Unsolvable Problems in Computer Security*

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* With a bit of a bias towards cryptography

Unsolvable Problems

You mean *unsolved*, right?

- Nope
- Some problems really have no known general solution
  - (This may be the first talk ever to admit that there exist security problems for which adding more cryptography isn't the answer)

Why are you telling us about them if there's no solution?

- To warn you about them so you can try alternatives
- To let you know that if you're finding it hard to deal with them then it's not your fault

Example: Secure Bootstrapping of Comms

How do you securely initiate communications with an entity that you've never communicated with before?

- The killer problem
- The elephant in the room
- The mixed metaphor

… of Internet security protocols

We simply have no way of doing this

Example: Secure Bootstrapping of Comms

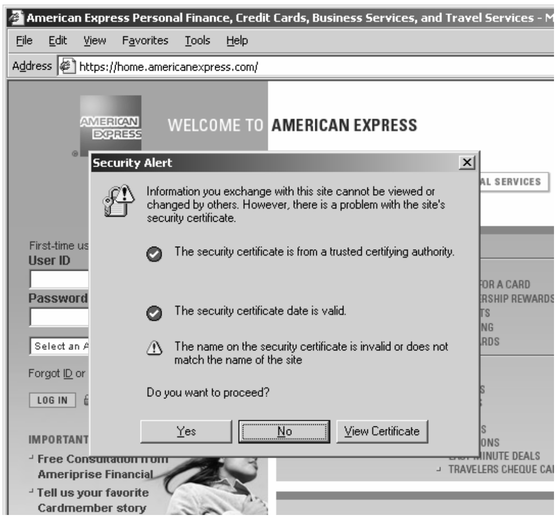
What about PKI?

PKI
It Could Be that the Purpose of Your Life Is Only to Serve as a Warning to Others.

Source: www.despair.com

Example: Secure Bootstrapping of Comms

What about PKI?


American Express Personal Finance, Credit Cards, Business Services, and Travel Services - M
File Edit View Favorites Tools Help
Address https://home.americanexpress.com/
WELCOME TO AMERICAN EXPRESS
Security Alert
Yes
No
View Certificate

Information you exchange with this site cannot be viewed or changed by others. However, there is a problem with the site's security certificate.

The security certificate is from a trusted certifying authority.

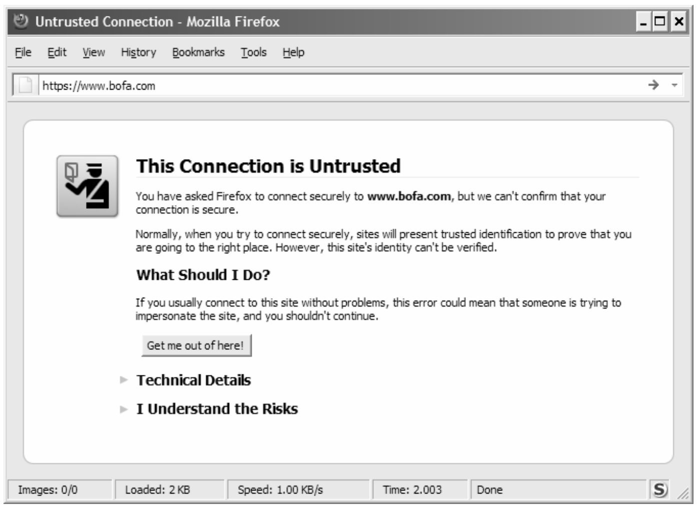
The security certificate date is valid.

The name on the security certificate is invalid or does not match the name of the site

Do you want to proceed?

Example: Secure Bootstrapping of Comms

What about PKI?



This Connection is Untrusted

You have asked Firefox to connect securely to **www.bofa.com**, but we can't confirm that your connection is secure.

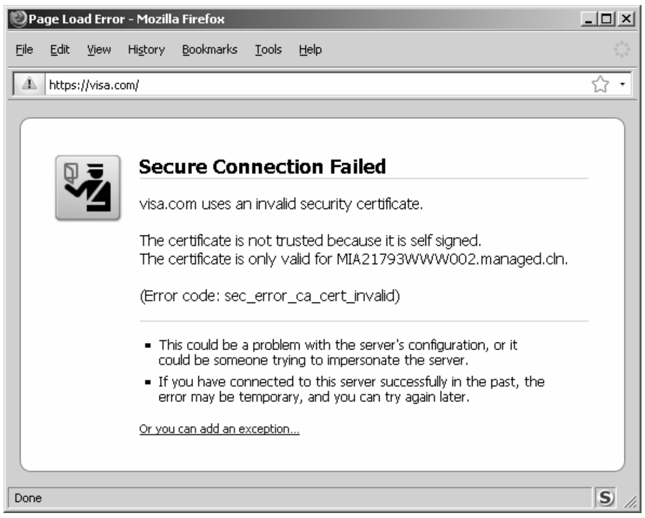
Normally, when you try to connect securely, sites will present trusted identification to prove that you are going to the right place. However, this site's identity can't be verified.

What Should I Do?

If you usually connect to this site without problems, this error could mean that someone is trying to impersonate the site, and you shouldn't continue.

Example: Secure Bootstrapping of Comms

What about PKI?


Page Load Error - Mozilla Firefox
File Edit View History Bookmarks Tools Help
https://visa.com/
Done

Secure Connection Failed

visa.com uses an invalid security certificate.

The certificate is not trusted because it is self signed.
The certificate is only valid for MIA21793WWW002.managed.cln.

