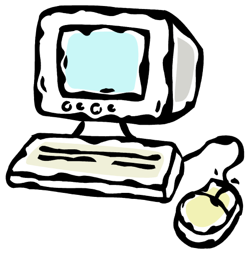
State management



```
GET /index.php HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
```

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: sessionID=528fa623; path=/;
Expires=Wed,  09 Mar 2014 11:00:00 GMT

<html><body>
<a href="mission.php">Mission statement</a>
<a href="press.php">Press releases</a>
…
```

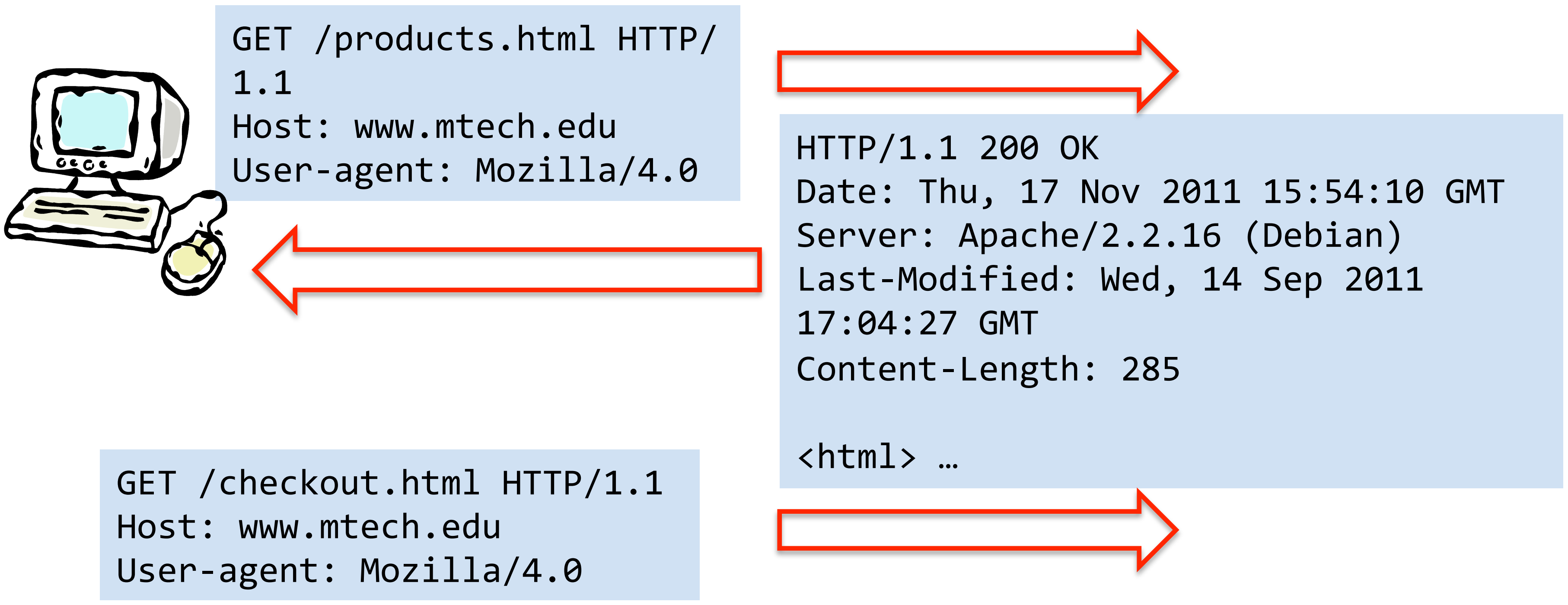
```
GET /mission.php HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
Cookie: sessionID=528fa623
```

Overview

- The state management problem
  - For now, assume a single web server
- Possible solutions
  - IP address
  - Query string
  - Hidden form fields
  - Cookies
- State management in PHP

The state management problem

- HTTP protocol
  - Designed as a stateless, request/response protocol
  - No provisions for sessions spanning multiple request/response cycles



```
GET /products.html HTTP/
1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
```

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Last-Modified: Wed, 14 Sep 2011
17:04:27 GMT
Content-Length: 285

<html> …
```

