MarkLogic Server

Understanding and Using Security Guide

MarkLogic 8
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Understanding and Using Security Guide

1.0 Introduction to Security

When you create systems that store and retrieve data, it is important to protect the data from unauthorized use, disclosure, modification or destruction. Ensuring that users have the proper authority to see the data, load new data, or update existing data is an important aspect of application development. Do all users need the same level of access to the data and to the functions provided by your applications? Are there subsets of users that need access to privileged functions? Are some documents restricted to certain classes of users? The answers to questions like these help provide the basis for the security requirements for your application.

MarkLogic Server includes a powerful and flexible role-based security model to protect your data according to your application security requirements. There is always a trade-off between security and usability. When a system has no security, then it is open to malicious or unmalicious unauthorized access. When a system is too tightly secured, it might become difficult to use successfully. Before implementing your application security model, it is important to understand the core concepts and features in the MarkLogic Server security model. This chapter introduces the MarkLogic Server security model and includes the following sections:

1.1 Security Overview

This section provides an overview of the three main principles used in MarkLogic Server security:

1.1.1 Authentication and Access Control

Authentication is the process of verifying user credentials for a named user. Authentication makes sure you are who you say you are. Users are typically authenticated with a username and password. Authentication verifies user credentials and associates an application session with the authenticated user. Every request to MarkLogic Server is issued from an authenticated user. Authentication, by itself, does not grant access or authority to perform specific actions. There are several ways to set up server authentication in MarkLogic Server.

Authentication by username and password is only part of the story. You might grant access to users based on something other than identity, something such as the originating IP address for the requests. Restricting access based on something other than the identity of the user is generally referred to as *access control*.

For details on authentication, see “Authenticating Users” on page 32.

1.1.2 Authorization

Authorization provides the mechanism to control document access, XQuery and JavaScript code execution, and document creation. For an authenticated user, authorization determines what you are allowed to do. For example, authorization is what allows the user named *Melanie* to read and update a document, allows the user named *Roger* to only read the document, and prevents the user named *Hal* from knowing the document exists at all. In MarkLogic Server, authorization is used to protect documents stored in a database and to protect the execution of XQuery or JavaScript code. For details on authorization in MarkLogic Server, see “Protecting Documents” on page 17 and “Protecting XQuery and JavaScript Functions With Privileges” on page 29.

1.1.3 Administration

Administration is the process of defining, configuring, and managing the security objects, such as users, roles, privileges, and permissions that implement your security policies. For details on security administration procedures in MarkLogic Server, see “Security Administration” on page 10 and the *Administrator’s Guide*.

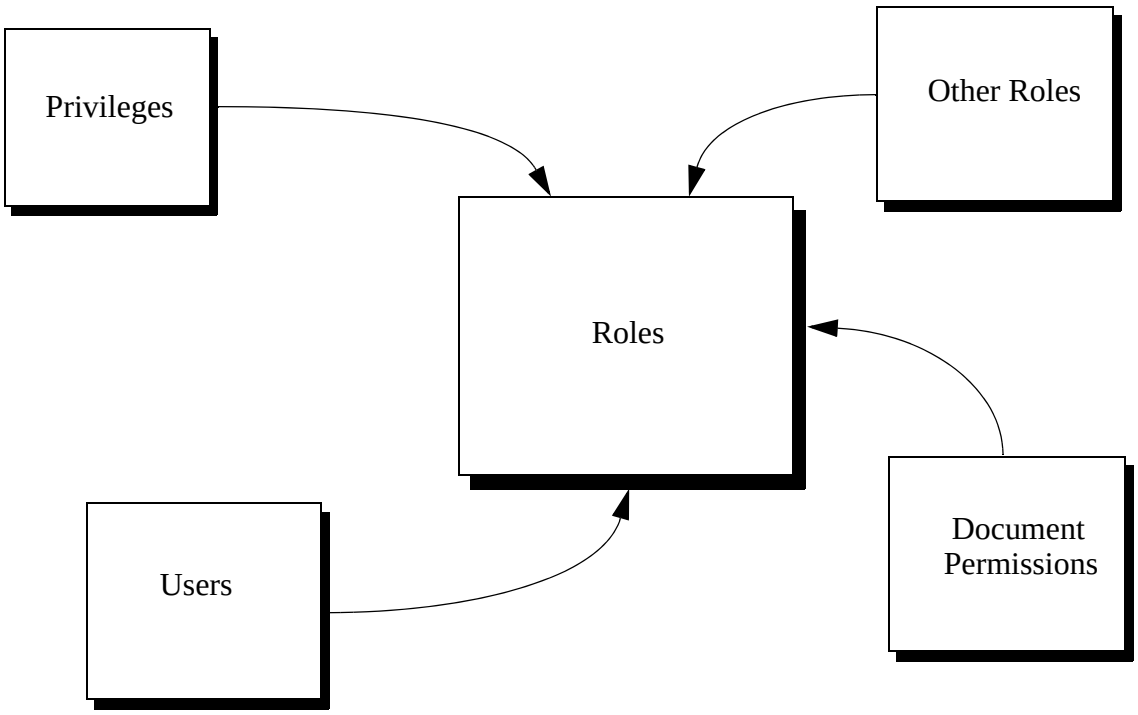
1.2 MarkLogic Security Model

The MarkLogic Server security model is flexible and enables you to set up application security with the level of granularity needed by your security requirements. This section contains the following topics:

- Role-Based Security Model (Authorization)
- Access Control With the Security Database
- Security Administration

1.2.1 Role-Based Security Model (Authorization)

Roles are the central point of authorization in the MarkLogic Server security model. Privileges, users, other roles, and document permissions all relate directly to roles. The following conceptual diagram shows how each of these entities points into one or more roles.



There are two types of privileges: URI privileges and execute privileges. URI privileges are used to control the creation of documents with certain URIs. Execute privileges are used to protect the execution of functions in XQuery and JavaScript code.

Privileges are assigned to zero or more roles, roles are assigned to zero or more other roles, and users are assigned to zero or more roles. A privilege is like a door and, when the door is locked, you need to have the key to the door in order to open it. If the door is unlocked (no privileges), then you can walk right through. The keys to the doors are distributed to users through roles; that is, if a user inherits a privilege through the set of roles to which she is assigned, then she has the keys to unlock those inherited privileges.

Permissions are used to protect documents. Permissions are assigned to documents, either at load time or as a separate administrative action. Each permission is a combination of a role and a capability (`read`, `insert`, `update`, `execute`).

Permission

Role	Capability (`read`, `insert`, `update`, or `execute`)

Users assigned the role corresponding to the permission have the ability to perform the capability. You can set any number of permissions on a document.

Capabilities represent actions that can be performed. There are four capabilities in MarkLogic Server:

- `read`
- `insert`
- `update`
- `execute`

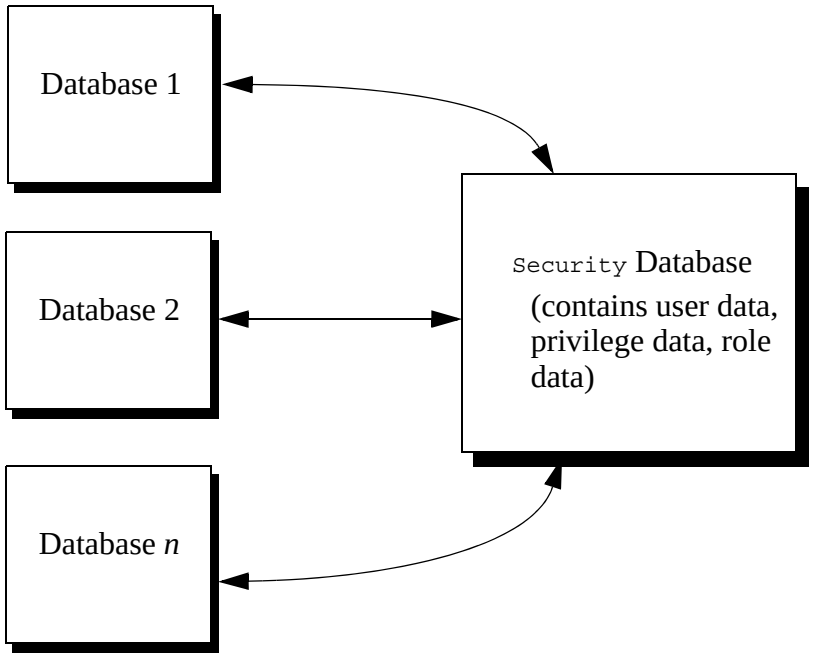
Users inherit the sum of the privileges and permissions from their roles.

For more details on how roles work in MarkLogic Server, see "Role-Based Security Model" on page 12. For more details on privileges and permissions, see "Protecting Documents" on page 17.

1.2.2 Access Control With the Security Database

MarkLogic Server uses a *security database* to store the user data, privilege data, role data, and other security information. Each database in MarkLogic Server references a security database. A database named `Security`, which functions as the default security database, is created as part of the installation process.

The following figure shows that many databases can be configured to use the same security database for authentication and authorization.



The security database is accessed to authenticate users and to control access to documents. For details on authentication, the security database, and ways to administer objects in the security database, see "Authenticating Users" on page 32 and "Administering Security" on page 49.

1.2.3 Security Administration

MarkLogic Server administrators are privileged users who have the authority to perform tasks such as creating, deleting, modifying users, roles, privileges, and so on. These tasks change or add data in the security database. Users who perform these tasks must have the `security` role, either explicitly or by inheriting it from another role (for example, from the `admin` role). Typically, users who perform these tasks have the `admin` role, which provides the authority to perform any tasks in the database. Use caution when assigning users to the `security` and/or `admin` roles; users who are assigned the `admin` role can perform any task on the system, including deleting data.

MarkLogic Server provides the following ways to administer security:

- Admin Interface
- REST Management API
- XQuery and JavaScript server-side security administration functions

For details on administering security, see "Administering Security" on page 49.

1.3 Terminology

This section defines the following terms, which are used throughout the security documentation:

- User
- Role
- Execute Privilege
- URI Privilege
- Permission
- Amp

1.3.1 User

A *user* is a named entity used to authenticate a request to an HTTP, WebDAV, ODBC, or XDBC server. For details on users, see "Authenticating Users" on page 32.

1.3.2 Role

A *role* is a named entity that provides authorization privileges and permissions to other roles or to users. You can assign roles to other roles (which can in turn include assignments to other roles, and so on). Roles are the fundamental building blocks that you use to implement your security policies. For details on roles, see "Role-Based Security Model" on page 12.

1.3.3 Execute Privilege

An *execute privilege* provides the authority to perform a protected action. Examples of protected actions are the ability to execute a specific user-defined function, the ability to execute a built-in function (for example, `xdmp:document-insert`), and so on. For details on execute privileges, see "Protecting XQuery and JavaScript Functions With Privileges" on page 29.

1.3.4 URI Privilege

A *URI privilege* provides the authority to create documents within a base URI. When a URI privilege exists for a base URI, only users assigned to roles that have the URI privilege can create documents with URIs starting with the base string. For details on URI privileges, see "Protecting Documents" on page 17.

1.3.5 Permission

A *permission* provides a role with the capability to perform certain actions (`read`, `insert`, `update`, `execute`) on a document or a collection. Permissions consist of a role and a capability. Permissions are assigned to documents and collections. For details on permissions, see "Protecting Documents" on page 17.

1.3.6 Amp

An *amp* provides a user with the additional authorization to execute a specific function by temporarily giving the user additional roles. For details on amps, see "Temporarily Increasing Privileges with Amps" on page 31.

2.0 Role-Based Security Model

MarkLogic Server uses a role-based security model. Each security entity is associated with a role. This chapter describes the role-based security model and includes the following sections:

2.1 Understanding Roles

As described in "Role-Based Security Model (Authorization)" on page 7, roles are the central point of authorization in MarkLogic Server. This section describes how the other security entities relate to roles, and includes the following sections:

2.1.1 Assigning Privileges to Roles

Execute privileges control access to XQuery and JavaScript code. URI privileges control access to creating documents in a given URI range. You associate roles with privileges by assigning the privileges to the roles.

2.1.1.1 Execute Privileges

Execute privileges allow developers to control authorization for the execution of an XQuery or JavaScript function. If an XQuery or JavaScript function is protected by an execute privilege, the function must include logic to check if the user executing the code has the necessary execute privilege. That privilege is assigned to a user through a role that includes the specific execute privilege. There are many execute privileges pre-defined in the security database to control execution of built-in XQuery and JavaScript functions.

For more details on execute privileges, see "Protecting XQuery and JavaScript Functions With Privileges" on page 29.

2.1.1.2 URI Privileges

URI privileges control authorization for creation of a document with a given URI prefix. To create a document with a prefix that has a URI privilege associated with it, a user must be part of a role that has the needed URI privilege.

For more details on how URI privileges interact with document creation, see "Protecting Documents" on page 17.

2.1.2 Associating Permissions With Roles

Permissions are security characteristics of documents that associate a role with a capability. The capabilities are the following:

- `read`
- `insert`
- `update`
- `execute`

Users gain the authority to perform these capabilities on a document if they are assigned a role to which a permission is associated.

For more details on how permissions interact with documents, see "Document Permissions" on page 18.

2.1.3 Default Permissions in Roles

Roles are one of the places where you can specify *default permissions*. If permissions are not explicitly specified when a document is created, the default permissions of the user creating the document are applied. The system determines the default permissions for a user based on the user's roles. The total set of default permissions is derived from the user's roles and all inherited roles.

For more details on how default permissions interact with document creation, see "Default Permissions" on page 21.

