CIS 551 / TCOM 401

Computer and Network Security

Spring 2007
Lecture 22

Announcements

- Project 4 is available on the web:
  - Due Friday April 20th at 11:59 PM

- Some of today's slides adopted from Dan Boneh and John Mitchell's courses at Stanford

Maintaining State

- HTTP is a stateless protocol
  - Server doesn't store any information about the connections it handles (each request is treated independently)
  - Makes it hard to maintain session information
- Encode state in the URL:
  - …/cgi-bin/nxt?state=-189534fjk
  - Used commonly on message boards, etc. to track thread
- Use HIDDEN input fields
  - When user fills in web forms, the POST request gives server the data
  - You can embed state in invisible "input" fields
- Cookies
  - Store data on the client's machine

Hidden Fields

```
<html>
<head> <title>My Page</title> </head>
<body>
 <form name="myform"
       action="http://…/handle.cgi"
       method="POST">
 <div align="center">
  <input type="text" size="25" value="Name?">
  <input type="hidden" name="Language"
  value="English">
 <br><br> </div> </form>
</body>
</html>
```

Cookies (Client-side state)

- Server can store cookies on the client machine by issuing:

```
Set-Cookie: NAME=VALUE; [expires=DATE;]
[path=PATH;] [domain=DOMAIN_NAME;]
[secure]
```

- Domain and Path restrict the servers (and paths on those servers) to which the cookie will be sent
- The "secure" flag says that the cookie should only be sent over HTTPS
- Uses:
  - User authentication
  - Personalization
  - User tracking: e.g. Doubleclick (3rd party cookies)

Cookies (cont'd)

- When the client requests a URL from a server, the browser matches the URL against all cookies on the client.
- If they match, then the client request includes the line:

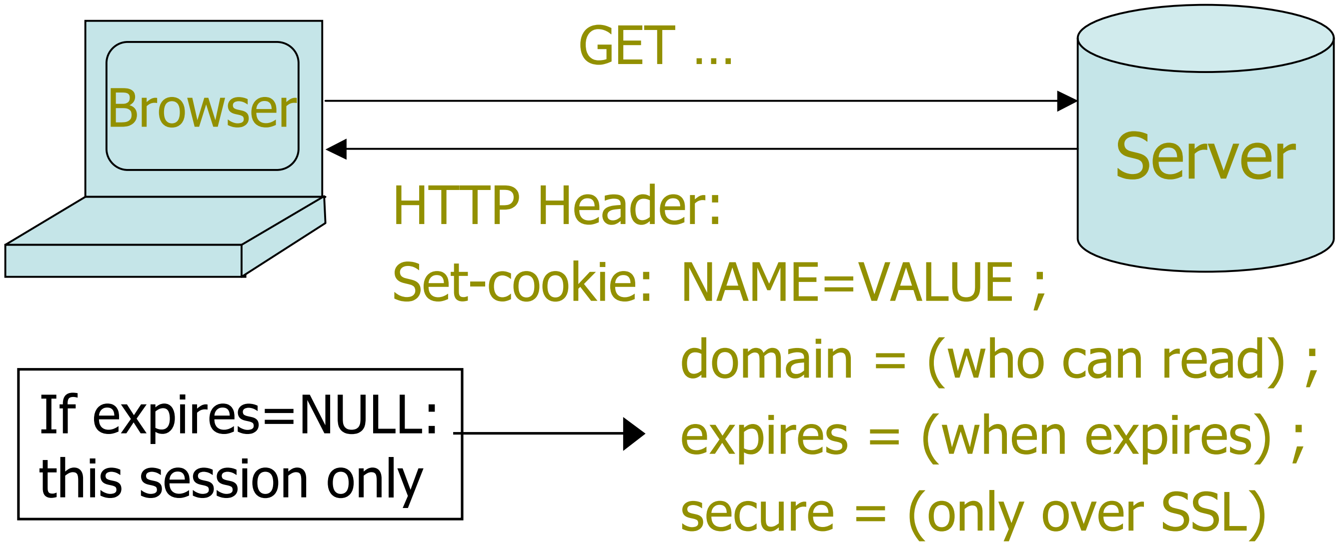
  `Cookie:` *`NAME1=STRING1`*`;` *`NAME2=STRING2`*`;…`

- Notes:
  - New instances of cookies overwrite old ones
  - Clients aren't required to purge expired cookies (though they shouldn't send them)
  - Cookies can be at most 4k, at most 20 per site
  - To delete a cookie, the server can send a cookie with expires set to a past date
  - HTTP proxy servers shouldn't cache Set-cookie headers…

Cookies

Http is stateless protocol; cookies add state

- Used to store state on user's machine

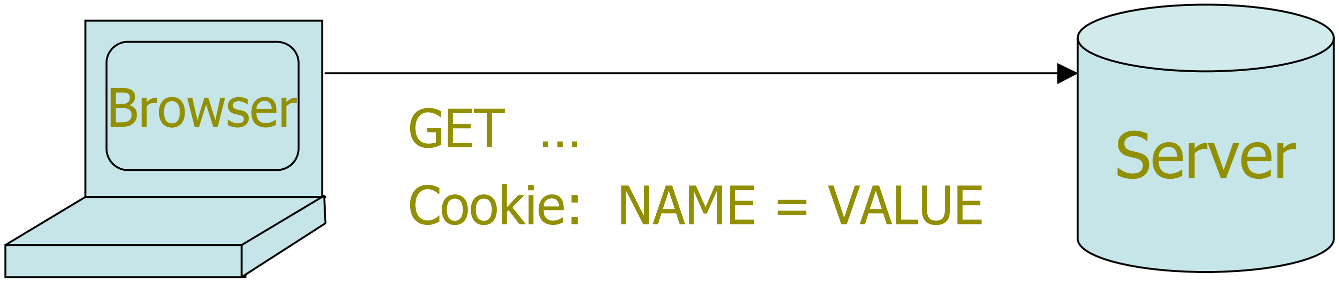


GET …

HTTP Header:

Set-cookie: NAME=VALUE ;
domain = (who can read) ;
expires = (when expires) ;
secure = (only over SSL)

If expires=NULL:
this session only



GET …

Cookie: NAME = VALUE

Cookie risks

- Danger of storing data on browser:
  - User can change values
- **<u>Silly example</u>**: Shopping cart software.

```
Set-cookie:    shopping-cart-total = 150  ($)
```

