ForceHTTPS: Protecting High-Security Web Sites from Network Attacks

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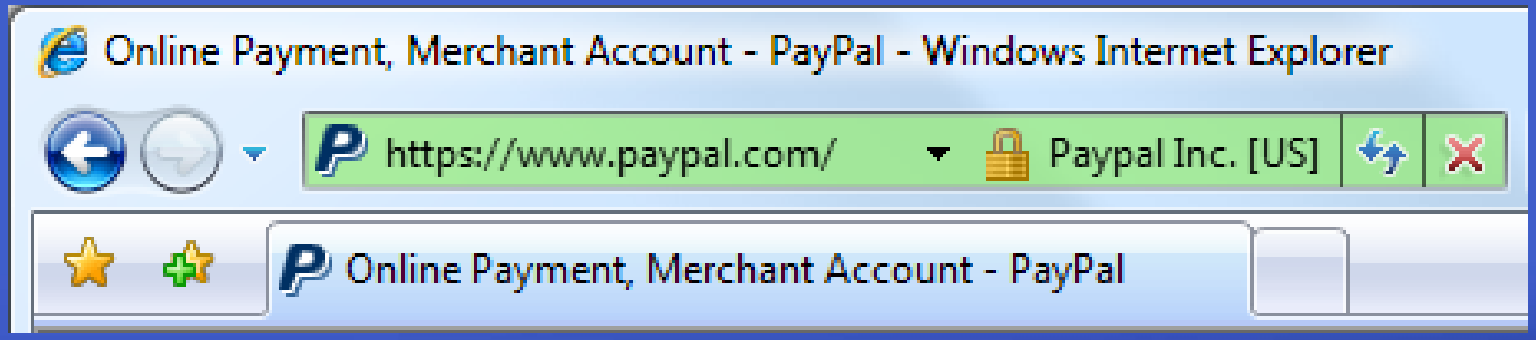
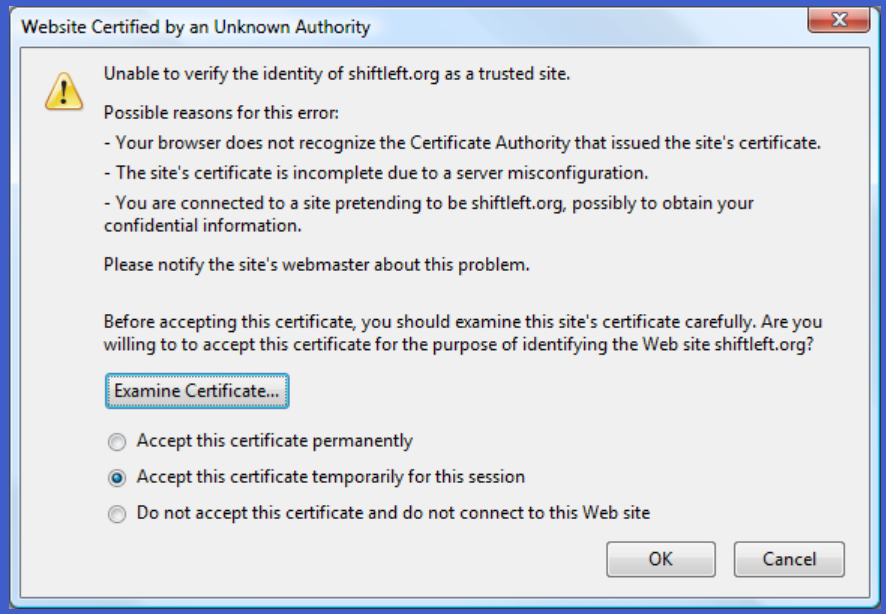
HTTPS and Network Attackers

- High-security sites employ HTTPS
  - Protects against active network attackers
  - Passwords encrypted
  - “Secure” cookies kept confidential
- Especially important for wireless networks



