Kerberos
The Network Authentication Protocol

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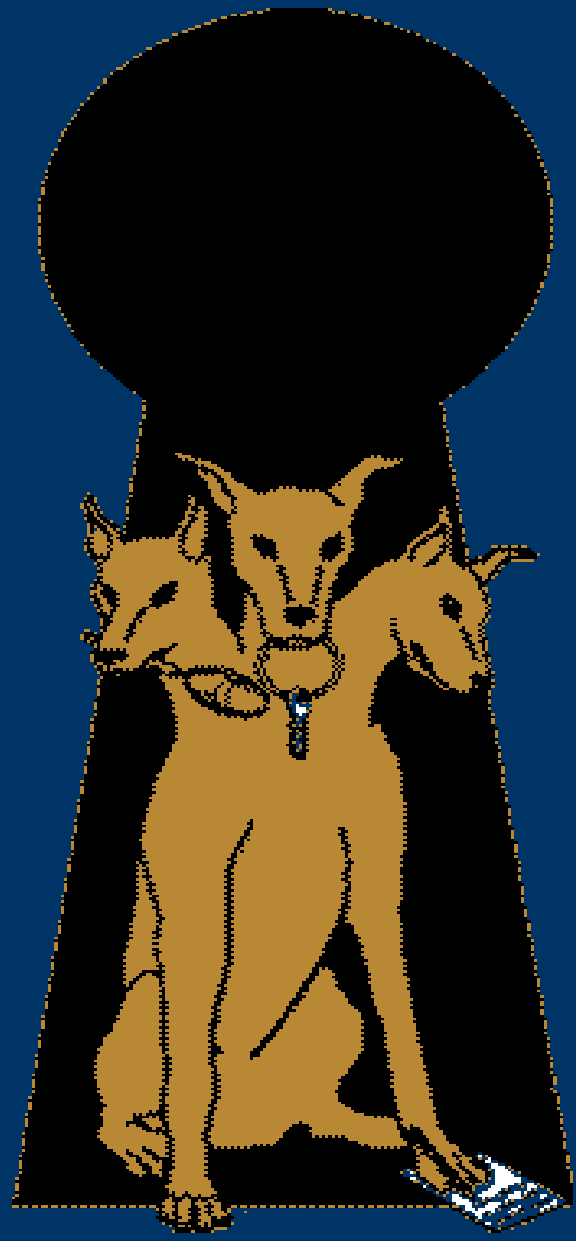
Overview of presentation

- What is Kerberos?
- How does it work?
- How do I configure it?
- How do I use it?

What is Kerberos?

- Kerberos is a three-headed dog
- Kerberos stands at the gates of the House of Hades and fawns on the dead as they enter but will savagely eat anyone trying to pass back through the gates and return to the land of the living
- Kerberos is also known as Cerberus, when using the Latin spelling



What is Kerberos?

- A network authentication protocol developed at MIT as part of Project Athena
- Uses private-key cryptography for providing authentication across open networks
- Mediates authentication through a trusted 3rd party
- Developed before the popularity of public-key cryptography and systems like SSL

What's with the 3 heads?

- Authentication
  - The confirmation that a user who is requesting services is a valid user of the network services requested
- Authorization
  - The granting of specific types of service to a user, based on their authentication, what services they are requesting, and the current system state
- Accounting
  - The tracking of the consumption of network resources by users

Different types of cryptography

- Symmetric Key
  - The same key is used for both encryption and decryption
  - Examples: DES, 3DES, AES
- Public Key
  - Two keys are used for encryption and decryption
    - “Private key” is used for encryption
    - “Public key” is used for decryption
  - Examples: RSA
- While many systems today use public key cryptography for authentication, Kerberos manages to do it with symmetric key cryptography

Benefits of Kerberos

- Standards-based strong authentication
- Broad operating-system support
- Provides for single sign-on (SSO) capability
- Passwords never traverse the network
- Password guessing more difficult
- Stolen authentication tickets are hard to reuse

