HTTP

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Index

Introduction

HTTP

- **H**yper **T**ext **T**ransfer **P**rotocol.
- **Application-layer** protocol for transmitting hypermedia documents.
- **Client-server** model.
- **Stateless** protocol.

History

- **HTTP/0.9** (1991) Only **GET** method
- **HTTP/1.0** (1992–96) Files of different types. **HEAD** and **POST**.
- **HTTP/1.1** (1995–97) Reuse connections. **Host** header.

Since then, the **HTTP 1.1** protocol evolved by adding new headers.

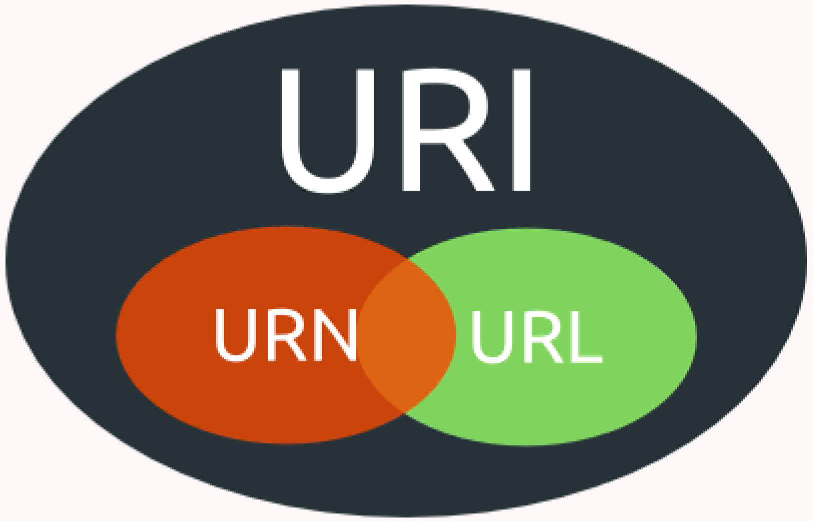
- **HTTP/2.0** (2014–15) A major revision of the **HTTP** network protocol.
- **HTTP/3** (2019–) Or just **H3**, a HTTP mapping over **QUIC** (a general-purpose transport layer network protocol designed by Jim Roskind at Google).

URIs and URLs

URI

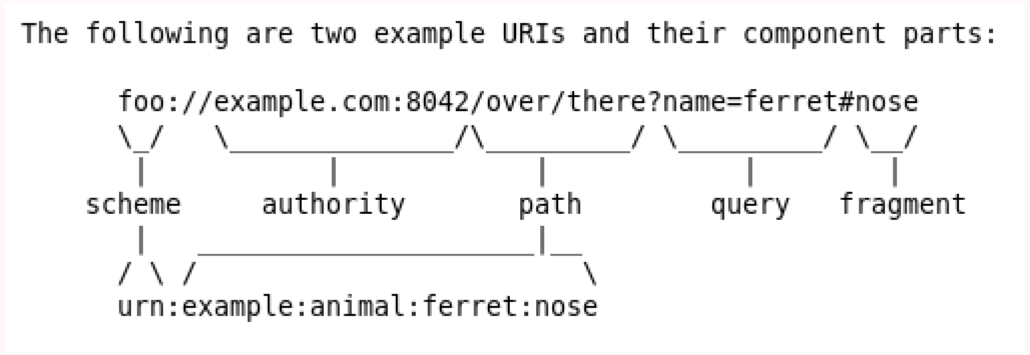
Uniform Resource Identifier

- An identifier is an object that can act as a **reference** to something that has **identity**.
- In the case of a URI, the object is a sequence of characters with a restricted **syntax** RFC3986.
- A URI can be further classified as a locator (**URL**), a name (**URN**), or both.
- URI components: scheme, authority, path, query, fragment



URN

Uniform Resource Names are intended to serve as **persistent**, **location-independent**, resource **identifiers** RFC2141.



```
The following are two example URIs and their component parts:

         foo://example.com:8042/over/there?name=ferret#nose
         \_/   \______________/\_________/ \_________/ \__/
          |           |            |            |        |
       scheme     authority       path        query   fragment
          |   _____________________|__
         / \ /                        \
         urn:example:animal:ferret:nose
```

Source: RFC3986

URL

Uniform **R**esource **L**ocator

URL refers to the **subset** of URI that identify resources via a representation of their primary access mechanism (e.g., their network *location*), rather than identifying the resource by name or by some other attribute(s) of that resource.