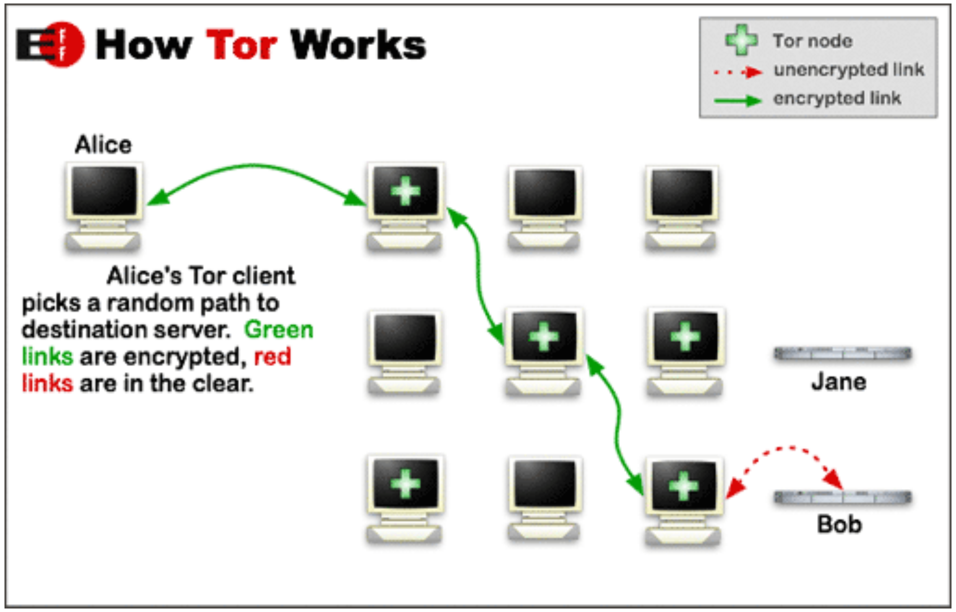
```
GET /checkout.html HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
```

The goal of session-ness

- We want web apps to behave like desktop apps
  - Series of query/responses made to appear as an one ongoing user experience
    - e.g. We don't want to re-login on every page
- Problem 1: How to uniquely ID a session?
  - What exactly do we mean by "session"?
    - Person
    - Person + computer
    - Person + computer + browser
    - Person + computer + browser + browser tab
- Problem 2: Where to store the session data?
  - On the client, on the server, on the page?

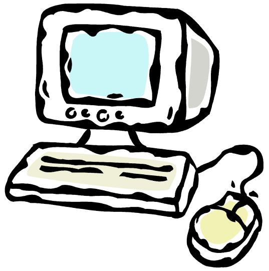
Identifying a session

- Option 1: IP address
  - Web server could use the IP address of the requestor
  - Not very reliable, broken by:
    - NAT - Different users on same net look like same user
    - Anonymity services such as Tor


How Tor Works
Tor node
unencrypted link
encrypted link
Alice
Alice's Tor client picks a random path to destination server. Green links are encrypted, red links are in the clear.
Jane
Bob

Identifying a session

- Option 2: Put something in the URLs
  - First hit to server, just plain URL
  - Server adds to every returned link
    - e.g. http://myserver.com/index.php?id=528fa623



```
GET /index.html HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
```

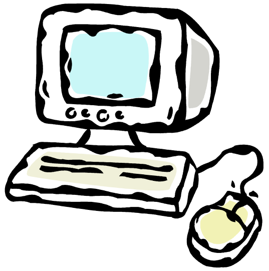
```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285

<html><body>
<h1><blink>Welcome to Montana Tech.</blink></h1>
<a href="mission.php?id=528fa623">Mission statement</
a>
<a href="press.php?id=528fa623">Press releases</a>
<a href="alumninews.php?id=528fa623">Alumni news</a>
…
```

Identifying a session

- Option 2: Put something in the URLs
  - First hit to server, just plain URL
  - Server adds to every returned link
    - e.g. http://myserver.com/index.php?id=528fa623
  - Advantages:
    - Will work, can't be disabled
    - Could support independent sessions in same browser
  - Disadvantages:
    - User can easily see/change/delete the ID
    - Bookmark and use much later, no built-in expiration
    - Only lives as long as the browser window
    - Leaks ID to log files on web server, firewalls, other web sites via HTTP REFERER field, to friends via emailing link

Identifying a session

- Option 3: Use hidden form fields
  - First hit to server, add ID to hidden field in returned form
  - User submits form, hidden ID passed to server



```
GET /index.html HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
```

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285

<html><body>
<form action="submit.php" method="POST">
<input type="text" name="username" value="" />
<input type="hidden" value="528fa623" />
</form>
…
```

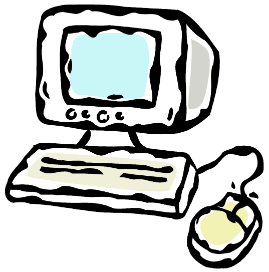
Identifying a session

- Option 3: Use hidden form fields
  - First hit to server, add ID to hidden field in returned form
  - User submits form, hidden ID passed to server
  - Advantages:
    - Will work, can't be disabled
    - Using POST
      - Not as obvious as embedding in URL string
      - Doesn't appear in bookmarks, log files, etc.
    - Could support independent sessions in same browser
  - Disadvantages:
    - More complicated web pages
    - Everything becomes a form submission

Cookies

- Option 4: Browser Cookies
  - Introduced in Netscape, 1994
    - e-commerce app, needed to implement a shopping cart
  - Name/value pairs originally sent from server
  - Stored in browser (if cookies enabled)
    - User can delete
    - Expire after session or after elapsed time
  - Browser makes HTTP request to particular site
    - Sends any cookies marked for that domain
    - Server can use cookie to ID session
  - They cannot carry malware
  - They can have privacy implications

Anatomy of a cookie