  - User edits cookie file (cookie poisoning):

```
Cookie:        shopping-cart-total = 15   ($)
```

  - … bargain shopping.
- Similar behavior with hidden fields:

```
<INPUT TYPE=“hidden” NAME=price VALUE=“150”>
```

Not so silly … (as of 2/2000)

- D3.COM Pty Ltd: **ShopFactory 5.8**
- @Retail Corporation: **@Retail**
- Adgrafix: **Check It Out**
- Baron Consulting Group: **WebSite Tool**
- ComCity Corporation: **SalesCart**
- Crested Butte Software: **EasyCart**
- Dansie.net: **Dansie Shopping Cart**
- Intelligent Vending Systems: **Intellivend**
- Make-a-Store: **Make-a-Store OrderPage**
- McMurtrey/Whitaker & Associates: **Cart32 3.0**
- pknutsen@nethut.no: **CartMan 1.04**
- Rich Media Technologies: **JustAddCommerce 5.0**
- SmartCart: **SmartCart**
- Web Express: **Shoptron 1.2**

- Source: http://xforce.iss.net/xforce/xfdb/4621

Example: dansie.net shopping cart

- http://www.dansie.net/demo.html (April, 2007)

```
<FORM METHOD=POST
       ACTION="http://www.dansie.net/cgi-bin/scripts/cart.pl">

  Black Leather purse with leather straps<BR>Price: $20.00<BR>

  <INPUT TYPE=HIDDEN NAME=name     VALUE="Black leather purse">
  <INPUT TYPE=HIDDEN NAME=price    VALUE="20.00">
  <INPUT TYPE=HIDDEN NAME=sh       VALUE="1">
  <INPUT TYPE=HIDDEN NAME=img      VALUE="purse.jpg">
  <INPUT TYPE=HIDDEN NAME=return
VALUE="http://www.dansie.net/demo.html">
  <INPUT TYPE=HIDDEN NAME=custom1  VALUE="Black leather purse
       with leather straps">

  <INPUT TYPE=SUBMIT NAME="add" VALUE="Put in Shopping Cart">

</FORM>
```

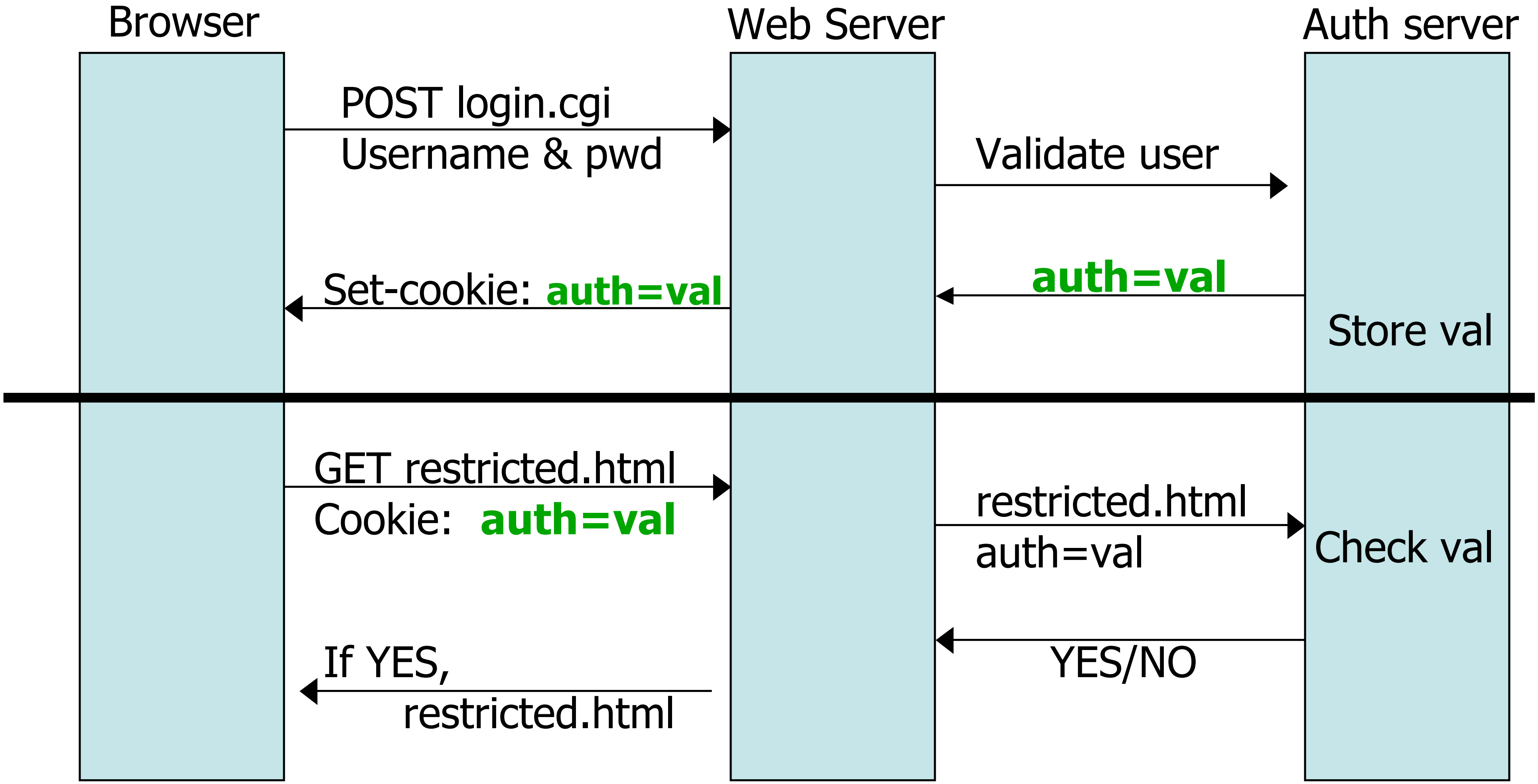
- CVE-2000-0253 (Jan. 2001), BugTraq ID: 1115

Solution

- When storing state on browser MAC data using server secret key.

