SHARKFEST '12

Wireshark Developer and User Conference

Understanding Encryption Services Using Wireshark

Sunday June 24th 2012

Larry Greenblatt

Jedi Knight | InterNetwork Defense

SHARKFEST '12

UC Berkeley

June 24-27, 2012

About me

Musician:

Gung Ho! - Lead Guitar / Vocals / Songwriter

– *Produced by Otto Capobianco*

Max Quasar & Lorenzo Verti - “” & Producer

The Swinging Johnsons – Vocals

Martial Artist:

Black Sash Taiji

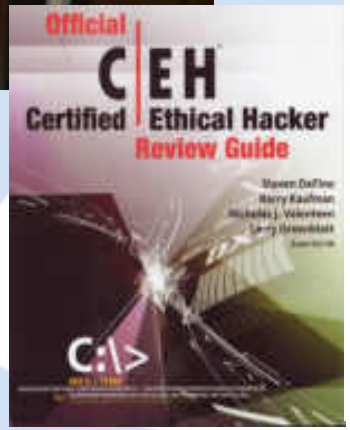
3rd Degree Black Belt JLFS

Hobbies (my day job):

Network nerd (& InfoSec geek) 1984

Consultant / Instructor / Author

CISM, CISSP, CEH, ECSA, Security+



Intro to Crypt0

with Bob & Alice

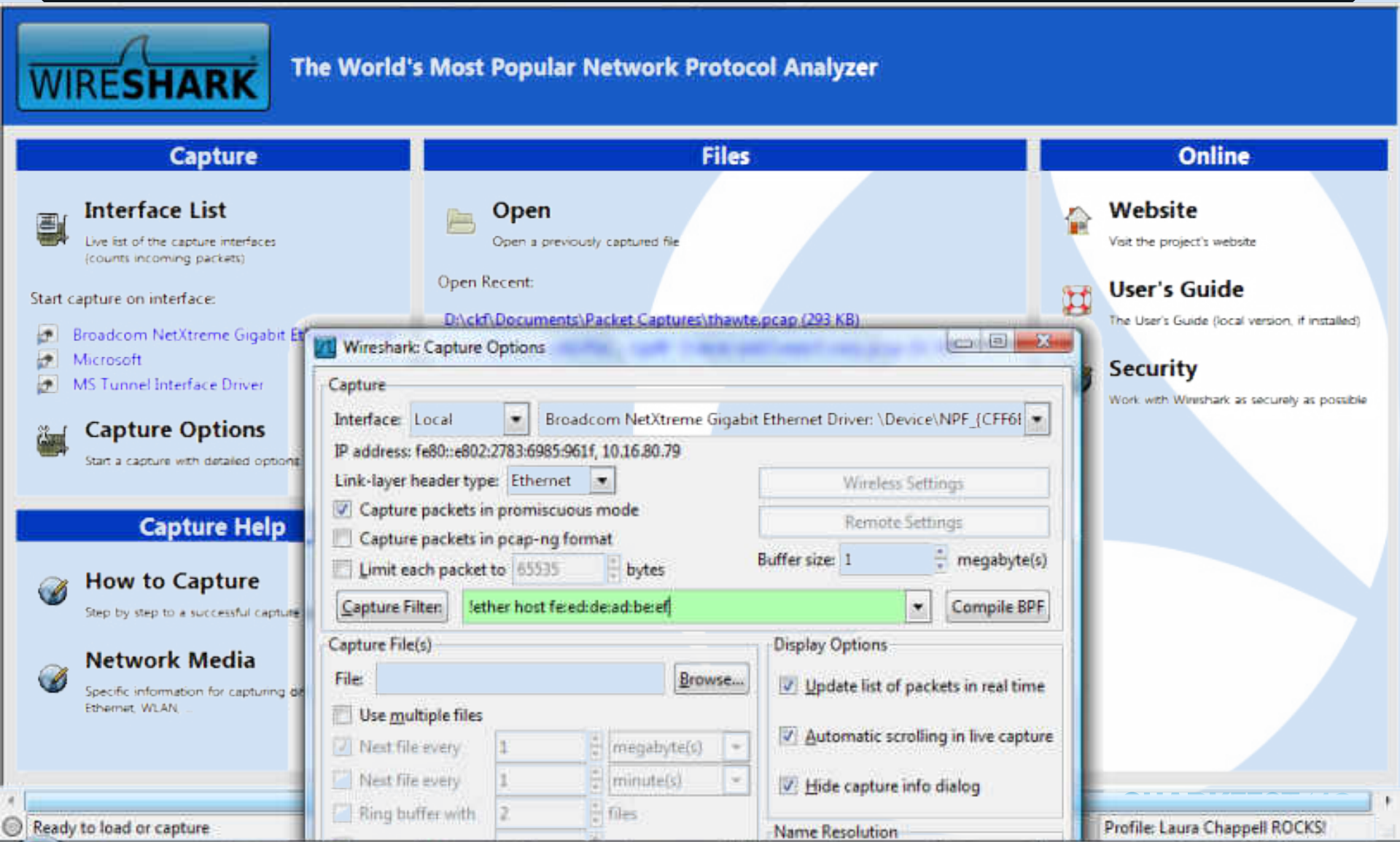
A Consumers Guide to:

1) Confidentiality
2) Authentication
3) Integrity
4) Non-Repudiation

By Employing:

Symmetric, **Asymmetric** and **Hashing** Algorithms

It is said that “Packets Do Not Lie”



The Intelligent Consumer

welcome to the crypto-Mart

Aisle 1
Symmetric Algorithms
(Shared Secret)

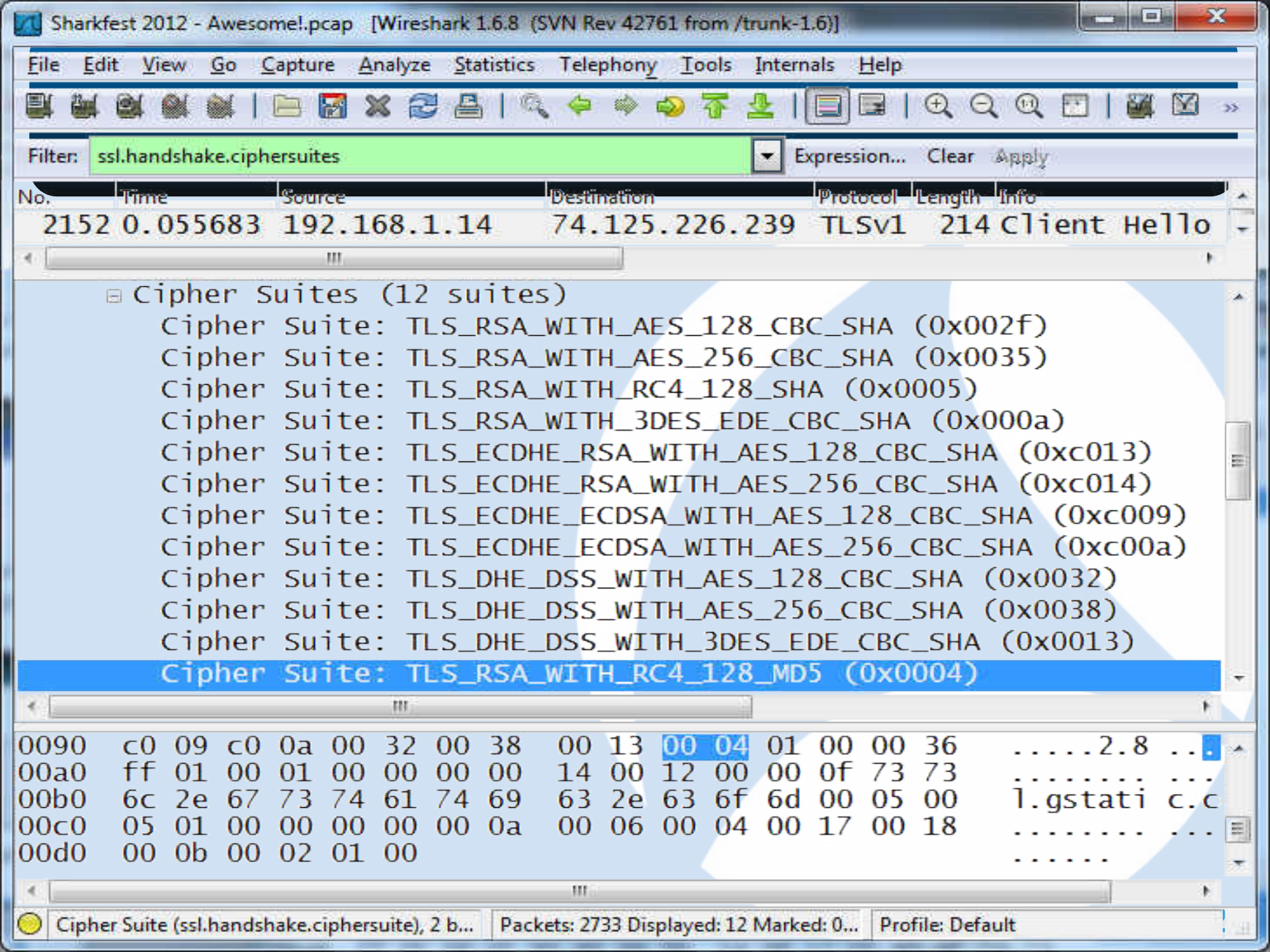
RC4
AES
Twofish
Blowfish
DES &3DES
E0

Aisle 2
Asymmetric Algorithms
(Public/Private)

Diffie-Hellman
RSA
ECC
El Gamal

Aisle 3
Hashing Algorithms
(Message Digests)

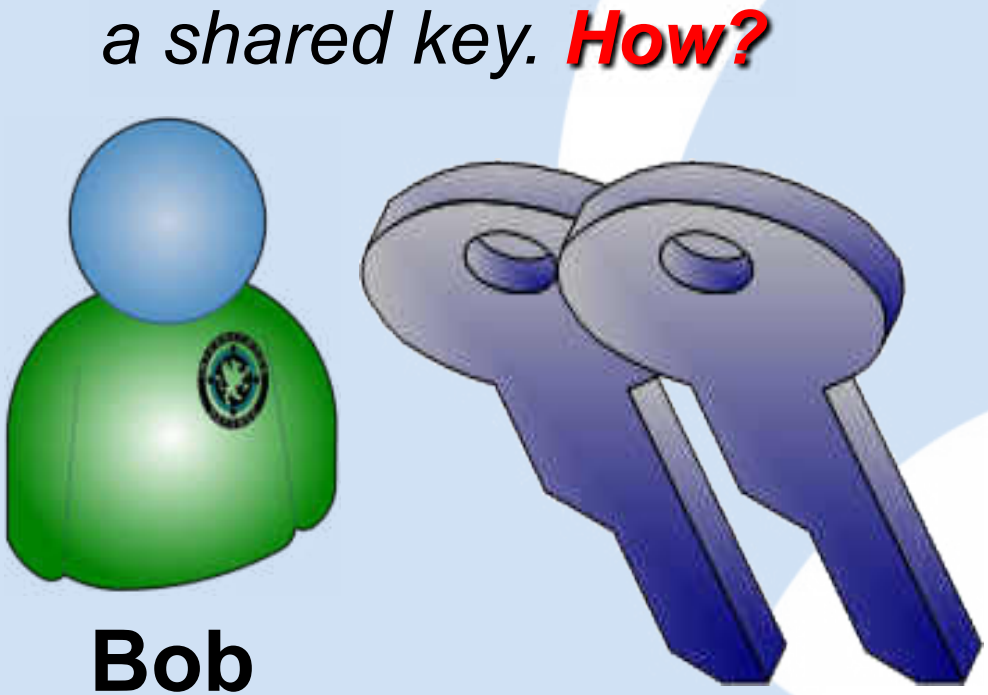
MD5
SHA1, SHA2 & SHA3
Skein
Whirlpool


Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: ssl.handshake.ciphersuites
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2152 0.055683 192.168.1.14 74.125.226.239 TLSv1 214 Client Hello
Cipher Suites (12 suites)
Cipher Suite: TLS_RSA_WITH_AES_128_CBC_SHA (0x002f)
Cipher Suite: TLS_RSA_WITH_AES_256_CBC_SHA (0x0035)
Cipher Suite: TLS_RSA_WITH_RC4_128_SHA (0x0005)
Cipher Suite: TLS_RSA_WITH_3DES_EDE_CBC_SHA (0x000a)
Cipher Suite: TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA (0xc013)
Cipher Suite: TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA (0xc014)
Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA (0xc009)
Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA (0xc00a)
Cipher Suite: TLS_DHE_DSS_WITH_AES_128_CBC_SHA (0x0032)
Cipher Suite: TLS_DHE_DSS_WITH_AES_256_CBC_SHA (0x0038)
Cipher Suite: TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA (0x0013)
Cipher Suite: TLS_RSA_WITH_RC4_128_MD5 (0x0004)
0090 c0 09 c0 0a 00 32 00 38 00 13 00 04 01 00 00 36 .....2.8 ...
00a0 ff 01 00 01 00 00 00 00 14 00 12 00 00 0f 73 73 ....
00b0 6c 2e 67 73 74 61 74 69 63 2e 63 6f 6d 00 05 00 l.gstati c.c
00c0 05 01 00 00 00 00 00 0a 00 06 00 04 00 17 00 18 ....
00d0 00 0b 00 02 01 00 ....
Cipher Suite (ssl.handshake.ciphersuite), 2 b...
Packets: 2733 Displayed: 12 Marked: 0...
Profile: Default

