# NITRO·FS

## High-integrity transactional file system

Tuxera NitroFS ensures rock-solid data reliability while providing the performance needed to create an optimal user experience. It is a transactional file system created specifically for embedded devices where power loss may occur, protecting critical system and user data from corruption. Additionally, NitroFS assures reliability of each metadata block with CRC32, and works with a broad array of storage media – including raw flash memory, e.MMC, UFS, USB mass storage, and SD/MMC. The unique combination of tree-based directory architecture, extent based design, and fast atomic transactions, improves performance for I/O throughput and metadata operations. Dynamic Transaction Point™ technology gives developers unprecedented control over the file system.

**Figure 1. Tuxera NitroFS sequential write performance superior to FAT alternatives**

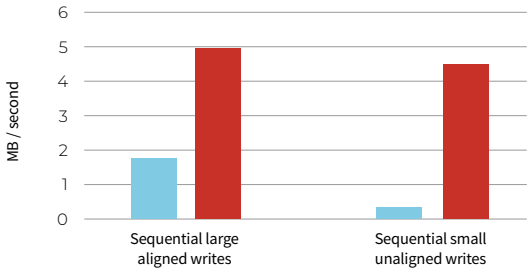
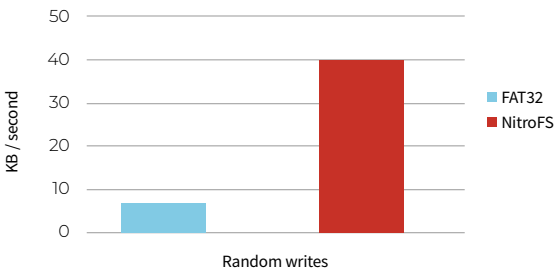



**Figure 2. Tuxera NitroFS is more than 4x faster on random writes**




FSIOTest measured the performance of file systems mounted on a PNY 4 GB SD card, producing throughput values for reading from and writing to a file in various patterns. This performance was measured on an i.MX6 Sabre SD embedded board.

### REQUIREMENTS

| | |
|---|---|
| **Target configuration** | 32- or 64-bit OS, any CPU, virtually any storage media. Preported to Linux and VxWorks. |
| **Development system** | Windows 32- or 64-bit host; 4 MB of disk space for Tuxera NitroFS. Linux hosts work as well |
| **Supported media** | Flash memory, e.MMC and UFS, SSD, RAM, HDD, CF cards, USB mass storage, SD/MMC |
| **RAM memory required** | 100 KB to 150 KB (nominal) |
| **Media volume size** | Each partition (or disk) can be scaled from 100 KB to 32 TB |
| **Max file size/name length** | Available free space/1,024 UTF-8 bytes (or OS imposed limits) |

| FEATURE | NitroFS | HRFS |
|---|---|---|
| **Fault tolerant during unexpected shutdown** | Structure & Data | • |
| **Never overwrites live data** | • | |
| **Flexible transaction point settings can be set at runtime** | • | |
| **Fast I/O performance** | • | |
| **Power loss recovery time** | Fast | Slow |
| **Flash-based media discards** | • | |
| **Smart Discards** | • | |
| **Tree-based for fast file access** | • | |
| **CRC32 protects all metadata** | All | |
| **CRC32 supports Merkle Trees** | • | |
| **Optional CRC32 for user file data** | • | |
| **File level secure delete** | • | |
| **Common data format across multiple operating systems** | • | |
| **Data exchangeability with Windows-based desktops** | • | |
| **Guaranteed response support time** | • | • |

## Rock-solid data reliability

Device reliability is multi-faceted; implications include everything from device corruption to a less than optimal user experience, creating real-world problems ranging from warranty returns to user annoyance. Because NitroFS is a copy-on-write transactional file system, live data is never overwritten, making the system fault tolerant, even after an uncontrolled system shutdown caused by power loss or component failure. Transactional architecture ensures rock-solid data reliability; Tuxera NitroFS maintains complete metadata and file data integrity while providing the performance needed to create an optimal user experience. Dynamic Transaction Point technology gives developers compile-time and run-time control.

