

HP OpenVMS ACME LDAP Installation and Configuration Guide



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About This Document

This guide describes how to configure ACME LDAP agent and Directory server to enable external authentication for users. This guide also describes how to enable global and local mapping for external user logins.

Intended Audience

This document is intended for OpenVMS system administrators. For more information about security, see the HP OpenVMS Guide to System Security:

<http://h71000.www7.hp.com/doc/>

Typographic Conventions

Table 1 lists the typographic conventions used in the document.

Table 1 Typographic Conventions

Convention	Description
...	A horizontal ellipsis in a figure or examples indicates the following possibilities: <ul style="list-style-type: none">• Additional optional arguments in a statement have been omitted.• The preceding item or items can be repeated one or more times.• Additional parameters, values, or other information can be entered.
.	A vertical ellipsis indicates the omission of items from a code example or command format; the items are omitted because they are not important to the topic being described.
()	In command format descriptions, parentheses indicate that you must enclose choices in parentheses if you specify more than one. In installation or upgrade examples, parentheses indicate the possible answers to a prompt, such as: <code>Is this correct? (Y/N) [Y]</code> .
[]	In command format descriptions, brackets indicate optional choices. You can choose one or more items or no items. Do not type the brackets on the command line. However, you must include the brackets in the syntax for OpenVMS directory specifications and for a substring specification in an assignment statement.
{}	In command format descriptions, braces indicate required choices; you must choose at least one of the items listed. Do not type the braces on the command line.
Example	This typeface indicates code examples, command examples, and interactive screen displays. In text, this type also identifies website addresses, OpenVMS command and pathnames, PC-based commands and folders, and certain elements of the C programming language.
<i>italic type</i>	Italic type indicates important information, complete titles of manuals or variables. Variables include information that varies in system output (for example, Internal error number), in command lines (<code>/PRODUCER=name</code>), and in command parameters in text (where <code>dd</code> represents the predefined code for the device type).
UPPERCASE TYPE	Uppercase indicates the name of a command, routine, file, file protection code, or the abbreviation of a system privilege.
-	A hyphen at the end of a command format description, command line, or code line indicates that the command or statement continues on the following line.
WARNING	A warning calls attention to important information that if not understood or followed will result in personal injury or nonrecoverable system problems.
CAUTION	A caution calls attention to important information that if not understood or followed will result in data loss, data corruption, or damage to hardware or software.

Table 1 Typographic Conventions *(continued)*

Convention	Description
IMPORTANT	This alert provides essential information to explain a concept or to complete a task.
NOTE	A note contains additional information to emphasize or supplement important points of the main text.

HP Encourages Your Comments

HP encourages your comments and suggestions on this document. Please send comments to: openvmsdoc@hp.com

1 Overview

Lightweight Directory Access Protocol (LDAP) is combined with the Authentication and Credentials Management Extension (ACME) authentication mechanism to provide a solution to customers to manage all accounts in a centralized directory.

The ACME LDAP agent provided with OpenVMS provides "simple bind" authentication during login using an LDAP-compliant directory server. In this authentication method, users enter their LDAP entry name and password. An LDAP attribute is configured, which is used to match the entered username so that the authentication can take place. The following sections provide information on how to install and configure the standard ACME LDAP agent.

Secure Socket Layer (SSL)/Transport Layer Security(TLS) LDAP communication is supported to prevent cleartext passwords from being exposed over the network. Dedicated SSL port and the startTLS operation over the standard port are supported.

2 Installing and configuring ACME LDAP agent

Prerequisites

- You must be running OpenVMS Alpha or Integrity Version 8.3 or later.
- You must install the SYS\$ACM-enabled LOGINOUT.EXE (<osversion>_ACMELOGIN, for example, V84_ACMELOGIN-V0101) kit.

The ACMELOGIN kit can be found in the SYS\$UPDATE:ACME_DEV_KITS.BCK save set. For more information, see the SYS\$HELP:ACME_DEV_README.TXT file.

General setup

You must first configure and populate your LDAP directory server with user entries.

The ACME LDAP agent is configured by performing the following steps.

1. “Installing the ACMELOGIN and ACMELDAP_STD kits” (page 13)
2. “Setting up LDAP persona extension” (page 15)
3. “Configuring ACME LDAP agent” (page 15)
4. “Starting ACME LDAP agent” (page 19)

Installing the ACMELOGIN and ACMELDAP_STD kits



NOTE: If you are using OpenVMS Version 8.4 and later, the files inside ACMELDAP_STD kit is already a part of the operating system. You do not have to install the ACMELDAP_STD kit separately.

To install the ACMELOGIN and ACMELDAP_STD kits, perform the following steps:

1. Restore the PCSI kits by executing the following command:

```
$ BACKUP/VERIFY/LOG SYS$UPDATE:ACME_DEV_KITS.BCK/SAVE -
_$ [destination_directory]*.*
```

Check if the following files have been restored:

- HP-I64VMS-<os version>_ACMELOGIN-VXXXX--4.PCSI

or

```
DEC-AXPVMS-<os version>_ACMELOGIN-VXXXX--4.PCSI
```

Where <os version> is the version of the OpenVMS operating system version and "XXXX" is the version of ACMELOGIN kit. For example, V84_ACMELOGIN_V0106.

The ACMELOGIN kit contains the sys\$acm-enabled LOGINOUT.EXE and SETP0.EXE. For more information on the kit contents, see SYS\$HELP:ACME_DEV_README.TXT.

- HP-I64VMS-<os version>_ACMELDAP_STD-VXXXX--4.PCSI

or

```
DEC-AXPVMS-<os version>_ACMELDAP_STD-VXXXX--4.PCSI
```

This kit is not provided with OpenVMS Version 8.4 and later and the files are already part of the operating system.

- HP-I64VMS-<os version>_LOGIN-VXXXX--4.PCSI

or

```
DEC-AXPVMS-<os version>_LOGIN_STD-VXXXX--4.PCSI
```

The LOGIN kit contains the non-sys\$acm-enabled LOGINOUT.EXE and SETP0.EXE, which is shipped by default on your operating system. For more information, see SYS\$HELP:ACME_DEV_README.TXT.

2. Install sys\$acm-enabled LOGINOUT.EXE and SETP0.EXE using the following command:

```
$ PRODUCT INSTALL/SAVE <OS Version>ACMELOGIN
```

3. Check the image identification using the following commands:

```
ANALYZE/IMAGE/INTER SYS$COMMON:[SYSEXE] LOGINOUT.EXE
```

```
ANALYZE/IMAGE/INTER SYS$COMMON:[SYSEXE] SETP0.EXE
```

You must get LOGIN98 as a part of the **Image file identification:** field.

It is recommended to login to the system using any user account to test after installing the ACMELOGIN kit.

4. Install ACMELDAP_STD kit on OpenVMS Version 8.3 or 8.3-1H1 using the following command:

```
$ PRODUCT INSTALL/SAVE <OS Version>ACMELDAP_STD
```

When the ACME LDAP agent is installed, proceed to the next section, "Setting up LDAP persona extension" (page 15).

For more detailed steps on installation, see the SYS\$HELP:ACME_DEV_README.TXT.

Setting up LDAP persona extension

To set up the persona extension, do as follows:

1. Install the persona extension image using the following commands:

```
$ MCR SYSMAN
SYSMAN> SYS_LOADABLE ADD LDAPACME LDAPACME$EXT
SYSMAN> exit
$ @SYS$UPDATE:VMS$SYSTEM_IMAGES.COM
```

2. Reboot the system:

```
$ @SYS$SYSTEM:SHUTDOWN
```

During reboot, an error message appears if the persona extension image is not loaded. If the error message is not displayed, it means that the image is loaded as required.

After setting up the LDAP persona extension, you can proceed towards configuring your ACME LDAP agent, “Configuring ACME LDAP agent” (page 15).

Configuring ACME LDAP agent

Configuration of ACME LDAP agent involves the following:

1. “Editing LDAP configuration file” (page 15)
2. “Starting ACME LDAP agent” (page 19)

The attribute used for usernames is specified by the *login_attribute* directive in your ACME LDAP INI configuration file. For more information about *login_attribute*, see Table 2-1 (page 16).

The ACME LDAP agent searches this attribute on directory server for matching usernames (entered at “Username” prompt during login). The search is done in the set of LDAP entries below the point in your directory tree specified by the *base_dn* directive.

The username (entered at “Username” prompt during login) is mapped to the username in the SYSUAF.DAT file. This mapping is one-to-one on OpenVMS Version 8.3 and 8.3-1H1. In one-to-one mapping, the username entered must be the same as the username in the SYSUAF.DAT file. On OpenVMS Version 8.4 and later, global and local mappings are also supported. For more information on global and local mapping, see “Global and local mapping” (page 23).

OpenVMS-specific information, such as privileges, identifiers, and so on are taken from SYSUAF.DAT file.

A user scenario on configuring ACME LDAP and sample login is provided in Chapter 4 (page 27).

Editing LDAP configuration file

To edit the ACME LDAP INI file, perform the following steps:

1. Make a copy of SYS\$STARTUP:LDAPACME\$CONFIG-STD.INI_TEMPLATE and rename it to any file name of your choice. For example, SYS\$STARTUP:LDAPACME\$CONFIG-STD.INI using the following command:

```
$ COPY SYS$STARTUP:LDAPACME$CONFIG-STD.INI_TEMPLATE
SYS$STARTUP:LDAPACME$CONFIG-STD.INI
```

2. Edit SYS\$STARTUP:LDAPACME\$CONFIG-STD.INI to specify the directives that correspond to your requirements.

For description on the directives present in the LDAPACME\$CONFIG-STD.INI file, see Table 2-1.

Table 2-1 LDAP configuration attributes

Column Head	Column Head
server	<p>This is a mandatory directive.</p> <p>The IP address (or DNS host name) for your directory server.</p>
port	<p>This is a mandatory directive.</p> <p>The port that your directory server is listening for. Defaults to the standard port 389 (or 636 for SSL/TLS).</p>
login_attribute	<p>This is a mandatory directive.</p> <p>The LDAP schema attribute that contains the username for login purposes. This is often specified as 'uid', but may be different in your configuration. For Active Directory, this is usually <i>samaccountname</i>.</p>
password_type	<p>Select one of the following:</p> <ul style="list-style-type: none">• standard (default)• active-directory <p>If this directive is not specified, the command <code>\$ SET PASSWORD</code> will not work.</p> <p>If using active directory server, <code>\$ SET PASSWORD</code> will not work if <i>password_type</i> is not set to "active-directory"</p>
password_update	<p>Applies only when <i>password_type</i> = <code>standard</code> is set. Some directory servers require the old password to be supplied when changing <code>userPassword</code> attribute; others do not.</p> <p>Select one of the following:</p> <ul style="list-style-type: none">• replace (default)• remove-and-add
base_dn	<p>The LDAP users are stored in a tree structure in your directory server.</p> <p>The <i>base_dn</i> directive is the distinguished name of a tree element on the directory server. All the user entries must be present under this tree element as sub-tree elements. The ACME LDAP will search for matching entries within this sub-tree based on the attribute specified by <i>login_attribute</i>. (See the <i>scope</i> directive.)</p>
scope	<p>Controls the depth of the search beneath the <i>base_dn</i>. Valid keywords are:</p> <ul style="list-style-type: none">• sub: searches the base entry and all entries at all levels below the base entry• one: searches all entries at one level below the base entry• base: searches only the base entry <p>If you are not sure about the keyword to be used, you can use "sub" as the keyword.</p>
filter	<p>This directive is optional.</p> <p>Search filter for limiting the objects that will be searched for users in the LDAP tree. Defaults to <code>objectclass=*</code>.</p>

Table 2-1 LDAP configuration attributes *(continued)*

Column Head	Column Head
bind_dn	<p>The distinguished name (DN) of a user account (directory entry) that is granted "search" permission through the directory sub-tree specified by <i>base_dn</i>.</p> <p>The <i>bind_dn</i> along with the <i>bind_password</i> is used to bind to your directory servers, before searching for users on the directory servers.</p> <p>Some directory servers (such as Active directory) will not allow the ACME LDAP agent to bind to them by default without <i>bind_dn</i> and <i>bind_password</i>. The <i>bind_dn</i> and <i>bind_password</i> must be specified in such cases.</p> <p>Some directory servers will support anonymous binds to happen and you do not have to provide the <i>bind_dn</i> and <i>bind_password</i> directives for working with these directory servers.</p>
bind_password	<p>The password for the directory DN specified by <i>bind_dn</i>.</p>
port_security	<p>This is a mandatory directive.</p> <p>Specifies the method used to encrypt communications over the LDAP port. Possible values are "starttls" (the default), "ssl" (dedicated SSL port) or "none" (not recommended).</p>
ca_file	<p>This directive is optional.</p> <p>Specifies the file path of a PEM-format file containing the public key of the certificate authority that signed your directory server's public key.</p> <p>The ACME LDAP agent checks this certificate file and whether it is connecting to the right directory server, when the <i>port_security</i> is set to "ssl" or "starttls".</p> <p>If this attribute is not used, the LDAP server's certificate is NOT verified.</p>
mapping	<p>Specifies whether the mapping is global or local. You are provided two options for this directive:</p> <ul style="list-style-type: none">• Server• Local <p>For example: <code>mapping=server</code> indicates that global mapping is enabled for the user. <code>mapping=local</code> indicates the local mapping is enabled for the user. If "mapping" directive is not used, mapping will be one-to-one.</p>
mapping_attribute	<p>This directive is applicable only for global mapping. Set this to the attribute on directory server that is used for user mapping.</p> <p>For example:</p> <p><i>mapping_attribute</i> can be referenced to the description attribute for the user in the directory server.</p> <p><code>mapping_attribute=description</code></p> <p>You can also use any newly created attribute on the directory server for mapping. The attribute should be an IA5 multi-valued string.</p>

Table 2-1 LDAP configuration attributes *(continued)*

Column Head	Column Head
mapping_target	<p>This directive is applicable only for global mapping. The <i>mapping_target</i> is searched in the value of directory server's <i>mapping_attribute</i> field. For example:</p> <p>Let the LDAP INI file have:</p> <pre>mapping_attribute=description mapping_target= VMSUsers.hp.com</pre> <p>Let the description (field in Directory Server) be populated with:</p> <pre>VMSUsers.hp.com/jdoe</pre> <p>The ACME LDAP agent then searches in <i>VMSUsers.hp.com/jdoe</i>, for a prefix of <i>VMSUsers.hp.com/</i>(with a forward slash (/) along with the <i>mapping_target</i>). The rest of the value that is, "jdoe" is considered as the user name present in <i>SYSUAF.DAT</i> file. If a multi-valued string attribute is used, the "VMSUsers.hp.com/jdoe" must be one of the array elements of the multi-valued string.</p>
mapping_file	<p>This directive is applicable only for local mapping. Set this to the complete path of the text database file to be searched for mapping users.</p> <p>A template file is available in <code>SYS\$STARTUP:LDAP_LOCALUSER_DATABASE.TXT_TEMPLATE</code>. This file includes the LDAP username and VMS username separated by a comma, where LDAP username is the name of the user in the domain (entered at the "username" prompt during login).</p> <p>For information on how to populate and load the contents of the database file, see <code>SYS\$STARTUP:LDAP_LOCALUSER_DATABASE.TXT_TEMPLATE</code>.</p>

3. Edit `SYS$MANAGER:ACME$START.COM` and define the following logical names:
The `LDAPACME$INIT` logical must contain the path name to the initialization for the ACME LDAP Agent Server.

```
$ DEFINE/SYSTEM/EXECUTIVE LDAPACME$INIT
SYS$STARTUP:LDAPACME$CONFIG-STD.INI
```
4. Remove the comment from the following line from `SYS$MANAGER:ACME$START.COM`:

```
$! @SYS$STARTUP:LDAPACME$STARTUP-STD ! LDAP
```



IMPORTANT: The LDAPACME\$INIT logical must be defined prior to starting the ACME LDAP agent. HP recommends that you place this logical name in SYS\$MANAGER:ACME\$START.COM before the SYS\$STARTUP:LDAPACME\$STARTUP-STD procedure executes.

5. Ensure that the LDAP configuration file and the LDAP local database mapping file are accessible for privileged users only. You can set the security of these files appropriately based on your security requirements. For example, the following command sets the accessibility of LDAPACME\$CONFIG-STD.INI and LDAP_LOCALUSER_DATABASE.TXT files only for system user:

```
SET SECURITY / PROTECTION = (system:"RWED", OWNER:"", GROUP:"",
WORLD:"") SYS$COMMON:[SYS$STARTUP]LDAPACME$CONFIG-STD.INI
```

```
SET SECURITY / PROTECTION = (system:"RWED", OWNER:"", GROUP:"",
WORLD:"") SYS$COMMON:[SYS$STARTUP]LDAP_LOCALUSER_DATABASE.TXT
```

Starting ACME LDAP agent

Restart the ACME_SERVER process:

```
$ SET SERVER ACME/EXIT/WAIT
$ SET SERVER ACME/START=AUTO
```



NOTE: You can place this command in your SYS\$MANAGER:SYSTARTUP_VMS.COM procedure to have the ACME LDAP agent started automatically at boot.

Specifying EXTAUTH and VMSAUTH flags on OpenVMS

For any user to be externally authenticated (via LDAP), the **ExtAuth** flag has to be set for the user account in SYSUAF.DAT. When the **ExtAuth** flag is specified for a user account, the user is validated only externally using external authenticator (LDAP). If you want this user to be authenticated locally as well against SYSUAF.DAT file, set **VMSAuth** flag for the user account in SYSUAF.DAT file and use **/local** qualifier during login as described in the following section.

To set **ExtAuth** flag to the user, enter the following:

```
$ SET DEFAULT SYS$SYSTEM
$ MCR AUTHORIZE MODIFY <username> /FLAGS=(EXTAUTH,VMSAUTH)MC AUTHORIZE
```

A sample user profile is shown as follows:

```
$ SET DEF SYS$SYSTEM
$ MC AUTHORIZE
UAF> modify jdoe/flags=(EXTAUTH,VMSAUTH)
%UAF-I-MDFYMSG, user record(s) updated
UAF> sh jdoe
```

```
Username: JDOE                               Owner:
Account: TEST                                UIC: [201,2011] ([JDOE])
CLI: DCL                                     Tables: DCLTABLES
Default: SYS$SYSDEVICE:[JDOE]
LGICMD:
Flags: ExtAuth VMSAuth
Primary days: Mon Tue Wed Thu Fri
Secondary days:                               Sat Sun
No access restrictions
Expiration: (none) Pwdminimum: 6 Login Fails: 1
Pwdlifetime: 90 00:00 Pwdchange: (pre-expired)
Last Login: (none) (interactive), (none) (non-interactive)
Maxjobs: 0 Fillm: 128 Byt1m: 128000
Maxacctjobs: 0 Shrfillm: 0 Pbyt1m: 0
Maxdetach: 0 BI01m: 150 JTquota: 4096
```

```

Prclm:      8  DI0lm:      150  WSdef:      4096
Prio:       4  ASTlm:      300  WSquo:      8192
Queprio:    4  TQElm:      100  WSextent:   16384
CPU:        (none) Enqlm:    4000  Pgflquo:    256000
Authorized Privileges:
  NETMBX      TMPMBX
Default Privileges:
  NETMBX      TMPMBX
UAF>

```

If your directory server is configured and your SYSUAF account is mapped with the user name on the directory server, you can now login to the system using ACME LDAP as the authentication agent as shown in the following example.

The password for user “jdoe” is validated against the password from directory server. Note that if the password in directory server is different from the password in SYSUAF .DAT file, then the password on SYSUAF .DAT file will be synchronized to the password on directory server. You can disable the password synchronization for a specific user or for all the users on the system. For more information on disabling the password synchronization, see the sections “Enabling External Authentication” and “Authentication and Credentials Management Extensions (ACME) Subsystem” in *HP OpenVMS Guide to System Security*.

```

$ telnet 127.0.0.1
%TELNET-I-TRYING, Trying ... 127.0.0.1
%TELNET-I-SESSION, Session 01, host 127.0.0.1, port 23
-TELNET-I-ESCAPE, Escape character is ^]

Welcome to HP OpenVMS Industry Standard 64 Operating System, Version V8.3-1H1

Username: jdoe
Password:
  HP OpenVMS Industry Standard 64 Operating System, Version V8.3-1H1
  **** Logon authenticated by LDAP ****
  OpenVMS password has been synchronized with external password

```

In the following example, the user “jdoe” is validated against the SYSUAF .DAT file. Note that the user will not be mapped when the “/local” qualifier is provided during login. The username “jdoe” must be present in SYSUAF .DAT file.

```

$ telnet 127.0.0.1
%TELNET-I-TRYING, Trying ... 127.0.0.1
%TELNET-I-SESSION, Session 01, host 127.0.0.1, port 23
-TELNET-I-ESCAPE, Escape character is ^]

Welcome to HP OpenVMS Industry Standard 64 Operating System, Version V8.3-1H1

Username: jdoe/local
Password:
  HP OpenVMS Industry Standard 64 Operating System, Version V8.3-1H1
  Last interactive login on Tuesday, 1-DEC-2009 01:34:50.26
  **** Logon authenticated by LDAP ****

```

For a user scenario on configuring a standalone Active directory server, see “User Scenario: Configuring a simple standalone Active directory server and OpenVMS ACME LDAP agent” (page 27).

