Injibara University

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Department of Information Technology

Network and System Administration (CoSc 4036)

Chapter Three: File Systems and Management of Data Storages

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- File System Administration
- Logical Volume Management
- Redundant Array of Independent Disks

File System Administration

File System Types

- Creating a file system **writes information** to the device and creates order of the empty space.
- This file system targeted on **data consumes** a small percentage of the space.
- The remaining space on the disk drive is split into **small, consistently sized segments** called **blocks**.
- **Windows supports** a number of file system types, some of which are described as follows.
- Microsoft Windows employs two major file systems: File Allocation Table – FAT and New Technology File System - NTFS

Cont …

- ✓ **FAT**: which was inherited from **old DOS** and has **exFAT** as its later extension.
- ✓ **NTFS:** the primary format most modern versions of this OS use by default.
- ✓ **ReFS** was also introduced by Microsoft for **server computers** starting from Windows Server 2012.
- ✓ **HPFS** developed by Microsoft together with **IBM** can be found only on extremely **old machines** running Windows NT up to 3.5.

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FAT

- *FAT* (File Allocation Table) is one of the simplest FS types, which has been around since the 1980s.
- It consists of the *FS descriptor sector* (boot sector or superblock), *the block allocation table* (referred to as the File Allocation Table) and *plain storage space* for storing data.
- Files in FAT are stored in **directories**.
- Any **next block** can be found through the **block allocation table** by using it as a linked list.
- The block allocation table contains an array of block descriptors.

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- The numbers in *FAT12*, *FAT16*, *FAT32* stand for the number of bits used to address block.
- This means that **FAT12** can use up to 4096 block references, while **FAT16** and **FAT32** can use up to 65536 and 4,294,967,296 accordingly.
- *FAT12* and *FAT16* used to be applied to **old floppy disks** and do not find extensive employment nowadays.
- *FAT32* is still widely used for **memory cards** and **USB sticks**.
- The format is supported by **smartphones, digital cameras and other portable devices**.

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- *FAT32* can be used on **Windows-compatible** external storages or disk partitions with the *size under **32 GB*** when they are **formatted** with the **built-in tool** of this OS, or up to **2 TB** when other means are employed **to format the storage**.
- The file system also doesn't allow **creating files** the size of which exceeds ***4 GB***.
- To address this issue, **exFAT** was introduced, which doesn't have any realistic limitations concerning the size of a file and is frequently utilized on modern **external hard drives** and **SSDs (Solid State Drives).**

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NTFS

- *NTFS (New Technology File System)* was introduced in 1993 with Windows NT and is currently the most common file system for **end user computers** based on Windows.
- Most operating systems of the **Windows Server** line use this format as well.
- This FS type is quite reliable and supports **many features**, **including *access control*, *encryption*, etc.**
- Each file in NTFS is stored as a descriptor in the ***Master File Table*** and its data content.
- The **Master file table** contains entries with all information about them: **size, allocation, name, etc**.

Cont …

- The first and the last sectors of the file system contain its ***settings*** (the boot record or **the superblock**).
- This format uses ***48*** and ***64 bit*** values to reference files, thus being able to support data storages with extremely high capacity.
- NT file system (NTFS), also called the New Technology File System, is a process that the Windows NT operating system uses for **storing, organizing, and finding files** on a **hard disk efficiently**.

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Benefits of NTFS:

- **Performance**: NTFS allows **file compression** and provide increased storage space on a disk.
- **Security Access control**: NTFS will enable us to place **permissions on files and folders** to restrict access to mission-critical data.
- **Reliability**: NTFS focuses on the **consistency of the file system** so that in the event of a disaster (such as a power loss or system failure), to quickly restore your data.
- **Disk space utilization**: in addition to file compression, NTFS also allows **disk quotas** to have more **control over storage space**.

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ReFS

- *ReFS (Resilient File System)* is the latest development of Microsoft introduced with Windows 8 and now available for Windows 10.
- Its architecture absolutely differs from other Windows formats.
- ***ReFS*** has high **tolerance to failures** due to new features included into it.

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HPFS

- *HPFS (High Performance File System)* was created by **Microsoft in cooperation with IBM** and introduced in 1989 as a **file system for servers** that could provide much better performance when compared to FAT.
- HPFS seeks to arrange the file in **contiguous blocks.**
- HPFS ensure that its fragments are placed maximally close to each other.

