Embedding the Operating System: a Case Study LMDE 3 on a USB Flash Drive

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Abstract. The Operating system is growing rapidly in the era of information technology and the particular Desktop Operating System, one of the desktop operating system is LMDE 3 “Cindy” Linux-based, this research will discuss 2 techniques for embedding operating system (EOS) LMDE 3 Live-USB and permanent installation on a USB Flash Drive, and test performance.

1. Introduction

1.1. Universal Serial Bus (USB)
Universal Serial Bus (USB) is a connectivity specification that provides ease for use, the device is first released in 1995 for the Personal Computer (PC) which is currently growing rapidly as the embedded system replaces the interface such as serial and parallel, as a liaison of communication are most preferred. USB is not a protocol peer-to-peer such as Ethernet, Universal Serial Bus (USB) has additional device called a USB Device or a USB Peripheral and is divided into several layers, among others: a) the USB Device Controller Driver, functioning as a controller and data transfer in read and write to the registers, b) the USB Device Stack, serves as the USB Protocol to control the device – the USB device and c) the USB Function Driver, is used to communicate on the level of the driver and control the actual device. As we all know, devices – USB devices widely used in daily life, such as: USB Disk Drive, USB Modem, USB Audio and other.[1]

Figure 1. PC to Device via USB Disk
USB is the interface fast and flexible to connect with computer devices, each personal computer or laptop of course has a USB port, the development of usb device and software that communicate with each other requires some knowledge of how usb and your personal computer or laptop written to implement the interface.[2]

1.2. USB Flash Drive
USB flash drive is a usb device that is most popular today, the method most simple, cheap to transfer data from one computer to the other, but a USB flash drive requires a USB host to be able to communicate. USB host in the design specifically to plug and play, the necessary components – supporting components as seen in the Figure 2.

![Figure 2. Block Diagram of USB Flash Drive](image2)

Most USB flash drives have a utility file system such as : FAT16 or FAT32.[4]

2. Related Work
USB Devices provide several advantages in terms of storage which is reliable in data transmission, the USB flash memory is usually used as a storage media, the benefits are also many, not only in terms of performance but also, be aware of the events don't deserve, which can inhibit the function of normally.[5]

The operating system is a solution to accommodate the hardware as well as the beginning of a number of operating systems, although execution of the operating system is centered between the ix86 using Linux.[6]

Operating system open-source can be an alternative to commercial operating systems, linux operating system be userfriendly since it was introduced in 1991, the many distributions of the linux operating system and supported by various community and sponsors. Linux also fits on the old computer with the choice of many distributions, and can run only using the cd and flash drive.[7]

3. Research Method
In this paper will be discussed some related components, among others : the Technique of embedding the Operating System LMDE 3 on a USB Flash Drive, Advantages and Disadvantages

3.1. Operating System
The operating system is software that manages computer hardware, can also be regarded as the basis of an application that bridges between computer users and computer hardware. Some operating systems designed for easy, efficient in its use, is an important part of the components of the computer system, we can see on the picture the components of a computer system, can be seen on the Figure 3 View of Computer System Component.

![Figure 3. View of Computer System Component](image3)
Modern computer systems generally aim to provide access to the shared memory consists of a collection of cpu's and set the device controller. Can be seen on the Figure 4. [8]

Figure 4. A Modern Computer System

The operating system is a collection of programs and data that make the computer work, including managing the hardware resources, providing service for the application, and other.

Computer (PC or Laptop) main purpose designed to be as flexible as possible, able to do different tasks, such as editing documents, internet, E-mail, audio-video player, graphic design, game servers, and other computing devices is specifically called embedded systems such as smart devices, network devices, financial devices and other.[9]

The ultimate goal of this paper is the Embedding of the Operating System on a flash disk drive, as an alternative to the use of desktop operating system based on linux.

3.2. LMDE 3 “Cindy”

LMDE stands for “Linux Mint Debian Edition” is the distribution of desktop operating system based Debian, developed by the team or the community responsible for the project – project Linux Mint is based on Ubuntu Desktop. Linux Mint is mostly developed by Clement Lefebvre in france in 2006 “There”, in the year 2010,[10] the year 2018, the Linux Mint Project released LMDE 3 “Cindy”. [11]

The linux operating system was created based on the 3 (three) parts, such as kernel, shell and programs. [9]. According to the Nandhini U., Nivetha B, Shobana D. An Analysis of the Linux Operating System, explain the advantages and disadvantages of linux, among other things :

| Table 1. A advantages and disadvantages of Linux [6] |
|---------------------------------------------------|
| Advantages                        | Disadvantages          |
|-----------------------------------|------------------------|
| • Cost                            | • Non-Compatible Software |
| • Security                        | • Unsupported Hardware  |
| • Reliability                     |                         |
| • Capabilities                    |                         |

LMDE is less mainstream than Linux Mint, has a user base that is compatible with PPA's and less has several features, a little more difficult to use and more difficult to seek help, so not advised for novice users. However, LMDE is a bit faster than Linux Mint and run the new packages, not determined the final release, except in the case of bug fixes and basic package.[10] Can be seen on the Figure 5. [12]
3.3. System Requirements

- 1 GB RAM (recommended 2 GB, for better use and comfortable)
- 15 GB disk space (recommended 20 GB)
- Screen Resolution 1024 x 768.[11]
- Support 32-bit and 64-bit.

3.4. Implementation LMDE 3

The implementation in this paper using the technique of embedded operating system LMDE 3 “Cindy” on a flash disk drive with Live-USB and permanent installation.

