

Linux Essentials

Linux Essentials is a professional development certificate program that covers basic knowledge for those working and studying Open Source and various distributions of Linux.

Exam Objectives Version: Version 1.5 (last updated: May 2015)

Exam Covered: Linux Essentials (LPI-010); Exam 1 of 1 to obtain Linux Essentials Professional Development Certificate

Objectives Reflected in Published Exam: May 2015

Required Prerequisite: None

About Objective Weights: Each objective is assigned a weighting value. The weights range roughly from 1 to 10 and indicate the relative importance of each objective. Objectives with higher weights will be covered in the exam with more questions.

Special Note! To accommodate candidates that have studied from the previous version of the objectives (version 1.0), candidates may elect to take [version 1.0](#) of the Linux Essentials exam through November 2015 just make sure to select 010-100 for the old version of the exam. [More details...](#)

Linux Essentials Exam Objectives Topics:

- [1 – The Linux community and a career in open source](#)
- [2 – Finding your way on a Linux system](#)
- [3 – The power of the command line](#)
- [4 – The Linux operating system](#)
- [5 – Security and file permissions](#)

Topic 1: The Linux Community and a Career in Open Source (weight: 7)

1.1 Linux Evolution and Popular Operating Systems

Weight: 2

Description: Knowledge of Linux development and major distributions.

Key Knowledge Areas:

- Open Source Philosophy
- Distributions
- Embedded Systems

The following is a partial list of the used files, terms and utilities:

- Android
- Debian, Ubuntu (LTS)
- CentOS, openSUSE, Red Hat
- Linux Mint, Scientific Linux

1.2 Major Open Source Applications

Weight: 2

Description: Awareness of major applications as well as their uses and development.

Key Knowledge Areas:

- Desktop Applications
- Server Applications
- Development Languages

- Package Management Tools and repositories

Terms and Utilities:

- OpenOffice.org, LibreOffice, Thunderbird, Firefox, GIMP
- Apache HTTPD, NGINX, MySQL, NFS, Samba
- C, Java, Perl, shell, Python, Samba
- dpkg, apt-get, rpm, yum

1.3 Understanding Open Source Software and Licensing

Weight: 1

Description: Open communities and licensing Open Source Software for business.

Key Knowledge Areas:

- Licensing
- Free Software Foundation (FSF), Open Source Initiative (OSI)

Terms and Utilities:

- GPL, BSD, Creative Commons
- Free Software, Open Source Software, FOSS, FLOSS
- Open Source business models

1.4 ICT Skills and Working in Linux

Weight: 2

Description: Basic Information and Communication Technology (ICT) skills and working in Linux.

Key Knowledge Areas:

- Desktop Skills
- Getting to the Command Line
- Industry uses of Linux, Cloud Computing and Virtualization

Terms and Utilities:

- Using a browser, privacy concerns, configuration options, searching the web and saving content
- Terminal and Console
- Password issues
- Privacy issues and tools
- Use of common open source applications in presentations and projects

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Topic 2: Finding Your Way on a Linux System (weight: 9)

2.1 Command Line Basics

Weight: 3

Description: Basics of using the Linux command line.

Key Knowledge Areas:

- Basic shell
- Command line syntax
- Variables
- Globbing
- Quoting

Terms and Utilities:

- Bash
- echo
- history
- PATH env variable
- export
- type

2.2 Using the Command Line to Get Help

Weight: 2

Description: Running help commands and navigation of the various help systems.

Key Knowledge Areas:

- Man
- Info

Terms and Utilities:

- man
- info
- Man pages
- /usr/share/doc/
- locate

2.3 Using Directories and Listing Files

Weight: 2

Description: Navigation of home and system directories and listing files in various locations.

Key Knowledge Areas:

- Files, directories
- Hidden files and directories
- Home
- Absolute and relative paths

Terms and Utilities:

- Common options for ls
- Recursive listings
- cd
- . and ..
- home and ~

2.4 Creating, Moving and Deleting Files

Weight: 2

Description: Create, move and delete files and directories under the home directory.

Key Knowledge Areas:

- Files and directories
- Case sensitivity
- Simple globbing and quoting

Terms and Utilities:

- mv, cp, rm, touch
- mkdir, rmdir

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Topic 3: The Power of the Command Line (weight: 9)

3.1 Archiving Files on the Command Line

Weight: 2

Description: Archiving files in the user home directory.

Key Knowledge Areas:

- Files, directories
- Archives, compression

Terms and Utilities:

- tar
- Common tar options
- gzip, bzip2
- zip, unzip

3.2 Searching and Extracting Data from Files

Weight: 3

Description: Search and extract data from files in the home directory.

Key Knowledge Areas:

- Command line pipes
- I/O re-direction
- Basic Regular Expressions ., [], *, ?

Terms and Utilities:

- grep
- less
- cat, head, tail
- sort
- cut
- wc

3.3 Turning Commands into a Script

Weight: 4

Description: Turning repetitive commands into simple scripts.

Key Knowledge Areas:

- Basic shell scripting
- Awareness of common text editors

Terms and Utilities:

- #! (shebang)
- /bin/bash
- Variables
- Arguments
- for loops
- echo
- Exit status

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Topic 4: The Linux Operating System (weight: 8)

4.1 Choosing aTerms and Utilities:

- mv, cp, rm, touch
- mkdir, rmdir

[Return to Top](#)n Operating System

Weight: 1

Description: Knowledge of major operating systems and Linux distributions.

Key Knowledge Areas:

- Windows, Mac, Linux differences
- Distribution life cycle management

Terms and Utilities:

- GUI versus command line, desktop configuration
- Maintenance cycles, Beta and Stable

4.2 Understanding Computer Hardware

Weight: 2

Description: Familiarity with the components that go into building desktop and server computers.

Key Knowledge Areas:

- Hardware

Terms and Utilities:

- Motherboards, processors, power supplies, optical drives, peripherals
- Hard drives and partitions, /dev/sd*
- Drivers

4.3 Where Data is Stored

Weight: 3

Description: Where various types of information are stored on a Linux system.

Key Knowledge Areas:

- Programs and configuration, packages and package databases
- Processes, memory addresses, system messaging and logging

Terms and Utilities:

- ps, top, free
- syslog, dmesg
- /etc/, /var/log/
- /boot/, /proc/, /dev/, /sys/

4.4 Your Computer on the Network

Weight: 2

Description: Querying vital networking configuration and determining the basic requirements for a

computer on a Local Area Network (LAN).

Key Knowledge Areas:

- Internet, network, routers
- Querying DNS client configuration
- Querying Network configuration

Terms and Utilities:

- route, ip route show
- ifconfig, ip addr show
- netstat, ip route show
- /etc/resolv.conf, /etc/hosts
- IPv4, IPv6
- ping
- host

Topic 5: Security and File Permissions (weight: 7)

5.1 Basic Security and Identifying User Types

Weight: 2

Description: Various types of users on a Linux system.

Key Knowledge Areas:

- Root and Standard Users
- System users

Terms and Utilities:

- /etc/passwd, /etc/group
- id, who, w
- sudo, su

5.2 Creating Users and Groups

Weight: 2

Description: Creating users and groups on a Linux system.

Key Knowledge Areas:

- User and group commands
- User IDs

Terms and Utilities:

- /etc/passwd, /etc/shadow, /etc/group, /etc/skel/
- id, last
- useradd, groupadd
- passwd

5.3 Managing File Permissions and Ownership

Weight: 2

Description: Understanding and manipulating file permissions and ownership settings.

Key Knowledge Areas:

- File/directory permissions and owners

Terms and Utilities:

- ls -l, ls -a
- chmod, chown

5.4 Special Directories and Files

Weight: 1

Description: Special directories and files on a Linux system including special permissions.

Key Knowledge Areas:

- Using temporary files and directories
- Symbolic links

Terms and Utilities:

- /tmp/, /var/tmp/ and Sticky Bit
- ls -d
- ln -s

LPIC-1 101

- [101 – System Architecture](#)
- [102 – Linux Installation and Package Management](#)
- [103 – GNU and Unix Commands](#)
- [104 – Devices, Linux Filesystems, Filesystem Hierarchy Standard](#)

Topic 101: System Architecture

101.1 Determine and configure hardware settings

Weight: 2

Description: Candidates should be able to determine and configure fundamental system hardware.

Key Knowledge Areas:

- Enable and disable integrated peripherals
- Configure systems with or without external peripherals such as keyboards
- Differentiate between the various types of mass storage devices
- Know the differences between coldplug and hotplug devices
- Determine hardware resources for devices
- Tools and utilities to list various hardware information (e.g. lsusb, lspci, etc.)
- Tools and utilities to manipulate USB devices
- Conceptual understanding of sysfs, udev, dbus

The following is a partial list of the used files, terms and utilities:

- /sys/
- /proc/
- /dev/
- modprobe
- lsmod
- lspci
- lsusb

101.2 Boot the system

Weight: 3

Description: Candidates should be able to guide the system through the booting process.

Key Knowledge Areas:

- Provide common commands to the boot loader and options to the kernel at boot time
- Demonstrate knowledge of the boot sequence from BIOS to boot completion
- Understanding of SysVinit and systemd
- Awareness of Upstart
- Check boot events in the log files

Terms and Utilities:

- dmesg
- BIOS
- bootloader
- kernel
- initramfs
- init
- SysVinit
- systemd

101.3 Change runlevels / boot targets and shutdown or reboot system

Weight: 3

Description: Candidates should be able to manage the SysVinit runlevel or systemd boot target of the system. This objective includes changing to single user mode, shutdown or rebooting the system. Candidates should be able to alert users before switching runlevels / boot targets and properly terminate processes. This objective also includes setting the default SysVinit runlevel or systemd boot target. It also includes awareness of Upstart as an alternative to SysVinit or systemd.

Key Knowledge Areas:

- Set the default runlevel or boot target
- Change between runlevels / boot targets including single user mode
- Shutdown and reboot from the command line
- Alert users before switching runlevels / boot targets or other major system events
- Properly terminate processes

Terms and Utilities:

- /etc/inittab
- shutdown
- init
- /etc/init.d/
- telinit
- systemd
- systemctl
- /etc/systemd/
- /usr/lib/systemd/
- wall

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Topic 102: Linux Installation and Package Management

102.1 Design hard disk layout

Weight: 2

Description: Candidates should be able to design a disk partitioning scheme for a Linux system.

Key Knowledge Areas:

- Allocate filesystems and swap space to separate partitions or disks
- Tailor the design to the intended use of the system
- Ensure the /boot partition conforms to the hardware architecture requirements for booting
- Knowledge of basic features of LVM

Terms and Utilities:

- / (root) filesystem
- /var filesystem
- /home filesystem
- /boot filesystem
- swap space
- mount points
- partitions

102.2 Install a boot manager

Weight: 2

Description: Candidates should be able to select, install and configure a boot manager.

