CHAPTER 16

LDAP Directory Integration

Directories are specialized databases that are optimized for a high number of reads and searches, and occasional writes and updates. Directories typically store data that does not change often, such as employee information, user privileges on the corporate network, and so on.

Another aspect of directories is that they are extensible, which means that the type of information stored in them can be modified and extended. The term *directory schema* refers to the type of stored information and the rules it obeys.

The Lightweight Directory Access Protocol (LDAP) provides applications with a standard method for accessing and potentially modifying the information stored in the directory. This capability enables companies to centralize all user information in a single repository available to several applications, with a remarkable reduction in maintenance costs through the ease of adds, moves, and changes.

This chapter covers the main design principles for integrating a Cisco IP Communications system based on Cisco Unified CallManager 5.0 with a corporate LDAP directory. The main topics include:

- What is Directory Integration?, page 16-2

  This section analyzes the various requirements for integration with a corporate LDAP directory in a typical enterprise IT organization.

- Directory Access for IP Telephony Endpoints, page 16-3

  This section describes the technical solution to enable directory access for Cisco Unified Communications endpoints and provides design best-practices around it.

- Directory Integration with Cisco Unified CallManager 5.0, page 16-5

  This section describes the technical solutions and provides design best-practices for directory integration with Cisco Unified CallManager 5.0, including the LDAP synchronization and LDAP authentication functions.

The considerations presented in this chapter apply to Cisco Unified CallManager 5.0 as well as the following applications bundled with it: Extension Mobility, Cisco Unified CallManager Assistant, WebDialer, Bulk Administration Tool, and Real-Time Monitoring Tool.

For earlier releases of Cisco Unified CallManager, refer to the *Cisco Unified Communications SRND for Cisco Unified CallManager 4.0 and 4.1*, and for all other Cisco voice applications refer to the respective product documentation available at:

http://www.cisco.com

In particular, for Cisco IP Contact Center refer to the *Cisco Cisco Unified Contact Center Enterprise Edition SRND* and the *Cisco Cisco Unified Contact Center Express SRND*, both available at

http://www.cisco.com/go/srnd

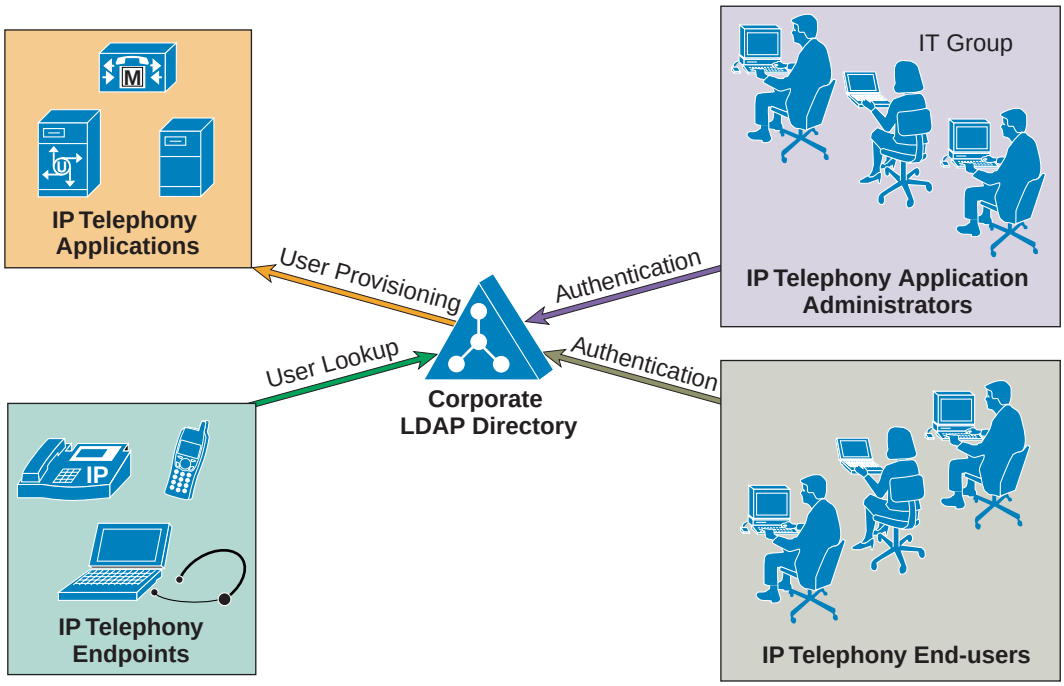
For Cisco Unity, refer to the *Cisco Unity Design Guide* and to the following white papers: *Cisco Unity Data and the Directory*, *Active Directory Capacity Planning*, and *Cisco Unity Data Architecture and How Cisco Unity Works*, also available at

http://www.cisco.com

What is Directory Integration?

Integration between voice applications and a corporate LDAP directory is a common task for many enterprise IT organizations. However, the exact scope of the integration varies from company to company, and it can translate to one or more specific and independent requirements, as shown in Figure 16-1.

Figure 16-1 Various Requirements for Directory Integration



For example, one common requirement is to enable user lookups (sometimes called the "white pages" service) from IP phones or other voice and/or video endpoints, so that users can dial a contact directly after looking up their number in the directory.

Another requirement is to provision users automatically from the corporate directory into the user database of voice and/or video applications. This method avoids having to add, remove, or modify core user information manually each time a change occurs in the corporate directory.

Often authentication of end-users and administrators of the voice and/or video applications using the corporate directory credentials is also required. This method enables the IT department to deliver single log-on functionality and reduces the number of passwords that each user needs to maintain across different corporate applications.

Each of these requirements can be satisfied by a Cisco IP Communications system using different mechanisms according to the Cisco Unified CallManager version used, as summarized in Table 16-1.

Table 16-1 Directory Requirements and Cisco Solutions

Requirement	Cisco Solution	Cisco Unified CallManager 4.*x* Feature	Cisco Unified CallManager 5.0 Feature
User lookup for endpoints	Directory access	Cisco Unified IP Phone Services SDK	Cisco Unified IP Phone Services SDK
User provisioning	Directory integration	Cisco Customer Directory Configuration Plugin	LDAP Synchronization
Authentication for IP Telephony end users	Directory integration	Cisco Customer Directory Configuration Plugin	LDAP Authentication
Authentication for IP Telephony application administrators	Directory integration	Cisco Customer Directory Configuration Plugin + Cisco Multilevel Administration	LDAP Authentication

As shown in Table 16-1, within the context of a Cisco IP Communications system, the term *directory access* refers to mechanisms and solutions that satisfy the requirement of user lookups for IP Telephony endpoints, while the term *directory integration* refers to mechanisms and solutions that satisfy the requirements of user provisioning and authentication (for both end users and administrators).

The remainder of this chapter describes how to address these requirements in a Cisco IP Communications system based on Cisco Unified CallManager Release 5.0. For a detailed description of directory integration solutions with earlier releases of Cisco Unified CallManager, refer to the *Cisco Unified Communications SRND for Cisco Unified CallManager 4.0 and 4.1*, available at

http://www.cisco.com/go/srnd

Note Another interpretation of the term *directory integration* revolves around the ability to add application servers to a Microsoft Active Directory domain in order to centralize management and security policies. Cisco Unified CallManager 5.0 is an appliance that runs on a customized embedded operating system, and it cannot currently be added to a Microsoft Active Directory domain. Server management for Cisco Unified CallManager is provided through the Cisco Real Time Monitoring Tool (RTMT). Strong security policies tailored to the application are already implemented within the embedded operating system, and a customized version of Cisco Security Agent can be installed on every server. It is also possible to manage security policies centrally with the CiscoWorks Management Center for Cisco Security Agents.

Directory Access for IP Telephony Endpoints

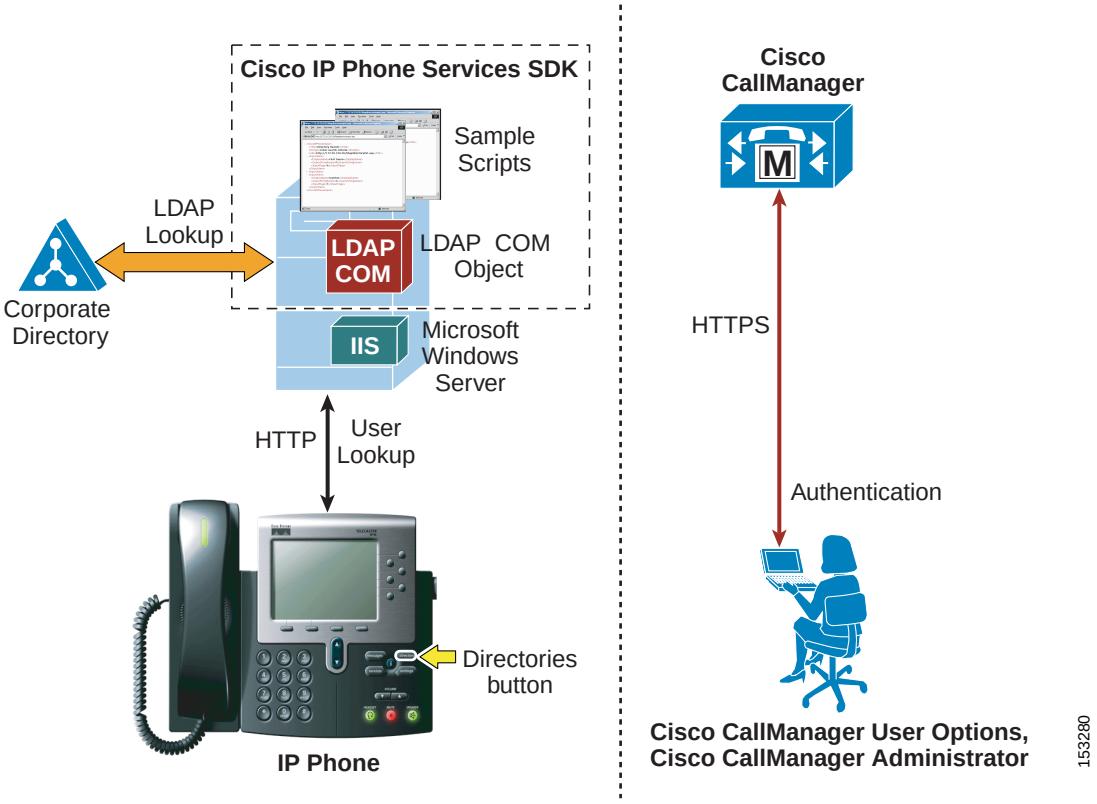
This section describes how to configure corporate directory access to any LDAP-compliant directory server to perform user lookups from Cisco Unified Communications endpoints (such as Cisco Unified IP Phones). The guidelines contained in this section apply regardless of whether Cisco Unified CallManager or other IP Telephony applications have been integrated with a corporate directory for user provisioning and authentication.

