How to Rob an Online Bank

(and get away with it)

SOURCE Boston 2012

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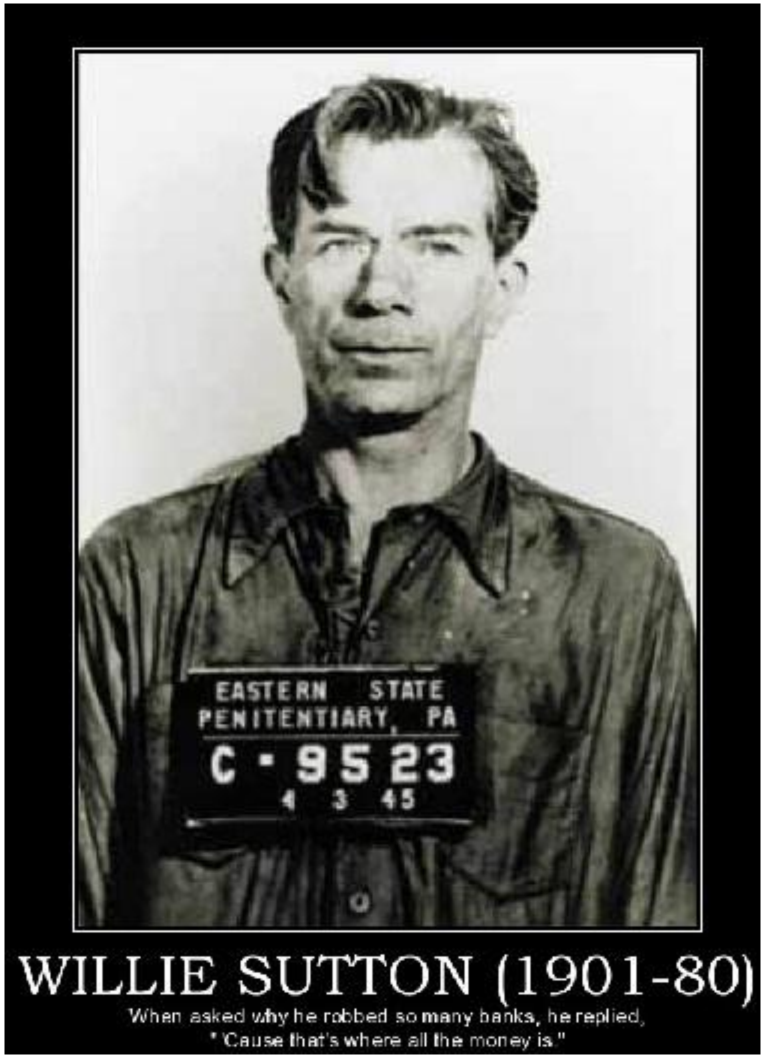
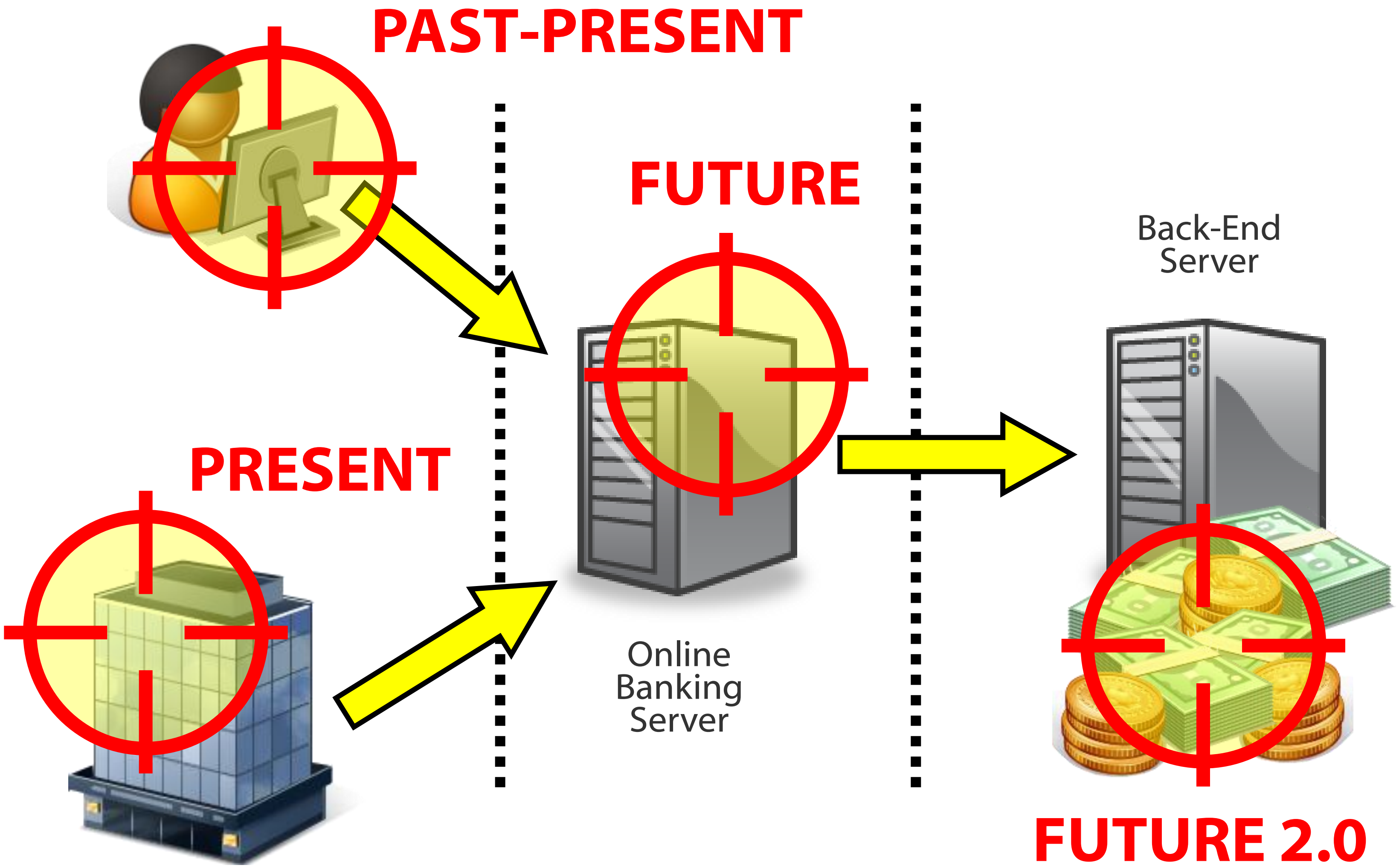

