Study Guide for

Advanced Linux Network Administration

Lab work for LPI 202

April 2004

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Introduction:

Acknowledgments

The original material was made available by LinuxIT's technical training centre www.linuxit.com.

The manual is available online at http://savannah.nongnu.org/projects/lpi-manuals/. We would like to thank the Savannah Volunteers for assessing the project and providing us with the Web space.

History

CVS version 0.0 January 2004, Adrian Thomasset <adrian@linuxit.com>.
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Review/Update May 2005, Adrian Thomasset <adriant@linuxit.com>

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DNS

1. Using dig and host

The **bind-utils** package (or **dnsutils** for Debian based systems) provides tools used to query DNS servers. We will use **dig** and **host** to illustrate different types of queries.

1.1 Non-recursive queries

By forcing all queried DNS servers not to perform *recursive* queries we will discover that we need to manually follow the thread of information (list of DNS servers for each domain) in order to get an answer.

For this we need to query a hostname that has not been cached on our local server yet.

QUERY 1

```
dig +norecursive  +nostats www.tldp.org @127.0.0.1

;; flags: qr ra; QUERY: 1, ANSWER: 0, AUTHORITY: 7, ADDITIONAL: 0
;; QUESTION SECTION:
;www.tldp.org.                  IN      A

;; AUTHORITY SECTION:
.                       3600000 IN      NS      A.ROOT-SERVERS.NET.
.                       3600000 IN      NS      B.ROOT-SERVERS.NET.
.                       3600000 IN      NS      C.ROOT-SERVERS.NET.
.                       3600000 IN      NS      D.ROOT-SERVERS.NET.
.                       3600000 IN      NS      E.ROOT-SERVERS.NET.
.                       3600000 IN      NS      F.ROOT-SERVERS.NET.
.                       3600000 IN      NS      G.ROOT-SERVERS.NET.
```

Result: the local cache does not contain the required information so it queries the root servers (.) which return alternative DNS servers.

QUERY 2

```
dig +norecursive  +nostats www.tldp.org @L.root-servers.net

;; flags: qr; QUERY: 1, ANSWER: 0, AUTHORITY: 2, ADDITIONAL: 2
;; QUESTION SECTION:
;www.tldp.org.                  IN      A

;; AUTHORITY SECTION:
org.                    172800  IN      NS      TLD1.ULTRADNS.NET.
org.                    172800  IN      NS      TLD2.ULTRADNS.NET.

;; ADDITIONAL SECTION:
TLD1.ULTRADNS.NET.      172800  IN      A       204.74.112.1
TLD2.ULTRADNS.NET.      172800  IN      A       204.74.113.1
```

Result: The root DNS server L.ROOT-SERVERS.NET is queried. This server returns the

names and additional IP address for 2 new DNS servers authoritative on the .ORG domain.

QUERY 3

```
dig +norecursive  +nostats www.tldp.org @tld2.ultradns.net

;; flags: qr; QUERY: 1, ANSWER: 0, AUTHORITY: 2, ADDITIONAL: 0
;; QUESTION SECTION:
;www.tldp.org.                  IN      A

;; AUTHORITY SECTION:
TLDP.ORG.               172800  IN      NS      NS2.UNC.EDU.
TLDP.ORG.               172800  IN      NS      NS.UNC.EDU.
```

Result: Querying one of the .ORG DNS server we receive the names for two authoritative DNS servers on the TLDP.ORG domain. The next query should yield an answer!

QUERY 4

```
dig +norecursive  +nostats www.tldp.org @ns.unc.edu

;; flags: qr aa; QUERY: 1, ANSWER: 1, AUTHORITY: 3, ADDITIONAL: 4
;; ANSWER SECTION:
www.tldp.org.           86400   IN      A       152.2.210.81

;; AUTHORITY SECTION:
tldp.org.               86400   IN      NS      ns.unc.edu.
tldp.org.               86400   IN      NS      ns2.unc.edu.
tldp.org.               86400   IN      NS      ncnoc.ncren.net.

;; ADDITIONAL SECTION:
ns.unc.edu.             172800  IN      A       152.2.21.1
ns2.unc.edu.            172800  IN      A       152.2.253.100
ncnoc.ncren.net.        885     IN      A       128.109.193.1
ncnoc.ncren.net.        885     IN      A       192.101.21.1
```

Result: As expected the DNS servers on the TLDP.ORG domain have a record for www.tldp.org.

NOTICE

The above sequence of queries was necessary only because the host www.tldp.org was not cached on the local caching server. The **dig** instruction queried the remote DNS servers without using the local server. Typing

```
host www.tldp.org 127.0.0.1
```

and then

```
dig +norecursion www.tldp.org @127.0.0.1
```

would yield an answer since all the information is now cached on the local caching server

Search NS record for domain (authoritative DNS servers)

```
host -t NS tldp.org

tldp.org name server ns2.unc.edu.
tldp.org name server ncnoc.ncren.net.
tldp.org name server ns.unc.edu.
```

Search MX record for domain

```
host -t MX tldp.org

tldp.org mail is handled by 0 gabber.metalab.unc.edu
```

Finally, it is possible to see all records with **host -a**.

2. Basic Bind 8 Configuration

The configuration file for a Bind 8 server is **/etc/named.conf** This file has the following main entries:

Main entries in **named.conf**	
logging	Specify where logs are written too and what needs to be logged
options	Global options are set here (e.g the path to the zone files)
zone	Defines a zone: the name, the zone file, the server type
acl	Access control list
server	Specific options for remote servers

Let's look at a typical configuration file for a caching only server. We will add entries to it as we go to create new zones, logging facilities, security, etc.

Skeleton **named.conf** file

```
options {
        directory "/var/named";
        datasize 100M;
};

zone "." IN {
        type hint;
        file "named.ca";
};

zone "localhost" IN {
        type master;
```

```
        file "localhost.zone";
        allow-update { none; };
};

zone "0.0.127.in-addr.arpa" IN {
        type master;
        file "named.local";
        allow-update { none; };
};
```

2.1 The Logging Statement:

The syntax for logging is:

```
 logging {
       channel "channel_name" {
                  file "file_name";
            versions number_of_files;
                        size log_size;
                  syslog < daemon | auth | syslog | authpriv | local0 -to-
local7 | null >;
                  severity <critical | error | warning | notice | info  | debug
| dynamic > ;
      print-category yes_or_no;
            print-severity yes_or_no;
            print-time yes_or_no;
       };
       category "category_name" {
         "channel_name";
       };
```

The **channel** defines where logs are sent to (file, syslog or null). If syslog is selected then the facility and the log level can be specified too.

The **category** clause defines the type of information sent to a given channel (or list of channels). The type of channel is given then the default logging facility is used

```
category default { default_syslog; default_debug; };
```

Example:

We choose not to use the syslog daemon and log everything to a file called "LOG" that will be created in the same directory as the zone files (default **/var/named/**). For this we will create the **channel** *foo_channel*. Next we want to log `queries` using this channel.

The entry in **named.conf** will look like this:

```
logging {
```

```
     channel foo_channel {
                file "LOG";
                print-time yes;
                print-category yes;
                print-severity yes;
        };
     category "queries" {
                "foo_channel";
        };
};
```

Categories such as `queries` are predefined and listed in the **named.conf(5)** manpages. However some of the names have changed since BIND 8, so we include as a reference the list of categories for BIND 9 below:

BIND 9 Logging Categories	
default	Category used when no specific channels (log levels, files ...) have been defined
general	Catch all for messages that haven't been classified below
database	Messages about the internal zone files
security	Approval of requests
config	Processing of the configuration file
resolver	Infornation about operations performed by clients
xfer-in or xfer-out	Received or sent zone files
notify	Log NOTIFY messages
client	Client activity
update	Zone updates
queries	Client Queries
dnssec	DNSEC transactions
lame-servers	Transactions sent from servers marked as lame-servers

2.2 The Options Statement

The global options for the server are set at the beginning of **named.conf**. The syntax is:

```
options{
     option1;
     option2;
```

```
      ....
};
```

We next cover the most common options.

version	
Manpage says “The version the server should report via the ndc command. The default is the real version number of this server, but some server operators prefer the string (surely you must be joking)”	`version “(surely you must be joking)”;`

directory	
The working directory of the server	`directory “/var/named”;`

fetch-glue (default *yes*) - obsolete
Prevent the server from resolving NS records (the additional data section). When a record is not present in the cache BIND can determine which servers are authoritative for the newly queried domain. This is often used in conjunction with *recursion no*.

notify (default *yes*)
Send `DNS NOTIFY` messages to the slave servers to notify zone changes (helps speed up convergence)

recursion (default *yes*)
The server will perform recursive queries when needed

forward (*only* or *first*)
The default value is *first* and causes the sever to query the forwarders before attempting to answer a query itself. If the option is set to *only* the server will always ask the forwarders for an answer. This option has to be used with **forwarders**.

forwarders (list)	
List of servers to be used for forwarding. The default is an empty list.	`forwarders { 10.0.0.1; 10.0.0.10;};`

datasize	
Limit the size of the cache	`datasize 512M;`

allow-query (list)
A lists of hosts or networks that may query the server

allow-recursion (list)
List of hosts that can submit recursive queries

allow-transfer (list)
List of hosts (usually the slaves) who are allowed to do zone transfers

2.3 The Zone Statement

The syntax for a zone entry in **named.conf** is as follows:

```
zone domain_name {
     type zone_type;
     file zone_file;
     local_options;
};
```

We first look at the *local_options* available. Some of these are the same options with the same syntax as the global options we have just covered (with some additional ones). The most common ones are **notify**, **allow-transfer** and **allow-query**. Additional ones are **masters** (list of master servers) or **dialup**.

The *domain_name* is the name of the domain we want to keep records for. For each domain name there is usually an additional zone that controls the local in-addr.arpa zone.

The *zone_type* can either be
master the server has a master copy of the zone file
slave the server has a version of the zone file that was downloaded from a master server
hint predefined zone containing a list of root servers
stub similar to a **slave** server but only keeps the NS records

The *zone_file* is a path to the file containing the zone records. If the path is not an absolute path then the path is taken relatively to the directory given earlier by the **directory** option (usually /var/named).

Example master zone entries, allowing zone transfers to a slave server at 10.1.2.3:

```
zone seafront.bar {
     type master;
     file "seafront.zone";
     allow-transfer{10.1.2.3;);
};

zone 2.1.10.in-addr.arpa {
     type master;
     file "10.1.2.zone"
     allow-transfer{10.1.2.3;);
};
```

The next example is the corresponding **named.conf** *zone* section for the slave server, assuming the master has the IP 10.1.2.1:

```
zone "seafront.bar" IN {
        type slave;
        masters {10.1.2.1;};
        file "slave/seafront.zone";
};

zone "2.1.10.in-addr.arpa" IN {
        type slave;
        masters {10.1.2.1;};
        file "slave/10.1.2.local";
};
```

2.4 The Access Control Lists (acl) Statement

Rather than use IPs it is possible to group lists of IP addresses or networks and assign a name to this grouping.

Exmaple acl:

acl internal_net {10.0.0.0/8; };

There are built-in ACLs as follow:

any	all hosts
none	no host
localhost	all IP address for the local interfaces
localnets	network associated to the localhost interfaces

The Server Statement

This statement is used to assign configuration options for a specific server. For example if a server is giving bad information it can be marked as **bogus**. One can also set the **keys** associated with a server for hosts *authentication* when using DNSSEC (see section 4. Securing a DNS Server)

3. Create and Maintain Zone Files

The format of the zone files is defined in RFC 1035 and contains resource records (RR) for the administered domain or sub-domain.

The types of resource records are:

1 – Start Of Authority (SOA) describes to root of the zone:

```
root-name TTL IN SOA name-server email-address (
                                     serial number;
                                     refresh;
                                     retry;
                                     expire;
                                     minimum;
                                     )
```

The root-name is often replaced with an "@" symbol which resolves to the name of the zone specified in **named.conf**.

Example:

```
$TTL    86400
@     1D    IN    SOA   ns.seafront.bar. root.seafront.bar. (
                                    46              ; serial (d. adams)
                                    1H              ; refresh
                                    15M             ; retry
                                    1W              ; expiry
                                    1D )            ; minimum
```

2 – Records defining the name-servers for this domain, NS records

```
domain-name IN NS name-server
```

Example:

```
     IN   NS   ns
```

NOTICE

1. If the name of the domain is missing then @ is assumed

2. The fully qualified name of the name-server is `ns.seafront.bar.`. A host name that doesn't end with a dot will automatically have the domain-name '@' appended to it. Here for example

`ns` becomes `ns.seafront.bar.`

3 – Records defining the mail-servers for this domain, MX records

`domain-name` `IN MX` *`PRI mail-server`*

The *PRI* entry is a priority number. If several mail-servers are defined for a domain then the servers with the lowest priority number are used first.

