Access Control and Privacy Policies (1)

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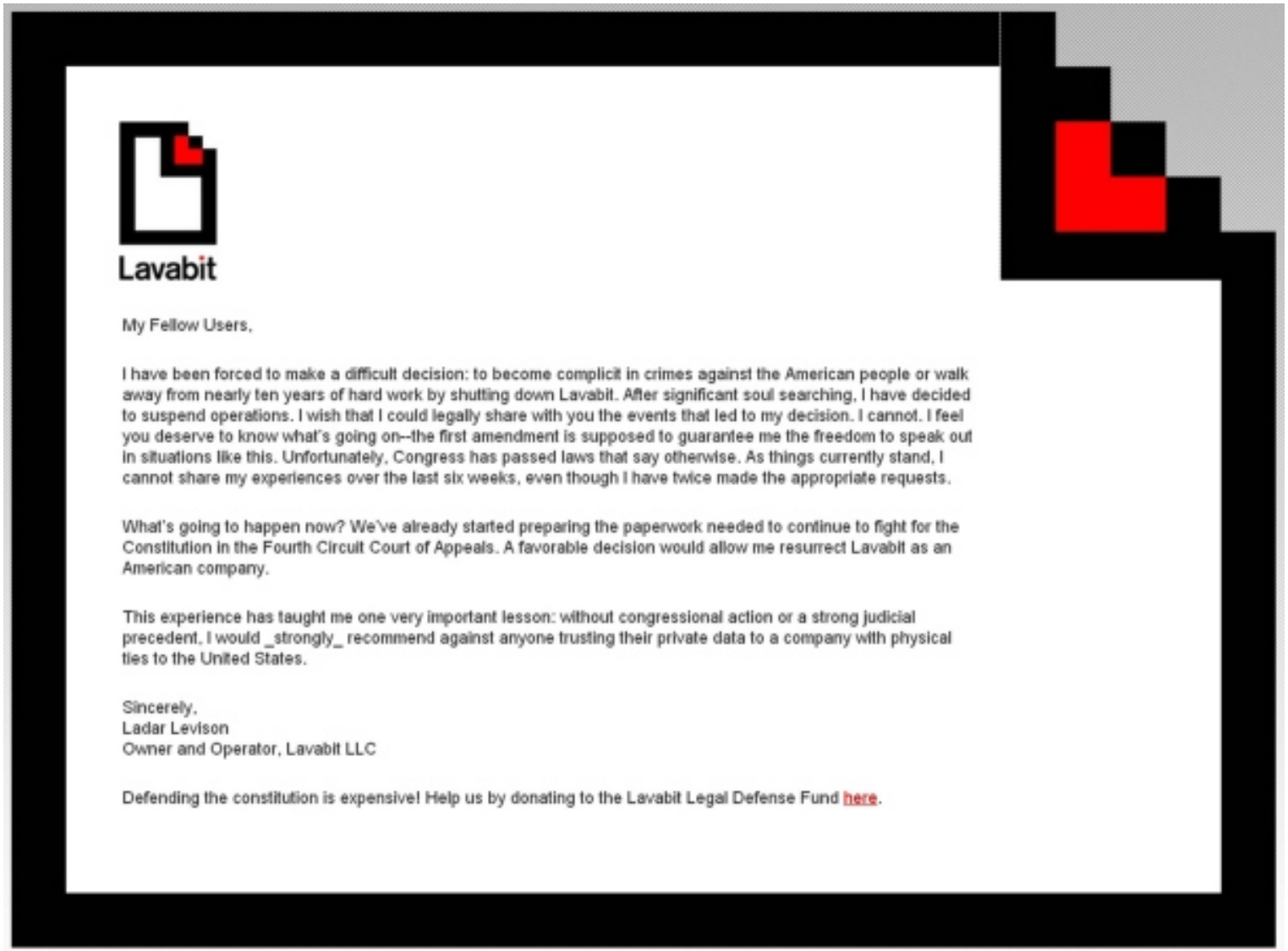
Slides: KEATS


NATIONAL SECURITY AGENCY
UNITED STATES OF AMERICA


GCHQ

• • •



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

Also Bad Guys

Annonymous Hacker operating a 10k 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/UWluh0

This is a Misconception!

Without encryption:

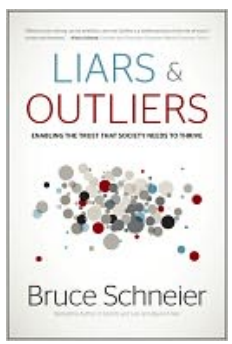
With encryption:

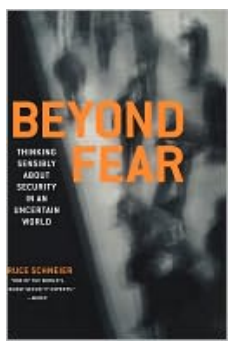
The NSA can probably not brute force magically better than the “public”.

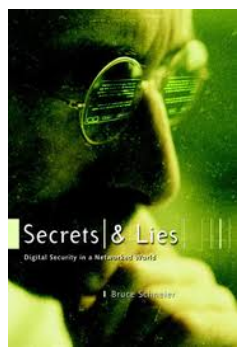
Security Engineers

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 do you "break" this and how to defend against it?

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?

