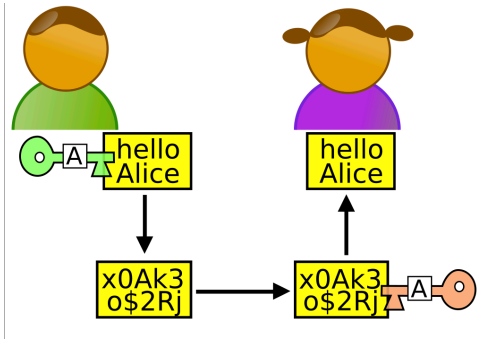
Security

Charles Severance

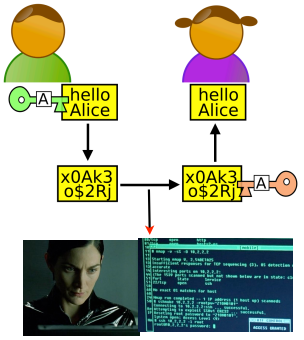
Lets Meet some Nice People



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.*
- .....

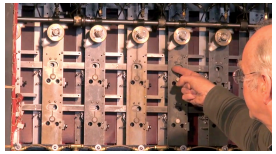


http://en.wikipedia.org/wiki/Alice_and_Bob

Paranoia

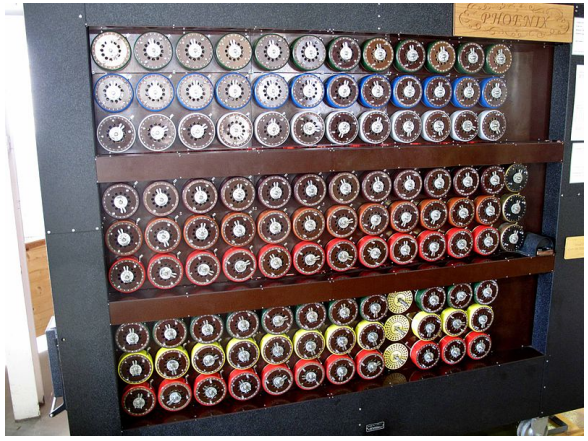
- Who is out to get you?
- If you are interesting or influential people want to get into your personal info.
- If you are normal, folks want to use your resources or take your information to make money…
- Usually no one cares… But it is safest to assume some is always trying…

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_ft0Lf1s



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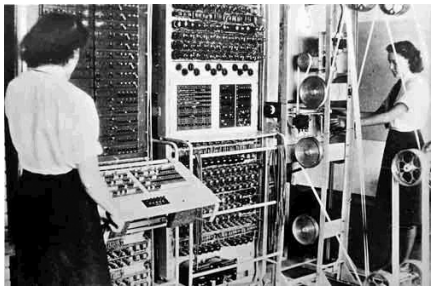
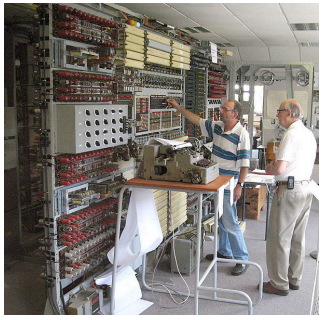




http://en.wikipedia.org/wiki/Tony_Sale

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

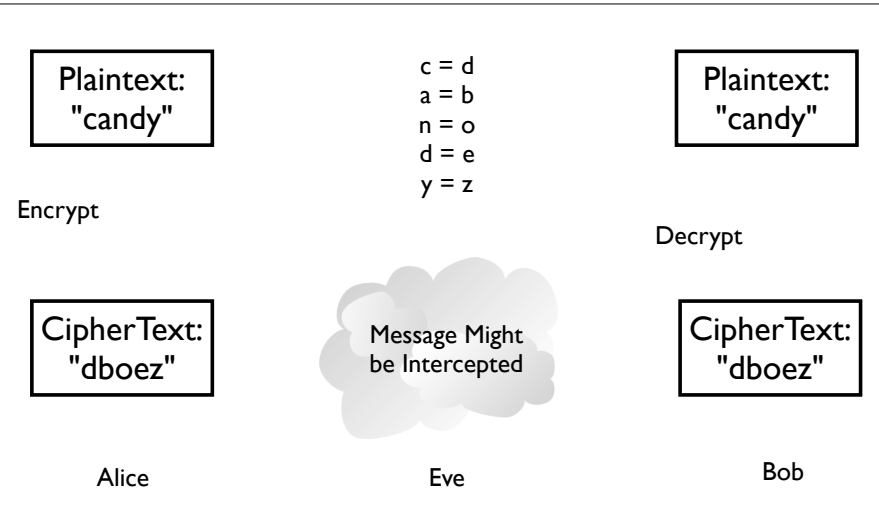
- Plaintext is a message that will be put into secret form.
- Ciphertext is a transformed version of plaintext that is unintelligible to anyone without the means to decrypt

