Saving State on the WWW

The Issue

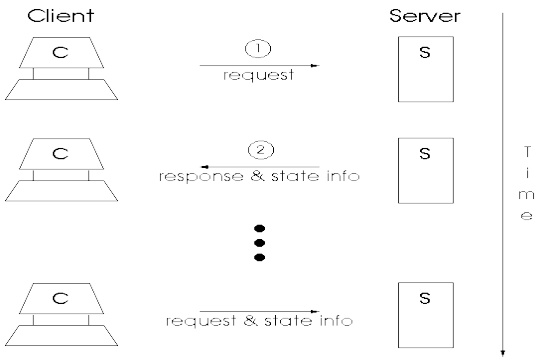
- Connections on the WWW are stateless
- Every time a link is followed is like the first time to the server — it has no memory for connections

Why Bother To Fix This?

By saving state we can…

- Save configuration information between sessions
- Make adaptive websites (change themselves to suit user's behaviour)
- Enable e-commerce applications (shopping carts)
- Violate users' privacy by tracking which websites and webpages they visit

Saving State In General



Methods of Saving State

- Cookies
- Session-level authentication
- `form`s
- URL Rewriting

Method 1: Cookies

- Basic idea
  - Client stores data for the server
  - Client sends data to server with each request
- Details (Version 0)
  - Required fields: *name*=*value*
  - Optional fields: domain, path, secure, expires
  - Size: maximum 4 kilobytes
  - Number: maximum 1024 cookies

Aside: Cookie Concept

- Cookie is a computing term from long ago.
- According to *The New Hacker's Dictionary*:
  - Something passed between subroutines or programs that enables the receiver to do something useful
  - The thing being passed is opaque to the sender (e.g. `time_t` type C libraries use)
  - Cookies are also small
- 'The phrase "it hands you a magic cookie" means it returns a result whose contents are not defined but which can be passed back to the same or some other program later.' [source for quote at end]

Cookie Examples

Examples at course website

- `time1.cgi` vs. `time2.cgi`
  Compare form method with cookie method
- `cookie-colour`
  - One program to write cookies
  - One program to read cookies
  - Use `env.cgi` to see cookies in headers

Method 2: Session-level Authentication

- See §12.2 (Basic Authentication) in *HTTP: The Definitive Guide* by David Gourley & Brian Totty, © 2002 by O'Reilly & Associates, Inc. (ISBN: 1-56592-509-2)
- Session (from ISO Reference Model)
  - Logical communication between two network end points
  - Sessions are composed of requests and responses that occur between applications in different network hosts.
  - In browser terms a session is the longevity of the O/S process

The Steps of Basic Authentication

1. Browser requests resource from server application
   usually with GET protocol
2. Server replies with code 401 (authorization required)
3. Browser prompts user
   for name & password
4. Browser resends request including the name & password (in the network header)
   - Every time the browser makes a request for that resource it will send the name & password, until the end of the session
   - The name & password are like a cookie that is stored in RAM
   - Because they are in RAM they will be forgotten when the browser quits (i.e., at the end of the session)

Method 3: `forms` with hidden fields

- We usually pull webpages in from a server
- Forms are for pushing data to the server
- To use forms we need to use CGI protocol
  - CGI = common gateway interface
  - An application layer protocol that allows client to send data to the server

Two `form` Methods

`method="get"`	`method="post"`
Data is part of URL	Data is not part of URL
Only used for simple requests (e.g. search engine queries)	Can be used for file upload
Conceptually: a query of a database	Conceptually: an alteration to a database

See `form` examples online

Saving State With `forms`

- Hidden post & simple get
- Did you see the hidden field?
- Did you see the hidden data?

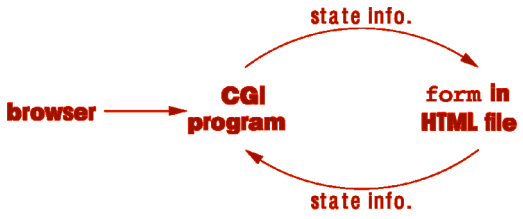
- That's one way of saving state:
  Placing the data in a `form` so that every time the form is submitted (sent to the server) the data is sent too

  - Examples using CGI program to generate a `form`
    - Loan.cgi & multi-page.cgi

Essence of State Saving Using `forms`

- There must be an uninterrupted sequence of request/responses pairs from the browser to a CGI program (or programs)
- The state must be
  - represented in the `form`, and
  - recognized by the CGI program(s)
- The CGI program(s) must encode the state in the `form`

Essence of State Saving Using `forms`



This diagram is for a single CGI program and a single form, but the same thing could be done with multiple programs & forms

Method 4: Servlets & URL Rewriting

- Recall that `method="get" form`s pass their data in the URL
- These URLS are designed to be cached
  - You don't need a browser that can understand `form`s to use them
  - You can just type them in like any other web address

URL Rewriting Explained

So why not put the state information from `method="get" form`s in the `href` of every anchor

Instead of

```
<a href="foo.html"
   >click here</a>
```

do

```
<a href="foo.html?session=…"
   >click here</a>
```

Servlets (1 of 2)

- Many users dislike long URLs — they are hard to mail to friends & look ugly
- Some browser software don't support cookies — and many users have such support disabled
- Wouldn't it be great if your server would use cookies when the client supported them, and URL rewriting when it didn't?

Servlets (2 of 2)

- Servlets (and other server-side software) do that!
- Servlets are server-side programs
  - often written in Java, but
  - servlet is the generic name
- Other server-side technologies work the same way but are implemented in other languages

See also Servlets lecture

What Data Do We Pass?

- But isn't that a lot of state information to send back and forth?
- Not really, because we don't have to pass all of the data back and forth
- We can pass a user or session ID and the server will maintain a database keyed by those IDs

Resources

- Cookie resources at course website
- *HTTP: The Definitive Guide* in the e-book collection
- Cookie examples at course website
- SessionTrack servlet example at course website
  - Note that servlets are not always running at FCS

Bibliography

1. CS3172 Resource List
2. *Web Protocols and Practice*
   Balachander Krishnamurthy & Jennifer Rexford
   Addison-Wesley May 2001
   © 2001 by AT&T Corp. (ISBN 0-201-71088-9)
3. *HTTP: The Definitive Guide*
   David Gourley & Brian Totty, with others
   O'Reilly & Assoc. Sept. 2001
   (ISBN 1-56592-509-2)
4. The New Hacker's Dictionary
   Eric S. Raymond (editor)
   Online version used at
   <URL:http://www.logophilia.com/jargon/jargon_28.html#TAG1093>