- .NET 2.0:
  - System.Web.Configuration.MachineKey
    - Secret web server key intended for cookie protection
  - HttpCookie cookie = new HttpCookie(name, val);
    HttpCookie encodedCookie =
    HttpSecureCookie.Encode (cookie);
  - **HttpSecureCookie.Decode** (cookie);

Cookie authentication



Browser

Web Server

Auth server

POST login.cgi
Username & pwd

Validate user

auth=val

Store val

Set-cookie: **auth=val**

GET restricted.html
Cookie: **auth=val**

restricted.html
auth=val

Check val

YES/NO

If YES,
restricted.html

Weak authenticators: security risk

- Predictable cookie authenticator
  - Verizon Wireless - counter
  - Valid user logs in, gets counter, can view sessions of other users.

- Weak authenticator generation:
  - WSJ.com: cookie = **{user, MAC_k(user) }**
  - Weak MAC exposes **K** from few cookies.

- Apache Tomcat: generateSessionID()
  - MD5(PRNG) … but weak PRNG
  - Predictable SessionID's

Cookie auth is insufficient

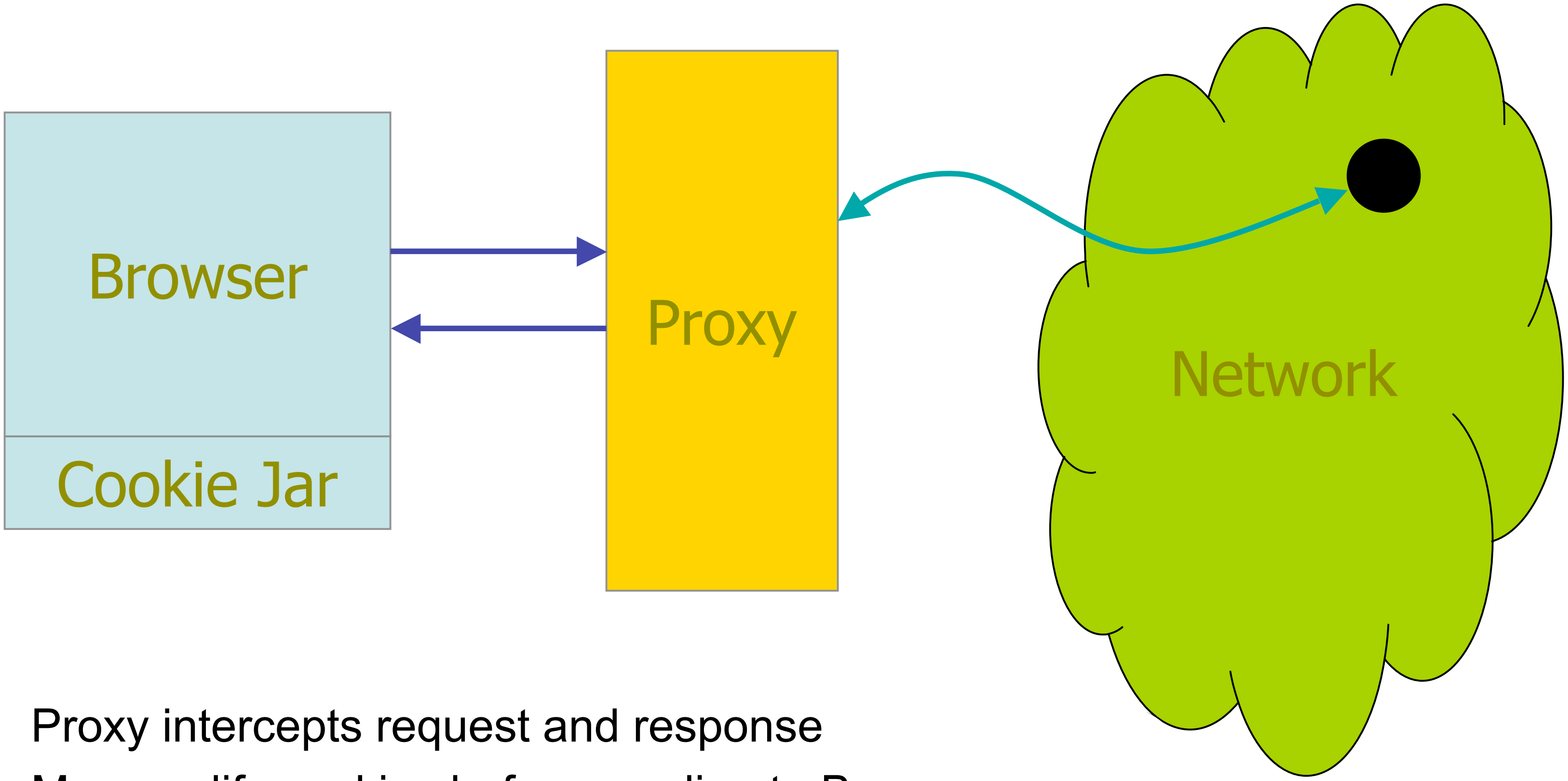
- Example:
  - User logs in to bank.com. Forgets to sign off.
  - Session cookie remains in browser state
  - Then user visits another site containing:

```
<form  name=F  action=http://bank.com/BillPay.php>
<input  name=recipient   value=badguy> …
<script> document.F.submit(); </script>
```

  - Browser sends user auth cookie with request
    - Transaction will be fulfilled

- Problem:
  - cookie auth is insufficient when side effects can happen
  - Correct use: use cookies + hidden fields

Managing cookie policy via proxy



- Proxy intercepts request and response
- May modify cookies before sending to Browser
- Can do other checks: filter ads, block sites, etc.