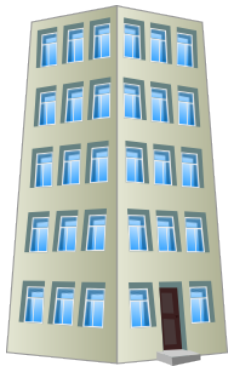
(Some other countries still use the old method.)

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

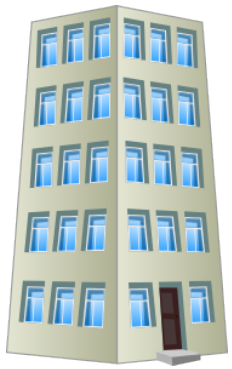
But let's see ...



Bank

costumer / you

But let's see ...



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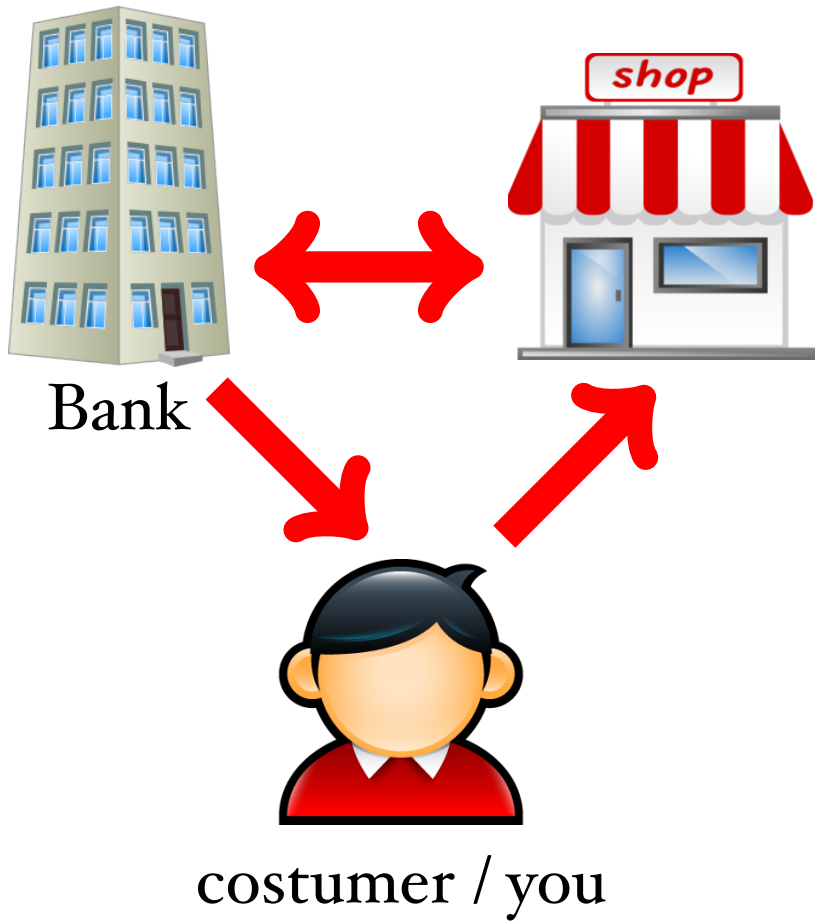

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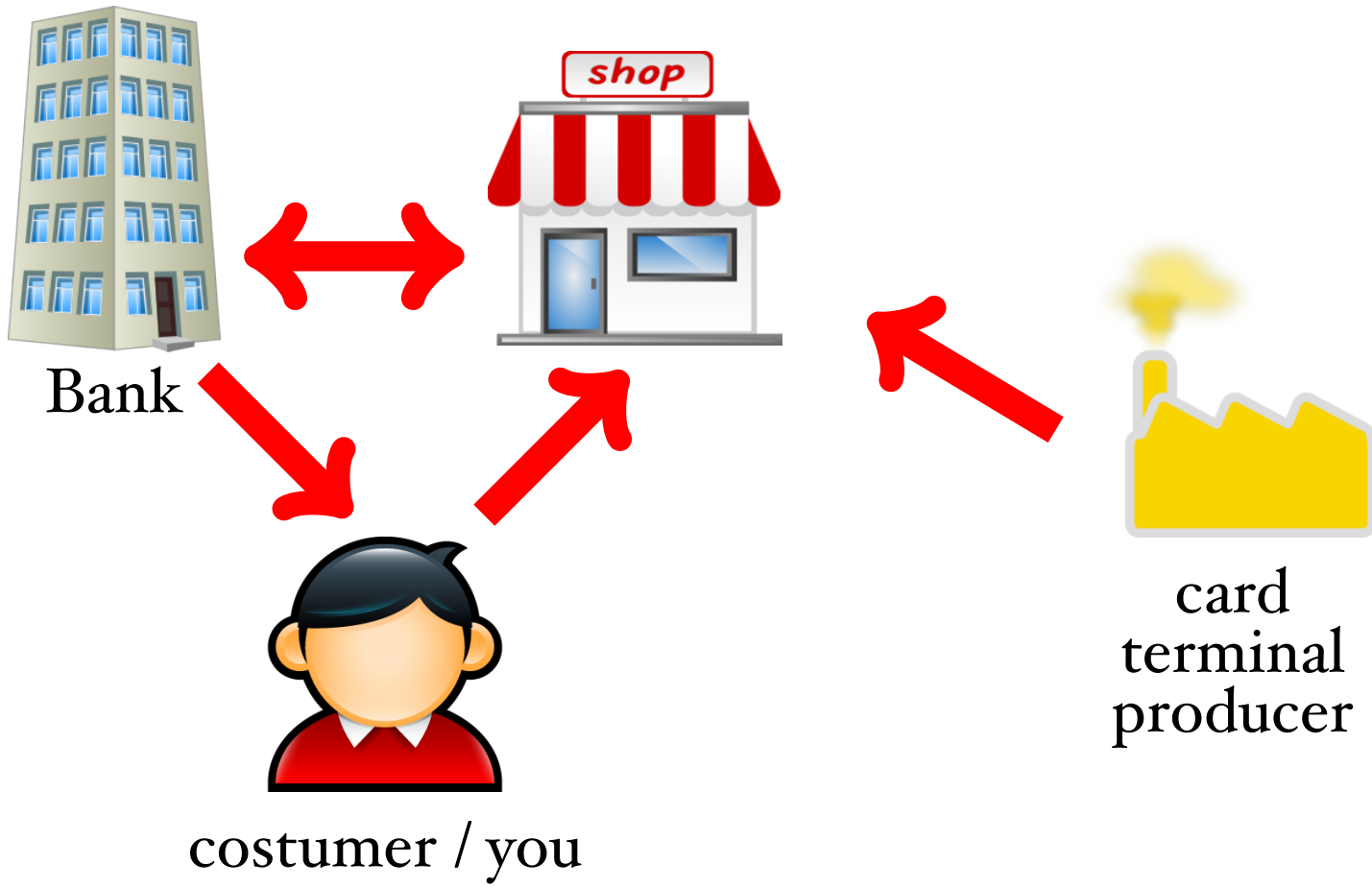


