

DevOps



Caltech

**Center for Technology &
Management Education**

Post Graduate Program in DevOps

DevOps



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CI/CD Pipeline with Jenkins

Exploring Jenkins

Learning Objectives

By the end of this lesson, you will be able to:

- Describe Graphical User Interface (GUI) of Jenkins
- Discuss system and Global Tool Configuration for Jenkins
- Discuss how to manage nodes, credentials, users, and plugins
- Describe how to access the global security configuration
- Enumerate the differences between Freestyle and Pipeline Jenkins Jobs
- Present an overview of Job Import plugin



Exploring Jenkins GUI

Introduction to Jenkins Interface

Jenkins is a web-based portal used by developers to configure Continuous Integration and Continuous Deployment.

Has its own graphical user interface but only admins can customize Jenkins appearance with custom themes



Supports plugins which can be used to change the overall appearance of Jenkins interface

Introduction to Jenkins Interface

Here are some of the links that can be referred to for a clear understanding of available themes in Jenkins:

1

<https://plugins.jenkins.io/simple-theme-plugin/>

2

<https://plugins.jenkins.io/login-theme/>

3

<https://tobix.github.io/jenkins-neo2-theme/>

Introduction to Jenkins Interface

The various sections available in the Jenkins interface dashboard are shown below:

The screenshot shows the Jenkins dashboard interface. The top navigation bar includes the Jenkins logo, a search bar, a help icon, a notification badge with '1', the user name 'Jenkins', and a 'log out' button. The left sidebar contains a 'Dashboard' menu and several links: 'New Item', 'People', 'Build History', 'Manage Jenkins', 'My Views', 'Lockable Resources', and 'New View'. The main content area displays a 'Welcome' message, a 'Start building your software project' section with links for 'Create a job', 'Set up a distributed build' (which includes 'Set up an agent' and 'Configure a cloud'), and 'Learn more about distributed builds'. The 'Build Queue' section shows 'No builds in the queue.' The 'Build Executor Status' section lists two idle build executors.

Jenkins Configuration Section

Search Job Section

User Details Section

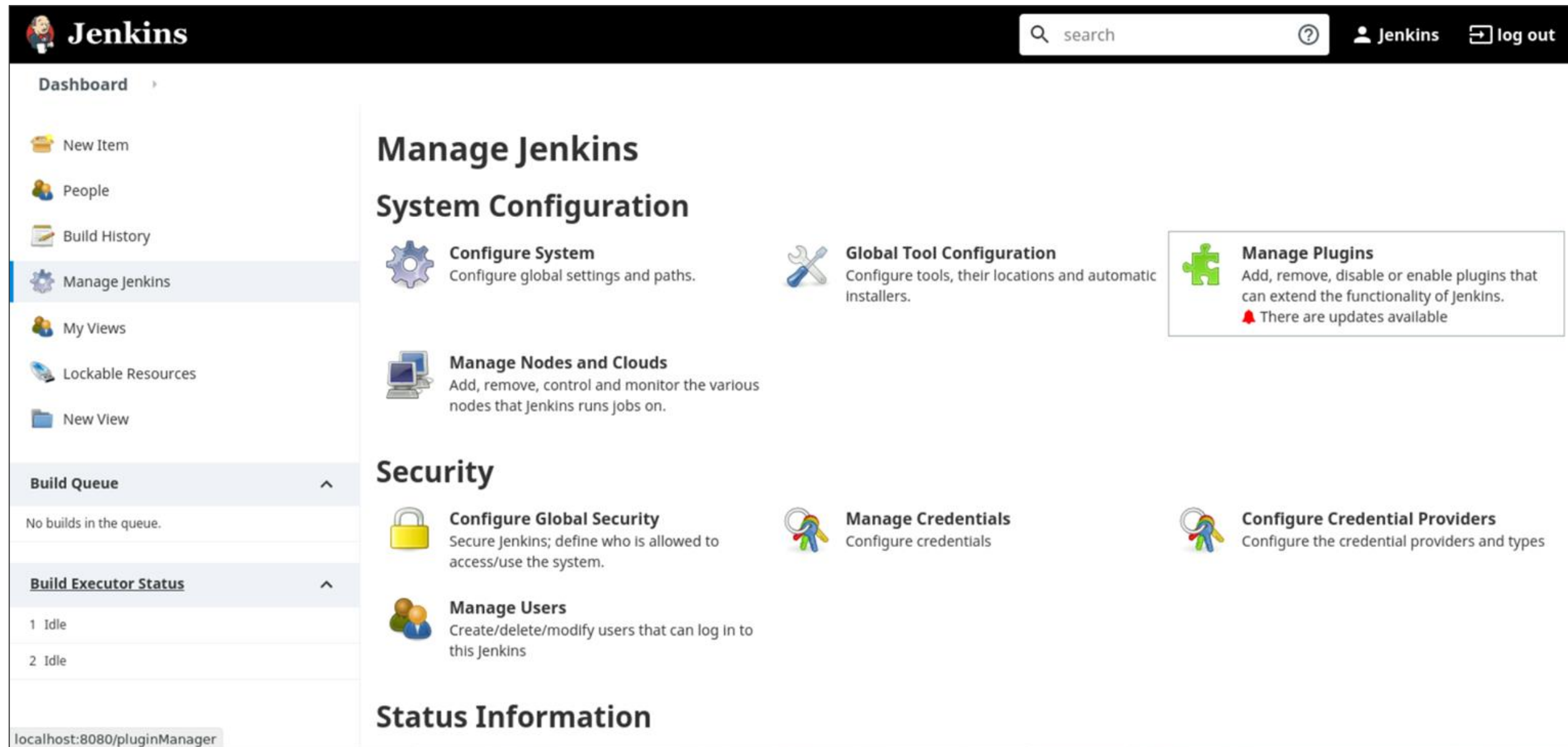
Jenkins Job Build Queue Section

Build Agents Section

Job Management Section

Manage Jenkins

Jenkins can be managed using the **Manage Jenkins** page where admins can modify and extend Jenkins.



The screenshot displays the Jenkins web interface, specifically the 'Manage Jenkins' page. The top navigation bar includes the Jenkins logo, a search bar, and links for 'Jenkins' and 'log out'. The left sidebar contains a 'Dashboard' menu with options like 'New Item', 'People', 'Build History', 'Manage Jenkins' (which is highlighted), 'My Views', 'Lockable Resources', and 'New View'. Below this, there are sections for 'Build Queue' (showing 'No builds in the queue.') and 'Build Executor Status' (showing two 'Idle' executors). The main content area is titled 'Manage Jenkins' and is divided into two main sections: 'System Configuration' and 'Security'. Under 'System Configuration', there are three options: 'Configure System' (with a gear icon), 'Global Tool Configuration' (with a wrench icon), and 'Manage Plugins' (with a puzzle piece icon and a red bell icon indicating updates). Under 'Security', there are three options: 'Configure Global Security' (with a padlock icon), 'Manage Credentials' (with a key icon), and 'Configure Credential Providers' (with a key icon). At the bottom left of the main content area, there is a 'Status Information' section. The URL 'localhost:8080/pluginManager' is visible at the bottom left of the page.

Jenkins search ? Jenkins log out

Dashboard

- New Item
- People
- Build History
- Manage Jenkins**
- My Views
- Lockable Resources
- New View

Build Queue ^

No builds in the queue.




Build Executor Status ^

- 1 Idle
- 2 Idle




localhost:8080/pluginManager

Manage Jenkins

System Configuration

-  **Configure System**
Configure global settings and paths.
-  **Global Tool Configuration**
Configure tools, their locations and automatic installers.
-  **Manage Plugins**
Add, remove, disable or enable plugins that can extend the functionality of Jenkins.
🔔 There are updates available

Security

-  **Configure Global Security**
Secure Jenkins; define who is allowed to access/use the system.
-  **Manage Credentials**
Configure credentials
-  **Configure Credential Providers**
Configure the credential providers and types

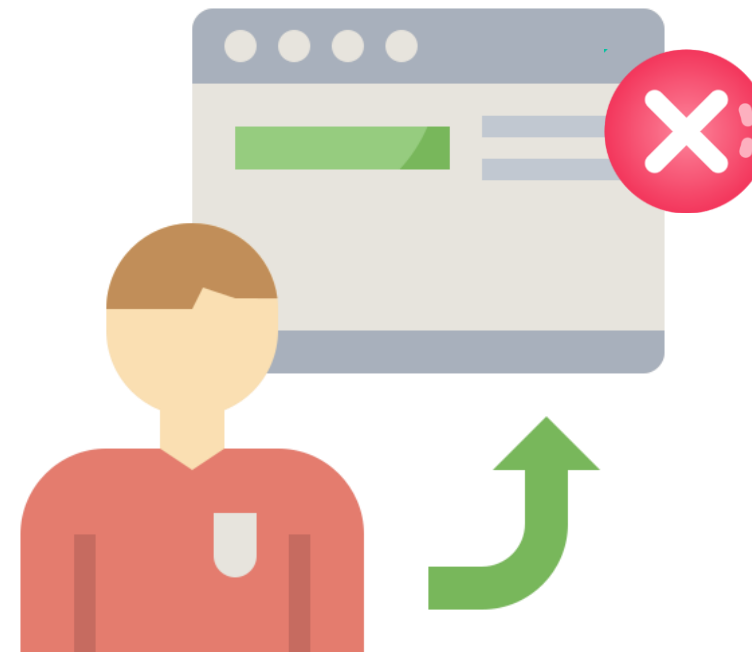
Status Information

Manage Jenkins

Manage Jenkins page can be accessed by:



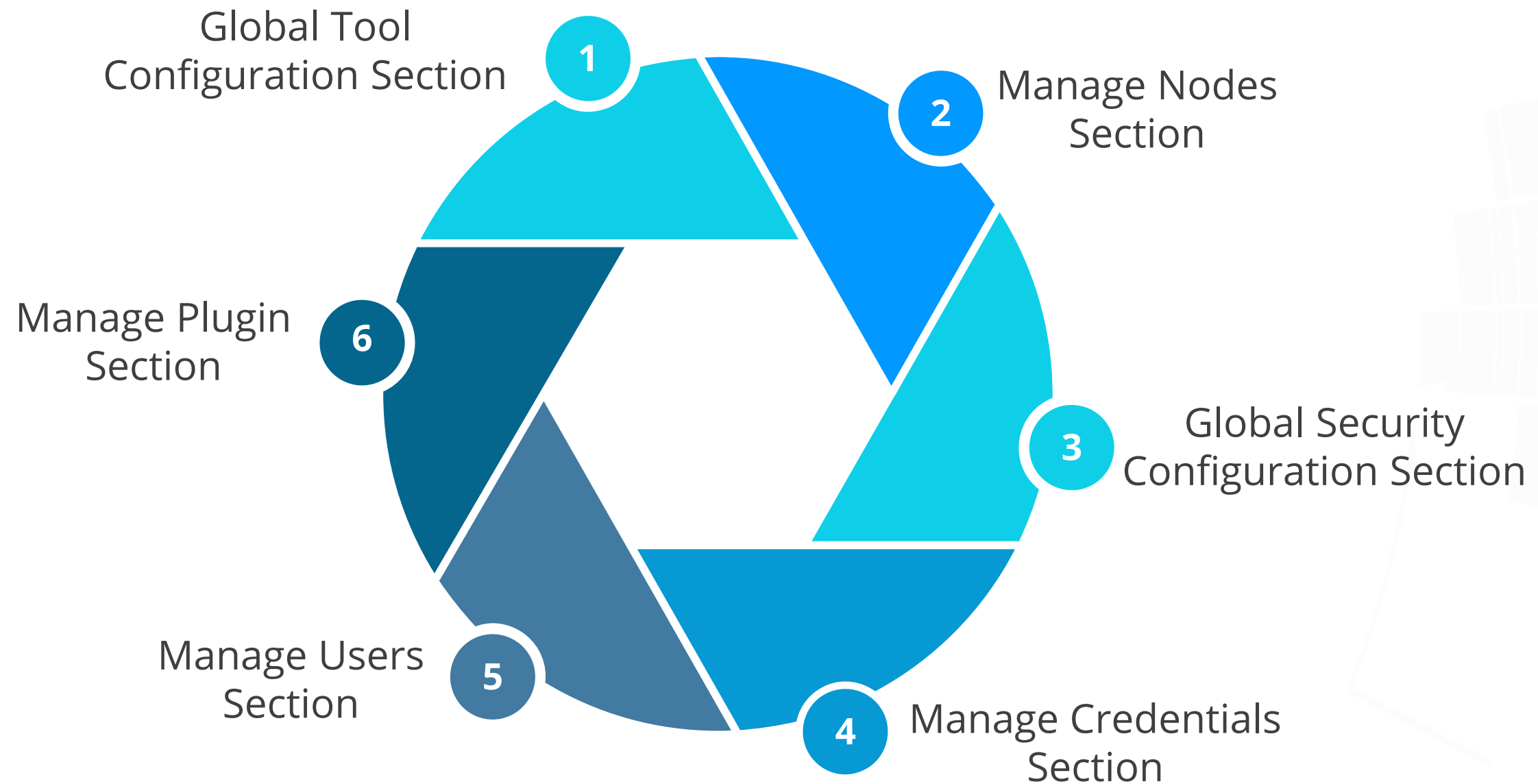
Administrators



Developers

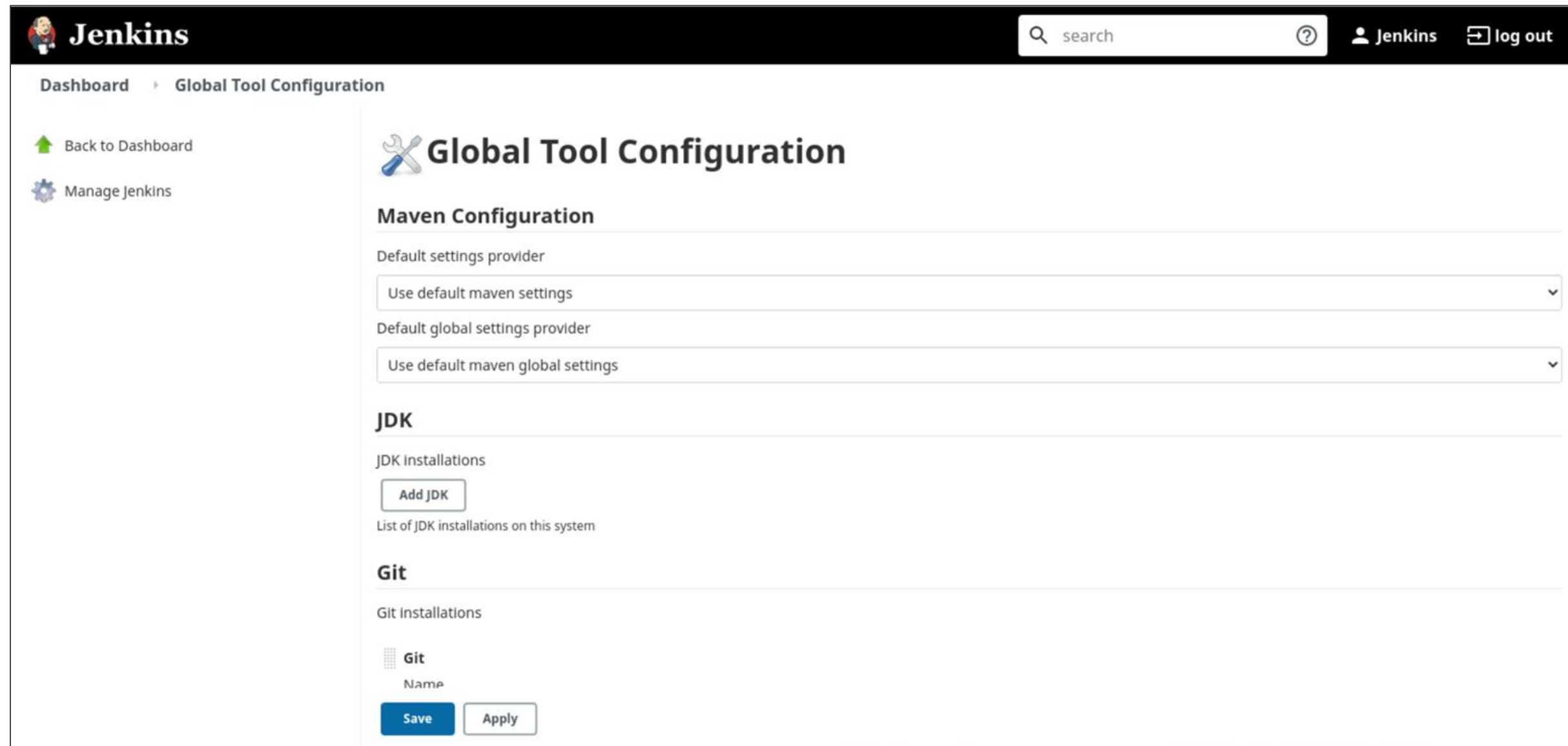
Manage Jenkins

The sections provided by Jenkins are:



Global Tool Configuration

The **Global Tool Configuration** section in Jenkins is used to manage Build tool installations on Jenkins Master or Slave machines while execution.



The screenshot shows the Jenkins web interface. At the top is a black navigation bar with the Jenkins logo, a search bar, and links for 'Jenkins' and 'log out'. Below the navigation bar, the breadcrumb 'Dashboard > Global Tool Configuration' is visible. On the left sidebar, there are links for 'Back to Dashboard' and 'Manage Jenkins'. The main content area is titled 'Global Tool Configuration' with a wrench icon. It contains three sections: 'Maven Configuration' with dropdowns for 'Default settings provider' and 'Default global settings provider', both set to 'Use default maven settings'; 'JDK' with an 'Add JDK' button and a list of installations; and 'Git' with a 'Git' button and a 'Name' field. At the bottom of the Git section are 'Save' and 'Apply' buttons.

Jenkins search ? Jenkins log out

Dashboard > Global Tool Configuration

Back to Dashboard

Manage Jenkins

Global Tool Configuration

Maven Configuration

Default settings provider

Use default maven settings

Default global settings provider

Use default maven global settings

JDK

JDK Installations

Add JDK

List of JDK installations on this system

Git

Git Installations

Git

Name

Save Apply

Global Tool Configuration



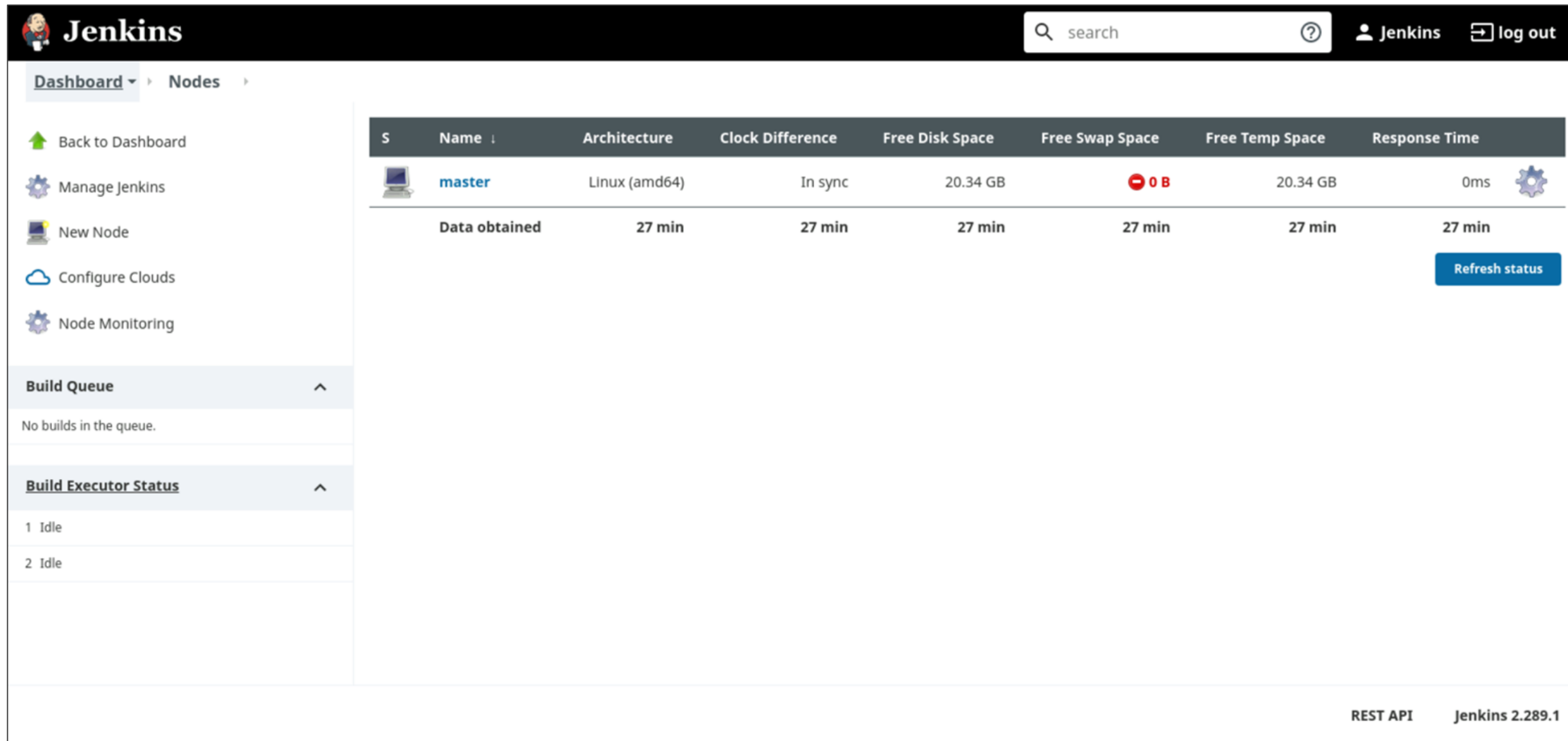
Developers are not required to perform installation of Build tools manually.



