BAHIR DAR UNIVERSITY
BAHIR DAR INSTITUTE OF TECHNOLOGY
FACULTY OF COMPUTING

DEPARTMENT: SOFTWARE ENGINEERING (2ND YEAR)

ASSIGNMENT: OPERATNG SYSTEM AND SYSTEM PROGRAMMING

TITLE: INSTALLATNG AND RUNNING Ubuntu 24.04.1 LTS OPERATING SYSTEM ON ORACLE VIRTUAL BOX

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INTRODUCTION:

Operating systems are the fundamental software layer that manages computer hardware and provides essential services for computer programs. They form the bridge between users and the machine, enabling everything from running applications to managing files. System programming involves writing software that interacts directly with the operating system kernel, allowing for fine-grained control over system resources. This is crucial for tasks like optimizing performance, ensuring security, and developing system utilities. In contemporary computing, virtualization has become increasingly important, allowing multiple operating systems to run concurrently on a single physical machine, enhancing resource utilization and flexibility. The project will specifically focus on Ubuntu 24.04.1 LTS, a widely-used Linux distribution known for its stability and extensive features. The knowledge and skills gained from this project will provide a solid foundation for further studies and professional practice in software engineering, particularly in areas related to system administration, DevOps, and embedded systems development.

MOTIVATION:

This documentation outlines the process of installing Ubuntu 24.04.1 LTS Desktop, a stable and widely used Linux distribution with long-term support, within Oracle VM VirtualBox. The motivation behind this exercise is to gain practical experience in operating system installation within a virtualized environment, understand the requirements and steps involved, and explore fundamental operating system concepts like filesystem support.

OBJECTIVES OF THE PROJECT:

The objectives of this project are to:

1. Gain a comprehensive understanding of operating system principles and system programming techniques.

2. Develop practical skills in operating system installation and configuration within a virtualized environment (if applicable).

3. Explore the concepts and applications of virtualization in modern computing environments, analyzing its benefits and role in resource utilization.

4. Analyze the importance of UNIX standardization, describing key standards (ISO C, IEEE POSIX) and evaluating their impact on software portability and compatibility.

5. Acquire proficiency in system programming tools and techniques, specifically by developing shell scripts to address system-level challenges related to file safety and security.

6. Document the operating system installation process, including key steps and configurations (if applicable).

7. Implement and demonstrate the use of system calls for performing specific operating system tasks.

8. Explain the differences between various UNIX standards and specifications, such as POSIX.1 and POSIX.2.

9. Identify and analyze common system-level problems or issues and develop appropriate solutions.

WHAT, WHY, AND HOW OF VIRTUALIZATION:

What is Virtualization?

Virtualization is a technology that allows you to create multiple simulated environments or dedicated resources from [1] a single, physical hardware device. In simpler terms, it allows you to run multiple operating systems or applications on one physical machine, as if they were running on separate machines.

Why Use Virtualization?

- **Resource Optimization:** Virtualization allows for better utilization of hardware resources. Instead of having multiple physical servers each running a single application, you can consolidate them onto fewer physical machines, each running multiple virtual machines. This reduces hardware costs, power consumption, and cooling needs.
- **Isolation:** Virtual machines are isolated from each other. If one VM crashes, it doesn't affect the others. This improves stability and security.
- **Flexibility and Scalability:** Virtualization makes it easy to provision and deploy new servers. You can quickly create new VMs as needed, and you can easily scale resources (like CPU, RAM, and storage) up or down.
- **Testing and Development:** Virtualization provides an excellent environment for testing and development. You can easily create and destroy VMs to test different software configurations without affecting your main system.
- **Disaster Recovery:** Virtualization simplifies disaster recovery. You can easily back up and restore VMs, allowing for quick recovery in case of hardware failure or other disasters.
- **Cloud Computing:** Virtualization is the foundation of cloud computing. Cloud providers use virtualization to offer services like Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

How Does Virtualization Work?

Virtualization works by adding a layer of software called a **hypervisor** (or Virtual Machine Monitor - VMM) between the physical hardware and the operating systems. The hypervisor is responsible for abstracting the physical hardware resources (CPU, RAM, storage, network) and allocating them to the virtual machines.