Examples of configuration files

Example 2-1 Red Hat or Fedora Directory Server configuration file

A sample configuration file using the Red Hat or Fedora directory server

```
server = roux.zko.hp.com
port = 636
port_security = ssl
bind_dn = uid=acme-admin,ou=people,dc=acme,dc=mycompany,dc=com
bind_password = swordfish
base_dn = ou=people,dc=acme,dc=mycompany,dc=com
login_attribute = uid
scope = sub
ca_file = sys$manager:acme_ca.crt
```

Example 2-2 Active Directory configuration file

```
server = acme.mycompany.com
port = 636
port_security = ssl
password_type = active-directory
bind_dn = cn=acme-admin,cn=users,dc=acme,dc=mycompany,dc=com
bind_password = swordfish
base_dn = cn=users,dc=acme,dc=mycompany,dc=com
login_attribute = samaccountname
scope = sub
ca_file = sys$manager:acme_ca.crt

server = cssn-ddrs.testdomain.hp.com
port = 389
bind_dn = CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com
bind_password = welcome@123
base_dn = DC=testdomain,DC=hp,DC=com
scope = sub
port_security = none
password_type = active-directory

server = cssn-ddrs.testdomain.hp.com
port = 389
bind_dn = CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com
bind_password = welcome@123
base_dn = DC=testdomain,DC=hp,DC=com
scope = sub
port_security = starttls
password_type = active-directory
ca_file = sys$manager:cssn-ddrs.cer
```

3 Global and local mapping

The authentication method for OpenVMS version ACME LDAP agent on Version 8.3 and Version 8.3-1H1 supports only one-to-one mapping for users. In one-to-one mapping, the user logging in to an OpenVMS system from an LDAP server must have a matching username in the SYSUAF.DAT file. Hence, a user must login with the exact username entry stored in the SYSUAF.DAT file. To overcome this issue of one-to-one mapping, the ACME LDAP agent uses the concept of global and local mapping.

The following diagrams explain the issues of one-to-one mapping and how global or local mapping solves the issue. In this section, "jdoe" is used as a sample account in SYSUAF.DAT file and "John Doe" as the sample domain user name.

Figure 3-1 One-to-One Mapping

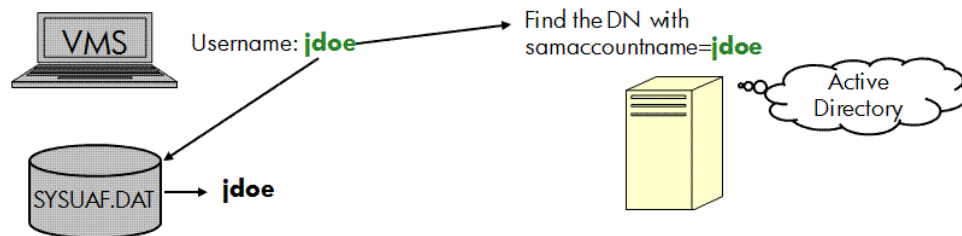


Figure 3-2 One-to-One Mapping Issue

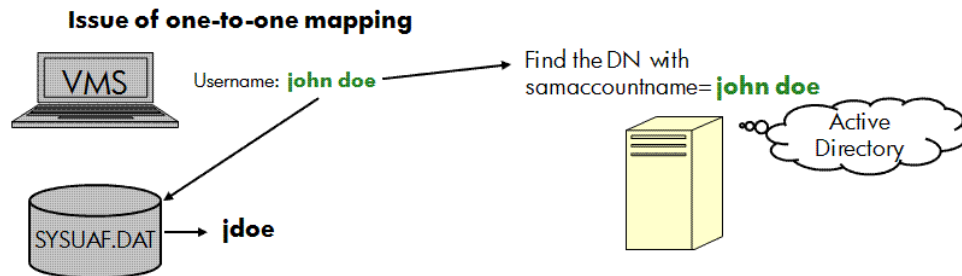


Figure 3-2 illustrates that in one-to-one mapping, the system is not able to match the username "John Doe" with the username in the SYSUAF.DAT, where it is stored as "jdoe".

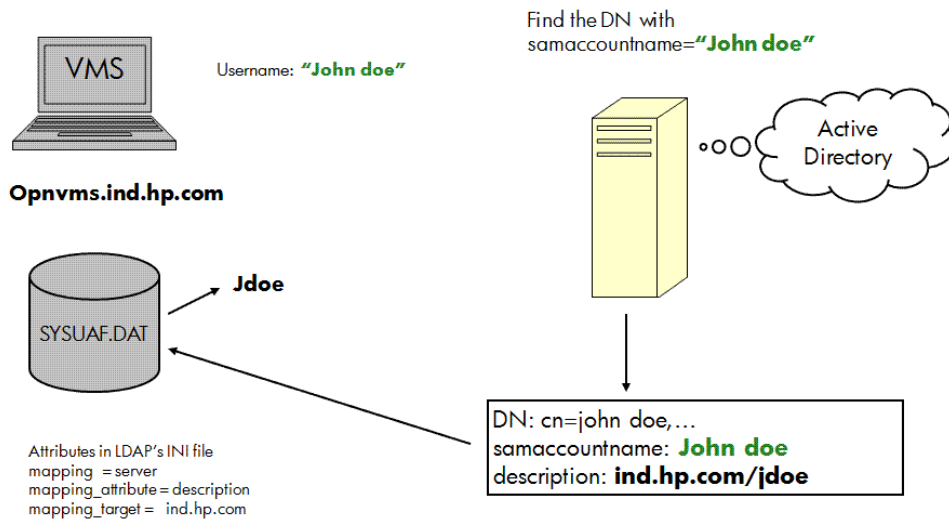
Using the global and local mapping:

- Users can enter the user name that is common across the domain, at the user name prompt of OpenVMS.
- User name is mapped to a different name in the SYSUAF.DAT file during login.
- OpenVMS session after login uses the name and the privileges in the SYSUAF.DAT for all purposes.
- SET PASSWORD command has the capability to understand that this is a mapped user and synchronize any password change to the directory server.

In global mapping, the user's login name is mapped based on some attributes stored in the directory server. In local mapping, a text database file is used to store the LDAP user name (name of the user in the domain) and the name in SYSUAF.DAT in the .CSV format.

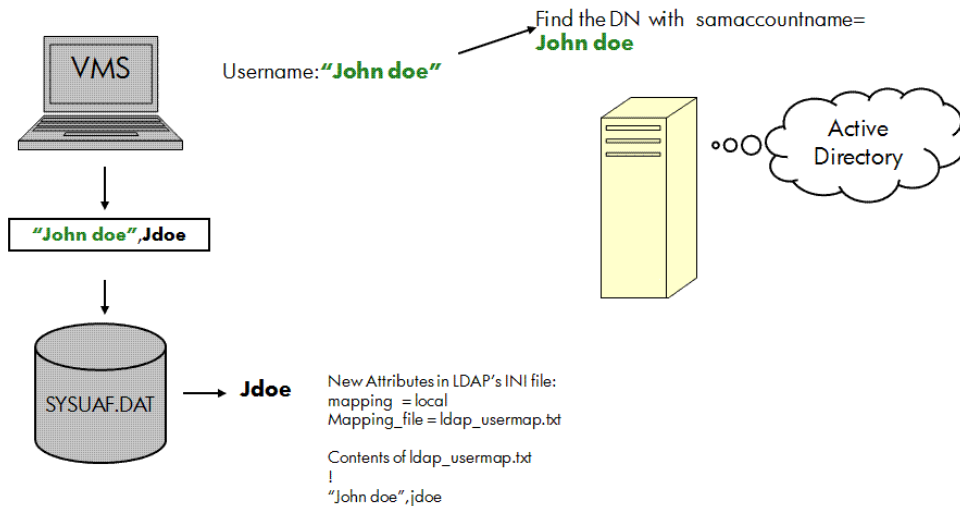
Figure 3-3 illustrates global mapping and local mapping:

Figure 3-3 Global Mapping



In Figure 3-4, the user name "John Doe" is mapped with "jdoe" in the SYSUAF.DAT and "John Doe" in the Active Directory. Three new directives, namely *mapping*, *mapping_attribute*, and *mapping_target* are added to configure global mapping. For more information on the global mapping directives, see Table 2-1 (page 16).

Figure 3-4 Local Mapping



In this figure, the username "John Doe" is mapped with "jdoe" and "John Doe" in the local database file.

Two new directives, namely *mapping* and *mapping_file* are added to configure local mapping. For more information local mapping directives, see Table 2-1 (page 16).

User Scenario: Configuring global and local mapping

Global mapping configuration

In the SYSUAF.DAT file, the username is stored as “jdoe” and “jhardy”. To enable global mapping, perform the following steps:

1. Update the attributes in SYS\$STARTUP:LDAPACME\$CONFIG-STD.INI file along with the other mandatory attributes:

```
mapping = server
mapping_attribute = description
mapping_target = VMSusers.hp.com
```

For example: Two users, John Doe and Joe Hardy have the following attributes specified in the user profile of the Active directory:

```
DN: cn=john doe,...
samaccountname: John Doe
description: VMSUsers.hp.com/jdoe
DN: cn=jhardy,...
samaccountname: jhardy
description: VMSUsers.hp.com/jhardy
```

2. Restart the ACME server:

```
$ SET SERVER ACME/EXIT/WAIT
$ SET SERVER ACME/START=AUTO
```

3. Login to the host system using the login “John Doe” for the user “John Doe”



NOTE: Note that at the user name prompt, you must give this name in quotes, as the name has a space (special character) in-between.

4. Login to the host system using the login jhardy for the other user.

Local mapping configuration

To enable local mapping, perform the following steps:

1. Make a copy of the SYS\$STARTUP:LDAP_LOCALUSER_DATABASE.TXT_TEMPLATE and rename it to a filename of your choice. For example, SYS\$STARTUP:LDAP_LOCALUSER_DATABASE.TXT on the OpenVMS system.
2. Update the SYS\$STARTUP:LDAP_LOCALUSER_DATABASE.TXT with the LDAP username and VMS username separated by a comma. If the LDAP username contains spaces, commas, or exclamation, provide it within quotes.

```
“John Doe”,jdoe
jhardy,jhardy
```

For example, two users John Doe and Joe Hardy have the following attributes specified in the user profile of the Active directory:

```
DN: cn=john doe,...
samaccountname: John Doe
DN: cn=jhardy,...
samaccountname: jhardy
```

3. Update the directives in the SYS\$STARTUP:LDAPACME\$CONFIG-STD.INI file along with the other mandatory attributes:

```
mapping = local
mapping_file = SYS$COMMON:[SYS$STARTUP]LDAP_LOCALUSER_DATABASE.TXT
```

4. Load the new database file by performing the following:
 - a. Restart the ACME server:

```
$ SET SERVER ACME/EXIT/WAIT
$ SET SERVER ACME/START=AUTO
```

OR:
 - b. Using LDAP_LOAD_LOCALUSER_DATABASE.EXE:

```
$ load_localuser_db:=="$SYS$SYSTEM:LDAP_LOAD_LOCALUSER_DATABASE.EXE"
$ load_localuser_db SYS$COMMON:[SYS$STARTUP]LDAP_LOCALUSER_DATABASE.TXT
```
5. Login to the host system using the login "John Doe" and jhardy.

4 User Scenario: Configuring a simple standalone Active directory server and OpenVMS ACME LDAP agent

This chapter provides a user scenario on how to configure an Active directory server with an OpenVMS ACME LDAP agent. This user scenario guides the user through the various steps of configuring a sample standalone Active directory server, creating an account, and creating certificates. It also provides the steps to extract the relevant values from the Active directory server to populate the ACME LDAP configuration file.



IMPORTANT: This chapter aims at providing the end-user with a detailed overview of configuring a sample directory server (here, Active directory is chosen as the sample directory server) and an OpenVMS ACME LDAP agent.

Note that in most of the system administration setup, the sub-procedures for certain sections such as “Configuring Active directory” (page 28), “Creating Active directory certificates” (page 46) may have been already completed. Therefore, you may not have to perform these steps again.

Sample account names such as, “query_account” have been used throughout this chapter and must not be considered as a standard proxy account name. You can create any account of your choice.

Similarly, other accounts and system names used in this chapter are also examples and you can use any account name or system of your choice.

Figure 4-1 illustrates how an ACME LDAP agent configured with an Active directory server works.

Figure 4-1 ACME LDAP Process Flow Diagram

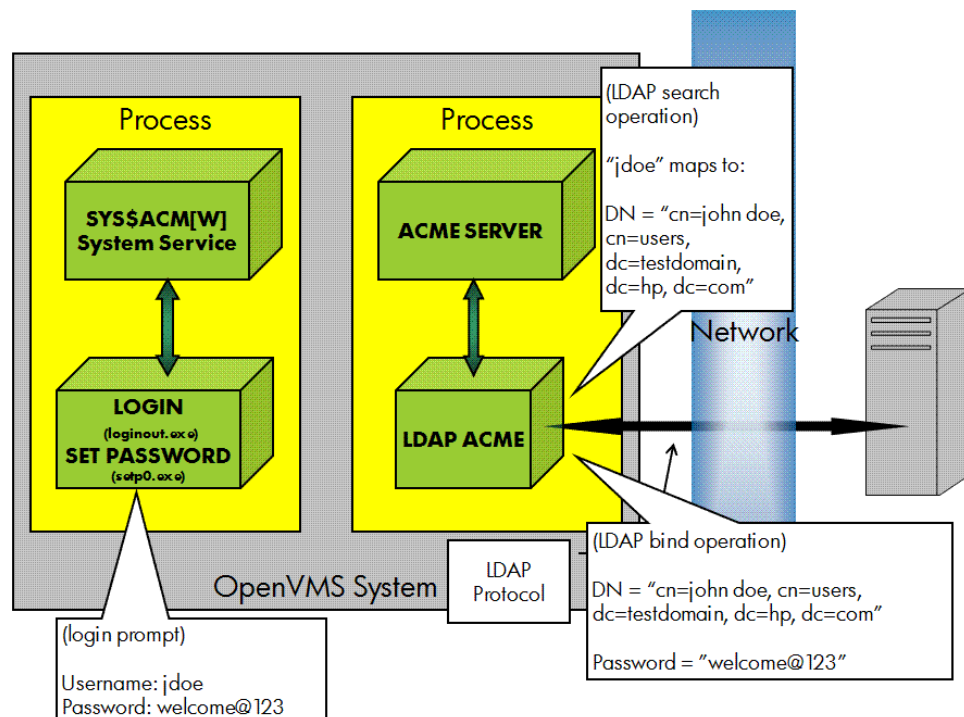


Figure 4-1 illustrates how a VMS user logs in to a VMS system using LDAP authentication. In this figure, two systems are involved, which communicate over TCP/IP.

The gray box on the left is the VMS system with enhanced versions of LOGINOUT.EXE and SETP0.EXE installed and the ACME LDAP agent running within the ACME_SERVER process.

On the right, is the Active directory server running Windows Server 2003. Active Directory is also an LDAP server.

The ACME LDAP agent communicates with Active directory using LDAP protocol over a TCP session, which can be protected by SSL (required for Active directory LDAP password changes). The LDAP “search” and “bind” operations are standard LDAP operations accessed through standard C bindings. These are operations that work with any standard LDAP server and are used pervasively in many applications to provide LDAP-based authentication services.

Enabling your Active Directory to use ACME LDAP agent for authentication on OpenVMS system involves the following steps:

1. “Configuring Active directory” (page 28)
 - a. “Setting Active directory as the domain controller” (page 28)
 - b. “Installing Active directory ” (page 32)
2. “Creating accounts on Active directory” (page 38).
3. “Extracting ACME LDAP configuration parameter values” (page 41)
4. “Creating Active directory certificates” (page 46)
5. “Viewing the certificate on Active directory” (page 52)
6. “Adding the certificate to OpenVMS” (page 60)

Configuring Active directory

Configuring active directory involves the following:

1. “Setting Active directory as the domain controller” (page 28)
2. “Installing Active directory ” (page 32)
3. “Creating accounts on Active directory” (page 38)

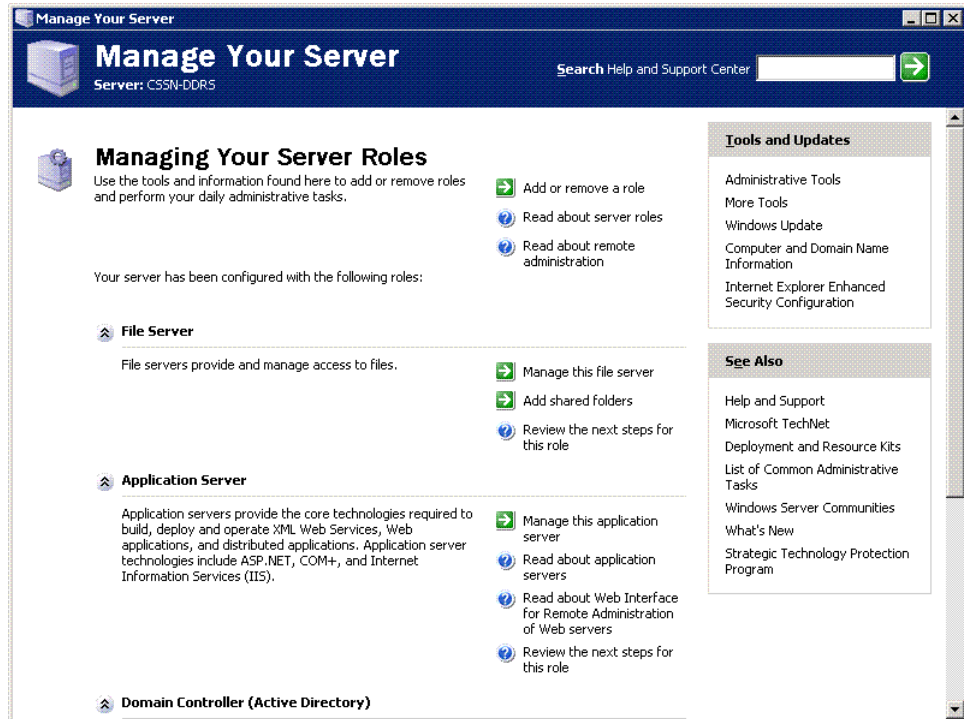
Setting Active directory as the domain controller

The following procedure describes how to set up Active directory as a standalone domain controller on a Windows 2003 server.

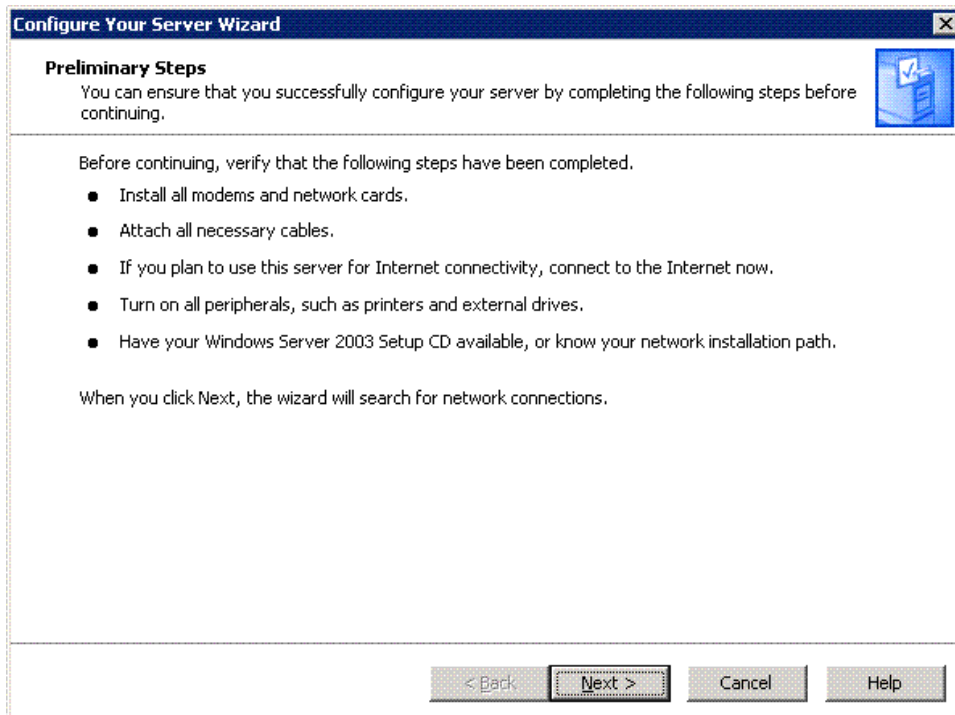


NOTE: In a corporate network, the Active directory might not be standalone and usually the Active directory may have been already set up.

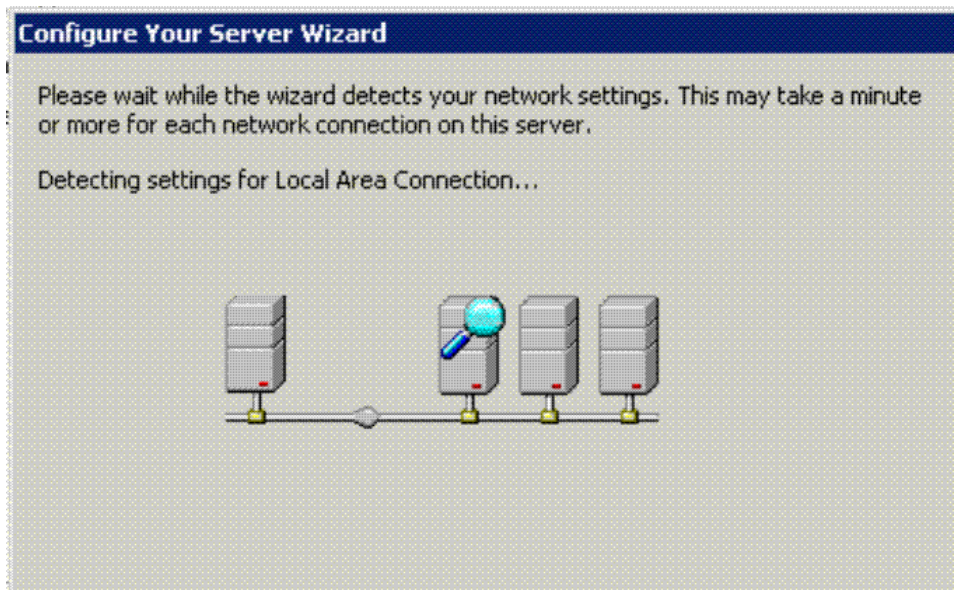
1. Go to **Start > All Programs > Manage Your Server** to open the **Manage Your Server** window.