EASTERN STATE
PENITENTIARY, PA
C - 9523
4 3 45
WILLIE SUTTON (1901-80)
When asked why he robbed so many banks, he replied,
"'Cause that's where all the money is."

Evolution Of E-banking Attacks



Attacks Against Individual Users

Goal: Identity Theft

Methods

- Phishing, Fake security alerts
- XSS, CSRF
- Malware (man in the browser, extraction of certs and private keys)

Problems

- User awareness
- 2-factor authentication
- OOB transaction confirmations
- Additional passwords/PINs
- “Known good” target accounts

Attacks Against Corporate Users

Goal: Identity Theft

Methods & Problems

Same as with individual users

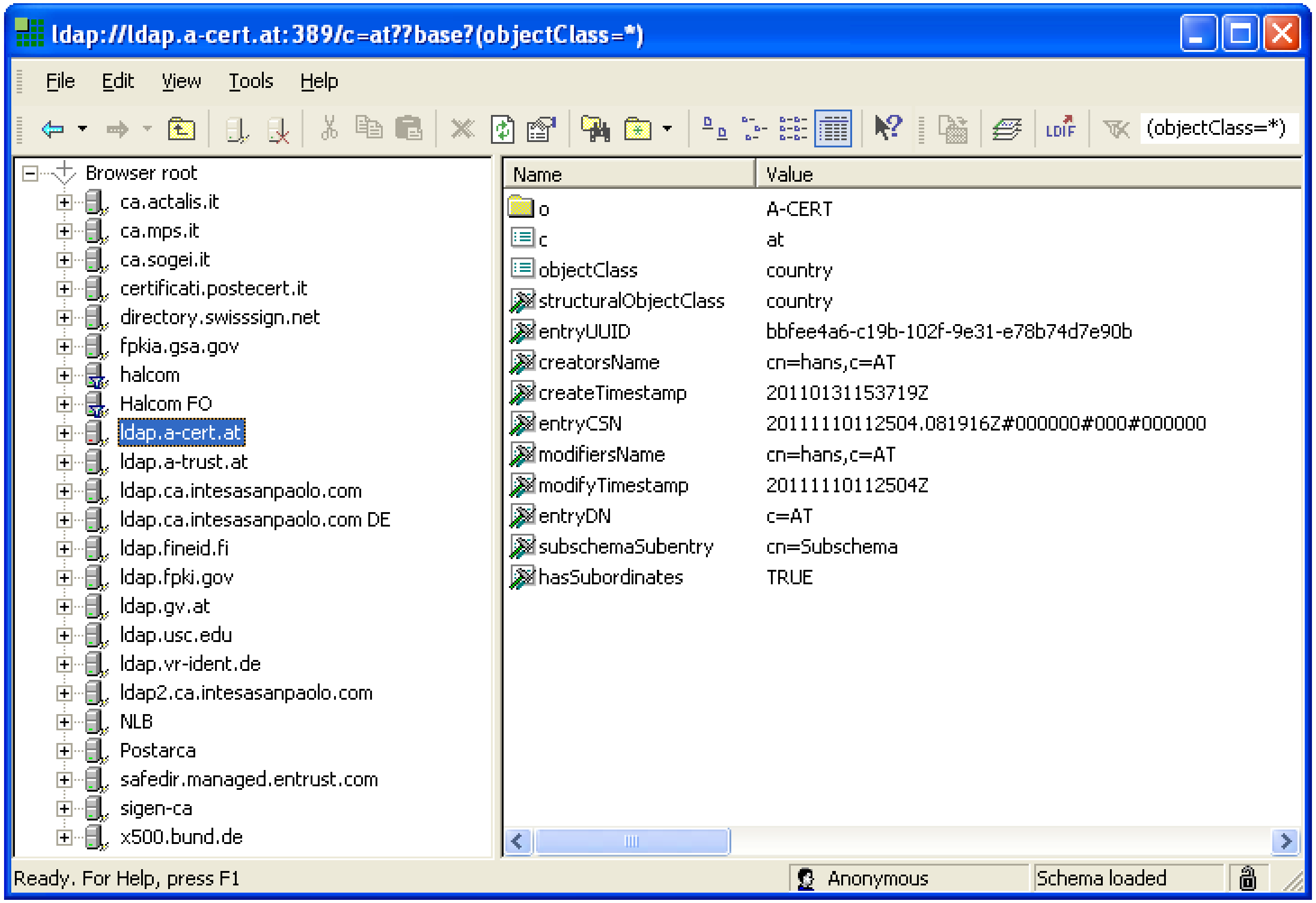
Advantages

More money

Large transactions not unusual

Targets can be found in public certificate directories

LDAP Explorer – Online Bank Robber's Google



ldap://ldap.a-cert.at:389/c=at??base?(objectClass=*)

