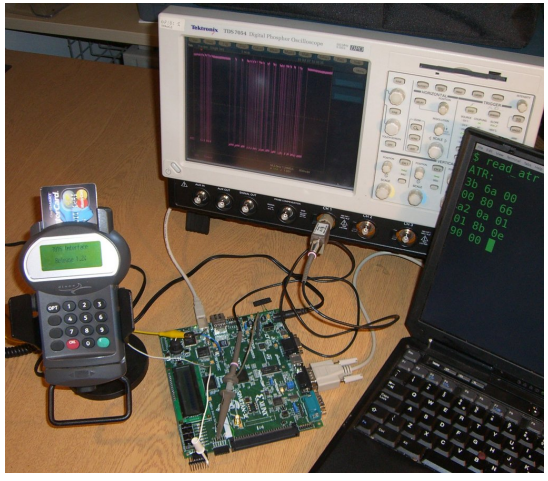
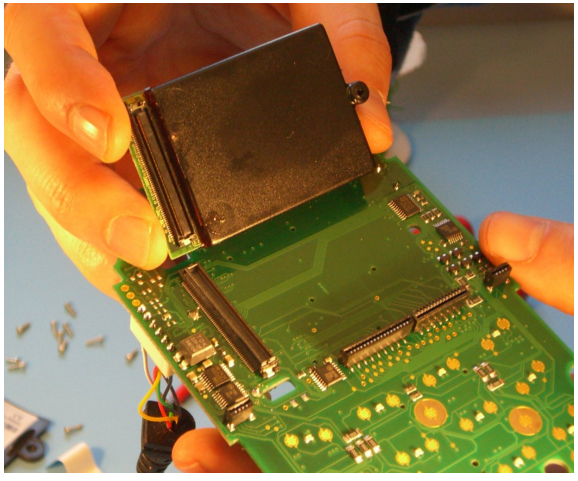
Online Banking Security