Key Knowledge Areas:

- Providing alternative boot locations and backup boot options
- Install and configure a boot loader such as GRUB Legacy
- Perform basic configuration changes for GRUB 2
- Interact with the boot loader

The following is a partial list of the used files, terms and utilities:

- menu.lst, grub.cfg and grub.conf
- grub-install
- grub-mkconfig
- MBR

102.3 Manage shared libraries

Weight: 1

Description: Candidates should be able to determine the shared libraries that executable programs depend on and install them when necessary.

Key Knowledge Areas:

- Identify shared libraries
- Identify the typical locations of system libraries
- Load shared libraries

Terms and Utilities:

- ldd
- ldconfig
- /etc/ld.so.conf
- LD_LIBRARY_PATH

102.4 Use Debian package management

Weight: 3

Description: Candidates should be able to perform package management using the Debian package tools.

Key Knowledge Areas:

- Install, upgrade and uninstall Debian binary packages
- Find packages containing specific files or libraries which may or may not be installed
- Obtain package information like version, content, dependencies, package integrity and installation status (whether or not the package is installed)

Terms and Utilities:

- /etc/apt/sources.list
- dpkg
- dpkg-reconfigure
- apt-get
- apt-cache
- aptitude

102.5 Use RPM and YUM package management

Weight: 3

Description: Candidates should be able to perform package management using RPM and YUM tools.

Key Knowledge Areas:

- Install, re-install, upgrade and remove packages using RPM and YUM
- Obtain information on RPM packages such as version, status, dependencies, integrity and signatures
- Determine what files a package provides, as well as find which package a specific file comes from

Terms and Utilities:

- rpm
- rpm2cpio
- /etc/yum.conf
- /etc/yum.repos.d/
- yum
- yumdownloader

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Topic 103: GNU and Unix Commands

103.1 Work on the command line

Weight: 4

Description: Candidates should be able to interact with shells and commands using the command line. The objective assumes the Bash shell.

Key Knowledge Areas:

- Use single shell commands and one line command sequences to perform basic tasks on the command line

- Use and modify the shell environment including defining, referencing and exporting environment variables
- Use and edit command history
- Invoke commands inside and outside the defined path

Terms and Utilities:

- bash
- echo
- env
- export
- pwd
- set
- unset
- man
- uname
- history
- .bash_history

103.2 Process text streams using filters

Weight: 3

Description: Candidates should be able to apply filters to text streams.

Key Knowledge Areas:

- Send text files and output streams through text utility filters to modify the output using standard UNIX commands found in the GNU textutils package

Terms and Utilities:

- cat
- cut
- expand
- fmt
- head
- join
- less
- nl
- od
- paste
- pr
- sed
- sort
- split
- tail
- tr
- unexpand
- uniq
- wc

103.3 Perform basic file management

Weight: 4

Description: Candidates should be able to use the basic Linux commands to manage files and directories.

Key Knowledge Areas:

- Copy, move and remove files and directories individually
- Copy multiple files and directories recursively
- Remove files and directories recursively
- Use simple and advanced wildcard specifications in commands
- Using find to locate and act on files based on type, size, or time
- Usage of tar, cpio and dd

Terms and Utilities:

- cp
- find
- mkdir
- mv
- ls
- rm
- rmdir
- touch
- tar
- cpio
- dd
- file
- gzip
- gunzip
- bzip2
- xz
- file globbing

103.4 Use streams, pipes and redirects**Weight: 4**

Description: Candidates should be able to redirect streams and connect them in order to efficiently process textual data. Tasks include redirecting standard input, standard output and standard error, piping the output of one command to the input of another command, using the output of one command as arguments to another command and sending output to both stdout and a file.

Key Knowledge Areas:

- Redirecting standard input, standard output and standard error
- Pipe the output of one command to the input of another command
- Use the output of one command as arguments to another command
- Send output to both stdout and a file

Terms and Utilities:

- tee
- xargs

103.5 Create, monitor and kill processes**Weight: 4**

Description: Candidates should be able to perform basic process management.

Key Knowledge Areas:

- Run jobs in the foreground and background
- Signal a program to continue running after logout
- Monitor active processes
- Select and sort processes for display
- Send signals to processes

Terms and Utilities:

- &
- bg
- fg
- jobs
- kill
- nohup
- ps
- top
- free
- uptime
- pgrep
- pkill
- killall
- screen

103.6 Modify process execution priorities

Weight: 2

Description: Candidates should be able to manage process execution priorities.

Key Knowledge Areas:

- Know the default priority of a job that is created
- Run a program with higher or lower priority than the default
- Change the priority of a running process

Terms and Utilities:

- nice
- ps
- renice
- top

103.7 Search text files using regular expressions

Weight: 2

Description: Candidates should be able to manipulate files and text data using regular expressions. This objective includes creating simple regular expressions containing several notational elements. It also includes using regular expression tools to perform searches through a filesystem or file content.

Key Knowledge Areas:

- Create simple regular expressions containing several notational elements
- Use regular expression tools to perform searches through a filesystem or file content

Terms and Utilities:

- grep
- egrep
- fgrep
- sed
- regex(7)

103.8 Perform basic file editing operations using vi

Weight: 3

Description: Candidates should be able to edit text files using vi. This objective includes vi navigation, basic vi modes, inserting, editing, deleting, copying and finding text.

Key Knowledge Areas:

- Navigate a document using vi
- Use basic vi modes
- Insert, edit, delete, copy and find text

Terms and Utilities:

- vi
- /, ?
- h,j,k,l
- i, o, a
- c, d, p, y, dd, yy
- ZZ, :w!, :q!, :e!

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Topic 104: Devices, Linux Filesystems, Filesystem Hierarchy Standard

104.1 Create partitions and filesystems

Weight: 2

Description: Candidates should be able to configure disk partitions and then create filesystems on media such as hard disks. This includes the handling of swap partitions.

Key Knowledge Areas:

- Manage MBR partition tables
- Use various mkfs commands to create various filesystems such as:
 - ext2/ext3/ext4
 - XFS
 - VFAT
- Awareness of ReiserFS and Btrfs
- Basic knowledge of gdisk and parted with GPT

Terms and Utilities:

- fdisk
- gdisk
- parted
- mkfs
- mkswap

104.2 Maintain the integrity of filesystems

Weight: 2

Description: Candidates should be able to maintain a standard filesystem, as well as the extra data associated with a journaling filesystem.

Key Knowledge Areas:

- Verify the integrity of filesystems
- Monitor free space and inodes

- Repair simple filesystem problems

Terms and Utilities:

- du
- df
- fsck
- e2fsck
- mke2fs
- debugfs
- dumpe2fs
- tune2fs
- XFS tools (such as xfs_metadump and xfs_info)

104.3 Control mounting and unmounting of filesystems

Weight: 3

Description: Candidates should be able to configure the mounting of a filesystem.

Key Knowledge Areas:

- Manually mount and unmount filesystems
- Configure filesystem mounting on bootup
- Configure user mountable removable filesystems

Terms and Utilities:

- /etc/fstab
- /media/
- mount
- umount

104.4 Manage disk quotas

Weight: 1

Description: Candidates should be able to manage disk quotas for users.

Key Knowledge Areas:

- Set up a disk quota for a filesystem
- Edit, check and generate user quota reports

Terms and Utilities:

- quota
- edquota
- repquota
- quotaon

104.5 Manage file permissions and ownership

Weight: 3

Description: Candidates should be able to control file access through the proper use of permissions and ownerships.

Key Knowledge Areas:

- Manage access permissions on regular and special files as well as directories
- Use access modes such as suid, sgid and the sticky bit to maintain security
- Know how to change the file creation mask
- Use the group field to grant file access to group members

Terms and Utilities:

- chmod
- umask
- chown
- chgrp

104.6 Create and change hard and symbolic links

Weight: 2

Description: Candidates should be able to create and manage hard and symbolic links to a file.

Key Knowledge Areas:

- Create links
- Identify hard and/or soft links
- Copying versus linking files
- Use links to support system administration tasks

Terms and Utilities:

- ln
- ls

104.7 Find system files and place files in the correct location

Weight: 2

Description: Candidates should be thoroughly familiar with the Filesystem Hierarchy Standard (FHS), including typical file locations and directory classifications.

Key Knowledge Areas:

- Understand the correct locations of files under the FHS
- Find files and commands on a Linux system
- Know the location and purpose of important file and directories as defined in the FHS

Terms and Utilities:

- find
- locate
- updatedb
- whereis
- which
- type
- /etc/updatedb.conf

LPIC-1 102 Exam Objectives Topics:

- [105 – Shells, Scripting and Data Management](#)
- [106 – Interfaces and Desktops](#)
- [107 – Administrative Tasks](#)
- [108 – Essential System Services](#)
- [109 – Networking Fundamentals](#)
- [110 – Security](#)

Topic 105: Shells, Scripting and Data Management

105.1 Customize and use the shell environment

Weight: 4

Description: Candidates should be able to customize shell environments to meet users' needs. Candidates should be able to modify global and user profiles.

Key Knowledge Areas:

- Set environment variables (e.g. PATH) at login or when spawning a new shell
- Write Bash functions for frequently used sequences of commands
- Maintain skeleton directories for new user accounts
- Set command search path with the proper directory

The following is a partial list of the used files, terms and utilities:

- .
- source
- /etc/bash.bashrc
- /etc/profile
- env
- export
- set
- unset
- ~/.bash_profile
- ~/.bash_login
- ~/.profile
- ~/.bashrc
- ~/.bash_logout
- function
- alias
- lists

105.2 Customize or write simple scripts

Weight: 4

Description: Candidates should be able to customize existing scripts, or write simple new Bash scripts.

Key Knowledge Areas:

- Use standard sh syntax (loops, tests)
- Use command substitution
- Test return values for success or failure or other information provided by a command
- Perform conditional mailing to the superuser
- Correctly select the script interpreter through the shebang (!) line
- Manage the location, ownership, execution and suid-rights of scripts

Terms and Utilities:

- for
- while
- test
- if
- read
- seq
- exec

105.3 SQL data management

Weight: 2

Description: Candidates should be able to query databases and manipulate data using basic SQL commands. This objective includes performing queries involving joining of 2 tables and/or subselects.

Key Knowledge Areas:

- Use of basic SQL commands
- Perform basic data manipulation

Terms and Utilities:

- insert
- update
- select
- delete
- from
- where
- group by
- order by
- join

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Topic 106: User Interfaces and Desktops

106.1 Install and configure X11

Weight: 2

Description: Candidates should be able to install and configure X11.

Key Knowledge Areas:

- Verify that the video card and monitor are supported by an X server
- Awareness of the X font server
- Basic understanding and knowledge of the X Window configuration file

Terms and Utilities:

- /etc/X11/xorg.conf
- xhost
- DISPLAY
- xwininfo
- xdpyinfo
- X

106.2 Setup a display manager

Weight: 1

Description: Candidates should be able to describe the basic features and configuration of the LightDM display manager. This objective covers awareness of the display managers XDM (X Display Manager), GDM (Gnome Display Manager) and KDM (KDE Display Manager).

