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Security of National eID (smartcard-based) Web Applications

Raul Siles

raul@taddong.com

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Outline

- Introduction to eID
- eID security state-of-the-art
- Pen-testing eID web-apps
  - HTTPS, **eID** & session management
- Results & Recommendations from real-world pen-tests
  - HTTPS, eID & session management
- Conclusions

eID (or e-ID)

- (National) electronic IDentification (eID)
  - Username/password, mobile, **smartcard**…
- By example: Spanish eID (DNIe or eDNI)
  - DNIe internal layout
    - Zones: public, private (PIN) & security
    - Biometric data (fingerprint, picture y signature)

  - ISO 7816 (PKCS#15 evolution)
  - Certificates (& two associated key-pairs)
    - Identification (KeyUsage = Digital Signature)
    - Signature (KeyUsage = contentCommitment)

  - Legal validity & CWA 14169: Secure signature-creation device (EAL4+)

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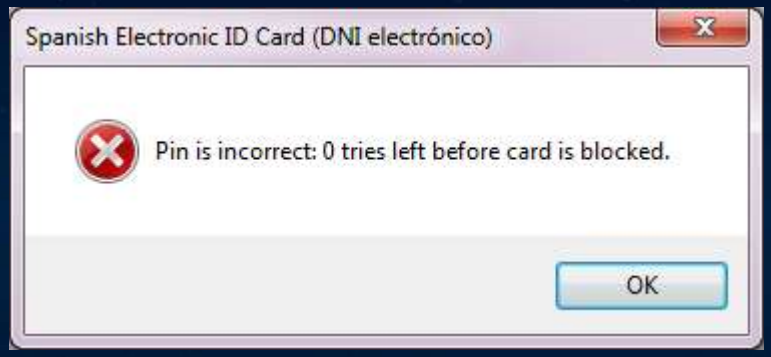
The eID is Secure…



The New eID is 10-Times More Secure…

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Real eID Security Threats

- Physical eID access and PIN knowledge
- End-user computer compromised
- Examples: (eID/*smartcards*)
  - “Man-In-Remote: PKCS11 for fun and non-profit”. Gabriel González. RootedCON 2011
    - Remote PIN & PKCS#11 invocation
  - Sykipot trojan variant – China (AlientVault)
    - US DoD *smartcards* PIN acquisition
    - Keylogger + Windows certs. memory access
    - Remote user impersonation (*proxy*)
      - December 2011 (March?)

The eID is Secure, But... Where Is It Being Used?

Who Has an eID? (in Spain)

- 25 million eIDs dispatched (Sep 29, 2011)
  - Project started in 2005
  - More than half of the Spanish population
- Spain is a **worldwide leader in electronic signature-based smartcards** (electronic ID)
  - 26 countries all over the world (smartcard & signature)
- National Home Office (police department)
  - +1,500 dispatch offices (+341M €)

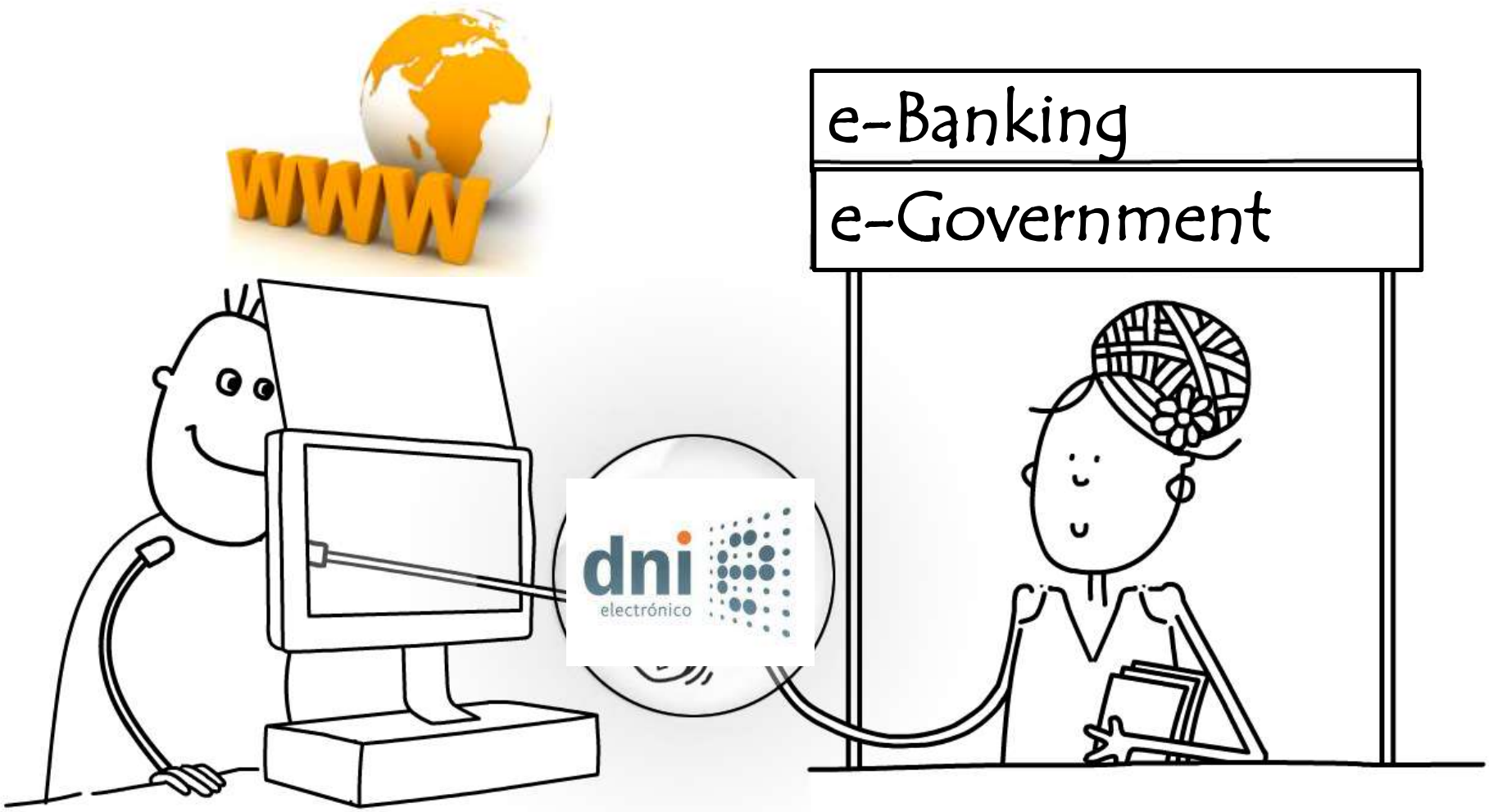
http://www.mir.es/press/la-policia-nacional-supera-los-25-millones-de-dni-electronicos-expedidos-12920

What Do We Use the eID For?