Steven J. Murdoch

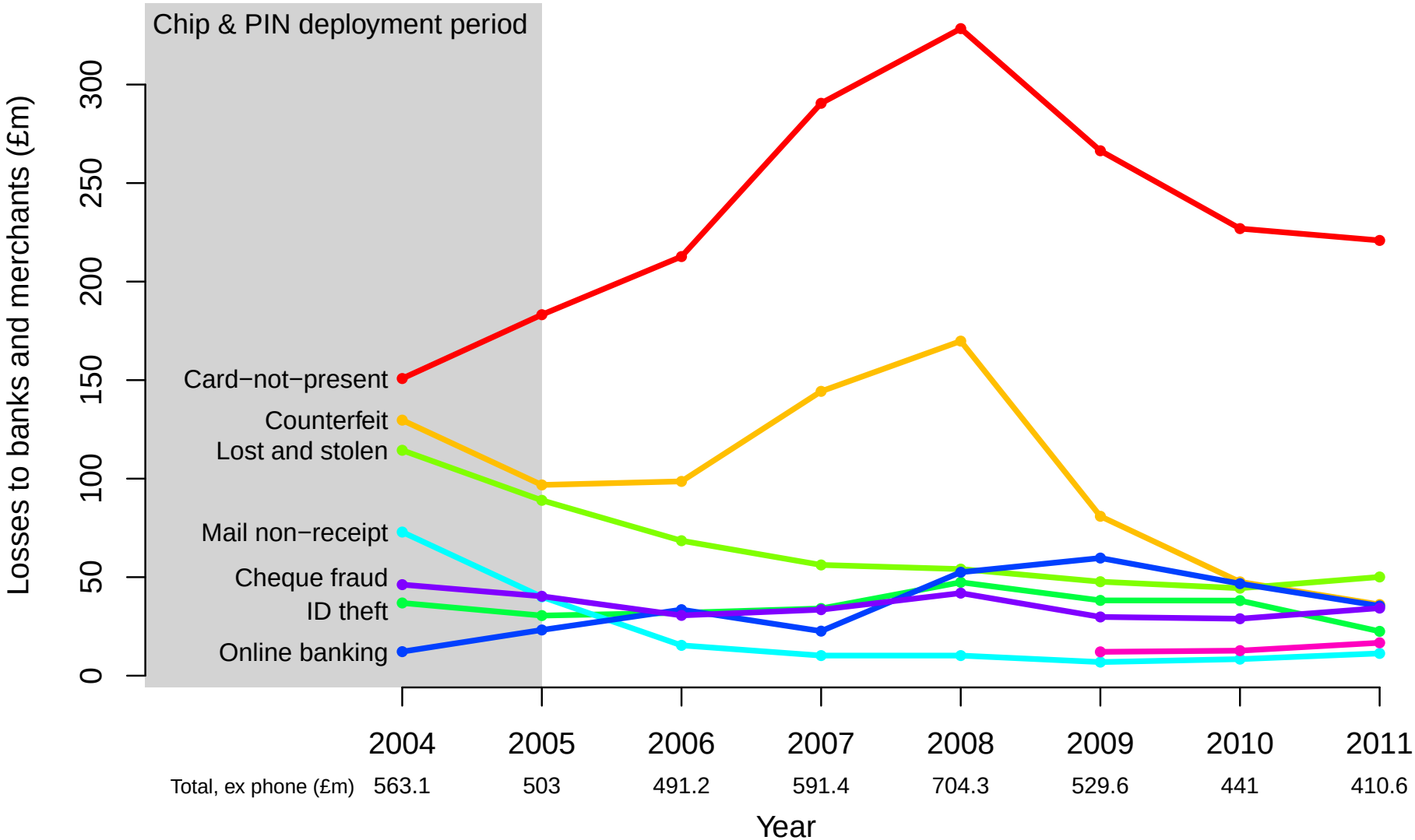
http://www.cl.cam.ac.uk/users/sjm217/

work with Saar Drimer, Ross Anderson, Mike Bond

UNIVERSITY OF CAMBRIDGE
Computer Laboratory

SecAppDev, February 2014, Leuven, BE

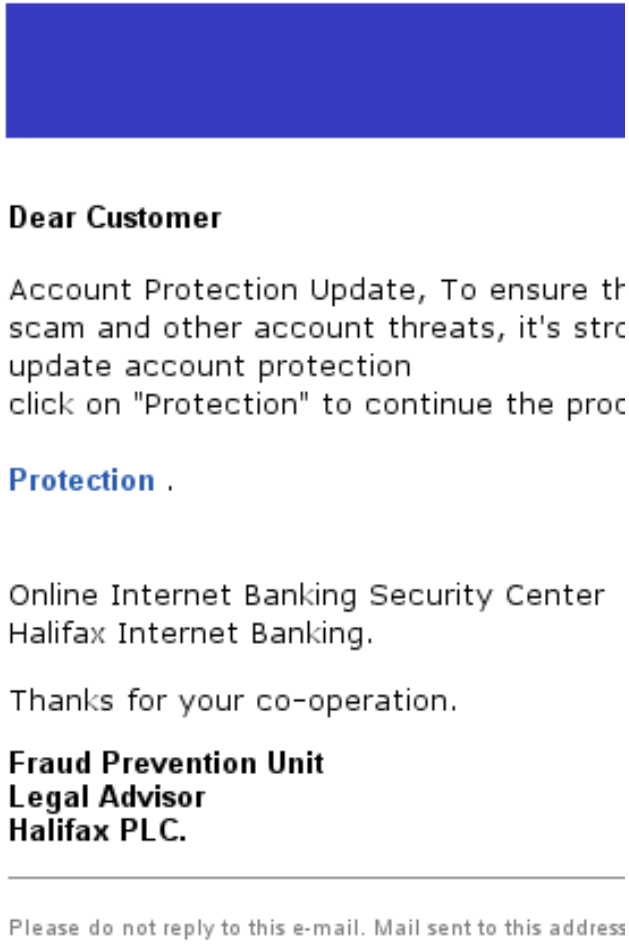
UK fraud figures 2004–2011



Source: Financial Fraud Action UK

Online banking fraud is a significant and growing problem in the UK

- 174% increase in users between 2001 and 2007
- 185% increase in fraud in 2007–2008 (£ 21.4m in first 6 months of 2008)
- Simple fraud techniques dominate in the UK:
  - Phishing emails
  - Keyboard loggers
- Still work, and still used by fraudsters, due to the comparatively poor security



Dear Customer

Account Protection Update, To ensure th
scam and other account threats, it's strc
update account protection
click on "Protection" to continue the proc

Protection .

Online Internet Banking Security Center
Halifax Internet Banking.

Thanks for your co-operation.

Fraud Prevention Unit
Legal Advisor
Halifax PLC.

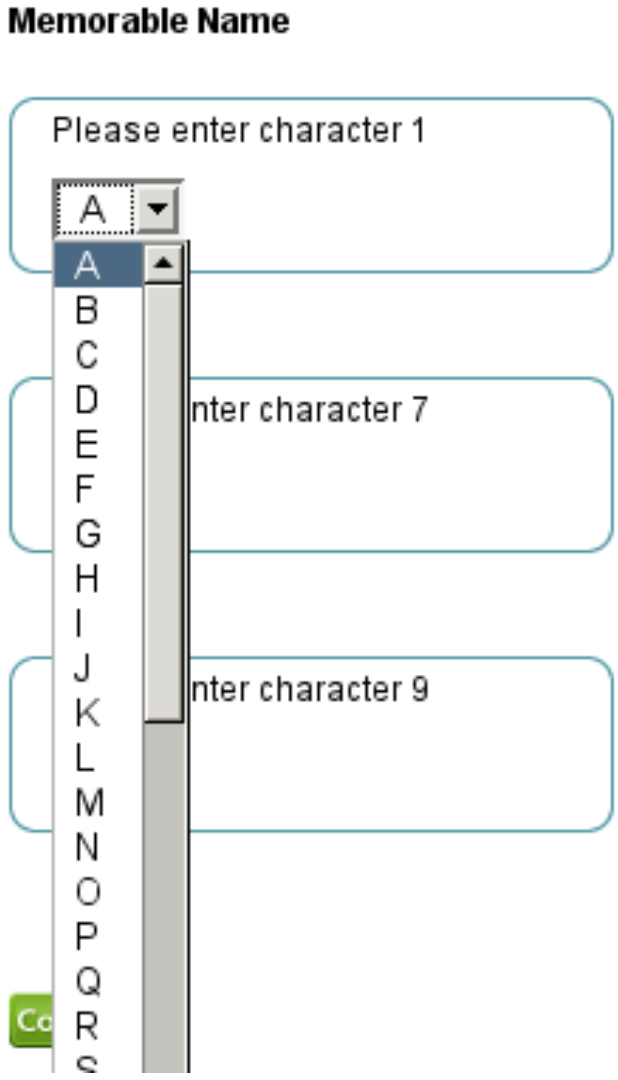
Please do not reply to this e-mail. Mail sent to this address

