Windows File Systems

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This video looks at the four file systems supported by Windows. These are ReFS, NTFS, FAT and exFAT. The video looks at what each file system is capable of and its limitations.

Resilient File System (ReFS)

- New generation of file system
  - Data integrity/Reduce corruption and Downtime
- Requires Windows 8 or Windows Server 2012
- Works with Windows Storage Spaces
- Fixes problems while online
  - No chkdsk
- Built from the ground up

Resilient File System (ReFS)

The Resilient File System is a new file system built from scratch by Microsoft. Since it is a new file system it requires Windows 8 or Windows Server 2012 in order to operate. The main design difference between it and previous operating systems is that it is designed to fix problems while the operating system is online. For this reason the check disk feature that is found in previous operating systems that can be run to fix problems no longer exists. Given a new approach has been taken in the operating system, it is better at ensuring data integrity and corruption than previous operating systems.

ReFS Limitations

- Does not support
  - Disk quotas
  - NTFS compression and EFS
  - Hard links (Data deduplication)
  - Booting the OS
  - Named streams/Object ID's
  - Extended attributes/8.3 Filenames
- Software support. E.g. Limited SQL server support
- No way to convert from NTFS to ReFS

ReFS Limitations

ReFS was designed to replace NTFS, but at the present time there are some limitations which may mean that you will need to stay with NTFS.

Disk quotas: Disk quotes are not supported. Microsoft states in a blog post that this is a feature that can be supported outside the file system so it is possible for this feature to be supported in software. Possibly Microsoft will add this feature later on or some 3rd party software is available that will add this feature.

NTFS compression and EFS: File compression and encryption (Encrypting File System) are not supported.

Hard links: Hard links are not supported which is required by data duplication. Data duplication allows a file in the drive to be stored in one location but referenced in many different locations. It is used in the Windows Side by Side store (used to store software and drivers in the Windows directory) and may be the reason why ReFS cannot be used for the operating system at this time.

Booting the OS: The biggest limitation is that ReFS does not support being used to boot the operating system. For the present, the drive containing the operating system will need to use a different operating system.

Named streams/Object ID's: Named stream allows a name to be given to a file stream by the software. This is generally a feature that is used on alternative operating systems not Windows systems. Object ID's allow a file to be given a number. This is generally used for indexing software.

Extended attributes/8.3 Filenames: Extended attributes are also not supported. Extended attributes is a feature that allows software to add additional attributes to a file in addition to the standard read only, hidden, archive and system. This feature is mostly used on alternative operating systems. It is rare for Windows software to use these features. 8.3 filenames are not supported. This dates back to the MS-Dos days. Windows 95 introduced long file names.

Software support: Because ReFS also does not support named streams and object ID's. Some software does make use of these features so it is important to check all software before using it. For example SQL does not fully support ReFS.

Convert from NTFS: Currently there is no software available which will convert a drive for NTFS to ReFS or ReFS to NTFS. If you want to change file systems you will need to back up your data, reformat the drive and then restore the data to the drive.

Demonstration ReFS
To format a drive to use ReFS, right click the drive in Windows Explorer and select the option ReFS from the file systems menu.
To view the properties for a file, right click the file and select the properties option. In ReFS the only file attributes that are available are Read-only, Hidden and Archive. If you compare this with the properties of a file stored on a NTFS drive, the properties will have the following which are not found on ReFS. "Allow this file to have contents indexed in addition to file properties", "Compress contents to save disk space" and "Encrypt contents to secure data". The option "File is ready for archiving" is effectively the archive attribute found in ReFS.

