

# RedHat Enterprise Linux 9 for Beginners

---

*A comprehensive guide to learning,  
administration, and deployment*

---

**Vishesh Kumar**  
**Geetanjali Mehra**



[www.bpbonline.com](http://www.bpbonline.com)

First Edition 2024

Copyright © BPB Publications, India

ISBN: 978-93-55516-626

*All Rights Reserved.* No part of this publication may be reproduced, distributed or transmitted in any form or by any means or stored in a database or retrieval system, without the prior written permission of the publisher with the exception to the program listings which may be entered, stored and executed in a computer system, but they can not be reproduced by the means of publication, photocopy, recording, or by any electronic and mechanical means.

### **LIMITS OF LIABILITY AND DISCLAIMER OF WARRANTY**

The information contained in this book is true to correct and the best of author's and publisher's knowledge. The author has made every effort to ensure the accuracy of these publications, but publisher cannot be held responsible for any loss or damage arising from any information in this book.

All trademarks referred to in the book are acknowledged as properties of their respective owners but BPB Publications cannot guarantee the accuracy of this information.

To View Complete  
BPB Publications Catalogue  
Scan the QR Code:



**Dedicated to**

*My mother:*

***Ibha Jha***

*and*

*My father:*

***Vijay Kant Jha***

## About the Authors

- **Vishesh Kumar** is a seasoned Linux professional and technical writer with over 20 years of extensive experience in Linux, system administration, networking, cyber security and cloud technologies. His journey commenced in 2002 with Red Hat Linux 3, and since then, he has been actively involved in professional work across multiple Linux, Unix, and Cloud platforms. Additionally, Vishesh holds multiple certifications in Red Hat Enterprise Linux and IT Security. As the founder of “Linux Mantra IT Services,” Vishesh leads a global team providing comprehensive Linux and Cloud-based services and solutions. Over the years, he has collaborated with numerous national and international organizations, including Yatra Ltd, Infoedge Ltd, Fortum, Ebix, Capgemini, Gilpin Travels, Radius Synergies, and many others, offering consultancy and services.
- **Geetanjali Mehra**, with over 17 years of experience in IT industry has played a key role in various organizations to manage various databases on multiple flavours of Linux. She has automated various server and database administration related routine tasks via the use of bash scripts. Her commitment to learn new technology and innovative problem-solving approach make her a valuable asset in the field. Geetanjali’s dedication to sharing her knowledge is evident in her book.

---

## About the Reviewers

- ❖ **Alberto Gonzalez** is a seasoned Principal Architect at Red Hat with two decades of professional experience in various roles. Currently specializing in infrastructure, cloud computing, and virtualization, he brings a wealth of expertise to the field. Alberto is also an accomplished author, having written three influential books. His works include a comprehensive guide on automation with Ansible, another on containers featuring Docker, and the latest publication titled *Linux Server Cookbook: Get Hands-on Recipes to Install, Configure, and Administer a Linux Server Effectively*, published by BPB Publications.

Beyond his written contributions, Alberto has a rich history of creating engaging content and delivering effective teaching sessions. He frequently shares his insights at conferences, where he passionately discusses emerging technologies. Additionally, he actively contributes to the learning experience by designing and leading hands-on labs for participants, enhancing their practical understanding of the subject matter.

- ❖ **Sidhartha Rajak** is presently serving as a Technical Officer - 'A' in the Ministry of Defence, Government of India, accumulating over 6 years of valuable experience in Linux Server Administration and Virtual Machines. His array of certifications includes 'Cyber Security - Information Assurance Professional' from the esteemed DIAT (Defence Institute of Advanced Technology), 'Information Security' & 'Computer Networking and Security' from C-DAC (Centre for Development of Advanced Computing), and 'Virtualization & Cloud Computing' from NIELIT (National Institute of Electronics & Information Technology). Sidhartha has also undergone concise training in "Log Analysis Techniques and Management" from CERT-In (Indian Computer Emergency Response Team).

His ongoing research endeavors focus on exploring Bare Metal Hypervisors, Cron Jobs, and optimizing Incremental Backup strategies within Linux Server Administration. In addition to his core competencies, Sidhartha is skilled in Dynamic Web Application Development, possesses proficiency in Hosting, Domain Configuration, and exhibits adept skills in Database Server Management.

## Acknowledgement

I want to express my deepest gratitude to my family and friends for their unwavering support and encouragement that I received while writing this book, especially my mother and father.

I am also grateful to BPB Publications for allowing me to write this book. I am also thankful to them for their guidance and editorial expertise in bringing this book to fruition. I am also deeply grateful to all the reviewers who gave their spare time to review the book's contents editorially as well as technically. The valuable participation and collaboration of all the reviewers, technical experts, and editors is really remarkable.

I would also like to express my gratitude for the invaluable contributions of my clients and colleagues throughout my years in the tech industry. Their challenging assignments and projects have played a significant role in enhancing my understanding and expertise in various technologies, enabling me to delve deeper into the subject matter.

I also extend my heartfelt gratitude to all the readers who have shown interest in this book. If this book proves helpful to you in any capacity, then the months dedicated to its creation will have been incredibly meaningful to me. Thank you for your support and engagement.

---

# Preface

RHEL is the widely used enterprise level Linux distribution and learning Linux is the demand of the hour. It is accepted as a de-facto standard worldwide to host several types of servers because it is scalable , reliable, and durable . Most of the IT-Industry software has Linux as its base, thus increasing the demand of specialists who can manage Linux Servers and thus drive the IT industry. This book will help you understand the Linux Operating System so that you will be the future Linux System Administrator.

In this book, you will learn the concepts of Linux/Unix from scratch easily and practically. It offers a comprehensive guide for effectively handling, managing, and administering one or multiple RHEL servers. It covers a wide spectrum of topics, including installation of RHEL, managing services and processes, various user-level and administrative-level commands, user management, managing filesystem and disk partitions, concepts of cloud and containers, package installation and management, database and web server setup, understanding shell scripts, strategies for enhancing server performance and much more.

After reading a wide array of topics given in this book, you will be able to install and handle not only Redhat Linux servers but many of the other Linux distributions. This book will allow you to become a competent Linux system specialist easily and practically.

This book is designed for System Engineers, Network Engineers, Linux Jr. Administrators, and Windows Administrators who want to gain knowledge in managing RHEL on a daily basis. This book also caters for the needs of Red Hat professionals who want to refresh their knowledge and get comfortable in using RHEL 9.

**Chapter 1: The First Step to Linux** – This book starts with a basic understanding of Linux Systems. In the first chapter, you will get acquainted with this open-source software and its application in today’s world. This chapter will make you familiar with important Linux terminologies and its architecture to get you started. Then, this will guide you how to install/simulate RHEL 9 to get your system ready. Then it moves ahead to guiding how you get into your newly installed machine and how you can interact with your machine in the first place. Here you will try to get information about your machine

**Chapter 2: Linux Filesystem and Administration** – The second chapter will give you insight into the Linux Filesystem structure. Here you will know how the files in Linux are organized in the storage space of RHEL.

**Chapter 3: Knowing Linux Commands** – This chapter provides the essential content of the book. Here, you will master various basic and administrative-level commands to get the most out of the Linux box.

**Chapter 4: Managing Processes and Services in RedHat Linux** – The chapter discusses processes and services in Linux, and how are they managed.

**Chapter 5: Handling and Managing Files** – This chapter describes how you will handle files and directories and perform other operations on them.

**Chapter 6: Managing Users and File Permissions** – This chapter discusses user management and demonstrates the procedure to set permissions on files so that users can access them according to their roles.

**Chapter 7: Interacting with Bash Shell and Scripting** – This chapter will introduce you to an agent that is used to interact with Linux Systems. And that agent is a shell which makes it possible to do great things on Linux. Shell, actually, beautifies Linux. Here you will also learn how to interact with the shell and write shell scripts that can automate any task.

**Chapter 8: Security and Networking in Linux** – Chapter 8 will show how you can secure Linux Server and its network.

**Chapter 9: Partitioning in Linux** – Chapter 9 will show you how to create and manage disk partitions using the traditional vs LVM way.

**Chapter 10: Containers** – In this chapter, you will learn the fundamentals of containers. This chapter discusses various tools that you can use to build and manage containers. Containers allow you to host and run multiple applications independently on the same machine.

**Chapter 11: Cloud Computing** – Chapter 11 will give you highlights of Cloud computing in RHEL9.

**Chapter 12: Graphical User Interface** – Chapter 12 gives you highlights on the Desktop environment of RHEL machine. It shows how you can use and run various graphical applications on Linux environment.

**Chapter 13: Software Updates and Patch Management** – This chapter demonstrates how can you subscribe to RedHat Subscription Manager (RHSM), register your machines to RHSM and perform updates on them.

**Chapter 14: Package Installation** – Chapter 14 describes package installation and management in detail.



**Chapter 15: Performance Monitoring and Tuning** – Chapter 15 discusses various tools and utilities that are available to monitor the system’s health and its current status. It will also give you hands-on performance monitoring and tuning of the Linux System.

**Chapter 16: Backup and Troubleshooting in Linux** – Chapter 16 deals with various utilities that can be used to take backup of the available data and how you can restore data and perform recovery when required.

**Chapter 17: Web Server and Database Server Setup in Linux** – This chapter demonstrates the webserver and database server setup in Linux.

**Chapter 18: Miscellaneous** – Miscellaneous topics are also covered in this book so that the readers can learn more and gain more.

## Coloured Images

Please follow the link to download the  
*Coloured Images* of the book:

**<https://rebrand.ly/460y2yk>**

We have code bundles from our rich catalogue of books and videos available at <https://github.com/bpbpublications>. Check them out!

## Errata

We take immense pride in our work at BPB Publications and follow best practices to ensure the accuracy of our content to provide with an indulging reading experience to our subscribers. Our readers are our mirrors, and we use their inputs to reflect and improve upon human errors, if any, that may have occurred during the publishing processes involved. To let us maintain the quality and help us reach out to any readers who might be having difficulties due to any unforeseen errors, please write to us at :

**[errata@bpbonline.com](mailto:errata@bpbonline.com)**

Your support, suggestions and feedbacks are highly appreciated by the BPB Publications' Family.

Did you know that BPB offers eBook versions of every book published, with PDF and ePub files available? You can upgrade to the eBook version at [www.bpbonline.com](http://www.bpbonline.com) and as a print book customer, you are entitled to a discount on the eBook copy. Get in touch with us at :

**[business@bpbonline.com](mailto:business@bpbonline.com)** for more details.

At [www.bpbonline.com](http://www.bpbonline.com), you can also read a collection of free technical articles, sign up for a range of free newsletters, and receive exclusive discounts and offers on BPB books and eBooks.

## Piracy

If you come across any illegal copies of our works in any form on the internet, we would be grateful if you would provide us with the location address or website name. Please contact us at **business@bpbonline.com** with a link to the material.

## If you are interested in becoming an author

If there is a topic that you have expertise in, and you are interested in either writing or contributing to a book, please visit **www.bpbonline.com**. We have worked with thousands of developers and tech professionals, just like you, to help them share their insights with the global tech community. You can make a general application, apply for a specific hot topic that we are recruiting an author for, or submit your own idea.

## Reviews

Please leave a review. Once you have read and used this book, why not leave a review on the site that you purchased it from? Potential readers can then see and use your unbiased opinion to make purchase decisions. We at BPB can understand what you think about our products, and our authors can see your feedback on their book. Thank you!

For more information about BPB, please visit **www.bpbonline.com**.