Terminology

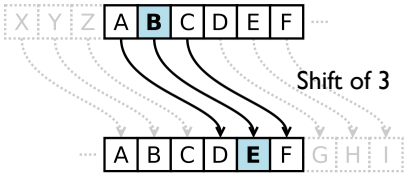
- The transformation of plaintext to ciphertext is referred to as encryption.
- Returning the ciphertext back to plaintext is referred to as decryption.
- The strength of a cryptosystem is determined by the encryption and decryption techniques and the length of the key.

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.

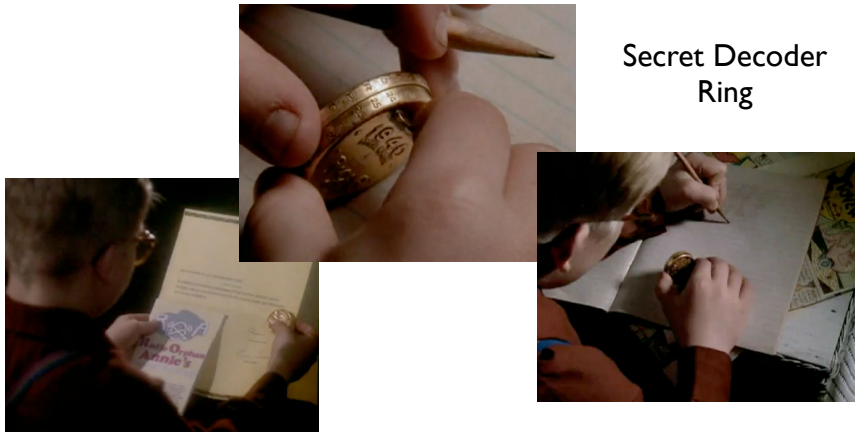


Caeser Cipher



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 II

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

Cryptographic Hashes
Integrity

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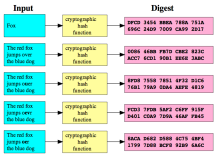
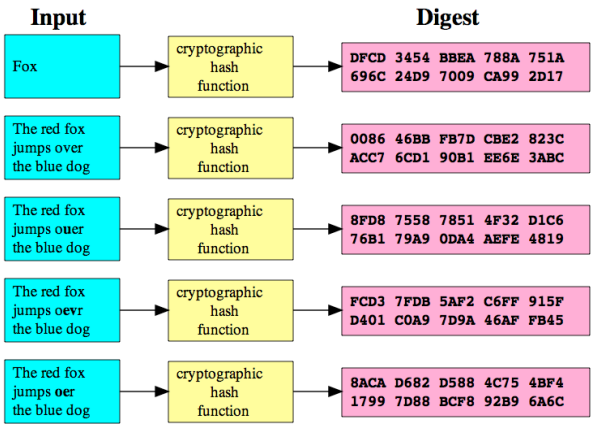
Cryptographic Hash



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

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 — d9d71ab718931a89de1e986bc62f6c988ddc1813

Log in attempt

pony — SHA-1 — 2629fb6d2384da89796a4811ef6db5f2ac657bab

fluffy — SHA-1 — d9d71ab718931a89de1e986bc62f6c988ddc1813

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

"Eat More
Ovaltine
-- Annie"

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 — SHA-1 — a79540

Eat More Ovaltinea79540

Eat Less Ovaltinea79540

Eat Less Ovaltine

Eat Less OvaltineSanta — SHA-1 — 109a15

a79540

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

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

www.rot13.com

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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

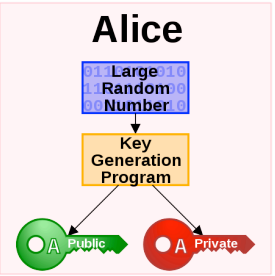
https://www.youtube.com/watch?v=ROCray7RTqM

