajax.html:30
1                                                ajax.html:23
After Request                                    ajax.html:33
2                                                ajax.html:23
3                                                ajax.html:23
4                                                ajax.html:23
>
```



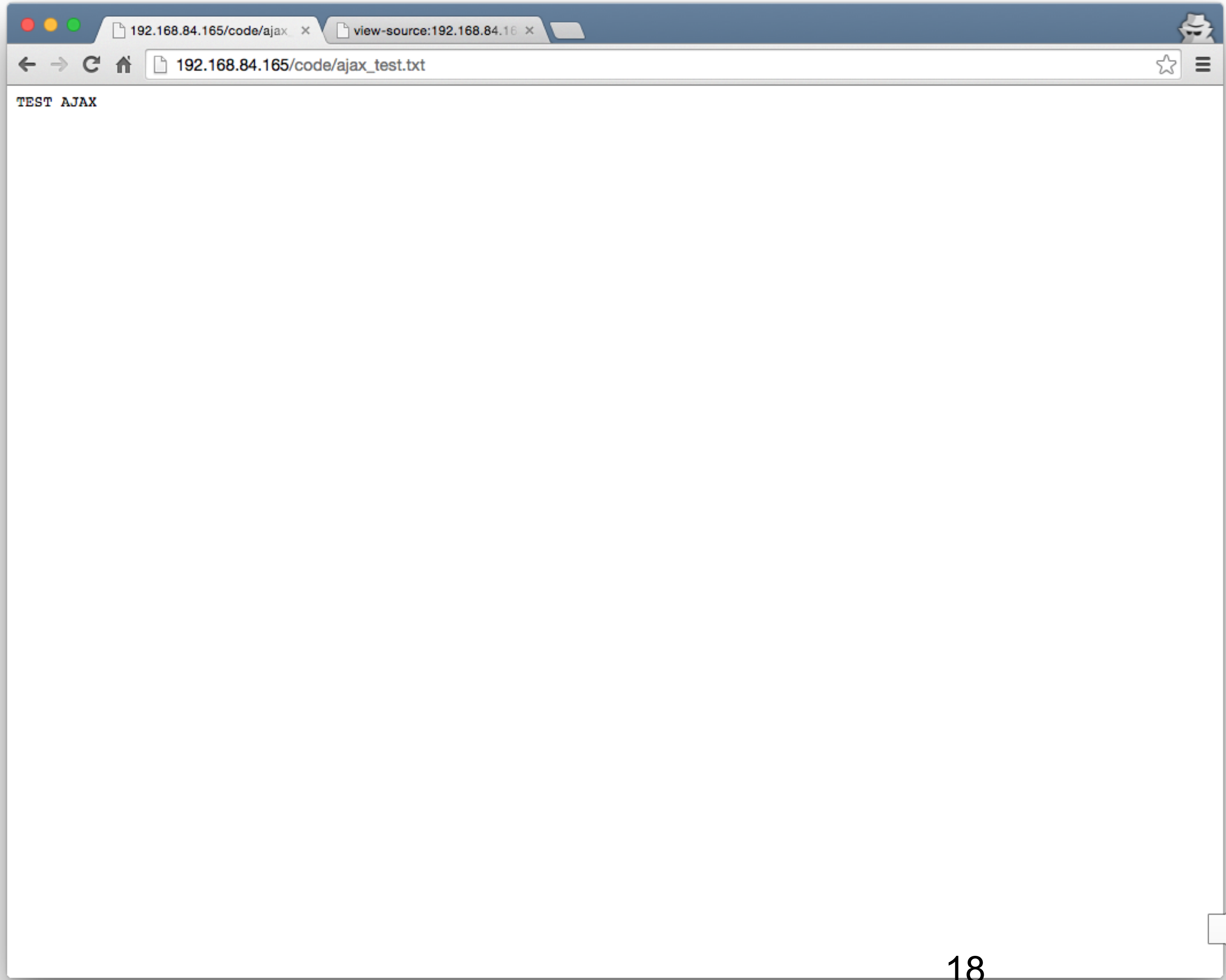
AJAX Example

TEST AJAX

Name / Path	Method	Status / Text	Type	Initiator	Size / Content	Time / Latency
ajax.html /code	GET	200 OK	text/ht...	Other	809 B 983 B	6 ms 4 ms
ajax_test.txt /code	GET	304 Not M...	text/pl...	ajax.html:32 Script	177 B 10 B	4 ms 3 ms

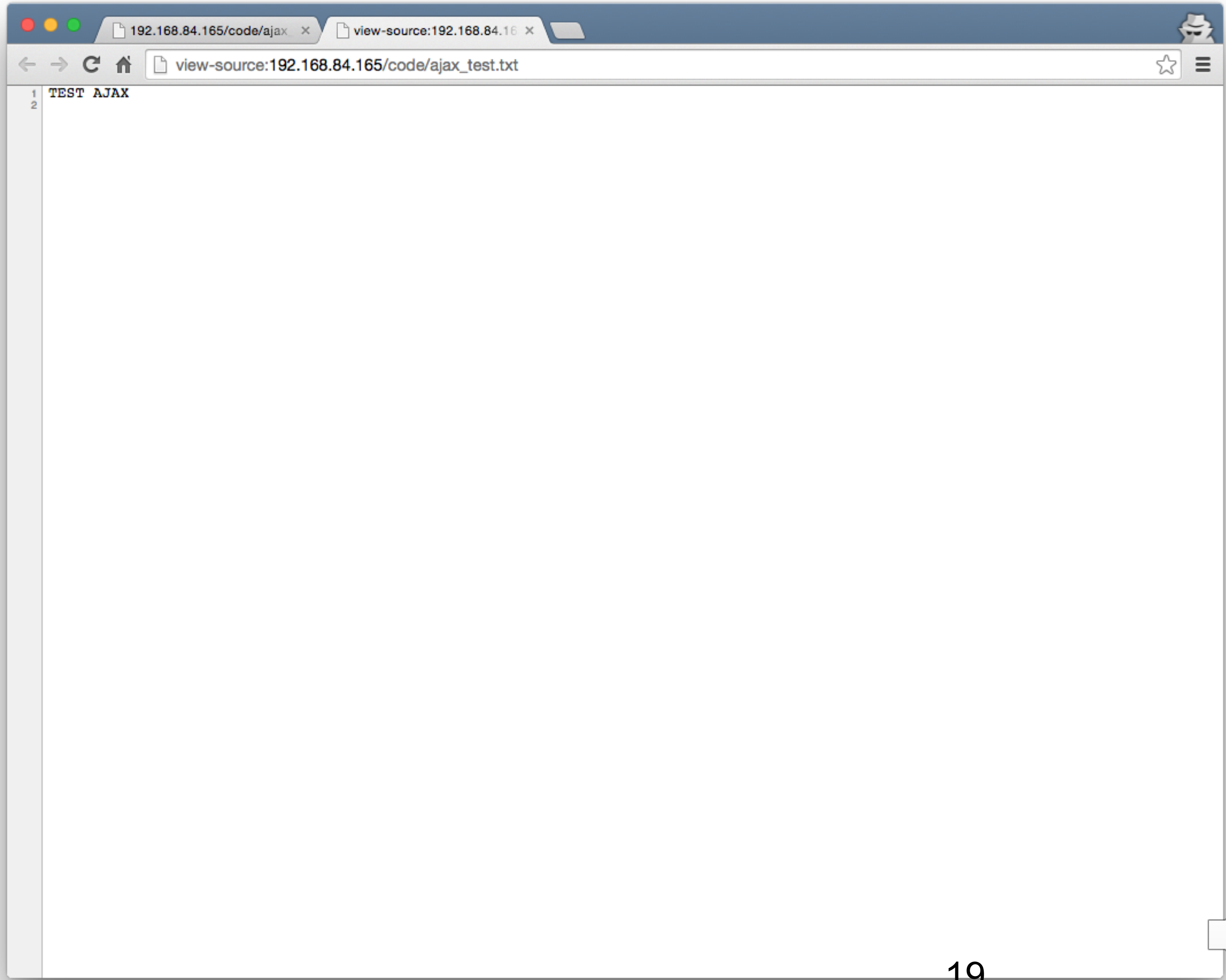
2 requests | 986 B transferred | 2.94 s (load: 4.52 s, DOMContentLoaded: 4.52 s)