A variety of solutions have been proposed to resist phishing

- On-screen keyboards
- Picture passwords
- Device fingerprinting
- One-time-passwords/iTAN

All of these defences have been broken by fraudsters

- Malware
- Man in the Middle (MITM)
- Combination: Man in the Browser



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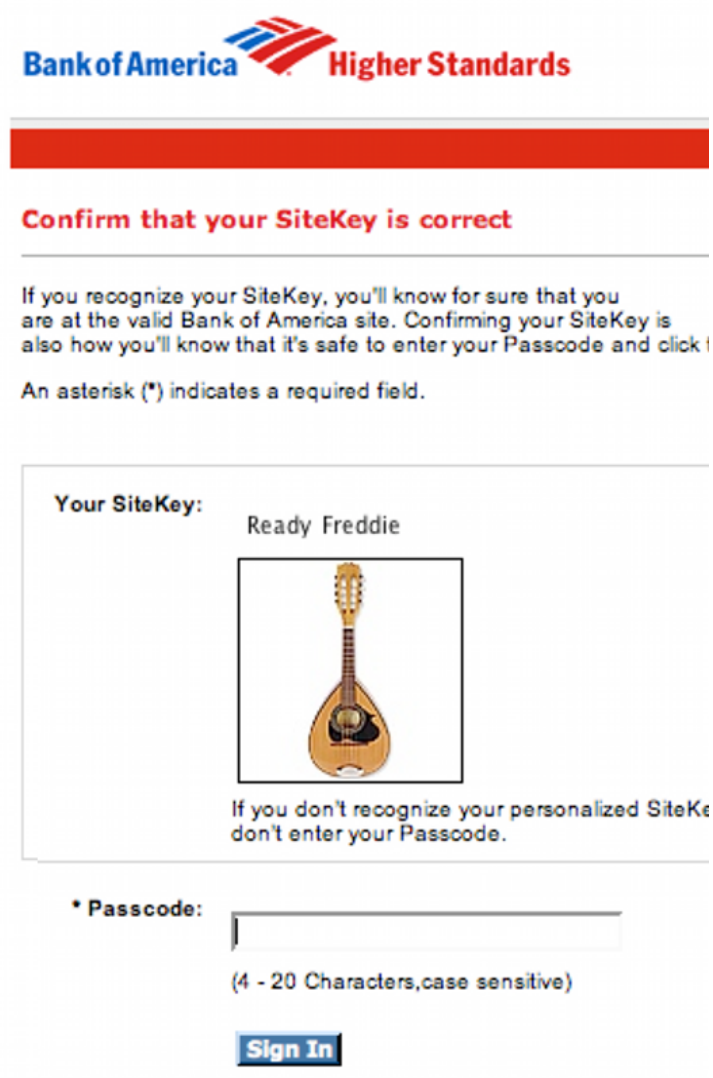

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HTTP Header Information

Which headers does your browser send? When communicating with the webs
contain information about which type of images are supported, which kind of d
cookies etc.

HTTP Header	Value
HTTP_ACCEPT	text/html,application/xhtml+xml,applicatio
HTTP_ACCEPT_CHARSET	ISO-8859-1,utf-8;q=0.7,*;q=0.7
HTTP_ACCEPT_ENCODING	gzip,deflate
HTTP_ACCEPT_LANGUAGE	en-us,en;q=0.5
HTTP_CONNECTION	keep-alive
HTTP_HOST	browserspy.dk
HTTP_KEEP_ALIVE	300
HTTP_REFERER	http://browserspy.dk/geolocation.php
HTTP_USER_AGENT	Mozilla/5.0 (Macintosh; U; Intel Mac OS X
QUERY_STRING	
REMOTE_ADDR	128.232.9.64
REMOTE_PORT	50625
REQUEST_METHOD	GET
REQUEST_URI	/headers.php
REQUEST_TIME	1261872241