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

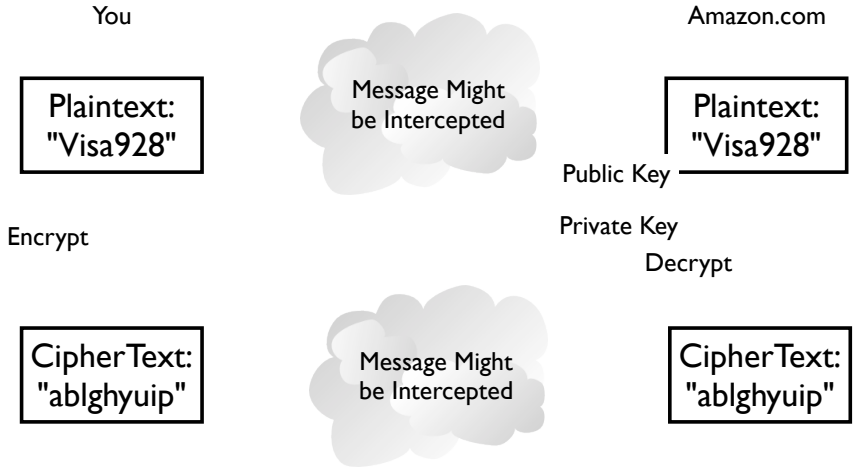
Public Key Math (light)

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

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

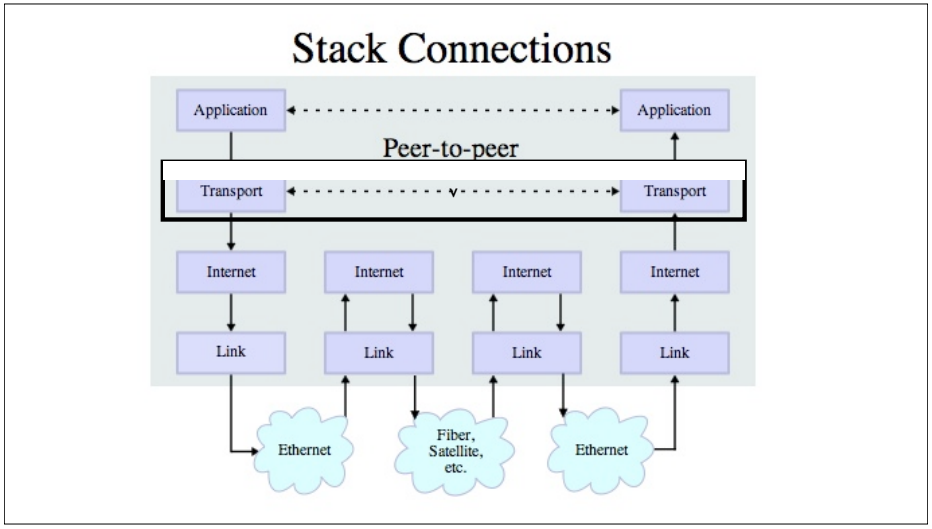
Public Key Math (light)

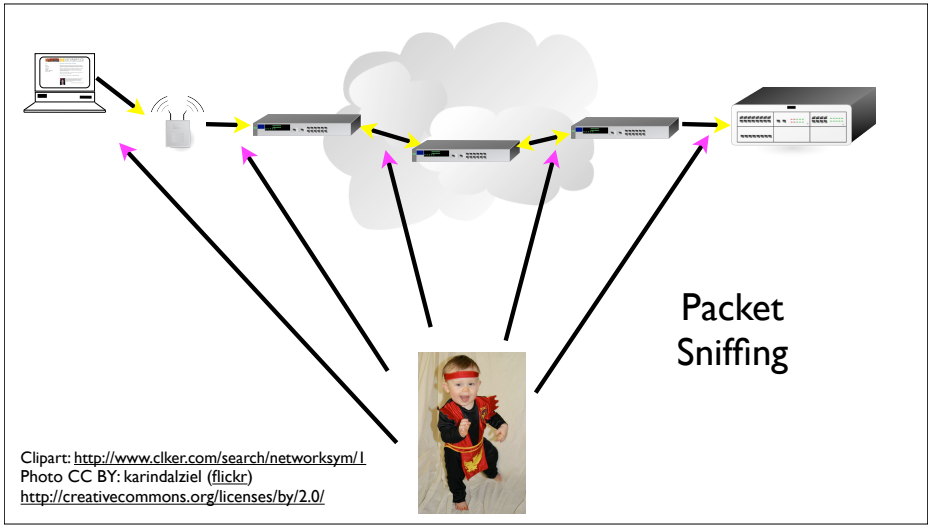
- What are the factors of 55,124,159 (a nearly prime number)
- What do you multiply 7919 by to get 55,124,159?
- If you know that one of the factors is 7919, it's also easy to find 6961!