```
Before Request                                                ajax.html:30
1                                                             ajax.html:23
After Request                                                 ajax.html:33
2                                                             ajax.html:23
3                                                             ajax.html:23
4                                                             ajax.html:23
>
```

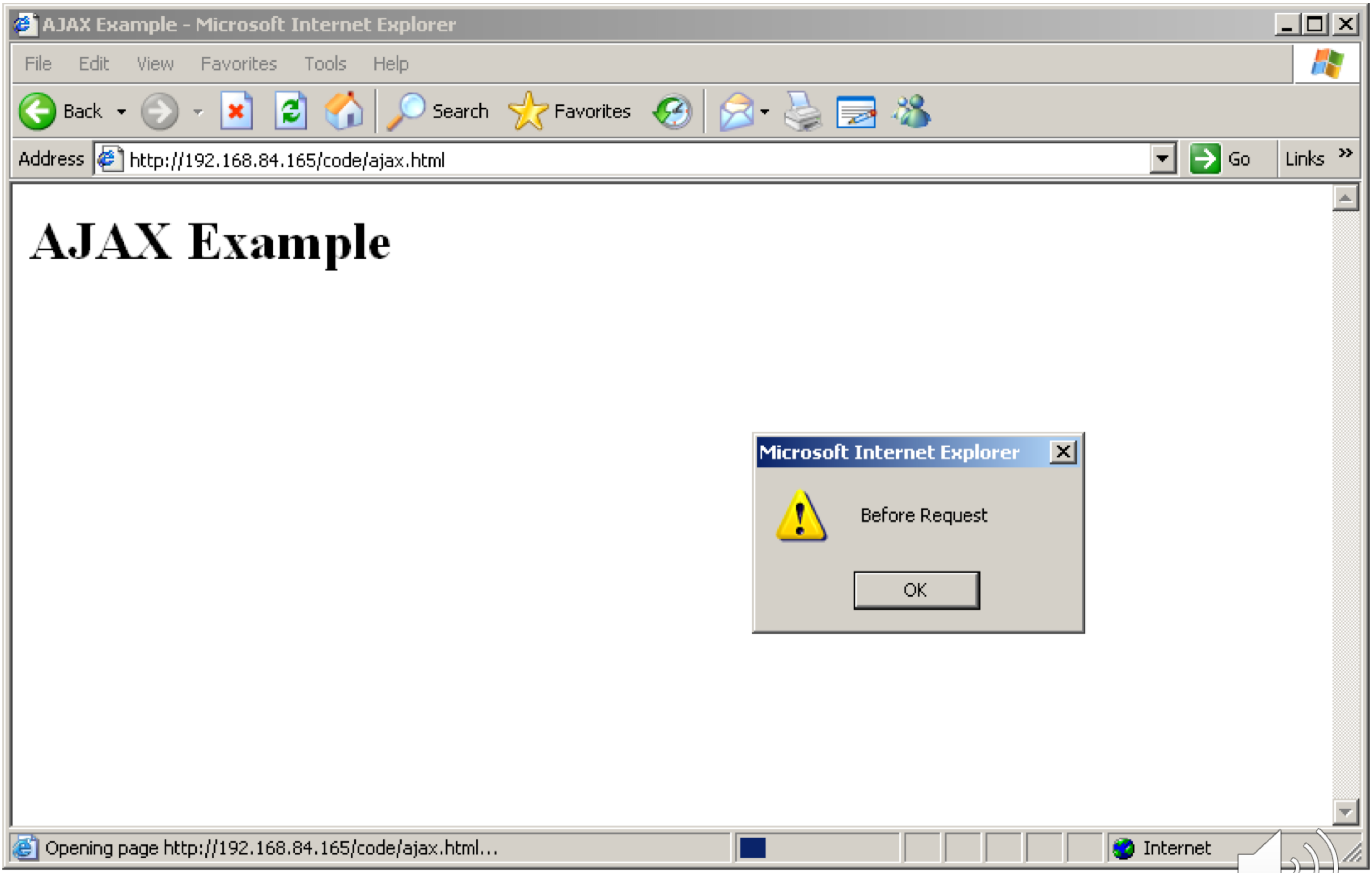


192.168.84.165/code/ajax_test.txt

```
TEST AJAX
```


192.168.84.165/code/ajax
view-source:192.168.84.16
view-source:192.168.84.165/code/ajax_test.txt