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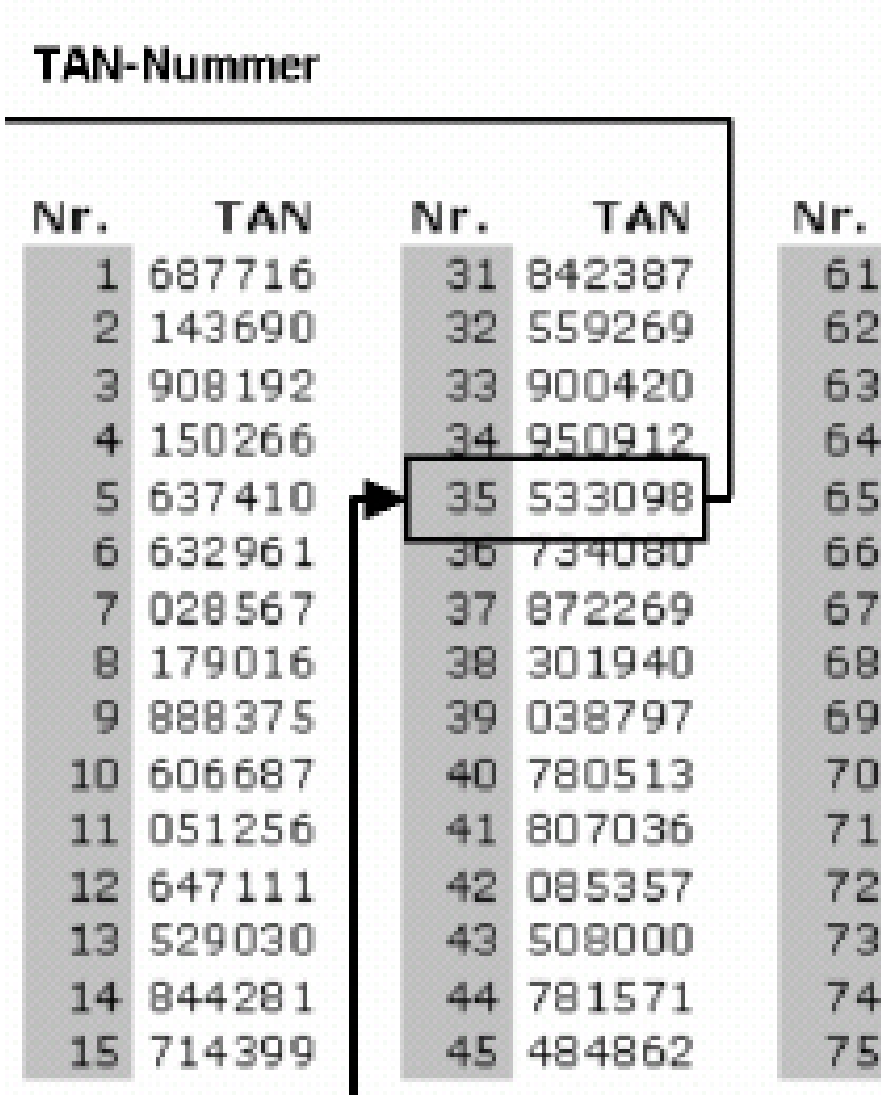

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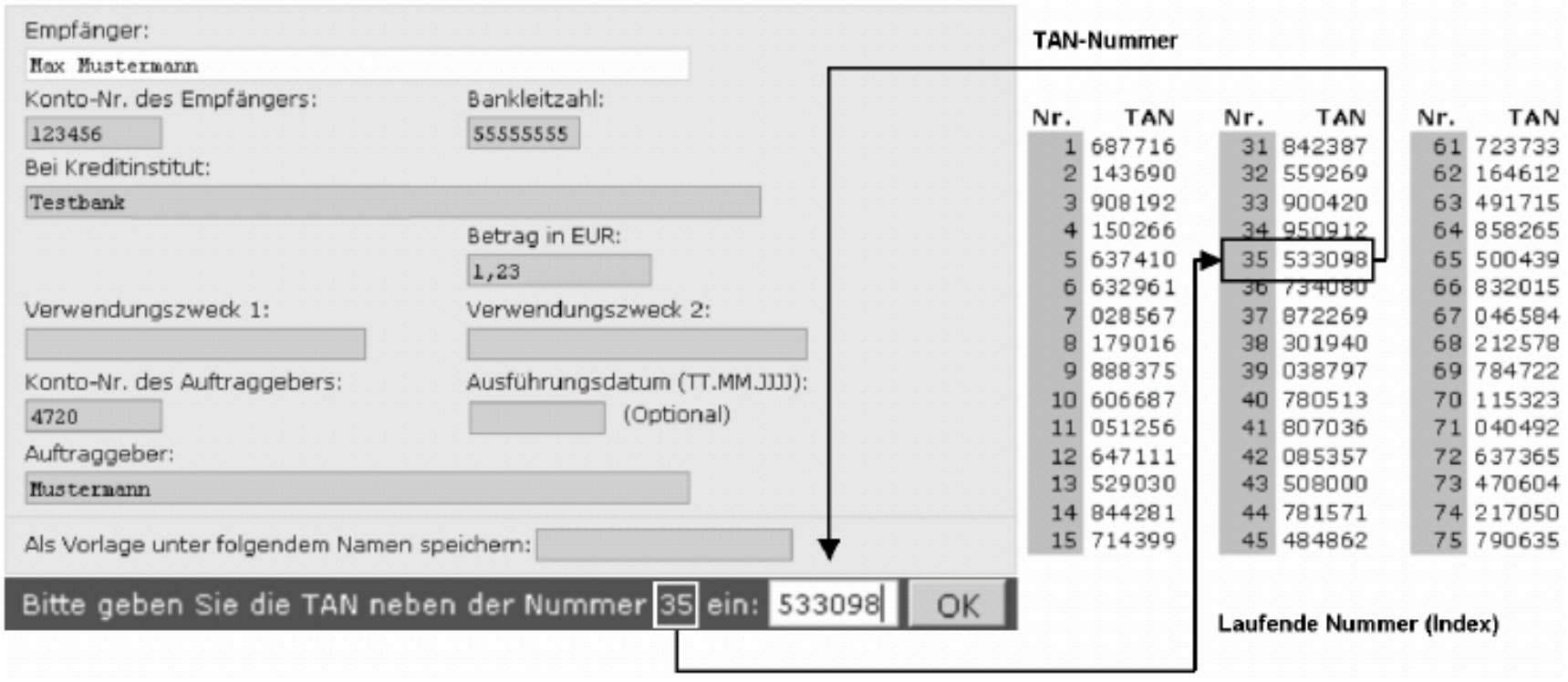
iTAN