Chip-and-PIN

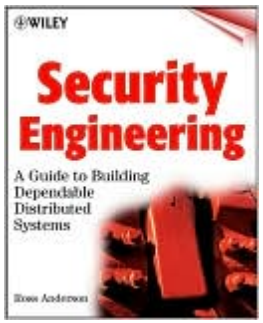
- A "tamperesitant" terminal playing Tetris on youtube.

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

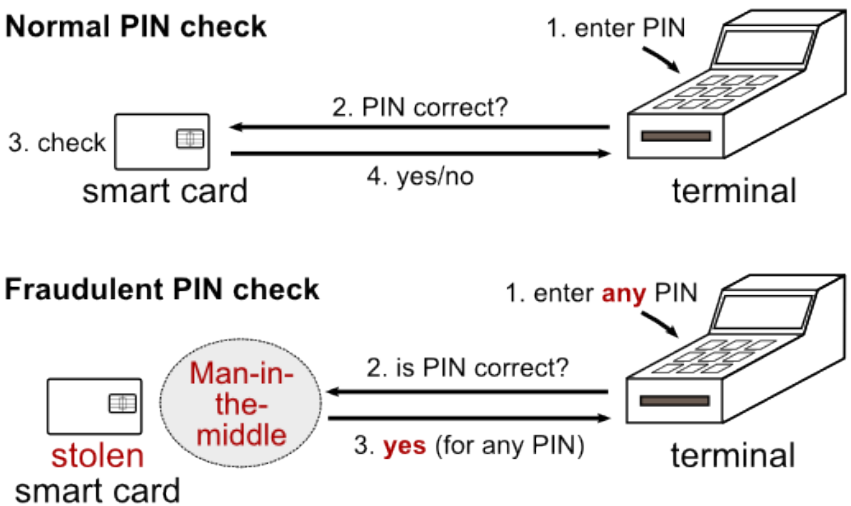
Chip-and-PIN

- 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

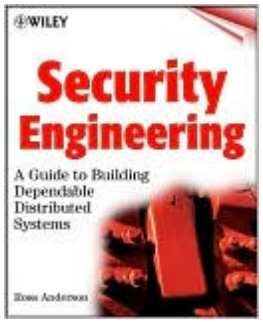


- man-in-the-middle attacks by the group around Ross Anderson



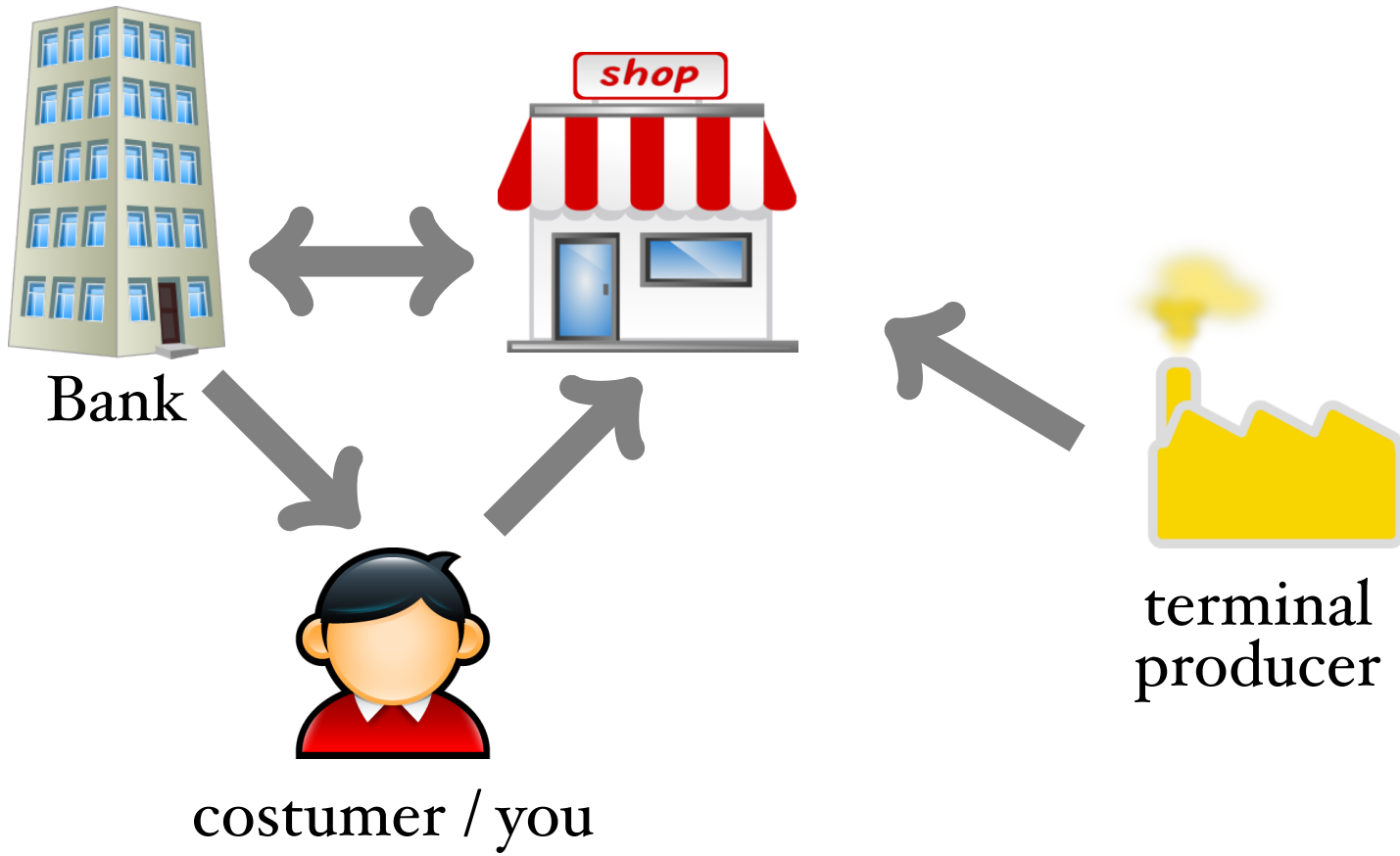
on BBC Newsnight in 2010 or youtube

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 costumer (until approx. 2009/10)