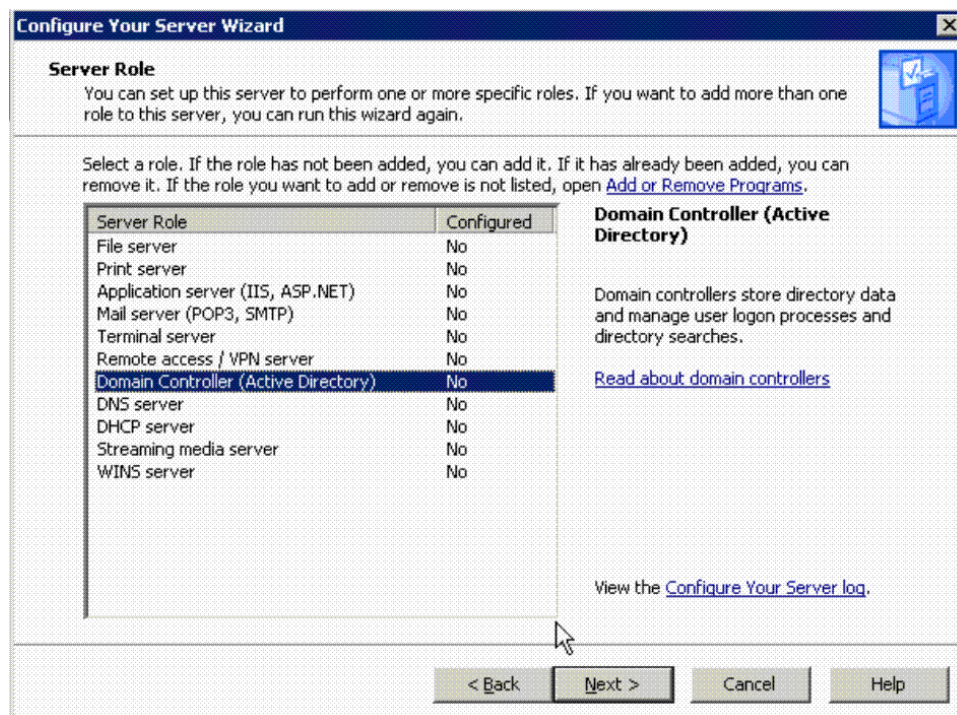
2. Select the **Add or remove a role** option in the **Manage Your Server** window. The **Configure Your Server Wizard** dialog box is displayed.



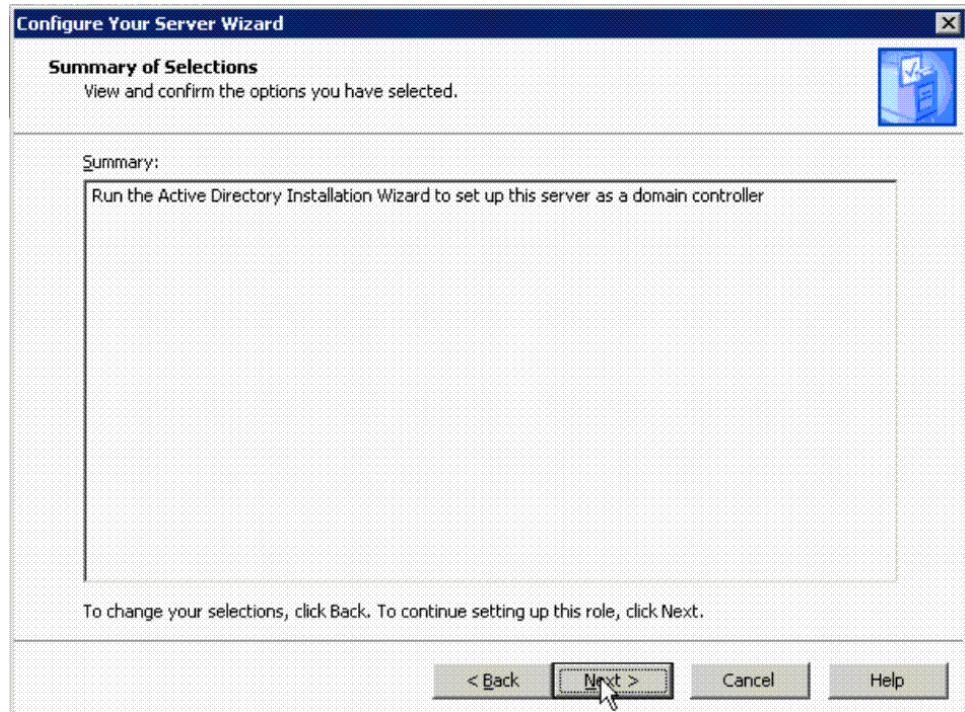
3. Click **Next**. Wait while the wizard detects your network settings. The **Server Role** dialog box is displayed.



4. Select the **Domain Controller (Active Directory)** server role to set Active Directory as the domain controller and click **Next** to display the **Summary of Selections** dialog box.



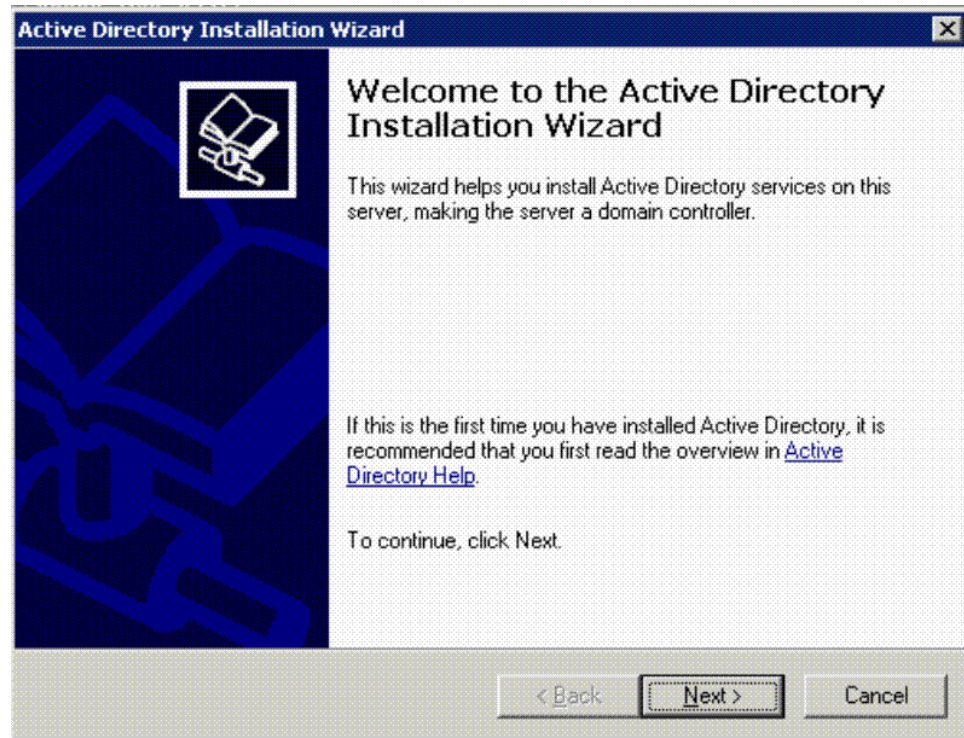
5. Click **Next** to start installing the Active Directory server as the domain controller. You will get the Active Directory Installation Wizard.



Installing Active directory

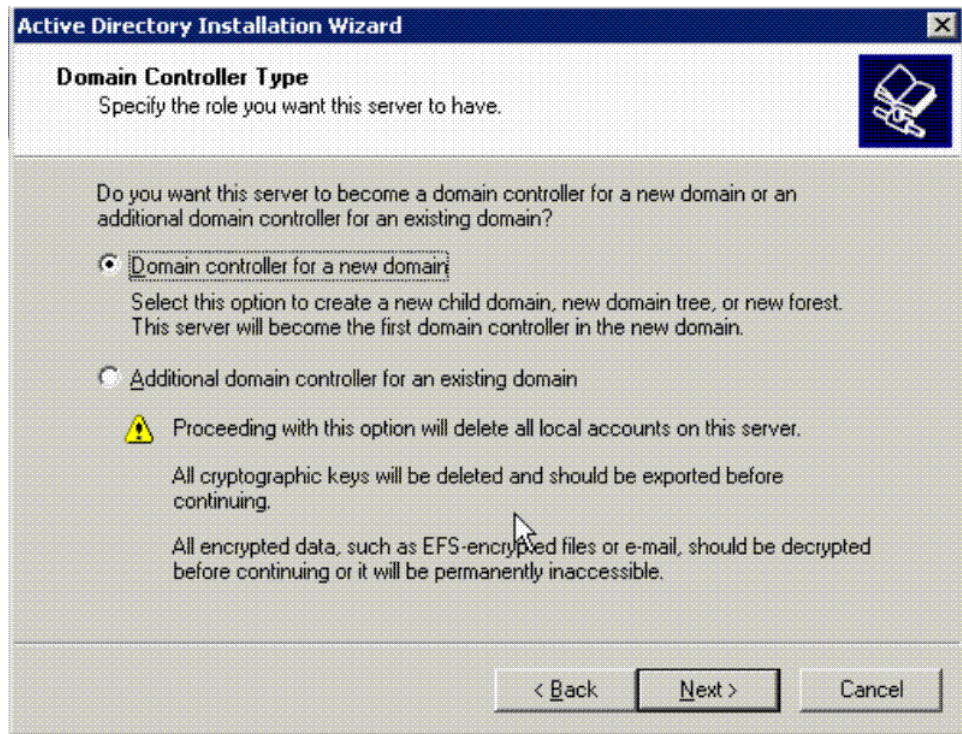
The **Active Directory Installation Wizard** guides you through a series of steps to install Active Directory. The following procedure illustrates the same:

1. Click **Next** in the **Welcome to the Active Directory Installation Wizard** dialog box to display the **Operating System Compatibility** dialog box. Click **Next** to get the **Domain Controller Type** dialog box.

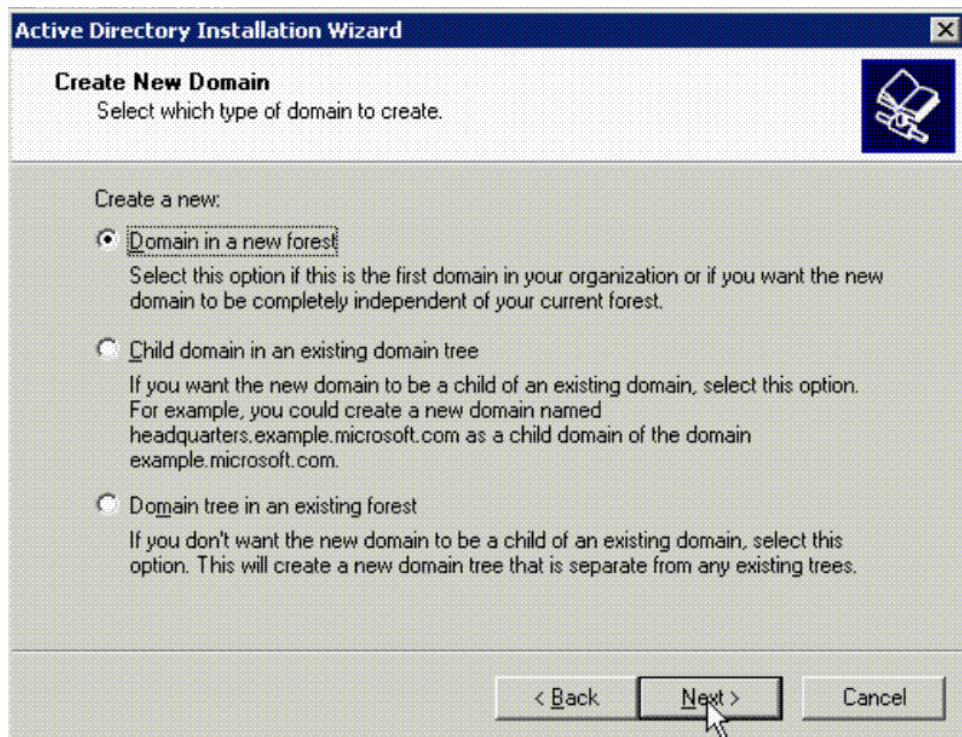


2. Select the required option in the **Domain Controller Type** dialog box based on whether you want to create a new domain or an additional domain. Note that if you select **Additional domain controller for an existing domain**, all local accounts and cryptographic keys will be deleted. The caution is provided in the wizard dialog box. In this example, the option **Domain controller for a new domain** is selected.

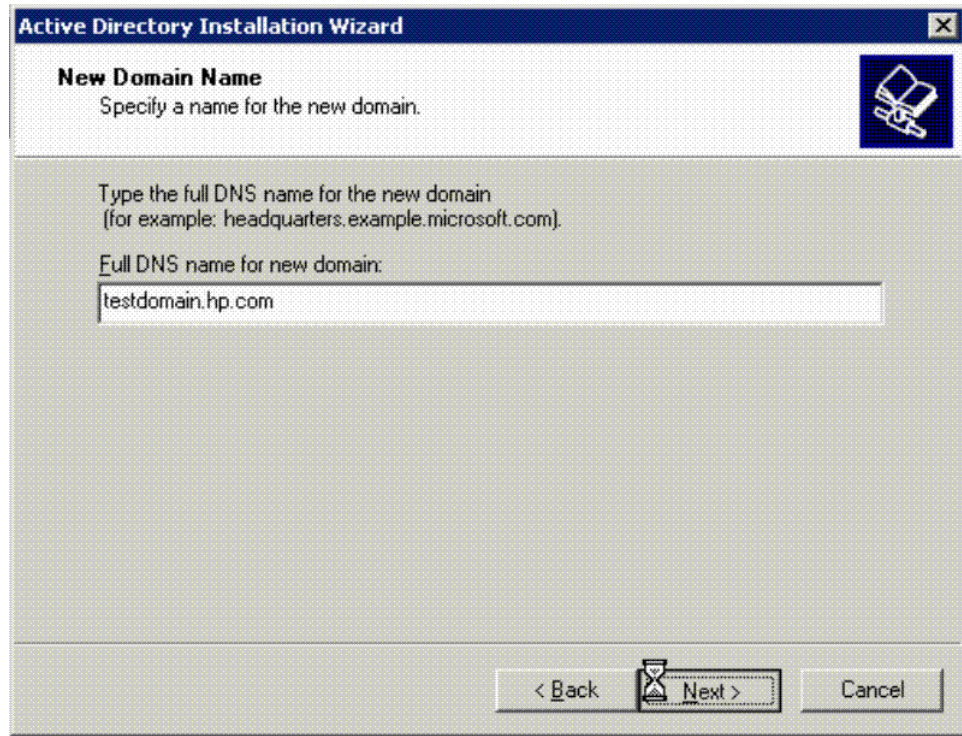
Click **Next** to display the **Create New Domain** dialog box.



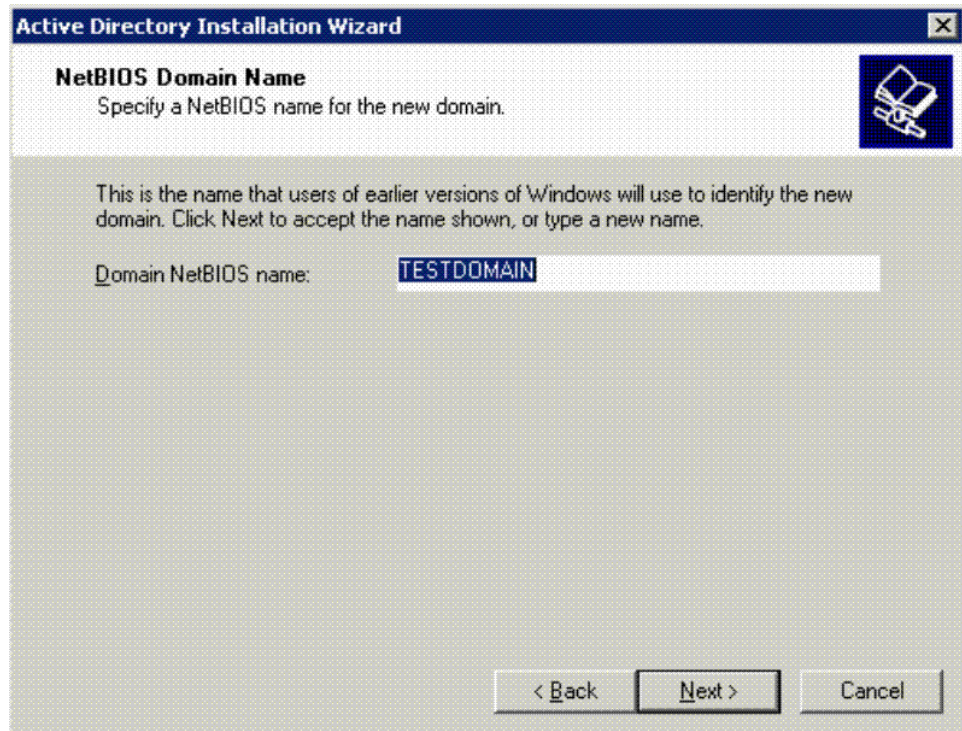
3. Select the required option in the **Create New Domain** dialog box and click **Next**. In this example, the option **Domain in a new forest** is selected.



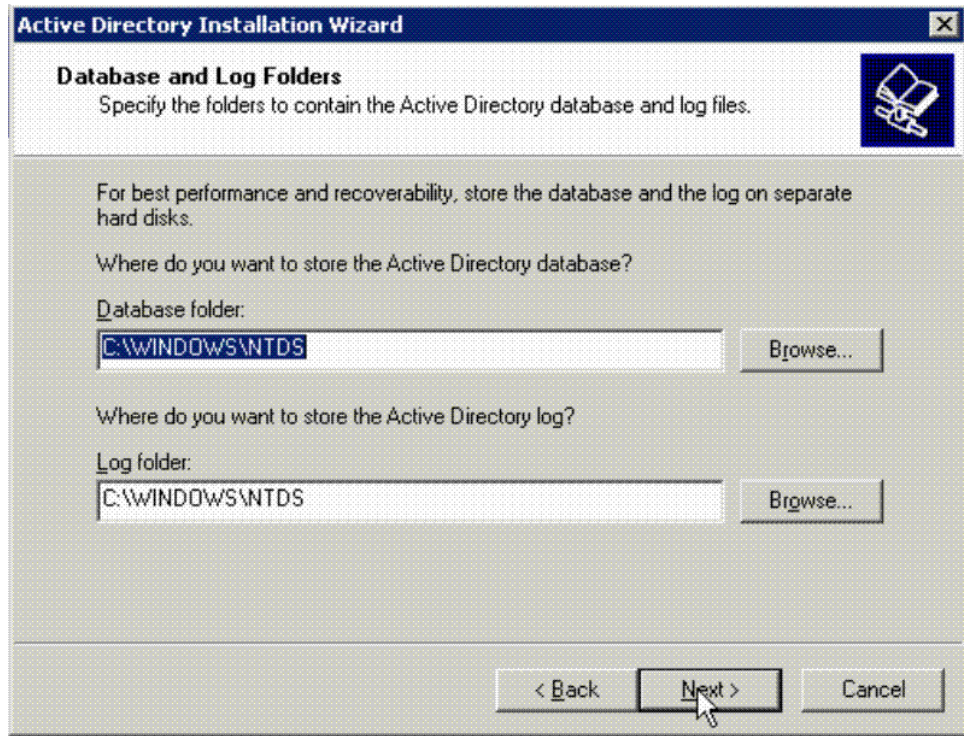
4. Enter the DNS name in the **Full DNS name for new domain:** field and click **Next** to display the **NetBIOS Domain Name** dialog box.



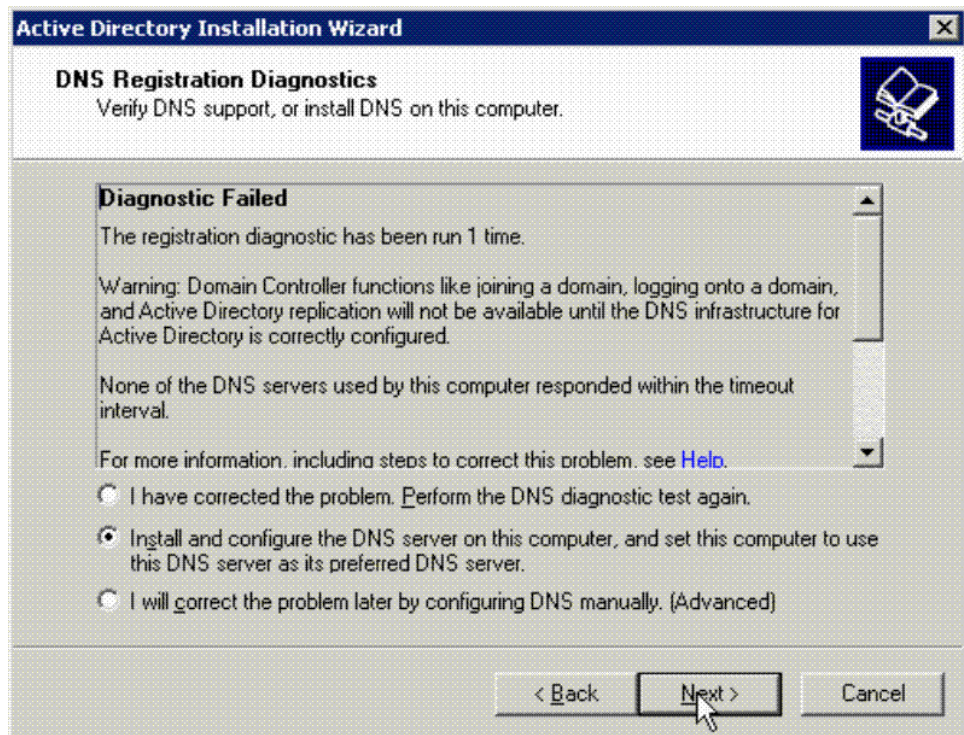
5. Enter the **Domain NetBIOS name:** or click **Next** if you do not want to change the displayed name. Click **Next** to display the **Database and Log Folders** dialog box.