Limitations of Kerberos

- Of the three A's, Kerberos only provides authentication
  - Other protocols (such as NIS or LDAP) are still needed for authorization
- Applications must be “Kerberized” to take advantage
  - Kerberos provides standard APIs to help with this
  - There are also PAM modules for Kerberos authentication
- Cannot migrate existing password hashes into the Kerberos database
- Authentication is only as good as the user's password
- Assumes relatively secure hosts on an insecure network

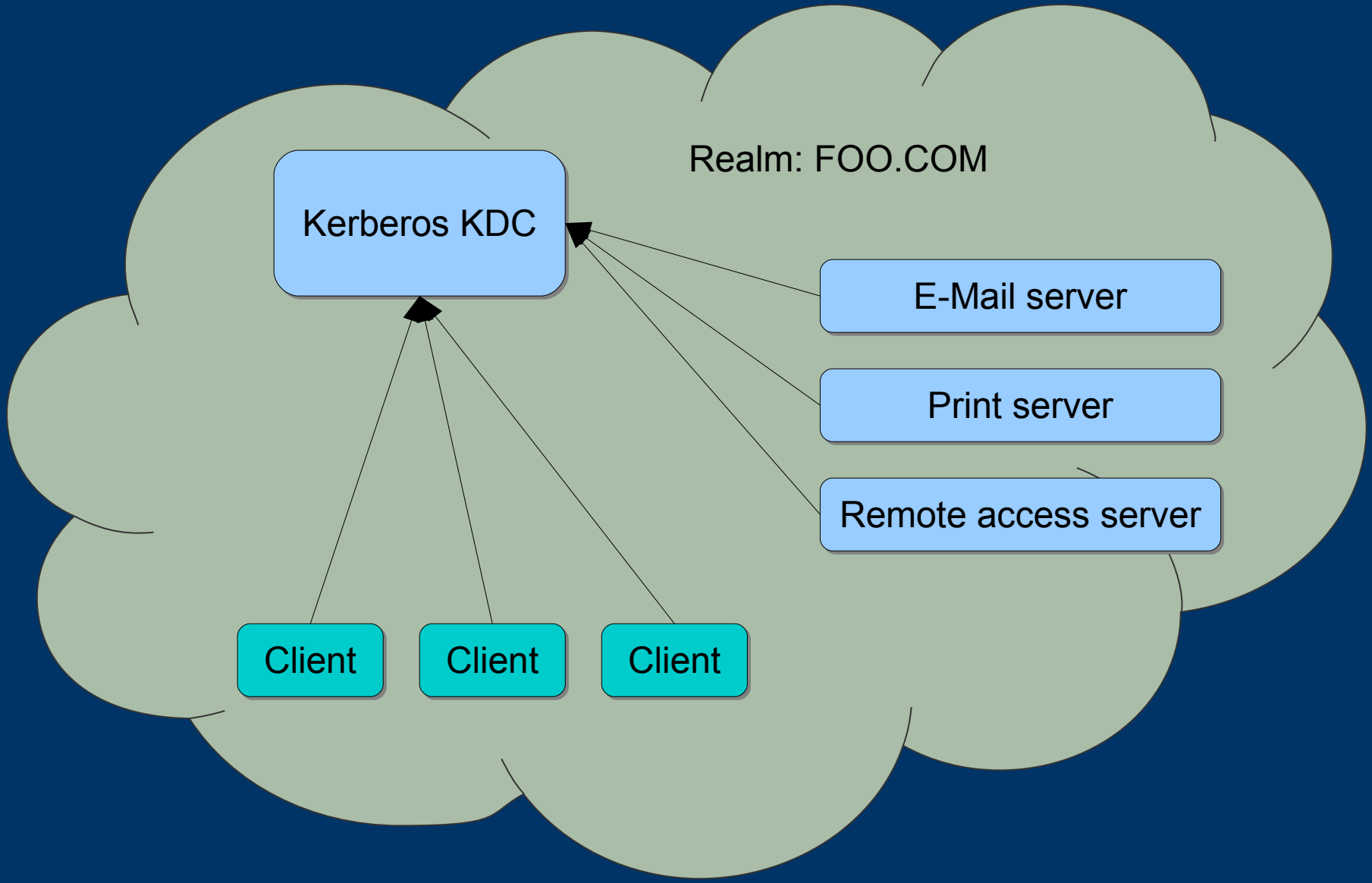
Implementations of Kerberos

- Kerberos 5 protocol is described in RFC 1510
  - http://www.ietf.org/rfc/rfc1510.txt
- Major implementations
  - MIT Kerberos
    - http://web.mit.edu/kerberos/www/
  - Heimdal Kerberos
    - http://www.pdc.kth.se/heimdal/
  - Sun's SEAM Kerberos
- All implementations have similar commands and interfaces
  - They are compatible for authentication
  - Administrative interfaces are not always compatible

How to authenticate services

- Directly
  - Program is linked against Kerberos libraries
  - This interface is not standard across Kerberos implementations
- GSSAPI
  - Generic Security Services Application Programming Interface
  - Standard API for client/server authentication
  - Supported by most major KerberosV implementations