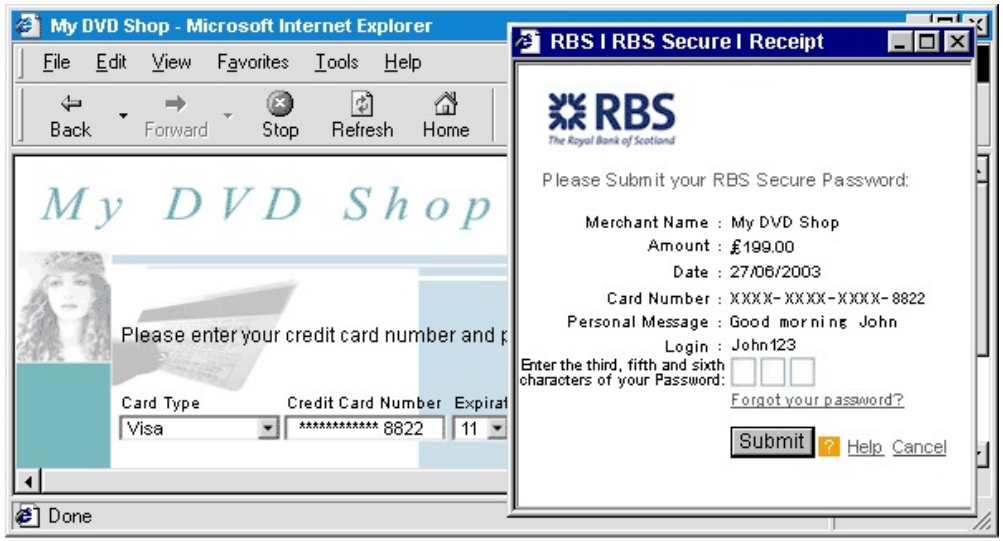
The Bad Guy Again

"The Annonymous 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/UWluh0

Being Screwed Again

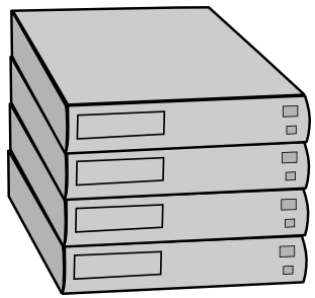


- **Responsibility**

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

  https://www.rbssecure.co.uk/rbs/tdsecure/terms_of_use.jsp

Web Applications

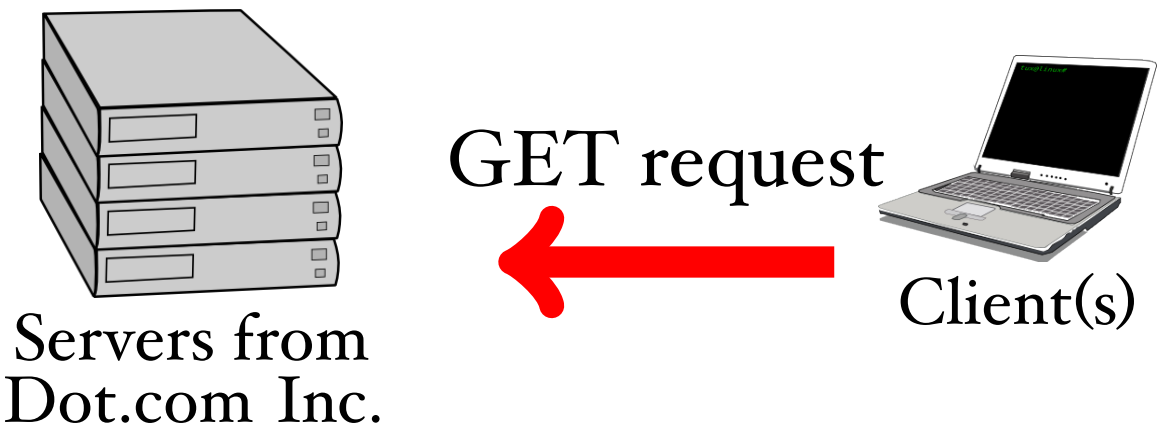


Servers from
Dot.com Inc.

Client(s)

- What are pitfalls and best practices?

Web Applications



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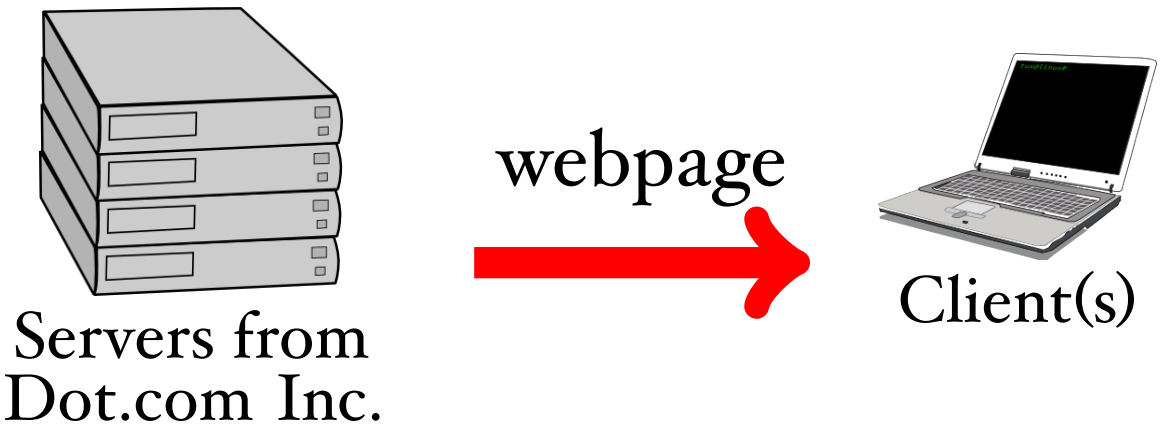
Web Applications



- What are pitfalls and best practices?

