Web Foundations (URI and HTTP)

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Contents

Abstract (2)

The Web's architecture has very simple principles revolving around the ideas of placing a heavy emphasis on a consistent and global identification mechanism for resources, a standardized way of how resource representations can be retrieved, and a standardized way of how resource representations should be usable by using standardized media types. Based on the Internet, the Web's transport protocol transmits representations of resources identified by a *Uniform Resource Identifier (URI)* between Web servers and clients. The most important protocols for data transfer on the Web is the *Hypertext Transfer Protocol (HTTP)*.

Web Server Service (3)

- Web servers do more than just "deliver files"
- They receive a request for acting on a resource
  - this may be a simple file retrieval
  - additional information is available from the request's header fields [HTTP Header Fields (1)]
  - the request URI may contain additional *query information*
  - the request may transmit complex data (such as a form submission)
- Processing can mean anything, it is transparent for the client
  - the result of processing yields a *resource representation*
  - in many cases, a Web server is just part of an application
  - the *application server* is the application-specific logic

Uniform Resource Identifier (URI)

Resource Identification (5)

- The Web is centered around resources
  - HTTP has been designed to manipulate resources
  - HTTP provides methods for getting, putting, updating, and even deleting resources
- Resources are useful abstractions for interfaces
  - instead of an API, interaction is built around manipulating resources
  - APIs change and bind closely, documents can better withstand change and bind loosely
  - the whole Web is built around resources, not APIs

URI Schemes (6)

```
URI = scheme ":" hier-part [ "?" query ] [ "#" fragment ]
```

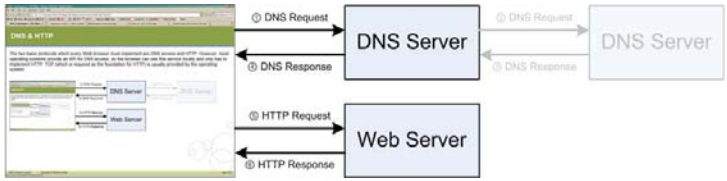
http://dret.net/lectures/web-spring09/foundations#uri-schemes

- URIs in their general case are very simple
  - the scheme identifies how resources are identified
  - the identification may be hierarchical or non-hierarchical
- Many URI schemes are hierarchical
  - it is then possible to use relative URIs such as in a href="../"
  - the slash character is not just a character, in URIs it has semantics
- Query components specify additional information
  - it is non-hierarchical information further identifying the resource
  - in most cases, it can be regarded as "input" to the resource

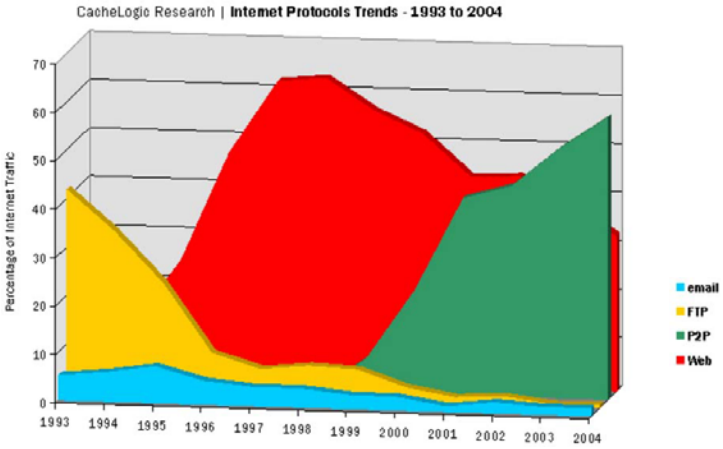
Hypertext Transfer Protocol (HTTP)

DNS & HTTP (8)

The two basic protocols which every Web browser must implement are DNS [Internet Architecture; Domain Name System (DNS) (1)] access and HTTP [Hypertext Transfer Protocol (HTTP) (1)]. However, most operating systems provide an API for DNS access, so the browser can use this service locally and only has to implement HTTP. TCP [Internet Architecture; Transmission Control Protocol (TCP) (1)] (which is required as the foundation for HTTP) is usually provided by the operating system.



