

# Access Control and Privacy Policies (1)



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Slides: KEATS







Lavabit

My Fellow Users,

I have been forced to make a difficult decision: to become complicit in crimes against the American people or walk away from nearly ten years of hard work by shutting down Lavabit. After significant soul searching, I have decided to suspend operations. I wish that I could legally share with you the events that led to my decision. I cannot. I feel you deserve to know what's going on—the first amendment is supposed to guarantee me the freedom to speak out in situations like this. Unfortunately, Congress has passed laws that say otherwise. As things currently stand, I cannot share my experiences over the last six weeks, even though I have twice made the appropriate requests.

What's going to happen now? We've already started preparing the paperwork needed to continue to fight for the Constitution in the Fourth Circuit Court of Appeals. A favorable decision would allow me resurrect Lavabit as an American company.

This experience has taught me one very important lesson: without congressional action or a strong judicial precedent, I would strongly recommend against anyone trusting their private data to a company with physical ties to the United States.

Sincerely,  
Ladar Levison  
Owner and Operator, Lavabit LLC

Defending the constitution is expensive! Help us by donating to the Lavabit Legal Defense Fund [here](#).

Lavabit email service closed down on 8 August 2013.  
[goo.gl/bgSrVp](http://goo.gl/bgSrVp)

# Also Bad Guys



Anonymous Hacker operating a tok bonnet using the ZeuS hacking tool wrote:

“FYI I do not cash out the bank accounts or credit cards, I just sell the information (I know, its just as bad, hur dur...), there isn't even a law against such in most countries, dealing with stolen information is most of the time a legaly greyzone (I was just as surprised when I looked it up), I'm not talking about 3rd world countries, but about European like Spain (The Mariposa botnet owner never got charged, because a botnet isn't illegal, only abusing CC information is, but that did other guys).”

[goo.gl/UW1uh0](http://goo.gl/UW1uh0)

# This is a Misconception!

**Without encryption:**



**With encryption:**



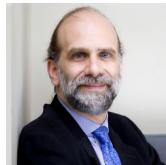
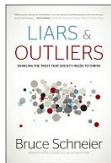
The NSA can probably not brute-force magically better than the “public”.

# Security Engineers

**Security engineers** require a particular **mindset**:

“Security engineers — at least the good ones — see the world differently. They can’t walk into a store without noticing how they might shoplift. They can’t use a computer without wondering about the security vulnerabilities. They can’t vote without trying to figure out how to vote twice. They just can’t help it.”

—Bruce Schneier



# Breaking Things

For example:

Prof. V. Nasty gives the following final exam question (closed books, closed notes):

Write the first 100 digits of  $\pi$ :

3.-----

How can you cheat in this exam and how can you defend against such cheating?



# Chip-and-PIN



- Chip-and-PIN was introduced in the UK in 2004
- before that customers had to sign a receipt
- Is Chip-and-PIN a more secure system?

(Some other countries still use the old method.)

# Yes ...

“Chip-and-PIN is so effective in this country [UK] that fraudsters are starting to move their activities overseas,” said Emile Abu-Shakra, spokesman for Lloyds TSB (in the Guardian, 2006).

- mag-stripe cards cannot be cloned anymore
- stolen or cloned cards need to be used abroad
- fraud on lost, stolen and counterfeit credit cards was down £60m (24%) on 2004's figure

