

Security

Charles Severance

open.michigan

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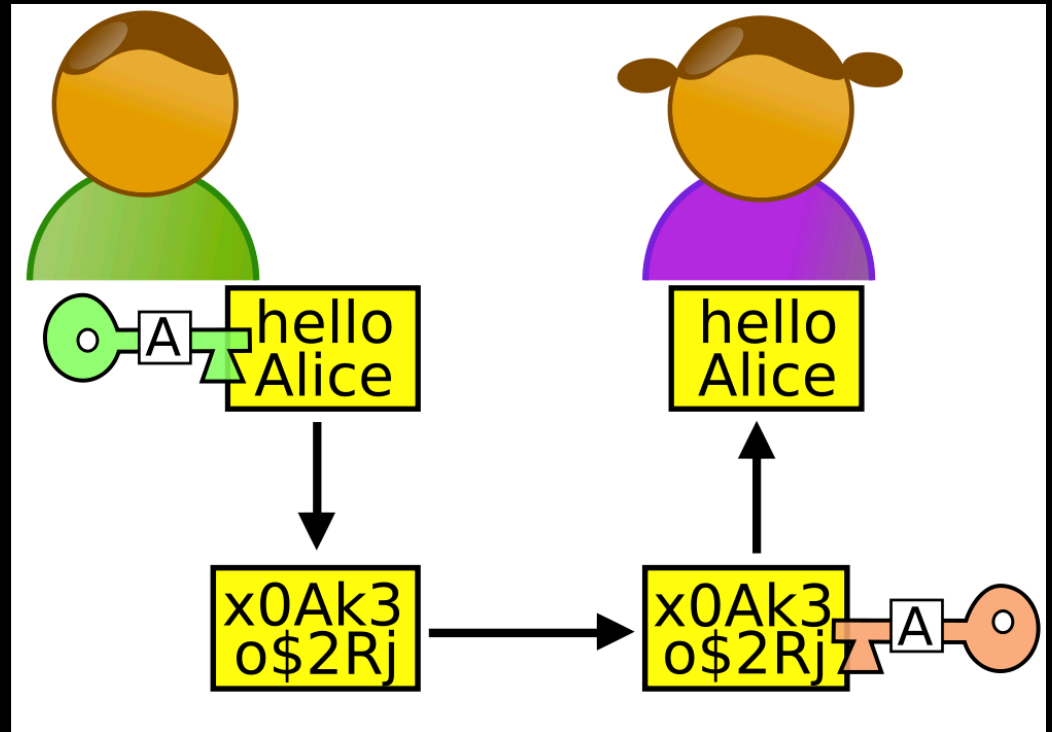
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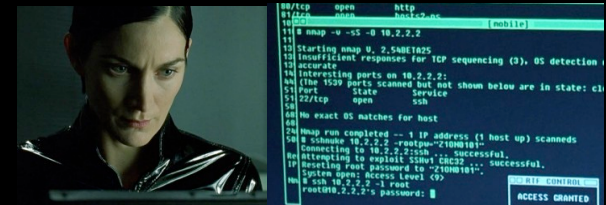
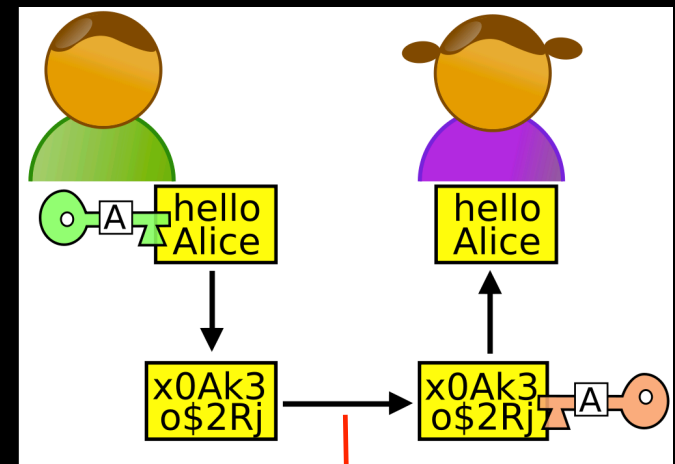
Lets Meet
some Nice
People



http://en.wikipedia.org/wiki/Alice_and_Bob

People With Bad Intent

- Carol, Carlos or Charlie, as a third participant in communications.
- Chuck, as a third participant usually of malicious intent
- Dan or Dave, a fourth participant,
- Eve, an eavesdropper, is usually a passive attacker. While she can listen in on messages between Alice and Bob, she cannot modify them.
-



http://en.wikipedia.org/wiki/Alice_and_Bob

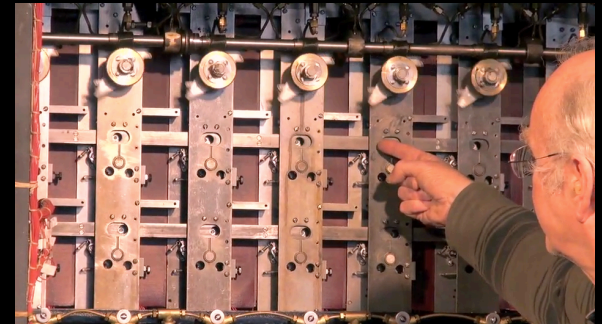
Paranoia

- Who is out to get you?
- If you are interesting or influential people want to get into your personal info.
- If you are normal, folks want to use your resources or take your information to make money...
- Usually no one cares... But it is safest to assume some is always trying...

Alan Turing and Bletchley Park

- Top secret code breaking effort
- 10,000 people at the peak (team effort)
- BOMBE: Mechanical Computer
- Colossus: Electronic Computer

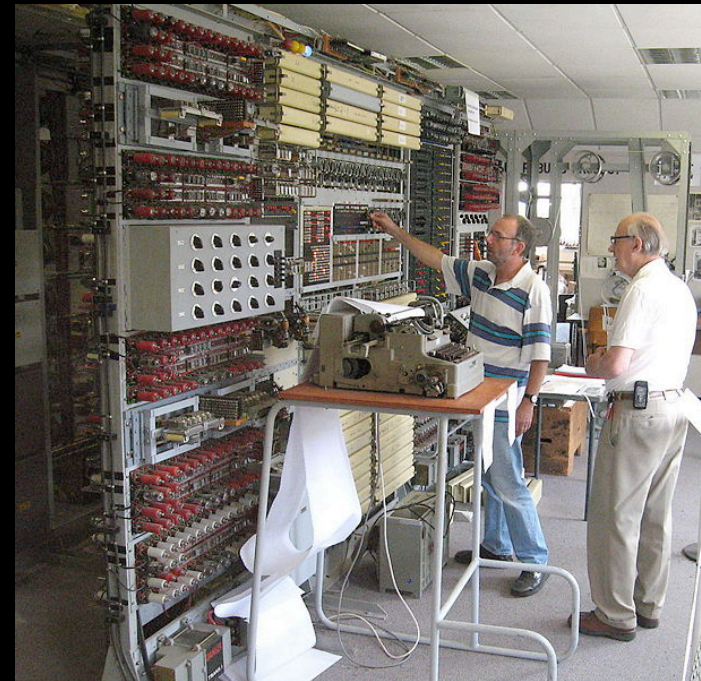
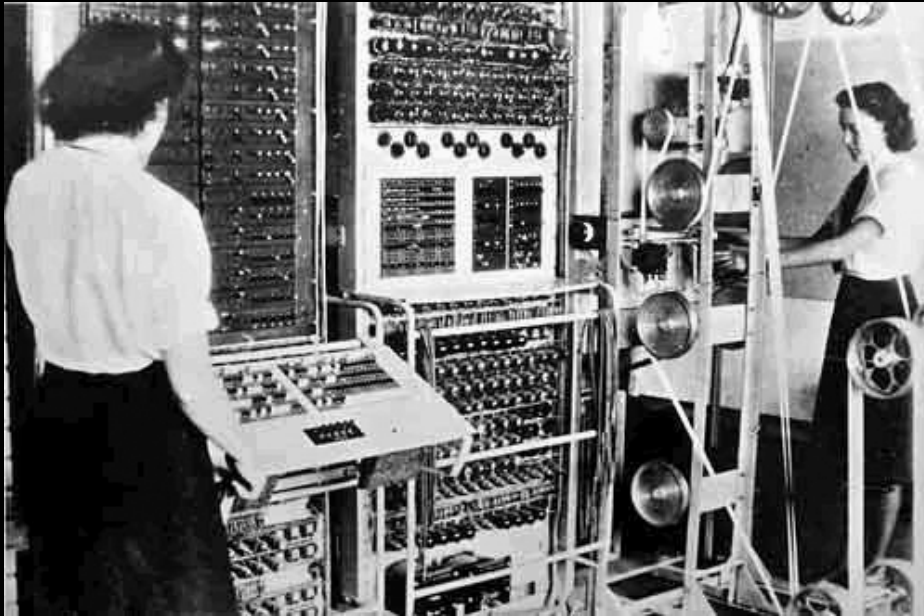
http://www.youtube.com/watch?v=5nK_ft0LfIs