```
TEST AJAX
```

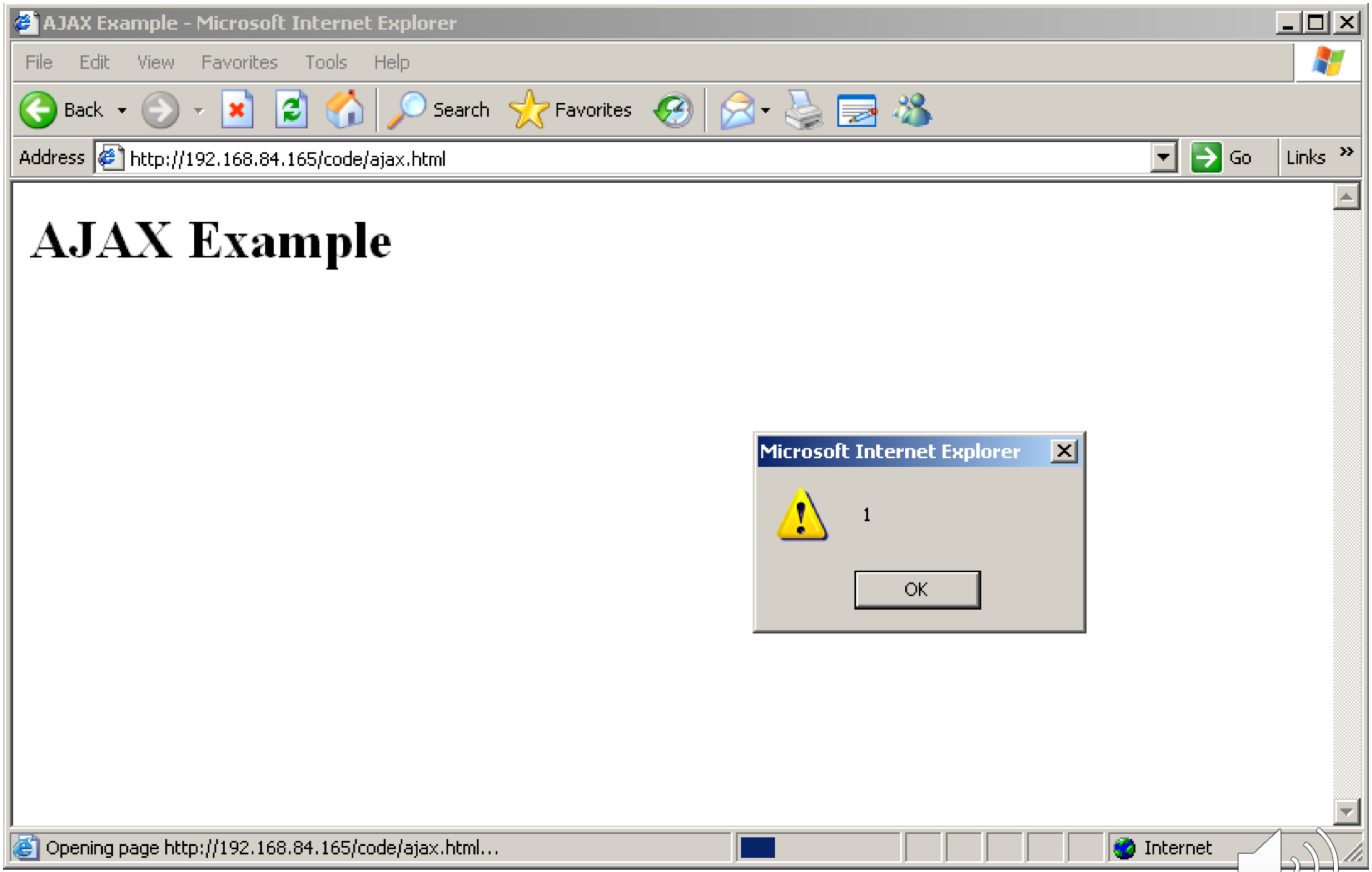

AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax.html Go Links

AJAX Example

Microsoft Internet Explorer

Before Request

Opening page http://192.168.84.165/code/ajax.html...

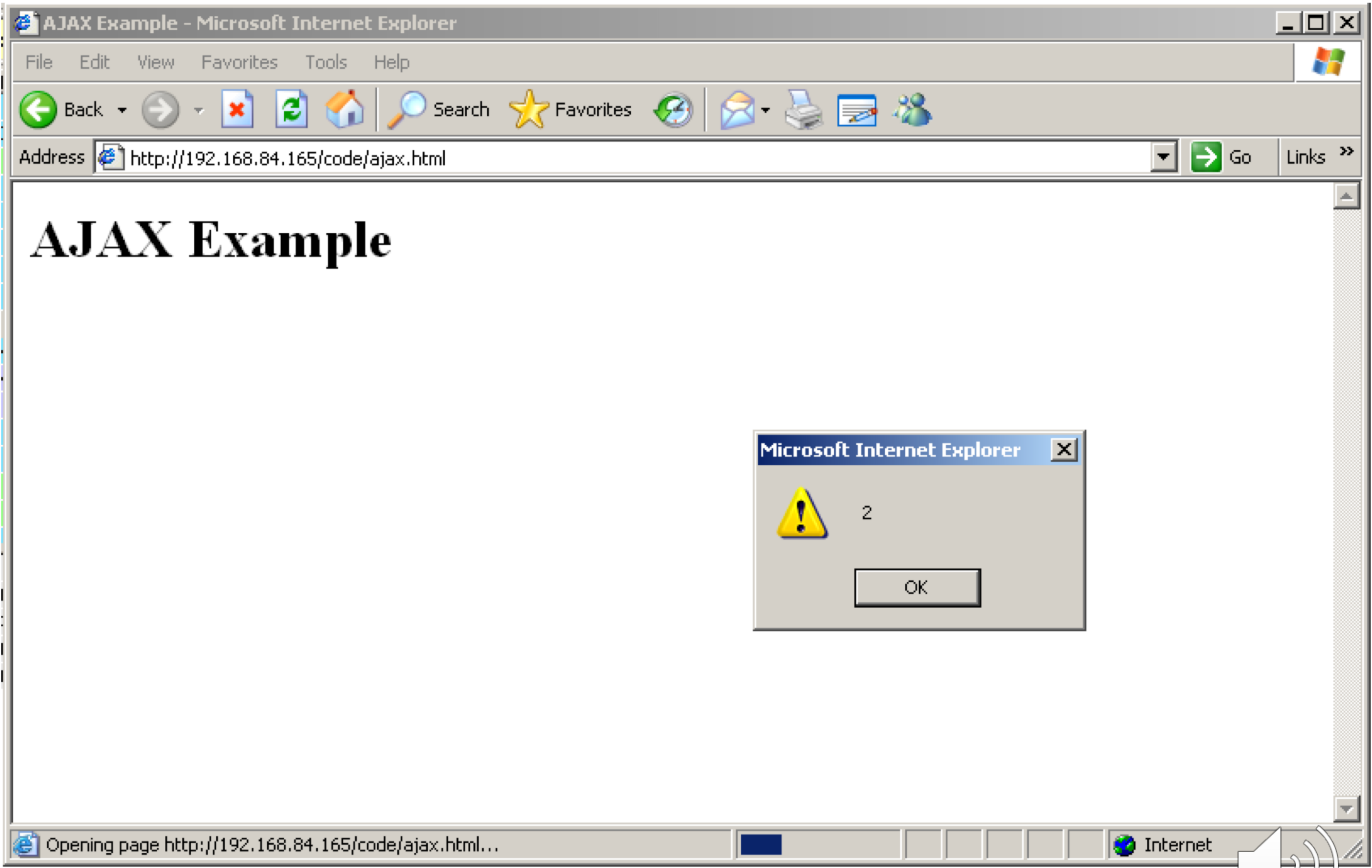

AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax.html Go Links
OK
Internet

AJAX Example

Microsoft Internet Explorer

1

Opening page http://192.168.84.165/code/ajax.html...


AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Address
Go
Links

http://192.168.84.165/code/ajax.html

AJAX Example

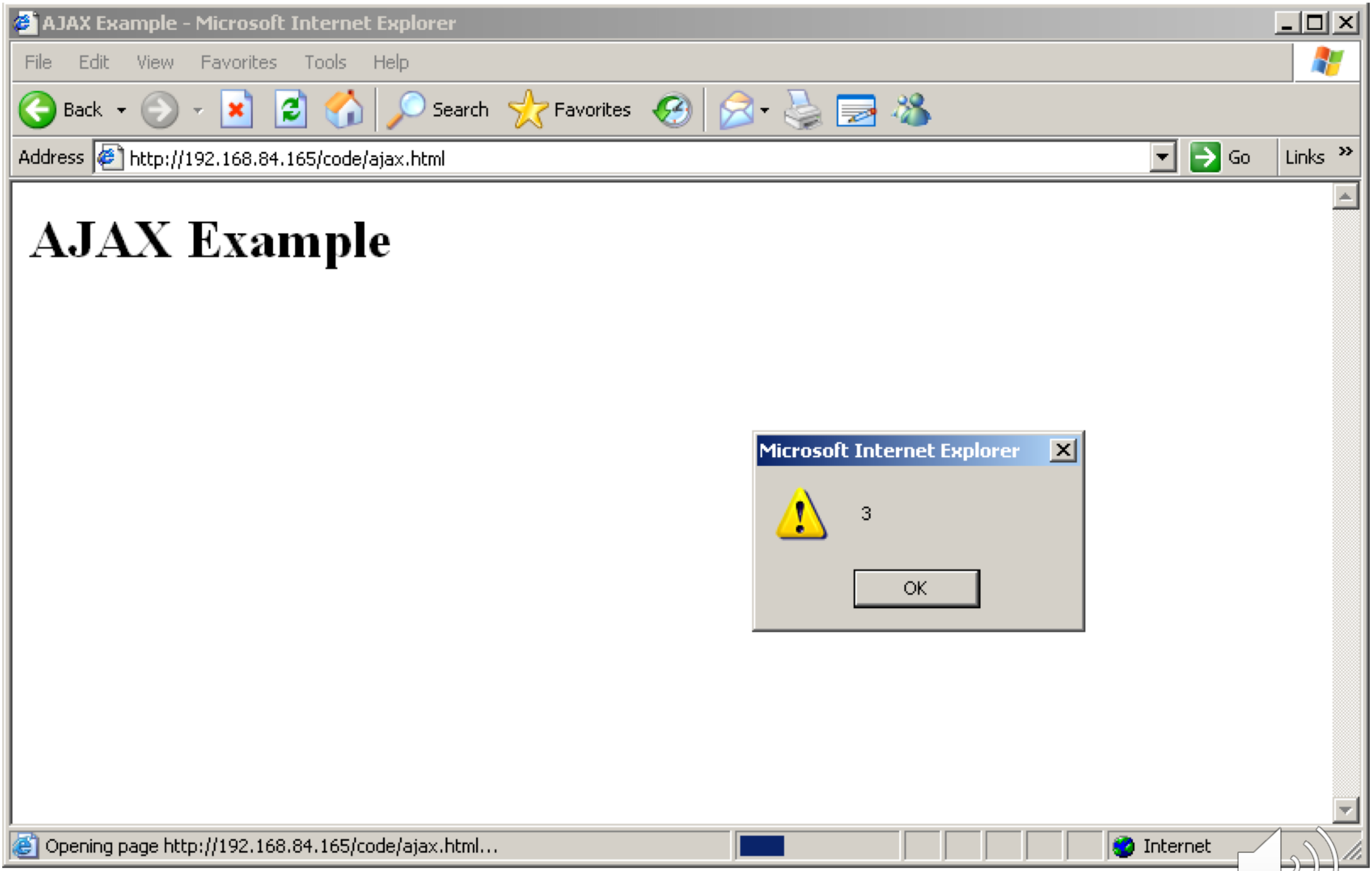
Microsoft Internet Explorer

2

OK

Opening page http://192.168.84.165/code/ajax.html...

Internet

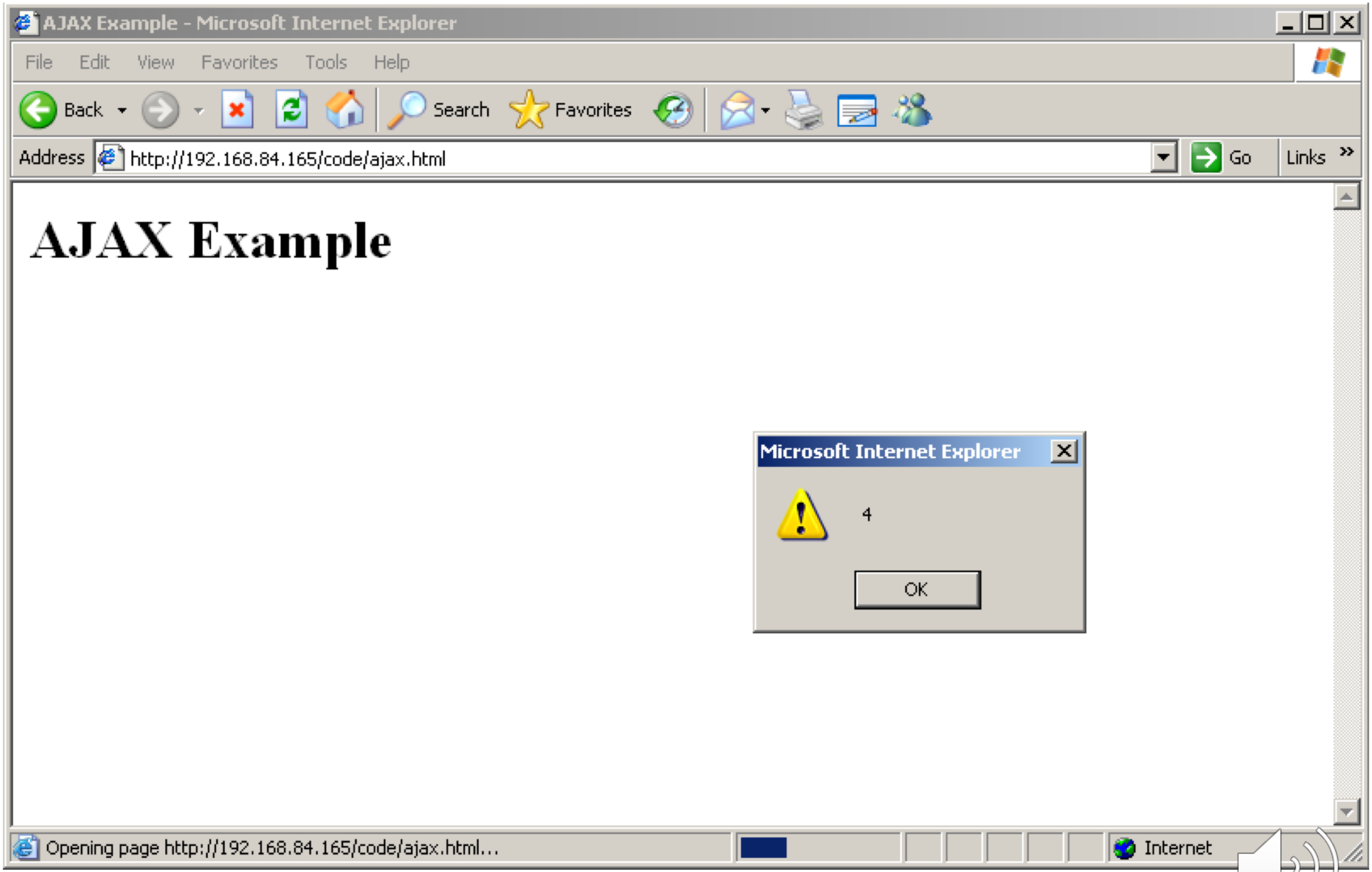

AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Address
Go
Links
Internet
Microsoft Internet Explorer
OK

http://192.168.84.165/code/ajax.html

AJAX Example

3

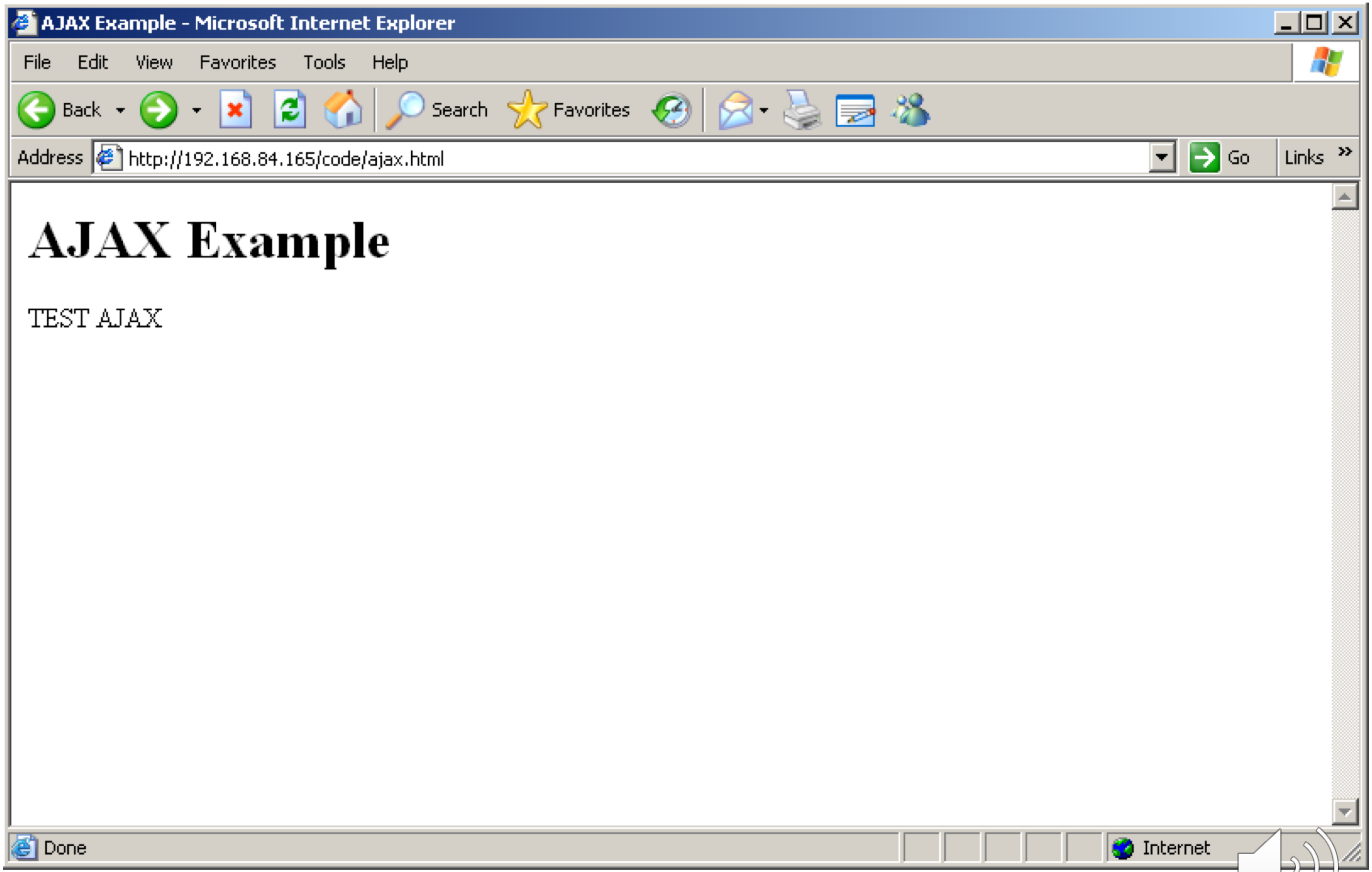
Opening page http://192.168.84.165/code/ajax.html...


AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax.html
Go Links
Microsoft Internet Explorer
OK
Internet

AJAX Example

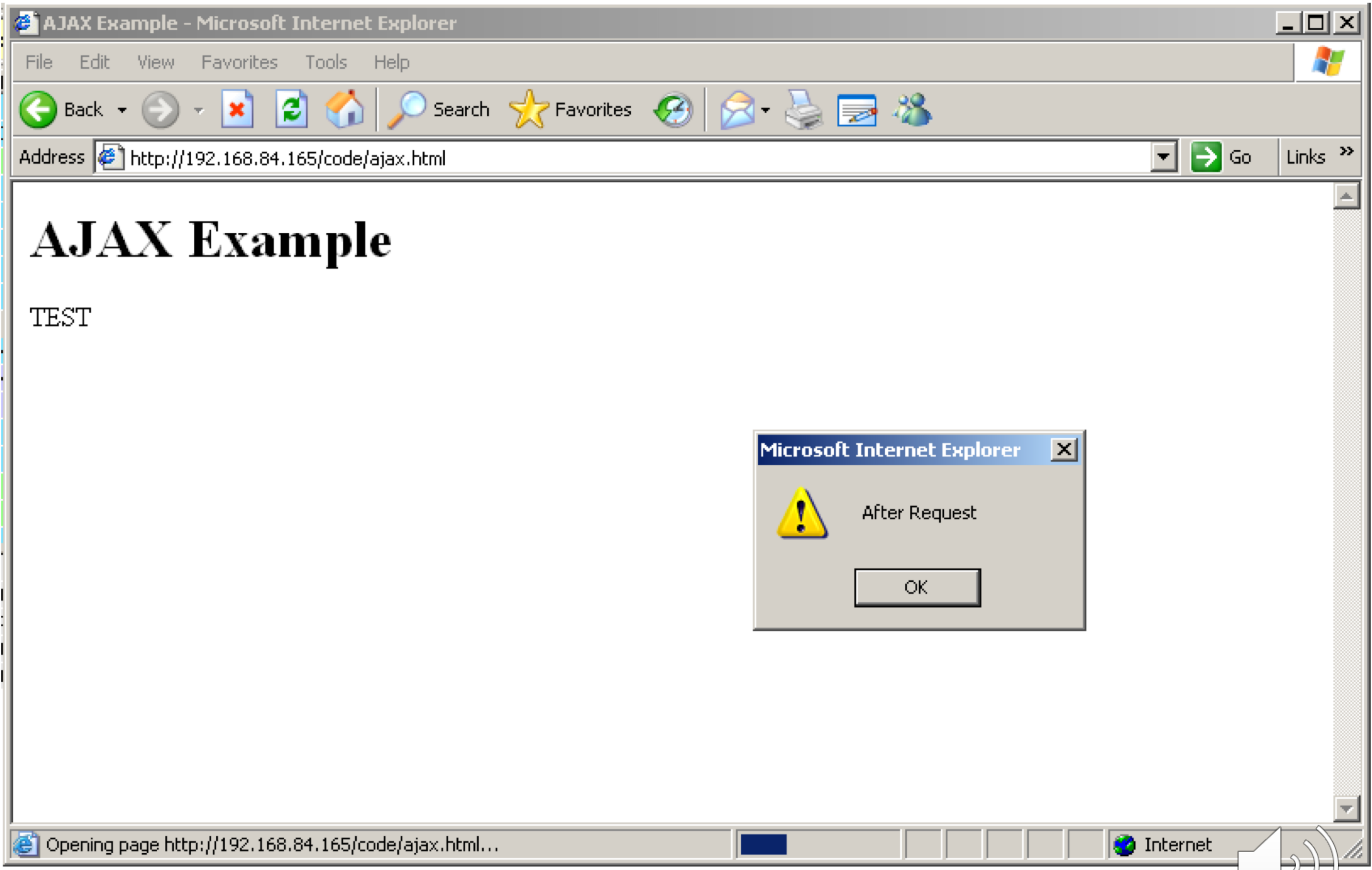
4

Opening page http://192.168.84.165/code/ajax.html...


AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax.html
Go Links
Done
Internet

AJAX Example

TEST AJAX


AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Address
Go
Links
OK
Internet

http://192.168.84.165/code/ajax.html

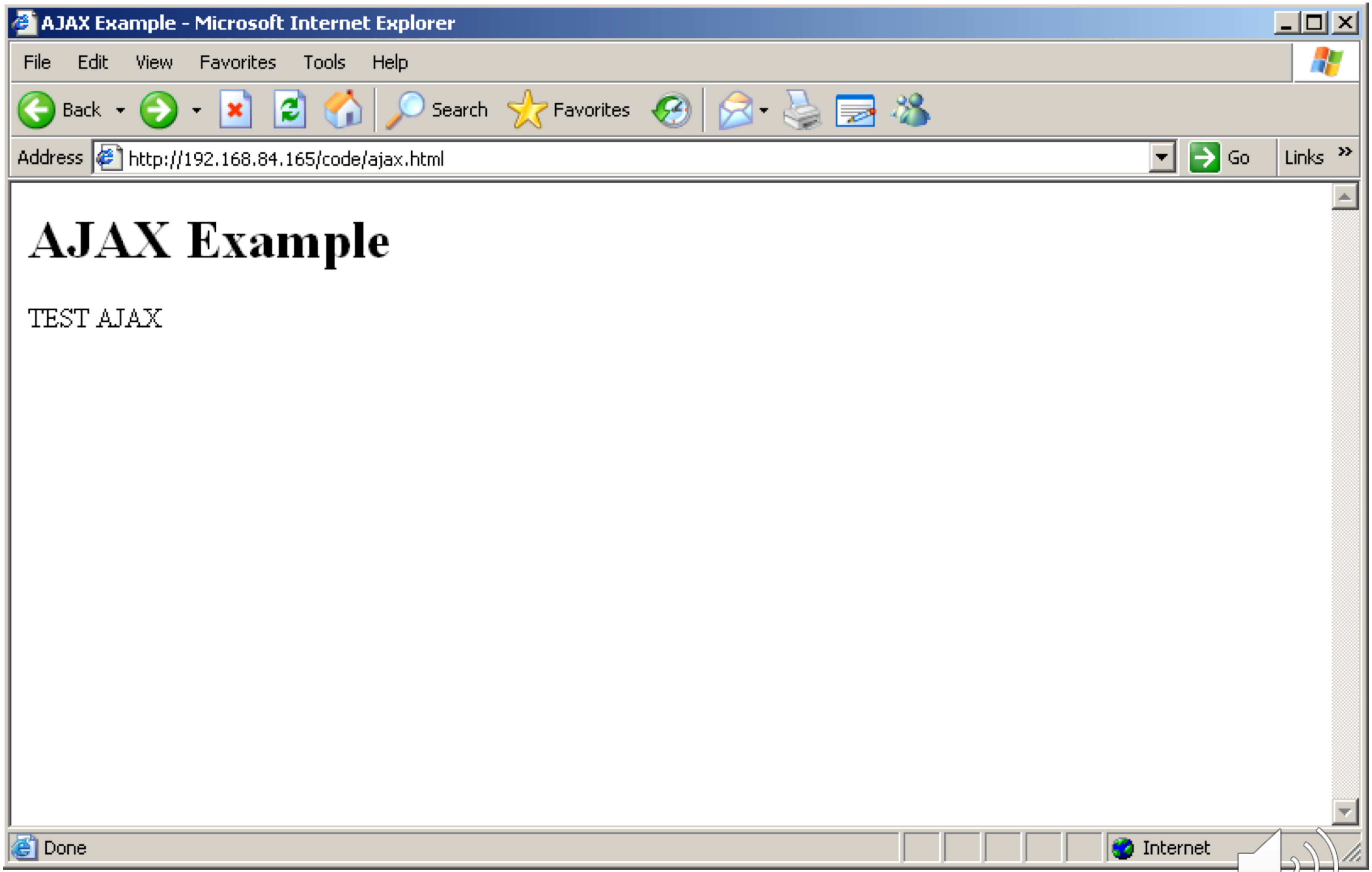
AJAX Example

TEST