# But let's see ...



Bank



customer / you

# But let's see ...

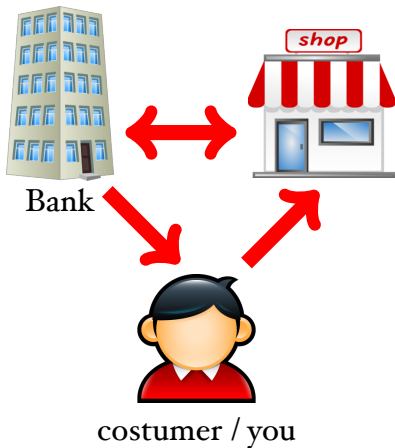


Bank

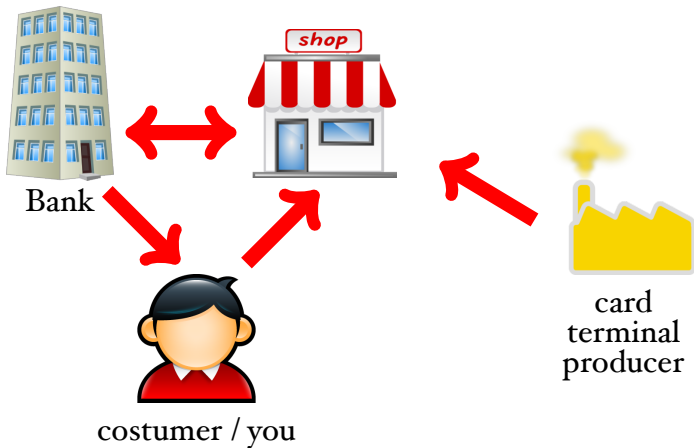


customer / you

# But let's see ...



# But let's see ...



# Chip-and-PIN

- A “tamperesitant” terminal playing Tetris on [youtube](http://www.youtube.com/watch?v=wWTzkD9M0sU).

(<http://www.youtube.com/watch?v=wWTzkD9M0sU>)

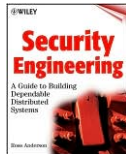


# Chip-and-PIN

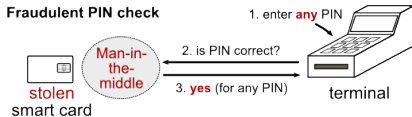
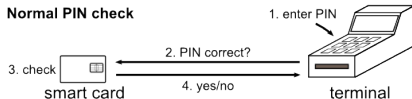
- in 2006, Shell petrol stations stopped accepting Chip-and-PIN after £1m had been stolen from customer accounts
- in 2008, hundreds of card readers for use in Britain, Ireland, the Netherlands, Denmark, and Belgium had been expertly tampered with shortly after manufacture so that details and PINs of credit cards were sent during the 9 months before over mobile phone networks to criminals in Lahore, Pakistan



# Chip-and-PIN is Broken

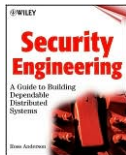


- man-in-the-middle attacks by the group around Ross Anderson



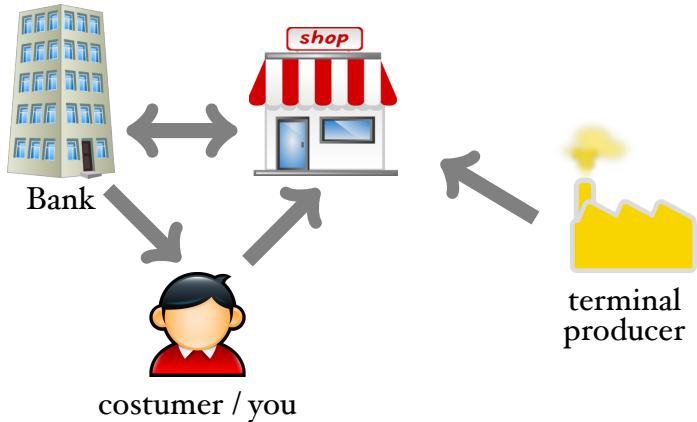
on BBC Newsnight  
in 2010 or [youtube](#)

# Chip-and-PIN is Really Broken



- same group successfully attacked in 2012 card readers and ATM machines
- the problem: several types of ATMs generate poor random numbers, which are used as nonces

# The Real Problem ...



- the burden of proof for fraud and financial liability was shifted to the customer (until approx. 2009/10)

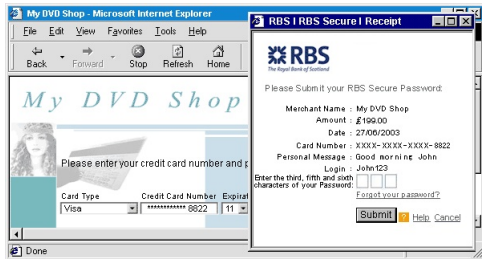
# The Bad Guy Again

The Anonymous Hacker from earlier:

“Try to use ‘Verified-By-Visa’ and ‘Mastercard-Securecode’ as rarely as possible. If only your CVV2 code is getting sniffed, you are not liable for any damage, because the code is physically printed and could have been stolen while you payed with your card at a store. Same applies if someone cloned your CC reading the magnetic stripe or sniffing RFID. Only losing your VBV or MCSC password can cause serious trouble.”

[goo.gl/UW1uh0](http://goo.gl/UW1uh0)

# Being Screwed Again

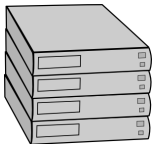


- **Responsibility**

“You understand that you are financially responsible for all uses of RBS Secure.”