Secure Sockets Layer (SSL) Security for TCP

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





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...

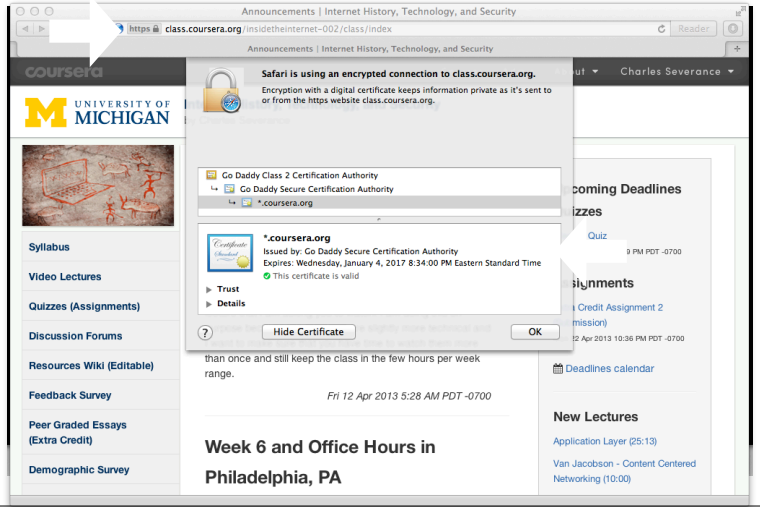
System to System Secure TCP/IP

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...

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

Certificate Authorities Integrity



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.

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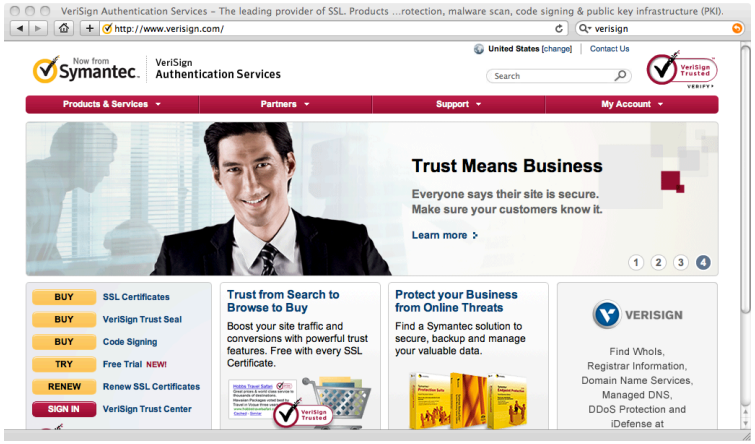
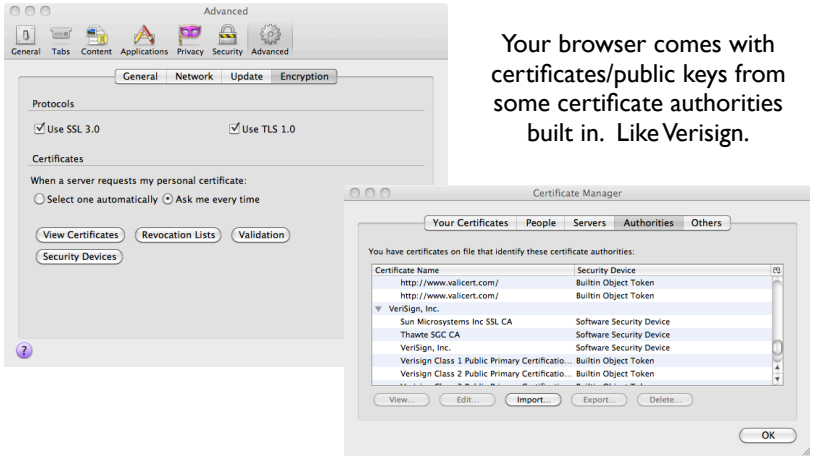




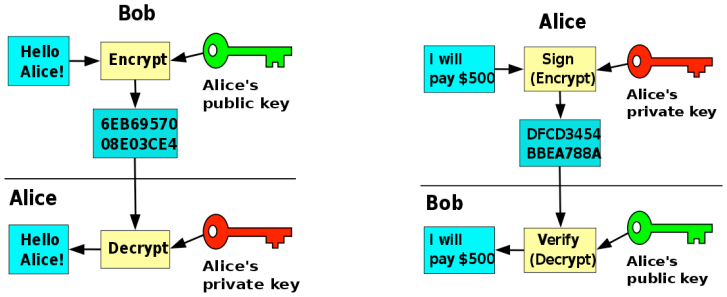
Your browser comes with certificates/public keys from some certificate authorities built in. Like Verisign.