3.4.1. Live-USB. Containing a full operating system that can be booted. Although they are closely related to live CDs in that they can be used in embedded systems for system administration, data recovery, or test pre-installation the USB flash drive.

- Formatting Live-USB flash drive
  irwan@magansa:~/Documents$sudo fdisk -l
  Disk /dev/sda: 298.1 GiB, 32007293376 bytes, 625142448 sectors
  Units: sectors of 1 * 512 = 512 bytes
  Sector size (logical/physical): 512 bytes / 512 bytes
  I/O size (minimum/optimal): 512 bytes / 512 bytes
  Disklabel type: dos
  Disk identifier: 0xcb33805e
  Device Boot Start End Sectors Size Id Type
  /dev/sda1  2048 7999487 7997440 3.8G 82 Linux swap / Solaris
  /dev/sda2 * 7999488 163842047 155842560 74.3G 83 Linux
  /dev/sda3 163842048 471040247 307200000 146.5G 7 HPFS/NTFS/exFAT
  /dev/sda4 471046142 625141759 154095618 73.5G 5 Extended
  /dev/sda5 471046144 481781759 10735616 5.1G 82 Linux swap / Solaris
  /dev/sda6 481783808 625141759 143357952 68.4G 83 Linux
  Disk /dev/sdb: 3.6 GiB, 3869544448 bytes, 7557704 sectors
  Units: sectors of 1 * 512 = 512 bytes
  Sector size (logical/physical): 512 bytes / 512 bytes
  I/O size (minimum/optimal): 512 bytes / 512 bytes
  Disklabel type: dos
  Disk identifier: 0x2aa52a15
  Device Boot Start End Sectors Size Id Type
  /dev/sdb1 2048 7557703 7555656 3.6G c W95 FAT32 (LBA)
The process of copying system lmde 3 to a flash disk drive using dd command
irwan@magansa:~/Documents$ sudo dd if=/home/irwan/Documents/lmde-3-201808-cinnamon-32bit.iso of=/dev/sdb

508865+0 records in
508865+0 records out
260538880 bytes (261 MB, 248 MiB) copied, 112.11 s, 2.3 MB/s
3256320+0 records in
3256320+0 records out
1667235840 bytes (1.7 GB, 1.6 GiB) copied, 1154.66 s, 1.4 MB/s

3.4.2. Permanent Installation. Containing a full operating system that can be booted in that they can be used in embedded systems for system administration, data recovery, save setting and install all packages on usb flash drive.

3.5. Advantages and Disadvantages
After embedding the operating system LMDE 3 onto a USB Flash Drive Live USB and Permanent Installation, in this research, conclusions can be drawn about the excess and the lack of LMDE 3 as operating system-based desktop.

3.5.1. Advantages of LMDE 3 embedded on USB Flash Drive. Embeds the operating system LMDE 3 with the technique of Live-USB is relatively faster, the data storage can be done on a Permanent Installation, the appearance of the desktop environment more attractive, can be used as an alternative desktop operating system, is plug and play on all personal computers/ laptops that support the architecture i386 and x86_64.

3.5.2. Disadvantages of LMDE 3 embedded on USB Flash Drive. Embeds the operating system LMDE 3 relatively longer into the USB Flash denganteknik permanent installation, the storage is not permanent on the Live-USB, it requires a personal computer or laptop to boot the operating system.

4. Result and Conclusion
4.1. The result of booting the LMDE 3 and Performance chart on flash drive Live-USB

Figure 6. (a) Result of booting the LMDE 3 on flash drive Live-USB

Figure 6. (b) Performance Chart on Live-USB
4.2. The result of booting the LMDE 3 and performance chart permanent installation on flash drive

Figure 7. (a) Result of booting the LMDE 3 on flash drive Permanent Installation.

Figure 7. (b) Performance Chart on flash drive permanent installation

4.3. Comparison of LMDE 3 on Live-USB and permanent installation in flash drive

Table 2. Comparison of LMDE 3 on Live-USB and Permanent Installation in Flash Drive.

| No  | Test Item                  | LMDE 3 on Live-USB                  | LMDE 3 on Permanent Installation |
|-----|----------------------------|------------------------------------|----------------------------------|
| 1.  | Embedding the LMDE 3       | Using dd Command                   | Full Installation                |
| 2.  | Booting Process            | PC or Laptop Must Support Boot from USB Flash Drive | PC or Laptop Must Support Boot from USB Flash Drive |
| 3.  | Flexibility                | Plug and Play                      | Plug and Play                    |
| 4.  | Cost-effectiveness         | Fast and Lower Cost                | Fast and Lower Cost              |
| 5.  | Storage                    | Volatile                           | Non-Volatile                     |
| 6.  | Office                     | Yes                                | Yes                              |
| 7.  | Multimedia                 | Yes                                | Yes                              |
| 8.  | Internet                   | Yes                                | Yes                              |
| 9.  | Package Installer          | Yes                                | Yes                              |
| 10. | Restart Process            | Abnormal                           | Normal                           |
| 11. | Shutdown Process           | Abnormal                           | Normal                           |

5. Conclusion
The Benefits Linux Desktop Free!, linux operating system is free. Users can search the app needed for free. Make It Your Own, linux can be kustomasi in accordance with the needs. Lock It Down, linux has security. It's a Natural Development Platform, the Linux desktop has the added benefit of including the GNU C Compiler. Community Is at the Heart of Everything Linux, linux Distributions have communities scattered in different parts of the world.[9]

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