Developers can perform both installation and upgrades for Build tools only by using Jenkins Master and Slave machines.

Manage Nodes

Distributed Build is one of the important features of Jenkins. It provides mechanisms to run Builds across multiple node machines.



The screenshot shows the Jenkins web interface. At the top, there's a navigation bar with the Jenkins logo, a search bar, and user information (Jenkins, log out). Below the navigation bar, the left sidebar contains links: Dashboard (selected), Nodes, Back to Dashboard, Manage Jenkins, New Node, Configure Clouds, and Node Monitoring. The main content area displays the 'Nodes' page. It features a table with columns: S, Name, Architecture, Clock Difference, Free Disk Space, Free Swap Space, Free Temp Space, and Response Time. The table lists one node, 'master', which is a Linux (amd64) machine. The 'Free Swap Space' column shows a red minus sign and '0 B'. Below the table, there's a 'Refresh status' button. The bottom of the page shows 'REST API' and 'Jenkins 2.289.1'.

S	Name	Architecture	Clock Difference	Free Disk Space	Free Swap Space	Free Temp Space	Response Time
	master	Linux (amd64)	In sync	20.34 GB	0 B	20.34 GB	0ms
Data obtained		27 min	27 min	27 min	27 min	27 min	27 min

Refresh status

REST API Jenkins 2.289.1

Manage Nodes

By default, Jenkins has only a single Master Node, which executes all Jenkins jobs. It supports multiple Slave machines.

Slave Machines

Slave Machines can be added to build and run heavy projects.

Master Node

The Master Node distributes load across multiple slave machines so that if one slave machine is down, another machine executes the build.

Global Security Configuration

Jenkins supports global security feature, which helps to make existing Jenkins more secure.

Authorization and Authentication

Ensures access is restricted to limited users only

Roles and Permissions

Provides roles and permissions for individual users to restrict global access

Custom Permissions

Assigns custom permissions to different users in the Jenkins application for security

Global Security Configuration

There are two important settings in Jenkins to manage security:

Security Realm (Authentication):

Helps select authentication source which will be used by Jenkins to authenticate users

Security Realm

- ☐ Delegate to servlet container
- ☒ Jenkins' own user database
 - ☐ Allow users to sign up
- ☐ LDAP
- ☐ Unix user/group database
- ☐ None

Global Security Configuration

Authorization

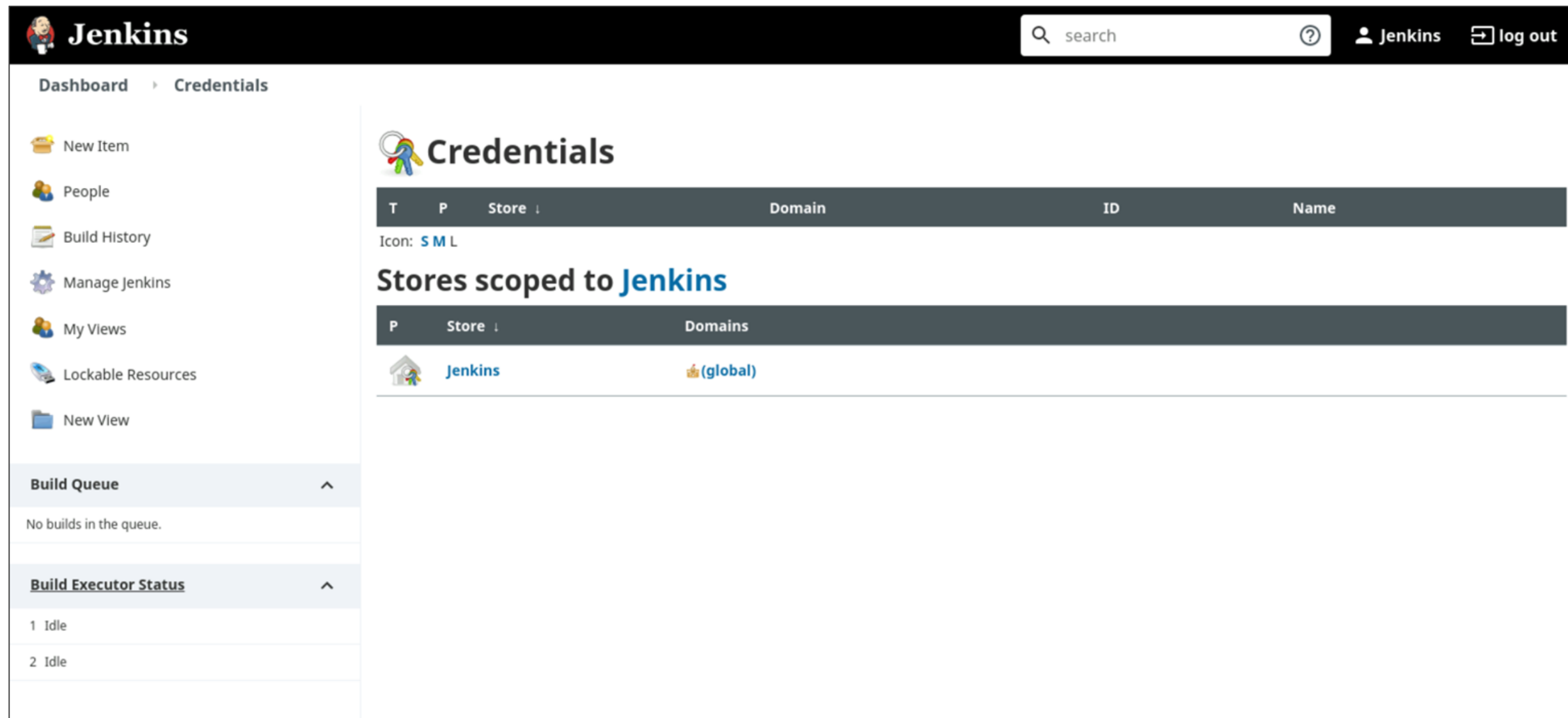
Assigns roles to individual users without giving similar admin access to every user

Authorization

- ☐ Anyone can do anything
- ☐ Legacy mode
- ☒ Logged-in users can do anything
 - ☐ Allow anonymous read access
- ☐ Matrix-based security
- ☐ Project-based Matrix Authorization Strategy

Manage Credentials

While automating CI/CD pipelines, Jenkins performs various kinds of integrations with third-party applications and software.



The screenshot shows the Jenkins web interface. At the top is a black navigation bar with the Jenkins logo, a search bar, and user information. Below this is a sidebar with navigation links. The main content area is titled 'Credentials' and shows a table of stores scoped to Jenkins. The table has columns for Type (T), Priority (P), Store, Domain, ID, and Name. Below the table, there is a section for 'Stores scoped to Jenkins' with a table showing the 'Jenkins' store and its domain '(global)'.

Jenkins

search ? Jenkins log out

Dashboard > Credentials

New Item
People
Build History
Manage Jenkins
My Views
Lockable Resources
New View

Credentials

T	P	Store	Domain	ID	Name
---	---	-------	--------	----	------

Icon: S M L

Stores scoped to Jenkins

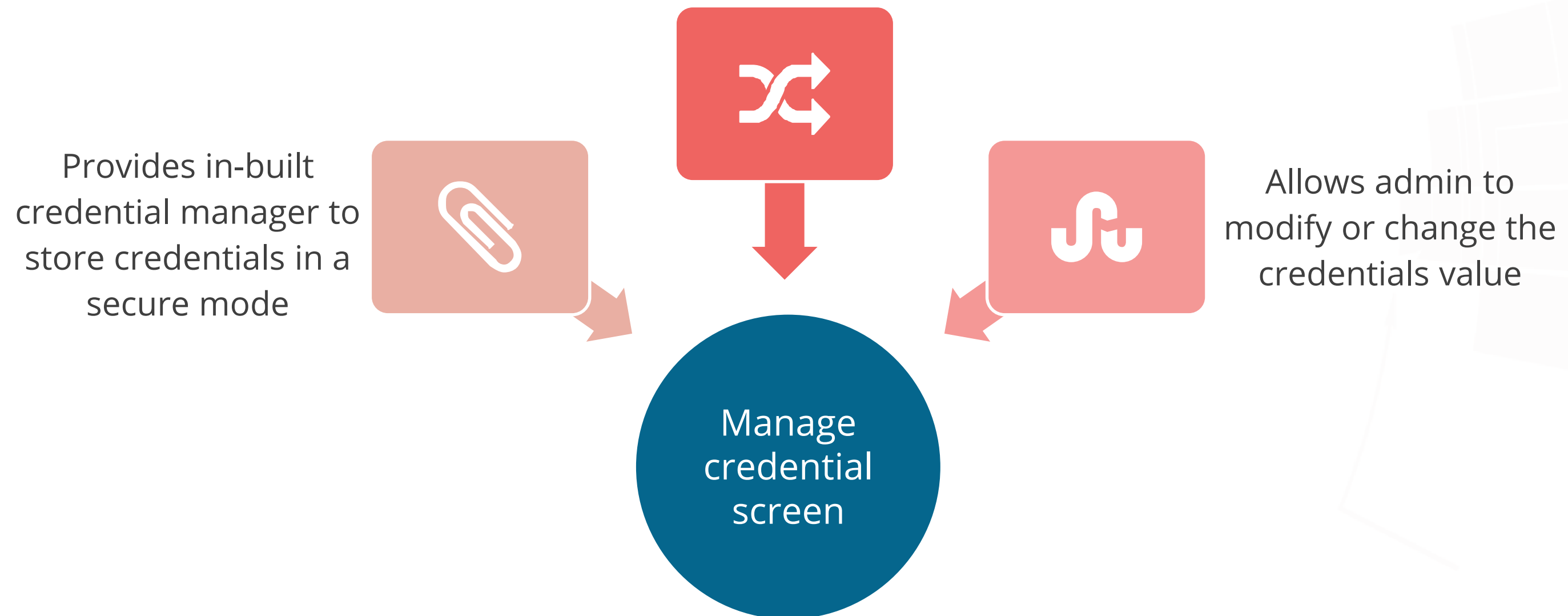
P	Store	Domains
	Jenkins	(global)

Build Queue ^
No builds in the queue.