Enabling on Windows 8
On Windows 8 you will not by default be able to format a drive to use ReFS, however Windows 8 will be able to read a drive formatted with ReFS. If you want to enable Windows 8 to be able to format a drive with the ReFS file system you need to add the following to the registry.
Create DWORD with the value of 1 in the following location to enable ReFS for Windows 8.
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\MiniNT\AllowRefsFormatOverNonmirrorVolume

New Technology File System (NTFS)

- First introduced in 1993
- Introduces the following features
  - Transaction log
  - Security
  - Compression/Encryption

New Technology File System (NTFS)
This file system was first introduced in 1983 with Windows NT. It differed from the previous operating system in that it supported security. It also has additional features like compression and encryption. File systems like NTFS, ReFS and Linux system Ext3 use a transaction log. When changes are made these changes are stored in a log file before being written to the drive. This does slow the drive down a little, however it makes the drive less prone to data corruption and data loss, in particular during power outages. Since NTFS has been introduced there have been many different versions of NTFS offering additional features. Features like self-healing have been added, however these are limited to what they can do due to their limitations by the original design.

File Allocation Table (FAT)

- FAT32
  - Offers no security/Compression/Encryption
  - Less overhead than NTFS/ReFS
  - Compatible with everything
  - Often use with removable media

File Allocation Table (FAT)

The file system FAT was first introduced in Dos. The FAT32 system that is found in modern Windows is an improved FAT system of the original FAT file system. Since FAT has been around for such a long time it is compatible with almost all operating systems including alternative operating systems. It does not offer additional features like security, compression or encryption. Since it is a basic operating system with a lot of compatibility it is often used in removable media. For example USB thumb drives.

Extended File Allocation Table (exFAT)

- Microsoft file systems
    - Proprietary and patented
    - Support in Windows XP and above
- Optimized for flash drives
- Better large drive performance than FAT32

Extended File Allocation Table (exFAT)
This file system was created by Microsoft. For this reason it is proprietary and patented. In order for a devices like a TV to use this file system they need to pay Microsoft a fee. Support for it is available in Windows XP and above, however you may need to apply some updates in Windows XP to use the file system. The file system itself was not designed to be used as a replacement to NTFS or other file systems as it does not support features like file compression and encryption. The file system itself is optimized for flash drives. When comparing it to FAT32, it supports big drives and offers better performance, however is not supported on as many devices or operating systems.

File System Comparisons

	ReFS	NTFS	exFAT	FAT32
Max size of single file	16 Exabyte	16 Exabyte	16 Exabyte	4 Gigabytes
Max volume size	256 Zettabyte	16 Exabyte	127 Petabytes	2 Terabyte
Max filename length	~~32768~~ 255 *	255	255	8.3 or 255
File compression	No	Yes	No	No
Encryption	No	Yes	No	No
OS Support	Windows 8/2012 and above	Windows NT and above	Windows XP and above	DOS v7 and above

* Originally 32768 but dropped to 255 when RTM

File System Comparisons
When deciding which operating system to use, you need to decide which features you want and which operating system you want the operating system to be able to be used in. If you require encryption or compression you will need the NTFS file system. If you do not require these, the FAT32 file system offers the most compatibility being supported since Dos version 7. Fat32 is limited to 4 Gigabytes max file size and 2 Terabytes max drive size. For this reason and the reasons of compatibility, it is often used for removable media like flash drives. In some references they may state that in ReFS the max file size is 32k (32768 bytes) however when released this was reduced to 255. This was most likely done for compatibility reasons.

Orders Of Magnitude Of Data

- Zettabytes
- Exabytes
- Petabytes
- Terabytes
- Gigabytes
- Megabytes
- Kilobytes

Demonstration

- When formatting a drive
  - Windows will choose a file system it thinks appropriate by default

Demonstration

To Format a drive in Windows, right click it and select the format option. Window will choose the file system that it thinks is most appropriate. You are free to change this file system to what you want. In Windows 8 client operating system and above, the file system ReFS is not available. To make it available you need to configure the following DWORD in the registry.

Create DWORD with the value of 1 in the following location to enable ReFS for Windows 8.

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\MiniNT\AllowRefsFormatOverNonmirrorVolume

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