File Edit View Tools Help

(objectClass=*)

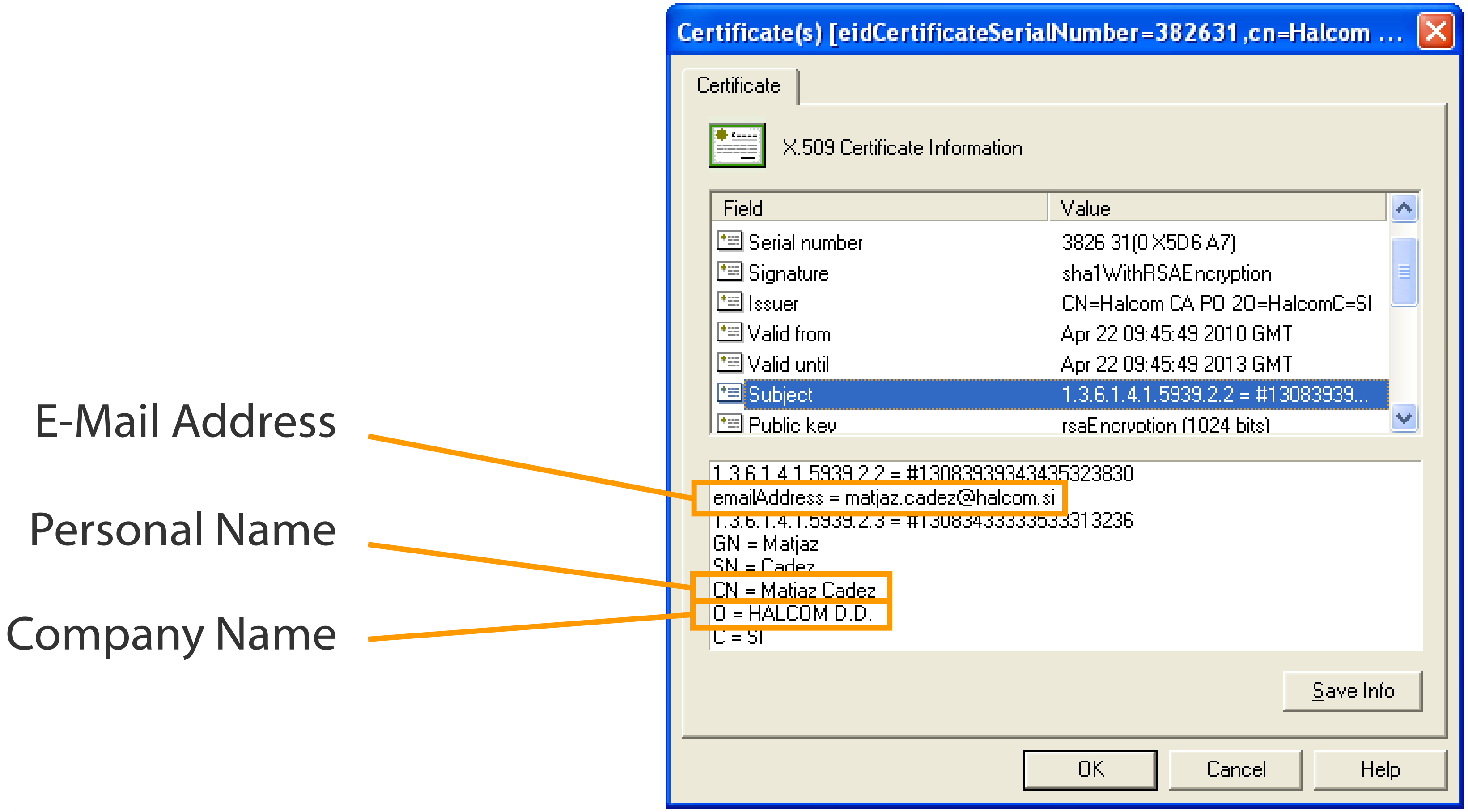
- Browser root
  - ca.actalis.it
  - ca.mps.it
  - ca.sogei.it
  - certificati.postecert.it
  - directory.swisssign.net
  - fpkia.gsa.gov
  - halcom
  - Halcom FO
  - ldap.a-cert.at
  - ldap.a-trust.at
  - ldap.ca.intesasanpaolo.com
  - ldap.ca.intesasanpaolo.com DE
  - ldap.fineid.fi
  - ldap.fpki.gov
  - ldap.gv.at
  - ldap.usc.edu
  - ldap.vr-ident.de
  - ldap2.ca.intesasanpaolo.com
  - NLB
  - Postarca
  - safedir.managed.entrust.com
  - sigen-ca
  - x500.bund.de

Name	Value
o	A-CERT
c	at
objectClass	country
structuralObjectClass	country
entryUUID	bbfee4a6-c19b-102f-9e31-e78b74d7e90b
creatorsName	cn=hans,c=AT
createTimestamp	20110131153719Z
entryCSN	20111110112504.081916Z#000000#000#000000
modifiersName	cn=hans,c=AT
modifyTimestamp	20111110112504Z
entryDN	c=AT
subschemaSubentry	cn=Subschema
hasSubordinates	TRUE

Ready. For Help, press F1 | Anonymous | Schema loaded

Example: Published Corporate Certificate

```
ldap://ldap.halcom.si:389/eidCertificateSerialNumber=382631
```



Certificate(s) [eidCertificateSerialNumber=382631,cn=Halcom ...

