Security & Cryptographic Methods

PacNOG 6

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Reminder: Core Security Principals

What are they?

(1)-- **C**onfidentiality

(2)-- **I**ntegrity

(3)-- **A**uthentication

- Access Control
- Verification

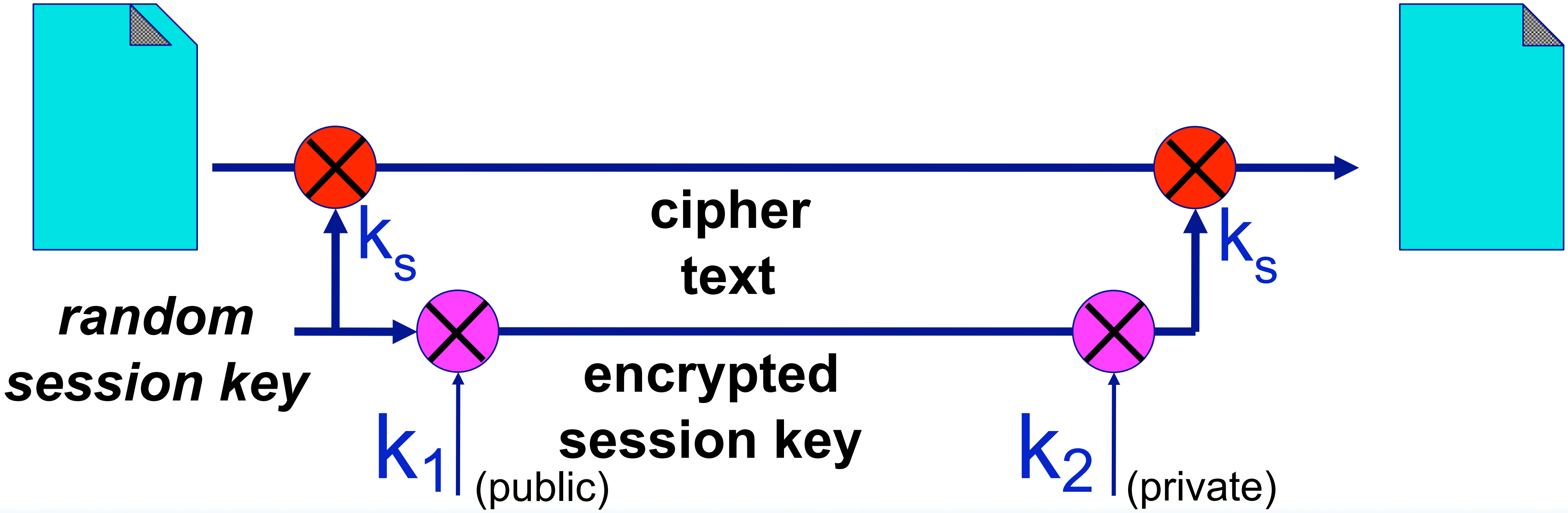
(4)-- **A**vailability

What We'll Cover

- Digital signatures
- TLS/SSL
- SSH
- PGP

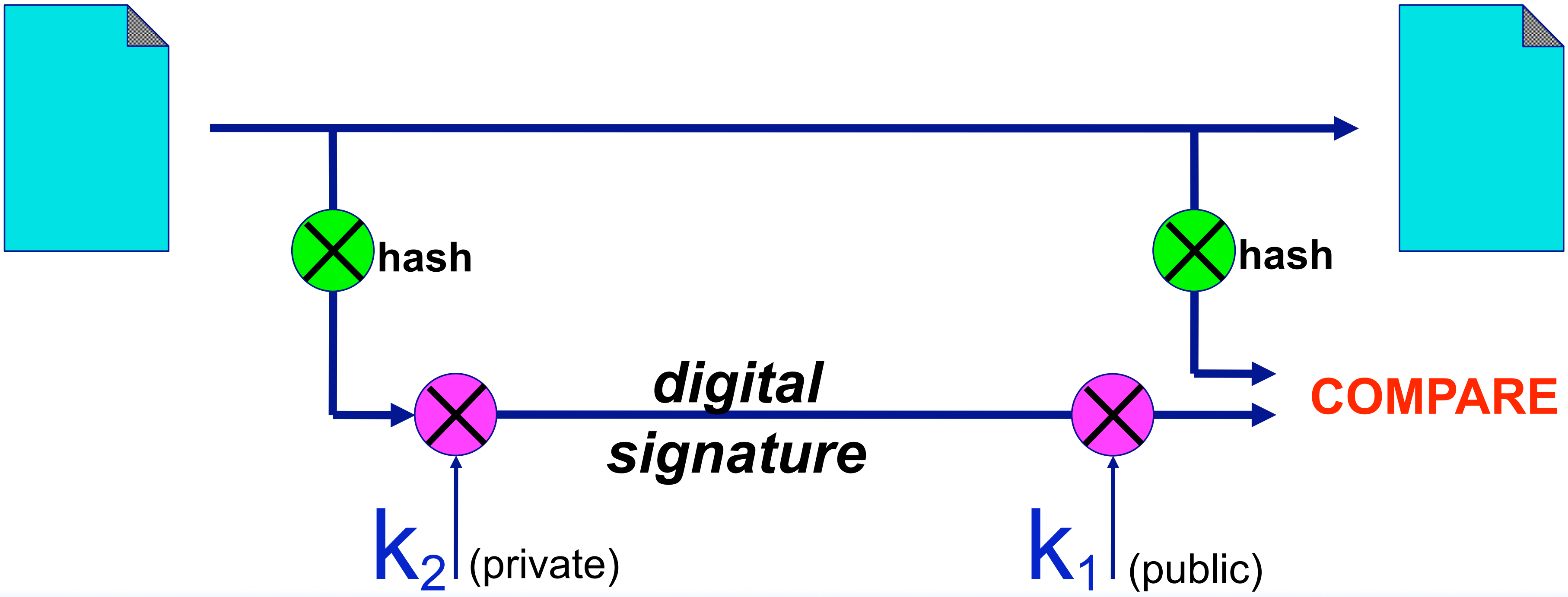
When encrypting (review):