Cisco Unified IP Phones equipped with a display screen can search a user directory when a user presses the Directories button on the phone. The IP Phones use Hyper-Text Transfer Protocol (HTTP) to send requests to a web server. The responses from the web server must contain some specific Extensible Markup Language (XML) objects that the phone can interpret and display.

By default, Cisco Unified IP Phones are configured to perform user lookups against Cisco Unified CallManager's embedded database. However, it is possible to change this configuration so that the lookup is performed on a corporate LDAP directory. In this case, the phones send their HTTP requests to an external web server that operates as a proxy and translates these requests into LDAP queries against the corporate directory. The LDAP responses are then encapsulated in the appropriate XML objects and sent back to the phones via HTTP.

Figure 16-2 illustrates this mechanism in a deployment where Cisco Unified CallManager has not been integrated with the corporate directory. Note that, in this scenario, Cisco Unified CallManager is not involved in the message exchange related to the user lookup.

Figure 16-2 Directory Access for Cisco Unified IP Phones Using the Cisco Unified IP Phone Services SDK



In the example shown in Figure 16-2, the web server proxy function is provided by the Cisco LDAP Search Component Object Model (COM) server, which is included in the Cisco Unified IP Phone Services Software Development Kit (SDK) version 3.3(4) or later. You can download the latest Cisco Unified IP Phone Services SDK from Cisco Developer Support Central at

http://www.cisco.com/pcgi-bin/dev_support/access_level/product_support

The IP Phone Services SDK can be installed on a Microsoft Windows web server running IIS 4.0 or later, but it cannot be installed on a Cisco Unified CallManager server. The SDK includes some sample scripts to provide simple directory lookup functionality.

To set up a corporate directory lookup service using the IP Phone Services SDK, perform the following steps:

Step 1 Modify one of the sample scripts to point to your corporate LDAP directory, or write your own script using the LDAP Search COM Programming Guide provided with the SDK.

Step 2 In Cisco Unified CallManager, configure the URL Directories parameter (under **System** > **Enterprise Parameters**) to point to the URL of the script on the external web server.

Step 3 Reset the phones to make the changes take effect.

Note If you want to offer the service only to a subset of users, configure the URL Directories parameter directly within the Phone Configuration page instead of the Enterprise Parameters page.

In conclusion, the following design considerations apply to directory access with the Cisco Unified IP Phone Services SDK:

- User lookups are supported against any LDAP-compliant corporate directory.
- When querying Microsoft Active Directory, you can perform lookups against the Global Catalog by pointing the script to a Global Catalog server and specifying port 3268 in the script configuration. This method typically results in faster lookups.
- There is no impact on Cisco Unified CallManager for this functionality, and only minimal impact on the LDAP directory server.
- The sample scripts provided with the SDK allow only a minimal amount of customization (for example, you can prefix a digit string to all returned numbers). For a higher degree of manipulation, you will have to develop custom scripts, and a programming guide is included with the SDK to aid in writing the scripts.
- This functionality does not entail provisioning or authentication of Cisco Unified CallManager users with the corporate directory.

Directory Integration with Cisco Unified CallManager 5.0

This section describes the mechanisms and best practices for directory integration with Cisco Unified CallManager 5.0 to allow for user provisioning and authentication with a corporate LDAP directory. This section covers the following topics:

- Comparison with the Cisco Unified CallManager 4.x Approach, page 16-6

  The approach to directory integration has changed significantly between Cisco Unified CallManager releases 4.*x* and 5.0, and this section introduces the new approach by comparing it with the old one.

- Cisco Unified CallManager 5.0 Directory Architecture, page 16-7

  This section provides an overview of the user-related architecture in Cisco Unified CallManager 5.0.

- LDAP Synchronization, page 16-10

  This section describes the functionality of LDAP synchronization and provides design guidelines for its deployment, with additional considerations for Microsoft Active Directory.

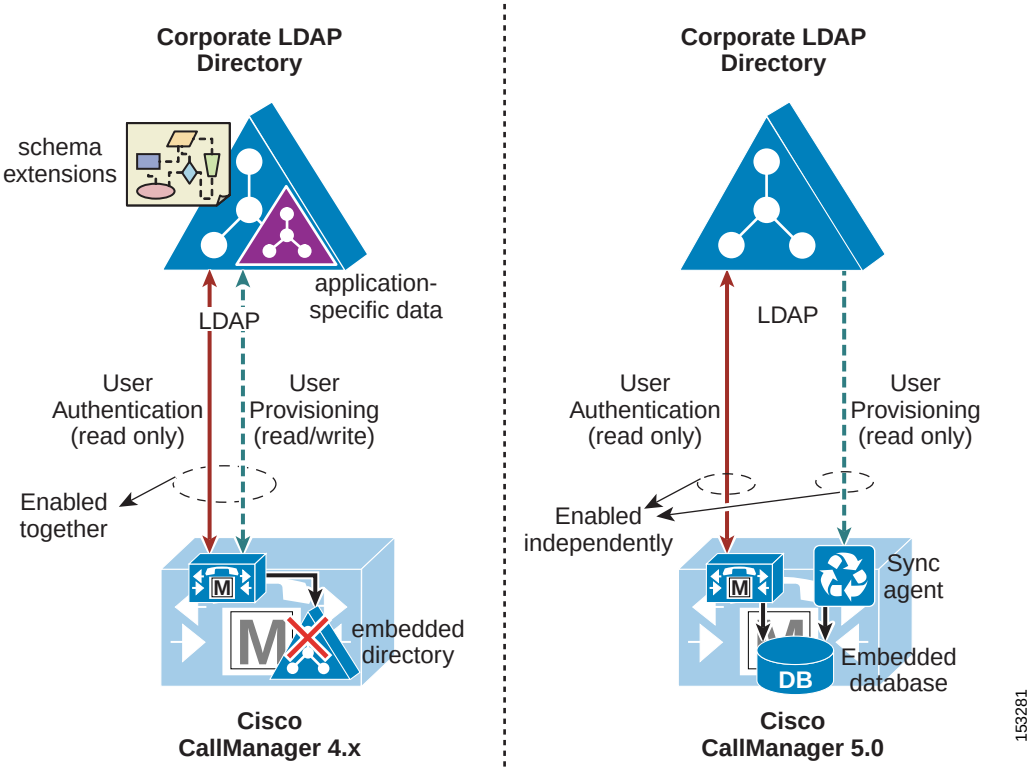
- LDAP Authentication, page 16-18

  This section describes the functionality of LDAP authentication and provides design guidelines for its deployment, with additional considerations for Microsoft Active Directory.

Comparison with the Cisco Unified CallManager 4.x Approach

Figure 16-3 shows high-level functional diagrams of the directory integration approaches for user provisioning and authentication with *Cisco Unified CallManager 4.x* and 5.0.

Figure 16-3 Directory Integration Approaches in Cisco Unified CallManager 4.x and 5.0



Cisco Unified CallManager Release 4.*x* used an embedded LDAP directory to store user-related information. Directory integration was enabled by extending the corporate directory schema, shutting down the embedded directory, and using the corporate directory to store the application-specific data related to the users. Because the corporate directory was effectively used as the back-end storage repository for user information, this method satisfied the requirement for both user provisioning and user authentication. Any changes to user data in the corporate directory were immediately picked up by Cisco Unified CallManager because it accessed the same data store.

However, this approach had an impact on the corporate directory in terms of schema extensions and additional data, and it also introduced dependencies between the real-time functionality of the IP Communications system and the availability of the directory. When connectivity was lost or the directory became unavailable, Cisco Unified CallManager was unable to access all user-related configurations, which impacted applications such as Extension Mobility, Attendant Console, and IP Contact Center Express. In this approach, the user provisioning and user authentication functions had to be enabled at

the same time because they relied on the same integration process. In addition, using the corporate directory as the storage repository for application-specific data also imposed limitations on the day-to-day maintenance operations on the corporate directory itself.