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



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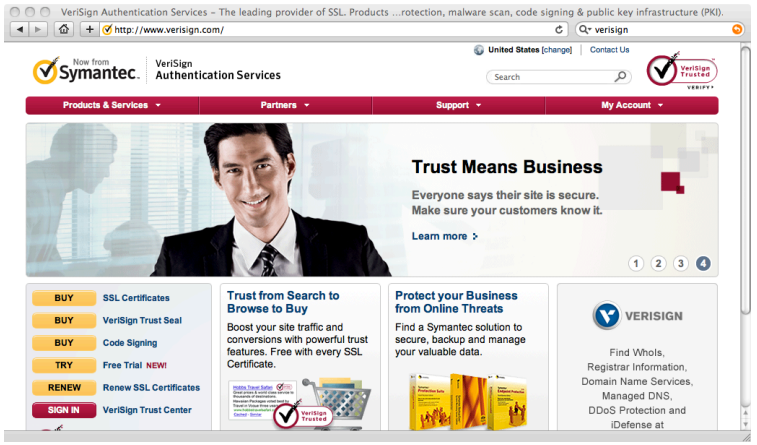

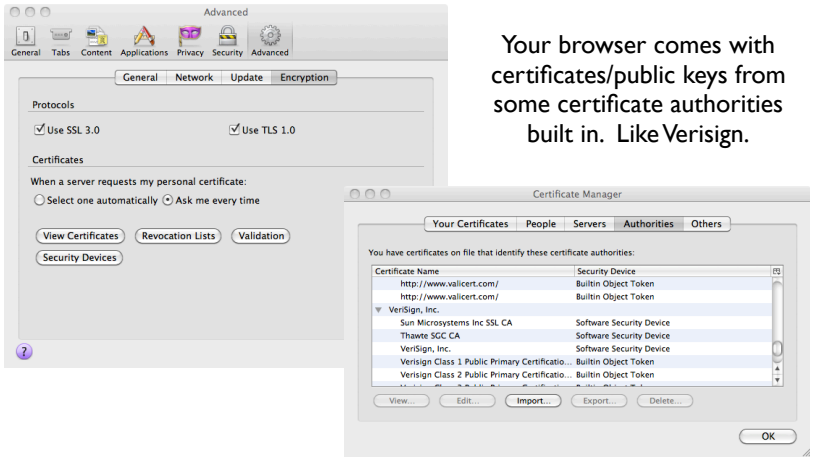

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How Amazon gets a public key signed by Verisign

