1. Introduction

A ROM is the operating system software that runs the Android. It is stored in the Read Only Memory portion of the hardware on the Android smartphone and/or tablet. All Android devices come with a stock ROM installed by the manufacturer. But, if you root your device, you gain the ability to install custom ROMs that will completely change the look and feel of the software. This is one of the major reasons that people choose to root their Android devices.

There are two types of ROM's available for the android device, they are described below:

1) Stock ROM: The ROM or the operating system provided by default by the device manufacturer. It is the official ROM for the device.

2) Custom ROM: It is not the default ROM, it is developed mostly by the third party developers. It can either be a modified version of the stock ROM or it can be completely different from the stock ROM. Both custom ROM's and Stock ROM's for Android have their own advantages as well as limitations that are discussed further in this paper. Generally, it is difficult to remove the bloat ware from the android device but, the custom ROM can do so. Though rooting is an illegal process, still most of the users root their devices to get a modified version of the operating system or the version that the manufacturer has decided not to release for their devices. Rooting may increase the performance of the device, it may also improve the battery life, add tweaks & additional features like themes etc.

Problems in existing stock ROM-

1. Updates aren't frequent, as development is don mainly by the corporation who have to follow a scheduled release cycle.
2. Some Android devices slow down over time. Others are slow out of the box due to stock ROM.
3. Smartphone's battery backup and battery life tears down over a period of time which troubles us in day to day life.

To solve the all the above problems use the CUSTOM ROM. A custom ROM replaces your device's Android operating system with a new version of the android operating system.

2. Literature Survey

2.1 . IEEE Research Paper : Muhammad Suleman (2020) [1]

As the most popular and the most widely used mobile operating system, Android OS is open source with rich features. Many developers customize it to fulfill their needs or what the end users demand. The advantages of custom ROMs are analyzed systematically in this paper. The customized ROMs are experimentally demonstrated to be better than the stock ROMs in terms of performance, storage, user interface etc.

2.1.1 Need Of Custom ROMs With existence of Stock Android :

In Android OS, a user cannot modify any of the core system files or settings by default. The devices with stock ROMs also have some restrictions that are put by the vendor or carrier. Moreover, many top-paid apps need root access. To overcome these limitations, the device needs to be rooted with Custom ROM.

2.1.2 Future Work To be done In Domain:

56% of the modifications in LineageOS can be safely automated into the future release of Android. In this context, the optimum features from existing distributions related to power savings, customizations, UI etc. can be introduced into the official ones or even into a new, much more optimized and stable custom distribution. This work can be expanded to include more Android versions and custom distributions. The number of devices put to test can also be increased.

2.1.3 Specifying Auxiliary Tool on Android Distributions :

The application allows users to learn about custom Android distributions and is divided into four sections viz. distributions, devices, about current phone, and comments. In the distributions section, details of each distribution along with its features and images are given. A comparison of ROMs from different Android versions and distributions (including stock) is made on the basis of ROM size, boot time, memory usage, performance and features. These details would help the user to know about the potential of custom ROMs as compared to the stock (RQ1). Further, it will give them a fair idea of the specific features of each distribution (RQ2). In the devices section, users can check for root, custom recoveries and ROMs for devices. Details of each ROM such as Android version, security patch level, build date, size,

boot time, memory usage, performance, UI etc. are provided which would help them in selecting a ROM that fits their needs. The about phone section allows users to check their phone details. These include details related to root status, up time, hardware, software, CPU, GPU, memory, internal and external storage, screen, battery, sensors, network etc.\In the comments section, users can provide feedback and share their comments. This functionality will hopefully encourage others to give custom ROMs a try.

2.2 XDA Developer Forum: Skanda Hazarika (2013) [2]

As soon as Google drops the source code of a new version to the Android Open Source Project (AOSP), the modding community starts working toward making the latest flavor of Android accessible to more and more devices in the form of custom ROMs. As such, there are a number of Android custom ROM distributions to choose from. If you're itching to try out the vanilla Android experience on your shiny new Android phone or just want to breathe new life into an old device stored in your closet, but unable to pick the perfect candidate, then this guide is for you. Below you can find the most popular custom ROMs in the domain of Android.