## Join our book's Discord space

Join the book's Discord Workspace for Latest updates, Offers, Tech happenings around the world, New Release and Sessions with the Authors:

<https://discord.bpbonline.com>



# Table of Contents

<b>1. The First Step to Linux .....</b>	<b>1</b>
Introduction .....	1
Structure .....	1
Objectives .....	2
Open-source software vs Enterprise solution .....	2
<i>Benefits of open-source software.....</i>	<i>2</i>
<i>Problems with open source .....</i>	<i>2</i>
<i>Features of Enterprise open source.....</i>	<i>3</i>
Features of RedHat Enterprise Linux.....	4
Linux architecture .....	5
<i>Kernel .....</i>	<i>5</i>
<i>System libraries .....</i>	<i>6</i>
<i>Utility programs/applications .....</i>	<i>6</i>
<i>Shell .....</i>	<i>6</i>
<i>Linux FileSystem .....</i>	<i>6</i>
<i>SuperUser.....</i>	<i>7</i>
<i>GUI.....</i>	<i>8</i>
Installation of RHEL9 .....	8
<i>Getting the software .....</i>	<i>8</i>
<i>Hardware compatibility.....</i>	<i>9</i>
<i>Installation using VMware .....</i>	<i>9</i>
<i>Download and install VMware .....</i>	<i>9</i>
<i>Using VMware .....</i>	<i>10</i>
<i>Installation of RHEL9 on Virtual Machine.....</i>	<i>14</i>
<i>Installation using bootable pendrive .....</i>	<i>20</i>
<i>Preparing bootable USB.....</i>	<i>20</i>
<i>Installing RHEL9 using bootable USB.....</i>	<i>22</i>

---

Using RHEL machine .....	25
<i>Logging In</i> .....	25
<i>Getting information about the machine</i> .....	26
<i>Using basic commands</i> .....	26
<i>Starting and stopping RHEL machine</i> .....	31
Conclusion .....	32
<b>2. Linux Filesystem and Administration</b> .....	<b>33</b>
Introduction .....	33
Structure .....	34
Objectives .....	34
Linux Filesystem .....	34
<i>Types of Filesystems</i> .....	36
<i>Supported FileSystem in RHEL9.0</i> .....	36
<i>XFS FileSystem</i> .....	36
<i>EXT4 filesystem</i> .....	37
<i>NFS Filesystem</i> .....	37
<i>CIFS Filesystem</i> .....	37
<i>Tmpfs filesystem</i> .....	37
<i>Choosing XFS or EXT4</i> .....	37
Filesystem structure .....	38
Symbolic link .....	43
Searching files in the filesystem .....	44
Mounting a Filesystem.....	44
<i>/etc/mtab</i> .....	45
<i>/etc/fstab</i> .....	46
Unmounting filesystem.....	47
Filesystem space usage .....	47
Administering filesystem.....	48
<i>Creating a partition</i> .....	48
<i>Creating a filesystem</i> .....	50
<i>Labelling filesystem</i> .....	51

---

<i>Mounting and unmounting filesystem</i> .....	52
<i>Checking filesystem</i> .....	54
Conclusion .....	54
References.....	54
<b>3. Knowing Linux Commands</b> .....	<b>55</b>
Introduction .....	55
Structure .....	56
Objectives .....	56
Understanding commands .....	56
<i>Type of commands</i> .....	58
<i>Using command terminal</i> .....	58
Standard input, standard output, and standard error.....	59
<i>Redirection of standard I/O and error</i> .....	60
Pattern matching and regular expression.....	63
<i>Wild card characters</i> .....	64
<i>* to match many files names</i> .....	64
<i>? Matching a single character</i> .....	66
<i>[] character class</i> .....	67
Metacharacters .....	69
<i>Executing commands together</i> .....	69
<i>Pipe ( ) operator</i> .....	70
<i>Whitespaces (space, tabs, and new line)</i> .....	70
<i>{ } Giving multiple patterns in command line</i> .....	71
<i>Command substitution</i> .....	72
<i>grouping commands</i> .....	72
<i>Quoting the quote character</i> .....	72
<i>Precautions when special characters are included in filenames</i> .....	73
Regular expression .....	73
<i>A period (.)</i> .....	74
<i>Character class</i> .....	74
<i>Named character classes</i> .....	75

---

Anchor characters .....	75
Special characters .....	76
Repetition .....	76
Matching the alternate expression .....	77
Grouping patterns .....	77
Back-references and <code>\()</code> .....	77
User commands .....	79
<i>date</i> .....	79
<i>Pager</i> .....	81
<i>more</i> .....	81
<i>less</i> .....	82
<i>whereis</i> .....	83
<i>which</i> .....	84
<i>man</i> .....	84
<i>whatis</i> .....	85
<i>apropos</i> .....	86
<i>type</i> .....	86
<i>history</i> .....	87
<i>who</i> .....	87
<i>write</i> .....	88
<i>mesg</i> .....	88
<i>wall</i> .....	89
<i>set</i> .....	89
<i>cat</i> .....	91
<i>wc</i> .....	92
<i>cut</i> .....	93
<i>paste</i> .....	94
<i>sort</i> .....	95
<i>time</i> .....	97
<i>xargs</i> .....	97
<i>echo</i> .....	98

<i>alias</i> .....	99
<i>info</i> .....	100
<i>bc</i> .....	100
<i>clear</i> .....	101
<i>script</i> .....	101
<i>printf</i> .....	101
<i>uname</i> .....	102
<i>tty</i> .....	103
<i>sleep</i> .....	103
<i>uniq</i> .....	103
<i>at</i> .....	105
<i>batch</i> .....	106
<i>grep</i> .....	106
<i>basename</i> .....	109
<i>nl</i> .....	109
<i>eval</i> .....	110
<i>expr</i> .....	110
<i>head</i> .....	111
<i>tail</i> .....	112
<i>id</i> .....	112
<i>od</i> .....	113
<i>split</i> .....	113
<i>strings</i> .....	114
<i>sum</i> .....	115
<i>tee</i> .....	115
<i>tr</i> .....	115
Admin commands .....	117
<i>su</i> .....	117
<i>mkfifo</i> .....	118
<i>dd</i> .....	118
<i>du</i> .....	121
<i>lastlog</i> .....	122



---

Here document (another way to read standard input) .....	123
Conclusion .....	124
<b>4. Managing Processes and Services in RedHat Linux .....</b>	<b>125</b>
Introduction .....	125
Structure .....	126
Objectives .....	126
Understanding process .....	126
<i>Creation of processes</i> .....	127
<i>Zombie and orphan process</i> .....	127
Viewing running process .....	128
<i>Process categories</i> .....	128
<i>Daemons</i> .....	129
<i>Fetching process information</i> .....	129
<i>More options with ps command</i> .....	129
<i>Output columns in ps</i> .....	130
<i>Usages of ps options</i> .....	131
Searching processes using pgrep .....	133
<i>Process state</i> .....	134
Managing process .....	135
<i>Stopping a running process</i> .....	135
<i>Suspending a process</i> .....	135
<i>Terminating a process</i> .....	135
Running process in background .....	137
Setting priority of a process: Nice and renice .....	137
System and service manager .....	139
<i>Systemd features</i> .....	140
<i>Systemd units</i> .....	141
<i>Systemd Daemon</i> .....	142
<i>Configuration of systemd</i> .....	144
<i>Systemd Unit Files</i> .....	144
<i>Systemd target</i> .....	145

---

<i>Using systemctl</i> .....	148
<i>Listing Unit dependencies</i> .....	148
<i>Listing before and after dependency</i> .....	149
<i>Listing all the active units</i> .....	149
<i>Listing all the available units</i> .....	149
<i>List all the active units of a specific unit type</i> .....	150
<i>Fetching information of a particular unit</i> .....	150
<i>Listing installed unit files</i> .....	150
<i>Viewing the contents of a unit file</i> .....	151
<i>Listing inactive units</i> .....	151
Managing services by systemd .....	152
Conclusion .....	155
References.....	156
<b>5. Handling and Managing Files</b> .....	<b>157</b>
Introduction .....	157
Structure .....	157
Objectives .....	158
Object identity in Linux .....	158
<i>Regular file</i> .....	158
<i>Directory</i> .....	159
<i>Device files</i> .....	159
<i>Special files</i> .....	160
File-related attributes and inode.....	160
<i>Inode</i> .....	161
<i>Fetching file attributes</i> .....	163
<i>Understanding timestamps in file</i> .....	164
<i>Working with hard links</i> .....	164
Working with regular files .....	166
<i>Creation of regular files</i> .....	166
<i>Modifying file contents</i> .....	169
<i>Viewing the contents of a file</i> .....	169

---

<i>less file1</i> .....	170
<i>more file1</i> .....	170
Navigating around the filesystem .....	170
Working with directory .....	172
<i>Creating a directory and a subdirectory</i> .....	172
<i>Listing the contents of a directory</i> .....	173
Operations related to files .....	175
<i>Renaming file and directory</i> .....	175
<i>Copying files and directory</i> .....	176
<i>Deleting file and directory</i> .....	177
<i>Comparing two files</i> .....	178
<i>cmp</i> .....	178
<i>comm</i> .....	179
<i>diff</i> .....	180
<i>Compressing file</i> .....	180
<i>zip</i> .....	181
<i>gzip</i> .....	182
Text editor: vim .....	183
<i>Options in command mode</i> .....	184
<i>Options in Normal mode</i> .....	186
Text processing .....	190
<i>gawk</i> .....	190
<i>Stream editor: sed</i> .....	192
Searching files: find .....	196
Conclusion .....	200
<b>6. Managing Users and File Permissions</b> .....	<b>203</b>
Introduction .....	203
Structure .....	204
Objectives .....	204
Your identity as a Linux user .....	204
<i>Viewing users list</i> .....	205

---

Creating a new user .....	206
<i>Adding the user in the system</i> .....	207
<i>Default file and configuration</i> .....	207
<i>Options with useradd</i> .....	210
<i>Setting the password</i> .....	211
<i>Options in passwd</i> .....	214
User groups.....	215
<i>Creating a new group</i> .....	215
<i>Viewing user groups</i> .....	216
<i>Options in groupadd</i> .....	216
Modifying users and group attributes .....	217
<i>usermod</i> .....	217
<i>groupmod</i> .....	219
Deleting users and groups.....	220
Privilege delegation .....	221
Understanding permissions on files.....	224
<i>Default permissions</i> .....	225
<i>Octal representation of file permissions</i> .....	227
<i>Base permissions and umask</i> .....	228
<i>Viewing and setting the umask</i> .....	229
Modifying file permissions .....	229
<i>Using the chmod command</i> .....	230
Conclusion .....	231
References.....	232
<b>7. Interacting with Bash Shell and Scripting .....</b>	<b>233</b>
Introduction .....	233
Structure .....	234
Objectives .....	234
Introducing Bash .....	234
Bash default environment.....	235
<i>Bash configuration</i> .....	238

---

<i>Bash initialization files</i> .....	239
<i>/etc/profile : system-wide profile file</i> .....	239
<i>~/.bash_profile : user-specific profile file</i> .....	239
<i>.bashrc : user-specific rc file</i> .....	239
<i>/etc/bashrc : system-wide rc file</i> .....	239
<i>.bash_logout : user-specific logout file</i> .....	240
<i>Changing configuration in bash</i> .....	240
Bash shell facilities .....	242
<i>Redirection facility and various metacharacters</i> .....	242
<i>Logical &amp;&amp; and    operator to execute the commands</i> .....	242
<i>Exit status of each executed command</i> .....	243
<i>Changing shell options using set and shopt</i> .....	243
<i>Special bash shell parameters</i> .....	244
<i>Read-only variables</i> .....	244
Bash scripting .....	246
<i>Reading user input</i> .....	248
<i>Evaluating expressions in Bash</i> .....	249
<i>Arithmetic operations in bash</i> .....	251
<i>Flow control</i> .....	252
<i>Validating conditions using if</i> .....	252
<i>Looping in Bash</i> .....	256
<i>Case in bash</i> .....	262
Redirection in script.....	265
Running shell script with arguments.....	266
<i>Setting positional parameters automatically</i> .....	269
Here document .....	269
Debugging shell script.....	271
Error handling in Bash .....	271
Awk revisited.....	272
Conclusion .....	276