4 – Authoritative information for hosts on the domain, called A records

`host-name` `IN A` *`IP-address`*

Authority Delegation

5 – When defining the name-servers responsible for another sub-domain additional NS records are added as well as some *glue records* which are simple A records resolving the DNS servers.

Example:

```
devel.myco.com      IN NS     ns1.devel.myco.com
ns1                 IN A      192.168.21.254
```

Reverse zone files:

6 – Authoritative PTR records, resolving IP addresses

`n` `IN PTR` *`host-name`*

4. Securing a DNS Server

In 1995, following major security flaws discovered in DNS, a new topic called DNSSEC was started within the IETF. This DNSSEC protocol is described in a sequence of three draft documents known as RFC2535bis and proposes to handle server **authentication** as well as data **authenticity**.

4.1 Server Authentication

DNSSEC attempts to handle vulnerabilities that occur during **unauthorised dynamic updates** as well as spoofed **master impersonations**. These involve host-to-host authentications between either a DHCP or a slave server and the master server.

The **dnssec-keygen** tool is used to generate a host key on the master server that can then be transferred on a slave server. This authentication mechanism is call TSIG and stands for Transaction Signature. Another mechanism is SIG0 and is not covered in these notes.

- **Master Configuration**

1. First generate the host key on the master server called seafront.bar:

```
dnssec-keygen -a HMAC-MD5 -b 256 -n host seafront.bar.
```

This will create the following public and a private key pair:

```
Kseafront.bar.+157+49196.key
Kseafront.bar.+157+49196.private
```

Notice: These keys must NOT be inserted in the zone files (there is an IN KEY section in the public key that is misleading, looks like a RR).
The public and the private keys are identical: this means that the private key can be kept in any location. This also means that the public key shouldn't be published.

The content of the Kseafront.bar.+157+49196.key is:

```
seafront.bar. IN KEY 512 3 157
QN3vIApnV76WS+a2Hr3qj+AqZjpuPjQgVWeeMMGSBC4=
```

2. In the same directory as the server's **named.conf** configuration file. Create the file **slave.key** with the following content:

```
key "seafront.bar." {
        algorithm hmac-md5;
        secret "QN3vIApnV76WS+a2Hr3qj+AqZjpuPjQgVWeeMMGSBC4=";
};
```

3. Apply the following changes in **named.conf:**

```
include "/etc/slave.key";

zone "seafront.bar" IN {
```

```
        type master;
        file "seafront.zone";
        allow-transfer { key seafront.bar.; };
};


zone 2.1.10.in-addr.arpa {
     type master;
     file "10.1.2.zone"
     allow-transfer{key seafront.bar.;);
};
```

- **Slave Configuration**

Copy the **slave.key** file to the slave server in the directory containing **named.conf**. Add the following **server** and **include** statements to **named.conf**:

```
server 10.1.2.1 {                    (this is the IP for the master server)
       keys {seafront.bar.;};
};

include "/etc/slave.key";
```

- **Troubleshooting**

Restart **named** on both servers and monitor the logs. Notice that DNSSEC is sensitive to time stamps so you will need to synchronise the servers (using NTP). Then run the following command on the master server in the same directory where the dnssec keys where generated:

```
dig @10.1.2.1 seafront.bar AXFR -k Kseafront.bar.+157+49196.key
```

4.2 DATA Integrity and Authenticity

This aspect of DNSSEC is above the level of this manual and is simply a summary of the concepts involved.

Data authenticity may be compromised at different levels. The recognised areas are:

- altered slave zone files
- cache impersonation
- cache poisoning

New RR records

The integrity and authenticity of data is guarantied by signing the Resource Records using a private key. These signatures can be verified using a public DNSKEY. Only the validity of the DNSKEY needs to be established by the parent server or “delegation signer” DS.

So we have the following new RRs in the zone files:

RRSIG	the signature of the RR set
DNSKEY	public key used to verify RRSIGs
DS	the Delegation Signer

Signing Zone Records

These are the basic steps:

1. Create a pair of public/private zone signing keys (ZSK)

```
dnssec-keygen -a DSA -b 1024 -n zone  seafront.bar.
```

You should get two files such as these:

Kseafront.bar.+003+31173.key
Kseafront.bar.+003+31173.private

2. Insert the public key into the unsigned zone file:

```
cat  Kseafront.bar.+003+31173.key   >> seafront.bar
```

3. Sign the zone file

```
dnssec-signzone  -o  seafront.bar   Kseafront.bar.+003+31173
```

You should see a message such as:

```
WARNING WARNING WARNING WARNING WARNING WARNING WARNING WARNING WARNING
WARNING                                                             WARNING
WARNING                                                             WARNING
WARNING     This version of dnssec-signzone produces zones that are WARNING
WARNING     incompatible with the forth coming DS based DNSSEC      WARNING
WARNING     standard.                                               WARNING
WARNING                                                             WARNING
WARNING WARNING WARNING WARNING WARNING WARNING WARNING WARNING WARNING
```

```
seafront.zone.signed
```

This is due to the fact that the dnssec-signzone tool doesn't support the **-k** switch which would allow to make use of a key signing key (KSK) which is then forwarded to a parent zone to generate a DS record ...

If you want to make use of this signed zone, change the filename in **named.conf** to “seafront.bar.signed”

Sendmail

1. Using Sendmail

1.1 Configuration Settings

DNS Settings

1. We first want to make sure that mail will be sent to our machine. We assume that we have properly configured a domain called `seafront.bar` with BIND 8 or 9. Let's make sure that the zone file for this domain has an MX record pointing to our system.

For example if our machine is called `test1` and has the IP `192.168.246.12` then we need the following lines:

```
seafront.bar.            IN   MX 10     test1.seafront.bar.
test1.seafront.bar.      IN   A          192.168.246.12
```

2. Next we need to make sure that this information is read by the resolvers, so we add the following at the top of the file **/etc/resolv.conf**:

```
nameserver 127.0.0.1
domain seafront.bar
```

Sendmail Settings

We go into sendmail's main configuration directory **/etc/mail**. Here we need to do the following:

1. By default sendmail is configured to listen for connections ONLY for the 127.0.0.1 interface. In order to make sendmail listen to all interfaces we need to comment out the following line in **/etc/mail/sendmail.mc** using 'dnl' which stands for “do next line”:

```
 dnl  DAEMON_OPTIONS(`Port=smtp,Addr=127.0.0.1, Name=MTA')dnl
```

Once this is done run:

```
m4 /etc/mail/sendmail.mc > /etc/mail/sendmail.cf
```

Notice: Make sure /etc/sendmail.cf isn't also there, if it is, delete it.

Restart sendmail and try the following:

```
telnet test1.seafront.bar 25
```

Warning: If you get a connection then sendmail is responding. This doesn't mean that sendmail will deliver mail (relay) for you!

3. To configure sendmail to relay for you you need to add the IP for your machine to the **/etc/mail/access** file:

```
192.168.246.12 RELAY
```

4. Finally, we also need to tell sendmail to accept mail for `@seafront.bar` addresses. For this, add the domain name to **/etc/mail/local-host-names**:

```
seafront.bar
```

Restart sendmail and send a mail to an existing user. If you have a user *tux* on the machine then check the output of the following:

```
mail –v –s "test seafront domain" tux@seafront.bar < /etc/passwd
```

1.2 Virtual Hosting

We want the server `seafront.bar` to accept mail for the `city.bar domain`. For this we follow the following steps.

The DNS entries

We need to add an MX record for the city.bar domain. Here is the whole block for clarity:

```
seafront.bar.           IN   MX 10     test1.seafront.bar.
city.bar.               IN   MX 10     test1.seafront.bar.
test1.seafront.bar.     IN   A         192.168.246.12
```

Reload the zone file:

```
rndc reload
```

Sendmail Settings

1. We need to make sendmail accept mail for users at @city.bar. For this we add the next line to the **local-host-names** file:

```
city.bar
```

If mail is sent to *tux@city.bar* and *tux* is a valid user on `test1.seafront.bar` then mail will be delivered to the local user *tux*.

To avoid this we can use the **/etc/mail/virtusertable** database.

2. If you want to forward mail onto another account here are example entries for the **virtusertable** database:

tux@city.bar mr.tux@otherdomain.org
@city.bar administrator
list@city.bar local-list

Here mail for user tux is diverted to mr.tux@otherdomain.org, the user administrator is the catchall account, lists are redirected to local lists (this needs to point to a valid list defined in the aliases

2. Configuring Mailing Lists

2.1 Majordomo and Sendmail

Download the code from

http://www.greatcircle.com/majordomo/

Source version: majordomo-1.94.5.tar.gz

Pre-installation Configuration

1. In the Makefile, replace **/bin/perl** with the path to the perl binary on your system (usually /usr/bin/perl):

```
PERL = /usr/bin/perl
```

To make things easier we will leave the W_HOME as is:

```
W_HOME = /usr/test/majordomo-$(VERSION)
```

You need to create the directory **/usr/test**

```
mkdir /usr/test
```

Create a group called **majordomo** with GID **45**, and add a user called **majordomo** with UID **123**

```
groupadd -g 45 majordomo
useradd -g 45 -u 123 majordomo
```

2. In the **sample.cf** file we need to define our domain (for example seafront.bar). This is also where the path to the sendmail binary is set:

```
$whereami = "seafront.bar";
$sendmail_command = "/usr/sbin/sendmail";
```

Now we can run

```
make install
make install-wrapper
```

Finally you can test the configuration as suggested with the following:

```
cd /usr/test/majordomo-1.94.5; ./wrapper config-test
```

If all goes well you will be prompted to register to the majordomo mailing list. Since we do not have a valid email address, answer NO to the question.

Sendmail Configuration

The sendmail configuration involves adding appropriate entries in **/etc/aliases** for each mailing list we create. But before that we need a symbolic link in **/etc/smrsh** pointing to the majordomo **wrapper** binary, and here is why.

In order to limit the number of programs mail can be piped to (using a '| command' instead of an email address) sendmail defines a set of commands known as “sendmail restricted shells” or smrsh. The list of restricted shells is contained in **/etc/smrsh** which are symbolic links to the actual binaries we allow mail to be piped to.

We will make the **wrapper** binary available, which is located in /usr/test/majordomo-1.94.5, with the following:

```
ln -s  /usr/test/majordomo-1.94.5/wrapper /etc/smrsh
```

Before adding the entries to **/etc/aliases** we need to decide on a name for our first list, and we choose ... *test*.

Remember that before sending mail to the list test@seafront.bar we first need to subscribe to this list by sending a mail to majordomo@seafront.bar with the contents `subscribe test`. Some work needs to be done for this to work.

Creating the list “`test`” (as documented in NEWLIST):

1 . create an empty file called `test` and a file containing information about the list called `test.info` in the directory /usr/test/majordomo-1.94.5/lists/

2. Create the following aliases in **/etc/aliases**:

```
majordomo:      "|/usr/test/majordomo-1.94.5/wrapper majordomo"
test:           "|/usr/test/majordomo-1.94.5/wrapper resend -l
test test-list"
test-list:      :include:/usr/test/majordomo-1.94.5/lists/test
test-request:   "|/usr/test/majordomo-1.94.5/wrapper request-
answer test"
owner-test:     tux
test-approval:  tux
```

3. Run **newaliases** and restart **sendmail**.

Majordomo Test

Send an email to `majordomo@seafront.bar` with the content:

```
subscribe test
```

If all goes well you will receive a response with further steps to be taken.

3. Managing Mail Traffic

3.1 Using Procmail

In depth information can be found in the **procmail**, **procmailrc** and **procmailex** manpages. Here are a few examples taken from **procmailex(5)**

A promailrc file is a sequence of recipes of the form:

```
:0 [flags] [ : [locallockfile] ]
   <zero or more conditions (one per line)>
   <exactly one action line>
```

The next tables cover the main flags, conditions and actions available.

Flags	Description
H	Egrep the header (default).
B	Egrep the body
E	This recipe only executes if the immediately preceding recipe was not executed.
e	This recipe only executes if the immediately preceding recipe failed
w	Wait for the filter or program to finish and check its exitcode

The conditions are extended regular expressions with the additional conditions below:

Conditions	Description
!	Invert the condition
$	Evaluate the remainder of this condition according to sh(1) substitution rules inside double quotes, skip leading whitespace, then reparse it
?	Use the exitcode of the specified program
<	Check if the total length of the mail is shorter than the specified (in decimal) number of bytes
>	Check if the total length of the mail is larger than the specified (in decimal) number of bytes

The action line can start with one of

Action line	Description
!	Forwards to all the specified mail addresses
|	Starts the specified program
{	Followed by at least one space, tab or newline will mark the start of a nesting block
Anything else	interpret as a mailbox (file or directory relative to current directory or MAILDIR)

Examples:

Sort all mail coming from the lpi-dev mailing list into the mail folder LPI:

```
:0:
* ^TO_lpi-dev
LPI
```

Forward mails between two accounts *main.address* and *the-other.address.* This rule is for the procmailrc on the main address account. Notice the X-Loop header used to prevent loops:

```
:0 c
* !^X-Loop: yourname@main.address
| formail -A "X-Loop: yourname@main.address" | \
$SENDMAIL -oi yourname@the-other.address
```

The **c** option tells procmail to keep a local copy.