[https://www.rbssecure.co.uk/rbs/tdsecure/terms\\_of\\_use.jsp](https://www.rbssecure.co.uk/rbs/tdsecure/terms_of_use.jsp)

# Web Applications



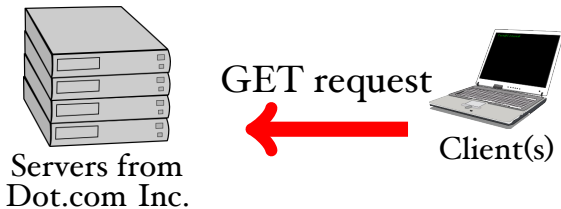
Servers from  
Dot.com Inc.



Client(s)

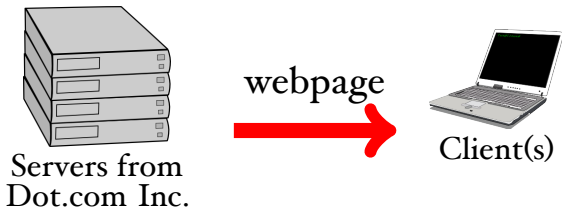
- What are pitfalls and best practices?

# Web Applications



- What are pitfalls and best practices?

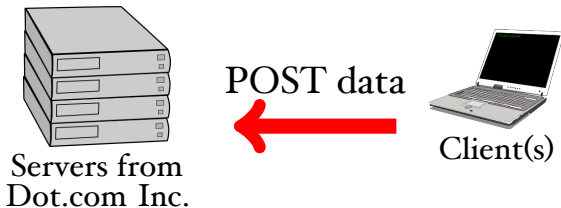
# Web Applications



- What are pitfalls and best practices?



# Web Applications



- What are pitfalls and best practices?

# Why Scala?

twitter 

Linked 

theguardian

Morgan Stanley

CREDIT SUISSE 



edf  
ENERGY

Novell.

foursquare™

HSBC 

...

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twitter 

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CREDIT SUISSE 



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...



5 yrs {

- 2013: 1%
- 2014: 3%
- 2015: 9%
- 2016: 27%
- 2017: 81%
- 2018: 243% 😊

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theguardian

Morgan Stanley

CREDIT SUISSE 

  
edf  
ENERGY

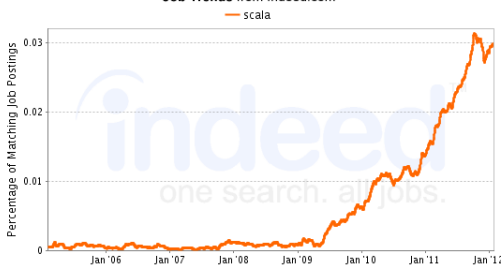
Novell

foursquare™

HSBC 

...

Job Trends from Indeed.com



5 yrs {  
2013: 1%  
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**in London today:** 1 Scala job for every 30 Java jobs;  
Scala programmers seem to get up to 20% better salary

# Why Scala?

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Morgan

CREDIT S

  
edf  
ENERGY

Novel

foursquare

HSBC 

...

Job Trends from Indeed.com



Scala is a functional and object-oriented programming language; compiles to the JVM; does not need null-pointer exceptions; a course on Coursera

<http://www.scala-lang.org>

2016: 27%

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**in London today:** 1 Scala job for every 30 Java jobs;  
Scala programmers seem to get up to 20% better salary

# Scala + Play

a simple response from the server:

```
1 package controllers
2 import play.api.mvc._
3
4 object Application extends Controller {
5
6     // answering a GET request
7     val index = Action { request =>
8         Ok("Hello world!")
9     }
10 }
```

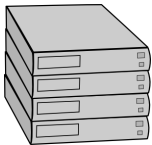
alternative response:

```
Ok("<H1>Hello world!</H1>").as(HTML)
```

```
1  object Application extends Controller {
2
3  // GET request -> present login form
4  val index = Action { request =>
5
6      val form =
7          """<form method="post">
8              Login: <input type="text" name="login"><br>
9              Password: <input type="password" name="password"><br>
10             <input type="submit"></form>"""
11
12     Ok(form).as(HTML)
13 }
14
15 // POST data: processing the login data
16 val receive = Action { request =>
17
18     val form_data = Form(tuple ("login" -> text, "password" -> text))
19     def (login, passwd) = form_data.bindFromRequest()(request).get
20
21     Ok(s"Received login: $login and password: $passwd")
22 }
23 }
```



