Lecture

The Web Server

Outline

- Available Web Servers
- Server Features
  - Document Root
  - Authentication
  - Proxy Servers
  - Caching
  - CGI Scripting
  - Application Program Interface
- Configuring a Server
- Analyzing a Server's Performance
- Server Log Files

What Does the WWW Server Do?

- Enables browser requests
- Mainly provides
  - Support for retrieving hypertext documents
  - Manages access to the Web site
  - Provides several mechanisms for executing server-side scripts
    - Common Gateway Interface (CGI)
    - Application Program Interface (API)
    - Direct Module Interfaces (SAPI)
  - provides log files and usage statistics

What to Look for in a Web Server

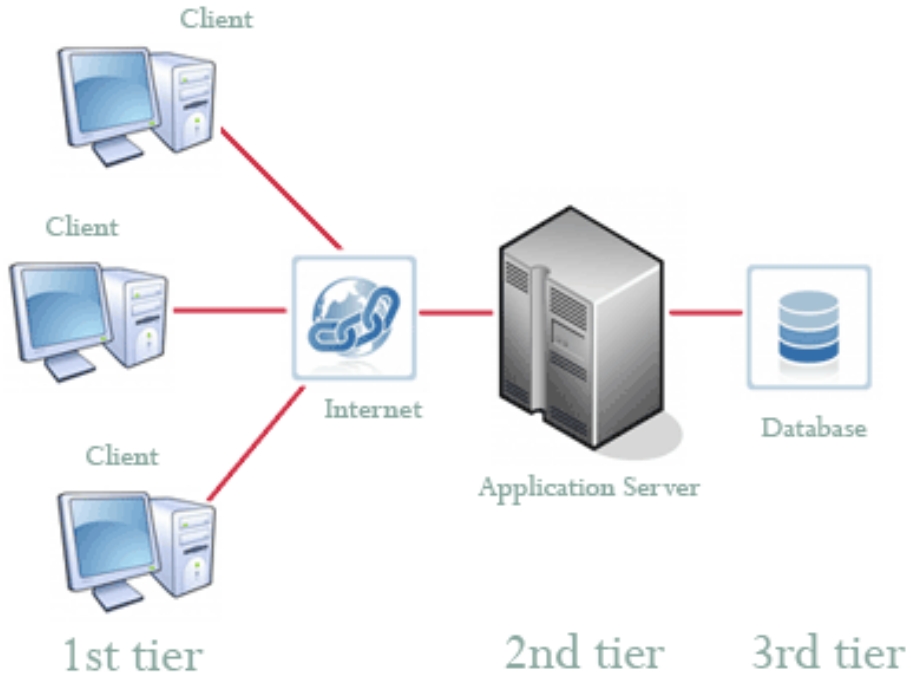
- Main features
  - platform they run on;
  - complete support for HTTP 1.1 / HTTP 2
  - Multithreading, load balancing
- Security features
  - ability to provide IP address restriction
  - ability to provide domain name restriction
  - Support for secure transactions: SSL
  - Ability to act as a proxy server

How Servers Handle Multiple Requests

- For each request, a complete copy of the server is made and executed
  - Initially a parent process waits for requests; for each new request a child process is spawned
- Or a single server program handles many requests simultaneously (multithreaded)
  - the server must keep track of all requests and switch between them as needed
  - writing multithreaded programs is easier in a language that supports multiple threads, e.g., Java, C#, Swift, Kotlin, …

Application Web Server

- An **application server** is software that typically interfaces one or more databases to convey processed data to and from a user interface such as a web browser
- It performs **business logic**



- An application server acts as a set of components accessible through an API
- For web applications, these components are usually performed in the same machine where the web server is running, and their main job is to support the construction of dynamic pages.
- For example, Apache Tomcat is a popular, light-weight application container, but not a full application server as it doesn't provide the services specified in the J2EE specification.

The web modules include servlets. Business logic resides in Enterprise JavaBeans (EJB).

Some Available Web & Application Servers

Publisher	Product	Platform	URL
Web Servers			
apache	**apache** (2.4)	Win32/UNIX	http://httpd.apache.org/
Microsoft	**IIS** 7-10.0	Win32	http://www.iis.net
NGINX	**nginx** (open source)	Linux, BSD, Win32	http://nginx.org
NGINX (F5)	**NGINX Plus**	Ubuntu, AWS GCP, Azure	http://www.nginx.com
Application Servers			
Oracle	**GlassFish** 4.1	Solaris/Win32/Linux	https://javaee.github.io/glassfish/ (now Open-Source Java EE Reference Implementation)
IBM	**WebSphere**	Win32/UNIX/Linux	https://www.ibm.com/cloud/websphere-application-server https://www.ibm.com/us-en/marketplace/java-ee-runtime
Oracle	**WebLogic** Server	Win32/UNIX/Linux	https://www.oracle.com/java/weblogic/

For a comparison of web servers see http://www.serverwatch.com/, click on Server Comparison Tool