HTTPS Certificate Errors

- Low-security sites
  - Self-signed certs
  - Passive attackers
- Cert errors common
  - Browser shows warning
  - Users override errors
- Misconfig or attack?
  - Browser doesn't know
  - User doesn't know



Strong Threat Model

- Active network attacker
  - Controls the network
  - Has a certificate for attacker.com
  - Does not have a certificate for bank.com
- User click through certificate errors
  - Only type bank password at https://bank.com
  - Second factor in Secure cookie (e.g., BofA SiteKey)
- Realistic: Wireless networks

Related Work: WSKE

- Web Server Key-Enabled Cookies
  - Secure cookies only sent for same TLS key
  - Intended to secure the user's second-factor cookie

User

Attacker

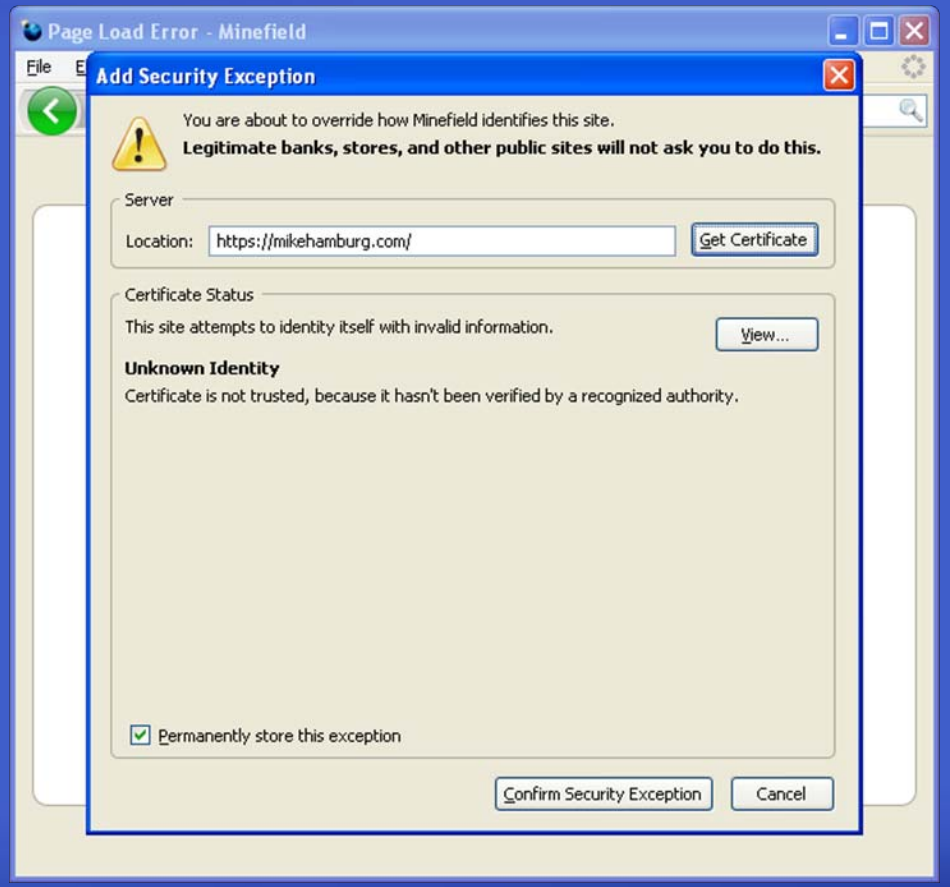
Bank

Related Work: Locked SOP

- Locked same-origin policy
  - “Broken” HTTPS page can’t script valid HTTPS page
  - Sites cannot use <script src=“…”>, CSS, SWF, etc
- Importing libraries ignore scripting policy
  - <script src=“https://www.paypalobjects.com/...”>
  - User clicks through cert error for paypalobjects.com
  - Real PayPal imports script from paypalobjects.com
  - Attacker runs script as “unbroken” PayPal

Related Work: Firefox 3

- Firefox 3 – Four clicks
  - User override harder
  - Controversial balance
    - Security
    - Compatibility
  - Low-security sites
    - Harder to use
  - High-security sites
    - User can still override
- How will users react?