Picture: Volksbank Dill eG

Customer must provide the requested one time password

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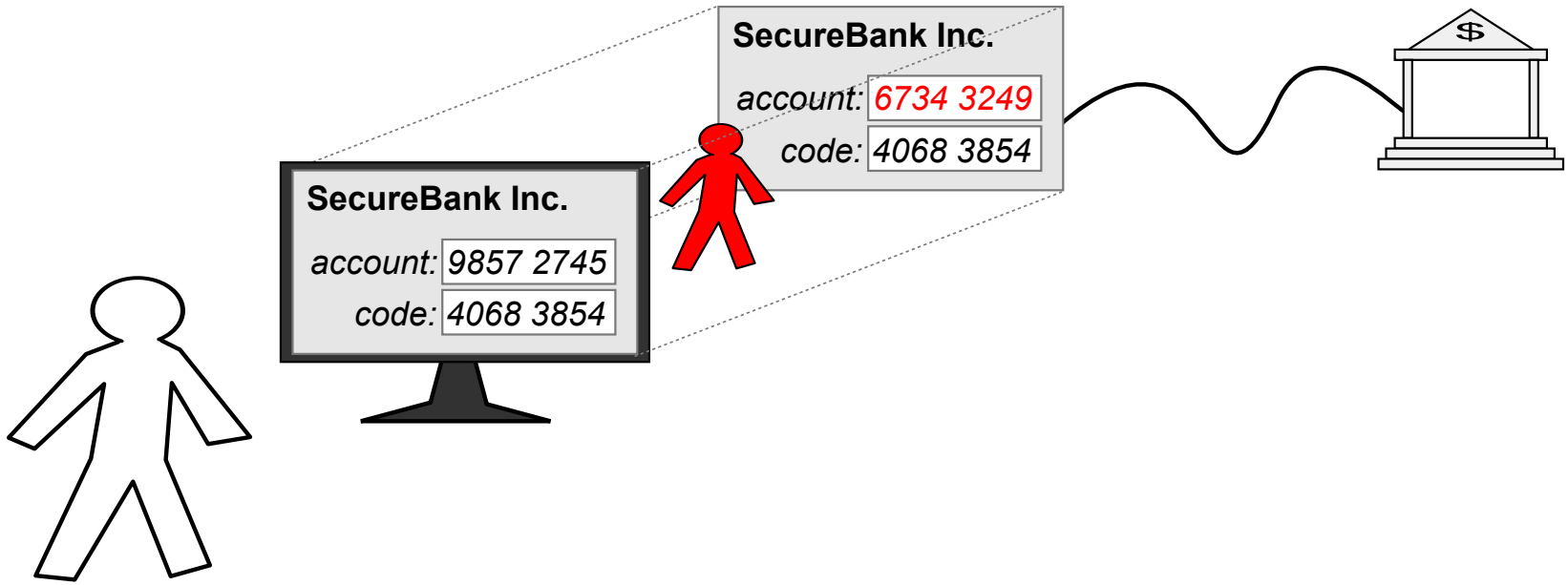
Man in the browser