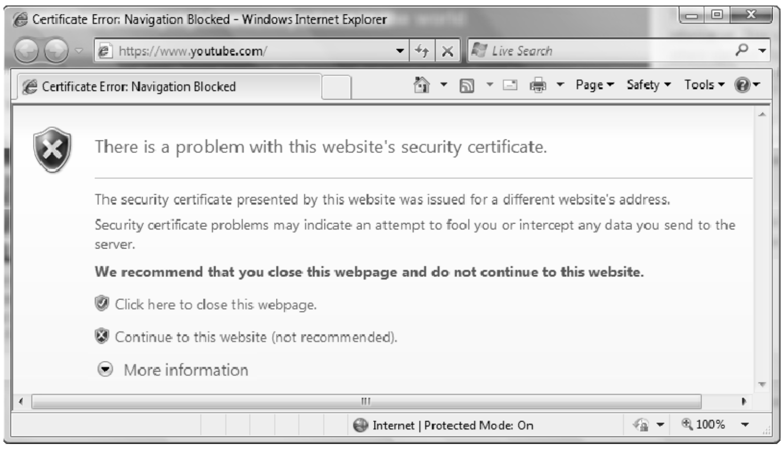
(Error code: sec_error_ca_cert_invalid)

- This could be a problem with the server's configuration, or it could be someone trying to impersonate the server.
- If you have connected to this server successfully in the past, the error may be temporary, and you can try again later.

Or you can add an exception...

Example: Secure Bootstrapping of Comms

What about PKI?


Certificate Error: Navigation Blocked - Windows Internet Explorer
https://www.youtube.com/
Live Search
Certificate Error: Navigation Blocked
Page
Safety
Tools
Internet | Protected Mode: On
100%

There is a problem with this website's security certificate.

The security certificate presented by this website was issued for a different website's address.

Security certificate problems may indicate an attempt to fool you or intercept any data you send to the server.

We recommend that you close this webpage and do not continue to this website.

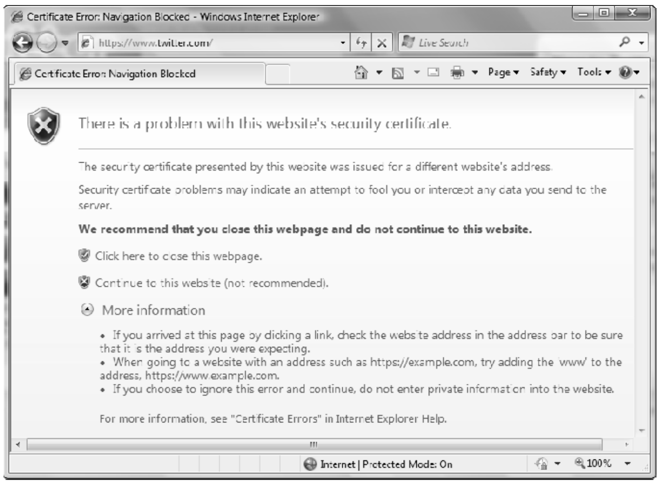
Click here to close this webpage.

Continue to this website (not recommended).

More information

Example: Secure Bootstrapping of Comms

What about PKI?



Certificate Error: Navigation Blocked - Windows Internet Explorer
https://www.twitter.com/
Live Search
Certificate Error: Navigation Blocked
Page
Safety
Tools

There is a problem with this website's security certificate.

The security certificate presented by this website was issued for a different website's address.

Security certificate problems may indicate an attempt to fool you or intercept any data you send to the server.

We recommend that you close this webpage and do not continue to this website.

Click here to close this webpage.

Continue to this website (not recommended).

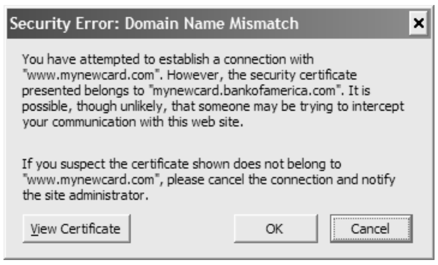
More information

- If you arrived at this page by clicking a link, check the website address in the address bar to be sure that it is the address you were expecting.
- When going to a website with an address such as https://example.com, try adding the 'www' to the address, https://www.example.com.
- If you choose to ignore this error and continue, do not enter private information into the website.

For more information, see "Certificate Errors" in Internet Explorer Help.

Example: Secure Bootstrapping of Comms

What about PKI?

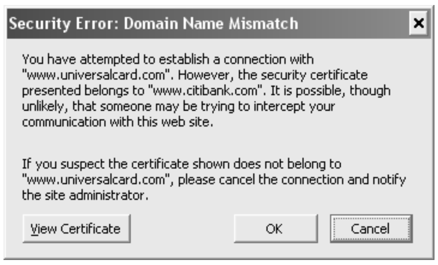

Security Error: Domain Name Mismatch

You have attempted to establish a connection with "www.mynewcard.com". However, the security certificate presented belongs to "mynewcard.bankofamerica.com". It is possible, though unlikely, that someone may be trying to intercept your communication with this web site.

If you suspect the certificate shown does not belong to "www.mynewcard.com", please cancel the connection and notify the site administrator.

Example: Secure Bootstrapping of Comms

What about PKI?



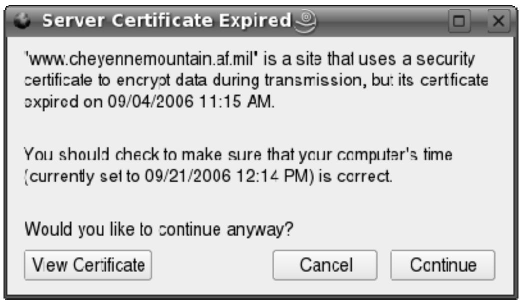
Security Error: Domain Name Mismatch

You have attempted to establish a connection with "www.universalcard.com". However, the security certificate presented belongs to "www.citibank.com". It is possible, though unlikely, that someone may be trying to intercept your communication with this web site.

If you suspect the certificate shown does not belong to "www.universalcard.com", please cancel the connection and notify the site administrator.

Example: Secure Bootstrapping of Comms

What about PKI?



Server Certificate Expired

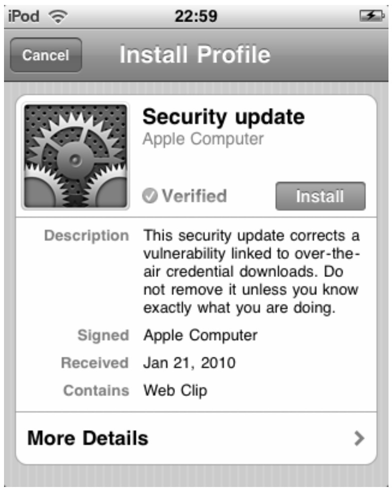
'www.cheyennemountain.af.mil' is a site that uses a security certificate to encrypt data during transmission, but its certficate expired on 09/04/2006 11:15 AM.