Use a symmetric cipher with a random key (the "session key"). Use a public key cipher to encrypt the session key and send it along with the encrypted document.



When authenticating (review):

Take a hash of the document and encrypt only that. An encrypted hash is called a "digital signature"



Digital Signatures have many uses, for example:

- E-commerce. An instruction to your bank to transfer money can be authenticated with a digital signature.
  Legislative regimes are slow to catch up

- A trusted third party can issue declarations such as "the holder of this key is a person who is legally known as Alice Hacker"

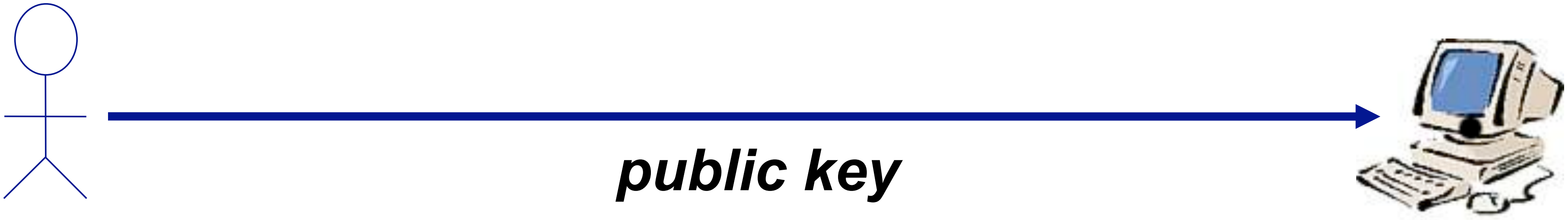
Like a passport binds your identity to your face

- Such a declaration is called a "certificate"

- You only need the third-party's public key to check the signature

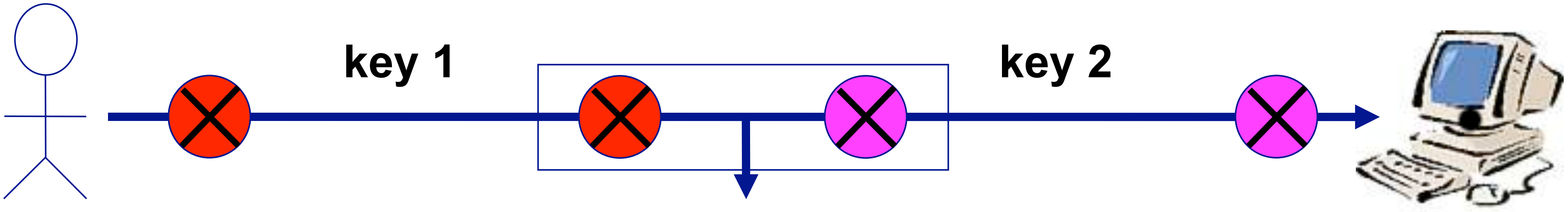
Do public keys ***really*** solve the key distribution problem?

- Often we want to communicate securely with a remote party whose key we don't know
- We can retrieve their public key over the network
- But what if there's someone in between intercepting our traffic?