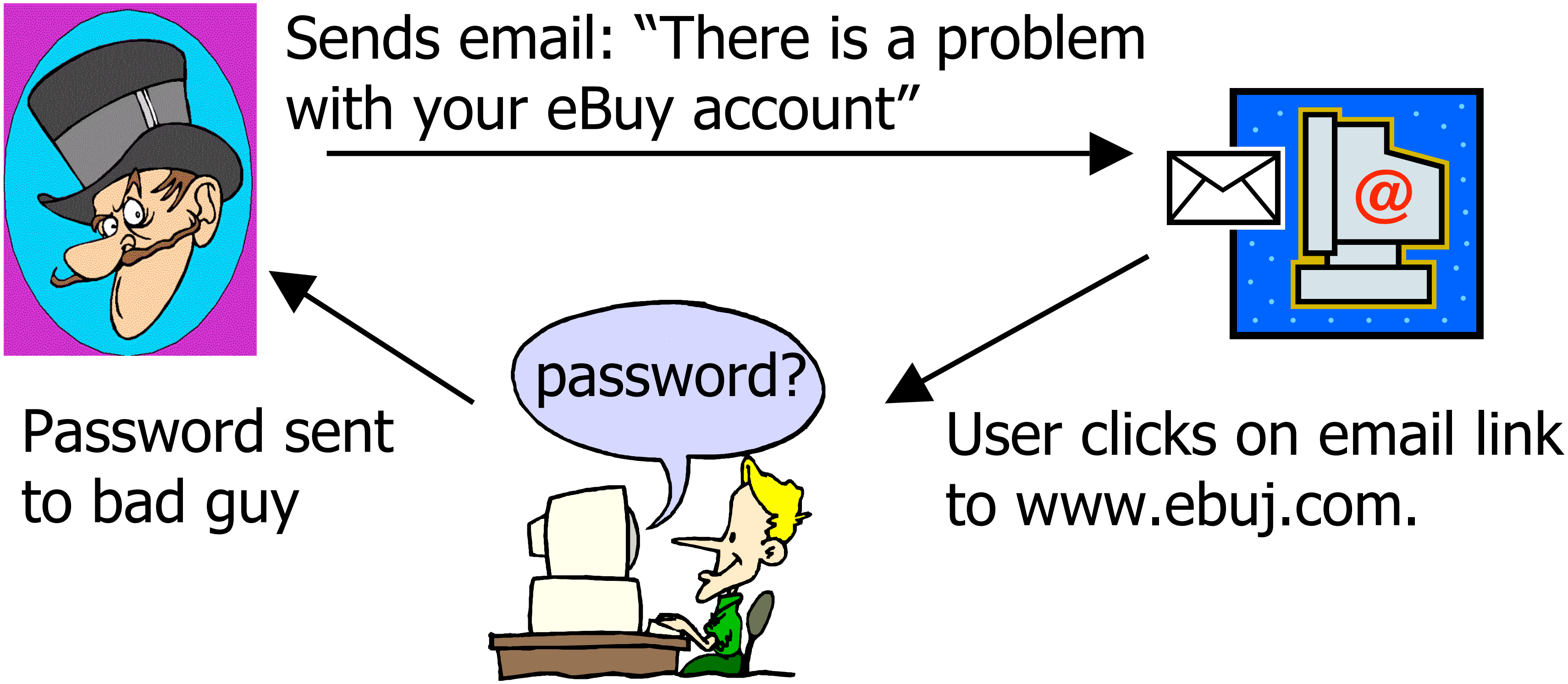
Sample Proxy:

JUNKBUSTERS

- Cookie management by policy in *cookiefile*
  - Default: all cookies are silently crunched
  - Options
    - Allow cookies only to/from certain sites
    - Block cookies to browser (but allow to server)
    - Send vanilla wafers instead
- Block URLs matching any pattern in *blockfile*
  - Example: pattern /*.*/ad matches http://nomatterwhere.com/images/advert/g3487.gif

Easy to write your own http proxy; you can try *this* at home

Fooling the user



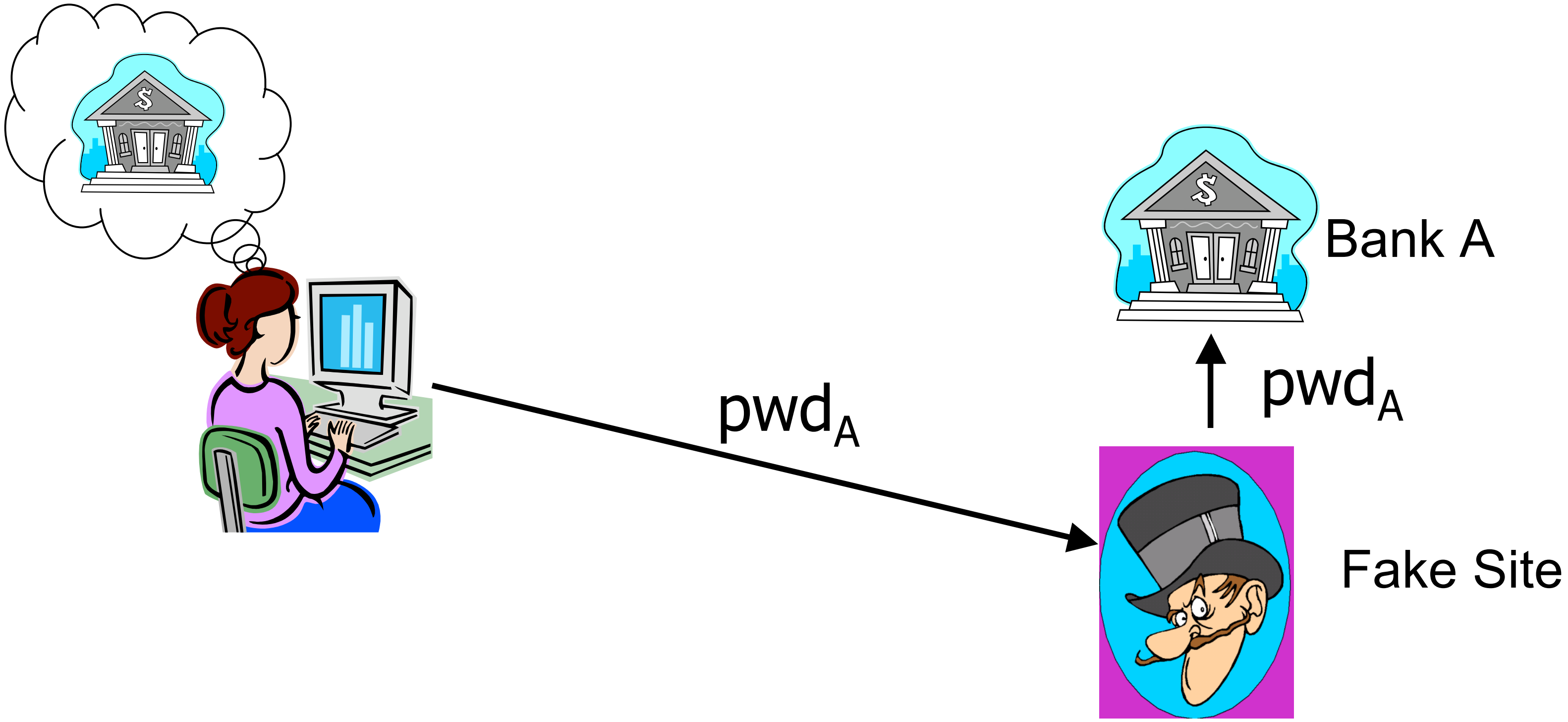
Sends email: "There is a problem with your eBuy account"

User clicks on email link to www.ebuj.com.