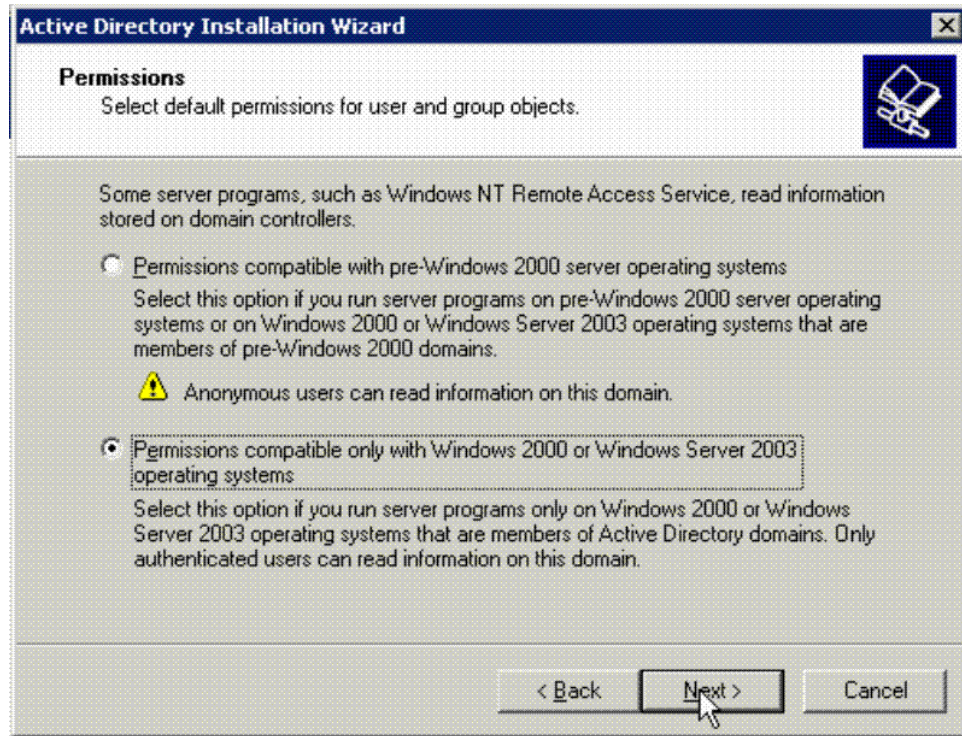
6. Browse and select the **Database folder** and **Log folder** or retain the default folder names and click **Next**.



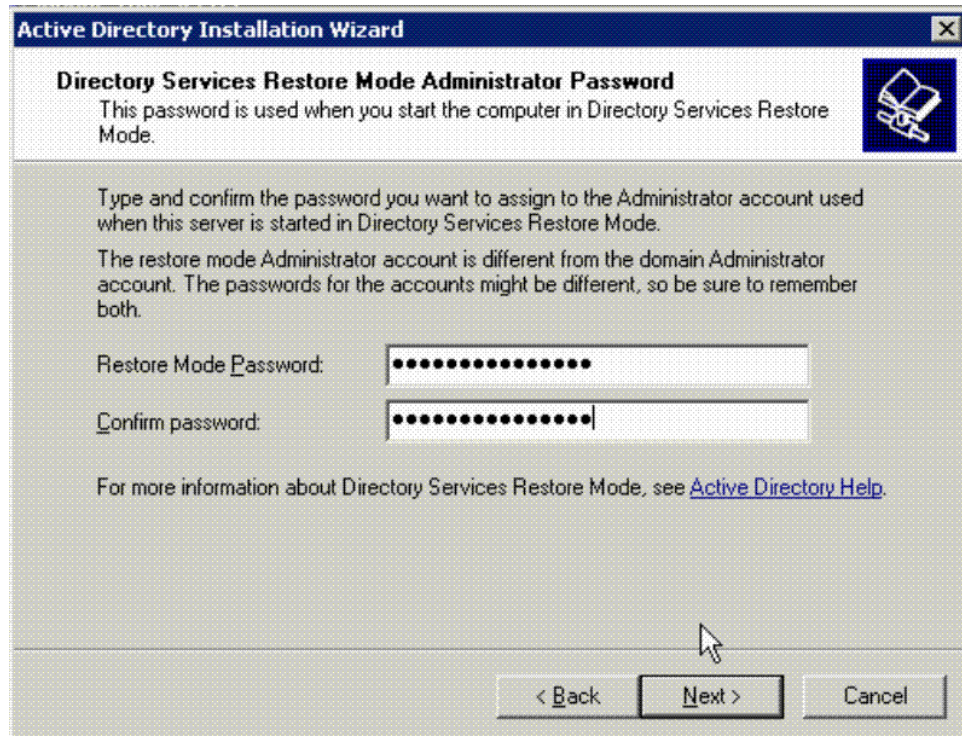
7. If DNS is not installed, the DNS registration diagnostics will fail and an option is provided to configure the DNS. Use the appropriate option and click **Next**.



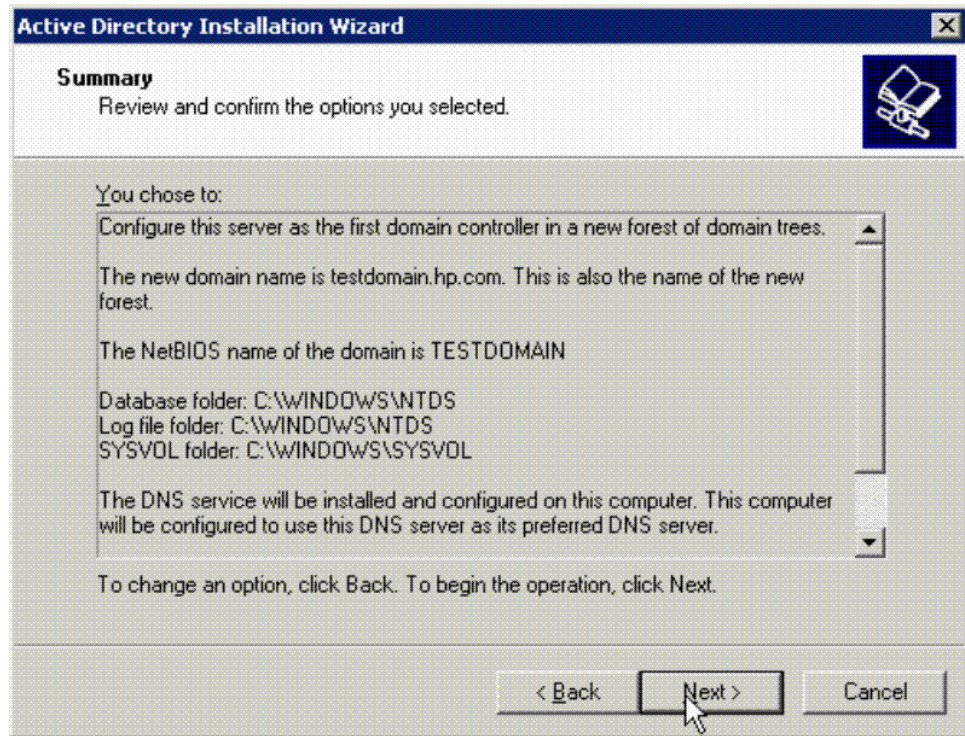
8. Select the required option and click **Next** to display the **Directory Services Restore Mode Administrator Password** dialog box.



9. Enter the password for the administrator account and confirm the same in the respective fields and click **Next** to display the **Summary** dialog box.



10. Click **Next** or **Finish** as required, in the next series of wizards after **Summary** dialog box to complete the Active directory installation.



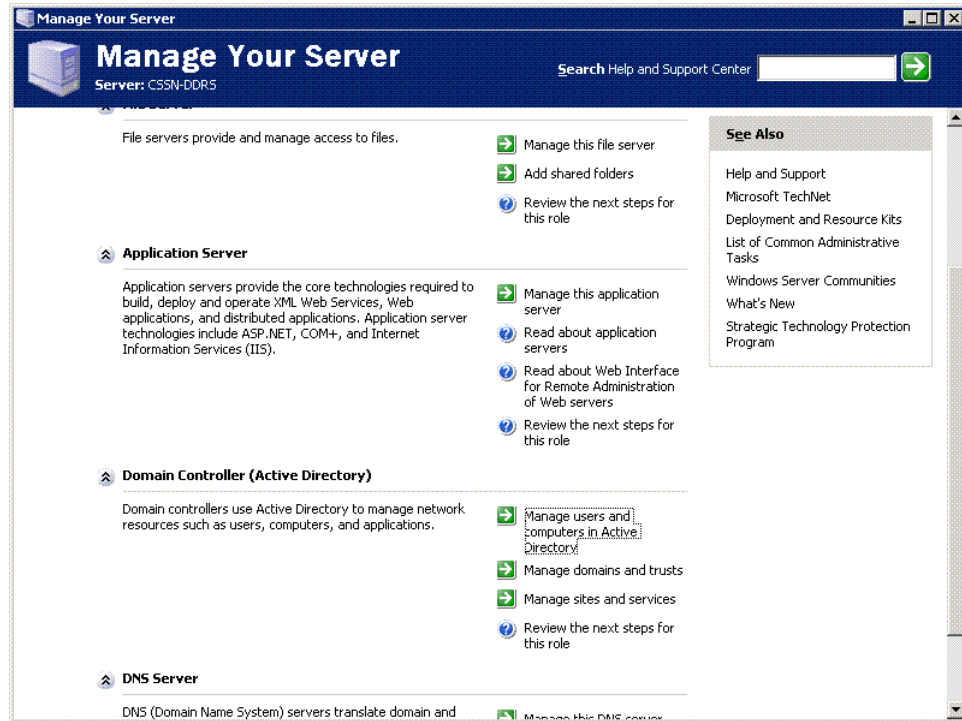
11. **Restart** the system for the Active directory configuration to take effect.

Creating accounts on Active directory

Create two accounts on the directory server, one a binding account, for example, “query_account” and the second, a test user account, for example, “jdoe” on the directory server. The “query_account” will be used by the ACME LDAP to connect to the Active directory server. The following sections provide information on how to get the distinguished name of the “query_account” and use in the ACME LDAP configuration file. You can use any account name of your choice here. “query_account” is an example. The account “jdoe” is a sample user account.

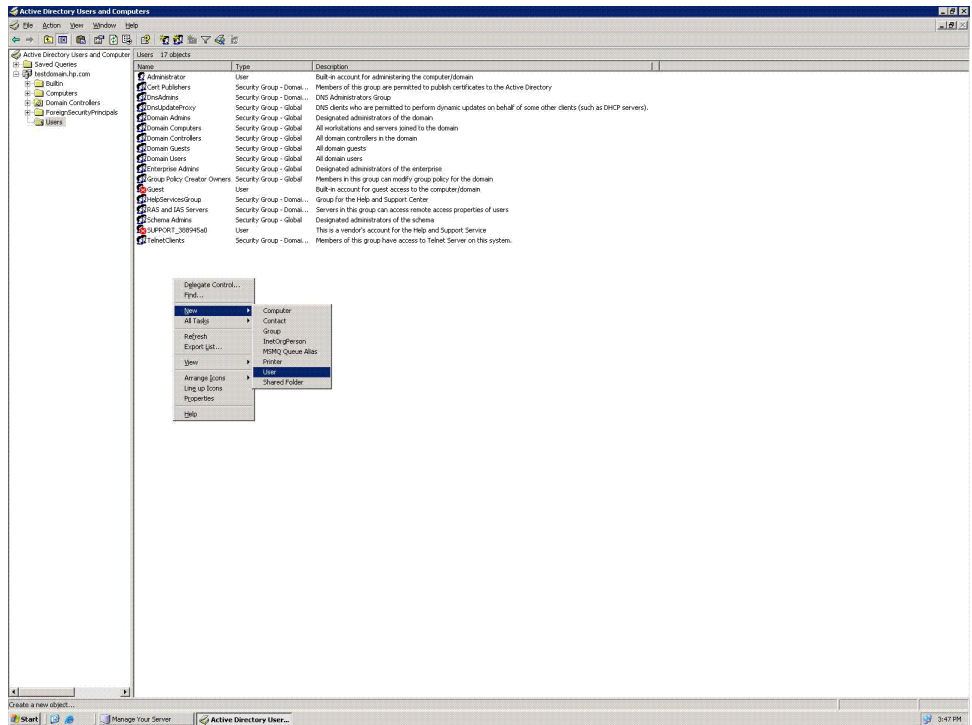
To create the accounts, perform the following steps:

1. Select the **Manage users and computers in Active Directory** option in the **Domain Controller (Active Directory)** panel. The **Active Directory Users and Computers** window is displayed.

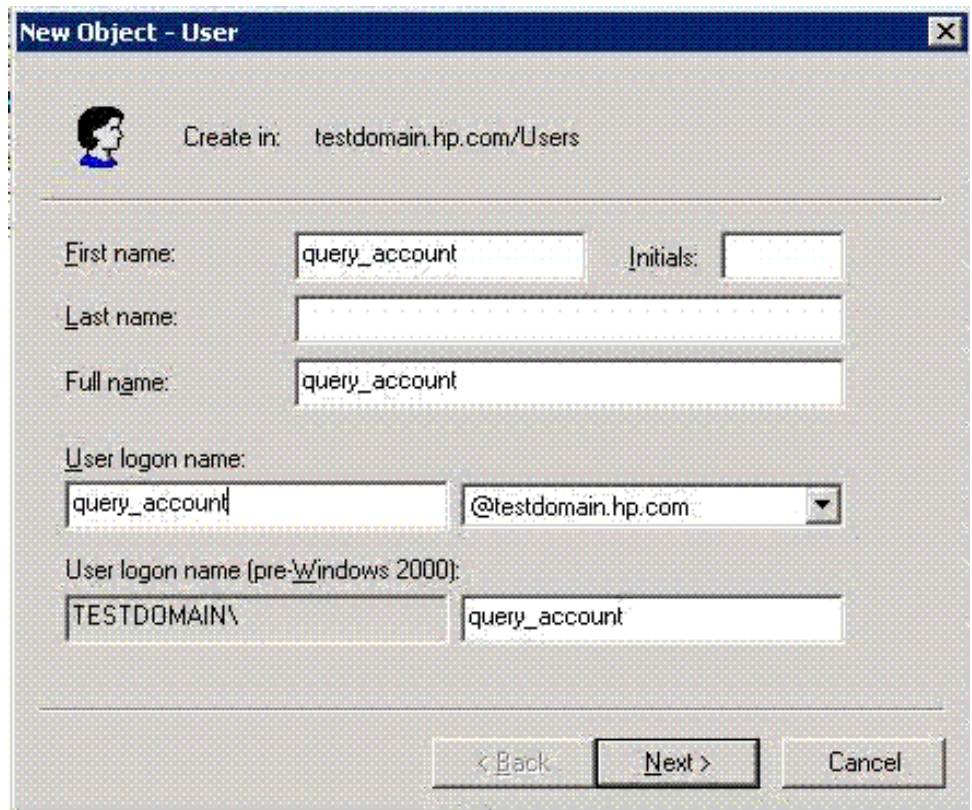


2. Select testdomain.hp.com under **Active Directory Users and Computers** tree to display the subtree **Users**.

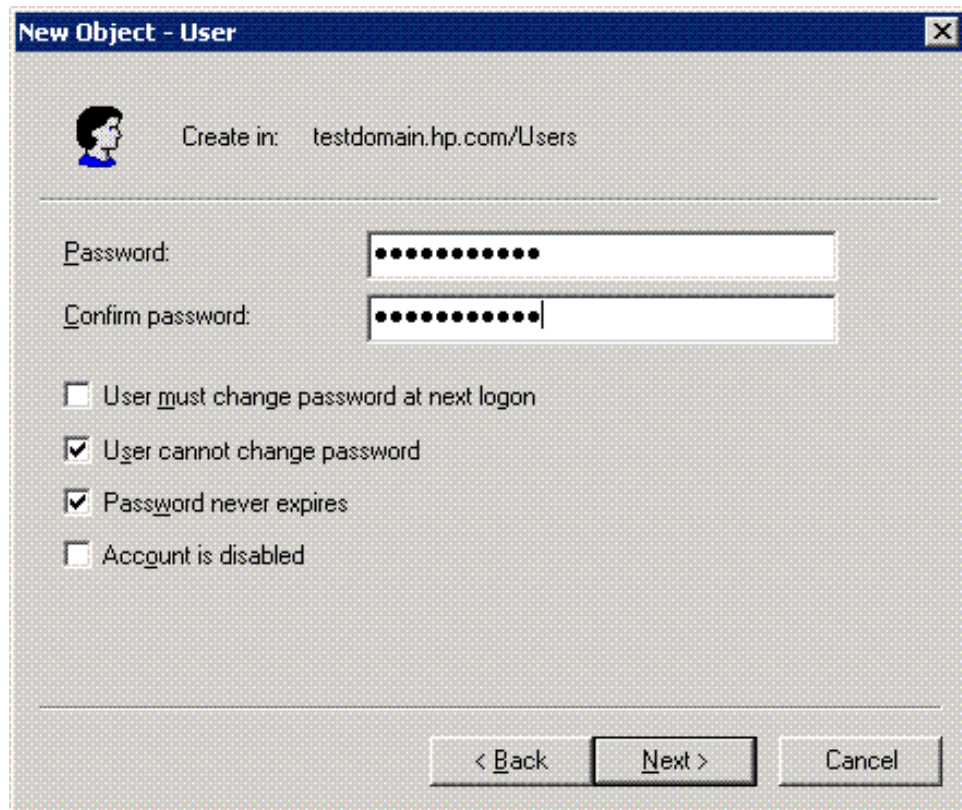
Right-click and select **New > User** from the pop-up menu in the **Active Directory Users and Computers** window. The **New Object-User** dialog box is displayed.



3. Enter the required details for the account and click **Next**. The following figures show the details entered for the “query_account” and for the user account.
Create the binding account, “query_account”:

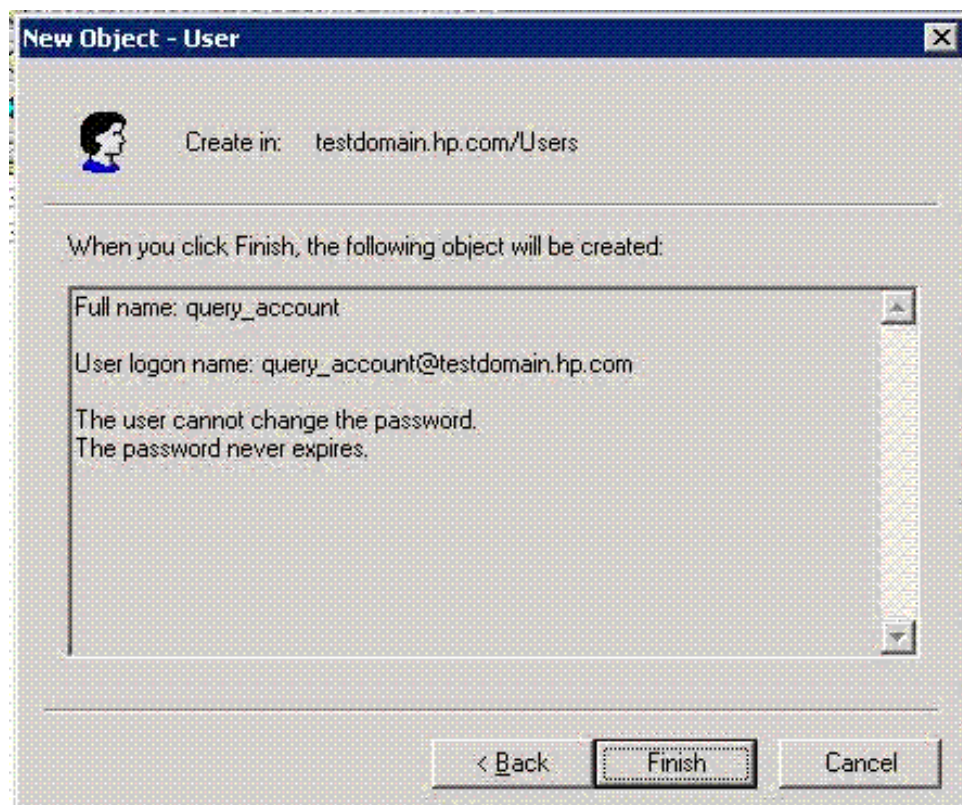


4. Enter the password for the user in the specific domain and click **Next**.



5. The **New Object-User** dialog box displays the details for the user and selected password settings. Click **Finish** to create the user profile.

Details of “query_account”:



6. Create the test user account “jdoe”, similar to the “query_account”.

Extracting ACME LDAP configuration parameter values

You require the following information from the Active directory to populate the LDAP INI configuration file.

- LDAP port (This is usually 389 - the non-secure port and 636 the secure port). For detailed steps on how to obtain this information, see “Querying LDAP port” (page 41).
- Base Distinguished Name (DN) under which all users are present.
- Distinguished Name and password of the “query_account”.
- Login attribute (usually “samaccountname”).