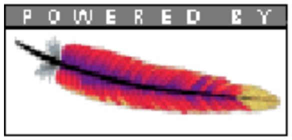
The "man-in-the-middle" Attack

- Passive sniffing is no problem
- But if they can modify packets, they can substitute a different key
- The attacker uses separate encryption keys to talk to both sides
- You think your traffic is secure, but it isn't!



Attacker sees all traffic in plain text - and can modify it!

TLS/SSL – Digital Certificates



Digital Certificates can solve the man-in-the-middle problem

- **Problem:** I have no prior knowledge of the remote side's key, so cannot tell if a different one has been substituted
- But maybe someone else does
- A trusted third party can vouch for the remote side by signing a certificate which contains the remote side's name & public key
- I can check the validity of the certificate using the trusted third party's public key

Example: TLS (SSL) web server with digital certificate

- I generate a private key on my webserver
- I send my public key plus my identity (my webserver's domain name) to a certificate authority (CA)
- The CA manually checks that I am who I say I am, i.e. I own the domain
- They sign a certificate containing my public key, my domain name, and an expiration date
- I install the certificate on my web server

When a client's web browser connects to me using HTTPS:

- They negotiate an encrypted session with me, during which they learn my public key
- I send them the certificate
- They verify the certificate using the CA's public key, which is built-in to the browser
- If the signature is valid, the domain name in the URL matches the domain name in the certificate, and the expiration date has not passed, they know the connection is secure
  - (Q: why is there an expiration date?)

The security of TLS depends on:

- ✓ Your webserver being secure

  So nobody else can obtain your private key

- ✓ The CA's public key being in all browsers

- ✓ The CA being well managed

  How carefully do they look after their own private keys?

- ✓ The CA being trustworthy

  Do they vet all certificate requests properly?

  Could a hacker persuade the CA to sign their key pretending to be someone else? What about a government?

  Do you trust them? Why?

Testing TLS (SSL) Applications

There is an equivalent of telnet you can use:

```
openssl s_client
```

It opens a TCP connection, negotiates TLS, then lets you type data

```
$ openssl s_client -connect nsrc.org:443
CONNECTED(00000003)
depth=1 /C=US/ST=Washingron/L=Bainbridge Island/O=RGnet/PSGnet/OU= \
Engineering/CN=RGnet Root CA/emailAddress=randy@psg.com
verify error:num=19:self signed certificate in certificate chain
verify return:0
...
New, TLSv1/SSLv3, Cipher is DHE-RSA-AES256-SHA
...
      And, at the end you see:

Verify return code: 19 (self signed certificate in certificate chain)
```

Limitations of s_client

- Works only for protocols which use TLS from the very beginning of the connection
  - These protocols are identified by using a different port number to the non-encrypted version

    (HTTP port 80), HTTPS port 443

    (POP3 port 110), POP3S port 995

- Other protocols start unencrypted and then "upgrade" the connection to encrypted on request
  - e.g. SMTP has a "STARTTLS" command
  - s_client is not usable for these

SSH

SSH Uses a Simple Solution to man-in-the-middle

- The first time you connect to a remote host, remember its public key

Stored in ~/.ssh/known_hosts

- The next time you connect, if the remote key is different, then maybe an attacker is intercepting the connection!
  - Or maybe the remote host has just got a new key, e.g. after a reinstall. But it's up to you to resolve the problem

- Relies on there being no attack in progress the *first* time you connect to a machine

- Connect on LAN *before* travelling with laptop

SSH Can Eliminate Passwords

- Use public-key cryptography to prove who you are

- Generate a public/private key pair locally

```
ssh-keygen -t rsa
```

Private key is ~/.ssh/id_rsa

Public key is ~/.ssh/id_rsa.pub

- Install your PUBLIC key on remote hosts

```
mkdir ~/.ssh
chmod 755 ~/.ssh
```

Copy public key into ~/.ssh/authorized_keys

- Login!

Notes on SSH Authentication

- Private key is protected by a passphrase
  - So you have to give it each time you log in
  - Or use "ssh-agent" which holds a copy of your passphrase in RAM
- No need to change passwords across dozens of machines
- Disable passwords entirely!
  - /etc/ssh/sshd_config
- There are currently <u>two</u> different types of SSH keys in use:
  - SSH2 DSA, SSH2 RSA
  - (SSH1 RSA is deprecated)

PGP/GPG – Pretty Good Privacy

PGP Takes a Different View

- We don't trust anyone except our friends (especially not big corporate monopolies)
- You sign your friends' keys to vouch for them
- Other people can choose to trust your signature as much as they trust you
- Generates a distributed "web of trust"
- Sign someone's key when you meet them face to face - "PGP key signing parties"