Password sent to bad guy

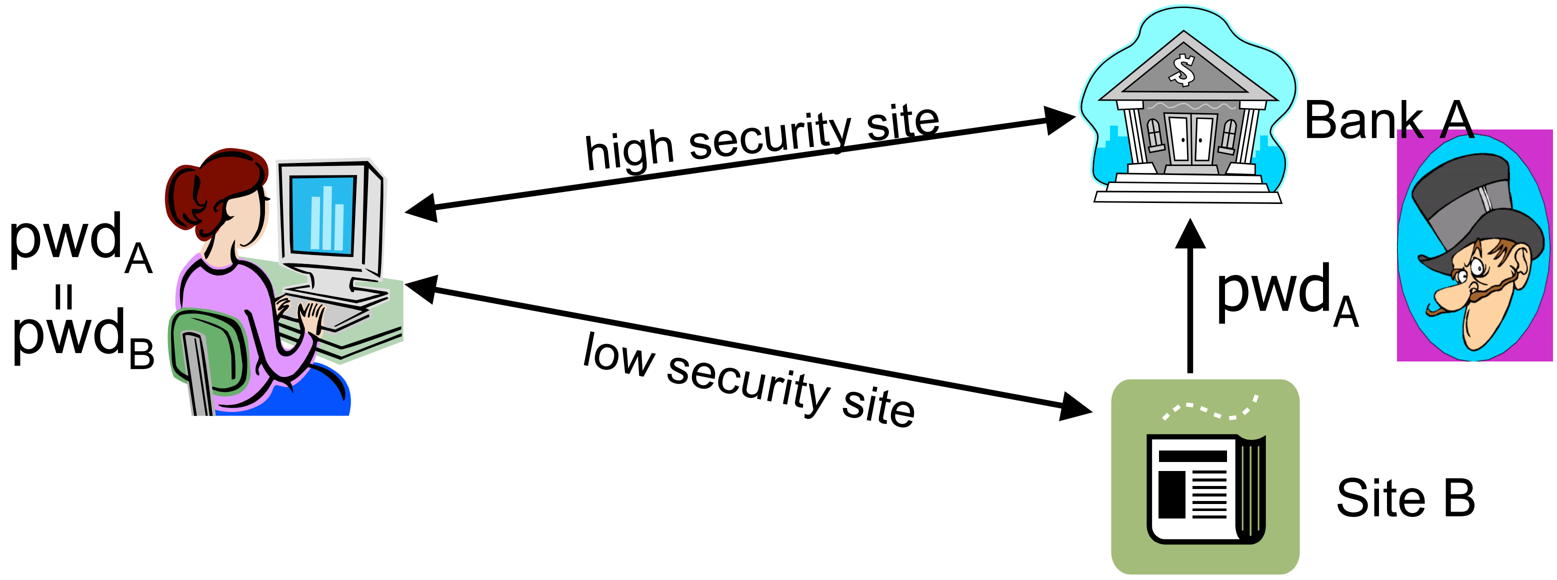
User thinks it is ebuy.com, enters eBuy username and password.

Password Phishing Problem



- User cannot reliably identify fake sites
- Captured password can be used at target site

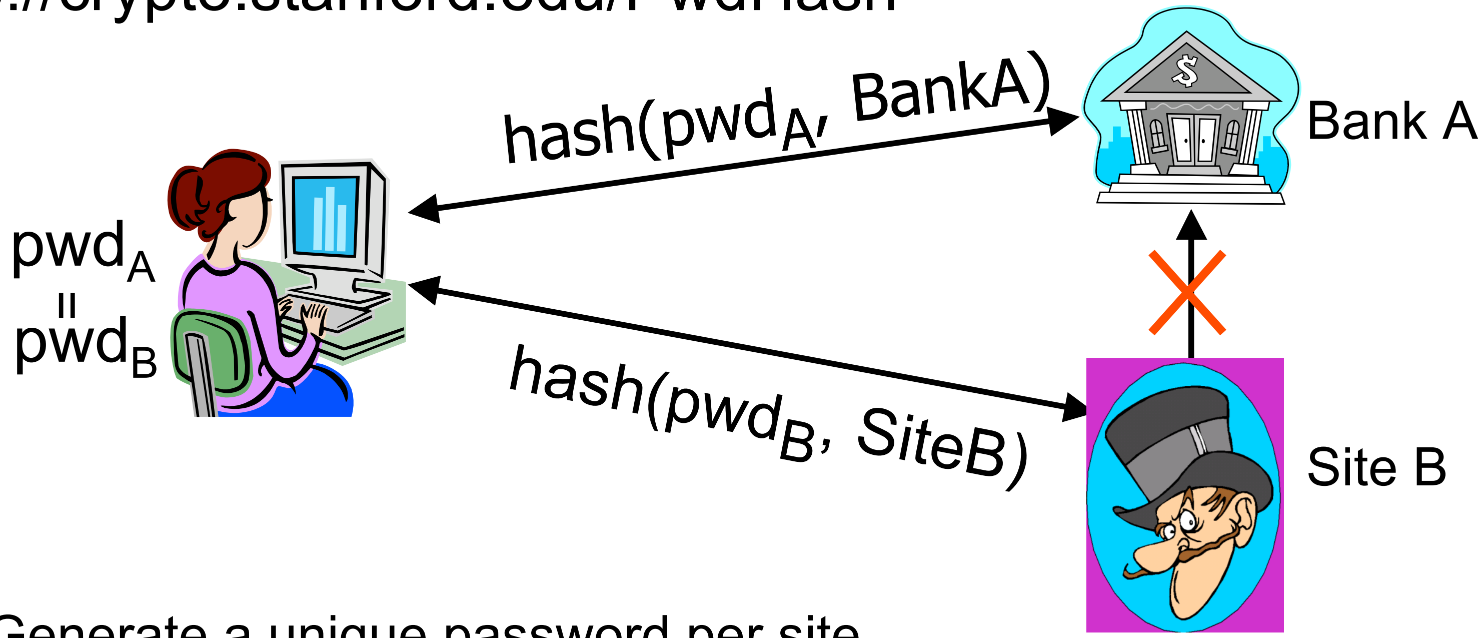
Common Password Problem



- Phishing attack or break-in at site B reveals pwd at A
  - Server-side solutions will not keep pwd safe
  - Solution: Strengthen with client-side support