Part 1

Symmetric Encryption

- **Bob wants to share a secret with Alice**
  - *First they must both secretly agree on a shared key.* ***How?***



Symmetric Encryption

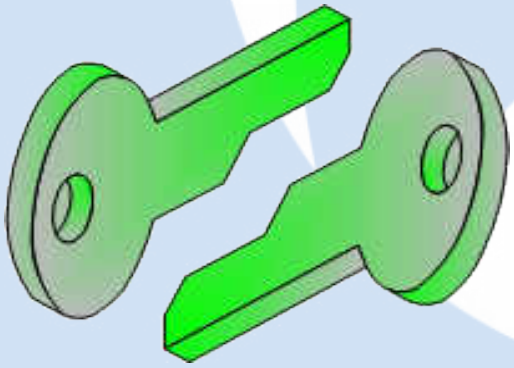
- **Strengths**
  - Fast
- **Challenges**
  - Key Agreement
  - Scalability
    - *N(N-1)/2*
- **Security Services:**
  - Confidentiality
  - Limited* authenticity

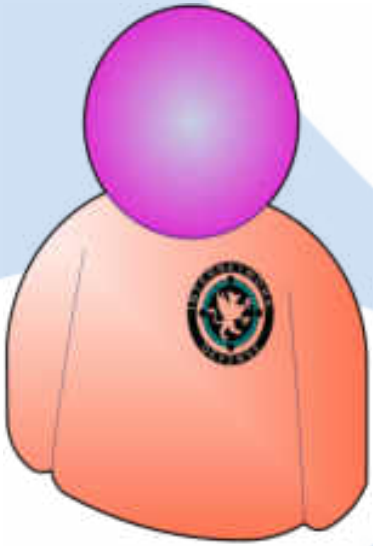
**Alice knows it is Bob, but she can't prove it!*

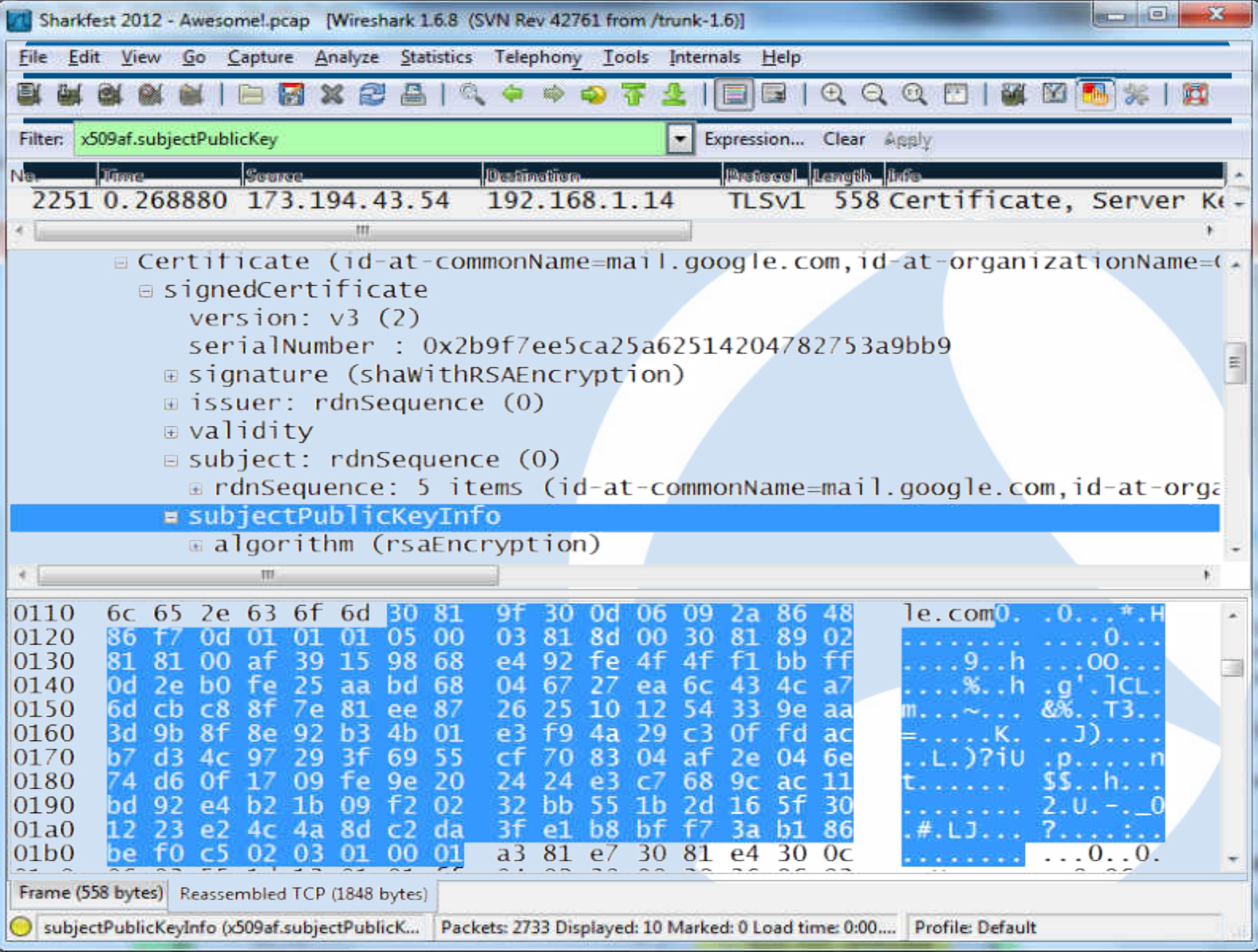
Part 2

Asymmetric Encryption

- **Alice creates a related key pair**
  - She keeps one to herself *(private key will sign)*
  - Gives the other to anyone who wants it *(public)*
    - **Public key:**
      - ***ID card***
      - ***PKI: Validates x.509 name***