2.1.4 Assigning Roles to Users

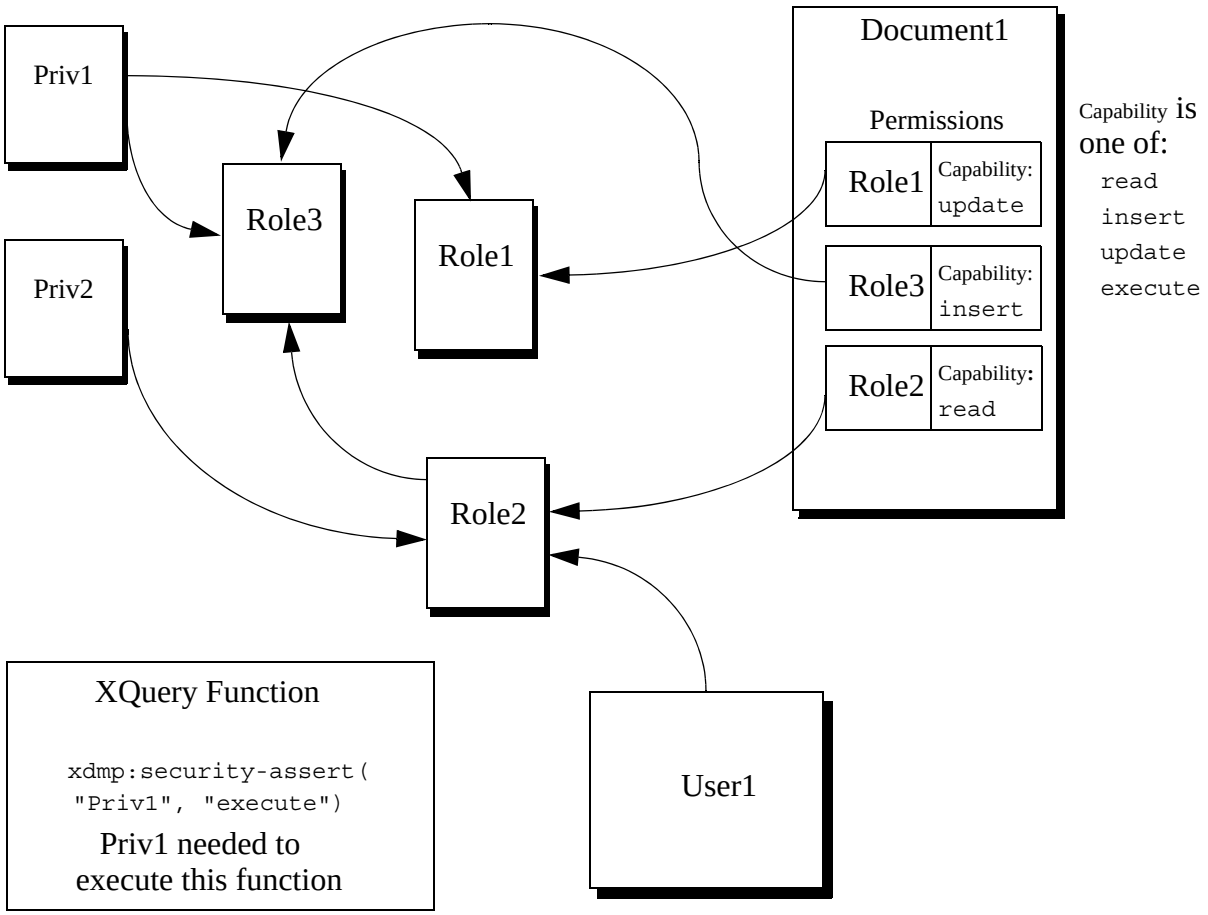
Users are authenticated against the security database configured for the database being accessed. Roles are the mechanism by which authorization information is derived. You assign roles to a user. The roles provide the user with a set of privileges and permissions that grant the authority to perform actions against code and documents. At any given time, a user *possesses* a set of privileges and default permissions that is the sum of the privileges and default permissions inherited from all of the roles currently assigned to that user.

Use the Admin Interface to display the set of privileges and default permissions for a given user; do not try and calculate it yourself as it can easily get fairly complex when a system has many roles. To display a user's security settings, use Admin Interface > Security > User > Describe. You need to select a specific user to see the Describe tab.

For more details on users, see "Authenticating Users" on page 32.

2.1.5 Roles, Privileges, Document Permissions, and Users

Privileges, document permissions, and users all interact with roles to define your security policies. The following diagram shows an example of how these entities interact.



Notice how all of the arrows point into the roles; that is because the roles are the center of all security administration in MarkLogic Server. In this diagram, `User1` is part of `Role2`, and `Role2` inherits `Role3`. Therefore, even though `User1` has only been assigned `Role2`, `User1` possesses all of the privileges and permissions from both `Role2` and `Role3`. Following the arrows pointing into `Role2` and `Role3`, you can see that the user possesses `Priv1` and `Priv2` based on the privileges assigned to these roles and `insert` and `read` capabilities based on the permissions applied to `Document1`.

Because `User1` possesses `Priv1` (based on role inheritance), `User1` is able to execute code protected with a `xdmp:security-assert("Priv1", "execute")` call; users who do not have the `Priv1` privilege can not execute such code.

2.2 The admin and security Roles

MarkLogic Server has a special role named `admin`. The `admin` role has full authority to do everything in MarkLogic Server, regardless of the permissions or privileges set. In general, the `admin` role is only for administrative activities and should not be used to load data and run applications. Use extreme caution when assigning users the `admin` role, because it gives them the authority to perform any activity in MarkLogic, included adding or deleting users, adding or deleting documents, changing passwords, and so on.

MarkLogic Server also has a built-in role named `security`. Users who are part of the `security` role have execute privileges to perform security-related tasks on the system using the functions in the `security.xqy` Library Module.

The `security` role does not have access to the Admin Interface. To access the Admin Interface, a user must have the `admin` role. The `security` role provides the privileges to execute functions in the `security.xqy` module, which has functions to perform actions such as creating users, creating roles, and so on. For details on managing security objects programmatically, see Creating and Configuring Roles and Users and User Maintenance Operations in the *Scripting Administrative Tasks Guide*.

2.3 Example—Introducing Roles, Users and Execute Privileges

Consider a simple scenario with two roles – `engineering` and `sales`. The `engineering` role is responsible for making widgets and has privileges needed to perform activities related to making widgets. The `sales` role is responsible for selling widgets and has privileges to perform activities related to selling widgets.

To begin, create two roles in MarkLogic Server named `engineering` and `sales` respectively.

The `engineering` role needs to be able to make widgets. You can create an execute privilege with the name `make-widget`, and action URI `http://widget.com/make-widget` to represent that privilege. The `sales` role needs to sell widgets,so you create an execute privilege with the name `sell-widget` and action URI `http://widget.com/sell-widget` to represent that privilege.

> **Note:** Names for execute privileges are used only as display identifiers in the Admin Interface. The action URIs are used within XQuery code to identify the privilege.

Ron is an engineer in your company so you create a user for Ron and assign the `engineering` role to the newly created user. Emily is an account representative so you create a user for Emily and assign her the `sales` role.

In your XQuery code, use the `xdmp:security-assert` function to ensure that only engineers make widgets and only account representatives sell widgets (if you are using JavaScript, you can similary call `xdmp.securityAssert` in your JavaScript function to protect the code). For example:

```
xquery version "1.0-ml"
define function make-widget(...) as ...
{
  xdmp:security-assert("http://widget.com/make-widget",
     "execute"), make widget...}
```

If Ron is logged into the application and executes the `make-widget()` function, `xdmp:security-assert("http://widget.com/make-widget", "execute")` succeeds since Ron is of the engineering role which has the execute privilege to make widgets.

If Emily attempts to execute the `make-widget` function, the `xdmp:security-assert` function call throws an exception. You can catch the exception and handle it with a `try/catch` in the code. If the exception is not caught, the transaction that called this function is rolled back.

Some functions are common to several protected actions. You can protect such a function with a single `xdmp:security-assert` call by providing the appropriate action URIs in a list. For example, if a user needs to execute the `count-widgets` function when making or selling widgets, you might protect the function as follows:

```
xquery version "1.0-ml"
define function count-widgets(...) as ...
{
  xdmp:security-assert( ("http://widget.com/make-widget",
            "http://widget.com/sell-widget"), "execute"),
  count-widget...
}
```

If there is a function that requires more than one privilege before it can be performed, place the `xdmp:security-assert` calls sequentially. For example, if you need to be a manager in the sales department to give discounts when selling the widgets, you can protect the function as follows:

```
xquery version "1.0-ml"
define function discount-widget(...) as ...
{
  xdmp:security-assert( "http://widget.com/sell-widget",
    "execute"),
  xdmp:security-assert( "http://widget.com/change-price",
    "execute"),
  discount widget...
}
```

where `http://widget.com/change-price` is an action URI for a `change-price` execute privilege assigned to the `manager` role. A user needs to have the `sales` role and the `manager` role, which provides the user with the `sell-widget` and `change-price` execute privileges, to be able to execute this function.

3.0 Protecting Documents

The MarkLogic Server security model has a set of tools you can use to control access to documents. These authorization tools control creating, inserting into, updating, and reading documents in a database. This chapter describes those tools and includes the following sections:

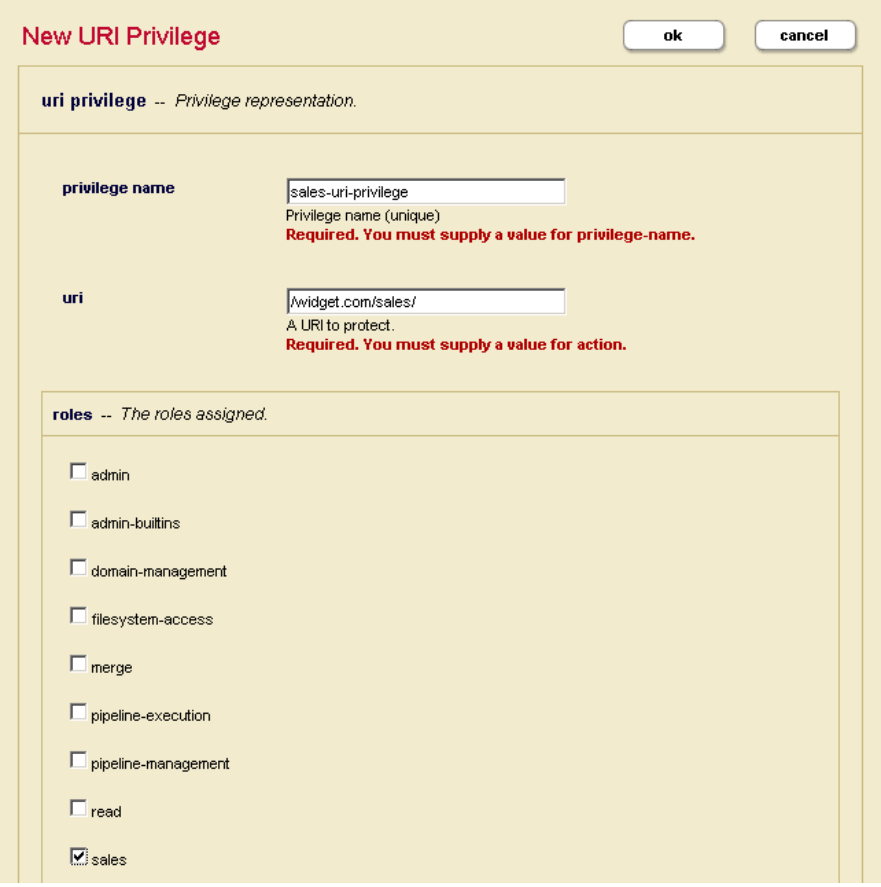
3.1 Creating Documents

To create a document in a MarkLogic Server database, a user must possess the needed privileges to create a document with a given URI. The ability to create documents based on the URI is controlled with URI privileges and with two built-in execute privileges (`any-uri` and `unprotected-uri`). To possess a privilege, the user must be part of a role (either directly or indirectly, through role inheritance) to which the privilege is assigned. This section describes these different privileges.

3.1.1 URI Privileges

URI privileges control the ability to create a new document with a given URI prefix. Using a URI privilege for a given URI protects that URI from new document creation; only users possessing the URI privilege can create a new document with the prefix.

For example, the screenshot below shows a URI privilege with `/widget.com/sales/` as the protected URI. Any URI with `/widget.com/sales/` as the prefix is protected. Users must be part of the `sales` role to create documents with URIs beginning with this prefix. In this example, you need this URI privilege (or a privilege with at least as much authority) to create a document with the URI `/widget.com/sales/my_process.xml`.



3.1.2 Built-In URI Execute Privileges

The following built-in execute privileges control the creation of URIs:

- `any-uri`
- `unprotected-uri`

The `any-uri` privilege provides the authority to create a document with any URI in the database, even if the URI is protected with a URI privilege. The `unprotected-uri` privilege provides the authority to create a document at any URI in the database except for URIs that are protected with a URI privilege.

3.2 Document Permissions

Permissions set on a document define access to capabilities (`read`, `insert`, `update`, and `execute`) for that document. Each permission consists of a capability and a role. This section describes how to set permissions on a document. It includes the following subsections:

- Capabilities Associated Through Permissions
- Setting Document Permissions

3.2.1 Capabilities Associated Through Permissions

Document permissions pair a role with a capability to perform some action on a document. You can add multiple permissions to a document. If a user is part of a role (either directly or through inheriting the role) specified as part of a document permission, then the user has that capability for the given document. Each permission associates a role with one of the following capabilities:

- Read
- Update
- Insert
- Execute

3.2.1.1 Read

The `read` capability provides the authority to see the content in the document. Being able to see the content does not allow you to modify the document.

3.2.1.2 Update

The `update` capability provides the authority to modify content in the document or delete the document. However, `update` does not provide the authority to read the document. Reading the document requires the `read` capability. Users with `update` capability, but not `read` capability, can call the `xdmp:document-delete` and `xdmp:document-insert` functions successfully. However, node update functions, such as `xdmp:node-replace`, `xdmp:node-delete`, and `xdmp:node-insert-after`, cannot be called successfully. Node update functions require a node from the document as a parameter. If a user cannot read the document, he cannot access the node in the document and supply it as a parameter.

There is a way to get around the issue with node update functions. The `update` capability provides the authority to change the permissions on a document. Therefore, you can use the `xdmp:document-add-permissions` function to add a new permission to the document with `read` capability for a given role. A user withboth `read` and `update` capabilities can call node update functions succesfully.

3.2.1.3 Insert

The `insert` capability provides a subset of the `update` capability. The `insert` capability provides the authority to add new content to the document. The `insert` capability by itself does not allow a user to change existing content or remove an existing document (for example, calls to `xdmp:document-insert` and `xdmp:document-delete` on an existing document fail). Furthermore, you need `read` capability on the document to perform actions that use any of the node insert functions (`xdmp:node-insert-before`, `xdmp:node-insert-after`, `xdmp:node-insert-child`), as explained above in the description for `update`. Therefore, a permission with an `insert` capability must be paired with a permission with a `read` capability to be useful.

3.2.1.4 Execute

The `execute` capability provides the authority to execute application code contained in that document, if the document is stored in a database which is configured as a modules database. Users without permissions for the `execute` capability on a stored module, are not able to execute that module.

3.2.2 Setting Document Permissions

When you create documents in a database, you must think about setting permissions on the document. If a document has no permission set on it, no one, other than users with the `admin` role, can read, update, insert, or delete it. Additionally, non-admin users must add update permissions on documents when creating them; attempts to create a document without at least one update permission result in an `XDMP-MUSTHAVEUPDATE` exception.