Logical Volume Management - LVM

- *LVM*, or Logical Volume Management, is a **storage device management technology** that gives users the power to manage the physical layout of component **storage devices** for flexible administration.
- The main advantages of LVM are increased flexibility, and control.
- Logical volumes can have meaningful names like **databases**.
- Volumes can also be **resized dynamically** as space requirements change, and **migrated** between physical devices on a running system or exported.
- LVM also offers advanced features like snapshotting, striping, and mirroring.

Redundant Array of Independent Disks - RAID

- RAID is a system of data storage that uses **multiple hard disk drives** to store data.
- A variety of different **storage techniques** can be used to achieve different levels of **redundancy, error recovery and performance**.
- A RAID is a common system for high-volume data storage at the **server level**.
- RAID systems use many **small-capacity disk drives** to store large amounts of data and to provide increased reliability and redundancy.
- Such an array appears to the computer as a **single logical unit** consisting of **multiple disk drives.**

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- RAID storage can be done in a number of ways.
- Some RAID types emphasize **performance**, **others reliability, fault tolerance or error correction.**
- We choose depends on what we are trying to accomplish.
- Three common RAID implementations are:.
  - ✓ RAID level 0
  - ✓ RAID level 3
  - ✓ RAID level 5

Cont …

RAID level 0

- RAID Level 0, **disk striping**, is the most basic model.
- On a normal hard drive, data is stored on consecutive sectors of the same disk.
- RAID 0 uses a minimum of **two disk drives** and divides data into blocks that range from **512 bytes to several megabytes**, which are written alternately to the disks.
- Segment 1 is written to Disk 1, Segment 2 to Disk 2, and so on.
- **Striping** the data distributes the I/O load to all the drives.

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- Drives can be **written to** or **read from** simultaneously and performance increases.
- But there is no data protection.
- If a disk fails, data is lost.
- RAID 0 isn’t used for **mission-critical** environments,
- It is used for applications such as **video production and editing or image editing**.

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RAID level 3

- RAID Level 3 includes **data striping**, it also assigns one drive to store **parity information.**
- This provides **fault tolerance** and is especially useful in data-intensive or **single-user** environments for accessing **long sequential records**.
- RAID 3 doesn't overlap I/O, and it requires **synchronized-spindle drives** to prevent performance degradation with short records.

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RAID level 5

- RAID Level 5 is similar to Level 0, but instead of **dividing data into blocks**, it stripes the bits of each byte across **multiple disks**.
- This byte-striping adds **overhead**, but if a drive fails, it can be replaced and the data reconstructed from **parity and error-correcting** codes.
- RAID 5 overlaps all read/write operations.
- It requires **three to five disks** for the array and is best suited to **multiuser systems.**

Security

- Security is an important aspect of operating system design because it **safeguards** against access to resources by **unauthorized users**.
- The security mechanism can be broken in two steps: **authentication and authorization**.
- Authentication involves **identifying a user**, while authorization ensures that an identified user has access only to resources that has been permitted to use.

Access control mechanism is a mechanism that:

- Permits authorized access to a system, such as a communication, computer, and data processing system.
- Prevents **unauthorized access** to the system.
- Is considered to have **failed** when **unauthorized access is permitted** or when authorized access is prevented.

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- Access control is a more general way of talking about controlling access to a resource.
- Access can be **granted or denied** based on a wide variety of criteria, such as the **network address of the client**, the **identity** of the person who wants access, or the **browser** which the visitor is using.
- It is important by **controlling access** to know who has access and who does not have access to a resource.

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Access Control List

- An access control list (ACL) is a **list** that tells to the operating system which **access rights** each user has to a particular system object, such as a **file directory or individual file**.
- The most common rights include the ability to **read a file** (or all the files in a directory), **to write** to the file (s), and **to execute** the file (if it is executable).

Advantage and disadvantage of ACLs

- In access control lists (**ACL**), it is easy to see **all subjects** that have **access rights on an object** and it is also easy to revoke access rights.
- The **disadvantage** with ACL's is that the **list could be very large**.
- It takes a lot of time to determine for a subject all the objects on which he has access rights.
- Since one have to read through all ACLs.

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Offline files

- Offline files is a document management features that provides the user with consistent **online and offline access to network files.**

Advantages of using offline files are:

- Support for mobile users.
- Automatic synchronization.
- The data is available with out internet connection.