A Uniform Resource Name (URN) functions like a person’s **name**, while a Uniform Resource Locator (URL) resembles that person’s unique **address**.

HTTP URL

HTTP URL

Every **HTTP URL** consists of the following, in the given order:

- the **scheme** name (or protocol, *i.e.*, http or https)
- a colon (:), two slashes (//)
- a **host** (domain name or IP address)
- optionally a colon (:) followed by a **port** number
- the full **path** of the resource
- optionally a **query** string
- optionally a **fragment** identifier

ℹ scheme://domain:port/path?query_string#fragment_id

Scheme Name

- For HTTP connections the scheme name can be either **http** or **https**.
- **H**ypertext **T**ransfer **P**rotocol **S**ecure (HTTPS) is just HTTP on top of the **SSL/TLS** protocol.

http://

Hostname

- The hostname as either a registered name or an IP address.

www.google.com

127.0.0.1

Port

- The **default port** for a HTTP server on a computer is port **80**.
- Others are also normally used: 8080, 8000.
- The port number can be **omitted** from the URL if it is the default one.

:80

Path

- The full path of the resource.
- A sequence of segments separated by slashes.
- **May** resemble or map exactly to a file system path **but not necessarily**.

/somewhere/on/this/server.php

Query String

- The query string contains **data** to be passed to software running on the server.
- It may contain **name/value pairs** separated by ampersands.

For example:

```
?first_name=John&last_name=Doe
```

Fragment Identifier

- The fragment identifier, if present, specifies a **part** or a **position** within the overall resource or document.
- If used with HTML, represents an element in the page identified by its **id**.

#content

Session

Session

A **HTTP** session consists of three phases:

- The client establishes a TCP **connection**.
- The client sends its **request** and then waits for the answer.
- The server processes the request and sends back its **response**, containing a **status code** and the appropriate data.

The session then ends. The HTTP protocol is **stateless**. No state is kept on the server about the session.

HTTP Request

Request

The first line contains a request **method** followed by its parameters:

- the **path** of the document (an absolute URL without the protocol and the domain name).
- the HTTP protocol **version** used.

```
GET /~arestivo/index.php HTTP/1.1
```

The subsequent lines each represent a specific HTTP **header**.

The final block is the optional **data block**. Its separated from the headers by a blank line and contains further data. Mainly used by the POST method.

Examples

A **GET** request:

```
GET /search.php?name=john HTTP/1.1
Host: www.example.com
Accept-Language: pt
```

A **POST** request:

```
POST /path/save.php HTTP/1.1
Host: www.example.com
Content-Type: application/x-www-form-urlencoded

name=John%20Doe&username=johndoe
```

HTTP 1.1 **requires** the Host header.

Methods

Methods

- The request method indicates the **action** to be performed by the server.
- The HTTP/1.1 standard defines **nine** methods.
- Other standards can add extra methods.

Safe Methods

A **safe** method is a method that **doesn't have** any **side-effects** on the server:

- **GET**: used to retrieve information identified by the request URI.
- **HEAD**: identical to GET but without the message body sent.

All HTTP servers must implements these methods.

Idempotent Methods

A idempotent method is a method where the side-effects on the server of several identical requests with the method are the same as the side-effects of one single request.

- **PUT** requests that the enclosed entity be stored under the supplied URI.
- **DELETE** used to delete the resource identified by the URI.

These methods are **optional**.

- **HEAD** and **GET** are also idempotent.

Other Methods

- **POST**: used to request that the server accept the entity enclosed in the request as a new subordinate of the resource identified by the URI.
- **OPTIONS**, **TRACE**, **CONNECT** and **PATCH**.

These methods are **optional**.

All methods

Response

Response

- When answering a client request, the server sends back a **three-digit** number indicating whether the request was successfully processed.
- Responses can be grouped in five categories: **informational** (1xx), **success** (2xx), **redirection** (3xx), **client error** (4xx) and **server error** (5xx).

All response codes

Response Example

```
HTTP/1.0 200 OK
Date: Fri, 31 Dec 1999 23:59:59 GMT
Content-Type: text/html
Content-Length: 1354

<html>
<body>
<h1>Hello World!</h1>
(more file contents)
  .
  .
  .
</body>
</html>
```

Status Line

The **status line** is the first line in the response message.