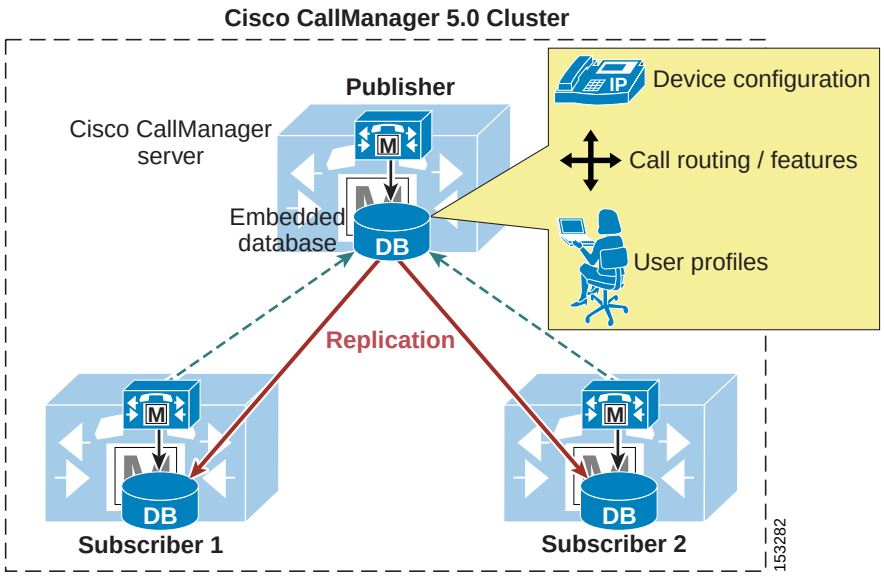
By contrast, the approach to directory integration adopted by Cisco Unified CallManager Release 5.0 relies on two separate components to satisfy the user provisioning and user authentication requirements independently. User provisioning is performed with a one-way synchronization of user data from the corporate directory to the Cisco Unified CallManager embedded database. The synchronization uses standard LDAPv3 and can be triggered manually or scheduled periodically to ensure that changes are incorporated into the Cisco IP Communications system. This solution avoids the need to write anything to the corporate directory, and it does not require any schema extensions.

User authentication is enabled independently from user provisioning, and it provides authentication of end-user passwords against the corporate directory credentials. With this approach, the Cisco IP Communications system preserves all of its real-time functionality even when the corporate directory is unavailable or unreachable.

Cisco Unified CallManager 5.0 Directory Architecture

Figure 16-4 shows the basic architecture of a Cisco Unified CallManager 5.0 cluster. The embedded database stores all configuration information, including device-related data, call routing, and other features and user profiles. The database is present on all servers within a Cisco Unified CallManager cluster and is replicated automatically from the publisher server to all subscriber servers.

Figure 16-4 Cisco Unified CallManager 5.0 Architecture



By default, all users are provisioned manually into the database via the Cisco Unified CallManager Administration interface. Cisco Unified CallManager 5.0 introduces an important new concept by dividing the users in its database in two categories:

- End users — All users associated with a physical person and an interactive login. This category includes all IP Telephony users as well as Cisco Unified CallManager administrators when using the User Groups and Roles configuration (equivalent to the Cisco Multilevel Administration feature in prior Cisco Unified CallManager versions).
- Application users — All users associated with other Cisco IP Communications features or applications, such as Cisco Attendant Console, Cisco IP Contact Center Express, or Cisco Unified CallManager Assistant. These applications need to authenticate with Cisco Unified CallManager, but these internal "users" do not have an interactive login and serve purely for internal communications between applications.

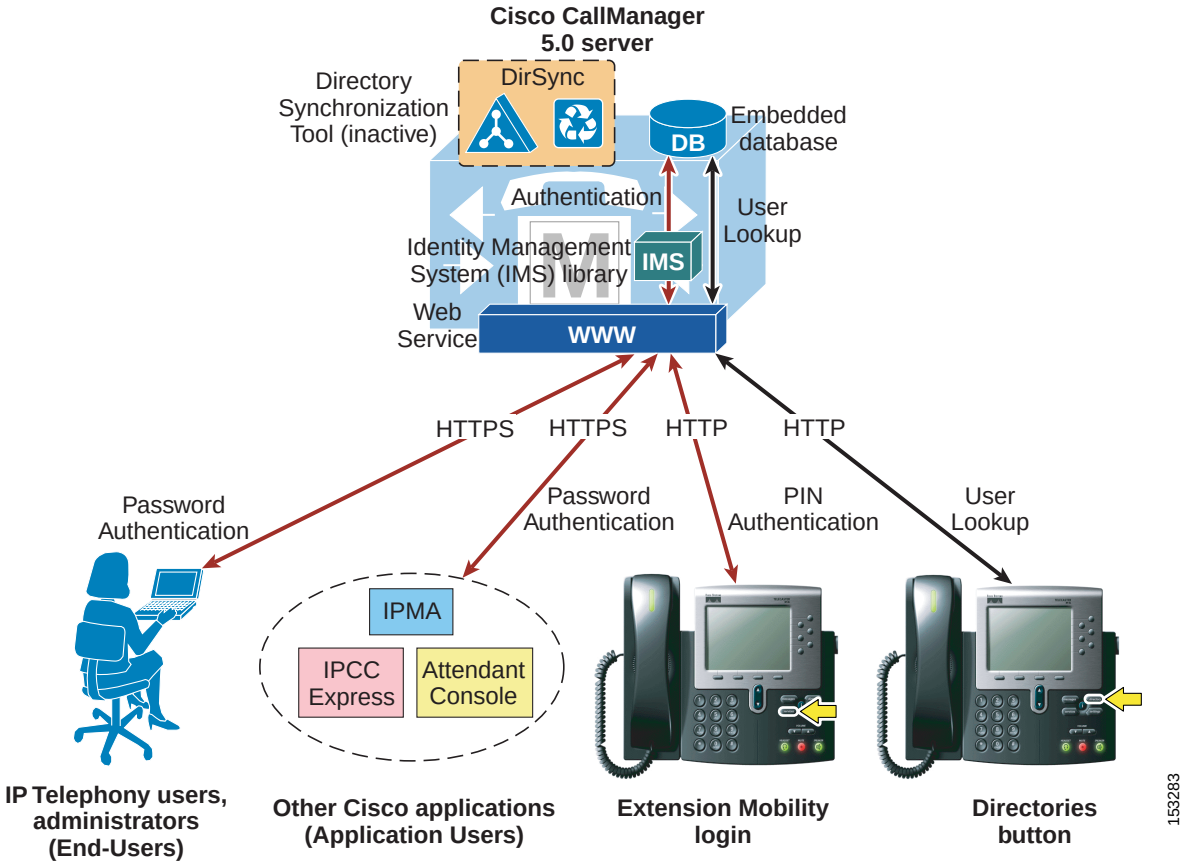
Table 16-2 lists the application users created by default in the Cisco Unified CallManager database, together with the feature or application that uses them. Additional application users can be created manually when integrating other Cisco IP Communications applications (for example, the **ac** application user for Cisco Attendant Console, the **jtapi** application user for Cisco IP Contact Center Express, and so forth).

Table 16-2 Default Application Users for Cisco Unified CallManager 5.0

Application User	Used by:
CCMAdministrator	Cisco Unified CallManager Administration (default "super user")
CCMQRTSecureSysUser	Cisco Quality Reporting Tool
CCMQRTSysUser	
CCMSysUser	Cisco Extension Mobility
IPMASecureSysUser	Cisco Unified CallManager Assistant
IPMASysUser	
WDSecureSysUser	Cisco WebDialer
WDSysUser	

Based on these considerations, Figure 16-5 illustrates the default behavior in Cisco Unified CallManager 5.0 for user-related operations such as lookups, provisioning, and authentication.

Figure 16-5 Default Behavior for User-Related Operations for Cisco Unified CallManager 5.0



End users access the Cisco Unified CallManager User Options page via HTTPS and authenticate with a user name and password. If they have been configured as administrators by means of User Groups and Roles, they also access the Cisco Unified CallManager Administration pages with the same credentials.

Similarly, other Cisco features and applications authenticate to Cisco Unified CallManager via HTTPS with the user name and password associated with their respective application users.

The authentication challenges carried by the HTTPS messages are relayed by the web service on Cisco Unified CallManager to an internal library called Identity Management System (IMS). In its default configuration, the IMS library authenticates both end users and application users against the embedded database. In this way, both "physical" users of the IP Communications system and internal application accounts are authenticated using the credentials configured in Cisco Unified CallManager.

End users may also authenticate with their user name and a numeric password (or PIN) when logging into the Extension Mobility service from an IP phone. In this case, the authentication challenge is carried via HTTP to Cisco Unified CallManager but is still relayed by the web service to the IMS library, which authenticates the credentials against the embedded database.

In addition, user lookups performed by IP Telephony endpoints via the Directories button communicate with the web service on Cisco Unified CallManager via HTTP and access data on the embedded database.

The importance of the distinction between End Users and Application Users becomes apparent when integration with a corporate directory is required. As mentioned in the previous section, this integration is accomplished by means of the following two separate processes:

- LDAP synchronization

  This process uses an internal tool called Cisco Directory Synchronization (DirSync) on Cisco Unified CallManager to synchronize a number of user attributes (either manually or periodically) from a corporate LDAP directory. When this feature is enabled, users are automatically provisioned from the corporate directory. This feature applies only to End Users, while Application Users are kept separate and are still provisioned via the Cisco Unified CallManager Administration interface. In summary, End Users are defined in the corporate directory and synchronized into the Cisco Unified CallManager database, while Application Users are stored only in the Cisco Unified CallManager database and do not need to be defined in the corporate directory.