Microsoft Internet Explorer

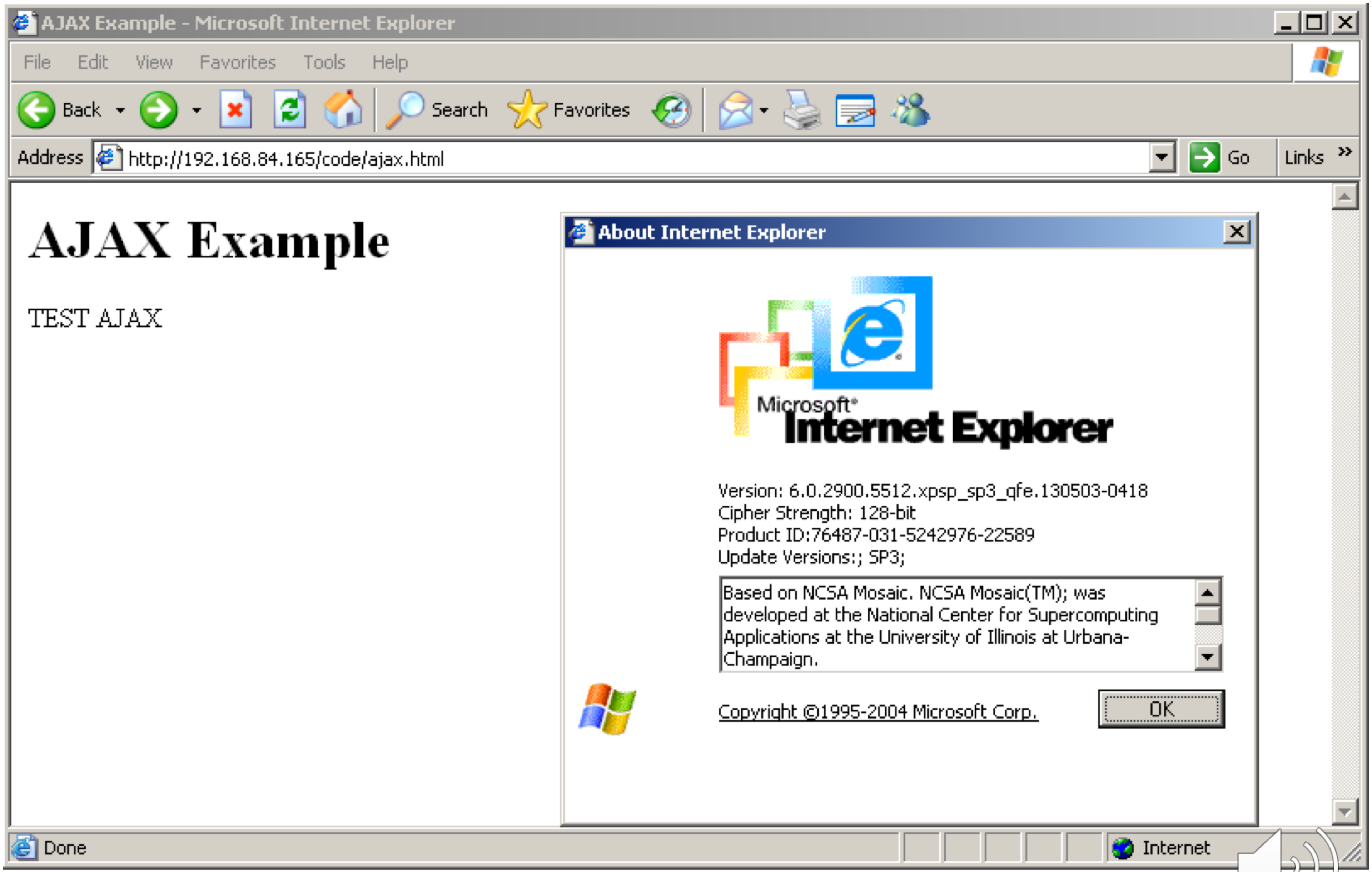
After Request

Opening page http://192.168.84.165/code/ajax.html...


AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax.html
Go Links
Done
Internet

AJAX Example

TEST AJAX


AJAX Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax.html Go Links
About Internet Explorer
Microsoft Internet Explorer
OK
Done
Internet

AJAX Example

TEST AJAX

Version: 6.0.2900.5512.xpsp_sp3_qfe.130503-0418
Cipher Strength: 128-bit
Product ID:76487-031-5242976-22589
Update Versions:; SP3;

Based on NCSA Mosaic. NCSA Mosaic(TM); was developed at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.

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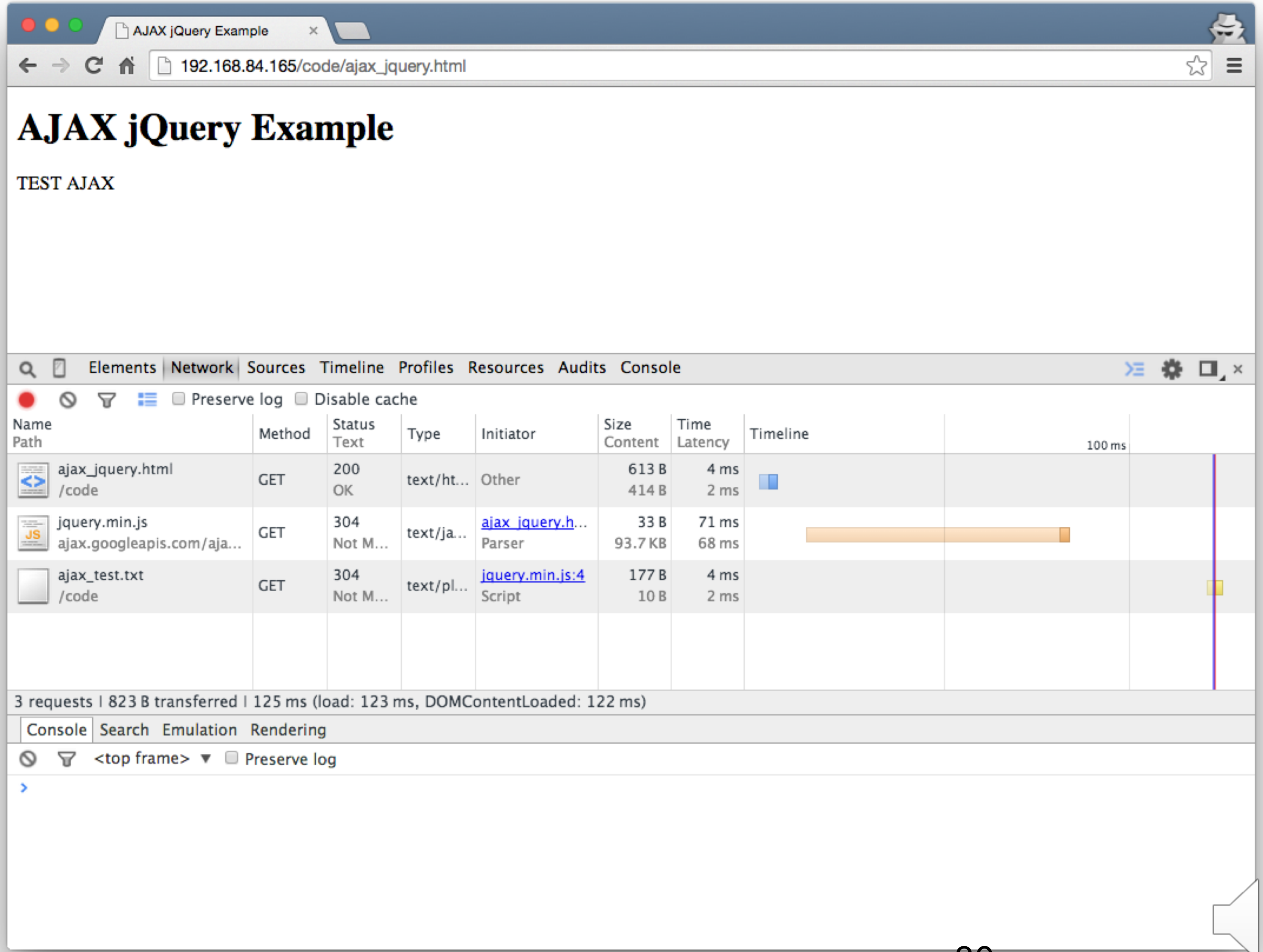
XMLHttpRequest with jQuery