Our Proposal: ForceHTTPS

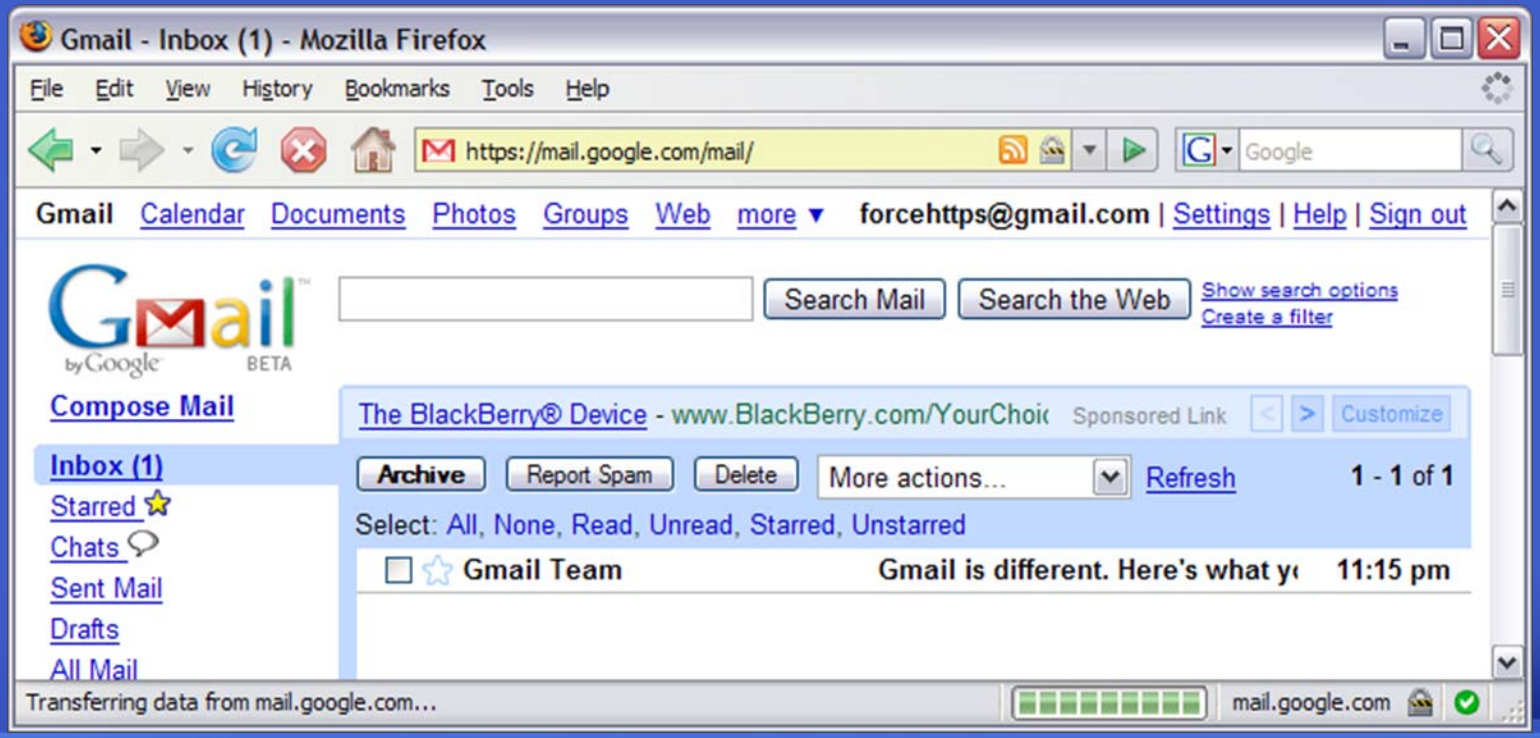
- Site sets a “ForceHTTPS” cookie
  - Opts in to strict error processing
  - Not interested in compatibility
  - Treat errors as an attack, not a misconfiguration
- Specification
  - Non-HTTPS connections redirect to HTTPS
  - HTTPS errors treated as fatal
  - Importing non-HTTPS content (mixed content) fails