Certificate

X.509 Certificate Information

Field	Value
Serial number	3826 31(0 X5D6 A7)
Signature	sha1WithRSAEncryption
Issuer	CN=Halcom CA PO 2O=HalcomC=SI
Valid from	Apr 22 09:45:49 2010 GMT
Valid until	Apr 22 09:45:49 2013 GMT
Subject	1.3.6.1.4.1.5939.2.2 = #13083939...
Public key	rsaEncryption (1024 bits)

```
1.3.6.1.4.1.5939.2.2 = #13083939343435323830
emailAddress = matjaz.cadez@halcom.si
1.3.6.1.4.1.5939.2.3 = #13083433333533313236
GN = Matjaz
SN = Cadez
CN = Matjaz Cadez
O = HALCOM D.D.
C = SI
```

Attacks Against Online Banking Servers

Goal: Exploiting Application Flaws

Methods

Hacking

Problems

Getting noticed while looking for flaws

Advantages

Unlimited amount of money

No user interaction (social engineering)

Possible creation of new money

Direct Resource Access

Direct Resource Access – URL Cleartext ID

https://bank/balance?uid=7728356
(my account balance data)

https://bank/balance?uid=772835**5**
(another user's account balance data)

Direct Resource Access – URL Base64 encoding

https://bank/balance?dWlkPTc3MjgzNTY=
(my account balance data)

↓ Base64decode("dWlkPTc3MjgzNTY=")

"uid=7728356"

↓ Base64encode("uid=772835**5**")

https://bank/balance?dWlkPTc3MjgzNTU=
(another user's account balance data)

Direct Resource Access – URL Encryption

/balance?Ko7hIGJJ2GqfhSZ9... (Base64)

/balance?AF86B301008AEF5... (Hex)

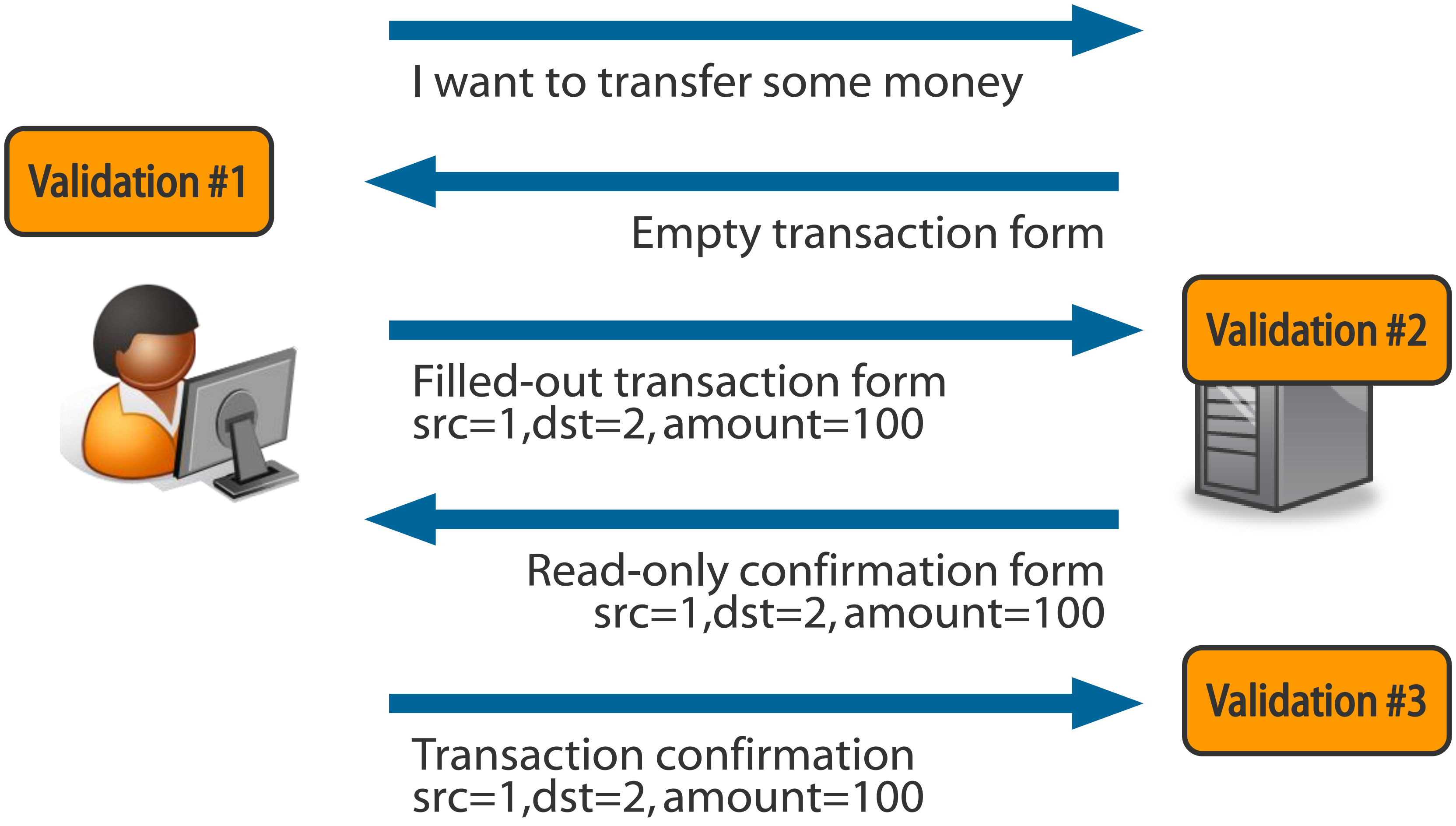
```
params = "uid=7728356"
enc_params = AES_encrypt(params, key)
path = "/balance?" + base64(enc_params)
```