---

<b>8. Security and Networking in Linux .....</b>	<b>277</b>
Introduction .....	277
Structure .....	278
Objectives .....	278
Securing Linux.....	278
<i>Access control list</i> .....	279
<i>Special permission bits</i> .....	280
<i>suid</i> .....	281
<i>sgid</i> .....	281
<i>Sticky bit</i> .....	281
<i>Setting the special permission bit</i> .....	282
<i>DAC vs MAC</i> .....	283
<i>Security context</i> .....	283
<i>Configuration of SELinux</i> .....	284
<i>User and file context</i> .....	285
<i>Chroot jail</i> .....	287
Networking concepts.....	288
<i>Client/server model</i> .....	288
<i>TCP/IP</i> .....	289
<i>IP addresses</i> .....	289
<i>Packets</i> .....	290
<i>Communication across the network</i> .....	291
<i>Intranet</i> .....	292
<i>Loop back address</i> .....	292
<i>Internet</i> .....	292
<i>IPv4 vs IPv6</i> .....	293
<i>Host naming</i> .....	293
<i>WWW</i> .....	294
<i>HTTP/HTTPS</i> .....	295
<i>FTP</i> .....	295
<i>CIDR</i> .....	295

---

Configuring network.....	296
<i>Networking configuration tools</i> .....	296
<i>Assigning host name</i> .....	296
<i>Configuring network interfaces</i> .....	297
DHCP.....	299
Domain Name System.....	300
Viewing network connectivity information .....	302
Ping .....	302
<i>Finding port</i> .....	302
<i>Tracing the path</i> .....	303
Securing network.....	303
Cryptography .....	304
<i>Objectives of cryptography</i> .....	305
<i>Type of cryptography</i> .....	305
Secure services.....	306
Secure shell.....	306
Configuration of ssh .....	310
Scp.....	310
Firewall.....	311
Wireless network and profiles.....	312
<i>Finding out Wi-Fi device</i> .....	312
<i>Configuring Wi-Fi device</i> .....	312
Monitoring logs.....	313
Rsyslog .....	314
Structure of log.....	317
Journal log .....	317
Forwarding of journal log to syslog .....	319
Viewing NetworkManager Logs .....	319
Security Information and Event Management .....	320
Global security benchmarks for Linux.....	320
Conclusion .....	320

<b>9. Partitioning in Linux .....</b>	<b>323</b>
Introduction .....	323
Structure .....	324
Objectives .....	324
Partitioning in RHEL9 .....	324
Partition types.....	326
Creating a regular partition.....	326
Logical volume management.....	329
<i>Creating a physical volume .....</i>	<i>330</i>
<i>Creating a volume group.....</i>	<i>330</i>
<i>Creating logical volume.....</i>	<i>331</i>
Managing LVM.....	331
Storing data in partitions .....	332
Conclusion .....	333
<b>10. Containers.....</b>	<b>335</b>
Introduction .....	335
Structure .....	336
Objectives .....	336
Understanding containers and container image .....	336
<i>Tools for containers.....</i>	<i>337</i>
<i>Configuration files.....</i>	<i>338</i>
<i>Setting up containers .....</i>	<i>338</i>
<i>Using podman .....</i>	<i>340</i>
<i>Working with containers.....</i>	<i>340</i>
<i>Working with images .....</i>	<i>343</i>
<i>Saving a container as image.....</i>	<i>344</i>
<i>Managing a container network.....</i>	<i>345</i>
<i>Attaching disk in container.....</i>	<i>345</i>
Container orchestration.....	347
Conclusion .....	348



---

<b>11. Cloud Computing</b> .....	<b>349</b>
Introduction .....	349
Structure .....	350
Objectives .....	350
Understanding the terminology .....	350
Advantages of cloud computing .....	351
Types of cloud computing services .....	352
<i>Infrastructure as a Service</i> .....	352
<i>Platform as a Service</i> .....	353
<i>Software as a Service</i> .....	354
Models of cloud computing.....	355
<i>Public cloud</i> .....	355
<i>Private cloud</i> .....	356
<i>Hybrid cloud</i> .....	357
Images and instances.....	358
Networking in cloud .....	358
Cloud features provided in RHEL9.....	360
Conclusion .....	360
<b>12. Graphical User Interface</b> .....	<b>361</b>
Introduction .....	361
Structure .....	361
Objectives .....	362
GNOME: The desktop environment .....	363
Knowing your desktop .....	364
Opening applications in GNOME .....	364
Facilities in GNOME.....	365
<i>Activities overview</i> .....	366
<i>Virtual workspace</i> .....	366
<i>Uncluttered desktop</i> .....	366
<i>GNOME Extensions</i> .....	367
<i>User productivity</i> .....	367

---

More in GNOME.....	367
<i>System menu in GNOME</i> .....	368
<i>Searching in GNOME</i> .....	368
<i>Modifying user/system settings</i> .....	370
Accessing remote desktop .....	370
File-related operations.....	372
<i>Folder views</i> .....	372
<i>Setting preferences</i> .....	373
<i>Searching for files</i> .....	375
<i>Customizing search results</i> .....	375
Adding applications in Favorites .....	376
Setting up networking and Bluetooth.....	376
<i>Wi-Fi and wired network connections</i> .....	376
<i>Using nm-connection-editor</i> .....	377
<i>Changing the hostname</i> .....	377
<i>Bluetooth</i> .....	377
Desktop background and general settings.....	377
Application-related settings .....	378
Privacy .....	378
<i>Application permissions</i> .....	378
<i>File history and trash</i> .....	378
<i>Screen lock</i> .....	379
Managing users using GNOME GUI.....	379
Changing date and time in GNOME.....	380
Browsing remote files .....	380
Customizing the locals .....	380
Keyboard and mouse.....	380
Default applications.....	381
Managing software in GNOME.....	381
<i>Listing installed software</i> .....	382
<i>Adding or removing software</i> .....	382
Log viewer.....	382

---

Managing disk in GNOME.....	383
System monitor .....	383
GNOME Virtual File System .....	384
Conclusion .....	384
<b>13. Software Updates and Patch Management .....</b>	<b>385</b>
Introduction .....	385
Structure .....	386
Objectives .....	386
Understanding patching .....	386
<i>Patching process in RHEL9 .....</i>	<i>389</i>
<i>Patch management in RHEL9 .....</i>	<i>389</i>
Tools for subscription management .....	391
<i>Managing subscription using portal.....</i>	<i>391</i>
<i>Adding system to RHSM.....</i>	<i>393</i>
<i>Subscription to RHSM using GUI.....</i>	<i>393</i>
<i>Subscription to RHSM using CLI.....</i>	<i>394</i>
<i>Subscription using the RHSM client tool .....</i>	<i>394</i>
Conclusion .....	395
<b>14. Package Installation.....</b>	<b>397</b>
Introduction .....	397
Structure .....	397
Objectives .....	398
Package management in RHEL9.....	398
Using dnf: the default package manager.....	399
<i>DNF configuration.....</i>	<i>400</i>
<i>Viewing repository .....</i>	<i>402</i>
<i>Adding a new repository .....</i>	<i>403</i>
<i>Manual method of adding repository.....</i>	<i>403</i>
<i>Automatic method of creating a repository.....</i>	<i>406</i>
<i>Creating a repository.....</i>	<i>406</i>

---

<i>Getting EPEL repository</i> .....	409
<i>Handling repository</i> .....	409
<i>Getting information about repository and packages</i> .....	410
<i>Installing software</i> .....	415
<i>Updating software</i> .....	417
<i>Listing packages</i> .....	418
<i>Removing a package</i> .....	419
Package groups.....	420
Using transaction history.....	422
Conclusion .....	424
<b>15. Performance Monitoring and Tuning.....</b>	<b>425</b>
Introduction .....	425
Structure .....	425
Objectives .....	426
Identifying performance problems.....	426
System monitoring tools .....	428
<i>/proc filesystem</i> .....	428
<i>sar</i> .....	429
<i>top</i> .....	432
<i>free</i> .....	434
<i>vmstat</i> .....	435
<i>iostat</i> .....	437
<i>Gnome's system monitor</i> .....	439
<i>Using performance logs</i> .....	440
Performing root cause analysis of slow response .....	441
Setting alerts using cron.....	442
Conclusion .....	444
<b>16. Backup and Troubleshooting in Linux.....</b>	<b>447</b>
Introduction .....	447
Structure .....	447
Objectives .....	448

---

Backup needs .....	448
<i>What to back up</i> .....	448
<i>Considerations when taking backups</i> .....	449
<i>Backup types</i> .....	450
Backup tools .....	450
<i>rsync</i> .....	450
<i>tar</i> .....	453
Restoring lost files .....	456
Troubleshooting using LogFiles .....	457
<i>Reading logs</i> .....	457
<i>Retaining and rotating log files</i> .....	458
<i>Understanding logrotate</i> .....	459
<i>logrotate as a systemd service</i> .....	462
Recovering system .....	465
Conclusion .....	466
References .....	467
<b>17. Web Server and Database Server Setup in Linux .....</b>	<b>469</b>
Introduction .....	469
Structure .....	469
Objectives .....	470
Defining a web server .....	470
Apache HTTP server .....	471
<i>Installing httpd</i> .....	471
<i>Configuring Apache</i> .....	472
<i>Managing httpd server</i> .....	474
<i>Creating your first web page</i> .....	476
Understanding Httpd log .....	477
Name-based virtual host .....	479
Securing HTTP communication .....	482
Database server .....	484
<i>Installing MySQL server</i> .....	484

---

<i>Using database server</i> .....	488
<i>Login to MySQL server</i> .....	488
<i>Querying database</i> .....	489
<i>Configuring MySQL</i> .....	493
Conclusion .....	493
<b>18. Miscellaneous</b> .....	<b>495</b>
Introduction .....	495
Structure .....	495
Objectives .....	495
Configuring and using email client.....	496
Fetching hardware information .....	498
<i>lsblk</i> .....	498
<i>findmnt</i> .....	499
<i>lspci</i> .....	499
<i>lsusb</i> .....	499
<i>lscpu</i> .....	500
curl .....	500
Udev rules.....	500
Time synchronization .....	502
Audit log.....	504
<i>Configuring Auditd</i> .....	505
<i>Managing auditd</i> .....	506
<i>Defining rules</i> .....	507
<i>Viewing audit log</i> .....	508
<i>Using aureport</i> .....	510
<i>Using ausearch</i> .....	510
Changing kernel parameters .....	511
Conclusion .....	513
References.....	513
<b>Index</b> .....	<b>515-526-</b>

# CHAPTER 1

# The First Step to Linux

## Introduction

Today, Linux is used as the base operating system on almost all kinds of IT deployments and servers. It is used as a de-facto standard to host several types of applications and software, as it is scalable, reliable and durable. Linux is an open-source operating system released under GPL. Multiple distributions of Linux have been made available since its birth. RHEL is the widely used enterprise-level Linux distribution among them. It is an open-source operating system software backed by an organization named RedHat. This is why it is named RedHat Enterprise Linux System. This open-source software distribution is added with enhanced security features and support services so that it can readily be made available to big enterprises for their production use.

## Structure

In this chapter, you will learn about the following topics:

- Open source software vs Enterprise solution
- Features of RedHat Enterprise Linux
- Linux architecture
- Installation of RHEL9
- Using RHEL machine

## Objectives

The objective of this chapter is multifold. This chapter will help you understand the benefits of using RHEL over other open-source distributions. This chapter will help you learn the basic terminologies used in Linux systems. You will learn about the various ways to install RHEL9 and look at step-by-step instructions, along with screenshots, to make a RHEL9 machine ready. You will also learn various basic commands to get information about the system.

## Open-source software vs Enterprise solution

When any open-source distribution is supported by an enterprise, organizations using that software distribution receive the benefits of enterprise support, reliability, scalability, and quality. Before delving into the key benefits of using RHEL, let us discuss why one should use open-source software and look at the benefits of using its enterprise counterpart.

