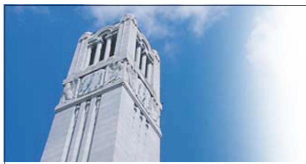


NC STATE UNIVERSITY Computer Science

CSC 474/574
Information Systems Security

Topic 5.1 Kerberos

The Authentication Problem

- Assume an open distributed environment in which users at workstations wish to access services on servers distributed throughout the network.
- Restrict access to authorized users and to be able to authenticate requests for service.

Can we rely on workstation for authentication service?

- Three threats:
  - – A user may gain access to a particular workstation and pretend to be another user operating from that workstation.
  - – A user may alter the network address of a workstation so that the requests sent from the altered workstation appear to come from the impersonated workstation.
  - – A user may eavesdrop on exchanges and use a replay attack to gain entrance to a server or to disrupt operations.

Authentication Service Provided by Kerberos

- A centralized authentication service
  - – Authenticate users to services
  - – Authenticate services to users
  - – Servers are relieved of the burden of maintaining authentication information.
- Facts about Kerberos
  - – Rely exclusively on conventional encryption.
    - Public key based Kerberos has been considered.
  - – Stateless: Kerberos server doesn't need to maintain the state information about any entities being authenticated.

Requirements for Kerberos

- Secure
  - A network eavesdropper should not be able to obtain the necessary to impersonate a user.
- Reliable
  - Kerberos should be highly available and should employ a distributed server architecture.
- Transparent
  - The user shouldn't be aware that authentication is taking place.
- Scalable
  - The system should be capable of supporting large numbers of clients and servers.

The Kerberos Protocol

- Outline of the introduction to the Kerberos protocol
  - A simple authentication protocol
  - A more secure authentication protocol
  - Kerberos Version 4 authentication protocol

A Simple Authentication Protocol

- Use an authentication server (AS)
- Basic idea: use a *ticket* to authenticate a user to a server.
- Protocol
  1. $C \rightarrow AS$: $ID_C \| P_C \| ID_V$
  2. $AS \rightarrow C$: Ticket
  3. $C \rightarrow V$: $ID_C \|$ Ticket
  – Ticket = $E_{K_V}[ID_C \| AD_C \| ID_V]$

A Simple Authentication Protocol (Cont'd)

- Advantages
  – A centralized authentication service
- Weaknesses
  – A user needs to enter a password for every different service.
  – Password is transmitted in plaintext.

A More Secure Authentication Protocol

- A new server: ticket-granting server (TGS)
- Protocol
  - Once per user logon session
    1) $C \rightarrow AS$: $ID_C \| ID_{tgs}$
    2) $AS \rightarrow C$: $E_{K_C}[Ticket_{tgs}]$
  - Once per type of service
    3) $C \rightarrow TGS$: $ID_C \| ID_V \| Ticket_{tgs}$
    4) $TGS \rightarrow C$: $Ticket_V$
  - Once per service session
    5) $C \rightarrow V$: $ID_C \| Ticket_V$
  - $Ticket_{tgs} = E_{K_{tgs}}[ID_C \| AD_C \| ID_{tgs} \| TS_1 \| lifetime_1]$
  - $Ticket_V = E_{K_V}[ID_C \| AD_C \| ID_V \| TS_2 \| lifetime_2]$

A More Secure Authentication Protocol (Cont'd)

- Ticket-granting ticket (TGT): $Ticket_{tgs}$.
- Service-granting ticket: $Ticket_V$.
- Weaknesses
  - Replay attack: No authentication of the valid ownership of the tickets.
  - No authentication of the servers.

- What are the components in the tickets?
- Why do we have them?

Kerberos Version 4 Protocol

- Basic idea to address the previous weaknesses
  - Session key
    - Authentication of the valid ownership of the tickets
    - Provide authentication of servers.