<http://en.wikipedia.org/wiki/Bombe>

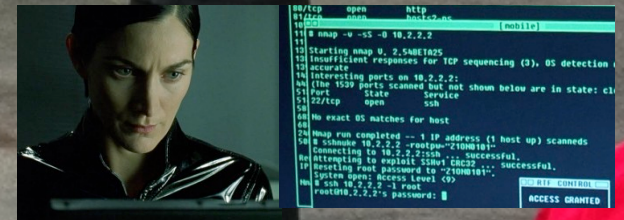
http://en.wikipedia.org/wiki/Colossus_computer



http://en.wikipedia.org/wiki/Tony_Sale



<http://nmap.org/movies.html>



Security is always a Tradeoff

- "Perfect security" is unachievable - Must find the right tradeoff
- Security .versus. Cost
- Security .versus. Convenience (See also, "profit")
- "More" is not always better – vendors of products will try to convince you that you *cannot live* without their particular gadget

Terminology

- Confidentiality
 - Prevent unauthorized viewing of private information
- Integrity
 - Information is from who you think it is from and has not been modified since it was sent

Ensuring Confidentiality Encryption and Decryption

Terminology

- **Plaintext** is a message that will be put into secret form.
- **Ciphertext** is a transformed version of **plaintext** that is unintelligible to anyone without the means to decrypt

Terminology

- The transformation of **plaintext** to **ciphertext** is referred to as **encryption**.
- Returning the **ciphertext** back to **plaintext** is referred to as **decryption**.
- The strength of a cryptosystem is determined by the encryption and decryption techniques and the length of the **key**.

Two Kinds of Systems

- Two basic types of cryptosystems exist, **secret-key** and **public-key**.
- In a secret-key scheme, the key used for encryption must be the same key used for decryption. Also called symmetric-key cryptosystem.
- Secret-key cryptosystems have the **problem of secure key distribution** to all parties using the cryptosystem.

Plaintext:
"candy"

Encrypt

CipherText:
"dboez"

Alice

c = d
a = b
n = o
d = e
y = z

Message Might
be Intercepted

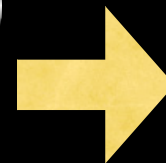
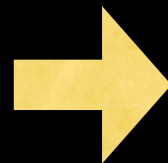
Eve

Plaintext:
"candy"

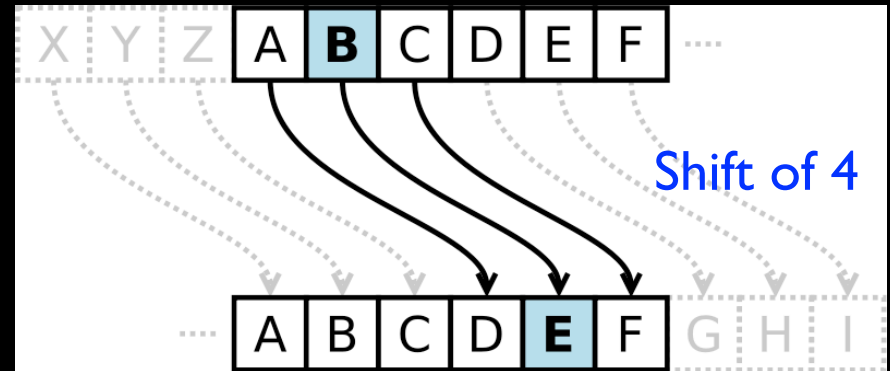
Decrypt

CipherText:
"dboez"

Bob



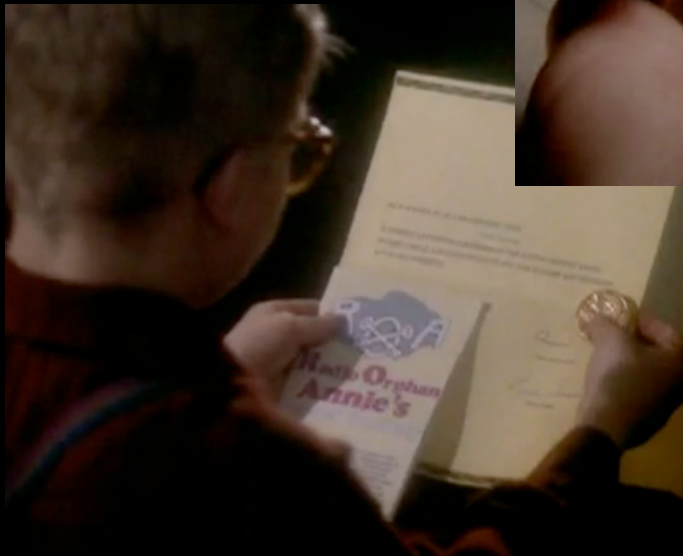
Caesar Cipher



Caesar cipher is one of the simplest and most widely known encryption techniques. It is a type of substitution cipher in which each letter in the plaintext is replaced by a letter some fixed number of positions down the alphabet.

http://en.wikipedia.org/wiki/Caesar_cipher

Secret Decoder Ring



http://www.youtube.com/watch?v=zdA__2tKoIU

Secret Decoder Ring - Shift Number

PP:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
01:	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
02:	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
08:	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
09:	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
10:	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
11:	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
12:	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
13:	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
14:	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N

<http://www.dr-chuck.com/Secret-Decoder.pdf>

Break the Code I

CipherText:
"upbtu"

For each number 1..26, see if
when you decrypt the
message using that shift, it
makes sense.

Break the Code I

CipherText:
"upbtu"

Plaintext:
"toast"

00:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
01:	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A

A shift of 1

Break the Code II

Uryyb, zl anzr vf Puhpx naq V arrq zbarl naq n wrq.

Break the Code II

Uryyb, zl anzr vf Puhpx naq V arrq zbarl naq n wrq.