2.2.1 Serveral Existing Custom ROMs :

2.2.1.2 LineageOS :

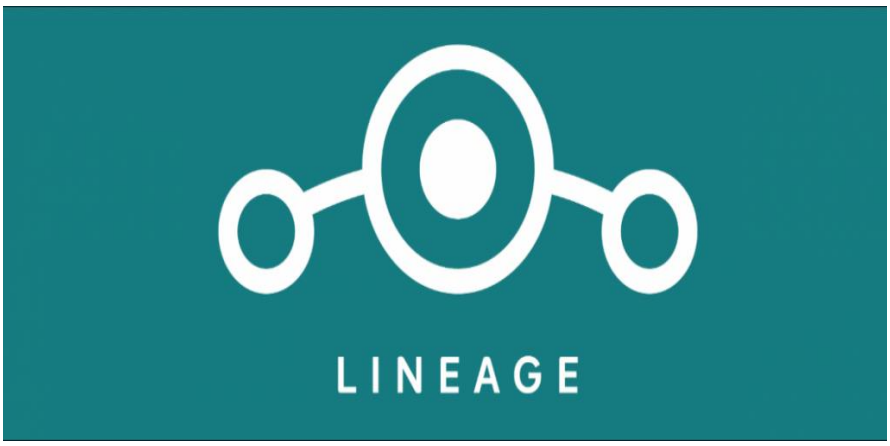

Fig1: Lineage OS

Truth be told, the LineageOS project doesn't really need an introduction at this point. Being the true successor to the legendary CyanogenMod project, LineageOS is a lightweight ROM with the bare minimum in additional features, resulting in a high-performance, high versatility Android variant one can imagine. The official LineageOS builds are standardized against a Device Support Requirements charter, which ensures that all the basic hardware functionalities

(such as Wi-Fi, Bluetooth, GPS, Camera, NFC, etc.) continue to operate after replacing the factory-installed software with LineageOS.It has set itself as the highest benchmark in the world of custom ROMs.

2.2.1.2 Pixel Experience:

Fig2: Pixel Experience

If you're a stock Android enthusiast and want to experience vanilla Android just like on Google's own Pixel devices, then you should definitely check out the Pixel Experience project. The custom ROM comes with all Google apps and Pixel goodies, like the launcher, wallpapers, icons, font, and boot animation out of the box.

2.2.1.3 Evolution X:

Fig3: EvolutionX

Are you a vanilla Android enthusiast and looking for a Pixel-esque ROM that also offers some useful UI/UX customizations? Take a look at the Evolution X project. The ROM comes with preinstalled Google apps and Pixel goodies, and features several customizations like Status Bar visibility toggle and Gaming Mode Quick Settings Tile.

2.2.1.4 Xiaomi.EU

Fig 4: XIAOMI EU

For those of you with a Xiaomi, Redmi, or POCO device, and who just want to get rid of the bloatware and advertisements of the MIUI skin, you can go for the Xiaomi.EU ROM. This particular distribution is not an actual custom ROM in the truest sense of the term, but the extensive modifications make it quite an equivalent one in the MIUI ecosystem.The daily builds of the ROM are based on Chinese MIUI beta firmware packages and have further been localized for the international markets. As a result, users can get their hands on all the bleeding edge functionalities introduced in the Chinese variant of MIUI before Xiaomi officially ports them to the global ROM.

3. Methodology

3.1 Android Architecture -

I. **Application framework:** The application framework is used most often by application developers. As a hardware developer, you should be aware of developer APIs as many map directly to the underlying HAL interfaces and can provide helpful information about implementing drivers.

II. **Binder IPC :** The Binder Inter-Process Communication (IPC) mechanism allows the application framework to cross process boundaries and call into the Android system services code. This enables high level framework APIs to interact with Android system services. At the application framework level, this communication is hidden from the developer and things appear to "just work".

III. **System services:** System services are modular, focused components such as Window Manager, Search Service, or Notification Manager. Functionality exposed by application framework APIs communicates with system services to access the underlying hardware. Android includes two groups of services: system (such as Window Manager and Notification Manager) and media (services involved in playing and recording media).

