

eXtremeDB® for Rail Systems

For rail systems that demand high performance, simplified development, and the utmost in safety and reliability.

“In our testing, we found McObject’s eXtremeDB to be the only DBMS available that provides the necessary real-time performance.”

-- RGUPS

eXtremeDB, the real-time embedded database used in rail systems around the world.

Overview

On board train control technology is ‘safety critical’. Often, that means a certified operating system is selected. Certified operating systems impose significant restrictions such as no dynamic memory allocation, or dependence on the C run-time library. *eXtremeDB* is the only database system that can address the requirement.

Further, like much of the Industrial Internet of Things (IIoT), rail systems generate and continuously share information, both internally and with other systems. This growing volume of complex data and data movement presents multifaceted embedded database requirements, including high performance, concurrent access, high availability, replication and efficient searching.

Above all, rail systems must be dependable and secure. The technology stack – including an embedded database system – must be predictable, immune from crashes, and must not harm or interfere with other application processes.

McObject’s *eXtremeDB* is a real-time off-the-shelf (COTS) embedded database system that meets the critical need for a fast and reliable embedded database for rail systems. *eXtremeDB* offers a tiny footprint (approximately 200K code size) alongside advanced capabilities including high availability and clustering, low-level native and SQL APIs, hybrid in-memory/on-disk data storage, and unique features to ensure ultra-reliable code. Rail system manufacturers are enjoying its performance, reliability, and time-to-market benefits.

Reliable and Secure by Design

eXtremeDB reflects a development focus on safety and security, from the product's features down to the coding techniques used to implement them. The system avoids dynamic memory allocation, eliminating a common source of software failure. The low-level native API is type-safe, catching data-typing errors at compile-time, which removes a source of database corruption. Built-in error handling provides diagnostics to help ensure that *eXtremeDB* is being used properly.



A key dispatch system for Southern Russia Railways relies on *eXtremeDB* to coordinate trains’ movements based on communication with a central dispatch controller and local stations.

Use Case: Positive Train Control (PTC)

PTC monitors and, when necessary, controls train movements to prevent train-to-train collisions and derailments due to excessive speed. Reliability is critical, so a fail-safe embedded database capable of 5-nines (99.999%) high availability is mandatory. In this use case, the communication channel was via a Solace router for maximum performance and message delivery assurance. *eXtremeSQL* was used to transmit real-time data to an *eXtremeDB* database outside the HA system, for backup and future database provisioning purposes.

Use Case: High-Speed Railway Locomotives

Thousands of high-speed locomotives employ *eXtremeDB* to collect and analyze analog and digital indicator and alarm data. Having on-board storage and analysis enables raising of warnings to the train control system immediately, versus the latency necessary to transmit data to a control center and receive a response. At 350 km/h, time is of the essence!

Use Case: Interoperable Train Control Messaging (ITCM)

Messages pass between locomotives, wayside systems and central systems over disparate protocols: MPLS, cellular, 802.11, etc. Hundreds of thousands of connections must be managed. A message router was implemented with *eXtremeDB* that resembles an internet router. It knows the source and destination of a message and must determine the optimal path. Reliability, high performance and high availability were the primary considerations for choosing *eXtremeDB*.

eXtremeDB Features & Benefits at a glance

Hybrid data management - *eXtremeDB* combines in-memory and on-disk storage in one embedded database system, to optimize applications for persistence, speed, cost and form factor.

Better, safer code – A type-safe, intuitive native C/C++ API shortens the database learning curve, produces more easily maintained code, and eliminates costly run-time errors. *eXtremeDB*'s design avoids dynamic memory allocation.

High Availability- With synchronous replication implemented via a time-cognizant, two-phase commit protocol, or ultra-fast asynchronous replication, *eXtremeDB*-HA delivers the highest degree of database reliability for applications that cannot afford to fail.

Highly portable – *eXtremeDB* supports the widest range of RTOS, desktop and server platforms. To maximize portability, *eXtremeDB* source code minimizes reliance on operating system features. *eXtremeDB* source code is available for less common RTOS/hardware platforms.

Proven Solution – Industry leaders including GE/Wabtec, Bombardier, and Union Pacific enjoy *eXtremeDB*'s technological and time-to-market benefits.

Technical Specs

- Supported indexes include R-trees for geospatial data, Patricia tries for IP/telecom, KD-trees for multi-dimensional data and Query-by-Example (QBE), B-trees, hash indexes, trigram index for fuzzy search, and more.
- Optional multi-version concurrency control (MVCC) transaction manager eliminates “pessimistic” locking to enhance speed and scalability of multi-threaded applications running on multi-core CPUs.

- Transaction performance measured in microseconds.
- APIs: native, type-safe C/C++ API is generated when the database schema is compiled, thus reflecting the application's data model and purpose; high-performance SQL JDBC and ODBC interface; native Java, C#, Python and Rust APIs.
- Source code and object code licenses are available.

Architectures supported

Any 32- or 64-bit CPU, e.g. ARM, DSP, x86, Freescale (Coldfire, MCore, HC08 etc.), MIPS, Power Architecture™ (including PowerPC), XScale, TileGx.

Operating systems supported

VxWorks CERT, VxWorks 653, INTEGRITY, QNX Neutrino, Linux and embedded Linux distributions (Wind River, MontaVista, LynuxWorks etc.), Windows Embedded, eCos, LynxOS, uCLinux, uC/OS-II, HP-UX, Sun Solaris, bare bones boards (no operating system required).



eXtremeDB's streamlined design and in-memory deployment deliver the near-zero-latency responsiveness required for advanced rail systems like positive train control. Integrating a commercial, off-the-shelf DBMS cuts developer-months from an application's time-to-market.