There are two main types of hypervisors:

- **Type 1 (Bare-Metal) Hypervisors:** These hypervisors run directly on the physical hardware, like an operating system. They have direct access to the hardware and are very efficient. Examples include VMware ESXi, Microsoft Hyper-V, and KVM.
- **Type 2 (Hosted) Hypervisors:** These hypervisors run on top of a host operating system, like an application. They rely on the host OS to access the hardware. Examples include Oracle VirtualBox and VMware Workstation/Player.

Key Components of Virtualization:

- **Host Machine:** The physical machine on which the virtualization software (hypervisor) is installed.
- **Guest Machine (Virtual Machine - VM):** The virtualized environment that runs on the host machine. Each VM has its own operating system and applications.
- **Hypervisor:** The software that creates, runs, and manages virtual machines. It allocates hardware resources to the VMs.
- **Virtual Hardware:** The emulated hardware resources (CPU, RAM, storage, network adapter) that are presented to the guest operating systems

Now, we'll dive into the processes (steps) to install and run Ubuntu operating system on Oracle VirualBox.

REQUIREMENTS FOR Ubuntu 24.04.1 LTS:

Hardware Requirements for Ubuntu 24.04.1 LTS

These are the minimum recommended hardware requirements. For a smoother and more efficient experience, especially if you plan to run demanding applications or use a desktop environment with many features, having more resources is beneficial.

- **Processor:**
  - Minimum: 2 GHz dual-core processor
  - It can be either Intel or AMD
- **RAM:**
  - Minimum: 4 GB RAM
  - Recommended: 8 GB RAM or more

- **Storage:**
  - Minimum: 25 GB of free disk space
  - Recommended: 50 GB or more, especially if you plan to install many applications or use it for development
- **Graphics Card:**
  - A graphics card with at least 256 MB of memory
  - Most modern graphics cards from Intel, NVIDIA, and AMD are supported
- **Other:**
  - DVD drive or USB port for installation media
  - Internet access is helpful for downloading updates and additional software

Software Requirements for Ubuntu 24.04.1 LTS

Ubuntu itself is a piece of software, so the "software requirements" are more about what software is needed to run or support Ubuntu effectively, or software that comes with it:

- **Virtualization Software (If applicable):**
  - If you are installing Ubuntu in a virtual machine, you'll need virtualization software like:
    - VMware Workstation/Player
    - Oracle VirtualBox
    - Hyper-V (if on Windows)
- **Bootloader:**
  - GRUB (GRand Unified Bootloader) is the standard bootloader used by Ubuntu
- **Desktop Environment (if using a GUI):**
  - GNOME is the default desktop environment for Ubuntu
  - Other desktop environments are available (e.g., KDE Plasma, XFCE) but are optional
- **Core Utilities:**
  - Ubuntu includes a wide range of core utilities and libraries, such as:
    - GNU C Library (glibc)
    - Linux kernel
    - Shell (usually Bash)
    - File management tools
- **Installation Media:**
  - You'll need a way to install Ubuntu, typically:
    - A USB drive with the Ubuntu ISO image
    - A DVD with the Ubuntu ISO image

INSTALLATION STEPS

A. Preparation

1. **Download and Install VirtualBox**
   - Download the latest version of Oracle VirtualBox from the official website (virtualbox.org) and install it on your host operating system (Windows, macOS, or Linux).
2. **Download the Ubuntu ISO Image**
   - Download the Ubuntu 24.04.1 LTS ISO image from the official Ubuntu website (ubuntu.com).
3. **Create a New Virtual Machine**
   - Open VirtualBox and click on **"New"**.
   - Give your virtual machine a name (e.g., *"Ubuntu 24.04.1 LTS"*).
   - Select **"Linux"** as the type and **"Ubuntu (64-bit)"** as the version.
   - Allocate RAM (minimum 4 GB recommended; 8 GB or more is better if available).
   - Create a virtual hard disk:
     - Choose **"Create a virtual hard disk now"**.
     - Select **"VDI (VirtualBox Disk Image)"** as the disk file type.
     - Choose **"Dynamically allocated"** for physical storage.
     - Allocate disk space (minimum 25 GB; 50 GB or more is recommended).
4. **Configure the Virtual Machine**
   - Select your new VM and click **"Settings"**.
   - **Storage:**
     - Go to the **"Storage"** section.
     - Under **"Controller: IDE"** or **"SATA"**, click the empty disk icon.
     - Click the small disk icon on the right and select **"Choose a disk file..."**.
     - Browse to and select the downloaded Ubuntu 24.04.1 LTS ISO file.
   - **Network:**
     - Ensure the network adapter is enabled.
     - Set to **"NAT"** (default setting for internet access).
   - You may adjust other settings as needed (e.g., shared folders, USB access), but defaults are generally sufficient.