Web Applications

- What are pitfalls and best practices?

Why Scala?

Morgan Stanley

...

Why Scala?

twitter

LinkedIn

theguardian

Morgan Stanley

CREDIT SUISSE

EDF ENERGY

Novell

foursquare

HSBC

...

Why Scala?

twitter

LinkedIn

theguardian

Morgan Stanley

CREDIT SUISSE

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...

5 yrs {
- 2013: 1%
- 2014: 3%
- 2015: 9%
- 2016: 27%
- 2017: 81%
- 2018: 243% 😁

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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

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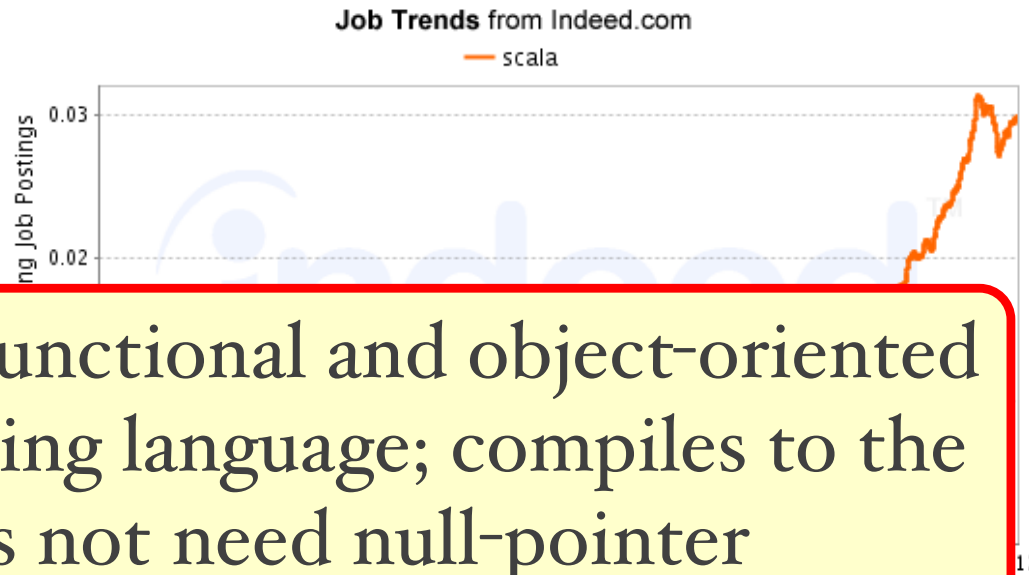