# Cookies



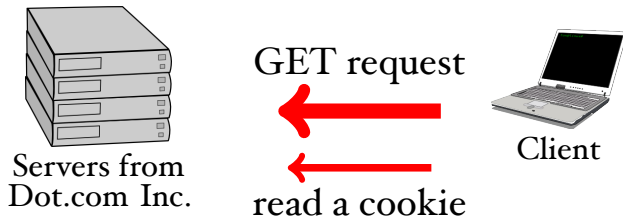
Servers from  
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GET request

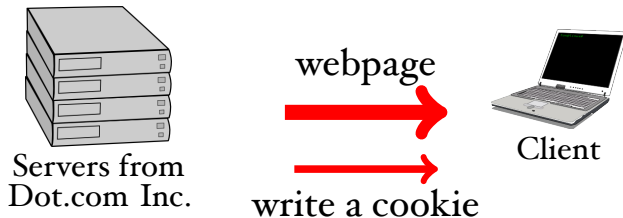


Client

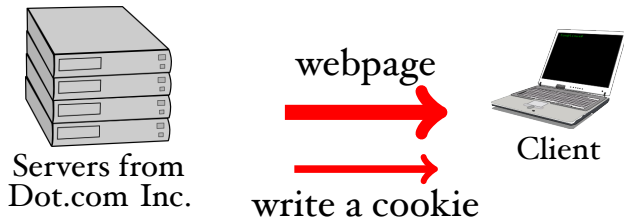
# Cookies



# Cookies



# Cookies



- cookies: max 4KB data
- cookie theft, cross-site scripting attacks
- session cookies, persistent cookies, HttpOnly cookies, third-party cookies, zombie cookies

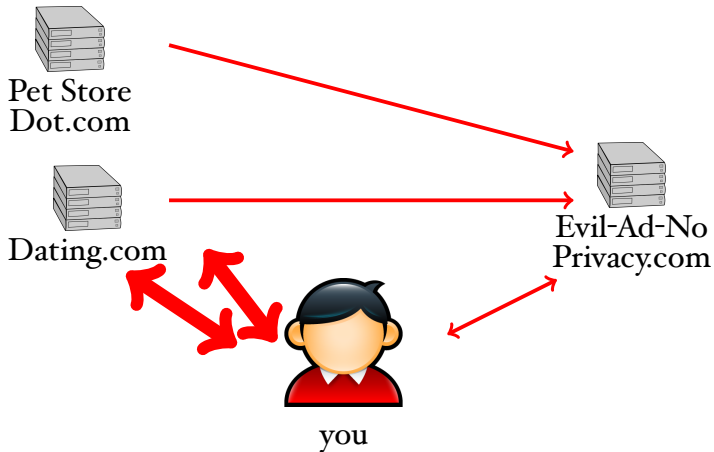
# Cookies

## **EU Privacy Directive about Cookies:**

“In May 2011, a European Union law was passed stating that websites that leave non-essential cookies on visitors’ devices have to alert the visitor and get acceptance from them. This law applies to both individuals and businesses based in the EU regardless of the nationality of their website’s visitors or the location of their web host. It is not enough to simply update a website’s terms and conditions or privacy policy. The deadline to comply with the new EU cookie law was 26th May 2012 and failure to do so could mean a fine of up to £500,000.” →BBC News, [goo.gl/RI4qhh](http://goo.gl/RI4qhh)

- session cookies, persistent cookies, HttpOnly cookies, third-party cookies, zombie cookies

- While cookies are per web-page, this can be easily circumvented.



# My First Webapp

## GET request:

- 1 read the cookie from client
- 2 if none is present, set visits to 0
- 3 if cookie is present, extract visits counter
- 4 if visits is greater or equal 10,  
print a valued customer message  
otherwise just a normal message
- 5 increase visits by 1 and store new cookie with  
client

```

1  object Application extends Controller {
2
3      def gt_cookie(c: Cookie) : Int = c.value match {
4          case s if (s.forall(_.isDigit)) => s.toInt
5          case _ => 0
6      }
7
8      def mk_cookie(i: Int) : Cookie = Cookie("visits", i.toString)
9
10     // GET request: read cookie data first
11     def index = Action { request =>
12
13         //reads the cookie and extracts the visits counter
14         val visits_cookie = request.cookies.get("visits")
15         val visits = visits_cookie.map(gt_cookie).getOrElse(0)
16
17         //printing a message according to value of visits counter
18         val msg =
19             if (visits >= 10)
20                 s"You are a valued customer who has visited this site $visits
21                 else s"You have visited this site $visits times."
22
23         //send message with new cookie
24         Ok(msg).withCookies(mk_cookie(visits + 1))
25     }
26 }