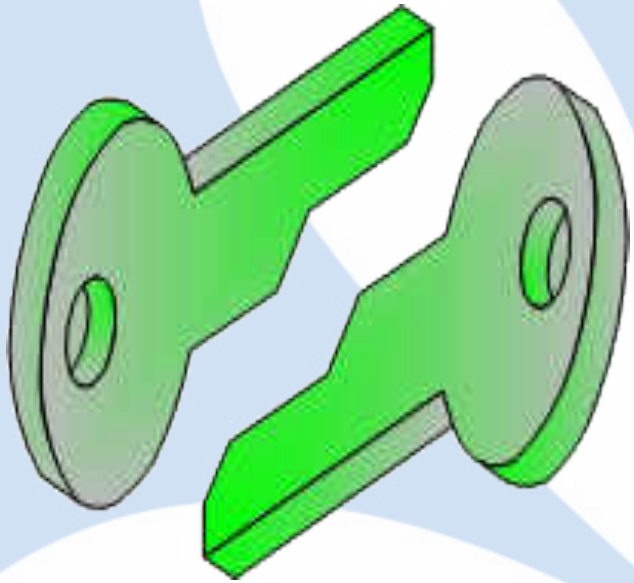


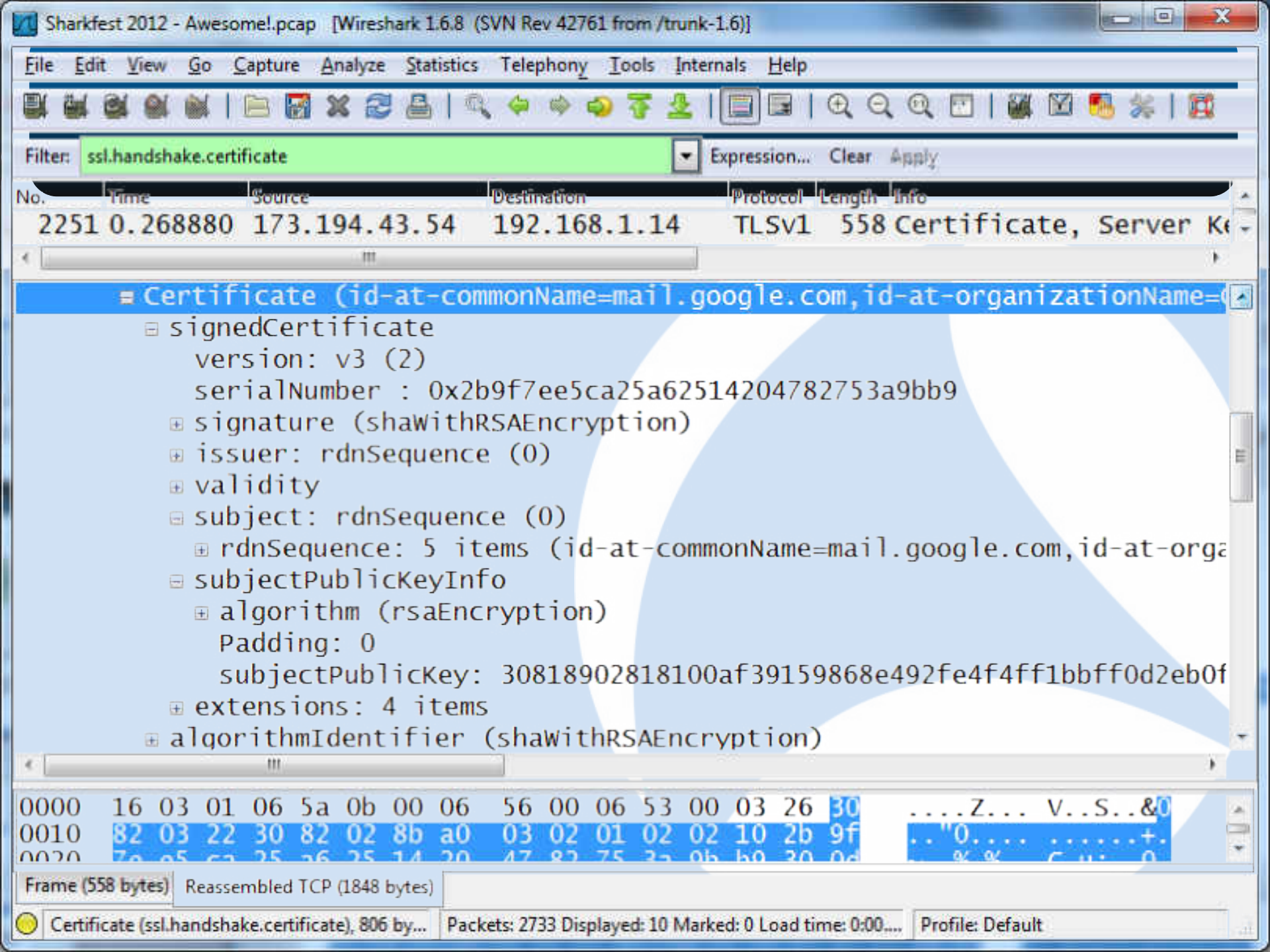


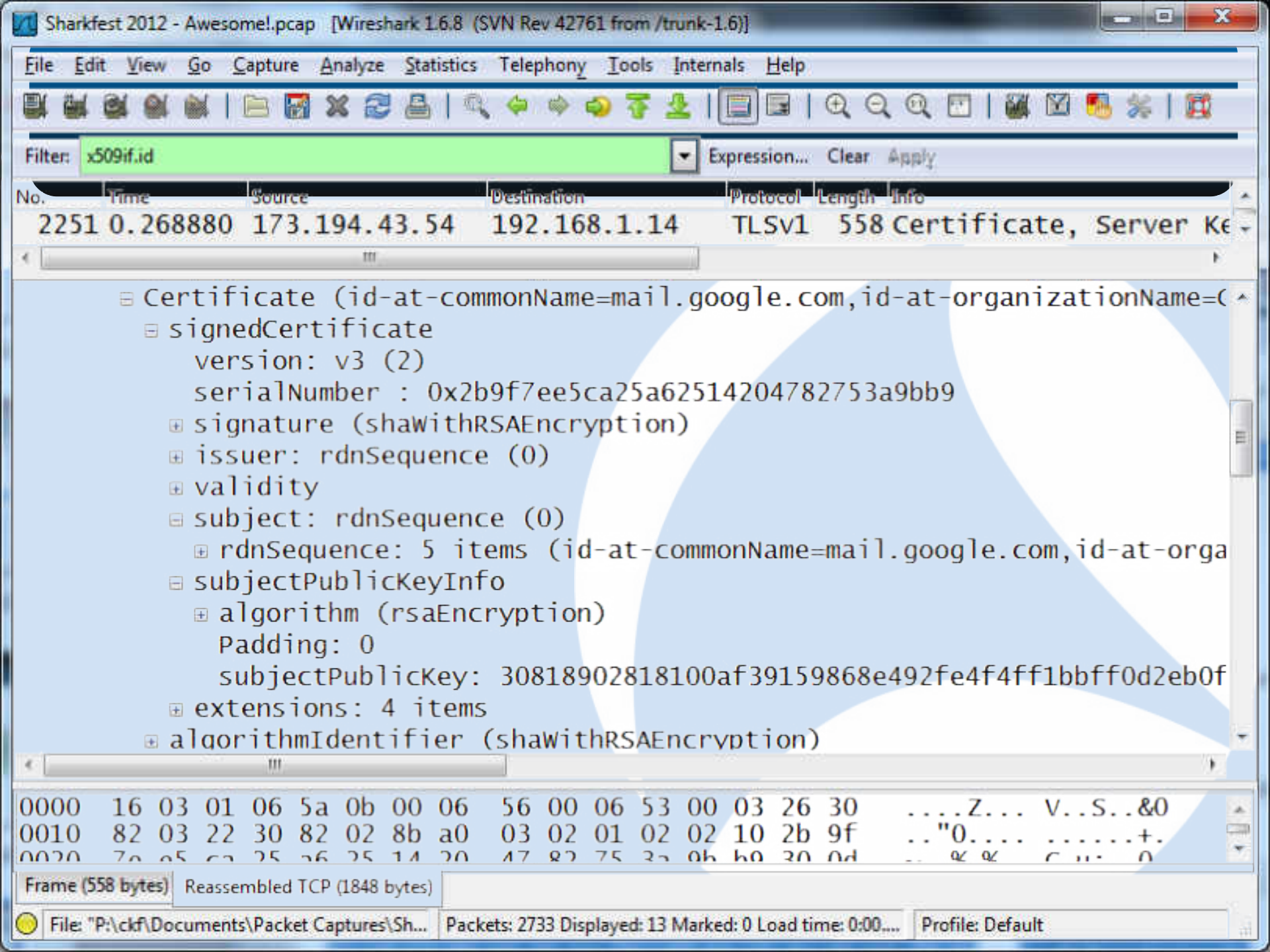

Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: x509af.subjectPublicKey
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2251 0.268880 173.194.43.54 192.168.1.14 TLSv1 558 Certificate, Server K
Certificate (id-at-commonName=mail.google.com,id-at-organizationName=
signedCertificate
version: v3 (2)
serialNumber : 0x2b9f7ee5ca25a625142047827 53a9bb9
signature (shaWithRSAEncryption)
issuer: rdnSequence (0)
validity
subject: rdnSequence (0)
rdnSequence: 5 items (id-at-commonName=mail.google.com,id-at-orga
subjectPublicKeyInfo
algorithm (rsaEncryption)
0110 6c 65 2e 63 6f 6d 30 81 9f 30 0d 06 09 2a 86 48 le.com0. .0...*.H
0120 86 f7 0d 01 01 01 05 00 03 81 8d 00 30 81 89 02 ....0...
0130 81 81 00 af 39 15 98 68 e4 92 fe 4f 4f f1 bb ff ....9..h ...OO...
0140 0d 2e b0 fe 25 aa bd 68 04 67 27 ea 6c 43 4c a7 ....%..h .g'.lCL.
0150 6d cb c8 8f 7e 81 ee 87 26 25 10 12 54 33 9e aa m...~... &%..T3..
0160 3d 9b 8f 8e 92 b3 4b 01 e3 f9 4a 29 c3 0f fd ac =.....K. ..J)....
0170 b7 d3 4c 97 29 3f 69 55 cf 70 83 04 af 2e 04 6e ..L.)?iU .p.....n
0180 74 d6 0f 17 09 fe 9e 20 24 24 e3 c7 68 9c ac 11 t..... $$..h...
0190 bd 92 e4 b2 1b 09 f2 02 32 bb 55 1b 2d 16 5f 30 .... 2.U.-._0
01a0 12 23 e2 4c 4a 8d c2 da 3f e1 b8 bf f7 3a b1 86 .#.LJ... ?....:..
01b0 be f0 c5 02 03 01 00 01 a3 81 e7 30 81 e4 30 0c ....0..0.
Frame (558 bytes) Reassembled TCP (1848 bytes)
subjectPublicKeyInfo (x509af.subjectPublicK...
Packets: 2733 Displayed: 10 Marked: 0 Load time: 0:00....
Profile: Default

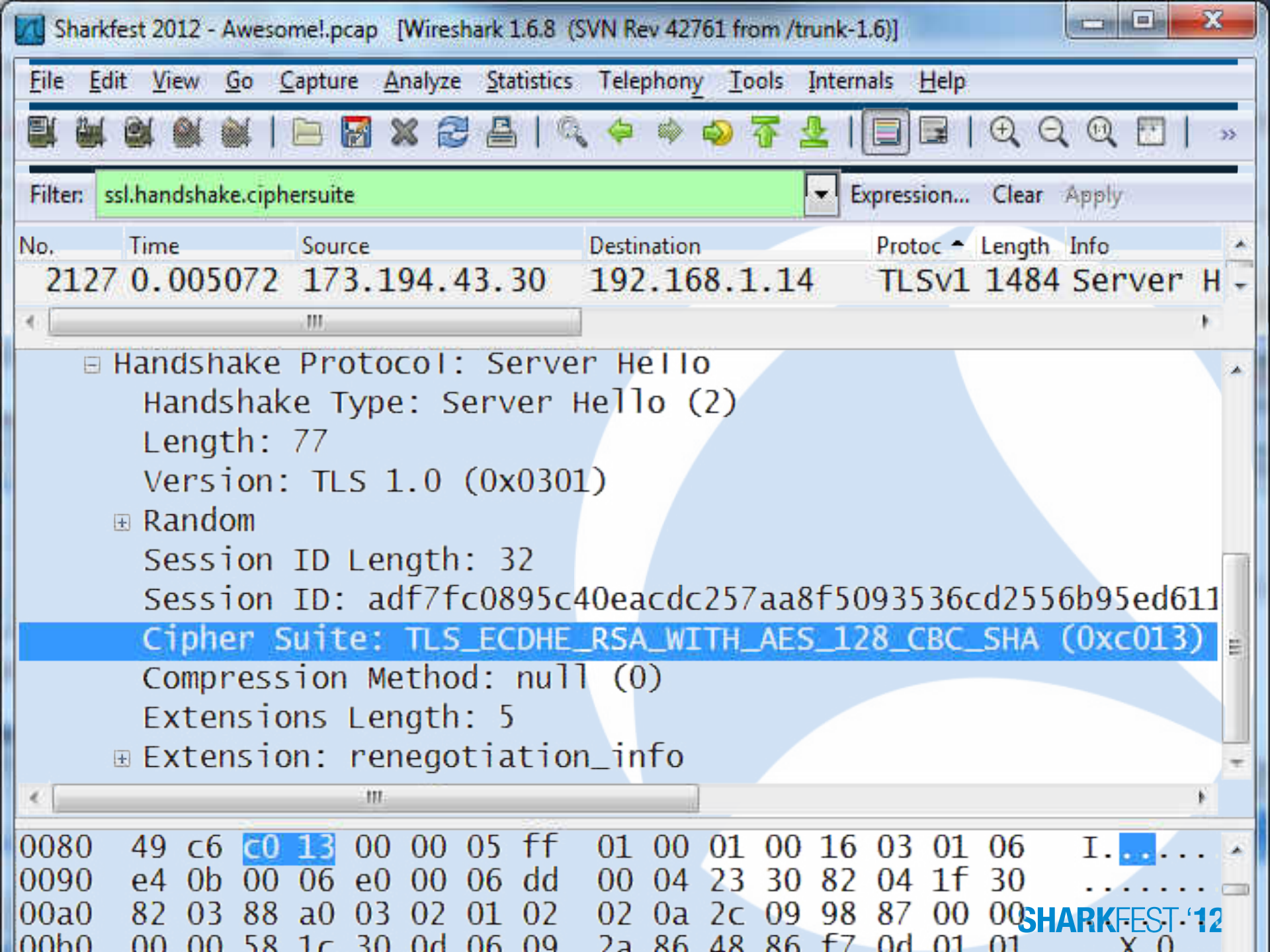
Asymmetric Encryption

- **Advantages over symmetric**
  - Key Distribution
  - Scalability (2N)
  - Provides Non-Repudiation
- **Disadvantages**
  - Much slower
  - Requires Trusted 3rd Party
    - PKI Hierarchy
    - OpenPGP Web of Trust




Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: ssl.handshake.certificate
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2251 0.268880 173.194.43.54 192.168.1.14 TLSv1 558 Certificate, Server Ke
Certificate (id-at-commonName=mail.google.com,id-at-organizationName=
signedCertificate
version: v3 (2)
serialNumber : 0x2b9f7ee5ca25a625142047827 53a9bb9
signature (shaWithRSAEncryption)
issuer: rdnSequence (0)
validity
subject: rdnSequence (0)
rdnSequence: 5 items (id-at-commonName=mail.google.com,id-at-orga
subjectPublicKeyInfo
algorithm (rsaEncryption)
Padding: 0
subjectPublicKey: 30818902818100af39159868e492fe4f4ff1bbff0d2eb0f
extensions: 4 items
algorithmIdentifier (shaWithRSAEncryption)
0000 16 03 01 06 5a 0b 00 06 56 00 06 53 00 03 26 30
0010 82 03 22 30 82 02 8b a0 03 02 01 02 02 10 2b 9f
Frame (558 bytes) Reassembled TCP (1848 bytes)
Certificate (ssl.handshake.certificate), 806 by...
Packets: 2733 Displayed: 10 Marked: 0 Load time: 0:00....
Profile: Default


Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: x509if.id
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2251 0.268880 173.194.43.54 192.168.1.14 TLSv1 558 Certificate, Server Ke
Certificate (id-at-commonName=mail.google.com,id-at-organizationName=(
signedCertificate
version: v3 (2)
serialNumber : 0x2b9f7ee5ca25a625142047827 53a9bb9
signature (shaWithRSAEncryption)
issuer: rdnSequence (0)
validity
subject: rdnSequence (0)
rdnSequence: 5 items (id-at-commonName=mail.google.com,id-at-orga
subjectPublicKeyInfo
algorithm (rsaEncryption)
Padding: 0
subjectPublicKey: 30818902818100af39159868e492fe4f4ff1bbff0d2eb0f
extensions: 4 items
algorithmIdentifier (shaWithRSAEncryption)
0000 16 03 01 06 5a 0b 00 06 56 00 06 53 00 03 26 30 ....Z... V..S..&0
0010 82 03 22 30 82 02 8b a0 03 02 01 02 02 10 2b 9f ..."0.... ......+.
Frame (558 bytes)
Reassembled TCP (1848 bytes)
File: "P:\ckf\Documents\Packet Captures\Sh...
Packets: 2733 Displayed: 13 Marked: 0 Load time: 0:00....
Profile: Default


Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: ssl.handshake.ciphersuite
Expression... Clear Apply
No. Time Source Destination Protoc Length Info
2127 0.005072 173.194.43.30 192.168.1.14 TLSv1 1484 Server H
Handshake Protocol: Server Hello
Handshake Type: Server Hello (2)
Length: 77
Version: TLS 1.0 (0x0301)
Random
Session ID Length: 32
Session ID: adf7fc0895c40eacdc257aa8f5093536cd2556b95ed611
Cipher Suite: TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA (0xc013)
Compression Method: null (0)
Extensions Length: 5
Extension: renegotiation_info
0080 49 c6 c0 13 00 00 05 ff 01 00 01 00 16 03 01 06
0090 e4 0b 00 06 e0 00 06 dd 00 04 23 30 82 04 1f 30
00a0 82 03 88 a0 03 02 01 02 02 0a 2c 09 98 87 00 00
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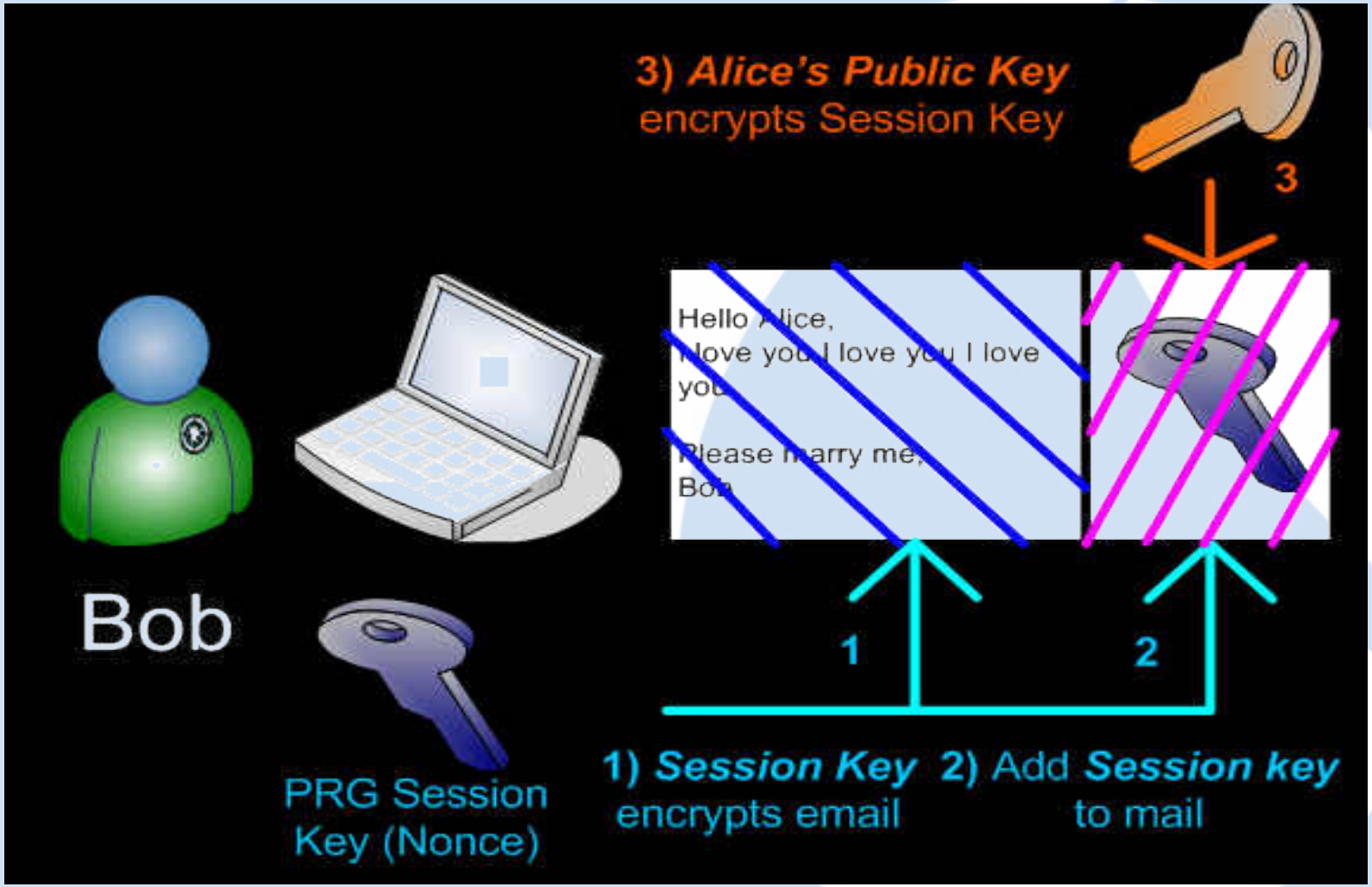
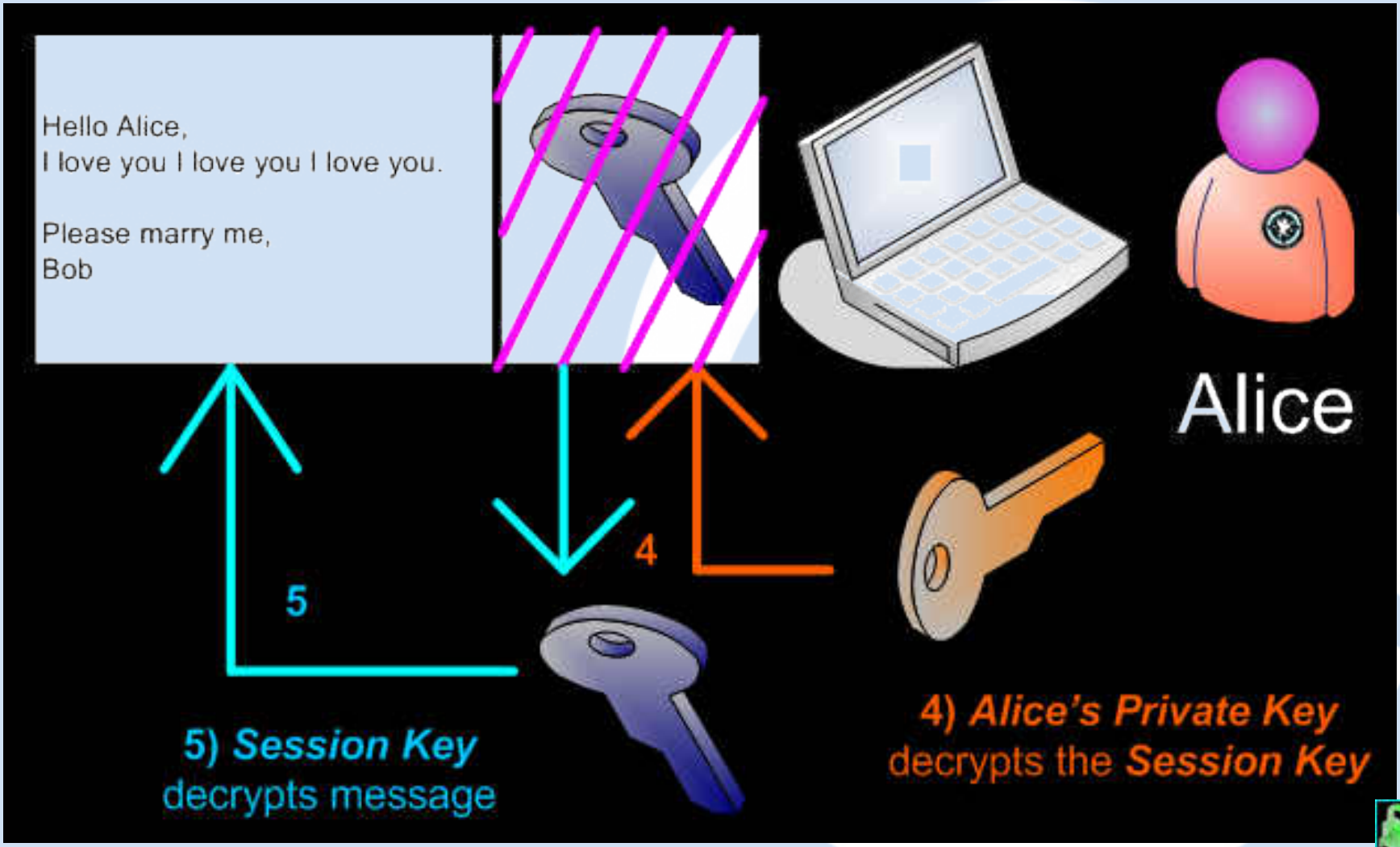
Encrypting eMail



Decrypting eMail



Part 3

Hashing Algorithms

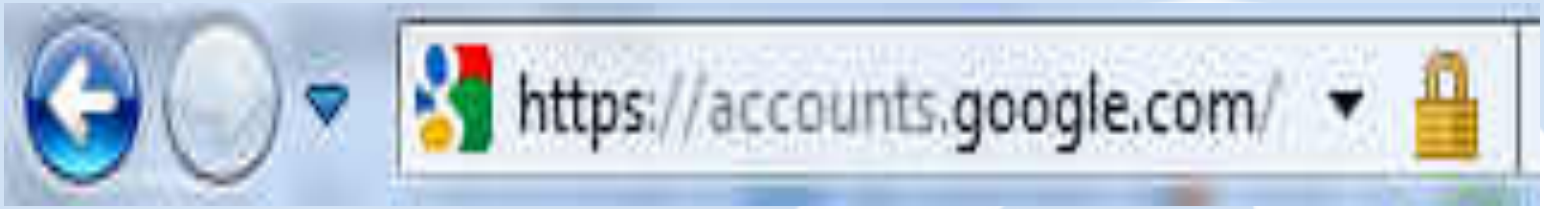
Understand Integrity checks with:

a) Message Digests

b) Message Authentication Codes

c) Digital Signatures

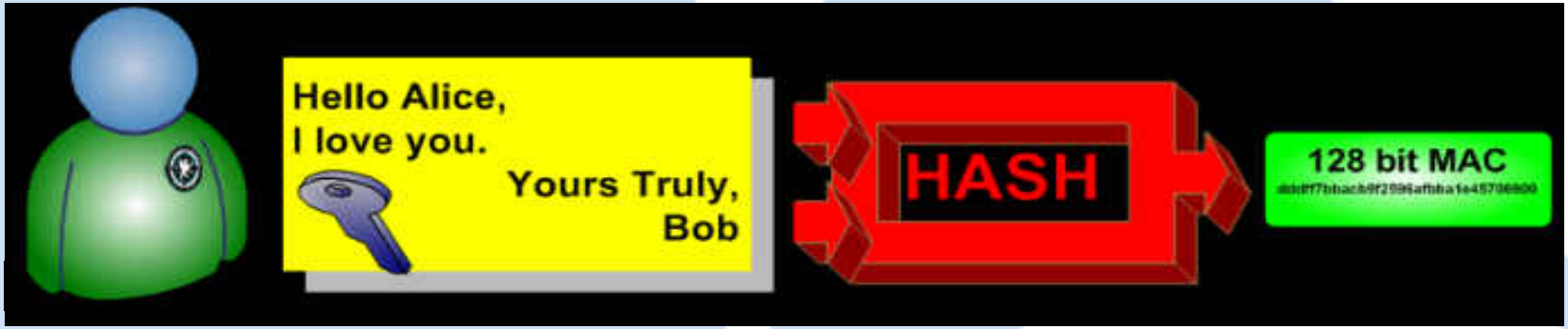
Authenticating the Hash



- **Message Digest**
  - Not-Authenticated
- **Message Authentication Code (MAC)**
  - Authenticated Symmetrically
    - Authentication only *(message can be repudiated)*
- **Digital Signatures**
  - Authenticated Asymmetrically
    - Authentication
    - Non-Repudiation