Password Hashing

http://crypto.stanford.edu/PwdHash



pwd_A

=

pwd_B

hash(pwd_A, BankA)

hash(pwd_B, SiteB)

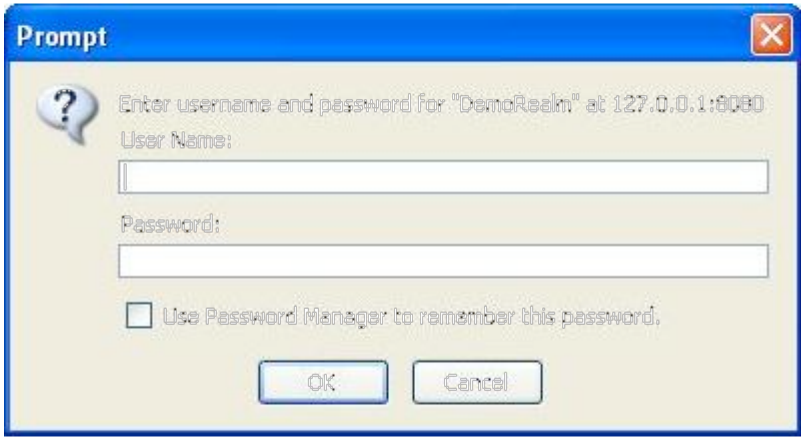
Bank A

Site B

- Generate a unique password per site
  - HMAC$_{fido:123}$(banka.com) ⇒ Q7a+0ekEXb
  - HMAC$_{fido:123}$(siteb.com) ⇒ OzX2+ICiqc
- Hashed password is not usable at any other site
  - Protects against password phishing
  - Protects against common password problem

The Spoofing Problem

- JavaScript can display password fields or dialogs:



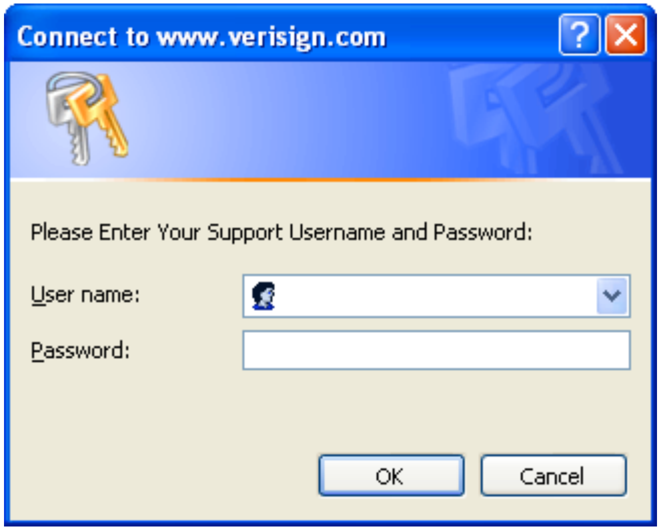
Enter username and password for "DemoRealm" at 127.0.0.1:8080

User Name:

Password:

□ Use Password Manager to remember this password.

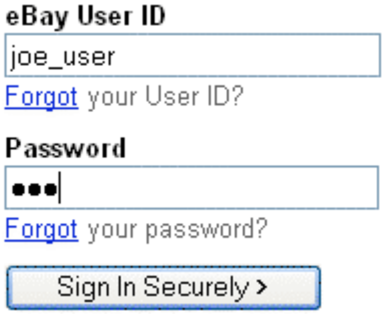
- Unhashed password sent to attacker in clear



Please Enter Your Support Username and Password:

User name:

Password:



eBay User ID

joe_user

Forgot your User ID?