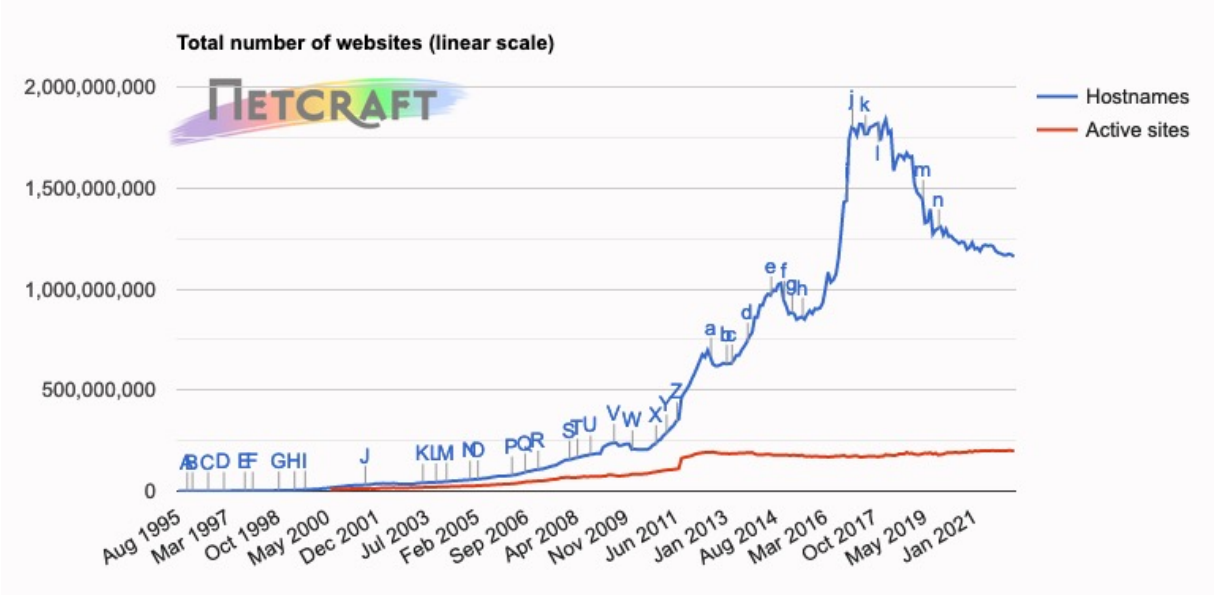
Web Server Usage

- Netcraft has identified more than 1,160,964,134 sites (4/2022)
  - Apache no longer dominates Internet servers
  - NGINX on top at 31%, Apache at #2 at 23%, OpenResty at 8%
- Statistics on intranets are difficult to determine
  - http://news.netcraft.com/archives/category/web-server-survey/

Developer	March 2022	Percent	April 2022	Percent	Change
nginx	361,976,272	30.95%	361,438,143	31.13%	0.18
Apache	272,919,651	23.33%	268,005,916	23.08%	-0.25
OpenResty	91,479,385	7.82%	92,950,864	8.01%	0.19
Cloudflare	63,739,599	5.45%	63,701,232	5.49%	0.04

Web Server Survey Takeaways

- From Netcraft **April 2022** and previous surveys we can make these observations
  - **Nginx and Apache** have each achieved their widespread popularity in the server market due to their general availability, but many large companies in the web industry choose to roll out their own solutions. **Microsoft disappeared.**
  - **Google's custom server software ("GSE")** operates on over 37 million hostnames and 2.0 million domains. Google open-sourced the **Google Servlet Engine**, at the end of 2008, but the software has not received any official public updates in 11 years.
  - **Taobao**, China's largest online marketplace and part of Alibaba Group, developed their own **fork of nginx**. The fork, known as **Tengine**, was released back to the community as open source, leading to wider adoption. Tengine now runs on 56.8 million sites, making it the fourth most popular web server by this metric, despite it having only 1.2 million domains.
  - **OpenResty**, based on nginx 1.21.4, a scalable Web Platform by Extending NGINX with Lua.



Web Server Features

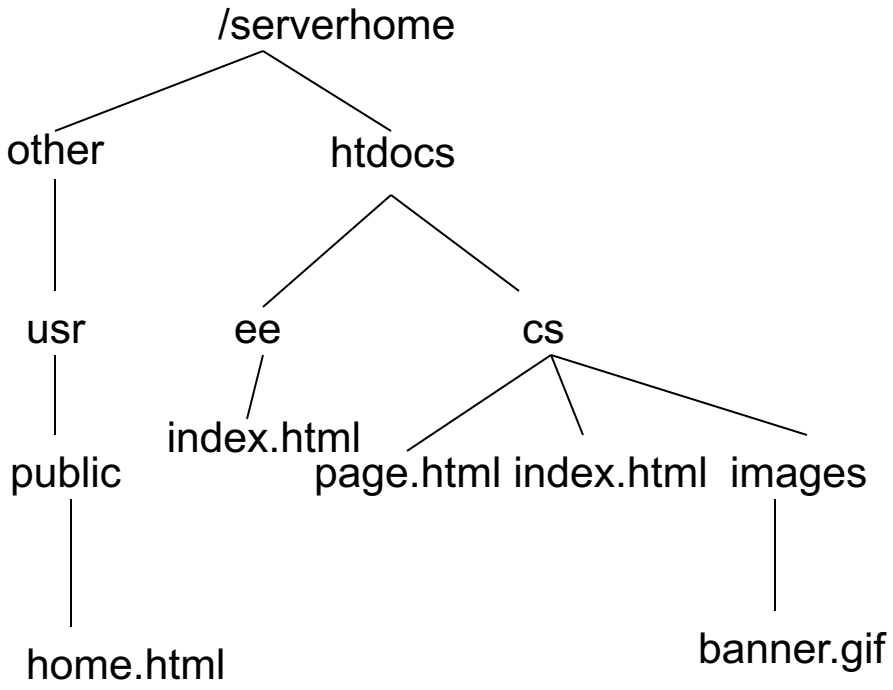
- Document Root
- Authentication
- Proxy Servers
- Caching
- CGI Scripting
- Application Program Interface