You should check to make sure that your computer's time (currently set to 09/21/2006 12:14 PM) is correct.

Would you like to continue anyway?

Example: Secure Bootstrapping of Comms

What about PKI?



iPod 22:59

Cancel Install Profile

Security update
Apple Computer

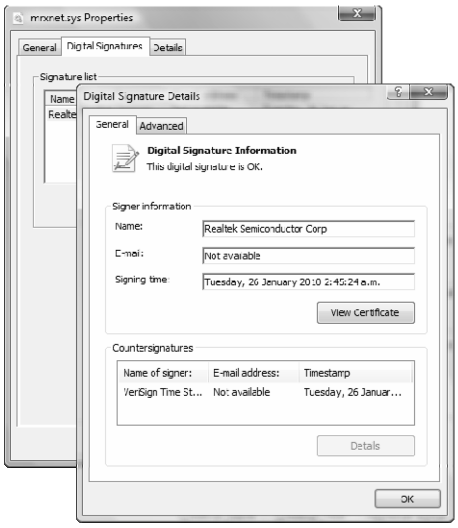
Verified Install

Description	This security update corrects a vulnerability linked to over-the-air credential downloads. Do not remove it unless you know exactly what you are doing.
Signed	Apple Computer
Received	Jan 21, 2010
Contains	Web Clip

More Details

Example: Secure Bootstrapping of Comms

What about PKI?



mrxnet.sys Properties

General | Digital Signatures | Details

Signature list

Name
Realte

Digital Signature Details

General | Advanced

Digital Signature Information
This digital signature is OK.

Signer information

Name:	Realtek Semiconductor Corp
E-mail:	Not available
Signing time:	Tuesday, 26 January 2010 2:45:24 a.m.

View Certificate

Countersignatures

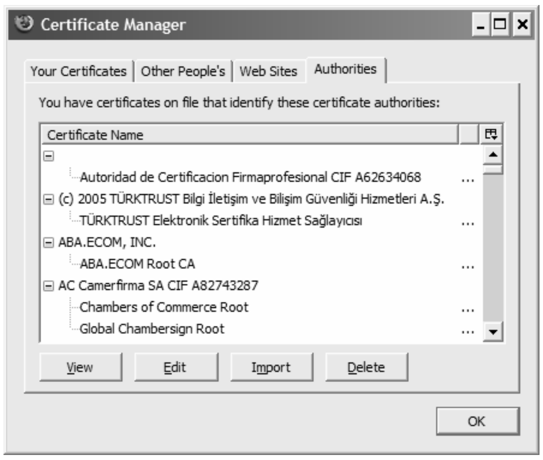
Name of signer:	E-mail address:	Timestamp
VeriSign Time St...	Not available	Tuesday, 26 Januar...

Details

OK

Example: Secure Bootstrapping of Comms

What about PKI?

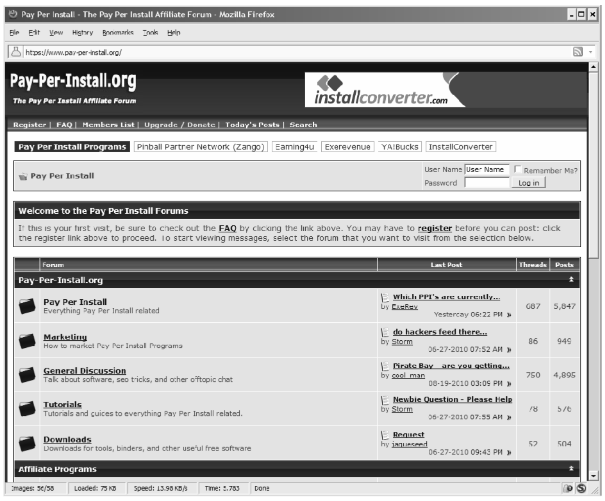


You have certificates on file that identify these certificate authorities:

Certificate Name
Autoridad de Certificacion Firmaprofesional CIF A62634068
(c) 2005 TÜRKTRUST Bilgi İletişim ve Bilişim Güvenliği Hizmetleri A.Ş.
TÜRKTRUST Elektronik Sertifika Hizmet Sağlayıcısı
ABA.ECOM, INC.
ABA.ECOM Root CA
AC Camerfirma SA CIF A82743287
Chambers of Commerce Root
Global Chambersign Root

Example: Secure Bootstrapping of Comms

What about PKI?


Pay Per Install - The Pay Per Install Affiliate Forum - Mozilla Firefox
File Edit View History Bookmarks Tools Help
https://www.pay-per-install.org/
Pay-Per-Install.org
The Pay Per Install Affiliate Forum
installconverter.com
Register | FAQ | Members List | Upgrade / Donate | Today's Posts | Search
Pay Per Install Programs
Pinball Partner Network (Zango)
Earning4u
Exerevenue
YA!Bucks
InstallConverter
Pay Per Install
User Name
Password
Remember Me?
Log in
Images: 56/58
Loaded: 75 KB
Speed: 13.98 KB/s
Time: 5.783
Done

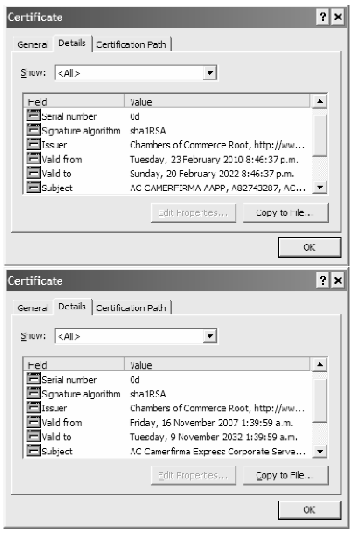
Welcome to the Pay Per Install Forums

If this is your first visit, be sure to check out the **FAQ** by clicking the link above. You may have to **register** before you can post: click the register link above to proceed. To start viewing messages, select the forum that you want to visit from the selection below.