Transferring Money From Other People's Accounts

/transfer? src=1 & dest=2 & amount=100
(from my account)

/transfer? src=**42** & dest=2 & amount=100
(from another user's account)

Transaction Creation Process



Validation #1

I want to transfer some money

Empty transaction form

Filled-out transaction form
src=1,dst=2,amount=100

Validation #2

Read-only confirmation form
src=1,dst=2,amount=100

Transaction confirmation
src=1,dst=2,amount=100

Validation #3

Negative Numbers

Negative Numbers – A Devastating Oversight

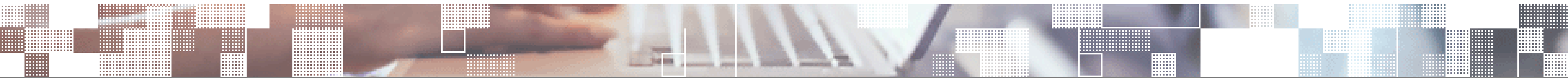
```
IF RequestedAmount > DisposableAmount
THEN ERROR();

IF 3,000 > 2,000
THEN ERROR(); // Error – Insufficient Funds

IF -100 > 2,000
THEN ERROR(); // No Error Here
```

"Here's minus hundred bucks for you"

Attacker:	0 $
Victim:	100 $

(Transfer -100 $ to Victim)

Attacker:	100 $
Victim:	0 $

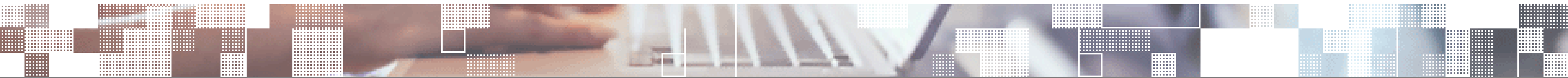


Creating Money Out Of Thin Air

Normal Account:	0 $
Savings Account:	0 $

(Transfer -100 $ to Savings Account)

Normal Account:	100 $
Savings Account:	0 $



Bypassing Limit Checks

Normal Overdraft

Account #1:	100 $
Account #2:	0 $

(Transfer 1,000 $ from #1 to #2)

Account #1:	-900 $
Account #2:	1,000 $

“Over-Overdraft”

Account #1:	100 $
Account #2:	0 $

↓

(Transfer 1,000,000 $ from #1 to #2)

↓

Account #1:	-999,900 $
Account #2:	1,000,000 $

HTTP Parameter Pollution

Luca Carettoni & Stefano di Paola
http://www.slideshare.net/Wisec/http-parameter-pollution-a-new-category-of-web-attacks

User – Public Server – Back End Server

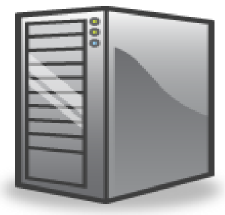
POST /transfer
source=1 & dest=2 & amount=100

JSP

```
source = request.getParameter("source") // 1
amount = request.getParameter("amount") // 100
IF NOT user_authorized_for(source) THEN ERROR()
IF disposable(source) < amount THEN ERROR()
Call BackEndTransaction(request)
```

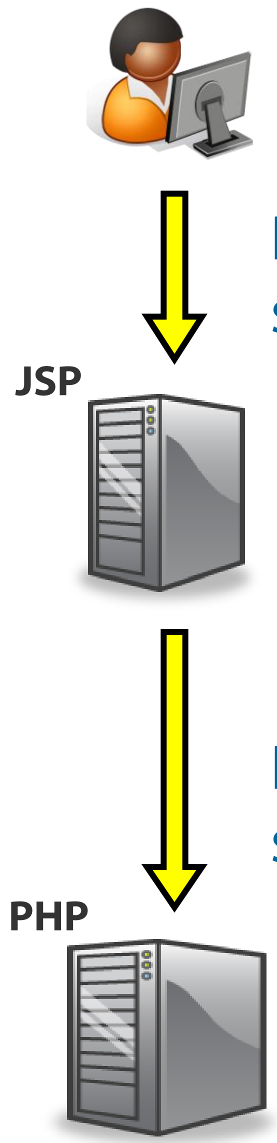
POST /BackEndTransaction
source=1 & dest=2 & amount=100

PHP



```
source = $_POST["source"] // 1
dest = $_POST["dest"]     // 2
amount = $_POST["amount"] // 100
```