Web Services

1. Implementing a Web Server

1.1 Installing Apache

The apache source code can be downloaded from www.apache.org.

There are two versions of the apache server: 1.3 and 2.0

The configure script allows us to customise the installation. In particular we can choose which modules we want to compile etc. Modules can either be

- statically compiled with
  `--enable-MODULE` (where MODULE is the *Module Indentifier*) or
  `--enable-modules="MOD1 MOD2 ..."`

- dynamically compiled with
  `--enable-mods-shared="MOD1 MOD2 ..."`

-disabled with
  `--disable-MODULE`

Task: Download the source code for apache 1.3 (apache_1.3.29.tar.gz) and compile support for mod_php and mod_perl

1.2 Monitoring apache load

SNMP
Create a read-only SNMP community and restart the snmpd daemon:

/etc/snmp/snmp.conf
rocommunity lifesavers

Restart the snmpd service:

```
/etc/init.d/snmpd restart
```

Check that you can browse information about your system using the community name lifesavers:

```
snmpwalk -v 1 -c lifesavers localhost ip
```

MRTG

MRTG stands for “multi-router traffic grapher” and uses SNMP to get information about the system.

```
cfgmaker  --output=/etc/mrtg/seafront.cfg \
          -ifref=ip --global "workdir: /var/www/mrtg/stats"
          lifesavers@localhost
```

This will create a file called /etc/mrtg/seafront.cfg. We next update the information in /var/www/mrtg/stats with the following command:

```
mkdir /var/www/mrtg/stats
mrtg /etc/mrtg/seafront.cfg
```

This should be run at regular intervals so it should be run through a cron job.

Task: The graphical output for MRTG will be saved in /var/www/mrtg/stats as an HTML document. This is not a usual place to keep files for the apache server. After the next section, we will make the appropriate changes to **httpd.conf** to make this directory accessible through the webserver.

Many other tools are available such as **Webaliser** which analyse the access logs of the apache server (we will configure this tool for **squid**.

1.3 Using Apachectl

The **apachectl** script is used to control the **httpd** daemon. It takes the following options:

apachectl option	**Description** – extract from apachectl(8)
start	Start the Apache httpd daemon. Gives an error if it is already running. This is equivalent to **apachectl -k start**
stop	Stops the Apache httpd daemon. This is equivalent to **apachectl -k stop**

restart	Restarts the Apache httpd daemon. If the daemon is not running, it is started. This command automatically checks the configuration files as in configtest before initiating the restart to make sure the daemon doesn't die. This is equivalent to **apachectl -k restart**
fullstatus	Displays a full status report from mod_status. For this to work, you need to have mod_status enabled on your server and a text-based browser such as lynx available on your system. The URL used to access the status report can be set by editing the STATUSURL variable in the script.
Status	Displays a brief status report. Similar to the `fullstatus` option, except that the list of requests currently being served is omitted
graceful	Gracefully restarts the Apache httpd daemon. If the daemon is not running, it is started. This differs from a normal restart in that currently open connections are not aborted. This is equivalent to **apachectl -k graceful**
configtest	Run a configuration file syntax test. It parses the configuration files and either reports `Syntax Ok` or detailed information about the particular syntax error. This is equivalent to **apachectl -t**

1.4 Basic Configuration Options

- Section 1: General Options

KeepAlive on/off	Allows a client to perform multiple requests through a single connection
MaxKeepAliveRequests 100	Maximum number of requests during a persistent connection
KeepAliveTimeout 15	Number of seconds to wait for a next request on the same connection

Single Threaded Server:

The httpd daemon is a single threaded process which needs to fork child daemons to deal with multiple connections – only with apache2 is it possible to build a multi threaded server.

StartServers 8	Number of httpd servers to start
MinSpareServers 5	Minimum number of spare servers to keep loaded in memory

MaxSpareServers 20	Maximum number of spare servers to keep loaded in memory
MaxClients 150	Maximum number of server processes allowed at any one time
MaxRequestsPerChild 1000	Maximum number of requests before a child is “retired”

Multi Threaded Server:

Options available only for apache2 and onwards. You need to recompile apache to enable threads. Most current apache2 binary distributions are still single threaded because of conflicts with most dynamic modules which don't support multi threading yet.

StartServers 2	Notice that this is much lower than the single threaded server
MinSpareThreads 25	Minimum number of spare threads
MaxSpareThreads 75	Maximum number of spare threads
ThreadsPerChild 25	Number of worker threads per child
MaxClients 150	Maximum number of server processes allowed at any one time
MaxRequestsPerChild 0	Never retires?

Listen 80	Specify which port to listen on. Can be of the form IP:port
LoadModule MODULE INDENTIFIER /PATH-TO/MODULE	Section where dynamic modules are loaded
Include *FILE*	Read extra configuration options from *FILE*. Apache2 has a conf.d directory for this

- Section 2 :Server Configuration

ServerName	The name of the server – can be different
User	Name of the user the server runs as
Group	Name of the group the server runs as
DocumentRoot	The directory the where HTML files are kept
<Directory>	Specify options (access control,...) for directories containing HTML files
Alias	URL alias for a given directory

AliasScript	Same as “Alias” option but for directories containing CGI scripts
DirectoryIndex	Set the name of the file which will be used as an index

- Section 3: Virtual Hosts

We will cover virtual hosts when configuring SSL servers later in this chapter. For now we distinguish two concepts:

<VirtualHost IP:PORT>	IP based virtual host
<VirtualHost HOSTNAME:PORT>	Name based virtual

1.5 Restricting Client Access

Host based control is available using the keywords **Order**, **Deny from** and **Allow from** on directories

<Directory *PATH-TO-DIRECTORY*> ... </Directory>
or locations
<Location *URL*> ... </Location>

The next configuration paragraph will allow anybody to access the directory /var/www/safe except the host with IP 192.168.3.101:

```
<Directory /var/www/safe>

Order allow,deny
Deny from 192.168.3.101
Allow from all

</Directory>

Alias /safe /var/www/safe
```

Notice: The **Order** keyword is important. If we reverse the above order to `Order deny,allow` then the following would happen: host 192.168.3.101 would first be denied

access because of the Deny rule but the Allow rule is read last and will subsequently grant it access. The default access is given by the last argument in the order directive. I.e. “Order allow,deny” has a default of “deny”.

1.6 Client Basic Authentication

The htpasswd tool is used to create passwords for users. For example, we create a new file in the ServerRoot directory called `passwords-for-directory1` with a password for user `gnu`:

```
htpasswd -c passwords-for-directory1 gnu
```

If we choose to implement client authentication for the directory /var/www/html/seafront we need to add the following paragraph to **httpd.conf**:

```
<Directory /var/www/html/seafront>
AuthType basic
AuthName "protected site"
AuthUserFile conf/seafront.passwd
Require user gnu
</Directory>
```

Notice: Alternatively, with httpd2 configurations we could create a file called seafront.conf with the above content and save it in the /etc/httpd/conf.d directory.

Reread the configuration file with:

```
apachectl graceful
```

2. Maintaining a Web Server

2.1 HTTPS Overview

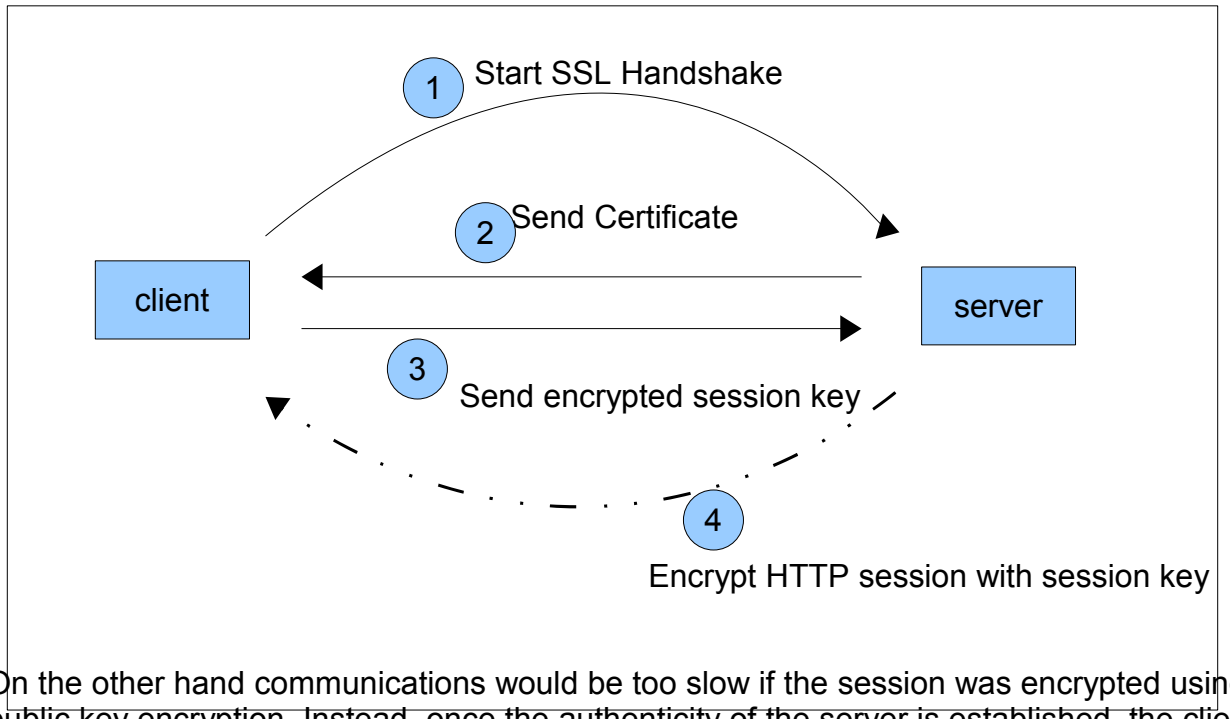
The secure socket layer protocol SSL allows any networked applications to use encryption. This can be thought of as a process which wraps the socket preparing it to use encryption at the application level.

In the case of HTTPS, the server uses a pair of keys, public and private. The server's public key is used by the client to encrypt the session key, the private key is then used to decrypt the session key for use.

The public key is published using certificates. A certificate contains the following information:

- Name and Address, Hostname, etc.
- Public Key
- TTL
- (optional) ID + Signature from a certificate authority (CA)

The certificate will be used to establish the authenticity of the server. A valid signature from a known CA is automatically recognised by the client's browser. With Mozilla for example these trusted CA certificates can be found by following the links: **Edit -> Preferences -> Privacy & Security -> Certificates** then clicking on the "*Manage Certificates*" button and the Authorities TAB



On the other hand communications would be too slow if the session was encrypted using public key encryption. Instead, once the authenticity of the server is established, the client generates a unique secret session key which is encrypted using the servers public key found in the certificate. Once the server receives this session key it can decrypt it using the private key associated with the certificate. From there on the communication is encrypted and decrypted using this secrete session key generated by the client.

2.2 SSL Virtual Hosts

A separate apache server can be used to listen on port 443 and implement SSL connections. However most default configurations involve a single apache server listening on both ports 80 and 443.

For this an additional **Listen** directive is set in **httpd.conf** asking the server to listen on

port 443. Apache will then bind to both ports 443 and 80. Non encrypted connections are handled on port 80 while an SSL aware virtual host is configured to listen on port 443:

```
<VirtualHost _default_:443>

SSL CONFIGURATION

</VirtualHost>
```

The SSL CONFIGURATION lines are:

```
SSLEngine on
SSLCipherSuite ALL:!ADH:!EXPORT56:RC4+RSA:+HIGH:+MEDIUM:+LOW:
+SSLv2:+EXP
SSLCertificateFile PATH_TO_FILE.crt
SSLCertificateKeyFile PATH_TO_FILE.key
```

We need to generate the servers private key (FILE.key) and certificate (FILE.crt) to complete this configuration.

2.3 Managing Certificates

The keys and certificates are usually kept in subdirectories of **/etc/httpd/conf** called **ssl.crt** and **ssl.key**.
There should also be a Makefile that will generate both a KEY and a CERTIFICATE in PEM format which is base64 encoded data.

