



Tiny, power failsafe file system for IoT edge devices

Tuxera Reliance™ Edge is the only file system designed to capture and preserve decision-quality data with deterministic behavior required by today's autonomous systems. Reliance Edge is a transactional file system that protects critical system and user data from corruption, specifically for systems where power loss may occur. Tuxera's unique file system works with a broad array of storage media including: eMMC, SD/MMC, NVRAM, USB mass storage, and SATA disks and has been ported to many RTOSs, including FreeRTOS, SafeRTOS, µC/OS, ARM mbed, and MQX, as well as INTEGRITY, eMCOS, and AWS. Reliance Edge continues the legacy of file system products in the Reliance family that have shipped in hundreds of millions of devices and is supported by Tuxera's award-winning support organization.

Reliance Edge can be configured to meet the specific needs of your application by reducing complexity, optimizing resource use, and maximizing performance. Whether your application requires a single log file, a pre-defined set of files with fixed names, or complete flexibility to modify file hierarchy during runtime, Reliance Edge has options that are easy to understand. Data storage experts at Tuxera can help you make the most of them. Our POSIX-like API option makes integration straightforward and Reliance Edge has the configuration flexibility to fit into even the tiniest of systems.

FEATURES	CONFIGURATION OPTIONS		
	Full POSIX	Small POSIX	FSEssentials
Metadata failsafety	•	•	•
File data failsafety	•	•	•
Never overwrites live data	•	•	•
Transaction controls	•	•	•
Metadata CRC	•	•	•
API set	POSIX-like	POSIX-like *	Constrained
Number of files	Variable	Variable	Fixed
Number of volumes	Multiple	Multiple	Multiple
Maximum stack depth	824	744	556
Buffers (minimum)	12	6	5
Thread-safe	•	•	•
File references	Names	Names	Numbers
Code size (ROM)	17.6 KB	16.7 KB	10.6 KB
RAM requirement	8.4 KB	5.3 KB	3.9 KB

* not including rename

Ultimate control with determinism

Reliance Edge configuration options allow developers complete control over which features are included, providing ultimate control to make the file system fit your specific use case. Regardless of how it’s configured, Reliance Edge’s key file system operations are deterministic, providing unprecedented predictability.

Full POSIX Configuration:

This configuration includes a full POSIX-like file system API, including path-based file access, file handles, directory operations (including atomic rename), transactions, and file system formatter. Configuration options with support for up to ten tasks, ten open file handles, 512-byte block size, and twelve buffers (the minimum for this configuration) were used to determine code size and RAM requirement.

Small POSIX Configuration:

A reduced RAM option is illustrated by the Small POSIX configuration, which excludes rename but includes all remaining POSIX-like APIs. The number of buffers used in this configuration was reduced to the new minimum of six, which reduces the RAM requirement. Configuration options were otherwise the same as the Full POSIX configuration.

FSEssentials Configuration:

This configuration includes the full FSE API, which supports read, write and truncate on numbered files, as well as transactions. Configuration options of 512-byte block size and twelve buffers (the minimum for this configuration) were used to determine code size and RAM requirement.

Fast, consistent mount times

In cases where power failure may occur, Reliance Edge has a definite mount time advantage. There is no need to replay a journal or perform any other file system checks—Reliance Edge always keeps the disk in a known good state.

PACKAGE COMPARISON

Item	Open-source package	Commercial package
Source code	•	•
Utilities		
Configuration utility	•	•
Formatter	•	•
Checker		•
Image builder	•	•
Image copier		•
Tests		
Disk full tests		•
API tests		•
fs stress test	•	
Documentation		
Detailed comments	•	•
Reference manual	available ¹	•
Readme	•	•

¹ Can be downloaded for no charge from Tuxera website

Better reliability for a better user experience

Device reliability means different things to different people. Lack of reliability can have consequences ranging from a failed mission due to lost or corrupted data, warranty returns due to program corruption, or a frustrating user experience – the enemy of customer loyalty. Because Reliance Edge is a copy-on-write transactional file system, live data is never overwritten. This makes the system extremely fault tolerant even after an unexpected system shutdown caused by power loss or component failure. True transactional architecture designed into Reliance Edge ensures rock-solid data reliability as Reliance Edge maintains complete metadata and file data integrity, while providing the performance needed to create an optimal user experience. Dynamic Transaction Point™ technology gives developers complete compile-time and run-time control.