```
GET /index.php HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
```

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: sessionID=528fa623; path=/;
Expires=Wed,  09 Mar 2014 11:00:00 GMT

<html><body>
<a href="mission.php">Mission statement</a>
<a href="press.php">Press releases</a>
…
```

```
GET /mission.php HTTP/1.1
Host: www.mtech.edu
User-agent: Mozilla/4.0
Cookie: sessionID=528fa623
```

Cookie attributes

- Domain
  - Defaults to domain of page that set cookie
  - Browser only sends cookie back to this domain
  - All hosts at a domain, leave off first part: .mtech.edu
  - Cannot be different from page sent from

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: sessionID=528fa623; path=/; Expires=Wed,  09 Mar 2014
11:00:00 GMT

<html><body>
…
```

Cookie attributes

- Path
  - Defaults to path of page that set cookie
  - Browser only sends cookie back to pages below the path
    - If path is "/products/" only sent to pages in products directory of web site

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: sessionID=528fa623; path=/; Expires=Wed,  09 Mar 2014
11:00:00 GMT

<html><body>
…
```

Cookie attributes

- Expires
  - If not set, delete when browser closes
  - Specifies date and time of expiration
    - DOW, DD, MON, YYYY HH:MM:SS GMT
- Max-Age
  - Alternate to Expires, seconds in future

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: sessionID=528fa623; path=/; Expires=Wed,  09 Mar 2014
11:00:00 GMT

<html><body>
…
```

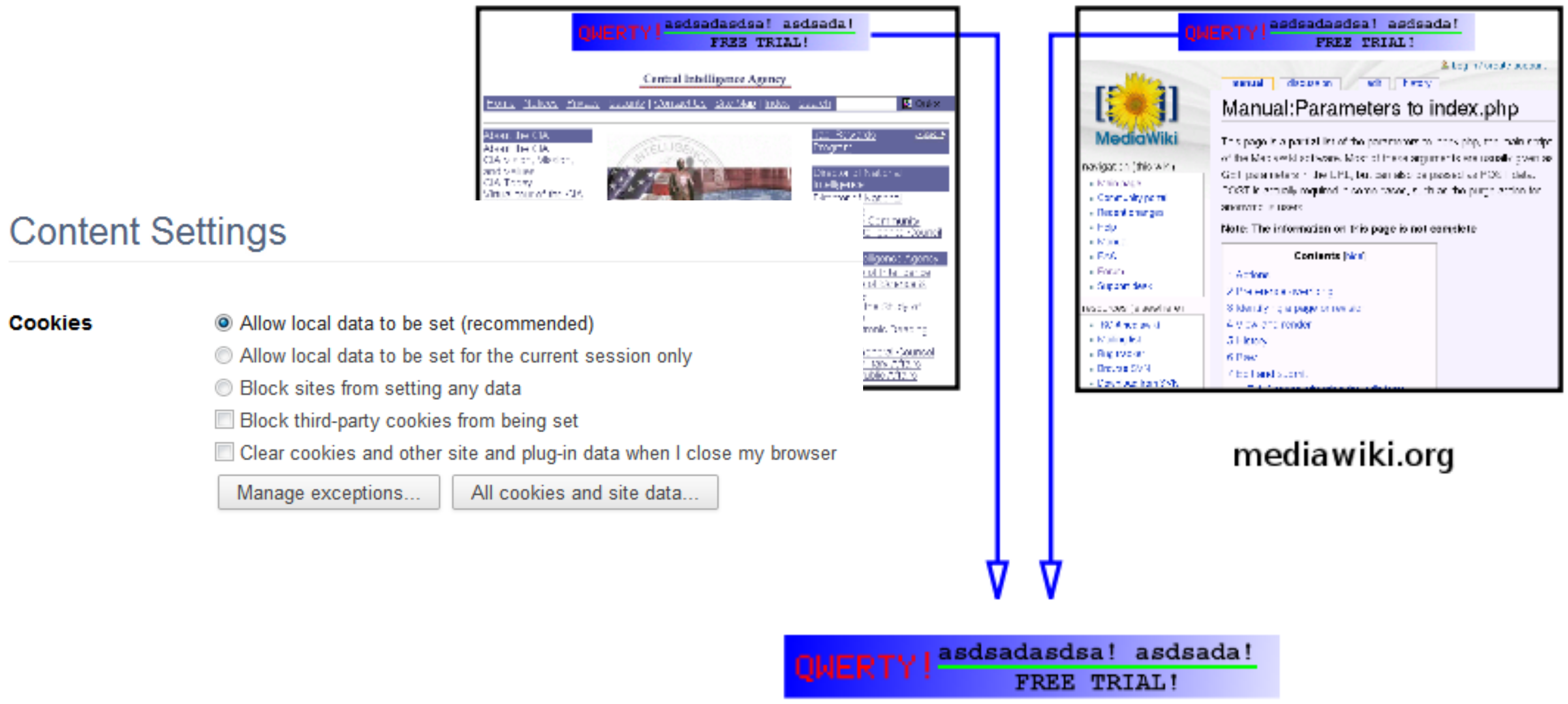
Cookie attributes

- Secure
  - If present, browser only sends if on secure page
  - Server probably should only set on secure page!
- HttpOnly
  - Use cookies via HTTP protocol only
  - e.g. Can't access via JavaScript
    - Avoid a cross-site scripting attack stealing cookies

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: sessionID=528fa623; path=/; Expires=Wed,  09 Mar 2014
11:00:00 GMT; Secure; HttpOnly

<html><body>
```