You set document permissions in the following ways:

- Explicitly set permissions on a document at load time (as a parameter to `xdmp:document-load` or `xdmp:document-insert`, for example).
- Explicitly set and remove permissions on a document using the following functions:
  - `xdmp:document-add-permissions`
  - `xdmp:document-set-permissions`
  - `xdmp:document-remove-permissions`
- Implicitly set permissions when the document is created based on the default permissions of the user who creates the documents. Permissions are applied to a document at document creation time based on the default permissions of the user who creates the document.

For examples of setting permissions on documents, see “Example—Using Permissions” on page 21.

3.3 Securing Collection Membership

You can also secure membership in collections by assigning permissions to collections. To assign permissions to collections, you must use the Admin Interface or the `security.xqy` Library Module functions. You cannot assign permissions to collections implicitly with default permissions.

For more information about permissions on collections, see Collections and Security in the *Search Developer’s Guide*.

3.4 Default Permissions

When a document is created, it is initialized with a set of permissions. If permissions are not explicitly set (by using `xdmp:document-load` or `xdmp:document-insert`, for example), then the permissions are set to the *default permissions*. The default permissions are determined based on the roles assigned (both explicitly and inherited from roles assigned to other roles) to the user who creates the document and on any default permissions assigned directly to the user.

If users are creating documents in a database, it is important to configure default permissions for the roles assigned to that user. Without default permissions, it is easy to create documents that no users (except those with the `admin` role) can read, update, or delete.

3.5 Example—Using Permissions

It is important to consider document permissions when you load content into a database, whether you load data using the built-in functions (for example, `xdmp:document-load` or `xdmp:document-insert`), WebDAV (for example, dragging and dropping files into a WebDAV folder), the REST API, the Java API, or a custom program. In each case, setting permissions is necessary, whether explicitly or by taking advantage of default permissions. This example shows several ways of setting permissions on documents.

Suppose that Ron, of the `engineering` role, is given the task to create a document to describe new features that will be added to the next version of the widget. Once the document is created, other users with the `engineering` role contribute to the document and add the features they are working on. Ian, of the `engineering-manager` role, decides that users of the `engineering` role should only be allowed to read and add to the document. This enables Ian to control the process of removing or changing features in the document. To implement this security model, the document should be created with `read` and `insert` permissions for the `engineering` role, and `read` and `update` permissions for the `engineering-manager` role.

There are two ways to apply permissions to documents at creation time:

- Setting Permissions Explicitly
- Default Permission Settings

3.5.1 Setting Permissions Explicitly

Assume that the following code snippet is executed as user `Ron` of the `engineering` role. The code inserts a document with the following permissions:

- `read` and `insert` permissions for the `engineering` role
- `update` and `read` permissions for the `engineering-manager` role

```
...
xdmp:document-insert("/widget.com/engineering/features/2004-q1.xml",
        <new-features>
          <feature>
            <name>blue whistle</name>
            <assigned-to>Ron</assigned-to>
            ...
           </feature>
          ...
        </new-features>,
        (xdmp:permission("engineering", "read"),
         xdmp:permission("engineering", "insert"),
         xdmp:permission("engineering-manager", "read"),
         xdmp:permission("engineering-manager", "update")))
...
```

If you specify permissions to the function call explicitly, as shown above, those permissions override any default permission settings associated with the user (through user settings and role inheritance).

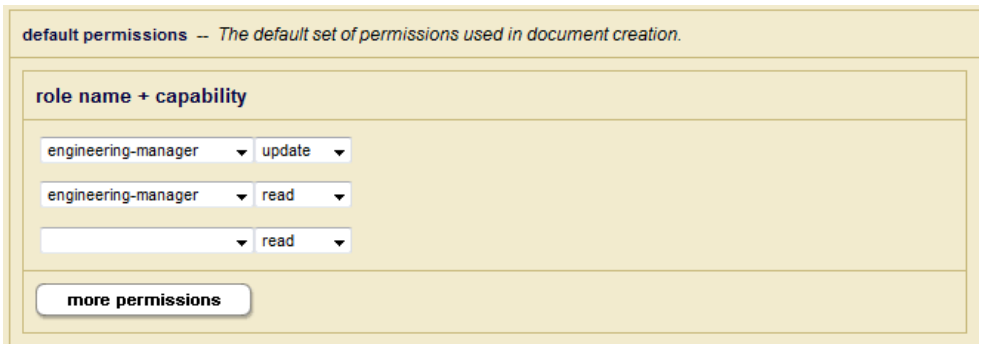
3.5.2 Default Permission Settings

If there is a set of permission requirements that meets the needs of most application scenarios, MarkLogic recommends creating the appropriate default permission settings at the role or user level. This avoids having to explicitly create and set document permissions each time you call `xdmp:document-load` or `xdmp:document-insert`.

Default permission settings that apply to a user, either through a role or through the user definition, are important if you are loading documents using a WebDAV client. When you drag and drop files into a WebDAV folder, the permissions are automatically set based on the default permissions of the user logged into the WebDAV client. For more information about WebDAV servers, see WebDAV Servers in the *Administrator's Guide*.

The following screenshot shows a portion of the Admin Interface for the `engineering` role. It shows `read` and `insert` capabilities being added to the `engineering` role's default permissions.

A user's set of default permissions is additive; it is the aggregate of the default permissions for all of the user's role(s) as well as for the user himself. Below is another screenshot of a portion of a User configuration screen for Ron. It shows read and update capabilities being added to the `engineering-manager` role as Ron's default permissions at the user level.



> **Note:** Ron has the `engineering` role and does not have the `engineering-manager` role. A user does not need to have a certain role in order to specify that role in its default permission set.

You can also use a hybrid of the two methods described above. Assume that `read` and `insert` capabilities for the `engineering` role are specified as default permissions forthe `engineering` role as shown in the first screenshot. However, `update` and `read` capabilities are not specified for the `engineering-manager` at the user or `engineering` role level.

Further assume that the following code snippet is executed by Ron. It achieves the desired objective of giving the `engineering-manager` role `read` and `update` capabilities on the document, and the `engineering` role `read` and `insert` capabilities.

```
...
xdmp:document-insert("/widget.com/engineering/features/2004-q1.xml",
       <new-features>
         <feature>
           <name>blue whistle</name>
           <assigned-to>Ron</assigned-to>
           ...
          </feature>
         ...
       </new-features>,
        (xdmp:default-permissions(),
         xdmp:permission("engineering-manager", "read")
         xdmp:permission("engineering-manager", "update")))
...
```

The `xdmp:default-permissions` function returns Ron's default permissions (from the role level in this example) of `read` and `insert` capabilities for the `engineering` role. The `read` and `update` capabilities for the `engineering-manager` role are then added explicitly as function parameters.

Note: The `xdmp:document-insert` function performs an update (rather than a create) function if a document with the specified document URI already exists. Consequently, if Ron calls the `xdmp:document-insert` function the second time with the same document URI, the call fails since Ron does not have update capability on the document.

Suppose that Ian, of the `engineering-manager` role, decides to give users of the `sales` role `read` permission on the document. (He wisely withholds `update` or `insert` capability or there will surely be an explosion of features!) The code snippet below shows how to add permissions to a document after it has been created.

```
...
xdmp:document-add-permissions(
  "/widget.com/engineering/features/2004-q1.xml",
  xdmp:permission("sales", "read"))
...
```

The `update` capability is needed to add permissions to a document. Therefore, the code snippet only succeed if it is executed by Ian, or another user of the `engineering-manager` role. This prevents Ron from giving Emily, his buddy in sales, `insert` capability on the document.

Note: Changing default permissions for a role or a user does not affect the permissions associated with existing documents. To change permissions on existing documents, you need to use the permission update functions. See the documentation for the MarkLogic Built-In Functions in *MarkLogic XQuery and XSLT Function Reference* for more details.

4.0 Compartment Security

The MarkLogic Server includes an extension to the security model called compartment security. Compartment security allows you to specify more complex security rules on documents.

To enable compartment security, a license key that includes compartment security is required. For details on purchasing a compartment security license, contact your MarkLogic sales representative.

This chapter describes compartment security and includes the following sections:

4.1 Understanding Compartment Security

A *compartment* is a name associated with a role. You specify that a role is part of a compartment by adding the compartment name to each role in the compartment. When a role is *compartmented*, the compartment name is used as an additional check when determining a user's authority to access or create documents in a database. Compartments have no effect on execute privileges. Without compartment security, permissions are checked using OR semantics.

For example, if a document has `read` permission for `role1` and `read` permission for `role2`, a user who possesses *either* `role1` or `role2` can read that document. If those roles have different compartments associated with them (for example, `compartment1` and `compartment2`, respectively), then the permissions are checked using AND semantics for each compartment, as well as OR semantics for each non-compartmented role. To access the document if `role1` and `role2` are in different compartments, a user must possess both `role1` and `role2` to access the document, as well as a non-compartmented role that has a corresponding permission on the document.

If any permission on a document has a compartment, then the user must have that compartment in order to access any of the capabilities, even if the capability is not the one with the compartment.

Access to a document requires a permission in each compartment for which there is a permission on the document, regardless of the capability of the permission. So if there is a `read` permission for a role in `compartment1`, there must also be an `update` permission for some role in `compartment1` (but not necessarily the same role). If you try to add `read`, `insert`, or `execute` permissions that reference a compartmented role to a document for which there is no `update` permission with the corresponding compartment, the `XDMP-MUSTHAVEUPDATE` exception is thrown.

4.2 Configuring Compartment Security

You can only add a compartment for a new role. To add a compartment, use the Admin Interface > Security > Roles > Create and enter a name for the compartment in the compartment field when you define each role in the compartment.

You cannot modify an existing role to use a compartment. To add a compartment to a role, you must delete the role and re-create it with a compartment. If you do re-create a role, any permissions you have on documents reference the old role (because they use the role ID, not the role name). So if you want those document permissions to use the new role, you need to update those documents with new permissions that reference the new role.

4.3 Example—Compartment Security

This section describes a scenario that uses compartment security. The scenario is not meant to demonstrate *the* correct way to set up compartment security, as your situation is likely to be unique. However, it demonstrates how compartment security works and may give you ideas for how to implement your own security model.

Description: For a MarkLogic application used by a government department, documents are classified with a security classification that dictates who may access the document. The department also restricts access to some documents based on the citizenship of the user. Additionally, some documents can only be accessed by employees with certain job functions.

To set up the compartment security for this scenario, you create the necessary roles, users, and documents with the example permissions. You will need access to both MarkLogic Admin Interface and Query Console.

To run through the example, perform the steps in each of the following sections:

- Create Roles
- Create Users
- Create the Documents and Add Permissions
- Test It Out

4.3.1 Create Roles

Using the Admin Interface > Security > Roles > Create, create the roles and compartments as follows:

1. Create roles named `US` and `Canada` and assign each of these roles the `country` compartment name. These roles form the `country` compartment.

2. Create roles named `Executive` and `Employee` and assign each of these roles the `job-function` compartment name. These roles form the `job-function` compartment.

3. Create roles named `top-secret` and `unclassified` and assign each of these roles the `classification` compartment name. These roles form the `classification` compartment.

4. Create a role named `can-read` with no compartment.

4.3.2 Create Users

Using the Admin Interface > Security > Users > Create, create users and give them the roles indicated in the following table.

User	Roles
Don	Executive, US, top-secret, can-read
Ellen	Employee, US, unclassified, can-read
Frank	Executive, Canada, top-secret, can-read
Gary	can-read
Hannah	unclassified, can-read

4.3.3 Create the Documents and Add Permissions

Using the MarkLogic Query Console, add a document for each combination of permissions in the following table:

Document	Permissions [Role and Capability]	Users with Access
doc1.xml	(Executive, read) (Executive, update) (US, read) (US, update) (top-secret, read) (top-secret, update) (can-read, read) (can-read, update)	Don
doc2.xml	(US, read) (US, update) (can-read, read) (can-read, update)	Don and Ellen
doc3.xml	(can-read, read) (can-read, update)	All users
doc4.xml	(Canada, read) (US, read) (US, update) (can-read, read) (can-read, update)	Frank, Don, Ellen
doc5.xml	(unclassified, read) (unclassified, update) (can-read, read) (can-read, update)	Ellen, Hannah

1. You can use XQuery code similar to the following example to insert the sample documents into a database of your choice. This code adds a document with a URI of `doc1.xml`, containing one `<a>` element and a set of five permissions.

```
xquery version "1.0-ml";
declare namespace html = "http://www.w3.org/1999/xhtml";
xdmp:document-insert(
         "/doc1.xml", <a>This is document 1.</a>,
            (xdmp:permission("can-read", "read"),
             xdmp:permission("can-read", "update"),
             xdmp:permission("US", "read"),
             xdmp:permission("US", "update"),
             xdmp:permission("Executive", "read"),
             xdmp:permission("Executive", "update"),
             xdmp:permission("top-secret", "read"),
             xdmp:permission("top-secret", "update")))
```

   The `doc1.xml` document can only be read by `Don` because the permissions designate all three compartments and `Don` is the only user with a role in all three of the necessary compartmented roles `Executive`, `US`, and `top-secret`, plus the basic `can-read` role.

2. Create the rest of the sample documents changing the sample code as needed. You need to change the document URI and the text to correspond to `doc2.xml`, `doc3.xml`, `doc4.xml`, and `doc5.xml` and modify the permissions for each document as suggested in the table in “Create the Documents and Add Permissions” on page 27.

4.3.4 Test It Out

Using Query Console, you can execute a series of queries to verify that the users can access each document as specified in the table in “Create the Documents and Add Permissions” on page 27.

For simplicity, this sample query uses `xdmp:eval` and `xdmp:user` to execute a query in the context of each different user. Modify the document URI and the user name to verify the permissions until you understand how the compartment security logic works. If you added the roles, users, and documents as described in this scenario, the query results should match the table in “Create the Documents and Add Permissions” on page 27.

```
xquery version "1.0-ml";
declare namespace html = "http://www.w3.org/1999/xhtml";

xdmp:eval('fn:doc("/doc1.xml")', (),
 <options xmlns="xdmp:eval">
  <user-id>{xdmp:user("Don")}</user-id>
</options>)
```

5.0 Protecting XQuery and JavaScript Functions With Privileges

Execute privileges provide authorization control for executing XQuery and JavaScript functions. MarkLogic provides three ways to protect XQuery and JavaScript functions:

- Built-in execute privileges, created by MarkLogic, control access to protected functions such as `xdmp:document-load`.
- Custom execute privileges, which you create using the Admin Interface or the security function in the `security.xqy` module, control access to functions you write.
- *Amps* temporarily amplify a user's authority by granting the authority to execute a single, specific function. You can only amp a function in a library module that is stored in the MarkLogic modules database.