```
<!DOCTYPE html>
<html>
 <head>
   <meta charset="UTF-8">
   <title>AJAX jQuery Example</title>
 </head>

 <body>
   <h1>AJAX jQuery Example</h1>
   <div id='insert_here'>
   </div>
   <script src="https://ajax.googleapis.com/ajax/libs/jquery/1.11.2/jquery.min.js">
   </script>
   <script>
    $.get( "ajax_test.txt", function( data ) {
      $( "#insert_here" ).html( data );
    });
  </script>
 </body>
</html>
```

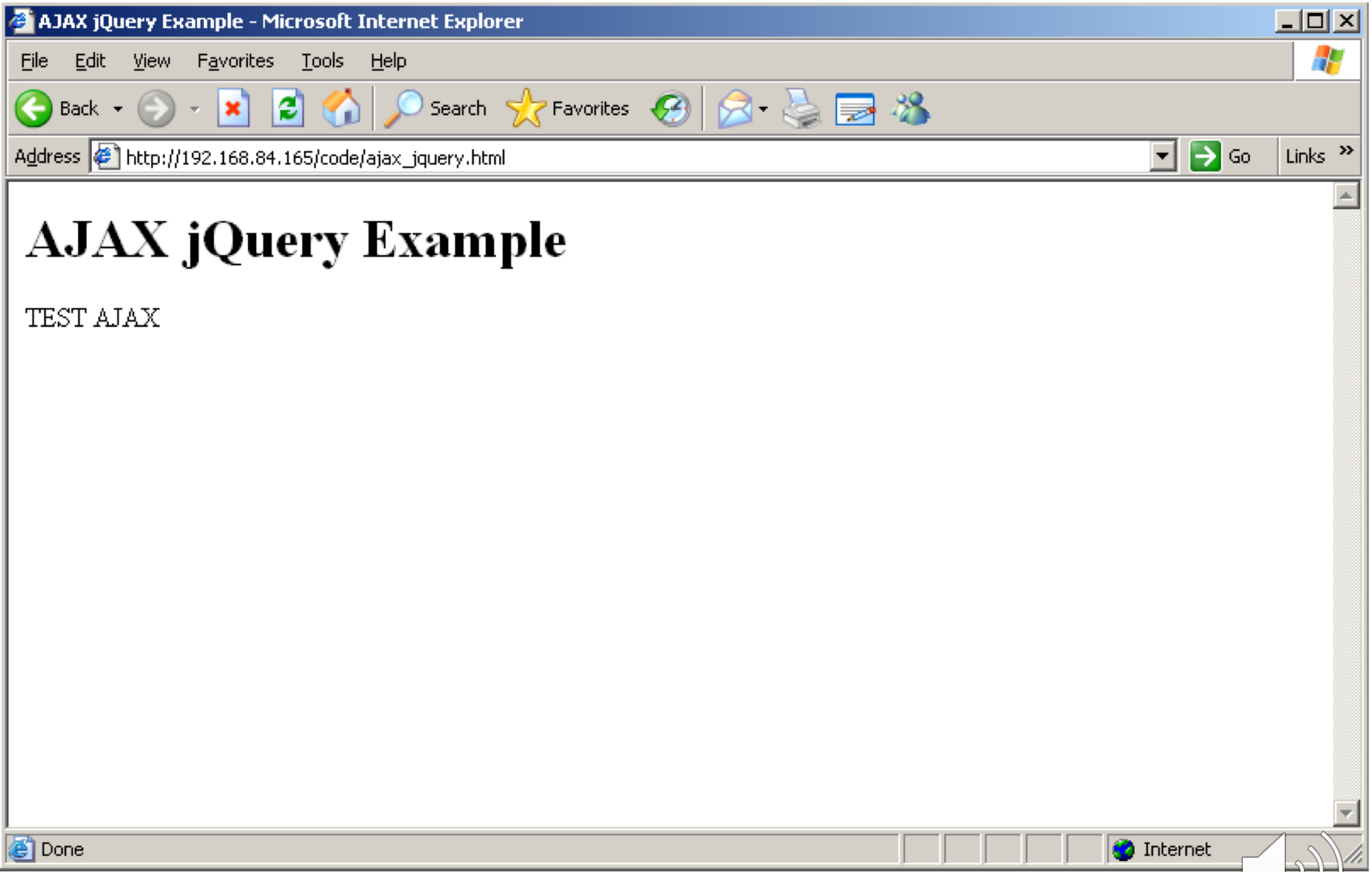


AJAX jQuery Example

TEST AJAX

Name / Path	Method	Status / Text	Type	Initiator	Size / Content	Time / Latency
ajax_jquery.html /code	GET	200 OK	text/ht...	Other	613 B 414 B	4 ms 2 ms
jquery.min.js ajax.googleapis.com/aja...	GET	304 Not M...	text/ja...	ajax_jquery.h... Parser	33 B 93.7 KB	71 ms 68 ms
ajax_test.txt /code	GET	304 Not M...	text/pl...	jquery.min.js:4 Script	177 B 10 B	4 ms 2 ms

3 requests | 823 B transferred | 125 ms (load: 123 ms, DOMContentLoaded: 122 ms)


AJAX jQuery Example - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.84.165/code/ajax_jquery.html
Go Links
Done
Internet

AJAX jQuery Example

TEST AJAX

Asynchronous JavaScript and XML – AJAX

- Can now make web applications that asynchronously fetch only the required data from the server
  - Can also respond to user input (clicks, form), and potentially load data
- First reference to the term AJAX
  - https://web.archive.org/web/20050223021343/http://adaptivepath.com/publications/essays/archives/000385.php

How to Design a Web Application

- Depends on the framework you use
- CGI applications
  - One single file that responds to multiple path infos
  - Multiple files that each respond to their own path
- PHP applications
  - Typically many files that correspond 1-1 with a URL
- ASP applications
  - Classic ASP is the same as PHP

"Natural" PHP code