- Personal Computers
  - Login (user authentication)
  - Sign documents (e.g. invoices)
  - Get access to Wi-Fi and VPN networks
  - VoIP call authentication...
- Madrid & Barcelona airports
  - Automatic frontier control project
    - ABC System (Indra) & National police
  - Self-service
  - eID +picture + fingerprint
- ATMs
- TDT (eAdmin via digital TV)
- Mobile phones (mDNI)

usa tu dni.es electrónico

What Do We Use the eID For?
In Reality...



eID is Used in Web-Apps

- Critical web applications
  - Public sector
    - e-Government services
      - March 2011: 2,015 online services
      - 99% procedures from the Central Government
  - Private sector
    - Financial (e-Banking), insurance, and utility companies (telecom, electricity, water, gas...)
    - e-Commerce
  - Most secure authentication method
    - Username/password (backup)

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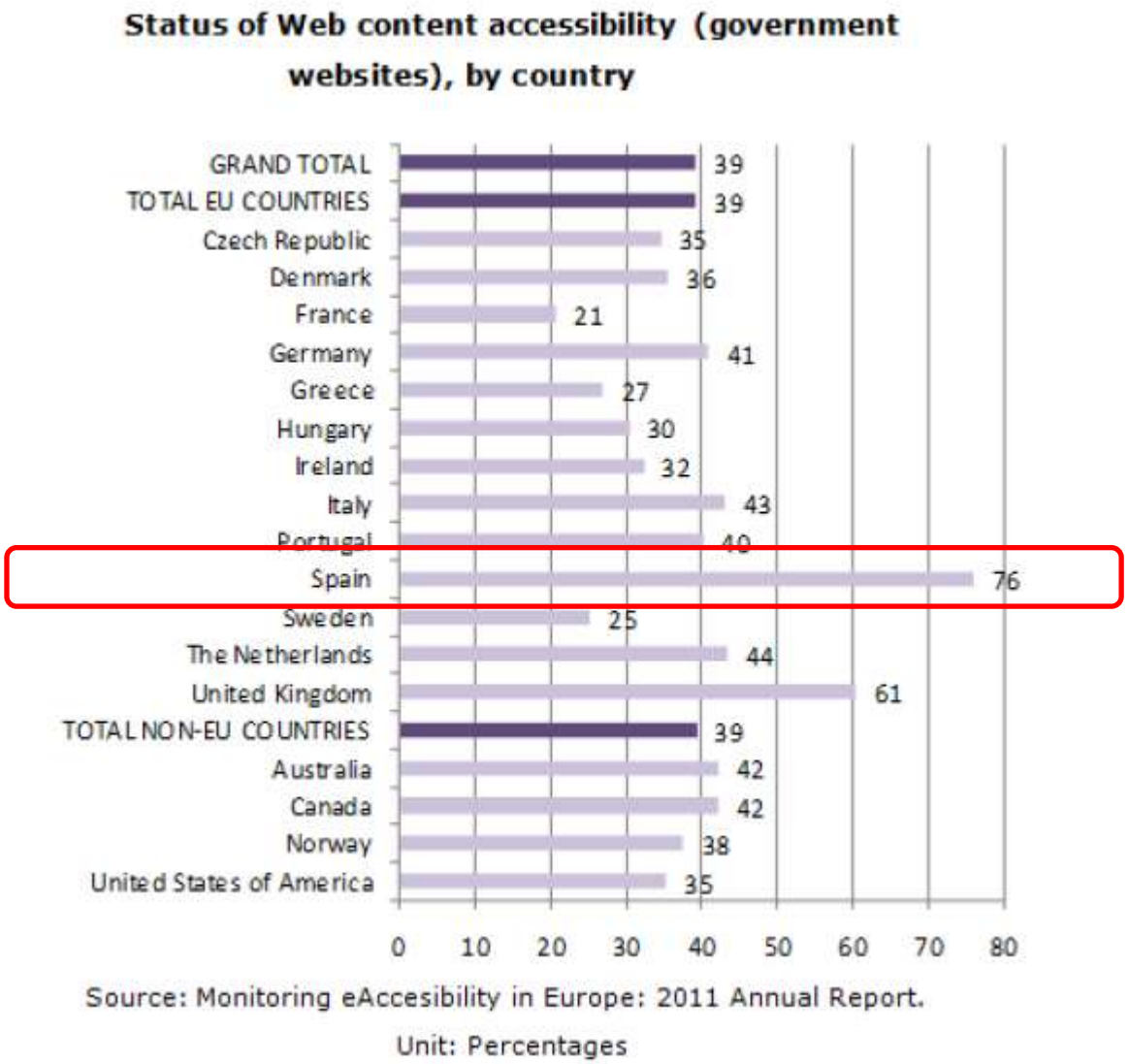
eAccesibility vs. eSecurity



European eID Regulation

- European Commission Press Release
  - June 4, 2012 (… 2014)
- Digital Agenda: new Regulation to enable cross-border electronic signatures and to get more value out of <u>electronic identification</u> in Digital Single Market
  - National electronic identification schemes (eIDs)
  - Electronic identification, signatures and trust services
    - Aceptance of cross-country citizen transactions

http://europa.eu/rapid/pressReleasesAction.do?reference=IP/12/558
http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/12/403

eID by Country

- eID (EU): smartcard
  - Belgium, Estonia, Finland, Germany, Italy, Portugal, Spain, Switzerland
- Pseudo eID (EU): user/pass + SMS, cert…
  - Austria (2), Czech Republic, Denmark, Holland, Iceland, Liechtenstein, Lithuania, Luxemburg, Slovakia, Slovenia, Sweden
  - Holland (July 2012) + 7 years
    - DigID 4.0: username & password (+ SMS code)
    - Future: Smartcard-based eID…
- Outside EU
  - Hong-Kong, Morocco, Saudi Arabia, South Korea, UAE

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The eID is Secure, It Is Used in Web-Apps, World-Wide, But... Is It Used in a Secure Way?

eID (Smartcard-Based) Web Applications

- eID web-based authentication
  - HTTPS protocol
    - Standard and transparent solution
    - Built-in client-based digital certificate (X.509) authentication in all web browsers
  - Web-based client components
    - Custom Java Applet or ActiveX control
  - eID cloud-based authentication
- eID web-based signatures
  - Web-based client components or JavaScript
    - JS: Proprietary IE (CAPICOM) o Firefox (crypto.signText())
    - Client components: local permissions required?

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Pen-Testing eID Web-Apps

Get Authorization

Pen-Testing eID Web-Apps Research Areas

1

2

dni electrónico

3

HTTPS

HTTPS Authentication: Client Certs.