This chapter describes the following:

5.1 Built-In MarkLogic Execute Privileges

Every installation of MarkLogic Server includes a set of pre-defined execute privileges. You can view this list either in the Admin Interface or in Appendix B: Pre-defined Execute Privileges of the *Administrator's Guide*.

5.2 Protecting Your XQuery and JavaScript Code with Execute Privileges

To protect the execution of an individual XQuery and JavaScript function that you have written, you can use an *execute privilege*. When a function is protected with an execute privilege, a user must have that specific privilege to run the protected XQuery or JavaScript function.

> **Note:** Execute privileges operate at the function level. To protect an entire XQuery or JavaScript document that is stored in a modules database, you can use execute permissions. For details, see "Document Permissions" on page 18.

This section describes the following:

5.2.1 Using Execute Privileges

The basic steps for using execute privileges are:

- Create the privilege.
- Assign the privilege to a role.
- Write code to test for the privilege.

You create privileges and assign them to roles using the Admin Interface. You use the `xdmp:security-assert` built-in function in your XQuery code to test for a privilege and you can use the `xdmp.securityAssert` built-in function in your JavaScript code to test for a privilege. This function tests to determine if the user running the code has the specified privilege. If the user possesses the privilege, then the code continues to execute. If the user does not possess the privilege, then the server throws an exception, which the application can catch and handle.

For example, to create an execute privilege to control the access to an XQuery function called `display-salary`, use the following steps:

1. Use the Admin Interface to create an execute privilege named `allow-display-salary`.

2. Assign any URI (for example, `http://my/privs/allow-display-salary`) to the execute privilege.

3. Assign a role to the privilege. You may want to create a specific role for this privilege depending on your security requirements.

4. Finally, in your `display-salary` XQuery function, include an `xdmp:security-assert` call to test for the `allow-display-salary` execute privilege as follows:

```
xquery version "1.0-ml";
declare function display-salary (
     $employee-id as xs:unsignedLong)
as xs:decimal
{
xdmp:security-assert("http://my/privs/allow-display-salary", "execute"),
...
} ;
```

5.2.2 Execute Privileges and App Servers

You can also control access to specific HTTP, WebDAV, ODBC, or XDBC servers using an execute privilege. Using the Admin Interface, you can specify that a privilege is required for server access. Any users that access the server must then possess the specified privilege. If a user tries to access an application on the server and does not possess the specified privilege, an exception is thrown. For an example of using this technique to control server access, see “Example: Using the Security Database in Different Servers” on page 52.

5.2.3 Creating and Updating Collections

To create or update a document and add it to a collection, the `unprotected-collections` privilege is required. You also need a role corresponding to an insert or update permission on the document. For a *protected collection* (a protected collection is created using the Admin Interface), you either need permissions to update that collection or the `any-collection` execute privilege. If the collection is an unprotected collection, then you need the `unprotected-collections` execute privilege. For details on adding collections while creating a document, see the documentation for `xdmp:document-load`, `xdmp:document-insert`, and `xdmp:document-add-collections` in the *MarkLogic XQuery and XSLT Function Reference*.

5.3 Temporarily Increasing Privileges with Amps

Amps provide users with additional authorization to execute a specific function. Assigning the user this authorization permanently could compromise the security of the system. When executing an *amped* function, the user is part of an amped role, which temporarily grants the user additional privileges and permissions of that role. Amps enable you to limit the effect of the additional roles (privileges and permissions) to a specific function.

For example, a user may need a count of all the documents in the database in order to create a report. If the user does not have read permissions on all the documents in the database, queries run by the user do not "see" all the documents in the database. If you want anyone to be able to know how many documents are in the database, regardless of whether they have permissions to see those documents, you can create a function named `document-count()` and use an amp on the function to elevate the user to a role with read permission for all documents. When the user executes the amped function, she temporarily has the necessary read permissions that enable the function to complete accurately. The administrator has in effect decided that, in the context of that `document-count()` function, it is safe to let anyone execute it.

Amps are security objects and you use the Admin Interface or Management API to create them. Amps are specific to a single function in a library module, which you specify by URI and local name when creating the amp. You can only amp a function that resides in a library module that is stored in a trusted directory on the filesystem, such as in the `Modules` directory (`<install_dir>/Modules`), or in the modules database configured for the server in which the function is executed. The recommended best practice is to put your library module code into the modules database. You cannot amp functions in XQuery modules or JavaScript modules stored in other locations. For example, you cannot amp a function in a module installed under the filesystem root of an HTTP server, and you cannot amp functions that reside in a main module. Functions must reside in the `Modules` database or in the `Modules` directory because these locations are trusted. Allowing amped functions from under a server root or from functions submitted by a client could compromise security. For details on creating amps, see the "Security Administration" chapter of the *Administrator's Guide*.

For an example that uses an amp, see "Access Control Based on Client IP Address" on page 63. For details on amps in JavaScript modules, see Amps and the module.amp Function in the *JavaScript Reference Guide*.

6.0 Authenticating Users

MarkLogic Server authenticates users when they access an application. This chapter describes users and the available authentication schemes, and includes the following sections:

6.1 Users

A *user* in MarkLogic Server is the basis for authenticating requests to a MarkLogic application server. Users are assigned to roles. Roles carry security attributes, such as privileges and default permissions. Permissions assigned to documents pair a role with a capability, therefore roles are central to document permissions. Users derive authorization to perform actions from their roles.

You configure users in the Admin Interface, where you assign a user a name, a password, a set of roles, and a set of default permissions. To see the security attributes associated with a given user, click on the `User:username` link in the Admin Interface screen for the given user. For details on configuring users in the Admin Interface, see the "Security Administration" chapter in the *Administrator's Guide*.

During the initial installation of MarkLogic Server, two users are created. One of the users is an authorized administrator who has the `admin` role. During the installation, you are prompted to specify the username and password for this user. The other user is a user named `nobody`, which is created with no roles assigned and is given a password which is randomly generated. For details about installing MarkLogic Server, see the *Installation Guide*.

6.2 Types of Authentication

You can control the authentication scheme for HTTP, WebDAV, ODBC, and XDBC App Servers. This section describes the authentication schemes and includes the following parts:

6.2.1 Basic

Basic authentication is the typical authentication scheme for web applications. When a user accesses an application page, she is prompted for a username and password. In basic mode, the password is obfuscated but not encrypted.

6.2.2 Digest

Digest authentication works the same way as basic, but offers encryption of passwords sent over the network. When a user accesses an application page, she is prompted for a username and password.

> **Note:** If you change an App Server from basic to digest authentication, it invalidates all passwords in the security database. You must then reenter the passwords in the Admin Interface. Alternatively, you can migrate to digest-basic mode initially, then switch to digest-only mode once all users have accessed the server at least once. The first time the user accesses the server after changing from basic to digest-basic scheme, the server computes the digest password by extracting the relevant information from the credentials supplied in basic mode.

6.2.3 Digest-Basic

The digest-basic authentication scheme uses the more secure digest scheme whenever possible, but reverts to basic authentication when needed. Some older browsers, for example, do not support digest authentication. The digest-basic scheme is also useful if you previously used basic authentication, but want to migrate to digest. The first time a user accesses the server after changing from basic to digest-basic authentication scheme, the server computes the digest password by extracting the relevant information from the credentials supplied in basic mode.

6.2.4 Limitations of Digest and Basic Authentication

Since the browser does not provide a way to clear a user's authentication information in basic or digest mode, the user remains logged in until the browser is shut down. In addition, there is no way to create a custom login page using these schemes. For certain deployments, application-level authentication may be more appropriate.

6.2.5 Application Level

Application-level authentication bypasses all authentication and automatically logs all users in as a specified *default user.* You specify the default user in the Admin Interface, and any users accessing the server automatically inherit the security attributes (roles, privileges, default permissions) of the default user. Application-level authentication is available on HTTP, ODBC, and WebDAV servers.

The default user should have the required privileges to at least read the initial page of the application. In many application scenarios, the user is then given the opportunity to explicitly log in to the rest of the application from that page. How much of the application and what data a user can access before explicitly logging in depends on the application and the roles that the default user is part of. For an example of this type of configuration, see "Using Custom Login Pages" on page 62.

7.0 External Authentication (LDAP and Kerberos)

MarkLogic Server allows you to configure MarkLogic Server so that users are authenticated using an external authentication protocol, such as Lightweight Directory Access Protocol (LDAP) or Kerberos. These external agents serve as centralized points of authentication or repositories for user information from which authorization decisions can be made.

This chapter describes how to configure MarkLogic Server for external authentication using LDAP and/or Kerberos. The topics in this chapter are:

7.1 Terms Used in this Chapter

The following terms are used in this chapter:

- *Authentication* is the process of verifying user credentials for a named user, usually based on a username and password. Authentication generally verifies user credentials and associates a session with the authenticated user. It does not grant any access or authority to perform any actions on the system. Authentication can be done *internally* inside MarkLogic Server, or *externally* by means of a Kerberos or LDAP server. This chapter describes how do configure MarkLogic Server for *external authentication* using either the Kerberos or LDAP protocol.
- *Authorization* is the process of allowing a user to perform some action, such as create, read, update, or delete a document or execute a program, based on the user's identity. Authorization defines what an authenticated user is allowed to do on the server. When an App Server is configured for external authentication, authorization can be done either by MarkLogic Server or by LDAP.
- *Lightweight Directory Access Protocol* (LDAP) is an authentication protocol for accessing server resources over an internet or intranet network. An LDAP server provides a centralized user database where one password can be used to authenticate a user for access to multiple servers in the network. LDAP is supported on Active Directory on Windows Server 2008 and OpenLDAP 2.4 on Linux and other Unix platforms.

- *Kerberos* is a ticket-based authentication protocol for trusted hosts on untrusted networks. Kerberos provides users with encrypted tickets that can be used to request access to particular servers. Because Kerberos uses tickets, both the user and the server can verify each other's identity and user passwords do not have to pass through the network.

  Note: Kerberos is not supported when running MarkLogic Server on Windows. However, you can run Kerberos on an external Windows server to access a remote instance of MarkLogic.

- An *External Authentication Configuration Object* specifies which authentication protocol and authorization scheme to use, along with any other parameters necessary for LDAP authentication. After an external authentication configuration object is created, multiple App Servers can use the same configuration object.
- A *Distinguished Name* (DN) is a sequence of *Relative Distinguished Names* (RDNs), which are attributes with associated values expressed by the form *attribute=value*. Each RDN is separated by a comma in a DN. For example, to identify the user, `joe`, as having access to the server `MARKLOGIC1.COM`, the DN for `joe` would look like:

  ```
  UID=joe,CN=Users,DC=MARKLOGIC1,DC=COM
  ```

  Note: The attributes after `UID` make up what is known as the *Base DN*.

  For details on LDAP DNs, see http://www.rfc-editor.org/rfc/rfc4514.txt.

- A *Principal* is a unique identity to which Kerberos can assign tickets. For example, in Kerberos, a user is a principal that consists of a user name and a server resource, described as a *realm*. Each user or service that participates in a Kerberos authentication realm must have a principal defined in the Kerberos database.

  A user principal is defined by the format: `username@REALM.NAME`. For example, to identify the user, `joe`, as having access to the server `MARKLOGIC1.COM`, the principal might look like:

  ```
  joe@MARKLOGIC1.COM
  ```

  For details on Kerberos principals, see http://www.kerberos.org/software/tutorial.html#1.3.2.

7.2 Overview of External Authentication

MarkLogic Server supports external authentication by means of LDAP and Kerberos. When a user attempts to access a MarkLogic App Server that is configured for external authentication, the requested App Server sends the username and password to the LDAP server or Kerberos for authentication. Once authenticated, the LDAP or Kerberos protocol is used to identify the user on MarkLogic Server. For details on how to configure an App Server for external authentication, see "Creating an External Authentication Configuration Object" on page 40 and "Configuring an App Server for External Authentication" on page 45.

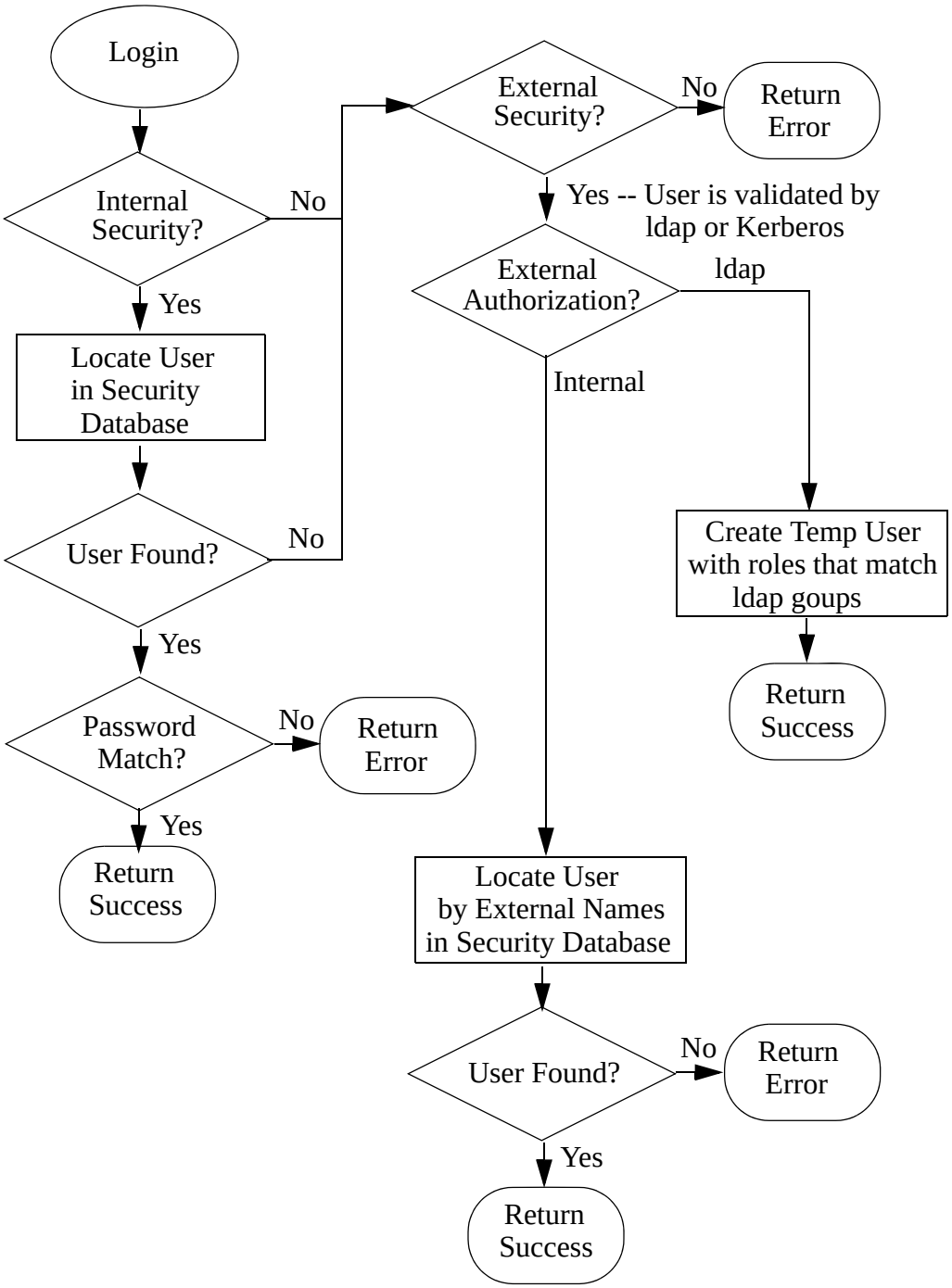
Users can be authorized either internally by MarkLogic Server, externally by an LDAP server, or both. If internal authorization is used, the user needs to exist in the MarkLogic Security database where his or her "external name" matches the external user identity registered with either LDAP or Kerberos, depending on the selected authentication protocol. For details on how to map a MarkLogic user to an LDAP Distinguished Name (DN) or a Kerberos User Principal, see "Assigning an External Name to a User" on page 43.