```





- data integrity needs to be ensured

```

1  object Application extends Controller {
2
3      //SHA-1, SHA-256
4      def mk_hash(s: String) : String = {
5          val hash_fun = MessageDigest.getInstance("SHA-1")
6          hash_fun.digest(s.getBytes).map{ "%02x".format(_) }.mkString
7      }
8
9      def gt_cookie(c: Cookie) : Int = c.value.split("/") match {
10         case Array(s, h)
11             if (s.forall(_.isDigit) && mk_hash(s) == h) => s.toInt
12         case _ => 0
13     }
14
15     def mk_cookie(i: Int) : Cookie = {
16         val hash = mk_hash(i.toString)
17         Cookie("visits", s"$i/$hash")
18     }
19
20     def index = Action { request => ... }
21 }

```

- the counter/hash pair is intended to prevent tampering

# SHA-1

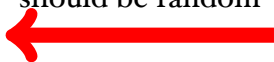
- SHA-1 is a cryptographic hash function (MD5, SHA-256, SHA-512, ...)
- message  $\rightarrow$  digest
- attacks exist:  $2^{80} \rightarrow 2^{61}$

# SHA-1

- SHA-1 is a cryptographic hash function (MD5, SHA-256, SHA-512, ...)
- message  $\rightarrow$  digest
- attacks exist:  $2^{80} \rightarrow 2^{61}$
  
- but dictionary attacks are much more effective for extracting passwords (later)

```
1 object Application extends Controller {
2
3   val salt = "my secret key"
4
5   //SHA-1 + salt
6   def mk_hash(s: String) : String = {
7     val hash_fun = MessageDigest.getInstance("SHA-1")
8     hash_fun.digest((s + salt).getBytes).map{ "%02x".format(_) }.mkStr
9   }
10
11  def gt_cookie(c: Cookie) : Int = c.value.split("/") match {
12    case Array(s, h)
13      if (s.forall(_.isDigit) && mk_hash(s) == h) => s.toInt
14    case _ => 0
15  }
16
17  def mk_cookie(i: Int) : Cookie = {
18    val hash = mk_hash(i.toString)
19    Cookie("visits", s"$i/$hash")
20  }
21
22  def index = Action { request => ... }
23 }
```

should be random



# Unix Passwords

- passwords must **not** be stored in clear text
- instead /etc/shadow contains

```
name:$1$QIGCa$/ruJs8AvmrknzKTzM2TYE.:other_info
```

- \$ is separator
- 1 is MD5 (actually SHA-512 is used nowadays, 6)
- QIGCa is salt
- ruJs8AvmrknzKTzM2TYE → password + salt

```
(openssl passwd -1 -salt QIGCa pippo)
```

# Plain-Text Passwords

# Plain-Text Passwords

On 25 September 2012, a report on a data breach at IEEE:

- IEEE is a standards organisation (not-for-profit)
- many standards in CS are by IEEE
- 100k plain-text passwords were recorded in logs
- the logs were openly accessible on their FTP server

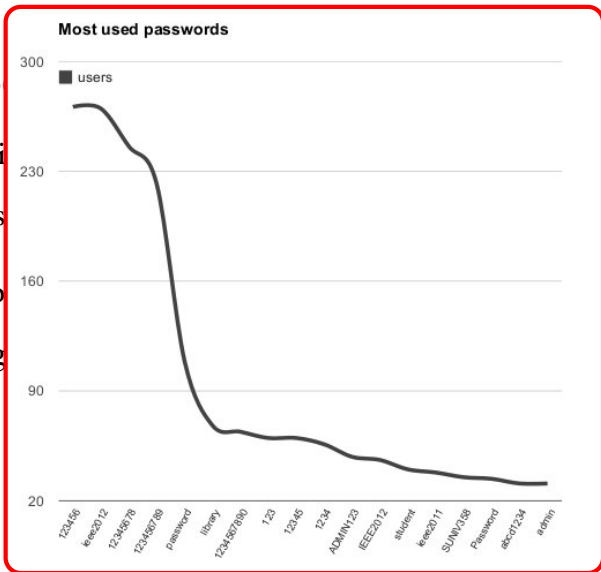
<http://ieeelog.com>



# Plain-Text Passwords

On 25 S

- IEEE i
- many s
- took p
- the log



IEEE:

log.com

# Other Password Blunders

- in late 2009, when an SQL injection attack against online games service RockYou.com exposed 32 million **plaintext** passwords
- 1.3 million Gawker credentials exposed in December 2010 containing unsalted(?) **MD5** hashes
- June 6th, 2012, 6 million unsalted SHA-1 passwords were leaked from linkedIn

(web user maintains 25 separate accounts but uses just 6.5 passwords.)