Key Knowledge Areas:

- Basic configuration of LightDM
- Turn the display manager on or off
- Change the display manager greeting
- Awareness of XDM, KDM and GDM

Terms and Utilities:

- lightdm
- /etc/lightdm/

106.3 Accessibility

Weight: 1

Description: Demonstrate knowledge and awareness of accessibility technologies.

Key Knowledge Areas:

- Basic knowledge of keyboard accessibility settings (AccessX)
- Basic knowledge of visual settings and themes
- Basic knowledge of assistive technology (ATs)

Terms and Utilities:

- Sticky/Repeat Keys
- Slow/Bounce/Toggle Keys
- Mouse Keys
- High Contrast/Large Print Desktop Themes
- Screen Reader
- Braille Display
- Screen Magnifier
- On-Screen Keyboard
- Gestures (used at login, for example GDM)
- Orca
- GOK
- emacspeak

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Topic 107: Administrative Tasks

107.1 Manage user and group accounts and related system files

Weight: 5

Description: Candidates should be able to add, remove, suspend and change user accounts.

Key Knowledge Areas:

- Add, modify and remove users and groups
- Manage user/group info in password/group databases
- Create and manage special purpose and limited accounts

Terms and Utilities:

- /etc/passwd
- /etc/shadow
- /etc/group

- /etc/skel/
- chage
- getent
- groupadd
- groupdel
- groupmod
- passwd
- useradd
- userdel
- usermod

107.2 Automate system administration tasks by scheduling jobs

Weight: 4

Description: Candidates should be able to use cron or anacron to run jobs at regular intervals and to use at to run jobs at a specific time.

Key Knowledge Areas:

- Manage cron and at jobs
- Configure user access to cron and at services
- Configure anacron

Terms and Utilities:

- /etc/cron.{d,daily,hourly,monthly,weekly}/
- /etc/at.deny
- /etc/at.allow
- /etc/crontab
- /etc/cron.allow
- /etc/cron.deny
- /var/spool/cron/
- crontab
- at
- atq
- atrm
- anacron
- /etc/anacrontab

107.3 Localisation and internationalisation

Weight: 3

Description: Candidates should be able to localize a system in a different language than English. As well, an understanding of why LANG=C is useful when scripting.

Key Knowledge Areas:

- Configure locale settings and environment variables
- Configure timezone settings and environment variables

Terms and Utilities:

- /etc/timezone
- /etc/localtime
- /usr/share/zoneinfo/
- LC_*
- LC_ALL
- LANG
- TZ

- /usr/bin/locale
- tzselect
- timedatectl
- date
- iconv
- UTF-8
- ISO-8859
- ASCII
- Unicode

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Topic 108: Essential System Services

108.1 Maintain system time

Weight: 3

Description: Candidates should be able to properly maintain the system time and synchronize the clock via NTP.

Key Knowledge Areas:

- Set the system date and time
- Set the hardware clock to the correct time in UTC
- Configure the correct timezone
- Basic NTP configuration
- Knowledge of using the pool.ntp.org service
- Awareness of the ntpq command

Terms and Utilities:

- /usr/share/zoneinfo/
- /etc/timezone
- /etc/localtime
- /etc/ntp.conf
- date
- hwclock
- ntpd
- ntpdate
- pool.ntp.org

108.2 System logging

Weight: 3

Description: Candidates should be able to configure the syslog daemon. This objective also includes configuring the logging daemon to send log output to a central log server or accept log output as a central log server. Use of the systemd journal subsystem is covered. Also, awareness of rsyslog and syslog-ng as alternative logging systems is included.

Key Knowledge Areas:

- Configuration of the syslog daemon
- Understanding of standard facilities, priorities and actions
- Configuration of logrotate
- Awareness of rsyslog and syslog-ng

Terms and Utilities:

- syslog.conf
- syslogd
- klogd
- /var/log/
- logger
- logrotate
- /etc/logrotate.conf
- /etc/logrotate.d/
- journalctl
- /etc/systemd/journald.conf
- /var/log/journal/

108.3 Mail Transfer Agent (MTA) basics

Weight: 3

Description: Candidates should be aware of the commonly available MTA programs and be able to perform basic forward and alias configuration on a client host. Other configuration files are not covered.

Key Knowledge Areas:

- Create e-mail aliases
- Configure e-mail forwarding
- Knowledge of commonly available MTA programs (postfix, sendmail, qmail, exim) (no configuration)

Terms and Utilities:

- ~/.forward
 - sendmail emulation layer commands
 - newaliases
 - mail
 - mailq
 - postfix
 - sendmail
 - exim
 - qmail
-
- ~/.forward
 - sendmail emulation layer commands
 - newaliases

108.4 Manage printers and printing

Weight: 2

Description: Candidates should be able to manage print queues and user print jobs using CUPS and the LPD compatibility interface.

Key Knowledge Areas:

- Basic CUPS configuration (for local and remote printers)
- Manage user print queues
- Troubleshoot general printing problems
- Add and remove jobs from configured printer queues

Terms and Utilities:

- CUPS configuration files, tools and utilities

- /etc/cups/
- lpd legacy interface (lpr, lprm, lpq)

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Topic 109: Networking Fundamentals

109.1 Fundamentals of internet protocols

Weight: 4

Description: Candidates should demonstrate a proper understanding of TCP/IP network fundamentals.

Key Knowledge Areas:

- Demonstrate an understanding of network masks and CIDR notation
- Knowledge of the differences between private and public “dotted quad” IP addresses
- Knowledge about common TCP and UDP ports and services (20, 21, 22, 23, 25, 53, 80, 110, 123, 139, 143, 161, 162, 389, 443, 465, 514, 636, 993, 995)
- Knowledge about the differences and major features of UDP, TCP and ICMP
- Knowledge of the major differences between IPv4 and IPv6
- Knowledge of the basic features of IPv6

Terms and Utilities:

- /etc/services
- IPv4, IPv6
- Subnetting
- TCP, UDP, ICMP

109.2 Basic network configuration

Weight: 4

Description: Candidates should be able to view, change and verify configuration settings on client hosts.

Key Knowledge Areas:

- Manually and automatically configure network interfaces
- Basic TCP/IP host configuration
- Setting a default route

Terms and Utilities:

- /etc/hostname
- /etc/hosts
- /etc/nsswitch.conf
- ifconfig
- ifup
- ifdown
- ip
- route
- ping

109.3 Basic network troubleshooting

Weight: 4

Description: Candidates should be able to troubleshoot networking issues on client hosts.

Key Knowledge Areas:

- Manually and automatically configure network interfaces and routing tables to include adding, starting, stopping, restarting, deleting or reconfiguring network interfaces
- Change, view, or configure the routing table and correct an improperly set default route manually
- Debug problems associated with the network configuration

Terms and Utilities:

- ifconfig
- ip
- ifup
- ifdown
- route
- host
- hostname
- dig
- netstat
- ping
- ping6
- traceroute
- traceroute6
- tracepath
- tracepath6
- netcat

109.4 Configure client side DNS

Weight: 2

Description: Candidates should be able to configure DNS on a client host.

Key Knowledge Areas:

- Query remote DNS servers
- Configure local name resolution and use remote DNS servers
- Modify the order in which name resolution is done

Terms and Utilities:

- /etc/hosts
- /etc/resolv.conf
- /etc/nsswitch.conf
- host
- dig
- getent

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Topic 110: Security

110.1 Perform security administration tasks

Weight: 3

Description: Candidates should know how to review system configuration to ensure host security in accordance with local security policies.

Key Knowledge Areas:

- Audit a system to find files with the suid/sgid bit set
- Set or change user passwords and password aging information
- Being able to use nmap and netstat to discover open ports on a system
- Set up limits on user logins, processes and memory usage
- Determine which users have logged in to the system or are currently logged in
- Basic sudo configuration and usage

Terms and Utilities:

- find
- passwd
- fuser
- lsof
- nmap
- chage
- netstat
- sudo
- /etc/sudoers
- su
- usermod
- ulimit
- who, w, last

110.2 Setup host security

Weight: 3

Description: Candidates should know how to set up a basic level of host security.

Key Knowledge Areas:

- Awareness of shadow passwords and how they work
- Turn off network services not in use
- Understand the role of TCP wrappers

Terms and Utilities:

- /etc/nologin
- /etc/passwd
- /etc/shadow
- /etc/xinetd.d/
- /etc/xinetd.conf
- /etc/inetd.d/
- /etc/inetd.conf
- /etc/inittab
- /etc/init.d/
- /etc/hosts.allow
- /etc/hosts.deny

110.3 Securing data with encryption

Weight: 3

Description: The candidate should be able to use public key techniques to secure data and communication.

Key Knowledge Areas:

- Perform basic OpenSSH 2 client configuration and usage
- Understand the role of OpenSSH 2 server host keys
- Perform basic GnuPG configuration, usage and revocation
- Understand SSH port tunnels (including X11 tunnels)

Terms and Utilities:

- ssh
- ssh-keygen
- ssh-agent
- ssh-add
- ~/.ssh/id_rsa and id_rsa.pub
- ~/.ssh/id_dsa and id_dsa.pub
- /etc/ssh/ssh_host_rsa_key and ssh_host_rsa_key.pub
- /etc/ssh/ssh_host_dsa_key and ssh_host_dsa_key.pub
- ~/.ssh/authorized_keys
- ssh_known_hosts
- gpg
- ~/.gnupg/

LPIC-2 201

- [200 – Capacity Planning](#)
- [201 – Linux Kernel](#)
- [202 – System Startup](#)
- [203 – Filesystem and Devices](#)
- [204 – Advanced Storage Device Administration](#)
- [205 – Networking Configuration](#)
- [206 – System Maintenance](#)

Topic 200: Capacity Planning

200.1 Measure and Troubleshoot Resource Usage

Weight: 6

Description: Candidates should be able to measure hardware resource and network bandwidth, identify and troubleshoot resource problems.

Key Knowledge Areas:

- Measure CPU usage
- Measure memory usage
- Measure disk I/O
- Measure network I/O
- Measure firewalling and routing throughput
- Map client bandwidth usage
- Match / correlate system symptoms with likely problems
- Estimate throughput and identify bottlenecks in a system including networking

The following is a partial list of the used files, terms and utilities:

- iostat
- netstat

- w
- top
- sar
- processes blocked on I/O
- blocks out
- vmstat
- pstree, ps
- Isof
- uptime
- swap
- blocks in

200.2 Predict Future Resource Needs

Weight: 2

Description: Candidates should be able to monitor resource usage to predict future resource needs.

Key Knowledge Areas:

- Use collectd to monitor IT infrastructure usage
- Predict capacity break point of a configuration
- Observe growth rate of capacity usage
- Graph the trend of capacity usage
- Awareness of monitoring solutions such as Nagios, MRTG and Cacti

The following is a partial list of the used files, terms and utilities:

- diagnose
- predict growth
- resource exhaustion

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Topic 201: Linux Kernel

201.1 Kernel Components

Weight: 2

Description: Candidates should be able to utilize kernel components that are necessary to specific hardware, hardware drivers, system resources and requirements. This objective includes implementing different types of kernel images, identifying stable and development kernels and patches, as well as using kernel modules.