Forum	Last Post	Threads	Posts
Pay-Per-Install.org			
Pay Per Install Everything Pay Per Install related	**Which PPI's are currently...** by ExeRev Yesterday 06:22 PM	687	5,847
Marketing How to market Pay Per Install Programs	**do hackers feed there...** by Storm 06-27-2010 07:52 AM	86	949
General Discussion Talk about software, seo tricks, and other offtopic chat	**Pirate Bay are you getting...** by cool_man 08-19-2010 03:09 PM	750	4,895
Tutorials Tutorials and guides to everything Pay Per Install related.	**Newbie Question - Please Help** by Storm 06-27-2010 07:55 AM	78	576
Downloads Downloads for tools, binders, and other useful free software	**Request** by jaqueseed 06-27-2010 09:43 PM	52	504
Affiliate Programs			

Example: Secure Bootstrapping of Comms

What about PKI?


Certificate

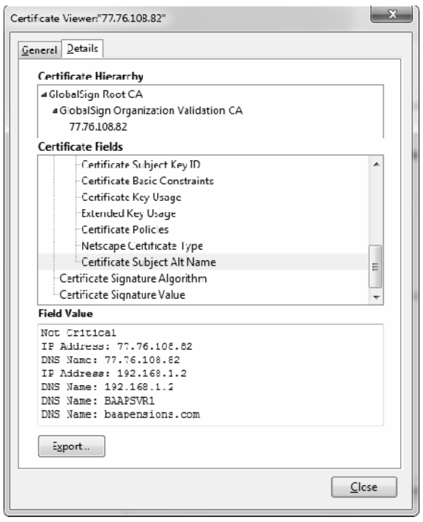
Field	Value
Serial number	0d
Signature algorithm	sha1RSA
Issuer	Chambers of Commerce Root, http://ww...
Valid from	Tuesday, 23 February 2010 8:46:37 p.m.
Valid to	Sunday, 20 February 2022 8:46:37 p.m.
Subject	AC CAMERFIRMA AAPP, A82743287, AC...

Certificate

Field	Value
Serial number	0d
Signature algorithm	sha1RSA
Issuer	Chambers of Commerce Root, http://ww...
Valid from	Friday, 16 November 2007 1:39:59 a.m.
Valid to	Tuesday, 9 November 2032 1:39:59 a.m.
Subject	AC Camerfirma Express Corporate Serve...

Example: Secure Bootstrapping of Comms

What about PKI?


Certificate Viewer:"77.76.108.82"

Certificate Hierarchy

- GlobalSign Root CA
  - GlobalSign Organization Validation CA
    - 77.76.108.82

Certificate Fields

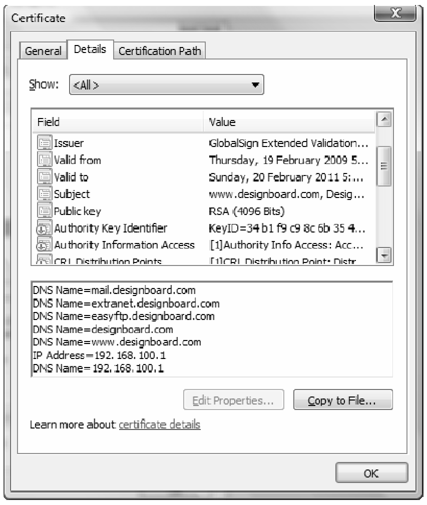
- Certificate Subject Key ID
- Certificate Basic Constraints
- Certificate Key Usage
- Extended Key Usage
- Certificate Policies
- Netscape Certificate Type
- Certificate Subject Alt Name
- Certificate Signature Algorithm
- Certificate Signature Value

Field Value

```
Not Critical
IP Address: 77.76.108.82
DNS Name: 77.76.108.82
IP Address: 192.168.1.2
DNS Name: 192.168.1.2
DNS Name: BAAPSVR1
DNS Name: baapensions.com
```

Example: Secure Bootstrapping of Comms

What about PKI?



Show: <All>

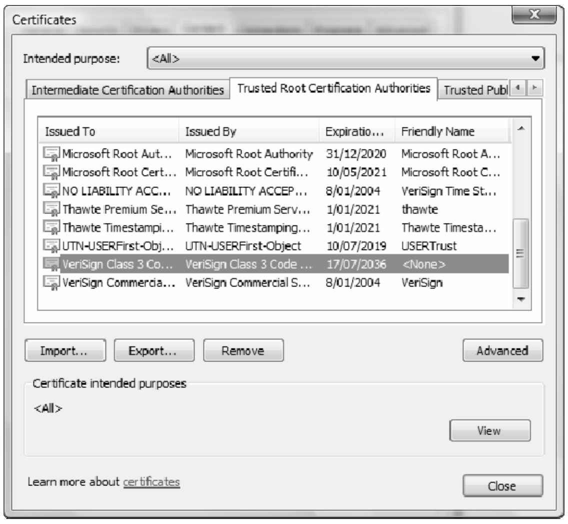
Field	Value
Issuer	GlobalSign Extended Validation...
Valid from	Thursday, 19 February 2009 5...
Valid to	Sunday, 20 February 2011 5:...
Subject	www.designboard.com, Desig...
Public key	RSA (4096 Bits)
Authority Key Identifier	KeyID=34 b1 f9 c9 8c 6b 35 4...
Authority Information Access	[1]Authority Info Access: Acc...
CRL Distribution Points	[1]CRL Distribution Point: Distr

```
DNS Name=mail.designboard.com
DNS Name=extranet.designboard.com
DNS Name=easyftp.designboard.com
DNS Name=designboard.com
DNS Name=www.designboard.com
IP Address=192.168.100.1
DNS Name=192.168.100.1
```

Learn more about certificate details

Example: Secure Bootstrapping of Comms

What about PKI?


