Overview of Kerberos(I)

- ❑ Network Authentication Protocol for C/S application based on symmetric cryptosystem
- ❑ TTP authentication service
- ❑ Based on secret key, single login
- ❑ Part of MIT's project Athena (public domain)
- ❑ Components: library, data base, authentication daemon, ticket-granting service, applications
- ❑ Uses authenticators (for users and servers) and tickets

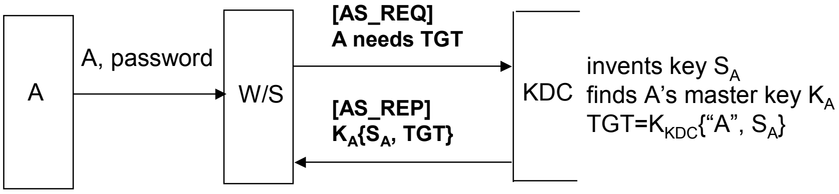
Kerberos : 3 headed dog guarding the Gate of Evil

Overview of Kerberos(II)

- ❑ Provides:
  1. authenticated messages
  2. safe messages (encrypted checksum)
  3. fully encrypted messages (encrypted telnet)
- ❑ Needs network time
- ❑ Uses one-way encryption (DES) (keys)
- ❑ Applications must be "kerbetized"
- ❑ Does not trust hosts
- ❑ V4 and V5 available

- ❑ Network Security Solution

S1. Obtaining TGT



A

A, password

W/S

[AS_REQ]
A needs TGT

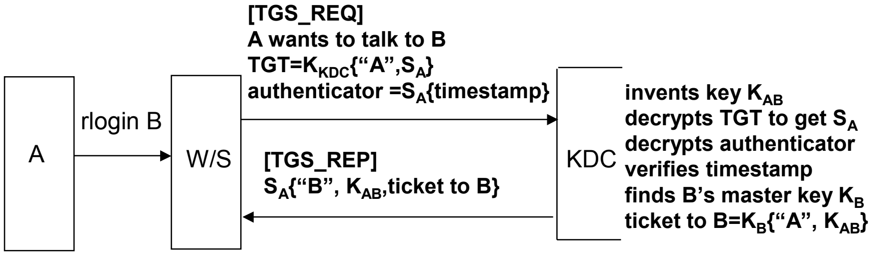
[AS_REP]
$K_A\{S_A$, TGT}

KDC

invents key S_A
finds A’s master key K_A
TGT=$K_{KDC}\{$“A”, $S_A\}$

TGT : Ticket-granting Ticket

S2 Getting ticket to B for A



A

rlogin B

W/S

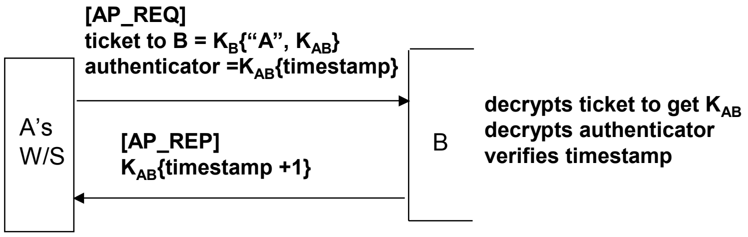
[TGS_REQ]
A wants to talk to B
TGT=$K_{KDC}\{$“A”,$S_A\}$
authenticator =S_A\{timestamp\}

[TGS_REP]
$S_A\{$“B”, K_{AB},ticket to B}

KDC

invents key K_{AB}
decrypts TGT to get S_A
decrypts authenticator
verifies timestamp
finds B’s master key K_B
ticket to B=$K_B\{$“A”, $K_{AB}\}$

S3 Logging into B from A's W/S

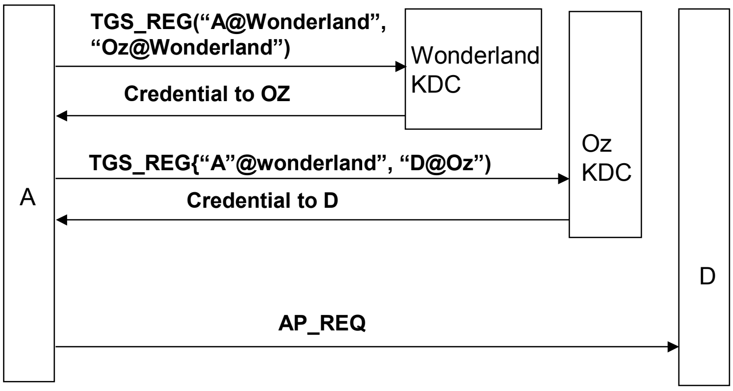


[AP_REQ]
ticket to B = K_B{"A", K_{AB}}
authenticator =K_{AB}{timestamp}

[AP_REP]
K_{AB}{timestamp +1}

decrypts ticket to get K_{AB}
decrypts authenticator
verifies timestamp

Interrealm Authentication



TGS_REG("A@Wonderland",
"Oz@Wonderland")

Credential to OZ

TGS_REG{"A"@wonderland", "D@Oz")