It consists of three items:

- The HTTP **version number**.
- A **status code**.
- A **reason phrase** (a human-readable text that summarizes the meaning of the status code).

```
HTTP/1.0 200 OK
```

Response Codes

Some Response Codes

Success

- **200 OK** - The request has succeeded. The information returned with the response is dependent on the method used in the request.
  - **GET** an entity corresponding to the requested resource is sent in the response.
  - **HEAD** the entity-header fields corresponding to the requested resource are sent in the response without any message-body.
  - **POST** an entity describing or containing the result of the action.
- **201 Created** - The request has been fulfilled and resulted in a new resource being created.

Some Response Codes

Success

- **202 Accepted** - The request has been accepted for processing, but the processing has not been completed.
- **204 No Content** - The server has fulfilled the request but does not need to return an entity-body.
- **206 Partial Content** - The server has fulfilled the partial GET request for the resource. The request MUST have included a *Range* **header**.

Some Response Codes

Redirect

- **301 Moved Permanently** - The requested resource has been assigned a new permanent URI and any future references to this resource should use one of the returned URIs. The new permanent URI should be given by the *Location* **header** in the response.
- **304 Not Modified** - If the client has performed a conditional GET request and access is allowed, but the document has not been modified.

Some Response Codes

Client Error

- **400 Bad Request** - The request could not be understood by the server due to malformed syntax.
- **401 Unauthorized** - The request requires user authentication. The response **must** include a *WWW-Authenticate* **header** containing a challenge applicable to the requested resource.
- **403 Forbidden** - The server understood the request, but is refusing to fulfill it. Authorization will not help and the request should not be repeated.

Some Response Codes

Client Error

- **404 Not Found** - The server has not found anything matching the requested URL.
- **405 Method Not Allowed** - The method specified in the request is not allowed for the resource identified by the URI. The response must include an *Allow* **header** containing a list of valid methods.
- **408 Request Timeout** - The client did not produce a request within the time that the server was prepared to wait.

Some Response Codes

418 I'm a teapot - "Any attempt to brew coffee with a teapot should result in the error code "418 I'm a teapot". The resulting entity body MAY be short and stout." -- RFC2324

> *This error is a reference to Hyper Text Coffee Pot Control Protocol which was an April Fools' joke in 1998.*

Some Response Codes

Server Error

- **500 Internal Server Error** – The server encountered an unexpected condition which prevented it from fulfilling the request.
- **502 Bad Gateway** – The server, while acting as a gateway or proxy, received an invalid response from the upstream server it accessed in attempting to fulfill the request.
- **503 Service Unavailable** – The server is currently unable to handle the request due to a temporary overloading or maintenance of the server.

All response codes

Headers

Client Headers

- **Accept** Content-Types that are acceptable for the response (text/html, image/jpeg, ...).
- **Accept-Charset** Character sets that are acceptable (utf-8, iso-8859-1, ...).
- **Accept-Encoding** List of acceptable encodings (gzip, deflate, ...).
- **Accept-Language** List of acceptable human languages for response.
- **Connection** What type of connection the user-agent would prefer (keep-alive, ...).
- **Cookie** A HTTP cookie previously sent by the server with **Set-Cookie**.
- **Content-Length** The length of the request body in octets (8-bit bytes).

Client Headers

- **Content-Type** The MIME type of the body of the request (used with POST and PUT requests).
- **Date** The date and time that the message was sent.
  Date: <day-name>, <day> <month> <year> <hour>:<minute>:<second> GMT
- **Host** The **domain name** of the server (for virtual hosting), and the TCP **port number** on which the server is listening. The port number may be omitted if the port is the standard port for the service requested. Mandatory since HTTP/1.1.
- **If-Modified-Since** Allows a **304 Not Modified** to be returned if content is unchanged.
- **Range** Request only part of an entity. Bytes are numbered from 0.
- **User-Agent** The user agent string of the user agent.