```php
<?php
session_start();
$_SESSION['username'] = 'admin';

$username_param = $_GET['username'];
if ($username_param != $_SESSION['username'])
{
  if ($_SESSION['username'] != 'admin')
  {
    echo "<h1>Sorry, you can only view your own comments.</h1>";
    exit(0);
  }
}

$username = $_SESSION['username'];

?>
```

"Natural" PHP code

```
<h1>CSC 591 Comments</h1>
<h2>Welcome <?php echo $username; ?>
<p>for debugging purposes you are: <span id='userinfo'><?php echo $_SESSION['loggedin2'];
?></span></p>
<h2>Here are the comments</h2>
  <?php
$db = sqlite_open("comments.sqlite");
$query = "select * from comments where username = '" . sqlite_escape_string($username_param) .
"';";
$res = sqlite_query($query, $db);
if ($res)
{
  while ($entry = sqlite_fetch_array($res, SQLITE_ASSOC))
  {
    ?>
    <p><?php echo $entry['comment']; ?>
    <br />- <?php htmlspecialchars($username); ?>
    </p>
    <?php
  }
?>
```

"Natural" PHP code

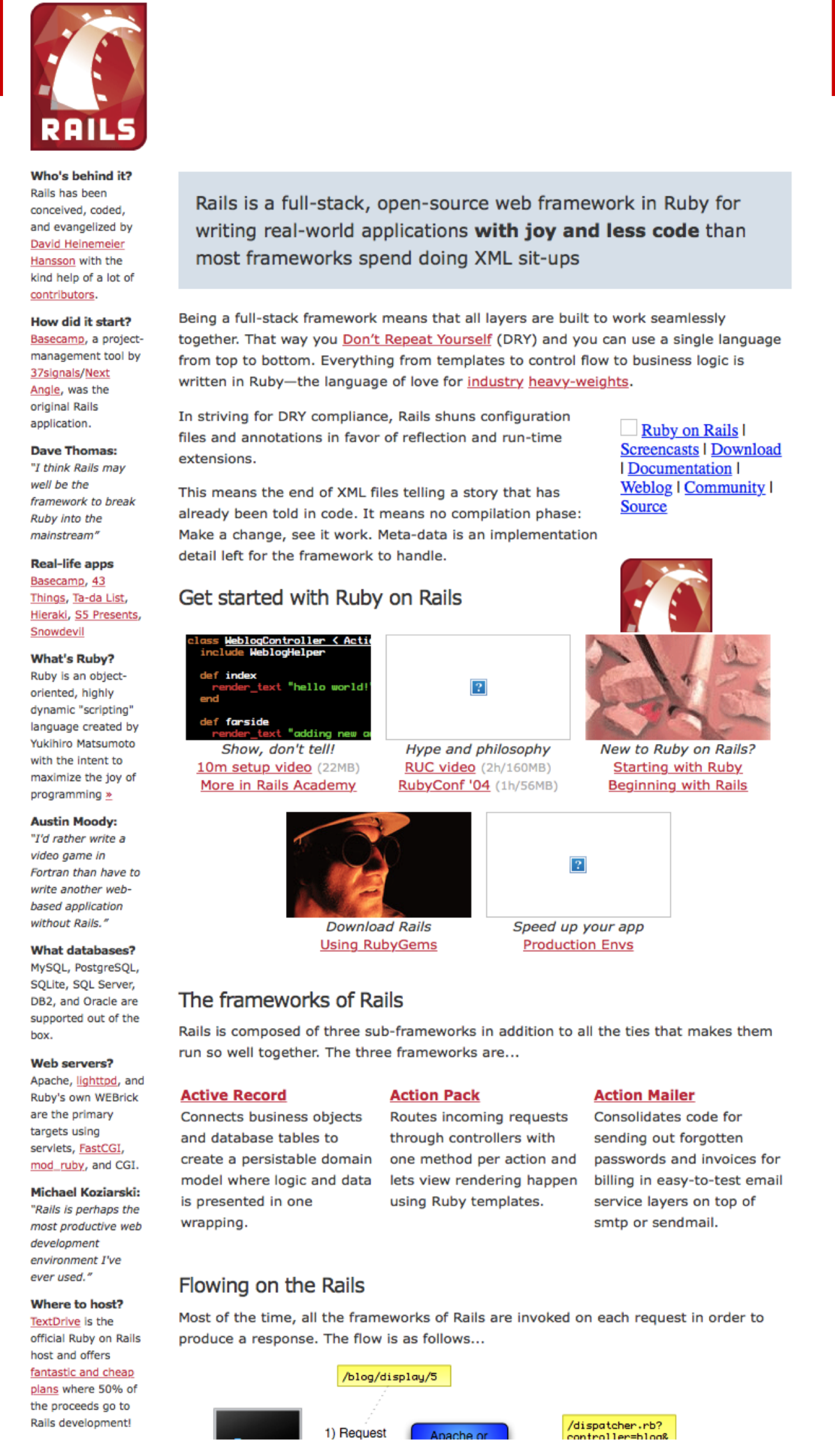
```
<h2>Make your voice heard!</h2>
<form action="add_comment.php?username=<?php echo urlencode($username); ?>"
method="POST">
<textarea name="comment"></textarea> <br>
<input type="submit" value="Submit" />
</form>
<p>
 <a href="logout.php">Logout</a>
 </p>
<?php
}
else {
?>
<h1>Error</h1><p> <?php echo
htmlspecialchars(sqlite_error_string(sqlite_last_error($db))); ?> </p>
<?php
}
?>
```

Spaghetti Code

- How maintainable is this code?
  - Imagine all the files are like this
  - You want to change how comments are stored, giving them extra metadata
  - You must change every single SQL query in every PHP files that touches the comments, as well as all the outputs
- HTML output intermixed with SQL queries intermixed with PHP code

Tight Coupling of URLs to Scripts

- The natural way to design a web application is to map every (valid) URL to a specific script that gets executed
- URLs look like:
  - http://example.com/add_comment.php
  - http://example.com/view_comments.php
  - http://example.com/users/view_users.php
  - http://example.com/admin/secret.php
- And map directly to the following file structure
  - add_comment.php
  - view_comments.php
  - users/view_users.php
  - admin/secret.php
- Is this necessary?



Who's behind it?
Rails has been conceived, coded, and evangelized by David Heinemeier Hansson with the kind help of a lot of contributors.

How did it start?
Basecamp, a project-management tool by 37signals/Next Angle, was the original Rails application.

Dave Thomas:
"I think Rails may well be the framework to break Ruby into the mainstream"

Real-life apps
Basecamp, 43 Things, Ta-da List, Hieraki, S5 Presents, Snowdevil

What's Ruby?
Ruby is an object-oriented, highly dynamic "scripting" language created by Yukihiro Matsumoto with the intent to maximize the joy of programming »

Austin Moody:
"I'd rather write a video game in Fortran than have to write another web-based application without Rails."

What databases?
MySQL, PostgreSQL, SQLite, SQL Server, DB2, and Oracle are supported out of the box.

Web servers?
Apache, lighttpd, and Ruby's own WEBrick are the primary targets using servlets, FastCGI, mod_ruby, and CGI.

Michael Koziarski:
"Rails is perhaps the most productive web development environment I've ever used."

Where to host?
TextDrive is the official Ruby on Rails host and offers fantastic and cheap plans where 50% of the proceeds go to Rails development!

Rails is a full-stack, open-source web framework in Ruby for writing real-world applications **with joy and less code** than most frameworks spend doing XML sit-ups

Being a full-stack framework means that all layers are built to work seamlessly together. That way you Don't Repeat Yourself (DRY) and you can use a single language from top to bottom. Everything from templates to control flow to business logic is written in Ruby—the language of love for industry heavy-weights.

In striving for DRY compliance, Rails shuns configuration files and annotations in favor of reflection and run-time extensions.

This means the end of XML files telling a story that has already been told in code. It means no compilation phase: Make a change, see it work. Meta-data is an implementation detail left for the framework to handle.

Ruby on Rails | Screencasts | Download | Documentation | Weblog | Community | Source

Get started with Ruby on Rails