Certificates
Intermediate Certification Authorities
Trusted Root Certification Authorities
Trusted Publ
Import...
Export...
Remove
Advanced
View
Close

Intended purpose: <All>

Issued To	Issued By	Expiratio...	Friendly Name
Microsoft Root Aut...	Microsoft Root Authority	31/12/2020	Microsoft Root A...
Microsoft Root Cert...	Microsoft Root Certifi...	10/05/2021	Microsoft Root C...
NO LIABILITY ACC...	NO LIABILITY ACCEP...	8/01/2004	VeriSign Time St...
Thawte Premium Se...	Thawte Premium Serv...	1/01/2021	thawte
Thawte Timestampi...	Thawte Timestamping...	1/01/2021	Thawte Timesta...
UTN-USERFirst-Obj...	UTN-USERFirst-Object	10/07/2019	USERTrust
VeriSign Class 3 Co...	VeriSign Class 3 Code ...	17/07/2036	<None>
VeriSign Commercia...	VeriSign Commercial S...	8/01/2004	VeriSign

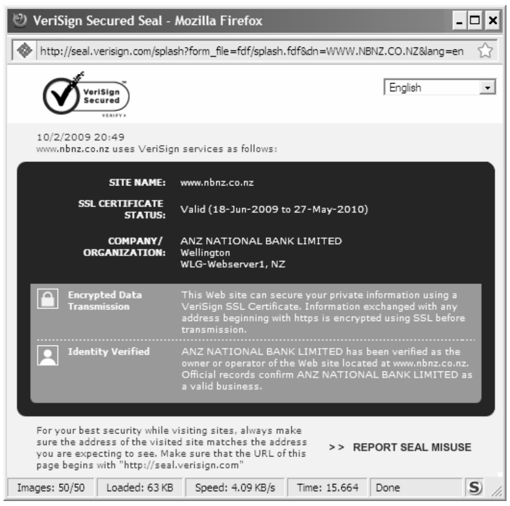
Certificate intended purposes

<All>

Learn more about certificates

Example: Secure Bootstrapping of Comms

What about PKI?



VeriSign Secured Seal - Mozilla Firefox

http://seal.verisign.com/splash?form_file=fdf/splash.fdf&dn=WWW.NBNZ.CO.NZ&lang=en

English

10/2/2009 20:49
www.nbnz.co.nz uses VeriSign services as follows:

SITE NAME:	www.nbnz.co.nz
SSL CERTIFICATE STATUS:	Valid (18-Jun-2009 to 27-May-2010)
COMPANY/ ORGANIZATION:	ANZ NATIONAL BANK LIMITED Wellington WLG-Webserver1, NZ
Encrypted Data Transmission	This Web site can secure your private information using a VeriSign SSL Certificate. Information exchanged with any address beginning with https is encrypted using SSL before transmission.
Identity Verified	ANZ NATIONAL BANK LIMITED has been verified as the owner or operator of the Web site located at www.nbnz.co.nz. Official records confirm ANZ NATIONAL BANK LIMITED as a valid business.

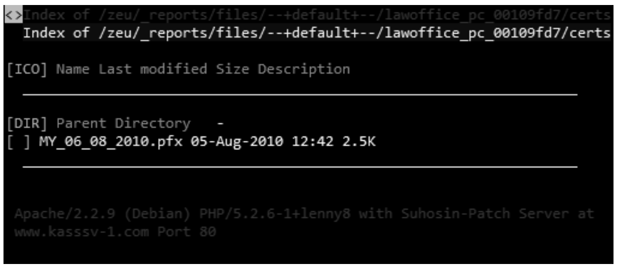
For your best security while visiting sites, always make sure the address of the visited site matches the address you are expecting to see. Make sure that the URL of this page begins with "http://seal.verisign.com"

>> REPORT SEAL MISUSE

Images: 50/50 | Loaded: 63 KB | Speed: 4.09 KB/s | Time: 15.664 | Done

Example: Secure Bootstrapping of Comms

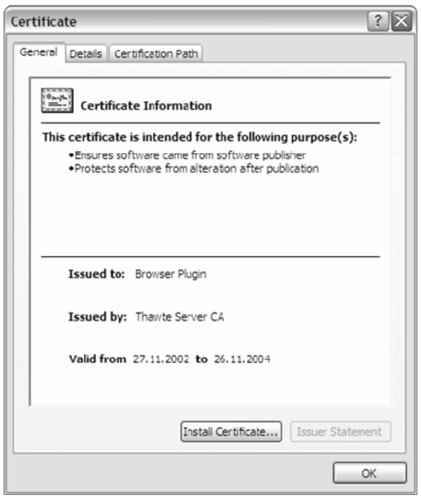
What about PKI?



```
<>Index of /zeu/_reports/files/--+default+--/lawoffice_pc_00109fd7/certs
  Index of /zeu/_reports/files/--+default+--/lawoffice_pc_00109fd7/certs

[ICO] Name Last modified Size Description

  ___________________________________________________________

[DIR] Parent Directory   -
[ ] MY_06_08_2010.pfx 05-Aug-2010 12:42 2.5K
  ___________________________________________________________


 Apache/2.2.9 (Debian) PHP/5.2.6-1+lenny8 with Suhosin-Patch Server at
 www.kasssv-1.com Port 80
```

Example: Secure Bootstrapping of Comms

What about PKI?



This certificate is intended for the following purpose(s):
•Ensures software came from software publisher
•Protects software from alteration after publication

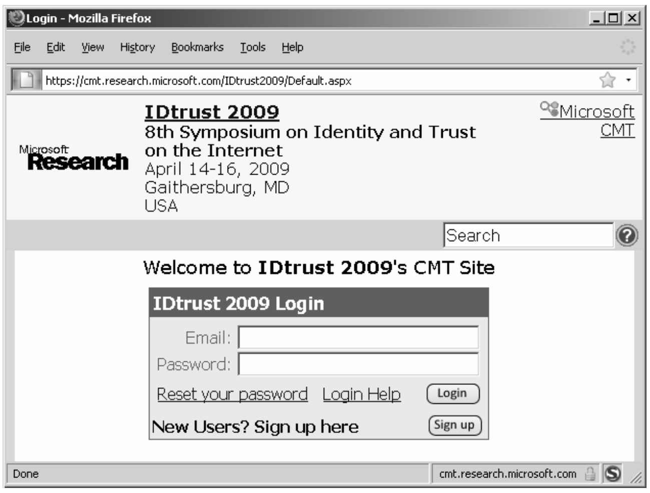
Issued to: Browser Plugin

Issued by: Thawte Server CA

Valid from 27.11.2002 to 26.11.2004

Example: Secure Bootstrapping of Comms

What about PKI?



https://cmt.research.microsoft.com/IDtrust2009/Default.aspx

IDtrust 2009
8th Symposium on Identity and Trust on the Internet
April 14-16, 2009
Gaithersburg, MD
USA

Welcome to IDtrust 2009's CMT Site

IDtrust 2009 Login
Email:
Password:
Reset your password Login Help
New Users? Sign up here

cmt.research.microsoft.com

Example: Secure Bootstrapping of Comms

What about PKI?