Malware embeds itself into the browser

Changes destination/amount of transaction in real-time

Any one-time password is valid, and mutual authentication succeeds

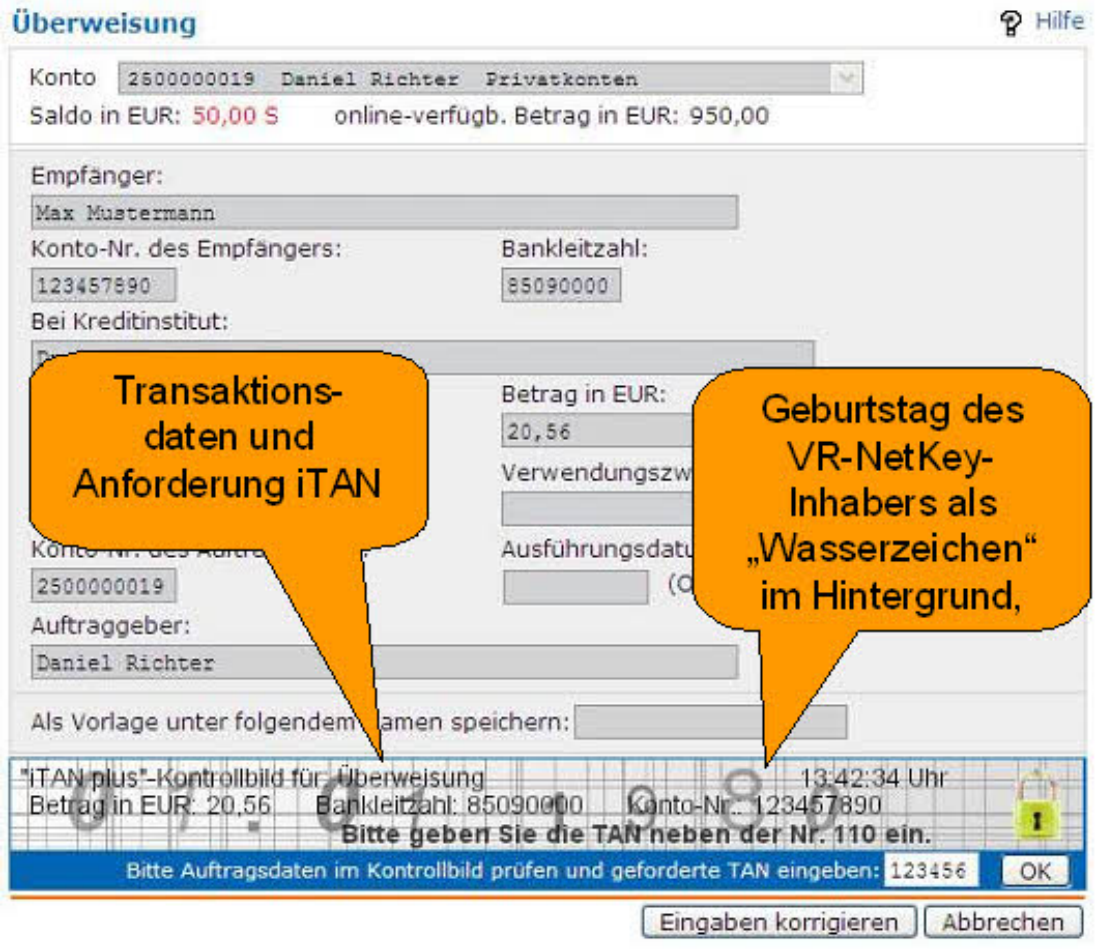
Patches up online statement so customer doesn't know

Somehow the response must be bound to the transaction to be authorised

Embed challenge in a CAPTCHA style image, along with transaction

Involving a human can defeat this

May move the fraud to easier banks



Picture: Volksbank Dill eG

Some UK banks have rolled out disconnected smart card readers

CAP (chip authentication programme) protocol specification secret, but based on EMV (Europay, Mastercard, Visa) open standard for credit/debit cards

Reader prompts for input and displays MAC generated by card

- Customer enters PIN
- Card verifies PIN
- Customer enters transaction details (varies between banks)
- Card calculates MAC over:
  - Counter on card
  - Information entered by customer
  - Result of PIN entry
- Reader displays decimal value from:
  - Some bits from the counter
  - Some bits from the MAC
  - (specified by the card's bit filter)

Usability failures aid fraudsters

CAP reader operates in three modes, which alters the information prompted for and included in the MAC

Identify	No prompt
Respond	8-digit challenge (`NUMBER:`)
Sign	Destination account number (`REF:`) and amount

Banks have inconsistent usage

Barclays	“Identify” for login, “Sign” for transaction
NatWest	“Respond” with first 4 digits random and last 4 being the end of the destination account number