The base distinguished name (*base_dn* directive), the distinguished name of the *query_account* (*bind_dn* directive), and the *samaccountname* (*login_attribute* directive) are obtained from the database log file, .ldf file. For more information on how to obtain the specific attribute value, see “Extracting *base_dn*, *bind_dn*, and *login_attribute*” (page 41).

Querying LDAP port

To query LDAP ports, you can install the PortQryUI tool provided by Microsoft. This tool is available for download from:<http://www.microsoft.com/downloads/en/confirmation.aspx?familyId=8355e537-1ea6-4569-aabb-f248f4bd91d0=en>

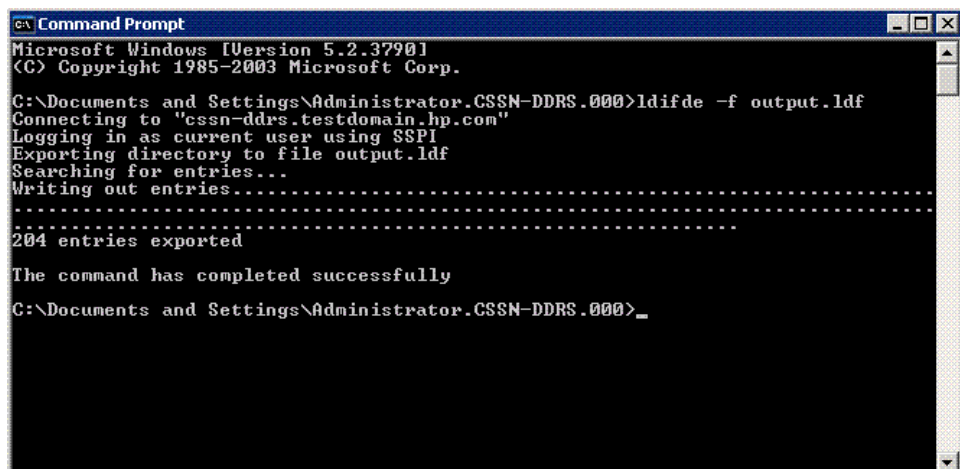
You can use any other query tool of your choice.

Extracting *base_dn*, *bind_dn*, and *login_attribute*

You can extract the values for *base_dn*, *bind_dn*, and *login_attribute* directives (in the ACME LDAP configuration file) from the .ldf file.

To extract the .ldf file, at the command prompt, enter the following command on your Windows system:

```
ldifde -f <filename>.ldf
```



```
c:\ Command Prompt
Microsoft Windows [Version 5.2.3790]
(C) Copyright 1985-2003 Microsoft Corp.

C:\Documents and Settings\Administrator.CSSN-DDRS.000>ldifde -f output.ldf
Connecting to "cssn-ddrs.testdomain.hp.com"
Logging in as current user using Sspi
Exporting directory to file output.ldf
Searching for entries...
Writing out entries.....
.....
204 entries exported

The command has completed successfully
C:\Documents and Settings\Administrator.CSSN-DDRS.000>
```

After the .ldf file is extracted, copy the *base_dn* and *bind_dn* value. For more information on the *base_dn* and *bind_dn* directives, see Table 2-1.

Figure 4-2 shows a sample .ldf file. Here, the account, “query_account” is identified as the binding account. The “*base_dn*” and “*bind_dn*” values are highlighted.

Figure 4-2 Sample LDF file

```
output_new.ldf - Notepad
File Edit Format View Help

dn: DC=testdomain,DC=hp,DC=com "b o a _ dn=DC=testdomain,DC=hp,DC=com"
changetype: add
objectclass: top
objectclass: domain
objectclass: domainDNS
distinguishedName: DC=testdomain,DC=hp,DC=com
instancetype: 5
whencreated: 20091204100612.0Z
whenchanged: 20091210034419.0Z
subRefs: DC=ForestDnsZones,DC=testdomain,DC=hp,DC=com
subRefs: DC=DomainDnsZones,DC=testdomain,DC=hp,DC=com
subRefs: CN=Configuration,DC=testdomain,DC=hp,DC=com
usncreated: 4098
usnchanged: 16717
name: testdomain
objectGUID:: R1C3ZmqGHU+9og12GGOFXQ==
creationTime: 12043928120468750
forceLogoff: -9223372036854775808
lockoutDuration: -18000000000
lockoutObservationWindow: -18000000000
lockoutThreshold: 0
maxPwdAge: -37108517437440
minPwdAge: -864000000000
dn: CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com
changetype: add
objectclass: top
objectclass: person
objectclass: organizationalPerson
objectclass: user
cn: query_account
givenName: query_account
distinguishedName: CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com "bind_cn=CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com"
instancetype: 4
whencreated: 20091204101609.0Z
whenchanged: 20091204101609.0Z
displayName: query_account
usncreated: 13913
usnchanged: 13913
name: query_account
objectGUID:: f6634xgfuyqjoeP0kn25w==
userAccountControl: 66048
badPwdCount: 0
codePage: 0
countryCode: 0
badPasswordTime: 0
lastLogoff: 0
lastLogon: 0
pwdLastSet: 129043953697031250
primaryGroupID: 513
objectSID: AQUAAAAAAAAAAAAAAAA/pKY0HK1WjNbkqRqTWQAAA==
accountExpires: 9223372036854775807
logonCount: 0
sAMAccountName: query_account "SAMAccountName: query_account"
userAccountType: 805206308
userPrincipalName: query_account@testdomain.hp.com
objectcategory:
CN=Person,CN=Schema,CN=Configuration,DC=testdomain,DC=hp,DC=com
```

Configuring ACME LDAP agent for non-secure port

To configure an ACME LDAP agent on a non-secure port, do the following:

1. Install the ACMELOGIN and ACMELDAP_STD kit as explained in “Installing the ACMELOGIN and ACMELDAP_STD kits” (page 13).
2. Check whether the images are loaded correctly:

```
ANALYZE/IMAGE/INTER SYS$COMMON: [SYSEXEXE] LOGINOUT.EXE
$ ANALYZE/IMAGE/INTER SYS$COMMON: [SYSEXEXE] LOGINOUT.EXE
This is an OpenVMS IA64 (Elf format) executable image file
```

Image Identification Information, in section 3.

```
Image name: "LOGINOUT"
Global Symbol Table name: "LOGINOUT"
Image file identification: "LOGIN98 X-1"
Image build identification: "XC7Q-BL4-000000"
Link identification: "Linker I02-37"
Link Date/Time: 8-FEB-2010 15:23:06.56
```

```
ANALYZE/IMAGE/INTER SYS$COMMON: [SYSEXEXE] SETP0.EXE
```

```
$ ANALYZE/IMAGE/INTER SYS$COMMON: [SYSEXEXE] SETP0.EXE
This is an OpenVMS IA64 (Elf format) executable image file
```

Image Identification Information, in section 3.

```
Image name: "SETP0"
Global Symbol Table name: "SETP0"
Image file identification: "LOGIN98 X-1"
Image build identification: "XC7Q-BL4-000000"
Link identification: "Linker I02-37"
Link Date/Time: 8-FEB-2010 15:25:05.14
```

3. Set up the LDAP persona extension. For more information on how to set the persona extension, see “Setting up LDAP persona extension” (page 15).
4. Restart the OpenVMS system after setting the persona extension.
5. For a non-secure port, enter the following values for the attributes in the LDAP configuration file, SYS\$STARTUP:LDAPACME\$CONFIG-STD.INI:

```
server = cssn-ddrs.testdomain.hp.com. Ensure that you are able to make a $
TCP/IP PING cssn-ddrs.testdomain.hp.com to the Active directory system.
```

```
port = 389. This is the default value for a non-secure port.
```

```
bind_dn = CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com. This
value can be obtained from the .ldf file. For information on how to extract the value, see
“Extracting base_dn, bind_dn, and login_attribute” (page 41).
```

```
bind_password = welcome@123. This is the password given for the query_account in
the Active directory. See “Creating accounts on Active directory” (page 38).
```

```
base_dn = DC=testdomain,DC=hp,DC=com. This is the base account under which all
other accounts reside. See “Creating accounts on Active directory” (page 38).
```

```
login_attribute = samaccountname. See “Creating accounts on Active directory”
(page 38).
```

```
scope = sub. Retain the default value “sub”.
```

```
port_security = none. Since this is a non-secure port, replace the default value with
“none”.
```

```
password_type = active-directory. Replace the default value with active-directory
since the configuration is done with an Active directory.
```

The populated configuration file will be as shown:

```

server = cssn-ddrs.testdomain.hp.com
port = 389
bind_dn = CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com
bind_password = welcome@123
base_dn = DC=testdomain,DC=hp,DC=com
login_attribute = samaccountname
scope = sub
port_security = none
password_type = active-directory

```

6. Add the following logical to the SYS\$MANAGER:ACME\$START.COM:

```

$ DEFINE/SYSTEM/EXECUTIVE LDAPACME$INIT
SYS$STARTUP:LDAPACME$CONFIG-STD.INI and uncomment the
@SYS$STARTUP:LDAPACME$STARTUP-STD.

```

7. Restart the ACME server.

```

$ SET SERVER ACME/EXIT/WAIT
$ SET SERVER ACME/START=AUTO

```

8. Execute SHOW SERVER ACME/FULL to check if the ACME LDAP agent has been loaded.

```

$ SHOW SERVER ACME/FULL
ACME Information on node EARWIG 18-FEB-2010 06:03:42.00 Uptime 0 00:15:24

```

```

ACME Server id: 2 State: Processing New Requests
Agents Loaded:      2 Active:      2
Thread Maximum:    1 Count:      1
Request Maximum:   826 Count:     0
Requests awaiting service: 0
Requests awaiting dialogue: 0
Requests awaiting AST: 0
Requests awaiting resource: 0
Logging status: Active
Tracing status: Inactive
Log file: "SYS$SYSROOT:[SYSMGR]ACME$SERVER.LOG;19"

```

```

ACME Agent id: 1 State: Active
Name: "VMS"
Image: "DISK$I64SYS:[VMS$COMMON.SYSLIB]VMS$VMS_ACMESHR.EXE;1"
Identification: "VMS ACME built 20-SEP-2006"
Information: "No requests completed since the last startup"
Domain of Interpretation: Yes
Execution Order: 1
Credentials Type: 1 Name: "VMS"
Resource wait count: 0

```

```

ACME Agent id: 2 State: Active
Name: "LDAP-STD"
Image: "DISK$I64SYS:[VMS$COMMON.SYSLIB]LDAPACME$LDAP-STD_ACMESHR.EXE;1"
Identification: "ACME LDAP Standard V1.5"
Information: "ACME_LDAP_DOI Agent is initialized"
Domain of Interpretation: Yes
Execution Order: 2
Credentials Type: 3 Name: "LDAP"
Resource wait count: 0

```

9. Add the user jdoe to the SYSUAF.DAT file.

```

@SYS$COMMON:[SYSHLP.EXAMPLES]ADDUSER.COM
*****
* Creating a NEW user account... If at ANY TIME you need help about a *
* prompt, just type "?". *
*****

```

Username(s) - separate by commas: jdoe

*** Processing JDOE's account ***

Full name for JDOE: John Doe

Password (password is not echoed to terminal) [JDOE]:

UIC Group number [200]:
UIC Member number: 201
Account name: TEST
Privileges [TMPMBX,NETMBX]:

Login directory [JDOE]:
Login device [SYS\$SYSDEVICE:]:

%CREATE-I-EXISTS, SYS\$SYSDEVICE:[JDOE] already exists
%UAF-I-PWDLESSMIN, new password is shorter than minimum password length
%UAF-E-UAEERR, invalid user name, user name already exists
%UAF-I-NOMODS, no modifications made to system authorization file
%UAF-I-RDBNOMODS, no modifications made to rights database

Check newly created account:

```
Username: JDOE                               Owner:
Account:  TEST                               UIC:    [201,2011] ([JDOE])
CLI:     DCL                                Tables: DCLTABLES
Default:  SYS$SYSDEVICE:[JDOE]
LGICMD:
Flags:   VMSAuth
Primary days:  Mon Tue Wed Thu Fri
Secondary days:                               Sat Sun
No access restrictions
Expiration:      (none)      Pwdminimum: 6      Login Fails:      1
Pwdlifetime:    90 00:00    Pwdchange:      (pre-expired)
Last Login:     (none) (interactive),      (none) (non-interactive)
Maxjobs:        0  Fillm:    128  Byt1m:    128000
Maxacctjobs:   0  Shrfillm:  0  Pbyt1m:    0
Maxdetach:     0  B1O1m:    150  JTquota:    4096
Prclm:         8  D1O1m:    150  WSdef:      4096
Prio:          4  AST1m:    300  WSquo:      8192
Queprio:       4  TQElm:    100  WSextent:   16384
CPU:           (none) Enqlm:   4000 Pgflquo:   256000
Authorized Privileges:
  NETMBX      TMPMBX
Default Privileges:
  NETMBX      TMPMBX
%UAF-I-NOMODS, no modifications made to system authorization file
%UAF-I-RDBNOMODS, no modifications made to rights database
```

Is everything satisfactory with the account [YES]:

10. Set **ExtAuth** and **VMSAuth** flag for the user **jdoue**. For information about adding a **SYSUAF** account, see “Specifying **EXTAUTH** and **VMSAUTH** flags on **OpenVMS**” (page 19).

```
$ SET DEF SYS$SYSTEM
$ MC AUTHORIZE
UAF> modify jdoue/flags=(EXTAUTH,VMSAUTH)
%UAF-I-MDFYMSG, user record(s) updated
UAF> SHOW jdoue
```

```
Username: JDOE                               Owner:
Account:  TEST                               UIC:    [201,2011] ([JDOE])
CLI:     DCL                                Tables: DCLTABLES
Default:  SYS$SYSDEVICE:[JDOE]
LGICMD:
Flags:   ExtAuth VMSAuth
Primary days:  Mon Tue Wed Thu Fri
Secondary days:                               Sat Sun
No access restrictions
Expiration:      (none)      Pwdminimum: 6      Login Fails:      1
Pwdlifetime:    90 00:00    Pwdchange:      (pre-expired)
Last Login:     (none) (interactive),      (none) (non-interactive)
Maxjobs:        0  Fillm:    128  Byt1m:    128000
Maxacctjobs:   0  Shrfillm:  0  Pbyt1m:    0
Maxdetach:     0  B1O1m:    150  JTquota:    4096
Prclm:         8  D1O1m:    150  WSdef:      4096
```

```

Prio:          4  ASTlm:          300  WSquo:          8192
Queprio:      4  TQElm:          100  WSextent:      16384
CPU:          (none)  Enqlm:         4000  Pgflquo:      256000
Authorized Privileges:
  NETMBX      TMPMBX
Default Privileges:
  NETMBX      TMPMBX
UAF>

```

11. Login to the system as user "jdoe".

Enabling ACME LDAP for secure ports

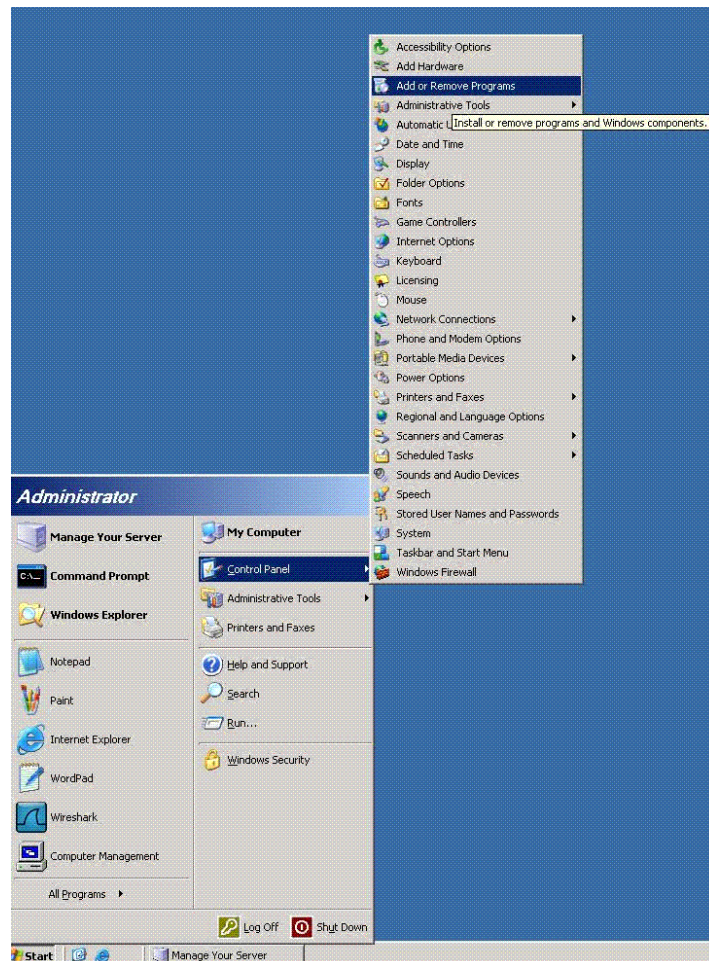
This section includes the following:

1. "Creating Active directory certificates" (page 46)
2. "Configuring ACME LDAP for secure port" (page 51)

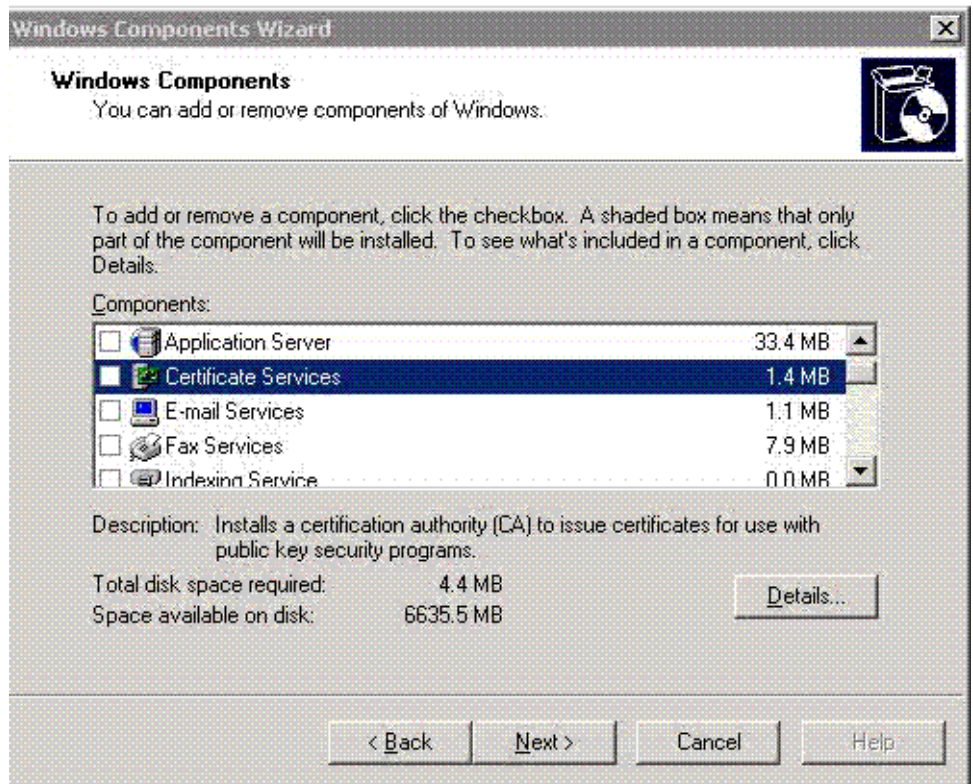
Creating Active directory certificates

To create a certificate file to enable secure authentication, you can install the Microsoft certification service and create the root CA as explained in the following procedure. Optionally, you can install third-party certificates. Refer to the knowledge brief provided by Microsoft: [How to enable LDAP over SSL with a third-party certification authority](#)"

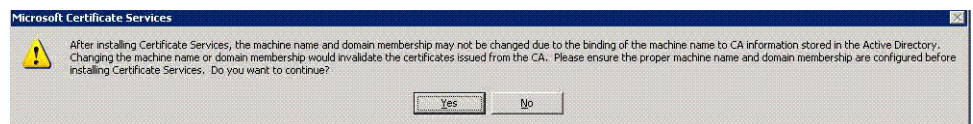
1. Go to **Start > All Programs > Control Panel > Add or Remove Programs** to open **Add or Remove Programs** window.



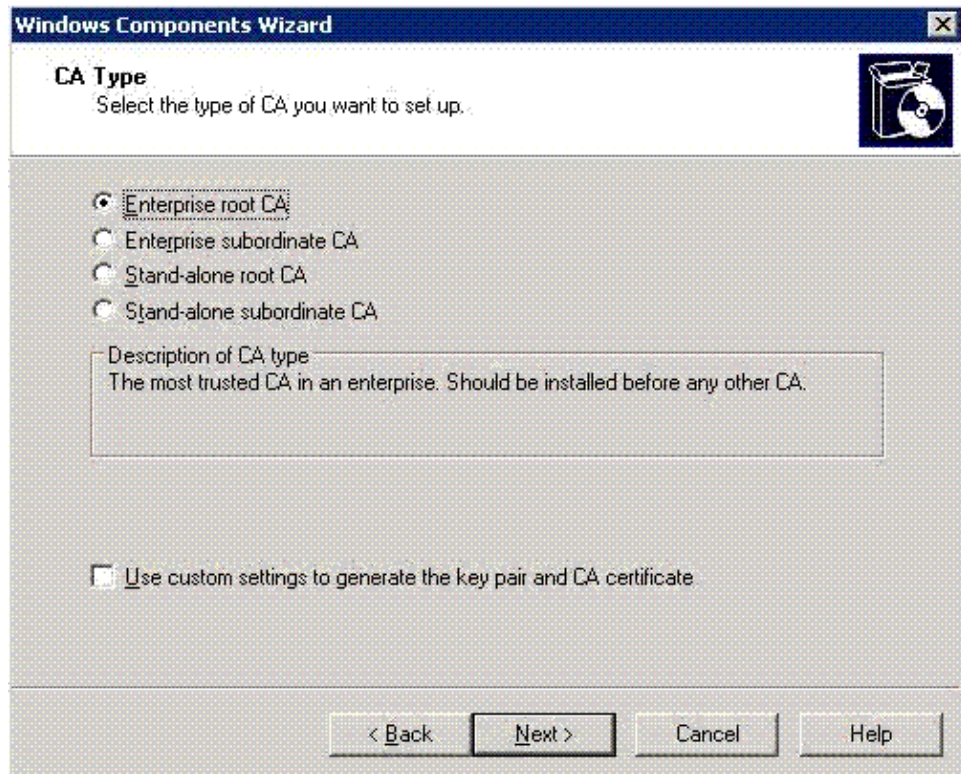
2. Click **Add or Remove Windows Components** option in the **Add or Remove Programs** window. The **Windows Components Wizard** dialog box is displayed.