  - Described by RFC 2473, RFC 1509, RFC1964
- SASL
  - Simple Authentication and Security Layer
  - A framework for adding authentication support to connection-based protocols
  - Decouples authentication mechanisms from application protocols
  - Described by RFC 2222
- PAM
  - Pluggable Authentication Modules
  - Many systems already include a “pam_krb5.so” module

How is Kerberos organized?



How is Kerberos organized?

- The Kerberos administrative domain is a “realm”
  - Realm names are typically the domain's DNS name in all caps (i.e. “foo.com” becomes “FOO.COM”)
- Authentication mediated through a central server called the “Key Distribution Center” (KDC)
  - Each user and service shares a secret key with the KDC
  - The KDC generates and distributes session keys
  - Communicating parties prove to each other that they know the session key

"Key Distribution Center"

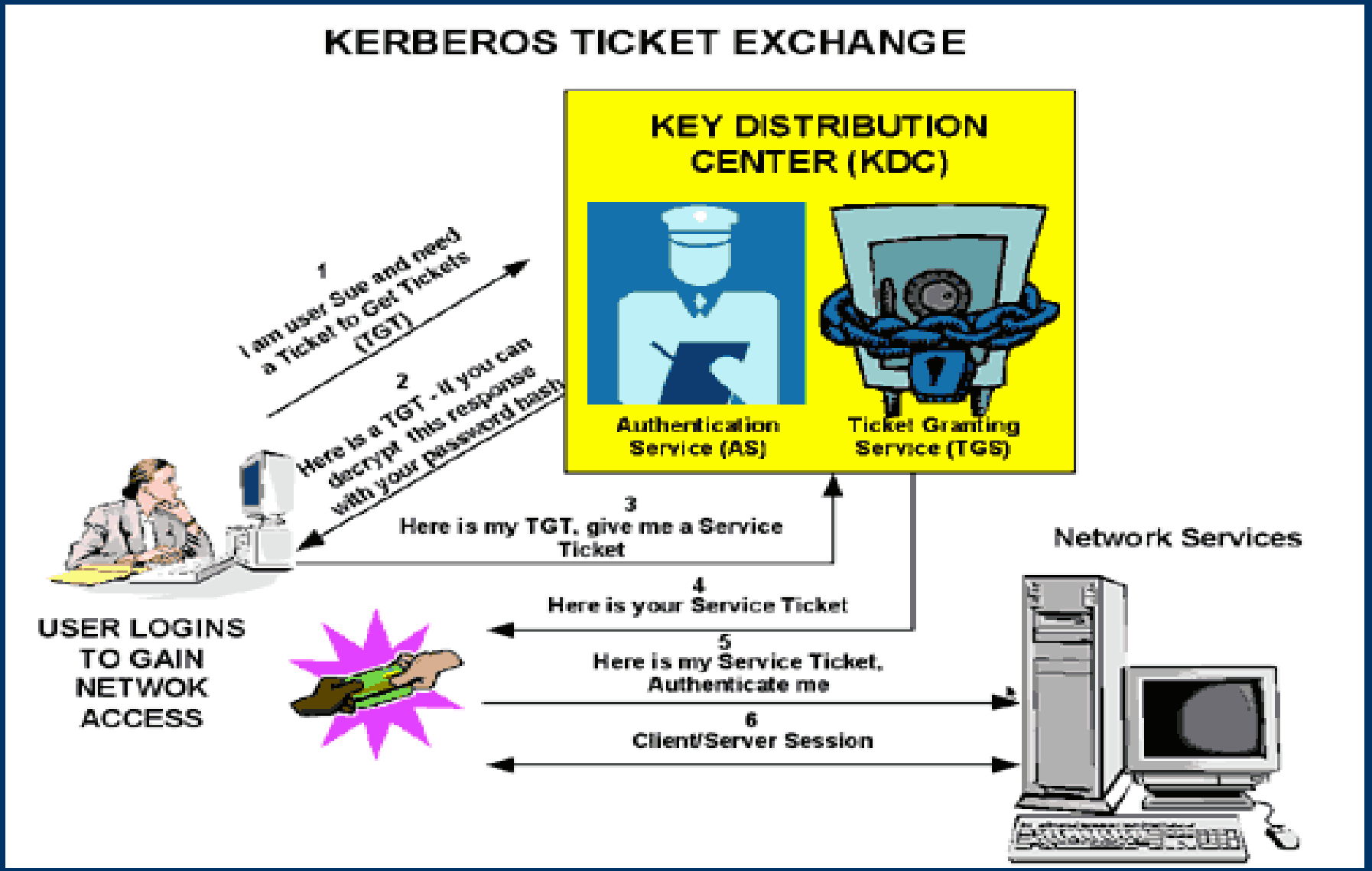
- The Kerberos KDC consists of two parts:
  - Authentication Server (AS)
    - Issues "Ticket-Granting Tickets" (TGT)
  - Ticket Granting Server (TGS)
    - Issues service tickets
- The Kerberos KDC must be secure and reliable
  - Replication can be used to improve availability
  - Security is required to avoid a compromise of the network