1

DNIe_auth_dnie.es_FULL.pcap - Graph Analysis

Time	192.168.1.207 / 213.170.35.240	Comment
0,049	54510 > https [SYN]	TCP: 54510 > https [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=4 SACK_PERM=1
0,116	https > 54510 [SYN,	TCP: https > 54510 [SYN, ACK] Seq=0 Ack=1 Win=4356 Len=0 MSS=1452 WS=1 SACK_PERM=1
0,116	54510 > https [ACK]	TCP: 54510 > https [ACK] Seq=1 Ack=1 Win=66792 Len=0
0,117	Client Hello	TLSv1: Client Hello
0,184	https > 54510 [ACK]	TCP: https > 54510 [ACK] Seq=1 Ack=185 Win=4540 Len=0
0,186	Server Hello	TLSv1: Server Hello
0,190	[TCP segment of a r	TCP: [TCP segment of a reassembled PDU]
0,190	[TCP segment of a r	TCP: [TCP segment of a reassembled PDU]
0,190	54510 > https [ACK]	TCP: 54510 > https [ACK] Seq=185 Ack=1524 Win=66792 Len=0
0,191	Certificate	TLSv1: Certificate
0,191	Certificate Request	TLSv1: Certificate Request
0,191	54510 > https [ACK]	TCP: 54510 > https [ACK] Seq=185 Ack=2222 Win=66092 Len=0
0,192	Server Hello Done	TLSv1: Server Hello Done
0,203	[TCP segment of a r	TCP: [TCP segment of a reassembled PDU]
0,289	https > 54510 [ACK]	TCP: https > 54510 [ACK] Seq=2231 Ack=1637 Win=5992 Len=0
0,289	Certificate, Client	TLSv1: Certificate, Client Key Exchange
0,357	https > 54510 [ACK]	TCP: https > 54510 [ACK] Seq=2231 Ack=3322 Win=7677 Len=0
1,985	Certificate Verify	TLSv1: Certificate Verify
1,985	Change Cipher Spec	TLSv1: Change Cipher Spec
1,985	Encrypted Handshake	TLSv1: Encrypted Handshake Message
2,052	https > 54510 [ACK]	TCP: https > 54510 [ACK] Seq=2231 Ack=3589 Win=7944 Len=0
2,053	https > 54510 [ACK]	TCP: https > 54510 [ACK] Seq=2231 Ack=3595 Win=7950 Len=0
2,054	https > 54510 [ACK]	TCP: https > 54510 [ACK] Seq=2231 Ack=3632 Win=7987 Len=0
2,056	Change Cipher Spec	TLSv1: Change Cipher Spec
2,056	Encrypted Handshake	TLSv1: Encrypted Handshake Message
2,056	54510 > https [ACK]	TCP: 54510 > https [ACK] Seq=3632 Ack=2274 Win=66040 Len=0
2,057	Application Data	TLSv1: Application Data

Save As Close

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Assessing HTTPS (SSL/TLS)

1

- TLSSLed (v1.2 - October 2011)
  - Web server SSL/TLS (HTTPS) implementation security assessments
  - sslscan & openssl (GNU/Linux & Mac OS X)
  - SSLv2, SSLv3/TLSv1, TLSv1.1/v1.2 (BEAST), NULL cipher, weak (40/56 bits) & strong (AES 128/256 bits) ciphers, MD5-signed certs., cert. key length, subject, issuer (CA), validity period, STS header, (un)secure cookies, RFC 5746: secure SSL/TLS renegotiation…
- Upcoming version at the end of 2012…

http://blog.taddong.com/2011/10/tlssled-v12.html

eID

Assessing eID Integration in Web-Apps

2

- In-depth web-app security analysis
  - Registration & authentication using the eID
  - Access controls
- Interception proxies: smartcard constraints
  - Commercial & open-source tools (Java)
    - Client certificate errors (HTTPS)
  - Need smartcard drivers or libraries
    - Built-in integration required

Main focus: OWASP ZAP…

Session Management

Secure Web-App Session Management

3

- Top web vulnerabilities: SQLi, XSS, CSRF…
  - Session management? OWASP Top 10 (A3)
- Malware: OddJob (February 2011)
  - Hijacks users sessions and keeps them active
    - US & EU banks
- OWASP Session Management Cheat Sheet
  - v1.0 (July 2011) & v2.0 (February 2012)
  - Challenges: HTTP is stateless, complexity, security on the developer's hands, cookies, HTTPS…

http://blog.taddong.com/2012/02/owasp-session-management-cheat-sheet.html
https://www.owasp.org/index.php/Session_Management_Cheat_Sheet

eID: PKCS#11 & Java

PKCS#11 (eID) & Java: Windows

- Statically (e.g. keytool)
  - Based on the OS: Win, Linux or Mac
  - %JAVA_HOME%/lib/security/java.security

```
security.provider.10=sun.security.pkcs11.SunPKCS11_C:/Program Files (x86)/Java/jre6/lib/security/dnie_pkcs11.cfg
```

  - Configuration file for SunPKCS11:

```
# Provider.getName() = SunPKCS11-DNIe
name = DNIe
# DNIe library
library = C:\WINDOWS\SysWOW64\UsrPkcs11.dll
```

Install eID libraries 1st…

PKCS#11 (eID) & Java: Linux

- Statically (e.g. keytool)
  - Based on the OS: Win, Linux or Mac
  - $JAVA_HOME/lib/security/java.security

```
security.provider.10=sun.security.pkcs11.SunPKCS11
 /usr/lib/jvm/java-6-sun/jre/lib/security/dnie_pkcs11.cfg
```

  - Configuration file for SunPKCS11:

```
# Provider.getName() = SunPKCS11-DNIe
name = DNIe
# DNIe library
library = /usr/lib/opensc-pkcs11.so
```

PKCS#11 (eID) & Java: Mac

- Statically (e.g. keytool)
  - Based on the OS: Win, Linux or Mac
  - $JAVA_HOME/lib/security/java.security

```
security.provider.10=sun.security.pkcs11.SunPKCS11
/.../1.6.0.jdk/Contents/Home/lib/security/dnie_pkcs11.cfg
```

  - Configuration file for SunPKCS11:

```
# Provider.getName() = SunPKCS11-DNIe
name = DNIe
# DNIe library
library = /usr/lib/opensc-pkcs11.so
```

32-bit Java VM:
$ java –d32 …

PKCS#11 (eID) & Java: Query eID

- Java keytool (e.g. Windows)
  - List eID contents (PKCS11 token)

```
C:\> keytool [-v] -keystore NONE -storetype PKCS11 -list
Escriba la contraseña del almacén de claves: ...
```

  - With no provider setup in java.security

```
C:\> keytool -keystore NONE -storetype PKCS11
        -providerClass sun.security.pkcs11.SunPKCS11
        -providerArg "C:\Program Files(x86)\Java\jre6\
                      \lib\security\dnie_pkcs11.cfg"
        -list
```

PKCS#11 (eID) & Java: Code

```
...
// Add PKCS11 provider
String cardConfig = "dnie_pkcs11.cfg"; // or InputStream
Provider pkcs11 = new sun.security.pkcs11.SunPKCS11(cardConfig);
Security.addProvider(pkcs11);

// Init the keystore
KeyStore ks = KeyStore.getInstance("PKCS11", pkcs11);
ks.load(null, pin.toCharArray());

KeyManagerFactory kmf =  KeyManagerFactory.getInstance("SunX509");
kmf.init(ks, pin.toCharArray());
KeyManager[] kms = kmf.getKeyManagers();

X509TrustManager trustManager = new X509TrustManager() { ... }
TrustManager[] tms = new TrustManager[] {trustManager};

// Init SSL context
SSLContext sc = SSLContext.getInstance("SSL");
sc.init(kms, tms, new java.security.SecureRandom());                ...
```

OWASP ZAP: Zed Attack Proxy

- Web interception proxy & much more…
  - Open source (Java)
    - Multiplatform: Windows, Linux & Mac OS X
  - Paros & Andiparos (& WebScarab) evolution
- Supports client-based certs. & smartcards
  - Tools - Options - Certificate
    - Keystore: PKCS11, PKCS12…
  - Unsecure SSL/TLS renegotiation
  - eID failed access attempts (PIN): PUK

https://www.owasp.org/index.php/OWASP_Zed_Attack_Proxy_Project
http://code.google.com/p/zaproxy/

ZAP DNIe Support

- PKCS#11 (after installing the DNIe drivers…)

1 – Windows: (XP & 7 – 32 & 64 bits)
  - C:\Windows\System32\UsrPkcs11.dll
  - C:\Windows\SysWOW64\UsrPkcs11.dll

0 – GNU/Linux: /usr/lib/opensc-pkcs11.so (or /usr/lib64/)

0 – Mac OS X: /Library/OpenSC/lib/opensc-pkcs11.so
  - /usr/lib/opensc-pkcs11.so (link) & Java 32 bits

- drivers.xml (OWASP ZAP SmartCard Project)

http://blog.taddong.com/2012/04/owasp-zap-smartcard-project.html

How To Get The Slot (eID & OS)?