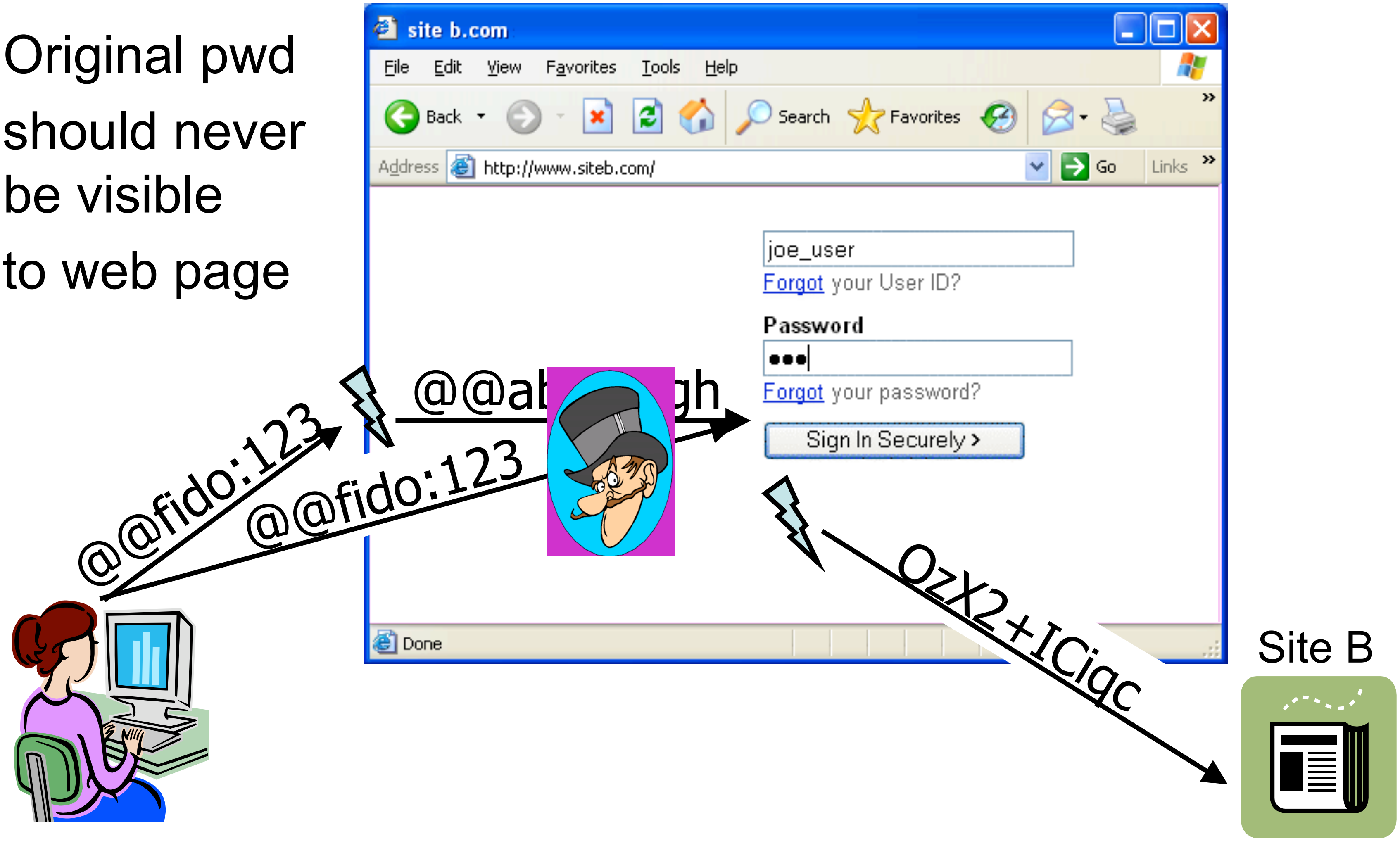
Password

●●●

Forgot your password?

Password Prefix

- Original pwd should never be visible to web page



site b.com

joe_user

Forgot your User ID?

Password

●●●

Forgot your password?

Sign In Securely >

Password Prefix: How it works

- Normal operation: Prefix in password field

  @@fido:123 ⇒ @@abcdefgh ⇒ **********

  abcdefgh ⇒ fido:123

  $\text{HMAC}_{\text{fido:123}}(\text{siteb.com}) \Rightarrow \text{Q7a+0ekEXb}$

- Abnormal operation: Prefix in non-password field
  - Can just ignore the prefix and not hash
  - Remind user not to enter password

The Perfect Phishing Email

Fooling the user using browser state

- Bank of America customers see:
  - “Click here to see your Bank of America statement”
- Wells Fargo customers see:
  - “Click here to see your Wells Fargo statement”
- Works in Outlook; behavior is by design

Reading browser history

- CSS properties of hyperlinks
- Can also use cache-based techniques

Violation of the same-origin principle:

> "One site cannot use information belonging to another site."

Visited link tracking http://www.safehistory.com/

- Visited links displayed in different color (74% of sites)
  - Information easily accessible by javascript
- Attacks also without javascript

```
<html><head>
<style> a { position:absolute; border:0; } a:link { display:none } </style>
</head><body>
<a href='http://www.bankofamerica.com/'><img src='bankofamerica.gif'></a>
<a href='https://www.wellsfargo.com/'><img src='wellsfargo.gif'></a>
<a href='http://www.usbank.com/'><img src='usbank.gif'></a>
...
</body></html>
```

  - Bank logo images are stacked on top of each other
  - CSS rules cause the un-visited links to vanish
  - Page displays bank logo of site that user has visited

Preserving web privacy

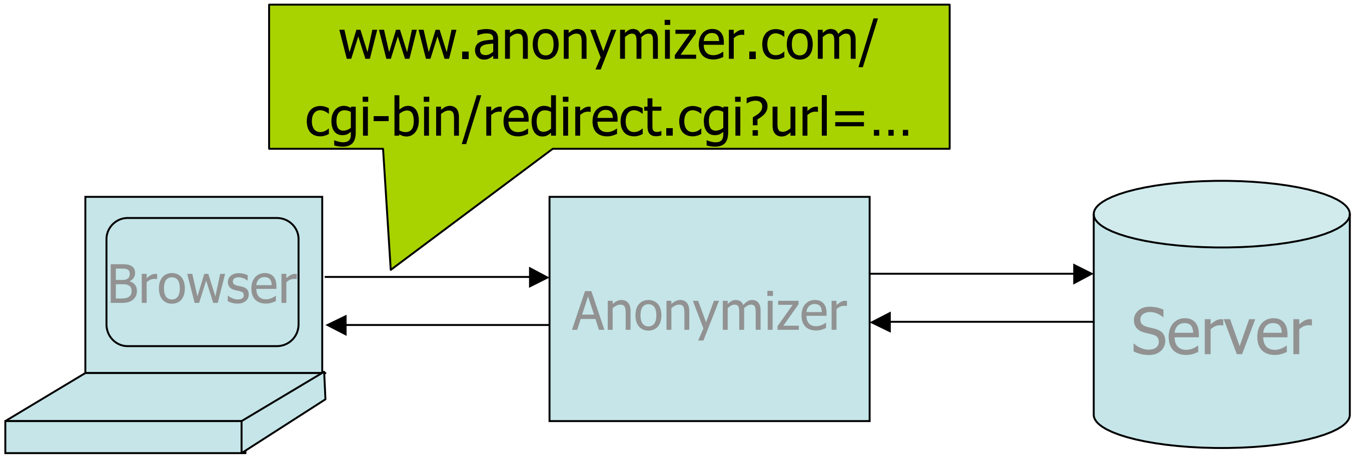
- Your IP address may be visible to web sites
  - This may reveal your employer, ISP, etc.
  - Can link activities on different sites, different times
- Can you prevent sites from learning about you?
  - Anonymizer
    - Single site that hides origin of web request
  - Crowds
    - Distributed solution

Anonymity?

- Sender anonymity:
  - The identity of the sender is hidden, while the receiver (and message) might not be
- Receiver anonymity:
  - The identity of the receiver is hidden (message and sender might not be)
- Unlikability of sender and receiver:
  - Although the sender and receiver can be identified as participating in communication, they cannot be identified as communicating *with each other*.

