Network Services, VU 2.0

HTTP, FTP

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Agenda

- URIs
- HTTP (Hyper Text Transfer Protocol)
- WebDAV
- FTP

URI

- Unique Resource Identifier
  - Remembered by people
  - Transcribed from one network resource to another -> characters accessible on each keyboard
- RFC 3896
- URI = scheme:hierachical-part [?query] [#fragment]
  - Hierarchical-part absolute or relative
  - Hierarchical-part may contain authority part

URI Examples

- ftp://ftp.is.co.za/rfc/rfc1808.txt
- http://www.ietf.org/rfc/rfc2396.txt
- ldap://[2001:db8::7]/c=GB?objectClass?one
- mailto:John.Doe@example.com
- news:comp.infosystems.www.servers.unix
- tel:+43-1-58801-58400
- telnet://192.0.1.8:25/
- urn:oasis:names:specification:docbook:dtd:xml:4.1.2

URI / 1

- http://www.ietf.org/rfc/rfc2396.txt

Scheme part

Authority part

Hierarchical part

URI / 2

- http://www.example.at/search?xyz=abc

Query-Part

- http://www.ex1.at/abc.html#my-anchor

Anchor

HTTP / 1

- Protocol for Information Systems
  - Distributed, collaborative, hypermedia
  - In use by WWW initiative since 1990
- General idea: request-response
- HTTP/0.9
  - Simple protocol for raw data transfer across Internet
- HTTP/1.0 (RFC 1945)
  - Extended by allowing messages to use MIME-format
- HTTP/1.1 (RFC 2616)
  - More strict
- Standard Port: TCP 80

HTTP / 2

- Request
  - Request method
  - URI
  - Protocol version
  - MIME-like message
    - Request modifiers
    - Client information
    - Body content
  - Generic syntax: "Method Request-URI HTTP-Version"
- Response
  - Status line
    - including message protocol version
    - Success or error code
  - MIME-like message
    - Server information
    - Entity metainformation (content-type, length, date of modification, ...)
    - Entity-body content

HTTP / 3 – Request methods

- GET
  - Retrieve information identified by Request-URI
  - May refer to a process instead to a data entity
    - See Dynamic Web
  - Conditional GET
  - if request message contains additional header fields
    - Eg. If-Modified Since, If-Match, If-None-Match, If-Range
    - Goal to reduce bandwidth
- HEAD
  - Like GET but does not return message-body
  - HTTP header identical

HTTP / 4 – Request methods

- POST
  - Requests entity enclosed in request as additional item for entity identified in Request-URI
  - URI determines handler for the post
  - Examples
    - Annotation of existing resources
    - Posting a message to bulleting boards, newsgroups, ...
    - Providing a block of data, such as the result of submitting a form, to a data-handling process
    - Extending a database through append operation
  - Actual Function determined by server
  - Response contains result of the action

HTTP / 5 – Request methods

- OPTIONS
  - Communication options availabe on the request/response chain identified by URI-Request
- PUT
  - Enclosed entity shall be stored under supplied Request-URI
- DELETE
  - Delete resource identified by Request-URI
- TRACE
  - Debugging method
- CONNECT
  - For proxies to dynamically switch being a tunnel (SSL)

HTTP / 6 – Status Codes

- Informational 1xx
  - Prior regular response
  - If unexpected May be ignored
  - Proxies must forward 1xx responses
  - 100 Continue
    - Client SHOULD continue with its request
- Successful 2xx
  - Request successful
  - 200 OK
  - 201 Created, 202 Accepted,...