- Adding support for new eIDs (or countries)
  - keytool –D… (debug)

```
C:\> keytool -keystore NONE -storetype PKCS11 -list
       -J-Djava.security.debug=sunpkcs11,pkcs11
Escriba la contraseña del almacén de claves: ...
```

  - Result:

Install eID libraries 1st…

```
...
All slots: 1 (ó 0,1,2,3…, 15)
Slots with tokens: 1
Slot info for slot 1:
  ...
Token info for token in slot 1:
  label: DNI electrónico ...
```

The eID is Secure, It Is Used in Web-Apps, Now We Can Assess Its Security, So... (Again) Is It Used in a Secure Way?

Results & Recommendations From Real-World Pen-Tests

Motivation, Scope & Goals

- Multiple penetration tests on eID-based web applications
  - Both national public and private sectors
  - Different online services (web-apps) using the eID for user authentication (Java, ASP .NET, PHP…)
  - May-December, 2011
- Security assessments focused on authentication (eID), access controls, and session management
  - Beyond SQLi, XSS, XSRF…
- Target web-apps: 15 (very relevant ones)

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Pen-Testing eID Web-Apps Vulnerable Areas

1

2

dni electrónico

3

Impact of Vulnerable Areas

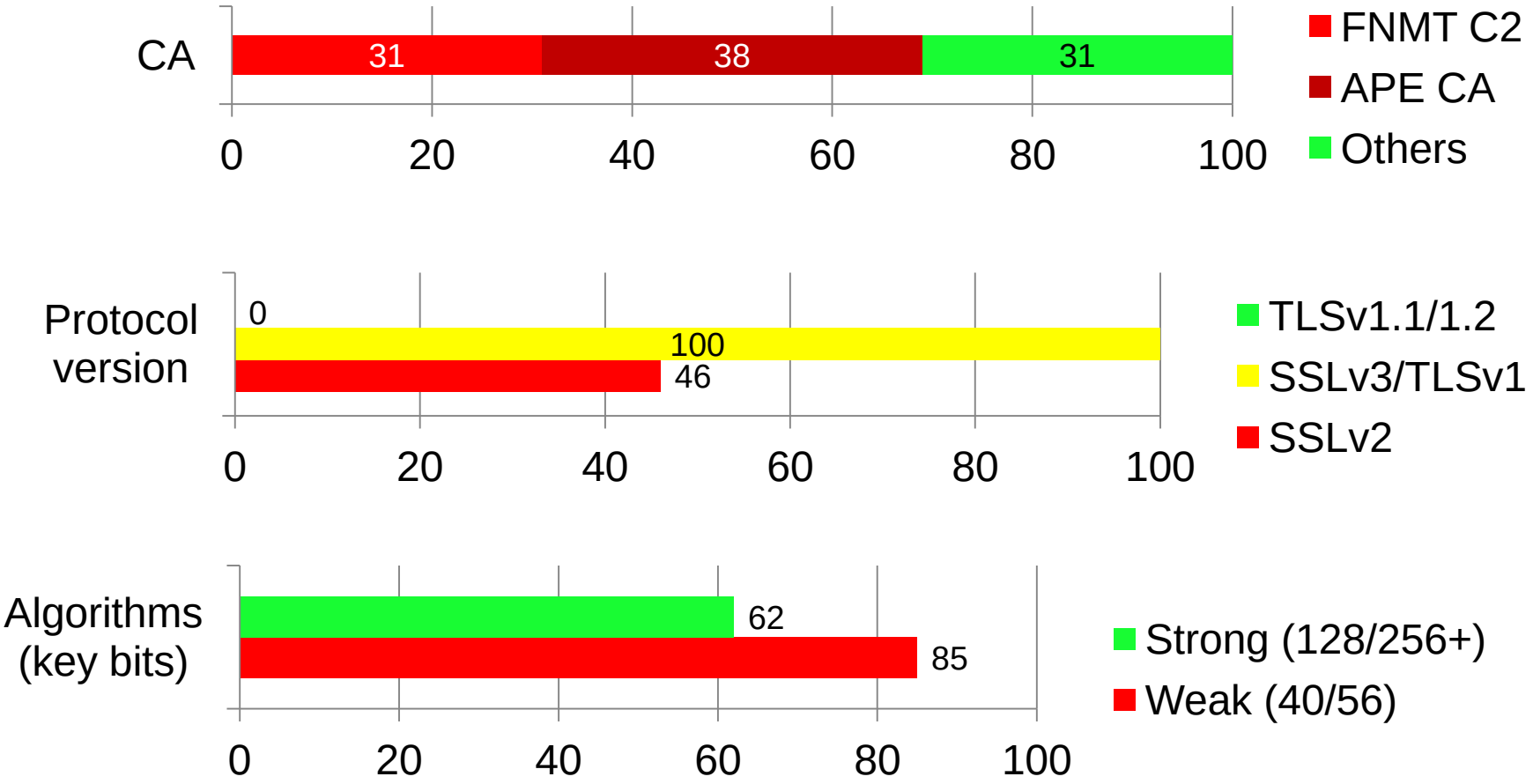
1. HTTPS (SSL/TLS) implementation
   - Native integration with eID & client digital certificates
   - Web traffic decryption, MitM attacks, DoS, etc
2. eID-based user authentication and registration
   - Manipulate authentication & registration data
   - Complete user impersonation (citizens)
3. Web-app session management
   - eID = session ID (cookie)
   - Complete user impersonation (citizens)

…but the eID is secure (we ~~are~~ were confident)