Hello, my name is Chuck and I need money and a jet.

www.rot13.com

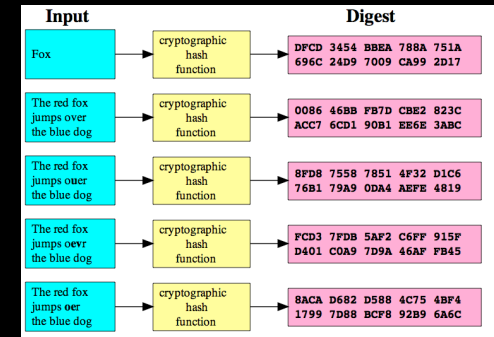
Cryptographic Hashes

Integrity

Terminology

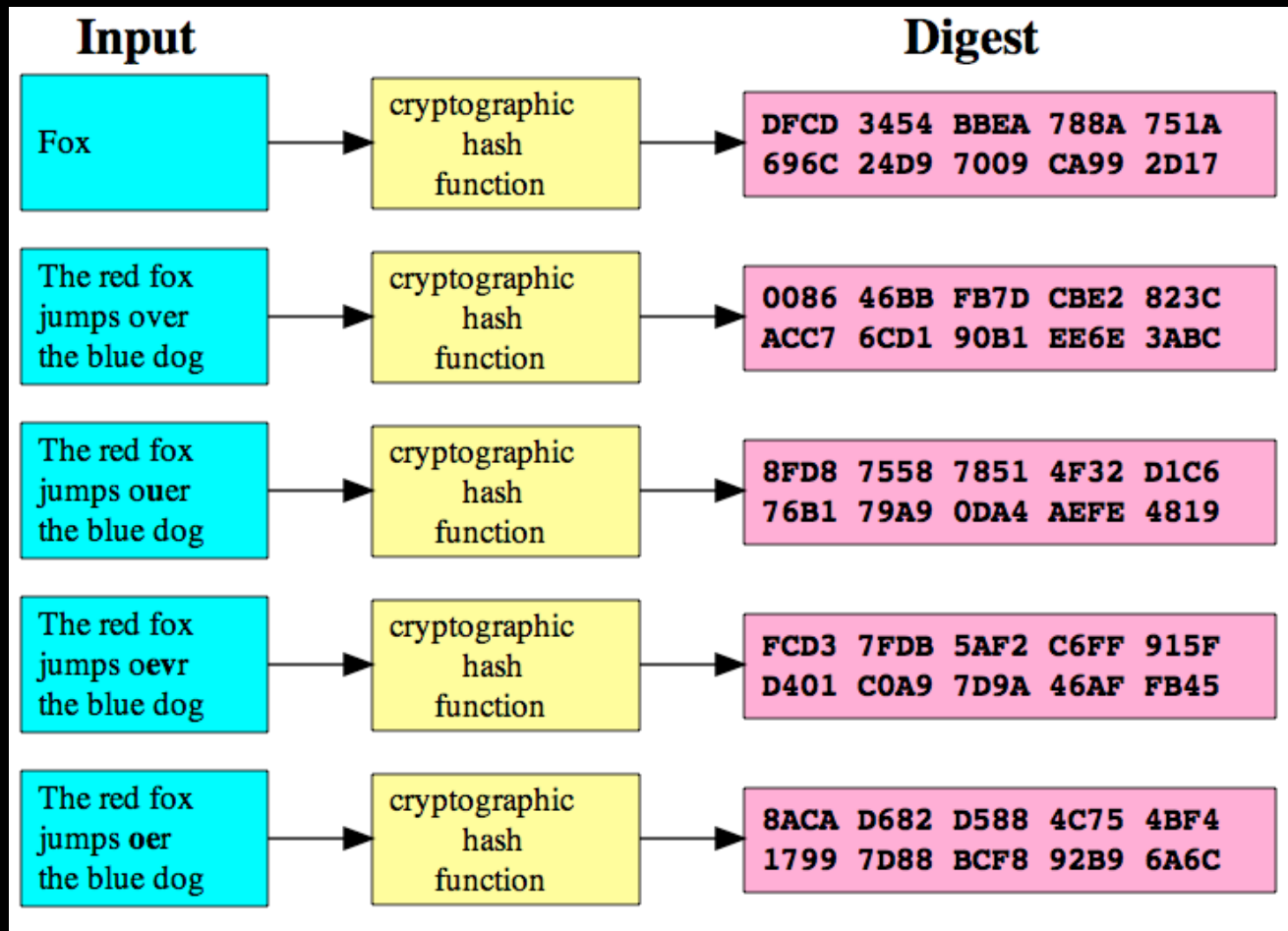
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Cryptographic Hash



A cryptographic hash function is a function that takes an arbitrary **block of data** and returns a **fixed-size bit string**, the (cryptographic) **hash** value, such that an accidental or intentional change to the data will change the **hash** value. The **data to be encoded** is often called the "**message**," and the **hash** value is sometimes called the **message digest** or simply **digest**.

http://en.wikipedia.org/wiki/Cryptographic_hash_function



http://en.wikipedia.org/wiki/Cryptographic_hash_function

<http://www.dr-chuck.com/sha1.php>

Dr. Chuck's Awesome SHA1 Calculator

fluffy

d9d71ab718931a89de1e986bc62f6c988

Courtesy of [www.dr-c](http://www.dr-chuck.com)

Dr. Chuck's Awesome SHA1 Calculator

Fluffy

3af4e2d1a82a1e2d2b16a25b47

Courtesy of [w](http://www.dr-chuck.com)

Dr. Chuck's Awesome SHA1 Calculator

```
<body> <center> <h2>Dr. Chuck's Sha1 Calculator</h2> <form
method="post"> <textarea name="text" rows="10" cols="50"> <?
php echo(htmlentities($_POST['text'])); $encoded = ""; if (
isset($_POST['text'])) { $encoded=sha1($_POST['text']); } ?>
</textarea> <p> <?php echo($encoded); ?> </p> <input
type="submit" value="Encode"> <input type="reset"
value="Reset"> Courtesy of <a href="http://www.dr-
chuck.com/">www.dr-chuck.com</a>.
```

b6a05874a08542245d016e2d2e9a3e5c130680af

Courtesy of www.dr-chuck.com.

<http://en.wikipedia.org/wiki/SHA-1>

Hashes for Passwords

- As a general rule, systems do not store your password in plain text their databases in case they 'lose' their data
- When you set the password, they compute a hash and store the hash
- When you try to log in they compute the hash of what you type as a password and if it matches what they have stored - they let you in.
- This is why a respectable system will never send your PW to you - they can only reset it!

Setting a new password

Store the 'hashed password' in the database.