Using the Makefile

For example if we want to generate a self-signed certificate and private key simply type:

```
make mysite.crt
```

The Makefile will generate both files mysite.key (the private key) as well as mysite.crt (the certificate file containing the public key). You can use the following directives in **httpd.conf**:

```
SSLCertificateFile  ... mysite.crt
SSLCertificateKeyFile ... mysite.key
```

Certificate Requests

On a production server you would need to generate a new file called a “certificate request”

with:

```
openssl    req -new  -key mysite.key -out mysite.csr
```

This file can be sent to a certificate authority (CA) to be signed. The certificate authority will send back the signed certificate.

- **Pass Phrases**

A private key can be generated with or without a passphase, and a private key without a passphrase can be constructed from an existing private key.

A passphrased file: If a private key has a passphrase set then the file starts with
-----BEGIN RSA PRIVATE KEY-----
Proc-Type: 4,ENCRYPTED
DEK-Info: DES-EDE3-CBC, ---- snip ----
.....
this means that the file is protected by a pass-phrase using 3DES. This was generate by the line
`/usr/bin/openssl genrsa` **`-des3`** `1024 > $@` in the Makefile. If the -des3 flag is omitted NO passphrase is set.

You can generate a new private key (mysite-nophrase.key) without a passphrase from the old private key (mysite.key) as follows:

```
openssl rsa -in mysite.key -out mysite-nopass.key
```

2.4 Virtual Hosts

- **Name based virtual hosts**

We will first discuss the situation where only one IP has been assigned to the server but there are several A records or CNAME records pointing to the same IP.

Task 1: Modify the zone files to include a new CNAME record for test1.seafront.bar to point to the actual name of the web server.

e.g	test1.seafront.bar.	IN CNAME	www.seafront.bar.
	www	IN A	192.x.x.x

In httpd.conf it will be enough to create the following:

<VirtualHost test1.seafront.bar:80>
ServerAdmin webmaster@seafront.bar

```
   DocumentRoot /var/www/html/test1
   ServerName test1.example.com
</VirtualHost>
```

Task 2: Create an SSL aware VirtualHost for test1

- make the certificate and the key: `make host1.seafront.bar`
- add these lines to **httpd.conf**:

```
<VirtualHost 192.168.3.200:443>
SSLEngine on
SSLCipherSuite ALL:!ADH:!EXPORT56:RC4+RSA:+HIGH:+MEDIUM:+LOW:+SSLv2:+EXP
SSLCertificateFile /etc/httpd/conf/test1.seafront.bar.crt
SSLCertificateKeyFile /etc/httpd/conf/test1.seafront.bar.out
ServerAdmin webmaster@seafront.bar
DocumentRoot /var/www/html/test1
ServerName test1.seafront.bar
</VirtualHost>
```

Notice that the certificate that is presented once you connect to the https://test1 site is incorrect. This is because test1.seafront.bar resolves to the servers IP address and the server will start the SSL handshake before looking at the HTTP request. The next section will fix that.

IP Based Virtual Hosts

We will directly create a series of virtual SSL aware hosts and verify that they present the client with the correct certificate.

Task: Assign new IP addresses to the eth0 interface: `ifconfig eth0:0 X.X.X.X`
For each IP enter a new A record: `www1 IN A X.X.X.X`
For each host create a self signed certificate
Enter a <VirtualHost X.X.X.X:443> paragraph in **httpd.conf**

Notice: You may have to change the existing SSL virtual host from

```
<VirtualHost _default_:443>
```

to

```
<VirtualHost 127.0.0.1:443>
```

This prevents the default host certificate from being presented irrespective of the site hostname.

Test that https://www1 and https://www2 do present the proper certificates.
Notice that if you permanently accept a certificate it will be added to the list of CA certificates on your browser!

3. Implementing a Proxy Server

3.1 Getting Started

You can verify that the squid proxy server is installed using:

```
rpm -q squid
```

Most versions will install the **/etc/init.d/squid** rc-script that creates the initial caching directories. If this is not the case squid can initialise these cache directories with the **-z** switch.

```
squid -z
```

NOTICE
You may need to add an access rule in the squid configuration file before being able to rebuild the cache (see the next section “Access Lists and Access Control”)

The configuration file is **/etc/squid/squid.conf**. The syntax of this file can be checked using the **-k** switch:

```
squid -k check
```

As with most network services the **/etc/init.d/squid** rc-script is used to start the service.

3.2 Access Lists and Access Control

- Access Lists (acl):

In **squid.conf** the access lists have the following format:

```
acl     aclname     acltype     string/file
```

In the most simple cases an *acl* defines a list of hosts, networks or domains and is given a name. This list can then be granted or denied access using the access control command *http_access* described in the next paragraph.

The next line defines an access list name called *localnet* corresponding to the local LAN:

```
acl localnet src 192.168.2.0/255.255.255.0
```

The main ACL types are listed below:

acltype	**description**
src	IP/netmask or IP1-IP2/netmask (client's IP address)
dst	IP/network (URL requested)
arp	MAC address
srcdomain	.example.com (client addresses)
dstdomain	.example.com (URLs requested)
time	range of times
port	space separated list of ports or range of the form p1-p2

- Access control (http_access)

With *http_access* a particular access list is either allowed or denied access via the proxy. The format is as follows:

```
http_access      allow|deny        aclname
```

The http_access requests are read in sequence and the first rule matched is used. To allow access to all

computers on the network insert the following *before* the **http_access deny all** line:

```
http_access allow localnet
```

3.3 Additional Configuration Options

The following table is a list of additional options available to further control the squid proxy.

Option	Description
http_port	the port squid uses to listen for requests (default 3128)
cache_peer	specify another proxy server to query whenever an object isn't cached
cache_mem	limit the amount of additional memory used to cache objects (this parameter doesn't limit the maximum process size)
cache_swap_low	percentage of swap utilisation. Once this limit is passed objects start to be cached to disk
cache_swap_high	percentage of swap utilisation. Once this limit is approached objects start getting evicted from the proxy cache
maximum_object_size	objects larger than this will not be cached
maximum_object_size_in_memory	objects larger than this will not be kept in the memory cache

Memory Management (from the SQUID FAQ section 8)

“This version of SQUID stores incoming objects only in memory, until the transfer is complete. At that point it decides whether or not to store the object on disk. This means that when users download large files, your memory usage will increase significantly. The squid.conf parameter *maximum_object_size* determines how much memory an in-transit object can consume before we mark it as uncachable. When an object is marked uncachable, there is no need to keep all of the object in memory, so the memory is freed for the part of the object which has already been written to the client. In other words, lowering *maximum_object_size* also lowers Squid-1.1 memory usage.”

“If your cache performance is suffering because of memory limitations, you might consider buying more memory. But if that is not an option, There are a number of things to try:

- Try a different malloc library [compile SQID with a different malloc]
- Reduce the *cache_mem* parameter in the config file. This controls how many ``hot'' objects are kept in memory. Reducing this parameter will not significantly affect performance, but you may recieve some warnings in *cache.log* if your cache is busy
- Turn the *memory_pools off* in the config file. This causes Squid to give up unused memory by calling *free()* instead of holding on to the chunk for potential, future use.
- Reduce the *cache_swap* parameter in your config file. This will reduce the number of objects Squid keeps. Your overall hit ratio may go down a little, but your cache will perform significantly better

- Reduce the *maximum_object_size* parameter (Squid-1.1 only). You won't be able to cache the larger objects, and your byte volume hit ratio may go down, but Squid will perform better overall”

3.4 Reporting Tools

Most log analysis tools available for squid are listed on the following site:

http://www.squid-cache.org/Scripts/

The main logfile for squid is the **/var/log/squid/access.log** file. Next is a short overview of **calamaris** and **webalizer**. Also notice that **webmin** produces log reports based on calamaris.

- **Cachemgr.cgi script**

The current squid package installs a CGI script in **/usr/lib/squid** called **cachemgr.cgi**. One can copy this across to the **/var/www/cgi-bin** directory where all CGI scripts can run from. It is recommended however to set up a separate directory with htaccess authentication.

- **Calamaris**

The code is GPL and can be downloaded from http://cord.de/tools/squid/calamaris. You can generate reports as follow:

```
cat /var/log/squid/access.log | calamaris
➔ # Summary
lines parsed:            221
invalid lines:             0
parse time (sec):          0

# Incoming requests by method
method                          request      %    Byte       %   sec  kB/sec
--------------------------------- --------- ------ -------- ------ ---- -------
GET                                   221 100.00  1244262 100.00    3    1.68
--------------------------------- --------- ------ -------- ------ ---- -------
Sum                                   221 100.00  1244262 100.00    3    1.68

# Incoming UDP-requests by status
no matching requests

# Incoming TCP-requests by status
status                          request      %    Byte       %   sec  kB/sec
--------------------------------- --------- ------ -------- ------ ---- -------
HIT                                    35  15.84    42314   3.40    0    6.11
MISS                                  182  82.35  1197840  96.27    1    4.97
ERROR                                   4   1.81     4108   0.33  120    0.01
--------------------------------- --------- ------ -------- ------ ---- -------
Sum                                   221 100.00  1244262 100.00    3    1.68
```

In order to get information on webpage requests per host one can use the **-R** switch:

There are many more switches available (check the manpages for calamaris).

There are also a number of scripts that can run hourly or monthly reports. These scipts are included in the EXAMPLES file distributed with calamaris.

```
calamaris -R 5 /var/log/squid/access.log
```

➔ # Incoming TCP-requests by host

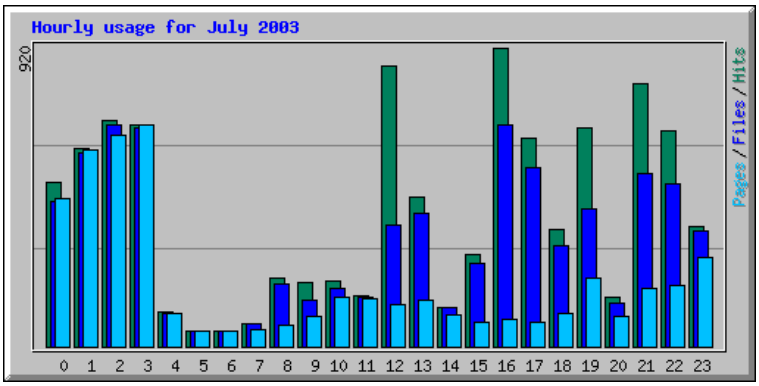
host / target	request	hit-%	Byte	hit-%	sec	kB/sec
192.168.2.103	72	0.00	323336	0.00	0	10.24
*.redhat.com	35	0.00	126726	0.00	0	10.44
*.suse.co.uk	20	0.00	63503	0.00	0	13.15
*.lemonde.fr	6	0.00	109712	0.00	1	16.39
207.36.15.*	5	0.00	8946	0.00	0	3.94
*.akamai.net	4	0.00	12428	0.00	1	4.43
other: 2 requested urlhosts	2	0.00	2021	0.00	1	0.71
192.168.2.101	63	0.00	295315	0.00	1	4.65
cord.de	17	0.00	115787	0.00	0	20.86
*.doubleclick.net	13	0.00	26163	0.00	1	2.07
*.google.com	10	0.00	30646	0.00	1	3.71
*.squid-cache.org	8	0.00	51758	0.00	1	6.53
<error>	4	0.00	4290	0.00	0	10474
other: 6 requested urlhosts	11	0.00	66671	0.00	5	2.28
Sum	135	0.00	618651	0.00	1	6.51

- **Webalizer**

This tool is often installed by default on some Linux distributions. It is also GPL'ed and can be downloaded from http://www.mrunix.net/webalizer/.

By editing the **/etc/webalizer.conf** file one can choose between apache access logs, ftp transfer logs or squid logs.

Example graphics generated with **webaliser**.



3.5 User Authentication (using PAM)

To prevent unauthorised users browsing on the Internet you can setup squid to ask for a username and password.

IMPORTANT: You cannot have user authentication and transparent proxy at the same time ! The work around is to block all outgoing requests on port 80, except the ones from the Squid proxy itself. Users are then forced to manually set up their browsers to use the proxy.

Configuration settings for PAM authentication:

Here are the list of options you need to set in the **squid.conf** file:

squid.conf	PAM authentication settings

```
[Older versions]
  authenticate_program /usr/lib/squid/pam_auth
[Squid V2.5]
  auth_param basic program /usr/lib/squid/pam_auth
  auth_param basic children 5
  auth_param basic realm Anvil Internet Proxy
  auth_param basic credentialsttl 2 hours

acl password proxy_auth REQUIRED

http_access allow password
```

The PAM configuration in /etc/pam.d:

Here we register squid to use the Pluggable Authentication Module.
This is done by adding a file in **/etc/pam.d/** called **squid** with the following content

/etc/pam.d/squid

```
auth required /lib/security/pam_stack.so service=system-auth

auth required /lib/security/pam_nologin.so

account required /lib/security/pam_stack.so service=system-auth

password required /lib/security/pam_stack.so service=system-auth
```

```
session required /lib/security/pam_stack.so service=system-auth
session required /lib/security/pam_limits.so
```

This is a standard policy description on what to do when a person logs on.
The login session is abstracted into 4 part: auth, account, password and session.