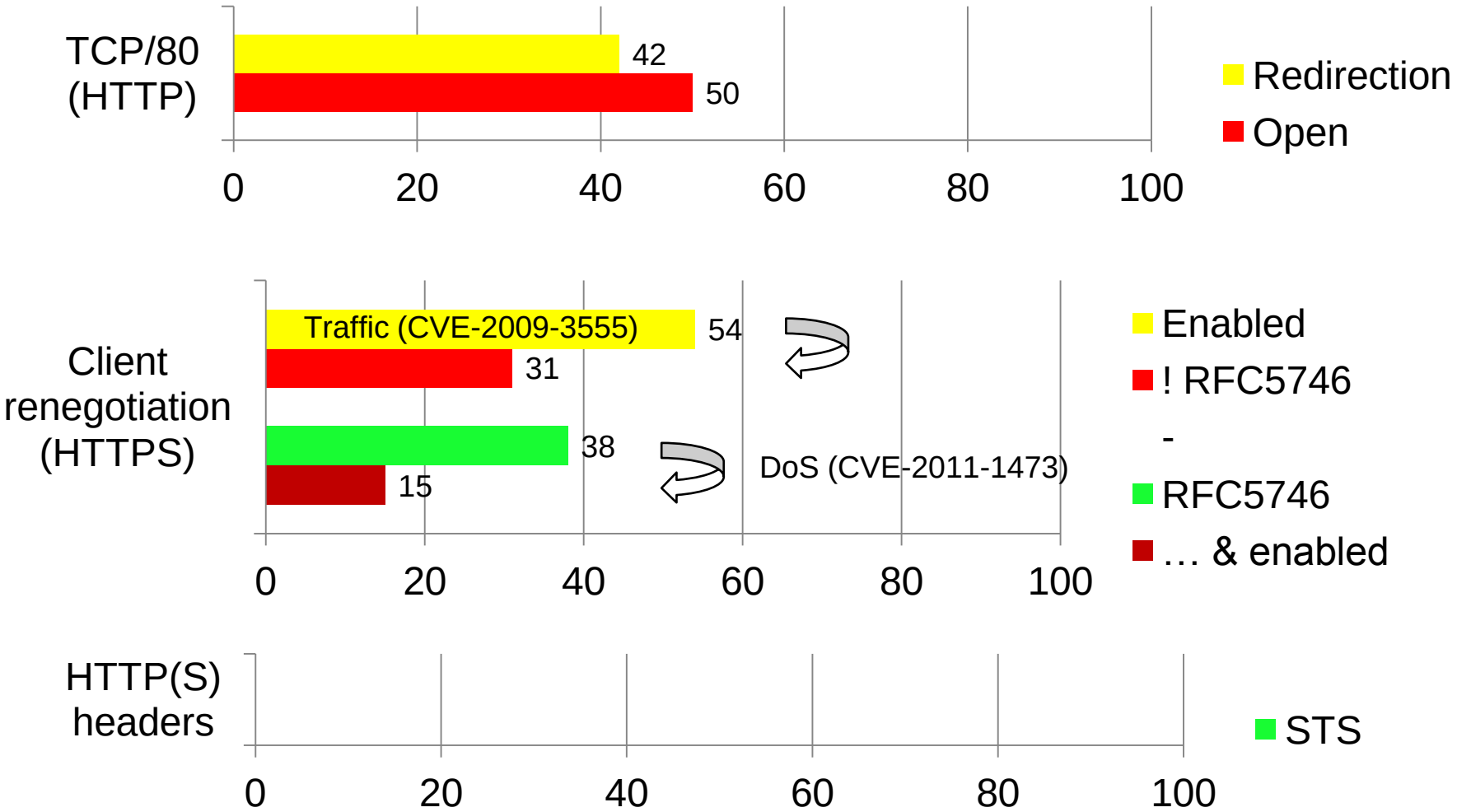
1

HTTPS

HTTPS Results (1/2)

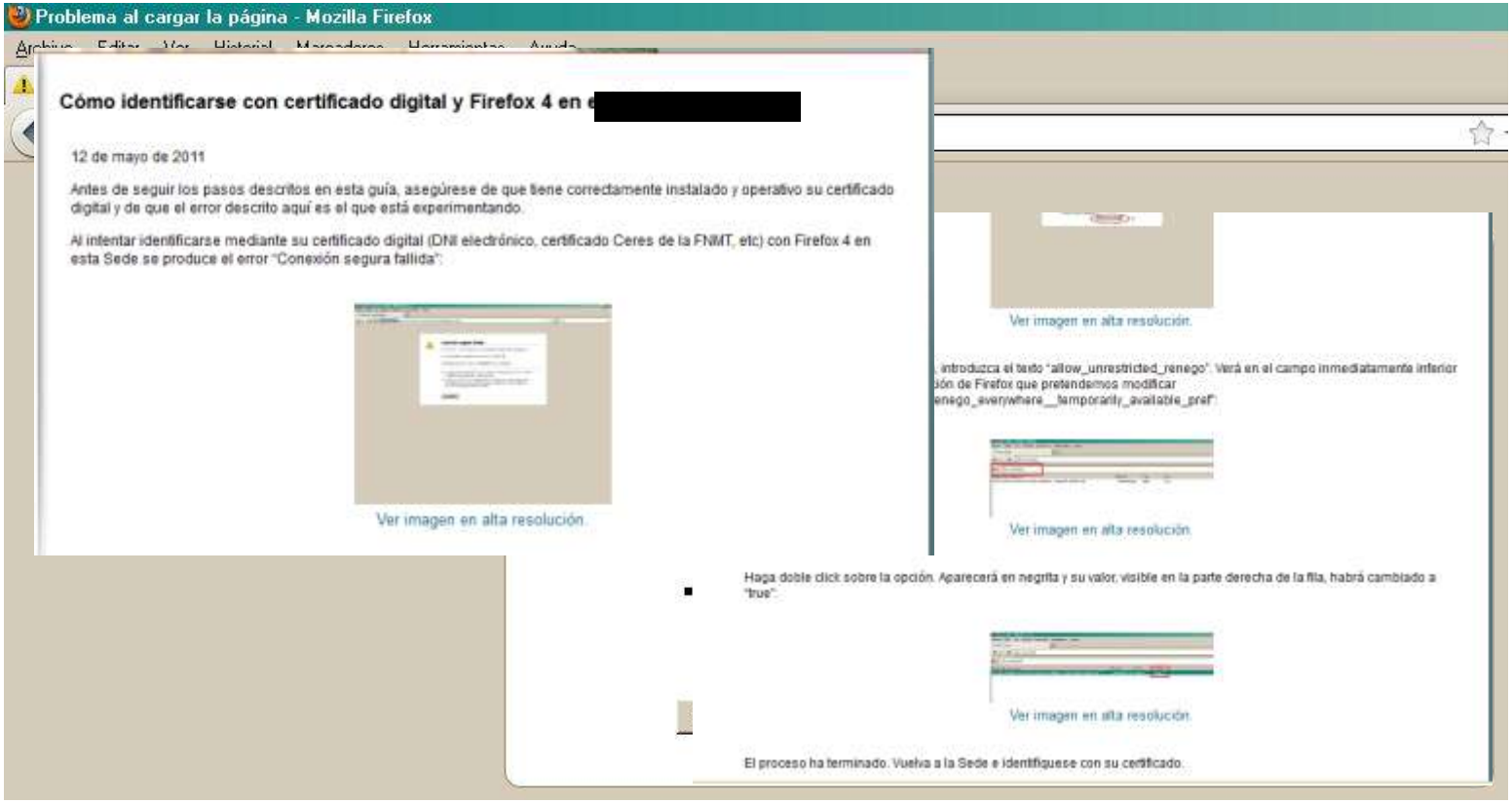


HTTPS Results (2/2)



