Union Filesystem Source Directory Protect Architecture

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ABSTRACT

Union filesystem has the advantage of providing a single integrated view of files on the same path by eliminating duplication of files on the same path at the mount point. A directory mounted by union filesystem should not be able to have access to that source directory in accordance with the security principle. However, the current operating system does not provide a separate security feature for the directory mounted by the union filesystem. In such an environment, there is a security threat in which unauthorized personnel access the source directory for mounting with union filesystem to create arbitrary files or change critical files. This study proposes an approach control architecture that can protect the directory to mount with union filesystem. The proposed architecture can work at the kernel level to block users from bypassing access. In order to verify the effectiveness of the proposed mechanism, the positive and negative function tests were conducted in this study. As a result, the proposed union filesystem source directivity architecture has been verified to be effective.

KEYWORDS

Access Control, AppArmor, AUFS, Device Mapper, Overlay, SecureOS, Security Principles, Security Requirement, SELinux, Source Directory Protect, ZVFS

INTRODUCTION

Union filesystem is a technology that extends the union mount supported by the Linux/Unix operating system to the filesystem. This technology utilizes other filesystems as one filesystem by continuously mounting them in the same location. Previously used only in the Linux/Unix operating system, but now the research is expanding in the Windows operating system.

To use union filesystem, you must select source directory and mount it. When calculating with union filesystem, check the configuration item of the source directory for mount and remove the duplicate item and mount it with one filesystem. Finally, the user can access the mounted filesystem and do file I/O.

However, union filesystem is a highly vulnerable structure for security. According to the principle of information protection for Isolation, only one use interface of all objects should be provided. Therefore, when using union filesystem, access should be made only through mount path. However, the union filesystem can be accessed through source directory as well as mount path. In particular,

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if a user directly accesses the source directory and changes the file structure, the change is reflected in the mounted filesystem.

If these security environments are exploited, when applications are being provided using union filesystem, critical files can be arbitrarily modulated to reduce the availability of the application, and access source directory to distribute malicious code.

In response to these security threats, the operating system used secureOS to block unauthorized access to critical files/directories. However, current secureOS is not considering union filesystem. For this reason, union filesystem has limitations that are not protected from unauthorized access.

This study proposes an approach control mechanism that can block unauthorized access to the unauthorized filesystem for these risks. If unauthorized access to union filesystem can be blocked, it will increase the integrity and availability of applications using Union filesystem. Since the proposed approach control mechanism needs to be verified for this purpose, positive and negative function tests are carried out.

This study consists of two chapters. Chapter 1 describes the background and purpose of the study. Chapter 2 introduces union filesystem and describes the security requirements that must be met to take advantage of it. Chapter 3 describes the current secureOS being provided and analyzes the security environment for union filesystem versus current file access control technology. Chapter 4 proposes an approach control mechanism for the targeted union filesystem in this study. Chapter 5 performs the validation of the effectiveness of the proposed approach control mechanism. Lastly, Chapter 6 summarizes and organizes the entire research.

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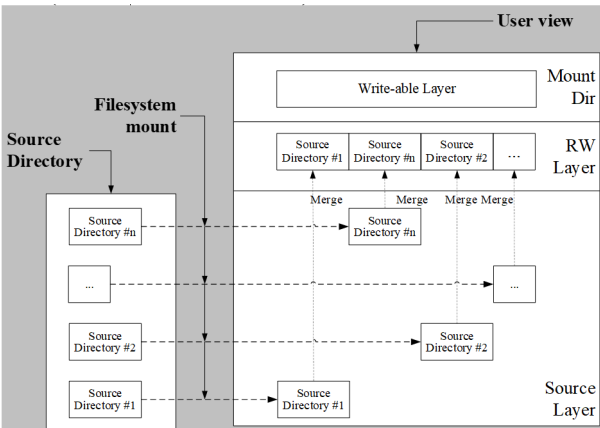
Union Filesystem

Union Filesystem Concept

Union filesystem is a concept that embodies the union mount (Blunck, 2005).

The union mount is the simultaneous mount of multiple filesystems in the same path, keeping the filesystem in the first mount state and overwrapping the filesystem in the next mount. The non-overlapping file is maintained, but the overwriting of the duplicate file is later performed by the mounted file(Klotzbücher, 2004).

Figure 1 shows the mount of advanced multi-layered notification filesystem (AUFS), a typical example of union filesystem. When the user selects the source directory to mount and mounts with

Figure 1. AUFS mount structure

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