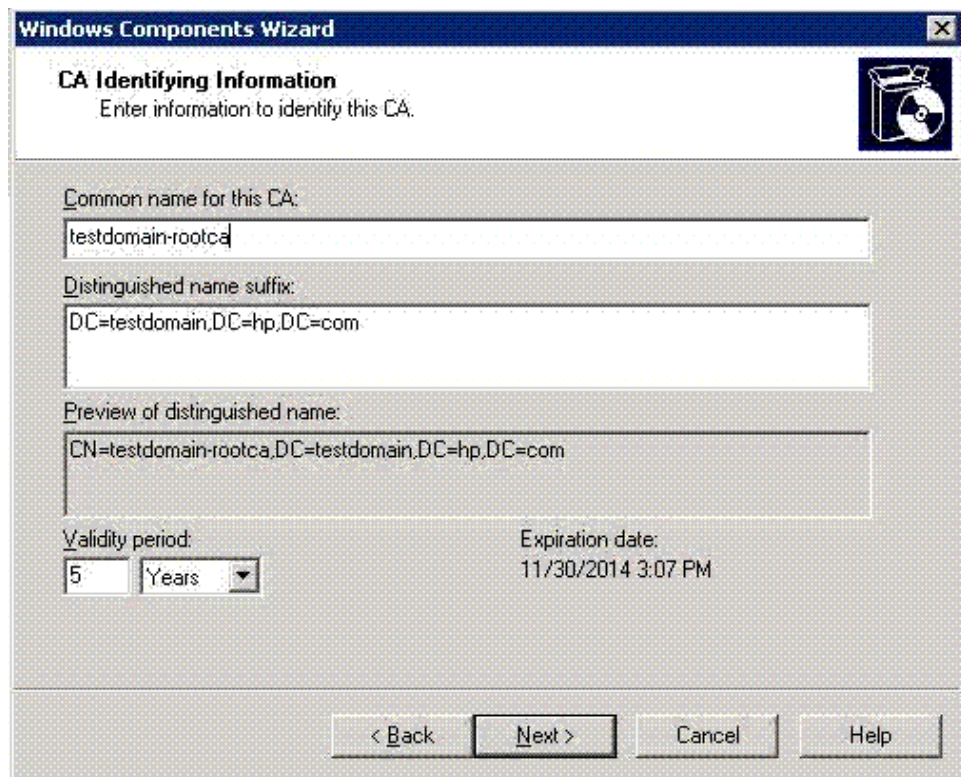
3. Select **Certificate Services**. You get the following warning message. Click **Yes** in the message box and **Next** in the **Windows Components Wizard** to continue installing the certificates.



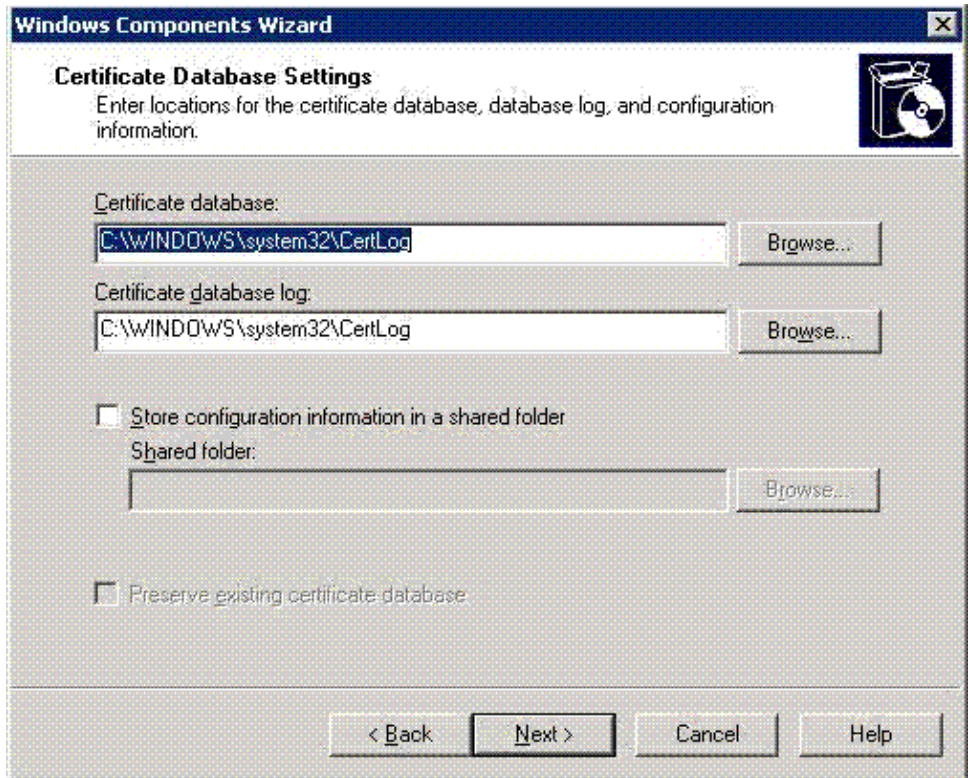
4. Select the required CA type from the options provided. The default is **Enterprise root CA**. Click **Next** to display the **CA Identifying Information** window.



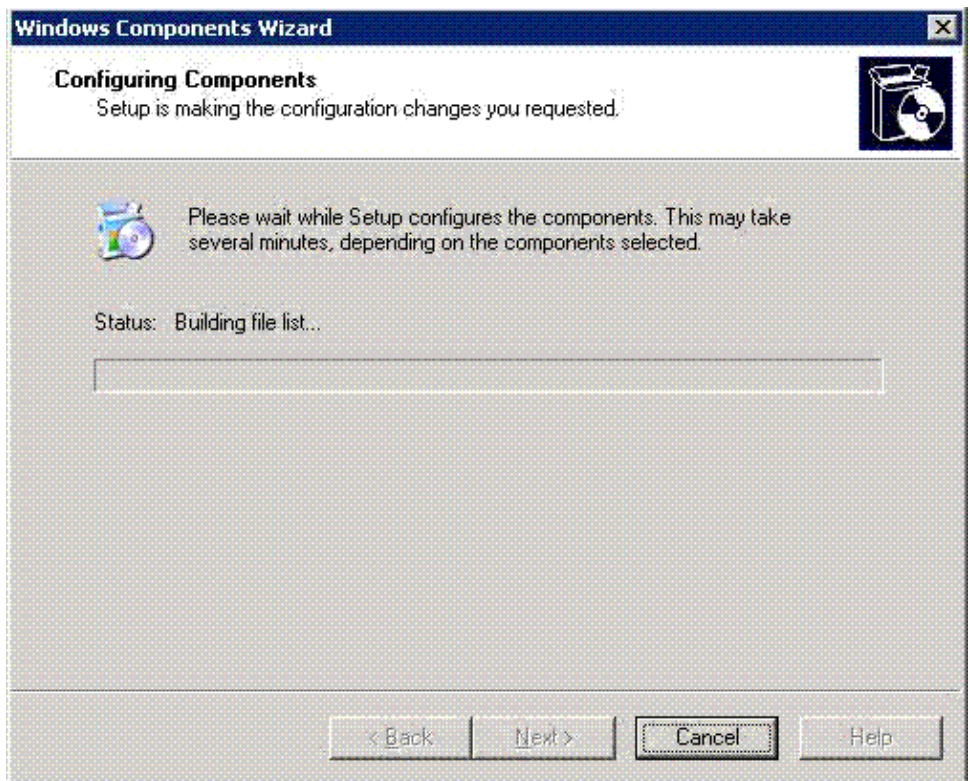
5. Enter the **Common name for this CA:** in the **CA Identifying Information** dialog box. Also, select the **Validity period**. Click **Next** to display the **Certificate Database Settings** dialog box.



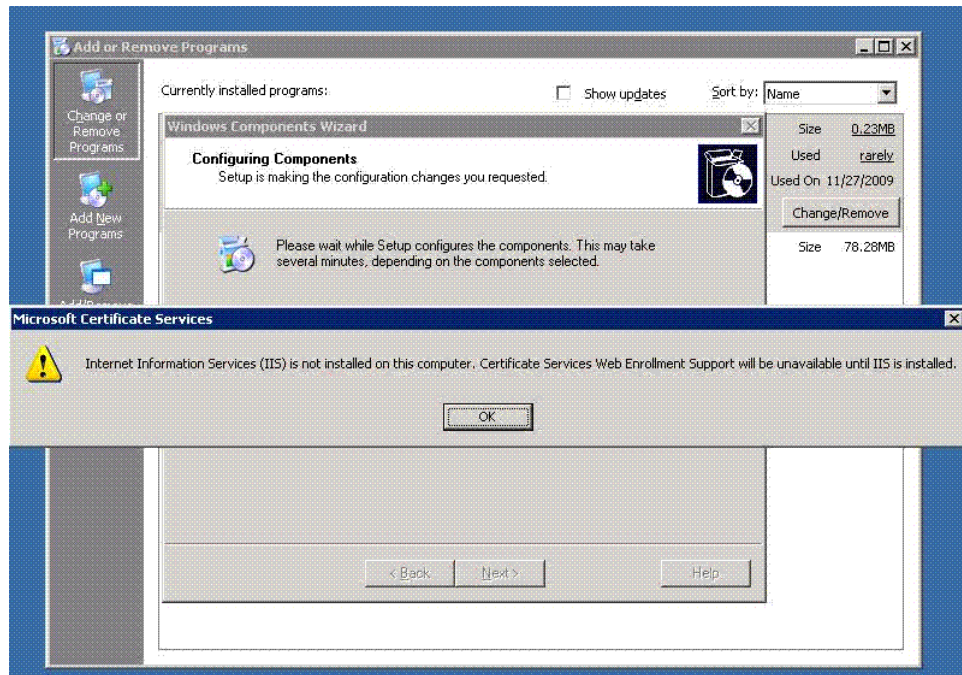
6. Browse and select the **Certificate database** and **Certificate database log:** folders or retain the default location and click **Next** to display the **Configuring Components** dialog box..



7. Wait while the certificate components are being configured. When the configuration is complete, click **Next**.



8. You may get the following message:
"Internet Information Services (IIS) is not installed on this computer. Certificate Services Web Enrollment Support will be unavailable until IIS is installed."
Click **OK** . The **Completing the Windows Components Wizard** dialog box is displayed.



9. Click **Finish** to complete installing certificates.



10. Restart the Windows system.

Configuring ACME LDAP for secure port

1. Update the LDAP configuration file, `SYS$STARTUP:LDAPACME$CONFIG-STD.INI` similar to how the file was updated in section “Configuring ACME LDAP for non-secure port”. The only difference is the values provided to the `port` and `port_security` directives.

See the following sample configuration file:

```
server = cssn-ddrs.testdomain.hp.com
port = 636
bind_dn = CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com
bind_password = welcome@123
base_dn = DC=testdomain,DC=hp,DC=com
scope = sub
port_security = ssl
password_type = active-directory
```

or

```
server = cssn-ddrs.testdomain.hp.com
port = 389
bind_dn = CN=query_account,CN=Users,DC=testdomain,DC=hp,DC=com
bind_password = welcome@123
base_dn = DC=testdomain,DC=hp,DC=com
scope = sub
port_security = starttls
password_type = active-directory
```

2. Restart `ACME_SERVER` and check the login as explained in section “Configuring ACME LDAP agent for non-secure port” (page 43).

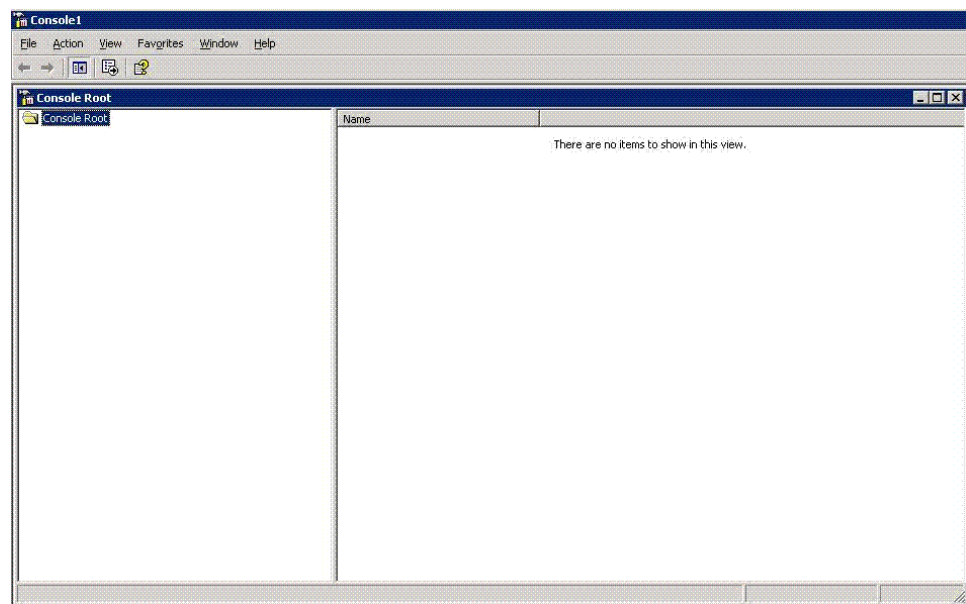
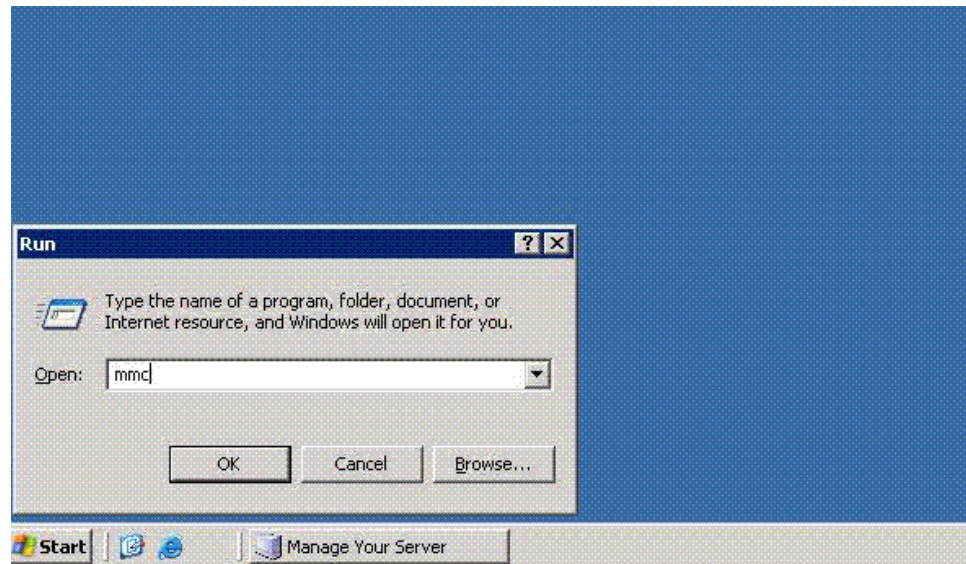
Providing Active directory certificates to ACME LDAP

This is an optional step, where you can export the public root certificate of the Active directory and provide it to the ACME LDAP agent. The ACME LDAP agent checks if it is connecting to the correct active directory server by validating the certificate.

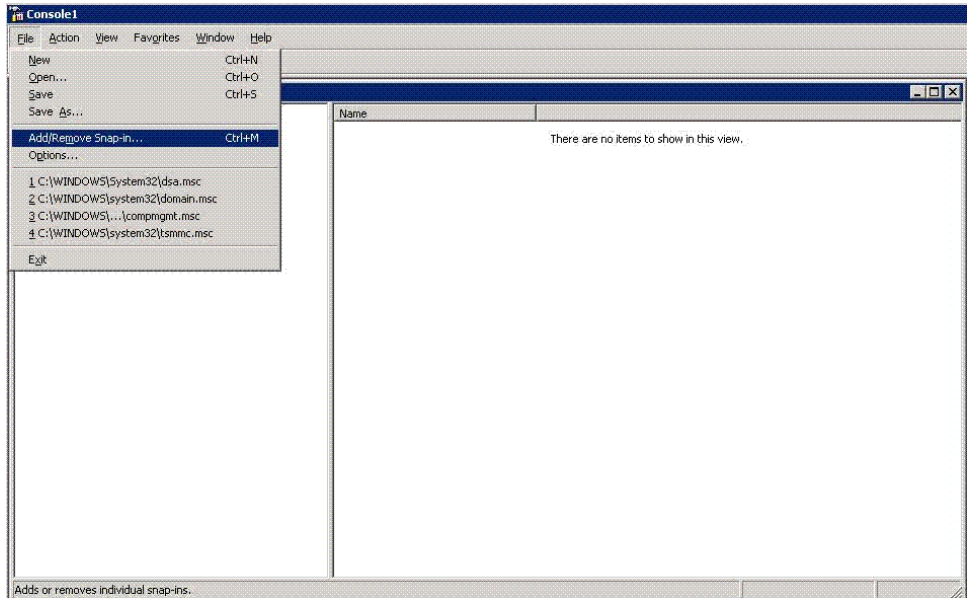
Viewing the certificate on Active directory

To view the certificate generated, perform the following steps:

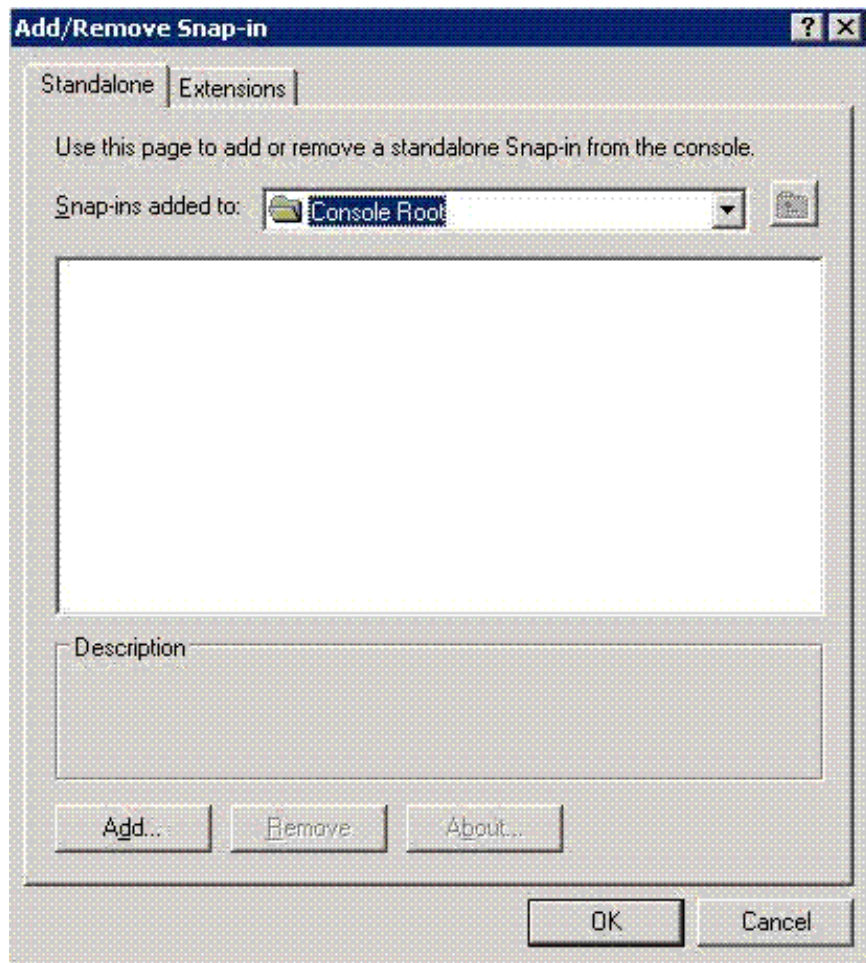
1. Go to **Run** and open **mmc** to open a console.