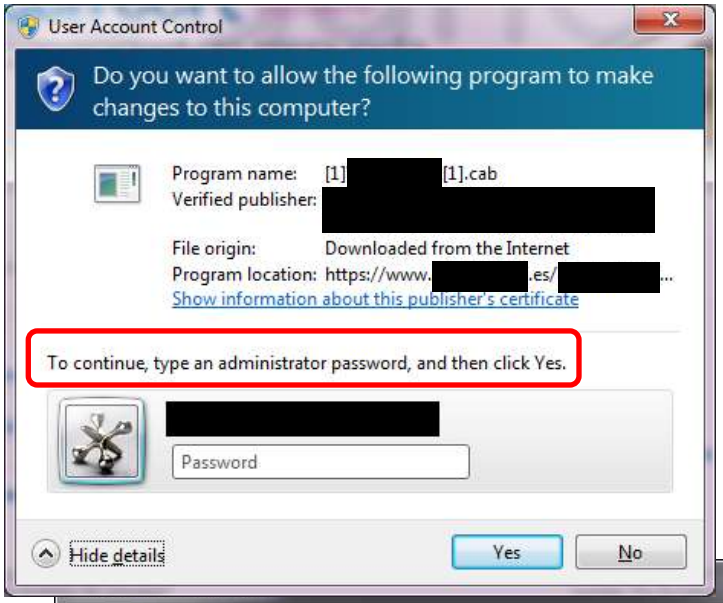
HTTPS Renegotiation

- Secure HTTPS (SSL/TLS) renegotiation

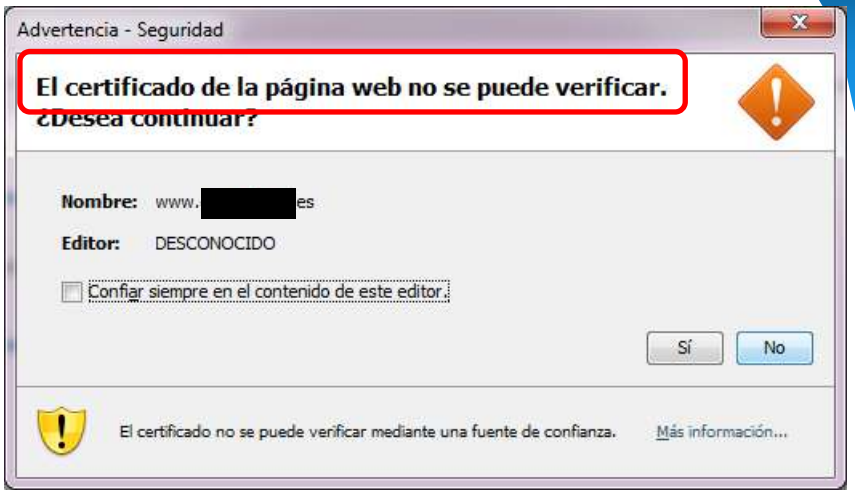


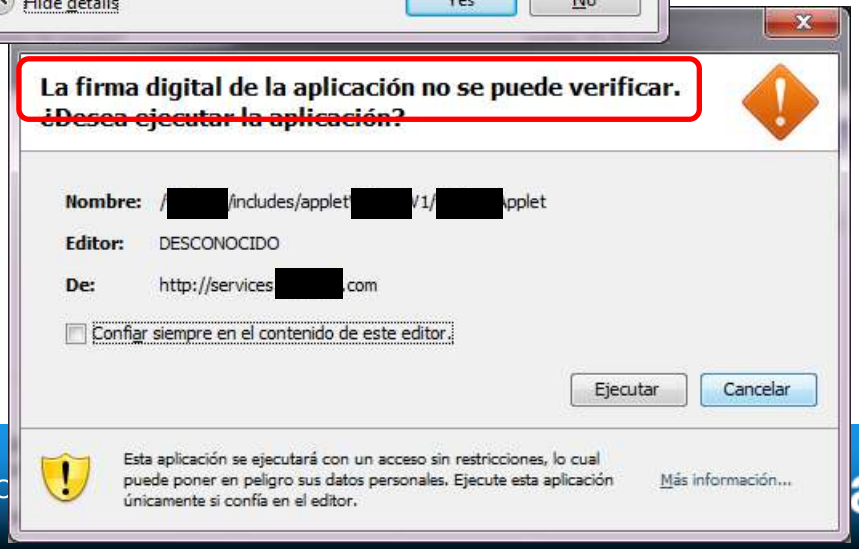
HTTPS Authentication

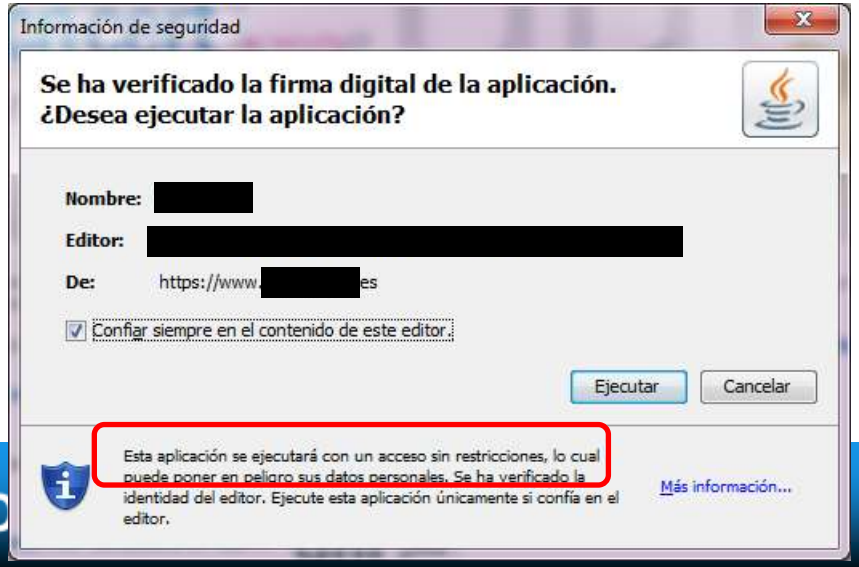
(Using web-based client components…)



HTTPS, component signature, permissions…







2

eID
(User Authentication and Registration)

eID-based User Registration Results

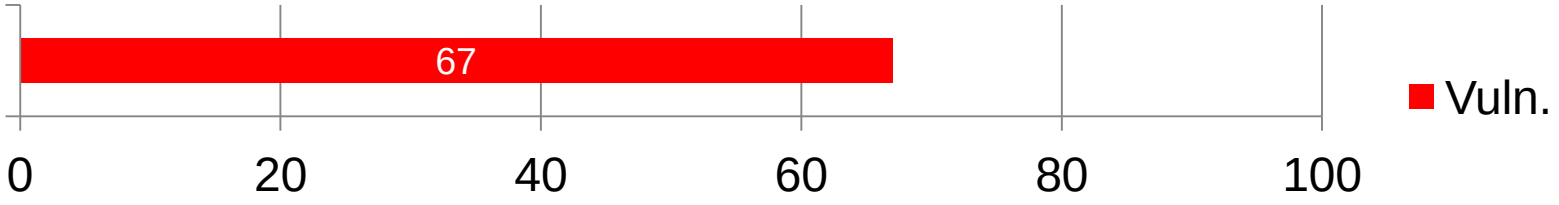
- Web-app requires user registration (eID)