If the App Server is configured for LDAP authorization, the user does not need to exist in MarkLogic Server. Instead, the external user is identified by a username with the LDAP server and the LDAP groups associated with the DN are mapped to MarkLogic roles. MarkLogic Server then creates a temporary user with a unique and deterministic id and those roles. For details on how to map a MarkLogic role to an LDAP group, see "Assigning an External Name to a Role" on page 44.

If the App Server is configured for both internal and LDAP authorization, users that exist in the MarkLogic Security database are authorized internally by MarkLogic Server. If a user is not a registered MarkLogic user, then the user must be registered on the LDAP server.

> **Note:** MarkLogic Server caches negative lookups to avoid overloading the external Kerberos or LDAP server. Successful logins are also cached. The cache can be cleared by calling the `sec:external-security-clear-cache` function.

The following flowchart illustrates the logic used to determine how a MarkLogic user is authenticated and authorized.



The possible external authorization configurations for accessing MarkLogic Server are shown in the following table.

Authentication Protocol	Authentication Scheme	Authorization Scheme	Description
`kerberos`	`kerberos-ticket`	`internal`	The user is authenticated by Kerberos and a Kerberos session ticket is used to authenticate the user to access MarkLogic Server. The user must exist in MarkLogic, where the user's "external name" matches the Kerberos User Principal.
`kerberos`	`application-level`	`internal`	The user is authenticated by Kerberos and a Kerberos session ticket is used at a time determined by the App Server to authenticate the user to access MarkLogic Server. The user must exist in MarkLogic, where the user's "external name" matches the Kerberos User Principal.
`kerberos`	`basic`	`internal`	The user is authenticated by Kerberos. No ticket is exchanged between the client and the App Server. Instead, the username and password are passed. This configuration is used when the client is not capable of ticket exchange and should only be used over SSL connections because the password is communicated as clear text. The user must exist in MarkLogic, where the user's "external name" matches the Kerberos User Principal.

Authentication Protocol	Authentication Scheme	Authorization Scheme	Description
`kerberos`	`kerberos-ticket | application-level | basic`	`ldap`	The user is authenticated by Kerberos and a Kerberos session ticket is used to identify the user to MarkLogic Server. MarkLogic extracts the user ID from the ticket and sends it to the LDAP directory. MarkLogic uses the information returned by the LDAP directory to create a temporary user with the correct roles to access MarkLogic. The user does not need to exist on MarkLogic.
`ldap`	`application-level | basic`	`internal`	The user is authenticated by LDAP. User must exist in MarkLogic, where the user's "external name" matches the LDAP Distinguished Name (DN).
`ldap`	`application-level | basic`	`ldap`	The user is authenticated by LDAP and the user's groups are mapped to the MarkLogic roles. The user does not need to exist on MarkLogic. Instead, the LDAP server creates a temporary user with the correct roles to access MarkLogic.

Note: When application-level authentication is enabled with Kerberos authentication, an application can use the `xdmp:gss-server-negotiate` function to obtain a username that can be passed to the `xdmp:login` function to log into MarkLogic Server.

Note: If running MarkLogic Server on Windows and using LDAP authentication to authenticate users, the user name must include the domain name of the form: `userName@domainName`.

7.3 Creating an External Authentication Configuration Object

This section describes how to create an external authentication configuration object in the Admin Interface. You can also use the `sec:create-external-security` function to create an external authentication configuration object. Once created, multiple App Servers can use the same external authentication configuration object.

1. In the Admin Interface, click the Security icon in the left tree menu.

2. Click the External Authentication icon.

3. Click the Create tab at the top of the External Authentication Summary window:

Field	Description
`external security name`	The name used to identify this External Authentication Configuration Object.
`description`	The description of this External Authentication Configuration Object.
`authentication`	The authentication protocol to use: `ldap` or `kerberos`.
`cache timeout`	The login cache timeout, in seconds. When the timeout period is exceeded, the LDAP server reauthenticates the user with MarkLogic Server.
`authorization`	The authorization scheme: `internal` for authorization by MarkLogic Server or `ldap` for authorization by an LDAP server.
`ldap server uri`	If authorization is set to `ldap`, then enter the URI for the LDAP server.
`ldap base`	If authorization is set to `ldap`, then enter the base DN for user lookup.
`ldap attribute`	If authorization is set to `ldap`, then enter the name of the attribute used to identify the user on the LDAP server.
`ldap default user`	The LDAP default user. If you specify an ldap-bind-method of simple, this must be a Distinguished Name (DN). If you specify an ldap-bind-method of MD5, this must be the name of a user registered with the LDAP server.
`ldap password` `confirm ldap password`	The password and confirmation password for the LDAP default user.
`ldap bind method`	The LDAP bind method to use. This can be either `MD5` or `simple`. MD5 makes use of the DIGEST-MD5 authentication method. If the bind method is `simple`, then the `ldap default user` must be a Distinguished Name (DN). If MD5, then the `ldap default user` must be the name of a valid LDAP user. When using a bind method of `simple`, the password is not encrypted, so it is recommended you use secure ldaps (LDAP with SSL).

4. Click Ok.

7.4 Assigning an External Name to a User

This section describes how to assign one or more external names to a user in the Admin Interface. You can also use the `sec:create-user` or `sec:user-set-external-names` function to assign one or more external names to a user. The external names are used to match the user with one or more Distinguished Names in an LDAP server or User Principals in a Kerberos server.

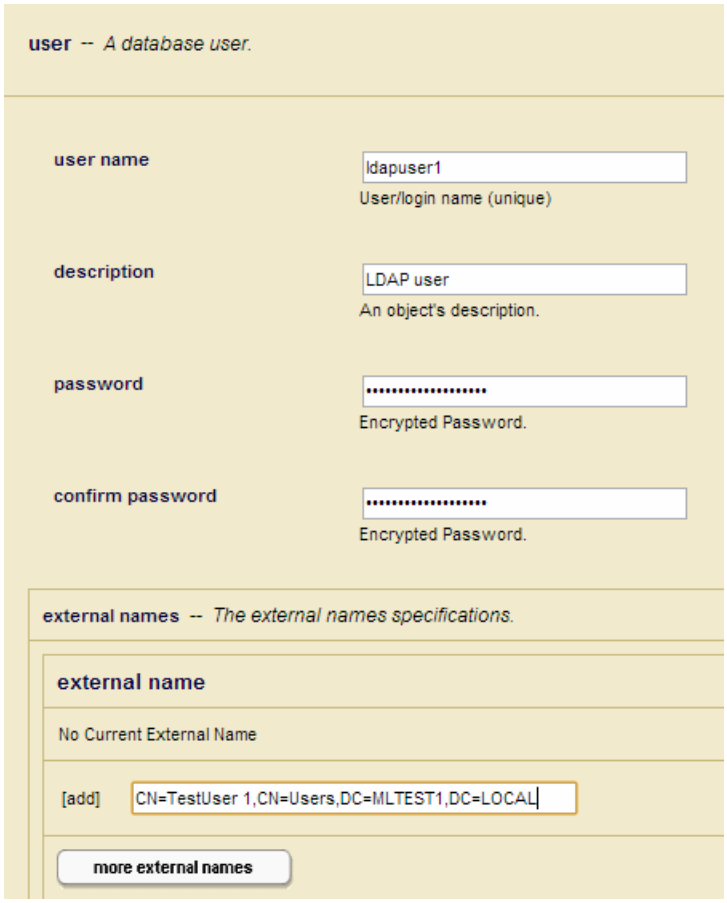
1. Click the Security icon in the left tree menu.

2. Click the Users icon.

3. Select a user or create a new one by clicking the Create tab at the top of the User Summary window.

4. In the User Configuration window, enter the external name for the user in the field in the External Name section. You can associate multiple external names with the user by clicking More External Name.

5. Click OK.



7.5 Assigning an External Name to a Role

When LDAP authorization is used, the LDAP groups associated with the user are mapped to MarkLogic roles. One or more groups can be associated with a single role. These LDAP groups are defined as External Names in the Role Configuration Page.

This section describes how to assign one or more external names to a role in the Admin Interface. You can also use the `sec:create-role` or `sec:role-set-external-names` function to assign one or more external names to a role.

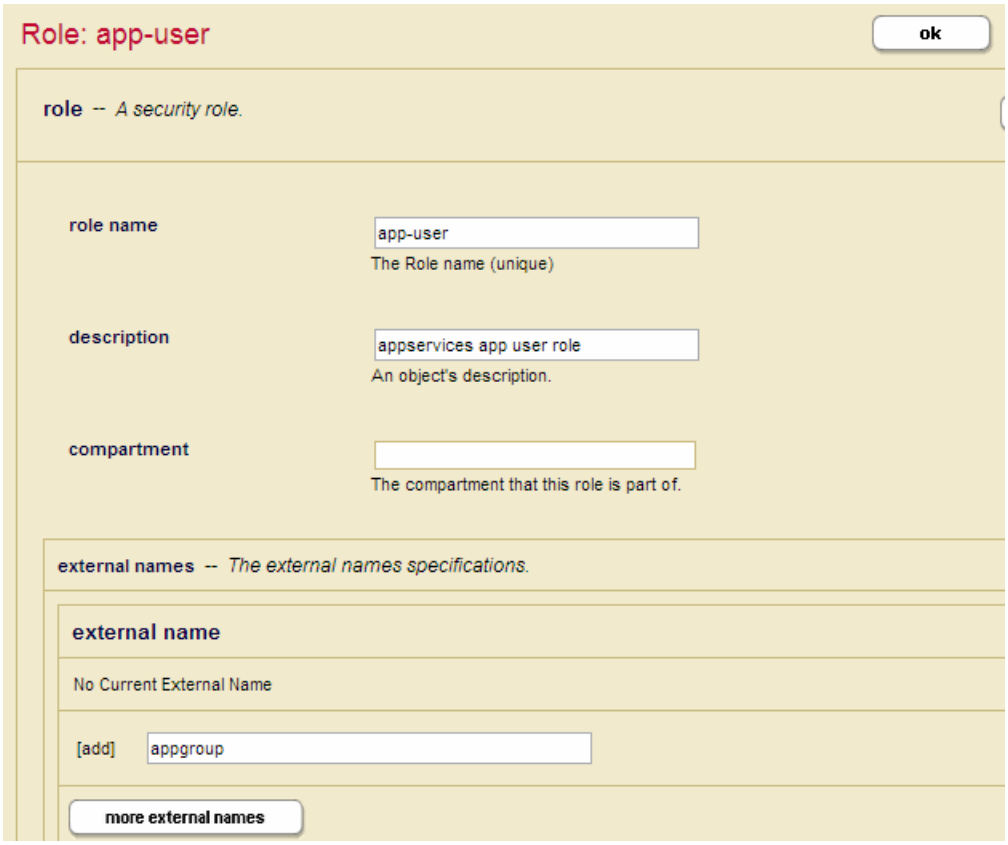
1. Click the Security icon in the left tree menu.

2. Click the Roles icon.

3. Select a role or create a new one by clicking the Create tab at the top of the Role Summary window.

4. In the Role Configuration window, enter the name of the LDAP group to be associated with the role in the field in the External Name section. You can associate multiple LDAP groups with the role by clicking More External Name.

5. Click OK.



7.6 Configuring an App Server for External Authentication

This section describes how to configure an App Server for external authentication.

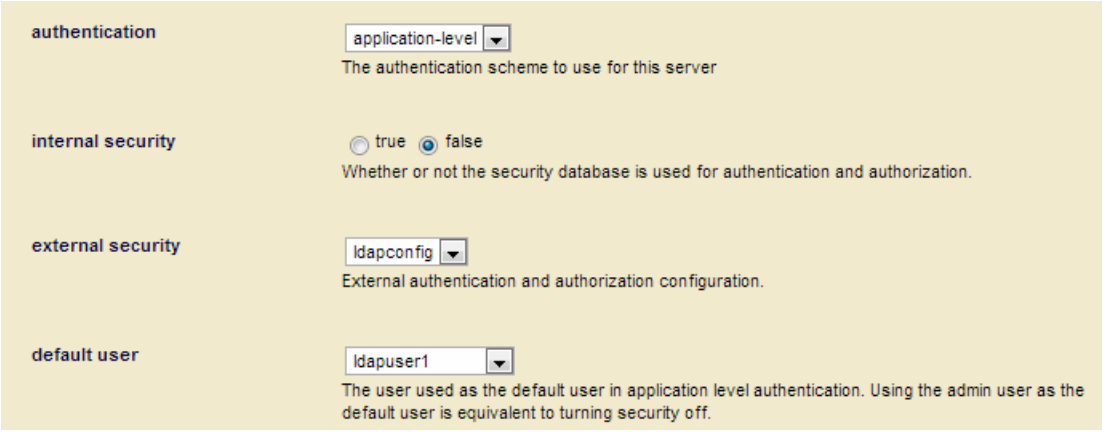
1. Click the Groups icon in the left frame.

2. Click the group in which you want to create or configure the App Server (for example, Default).

3. Click the App Servers icon on the left tree menu.

4. Select the Create HTTP tab to create a new App Server, or select an existing App Server from the Summary page.

5. In the App Server Configuration page, scroll down to the au ten tic at ion section and set the fields, as described in the table below.