Fraudsters can confuse customers to enter in the wrong thing

Transaction mode not included in MAC

Input to MAC does not include the selected operation mode

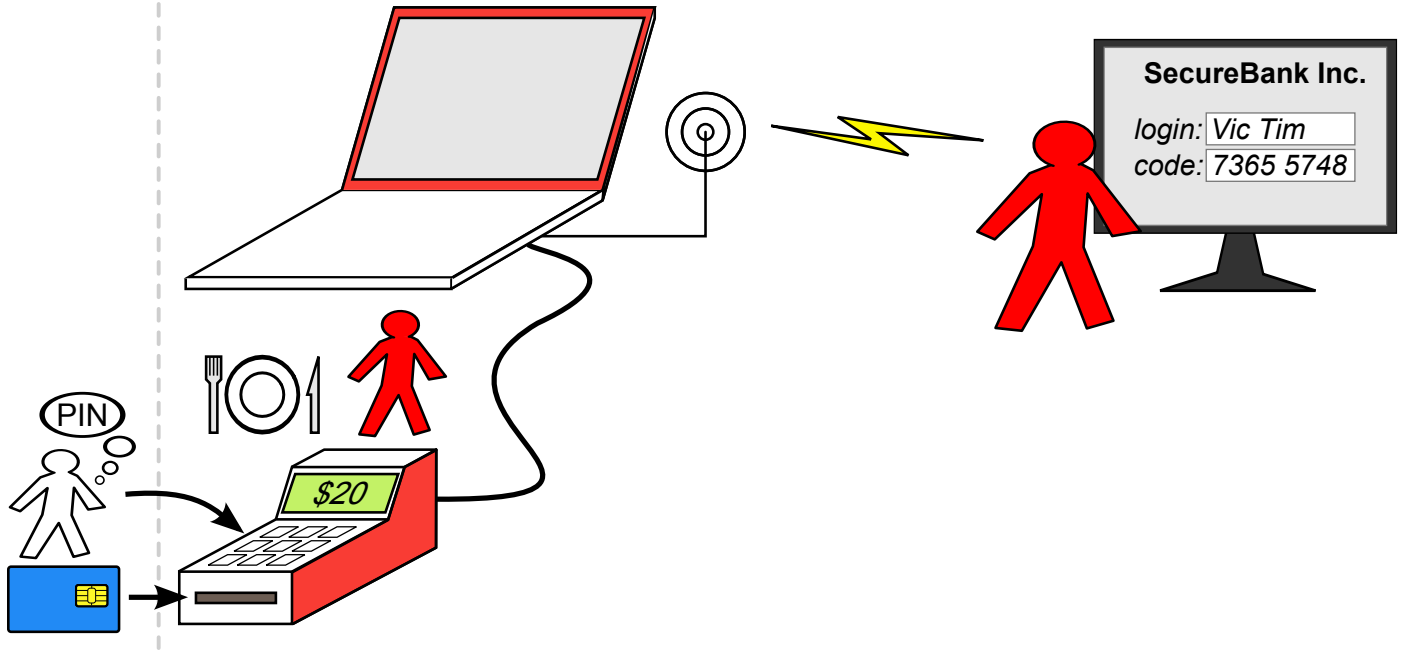
Identify	000000000000	00000000
Respond	000000000000	<challenge>
Sign	<amount>	<account number>

A “Sign” response, with an empty/zero amount, is also a valid “Respond” response

The account number field is overloaded as being nonce in one mode and destination account number in another

This ambiguity can be exploited by fraudsters when fooling customers to enter wrong thing

Nonce is small or absent



No nonce in Barclays variant so response stays valid; only a 4-digit nonce with NatWest (weak – 100 guesses = 63% success rate)

Fake point-of-sale terminal can get response in advance

Even if the nonce was big, a real-time attack still works

BBC Inside Out

We demonstrated this attack on the BBC television programme, Inside Out, earlier this year

CAP readers help muggers

guardian.co.uk

Police think French pair tortured for pin details

Matthew Taylor

The Guardian, Saturday July 5 2008

CAP reader tells someone whether a PIN is correct

Offers assistance to muggers

Affects customers with CAP-enabled cards, even if their bank doesn't use CAP

EMV specification always let this be built, but now devices are distributed for free