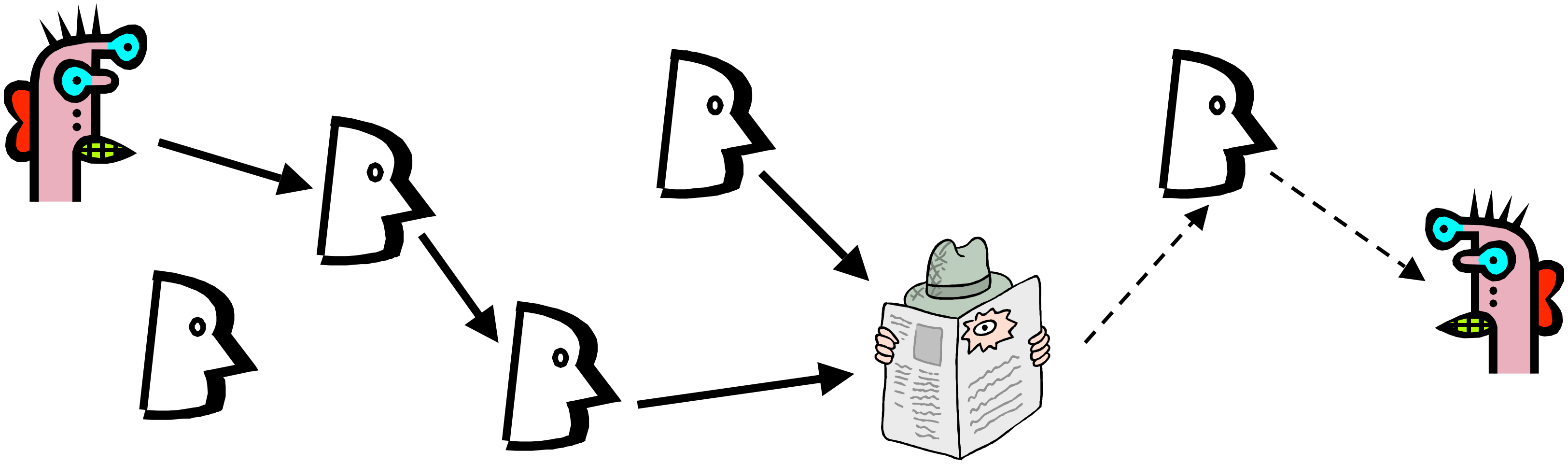
Browsing Anonymizers

- Anonymizer.com
- Web Anonymizer hides your IP address



- What does anonymizer.com know about you?

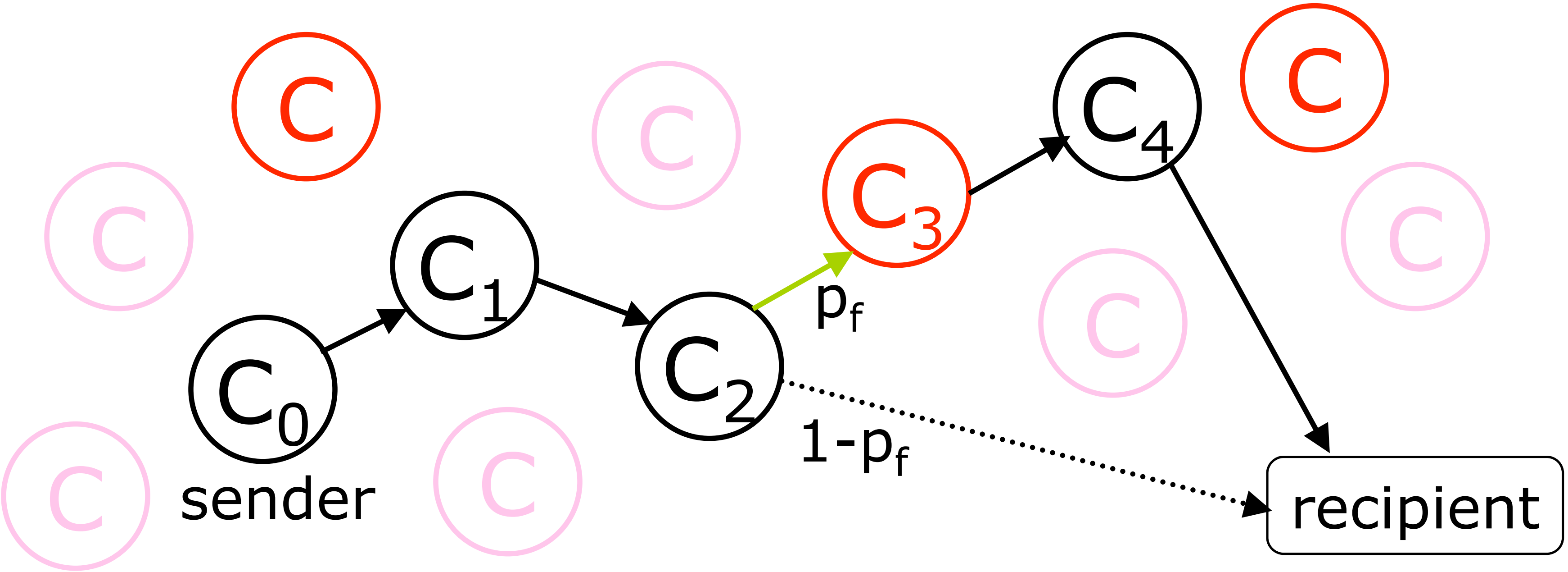
Related approach to anonymity



- Hide source of messages by routing them randomly
- Routers don’t know for sure if the apparent source of the message is the actual sender or simply another router
  - Only secure against local attackers!
- Existing systems: Freenet, Crowds, etc.

Crowds

http://avirubin.com/crowds.pdf [Reiter,Rubin '98]



- Sender randomly chooses a path through the crowd
- Some routers are honest, some corrupt
- After receiving a message, honest router flips a coin
  - With probability P_f routes to the next member on the path
  - With probability 1- P_f sends directly to the recipient

What Does Anonymity Mean?

- Degree of anonymity:
  - Ranges from absolute privacy to provably exposed
- Beyond suspicion
  - The observed source of the message is no more likely to be the actual sender than anybody else
- Probable innocence
  - Probability <50% that the observed source of the message is the actual sender

Guaranteed by Crowds if there are sufficiently few corrupt routers

- Possible innocence
  - Non-trivial probability that the observed source of the message is not the actual sender