fluffy → SHA-1 → d9d7lab7l893la89dele986bc62f6c988ddcl8l3

Log in attempt

pony → SHA-1 → 2629fb6d2384da89796a48llef6db5f2ac657bab

fluffy → SHA-1 → d9d7lab7l893la89dele986bc62f6c988ddcl8l3

Match

<http://www.dr-chuck.com/sha1.php>

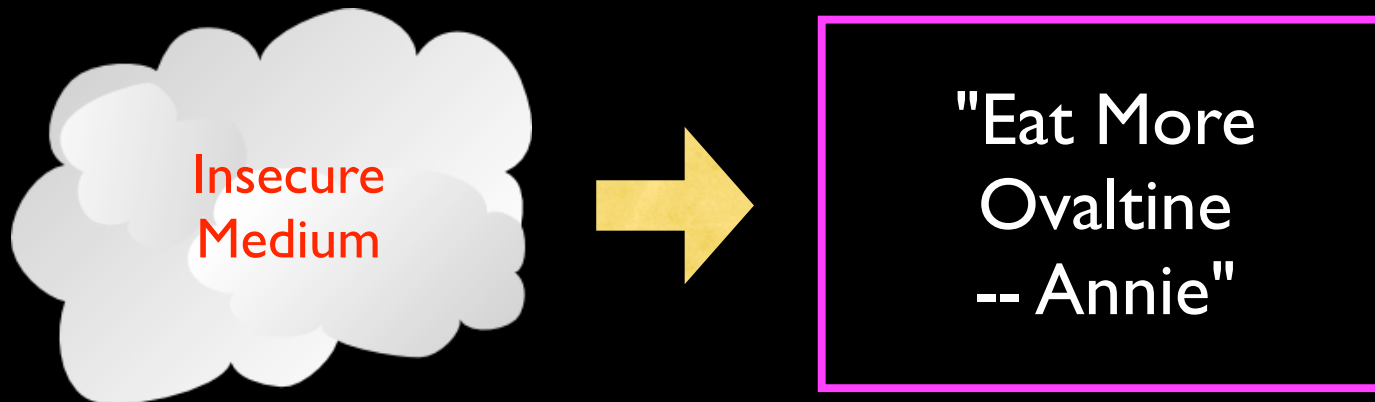
Digital Signatures

Message Integrity

Message Integrity

- When you get a message from someone, did that message really come from who you think it came from?
- Was the message altered while in transit or is the copy you received the same as the copy that was sent?

You



How might we be very sure this message really came from Annie and it was not altered enroute?

Simple Message Signing

- Shared secret transported securely 'out of band'
- Before sending the message, concatenate the secret to the message
- Compute the SHA digest of the message+secret
- Send message + digest across insecure transport

Receiving a Signed Message

- Receive message + digest from insecure transport
- Remove digest and add secret
- Compute SHA digest for message + secret
- Compare the computed digest to the received digest

Eat More Ovaltine

Eat More OvaltineSanta



SHA-1



a79540

Eat More Ovaltinea79540

Eat More Ovaltinea79540



Eat More Ovaltine

Eat More OvaltineSanta



SHA-1



a79540

a79540

Match! :)

<http://www.dr-chuck.com/sha1.php>

Eat More Ovaltine

Eat More OvaltineSanta



a79540

Eat More Ovaltinea79540

Eat Less Ovaltinea79540



Eat Less Ovaltine

Eat Less OvaltineSanta



a79540

109a15

NO MATCH!!

<http://www.dr-chuck.com/sha1.php>

Eat More Ovaltine

Eat More OvaltineSanta



SHA-1



a79540

Eat More Ovaltinea79540

Free Cookies84d211

Free Candy26497c

<http://www.dr-chuck.com/sha1.php>

Eat More Ovaltine

Eat More OvaltineSanta



a79540

Eat More Ovaltinea79540

Free Cookies84d211

Free CookiesSanta

c14d5d

✗

Free Candy26497c

Free CandySanta

26497c



<http://www.dr-chuck.com/sha1.php>

Secret Key Shortcomings

- Every pair of people/systems needs a secret key
- In the Internet, key distribution cannot be via the Internet because communications are insecure until you get the key!
- For the Internet to work we need an approach where keys can cross the insecure Internet and be intercepted without compromising security



Public Key Encryption Confidentiality

Grezvabybtl

- Pbasvqragvnyvgl

- Cerirag hanhgubevmrq ivrjvat bs cavingr vasbezngvba

- Vagrtevgl

- Vasbezngvba vf sebz jub lbh guvax vg vf sebz naq unf abg orra
zbqvsvrq fvapr vg jnf frag

www.rot13.com

Terminology

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Public Key Encryption

- Proposed by Whitfield Diffie and Martin Hellman in 1976
- Public-key cryptosystems rely on two keys which are mathematically related to one another. Also called asymmetric-key cryptosystem.
- One key is called the public key and is to be openly revealed to all interested parties.
- The second key is called the private key and must be kept secret.

http://en.wikipedia.org/wiki/Public-key_cryptography



http://en.wikipedia.org/wiki/Ralph_Merkle

http://en.wikipedia.org/wiki/Martin_Hellman

http://en.wikipedia.org/wiki/Whitfield_Diffie

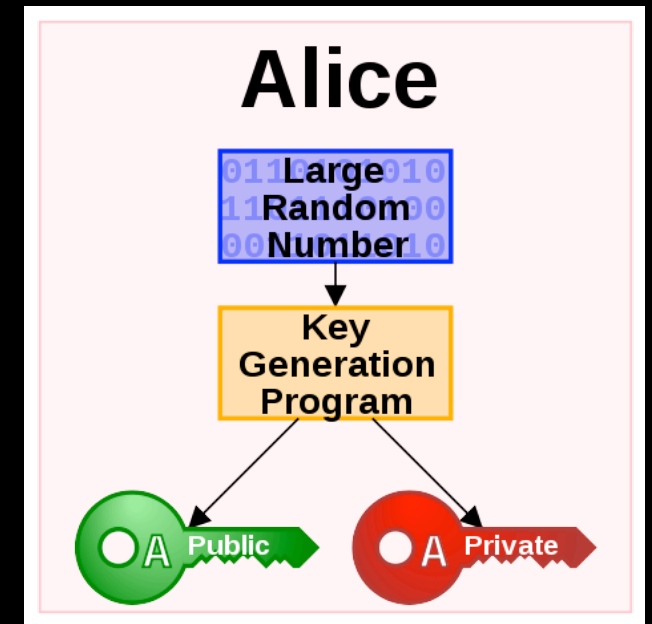
<https://www.youtube.com/watch?v=ROCray7RTqM>

Public Key

- A message encrypted with one of the keys can only be decrypted with the other key.
- It is computationally infeasible to recover one key from the other
- Public-key cryptosystems solve the problem of secure key distribution because the public key can be openly revealed to anyone without weakening the cryptosystem.

Generating Public/Private Pairs

- Choose two large* random prime numbers
- Multiply them
- Compute public and private keys from that very large number



*The definition of "large" keeps getting bigger as computers get faster

Public Key Math (light)

- Some functions are easy in “one direction”, but in the other, not so much!

Example: What are the factors of 55,124,159?

Public Key Math (light)

- What are the factors of 55,124,159 (a nearly prime number)
- What do you multiply 7919 by to get 55,124,159?
- If you know that one of the factors is 7919, it's also easy to find 6961!



You

Plaintext:
"Visa928"

Encrypt

CipherText:
"ablghyuip"

Message Might
be Intercepted

Message Might
be Intercepted

Amazon.com

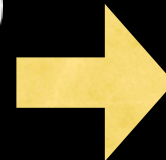
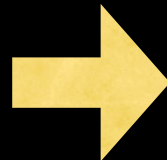
Plaintext:
"Visa928"