REQUIREMENTS

Target configuration	Typically a 32-bit microcontroller; with or without an RTOS; as little as 4 KB RAM (config. dependent)
Development system	Linux or Windows host; 40 MB of disk space for Reliance Edge
Supported media	eMMC, SD/MMC, CF cards, RAM, NVRAM, USB Mass Storage, or HDD
RAM required	4 KB to 19 KB (depending on configuration)
Maximum volume size	7.3 GB at 512 byte block size to 256 TB (terabytes) at 64 KB block size

Our Software Test team uses multiple tools to verify basic functionality via API tests, along with reliability via power fail simulation. Designed for maximum portability, Reliance Edge is also tested on FreeRTOS and Microsoft Windows using various implementations of GCC, including Atmel Studio 6.2.

Uncompromising performance

Reliance Edge has strong read and write performance, compared to FatFs and FAT SL on FreeRTOS. What is even more impressive is that this comparative advantage exists even though Reliance Edge is preventing data loss from power interruption while the native file systems are not.

The test used here was Tuxera’s general purpose file system I/O test (FSIOTest), which measures a variety of file I/O types and works with virtually any file system. Tuxera FSIOTest is included with Reliance Edge.

Each file system was configured to use a 4096 byte block size since reading and writing in chunks of this size provides the best performance. In the real world, especially in IoT devices, I/O sizes are often small, so the performance advantage offered by Reliance Edge when the write sizes are smaller than the block size is particularly meaningful.

Reliance Edge was configured to transact on fsync, file close, disk full and volume dismount. For the Fat Fs file system, the “fast seek” feature was enabled, which caches many of the FAT entries to improve performance. FAT SL does not have that option, and overall performance suffered as a result.

Integrity checking guards against data corruption due to media failure

Advanced instrumentation enables fast, precise diagnosis of errors within the storage subsystem. Finding the source of these storage media failures is normally a time-consuming part of the development process, which can delay market availability for many weeks. At the heart of Tuxera’s file system diagnostics are full metadata CRCs (Cyclic Redundancy Checks), which enable developers to continuously monitor reliability in any embedded system. Unlike basic file systems such as FAT, Reliance Edge is capable of monitoring metadata to detect inconsistencies and provide early warning of imminent media failure and data inconsistencies.

Write performance

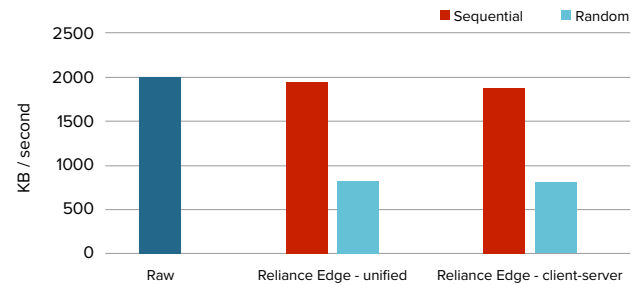


Figure 1. These performance numbers for all of these tests were gathered on a BeagleBone Black with a Sitara AM3358BZCZ100 ARM Cortex-A8 processor, using a 16GB SanDisk class-10 microSD card as the storage media on a 2GB partition.