### Benefits of open-source software

Open-source software's source code is readily available for use. Anyone can read, modify, and then freely redistribute it or even sell copies of the modified code, and all this can be done under the same license. It is a collaborative effort without any vendor lock-in. The code is freely accessible and is also reviewed and modified by the community from time to time. So, it has transparency features, as one can view the code and know what is going on inside. **Open-Source software (OSS)** solutions provide reliability as they are constantly and actively updated by peers. It is not owned by a single organization or a person but is a collaborative effort. Since this is community-maintained, any bug fixes and changes are done at a faster pace and more efficiently than by the teams of any proprietary software. OSS has longevity as it is reviewed by a community of users and not by a single person or organization. You are free to use the source code anywhere, anytime, and for anything.

So far, we have seen many benefits of open-source solutions, but what are its limitations that motivate organizations to use enterprise solutions. Let us discuss.

### Problems with open source

Open-source software is free, but you have to maintain it, secure it and make it production-ready for your business requirement yourself. This is not a complex task if you are a small / mid-sized organization, but organizations lined up for expansion and digital growth require backed-up support and security. They want a secure and reliable solution for their growing business needs. Bigger organizations have concerns for SSO, larger capacity data storage, security of their distributed growing information, etc. Their requirements are more complex than those of small and mid-sized businesses. This is where enterprise open-



source software comes in; it provides support and service-level agreement. They provide support such that a company's production environment remains stable, irrespective of workloads.

Anybody can download and install an open-source project, but that can carry risk. It can have security vulnerabilities that organizations have to tackle with their own. Most of the time, they need expert advice to identify the security breaches and mitigate them. And this is where enterprise open-source software comes in. A company providing enterprise open-source software has a dedicated security team that helps in identifying the potential threats and dealing with them in customers' business scenario. Their team provides security bug fixes and patching of the software from time to time.

Open-source software provides varied options for a particular business requirement. If we want to deploy a web server, it has multiple options to choose from. If we want a database server, it again has multiple solutions to choose from. For distributed storage, data streaming, and so on, open source provides varied options. But what if you want to work with all these stacks together. Integrating all these technologies requires expert advice. Here, you will need an enterprise solution that has an expert team guiding you through the deployment of multiple technologies safely and efficiently.

## Features of Enterprise open source

Any open-source product is said to be an enterprise open-source product if it has been produced after thorough testing and added security features, has been tuned for performance and retreated for security flaws, and it has a security team behind it and has processes in place for responding to new security vulnerabilities. They notify their customers about security issues and how to remediate them:

- **Added enterprise feature:** Big enterprises care about their growing information, its storage and complex IT infrastructure. Enterprise open-source software is software that is backed and supported by an organization so that enterprises receive more stable, reliable, secure and scalable solutions.
- **Support and service level agreement:** Enterprise open-source software provide a service level agreement that has concerns of running a production environment all the time. They provide a 24/7 support team that companies need during any unexpected downtimes. They also provide regular updates, security patches and bug fixes.
- **Integrating with multiple technology stacks:** At times, expanding organizations need to move into newer technology stacks. This decision requires several brainstorming sessions and expert guidance. Without proper steps and considerations, production can come to a halt while transitioning into the newer stack. Since a multitude of open-source software solutions are available, choosing

the best solution creates chaos among key decision makers without proper guidance. Any enterprise open-source software provides valuable consulting and guidance to the organizations in moving to newer technology stack.

- **Focused on customer requirement:** Enterprise open-source software is controlled and backed by a single entity responding to what the customer wants. New features are embedded into open-source software according to customers' needs.
- **Software life cycle:** Enterprise solution has longevity as it is maintained and updated by a single entity. When new releases are made, support for upgrading of the customer's system is immediately raised, thus supporting software up to a long life.
- **Auditing and compliance:** There are auditing and compliance concerns for bigger organizations. An enterprise open-source solution is valuable in this regard as well.
- **Delivers quality in IT infrastructure:** Companies providing enterprise open-source software test their software code with multiple hardware configurations before releases, ensuring quality software and solutions.
- **Enhanced quality of code:** Any open-source software lacks quality in code as it is reviewed by a community and not by a single person/organization. When an open-source software is backed up by experts inside an organization, companies gets enhanced quality of code.

Now, let's see what enterprise features are incorporated in RHEL by RedHat.

## Features of RedHat Enterprise Linux

RedHat uses community-built code, added some security and other enterprise features on it and what is developed is more stable and reliable OS that is, RHEL. Most enterprises are using RHEL for their OS platform.

Licensing is a legal authorization of using a product or solution. Software is also a product, and like any other product, the software also has a licensing scheme. RedHat also comes with different software products, and RedHat Enterprise Linux Version 9 is one of them.

Commercial use of RedHat Linux is not allowed without purchasing the required license of RedHat Enterprise Linux. RedHat does not provide software updates for Enterprise Linux without purchasing the license. Software updates are must-haves for machines in production, as security bugs are patched only through software updates. In the absence of proper licensing, RedHat does not provide any kind of support and services over call or email.

Commercially using RedHat Enterprise Linux without proper licensing may be considered illegal and actionable as per local regulatory laws. There are other Linux-related products

of RedHat that do not require a license, and they can be used if the user feels that they need RedHat Linux for some other purposes.

Other than licensing, RHEL is introducing new features with each new release. RHEL uses OpenSSL libraries for encryption and other security needs, with RHEL 9 OpenSSL version 3 being used in RHEL 9, and OpenSSL 3 supporting the Provider concept. OpenSSL 3 Provider module allows pluggable support for encryption/hashing and cipher algorithm. With the Provider module, new encryption algorithm support can be added without changing the OpenSSL Version of OS.

On the security front, RHEL 9 has disabled root login with password from SSH by default. So without changing configuration, remote login with the root account and password is discontinued now. Using a password increases the chances of brute force attacks, so key can be used for login with the root.

RHEL9 ships with control groups and Podman, a container Management utility. These days, containers are the backbone of cloud and serverless architecture, and building, deploying and running a container has become easy with control groups and Podman.

Previous RedHat Linux versions always had a common problem: not allowing the user to select a version before installing a particular software. RHEL 9 addresses that problem. The version selection helps the user to pick the right version for applications/software to install, as per business and technical requirements.

RedHat is enhancing its solution with each new release, providing a reliable and consistent solution to enterprises. We saw that many enhancements to the Linux Kernel have been made by RedHat and are still being made. These enhancements to Linux Kernel make RHEL a popular choice among enterprises.

Before looking at the installation of RHEL, let us study Linux core concepts. The next few sections will discuss Linux fundamentals briefly. Those who are already familiar with Linux internals and concepts can skip this section and move directly to the installation process.

## Linux architecture

Linux Kernel and a set of software packages make up the Linux OS. Important components of the Linux OS are Kernel, system library, utility programs, hardware layer and shell.

### Kernel

Any Linux OS distribution is based on Linux Kernel, which is the core part of Linux OS. It is fully developed in C language and interacts directly with the hardware. It performs all the fundamental operations of OS, such as hardware communication, memory management, process management, file management and service requests. It is the kernel that interacts with the hardware and the user processes. Linux kernel is a completely abstract layer,

invisible to the user, working in its own kernel space. Kernel has full access to system resources such as CPU and memory. So, if kernel crashes, the entire Linux OS crashes. To interact with the hardware, a set of software called system libraries are implemented at the OS level.

## System libraries

System libraries are used for implementing the operating system functionality, such as hardware communication. These system libraries are used to interact with the kernel to perform OS functionalities.

## Utility programs/applications

Utility programs/applications are required to manage system at user level and let the users perform their daily duties. User programs run at their own space. They are the processes managed by kernel but do not have access to all the system resources. So, when a user program/process crashes, the OS is still running.

## Shell

This is one of the pillars of Linux System. The beauty of Linux lies in shell, and Shell is what makes me love Linux. Seems silly? It's not. We hope you will feel the same after you learn about it in greater detail. Shell acts as an agent that sits between the user and the kernel. It take commands from the user and provides it to the kernel, and then the kernel preforms its functions, such as allocating memory and processor.

## Linux FileSystem

Linux File System is a hierarchical data structure that organizes data in the storage system. Data is stored in the form of files, as in other OSes such as Windows. Files are grouped into directories. When multiple files share common properties and are stored together in a group, it is a filesystem. There can be different filesystems supported in different Linux Distributions. Some of the commonly used filesystems are **ext2**, **ext3** and **ntfs**. Each filesystem is stored in a separate disk partition. So, we can say that files on Linux systems are physically organized into multiple filesystems and disk partitions. Logically, Linux filesystems are organized into a tree-like structure in the form of files, directories and subdirectories.

Root (*/*), being the top-level directory, is the parent directory in the Linux Filesystem. It is denoted by *'/'* (a forward slash). Any other subdirectories or files are stored inside the root directory (*/*). Whether it is user-created files or system-generated default files, they will reside only under the *'/'* directory.

By default, any Linux distribution has, at most, these files/directories inside the root (/) filesystem:

- `/bin`
- `/boot`
- `/dev`
- `/etc`
- `/home`
- `/lib`
- `/media`
- `/mnt`
- `/misc`
- `/opt`
- `/usr`
- `/root`
- `/sbin`
- `/tmp`
- `/proc`
- `/sys`
- `/var`

Each of these directories has been provided with some specific purposes. Some of the directories are being used to store just the system data, while other directories are user specific. Users can create further levels of subdirectories inside / (root) or any of its sub-directories with appropriate permissions. Each or some of the mentioned sub-directories may or may not be kept under separate disk partitions. Each partition is characterized by a filesystem. Further details regarding the Linux filesystem, specifically in RHEL, will be discussed in *Chapter 2, Linux File System and Administration*. What we have discussed so far would be sufficient to proceed with the installation of RHEL.

## SuperUser

Every Linux system has a top-level user known as root user. This is the default user created during installation. Root user is the powerful user who has all the access rights to the system and can view and do anything on the system. He is the super-user. Any

process or applications running on the system should not be owned or run by root. If any application is running with the privileges of root, then it can modify any system files or damage the complete system. When you install any software, you may have noticed that the use of root user is completely discouraged. A specific software that you install on the Linux machine should be owned by a specific non-root user who should be given only the permissions that are required for that software to perform its tasks. Moreover, root user is known to all as it is the default admin user on any Linux machine. A hacker may break into the system as the root user and perform any malicious activity. So, it is beneficial to never use this user; instead, create a normal user that can be given privileged rights to perform admin duties. Further details on delegation of super-user rights will be discussed in *Chapter 6, Managing Users and File Permissions*. Hopefully, this short discussion on super-user may have provided you with the sufficient knowledge to install the product which is the part of our next section.

## GUI

GUI gives you same experience with using Linux systems as you receive in Windows OS. Linux GUI provides you with an interface to interact with the system to perform some tasks. It gives you an experience of using desktop environments in Linux. Linux system provides multiple desktop environments, such as Gnome and KDE, but RHEL9 supports only Gnome. If you are more fascinated about GUI than about CLI, then *Chapter 12, Graphical User Interface*, is for you.

Now, we have enough knowledge about the Linux system to move on to the installation of RHEL 9.

## Installation of RHEL9

Now that you know some basics of Linux Fundamentals, you are ready to perform the installation procedures. RHEL9 can be installed in multiple ways. But here, we will talk only about standard methods and not the advanced ones. This chapter will demonstrate the default GUI-based Linux installation. The following section will show you the step-by-step installation of RHEL9 software.

## Getting the software

The first question that comes to your mind is to get the operating system. Here, we are talking about RedHat Enterprise Linux 9. It can be downloaded from the RedHat official website. The link to download RHEL9 software is <https://developers.RedHat.com/products/rhel/download>. With this link, you can download the trial version of the product or the subscription version.

Click on the **Download** button. It will ask you for your RedHat login credentials. If you don't have them, just register yourself and proceed with the login on the website.

After you log in, the software will begin to download automatically. After the download is complete, you will receive an iso image file **rhel-baseos-9.0-x86\_64-dvd** of size 7.99 GB.