The Web's Protocol (9)



provided by

CacheLogic Inc. [http://www.cachelogic.com/]

HTTP Basics

HTTP Messages (11)

- HTTP needs a reliable connection
  - the foundation for HTTP is the Transmission Control Protocol (TCP) [Internet Architecture; Transmission Control Protocol (TCP) (1)]
  - DNS resolution yields an IP address
  - open TCP connection to port 80 or port specified in URI (`http://rosetta.sims.berkeley.edu:8085/`)
- HTTP is a *text-based* protocol
  - the connection is used to transmit *text messages*
  - all HTTP messages are human-readable (not all *entities*, though)
  - basic HTTP operations can be carried out by hand

```
start-line
message-header *

message-body ?
```


HTTP Header Fields (12)

- Header fields contain information about the message
  - *general header:* `Date` as the message origination date
  - *request header:* `Accept-Language` indicates language preferences
  - *response header:* `Server` contains system information
  - *entity header:* `Content-Type` specifies the media type of the entity
- HTTP defines a number of header fields [http://www.cs.tut.fi/~jkorpela/http.html]
  - unknown fields must be ignored (extensibility)
  - unstandardized fields should use a "`X-`" prefix
- HTTP is about acting on these fields
  - HTTP defines what HTTP implementations must or should do

HTTP Requests (13)

- After opening a connection, the client sends a request
  - the method indicates the action to be performed on the resource
  - HTTP's most interesting methods are: GET, HEAD, POST
  - other interesting methods are: PUT, DELETE
- The URI identifies the resource to which the request should be applied
  - absolute URIs are required when contacting *proxies*
  - absolute paths are required when contacting a server directly
  - the URI may contain *query information*
- The `Host` header field must be included in every request

```
Method Request-URI HTTP/Major.Minor
[Header]*

[Entity]?
```


HTTP GET (14)

- Retrieval action based on the URI
  - maybe implemented by reading a file
  - maybe implemented by processing a file (PHP)
  - maybe implemented by invoking a process
- Semantics may change based on header fields
  - `If-*`: only reply with the entity if necessary
  - `Range`: only reply with the requested part of the entity
- Cacheability depends on header fields of the response

```
GET / HTTP/1.1
Host: ischool.berkeley.edu
```

HTTP Responses (15)

- The server's response to interpreting a request
  - the status code is given numerically and as text
  - 2** for variations of "ok"
  - 3** for redirections
  - 4** are different client side problems (404: not found)
  - 5** are different server side problems
- Header fields specify additional information
  - information about the server
  - information about the entity (media type, encoding, language)

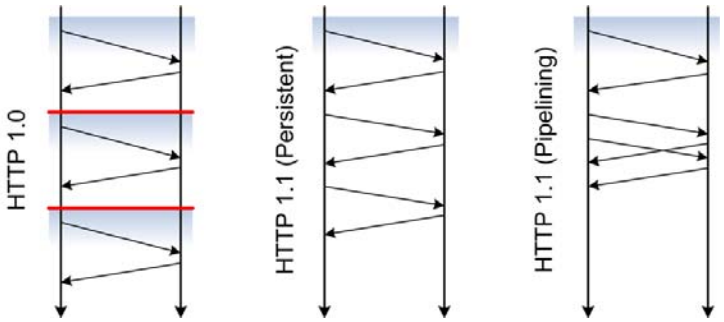
```
HTTP/Major.Minor Status-Code Text
[Header]*

[Entity]?
```


HTTP Performance (16)

- HTTP/1.0 allowed one transaction per connection
  - TCP connection setup and teardown are expensive
  - TCP's *slow start* slows down the initial phase of data transfer
  - typical Web pages use between 10-20 resources (HTML + images + CSS + scripts)
  - typically, these resources are stored on the same server
- HTTP/1.1 introduces *persistent connections*
  - the TCP connection stays open for some time (10 sec is a popular choice)
  - additional requests to the same server use the same TCP connection
- HTTP/1.1 introduces *pipelined connections*
  - instead of waiting for a response, requests can be queued
  - the server responds as fast as possible
  - the order may not be changed (there is no sequence number)