Authentication process

- The client sends a user name and server name to the KDC
- The KDC replies with a ticket and session key, encrypted with the user's password
  - This ticket is known as the “Ticket Granting Ticket” (TGT)
    - Yes, it is a ticket used to grant other tickets ;-)
  - The client decrypts the TGT with the user's password
- The TGT is then used to talk to the KDC to obtain service tickets.

Authentication process

(with a nice little graphic thanks to http://www.microsoft.com/technet/prodtechnol/windows2000serv/maintain/security/kerberos.mspx)



Kerberos principals

- Clients (users or services) are identified by “principals”
- Principals look like: primary/instance@realm
  - Primary: user or service name
  - Instance: optional for user principals, but required for service principals
  - Realm: the Kerberos realm
- Examples:
  - User: joe@FOO.COM
  - Service: imap/bar.foo.com@FOO.COM

User command examples

```
joe@bar:~$ kinit
Password for joe@FOO.COM:
joe@bar:~$ ssh things
Welcome to Things!
...do stuff...
joe@things:~$ exit
joe@bar:~$ pine
...read e-mail...

joe@bar:~$ klist
Ticket cache: FILE:/tmp/krb5cc_201
Default principal: joe@FOO.COM

Valid starting     Expires            Service principal
12/13/05 23:07:25  12/14/05 07:07:25  krbtgt/FOO.COM@FOO.COM
        renew until 12/14/05 23:07:24
12/13/05 23:11:57  12/14/05 07:07:25  host/things.foo.com@FOO.COM
        renew until 12/14/05 23:07:24
12/13/05 23:33:05  12/14/05 07:33:03  imap/mail.foo.com@FOO.COM
        renew until 12/14/05 17:33:03
```

Authenticate with KDC
(can also happen automatically on login)

SSH to another machine
(no password prompt)

Check E-Mail off an IMAP server
(no password prompt)

