eXtremeDB/rt for Real-time Systems

eXtremeDB/rt is the first of its kind – a commercially supported, deterministic, true real-time database system.

eXtremeDB/rt is a true real-time deterministic database for mission- and safety-critical systems.

Background

For mission- and safety-critical systems' software in avionics, autonomous systems, railroad, critical control systems, and the like, time is of the essence. These systems demand deterministic, predictable, fully controllable database management that complements modern real-time operating systems' time and space partitioning and advanced real-time schedulers. Often non-interruptible and with stringent requirements on timely execution, these systems' data management impose temporal constraints on critical data and transactions that can only be met with a true real-time database system.

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eXtremeDB/rt is a first-of-its-kind commercial, supported, database management system designed to preserve the temporal validity of data through time-cognizant transaction processing that guarantees predictable execution of critical transactions. In simpler terms, eXtremeDB/rt is a deterministic, true real-time database system.

Overview

eXtremeDB/rt extends conventional eXtremeDB transaction processing by adding semantics for, and enforcing, database transaction priorities and deadline scheduling. Like conventional eXtremeDB, eXtremeDB/rt is an embedded database management system that provides services for the storage, retrieval and manipulation of data. The differences lay in the temporal requirements of the managed data, transaction scheduling policy, timing constraints on transactions, and in performance goals. Conventional eXtremeDB, like other ACID-compliant DBMSs, maintains databases' internal consistency, preventing contradictory data in the same database. In addition to preserving internal consistency, eXtremeDB/rt ensures that stored data reflects the state of the real world at a moment in time (temporal consistency). The eXtremeDB/rt kernel exposes transaction deadline semantics through a real-time transaction manager that ensures transactions can "meet" (successfully commit) or "miss" (successfully abort) within their deadlines, but can never be "late" (run past their deadline) to commit or abort.

Implementation

The *eXtreme*DB/rt kernel modifies the conventional *eXtreme*DB kernel by making sure that all database kernel components are time-cognizant. The *eXtreme*DB/rt transaction scheduler implements the High Priority Earliest Deadline First (EDF) algorithm: transactions are scheduled for execution based on their priority and deadline. The deadlines are enforced through a time-cognizant rollback mechanism. The database kernel identifies transactions destined to be "late", interrupts them, and forces the rollback in time to satisfy the deadline. Transactions are allowed to modify or retrieve data only if they are able to complete within the set deadlines.

Supported Platforms

Real-time applications must run in the context of a real-time operating system, or be able to access hardware resources — interrupts, timers, memory management, etc. Therefore, *eXtreme*DB/rt is currently available for the following real-time operating systems on select hardware platforms (the list of platforms is constantly expanding):

- Deos, from DDC-I
- FreeRTOS, a widely used real-time operating system kernel for embedded systems
- INTEGRITY, from Green Hills Software
- LynxOS-178, from Lynx Software Technologies a hard real-time partitioning operating system developed and certified to FAA DO-178B/C DAL A safety standards
- VxWorks, from WindRiver
- Linux, x86-64-bit (for evaluation, not for production)
- Microsoft Windows Desktop (Visual Studio 2017, x64) (for evaluation, not for production)

*eXtreme*DB/rt is also available for Adaptive and Classic AUTOSAR platforms.

Transaction Queue Time Interval is the time that the transaction waits for execution in the transaction queue

Deadline Verification Checkpoints are places in the database runtime code at which a transaction's elapsed time is tested against the set deadline

Transaction Rollback Time Interval means the time to reverse changes made in the transaction

Start

End

Transaction Workload Time Interval is the time that the transaction spent doing "real payload work"

Deadline Control Point is the time elapsed from the start of an uncommitted transaction at which roll back must begin in order for the transaction to meet its deadline