Key Knowledge Areas:

- Kernel 2.6.x documentation
- Kernel 3.x documentation

Terms and Utilities:

- /usr/src/linux/
- zImage
- /usr/src/linux/Documentation/
- bzImage

201.2 Compiling a kernel

Weight: 3

Description: Candidates should be able to properly configure a kernel to include or disable specific features of the Linux kernel as necessary. This objective includes compiling and recompiling the Linux kernel as needed, updating and noting changes in a new kernel, creating an initrd image and installing new kernels.

Key Knowledge Areas:

- /usr/src/linux/
- Kernel Makefiles
- Kernel 2.6.x/3.x make targets
- Customize the current kernel configuration.
- Build a new kernel and appropriate kernel modules.
- Install a new kernel and any modules.
- Ensure that the boot manager can locate the new kernel and associated files.
- Module configuration files
- Awareness of dracut

Terms and Utilities:

- mkinitrd
- mkinitramfs
- make
- bzip2
- make targets (all, config, xconfig, menuconfig, gconfig, oldconfig, mrproper, zImage, bzImage, modules, modules_install, rpm-pkg, binrpm-pkg, deb-pkg)
- gzip
- module tool
- /usr/src/linux/.confi
- /lib/modules/kernel-version/
- depmod

201.3 Kernel runtime management and troubleshooting

Weight: 4

Description: Candidates should be able to manage and/or query a 2.6.x or 3.x kernel and its loadable modules. Candidates should be able to identify and correct common boot and run time issues. Candidates should understand device detection and management using udev. This objective includes troubleshooting udev rules.

Key Knowledge Areas:

- Use command-line utilities to get information about the currently running kernel and kernel modules
- Manually load and unload kernel modules
- Determine when modules can be unloaded
- Determine what parameters a module accepts
- Configure the system to load modules by names other than their file name.
- /proc filesystem
- Content of /, /boot/, and /lib/modules/
- Tools and utilities to analyze information about the available hardware
- udev rules

Terms and Utilities:

- /lib/modules/kernel-version/modules.dep
- module configuration files in /etc/
- /proc/sys/kernel/
- /sbin/depmod
- /sbin/rmmod
- /sbin/modinfo
- /bin/dmesg

- /sbin/lspci
- /usr/bin/lsdev
- /sbin/lsmmod
- /sbin/modprobe
- /sbin/insmod
- /bin/uname
- /usr/bin/lusb
- /etc/sysctl.conf, /etc/sysctl.d/
- /sbin/sysctl
- udevmonitor
- udevadm monitor
- /etc/udev/

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Topic 202: System Startup

202.1 Customizing SysV-init system startup

Weight: 3

Description: Candidates should be able to query and modify the behaviour of system services at various run levels. A thorough understanding of the init structure and boot process is required. This objective includes interacting with run levels.

Key Knowledge Areas:

- Linux Standard Base Specification (LSB)
- SysV init environment

Terms and Utilities:

- /etc/inittab
- /etc/init.d/
- /etc/rc.d/
- chkconfig
- update-rc.d
- init and telinit

202.2 System Recovery

Weight: 4

Description: Candidates should be able to properly manipulate a Linux system during both the boot process and during recovery mode. This objective includes using both the init utility and init-related kernel options. Candidates should be able to determine the cause of errors in loading and usage of bootloaders. GRUB version 2 and GRUB Legacy are the bootloaders of interest.

Key Knowledge Areas:

- GRUB version 2 and Legacy
- Grub shell
- Boot loader start and hand off to kernel
- Kernel loading
- Hardware initialization and setup
- Daemon/service initialization and setup
- Know the different boot loader install locations on a hard disk or removable device
- Overwriting standard boot loader options and using boot loader shells
- Awareness of UEFI

Terms and Utilities:

- mount
- fsck
- inittab, telinit and init with SysV init
- the contents of /boot/ and /boot/grub/
- GRUB
- grub-install
- initrd, initramfs
- Master boot record

202.3 Alternate Bootloaders

Weight: 2

Description: Candidates should be aware of other bootloaders and their major features.

Key Knowledge Areas:

- LILO
- SYSLINUX, ISOLINUX, PXELINUX
- Understanding of PXE

Terms and Utilities:

- lilo, /etc/lilo.conf
- syslinux
- extlinux
- isolinux.bin
- isolinux.cfg
- pxelinux.0
- pxelinux.cfg/

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Topic 203: Filesystem and Devices

203.1 Operating the Linux filesystem

Weight: 4

Description: Candidates should be able to properly configure and navigate the standard Linux filesystem. This objective includes configuring and mounting various filesystem types.

Key Knowledge Areas:

- The concept of the fstab configuration
- Tools and utilities for handling SWAP partitions and files
- Use of UUIDs

Terms and Utilities:

- /etc/fstab
- /etc/mtab
- /proc/mounts
- mount and umount
- sync
- swapon
- swapoff

203.2 Maintaining a Linux filesystem

Weight: 3

Description: Candidates should be able to properly maintain a Linux filesystem using system utilities. This objective includes manipulating standard filesystems and monitoring SMART devices.

Key Knowledge Areas:

- Tools and utilities to manipulate and ext2, ext3 and ext4
- Tools and utilities to manipulate xfs
- Awareness of Btrfs

Terms and Utilities:

- fsck (fsck.*)
- mkfs (mkfs.*)
- dumpe2fs, xfsdump, xfsrestore
- debugfs
- tune2fs
- mkswap
- xfs_info, xfs_check and xfs_repair
- smartd, smartctl

203.3 Creating and configuring filesystem options

Weight: 2

Description: Candidates should be able to configure automount filesystems using AutoFS. This objective includes configuring automount for network and device filesystems. Also included is creating filesystems for devices such as CD-ROMs and a basic feature knowledge of encrypted filesystems.

Key Knowledge Areas:

- autofs configuration files
- UDF and ISO9660 tools and utilities
- Awareness of CD-ROM filesystems (UDF, ISO9660, HFS)
- Awareness of CD-ROM filesystem extensions (Joliet, Rock Ridge, El Torito)
- Basic feature knowledge of encrypted filesystems

Terms and Utilities:

- /etc/auto.master
- /etc/auto.[dir]
- mkisofs

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Topic 204: Advanced Storage Device Administration

204.1 Configuring RAID

Weight: 3

Description: Candidates should be able to configure and implement software RAID. This objective includes using and configuring RAID 0, 1 and 5.

Key Knowledge Areas:

- Software raid configuration files and utilities

Terms and Utilities:

- mdadm.conf
- mdadm
- /proc/mdstat
- partition type 0xFD

204.2 Adjusting Storage Device Access

Weight: 2

Description: Candidates should be able to configure kernel options to support various drives. This objective includes software tools to view & modify hard disk settings including iSCSI devices.

Key Knowledge Areas:

- Tools and utilities to configure DMA for IDE devices including ATAPI and SATA
- Tools and utilities to manipulate or analyze system resources (e.g. interrupts)
- Awareness of sdparm command and its uses
- Tools and utilities for iSCSI

Terms and Utilities:

- hdparm, sdparm
- tune2fs
- sysctl
- /dev/hd*, /dev/sd*
- iscsiadm, scsi_id, iscsid and iscsid.conf
- WWID, WWN, LUN numbers

204.3 Logical Volume Manager

Weight: 3

Description: Candidates should be able to create and remove logical volumes, volume groups, and physical volumes. This objective includes snapshots and resizing logical volumes.

Key Knowledge Areas:

- Tools in the LVM suite
- Resizing, renaming, creating, and removing logical volumes, volume groups, and physical volumes
- Creating and maintaining snapshots
- Activating volume groups

Terms and Utilities:

- /sbin/pv*
- /sbin/lv*
- /sbin/vg*
- mount
- /dev/mapper/

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Topic 205: Network Configuration

205.1 Basic networking configuration

Weight: 3

Description: Candidates should be able to configure a network device to be able to connect to a local, wired or wireless, and a wide-area network. This objective includes being able to communicate between various subnets within a single network including both IPv4 and IPv6 networks.

Key Knowledge Areas:

- Utilities to configure and manipulate ethernet network interfaces
- Configuring basic access to wireless networks with iw, iwconfig and iwlist

Terms and Utilities:

- /sbin/route
- /sbin/ifconfig
- /sbin/ip
- /usr/sbin/arp
- /sbin/iwconfig
- /sbin/iwlist

205.2 Advanced Network Configuration and Troubleshooting

Weight: 4

Description: Candidates should be able to configure a network device to implement various network authentication schemes. This objective includes configuring a multi-homed network device and resolving communication problems.

Key Knowledge Areas:

- Utilities to manipulate routing tables
- Utilities to configure and manipulate ethernet network interfaces
- Utilities to analyze the status of the network devices
- Utilities to monitor and analyze the TCP/IP traffic

Terms and Utilities:

- /sbin/route
- /sbin/ifconfig
- /bin/netstat
- /bin/ping
- /usr/sbin/arp
- /usr/sbin/tcpdump
- /usr/sbin/lsof
- /usr/bin/nc
- /sbin/ip
- nmap

205.3 Troubleshooting Network Issues

Weight: 4

Description: Candidates should be able to identify and correct common network setup issues, to include knowledge of locations for basic configuration files and commands.

Key Knowledge Areas:

- Location and content of access restriction files

- Utilities to configure and manipulate ethernet network interfaces
- Utilities to manage routing tables
- Utilities to list network states.
- Utilities to gain information about the network configuration
- Methods of information about the recognized and used hardware devices
- System initialization files and their contents (SysV init process)
- Awareness of NetworkManager and its impact on network configuration

Terms and Utilities:

- /sbin/ifconfig
- /sbin/route
- /bin/netstat
- /etc/network/, /etc/sysconfig/network-scripts/
- /bin/ping
- System log files such as /var/log/syslog & /var/log/messages
- /etc/resolv.conf
- /etc/hosts
- /etc/hostname, /etc/HOSTNAME
- /bin/hostname
- /usr/sbin/traceroute
- /bin/dmesg
- /etc/hosts.allow, /etc/hosts.deny

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Topic 206: System Maintenance

206.1 Make and install programs from source

Weight: 2

Description: Candidates should be able to build and install an executable program from source. This objective includes being able to unpack a file of sources.

Key Knowledge Areas:

- Unpack source code using common compression and archive utilities
- Understand basics of invoking make to compile programs
- Apply parameters to a configure script
- Know where sources are stored by default

Terms and Utilities:

- /usr/src/
- gunzip
- gzip
- bzip2
- tar
- configure
- make
- uname
- install
- patch

206.2 Backup operations

Weight: 3

Description: Candidates should be able to use system tools to back up important system data.