Public Key

Private Key

Decrypt

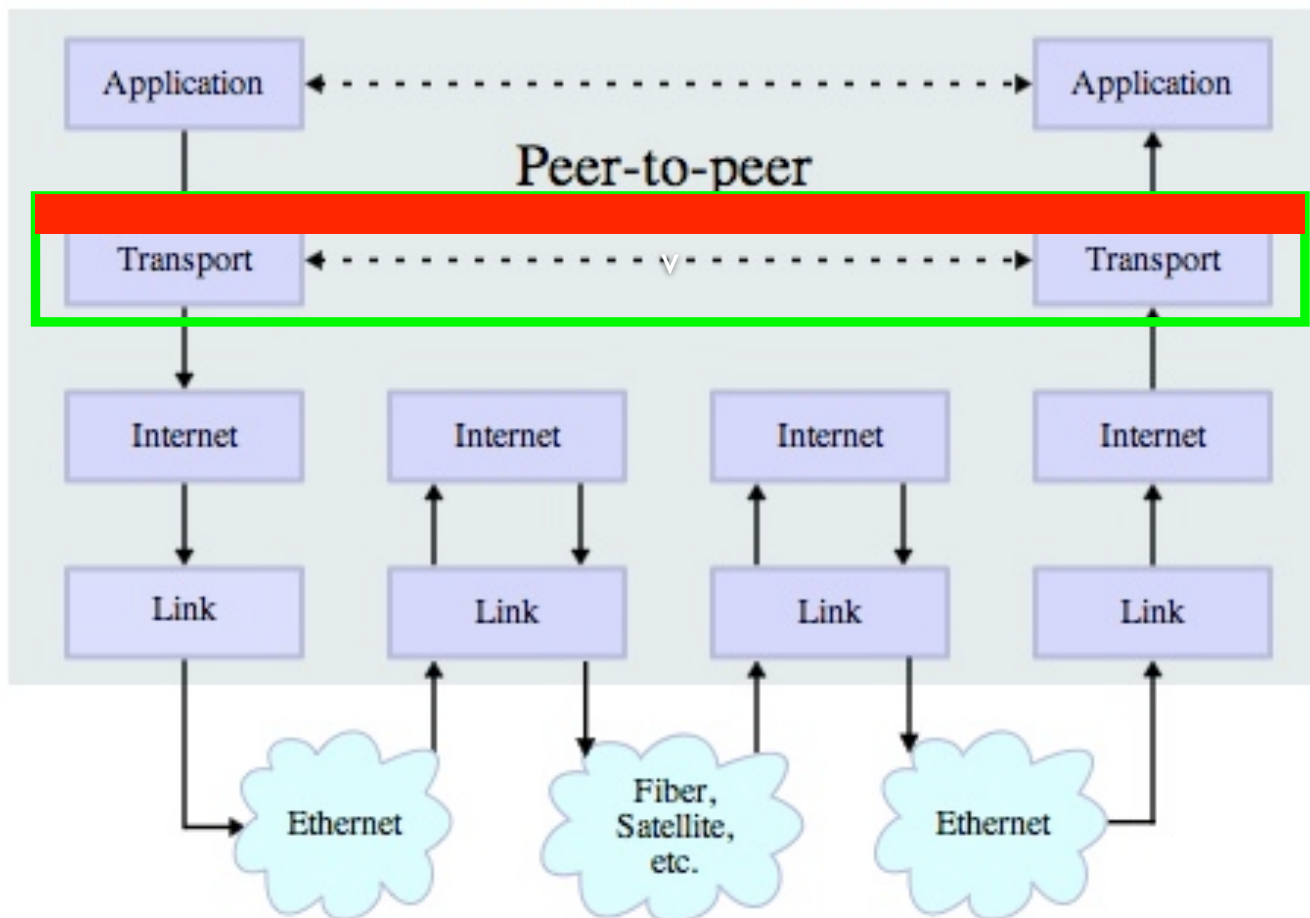
CipherText:
"ablghyuip"

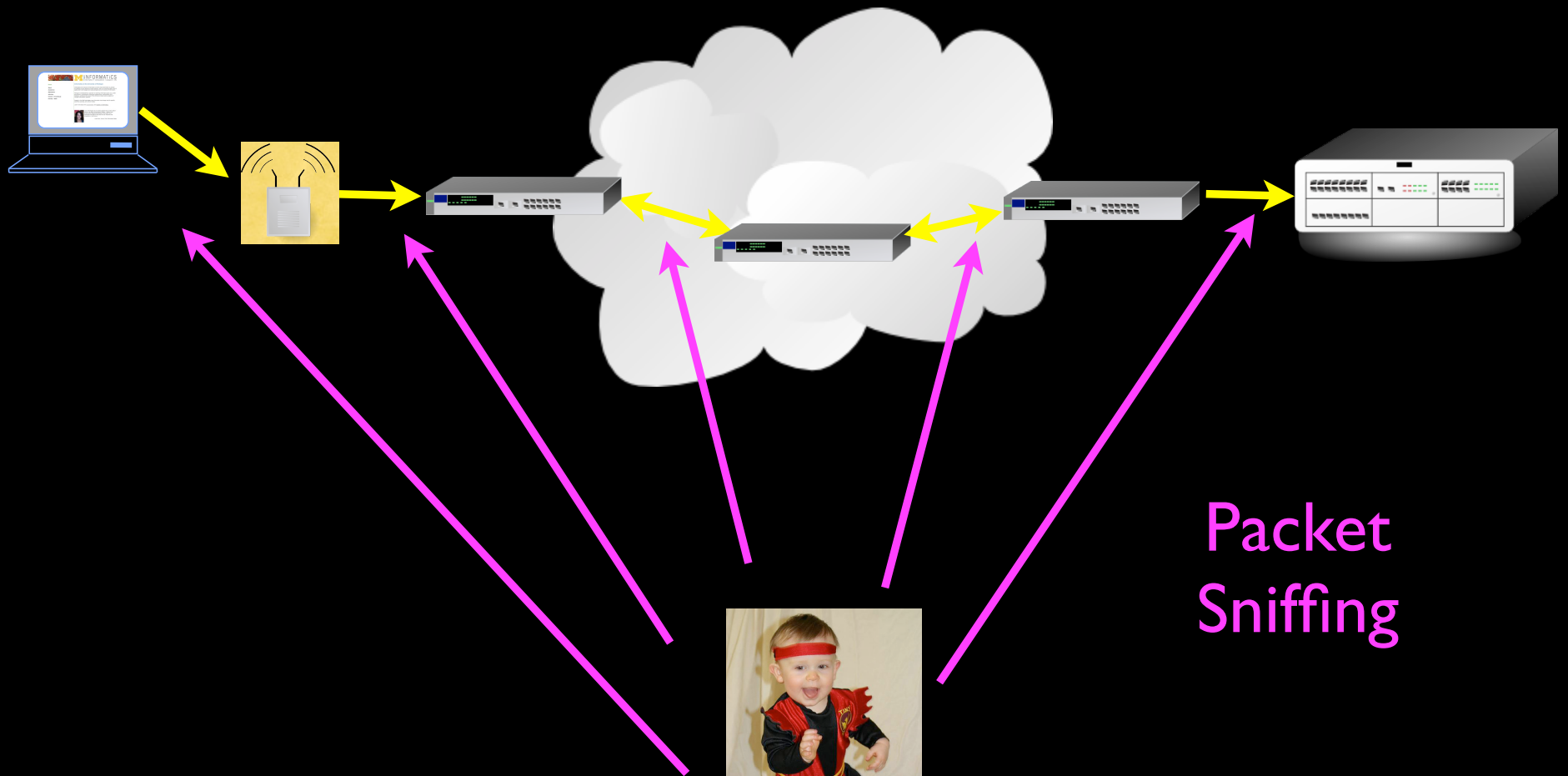


Secure Sockets Layer (SSL) Security for TCP

http://en.wikipedia.org/wiki/Secure_Sockets_Layer

Stack Connections





Clipart: <http://www.clker.com/search/networksym/>
Photo CC BY: karindalziel ([flickr](https://www.flickr.com/photos/karindalziel/))
<http://creativecommons.org/licenses/by/2.0/>



Packet
Sniffing

Transport Layer Security (TLS)

- Used to be called “Secure Sockets Layer” (SSL)
- Can view it as an extra layer “between” TCP and the application layer
- It is very difficult but not impossible to break this security - normal people do not have the necessary compute resources to break TLS
- Encrypting and decryption takes resources - so we use it for things when it is needed
- The IP and TCP are unaware whether data has been encrypted

Secure Application Protocols

- There are often secure and unencrypted application protocols
 - <http://www.facebook.com>
 - <https://www.facebook.com>
- Your browser tells you when using a secure connection - you should never type passwords into a non-secure connection
- Especially over wireless - especially at a security conference...