HTTP Parameter Pollution – Source account



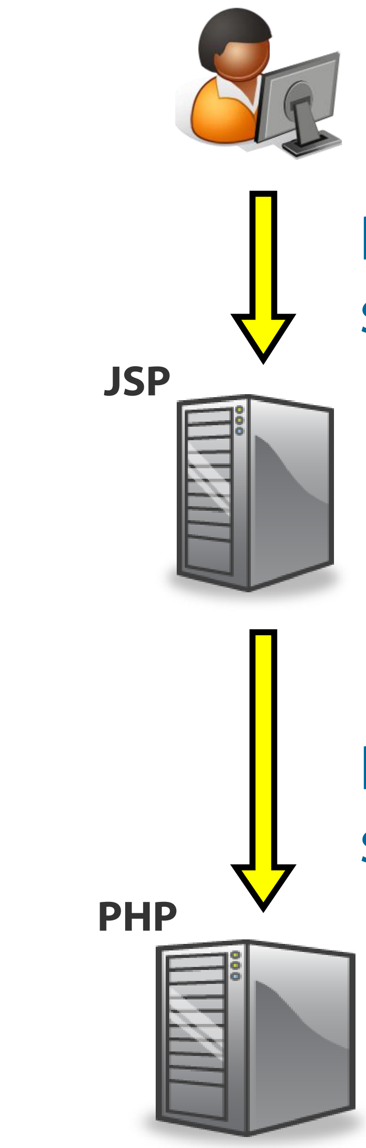
POST /transfer
source=1 & dest=2 & amount=100

```
source = request.getParameter("source") // 1
amount = request.getParameter("amount") // 100
IF NOT user_authorized_for(source) THEN ERROR()
IF disposable(source) < amount THEN ERROR()
Call BackEndTransaction(request)
```

POST /BackEndTransaction
source=1 & dest=2 & amount=100

```
source = $_POST["source"] // 42
dest = $_POST["dest"]     // 2
amount = $_POST["amount"] // 100
IF NOT user_authorized_for(source) THEN ERROR()
```

HTTP Parameter Pollution – Transfer Amount



POST /transfer
source=1 & dest=2 & amount=100 & amount=100000

```
source = request.getParameter("source") // 1
amount = request.getParameter("amount") // 100
IF NOT user_authorized_for(source) THEN ERROR()
IF disposable(source) < amount THEN ERROR()
Call BackEndTransaction(request)
```

POST /BackEndTransaction
source=1 & dest=2 & amount=100 & amount=100000

```
source = $_POST["source"] // 1
dest = $_POST["dest"]     // 2
amount = $_POST["amount"] // 100000
IF NOT user_authorized_for(source) THEN ERROR()
```

SQL Injection

SQL Injection – Data Theft

"SELECT rate FROM exch_rates
WHERE currency = '".$currency."'"

"SELECT rate FROM exch_rates
WHERE currency = '' UNION
SELECT balance FROM accounts
WHERE account_id = '887296'"

acros

SQL Injection – Messing With Transactions

“BEGIN TRANSACTION”

“UPDATE accounts SET balance = 0
WHERE account_id = ‘”.$acctid1.”’”

“UPDATE accounts SET balance = 100
WHERE account_id = ‘”.$acctid2.”’”

“COMMIT TRANSACTION”

SQL Injection – Messing With Transactions

“BEGIN TRANSACTION”

“UPDATE accounts SET balance = 0
WHERE account_id = ‘123’”

“UPDATE accounts SET balance = 100
WHERE account_id = ‘456’”

“COMMIT TRANSACTION”

SQL Injection – Messing With Transactions

“BEGIN TRANSACTION”