Build Executor Status ^
1 Idle
2 Idle

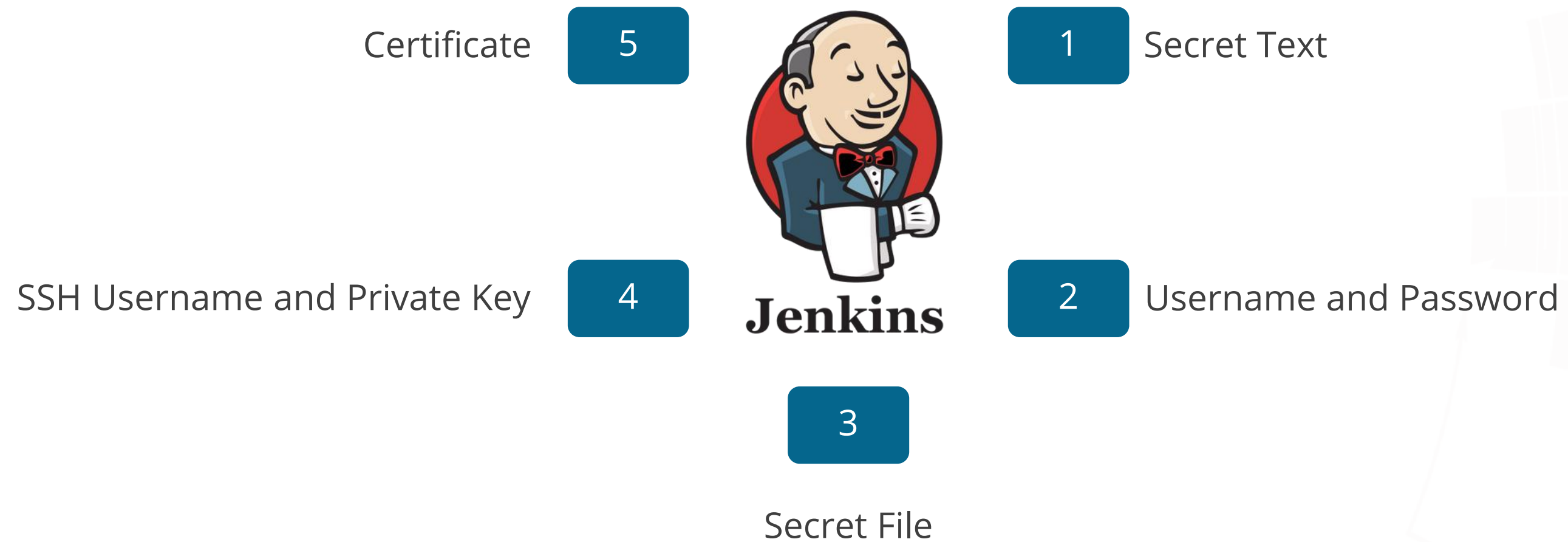
Manage Credentials

Stores the credentials across Jenkins for a specific project or Pipeline Job or folder



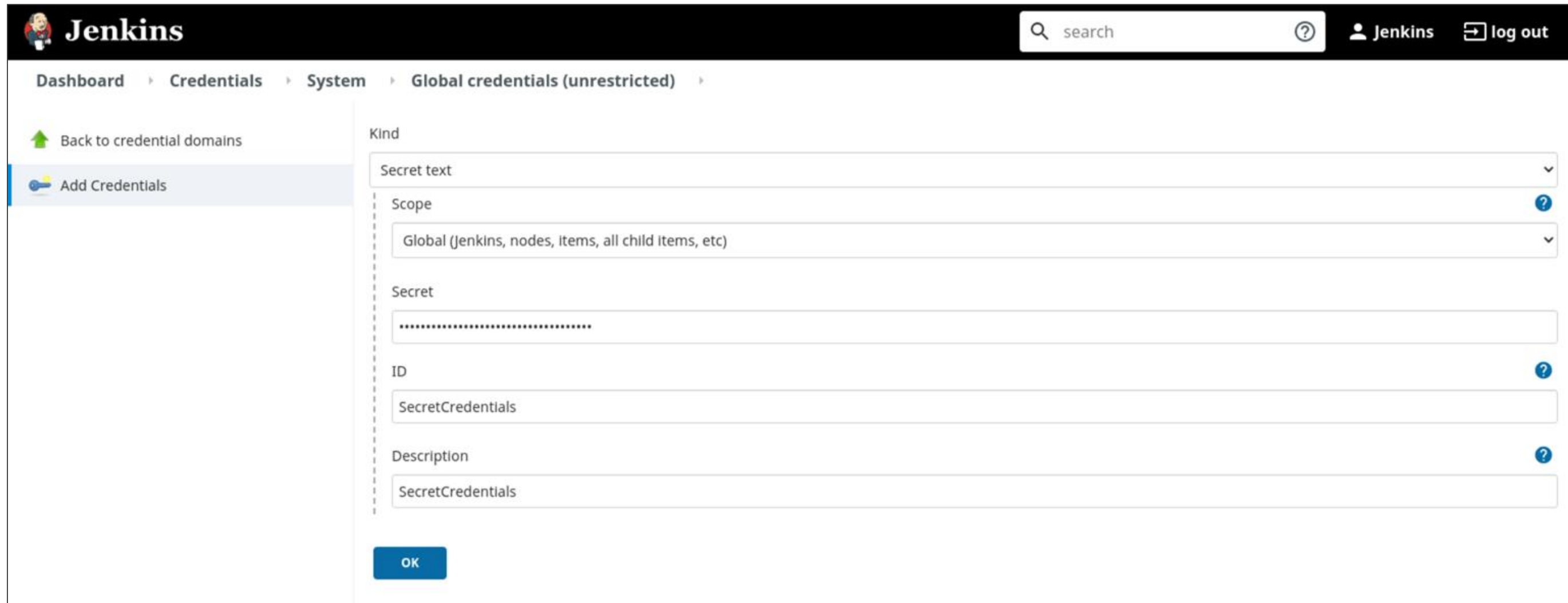
Manage Credentials

Jenkins supports storing of the following types of credentials:



Manage Credentials

This is a screenshot of the **Secret Text** credential type in Jenkins, which allows users to enter the secret text.



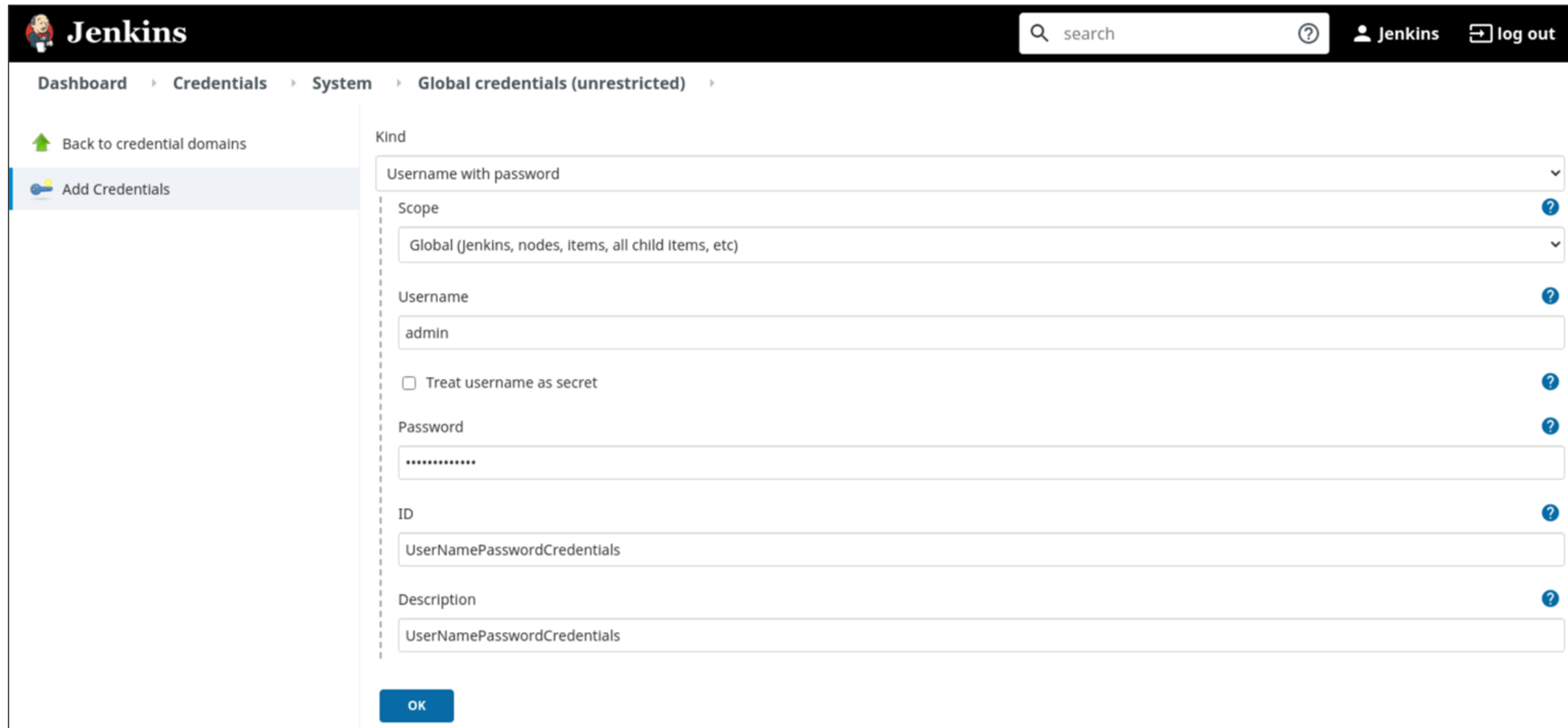
The screenshot shows the Jenkins web interface for adding a new credential. The top navigation bar includes the Jenkins logo, a search bar, and links for 'Jenkins' and 'log out'. The breadcrumb trail indicates the path: Dashboard > Credentials > System > Global credentials (unrestricted). On the left sidebar, there are links for 'Back to credential domains' and 'Add Credentials'. The main form area is titled 'Kind' and contains the following fields:

- Kind:** A dropdown menu set to 'Secret text'.
- Scope:** A dropdown menu set to 'Global (Jenkins, nodes, items, all child items, etc)'.
- Secret:** A text input field containing a series of dots to represent masked text.
- ID:** A text input field containing the value 'SecretCredentials'.
- Description:** A text input field containing the value 'SecretCredentials'.