- LDAP authentication

  This process enables the IMS library to authenticate user credentials against a corporate LDAP directory. When this feature is enabled, End User passwords are authenticated against the corporate directory, while Application User passwords are still authenticated locally against the Cisco Unified CallManager database. Cisco Extension Mobility PINs are also still authenticated locally.

Maintaining and authenticating the Application Users internally to the Cisco Unified CallManager database provides resilience for all the applications and features that use these accounts to communicate with Cisco Unified CallManager, independently of the availability of the corporate LDAP directory.

Cisco Extension Mobility PINs are also kept within the Cisco Unified CallManager database because they are an integral part of a real-time application, which should not have dependencies on the responsiveness of the corporate directory.

The next two sections describe in more detail LDAP synchronization and LDAP authentication, and they provide design best-practices for both functions.

Note As illustrated in the section on Directory Access for IP Telephony Endpoints, page 16-3, user lookups from endpoints can also be performed against a corporate directory by configuring the Cisco Unified IP Phone Services SDK on an external web server.

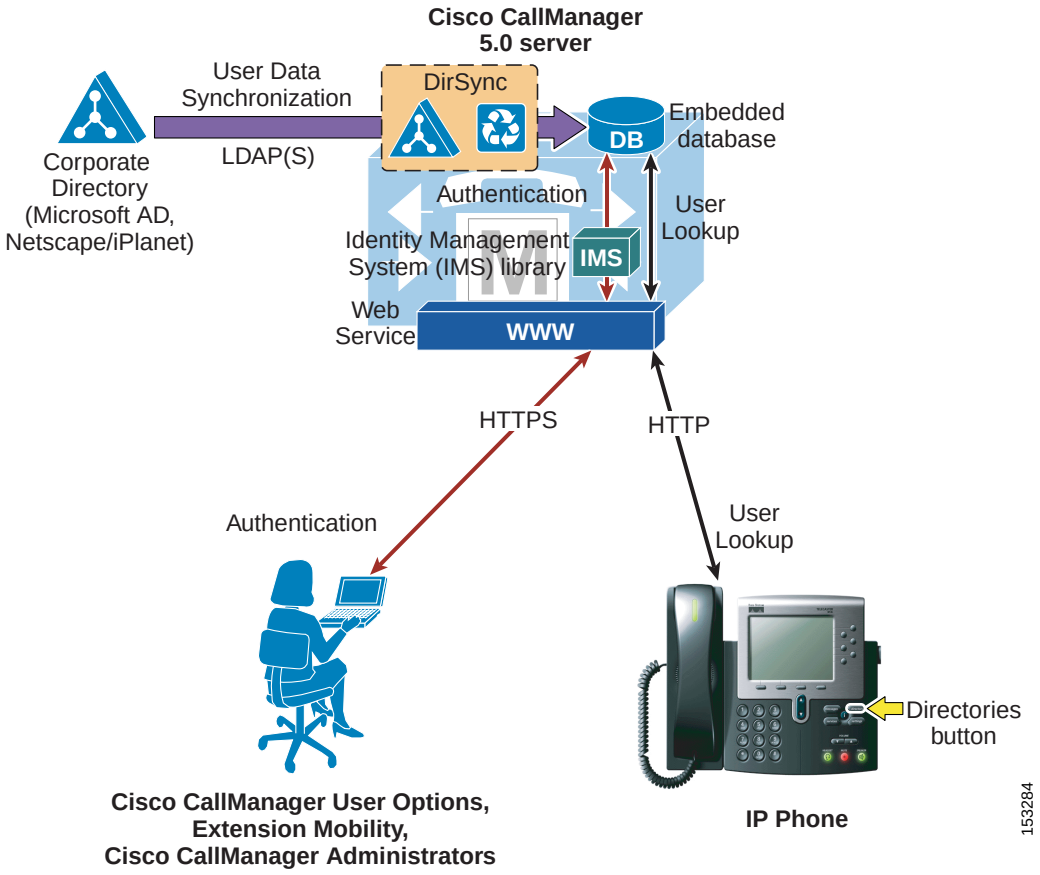
LDAP Synchronization

Synchronization of Cisco Unified CallManager with a corporate LDAP directory allows reuse of user data stored in the LDAP directory and allows the corporate LDAP directory to serve as the central repository for that information. Cisco Unified CallManager has an integrated database for storing user data and a web interface within Cisco Unified CallManager Administration for creating and managing user data in that database. When synchronization is enabled, that local database is still used, but the Cisco Unified CallManager facility to create user accounts becomes disabled. Management of user accounts is then accomplished through the interface of the LDAP directory. (See Figure 16-6.)

The user account information is imported from the LDAP directory into the database located on the Cisco Unified CallManager publisher server. Information that is imported from the LDAP directory may not be changed by Cisco Unified CallManager. Additional user information specific to the Cisco Unified CallManager implementation is managed by Cisco Unified CallManager and stored only within its local database. For example, device-to-user associations, speed dials, and user PINs are data

that are managed by Cisco Unified CallManager, and they do not exist in the corporate LDAP directory. The user data is then propagated from the Cisco Unified CallManager publisher server to the subscribers via the built-in database synchronization.

Figure 16-6 Enabling Synchronization of User Data



The following directories are supported by Cisco Unified CallManager for synchronization:

- Microsoft Active Directory (AD) 2000 and 2003
- Netscape Directory Server 4.x, iPlanet Directory Server 5.1, and Sun ONE Directory Server 5.2

When LDAP synchronization is activated, only one of the above groups of LDAP products may be chosen for the cluster at any one time. Also, one attribute of the directory user is chosen to map into the Cisco Unified CallManager User ID field. Cisco Unified CallManager uses standard LDAPv3 for accessing the data.

The data that Cisco Unified CallManager imports are all from standard attributes. Table 16-3 lists the attributes that are used, and they differ between the two groups of LDAP implementations. The data of the directory attribute that is mapped to the Cisco Unified CallManager User ID must be unique within all entries for that cluster. The **sn** attribute must be populated with data, otherwise that record will not be imported from the corporate directory. If the primary attribute used during import of end user accounts matches any Application User in the Cisco Unified CallManager database, that user is skipped.

Some Cisco Unified CallManager database fields provide a choice of directory attributes, and you can choose only a single mapping for each synchronization agreement.

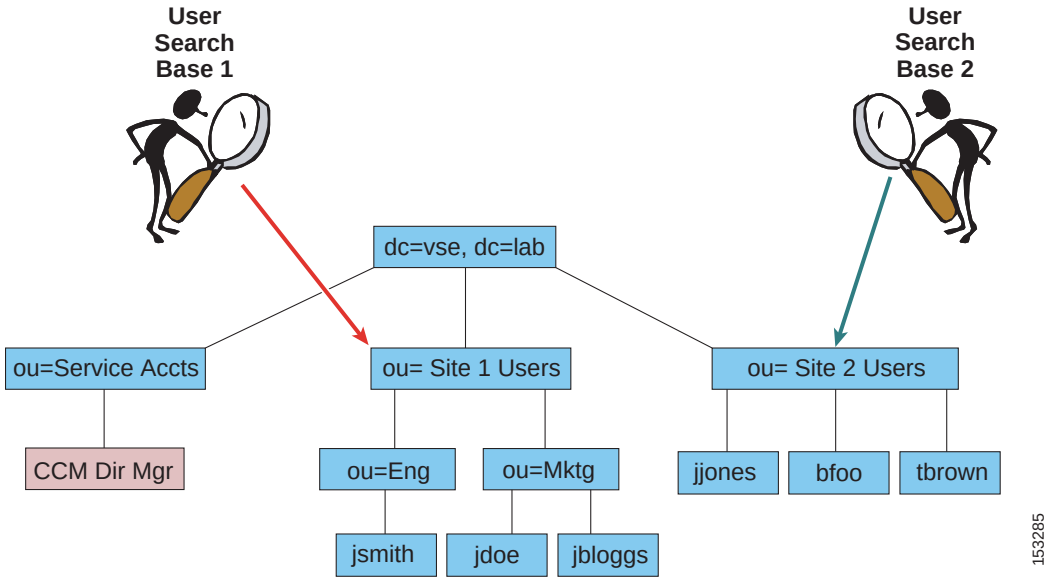
Table 16-3 Data Attributes Imported by Cisco Unified CallManager

Cisco Unified CallManager User Field	Microsoft Active Directory (AD) Attribute	Netscape, iPlanet, or Sun ONE Attribute
User ID	*One of:* sAMAccountName mail employeeNumber telephoneNumber UserPrincipalName	*One of:* uid mail employeeNumber telephonePhone
First Name	givenName	givenname
Middle Name	*One of:* middleName initials	initials
Last Name	sn	sn
Manager ID	manager	manager
Department	department	departmentnumber
Phone Number	*One of:* telephoneNumber ipPhone	telephonenumber
Mail ID	*One of:* mail sAMAccountName	*One of:* mail uid

The synchronization is performed by a process called Cisco DirSync, which is enabled through the Serviceability web page. When enabled, it allows one or more synchronization agreements to be configured in the system. An agreement specifies a search base that is a position in the LDAP tree where Cisco Unified CallManager will begin its search for user accounts. Cisco Unified CallManager can import only users that exist in the area of the domain specified by the search base for a particular synchronization agreement.