HTTP Connection Handling (17)

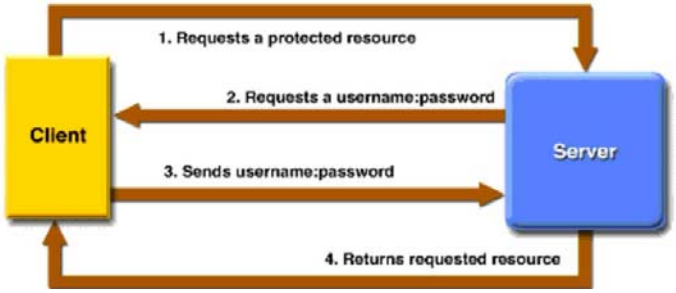


HTTP Authentication

HTTP Access Control (19)

- HTTP servers can deny access [http://en.wikipedia.org/wiki/List_of_HTTP_status_codes#4xx_Client_Error] because of access control
  - 401 `Unauthorized` means the resource is access controlled
  - 403 `Forbidden` means the resource is inaccessible
  - 405 `Method Not Allowed` signals a request using the wrong request method [HTTP Requests (1)]
- Two different approaches to unauthorized access are possible
  - repeat the HTTP request with the proper authentication credentials
  - redirect to a Login Page [Login Page (1)] and establish an authenticated Session [State Management (Cookies); Session (1)]

HTTP Authentication (20)



Basic HTTP Authentication (21)

- Authentication is based on *authentication realms*
  - a set of resources for which the authentication is required
  - an opaque name which is used to signal which login is required
  - username/password often is specific for a given realm
- Users supply username and password through the client
  - sent as Base64 [http://en.wikipedia.org/wiki/Base64] encoded "`username:password`" string
  - username and password are *not* transmitted securely [http://www.google.com/search?hl=en&q=base64+decoder]
  - basic authentication should *always* use HTTPS [Security & Privacy; HTTP over SSL (HTTPS) (1)]
- Authorization is handled on the server side

```
HTTP/1.0 401 Unauthorized
        WWW-Authenticate: Basic realm="SokEvo"
```

[http://en.wikipedia.org/wiki/Basic_access_authentication]

```
GET /private/index.html HTTP/1.0
        Authorization: Basic QWxhZGRpbjpvcGVuIHNlc2FtZQ==
```

[http://en.wikipedia.org/wiki/Basic_access_authentication]

Repeated Access (22)

- Clients typically access more than one protected resource
  - a perfectly stateless client would always request authentication from the user
  - using the *realm* clients can identify repeated accesses
- Web interactions by default are perfectly stateless
  - each request is completely independent from other requests
  - stateless interactions make the Web loosely coupled and scalable
  - concepts like the *realm* or State Management (Cookies) [State Management (Cookies)] introduce "state"
- Clients remember the authentication and replay it automatically
  - browsers provide little control over this feature
  - "logging out" of HTTP authenticated sessions is hard

Login Page (23)

- Basic HTTP Authentication [Basic HTTP Authentication (1)] works with browser controls (including the window)
  - no possibility to "log out" without using browser-specific controls
  - client side security depends on browser security measures
- Using HTML Forms [HTML Forms] gives more freedom in session management
  - Authentication [Security & Privacy; Authentication (1)] and Authorization [Security & Privacy; Authorization (1)] are completely application-based
  - if there were "secure personal browsers" this would not work very well

Conclusions (24)

- HTTP is much more than file transfer
  - it is a protocol for the concept of *resource manipulation*
  - it is a distinct step away from the *API approach* to building distributed systems
- HTTP servers can be configured to deliver good or bad service
  - this is a question of how well they are configured on the HTTP level
  - it is also a question of how good the Web design is
  - both issues together are required to set up a good Web server