Security & Cryptographic Methods

Linux System Administration

April 19, 2012
Dar es Salaam, Tanzania

Reminder: Core Security Principals

What are they?

(1)-- **C**onfidentiality

(2)-- **I**ntegrity

(3)-- **A**uthentication

- Access Control
- Verification

(4)-- **A**vailability

Cryptographic Methods

Critical for *confidentiality*, *integrity*, and *authentication*.

Indirectly they lead to better *availability*.

What are some methods and tools?

private keys

public keys

hashes

ssl

ssh

digital signatures

md5/sha1

des/3des/blowfish

pgp...

digital certificates

ciphers

...Do you have any more?

What We'll Cover

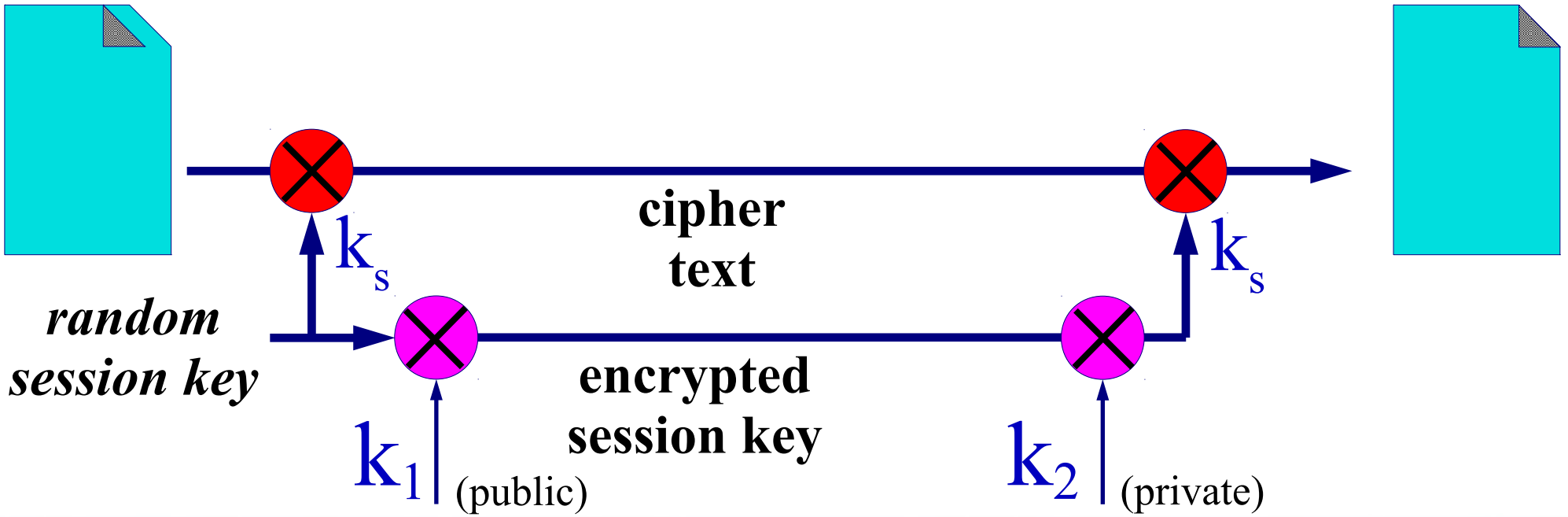
- Digital signatures
- SSH
- TLS/SSL
- PGP

Public Key Cryptosystems are Important

- But they require a lot of computation (expensive in CPU time)
- So we use some tricks to minimise the amount of data which is encrypted