In Figure 16-7, two synchronization agreements are represented. One synchronization agreement specifies User Search Base 1 and imports users jsmith, jdoe and jbloggs. The other synchronization agreement specifies User Search Base 2 and imports users jjones, bfoo, and tbrown. The CCMDirMgr account is not imported because it does not reside below the point specified by a user search base. When users are organized in a structure in the LDAP directory, you can use that structure to control which user groups are imported. In this example, a single synchronization agreement could have been used to specify the root of the domain, but that search base would also have imported the Service Accts. The search base does not have to specify the domain root; it may specify any point in the tree.

Figure 16-7 User Search Bases



To import the data into the Cisco Unified CallManager database, the system performs a bind to the LDAP directory using the account specified in the configuration as the LDAP Manager Distinguished Name, and reading of the database is done with this account. The account must be available in the LDAP directory for Cisco Unified CallManager to log in, and Cisco recommends that you create a specific account with permissions to allow it to read all user objects within the sub-tree that was specified by the user search base. The sync agreement specifies the full Distinguished Name of that account so that the account may reside anywhere within that domain. In the example in Figure 16-7, CCMDirMgr is the account used for the synchronization.

It is possible to control the import of accounts through use of permissions of the LDAP Manager Distinguished Name account. In this example, if that account is restricted to have read access to ou=Eng but not to ou=Mktg, then only the accounts located under Eng will be imported.

Synchronization agreements have the ability to specify multiple directory servers to provide redundancy. You can specify an ordered list of up to three directory servers in the configuration that will be used when attempting to synchronize. The servers are tried in order until the list is exhausted. If none of the directory servers responds, then the synchronization fails, but it will be attempted again according to the configured synchronization schedule.

Synchronization Mechanism

The synchronization agreement specifies a time for synchronizing to begin and a period for re-synchronizing that can be specified in hours, days, weeks, or months (with a minimum value of 6 hours). A synchronization agreement can also be set up to run only once at a specific time.

When synchronization is enabled for the first time on a Cisco Unified CallManager publisher server, user accounts that exist in the corporate directory are imported into the Cisco Unified CallManager database. Then either existing Cisco Unified CallManager end-user accounts are activated and data is updated, or a new end-user account is created according to the following process:

1. If end-user accounts already exist in the Cisco Unified CallManager database and a synchronization agreement is configured, all pre-existing accounts are marked inactive in Cisco Unified CallManager. The configuration of the synchronization agreement specifies a mapping of an LDAP database attribute to the Cisco Unified CallManager UserID. During the

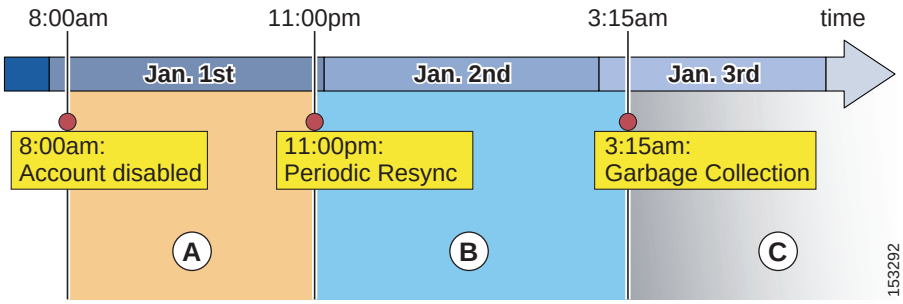
synchronization, accounts from the LDAP database that match an existing Cisco Unified CallManager account cause that Cisco Unified CallManager account to be marked active again.

2. After the synchronization is completed, any accounts that were not set to active are permanently deleted from Cisco Unified CallManager when the garbage collection process runs. Garbage collection is a process that runs automatically at the fixed time of 3:15 AM, and it is not configurable. The deletion of Cisco Unified CallManager accounts that do not match LDAP directory accounts is necessary because Cisco Unified CallManager cannot manage accounts while synchronization is configured.
3. Subsequently when changes are made in the corporate directory, the synchronization from Microsoft Active Directory occurs as a full re-synchronization at the next scheduled synchronization period. On the other hand, the Netscape, iPlanet, and Sun ONE products perform an incremental synchronization triggered by a change in the directory. The following sections present examples of each of these two scenarios.

Account Synchronization with Active Directory

Figure 16-8 shows an example timeline of events for a Cisco Unified CallManager deployment where LDAP Synchronization and LDAP Authentication have both been enabled. The re-synchronization is set for 11:00 PM daily.

Figure 16-8 Change Propagation with Active Directory



After the initial synchronization, the creation, deletion, or disablement of an account will propagate to Cisco Unified CallManager according to the timeline shown in Figure 16-8 and as described in the following steps:

1. At 8:00 AM on January 1, an account is disabled or deleted in AD. From this time and during the whole period A, password authentication (for example, Cisco Unified CallManager User Options page) will fail for this user because Cisco Unified CallManager redirects authentication to AD. However, PIN authentication (for example, Extension Mobility login) will still succeed because the PIN is stored in the Cisco Unified CallManager database.
2. The periodic re-synchronization is scheduled for 11:00 PM on January 1. During that process, Cisco Unified CallManager will verify all accounts. Any accounts that have been disabled or deleted from AD will at that time be tagged in the Cisco Unified CallManager database as inactive. After 11:00 PM on January 1, when the account is marked inactive, both the PIN and password authentication by Cisco Unified CallManager will fail.
3. Garbage collection of accounts occurs daily at the fixed time of 3:15 AM. This process permanently deletes user information from the Cisco Unified CallManager database for any record that has been marked inactive for over 24 hours. In this example, the garbage collection that runs at 3:15 AM on

January 2 does not delete the account because it has not been inactive for 24 hours yet, so the account is deleted at 3:15 AM on January 3. At that point, the user data is permanently deleted from Cisco Unified CallManager.

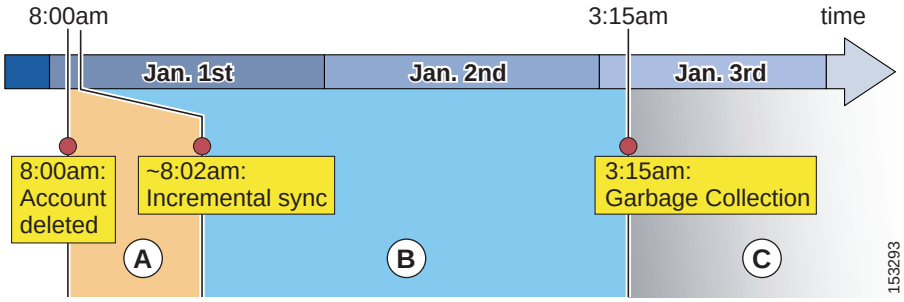
If an account has been created in AD at the beginning of period A, it will be imported to Cisco Unified CallManager at the periodic re-synchronization that occurs at the beginning of period B and will immediately be active on Cisco Unified CallManager.

Note The behavior described above applies to Cisco Unified CallManager Release 5.0(3) or later. With Releases 5.0(2) and 5.0(2), PIN authentication for users marked as inactive will not fail, so the deleted user in Figure 16-8 will still be able to log in the Extension Mobility service during period B. With these releases, if directory authentication is not enabled, password authentication will also succeed when the user is marked inactive (that is, during period B).

Account Synchronization with Netscape, iPlanet, or Sun ONE

The Netscape, iPlanet, and Sun ONE products support incremental synchronization agreements and use a different synchronization timeline than Active Directory. Figure 16-9 shows an example of this synchronization timeline for a Cisco Unified CallManager deployment with LDAP Synchronization and LDAP Authentication both enabled.

Figure 16-9 Change Propagation with Netscape, iPlanet, and Sun ONE



The example in Figure 16-9 involves the following steps:

1. An account is deleted from the corporate directory at 8:00 AM on January 1, which causes an incremental update to be sent from the LDAP server to Cisco Unified CallManager. Cisco Unified CallManager sets its corresponding copy of the data to inactive. Because LDAP authentication is configured, the user will be unable to log in via password as soon as the LDAP server has deleted the record. Also, the PIN may not be used for login at the moment the Cisco Unified CallManager record is marked inactive.
2. During period B, the user's record is still present in Cisco Unified CallManager, albeit inactive.
3. When the garbage collection runs at 3:15 AM on January 2, the record has not yet been inactive for 24 hours. The data remains in the Cisco Unified CallManager database until the beginning of period C on January 3, when the garbage collection process runs again at 3:15 AM and determines that the record has been inactive for 24 hours or more. The record is then permanently deleted from the database.

Accounts that are newly created in the directory are synchronized to Cisco Unified CallManager via incremental updates as well, and they may be used as soon as the incremental update is received.

Note The behavior described above applies to Cisco Unified CallManager Release 5.0(3) and later. With Releases 5.0(2) and 5.0(2), user accounts deleted from the Sun ONE Directory Server are immediately deleted from the Cisco Unified CallManager database as soon as the incremental synchronization occurs, without going through the inactive stage.

Security Considerations

During the import of accounts, no passwords or PINs are copied from the LDAP directory to the Cisco Unified CallManager database. If LDAP authentication is not enabled on Cisco Unified CallManager, the password and PIN for the end user are managed using Cisco Unified CallManager Administration. By default, the password is set to **ciscocisco** and the PIN is set to **12345** when the account is created. These settings can be changed by the user via the user web pages or by the administrator via the administrator web pages. The password and PIN are stored in an encrypted format in the Cisco Unified CallManager database. If you want to use the directory password to authenticate an end user, see the section on LDAP Authentication, page 16-18.