Each of the last three fields (Secret, ID, and Description) has a blue question mark icon to its right. At the bottom of the form is a blue 'OK' button.

Manage Credentials

This is a screenshot of the **Username and Password** credential type in Jenkins, which allows users to set the username and password.



The screenshot shows the Jenkins web interface for adding a new credential. The breadcrumb trail is: Dashboard > Credentials > System > Global credentials (unrestricted). The left sidebar has a 'Back to credential domains' link and an 'Add Credentials' button. The main form is titled 'Kind' and shows 'Username with password' selected. Below this, the 'Scope' is set to 'Global (Jenkins, nodes, items, all child items, etc)'. The 'Username' field contains 'admin'. There is an unchecked checkbox for 'Treat username as secret'. The 'Password' field is masked with dots. The 'ID' field contains 'UserNamePasswordCredentials'. The 'Description' field also contains 'UserNamePasswordCredentials'. There are blue question mark icons next to the Scope, Username, Treat username as secret, Password, ID, and Description fields. An 'OK' button is at the bottom.

Jenkins

search ? Jenkins log out

Dashboard > Credentials > System > Global credentials (unrestricted)

Back to credential domains

Add Credentials

Kind

Username with password

Scope

Global (Jenkins, nodes, items, all child items, etc)

Username

admin

☐ Treat username as secret

Password

.....

ID

UserNamePasswordCredentials

Description

UserNamePasswordCredentials

OK

Manage Credentials

This is a screenshot of the **Secret File** credential type in Jenkins, which allows the users to create a secret file.

The screenshot shows the Jenkins web interface. At the top, the Jenkins logo is on the left, and a search bar, user profile (Jenkins), and log out button are on the right. Below the header, a breadcrumb trail reads: Dashboard > Credentials > System > Global credentials (unrestricted). On the left sidebar, there is a link 'Back to credential domains' and a highlighted 'Add Credentials' button. The main content area is the 'Add Credentials' form for the 'Secret File' type. The form has the following fields: 'Kind' (a dropdown menu set to 'Secret file'), 'Scope' (a dropdown menu set to 'Global (Jenkins, nodes, items, all child items, etc)'), 'File' (a section containing a 'Choose File' button and the text 'No file chosen'), 'ID' (a text input field containing 'SecretFileCredentials'), and 'Description' (a text input field containing 'SecretFileCredentials'). Each of the last three fields has a blue question mark icon to its right. At the bottom of the form is a blue 'OK' button.

Manage Credentials

This is a screenshot of the **SSH Username and Private Key** credential type in Jenkins, which allows users to access files with private key.

The screenshot shows the Jenkins 'Add Credentials' form for the 'SSH Username with private key' type. The breadcrumb trail at the top is 'Dashboard > Credentials > System > Global credentials (unrestricted)'. On the left sidebar, there is a 'Back to credential domains' link and an 'Add Credentials' button. The main form area contains the following fields:

- Kind:** A dropdown menu set to 'SSH Username with private key'.
- Scope:** A dropdown menu set to 'Global (Jenkins, nodes, items, all child items, etc)'.
- ID:** A text input field containing 'SSHCredentials'.
- Description:** A text input field containing 'SSHCredentials'.
- Username:** A text input field containing 'root'.
- Treat username as secret:** An unchecked checkbox.
- Private Key:** A section with two radio buttons: 'Enter directly' (selected) and 'Passphrase'.
- Passphrase:** A text input field.

At the bottom left of the form is a blue 'OK' button. Each field has a blue question mark icon to its right for help.

Manage Credentials

This is a screenshot of the **Certificate** credential type in Jenkins, which allows users to upload the security certificate.

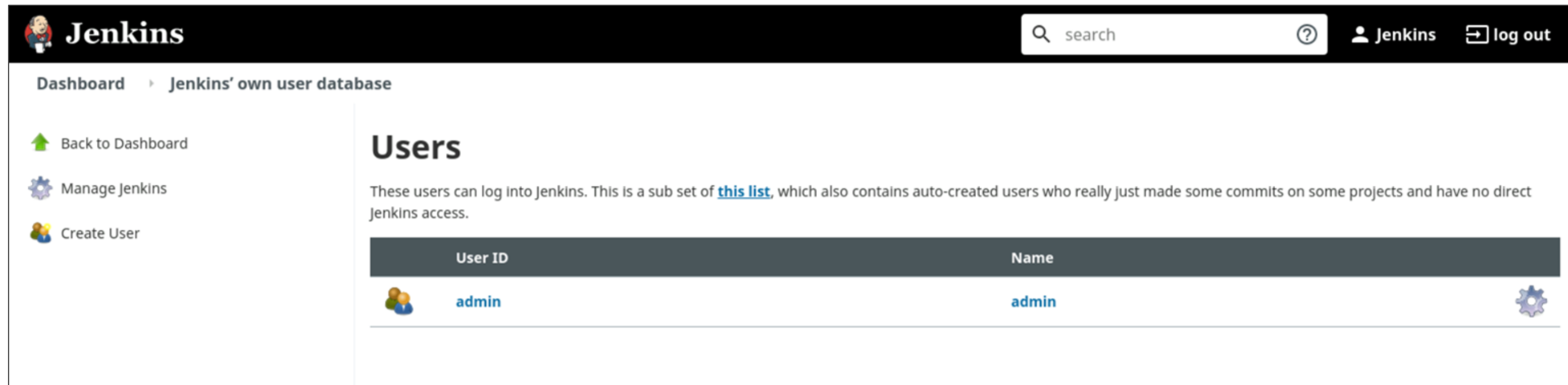
The screenshot shows the Jenkins web interface for adding a new credential. The breadcrumb trail is: Dashboard > Credentials > System > Global credentials (unrestricted). The left sidebar has a 'Back to credential domains' link and an 'Add Credentials' button. The main form is titled 'Kind' and contains the following fields:

- Kind:** A dropdown menu with 'Certificate' selected.
- Scope:** A dropdown menu with 'Global (Jenkins, nodes, items, all child items, etc)' selected.
- Certificate:** A section with a radio button for 'Upload PKCS#12 certificate'.
- Password:** A text input field with a lock icon and the text 'Concealed', followed by a 'Change Password' button.
- ID:** A text input field containing 'CertificateCredentials'.
- Description:** A text input field containing 'CertificateCredentials'.



An 'OK' button is located at the bottom of the form.

Manage Users

Jenkins allows admin to create different users. Multiple users can access Jenkins Web application.

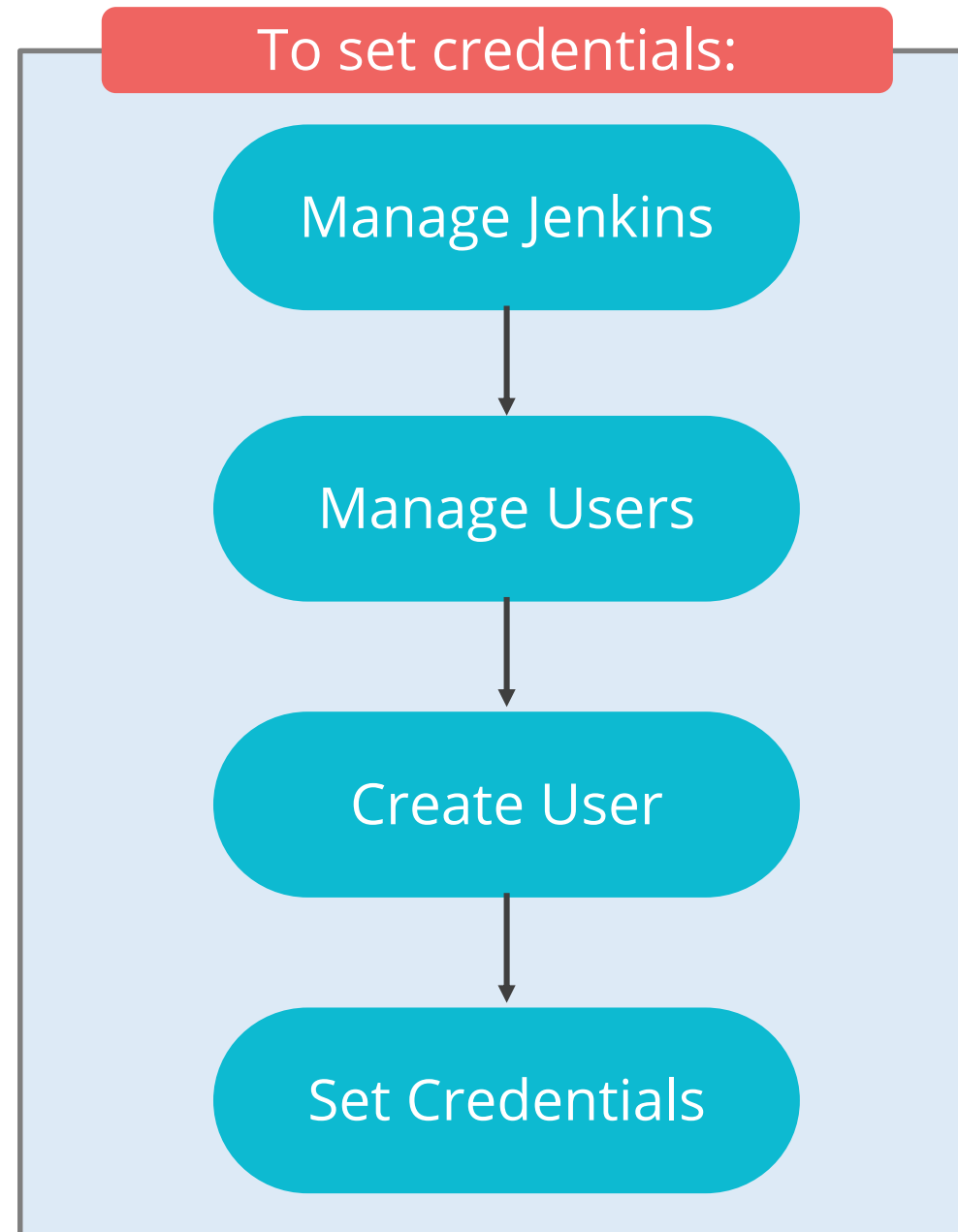


The screenshot displays the Jenkins web interface for managing users. The top navigation bar includes the Jenkins logo, a search bar, and links for 'Jenkins' and 'log out'. The breadcrumb trail shows 'Dashboard' > 'Jenkins' own user database'. The left sidebar contains links for 'Back to Dashboard', 'Manage Jenkins', and 'Create User'. The main content area is titled 'Users' and includes a descriptive paragraph: 'These users can log into Jenkins. This is a sub set of [this list](#), which also contains auto-created users who really just made some commits on some projects and have no direct Jenkins access.' Below this is a table with two columns: 'User ID' and 'Name'. The table contains one entry for the 'admin' user, with a gear icon for configuration on the right.