You can perform the installation on VMware or on a standalone machine. You also have the option to dual-boot your machine along with Windows or other operating systems. But the scope of this book is limited; we will only show the installation on a stand-alone machine or on a Windows machine. If you have a Windows machine, you can download and install VMware on it, and install and learn Linux inside VMware. In rest of the chapters, this book will be using standalone Linux installation box to demonstrate the concepts.

## Hardware compatibility

Let's discuss the prerequisites of the machine you are going to install RHEL9 on. However, the installation is completed without any glitch in most modern machines. The prerequisites are as follows:

- **Processor architecture:**

The CPU Architecture that is supported by RHEL9 are listed below:

- o AMD, Intel and ARM 64-bit Architectures
- o IBM Power Systems, Little Endian
- o 64-bit IBM Z

- **Disk space requirement:**

You must have at least 10 GB of free disk space available to install RHEL9.

- **Memory requirement:**

Recommended minimum RAM is 1.5GB.

## Installation using VMware

This section assumes that you have Windows machine with 64-bit CPU architecture. We will use VMware Workstation Player 16 to install VMware and then RHEL9.

## Download and install VMware

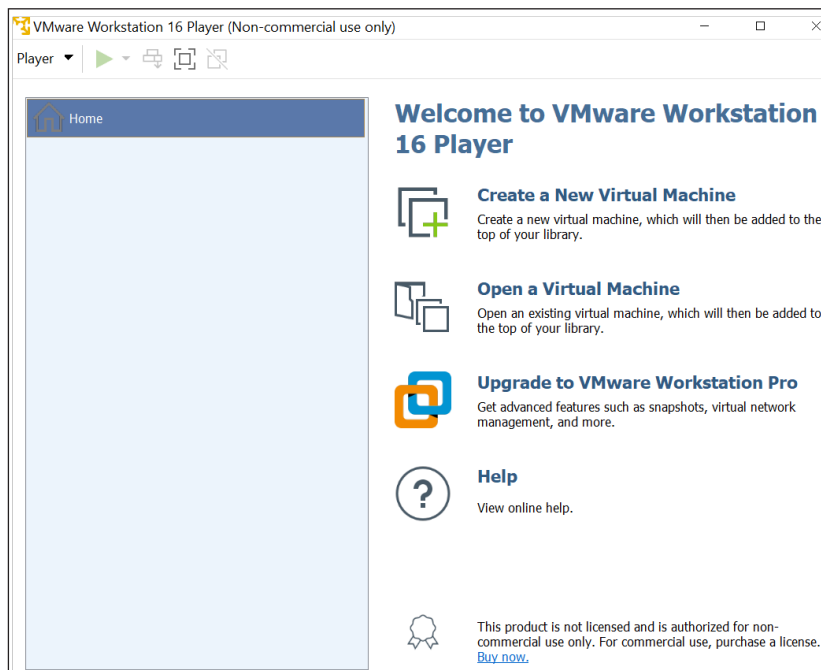
You can follow these steps to download and then install VMware:

1. You can download VMware using the following link:

[https://customerconnect.vmware.com/downloads/info/slug/desktop\\_end\\_user\\_computing/vmware\\_workstation\\_player/16\\_0](https://customerconnect.vmware.com/downloads/info/slug/desktop_end_user_computing/vmware_workstation_player/16_0)

Check whether the **Select Version** scroll button shows **16.0**. Click on **Go to Downloads**.

2. Scroll down and choose your platform. Click **Download Now** to start the VMware download.
3. You will receive an **.exe** file. Execute the file to install VMware software. This is GUI-based installation. Proceed to complete all the steps prompted, and your software will be ready to use.
4. The first screen asks, **Do you want to allow this app to make changes in your device** now? Click **Yes**.
5. Click **Next** on the **Welcome** screen.
6. On the next window, accept the license agreement and click **Next**.
7. Move to the following windows with all the default options set, and your installation will begin.
8. Click on **Finish** after it completes the installation.
9. Now, you can open your VMware from the **Start Menu**, as shown in *Figure 1.1*:



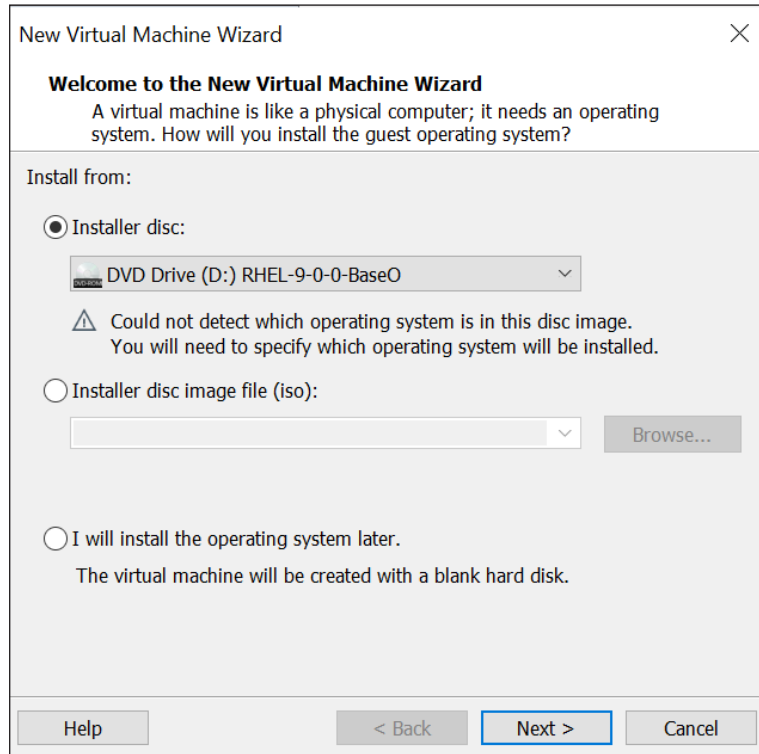
*Figure 1.1: VMware Workstation Player*

## Using VMware

Open VMware workstation from the **Start Menu**. You have to create a new Virtual Machine to install RHEL9 software. Following are the steps to create a new virtual machine:



1. Click on the **Create a New Virtual Machine** option to create a new virtual machine. **New Virtual Machine wizard** will open, as shown in *Figure 1.2*:



*Figure 1.2: New VM Wizard:choosing iso to install*

If you have already downloaded RHEL9 software’s iso, the system will detect it automatically. Use the default **Installer disc**: option. Else, select your installer disc image **.iso** file by clicking on the **Browse** button for the **Installer disc image file (iso)**: option. Click on **Next**.

2. The next window will ask you which OS you are going to install in this virtual machine. Select **Linux** for **Guest Operating System**. **Version** drop-down allows you to choose the version of the OS that you are going to install.

**Note: The version of VMware that this book is using is VMware Workstation 16 and this does not support RHEL9 which can become visible in future releases of VMware Workstation Player.**

So, choose **Other Linux 5.x kernel 64-bit** as RHEL9 is based on **kernel version 5.14**.

Refer to *Figure 1.3*:

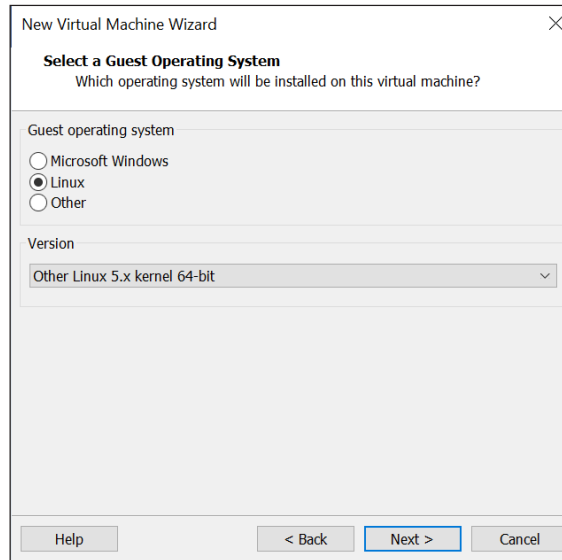


Figure 1.3: Selecting the type of OS that is being installed on VM

Click on **Next**.

3. Type the name of your new machine, using which you would like to identify it. We call it RHEL9Box. Choose the location where you want to keep your virtual machine. You can leave the default unchanged, as shown in Figure 1.4:

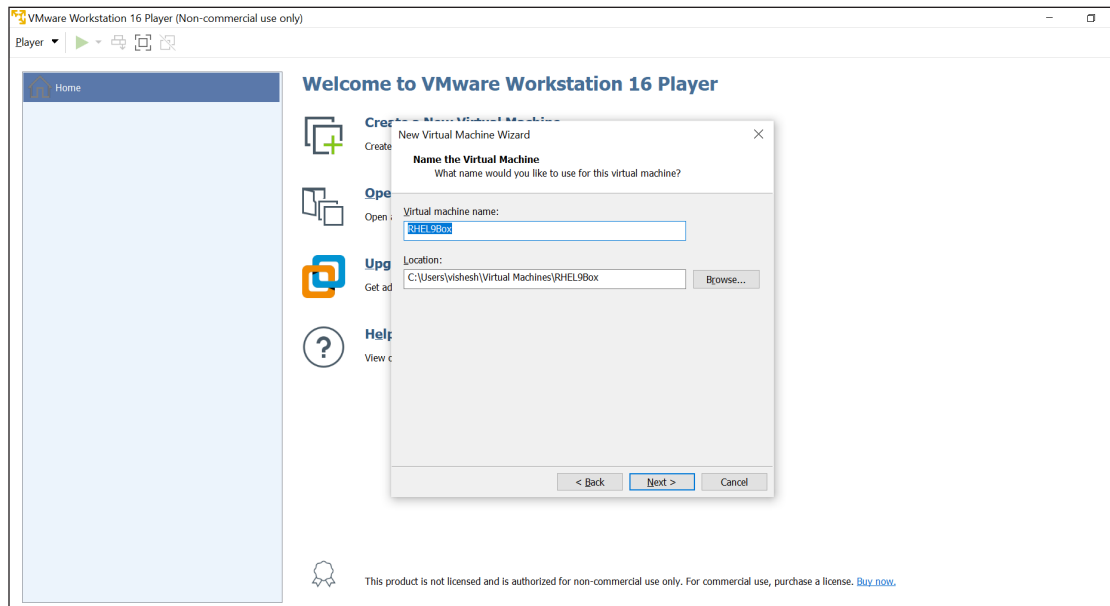
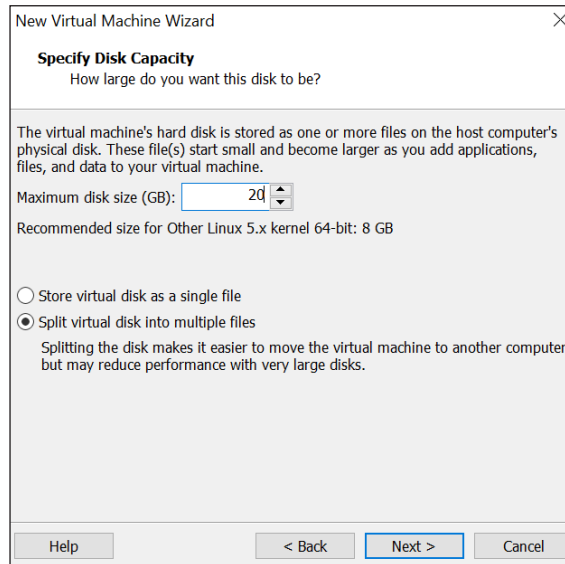


Figure 1.4: Choosing name and location of new VM

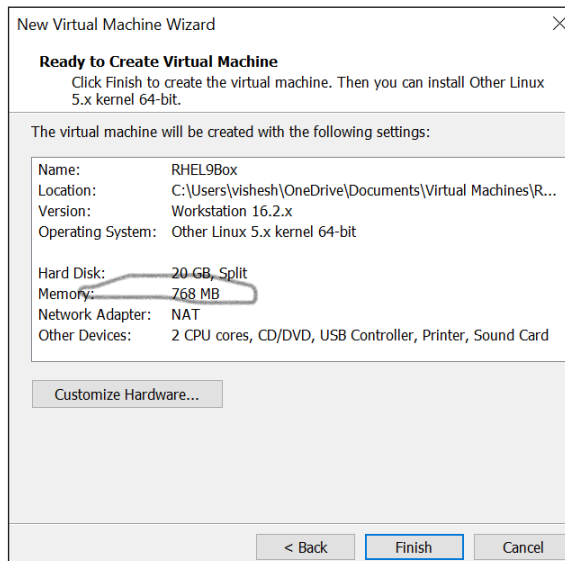
Click on the **Next** button.