Key Knowledge Areas:

- Knowledge about directories that have to be include in backups
- Awareness of network backup solutions such as Amanda, Bacula and BackupPC
- Knowledge of the benefits and drawbacks of tapes, CDR, disk or other backup media
- Perform partial and manual backups
- Verify the integrity of backup files
- Partially or fully restore backups

Terms and Utilities:

- /bin/sh
- dd
- tar
- /dev/st* and /dev/nst*
- mt
- rsync

206.3 Notify users on system-related issues

Weight: 1

Description: Candidates should be able to notify the users about current issues related to the system.

Key Knowledge Areas:

- Automate communication with users through logon messages
- Inform active users of system maintenance

Terms and Utilities:

- /etc/issue
- /etc/issue.net
- /etc/motd
- wall
- /sbin/shutdown

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- [208 – Web Services](#)
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- [210 – Network Client Management](#)
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Topic 207: Domain Name Server

207.1 Basic DNS server configuration

Weight: 3

Description: Candidates should be able to configure BIND to function as a caching-only DNS server. This objective includes the ability to managing a running server and configuring logging.

Key Knowledge Areas:

- BIND 9.x configuration files, terms and utilities
- Defining the location of the BIND zone files in BIND configuration files

- Reloading modified configuration and zone files
- Awareness of dnsmasq, djbdns and PowerDNS as alternate name servers

The following is a partial list of the used files, terms and utilities:

- /etc/named.conf
- /var/named/
- /usr/sbin/rndc
- kill
- host
- dig

207.2 Create and maintain DNS zones

Weight: 3

Description: Candidates should be able to create a zone file for a forward or reverse zone and hints for root level servers. This objective includes setting appropriate values for records, adding hosts in zones and adding zones to the DNS. A candidate should also be able to delegate zones to another DNS server.

Key Knowledge Areas:

- BIND 9 configuration files, terms and utilities
- Utilities to request information from the DNS server
- Layout, content and file location of the BIND zone files
- Various methods to add a new host in the zone files, including reverse zones

Terms and Utilities:

- /var/named/
- zone file syntax
- resource record formats
- dig
- nslookup
- host

207.3 Securing a DNS server

Weight: 2

Description: Candidates should be able to configure a DNS server to run as a non-root user and run in a chroot jail. This objective includes secure exchange of data between DNS servers.

Key Knowledge Areas:

- BIND 9 configuration files
- Configuring BIND to run in a chroot jail
- Split configuration of BIND using the forwarders statement
- Configuring and using transaction signatures (TSIG)
- Awareness of DNSSEC and basic tools

Terms and Utilities:

- /etc/named.conf
- /etc/passwd
- DNSSEC
- dnssec-keygen
- dnssec-signzone

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Topic 208: Web Services

208.1 Implementing a web server

Weight: 4

Description: Candidates should be able to install and configure a web server. This objective includes monitoring the server's load and performance, restricting client user access, configuring support for scripting languages as modules and setting up client user authentication. Also included is configuring server options to restrict usage of resources. Candidates should be able to configure a web server to use virtual hosts and customize file access.

Key Knowledge Areas:

- Apache 2.x configuration files, terms and utilities
- Apache log files configuration and content
- Access restriction methods and files
- mod_perl and PHP configuration
- Client user authentication files and utilities
- Configuration of maximum requests, minimum and maximum servers and clients
- Apache 2.x virtual host implementation (with and without dedicated IP addresses)
- Using redirect statements in Apache's configuration files to customize file access

Terms and Utilities:

- access logs and error logs
- .htaccess
- httpd.conf
- mod_auth
- htpasswd
- AuthUserFile, AuthGroupFile
- apache2ctl
- httpd

208.2 Apache configuration for HTTPS

Weight: 3

Description: Candidates should be able to configure a web server to provide HTTPS.

Key Knowledge Areas:

- SSL configuration files, tools and utilities
- Ability to generate a server private key and CSR for a commercial CA
- Ability to generate a self-signed Certificate from private CA
- Ability to install the key and Certificate
- Awareness of the issues with Virtual Hosting and use of SSL
- Security issues in SSL use

Terms and Utilities:

- Apache2 configuration files
- /etc/ssl/, /etc/pki/
- openssl, CA.pl
- SSLEngine, SSLCertificateKeyFile, SSLCertificateFile, SSLCertificateChainFile
- SSLCACertificateFile, SSLCACertificatePath
- SSLProtocol, SSLCipherSuite, ServerTokens, ServerSignature, TraceEnable

208.3 Implementing a proxy server

Weight: 2

Description: Candidates should be able to install and configure a proxy server, including access policies, authentication and resource usage.

Key Knowledge Areas:

- Squid 3.x configuration files, terms and utilities
- Access restriction methods
- Client user authentication methods
- Layout and content of ACL in the Squid configuration files

Terms and Utilities:

- squid.conf
- acl
- http_access

208.4 Implementing Nginx as a web server and a reverse proxy

Weight: 2

Description: Candidates should be able to install and configure a reverse proxy server, Nginx. Basic configuration of Nginx as a HTTP server is included.

Key Knowledge Areas:

- Nginx
- Reverse Proxy
- Basic Web Server

Terms and Utilities:

- /etc/nginx/
- nginx

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Topic 209: File Sharing

209.1 SAMBA Server Configuration

Weight: 5

Description: Candidates should be able to set up a SAMBA server for various clients. This objective includes setting up Samba for login clients and setting up the workgroup in which a server participates and defining shared directories and printers. Also covered is a configuring a Linux client to use a Samba server. Troubleshooting installations is also tested.

Key Knowledge Areas:

- Samba 3 documentation
- Samba configuration files
- Samba tools and utilities
- Mounting Samba shares on Linux
- Samba daemons
- Mapping Windows usernames to Linux usernames
- User-Level and Share-Level security

Terms and Utilities:

- smbd, nmbd
- smbstatus, testparm, smbpasswd, nmblookup
- net
- smbclient
- /etc/smb/
- /var/log/samba/

209.2 NFS Server Configuration

Weight: 3

Description: Candidates should be able to export filesystems using NFS. This objective includes access restrictions, mounting an NFS filesystem on a client and securing NFS.

Key Knowledge Areas:

- NFS version 3 configuration files
- NFS tools and utilities
- Access restrictions to certain hosts and/or subnets
- Mount options on server and client
- TCP Wrappers
- Awareness of NFSv4

Terms and Utilities:

- /etc/exports
- exportfs
- showmount
- nfsstat
- /proc/mounts
- /etc/fstab
- rpcinfo
- mountd
- portmapper

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Topic 210: Network Client Management

210.1 DHCP configuration

Weight: 2

Description: Candidates should be able to configure a DHCP server. This objective includes setting default and per client options, adding static hosts and BOOTP hosts. Also included is configuring a DHCP relay agent and maintaining the DHCP server.

Key Knowledge Areas:

- DHCP configuration files, terms and utilities
- Subnet and dynamically-allocated range setup

Terms and Utilities:

- dhcpd.conf
- /var/log/daemon.log and /var/log/messages
- dhcpd.leases
- arp

- dhcpd

210.2 PAM authentication

Weight: 3

Description: The candidate should be able to configure PAM to support authentication using various available methods.

Key Knowledge Areas:

- PAM configuration files, terms and utilities
- passwd and shadow passwords

Terms and Utilities:

- /etc/pam.d/
- pam.conf
- nsswitch.conf
- pam_unix, pam_cracklib, pam_limits, pam_listfile

210.3 LDAP client usage

Weight: 2

Description: Candidates should be able to perform queries and updates to an LDAP server. Also included is importing and adding items, as well as adding and managing users.

Key Knowledge Areas:

- LDAP utilities for data management and queries
- Change user passwords
- Querying the LDAP directory

Terms and Utilities:

- ldapsearch
- ldappasswd
- ldapadd
- ldapdelete

210.4 Configuring an OpenLDAP server

Weight: 4

Description: Candidates should be able to configure a basic OpenLDAP server including knowledge of LDIF format and essential access controls. An understanding of the role of SSSD in authentication and identity management is included.

Key Knowledge Areas:

- OpenLDAP
- Access Control
- Distinguished Names
- Changetype Operations
- Schemas and Whitepages
- Directories
- Object IDs, Attributes and Classes
- Awareness of System Security Services Daemon (SSSD)

Terms and Utilities:

- slapd
- slapd.conf
- LDIF
- slapadd
- slapcat
- slapindex
- /var/lib/ldap/
- loglevel

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Topic 211: E-Mail Services

211.1 Using e-mail servers

Weight: 4

Description: Candidates should be able to manage an e-mail server, including the configuration of e-mail aliases, e-mail quotas and virtual e-mail domains. This objective includes configuring internal e-mail relays and monitoring e-mail servers.

Key Knowledge Areas:

- Configuration files for postfix
- Basic knowledge of the SMTP protocol
- Awareness of sendmail and exim

Terms and Utilities:

- Configuration files and commands for postfix
- /etc/postfix/
- /var/spool/postfix/
- sendmail emulation layer commands
- /etc/aliases
- mail-related logs in /var/log/

211.2 Managing Local E-Mail Delivery

Weight: 2

Description: Candidates should be able to implement client e-mail management software to filter, sort and monitor incoming user e-mail.

Key Knowledge Areas:

- procmail configuration files, tools and utilities
- Usage of procmail on both server and client side

Terms and Utilities:

- ~/.procmailrc
- /etc/procmailrc
- procmail
- mbox and Maildir formats

211.3 Managing Remote E-Mail Delivery

Weight: 2

Description: Candidates should be able to install and configure POP and IMAP daemons.

Key Knowledge Areas:

- Courier IMAP and Courier POP configuration
- Dovecot configuration

Terms and Utilities:

- /etc/courier/
- dovecot.conf

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Topic 212: System Security

212.1 Configuring a router

Weight: 3

Description: Candidates should be able to configure a system to perform network address translation (NAT, IP masquerading) and state its significance in protecting a network. This objective includes configuring port redirection, managing filter rules and averting attacks.

Key Knowledge Areas:

- iptables configuration files, tools and utilities
- Tools, commands and utilities to manage routing tables.
- Private address ranges
- Port redirection and IP forwarding
- List and write filtering and rules that accept or block datagrams based on source or
- Destination protocol, port and address
- Save and reload filtering configurations
- Awareness of ip6tables and filtering

Terms and Utilities:

- /proc/sys/net/ipv4/
- /etc/services
- iptables

212.2 Securing FTP servers

Weight: 2

Description: Candidates should be able to configure an FTP server for anonymous downloads and uploads. This objective includes precautions to be taken if anonymous uploads are permitted and configuring user access.

Key Knowledge Areas:

- Configuration files, tools and utilities for Pure-FTPd and vsftpd
- Awareness of ProFTPd
- Understanding of passive vs. active FTP connections

Terms and Utilities:

- vsftpd.conf
- important Pure-FTPd command line options

212.3 Secure shell (SSH)

Weight: 4

Description: Candidates should be able to configure and secure an SSH daemon. This objective includes managing keys and configuring SSH for users. Candidates should also be able to forward an application protocol over SSH and manage the SSH login.