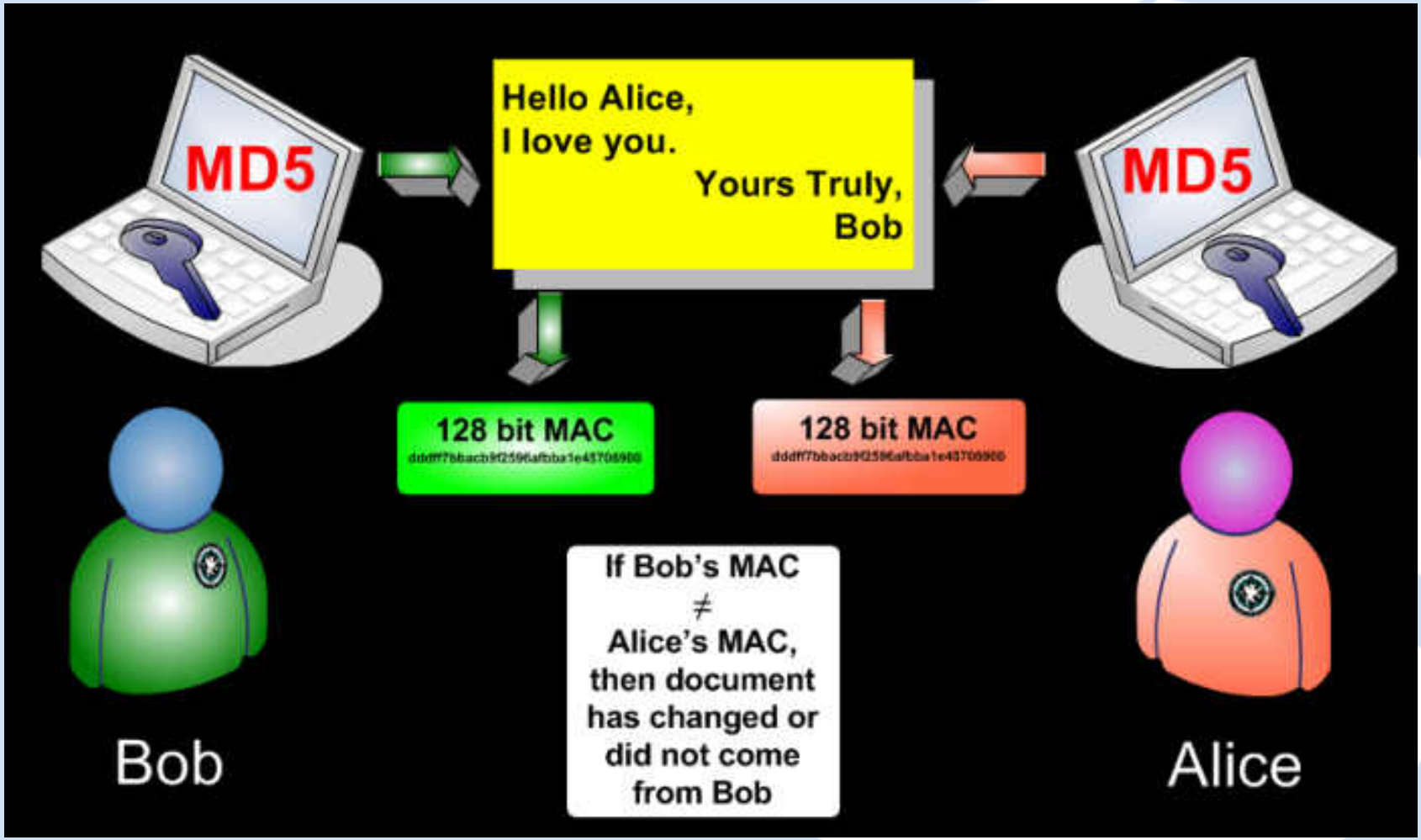
Message Authentication Codes

- Message digest is salted with symmetric key
  - Hash provides integrity
  - Symmetric key provides authenticity

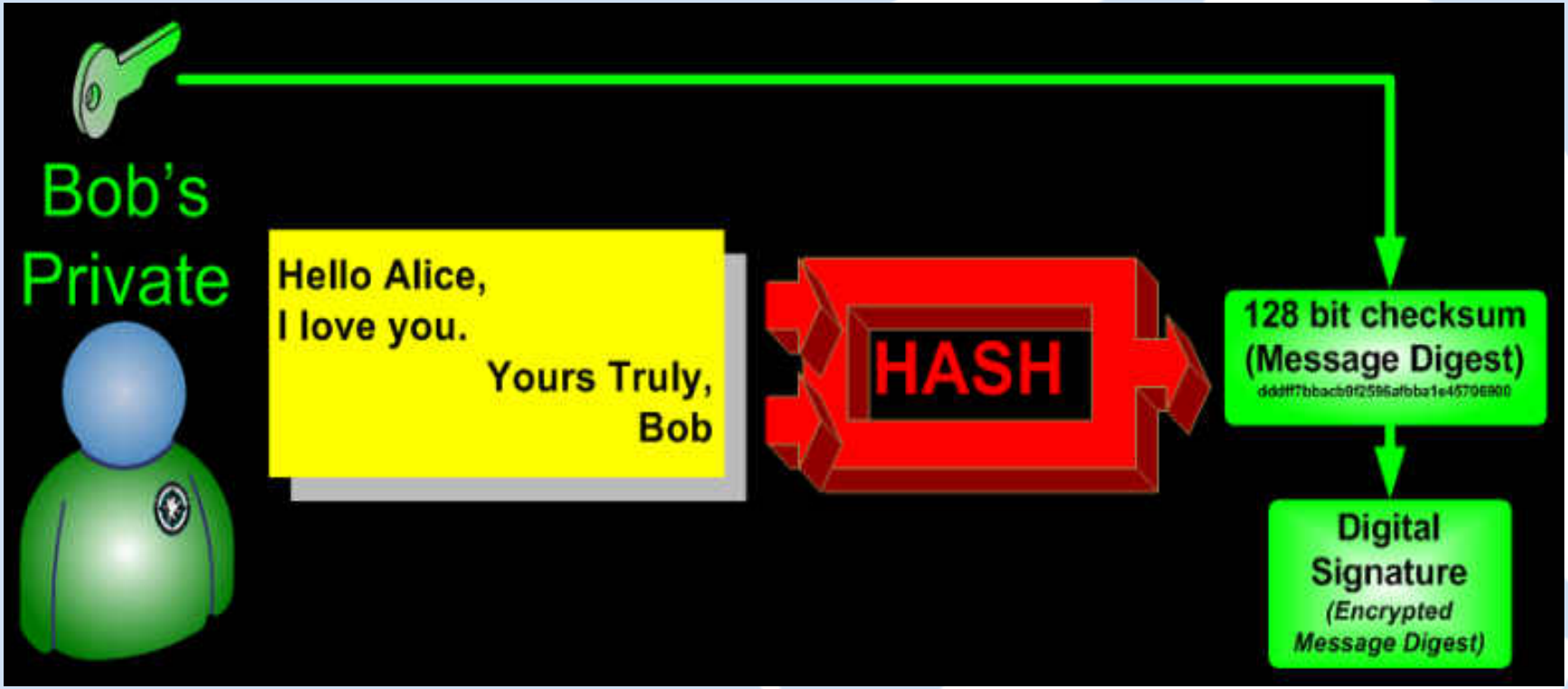


  - Bob Claims “Alice sent the message”

