System Programming - Linux

Week 2 - Linux Installation, Tools and Utilities

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1 Introduction

Linux's open-source principles create a diverse range of installation possibilities. New users can easily get started with WSL, which integrates well with Windows, while virtual machines offer a secure and isolated environment. For advanced users, bare-metal setups provide peak performance, whereas network installations facilitate efficient large-scale implementations. Cloud services deliver flexible, scalable Linux instances on demand. This versatility guarantees that whether you're looking for a straightforward trial or a comprehensive server configuration, Linux provides a customized approach, showcasing its dedication to user choice and adaptability.

This lecture notes describe some of the popularly used methods of Linux installation together with their strengths and shortfalls. The commonly used Linux tools and utilities shall also be presented.

2 Lecture Outcomes

Linux Installation

- Windows Subsystem for Linux (WSL)
- Dual Boot Installation
- Virtual Machine Installation
- Bare Metal Installation
- Network Installation
- Cloud-based Installation
- Live Environment Installation

3 Linux Installations

Linux provides various installation options to suit different user preferences and hardware setups. From dual-booting with current operating systems to creating virtual machines and utilizing live USB environments, each method offers distinct benefits and factors to consider when implementing Linux. Below is a general description of the different ways [1].

3.1 Windows Subsystem for Linux (WSL)

Windows Subsystem for Linux (WSL) creates a connection between Windows and Linux, allowing both to function together effortlessly. WSL removes the complexities associated with conventional virtual machines, providing a more streamlined solution. Developers gain direct access to Linux command-line tools and utilities right in their familiar Windows setup. WSL 1 accomplishes this by converting Linux system calls into their Windows counterparts, whereas WSL 2 uses a lightweight, specialized virtual machine that delivers enhanced performance with a true Linux kernel. This difference enables users to select the version that aligns with their performance and compatibility requirements, thus making Linux tools easily accessible to Windows users.

Installation

- Locate the “Turn Windows features” via the Start menu.
- Check the “Windows Subsystem for Linux” checkbox.
- Open Microsoft store to search for a Linux distribution of choice to download and install
- The Linux app can then be launched from the Start menu.

Alternatively

- Open PowerShell as an administrator.
- Execute the command ”wsl –install”
- For a default Linux distribution (usually Ubuntu) Or install another distributions from the Microsoft Store.

Advantages:

- Easy setup.
- Seamless integration with Windows.
- Lightweight and efficient.

Disadvantages:

- Limited performance compared to bare-metal installations.
- The may not effectively perform resource-intensive tasks.
- They provide limited hardware access compared to a standard Linux installation.

3.2 Virtual Machines (VMs) Installation

Virtual machines (VMs) like VirtualBox or VMware create a simulated computer environment within a host operating system, allowing it to run a guest operating system, such as Linux. Virtualization creates a logical separation for the guest operating system, offering a secure environment for testing or developing software. Multiple instances of operating systems can run at the same time, each in its window. This removes the necessity for distinct physical hardware, simplifying workflows and increasing flexibility. VMs are essential for trying out various operating systems without affecting the stability of the main system.

Installation

- Obtain virtualization software, such as VirtualBox or VMware
- Install the virtualization program
- Mount the Linux ISO file to the VM's virtual optical drive.
- Start the VM and follow the Linux installer's instructions.

Advantages:

- It is relatively safer because it is carried out in an isolated environment.
- The installation can run multiple operating systems.
- It is easy to create and delete virtual machines.

Disadvantages:

- Has a relatively higher performance overhead.
- It requires a significant amount of system resources.
- Can be complicated for new users.

3.3 Bare-Metal Installation

Installing Linux directly, whether as a complete replacement or by setting up a dual-boot system, allows the operating system to communicate directly with the hardware of your computer. This direct interaction removes the performance lag that comes with virtualization, resulting in a much quicker and more responsive experience. Applications can take full advantage of your CPU, RAM, and GPU, ensuring maximum performance. Resource-intensive activities like gaming, video editing, or intricate simulations see significant improvements from this unmediated access. Although it requires partitioning your hard drive, the performance enhancements and efficient resource usage make this approach extremely appealing for users who value speed and efficiency. Furthermore, this option circumvents the constraints typically found in virtualized settings.

Installation:

- Download a Linux distribution ISO image file.
- Create a bootable USB drive from the ISO file (using tools like Rufus or balenaEtcher).
- Boot your computer from the USB or DVD drive.
- Follow the Linux installer's instructions to:
  - Selecting a language.
  - Choosing a keyboard layout (Any of the US, Europe etc.).
  - Partitioning of the hard drive.
  - Creating a user account as you provide username and password.
  - Installation of the bootloader (GRUB).

Advantages:

- Maximum performance.
- Full control over hardware.
- Optimal for resource-intensive tasks.

Limitations

- Requires careful partitioning and bootloader configuration.
- There exists a risk of data loss if not done correctly.
- It can be intimidating for new users.