Key Knowledge Areas:

- OpenSSH configuration files, tools and utilities
- Login restrictions for the superuser and the normal users
- Managing and using server and client keys to login with and without password
- Usage of multiple connections from multiple hosts to guard against loss of connection to remote host following configuration changes

Terms and Utilities:

- ssh
- sshd
- /etc/ssh/sshd_config
- /etc/ssh/
- Private and public key files
- PermitRootLogin, PubKeyAuthentication, AllowUsers, PasswordAuthentication, Protocol

212.4 Security tasks

Weight: 3

Description: Candidates should be able to receive security alerts from various sources, install, configure and run intrusion detection systems and apply security patches and bugfixes.

Key Knowledge Areas:

- Tools and utilities to scan and test ports on a server
- Locations and organizations that report security alerts as Bugtraq, CERT or other sources
- Tools and utilities to implement an intrusion detection system (IDS)
- Awareness of OpenVAS and Snort

Terms and Utilities:

- telnet
- nmap
- fail2ban
- nc
- iptables

212.5 OpenVPN

Weight: 2

Description: Candidates should be able to configure a VPN (Virtual Private Network) and create secure point-to-point or site-to-site connections.

Key Knowledge Areas:

- OpenVPN

Terms and Utilities:

- /etc/openvpn/

- [openvpn](#)

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- [391 – OpenLDAP as an Authentication Backend](#)
- [392 – Samba Basics](#)
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- [394 – Samba User and Group Management](#)
- [395 – Samba Domain Integration](#)
- [396 – Samba Name Services](#)
- [397 – Working with Linux and Windows Clients](#)

Topic 390: OpenLDAP Configuration

390.1 OpenLDAP Replication

Weight: 3

Description: Candidates should be familiar with the server replication available with OpenLDAP.

Key Knowledge Areas:

- Replication concepts
- Configure OpenLDAP replication
- Analyze replication log files
- Understand replica hubs
- LDAP referrals
- LDAP sync replication

The following is a partial list of the used files, terms and utilities:

- master / slave server
- multi-master replication
- consumer
- replica hub
- one-shot mode
- referral
- syncrepl
- pull-based / push-based synchronization
- refreshOnly and refreshAndPersist
- replog

390.2 Securing the Directory

Weight: 3

Description: Candidates should be able to configure encrypted access to the LDAP directory, and restrict access at the firewall level.

Key Knowledge Areas:

- Securing the directory with SSL and TLS
- Firewall considerations
- Unauthenticated access methods
- User / password authentication methods
- Maintenance of SASL user DB
- Client / server certificates

Terms and Utilities:

- SSL / TLS

- Security Strength Factors (SSF)
- SASL
- proxy authorization
- StartTLS
- iptables

390.3 OpenLDAP Server Performance Tuning

Weight: 2

Description: Candidates should be capable of measuring the performance of an LDAP server, and tuning configuration directives.

Key Knowledge Areas:

- Measure OpenLDAP performance
- Tune software configuration to increase performance
- Understand indexes

Terms and Utilities:

- index
- DB_CONFIG

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Topic 391: OpenLDAP as an Authentication Backend

391.1 LDAP Integration with PAM and NSS

Weight: 2

Description: Candidates should be able to configure PAM and NSS to retrieve information from an LDAP directory.

Key Knowledge Areas:

- Configure PAM to use LDAP for authentication
- Configure NSS to retrieve information from LDAP
- Configure PAM modules in various Unix environments

Terms and Utilities:

- PAM
- NSS
- /etc/pam.d/
- /etc/nsswitch.conf

391.2 Integrating LDAP with Active Directory and Kerberos

Weight: 2

Description: Candidates should be able to integrate LDAP with Active Directory Services.

Key Knowledge Areas:

- Kerberos integration with LDAP

- Cross platform authentication
- Single sign-on concepts
- Integration and compatibility limitations between OpenLDAP and Active Directory

Terms and Utilities:

- Kerberos
- Active Directory
- single sign-on
- DNS

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Topic 392: Samba Basics

392.1 Samba Concepts and Architecture

Weight: 2

Description: Candidates should understand the essential concepts of Samba. As well, the major differences between Samba3 and Samba4 should be known.

Key Knowledge Areas:

- Understand the roles of the Samba daemons and components
- Understand key issues regarding heterogeneous network
- Identify key TCP/UDP ports used with SMB/CIFS
- Knowledge of Samba3 and Samba4 differences

Terms and Utilities:

- /etc/services
- Samba daemons: smbd, nmbd, samba, winbindd

392.2 Configure Samba

Weight: 4

Description: Candidates should be able to configure the Samba daemons for a wide variety of purposes.

Key Knowledge Areas:

- Knowledge of Samba server configuration file structure
- Knowledge of Samba variables and configuration parameters
- Troubleshoot and debug configuration problems with Samba

Terms and Utilities:

- smb.conf
- smb.conf parameters
- smb.conf variables
- testparm
- secrets.tdb

392.3 Regular Samba Maintenance

Weight: 2

Description: Candidates should know about the various tools and utilities that are part of a Samba installation.

Key Knowledge Areas:

- Monitor and interact with running Samba daemons
- Perform regular backups of Samba configuration and state data

Terms and Utilities:

- smbcontrol
- smbstatus
- tdbbackup

392.4 Troubleshooting Samba

Weight: 2

Description: Candidates should understand the structure of trivial database files and know how to troubleshoot problems.

Key Knowledge Areas:

- Configure Samba logging
- Backup TDB files
- Restore TDB files
- Identify TDB file corruption
- Edit / list TDB file content

Terms and Utilities:

- /var/log/samba/.
- log level
- debuglevel
- smbpasswd
- pdbedit
- secrets.tdb
- tdbbackup
- tdbdump
- tdbrestore
- tdbtool

392.5 Internationalization

Weight: 1

Description: Candidates should be able to work with internationalization character codes and code pages.

Key Knowledge Areas:

- Understand internationalization character codes and code pages
- Understand the difference in the name space between Windows and Linux/Unix with respect to share, file and directory names in a non-English environment
- Understand the difference in the name space between Windows and Linux/Unix with respect to user and group naming in a non-English environment
- Understand the difference in the name space between Windows and Linux/Unix with respect to computer naming in a non-English environment

Terms and Utilities:

- internationalization
- character codes
- code pages
- smb.conf
- dos charset, display charset and unix charset

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Topic 393: Samba Share Configuration

393.1 File Services

Weight: 4

Description: Candidates should be able to create and configure file shares in a mixed environment.

Key Knowledge Areas:

- Create and configure file sharing
- Plan file service migration
- Limit access to IPC\$
- Create scripts for user and group handling of file shares
- Samba share access configuration parameters

Terms and Utilities:

- smb.conf
- [homes]
- smbcquotas
- smbsh
- browseable, writeable, valid users, write list, read list, read only and guest ok
- IPC\$
- mount, smbmount

393.2 Linux File System and Share/Service Permissions

Weight: 3

Description: Candidates should understand file permissions on a Linux file system in a mixed environment.

Key Knowledge Areas:

- Knowledge of file / directory permission control
- Understand how Samba interacts with Linux file system permissions and ACLs
- Use Samba VFS to store Windows ACLs

Terms and Utilities:

- smb.conf
- chmod, chown
- create mask, directory mask, force create mode, force directory mode
- smbcaccls
- getfacl, setfacl
- vfs_acl_xattr, vfs_acl_tdb and vfs objects

393.3 Print Services

Weight: 2

Description: Candidates should be able to create and manage print shares in a mixed environment.

Key Knowledge Areas:

- Create and configure printer sharing
- Configure integration between Samba and CUPS
- Manage Windows print drivers and configure downloading of print drivers
- Configure [print\$]
- Understand security concerns with printer sharing
- Uploading printer drivers for Point'n'Print driver installation using 'Add Print Driver Wizard' in Windows

Terms and Utilities:

- smb.conf
- [print\$]
- CUPS
- cupsd.conf
- /var/spool/samba/.
- smbpool
- rpcclient
- net

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Topic 394: Samba User and Group Management

394.1 Managing User Accounts and Groups

Weight: 4

Description: Candidates should be able to manage user and group accounts in a mixed environment.

Key Knowledge Areas:

- Manager user and group accounts
- Understand user and group mapping
- Knowledge of user account management tools
- Use of the smbpasswd program
- Force ownership of file and directory objects

Terms and Utilities:

- pdbedit
- smb.conf
- samba-tool user (with subcommands)
- samba-tool group (with subcommands)
- smbpasswd
- /etc/passwd
- /etc/group
- force user, force group.
- idmap

394.2 Authentication, Authorization and Winbind

Weight: 5

Description: Candidates should understand the various authentication mechanisms and configure access control. Candidates should be able to install and configure the Winbind service.

Key Knowledge Areas:

- Setup a local password database
- Perform password synchronization
- Knowledge of different passdb backends
- Convert between Samba passdb backends
- Integrate Samba with LDAP
- Configure Winbind service
- Configure PAM and NSS

Terms and Utilities:

- smb.conf
- smbpasswd, tdbsam, ldapsam
- passdb backend
- libnss_winbind
- libpam_winbind
- libpam_smbpass
- wbinfo
- getent
- SID and foreign SID
- /etc/passwd
- /etc/group

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Topic 395: Samba Domain Integration

395.1 Samba as a PDC and BDC

Weight: 3

Description: Candidates should be able to setup and maintain primary and backup domain controllers. Candidates should be able to manage Windows/Linux client access to the NT-Style domains.

Key Knowledge Areas:

- Understand and configure domain membership and trust relationships
- Create and maintain a primary domain controller with Samba3 and Samba4
- Create and maintain a backup domain controller with Samba3 and Samba4
- Add computers to an existing domain
- Configure logon scripts
- Configure roaming profiles
- Configure system policies

Terms and Utilities:

- smb.conf
- security mode
- server role
- domain logons
- domain master
- logon script
- logon path

- NTConfig.pol
- net
- profiles
- add machine script
- profile acls

395.2 Samba4 as an AD compatible Domain Controller

Weight: 3

Description: Candidates should be able to configure Samba 4 as an AD Domain Controller.

Key Knowledge Areas:

- Configure and test Samba 4 as an AD DC
- Using smbclient to confirm AD operation
- Understand how Samba integrates with AD services: DNS, Kerberos, NTP, LDAP

Terms and Utilities:

- smb.conf
- server role
- samba-tool domain (with subcommands)
- samba

395.3 Configure Samba as a Domain Member Server

Weight: 3

Description: Candidates should be able to integrate Linux servers into an environment where Active Directory is present.

Key Knowledge Areas:

- Joining Samba to an existing NT4 domain
- Joining Samba to an existing AD domain
- Ability to obtain a TGT from a KDC

Terms and Utilities:

- smb.conf
- server role
- server security
- net command
- kinit, TGT and REALM

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Topic 396: Samba Name Services

396.1 NetBIOS and WINS

Weight: 3

Description: Candidates should be familiar with NetBIOS/WINS concepts and understand network browsing.