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

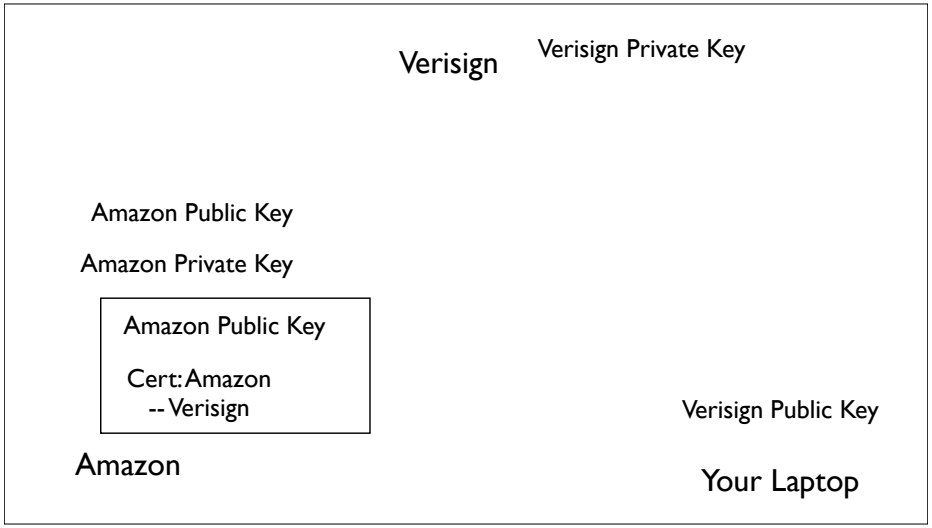
Amazon Public Key

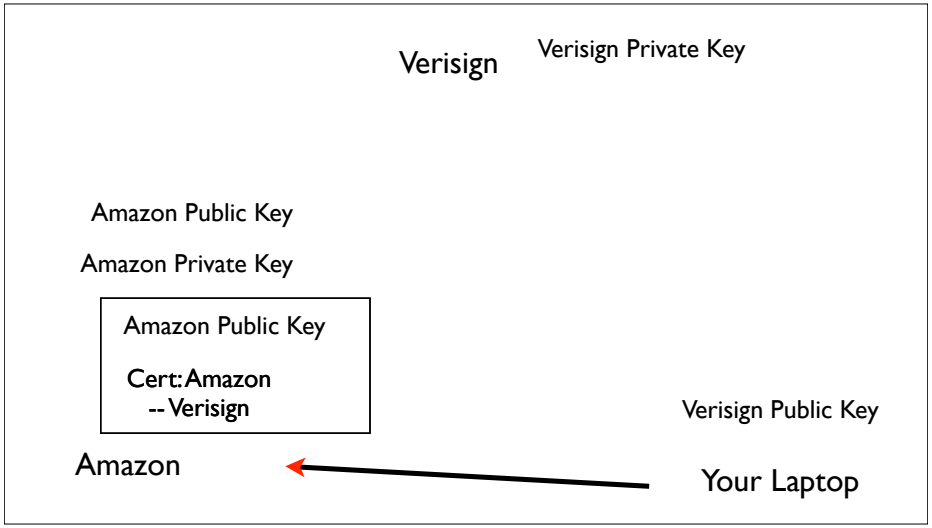
Amazon Private Key

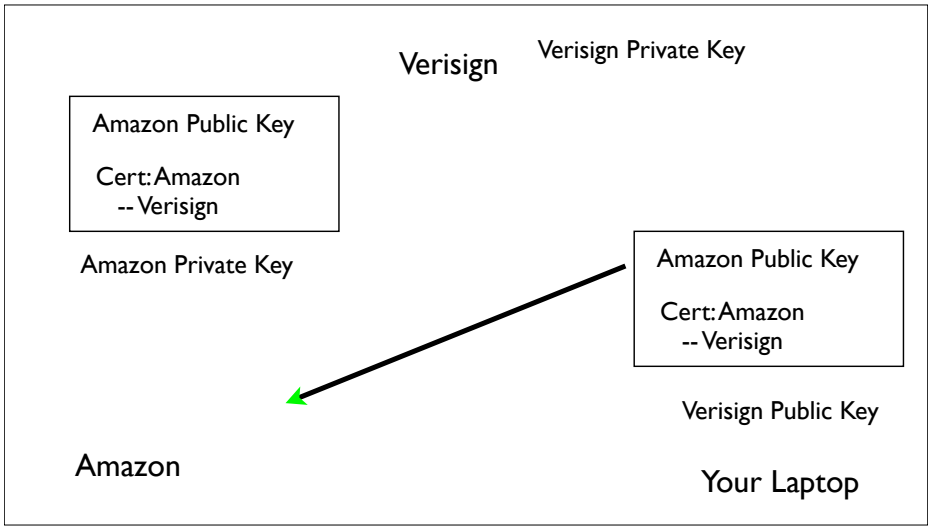
Verisign Public Key

Amazon

Your Laptop







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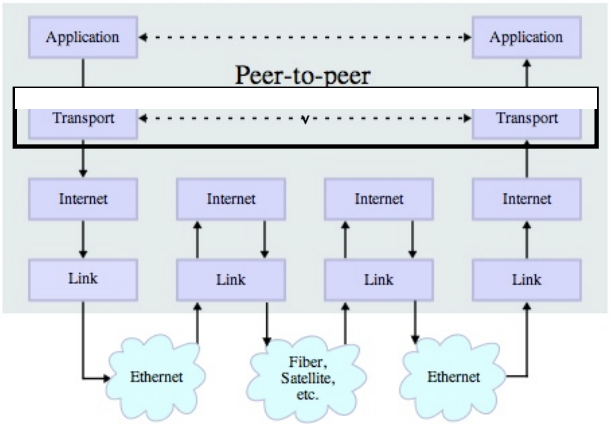
Stack Connections



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