HTTP / - Status Codes

- Redirection 3xx
  - Further actions need to be taken by user to fulfill request
  - 301 Moved Permanently
    - New URI given in Location field of response
    - If possible client shall change link
  - 302 Found
    - New URI given in Location field of
  - 303 See Other
    - Similar to 302 but different URI should be retrieved with GET
    - Primarily to allow output of POST-activated script to redirect user agent
  - 304 Not Modified
    - For conditional GET requests

HTTP – Status Codes

- Client Error 4xx
  - 400 Bad request
  - 401 Unautorized
  - 402 Forbidden
    - Authorization won't help, shall not be repeated
  - 404 Not Found
    - No match found for Request-URI
  - 408 Request Timeout
  - 410 Gone
    - Resource no longer at server

HTTP – Status codes

- Server Error 5xx
  - 500 Internal Server Error
  - 501 Implementation
  - 503 Service Unavailable
    - Overloading of server
  - 505 HTTP Version Not supported

HTTP – Persistent Connections

- HTTP connection closed after one request
  - Assumption that client fetches more requests to same server
  - Standard in HTTP/1.1 persistent connection desired
  - Controlled with Connection: close / keep-alive header
  - Server time-out closes connection automatically
- Advantages
  - Opening/closing fewer TCP connections
    - CPU time saved in routers and all participating hosts
    - Fewer packets caused by TCP opens
  - HTTP requests/responses pipelined
    - Client make multiple requests on same TCP connection without waiting for a response
  - Latency of subsequent requests reduced
    - No time spent in TCPs connection opening handshake

HTTP State Management

- HTTP Sessions to manage state
  - HTTP is stateless
  - Server manages variables for each session
  - Session-ID used to identify session in requests
- Identification of session
  - URL-Rewriting
    - http://www.example.com?sessionID=SID1234
  - HTML Hidden Field
    - <input type="hidden" name="sessionID" value="SID1234"/>
  - Cookies
    - Additional Request-Header-Field
      - Cookie: $Version="1"; sessionID="SID1234"
    - Cookie generated by server
    - Sent to user agent in response field
      - Set-Cookie2: $Version="1"; sessionID="SID1234"

HTTP Authentication

- Methods to authenticate users
  - Restrict access to resources
- Not secure unless used with external secure system (eg. SSL)
- Based on challenges
  - Server poses a challenge to client
  - Client has to response with correct answer
- Restriction is based on realms
  - String value
  - Defines/Names protection space

HTTP Authentication

- C: requests protected resource
- S: 401 Unauthorized
  - WWW-Authenticate header field includes at least one challenge that must be fulfilled by client
- C: Authorization header field in request
  - Contains credentials containing authentication information for a realm
- Server responds with resource

HTTP Authentication - Basic

- Client identifies iteself with UserID & Password
- Challenge: "Basic" realm
  - WWW-Authenticate: Basic realm="WaynesWorld"
- Credentials
  - "UserID:Password" base64 encoded
  - Authorization: Basic XYZ1235456==
- Weak
  - Problem: Base64 bijective