System to System Secure TCP/IP

Your local connection
(particularly when
wireless) is your greatest
exposure.



Generally, the backbone of
the Internet is pretty
secure to prying eyes
from generic baddies...

Clipart: <http://www.clker.com/search/networksym/1>
Photo CC BY: karindalziel (flickr)
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http://en.wikipedia.org/wiki/Secure_Sockets_Layer

Certificate Authorities Integrity



Announcements | Internet History, Technology, and Security

<https://class.coursera.org/insidetheinternet-002/class/index>

Announcements | Internet History, Technology, and Security



Syllabus

Video Lectures

Quizzes (Assignments)

Discussion Forums

Resources Wiki (Editable)

Feedback Survey

**Peer Graded Essays
(Extra Credit)**

Demographic Survey



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✔ This certificate is valid

► **Trust**

▶ **Details**

?

OK

than once and still keep the class in the few hours per week range.

Fri 12 Apr 2013 5:28 AM PDT -0700

Week 6 and Office Hours in Philadelphia, PA

coming Deadlines

izzes

Quiz

9 PM PDT -0700

Assignments

Credit Assignment 2

mission)

22 Apr 2013 10:36 PM PDT -0700

 [Deadlines calendar](#)

New Lectures

Application Layer (25:13)

Van Jacobson - Content Centered
Networking (10:00)

Digital Certificates

In cryptography, a **public key certificate** (also known as a digital certificate or identity certificate) is an **electronic document** which uses a digital signature to bind a public key with an identity — information such as the name of a person or an organization, their address, and so forth. **The certificate can be used to verify that a public key belongs to an individual.**

http://en.wikipedia.org/wiki/Public_key_certificate

Certificate Authority (CA)

A certificate authority is an entity that issues digital certificates. The digital certificate certifies the ownership of a public key by the named subject of the certificate. A CA is a trusted third party that is trusted by both the owner of the certificate and the party relying upon the certificate.

http://en.wikipedia.org/wiki/Certificate_authority

VeriSign Authentication Services – The leading provider of SSL. Products ...rotection, malware scan, code signing & public key infrastructure (PKI).

http://www.verisign.com/ verisign

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1 2 3 4

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BUY VeriSign Trust Seal

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SIGN IN VeriSign Trust Center

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Certified - Secure



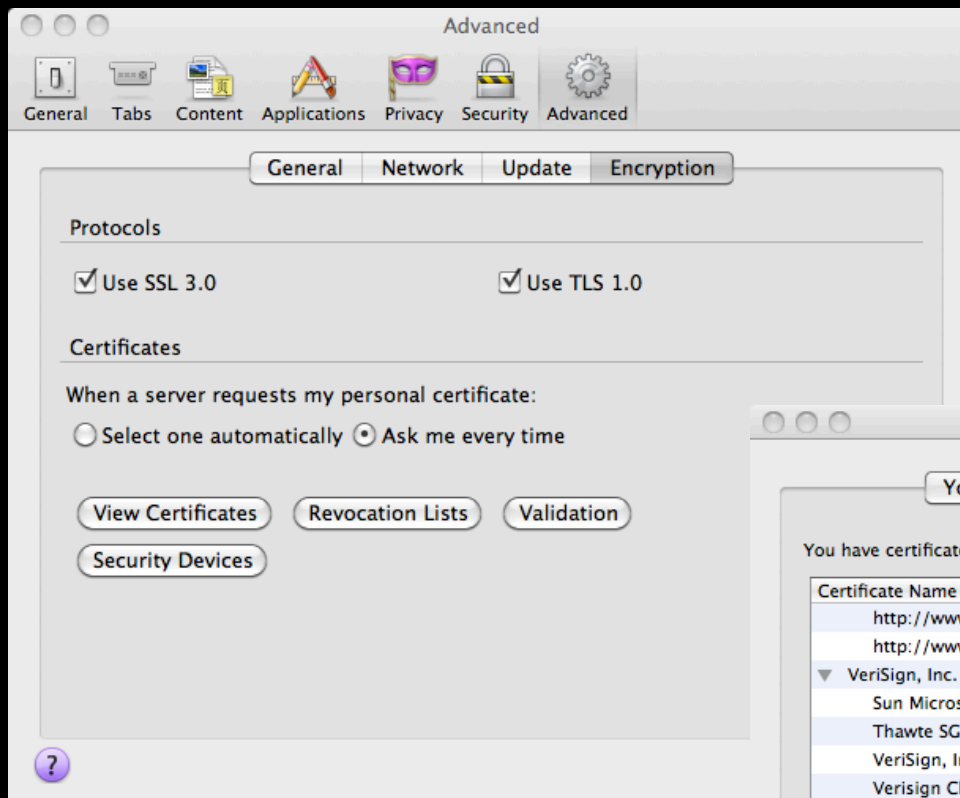
Protect your Business from Online Threats

Find a Symantec solution to secure, backup and manage your valuable data.

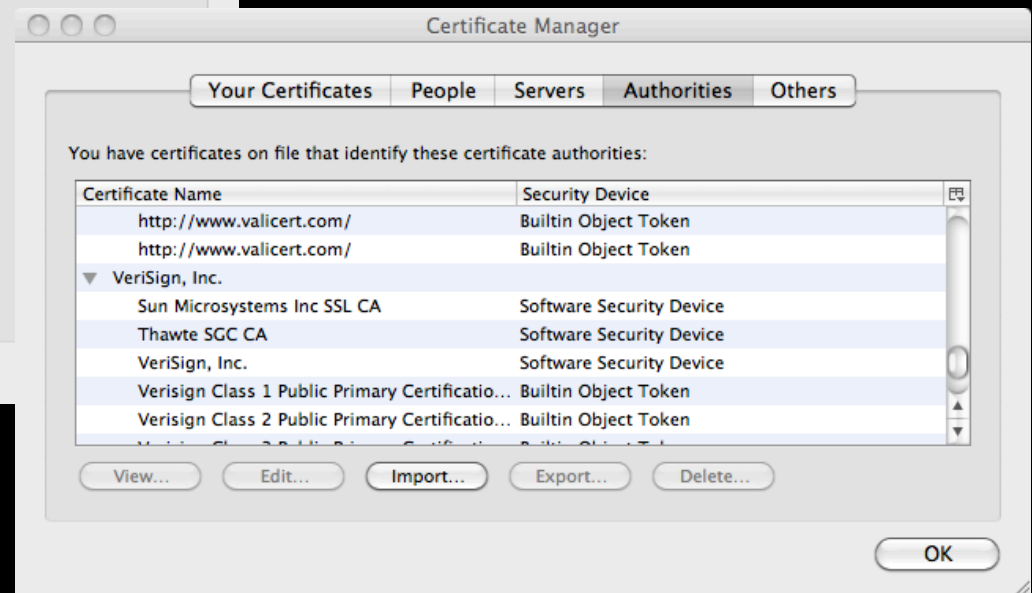


**VERISIGN**

Find WhoIs,
Registrar Information,
Domain Name Services,
Managed DNS,
DDoS Protection and
iDefense at



Your browser comes with certificates/public keys from some certificate authorities built in. Like Verisign.