Web Server Features - Document Root

- The Web server has access to a tree of files that it can deliver
  - the files are created by content providers
  - files may contain text, images, sound, video, other programs, etc.
- the document tree is organized by the web site administrator
- The root of the document tree is given to the web server when it starts

Managing the Document Tree

`http://domain/cs is mapped to /serverhome/htdocs/cs/index.html`



The document root is /serverhome/htdocs

index.html

```
<A HREF=page.html>Click here</a>

<A HREF=images/banner.gif>Display Image</a>

<A HREF=../ee/index.html>Click Here</a>

<A HREF=/serverhome/other/usr/public/home.html>
```

The last link is an error

Web Server Features (1)
Virtually Hosted Document Roots

- Hosting multiple web sites by the same web server
- It uses the host name or IP address to distinguish the document roots, e.g.

```
GET /index.html HTTP/1.0
Host: www.hardware.com
```

might return documents from /htdocs/hardware, while

```
GET /index.html HTTP/1.0
Host: www.antiques.com
```

might return documents from /htdocs/antiques

- This might be configured in, say apache by writing

```
<VirtualHost www.hardware.com>
ServerName www.hardware.com
DocumentRoot /htdocs/hardware
</VirtualHost>
```

```
<VirtualHost www.antiques.com>
  ServerName www.antiques.com
   DocumentRoot /htdocs/antiques
</VirtualHost>
```

Web Server Features (2)
Basic User Authentication

- Basic authentication is supported by all HTTP servers
  - The server administrator creates secure directories accessible via password files maintained by the server
  - Client requests a resource from a secure directory; e.g., **GET /secure/test.html HTTP/1.0**
  - Server responds with authentication request to the client; e.g., **HTTP/1.0 401 Unauthorized**
  - Browser requests username and password, scrambles them, and retries the request

GET /secure/test.html HTTP/1.0

Authorization: Basic 0<V%L:EB.G-E8W))$J

  - Server decodes name and password and checks it against its password file

Web Server Features (3)
Creating Server-Side Applications

- Web Servers offer several mechanisms
  - Application Programming Interface (API)
  - Common Gateway Interface (CGI)
  - J2EE / .NET interfaces
  - Chrome V8 JavaScript Engine (Google)
    - Node.js
  - Direct Module Interfaces (PHP)
    - Apache offers a PHP module
- Microsoft IIS server-side supports:
  - CGI applications
  - API applications compiled as DLL
  - Active Server Pages (written in VBScript)
  - ASP.NET applications (written in C++, VB.NET, C#, or HTML/CSS/JavaScript)

Configuring a Server

- No matter which operating system or server, you will need to define the
  1. location of the server (server root)
  2. location of documents to deliver (document root)
  3. location of CGI scripts or server-side components to execute

- You may also wish to define
  - Access restrictions
  - Fancy indexing
  - Sys admin e-mail
  - Other features

Port Numbers

- A typical computer will have thousands of ports
- System ports: 0 - 1023, are reserved for certain functions, typically assigned by IANA (Internet Assigned Number Authority), http://www.iana.org/
- Well-known TCP / UDP ports:

http://en.wikipedia.org/wiki/List_of_TCP_and_UDP_port_numbers#Well-known_ports

  - programs running on these ports must be started under root

- TCP/UDP ports used by Apple products:

http://support.apple.com/kb/HT6175

- Dynamic ports 49152 - 65535, ports that are freely available (check OS X possible conflicts)

Some Well-Known Port Numbers

Port	Protocol	Purpose
20	ftp	ftp data connection
21	ftp	ftp control connection
23	telnet	telnet session
25	SMTP	simple mail transfer protocol
53	DNS	domain name service
70	gopher	gopher protocol
79	finger	finger protocol
80	http	hypertext transfer protocol
88	kerberos	kerberos authentication protocol
110	pop3	post office protocol
113	ident	remote identity service
119	nntp	network news transfer protocol
143	IMAP	email access
161	snmp	simple network management proto
162	snmp	snmp traps
194	irc	internet relay chat
280	http mgmt	http management
389	ldap	lightweight directory access pr

Standard Port Numbers (cont'd)

Port	Protocol	Purpose
427	srvloc	server location protocol
443	https	secure http (SSL)
465	smtps	secure email (SSL)
535	iiop	internet inter-orb protocol
551	cybercash	secure money transaction
563	snews	secure news (SSL)
614	ssl shell	ssl shell
636	ldaps	secure ldap (SSL)
989	ftps	secure ftp data connection
990	ftps	secure ftp control connection
992	telnets	secure telnet (SSL)
993	imaps	secure imap (SSL)
994	ircs	secure irc (SSL)
995	pop3s	secure pop3 (ssl)
1080	socks	socks protocol, circuit level

The Apache Web Server

Apache Web Server

- Apache is based on code and ideas developed at NCSA in httpd version 1.3 (early 1995)
- The name "Apache" comes from the fact that it is A set of **PAtCHEs** to **NCSA's httpd**
- Apache is free and is downloadable from

