File system security features in Windows 11

**Description**

In this report we will be analysing the following features that Windows 11 brings to tackle issues related to file system security and comparing them with the features provided by Apple’s latest version of its macOS operating system, macOS Ventura:

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| **Bitlocker drive encryption** | Windows 11 utilises Bitlocker as its primary data encryption tool protecting all the files on a system’s drives from unauthorised access by rendering files on the drives unreadable by anybody without the password or recovery key. (et al., *Bitlocker* 2023) |
| **Personal data encryption (PDE)** | PDE is a data encryption tool that can be used on top of already existing encryption tools like Bitlocker. It is used to encrypt individual files rather than larger volumes of files or drives. (et al., *Personal Data Encryption (PDE)* 2022) |
| **Security descriptors** | Windows 11’s NTFS file system uses Security descriptors as a means of storing relevant information for each file/directory that dictates their different levels of access for users. (Sherer, *Security descriptors* 2021) |
| **Controlled folder access (CFA)** | Controlled folder access works by preventing access to files and folders on a system from applications that are not on a list of trusted apps set by an administrator. (et al., *Protect important folders with Controlled Folder Access* 2023) |
| **Windows File Protection (WFP)** | WFP prevents critical Windows system files from being replaced or overwritten by any other programs unless it is from a Windows verified source such as an OS update. (Support, *Description of the Windows File Protection feature*) |
| **Auditing** | Windows 11 uses an auditing system that logs specific security events including those related to file system security to provide information on any breaches that may occur in a system. (lorihollasch, *Auditing* 2021) |
| **File signature validation** | Files in Windows 11 have file signatures which identify the file type. This information can be used by Windows Defender to identify if a file is potentially dangerous or has been modified. (Malin et al., *Malware forensics field guide for windows systems: Digital Forensics Field Guides* 2012) |

**OS support**

**Bitlocker** is a key out-of-box feature that is deeply integrated into Windows 11. It utilises the AES-128 encryption standard alongside a TPM chip found in almost all modern computers’ motherboards to render all the files in a drive unreadable and inaccessible if the hardware is compromised, and the machine is modified, stolen or the drives themselves are stolen. (et al., *Bitlocker Security FAQ*) This behaviour is default and occurs as soon as Windows 11 is installed on a machine and logged into for the first time as an administrator. It also allows the option of an administrator set Key/Password and an external USB key as further methods of authorising access to a drive to enhance file security and it is often recommended to use all three methods together. (et al., *Protectkeywithtpmandpinandstartupkey method of the win32\_encryptablevolume class - win32 apps* 2021)

Alongside Bitlocker, Windows 11 also utilises **Personal data encryption** to protect individual files specified by the administrator of a system. It is able to work on top of existing encryption methods however unlike Bitlocker, it utilises ‘Windows Hello for Business’ to log in the user by scanning biometric information with onboard hardware such as a fingerprint scanner or facial recognition software and a camera. Upon receipt of authorised biometric data the key is released, and the files can be accessed. (et al., *Personal Data Encryption (PDE)* 2022)

Every object in Windows 11 is assigned a **security descriptor**. They can be assigned at a granular level for each individual file/parts of a file or broadly apply to a volume of many files. They are made up of security identifiers (SIDs) that describes the owner of the object or optionally an additional SID that describes a group ownership, where owners can reset the security of an object ( et al., *Security descriptors in file systems* 2021), a system access control list (SACL) describing which actions on the object are logged for **auditing** purposes and a discretionary access control list (DACL) describing which users can perform actions on the object. (Sherer, *Security descriptors* 2021)

With **Controlled folder access (CFA)**,users can select folders in a file system that will prevent untrusted applications from accessing the contents of these folders. Trusted applications are selected “based on their prevalence and reputation” (et al., *Protect important folders with Controlled Folder Access* 2023) or can be added to the list of trusted apps by the system administrator. Any applications that are not on this list will not be allowed to access specific folders, also chosen by the administrator of a system, and a log will be created in the device timeline view for every CFA block that occurs for **auditing** purposes.

**Windows File Protection (WFP)** protects crucial system files through 2 primary mechanisms. The first mechanism is a process that runs in the background of the operating system that alerts the system when a change is made to a file in a protected directory, it then uses **File signature validation** to check if the file was changed appropriately (e.g. Windows Update to system files). If not, the new file is replaced with its previous version held in the cache folder, network installation path or windows CD-ROM, and the attempted change is logged in the system log to be viewed by an administrator for **auditing** purposes. If the original file cannot be found, a dialogue box is opened for the admin of a system asking to have the physical installation media inserted to recover the unchanged file. (Support, *Description of the Windows File Protection feature*) The second mechanism used is the System File Checker tool which provides the same security checks but for the cache folder and catalog files responsible for providing the correct version of the system files in the first mechanism.

**File signature validation** identifies a file via its header with the first 20 bytes of the file as hexadecimal characters, the first two bytes of which identify the file type. It can be used by system admin’s to scan a system and look for unsigned files that can pose a risk to a system such as unsigned .exe files.

Timeline

Description automatically generated

**Comparison**

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| **Windows 11** | **macOS Ventura** |
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**Effects on developers**

**Conclusion**

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