Key Knowledge Areas:

- Understand WINS concepts
- Understand NetBIOS concepts
- Understand the role of a local master browser
- Understand the role of a domain master browser
- Understand the role of Samba as a WINS server
- Understand name resolution
- Configure Samba as a WINS server
- Configure WINS replication
- Understand NetBIOS browsing and browser elections
- Understand NETBIOS name types

Terms and Utilities:

- smb.conf
- nmblookup
- smbclient
- name resolve order
- lmhosts
- wins support, wins server, wins proxy, dns proxy
- domain master, os level, preferred master

396.2 Active Directory Name Resolution

Weight: 2

Description: Candidates should be familiar with the internal DNS server with Samba4.

Key Knowledge Areas:

- Understand and manage DNS for Samba4 as an AD Domain Controller
- DNS forwarding with the internal DNS server of Samba4

Terms and Utilities:

- samba-tool dns (with subcommands)
- smb.conf
- dns forwarder
- /etc/resolv.conf
- dig, host

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Topic 397: Working with Linux and Windows Clients

397.1 CIFS Integration

Weight: 3

Description: Candidates should be comfortable working with CIFS in a mixed environment.

Key Knowledge Areas:

- Understand SMB/CIFS concepts
- Access and mount remote CIFS shares from a Linux client
- Securely storing CIFS credentials
- Understand features and benefits of CIFS
- Understand permissions and file ownership of remote CIFS shares

Terms and Utilities:

- SMB/CIFS
- mount, mount.cifs
- smbclient
- smbget
- smbtar
- smbtree
- findsmb
- smb.conf
- smbquotas
- /etc/fstab

397.2 Working with Windows Clients

Weight: 2

Description: Candidates should be able to interact with remote Windows clients, and configure Windows workstations to access file and print services from Linux servers.

Key Knowledge Areas:

- Knowledge of Windows clients
- Explore browse lists and SMB clients from Windows
- Share file / print resources from Windows
- Use of the smbclient program
- Use of the Windows net utility

Terms and Utilities:

- Windows net command
- smbclient
- control panel
- rdesktop
- workgroup

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- [325 – Cryptography](#)
- [326 – Host Security](#)
- [327 – Access Control](#)
- [328 – Network Security](#)

Topic 325: Cryptography

325.1 X.509 Certificates and Public Key Infrastructures

Weight: 5

Description: Candidates should understand X.509 certificates and public key infrastructures. They should know how to configure and use OpenSSL to implement certification authorities and issue SSL certificates for various purposes.

Key Knowledge Areas:

- Understand X.509 certificates, X.509 certificate lifecycle, X.509 certificate fields and X.509v3 certificate extensions
- Understand trust chains and public key infrastructures
- Generate and manage public and private keys
- Create, operate and secure a certification authority

- Request, sign and manage server and client certificates
- Revoke certificates and certification authorities

The following is a partial list of the used files, terms and utilities:

- openssl, including relevant subcommands
- OpenSSL configuration
- PEM, DER, PKCS
- CSR
- CRL
- OCSP

325.2 X.509 Certificates for Encryption, Signing and Authentication

Weight: 4

Description: Candidates should know how to use X.509 certificates for both server and client authentication. Candidates should be able to implement user and server authentication for Apache HTTPD. The version of Apache HTTPD covered is 2.4 or higher.

Key Knowledge Areas:

- Understand SSL, TLS and protocol versions
- Understand common transport layer security threats, for example Man-in-the-Middle
- Configure Apache HTTPD with mod_ssl to provide HTTPS service, including SNI and HSTS
- Configure Apache HTTPD with mod_ssl to authenticate users using certificates
- Configure Apache HTTPD with mod_ssl to provide OCSP stapling
- Use OpenSSL for SSL/TLS client and server tests

Terms and Utilities:

- Intermediate certification authorities
- Cipher configuration (no cipher-specific knowledge)
- httpd.conf
- mod_ssl
- openssl

325.3 Encrypted File Systems

Weight: 3

Description: Candidates should be able to setup and configure encrypted file systems.

Key Knowledge Areas:

- Understand block device and file system encryption
- Use dm-crypt with LUKS to encrypt block devices
- Use eCryptfs to encrypt file systems, including home directories and PAM integration
- Be aware of plain dm-crypt and EncFS

Terms and Utilities:

- cryptsetup
- cryptmount
- /etc/crypttab
- ecryptfsd
- ecryptfs-* commands
- mount.ecryptfs, umount.ecryptfs
- pam_ecryptfs

325.4 DNS and Cryptography

Weight: 5

Description: Candidates should have experience and knowledge of cryptography in the context of DNS and its implementation using BIND. The version of BIND covered is 9.7 or higher.

Key Knowledge Areas:

- Understanding of DNSSEC and DANE
- Configure and troubleshoot BIND as an authoritative name server serving DNSSEC secured zones
- Configure BIND as an recursive name server that performs DNSSEC validation on behalf of its clients
- Key Signing Key, Zone Signing Key, Key Tag
- Key generation, key storage, key management and key rollover
- Maintenance and re-signing of zones
- Use DANE to publish X.509 certificate information in DNS
- Use TSIG for secure communication with BIND

Terms and Utilities:

- DNS, EDNS, Zones, Resource Records
- DNS resource records: DS, DNSKEY, RRSIG, NSEC, NSEC3, NSEC3PARAM, TLSA
- DO-Bit, AD-Bit
- TSIG
- named.conf
- dnssec-keygen
- dnssec-signzone
- dnssec-settime
- dnssec-dsfromkey
- rndc
- dig
- delv
- openssl

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Topic 326: Host Security

326.1 Host Hardening

Weight: 3

Description: Candidates should be able to secure computers running Linux against common threats. This includes kernel and software configuration.

Key Knowledge Areas:

- Configure BIOS and boot loader (GRUB 2) security
- Disable useless software and services
- Use systemctl for security related kernel configuration, particularly ASLR,
- Exec-Shield and IP / ICMP configuration
- Limit resource usage
- Work with chroot environments
- Drop unnecessary capabilities
- Be aware of the security advantages of virtualization

Terms and Utilities:

- grub.cfg

- chkconfig, systemctl
- ulimit
- /etc/security/limits.conf
- pam_limits.so
- chroot
- sysctl
- /etc/sysctl.conf

326.2 Host Intrusion Detection

Weight: 4

Description: Candidates should be familiar with the use and configuration of common host intrusion detection software. This includes updates and maintenance as well as automated host scans.

Key Knowledge Areas:

- Use and configure the Linux Audit system
- Use chkrootkit
- Use and configure rkhunter, including updates
- Use Linux Malware Detect
- Automate host scans using cron
- Configure and use AIDE, including rule management
- Be aware of OpenSCAP

Terms and Utilities:

- auditd
- auditctl
- ausearch, aureport
- /etc/auditd/auditd.conf
- /etc/auditd/auditd.rules
- pam_tty_audit.so
- chkrootkit
- rkhunter
- /etc/rkhunter.conf
- maldet
- conf.maldet
- aide
- /etc/aide/aide.conf

326.3 User Management and Authentication

Weight: 5

Description: Candidates should be familiar with management and authentication of user accounts. This includes configuration and use of NSS, PAM, SSSD and Kerberos for both local and remote directories and authentication mechanisms as well as enforcing a password policy.

Key Knowledge Areas:

- Understand and configure NSS
- Understand and configure PAM
- Enforce password complexity policies and periodic password changes
- Lock accounts automatically after failed login attempts
- Configure and use SSSD
- Configure NSS and PAM for use with SSSD
- Configure SSSD authentication against Active Directory, IPA, LDAP,
- Kerberos and local domains
- Obtain and manage Kerberos tickets

Terms and Utilities:

- nsswitch.conf
- /etc/login.defs
- pam_cracklib.so
- chage
- pam_tally.so, pam_tally2.so
- faillog
- pam_sss.so
- sssd
- sssd.conf
- sss_* commands
- krb5.conf
- kinit, klist, kdestroy

326.4 FreeIPA Installation and Samba Integration

Weight: 4

Description: Candidates should be familiar with FreeIPA v4.x. This includes installation and maintenance of a server instance with a FreeIPA domain as well as integration of FreeIPA with Active Directory.

Key Knowledge Areas:

- Understand FreeIPA, including its architecture and components
- Understand system and configuration prerequisites for installing FreeIPA
- Install and manage a FreeIPA server and domain
- Understand and configure Active Directory replication and Kerberos cross-realm trusts
- Be aware of sudo, autofs, SSH and SELinux integration in FreeIPA

Terms and Utilities:

- 389 Directory Server, MIT Kerberos, Dogtag Certificate System, NTP, DNS, SSSD, certmonger
- ipa, including relevant subcommands
- ipa-server-install, ipa-client-install, ipa-replica-install
- ipa-replica-prepare, ipa-replica-manage

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Topic 327: Access Control

327.1 Discretionary Access Control

Weight: 3

Description: Candidates are required to understand Discretionary Access Control and know how to implement it using Access Control Lists. Additionally, candidates are required to understand and know how to use Extended Attributes.

Key Knowledge Areas:

- Understand and manage file ownership and permissions, including SUID and SGID
- Understand and manage access control lists
- Understand and manage extended attributes and attribute classes

Terms and Utilities:

- getfacl

- setfacl
- getfattr
- setfattr

327.2 Mandatory Access Control

Weight: 4

Description: Candidates should be familiar with Mandatory Access Control systems for Linux. Specifically, candidates should have a thorough knowledge of SELinux. Also, candidates should be aware of other Mandatory Access Control systems for Linux. This includes major features of these systems but not configuration and use.

Key Knowledge Areas:

- Understand the concepts of TE, RBAC, MAC and DAC
- Configure, manage and use SELinux
- Be aware of AppArmor and Smack

Terms and Utilities:

- getenforce, setenforce, selinuxenabled
- getsebool, setsebool, togglesebool
- fixfiles, restorecon, setfiles
- newrole, runcon
- semanage
- sestatus, seinfo
- apol
- seaudit, seaudit-report, audit2why, audit2allow
- /etc/selinux/*

327.3 Network File Systems

Weight: 3

Description: Candidates should have experience and knowledge of security issues in use and configuration of NFSv4 clients and servers as well as CIFS client services. Earlier versions of NFS are not required knowledge.

Key Knowledge Areas:

- Understand NFSv4 security issues and improvements
- Configure NFSv4 server and clients
- Understand and configure NFSv4 authentication mechanisms (LIPKEY, SPKM, Kerberos)
- Understand and use NFSv4 pseudo file system
- Understand and use NFSv4 ACLs
- Configure CIFS clients
- Understand and use CIFS Unix Extensions
- Understand and configure CIFS security modes (NTLM, Kerberos)
- Understand and manage mapping and handling of CIFS ACLs and SIDs in a Linux system

Terms and Utilities:

- /etc/exports
- /etc/idmap.conf
- nfs4acl
- mount.cifs parameters related to ownership, permissions and security modes
- winbind
- getcifsacl, setcifsacl

Topic 328: Network Security

328.1 Network Hardening

Weight: 4

Description: Candidates should be able to secure networks against common threats. This includes verification of the effectiveness of security measures.