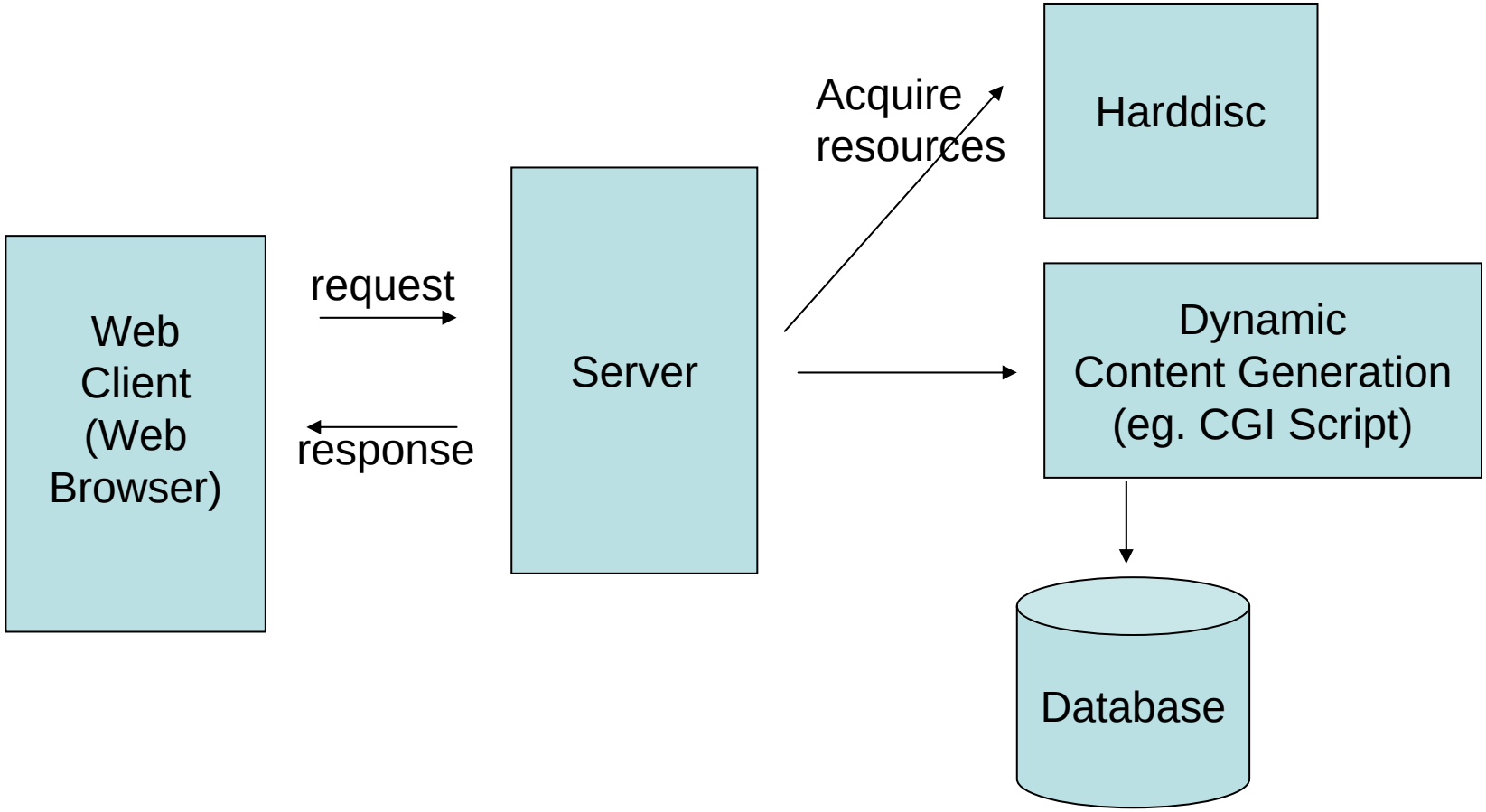
HTTP Authentication - Digest

- Challenge
  - contains a "nonce" value
- Valid response contains a checksum
  - Username + Password + nonce + HTTP method + Request-URI
  - Default uses MD5 checksums (128bit)
- Password never sent in the clear
- Quality of Protection (qop)
  - Different protection levels
    - Authentication, Integrity checking, Confidentiality checking

HTTP Authentication - Digest

- WWW-Authenticate: Digest
  - realm="WaynesWorld",
  - nonce="dcd98b1234567890acd23467",
  - opaque="12345",
- Authorization: Digest username="Wayne"
  - realm="WaynesWorld",
  - nonce="dcd98b1234567890acd23467",
  - uri="/index.html",
  - response="67890abcdef1234567890ab"