Client Headers

Examples

```
Accept: text/plain
Accept-Charset: utf-8
Accept-Encoding: gzip, deflate
Accept-Language: en-US
Connection: keep-alive
Cookie: username=johndoe; session_id=7f3fe5016a9cda0c4adbd44aeea9d511;
Content-Length: 348
Content-Type: application/x-www-form-urlencoded
Date: Tue, 15 Nov 1994 08:12:31 GMT
Host: www.google.com:80
If-Modified-Since: Sat, 29 Oct 2014 19:43:31 GMT
Range: bytes=500-999
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:12.0) Gecko/20100101 Firefox/21.0
```

Server Headers

- **Accept-Ranges** What partial content range types this server supports.
- **Allow** Valid actions for a specified resource. To be used for a **405 Method not allowed**.
- **Cache-Control** Tells all caching mechanisms from server to client whether they may cache this object. It is measured in seconds.
  (max-age=<seconds>, no-cache)
- **Content-Encoding** The type of encoding used on the data.
- **Content-Language** The language the content is in.
  (pt-PT, en-US, ...)
- **Content-Length** The length of the response body in octets (8-bit bytes)

Server Headers

- **Content-Location** An alternate location for the returned data.
- **Content-Range** Where in a full body message this partial message belongs.
- **Content-Type** The MIME type of this content.
- **Expires** Gives the date/time after which the response is considered stale.
- **Last-Modified** The last modified date for the requested object.
- **Location** Used in redirection, or when a new resource has been created.
- **Set-Cookie** A HTTP cookie.

> *The Multipurpose Internet Mail Extensions (MIME) type is a standardized way to indicate the nature and format of a document.*

Server Headers

Examples

```
Accept-Ranges: bytes
Allow: GET, HEAD
Cache-Control: max-age=36001
Content-Encoding: gzip
Content-Language: da
Content-Length: 348
Content-Location: /index.htm
Content-Range: bytes 21010-47021/47022
Content-Type: text/html; charset=utf-8
Expires: Thu, 01 Dec 1994 16:00:00 GMT
Last-Modified: Tue, 15 Nov 1994 12:45:26 GMT
Location: http://www.w3.org/pub/WWW/People.html
Set-Cookie: session_id=7f...; Domain=foo.com; Path=/; Expires=Wed, 13 ... GMT;
```

All header fields

REST

REST Cook Book

REST

REST (**Re**presentational **S**tate **T**ransfer) is a resource based architecture style for designing networked applications.

- **Resource Based** - the system is comprised of resources which are named using a URI.
- **Client-Server**: a pull-based interaction style.
- **Stateless**: each request from client to server must contain all the information necessary to understand the request, and cannot take advantage of any stored context on the server.
- **Cacheable**: to improve network efficiency responses must be capable of being labeled as cacheable or non-cacheable.
- **Uniform Interface**: all resources are accessed with a generic interface (e.g., HTTP GET, POST, PUT, DELETE).
- **Layered System** - intermediaries, such as proxy servers, cache servers, gateways, etc, can be inserted between clients and resources to support performance, security, etc.

First described by Roy T. Fielding in his PhD thesis

Resource Based

- Things (**resources**) instead of **actions**.
  employee.php instead of *getemployee.php/saveemployee.php*
- Individual resources are **identified** in requests using **URIs** as resource identifiers.
- When a client holds a representation of a resource, including any metadata attached, it has **enough information** to **modify** or **delete** the resource on the server.

Stateless

- Communication must be **stateless** in nature.
- Each request from client to server must contain **all of the necessary information** to understand the request, and cannot take advantage of any stored context on the server.
- Session **state** is therefore kept **entirely on the client**.

Cacheable

- Data within a response to a request should be implicitly or explicitly labeled as **cacheable** or **non-cacheable**.
- If a response is cacheable, then a client cache is **given the right to reuse** that response data for later, equivalent requests.

Uniform Interface

Use the HTTP standard to describe communication.

http://www.example.com/employee

- **GET** to list all employee.
- **POST** create a new employee.

http://www.example.com/employee/1234

- **GET** to get information about the employee 1234.
- **PUT** means that you want to create/update employee 1234.
- **DELETE** means that you want to delete employee 1234.