  Step 1: eID authentication

  Step 2: Registration details web form

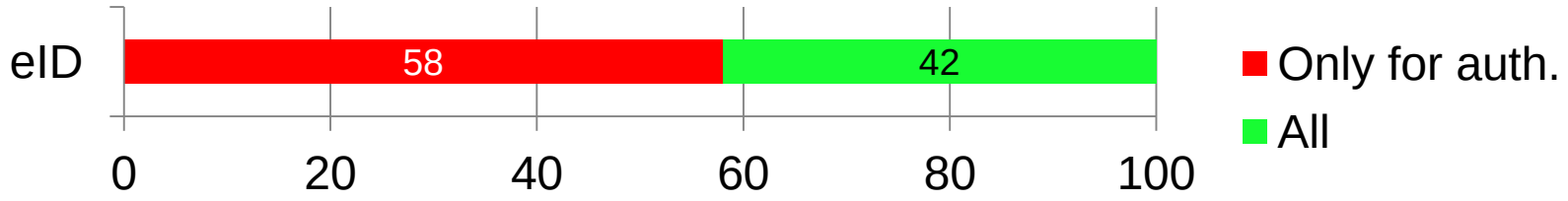
  - Lack of verification?
  - It is possible to manipulate all the victim user info: ID, name & surname, address, phone…

- Is it possible to manipulate registration details?
  - Only 25% web-apps required registration

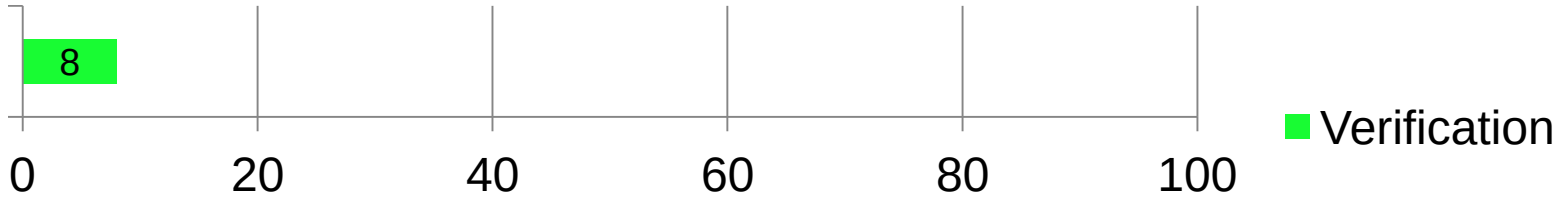


eID-based Authentication Results

- One or multi-step procedures and proceedings
- Is the eID required to access all resources?
  - User impersonation: anonymously or eID



- Matching between eID and session ID



Session Management

Session ID = Credentials

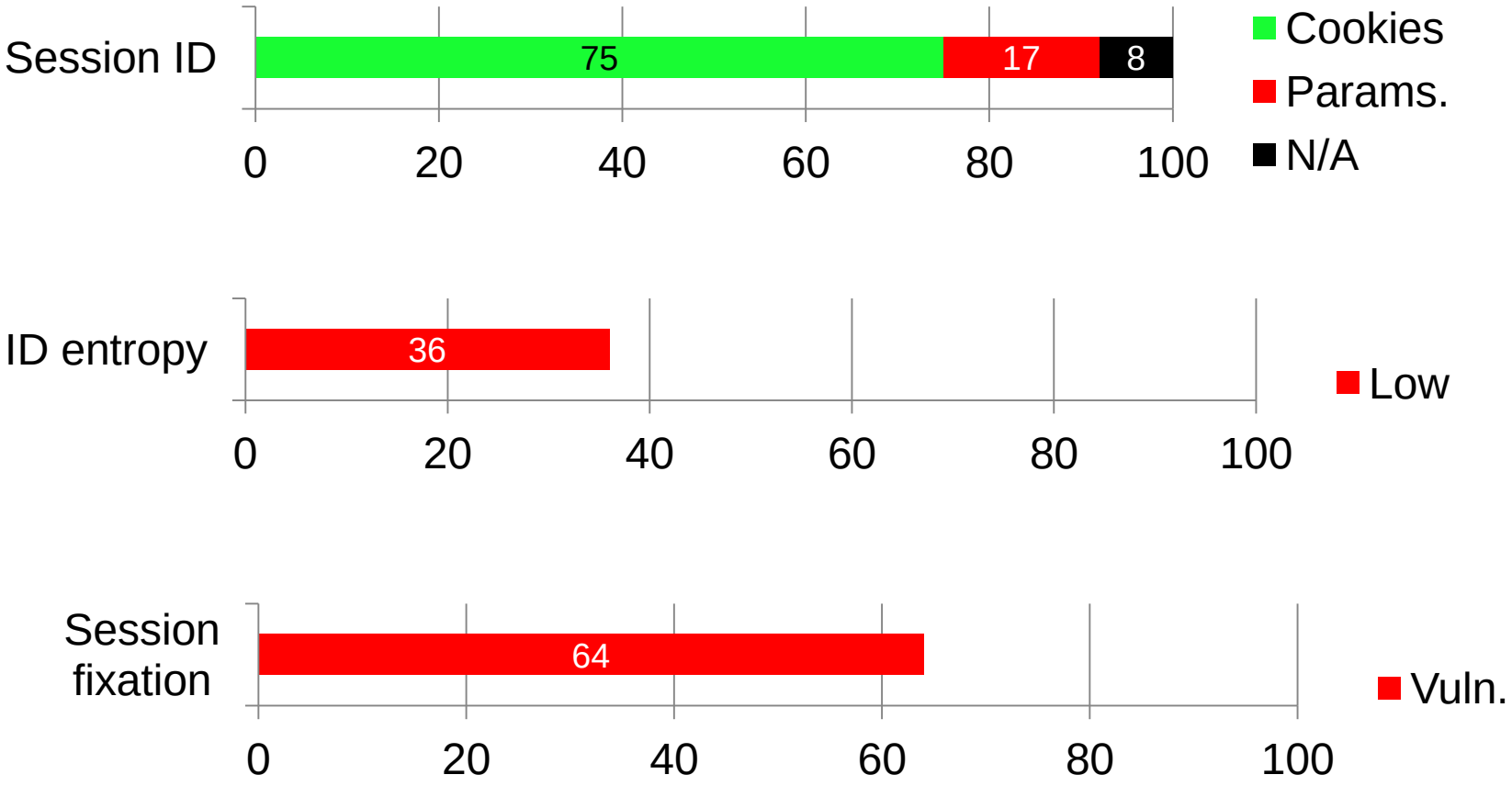
- Session management attacks trying to bypass advanced authentication mechanisms

- ID is equivalent (temporarily) to…
  - PIN & Passwords
  - Passphrases
  - Certificates
  - Smartcards
  - Biometry