What about it?

Example: Secure Bootstrapping of Comms

What about SSH?

Do SSH Fingerprints Increase Security?

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Abstract

No.

Example: Secure Bootstrapping of Comms

What about *insert-pet-mechanism-here*?

- No, that won’t solve it either

Wicked Problems

So why is this so hard?

This (and many other issues) are examples of wicked problems

- Concept from the field of social planning
- Proposed in the 1970s as a means of modelling the process for dealing with social, environmental, and political issues

Wicked Problems (ctd)

Amongst a wicked problem's weaponry are such diverse elements as…

- Lack of any definitive formulation of the problem
- Lack of a stopping rule
  - One of the core requirements for dealing with a wicked problem becomes not deciding too early which solution you're going to apply
- Solutions that are ratable only as "better" or "worse" and not true or false
- No clear idea of a which steps or operations are necessary to get to the desired goal
- A variety of ideological and political differences among stakeholders

Wicked Problems (ctd)

A wicked problem presents...

- No clear idea of what the problem is
- No clear idea of how to get to a solution
- No easy way to tell whether you've reached your goal or not
- All of the participants are pulling in different directions

Example: High-performance Sports Cars

Fit a more powerful engine

- Adds extra weight
  - Slows it down again
- Adds size
  - If taken to extremes leaves little room for anything else, including a driver

Example: High-performance Sports Cars (ctd)

Reduce weight by fitting a lighter engine

- Have to make the car lighter to compensate for the less powerful engine

If taken to extremes leads to a car that’s little more than an exoskeleton with a motorcycle engine

- Has limited appeal to the general market

Example: High-performance Sports Cars (ctd)

Use exotic materials like carbon fibre to decrease weight

- Raises the price and again discourages buyers

Example: High-performance Sports Cars (ctd)

Strip out as many weight-adding features as possible

- Trade-off between performance and comfort
- Some jurisdictions have safety regulations that affect what you can and can't do
- Tradeoff between being able to sell the car in a particular market and making performance-reducing changes

Example: High-performance Sports Cars (ctd)

High-end audio is like high-performance sports car design, only much sillier

Example: High-performance Sports Cars (ctd)

This perfectly illustrates the characteristics of a wicked problem…

No definitive formulation of what's required for a sports car

No stopping rule to tell you that you've definitely reached your goal

- Running out of money is one oft-encountered stopping rule

The various options can only be rated in terms of tradeoffs against each other

…continues…

Example: High-performance Sports Cars (ctd)

…continued…

It’s not obvious which steps are the best ones to take in getting to your goal

All manner of externalities

- Participants’ opinions of which option is best
- Externally-applied materials and regulatory constraints on what you can and can’t do

Problem: Secure Ops on Insecure Systems

Trying to perform safe operations on an untrusted system has historically been mostly of academic interest

- “Programming Satan’s Computer”, 1995
  - Satan’s Computer in 1995 was positively benign compared to what’s hiding inside many current PCs
- On the off chance that your machine gets compromised, reformat and reinstall from clean media

Today the sheer scale and scope of the problem has made this approach all but impossible

Problem: Secure Ops on Insecure Systems

What about trusted computing?

- Yeah, any year now...

Even if it's deployed, protects only a small part of the system, e.g. the OS core

- A fully-protected computer on which you can't make any changes isn't terribly useful

Even for the portions that it does protect, all it guarantees is that they're unchanged from the state they were in when the TPM initially examined them

- Just because it's TPM-verified doesn't mean that it's safe

Problem: Secure Ops on Insecure Systems

A typical industry figure for code defects is about twenty bugs in every thousand lines of code (KLOC)

- Feel free to substitute your own pet value at this point
- The important thing isn't the absolute value but the rough order of magnitude for estimation purposes

Widely-used operating systems like Linux and Windows weigh in at 50-100 million lines of code

- Again, depending on which version and what you count as being part of "Linux" and "Windows"

Problem: Secure Ops on Insecure Systems

That's between one and two million bugs in the OS

- Ignores the additional code that'll be added in the form of user-installed device drivers and other kernel components
  - A majority of Windows OS crashes are due to these additional drivers
- Ignores the perpetual churn of updates
- TPMs weren't really designed for a constantly-changing code base

So your TPM-verified boot guarantees that you're loading an OS core with only a million bugs

- As opposed to a tampered one with a million and one bugs

Problem: Secure Ops on Insecure Systems

Various other cat-and-mouse games are possible

- Graphical data-entry mechanisms
  - The malware takes a screenshot and/or records mouse actions
- Trying to hook the system at a lower level than the rootkit
  - Malware engages the application in a race to the bottom of the driver chain
  - The malware invariably wins
- And so on

Problem: Secure Ops on Insecure Systems

Accept the fact that you can never really trust anything that's done on a PC and treat it purely as a router?