Web Server

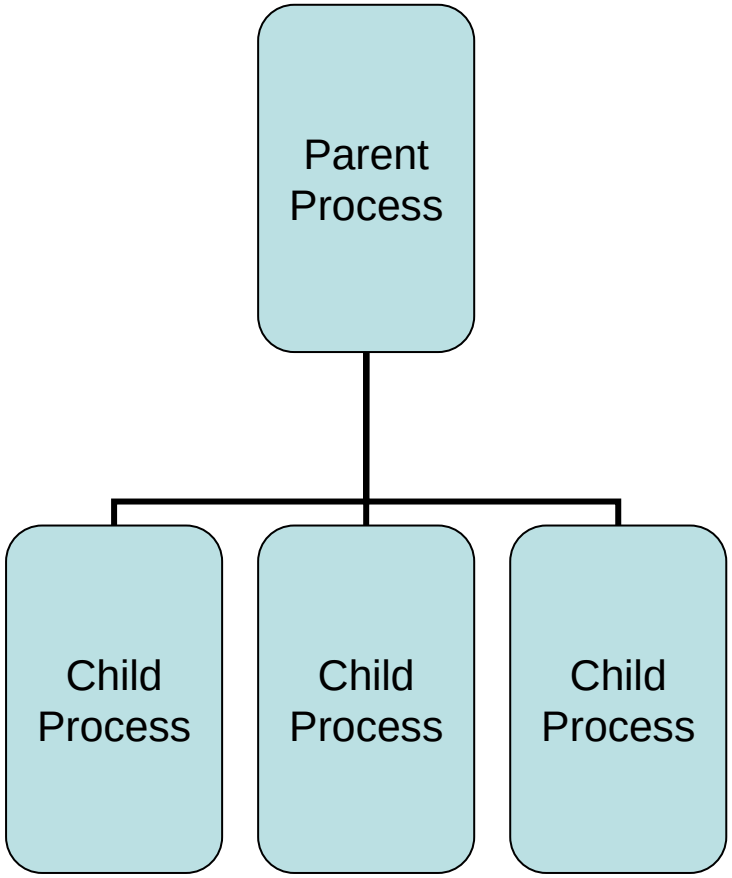

Web
Client
(Web
Browser)
request
response
Server
Acquire
resources
Harddisc
Dynamic
Content Generation
(eg. CGI Script)
Database

Web Server / Today

- Apache 1.3
  - Market leader
- Apache 2.0 / 2.1
- iPlanet (Sun ONE)
- Internet Information Server (IIS) 6.0

Apache Architecture 1.3

- Prefork model
  - Controlling parent process
  - Configurable number of child processes exist
- Each child listens on a socket for a request
- Parent process watches if appropriate number of child processes exist
  - Adjusts number of processes
- Characteristics
  - Robustness & Reliability
  - Problem: scalability on some platforms (processes heavyweight)
  - Security
    - all pages readable by user running child processes



Apache Architecture 2.0

- Based on Multi-Processing Module (MPMs)
  - Library of routines available on all platforms
    - Threading/Processing
    - Input/Output
- Prefork MPM (like in Apache 1.3)
- Worker MPM
- Perchild MPM
- WinNT MPM / OS-specific MPM

Apache 2.0 Architecture / Worker

- Hybrid thread/process MPM
  - Parent creates number of child processes
  - Each child has static number of threads
  - On thread/client devoted to listen to network
  - Each process may serve multiple requests
  - When server connects more connections
    - New client processes are created
      - Same number of threads
- Characteristics
  - Improved scalability
  - Less Reliability & Robustness
    - If One thread crashes entire process will terminate

Apache 2.0 Architecture / Perchild

- Hybrid thread/process MPM
  - Creates specific number of child processes
    - Each has specific number of threads
  - If load increases
    - One child creates new thread(s)
    - Number of child processes static
- Characteristics
  - Most scalable on the right platform (eg. Unix)
  - Least reliable
    - Administrators will configure fewer processes
    - The more threads run in one process the less reliable it becomes
  - Each child process can run as another user or group
    - Good when hosting many virtual hosts because security contexts are separated

Apache 2.0 Architecture / WinNT

- Single child process / multiple threads
- Takes advantage of Windows NT kernel features
  - Reuse of sockets created for previous requests
  - Increase of scalability by use of Completion ports
    - 2 operations at the same time: accepts a connection and reads first packet
- Characteristics
  - Child Process dies
    - Server becomes unresponsive
  - May run as a Windows NT server

Apache 2.0 / Architecture

- Extensible
  - By modules
  - Large variety of modules
    - mod_ssi (Server Side Includes)
    - mod_cgi (cgi scripts)
    - mod_dav (WebDAV)
    - mod_auth_basic, mod_auth_digest
    - ...