PAM then uses a specific library function which handles each stage.
Notice that most lines request the **system-auth** service which is the **/etc/pam.d/system-auth** file.

Also note the following from the pam_auth man page.

When used for authenticating to local UNIX shadow password databases the program must be running as root or else it won't have sufficient permissions to access the user password database. Such use of this program is not recommended, but if you absolutely need to then make the program setuid root

chown root pam_auth
chmod u+s pam_auth

Please note that in such configurations it is also strongly recommended that the program is moved into a directory where normal users cannot access it, as this mode of operation will allow any local user to brute-force other users passwords. Also note the program has not been fully audited and the author cannot be held responsible for any security issues due to such installations.

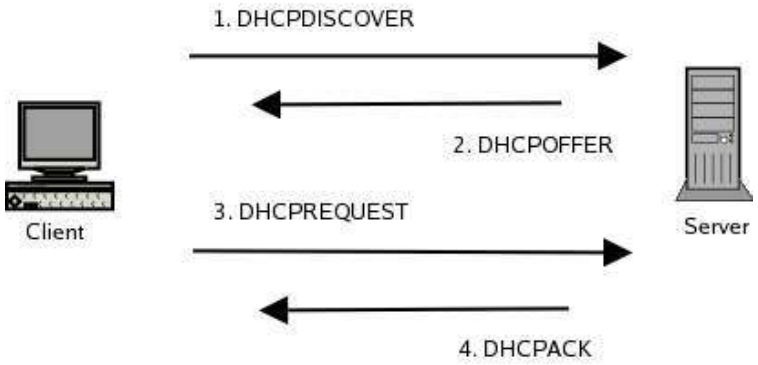
Network Client Management

1. DHCP Configuration

WARNING!! You should not attempt to run a DHCP server unless you are certain not to interfere with the network you are currently using – The safest option for this section is to be totally isolated from the network and use a hub or a switch to connect the classroom together.

1.1 Default DHCP Configurations

The basic communication process between a client workstation joining a TCP/IP network and the DHCP server is depicted below.



The DHCPDISCOVER request is sent using the broadcast 255.255.255.255

The DHCP server can use two methods to allocate IP addresses:

1. A dynamic IP is assigned for a client host chosen from a range of IPs
2. A fixed IP is assigned for a specific host (identified using the MAC address, similar to bootp)

Since a single DHCP server can be used to administer IPs over several network, the

DHCP Configuration

dhcpd.conf configuration file is composed of global options followed by network sections:

Example network block:

```
subnet 10.0.0.0 netmask 255.0.0.0 {
....
}
```

In the next example we will assign both dynamic IP addresses and a fixed IP address:

```
subnet 10.0.0.0 netmask 255.0.0.0 {
      range 10.5.5.10 10.5.5.200;
      host  proxy {
            hardware ethernet 00:80:C6:30:0A:7E;
                fixed-address 10.5.5.2;
        }
}
```

For each subnet it is possible to give information on network services, such as

- the default gateway
- the DNS domain name and the NIS domain name
- the DNS servers

In the subnet section above these directives would look like this:

```
      option routers                  10.254.254.254;
      option nis-domain               "nisdomain";
      option domain-name              "seafront.bar";
      option domain-name-servers      10.0.0.2;
```

The database of dynamically assigned IP addresses is stored in **/var/lib/dhcp/dhcpd.leases**

1.2 Dynamic DNS

We assume that we still have the private/public key used for the seafront TSIG authentication, we will use this same key to allow the DHCP server to update the zone files on the DNS server.

- **Additional Configurations on the DHCP Server**

On the DHCP server add the following to the **dhcpd.conf** file

```
ddns-update-style interim;
ignore client-updates;
key seafront.bar. {
       algorithm hmac-md5;
       secret QN3vIApnV76WS+a2Hr3qj+AqZjpuPjQgVWeeMMGSBC4=;
      };

      zone seafront.bar. {
        primary 192.168.3.100;
        key seafront.bar.;
      }

      zone 3.168.192.in-addr.arpa. {
        primary 192.168.3.100;
        key seafront.bar.;
      }
```

Optionally, it is possible to set a specific host name and domain name for a given host with the keywords

ddns-hostname *host_name*
ddns-domain-name *domain_name*

If the **ddns-hostname** option are not present then the DHCP server will try and use the name provided by the client. The domain on the other hand cannot be set by the client, so if **ddns-domain-name** is not present then the DHCP server will use the value given by the **domain-name** option.

Additional Configurations on the DNS Server

On the DNS server we need to do the following:

1. If you are using DNSSEC signed zone files then we need to use the unsigned zones
2. Add the an **allow-update** option to the seafront.bar entry:

```
zone "seafront.bar" IN {
      type master;
      file "seafront.zone";
      allow-update { key seafront.bar.;
      };
      allow-transfer { key seafront.bar.;
      };
};
```

and do the same with the in-addr.arpa zone:

```
zone "3.168.192.in-addr.arpa" IN {
        type master;
        file "192.168.3.local";
        allow-update { key seafront.bar.; };
        allow-transfer { key seafront.bar.;};
};
```

Client Configuration

On Linux clients it is possible to set the DHCP_HOSTNAME variable in the interface setup script. In Redhat-like variants this would be in the /etc/sysconfig/network-scripts/ifcfg-ethX files. Notice that this is simple a hostname, the domain name will be appended to that name on the DHCP sever.

1.3 DHCP Relay

The DHCPDISCOVER packets from clients reach the server through the broadcast 255.255.255.255, however broadcasts are blocked by routers.

So in a configuration with multiple networks and a single DHCP server each router needs to be able to relay DHCPDISCOVER broadcasts from a given network to the DHCP server.

For a Linux router this is done using the **dhcp-relay** or **dhcrelay** (more recent) tool. Both tools take a mandatory single argument which is th IP of the DHCP server.

By default the relay tools will listen on all network interfaces for DHCP requests. One can specify an interface with the **-i** option:

```
dhcrelay –i eth0  IP_FOR_DHCP_server
```

2. NIS Configuration

2.1 Master Server Configuration

On a Linux system the network information system (NIS) server is called **ypserv** (package name: ypserv). The RPM package has the same name and installs the following main files

Files installed with **ypserv**	Description
/etc/rc.d/init.d/yppasswdd	script for the daemon allowing users to change passwords
/etc/rc.d/init.d/ypserv	script for ypserv daemon
/etc/rc.d/init.d/ypxfrd	script for daemon used to speed up transfers to slave servers
/etc/ypserv.conf	main configuration file for ypserv
/var/yp/Makefile	Makefile for database files – should only be used on the master server

1. Choose a nisdomain name
In /etc/sysconfig/network set the variable NISDOMAIN. For example we can set the nisdomain to *linis* as follows\

```
NISDOMAIN=linis  # entry in /etc/sysconfig/network
```

The file **/etc/sysconfig/network** will be sourced by the **ypserv** initscript.

2. Make sure the master server will push map changes to the slave servers. For this you need to edit the file
/var/yp/Makefile and put

```
NOPUSH=false
```

3. Start the ypserv daemon

```
/etc/init.d/ypserv restart
```

4. Check that the nisdomain has been properly set

```
nisdomainname
linis
```

5. Create the databases, the **-m** option to **ypinit** is to indicate the server is a master server

```
/usr/lib/yp/ypinit -m
```

Enter the list of slave servers you will run on this domain. This will create a number of DBM files in
/var/yp/*linis* as well as a file called **/var/yp/ypservers**

2.2 Slave Server Configuration

On the slave server, we need to install the **ypserv** package too. This time we run **ypinit** and point it to the the master server:

```
/etc/rc.d/init.d/ypserv start
```

```
/usr/lib/yp/ypinit -s MASTER_IP
```

Also make sure to leave the line `NOPUSH=true` in **/var/yp/Makefile**

2.3 Client Setup

On the client the main service is called **ypbind** (package name: ypbind). This daemon is responsible for binding to a NIS server and successfully resolves names and passwords as needed.
The main configuration file is **/etc/yp.conf**.

If the NISDOMAIN variable is set in **/etc/sysconfig/network** which is sourced by the rc-script **/etc/init.d/ypbind** then the NIS server will be detected using the broadcast. One can also configure **yp.conf** and specify. Once this is set one can start **ypbind**

```
/etc/init.d/ypbind start
```

Make sure that the **nis** keyword is added to **/etc/nsswitch.conf.**

2.4 Setting up NFS home directories

Once the NIS server and clients are setup as above, anybody with an account on the NIS server can log onto a machine setup using **ypbind** pointing at the correct server.

All that is needed is for the user to access a home directory. This can be done in a number of ways. We will discribe one implementation using **NFS**.

We assume that all the home directories are on a single server with the following IP 10.0.0.1

All the clients are on the 10.0.0.0/8 network.

- **On the NFS server**

Edit /etc/exports and add

```
/home 10.0.0.1/8(rw)
```

Notice that root_squash will apply automatically.

- **On the client**

Edit /etc/fstab and add

```
10.0.0.1:/home /home     defaults  0    0
```

2.5 Basic NIS Administration

With the latest versions of **ypserv** a number of default maps are created using source files in **/etc**. It is possible to alter the `YPPWDDIR` and `YPSRCDIR` variables in the Makefile to build maps from alternative files from custom locations.

Updates are made with the Makefile in **/var/yp**. The targets are `all`, `passwd`, `group` ...

Copy the new maps to **/var/yp/linis** and run **yppush** to update the slave servers:

```
yppush MAP_NAME
```

Additional Commands

Command	Description
ypcat	get values from a database, for example `ypcat passwd`
ypwhich	return the name of the NIS server on the network

3. LDAP Configuration

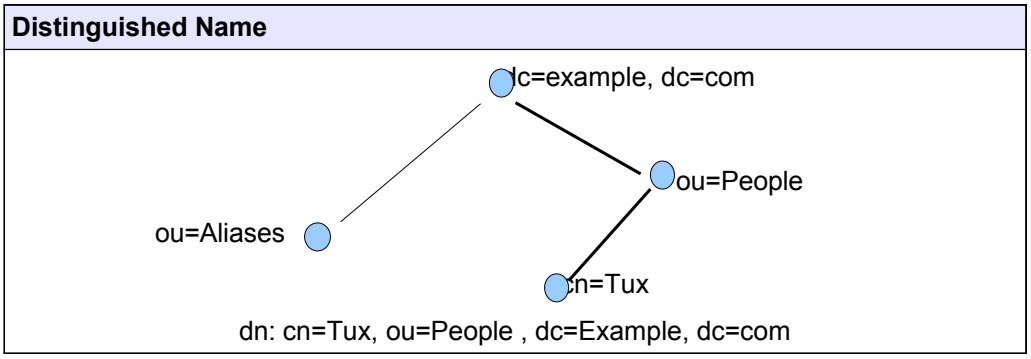
3.1 What is ldap

LDAP stands for Lightweight Directory Access Protocol. The protocol allows access to data in a tree-like structure using attributes. LDAP can be thought of as a specialised database which handles trees. Since directories are also trees, navigating LDAP fields is like navigating a directory. Added to this LDAP has been designed mainly for optimal access. This clarifies the words *Directory* and *Access*.

With this in mind let's see what characterises an LDAP database.

- **The Distinguished Name**

An item in the database can be referenced using a unique *Distinguished Name* (dn). This is similar to a file's full path in a directory. Each intermediate subfolder is called a *Relative Distinguished Name*.



- **More Terminology**

.

DIT The Data Information Tree
DN Distinguished Name
RDN Relative Distinguished Name
LDIF LDAP Data Interchange Format

Attributes:
dc Domain Component
cn Common Name
c Country
l Location
o Organisation
ou Organisational Unit
sn Surname
st State
uid User id

3.2 OpenLDAP server configuration

The server is called **slapd** (Standalone LDAP daemon) and it's configuration file is:

/etc/openldap/slapd.conf

We will cover each section of this file in more detail

- **Importing schemas**

There is an *include* clause in **slapd.conf** which tells the LDAP server which schemas should be loaded.