4. It will ask you for the maximum disk size. Choose a value more than the required minimum. Let's choose **20 GB**. You can choose any number greater than 10 if your system free space allows you to do so, as shown in *Figure 1.5*:



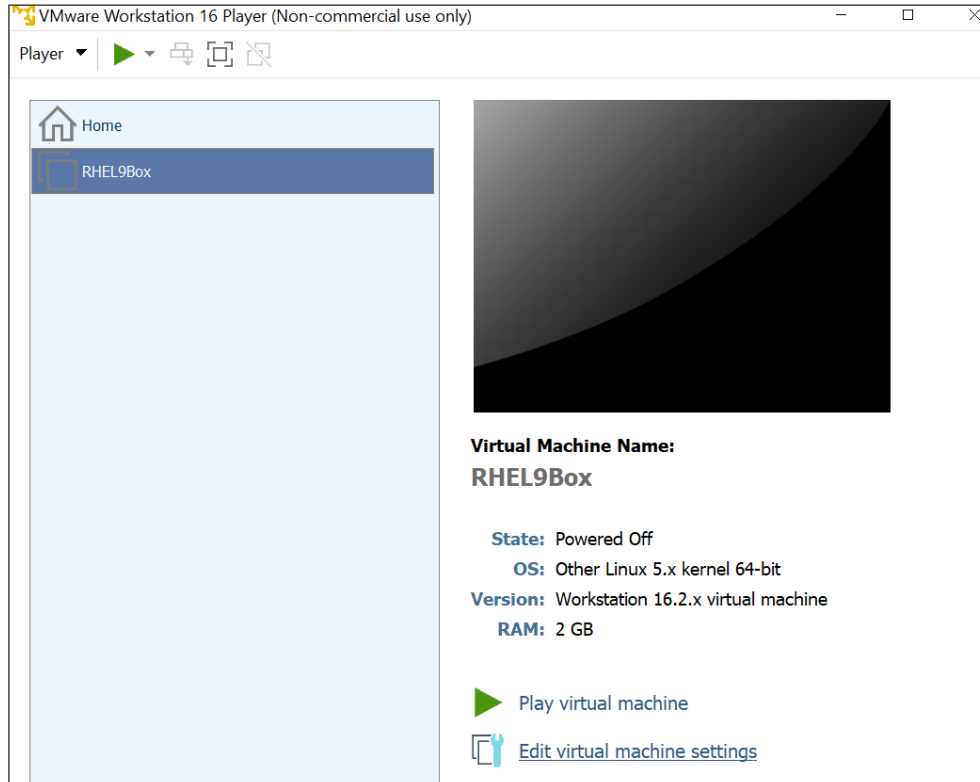
*Figure 1.5: Choosing correct disk size to install RHEL9*

5. The next window (see *Figure 1.6*) will show you the configuration using which your newly virtual machine will be created.



*Figure 1.6: Summary configuration of virtual machine that is to be created; memory size is not optimal here and needs to increase*

We have read that the minimum required RAM is 1.5 GB, but it lists only 768 MB. So, let's click on the **Customize Hardware** button and set memory to **1.5 GB**. You can set more than the minimum required. Click on **Finish** after setting the required memory size.



*Figure 1.7: A blank VM with no OS installed on it*

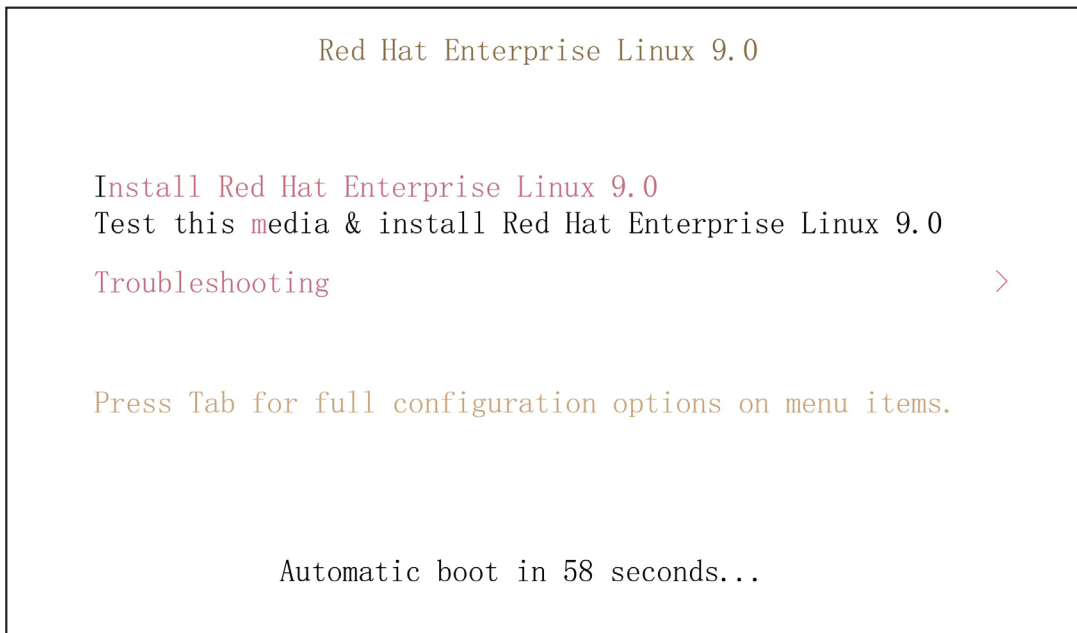
6. After this step, your virtual machine will be ready to power on. But what we have created so far is a blank machine with no OS in it, as shown in *Figure 1.7*. We have already provided the RHEL9 software iso file path while creating this virtual machine so that your virtual box knows about it. This iso will be used to install the OS on this particular VM.

## Installation of RHEL9 on Virtual Machine

By now, your virtual machine is ready to start with the installation procedures. These steps can be followed for the same:

1. Right now, your virtual machine is in the power off state. Let's power it on by clicking on the **Play Virtual Machine** option. Just ensure that the name of your newly created virtual machine is highlighted in the left pane.

2. Your virtual machine will automatically be booted using the DVD iso file that we specified while installing VMware.
3. *Figure 1.8* is the first screen that you will see when installing RHEL9. It will ask you to choose one option among these three:
  - **Install Red Hat Enterprise Linux 9.0:** This will immediately start RHEL Installer and the process to install RHEL 9.
  - **Test this media and install red hat Enterprise Linux 9.0:** This option is the default. It first verifies the integrity of your OS software and starts the installation.
  - **Troubleshooting:** This option only troubleshoots the existing installation.



*Figure 1.8: The first screen when RHEL9 installation starts*

Let us choose option 1, **Install Red Hat Enterprise Linux 9.0** using up and down arrow keys from the keyboard.

4. Then, it will show you a few lines of text. You should not worry about these lines at this stage of learning. These are just the logs or some testing that is being performed by the installer. After it displays enormous lines of logs on the screen, installation moves into GUI, which is supported by Anaconda.
5. In the next window, select your **Language** and click on **Continue**, as shown in *Figure 1.9*:

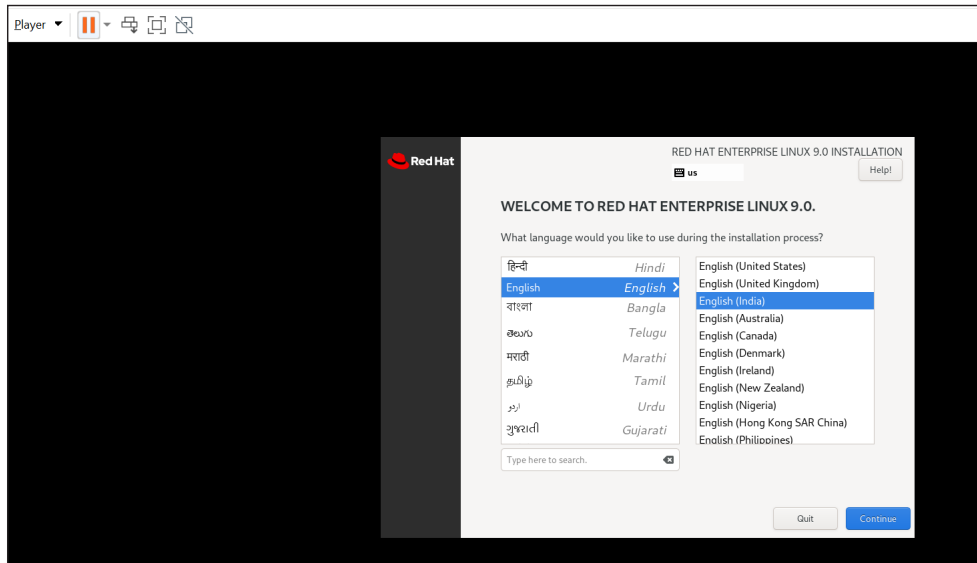


Figure 1.9: Anaconda installer asks to choose your language preference

6. Next, the installation summary is shown, as illustrated in Figure 1.10:

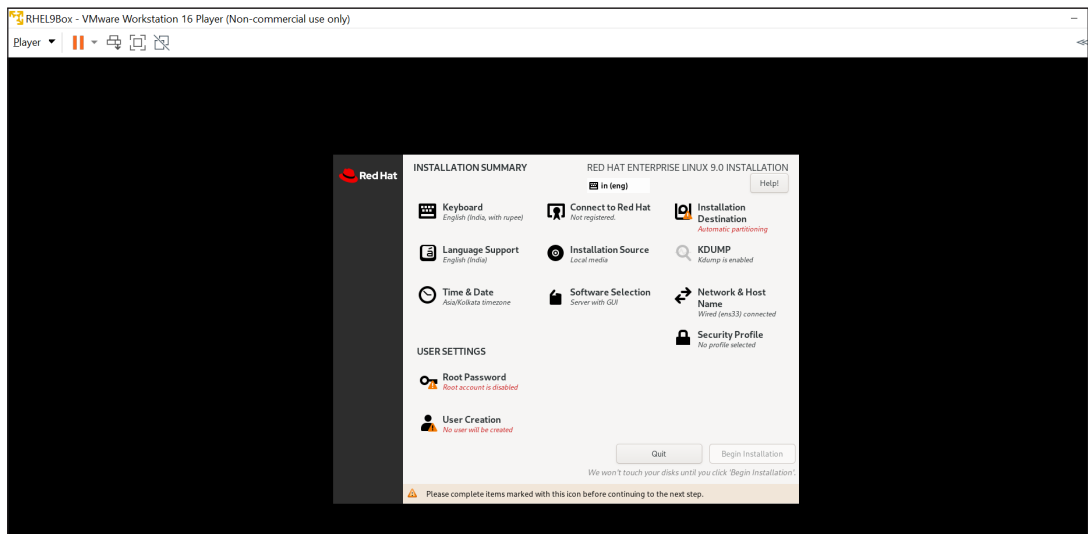
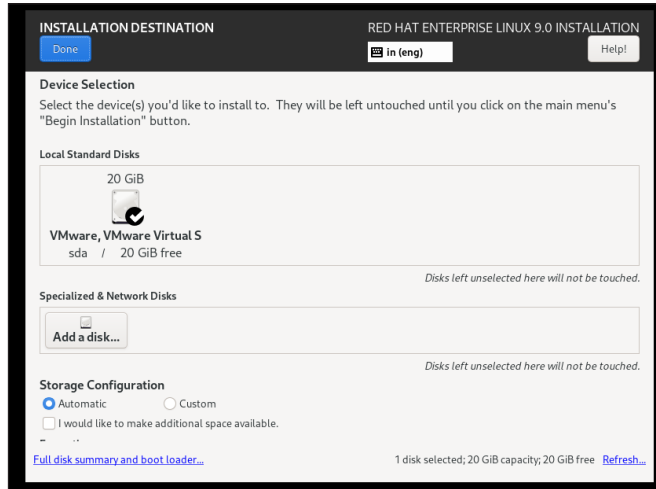


Figure 1.10: Anaconda Installer displaying installation summary and all the configuration using which RHEL9 will be installed.