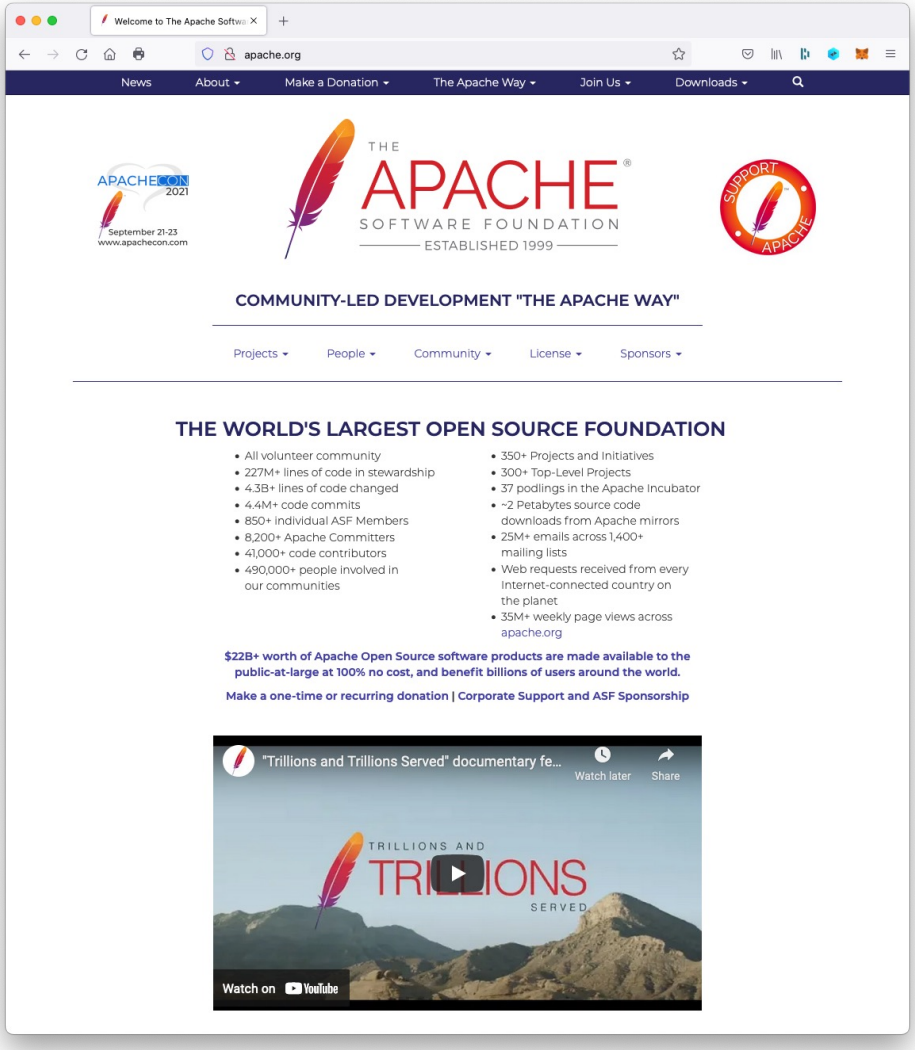
  http://httpd.apache.org
- Apache included in every version of macOS:

  https://jasonmccreary.me/articles/install-apache-php-mysql-mac-os-x-mojave/

  https://discussions.apple.com/docs/DOC-250004361
- Using Apache in Windows 10/11

  https://www.thewindowsclub.com/install-apache-on-windows-10
- **Apache HTTP Server version 2.4.53 is current.** Version **2.4.43** or newer is required in order to operate a **TLS 1.3** web server with **OpenSSL 1.1.1.**

Apache Home Page



Available for many platforms: Windows, Solaris, Linux, macOS, etc.

Apache httpd server

- The Apache httpd server
  - is a powerful, flexible, HTTP 1.1 & HTTP/2 compliant web server
  - implements **HTTP/2**, but not HTTP/3
  - is highly configurable and extensible with third-party modules
  - can be customized by writing 'modules' using the Apache module API
  - provides full source code and comes with an unrestrictive license
  - runs on Windows, Netware, Mac OS X, Linux, and most versions of Unix, as well as several other operating systems
  - Latest release 2.4.46

Configuring Apache

- server functionality is available through modules which are either built-into or loaded into the server
- server instructions
  - apache reads its run-time configuration instructions from text files
- no GUI available (visual start/stop available on Windows)
- 182 configuration directives in the basic package
- On UNIX, Apache starts several processes to implement the server and handle requests
- On Windows there are only two processes, a parent and a child that handles all requests. Within the child all requests are handled by separate “threads”
- See http://httpd.apache.org/docs/2.4/configuring.html

How does Apache Work?

- Apache runs under a multitasking operating system, e.g., UNIX, macOS, Windows
- the binary is called httpd
- Key directories include:
  - conf — contains configuration files
  - htdocs — contains html files
  - logs — contains logging data
  - cgi-bin — contains executable scripts
  - icons — set of *.gif files used e.g. in directory listings
  - src — contains actual source code if you download the source distribution
- Apache idles, listening to an IP address and port

Configuring Apache - conf Directory

- In the conf directory there is a file provided with model configuration parameters
  - httpd.conf
- This file must be edited
- Partial contents of the mime.types file

```
text/html                               html htm
text/plain                              txt
text/richtext                           rtx
video/mpeg                              mpeg mpg mpe
video/quicktime                         qt mov
video/x-msvideo                         avi
x-world/x-vrml                          wrl vrml
```

Apache Settings - httpd.conf

- Directives are keywords followed by their value,e.g.

```
Listen 9637
ServerAdmin horowitz@usc.edu
ServerRoot /home/scf-03/csci571/WebServer/apache_2.2
ErrorLog logs/error_log
DocumentRoot "/home/scf-17/csci571c/apache2/htdocs“
ScriptAlias /cgi-bin/ "/home/scf-17/csci571c/apache2/cgi-bin/"
```