Summary

Designing a Good Cryptosystem is Very Difficult

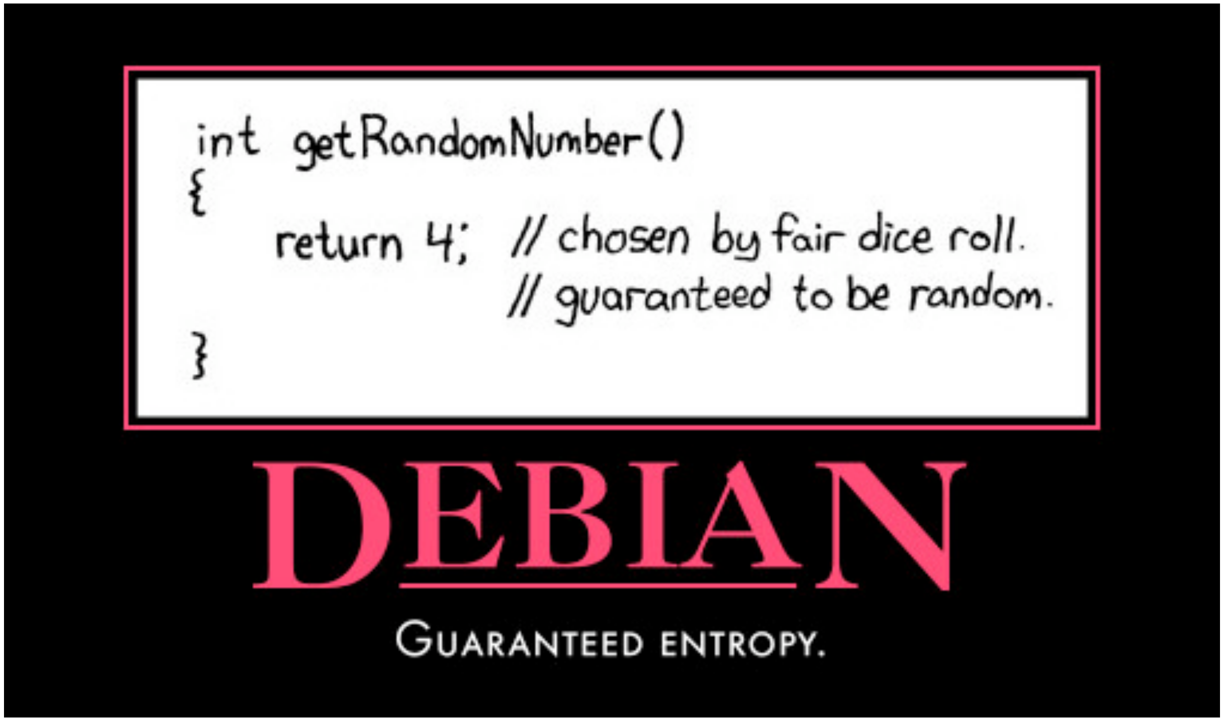
- Many possible weaknesses and types of attack, often not obvious
- DON'T design your own!
- DO use expertly-designed cryptosystems which have been subject to widespread scrutiny
- Understand how they work and where the potential weaknesses are
- Remember the other weaknesses in your systems, especially the human ones, speaking of which...

DILBERT By Scott Adams
TOUR OF ACCOUNTING
OVER HERE WE HAVE OUR RANDOM NUMBER GENERATOR.
www.dilbert.com
scottadams@aol.com
NINE NINE NINE NINE NINE NINE
© 2001 United Feature Syndicate, Inc.
ARE YOU SURE THAT'S RANDOM?
THAT'S THE PROBLEM WITH RANDOMNESS. YOU CAN NEVER BE SURE.
DEBIAN
YOU CAN NEVER BE SURE.

The following code was removed from md_rand.c on Debian:

```
MD_Update(&m,buf,j);
           [ .. ]
MD_Update(&m,buf,j); /* purify complains */
```

The end result was disastrous...



```
int getRandomNumber()
{
    return 4;  // chosen by fair dice roll.
               // guaranteed to be random.
}
```

This was a human issue, and a subtle one at that. More information is here:

http://metasploit.com/users/hdm/tools/debian-openssl/

Where can you apply these cryptographic methods?

At the link layer

PPP encryption

At the network layer

IPSEC, IPv6

At the transport layer

TLS (SSL): many applications support it

At the application layer

SSH: system administration, file transfers

PGP/GPG: for securing E-mail messages, stand-alone documents, software packages etc.

Tripwire (and others): system integrity checks

Start Using Cryptography Now!

- Use ssh for remote administration.
- Use scp/sftp for files transfer (except public ftp repositories).
- Install pop3/imap/smtp servers with tls support. Phase out the use of non-tls version.
- Use https for any web application where users enter passwords or confidential data
  - e.g. webmail, databases, wikis, nagios, cacti

Any questions?