Here, you must take action on marked items.

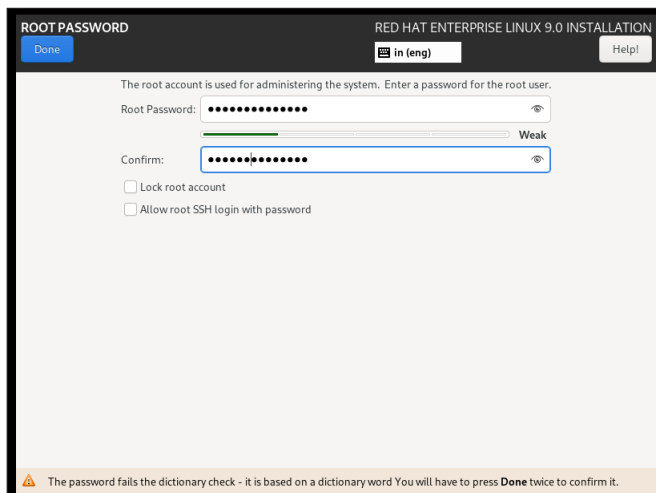
7. Let us click on **Installation destination** to verify the disk where the software will be installed and whether it is overwriting any useful data (Figure 1.11).

It will show you the virtual disk that you just created, while creating your virtual machine. See *Figure 1.11*; leave all the default values and click on **Done**.



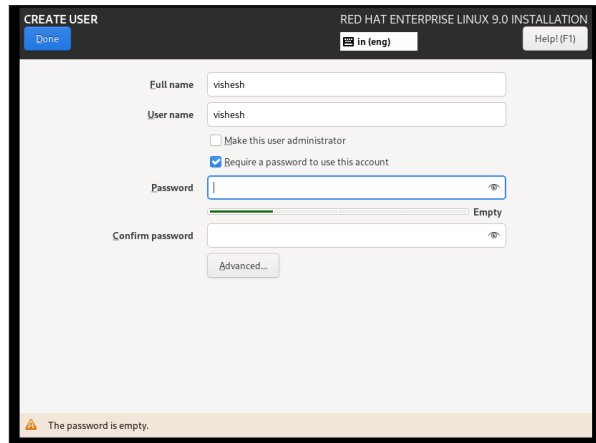
*Figure 1.11: Anaconda Installer: Storage disk verification*

8. It will jump to the previous installation summary window, as shown in *Figure 1.10*, to take action on other marked points. Another point to take action for is **Root Password**. So, click on **Root Password**. Here, the root account is locked. Let's unlock it and set the password. It will open a window that prompts for root password. Enter the root password and confirm it. You will notice that the password is not echoed on the screen. This is due to the security feature of Linux. Lock root account option is, by default, set to on. Turn it off as shown in *Figure 1.12* and click on **Done**.



*Figure 1.12: Setting root password*

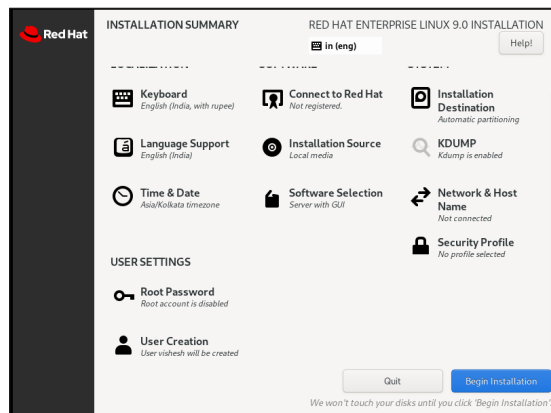
9. Once again, you will receive the installation summary window, as shown in *Figure 1.10*. See whether any other points are left for certain action. You will see that **User Creation** requires an action. Click on **User Creation**.



*Figure 1.13: Creating a non-root user*

This window will allow you to create a normal or non-root user. Enter the **Full name**, **Username** and **password** of the new user and click on **Done**, as shown in *Figure 1.13*. When you enter the password, this window will also verify the password strength. This is, again, a security feature in Linux, as simple passwords can be guessed easily. It is recommended to never use dictionary-based or plain passwords. If you have used dictionary-based or plain password here, you must click the **Done** button twice. To make your password strong, use a combination of letters, digits, and special symbols.

10. Now, you will come back to the installation summary. After you have verified all the points listed here, the **Begin Installation** button is activated and can be clicked on, as shown in *Figure 1.14*:

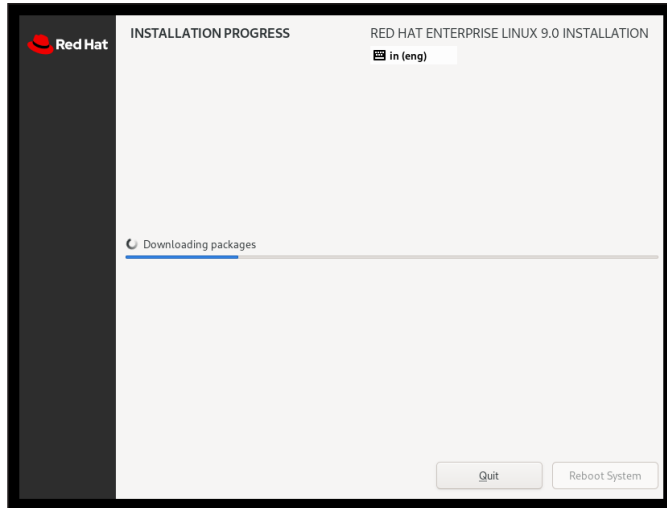


*Figure 1.14: Final installation summary,*



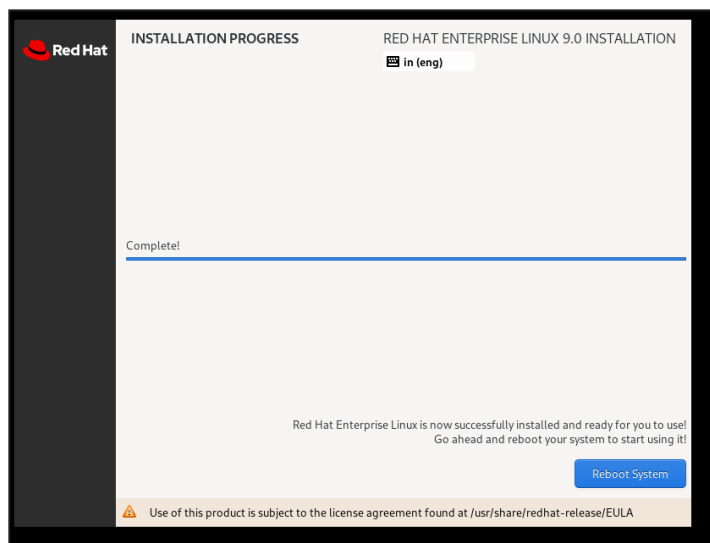
After this the installation proceeds without any **Back** or **Rewind** button; used disk will be overwritten even if you press **Quit** in the middle of the installation

11. Now, your installation will begin. You will see the window shown in *Figure 1.15*:



*Figure 1.15: rhel9.0 Installtion in progress*

12. In a few minutes, the installation will be completed. In the last screen of installation, as shown in *Figure 1.16*, it will prompt you to **Reboot** your system to explore your new RHEL box.



*Figure 1.16: Installation Complete Window*

13. Click on **Reboot System**.

## Installation using bootable pendrive

In this section, we will see how we can install RHEL9 on an individual machine with no OS in it, or on one with an OS and data that can be safely deleted to reuse the space.

### Preparing bootable USB

You can perform the installation on a standalone machine by using a pendrive that must be bootable. This section will demonstrate how you can prepare bootable USB media. There are various free tools available to prepare a bootable USB. Here, we will use **Fedora MediaWriter**. Follow these steps to write an iso file to a USB pendrive:

1. You can download **Fedora MediaWriter** using the following link:  
**Releases FedoraQt/MediaWriter-GitHub**  
Open the link and download the software for Windows.
2. Insert your USB drive into the correct port.
3. Double-click the exe file that is downloaded for *Fedora MediaWriter*.
4. Press **yes** when it asks for your permission to make changes to your device.
5. Then, accept the license agreement when it prompts.
6. It then opens *Fedora Media Writer Setup Window*, which will install Fedora Media Writer on your machine. The progress bar can be seen on this window.
7. At last, click on **Finish** to close the Fedora Media Writer Setup Window, and you can ensure that the **Run Fedora Media Writer** option is checked in this window, as shown in *Figure 1.17*.

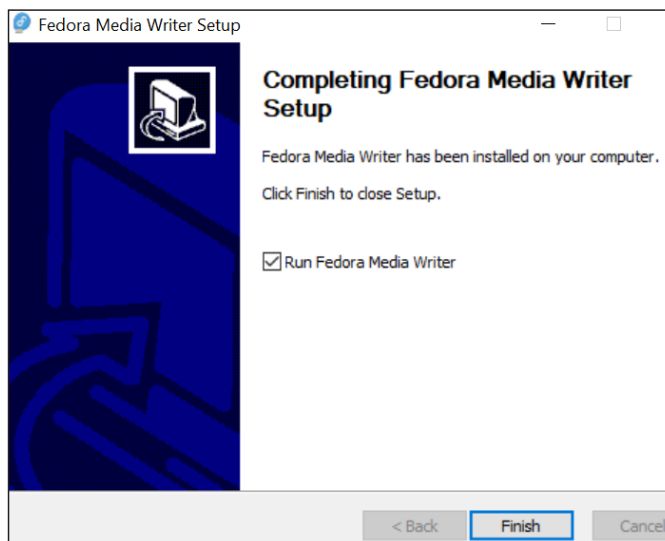
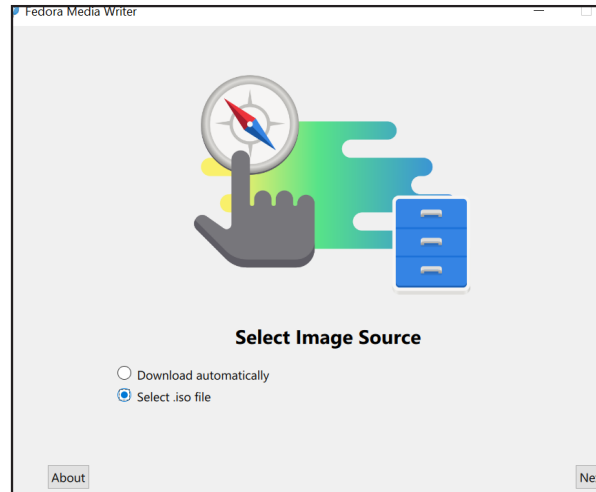


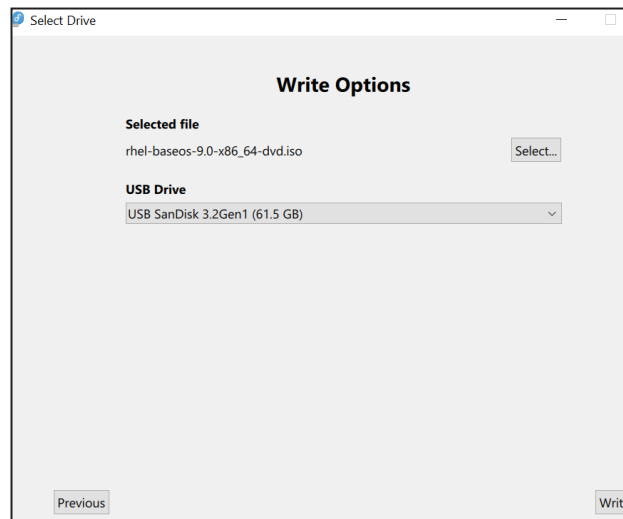
Figure 1.17: Completing the setup of Fedora Media Writer

8. Open Fedora Media Writer if it is not already open.
9. It will first prompt you to select the image source, as shown in *Figure 1.18*. Select the **.iso** file radio button since we have already downloaded the **.iso** file. Click on **Next**.