Content Negotiation

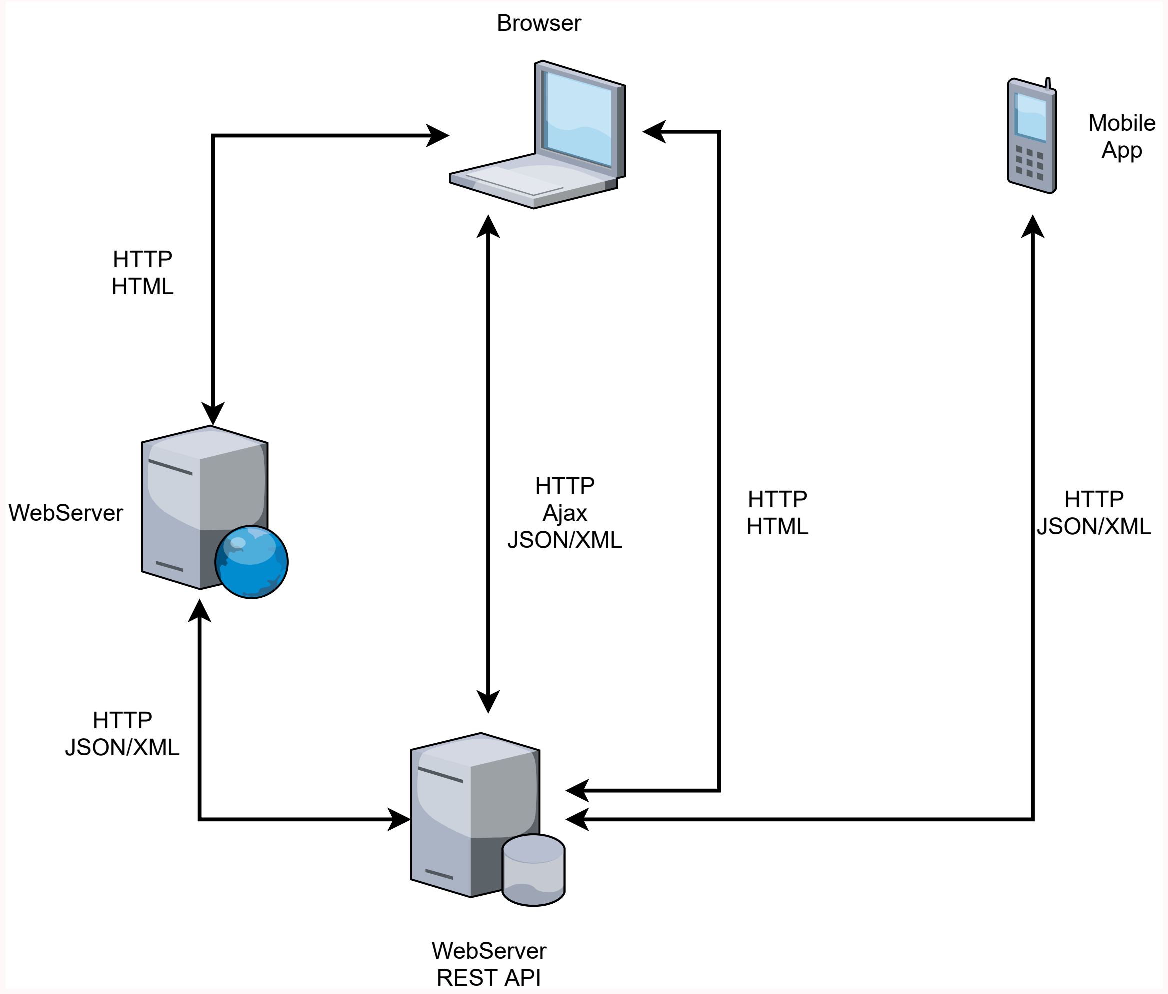
Use the **Accept** header to ask for a particular representation of the resource.

```
GET /employee/1234 HTTP/1.1
Host: www.example.com
Accept: application/json
```

```
GET /employee/1234 HTTP/1.1
Host: www.example.com
Accept: application/xml
```

```
GET /employee/1234 HTTP/1.1
Host: www.example.com
Accept: text/html
```

Scenarios


Browser
Mobile App
HTTP HTML
WebServer
HTTP Ajax JSON/XML
HTTP HTML
HTTP JSON/XML
HTTP JSON/XML
WebServer REST API

PHP and HTTP

Sending headers

To **add an header** to the response just use the **header** function:

```
header('Location: somewhere_else.php');
```

Just be careful to do it before outputting any data.

To send HTTP response codes:

```
header('HTTP/1.0 404 Nothing to see here');
```

Or:

```
http_response_code(418);
```

Finding HTTP method

To find which **HTTP method** was used to access the resource use the **$_SERVER** array:

```
if ($_SERVER['REQUEST_METHOD'] == 'PUT') {
  // update resource
}
```

Finding the Accept header

To find the **Accept** header sent by the client we can also use the **$_SERVER** array:

```
if ($_SERVER['HTTP_ACCEPT'] == 'application/json') {
  echo json_encode($employees);
}
```

Other headers can also be found in the $_SERVER array or using the apache_request_headers function.

```
$headers = apache_request_headers();

foreach ($headers as $header => $value) {
    echo "$header: $value <br />\n";
}
```