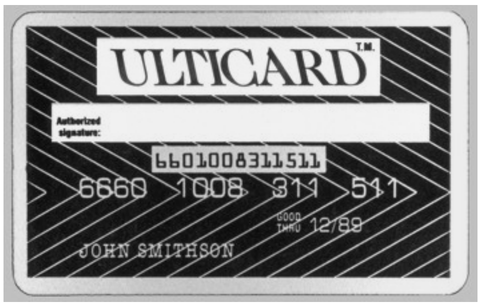
- Forward encrypted/authenticated content from a remote server to a self-contained device via USB or Bluetooth or NFC

Problem: Secure Ops on Insecure Systems

This "solution" gets re-invented every six to twelve months by academics and vendors

Problem: Secure Ops on Insecure Systems

The process has been ongoing for at least twenty years now



- It’s a remarkably persistent meme

Problem: Secure Ops on Insecure Systems

Doesn’t work too well as a general solution

- Expensive
- Requires deployment of specialised hardware
  - Unless you use a cellphone as your external device
  - Need to create an application that installs and runs on a range of completely incompatible platforms that their owners tend to swap out every year or two
- Requires custom protocols and mechanisms both on the client and the server in order to handle the constraints imposed by the attached device

Problem: Security vs. Availability

Availability concerns dictate that in the case of a problem the system allows things to continue

- Security concerns dictate that in the case of a problem the system doesn't allow things to continue

This is an umbrella problem that encompasses several other unsolvable sub-problems (covered later) as subclasses

- Unattended key storage
- Upgrade a product or device after a security breach

Problem: Security vs. Availability (ctd)

Availability concerns can be a powerful motivator

Data centre was built with marine diesel generators for backup power

- Marine diesels come with a built-in cooling system
- That would be "the ocean"

Less concern about overheating than conventional generators

- Makes them more compact than standard generators
- Space was a concern for the data centre in question

Problem: Security vs. Availability (ctd)

The data centre wasn’t anywhere near the ocean

- Used a stand-in consisting of a large water cistern whose contents were flushed through the generators’ cooling systems
- When the cistern had emptied, the generators’ thermal cut-outs shut them down

Management’s response to this was to have the safety interlocks on the generators disabled

- Might get an extra five or ten minutes out of them
- Could potentially ride out a power outage that they wouldn’t otherwise have survived

Problem: Security vs. Availability (ctd)

Preferable to run the generators to destruction than to risk having the data centre go down

- You won’t find this in the MCSE or CCNA training material

Problem: Security vs. Availability (ctd)

Sometimes you can reach a compromise…

Microsoft did this with the Windows XP SP2 firewall settings

- Finally, *finally* turned on by default in XP SP2

Found that home networks in which a computer acts as a file/print server were broken by having ports closed by default

- Open the ports required for print and file sharing…
  … but only for the local subnet

Problem: Security vs. Availability (ctd)

Home users are unlikely to be running computers on multiple subnets

- Anyone sophisticated enough do this will presumably know what a firewall is and what to do with it

Protects home users from Internet-based attacks without breaking their existing network setup

Problem: DRM and Copy Protection

Ugh, where to begin...

DRM is an attempt to fix a social and business-model problem using technology

- Functions even more poorly than most other cases where this is being attempted

No-one involved with the technology or its application has any interest in seeing it work

- Content vendors get the benefits
- Manufacturers and consumers carry the cost
- Variation of "moral hazard" from economics

Problem: DRM and Copy Protection (ctd)

Consider a manufacturer building some sort of DRM system into their product

- Best-case possible outcome, if the technology works one hundred percent perfectly, is that the user doesn't notice anything
- Net gain to the manufacturer from the expense and overhead of adding DRM is zero

Since no technology is ever perfect, a number of users will run into problems caused solely by the DRM

- Customer dissatisfaction leading to product returns and lost sales is a net loss for the manufacturer

Problem: DRM and Copy Protection (ctd)

Any manufacturer who doesn’t bother with the DRM won’t encounter these problems

- Creates a strong incentive for manufacturers to pay the barest lip service to DRM
- If they don’t cheat then someone else will

The more functional (less crippled) products from the other manufacturer will prevail in the marketplace

Problem: DRM and Copy Protection (ctd)

Example: HDCP strippers

High-bandwidth digital content protection is a protection scheme for HDMI/DVI/etc

- Glitches or implementation bugs can prevent legitimate content from being sent to legitimate devices
- High overhead of HDCP handshake can introduce long delays when a signal is switched from one port to another

To most users this indicates a faulty device

Problem: DRM and Copy Protection (ctd)

A few boutique vendors used to sell expensive HDCP strippers

- Quickly vanished under an avalanche of legal threats

Problem: DRM and Copy Protection (ctd)

You can still get HDCP strippers, they’re just not advertised or sold as such

- Lesser-known manufacturers of HDMI switches and repeaters made the economically rational decision to omit HDCP in their outputs
- Accept incoming HDCP signals and pass on HDMI-only signals
- Cheapest devices of this kind retail for around US $15
- Solve problems like sending Blu-ray output to a non-HDCP device

Problem: DRM and Copy Protection (ctd)

Revocation mechanisms don’t work in practice

- Try tracking down a small and ever-changing army of fly-by-night manufacturers of no-name HDMI switches

HDCP keying material was quite probably purloined from legitimate products by third-shift manufacturing practices

- Revoking the keys could potentially brick large numbers of legitimate products

Problem: DRM and Copy Protection (ctd)

DRM’s killer problem: No-one involved in manufacturing the devices that use it or using the devices that contain it has any interest in it actually working except for the minimum that’s enforced by legal threats

- (Also, “trying to make digital files uncopyable is like trying to make water not wet” — Bruce Schneier)

Problem: DRM and Copy Protection (ctd)

No end of companies will be all too happy to sell you as much DRM as you can afford

- There's an awful lot of money to be made in this area
  - None of these vendors will provide liability cover for you if their DRM fails

Do the minimum necessary to comply with what the lawyers want and make sure that you can't be sued when it breaks

- DRM compliance engineering
- Eventually it will break but if you've demonstrated sufficient diligence in your pursuit of compliance then you won't be held liable

Problem: DRM and Copy Protection (ctd)

If your business model is crucially dependent on functioning DRM then consider getting into another business

If your business model merely requires the appearance of functioning DRM then that's fine

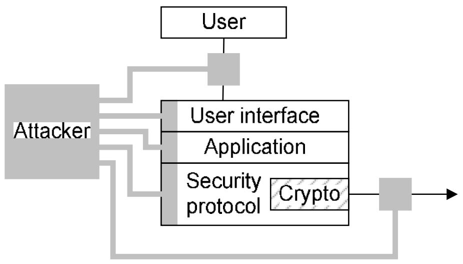
- You're getting that anyway no matter what DRM measures you employ

Problem: Upgrading Insecure Crypto

How do you recover from the catastrophic compromise of a security system?