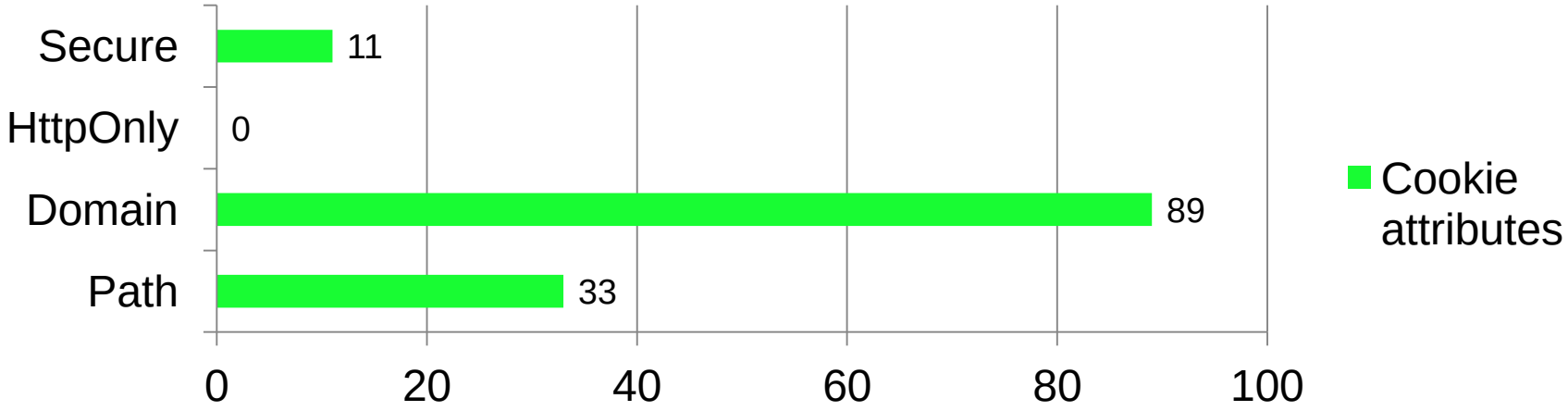
So The eID in Reality is Like…

=

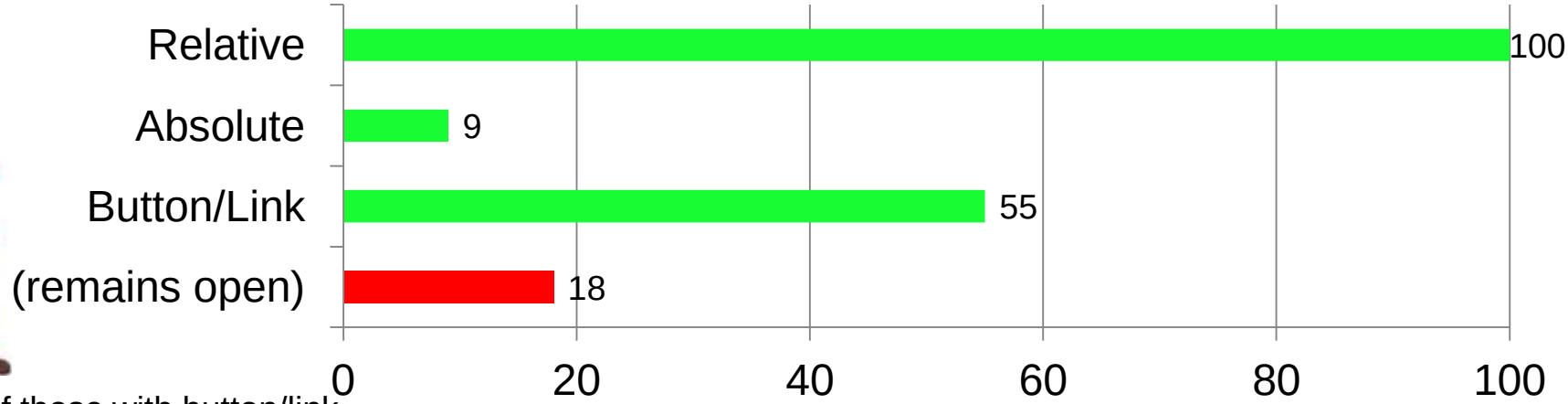
Session Management Results (1/2)



Session Management Results (2/2)



Session finalization (timeouts):

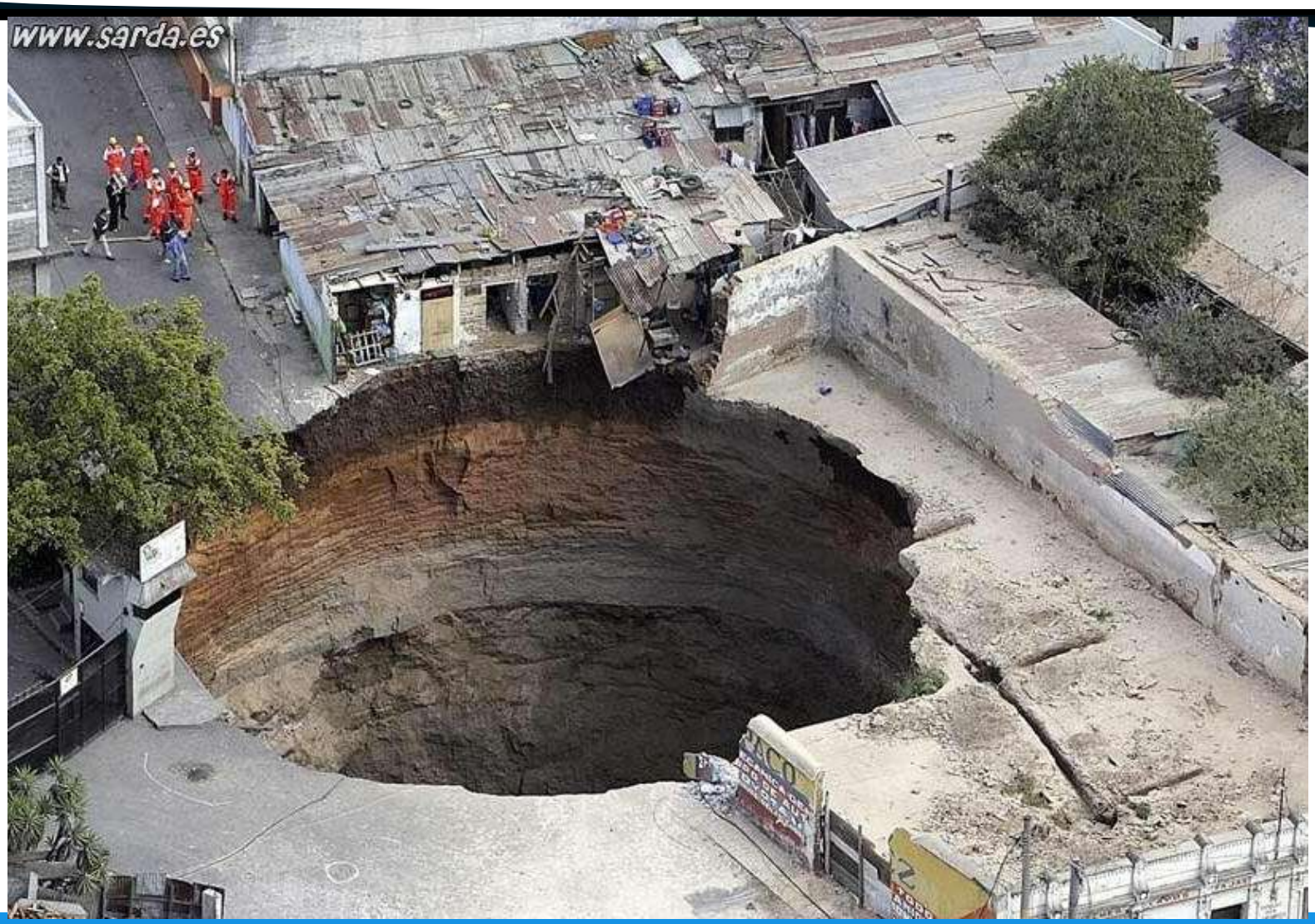


33% of those with button/link

The eID is Secure, It Is Used in Web-Apps, But... It Seems It Is NOT Being Used in a Secure Way

Conclusions

Conclusion



Warning

Solution

Thank You

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