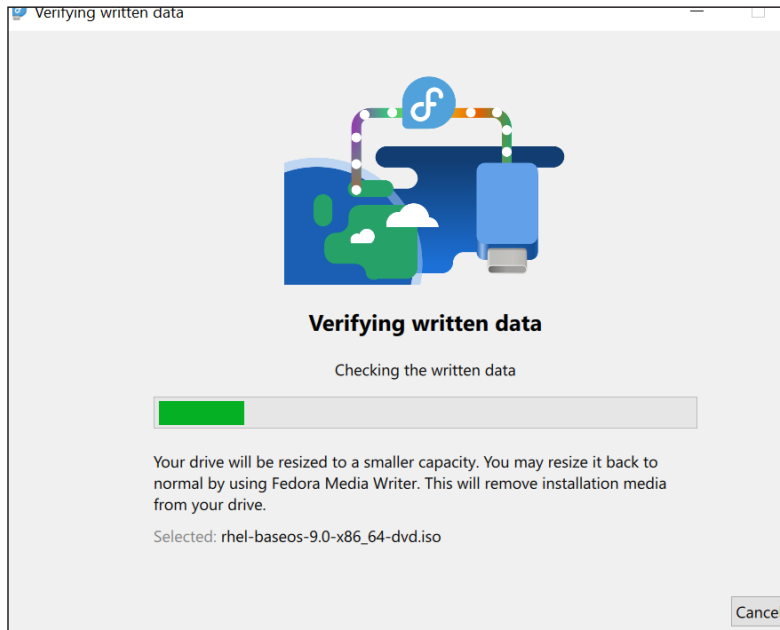
*Figure 1.18: Fedora Media Writer: selecting the source iso file to write on USB pendrive*

10. Then, it will ask you to select a source and destination for writing. For source, click on the **Select...** button to select your downloaded iso file. The destination drive will automatically be detected if inserted, as shown in *Figure 1.19*. Here, you can see that Fedora Media Writer has automatically detected the USB drive for writing. Click on **Write**.



*Figure 1.19: Fedora Media Writer: Verifying source and destination for writing image*

11. In the next window, as shown in *Figure 1.20*, the process to create a bootable USB drive starts.



*Figure 1.20: Fedora Media Writer: writing rhel9.0 iso to USB media*

It will take some time. So, be patient and let the process complete. After it completes successfully, click on finish and close the window.

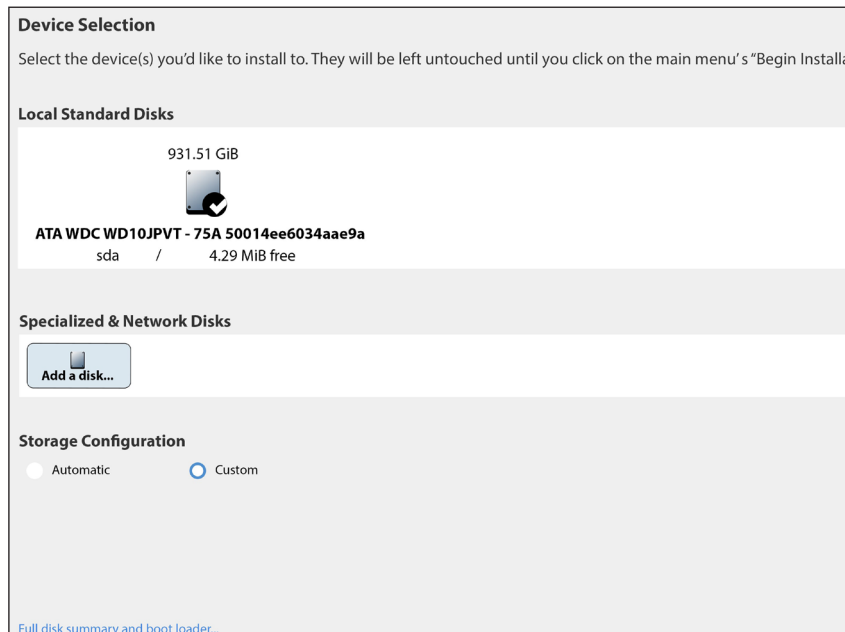
## Installing RHEL9 using bootable USB

We have just created a bootable media. Let's use this media to install RHEL9 on a new or old machine. You can follow these steps to install RHEL9 software:

1. Insert your bootable media in the machine where you want to install RHEL9 software.
2. Power on your machine with bootable media.
3. Your system should know that you want to boot using USB media and not from the hard disk. You have to set this priority by entering **BOOT Options**. To enter **BOOT Options**, you are required to press some keys when it is powered on. You have to check that key yourself according to your machine's model. In most machines, the machine boots into **BOOT Options** by pressing *F12*, but in some, the *Del* key works to do this.
4. After you enter **BOOT Options**, choose **USB media** and reboot the machine. Now, your machine boots from bootable USB.

5. The first screen that you receive is the same as *Figure 1.8*. Select **Install Red Hat Enterprise Linux 9.0** using the up and down arrow keys.
6. Some lines of logs will be displayed next.
7. Then, it will open Anaconda installer window. At first, it asks you to choose **Language**, as shown in *Figure 1.9*. After choosing your language preference, click on **Continue**.
8. Next, the installer will take you to the installation **Summary** window, as shown in *Figure 1.10*.
9. Click on the installation destination to verify this.

Next, the **Installation Destination** window opens. It will show you disks that are available/attached to this machine. If this is a used machine, then you have to decide whether you want to overwrite all the disks' data and make all the used space available to your new installation, or you want to use only the available free space. If you choose to overwrite all the disk data, you cannot get your data back after the installation begins. If you only want to use the free space available, then you are on the safer side. Be very careful while selecting the options in the forthcoming windows, as any mistake here will delete all your existing data on the hard disk. This demo will choose to delete all the data and provide all the used disk space to the installation of RHEL9.0. Refer to *Figure 1.21*. Here, the system hard disk has almost no disk space available. Choose **Storage Configuration Automatic** here (this is the default option set), and click **Done**.



*Figure 1.21: Anaconda Installer: Verifying storage disk for installation*

- Click on **Done**; it show you a window as shown in *Figure 1.22*. It will describe to you the actions that you can take if you have very little amount of disk space available.

**INSTALLATION OPTIONS**

Your current [Red Hat Enterprise Linux software selection](#) requires **13.8 GiB** of available space, including **6.04 GiB** for software and **7.76 GiB** for swap space. The disks you've selected have the following amounts of free space:

**4.29 MiB** Free space available for use.

**838.67 GiB** Free space unavailable but reclaimable from existing partitions.

You don't have enough space available to install Red Hat Enterprise Linux. You can shrink or remove existing partitions via our guided reclaim space tool, or you can adjust your partitions on your own in the custom partitioning interface.

Cancel & add more disks
Reclaim space

*Figure 1.22: Anaconda Installer: Reclaim space if you want to use all the used disk data*

If you have decided to use all the used space as you do not need the data further, click on **Reclaim Space**.

**RECLAIM DISK SPACE**

You can remove existing file systems you no longer need to free up space for this installation. Removing a file system will permanently delete all of the data it contains.

There is also free space available in pre-existing file systems. While it's risky and we recommend you back up your data first, you can recover that free disk space and make it available for this installation below.

Disk	Name	File System	Reclaimable Space	Action
931.5 GiB ATA WDC WD10JPVT - 75A 50014ee6034aae9a	sda		838.67 GiB total	Preserve
— / (Kali GNU/Linux 2021.2 for x86_64)	sda1	ext4	262.2 GiB of 279.4 GiB	Preserve
— /var (Kali GNU/Linux 2021.2 for x86_64)	sda5	ext4	83.7 GiB of 93.1 GiB	Preserve
— /tmp (Kali GNU/Linux 2021.2 for x86_64)	sda6	ext4	46.1 GiB of 46.6 GiB	Preserve
— /home (Kali GNU/Linux 2021.2 for x86_64)	sda7	ext4	446.7 GiB of 512.4 GiB	Preserve
Free space			4.3 MiB	

Preserve
Delete
Shrink
Delete all

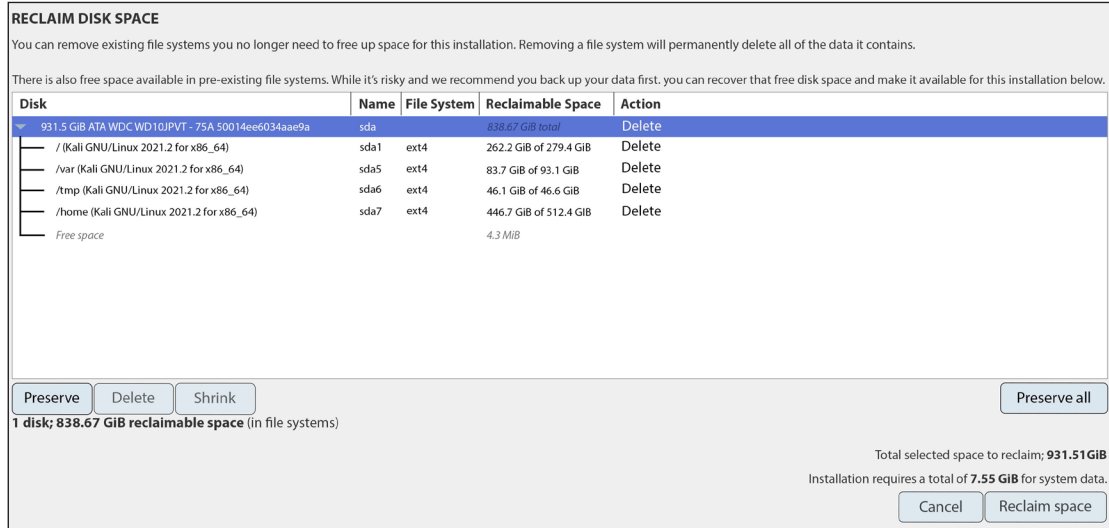
**1 disk; 838.67 GiB reclaimable space** (in file systems)

Total selected space to reclaim; **0**  
Installation requires a total of **7.55 GiB** for system data.

Cancel
Reclaim space

*Figure 1.23: Anaconda: Clicking on Delete or Delete all button marks selected disk or all the disks to be deleted during installation*

- Then, it will show you the **Reclaim Disk Space** window, as shown in *Figure 1.23*, where you can select the disk partition that can be deleted. You have the option to either preserve the partition or delete it. Be careful here; if you want to delete all the partitions, select the disk and click on the **Delete all** button.



*Figure 1.24: Anaconda: Reclaim Disk Space: Second chance to preserve any storage disk or its partition during installation*

- In *Figure 1.24*, you can see that the installer marked all the partitions of the disk to be deleted during installation. Here, you have the chance to preserve any partition if you want. Click on **Reclaim space**. The **Installation Destination** window opens again. Click on **Done** in this window.
- Next, you will get the **Installation Summary** window once again. Here, you have to take actions on the remaining marked points. Follow steps 8 to 13 mentioned in the *Installation of RHEL9 on Virtual Machine* section.

## Using RHEL machine

Now that you have the RHEL9 box ready, our next task is to get familiar with our new machine. This section will show you how will you can log in to the RHEL9 box and run various commands to fetch information about your machine.

## Logging In

After you reboot the machine, you will get the login page, asking for the password of a normal user that you have created during the installation process. Type the password and press *Enter*.