Apache 2.0

WebDAV

- Digital Authoring & Versioning (RFC 2518)
- Extends HTTP
  - Authoring of documents via HTTP
  - Kind of file system
    - HTTP URL namespace model
    - Accessible via HTTP (hence, Internet)
    - Platform independent
- Method parameter information
    - HTTP header (like in HTTP/1.1)
    - Encoded in XML request entity body

WebDAV / Terms

- Properties
  - Data about data (eg. Author, subject, ...)
- Collections
  - New type of Web resource
  - State consists of at least a list of internal members (resources itself)
- Locking
  - Ability to keep more than one person from working on a document

WebDAV

- HTTP methods for properties
  - Ability to create, remove, and query information about resources
- HTTP methods for collections
  - Ability to create sets of documents and to retrieve hierarchical membership listings (similar to file system directories)

WebDAV / HTTP methods

- PROPFIND
  - Retrieves properties defined on a resource
- PROPPATCH
  - Set/remove properties on a resource
- MKCOL
  - Create new collection
- GET,HEAD for collections
  - Retrieve whatever information is identified by Request-URI

WebDAV / HTTP methods

- DELETE
  - Depth infinity
- PUT
- COPY & MOVE
  - Copies or moves a resource/collection
  - Overwrite may be requested
  - Nesting depth may be provided for collections

WebDAV - Versioning

- What about the V in WebDAV?

- Not included in original WebDAV
  - RFC (2518)

WebDAV - Versioning

- Versioning Extensions (RFC 3253)
  - Defines extension to existing HTTP and WebDAV methods
  - New Resource types (properties & methods)
- Basic Versioning Features
- Advanced Versioning

WebDAV – Basic Versioning

- Goals
  - Put a resource under version control
  - Determine whether a resource is under version control
  - Determine whether a resource update will automatically be captured as a new version
  - Create and access distinct versions of a resource

WebDAV – Basic Versioning

- Methods
  - VERSION-CONTROL
    - Create a version-controlled resource at Request-URI
  - REPORT
    - Returns information about a resource (infos about multiple versions)
  - CHECKOUT
    - Applied to a checked-in version-controlled resource to allow modifications
  - CHECKIN
    - Applied to a checked-out version-controlled resource to produce a new version

WebDAV – Creating a Version-Controlled Resource

- VERSION-CONTROL request-URI
  - On versionable resource
- Creates 2 new resources
  - "Version History Resource"
    - Not necessarily visible in http scheme URL space
  - "Version Resource" (=Version)
    - Added to new version history resource
    - New and distinct URL
- Converts versionable resource into a "version-controlled" resource
  - Identifed by same resource as original versionable

WebDAV – CheckIn/CheckOut

- CheckIn
  - Goal: user wants to add a new version of a resource (after modification)
  - New "Version Resource" created
  - Added to "Version Resource History"
  - Become active resource

WebDAV – Advanced Versioning

- Goals
  - Parallel development
  - Configuration management of sets of web resources
  - Similar what CVS,Subversion,Perforce,etc can already do
- Methods
  - MERGE simultaneous changes

WebDAV - Extensions

- WebDAV Ordered Collections Protocol
  - RFC 3648
  - Server-side support for ordering of collection members
  - Client may change order
- WebDAV Access Control Protocol
  - RFC 3744
  - Permits clients to read and modify access control lists with permissions for resources on the server

WebDAV – Request Sample

```
PROPFIND /mydocs/thebible HTTP/1.1
Host: www.server.com
Depth: 1
Content-Type: text/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8"?>
<D:propfind xmlns:D="DAV:">
    <D:prop xmlns:R="http://www.server.com/mydocs/>
        <R:author/>
        <R:creation-date/>
    </D:prop>
</D:propfind
```