# Brute Forcing Passwords

- How fast can hackers crack SHA-1 passwords?

# Brute Forcing Passwords

- How fast can hackers crack SHA-1 passwords?
- The answer is 2 billion attempts per second using a Radeon HD 7970

| password length | time     |
|-----------------|----------|
| 5 letters       | 5 secs   |
| 6 letters       | 500 secs |
| 7 letters       | 13 hours |
| 8 letters       | 57 days  |
| 9 letters       | 15 years |



graphics card  
ca. £300

5 letters  $\approx 100^5 = 10$  billion combinations  
(1 letter - upper case, lower case, digits, symbols  $\approx 100$ )

# Passwords

How to recover from a breakin?

# Passwords

How to recover from a breakin?

- Do not send passwords in plain text.
- Security questions are tricky to get right.
- QQ (Chinese Skype) authenticates you via contacts.

# This Course

- break-ins (buffer overflows)
- access control  
(role based, data security / data integrity)
- electronic voting
- protocols (specification)
- access control logic
- privacy

*Scott McNealy:*

*“You have zero privacy anyway. Get over it.”*

- zero-knowledge proofs

# User-Tracking Without Cookies

Can you track a user **without**:

- Cookies
- Javascript
- LocalStorage/SessionStorage/GlobalStorage
- Flash, Java or other plugins
- Your IP address or user agent string
- Any methods employed by Panopticlick  
→ <https://panopticlick.eff.org/>

Even when you disabled cookies entirely, have Javascript turned off and use a VPN service.



# User-Tracking Without Cookies

Can you track a user **without**:

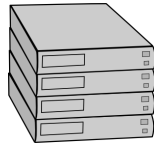
- Cookies
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- Flash, Java or other plugins
- Your IP address or user agent string
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→ <https://panopticlick.eff.org/>

Even when you disabled cookies entirely, have Javascript turned off and use a VPN service. And numerous sites already use it.

# Web-Protocol



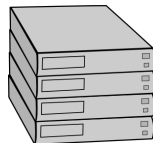
GET static.jpg



# Web-Protocol



GET static.jpg

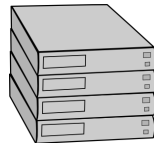


ETag: 7b33de1

# Web-Protocol



GET static.jpg



ETag: 7b33de1

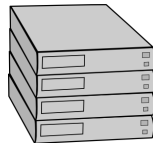
GET static.jpg ETag: 7b33de1



# Web-Protocol



GET static.jpg



ETag: 7b33de1

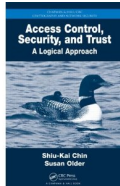
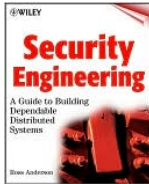
GET static.jpg ETag: 7b33de1



HTTP/1.1 304 (Not Modified)

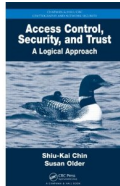
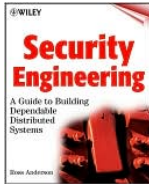
# Books + Homework

- There is no single book I am following



# Books + Homework

- There is no single book I am following



- The question “Is this relevant for the exams” is not appreciated!

Whatever is in the homework sheets (and is not marked optional) is relevant for the exam. No code needs to be written.

# This Course is about Satan's Computer

Ross Anderson and Roger Needham wrote:

“In effect, our task is to program a computer which gives answers which are subtly and maliciously wrong at the most inconvenient possible moment... we hope that the lessons learned from programming Satan's computer may be helpful in tackling the more common problem of programming Murphy's.”



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Murphy's computer



Satan's computers

# Take-Home Points

- Never store passwords in plain text.
- Always salt your hashes!
- Use an existing crypto algorithm; do not write your own!
- Make the party responsible for losses, who is in the position to improve things.