RELIANCE ASSURE

Certifiable, power-failsafe file system for data-at-risk

Tuxera Reliance™ Assure is the only file system designed to capture and preserve decision-quality data with deterministic behavior required by today's autonomous systems. Reliance Assure 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: e.MMC, SD/MMC, NVRAM, USB mass storage, and SATA disks. Reliance Assure has been ported to FreeRTOS and Green Hills INTEGRITY. The software can be ported to other RTOS environments, such as SafeRTOS. Reliance Assure continues the legacy of file system products in the Reliance family that have shipped in hundreds of millions of devices and benefits from Tuxera's award-winning support team.

Reliance Assure 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 Assure has options that are easy to understand. Data storage experts at Tuxera will help you make the most of them. Our POSIX-like API option makes integration straightforward, and Reliance Assure has the configuration flexibility to fit into even the tiniest of systems.

FEATURE	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	704	624	440
Block buffers (minimum)	12	6	5
Thread-safe	•	•	•
File references	Names	Names	Numbers
Code size (ROM)	20.3 KB	19.1 KB	13.3 KB
RAM requirement	8.7 KB	5.4 KB	4.0 KB
MISRA C:2012	•	•	•
Effective lines of code (eLOC)	7029	5117	4148
Average cyclomatic complexity	6.21	6.81	6.57

* not including rename

Certifiability, compliance, and traceability

Reliance Assure has been designed to help the industry meet the rapidly increasing demand for standards-compliant, reliable data management in embedded systems. Reliance Assure's code has been developed in compliance with MISRA C:2012 and by following the Automotive SPICE® quality management framework. Our team has the connections to comply with ISO 26262 and DO-178C projects. With Reliance Assure, we provide full bi-directional traceability, code reviews, and verification.

Ultimate control with determinism

Reliance Assure 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 Assure'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 Assure has a definite mount time advantage. There is no need to replay a journal or perform any other file system checks – Reliance Assure always keeps the disk in a known good state.

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 Assure 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 Assure ensures rock-solid data reliability as Reliance Assure 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.

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 Assure is also tested on FreeRTOS and Microsoft Windows using various implementations of GCC, including Atmel Studio 6.2. MISRA C compliance validation is also performed, assuring this software meets static code analysis requirements.

REQUIREMENTS

Target configuration	Typically a 32-bit microcontroller; with or without an RTOS; as little as 4 KB RAM (config. dependent)
Development system	Windows or Linux host; 40 MB of disk space for Reliance Assure; toolchain for target system
Supported media	e.MMC, 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

Uncompromising performance

Reliance Assure has strong read and write performance compared with native file systems, in this case msdosfs on Green Hills INTEGRITY. What is even more impressive is that this comparative advantage exists even though Reliance Assure is preventing data loss from power interruption while the native file systems are not.

The test used in Figures 1 and 2 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 Assure.

Each file system was configured to use 4096 byte block size on the media, a U3 class microSD card. While reading and writing in large sections demonstrates the best performance, Reliance Assure scaled easily to larger and smaller I/O sizes with similar performance improvements over the native file system.

Monitoring and diagnosing media failures

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 Assure is capable of monitoring metadata to detect inconsistencies and provide early warning of imminent media failure and data inconsistencies.

## 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 Assure 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.

Sequential write (4 KB I/O size)
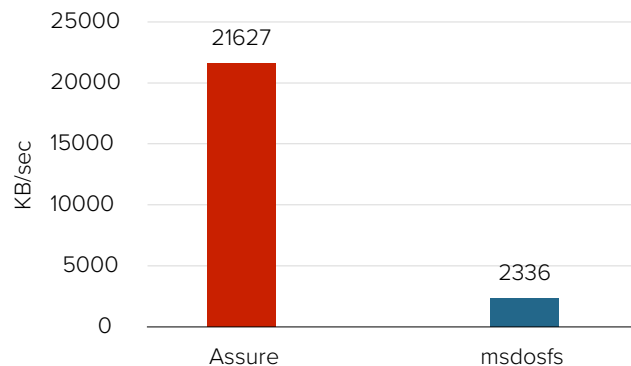
Figure 1. These performance numbers for these tests were gathered using the following setup: Hardware: R-Car H3 Starter Kit, SanDisk Extreme (U3 speed class) 64GB microSD card. Software: INTEGRITY v11.7.8, Reliance Assure v2.6.18

Random write (4 KB I/O size)
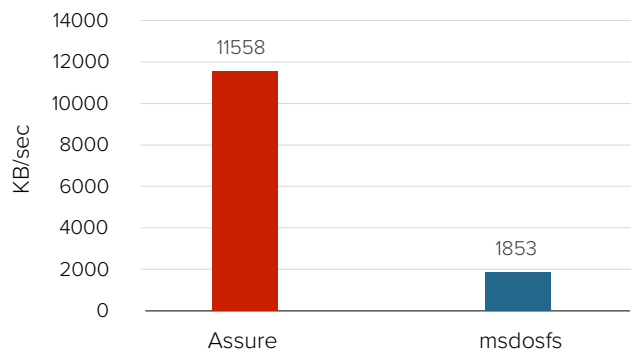
Figure 2. These performance numbers for these tests were gathered using the following setup: Hardware: R-Car H3 Starter Kit, SanDisk Extreme (U3 speed class) 64GB microSD card. Software: INTEGRITY v11.7.8, Reliance Assure v2.6.18

Discards

This feature provides significant performance benefits and creates 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 Assure.

Simple architecture, faster implementation

Reliance Assure is provided in well commented source code. The 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 use the fully tested Reliance Assure file system than to write a custom data storage that is both power-failsafe and well tested.

Data exchangeability

If the media used with Reliance Assure 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 Assure Image Copier/Image Builder command line utilities. A FUSE version of Reliance Assure is also available on Linux.

Software integration and licensing

Reliance Assure is available directly from Tuxera – contact us to purchase commercial licenses. In addition to full source code, commercially licensed kits include a comprehensive Developer's Guide, API reference, and validation utilities. Design Assurance documents and MISRA C:2012 compliance matrix are available to commercial licensees. Runtime commercial distribution can be licensed per product, processor family, or product line.

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**