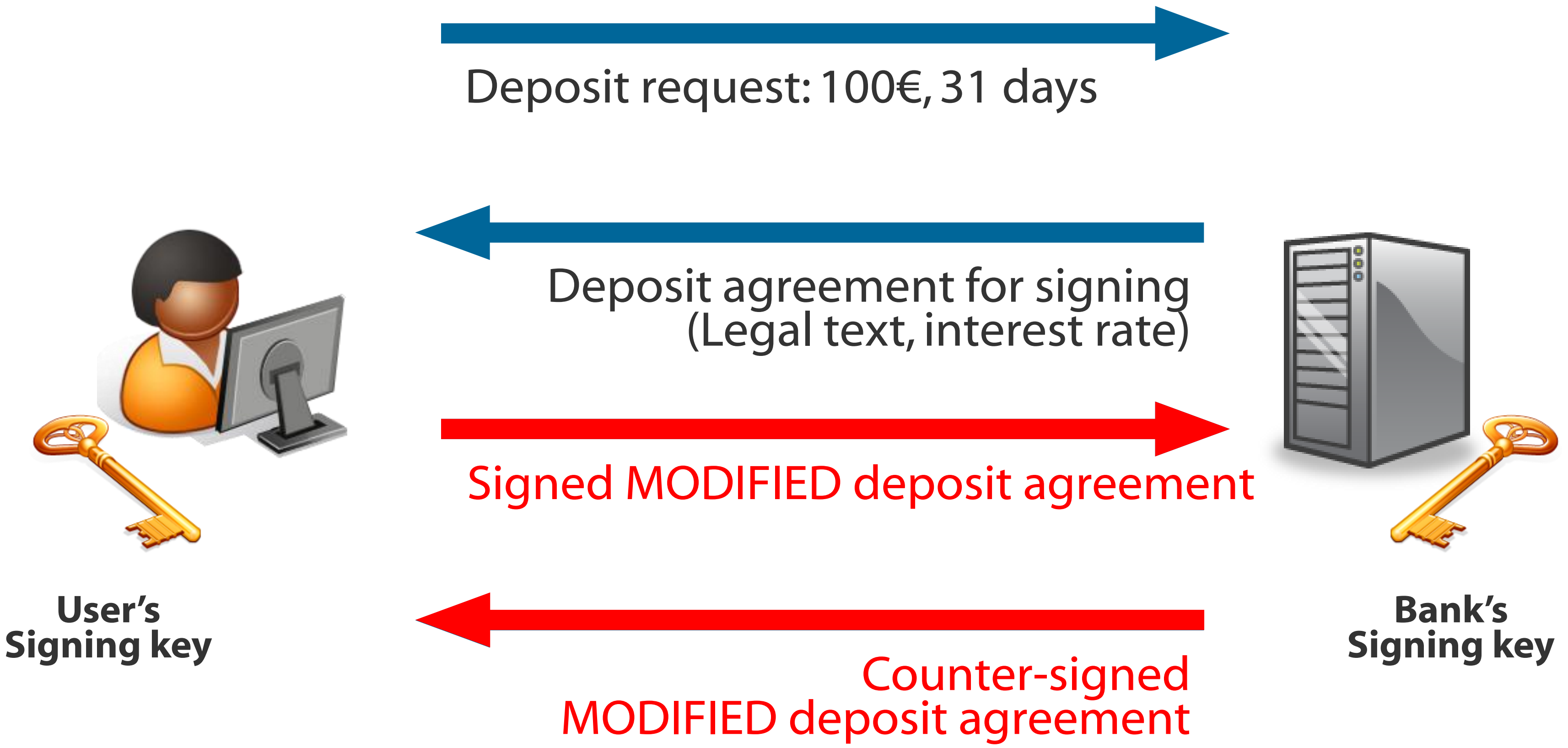
“UPDATE accounts SET balance = 0
WHERE account_id = ‘123’”

“UPDATE accounts SET balance = 100
WHERE account_id = ‘456’ OR
account_id = ‘123’”

“COMMIT TRANSACTION”

Forging Bank’s Digital Signatures

Automated Signing Of Deposit Agreement


Deposit request: 100€, 31 days
Deposit agreement for signing
(Legal text, interest rate)
Signed MODIFIED deposit agreement
Counter-signed
MODIFIED deposit agreement
User's
Signing key
Bank's
Signing key

Server-Side Code Execution

Server-Side Code Execution

Examples

Java code injection (JBoss bug in 2010)

PHP code injection (eval, system, includes...)

Shell argument injection (command1&command2)

Buffer overflows

Impact

Change e-banking application code

Obtain database/WS credentials,

issue direct requests to DB or back-end WS

The List Goes On...

Other Attacks

Session Puzzling

Insecure Mass Assignment

Numerical Magic: Overflows, Underflows, Exponential Notation, Reserved words (Corsaire whitepaper)

"Stale" Currency Exchange

Race Conditions

...

New functionalities: automated deposits, loans, investment portfolio management, ...