Extremely rare in properly-designed systems

- Attackers target the implementation, the way it's used, or some other aspect unrelated to the crypto
- "Crypto is bypassed, not attacked"



Easiest approach is to ignore it and hope that it never occurs

Problem: Upgrading Insecure Crypto (ctd)

Consider a system that uses two authentication algorithms in case one fails

- Device receives a message authenticated with algorithm A saying "Algorithm B has been broken, don't use it any more"
- Device also receives a message authenticated with algorithm B saying "Algorithm A has been broken, don't use it any more"
- Device may also receive a third message saying "All Cretans are liars"

Could address this with fault-tolerant design concepts

- Voting protocols for algorithm replacement

Adds a huge amount of design complexity and new attack surface

Problem: Upgrading Insecure Crypto (ctd)

Capability will only be exercised in extremely rare circumstances

- Complex, error-prone code that's never really exercised
- Has to sit there unused (but resisting all attacks) for years until it's needed
- Has to work perfectly the first time

How you safely load a replacement algorithm into a remote device when the existing algorithm that's required to secure the load has been broken?

Problem: Upgrading Insecure Crypto (ctd)

Security geeks to want to replace half the security infrastructure that you're relying on as a side-effect of any algorithm upgrade

- c.f. TLS 1.2
- Deployment has lagged for years because the change from TLS 1.1 to 1.2 was far bigger than from SSL to TLS
- Scan carried out by a browser vendor in mid-2010 found exactly two public web servers supporting TLS 1.2
  - Both were specially set-up test servers

Problem: Upgrading Insecure Crypto (ctd)

Situation-specific solutions are possible…

Small number of high-cost units

- Courier out replacement devices that clone their state from the existing one
- Used by some hardware security modules (HSMs)

Remote boxes administered from a central server

- Boxes communicate their state to the central server
- Central site loads it into a new device that gets sent out
- Used by some VoIP boxes rented from a provider

Watch out for supply-chain attacks!

Problem: Upgrading Insecure Crypto (ctd)

Opportunistic upgrade of algorithms

- If the other side presents a certificate with algorithm *n*+1 then switch all communication with the certificate owner to *n*+1 as well
- Lots of fun for security geeks to play with

May be subject to rollback attacks

Need to secure records over long periods of time

- Use standard document-retention mechanisms
- Crypto is little more than a complex gimmick for this
  - “We’ll solve this problem with cryptography”
  - Now you have two problems

Problem: Key Storage for Unattended Use

Another variant of security vs. availability

Storing keys in plaintext form is a cardinal sin in cryptography

- A user is expected to enter a password or PIN to unlock or decrypt keys so that they can be used

How do you do this for devices that have to be able to operate unattended?

How do you recover from a crash/power outage/OS upgrade/VM migration without explicit human intervention?

Problem: Key Storage for Unattended Use

Various cat-and-mouse games possible

- Poke hierarchies of keys into various locations
- Use them to decrypt other keys
- Hope that an attacker can’t work their way back far enough to grab the real keys

For unattended operation at some point you need to fall back to a fixed key stored in plaintext-equivalent form that can survive a crash or reboot

Problem: Key Storage for Unattended Use

None of the "obvious" general-purpose solutions to this problem actually solve it

TPMs can only store the fixed storage-protection key that's required to decrypt the real key

- TPMs are just repurposed smart cards and don't have the horsepower to perform anything more than lightweight crypto themselves
- Can't offload the overall encryption processing to them

For unattended operation they have to release their secrets without a PIN

- Merely provide plaintext key storage with one level of indirection

Problem: Key Storage for Unattended Use

Add custom encryption hardware and perform all of the crypto in that

- Most manufacturers will be reluctant to add $500 of specialised encryption hardware to a $50 embedded device
- Scaled up to PC terms, a $20,000 hardware security module (HSM) to a $2,000 server
  - If the HSM vendor has particularly good salespeople they'll sell the client at least two $20,000 HSMs (each storing a single key) for disaster recovery purposes.

Problem: Key Storage for Unattended Use

Not very secure against an attack that compromises the host system

- All the HSM does is move the key from the compromised machine into an external box that does anything that the compromised host tells it to

May be adequate to meet auditing or regulatory requirements though

- Adds an auditable physical artefact to the process

Problem: Key Storage for Unattended Use

If you're really concerned about security, move more of the security functionality into the HSM

- Instead of acting as a yes-box for crypto ops, implement whole portions of the underlying security protocol in the HSM
- Takes a large amount of programming effort

IBM used to sell a fully programmable high-security crypto coprocessor

- Almost no-one took advantage of its programming capabilities

A good idea in theory but practical experience has shown that few users will make the effort

Problem Structuring Methods

There is one problem-solving approach that may be usable here

- Soft operations research, or problem-structuring methods

Operations research dates back to just before WWII

- UK scientists got together to look at ways of optimising the management of military materiel and manpower
- Known in the UK as operations research and in the US as management science

In the 1970s and 1980s practitioners of traditional OR realised that it didn't work for wicked problems

- Came up with soft OR, or problem-structuring methods (PSMs)

Problem Structuring Methods (ctd)

Methods include...

- Interactive Planning
  - Notable principally because its first step is "Mess Formulation"
- Soft Systems Methodology (SSM)
- Strategic Assumption Surfacing and Testing (SAST)
- Strategic Choice Approach (SCA)
- Strategic Options Development and Analysis (SODA)
- Many, many more

To be tested at a future Auckland ISIG meeting :-)

Unsolvable Problems Redux

So how do we fix this?

Uhh, go back to the slide that introduces wicked problems

If do you run into any of the problems discussed here then you're not going to find any (general) solution to them

- Design your systems to deal with this
- Try something else that avoids the need to solve a wicked problem