Case Study: Gmail

- Login form always over HTTPS
- Mail available over HTTP and HTTPS
- Imperfect web developers

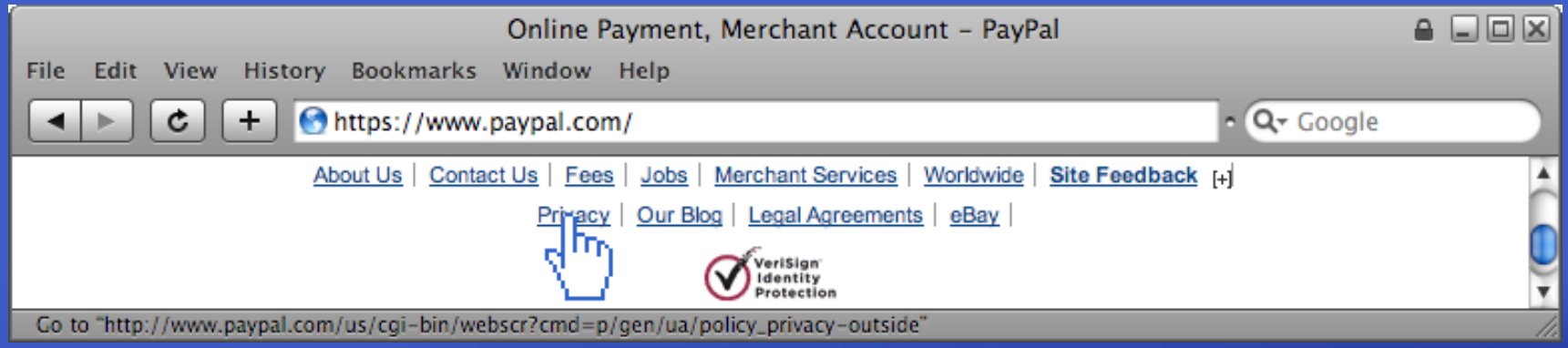
Gmail and SafeBrowsing

- New account, always visited over HTTPS
- Compromised by passive network attacker



Case Study: PayPal

- Entire website over HTTPS
  - HTTP redirects to HTTPS
  - Cert errors on some dark corners…
- Links on home page point to HTTP…
  - Not necessarily a vulnerability



Implementation: ForceHTTPS

- Firefox extension
  - Monitors all network connections
  - Blocks connections with cert errors for sites that opt-in
  - Blocks mixed contents for sites that opt-in
- Useful debugging tool
  - Logs to developer console
  - Found many issues with real sites just by browsing
  - Want to extend to combine with a web app scanner

Trick: Scheme Relative URLs

- Mixed content is hard to eliminate
  - Often host same content over HTTP and HTTPS
  - Only want to pay for HTTPS when needed
- Consider embedding scripts
  - <script src="http://a.com/foo.js"></script>
  - <script src="//a.com/foo.js"></script>
- Works in all browsers
  - Used extensively by Slashdot to save bandwidth

Conclusions

- Browsers trade off security for compatibility
  - High-security sites want more security
  - Browser can be stricter if sites opt-in
  - Simple kind of “content restriction”
- ForceHTTPS
  - “Please enable strict HTTPS error processing”
  - Strong threat model, difficult to get mechanism right
  - More details in the paper
    - Denial of service, error recovery, cookie integrity, privacy, etc