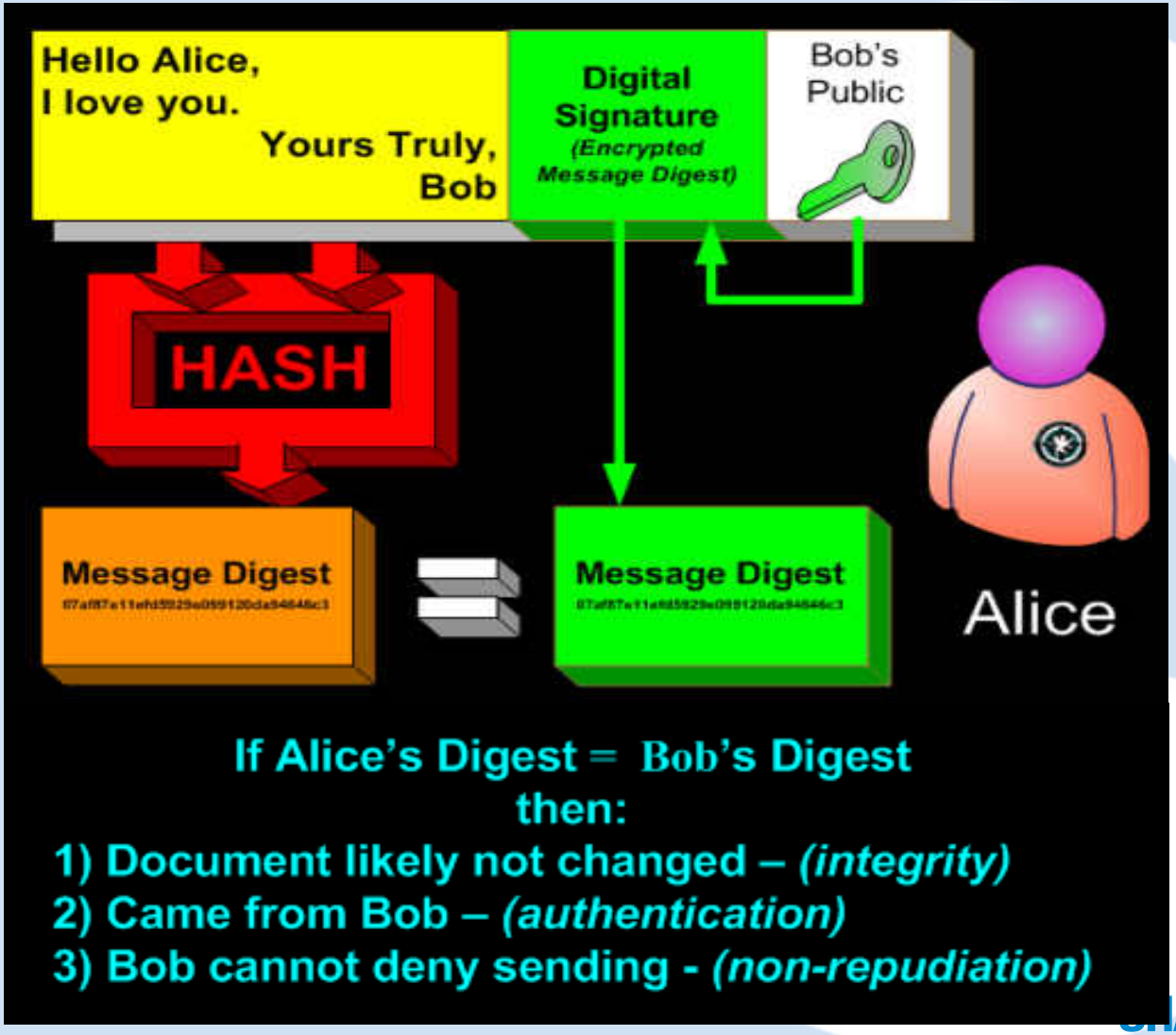
Message Authentication Codes

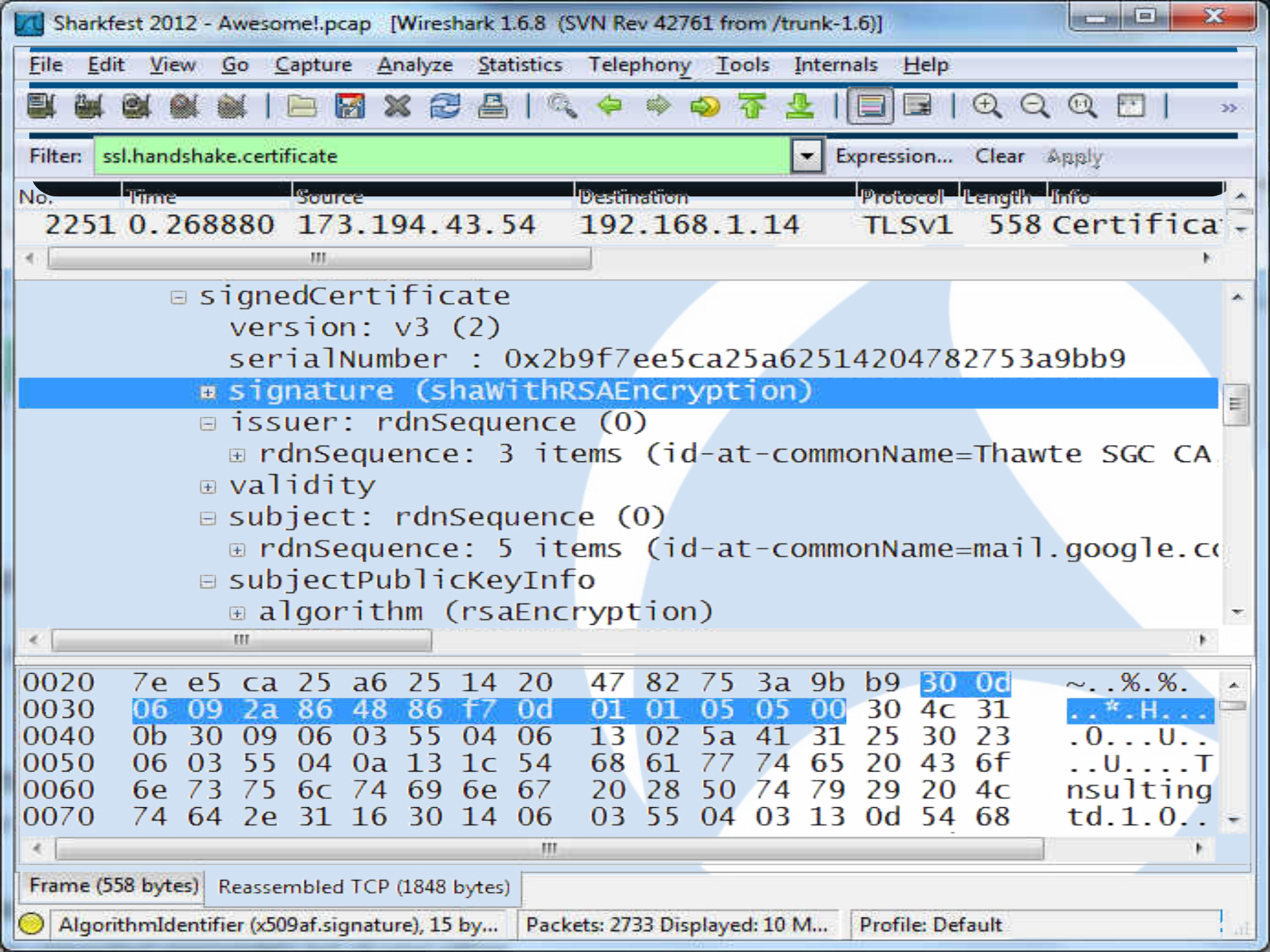


Signing a message



Validating the Signature



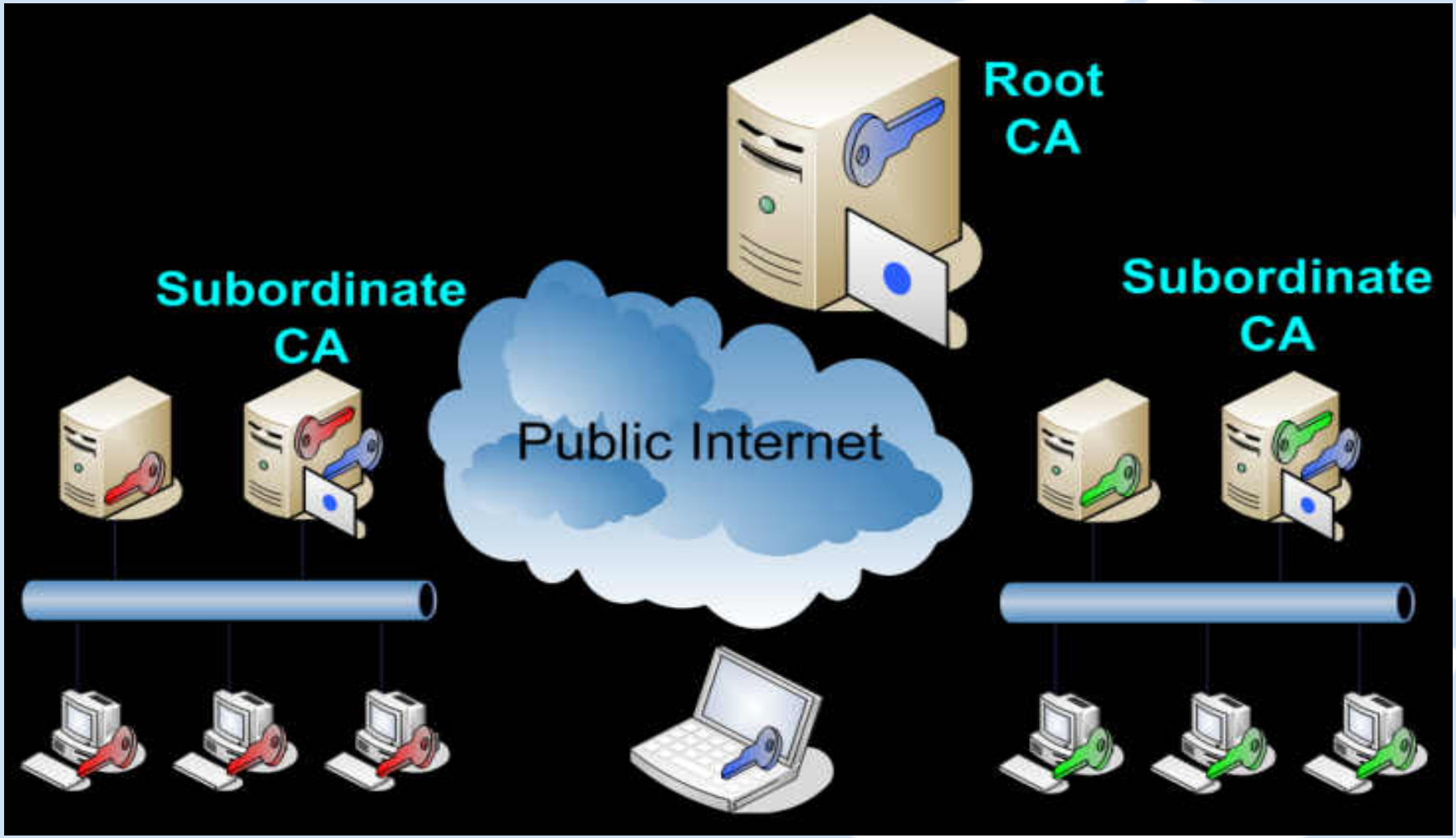

Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: ssl.handshake.certificate
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2251 0.268880 173.194.43.54 192.168.1.14 TLSv1 558 Certifica
signedCertificate
version: v3 (2)
serialNumber : 0x2b9f7ee5ca25a625142047827 53a9bb9
signature (shaWithRSAEncryption)
issuer: rdnSequence (0)
rdnSequence: 3 items (id-at-commonName=Thawte SGC CA
validity
subject: rdnSequence (0)
rdnSequence: 5 items (id-at-commonName=mail.google.c
subjectPublicKeyInfo
algorithm (rsaEncryption)
0020 7e e5 ca 25 a6 25 14 20 47 82 75 3a 9b b9 30 0d ~..%.%. G.u:..0.
0030 06 09 2a 86 48 86 f7 0d 01 01 05 05 00 30 4c 31 ..*.H... .....0L1
0040 0b 30 09 06 03 55 04 06 13 02 5a 41 31 25 30 23 .0...U.. ..ZA1%0#
0050 06 03 55 04 0a 13 1c 54 68 61 77 74 65 20 43 6f ..U....T hawte Co
0060 6e 73 75 6c 74 69 6e 67 20 28 50 74 79 29 20 4c nsulting (Pty) L
0070 74 64 2e 31 16 30 14 06 03 55 04 03 13 0d 54 68 td.1.0.. .U....Th
Frame (558 bytes)
Reassembled TCP (1848 bytes)
AlgorithmIdentifier (x509af.signature), 15 by...
Packets: 2733 Displayed: 10 M...
Profile: Default

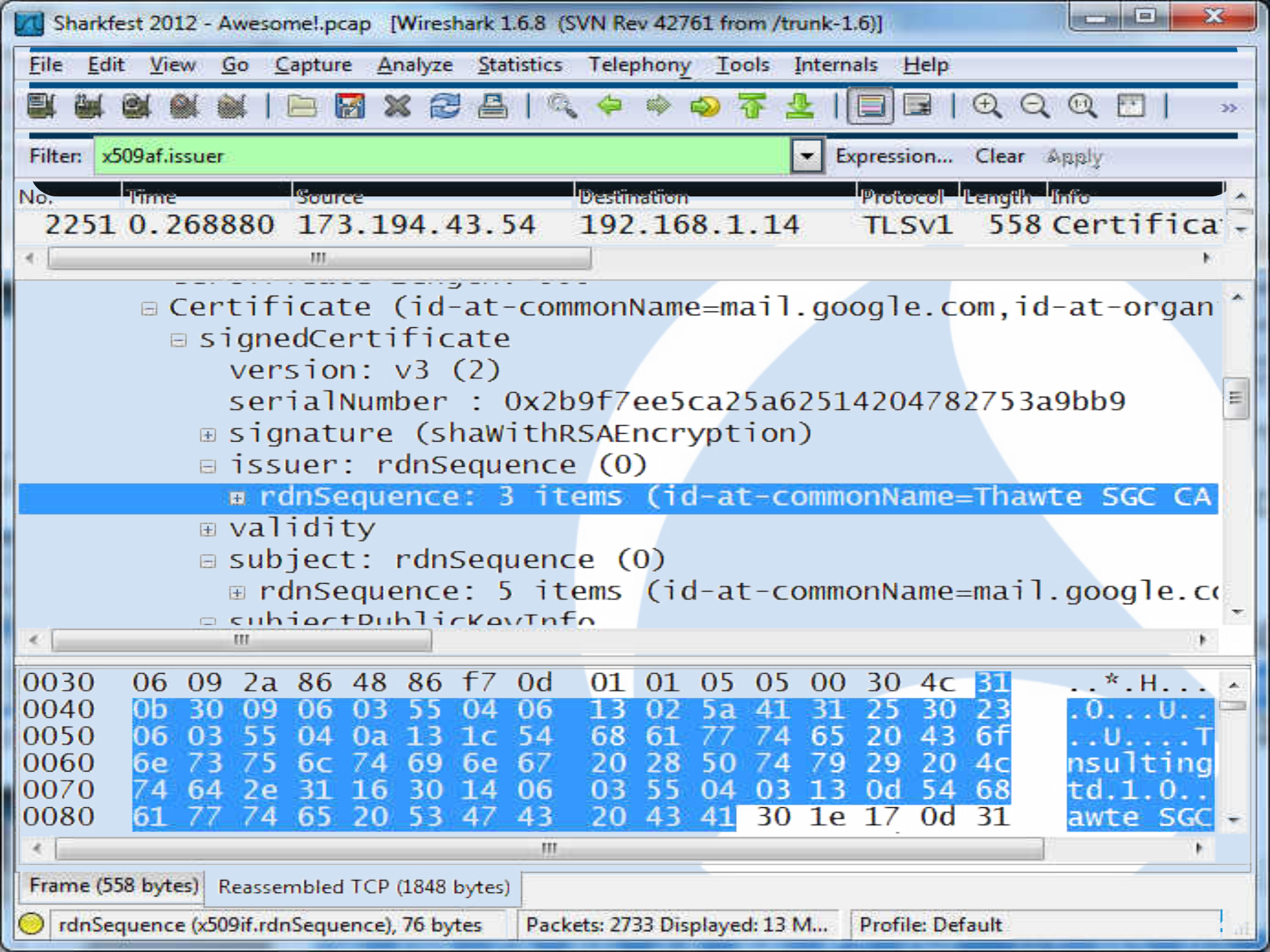
Who is a *"Trusted 3rd party"*

"Captain, the Federation's x.500 based hierarchical trust model of **PKI** is very logical. Perhaps we can trust the public **Certificate Authorities**"

"But Spock, I have never met **Thawte** or **Verisign**. I feel I can trust my friends. Call it a hunch, I trust OpenPGP more"

PKI Hierarchical Trust Model




Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: x509af.issuer
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2251 0.268880 173.194.43.54 192.168.1.14 TLSv1 558 Certifica
Certificate (id-at-commonName=mail.google.com,id-at-organ
signedCertificate
version: v3 (2)
serialNumber : 0x2b9f7ee5ca25a6251420478275 3a9bb9
signature (shaWithRSAEncryption)
issuer: rdnSequence (0)
rdnSequence: 3 items (id-at-commonName=Thawte SGC CA
validity
subject: rdnSequence (0)
rdnSequence: 5 items (id-at-commonName=mail.google.c
0030 06 09 2a 86 48 86 f7 0d 01 01 05 05 00 30 4c 31 ..*.H.... .0L1
0040 0b 30 09 06 03 55 04 06 13 02 5a 41 31 25 30 23 .0...U.. ..ZA1%0#
0050 06 03 55 04 0a 13 1c 54 68 61 77 74 65 20 43 6f ..U....T hawte Co
0060 6e 73 75 6c 74 69 6e 67 20 28 50 74 79 29 20 4c nsulting (Pty) L
0070 74 64 2e 31 16 30 14 06 03 55 04 03 13 0d 54 68 td.1.0... .U....Th
0080 61 77 74 65 20 53 47 43 20 43 41 30 1e 17 0d 31 awte SGC CA0...1
Frame (558 bytes)
Reassembled TCP (1848 bytes)
rdnSequence (x509if.rdnSequence), 76 bytes
Packets: 2733 Displayed: 13 M...
Profile: Default

Why Trust a CA?