- the above are ones that *must* be set

Some Apache Settings - httpd.conf

```
# Timeout: The number of seconds before receives
   and sends time out
Timeout 300
# KeepAlive: Whether or not to allow persistent
   connections (more than one request per
   connection). Set to "Off" to deactivate.
KeepAlive On
# MaxKeepAliveRequests: The maximum number of
   requests to allow during a persistent connection.
   Set to 0 to allow an unlimited amount. They
   recomend you leave this number high, for maximum
   performance.
MaxKeepAliveRequests 100
# KeepAliveTimeout: Number of seconds to wait for
   the next request
KeepAliveTimeout 15
```

Apache Settings – http-mpm.conf

```
# Server-pool size regulation. Apache dynamically
  adapts to the load it sees --- it tries to
  maintain enough server processes to handle the
  current load, plus a few spare servers to
  handle transient load spikes. It does this by
  periodically checking how many servers are
  waiting for a request.  If there are fewer than
  MinSpareServers, it creates a new spare.  If
  there are more than MaxSpareServers, some of
  the spares die off.

  MinSpareServers 2
  MaxSpareServers 2
  StartServers    2 #number of servers to start
  MaxClients      2
```

Apache Settings - httpd.conf

```
# DocumentRoot: The directory out of which you will
serve your documents.
DocumentRoot  /home/cscixxx/WebServer/apache/htdocs
# UserDir: The name of the directory which is
appended onto a user's home directory if a ~user
request is received.
UserDir public_html
# DirectoryIndex: Name of the file or files to use
as a pre-written HTML
DirectoryIndex index.html
# FancyIndexing is whether you want fancy directory
indexing or standard
IndexOptions FancyIndexing
```

Apache Settings - Scripting

```
# ScriptAlias: This controls which directories
  contain server scripts. Format: ScriptAlias
  fakename realname
ScriptAlias /cgi-bin/
  /home/cscixxx/WebServer/apache/cgi-bin/
# If you want to use server side includes, or CGI
  outside ScriptAliased directories, uncomment the
  following lines.
# AddType allows you to tweak mime.types without
  actually editing it, or to make certain files to be
  certain types. Format: AddType type/subtype ext1
# To use CGI scripts:
#AddHandler cgi-script .cgi
# To use server-parsed HTML files
#AddType text/html .shtml
#AddHandler server-parsed .shtml
```

Authentication in Apache

- There are two methods for controlling access to directories
  1. the file access.conf in the conf/ directory can be used
     - placing access directives in a <Directory> block is the preferred method
  2. per-directory access rules can be set by a file placed in a specific directory
     - the name of the file is set by the directive AccessFileName
     - .htaccess is the default name
     - however, using .htaccess slows down the server;
     - NOTE: initially .htaccess is turned OFF
- When the server attempts to retrieve a document, it looks for an access control file in the directory or the parent directory.
- The file it looks for is set by the directive AccessFileName

Some Sectioning Directives

- The server configuration files use sectioning directives to define special access rights within a section or sub-directory
- Example: <Directory> specifies directory to which directives apply
- Options controls which server features are available
  - None
  - All
  - FollowSymLinks follow symbolic links
  - ExecCGI execution of CGI scripts allowed
  - Includes server-side includes are enabled
  - Indexes will automatically return a list of files in the directory

Limit Sectioning Directive

- <Limit> controls which clients can access a directory; directives within LIMIT include:
  - order in which deny and allow are evaluated
  - deny from host1, host2, ...
  - allow from host1, host2, ...
  - require named-users or group-users or AuthUserFile
  - referer allows access only from this directory
  - satisfy all or any

Using LIMIT

- Host Filtering is used to limit document trees to certain machines
- Example 1: to limit access to the cscixxx public_html documents to USC only

```
<Directory /usr/~cscixxx/public_html/>
<Limit GET>
order deny,allow
deny from all
allow from .usc.edu
</Limit>
</Directory>
```

- If someone tries to access documents in this directory from outside of usc they get a 403 Forbidden message

Using LIMIT (cont'd)

- Example 2: to limit documents so USC people CANNOT access them

```
<Directory /usr/~cscixxx/public_html/>
<Limit GET>
order allow,deny
allow from all
deny from from .usc.edu
</Limit>
</Directory>
```

Using LIMIT (cont'd)

- Example 3: a directive used to limit access to only USC and ISI domains

```
<limit GET>
order deny, allow
deny from all
allow from 128.125
allow from 128.9
</Limit>
```

Using LIMIT (cont'd)

- Example 4: Suppose you want to restrict files in a directory called secure/ to the user named student1 and password XXXYYY
- Step 1. create a file called .htaccess in directory secure/ that contains these 7 lines:

```
AuthUserFile /otherdir/.htpasswd    must be a full
   UNIX pathname
AuthGroupFile /dev/null     there is no group file
AuthName ByPassword         any name is OK here
AuthType Basic              Basic or Digest is OK
<Limit GET>
require user student1
</Limit>
```

Using LIMIT (cont'd)

- Step 2. Next create the password file /otherdir/.htpasswd using the htpasswd program distributed with apache.
- Type

```
htpasswd -c /otherdir/.htpasswd student1
```

and enter the password twice.

- You are done.
- Step 3. To add other names and passwords run htpasswd without the -c option.