Scala is a functional and object-oriented programming language; compiles to the JVM; does not need null-pointer exceptions; a course on Coursera

http://www.scala-lang.org

2016: 27%
2017: 81%
2018: 243%

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:

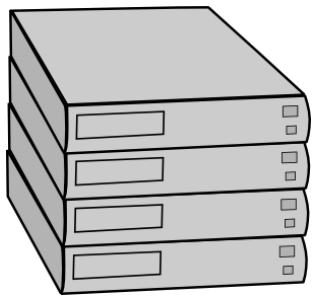
```
1  package controllers
2  import play.api.mvc._
3
4  object Application extends Controller {
5
6    // answering a GET request
7    val index = Action { request =>
8      Ok("Hello world!")
9    }
10 }
```

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

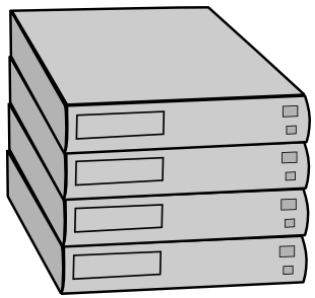


Servers from
Dot.com Inc.

GET request

Client

Cookies



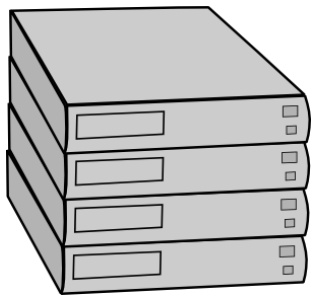
Servers from
Dot.com Inc.

GET request

read a cookie

Client

Cookies



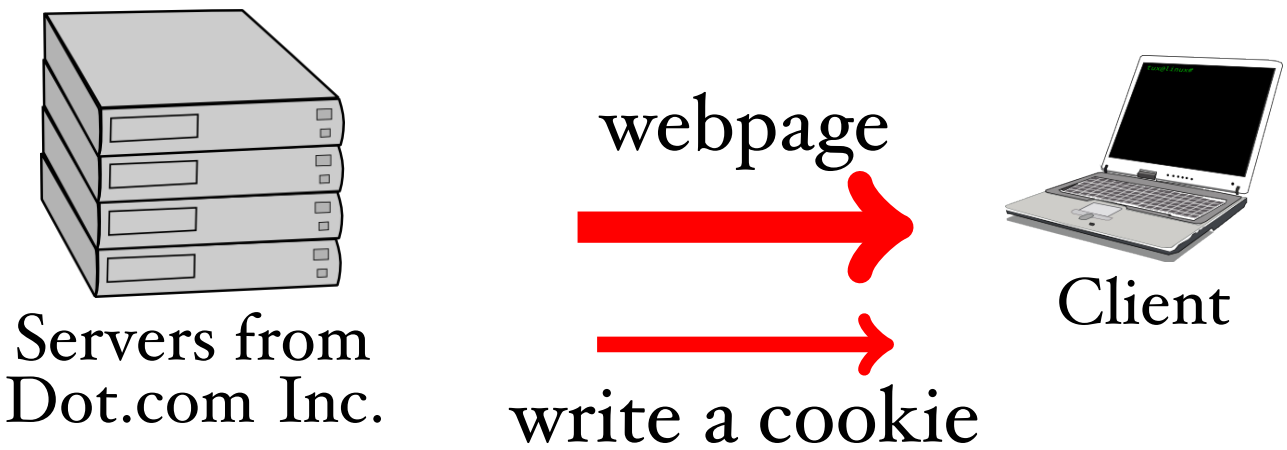
Servers from
Dot.com Inc.