Ticket Granting Ticket

Host service ticket

IMAP service ticket

Preparing for Kerberos

- Prerequisites
  - Configure NTP (time synchronization) across all machines
    - Kerberos depends on accurate and usable timestamps
  - Configure DNS
    - Kerberos requires fully qualified domain names (FQDN) that are resolvable in both forward and reverse directions for all servers
    - Special DNS zone configurations can simplify Kerberos client configurations

Kerberos-specific DNS records

Inside the forward zone file for foo.com:

```
...
kdc                     A       192.168.1.10
...
_kerberos               IN      TXT     ‘‘FOO.COM’’
_kerberos._udp          IN      SRV     0 0 88    kdc
_kerberos._tcp          IN      SRV     0 0 88    kdc
_kpasswd._udp           IN      SRV     0 0 464   kdc
_kerberos-adm._tcp      IN      SRV     0 0 749   kdc
```

Inside the reverse zone file for 192.168.1.0:

```
...
10    PTR    kdc.foo.com.
...
```

Configuring the KDC

- Configuration files
  - /etc/krb5.conf
  - /etc/kadm5.acl
- Prepare the Kerberos database
  - Initialize the Kerberos database
  - Add administrator's principal
  - Start the KDC and KDC administration processes
- Create user principals
  - Note: service principals are created when configuring your other services to support Kerberos authentication

Configuration files

```
# /etc/krb5.conf
[libdefaults]
    default_realm = FOO.COM
[realms]
    FOO.COM = {
        kdc = kdc.foo.com
        admin_server = kdc.foo.com
    }
[domain_realm]
    .foo.com = FOO.COM
    foo.com = FOO.COM
[logging]
    default = FILE:/var/log/kdc.log

# /etc/kadm5.acl
*/admin@FOO.COM     *
```

Prepare the Kerberos database

Initialize the Kerberos database:

```
kdc# kdb5_util create -s
```

...choose the master password...

Add the administrator's principal:

```
kdc# kadmin.local -q ‘‘addprinc root/admin’’
```

...choose the administrator password...

This creates a principal called: `root/admin@FOO.COM`

Start the KDC and KDC admin processes:

```
kdc# /etc/init.d/krb5kdc start
kdc# /etc/init.d/kadmin start
```

Create user principals

```
kdc# kadmin -p root/admin
```
...enter root/admin's password...
```
kadmin:  addprinc john
```
...enter password for john@FOO.COM...
```
kadmin:  addprinc jane
```
...enter password for jane@FOO.COM...
```
kadmin:  exit
```

Configuring Kerberos clients

- Configuration file
  - /etc/krb5.conf
  - You can just copy this from the KDC
- Service principals
  - Needed if this client will be providing services that use Kerberos authentication (i.e. remote access, e-mail)
  - Involves creating the principals, then adding them to the client's “keytab” file
- PAM (Pluggable Authentication Modules)
  - Needed if you want to be able to authenticate users logging into this machine via Kerberos

Create service principals

You do this part on the client machine:

```
bar# kadmin -p root/admin
```

...enter root/admin's password...

```
kadmin:  addprinc -randkey host/bar.foo.com
kadmin:  addprinc -randkey imap/bar.foo.com
kadmin:  ktadd host/bar.foo.com
kadmin:  ktadd imap/bar.foo.com
kadmin:  exit
```

This process populates “/etc/krb5.keytab”, which is not human readable. You can use the “ktutil” program to read and modify it, however.

PAM Configuration

The specific details of this vary enough to be beyond the scope of this presentation. However, you generally edit your pam configuration ("pam.conf" or files in "pam.d/") to include lines resembling the following at the appropriate places:

```
...
auth        sufficient    pam_krb5.so    try_first_pass
...
account     sufficient    pam_krb5.so    try_first_pass
...
password    sufficient    pam_krb5.so    try_first_pass
...
```

Common user commands

- kinit
  - Obtain and cache Kerberos ticket-granting ticket
  - Used to authenticate with the KDC
- klist
  - List cached Kerberos tickets
- kdestroy
  - Destroy Kerberos tickets
  - Used to clear out the ticket cache
- kadmin
  - Kerberos database administration program
- ktutil
  - Kerberos keytab file maintenance utility

Any questions?

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