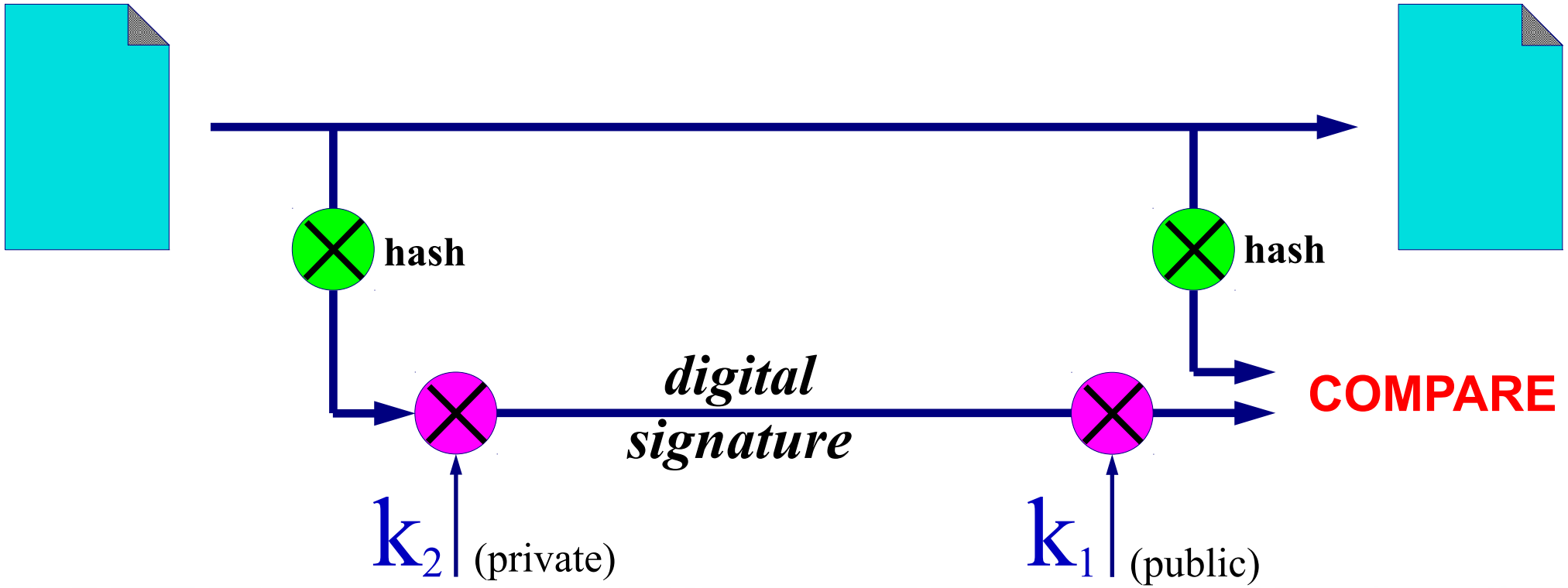
When encrypting (review):

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"

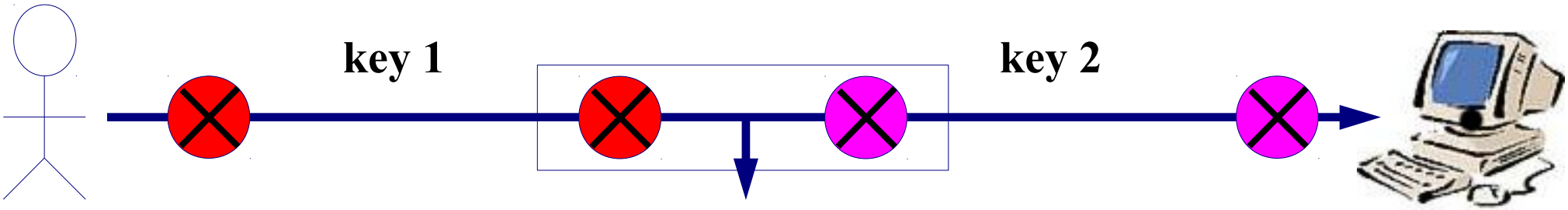


Do public keys ***really*** solve the key distribution problem?

- 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!

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

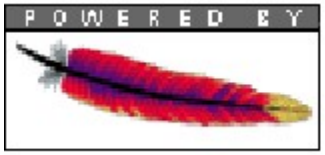
- Use public-key cryptography to verify identity
- Generate a public/private key pair locally
  ssh-keygen -t dsa -b 2048*
  Private key is ~/.ssh/id_rsa
  Public key is ~/.ssh/id_rsa.pub
- Install your PUBLIC key on remote hosts
  mkdir ~/.ssh
  chmod 700 ~/.ssh
  Copy public key into ~/.ssh/authorized_keys
- 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

    This is what your instructor does...