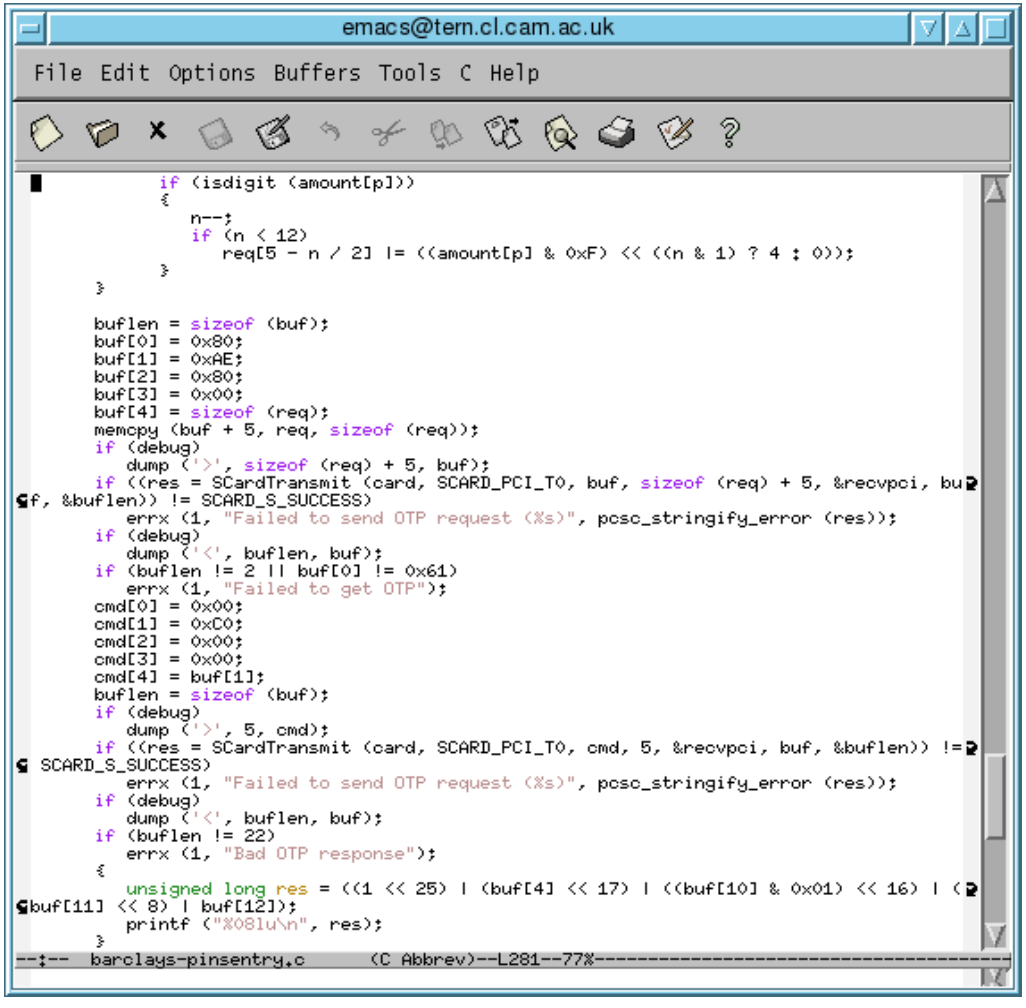
Software implementation of CAP is possible and desirable

CAP readers contain no secrets; possible to do black-box reverse engineering

CAP stops automated transactions: there is demand for a PC implementation

Some available now

If this software becomes popular, malware will attack it



What does this mean for customers?

CAP is far better than existing UK systems

- Authentication codes are dynamic
- Authentication codes are bound to transaction (although could be better)

Is this better for customers? Maybe no (at least in the UK)

Consumer protection law is vague: you are protected unless the bank considers you “negligent”

When the UK moved from signature to PIN for card payments, customers found it harder to be refunded for fraud (now 20% are left out of pocket)

The UK is moving from password to PIN for online banking. Might we see the same pattern (it is too soon to tell)?

Other authentication tokens fix many of the issues in the UK CAP

HHD 1.3 (standard from ZKA, Germany) is stronger than UK CAP, but more typing is required

- Many more modes, selected by initial digits of challenge
- Mode number alters the meaningful prompts
- Up to 7 digit nonce for all modes
- Nonce, and mode number, are included in MAC
- PIN verification is optional

RSA SecurID and Racal Watchword do PIN verification on server, and permit a duress PIN

More improvements require higher unidirectional bandwidth

For usability, customer should not have to type in full challenge

Allows versatility and better security

Flicker TAN

- Very similar to German CAP system (HHD 1.3)
- Rather than typing in transaction, encoded in a flickering image
- Easier to use, because no need to type in information twice
- Exactly as versatile and secure as HHD 1.3
- Customer needs to carry special reader and their card
- Flickering image may be annoying
- Offered by Sparkasse

USB connected readers

- Class-3 smart card reader (with keypad and display)
- For use with HBCI/FinTS online banking
- Requires drivers to be installed, so not usable while travelling
- Also not usable from work (where a lot of people do their online banking)
- Can also be used for digital signatures
- Can have good security, but details depend on protocol
- Offered by Sparkasse

Cronto PhotoTAN

- Transaction description encoded in a custom 2-D barcode
- More versatile than HHD 1.3 (allows for free text)
- Available on mobile phone (currently Android, iPhone. . .)
- Also dedicated hardware, for users without a suitable phone
- Secure and convenient, because most people keep their phone on their person
- Used by Commerzbank
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Conclusions

Systems based on EMV are open to a variety of attacks

- While the specification does not forbid implementing resistance measures, it offers little help
- In practice, implementers have slipped up, and customers have been left liable
- EMV's complexity, and large variety of options are particularly problematic
- In particular, not specifying security checks, and making essential data items optional, are a fundamental problem of EMV
- While the specification could be patched to fix the particular vulnerabilities identified, fixing the systemic problems needs a re-write of the protocol and specification
- For online banking, transaction authentication is now essential, which requires a trustworthy display

More: `http://www.cl.cam.ac.uk/research/security/banking/`