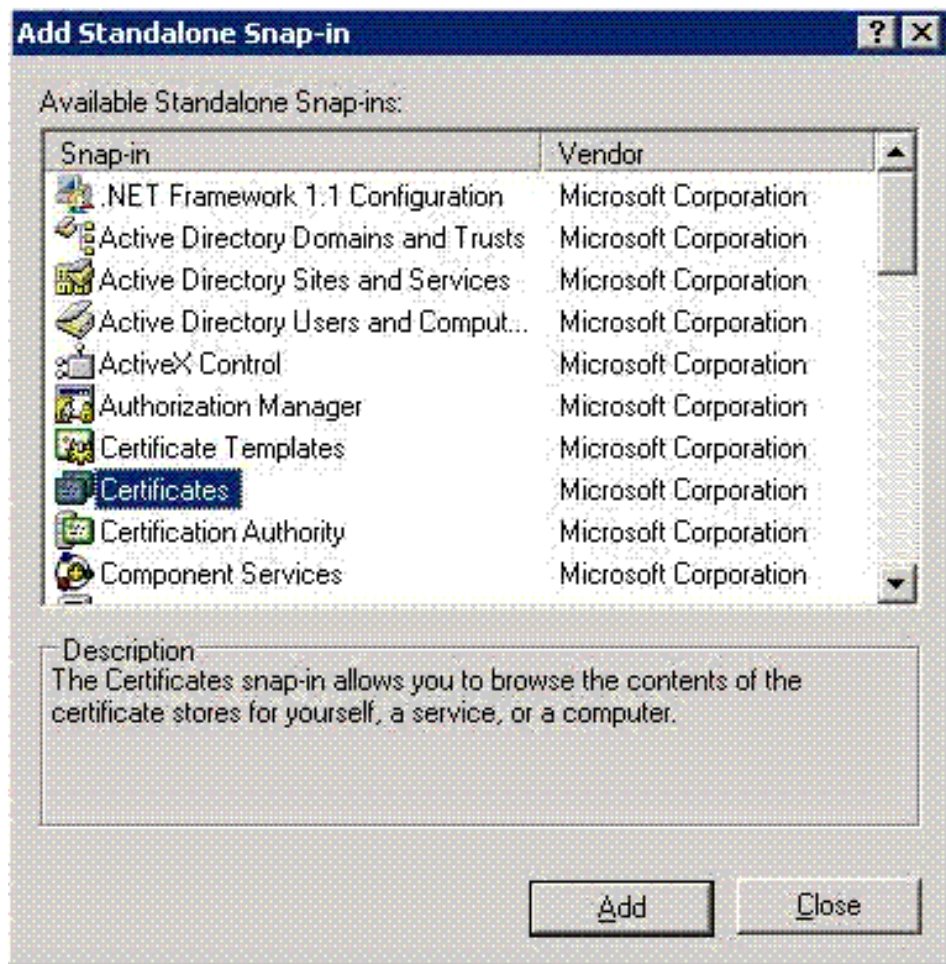
2. Go to **File > Add/Remove Snap-in** to open the **Add/Remove Snap-in** dialog box.



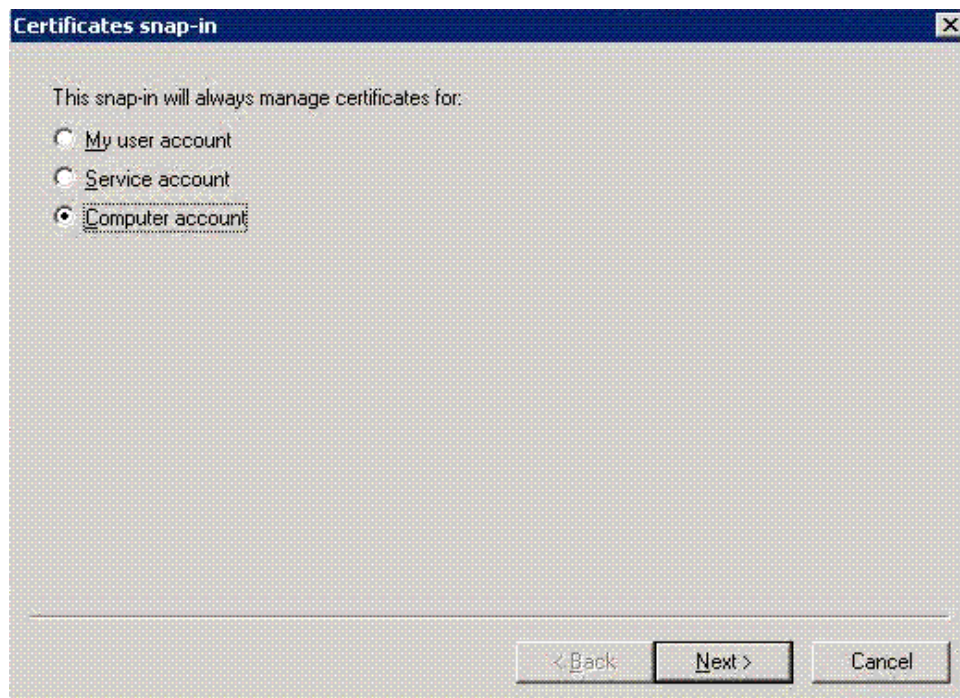
3. Click **Add** in the **Standalone** tab in the **Add/Remove Snap-in** dialog box. The **Add Standalone Snap-in** dialog box is displayed.



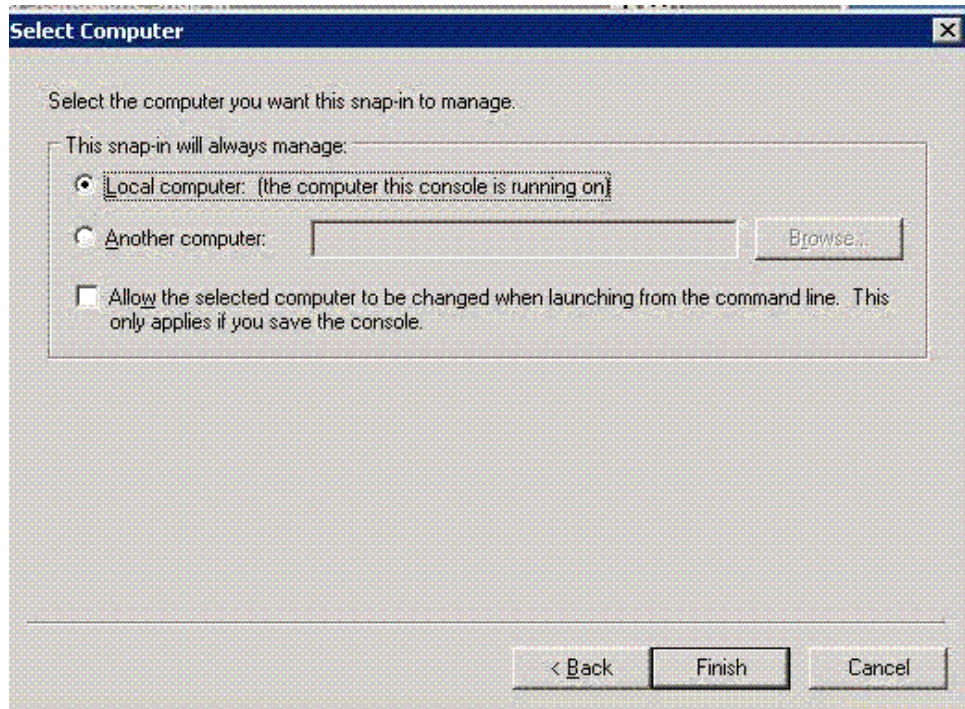
4. Select **Certificates** and click **Add** to display the **Certificates snap-in** dialog box. You will be required to enter details of the certificate in the next few dialog boxes.



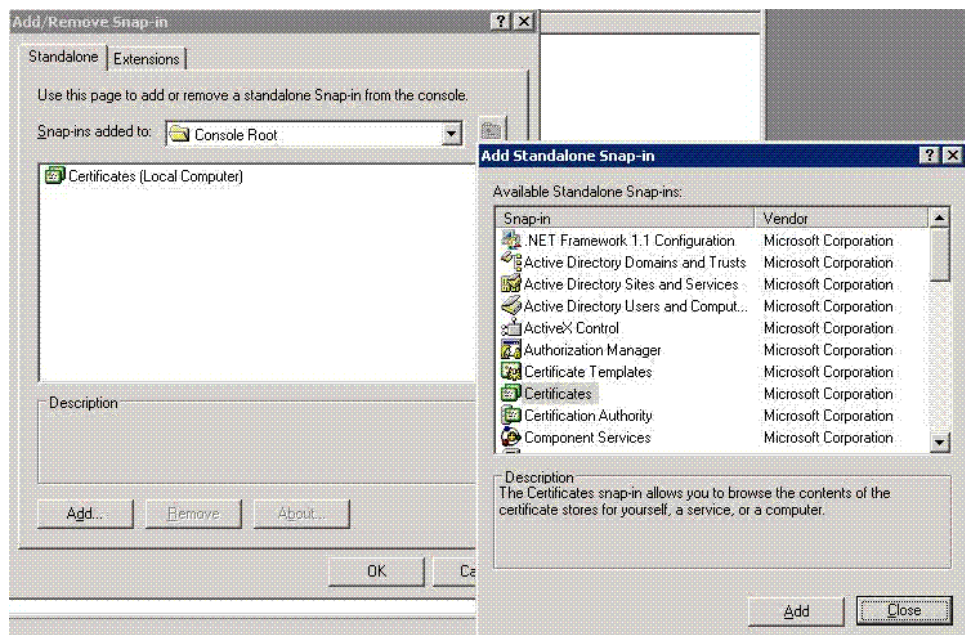
5. Select the **Computer account** option and click **Next** to display the **Select Computer** dialog box.



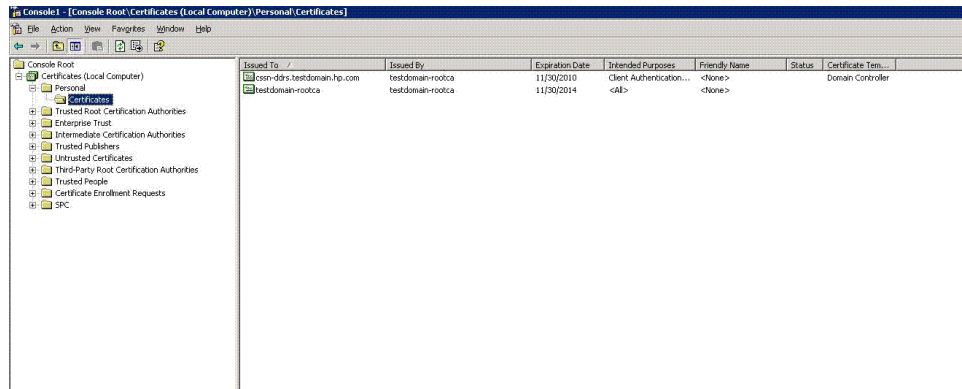
6. Select **Local computer (the computer this console is running on)** option and click **Finish** to complete the process of adding the certificate. You will be taken back to the **Add Standalone Snap-in** dialog box.



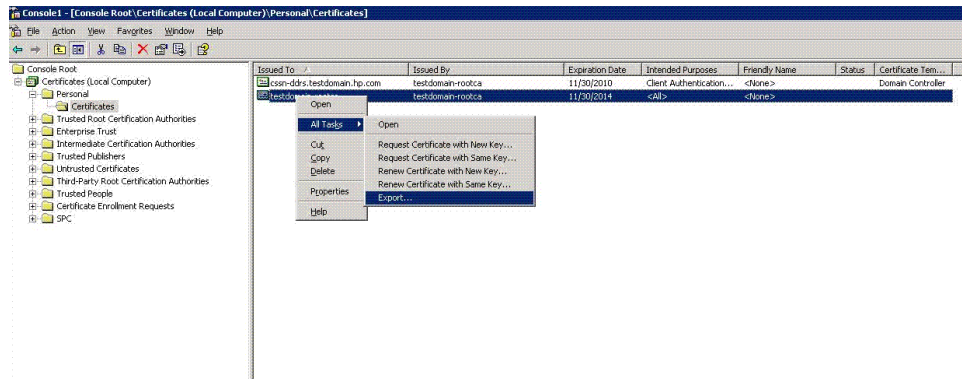
7. Click **Close** on the **Add Standalone Snap-in** dialog box. The **Add/Remove Snap-in** dialog box displays the certificates added to the snap-in. Click **OK** to close the **Add/Remove Snap-in** dialog box.



8. Go to **Console Root > Certificates > Personal > Certificates**. The available certificates are displayed in the right-hand side panel of the **Console Root** window.



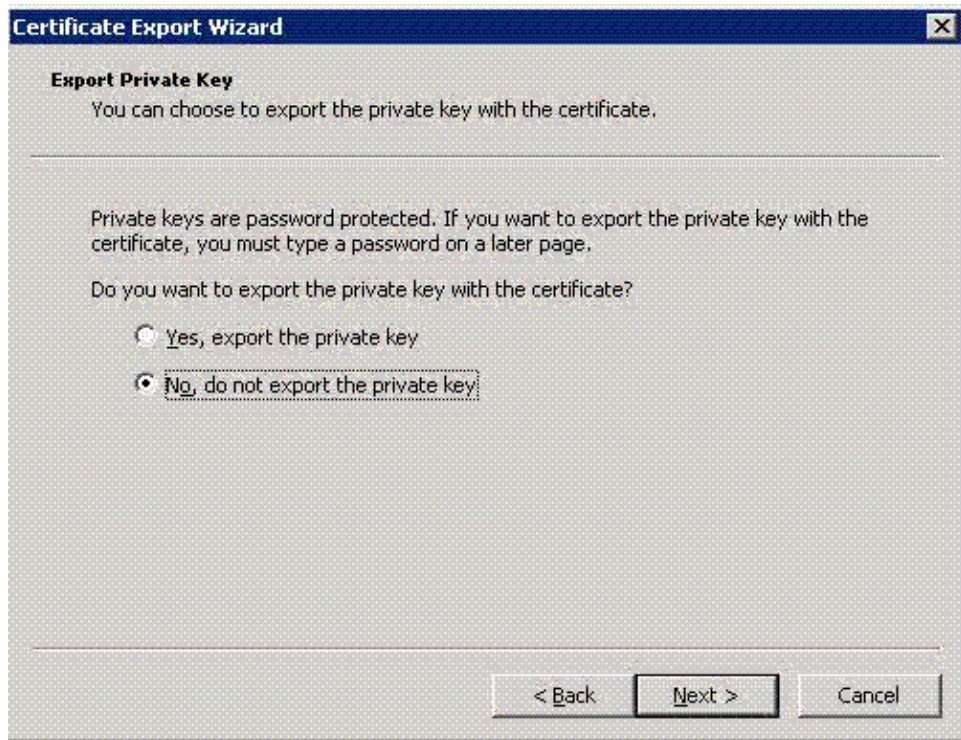
- Right-click on the certificate and select **All Tasks > Export** to export the certificate. The **Certificate Export Wizard** dialog box is displayed.



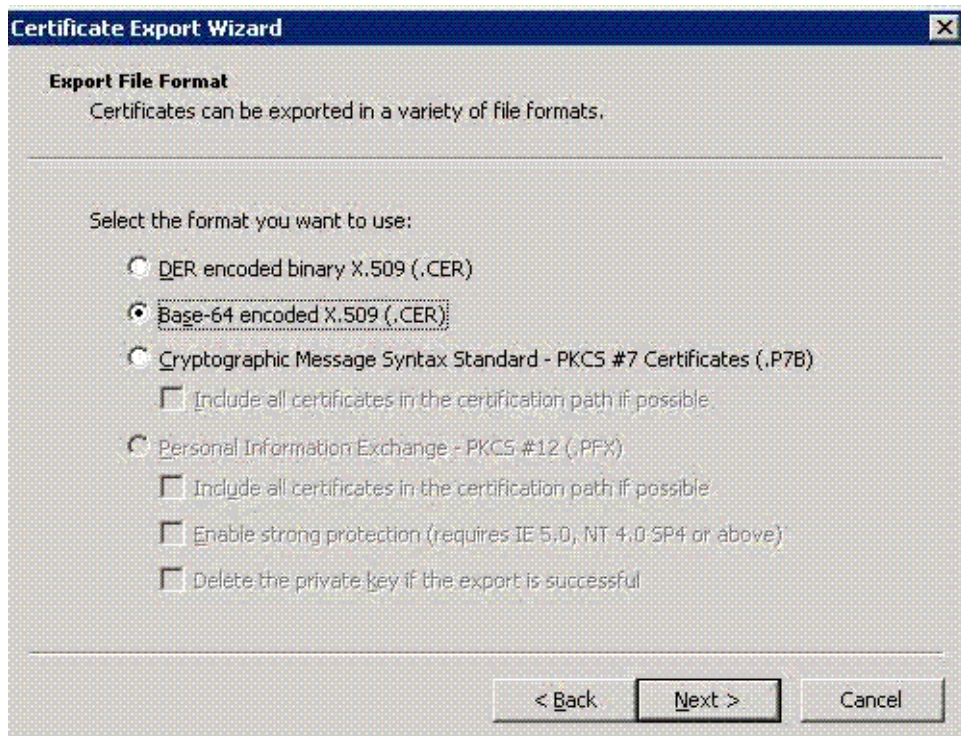
- Click **Next** in the **Welcome** dialog box to start exporting the certificate. The **Export Private Key** dialog box is displayed.



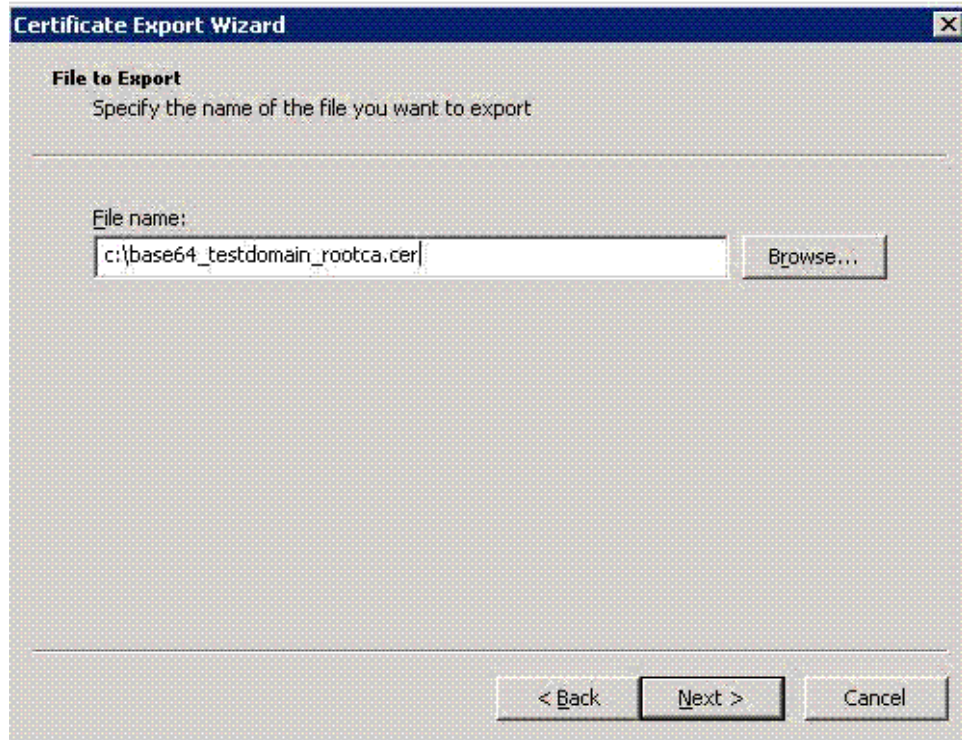
- Select **No, do not export the private key** and click **Next** to display the **Export File Format** dialog box.



12. Export the **certificate in Base-64 encoded X.509 format** only. Click **Next**. The **File to Export** dialog box is displayed.



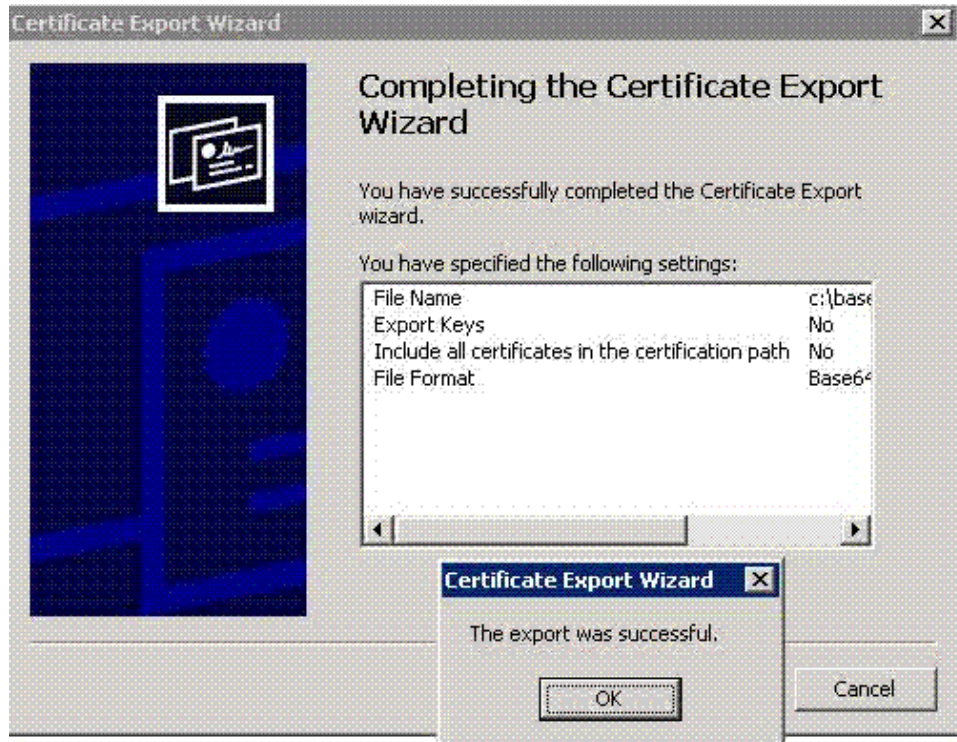
13. Browse and select the **File name:** or click **Next** with the default file name. The **Completing the Certificate Export Wizard** dialog box is displayed.