Field	Description
`authentication`	The authentication scheme: `basic` or `application-level` for LDAP authentication, or `kerberos-ticket` for Kerberos authentication.
`internal security`	Determines whether or not authentication for the App Server is to be done internally by MarkLogic Server.
`external security`	The name of the external authentication configuration object to use. For details on how to create an external authentication configuration object, see “Creating an External Authentication Configuration Object” on page 40.
`default user`	If you select `application-level` authentication, you will also need to specify a Default User. Anyone accessing the HTTP server is automatically logged in as the Default User until the user logs in explicitly. A Default User must be an internal user stored in the Security database.

7.7 Creating a Kerberos keytab File

If you are configured to Kerberos authentication, then you must create a `services.keytab` file and place it in the MarkLogic data directory.

> **Note:** The name of the generated keytab file must be `services.keytab`.

This section contains the following topics:

7.7.1 Creating a keytab File on Windows

On Windows platforms, the `services.keytab` file is created using Active Directory Domain Services (AD DS) on a Windows server.

> **Note:** Kerberos is not supported when running MarkLogic Server on Windows. However, you can run Kerberos on an external Windows server to access a remote instance of MarkLogic.

> **Note:** If you are using the MD5 bind method and Active Directory Domain Services (AD DS) on a computer that is running Windows Server 2008 or Windows Server 2008 R2, be sure that you have installed the hot fix described in http://support.microsoft.com/kb/975697.

To create a `services.keytab` file, do the following:

1. Using Active Directory Domain Services on the Windows server, create a "user" with the same name as the MarkLogic Server hostname. For example, if the MarkLogic Server is named `mysrvr.marklogic.com`, create a user with the name `mysrvr.marklogic.com`.

2. Create a keytab file with the principal `HTTP/`*`hostname`* using `ktpass` command of the form:

   ```
   ktpass princ HTTP/<hostname> mapuser <user-account> pass <password>
   out <filename>
   ```

   For example, to create a keytab file for the host named `mysrvr.marklogic.com`, do the following:

   ```
   ktpass princ HTTP/mysrvr.marklogic.com@MLTEST1.LOCAL
   mapuser mysrvr.marklogic.com@MLTEST1.LOCAL pass mysecret
   out services.keytab
   ```

3. Copy the `services.keytab` from the Windows server to the MarkLogic data directory on your MarkLogic Server.

7.7.2 Creating a keytab File on Linux

On Linux platforms, the `services.keytab` file is created as follows:

1. In a shell window, use `kadmin.local` to start the Kerberos administration command-line tool.

2. Use the `addprinc` command to add the principal to Kerberos.

3. Use the `addprinc` command to generate the `services.keytab` file for the principal.

   For example, to create a `services.keytab` file for the host named `mysrvr.marklogic.com`, do the following:

```
$ kadmin.local
> addprinc -randkey HTTP/mysrvr.marklogic.com
> ktadd -k services.keytab HTTP/mysrvr.marklogic.com
```

7.8 Example External Authorization Configurations

This section provides an example of how Kerberos and LDAP users and groups might be mapped to MarkLogic users and roles.

On Active Directory, there is a Kerberos user and an LDAP user assigned to an LDAP group:

- Kerberos Principal: `jsmith@MLTEST1.LOCAL`
- LDAP DN: `CN=John Smith,CN=Users,DC=MLTEST1,DC=LOCAL`
- LDAP memberOf: `CN=TestGroup Admin,CN=Users,DC=MLTEST1,DC=LOCAL`

On MarkLogic Server, the two users and the `ldaprole1` role are assigned external names that map them to the above users and LDAP group.

Kerberos User:

- User name: `krbuser1`
- External names: `jsmith@MLTEST1.LOCAL`

LDAP User:

- User name: `ldapuser1`
- External names: `CN=John Smith,CN=Users,DC=MLTEST1,DC=LOCAL`

Role:

- Role name: `ldaprole1`
- External names: `CN=TestGroup Admin,CN=Users,DC=MLTEST1,DC=LOCAL`

After authentication, the `xdmp:get-current-user` function returns a different user name, depending on the external authorization configuration. The possible configurations and returned name is shown in the following table.

Authentication Protocol	Authorization Scheme	Name Returned
kerberos	internal	`krbuser1`
kerberos	ldap	`jsmith@MLTEST1.LOCAL` (TEMP user with role `ldaprole1`)
ldap	internal	`ldapuser1`
ldap	ldap	`jsmith` (TEMP user with role `ldaprole1`)

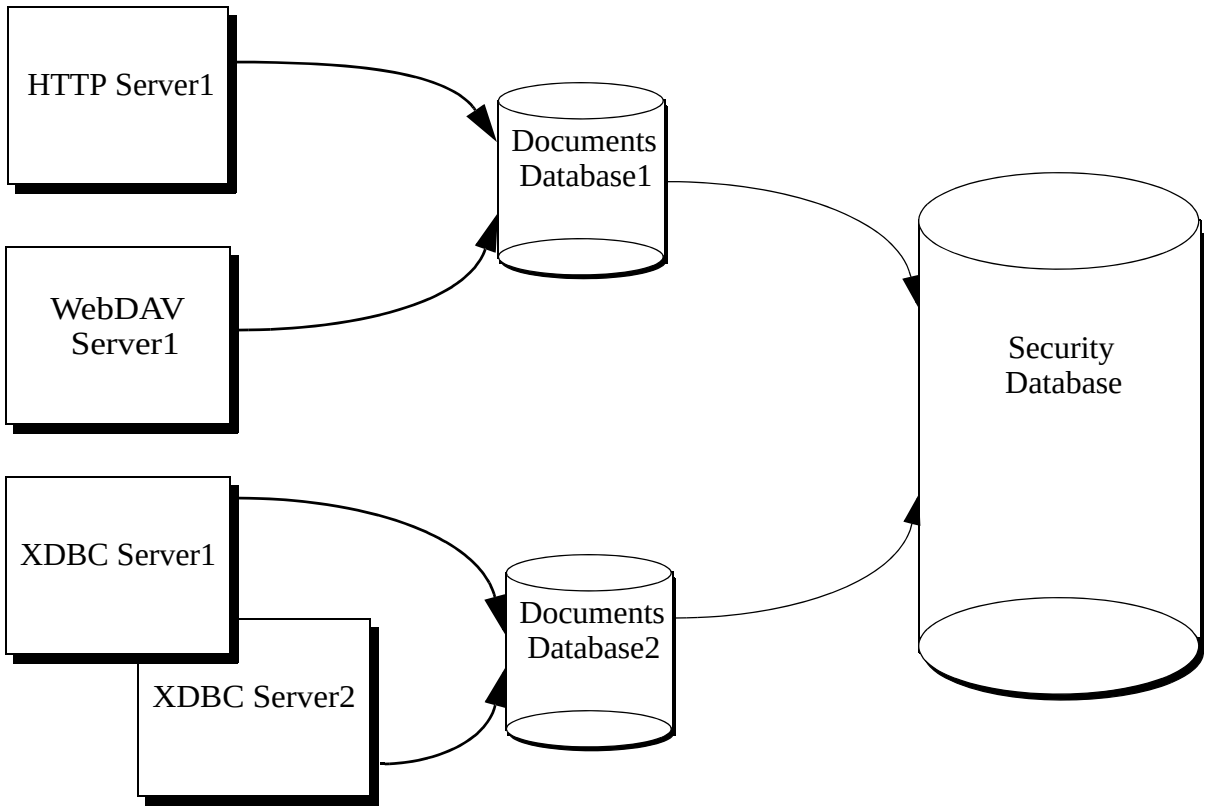
8.0 Administering Security

This chapter describes the basic steps to administer security in MarkLogic Server. It does not provide the detailed procedures for creating users, roles, privileges, and so on. For those procedures, see the "Security Administration" chapter of the *Administrator's Guide*. This chapter includes the following sections:

8.1 Overview of the Security Database

Authentication in MarkLogic Server occurs via the *security database*. The security database contains security objects such as privileges, roles, and users. A security database is associated with each HTTP, WebDAV, ODBC, or XDBC server. Typically, a single security database services all of the servers configured in a system. Actions against the server are authorized based on the security database. The security database works the same way for clustered systems as it does for single-node systems; there is always a single security database associated with each HTTP, WebDAV, ODBC, or XDBC server.

The configuration that associates the security database with the database and servers is at the database level. HTTP, WebDAV, ODBC, and XDBC servers each access a single documents database, and each database in turn accesses a single security database. Multiple documents databases can access the same security database. The following figure shows many servers accessing some shared and some different documents databases, but all accessing the same security database.

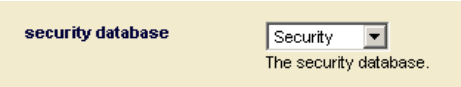


Sharing the security database across multiple servers provides a common security configuration. You can set up different privileges for different databases if that makes sense, but they are all stored in a common security database. For an example of this type of configuration, see “Example: Using the Security Database in Different Servers” on page 52.

In addition to storing users, roles, and privileges that you create, the security database also stores pre-defined privileges and pre-defined roles. These objects control access to privileged activities in MarkLogic Server. Examples of privileged activities include loading data and accessing URIs. The security database is initialized during the installation process. For a list of all of the pre-defined privileges and roles, see the corresponding appendixes in the *Administrator's Guide*.

8.2 Associating a Security Database With a Documents Database

When you configure a database, you must specify which database is its security database. You can associate the security database to another database in the database configuration screen of the Admin Interface. This configuration specifies which database the server will use to authenticate users and authorize requests. By default, the security database is named *Security*. The following screen shot shows the server configuration screen drop-list that specifies the security database.



8.3 Managing and Using Objects in the Security Database

There are two mechanisms available to add, change, delete, and use objects in the security database: the Admin Interface and the XQuery functions. provided by the `security.xqy` library module. This section describes what you can do with each of these mechanisms and includes the following topics:

- Using the Admin Interface
- Using the security.xqy Module Functions

8.3.1 Using the Admin Interface

The Admin Interface is an application installed with MarkLogic Server for administering databases, servers, clusters, and security objects. The Admin Interface is designed to manage the objects in the security database, although it manages other things, such as configuration information, too. You use the Admin Interface to create, change, or delete objects in the security database. Activities such as creating users, creating roles, assigning privileges to roles, and so on, are all done in the Admin Interface. By default, the Admin Interface application runs on port 8001.

For the procedures for creating, deleting, and modifying security objects, see the *Administrator's Guide*.

8.3.2 Using the security.xqy Module Functions

The installation process installs an XQuery library to help you use security objects in your XQuery code. The `security.xqy` library module includes functions to access user and privilege information, as well as functions to create, modify, and delete objects in the security database.

The functions in `security.xqy` must be executed against the security database. You can use these functions to do a wide variety of things. For example, you can write code to test which collections a user has access to, and use that information in your code.

For the signatures and descriptions of the functions in `security.xqy`, see the *MarkLogic XQuery and XSLT Function Reference*.

8.4 Backing Up the Security Database

The security database is the central entry point to all of your MarkLogic Server applications. If the security database becomes unavailable, no users can access any applications. Therefore, it is important to create a backup of the security database. Use the database backup utility in the Admin Interface to back up the security database. For details, see the "Backing Up and Restoring a Database" chapter of the *Administrator's Guide*.

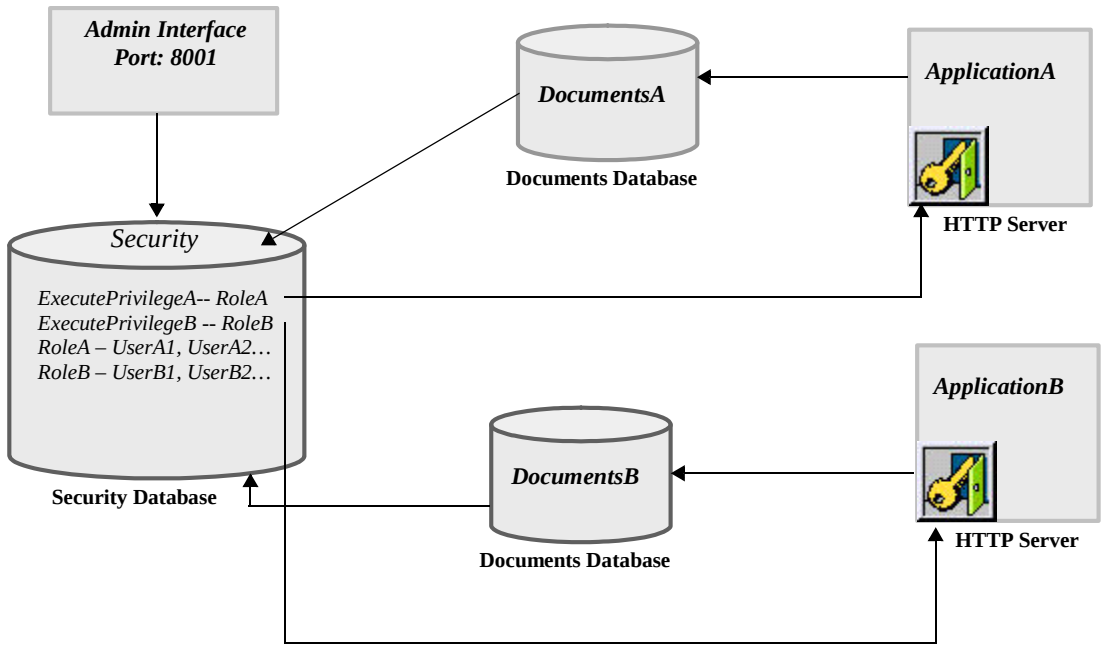
8.5 Example: Using the Security Database in Different Servers

The security database typically is used for the entire system, including all of the HTTP, WebDAV, ODBC, and XDBC servers configured. You can create distinct privileges to control access to each server. If each server accesses a different document database, these privileges can effectively control access to each database (because the database is associated with the server). Users must have the appropriate *login privileges* to log into the server, and therefore they have no way of accessing either the applications or the content stored in the database accessed through that server without possessing the appropriate privilege. This example describes such a scenario.

Consider an example with two databases—`DocumentsA` and `DocumentsB`. `DocumentsA` and `DocumentsB` share a single security database, `Security`. `Security` is the default security database managed by the Admin Interface on port 8001. There are two HTTP servers, `ApplicationA` and `ApplicationB`, connected to `DocumentsA` and `DocumentsB` respectively.

`ExecutePrivilegeA` controls login access to `ApplicationA`, and `ExecutePrivilegeB` to `ApplicationB`. `RoleA` is granted `ExecutePrivilegeA` and `RoleB` is granted `ExecutePrivilegeB`.