The connection between the Cisco Unified CallManager publisher server and the directory server can be secured by enabling Secure LDAP (SLDAP) on Cisco Unified CallManager and the LDAP server. Secure LDAP enables LDAP to be sent over a Secure Socket Layer (SSL) connection and can be enabled by uploading the SSL certificate from within the Cisco Unified CallManager Platform Administration. For detailed procedure steps, refer to the Cisco Unified CallManager product documentation available at http://www.cisco.com.

Best Practices for LDAP Synchronization

Observe the following design and implementation best practices when deploying LDAP synchronization with Cisco Unified CallManager 5.0:

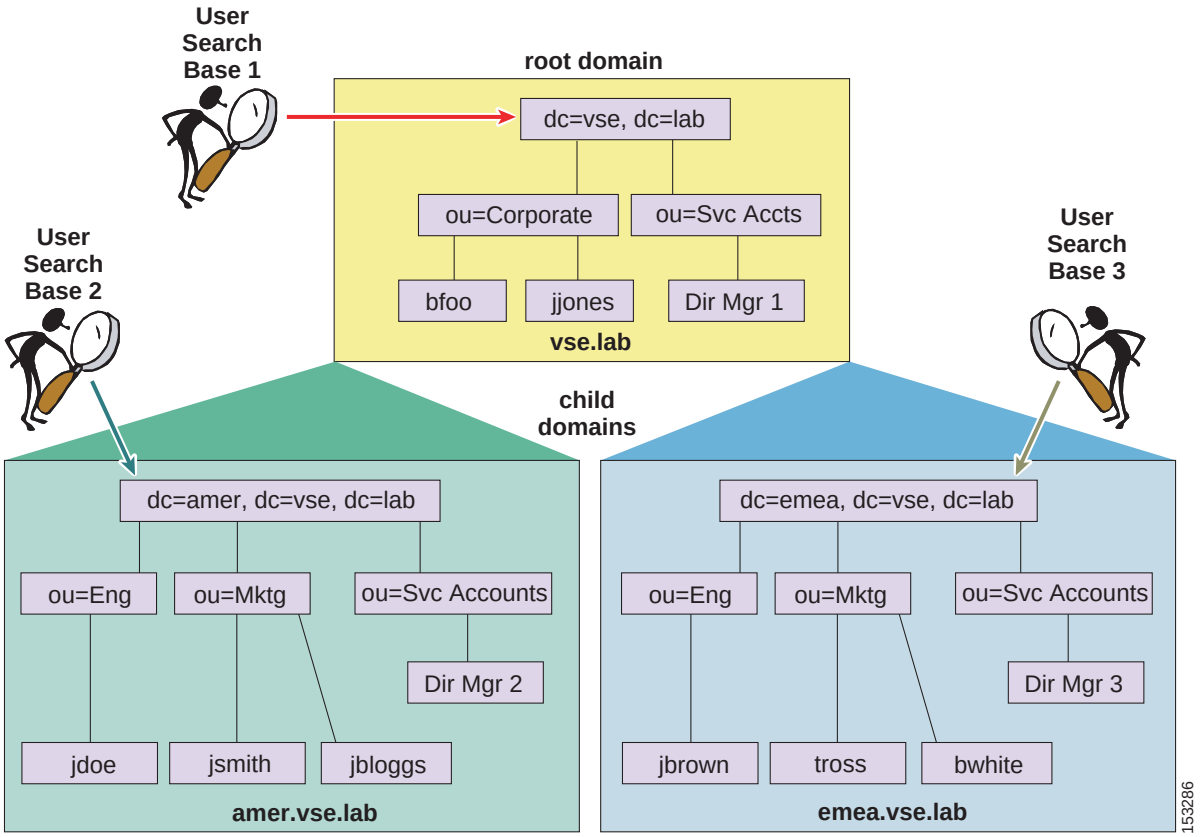
- Use a specific account within the corporate directory to allow the Cisco Unified CallManager synchronization agreement to connect and authenticate to it. Cisco recommends that you use an account dedicated to Cisco Unified CallManager, with minimum permissions set to "read" all user objects within the desired search base and with a password set never to expire. (When the password for this account changes in the directory, Cisco Unified CallManager must be reconfigured to take the change into account.)
- All synchronization agreements on a given cluster must integrate with the same family of LDAP servers (either Microsoft AD or Netscape, iPlanet, and Sun ONE).
- Stagger the periodicity of synchronization agreements so that multiple agreements are not querying the same LDAP servers simultaneously. Choose synchronization times that occur during quiet periods.
- If security of user data is of concern, enable Secure LDAP (SLDAP) by checking the **Use SSL** field on the LDAP Directory configuration page in Cisco Unified CallManager Administration.
- Ensure that the LDAP directory attribute chosen to map into the Cisco Unified CallManager UserID field is unique within all synchronization agreements for that cluster.
- The attribute chosen as UserID must not be the same as that for any of the Application Users defined in Cisco Unified CallManager.
- An existing account in the Cisco Unified CallManager database before synchronization is maintained only if an account imported from the LDAP directory has a matching attribute. The attribute that is matched to the Cisco Unified CallManager UserID is determined by the synchronization agreement.

- Configure at least two LDAP servers for redundancy. You can use IP addresses instead of host names to eliminate dependencies on Domain Name System (DNS) availability.
- Administer end-user accounts through the LDAP directory's management tools, and manage the Cisco-specific data for those accounts through the Cisco Unified CallManager Administration web page.

Additional Considerations for Microsoft Active Directory

A synchronization agreement for a domain will not synchronize users outside of that domain nor within a child domain because Cisco Unified CallManager does not follow AD referrals during the synchronization process. The example in Figure 16-10 requires three synchronization agreements to import all of the users. Although Search Base 1 specifies the root of the tree, it will not import users that exist in either of the child domains. Its scope is only VSE.LAB, and separate agreements are configured for the other two domains to import those users.

Figure 16-10 Synchronization with Multiple Active Directory Domains

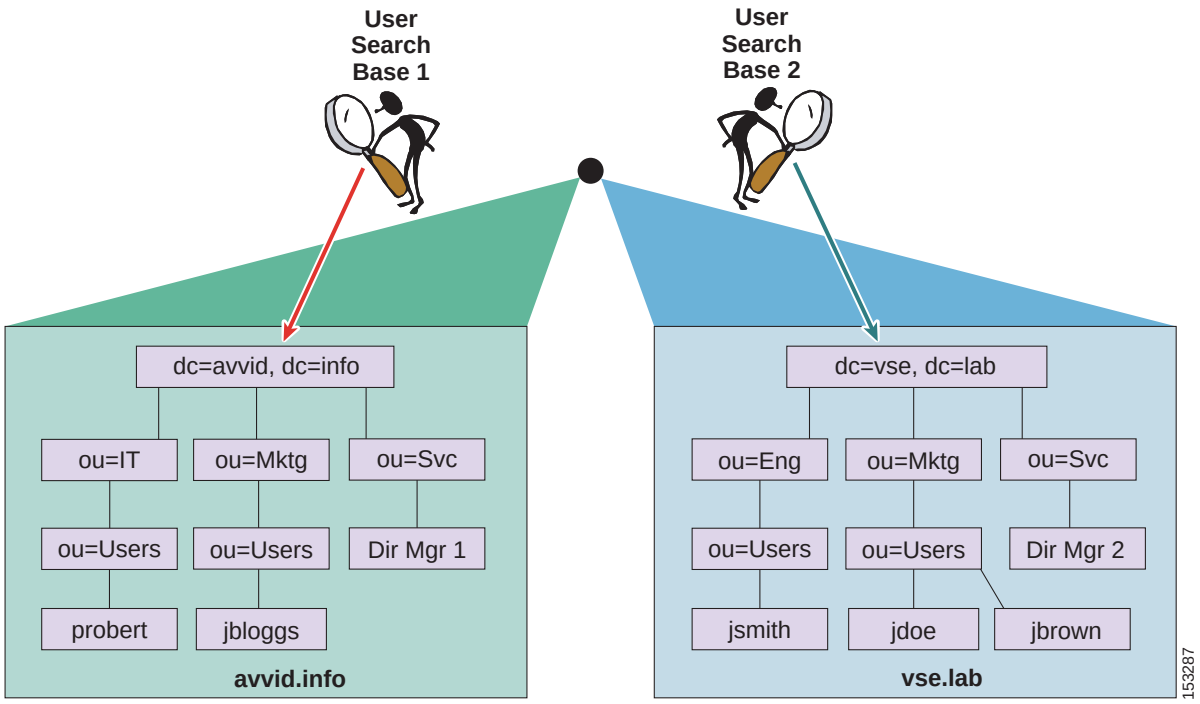


In Figure 16-10, each of the domains and sub-domains contains at least one domain controller (DC) associated to them, and the three synchronization agreements each specify the appropriate domain controller. The DCs have information only on users within the domain where they reside, therefore three synchronization agreements are required to import all of the users.

When synchronization is enabled with an AD forest containing multiple trees, as shown in Figure 16-11, multiple synchronization agreements are still needed for the same reasons listed above. Additionally, the UserPrincipalName (UPN) attribute is guaranteed by Active Directory to be unique across the forest and

must be chosen as the attribute that is mapped to the Cisco Unified CallManager UserID. For additional considerations on the use of the UPN attribute in a multi-tree AD scenario, see the section on Additional Considerations for Microsoft Active Directory, page 16-22.