Using LIMIT (cont'd)

- To generalize this example to include several students,
- Step 4. create a group file called /otherdir/.htgroup which looks like:

```
my-users: student1 student2 student3 student4
Alter the .htaccess file to look like
AuthUserFile /otherdir/.htpasswd
AuthGroupFile /otherdir/.htgroup    Now it points to the group file
AuthName ByPassword
AuthType Basic
<Limit GET>
require group my-users
</Limit>
```

Contents of .htaccess

- The .htaccess file contains pointers to the users file, the group file, and defines the name and type of authorization

```
nunki.usc.edu(10): more .htaccess
AuthUserFile  /home-scf-03/csci xxx/pwd/.htpasswd
AuthGroupFile /home-scf-03/csci xxx/pwd/.htgroup
AuthName OnlineCourse
AuthType Basic
```

Contents of .htpasswd

- This file contains a set of names and passwords

```
nunki.usc.edu(13): more .htpasswd
admin:kjpokufbLdrXU
chungw:2Ds5QooEqT1HM
csci351:ykGZC.bMvV8SY
csci351notes:7814Vi6oJtq9c
csci565:t.OSxBunNhigg
csci571:NUKyNCCLvgLH.

nunki.usc.edu(13): more .htgroup
admin: admin csci571 csci565

student: admin csci571 csci565
```

Adding a Smart Error Page

- When someone requests a page or directory that does not exist it is better to return an error page than a 404 Not Found message
- For an example try: http://www.usc.edu/x.html
- Look at /conf/httpd.conf
- find the section that describes the properties of your domain, e.g.

```
<VirtualHost www.test.com>
ServerAdmin webmaster@test.com
DocumentRoot /web/test
ServerName www.test.com
ErrorLog /log/test/error_log
transferLog /log/test/access_log
AgentLog /log/test/agent_log
RefererLog /log/test/refer_log
</VirtualHost>
```

Adding a Smart Error Page

- Insert the line

```
ErrorDocument 404 /error-page.html
```

- place the error page at

```
DocumentRoot/ErrorDocument or in this case
/web/test/error-page.html
```

Sample contents of error-page.html:

```
<HTML><HEAD><TITLE>Test Error Page</TITLE></HEAD>
<BODY>Error. You have requested a page that
   cannot be found. You may wish to return to the
   <A HREF=http://www.test.com/>home page by
   clicking here.</A>
</BODY></HTML>
```

Apache Approaches to Server-Side Processing

- **CGI -** the standard way to invoke an external process, e.g., perl & perl.exe
- **Fast CGI, Java Servlets -** Apache passes a request to another running server which executes the request and returns the result
  - see mod_fastcgi at http://www.fastcgi.com
- **Interpreters** embedded in the server itself. There are roughly two categories
  - Modules that answer or modify requests directly, e.g., mod_perl (Perl)
  - Modules aimed to process commands embedded in HTML pages before serving it to the client. e.g., **mod_php** (PHP)

Virtual Hosting

- *Virtual hosting* is a way of setting up your server so that it can appear to be multiple Web sites at once, depending upon how it's accessed by clients
- ISPs do this a lot
- The Apache Web server software allows you to create as many such virtual site identities as your system's limits will allow;
- Example of a virtual host definition.

```
<VirtualHost 10.0.0.1>
  ServerName WWW.Mydomain.Com
  ServerAdmin Webmaster@Mydomain.Com
  DocumentRoot /home/httpd/mydomain
  CustomLog logs/mydomain_log CLF
</VirtualHost>
```

Virtual Hosting (cont'd)

- there are two ways to do virtual hosting
  - *address-based* virtual hosting uses IP addresses
  - *name-based* hosting allow a single IP address to have multiple identities, e.g.

```
NameVirtualHost 10.0.0.1                this example assigns
<VirtualHost 10.0.0.1>                  two domain names to the
    ServerName WWW.Mydomain.Com         same IP address
    ServerAlias WWW.X.Com WWW.Y.Org
    ServerAdmin Webmaster@Mydomain.Com
    DocumentRoot /home/httpd/mydomain
    CustomLog logs/mydomain_log_CLF
</VirtualHost>
<VirtualHost 10.0.0.1>
    ServerName WWW.Other.Org
    ServerAlias WWW.Z.Net WWW.A.Org
    ServerAdmin Webmaster@Other.Org
    DocumentRoot /home/httpd/other
    CustomLog logs/other_log_CLF
</VirtualHost>
```

Content Negotiation

- The client provides a set of preferences concerning the preferred attributes of a document, and the server tries to come up with the best match from the versions available
  - If there's only one version of a document, then that's what the server is going to send
- The set of all versions of a document that are available to the server is called the resource's list of *variants*.
- The ways in which they differ, such as by language or encoding, are called its *dimensions*.
- The Apache server can negotiate along the
  - content-type,
  - encoding, and
  - language dimensions

Content Negotiation

- The primary use of negotiation on the Web today is to select translations of text.
  - Typically, a work is prepared in a default language such as English, and the result put in a file named text.html or some such. Then translated versions are prepared, and each is put into an appropriate-named file: text.html.da for Danish, text.html.fr for French, text.html.en-gb for English (Great Britain dialect), and so on.
- You can either prepare a list of variants yourself, or you can allow Apache's mod_negotiation module to calculate the list itself by scanning the directory.
- The latter method is more common, since it is easier and automatically pick up new variants as soon as they are available, but it *does* impose a slight performance penalty due to the directory scan.

Apache as a Proxy Server

- proxy servers are frequently used in fire walled environments to provide a single point of contact between the users inside and the Web outside the firewall.
  - The users ask for a page, the browser sends the request to the proxy server, the proxy server sends the request to the origin server, and the data flows back the same way.
- A second function commonly associated with proxy servers is caching.
- To use the proxy functions in your Apache Web server, the mod_proxy module must be activated, either by being statically linked in (less common than formerly), or turned on at run-time with directives, e.g.