Getting Rich
Without Breaking The Law

http://blog.acrossecurity.com/2012/01/is-your-online-bank-vulnerable-to.html

Rounding And Currency Exchange

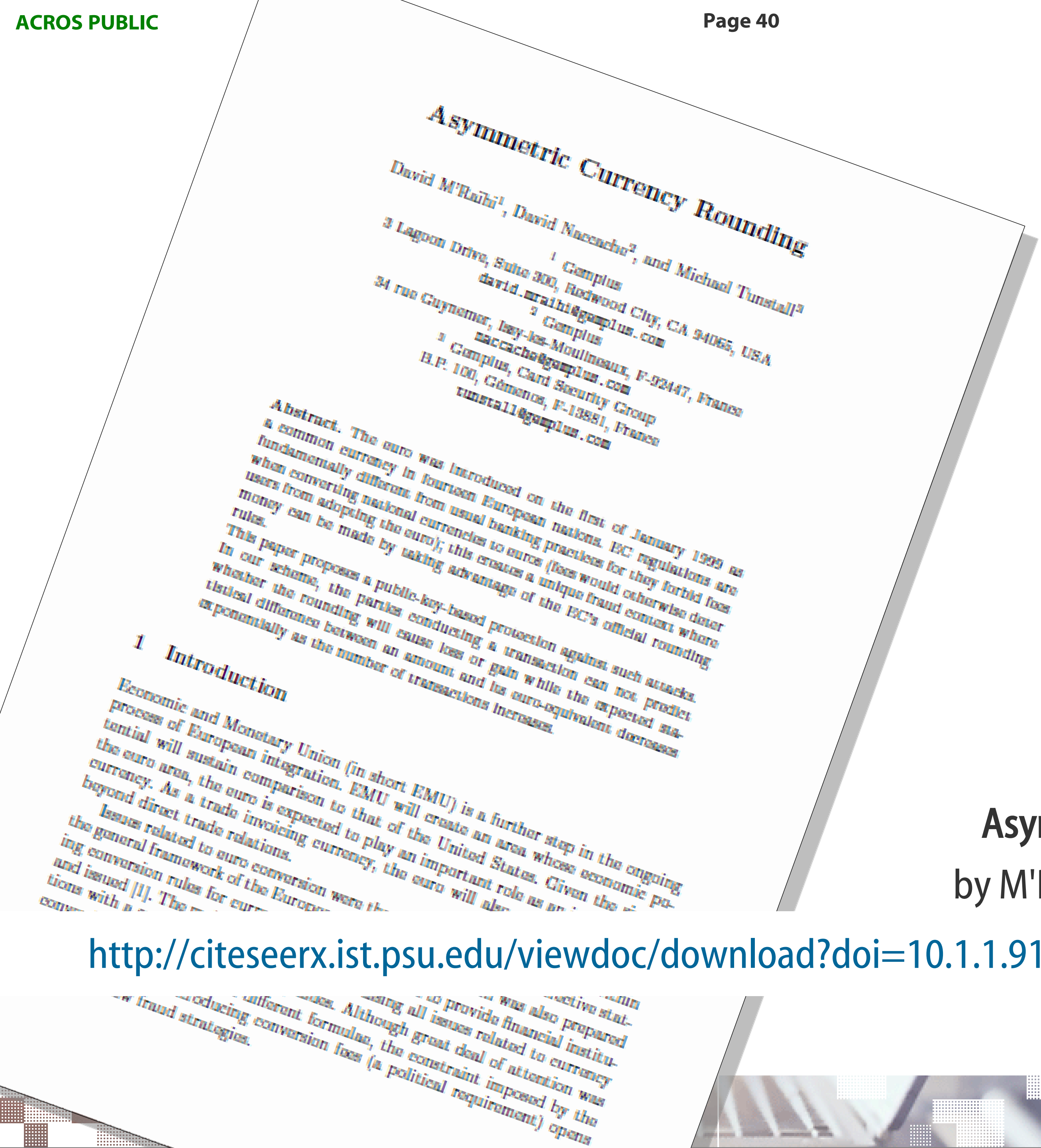
1 € ⇔ 1,364 $

0,01 € → 0,01 $

Loss : -0,00364 $ = -27%

0,01 € ← 0,01 $

Profit : +0,00266 € = +36%



Asymmetric Currency Rounding

David M'Raïhi[1], David Naccache[2], and Michael Tunstall[3]

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B.P. 100, Gémenos, F-13881, France
tunstall@gemplus.com

Abstract. The euro was introduced on the first of January 1999 as a common currency in fourteen European nations. EC regulations are fundamentally different from usual banking practices for they forbid fees when converting national currencies to euros (fees would otherwise deter users from adopting the euro); this creates a unique fraud context where money can be made by taking advantage of the EC's official rounding rules.

This paper proposes a public-key-based protection against such attacks. In our scheme, the parties conducting a transaction can not predict whether the rounding will cause loss or gain while the expected statistical difference between an amount and its euro-equivalent decreases exponentially as the number of transactions increases.

1 Introduction

Economic and Monetary Union (in short EMU) is a further step in the ongoing process of European integration. EMU will create an area whose economic potential will sustain comparison to that of the United States. Given the size of the euro area, the euro is expected to play an important role as an international currency. As a trade invoicing currency, the euro will also [illegible] beyond direct trade relations.

Issues related to euro conversion were th[illegible] the general framework of the Europ[illegible] ing conversion rules for curr[illegible] and issued [1]. The [illegible] tions with [illegible] cou[illegible]

[illegible] ective stat- [illegible] was also prepared [illegible] to provide financial institu- [illegible] ing all issues related to currency [illegible] different formulas. Although great deal of attention was [illegible] roducing conversion fees (a political requirement) opens [illegible] r fraud strategies.

KNOWN AT LEAST SINCE

2001

Asymmetric Currency Rounding

by M'Raïhi, Naccache and Tunstall

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.91.8055&rep=rep1&type=pdf

Currency Rounding Attack: Algorithm

```
1:  Convert 100€ to $
    // We have 136,40$

2:  for i = 1 to 13640
        Convert 0,01$ to 0,01€
    // Now we have 136,40€

3:  goto 1
```

Currency Rounding Attacks

The Speed Of Getting Rich

Assume: 10 exchanges / second

1 day = 86.400 seconds

Daily profit: 2.300 €

Monthly profit: ~ 70.000 €

Improvements

Optimal exchange rate (getting as close to 0,005 as possible)

Corporate banking: packets (1000s of exchanges in one packet)

Does it really work?

My personal e-banking: YES

My company's corporate e-banking: YES

Countermeasures

Limit minimum amount to 1 whole unit, exchange fee

Getting Away With It

Getting Away With It

Avoiding Detection

- While searching for vulnerabilities
- While performing the attack
  - Solution: *"User in the middle"* – hiding behind a user

Breaking The Money Trail

- ATMs, Western Union
- Money Mules
- BitCoin, WebMoney, Liberty Reserve, ...
- Chaining multiple *"users in the middle"* in different countries

ATM – The Final Destination

2007: iWire - $5M
(9,000 prepaid cards)

2008: Citibank - $2M
(hacked ATM network,
stolen PIN codes)

2008: WorldPay - $9M
(44 debit cards, lifted limit)

2011: Florida bank - $13M
(22 debit cards, lifted limit)

2012: Postbank – $6.7M
(stolen teller identity,
transfers to other accounts, lifted limit)

$$$ == 01101000100101

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Thanks: Mikko H. Hypponen, René Pfeiffer, Claudio Criscione, Stefan Ortloff and Candi Carrera for help with gathering information on national digital certificate usage