User ID	Name
 admin	admin 

Manage Users

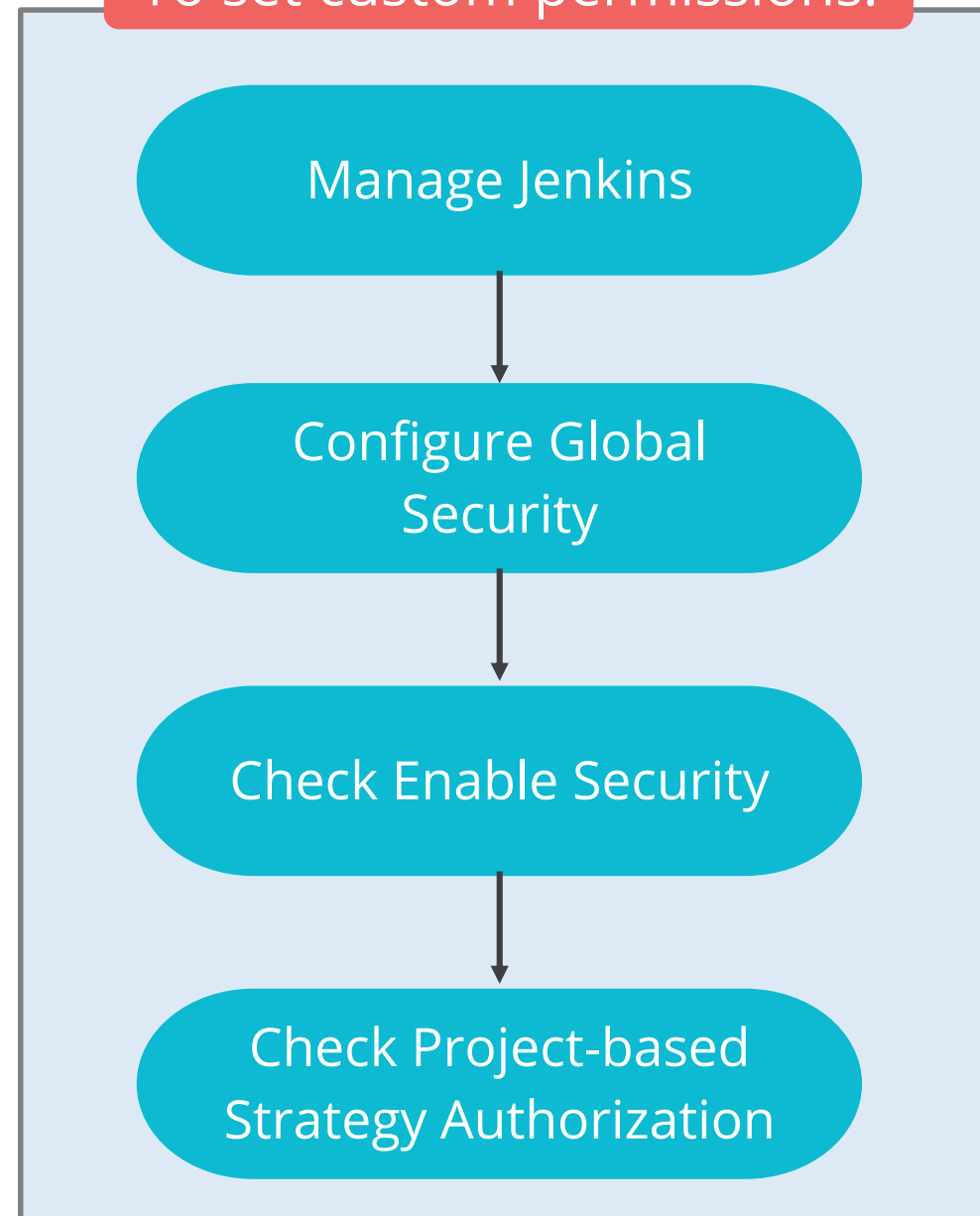
Jenkins allows admin to set credentials, based on roles.



Manage Users

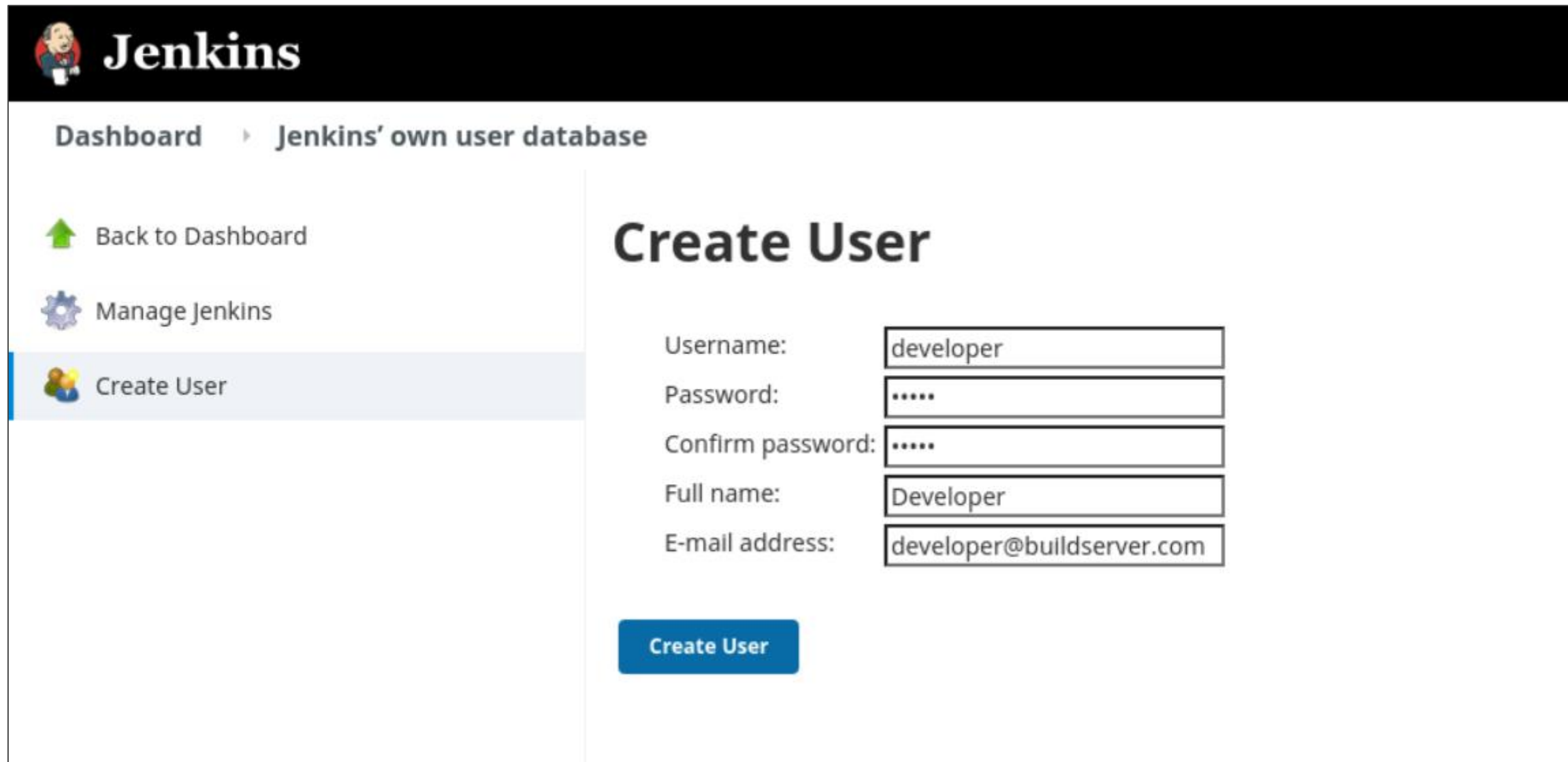
Jenkins allows admin to set custom permissions, based on roles.

To set custom permissions:



Manage Users

This is a screenshot of the **Create User** page in Jenkins, which allows the admin to create a user profile.