webpage

write a cookie

Client

Cookies



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

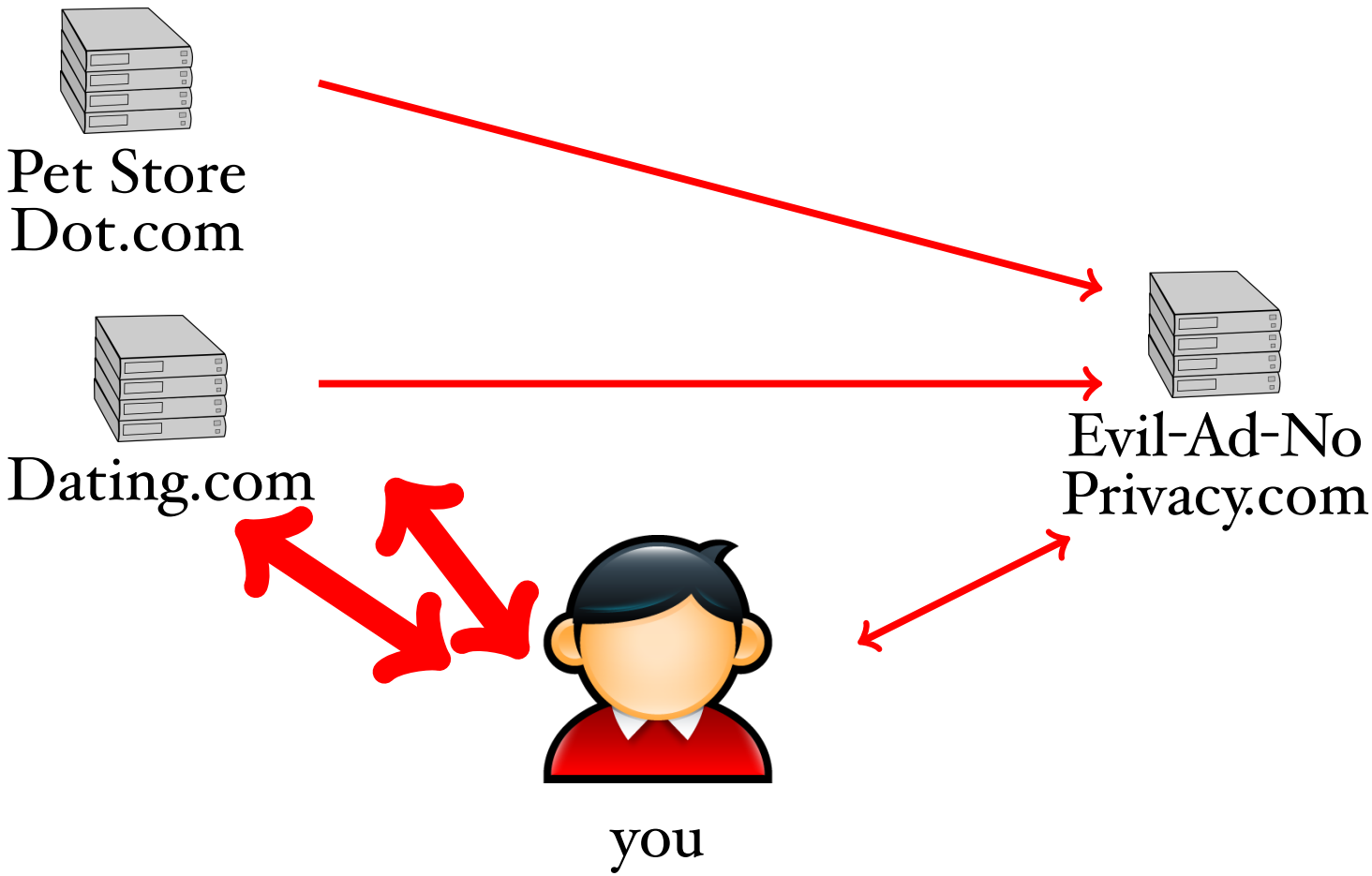
Cookies

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

- 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

```scala
object Application extends Controller {

  def gt_cookie(c: Cookie) : Int = c.value match {
    case s if (s.forall(_.isDigit)) => s.toInt
    case _ => 0
  }

  def mk_cookie(i: Int) : Cookie = Cookie("visits", i.toString)

  // GET request: read cookie data first
  def index = Action { request =>

    //reads the cookie and extracts the visits counter
    val visits_cookie = request.cookies.get("visits")
    val visits = visits_cookie.map(gt_cookie).getOrElse(0)

    //printing a message according to value of visits counter
    val msg =
      if (visits >= 10)
        s"You are a valued customer who has visited this site $visits
      else s"You have visited this site $visits times."

    //send message with new cookie
    Ok(msg).withCookies(mk_cookie(visits + 1))
  }
}
```

- 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 $\longrightarrow$ digest
- attack exists $2^{80} \longrightarrow 2^{61}$

SHA-1

- SHA-1 is a cryptographic hash function (MD5, SHA-256, SHA-512, ...)
- message $\longrightarrow$ digest
- attack exists $2^{80} \longrightarrow 2^{61}$

- but dictionary attacks are very 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)
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22   def index = Action { request => ... }
23 }
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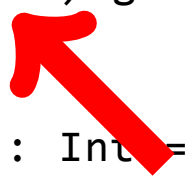


Unix Passwords

- 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` $\longrightarrow$ 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:

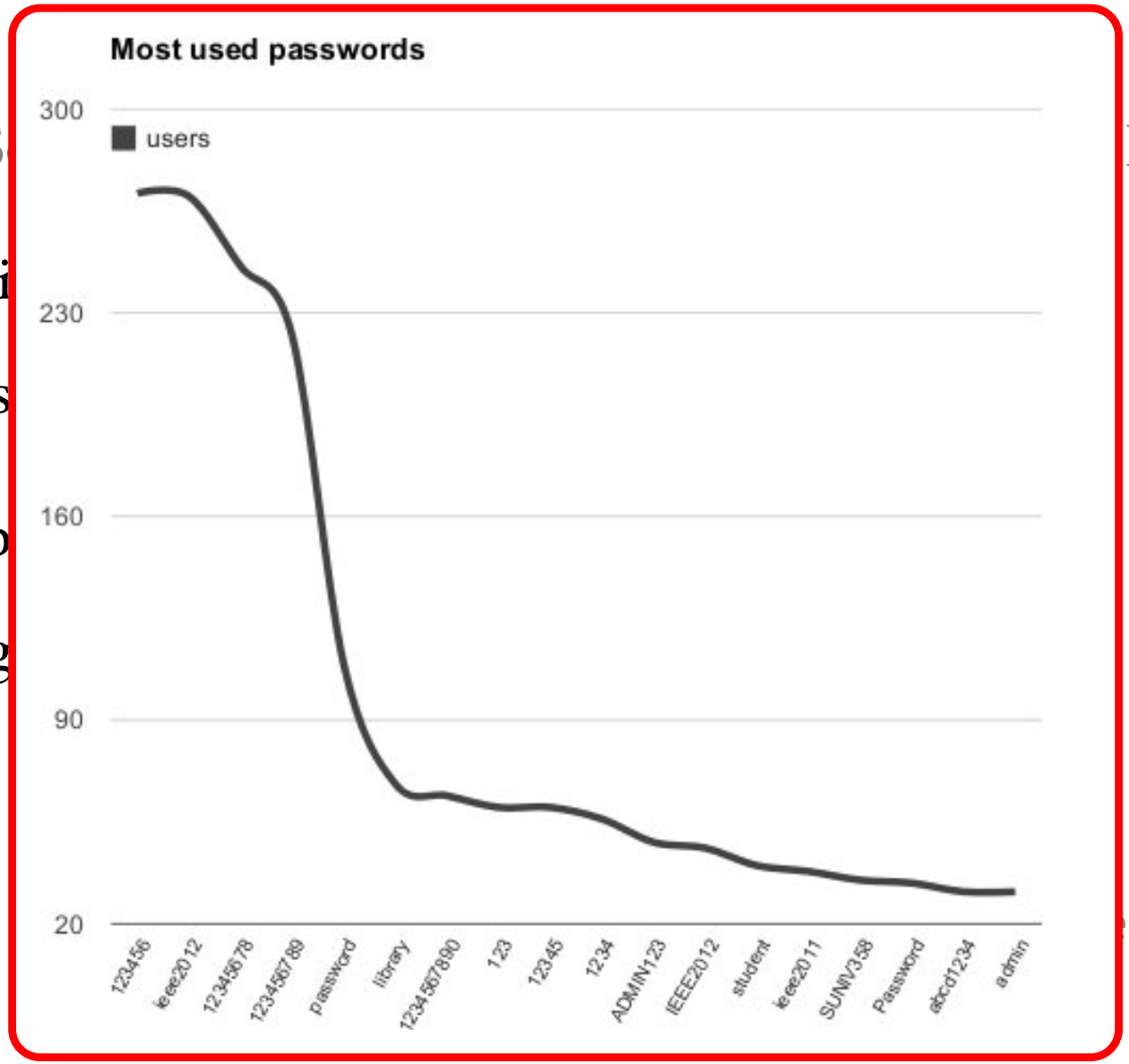
- IEEE is a standards organisation (not-for-profit)
- many standards in CS are by IEEE
- 100k plain-text passwords were recorded in logs
- the logs were openly accessible on their FTP server

`http://ieeelog.com`

Plain-Text Passwords

On 25 S… …EEE:

- IEEE i…
- many s…
- 100k p…
- the log…



…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 ≈ 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.

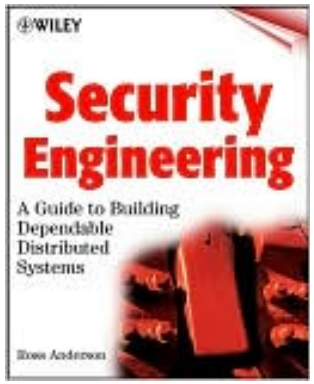
This Course

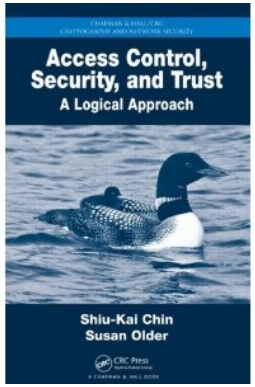
- break-ins (buffer overflows)
- access control
  (role based, data security / data integrity)
- protocols
  (specification)
- access control logic
- privacy

  Scott McNealy:
  "You have zero privacy anyway. Get over it."

Books + Homework

- there is no single book I am following





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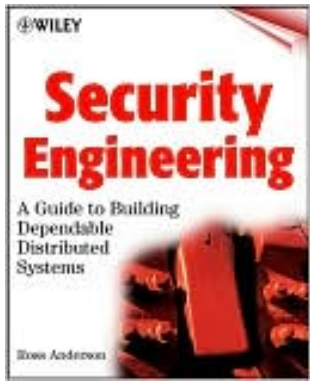

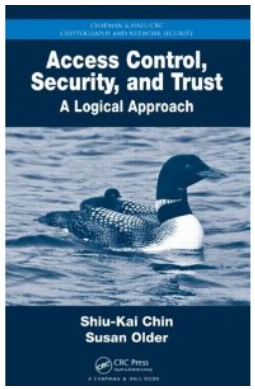

- The question "Is this relevant for the exams" is not appreciated!

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

Take-Home Points

- Never store passwords in plain text.
- Always salt your hashes!
- Use an existing algorithm; do not write your own!

Thinking as a Defender

- What are you trying to protect?
- What properties are you trying to enforce?
- Who are the attackers? Capabilities? Motivations?
- What kind of attack are we trying to protect?
- Who can fix any vulnerabilities?
- What are the weaknesses of the system?
- What will successful attacks cost us?
- How likely are the attacks?

Security almost always is **not** free!

The Security Mindset

- How things can go wrong.
- Think outside the box.

The difference between being criminal is to only **think** about how things can go wrong.

Maps in Scala

- `map` takes a function, say f, and applies it to every element of the list:

```
List(1, 2, 3, 4, 5, 6, 7, 8, 9)
```

```
List(1, 4, 9, 16, 25, 36, 49, 64, 81)
```