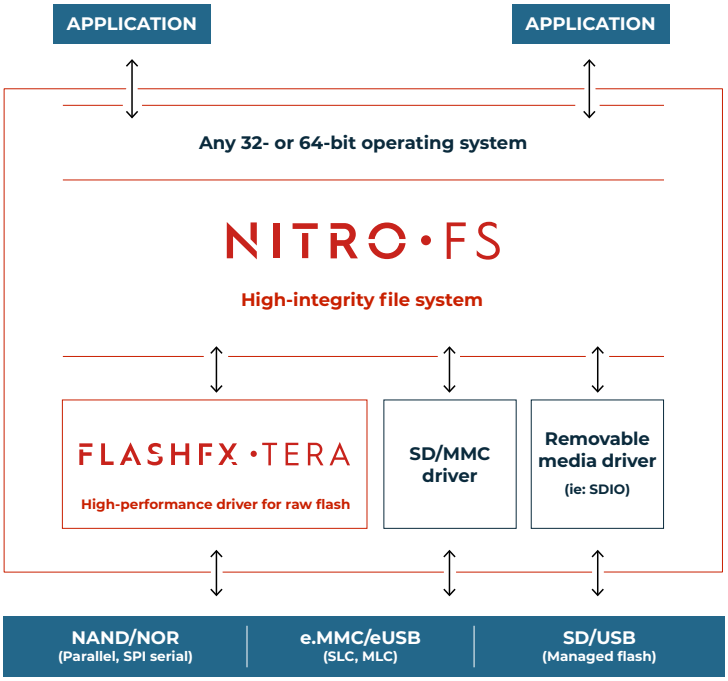
| TIME IN MM:SS | NitroFS | HRFS | DOSFS |
|---|---|---|---|
| **Create 1,000 files** | 00:10 | 09:34 | 00:56 |
| **Open 1,000 files** | 00:01 | 00:34 | 00:37 |
| **Delete 1,000 files** | 00:02 | 10:41 | 00:38 |
| **Create dir tree** | 00:19 | 12:11 | 01:35 |
| **Delete dir tree** | 00:14 | 26:28 | 01:41 |

## Better design flexibility

Every file system must balance the tradeoff between data-at-risk and maximum data throughput. Only the Dynamic Transaction Point technology found in NitroFS gives device manufacturers total control to find the ideal balance for any use case. This capability makes field upgrades fail-safe, as these applications must update several files in an atomic fashion. With other file systems, if a power interruption occurs before the update is complete, the application may not recover. This is easily accommodated with Nitro's run-time configurable transaction points.

## Improved file operations for better responsiveness

The tree-based directory structure of Tuxera NitroFS enables fast file operations, particularly when working with many small files. In a side-by-side test creating 1000 small files, then opening and deleting them, NitroFS demonstrated vastly improved operational performance over other alternatives. The test also measured the time to create and delete a directory tree. As the results demonstrate, raw throughput is not the only measurement that is important to file system performance. The way a system handles its metadata can be just as important.




## Smart discards

Tuxera NitroFS's smart discard algorithms provide the best overall performance, instead of having to choose between a decrease in performance without discards and an increase in latency with discards.

File system discards are the primary way of notifying flash based media that data is no longer in use. Once notified, the firmware will compact flash regions, which if done immediately can increase system latency. The smart discards in NitroFS deliver better performance of flash media over time by deferring discard requests until they are larger, or until they can be performed in the background, ensuring other processes don't suffer slowdowns in performance.

## Data exchangeability

NitroFS is used in millions of embedded devices worldwide, and often the data it protects needs to be viewed on and transferred to computers running Microsoft Windows. The Tuxera NitroFS Windows Driver allows full exchangability with data on Tuxera NitroFS formatted media.

## Faster mount times

In cases where power failure may occur, NitroFS has a mount time advantage. There's no need to replay a journal or perform any other file system checks – NitroFS always keeps the disk in a known good state. This and other performance features give your customers noticeably faster mount times, especially where there is a random I/O penalty such as on hard disk drives and many types of solid state media, like e.MMC.

## Self-diagnostics ensure continued reliability

Advanced instrumentation enables fast, precise diagnosis of errors within the flash memory subsystem. Finding the source of these flash storage failures is normally a time consuming part of the development process, which can delay market availability of embedded devices for many weeks. At the heart of our new file system diagnostics are full metadata and optional file data CRCs (Cyclic Redundancy Checks), which enable developers to continuously monitor data reliability in any embedded system.

Unlike basic file systems such as ext4, Tuxera NitroFS is capable of monitoring both user data and metadata to detect inconsistencies and provide early warning of imminent flash failure and/or data inconsistencies.

## Accessible, award-winning support

Tuxera's support for customers is well known in the embedded industry. It's been said that customers come to us for the great products, and stay for the excellent technical support. Our technical support team has a strong commitment to making your devices work reliably, from testing to implementation. Our hard-earned reputation for great customer service means that we regularly go above and beyond to make sure your project performs flawlessly.

## Software development kit and licensing

Tuxera NitroFS is licensed in ANSI C source and includes a comprehensive developer's guide as well as an API reference, and validation utilities. Runtime distribution can be licensed per unit or per project. Consult your Tuxera representative for options that apply to your project.

**Interested?** Get in touch: sales@tuxera.com

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