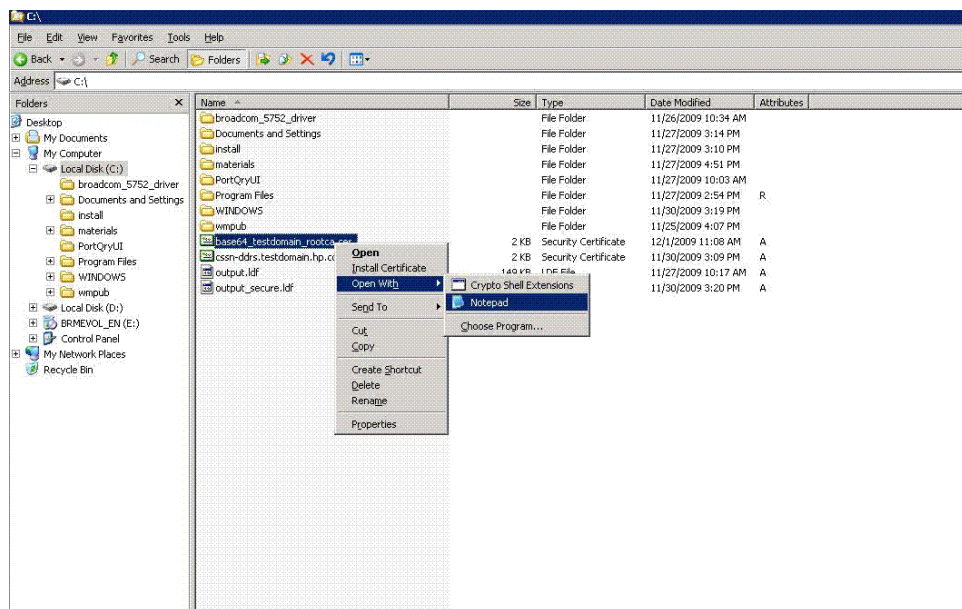
14. Click **Finish** to complete exporting the certificate. You get the following message if the export is successful.

The export was successful.





To view the certificate, open the certificate file with Notepad



The certificate generated on the system is shown in the following figure:

```

base64_testdomain_rootca.cer - Notepad
File Edit Format View Help
-----BEGIN CERTIFICATE-----
MIIEYtCCA7GgAwIBAgIQZwDwp4/sYrdFFgu2nJ1IzZANBgkqhkiG9w0BAQUFADBh
MRMwEYKCZIm1ZPylGQBGRYDY29tMRlWEAYKZIm1ZPylGQBGRYCaHAXGjAYBgoJ
k1aJk/IsZAEZfGp0ZxN0ZG9tYw1uMR0wGAYDVQQDEXF0ZxN0ZG9tYw1uLXJvb3Rj
YTAeFw0wOTE5MzAwOTI5NTN0ZD0wMDU0MjM1NTY0MjM1NTY0MjM1NTY0MjM1
ZAEZfGj0cDEaMBGgGcm5J0mT81xkArkwcNrl
c3Rkb21haw4xGjAYBGNVBAETXR1c3Rkb21haw4tcm9vdG90dG90dG90dG90dG90
9w0BAQEFAAOCAQ8AMIIBCgKCAQEAuThryHACRdf81d0+Gj+z1xosCSTqHkbbY6db
n7ZBUBKkYaz5X618ACTgweo468mqUEMq5M249671cLfs5kr6fyqrD6g21Xz05g0z
SF0M2Bj1jeeZ1zmjLDJKdza2JykwwvztfLqoydukexntZFD7Y1F13j9PG7QqFX
HKA7jQcy0S2n0YbreqIhV4x4Z4nau1and3/EkyC+I7yJ10WMO+MwRVLGC3t9fGh
QYF3c8t4/4pbU1seJw0nnf3UkrHmJewQ9xpCpHzrs9100w9spdfT1CHcty/sAw2
8Xx6t1wgw5ancqy04e1oJp3ZanrI/Fwf1J4Dqp4CE9mj9YPA8QIDAQABo4IBezCC
AXCwCwYDVR0PBQAQDAGGMA8GA1UdEwEB/wQFMAMBAF8wHQYDVR0OBBYEFF1ND700
j11q1gVnnoUoyvm2N1d4MIIBJAYDVR0FBIIbGZCCARcwggGTOIIBD6CCAQUgGcNS
ZGFw18L0N0PXR1c3Rkb21haw4tcm9vdG90dG90dG90dG90dG90dG90dG90dG90
Q049UHV1bg1jJTIwS2V5JTIwU2Vydm1jZXMzQ049U2Vydm1jZXMzQ049Q29uzm1n
dxJhdG1vb1xEQz10ZxN0ZG9tYw1uLERDPwhwLERDPwNvbT9jZxJ0awzpy2F0ZV11
dm9jYXRpb25MaXN0P2Jhc2U/b2JqZWN0Q2xhc3M9Y1JMRG1zdHJpYnV0aw9uUG9p
bn5GQ2hodHA6L9y9j3NuLWRkcnMudGvZdGRvbWFPpb15ocC5jB20vQ2VydeVucm9s
bc90ZxN0ZG9tYw1uLXJvb3RjY55jcmwEAYJKwYBBAQCNXUBBAMCAwQAYJKoZI
hvcNAQEFBQADggEBAJLFFPGA3vh1v1zLE9PT/9P5d2tHo/R0Cgw261Q35qL73B00I
ZbxDvWLn9xjhgVxjJL3kjpnmjR0Pvcbcf0+xsj55uKM9EA/BMZYf2wnsPgd7wZ
9tLDyGCaH0G0DgFedByKAag2bnHKSqjAN1VAvs/n1n1XeqhKk5P4vuwEwB79kYw
MS855nac8Nx9kVhenYpWchj6rCs1a28RMQwxtY6FZPgPFua00c2hnsXUL4z0LK1
3AQb2FOEILokrxNVzVl1P1PckP2cyqux80450j15Ly21cg/1M0TU8o/1ICPUkaty
110XLFgaLqwsTTsge215hynpNFx40Sdfdu3s56s=
-----END CERTIFICATE-----

```

Adding the certificate to OpenVMS

To add the certificate for LDAP authentication, perform the following steps:

1. Create a file `SYS$SYSROOT:[SYSMGR]<certificate name>`. For example, `SYS$SYSROOT:[SYSMGR]BASE64_TESTDOMAIN_ROOTCA.CER`, where `BASE64_TESTDOMAIN_ROOTCA.CER` is the name of the certificate.
2. Copy the certificate from the Active directory server and paste it on to the `BASE64_TESTDOMAIN_ROOTCA.CER` file.
3. Save the file.



NOTE: If you FTP this file, use ASCII mode.

4. Ensure that this file is protected.
`SET SECURITY/PROTECTION = (SYSTEM:"RWED", OWNER:" ", GROUP:" ", WORLD:" ")`
5. Open the `SYS$STARTUP:LDAPACME$CONFIG-STD.INI` file and edit the `ca_file` attribute with the exact directory location of the certificate file.
 For example, `ca_file = SYS$SYSROOT:[SYSMGR]:BASE64_TESTDOMAIN_ROOTCA.CER` and save the configuration file
6. Restart ACME server:
`$ SET SERVER ACME/EXIT/WAIT`
`$ SET SERVER ACME/START=AUTO`

5 Troubleshooting

Problem

System displays the following error when @SYS\$STARTUP:ACME\$START.COM is executed:

```
$ @sys$startup:acme$start.com
Please ensure the following logical is defined /SYSTEM/EXECUTIVE_MODE
LDAPACME$INIT
```

Solution

The LDAPACME\$INIT logical is not defined before the @SYS\$STARTUP:LDAPACME\$STARTUP-STD command in SYS\$COMMON:[SYSMGR]ACME\$START.COM. For more information, see the steps in “Editing LDAP configuration file” (page 15).

Problem

When @SYS\$STARTUP:ACME\$START.COM is executed, the system displays the following error, all ACME agent are in stopped state when using the SHOW SERVER ACME/FULL command and new logins are not permitted:

```
$ @sys$startup:acme$start.com
%ACME-E-INVPARAMETER, parameter selector or descriptor is invalid
```

Solution

The LDAPACME\$INIT logical is defined to a wrong INI file name. Perform the following steps:

1. Deassign the LDAPACME\$INIT logical

```
$ deassign /system/exec LDAPACME$INIT
```
2. Stop the ACME Server process

```
$ set server acme/exit/wait
```
3. Correct the LDAPACME\$INIT logical to point to the right path inside SYS\$STARTUP:ACME\$START.COM
4. Start the ACME server in auto mode so that it starts the ACME LDAP agent during startup.

```
$ set server acme/start=auto
```

Problem

The SHOW SERVER ACME/FULL command does not display the LDAP agent.

```
$ sh server acme/full
ACME Information on node EARWIG 18-FEB-2010 05:50:06.40 Uptime 0 00:01:48
```

```
ACME Server id: 2 State: Processing New Requests
Agents Loaded:      1 Active:      1
Thread Maximum:    1 Count:      1
Request Maximum:   826 Count:      0
Requests awaiting service: 0
Requests awaiting dialogue: 0
Requests awaiting AST: 0
Requests awaiting resource: 0
Logging status: Active
Tracing status: Inactive
Log file: "SYS$SYSROOT:[SYSMGR]ACME$SERVER.LOG;17"
```

```
ACME Agent id: 1 State: Active
Name: "VMS"
```

```

Image: "DISK$I64SYS:[VMS$COMMON.SYSLIB]VMS$VMS_ACMESHR.EXE;1"
Identification: "VMS ACME built 20-SEP-2006"
Information: "No requests completed since the last startup"
Domain of Interpretation: Yes
Execution Order: 1
Credentials Type: 1 Name: "VMS"
Resource wait count: 0

```

\$

Solution

Check if the `SYS$STARTUP:ACME$START.COM` has been updated with the LDAP logical names and `@SYS$STARTUP:LDAPACME$STARTUP-STD ! LDAP` command is uncommented in the file. For more information on updating the `SYS$STARTUP:ACME$START.COM`, see “Editing LDAP configuration file” (page 15).

```

ACME Server id: 2 State: Processing New Requests
Agents Loaded: 2 Active: 2
Thread Maximum: 1 Count: 1
Request Maximum: 826 Count: 0
Requests awaiting service: 0
Requests awaiting dialogue: 0
Requests awaiting AST: 0
Requests awaiting resource: 0
Logging status: Active
Tracing status: Inactive
Log file: "SYS$SYSROOT:[SYSMGR]ACME$SERVER.LOG;19"

```

```

ACME Agent id: 1 State: Active
Name: "VMS"
Image: "DISK$I64SYS:[VMS$COMMON.SYSLIB]VMS$VMS_ACMESHR.EXE;1"
Identification: "VMS ACME built 20-SEP-2006"
Information: "No requests completed since the last startup"
Domain of Interpretation: Yes
Execution Order: 1
Credentials Type: 1 Name: "VMS"
Resource wait count: 0

```

```

ACME Agent id: 2 State: Active
Name: "LDAP-STD"
Image: "DISK$I64SYS:[VMS$COMMON.SYSLIB]LDAPACME$LDAP-STD_ACMESHR.EXE;1"
Identification: "LDAP ACME Standard V1.5"
Information: "ACME_LDAP_DOI Agent is initialized"
Domain of Interpretation: Yes
Execution Order: 2
Credentials Type: 3 Name: "LDAP"
Resource wait count: 0

```

\$

Problem

All the ACME LDAP configuration is correct, but the user is unable to log in.

Solution 1

Use the Ping command to check whether the LDAP server provided in the server directive of the LDAP INI file is reachable:

```

$ tcpip ping
PING earwig (15.146.235.235): 56 data bytes
64 bytes from 15.146.235.235: icmp_seq=0 ttl=64 time=0 ms
64 bytes from 15.146.235.235: icmp_seq=1 ttl=64 time=0 ms
64 bytes from 15.146.235.235: icmp_seq=2 ttl=64 time=0 ms
64 bytes from 15.146.235.235: icmp_seq=3 ttl=64 time=0 ms

```

```
----earwig PING Statistics----
4 packets transmitted, 4 packets received, 0% packet loss
round-trip (ms)  min/avg/max = 0/0/0 ms
```

Solution 2

Ensure that the ExtAuth flag is provided for the user in SYSUAF.DAT file.

Solution 3

Use TCPDUMP to check whether data is flowing on the configured LDAP port.

```
$ tcpdump -w tcpdump.enc tcp port 389
tcpdump: Filtering in user process
tcpdump: listening on WE1, link-type EN10MB (Ethernet), capture size 96 bytes
*CANCEL*

24 packets captured
24 packets received by filter
0 packets dropped by kernel
$ dir .enc

Directory SYS$SYSROOT:[SYSMGR]

TCPDUMP.ENC;1

Total of 1 file.
$
$ tcpdump -r TCPDUMP.ENC
reading from file tcpdump.enc, link-type EN10MB (Ethernet)
05:39:16.726000 IP opnvms.ind.hp.com.49160 > CSSN-DDRS.TESTDOMAIN.HP.COM.389: S 1252791091:1252791091(0) win
61440 <mss 1460,nop,wscale 0>
05:39:16.726000 IP CSSN-DDRS.TESTDOMAIN.HP.COM.389 > opnvms.ind.hp.com.49160: S 1725693481:1725693481(0) ack
1252791092 win 16384 <mss 1460,nop,wscale 0>
05:39:16.726000 IP opnvms.ind.hp.com.49160 > CSSN-DDRS.TESTDOMAIN.HP.COM.389: . ack 1 win 62780
05:39:16.726000 IP opnvms.ind.hp.com.49160 > CSSN-DDRS.TESTDOMAIN.HP.COM.389: P 1:78(77) ack 1 win 62780
05:39:16.728000 IP CSSN-DDRS.TESTDOMAIN.HP.COM.389 > opnvms.ind.hp.com.49160: P 1:23(22) ack 78 win 65458
05:39:16.729000 IP opnvms.ind.hp.com.49160 > CSSN-DDRS.TESTDOMAIN.HP.COM.389: P 78:154(76) ack 23 win 62780
```

Solution 4 (for Programmers)

To troubleshoot issues with the LDAP configuration, use a compiled version of SYS\$EXAMPLES:LDAP_EXAMPLES.C

Note that the LDAP_EXAMPLE.C can currently only connect to the directory server on the standard (non-secure) port 389.

```
ld = ldap_init(argv[1], LDAP_PORT);
```

The LDAP_EXAMPLE.C assumes anonymous binding to the directory server. You can provide a DN (parameter 2) and password (parameter 3) to modify this behavior. If this is not the case, you can change the following code:

```
stat = ldap_simple_bind_s(ld, NULL, NULL); to
stat =
ldap_simple_bind_s(ld, "CN=query_account,CN=Users,DC=testdomain,DC=yourdomain,dc=com", "yourpassword");
```

Where, CN=query_account, CN=Users, DC=testdomain, DC=yourdomain, dc=com is the value provided to the *bind_dn* directive of the ACME LDAP configuration file and **yourpassword** is the value provided to the *bind_password* directive of the ACME LDAP configuration file.

A sample compilation and execution is shown as follows. In the following sample, the **cssn-ddrs.testdomain.yourdomain.com** is the value of the *server* directive, CN=Users, DC=testdomain, DC=yourdomain, dc=com is the value for the *base_dn* directive of the ACME LDAP configuration file.

```
$ set def sys$examples
$ cc LDAP_EXAMPLE
$ link LDAP_EXAMPLE
$ ldap_example:=="$sys$examples:LDAP_EXAMPLE.EXE"
$ ldap_example
Usage : opnvms$dka0:[sys0.] [syshlp.examples] ldap_example.exe;6 [server] [base] [filter] <
attributes>
```

```
Program terminating
$ ldap_example cssn-ddrs.testdomain.yourdomain.com "CN=Users,DC=testdomain,DC=yourdomain, dc=com" "" sAMAccountName
Number of entries returned : 34

dn = CN=Users,DC=testdomain,DC=yourdomain,dc=com
<Noattributes returned>
dn = CN=VMSUsers,CN=Users,DC=testdomain,DC=yourdomain,dc=com
sAMAccountName : VMSUsers
-
-
dn = CN=John Doe,CN=Users,DC=testdomain,DC=yourdomain,dc=com
sAMAccountName : John Doe

Program terminating
```


What events can be traced using the “\$ SET SERVER ACME/TRACE=<value>” command and how do we interpret the traces?

You can view critical errors logged by the agent in ACME\$SERVER.LOG without setting the SET SERVER ACME/TRACE=<value>. See Table 5-1 (page 65) for setting the appropriate values.

For example:

When ACME LDAP agent is configured to a Directory server, which is not reachable, the following error messages are displayed:

```
%ACME-I-LOGAGENT, agent initiated log event on 25-FEB-2010 10:41:06.43          ==> Time of Log
-ACME-I-THREAD, thread: id = 4, type = EXECUTION                            ==> Thread ID of the ACME Server
causing this error
-ACME-I-REQUEST, request information, id = 1, function = AUTHENTICATE_PRINCIPAL ==> Function code passed to
SYSSACM
-ACME-I-CLIENT, client information, PID = 2020044C                          ==> Process ID of the client
talking to ACME Server
-ACME-I-AGENT, agent information, ACME id = 2, name = LDAP-STD              ==> Agent handling this request.
-ACME-I-CALLOUT, active callout routine = acme$co_accept_principal          ==> Authentication routine handling
the request
-ACME-I-CALLBACK, active callback routine = acme$cb_send_logfile           ==> Callback routine.

-ACME -I-TRACE, message from LDAP ACME agent: Internal error. LDAP search operation failed ==> Status returned
by the ACME agent
```

Another example on giving port_security = nonenone instead of port_security = none in the configuration file:

```
%ACME-I-LOGAGENT, agent initiated log event on 25-FEB-2010 10:42:39.41
-ACME-I-THREAD, thread: id = 1, type = CONTROL
-ACME-I-CONTROL, control information, operation = STARTUP
-ACME-I-AGENT, agent information, ACME id = 2, name = LDAP-STD
-ACME-I-CALLOUT, active callout routine = acme$co_agent_startup
-ACME-I-CALLBACK, active callback routine = acme$cb_send_logfile
-ACME -I-TRACE, MESSAGE FROM LDAP ACME agent: Reading the config file (LDAPACME$INIT) failed ==>>> Error message
```

The information starting from “%ACME-I-” to the next “%ACME-I-” marks one trace.

When you execute \$ SET SERVER ACME/TRACE=<value>, tracing is enabled and logged to SYS\$MANAGER:ACME\$SERVER.LOG file.

You must look for the “MESSAGE FROM LDAP ACME agent” line in the ACME\$SERVER.LOG to locate status messages returned by the LDAP ACME agent

For details about the various flags that can be enabled for tracing execute \$ HELP SET SERVER ACME/TRACE on a OpenVMS system

The following table provides details about the trace flags:

Table 5-1 Bitmask

Bitmask	Event	Description
0	agent	Enable agent tracing.
1	general	General (non-specific) tracing.

Table 5-1 Bitmask *(continued)*

Bitmask	Event	Description
2	vm	Virtual memory operations. That is, trace the memory allocation and de-allocation of both the ACME_SERVER and the agent (if the agent uses the memory services provided by ACME_SERVER process). NOTE: Tracing is not enabled if the agent uses its own or standard (malloc, calloc, free) memory management routines.
3	ast	AST processing. Traces ASTs that are triggered by agents to the ACME_SERVER.
4	wqe	WQE parameter that flows between the ACME_SERVER process and agent.
5	report	Agent status or attribute operations.
6	message	Messaging operations.
7	dialog	Dialogue operations.
8	resource	Agent resource operations. Agents can request for some specific resource locks from the ACME_SERVER process.
9	callout	Agent callout routine. Routines that are implemented by individual agents such as ACME LDAP, that are called by the ACME_SERVER.
10	callout_status	Agent callout return status.

For example:

If you want tracing of “agent”, “general”, “report”, “message”, “dialog”, “callout”, and “callout_status”, use:

```
$ SET SERVER ACME/TRACE=1763
```

6 Restrictions

This section lists the restrictions associated with ACME LDAP agent.

Username and password restrictions

- Password modifications are made to the standard **userPassword** attribute or Active directory's **unicodePwd** attribute. The details of the configuration attributes are described in "Installing and configuring ACME LDAP agent" (page 13). The *ldap_modify* "replace" or "remove-old/add-new" semantics for password modifications can be configured to support a variety of directory servers based on the user requirements.

The following LDAP password policy client controls are supported to warn users of password expiration events:

```
Netscape "password has expired" "2.16.840.1.113730.3.4.4"  
Netscape "password expiration warning" "2.16.840.1.113730.3.4.5"
```



NOTE: Netscape controls are supported by Netscape Directory Server, Netscape/Sun iPlanet and Red Hat/Fedora Directory Server.

Password policy client controls other than the Netscape controls mentioned above are not supported.

Password expiration warnings will not be seen during OpenVMS login when using directory server software that does not support Netscape password policy client controls, such as Active Directory and Novell eDirectory.

- Characters used in user names and passwords are restricted to the 8-bit ISO 8859-1 (Latin-1) character set. UTF-8 support is not included in this release.
- Active directory password changes are restricted to the 7-bit ASCII subset of the ISO 8859-1 (Latin-1) character set in this release. The reason is that Active Directory expects UTF-8 character strings when updating the unicodePwd attribute.
- SET PASSWORD command will not work for SSH logins.

Mapping restrictions

- SSH login will not work for mapped users.
- While executing DECnet operations, such as DECnet copy, you must use the user name and password that is present in the SYSUAF.DAT file.
- The "SYSTEM" account is not mapped.

That is, if a user enters "SYSTEM" at the user name prompt, that user is mapped only to the "SYSTEM" account in SYSUAF.DAT.

The reverse is also true. That is, if the mapping is done for any user, for example, "johnd" to map to "SYSTEM" account in SYSUAF.DAT, this mapping will not happen and user gets a "Operation failure" error at login prompt.

7 References

The following resources can be referred for more information:

- `SYS$HELP:ACME_DEV_README.TXT`
- “Enabling External Authentication” and “Authentication and Credentials Management Extensions (ACME) Subsystem” sections in the *HP OpenVMS Guide to System Security* manual.
- *HP OpenVMS System Services Reference Manual*

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