Jenkins

Dashboard ▸ Jenkins' own user database

Back to Dashboard

Manage Jenkins

Create User

Create User

Username:

Password:

Confirm password:

Full name:

E-mail address:

Create User

Jenkins Plugins

Some of the plugins required by any project are:

Pipeline

Post Build task

Maven

Parameterized Trigger

Amazon EC2

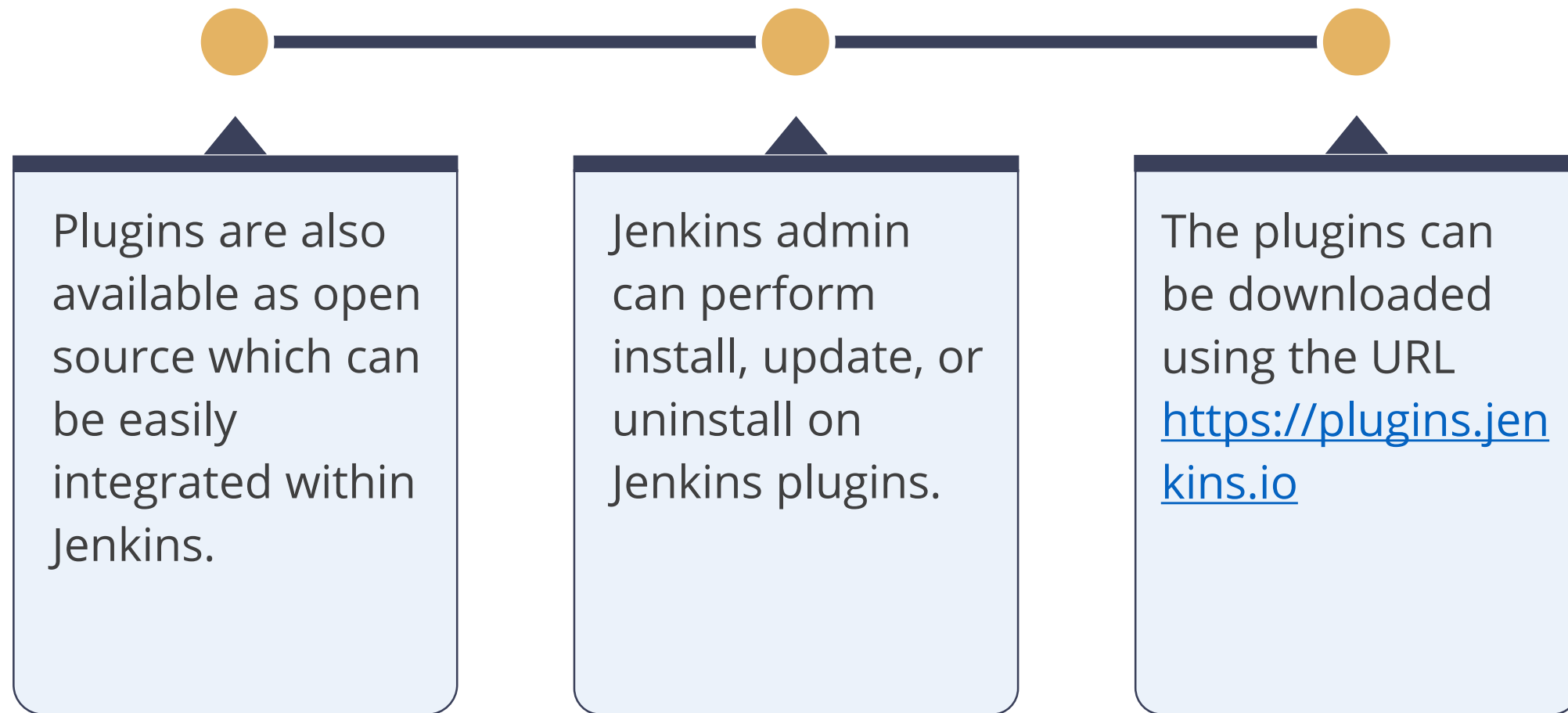
Throttle Builds

HTML Publisher

Green Balls

Manage Plugin

Plugins help enhance functionalities of the Jenkins application, as per user-specific requirements.



Manage Plugin

The **Updates** tab under Plugin Manager can be used by the admin to update plugins.

Dashboard ▾

Plugin Manager ▸

Back to Dashboard

Manage Jenkins

filter

Updates

Available

Installed

Advanced

Install	Name ↓	Version	Released	Installed
<input type="checkbox"/>	<div><div>ECharts API</div><div>api-plugin</div><div>Provides ECharts for Jenkins plugins.</div></div>	5.1.2-2	3 days 13 hr ago	5.1.0-2
<input type="checkbox"/>	<div><div>Font Awesome API</div><div>api-plugin</div><div>Provides the free fonts of Font Awesome for Jenkins plugins.</div></div>	5.15.3-3	4 days 12 hr ago	5.15.3-2
<input type="checkbox"/>	<div><div>Pipeline: API</div><div>api-plugin</div><div>Miscellaneous</div><div>Plugin that defines Pipeline API.</div></div>	2.44	5 days 12 hr ago	2.42
<input type="checkbox"/>	<div><div>Plugin Utilities API</div><div>api-plugin</div><div>Provides several utility classes that can be used to accelerate plugin development.</div></div>	2.3.0	4 days 12 hr ago	2.2.0
	<div><div>Snakeyaml API</div></div>			

Download now and install after restart

Update information obtained: 22 hr ago

Check now

Manage Plugin

The **Available** tab under Plugin Manager lists the available Jenkins plugins. The admin can download and install plugins.

Dashboard

Plugin Manager

Back to Dashboard

Manage Jenkins

search

Updates

Available

Installed

Advanced

Install	Name	Version	Released
<input type="checkbox"/>	<div>Authentication Tokens API</div> <div>This plugin provides an API for converting credentials into authentication tokens in Jenkins.</div>	1.4	11 mo ago
<input type="checkbox"/>	<div>Javadoc</div>	1.6	10 mo ago
<input type="checkbox"/>	<div>JavaScript GUI Lib: jQuery bundles (jQuery and jQuery UI)</div> <div>User Interface</div> <div>JavaScript GUI Lib: JQuery bundles (jQuery and JQuery UI) plugin.</div>	1.2.1	5 yr 3 mo ago
<input type="checkbox"/>	<div>Docker Commons</div> <div>api-plugin docker Library plugins (for use by other plugins)</div> <div>Provides the common shared functionality for various Docker-related plugins.</div>	1.17	11 mo ago
<input type="checkbox"/>	<div>Maven Integration</div> <div>Build Tools</div> <div>This plug-in provides, for better and for worse, a deep integration of Jenkins and Maven: Automatic triggers between projects depending on SNAPSHOTS, automated configuration of various Jenkins publishers (JUnit, ...).</div>	3.11	11 days ago
<div>Docker Pipeline</div>			

Install without restart

Download now and install after restart

Update information obtained: 22 hr ago

Check now

Manage Plugin

The **Installed** tab under Plugin Manager displays the details of the plugins installed in Jenkins.

Dashboard

Plugin Manager

Back to Dashboard

Manage Jenkins

filter

Updates

Available

Installed

Advanced

Enabled	Name	Version	Previously installed version	Uninstall
<input checked="" type="checkbox"/>	<div>Ant Plugin</div> <div>Adds Apache Ant support to Jenkins</div>	1.11		<div>Uninstall</div>
<input checked="" type="checkbox"/>	<div>Apache HttpComponents Client 4.x API Plugin</div> <div>Bundles Apache HttpComponents Client 4.x and allows it to be used by Jenkins plugins.</div> <div>This plugin is up for adoption! We are looking for new maintainers. Visit our Adopt a Plugin initiative for more information.</div>	4.5.13-1.0		<div>Uninstall</div>
<input checked="" type="checkbox"/>	<div>Bootstrap 4 API Plugin</div> <div>Provides Bootstrap 4 for Jenkins plugins.</div>	4.6.0-3		<div>Uninstall</div>
<input checked="" type="checkbox"/>	<div>bouncycastle API Plugin</div> <div>This plugin provides a stable API to Bouncy Castle related tasks.</div>	2.20		<div>Uninstall</div>
<input checked="" type="checkbox"/>	<div>Branch API Plugin</div> <div>This plugin provides an API for multiple branch based projects.</div>	2.6.4		<div>Uninstall</div>

Assisted Practice

Creating a new user in Jenkins

Duration: 10 min

Problem Statement:

1. Create a new user in Jenkins.

Assisted Practice: Guidelines

Steps to demonstrate how to create a new user in Jenkins:

1. Log in to Jenkins CI tool
2. Access User management section to manage Users

Jenkins Job Configuration

Introduction to Jenkins Job

Jenkins Job helps developers to automate CI/CD using Jenkins Continuous Integration Server.

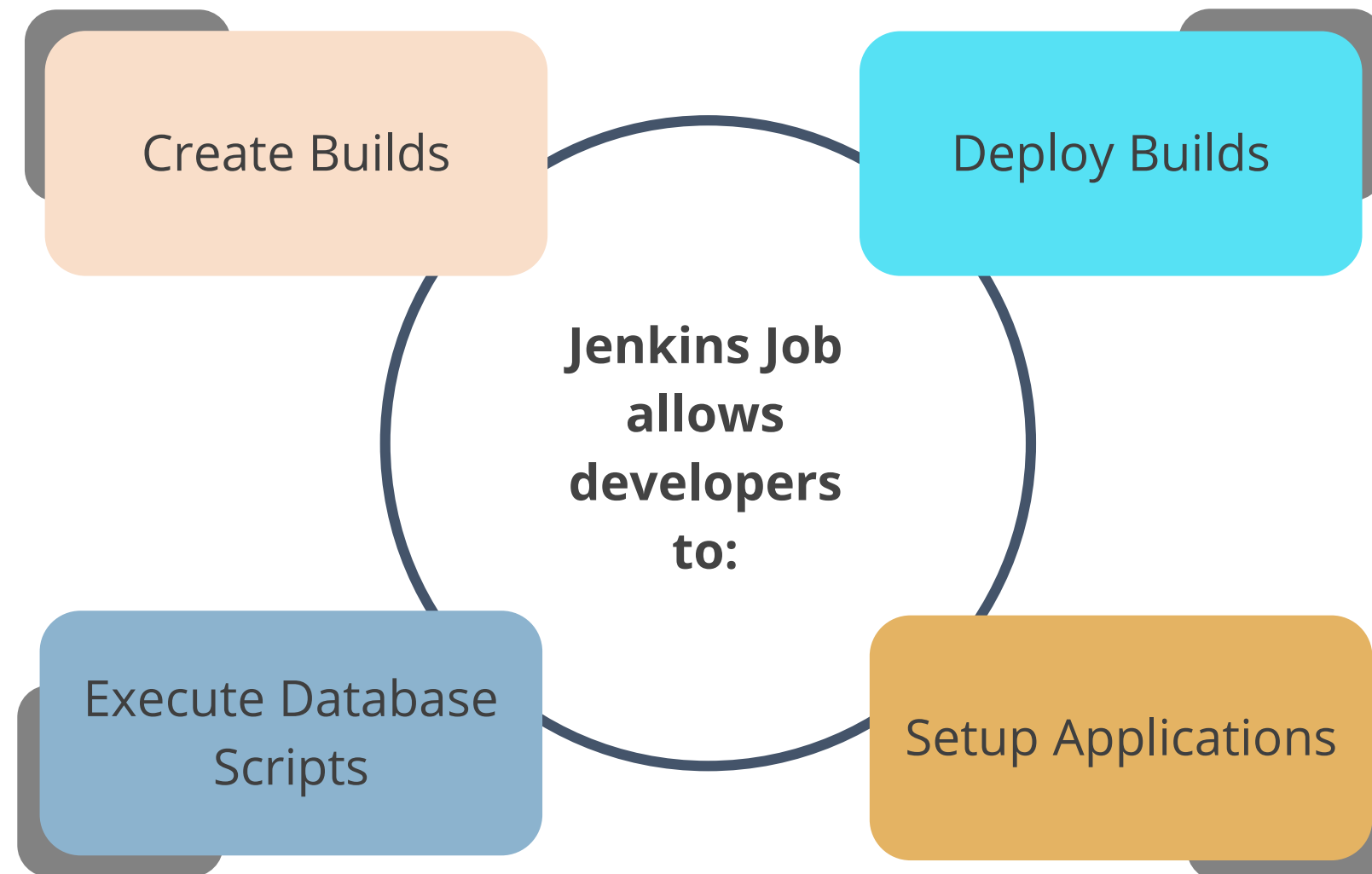
Jenkins Job supports various kinds of Build job configurations.