User profiles

- Profiles customize user environment, store profiles on server (roaming), restrict changes through **mandatory profiles.**
- A user profile is a collection of a user's personal files and settings that define **his or her working environment.**

Types of User profile

Local profile

- A local profile is a user profile stored on **the same system** where the user logs on.
- Local profiles are created from a **default profile** when the user **first logs on** to a specific machine.
- **Changes** on one local profile will not migrate to another local profile on another machine.
- For consistent profiles that reflect changes made on **multiple machines**, use **roaming profiles.**
- Any changes made to your **local user profile** are specific to the computer on which you made the changes.

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Roaming profile

- **Roaming Profiles is** what allows a user to logon onto **any computer in an organizations** and have all their personal files and setting apply to that computer as it was the last time they used a computer.
- This is really a Win/Win for Users and IT Professional as for a user this is **a big time saver** as they no longer need to waste time setting up their drives, printers and other personal settings when they use another computers.
- IT professional also get benefit when there is an **un-expected failure** or loss of a computer, then they don't have to go through a lengthily, costly process of **recovering the users data**.
- **Roaming profiles** have the advantage of users have their personal settings and files available on **all computers they login to.**
- But the only problem is **increased network activity** during logon and logoff.

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- Roaming profiles work by **copying the user's profile** to the client computer on which the user **logs on** and when the user **logs off** the files are **copied back to the server**.
- **Folder permissions and policies** have to be configured properly to ensure the **privacy of user files** are maintained, while the **administrator** is able to have access to **the user profiles**.

The followings are the major characteristics of **romancing profile** :

✓ A roaming profile **follows the user** no matter which computer he or she logs on to.

✓ Profile is **copied** from a network share when the user logs on to a computer in the network

✓ Creates a local copy of the roaming profile, called **a profile's cached copy.**

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- Changes made to the profile are then **replicated** from **locally cached copy** back to the profile on the network share when the **user logs off.**
- A roaming user profile is created by your **system administrator** and is stored on a server.
- This profile is available every time you log on to **any computer on the network**.
- Changes made to your roaming user profile are **updated** on the server.
- The **roaming profile** is created from one of two locations.
  - ✓ The **NETLOGON** share
  - ✓ The **Default profile** on the local system.

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Roaming user profiles have the following advantages:

- Automatic resource availability.
- **A user's unique profile** is automatically available when he or she logs on to any computer on the network.
- Users do not need to create a profile on each computer they use on a network.
- Simplified **computer replacement and backup**.
- When a user's computer must be replaced, it can be replaced easily because all of the user's profile information is maintained separately on the network, **independent** of an individual computer.
- When the user logs on to the **new computer** for the first time, **the server copy of the user's profile** is copied to the new computer.
- The user's profile is not loaded automatically when the user is logged on using the **Logon User** function.
- To load a roaming user profile programmatically, use the **LoadUserProfile** function.
- To unload a roaming user profile loaded by **LoadUserProfile**, call the **UnloadUserProfile** function.

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Mandatory Profiles

- A mandatory user profile is a special type of **pre-configured roaming user profile** that **administrators** can use to specify **settings for users**.
- With mandatory user profiles, a user can modify his or her desktop, but the **changes are not saved** when the user logs off.
- The next time the user logs on, the mandatory **user profile** created by the **administrator is downloaded**.
- There are two types of mandatory profiles: ***normal mandatory* profiles and *super-mandatory*** profiles.
- **User profiles** become mandatory profiles when the **administrator renames** the **NTuser.dat** file (the registry hive) on the server to NTuser.man.

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- The **.man extension** causes the user profile to be a **read-only profile**.
- User profiles become ***super-mandatory*** when the folder name of the **profile path** ends in **.man**; for example, \\server\share\mandatoryprofile.man\.
- **Super-mandatory user profiles** are similar to normal mandatory profiles, with the exception that users who have **super-mandatory profiles cannot log on** when the server that stores the mandatory profile is **unavailable**.
- Users with normal mandatory profiles can log on with the **locally cached copy** of the mandatory profile.

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The followings are the major characteristics of mandatory profile

- Used when you **don’t want users** to be able to change their profile, or only have the ability to **make temporary changes**.
- Mandatory profiles are fixed profile in which the **user changes will not be saved**.
- **Only administrators** can make changes to mandatory profiles.
- Commonly used in situations where a **common logon** is assigned for multiple users.
- Works like a roaming profile, but changes made to the profile **will not be copied to the server**.

Thank you