Key Knowledge Areas:

- Configure FreeRADIUS to authenticate network nodes
- Use nmap to scan networks and hosts, including different scan methods
- Use Wireshark to analyze network traffic, including filters and statistics
- Identify and deal with rogue router advertisements and DHCP messages

Terms and Utilities:

- radiusd
- radmin
- radtest, radclient
- radlast, radwho
- radiusd.conf
- /etc/raddb/*
- nmap
- wireshark
- tshark
- tcpdump
- ndpmon

328.2 Network Intrusion Detection

Weight: 4

Description: Candidates should be familiar with the use and configuration of network security scanning, network monitoring and network intrusion detection software. This includes updating and maintaining the security scanners.

Key Knowledge Areas:

- Implement bandwidth usage monitoring
- Configure and use Snort, including rule management
- Configure and use OpenVAS, including NASL

Terms and Utilities:

- ntop
- Cacti
- snort
- snort-stat
- /etc/snort/*
- openvas-adduser, openvas-rmuser
- openvas-nvt-sync
- openvassd
- openvas-mkcert
- /etc/openvas/*

328.3 Packet Filtering

Weight: 5

Description: Candidates should be familiar with the use and configuration of packet filters. This includes netfilter, iptables and ip6tables as well as basic knowledge of nftables, nft and ebtables.

Key Knowledge Areas:

- Understand common firewall architectures, including DMZ
- Understand and use netfilter, iptables and ip6tables, including standard modules, tests and targets
- Implement packet filtering for both IPv4 and IPv6
- Implement connection tracking and network address translation
- Define IP sets and use them in netfilter rules
- Have basic knowledge of nftables and nft
- Have basic knowledge of ebtables
- Be aware of conntrackd

Terms and Utilities:

- iptables
- ip6tables
- iptables-save, iptables-restore
- ip6tables-save, ip6tables-restore
- ipset
- nft
- ebtables

328.4 Virtual Private Networks

Weight: 4

Description: Candidates should be familiar with the use of OpenVPN and IPsec.

Key Knowledge Areas:

- Configure and operate OpenVPN server and clients for both bridged and routed VPN networks
- Configure and operate IPsec server and clients for routed VPN networks using IPsec-Tools / racoon
- Awareness of L2TP

Terms and Utilities:

- /etc/openvpn/*
- openvpn server and client
- setkey

LPIC-3 304: Exam Objectives Topics

- 330 – Virtualization
- 334 – High Availability Cluster Management
- 335 – High Availability Cluster Storage

Topic 330: Virtualization

330.1 Virtualization Concepts and Theory

Weight: 8

Description: Candidates should know and understand the general concepts, theory and terminology

of Virtualization. This includes Xen, KVM and libvirt terminology.

Key Knowledge Areas:

- Terminology
- Pros and Cons of Virtualization
- Variations of Virtual Machine Monitors
- Migration of Physical to Virtual Machines
- Migration of Virtual Machines between Host systems
- Cloud Computing

The following is a partial list of the used files, terms and utilities:

- Hypervisor
- Hardware Virtual Machine (HVM)
- Paravirtualization (PV)
- Container Virtualization
- Emulation and Simulation
- CPU flags
- /proc/cpuinfo
- Migration (P2V, V2V)
- IaaS, PaaS, SaaS

330.2 Xen

Weight: 9

Description: Candidates should be able to install, configure, maintain, migrate and troubleshoot Xen installations. The focus is on Xen version 4.x.

Key Knowledge Areas:

- Xen architecture, networking and storage
- Xen configuration
- Xen utilities
- Troubleshooting Xen installations
- Basic knowledge of XAPI
- Awareness of XenStore
- Awareness of Xen Boot Parameters
- Awareness of the xm utility

Terms and Utilities:

- Domain0 (Dom0), DomainU (DomU)
- PV-DomU, HVM-DomU
- /etc/xen/
- xl
- xl.cfg
- xl.conf
- xe
- xentop

330.3 KVM

Weight: 9

Description: Candidates should be able to install, configure, maintain, migrate and troubleshoot KVM installations.

Key Knowledge Areas:

- KVM architecture, networking and storage

- KVM configuration
- KVM utilities
- Troubleshooting KVM installations

Terms and Utilities:

- Kernel modules: kvm, kvm-intel and kvm-amd
- /etc/kvm/
- /dev/kvm
- kvm
- KVM monitor
- qemu
- qemu-img

330.4 Other Virtualization Solutions

Weight: 3

Description: Candidates should have some basic knowledge and experience with alternatives to Xen and KVM.

Key Knowledge Areas:

- Basic knowledge of OpenVZ and LXC
- Awareness of other virtualization technologies
- Basic knowledge of virtualization provisioning tools

Terms and Utilities:

- OpenVZ
- VirtualBox
- LXC
- docker
- packer
- vagrant

330.5 Libvirt and Related Tools

Weight: 5

Description: Candidates should have basic knowledge and experience with the libvirt library and commonly available tools.

Key Knowledge Areas:

- libvirt architecture, networking and storage
- Basic technical knowledge of libvirt and virsh
- Awareness of oVirt

Terms and Utilities:

- libvirtd
- /etc/libvirt/
- virsh
- oVirt

330.6 Cloud Management Tools

Weight: 2

Description: Candidates should have basic feature knowledge of commonly available cloud

management tools.

Key Knowledge Areas:

- Basic feature knowledge of OpenStack and CloudStack
- Awareness of Eucalyptus and OpenNebula

Terms and Utilities:

- OpenStack
- CloudStack
- Eucalyptus
- OpenNebula

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Topic 334: High Availability Cluster Management

334.1 High Availability Concepts and Theory

Weight: 5

Description: Candidates should understand the properties and design approaches of high availability clusters.

Key Knowledge Areas:

- Understand the most important cluster architectures
- Understand recovery and cluster reorganization mechanisms
- Design an appropriate cluster architecture for a given purpose
- Application aspects of high availability
- Operational considerations of high availability

Terms and Utilities:

- Active/Passive Cluster, Active/Active Cluster
- Failover Cluster, Load Balanced Cluster
- Shared-Nothing Cluster, Shared-Disk Cluster
- Cluster resources
- Cluster services
- Quorum
- Fencing
- Split brain
- Redundancy
- Mean Time Before Failure (MTBF)
- Mean Time To Repair (MTTR)
- Service Level Agreement (SLA)
- Disaster Recovery
- Replication
- Session handling

334.2 Load Balanced Clusters

Weight: 6

Description: Candidates should know how to install, configure, maintain and troubleshoot LVS. This includes the configuration and use of keepalived and ldirectord. Candidates should further be able to install, configure, maintain and troubleshoot HAProxy.

Key Knowledge Areas:

- Understanding of LVS / IPVS
- Basic knowledge of VRRP
- Configuration of keepalived
- Configuration of ldirectord
- Backend server network configuration
- Understanding of HAProxy
- Configuration of HAProxy

Terms and Utilities:

- ipvsadm
- syncd
- LVS Forwarding (NAT, Direct Routing, Tunneling, Local Node)
- connection scheduling algorithms
- keepalived configuration file
- ldirectord configuration file
- genhash
- HAProxy configuration file
- load balancing algorithms
- ACLs

334.3 Failover Clusters

Weight: 6

Description: Candidates should have experience in the installation, configuration, maintenance and troubleshooting of a Pacemaker cluster. This includes the use of Corosync. The focus is on Pacemaker 1.1 for Corosync 2.x.

Key Knowledge Areas:

- Pacemaker architecture and components (CIB, CRMD, PEngine, LRMd, DC, STONITHd)
- Pacemaker cluster configuration
- Resource classes (OCF, LSB, Systemd, Upstart, Service, STONITH, Nagios)
- Resource rules and constraints (location, order, colocation)
- Advanced resource features (templates, groups, clone resources, multi-state resources)
- Pacemaker management using pcs
- Pacemaker management using crmsh
- Configuration and Management of corosync in conjunction with Pacemaker
- Awareness of other cluster engines (OpenAIS, Heartbeat, CMAN)

Terms and Utilities:

- pcs
- crm
- crm_mon
- crm_verify
- crm_simulate
- crm_shadow
- crm_resource
- crm_attribute
- crm_node
- crm_standby
- cibadmin
- corosync.conf
- authkey
- corosync-cfgtool
- corosync-cmapctl
- corosync-quorumtool
- stonith_admin

334.4 High Availability in Enterprise Linux Distributions

Weight: 1

Description: Candidates should be aware of how enterprise Linux distributions integrate High Availability technologies.

Key Knowledge Areas:

- Basic knowledge of Red Hat Enterprise Linux High Availability Add-On
- Basic knowledge of SUSE Linux Enterprise High Availability Extension

Terms and Utilities:

- Distribution specific configuration tools
- Integration of cluster engines, load balancers, storage technology, cluster filesystems, etc.

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Topic 335: High Availability Cluster Storage

335.1 DRBD / cLVM

Weight: 3

Description: Candidates are expected to have the experience and knowledge to install, configure, maintain and troubleshoot DRBD devices. This includes integration with Pacemaker. DRBD configuration of version 8.4.x is covered. Candidates are further expected to be able to manage LVM configuration within a shared storage cluster.

Key Knowledge Areas:

- Understanding of DRBD resources, states and replication modes
- Configuration of DRBD resources, networking, disks and devices
- Configuration of DRBD automatic recovery and error handling
- Management of DRBD using drbdadm
- Basic knowledge of drbdsetup and drbdmeta
- Integration of DRBD with Pacemaker
- cLVM
- Integration of cLVM with Pacemaker

Terms and Utilities:

- Protocol A, B and C
- Primary, Secondary
- Three-way replication
- drbd kernel module
- drbdadm
- drbdsetup
- drbdmeta
- /etc/drbd.conf
- /proc/drbd
- LVM2
- clvmd
- vgchange, vgs

335.2 Clustered File Systems

Weight: 3

Description: Candidates should know how to install, maintain and troubleshoot installations using

GFS2 and OCFS2. This includes integration with Pacemaker as well as awareness of other clustered filesystems available in a Linux environment.

Key Knowledge Areas:

- Understand the principles of cluster file systems
- Create, maintain and troubleshoot GFS2 file systems in a cluster
- Create, maintain and troubleshoot OCFS2 file systems in a cluster
- Integration of GFS2 and OCFS2 with Pacemaker
- Awareness of the O2CB cluster stack
- Awareness of other commonly used clustered file systems

Terms and Utilities:

- Distributed Lock Manager (DLM)
- mkfs.gfs2
- mount.gfs2 Kaleidon
- fsck.gfs2
- gfs2_grow
- gfs2_edit
- gfs2_jadd
- mkfs.ocfs2
- mount.ocfs2
- fsck.ocfs2
- tuneufs.ocfs2
- mounted.ocfs2
- o2info
- o2image
- CephFS
- GlusterFS
- AFS