Jenkins

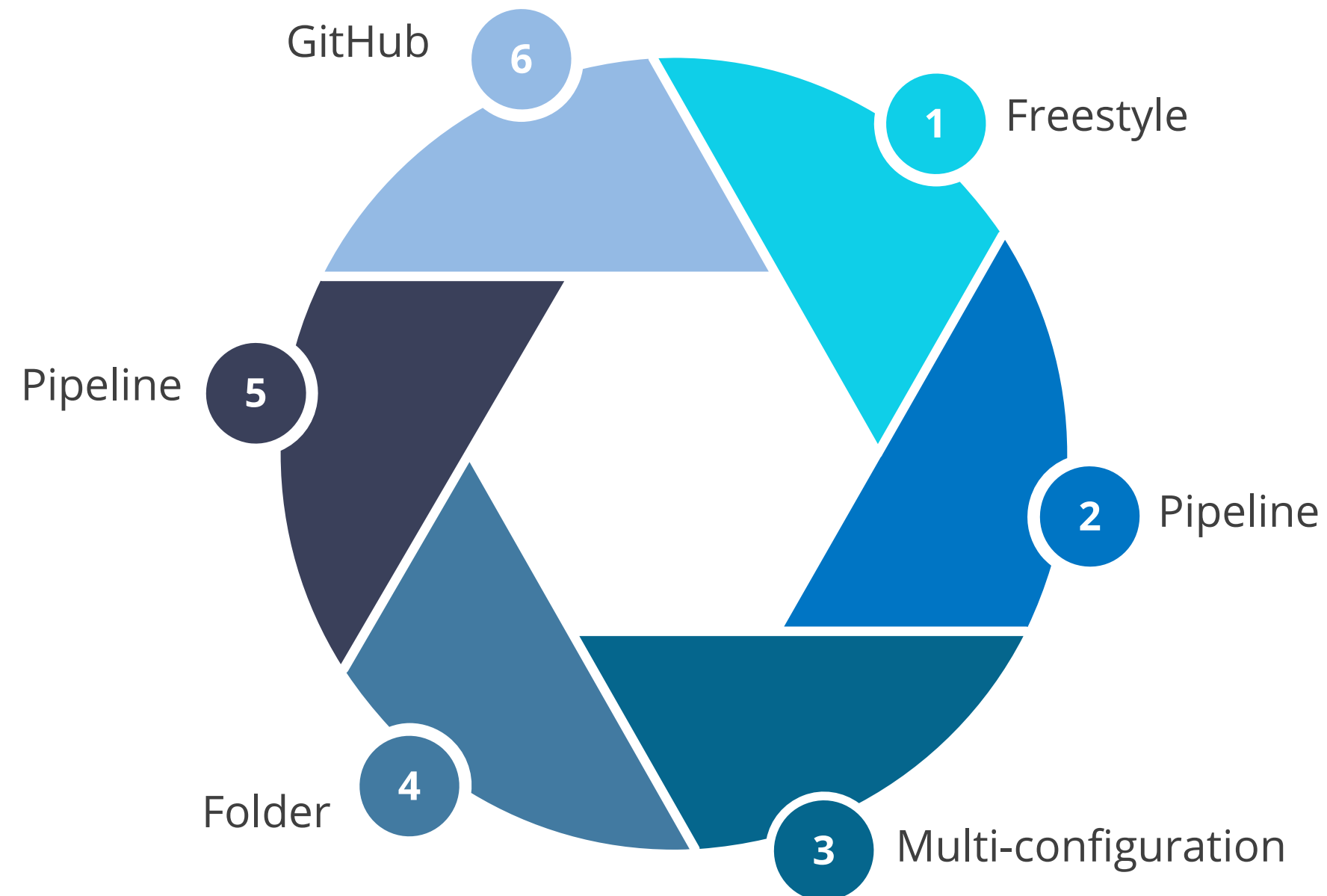
Jenkins Job Builds projects to automate different kinds of source code and projects.

Introduction to Jenkins Job



Types of Jenkins Job

Jenkins Job can be of the following types:



Types of Jenkins Job

Freestyle

- Is the central feature of Jenkins
- Is used to build projects; allows combining any SCM with any Build system
- Can be used for Builds other than software Build

Pipeline

- Orchestrates long-running activities spanning multiple Build agents
- Is suitable for building Pipelines and/or organizing complex activities that do not easily fit in free-style job type

Types of Jenkins Job

Multi-configuration

- Is suitable for projects that need a large number of different configurations
- Example: Testing on multiple environments and platform-specific Builds, etc

Folder

- Creates a container that stores nested items
- Is useful for grouping
- Creates a separate namespace, so that there can be multiple files of the same name as long as they are in different folders

Types of Jenkins Job

Multi-branch Pipeline

- Creates a set of Pipeline projects, based on the detected branches in one SCM repository

GitHub

- Scans a GitHub organization for all repositories matching some defined markers

Freestyle vs Pipeline Job

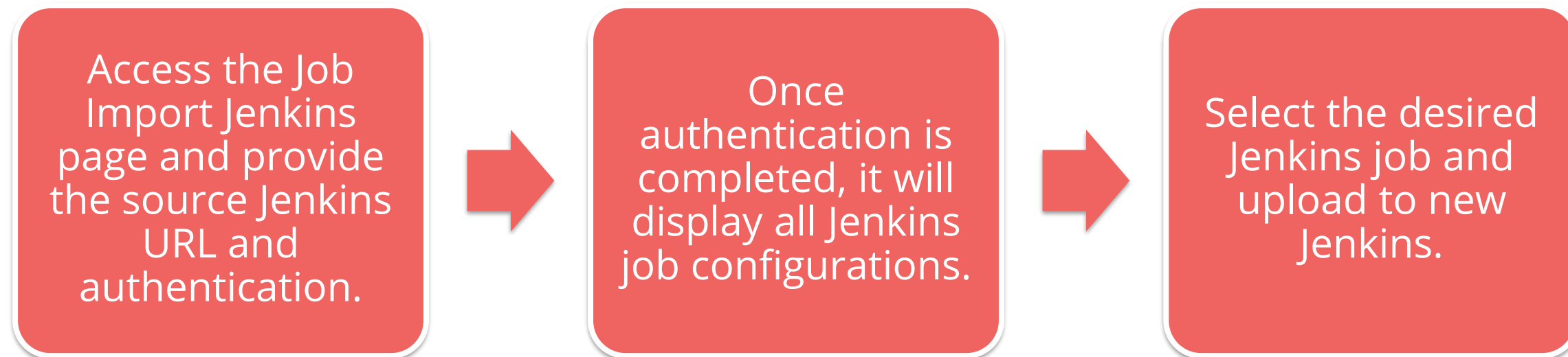
Some of the differences between Freestyle and Pipeline jobs are shown below:

Freestyle Job	Pipeline Job
It Is dependent on Jenkins admin to modify or update job configurations	It is not dependent on admins. CI scripts are stored in the repository.
Job configurations are updated directly into Jenkins.	With Pipeline, CI scripts can be easily modified by developers in the Git repository.
Build information is limited; it is difficult to manage Builds.	Pipeline Job offers a flexible view to provide Build information; it also supports Pipeline stage view.
Job configurations are directly preserved in Jenkins, which may get lost if Jenkins gets corrupted.	Jenkins Pipeline scripts are stored in Git repository, which can be easily restored if the Jenkins installation gets corrupted.

Job Import Plugin

Jenkins supports **Job Import** plugin, which helps to import Jenkins Job from one Jenkins to another.

Once the **Job Import** plugin is installed on Jenkins, follow the steps given below:



Job Import Plugin

To configure Jenkins from where jobs needs to be imported, configure the **Job Import** plugin in the **Manage Jenkins** Page.

Job Import Plugin

Remote Jenkins server configurations

Remote Jenkins

Name

SourceJenkins

Jenkins Server Name

Url

http://sourcejenkins.com:8080

Jenkins Server Url

Credentials

- none -

Add

Remove Jenkins

Assisted Practice

Implementing Job Import Plugin

Duration: 10 min

Problem Statement:

1. Demonstrate how to implement Job Import plugin in Jenkins.

Assisted Practice: Guidelines

Steps to implement Job Import Plugin:

1. Log in to Jenkins CI tool and install Job import plugin
2. Configure Job import plugin to import jobs from an existing Jenkins job

Key Takeaways

- 👁 Jenkins is a web-based portal used by developers to configure Continuous Integration and Continuous Deployment.
- 👁 Jenkins can be managed using the Manage Jenkins page where admins can modify and extend Jenkins.
- 👁 By default, Jenkins has only a single Master Node, which executes all Jenkins jobs.
- 👁 Jenkins allows the admin to set credentials and custom permissions, based on the roles.
- 👁 Jenkins Job helps developers to automate CI/CD with the help of the Jenkins Continuous Integration Server.



Lesson-End Project

Configure Maven Global Tool Configuration

Problem Statement:

Perform the following:

- Configuration of Maven Global tool

Access: Click on the **Labs** tab on the left side panel of the LMS. Copy or note the username and password that is generated. Click on the **Launch Lab** button. On the page that appears, enter the username and password in the respective fields, and click **Login**.





Thank You