```
class WeblogController < Acti
  include WeblogHelper

  def index
    render_text "hello world!
  end

  def farside
    render_text "adding new a
```

Show, don't tell!
10m setup video (22MB)
More in Rails Academy

Hype and philosophy
RUC video (2h/160MB)
RubyConf '04 (1h/56MB)

New to Ruby on Rails?
Starting with Ruby
Beginning with Rails

Download Rails
Using RubyGems

Speed up your app
Production Envs

The frameworks of Rails

Rails is composed of three sub-frameworks in addition to all the ties that makes them run so well together. The three frameworks are...

Active Record
Connects business objects and database tables to create a persistable domain model where logic and data is presented in one wrapping.

Action Pack
Routes incoming requests through controllers with one method per action and lets view rendering happen using Ruby templates.

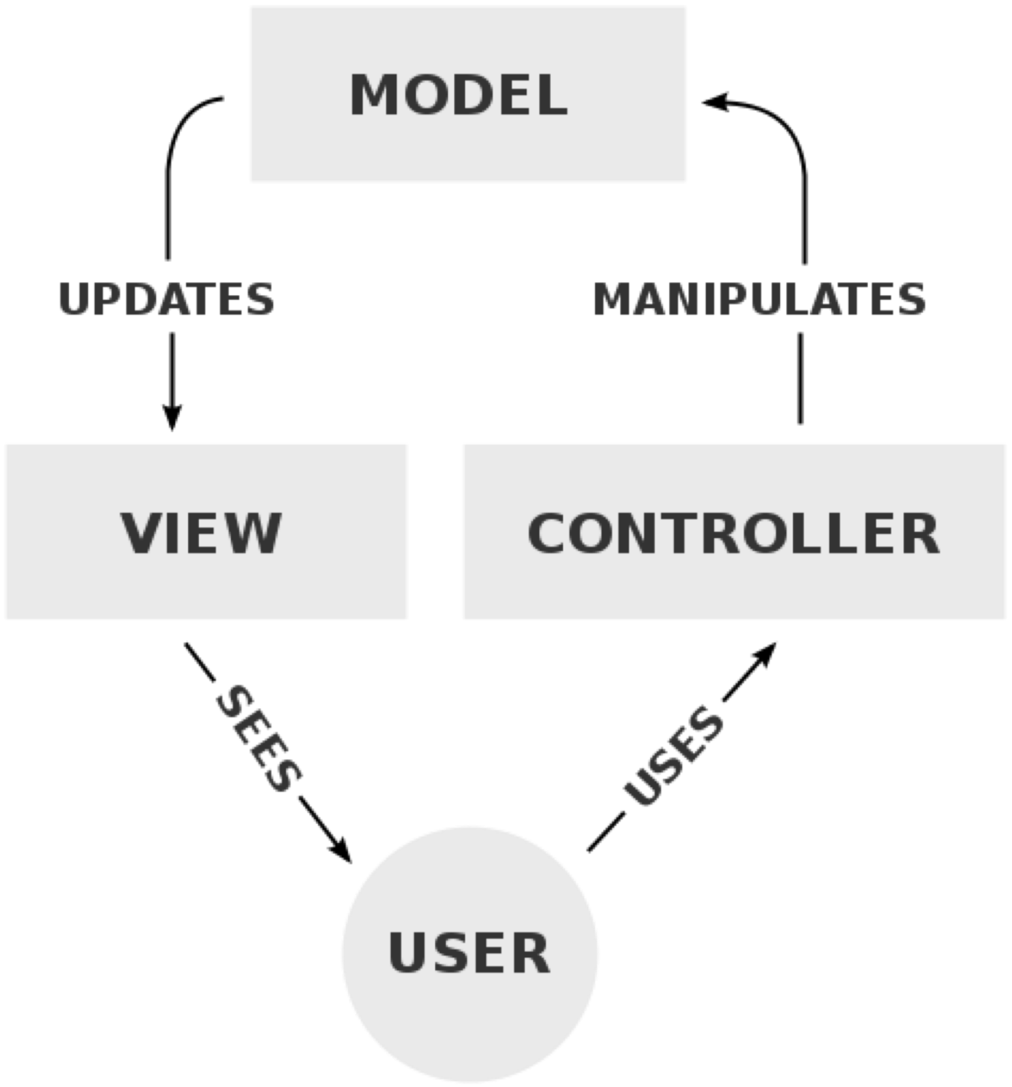
Action Mailer
Consolidates code for sending out forgotten passwords and invoices for billing in easy-to-test email service layers on top of smtp or sendmail.

Flowing on the Rails

Most of the time, all the frameworks of Rails are invoked on each request in order to produce a response. The flow is as follows...

Model-View-Controller

- User Interface design framework
  - A way to separate the concerns of a GUI
  - Originally created in the early '90s
- Popularized by Ruby on Rails to structure the server-side code of web applications


MODEL
UPDATES
MANIPULATES
VIEW
CONTROLLER
SEES
USES
USER

Separation of Concerns

- Model
  - Handles all the "business logic" of the application
  - Stores the application state
- View
  - Responsible for generating a view for the user of the data from the model
  - Usually a simple templating system to display the data from the model
- Controller
  - Responsible for taking input from the user, fetching the correct data from the model, then calling the correct view to display the data
  - Should be very simple

Object Relational Mapping

- As a programmer, you don't need to worry about the database or "SQL" language
- Rails (ActiveRecord)
  - `user = User.create(name: "David", occupation: "Code Artist")`
  - `david = User.find_by(name: 'David')`
  - `david.destroy()`
  - `Article.where('id > 10').limit(20).order('id asc')`

Routing

- Define a mapping between URLs and server-side functions
- Also define parameters that get passed to the function from the URL
- Rails example:

```
class BooksController < ApplicationController
   def update
     @book = Book.find(params[:id])
     if @book.update(book_params)
       redirect_to(@book)
     else
       render "edit"
     end
   end
   end
```

Routing

```
class BooksController < ApplicationController
   def index
     @books = Book.all
   end
 end
```

Templating

- Define the view as a simplified language
  - Input: well-defined variables or dictionaries
  - Output: HTML (or JSON or XML, …)
- Ruby on Rails uses ERB:

```
<h1>Listing Books</h1>
…
<% @books.each do |book| %>
 <tr>
   <td><%= book.title %></td>
   <td><%= book.content %></td>
   <td><%= link_to "Show", book %></td>
   <td><%= link_to "Edit", edit_book_path(book) %></td>
   <td><%= link_to "Remove", book, method: :delete, data: { confirm: "Are you
sure?" } %></td>
 </tr>
<% end %>
…
<%= link_to "New book", new_book_path %>
```

Flask & Jekyll

- Similar to Ruby on Rails, but in Python
- Very nice tutorial if you want to build your own (complicated) site
  - https://blog.miguelgrinberg.com/post/the-flask-mega-tutorial-part-i-hello-world
- Plain text -> static website
  - Jekyll: https://jekyllrb.com/
  - What I use for kapravelos.com
  - Originally developed for Github Pages
  - Easy to host
- Write your own website
  - Google App Engine with Flask (link)
  - Github Pages (link)