Note: Dual-Booting is a common variation of bare-metal installation where you install Linux alongside Windows or another operating system. This allows you to choose which OS to boot into at startup.

3.4 Network Installation Using the Preboot Execution (PXE) Plan

The PXE supports network-based installations of Linux, making it easier to deploy systems across multiple machines. A central server, is set up with the required installation files, sends them out to client computers as they boot up. This removes the requirement for separate installation media, thus simplifying deployments on a large scale. PXE booting is essential in corporate environments, allowing for quick and consistent operating system deployments. It automates the installation process, decreasing the need for manual input and ensuring consistency. The server serves as a central hub, providing the necessary files and configurations via the network.

Installation:

- Set up a PXE server with the necessary Linux installation files.
- Configure the client computers to boot from the network.
- The client computers will download the Linux installer over the network and proceed with the installation.

Advantages:

- Centralized deployment.
- Efficient for installing Linux on multiple computers.
- Allows for automated installations.

Disadvantages:

- It requires proper network infrastructure and server configuration.
- It is also calls for a more complex setup than other methods.

This server-based employment is especially appropriate for large-scale Linux installations such as data centers and other larger computer networks.

3.5 Cloud-Based Installations

Several cloud services AWS, GCP, etc) offer virtual machines featuring pre-set Linux distributions, which allows for swift server setup. This eliminates the necessity for physical hardware and manual operating system installations. Users can easily create and adjust Linux servers as needed. The only challenge is that it requires paying for these services. Cloud-based Linux servers provide scalability, and easy access, making them perfect for web hosting, application deployment, and data processing. These platforms also enhance server management by providing tools for monitoring, security, and upkeep.

Installation

- Create an account on a cloud platform.
- Launch an instance of the virtual machine.
- Choose a Linux distribution from the available list.
- Configure the VM's settings (This involves CPU, RAM, storage, network).
- Connect to the Virtual machine via SSH or any available web-based console.

Advantages:

- The approach is relatively more scalable.
- They are easy to deploy and manage Linux servers.
- It has a pay-as-you-go pricing.

Disadvantages:

- Reliance on the cloud providers' infrastructure.
- It requires an Internet connection.
- High-performance instances tend to be more costly.

3.6 Installing Linux from a Live Environment

Live environments are available through various Linux distributions. They enable users to boot into Linux directly from removable media such as USB drives or DVDs. It is a temporary OS function separated from your the hard drive, allowing one to try out Linux without making a permanent installation. It has been used in in checking hardware compatibility, testing distributions, and addressing system problems. A live environment can also help access and recover files from a malfunctioning system. Additionally, it offers a handy platform for beginning the complete installation of Linux on your hard drive, providing a

working environment for the setup process. This approach minimizes the risk of modifying your current operating system during the testing period.

Installation:

- Use available software (Rufus) to create a bootable USB drive or DVD from a Linux ISO file.
- Boot your computer from the live environment.
- If preferred, install Linux by running the installer from the live environment.

Advantages:

- It is possible to try Linux without necessarily installing it.
- Useful for data recovery and troubleshooting.
- It is easy to go through the installation process from the live environment.

Disadvantages:

- Live environments are slower than installed systems.

Linux offers a wide range of installation methods, catering for diverse user needs and scenarios. By understanding these methods, one can choose an approach that best suits his skill level, system requirements, security level, and to a good extent popularity of the distribution.

4 Linux Tools and Utilities

In the Linux environment, the terms "utility" and "tool" are frequently used synonymously, yet there are slight differences between them. A utility generally denotes a compact, specialized program crafted to execute a particular function, like ls for displaying files or grep for searching through text. These fundamental commands are commonly included in the core utility package and are crucial for essential system activities [2][3].

A Linux tool, although it is fundamentally a program, usually suggests a more intricate or specialized application. Tools can include wider functionalities, such as gcc for code compilation or vim for editing text. They may involve various features and are designed for more targeted tasks. Essentially, utilities serve as the fundamental components, whereas tools are more sophisticated instruments for particular workflows. Examples of utilities include:

- cd: change directory
- mkdir: make or create a directory

- grep: Searches text files for patterns.
- sed: A stream editor for text transformation.
- awk: A powerful text processing tool.
- ls: Lists directory contents.
- cp: Copies files and directories.
- mv: Moves or renames files and directories.
- rm: Removes files and directories.

The following are example Linux tools:

- gcc: C/C++ compiler.
- vim: Text editor.
- git: Version control.
- docker: Containerization.
- ssh: Remote login.
- systemctl: Service management.
- top: Process monitoring.
- htop: Interactive process viewer.
- wget: File downloader.
- curl: Data transfer tool.

List of References

1. Clinton, D., & Negus, C. (2020). Ubuntu Linux Bible. John Wiley & Sons.
2. Nemeth, E., Snyder, G., Hein, T. R., & Whaley, B. (2011). ADMINISTRATION HANDBOOK.
3. William Jr, E. (2012). The Linux command line: a complete introduction. No Starch Press.