B. Installation Process

1. **Start the Virtual Machine**
   - Select your VM and click **"Start"**. The VM will boot from the Ubuntu ISO.
2. **Start the Installation**
   - The Ubuntu installer will launch.
   - Choose **"Install Ubuntu"** when prompted.
3. **Follow the Ubuntu Installation Steps**
   - Set **keyboard layout**.
   - Choose options for **updates and software**.
   - Select **installation type** (e.g., "Erase disk" or "Something else" – be cautious with "Erase disk" even in a VM).
   - Choose **timezone**.
   - Enter **user details** (full name, computer name, username, password).
   - Begin the installation.

4. **Restart the Virtual Machine**
    - Once the installation completes, click **"Restart Now"**.
5. **Remove the ISO Image (Important)**
    - To prevent rebooting from the ISO:
        - Go to **VM Settings → Storage**.
        - Click on the mounted ISO.
        - Either:
            - Click the disk icon and select **"Remove Disk from Virtual Drive"**, or
            - Uncheck the **"Live CD/DVD"** box.
    - This ensures the VM boots from the installed system on the virtual hard disk.
6. **Log In**
    - After restarting, the Ubuntu login screen appears.
    - Log in using your username and password.

PROBLEMS AND THEIR SOLUTION DURING INSTALLATION:

Issues (Problem Faced)

- "Unable to boot from the ISO image." (Insert Snipped Image of the error message)

- "Slow installation performance."
- "Network connectivity issues within the virtual machine."

Solution

- "Solution for 'Unable to boot from the ISO image': Double-checked that the ISO was correctly attached to the virtual CD/DVD drive in the VM settings and that the boot order was set correctly."
- "Solution for 'Slow installation performance': Increased the amount of RAM allocated to the virtual machine."
- "Solution for 'Network connectivity issues within the virtual machine': Changed the network adapter setting in VirtualBox to 'Bridged Adapter' and ensured the host network was working correctly."

FILE SYSTEM SUPPORT IN Ubuntu 24.04.1 LTS

Ubuntu 24.04.1 LTS, like most Linux distributions, supports a variety of file systems. Here are some of the most common and important ones:

ext4 (Fourth Extended Filesystem): This is the default file system for Ubuntu.

ext3 (Third Extended Filesystem): The predecessor to ext4, still supported but less commonly used.

ext2 (Second Extended Filesystem): An older version, rarely used for system partitions today.

Btrfs (B-tree File System): A modern file system offering advanced features like snapshots and copy-on-write.

XFS: A high-performance journaling file system, often used for large storage systems.

FAT32: A file system commonly used on USB drives and older systems, but it has limitations (e.g., 4GB file size limit).

NTFS (New Technology File System): The primary file system used by Windows. Ubuntu can read and write to NTFS partitions, but it's not typically used for the Ubuntu system partition.

exFAT (Extended File Allocation Table): A file system designed for flash drives and external storage, offering larger file size support than FAT32.

Why ext4 is the Default

Ext4 is the preferred and default file system for Ubuntu for several reasons:

- **Performance:** Ext4 offers good performance in terms of read and write speeds.
- **Scalability:** It can handle large file sizes and large storage volumes.
- **Reliability:** Ext4 includes journaling, which helps to prevent file system corruption in case of a system crash.
- **Features:** It supports advanced features like extents (improves performance), delayed allocation (optimizes disk writes), and checksumming (data integrity).
- **Maturity:** Ext4 is a mature and stable file system, meaning it has been thoroughly tested and is less likely to have bugs or issues.

Why Other File Systems Are Supported

- **Interoperability:** Ubuntu supports file systems like FAT32, NTFS, and exFAT to ensure compatibility with other operating systems (like Windows) and external storage devices. This allows you to easily share files between different systems.
- **Specific Use Cases:** File systems like Btrfs and XFS are supported for users who need their advanced features, such as:

Advantages and Disadvantages of Ubuntu 24.04.1 LTS

- **Advantages**

Open Source and Free: Ubuntu is open-source, meaning it's free to download, use, and distribute. This is a significant advantage for users and organizations who want to avoid licensing costs.