Read performance

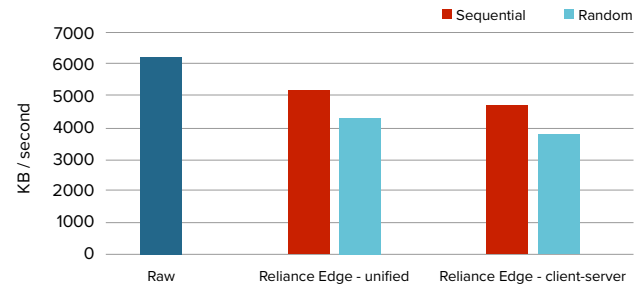


Figure 2. These performance numbers for all of these tests were gathered on a BeagleBone Black with a Sitara AM3358BZCZ100 ARM Cortex-A8 processor, using a 16GB SanDisk class-10 microSD card as the storage media on a 2GB partition.

Faster writes

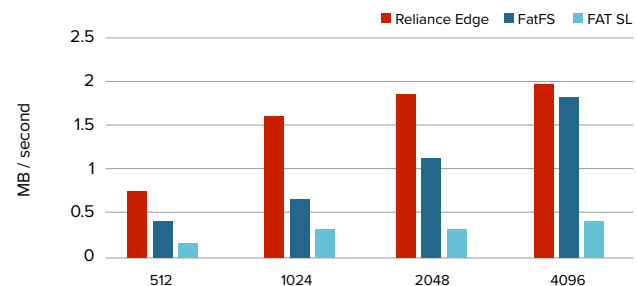


Figure 3. These performance numbers for all of these tests were gathered on a BeagleBone Black with a Sitara AM3358BZCZ100 ARM Cortex-A8 processor, using a 16GB SanDisk class-10 microSD card as the storage media on a 2GB partition.

Smart transaction model guarantees integrity

The design of Reliance Assure provides both system and data integrity with or without atomic sector writes. Most modern media support this feature, which guarantees the sector being written will contain either completely written new data or the original values. Reliance Edge provides stronger error checks at mount time if atomic sector writes are available. In cases where this feature is not available, data integrity is also guaranteed thanks to proprietary transaction technology.

Discards

In the commercially-licensed version, discards provide significant performance benefits and create less flash wear, which extends flash lifetime. This is achieved by enabling the disk to perform compactions more efficiently. File systems using the flash memory driver, FlashFX Tera, experience even greater performance improvements, making it the perfect complement to Reliance Edge.

Simple architecture enables faster implementation

The Reliance Edge RTOS services API is designed to be easy to implement for any RTOS, even a simple scheduler loop. Our comprehensive developer documentation provides a searchable reference to every library function and configuration, leaving the developer free to concentrate on a superior application for the customers. It is far quicker to utilize the fully tested Reliance Edge file system than to write a custom data storage that is both power fail safe and well tested.

Data exchangeability

If the media used with Reliance Edge is removable, such as a USB drive or a SD card, data on that media can be copied to and from a Windows-based computer using the Reliance Edge Image Copier/Image Builder command line utilities. A FUSE version of Reliance Edge is also available on Linux.

Software integration and licensing

Tuxera provides Integration and Optimization Services to create a custom binary module tuned for your project. Affordable runtime distribution licensing can be structured to fit your project budget. Commercially-licensed projects include a comprehensive Developer's Guide, API reference, and validation utilities.

Open-source licensing

A version of Reliance Edge is available as an open-source project for evaluation and personal use. That version may be used, modified, evaluated, and distributed without charge, provided the user adheres to v2 of the GNU General Public License (GPL) and does not remove the copyright notice. Please note that certain Reliance Edge features are only available in the commercially-licensed version. See comparison chart on page 2.

Commercial licensing

Businesses and individuals that, for commercial or other reasons cannot comply with the terms of the GPL v2 license, must obtain a commercial license before incorporating Reliance Edge for distribution in any form.

Professional technical support

Tuxera's award-winning technical support has a strong commitment to making your devices work reliably, from testing to implementation. Tuxera regularly goes above and beyond to make sure your project performs flawlessly.

Annual support subscriptions are available with a choice of service level options that provide reliable access to responsive Tuxera file system experts ensuring your project stays on schedule.

**Let us ensure your embedded storage remains responsive and stable.
Get in touch with us at sales@tuxera.com**