Kerberos Version 4 Protocol (Cont'd)

- Authentication Service Exchange: to obtain ticket-granting ticket
  1) $C \rightarrow AS$: $ID_C \| ID_{tgs} \| TS_1$
  2) $AS \rightarrow C$: $E_{K_C}[K_{C,tgs} \| ID_{tgs} \| TS_2 \| Lifetime_2 \| Ticket_{tgs}]$
  - $Ticket_{tgs} = E_{K_{tgs}}[K_{C,tgs} \| ID_C \| AD_C \| ID_{tgs} \| TS_2 \| Lifetime_2]$

Kerberos Version 4 Protocol (Cont'd)

- Ticket-Granting Service Exchange: to obtain service-granting ticket

3) $C \rightarrow TGS: ID_V \,||\, Ticket_{tgs} \,||\, Authenticator_c$
4) $TGS \rightarrow C: E_{K_{C,tgs}}[K_{C,V} \,||\, ID_V \,||\, TS_4 \,||\, Lifetime_4 \,||\, Ticket_V]$

– $Ticket_{tgs} = E_{K_{tgs}}[K_{C,tgs} \,||\, ID_C \,||\, AD_C \,||\, ID_{tgs} \,||\, TS_2 \,||\, Lifetime_2]$

– $Ticket_V = E_{K_V}[K_{C,V} \,||\, ID_C \,||\, AD_C \,||\, ID_V \,||\, TS_4 \,||\, Lifetime_4]$

– $Authenticator_c = E_{K_{C,tgs}}[ID_C \,||\, AD_C \,||\, TS_3]$

Kerberos Version 4 Protocol (Cont'd)

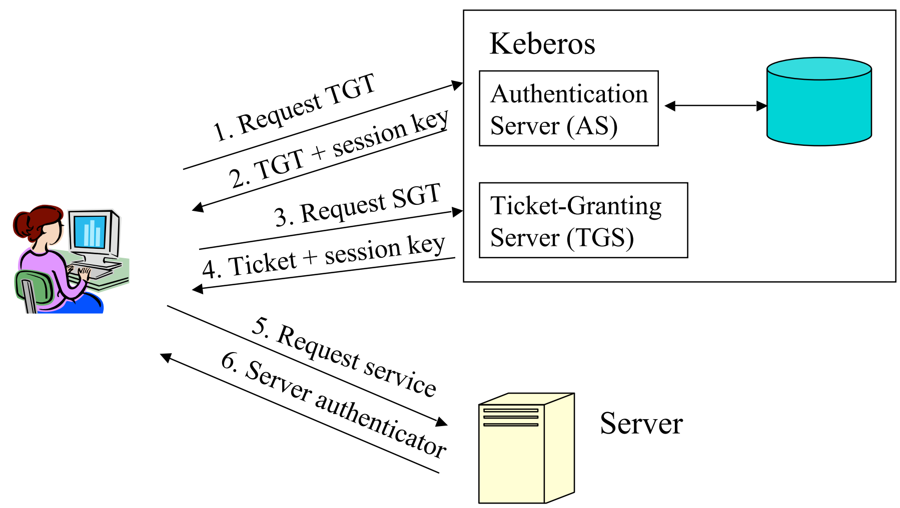
- Client/Server Authentication Exchange: to obtain service

5) $C \rightarrow V: Ticket_V \,||\, Authenticator_c$
6) $V \rightarrow C: E_{K_{C,V}}[TS_5 + 1]$

– $Ticket_V = E_{K_V}[K_{C,V} \,||\, ID_C \,||\, AD_C \,||\, ID_V \,||\, TS_4 \,||\, Lifetime_4]$

– $Authenticator_c = E_{K_{C,V}}[ID_C \,||\, AD_C \,||\, TS_5]$

The Whole Picture



Kerberos Deployment

- The Kerberos server must have the user ID and hashed password of all participating users in its database.
- The Kerberos server must share a secret key with each server.
- Kerberos are "physically" secured
- Kerberos libraries are distributed on all nodes with users, applications, and other Kerberos-controlled resources

Replicated Kerberos

- Multiple replica of Kerberos - availability and performance
- Keeping Kerberos databases consistent
  - Single master Kerberos as the point of direct update to principals' database entries
  - Updated database is downloaded from the master to all replica Kerberos
  - Periodic download or on-demand

Kerberos Realms and Multiple Kerberi

- Kerberos realm
  - A full-service Kerberos environment consisting of a Kerberos server, a number of clients, and a number of application servers
- Inter-realm authentication
  - The Kerberos server in each interoperating realm shares a secret key with the server in the other realm. The two Kerberos servers are registered with each other.

Inter-realm Authentication