Credential to D

AP_REQ

Kerberos credentials(I)

authenticator

1. name/instance/realm of the client
2. timestamp

❑ used only once

❑ generated each time client wants to use a service

❑ encrypted with server's session key

❑ inhibits replay

Kerberos credentials(II)

ticket

1. server
2. client
3. client workstation address
4. timestamp
5. lifetime
6. session key

❑ encrypted with server's key

❑ generated by TGS

❑ good for a single client and server

Setting up Kerberos

- ❑ get source from MIT (cygnus)
- ❑ designate secure authentication server machine
- ❑ maybe slave authentication servers
- ❑ build applications (r-utilities, login, ftp, pop, klogin, kinit, klist, kadmin)
- ❑ register principals (user, servers)
- ❑ data base is encrypted with master key
- ❑ install each server's key (/etc/servtab)

client-only easy, (PC/MAC versions)

Kerbetizing

- ❑ you can add Kerberos calls to your own client/servers
- ❑ need Kerberos data base, authenticator, ticket-granting server, and administrative programs
- ❑ can use klogin, but better if you have kerberized BSD utilities
- ❑ Kerberos calls added to login, r-utilities, NFS
- ❑ rlogin -x sets up encrypted session, every packet is encrypted

V4 implementation

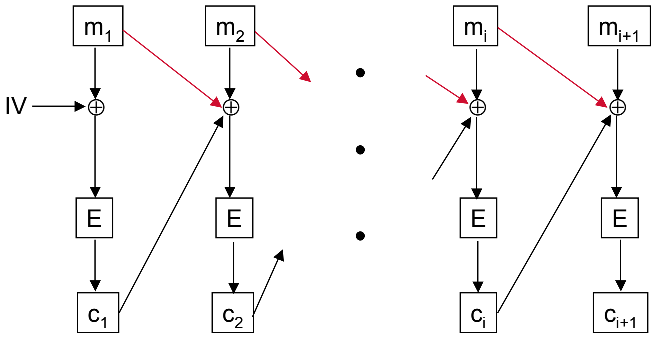
- typical client/server application
- library requests, just UDP packets
- Kerberos servers listening on well-known ports (88)
- encryption: modified DES CBC
- MAC: Juneman checksum on (key,msg)

Kerberos services

```
/etc/services
kerberos          88/udp    kdc     # Kerberos authentication--udp
kerberos          88/tcp    kdc     # Kerberos authentication--tcp
klogin            543/tcp           # Kerberos authenticated rlogin
kshell            544/tcp   cmd     # and remote shell
kerberos-adm      749/tcp           # Kerberos 5 admin/changepw
kerberos-adm      749/udp           # Kerberos 5 admin/changepw
kerberos-sec      750/udp           # Kerberos authentication--udp
kerberos-sec      750/tcp           # Kerberos authentication--tcp
kerberos_master   751/udp           # Kerberos authentication
kerberos_master   751/tcp           # Kerberos authentication
krb5_prop         754/tcp           # Kerberos slave propagation
kpop              1109/tcp          # Pop with Kerberos
eklogin           2105/tcp          # Kerberos encrypted rlogin

krb524            4444/tcp          # Kerberos 5 to 4 ticket xlator
```

Encryption for Privacy and Integrity



PCBC (Plaintext Cipher Block Chaining)

V5

- ❑ More functionality
- ❑ Principle names multicomponent
  - – v4 was NAME/INSTANCE/REALM(40 max)
  - – v5 : NAME/REALM
- ❑ New encodings (ASN 1.0)
- ❑ New ticket flags (delegation) and longer lifetimes
- ❑ Encryption/MAC replacement
- ❑ V5 will handle v4 requests

V5 tickets

- ❑ proxiable TGT - can be used to request tickets for a different net address (Alice can let Bob use her printer)
- ❑ forwardable TGT - can be presented to a remote TGS
- ❑ lifetimes
  - – longer lifetimes (v4 : 21 hrs) (v5:start/end)
  - – renewable (by KDC)
  - – postdated (good a week from now for 2 hrs, KDC clears INVALID flag)

V5 extensions

- ❑ MAC: DES of md5/md4/DES- CBC
- ❑ Encryption+MAC: DES + md4/md5/CRC
- ❑ Hierarchy of realms
  - – v4: principals in A to be authenticated in B, B's KDC must be registered in A's KDC

Why not?

- every network service must be modified
- Kerberos server must be physically secure
- export restrictions
- doesn't protect against Trojan horses
- off-line password attack on message from KDC to client
- if password is disclosed, eavesdropper can decrypt other tickets and spoof servers and users

Still, better than anything else.

new Kerberos features

- public key for initial authentication
- one-time password support
- Kerberos V5 RFC1510
- using Kerberos for authorization

Yaksha

- ❑ Problems of Kerberos
  - – AS keeps C’s secret key
  - – On issuing ticket, user authentication only, no digital signature
  - – Possible dictionary attack of password

- ❑ Ravi Ganesan, “The Yaksha Security System”, Communication of the ACM, Vol. 39, No.3, pp.55 -60, 1996