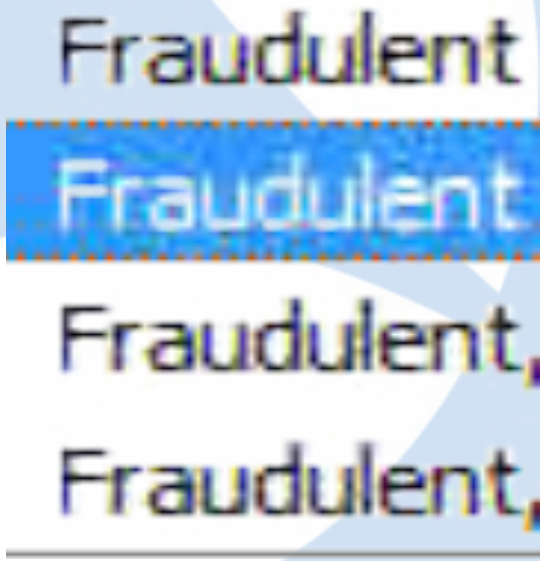
RFC-3280 (updated in 4630)

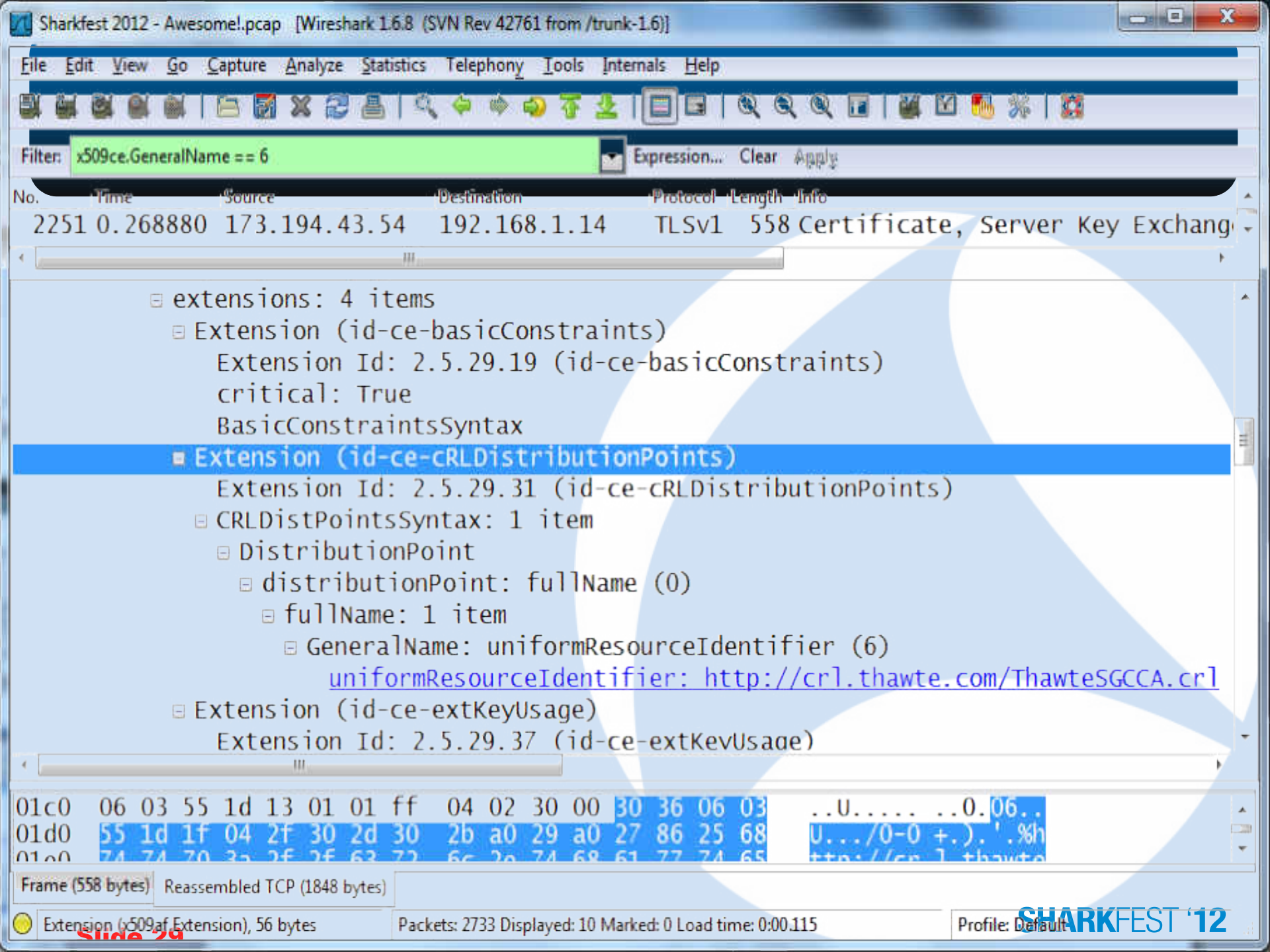
- **Top tier**
  - Internet Policy Registration Authority (IPRA)
    - *Internet PCA Registration Authority (MIT),?*
- **Second tier**
  - Policy Certification Authorities (PCAs)
    - *UNINETT, DFN-PCA, SURFnetPCA*
- **Third tier**
  - Certification Authorities (CAs)
    - *VeriSign, Duetsche Telekom, Thawte, etc.*