TLS/SSL – Digital Certificates



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

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 & identity (my webserver's domain name) to a certificate authority (CA)
- The CA 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 afnog.org:443
Subject=/C=ZA/ST=Unknown/L=Johannesburg/O=AfNOG/OU=AfNOG
Engineering/CN=afnog.org/emailAddress=afsys@psg.com
issuer=/CN=RGnet/PSGnet Security/C=US/ST=WA/L=Bainbridge Island/O=RGnet,
LLC/OU=PSGnet/emailAddress=randy@psg.com
---
No client certificate CA names sent
---
SSL handshake has read 2678 bytes and written 319 bytes
---
New, TLSv1/SSLv3, Cipher is DHE-RSA-AES256-SHA
...
```

And, at the end you see:

```
Verify return code: 21 (unable to verify the first certificate)
```

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
- (imap port 143), imaps port 993
- (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

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

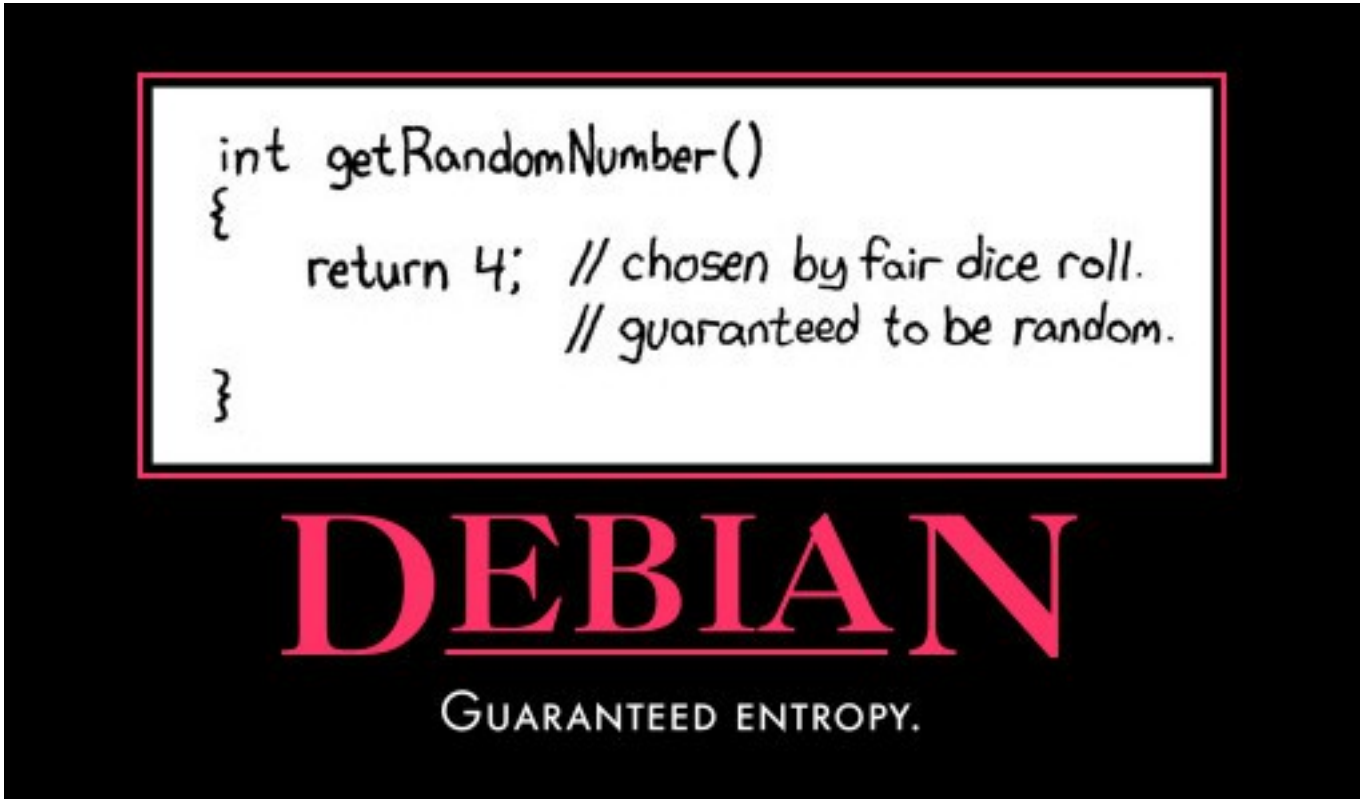
Designing a Good Cryptosystem is Very Difficult

- 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...

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...



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
- 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 versions (really!)
- Use https for any web application where users enter passwords or confidential data
  e.g. webmail, databases

Any questions?