We need at least the following:

```
include         /etc/openldap/schema/core.schema
include         /etc/openldap/schema/misc.schema
```

```
include         /etc/openldap/schema/cosine.schema
include         /etc/openldap/schema/nis.schema
include         /etc/openldap/schema/inetorgperson.schema
```

- **Database Definition**

Available DBMs (Database Managers) are *ldbm* or the more recent *bdb*.
We will use bdb:

```
database  bdb
```

You need to specify the root or base for the LDAP directory, as well as the directory where the database file will be kept. This is done below;

```
suffix          "dc=example,dc=com"
directory /var/lib/ldap/
```

The following lines are only needed when modifying the LDAP server online. You can then specify an adminstrator username/password. Use the **slappasswd** to generate an encrypted hash (see **3.4 Migrating System Files to LDAP**):

```
rootdn           "cn=Manager,dc=example,dc=com"
rootpw           {SSHA}KiXS5htbnVEQp7OrjoteQZHHICs0krBO
```

3.3 Client configuration files

There are two configuration files called ldap.conf. Here is what they do:

- The /etc/ldap.conf file is used by the nss_ldap and pam_ldap modules
- The file /etc/openldap/ldap.conf is used by the tools **ldapsearch** and **ldapadd**

For example, to save time typing:

```
ldapsearch -b "dc=example,dc=com"  -x
```

you can add the next lines to **/etc/openldap/ldap.conf**

```
BASE      dc=example, dc=com
HOST      127.0.0.1
```

*So far we have configured **slapd** and the configuration file for **ldapsearch** in particular. Once we have populated an LDAP directory we will be able to test our setup by typing:*

```
ldapsearch -x
```

3.4 Migrating System Files to LDAP

There are two methods available to populate an LDAP directory.

- If the ldap daemon **slapd** is stopped, we can do an *offline* update using **slapadd**
- While **slapd** is running, it is possible to perform an *online* update using **ldapadd** or **ldapmodify**

We will also use migration tools which can be downloaded from:

http://www.padl.com/OSS/MigrationTools.html

Creating LDAP directories *offline*

We are going to work in the directory containing the LDAP migration Perl scripts which we have downloaded from www.padl.com.

Notice: Some distributions may include the migration tools with the LDAP server package.

You should have the following files:

migrate_automount.pl
CVSVersionInfo.txt
Make.rules
MigrationTools.spec
README
ads
migrate_netgroup_byhost.pl
migrate_netgroup_byuser.pl
migrate_networks.pl
migrate_passwd.pl
migrate_profile.pl
migrate_protocols.pl
migrate_rpc.pl
migrate_base.pl
migrate_common.ph
migrate_fstab.pl
migrate_group.pl
migrate_hosts.pl
migrate_netgroup.pl
migrate_aliases.pl
migrate_all_netinfo_offline.sh
migrate_all_netinfo_online.sh
migrate_all_nis_offline.sh
migrate_all_nis_online.sh
migrate_all_nisplus_offline.sh
migrate_all_nisplus_online.sh

migrate_services.pl
migrate_slapd_conf.pl
migrate_all_offline.sh
migrate_all_online.sh

First edit **migrate_common.ph** and change the $DEFAULT_BASE variable to:

```
$DEFAULT_BASE = "dc=example,dc=com";
```

NOTICE
When migrating the /etc/passwd file one can either use shadow passwords or not. When using shadow passwords an added objectClass called shadowAccount is used in the LDAP record and there is no need to migrate the shadow password file.

We create our first LDIF file called **base.ldif** to serve as our root:

```
/migrate_base.pl > base.ldif
```

This flat file will be converted into bdb (or ldbm) files stored in **/var/lib/ldap** as follows:

```
slapadd -v < base.ldif
```

We next choose to migrate the password without shadow passwords as follows:

```
pwunconv
```

```
./migrate_passwd.pl /etc/passwd passwd.ldif
```

The entries in **passwd.ldif** should look like this:

```
dn: uid=test,ou=People,dc=example,dc=com
uid: test
cn: test
objectClass: account
objectClass: posixAccount
objectClass: top
userPassword: {crypt}$1$FGrRfa0u$lo5XwA9xxssmjboNB2Z361
loginShell: /bin/bash
uidNumber: 505
```

```
gidNumber: 506
homeDirectory: /home/test
```

Now let's add this LDIF file to our LDAP directory:(remember that LDAP is stopped so we are still offline)

```
slapadd -v -l passwd.ldif  or
slapadd -v < passwd.ldif
```

NOTICE:
Make sure all the files in **/var/lib/ldap** belong to user **ldap**

TESTING:

Restart the LDAP server

```
/etc/init.d/ldap restart
```

Search all the entries in the directory:

```
ldapsearch -x
```

If the **ldap** server does not respond, or the result from **ldapsearch** is empty, it is possible to show the content of the LDAP databases in **/var/lib/ldap** with the **slapcat** command.

- **Creating LDAP Directories Online**

The LDAP server can be updated online, without having to shut the ldap service down. For this to work however we must specify a **rootdn** and a **rootpw** in **/etc/openldap/slapd.conf**.

The password is generated from the command line as follows

```
sldappasswd
New password:
```

```
Re-enter new password:
{SSHA}XyZmHH1RlnSVXTj87UvxOAOCZA8oxNCT
```

We next choose the **rootdn** in **/etc/openldap/slapd.conf** to be

```
rootdn          "cn=Manager,dc=example,dc=com"
rootpw          {SSHA}XyZmHH1RlnSVXTj87UvxOAOCZA8oxNCT
```

The next line will update the LDAP entries

```
ldapmodify -f passwd.ldif -x -D "dc=example,dc=com" -W
Enter LDAP Password:
```

3.5 LDAP Authentication Scheme

- **Server Configuration**

We assume that the LDAP server has been configured as above.

The passwords in the LDAP directory can also be updated online with the **ldappasswd** command.

The next line will update the password for user *tux* on the LDAP server.

```
ldappasswd  -D "cn=Manager,dc=example,dc=com"  -S -x -W  \
"uid=tux,ou=People,dc=example,dc=com"
```

The **-S** switch is used to configure a new password.

We assume that the IP address for the server is 10.0.0.1 and that the domain component is "dc=example,dc=com"

You may allow users to change their passwords on the LDAP server as follows:

1. Copy the *passwd* PAM file **/etc/share/doc/nss_ldap**-*version*/**pam.d/passwd** to **/etc/pam.d**

2. Add the following access rule in **/etc/openldap/slapd.conf**

```
access to attrs=userPassword
  by self write
  by anonymous auth
  by * none
```

Client Configuration

The clients need to have the **nss_ldap** package installed (some distributions have a separate **pam_ldap** package with the PAM related modules and files). The following files and libraries are installed:

/etc/ldap.conf	set the hostname and the domain component of the LDAP server used for authentications
/lib/libnss_ldap-2.3.2.so	an ldap module for the NameService Switch
/lib/security/pam_ldap.so	the PAM ldap module
/usr/lib/libnss_ldap.so	a symbolic link to /lib/libnss_ldap-2.3.2.so
/usr/share/doc/nss_ldap-207/pam.d	sample files for programs using PAM

If we don't use SSL certificates then **/etc/ldap.conf** is as follows:

The **/etc/ldap.conf** file

```
host 10.0.0.1
base dc=example,dc=com
ssl no
pam_password md5
```

Next in **/etc/pam.d** replace the file called **login** with **/usr/share/doc/nss_ldap-207/pam.d/login**. This will tell the authentication binary **/bin/login** to use the pam_ldap.so module.

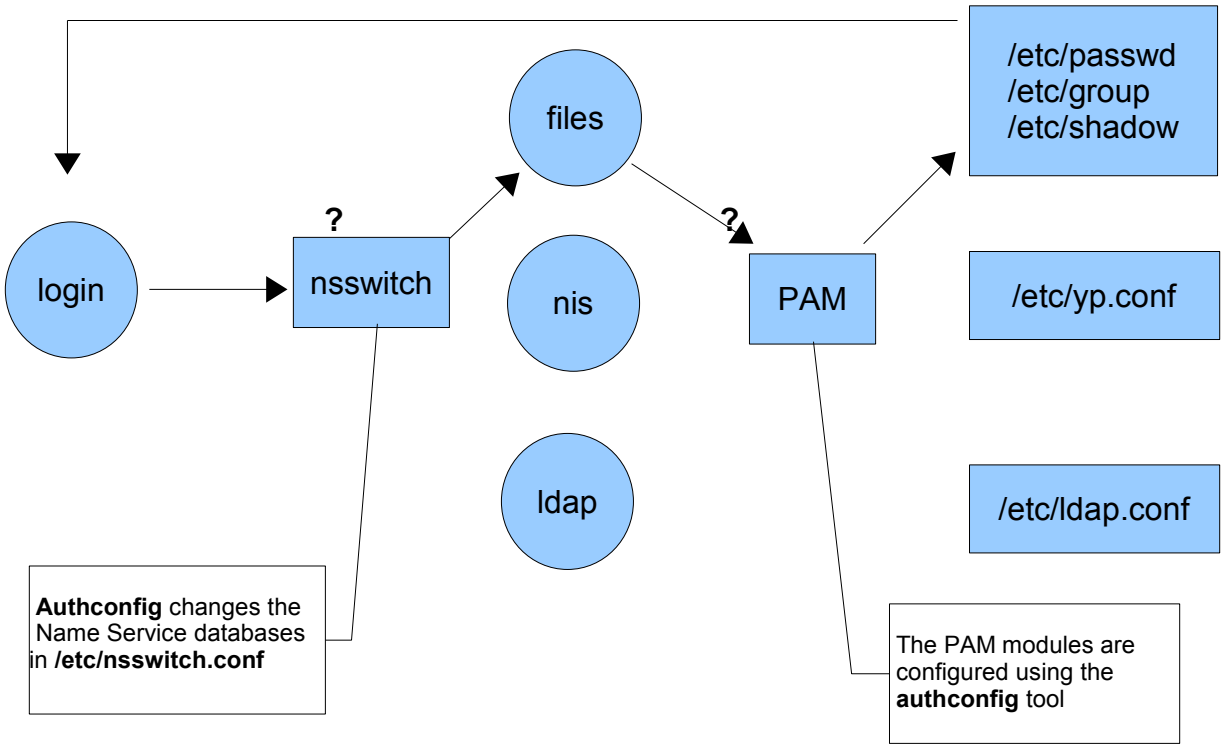
Finally the **/etc/nsswitch.conf** needs to have the following line:

```
passwd ldap files
```

Check the **/var/log/ldap/ldap.log** file on the server to follow the authentication process.

4. PAM Authentication

Services or applications which need authentication can use the pluggable authentication module (PAM) mechanism which offer a modular approach to the authentication process. For example, if a new hardware authentication scheme is added to a system, using smart cards or prime number generators, and if corresponding PAM library modules are available for this new scheme, then it is possible to modify existing services to use this new authentication scheme.



4.1 PAM Aware Applications

Services which use pluggable authentication modules have been compiled with **libpam**. For example **sshd** is such a service:

```
ldd `which sshd` | grep pam
        libpam.so.0 => /lib/libpam.so.0 (0x00941000)
```

These applications will scan the PAM configuration files which in turn tell the application how the authentication will take place.

4.2 PAM Configuration

PAM configuration is controlled with the single file **/etc/pam.conf**. This file contains a list of services and a set of instructions, as follows:

service type control module-path module-arguments

However, if the directory **/etc/pam.d** exists then **pam.conf** is ignored and each service is configured through a separate file in **pam.d**. These files are similar to **pam.conf** except that the *service* name is dropped:

type control module-path module-arguments

type : defines the “management group type”. PAM modules are classified into four management groups which define different aspects of the authentication process:

account: check the validity of the account (eg. does the users have a UNIX account? is the user authorised to use the application ...)

auth: the authentication method. This points to a module(s) responsible for the challenge-response

password: defines how to change user passwords, if at all.

session: modules that are run before and after a service is granted

control: defines what action to take if the module fails. The simple controls are:

requisite: a failure of the module results in the immediate termination of the authentication process

required: a failure of the module will result in the termination of the authentication once all the other modules of the same type have been executed

sufficient: success of the module is sufficient except if a prior **required** module has failed

optional: success or failure of this module are not taken into account unless it is the only requirement of its type

module-path: the path to a PAM module (usually in /lib/security)

module-arguments: list of arguments for a specific module

PAM Authentication

System Security

1. Iptables/Ipchains

So What's A Packet Filter?
A packet filter is a piece of software which looks at the header of packets as they pass through, and decides the fate of the entire packet. It might decide to DROP the packet (i.e., discard the packet as if it had never received it), ACCEPT the packet (i.e., let the packet go through), or something more complicated. - from the “Packet Filtering HOWTO” by Rusty Russell

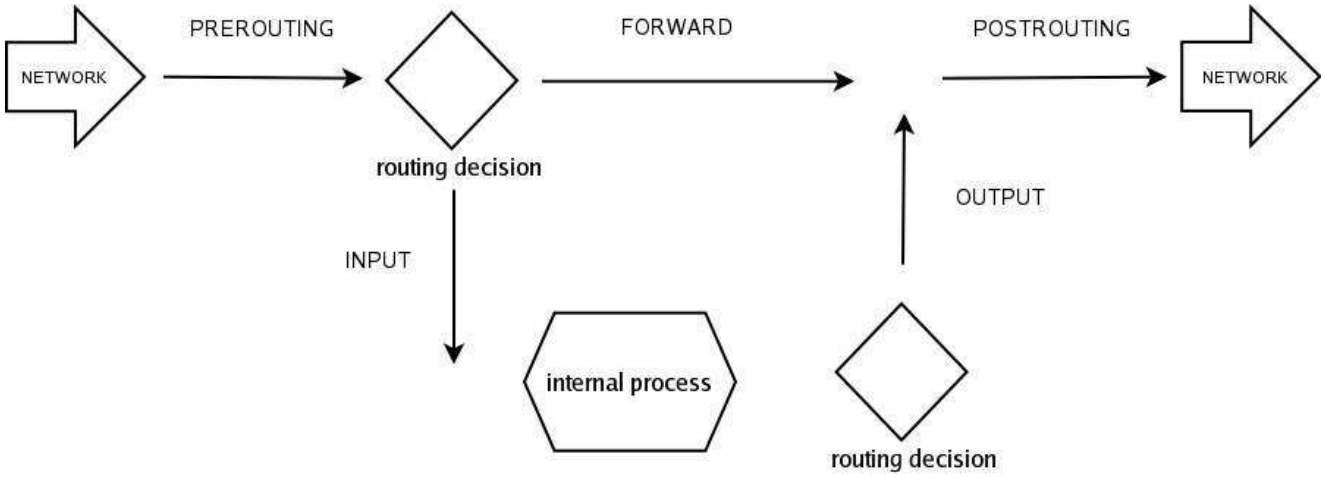
For more in depth information see the HOWTOs at www.netfilter.org.