  AddModule mod_proxy.c

Apache as a Proxy Server, Proxy Directives

- **ProxyRequests** – This is the 'master directive,' which enables and disables proxy operation overall. It takes a single keyword argument, which must be either On or Off
- **ProxyRemote** – tells the Apache server that certain requests are to be forwarded to yet another system rather than being handled locally, allowing for cascading of proxies
- **ProxyBlock** – allows you to selectively block the fetching of certain resources through the proxy. It takes a list of space-separated case-insensitive phrases or URI substrings which should be blocked.
  - "ProxyBlock foo" would block all requests in which "foo" appeared, in any combination of upper- and lower-case, including "http://foo.com/bar/" and "http://bar.org/zardofoo.html". You can block all proxy requests with "ProxyBlock *"

Controlling the Apache Cache

- **CacheRoot** – Defines the directory that's the top of the cache hierarchy
  - Apache uses its own naming conventions for the stuff it stores.
- **CacheSize** – Specifies the largest number of kilobytes of space you want to allocate to the proxy cache.
- **CacheDirLevels** – Controls how deep the cache directory tree is allowed to grow
- **CacheDirLength** – Used to define the number of characters used in naming each level of cache subdirectory
- **NoCache** – Identifies proxy-accessed documents that shouldn't be cached. The format is the same as for the ProxyBlock directive.

Proxy Host Example

- Usually, a proxy server is set up as a completely separate virtual host from the rest of the server's operation (which is likely to be handling normal requests).
- You can do this with a <VirtualHost> stanza. The <IfModule> container will only be evaluated if the proxy module is part of the running server

```
<IfModule mod_proxy.c>
   Listen 10.0.0.1:8080
   <VirtualHost 10.0.0.1:8080>
   ProxyRequests On
   DocumentRoot /home/httpd/htdocs/proxy
  </VirtualHost>
</IfModule>
```

Analyzing Web Server Log Files

- A sample entry from a log file

```
Host                date/time                    method file HTTP ver  status  bytes
marmot.usc.edu - - [17/Feb/2009:23:21:09 -0800] "GET   /    HTTP/1.0" 200     1316
```

- There are different log file formats
  - W3C Extended Log File Format
    - Date/time, server port, URL and query, protocol version, user agent and cookie, referrer, etc.
  - Microsoft IIS log file format
    - IP, user, date/time, server name, server IP, bytes received, bytes sent, protocol, method, etc.
  - Other file formats
    - Cerfnet, apache extended, CERN common, Lotus Domino, Netscape Common, etc.

Definition of Terms

- *A hit*: a request for a page, image, cgi script, etc.
- *A page view*: a request for an html page
- Unique host vs. unique visitor: aol.com is a unique host, so this statistic may not be useful; cookies are best way to track unique visitors
- *An impression*: is a view of an advertisement
- A *click-through* is when an advertisement is actually clicked on

Common Log Format

- Each visit to your site produces a record of the request in log file
- log files in Apache are typically stored in the logs directory
- Some fields include:
  - Host client hostname or IP address
  - ident remote identity, often a dash
  - usr authenticated user name
  - time date/time request is received
  - req HTTP request
  - s1 server's HTTP response status code
  - c1 Content-length
- Example entries from access log

```
marmot.usc.edu - - [17/Feb/2008:23:21:09 -0800]
  "GET / HTTP/1.0" 200 1316
128.125.229.195 - - [23/Feb/2008:10:32:09 -0800]
  "GET / HTTP/1.1" 200 1316
```

Other Entries in access Log

- ciscoserv-229-180.usc.edu - - [17/Feb/2008:23:16:51 -0800] "GET /cgi-bin/secure/admin/student.pl HTTP/1.1" 401 362
- 128.125.229.195 - admin [23/Feb/2008:10:56:21 -0800] "POST /cgi-bin/secure/admin/student.pl HTTP/1.1" 200 807
- 209.85.18.67 - - [27/Feb/2008:01:12:38 -0800] "GET /ftp/templates.zip HTTP/1.1” 200 30780
- nunki.usc.edu - - [28/Feb/2008:00:48:22 -0800] "GET / HTTP/1.0" 200 955
- nunki.usc.edu - - [28/Feb/2008:00:48:26 -0800] "GET /cgi-bin/Count.cgi?df=count.dat HTTP/1.0" 200 207

access_log Contents

- Here are some lines from a single user session

```
lvl-sun702.usc.edu - - [09/Feb/2008:19:15:36
-0800] "GET /newsdigest/index.html HTTP/1.0"
200 3630
lvl-sun702.usc.edu - - [09/Feb/2008:19:15:37
-0800] "GET / HTTP/1.0" 200 955
lvl-sun702.usc.edu - - [09/Feb/2008:19:15:39
-0800] "GET /newsdigest/index.html HTTP/1.0"
200 3630
```

- A *user session* includes all hits and requests made by a user terminated by "n" minutes of inactivity

Sample error_log Contents

- Here are some lines from the error_log file
  - **The file was not found**

    [Mon Jan 29 11:47:36 2008] httpd: access to /home/scf-13/csci665/www/pleader/horohome.html failed for internet-gw.watson.ibm.com, reason: No file matching URL: /pleader/horohome.html from -
  - **authorization entered is incorrect**

    [Thu Sep 24 10:17:41 2008] [error] [client 128.125.50.47] user csci571 not found: /cgi-bin/secure/test-cgi
  - **Perl script fails**

    [Sun Sep 30 01:15:01 2008] [error] [client 71.140.65.229] Premature end of script headers: /auto/home-scf-22/csci571/WebServer/Apache_1.3.36/cgi-bin/cgipm/test6.pl