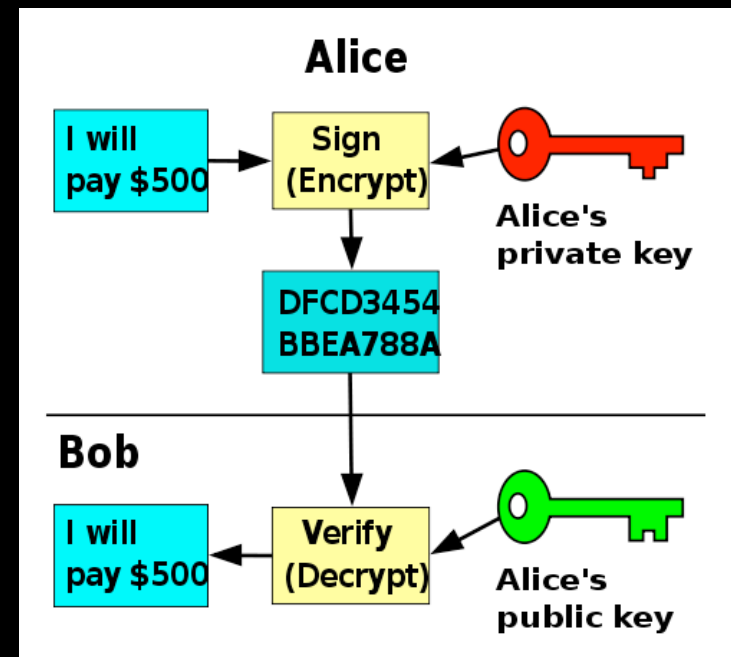
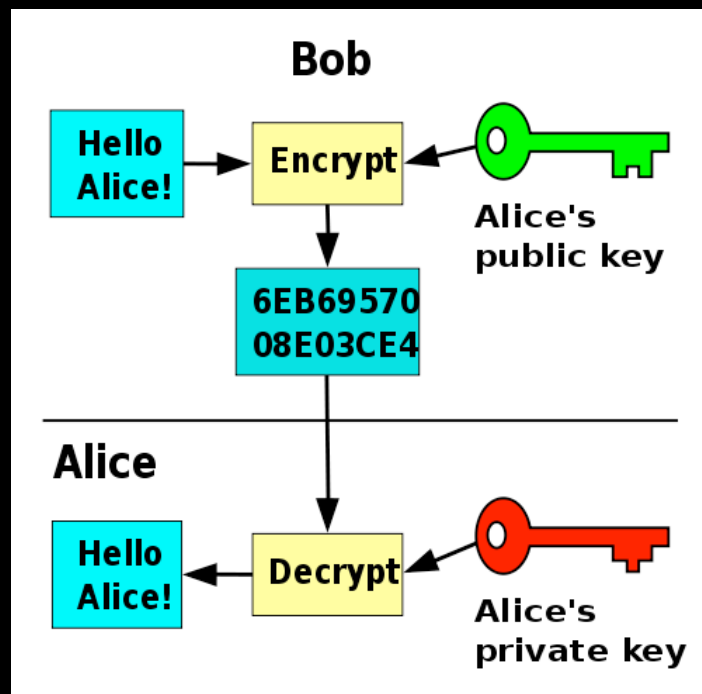


Public-Key Issues

- Public-key cryptosystems have the problem of securely associating a public key with an individual
- I am about to type in my credit card and send it - am I being Phished?
- The remote server sent me a public key.
- Should I use it? Is this really Amazon's public key?

<http://en.wikipedia.org/wiki/Phishing>

Public/Private Keys for Signing



http://en.wikipedia.org/wiki/Public-key_cryptography

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http://en.wikipedia.org/wiki/Certificate_authority

VeriSign Authentication Services – The leading provider of SSL. Products ...rotection, malware scan, code signing & public key infrastructure (PKI).

http://www.verisign.com/ verisign

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Boost your site traffic and conversions with powerful trust features. Free with every SSL Certificate.

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Certified - Secure



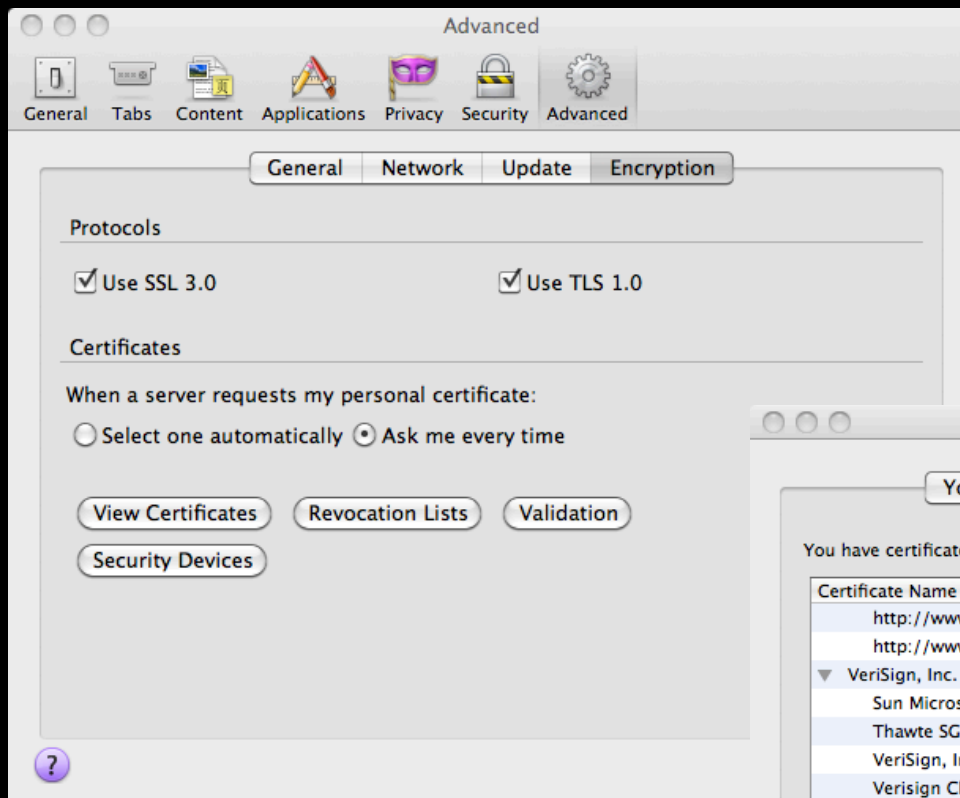
Protect your Business from Online Threats

Find a Symantec solution to secure, backup and manage your valuable data.