In this section we introduce the **iptables** concepts of chains, tables and targets. We then look at some examples to illustrate network address translation (NAT) as well as the special cases of masquerading and transparent redirections.

1.1 The Chains

A chain is a list of rules which by considering criteria found in the packet's header will make decisions about the type of action to take (target). There are five chains corresponding to different stages in the netfilter framework: PREROUTING, INPUT, FORWARD, POSTROUTING and OUTPUT.

Below is a diagram of the progression of a packet through the kernel netfilter framework:



1.2 The Tables

There are three built-in tables (the IP Tables) which allow to carry out different tasks as listed below.

filter: this is the default table and the packets are never altered. Packets are available from the following chains:	
INPUT	for packets coming into the box itself
OUTPUT	for locally-generated packets
FORWARD	for packets being routed through the box (check the value of /proc/sys/net/ipv4/ip_forward)

nat: this table only deals with network address translations (NAT) it is consulted when a packet creating a new connection is encountered. Packet headers connected with routing can be altered here. The following chains are considered:	
PREROUTING	alters the packets as they come in
POSTROUTING	alters packets as they go out
OUTPUT	alters locally generated packets before routing

mangle: used for specialized packet alterations. Targets in this table allow the TOS or TTL field to be modified.	
Until kernel 2.4.17 it could only interact with two chains:	
PREROUTING	for altering incoming packets before routing
OUTPUT	for altering locally-generated packets before routing
Since kernel 2.4.18, the three other chains are also supported:	
INPUT	for packets coming into the box itself
FORWARD	for altering packets being routed through the box
POSTROUTING	for altering packets as they are about to go out

1.3 The Targets

The part of a the filtering rule which determines what action to take if the rule is matched is called a *target* and is preceded by a **-j** flag (jump). Here is an overview of available targets for a given table:

all tables: ACCEPT, REJECT, DROP, LOG, ULOG, TCPMSS, MIRROR
filter: (nothing individual to this chain)
nat: DNAT, SNAT, MASQUERADE, REDIRECT
mangle: TOS, MARK, DSCP, ECN

There are more targets, but they come as part of additional extension kernel modules.

1.4 Example Rules

1. Example **filter** rules:

Drop incoming icmp-request as well as outgoing icmp-reply packets

```
iptables  -A INPUT -p icmp --icmp-type echo-request  -j DROP
iptables  -A OUTPUT -p icmp --icmp-type echo-reply  -j DROP
```

Notice: The protocol extension flags allow you to specify more information about a specific protocol. In the case of TCP packets for example you may have:

-p tcp –tcp-flags ALL SYN,ACK

ALL stands for SYN ACK FIN RST URG and PSH. This rule says that all flags must be examined and of those, if the SYN and ACK flags are set, the rule is true.

2. Example Destination Network Address Translation (DNAT):

All requests on port 80 for host 192.168.3.100 are redirected to the host 10.1.1.1 on port 80

```
iptables -t nat -A PREROUTING -p tcp -i eth0 -d 192.168.3.100 \
 --dport 80  -j DNAT --to 10.1.1.1:80
```

3. Example Source Network Address Translation (SNAT):

The SNAT target is used to change the Source Address. For example, in the case where a router switches the from address on all outgoing packets leaving through ppp0 to it's own (public) IP address. The line would look like this:

```
iptables –t nat –A POSTROUTING –o ppp0 –s 192.168.3.0/24 –d 0/0 \
 –j SNAT –to ROUTER_IP
```

This rule can also be written using the MASQUERADE target:

```
iptables –t nat –A POSTROUTING –o ppp0 –s 192.168.3.0/24 –d 0/0 –j MASQUERADE
```

4. Example Redirection

A redirection is a special case of DNAT where the `--to host` is the same host. For example if a proxy server is running on a router, all requests through port 80 can be PRE-routed through port 3128 with:

```
iptables –A PREROUTING –t nat –i eth0 –p tcp --dport 80 –j REDIRECT --to-port 3128
```

TASK: At this stage if you want to implement a transparent proxy with the previous redirection rule you will have to change the configuration file **squid.conf** and add the following:

```
httpd_accel_host virtual
httpd_accel_port 80
httpd_accel_with_proxy on
httpd_accel_uses_host_header on
```

Remember that if you have implemented an authentication scheme with squid you may have to disable it for the transparent proxy to work.

2. Differences with Ipchains

We will simply mention some of the main improvement over **ipchains**.

With *iptables, each filtered packet is only processed using rules from one chain rather than multiple chains.* In other words, a FORWARD packet coming into a system using

ipchains would have to go through the INPUT, FORWARD, and OUTPUT chains in order to move along to its destination. However, **iptables** only sends packets to the INPUT chain if they are destined for the local system and only sends them to the OUTPUT chain if the local system generated the packets. For this reason, you must be sure to place the rule designed to catch a particular packet in the correct chain that will actually see the packet. The advantage is that you now have finer-grained control over the disposition of each packet. If you are attempting to block access to a particular website, it is now possible to block access attempts from clients running on hosts which use your host as a gateway. An OUTPUT rule which denies access will no longer prevent access for hosts which use your host as a gateway.

Additional Matching Extensions

Matching extensions are implemented in **iptables** as modules. Modules are invoked with the **-m** switch.

For example the **state** module makes it possible to distinguish new packets and packets from an established connect. The packet is tested for a matching **state**. Particular state values are NEW, ESTABLISHED, RELATED or INVALID.

```
iptables –A INPUT –p tcp –m state --state ESTABLISHED –j ACCEPT
iptables –A OUTPUT –p tcp –m state --state NEW,ESTABLISHED –j ACCEPT
```

Matching extension modules are listed below.

Module	Description	Option (example)
connrate	matches the current connection rate	**--connrate** `[!] [from]:[to]`
dstlimit	This module allows you to limit the packet per second (pps) rate on a per destination IP or per destination port base	**--dstlimit** `avg`
icmp	this extension is loaded if '--protocol icmp' is specified	**--icmptype** `[!] typename`
iprange	specify a range of IPs	**--src-range** `IP-IP`
length	matches the length of the packet	**--length** `length`
mac	match the MAC source	**--mac-source** `[!] address`

state	determine the state of a packet (NEW,ESTABLISHED,RELATED, INVALIDE)	–**state** `state`

3. Security Tools

3.1 SSH

For a first description of the **ssh** client and **sshd** server see the section on “Basic Security” in the lpi-manuals document for LPI 102. For an in depth presentation see the Internet draft “The SSH (Secure Shell) Remote Login Protocol” at http://www.free.lp.se/fish/rfc.txt.

This section covers the server configuration file and briefly discusses other mechanisms that the SSH protocol offers such as X11 forwarding and port forwarding.

- **sshd_con fig overview**

Port 22	Specify which port to listen on. Multiple “Port” options can be used
Protocol 2,1	Specify version 1 or version 2 SSH protocol. Can be a comma separated list. If both are supplied, they are tried in the order presented.
DenyUsers [USER]@HOST	Deny users from a specific host. Wild cards such as * can be used
IgnoreRhosts yes/no	Default is yes – Ignore the ~/.rhosts and ~/.shosts files
PermitEmptyPasswords yes/no	Default is no – Allow login with an empty passwords when password authentication is allowed
PermitRootLogin yes/no	Allow or disallow root access
X11Forwarding yes/no	Instructs the remote end to route X11 traffic back through the ssh tunnel to the user's X session. Unless disabled, the xauth settings will be transferred in order to properly authenticate remote X applications

- **Port Forwarding**

It is possible to do port forwarding with the SSH client. This is often used to provide a simple mechanism to encrypt a connection. For example one can open a local (-L) port (1234) pointing to the remote host (www.google.com) on another port (80) as follows:

```
ssh -L 1234:www.google.com:80 127.0.0.1
```

- **Quick VPN**

This is a user-space VPN as opposed to other types of VPNs which are kernel based.

```
/usr/sbin/pppd noauth pty \
"ssh SOME_HOST -l root '/usr/sbin/pppd notty noauth
192.168.0.1:192.168.0.2'"   \
192.168.0.2:192.168.0.1
```

3.2 LSOF

lsof - show open files used by processes

Traditionally used to list PIDs of processes running on a given directory:

```
lsof +D DIRECTORY
```

lsof will output the following information:

NAME:	name of the process
PID:	process ID
USER:	name of the user to whom the process belongs
FD:	File desciptor (e.g u = read write, r = read, w = write)
TYPE:	The file type (e.g REG = regular file)
DEVICE:	Major/Minor number (e.g 3,16 =/dev/hda16)
SIZE:	Size or offset of the file
NODE:	Inode of the file
NAME:	The name of the file

Lsof can also be used to display network sockets. For example the following line will list all internet connections:

```
lsof -i
```

You can also list connections to a single host:

```
lsof -i @HOST
```

For example if a host TOFFY is connected to your localhost on port 1234, the following would display information about the connection:

```
lsof -i @TOFFY:1234
```

3.3 NETSTAT

netstat - Print network connections, routing tables ...

Main options are:

-r	display routing tables	-l	only listening services
-C	display route cache	--inet	restrict to network sockets

Protocol types:

-t	select tcp
-u	select udp

3.4 TCPDUMP

tcpdump – dump traffic on a network

This is taken directly from the man pages:

- **The TCP Packet**

"The general format of a tcp protocol line is:

```
src > dst: flags data-seqno ack window urgent options
```

Src and **dst** are the source and destination IP addresses and ports.

Flags are some combination of S (SYN), F (FIN), P (PUSH) or R (RST) or a single '.' (no flags).

Data-seqno describes the portion of sequence space covered by the data in this packet (see example below).

Ack is sequence number of the next data expected in the other direction on this connection.

Window is the number of bytes of receive buffer space available in the other direction on this connection.

Urg indicates there is 'urgent' data in the packet.

Options are tcp options enclosed in angle brackets `(e.g., <mss 1024>)`

◆ **Capturing TCP packets with particular flag combinations (e.g SYN-ACK, URG-ACK, etc.)**

There are 8 bits in the control bits section of the TCP header:

```
CWR | ECE | URG | ACK | PSH | RST | SYN | FIN
```

Let's assume that we want to watch packets used in establishing a TCP connection. Recall the structure of a TCP header without options:

```
 0                            15                              31
-----------------------------------------------------------------
|          source port          |       destination port        |
-----------------------------------------------------------------
|                        sequence number                        |
-----------------------------------------------------------------
|                     acknowledgment number                     |
-----------------------------------------------------------------
|  HL   | rsvd  |C|E|U|A|P|R|S|F|        window size            |
-----------------------------------------------------------------
|         TCP checksum          |       urgent pointer          |
-----------------------------------------------------------------
```

A TCP header usually holds 20 octets of data, unless options are present. The first line of the graph contains octets 0 - 3, the second line shows octets 4 - 7 etc

Starting to count with 0, the relevant TCP control bits are contained in octet 13:

```
 0             7|             15|             23|             31
----------------|---------------|---------------|----------------
|  HL   | rsvd  |C|E|U|A|P|R|S|F|        window size             |
----------------|---------------|---------------|----------------
|               |  13th octet   |               |               |
```

Let's have a closer look at octet no. 13:

```
                |               |
                |---------------|
                |C|E|U|A|P|R|S|F|
                |---------------|
                |7   5   3     0|
```

These are the TCP control bits we are interested in. We have numbered the bits in this octet from 0 to 7, right to left, so the PSH bit is bit number 3, while the URG bit is number 5.