Retrieves Named Properties

WebDAV – Response Sample

```
HTTP/1.1 207 Multi-Status
Content-Type: text/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8"?>
<D:multistatus xmlns:D="DAV:">
    <D:response>
        <D:href>http://www.server.com/mydocs/thebible.doc</D:href>
            <D:propstat>
                <D:prop xmlns:R=http://www.server.com/mydocs/>
                <R:author>
                    <R:Name>unknown</R:Name>
                </R:author>
                ...
            <D:status>HTTP/1.1 200 OK</D:status>
            </D:propstat>
        </D:href>
    </D:response>
</D:multistatus>
```

File Transfer Protocol

- RFC 959
- Started in 1971 (!), RFC 114
- Transfer of a file from one host to another
- Based on 2 connections
  - Control connection (Server TCP port 21)
  - Data connection created each time a file is transfered (Server TCP port 20)
- Uses TELNET NVT protocol on control connection
- Limited number of file types supported
  - ASCII, Binary, sometimes EBCDIC

File Transfer Protocol

- Client initiates always Control connection
- Active FTP
  - Client opens a random data port for listening
  - Server connects to this open client data port with its own port 20
  - Firewall problem – server has to go through client firewall
- Passive FTP
  - Server listens on data port (not port 20)
  - Client connects to open server data port
  - Not all FTP clients/servers support passive FTP

FTP commands

- Access Control
  - USER & PASS
  - CWD (Change Working Directory)
- Transfer Parameter Commands
  - PORT – specifies data port
  - PASV – passive mode
  - TRANSFER MODE (Stream, Block, Compressed)
- Service Commands
  - RETR retrieve a file)
  - STOR store a file
  - LIST list files
  - RMD, MKD remove, make directory
  - STATUS

WWW Robot / 1

- Program that traverses hypertext structure
  - Automatically by following hyperlinks
  - Also called Spider, or Web crawling
- Primarily used for Search Engines
  - index and rank documents
  - Extract references to external documents
- Problems with robots
  - Rapid fire: many (parallel retrievals in a short time
    - Server and network being overloaded
  - Black hole: endless loop, robot trapped

WWW Robots / 2

- "How do I Get My Site Listed on Google"
  - http://www.google.com/webmasters/1.html
  - URL Form: added to a list but not into search engine
  - On next crawl URL robot is applied on this URL
- Robot Exclusion
  - Not desirable to include all files in Robot traversal
  - File on Local URL: /robots.txt
    - User-Agent: *
    - Disallow: /tmp/
  - Alternative: Meta-Tag in HTML files
    - <meta name="robots" content="noindex,nofollow"S>

WWW Caching

- Browser cache
  - Included in Web browser
  - Checks if representation stored on local disc is up-to-date
- Proxy cache
  - Larger scale (100-1000s users)
  - Good at reducing latency and network traffic
  - For Popular representations used in departments/companies, ...
  - Examples
    - Squid (www.squid-cache.org),
    - MS Internet Security and Acceleration Server
- Gateway cache
  - To make sites themselves more scalable
  - Eg. Akamai

WWW Caching

- HTML Meta Tag
  - META No-cache
  - Problem: not all browsers support it
- HTTP Header
  - Expires: Thu, 2 Jun 2005 13:10:00 GMT
    - Good for files that change rarely
    - Clock synchronisation of WebServer and cache
  - Cache-Control response Header
    - no-store, max-age (similar to expires but relative)
    - no-cache (cache submits request to server)
- Internet Cache Protocol (RFC 2186, RFC 2187)
  - Synchronisation of Caches
  - More lightweight than HTTP
    - On miss a cache submits an ICP request to cache siblings
    - Returns HITs and/or MISSes
    - Original cache uses these returns to resolve its own miss (via HTTP)