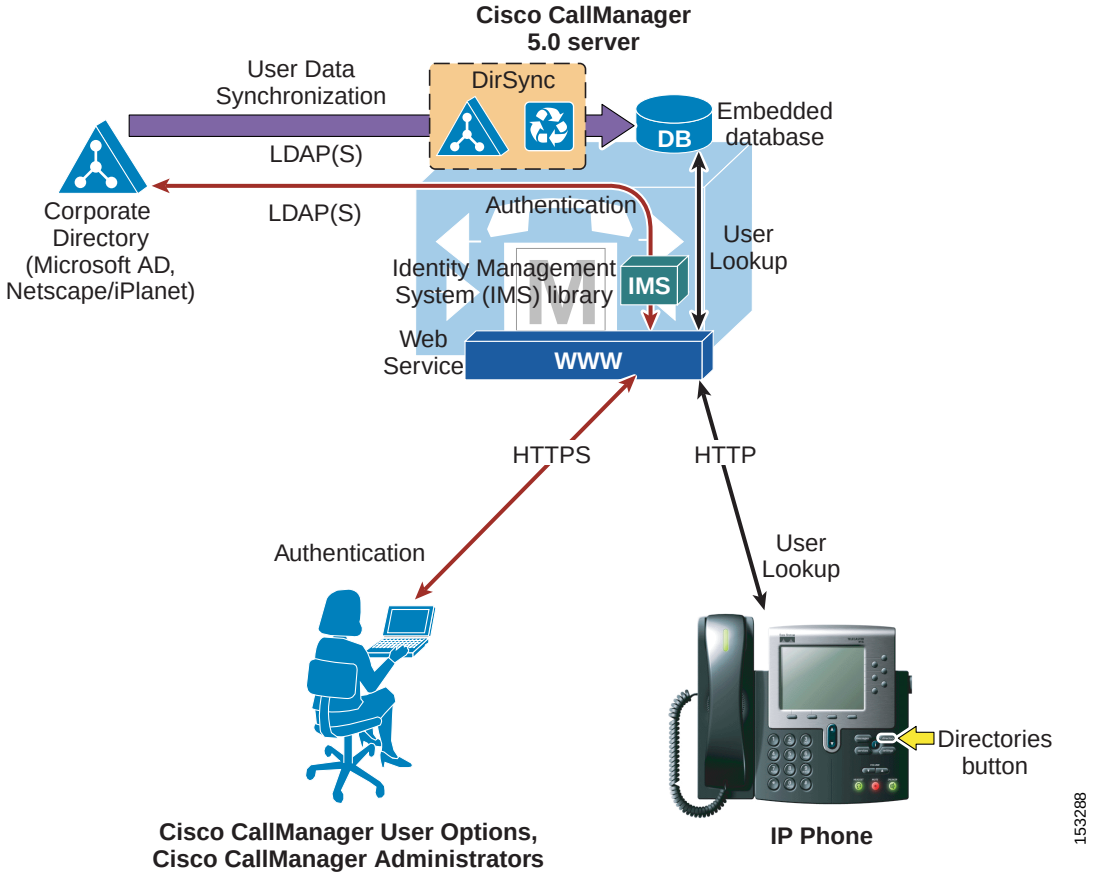
Figure 16-11 Synchronization with Multiple AD Trees (Discontiguous Namespaces)



LDAP Authentication

The LDAP authentication feature enables Cisco Unified CallManager to authenticate end user passwords against a corporate LDAP directory instead of using the embedded database. This authentication is accomplished with an LDAPv3 connection established between the IMS module within Cisco Unified CallManager and a corporate directory server, as shown in Figure 16-12.

Figure 16-12 Enabling LDAP Authentication



As in the case of the LDAP synchronization feature, the supported corporate directory products are:

- Microsoft Active Directory (AD) 2000 and 2003
- Netscape Directory Server 4.x, iPlanet Directory Server 5.1, and Sun ONE Directory Server 5.2

The authentication function allows configuration of up to three servers for redundancy, and it also supports secure connections to the directory server if you optionally enable LDAP over SSL (SLDAP). It can be enabled independently of the LDAP synchronization function. However, if authentication is enabled alone, you have to make sure that the user IDs in Cisco Unified CallManager match the user IDs defined in the corporate directory.

The following statements describe Cisco Unified CallManager's behavior when authentication is enabled:

- End user passwords are authenticated against the corporate directory.
- Application user passwords are authenticated against the Cisco Unified CallManager database.
- End user PINs are authenticated against the Cisco Unified CallManager database.

This behavior is in line with the guiding principle of providing single logon functionality for end users while making the operation of the real-time IP Communications system independent of the availability of the corporate directory, and is shown graphically in Figure 16-13.

Figure 16-13 Authenticating End User Passwords, Application User Passwords, and End User PINs

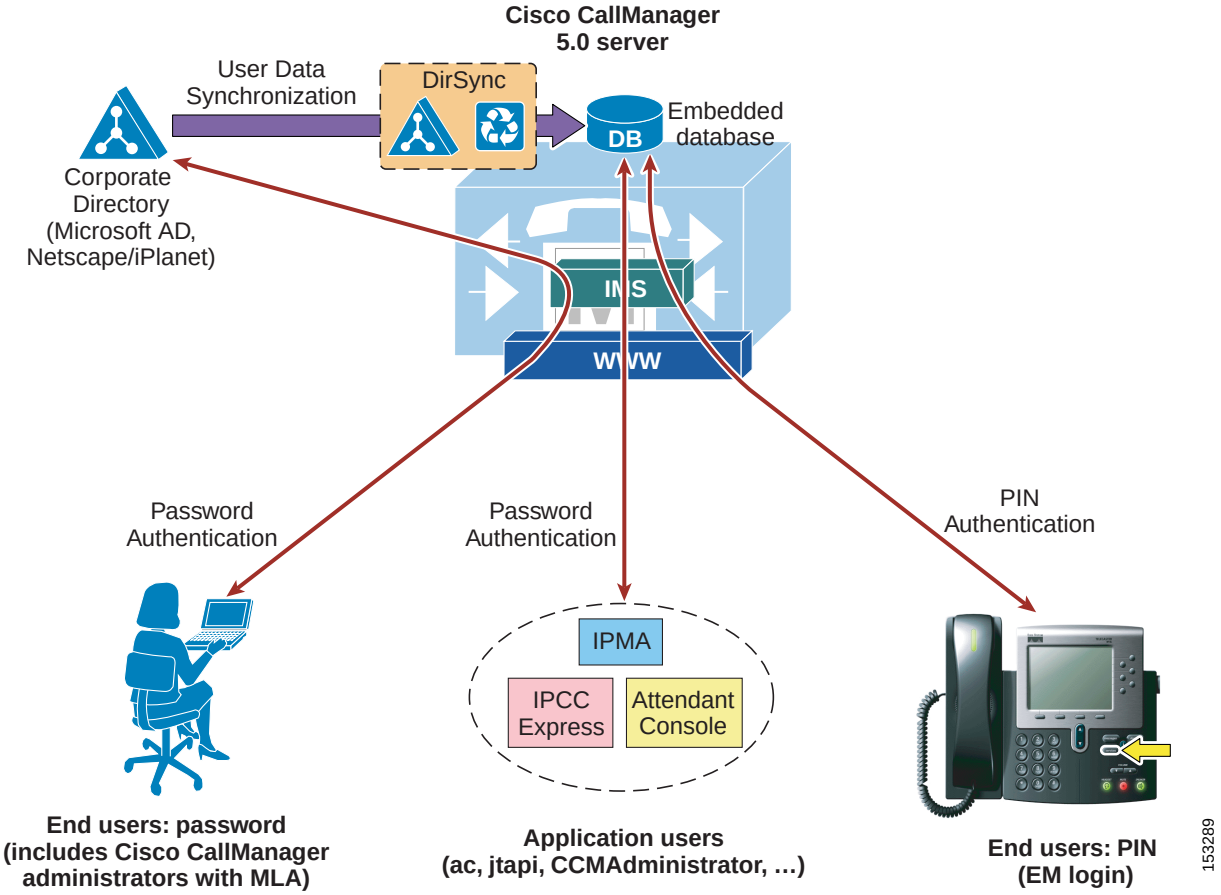
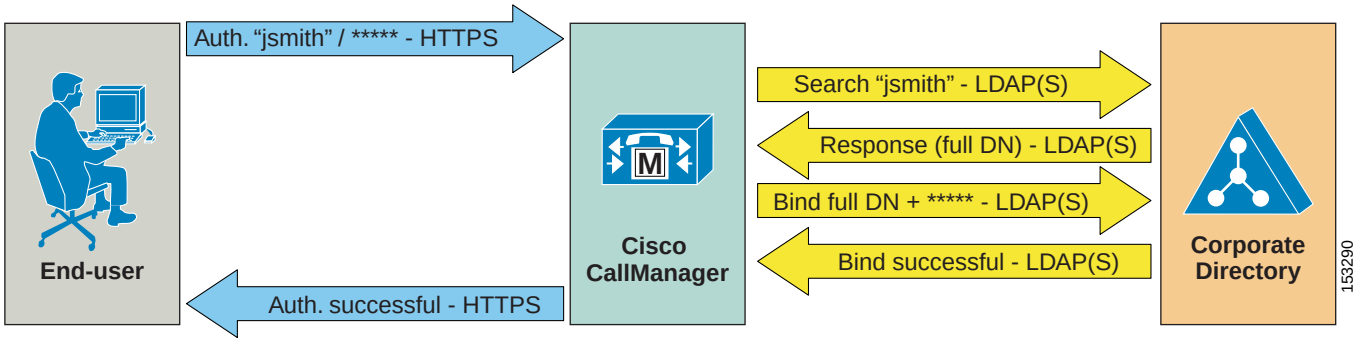


Figure 16-14 illustrates the following process, adopted by Cisco Unified CallManager to authenticate an end user against a corporate LDAP directory:

1. First, a user connects to the Cisco Unified CallManager User Options page via HTTPS and attempts to authenticate with a user name and password. In this example, the user name is jsmith.
2. Cisco Unified CallManager then issues an LDAP query for the user name jsmith, using the value specified in the LDAP Search Base on the LDAP Authentication configuration page as the scope for this query. If SLDAP is enabled, this query travels over an SSL connection.
3. The corporate directory server replies via LDAP with the full Distinguished Name (DN) of user jsmith (for example, "cn=jsmith, ou=Users, dc=vse, dc=lab").
4. Cisco Unified CallManager then attempts an LDAP bind using this full DN and the password provided by the user.
5. If the LDAP bind is successful, Cisco Unified CallManager allows the user to proceed to the configuration page requested.