Recall that we want to capture packets with only SYN set. Let's see what happens to octet 13 if a TCP datagram arrives with the SYN bit set in its header:

```
                |C|E|U|A|P|R|S|F|
                |---------------|
                |0 0 0 0 0 0 1 0|
                |---------------|
                |7 6 5 4 3 2 1 0|
```

Looking at the control bits section we see that only bit number 1 (SYN) is set.

Assuming that octet number 13 is an 8-bit unsigned integer in network byte order, the binary value of this octet is

```
00000010
```

and its decimal representation is

```
   7     6     5     4     3     2     1     0
0*2 + 0*2 + 0*2 + 0*2 + 0*2 + 0*2 + 1*2 + 0*2  =  2
```

We're almost done, because now we know that if only SYN is set, the value of the 13th octet in the TCP header, when interpreted as a 8-bit unsigned integer in network byte order, must be exactly 2.

This relationship can be expressed as

```
tcp[13] == 2
```

3.5 NMAP

nmap - Network exploration tool and security scanner

The scanner makes use of the fact that a closed port should (according to RFC 793) send back an RST. In the case if a SYN scan, connections that are half opened are immediately close by nmap by sending an RST itself.

Scan Types:

SYN or Half-open: -sS
Nmap will send a synchronisation packet SYN asking for a connection. If the remote host send a RST/ACK it is assumed that the port is closed. If the remote host sends a SYN/ACK this indicates that the port is listening.

UDP: -sU
UDP is connectionless. So there is no need for a 3 way handshake as with TCP. If a port is closed the server will send back a ICMP PORT UNREACHABLE. One then deduces that all the other ports are open (not reliable in the case were ICMP messages are blocked).

TCP NULL: -sN
TCP packet with no flags set. Closed port will send a RST when receiving this packets (except with MS Windows).

TCP Xmas: -sX
TCP packet with the FIN+URG+PUSH flags set. The remote host should send back a RST for all closed ports when receiving a Xmas packet.

++++ many more, Ack scans -sA, RPC scan -sR ...

TASKS:

```
- Configure iptable rules to log the different nmap scans using the –tcp-flags
option.

- Notice that tcpdump can take compound options such as
tcpdump host A and not host B
tcpdump ip proto ICMP and host HOST ...

- Out of interest, go to www.tcpdump.org and try the libpcap tutorials (remember to
compile the codes CODE.c with "gcc CODE.c -l pcap" ...)
```

Exam 202: Detailed Objectives

This is a required exam for LPI certification Level 2. It covers advanced network administration skills that are common across all distributions of Linux.

Each objective is assigned a weighting value. The weights range roughly from 1 to 10, and indicate the relative importance of each objective. Objectives with higher weights will be covered in the exam with more questions.

Topic 205: Networking Configuration

*** 2.205.1 Basic networking configuration**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 5

Description: The candidate should be able to configure a network device to be able to connect to a local network and a wide-area network. This objective includes being able to communicate between various subnets within a single network, configure dialup access using mgetty, configure dialup access using a modem or ISDN, configure authentication protocols such as PAP and CHAP, and configure TCP/IP logging.

Key files, terms, and utilities include:

```
/sbin/route
/sbin/ifconfig
/sbin/arp
/usr/sbin/arpwatch
/etc/
```

*** 2.205.2 Advanced Network Configuration and Troubleshooting**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 3

Description: The candidate should be able to configure a network device to implement various network authentication schemes. This objective includes configuring a multi-homed network device, configuring a virtual private network and resolving networking and communication problems.

Key files, terms, and utilities include:

```
/sbin/route
/sbin/route
/sbin/ifconfig
/bin/netstat
/bin/ping
/sbin/arp
/usr/sbin/tcpdump
/usr/sbin/lsof
/usr/bin/nc
```

Topic 206 Mail & News

*** 2.206.1 Configuring mailing lists**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 1

Description: Install and maintain mailing lists using majordomo. Monitor majordomo problems by viewing majordomo logs.

Key files, terms, and utilities include:
Majordomo2

*** 2.206.2 Using Sendmail**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 4

Description: Candidates should be able to manage a Sendmail configuration including email aliases, mail quotas, and virtual mail domains. This objective includes configuring internal mail relays and monitoring SMTP servers.

Key files, terms, and utilities include:

```
/etc/aliases
sendmail.cw
virtusertable
genericstable
```

*** 2.206.3 Managing Mail Traffic**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 3

Description: Candidates shold be able to implement client mail management software to filter, sort, and monitor incoming user mail. This objective includes using software such as procmail on both server and client side.

Key files, terms, and utilities include:
`procmail`

*** 2.206.4 Serving news**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 1

Description: Candidates should be able to install and configure news servers using inn. This objective includes customizing and monitoring served newsgroups.

Key files, terms, and utilities include:
`innd`

Topic 207: DNS

*** 2.207.1 Basic BIND 8 configuration**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: The candidate should be able to configure BIND to function as a caching-only DNS server. This objective includes the ability to convert a BIND 4.9 named.boot file to the BIND 8.x named.conf format, and reload the DNS by using kill or ndc. This objective also includes configuring logging and options such as directoryh location for zone files.

Key files, terms, and utilities include:
`/etc/named.conf`
`/usr/sbin/ndc`

```
/usr/sbin/named-bootconf
kill
```

*** 2.207.2 Create and maintain DNS zones**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 3

Description: The candidate should be able to create a zone file for a forward or reverse zone or root level server. This objective includes setting appropriate values for the SOA resource record, NS records, and MX records. Also included is adding hosts with A resource records and CNAME records as appropriate, adding hosts to reverse zones with PTR records, and adding the zone to the /etc/named.conf file using the zone statement with appropriate type, file and masters values. A candidate should also be able to delegate a zone to another DNS server.

Key files, terms, and utilities include:
contents of /var/named
zone file syntax
resource record formats

```
dig
nslookup
host
```

*** 2.207.3 Securing a DNS server**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 3

Description: The candidate should be able to configure BIND to run as a non-root user, and configure BIND to run in a chroot jail. This objective includes configuring DNSSEC statements such as key and trusted-keys to prevent domain spoofing. Also included is the ability to configure a split DNS configuration using the forwarders statement, and specifying a non-standard version number string in response to queries.

Key files, terms, and utilities include:
SysV init files or rc.local

```
/etc/named.conf
/etc/passwd
dnskeygen
```

Topic 208 Web Services

*** 2.208.1 Implementing a web server**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: Candidates should be able to install and configure an Apache web server. This objective includes monitoring Apache load and performance, restricting client user access, configuring mod_perl and PHP support, and setting up client user authentication. Also included is configuring Apache server options such as maximum requests, minimum and maximim servers, and clients.

Key files, terms, and utilities include:

```
access.log
    .htaccess
    httpd.conf
    mod_auth
    htpasswd
    htgroup
```

*** 2.208.2 Maintaining a web server**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: Candidates should be able to configure Apache to use virtual hosts for websites without dedicated IP addresses. This objective also includes creating an SSL certification for Apache and defining SSL definitions in configuration files using OpenSSL. Also included is customizing file access by implementing redirect statements in Apache's configuration files.

Key files, terms, and utilities include:

```
httpd.conf
```

*** 2.208.3 Implementing a proxy server**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: Candidates should be able to install and configure a proxy server using Squid. This objective includes impelementing access policies, setting up authentication, and utilizing memory usage.

Key files, terms, and utilities include:
`squid.conf`
`acl`
`http_access`

Topic 210 Network Client Management

*** 2.210.1 DHCP configuration**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: The candidate should be able to configure a DHCP server and set default options, create a subnet, and create a dynamically-allocated range. This objective includes adding a static host, setting options for a single host, and adding bootp hosts. Also included is to configure a DHCP relay agent, and reload the DHCP server after making changes.

Key files, terms, and utilities include:
`dhcpd.conf`
`dhcpd.leases`

*** 2.210.2 NIS configuration**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 1

Description:The candidate should be able to configure an NIS server and create NIS maps for major configuration files. This objective includes configuring a system as a NIS client, setting up an NIS slave server, and configuring ability to search local files, DNS, NIS, etc. in nsswitch.conf.

Key files, terms, and utilities include:
`nisupdate, ypbind, ypcat, ypmatch, ypserv, ypswitch, yppasswd, yppoll, yppush, ypwhich, rpcinfo`
`nis.conf, nsswitch.conf, ypserv.conf`
Contents of `/etc/nis/: netgroup, nicknames, securenets Makefile`

*** 2.210.3 LDAP configuration**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 1

Description: The candidate should be able to configure an LDAP server. This objective includes configuring a directory hierarchy, adding group, hosts, services and other data to the hierarchy. Also included is importing items from LDIF files and add items with a management tool, as well as adding users to the directory and change their passwords.

Key files, terms, and utilities include:

```
slapd
slapd.conf
```

*** 2.210.4 PAM authentication**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: The candidate should be able to configure PAM to support authentication via traditional /etc/passwd, shadow passwords, NIS, or LDAP.

Key files, terms, and utilities include:

```
/etc/pam.d
pam.conf
```

Topic 212 System Security

*** 2.212.2 Configuring a router**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: The candidate should be able to configure ipchains and iptables to perform IP masquerading, and state the significance of Network Address Translation and Private Network Addresses in protecting a network. This objective includes configuring port redirection, listing filtering rules, and writing rules that accept or block datagrams based upon source or destination protocol, port and address. Also included is saving and reloading filtering configurations, using settings in /proc/sys/net/ipv4 to respond to DOS attacks, using /proc/sys/net/ipv4/ip_forward to turn IP forwarding on and off, and using tools such as

PortSentry to block port scans and vulnerability probes.

Key files, terms, and utilities include:
/proc/sys/net/ipv4
/etc/services
ipchains
iptables
routed

*** 2.212.3 Securing FTP servers**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: The candidate should be able to configure an anonymous download FTP server. This objective includes configuring an FTP server to allow anonymous uploads, listing additional precautions to be taken if anonymous uploads are permitted, configuring guest users and groups with chroot jail, and configuring ftpaccess to deny access to named users or groups.

Key files, terms, and utilities include:
ftpaccess, ftpusers, ftpgroups
/etc/passwd
chroot

*** 2.212.4 Secure shell (OpenSSH)**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 2

Description: The candidate should be able to configure sshd to allow or deny root logins, enable or disable X forwarding. This objective includes generating server keys, generating a user's public/private key pair, adding a public key to a user's authorized_keys file, and configuring ssh-agent for all users. Candidates should also be able to configure port forwarding to tunnel an application protocol over ssh, configure ssh to support the ssh protocol versions 1 and 2, disable non-root logins during system maintenance, configure trusted clients for ssh logins without a password, and make multiple connections from multiple hosts to guard against loss of connection to remote host following configuration changes.

Key files, terms, and utilities include:
ssh, sshd
/etc/ssh/sshd_config

```
~/.ssh/identity.pub and identity, ~/.ssh/authorized_keys
.shosts, .rhosts
```

*** 2.212.5 TCP_wrappers**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 1

Description: The candidate should be able to configure tcpwrappers to allow connections to specified servers from only certain hosts or subnets.

Key files, terms, and utilities include:

```
inetd.conf, tcpd
hosts.allow, hosts.deny
xinetd
```

*** 2.212.6 Security tasks**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 3

Description: The candidate should be able to install and configure kerberos and perform basic security auditing of source code. This objective includes arranging to receive security alerts from Bugtraq, CERT, CIAC or other sources, being able to test for open mail relays and anonymous FTP servers, installing and configuring an intrusion detection system such as snort or Tripwire. Candidates should also be able to update the IDS configuration as new vulnerabilities are discovered and apply security patches and bugfixes.

Key files, terms, and utilities include:

```
Tripwire
telnet
nmap
```

Topic 214 Network Troubleshooting

*** 2.214.7 Troubleshooting network issues**
Modified: 2001-August-24
Maintainer: Dimitrios Bogiatzoules
Weight: 1

Description: Candidates should be able to identify and correct common network setup

issues to include knowledge of locations for basic configuration files and commands.

Key files, terms, and utilities include:
`/sbin/ifconfig`
`/sbin/route`
`/bin/netstat`
`/etc/network` or `/etc/sysconfig/network-scripts/`
system log files such as `/var/log/syslog` and `/var/log/messages`
`/bin/ping`
`/etc/resolv.conf`
`/etc/hosts`
`/etc/hosts.allow && /etc/hosts.deny`
`/etc/hostname || /etc/HOSTNAME`
`/sbin/hostname`
`/usr/sbin/traceroute`
`/usr/bin/nslookup`
`/usr/bin/dig`
`/bin/dmesg`
`host`