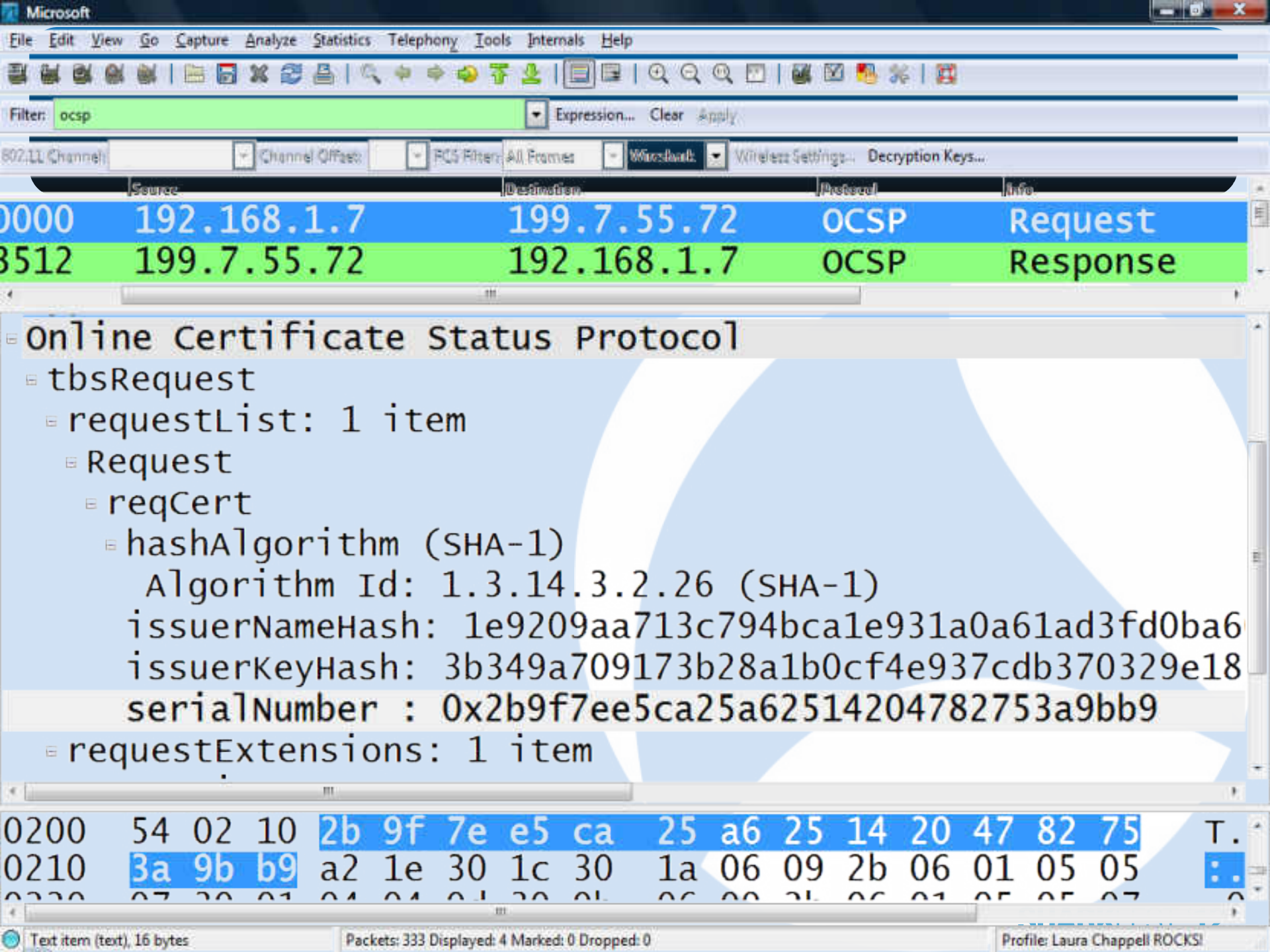
Certificate Revocation

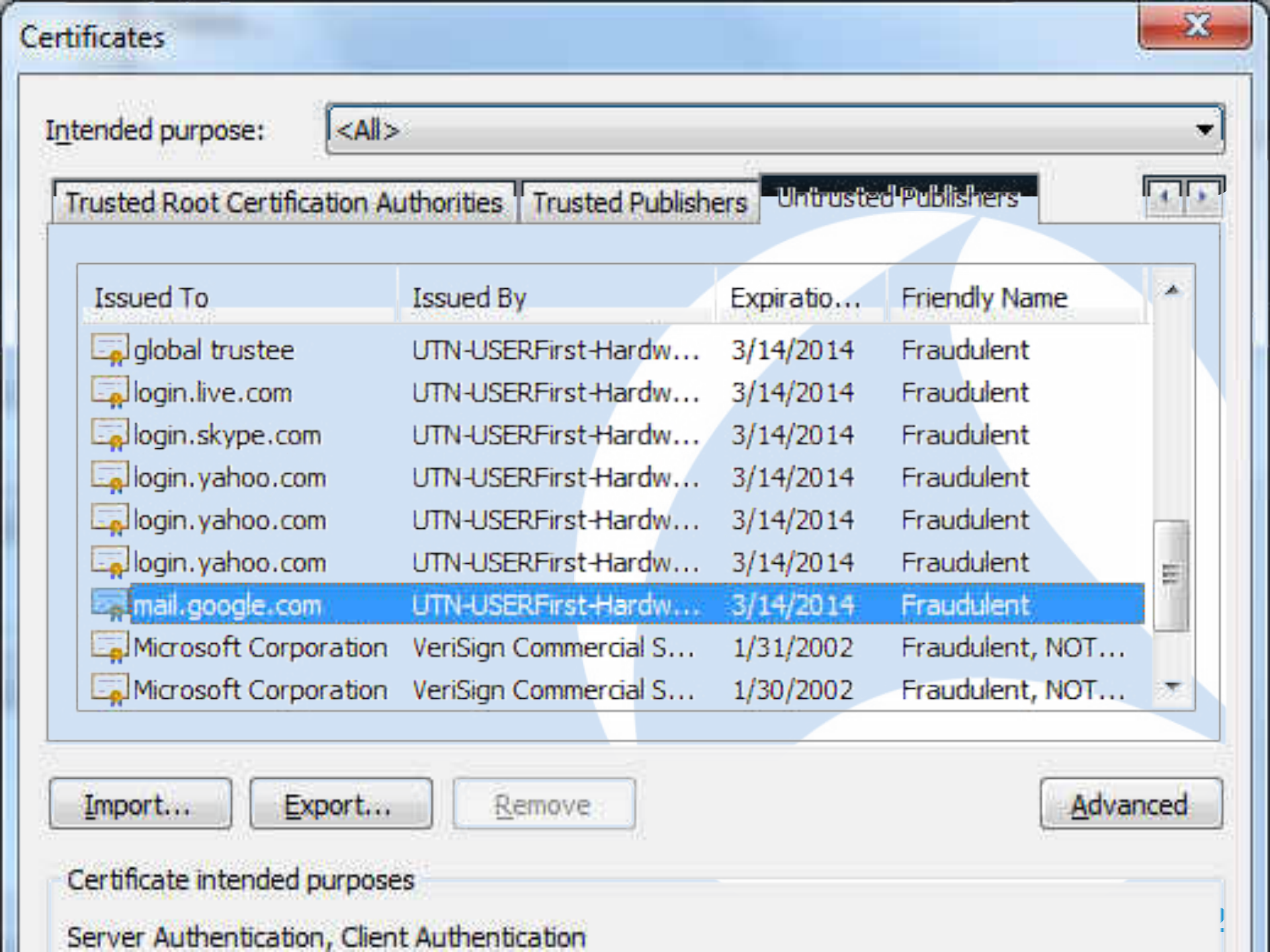
Compromised Private Keys

- **Certificate Revocation Lists (CRL)**
- **Online Certificate Status Protocol (OCSP)**
- **Problems:**
  - Client checking may be disabled
  - Browsers configured to fail soft
  - Upstream servers may block CRL
  - Compromised CA certificates
  - Algorithms cracked
  - More...




Sharkfest 2012 - Awesome!.pcap [Wireshark 1.6.8 (SVN Rev 42761 from /trunk-1.6)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: x509ce.GeneralName == 6
Expression... Clear Apply
No. Time Source Destination Protocol Length Info
2251 0.268880 173.194.43.54 192.168.1.14 TLSv1 558 Certificate, Server Key Exchang
extensions: 4 items
Extension (id-ce-basicConstraints)
Extension Id: 2.5.29.19 (id-ce-basicConstraints)
critical: True
BasicConstraintsSyntax
Extension (id-ce-cRLDistributionPoints)
Extension Id: 2.5.29.31 (id-ce-cRLDistributionPoints)
CRLDistPointsSyntax: 1 item
DistributionPoint
distributionPoint: fullName (0)
fullName: 1 item
GeneralName: uniformResourceIdentifier (6)
uniformResourceIdentifier: http://crl.thawte.com/ThawteSGCCA.crl
Extension (id-ce-extKeyUsage)
Extension Id: 2.5.29.37 (id-ce-extKeyUsage)
01c0 06 03 55 1d 13 01 01 ff 04 02 30 00 30 36 06 03 ..U..... ..0.06..
01d0 55 1d 1f 04 2f 30 2d 30 2b a0 29 a0 27 86 25 68 U.../0-0 +.).'.%h
Frame (558 bytes)
Reassembled TCP (1848 bytes)
Extension (x509af.Extension), 56 bytes
Packets: 2733 Displayed: 10 Marked: 0 Load time: 0:00.115
Profile: Default
Slide 29
SHARKFEST '12


Microsoft
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: ocsp
Expression... Clear Apply
Decryption Keys...
Source Destination Protocol Info
0000 192.168.1.7 199.7.55.72 OCSP Request
3512 199.7.55.72 192.168.1.7 OCSP Response
Online Certificate Status Protocol
tbsRequest
requestList: 1 item
Request
reqCert
hashAlgorithm (SHA-1)
Algorithm Id: 1.3.14.3.2.26 (SHA-1)
issuerNameHash: 1e9209aa713c794bca1e931a0a61ad3fd0ba6
issuerKeyHash: 3b349a709173b28a1b0cf4e937cdb370329e18
serialNumber : 0x2b9f7ee5ca25a625142047827 53a9bb9
requestExtensions: 1 item
0200 54 02 10 2b 9f 7e e5 ca 25 a6 25 14 20 47 82 75 T. .%.% G.u
0210 3a 9b b9 a2 1e 30 1c 30 1a 06 09 2b 06 01 05 05 :....0.0 ...+....
Text item (text), 16 bytes
Packets: 333 Displayed: 4 Marked: 0 Dropped: 0
Profile: Laura Chappell ROCKS!


Certificates
Intended purpose:
<All>
Trusted Root Certification Authorities
Trusted Publishers
Untrusted Publishers
Issued To
Issued By
Expiratio...
Friendly Name
global trustee
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
login.live.com
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
login.skype.com
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
login.yahoo.com
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
login.yahoo.com
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
login.yahoo.com
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
mail.google.com
UTN-USERFirst-Hardw...
3/14/2014
Fraudulent
Microsoft Corporation
VeriSign Commercial S...
1/31/2002
Fraudulent, NOT...
Microsoft Corporation
VeriSign Commercial S...
1/30/2002
Fraudulent, NOT...
Import...
Export...
Remove
Advanced
Certificate intended purposes
Server Authentication, Client Authentication

How Well Does Certificate Revocation Really Work?

Detecting Certificate Authority compromises and web browser collusion

Posted March 22nd, 2011 by iberror in ssl tls ca tor certificates torbrowser

Thanks to Ian Gallagher, Seth Schoen, Jesse Burns, Chris Palmer, and other anonymous birds for their invaluable feedback on this writeup.

The Tor Project has long understood that the certification authority (CA) model of trust on the internet is susceptible to various methods of compromise. Without strong anonymity, the ability to perform targeted attacks with the blessing of a CA key is serious. In the past, I've worked on attacks relating to SSL/TLS trust models and for quite some time, I've hunted for evidence of non-academic CA compromise in the wild.

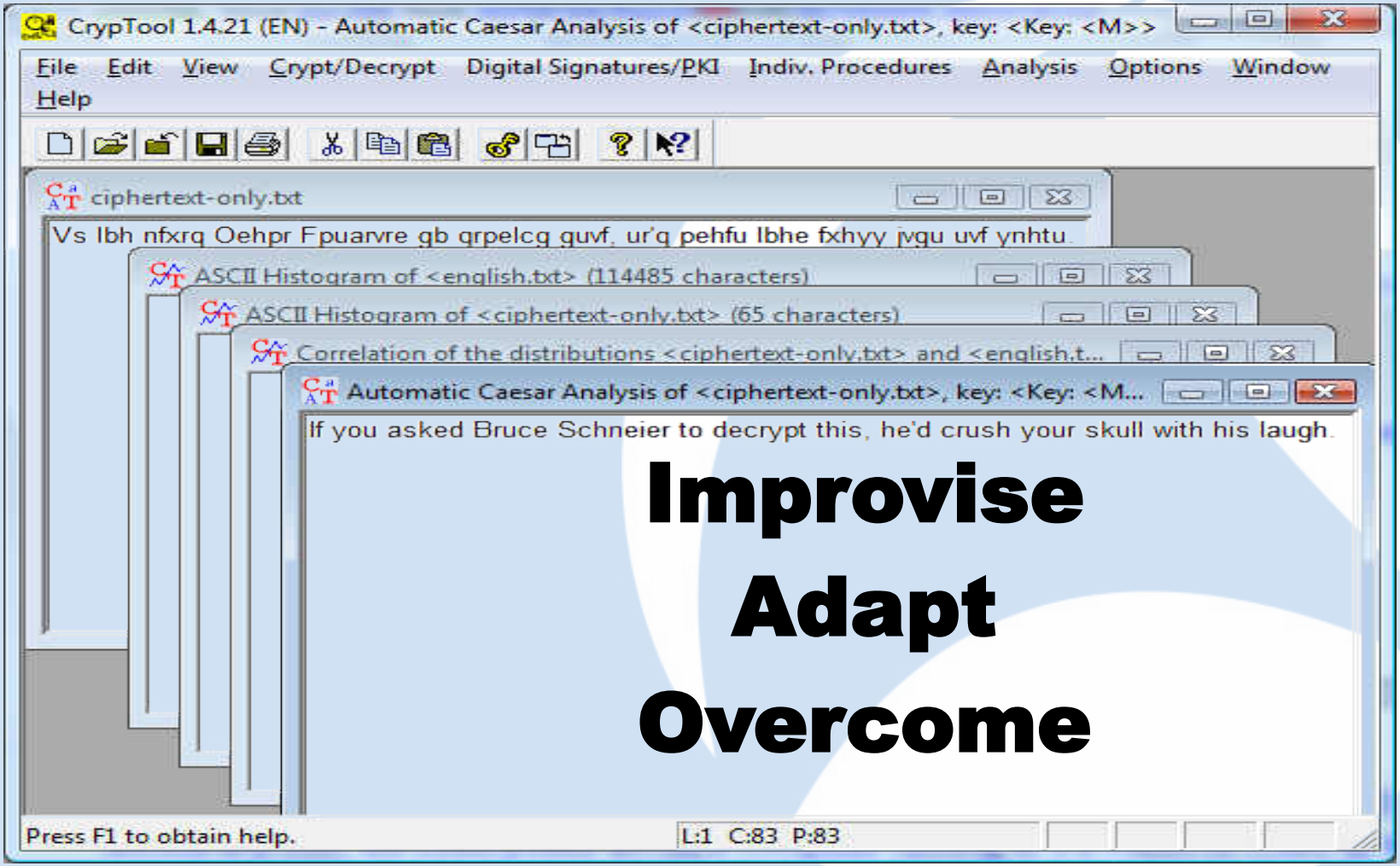
I've also looked for special kinds of cooperation between CAs and browsers. Proof of collusion will give us facts. It will also give us a real understanding of the faith placed in the strength of the underlying systems.

Does certificate revocation really work? **No, it does not**. How much faith does a vendor actually put into revocation, when verifiable evidence of malice is detected or known? Not much, and that's the subject of this writing.

Last week, a smoking gun came into sight: A Certification Authority appeared to be compromised in some capacity, and the attacker issued themselves valid HTTPS

https://blog.torproject.org/blog/detecting-certificate-authority-compromises-and-web-browser-collusion

Thank You!


CrypTool 1.4.21 (EN) - Automatic Caesar Analysis of <ciphertext-only.txt>, key: <Key: <M>>
File Edit View Crypt/Decrypt Digital Signatures/PKI Indiv. Procedures Analysis Options Window Help
ciphertext-only.txt
Vs lbh nfxrq Oehpr Fpuarvre gb qrpelcg guvf, ur'q pehfu lbhe fxhyy jvgu uvf ynhtu.
ASCII Histogram of <english.txt> (114485 characters)
ASCII Histogram of <ciphertext-only.txt> (65 characters)
Correlation of the distributions <ciphertext-only.txt> and <english.t...
Automatic Caesar Analysis of <ciphertext-only.txt>, key: <Key: <M...
If you asked Bruce Schneier to decrypt this, he'd crush your skull with his laugh.
Improvise
Adapt
Overcome
Press F1 to obtain help.
L:1 C:83 P:83