With this configuration, users who are assigned `RoleA` can access documents in `DocumentsA` and users of `RoleB` can access documents in `DocumentsB`. Assuming that `ExecutePrivilegeA` or `ExecutePrivilegeB` are appropriately configured as login privileges on every HTTP and XDBC server that accesses either `DocumentsA` or `DocumentsB`, user access to these databases can conveniently be managed by assigning users the role(s) `RoleA` and/or `RoleB` as required.



Note: The Admin Interface at port 8001 is also used to configure all databases, HTTP servers, hosts, and so on. The connection between the Admin Interface and the `Security` database in the diagram simply indicates that the Admin Interface is storing all security objects—users, roles, and privileges—in `Security` database.

The steps below outline the process to create the configuration in the above example.

1. Create two document databases: `DocumentsA` and `DocumentsB`. Leave the security database for the document databases as `Security` (the default setting).

2. Create two execute privileges: `ExecutePrivilegeA` and `ExecutePrivilegeB`. They represent the privilege to access `ApplicationA` and `ApplicationB` respectively. `ApplicationA` and `ApplicationB` are two HTTP servers that are created later in this procedure.

   Note: The new execute privileges created using the Admin Interface are stored in the `Security` database. The new roles and users created below are also stored in the `Security` database.

3. Create two new roles. These roles are used to organize users into groups and to facilitate granting access to users as a group.

   a. Create a new role. Name it `RoleA`.

   b. Scroll down to the Execute Privileges section and select `ExecutePrivilegeA`. This associates `ExecutePrivilegeA` with `RoleA`. Any user assigned `RoleA` is granted `ExecutePrivilegeA`.

   c. Repeat the steps for `RoleB`, selecting `ExecutePrivilegeB` instead.

4. Create two new HTTP servers:

   a. Create a new HTTP server. Name it `ApplicationA`.

   b. Select `DocumentsA` as the database. `ApplicationA` is now attached to `DocumentsA` which in turn uses `Security` as its security database.

   c. Select basic, digest or digest-basic authentication scheme.

   d. Select `ExecutePrivilegeA` in the privilege drop down menu. This indicates that `ExecutePrivilegeA` is required to access `ApplicationA`.

   e. Repeat the steps for `ApplicationB`, selecting `ExecutePrivilegeB` instead.

5. Create new users.

   a. Create a new user named `UserA1`.

b. Scroll down to the Roles section and select `RoleA`.

c. Repeat the steps for `UserB1`, selecting `RoleB` in the roles section.

`UserA1` is granted `ExecutePrivilegeA` by virtue of its role (`RoleA`) and has login access to `ApplicationA`. Because `ApplicationA` is connected to `DocumentsA`, `UserA1` is able to access documents in `DocumentsA` assuming no additional security requirements are implemented in `ApplicationA`, or added to documents in `DocumentsA`. The corresponding is true for `UserB1`.

The configuration process is now complete. Additional users can be created by simply repeating step 5 and selecting the appropriate role. All users assigned `RoleA` have login access to `ApplicationA` and all users assigned `RoleB` have login access to `ApplicationB`.

This approach can also be easily extended to handle additional discrete databases and user groups by creating additional document databases, roles and execute privileges as necessary.

9.0 Auditing

Auditing is the monitoring and recording of selected operational actions from both application users and administrative users. You can audit various kinds of actions related to document access and updates, configuration changes, administrative actions, code execution, and changes to access control. You can audit both successful and failed activities. This chapter contains the following parts:

- Why Is Auditing Used?
- MarkLogic Auditing
- Configuring Auditing
- Best Practices

For procedures on setting up auditing as well as a list of audit events, see Auditing Events in the *Administrator's Guide*.

9.1 Why Is Auditing Used?

You typically use auditing to perform the following activities:

- Enable accountability for actions. These might include actions taken on documents, changes to configuration settings, administrative actions, changes to the security database, or system-wide events.
- Deter users or potential intruders from inappropriate actions.
- Investigate suspicious activity.
- Notify an auditor of the actions of an unauthorized user.
- Detect problems with an authorization or access control implementation. For example, you can design audit policies that you expect to never generate an audit record because the data is protected in other ways. However, if these policies generate audit records, then you know the other security controls are not properly implemented.
- Address auditing requirements for regulatory compliance.

9.2 MarkLogic Auditing

MarkLogic Server includes an auditing capability. You can enable auditing to capture security-relevant events to monitor suspicious database activity or to satisfy applicable auditing requirements. You can configure the generation of audit events by including or excluding MarkLogic Server roles, users, or documents based on URI. Some actions that can be audited are the following:

- startup and shutdown of MarkLogic Server
- adding or removing roles from a user
- usage of amps
- starting and stopping the auditing system

For the complete list of auditable events and their descriptions, see Auditing Events in the *Administrator's Guide*.

9.3 Configuring Auditing

Auditing is configured at the MarkLogic Server cluster management group level. A MarkLogic Server group is a set of similarly configured hosts in a cluster, and includes configurations for the HTTP, WebDAV, ODBC, and XDBC App Servers in the group. The group auditing configuration includes enabling and disabling auditing for each cluster management group.

Audit records are stored on the local file system of the host on which the event is detected and on which the Server subsystem is running.

Rotation of the audit logs to different files is configurable by various intervals, and the number of audit files to keep is also configurable.

For more details and examples of audit event logs, see Auditing Events in the *Administrator's Guide*.

9.4 Best Practices

Auditing can be an effective method of enforcing strong internal controls enabling your application to meet any applicable regulatory compliance requirements. Appropriate auditing can help you to monitor business operations and detect activities that may deviate from company policy. If it is important to your security policy to monitor this type of activity, then you should consider enabling and configuring auditing on your system.

Be selective with auditing and ensure that it meets your business needs. As a general rule, design your auditing strategy to collect the amount and type of information that you need to meet your requirements, while ensuring a focus on events that cause the greatest security concerns.

If you enable auditing, develop a monitoring mechanism to use the audit event logs. Such a system might periodically archive and purge the audit event logs.

10.0 Designing Security Policies

This chapter describes the general steps to follow when using security in an application. Because of the flexibility of the MarkLogic Server security model, there are different ways to implement similar security policies. These steps are simple guidelines; the actual steps you take depends on the security policies you need to implement. The following sections are included:

10.1 Research Your Security Requirements

As a first step in planning your security policies, try to have answers for the following types of questions:

- What documents do you want to protect?
- What code do you want to control the execution of?
- Are there any natural categories you can define based on business function (for example, marketing, sales, engineering)?
- What is the level of risk posed by your users? Are your applications used only by trusted, internal people or are they open to a wider audience?
- How sensitive is the data you are protecting?

This list is not necessarily comprehensive, but is a good way to start thinking about your security policy.

10.2 Plan Roles and Privileges

Depending on your security requirements and the structure of your enterprise or organization, plan the roles and privileges that make the most sense.

1. Determine the level of granularity with which you need to protect objects in the database.
2. Determine how you want to group privileges together in roles.
3. Create needed URI and execute privileges.
4. Create roles.
5. Create users.
6. Assign users to roles.
7. Set default permissions for users, either indirectly through roles or directly through the users.

8. Protect code with `xdmp:security-assert` functions, where needed.

9. Load your documents with the appropriate permissions. If needed, change the permissions of existing documents using the `xdmp:document-add-permissions`, `xdmp:document-set-permissions`, and `xdmp:document-remove-permissions` functions.

10. Assign access privileges to HTTP, WebDAV, ODBC, and XDBC servers as needed.

11.0 Sample Security Scenarios

This chapter describes some common scenarios for defining security policies in your applications. The scenarios shown here are by no means exhaustive. There are many possibilities for how to set up security in your applications. The following sections are included:

11.1 Protecting the Execution of XQuery Modules

One simple way to restrict access to your MarkLogic Server application is to limit the users that have permission to run the application. If you load your Xquery code into a modules database, you can use an execute permission on the XQuery document itself to control who can run it. Then, a user must possess `execute` permissions to run the module. To set up a module to do this, perform the following steps:

1. Using the Admin Interface, specify a modules database in the configuration for the App Server (HTTP or WebDAV) that controls the execution of your XQuery module.

2. Load the XQuery module into the modules database, using a URI with an `.xqy` extension, for example `my_module.xqy`.

3. Set `execute` permissions on the XQuery document for a given role. For example, if you want users with the `run_application` role to be able to execute an XQuery module with the URI `http://modules/my_module.xqy`, run a query similar to the following:

```
xdmp:document-set-permissions("http://modules/my_module.xqy",
      xdmp:permission("run_application", "execute") )
```

4. Create the `run_application` role.

5. Assign the `run_application` role to the users who can run this application.

Now only users with the `run_application` role can execute this document.

> **Note:** Because your application could also contain amped functions, this technique can help restrict access to applications that use amps.

11.2 Choosing the Access Control for an Application

The role-based security model in MarkLogic Server combined with the supported authentication schemes provides numerous options for implementing application access control. This section describes common application access control alternatives:

- Open Access, No Log In
- Providing Uniform Access to All Authenticated Users
- Limiting Access to a Subset of Users
- Using Custom Login Pages
- Access Control Based on Client IP Address

For details on the different authentication schemes, see “Types of Authentication” on page 32.

11.2.1 Open Access, No Log In

This approach may be appropriate if security is not a concern for your MarkLogic Server implementation or if you are just getting started and want to explore the capabilities of MarkLogic Server before contemplating your security architecture. This scenario provides all of your users with the `admin` role.

You can turn off access control for each HTTP or WebDAV server individually by following these steps using the Admin Interface:

1. Go to the Configure tab for the HTTP server for which you want to turn off access control.
2. Scroll down to the authentication field and choose `application-level` for the authentication scheme.
3. Choose a user with the `admin` role for the default user. For example, you may choose the `admin` user you created when you installed MarkLogic.

   Note: To assist with identifying users with the `admin` role, the default user selection field places *(*`admin`*)* next to `admin` users.

In this scenario, all users accessing the application server are automatically logged in with a user that has the `admin` role. By default, the `admin` role has the privileges and permissions to perform any action and access any document in the server. Therefore, security is essentially turned off for the application. All users have full access to the application and database associated with the application server.

11.2.2 Providing Uniform Access to All Authenticated Users

This approach allows you to restrict application access to users in your security database, and gives those users full access to all application servers defined in MarkLogic Server. There are multiple ways to achieve the same objective but this is the simplest way.

1. In the Admin Interface, go to the Users tab under Security.

2. Give all users in the security database the `admin` role.

3. Go to the Configuration tab for all HTTP and WebDAV servers in the system.

4. Go to the authentication field and choose `digest`, `basic` or `digest-basic` authentication.

5. Leave the privilege field blank since it has no effect in this scenario. This field specifies the privilege that is needed to log into application server. However, the users are assigned the `admin` role and are treated as having all privileges.

In this scenario, all users must authenticate with a username and password. Once they are authenticated, however, they have full access to all functions and data in the server.

11.2.3 Limiting Access to a Subset of Users

This application access control method can be modified or extended to meet the requirements in many application scenarios. It uses more of the available security features and therefore requires a better understanding of the security model.

To limit application access to a subset of the users in the security database, perform the following steps using the Admin Interface:

1. Create an execute privilege named `exe-priv-app1` to represent the privilege to access the App Server.

2. Create a role named `role-app1` that has `exe-priv-app1` execute privilege.

3. Add `role-app1` to the roles of all users in the security database who should have access to this App Server.

4. In the Configuration page for this App Server, scroll down to the authentication field and select `digest`, `basic` or `digest-basic`. If you want to use application-level authentication to achieve the same objective, a custom login page is required. See the next section for details.

5. Select `exe-priv-app1` for the privilege field. Once this is done, only the users who have the `exe-priv-app1` by virtue of their role(s) are able to access this App Server.

   Note: If you want any user in the security database to be able to access the application, leave the privilege field blank.

At this point, the application access control is configured.

This method of authentication also needs to be accompanied by the appropriate security configuration for both users and documents associated with this App Server. For example, functions such as `xdmp:document-insert` and `xdmp:document-load` throw exceptions unless the user possesses the appropriate execute privileges. Also, users must have the appropriate default permissions (or specify the appropriate permissions with the API) when creating new documents in a database. Documents created by a user who does not have the `admin` role must be created with at least one update permission or else the transaction throws an `XDMP-MUSTHAVEUPDATE` exception. The update permission is required because otherwise once the documents are created no user (except users with the `admin` role) would be able to access them, including the user who created them.

11.2.4 Using Custom Login Pages

Digest and basic authentication use the browser's username and password prompt to obtain user credentials. The server then authenticates the credentials against the security database. There is no good way to create a custom login page using digest and basic authentication. To create custom login pages, you need to use application-level authentication.

To configure MarkLogic Server to use a custom login page for an App Server, perform the following steps using the Admin Interface:

1. Go to the Configuration tab for the HTTP App Server for which you want to create a custom login page.

2. Scroll down to the authentication field and select application-level.

3. Choose `nobody` as the default user. The `nobody` user is automatically created when MarkLogic Server is installed. It does not have an associated role and therefore has no privileges. The `nobody` user can only access pages and perform functions for which no privileges are required.

4. Create a custom login page that meets your needs. We refer to this page as `login.xqy`.

5. Make `login.xqy` the default page displayed by the application server. Do not require any privilege to access `login.xqy` (that is, do not place `xdmp:security-assert()` in the beginning of the code for `login.xqy`. This makes `login.xqy` accessible by `nobody`, the default user specified above, until the actual user logs in with his credentials.

   The `login.xqy` page likely contains a snippet of code as shown below:

```
...return
if xdmp:login($username, $password) then
  ... protected page goes here...
else
  ... redirect to login page or display error page...
```

The rest of this example assumes that all valid users can access all the pages and functions within the application.

Note: If you are using a modules database to store your code, the `login.xqy` file still needs to have an `execute` permission that allows the `nobody` (or whichever is the default) user to access the module. For example, you can put an `execute` permission paired with the `app-user` role on the `login.xqy` module document, and make sure the `nobody` user has the `app-user` role (which it does by default).

6. Create a role called `application-user-role`.

7. Create an execute privilege called `application-privilege`. Add this privilege to the `application-user-role`.

8. Add the `application-user-role` to all users who are allowed to access the application.

9. Add this snippet of code before the code that displays each of the pages in the application, except for `login.xqy`:

```
try
{
  xdmp:security-assert("application-privilege","execute")
}
catch($e)
{
  xdmp:redirect-response("login.xqy")
}
```

or

```
if(not(xdmp:has-privilege("application-privilege","execute")))
then
(
  xdmp:redirect-response("login.xqy")
)
else ()
```

This ensures that only a user who has the `application-privilege` by virtue of his role can access these protected pages.

Similar to the previous approach, this method of authentication requires the appropriate security configuration for users and documents. See “Introduction to Security” on page 6 for background on the security model.