More Examples of Error Log File Entries

- Undefined subroutine &main::Export_to_Excel called at /home/scf-03/csci571/WebServer/apache_1.2.5/cgi-bin/admin/student_db.pl line 75.
- [Tue Dec 29 02:07:47 2008] access to /auto/home-scf-03/csci571/WebServer/apache_1.2.5/htdocs/robots.txt failed for 193.189.227.21, reason: File does not exist
- [Tue Dec 29 20:11:22 2008] send directory lost connection to client 128.125.223.237

Performance and Security Considerations

- Don't log more than needed
- Look for 401 (unauthorized) and 403 forbidden status codes
- Look at the response times
  - Which parts of the web site have the longest response times?
  - Where are the bottlenecks
- Look for failed page hits (404, 5xx)
- Look for cached hits
- Look for browsers and platforms of clients

Tools to Analyze Log Files

- Some commercially available tools for IIS
  - **WebTrends**
    http://www.webtrends.com
  - Dynatrace
    https://www.dynatrace.com/

Google Analytics

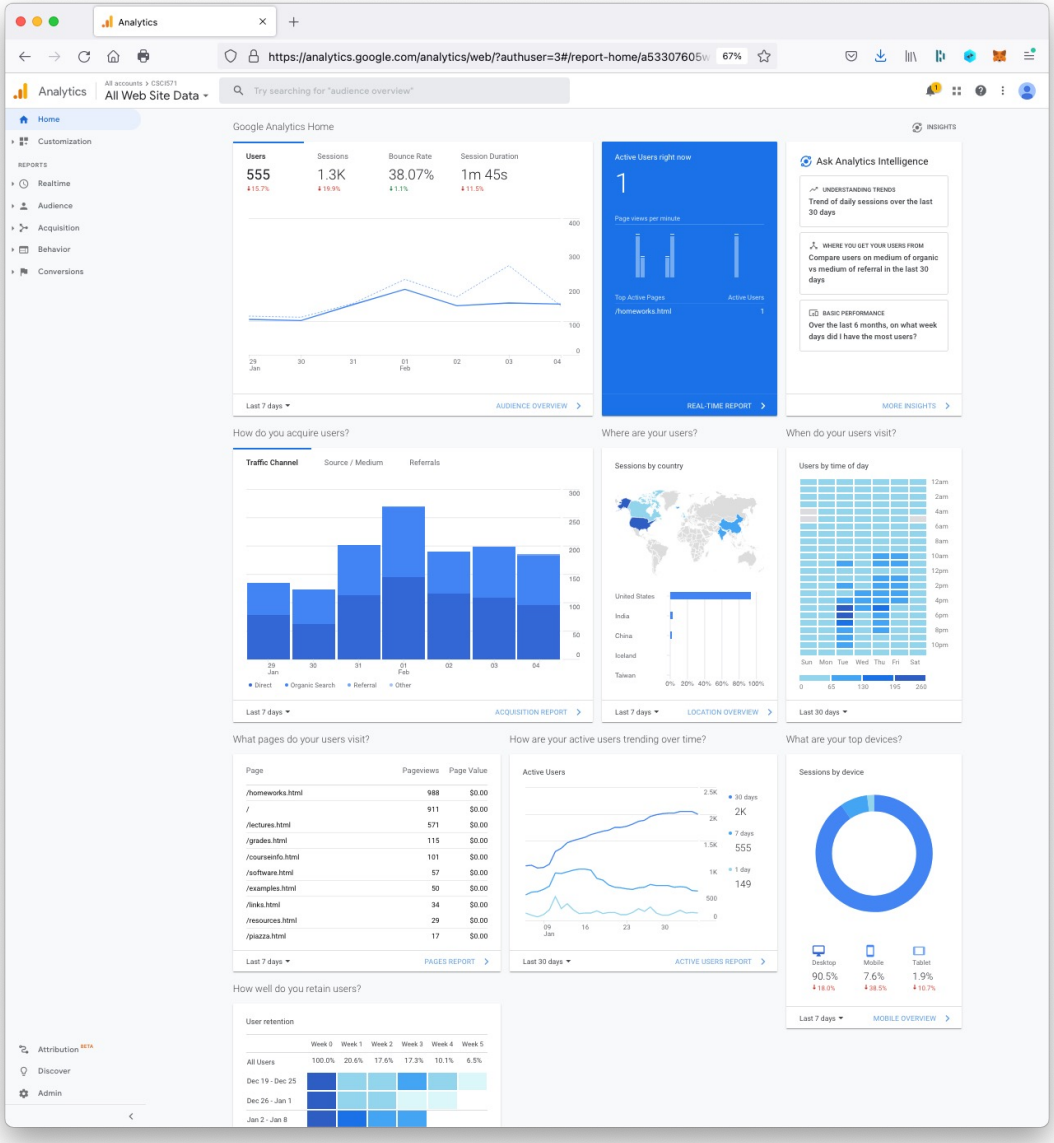
- For any web server
  - **Google Analytics**. See:
    http://www.google.com/analytics/

- Install **global site tag**, after <head> tag, on every site page.
  https://developers.google.com/tag-platform/gtagjs

```
<!-- Global site tag (gtag.js) - Google Analytics -->
<script async src="https://www.googletagmanager.com/gtag/js?id=GA_MEASUREMENT_ID"></script>
<script>
  window.dataLayer = window.dataLayer || [];
  function gtag(){window.dataLayer.push(arguments);}
  gtag('js', new Date());

  gtag('config', 'GA_MEASUREMENT_ID');
</script>
```

Google Analytics Dashboard



Google Analytics Behavior Flow