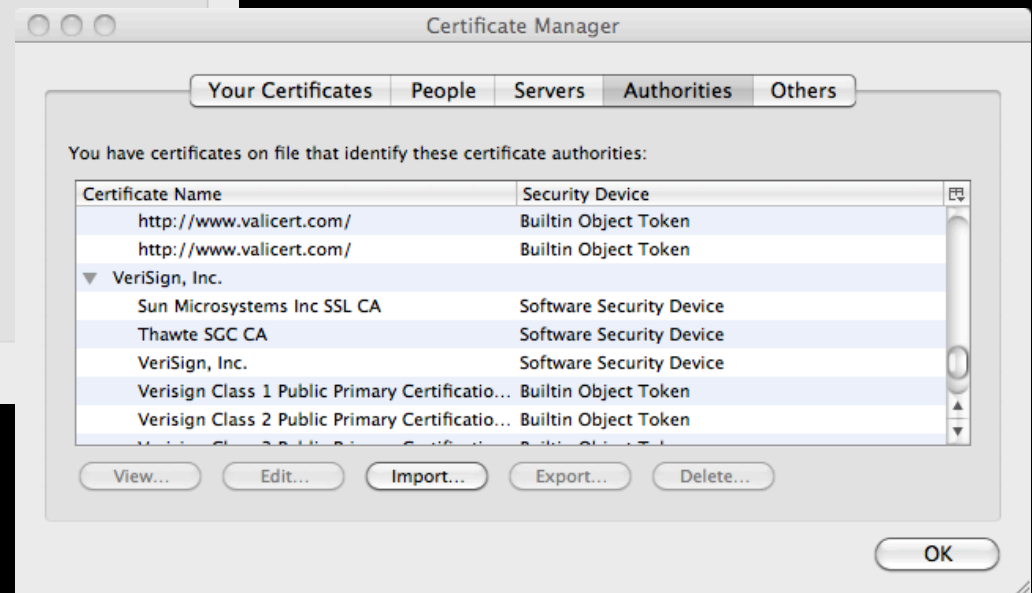


**VERISIGN**

Find WhoIs,
Registrar Information,
Domain Name Services,
Managed DNS,
DDoS Protection and
iDefense at



Your browser comes with certificates/public keys from some certificate authorities built in. Like Verisign.



How Amazon
gets a public
key signed by
Verisign

Verisign

Verisign Private Key

Verisign Public Key

Amazon

Your Laptop

Verisign

Verisign Private Key

Cert:Amazon
-- Verisign

Amazon Public Key

Amazon Private Key

Verisign Public Key

Amazon

Your Laptop

Verisign

Verisign Private Key

Amazon Public Key

Cert:Amazon
-- Verisign

Amazon Public Key

Amazon Private Key

Verisign Public Key

Amazon

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Verisign

Verisign Private Key

Amazon Public Key

Amazon Private Key

Amazon Public Key

Cert: Amazon
-- Verisign

Verisign Public Key

Amazon

Your Laptop



Verisign

Verisign Private Key

Amazon Public Key

Cert:Amazon
-- Verisign

Amazon Private Key

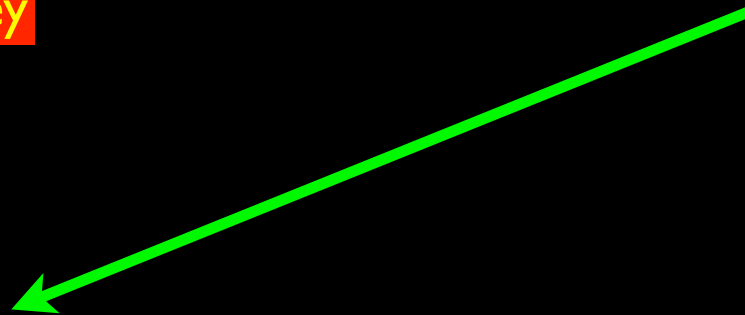
Amazon Public Key

Cert:Amazon
-- Verisign

Verisign Public Key

Amazon

Your Laptop

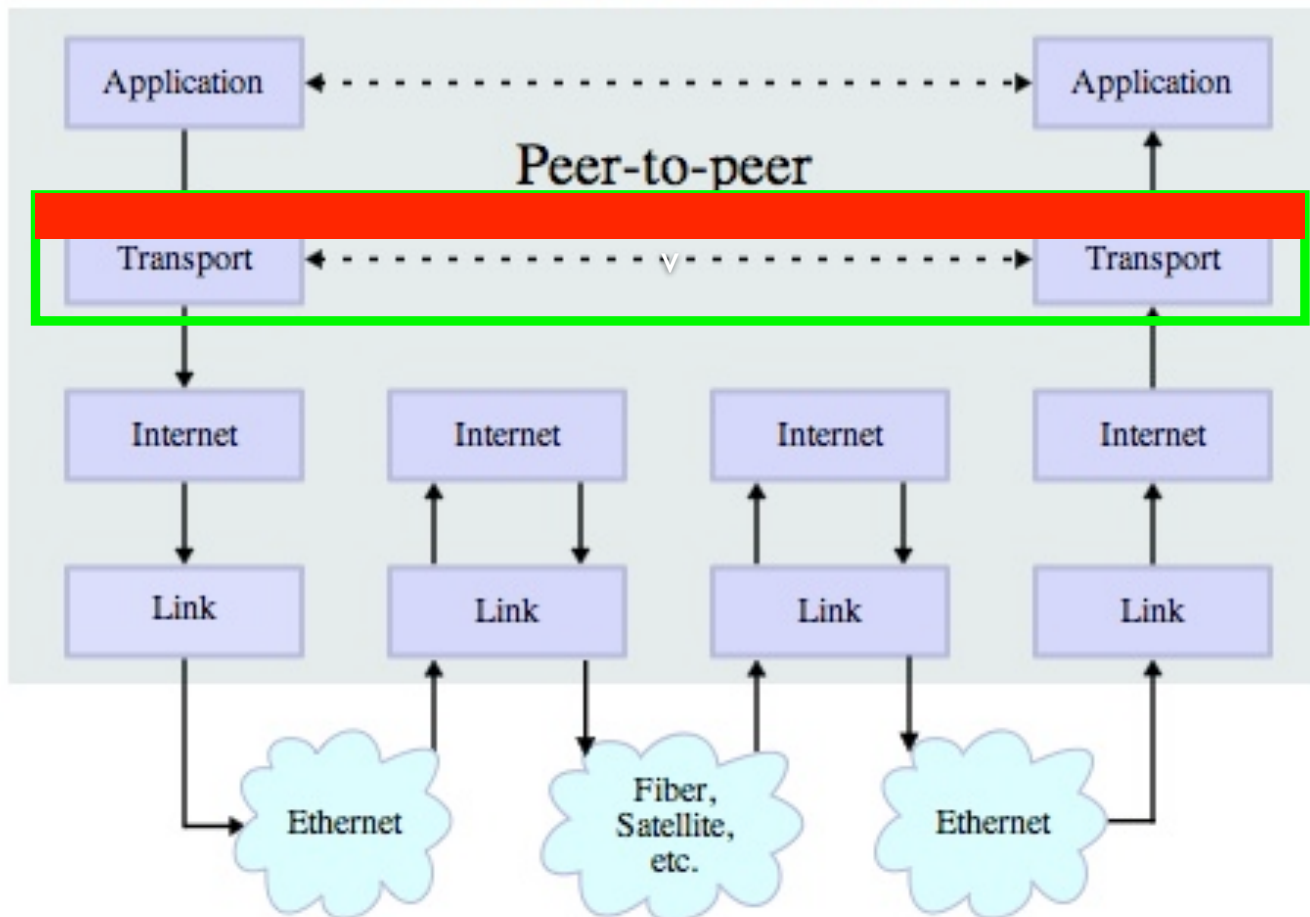


Certificate Authority (CA)

A certificate authority is an entity that issues digital certificates. The digital certificate certifies the ownership of a public key by the named subject of the certificate. A CA is a trusted third party that is trusted by both the owner of the certificate and the party relying upon the certificate.

http://en.wikipedia.org/wiki/Certificate_authority

Stack Connections



Summary

- Message Confidentiality / Message Integrity
- Encrypting / Decrypting
- Message digests and message signing
- Shared Secret Key / Public Private Key

Reuse of these materials

- I intend for these materials to be reusable as open educational resources for those who would do so in a responsible manner
- Please contact me if you are interested in reusing or remixing these materials in your own teaching or educational context