Figure 16-14 Authentication Process



Observe the following design and implementation best-practices when deploying LDAP authentication with Cisco Unified CallManager 5.0:

- Create an account within the corporate directory to allow Cisco Unified CallManager to connect and authenticate to it. Cisco recommends that you use an account dedicated to Cisco Unified CallManager, with minimum permissions set to "read" all user objects within the desired search base and with a password set to never expire. (When the password for this account changes in the directory, Cisco Unified CallManager must be reconfigured to take the change into account.) If LDAP synchronization is also enabled, you can use the same account for both functions.
- Enable LDAP authentication on Cisco Unified CallManager by specifying the credentials of the aforementioned account under LDAP Manager Distinguished Name and LDAP Password, and by specifying the directory subtree where all the users reside under LDAP User Search Base.
- Configure at least two LDAP servers for redundancy. You can use IP addresses instead of host names to eliminate dependencies on Domain Name System (DNS) availability.
- This method provides single logon functionality to all end users: when they log in to the Cisco Unified CallManager User Options page, they can now use their corporate directory credentials.
- Manage end user passwords from within the corporate directory interface. (Note that the password field is no longer displayed in the Cisco Unified CallManager Administration pages when authentication is enabled.)
- Manage end user PINs from within Cisco Unified CallManager Administration or from the Cisco Unified CallManager User Options page.
- Manage Application User passwords from within Cisco Unified CallManager Administration. (Remember that these virtual users are only for communication with other Cisco IP Communications functions and applications, and they are not associated with real people.)
- Enable single logon for Cisco Unified CallManager administrators by adding their corresponding end user to the Unified CM Super Users user group from within the Cisco Unified CallManager Administration pages. Multiple levels of administrator rights can be defined by creating customized user groups and roles.

Additional Considerations for Microsoft Active Directory

When you enable LDAP authentication with Microsoft Active Directory, Cisco recommends that you configure Cisco Unified CallManager to query a Microsoft Active Directory Global Catalog server for faster response times.

To enable queries against the Global Catalog, simply configure the LDAP Server Information in the LDAP Authentication page to point to the IP address or host name of a Domain Controller that has the Global Catalog role enabled, and configure the LDAP port as 3268.

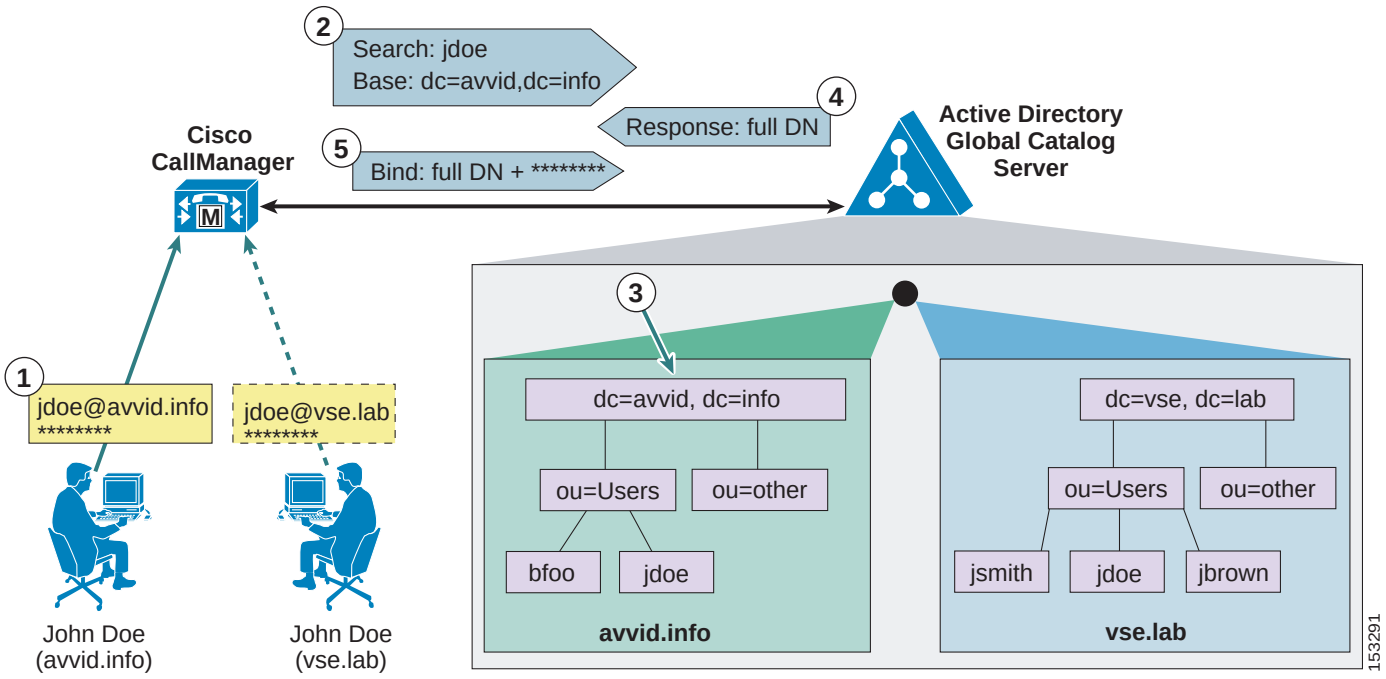
The use of Global Catalog for authentication becomes even more efficient if the users synchronized from Microsoft AD belong to multiple domains, because it allows Cisco Unified CallManager to authenticate users immediately without having to follow referrals. For these cases, point Cisco Unified CallManager to a Global Catalog server and set the LDAP User Search Base to the top of the root domain.

In the case of a Microsoft AD forest that encompasses multiple trees, some additional considerations apply. Because a single LDAP search base cannot cover multiple namespaces,
Cisco Unified CallManager must use a different mechanism to authenticate users across these discontiguous namespaces.

As mentioned in the section on LDAP Synchronization, page 16-10, in order to support synchronization with an AD forest that has multiple trees, the UserPrincipalName (UPN) attribute must be used as the user ID within Cisco Unified CallManager. When the user ID is the UPN, the LDAP authentication configuration page within Cisco Unified CallManager Administration does not allow you to enter the LDAP Search Base field, but instead it displays the note, "LDAP user search base is formed using userid information."

In fact, the user search base is derived from the UPN suffix for each user, as shown in Figure 16-15. In this example, a Microsoft Active Directory forest consists of two trees, avvid.info and vse.lab. Because the same user name may appear in both trees, Cisco Unified CallManager has been configured to use the UPN to uniquely identify users in its database during the synchronization and authentication processes.

Figure 16-15 Authentication with Microsoft AD Forests with Multiple Trees



As shown in Figure 16-15, a user named John Doe exists in both the avvid.info tree and the vse.lab tree. The following steps illustrate the authentication process for the first user, whose UPN is jdoe@avvid.info:

1. The user authenticates to Cisco Unified CallManager via HTTPS with its user name (which corresponds to the UPN) and password.
2. Cisco Unified CallManager performs an LDAP query against a Microsoft Active Directory Global Catalog server, using the user name specified in the UPN (anything before the @ sign) and deriving the LDAP search base from the UPN suffix (anything after the @ sign). In this case, the user name is jdoe and the LDAP search base is "dc=avvid, dc=info".
3. Microsoft Active Directory identifies the correct Distinguished Name corresponding to the user name in the tree specified by the LDAP query. In this case, "cn=jdoe, ou=Users, dc=avvid, dc=info".
4. Microsoft Active Directory responds via LDAP to Cisco Unified CallManager with the full Distinguished Name for this user.
5. Cisco Unified CallManager attempts an LDAP bind with the Distinguished Name provided and the password initially entered by the user, and the authentication process then continues as in the standard case shown in Figure 16-14.

Note Support for LDAP authentication with Microsoft AD forests containing multiple trees relies exclusively on the approach described above. Therefore, support is limited to deployments where the UPN suffix of a user corresponds to the root domain of the tree where the user resides. If the UPN suffix is disjointed from the actual namespace of the tree, it is not possible to authenticate Cisco Unified CallManager users against the entire Microsoft Active Directory forest. (It is, however, still possible to use a different attribute as user ID and limit the integration to a single tree within the forest.)