IV. **Hardware abstraction layer (HAL):** A HAL defines a standard interface for hardware vendors to implement, which enables Android to be agnostic about lower-level driver implementations. Using a HAL allows you to implement functionality without affecting or modifying the higher level system. HAL implementations are packaged into modules and loaded by the Android system at the appropriate time. For details, see Hardware Abstraction Layer (HAL).

V. **Linux kernel:** Developing your device drivers is similar to developing a typical Linux device driver. Android uses a version of the Linux kernel with a few special additions such as Low Memory Killer (a memory management system that is more aggressive in preserving memory), wake locks (a Power Manager system service), the Binder IPC driver, and other features important for a mobile embedded platform. These additions are primarily for system functionality and do not affect driver development. You can use any version of the kernel as long as it supports the required features (such as the binder driver). However, we recommend using the latest version of the Android kernel.

3.2 Custom Rom Installation Process Flow Chart:

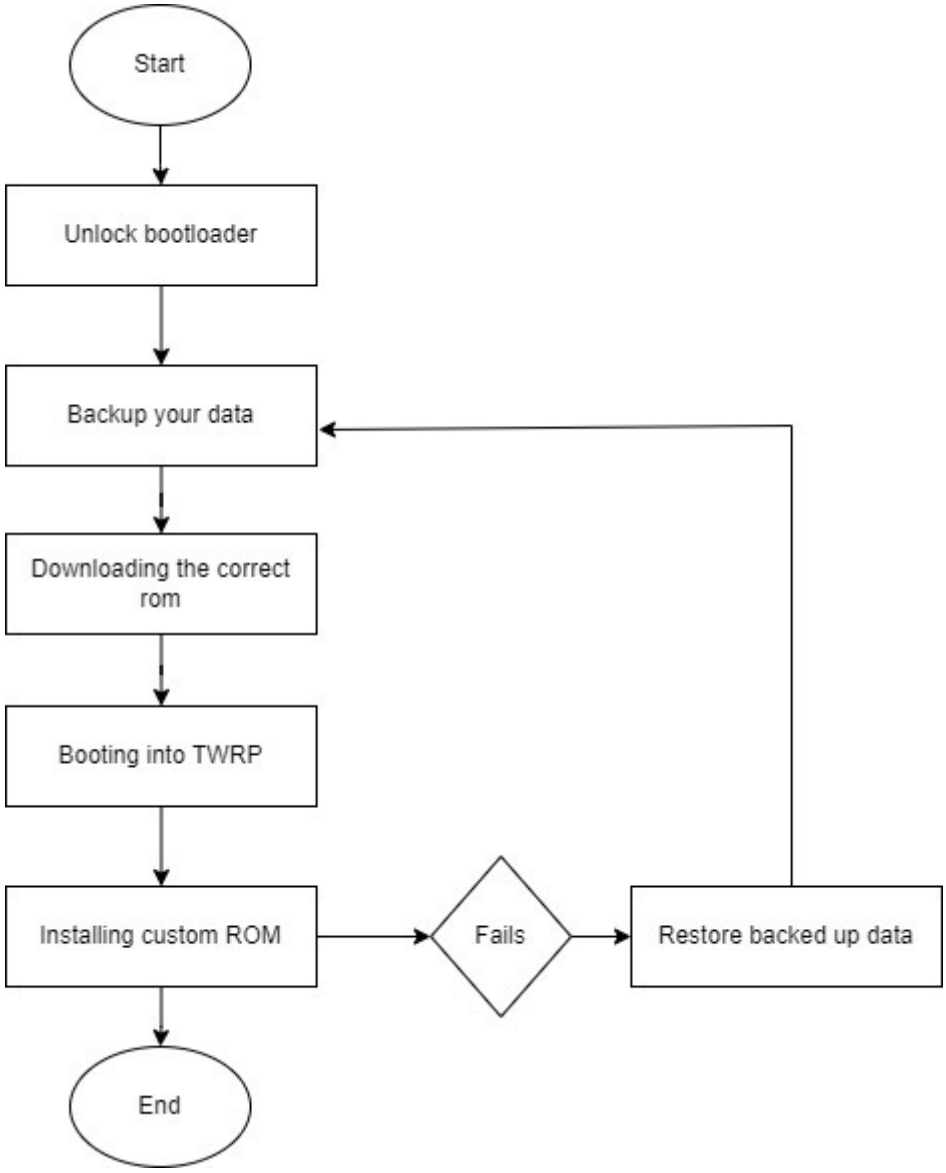

Fig 5: flow chart of installation of C ROM

Figure 5 depicts the process of how one can install custom ROM on the any supported android device.This process involves sub-processes like booting into TWRP ,Restoring backed up data and such.