Large Community and Support: Ubuntu has a massive and active community. This translates to excellent online support, forums, tutorials, and a wealth of resources for troubleshooting and learning.

User-Friendly: Ubuntu is designed to be user-friendly, especially for beginners. It offers a graphical user interface (GNOME) that is intuitive and easy to navigate.

Stability and Reliability: Ubuntu LTS (Long Term Support) releases, like 24.04.1, are known for their stability. They receive updates and security patches for an extended period (usually 5 years), making them suitable for both desktops and servers.

Security: Ubuntu is considered a secure operating system. It benefits from regular security updates and a robust security model inherited from Linux.

Software Availability: Ubuntu has access to a vast software repository. The Ubuntu Software Center provides easy access to thousands of applications, and the apt package manager makes installing and updating software simple.

Customization: Ubuntu is highly customizable. Users can modify the desktop environment, themes, and system settings to suit their preferences.

Hardware Compatibility: Ubuntu generally has good hardware compatibility, supporting a wide range of devices and peripherals.

Virtualization Support: Ubuntu works well in virtualized environments and is also a popular choice for hosting virtual machines.

Development Platform: Ubuntu is a favorite among developers. It provides excellent tools and libraries for programming in various languages.

- **Disadvantages**

Hardware Driver Issues: While generally good, there can sometimes be compatibility issues with specific hardware, particularly with less common devices. This might require manual driver installation.

Gaming Performance: While gaming on Linux has improved, it might not always offer the same level of performance or compatibility as Windows, especially for cutting-edge AAA titles.

Proprietary Software Compatibility: Some proprietary software might not have native Linux versions, requiring users to find alternatives or use compatibility layers like Wine.

Learning Curve (for Windows Users): Users transitioning from Windows might experience a learning curve as they adapt to the Linux file system structure, command-line interface, and package management system.

Limited Vendor Support: Compared to Windows, some hardware and software vendors might offer less official support for Ubuntu.

CONCLUSION:

This section provided a comprehensive overview of Ubuntu 24.04.1 LTS, covering its installation process, file system capabilities, and key advantages and disadvantages. The installation process, while detailed, is made relatively straightforward by the user-friendly installer and strong community support. Ubuntu's reliance on the ext4 file system demonstrates its commitment to performance and stability, while its support for other file systems ensures compatibility with diverse storage solutions and operating systems.

Overall, Ubuntu 24.04.1 LTS proves to be a robust and versatile operating system suitable for a wide range of tasks, aligning well with the objectives of this project. Its strengths in terms of stability, software availability, and community support make it an excellent platform for both learning about and working with operating systems.

RECOMMENDAION:

Ubuntu 24.04.1 LTS is highly recommended for this operating systems and system programming project. Its robust command-line environment and excellent support for scripting and development tools make it particularly well-suited for tasks involving system calls, shell programming, and exploring UNIX concepts. The extensive online resources and community support surrounding Ubuntu greatly facilitate troubleshooting and learning, enabling students to effectively engage with the project material.

While some initial learning curve may be encountered by those unfamiliar with Linux, the benefits of using Ubuntu significantly outweigh this challenge. Its stability, security, and access to a vast software ecosystem provide a solid foundation for gaining practical experience in operating system principles and system programming techniques.

For future projects with similar objectives, Ubuntu 24.04.1 LTS, or a similarly robust and well-supported Linux distribution, would be an ideal choice. The continued evolution of the Linux ecosystem ensures that it remains a relevant and powerful platform for both education and professional software development.

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- AMD Virtualization (AMD-V) Technology Documentation: https://www.amd.com/en/technologies/virtualization
- IEEE POSIX Standards: https://standards.ieee.org/standard/1003_1-2017.html
- ISO C Standard Documents: Search for "ISO/IEC 9899" (followed by the year)
- FIPS Publications (NIST): https://csrc.nist.gov/publications/fips
- *UNIX System Programming* by Kay A. Robbins and Steven F. Robbins
- *The Design of the UNIX Operating System* by Maurice J. Bach
- BSD and macOS Documentation (official websites)
- Solaris Documentation (Oracle website)
- Resources from cybersecurity organizations (e.g., SANS Institute, OWASP)