Third party cookies

- Cookies are sent only to server setting them
  - Except a site can link external images
    - e.g. banner ads
  - Most browsers default to allowing 3rd-party cookies


QWERTY! asdsadasdsa! asdsada! FREE TRIAL!
Central Intelligence Agency
Manual:Parameters to index.php
MediaWiki
mediawiki.org
QWERTY! asdsadasdsa! asdsada! FREE TRIAL!

Content Settings

Cookies

- [✓ Allow local data to be set (recommended)]
- Allow local data to be set for the current session only
- Block sites from setting any data
- ☐ Block third-party cookies from being set
- ☐ Clear cookies and other site and plug-in data when I close my browser

Manage exceptions... | All cookies and site data...

Storing session data

- Now that we have a session ID, where to store other session data?
- On the client:
  - In the URL string
  - In hidden form fields
  - In browser cookies
- On the server, using session ID as key:
  - In shared memory
  - In a disk file
  - In a database

Cookie-only state

- Complete state in client-side cookies
  - No server-side state, great for scalability!
  - Limits to the amount of data (browser dependent)
  - Only one session per browser
  - Only works if cookies enabled
  - Users can delete or muck with cookies

```
HTTP/1.1 200 OK
Date: Thu, 17 Nov 2011 15:54:10 GMT
Server: Apache/2.2.16 (Debian)
Content-Length: 285
Set-Cookie: products=343984,545454,98983;username=bob; path=/;
Expires=Wed,  09 Mar 2014 11:00:00 GMT

<html><body>
…
```

PHP sessions

- PHP session support
  - Provides a unique session ID
    - Done via cookies and/or URL fallback
  - Stores name/value pairs according to session ID
    - Defaults to using a temp file in /tmp
    - Works for a single server
    - Multiple servers requires a shared store:
      - Database (e.g. MySQL)
      - Shared memory cache (e.g. memcached)
      - Shared file system

Using PHP sessions

- Starting a PHP session
  - Assume for now cookies are enabled
  - Every PHP script runs `session_start()` function
    - You must do this before any other output on the page!
  - Sets a unique ID the first time
  - Returns the same ID every other time
  - ID is available using `session_id()` function

```
<?
    session_start();
    echo "<p>Your session ID is " . session_id() . "</p>";
?>
```

Using PHP sessions

- Storing sessions variables
  - Make sure session is started at top of page
  - Use `$_SESSION` superglobal to get/set values

```
<?
    session_start();
    $_SESSION["product1"] = "Snickers";
    $_SESSION["price1]    = "1.25";
    echo "Product added.";
?>
```

First page that sets two session variables.

```
<?
    session_start();
    echo "Product: " . $_SESSION["product1"] . "<br />";
    echo "Price: "   . $_SESSION["price1]    . "<br />";
?>
```

Second page that shows what is currently stored in the session variables.

Using PHP sessions

- What if cookies not enabled?
  - If cookie value not available, constant `SID` set
  - Append `SID` to GET parameters of every link on page
  - `session_start()` loads from GET instead of cookie
  - Session variables work as normal
  - BUT:
    - Turned off in PHP by default to guard against exploits

```
<a href="order.php?<? echo SID; ?>">Order form</a>
```

⇩

```
<a href="order.php?PHPSESSID=738feaw23872">Order form</a>
```

Summary

- Forcing state onto stateless HTTP protocol
- Find a way to unique track session
  - Using URLs
  - Using hidden form fields
  - Using cookies
- Store state somewhere
  - Client-side
  - Server-side