4. Advantages

4.1 Latest Android Version:

One of the most common reasons to install it is the updated Android version. Users can install the latest version of Android on their phone, which makes their old phones look like new. This not only makes them look new, but also gives the user better performance, because the new version is more stable than the old one.

4.2 Customization:

Another reason people choose to install it on their Android phone is the multitude of customizations available. Stunning themes can bring a new look to their devices. It allows users to customize the UI (User Interface) to their liking.

4.3 Overclocking and Underclocking:

This is not much of a benefit to installing a custom ROM, but instead it is associated with the custom kernel (a system file that is like a driver for the operating system) installed with that ROM. Either way, it allows a user to overclock or under clock their device. Overclock means running the device's CPU or GPU at a speed higher than intended by the manufacturer. This gives you higher performance, but I will not recommend it as it may damage the device. Under clocking is the opposite. It is the modification of the system so that it operates at a lower speed than intended. It gives you longer battery life, but in return for some performance. You can also install custom kernels.

4.4 Bloatware Removal:

Although rooting allows the user to remove bloatware apps installed by the manufacturer, the user still has to choose the app they want to use and the one they don't use and manually uninstall any that they do. he does not wish to use. While custom ROM developers remove these apps while they are creating these ROMs, they don't include them in their operating system so the user just needs to install it and now their device is bloatware free.

4.5 Custom Mods:

Tons of custom mods available for Custom ROM entice users to install it on their device. These

custom mods vary from being very simple like increasing volume beyond manufacturer limit to huge custom ROM mod like multi window mod or pie control mod.

4.6 User Interface Scope:

It allows a user to experience a wide range of user interfaces and choose the one that suits them best. Like the Sense user interface for HTC phones which has been ported to many different phones, allowing users to experience an HTC phone without even purchasing an HTC phone.

5. Disadvantages

5.1 Lighter :

Another reason the user is reluctant to install a custom ROM on their device is fear of brickwork which renders the device unusable and nothing more than a block of brick. This is mostly dreaded as there is no way to recover a device from this state.

5.2 Battery Life Problem:

These ROMs may not be fully optimized for your device resulting in battery life issues causing it to drain more, not charge properly, or even damage the battery.

5.3 Hardware Problems:

These ROMs may not support all the hardware in your device, which may cause hardware malfunction or other issues, such as the camera not working or taking inferior photos.

5.4 Bugs:

These ROMs are not tested like the one preloaded by the manufacturer, so this produces bugs that produce instability, such as forcing apps to close (which can be really annoying) or random restarts of the phone or with the phone stuck. in a boot loop (really terrifying for a beginner).

6. Conclusion and Future Scope

There are many advantages of using custom ROMs. However, most of the Android users always keep using the stock ROMs, and thus are unable to get the most of their devices. This project compares the custom ROMs with the official ROMs through experiments to determine the advantages and functionalities of the custom ROMs. The results show that the custom ROMs are superior to stock in terms of size, boot time, memory usage, performance, power usage, etc. Utilization of custom ROMs, operating system and kernels made by experienced developers help users to utilize their phone's complete power. Generally, Custom ROMs allows for better understanding of aspects and features that can be added or available to our phones.

The most defining aspect of custom ROM development is the fact that one may extend the longevity of their phone's life span. This is done by alleviating older software to be present which would've accumulated junk files. And replacing it with newer more advanced and updated software that is released by Google under the Android Open Source Project [3].

References

[1] Muhammad Suleman “Empirical Research And Auxiliary Tool For Custom Android ROMs”, IEEE ACCESS , Apr. 2020

[2] Skanda Hazarika “Most Popular Custom ROMs for Android: LineageOS, Pixel Experience, Paranoid Android, and more!” , June 2013

[3] XDA Developers “Android with Custom ROM” , May 2009 ,ACCESSED APR 2022