11.2.5 Access Control Based on Client IP Address

MarkLogic Server supports deployments in which a user is automatically given access to the application based on the client IP address.

Consider a scenario in which a user is automatically logged in if he is accessing the application locally (as `local-user`) or from an approved subnet (as `site-user`). Otherwise, the user is asked to login explicitly. The steps below describe how to configure MarkLogic Server to achieve this access control.

1. Using the Admin Interface, configure the App Server to use a custom login page:

    a. Go to the Configuration tab for the HTTP or WebDAV App Server for which you want to create a custom login page.

    b. Scroll down to the authentication field and select application-level.

    c. For this example, choose `nobody` as the default user. The `nobody` user is automatically created when MarkLogic Server is installed. It does not have an associated role and hence has no privileges. The `nobody` user can only access pages and perform functions for which no privileges are required.

2. Add the following code snippet to the beginning of the default page displayed by the application, for example, `default.xqy`.

```
xquery version "1.0-ml"

declare namespace widget ="http://widget.com"
import module "http://widget.com" at "/login-routine.xqy"

let $login := widget:try-ip-login()
return
if($login) then
  <html>
    <body>
      The protected page goes here.
      You are {xdmp:get-current-user()}
    </body>
  </html>
else
  xdmp:redirect-response("login.xqy")
```

The `try-ip-login` function is defined in `login-routine.xqy`. It is used to determine if the user can be automatically logged in based on the client IP address. If the user cannot be logged in automatically, he is redirected to a login page called `login.xqy` where he has to log in explicitly. See “Using Custom Login Pages” on page 62 for example code for `login.xqy`.

3. Define `try-ip-login`:

    a. Create a file named `login-routine.xqy` and place the file in the `Modules` directory within the MarkLogic Server program directory. You create an amp for `try-ip-login` in `login-routine.xqy` in the next code sample. For security reasons, all amped

functions must be located in the specified `Modules` directory or in the `Modules` database for the App Server.

b. Add the following code to `login-routine.xqy`:

```
xquery version "1.0-ml"

module "http://widget.com"
declare namespace widget ="http://widget.com"

define function try-ip-login()as xs:boolean
{
  let $ip := xdmp:get-request-client-address()
  return
  if(compare($ip,"127.0.0.1") eq 0) then (:local host:)
    xdmp:login("localuser",())
  else if(starts-with($ip,<approved-subnet>)) then
    xdmp:login("site-user",())
  else
    false()
}
```

If the user is accessing the application from an approved IP address, `try-ip-login` logs in the user with username `local-user` or `site-user` as appropriate and returns `true`. Otherwise, `try-ip-login` returns `false`.

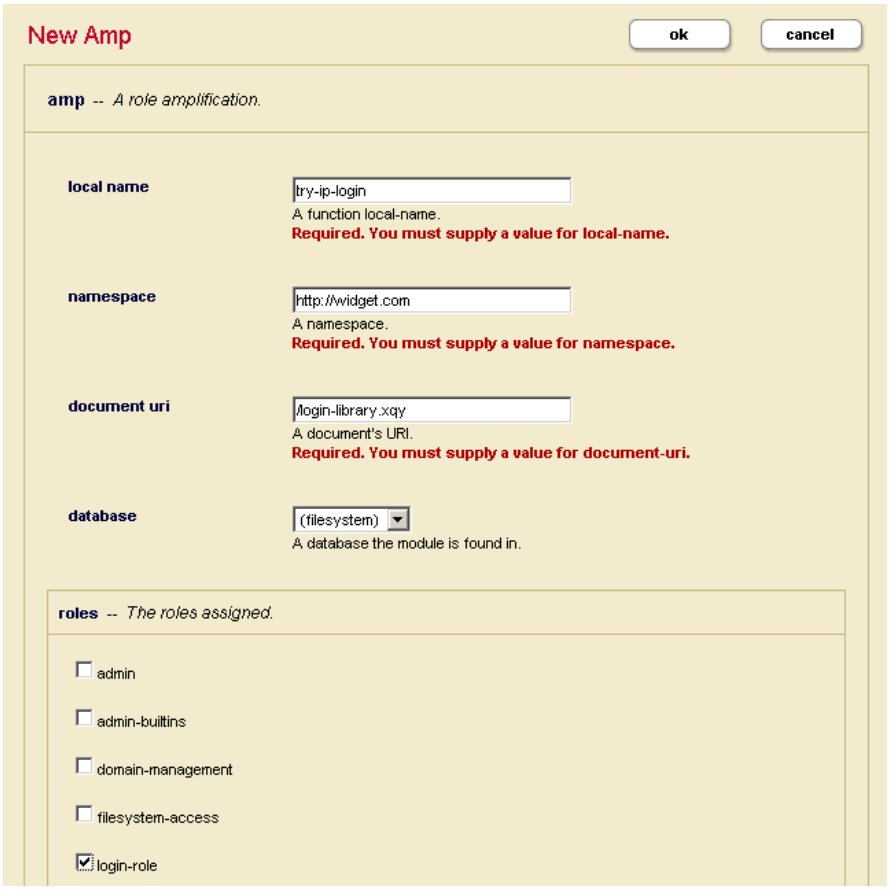
Note: In the code snippet above, the empty sequence () is supplied in place of the actual passwords for `local-user` and `site-user`. The pre-defined `xdmp-login` execute privilege grants the right to call `xdmp:login` without the actual password. This makes it possible to create deployments in which users can be automatically logged in without storing user passwords outside the system.

4. Finally, to ensure that the code snippet above is called with the requisite xdmp-login privilege, configure an amp for `try-ip-login`:

   a. Using the Admin Interface, create a role called `login-role`.

   b. Assign the pre-defined `xdmp-login` execute privilege to `login-role`. The `xdmp-login` privilege gives a user of the `login-role` the right to call `xdmp:login` for any user without supplying the password.

   c. Create an amp for `try-ip-login` as shown below:



An amp temporarily assigns additional role(s) to a user only for the execution of the specified function. The amp above gives any user who is executing `try-ip-login()` the `login-role` temporarily for the execution of the function.

In this example, `default.xqy` is executed as `nobody`, the default user for the application. When the `try-ip-login` function is called, the `nobody` user is temporarily amped to the `login-role`. The `nobody` user is temporarily assigned the `xdmp:login` execute privilege by virtue of the `login-role`. This enables `nobody` to call `xdmp:login` in `try-ip-login` for any user without the corresponding password. Once the login process is completed, the user can access the application with the permissions and privileges of `local-user` or `site-user` as appropriate.

5. The remainder of the example assumes that `local-user` and `site-user` can access all the pages and functions within the application.

   a. Create a role called `application-user-role`.

   b. Create an execute privilege called `application-privilege`. Add this privilege to the `application-user-role`.

   c. Add the `application-user-role` to `local-user` and `site-user`.

d. Add this snippet of code before the code that displays each of the subsequent pages in the application:

```
try
{
  xdmp:security-assert("application-privilege","execute")
  ...
}
catch($e)
{
  xdmp:redirect-response("login.xqy")
}
```

or

```
if(not(xdmp:has-privilege("application-privilege","execute")))
then
(
  xdmp:redirect-response("login.xqy")
)
else ()
```

This ensures that only the user who has the `application-privilege` by virtue of his role can access these protected pages.

11.3 Implementing Security for a Read-Only User

In this scenario, assume that you want to implement a security model that enables your users to run any XQuery code stored in the modules database for a specific App Server with read-only permissions on all documents in the database.

Reviewing the MarkLogic security model, recall that users do not have permissions, documents have permissions. And permissions are made up of a role paired with a capability. Additionally, execute privileges protect code execution and URI privileges protect the creation of documents in a specific URI namespace. This example shows one way to implement the read-only user and is devided into the following parts:

- Steps For Example Setup
- Troubleshooting Tips

11.3.1 Steps For Example Setup

To set up this example scenario, perform the following steps, using the Admin Interface:

1. Create a role named `ReadsStuff`.

2. Create a user named `ReadOnly` and grant this user the `ReadsStuff` role.

3. Create a role named `WritesStuff` and grant this role the `ReadsStuff` role.

4. Grant the `WritesStuff` role the `any-uri` privilege, as well as any execute privileges needed for your application code.

5. Create a user named `LoadsStuff` and grant this user the `WritesStuff` role. When you load documents, load them as the `LoadsStuff` user and give each document an update and insert permission for the `WritesStuff` role and a read permission for the `ReadsStuff` role.

   Here is sample code to create a set of permissions to do this as on option to either the `xdmp:document-insert` function or the `xdmp:document-load` function:

```
(xdmp:permission("ReadsStuff", "read"),
xdmp:permission("WritesStuff", "insert"),
xdmp:permission("WritesStuff", "update"))
```

An alternative to specifying the permissions when you load documents is to assign default permissions to the `LoadsStuff` user or the `WritesStuff` role.

11.3.2 Troubleshooting Tips

If you are running a URL rewriter (or an error handler), you need to give the `ReadsStuff` role to the `nobody` user or whichever user is the default user for your App Server. When the URL rewriter executes, the request has not yet been authenticated, so it runs as the default user. The default user is `nobody` unless you have specified a different default for your App Server. The best practice is to create another role, for example `my-app-user` and add an execute permission for the URL rewriter and your error handler (if any) for the `my-app-user` role. This is better because you do not want the `nobody` user to have access to your database.

12.0 Securing Your Production Deployment

A security system is only as good as its weakest link. This chapter describes some genral principles to think about with an eye toward hardening your entire environment for security, and contains the following sections:

- Add Password Protections
- Adhere to the Principle of Least Privilege
- Infrastructure Hardening
- Implement Auditing
- Develop and Enforce Application Security
- Use MarkLogic Security Features
- Read About Security Issues

12.1 Add Password Protections

When your data and business requirements warrant it, design and implement password protections. These protections can range from providing guidelines to your users to implementing programmatic checking to enforce password complexity and management.

Complexity verification verifies that each password is complex enough to provide reasonable protection against intruders who try to break into the system by guessing passwords. This encourages users to create strong passwords.

Password managment includes things such as password aging and expiration, automatically locking users out of the application after failed login attempts, and controlling the reuse of old passwords.

To enforce password complexity programmatically, use the password plugins. For more information about the plugin framework and to view a sample password plugin, see System Plugin Framework and Password Plugin Sample in the *Application Developer's Guide*.]

12.2 Adhere to the Principle of Least Privilege

Grant necessary privileges only. Do not provide users or roles more privileges than are necessary. If possible, grant privileges to roles, not individual users. The principle of least privilege is that users are given only those privileges that are actually required to efficiently perform their jobs.

Restrict the following as much as possible:

- The number of users granted the `admin` or `security` roles.
- The number of roles or users who are allowed to make changes to security objects, such as roles, users, and document permissions.

- The number of roles that have capabilities to add, change or remove security-related privileges.

12.3 Infrastructure Hardening

Most computer platforms offer network security features to limit outside access to the system. The purpose of infrastructure hardening is to eliminate as many security risks as possible. It can involve both hardware and software, as well as physical restrictions. The following are some infrastructure hardening topics:

- OS-Level Restrictions
- Network Security
- Port Management
- Physical Access

12.3.1 OS-Level Restrictions

The United States National Security Agency develops and distributes security configuration guidance for a wide variety of software, including the most common operating system platforms. You can view this guidance on their website at:
http://www.nsa.gov/ia/mitigation_guidance/security_configuration_guides/operating_systems.shtml.

12.3.2 Network Security

Encrypt network traffic between the browser and MarkLogic Server by enabling SSL. You can also enable SSL for intra-cluster communication. For high security needs, make sure MarkLogic Server runs in FIPS mode (which is the default mode). This option restricts your SSL ciphers to those that have met the FIPS 140-2 Level 1 validation requirements. For information on how to configure SSL and FIPS mode, see Clusters in the *Administrator's Guide*.

12.3.3 Port Management

Protect access to MarkLogic's Admin Interface and development tool ports:8000, 8001, 8002 behind a corporate firewall. While your MarkLogic application may run on a publicly available port, such as port 80, it is good practice to secure the MarkLogic Admin Interface and other development application ports behind a firewall.

12.3.4 Physical Access

Ensure that machines running MarkLogic Server are in a physically secure location. Physical access to a server is a high security risk. Physical access to a server by an unauthorized user could result in unauthorized access or modification, as well as installation of hardware or software designed to circumvent security. To maintain a secure environment, you should restrict physical access to your MarkLogic Server host computers.

12.4 Implement Auditing

MarkLogic includes an auditing capability. Designing and implementing an auditing policy can be an important part of your overall security planning. For more details, see Auditing in this guide. For procedures related to enabling auditng, see Auditing Events in the *Administrator's Guide*.

12.5 Develop and Enforce Application Security

An important step in creating a MarkLogic application is to ensure that it is properly secure. Network security mostly ignores the contents of HTTP traffic, therefore you can't use network layer protection (firewall, SSL, IDS, hardening) to stop or detect application layer attacks. The Open Web Application Security Project is an open group focused on understanding and improving the security of web applications and web services. You can visit their site at: http://www.owasp.org/. The OWASP Top Ten Project is one starting point for understanding how you can build good security into your application.

12.6 Use MarkLogic Security Features

Let collections and document permissions restrict the data access for the user. Do not write your own access restriction code. Write code so that it uses the MarkLogic Server security model and operates on the correct data based on the user's permissions and the current documents in use.

12.7 Read About Security Issues

Many excellent resources exist on the Internet. These sources contain valuable security-related information for everyone in the enterprise software development and deployment chain from software developers and system administrators to managers. For example, the Defense Information Systems Agency (DISA) sponsors the Information Assurance Support Environment website found at http://iase.disa.mil/index2.html. This site contains Security Technical Implementation Guides (STIGs). The STIGs contain technical guidance to "lock down" information systems and software that might otherwise be vulnerable to a malicious computer attack.

Another example is the CERT Program, a part of the Software Engineering Institute, a federally funded research and development center operated by Carnegie Mellon University. This organization is devoted to ensuring that appropriate technology and systems management practices are used to resist attacks on networked systems and to limit damage and ensure continuity of critical services in spite of successful attacks, accidents, or failures. For more detailed information about CERT visit their website: http://www.cert.org/.

13.0 Technical Support

MarkLogic provides technical support according to the terms detailed in your Software License Agreement or End User License Agreement.

We invite you to visit our support website at http://help.marklogic.com to access information on known and fixed issues, knowledge base articles, and more. For licensed customers with an active maintenance contract, see the Support Handbook for instructions on registering support contacts and on working with the MarkLogic Technical Support team.

Complete product documentation, the latest product release downloads, and other useful information is available for all developers at http://developer.marklogic.com. For general questions, join the general discussion mailing list, open to all MarkLogic developers.

14.0 Copyright

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